COMPUTER MODELING AND SIMULATION OF TANNERY WASTE TREATMENT OPTIONS USING THE PROCESS ANALYSIS SYSTEM PACKAGE FOR COMPARATIVE STUDY

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PREFACE

This study is concerned with the modeling and simulation of three different waste treatment options for a tannery. The simulation package used is the Process Analysis System (PAS) which has been developed by the School of Chemical Engineering at Oklahoma State University, Stillwater, Oklahoma. The primary objective of this study is to design the various processing units as well as compute all annual costs in each case. The results of the simulation run is used to carry out a comparative analysis of the three waste treatment options under consideration.

The author wishes to express his since gratitude to Mrs. Barbara Radhen, who made pursuing higher education in the United States possible. The author also wishes to express his appreciation to his major adviser, Dr. Ambrose Goicoechea, who not only offered guidance and assistance through the course of this study but also offered a research assistant position when it was most needed. Special appreciation is also expressed to Dr. Joe H. Mize and Dr. M. P. Terrell for having given the author the privelege of pursuing a master's degree in Industrial Engineering as well as accepting to be committee members and offer invaluable assistance in the preparation of the final manuscript. Appreciation is also expressed to the other committee member Dr. Robert L. Henrickson for his constant encouragement and permitting me to be part of the research team on the 'Hides' project at Oklahoma State University. Research for this study was financed in part by U.S.D.A., Science and Education Administration, Eastern Regional Research Center, Philadelphia, Pennsylvania, Cooperative Agreement No. 58 - 32 - U - 4 - 8 - 2.

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CHAPTER I

INTRODUCTION

The universal appreciation of natural products is an established fact. Leather is an extraordinary example of a product that has enjoyed universal appeal through out the ages. It is no doubt a timeless fashion, and is destined to continue as such. The smartest outerwear for men and women, the upholstery for the best cars and professional baseball gloves, are made of leather. Leather products depicts prestige, durability, eye-appeal and healthful properties. Leather has been held in high esteem from earliest civilizations right up to present times.

Unfortunately, the leather industries in the United States are in dire straits and are on the brink of financial ruin. To overcome the present predicament, the hide and leather industries in the U.S., meeds to make major economizing organizational changes to tide over the present state of affairs. The United States happens to be the largest producer of cattle hides in the world. The current state of affairs can be attributed to many reasons. Among them are the current U.S. policy on export of hides and imports of finished leather products, decline in the number of hides produced in the country in recent years, and strict pollution control standards imposed by the Environmental Protection Agency (1). During the year 1977 alone, U.S. exporters received $ 583 million for cattle hides but the American consumer forked out $ 2.39 billion for finished leather products from foreign countries. This means a trade deficit of $ 1.8 billion (2).

The Tanners Council of America, Inc., is concerned about the predicament of the hide and leather industries and is drawing the attention of Senators and Congress on U.S. Export Policy. United States hides and skin exports have been steadily increasing each year. As such, imports of shoes and other leather products have also been increasing each year. Such policy on the part of the U.S. Government has resulted in a net deficit in foreign trade of hides and skins. These figures and graphs are depicted in Appendix A.

The tanning industry in the U.S. is thus faced with increased production costs caused in part by stricter pollution control regulations and increased competition from foreign tanneries for hides. Over the years as the amount of hides produced in the U.S., has been declining, the demand for leather goods have been steadily increasing. The reduced supply of hides and the increased competition from foreign tanneries has resulted in domestic tanneries paying more for their hides.

Since hides are a by-product of live stock production, the supply of hides does not respond to the price of hides. In other words, the supply of hides are inelastic to prices of hides. As such, the tanning industry does not influence the supply of hides. However, the price of hides are influenced by the export policy of the U.S. Government as nearly 60 percent of hide production are exported annually (1).

For hundreds of years the tanning industries have been located in the north eastern region of the country. Hides are to a very large extent produced in the midwest region of the country. Hide, which happens to be the leading by-product from cattle, is the number one animal renewable agricultural resource produced in Oklahoma. During the year 1976, hide sales in Oklahoma generated an income of over $ 15 million. The location of Western Oklahoma within the center of the high plains cattle feeding area (Oklahoma, Texas, New Mexico, Colorado and Kansas) provides access to 12,275,000 hides or approximately 25 percent of the annual U.S. supply. Slaughter facilities scattered throughout the high plains area total 995 plants, and 52 of these plants each slaughters over 50,000 head annually. It is also found that the hides from Oklahoma and the high plains feedlot area command a premium price because of their potential leather quality (3).

It is therefore argued that the general economy of Oklahoma would benefit by the location and development of a tanning industry in Oklahoma. A feasibility study which is being conducted at Oklahoma State University by the Research Team is considering five potential sites within the state for location and development of such an industry. This is shown by Figure 1 in Appendix B. Presently, hides are salted for pickup and delivery to one of the several centralized collection points such as Oklahoma city, Enid and Muskogee, where they are sold and exported to other states.

The hides from the slaughter houses in these regions are salted to prevent deterioration and then transported to the tanneries. This causes a special problem for tanneries in the eastern region as the waste streams contain a large proportion of salts and E.P.A. insists that any effluent discharged from tanneries should be free of salts.

Salt removal is an expensive process and tanneries are in a dilemma. Also, transporting hides from the high plains region (Oklahoma, Colorado, New Mexico, Texas and Kansas) to tanneries is North-eastern part of the country is expensive. It has therefore been recognized by a team of Research Scientists headed by Dr. R. L. Henrickson at Oklahoma State University, that it would be wise to establish a tannery in the high plains area close to source of fresh hides and thus minimize costs. In particular, the climatic conditions of Oklahoma would be very conducive to the operation of any kind of tannery enabling disposing of effluent waste by lagoon evaporation and residual burial (4).

The Eastern Regional Research Center, Agricultural Research Center, U.S.D.A., located at Philadelphia, Pennsylvania, has been for long cognizant of the state of affairs concerning the hide and leather industries in the United States. As such, they have been conducting studies and surveys in order to seek better operation methods of tanneries in the U.S. The Eastern Regional Research Center was also aware of the interest shown by the team of scientists at Oklahoma State University for establishing a tannery in Oklahoma. The Research Center then nominated Oklahoma State University to study and develop a systems model capable of assimilating known information about the industry and providing information with which to analyze problems faced by the industry. Thus the systems model should focus upon:

1. Modeling the hide processing plant and waste treatment processes.

2. Determination of the optimal location and scale of hide processing facilities.

3. Developing transportation models to aid in efficient collection and distribution of hides and hides products.

4. Analyzing the factors affecting hide supply and product demand.

To carry out such a large scale and ambitious study, joint and concerted effort on the part of the various departments at Oklahoma State University is essential. Thus, the research team consists of experts from various departments such as Industrial Engineering, Agricultural Engineering, Agricultural Economics, Chemical Engineering, Environmental Engineering and Meat Sciences. This is one such case where so many departments were jointly involved with a single project at Oklahoma State University which by itself conveys the nature and magnitude of the research effort.

This report will however confine with the portrayl of the waste treatment sub-system model wherein three different effluent handling schemes have been currently proposed by the research effort at O.S.U. The mathematical models developed would be capable of predicting the capital and operation costs for each unit process as well as sizing each. The computer model would be capable of simulating each unit operation as well as couple all unit processes and present individual schemes. It is desired that all processes be modern and are designed with the future requirements in mind for years ahead.

System simulation is rapidly becoming popular and is a powerful tool for examining various alternatives for a problem at considerably less cost. The electronic computer has proved to the very useful for simulating various systems. Thus, the significant increase in systems simulation has almost paralleled the growth of electronic computers.

Some of the systems that have been successfully simulated are business/ economic systems, social systems, environmental systems or even other computer systems. One of the many reasons for simulating systems on a digital computer is the rapidity with which results could be obtained. Another reason is the provision it gives to consider the problem to any level of detail. It is therefore the ambition of the research team on the 'Hide Project' at O.S.U. to build a comprehensive model for a modern tannery that would be ideally located and operate efficiently and at optimal costs.

Statement of the Problem

It is an established fact that the U.S. tanning industry is currently in an economic bind. The industry is faced with increasing production costs, partly due to stricter pollution regulations and partly due to increased competition from foreign tanneries for hides. In addition, U.S. hide supply has been declining while the demand for finished leather has been increasing. Cheaper synthetic products are competing keenly with leather products and energy prices are increasing rapidly in recent years. It is therefore very important for tanners to make the right decision with regard to various tanning processes options involved including the various waste treatment options available.

Since pollution control happens to be one of the major cost factors for the efficient operation of a tannery, the computer simulation technique is adopted to study the various waste treatment options under consideration and to aid in making the optimal choice. The problem of this report is therefore to:

a) model 3 different schemes for waste water disposal for a modern tannery

b) simulate the individual schemes with the help of the electronic computer

c) analyze and compare the results obtained on cost basis to aid the decision maker.

Significance of the Study

The mathematical and computer model presented in this study can be useful to any tanner who wishes to analyze waste water disposal schemes for existing or new tanneries. The model is flexible and the various parameters can be varied according to users choice. The model will provide a quick appraisal of the different schemes under consideration.

Limitations of the Study

The model in its present state is limited to handling waste water disposal schemes for tanneries. The model could be modified and used for handling other industrial and municipal wastes as well as simulate production lines.

Definition of Terms

Biochemical Oxygen demanding material (BOD):

This is the most widely used measurement of effluent purification or efficiency of waste water treatment processes and is the amount of biochemical oxygen demanding material which has been removed by the process. The units used are mg/l. Waste waters contain organic food (i.e., proteins, carbo hydrates etc.) and microorganisms feeding on them require oxygen and thus deplete the dissolved oxygen in the streams. If wastes are led into rivers and streams, depletion of dissolved oxygen is very serious and harmful to fish and other water life. The more the organic food in the stream, the more will be the oxygen demanded by the microorganisms feeding on them. Thus the amount of oxygen demanded is an indirect measure of the degree of pollution the waste water stream contains.

Organization of the Study

In Chapter I is included the Introduction, Statement of Problem, Significance of the study, Limitations of the study and Definition of terms. Chapter II is the Review of Literature section for design calculation of various unit processes and cost evaluation. Methods and procedures used are described in Chapter III while analysis of results from computer output is included in Chapter IV. Chapter V is the summary, conclusions and recommendations section of the study.

CHAPTER II

REVIEW OF LITERATURE

Until very recently, the designing of waste treatment plants have been primarily a rule-of-the-thumb method. As Environmental Protection Agency (EPA) standards have become more stringent, the need for more accurate and efficient design is inevitable (5).

Kincannon and Gaudy (1974) discuss the result of Carbon content in effluents. Micro-organisms require oxygen to convert this carbon to carbon dioxide and water. During this process there results formation of more micro-organisms or cells and these seperate out as biological sludge. The more the substrate (organic food) is consumed the more will be the sludge formation. It is therefore necessary that we try to help the microorganisms to consume as much of the substrate by supplying it sufficient oxygen so that the ongoing effluent meets E P A standards.

A feasibility study conducted by Roit Corporation (1975) for the office of Community Affairs and Planning, State of Oklahoma indicates that approximately 60 percent of the tanneries discharge their effluent into municipal systems and pay for the services. In recent years, there is however a trend toward atleast some pretreatment by all tanneries following increased effluent restrictions imposed by municipal systems. The survey results by Roit also indicate that only 15 percent of the tanneries in the country have viable secondary waste treatment facilities at the plant site. Thus waste treatment practices in tanneries vary widely, ranging from no treatment to activated sludge systems. For those plants discharging directly into rivers or streams, waste treatment facilities are said to be severely lacking in the industry. The survey concludes that no exemplary waste treatment plants handling only tannery wastes presently exist.

Kincannon and Gaudy (1975) show a typical scheme that ought to be employed for secondary treatment of wastes if strict E P A standards exists. Such a scheme would be as indicated in Figure 1.

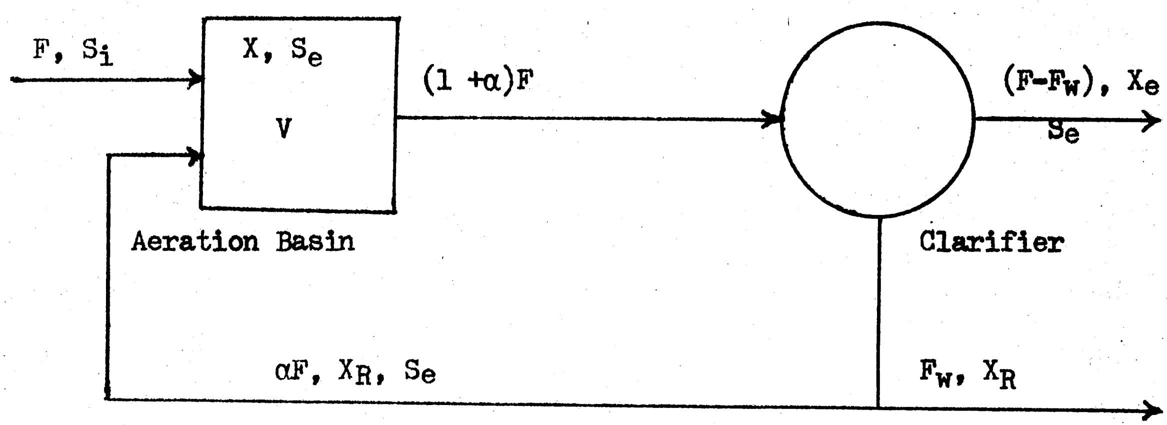


Figure 1. Simple Waste Treatment Scheme

The diagram merely indicates material balance as effluent flows from one unit process to another. The influent rate to the aeration basin is represented as F amd the B O D content or substrate is indicated as S_i. In the aeration basin it is required that the mass be throughly mixed and sufficient quantity of oxygen is supplied for the conversion of the substrate into biological solids. Note that the diagram shown is the case of a continuous process and the aeration basin and clarifier need to be appropriately designed for the desired level of substrate consumption. In the aeration basin, S_i is reduced to S_e and X is the amount of biological solids (cells) formed. In the clarifier then much of the solids are separated and $(F - F_w)$ is the flow rate and S_e is the substrate level (desired level by user or E P A) and X_e is the amount of solids still in the stream. Part of the sludge recovered from the clarifier is then pumped back to the aeration basin. The purpose of this is to achieve quicker conversion of substrate into carbon dioxide and water.

The biological cells are nothing but microorganisms or cell population. As more cells are introduced into the aeration basin, they demand more food. Hence the cells are always in a starved condition and thus quickly consume the substrate entering the aeration basin. This process is cheap as sludge formed are reused to separate out more solids.

Cost curves for estimating capital cost for each unit process has been established by Weston Consultant Designers (6), while conducting a survey for the Environmental Protection Agency during 1977. Cost curves for predicting labor costs and power costs for each unit operation are also available in the research series published by the Environmental Protection Agency (7). Dr. Kincannon at Oklahoma State University developed cost equations that best fit the above mentioned cost curves.

CHAPTER III

METHODS AND PROCEDURES

Introduction

Conversion of hide into leather involves many machines and facilities. Also, hide processors are confronted with many alternatives to decrease costs per unit of marketed commodity. A critical set of alternatives is the waste treatment possibilities. It is therefore necessary to completely analyze various alternative operations in order to avoid costly mistakes. Negligence in completely considering waste treatment may result in forced shut down of the processing operation. At the same time, management will be faced with making critical decisions in selecting the right size of treatment plant which would be compatible with capital and labor resources.

A computer program to enable the rapid computation of waste treatment alternatives will be developed. The waste treatment model will be designed for maximum flexibility using minimum inputs. This will enable the user to change waste treatment steps or conditions easily. The program will also calculate the size of each unit operation and predict expenses for each process or facility. The program will also be such that all other programs can be combined and thus provide a total system model. The user will be responsible for selecting basic process elements and inputs.

ALTERNATIVE SYSTEMS:

The three waste treatment schemes that will be modeled in this report are:

1. Screening plus Evaporation Pond
2. Screening plus Aeration Basin plus Evaporation Pond
3. Complete Activated Sludge Treatment

System I

A schematic diagram depicting scheme I is shown in Figure 2.

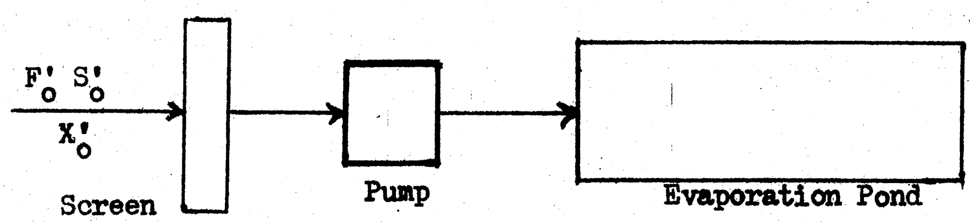


Figure 2. Waste Treatment System I

In this scheme the waste water stream from the tannery plant is first filtered by passing through a screen. Here, most of the suspended solids including hair is filtered and the effluent is then pumped into an open evaporation pond. No treatment or reduction in BOD content is attempted in this scheme. The waste is left open for natural evaporation to take place.

The design amd cost equations for the screen and the evaporation pond elements as compiled by Dr. Kincannon at Oklahoma State University is as follows:

SCREEN:

Capital Cost in \$ = $0.0158(F')^{0.93}$

Operation and Maintenance Cost = \$/Yr = $(1700+18.5T)(F')^{0.056}$

EVAPORATION POND:

$$\text{Pond Area in acres} = \frac{3.08 \times 10^{-6} F'T}{E-R}$$

$$\text{Capital Cost in \$} = 3.4 \left(\frac{F'T}{E-R}\right)^{0.713}$$

OPERATION AND MAINTENANCE COSTS:

FOR WARM CLIMATES:

$$\text{manhours/Yr} = 1.73 \times 10^{-2} \left(\frac{F'T}{E-R}\right)^{0.624}$$

$$\text{Material and Supply Cost in \$/Yr} = 0.45 \left(\frac{F'T}{E-R}\right)^{0.509}$$

FOR COOL CLIMATES:

$$\text{manhours/Yr} = 9.89 \times 10^{-3} \left(\frac{F'T}{E-R}\right)^{0.63}$$

$$\text{Material and Supply Costs/Yr} = 0.234 \left(\frac{F'T}{E-R}\right)^{0.511}$$

where

F' = Flow rate, gals/day

S_o' = Influent BOD, mg/l

X'_o = Suspended solids, mg/l

E = Annual Evaporation, ft.

R = Annual Rainfall, ft.

T = Working days per year

USER INSTRUCTIONS:

1. Must establish working days per year.

2. Must determine evaporation and rainfall rates for location of plant.

System II

Scheme II is very similar to Scheme I except that an aeration basin is provided before the waste is led into the evaporation pond. Air or oxygen is supplied to the waste stream in the aeration basin so that most of the sulphides are converted to sulphur dioxide. This would eliminate any odor emanating from the evaporation pond. A schematic diagram of system is shown in Figure 3.

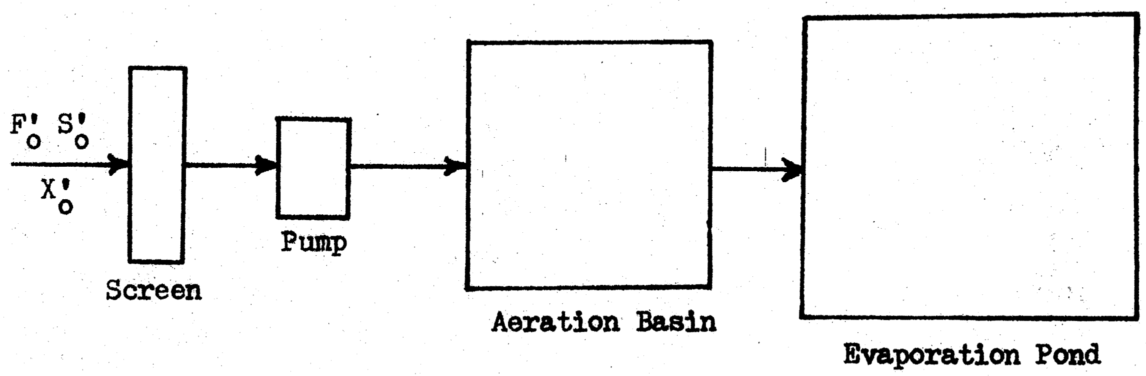


Figure 3. Waste Treatment System II

The design and cost equations for the screen and pond elements remains unchanged. The design and cost equations pertaining to the aeration basin are shown below:

$$\text{Area of basin in acres} = 7.4 \times 10^{-5} \left(\frac{F't_a}{D}\right)$$

$$\text{Capital Cost in \$} = 2.4 \left(\frac{F't_a}{D}\right)^{0.619} + 0.698(F't_a)^{0.654}$$

$$\text{Operation Labor, manhours/yr} = 6.235 \left(\frac{F'T}{E-R}\right)^{0.372}$$

Maintenance Labor, manhours/yr = $0.619 \left(\frac{F'T}{E-R}\right)^{0.415}$

Power Costs/yr in \$ = $0.012 \left(F't_a\right)^{0.825}$

Material and Supply Costs/yr = $0.012 \left(F't_a\right) 0.531$

USER INSTRUCTIONS:

1. Must set depth of aeration basin - typical value = 10'.

2. Must set detention time of aeration basin - typical value = 72 hours.

where

D = Depth of Aeration basin, ft.

t_a = Detention time in aeration basin, hours

System III

Such a system would have to be adopted wherein the quality of the effluent exiting a tannery has to conform to strict pollution control standards. Unlike the other two systems described earlier, this system is more complicated and involves a number of unit processes as indicated in the diagram. Such a system would be considered as a secondary treatment system and as mentioned earlier, there are hardly any such treatment facility among the tanneries in this country. Such treatment facilities are relatively new for tannery waste treatment and many tanneries in the country may be forced to adopt such treatment schemes in the near future, owing to more stringent EPA laws. A schematic diagram of System III is depicted by Figure 4.

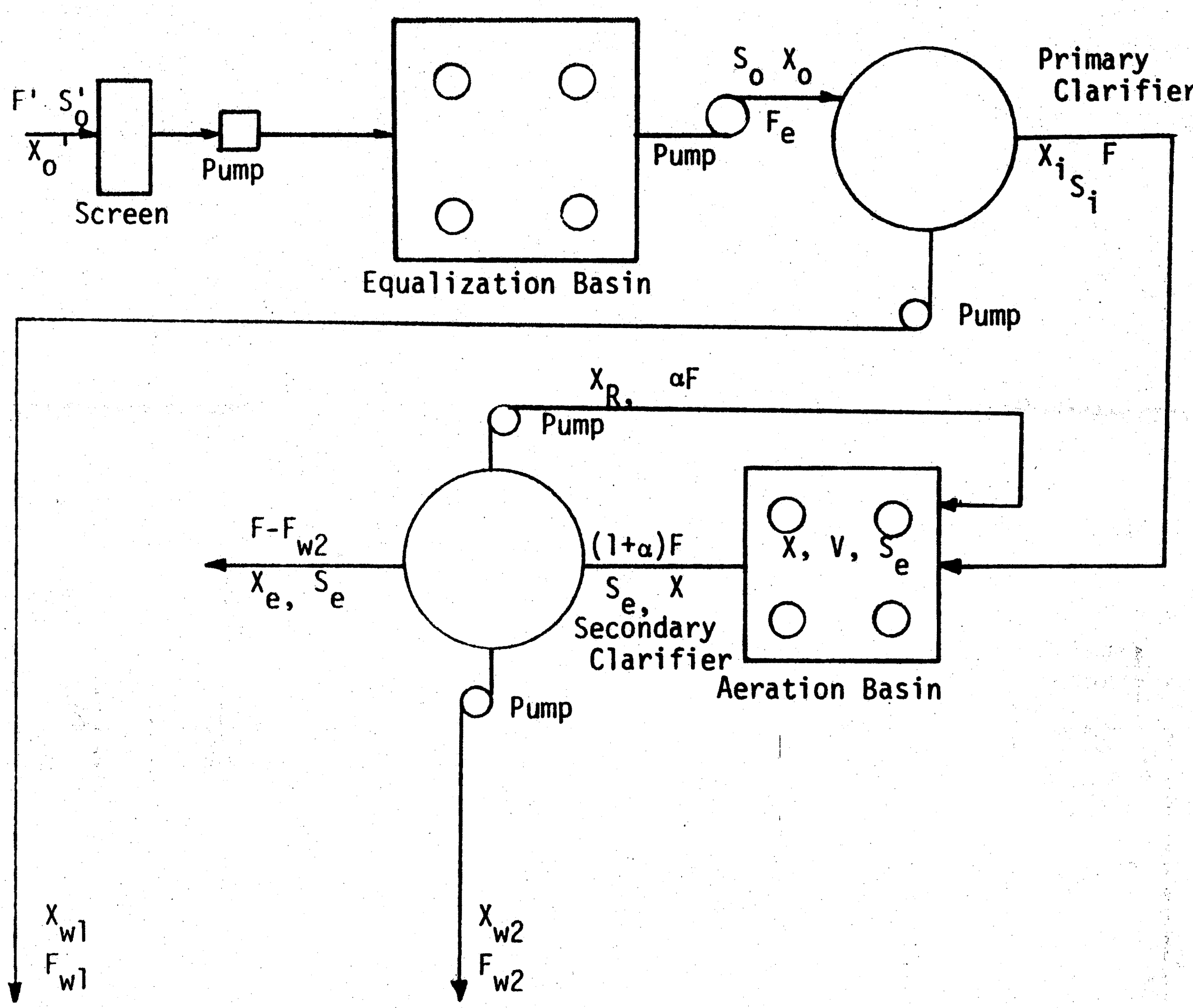


Figure 4. **Waste Treatment System III**

The effluent leaving such a system can be made to conform to E P A standards and as such can be led into municipal sewers or a river or stream if one is close by. The equilization basin serves the purpose of feeding the system with a constant load. The characteristics of the waste water from tanneries is likely to vary from day to day or even shift to shift. The provision of an equilization basin ensures a uniform load on the system so that the system will not be over loaded or under loaded at any time. Thus, efficient operation of the plant is ensured.

Effluent from the equilization basin is first led into a primary clarifier. The purpose of a primary clarifier is to slow down the velocity of flow and cause settlement. This results in the removal of some of the soluble organic solids from the stream. The bottoms or settled material is led from the bottom and taken over for sludge treatment processes. The effluent leaving the primary clarifier is then led into am Aeration Basin.

The purpose of the aeration basin is to supply air or oxygen to the microorganisms present in the waste stream. This facilitates the microorganisms to feed on the substrate or carbon compounds present in the waste stream. This process results in the emission of carbon dioxide and flocculation of the microorganisms. Also, more cells separated in the final clarifier are fed back into the aeration basin thus increasing the cell or microorganism population. As the population increases, the demand for more food also increases and the conversion of carbon compounds into carbon dioxide is also increased. The substrate or soluble BOD still remaining in the waste stream can be controlled in the aeration basin to conform to the desired level or standards set by E P A.

The secondary clarifier serves the main purpose of separating biological salts precipitated in the aeration basin. This results in a clear effluent leaving the system. Part of the precipitated micro-organisms are pumped back to the aeration basin or reactor for the purposes of breeding the population. The rest of the biological solids are drawn for further sludge treatment processes.

The design and cost equations for the various elements or unit processes in the activated sludge system are given below:

Equilization Basin:

$$\text{Capital Cost of basin in \$} = 2.75(F_e t_e)^{0.619} + 0.8(F_e t_e)^{0.654}$$

$$\text{Operating Labor, manhours/yr} = 4.2\, F_e^{0.372}$$

$$\text{Maintenance Labor, manhours/yr} = 0.4\, F_e^{0.415}$$

$$\text{Power Costs/yr, \$} = 0.385\, F_e^{0.825}$$

$$\text{Material and Supply Cost/yr, \$} = 1.12\, F_e^{0.531}$$

where

F_e = Waste water flow rate, gal/day

t_e = Maximum shutdown time per week, hours

Primary Clarifier:

$$S_i = S_o\,(0.564 + 0.00132\, F_{orl})$$

$$X_i = 1 - (0.711 - 0.00474\, F_{orl})\, X_o$$

$$X_{wl} = (0.711 - 0.00474\, F_{orl})\, X_o\, F_e\, 834$$

$$F_{wl} = 2.4\, X_{wl}$$

$$\text{Capital Cost, \$} = 1200\left(\frac{F_e}{F_{orl}}\right)^{0.587}$$

$$\text{Operation Labor, manhours} = 4.0\left(\frac{F_e}{F_{orl}}\right)^{0.613}$$

$$\text{Maintenance Labor, manhours} = 2.2\left(\frac{F_e}{F_{orl}}\right)^{0.613}$$

$$\text{Material and Supply, \$/yr} = 3.5\left(\frac{F_e}{F_{orl}}\right)^{0.735}$$

where:

S_i = BOD concentration after primary clarifier, mg/l

X_i = Suspended solids in flow from primary clarifier, mg/l

X_{wl} = Solids in underflow of primary clarifier, lbs/day

F_{wl} = Sludge flow rate from primary clarifier, gal/day

S_o = BOD after equilization basin

X_o = Suspended solids in flow from equilization basin, mg/l

F_{orl} = Overflow rate for primary clarifier

AERATION BASIN:

$$U_n = U_{max} \frac{S_e}{K_s + S_e} - K_d$$

$$X = \frac{\dfrac{Y_t\left[S_i - (1+\alpha)S_e\right]}{1 + K_d/U_n} + \alpha X_r}{1 + \alpha}$$

$$V_{as} = \frac{Y_t\, F\left[S_i - (1+\alpha)S_e\right] + \alpha X_r F}{K_d X} - \frac{(1+\alpha)F}{K_d}$$

$$F_a = 4.16\text{x}10^{-6} \quad \frac{(S_i - S_e)F}{0.68} + 2(S_{fi} - S_{fe})F - 1.42 V_{as} X U_n$$

$$H_p = \frac{3.475\text{x}10^{-7}}{N} \quad \frac{(S_i - S_e)F}{0.68} + 2(S_{fi} - S_{fe})F - 1.42 V_{as} X U_n$$

FOR MACHANICAL AERATION:

$$\text{Capital Cost, \$} = 12.7\ (V_{as})^{0.743} + 5.8 \quad \frac{S_i - S_e)F}{0.68N} + \frac{2(S_{fi} - S_{fe})F}{N}$$

$$- \frac{1.42V_{as}XU_n}{N} \quad 0.67$$

$$\text{Labor manhours/yr} = 190\ (H_p)^{0.543} + 67\ (H_p)^{0.630}$$

$$\text{Power Costs, \$/yr} = 6.93 \times 10^{-3}\ (F)^{0.803}$$

$$\text{Material and Supply Cost, \$/yr} = 1.32\ (F)^{0.477}$$

FOR DIFFUSED AERATION:

$$\text{Capital Cost, \$} = 12.7\ (V_{as})^{0.743} + 126.8 \quad \frac{(S_i - S_e)F}{0.68} +$$

$$2(S_{fi} - S_{fe})F - 1.42V_{as}\ XU_n \quad 0.67$$

$$\text{Labor manhours/yr} = 39.5\ (F_a)^{0.53} + 11.6\ (F_a)^{0.607}$$

$$\text{Power Costs/yr} = 5.96 \times 10^{-3}\ (F)^{0.797}$$

$$\text{Material and Supply Costs, \$/yr} = 1.32\ (F)^{0.477}$$

where

U_n = Net specific growth rate/day

U_{max} = Maximum growth rate/day

S_i = BOD concentration after primary clarifier, mg/l

S_e = Effluent BOD, mg/l

α = Recirculation rate

K_s = Biological constant, mg/l

K_d = Decay coefficient/day

X = Mixed liquor biological solids

V_{as} = Volume of activated sludge basin, gallons

Y_t = True sludge yield

F_a = Air flow rate, cubic feet per minute

N = Oxygen transfer rate, lbs O_2/H_p - hour

S_{fi} = Sulfide concentration of waste water, mg/l

S_{fe} = Sulfide concentration after oxidation, mg/l

Secondary Clarifier:

$$X_{w2} = (8.34 \times 10^{-6})\ V_{as}\ X\ U_n$$

$$\text{Capital Cost, \$} = 1200 \left\{\frac{F}{F_{or2}}\right\}^{0.587}$$

$$\text{Operation Labor, manhours/yr} = 4.0 \left\{\frac{F}{F_{or2}}\right\}^{0.613}$$

$$\text{Maintenance Labor, manhours/yr} = 2.2 \left\{\frac{F}{F_{or2}}\right\}^{0.613}$$

$$\text{Material and Supply Costs, \$/yr} = 3.5 \left\{\frac{F}{F_{or2}}\right\}^{0.735}$$

where

X_{w2} = Solids in underflow of final clarifier, lbs/day

F_{or2} = Overflow rate for final clarifier, gal/day/ft^2

F = Waste water flow rate, gal/day

USER INSTRUCTIONS:

1. Must set maximum continuous shut down time per week. If

plant shuts down at 5.00 p m Friday and starts up again Monday at 8.00 a m, then t_e = 63 hours.

2. Select overflow rate for primary clarifier, typical value = 600 gal/day/ft^2. (F_{or1})

3. Select overflow rate for final clarifier, typical value = 700 gal/day/ft^2. (F_{or2})

4. Select values for biological constants - typical values are:

U_{max} = 3.0/day

K_s = 150 mg/l

K_d = 0.05/day

Y_t = 0.5

5. Select values for recirculation rate, an acceptable value is 0.2 (α)

6. Select underflow solids concentration, an acceptable value is 8000 mg/l (X_R)

7. Select oxygen transfer value (N). Typical value of N = 2 lbs of O_2/H_p - hr.

The sludge from the underflow of the Primary and Secondary clarifiers are taken for sludge treatment. There are many schemes available for treating this sludge material. The sludge could be filtered or centrifuged and the cake can be incinerated or used to land fill. The scheme simulated in this report is shown schematically in Figure 5.

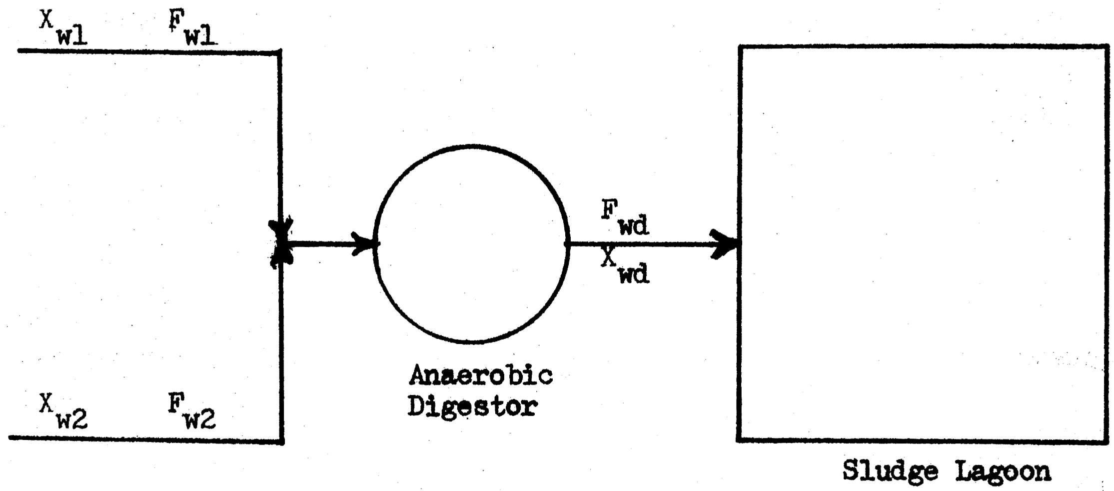


Figure 5. Sludge Treatment Scheme

The sludge collected in the primary and secondary clarifiers are then led into an anaerobic digestor. Here part of the sludge is reduced to methane and carbon dioxide and the remaining sludge is then led into open sludge lagoons. This is just one aspect of handling the sludge material among many alternatives already enumerated.

The design and cost equations for an anaerobic digestor is given below:

$$X_{wd} = 0.65\ (X_{w1} + X_{w2})$$

$$F_{wd} = 2\ X_{wd}$$

$$V_d = \frac{F_{w1} + F_{w2})\ t_d}{7.48}$$

When V_d is less than or equal to 100,000 Cu ft:

$$\text{Capital Cost, \$} = 10{,}116 \left\{\frac{(F_{w1} + F_{w2})t_d}{7.48}\right\}^{0.328}$$

$$\text{Operation Labor, manhours/yr} = 185 \left\{\frac{(F_{w1} + F_{w2})t_d}{7.48}\right\}^{0.2}$$

$$\text{Maintenance Labor, manhours/yr} = 167 \left\{\frac{(F_{w1} + F_{w2})t_d}{7.48}\right\}^{0.16}$$

$$\text{Material and Supply Cost, \$/yr} = 1.84 \left\{\frac{(F_{w1} + F_{w2})t_d}{7.48}\right\}^{0.693}$$

When V_d is greater than or equal to 100,000 Cu ft:

$$\text{Capital Cost, \$} = 27.7 \left\{\frac{(F_{w1} + F_{w2})t_d}{7.48}\right\}^{0.84}$$

$$\text{Operation Labor, manhours/yr} = 0.00032 \left\{\frac{(F_{w1} + F_{w2})t_d}{7.48}\right\}^{0.775}$$

$$\text{Maintenance Labor, manhours/yr} = 0.00054 \left\{\frac{(F_{w1} + F_{w2})t_d}{7.48}\right\}^{0.792}$$

$$\text{Material and Supply, \$/yr} = 1.84 \left\{\frac{(F_{w1} + F_{w2})t_d}{7.48}\right\}^{0.693}$$

where

t_d = Detention time in anaerobic digestor, days

X_{wd} = Solids from anaerobic digestor, lbs/day

F_{wd} = Sludge flow rate from anaerobic digestor, gal/day

V_d = Volume of anaerobic digestor, gallons

FOR SLUDGE LAGOON:

$$\text{Capital Cost, \$} = 512\ (X_{wd})^{0.603}$$

$$\text{Operation Labor, manhours/yr} = 12\ (X_{wd})^{0.26}$$

Maintenance Labor, manhours/yr 18 $(X_{wd})^{0.26}$

Material Supply Costs, \$/yr 10 $(X_{wd})^{0.78}$

USER INSTRUCTIONS:

Select detention time of anaerobic digestor, typical value 30 days.

Up to this point the three different schemes were individually discussed and the design and cost equations that apply to each of the schemes were presented. Next, the software package that was used to model and simulate the three different schemes will be discussed.

A Computer Simulation

The software package that was used to model the three waste schemes as well as processes for a modern tannery is the Process Analysis System, also known as P A S. This computer package is modular and very similar to the other simulation language such as Gasp IV. This package has been designed by the School of Chemical Engineering, Oklahoma State University, Stillwater, Oklahoma.

The P A S package is basically designed for petro-chemical processes wherein the user specifies the inputs depending upon the problem and the program computes all the necessary design calculations and the physical state of each stream after it leaves a unit process. In addition, the package has the capability of accepting additional subroutines depending on the nature of the problem. This capability of the P A S system has been exploited for modeling a complete systems model for a modern tannery by the research team on the 'Hide Project', at Oklahoma State University.

The P A S package has this convenient feature of keeping track of the various streams as they flow from one process element to another. Each process unit is a subroutine and physical changes to the streams are accounted for in each subroutine. However, it is important that each stream and unit process bear a unique number when data is input. Process subroutine can estimate the size of selected process equipment and also calculate all process stream rates and compositions, including recycle streams.

All outputs are in standard format, regardless of the type of process. The output includes process flow description and all input process data. The feeds and products for all process elements and selected calculated process element data will be printed. Error comments will aid the user in correcting the input data or revising poorly specified process conditions (8).

The P A S package is loaded on disc and can be called by using the proper control cards. The P A S simulation model is very identical to the Gasp IV simulation model. It consists of a set of process programs or state variable equations, or both, that describes the system's behavior. Lists and matrices store information and an executive routine directs the flow of information and control within the model. Support routines are called by the main program at appropriate times.

A skeleton flowchart for hide processing subroutines is shown in Figure 6.

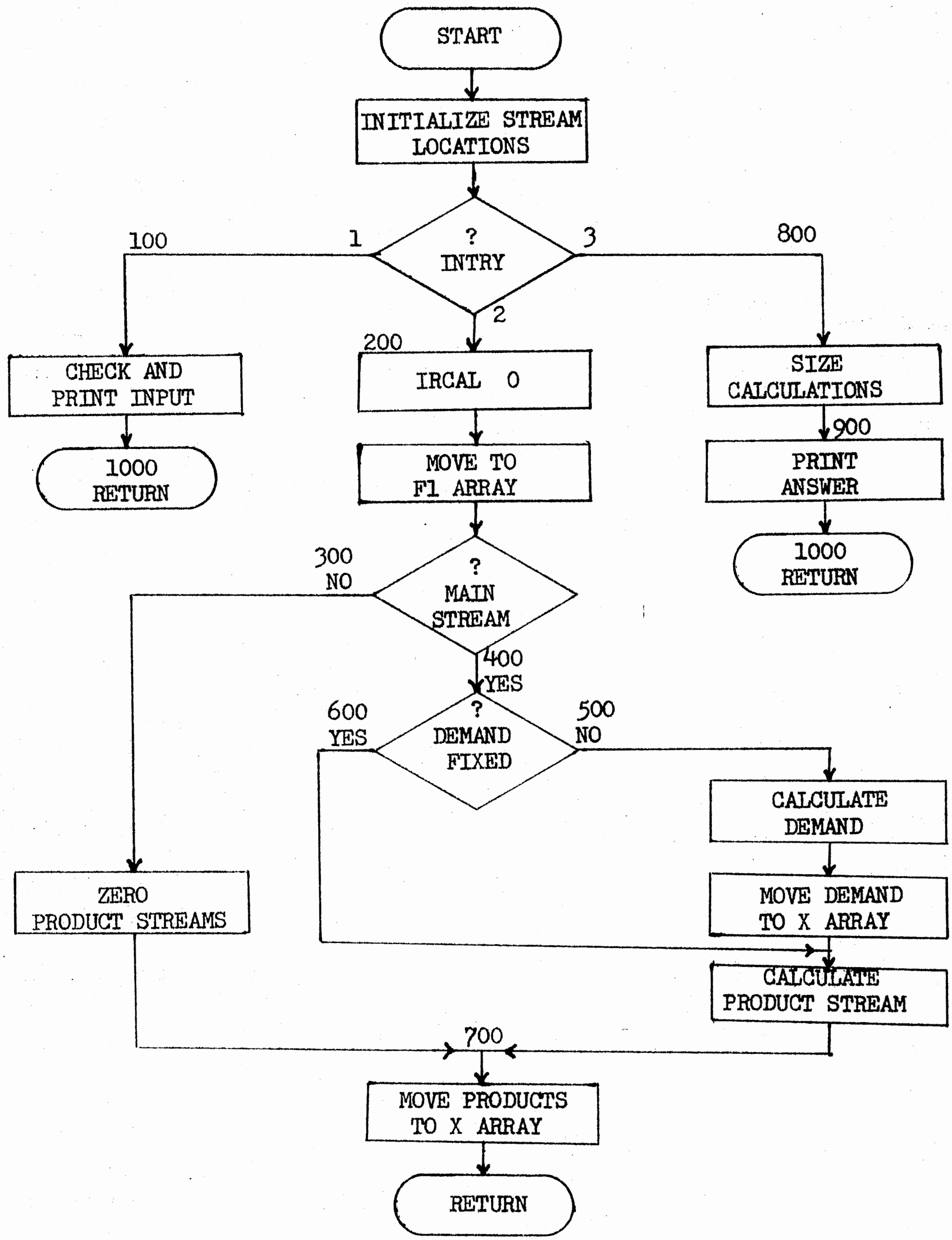


Figure 6. Skeleton Flowchart For Waste Treatment Subroutines

When the main program is called or linked, various P A S variables are initialized. The first entry to the element or hide subroutine occurs when the variable INTRY = 1. During this stage the input data to the element are checked and printed. If any descrepancy is detected, appropriate error messages will also be printed. If serious errors are detected such as improper sequencing of streams and elements the program will be aborted. On the other hand, if no errors are detected, the input data will be printed and control returned to the main program. Before returning control to the main program, technical calculations are usually not performed at this stage.

The second entry and subsequent entries in the case of recycle systems to the element occurs when the variable INTRY = 2. At this stage actual technical calculations are performed. The results of the calculations are retained as stream compositions and unit operation size data. Immediately after entering the second phase of calculation, the element name and number should be printed and the recycle recalculation should be set to zero indicating that the element has been recalculated. The stream data are stored in the main array or 'X' array which is two dimensional. Streams are associated with the correct element based on the element number and the stream numbers provided in the input data. The feed streams are then moved from the permanent stream storage array, 'X' to the working storage array F 1. This transfer is achieved by calling SUBROUTINE MOVER. This ensures that the values stored in the permanent storage array are not lost or erased.

It should be mentioned here that each element or unit process can have upto a maximum of four feeds entering it. The next step then is to test or determine if the element feeds are zero, or which, if any, feeds are Zero. If all feeds are zero, zero products should be transferred to the permanent array, 'X'. For that stream that passes through the element, we check to see if it requires any demand. Demand here is meant in the context as to whether the stream requires the addition of any chemicals or other material. The 'X' array stores characteristics of each stream such as quantity of water in the stream, amount of salts or grease etc. The calculated demand is then moved to the 'X' array and stored in the proper position in the array for that stream. The next step is to calculate product streams and then store them in the 'X' array. Next, the control is once again returned to the element subroutine when the variable INTRY = 3. At this stage size calculations if any may be done depending on the element requirements. Any calculation not affecting stream compositions should be done during this step of the program. The necessary answers are next printed and control is returned back to the main program.

A general procedure for writing additional subroutines is included in Appendix B. Any subroutine or element that is added must recognize the variable names used in the various labelled commons and be consistent with standard Fortran programming conventions. A unique four character name must be used to define the new subroutine. An example will best illustrate the use of subroutine names. Take the case of the evaporation pond where the waste water is led into it and exposed to natural evaporation. The name assigned to the routine that calculates the size and cost is given the name EVAP (JXX). JXX is the element number that is provided with the input data by the user.

The common cards that have to be used with each subroutine for the waste treatment schemes is given below:

```
 COMMON/SAVE/SAVE1(26,90)
 COMMON/CNTR1/NCP,NT,NP,NFVL,NHM,NUNT,INTRY,ITEST,TL1,TL2,ICDS
$(25)
 COMMON/CNTR2/IFED(100,4),IDPRO(100),IPD(100,4),IRCAL(100)
 COMMON/CNTR3/INAME(2,30),ITCCNT(50),STNAME(201,3),ELNAME(35,6)
 COMMON/CNTR4/ICHKR(100),ERRMAX,IR1MAX,IR2MAX
 COMMON/INOUT/NI,NO,ANAME(20),MAXSR,NPRNT,LPMAX,NELM,IEND,NPAGE
 COMMON/PRDAT/PDATA(100,30)
 COMMON/PRICEA/PRICE(30),FACTOR(30)
 COMMON/UTILA/UTIL(100,30)
 COMMON/STRMS/X(30,201),F1(30,12)
 COMMON/COSTA/COST(100,30),IEQUIP,IUTIL1,IUTIL2,IUTIL3,IUTIL4,
$ILAB1,ILAB2,ILAB3,ILAB4,ILAB5,IMAINT,ICHEM1,ICHEM2,ICHEM3,ICH
$EM4,IUTIL5,CSTID2,CSTID3,CSTID4,BSTID1,BSTID2,BSTID3,BSTID4
 COMMON/EQPLST/FORKD(10),SCALD(10,2),STORD(5),TAPED(10,2)
 COMMON/EQPLSB/SORTD(15,2),BALPD(10),SPLTD(12,2)
```

The stream data for the hide project has for the present about 25 different characteristics. This could be expanded upto 30 characteristics if need arises. The following is an explanation of the stream data which is assigned for the hide project as shown in Table I.

Row numbers 20, 21 and 22 contain the data required for the design of waste treatment schemes. The waste loads dumped after each unit process is based on the E P A's study on various tanneries in the country. The units that E P A currently adopts for BOD and suspended solids are mg/l, while the flow is measured in gals/day. However, in order to maintain uniformity with units, the BOD, total flow and solids content are expressed in lbs/day. All calculations in the subroutines conform to E P A procedures and units. The output can be generated in any units by the user by including or deleting the conversion factors in each subroutine as the case may be.

TABLE I

ASSIGNMENT OF STREAM CHARACTERISTICS

No.	Property	Suggested Data	Units
1	* Hide	1000.0	HIDES/DAY
2	* Hide Area	40.0	SQ.FT./HIDE
3	* Weight (Dry)	25.0	LB/HIDE
4	* Hair	0.5	LB/HIDE
5	* Dirt	1.0	LB/HIDE
6	* Water	28.0	LB/HIDE
7	* Salt	7.0	LB/HIDE
8	* Grease/Fat	0.5	LB/HIDE
9	* Flesh	0.5	LB/HIDE
10	* Manure	0.25	LB/HIDE
11	Chromium	-	LB/HIDE
12	H_2SO_4	-	LB/HIDE
13	Lime	-	LB/HIDE
14	Detergent	-	LB/HIDE
15	Sulfite	-	LB/HIDE
16	HCL	-	LB/HIDE
17	NAOH	-	LB/HIDE
18	Soluble N2	-	LB/HIDE
19	Unassigned	-	-
20	BOD	-	LB/DAY
21	Suspended Solids	-	LB/DAY
22	Total Flow	-	LB/DAY
23	Unassigned	-	-
24	Unassigned	-	-
25	Unassigned	-	-

* Items Present In Hide Before Processing

The above data will be stored in the 'X' array for each stream. Changes or manipulation to the data is done in the individual routines by moving the data to the working or 'F1' array. When the data have been worked upon, they are then put back in the 'X' array. The type of manipulation that is usually done on waste treatment schemes are splitting one stream into two stream and making sure that a complete material balance is achieved after this type of manipulation. A simple example is the case of the screen routine. The fundamental purpose of providing a screen is to filter out as much of the suspended solids as possible. In such a case there will be essentially one stream entering and two streams leaving the element. One of the streams leaving will be the through stream or main stream which has given up most of the suspended solids, dirt and hair. The other stream is that which contains the dirt and other solids trapped including a certain amount of water. So depending on the mesh size one can estimate the percentage of solids removed and the sum of the individual data in the two product streams should equal the corresponding data in the coming stream.

User's Input Program

A Pictorial representation of the simplest hypothetical hide processing system is shown in Figure 7. Only a few processing elements are represented here for illustrative purposes. The same principle and procedure is involved if all the various processing units are included. This system illustrates how hides flow through a tannery and how waste streams are generated and handled in a plant.

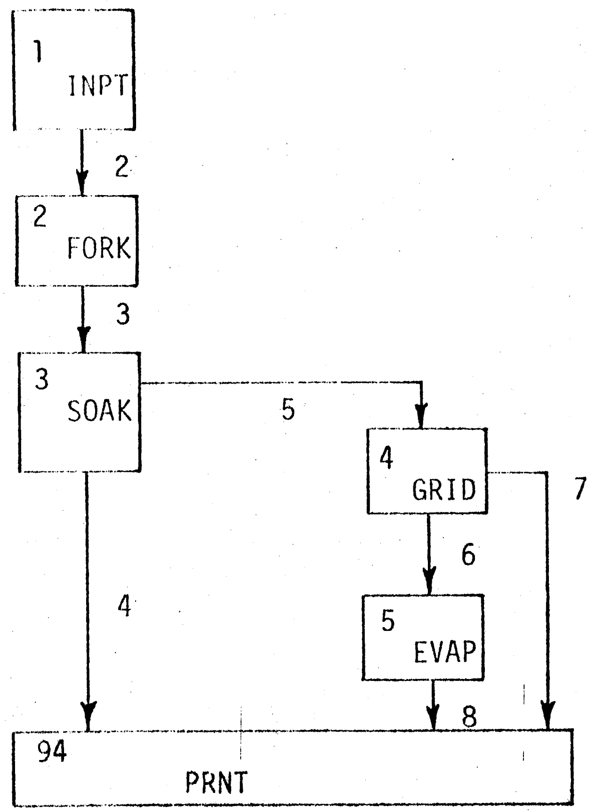


Figure 7. A Hypothetical Hide Processing System Including Waste Treatment

The flow of hides through the plant is shown passing from a fork lift (FORK) through a soaking unit (SOAK). The two components are examples of:

1. A 'through' process and

2. A process producing a by-product stream

The by-product stream from the soak unit is shown passing through a screen (GRID) process into an evaporation pond (EVAP). Note, the first process creates a by-product which constitutes the trapped solids in the waste stream. The second process behaves like a 'through' process even if nothing leaves the evaporation pond.

The user's program to implement the example process system is shown in Figure 8.

```
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, EVAP
PRCLMTINPT 1                                  2
PRCLMTFORK 2     2                            3
PRCLMTSOAK 3     3                            4     5
PRCLMTGRID 4     5                            6     7
PRCLMTEVAP 5     6                            8
PRCLMTPRNT94     4      7       8
ELNAME       2FORK
ELNAME       3SOAKER
ELNAME       4SCREENS
ELNAME       5EVAPORATION POND
ELNAME      94PRINT
FINISH
STDAT1       21000.0  40.0  25.0   0.5   1.0  28.0   7.0   0.0   0.0  0.25
STDAT2       2    0.0   0.0   0.0   0.0   0.0   0.0   0.0  1.25   7.5   1.0
STDAT3       2    1.0   1.0   1.0   1.0   1.0
FINISHSTOP
```

Figure 8. User Input for Simple Process System

The user organized the data in the program beginning with the title line. The user can write any descriptive label after the key-word 'TITLE'.

The lines beginning with PRCLMT (For Process Element) defines the type of each element and the streams entering or exiting the element. Each number is numbered by the user according to the numbered block on the process flow chart.

The first PRCLMT line is the input (INPT) element. The function of the input element is to create the input flow to the process system. In this example the input stream is numbered 2. The second PRCLMT line is for the fork lift element with stream 2 (the input) entering and stream 3 leaving. The third PRCLMT line is for the soak element with stream 3 entering and two streams exiting. Stream 4 represents the hides moving on to the next hide process step. Stream 5 is the by-product stream.

The fourth PRCLMT is for the waste screening process (GRID). Note the by-product stream 5 from the soak element enters the grid and the output streams are 6 and 7. The fifth PRCLMT line is for the evaporation pond with stream 6 entering and stream 8 leaving.

The last element is the print element (PRNT). Note the print element has been arbitrally assigned an element number 94. Any of the elements could be assigned any unused number from 1 to 99. The print element has as input all streams not going to another process element.

If there are specific data for each element that the user wishes to use he could achieve this by using PRDAT1 line immediately following the PRCLMT line for that element. This enables the user to make multiple runs by changing the data for each run. Each data should appear in the appropriate position on the PRDAT1 line. If the number of data is more and cannot be accomodated on one line, then PRDAT2 and if necessary PRDAT3 lines may be used. If data remains constant with multiple runs then the data could be initialized in the element subroutine itself. If data is initialized in the subroutine and if data is provided with PRDAT lines, then the values on the PRDAT line will be used by default.

The user can use his own description of the elements in the ELNAME lines. The names will reappear on the printout and assist with identification of specific elements.

The composition of stream 2, exiting from the INPT element is defined by the data in the STDAT1, STDAT2, and STDAT3 lines. These numbers represent the amount of specific components in the stream. An arbitrary stream description has been used here. The user can adjust this input data set to describe his average incoming hide characteristics. Table I, which has been already described, displays the assignments of the components and the units associated with the stream.

Up to now, the general procedure of how a waste treatment routine functions was described as well as the procedure to be followed by the user while setting up a simulation run.

The Simulation Run

The three alternative systems are now each loaded with the same amounts of wastes and simulated. The hypothetical plant considered is a 1000 hides/day processing unit. The raw hides are transported to the plant from slaughter houses before the hides begin to deteriorate and lose their tanning properties. In order to prevent deterioration and tanning properties, raw hides are salt cured at the slaughter houses. The raw hides arriving at the processing plant are transported to the various processing stages by means of fork lifts. The hides are weighed on scales first as all processing material added are based on the weight basis of the hides. Each unit process and the subroutine names describing each of these processes is shown in Table II.

During the various stages of hide processing, various material including water will be added to the hide stream. At the end of each unit process, there may be one or two streams leaving the process. The stream that contains hides would move on to the next processing stage. The second stream which will usually be a waste stream is led to the waste treatment plant or facility. The bod concentration or load at

TABLE II

SYMBOL AND FUNCTION OF HIDE PROCESSING AND WASTE TREATMENT SUBROUTINE

Symbol	Meaning	Symbol	Meaning
FORK	Fork Lift	BOIL	Boiler
SCAL	Scale	CROM	Chrome Recovery
STOR	Storage	SIDE	Cut Hide to Sides
DEMN	Demanure	MSUR	Measure
SOAK	Soak	SORT	Sort
UNHR	Unhair	SPLIT	Splitting
BATE	Bate	SHAV	Shaving
PICK	Pickling	TRIM	Trimming
TANN	Tanning	BALP	Baling Press
WRNG	Wringing	RTAN	Retanning
COLR	Coloring	FATL	Fat Liquoring
WASH	Washing	DRY	Drying
GRID	Screen	EVAP	Evaporation Pond
AIR1	Aeration Basin 1	AIR2	Aeration Basin 2
EQUI	Equilization Basin	CLAR	Primary Clarifier
FCLR	Final Clarifier	DIGT	Digestor
SLAG	Sludge Lagoon	ADDR	Stream Adder

each stage will vary and depend on the nature of the unit process. A complete diagram showing the various sequence of hide processing is included in Appendix C.

In the simulation run in this report, only a few of the processing elements are linked together and waste loads generated by these processes are passed on to each of the three alternate waste treatment systems. Block diagrams indicating the three schemes are shown in

Figures 9a, 9b and 9c.

SYSTEM I:

Figure 9a is the first waste treatment option wherein the waste stream is first led to a filter to remove most of the suspended solids in the stream. The ongoing stream is then led into the evaporation pond. The various process elements and streams are numbered as shown in figure 9a.

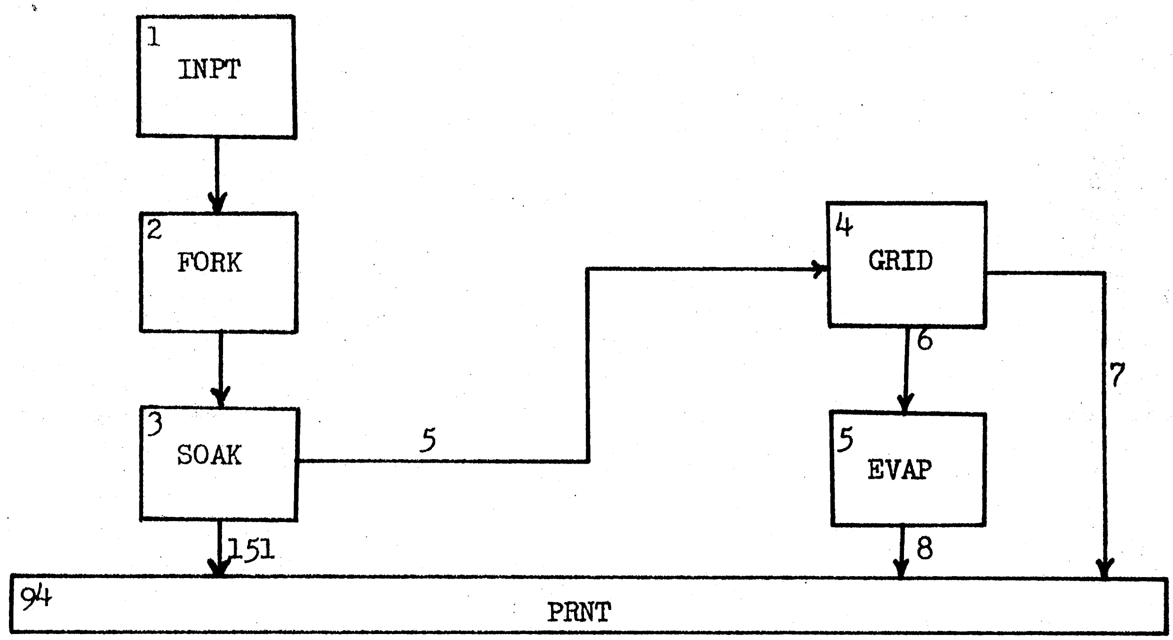
SYSTEM II:

Figure 9b depicts the second waste treatment option linked to the hide processing elements. The input program has the stream and element numbers as shown in the figure.

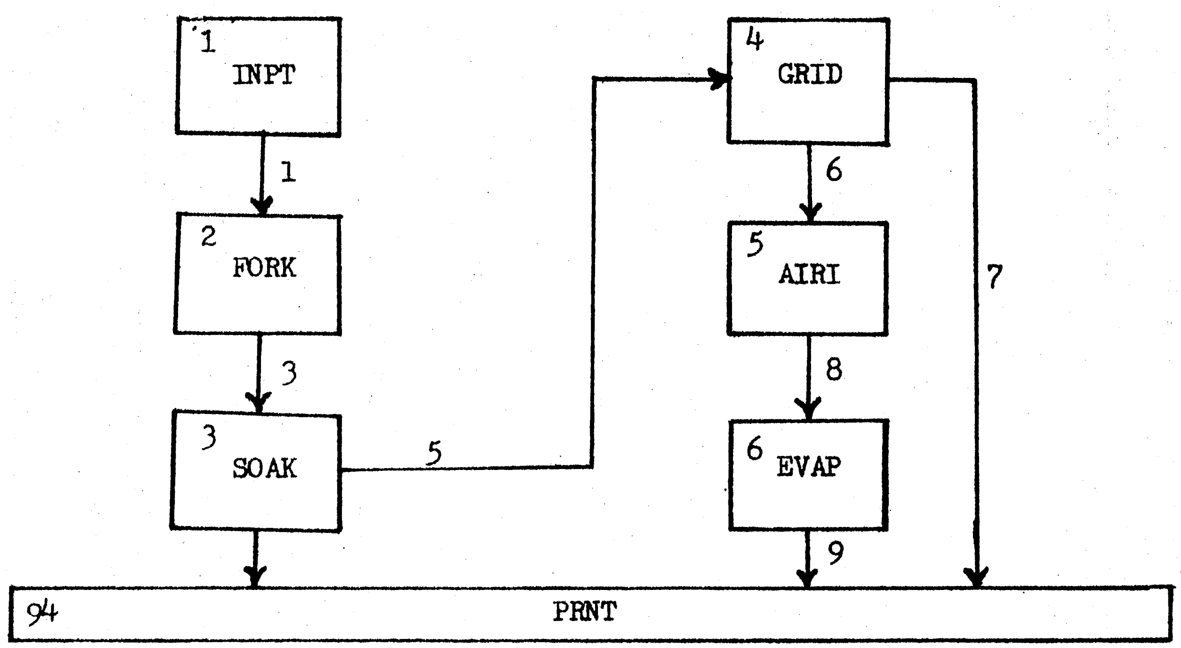
SYSTEM III:

Figure 9c couples the same hide processing schemes with the third waste treatment option. The input program uses the same numbering scheme as shown in the figure. All the hide processing subroutines could have been easily linked together and simulated but for illustrative purposes only some of the processes are shown in this report. Subroutine ADDR adds all waste streams.

The waste load dumped by each hide process is established by a study conducted by the Research and Development Division of U.S. Environmental Protection Agency at the Industrial Environmental Research Laboratory, Cincinnati, Ohio (10). A complete table showing typical BOD loads after each stage or process which contribute to waste treatment loads is shown in Appendix D. It should be noted that all hide processes do not contribute towards waste treatment loads. Only those processes that contribute to BOD loads are shown in the table.

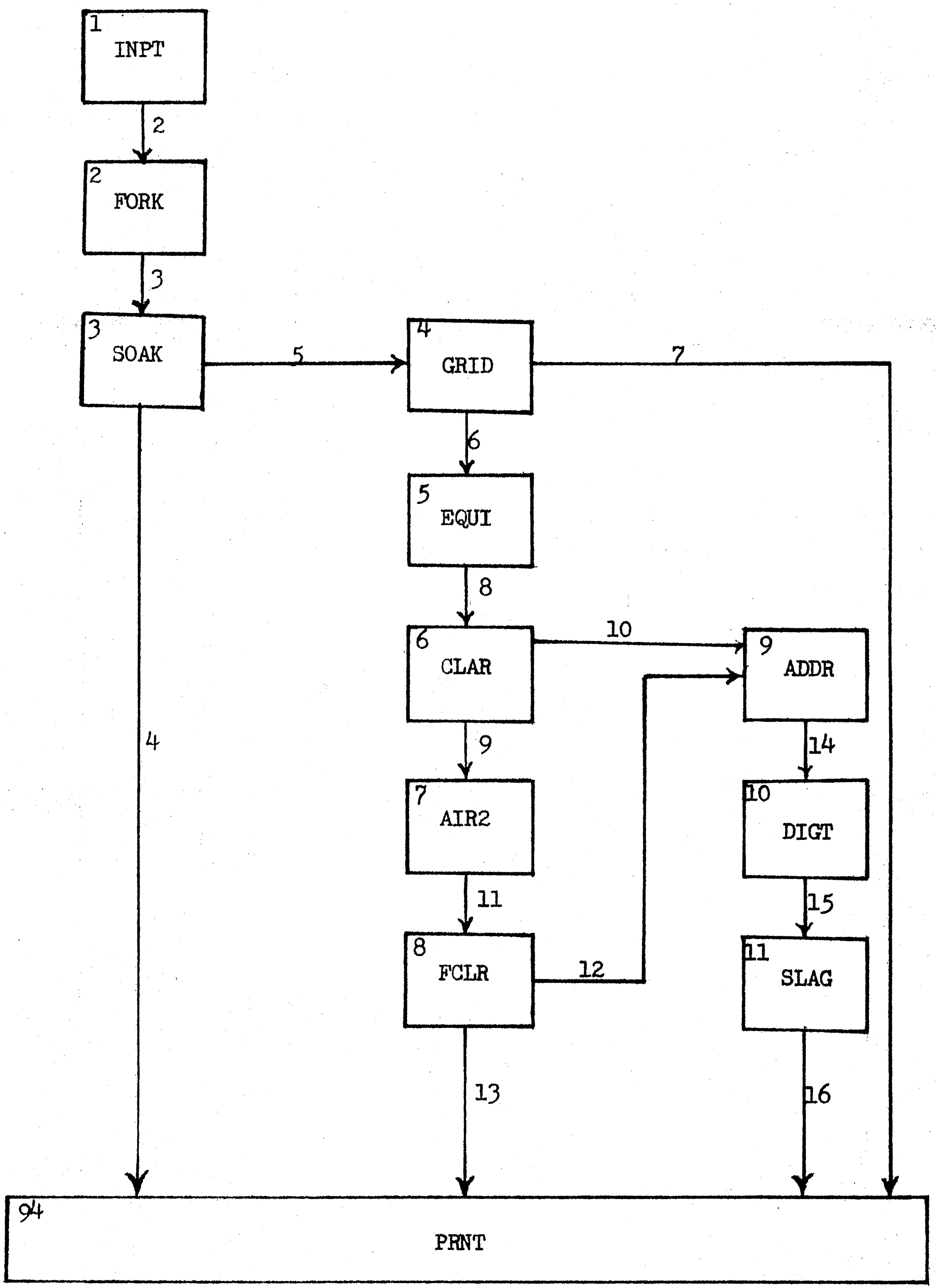


(a) System I



(b) System II

Figure 9. Waste Treatment Systems I, II, III



(c) System III

Figure 9. (Continued)

A complete listing of all the subroutines used in the simulation runs is included in Appendix E. User's program for each simulation option and computer output is included in Appendix F.

The computer hardware used for simulating the waste treatment processes is the IBM System 370, Model 158 with a memory of 4 million bytes at Oklahoma State University. All programs are stored on disk and the Visual Display Terminals (CRT) is being used to store, edit and run programs.

Model Validation

Since the system model being developed at Oklahoma State University is the first of its kind, there is little scope to completly validate the model. However, the Roit Report serves as a useful guideline in most cases. As far as the design aspect of Waste Treatment Unit Processes are concerned, the results from the computer output were submitted to Dr. Kincannon for his approval. Where necessary, Dr. Kincannon modified the design and cost equations and new simulation runs were made until Dr. Kincannon was completly satisfied with the results.

CHAPTER IV

ANALYSIS OF THE DATA

Introduction

One of the reasons for building and using simulation programs is due to the fact that a simulator is an artificial laboratory. Once a system is modeled and programmed, experiments can be performed using the model. From the experiments or simulation runs, one can draw inferences about the system. Simulation is also a very powerful tool with regard to proposed systems as we need not build the actual system. Operating systems can be experimented by simulation without disturbing normal operation. Simulation is also very handy when stress limits of certain systems have to be determined. This means that we do not have to destroy actual systems in order to determine their stress limits (9).

In Chapter III, the general procedure for setting up simulation runs using the PAS computer package for the waste treatment options for a tannery were elaborated. In chapter IV, it is attempted to show the simulation capability with regard to the three waste treatment options under consideration. Results from the computer output of the three waste treatment systems will be compared and discussed. The results of the simulation runs are included in Appendix G. The results from the computer output will be first discussed in this chapter. At the end of the chapter, the three waste treatment systems would be compared.

Since System III is a complicated system when compared to Systems I and II, this system will be discussed more elaborately. It will be attempted to take the reader through the various simulation steps in great detail so that the computer results can be easily followed and understood.

Computer Results of System III:

The first step during a simulation run is to check that all streams and units are uniquely numbered and that proper stream numbers feed or exit a given unit. If no errors exists in the input program the various process units and streams are identified and printed as shown at the beginning of the printout. Following this echo check, stream components specified in the simulation run for tanning processes are printed out. Components 1 through 22 are specified while components 23, 24 and 25 are not specified.

A summary table follows wherein all mechanical equipments costs and other necessary details pertaining to each equipment are printed out. Following this summary table, typical stream component values on a per hide basis is printed. The total quantity of each component is obtained by multiplying this value with the number of hides being processed per day. For example, a typical hide has an area of about 40 sq.ft., and its dry weight is about 25 lbs. The above details as well as other typical values are printed as shown. A value of 1.0 is put in slots 23, 24 and 25. Since components 23, 24 and 25 are not currently used the values appearing in these rows of no consequence as they do not enter the calculations. However, when the product of the total number of hides processed and value in slots 23, 24 and 25 are calculated we get a value equal to the total number of hides processed. Since waste streams do not contain hides, these values convey the idea to a reader as to the capacity of the plant being simulated. The first waste treatment routine will get these values and convey the capacity of the plant.

The first process element involves the movement of hides to the processing area from storage by means of fork-lifts. Essentially, no changes occur to the characteristics of the hide stream and this can be seen from the printout of the fork-lift process. Following this is a summary of cost for the operation of fork-lifts in the plant. For a 1000 hides processing plant it can be seen that one fork-lift would be sufficient and the annual costs incurred for maintaining the fork-lift would be about $3268.16. Other requirements for operating the fork-lift such as average depreciation, average tax, average repair costs, insurance, interest, life of equipment and buildings, etc., are summarised in the table.

The next process simulated is the soaking process, wherein, the salt cured hides transported by fork-lifts are soaked in water in soaking vats or drums. Stream number 3 is the hides stream entering the soaking units while stream number 171 is the demand stream. The demand stream is given the number 171 so as to make it as unique as possible and not duplicate other streams. As can be seen from the printout, for soaking and washing 1000 hides/day it requires about 406, 979.94 gallons of water and about 12 lbs of detergent and about 9 lbs of sulfite salts. This process relieves the hide stream of some of the salts and other waste products. The hide stream leaving the process is numbered 4 and its characteristics is as shown in the printout. Stream number 5 is a waste stream and its characteristics are as shown in the printout. The total flow resulting from the soaking and washing process is 418, 230.87 lbs/day. This is the result of summing up all the values appearing in rows 3 through 19. The BOD loading resulting from this process is 902 lbs while the suspended solids present in the waste stream amount to 1504 lbs. These values are printed in rows 20 and 21 for stream number 5. Thus, stream numbers 3 and 171 combine and then split to form stream numbers 4 and 5. Stream would normally flow to the next processing stage. But since this is only for demonstration, no further hide processing is involved and this stream is merely printed out. However, the waste stream proceeds further for treatment through the waste treatment plant. A summary table next summarizes the various data pertaining to the soaking process including the number of vats or drums required for processing 1000 hides per day.

The waste stream, which is identified as number 5 enters the first waste treatment process. This is a filteration process wherein the solid matter present in the stream are removed as far as possible depending on the mesh design. At this point, the waste stream has been split in two, one constituting the solids trapped by the meshes while the other is the matter that permeates through the screens. The ongoing stream numbered as 6 in the input program, appears as such while stream number 7 is the solid waste stream also identified in the input program.

From this stage onwards, the values appearing in rows 20, 21 and

22 are of prime importance as these are essential parameter values for calculation purposes. The rest of the values merely depict stream characteristics. Owing to the filteration process, the BOD load has been reduced from 902 lbs to 766.70 lbs in the ongoing stream number 6. The remaining 135.30 lbs of BOD is given up in the solid waste stream as shown in the printout. Likewise, the entering suspended solids amount to 1504 lbs which reduces to 225.6 lbs in the ongoing stream and 1278.4 lbs in the solid waste stream. As mentioned earlier, the value 1000 appearing in rows 23, 24 and 25 is of no consequence but merely conveys the capacity of the plant being simulated.

Cost data with regard to the screening process is printed below the stream characteristics. The initial cost of installing the filters is about $ 371.44 for handling the incoming stream characteristics as given by stream number 5 and splitting it into two streams as given by stream numbers 6 and 7. The operation and maintenance costs of the screens results in an annual expense of $ 15,325.70. This involves repairing as well as cleaning the screens periodically.

The ongoing stream number 6 next passes on to the equilization basin. As elaborated earlier, this stage is merely to feed a constant BOD concentration or load to the other processing stages. As such, no physical change is experienced by the exiting stream. Therefore, the characteristics of stream number 8 is identical to stream number 6. However, sizing of the basin and other relevant annual costs are computed and summarized as shown. To successfully handle the incoming quantity of flow, the basin must be 19,550.45 cu ft. in capacity with a base area of 1955.05 sq ft. Labor, power and material costs are also summarized. Labor costs would involve pumping effluent to and from the equalization basin.

The next processing stage is the primary clarifier stage. During this process part of the suspended solids and BOD contents are seperated out. The incoming stream number 8 breaks up into stream numbers 9 and 10. The BOD content of the ongoing stream is reduced from 766.70 lbs to 492.90 lbs while the underflow stream number 10 carries with it the remaining 273.80 lbs. Similarly, 96.30 lbs of suspended solids are settled and seperated from the ongoing stream.

The primary clarifier would incur an initial cost of $ 15,627.00 and this has been computed and printed. Operation and maintenance costs have also been computed as shown. The labor costs involved are low since the process does not require any skilled labor nor constant attention. It is merely a settling tank and involves no mechanical devices either.

The next process involved is the activated sludge process or the aeration process. Here oxygen demanded is supplied to the micro-organisms by mechanical means or by bubbling in compressed air. Mechanical aeration involves churning the liquid and throwing it up in the atmosphere. The microorganisms feed on the substrate and seperate out as sludge. Thus, after this stage the BOD load is further reduced. Oxidation of sulphites also occur during this process. The BOD content is reduced from 492.90 lbs to 191.88 lbs. On the other hand the incoming solids were only 129.30 lbs while with the sludge formation the solids have increased to 635.18 lbs. Also, CO_2 and SO_2 gas is liberated during this process.

In the case of diffused aeration the capital cost involved is about $ 37,923.10 while the labor costs involved is $ 6144.45. Power and material costs are also summarized as shown. Similar cost data are also computed for mechanical aeration system as shown.

The next processing stage is the final clarifier stage which performs identical to the primary clarifier stage. Stream number 12 is the under flow from the clarifier and it contains 128.53 lbs of sludge material. Some BOD content is also withdrawn along with the underflow as shown. The final effluent leaving the waste treatment plant is represented by stream number 13. Its characteristics are as shown. The BOD level is reduced to about 163.1 lbs and the total flow is about 472,392.19 lbs/day. Costs involved for operating this process on an annual basis is summarized as shown.

The next routine merely sums up the underflow streams from the primary and secondary clarifiers. This is shown by adding up stream numbers 10 and 12 and the resulting stream is stream number 14. This stream is now passed on to the first stage of sludge treatment.

In the Anaerobic Digestor, the organic material or sludge is converted to methane gas. This results in the reduction of the total sludge mass. The total sludge mass entering the digestor is 224.83 lbs while only about 146.14 lbs leave after the process. Water content is also reduced from a total of 3408.5 lbs to 2437.57 lbs. Annual costs for operating the digestor are summarized as shown.

Following the digestor stage, the residual organic material is fed into a sludge lagoon. If such a procedure is viable at a particular plant the residual material are just fed into lagoons and exposed to atmosphere. Cost tables are summarized as shown by the computer results.

The final step of the simulation process is to print all the streams including any demand stream. These can be seen after the sludge lagoon process in the computer output. A complete summary table of costs follows the stream summary tables. Now the simulation run of System III is complete.

Computer Results of Systems I and II

Simulation results of System I and System II follows the simulation results of System III in Appendix G. The results are presented in the same manner as already elaborated for System III. As before all the stream and unit numbers are first verified and printed. If no discrepencies exist, then the simulation proceeds to the next step.

Since capacity of the plant simulated is 1000 hides/day, all common plant and waste treatment processes convey identical results for the three systems. The results of the Fork, Soak and Grid routines are identical for System I and II as well as System III.

In case of System I, the simulation process following the screening process is the evaporation process. The effluent after it is seperated from most of the suspended solids is directly led into an evaporation pond. This pond as already described is open to atmosphere and subjected to natural evaporation. For the quantity of effluent generated in this simulation run, the area of the pond would be 8.79 acres as generated by the computer results. The flow entering the pond amounts to 47,546.71 gals/day. Cost tables are also summarized as shown. The program for this process is capable of taking into consideration the geographical location of the plant. Cost data can be simulated for warm or cool climates, as the case may be, depending on the location of the tannery. Cost figures for cool climate has been arbitrarly simulated in this example. At this stage, the simulation process is completed and once again summary tables are presented at the end of the simulation run.

In case of System II however, the process is very similar to System I except that an intermediate process is introduced between the screening and the evaporation process. This is the aeration process to reduce any bad odor that may emanate from the evaporation pond. Oxygen is supplied to the effluent in the aeration basin, similar to the activated sludge process. The oxygen reduces the sulfites present to SO_2. Also, the BOD will be partly reduced during this process but degree of reduction is of no concern as the next process is merely an evaporation process. From the results generated for the aeration process, we note that basin area required would be 2005.30 sq.ft. and the capital cost would be $20,180.28. Other cost data are printed as shown.

Comparison of System I, II and III

System I is a very simple system when compared to Systems II and III. It comprises of only two stages, namely, screening and evaporation. The total capital cost involved is $145,329.87.

System II has an additional aeration stage when compared to System I. However, it is also a simple system when compared with System III which is more complex in nature. When compared to System I, the additional cost involved is only that due to the aeration basin. The capital cost in this case including land costs will be $165,911.13.

System III, which is a more complex system has many more stages involved when compared to Systems I and II. Naturally, the initial cost is much higher in this case as well as the annual operation and maintenance costs. The capital cost involved for handling the waste load generated in this example for System III would be $239,705.92.

Power costs would not apply for System I since gravitational flow can be adopted. However, an annual cost for System II amounts to $3084.52 for pumping the effluent into the basin and supplying oxygen for sulfite reduction. The total power costs in the case of System III amounts to $4115.12. Annual labor costs involved is the least for System I while System III has more stages involved and incurs the highest labor costs.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The Hides and Leather Industry in the U.S. is faced with intense economic pressures. This is mainly attributed to stiff competition from foreign imports of leather products and stricter pollution control measures adopted in this country in recent times. Foreign tanneries buy raw hides from the U.S. and are able to produce leather and other finished products at a much cheaper rate when compared to American tanners. This is true as labor is comparatively cheaper overseas and strict pollution control measures do not exist. This situation is responsible for the closure of many tanneries in this country in the past and these numbers are likely to increase in the near future if drastic measures are not resorted to now. The U.S. Government is aware of the predicament of the tanning industry in this country but has done little to change the current export policy of raw hides or import policy of leather and other finished leather goods.

Tanners all over the country are concerned about the present situation and it appears that the only recourse left is to try and economize as much as possible, particularly with proposed plants. In this light, the Eastern Regional Research Center, USDA, Philadelphia, Pennsylvania, has authorized Oklahoma State University, Stillwater, Oklahoma, to carry out a comprehensive study concerning the industry.

The study will be more oriented in trying to establish a tannery in Oklahoma close to the green hide belt shown in Appendix H.

Thus, the computer model being developed at Oklahoma State University is aimed at including as many option as possible with regard to plant processing techniques, waste disposal methods, market penetration, plant location and marketing logistics, etc. This would permit multiple computer simulation runs by varying the different parameters and management policies. This would enable complete analysis of the industry as well as carry out interesting sensitivity analysis of the industry. It will then be possible to make a final decision with regard to location and plant operations in case of proposed plants. The model would also be helpful in case of existing plants as the model can be simulated based on any existing facility. This would enable management to make necessary policy changes where necessary, without experimenting with the actual system. The systems model developed at Oklahoma State University is appropriately given the name 'Hides'.

Besides costs there are other factors that would influence the location of a tannery. Some of these factors are availability of land, availability and source of funds, state government influence, vested interest of people involved such as local ranchers and business-man, senators representing the State of Oklahoma, etc. Besides local senators, the Economic Development Association and the State Chamber of Commerce are keen in establishing a tannery in Oklahoma (11).

Summary of Findings

The three waste treatment options simulated in this report is only a subsystem of the total system model called 'Hides', which is being developed at Oklahoma State University. The three systems considered in the study were:

1. System I, Screening plus Evaporation
2. System II, Screening plus Aeration plus Evaporation
3. System III, Complete Activated Sludge Treatment.

System I is a very simple process and the capital cost involved in adopting such a system is about $ 145,330.00. Power costs are zero in this case as gravitational flow can be resorted to. System II which has an additional aeration stage to reduce sulfite content and odor involves an initial investment of about $ 165,900.00. Power costs are involved for this system and would amount to about $ 3085.00 annually. System III would have a total capital cost of about $ 239,705.00. The annual power costs for this system is expected to be around $ 4115.00. The total annual labor cost involved is highest for System III and least for System I as can be expected.

Conclusions

From the results of the computer output System I seems to be the natural choice in terms of all the costs such as capital, power and labor. But System I will not be the optimum choice if the plant is located in an area where annual rainfall exceeds annual evaporation. Also, the evaporation pond may not be viable if the plant is situated in the heart of a city and land area is very restricted and odors cannot be tolerated. However, such a system would be very favorable in places where the annual evaporation far exceeds the annual rainfall and the climate is hot and dry. With regard to Oklahoma, the panhandle region would be ideal for such a method of waste disposal. This system could also be adopted if the plant is situated near a residential area if it is possible to construct the pond far away from residential areas. In this case, additional power costs would be involved for pumping the effluent to a distant pond.

System II compares very similar to System I in many respects. Unlike System I, System II can be opted if sufficient land is available in the heart of residential areas. The aeration or oxidation process will considerably reduce any bad odors and thus not give any room for legal or institutional problems. However, Systems I and II cannot be resorted to under all conditions since basically a dry and hot climate is very essential. These two options with regard to Oklahoma can be adopted for plants located in the panhandle region.

System III is a very complete system and can be resorted to in any part of the country. The treated effluent can be led into municipal sewers or nearby rivers without any legal problems. The design parameters of such a system are controlled by EPA and hence confrontation with EPA with regard to pollution can be avoided. The cost to build and operate such a scheme is rather high when compared to the other systems. But all future problems can be resolved. It should be remembered that EPA is going to make stricter pollution control laws in the future. With options I and II, there is a possibility that EPA could force them at a later date to be one of secondary treatment type. If this is the case, then conversion from one system to another might prove rather expensive. The proposed model 'Hides' will pinpoint the location of proposed plant and the processes to be adopted based on costs. With these results management may be called upon to make a final decision based on multiple criteria that may exist.

Recommendations

As seen in this study, system simulation is a very useful and powerful tool to help management make decisions. The proposed system model 'Hides' should be made as comprehensive as possible and also include as many plant processes and waste treatment options as possible. Other waste treatment options such as trickling filter and aerated lagoons should also be included in the model. Routing and transportation of raw hides could prove rather expensive as raw hides are a perishable commodity. It is therefore important to incorporate a suitable routing algorithm in the model.

The results generated by the model will be one based on minimum costs alone. Sometimes due to legal, institutional or political reasons, the solution based on a single objective such as cost alone may not be totally acceptable. In such cases a multiple objective analysis is recommended and techniques such as goal programming or electre should prove to be an useful tool. It might therefore prove very useful to include such analysis in the 'Hides' model in order to obtain an agreeable solution under any given set of criteria or objectives.

The model in its present state is purely theoretical in nature. It is essential to calibrate the model with respect to existing plants. The model then would provide the user with more meaningful and realistic solutions.

Future Research Needs

The Waste Treatment Process is only a subsystem of the total system model being developed by the Research Team at Oklahoma State University. So far, the designing aspect of waste treatment options as well as computer modeling and simulation were elaborated and results were analyzed. It will be now attempted to project the other subsystems and identify areas where need for future research exists.

Total Systems Approach

The total systems concept is an approach that views a firm or industry as a single unit. This unit or system will be composed of many interrelated and interdependent subsystems that need to function effectively and efficiently in order to fulfil management objectives at all times. The concept of total system will be effective if there is quick and accurate flow of information from one subsystem to another. The advent of computers and the creation of a data base makes the total system concept function effectively. Policy changes or constraints on a particular subsystem will have an effect on the functioning of the system as a whole. The total systems approach will be able to quickly identify such effects. An overall system model specifically addressed to the 'Hides Project' will appear as shown in Figure 12, appearing in Appendix I.

Comparison of Alternative Systems

Traditionally, many problems in industrial engineering and other disciplines have considered a single objective within their respective frameworks for analysis, e.g. maximizing use of production capacity, minimizing operating costs, profit maximization, etc. In the last ten years, however, there has been an increased awareness for the need to identify and consider simultaneously several objectives in the analysis and solution of problems, in particular those derived from the study of large scale systems. To handle such problems, there are several techniques available to aid the decision maker. Goal programing is one such technique that has been successfully used in the past. Another technique that appears to be very promising is the Electre method developed by Roy (3).

In case of establishing a tannery in the State of Oklahoma, there may be a number of sites that may be under consideration. Also, the tanning and waste treatment processes may depend upon the sites under consideration. To evaluate and choose an optional site, it would not be appropriate to base the choice on any single criteria alone. There may be a set of criteria that may have to be analyzed simultaneously in order to make a wise choice. Table 6 shows a hypothetical problem chosen by Goicoechea et al (3), to demonstrate the use of the Electre method for decision making. It would therefore the appropriate to include such multi-objective analysis models in the 'Hide' model.

Hides Collection Model

Hides are perishable items and as such need to processed as quickly as possible to ensure that tanning properties are not lost. Common salt is a traditional method of preserving hides temporarily. But salt curing creates problems for effluent treatment and disposal. As such, it would be favorable to locate hide plants close to the source of fresh hides.

TABLE VI

EVALUATION OF ALTERNATIVE SYSTEMS

Criteria used in evaluation	SYSTEM I Evaporation Ponds, Close To Source Of Hides	SYSTEM II Evaporation Ponds, Aeration Basins, Vicinity of OSU	SYSTEM III Sulfide Reclamation, Close To Source Of Hides	SYSTEM IV Chrome Recycling, Vicinity of OU	SYSTEM V Access To River For Waste Water Discharge
1. Hide Availability (per Day)	4000	1500	3000	1000	1000
2. Energy Requirements (1000 BTU/Hide)	150	272	180	250	200
3. Water Requirements (Gallons/Day)	900,000	500,00	900,000	400,000	200,000
4. Waste Water Disposal Mode	Good	Very Good	Fair	Excellent	Good
5. Plant and Equipment Cost (Millions)	$10.9	$4.11	$8.2	$2.7	$1.8
6. Operating Costs (Millions/Year)	$12.4	$4.6	$9.3	$3.1	$3.1
7. Relative Regional Economic Improvement	Excellent	Fair	Very Good	Fair	Good
8. Opportunities for Research Program Development	Few	Very Many	Some	Many	Some
9. Return on Investment	1.00(Base)	1.15	1.20	0.64	0.84

To be economically feasible a tannery must process at least 1000 hides/day. To meet such a demand, a tannery must invariable buy hides from more than one slaughter house. The tannery must therefore aim at picking up all the available hides from all the slaughter houses such that its daily demands are met and delivery time and costs are minimized. With a number of slaughter houses existing in the High Plains Region, the establishment of a tannery in the State of Oklahoma would present a very complicated but interesting routing problem.

There are many algorithms available for handling problems in routing. One such approach is known as the Travelling Salesman problem as discussed by Taha (12). This is an extension of Integer programming and a special algorithm based on the idea of the "branch - and - bound" technique can be efficiently used.

Prospects for Financing

A project of this nature involves a lot of effort, time and funds to be successful. Funds for this project have been provided by Eastern Regional Research Center, Agricultural Research Center, USDA, Philadelphia, Pennsylvania for the years 1978 to 1979 and funds have been further approved for the years 1979 to 1980. It is likely that funds from businessmen, tanners and ranchers may be forthcoming in the future.

Presently, there is a strong possibility of establishing a tannery at Red Rock, Oklahoma. The Irving Tanning Company, Hartland, Maine, has agreed to expand their facility to Oklahoma. Capital for starting this plant at Red Rock may be made available by Economic Development Association (EDA) and Bank of Tulsa. The Otoe - Missouri tribe of Oklahoma will provide land for building the proposed plant and also provide utilities. Two other Indian tribes are also willing to provide land for a tannery in their own interest. A complete analysis of the various plant sites is warranted before a final choice can be made.

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APPENDIXES

APPENDIX A

U.S. HIDES AND LEATHER STATISTICS

Tanners' Council of America, Inc.

JEROME WEINSTEIN
CHAIRMAN OF THE BOARD
ROBERT G. AMYOUNY
TREASURER
IRVING R. GLASS
PRESIDENT
HERBERT F. MILLER
SECRETARY

411 FIFTH AVENUE · NEW YORK, N.Y. 10016
(212) 686-7950 CABLES: TANNERCIL, NEWYORK

April 23, 1973

Prof. R. L. Henrickson
Dept. of Animal Science & Industry
Oklahoma State University
Meat Science Building
Stillwater, Oklahoma

Dear Professor Henrickson :

I am acknowledging your letter of April 18.

We certainly agree with your premises and your thought as to the potential for leather tanning in the Southwest. The remarkable expansion both in feedlots and packing in your area should be a logical geographic determinant for the location of tanning plants. That possibility has been very much in our minds since the progressive shift of cattle supply and packing plants to the Southwest.

The specific information you ask on technology and economic matters can be readily furnished to you. It would be desirable to do so at much greater length than brief answer to your broad questions. You can surmise that there are various qualifying elements involved due to the type or character of the leather to be made, the nature of the process selected, marketing considerations and so on. However, as a starting point it is possible to state that:

(a) Economic Unit - A tannery processing at least 1,000 hides a day would currently be the minimal economic unit in terms of required capital investment for plant and equipment.

(b) Water Requirements - A tannery processing 1,000 hides a day would require between 100,000 and 250,000 gallons of water daily.

(c) Waste Disposal - Dependent on the nature of the process, type of leather and effluent treatment installations. Virtually all water input must be discharged. Present technology enables such discharge to meet the requirements of municipal sewage plants or direct discharge standards of the Environmental Protection Agency. Solid wastes can also be handled very feasibly by incineration or by disposition for land fill. Specific unit waste parameters involve nature of end product and process employed.

(d) Employment - The number of people required would be a direct function of the type of leather to be made or the final stage of processing contemplated. For example, a tannery carrying cattlehides through the semi-tanned level (blue or crust leather) would need 75 to 100 people per thousand hide unit. If finished leather ins produced, personnel requirements would rise to 150-175.

Finally, you ask the names and addresses of potential companies. I am glad to enclose our current Directory of U. S. Tanners because in theory virtually all our members would be interested. But, I also feel it necessary to apprise you of the significant current deterrent to leather industry expansion.

It is the national foreign trade policy of the United States which permits the unhindered import of such finished goods as shoes and leather and also allows the unrestr icted export of cattlehides from the United States. This position by the U. S. has resulted in gross inequity to the U. S. tanning industry. Equally important it has completely blocked tanning expansion at home and has frozen the confidence of tanners who would be thronging the Southwest under more favorable circumstances.

Contrary to the opinion apparently held by some representatives of the agricultural community our interests are not divided. On the contrary they are identical. We can and should make common cause for our common welfare. If the leather and shoe industries could get a fair shake in foreign trade, if we would curb the unfair practice of other nations, we would then process more hides at home to the benefit of agriculture, industry and labor. Do you know that to this day countries such as Japan will not permit the import of U. S. leather although we tolerate their purchase of our raw material and their dumping of finished products on our shores. Join us in the battle for economic equity so that new industry can flourish in your community.

I take the liberty of enclosing a recent letter and chart addressed to the Congress. This spells out the incredible economic facts. If agricultural interests would support the plea of the tanning industry for reasonable limits on cattlehide exports, there would be a tremendous revival of investment confidence in the leather business of the U. S. Communities in Oklahoma would feel the impact immediately through the establishment of tanning facilities at various points contiguous to cattlehide supply.

I need not say that we shall be very pleased to give you any additional information or to work with you in any way possible.

Sincerely yours

Irving R. Glass
President

irg/mr

Tanners' Council of America, Inc.

JEROME WEINSTEIN
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SECRETARY
411 FIFTH AVENUE • NEW YORK, N.Y. 10016
(212) 686-7950
CABLES: TANNERCIL, NEWYORK

February 27, 1973

Dear Senator:

We are all shocked by the dimensions of the money and foreign trade problems which the events of the last two weeks have disclosed. Many of us doubt more than ever that the stop-gap remedy of devaluation, for the second time in a little more than a year, really gets at the root cause of our trade imbalance. Those of us who have been urging realistic steps for several years believe the time has come for positive, forthright action. We do not think that band aids can cure a cancer.

The chart on the next page is a shocking illustration, in just one product area, of what the U. S. has permitted to happen. The tremendous rise in hide exports has given low wage countries the raw material with which to make shoes and other leather products to ship back to the U. S. Result - A net cost, a deficit of $1 billion in 1972. That is only part of the price paid for the folly of letting hides move out and shoes move in without let or hindrance. And the other part includes factories closed, jobs lost and staggering relief rolls. Welfare recipients don't pay taxes.

We believe the time has come to act decisively, to stop the trade inequities that are destroying our manufacturing economy. We must apply reasonable measures of control to the flow of vital raw material out of the country and to the flood of imported goods made by cheap foreign labor. An import surcharge across the board will certainly help as a temporary measure. Long range, we must do what virtually every other country in the world has done - Control the trade bridge between ourselves and the rest of the world.

Sincerely yours

Irving R. Glass
President

irg/mr

TABLE III

EXPORTS OF CATTLE HIDES FROM THE UNITED STATES*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1971	1,207	1,251	1,611	1,239	1,304	1,235	694	1,166	1,338	1,565	1,696	1,656	15,962
1972	1,272	1,153	1,686	1,210	1,437	1,317	2,152	1,324	1,290	1,893	1,733	1,524	17,589
1973	1,461	1,837	1,802	1,340	1,411	1,266	1,155	1,100	1,229	1,463	1,412	1,391	16,867
1974	1,423	1,500	1,462	1,567	1,554	1,123	1,615	1,529	1,423	1,619	1,708	1,905	18,428
1975	1,663	1,810	1,989	2,045	1,834	1,719	1,551	1,548	1,714	1,678	1,965	1,753	21,269
1976	2,172	1,658	2,407	2,386	2,075	2,030	2,002	2,073	2,016	2,040	2,042	2,282	25,270
1977	2,276	1,998	2,289	2,167	2,016	2,023	2,189	1,937	2,157	1,631	1,572	2,235	24,490

*In thousands of hides

Source: Commodity Year Book, 1978

TABLE IV

UNITED STATES PRODUCTION OF SHOES AND SLIPPERS*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1967	52.2	49.5	53.5	46.1	48.5	48.8	40.6	57.8	50.3	53.6	51.3	47.7	600.0
1968	56.3	55.4	57.8	55.8	56.0	49.6	47.9	57.1	50.9	59.0	49.2	47.3	642.4
1969	53.0	48.4	52.7	48.7	47.9	47.2	42.7	49.3	47.1	52.5	42.8	44.8	577.0
1970	47.6	47.5	50.2	48.6	46.3	47.9	42.9	47.3	47.7	49.0	40.9	43.4	562.3
1971	44.8	44.9	50.3	46.8	44.1	46.7	37.6	46.3	45.7	45.1	40.7	42.9	535.8
1972	44.5	44.3	48.7	44.1	45.2	46.2	36.1	46.2	44.2	46.4	41.1	38.5	526.5
1973	42.9	41.9	46.8	41.9	41.7	41.7	32.1	43.9	39.2	45.2	38.5	34.2	490.0
1974	40.8	41.1	42.9	39.0	43.2	39.9	32.9	37.3	34.8	36.9	33.2	30.2	453.0
1975[1]	33.9	32.3	32.1	33.9	33.7	35.8	34.1	38.3	37.7	42.4	34.6	35.0	413.1
1976[1]	39.0	38.0	44.4	41.6	40.7	39.1	31.0	36.6	36.9	34.8	31.5	29.2	422.5
1977[1]	30.9	31.3	34.6	31.3	32.8	33.2	24.9	34.6	32.9	33.7	33.2	30.9	384.3

*In millions of pairs

Source: Commodity Year Book, 1978

APPENDIX B

ADDING A NEW PROCESS ELEMENT

Adding a New Process Element

Up to 16 new process elements can be added to PAS without substantial program modification. If more than 16 elements are to be added, any of the existing elements which are infrequently used can be replaced using the techniques outlined below. Any element that is added must recognize the variable names used in the various labelled COMMONS and be consistent with standard FORTRAN programming conventions. Any of the service subroutines described in Appendix ___ can be used in the new element; their usage is encouraged to reduce core storage requirements and expedite programming efforts.

The following discussion outlines in broad perspective the steps to be followed in programming a new element. Specific computational details have been omitted since the technical detail of the new elements will vary too widely to warrant description.

I. Select a unique four character name that will be used in the PRCLMT card to define the new subroutine. This name will appear in columns 7 through 10 of the PRCLMT card.

II. Change one of the names currently appearing in NAME array (initialized in BLOCK DATA) to the name selected in I.

III. Change the name of the called subroutine (CALL ____(JXX)) from the name originally in INAME to the new name. Check to be certain that the number following the revised name in INAME (the transfer location indicated in the computed GO TO in DESIGN) and indicated transfer point agree.

IV. Remove the dummy subroutine currently in the program and replace it with the new subroutine which bears the name selected in Step I.

V. Develop the new element program following the steps outlined below.

Since the programming details of new elements will vary with the technical requirements of the calculations, specific programming comments are excluded. The following discussion outlines the PAS requirements for the structure of the new element. In general, there are three categories of entry to the element (designated by the variable INTRY):

1. The first entry to the element during the element input data and checking step (INTRY=1). Technical calculations are not usually performed during this step.

2. The second entry (and subsequent entries in the case of recycle systems) in which the actual technical calculations are performed (INTRY=2). The results of the calculations are retained as stream compositions and perhaps unit operation size data.

3. The last entry to the element which causes the streams associated with the element and any calculated process data to be printed (INTRY=3). Technical calculations may or may not be done during this step depending on the element requirements. Any calculation not affecting stream compositions (sizing calculations, area determination, etc.) should be done during this step of the program. Following this procedure will generally speed the solution and will in no way detract from the overall quality of the solution.

Careful checking of the element input data during Step 1 is essential to successful use of any new element. Some of the items that could be checked are:

(1) are the temperatures and/or pressures specified in the input data for the element within the acceptable ranges of the thermodynamics correlstions being used?

(2) are the unit operation specifications reasonable?

(3) are the number of feeds to the element and the number of products from the element in an acceptable range?

In some cases, any variable that is found to be unreasonable can be adjusted to an acceptable value by programming; other situations in the program should be stopped after checking all input data for all elements in the simulation. These decisions must be left to the programmer/engineer responsible for developing the new element.

During the second phase of the calculation, the calculations procedure should include the following steps:

(1) Check to determine if any of the feeds to the element are zero. If all feeds to the element are zero, all product rates should be assigned zero values in the pressure of the product streams should not be set to zero.

(2) Reset the calculation status indicator (IRCAL (JXX)) to zero to indicate that the element has been recalculated.

(3) Perform the desired technical calculations on the stream.

(4) Transfer the calculated streams to the permanent stream storage array and determine if the change in the stream composition is large enough to require recomputation of the elements which receive these products as feed.

Final output from the element should occur in the third phase of the calculational procedure. During this phase of the element, additional sizing and/or costing calculations can be carried out, if desired.

Coding for the new process element should follow the general structure listed below:

SUBROUTINE NAME (JXX)

The subroutine NAME must be a unique name containing four (or less) characters. It is the name selected to describe the unit operation and entered in the INAME array and call statement in DESIGN.

The variable JXX corresponds to element number assigned by the user in preparing the input data. It defines the location of the (stream numbers) feeds to the element in the IFED (JXX,I) array; the location of the products (stream numbers) from the element in the IPD (JXX,I) and the location of the process element input data in the PDATA (JXX,I) array. The feed and product stream number arrays should be referenced immediately after entry to the subroutine are:

```
                                        Use for
                            ________________________________________
INDF1 = IFED (JXX,1) }1 feed  ]          ]            ]
INDF2 = IFED (JXX,2)          }2 feeds   |            |
INDF3 = IFED (JXX,3)                     }3 feeds     }4 feeds
INDF4 = IFED (JXX,4)                                  ]
```

```
                                        Use for
                            ___________________________________________
INDP1 = IPD (JXX,1) } 1 product ]             ]              ]
INDP2 = IPD (JXX,2)             }2 products   |              |
INDP3 = IPD (JXX,3)                           }3 products    }4 products
INDP4 = IPD (JXX,4)                                          ]
```

Note that the data in the IFED and IPD arrays will be taken fr from the PRCLMT card columns listed below:

Array element	Card columns
IFED (JXX,1)	16-18
2	22-24
3	28-30
4	34-36
IPD (JXX,1)	40-42
2	46-48
3	52-54
4	58-60

The various labelled COMMONS should be inserted immediately following the SUBROUTINE card. Typically, the required COMMONS are THERM1, INØUT, CNTR1, CNTR2, CNTR3, CNTR4, PRDAT, and STRMS. Other COMMONS may be used as required.

The next statement should usually be: (If there are calculations or tests which are common to the input data checking phase, technical calculation phase and the output phase, they should be done here to avoid duplication.)

```
GO TO (100, 200, 300), INTRY
```

This statement controls transfer to the invididual phases of the program for input data checking (INTRY = 1 and transfer control to statement number 100), technical calculations (INTRY = 2 and transfer control to statement number 200) or the output phase (INTRY = 3 and transfer control to statement number 300).

```
100 CONTINUE
```

This is the input data checking phase of the program. For diagnostic purposes, the following statements should be included.

```
WRITE (NO,1) JXX
1 FORMAT (5H NAME, I4)
```

Following this statement the type of material/heat balance checking to be performed by DESGN to insure recycle closure is specified.

ICHKR (JXX) = 0,1,2,3

ICHKR (JXX) value	function
0	perform no material or heat balance checks on the element
1	perform both heat and material balances
2	perform only material balance checks
3	perform only heat balance checks

The number of feeds to and products from the element must be checked for being in an acceptable range. For example, if the element expects to receive only one feed and it receives two feeds, the pipeline closure/duplicity checks can be satisfied but the problem statement is still an unacceptable problem definition.

```
CALL FDCHK (I1, I2, I3, I4, JXX, JJJ)
```

I1 - minimum acceptable number of feeds
I2 - maximum acceptable number of feeds
$1 \le I1 \le 4$; $1 \le I2 \le 4$; $I1 \le I2$
I3 - minimum acceptable number of products
I4 - maximum acceptable number of products
$1 \le I3 \le 4$; $1 \le I4 \le 4$; $I3 \le I4$

JXX - element number
JJJ - error indicator - JJJ returned as 1 if number of feeds/products if within acceptable range
JJJ returned as 2 if number of feeds/products is not within acceptable range
Check for JJJ equal to 2

```
IF (JJJ.EQ.2) WRITE (NO,2)

2 FORMAT (14H ERROR IN NAME, I4, I5H FEEDS/PRODUCTS)
```

Perform the necessary tests on the input data to the element. These data will be located in the PDATA array as PDATA (JXX,1) through PDATA (JXX,30). The contents of each element of the vector PDATA (JXX,I) and the relationship to the PRDAT cards is:

PDATA(JXX,I)	Card Column
I=1	PRDAT1 13-18
I=2	PRDAT1 19-24
:	:
I=11	PRDAT1 73-78
I=12	PRDAT2 13-18
I=13	PRDAT2 19-24
:	:
I=22	PRDAT2 73-78
I=23	PRDAT3 13-18
I=24	PRDAT3 19-24
:	:
I=30	PRDAT3 55-60

The tests should insure that none of the input data are beyond acceptable limits such as the thermodynamics correlation upper pressure limit or upper and lower temperature limits. If some of the input data exceeds these limits you can eigher assume a value for the user or set ITEST = 1 which will abort the run at the end of the input data checking step. Comments to assist the user in debugging his input deck could be made whenever an error is found.

All element input data should be printed after the checkd have been performed and the adjustments, if any, made. There is no other way to document the basis for the run. Note - The units of the input data in the PDATA array should not be changed during the checking step. Two reasons: (1) changing the units makes it more difficult for the user to check his input and (2) if multiple cases are being run, the wrong value will be used during the second and subsequent runs since the input data are checked (converted) and printed during the first iteration through each case.

These steps essentially complete the first calculation phase of the element. The program can now be sent to a RETURN step.

```
GO TO 400
```

The next part of the discussion deals with the technical calculation phase of the program (INTRY=2)

```
200 CONTINUE
```

Immediately after entering the second phase of calculation, the element name and number should be printed and the recycle recalculation indicator should be set to zero (indicating that the element has been recalculated).

```
WRITE (NO,1) JXX
IRCAL (JXX)=0
```

The feeds should then be moved from the permanent stream storage array, X, to the working storage array, F1. This transfer can be accomplished by using SUBROUTINE MOVER.

```
CALL MOVER (INDF1, 1)
      :
CALL MOVER (INDF4, 4)
```

The total amount of each feed should be calculated using SUBROUTINE SUMMR.

```
CALL SUMMR (1, F1, SUMFD1)
      :
CALL SUMMR (4, F1, SUMFD4)
```

Tests should then be performed to determine if the element feeds are zero, or which, if any, feeds are zero. If all feeds are zero, zero products should be transferred to the permanent array, X. An example of this step is: (Based on 1 feed to the element and 1 product from the element).

```
IF (SUMFD1. NE.0.0) GO TO 201

CALL MOVER (201,5)

     F1(NP,5) = PXX

GO TO 400 - CALL MOVER (5, INDP1)
```

If there are two or more feeds to the element and one of the feeds is equal to zero, calculations may proceed in a normal fashion (for example, in the ADDR element) or the calculations may have to be bypassed (for example, in the HEX element simulating a counter-current heat exchanger or in the ABSR element) In the latter two examples (HEX and ABSR) the non-zero feed should be passed on through the element without change (unless there is a pressure drop in the element). The product corresponding to the other feed should be set to zero. The mechanism for determine these conditions is a function of the technical calculations and the organization of the program including the order of feeds and products and the assumptions that can be made about the feeds/products.

201 CONTINUE

If the feed slate to the element is such that calculations can continue, control is transferred to statement 201. At this point, the following data are available:

F1(1,1) ··· F1(1,4)	component 1 flow rate to element
F1(2,1) ··· F1(2,4)	
F1(N,1) ··· F1(N,4)	component N
F1(NT,1)··· F1(NT,4)	Temperature of each stream in base temperature units, (°R, °K)
F1(NP,1)··· F1(NP,4)	Pressure of each stream in base pressure units (psia, atm, etc.)
F1(NHM,1)·· F1(NHM,4)	Enthalpy of each stream in base energy units (BTU, KCAL,)
F1(NFVL) ·· F1(NFVL,4)	Fraction vapor.
F1(NUNT,1)· F1(NUNT,4)	Destination of the stream.

The process element data in PDATA (JXX,I) are also available for use.

At this point, the technical calculations are ready to be performed. The only limitations on the technical calculations that can be performed are core capacity and machine time. If there are or will be computational problems during this segment of the calculations, the appropriate diagnostics should be printed to alert the user about possibly invalid results.

In general, the final product streams should be placed in the working storage array, F1, to expedite their return to the permanent storage array and the checking procedure to determine if the rates have changed sufficiently to warrant recalculation of any element (SUBROUTINE MOVES performs both functions). Additional arrays may be dimensioned and used if necessary. The arrays XL, XLB, XV may be used to transfer mol fraction data to the various service or thermodynamic property prediction subroutines. The following service subroutines and thermodynamics properties prediction routines are available for use:

Service Subroutines	Thermodynamic Property Prediction Subroutines
a. SUMMR	a. KVALU
b. WTMOL	b. CSHL
c. MOVER	c. CSHV

d. MOVES
e. EQUIL
f. HBAL
g. RHOL
h. RHOV
i.
j.

d. ENTROP

After completing all calculations, the products must be moved from the working array, F1, to the permanent storage array, X. This operation is performed by SUBROUTINE MOVES:

If trial and error calculations are used in the technical calculation which involve either the equil brium (EQUIL), enthalpy (CSHV, CHSL) or heat balance (HBAL) subroutines, the tolerance levels of closure in these subroutines must be considered. The subroutine EQUIL has a tolerance of 0.00005 on the flash/bubble point/dew point calculation, and HBAL has a tolerance of 0.0001 on the enthalpy matching procedure. To ask for a closure of say 0.00005 in a large heat balancing loop involving several calculations through HBAL/EQUIL would probably lead to no convergence in the major loop simply because the level of errors in the computed values are cumulative. The resulting total loop error will be too large to ever achieve closure to the designated level of error.

```
CALL MOVES (5, INDP1)
     :
CALL MOVES (8, INDP4)
```

If calculated data specific to this calculation need to be retained for subsequent use, (either print-out or calculations) it may be stored in any <u>unused</u> locations in PDATA (JXX,I). On initial entry to the program these data spaces will contain zeroes. Saving this information can expedite the printout or subsequent calculations.

After the product streams have been transferred to the X array and the necessary information saved in PDATA (JXX,I) the program can be sent to a return step.

```
GO TO 400
```

The output phase of the calculation is entered when, the recycle calculations are complete or the maximum number of iterations has been exceeded. This status is indicated by INTRY = 3 which transfers control to statement 300.

```
300 CONTINUE
```

At this point, the following steps should be taken:

CALL TITLE

This operation causes the program to skip to a new page, print a new page number and the problem identification.

WRITE (NO,4) (ELNAME (JXX,1), I=1, 6)

4 FORMAT (/// __H DESCRIPTIVE TITLE FOR SUBROUTINE ***, 6A4

WRITE (NO,5)

5 FORMAT (__X, 5H FEEDS, __X, 8H PRODUCTS//)

These two WRITE Statements provide additional information for ease in interpreting the output.

CALL SPOUT (INDF1, INDF2, INDP1, INDP2, INDP3)

Subroutine SPOUT will print the component rates and associated information for the feeds to and products from the elements. If the total number of feeds and products from the element exceeds five, SPOUT will have to be called twice, once for the feeds, the other for the products. Any missing feeds/product indices should be set to zero.

If there are additional calculations to be done and/or information to be printed, they may be done at this point. After these operations are accomplished the third phase is complete

400 CONTINUE

RETURN

END

APPENDIX C

BLOCK DIAGRAM OF HIDE PROCESSES

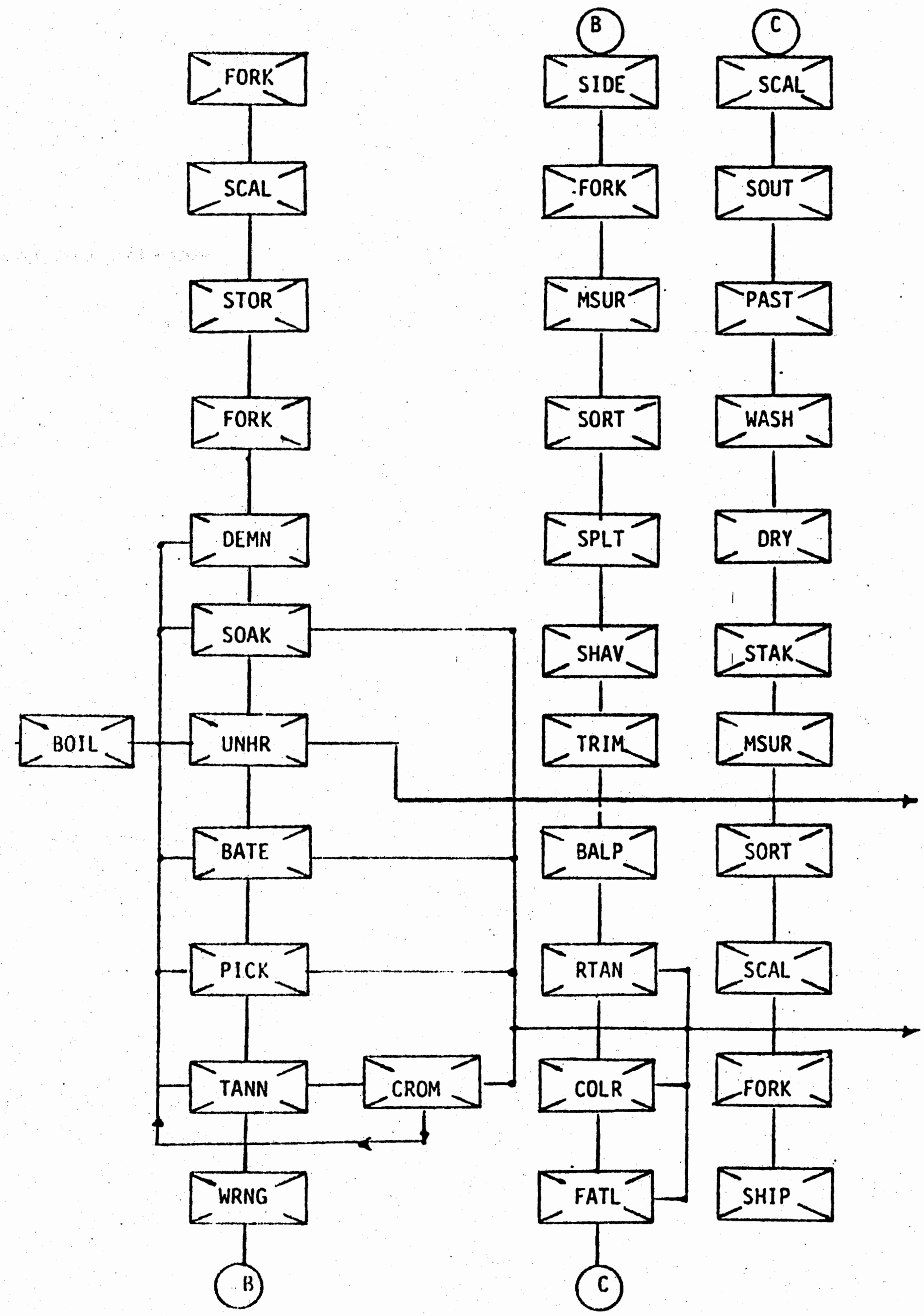

Figure 10. Block Diagram of Hide Processes

APPENDIX D

ESTIMATED EFFLUENT STREAM LOAD

TABLE V

ESTIMATED EFFLUENT STREAM LOAD FROM A 1000 CATTLE HIDE/DAY TANNERY

Processing Steps	Flow (10^3 ℓ/day)	BOD (kg/day)	Total suspended solids (kg/day)	Total solids (kg/day)	Oil and grease (kg/day)	Sulfide (kg/day)	Chromium (kg/day)	pH
Soaking	189	409	682	5,864	--	--	--	6.0-8.0
Unhairing	189	1,364	1,773	4,090	273	205	--	11.0-12.5
Liming	379	273	409	1,364	136	273	--	11.0-12.5
Bating	227	22.7	191	545	545	--	--	7.0-10.0
Chrome tanning	57	10.9	136	4,090	273	--	136	3.5-4.0
Retan, coloring and fatliquoring	379	54.5	81.8	545	45.5	--	27.3	4.0-5.0
Finishing	189	81.8	136	218	273	--	--	5.0-8.0

Source: Thorstensen, T. C., "Practical Leather Technology", R. E. Krieger Publishing Company, Huntington, New York, 1976, p. 263.

APPENDIX E

LISTING OF SUBROUTINES

```
*LEVEL 2.3.0 (JUNE 78)                    OS/360  FORTRAN H EXTENDED                    DATE 79.177/12.28.20

REQUESTED OPTIONS: GOSTMT

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(60) SIZE(MAX) AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT NOMAP NOFORMAT GOSTMT NOXREF NOALC NOANSF TERM IBM

                 C***EVAP      (IN AND OUT-NO SIDE STREAM)
    ISN 0002           SUBROUTINE EVAP (JXX)
    ISN 0003           DIMENSION EVAP1(20)
    ISN 0004           COMMON/SAVE1/SAVF(26,90)
    ISN 0005           COMMON/CNTR1/NCP,NT,NP,NFVL,NHM,NUNT,INTRY, ITEST,TL1,TL2,IDCS(25)
    ISN 0006           COMMON/CNTR2/IFED(100,4),IDPRD(100),IPD(100,4),IRCAL(100)
    ISN 0007           COMMON/CNTR3/INAME(2,30),ITCCNT(50),STNAME(201,3),ELNAME(35,6)
    ISN 0008           COMMON/CNTR4/ICHKR(100),ERRMAX,IR1MAX,IR2MAX
    ISN 0009           COMMON/INOUT/NI,NO,ANAME(20),MAXSR,NPRNT,LPMAX,NELM,IEND,NPAGE
    ISN 0010           COMMON/PRDAT/PDATA(100,30)
    ISN 0011           COMMON/PRICEA/PRICE(150),FACTOR(150,6)
    ISN 0012           COMMON/STRMS/X(30,201),F1(30,12)
    ISN 0013           COMMON/COSTB/COST(10,150),IEQUIP,IUTIL1,IUTIL2,IUT
                      1IL3,IUTIL4,ILAB1,ILAB2,ILAB3,ILAB4,ILAB5,IMAINT,IC
                      2HEM1,ICHEM2,ICHEM3,ICHEM4,IUTIL5,CSTID2,CSTID3,CST
                      3ID4,BSTID1,BSTID2,BSTID3,BSTID4,
                      4  NUMBR(130,150),NUMBR2(10,150),CAPITL(10,150)
    ISN 0014           COMMON/EQPLST/FORKD(3,15),SCALD(10,2),STORD(5),TAPED(10,2)
    ISN 0015           COMMON/EQPLSB/SORTD(15,2),BALPD(10),SPLTD(12,2),EVAPD(15)
    ISN 0016           COMMON/CNTRL8/ICXNST(25)
    ISN 0017           DATA EVAP1/360.0,12.0,6.0,1000.0,8.25,15*0.0/
    ISN 0018         1 FORMAT(5H EVAP,I4)
    ISN 0019         2 FORMAT(14H ERROR IN EVAP,I4,15H FEEDS/PRODUCTS)
                 C                          INITIALIZE STREAM LOCATIONS & (OTHER)
    ISN 0020           INDF1=IFED(JXX,1)
    ISN 0021           IPRD=IPD(JXX,1)
    ISN 0022           GO TO (100,200,800),INTRY
    ISN 0023       100 CONTINUE
    ISN 0024           WRITE(NO,1) JXX
    ISN 0025           ICHKR(JXX)=0
    ISN 0026           CALL FDCHK (1,1,1,1,JXX,JJJ)
    ISN 0027           DO 110 I=1,20
    ISN 0028           IF(PDATA(JXX,I).EQ.0.0)PDATA(JXX,I)=EVAP1(I)
    ISN 0030       110 CONTINUE
                 C **** BRING IN SUBROUTINE PARAMETERS, IF ANY ****
    ISN 0031           T1=PDATA(JXX,1)
    ISN 0032           E=PDATA(JXX,2)
    ISN 0033           R=PDATA(JXX,3)
    ISN 0034           IF(JJJ.EQ.2)WRITE(NO,2)JXX
    ISN 0036           GO TO 1000
    ISN 0037       200 CONTINUE
    ISN 0038           IRCAL(JXX)=0
    ISN 0039           WRITE(NO,1)JXX
    ISN 0040           CALL MOVER(INDF1,1)
    ISN 0041           CALL TFLJ(F,1)
    ISN 0042           F1(22,1)=F
    ISN 0043                F = F / 8.34
    ISN 0044           CALL SUMMR(F1,1,SUM1)
    ISN 0045           IF(SUM1.EQ.0.0)GO TO 300
                 C **** PERFORM CHANGES ON STREAM CHARACTERISTICS, IF ANY ****
    ISN 0047       300 CONTINUE
    ISN 0048           CALL MOVER(201,2)
    ISN 0049           CALL MOVES(2,IPRD)
```

```
*LEVEL 2.3.0 (JUNE 78)          EVAP            OS/360  FORTRAN H EXTENDED            DATE 79.177/12.28.20

  ISN 0050             GO TO 1000
  ISN 0051         800 CONTINUE
                 C **** AREA OF POND ****
  ISN 0052             AREA=(F*T1*3.08E-06)/(E-R)
  ISN 0053                       NUMBR(JXX,5) = AREA
                 C **** LAND COST OF POND ****
  ISN 0054             C1=AREA*PRICE(5)
                 C **** ASSUMED 10 % INTEREST FOR LAND
  ISN 0055                       SAVE(24,JXX) = C1 * 0.10
                 C **** CAPITAL COST OF POND ****
  ISN 0056             C2=3.4*((F*PDATA(JXX,1)/(E-R))**0.713)
  ISN 0057                 IF((CKNST(23).EQ.1) GO TO 400
                 C **** MANHOURS & MATERIAL & SUPPLY COSTS -- WARM CLIMATE ****
  ISN 0059             FMHRS1=1.73*1.0E-02*((F*PDATA(JXX,1)/(E-R))**0.624)
  ISN 0060             C3=FMHRS1*PRICE(15)
  ISN 0061             C4=0.45*((F*PDATA(JXX,1)/(E-R))**0.509)
                 C **** ASSUMED 5 % FOR LABOR INSURANCE
  ISN 0062                       SAVE(7,JXX) = C3 * 0.05
  ISN 0063                       SAVE(8,JXX) = C4
  ISN 0064                       NUMBR(JXX,15) = FMHRS1
  ISN 0065                       FMHRS2 = 0.0
  ISN 0066                       C5 = 0.0
  ISN 0067                       C6 = 0.0
  ISN 0068                 GO TO 500
                 C **** MANHOURS & MATERIAL & SUPPLY COSTS -- COOL CLIMATE ****
  ISN 0069         400 FMHRS2=9.89*1.0E-03*((F*PDATA(JXX,1)/(E-R))**0.63)
  ISN 0070             C5=FMHRS2*PRICE(15)
  ISN 0071             C6=0.23*((F*PDATA(JXX,1)/(E-R))**0.511)
                 C **** ASSUMED 5 % FOR LABOR INSURANCE
  ISN 0072                       SAVE(7,JXX) = C5 * 0.05
  ISN 0073                       SAVE(8,JXX) = C6
  ISN 0074                       NUMBR(JXX,15) = FMHRS2
  ISN 0075                       FMHRS1 = 0.0
  ISN 0076                       C3 = 0.0
  ISN 0077                       C4 = 0.0
  ISN 0078         500 CALL SPOUTX(JXX)
  ISN 0079             WRITE(NO,8)AREA,F,C1,C2,FMHRS1, FMHRS2,C3,C5,C4,C6
  ISN 0080           8 FORMAT(1H0,9X,'ITEM',12X,'NUMBER',10X,'UNITS'//
                    1  9X,'POND',10X,F9.2,10X,'ACRES' /
                    2  9X,'WATER FLOW',4X,F9.2,9X,'GAL/DAY' /
                    3  9X,'LAND COST',5X,F9.2,9X,'DOLLARS' /
                    4  9X,'CAPT. COST',4X,F9.2, 9X,'DOLLARS'//
                    5  20X,'FOR WARM CLIMATES',4X,'FOR COOL CLIMATES' /
                    6  26X,'NUMBER',15X,'NUMBER',9X,'UNITS' //
                    7  9X,'LABOR',8X,F10.2,11X,F10.2,6X,'MANHOURS' /
                    8  9X,'LABOR COST',3X,F10.2,11X,F10.2,7X,'DOLLARS' /
                    9  9X,'MATERIALS',4X,F10.2,11X,F10.2,7X,'DOLLARS' )
  ISN 0081        1000 CONTINUE
  ISN 0082             RETURN
  ISN 0083             END

*OPTIONS IN EFFECT*NAME(MAIN) NOOPTIMIZE LINECOUNT(60) SIZE(MAX) AUTODBL(NONE)

*OPTIONS IN EFFECT*SOURCE EBCDIC NOLIST NODECK OBJECT NOMAP NOFORMAT GOSTMT NOXREF NOALC NOANSF TERM IBM FI

*STATISTICS*     SOURCE STATEMENTS =       82, PROGRAM SIZE =      2654, SUBPROGRAM NAME =  EVAP

*STATISTICS*  NO  DIAGNOSTICS GENERATED
```

```
*LEVEL 2.3.0 (JUNE 78)                    OS/360  FORTRAN H EXTENDED                DATE 79.177/12.31.08

REQUESTED OPTIONS: GOSTMT

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(60) SIZE(MAX) AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT NOMAP NOFORMAT GOSTMT NOXREF NOALC NOANSF TERM IBM

                      C***SOAK      (IN AND OUT-NO SIDE STREAM)
      ISN 0002              SUBROUTINE SOAK (JXX)
      ISN 0003              COMMON/SAVE1/SAVE(26,90)
      ISN 0004              COMMON/CNTR1/NCP,NT,NP,NFVL,NHH,NUNT,INTRY, ITEST,TL1,TL2,IDCS(25)
      ISN 0005              COMMON/CNTR2/IFED(100,4),IOPRO(100),IPD(100,4),IRCAL(100)
      ISN 0006              COMMON/CNTR3/INAME(2,30),ITCCNT(50),STNAME(201,3),ELNAME(35,6)
      ISN 0007              COMMON/CNTR4/ICHKR(100),ERRMAX,IR1MAX,IR2MAX
      ISN 0008              COMMON/INOUT/NI,NO,ANAME(20),MAXSR,NPRNT,LPMAX,NELP,IEND,NPAGE
      ISN 0009              COMMON/PRDAT/PDATA(100,30)
      ISN 0010              COMMON/STRMS/X(30,201),F1(30,12)
      ISN 0011              COMMON/COSTB/COST(10,150),IEQIUP,IUTIL1,IUTIL2,IUTIL3,IUTIL4,
                           1 ILAB1,ILAB2,ILAB3,ILAB4,ILAB5,IMAINT,ICHEM1,ICHEM2,ICHEM3,
                           2 ICHEM4,CSTID1,CSTID2,CSTID3,CSTID4,BSTID1,BSTID2,BSTID3,
                           3 BSTID4,NUMBR(100,150),NUMBR2(10,150),CAPITL(10,150)
      ISN 0012              COMMON/PRLIST/XNAME(150,6),XUNIT(150,2)
      ISN 0013              COMMON/PRICEA/PRICF(150),FACTOR(150,6)
      ISN 0014              COMMON/EQPLST/FORKD(3,15),SCALD(10,2),STORD(5),TAPED(10,2)
      ISN 0015              COMMON/EQPLSC/WRNGD(15),DEMND(15),SOAKD(30)
      ISN 0016              COMMON/EQPLSB/SORTD(15,2),BALPD(10),SPLTD(12,2),SHAVD(15)
      ISN 0017              COMMON/DEMAND/IDMSH(30)
      ISN 0018            4 FORMAT (6X,7HMACHINE,8X,F8.2,5X,5HEACH ,4F10.2)
      ISN 0019           11 FORMAT (6X,10HBUILDING *,3X,F10.2,4X,5HSQ.FT,1X,4F10.2)
      ISN 0020           12 FORMAT(6X,5HWATER,4X,F14.2,6X,3HLBS,21X,2F10.2)
      ISN 0021           13 FORMAT(6X,'LAND COST',4X,F10.2,4X,'SQ.FT ',2F10.2,10X,F10.2)
      ISN 0022            7 FORMAT(6X,13HPLUMBING COST,20X,4F10.2)
      ISN 0023           16 FORMAT(06X,8HOPERATOR,7X,F8.2,6X,3HMEN,21X,2F10.2)
      ISN 0024           20 FORMAT(6X,9HWIRE COST,24X,4F10.2)
      ISN 0025           21 FORMAT(6X,10HMANAGEMENT,5X,F8.2,6X,3HMEN,11X,F10.2,10X,F10.2)
      ISN 0026           22 FORMAT(6X,7HFOREMAN,8X,F8.2,6X,3HMEN,11X,F10.2,10X,F10.2)
      ISN 0027           23 FORMAT(6X,12HSEMI-SKILLED,13X,F8.2,6X,3HMEN,21X,2F10.2)
      ISN 0028           26 FORMAT(6X,7HSULFIDE,2X,F14.2,6X,3HLBS,21X,2F10.2)
      ISN 0029           25 FORMAT(6X,9HDETERGENT,F14.2,6X,3HLBS,21X,2F10.2)
      ISN 0030           24 FORMAT(6X,7HLABORER,8X,F8.2,6X,3HMEN,21X,2F10.2)
      ISN 0031           27 FORMAT(6X,7HHEATING,2X,F14.2,6X,3HKWH,21X,2F10.2)
      ISN 0032           29 FORMAT(7H ADEP=$,F8.2,2X,6HATAX=$,F8.2,2X,6HAREP=$,F8.2,2X,
                           1        5HSJR=$,F8.2,2X,5HTER=$,F8.2,2X,5HYEAR=, I2)
      ISN 0033           31 FORMAT(//,5X,'NOTE : BUILDING COST IS ASSOCIATED WITH FOLLOWING VA
                           1RIABLES', //)
      ISN 0034           32 FORMAT(12X,'MANUFACTURING SPACE =',F10.1,' SQ.FT, COST = $',F10.1)
      ISN 0035           33 FORMAT(12X,'OFFICE SPACE        =',F10.1,' SQ.FT, COST = $',F10.1)
      ISN 0036           34 FORMAT(12X,'OFFICE FURNITURE AND EQUIPMENTS COSTS        = $',
                           1  F10.1 )
      ISN 0037           35 FORMAT(//,1X,'SOAKING MACHINE DEPRECIATION ROUTINE')
      ISN 0038           36 FORMAT(//,1X,'BUILDING DEPRECIATION ROUTINE')
      ISN 0039          101 FORMAT(1H1,////,1X,'SOAKING COMPUTATION OUTPUT',I3,'***SOAK',//)
      ISN 0040            9 FORMAT(17H TOTAL ANNUAL COSTS,46X,F14.2)
      ISN 0041           10 FORMAT(6X,4HITEM,13X,6HNUMBER,4X,5HUNITS, 3X,8HORIGINAL, 5X,
                           1        5HFIXED, 2X,8HVARIABLE, 4X,6HANNUAL,/, 44X,5HCOSTS,
                           2        5X,5HCOSTS,5X,5HCOSTS, 5X,5HCOSTS )
      ISN 0042            1 FORMAT(5H SOAK,I4)
      ISN 0043            2 FORMAT(14H ERROR IN SOAK,I4,15H FEEDS/PRODUCTS)
      ISN 0044            3 FORMAT(1X,'ORIGINAL COST',2X,F10.2,3X,'SALVAGE VALUE',2X,
                           1  F10.2,3X,'LIFE',10X,F10.2 / 1X,'CAPACITY',7X,F10.2 3X,
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*LEVEL 2.3.0 (JUNE 78)           SOAK          OS/360  FORTRAN H EXTENDED          DATE 79.177/12.31.08

                        2  'SOAK TIME',6X,F10.2,3X,'% TOTAL TIME',5X,F7.2 /          00000600
                        3  1X,'SPACE',10X,F10.2,3X,'RPM',12X,F10.2,3X,'FLOAT',12X,   00000610
                        4  F7.2 /  1X,'TEMP. OF FLOAT',F11.2,3X,'PH',13X,F10.2,3X,   00000620
                        5  '% DETERGENT',6X,F7.2, / 1X,'% SULFIDE',6X,F10.2,3X,      00000630
                        6  'MANAGEMENT',8X,F7.2,3X,'FOREMAN',10X,F7.2 / 1X,'OPERATOR', 00000640
                        7  10X,F7.2,3X,'LABORER',11X,F7.2,3X,'SHIFTS',11X,F7.2 /     00000650
                        8  1X,'% DIRT REMAINING',2X,F7.2,3X,'% WATER REMAINING',     00000660
                        9  F8.2,3X,'% SALT REMAINING',F8.2 //)                       00000670
                  C                  INITIALIZE STREAM LOCATIONS & (OTHER)           00000680
   ISN 0045             IFD=IFED(JXX,1)                                              00000690
   ISN 0046                 IF( INTRY.GT.1) GO TO 39                                 00000710
   ISN 0048                      I = 1                                               00000720
   ISN 0049          37     IF(IDMSM(I).EQ.0) GO TO 38                               00000730
   ISN 0051                  I = I + 1                                               00000740
   ISN 0052                 IF(I.LE.30) GO TO 37                                     00000750
   ISN 0054                 GO TO 39                                                 00000760
   ISN 0055          38          IDMSM(I) = 1                                        00000770
   ISN 0056                      IFED(JXX,2) = 170 + I                               00000780
   ISN 0057          39 CONTINUE                                                     00000790
   ISN 0058                 IFDB = IFED(JXX,2)                                       00000800
   ISN 0059             IPRD=IPD(JXX,1)                                              00000810
   ISN 0060             IPRDB=IPD(JXX,2)                                             00000820
   ISN 0061             GO TO (100,200,800),INTRY                                    00000830
   ISN 0062         100 CONTINUE                                                     00000840
   ISN 0063             WRITE(NO,1) JXX                                              00000850
   ISN 0064             ICHKR(JXX)=2                                                 00000860
   ISN 0065             CALL FDCHK (1,2,1,2,JXX,JJJ)                                 00000870
   ISN 0066             DO 110 I=1,23                                                00000880
   ISN 0067             IF(PDATA(JXX,I).EQ.0.0)PDATA(JXX,I)=SOAKD(I)                 00000890
   ISN 0069         110 CONTINUE                                                     00000900
   ISN 0070             IF(PDATA(JXX,1).EQ.0.0)WRITE(NO,3) (PDATA(JXX,J),J=3,23)     00000910
   ISN 0072             IF(JJJ.EQ.2)WRITE(NO,2)JXX                                   00000920
   ISN 0074             GO TO 1000                                                   00000930
   ISN 0075         200 CONTINUE                                                     00000940
   ISN 0076             IRCAL(JXX)=0                                                 00000950
   ISN 0077             WRITE(NO,1) JXX                                              00000960
                  C          MOVE STREAMS TO WORKING ARRAY FI                        00000970
   ISN 0078             CALL MOVER(IFD,1)                                            00000980
                  C          CALCULATIONS OF STREAM AND PROCESS INTERACTION.         00000990
                  C          1.       CHECK FOR ZERO MAIN STREAM IF NO GO TO 300     00001000
   ISN 0079             CALL SUMMR(FI,1,SUML)                                        00001010
   ISN 0080             IF(SUML.EQ.0.0)GO TO 300                                     00001020
   ISN 0082             IF(FI(1,1).LT.1.0)GO TO 300                                  00001030
   ISN 0084             SHIDE=0.0                                                    00001050
   ISN 0085             DO 40 I=3,10                                                 00001060
   ISN 0086          40 SHIDE=FI(I,1)+SHIDE                                          00001070
   ISN 0087             NHIDE=(PDATA(JXX,6)/SHIDE)+0.5                               00001080
   ISN 0088             NBATCH=(FI(1,1)/NHIDE)+0.25                                  00001090
   ISN 0089             BATCH=NBATCH                                                 00001100
   ISN 0090             WATER=BATCH*PDATA(JXX,6)*PDATA(JXX,20)*PDATA(JXX,11)         00001110
   ISN 0091             DETER=BATCH*PDATA(JXX,6)*PDATA(JXX,20)*PDATA(JXX,14)         00001120
   ISN 0092             SULF=BATCH*PDATA(JXX,6)*PDATA(JXX,20)*PDATA(JXX,15)          00001130
   ISN 0093             NMACH=BATCH/((PDATA(JXX,20)*480.0)/PDATA(JXX,7))+0.5         00001140
   ISN 0094             XMACH=NMACH                                                  00001150
   ISN 0095             T = ((BATCH/XMACH)*PDATA(JXX,7))/60.0                        00001160
   ISN 0096             WTER=WATER*255.00                                            00001170
                  C     CONVERT POUNDS OF WATER TO GALLONS                           00001180
   ISN 0097                 WTERG = WTER / 8338.0                                    00001190
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ISN 0098          DTER=DETER*255.00
ISN 0099          SUF=SULF*255.00
ISN 0100          BTU=(WATER/(PDATA(JXX,20)*8.0))*(PDATA(JXX,12)-50.0)
ISN 0101          BT = BTU * 255.0
ISN 0102          BT = BT / 3413.0
ISN 0103                  F1(6,4) = WATER
ISN 0104                  F1(15,4) = SULF
ISN 0105                  F1(14,4) = DETER
ISN 0106                 NUMBR(JXX,22) = BT
ISN 0107                 NUMBR(JXX,21) = WTERG
ISN 0108                 NUMBR(JXX,35) = DTER
ISN 0109                 NUMBR(JXX,36) = SUF
ISN 0110                 NUMBR(JXX,104) = XMACH
            C             2.        CALCULATE OUTPUT STREAMS
ISN 0111          DO 610 I=1,30
ISN 0112          F1(I,3)=F1(I,1)
ISN 0113      610 CONTINUE
ISN 0114          CALL MOVER(201,3)
ISN 0115          F1(5,3)=F1(5,1)*(1.0-PDATA(JXX,21))
ISN 0116          IF(PDATA(JXX,22).LE.1.0)
                 $F1(6,3)=F1(6,1)*(1.0-PDATA(JXX,22))
ISN 0118          F1(7,3)=F1(7,1)*(1.0-PDATA(JXX,23))
ISN 0119          F1(5,2)=F1(5,1)*PDATA(JXX,21)
ISN 0120          F1(6,2)=F1(6,1)*PDATA(JXX,22)
ISN 0121          F1(7,2)=F1(7,1)*PDATA(JXX,23)
ISN 0122          F1(28,3)=1.0
ISN 0123          F1(4,2)=F1(4,1)
ISN 0124          F1(4,3)=0.0
ISN 0125          DO 615 I=8,25
ISN 0126          F1(I,3)=F1(I,1)
ISN 0127          F1(I,2)=0.0
ISN 0128      615 CONTINUE
ISN 0129          DO 82 I=4,30
ISN 0130          F1(I,3)=F1(I,3)*F1(1,1)
ISN 0131       82 CONTINUE
ISN 0132          F1(6,3)=F1(6,3)+WATER
ISN 0133          F1(14,3)=DETER
ISN 0134          F1(15,3)=SULF
ISN 0135              F1(20,3) = 0.902*F1(1,1)
ISN 0136              F1(21,3) = 1.504*F1(1,1)
ISN 0137          IF(PDATA(JXX,22).GT.1.0)
                 $F1(6,3)=WATER-((F1(6,2)-F1(6,1))*F1(1,1))
ISN 0139          GO TO 700
ISN 0140      300 CONTINUE
ISN 0141          CALL MOVER(201,2)
ISN 0142      700 CONTINUE
ISN 0143          CALL IFLO(FLOW,2)
ISN 0144                  F1(22,2) = FLOW
ISN 0145          CALL MOVES(2,IPRD)
ISN 0146              IF(IPROB.LE.0) GO TO 1000
ISN 0148          CALL IFLO(FLOW,3)
ISN 0149                  F1(22,3) = FLOW
ISN 0150          CALL MOVES(3,IPROB)
ISN 0151          CALL IFLO(FLOW,4)
ISN 0152                  F1(22,4) = FLOW
ISN 0153          CALL MOVES(4,IFOB)
ISN 0154          GO TO 1000
ISN 0155      800 CONTINUE
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ISN 0156          IWRITA=PDATA(JXX,1)
           C        COMPUTE DEPRECIATION,REPAIRS,INTEREST,INSURANCE,TAX
ISN 0157          CALL DEP(PDATA(JXX,3),PDATA(JXX,4),PDATA(JXX,5),T,
                 $ADEP,AREP,ATAX,SUR,TER,J)
           C                                  COMPUTE CAPITAL
ISN 0158          CAPITAL=PDATA(JXX,3)*XMACH
ISN 0159          FXCOST = ATAX + SUR + TER
ISN 0160          VRCOST = ADEP + AREP
ISN 0161              FXCOST = FXCOST * XMACH
ISN 0162              VRCOST = VRCOST * XMACH
ISN 0163              ACCAPI = FXCOST + VRCOST
           C *** ASSUMED 80 % OF DEPRECIATION FOR VARIABLE AND 20 % FOR FIXED
ISN 0164              SAVE(1,JXX) = 0.80 * ADEP
ISN 0165              SAVE(11,JXX) = 0.20 * ADEP
ISN 0166              SAVE(4,JXX) = AREP
ISN 0167              SAVE(14,JXX) = ATAX
ISN 0168              SAVE(17,JXX) = SUR
ISN 0169              SAVE(21,JXX) = TER
           C         COMPUTE SPACE
ISN 0170          SPACE=PDATA(JXX,9)*XMACH
ISN 0171          SPACST=SPACE*PRICE(1)
ISN 0172                   OFFSP = 0.027*SPACE
ISN 0173                   FURNI = 0.268*OFFSP
ISN 0174                   OFFCST = OFFSP*PRICE(2)
ISN 0175                   FURCST = FURNI*PRICE(3)
ISN 0176              BUICST = SPACST + OFFCST + FURCST
ISN 0177              TSPACE = SPACE + OFFSP
           C *** ASSUMED 10 % OF SPACE COST FOR THE SAVAGE SPACE VALUE
ISN 0178              SVSPAC = 0.10 * BUICST
ISN 0179          CALL DEP(BUICST,SVSPAC,25.0,8.0,ADEP1,AREP1,ATAX1,SUR1,TER1,J1)
ISN 0180              FOCOST = ATAX1 + SUR1 + TER1
ISN 0181              VOCOST = ADEP1 + AREP1
ISN 0182              ACSPAC = FOCOST + VOCOST
ISN 0183              SAVE(3,JXX) = ADEP1 * 0.80
ISN 0184              SAVE(13,JXX) = ADEP1 * 0.20
ISN 0185              SAVE(6,JXX) = AREP1
ISN 0186              SAVE(16,JXX) = ATAX1
ISN 0187              SAVE(19,JXX) = SUR1
ISN 0188              SAVE(23,JXX) = TER1
ISN 0189                   NUMBR(JXX,1) = SPACE
ISN 0190                   NUMBR(JXX,2) = OFFSP
ISN 0191                   NUMBR(JXX,3) = FURNI
           C *** COMPUTE LAND COST
           C *** ASSUMED 10% INTEREST AND 3% TAX FOR LAND
ISN 0192                   TLAND = 1.5 * TSPACE
ISN 0193                   TLCST = TLAND * PRICE(4)/43560.0
ISN 0194                   TLINT = TLCST * 0.10
ISN 0195                   TLTAX = TLCST * 0.03
ISN 0196                   FXLAND = TLINT + TLTAX
ISN 0197                   SAVE(24,JXX) = TLINT
ISN 0198              NUMBR(JXX,4) = TLAND
           C                COMPUTE CHEMICALS
ISN 0199          DETCST=DTER*PRICE(35)
ISN 0200          SUFCST=SUF*PRICE(36)
           C           COMPUTE ELECTRICITY COST
ISN 0201          BTUCST=DT*PRICE(22)*PDATA(JXX,20)
           C                                  COMPUTE LABOR
ISN 0202          WKU=PDATA(JXX,16)*XMACH
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ISN 0203          WKT=PDATA(JXX,17)*XMACH
ISN 0204          WKH=PDATA(JXX,18)*XMACH
ISN 0205          WKF=PDATA(JXX,19)*XMACH
ISN 0206                    STANT = PDATA(JXX,20)*2040.0
ISN 0207                    TKO = STANT*WKO
ISN 0208                    TKT = STANT*WKT
ISN 0209                    TKH = STANT*WKH
ISN 0210                    TKF = STANT*WKF
ISN 0211                    NUMBR(JXX,11) = TKO
ISN 0212                    NUMBR(JXX,12) = TKT
ISN 0213                    NUMBR(JXX,13) = TKH
ISN 0214                    NUMBR(JXX,15) = TKF
ISN 0215               WKCSTO = TKO*PRICE(11)
ISN 0216               WKCSTT = TKT*PRICE(12)
ISN 0217               WKCSTH = TKH*PRICE(13)
ISN 0218               WKCSTF = TKF*PRICE(15)
               C **** ASSUMED 5 % OF MANAGEMENT FOR MANAGEMENT INSURANCE
               C **** ASSUMED 5 % OF LABOR COSTS FOR LABOR INSURANCE
ISN 0219              SAVE(20,JXX)=(WKCSTO + WKCSTT)*0.05
ISN 0220              SAVE(7,JXX) =(WKCSTH +WKCSTF)*0.05
               C                  COMPUTE UTILITIES
ISN 0221          WIRCST=XMACH*PRICE(76)
ISN 0222               NUMBR(JXX,76) = XMACH
ISN 0223          ACWIRE=WIRCST*FACTOR(76,1)
ISN 0224               AWV = 0.80*ACWIRE
ISN 0225               AWF = 0.20*ACWIRE
ISN 0226               WREP = 0.01 * WIRCST
ISN 0227               WTAX = 0.02 * WIRCST
ISN 0228               WINS = 0.01 * WIRCST
ISN 0229               WINT = 0.05 * WIRCST
ISN 0230               AWVV = AWV + WREP
ISN 0231               AWFF = AWF + WTAX + WINS + WINT
ISN 0232               ACWIRE = AWVV + AWFF
               C       COMPUTE PLUMBING
ISN 0233          PLCST=PRICE(75)*XMACH
ISN 0234          ACPLM=PLCST*FACTOR(75,1)
ISN 0235               APLV = 0.80 * ACPLM
ISN 0236               APLF = 0.20 * ACPLM
ISN 0237               PLREP = 0.01 * PLCST
ISN 0238               PLTAX = 0.02 * PLCST
ISN 0239               PLINS = 0.01 * PLCST
ISN 0240               PLINT = 0.05 * PLCST
ISN 0241               APLVV = APLV + PLREP
ISN 0242               APLFF = APLF + PLTAX +PLINS + PLINT
ISN 0243               ACPLM = APVV + APLFF
ISN 0244               NUMBR(JXX,75) = XMACH
ISN 0245               SAVE(2,JXX) = APLV +AWV
ISN 0246               SAVE(12,JXX) = APLF + AWF
ISN 0247               SAVE(5,JXX) = PLREP + WREP
ISN 0248               SAVE(15,JXX) = PLTAX + WTAX
ISN 0249               SAVE(18,JXX) = PLINS + WINS
ISN 0250               SAVE(22,JXX) = PLINT + WINT
               C      COMPUTE HOT WATER COSTS
               C      1 GAL = 8.338 LB., 1 LB = $0.0001
ISN 0251           ACWAT=WTER*PRICE(21) / 8338.0
               C                            COMPUTE TOTAL COSTS
ISN 0252          TOTLAC=ACWRKC+ACCAPT+ACWIRE+ACPLM+ACWAT+ACSPAC
                 $+WKCSTO+BTUCST+WKCSTT+WKCSTH+WKCSTF+DETCST+SUFCST + EXLAND
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*LEVEL 2.3.0 (JUNE 78)            SOAK            OS/360  FORTRAN H EXTENDED            DATE 79.177/12.31.08

   ISN 0253          IF(WRITA.GE.2)GO TO 1000                                               00002940
              C                      PRINT ANSWERS                                          00002950
   ISN 0255          CALL SPOUTX(JXX)                                                       00002960
   ISN 0256          WRITE(NO,101) JXX                                                      00002970
   ISN 0257          WRITE(NO,10)                                                           00002980
   ISN 0258          IF(CAPTAL.GT.0.0)WRITE(NO,4)XMACH,CAPTAL,FXCOST,VRCOST,ACCAPT          00002990
   ISN 0260          IF(WKCSTO.GT.0.0)WRITE(NO,21)WKO,WKCSTO,WKCSTO                         00003000
   ISN 0262          IF(WKCSTT.GT.0.0)WRITE(NO,22)WKT,WKCSTT,WKCSTT                         00003010
   ISN 0264          IF(WKCSTH.GT.0.0)WRITE(NO,16)WKH,WKCSTH,WKCSTH                         00003020
   ISN 0266          IF(WKCSTF.GT.0.0)WRITE(NO,24)WKF,WKCSTF,WKCSTF                         00003030
   ISN 0268          IF(DETCST.GT.0.0)WRITE(NO,25)DTER,DETCST,DETCST                        00003040
   ISN 0270          IF(SUFCST.GT.0.0)WRITE(NO,26)SUF,SUFCST,SUFCST                         00003050
   ISN 0272          IF(BTUCST.GT.0.0)WRITE(NO,27)BT,BTUCST,BTUCST                          00003060
   ISN 0274          IF(ACPLM.GT.0.0)WRITE(NO,7)PLCST,APLVV,APLFF,ACPLM                     00003070
   ISN 0276          IF(ACWIRE.GT.0.0)WRITE(NO,20)WIRCST,AWFF,AWVV,ACWIRE                   00003080
   ISN 0278          IF(ACSPAC.GT.0.0)WRITE(NO,11)TSPACE,BUICST,FOCOST,VOCOST,ACSPAC        00003090
   ISN 0280          IF(TLCST.GT.0.0) WRITE(NO,13)TLAND,TLCST,FXLAND,FXLAND                 00003100
   ISN 0282          IF(ACWAT.GT.0.0)WRITE(NO,12)WTER,ACWAT,ACWAT                           00003110
   ISN 0284          WRITE(NO,9)TOTLAC                                                      00003120
   ISN 0285          WRITE(NO,31)                                                           00003130
   ISN 0286          WRITE(NO,32) SPACE,SPACST                                              00003140
   ISN 0287          WRITE(NO,33) OFFSP,OFFCST                                              00003150
   ISN 0288          WRITE(NO,34) FURCST                                                    00003160
   ISN 0289          WRITE(NO,35)                                                           00003170
   ISN 0290          WRITE(NO,29)ADEP,ATAX,AREP,SUR,TER,J                                   00003180
   ISN 0291          WRITE(NO,36)                                                           00003190
   ISN 0292          WRITE(NO,29) ADEP1,ATAX1,AREP1,SUR1,TER1,J1                            00003200
   ISN 0293     1000 CONTINUE                                                               00003210
   ISN 0294          RETURN                                                                 00003220
   ISN 0295          END                                                                    00003230

*OPTIONS IN EFFECT*NAME(MAIN) NOOPTIMIZE LINECOUNT(60) SIZE(MAX) AUTODBL(NONE)

*OPTIONS IN EFFECT*SOURCE EBCDIC NOLIST NODECK OBJECT NOMAP NOFORMAT GOSTMT NOXREF NOALC NOANSF TERM IBM FLAG(I

*STATISTICS*     SOURCE STATEMENTS =      294, PROGRAM SIZE =      8746, SUBPROGRAM NAME =  SOAK

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                        44K BYTES OF CORE NOT USED
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*LEVEL 2.3.0 (JUNE 78)                    OS/360  FORTRAN H EXTENDED                DATE 79.177/12.26.17

REQUESTED OPTIONS: GOSTMT

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(60) SIZE(MAX) AUTODBL(NONE)
                   SOURCE EBCDIC NOLIST NODECK OBJECT NOMAP NOFORMAT GOSTMT NOXREF NOALC NOANSF TERM IBM

                 C **** THIS SUBROUTINE CALCULATES PERFORMANCE AND PHYSICAL DESIGN           00000070
                 C      PARAMETERS FOR AN AERATION BASIN ****                                00000080
  ISN 0002             SUBROUTINE AIR2(JXX)                                                  00000090
  ISN 0003             DIMENSION AIR2D(20)                                                   00000100
  ISN 0004             COMMON/SAVE/SAVE1(26,90)                                              00000110
  ISN 0005             COMMON/CNTR1/NCP,NT,NP,NFVL,NIM,NUNT,INTRY,ITEST,TL1,TL2,IDCS(25)     00000120
  ISN 0006             COMMON/CNTR2/IFED(100,4),IDPRO(100),IPD(100,4),IRCAL(100)             00000130
  ISN 0007             COMMON/CNTR3/INAME(2,30),ITCCNT(50),STNAME(201,3),ELNAME(35,6)        00000140
  ISN 0008             COMMON/CNTR4/ICHKR(100),ERRMAX,IR1MAX,IR2MAX                          00000150
  ISN 0009             COMMON/INOUT/NI,NO,ANAME(20),MAXSR,NPRNT,LPMAX,NELM,IFND,NPAGE        00000160
  ISN 0010             COMMON/PRDAT/PDATA(100,30)                                            00000170
  ISN 0011             COMMON/PRICEA/PRICE(30),FACTOR(30)                                    00000180
  ISN 0012             COMMON/STRMS/X(30,201),F1(30,12)                                      00000190
  ISN 0013             COMMON/THERM1/CSXX(40,100),VAS,UN,FOX                                 00000200
  ISN 0014             DATA AIR2D/8000.0,3.0,100.0,100.0,3.0,150.0,0.05,0.5,0.2,1.5,         00000210
                      $0.5,0.25,120.0,7*0.0/                                                 00000220
                 C***** F=INFLUENT FLOW RATE, GAL/DAY                                        00000230
                 C***** SI=INFLUENT BOD                                                      00000240
                 C***** UMAX=MAXIMUM GROWTH RATE/DAYS, =3.0/DAY                              00000250
                 C***** X=MIXED LIQUOR BIOLOGICAL SOLIDS MG/L                                00000260
                 C***** UN=NET SPECIFIC GROWTH RATE PER DAY                                  00000270
                 C***** FKS=BIOLOGICAL CONSTANT, MG/L                                        00000280
                 C***** FKD=DECAY COEFFICIENT PER DAY                                        00000290
                 C***** YT=TRUE SLUDGE YIELD                                                 00000300
                 C***** VAS=VOLUME OF AERATION BASIN                                         00000310
                 C***** ALPHA=RECIRCULATION RATE                                             00000320
                 C***** XR=RECIRCULATION SOLIDS CONCENTRATION                                00000330
                 C***** SE=EFFLUENT BOD - SOLUBLE                                            00000340
                 C***** FA=AIR FLOW RATE CU. FT./MIN                                         00000350
  ISN 0015           1 FORMAT(5H AIR2,I4)                                                    00000360
  ISN 0016           2 FORMAT(14H ERROR IN AIR2,I4,15H FEEDS/PRODUCTS)                       00000370
                 C***** INITIALIZE STREAM LOCATIONS *****                                    00000380
  ISN 0017             INDF1=IFED(JXX,1)                                                     00000390
  ISN 0018             IPRO=IPD(JXX,1)                                                       00000400
  ISN 0019             GO TO(100,200,800),INTRY                                              00000410
  ISN 0020         100 CONTINUE                                                              00000420
  ISN 0021             WRITE(NO,1)JXX                                                        00000430
  ISN 0022             ICHKR(JXX)=0                                                          00000440
  ISN 0023             CALL FDCHK(1,1,1,1,JXX,JJJ)                                           00000450
  ISN 0024             DO 110 J=1,20                                                         00000460
  ISN 0025             IF(PDATA(JXX,J).EQ.0.0)PDATA(JXX,J)=AIR2D(J)                          00000470
  ISN 0027         110 CONTINUE                                                              00000480
  ISN 0028             IF(JJJ.EQ.2)WRITE(NO,2)JXX                                            00000490
  ISN 0030                GO TO 1000                                                         00000500
  ISN 0031         200 CONTINUE                                                              00000510
  ISN 0032             IRCAL(JXX)=0                                                          00000520
  ISN 0033             WRITE(NO,1) JXX                                                       00000530
  ISN 0034             CALL MOVER(INDF1,1)                                                   00000540
                 C ***** MOVE STREAMS TO WORKING ARRAY F1 *****                              00000550
  ISN 0035             CALL IFLU(F,1)                                                        00000560
  ISN 0036             F1(22,1)=F                                                            00000580
  ISN 0037                F = F / 8.34                                                       00000581
  ISN 0038             CALL SUMMR(F1,1,SUMFD1)                                               00000590
```

```
*LEVEL 2.3.0 (JUNE 78)          AIR2          OS/360  FORTRAN H EXTENDED          DATE 79.177/12.26.17

ISN 0039             IF(SUMFD1.EQ.0.0) GO TO 300                              00000600
ISN 0041          DO 210 I=1,28                                               00000610
ISN 0042          F1(I,2)=F1(I,1)                                             00000620
ISN 0043      210 CONTINUE                                                    00000630
            C *** CONVERT F1(20,1) AND F1(21,1) TO MG/L                       00000631
ISN 0044             SI = (F1(20,1)*453514.74) / (F*3.78)                     00000632
ISN 0045             XI = (F1(21,1)*453514.74) / (F*3.78)                     00000633
ISN 0046             F1(15,2)=0.0                                             00000634
            C ***** AERATION BASIN DESIGN PROCEDURE *****                     00000660
ISN 0047             ES = 8.0                                                 00000670
ISN 0048             EX = 10.0                                                00000680
ISN 0049             SE1 = (((60.0*ES*1000.0)/F)*1000.0)/8.34                 00000690
ISN 0050             SE2 = ((((60.0*EX*1000.0)/F)*1000.0)/8.34)*0.40          00000700
ISN 0051             SE = SE1 - SE2                                           00000710
ISN 0052                   F1(20,2) = (SE*F*3.78)/453514.74                   00000720
ISN 0053             UN1 = SE / (SE + PDATA(JXX,6))                           00000730
ISN 0054             UN = PDATA(JXX,5)*UN1 - PDATA(JXX,7)                     00000740
ISN 0055             FOX1 = SI - (1.0 + PDATA(JXX,9))*SE                      00000750
ISN 0056             FOX2 = PDATA(JXX,9) * PDATA(JXX,1)                       00000760
ISN 0057             FOX3 = 1 + PDATA(JXX,7) / UN                             00000770
ISN 0058             FOX4 = (PDATA(JXX,8)*FOX1 / FOX3) + FOX2                 00000780
ISN 0059             FOX = FOX4 / (1.0 + PDATA(JXX,9))                        00000790
ISN 0060             VAS2 = FOX2*F                                            00000800
ISN 0061             VAS3 = PDATA(JXX,7) * FOX                                00000810
ISN 0062             VAS4 = (1.0 + PDATA(JXX,9))*F / PDATA(JXX,7)             00000820
ISN 0063             VAS5 = (PDATA(JXX,8)*F*FOX1 + VAS2) / VAS3               00000830
ISN 0064             VAS = VAS5 - VAS4                                        00000840
ISN 0065             FA1 = (SI - SE)*F / 0.68                                 00000850
ISN 0066             FA2 = 2.0*(PDATA(JXX,10) - PDATA(JXX,11)) * F            00000860
ISN 0067             FA3 = 1.42*VAS*FOX*UN                                    00000870
ISN 0068             FA = 4.16*1.0E-06*(FA1 + FA2 - FA3)                      00000880
ISN 0069             HP1 = 3.475 * 1.0E-07 / 2.0                              00000890
ISN 0070             HP = HP1 * (FA1 + FA2 - FA3)                             00000900
ISN 0071             C11 = VAS**0.743                                         00000910
ISN 0072             C14 = (FA1 + FA2 -FA3) / 2.0                             00000920
ISN 0073             C15 = C14**0.67                                          00000930
ISN 0074             C1 = 12.7 * C11 + 0.170 * C15                            00000940
ISN 0075             FMHRS1 = 190.0*HP**0.543 + 67.0*HP**0.63                 00000950
ISN 0076             C2 = FMHRS1 * PDATA(JXX,12)                              00000960
ISN 0077             C3 = 0.29*F**0.803                                       00000970
ISN 0078             C4 = 1.32*F**0.477                                       00000980
ISN 0079             C51 = FA1 + FA2 - FA3                                    00000990
ISN 0080             C52 = C51 **0.67                                         00001000
ISN 0081             C5 = 12.7*C11 + 0.3*C52                                  00001010
ISN 0082             FMHRS2 = 39.5 * FA **0.53 + 11.6 * FA **0.607            00001020
            C ***** LABOR COSTS *****                                         00001030
ISN 0083          C6=FMHRS2*PDATA(JXX,12)                                     00001040
            C ***** POWER COSTS *****                                         00001050
ISN 0084          C7=0.25*F**0.797                                            00001060
            C ***** MATERIAL AND SUPPLY COSTS *****                           00001070
ISN 0085          C8=1.32*F**0.477                                            00001080
ISN 0086          WRITE(NO,91) F1(22,1),F,C14,C15                             00001090
ISN 0087          WRITE(NO,91) SE1,SE2,SE,UN1                                 00001100
ISN 0088          WRITE(NO,91) UN,FOX1,FOX2,FOX3                              00001110
ISN 0089          WRITE(NO,91) FOX4,FOX,VAS,FA1                               00001120
ISN 0090          WRITE(NO,91) FA2,FA3,FA,HP                                  00001130
ISN 0091       91 FORMAT(5X,'CHECK',4F12.2)                                   00001140
ISN 0092             F1(21,2) = (FOX*F*3.78) / 453514.74                      00001141
```

```
*LEVEL 2.1.0 (JUNE 78)          AIR2          OS/360  FORTRAN H EXTENDED          DATE 79.177/12.26.17

   ISN 0093              F1(22,2) = 1.2*F1(22,1)                                   00001142
   ISN 0094              F1(6,2) = F1(22,2) - F1(22,1) + F1(6,2)                   00001143
   ISN 0095              GO TO 700                                                 00001150
   ISN 0096         300 CONTINUE                                                   00001160
   ISN 0097              CALL MOVER(201,2)                                         00001170
   ISN 0098         700 CONTINUE                                                   00001180
   ISN 0099              CALL MOVES(2,IPRO)                                        00001190
   ISN 0100                 GO TO 1000                                             00001200
   ISN 0101         800 CONTINUE                                                   00001210
                 C ***** PRINT RESULTS *****                                       00001220
   ISN 0102              CALL SPOUTX(JXX)                                          00001230
   ISN 0103              WRITE(NO,3)C1,FMHRS1,C2,C3,C4,C5,FMHRS2,C6,C7,C8          00001240
   ISN 0104            3 FORMAT(1H1,9X,'***** COST FOR MECHANICAL AERATION *****'//  00001250
                      $9X,'CAPITAL COST',12X,F12.2,2X,'DOLLARS'/                   00001260
                      $9X,'MANHOURS',16X,F12.2,2X,'MANHOURS'/                      00001270
                      $9X,'LABOR COST',14X,F12.2,2X,'DOLLARS'/                     00001280
                      $9X,'POWER COST',14X,F12.2,2X,'DOLLARS'/                     00001290
                      $9X,'MATERIALS',15X,F12.2,2X,'DOLLARS'//                     00001300
                      $9X,'***** COSTS FOR DIFFUSED AERATION *****'//              00001310
                      $9X,'CAPITAL COST',12X,F12.2,2X,'DOLLARS'/                   00001320
                      $9X,'MANHOURS',16X,F12.2,2X,'MANHOURS'/                      00001330
                      $9X,'LABOR COST',14X,F12.2,2X,'DOLLARS'/                     00001340
                      $9X,'POWER COST',14X,F12.2,2X,'DOLLARS'/                     00001350
                      $9X,'MATERIALS',15X,F12.2,2X,'DOLLARS')                      00001360
   ISN 0105        1000 CONTINUE                                                   00001370
   ISN 0106              RETURN                                                    00001380
   ISN 0107              END                                                       00001390

*OPTIONS IN EFFECT*NAME(MAIN) NOOPTIMIZE LINECOUNT(60) SIZE(MAX) AUTODBL(NONE)

*OPTIONS IN EFFECT*SOURCE EBCDIC NOLIST NODECK OBJECT NOMAP NOFORMAT GOSTMT NOXREF NOALC NOANSF TERM IBM :

*STATISTICS*     SOURCE STATEMENTS =      106, PROGRAM SIZE =      3694, SUBPROGRAM NAME =  AIR2

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                     72K BYTES OF CORE NOT USED
```

APPENDIX F

LISTING OF USERS PROGRAM

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=U16817A.PROCESS3.CNTL

//J16817A JOB (16817,442-60-3809),'KARPEL',CLASS=F,TIME=(0,15),
// MSGCLASS=A
/*PASSWORD HIDE
/*ROUTE     PRINT RITA
// EXEC FORTHLG,PARM.LKED='LET,LIST',REGION.GO=346K
//LKED.LIB DD DSNAME=OSU.ACT16817.HIDE,DISP=SHR
//LKED.LIBTWO DD DSNAME=OSU.ACT16817.LEATHER,DISP=SHR
//LKED.SYSIN DD *
  INCLUDE LIB(SPOUTY,DSUP04,DSUP00,DSUPEC,DSUFEED)
  INCLUDE LIB(CATAL,FORK,SCAL,STOR,4SUB,SORT)
  INCLUDE LIBTWO(DALF,SPLT,SHAV,TRIM,REPORT,PLST,STABLE,ST2373,ST6)
  INCLUDE LIBTWO(WRNG,DEMN,SOAK,DEP,EVAP,GRID,UNHR,TFLC,ST1,STS)
  INCLUDE LIB(XTRA)
  ENTRY DSUP34
//GO.SYSIN DD *
TITLE DEMONSTRATION SIMPLE SYSTEM; FORK, SOAK, GRID, EVAP
COMPID      1     1     2     3     4     5     6     7     8     9    10    11
COMPID      2    12    13    14    15    16    17    18    19    20    21    22
COMPID      3    23    24    25
PHYPRO      1 1 HIDE
PHYPRO      2 2 HIDE AREA
PHYPRO      3 3 WEIGHT (DRY)
PHYPRO      4 4 HAIR
PHYPRO      5 5 DIRT
PHYPRO      6 6 WATER
PHYPRO      7 7 SALT
PHYPRO      8 8 GREASE/FAT
PHYPRO      9 9 FLESH
PHYPRO     1010 MANURE
PHYPRO     1111 CHROMIUM
PHYPRO     1212 H2SO4
PHYPRO     1313 LIME
PHYPRO     1414 DETERGENT
PHYPRO     1515 SULFITE
PHYPRO     1616 HYDROCHL ACID
PHYPRO     1717 NAOH
PHYPRO     1818 SOLUBLE N
PHYPRO     1919 OTHER CHEMICALS
PHYPRO     2020 BOD
PHYPRO     2121 LIQ. SUS SOLIDS
PHYPRO     2222 TOTAL FLOW
PHYPRO     2323 COMPONENT 23
PHYPRO     2424 COMPONENT 24
PHYPRO     2525 COMPONENT 25
PRCLMTINPT 1                               1
PRCLMTFORK 2     1                         3
PRCLMTSOAK 3     3                       151     5
PRCLMTGRID 4     5                         6     7
PRCLMTEVAP 5     6                         8
PRCLMTPRNT94   151     7     4
CONTRL      1     2     3     4     5     0     0     0     0     0     0     0
CONTRL      2     0     0     0     0     0     0     0
CONTRL      3     1
ELNAME      2FORK
ELNAME      3SOAKER
ELNAME      4SCREENS
ELNAME      5EVAPORATION POND
ELNAME     94PRINT
STNAME      1HIDE FLOW
STNAME      3HIDE FLOW
STNAME    171SOAK DEMAND
STNAME    151BLUE STOCK
STNAME      5SOAK WASTE
STNAME      6SCREEN LIQ.
STNAME      7SCREEN SOLID
FINISH
STDAT1      11000.0   40.0   25.0    0.5    1.0   28.0    7.0    0.0    0.0   0.25    0.0
STDAT2      1    0.0    0.0    0.0    0.0    0.0    0.0    0.0   1.25    0.5    1.0    1.0
STDAT3      1    1.0    1.0    1.0    1.0    1.0
FINISHSTOP
//
```

```
**** TSC FOREGROUND HARDCOPY ****
DSNAME=U16817A.PROCESS3.CNTL

//U16817A JOB (16817,442-50-5804),'KARFEL',CLASS=F,TIME=(0,15),
// MSGCLASS=A
/*PASSWORD HIDE
/*ROUTE     PRINT RMT4
// EXEC FORTHLG,PARM.LKED='LET,LIST',REGION.GO=84SK
//LKED.LIB DD DSNAME=ISU.ACT16817.HIDE,DISP=SHR
//LKED.LIBTWO DD DSNAME=USU.ACT16817.LEATHER,DISP=SHR
//LKED.SYSIN DD *
  INCLUDE LIB(CSUPEM,BMUPDD,DSUPBC,CPUPEE)
  INCLUDE LIB(DATAB,FORK,SCAL,STOR,MSUS,SCFT)
  INCLUDE LIBTWO(SALP,SPLT,SHAV,TRIM,AIR2,EAS1,GAS2,BURN)
  INCLUDE LIBTWO(WRNC,DCHN,SOAK,DEP,GRID,EQUI,FILT,TFLO)
  INCLUDE LIB(XTRA)
  ENTRY CSUPBM
//GO.SYSIN DD *
TITLE   WASTE TREATMENT SYSTEM;FORK,SCAK,GRID,EQUI,FILT,AIR2,ADDR,EAS1,EAS2,BURN
COMPID      1     1     2     3     4     5     6     7     8     9    10    11
COMPID      2    12    13    14    15    16    17    18    19    20    21    22
COMPID      3    23    24    25
PHYPRO      1  1 HIDE
PHYPRO      2  2 HIDE AREA
PHYPRO      3  3 WEIGHT (DRY)
PHYPRO      4  4 HAIR
PHYPRO      5  5 DIRT
PHYPRO      6  6 WATER
PHYPRO      7  7 SALT
PHYPRO      8  8 GREASE/FAT
PHYPRO      9  9 FLESH
PHYPRO     1010 MANURE
PHYPRO     1111 CHROMIUM
PHYPRO     1212 H2SO4
PHYPRO     1313 LIME
PHYPRO     1414 DETERGENT
PHYPRO     1515 SULFITE
PHYPRO     1616 HYDROCHL ACID
PHYPRO     1717 NAOH
PHYPRO     1818 SOLUBLE N
PHYPRO     1919 OTHER CHEMICALS
PHYPRO     2020 BOD
PHYPRO     2121 LIQ. SUS SOLIDS
PHYPRO     2222 TOTAL FLOW
PHYPRO     2323 COMPONENT 23
PHYPRO     2424 COMPONENT 24
PHYPRO     2525 COMPONENT 25
PRCLMTINFT 1                                  2
PRCLMTFORK 2      2                           3
PRCLMTSCAK 3      3                           4     5
PRCLMTGRID 4      5                           6     7
PRCLMTEQUI 5      6                           8
PRCLMTFILT 6      8                           9    10
PRCLMTAIR2 7      9                          11
PRCLMTEAS1 8     11                          12    13
PRCLMTADDR 9     10    12                    14
PRCLMTEAS210     14                          15
PRCLMTBURN11     15                          16
PRCLMTPRNT94      4     7    13    16
CONTRL      1     2     3     4     5     0     0     0     0     0     0
CONTRL      2     0     0     0     0     0     0     0
CONTRL      3     1
ELNAME      2FORK
ELNAME      3SCAKER
ELNAME      4SCREENS
ELNAME      5EQUILIZATION BASIN
ELNAME      6PRIMARY CLARIFIER
ELNAME      7AERATION BASIN
ELNAME      8FINAL CLARIFIER
ELNAME      9FLOOR DRAIN
ELNAME     10DIGESTOR
ELNAME     11SLUDGE LAGOON
ELNAME     94PRINT
FINISH
STDAT1      2100.0  40.0  25.0  0.5   1.0   23.0  7.0   0.0   0.0   0.25  0.0
STDAT2      2     0.0   0.0   0.0   0.0   0.0   0.0   0.0   1.25  0.9   0.0   1.0
STDAT3      1     1.0   1.0   1.0   1.0   1.0
FINISHSTOP
//
```

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=U16817A.PROCESS7.CNTL

//U16817A JOB (16817,442-60-5809),'KARPEL',CLASS=F,TIME=(0,15),             0000000
// MSGCLASS=A                                                               0000000
/*PASSWORD HIDE                                                             0000000
/*ROUTE     PRINT RMT4                                                      0000000
// EXEC FORTHLG,PARM.LKED='LET,LIST',REGION.GO=84K                          0000000
//LKED.LIB DD DSNAME=USG.ACT16817.HIDE,DISP=SHR                             0000000
//LKED.LIBT DD DSNAME=USG.ACT16817.LEATHER,DISP=SHR                         0000000
//LKED.SYSIN DD *                                                           0000000
  INCLUDE LIB(DSUPRV,DSUPLD,DSUPRC,DSUPDB)                                  0000000
  INCLUDE LIB(DATAB,FORK,SOAK,STOP,ASUR,SORT)                               0000000
  INCLUDE LIBT.C(BALF,SPLT,DRAW,TRIM,ADRCRT,PLST,STABLE,ST2373,AIR1)
  INCLUDE LIBTAU(WRNG,DEAN,SOAK,DEP,EVAP,GRID,UNHR,TFLO,STI,ST5,ST6)
  INCLUDE LIB(XTRA)                                                         0000000
  ENTRY DSUPS4                                                              0000000
//GO.SYSIN DD *                                                             0000000
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIR1, EVAP                   00
COMPID      1      1      2      3      4      5      6      7      8      9   100000110
COMPID      2     12     13     14     15     16     17     18     19     20   210000220
COMPID      3     23     24     25                                            0000000
PHYPRO      1 1 HIDE                                                          0000000
PHYPRO      2 2 HIDE AREA                                                     0000000
PHYPRO      3 3 WEIGHT (DRY)                                                  0000000
PHYPRO      4 4 HAIR                                                          0000000
PHYPRO      5 5 DIRT                                                          0000000
PHYPRO      6 6 WATER                                                         0000000
PHYPRO      7 7 SALT                                                          0000000
PHYPRO      8 8 GREASE/FAT                                                    0000000
PHYPRO      9 9 FLESH                                                         0000000
PHYPRO     1010 MANURE                                                        0000000
PHYPRO     1111 CHROMIUM                                                      0000000
PHYPRO     1212 H2SO4                                                         0000000
PHYPRO     1313 LIME                                                          0000000
PHYPRO     1414 DETERGENT                                                     0000000
PHYPRO     1515 SULFITE                                                       0000000
PHYPRO     1616 HYDROCHL ACID                                                 0000000
PHYPRO     1717 NAOH                                                          0000000
PHYPRO     1818 SOLUBLE N                                                     0000000
PHYPRO     1919 OTHER CHEMICALS                                               0000000
PHYPRO     2020 BOD                                                           0000000
PHYPRO     2121 LIQ. SUS SOLIDS                                               0000000
PHYPRO     2222 TOTAL FLOW                                                    0000000
PHYPRO     2323 COMPONENT 23                                                  0000000
PHYPRO     2424 COMPONENT 24                                                  0000000
PHYPRO     2525 COMPONENT 25                                                  0000000
PRCLMTINPT 1                                     1                            0000000
PRCLMTFORK 2       1                             3                            0000000
PRCLMTSOAK 3       2                           151      5                     0000000
PRCLMTGRID 4       5                             6      7                     0000000
PRCLMTAIR1 5       6                             3                            0000000
PRCLMTEVAP 6       8                             5                            0000000
PRCLMTPRNT94     151      7      9                                            0000000
CONTRL      1      2      3      4      0      0      0      0      0      0  0000000
CONTRL      2      0      0      0      0      0      0      0                0000000
CONTRL      3      1                                                          0000000
ELNAME      2FORK                                                             0000000
ELNAME      3SOAKER                                                           0000000
ELNAME      4SCREENS                                                          0000000
ELNAME      5AERATION BASIN                                                 0000000
ELNAME      6EVAPORATION POND
ELNAME     94PRINT                                                            0000000
STNAME      1HIDE FLOW                                                        0000000
STNAME      3HIDE FLOW                                                        0000000
STNAME    171SOAK DEMAND                                                      0000000
STNAME    151BLUE STOCK                                                       0000000
STNAME      5SOAK WASTE                                                       0000000
STNAME      6SCREEN LIQ.                                                      0000000
STNAME      7SCREEN SOLID                                                     0000000
STNAME      8EFFLUENT
STNAME      9EFFLUENT
FINISH
STDAT1      11000.0  40.0  25.0   0.5   1.0  25.0   7.0   0.0   0.0  0.25   1.0
STDAT2      1   0.0   1.0   0.0   1.0   0.0   1.0   0.0  1.25   0.5   1.0   1.0
STDAT3      1   1.0   1.0   1.0   1.0   1.0
FINISHSTOP
//
```

APPENDIX G

OUTPUT OF SYSTEM I, SYSTEM II, AND SYSTEM III

```
LEATHER
PAGE  1
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, EVAP

PROCESS ELEMENT   1 IS A INPT UNIT. IT HAS  0 FEEDS,   0,   0,   0,   0,
                    AND  1 PRODUCTS,   1,   0,   0,   0,
PROCESS ELEMENT   2 IS A FORK UNIT. IT HAS  1 FEEDS,   1,   0,   0,   0,
                    AND  1 PRODUCTS,   3,   0,   0,   0,
PROCESS ELEMENT   3 IS A SOAK UNIT. IT HAS  1 FEEDS,   3,   0,   0,   0,
                    AND  2 PRODUCTS, 151,   5,   0,   0,
PROCESS ELEMENT   4 IS A GRID UNIT. IT HAS  1 FEEDS,   5,   0,   0,   0,
                    AND  2 PRODUCTS,   6,   7,   0,   0,
PROCESS ELEMENT   5 IS A EVAP UNIT. IT HAS  1 FEEDS,   6,   0,   0,   0,
                    AND  1 PRODUCTS,   8,   0,   0,   0,
PROCESS ELEMENT  94 IS A PRNT UNIT. IT HAS  3 FEEDS, 151,   7,   8,   0,
                    AND  0 PRODUCTS,   0,   0,   0,   0,
```

```
LEATHER
PAGE  3
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, EVAP

INPT    1
FORK    2
ORIGINAL COST     13600.00   SALVAGE VALUE        500.00   LIFE                10.00
CAPACITY            375.00   WORKING HOUR/DAY      16.00   SPACE ALLOTTED     350.00
HIDES/LABORER       500.00   HIDES/PALLET           3.33

SOAK    3
ORIGINAL COST     18000.00   SALVAGE VALUE        500.00   LIFE                20.00
CAPACITY           5000.00   SOAK TIME            240.00   % TOTAL TIME         0.80
SPACE              1500.00   RPM                   30.00   FLOAT                6.78
TEMP. OF FLOAT      212.00   PH                    11.00   % DETERGENT          0.00
% SULFIDE             0.00   MANAGEMENT             0.25   FOREMAN              0.50
OPERATOR              0.50   LABORER                0.25   SHIFTS               1.00
% DIRT REMAINING      0.02   % WATER REMAINING      0.75   % SALT REMAINING     0.75

GRID    4
EVAP    5
PRNT   94
```

LEATHER
PAGE 5
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, EVAP

FEED STREAMS TO UNIT

STREAM NUMBER	1
COMPONENT	HIDE FLOW
1 HIDE	1000.00
2 HIDE AREA	40.00
3 WEIGHT (DRY)	25.00
4 HAIR	0.50
5 DIRT	1.00
6 WATER	28.00
7 SALT	7.00
8 GREASE/FAT	0.0
9 FLESH	0.0
10 MANURE	0.25
11 CHROMIUM	0.0
12 H2SO4	0.0
13 LIME	0.0
14 DETERGENT	0.0
15 SULFITE	0.0
16 HYDROCHL ACID	0.0
17 NAOH	0.0
18 SOLUBLE N	0.0
19 OTHER CHEMICALS	1.25
20 BOD	0.90
21 LIQ. SLS SOLIDS	1.00
22 TOTAL FLOW	1.00
23 COMPONENT 23	1.00
24 COMPONENT 24	1.00
25 COMPONENT 25	1.00

LEATHER
PAGE 6
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, EVAP

FORKLIFT*** 2 ***FORK

	FEEDS*********	PRODUCTS******
STREAM NUMBER	1 HIDE FLOW	3 HIDE FLOW
COMPONENT		
1 HIDE	1000.00	1000.00
2 HIDE AREA	40.00	40.00
3 WEIGHT (DRY)	25.00	25.00
4 HAIR	0.50	0.50
5 DIRT	1.00	1.00
6 WATER	28.00	28.00
7 SALT	7.00	7.00
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	0.25	0.25
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	0.0	0.0
15 SULFITE	0.0	0.0
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	1.25	1.25
20 BOD	0.90	0.90
21 LIQ. SLS SOLIDS	1.00	1.00
22 TOTAL FLOW	1.00	63.00
23 COMPONENT 23	1.00	1.00
24 COMPONENT 24	1.00	1.00
25 COMPONENT 25	1.00	1.00
TOTAL	1108.90	1170.90

FORKLIFT COMPUTATION OUTPUT 2***FORK

ITEM	NUMBER	UNITS	ORIGINAL COST	FIXED COSTS	VARIABLE COSTS	ANNUAL COSTS
FORKLIFT	1.0	EACH	13800.00	1617.73	1650.43	3268.16
FORKLIFT OPERATOR	1	MAN			10500.00	10500.00
LABORERS	2	MEN			20400.00	20400.00
BUILDING *	359.4	SQ.FT	6659.47	726.04	1299.00	2025.03
LAND COST	539.2	SQ.FT	18.57	2.41		2.41
PALLETS	300.3	EACH,	1900.90	277.53	520.85	798.38
TOTAL ANNUAL COSTS						36993.97

NOTE : BUILDING COST IS ASSOCIATED WITH FOLLOWING VARIABLES

MANUFACTURING SPACE = 350.0 SQ.FT, COST = $ 6300.0
OFFICE SPACE = 9.4 SQ.FT, COST = $ 283.5
OFFICE FURNITURE AND EQUIPMENTS COSTS = $ 76.0

FORKLIFT DEPRECIATION ROUTINE
ADEP=$ 1330.00, ATAX=$ 193.57, AKEP=$ 320.43, SUR=$ 44.16, TER=$ 1380.00, YEAR= 10

BUILDING DEPRECIATION ROUTINE
ADEP=$ 456.31, ATAX=$ 38.78, AKEP=$ 842.69, SUR=$ 21.31, TER=$ 665.95, YEAR= 11

LEATHER
PAGE 7
TITLE DEMONSTRATION SIMPLE SYSTEM: HORK, SOAK, GRID, EVAP

SOAK*** 3 ***SOAKER

	FEEDS********************************	***PRODUCTS************	************************	
STREAM NUMBER	3	171	151	5
	HIDE FLOW			SOAK WASTE
COMPONENT				
1 HIDE	1000.00	0.0	1000.00	0.0
2 HIDE AREA	40.00	0.0	40.00	0.0
3 WEIGHT (DRY)	25.00	0.0	25.00	0.0
4 HAIR	0.50	0.0	0.50	0.0
5 DIRT	1.00	0.0	0.02	980.00
6 WATER	28.00	406979.94	21.00	413979.94
7 SALT	7.00	0.0	5.25	1750.00
8 GREASE/FAT	0.0	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0	0.0
10 MANURE	0.25	0.0	0.0	250.00
11 CHROMIUM	0.0	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0	0.0
14 DETERGENT	0.0	12.00	0.0	12.00
15 SULFITE	0.0	9.00	0.0	9.00
16 HYDROCHL ACID	0.0	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0	0.0
19 OTHER CHEMICALS	1.25	0.0	0.0	1250.00
20 BOD	0.90	0.0	0.0	902.00
21 LIQ. SUS SOLIDS	1.00	0.0	0.0	1504.00
22 TOTAL FLOW	63.00	407000.87	51.77	418230.87
23 COMPONENT 23	1.00	0.0	0.0	1000.00
24 COMPONENT 24	1.00	0.0	0.0	1000.00
25 COMPONENT 25	1.00	0.0	0.0	1000.00
TOTAL	1170.90	814001.75	1143.54	841867.69

SOAKING COMPUTATION OUTPUT 3***SOAK

ITEM	NUMBER	UNITS	ORIGINAL COSTS	FIXED COSTS	VARIABLE COSTS	ANNUAL COSTS
MACHINE	6.00	EACH	108000.00	11920.13	22529.89	34450.02
MANAGEMENT	1.50	MEN		24480.00		24480.00
FOREMAN	3.00	MEN		36720.00		36720.00
OPERATOR	3.00	MEN			32130.00	32130.00
LABORER	1.50	MEN			15300.00	15300.00
DETERGENT	3060.00	LBS			1009.80	1009.80
SULFIDE	2295.00	LBS			5278.50	5278.50
HEATING	615746.37	KWH			17240.90	17240.90
PLUMBING COST			24000.00	2160.00	2400.00	2400.00
WIRE COST			22290.00	2229.00	2006.10	4235.10
BUILDING *	9243.00	SQ.FT	171243.62	18669.52	33402.80	52072.32
LAND COST	13864.49	SQ.FT	477.43	62.07		62.07
WATER	103779872.	LBS			4978.64	4978.64
TOTAL ANNUAL COSTS						230357.25

NOTE : BUILDING COST IS ASSOCIATED WITH FOLLOWING VARIABLES

MANUFACTURING SPACE = 9000.0 SQ.FT. COST = $ 162000.0
OFFICE SPACE = 243.0 SQ.FT. COST = $ 7290.0
OFFICE FURNITURE AND EQUIPMENTS COSTS = $ 1953.7

SOAKING MACHINE DEPRECIATION ROUTINE
ADEP=$ 1278.84 ATAX=$ 129.09 AREP=$ 2476.14 SUR=$ 57.60 TER=$ 1800.00 YEAR=13

BUILDING DEPRECIATION ROUTINE
ADEP=$11733.66 ATAX=$ 997.16 AREP=$21669.13 SUR=$ 547.98 TER=$17124.36 YEAR=11

LEATHER
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TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, EVAP

SCREEN*** 4 ***SCREENS

	FEEDS********PRODUCTS*******************		
STREAM NUMBER	5	6	7
	SOAK WASTE	SCREEN LIQ.	SCREEN SOLID
COMPONENT			
1 HIDE	0.0	0.0	0.0
2 HIDE AREA	0.0	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0	0.0
4 HAIR	0.0	0.0	0.0
5 DIRT	980.00	490.00	490.00
6 WATER	413979.94	393280.87	20699.00
7 SALT	1750.00	1400.00	350.00
8 GREASE/FAT	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0
10 MANURE	250.00	225.00	25.00
11 CHROMIUM	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0
14 DETERGENT	12.00	10.80	1.20
15 SULFITE	9.00	8.10	0.90
16 HYDROCHL ACID	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0
19 OTHER CHEMICALS	1250.00	1125.00	125.00
20 BOD	932.00	766.70	135.30
21 LIQ. SLS SOLIDS	1504.00	225.60	1278.40
22 TOTAL FLOW	418230.87	396539.56	21691.09
23 COMPONENT 23	1000.00	0.0	1000.00
24 COMPONENT 24	1000.00	0.0	1000.00
25 COMPONENT 25	1000.00	0.0	1000.00
TOTAL	841867.69	794071.37	47795.87

CAPITAL COST = $ 371.44

O&M COSTS = $ 15325.70

LEATHER
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TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, EVAP

EVAPORATION POND*** 5 ***EVAPORATION POND

	FEEDS********PRODUCTS******	
STREAM NUMBER	6	8
	SCREEN LIQ.	
COMPONENT		
1 HIDE	0.0	0.0
2 HIDE AREA	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0
4 HAIR	0.0	0.0
5 DIRT	490.00	0.0
6 WATER	393280.87	0.0
7 SALT	1400.00	0.0
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	225.00	0.0
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	10.80	0.0
15 SULFITE	8.10	0.0
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	1125.00	0.0
20 BOD	766.70	0.0
21 LIQ. SLS SOLIDS	225.60	0.0
22 TOTAL FLOW	396539.56	0.0
23 COMPONENT 23	0.0	0.0
24 COMPONENT 24	0.0	0.0
25 COMPONENT 25	0.0	0.0
TOTAL	794071.37	0.0

ITEM	NUMBER	UNITS
POND	8.79	ACRES
WATER FLOW	47546.71	GAL/DAY
LAND COST	6786.62	DOLLARS
CAPT. COST	136171.81	DOLLARS

	FOR WARM CLIMATES	FOR COOL CLIMATES	
	NUMBER	NUMBER	UNITS
LABOR	0.0	115.35	MANHOURS
LABOR COST	0.0	576.75	DOLLARS
MATERIALS	0.0	457.48	DOLLARS

LEATHER
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TITLE DEMONSTRATION SIMPLE SYSTEM: PORK, SOAK, GRID, EVAP

PROCESS STREAMS LEAVING THE UNIT

STREAM NUMBER COMPONENT	151	7 SCREEN SOLID	8
1 HIDE	1000.00	0.0	0.0
2 HIDE AREA	40.00	0.0	0.0
3 WEIGHT (DRY)	25.00	0.0	0.0
4 HAIR	0.50	0.0	0.0
5 DIRT	0.02	490.00	0.0
6 WATER	21.00	20699.00	0.0
7 SALT	5.25	350.00	0.0
8 GREASE/FAT	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0
10 MANURE	0.0	25.00	0.0
11 CHROMIUM	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0
14 DETERGENT	0.0	1.20	0.0
15 SULFITE	0.0	0.90	0.0
16 HYDROCHL ACID	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0
19 OTHER CHEMICALS	0.0	125.00	0.0
20 BOD	0.0	135.30	0.0
21 LIQ. SUS SOLIDS	0.0	1278.40	0.0
22 TOTAL FLOW	51.77	21691.09	0.0
23 COMPONENT 23	0.0	1000.00	0.0
24 COMPONENT 24	0.0	1000.00	0.0
25 COMPONENT 25	0.0	1000.00	0.0

TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, EVAP

HEAT AND MATERIAL BALANCE SHEETS

STREAM NUMBER	1	3	5	6	7
COMPONENT					
	HIDE FLOW	HIDE FLOW	SOAK WASTE	SCREEN LIC.	SCREEN SOLID
1 HIDE	1000.00	1000.00	0.0	0.0	0.0
2 HIDE AREA	40.00	40.00	0.0	0.0	0.0
3 WEIGHT (DRY)	25.00	25.00	0.0	0.0	0.0
4 HAIR	0.50	0.50	0.0	0.0	0.0
5 DIRT	1.00	1.00	980.00	490.00	490.00
6 WATER	28.00	28.00	413979.94	393280.87	20699.00
7 SALT	7.00	7.00	1750.00	1400.00	350.00
8 GREASE/FAT	0.0	0.0	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0	0.0	0.0
10 MANURE	0.25	0.25	250.00	225.00	25.00
11 CHROMIUM	0.0	0.0	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0	0.0	0.0
14 DETERGENT	0.0	0.0	12.00	10.80	1.20
15 SULFITE	0.0	0.0	9.00	8.10	0.90
16 HYDROCHL ACID	0.0	0.0	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0	0.0	0.0
19 OTHER CHEMICALS	1.25	1.25	1250.00	1125.00	125.00
20 BOD	0.90	0.90	902.00	766.70	135.30
21 LIQ. SUS SOLIDS	1.00	1.00	1504.00	225.60	1278.40
22 TOTAL FLOW	1.00	63.00	418230.87	396539.56	21691.09
23 COMPONENT 23	1.00	1.00	1000.00	0.0	1000.00
24 COMPONENT 24	1.00	1.00	1000.00	0.0	1000.00
25 COMPONENT 25	1.00	1.00	1000.00	0.0	1000.00

LEATHER
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TITLE DEMONSTRATION SIMPLE SYSTEM; FORK, SOAK, GRID, EVAP

HEAT AND MATERIAL BALANCE SHEETS

STREAM NUMBER COMPONENT	151	171
1 HIDE	1000.00	0.0
2 HIDE AREA	40.00	0.0
3 WEIGHT (DRY)	25.00	0.0
4 HAIR	0.50	0.0
5 DIRT	0.02	0.0
6 WATER	21.00	406979.94
7 SALT	5.25	0.0
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	0.0	0.0
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	0.0	12.00
15 SULFITE	0.0	9.00
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	0.0	0.0
20 BOD	0.0	0.0
21 LIQ. SLS SOLIDS	0.0	0.0
22 TOTAL FLOW	51.77	407000.87
23 COMPONENT 23	0.0	0.0
24 COMPONENT 24	0.0	0.0
25 COMPONENT 25	0.0	0.0

1. BUILDING AND LAND COSTS

PROCESS ITEM	A	B	C	D	E	F	TOTAL
CAPITAL COST OF							
MANUFACTURING SPACE	168300.0	0.0	0.0	0.0	0.0	0.0	168300.0
OFFICE SPACE	7530.0	0.0	0.0	0.0	0.0	0.0	7530.0
TOTAL SPACE COSTS	175830.0	0.0	0.0	0.0	0.0	0.0	175830.0
OFFICE FURNITURE	2010.0	0.0	0.0	0.0	0.0	0.0	2010.0
TOTAL BUILDING COSTS	177840.0	0.0	0.0	0.0	0.0	0.0	177840.0
LAND	496.0	0.0	0.0	0.0	0.0	0.0	496.0
WASTE MANAGEMENT LAND	0.0	8000.0	0.0	0.0	0.0	0.0	8000.0
TOTAL COST OF LAND AND BUILDING	178336.0	8000.0	0.0	0.0	0.0	0.0	186336.0

2. REQUIRED EQUIPMENTS

PROCESS TYPE OF EQUIPMENT	A	B	C	D	E	F	TOTAL
PALLET	300.0	0.0	0.0	0.0	0.0	0.0	300.0
PLUMBING	6.0	0.0	0.0	0.0	0.0	0.0	6.0
WIRING	6.0	0.0	0.0	0.0	0.0	0.0	6.0
FORKLIFT (ELECTRIC)	1.0	0.0	0.0	0.0	0.0	0.0	1.0
TANNING DRUM MULTI SP	6.0	0.0	0.0	0.0	0.0	0.0	6.0
SCREENING MACHINE	0.0	3.0	0.0	0.0	0.0	0.0	3.0

3. EQUIPMENT COSTS

PROCESS TYPE OF EQUIPMENT	A	B	C	D	E	F	TOTAL
PALLET	1899.0	0.0	0.0	0.0	0.0	0.0	1899.0
PLUMBING	24000.0	0.0	0.0	0.0	0.0	0.0	24000.0
WIRING	22290.0	0.0	0.0	0.0	0.0	0.0	22290.0
FORKLIFT (ELECTRIC)	13800.0	0.0	0.0	0.0	0.0	0.0	13800.0
TANNING DRUM MULTI SP	108000.0	0.0	0.0	0.0	0.0	0.0	108000.0
SCREENING MACHINE	0.0	300.0	0.0	0.0	0.0	0.0	300.0
TOTAL CAPITAL COSTS	169989.0	300.0	0.0	0.0	0.0	0.0	170289.0

4. REQUIRED LABORS

PROCESS / TYPE OF LABOR	A	B	C	D	E	F	TOTAL
PERMANENT							
SUPERVISOR (DEPT)	3060.0	0.0	0.0	0.0	0.0	0.0	3060.0
FOREMAN	6120.0	0.0	0.0	0.0	0.0	0.0	6120.0
VARIABLE (HOURLY)							
MACHINE OPERATOR	8160.0	0.0	0.0	0.0	0.0	0.0	8160.0
LABORER	7140.0	3180.0	0.0	0.0	0.0	0.0	10320.0

5. LABOR COSTS

PROCESS / TYPE OF LABOR	A	B	C	D	E	F	TOTAL
PERMANENT							
SUPERVISOR (DEPT)	24480.0	0.0	0.0	0.0	0.0	0.0	24480.0
FOREMAN	36720.0	0.0	0.0	0.0	0.0	0.0	36720.0
VARIABLE (HOURLY)							
MACHINE OPERATOR	42840.0	0.0	0.0	0.0	0.0	0.0	42840.0
LABORER	35700.0	15900.0	0.0	0.0	0.0	0.0	51600.0
TOTAL							
PERMANENT LABOR COSTS	61200.0	0.0	0.0	0.0	0.0	0.0	61200.0
HOURLY LABOR COSTS	78540.0	15900.0	0.0	0.0	0.0	0.0	94440.0
TOTAL LABOR COSTS	139740.0	15900.0	0.0	0.0	0.0	0.0	155640.0

6. OVERHEAD COSTS

PROCESS TYPE OF OVERHEAD	A	B	C	D	E	F	TOTAL
VARIABLE							
WATER	4978.4	0.0	0.0	0.0	0.0	0.0	4978.4
ELECTRICITY	17240.9	0.0	0.0	0.0	0.0	0.0	17240.9
DEPRECIATION							
EQUIPMENTS	2087.1	0.0	0.0	0.0	0.0	0.0	2087.1
ACCESSORY EQUIPMENTS	4205.0	0.0	0.0	0.0	0.0	0.0	4205.0
BUILDING	9752.0	0.0	0.0	0.0	0.0	0.0	9752.0
REPAIR							
EQUIPMENTS	2796.6	0.0	0.0	0.0	0.0	0.0	2796.6
ACCESSORY EQUIPMENTS	481.9	0.0	0.0	0.0	0.0	0.0	481.9
BUILDING	22511.8	0.0	0.0	0.0	0.0	0.0	22511.8
INSURANCE							
LABORS	3927.0	795.1	0.0	0.0	0.0	0.0	4722.1
FACTORY SUPPLIES	0.0	457.5	0.0	0.0	0.0	0.0	457.5
FIXED							
DEPRECIATION							
EQUIPMENTS	521.8	0.0	0.0	0.0	0.0	0.0	521.8
ACCESSORY EQUIPMENTS	1051.3	0.0	0.0	0.0	0.0	0.0	1051.3
BUILDING	2438.0	0.0	0.0	0.0	0.0	0.0	2438.0
TAX							
EQUIPMENTS	322.7	0.0	0.0	0.0	0.0	0.0	322.7
ACCESSORY EQUIPMENTS	963.8	0.0	0.0	0.0	0.0	0.0	963.8
BUILDING	1036.0	0.0	0.0	0.0	0.0	0.0	1036.0

6. OVERHEAD COSTS (CONTINUED)

PROCESS TYPE OF OVERHEAD	A	B	C	D	E	F	TOTAL
INSURANCE							
EQUIPMENTS	101.8	0.0	0.0	0.0	0.0	0.0	101.8
ACCESSORY EQUIPMENTS	481.9	0.0	0.0	0.0	0.0	0.0	481.9
BUILDING	569.3	0.0	0.0	0.0	0.0	0.0	569.3
MANAGEMENTS	3060.0	0.0	0.0	0.0	0.0	0.0	3060.0
INTEREST							
EQUIPMENTS	3180.0	0.0	0.0	0.0	0.0	0.0	3180.0
ACCESSORY EQUIPMENTS	2409.5	0.0	0.0	0.0	0.0	0.0	2409.5
BUILDING	17790.3	0.0	0.0	0.0	0.0	0.0	17790.3
LAND	47.7	915.8	0.0	0.0	0.0	0.0	963.5
TOTAL							
VARIABLE COSTS	67980.7	1252.6	0.0	0.0	0.0	0.0	69233.3
FIXED COSTS	33974.0	915.8	0.0	0.0	0.0	0.0	34889.8
TOTAL OVERHEAD COSTS	101954.7	2168.4	0.0	0.0	0.0	0.0	104123.1

7. REQUIRED CHEMICALS

PROCESS TYPE OF CHEMICAL	A	B	C	D	E	F	TOTAL
DETERGENT	3059.0	0.0	0.0	0.0	0.0	0.0	3059.0
SULFIDE	2295.0	0.0	0.0	0.0	0.0	0.0	2295.0

8. CHEMICAL COSTS

PROCESS TYPE OF CHEMICAL	A	B	C	D	E	F	TOTAL
DETERGENT	1009.5	0.0	0.0	0.0	0.0	0.0	1009.5
SULFIDE	5278.5	0.0	0.0	0.0	0.0	0.0	5278.5
TOTAL CHEMICAL COSTS	6288.0	0.0	0.0	0.0	0.0	0.0	6288.0

9. CAPITAL SUMMARY

PROCESS / TYPE OF COST	A	B	C	D	E	F	TOTAL
BUILDING AND LAND	178336.0	0.0	0.0	0.0	0.0	0.0	178336.0
WASTE TREATMENT LAND	0.0	8000.0	0.0	0.0	0.0	0.0	8000.0
EQUIPMENT	169989.0	300.0	0.0	0.0	0.0	0.0	170289.0
TOTAL CAPITAL COSTS	348325.0	8300.0	0.0	0.0	0.0	0.0	356625.0

10. OPERATING SUMMARY (ANNUAL COSTS)

PROCESS / TYPE OF COST	A	B	C	D	E	F	TOTAL
PERMANENT LABOR	61200.0	0.0	0.0	0.0	0.0	0.0	61200.0
HOURLY LABOR	78540.0	15900.0	0.0	0.0	0.0	0.0	94440.0
TOTAL LABOR	139740.0	15900.0	0.0	0.0	0.0	0.0	155640.0
FIXED OVERHEAD	33974.0	915.8	0.0	0.0	0.0	0.0	34889.8
VARIABLE OVERHEAD	67980.7	1252.6	0.0	0.0	0.0	0.0	69233.3
TOTAL OVERHEAD	101954.7	2168.4	0.0	0.0	0.0	0.0	104123.1
TOTAL CHEMICAL	6288.0	0.0	0.0	0.0	0.0	0.0	6288.0
TOTAL OPERATING COSTS	247982.7	18068.4	0.0	0.0	0.0	0.0	266051.1

*
OPERATING COST / HIDE = $ 1.0433

COST / SQUARE FOOT OF LEATHER = $ 0.0261

VALUES FOR HIDE PROCESSING

L	ITEMS	UNITS	PRICE/UNIT	FACTORS 1	2	3	4	5	6
	BUILDING AND LAND								
1	MANUFACTURING SPACE	SQ.FT	18.000	0.15	0.0	0.0	0.0	0.0	0.0
2	OFFICE SPACE	SQ.FT	30.000	0.15	0.0	0.0	0.0	0.0	0.0
3	OFFICE FURNITURE	UNIT	30.000	0.0	0.0	0.0	0.0	0.0	0.0
4	LAND	ACRE	1500.000	0.0	0.0	0.0	0.0	0.0	0.0
5	WASTE MANAGEMENT LAND	ACRE	1000.000	0.0	0.0	0.0	0.0	0.0	0.0
6			0.0	0.0	0.0	0.0	0.0	0.0	0.0
7			0.0	0.0	0.0	0.0	0.0	0.0	0.0
8			0.0	0.0	0.0	0.0	0.0	0.0	0.0
9			0.0	0.0	0.0	0.0	0.0	0.0	0.0
10			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LABOR								
11	SUPERVISOR (DEPT)	HOUR	8.000	0.0	0.0	0.0	0.0	0.0	0.0
12	FOREMAN	HOUR	6.000	0.0	0.0	0.0	0.0	0.0	0.0
13	MACHINE OPERATOR	HOUR	5.250	0.0	0.0	0.0	0.0	0.0	0.0
14	SEMI SKILLED LABORER	HOUR	5.100	0.0	0.0	0.0	0.0	0.0	0.0
15	LABORER	HOUR	5.000	0.0	0.0	0.0	0.0	0.0	0.0
16	MACHINE OPERATOR	HOUR	4.250	0.0	0.0	0.0	0.0	0.0	0.0
17	SEMI SKILLED LABORER	HOUR	4.100	0.0	0.0	0.0	0.0	0.0	0.0
18	LABORER	HOUR	4.000	0.0	0.0	0.0	0.0	0.0	0.0
19			0.0	0.0	0.0	0.0	0.0	0.0	0.0
20			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	OVERHEAD (UTILITIES)								
21	WATER	1000 GAL	0.400	0.0	0.0	0.0	0.0	0.0	0.0
22	ELECTRICITY	KWH	0.028	0.0	0.0	0.0	0.0	0.0	0.0
23	GASOLINE	GAL	0.650	0.0	0.0	0.0	0.0	0.0	0.0
24	NATURAL GAS	MCF	2.000	0.0	0.0	0.0	0.0	0.0	0.0
25	STEAM	1000 BTU	0.010	0.0	0.0	0.0	0.0	0.0	0.0
26			0.0	0.0	0.0	0.0	0.0	0.0	0.0
27			0.0	0.0	0.0	0.0	0.0	0.0	0.0
28			0.0	0.0	0.0	0.0	0.0	0.0	0.0
29			0.0	0.0	0.0	0.0	0.0	0.0	0.0
30			0.0	0.0	0.0	0.0	0.0	0.0	0.0
	CHEMICALS								
31	SALT	LB	0.650	0.0	0.0	0.0	0.0	0.0	0.0
32	CHROMIUM	LB	0.750	0.0	0.0	0.0	0.0	0.0	0.0
33	H2SO4	LB	0.650	0.0	0.0	0.0	0.0	0.0	0.0
34	LIME	LB	1.750	0.0	0.0	0.0	0.0	0.0	0.0
35	DETERGENT	LB	0.330	0.0	0.0	0.0	0.0	0.0	0.0
36	SULFIDE	LB	2.300	0.0	0.0	0.0	0.0	0.0	0.0
37	HYDROCHLORIC ACID	LB	1.000	0.0	0.0	0.0	0.0	0.0	0.0
38	NAOH	LB	1.000	0.0	0.0	0.0	0.0	0.0	0.0
39	CALCIUM HYDROXIDE	LB	1.750	0.0	0.0	0.0	0.0	0.0	0.0
40	NACL	LB	0.250	0.0	0.0	0.0	0.0	0.0	0.0
41	SODIUM BICARBONATE	LB	0.480	0.0	0.0	0.0	0.0	0.0	0.0
42	DELIMING CHEMICALS	LB	1.000	0.0	0.0	0.0	0.0	0.0	0.0

43		0.0	0.0	0.0	0.0	0.0	0.0	0.0
44		0.0	0.0	0.0	0.0	0.0	0.0	0.0
45		0.0	0.0	0.0	0.0	0.0	0.0	0.0
46		0.0	0.0	0.0	0.0	0.0	0.0	0.0
47		0.0	0.0	0.0	0.0	0.0	0.0	0.0
48		0.0	0.0	0.0	0.0	0.0	0.0	0.0
49		0.0	0.0	0.0	0.0	0.0	0.0	0.0
50		0.0	0.0	0.0	0.0	0.0	0.0	0.0
51		0.0	0.0	0.0	0.0	0.0	0.0	0.0
52		0.0	0.0	0.0	0.0	0.0	0.0	0.0
53		0.0	0.0	0.0	0.0	0.0	0.0	0.0
54		0.0	0.0	0.0	0.0	0.0	0.0	0.0
55		0.0	0.0	0.0	0.0	0.0	0.0	0.0
56		0.0	0.0	0.0	0.0	0.0	0.0	0.0
57		0.0	0.0	0.0	0.0	0.0	0.0	0.0
58		0.0	0.0	0.0	0.0	0.0	0.0	0.0
59		0.0	0.0	0.0	0.0	0.0	0.0	0.0
60		0.0	0.0	0.0	0.0	0.0	0.0	0.0
61		0.0	0.0	0.0	0.0	0.0	0.0	0.0
62		0.0	0.0	0.0	0.0	0.0	0.0	0.0
63		0.0	0.0	0.0	0.0	0.0	0.0	0.0
64		0.0	0.0	0.0	0.0	0.0	0.0	0.0
65		0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACCESSORY EQUIPMENTS								
66 PALLET	EACH	6.330	0.33	0.0	0.0	0.0	0.0	0.0
67 HORSE (LOW TYPE)	EACH	150.000	0.15	0.0	0.0	0.0	0.0	0.0
68 HORSE (HIGH TYPE)	EACH	125.000	0.15	0.0	0.0	0.0	0.0	0.0
69 SPLIT TRIMMING TABLE	EACH	200.000	0.15	0.0	0.0	0.0	0.0	0.0
70 TABLE (WOODEN)	EACH	100.000	0.15	0.0	0.0	0.0	0.0	0.0
71 WRAPPING TABLE	EACH	150.000	0.15	0.0	0.0	0.0	0.0	0.0
72 LIME LIQUOR TANK	EACH	10000.000	0.15	0.0	0.0	0.0	0.0	0.0
73 DEEP TANK	EACH	20000.000	0.15	0.0	0.0	0.0	0.0	0.0
74 TUB	EACH	2210.000	0.15	0.0	0.0	0.0	0.0	0.0
75 PLUMBING	JOB	4000.000	0.10	0.0	0.0	0.0	0.0	0.0
76 WIRING	JOB	3715.000	0.10	0.0	0.0	0.0	0.0	0.0
77		0.0	0.0	0.0	0.0	0.0	0.0	0.0
78		0.0	0.0	0.0	0.0	0.0	0.0	0.0
79		0.0	0.0	0.0	0.0	0.0	0.0	0.0
80		0.0	0.0	0.0	0.0	0.0	0.0	0.0
81		0.0	0.0	0.0	0.0	0.0	0.0	0.0
82		0.0	0.0	0.0	0.0	0.0	0.0	0.0
83		0.0	0.0	0.0	0.0	0.0	0.0	0.0
84		0.0	0.0	0.0	0.0	0.0	0.0	0.0
85		0.0	0.0	0.0	0.0	0.0	0.0	0.0
86		0.0	0.0	0.0	0.0	0.0	0.0	0.0
87		0.0	0.0	0.0	0.0	0.0	0.0	0.0
88		0.0	0.0	0.0	0.0	0.0	0.0	0.0
89		0.0	0.0	0.0	0.0	0.0	0.0	0.0
90		0.0	0.0	0.0	0.0	0.0	0.0	0.0
91		0.0	0.0	0.0	0.0	0.0	0.0	0.0
92		0.0	0.0	0.0	0.0	0.0	0.0	0.0
93		0.0	0.0	0.0	0.0	0.0	0.0	0.0
94		0.0	0.0	0.0	0.0	0.0	0.0	0.0
95		0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANUFACTURING EQUIPMENTS								
96 FORKLIFT (ELECTRIC)	EACH	13800.000	0.20	0.0	0.0	0.0	0.0	0.0
97 FORKLIFT (PROPANE FUEL)	EACH	11000.000	0.20	0.0	0.0	0.0	0.0	0.0
98 FORKLIFT	EACH	11000.000	0.20	0.0	0.0	0.0	0.0	0.0
99 SCALE (6000 LB DIAL)	EACH	4600.000	0.20	0.0	0.0	0.0	0.0	0.0
100 SCALE (60 LB DIAL)	EACH	500.000	0.20	0.0	0.0	0.0	0.0	0.0
101 SCALE	EACH	400.000	0.20	0.0	0.0	0.0	0.0	0.0
102 FLESHING & DEMANUR ING	EACH	62000.000	0.20	0.0	0.0	0.0	0.0	0.0

103	TANNING DRUM 3-SP	EACH	8300.000	0.20	0.0	0.0	0.0	0.0	0.0
104	TANNING DRUM MULTI SP	EACH	16000.000	0.20	0.0	0.0	0.0	0.0	0.0
105	HIDE WRINGER	EACH	21000.000	0.20	0.0	0.0	0.0	0.0	0.0
106	SIDING MACHINE	EACH	7500.000	0.20	0.0	0.0	0.0	0.0	0.0
107	SIDE SPLITTING MACHINE	EACH	32500.000	0.20	0.0	0.0	0.0	0.0	0.0
108	SIDE SHAVING MACHINE	EACH	19700.000	0.20	0.0	0.0	0.0	0.0	0.0
109	SORTING MACHINE	EACH	3000.000	0.20	0.0	0.0	0.0	0.0	0.0
110	MEASURING MACHINE	EACH	23500.000	0.20	0.0	0.0	0.0	0.0	0.0
111	COLOR DRUM, MULTI SP	EACH	18000.000	0.20	0.0	0.0	0.0	0.0	0.0
112	COLOR DRUM, 3 SP	EACH	14000.000	0.20	0.0	0.0	0.0	0.0	0.0
113	BALING PRESS	EACH	12000.000	0.20	0.0	0.0	0.0	0.0	0.0
114	SETOUT MACHINE	EACH	21000.000	0.20	0.0	0.0	0.0	0.0	0.0
115	PASTE PLATE DRYER SYSTEM	EACH	290000.000	0.20	0.0	0.0	0.0	0.0	0.0
116	STAKING MACHINE	EACH	31800.000	0.20	0.0	0.0	0.0	0.0	0.0
117	BRUSHING MACHINE	EACH	9600.000	0.20	0.0	0.0	0.0	0.0	0.0
118	STAKER (AUTOMATIC)	EACH	6850.000	0.20	0.0	0.0	0.0	0.0	0.0
119	DRYER (VACUUM TYPE)	EACH	19200.000	0.20	0.0	0.0	0.0	0.0	0.0
120	SCREENING MACHINE	SQ.FT	100.000	0.20	0.0	0.0	0.0	0.0	0.0
121	MISCELLANEOUS PUMP	EACH	5000.000	0.20	0.0	0.0	0.0	0.0	0.0
122	AERATOR	EACH	5000.000	0.20	0.0	0.0	0.0	0.0	0.0
123	BATING MACHINE	EACH	18000.000	0.0	0.0	0.0	0.0	0.0	0.0
124	BOILER 100 HP	EACH	20800.000	0.0	0.0	0.0	0.0	0.0	0.0
125	BOILER 150 HP	EACH	25800.000	0.0	0.0	0.0	0.0	0.0	0.0
126	BOILER 200 HP	EACH	30800.000	0.0	0.0	0.0	0.0	0.0	0.0
127	BOILER 250 HP	EACH	35800.000	0.0	0.0	0.0	0.0	0.0	0.0
128	BOILER 300 HP	EACH	40800.000	0.0	0.0	0.0	0.0	0.0	0.0
129	BOILER 350 HP	EACH	45800.000	0.0	0.0	0.0	0.0	0.0	0.0
130	PICKLING MACHINE	EACH	18000.000	0.0	0.0	0.0	0.0	0.0	0.0
131			0.0	0.0	0.0	0.0	0.0	0.0	0.0
132			0.0	0.0	0.0	0.0	0.0	0.0	0.0
133			0.0	0.0	0.0	0.0	0.0	0.0	0.0
134			0.0	0.0	0.0	0.0	0.0	0.0	0.0
135			0.0	0.0	0.0	0.0	0.0	0.0	0.0
136			0.0	0.0	0.0	0.0	0.0	0.0	0.0
137			0.0	0.0	0.0	0.0	0.0	0.0	0.0
138			0.0	0.0	0.0	0.0	0.0	0.0	0.0
139			0.0	0.0	0.0	0.0	0.0	0.0	0.0
140			0.0	0.0	0.0	0.0	0.0	0.0	0.0
141			0.0	0.0	0.0	0.0	0.0	0.0	0.0
142			0.0	0.0	0.0	0.0	0.0	0.0	0.0
143			0.0	0.0	0.0	0.0	0.0	0.0	0.0
144			0.0	0.0	0.0	0.0	0.0	0.0	0.0
145			0.0	0.0	0.0	0.0	0.0	0.0	0.0
146			0.0	0.0	0.0	0.0	0.0	0.0	0.0
147			0.0	0.0	0.0	0.0	0.0	0.0	0.0
148			0.0	0.0	0.0	0.0	0.0	0.0	0.0
149			0.0	0.0	0.0	0.0	0.0	0.0	0.0
150			0.0	0.0	0.0	0.0	0.0	0.0	0.0

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LEATHER
PAGE  1
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIR1, EVAP


PROCESS ELEMENT   1 IS A INPT UNIT. IT HAS  0 FEEDS.    0.    0.    0.    0.
                    AND  1 PRODUCTS.    1.    0.    0.    0.
PROCESS ELEMENT   2 IS A FORK UNIT. IT HAS  1 FEEDS.    1.    0.    0.    0.
                    AND  1 PRODUCTS.    3.    0.    0.    0.
PROCESS ELEMENT   3 IS A SOAK UNIT. IT HAS  1 FEEDS.    3.    0.    0.    0.
                    AND  2 PRODUCTS.  151.    5.    0.    0.
PROCESS ELEMENT   4 IS A GRID UNIT. IT HAS  1 FEEDS.    5.    0.    0.    0.
                    AND  2 PRODUCTS.    6.    7.    0.    0.
PROCESS ELEMENT   5 IS A AIR1 UNIT. IT HAS  1 FEEDS.    6.    0.    0.    0.
                    AND  1 PRODUCTS.    8.    0.    0.    0.
PROCESS ELEMENT   6 IS A EVAP UNIT. IT HAS  1 FEEDS.    8.    0.    0.    0.
                    AND  1 PRODUCTS.    9.    0.    0.    0.
PROCESS ELEMENT  94 IS A PRNT UNIT. IT HAS  3 FEEDS.  151.    7.    9.    0.
                    AND  0 PRODUCTS.    0.    0.    0.    0.
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TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIR1, EVAP

COMPONENTS SPECIFIED FOR USE IN SIMULATION

COMPONENT NUMBER	COMPONENT NAME
1	1 HIDE
2	2 HIDE AREA
3	3 WEIGHT (DRY)
4	4 HAIR
5	5 DIRT
6	6 WATER
7	7 SALT
8	8 GREASE/FAT
9	9 FLESH
10	10 MANURE
11	11 CHROMIUM
12	12 H2SO4
13	13 LIME
14	14 DETERGENT
15	15 SULFITE
16	16 HYDROCHL ACID
17	17 NAOH
18	18 SOLUBLE N
19	19 OTHER CHEMICALS
20	20 BOD
21	21 LIQ. SUS SOLIDS
22	22 TOTAL FLOW
23	23 COMPONENT 23
24	24 COMPONENT 24
25	25 COMPONENT 25

SPECIFIED UNITS

INPUT TEMPERATURES ARE IN DEG F
OUTPUT TEMPERATURES ARE IN DEG F
INPUT PRESSURES ARE IN PSIA
OUTPUT PRESSURES ARE IN PSIA
TIME BASIS IS HR
OUTPUT ENERGY UNITS ARE USA
INPUT ENERGY UNITS ARE USA

RELATIVE RECYCLE TOLERANCE 0.00010
SPECIFIED MAXIMUM ITERATIONS 20
NUMBER OF RECYCLE STREAMS 0
NUMBER OF SEPARATE LOOPS 0

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LEATHER
PAGE  1
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIR1, EVAP                00

INPT    1
FORK    2
ORIGINAL COST     13800.00   SALVAGE VALUE       500.00   LIFE                 10.00
CAPACITY            375.00   WORKING HOUR/DAY     16.00   SPACE ALLOTTED      350.00
HIDES/LABORER       500.00   HIDES/PALLET          3.33

SOAK    3
ORIGINAL COST     18000.00   SALVAGE VALUE       500.00   LIFE                 20.00
CAPACITY           5000.00   SOAK TIME           240.00   % TOTAL TIME          0.80
SPACE              1500.00   RPM                  30.00   FLOAT                 6.78
TEMP. OF FLOAT      212.00   PH                   11.00   % DETERGENT           0.00
% SULFIDE             0.00   MANAGEMENT            0.25   FOREMAN               0.50
OPERATOR              0.50   LABORER               0.25   SHIFTS                1.00
% DIRT REMAINING      0.02   % WATER REMAINING     0.75   % SALT REMAINING      0.75

GRID    4
AIR1    5
EVAP    6
PRNT   94
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LEATHER
PAGE 5
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIR1, EVAP

FEED STREAMS TO UNIT

STREAM NUMBER	1
COMPONENT	
	HIDE FLOW
1 HIDE	1000.00
2 HIDE AREA	40.00
3 WEIGHT (DRY)	25.00
4 HAIR	0.50
5 DIRT	1.00
6 WATER	28.00
7 SALT	7.00
8 GREASE/FAT	0.0
9 FLESH	0.0
10 MANURE	0.25
11 CHROMIUM	0.0
12 H2SO4	0.0
13 LIME	0.0
14 DETERGENT	0.0
15 SULFITE	0.0
16 HYDROCHL ACID	0.0
17 NAOH	0.0
18 SOLUBLE N	0.0
19 OTHER CHEMICALS	1.25
20 BOD	0.90
21 LIQ. SLS SOLIDS	1.00
22 TOTAL FLOW	1.00
23 COMPONENT 23	1.00
24 COMPONENT 24	1.00
25 COMPONENT 25	1.00

LEATHER
PAGE 6
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIR1, EVAP

FORKLIFT*** 2 ***FORK

	FEEDS*********	PRODUCTS******
STREAM NUMBER	1	3
	HIDE FLOW	HIDE FLOW
COMPONENT		
1 HIDE	1000.00	1000.00
2 HIDE AREA	40.00	40.00
3 WEIGHT (DRY)	25.00	25.00
4 HAIR	0.50	0.50
5 DIRT	1.00	1.00
6 WATER	28.00	28.00
7 SALT	7.00	7.00
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	0.25	0.25
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	0.0	0.0
15 SULFITE	0.0	0.0
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	1.25	1.25
20 BOD	0.90	0.90
21 LIQ. SLS SOLIDS	1.00	1.00
22 TOTAL FLOW	1.00	63.00
23 COMPONENT 23	1.00	1.00
24 COMPONENT 24	1.00	1.00
25 COMPONENT 25	1.00	1.00
TOTAL	1108.90	1170.90

FORKLIFT COMPUTATION OUTPUT 2***FORK

ITEM	NUMBER	UNITS	ORIGINAL COST	FIXED COSTS	VARIABLE COSTS	ANNUAL COSTS
FORKLIFT	1.0	EACH	13800.00	1617.73	1650.43	3268.16
FORKLIFT OPERATOR	1	MAN			10500.00	10500.00
LABORERS	2	MEN			20400.00	20400.00
BUILDING *	359.4	SQ.FT	6659.47	726.04	1299.00	2025.03
LAND COST	539.2	SQ.FT	18.57	2.41		2.41
PALLETS	300.3	EACH.	1900.90	277.53	520.85	798.38
TOTAL ANNUAL COSTS						36993.97

NOTE : BUILDING COST IS ASSOCIATED WITH FOLLOWING VARIABLES

MANUFACTURING SPACE = 350.0 SQ.FT, COST = $ 6300.0
OFFICE SPACE = 9.4 SQ.FT, COST = $ 283.5
OFFICE FURNITURE AND EQUIPMENTS COSTS = $ 76.0

FORKLIFT DEPRECIATION ROUTINE
ADEP=$ 1330.00, ATAX=$ 193.57, AREP=$ 320.43, SUR=$ 44.16, TER=$ 1380.00, YEAR= 10

BUILDING DEPRECIATION ROUTINE
ADEP=$ 456.31, ATAX=$ 36.78, AREP=$ 842.69, SUR=$ 21.31, TER=$ 665.95, YEAR= 11

LEATHER
PAGE 7
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIRI, EVAP 00

SOAK*** 3 ***SOAKER

FEEDS********************************PRODUCTS**********************

STREAM NUMBER	3 HIDE FLOW	171	151	5 SOAK WASTE
COMPONENT				
1 HIDE	1000.00	0.0	1000.00	0.0
2 HIDE AREA	40.00	0.0	40.00	0.0
3 WEIGHT (DRY)	25.00	0.0	25.00	0.0
4 HAIR	0.50	0.0	0.50	0.0
5 DIRT	1.00	0.0	0.02	980.00
6 WATER	28.00	406979.94	21.00	413979.94
7 SALT	7.00	0.0	5.25	1750.00
8 GREASE/FAT	0.0	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0	0.0
10 MANURE	0.25	0.0	0.0	250.00
11 CHROMIUM	0.0	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0	0.0
14 DETERGENT	0.0	12.00	0.0	12.00
15 SULFITE	0.0	9.00	0.0	9.00
16 HYDROCHL ACID	0.0	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0	0.0
19 OTHER CHEMICALS	1.25	0.0	0.0	1250.00
20 BOD	0.90	0.0	0.0	902.00
21 LIQ. SLS SOLIDS	1.00	0.0	0.0	1504.00
22 TOTAL FLOW	63.00	407000.87	51.77	418230.87
23 COMPONENT 23	1.00	0.0	0.0	1000.00
24 COMPONENT 24	1.00	0.0	0.0	1000.00
25 COMPONENT 25	1.00	0.0	0.0	1000.00
TOTAL	1170.90	814001.75	1143.54	841867.69

SOAKING COMPUTATION OUTPUT 3***SOAK

ITEM	NUMBER	UNITS	ORIGINAL COSTS	FIXED COSTS	VARIABLE COSTS	ANNUAL COSTS
MACHINE	6.00	EACH	108000.00	11920.13	22529.89	34450.02
MANAGEMENT	1.50	MEN		24480.00		24480.00
FOREMAN	3.00	MEN		36720.00		36720.00
OPERATOR	3.00	MEN			32130.00	32130.00
LABORER	1.50	MEN			15300.00	15300.00
DETERGENT	3060.00	LBS			1009.80	1009.80
SULFIDE	2295.00	LBS			5278.50	5278.50
HEATING	615746.37	KWH			17240.90	17240.90
PLUMBING COST			24000.00	2160.00	2400.00	2400.00
WIRE COST			22290.00	2229.00	2006.10	4235.10
BUILDING *	9243.00	SQ.FT	171243.62	18669.52	33402.80	52072.32
LAND COST	13864.49	SQ.FT	477.43	62.07		62.07
WATER	103779872.	LBS			4978.64	4978.64
TOTAL ANNUAL COSTS						230357.25

NOTE : BUILDING COST IS ASSOCIATED WITH FOLLOWING VARIABLES

MANUFACTURING SPACE = 9000.0 SQ.FT, COST = $ 162000.0
OFFICE SPACE = 243.0 SQ.FT, COST = $ 7290.0
OFFICE FURNITURE AND EQUIPMENTS COSTS = $ 1953.7

SOAKING MACHINE DEPRECIATION ROUTINE
ADEP=$ 1278.84 ATAX=$ 129.09 AREP=$ 2476.14 SUR=$ 57.60 TER=$ 1800.00 YEAR=13

BUILDING DEPRECIATION ROUTINE
ADEP=$11733.66 ATAX=$ 997.18 AREP=$21669.13 SUR=$ 547.98 TER=$17124.36 YEAR=11

LEATHER
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TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIRL, EVAP

SCREEN*** 4 ***SCREENS

FEEDS*********PRODUCTS*******************

STREAM NUMBER	5 SOAK WASTE	6 SCREEN LIQ.	7 SCREEN SOLID
COMPONENT			
1 HIDE	0.0	0.0	0.0
2 HIDE AREA	0.0	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0	0.0
4 HAIR	0.0	0.0	0.0
5 DIRT	980.00	490.00	490.00
6 WATER	413979.94	393280.87	20699.00
7 SALT	1750.00	1400.00	350.00
8 GREASE/FAT	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0
10 MANURE	250.00	225.00	25.00
11 CHROMIUM	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0
14 DETERGENT	12.00	10.80	1.20
15 SULFITE	9.00	8.10	0.90
16 HYDROCHL ACID	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0
19 OTHER CHEMICALS	1250.00	1125.00	125.00
20 BOD	902.00	766.70	135.30
21 LIQ. SUS SOLIDS	1504.00	225.60	1278.40
22 TOTAL FLOW	418230.87	396539.56	21691.09
23 COMPONENT 23	1000.00	0.0	1000.00
24 COMPONENT 24	1000.00	0.0	1000.00
25 COMPONENT 25	1000.00	0.0	1000.00
TOTAL	841867.69	794071.37	47795.87

CAPITAL COST = $ 371.44

O&M COSTS = $ 15325.70

LEATHER
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TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIR1, EVAP

AERATION BASIN*** 5 ***AERATION BASIN

	FEEDS*********	PRODUCTS******
STREAM NUMBER	6	8
	SCREEN LIQ.	EFFLUENT
COMPONENT		
1 HIDE	0.0	0.0
2 HIDE AREA	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0
4 HAIR	0.0	0.0
5 DIRT	490.00	490.00
6 WATER	393280.87	393280.87
7 SALT	1400.00	1400.00
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	225.00	225.00
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	10.80	10.80
15 SULFITE	0.10	0.0
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	1125.00	1125.00
20 BOD	766.75	107.34
21 LIQ. SUS SOLIDS	225.60	225.60
22 TOTAL FLOW	396539.56	396531.50
23 COMPONENT 23	0.0	0.0
24 COMPONENT 24	0.0	0.0
25 COMPONENT 25	0.0	0.0
TOTAL	794071.37	793395.87

ITEM	NUMBER	UNITS
AREA	2005.33	SQ FT
CAPITAL COST	20180.26	DOLLARS
LAND COST	401.06	DOLLARS
OP LABOR COST	8456.47	DOLLARS
MN LABOR COST	1519.44	DOLLARS
POWER COST	3084.52	DOLLARS
MATERIAL COST	36.41	DOLLARS

LEATHER
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TITLE DEMONSTRATION SIMPLE SYSTEM: PORK, SOAK, GRID, AIR1, EVAP

EVAPORATION POND*** 6 ***EVAPORATION POND

	FEEDS*********	PRODUCTS******
STREAM NUMBER	8	9
	EFFLUENT	EFFLUENT
COMPONENT		
1 HIDE	0.0	0.0
2 HIDE AREA	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0
4 HAIR	0.0	0.0
5 DIRT	490.00	0.0
6 WATER	393280.67	0.0
7 SALT	1400.00	0.0
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	225.00	0.0
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	10.60	0.0
15 SULFITE	0.0	0.0
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	1125.00	0.0
20 BOD	137.34	0.0
21 LIQ. SLS SOLIDS	225.60	0.0
22 TOTAL FLOW	396531.50	0.0
23 COMPONENT 23	0.0	0.0
24 COMPONENT 24	0.0	0.0
25 COMPONENT 25	0.0	0.0
TOTAL	793395.67	0.0

ITEM	NUMBER	UNITS
POND	8.79	ACRES
WATER FLOW	47545.74	GAL/DAY
LAND COST	8786.45	DOLLARS
CAPT. COST	136169.87	DOLLARS

	FOR WARM CLIMATES NUMBER	FOR COOL CLIMATES NUMBER	UNITS
LABOR	0.0	115.35	MANHOURS
LABOR COST	0.0	576.74	DOLLARS
MATERIALS	0.0	457.47	DOLLARS

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TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIR1, EVAP

PROCESS STREAMS LEAVING THE UNIT

STREAM NUMBER COMPONENT	151	7	9
		SCREEN SOLID	EFFLUENT
1 HIDE	1000.00	0.0	0.0
2 HIDE AREA	40.00	0.0	0.0
3 WEIGHT (DRY)	25.00	0.0	0.0
4 HAIR	0.50	0.0	0.0
5 DIRT	0.02	490.00	0.0
6 WATER	21.00	20699.00	0.0
7 SALT	5.25	350.00	0.0
8 GREASE/FAT	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0
10 MANURE	0.0	25.00	0.0
11 CHROMIUM	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0
14 DETERGENT	0.0	1.20	0.0
15 SULFITE	0.0	0.90	0.0
16 HYDROCHL ACID	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0
19 OTHER CHEMICALS	0.0	125.00	0.0
20 BOD	0.0	135.30	0.0
21 LIQ. SUS SOLIDS	0.0	1278.40	0.0
22 TOTAL FLOW	51.77	21691.09	0.0
23 COMPONENT 23	0.0	1000.00	0.0
24 COMPONENT 24	0.0	1000.00	0.0
25 COMPONENT 25	0.0	1000.00	0.0

LEATHER
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TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIRL, EVAP 00

HEAT AND MATERIAL BALANCE SHEETS

STREAM NUMBER COMPONENT	1	3	5	6	7
	HIDE FLOW	HIDE FLOW	SOAK WASTE	SCREEN LIQ.	SCREEN SOLID
1 HIDE	1000.00	1000.00	0.0	0.0	0.0
2 HIDE AREA	40.00	40.00	0.0	0.0	0.0
3 WEIGHT (DRY)	25.00	25.00	0.0	0.0	0.0
4 HAIR	0.50	0.50	0.0	0.0	0.0
5 DIRT	1.00	1.00	980.00	490.00	490.00
6 WATER	28.00	28.00	413979.94	393280.87	20699.00
7 SALT	7.00	7.00	1750.00	1400.00	350.00
8 GREASE/FAT	0.0	0.0	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0	0.0	0.0
10 MANURE	0.25	0.25	250.00	225.00	25.00
11 CHROMIUM	0.0	0.0	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0	0.0	0.0
14 DETERGENT	0.0	0.0	12.00	10.80	1.20
15 SULFITE	0.0	0.0	9.00	8.10	0.90
16 HYDROCHL ACID	0.0	0.0	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0	0.0	0.0
19 OTHER CHEMICALS	1.25	1.25	1250.00	1125.00	125.00
20 BOD	0.90	0.90	902.00	766.70	135.30
21 LIQ. SUS SOLIDS	1.00	1.00	1504.00	225.60	1278.40
22 TOTAL FLOW	1.00	63.00	418230.87	396539.56	21691.09
23 COMPONENT 23	1.00	1.00	1000.00	0.0	1000.00
24 COMPONENT 24	1.00	1.00	1000.00	0.0	1000.00
25 COMPONENT 25	1.00	1.00	1000.00	0.0	1000.00

LEATHER
PAGE 13
TITLE DEMONSTRATION SIMPLE SYSTEM: FORK, SOAK, GRID, AIR1, EVAP

HEAT AND MATERIAL BALANCE SHEETS

STREAM NUMBER / COMPONENT	6	151	171
	EFFLUENT		
1 HIDE	0.0	1000.00	0.0
2 HIDE AREA	0.0	40.00	0.0
3 WEIGHT (DRY)	0.0	25.00	0.0
4 HAIR	0.0	0.50	0.0
5 DIRT	490.00	0.02	0.0
6 WATER	393280.87	21.00	406979.94
7 SALT	1400.00	5.25	0.0
8 GREASE/FAT	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0
10 MANURE	225.00	0.0	0.0
11 CHROMIUM	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0
14 DETERGENT	10.80	0.0	12.00
15 SULFITE	0.0	0.0	9.00
16 HYDROCHL ACID	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0
19 OTHER CHEMICALS	1125.00	0.0	0.0
20 BOD	107.34	0.0	0.0
21 LIQ. SUS SOLIDS	225.60	0.0	0.0
22 TOTAL FLOW	390531.50	51.77	407000.87
23 COMPONENT 23	0.0	0.0	0.0
24 COMPONENT 24	0.0	0.0	0.0
25 COMPONENT 25	0.0	0.0	0.0

1. BUILDING AND LAND COSTS

PROCESS ITEM	A	B	C	D	E	F	TOTAL
CAPITAL COST OF							
MANUFACTURING SPACE	168300.0	0.0	0.0	0.0	0.0	0.0	168300.0
OFFICE SPACE	7530.0	0.0	0.0	0.0	0.0	0.0	7530.0
TOTAL SPACE COSTS	175830.0	0.0	0.0	0.0	0.0	0.0	175830.0
OFFICE FURNITURE	2010.0	0.0	0.0	0.0	0.0	0.0	2010.0
TOTAL BUILDING COSTS	177840.0	0.0	0.0	0.0	0.0	0.0	177840.0
LAND	496.0	0.0	0.0	0.0	0.0	0.0	496.0
WASTE MANAGEMENT LAND	0.0	2013000.0	0.0	0.0	0.0	0.0	2013000.0
TOTAL COST OF LAND AND BUILDING	178336.0	2013000.0	0.0	0.0	0.0	0.0	2191336.0

2. REQUIRED EQUIPMENTS

PROCESS TYPE OF EQUIPMENT	A	B	C	D	E	F	TOTAL
PALLET	300.0	0.0	0.0	0.0	0.0	0.0	300.0
PLUMBING	6.0	0.0	0.0	0.0	0.0	0.0	6.0
WIRING	6.0	0.0	0.0	0.0	0.0	0.0	6.0
FORKLIFT (ELECTRIC)	1.0	0.0	0.0	0.0	0.0	0.0	1.0
TANNING DRUM MULTI SP	6.0	0.0	0.0	0.0	0.0	0.0	6.0
SCREENING MACHINE	0.0	3.0	0.0	0.0	0.0	0.0	3.0
AERATOR	0.0	4.0	0.0	0.0	0.0	0.0	4.0

3. EQUIPMENT COSTS

PROCESS TYPE OF EQUIPMENT	A	B	C	D	E	F	TOTAL
PALLET	1899.0	0.0	0.0	0.0	0.0	0.0	1899.0
PLUMBING	24000.0	0.0	0.0	0.0	0.0	0.0	24000.0
WIRING	22290.0	0.0	0.0	0.0	0.0	0.0	22290.0
FORKLIFT (ELECTRIC)	13800.0	0.0	0.0	0.0	0.0	0.0	13800.0
TANNING DRUM MULTI SP	108000.0	0.0	0.0	0.0	0.0	0.0	108000.0
SCREENING MACHINE	0.0	300.0	0.0	0.0	0.0	0.0	300.0
AERATOR	0.0	20000.0	0.0	0.0	0.0	0.0	20000.0
TOTAL CAPITAL COSTS	169989.0	20300.0	0.0	0.0	0.0	0.0	190289.0

4. REQUIRED LABORS

PROCESS / TYPE OF LABOR	A	B	C	D	E	F	TOTAL
PERMANENT							
SUPERVISOR (DEPT)	3060.0	0.0	0.0	0.0	0.0	0.0	3060.0
FOREMAN	6120.0	0.0	0.0	0.0	0.0	0.0	6120.0
VARIABLE (HOURLY)							
MACHINE OPERATOR	8160.0	1610.0	0.0	0.0	0.0	0.0	9770.0
LABORER	7140.0	3483.0	0.0	0.0	0.0	0.0	10623.0

5. LABOR COSTS

PROCESS / TYPE OF LABOR	A	B	C	D	E	F	TOTAL
PERMANENT							
SUPERVISOR (DEPT)	24480.0	0.0	0.0	0.0	0.0	0.0	24480.0
FOREMAN	36720.0	0.0	0.0	0.0	0.0	0.0	36720.0
VARIABLE (HOURLY)							
MACHINE OPERATOR	42840.0	8452.5	0.0	0.0	0.0	0.0	51292.5
LABORER	35700.0	17415.0	0.0	0.0	0.0	0.0	53115.0
TOTAL							
PERMANENT LABOR COSTS	61200.0	0.0	0.0	0.0	0.0	0.0	61200.0
HOURLY LABOR COSTS	76540.0	25867.5	0.0	0.0	0.0	0.0	104407.5
TOTAL LABOR COSTS	139740.0	25867.5	0.0	0.0	0.0	0.0	165607.5

6. OVERHEAD COSTS

PROCESS TYPE OF OVERHEAD	A	B	C	D	E	F	TOTAL
VARIABLE							
WATER	4978.4	0.0	0.0	0.0	0.0	0.0	4978.4
ELECTRICITY	17240.9	3084.5	0.0	0.0	0.0	0.0	20325.4
DEPRECIATION							
EQUIPMENTS	2087.1	0.0	0.0	0.0	0.0	0.0	2087.1
ACCESSORY EQUIPMENTS	4205.0	0.0	0.0	0.0	0.0	0.0	4205.0
BUILDING	9752.0	0.0	0.0	0.0	0.0	0.0	9752.0
REPAIR							
EQUIPMENTS	2796.6	0.0	0.0	0.0	0.0	0.0	2796.6
ACCESSORY EQUIPMENTS	481.9	0.0	0.0	0.0	0.0	0.0	481.9
BUILDING	22511.8	0.0	0.0	0.0	0.0	0.0	22511.8
INSURANCE							
LABORS	3927.0	1293.9	0.0	0.0	0.0	0.0	5220.9
FACTORY SUPPLIES	0.0	493.9	0.0	0.0	0.0	0.0	493.9
FIXED							
DEPRECIATION							
EQUIPMENTS	521.8	0.0	0.0	0.0	0.0	0.0	521.8
ACCESSORY EQUIPMENTS	1051.3	0.0	0.0	0.0	0.0	0.0	1051.3
BUILDING	2438.0	0.0	0.0	0.0	0.0	0.0	2438.0
TAX							
EQUIPMENTS	322.7	0.0	0.0	0.0	0.0	0.0	322.7
ACCESSORY EQUIPMENTS	963.8	0.0	0.0	0.0	0.0	0.0	963.8
BUILDING	1036.0	0.0	0.0	0.0	0.0	0.0	1036.0

6. OVERHEAD COSTS (CONTINUE)

PROCESS TYPE OF OVERHEAD	A	B	C	D	E	F	TOTAL
INSURANCE							
EQUIPMENTS	101.8	0.0	0.0	0.0	0.0	0.0	101.8
ACCESSORY EQUIPMENTS	481.9	0.0	0.0	0.0	0.0	0.0	481.9
BUILDING	569.3	0.0	0.0	0.0	0.0	0.0	569.3
MANAGEMENTS	3060.0	0.0	0.0	0.0	0.0	0.0	3060.0
INTEREST							
EQUIPMENTS	3180.0	0.0	0.0	0.0	0.0	0.0	3180.0
ACCESSORY EQUIPMENTS	2409.5	0.0	0.0	0.0	0.0	0.0	2409.5
BUILDING	17790.3	0.0	0.0	0.0	0.0	0.0	17790.3
LAND	47.7	955.9	0.0	0.0	0.0	0.0	1003.6
TOTAL							
VARIABLE COSTS	67980.7	4872.3	0.0	0.0	0.0	0.0	72853.0
FIXED COSTS	33974.0	955.9	0.0	0.0	0.0	0.0	34929.9
TOTAL OVERHEAD COSTS	101954.7	5828.2	0.0	0.0	0.0	0.0	107782.9

7. REQUIRED CHEMICALS

PROCESS TYPE OF CHEMICAL	A	B	C	D	E	F	TOTAL
DETERGENT	3059.0	0.0	0.0	0.0	0.0	0.0	3059.0
SULFIDE	2295.0	0.0	0.0	0.0	0.0	0.0	2295.0

8. CHEMICAL COSTS

PROCESS TYPE OF CHEMICAL	A	B	C	D	E	F	TOTAL
DETERGENT	1009.5	0.0	0.0	0.0	0.0	0.0	1009.5
SULFIDE	5278.5	0.0	0.0	0.0	0.0	0.0	5278.5
TOTAL CHEMICAL COSTS	6288.0	0.0	0.0	0.0	0.0	0.0	6288.0

9. CAPITAL SUMMARY

PROCESS TYPE OF COST	A	B	C	D	E	F	TOTAL
BUILDING AND LAND	178336.0	0.0	0.0	0.0	0.0	0.0	178336.0
WASTE TREATMENT LAND	0.0	2013000.0	0.0	0.0	0.0	0.0	2013000.0
EQUIPMENT	169989.0	20300.0	0.0	0.0	0.0	0.0	190289.0
TOTAL CAPITAL COSTS	348325.0	2033300.0	0.0	0.0	0.0	0.0	2381625.0

10. OPERATING SUMMARY (ANNUAL COSTS)

PROCESS TYPE OF COST	A	B	C	D	E	F	TOTAL
PERMANENT LABOR	61200.0	0.0	0.0	0.0	0.0	0.0	61200.0
HOURLY LABOR	78540.0	25867.5	0.0	0.0	0.0	0.0	104407.5
TOTAL LABOR	139740.0	25867.5	0.0	0.0	0.0	0.0	165607.5
FIXED OVERHEAD	33974.0	955.9	0.0	0.0	0.0	0.0	34929.9
VARIABLE OVERHEAD	67980.7	4872.3	0.0	0.0	0.0	0.0	72853.0
TOTAL OVERHEAD	101954.7	5828.2	0.0	0.0	0.0	0.0	107782.9
TOTAL CHEMICAL	6288.0	0.0	0.0	0.0	0.0	0.0	6288.0
TOTAL OPERATING COSTS	247982.7	31695.7	0.0	0.0	0.0	0.0	279678.4

*
OPERATING COST / HIDE = $ 1.0968

COST / SQUARE FOOT OF LEATHER = $ 0.0274

VALUES FOR HIDE PROCESSING

I ITEMS	UNITS	PRICE/UNIT	FACTORS 1	2	3	4	5	6
BUILDING AND LAND								
1 MANUFACTURING SPACE	SQ.FT	18.000	0.15	0.0	0.0	0.0	0.0	0.0
2 OFFICE SPACE	SQ.FT	30.000	0.15	0.0	0.0	0.0	0.0	0.0
3 OFFICE FURNITURE	UNIT	30.000	0.0	0.0	0.0	0.0	0.0	0.0
4 LAND	ACRE	1500.000	0.0	0.0	0.0	0.0	0.0	0.0
5 WASTE MANAGEMENT LAND	ACRE	1000.000	0.0	0.0	0.0	0.0	0.0	0.0
6		0.0	0.0	0.0	0.0	0.0	0.0	0.0
7		0.0	0.0	0.0	0.0	0.0	0.0	0.0
8		0.0	0.0	0.0	0.0	0.0	0.0	0.0
9		0.0	0.0	0.0	0.0	0.0	0.0	0.0
10		0.0	0.0	0.0	0.0	0.0	0.0	0.0
LABOR								
11 SUPERVISOR (DEPT)	HOUR	8.000	0.0	0.0	0.0	0.0	0.0	0.0
12 FOREMAN	HOUR	6.000	0.0	0.0	0.0	0.0	0.0	0.0
13 MACHINE OPERATOR	HOUR	5.250	0.0	0.0	0.0	0.0	0.0	0.0
14 SEMI SKILLED LABORER	HOUR	5.100	0.0	0.0	0.0	0.0	0.0	0.0
15 LABORER	HOUR	5.000	0.0	0.0	0.0	0.0	0.0	0.0
16 MACHINE OPERATOR	HOUR	4.250	0.0	0.0	0.0	0.0	0.0	0.0
17 SEMI SKILLED LABORER	HOUR	4.100	0.0	0.0	0.0	0.0	0.0	0.0
18 LABORER	HOUR	4.000	0.0	0.0	0.0	0.0	0.0	0.0
19		0.0	0.0	0.0	0.0	0.0	0.0	0.0
20		0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVERHEAD (UTILITIES)								
21 WATER	1000 GAL	0.400	0.0	0.0	0.0	0.0	0.0	0.0
22 ELECTRICITY	KWH	0.028	0.0	0.0	0.0	0.0	0.0	0.0
23 GASOLINE	GAL	0.650	0.0	0.0	0.0	0.0	0.0	0.0
24 NATURAL GAS	MCF	2.000	0.0	0.0	0.0	0.0	0.0	0.0
25 STEAM	1000 BTU	0.010	0.0	0.0	0.0	0.0	0.0	0.0
26		0.0	0.0	0.0	0.0	0.0	0.0	0.0
27		0.0	0.0	0.0	0.0	0.0	0.0	0.0
28		0.0	0.0	0.0	0.0	0.0	0.0	0.0
29		0.0	0.0	0.0	0.0	0.0	0.0	0.0
30		0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHEMICALS								
31 SALT	LB	0.650	0.0	0.0	0.0	0.0	0.0	0.0
32 CHROMIUM	LB	0.750	0.0	0.0	0.0	0.0	0.0	0.0
33 H2SO4	LB	0.650	0.0	0.0	0.0	0.0	0.0	0.0
34 LIME	LB	1.750	0.0	0.0	0.0	0.0	0.0	0.0
35 DETERGENT	LB	0.330	0.0	0.0	0.0	0.0	0.0	0.0
36 SULFIDE	LB	2.300	0.0	0.0	0.0	0.0	0.0	0.0
37 HYDROCHLORIC ACID	LB	1.000	0.0	0.0	0.0	0.0	0.0	0.0
38 NAOH	LB	1.000	0.0	0.0	0.0	0.0	0.0	0.0
39 CALCIUM HYDROXIDE	LB	1.750	0.0	0.0	0.0	0.0	0.0	0.0
40 NACL	LB	0.250	0.0	0.0	0.0	0.0	0.0	0.0
41 SODIUM BICARBONATE	LB	0.480	0.0	0.0	0.0	0.0	0.0	0.0
42 DELIMING CHEMICALS	LB	1.000	0.0	0.0	0.0	0.0	0.0	0.0

43		0.0	0.0	0.0	0.0	0.0	0.0	0.0
44		0.0	0.0	0.0	0.0	0.0	0.0	0.0
45		0.0	0.0	0.0	0.0	0.0	0.0	0.0
46		0.0	0.0	0.0	0.0	0.0	0.0	0.0
47		0.0	0.0	0.0	0.0	0.0	0.0	0.0
48		0.0	0.0	0.0	0.0	0.0	0.0	0.0
49		0.0	0.0	0.0	0.0	0.0	0.0	0.0
50		0.0	0.0	0.0	0.0	0.0	0.0	0.0
51		0.0	0.0	0.0	0.0	0.0	0.0	0.0
52		0.0	0.0	0.0	0.0	0.0	0.0	0.0
53		0.0	0.0	0.0	0.0	0.0	0.0	0.0
54		0.0	0.0	0.0	0.0	0.0	0.0	0.0
55		0.0	0.0	0.0	0.0	0.0	0.0	0.0
56		0.0	0.0	0.0	0.0	0.0	0.0	0.0
57		0.0	0.0	0.0	0.0	0.0	0.0	0.0
58		0.0	0.0	0.0	0.0	0.0	0.0	0.0
59		0.0	0.0	0.0	0.0	0.0	0.0	0.0
60		0.0	0.0	0.0	0.0	0.0	0.0	0.0
61		0.0	0.0	0.0	0.0	0.0	0.0	0.0
62		0.0	0.0	0.0	0.0	0.0	0.0	0.0
63		0.0	0.0	0.0	0.0	0.0	0.0	0.0
64		0.0	0.0	0.0	0.0	0.0	0.0	0.0
65		0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACCESSORY EQUIPMENTS								
66 PALLET	EACH	6.330	0.33	0.0	0.0	0.0	0.0	0.0
67 HORSE (LOW TYPE)	EACH	150.000	0.15	0.0	0.0	0.0	0.0	0.0
68 HORSE (HIGH TYPE)	EACH	125.000	0.15	0.0	0.0	0.0	0.0	0.0
69 SPLIT TRIMMING TABLE	EACH	200.000	0.15	0.0	0.0	0.0	0.0	0.0
70 TABLE (WOODEN)	EACH	100.000	0.15	0.0	0.0	0.0	0.0	0.0
71 WRAPPING TABLE	EACH	150.000	0.15	0.0	0.0	0.0	0.0	0.0
72 LIME LIQUOR TANK	EACH	10000.000	0.15	0.0	0.0	0.0	0.0	0.0
73 DEEP TANK	EACH	20000.000	0.15	0.0	0.0	0.0	0.0	0.0
74 TUB	EACH	2210.000	0.15	0.0	0.0	0.0	0.0	0.0
75 PLUMBING	JOB	4000.000	0.10	0.0	0.0	0.0	0.0	0.0
76 WIRING	JOB	3715.000	0.10	0.0	0.0	0.0	0.0	0.0
77		0.0	0.0	0.0	0.0	0.0	0.0	0.0
78		0.0	0.0	0.0	0.0	0.0	0.0	0.0
79		0.0	0.0	0.0	0.0	0.0	0.0	0.0
80		0.0	0.0	0.0	0.0	0.0	0.0	0.0
81		0.0	0.0	0.0	0.0	0.0	0.0	0.0
82		0.0	0.0	0.0	0.0	0.0	0.0	0.0
83		0.0	0.0	0.0	0.0	0.0	0.0	0.0
84		0.0	0.0	0.0	0.0	0.0	0.0	0.0
85		0.0	0.0	0.0	0.0	0.0	0.0	0.0
86		0.0	0.0	0.0	0.0	0.0	0.0	0.0
87		0.0	0.0	0.0	0.0	0.0	0.0	0.0
88		0.0	0.0	0.0	0.0	0.0	0.0	0.0
89		0.0	0.0	0.0	0.0	0.0	0.0	0.0
90		0.0	0.0	0.0	0.0	0.0	0.0	0.0
91		0.0	0.0	0.0	0.0	0.0	0.0	0.0
92		0.0	0.0	0.0	0.0	0.0	0.0	0.0
93		0.0	0.0	0.0	0.0	0.0	0.0	0.0
94		0.0	0.0	0.0	0.0	0.0	0.0	0.0
95		0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANUFACTURING EQUIPMENTS								
96 FORKLIFT (ELECTRIC)	EACH	13800.000	0.20	0.0	0.0	0.0	0.0	0.0
97 FORKLIFT (PROPANE FUEL)	EACH	11000.000	0.20	0.0	0.0	0.0	0.0	0.0
98 FORKLIFT	EACH	11000.000	0.20	0.0	0.0	0.0	0.0	0.0
99 SCALE (6000 LB DIAL)	EACH	4600.000	0.20	0.0	0.0	0.0	0.0	0.0
100 SCALE (60 LB DIAL)	EACH	500.000	0.20	0.0	0.0	0.0	0.0	0.0
101 SCALE	EACH	400.000	0.20	0.0	0.0	0.0	0.0	0.0
102 FLESHING & DEMANURING	EACH	62000.000	0.20	0.0	0.0	0.0	0.0	0.0

103	TANNING DRUM 3-SP	EACH	8300.000	0.20	0.0	0.0	0.0	0.0	0.0
104	TANNING DRUM MULTI SP	EACH	18000.000	0.20	0.0	0.0	0.0	0.0	0.0
105	HIDE WRINGER	EACH	21000.000	0.20	0.0	0.0	0.0	0.0	0.0
106	SIDING MACHINE	EACH	7500.000	0.20	0.0	0.0	0.0	0.0	0.0
107	SIDE SPLITTING MACHINE	EACH	32500.000	0.20	0.0	0.0	0.0	0.0	0.0
108	SIDE SHAVING MACHINE	EACH	19700.000	0.20	0.0	0.0	0.0	0.0	0.0
109	SORTING MACHINE	EACH	3000.000	0.20	0.0	0.0	0.0	0.0	0.0
110	MEASURING MACHINE	EACH	23500.000	0.20	0.0	0.0	0.0	0.0	0.0
111	COLOR DRUM, MULTI SP	EACH	18000.000	0.20	0.0	0.0	0.0	0.0	0.0
112	COLOR DRUM, 3 SP	EACH	14000.000	0.20	0.0	0.0	0.0	0.0	0.0
113	BALING PRESS	EACH	12000.000	0.20	0.0	0.0	0.0	0.0	0.0
114	SETOUT MACHINE	EACH	21000.000	0.20	0.0	0.0	0.0	0.0	0.0
115	PASTE PLATE DRYER SYSTEM	EACH	290000.000	0.20	0.0	0.0	0.0	0.0	0.0
116	STAKING MACHINE	EACH	31800.000	0.20	0.0	0.0	0.0	0.0	0.0
117	BRUSHING MACHINE	EACH	9600.000	0.20	0.0	0.0	0.0	0.0	0.0
118	STAKER (AUTOMATIC)	EACH	6850.000	0.20	0.0	0.0	0.0	0.0	0.0
119	DRYER (VACUUM TYPE)	EACH	19200.000	0.20	0.0	0.0	0.0	0.0	0.0
120	SCREENING MACHINE	SQ.FT	100.000	0.20	0.0	0.0	0.0	0.0	0.0
121	MISCELLANEOUS PUMP	EACH	5000.000	0.20	0.0	0.0	0.0	0.0	0.0
122	AERATOR	EACH	5000.000	0.20	0.0	0.0	0.0	0.0	0.0
123	BATING MACHINE	EACH	18000.000	0.0	0.0	0.0	0.0	0.0	0.0
124	BOILER 100 HP	EACH	20800.000	0.0	0.0	0.0	0.0	0.0	0.0
125	BOILER 150 HP	EACH	25800.000	0.0	0.0	0.0	0.0	0.0	0.0
126	BOILER 200 HP	EACH	30800.000	0.0	0.0	0.0	0.0	0.0	0.0
127	BOILER 250 HP	EACH	35800.000	0.0	0.0	0.0	0.0	0.0	0.0
128	BOILER 300 HP	EACH	40800.000	0.0	0.0	0.0	0.0	0.0	0.0
129	BOILER 350 HP	EACH	45900.000	0.0	0.0	0.0	0.0	0.0	0.0
130	PICKLING MACHINE	EACH	18000.000	0.0	0.0	0.0	0.0	0.0	0.0
131			0.0	0.0	0.0	0.0	0.0	0.0	0.0
132			0.0	0.0	0.0	0.0	0.0	0.0	0.0
133			0.0	0.0	0.0	0.0	0.0	0.0	0.0
134			0.0	0.0	0.0	0.0	0.0	0.0	0.0
135			0.0	0.0	0.0	0.0	0.0	0.0	0.0
136			0.0	0.0	0.0	0.0	0.0	0.0	0.0
137			0.0	0.0	0.0	0.0	0.0	0.0	0.0
138			0.0	0.0	0.0	0.0	0.0	0.0	0.0
139			0.0	0.0	0.0	0.0	0.0	0.0	0.0
140			0.0	0.0	0.0	0.0	0.0	0.0	0.0
141			0.0	0.0	0.0	0.0	0.0	0.0	0.0
142			0.0	0.0	0.0	0.0	0.0	0.0	0.0
143			0.0	0.0	0.0	0.0	0.0	0.0	0.0
144			0.0	0.0	0.0	0.0	0.0	0.0	0.0
145			0.0	0.0	0.0	0.0	0.0	0.0	0.0
146			0.0	0.0	0.0	0.0	0.0	0.0	0.0
147			0.0	0.0	0.0	0.0	0.0	0.0	0.0
148			0.0	0.0	0.0	0.0	0.0	0.0	0.0
149			0.0	0.0	0.0	0.0	0.0	0.0	0.0
150			0.0	0.0	0.0	0.0	0.0	0.0	0.0

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 LEATHER
 PAGE  1
TITLE  WASTE TREATMENT SYSTEM;FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

PROCESS ELEMENT   1 IS A INPT UNIT. IT HAS  0 FEEDS,   0,   0,   0,   0,
                    AND  1 PRODUCTS,   2,   0,   0,   0,
PROCESS ELEMENT   2 IS A FORK UNIT. IT HAS  1 FEEDS,   2,   0,   0,   0,
                    AND  1 PRODUCTS,   3,   0,   0,   0,
PROCESS ELEMENT   3 IS A SOAK UNIT. IT HAS  1 FEEDS,   3,   0,   0,   0,
                    AND  2 PRODUCTS,   4,   5,   0,   0,
PROCESS ELEMENT   4 IS A GRID UNIT. IT HAS  1 FEEDS,   5,   0,   0,   0,
                    AND  2 PRODUCTS,   6,   7,   0,   0,
PROCESS ELEMENT   5 IS A EQUI UNIT. IT HAS  1 FEEDS,   6,   0,   0,   0,
                    AND  1 PRODUCTS,   8,   0,   0,   0,
PROCESS ELEMENT   6 IS A FILT UNIT. IT HAS  1 FEEDS,   8,   0,   0,   0,
                    AND  2 PRODUCTS,   9,  10,   0,   0,
PROCESS ELEMENT   7 IS A AIR2 UNIT. IT HAS  1 FEEDS,   9,   0,   0,   0,
                    AND  1 PRODUCTS,  11,   0,   0,   0,
PROCESS ELEMENT   8 IS A BAS1 UNIT. IT HAS  1 FEEDS,  11,   0,   0,   0,
                    AND  2 PRODUCTS,  12,  13,   0,   0,
PROCESS ELEMENT   9 IS A ADDR UNIT. IT HAS  2 FEEDS,  10,  12,   0,   0,
                    AND  1 PRODUCTS,  14,   0,   0,   0,
PROCESS ELEMENT  10 IS A BAS2 UNIT. IT HAS  1 FEEDS,  14,   0,   0,   0,
                    AND  1 PRODUCTS,  15,   0,   0,   0,
PROCESS ELEMENT  11 IS A BURN UNIT. IT HAS  1 FEEDS,  15,   0,   0,   0,
                    AND  1 PRODUCTS,  16,   0,   0,   0,
PROCESS ELEMENT  94 IS A PRNT UNIT. IT HAS  4 FEEDS,   4,   7,  13,  16,
                    AND  0 PRODUCTS,   0,   0,   0,   0,
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LEATHER
PAGE 2
TITLE WASTE TREATMENT SYSTEM:FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

COMPONENTS SPECIFIED FOR USE IN SIMULATION

COMPONENT NUMBER	COMPONENT NAME
1	1 HIDE
2	2 HIDE AREA
3	3 WEIGHT (DRY)
4	4 HAIR
5	5 DIRT
6	6 WATER
7	7 SALT
8	8 GREASE/FAT
9	9 FLESH
10	10 MANURE
11	11 CHROMIUM
12	12 H2SO4
13	13 LIME
14	14 DETERGENT
15	15 SULFITE
16	16 HYDROCHL ACID
17	17 NAOH
18	18 SOLUBLE N
19	19 OTHER CHEMICALS
20	20 BOD
21	21 LIQ. SUS SOLIDS
22	22 TOTAL FLOW
23	23 COMPONENT 23
24	24 COMPONENT 24
25	25 COMPONENT 25

SPECIFIED UNITS

INPUT TEMPERATURES ARE IN DEG F
OUTPUT TEMPERATURES ARE IN DEG F
INPUT PRESSURES ARE IN PSIA
OUTPUT PRESSURES ARE IN PSIA
TIME BASIS IS HR
OUTPUT ENERGY UNITS ARE USA
INPUT ENERGY UNITS ARE USA

RELATIVE RECYCLE TOLERANCE 0.00010
SPECIFIED MAXIMUM ITERATIONS 20
NUMBER OF RECYCLE STREAMS 0
NUMBER OF SEPARATE LOOPS 0

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LEATHER
PAGE  3
TITLE  WASTE TREATMENT SYSTEM;FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN


INPT    1
FORK    2
ORIGINAL COST     13800.00   SALVAGE VALUE        500.00   LIFE                 10.00
CAPACITY            375.00   WORKING HOUR/DAY      16.00   SPACE ALLOTTED      350.00
HIDES/LABORER       500.00   HIDES/PALLET           3.33


SOAK    3
ORIGINAL COST     18000.00   SALVAGE VALUE        500.00   LIFE                 20.00
CAPACITY           5000.00   SOAK TIME            240.00   % TOTAL TIME          0.80
SPACE              1500.00   RPM                   30.00   FLOAT                 6.78
TEMP. OF FLOAT      212.00   PH                    11.00   % DETERGENT           0.00
% SULFIDE             0.00   MANAGEMENT             0.25   FOREMAN               0.50
OPERATOR              0.50   LABORER                0.25   SHIFTS                1.00
% DIRT REMAINING      0.02   % WATER REMAINING      0.75   % SALT REMAINING      0.75


GRID    4
EQUI    5
CLAR    6
AIR2    7
FINAL CLARIFIER    8
ADDR    9
DIGT   10
SLAG   11
PRNT   94
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LEATHER
PAGE 6
TITLE WASTE TREATMENT SYSTEM:FURK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

FEED STREAMS TO UNIT

STREAM NUMBER	2
COMPONENT	
1 HIDE	1000.00
2 HIDE AREA	40.00
3 WEIGHT (DRY)	25.00
4 HAIR	0.50
5 DIRT	1.00
6 WATER	28.00
7 SALT	7.00
8 GREASE/FAT	0.0
9 FLESH	0.0
10 MANURE	0.25
11 CHROMIUM	0.0
12 H2SO4	0.0
13 LIME	0.0
14 DETERGENT	0.0
15 SULFITE	0.0
16 HYDROCHL ACID	0.0
17 NAOH	0.0
18 SOLUBLE N	0.0
19 OTHER CHEMICALS	1.25
20 BOD	0.90
21 LIQ. SUS SOLIDS	0.0
22 TOTAL FLOW	1.00
23 COMPONENT 23	1.00
24 COMPONENT 24	1.00
25 COMPONENT 25	1.00

LEATHER
PAGE 7
TITLE WASTE TREATMENT SYSTEM:FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

FORKLIFT*** 2 ***FORK

	FEEDS*********	PRODUCTS******
STREAM NUMBER	2	3
COMPONENT		
1 HIDE	1000.00	1000.00
2 HIDE AREA	40.00	40.00
3 WEIGHT (DRY)	25.00	25.00
4 HAIR	0.50	0.50
5 DIRT	1.00	1.00
6 WATER	28.00	28.00
7 SALT	7.00	7.00
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	0.25	0.25
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	0.0	0.0
15 SULFITE	0.0	0.0
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	1.25	1.25
20 BOD	0.90	0.90
21 LIQ. SLS SOLIDS	0.0	0.0
22 TOTAL FLOW	1.00	63.00
23 COMPONENT 23	1.00	1.00
24 COMPONENT 24	1.00	1.00
25 COMPONENT 25	1.00	1.00
TOTAL	1107.90	1169.90

FORKLIFT COMPUTATION OUTPUT 2***FORK

ITEM	NUMBER	UNITS	ORIGINAL COST	FIXED COSTS	VARIABLE COSTS	ANNUAL COSTS
FORKLIFT	1.0	EACH	13800.00	1617.73	1650.43	3268.16
FORKLIFT OPERATOR	1	MAN			10500.00	10500.00
LABORERS	2	MEN			20400.00	20400.00
BUILDING *	359.4	SQ.FT	6659.47	726.04	1299.09	2025.03
LAND COST	539.2	SQ.FT	18.57	2.41		2.41
PALLETS	500.3	EACH.	1900.90	277.53	520.85	798.38
TOTAL ANNUAL COSTS						36993.97

NOTE : BUILDING COST IS ASSOCIATED WITH FOLLOWING VARIABLES

MANUFACTURING SPACE = 350.0 SQ.FT, COST = $ 6300.0
OFFICE SPACE = 9.4 SQ.FT, COST = $ 283.5
OFFICE FURNITURE AND EQUIPMENTS COSTS = $ 76.0

FORKLIFT DEPRECIATION ROUTINE
ADEP=$ 1330.00, ATAX=$ 195.57, AREP=$ 320.43, SUR=$ 44.16, TER=$ 1380.00, YEAR= 10

BUILDING DEPRECIATION ROUTINE
ADEP=$ 456.31, ATAX=$ 38.78, AREP=$ 842.69, SUR=$ 21.31, TER=$ 665.95, YEAR= 11

LEATHER
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TITLE WASTE TREATMENT SYSTEM:FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

SOAK*** 3 ***SOAKER

	FEEDS**********	************	**PRODUCTS********	************
STREAM NUMBER	3	171	4	5
COMPONENT				
1 HIDE	1000.00	0.0	1000.00	0.0
2 HIDE AREA	40.00	0.0	40.00	0.0
3 WEIGHT (DRY)	25.00	0.0	25.00	0.0
4 HAIR	0.50	0.0	0.50	0.0
5 DIRT	1.00	0.0	0.02	980.00
6 WATER	28.00	406979.94	21.00	413979.94
7 SALT	7.00	0.0	5.25	1750.00
8 GREASE/FAT	0.0	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0	0.0
10 MANURE	0.25	0.0	0.0	250.00
11 CHROMIUM	0.0	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0	0.0
14 DETERGENT	0.0	12.00	0.0	12.00
15 SULFITE	0.0	9.00	0.0	9.00
16 HYDROCHL ACID	0.0	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0	0.0
19 OTHER CHEMICALS	1.25	0.0	0.0	1250.00
20 BOD	0.90	0.0	0.0	902.00
21 LIQ. SLS SOLIDS	0.0	0.0	0.0	1504.00
22 TOTAL FLOW	63.00	407000.87	51.77	418230.87
23 COMPONENT 23	1.00	0.0	0.0	1000.00
24 COMPONENT 24	1.00	0.0	0.0	1000.00
25 COMPONENT 25	1.00	0.0	0.0	1000.00
TOTAL	1159.90	814001.75	1143.54	841867.69

SOAKING COMPUTATION OUTPUT 3***SOAK

ITEM	NUMBER	UNITS	ORIGINAL COSTS	FIXED COSTS	VARIABLE COSTS	ANNUAL COSTS
MACHINE	6.00	EACH	108000.00	11920.13	22529.89	34450.02
MANAGEMENT	1.50	MEN		24480.00		24480.00
FOREMAN	3.00	MEN		36720.00		36720.00
OPERATOR	3.00	MEN			32130.00	32130.00
LABORER	1.50	MEN			15300.00	15300.00
DETERGENT	3060.00	LBS			1009.80	1009.80
SULFIDE	2295.00	LBS			5278.50	5278.50
HEATING	615746.37	KWH			17240.90	17240.90
PLUMBING COST			24000.00	2160.00	2400.00	2400.00
WIRE COST			22290.00	2229.00	2006.10	4235.10
BUILDING *	9243.00	SQ.FT	171243.62	18669.52	33402.80	52072.32
LAND COST	13864.49	SQ.FT	477.43	62.07		62.07
WATER	103779872.	LBS			4978.64	4978.64
TOTAL ANNUAL COSTS						230357.25

NOTE : BUILDING COST IS ASSOCIATED WITH FOLLOWING VARIABLES

MANUFACTURING SPACE = 9000.0 SQ.FT, COST = $ 162000.0
OFFICE SPACE = 243.0 SQ.FT, COST = $ 7290.0
OFFICE FURNITURE AND EQUIPMENTS COSTS = $ 1953.7

SOAKING MACHINE DEPRECIATION ROUTINE
ADEP=$ 1278.84 ATAX=$ 129.09 AREP=$ 2476.14 SUR=$ 57.60 TER=$ 1800.00 YEAR=13

BUILDING DEPRECIATION ROUTINE
ADEP=$11733.66 ATAX=$ 997.18 AREP=$21669.13 SUR=$ 547.98 TER=$17124.36 YEAR=11

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TITLE WASTE TREATMENT SYSTEM:FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

SCREEN*** 4 ***SCREENS

	FEEDS*********PRODUCTS*******************		
STREAM NUMBER	5	6	7
COMPONENT			
1 HIDE	0.0	0.0	0.0
2 HIDE AREA	0.0	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0	0.0
4 HAIR	0.0	0.0	0.0
5 DIRT	980.00	490.00	490.00
6 WATER	413979.94	393280.87	20699.00
7 SALT	1750.00	1400.00	350.00
8 GREASE/FAT	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0
10 MANURE	250.00	225.00	25.00
11 CHROMIUM	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0
14 DETERGENT	12.00	10.80	1.20
15 SULFITE	9.00	8.10	0.90
16 HYDROCHL ACID	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0
19 OTHER CHEMICALS	1250.00	1125.00	125.00
20 BOD	902.00	766.70	135.30
21 LIQ. SUS SOLIDS	1504.00	225.60	1278.40
22 TOTAL FLOW	418230.87	396539.56	21691.09
23 COMPONENT 23	1000.00	0.0	1000.00
24 COMPONENT 24	1000.00	0.0	1000.00
25 COMPONENT 25	1000.00	0.0	1000.00
TOTAL	841867.69	794071.37	47795.87

CAPITAL COST = $ 371.44

O&M COSTS = $ 15325.70

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TITLE WASTE TREATMENT SYSTEM:FURK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

CENTRIFUGE*** 5 ***EQUILIZATION BASIN

	FEEDS*********	PRODUCTS******
STREAM NUMBER	6	8
COMPONENT		
1 HIDE	0.0	0.0
2 HIDE AREA	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0
4 HAIR	0.0	0.0
5 DIRT	490.00	490.00
6 WATER	393280.87	393280.87
7 SALT	1400.00	1400.00
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	225.00	225.00
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	10.80	10.80
15 SULFITE	8.10	8.10
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	1125.00	1125.00
20 BOD	766.70	766.70
21 LIQ. SUS SOLIDS	225.60	225.60
22 TOTAL FLOW	396539.56	396539.56
23 COMPONENT 23	0.0	0.0
24 COMPONENT 24	0.0	0.0
25 COMPONENT 25	0.0	0.0
TOTAL	794071.37	794071.37

AREA	1955.05	SQ FT.
VOLUME	19550.45	CU FT.
CAPT COST	41833.73	DOLLARS
OP LBR COST.	1903.67	DOLLARS
MN LBR COST	288.08	DOLLARS
POWER COSTS	2780.26	DOLLARS
MATERIAL COST	341.01	DOLLARS

LEATHER
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TITLE WASTE TREATMENT SYSTEM;FURR,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

VACUUM FILTER*** 6 ***PRIMARY CLARIFIER

	FEEDS*********	PRODUCTS******	**************
STREAM NUMBER	8	9	10
COMPONENT			
1 HIDE	0.0	0.0	0.0
2 HIDE AREA	0.0	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0	0.0
4 HAIR	0.0	0.0	0.0
5 DIRT	490.00	490.00	0.0
6 WATER	393280.87	393088.12	192.75
7 SALT	1400.00	1400.00	0.0
8 GREASE/FAT	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0
10 MANURE	225.00	225.00	0.0
11 CHROMIUM	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0
14 DETERGENT	10.80	10.80	0.0
15 SULFITE	8.10	8.10	0.0
16 HYDROCHL ACID	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0
19 OTHER CHEMICALS	1125.00	1125.00	0.0
20 BOD	766.70	492.90	273.80
21 LIQ. SUS SOLIDS	225.60	129.30	96.30
22 TOTAL FLOW	396539.56	396346.81	192.75
23 COMPONENT 23	0.0	0.0	0.0
24 COMPONENT 24	0.0	0.0	0.0
25 COMPONENT 25	0.0	0.0	0.0
TOTAL	794071.37	793315.75	755.60

CAPITAL COST = $ 15627.00

OPR. LABOR COST = $ 481.46

MNT. LABOR COST = $ 264.82

MATERIAL COST = $ 87.06

LEATHER
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TITLE WASTE TREATMENT SYSTEM:FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

BACTERIA AERATION*** 7 ***AERATION BASIN

	FEEDS*********	PRODUCTS******
STREAM NUMBER	9	11
COMPONENT		
1 HIDE	0.0	0.0
2 HIDE AREA	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0
4 HAIR	0.0	0.0
5 DIRT	490.00	490.00
6 WATER	393068.12	472357.37
7 SALT	1400.00	1400.00
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	225.00	225.00
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	10.80	10.80
15 SULFITE	8.10	0.0
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	1125.00	1125.00
20 BOD	492.90	191.88
21 LIQ. SLS SOLIDS	129.30	635.18
22 TOTAL FLOW	396346.81	475616.06
23 COMPONENT 23	0.0	0.0
24 COMPONENT 24	0.0	0.0
25 COMPONENT 25	0.0	0.0
TOTAL	793315.75	952051.06

***** COST FOR MECHANICAL AERATION *****

CAPITAL COST	17593.68	DOLLARS
MANHOURS	671.55	MANHOURS
LABOR COST	5540.32	DOLLARS
POWER COST	1651.79	DOLLARS
MATERIALS	224.63	DOLLARS

***** COSTS FOR DIFFUSED AERATION *****

CAPITAL COST	37923.10	DOLLARS
MANHOURS	744.78	MANHOURS
LABOR COST	6144.45	DOLLARS
POWER COST	1334.86	DOLLARS
MATERIALS	224.63	DOLLARS

LEATHER
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TITLE WASTE TREATMENT SYSTEM;FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

SOLID SETTLING BASIN*** 8 ***FINAL CLARIFIER

	FEEDS*********PRODUCTS********************		
STREAM NUMBER	11	12	13
COMPONENT			
1 HIDE	0.0	0.0	0.0
2 HIDE AREA	0.0	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0	0.0
4 HAIR	0.0	0.0	0.0
5 DIRT	490.00	0.0	490.00
6 WATER	472357.37	3215.75	469141.56
7 SALT	1400.00	0.0	1400.00
8 GREASE/FAT	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0
10 MANURE	225.00	0.0	225.00
11 CHROMIUM	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0
14 DETERGENT	10.80	0.0	10.80
15 SULFITE	0.0	0.0	0.0
16 HYDROCHL ACID	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0
19 OTHER CHEMICALS	1125.00	0.0	1125.00
20 BOD	191.88	28.78	163.10
21 LIQ. SUS SOLIDS	635.18	128.53	506.66
22 TOTAL FLOW	475616.06	3215.75	472392.19
23 COMPONENT 23	0.0	0.0	0.0
24 COMPONENT 24	0.0	0.0	0.0
25 COMPONENT 25	0.0	0.0	0.0
TOTAL	952051.06	6588.81	945454.06

CAPITAL COST	15882.87	DOLLARS
OPR LABOR HOURS	59.36	MANHOURS
OPR LABOR COST	489.72	DOLLARS
MNT LABOR HOURS	32.65	MANHOURS
MNT LABOR COST	269.35	DOLLARS
MATERIALS	88.85	DOLLARS

TITLE WASTE TREATMENT SYSTEM;FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

STREAM ADDER*** 9 ***FLOOR DRAIN

	FEEDS***********************		PRODUCTS******
STREAM NUMBER	10	12	14
COMPONENT			
1 HIDE	0.0	0.0	0.0
2 HIDE AREA	0.0	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0	0.0
4 HAIR	0.0	0.0	0.0
5 DIRT	0.0	0.0	0.0
6 WATER	192.75	3215.75	3408.50
7 SALT	0.0	0.0	0.0
8 GREASE/FAT	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0
10 MANURE	0.0	0.0	0.0
11 CHROMIUM	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0
14 DETERGENT	0.0	0.0	0.0
15 SULFITE	0.0	0.0	0.0
16 HYDROCHL ACID	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0
19 OTHER CHEMICALS	0.0	0.0	0.0
20 BOD	273.80	28.78	302.58
21 LIQ. SUS SOLIDS	96.30	128.53	224.83
22 TOTAL FLOW	192.75	3215.75	3408.50
23 COMPONENT 23	0.0	0.0	0.0
24 COMPONENT 24	0.0	0.0	0.0
25 COMPONENT 25	0.0	0.0	0.0
TOTAL	755.60	6588.81	7344.41

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TITLE WASTE TREATMENT SYSTEM;FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

BACTERIA BASIN*** 10 ***DIGESTOR

FEEDS*********PRODUCTS******

STREAM NUMBER	14	15
COMPONENT		
1 HIDE	0.0	0.0
2 HIDE AREA	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0
4 HAIR	0.0	0.0
5 DIRT	0.0	0.0
6 WATER	3408.50	2437.57
7 SALT	0.0	0.0
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	0.0	0.0
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	0.0	0.0
15 SULFITE	0.0	0.0
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	0.0	0.0
20 BOD	302.58	302.58
21 LIQ. SUS SOLIDS	224.83	146.14
22 TOTAL FLOW	3408.50	2437.57
23 COMPONENT 23	0.0	0.0
24 COMPONENT 24	0.0	0.0
25 COMPONENT 25	0.0	0.0
TOTAL	7344.41	5323.86

VOLUME OF DIGESTOR	1639.14	CU FT.
CAPITAL COST	114657.62	DOLLARS
OPR LABOR	813.01	MANHOURS
OPR LABOR COST	6707.32	DOLLARS
MNT LABOR	545.83	MANHOURS
MNT LABOR COST	4503.07	DOLLARS
MATERIALS	310.85	DOLLARS

TITLE WASTE TREATMENT SYSTEM;FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

BURIAL OR BURNIG*** 11 ***SLUDGE LAGOON

	FEEDS*********PRODUCTS******	
STREAM NUMBER	15	16
COMPONENT		
1 HIDE	0.0	0.0
2 HIDE AREA	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0
4 HAIR	0.0	0.0
5 DIRT	0.0	0.0
6 WATER	2437.57	2437.57
7 SALT	0.0	0.0
8 GREASE/FAT	0.0	0.0
9 FLESH	0.0	0.0
10 MANURE	0.0	0.0
11 CHROMIUM	0.0	0.0
12 H2SO4	0.0	0.0
13 LIME	0.0	0.0
14 DETERGENT	0.0	0.0
15 SULFITE	0.0	0.0
16 HYDROCHL ACID	0.0	0.0
17 NAOH	0.0	0.0
18 SOLUBLE N	0.0	0.0
19 OTHER CHEMICALS	0.0	0.0
20 BOD	302.58	302.58
21 LIQ. SUS SOLIDS	146.14	146.14
22 TOTAL FLOW	2437.57	2437.57
23 COMPONENT 23	0.0	0.0
24 COMPONENT 24	0.0	0.0
25 COMPONENT 25	0.0	0.0
TOTAL	5323.86	5323.86

CAPITAL COST	13410.16	DOLLARS
MNT MANHOURS	73.58	MANHOURS
MNT LABOR COST	607.03	DOLLARS
OPR MANHOURS	49.05	MANHOURS
OPR LABOR COST	404.68	DOLLARS
MATERIALS	663.03	DOLLARS

LEATHER
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TITLE WASTE TREATMENT SYSTEM;FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

PROCESS STREAMS LEAVING THE UNIT

STREAM NUMBER COMPONENT	4	7	13	16
1 HIDE	1000.00	0.0	0.0	0.0
2 HIDE AREA	40.00	0.0	0.0	0.0
3 WEIGHT (DRY)	25.00	0.0	0.0	0.0
4 HAIR	0.50	0.0	0.0	0.0
5 DIRT	0.02	490.00	490.00	0.0
6 WATER	21.00	20699.00	469141.56	2437.57
7 SALT	5.25	350.00	1400.00	0.0
8 GREASE/FAT	0.0	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0	0.0
10 MANURE	0.0	25.00	225.00	0.0
11 CHROMIUM	0.0	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0	0.0
14 DETERGENT	0.0	1.20	10.80	0.0
15 SULFITE	0.0	0.90	0.0	0.0
16 HYDROCHL ACID	0.0	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0	0.0
19 OTHER CHEMICALS	0.0	125.00	1125.00	0.0
20 BOD	0.0	135.30	163.10	302.58
21 LIQ. SUS SOLIDS	0.0	1278.40	506.66	146.14
22 TOTAL FLOW	51.77	21691.09	472392.19	2437.57
23 COMPONENT 23	0.0	1000.00	0.0	0.0
24 COMPONENT 24	0.0	1000.00	0.0	0.0
25 COMPONENT 25	0.0	1000.00	0.0	0.0

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TITLE WASTE TREATMENT SYSTEM:FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

HEAT AND MATERIAL BALANCE SHEETS

STREAM NUMBER / COMPONENT	2	3	4	5	6
1 HIDE	1000.00	1000.00	1000.00	0.0	0.0
2 HIDE AREA	40.00	40.00	40.00	0.0	0.0
3 WEIGHT (DRY)	25.00	25.00	25.00	0.0	0.0
4 HAIR	0.50	0.50	0.50	0.0	0.0
5 DIRT	1.00	1.00	0.02	980.00	490.00
6 WATER	28.00	28.00	21.00	413979.94	393280.87
7 SALT	7.00	7.00	5.25	1750.00	1400.00
8 GREASE/FAT	0.0	0.0	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0	0.0	0.0
10 MANURE	0.25	0.25	0.0	250.00	225.00
11 CHROMIUM	0.0	0.0	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0	0.0	0.0
14 DETERGENT	0.0	0.0	0.0	12.00	10.80
15 SULFITE	0.0	0.0	0.0	9.00	8.10
16 HYDROCHL ACID	0.0	0.0	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0	0.0	0.0
19 OTHER CHEMICALS	1.25	1.25	0.0	1250.00	1125.00
20 BOD	0.90	0.90	0.0	902.00	766.70
21 LIQ. SUS SOLIDS	0.0	0.0	0.0	1504.00	225.60
22 TOTAL FLOW	1.00	63.00	51.77	418230.87	396539.56
23 COMPONENT 23	1.00	1.00	0.0	1000.00	0.0
24 COMPONENT 24	1.00	1.00	0.0	1000.00	0.0
25 COMPONENT 25	1.00	1.00	0.0	1000.00	0.0

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TITLE WASTE TREATMENT SYSTEM;FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

HEAT AND MATERIAL BALANCE SHEETS

STREAM NUMBER COMPONENT	7	8	9	10	11
1 HIDE	0.0	0.0	0.0	0.0	0.0
2 HIDE AREA	0.0	0.0	0.0	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0	0.0	0.0	0.0
4 HAIR	0.0	0.0	0.0	0.0	0.0
5 DIRT	490.00	490.00	490.00	0.0	490.00
6 WATER	20699.00	393280.87	393088.12	192.75	472357.37
7 SALT	350.00	1400.00	1400.00	0.0	1400.00
8 GREASE/FAT	0.0	0.0	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0	0.0	0.0
10 MANURE	25.00	225.00	225.00	0.0	225.00
11 CHROMIUM	0.0	0.0	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0	0.0	0.0
14 DETERGENT	1.20	10.80	10.80	0.0	10.80
15 SULFITE	0.90	8.10	8.10	0.0	0.0
16 HYDROCHL ACID	0.0	0.0	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0	0.0	0.0
19 OTHER CHEMICALS	125.00	1125.00	1125.00	0.0	1125.00
20 BOD	135.30	766.70	492.90	273.80	191.88
21 LIQ. SUS SOLIDS	1278.40	225.60	129.30	96.30	635.18
22 TOTAL FLOW	21691.09	396539.56	396346.81	192.75	475616.06
23 COMPONENT 23	1000.00	0.0	0.0	0.0	0.0
24 COMPONENT 24	1000.00	0.0	0.0	0.0	0.0
25 COMPONENT 25	1000.00	0.0	0.0	0.0	0.0

TITLE WASTE TREATMENT SYSTEM:FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

HEAT AND MATERIAL BALANCE SHEETS

STREAM NUMBER COMPONENT	12	13	14	15	16
1 HIDE	0.0	0.0	0.0	0.0	0.0
2 HIDE AREA	0.0	0.0	0.0	0.0	0.0
3 WEIGHT (DRY)	0.0	0.0	0.0	0.0	0.0
4 HAIR	0.0	0.0	0.0	0.0	0.0
5 DIRT	0.0	490.00	0.0	0.0	0.0
6 WATER	3215.75	469141.56	3408.50	2437.57	2437.57
7 SALT	0.0	1400.00	0.0	0.0	0.0
8 GREASE/FAT	0.0	0.0	0.0	0.0	0.0
9 FLESH	0.0	0.0	0.0	0.0	0.0
10 MANURE	0.0	225.00	0.0	0.0	0.0
11 CHROMIUM	0.0	0.0	0.0	0.0	0.0
12 H2SO4	0.0	0.0	0.0	0.0	0.0
13 LIME	0.0	0.0	0.0	0.0	0.0
14 DETERGENT	0.0	10.80	0.0	0.0	0.0
15 SULFITE	0.0	0.0	0.0	0.0	0.0
16 HYDROCHL ACID	0.0	0.0	0.0	0.0	0.0
17 NAOH	0.0	0.0	0.0	0.0	0.0
18 SOLUBLE N	0.0	0.0	0.0	0.0	0.0
19 OTHER CHEMICALS	0.0	1125.00	0.0	0.0	0.0
20 BOD	28.78	163.10	302.58	302.58	302.58
21 LIQ. SUS SOLIDS	128.53	506.66	224.83	146.14	146.14
22 TOTAL FLOW	3215.75	472392.19	3408.50	2437.57	2437.57
23 COMPONENT 23	0.0	0.0	0.0	0.0	0.0
24 COMPONENT 24	0.0	0.0	0.0	0.0	0.0
25 COMPONENT 25	0.0	0.0	0.0	0.0	0.0

TITLE WASTE TREATMENT SYSTEM;FORK,SOAK,GRID,EQUI,FILT,AIR2,ADDR,BAS1,BAS2,BURN

HEAT AND MATERIAL BALANCE SHEETS

STREAM NUMBER	171
COMPONENT	
1 HIDE	0.0
2 HIDE AREA	0.0
3 WEIGHT (DRY)	0.0
4 HAIR	0.0
5 DIRT	0.0
6 WATER	406979.94
7 SALT	0.0
8 GREASE/FAT	0.0
9 FLESH	0.0
10 MANURE	0.0
11 CHROMIUM	0.0
12 H2SO4	0.0
13 LIME	0.0
14 DETERGENT	12.00
15 SULFITE	9.00
16 HYDROCHL ACID	0.0
17 NAOH	0.0
18 SOLUBLE N	0.0
19 OTHER CHEMICALS	0.0
20 BOD	0.0
21 LIQ. SUS SOLIDS	0.0
22 TOTAL FLOW	407000.87
23 COMPONENT 23	0.0
24 COMPONENT 24	0.0
25 COMPONENT 25	0.0

APPENDIX H

GREEN HIDE BELT

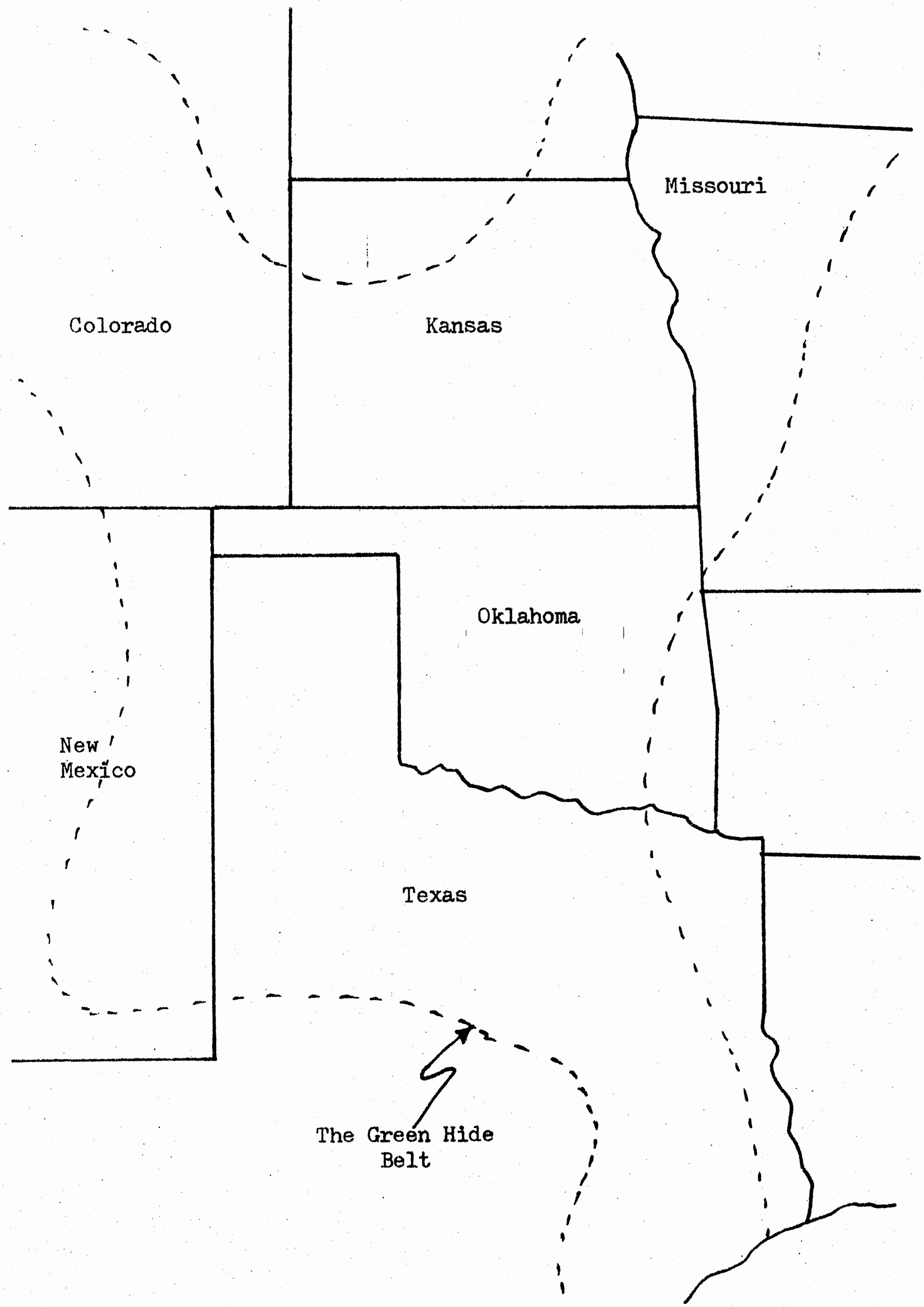

Figure 11. The Green Hide Belt

APPENDIX I

OVERALL SYSTEM MODEL

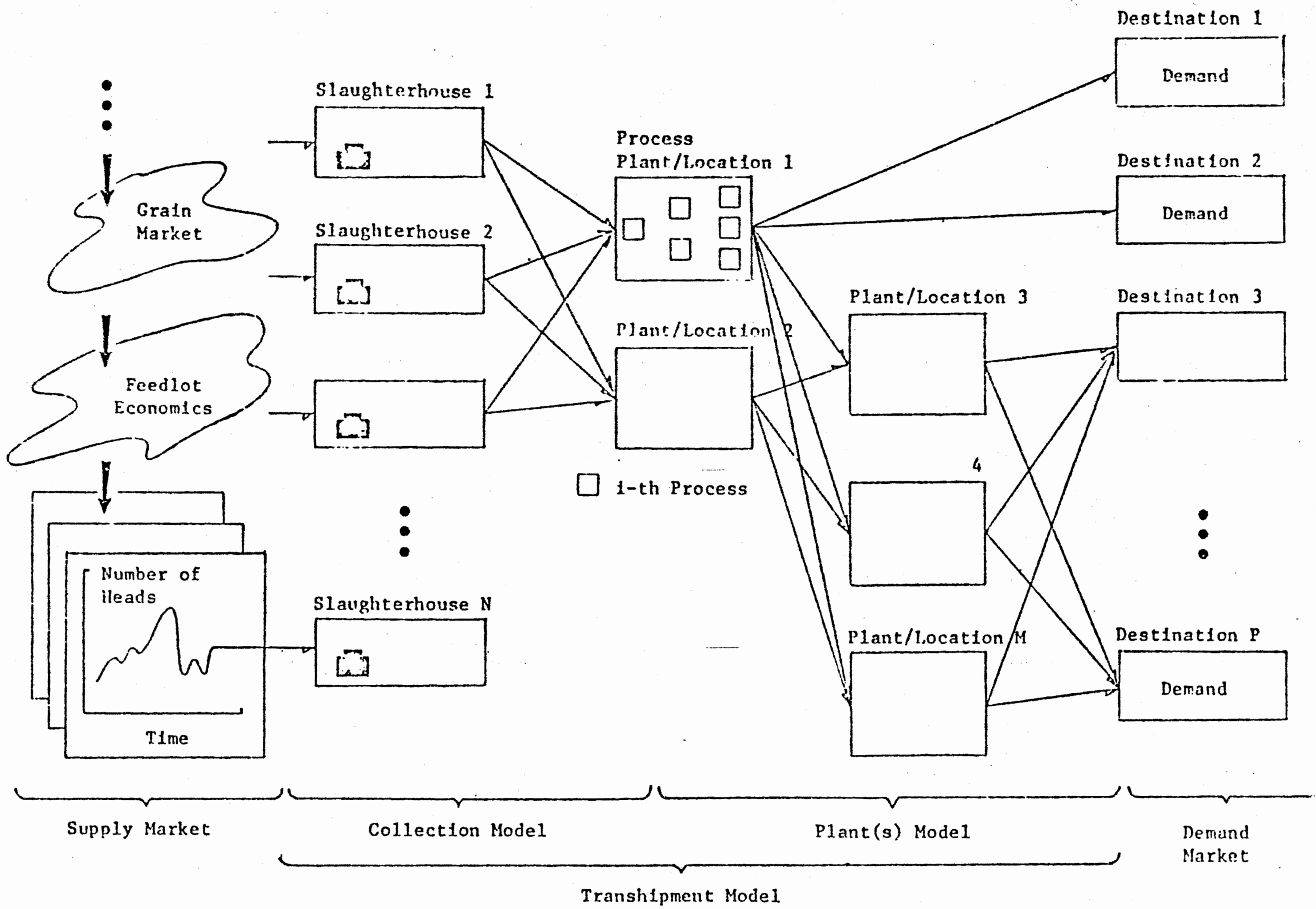

Figure 12. Overall System Model

VITA[2]

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Candidate for the Degree of

Master of Science

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