WASTE WATER TREATMENT COSTS IN POULTRY RENDERING PLANTS IN GEORGIA

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INTRODUCTION

Poultry products are an important source of agricultural income in Georgia and other southeastern states. Yet, the waste from poultry operations can lower water quality unless ways are found to reduce quantities discharged into streams and waterways. Present regulations require that all sewage discharged from processing and rendering plants have the equivalent of secondary stage treatment as defined by conventional biological standards [4].[1] More stringent regulations that would completely eliminate discharge of pollutants into waterways have been proposed [10]. Poultry processing and rendering plants must therefore adopt more advanced in-plant processes or private treatment systems or utilize public systems to achieve higher levels of waste water treatment in future years.

A substantial part of the waste from poultry slaughtering and processing operations consists of blood, feathers, and offal [12]. These waste products are sold to rendering plants where they are transformed into salable end products such as feather meal, by-product meal, or pet food. Rendering plants have waste water disposal problems and air pollution problems. The purpose of this paper is to describe the current practices and characteristics of rendering plants in Georgia and determine their capital expenditures and operating costs for waste water treatment facilities. The results should be useful in evaluating the potential economic impact of more stringent water quality regulations which are in the process of being developed.

Information was obtained from nine poultry by-product rendering plants and 19 poultry processing plants in Georgia in the summer of 1972 [7]. Personal interviews were conducted with managers, but complete information was not available from all plants. The rendering plants contacted utilized by-products from approximately 35 poultry processors who slaughtered nearly 432 million birds in 1972.

RENDERING PLANT OPERATIONS

Rendering plants process poultry by-products such as blood, feathers, fat, and offal into salable end products [8]. Most poultry processors salvage these items as a part of their slaughtering operations because: (1) they have a high pollution potential if discharged into streams, and (2) they are an important source of supplemental income. Some processors have rendering operations located on-site at their primary processing facility, but most processors transport by-products to larger and more specialized rendering plants at distant locations.

By-Products Used

Poultry processing plants salvage most of the feathers from processing operations. Feathers account for 4.8 to 8.5 percent of the total live weight of chickens, with 8.1 percent typical for broilers [8, p. 63]. Feathers are relatively easy to recover within the plant and a screening process is used to collect any residue that gets into the waste water. Feather yields vary widely depending upon their moisture content when received by the rendering plant. However, an average poultry processing plant slaughtering 62,500 birds per day will produce about 17,500 lbs. of

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[1] Secondary treatment is defined as removal or stabilization of oxidizable organic solids to 85 percent of the BOD levels entering the plant [3]. BOD refers to Biochemical Oxygen Demand. It is an indirect measure of the concentration of biologically degradable material present in organic wastes, i.e., the amount of free oxygen utilized by aerobic organisms when allowed to attack the organic matter in a specific environment [9].

feathers. The characteristics of chicken feathers vary greatly with age and sex of birds and other factors, but they are used primarily for livestock and poultry feed, bedding, ornaments, sporting equipment, and fertilizers.

Blood is one of the most important sources of pollution in poultry processing plants [11]. Approximately 3.3 to 4.8 percent of the live weight of a chicken is blood. If all blood from poultry processing operations were allowed to enter the sewer, the BOD content of the water would be increased at the rate of 40 lbs. per thousand birds processed. A blood collection efficiency level of 90 percent would reduce total BOD loads by approximately 38 percent. Blood collection is therefore a primary concern of poultry processors. Most processors in this study recovered 80 to 90 percent of the blood which was then transported to rendering plants for processing into poultry by-product meals.

Offal from poultry processing plants consists of heads, feet, and inedible viscera such as lungs, spleen, windpipes, intestines, preen glands, reproductive organs, and other bits of flesh [8]. These parts constitute approximately 16 percent of the total live weight of the bird. Many of these items are easily salvaged from slaughtering and eviscerating operations, although there is a small amount of suspended material that escapes the final screening process and enters the plant waste water effluent. The evisceration process accounts for the bulk of the offal which is 40 to 50 percent of the BOD load from poultry processing plants [12]. Offal is used for poultry by-product meals, pet food, and sometimes other animal feeds.

Purchase Value

Most rendering plants purchased by-products from poultry processing plants on a regular basis. The purchase value for blood, feathers, and offal combined for 11 poultry processing plants in this study ranged from $8 to $14 per 1,000 birds processed (Table 1). The average purchase value was $10.7 per 1,000 birds processed. Some by-products are given to renderers or combined in mixed loads. An average size poultry processing firm with a volume of 62,500 birds per day would receive about $668 per day for by-product sales. This represents an important source of income for the poultry processing industry.

Transportation Costs

Transporting by-products to rendering plants can be very expensive. Special watertight trucks are needed to eliminate odor problems, and frequent deliveries are necessary. Two rendering plants were located on-site, and they flumed offal directly from processing plants. However, cost data were not available from these operations. Processing plants usually shipped by-products two or three times daily. Fourteen poultry processors contacted in this study shipped by-products an average of 55 miles. Distances to the rendering plants varied from two to 130 miles. Rendering plants usually haul by-products with their own trucks, although some poultry processing firms hauled by-products with other equipment. Five firms reported an average cost of 35.6 cents per mile for hauling by-products, with costs for individual plants ranging from 25 to 50 cents per mile. One firm reported a cost of $2 per 1,000 birds for hauling by-products.

Plant Volume and Water Use

Two rendering plants in this study produced pet foods, and seven plants produced various other by-product meals, poultry fat, and feather meal, which are used as protein supplements in animal and poultry feeds. The plants producing poultry meat and feather meal products processed an average of nearly 42,000 tons of poultry by-products annually (Table 2). Small rendering operations processed an average of 8,900 tons per year, and the largest operations processed about 109,000 tons per year. The number of employees in these plants ranged from an average of 12 workers in the smallest plants to 48 workers in the largest. Average employment was 25 workers per plant (Table 2).

The quantity of water used in rendering plants depends upon the amount and type of raw materials processed, the processing technology used, and the type of end products produced. The smallest operations in the study used about 115,000 gallons of water per day. The largest plants used almost a million gallons of water per day. The average water use for the seven plants in the study was 462,000 gallons per day or approximately 3,172 gallons per ton of raw by-products processed (Table 2). Not all of this water was discharged from the plants, however, since some water is evaporated in the cooking process and a number of plants have recycling processes.

Most plants received a by-product mix ranging from 55 to 65 percent offal, 30 to 45 percent feathers and up to 10 percent blood. Yields from these by-product combinations varied widely. It has been estimated that about 20 to 30 percent of the total raw material input in rendering operations will be yielded as meal or fat [5]. Other studies show that

Table 1. PURCHASE VALUE OF BY-PRODUCTS SOLD BY 11 POULTRY PROCESSING PLANTS, GEORGIA, 1972

Type of Plant Operation	Number of Plants	Value of By-Products Sold[a/]		
		Low	Average	High
		(dollars per 1,000 birds processed)		
Slaughtering and Eviscerating	9	8.00	10.56	13.94
Slaughtering, Eviscerating, and Further Processing	2	10.00	11.25	12.50
Total Processors	11	8.00	10.69	13.94

[a]Includes amount received for blood, feathers, and offal combined.

Table 2. ANNUAL VOLUME, NUMBER OF EMPLOYEES, AND WATER USE IN SEVEN POULTRY RENDERING PLANTS, GEORGIA, 1972

Size of Plants	Average Employees	Operating Days Annually	Volume of By-Products Processed		Water Used by Plants		Water Used per Ton of By-Products
			Daily	Annually	Daily	Annually	
	(number)	(number)	(tons)	(tons)	(000 gallons)		(gallons)
Small	12	288	31.2	8,903	115	33,640	3,692
Medium	22	268	87.5	23,675	340	93,640	3,886
Large	48	293	375.0	109,105	929	247,355	2,478
Average	25	284	146.0	41,753	462	119,559	3,172
Total	176	1,987	1,020	292,269	2,890	836,910	-

total yields will approximate 12 percent of the live weight of the poultry slaughtered, with yields for feather meal at 5.5 percent; meat meal, 5.2 percent; blood meal, 0.8 percent, and grease about 0.6 percent [1].

PLANT INVESTMENT AND OPERATING COSTS

Poultry rendering plants vary in size and complexity of operations depending upon the type and quantity of by-products processed and the end product mix. Most installations processing feather or by-product meals consist of a set of pressure cookers, several boilers, dryers, pressing machines, grinding and bagging equipment, and various types of conveying equipment [6]. Capital investment requirements and costs are relatively high due to the nature of the processing techniques, irregularity of by-products flowing to the plant, and relatively low yields per ton of raw material processed.

Capital investment for five of the rendering plants in this study varied from an average of $138,000 for small plants to slightly over $2.2

Table 3. PLANT AND EQUIPMENT INVESTMENT AND ANNUAL OPERATING COSTS FOR FIVE POULTRY RENDERING PLANTS, GEORGIA, 1972

Size of Plants	Original Plant and Equipment Costs [a]	Annual Fixed Costs of Facilities [b]	Annual Operating Costs [c]	Annual Total Costs	Cost per Ton of By-Products Processed			Capital Expenditures per Ton of Annual Volume
					Fixed	Operating	Total	
	(000 dollars)				(dollars)			(dollars)
Small	138	21	102	123	2.51	12.43	14.94	16.76
Medium	300	45	450	495	1.57	15.74	17.31	10.49
Large	2,250	338	2,415	2,753	3.09	22.14	25.23	20.62
Average	1,015	152	1,097	1,249	2.89	20.84	23.73	19.28
Total	5,075	761	5,484	6,245	-	-	-	-

[a]Small and medium size plants were constructed during late 1960's and large plants constructed during late 1940's and early 1950's with major renovations since that time included.

[b]Includes depreciation, interest, taxes, and insurance for buildings and equipment based on 15 percent of the original investment. Depreciation was assumed at 5 percent a year for buildings and 10 percent a year for equipment, which is equivalent to total useful lives of 20 years and 10 years, respectively. Interest was calculated at 4 percent of initial cost or approximately 8 percent of the average value of the fixed assets over their useful life. Taxes were estimated at 2 percent of the initial cost of the facilities, and insurance at 1 percent of initial cost.

[c]Includes labor, supplies, fuel, utilites, and maintenance.

million for the largest plants (Table 3). All five plants produced hydrolyzed feather meal, poultry meal, blood meal, poultry fat, or some combination of these products. These facilities were constructed at various points in time with the small and medium size plants built in the late 1960's and the largest plants built in the late 1940's and early 1950's. The older plants have been renovated, however, and major renovation costs are included. Capital expenditures per ton of volume handled annually varied from $10 to $20 per ton (Table 3).

The total annual costs for operating these facilities involve both fixed and operating costs. Annual fixed costs, which consist of depreciation, interest, taxes and insurance, were calculated at 15 percent of the original capital investment.[2] Operating costs include labor, supplies, fuel, utilities, and maintenance. The combined total of fixed and operating costs for plants in this study ranged from an average of $123,000 in the smallest plants to $2.75 million in the largest plants (Table 3). The cost per ton of raw by-products processed varied from approximately $15 to $25 per ton depending on the size of plant.

WATER TREATMENT FACILITIES AND COSTS

Poultry rendering plants either utilized existing sewerage facilities of municipalities or constructed their own private on-site wastewater treatment systems. Seven plants in this study used private treatment systems. Five of these plants discharged treated water into streams, whereas two plants discharged into public sewerage systems. All seven plants produced poultry meat and feather meal products. Two other rendering plants that specialized in pet food production used public sewerage systems.

Most waste water from poultry rendering plants was receiving pollution abatement control equivalent to the secondary stage of treatment. Secondary treatment involves processing of sewerage by biological methods so that approximately 85 percent of the BOD and suspended solids (SS) are removed. The secondary stage follows primary treatment where

[2]See Table 3 for assumptions used in calculating fixed costs.

Table 4. CAPITAL EXPENDITURES AND ANNUAL OPERATING COSTS FOR WASTE WATER TREATMENT FACILITIES IN FOUR POULTRY RENDERING PLANTS, GEORGIA, 1972.

Item	Units	Low	Average	High
Capital Expenditures[a]	(dollars)	40,000	395,000	750,000
Annual Fixed Costs[b]	(dollars)	6,000	59,250	112,500
Annual Operating Costs[c]	(dollars)	4,000	22,000	40,000
Annual Total Costs	(dollars)	10,000	81,250	152,500
Volume of By-Products Processed Annually	(tons)	9,750	44,625	79,500
Cost per Ton of By-Products Processed	(dollars)	1.03	1.82	1.92
Capital Expenditures per Ton of Annual Volume	(dollars)	4.10	8.85	9.43
Volume of Water Used Annually	(000 gallons)	33,120	200,310	367,500
Cost per 1,000 Gallons of Water Used	(dollars)	.302	.406	.415

[a]Based on facilities constructed during the 1967-1968 period.

[b]Includes depreciation, interest, taxes and insurance for treatment facilities based on 15 percent of the original investment. Depreciation was assumed at 8 percent a year which is equivalent to a total useful life of 12.5 years for facilites. Interest was calculated at 4 percent of initial cost or approximately 8 percent of the average value of the fixed assets over their useful life. Taxes were estimated at 2 percent of the initial cost of the facilities, and insurance at 1 percent of initial cost.

[c]Includes both maintenance and operating expenses.

settleable organic and inorganic solids are removed by the process of sedimentation.[3] BOD levels in these plants ranged from 41 to 250 parts per million (ppm) and suspended solids were as high as 80 ppm in one plant. It is estimated that nearly half of the BOD and SS load is due to floor washings and cleanup operations in rendering plant operations [2].

All plants had preliminary screening processes where most of the solids and floating materials were removed before the water was treated. The plant treatment systems were of the lagoon type with both anaerobic and aerobic ponds. The lagoons ranged in size from three to 12 acres with most plants having more than one pond in the system. Capacity utilization of the lagoon systems varied from 65 to 100 percent of their maximum potential. The sludge residue from these systems was disposed of in a variety of ways: some plants buried or dumped the residue, some used it as fertilizer, others recycled the residue into animal feeds.

The capital expenditures for private waste water treatment facilities for poultry rendering plants ranged from $40,000 to $750,000 depending on the size of the plant (Table 4). These expenditures accounted for 25 to 30 percent of total plant capital investment based on costs for treatment facilities constructed during the late 1960's, primarily 1967 and 1968. Capital expenditures per ton of annual volume of raw by-products processed ranged from $4.10 to $9.43 with an average of $8.85 per ton.

Annual fixed costs for waste water treatment facilities were much greater than annual operating and maintenance costs (Table 4). The fixed costs were calculated at 15 percent of the original investment including depreciation, interest, taxes, and insurance.[4] Fixed costs varied from $6,000 per year

[3]For classification and definition of sewage treatment processes see [3].

[4]See Table 4 for assumptions used in calculating fixed costs.

in the smallest plant to $112,500 per year in the largest plant. Annual operating and maintenance costs ranged from $4,000 to $40,000 per year, which was 2.3 to 3.3 percent of the total operating costs of rendering plants. The total water treatment cost per ton of raw by-products processed in these plants ranged from $1.03 to $1.92, with an average cost of $1.82 per ton.

Rendering plants that used public sewerage systems reported municipal charges that ranged from 12 to 14 cents per 1,000 gallons in small communities to as high as 48 to 60 cents per 1,000 gallons in larger cities. Some public systems charged a minimum rate plus a surcharge based on BOD levels or the strength of the waste loads discharged into the system. Public sewerage charges at the time of this study were wider and more variable than the costs incurred by firms using private waste water treatment facilities which ranged from 30.2 to 41.5 cents per 1,000 gallons (Table 4).

SUMMARY AND CONCLUSIONS

Poultry rendering plants utilize by-product wastes from processing plants and reduce the water pollution potential of the industry. This study was undertaken to determine the costs of water treatment control in rendering plants.

Information was obtained from nine rendering plants that utilized by-products from 35 poultry processors operating in Georgia in 1972. The main by-products used were blood, feathers, fat, and offal. These items had a purchase value to processors of $10 per 1,000 birds processed, or approximately $4.3 million for the Georgia poultry industry during 1972. These by-products were processed into a variety of meat and feather meals and pet foods. Processing costs for rendering plants ranged from $15 to $25 per ton of raw by-products handled. Capital investment in rendering facilities ranged from $138,000 to $2.25 million per plant.

Seven plants in the study had water pollution treatment processes equivalent to the secondary stage of treatment where approximately 85 percent of the BOD and suspended solids are removed. Capital expenditures for private waste water treatment facilities ranged from $40,000 to $750,000, depending on size of plant. The total costs for water treatment processes ranged from $1.03 to $1.92 per ton of raw by-products processed. Costs per 1,000 gallons of water used ranged from 30.2 cents to 41.5 cents per gallon. These costs are comparable with municipal public sewerage charges of 12 to 60 cents per gallon.

Future costs for private waste water treatment in rendering plants will probably increase as more stringent regulations are imposed on agricultural processing industries. Environmental Protection Agency regulations state that all plants must adopt the best available control technology by 1985 in order to eliminate discharge of pollutants into navigable waters. Increased costs of municipal sewerage operations also will lead to higher base rates and increased surcharges for plants discharging into public systems. This study should provide a basis for assessing the level of expenditures needed to meet these additional requirements.

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