DELAWARE RECLAMATION PROJECT

by

N. C. Vasuki
General Manager

P. S. Canzano
Chief Engineer

J. L. Pase
Chief Planner
Delaware Solid Waste Authority
Dover, Delaware 19901
U.S.A.

The State of Delaware is the second smallest state in the Union, occupying an area of 1982 square miles. According to the 1980 Census, the population of the State was about 600,000. The State of Delaware is composed of three counties—New Castle, Kent and Sussex. New Castle County has a population of approximately 400,000. Kent and Sussex Counties each has approximately 100,000 persons. New Castle County is also the most urbanized of the three counties.

About 70% of the population of Delaware depends on groundwater as the only source of potable water. Delaware, like other states, depended on dumps for disposal of solid wastes throughout the fifties and sixties. Such solid wastes disposal practices resulted in several severe groundwater pollution problems.

While the State's environmental protection program has taken an active role in the clean up and minimizing the effect of such pollution, it nevertheless became obvious to the political leaders that proper and adequate attention must be given to future disposal programs. Water resources protection is, therefore, playing an important role in Delaware's program for solid waste and sewage sludge disposal.

PROBLEM DEFINITION

During the next 20 years, approximately 14 million tons of solid wastes will be generated in the State of Delaware. Of this amount, New Castle County will generate 8.9 million tons (64%). Kent and Sussex Counties together are expected to contribute approximately 5.1 million tons (36%) over the same time period. These projections assume normal anticipated growth which is 2% per year in New Castle County and 4% per year in Kent and Sussex Counties. In addition, two million tons of sewage sludge (20% solids) will be generated by the New Castle County-City of Wilmington Regional Wastewater Treatment Plant.

The area required for disposal of such wastes by landfilling would be approximately 700 acres, assuming that such landfills would reach an average height of 40 feet above ground. In addition to the actual landfill space, additional space would be required for buffer, roads, and other ancillary facilities.

CURRENT DISPOSAL PRACTICE

There are four sanitary landfills in operation in Delaware at this time. Two are operated by the Delaware Solid Waste Authority and they account for approximately 80% of the total wastes generated in the State. The remaining 20% is disposed in two landfills owned by Sussex County Council. Of the four landfills, the two operated by the Delaware Solid Waste Authority have leachate collection systems and gas venting systems, while only one has an impermeable synthetic membrane as a liner. By utilizing resource recovery in Delaware, the capacity of 700 acres, which are required over the next twenty years for landfilling could be substantially extended. For example, if, out of the 14 million tons approximately 7 million tons or 50% is utilized for energy production and materials recovery, the remaining 7 million tons would require only 350 acres of land for disposal. The original 700 acres requirement would, therefore, serve the State's needs, not for a period of just twenty years, but for a period of forty years! Therefore, the emphasis in Delaware is to *minimize the material requiring landfilling while maximizing materials and energy recovery.*

BACKGROUND—DELAWARE RECLAMATION PROJECT

In 1970, when Russell W. Peterson was the Governor of Delaware, the State General Assembly appropriated $1 million towards research and development (R&D) efforts for finding technological alternatives to landfilling. The state contracted with Hercules, Inc. to perform the R&D effort. The joint State/Hercules effort resulted in the formulation of the Delaware

DELAWARE RECLAMATION PLANT

Reclamation Project—a multi-materials resource recovery program.

As a result of the State's R&D efforts, the U.S. Environmental Protection Agency Solid Waste Group awarded the State a Grant of $9 million for this project under Section 208 of P.L. 91-512. Although the Grant was awarded in 1972, because of various external factors, the project was not allowed to proceed with construction until 1978. The EPA Water Programs Group also awarded a $28 million Grant for the Sewage Sludge Processing Module portion of the project.

In 1975, recognizing some of the legal issues involved in solid waste flow control, the Delaware General Assembly created the Delaware Solid Waste Authority, an independent Authority of the State, to plan and implement a long range program for solid waste disposal. The responsibility for developing the Delaware Reclamation Project was transferred from the Department of Natural Resources and Environmental Control to the Delaware Solid Waste Authority in 1975.

DELAWARE SOLID WASTE AUTHORITY

The Authority is a body politic of the State with substantial powers to plan and implement an innovative solid wastes disposal program. The Authority has the power to 1) arrange for long term contracts; 2) negotiate contracts; 3) own and operate facilities; 4) control the flow of solid wastes in the State; 5) license collectors; 6) exercise eminent domain for necessary real estate; 7) issue bonds or other notes for the construction and operation of its facilities (although such bonds do not carry the full faith and credit of the State of Delaware); 8) to receive and use Federal Grants to construct necessary facilities; 9) coordinate disposal activities; and 10) pursue research and development activities as necessary for furthering resource recovery in Delaware.

OVERVIEW OF THE TOTAL DISPOSAL PLAN

The Authority has concentrated primarily on New Castle County because this County generates approximately 64% of the wasteload in the State. The Delaware Reclamation Project will serve New Castle County, an area with a population of approximately 400,000 persons and a substantial industrial base. The project site is in an industrial area (see Figure 1) which has good access to the highway system, the railroad and the Port of Wilmington. The plant location is also adjacent to the largest landfill in the State—the 125 acre Northern Solid Waste Facility. This landfill, when completed in March, 1985, will have approximately 4 million tons of solid wastes deposited in it. By that time, the Authority will have developed a new (approximately 400 acres) site, one of three currently under consideration.

The Delaware Reclamation Project consists of two processing modules—the Solid Waste Processing Module (SWPM) and the Sewage Sludge Processing Module (SSPM) (see Figure 2). The feedstocks to the Delaware Reclamation Project consist of 1000 tons per day of municipal solid wastes and 350 tons per day of 20% solids digested sewage sludge. The sludge is generated at the City of Wilmington Regional Wastewater Treatment Plant capable of processing 90 million gallons of sewage per day. Any excess or non-processible solid wastes will be directed to a new transfer station now under construction. The process materials balance is indicated in Figure 3. The products recovered in the process are Refuse Derived Fuel (RDF), ferrous and non-ferrous metals, glass and humus.

The Authority anticipates burning the RDF in a boiler to produce electricity and is currently requesting proposals for construction of such a plant. Approximately 13 MW (megawatts) of power can be generated from the RDF (500 tons/day). The Delaware Reclamation Project can use approximately 6 MW and the remaining 7 MW will be sold to a local electric utility. When completed in 1985, this complex will provide a

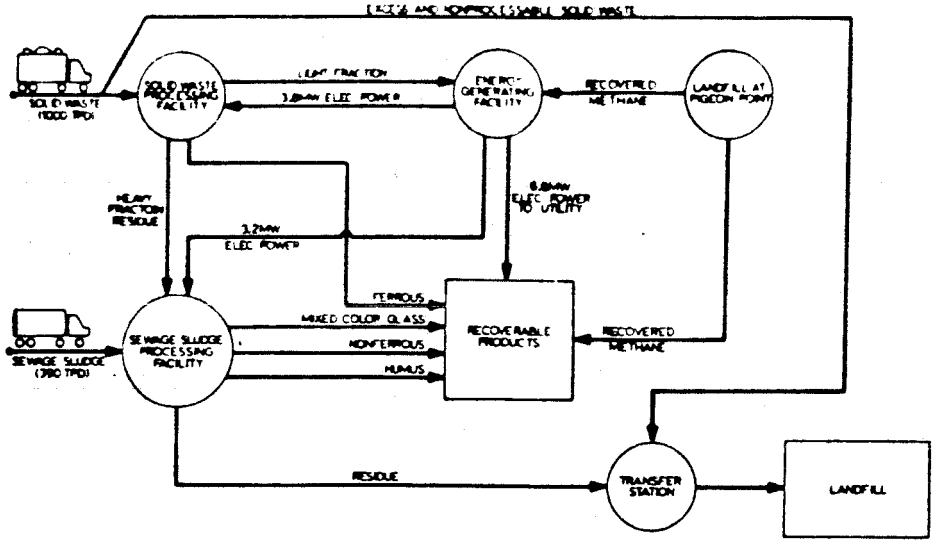


FIGURE 2
DELAWARE SOLID WASTE AUTHORITY

SWMF 66-2-22). A cross-conveyor removes the ferrous metals (picked up by the Dings Magnet) to the outside of the building to a Newell drum magnet which removes the light ferrous fraction from the heavy ferrous fraction.

The glass removal and processing steps are shown schematically in Figure 4. The solid waste fraction, after removal of the ferrous materials, proceeds to the Wet Process Building where it is trommeled in a Triple S Trommel (9 feet in diameter and 24 feet long). The trommel has 1/2 inch size holes on 3/4 inch staggered centers. The trommel undersize, consisting predominantly of glass, is removed and stored in a bin (2700 cubic feet in volume, manufactured by Kinergy Corporation). The trommel oversize is then conveyed to a solid wastes storage bin adjacent to the Humus Processing section of the plant. This storage bin, manufactured by Fairfield Company, can hold 11,800 cubic feet of material.

The stored trommel undersize is then conveyed to an Organic Removal Jig (Model No. DA [double action], 5′ × 11′ Remer Jig, manufactured by Wemco) which separates the glass and other heavy materials from the light materials such as organics, paper, and plastics. The light materials are dewatered in a Rotating Strainer (Model No. RSA-36120, manufactured by Hycor Corporation) and then fed into a Compression Device (Model RVP-60-K V-Press, manufactured by Rietz Manufacturing Co.). After squeezing the free running water out of the light fraction, the V-Press discharge is conveyed to the Humus Processing section of the plant.

The glass-rich fraction from the Jig is then conveyed to the Rod Mill Feed Storage Tank (1700 cubic feet in size, manufactured by Kinergy Corporation) and is fed into a Rod Mill (4′ diameter × 10′ long, with a 3′ drum feeder, manufactured by Koppers, Inc.) which crushes the predominantly glass feedstock into particle size of approximately 20 mesh (850 microns). The discharge from the Rod Mill is screened in two vibrating screens (Model KDSNTD-60-HD, manufactured by Kinergy Corporation). The screen oversize is fed back into the Rod Mill for regrinding.

The screen undersize is pumped to a desliming cyclone and classifier (38″ spiral Model S-H, manufactured by Wemco) which separates fine particles from the feed. The deslimed feed, after mixing with an amine acetate solution, is pumped into two banks of four flotation cells (manufactured by Denver Equipment Co., Model No. 18SP DR and C/C) arranged in a series. The amine acetate solution makes the glass particles hydrophobic and a detergent in the float cells lifts the glass particles with the froth. The froth-floated glass is then conveyed to a vacuum filter (6 feet in diameter, manufactured by Dorr-Oliver, Inc.) where it is dewatered and then dried in a 4′ diameter × 20′ long Rotary Dryer (manufactured by Bethlehem Corporation).

The dryer is fired with No. 2 fuel oil and the glass is discharged at a temperature of 80 degrees centigrade. The dried glass is then fed to a high intensity magnetic separator (30″-3 Roll B/BIMR, manufactured by Eriez Magnetics) for removing any fine particles of iron. The material settling in the flotation cell (non-glass particles) and the slimes are conveyed to a clarifier from where the water is recycled back into the grinding and screening operations.

After dewatering in a rotary vacuum drum filter (manufactured by Eimco, 8′ face × 6′ diameter), the sludge removed from the clarifier is more like sand. Such sand will be used in the landfill. The froth-floated dried glass will be shipped to glass bottle makers for manufacturing amber or green colored bottles.

At the Wilmington Wastewater Treatment Plant, the primary and waste activated sludge are thickened and digested in four high rate anaerobic digesters. The City of Wilmington has started construction of a Belt Filter Press Plant which will convert the digester discharge into 20% solids filtercake for conveyance to the Delaware Reclamation Project.

The sludge from the treatment plant will be stored in three sludge receiving hoppers manufactured by Fairfield Company. These hoppers have a capacity for holding 45 tons of sludge. The solid wastes heavy fraction (after removal of ferrous and

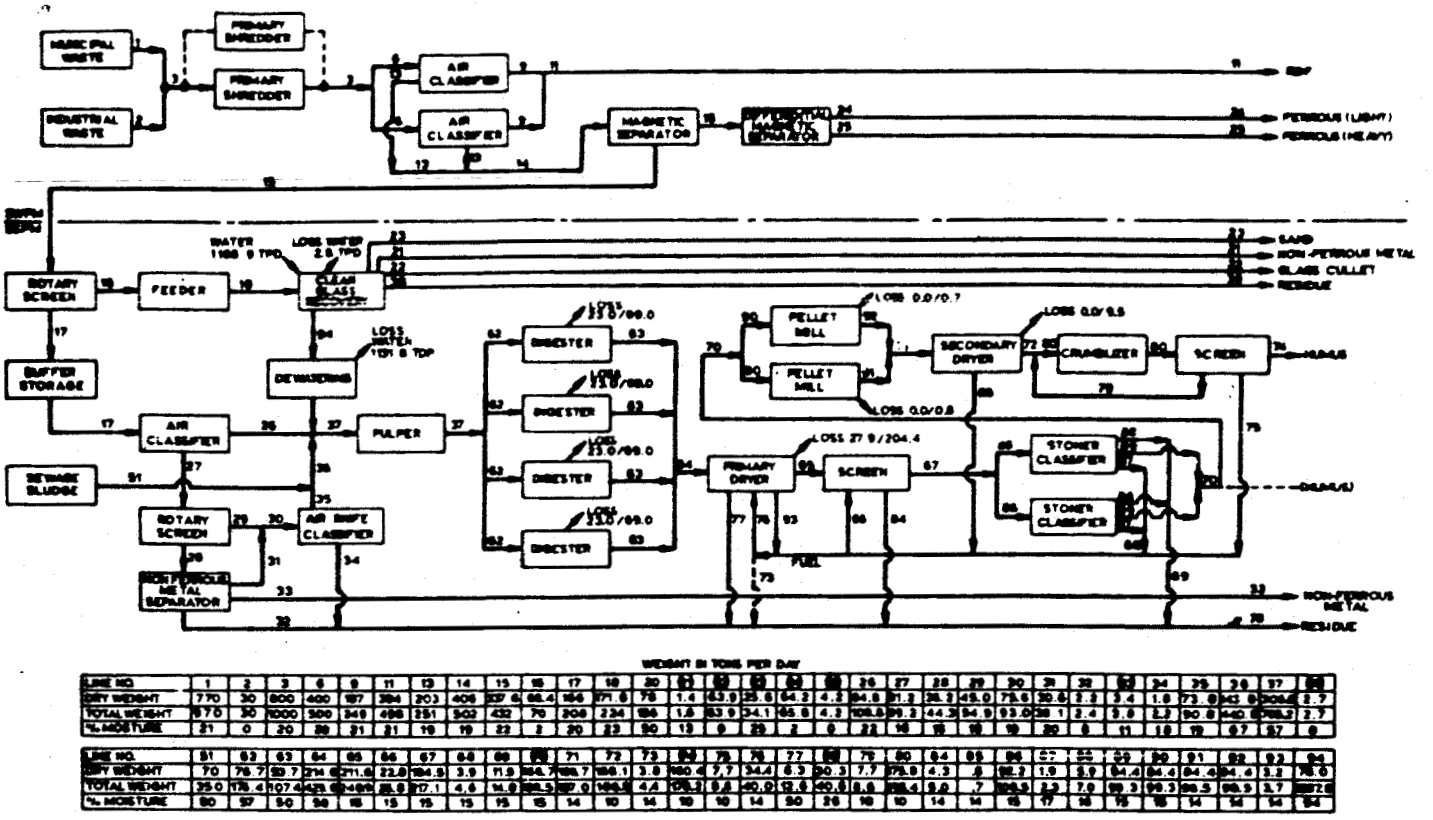


FIGURE 3

DELAWARE RECLAMATION PROJECT

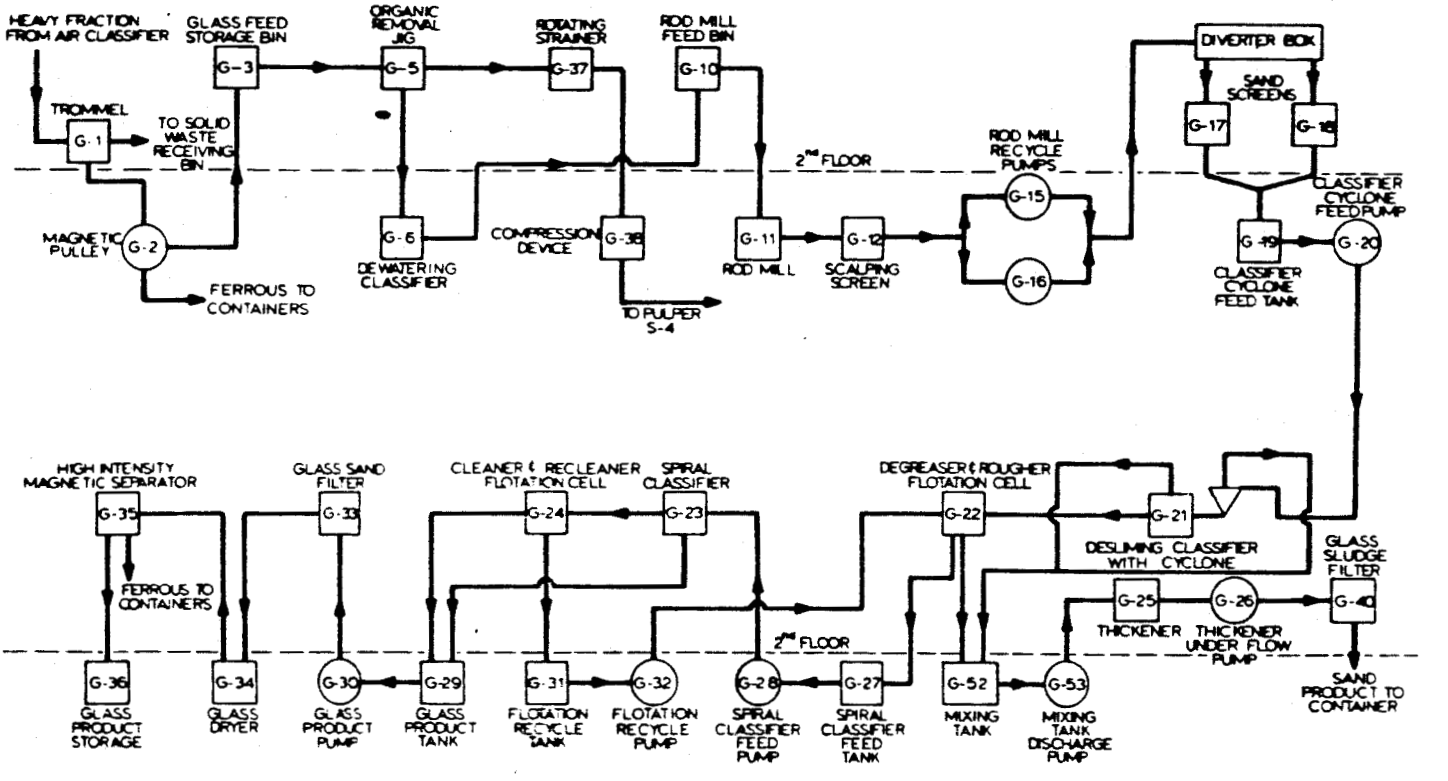


FIGURE 4

DELAWARE SOLID WASTE AUTHORITY

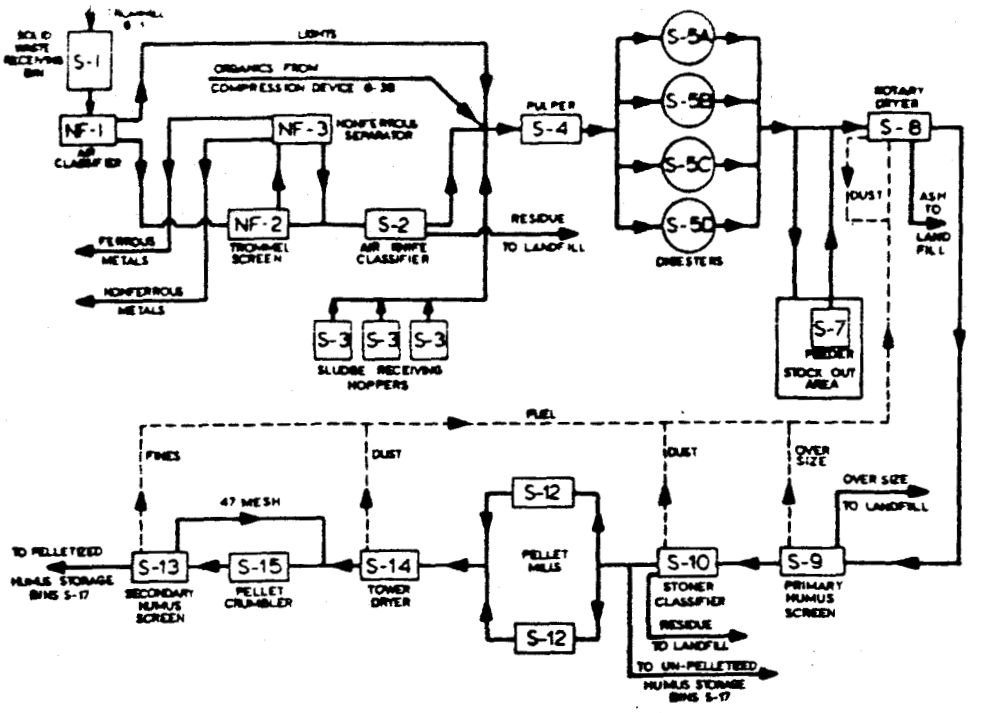


FIGURE 5
DELAWARE SOLID WASTE AUTHORITY
HUMUS PROCESSING MODULE

glass fractions) is next conveyed to an Air Knife and a Secondary Air Classifier (6'8" in diameter and 20 feet long, manufactured by Iowa Manufacturing Co.). The Secondary Air Classifier is designed to remove a non-ferrous (mostly aluminum) rich fraction which feeds a trommel. The trommel undersize will pass through a drum magnet and become the feedstock to the non-ferrous removal system manufactured by Iowa Manufacturing Company.

This system consists of stainless steel sliding boards inclined at 45° angle. Permanent magnets of alternating polarity are embedded underneath the stainless steel boards. The non-ferrous fraction is then allowed to slide down the boards. The eddy currents induced in the non-ferrous particle make it move at right angles to the direction of the magnetic field, thereby sliding at a 45° angle. The nonmetallic particles slide straight down the board. Two successive stages of nonferrous separation are expected to yield approximately 60% pure aluminum.

The Humus Processing section of the plant is shown schematically in Figure 5. The remaining fraction of the solid waste is then conveyed to a Cage Mill (Model No. 75-B, manufactured by T. J. Grundlach Machine Co.) where it is blended with sewage sludge from the storage bins. The solid waste-sewage sludge feed ratio is 3.7 to 1. The homogenized mixture (at an average moisture content of 55%) is then fed into four (4) Fairfield Digesters. Each digester has a diameter of 100 feet and an operating depth of 6'1". These digesters have the capability of composting the solid waste/sewage sludge mixture in an aerobic environment. The digester consists of a rotating bridge, half of which is fitted with augers which mix and move the solid waste material from the periphery of the circular tank to the center of the tank. The remaining half of the bridge acts as the feed mechanism for the sewage sludge/solid waste mixture. The tank itself is covered with an aluminum dome which would prevent precipitation from affecting the moisture content. The sewage sludge/solid waste feedstock will have a residence time of approximately five (5) to seven (7) days in the digesters.

The composted material is removed from a central annular space to conveyors which feed a Heil Triple Pass Air Drier (Model SD125-54, manufactured by Heil Company, Milwaukee, Wisconsin). The drier is initially fired with No. 2 fuel oil. The dried humus is fed to a coarse humus screen (Model No. 6 × 14 SPL, manufactured by Sprout-Waldron) which makes an initial separation of non-compostable plastics and other materials from the compost. The screened humus is further refined in another vibrating screen (Model No. 6 × 14 SPL, manufactured by Sprout-Waldron) with an effective screen size of 7 and 20 mesh. The screen undersize is then fed back into the humus drier system. The fine humus then becomes the main fuel for providing the heat necessary for drying humus and the oil supply to the drier reduced.

The dried humus, after screening, is stored in bins for shipping to users. Approximately 50% of the total humus will be pelletized and granulated for sale to the fertilizer industry. The remaining humus will be sold as unpelletized bedding material for use in broiler housing units. Any excess humus produced can be stockpiled in a humus stockout area. The stored humus can be fed back to the Heil Dryer as required. The residues from the humus cleanup screens will be landfilled. The input/output relationship of the Delaware Reclamation Project is presented in Table 1.

Table 1

DELAWARE SOLID WASTE AUTHORITY
DELAWARE RECLAMATION PROJECT
INPUTS AND OUTPUTS
Dry Weight Basis

INPUTS	*TONS/YEAR*
Solid Wastes	208,000
Sewage Sludge	18,000
TOTAL	226,000
OUTPUTS	*TONS/YEAR*
Refuse Derived Fuel	103,000
Humus	37,000
Ferrous Metals	18,000
Glass	18,000
Internal Fuel (Humus)	9,800
Sand	8,100
Non-Ferrous Metals	1,300
Residue	8,600
Loss in Process*	22,200
TOTAL	226,000

• Conversion of Solids to Gases in Digesters

Table 2
DELAWARE RECLAMATION PROJECT
PROCESS MODULES COST

ITEM	*SWPM* $\$ \times 10^6$	*SSPM* $\$ \times 10^6$	*TRANSFER STATION* $\$ \times 10^6$
Engineering	1.245	1.984	.265
Construction Supervision	1.258	3.059	.237
Construction	22.354	36.731	6.118*
Startup	2.741	2.153	-0-
TOTAL	27.598	43.927	6.620
SOURCE OF FUNDS			
EPA—Solid Waste	8.735	-0-	-0-
EPA—Water Programs	-0-	30.225	-0-
State Grants	-0-	3.044	-0-
Revenue Bonds	18.863	10.658	6.620
TOTAL	27.598	43.927	6.620

• Transfer Station Structure to be Bid in First Quarter of 1983

CONSTRUCTION STATUS

The Solid Waste Processing Module has been completed and tested. Raytheon Service Company, the system designer and operator, has started Trial Operations of the Solid Waste Processing Module. The Sewage Sludge Processing Module is approaching construction completion (approximately 95% complete). No-load testing of the equipment is now under way. It is anticipated that sewage sludge will be fed into the system for trial operations in February, 1983.

Raytheon Service Company has six months for trial operations prior to Acceptance Testing. After completion of Trial Operations, the facility will be tested. The test requirements are as follows.

Table 3

DELAWARE RECLAMATION PROJECT
FY 1985

ITEM	*SWPM* $\$ \times 10^6$	*SSPM* $\$ \times 10^6$	*TRANSFER STATION & LANDFILL*
Debt Service	5.219	1.610	-0-
Operation & Maintenance	5.364	3.226	4.589
Utilities	0.596	1.694	-0-
Management Fee	0.712	0.165	-0-
Subtotal	12.161	6.696	4.589
Less Guaranteed Revenues	0.235	1.200	-0-
Total	11.926	5.496	4.589

Anticipated Tonnage: 360,000 Tons Solid Wastes
91,000 Tons Sewage Sludge

Anticipated Disposal Fee: $ 33.13/Ton Solid Wastes
$ 60.40/Ton Sewage Sludge (20% Solids*)

* On a Dry Weight Basis the Fee Will Be $302.00

The facility must receive and process 1000 tons of municipal solid wastes and 350 tons of 20% solids sewage sludge per day. The facility must be operated in an integrated fashion for five successive days with two shifts of processing each day and produce products of specified quality. The company has the ability to chose any five successive days during the Acceptance Test Period for such demonstration.

During Acceptance Testing, the subsystem performance efficiencies are also checked. Should the subsystems fail to perform as designed, the facility could still be accepted (with a lower efficiency.) However, Raytheon Service Company would be obligated to pay back a portion of the capital costs of the subsystem. The payback is proportional to the reduction in materials recovery efficiency.

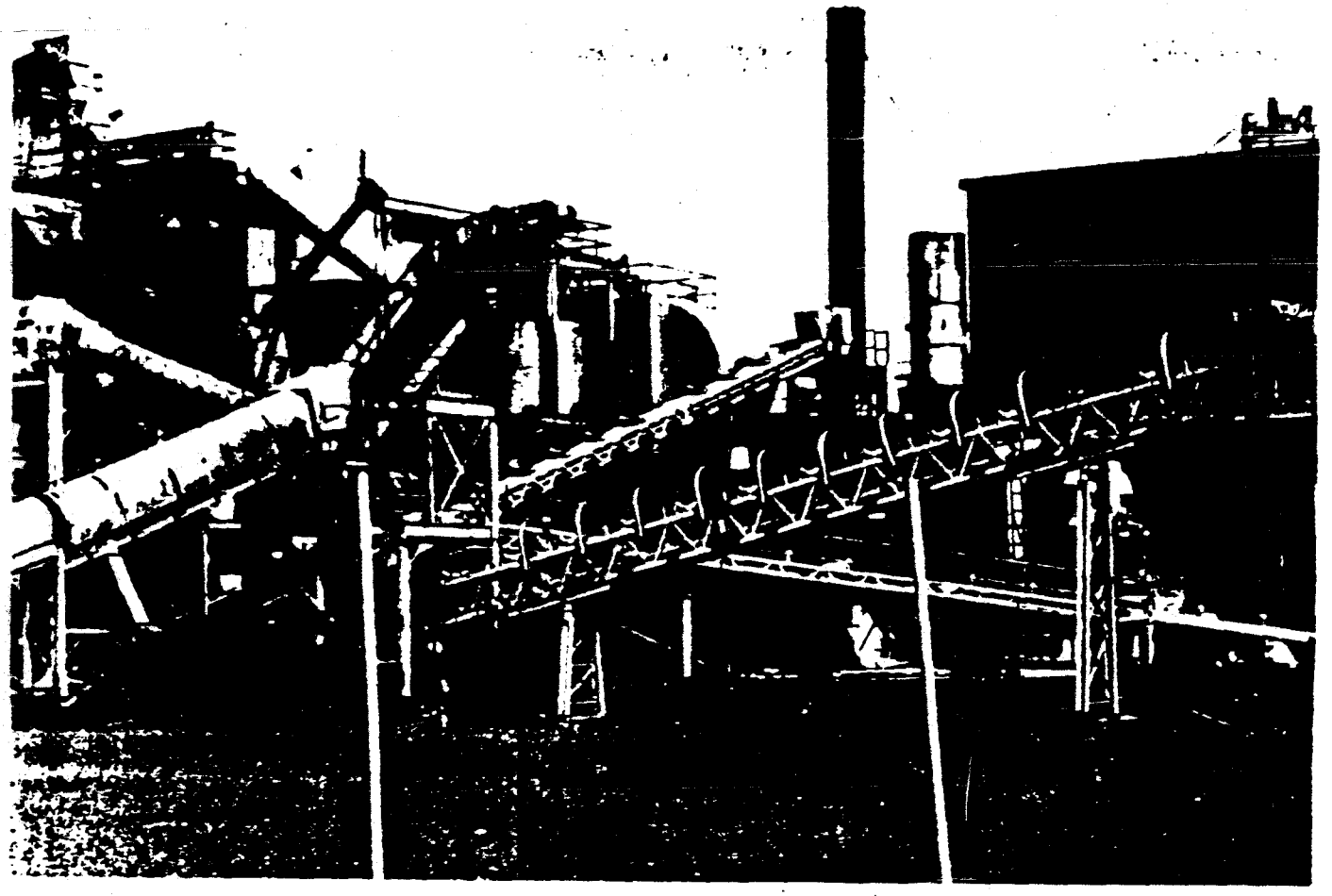
As a result of the processing, the plant is designed to produce annually 103,000 tons (dry weight) of RDF, of which 77% must be combustible material. The system is also designed to produce 18,000 tons of glass, 18,000 tons of ferrous metals, and 1300 tons of non-ferrous metals and 47,000 tons of humus. Raytheon Service Company is allowed to dispose, free, up to 26,000 tons of residue annually (while processing 260,000 tons) in the Authority's landfill.

COSTS

The facility has been financed through Federal Grants, State Grants, and Bonds issued by the Delaware Solid Waste Authority. Table 2 give a summary of the costs.

Until the energy recovery plant is completed, the RDF will be landfilled. On that basis, the project financing was arranged and bonds sold in 1979. Table 3 shows the estimated annual Operation and Maintenance cost. Raytheon Service Company has guaranteed revenues of $1.4 million from the sale of recovered products (glass, humus, ferrous and non-ferrous materials).

The Authority anticipates the tipping fees for this resource recovery project to reach approximately $33.13 a ton by July,



1984. The cost of processing the sewage sludge (approximately $302/ton dry weight) will be charged directly to the City of Wilmington which, in turn, will charge other users of its system.

The Authority has also determined, through its detailed weighing program, that an average family in New Castle County generates about 1.6 tons of solid wastes per year. Consequently, the disposal cost (through this complete solid wastes and sewage sludge processing system) would be about $53.00 per family per year (July, 1984) or approximately $0.15 per day per family. Assuming that an average family generates 0.15 ton sludge (dry weight) per year (through the City of Wilmington's high efficiency secondary treatment plant), the disposal cost for sludge would be approximately $45.30 per year, or approximately $0.12 per day per family. When the transportation costs are added to the disposal costs, the same family will be spending approximately $15.00 per month for solid wastes disposal.

On an annual basis, an average family in New Castle County, Delaware, would pay approximately $180 per year for complete solid wastes disposal and $179 per year for complete sewage treatment and sludge disposal. In FY 1984, the median annual income of a family is estimated at $24,000. Therefore, the annual solid wastes and sewage disposal service cost is about 1.5% of the median annual income. Out of the $359 annual cost, the Authority receives approximately $98 as disposal costs. The remaining $261 is divided between the solid waste collection companies and local governments.

There are indirect benefits which inure to the urban population as a result of completing a comprehensive solid waste and sewage sludge disposal program. While these benefits cannot be directly quantified, they positively affect the "quality of life" in Northern Delaware by conserving land and water resources.

ACKNOWLEDGEMENT

The authors are grateful to Mr. J. Linskey and Mr. P. Huitfeldt of Bechtel Civil & Minerals, Inc., Mr. Ashok Gupta of Raytheon Service Company, Mr. Carlos McCleave of Fairfield Service Company and Ms. J. Peacock of the Delaware Solid Waste Authority for reviewing the paper.