DETAILED PLANS FOR THE REDUCTION IN WASTE LOAD FROM A DAIRY AND ICE CREAM PLANT

Submitted by

Maola Milk and Ice Cream Company

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EXECUTIVE SUMMARY

Maola Milk and Ice Cream Company is a multiproduct dairy located in New Bern, NC. The plant discharges its waste to the City of New Bern municipal treatment system. This project is a continuation of the feasibility study entitled "Reduction in Waste Load from a Dairy and Ice Cream Plant" for the reduction of waste load by the recovery and reuse of process waste.

The plant was surveyed in the above referenced study to identify sources of milk solids losses from production processes. Methods were suggested to reduce or recover and reuse the milk solids lost from the system. Costs and payback period for changes relating to pollution prevention were evaluated.

Waste load from a dairy processing plant like Maola is primarily a result of milk products lost to the sewer system. The production manager and supervisors reduced milk loss with a corresponding reduction in waste load. Milk plant losses dropped 100,000 lbs of milk per month reflecting annual savings of $165,000.

To further decrease pollution from the Maola plant, recovery systems and procedures were implemented. The waste reduction for Maola was predicted to be 300,000 lb BOD_5/yr when these changes are implemented. An initial investment for the changes was estimated at $54,000. Annual increased costs were estimated to total $35,000. With implementation and the above investment it is estimated that the net savings per year could total as much as $300,000.

The plant that was last remodeled in the late 1950's requires a total renovation of its building and processes. Maola's management has retained engineering services to implement some of the recommended changes.

However, as these plans are being developed during the period of this project, immediate action to reduce pollution was initiated at the request of the City of New Bern. This project details changes to immediately impact the pollution load of Maola.

ACKNOWLEDGMENTS

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The authors are deeply indebted to the North Carolina Agricultural Extension Service and the Department of Food Science at N.C. State University for their support toward these activities and for allowing the subcontract to help implement this project.

The foresight of Mr. Roger Schecter and Mr. Gary Hunt of the N.C. "Pollution Prevention Pays" program allows for such projects to be instituted. Their help, concern and patience throughout this study is especially appreciated. They should be commended for their unique approach to helping industry find ways to prevent pollution. Funds for this project were provided through Agreement C-1539 of the Pollution Prevention Pays program of the North Carolina Department of Natural Resources and Community Development.

The authors extend their appreciation to Ms. Lisa Nance for her invaluable assistance in typing this report and for other materials prepared for this project. The editorial assistance of Ms. Susan Borowski is gratefully acknowledged.

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SCOPE OF WORK

Maola Milk and Ice Cream Co., under the direction of Mr. R.A. Bullard, submitted the project entitled "Detailed Plans for the Reduction in the Waste Load from a Dairy and Ice Cream Plant" to the NC "Pollution Prevention Pays" program on July 31, 1986. An agreement (No. C-1539) was signed to authorize the project. A Memorandum of Agreement was entered into by Maola and NC State University, who would assist in the project. Drs. Carawan and Rushing of the Food Science Department and the Agricultural Extension Service cooperated in the study.

This project included the study of plans and costs for implementing changes suggested in the previous study entitled "Reduction in Waste Load from a Dairy and Ice Cream Plant." Since final drafts of long range plans were delayed, the focus of this project was shifted toward immediate changes to meet the demands of the City of New Bern for reducing its total wasteload. This allowed Maola to assist the city in meeting its permit obligations.

INTRODUCTION

The waste load from a dairy processing plant is largely a result of milk products which are intentionally or inadvertently lost to the sewer system. Researchers have estimated that over 90 percent of the waste load is of product origin (milk and milk products). The reduction of water and waste requires the application of the best technology to achieve reduced product loss, reduced water usage and reduced ingredient loss.

There are two proven ways to reduce water use, wastewater discharge, waste loads and product loss. One method is to operate the plant more efficiently. The other is to institute process changes which have been shown to reduce water use, product waste and wasteloads. This project places emphasis on detailing those losses, recovering these losses, and preventing the milk solids from becoming part of the waste load.

Water, sewer, surcharge and related costs are significant to any dairy plant as would be any realized savings in these areas. In the previous Maola[1] study, the plant was predicted to be able to achieve an annual net savings of $240,000 with an investment of $206,000 and increased operating costs of $111,000. Maola currently processes in excess of 300,000 lb/day. Management considered that these savings were significant and plans should be made for implementation at production rates up to 600,000 lb/day.

Another factor that can influence a dairy to consider water and waste reduction programs is external restraints. These restraints can include effluent restrictions on selected wastewater parameters such as BOD, COD, FOG, TKN, and flow. The City of New Bern imposed such limits during this study to help provide for more efficient wastewater treatment.

Maola has always tried to be an exemplary corporate citizen. Reducing waste load from the dairy plant will not only reduce dairy processing cost; it will also help the city by reducing load, reducing treatment costs and allowing expansion needed to accommodate new citizens and businesses.

[1]The Bullard, Carawan and Rushing (1986) study entitled "Reduction In Waste Load from a Dairy and Ice Cream Plant" will be referred to as the Maola study throughout this report.

DAIRY WASTEWATER CHARACTERISTICS

Introduction

A basic understanding of the nature of dairy wastewater and influencing factors is essential for the control of dairy wastewaters. Harper et al., 1971, found that many dairy wastewaters, such as those from ice cream processing, have greater than 3000 mg/l biochemical oxygen demand (BOD). However, the authors of and EPA document (1974) suggest that 600 mg/l is achievable with maximum effort and cost for a fluid milk plant. Pollutants consist primarily of lost milk products.

The major source of waste load from Maola include milk and ice cream lost to the drain. Non-dairy ingredients that contribute to the waste load include sugars, fruits, nuts, cleaners, sanitizers, lubricants and domestic sewage.

Waste Load

The basis for water or wasteloads is not always consistent. Some authors use milk equivalents (ME); others use milk received (MR) and others products (P). Readers are cautioned to use a standard basis. Conversions are done throughout this report by the method of Carawan (1977) to present all water use and waste loads per amounts of products produced.

EPA published a summary (Harper et al., 1971) of waste loads from dairy plants. BOD_5 data included the following:

Type Plant	Waste Load ($lb\ BOD_5/1000\ lb\ MR$)	Waste Load ($lb\ BOD_5/1000\ lb\ P$)
Fluid Milk	4.20	6
Ice Cream	5.76	24

Waste loads vary with the level of management, the type of products and the processing equipment. For example, a fluid milk plant would be expected to have a smaller waste load than an ice cream plant because of the nature and composition of the products.

Water Use/Wastewater Discharge

Most dairy plants use more water than milk in processing. Water is used extensively in a number of areas. Harper et al. (1971) found that wastewater (WW) in dairy plants was as follows:

Type Plant	Wastewater (lb WW /lb MR)	Wastewater (Gal WW /1000 lb P)
Fluid Milk Plant	3.25	390
Ice Cream Plant	2.80	907

Water use (WU) for a multiproduct dairy in the NCSU study (1972) included the following areas:

Area		Water Use (Gal WU/1000 lb P)
Processing Plant		434.0
Offices		2.4
Refrigeration Shop		1.2
Garage		10.8
	Total	448.4

Water use in this study varied with the products produced as follows:

Product	Water Use (Gal WU/1000 lb P)
Fluid Products	205
Frozen Products	2146

WATER USE, WASTE LOAD, PRODUCT LOSS AND PRODUCT RECOVERY

To evaluate the effectiveness of a water and waste management control program, management must first estimate or measure water use, product loss and waste load. Sound judgment and good management require that scarce capital dollars be used first in those areas expected to yield the greatest increase in profits or reduction in operating costs.

Water and Waste Coefficients

Water use is always greater than wastewater discharge in a dairy plant. Reasons include consumptive water used in product, steam evaporation, and cooling tower losses. The authors of this report have observed dairy plants where the wastewater discharged was less than 50 percent of the water use.

Estimated water and waste coefficients for Maola after management action are shown in Table 1. Observed coefficients for Maola need to be determined and compared with estimated coefficients. Multiple sewer drains and water meter problems put these determinations beyond the time and resources of this project.

Product Recovery

Product recovery schemes can be a vital part of any water and waste management control program. A product recovery schematic with estimated volumes of product/water mix was prepared in the Maola study. Actual recoveries may vary greatly depending on operating practices. These estimates were prepared to help the project team explore the plant for product loss sources that contribute to waste load.

Projected recoveries (Table 2) were 3,005 gallons per day (GPD) of high solids product/water material. Other dairies report that this recovered material has about 2-2.5 percent BF and 2-6 percent MSNF. The value of this material as an ice cream ingredient could be about $400,000 annually. In addition, about 120 GPD of remelted ice cream valued at $80,000 annually could be recovered. Thus, Maola was judged by the research team to have the potential for recovering as much as 2410 GPD of ice cream ingredient valued at $480,000 annually.

However, equipment and product limitations for the proposed system will limit recovery to some level below this optimum. Also, this volume of recovered material may not be feasibly reused throughout the year. If the recovered material is not used as an ice cream ingredient, as much as 3,005 GPD of material could be used as animal food.

Table 1. Estimated Maola Waste and Wastewater Coefficients[a]

Product	Wastewater	Waste
	(gal/1000 lb)	(lb BOD/1000 lb)
Fluid Milk	300	4.5
Ice Cream	750	18
Drinks	75	1.5
Ice Cream Base	375	9
Total	350	8.5

[a]From Carawan, 1977

Table 2. Projected Recoveries[a]

Charge	Recovery
	(GPD)
CIP Raw Rinses	540
CIP Pasteurized Rinses	770
HTST Chases/Flushes	480
Filler	500
Ice Cream Remelt	120
Total Usable	2,410
Unusable	595
Total	3,005

[a]Maola study

RECLAMATION AND REUSE OF DAIRY SOLIDS

Milk is composed of approximately 12 percent solids dispersed in a water phase. These are the major components: fat 3.7%, protein 3.5%, lactose 4.2%, ash (minerals) 0.6%, and water 88.0%.

These solids can be concentrated, separated or dried. The typical ice cream and frozen dessert plant will use all forms of these solids. In many products, various sugars (cane, beet, or corn), powders such as cocoa, and other ingredients like candy, fruit, nuts and flavors are added. Stabilizers and emulsifiers may be used to control functional characteristics.

Since the milk solids used in frozen desserts are from a common source, these solids can be reclaimed from the manufacturing process to be reused in other products. Chief concerns with the reuse of reclaimed dairy solids are sanitation of the reclaimed products, their microbiological condition, wholesomeness or freedom from adulteration and compliance with applicable regulations. Other factors of concern are color (added chocolate or added flavor/color compounds), the presence of fruit, nuts and candy, or fermentation flavors as in the case of buttermilk.

Typically, in the ice cream industry, chocolate ice cream is chosen to rework flavored and colored reclaimed solids. A major hindrance to this is the presence of overpowering flavor compounds such as mint or the presence of particulates. Chocolate ice cream production may be limited in certain plants, restricting the use of reclaimed solids. For this reason, colored and/or flavored solids and white, unflavored solids should be separated.

Dairy products manufacture is covered by a host of applicable regulations. These regulations concern the origin of dairy solids, the holding of these solids and the final composition of the products in which they are used. These regulations were reviewed in detail in the Maola study.

Maola produces a chocolate imitation milk drink which uses vegetable fat in combination with dairy solids. If any of this product is recovered, the vegetable fat would be an adulterant for ice cream and other standardized frozen desserts currently produced by Maola. However, some shake bases could be formulated which use these types of solids.

Juices and fruit drinks contain solids not useful in certain ice cream mixes, but they could be reworked into products of their own kind. All the above products could be saved and returned to similar products, but a system would have to be designed to keep the solids separate.

A multiproduct plant such as Maola has an excellent opportunity to reuse the majority of solids in frozen dessert mixes. Recovered material not suitable for frozen desserts can be utilized as an animal food.

WASTE-RELATED PROCESS CHANGES AND ALTERNATIVES

Introduction

Waste-related process changes and process alternatives to decrease the BOD_5 load were evaluated collectively and individually. Changes utilized product-water recovery for use either as a raw material in ice cream mix or as an animal food. This study utilizes initial plans and cost information developed by Seiberling Associates for this plant including process modernization. These long range plans are combined with planned immediate projects for product recovery by M.G. Newell, Incorporated.

The recovered product must be microbiologically and chemically safe and legal for use as a product. Only in-plant tests can confirm the sanitary safety of a process.

These changes do not include all the waste prevention changes that a dairy could make but were selected for Maola. This evaluation was to study how these changes could be incorporated into Maola's plant.

Product loss and product recovery estimates and pollution prevented represent the best judgment of the research team. Losses and recoveries must be measured and documented after installation is complete. Materials recovered by this system and suitable for reuse in ice cream would mean increased revenue and reduction in pollution load.

Waste-related alternatives evaluated include:

(1) a collection tank for products or product-water mixtures
(2) a system to recover the HTST startup and changeovers from both pasteurizers which are product-water mixtures
(3) a system to aid in the recovery of frozen ice cream
(4) a system to aid the fluid milk filler operator in disposing of the milk products from the filler bowls and from damaged or underfilled cartons
(5) a system to recover an initial potable water rinse for the pasteurized product lines and tanks CIP system
(6) a similar system on the raw milk CIP system
(7) a system to aid in the collection for use or disposal of the milk-water mixtures from change (Figure 1)
(8) a collection tank for the collection of product water mixes for animal food
(9) a system to aid in the collection of materials from items (5) and (6)
(10) a sealed dumpster for solid waste
(11) elimination of water chases between products on the HTST's
(12) a loss prevention program for the plant

Summary

The changes were evaluated collectively (Figure 1). The total waste reduction for Maola was predicted to be 320,000 lb/yr of BOD_5 (Table 3). An initial investment for the changes was estimated at $53,530. Annual increased costs were estimated to total $35,006. The total net savings per year for the changes is estimated to be $302,050.

Figure 1. Waste Reduction in Maola.

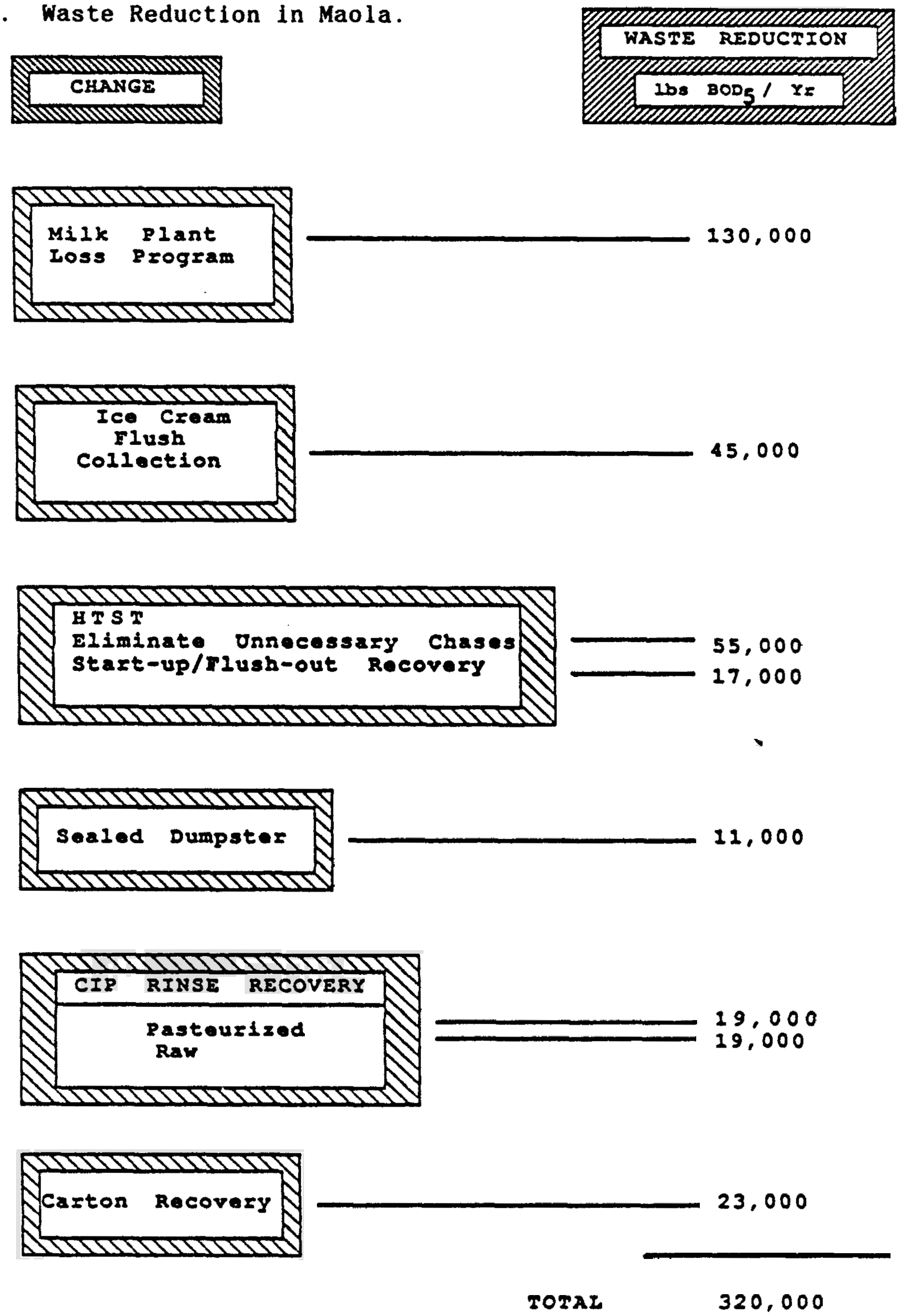


Table 3. Summary of Waste Reduction (BOD_5), Costs and Savings

Effect	Amount
Waste Reduction (lbs/yr)	320,000
Investment	$ 53,530
Annual Increased Costs	$ 35,006
Net Savings Per Year	$ 302,050

The waste reductions for the alternatives were as follows (Table 4): HTST recovery system, 17,000 lb BOD_5/yr; carton recovery system 23,000 lb BOD_5/yr; initial rinse recovery system for the pasteurized side, 19,000 BOD_5/yr; and the initial rinse recovery system for the raw side, 19,000 lb BOD_5/yr; milk plant loss programs, and sealed dumpster, 11,000 lb BOD_5/yr.

Initial Costs

Initial costs for the changes studied are summarized in Table 5. Costs were developed using estimates or quotes from manufacturers or suppliers. Most of the material costs are known while the labor for installation was from quotes or estimates.

Initial costs ranged from $22,620 for the animal food system to $1,920 for the carton recovery system. Several of the plant procedural changes were assumed by the team to have no initial cost. Total initial costs were $53,530.

Annual Budget Development

Budgets are developed with the methods and procedures detailed by Carawan, 1977. Values used for calculations are given in Table 6.

Reduced costs include potential surcharge prevention at $0.10 per lb. Actually, Maola is not paying a surcharge, but the value used is comparable to the costs for other nearby cities.

Increased revenues are shown for product loss prevented (if not lost, then milk need not be purchased) and for recovered butterfat and solids useful for ice cream formulation.

Loss prevention is calculated as a reduced cost. Loss prevention emcompasses energy cost, employee labor, etc. for products which are not lost but recovered. The values used are $0.02/lb for fluid milk and $0.05/lb for ice cream.

Increased costs are summarized in Table 7 and calculated utilizing in Table 6. Increased costs include maintenance, interest, depreciation, labor and utilities. Utilities include water use, energy cost and chemicals necessary for cleaning.

Increased revenue and reduced costs are added together for total savings (Table 8). Changes such as the Animal Food Recovery system with no reduced costs or increased revenue are shown with a negative net savings or loss.

Pasteurized Rinse Recovery

Rationale. Carawan (1977) noted that rinse recovery from tanks and lines can recover product loss and prevent pollution. He concluded that as much as 500 gal/day of product could be left in a dairy just from the design capacity of the included piping. Systems were presented for the recovery of product rinses.

Table 4. Dairy Product Recovery and Annual BOD_5 Recovery

Change	Daily Product Recovery	Recovered Product Description	Annual BOD_5 Recovery
	(lbs/day)		(lbs/yr)
Milk Plant Loss Program	5,000	milk	130,000
Ice Cream Flush	900	ice cream/water	45,000
Elimination of Selected HTST Product/Water Chases	4,000	milk/water	55,000
Sealed Dumpster	400	milk	11,000
HTST Start-up (Flush-out) Recovery	1,300	milk/water	17,000
CIP Rinse Recovery (Raw)	2,400	milk/water	19,000
CIP Rinse Recovery (Past.)	2,400	milk/water	19,000
Carton Recovery	860	milk	23,000
Total			320,000

Table 5. Initial Costs for Changes

Change	Material	Installation	Cost
	($)	($)	($)
HTST's Recovery	10,370	3,620	13,990
Ice Cream Flush Recovery	NC	NC	NC
High Solids Tank	a	a	a
Carton Recovery	1,800	120	1,920
Past. Rinse Recovery	b	b	b
Raw Rinse Recovery	b	b	b
Animal Food Recovery System	15,100	7,520	22,620
Sealed Dumpster	13,000	2,000	15,000
	Total		53,530

[a] Included with HTST's Recovery
[b] Included with Animal Food Recovery System where NC = no cost

Table 6. Notes on Costs and Budgets

1. Maintenance - 15% of material cost

2. Interest - 10.5%

3. Labor -
   Construction $20/hr
   Electrical $20/hr
   Sanitary Piping $30/hr

4. Plant labor - $8/hr

5. Electricity - $0.0557/kwh

6. Trucking - $0.60/mile

7. Butterfat - $1.81/lb

8. Milk - $23.80/100 lbs

9. Depreciation - Hoses, Nozzles, Tanks, Lines, etc.
   Expense 7 yrs. (14.3%); Buildings 20 yrs. (5%)

10. Ice Cream - $2.00/gal mix
    $0.22/lb mix

11. Dry Milk Solids - $0.90/lb

12. Surcharge - $0.10/lb BOD

13. Loss Prevention - $0.02/lb fluid recovery, $0.05/lb IC recovery

14. Sugar - $0.28/lb

Table 7. Increased Costs for Changes

Change	Labor/ Services	Maint.	Deprec.	Int.	Util.
	($)	($)	($)	($)	($)
HTST's	500	1,556	2,000	734	2,000
Ice Cream Flush Recovery	3,000				
High Solids Tank	a	a	a	a	a
Carton Recovery	2,000	270	274	101	250
Past Rinse Recovery	b	b	b	b	b
Raw Rinse Recovery	b	b	b	b	b
Animal Food Recovery System	12,500	2,265	3,235	1,188	1,000
Sealed Dumpster		1,950	2,145	788	250

Where: Maint. = Maintenance
Deprec. = Depreciation
Int. = Interest
Util. = Utilities
Labor = Additional time needed to incorporate change (includes cleaning)

[a]Services = charges such as transportation
[b]Included with Animal Food Recovery System

Table 8. Annual Budgets for Changes

Change	Increased Revenue	Reduced Costs: Potential Surcharge	Reduced Costs: Loss Prevention	Total Savings	Total[a] Increased Costs	Net Savings (Loss)
	($)	($)	($)	($)	($)	($)
Loss Prevention Program	172,500	12,500	25,000	210,000	-----	210,000
HTST's Recovery	7,056	1,700	3,250	12,006	6,790	5,216
Sealed Dumpster	-------	1,100	------	1,100	5,133	(4,033)
Ice Cream Flush	-------	------	------	-------	-----	--------
HTST Chase Elimination	69,000	5,500	10,000	84,500	-----	84,500
High Solids Tank	b	b	b	b	b	b
Carton Recovery	23,500	2,150	------	25,650	2,895	22,755
Past. Rinse Recovery	c	c	c	c	c	c
Raw Rinse Recovery	c	c	c	c	c	c
Animal Food Recovery System	-------	3,800	------	3,800	20,188	(16,388)
Totals	272,056	26,750	38,250	337,056	35,006	302,050

[a] From Table 7
[b] Included with HTST's Recovery
[c] Included with Animal Food Recovery System

Description. The recovery of the initial rinse of the CIP lines is recommended as a process alternative to recover product left in tanks and lines. It would also wash away removable residual product from the tank and line walls. The water would be discharged through the systems totaling about 20 gal water for each CIP cycle. The recovered material would be used for animal food.

Initial Cost. Costs are included with the recovery for animal food system.

Annual Budget. Savings and costs are included with the animal food system. Raw Rinse Recovery

Raw Rinse Recovery

Rationale. Justification for the raw rinse recovery for the raw side is the same as the pasteurized rinse recovery. Recovery on the raw side would be from the tankers, raw milk lines and raw tanks.

Description. The water rinse recovery technique as used for the pasteurized side would be recommended. A refrigerated tank will be required to recover the rinse materials during the day. The system is shown in Figure 2.

Initial Cost. Costs are included with the animal food system.

Annual Budget. Savings and costs are included with the animal food system.

Animal Food Recovery System

Rationale. Product recovered that is not needed or is unsuitable for product use can be sent to dairy or beef cattle farms for feeding cattle. Each 1000 gallon of this recovered product-water mix collected and sent to the farm removes about 260 lb BOD_5 from the BOD_5 load of the Maola plant.

Description. Product and product-water mixes would be recovered from the ice cream plant, pasteurized CIP rinse recovery and raw CIP recovery. Materials necessary would include piping, air valves, fitting and pipe, load out pump, a tank (1,000 gal) and a truck with a tank.

Initial Cost. Costs were detailed to include tank, five air valves, one check valve, three sight glasses, five pilot valves for air valves, load out pump and necessary hangers, fittings and pipe (Table 5). A truck was assumed to be bought by someone else and the cost will be show as transportation charges or service.

Initial costs for materials were $15,100. Installation labor was estimated to total $7,520.

Annual Budget. Reduced costs for the animal food recovery system included potential surcharge elimination of $3,800 for the 38,000 lb BOD_5 recovered (Table 8). Increased costs totaled $20,188 largely as a result of the $50/day projected for transportation of the recovered material. The annual loss was $16,388.

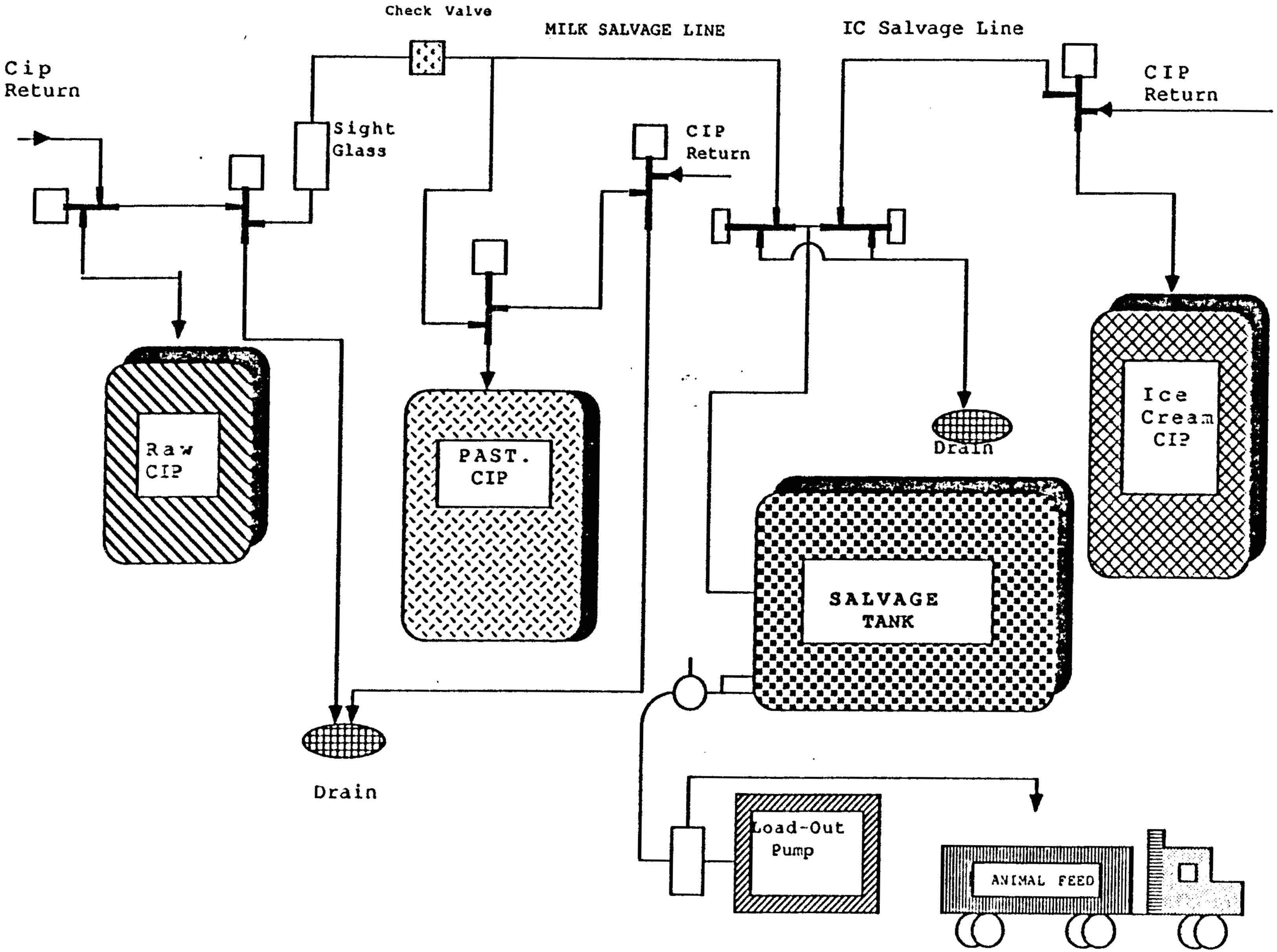


Figure 2. Animal Food Recovery System.

Sealed Dumpster

Rationale/Description. A sealed bottom dumpster was purchased to contain any product from returned product cartons or damaged packages. The sealed unit contains the solids which are pumped to barrels for use as animal food.

Initial Cost. The initial costs of the system with pad and electrical approached $15,000 as shown in Table 5.

Annual Budget. Reduced costs included only surcharge reduction of $1,100 (Table 8). Increased costs were $5,133. Net loss for the year was $4,033.

Recovery System for HTST's

Rationale. Carawan (1977) reviewed the merits and techniques for the recovery of HTST startup, changeover and shutdown mixtures of product and water. Suggested methods included systems utilizing manual timing, automatic timing or meter-controlled volume measurement.

Description. The manually-controlled system was selected on the recommendation of a dairy industry supplier. The system will be manually controlled using sight glasses. The recovered material will be directed with the valves into the High Solids Recovery Tank (Figure 3). After a test for butterfat and solids, the recovered material will be sent to the ice cream plant to be used as an ingredient.

Necessary materials include tank, transfer pump, air valves, sight glasses, tubing, fittings and hangers.

Initial Cost. Material costs totaled $10,370 (Table 5). Labor for installation was $3,620. The total estimated costs for installation were $13,990.

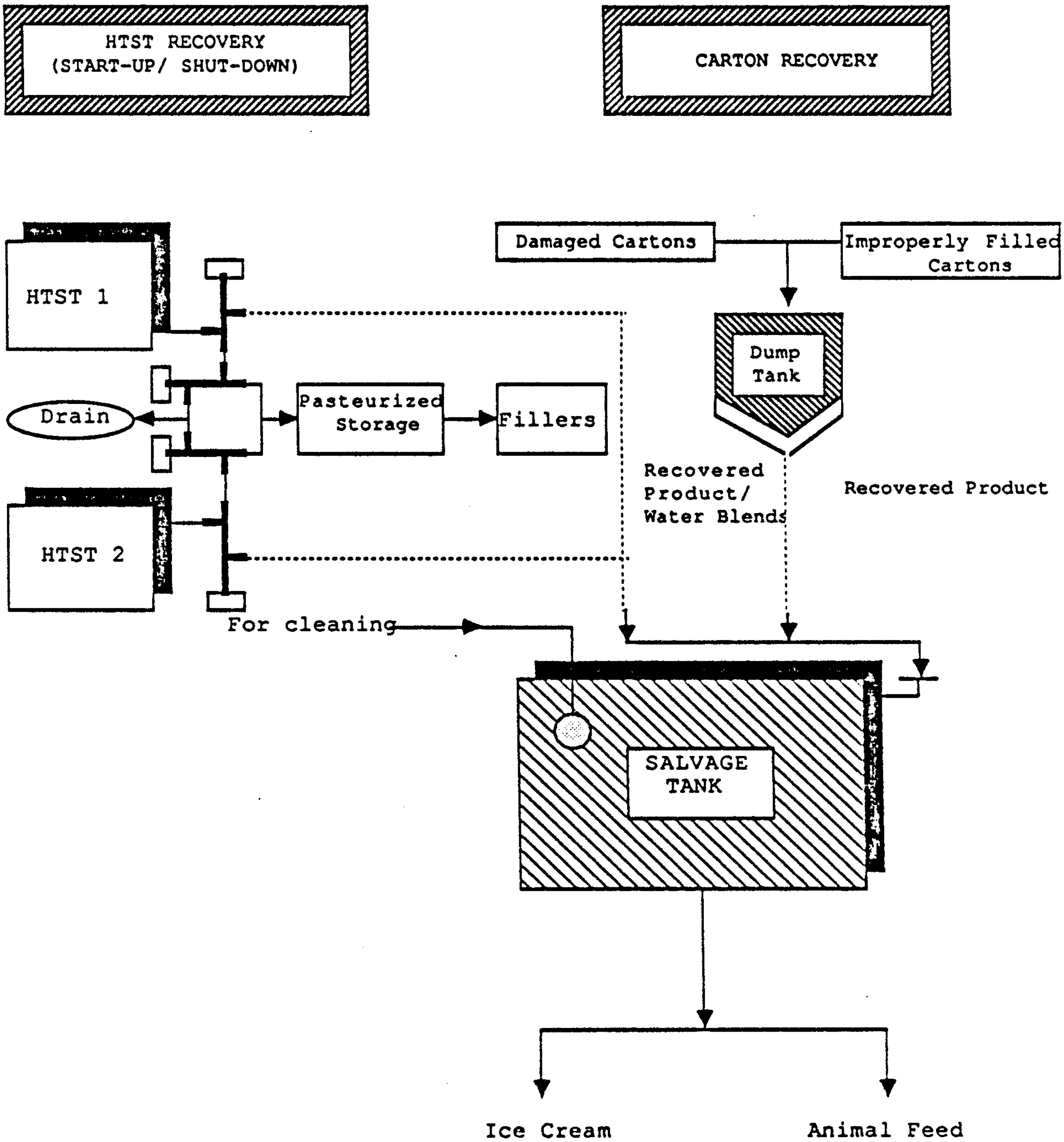
Annual Budget. Reduced costs were $1,700 for surcharge elimination and $3,250 for loss prevention reduction (Table 8). Increased revenue was estimated at $7,056 for the butterfat and milk solids recovered for ice cream. Total savings were then $12,006.

Increased costs are expected to be $6,790 annually. The recovery of HTST startup and shutdown mixtures will save Maola $5,216 annually.

Carton Recovery System

Rationale. A filler recovery system for foam filler bowl dump and damaged or underfilled cartons was first described in an EPA development document (1974) and has been subsequently described by Carawan (1977). A limited number of the systems are installed and functioning in the industry. Based on operating plant performance data, it is determined that such a system could recover as much as 500 gal/day of product.

Figure 3. High Solids Recovery System.



Description. The system proposed for filler recovery was a recovery tank to be used by the machine opertor to dump damaged or improperly filled cartons. The recovered material is pumped to the high solids recovery tank.

The recovered material, having been collected in a sanitary fashion, is considered suitable for use as an ice cream ingredient. The recovery should approximate 100 gal/day or 860 lb/day of milk. Pollution prevented would be 86 lb/day of BOD_5

Materials needed would include a 50 gallon tank, sanitary pump, float switch, valve and piping. The recovery tank would be located adjacent to the High Solids Recovery Tank.

Initial Cost. Costs for the system were estimated at $1,920 (Table 5). These include $1,800 for equipment and $1200 for labor.

Annual Budget. Reduced costs for the carton recovery system include surcharge prevention and is shown in Table 8. Total reduced costs were $2,150. Increased revenue of $23,500 was predicted from the use of butterfat and solids. Total savings were $22,755.

High Solids Recovery System

Rationale. The high solids recovery system was a necessary part of other systems evaluated for waste reductions. The carton filler recovery and the HTST recovery systems required a system through which their recovered materials could be used most beneficially (ice cream formulation).

Description. The high solids collection system was a two-compartment 1,000 gal refrigerated tank with two inlets and one outlet. The outlet had a pump and air valve to direct the material either to the ice cream blending area or to the collection tank for disposal or animal feeding. A 3-valve cluster would be required on one inlet.

Initial Cost. The initial cost is included with the HTST recovery system.

Annual Budget. The costs and savings are prorated with the changes utilizing this system.

Milk Plant Loss Program

Rationale. Researchers at N.C. State University (Carawan et al., 1972), Purdue University (Chambers et al., 1981) and The Ohio State University (Harper et al., 1971) have consistently shown that real losses of milk exceed accounting losses by 2-20 fold or more. Reasons for the difference may include:

(1) Leaks
(2) Foaming
(3) Losses from defective cartons
(4) Losses from damaged cartons

(5) Neglect of product weight control in cartons and containers
(6) Inaccurate or inconsistent standardizing
(7) Basic inaccuracy of tests used by dairy industry such as the Babcock test for butterfat
(8) Failure to obtain representative samples
(9) Assumptions used in fat and milk loss accounting, such as the assumption that every carton of a given product contains an exact amount of a given composition. This is not always accurate.

Description. Management at Maola is dedicated to maintaining accurate records to reveal losses and waste. New waste management controls are still being planned, but are beyond the scope and time frame of the current project. However, management emphasis during this project has resulted in impressive gains in accounting for milk solids. A new system was developed and implemented in September of 1985.

The Maola study reported that management at Maola had made impressive reductions in losses of product to the drain. These reductions were achieved through employee training and the institution of more accurate records to reveal losses and wastes. As the system was implemented in 1985, milk loss was reduced by more than 100,000 lbs/mo over the final quarter of the year.

Even with these reductions achieved in the final quarter of 1985, plant records for 1986 revealed a 34 percent reduction in milk loss in 1986 as compared with 1985. The loss prevention program saved 1,571,445 pounds of milk for the year. This is equivalent to 6,286 pounds of milk per day and a pollution reduction of 629 pounds per year.

Some of this loss prevention may be a part of other changes reported elsewhere in this report. The authors believe that a 500 lb/day reduction in BOD_5 is reasonable to attribute to this program.

Initial Cost. There were no costs that can be attributed to this program. The authors acknowledge that management time was spent on this program. Also, training of supervisors and employees was critical to the successful implementation. However, the research team believes that this was part of normal management activities that was more successful than past efforts. The success can be directly related to management interest and concern about pollution and waste.

Annual Budget. Increased revenue was $172,500 for the 1,250,000 lbs of milk saved (Table 8). Reduced costs from this product loss prevention included $12,500 in potential surcharges and $25,000 in loss prevention. Total savings were $210,000 with the same net savings.

HTST Chase Elimination

Rationale. Many dairy plants have elminated the water chase between products by careful scheduling. Maola management had not done this until the waste implication was weighed with product quality concerns.

<u>Description</u>. The scheduling of products through the HTST was reviewed. A scheme was developed and implemented to minimize the need for water chasing between products.

<u>Initial Cost</u>. There were no costs associated with this program.

<u>Annual Budget</u>. Increased revenues for an annual basis were projected at $69,000 (Table 8). Reduced costs included surcharge prevention ($5,500) and loss prevention ($10,000). As there were no increased costs, total saving was equal to net savings ($84,500).

Summary and Discussion

Annual waste reduction with all changes incorporated would total 320,000 lb BOD_5 per year (Table 4). Net savings would total $302,050 (Table 3). Investment needed would be $53,530 (Table 3) with annual increased costs of $35,006 (Table 3).

A plant that was last remodeled in the late 1950's would require a total renovation of its building and processes. Maola's management has begun to contract engineering service for process and building changes.

Ultimate changes, which would include re-piping and automation, would exceed $1,000,000 and may exceed $2,000,000 to include the latest automated controls and computer-drive operation. These all-inclusive changes will aid in eliminating bad employee decisions which hinder product recovery and pollution prevention.

Other plant managers reviewing this report should note that the largest waste reduction changes with the greatest savings involved no initial costs. The research team questioned whether the projected savings could be maintained when the new systems are installed. The losses are continuing even though there has been a dramatic reduction in loss over the last year (34 percent).

The surcharge used for predicting savings was lowered to move accurately reflect expected surcharge costs. The Maola report had used $.20/lb BOD_5 while this report uses $0.10/lb BOD_5.

This report reflects similar reductions in pollution load (BOD_5) when compared with the previous report. However, there are significant differences in initial and annual costs. The research team projects that smaller investments will lend to smaller savings. This is largely due to the use of manual controls instead of the automated controls projected in the earlier report. This selection was dictated by the immediate need to achieve reductions in waste load.

In the near future, the research team would encourage the installation of more automated recovery systems. When this happens, more of the recovered material should be suitable for food grade uses.

CONCLUSIONS AND RECOMMENDATIONS

This project was a continuation of a feasibility study for the reduction of waste load in the Maola plant by waste prevention and the recovery and reuse of milk solids. Milk plant losses dropped over 100,000 lbs per month.

Management's encouragement is an important factor in making the loss prevention/waste control program successful. For the program to function, it must have top management backing and be thoroughly understood at all employee levels. Maola has demonstrated its dedication to pollution prevention through initiation of recommended programs.

A recovery system was designed to recover lost solids for reuse in ice cream or for use as an animal food. Implementation of the complete system is expected to eliminate 320,000 lb BOD_5/yr.

A dairy plant can reduce pollution. Most of the changes being incorporated into Maola were found to be cost beneficial. The recovery of product for animal food was not found to be cost beneficial, but is an effective method of reducing pollutional load (BOD_5). As the cost of treatment of BOD_5 increases, so does the savings from animal feed recovery.

It is recommended that:

1. More effort be made toward an accurate assesment of water use and waste load.

2. Management must maintain supervisory and employee awareness of the critical nature of waste control.

3. Management must continue to work with the City of New Bern to develop a mutual understanding and respect for common wastewater concerns. New production, products and processes must be carefully implemented with full care and concern for pollution.

4. The dairy industry needs to seek new process to reduce losses and new regulations to allow use of recovered material.

5. The strict and more accurate product loss accounting system must remain implemented and be improved if feasible.

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