SOLID WASTE AND FIBER RECOVERY DEMONSTRATION PLANT FOR THE CITY OF FRANKLIN, OHIO: AN INTERIM REPORT

N. Thomas Neff

A. M. Kinney, Incorporated
Cincinnati, Ohio

1972

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The Franklin, Ohio, resource recovery demonstration project has elicited widespread interest, so this interim report was prepared to: (1) present a preliminary analysis of the solid waste disposal and fiber recovery portions of the project; (2) provide preliminary data by which others may be guided in evaluating emerging solid waste disposal and resource recovery technologies. The historical development of this EPA-sponsored project and a general description and evaluation of the process used are included. The preliminary plant economics presented are based on construction costs and the first six months of operation. The plant began functioning in June 1971 and is now in regular operation recovering ferrous metals and paper fibers which are sold to local industries. The final report is scheduled for submittal to EPA in February 1973.

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SOLID WASTE AND FIBER RECOVERY DEMONSTRATION PLANT

FOR THE CITY OF FRANKLIN, OHIO

An Interim Report

This interim report (SW-47d.i) on work performed under Federal solid waste management demonstration grant no. G06-EC-00194 to the City of Franklin, Ohio, was written by N. THOMAS NEFF *A. M. Kinney, Inc., Consulting Engineers, Cincinnati, Ohio and is reproduced as received from the grantee.*

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U.S. ENVIRONMENTAL PROTECTION AGENCY

1972

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An environmental protection publication in the solid waste management series (SW-47d.i).

FOREWORD

The Franklin, Ohio, project was funded in 1968 to demonstrate an innovative solid waste disposal technique utilizing wet grinding and subsequent incineration. Later the scope of the project was expanded to recycle portions of the solid waste stream. The facility presently includes the capability to separate ferrous metals and reuseable paper fibers for recycling prior to disposing of the remaining solid wastes. Further construction is now in progress which will also add to the plant the capability to recover color-sorted glass and aluminum. This pilot plant now represents one of the first resource recovery facilities in the country, and the project has become one of the most successful projects ever funded by the solid waste demonstration program.

This small system is a completely unique environmental control complex which has been toured by visitors from many parts of the world. The project's contributions to solid waste processing and resource recovery technology have been immense.

Due to the widespread interest in the project, this report has been prepared as a preliminary effort to describe and evaluate the first seven months of plant operation. The U.S. Environmental Protection Agency project managers who have followed the development of this project are: R. Kent Anderson, Dennis A. Huebner, Thomas C. Leslie, Ora E. Smith, and David G. Arella.

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SOLID WASTE AND FIBER RECOVERY DEMONSTRATION PLANT

FOR THE CITY OF FRANKLIN, OHIO

An Interim Report

This report was prepared for the
City of Franklin, Ohio, under Grant No. G06-EC-00194

SECTION I - PREFACE

This interim report was prepared in advance of the final demonstration operations report because of the widespread interest that has been shown in the Franklin, Ohio, solid waste and fiber recovery plant. Cost data is reported for the period of June 1 to Dec. 31, 1971, and the operational data is for the period from May 17, 1971, to Feb. 29, 1972.

This project has been supported by Grants No. 1-D01-UI-00194, 2-G06-EC-00194, and 3-G06-EC-00194-1S1 from the Environmental Protection Agency, pursuant to the Solid Waste Disposal Act as amended. The plant is now in regular operation, and the testing and evaluation phase of the project is in progress. The final report is scheduled for submittal in February 1973.

The plant demonstrates: (1) the "Hydrasposal"* system developed by The Black Clawson Company for the disposal of essentially unsorted municipal refuse, in which metals and glass are separated for recycling; and (2) the "Fibreclaim"*

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*Copyrighted trademarks of The Black Clawson Company, Middletown, Ohio, for systems for the disposal of solid wastes and for the recovery of paper therefrom, covered by various U.S. patents.

process for the recovery of recyclable paper fiber. In addition, raw sludge from an adjoining sewage treatment plant will be mixed with the organic residue from the Hydrasposal and Fibreclaim processes and burned in the fluid bed reactor which is an integral part of the Hydrasposal system.

The solid waste and fiber recovery plant is the first part of a total environmental control project planned for the City of Franklin. The sewage treatment plant will receive and treat municipal and industrial waste water from the Franklin region, thus replacing an obsolete municipal sewage plant and thereby preventing the discharge of sewage pollutants into a part of the Great Miami River. This plant, being built by the Miami Conservancy District with financial assistance from the Environmental Protection Agency, Office of Water Programs, is expected to be operational in July 1972.

In addition to the solid waste plant, a glass recovery system is now being designed which will take one of the reject streams from the Hydrasposal system and extract recyclable aluminum and glass cullet. The cullet will be further sorted into brown, green, and clear colors. This addition is sponsored jointly by the Glass Container Manufacturers Institute and the Environmental Protection Agency.

Application has been made for Federal assistance to build an industrial waste liquids disposal facility which would utilize the fluid bed reactor portion of the Hydrasposal system to incinerate the collected and blended wastes during time when the reactor is not being used to incinerate solid waste. This facility is expected to safely dispose of more than 10,000 gallons per day of oils and solvents, which are now being dumped on the land, into streams, or are being burned improperly.

The intent of this report is to present a preliminary analysis of the operation of the solid waste disposal and fiber recovery portions of the Franklin Total Environmental Control Complex, and to provide preliminary data by which others may be guided in evaluating emerging technology of solid waste disposal and resource recovery.

SECTION II - ABSTRACT

Title: System for total refuse disposal by fluid mechanical separation of solid wastes and fluid bed oxidation of combustibles, and reclamation of paper fibers.

Grantee: City of Franklin, Ohio
35 East Fourth Street
Franklin, Ohio 45005

Project Director: Bernard F. Eichholz, City Manager

Date Project Started: Sep. 24, 1968

Date Project Ends: Feb. 28, 1973

Objectives: To design, construct, operate, and evaluate a demonstration plant utilizing an innovative system for disposal of municipal solid waste and the recovery of metals, glass, and paper fibers therefrom. The system is designed to receive virtually unsorted refuse and to separate it using a fluid-mechanical process. Reuseable paper fibers, metals, and noncombustibles are separated in the process, and the remaining combustible solids are mixed with sewage sludge from an adjoining sewage treatment plant. This residual mixture is then burned in a fluid bed reactor.

Procedures: The project has been conducted in three phases--design, construction, and operation. The first two of these have been completed, and initial operating data have been obtained.

The initial two-thirds Federal grant, awarded Sep. 24, 1968, encompassed the design of a facility to receive unsorted municipal refuse, to wet-grind it into an aqueous slurry using a Hydrapulper, to hydrodynamically remove metals, glass, and other noncombustibles, and to burn the organic solid residue, along with raw sewage sludge, in a fluid bed reactor. The City of Franklin retained

A. M. Kinney, Inc., Consulting Engineers, Cincinnati, Ohio, to design the plant, based on process design data supplied by The Black Clawson Company of Middletown, Ohio. The one-third matching funds for this phase were supplied by the City from the sale of bonds.

Before design was completed, an adjunctive process was developed by The Black Clawson Company which would mechanically separate reclamable paper pulp fibers from the aqueous slurry prior to its being mixed with the sewage sludge. Further supplemental grant funds were received to add a method of magnetically separating ferrous metals from the junk removed from the Hydrapulper. The one-third matching funds for the fiber reclamation portion of the plant were reimbursed to the grantee by The Black Clawson Company.

The second phase of the demonstration project was begun on July 24, 1970, with the award of lump sum contracts for the construction of the solid waste and fiber recovery plant; and for procurement of the process equipment. Construction was essentially completed by May 17, 1971, when start-up personnel reported to the jobsite. The ensuing month was spent in testing, making operating adjustments, and training personnel. On June 14, 1971, the first collection trucks were received, and on June 21, 1971, all municipal refuse was routed to the new plant. The plant has been operating on one shift per day, five to five-and-a-half days per week since that date, processing 40 to 50 tons per day. The plant is being operated for the City of Franklin under a contract with Black Clawson Fibreclaim, Inc., a subsidiary of The Black Clawson Company. The total cost of engineering and construction to this stage is $1,988,000.

The third phase of the project began with the initial operation of the plant. The City of Franklin authorized A. M. Kinney, Inc., to obtain physical and fiscal data on the plant during the demonstration period and to prepare the interim and final reports on the project. The Federally-supported demonstration period is for 15 months from initial operation (May 17, 1971, to Aug. 17, 1972). The final report on the project is required to be submitted by Feb. 17, 1973.

SECTION III - HISTORY AND DEVELOPMENT OF PROJECT

The Franklin project was begun in 1967, when the City realized its landfill would be full in another 3 to 4 years. Studies of new sites were meeting the usual opposition from residents who did not want a landfill near their properties.

One of the members of the Franklin City Council was Mr. Joe Baxter, Jr., an engineer employed by the Shartle-Pandia Division of The Black Clawson Company, Middletown, Ohio, manufacturers of paper mill machinery. Mr. Baxter conceived the idea of utilizing an array of this machinery to pulp solid waste, automatically eject nonpulpable objects from the pulper, hydrodynamically separate finely chopped noncombustibles, and burn the residual pulped combustibles in a fluid bed reactor, in the same manner as sewage sludge is burned.

Entirely at The Black Clawson Company's expense, a pilot plant was built in the Research and Development Laboratory of their plant at Middletown, to prove the idea was feasible. The Black Clawson Company retained the services of A. M. Kinney, Inc., Consulting Engineers, to evaluate the process. Pilot plant tests showed that municipal solid waste could be pulped in a Hydrapulper, that the noncombustible content of the refuse could be separated from the organic residue, that mixing sewage sludge with the combustible remainder increased the filterability of the sludge, and that the remainder going to landfill constituted a 90 to 95 percent reduction in landfill volume requirements.

Since the Middletown pilot plant did not include a fluid bed reactor, other pilot operations were performed to determine the combustion characteristics of the pulped organic residue. Pilot plant tests were performed in a Copeland reactor and a full scale test was made in the Dorr-Oliver, Inc., sludge-burning reactor at the Ocean City, Maryland, sewage treatment plant, both using organic rejects from the Middletown pilot plant.

On the basis of the feasibility study, application was made, under the Solid Waste Act of 1965, for a demonstration grant to design and build a full scale plant in Franklin, Ohio, which would demonstrate this innovative method at minimum cost, and at the same time would solve Franklin's solid waste problem.

Grant No. 1-D01-UI-00194 was received on Sep. 24, 1968, and the City retained A. M. Kinney, Inc., to prepare a preliminary Design Manual to establish design concepts and estimated construction costs.

During this period, the Miami Conservancy District became responsible for the water quality of the Great Miami River, and started planning a regional sewage treatment plant for the Franklin area. They acquired a tract of land adjacent to the southwest edge of the City, and offered a part of this property to the City as the site for the solid waste plant. The inter-relationship of the two plants is shown in Figure 1. Provisions were made in the construction of the solid waste plant for the connections to the sewage treatment plant which is now under construction.

Also during this time, further development work was done by The Black Clawson Company in the application of other paper mill-type equipment to the separation of reuseable paper fiber from the aqueous slurry. The pilot plant

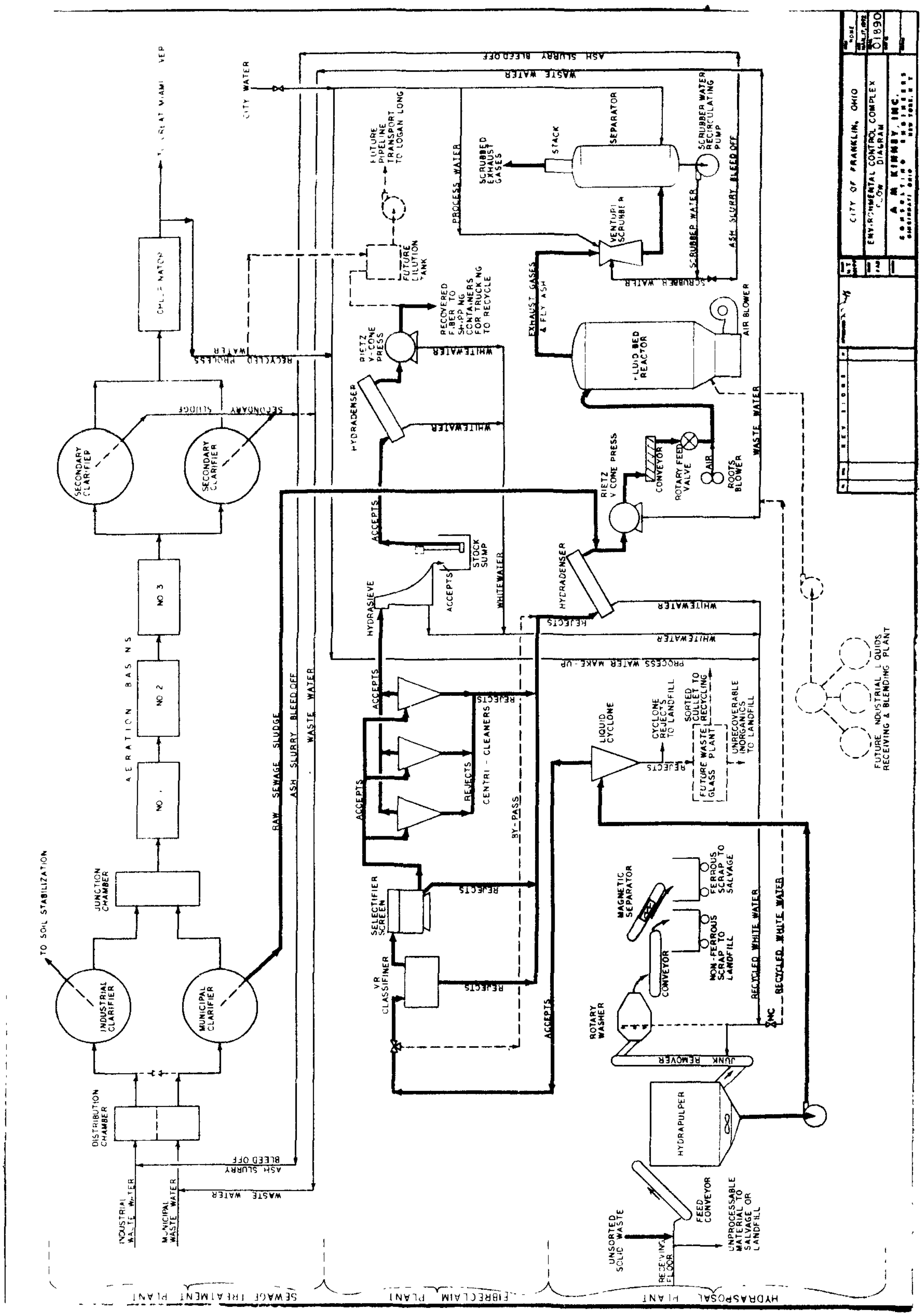


Figure 1. Environmental control complex flow diagram.

at Middletown was expanded to prove the feasibility of this process. On the basis of the pilot plant results, a supplementary grant application was made and funds were awarded to include the Fibreclaim process in the Franklin plant.

The solid waste system Design Manual and the fiber recovery system Design Manual, both prepared by A. M. Kinney, Inc., for the City of Franklin, formed the bases for award of the construction grants No. 2-G06-EC-00194-02 and 3-G06-EC-00194-1S1, which was made on Mar. 2, 1970. Final design drawings and specifications were then prepared, and lump sum bids solicited, in accordance with the laws of the State of Ohio governing bidding for municipal projects.

While the solid waste and fiber recovery plant was being built, the Glass Container Manufacturers Institute announced that it had completed a series of tests and trial operations using the glass-rich fraction separated from the pulped refuse by the liquid cyclone in the Middletown pilot plant. Using a train of screening and classifying equipment to separate extraneous material, the Glass Container Manufacturers Institute equipment train was capable of recovering a stream of color-sorted cullet and an aluminum rich stream. The cullet was separated by the use of a Sortex optical sorter.

The Glass Container Manufacturers Institute proposed that the City of Franklin apply for a supplementary grant to add this equipment train to the Franklin plant, on the condition that the Glass Container Manufacturers Institute would reimburse the City for the matching funds. Award of this grant (No. 3-G06-EC-00194-03S2) was made by the Environmental Protection

Agency, Office of Solid Waste Management Programs on June 8, 1971. Design of this addition is now under way, and construction is expected to begin in the summer of 1972, with completion scheduled before the end of the year.

Construction of the solid waste plant was completed on May 17, 1971, and the fiber recovery plant was completed on June 28, 1971. The plant was dedicated on Aug. 11, 1971, by Mr. Richard D. Vaughan, then Director of the Office of Solid Waste Management Programs, Congressman Walter E. Powell of the 24th District of Ohio, and Mr. Bernard F. Eichholz, City Manager, City of Franklin, Ohio.

The Miami Conservancy District, in expanding its role from flood control of the Great Miami River to that of total water management of that stream, recognized that a major source of pollution was industrial waste liquids being dumped in sewers, streams, and land draining to the river. The District commissioned a survey study of these pollutants and of possible alternative disposal means for them. The result of this study was a recommendation that a regional disposal center be built at Franklin to take advantage of the Hydrasposal system's integral fluid bed reactor. The reactor at Franklin is capable of incinerating many of the industrial liquid wastes, and is expected to be used a maximum of two shifts per day, five-and-a-half days per week through most of the 1980's.

The City of Franklin retained A. M. Kinney, Inc., to prepare specifications for the design and construction of a receiving, storage, and blending facility which would be added to the solid waste recycling-sewage treatment complex. Proposals were received by public bidding, and a firm was selected to build the industrial liquid disposal facility, conditional upon receipt of Federal assistance. Application for a Federal grant to build the facility has been made by the City.

Even in its present, unfinished state the Franklin Environmental Control Complex has attracted inquiries and visitors from many parts of the world.

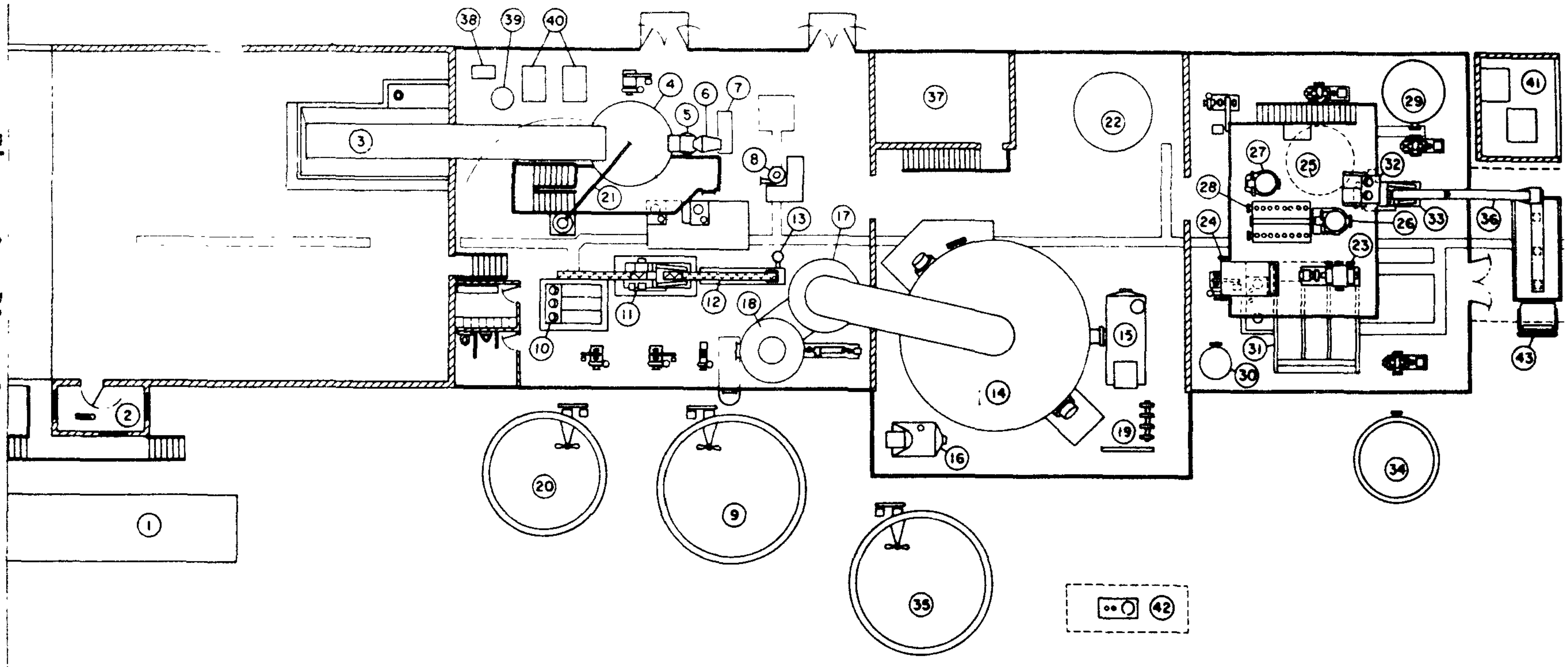
Because it is a full scale commercial plant, operating in regular daily service to the City and its environs, demonstrating a new approach to resource recovery and solid waste disposal, visitors have come from nearly every state of the Union, and from such foreign countries as Sweden, Australia, Italy, Japan, and Great Britain to observe its operation.

The future of the plant is not only a function of the completion of the other parts of the complex, but is largely dependent upon the economic viability of its operation. The process lends itself to more innovation, so that other recovery facilities may be added in the future to reduce its operating costs.

SECTION IV - PRELIMINARY OPERATIONS ANALYSIS

A. General Description of Process. The flow of material through the plant is shown schematically in Figure 1, and the physical arrangement of equipment is shown in Figure 3. As shown in these diagrams, refuse is delivered to the plant by private contractors and individual citizens. All incoming refuse is weighed and recorded at the scale, except that from passenger vehicles and small pickup trucks. The vehicles dump their loads onto the concrete receiving floor, from which the refuse is pushed onto the feed conveyor by a front-end loader.

The conveyor feeds the refuse into the Hydrapulper at a controlled rate. The Hydrapulper is a Black Clawson Model SW pulping machine, 12 feet diameter, and equipped with a 300 horsepower motor. Recycled water is mixed with the refuse, and all pulpable and friable materials are converted into a water slurry (with approximately 4 percent solids content) by the action of a high speed cutting rotor in the bottom of the Hydrapulper tub. Pieces of metal, tin cans, and other nonpulpable and nonfriable materials are ejected from the Hydrapulper through an opening in the side of the tub. These materials pass down a chute which connects the tub opening to a specially designed bucket elevator known as the junk remover. In this chute they receive a preliminary washing by the water which is being recycled back into the pulper. The junk remover discharges the materials into a rotating drum washer, where they are again washed with the recycled water. They are then conveyed under a magnetic separator where the cans and other ferrous objects are separated for recycling. The nonferrous materials are collected for



LEGEND

1 - SCALE
2 - SCALE OFFICE
3 - CONVEYOR
4 - HYDRAPULPER
5 - JUNK REMOVER
6 - JUNK WASHER
7 - MAGNETIC SEPARATOR
8 - LIQUID CYCLONE
9 - NON-RECOVERABLE ORGANICS STORAGE TANK
10 - HYDRADENSER
11 - CONE PRESS
12 - REACTOR FEED CONVEYOR
13 - PNEUMATIC FEED
14 - FLUID BED REACTOR
15 - FLUIDIZING AIR BLOWER
16 - PRE-HEAT BURNER BLOWER
17 - VENTURI SCRUBBER
18 - SEPARATOR
19 - FUEL OIL PUMPS
20 - WHITE WATER TANK
21 - CRANE
22 - FIBER RECOVERY STORAGE TANK
23 - VR CLASSIFINER
24 - GYRO-FLOTE
25 - SCREEN SUPPLY DILUTION TANK
26 - 24-P SELECTIFIER SCREEN
27 - 12-P SELECTIFIER SCREEN
28 - CENTRIFUGAL-CLEANERS
29 - CLEANER SUPPLY TANK
30 - REJECTS TANK
31 - FINES SCREEN
32 - HYDRADENSER
33 - CONE PRESS
34 - WHITE WATER TANK
35 - SLUDGE TANK
36 - TRUCK LOADING CONVEYOR
37 - CONTROL ROOM
38 - COMPRESSED AIR DRYER
39 - COMPRESSED AIR RECEIVER
40 - AIR COMPRESSORS
41 - SUB STATION
42 - FUEL OIL STORAGE
43 - TRUCK

Figure 3. Plant layout.

landfill burial.

The slurry is extracted from the Hydrapulper through a perforated plate located beneath the rotor in the bottom of the tub. In addition to paper fiber, the slurry contains almost all of the organic content of the refuse, plus most of the glass, small pieces of metal, ceramics, and much of the aluminum. To remove the inorganics, the slurry is pumped to the liquid cyclone, where the heavier materials are separated by centrifugal action.

The heavier materials pass into a chamber in the bottom of the liquid cyclone from which they are conveyed into hoppers for landfill disposal. The waste glass recovery demonstration plant, to be built later in 1972, will interface with the solid waste plant at the discharge of the liquid cyclone conveyor.

After the metals and glass have been removed for recycling, the slurry is pumped to the Fibreclaim process for extraction of paper fiber. In this process, the long paper-making fibers are mechanically separated from the coarse organics, such as rubber, textiles, leather, yard waste, and high wet strength paper, paper coatings and fillers, paper fines, and very small pieces of glass, dirt, and sand.

The coarse contaminants are removed in two stages of screening. The first stage is a Black Clawson VR Classifiner, in which the acceptable material is passed through a screen having 1/8 inch diameter openings. The second stage screen is a Selectifier screen having 1/16 inch diameter openings.

The fine glass and dirt is removed by pumping the Selectifier screen accepts through a battery of centrifugal cleaners. Separation of the organic fines from the long fibers is accomplished by passing the slurry over an inclined, slotted fine screen known as a Hydrasieve, manufactured by the Bauer division of Combustion Engineering Company. Long fibers are retained on the screen, while the fines pass through the 0.020 inch slots.

Finally, the reclaimed long fibers are dewatered in two stages. The first stage is a Black Clawson Hydradenser, which is an inclined screw conveyor type thickener which removes most of the water. Additional water is removed by squeezing the partially dewatered pulp in a cone press manufactured by the Rietz Manufacturing Company. The pulp is delivered by screw conveyor to a waiting truck or shipping container at 40 to 50 percent moisture.

When the Miami Conservancy District completes installation of its area waste water treatment plant, the dewatered recovered fiber will be rediluted with the sewage plant effluent water, and pumped directly to the Logan-Long Company, who now buy the recovered pulp for use in making dry felt for asphalt roofing.

The unrecoverable organic rejects from the fiber recovery operations are combined and pumped to a storage tank. From the storage tank they are returned to the Hydrasposal system.

As the organic rejects are drawn from the storage tank at a desired rate they are dewatered to 40 percent solids content in two stages. An inclined screw thickener (Hydradenser) discharges to a Rietz cone press. The press discharges to a screw conveyor which breaks the dewatered cake into lumps 5/8 inch to 1-1/2 inches in size. These are then fed through a rotary star-feeder into a pneumatic conveyor system which delivers the material to the fluid bed reactor.

The fluid bed reactor is a 25 foot inside diameter vertical cylindrical unit supplied by Dorr-Oliver, Inc. In this unit, room temperature air is blown by a 500 horsepower Spencer blower into a windbox at approximately 4-1/2 psig. The air flows upward through a perforated plate and gravel dispersal layer into a layer of sand, which becomes fluidized by the air. When starting up from a cold condition the fluidized bed is initially preheated by oil burners. After the fluidized sand reaches operating temperature of 1300 F to 1500 F, the injection of the organic rejects supplies sufficient fuel to continue their combustion, so that no auxiliary fuel is required in normal operation. For shutdown periods in excess of 24 hours, small quantities of fuel are used to maintain bed temperature.

The exhaust gases are cleaned of particulate matter in a venturi scrubber, and are discharged through a gravity separator as a clean, nonpolluting odorfree white plume.

Sludge from the adjoining sewage treatment plant will be mixed with the organic rejects between the Hydradenser and the cone press so that it will be dewatered without the aid of flocculating agents in the press, and burned in the fluid bed reactor.

B. Description and Evaluation of Process Streams. The impact of the Franklin plant on the environment can be measured only by comparison of the inflows, which formerly were dumped or buried, with the outflows which are now either recycled, passed on to downstream treatment facilities, or emitted into the air. The process flows within the Hydrasposal and Fibreclaim processes are actually of little importance to this report. This section of the report, therefore, is confined to the environmental impact concept.

1. Solid Waste Receipts. Between June 21, 1971, and Dec. 31, 1971, a total of 6,299 tons of refuse were received at the plant. Of this amount, 6,140 tons were processed through the system.

Although no categories have been recorded, the plant operators have estimated that 85 to 90 percent of the receipts are from residential sources.

The tonnage received and not processed consisted primarily of large items which are not grindable by a Hydrapulper, such as vehicle tires, refrigerators, water heaters, iron and wooden furniture, industrial pallets, automotive parts, kitchen and laundry appliances, building demolition waste, dead tree trunks, and lumber.

Some items not originally considered as processable by a Hydrapulper have proven to be, such as dead small animals, aluminum lawn furniture, small appliances, television sets, and light drums.

Incoming refuse from commercial haulers is received from packer trucks, and open dump trucks. Individuals and small haulers bring refuse in pickup trucks, station wagons, rental trailers, and automobiles. Obviously processable loads are dumped on the receiving floor and pushed onto the feed conveyor by means of a front-end loader. One plant operator acts as weighmaster, receiving clerk, cashier, and loader operator. It is incumbent upon this operator to scan the incoming loads and the material being pushed onto the conveyor to extract unprocessable materials. During early operations, several instances occurred where ungrindable items were charged into the

Hydrapulper with resulting downtime while the object was removed, and, if necessary, repairs were made to the Hydrapulper. When these materials are spotted, they are pulled out, set aside, and periodically sold as scrap to a junk dealer. Unsaleable items must be landfilled, but these amount to only about 1-1/2 percent of the tonnage received. A change in the baffle plate has virtually eliminated Hydrapulper downtime resulting from damage by this type of material.

Figure 7 shows the variations in refuse received and processed during this report period.

2. Junk Remover Rejects. Of the tonnage processed, approximately 11 percent is ejected by centrifugal action through the junk chute of the Hydrapulper into the junk remover.

The magnetizable, or ferrous, fraction averages 68 percent of the junk remover rejects, or 7.2 percent of the total refuse received. This consists mostly of cans, but also contains bottle tops, spark plugs, nails, bolts, and an infinite variety of unrecognizable pieces. This material is dumped into detachable truck bodies in which it is hauled several times a week to a nearby steel company (Armco) which pays the equivalent price of No. 2 bundles (presently $13.30 per short ton) for it.

No further recycling process is immediately contemplated for the nonmagnetizable rejects. These rejects average 1.45 tons per day, or 3.5 percent of the refuse tonnage received. They are disposed of in the nearby plant landfill.

Typical analyses of the junk remover reject streams are as

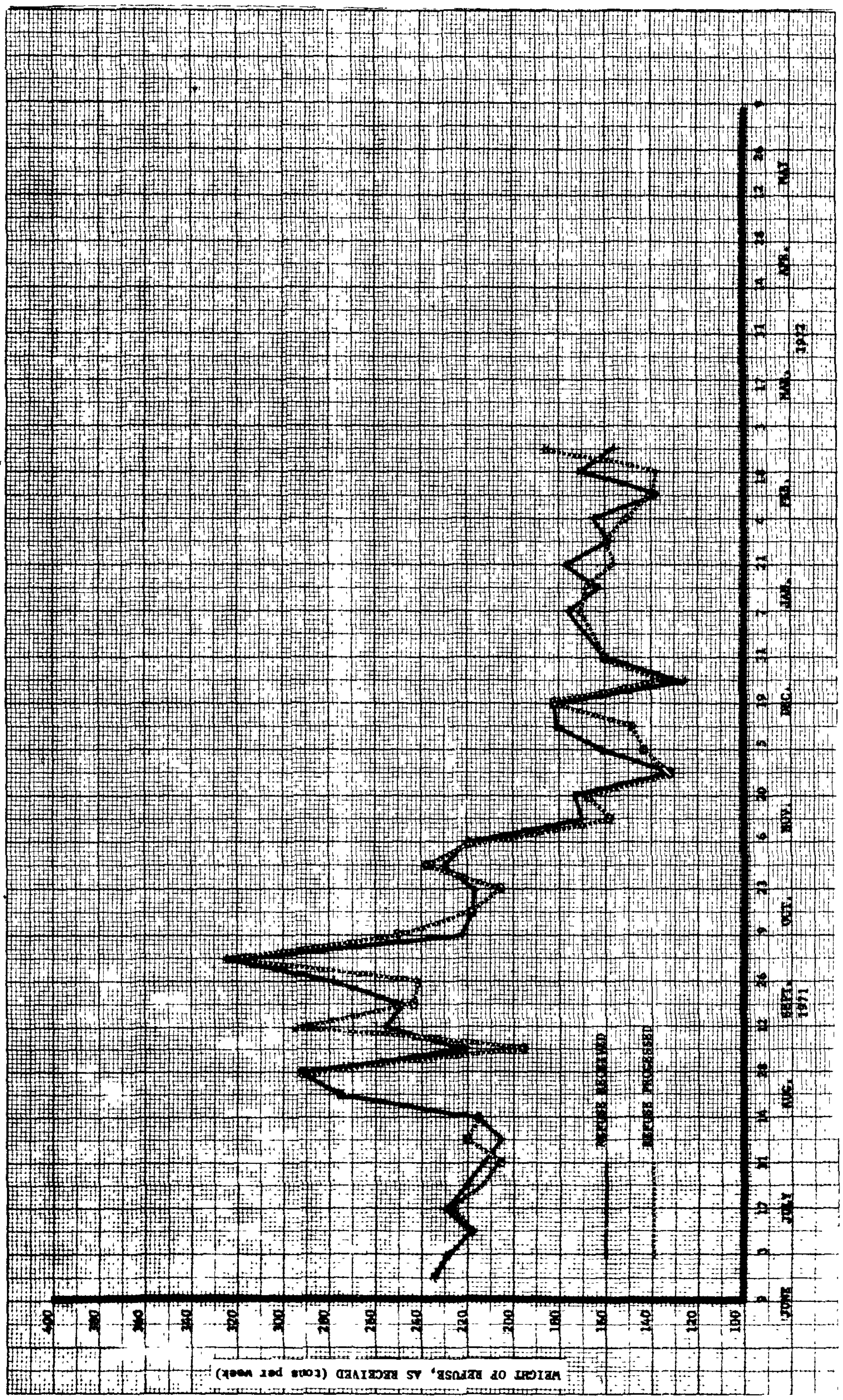


Figure 7. Waste load variation.

follows:

Sixty-eight percent of junk remover rejects are collected by the magnetic separator. Approximately 80 percent of this fraction is all steel cans and steel cans with aluminum tops. The remaining 20 percent usually is spark plugs, nuts, bolts, wire, and automobile and appliance parts. Of the 32 percent not collected by the magnetic separator 6 to 16 percent is nonferrous metal, 1/2 to 2 percent is ferrous metal missed by the separator, and 82 to 94 percent is miscellaneous objects such as rubber, heavy plastics, stones, and large pieces of glass.

3. Liquid Cyclone Rejects. Approximately 10.5 percent, by weight, of the total refuse received is separated by the liquid cyclone.

An average of analyses of the liquid cyclone rejects shows this stream consists of:

Description	Percent (Dry Basis)	
Clear glass	38.4	
Green glass	4.9	
Amber glass	21.8	65.1
Magnetic metals	3.3	
Aluminum	2.3	
Other metals	0.8	6.4
Large stones (greater than No. 4 mesh)		4.6
Loss on ignition		6.0
Miscellaneous materials (plastics, rubber, etc.)		17.9
Total		100.0

The waste glass plant now being designed will receive its input from the liquid cyclone discharge conveyor. At present, however, this material, along with the nonferrous junk remover rejects and the unsaleable, unprocessable material, is buried in the plant landfill. The cyclone rejects contain a higher percentage of adherent organic material than was anticipated. The waste glass plant equipment train will include washing and screening operations to remove this material before color sorting the glass, and will return it to the main plant for burning.

Figure 9 shows the trends in cyclone rejects analyses during the report period.

4. Recovered Fiber. Fiber recovery operation began during July 1971, and continued through Aug. 28, 1971. During this period 76.3 tons of fiber (air dried basis) were produced, which was sold to the Logan-Long Company of Franklin, Ohio, manufacturers of roofing products.

On Aug. 28, 1971, fiber production for Logan-Long Company was stopped because of operating problems on their paper machine. Between Sep. 1 and Sep. 15, 1971, Logan-Long Company evaluated the performance of their machine using no reclaimed fiber. During this same period, The Black Clawson Company and Logan-Long Company conducted laboratory investigations into the cause of the problems. The results of these investigations are discussed in this report under the heading of "Operating Problems and Improvements Under Study".

Fiber recovery operations were resumed in September and October to produce fiber for a series of experimental papermaking tests being made by the St. Regis Paper Company, and were again resumed in November for Logan-Long Company after both they and The Black Clawson Company made process changes

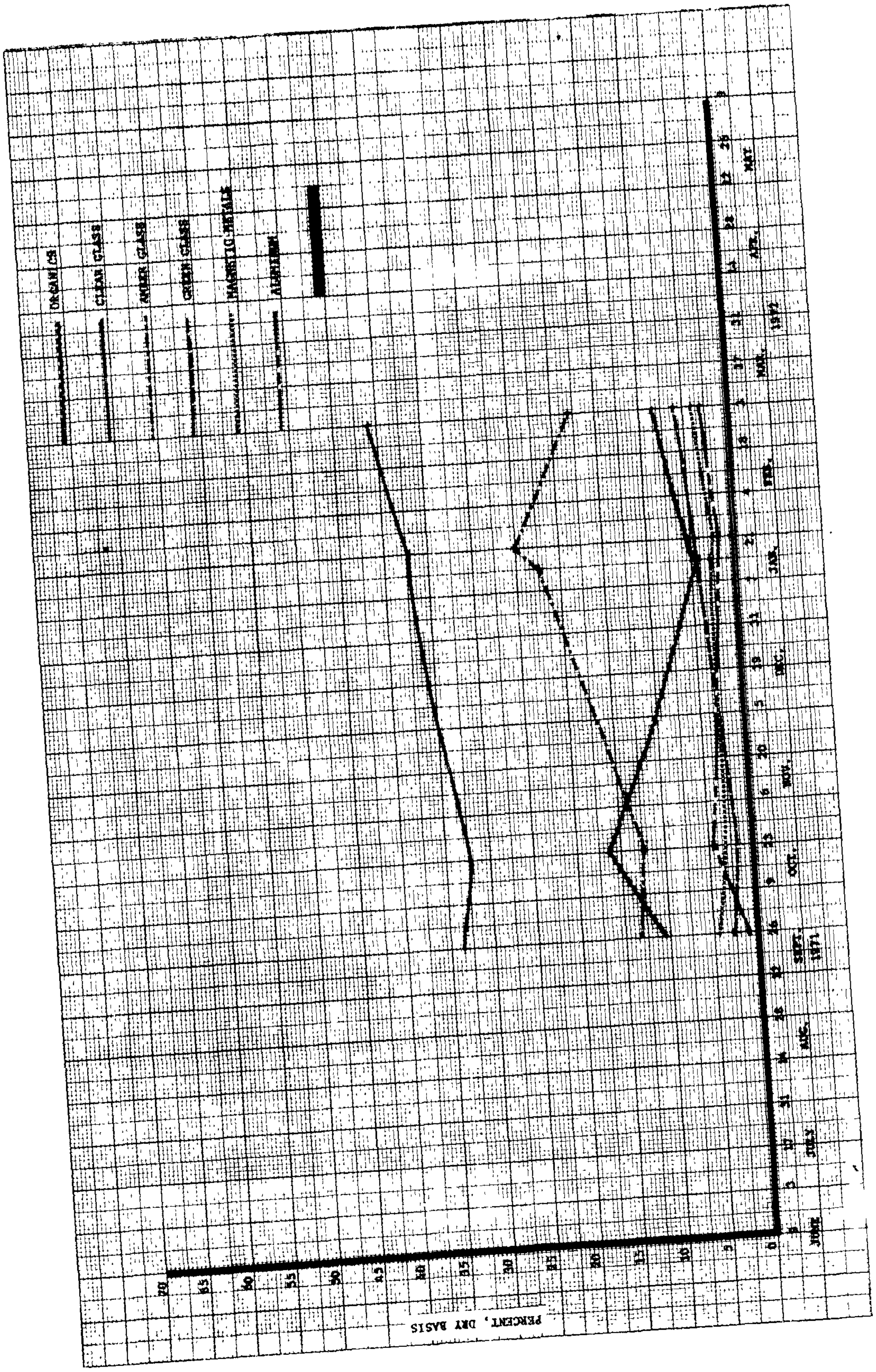


Figure 9. Cyclone rejects analysis.

which enabled Logan-Long to use the recycled fiber.

The quality of recycled fiber, when processed in a paperboard mill equipped to eliminate lipids and fines, is reported to be good. No analytical data on the experimental paper and board manufactured from the recovered fiber has been reported, because it is not considered conclusive in view of the production difficulties encountered. The Logan-Long Company has reported that the fiber is the equivalent of the corrugated board, old newsprint, and mixed paper currently used by them in the production of roofing felt.

The commercial viability of the fiber recovery process depends not only on the physical usefulness of the fiber, but also on the financial return which would result from the additional capital required for this adjunct to the Hydrasposal system. Operating data indicates that the oven-dried fiber yield at the Franklin plant was 5 to 7.6 percent of the refuse tonnage as received compared to the 18 percent yield indicated by the Middletown pilot plant operation and several experimental runs at Franklin. Several modifications to the system are required to increase the yield. On The Black Clawson Company's recommendation, the City has included the funds for yield and quality improvement modifications in a supplementary grant application.

The tonnage of fiber produced during the report period is shown in Figure 10.

5. White Water Waste. An estimated 50 gpm of waste water was routinely discharged from the process water system through December 1971.

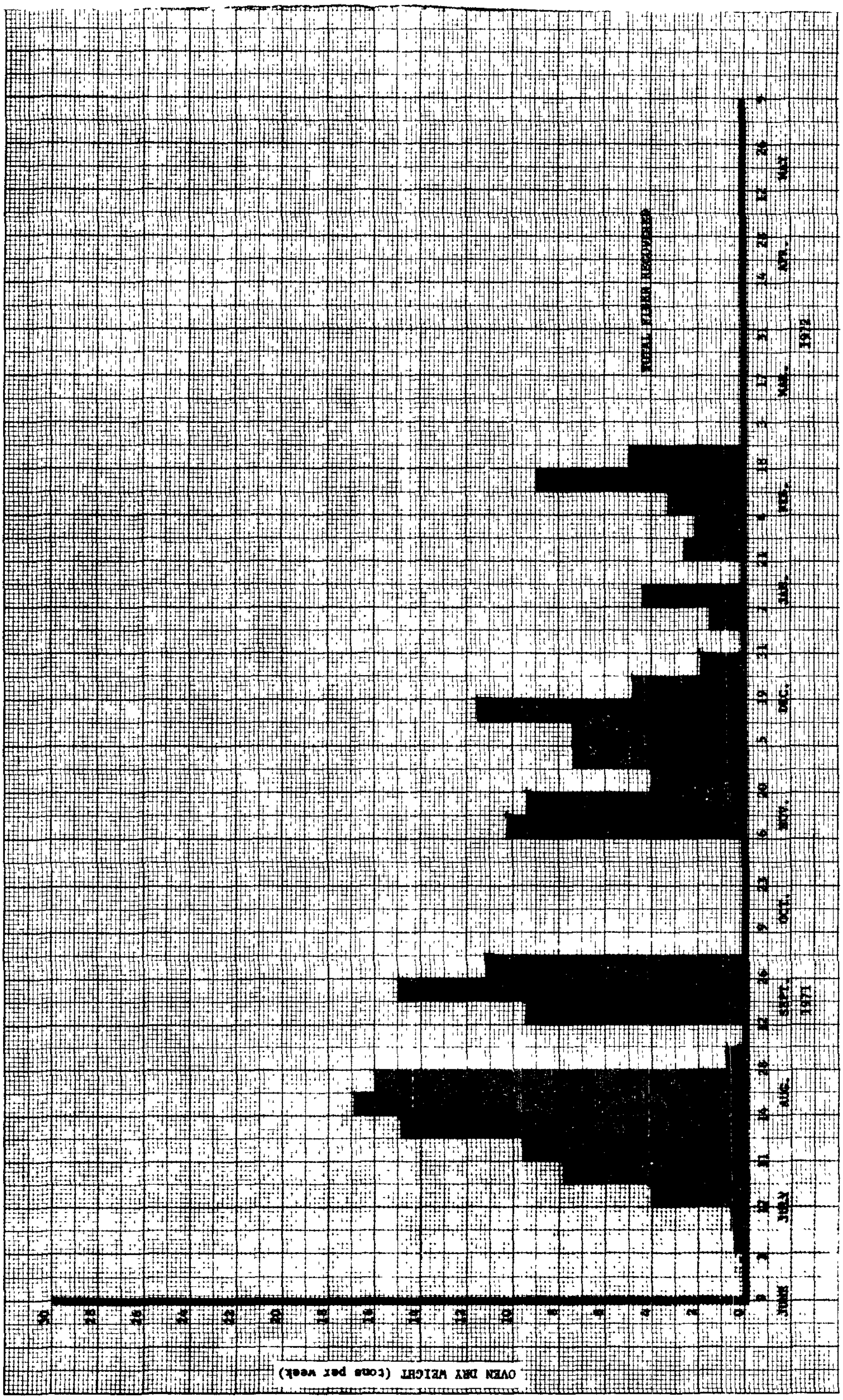


Figure 10. Reuseable paper fiber recovered.

Under design conditions, with sewage sludge dewatered and burned in the fluid bed reactor, part of the total discharge will be the water which will convey the sludge. This will be done to prevent contamination of the plant process water with untreated sewage water.

White water is constantly withdrawn from the system to reduce the level of total and dissolved solids in the process water. This is replaced with fresh water makeup.

An average analysis of the waste water is as follows:

pH	5.6
Five day BOD	3,148 mg/liter
Suspended solids	3,411 mg/liter
Total dissolved solids	3,315 mg/liter
Settleable solids	83 ml/liter

Temporarily, the waste water is piped to an aeration basin installed by the Miami Conservancy District to serve until the sewage treatment plant is completed. The treated water is now discharged to ground absorption.

Figures 12, 13, 14, 15, and 16 show the physical and chemical characteristics of the various plant waters.

6. Sewage Sludge. Because the area waste water treatment plant being built by the Miami Conservancy District has not been completed, no sewage sludge has been burned to date in the process.

7. Ash Slurry. Approximately 40 gpm of ash slurry is bled from the scrubber-separator water recirculating system. This quantity can be varied to limit the amount of total solids in this system, but it is now run at a constant rate because of failure of the flowmeter supplied with the scrubber.

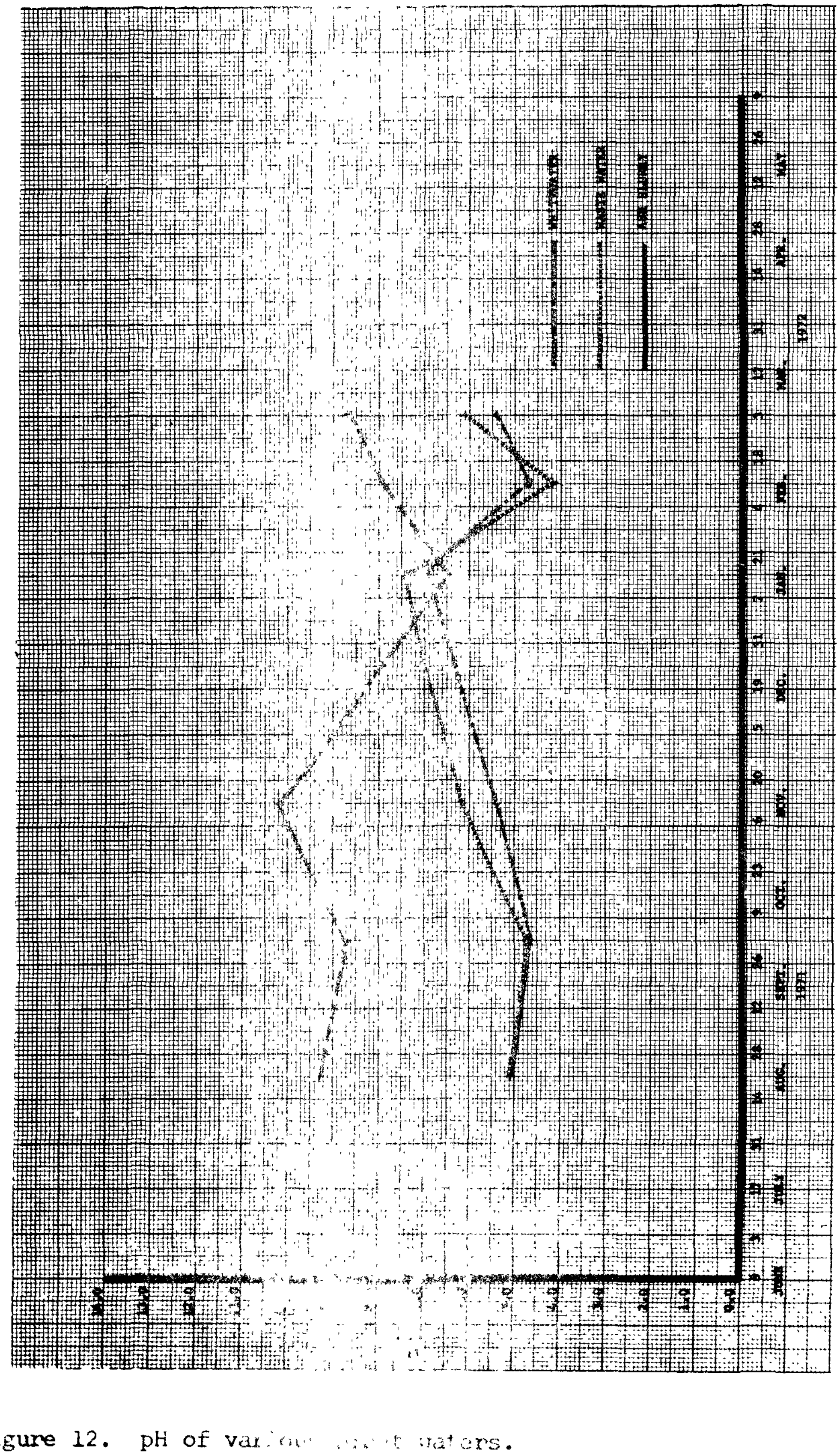


Figure 12. pH of various plant waters.

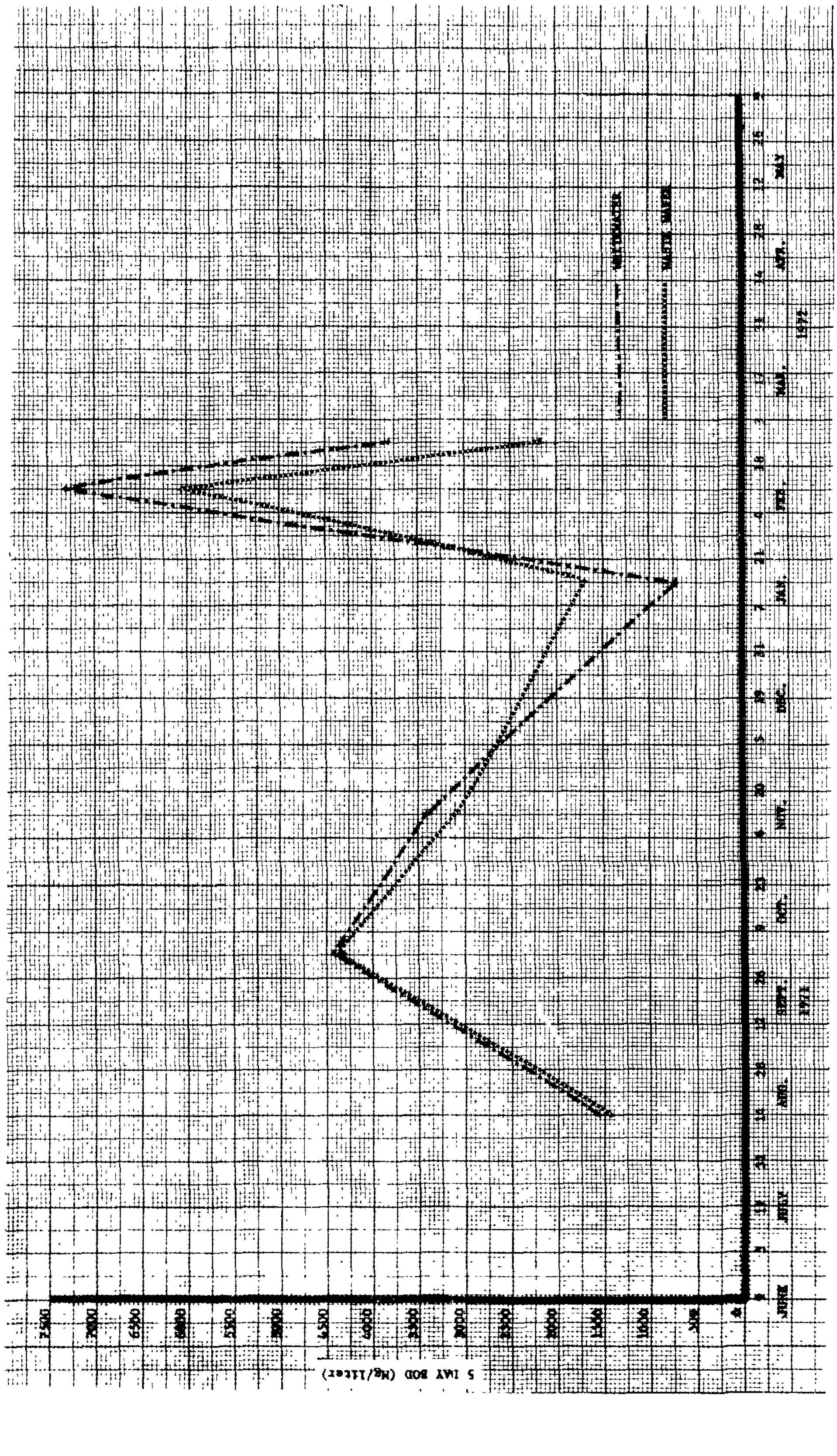


Figure 13. Biochemical oxygen demand of various plant waters.

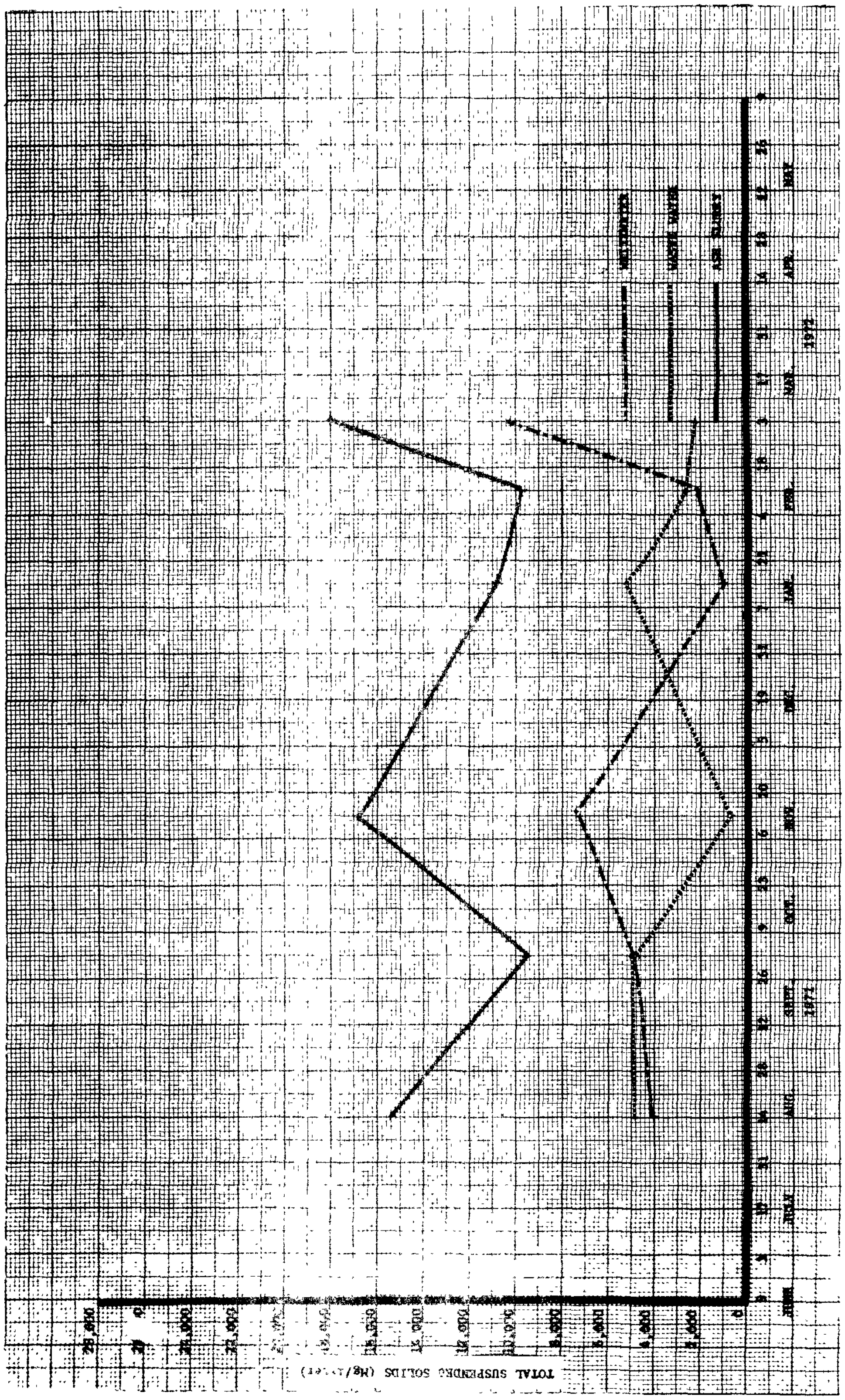


Figure 14. Total suspended solids in various plant waters.

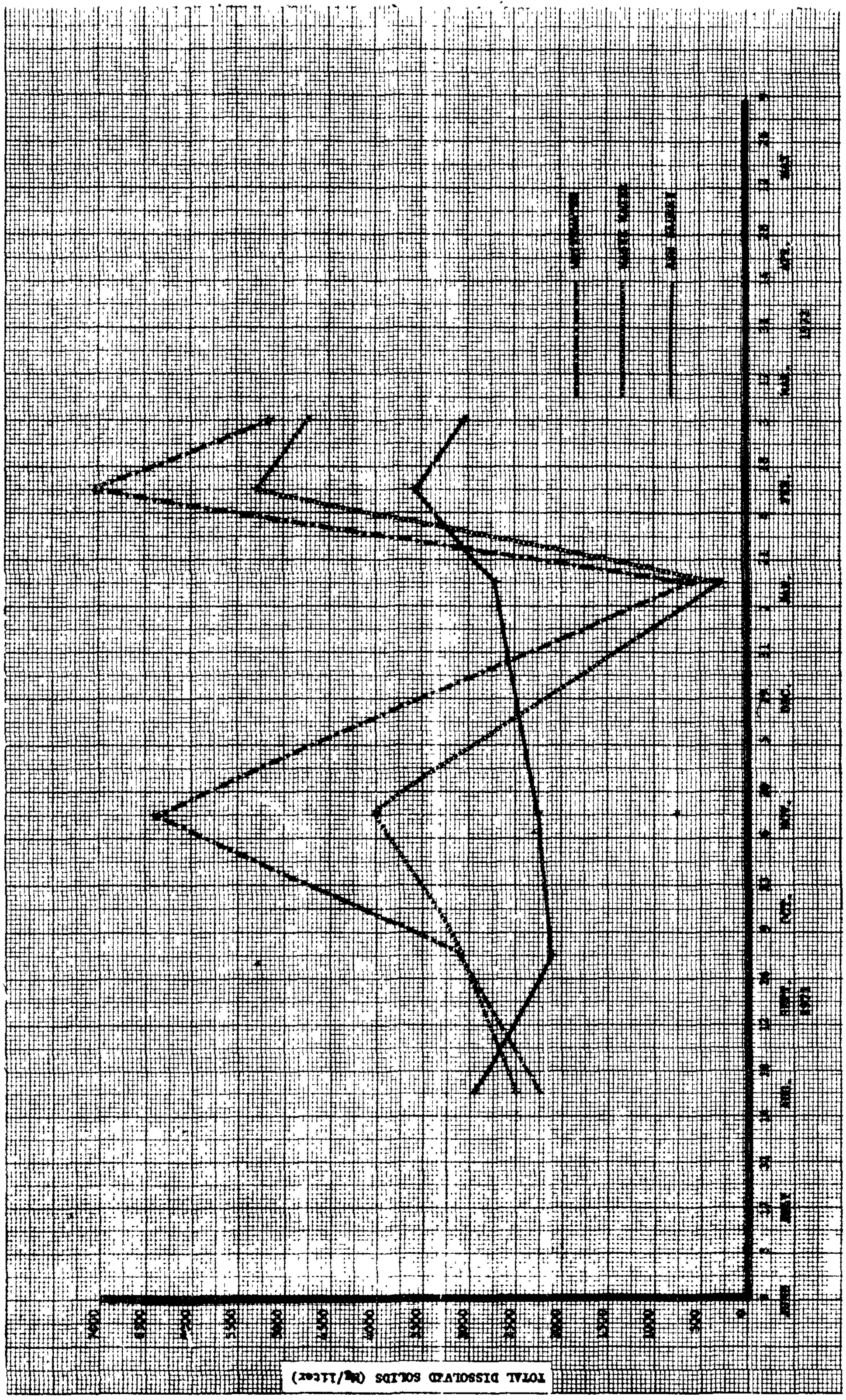


Figure 15. Total dissolved solids in various plant waters.

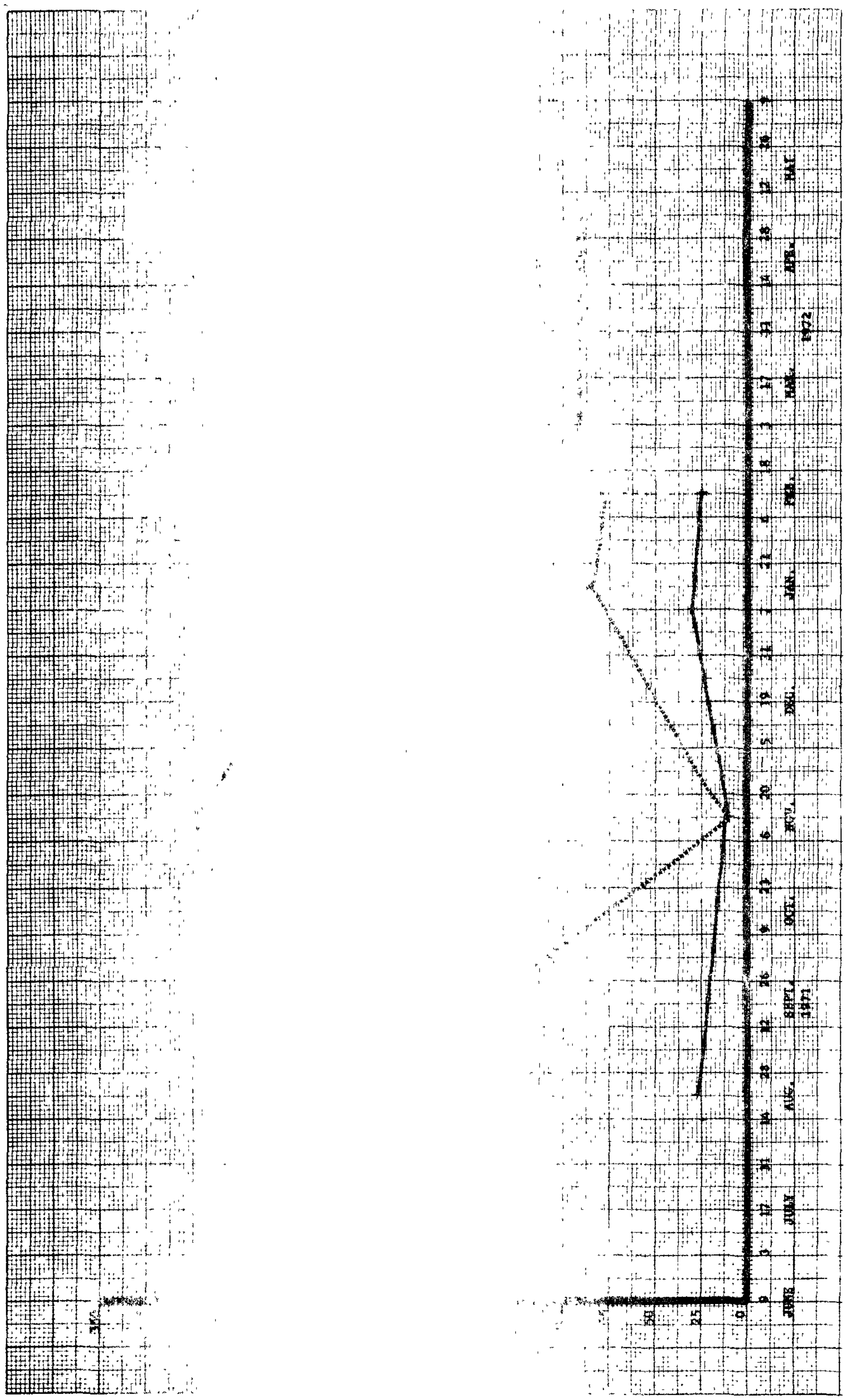


Figure 16. Sett[illegible] waters.

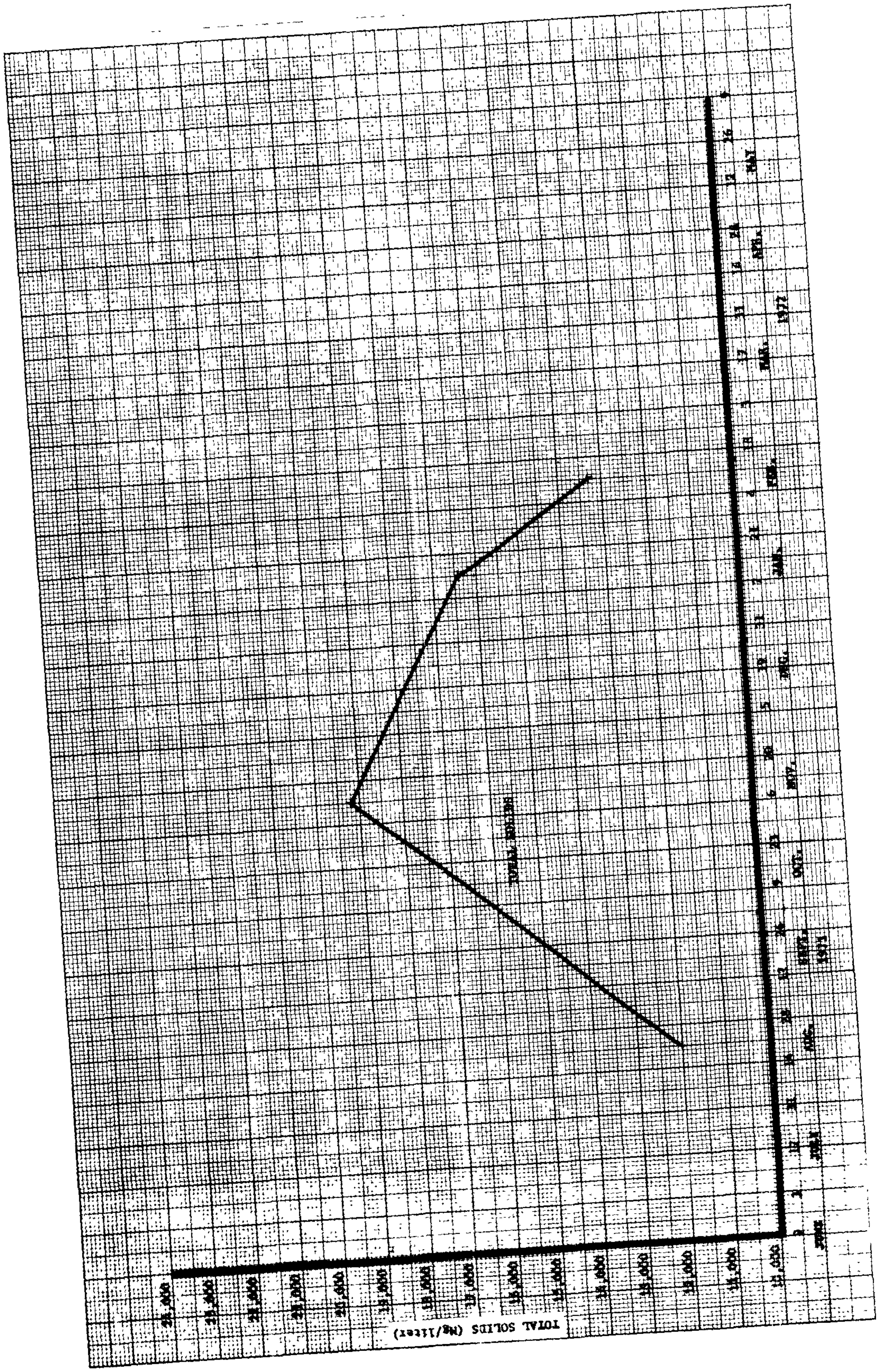


Figure 17. Total solids in ash slurry.

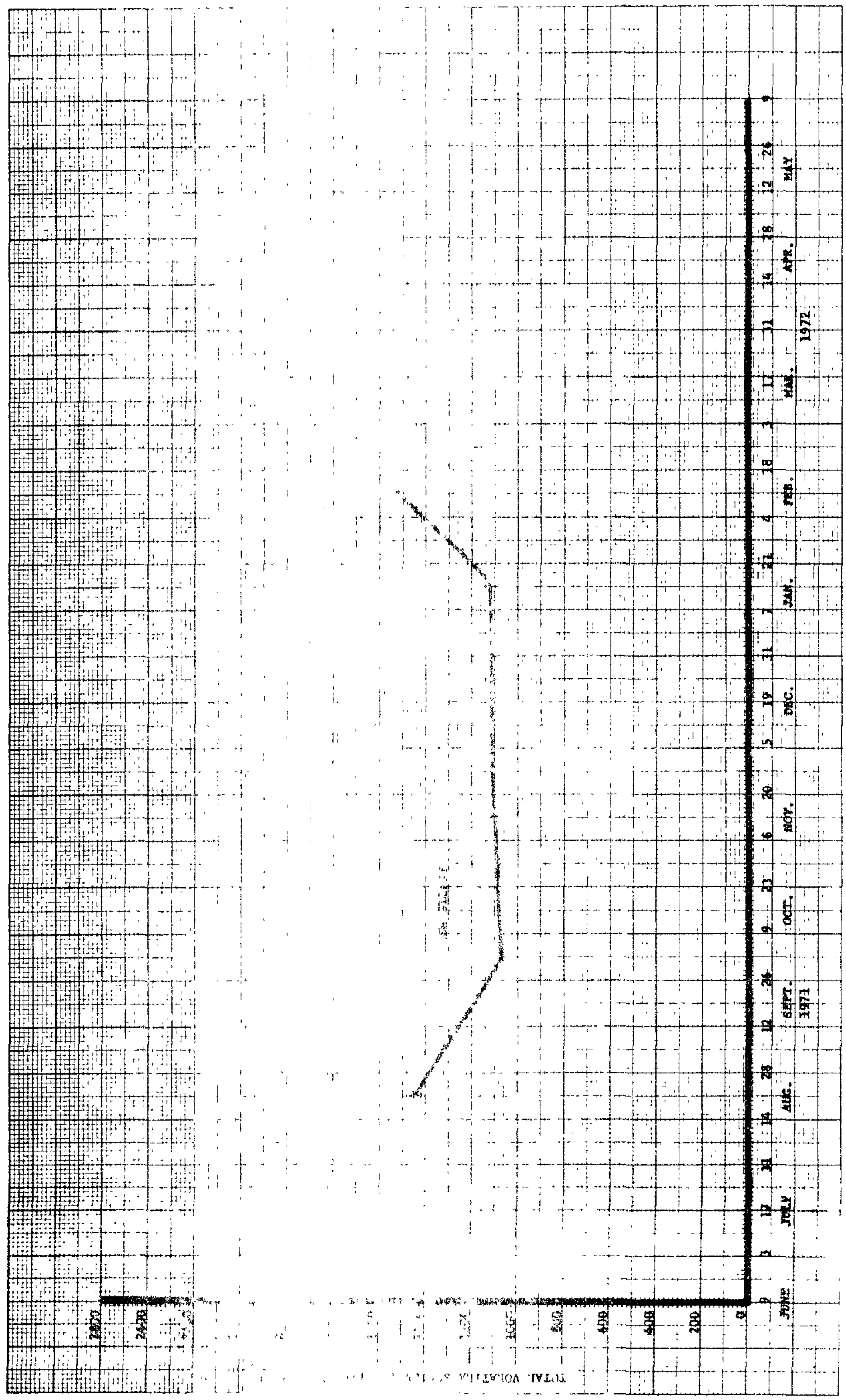


Figure 18. Total vola[illegible] solids in ash slurry.

An average analysis of the ash slurry water is as follows:

pH	8.5
Total solids	16,100 mg/liter
Suspended solids	13,400 mg/liter
Dissolved solids	2,700 mg/liter
Settleable solids	25 ml/liter
Total volatile solids	1,500 mg/liter

Figures 12, 14, 15, 16, 17, and 18 illustrate variations in the chemical and physical properties of the ash slurry.

Until the Miami Conservancy District sewage treatment plant is completed, the ash slurry is being discharged to surface drainage. When the sewage treatment plant is operational, this slurry will be piped to the industrial primary clarifier where it is expected to be used as a settling agent. (See Figure 1).

8. Stack Gases. The products of combustion from the fluid bed reactor are conveyed through a downflow venturi scrubber, then up through a gravity separator column before being discharged to atmosphere.

From Dec. 28, 1971, through Jan. 4, 1972, a field crew from Environmental Sciences, Inc., of Pittsburgh, Pennsylvania, performed a series of three tests covering simultaneous sampling of the emissions from the fluid bed reactor and the emissions from the scrubber serving the reactor. The data taken consisted of the collection and analysis of the particulate and gaseous emissions in the stack gases. Also during each test, samples of the inlet and outlet scrubber water, and of organic rejects fed to the reactor were collected, so that a complete material balance could be performed on the entire system.

The purpose of the testing program was to determine the air pollution emissions from the fluid bed reactor in order to certify to the City of Franklin and to the State of Ohio the quantity and nature of the air pollutants being emitted from the process. Tests of the fluid bed reactor and the venturi scrubber were also needed by A. M. Kinney, Inc., to prepare a comprehensive evaluation of the treatment process. The testing program allowed for the determination of the emissions from the fluid bed reactor when operating at normal operating capacity at steady state, as well as allowing the determination of the collection efficiency of the venturi scrubber serving the fluidized bed reactor.

Based upon the results of the three tests performed on the inlet and outlet of the scrubber, the following average results were reported by Environmental Sciences, Inc.

Scrubber dry solids removal efficiency	98.8 percent
Scrubber condensables removal efficiency	23.5 percent
Solid particulate loss on ignition (900 C)	3.3 percent

Parameter	Inlet	Outlet
Grain loadings - grains per standard dry cu ft (SDCF) at 12 percent carbon dioxide	4.5	0.076
Grain loadings - grains per SDCF - actual reading	2.542	0.043
Condensables - percent	1.0	45.5
Particulate flow - lb/hr	358	6.11
Volumetric flow rate SDCF per minute	16,500	--
Gas temperature - F	1400	190
Water - percent	5.5	34.1

Parameter	Inlet	Outlet
Sulfur dioxide--parts per million (ppm)	45	less than 7
Nitrogen oxides--ppm	143	125
Aldehydes	none	none
Hydrocarbons	none	none
Carbon monoxide	trace	trace
Chlorides--lb/hr	4.7	0.43

The data given above generally show that the effluent from the fluid bed reactor contains only a trace of combustible material, either as gases or solids. These results, coupled with an exit gas temperature of 1400 F, indicate that the reactor is efficient and operating well. The venturi scrubber and mist separator remove about 98 percent of the dry and condensable particulate. Considering that the scrubber system operates at a differential of only 7 inches of water, its performance is excellent.

The analysis of the impinger water indicates undetectable amounts of nitrates and fluorides, with most of the soluble, condensable material being in the form of sulfates and chlorides. The impinger water was very acidic (pH--2.5). The chemical analysis of the scrubber water indicated large amounts of solid and dissolved particulate with high quantities of sulfate and chlorides, and only minor contributions from other ions. The scrubber water was only slightly acidic (pH--6.0).

The quality and quantity of the particulate and gases theoretically emitted from the reactor and the measured quantities of material picked up by the scrubber water system did not balance well with the measured concentrations of pollutants in the stack gas due to errors involved in: (1) obtaining a representative sample of scrubber water; (2) estimating scrubber water flows and refuse fuel consumption; (3) an accurate fuel analysis; (4) not chemically analyzing the solid particulate collected during the test, and (5) miscellaneous problems that could be isolated and solved only by extensive research.

These tests show that the emissions from the scrubber are below the limit of 0.1 grain per standard dry cubic foot of gas flow (corrected to 12 percent carbon dioxide) set by the specifications, which were based on Federal guideline specifications which were in effect at that time.

However, regulations adopted by the State of Ohio, Air Pollution Control Board, on Jan. 28, 1972, with an effective date of Feb. 15, 1972, limit dust emissions from incinerators to 0.1 pounds of particulate per 100 pounds of combustible refuse charged, when operating at the manufacturer's maximum rating. At the time this report was written, it was uncertain whether the Franklin reactor would meet this requirement, since the plant does not function like a conventional incinerator. The City's consulting engineers have requested the State of Ohio to clarify whether the "combustible refuse charged" should be measured at (1) the reactor inlet, excluding the noncombustibles removed by the junk remover and liquid cyclone as at Franklin, or (2) the plant receiving floor, as would be the case with a conventional incinerator.

It is planned by the plant operating contractor to have another stack test made as an acceptance test of the Dorr-Oliver equipment. These results will be included in the final report.

9. Organic Rejects. Although it is not an external stream, the fuel feed to the fluid bed reactor also is being monitored during the evaluation period in order to gather operating data on this key part of the Hydrasposal system. The physical characteristics of the reactor sand bed and the ash from the reactor fuel are also analyzed at regular intervals.

Typical analyses of the organic rejects are as follows:

Ultimate Analysis	Percent
Moisture	54.36
Carbon	22.90
Hydrogen	2.84
Oxygen	15.18
Nitrogen	0.02
Sulfur	0.07
Ash	4.63

Proximate Analysis	Percent
Moisture	54.36
Volatile	36.03
Ash	4.63
Fixed carbon	4.98

Heating value (oven dry basis) 8,345 Btu per pound

Figure 19 illustrates the variations in proximate analyses of the reactor fuel.

10. Auxiliary Fuel. No. 2 commercial fuel oil is used to preheat the bed sand in the fluid bed reactor in order to bring it up to minimum operating temperature. When the bed reaches this temperature, feeding the dewatered organic rejects is begun, and, under normal operation all of the rejects burn autogenously. Under unusual or upset conditions, it has been necessary to

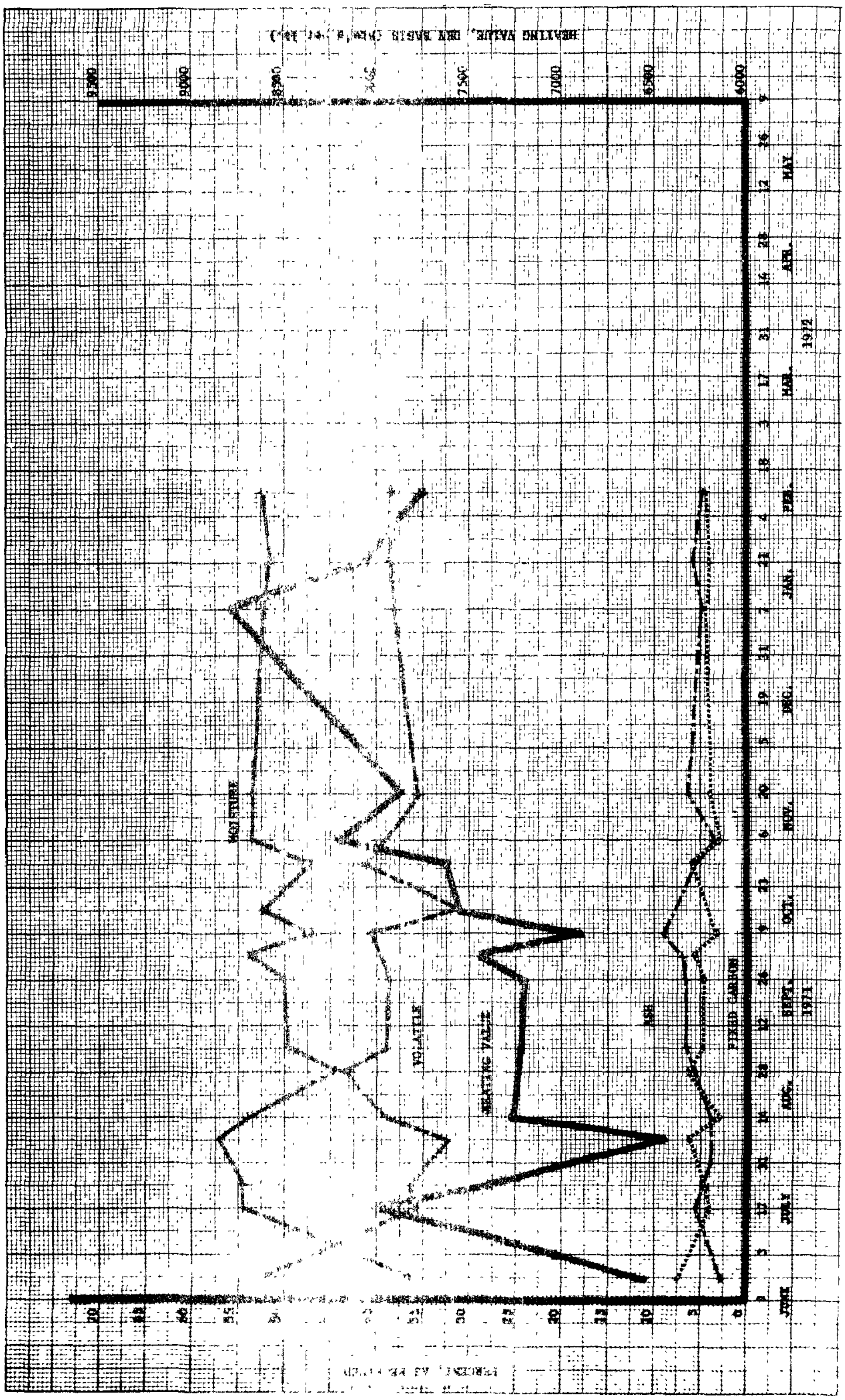


Figure 19. Proximate analysis of reactor feed.

fire supplementary fuel through oil guns located within the static bed level to maintain minimum bed temperature. During the period of this report a total of 22,120 gallons of fuel oil were used, including approximately 4,600 gallons used during a period when organic rejects were drawn off intermittently for test purposes, thus interrupting continuous feed to the reactor.

11. City Water. At the present time, city water is used as the sole source of makeup water to the system. When the sewage treatment plant is completed, its effluent will be recycled for use as process water. Process usage of some city water may continue, as for example in the venturi scrubber sprays and as seal water.

Actual quantities of city water used are not recorded, because the plant operators removed the city water meter in an attempt to solve a problem of low water pressure at the scrubber sprays, and replaced it after the report period. The average water usage is calculated as follows:

Waste water to pond (measured)	50 gpm
Ash water to surface (measured)	40 gpm
Water evaporated by scrubber (from stack analysis)	50 gpm
Total	140 gpm

Average consumption of water per ton of refuse processed is calculated as follows:

Hydrapulper operating time	783.3 hours
Reactor and scrubber operating time	866.8 hours
Tons of refuse processed	6,140
Hydrapulper usage:	
783.3 hours at 50 gpm x 60 minutes per hour	2,349,900 gallons
Reactor usage:	
866.8 hours at 90 gpm x 60 minutes per hour	4,680,700 gallons
	7,030,600 gallons

The 7,030,000 gallons consumed, divided by the 6,140 tons processed, equals 1,145 gallons per ton of refuse.

12. Electric Power. Electric power service to the plant is supplied by The Cincinnati Gas & Electric Company, through a single 1,500 kilovolt-ampere (kva) transformer and a meter serving both the Hydrosposal and Fibreclaim systems. A separate temporary connection is installed to serve the floating aerator in the temporary waste water treatment basin. When the sewage treatment plant is completed, it will be served by its own transformer and meter.

Power consumption for the report period was a total of 935,600 kilowatt-hours (kwh). No measurement of the division between Hydrasposal and Fibreclaim systems is available.

The unit consumption of electric power during report period is computed as follows:

935,600 kwh consumed, divided by the 6,140 tons processed, equals 153 kwh per ton of refuse. Because this quantity includes the start-up period it is to be considered as order-of-magnitude only. Recent data has indicated consumption of approximately 180 kwh per ton.

13. Rejects to Landfill. The three streams which go to landfill are summarized as follows:

a. Unprocessable Refuse Received. Consists of large or heavy ungrindable or unfriable items. This fraction averages approximately 0.66 tons per day or 1-1/2 percent (by weight) of refuse received.

b. Nonferrous Junk Remover Rejects. Consists of smaller ungrindable or unfriable materials. This fraction averages approximately 1.45 tons per day, or 3.5 percent (by weight) of the refuse received.

c. Liquid Cyclone Rejects. Consists of inorganic rejects, 3/4 in. and smaller, which have passed through the extractor plate of the Hydrapulper. This stream contains 5 to 15 percent putrescible organics.

All of the cyclone rejects, which now go to landfill, average approximately 10.5 percent (by weight) of the refuse received.

In the latter part of 1972, this stream will be diverted to the waste glass recovery system, where the glass and aluminum between 1/8 in. and 3/4 in. will be recovered for recycling. The remaining undersize and oversize material, stones, plastics, and metals will continue to go to landfill, but the putrescible organic will be returned to the Hydrasposal system for incineration in its fluid bed reactor.

The total of reject streams going to landfill during the report period average 15.5 percent of the tonnage received. No total measurement of volume to landfill was made, but it is estimated at less than 5 percent of the total volume received at this plant, or 8.3 percent of the volume required for conventional landfill operation.

Figure 20 shows the variations in quantities and constituents of the material taken to the plant landfill. Quantities are reported by the plant operators on an oven-dried basis, in order to eliminate variations in actual tonnage due to varying moisture contents.

C. Operating Problems and Improvements Under Study. While the physical data in this report are concerned primarily with quantitative and qualitative

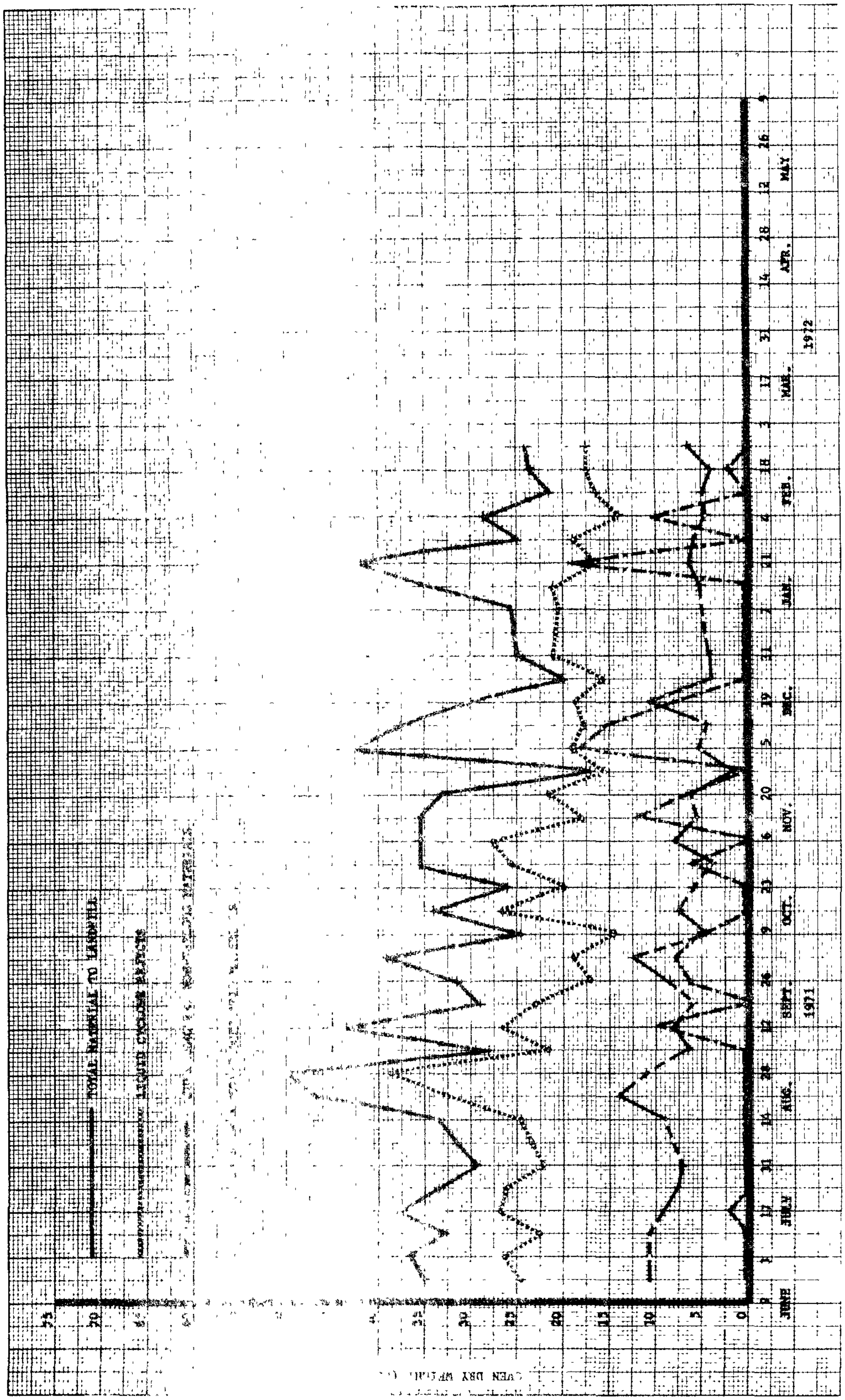


Figure 20. Rejects to landfill.

analysis of external process streams, the overall effectiveness of the Franklin demonstration plant is dependent on its internal operation.

The problems which have affected overall plant operation, and the improvements which are being considered, are thus an integral part of this analysis.

1. Refuse Receiving. For economy reasons, the refuse receiving area was designed as an open-ended, high-walled shed. The basis for computation of receiving floor space was that the entire area, except for walking aisle space, would be used for receipts. This has proved impractical for operation of the front-end loader. As a result, when a number of trucks arrive in a short time span, it is necessary to accumulate the refuse on the ramp leading to the receiving floor until the peak is worked off. Although this has been unsightly, and operation of the front-end loader outside during inclement weather is inconvenient, the plant operators feel no remedial action is economically justifiable.

Another operating problem was one of maggots in the apron conveyor pit and sump, on the receiving floor, and on the operating floor. This problem was worst during the warm weather, but it has been controlled by use of insecticides.

A continuing problem is the tire wear on the front-end loader. The operating conditions for this machine result in the need for replacement of the tires approximately every 6 months despite switching to solid heavy-duty industrial tires.

To compensate for maintenance downtime on the front-end loader, the plant service truck was purchased with a snowplow blade, which permits its use in pushing refuse onto the conveyor.

2. Hydrasposal System.

a. Hydrapulper.

(1) It was found in initial operation that the apron conveyor caused large quantities of dust and dirt to fall out onto equipment and personnel below it, and that the Hydrapulper was splashing dirty water over the floor and visitors. Therefore, a fiber glass cover has been fitted over the Hydrapulper and conveyor. The cover is equipped with access doors and a monorail for access to the pulper. Rapid access is needed in order to remove ungrindable materials and to work on the rotor.

(2) A high maintenance item is replacement of the swing hammers on the rotor of the Hydrapulper. At the present time, life is about 300 operating hours, or about 1,800 tons. Hammer replacement time is approximately one hour. Development work continues to improve the effectiveness and service life of the hammers.

(3) Retrieval of unprocessable material that inadvertently entered the Hydrapulper, and repair of damage caused by it, caused some minor service interruptions during early operating periods. Changes in baffle clearance have apparently corrected the problem. Outages of this type have ranged from 1/2 hour to 2 days.

(4) Excessive vibration of the Hydrapulper occurred during the initial operation period. Addition of heavy crossbracing to pulper supporting structure has largely eliminated this problem.

b. Hydradensers. The lack of consistent performance by the solid waste plant Hydradensers (dewatering screws) has been the subject of continuing developmental work. The erratic water removal characteristics and the need for frequent adjustment has had an adverse effect on experimental work on the burning of organic rejects, and on the plant maintenance costs. Recent design changes have corrected this situation.

c. Fluid Bed Reactor.

(1) Two problems which have occurred during this report period are related to the sand bed of the reactor.

A gradual attrition of the sand in the fluid bed, caused by the mechanical agitation of the sand, has caused fine particles of silica to be carried over into the scrubber-separator. The result has been a buildup of silicon-rich scale in the separator. This was manifested as stones which caused some damage to the scrubber water pump before the operators began to inject a dispersion agent into the system. This chemical tends to keep the scale soft and in suspension in the scrubber water.

The other problem related to the fluid bed is the gradual agglomeration of the sand and its retention of mineral ash and glass particles. From sieve analyses and increases in fluidizing air blower horsepower requirements it became evident that the size of the bed sand particles was increasing. In February 1972, it was necessary to replace the entire sand bed, when large masses of agglomerated sand accumulated. The operating contractor has instituted a program of periodic replacement of a portion of the sand bed, and has reduced the maximum operating temperature limit.

(2) The rotary feed valve which passes the pulped organic rejects into the pneumatic feeder supply to the fluid bed reactor has repeatedly plugged and constantly limited the firing rate. This feeder was replaced with one of a different design to overcome this problem.

d. Miscellaneous. A number of relatively minor additions and corrections were made during the start-up period, or are planned, to improve the operation of the Hydrasposal process. Among these have been modifications to the junk remover to eliminate excessive water carryover, relocating access doors in the junk remover, instrument and control modifications, improvements to platforms at the fluid bed reactor, and improvement of forklift tractor access doors. In addition, it is planned to replace the present 1,500 kva transformer with a 2,000 kva transformer in order to provide electrical power capacity for the waste glass recovery plant and for changes in the fiber recovery process.

e. Plant Design Limitations. The requirement of minimal first cost placed limitations on the design of the Franklin plant which have resulted in several operating problems which cannot be economically corrected, but which should be considered in the design of future plants.

In addition to the previously mentioned space problem in the receiving area, limited space in the Hydrasposal area has resulted in a crowded equipment arrangement, making access to some areas for maintenance and housekeeping difficult.

An operating problem which is somewhat annoying is an excessive amount of process water spillage on the operating floor in the

Hydrasposal area. While the amount of water on the floor would possibly not be considered excessive by contemporary paper mill standards, it is excessive from a housekeeping and sanitary standpoint. Consideration should be given, in future designs, to improving drainage in this area.

Another problem for which there is no simple solution at the Franklin plant is the high noise level around the Hydrapulper. Future plants may overcome this problem, but the Franklin plant layout precludes construction of sound-attenuating walls. The operator's station at Franklin is in the control room where the sound level is below the 80 dbA continuous occupancy limits of the Occupational Safety and Health Act. Occupancy of areas having sound levels higher than 80 dbA is abnormal and for a relatively short time.

3. Fibreclaim System.

a. Fiber Quality. As stated heretofore, fiber recovery production for the Logan-Long Company was stopped on Aug. 28, 1971, because of problems experienced in using the Franklin recycled fiber on their paper machine. The Black Clawson Company later reported that tests made by Logan-Long Company with their paper machine, and tests made by The Black Clawson Company in their laboratory indicated the cause of the problem was the concentration of lipids and fines which occurred when the white water system was closed up, i.e., when a higher percentage of the total white water flow was recirculated. This caused an increased amount of lipids and fines to adhere to the fiber.

In the papermaking operation, as at Logan-Long Company, water is removed from the newly formed sheet by pressing it out through a series of wringers, called press rolls. The sheet of paper is supported at the press rolls by a very porous woolen blanket, which also serves as a medium by which the pressed out water may be removed, i.e., the water leaves through the pores in the blanket. The excessive fines and lipids apparently filled up these pores, resulting in very reduced life of the blankets.

The condition was corrected temporarily by employing an excessive amount of fresh water in the fiber recovery operation, with equivalent increased bleed-off from the system to reduce the equilibrium level of fines and lipids in the white water, and by installation of a high pressure shower to clean the blanket on the Logan-Long Company paper machine.

For a permanent correction, a supplemental grant request has been made to install a flotation clarifier in the white water recycling system.

b. Fiber Yield. Primarily due to problems associated with scaling up from pilot plant operation to full scale commercial operation, the yield of recovered fiber has been substantially below expectations.

The screening system, which selectively sorts out the recyclable long fibers, was sized according to secondary fiber paper mill standards. The screens were found to be inadequate due to the much higher quantities of plastics, leather, rubber, etc., present in the slurry. As a result, the fiber recovery department can operate at only about one-half the capacity of the balance of the plant, and much fiber is lost as a result. Several experimental runs were made at reduced overall capacity, and the anticipated yield (20% plus, air-dried basis) was realized.

A supplemental request has been made to install additional screening capacity.

SECTION V - PRELIMINARY PLANT ECONOMICS

A. Construction Costs. The following cost data are based on the latest contract value for the process equipment and the final contract value for the construction contracts for the Franklin plant. The final value given for the mechanical contract includes $3,230 for installing additional nozzles and temporary scaffolding to make the stack gas analysis. The process equipment contract is being kept open to permit process changes.

The general construction work, including site development, grading, foundations, structural and miscellaneous steel, building work, paving, painting, and landscaping, was done by the Monarch Construction Company of Cincinnati, Ohio.

The mechanical construction, including installation of all Owner-furnished process equipment, contractor-furnished mechanical equipment, piping, ductwork, instrumentation heating, ventilating, and plumbing was done by Hughes-Bechtol, Inc., of Dayton, Ohio.

Electrical construction work, including furnishing and installing temporary construction power and all lighting, electrical conduit, wire, fixtures and equipment, grounding system, electrical controls, and instrumentation was done by The Gustav Hirsch Organization, Inc., of Columbus, Ohio.

Sprinkler construction work including furnishing and installing all materials for the sprinkler system in the receiving area, was done by the Cincinnati Sprinkler Company of Cincinnati, Ohio.

Process equipment includes the Hydrapulper liquid cyclone, tanks, pumps, fluid bed reactor, venturi scrubber and gravity separator, screens, process instruments, and controls. This was supplied by the Shartle-Pandia Division of The Black Clawson Company of Middletown, Ohio, who also supplied the process design information, including flow rates, pressures, consistencies, and equipment dimensions and weights.

The sound system for the project included furnishing of equipment for an industrial page-party phone and speaker system. This was done by J. W. Thompson Company of Middletown, Ohio. Installation was under the electrical contract.

Construction costs are shown in the General Cost Summary on the following pages.

CITY OF FRANKLIN, OHIO

SOLID WASTE AND FIBER RECOVERY PLANT

COST ANALYSIS

GENERAL COST SUMMARY

Item	City Unreimbursed	Solid Waste Plant Federal Share	Solid Waste Plant City Share	Solid Waste Plant Total
Process equipment	$ 2,500.00	$ 506,761.06	$ 253,380.55	$ 760,141.61
Construction				
General construction	--	$ 152,260.34	$ 76,130.16	$ 228,390.50
Mechanical construction	$ 779.00	179,075.33	89,537.67	268,613.00
Electrical construction	--	66,765.15	33,382.57	100,147.72
Fire protection	--	2,900.00	1,450.00	4,350.00
Sound system	--	445.11	222.55	667.66
Sub-total	$ 779.00	$ 401,445.93	$ 200,722.95	$ 602,168.88
Miscellaneous equipment	--	24,771.23	12,385.59	37,156.82
Present construction and equipment contracts	$ 3,279.00	$ 932,978.22	$ 466,489.09	$1,399,467.31
Engineering (as of Dec. 31, 1971)	--	81,994.12	40,997.06	122,991.18
Total	$ 3,279.00	$1,014,972.34	$ 507,486.15	$1,522,458.49

Fiber Recovery Plant			Sewage Plant	
Federal Share	Black Clawson Share	Total	Miami Conservancy District Share	Combined Totals
$ 126,962.67	$ 63,481.33	$ 190,444.00	$ --	$ 953,085.61
$ 48,346.67	$ 24,173.33	$ 72,520.00	$ 3,465.50	$ 304,376.00
65,317.99	32,659.01	97,977.00	6,973.00	374,342.00
31,082.58	15,541.28	46,623.86	--	146,771.58
--	--	--	--	4,350.00
--	--	--	--	667.66
$ 144,747.24	$ 72,373.62	$ 217,120.86	$ 10,438.50	$ 830,507.24
1,663.20	831.60	2,494.80	--	39,651.62
$ 273,373.11	$ 136,686.55	$ 410,059.66	$ 10,438.50	$1,823,244.47
--	41,138.55	41,138.55	--	164,129.73
$ 273,373.11	$ 177,825.10	$ 451,198.21	$ 10,438.50	$1,987,374.20

The construction cost figures shown in the following table are estimated for a 150 ton per day plant similar to the Franklin plant but built today without Federal assistance. They are based on The Black Clawson Company estimates that a complete, installed plant identical to the Franklin plant would cost about $3,000,000. This estimate includes building, foundations, process equipment, reactor, auxiliary equipment, instruments, controls, and engineering for complete functional Hydrasposal and Fibreclaim plant, but does not include cost of land, nor does it include cost of any standby equipment.

PROJECTED CONSTRUCTION COSTS

150 Ton per day plant estimated at today's costs	Hydrasposal	Fibreclaim	Total
Process equipment	$ 1,140,000	$ 360,000	$ 1,500,000
Construction			
General construction	$ 340,000	$ 120,000	$ 460,000
Mechanical construction	400,000	160,000	560,000
Electrical construction	150,000	70,000	220,000
Sub-total	$ 890,000	$ 350,000	$ 1,240,000
Miscellaneous equipment	55,000	5,000	60,000
Total construction and equipment	$ 2,085,000	$ 715,000	$ 2,800,000
Engineering	165,000	35,000	200,000
Total	$ 2,250,000	$ 750,000	$ 3,000,000

B. Operating Costs. The operating costs shown in the following table are projected for a hypothetical 150 ton per day plant constructed without the 2/3 Federal funding received by the Franklin plant and operating with the efficiencies and yields predicted by The Black Clawson Company to be achieved at Franklin by August 1973. By that time, the plant will have been operating for one full year burning sewage sludge and recovering design quantities of paper fiber.

The projected costs for a hypothetical 500 ton per day plant have been made by A. M. Kinney, Inc., on the basis of previous studies, amended to reflect projected Franklin unit costs.

It was assumed such a plant would operate 24 hours per day, 7 days per week, 52 weeks per year. A detailed explanation of the elements of this projection is given in Appendix A of this report.

The rate schedule charged for solid waste receipts as of Feb. 16, 1972, is as follows:

Loads received from trucks	$6.00 per ton
Loads received from pickup trucks	$2.25 each
Loads received from automobiles	$0.75 each
Large appliances	$2.50 each
Tires	$0.25 each

OPERATING COSTS

	Load Rate 50 tons/day 13,000 tons/yr		Load Rate 100 tons/day 26,000 tons/yr	
	per year	per ton	per year	per ton
Hydrasposal				
Operating labor	$ 44,600	$ 3.43	$ 89,200	$ 3.43
Total maintenance	46,900	3.60	84,400	3.24
Fuel oil	3,100	0.24	3,100	0.12
Power--electrical	40,100	3.08	57,800	2.22
Office supplies	100	0.01	100	--
Telephone, etc.	360	0.03	360	0.01
Equipment rental	2,400	0.18	4,800	0.18
Plant security	480	0.04	480	0.02
Insurance	6,900	0.53	6,900	0.27
Debt service	175,500	13.50	175,500	6.75
Operating supplies	5,200	0.40	7,800	0.30
Water cost	730	0.06	1,460	0.06
Gross operating cost	$326,370	$25.10	$431,900	$16.60
Credit sludge	- 10,000	- 0.77	- 20,000	- 0.77
Credit metal	- 12,100	- 0.93	- 24,200	- 0.93
Net operating cost	$304,270	$23.40	$387,700	$14.90
Fibreclaim				
Operating labor	$ 17,100	$ 1.32	$ 34,200	$ 1.32
Total maintenance	8,060	0.62	14,570	0.56
Power--electrical	14,600	1.12	21,700	0.83
Telephone, etc.	180	0.01	180	0.01
Plant security	240	0.02	240	0.01
Insurance	2,100	0.16	2,100	0.08
Makeup water cost	410	0.03	820	0.03
Waste water disposal	4,450	0.34	8,900	0.34
Debt service	58,500	4.50	58,500	2.25
Operating supplies	700	0.05	1,050	0.04
Gross operating cost	$106,340	$ 8.17	$142,260	$ 5.47

Load Rate 150 tons/day 39,000 tons/yr		Load Rate 500 tons/day 182,500 tons/yr	
per year	per ton	per year	per ton
$133,800	$ 3.43	$ 290,000	$ 1.59
126,600	3.24	298,000	1.63
3,100	0.08	5,000	0.03
75,000	1.92	313,000	1.72
100	--	500	--
360	0.01	1,080	0.01
7,200	0.18	70,000	0.38
480	0.01	960	--
6,900	0.18	15,300	0.08
175,500	4.50	398,000	2.18
10,400	0.27	16,000	0.10
2,190	0.06	11,000	0.06
$541,630	$13.88	$1,418,840	$ 7.78
- 30,000	- 0.77	- 100,000	- 0.55
- 36,300	- 0.93	- 169,200	- 0.93
$475,330	$12.18	$1,149,640	$ 6.30
$ 51,300	$ 1.32	$ 140,000	$ 0.77
21,850	0.56	100,000	0.55
28,600	0.73	110,000	0.60
180	--	540	--
240	0.01	480	--
2,100	0.05	8,100	0.04
1,230	0.03	5,500	0.03
13,350	0.34	35,000	0.19
58,500	1.50	211,000	1.15
1,400	0.04	2,300	0.01
$178,750	$ 4.58	$ 612,920	$ 3.34

OPERATING COSTS

	Load Rate 50 tons/day 13,000 tons/yr		Load Rate 100 tons/day 26,000 tons/yr	
	per year	per ton	per year	per ton
Fibreclaim gross operating cost (see previous sheet)	$ 106,340	$ 8.17	$ 142,260	$ 5.47
Based on 15% fiber yield				
Credit fiber sales	$ - 48,700	$ -3.75	$ - 97,400	$ -3.75
Net operating cost fiber recovery	$ 57,640	$ 4.42	$ 44,860	$ 1.72
Net operating cost Hydrasposal	$ 304,270	$ 23.40	$ 387,700	$ 14.90
Combined Hydrasposal and Fibreclaim net operating cost	$ 361,910	$ 27.82	$ 432,560	$ 16.62
Tons of fiber produced	1,950	--	3,900	--
Based on 20% fiber yield				
Credit fiber sales	$ - 65,000	$ -5.00	$ -130,000	$ -5.00
Net operating cost fiber recovery	$ 41,340	$ 3.17	$ 12,260	$ 0.47
Net operating cost Hydrasposal	$ 304,270	$ 23.40	$ 387,700	$ 14.90
Combined Hydrasposal and Fibreclaim net operating cost	$ 345,610	$ 26.57	$ 399,960	$ 15.37
Tons of fiber produced	2,600	--	5,200	--

Load Rate 150 tons/day 39,000 tons/yr		Load Rate 500 tons/day 182,500 tons/yr	
per year	per ton	per year	per ton
$ 178.750	$ 4.58	$ 612,920	$ 3.34
$ -146,100	$ -3.75	$ -685,000	$ -3.76
$ 32,650	$ 0.83	$ - 72,080	$ -0.42
$ 474,330	$ 12.18	$1,149,640	$ 6.30
$ 506,980	$ 13.01	$1,077,560	$ 5.88
5,850	--	27,400	--
$ -195,000	$ -5.00	$ -914,000	$ -5.00
$ - 16,250	$ -0.42	$ -301,080	$ -1.66
$ 474,330	$ 12.18	$1,149,640	$ 6.30
$ 458,080	$ 11.76	$ 848,560	$ 4.64
7,800	--	36,500	--

The cost data for the 500 ton per day plant in the foregoing tabulation assumes public ownership of the plant. If the plant were privately owned the annual operating costs would be increased as follows:

	Hydrasposal	Fibreclaim
Additional cost of money	$ 398,000	$211,000
Taxes, etc. (1 percent capital)	39,000	30,000
Total	$ 437,000	$241,000
With 15 percent fiber yield		
Net operating cost	$1,512,110	$163,775
Net cost per ton	$ 8.29	$ 0.90
Combined operating cost per ton	$9.19	
With 20 percent fiber yield		
Net operating cost	$1,512,110	$ -65,225
Net cost per ton	$ 8.29	$ - 0.36
Combined operating cost per ton	$7.93	

SECTION VI - SUMMARY AND CONCLUSIONS

A. Summary. The Franklin, Ohio, Solid Waste and Fiber Recovery Plant, in its first seven months of operation has successfully demonstrated its basic premises. On a commercial scale, essentially unsorted municipal refuse can be successfully wet-ground in a Hydrapulper; relatively small ungrindable items such as tin cans can be removed from the Hydrapulper slurry and separated into ferrous and nonferrous fractions; the quantity of noncombustibles remaining in the slurry can further be reduced by inertial separation in a liquid cyclone; recyclable paper fiber can be successfully removed from the slurry by the Fibreclaim process; and the nonrecoverable organic residue can be burned in a fluid bed reactor.

While these objectives have been obtained, and technical feasibility established in the first seven months of operation, the corollary objectives of determining the economic viability of the Hydrasposal and Fibreclaim processes have not been clearly obtained. The data on actual operating costs during this initial period reflect not only the developmental nature of the process, but also unforeseen start-up and training expenses, both of which are fundamental to emerging technology. It is to be expected that the results of the second eight months of operation will be more conclusive than the first seven. When the necessary process changes are authorized, as requested, a second year of operational evaluation could further improve the quality of analytical results. Whether the target costs projected by the plant operators for August 1973 are achieved depends on many unknowns, and it is felt that the final report will reflect some modification as experience eliminates these unknowns.

B. Conclusions.

1. The technical successes achieved in operating this plant have warranted the Federal support received so far, in advancing the technology of resource recovery methods. They have also more than warranted the enlightened action of the City Council and City Manager in pursuing the project.

2. Continued Federal support in funding process and plant modifications is warranted because the amounts requested represent a small fraction of the total cost of the plant, and the results which they would obtain would not only increase the cost effectiveness of the operation, but provide significant technological advancement of an already innovative process. By extending the demonstration support period, the opportunity to obtain analytical data is increased.

3. The impact on the environment of the Franklin plant is already favorable, and the planned expansion of the plant will make it even more noteworthy.

4. The predicted economic viability of the Franklin plant is still under study, and will not be accurately known until approximately mid-1973.

5. On the basis of data obtained at Franklin, the economics of a 500 ton per day, or larger, plant are indicated to be attractive, compared to an incinerator for which adequate air pollution controls are provided.

APPENDIX

Each shift works basic 40 hours per week. Labor figures include 50 percent markup for fringe benefits and administrative burden.

6. Sludge credit is based on sludge load increasing in a straight line ratio to refuse load.

7. Fibreclaim power costs include clarification of recirculating whitewater by air flotation, and aeration of waste water to reduce B.O.D. to acceptable levels before discharging to existing sanitary sewers.

8. Waste water disposal costs include sewerage charges based on approximate rates in effect in southwestern Ohio for "normal" sewage.

9. Capital investment is amortized over 25 year period at 6 percent interest rate.

Calculations for 50 tons per day load rate are given as follows. Similar calculations were used to obtain costs for other load rates.

Fifty tons per day (t/d) can be processed in one 8-hour shift.

(50 x 2,000 x .55)/480 = 114.5 lb/min oven dried solids to reactor (capacity: 132 lb/min).

1. Operating labor--Hydrasposal

Assume: one control operator
one weighmaster
one material handler
two-thirds plant manager

Plant manager: 2/3 x $12,000	=	$ 8,000
3 men at $3.48 per hour average	=	21,750
		$29,750

Fringe benefits and administrative burden = 50 percent

1.5 x $29,750 = $44,600 per year

Operating labor - Fibreclaim

One operator: \$3.48 x 2,080	= \$ 7,400
One-third plant manager	= 4,000
	\$11,400

1.5 x \$11,400 = \$17,100 per year

2. Maintenance. The Black Clawson Company has projected a cost of \$3.60 per ton for Hydrasposal at Franklin. Similarly the maintenance cost for Fibreclaim was projected at \$0.62 per ton at Franklin.

Hydrasposal--13,000 x \$3.60	= \$46,900
Fibreclaim--13,000 x \$0.62	= \$ 8,060

3. Fuel Oil Costs. In the most recent 8-week period Franklin burned 3,395 gallons of No. 2 fuel oil to reheat reactor, or about 424 gallons per week. Reactor is reheated once each week after being off on week-end.

424 x 52 = 22,000 gallons per year

22,000 gallons x \$0.14 per gallon = \$3,085 per year

4. Power--Electrical. Unit consumption of electrical power at Franklin for first 28 weeks of operation is:

935,600 kwh/6,140 tons = 153 kwh per ton of refuse

If fiber recovery had been in full operation during that period, the unit consumption would have been 180 kwh per ton of refuse according to the plant operators. Additions planned for fiber recovery will increase this figure to 204 kwh per ton.

The maximum demand experienced at Franklin is 1,152 kw.

Demand charge--per month:

20 kw @ $2.00	=	$ 40.00	
80 kw @ $1.90	=	152.00	
900 kw @ $1.45	=	1,330.00	
152 kw @ $1.35	=	205.00	
		$1,727.00	Demand

Energy charge:

204 x 13,000 tons = 2,650,000 kwh per year

2,650,000/12 = 221,000 kwh per month

Per current Cincinnati Gas & Electric rate schedule:

1,000 kwh @ 2.5¢	=	$ 25.00	
5,000 kwh @ 1.45¢	=	72.50	
60 x 1,152 = 69,120 kwh @ 1.0¢	=	691.20	
120 x 1,152 = 138,240 kwh @ 0.8¢	=	1,109.00	
7,640 kwh @ 0.575¢	=	44.00	
		$1,941.70	per month

Fuel adjustment: 221,000 kwh x .003545	$ 784.00	
Demand charge	$1,727.00	
Total electrical cost	$4,452.70	per month

Total annual power cost:

$4,452.70 x 12 = $53,500

The Black Clawson Company suggests split 25 percent Fibreclaim, 75 percent Hydrasposal.

$53,500 x 0.75 = $40,100 Hydrasposal

$53,500 x 0.25 = $13,400 Fibreclaim

See also water treatment cost calculation.

5. Office Supplies. Same as at Franklin--say $100 per year.

6. Telephone. Same as at Franklin.
   Hydrasposal--$360 per year
   Fibreclaim--$180 per year

7. Equipment Rental. Detachable truck bodies to handle ferrous metal. Same as at Franklin--$2,400 per year.

8. Plant Security. Same as at Franklin.
Hydrasposal--$480 per year
Fibreclaim--$240 per year

9. Insurance. Franklin cost totals $6,135 for $2,000,000 investment, or 0.3 percent.

See construction cost estimate:

Hydrasposal: $2,250,000 x 0.003 = $6,750
Use $6,900

Fibreclaim: $ 750,000 x 0.003 = $2,250
Use $2,100

10. Debt Service. Assume money amortized at 6 percent for 25 years. Capital recovery factor = 0.078.

$2,250,000 x 0.078 = $175,500 Hydrasposal

$ 750,000 x 0.078 = $ 58,500 Fibreclaim

11. Operating Supplies. Assume same cost per ton as at Franklin ($0.40 for Hydrasposal, $0.05 for Fibreclaim).

$13,000 x 0.40 = $5,200 Hydrasposal

$13,000 x 0.05 = $ 650 say $700 for Fibreclaim

It is assumed that this cost would increase by 50 percent with each 50 ton per day load increase.

12. Water Cost. Water useage at Franklin for 10,000 ton per year load rate is estimated to be 90 gpm for Hydrasposal system and 50 gpm for Fibreclaim.

Using the clarified effluent from the sewage treatment plant as makeup process water, the cost is $0.05 per 1,000 gallons.

Water cost for 50 ton per day load rate:

Hydrasposal--(1.3 x 90 x 60 x 8 x 260 x .05)/1,000 = $730

Fibreclaim--(1.3 x 50 x 60 x 8 x 260 x .05)/1,000 = $406 say $410

13. Credit for Sludge Burning. Assume sludge load equal to Franklin.

400 tons per year (oven dried solids) @ $25 per ton = $10,000 per year

14. Credit for Metal Sales. Recoverable metal equals about 7 percent of refuse processed. No. 2 bundles price about $13.27 per ton.

.07 x 13,000 = 910 tons

910 x $13.27 = $12,090 say $12,100

15. Water Treatment Costs. At Franklin it is not required to reduce the B.O.D. in the waste water before discharging to sewage treatment plant. Therefore, this cost is not included in 204 kwh per ton power requirement. In most localities it will be necessary to reduce B.O.D. to approximately 300 parts per million (ppm).

65 gpm @ 3,200 ppm B.O.D.

(65 [3,200 - 300] x 60 x 8.3)/1,000,000 = 93.9 lb B.O.D/hr

1 horsepower hour per 2 lb B.O.D.

93.9/2 = 47 horsepower requirement

47 x 0.746 = 35 kw

35 x $1.40 = $ 49.00 demand per month
35 x 8 x 260/12 x .0085 = 51.40 energy per month (including fuel adjustment)

$100.40 x 12 = $1,200 per year

Add to power costs for Fibreclaim:

$13,400 + $1,200 = $14,600

16. Waste Water Disposal.

Estimated water to sewer = 65 gpm

Approximate sewerage charges--"Normal"

Sewage--secondary treatment plant = $0.55 per 1,000 gallons

(65 x 60 x 8 x 260 x 0.55)/1,000 = $4,450 per year

17. Credit--Fiber Sales.

For 15 percent fiber yield:

Fiber recovered = .15 x 13,000 = 1,950 tons per year (air dry)

1,950 tons @ $25 per ton = $48,700

For 20 percent fiber yield:

Fiber recovered = .20 x 13,000 = 2,600 tons per year (air dry)

2,600 tons at $25 per ton = $65,000 per year

OPERATING COST ELEMENTS FOR A 500 TON PER DAY PLANT

In computing the cost projections for an hypothetical 500 tons per day plant, the following assumptions were made:

1. Total actual maintenance costs for Hydrasposal system at Franklin equals about 14 percent per year of total electrical and mechanical capital costs. Minimum predicted costs are approximately 5 percent. Therefore, maintenance costs for the larger system have been projected at 10 percent of estimated mechanical process equipment and electrical costs, and 5 percent of reactor costs as a median rather than flat cost per ton. Similarly, Fibreclaim costs are projected at 5 percent of electrical and mechanical costs.

2. Power costs were calculated on kw per ton of capacity demand charges and kwh per ton of refuse processed energy charge using Cincinnati Gas & Electric rate schedule. One-fourth of total charged to Fibreclaim.

3. Plant is assumed to run continuously 24 hours per day, seven days per week, 52 weeks per year.

4. Water costs are based on low cost water source such as at Franklin.

5. Operating labor includes the following personnel divided into four shifts, each working a basic 42 hour week:

    one plant manager

    four shift supervisors

    four crane operators

    four weighmasters

    ten laborers - operator trainees

    thirteen Fibreclaim operators

Labor figures include 50 percent markup for fringe benefits and administrative burden.

6. Sludge credit is based on assumption that 500 tons per day plant would have approximately ten times the sewage load.

7. Fibreclaim power costs include clarification of recirculating white water by air flotation and aeration of waste water to reduce B.O.D. to acceptable levels before discharging to existing sanitary sewers.

8. Waste water disposal costs include sewer charges based on approximate rates in effect in southwestern Ohio for "normal" sewage.

9. Capital investment amortized over 25 year period at 6 percent interest rate.

Calculations for a 500 ton per day plant are given as follows:

1. Operating Labor--Hydrasposal

Assume:	one plant manager	$ 12,000
	four shift supervisors	40,000
	four crane operators	36,000
	four weighmasters	36,000
	ten laborers	69,500
		$193,500

Assume fringe benefits and administrative burden at 50 percent.

$193,500 x 1.5 = $290,000

Operating labor--Fibreclaim

3 men per shift = 12 men

Plus 1 man extra on day shift = 13 men

13 x $7,200 x 1.5 = $140,000

2. Maintenance--Hydrasposal.

Installed capital costs:

Process equipment:	$1,580,000
Electrical:	400,000
	$1,980,000
Reactors:	$2,000,000
Process equipment and electrical maintenance estimated at 10 per cent, or	$ 198,000
Reactor maintenance estimated at 5 percent, or	$ 100,000
	$ 298,000 per year

Maintenance--Fibreclaim

Total mechanical and electrical costs estimated at $2,000,000

.05 x 2,000,000 = $100,000

3. Fuel Oil. Reactors assumed to be running continuously. No fuel requirement for preheating.

Allow:	$4,000	building heating
	1,000	reheat and support fuel
	$5,000	

4. Power--Electrical.

Total energy used at Franklin first 6 months = 935,600 kwh

Refuse processed: 6,140 tons

935,600/6,140 = 153 kwh per ton

If fiber recovery had been operating full time The Black Clawson Company estimates this number would be 180 kwh per ton.

With additional screening capacity and clarifier added to fiber recovery, energy required per ton expected to be 204 kwh per ton.

The maximum demand experienced at Franklin is 1,152 kw.

500 tons per day demand = 1,152 x 500/150 = 3,840 kw

500 tons per day energy = 204 x 182,500/12 = 3,100,000 kwh per month

Demand charge--3,840 kw:

20 kw @ $2.00	=	$ 40.00
80 kw @ $1.90	=	152.00
900 kw @ $1.45	=	1,330.00
2,840 kw @ $1.35	=	3,835.00
Total demand		$5,357.00 per month

Energy charge--3,100,000 kwh:

1,000 kwh @ 2.5¢	=	$ 25.00
5,000 kwh @ 1.45¢	=	72.50
60 x 3,840 = 230,500 kwh @ 1.0¢	=	2,300.00
120 x 3,840 = 461,000 kwh @ 0.8¢	=	3,690.00
461,000 kwh @ 0.575¢	=	2,640.00
1,942,000 kwh @ 0.5¢	=	9,710.00
Total energy		$18,437.50

Fuel and tax adjustment = 3,100,000 x $0.003545 = $11,000.00

$5,357 plus $18,437 plus $11,000 = $34,794 per month--total

$34,794 x 12 = $417,000 per year--total

The Black Clawson Company suggests split 25 percent Fibreclaim and 75 percent Hydrasposal.

$417,000/4 = $104,000--Fibreclaim

$313,000--Hydrasposal

See also water treatment cost calculation.

5. Office Supplies. Say $500 per year.

6. Telephone. Franklin--$360 per year--Hydrasposal
$180 per year--Fibreclaim

Say 3 x $360 = $1,080 per year--Hydrasposal

Say 3 x $180 = $540 per year--Fibreclaim

7. Equipment Rental or Disposal of Rejects to Landfill.

Rejects = 20 percent of refuse received

.2 x 182,500 = 365,000 tons per year at $2.00 per ton = $73,000

Say $70,000

8. Plant Security. Two times Franklin actual cost.

$960 per year--Hydrasposal

$480 per year--Fibreclaim

9. Insurance. Insurance costs at Franklin are approximately 0.3 percent of capital costs.

.003 x 5,110,000 = $15,300 for Hydrasposal

.003 x 2,700,000 = $ 8,100 for Fibreclaim

10. Debt Service.

Total cost Hydrasposal system, less reactor	$3,110,000
Reactors	2,000,000
Total investment	$5,110,000

Assume amortization at 6 percent for 25 years

Capital recovery factor = 0.078

$5,110,000 x 0.078 = $398,000

Total investment Fibreclaim = $2,700,000

$2,700,000 x 0.078 = $211,000

11. Operating Supplies.

500/150 x $5,200 = $16,690 Say $16,000 Hydrasposal

500/150 x $700 = $2,340 Say $2,300 Fibreclaim

12. Water Cost. See calculation for 150 tons per day plant.

Water cost--Hydrasposal = $0.06 per ton

0.06 x $182,500 = $10,920 Say $11,000

Water cost--Fibreclaim = $0.03 per ton

0.03 x $182,500 = $5,460 Say $5,500

13. Sludge Credit. Assumed 500 ton per day refuse load would mean area sludge load equals 10 times 50 ton per day refuse load area.

10 x $10,000 = $100,000

14. Ferrous Metal. Recoverable ferrous metal equals about 7 percent of refuse processed.

0.07 x 182,500 = 12,750 tons

12,750 tons at $13.27 per ton = $169,200

15. Water Treatment Costs. See calculation for 50 ton per day load.

Previous studies by A. M. Kinney, Inc., indicate 130 gpm of waste water must be discharged from 500 ton per day plant.

130 x 60 x 8.3 x (3200 - 300)/1,000,000 = 188 lb B.O.D. per hour
@ 2 lb B.O.D. per horsepower hour = 94 horsepower requirement

94 x 0.746 = 70 kw

70 kw x 1.40 = $98.00 demand charge

70 x 24 x 365/12 = 51,100 kwh

51,100 kwh @ $0.005 = $255
51,100 kwh @ $0.003545 = $181 fuel adjustment

$98 plus $255 plus $181 = $534 per month x 12 = $6,400 per year

Add to power cost previously calculated

$104,000 plus $6,400 = $110,400   Say $110,000

16. Waste Water Disposal.

Estimated water flow to sewers per month:

130 gpm x 1,440 x 30 = 5,620,000 gallons

Based on Cincinnati, Ohio, current rate schedule:

Minimum	$ 90.00
3,750,000 gallons @ $0.27 per 1,000 gallons	900.00
1,870,000 gallons @ $0.19 per 1,000 gallons	355.00
	$1,345.00

Average $0.24 per 1,000 gallons

These rates are based on primary treatment only. Secondary treatment will be required in future at approximately double this cost.

5,620,000 x 2 x $0.24/1,000 = $2,690 per month

$2,690 x 12 = $32,350   say $35,000

17. Credit--Fiber Sales.

For 15 percent fiber yield:

Fiber produced = .15 x 182,500 = 27,400 air dried tons

27,400 tons @ $25 per ton = $685,000 per year

For 20 percent yield:

Fiber produced = .20 x 182,500 = 36,500 air dried tons

36,500 tons @ $25 per ton = $914,000 per year

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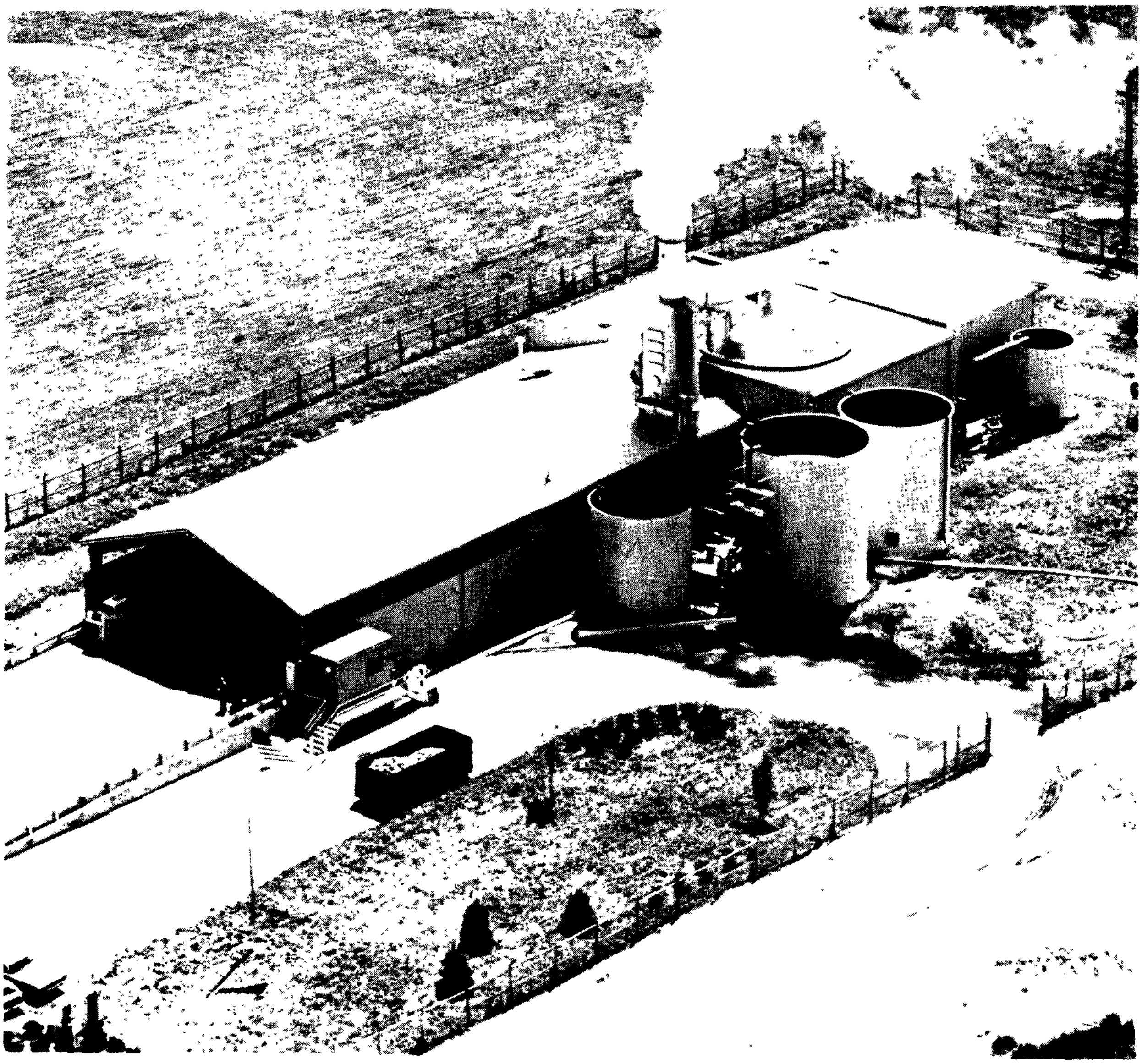

Frontispiece - Aerial View of Franklin Plant

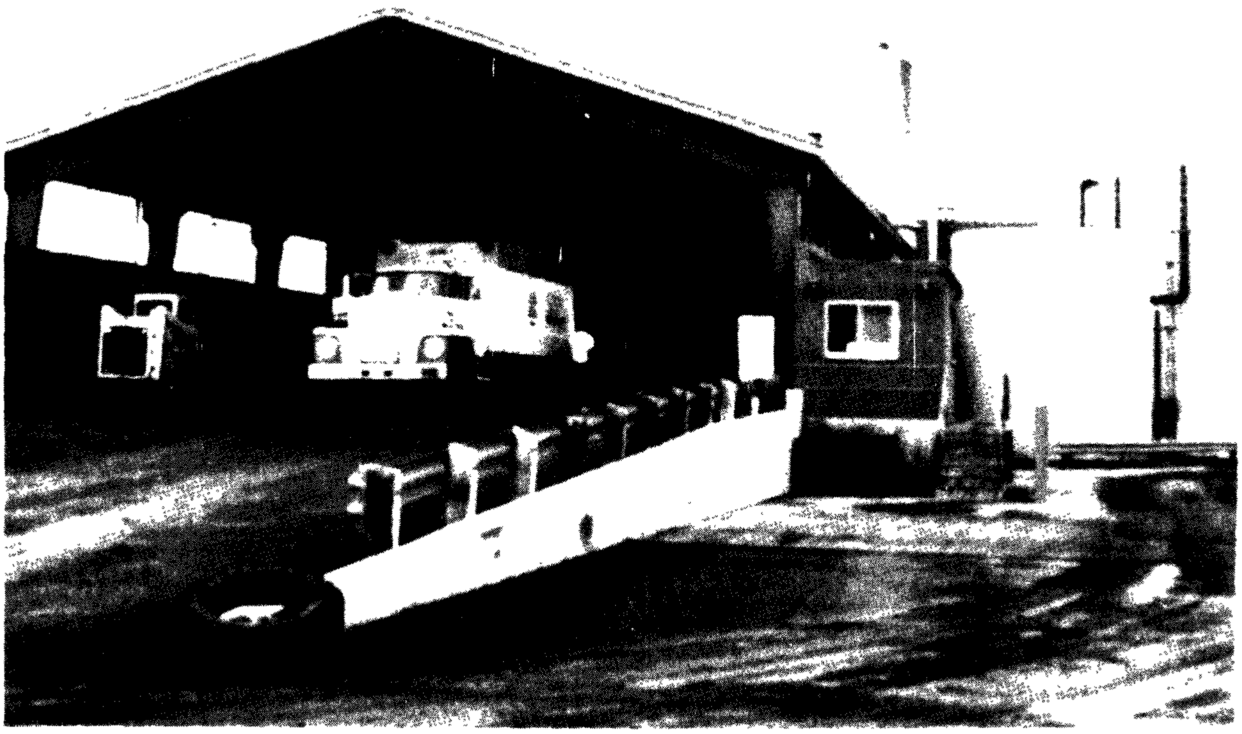

Figure 2. Receiving floor.

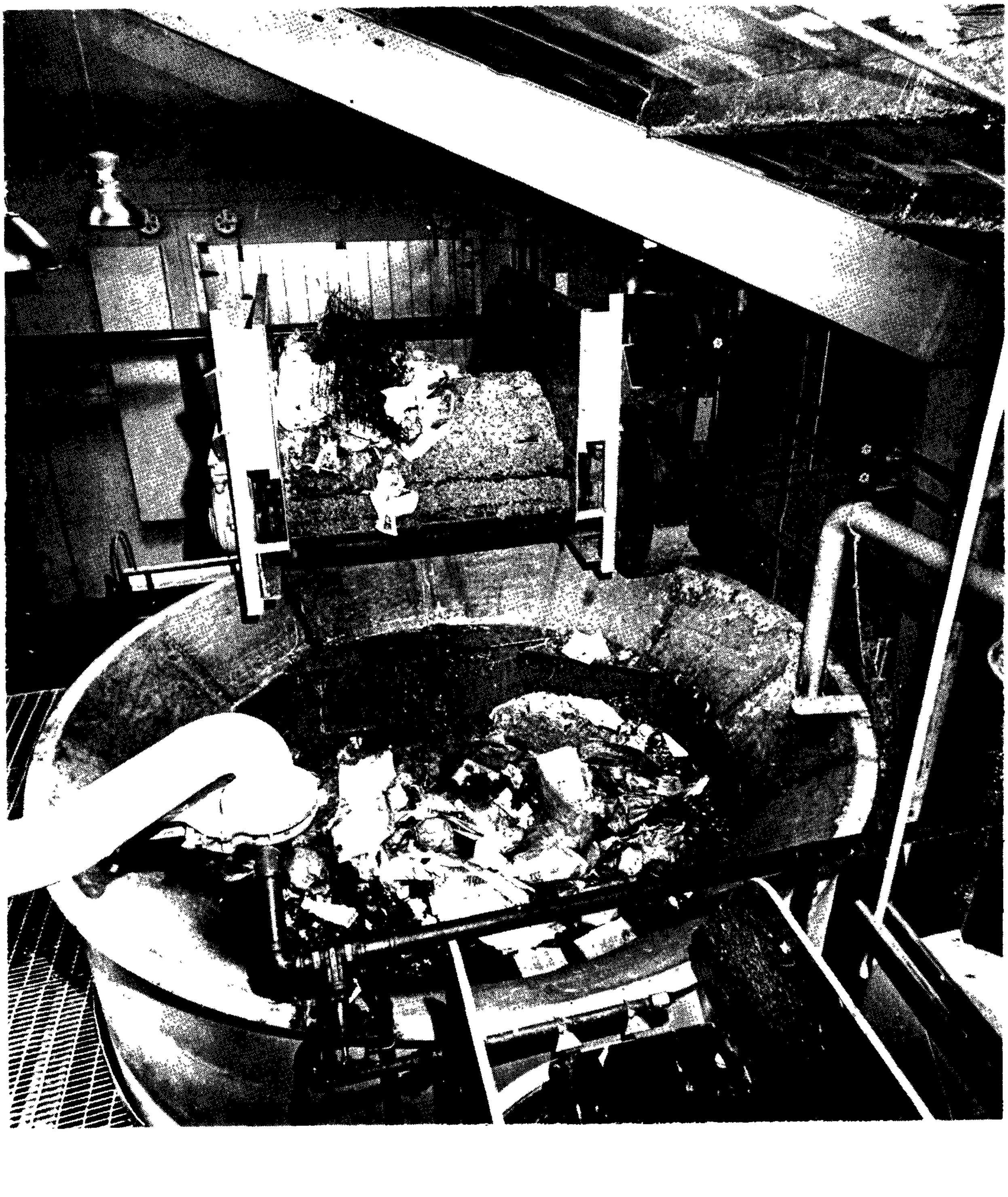

Figure 4. Hydrapulper.

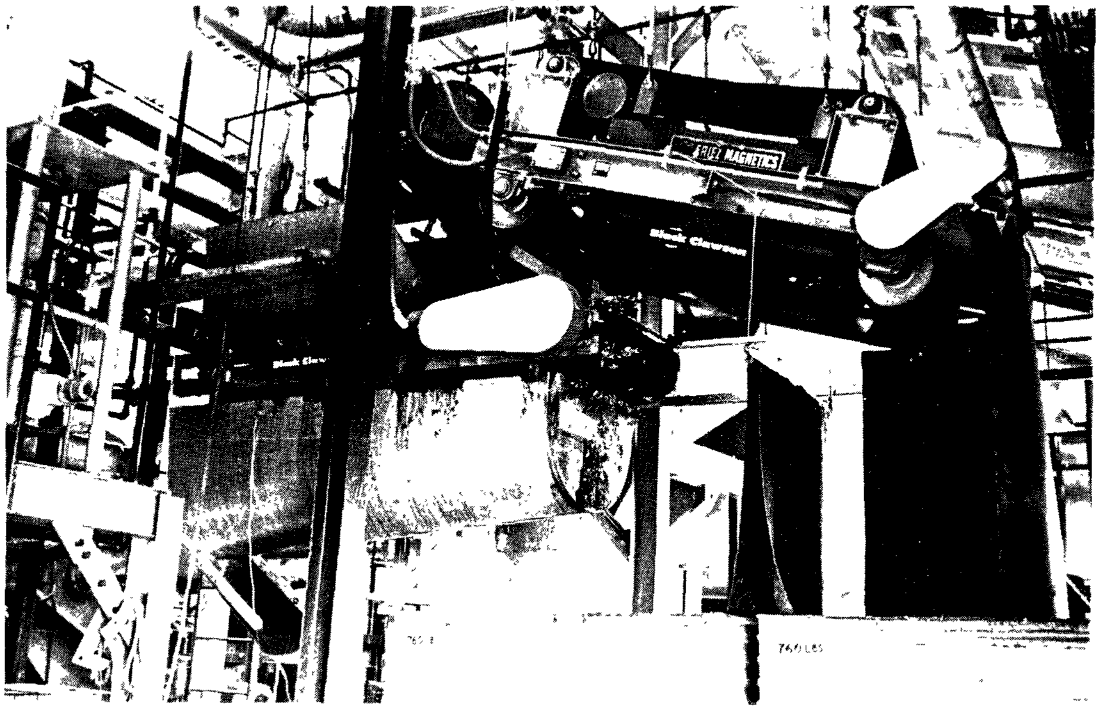

Fig. 5a—Magnetic Separator

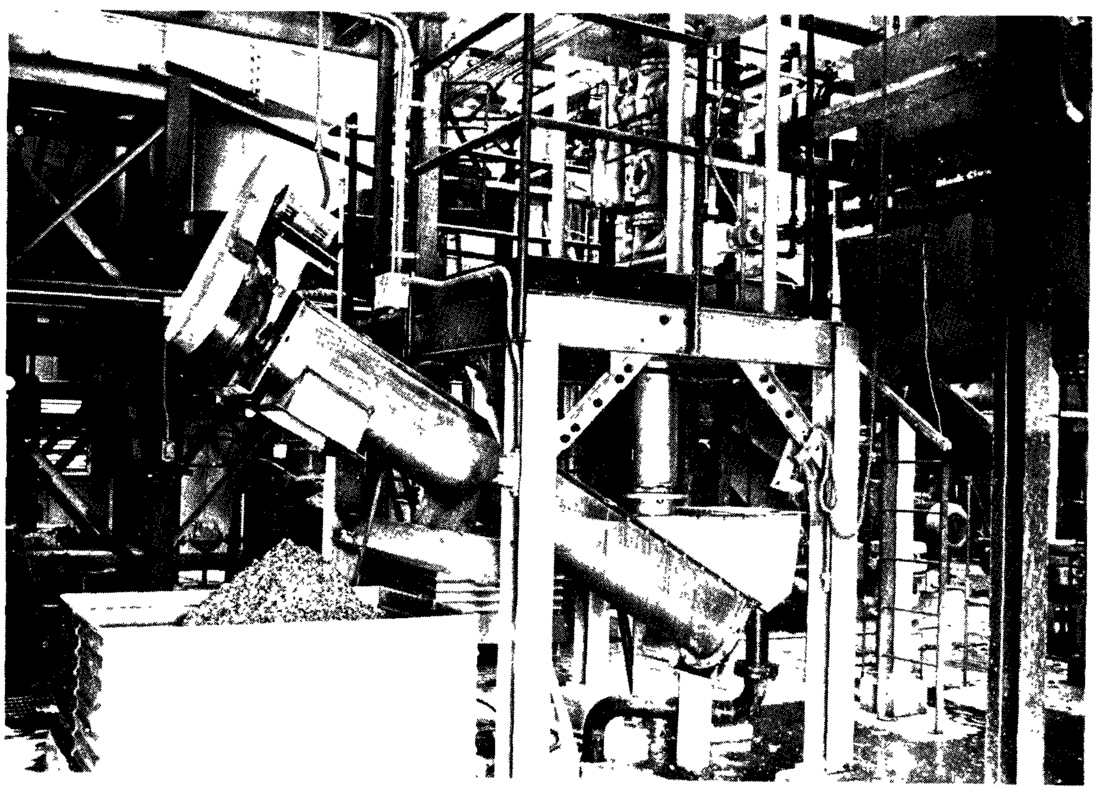

Fig.5b—Liquid Cyclone

Figure 5. Magnetic separator and liquid cyclone.

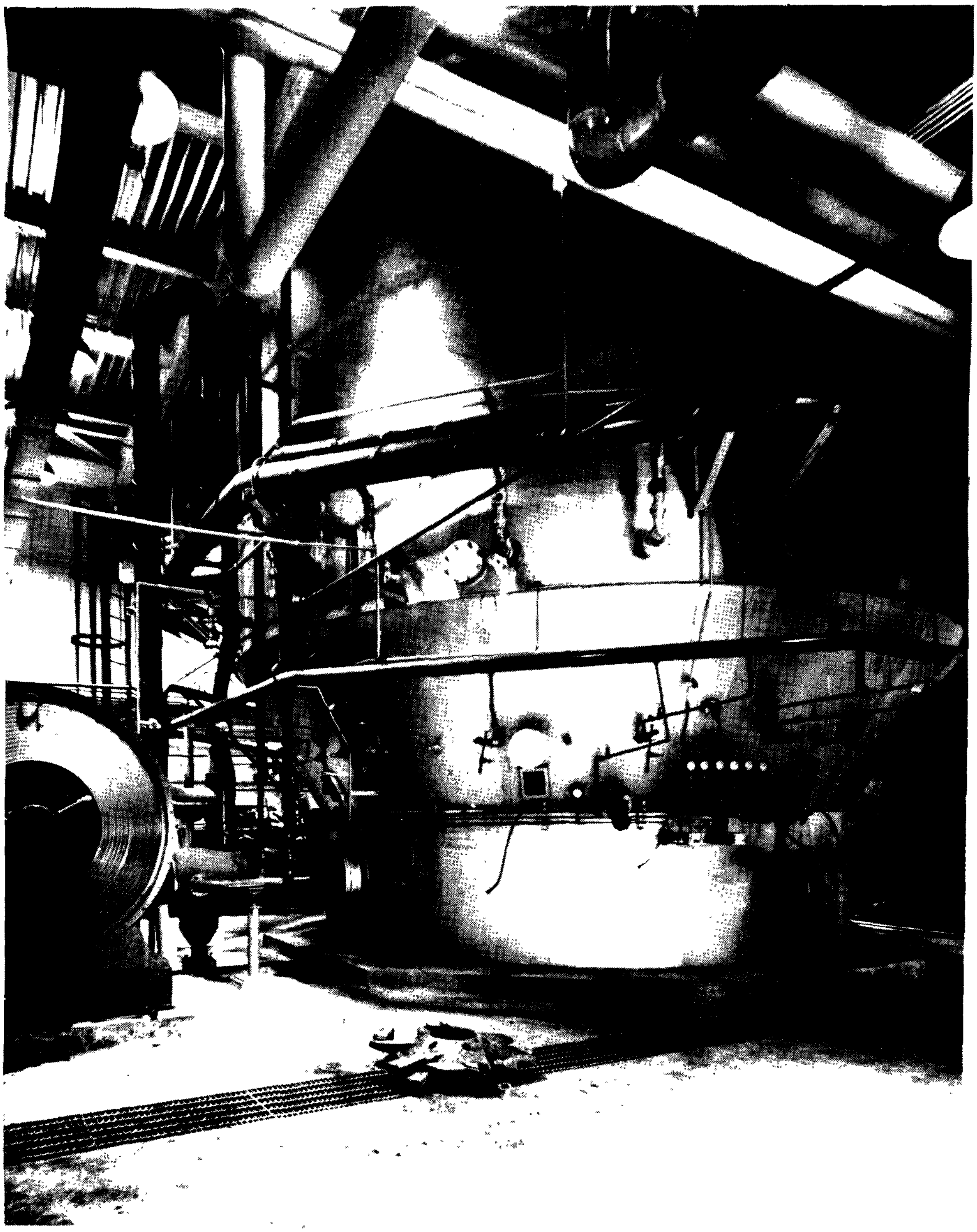

Figure 6. Fluid bed reactor.

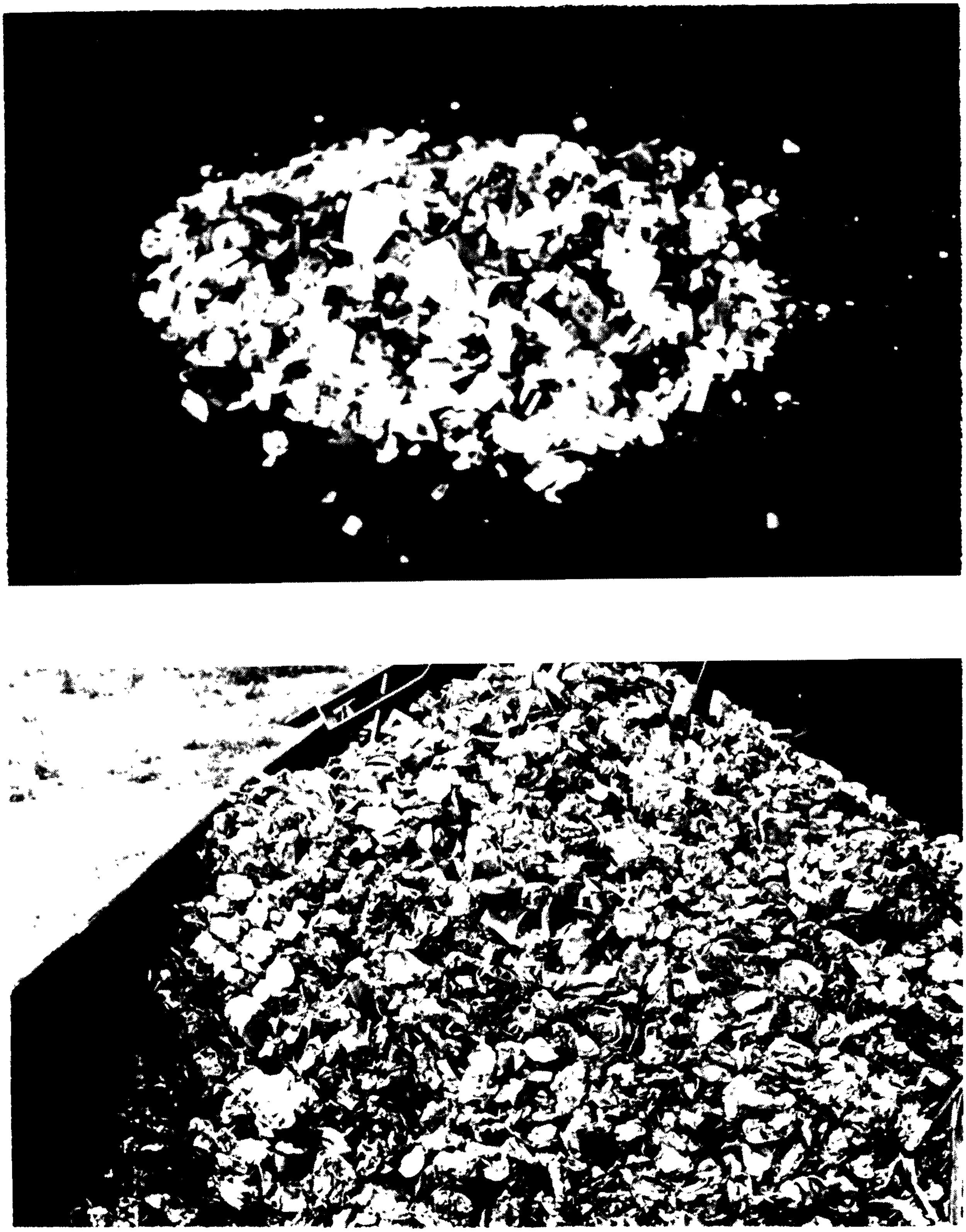

Figure 8. Cyclone rejects and junk remover rejects.

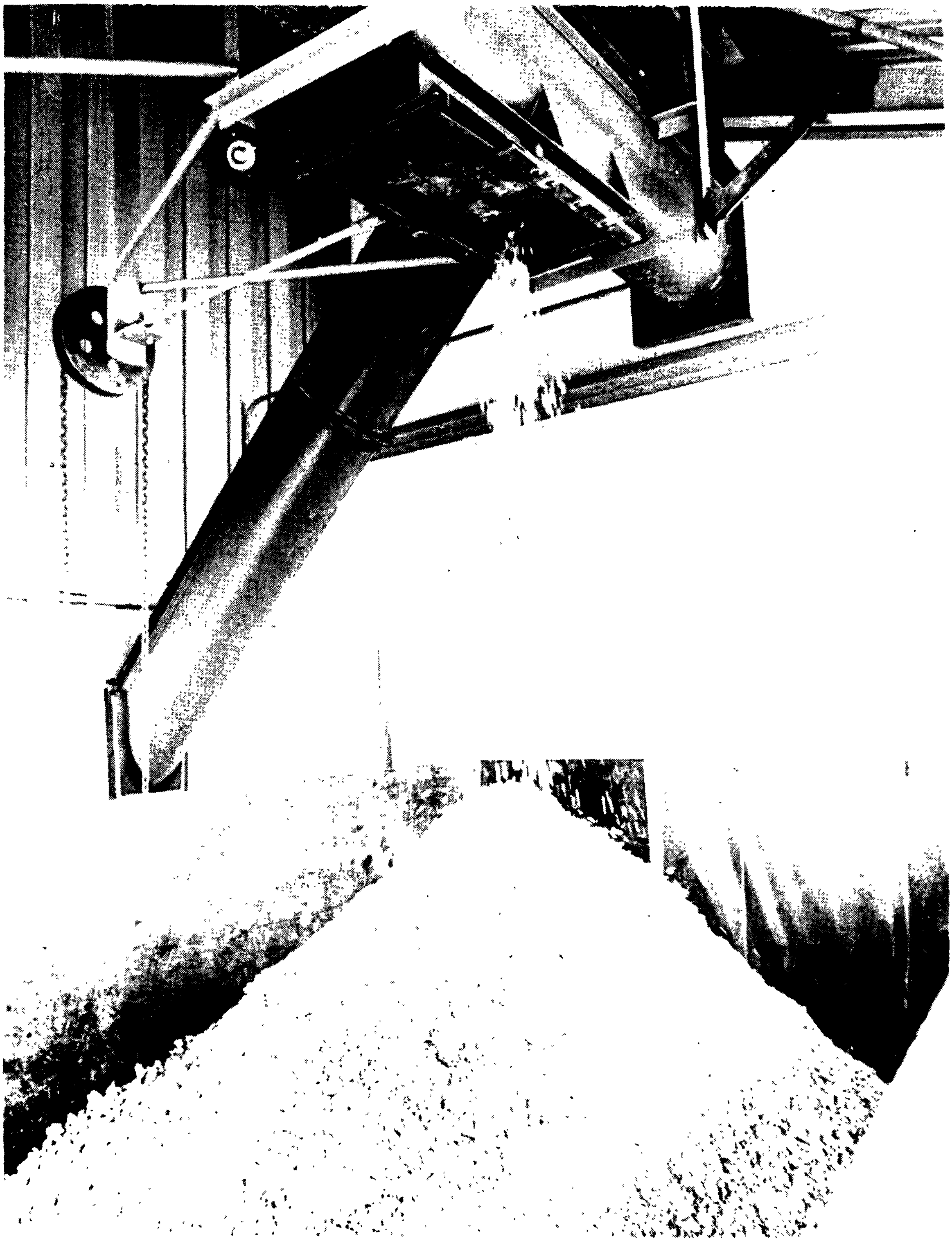

Figure 11. Paper fiber being loaded for shipment.