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APPENDIX IV.
DOCUMENTATION
USER'S GUIDE FOR TREATMENT SYSTEM AND
INDICATOR MODEL.

(10) Thomas M. Keinath
Roger Smith

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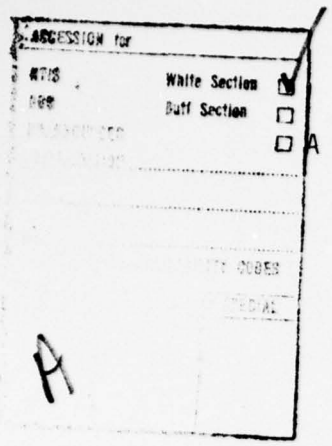

A SYSTEMS ANALYSIS OF WATER QUALITY SURVEY DESIGN

Documentation of the Treatment
System and Indicator Models
User's Guide
Appendix IV

Authors: Dr. T.M. Keinath, Mr. Roger Smith

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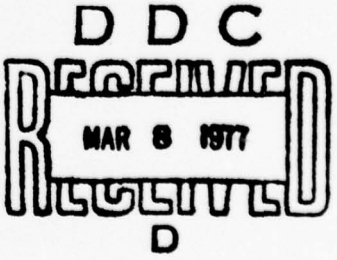

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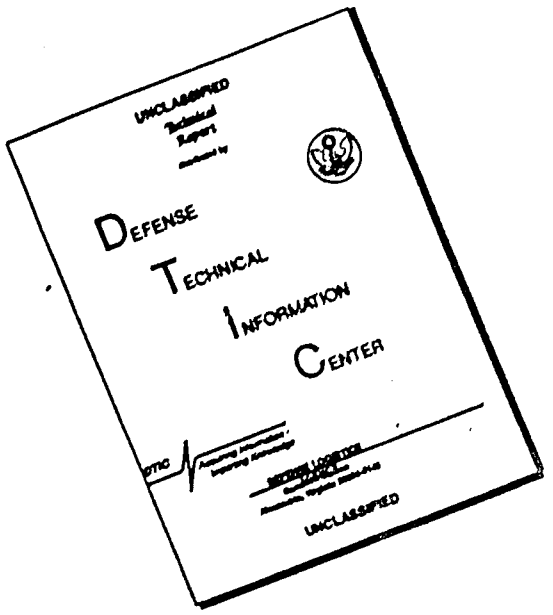

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is the final report of a three year project titled, "A Systems Analysis of Water Quality Survey Design."

In this project a study was made of water quality surveys conducted by the United States Army Environmental Hygiene Agency (AEHA). Mainly data and reports from studies of Army Ammunition Plants (AAP) were used.

The focus of this project was the development of computer aided procedures which would assure efficient use of manpower and equipment and assure that the measurements taken give a reasonalbe representation of the system. Planning the

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survey, conducting the survey and reporting on the survey were included in the study.

The site modeling program models the manufacturing processes which contribute pollutants to the system, models the sewer system, and models the treatment system including acid or caustic neutralization, settling ponds, and domestic treatment. The inputs to the model are the production levels of the manufacturing processes and the outputs are the predicted pollutant measurement values at each possible measure point in the system.

The resource matching program accepts data defining proposed measurements and matches these against the available time, manpower, and equipment. The output lists the pollutant to be measured at each measure point, the total commitment of time for each analyst and for each piece of equipment. Note is made of any overcommitment of manpower or equipment.

The model refinement or updating program accepts measurements taken during a preliminary survey or during a regular survey and computes suggested new parameters for the process models.

The indicator model program evaluates the performance of sanitary treatment facilities.

The program uses design data, data from the operating log and/or data generated during the survey and computes key operational characteristics. Comparing these with desirable values as cited in design books and manuals will give the survey planner insight into the operation of the system and suggest the need for more survey measurements or the need for changes in operation.

A system was developed for automatic instrumentation of pH, conductivity, and other parameters which use strip charp recordings. Interface hardware was selected and purchased and interface software was developed for direct connection to a digital computer.

A data handling system was developed for use during and after the survey. A PDP8-OS/8 and peripheral equipment was purchased. Software was developed to perform data handling functions and to direct the user in application of the software. The program accepts raw data from the analytical chemist and performs data conversions, transcriptions, and data logging functions. Output is available in several forms as may be needed for various reports during and at the end of the survey.

Recommendations are: the survey planner should obtain sufficient data in a proliminary survey to model and analyze the site; measurements should be automated to the maximum extent possible; data handling should be delegated to the computer when the operations are well defined and repetitive. The programs, software and hardware included here will assist the survey planner in following these recommendations and design a more effective survey.

ABSTRACT

The U.S. Army Environmental Hygiene Agency's Sanitary Engineer is tasked with making decisions in a wide variety of water and wastewater treatment areas. To assist him in two of these areas, this project was undertaken with an objective of developing some computer tools with the engineer in mind.

Estimation of a wastewater treatment plant's capability to cope with an increased load due to a post's expansion is the first area. Given the approximate character of the wastewater resulting from a post's expansion, a steady-state model of the treatment process is used to predict the character of the treatment plant's effluent. Some guidance is thus provided to to the engineer in determining the present treatment scheme's ability to provide adequate treatment after expansion.

The other area in which aid is provided is in the direction and analysis of the water quality engineering special study or "survey". Utilizing design and operational data, a computer model evaluates the operational characteristics of the system. Evaluation may be accomplished with operational data available before the survey and with the data generated by the survey. Operational characteristics calculated are then used by the engineer to evaluate the system's operational condition and to then plan and conduct the survey.

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wastewater plant serving the installation will experience fluctuations in loading. In addition to these changes in personnel strength, many other adjustments to the operation of the post can have dramatic effects on the loading of the wastewater treatment plant.

Projecting the effect of such new loadings on a wastewater treatment facility, the sanitary engineer must make decisions as to what physical or operational changes may be required to ensure continued satisfactory plant performance. Estimates of the new loading produced by the population or other changes can be made by the engineer using one of the several methods available in the sanitary engineering literature. An estimate of the future loadings in itself, nonetheless, does not establish the plant's ability to perform satisfactorily under the new loading. The new loading estimate, however, can be used as an input to a computer model of the treatment plant to predict the plant's future performance. Such predictions can be employed by the sanitary engineer in formulating a plan of action to meet future requirements. The model will not give exact predictions of the plant effluent. If the engineer is cognizant of this fact, however, the model will serve as a valuable aid in the decision making process.

The TSM simulates two basic types of treatment systems: those employing either (1) a trickling filter, or (2) an activated sludge system. These two types were chosen because of their prevalent use at U.S. Army installations.

Indicator Model

Analysis of the operation of wastewater treatment plants is a necessity

when increased loadings are expected. Of equal importance is the surveillance and evaluation of a plant's routine operations. Subsequent recommendations regarding process modifications ensure continued satisfactory performance. Consequently, a detailed examination of the system's operational condition is periodically required. This is accomplished by the sanitary engineer through the water quality engineering special study or "survey".

In preparation for a survey, the sanitary engineer or "survey officer" must decide on the protocol for the survey, that is, what water quality parameters are of most interest and where in the system do they need to be determined. This is, of course, predicated on what information is needed to describe the operational state of the system. Models have been developed by others for this purpose. In particular, there are the Process, Topology, and Resource Matching Models developed by the Clemson University Department of Electrical and Computer Engineering. One feature of the Topology model is the provision allowing the survey officer to flag for measurement during the survey, any particular water quality parameter at any point in the system. Flaging in this manner usually is done when the survey officer "feels" a particular parameter may have a significant effect upon the overall operational state of the system.

A preliminary evaluation of the process variables of a treatment plant will provide an initial estimate of its operational state. These process variables, such as weir overflow rates and process loading intensity, are functions of the design and operation of the treatment plant and the character of the wastewater. Thus, a preliminary evaluation of the process

variables will indicate possible areas where stress on the plant exists. The survey officer then determines whether certain key parameters should be flaged and whether measurements within the wastewater treatment plant should be made during the survey.

After completion of the survey, the survey officer must analyze the data collected. This analysis results in the final determination of the treatment plant's operational condition and forms a basis for the survey officer's recommendations to improve treatment plant performance. Again, evaluation of the process variables, this time using the data generated by the survey, will assist the survey officer in determining the plant's operational condition. These variables will indicate areas where design or operational inadequacies exist which may be the cause of unsatisfactory plant performance. Trouble spots in the system can, therefore, be pinpointed. Also, the survey officer can determine, through analysis of the process variables, what remedial action will likely improve plant performance.

The Indicator Model was developed to evaluate these process variables for two types of wastewater treatment systems: trickling filter and activated sludge type of plants. The model can be used to compute the process variables utilizing preliminary operational data that is available prior to the inception of the survey or the operations data generated during the survey.

II TREATMENT SYSTEM MODEL

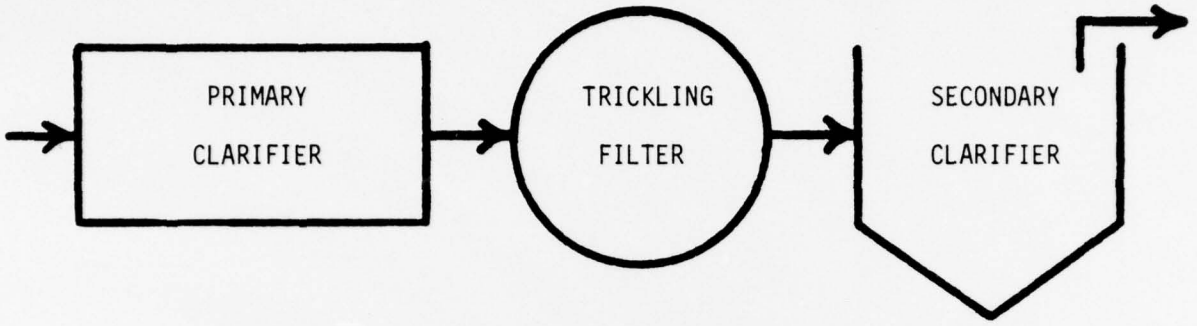
Introduction

A wide variety of computer models have been developed to simulate different wastewater treatment systems. Both steady state and dynamic models have been proposed. While the steady state model does not represent the transient operation of a process and, as such, is generally more simplistic than the dynamic model, it does give an estimate of a process' long-term performance. Since this long-term estimate is what the model is intended to provide, the steady state approach has been used in this development. To quote Andrews [12]:

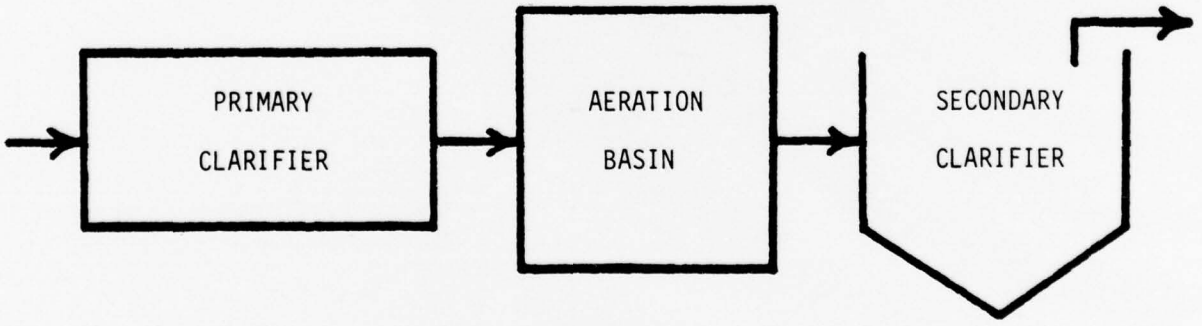
> ...the simplest possible expression should be used. The purposes for which the model is to be used must be defined so that one can be developed which is adequate for the intended use. Mathematical elegance should be secondary and it should be remembered that a model which is too complex may be subject to either misuse or disuse.

Model Formulation

Actually, the overall model which has been developed is a combination of several steady state process models. All the unit processes that are included in the system have been modeled and linked one to another. These include: primary clarification, secondary clarification, the trickling filter, and the activated sludge process. As mentioned before, these unit processes are grouped into two basic treatment trains, one incorporating the trickling filter while the other includes the activated sludge process (see Figure 1).



a. TRICKLING FILTER TRAIN



b. ACTIVATED SLUDGE TRAIN

Figure 1: BASIC TREATMENT TRAINS

Complex interactions between unit processes are not explicitly considered in the formulation of the model. Again, this is not necessary for the intended use of this treatment system model. A more detailed explanation of these complex interactions may be found in the sections dealing with the two treatment trains.

Water Quality Evaluation

Trickling filter and activated sludge systems are both biological processes, *i.e.*, they employ microorganisms to assimilate and metabolize the pollutants in the wastewater. As such, these two systems can only be used to treat biodegradable wastes such as "domestic" wastes and certain types of industrial wastes. To establish the quality of these wastes, a number of water quality parameters have been used in the past.

Four such parameters are most commonly used by sanitary engineers, not only to indicate the wastewater quality, but also to determine the amount of treatment accorded the wastewater by the treatment system. These parameters are as follows: 1) five-day biochemical oxygen demand (BOD_5); 2) suspended solids (SS); 3) ammonia; and 4) nitrates. Given the influent levels of these four water quality parameters and the influent flow rate, the model predicts their respective concentrations in the effluent of a treatment plant.

Performance of each unit process which is incorporated in the treatment train is described by a mathematical expression. The expression is used to calculate the values of the water quality parameters in the effluent of the process. These values then become the input to the next unit process in the

treatment train. The output conditions calculated for the last unit process in the treatment train become the plant's effluent conditions.

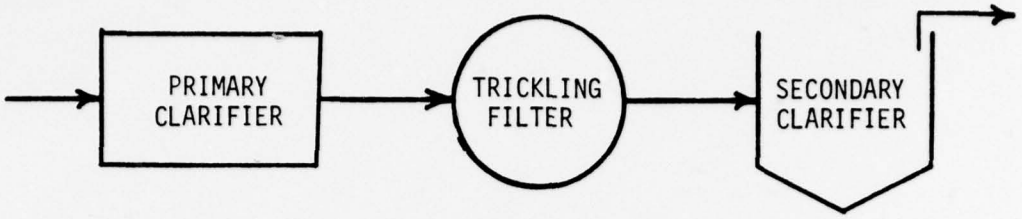
Effects of Process Dynamics

Since the TSM is a steady state model, the influent and predicted effluent concentrations must, of necessity, be averages. If the influent flow rate or concentrations are known to fluctuate drastically, the steady state model predictions are less accurate. The engineer must consider this fact when applying the model and when interpreting the results of the model.

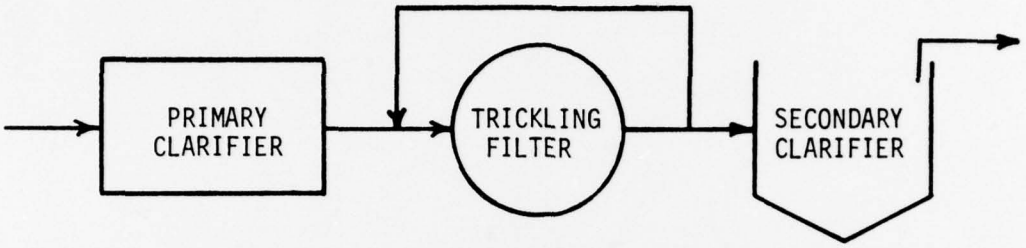
Trickling Filter System

Wastewater treatment systems utilizing the trickling filter can take on many different configurations depending on whether the filters are staged and on the recycle pattern. The model presented here allows for three distinct variations. All three are for single-stage filters, *i.e.*, filters in a parallel but not in series. The first is for no recycle; the second for recycle from the filter effluent; and the third for recycle from the secondary clarifier effluent (see Figures 2 a,b,c).

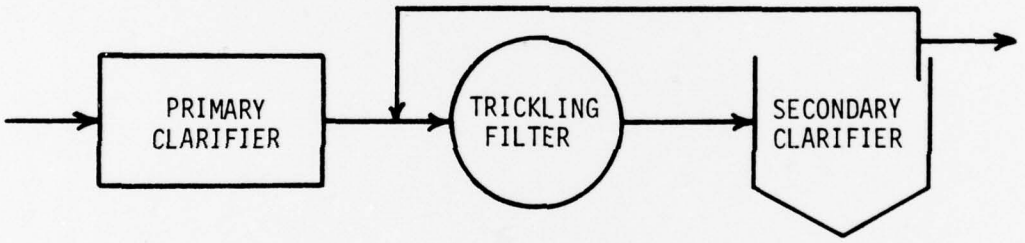
The type of system modeled is controlled by specification of a recirculation data input to the model. If both of the recycle terms are initialized at zero, then a no recycle system is specified. (Figure 2a). If the recycle to the filter is not zero, but recycle from the filter effluent is, then a system with recycle from the secondary clarifier will be modeled (Figure 2c).



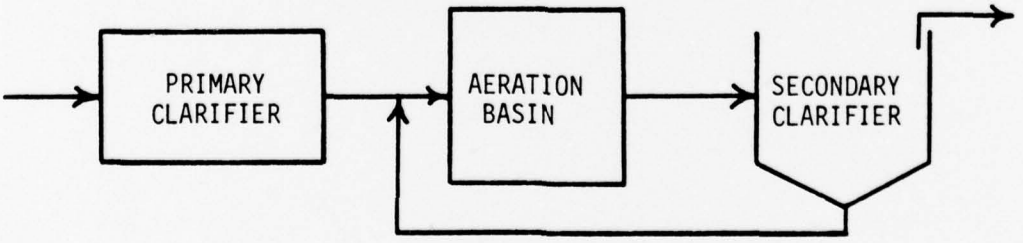
a. Trickling Filter: No Recycle



b. Trickling Filter: Recycle from Trickling Filter Effluent



c. Trickling Filter: Recycle from Secondary Clarifier Effluent



d. Activated Sludge System

Figure 2: Schematic of Treatment Systems

Finally, if the recycle flow rate from the filter is equal to the recycle flow rate to the filter and is not equal to zero, the model simulates a system where recycle is from the filter effluent (Figure 2b).

Other Considerations

Factors which may effect the operation of the system but are not incorporated in the formulation of the model include the effect of the trickling filter media type on the BOD reduction; certain complex interactions between the unit processes; and the additional hydraulic and solids loading imposed on the primary clarifier by wasting secondary sludge to the primary clarifier influent.

One example of complex interactions between unit processes is the effect of the primary clarifier on the performance of the trickling filter. The model predicts the case in which the primary clarifier is overloaded thereby permitting large suspended solids carryover. Conversely, the model does not account for the situation if the high solids concentration in the trickling filter influent were to clog the filter or otherwise degrade its performance. While the exclusion of these and other considerations may result in minor errors, such errors are usually negligible. With an understanding of the structure of the model, as just presented, and a knowledge of the mathematical relationships incorporated in the model, the engineer can utilize the present trickling filter system model to great advantage or modify it to more suitably fit his needs.

Mathematical Relationships

A listing of the expressions that were used in forming the overall model of the trickling filter system follows. These relationships are used to evaluate the operation of the unit processes.

Primary Clarifier[1]

$$RF = \frac{1.0 - 0.82EXP(-Q/2780A)}{1.0 - 0.00205EXP(-Q/2780A)}$$

RF = Removal factor
Q = Plant flow (MGD)
A = Total surface area of clarifier (acres)

$$SS_{out} = SS_{in} * RF$$

$$BOD_{out} = (BOD_{in})(0.3) + (BOD_{in})(RF)(0.7)$$

No effect on ammonia or nitrates

Trickling Filter

BOD reduction [2]

$$E = \frac{1.0}{1.0+0.0085\left(\frac{W}{VF}\right)^{\frac{1}{2}}}$$

E = Decimal BOD removal efficiency
W = BOD loading (lbs/day) to filter (not including recycle)
V = Volume of filter (Acre - Ft)
F = Recirculation factor $\frac{1.0+R}{(1.0+0.1R)^2}$ where R = $\frac{\text{recycle}}{\text{influent}}$

A temperature correction has also been incorporated [3], [4]

$$E_t = E\ (1.038)^{T-20}$$

E_t = Filter efficiency at temperature, T
E = Filter efficiency as above
T = Temperature of wastewater, deg C

$$BOD_{out} = BOD_{in} * (1.0 - E_t)$$

Suspended Solids [5]

Lbs solids produced = 0.2(lbs BOD_{in}-lbs BOD_{out})

$$SS_{out} = SS_{in} + \frac{\text{lbs solids produced}}{8.34(\text{flow+recycle})}$$

Nitrification[6]

$$E = EXP(-KD/Q^n)$$

E = Decimal reduction in NH_3-N concentration
K = Reaction constant related to the specific surface of the media
D = Depth of filter (Ft)
Q = Hydraulic loading rate (MGAD)
n = Constant related to the specific surface and configuration of packing

K_{20}=K at 20° C =0.23 1 " rock media
=0.13 2½" rock media

$K=K_{20}(1.07)^{T-20}$ where T is temp. (°C)

n = 2.36 1 " rock media
3.80 2½"rock media

$$[NH_3\text{-}N]_{out} = [NH_3\text{-}N]_{in} * E$$

$$[NO_3\text{-}N]_{out} = [NO_3\text{-}N]_{in} + [NH_3\text{-}N]_{in} - [NH_3\text{-}N]_{out}$$

Secondary Clarifier[1]

The secondary clarifier for the trickling filter

system is assumed to operate similar to the primary and the same equation is utilized. The exception being that only suspended solids removal is considered.

Data Input

Following is a listing of the data input necessary to implement the simulation of a trickling filter plant.

Card 1

Column 1: Type of plant; 1 for trickling filter plant

Columns 2-9: Flow rate to plant (MGD)

Columns 10-17: BOD concentration in wastewater (mg/l)

Columns 18-25: Suspended solids conc. in water (mg/l)

Columns 26-33: Ammonia conc. in water (mg/l NH_3 as N)

Columns 34-41: Nitrate conc. in water (mg/l NO_3 as N)

Columns 42-49: Temperature of water (^{o}C)

Card 2

Columns 1-8: Total surface area of primary clarifier (acres)
(2 clarifiers @ 2 acres ea. = 4 acres)

Card 3

Columns 1-8: Total filter volume (acre-ft)
(2 filters @ 3 acre-ft ea. = 6 acre-ft)

Columns 9-16: Total filter surface area (acres)
(3 filters @ 4 acres ea. = 12 acres)

Columns 17-24: Total recycle to filters (MGD)

Columns 25-32: Total recycle from filter effluent (MGD)

Columns 33-40: Media coefficient (K) 0.23 1" rock media
0.13 2½" rock media

Columns 41-48: Media coefficient (n) 2.36 1" rock media
3.80 2½" rock media

Card 4

Columns 1-8: Total surface area of secondary clarifier (acres)
(2 clarifiers @ 2 acres = 4.0)

Activated Sludge System

As with the trickling filter type of wastewater treatment plant, many different modifications of the activated sludge process exist. The mode of operation of the treatment plant determines which process modification it employs. Of first concern is the fluid regime, *i.e.*, whether the flow is complete-mix or plug-flow. The model presented here is based on complete-mix conditions. It can also be applied to a plug-flow operation though, since the complete-mix formulation generally underestimates the treatment level attainable with a plug-flow system. Because this underestimation is not generally severe, the model can be considered adequate for application to plug-flow systems. The model, therefore, can simulate the complete-mix process including the extended aeration modification of that process, and is acceptable for the plug-flow modification (See Figure 2d).

Specification by the engineer of the type of activated sludge system to be simulated by the model is not necessary. Input of the correct aeration basin operational characteristics will result in a simulation of the appropriate modification.

Aeration Basin Operational Characteristics

Accuracy of the model's predictions is also highly dependent upon the

estimate of the aeration basin's operational characteristics made by the survey engineer. To obtain reliable results, values for the mixed liquor suspended solids, recycle rate, and net yield terms must closely approximate those that exist during actual operation.

While accurate estimates of these characteristics are mandatory, it is often quite difficult to obtain them. The aeration basin's interdependence on the operation of the other unit processes which surround it, especially the secondary clarifier, is the cause of this difficulty. In the situation where the secondary clarifier is underloaded (that is, the sludge blanket is at the bottom), the MLSS is determined solely by the amount of sludge wasted and is easily controlled at the desired level. However, future conditions may result in a critically loaded or overloaded clarifier. This situation is a function of the secondary clarifier solids loading and the settleability of the sludge. Here, the interdependence between aeration basin and secondary clarifier exists and governs what the aeration basin's operational characteristics will be. Should overloading occur, plant failure will result. An overload can not be predicted by the model but must be accounted for by the engineer when he estimates the aeration basin's operational characteristics.

One of the most useful tools for estimating these parameters with accuracy is experience. Comparison of the situation to those currently in existence or in the literature that are similar in nature can also be of considerable aid.

With an understanding of the structure of the activated sludge model as just presented, and a knowledge of the mathematical relationships that describe the operation of the different unit processes in the system, the

engineer should be able to use the model to advantage or modify it to more suitably fit his needs.

Mathematical Relationships

Following is a listing of the expressions that were used in forming the overall model of the activated sludge system.

Primary Clarifier

The relationship is the same as that used for the trickling filter system.

Aeration Basin

BOD reduction[7]

$$BOD_{out} = BOD_{in} - \frac{(MLSS)(Vol)}{(Y_n)(Theta)(FLOWR)}$$

MLSS = Mixed liquor suspended solids (mg/l)
Vol = Aeration basin volume (MG)
Y_n = Net yield (lb SS produced/lb BOD used)
FLOWR = Plant flow + recycle flow (MGD)
Theta = Sludge age or sludge retention time

$$= \frac{1.0}{Y_n(PLI)} \quad \text{where PLI} = \frac{BOD_{in}\ (Flow)}{(MLSS)(Vol)}$$

Nitrification[8]

A double "halving" or Balzano type iteration is performed on the effluent concentrations of ammonia and the nitrifying bacteria, Nitosomonas, until the governing system equations are satisfied:

$$S_i = S_o + \frac{K_r S_o X_o D_t}{Y(K_s + S_o)}$$

$$X_i = X_o - \frac{K_r S_o X_o D_t}{K_s + S_o}$$

where:

S_i = Ammonia in

S_o = Ammonia out

K_r = Synthesis rate constant

Y = Yield coefficient

K_s = Saturation coefficient

X_i = Nitrosomonas in

X_o = Nitrosomonas out

D_t Detention time (Vol/Flow)

A detailed explanation and justification of assumptions may be found in 8.

Secondary Clarifier[9]

$$SS_{out} = 4.5 + 8.6SSF$$

$$SSF = \frac{SS_{in}\ (FR)\ 3.785}{24A} = \text{Solids surface feed } (kg/m^2 - hr)$$

where: FR = Plant flow + recycle (MGD)
A = Surface area of clarifier (m^2)

Data Input

Following is a listing of the data input necessary to implement the simulation of an activated sludge plant.

Card 1

Column 1: Type of plant: 2 for activated sludge plant

Columns 2-9: Predicted flow to plant (MGD)

Columns 10-17: Predicted BOD of influent (mg/l)

Columns 18-25: Predicted suspended solids of influent (mg/l)

Columns 26-33: Predicted ammonia in influent (mg/l NH_3 as N)

Columns 34-41: Predicted nitrate in influent (mg/l NO_3 as N)

Columns 42-49: Predicted temperature of influent (deg. C)

Card 2

Columns 1-8: Total surface area of primary clarifiers (acres)
(2 clarifiers @ 2 acres ea. = 4 acres)

Card 3

Columns 1-8: Total volume of aeration tanks (MG)
2 tanks @ 3 MG ea. = 6 MG

Columns 9-16: Estimated operating concentration of MLSS (mg/l)

Columns 17-24: Estimated operating recycle rate (MGD)

Columns 25-32: Net yield (lb SS/lb BOD)
If not readily available, calculate:

$$Y_n = \frac{(\text{lb SS wasted/day}) + (\text{effluent SS})\ (\text{Flow})}{(BOD_{in} - BOD_{out})\ \text{Flow}}$$

Card 4

Columns 1-8: Total surface area of secondary clarifiers (acres)
(2 clarifiers @ 2 acres ea. = 4 acres)

III INDICATOR MODEL

Introduction

The indicator model is used to calculate certain parameters, generally termed process variable or operating characteristics, that indicate the operational state of the system. These calculated values can then be compared with the desirable values as cited in design books or manuals [7, 10, 11]. A comparison will give the engineer insight into the operation of the system such that problem areas and possible causes of these problems are more readily apparent. It can also indicate whether inadequate plant performance is due to design deficiencies or poor operational practices.

An example should help to illustrate the use of the indicator model more clearly. If a plant's effluent suspended solids concentration is too high, the engineer might first suspect the secondary clarifier. Solids removal efficiency calculated by the model will indicate whether or not the secondary clarifier is performing poorly. If the secondary clarifier does appear to be performing poorly, operating characteristics such as surface settling rate and solids loading rate, calculated by the model, can be compared to those suggested in the literature. If the clarifier is failing due to a hydraulic overload, comparison of the surface settling rate to common values should indicate this. If the operational characteristics of the secondary clarifier compare favorably with those in the literature, but it still appears to be failing, an investigation of the

operational characteristics of the other unit processes might be helpful. Should the process loading intensity of the aeration basin not compare favorably with cited values, a poorly settling sludge might well be the cause of the secondary clarifier's failure.

Operational Characteristics

Like the treatment system model, the indicator model is applicable to trickling filter and activated sludge type treatment plants. Operational characteristics calculated by the model are as follows:

Primary Clarifier

Detention time (hrs)

Surface settling rate (GPD/ft^2)

Weir overflow rate (GPD/ft)

Solids loading rate (lb SS/ft^2-day)

Solids removal efficiency (%)

Trickling Filter

Hydraulic loading (MGAD)

Organic loading (lb BOD/day/acre-ft)

Recirculation ratio

BOD removal efficiency (%)

Aeration Basin

Detention time (hrs)

Volumetric loading (lb BOD/day/1000 ft^3)

Process loading intensity (lb BOD/day/lb MLSS)

Sludge age or retention time (days)

Diffused aeration

Volumetric air supply (CFM/1000 ft^3)

Organic air supply (ft^3/lb BOD)

Mechanical aeration

Volumetric power supply (HP/1000 ft^3)

Organic oxygen supply (lb oxygen/lb BOD)

BOD removal efficiency (%)

Secondary Clarifier

Detention time (hrs)

Surface settling rate (GPD/ft^2)

Weir overflow rate (GPD/ft)

Solids loading rate (lb SS/day/ft^2)

Solids removal efficiency (%)

Overall Plant

BOD removal efficiency (%)

Solids removal efficiency (%)

Mathematical Relationships

Each of the operational characteristics calculated by the model is represented by a mathematical expression. Many of these expressions are evaluated at both average and peak flow conditions. This is done by using either the average or peak flow term in the expression. However,

this may not always be completely accurate, as the BOD suspended solids concentrations also vary diurnally. Peak values for the operational characteristics, therefore, may be in error because only the peak flows and not the peak concentrations were used in the calculations. Such error may be overcome, if desired, by substituting the peak values of these parameters (BOD, flow, etc.) for the average values as input data and running the model another time. Values of the operational characteristics calculated on this second run, which are printed out as average, will then represent the peak values. Following is a listing of the relationships:

Primary Clarifier

Detention time: $DT = \frac{V}{1000\ F/24}$

V = clarifier volume (1000 gal)
F = plant flow (MGD)

Surface settling rate:

$$SSR = \frac{F * 10^6}{A}$$

F = plant flow (MGD)
A = clarifier surface area (ft^2)

Weir overflow rate:

$$WOR = \frac{F * 10^6}{L}$$

F = plant flow (MGD)
L = weir length (ft)

Solids loading:

$$SL = \frac{(SS)\ (F)\ (8.34)}{A}$$

SS = influent suspended solids (mg/l)
F = plant flow (MGD)
A = clarifier surface area (ft^2)

Solids removal efficiency:

$$SRE = \frac{SSI - SSO}{SSI} * 100.$$

SSI = plant influent suspended solids (mg/l)
SSO = primary effluent suspended solids (mg/l)

Trickling Filter

Hydraulic loading:

$$HL = \frac{F + R}{A}$$

F = plant flow (MGD)
R = recycle flow to filter (MGD)
A = filter surface area (acres)

Organic loading:

$$OL = \frac{(F)\ (BOD)\ (8.34)}{V}$$

F = plant flow (MGD)
BOD = primary effluent BOD (mg/l)
V = filter volume (acre-ft)

Recirculation ratio:

$$RR = \frac{R}{F}$$

F = plant flow (MGD)
R = recycle flow to filter (MGD)

BOD removal efficiency:

$$E = \frac{BOD_1 - BOD_0}{BOD_1} * 100.$$

BOD_1 = primary effluent BOD (mg/l)
BOD_0 = plant effluent BOD (mg/l)

Aeration Basin

Detention time:

$$DT = \frac{24V}{(F+R)1000}$$

Aeration Basin (Continued)

V = aeration basin volume (1000)
F = plant flow (MGD)
R = recycle flow (MGD)

Volumetric loading:

$$VL = \frac{(BOD)\ (F)\ (8.34)\ (7.481)}{V}$$

BOD = primary effluent BOD (mg/l)

Process loading intensity:

$$PLI = \frac{(BOD)\ (F)\ (8.34)\ (1000)}{(MLSS)\ (V)\ (8.34)}$$

BOD = primary effluent BOD (mg/l)
F = plant flow (MGD)
MLSS= mixed liquor suspended solids (mg/l)
V = aeration basin volume (1000 gal)

Sludge age:

$$SA = \frac{(MLSS)(0.001V)(8.34)}{(F_w)(RSS)(8.34) + (F-F_w)(SS)(8.34)}$$

MLSS= mixed liquor suspended solids (mg/l)
V = aeration basin volume (1000 gal)
F_w = waste sludge flow rate (MGD)
RSS = return sludge suspended solids (mg/l)
F = plant flow (MGD)
SS = plant effluent suspended solids (mg/l)

A basic assumption made in the sludge age formulation is that sludge wasting is from the sludge recycle line. If the wasting is from the aeration basin, the actual waste sludge flow rate must be adjusted before input to the model.

$$F_i = \frac{(Fa)\ (MLSS)}{RSS}$$

F_i = input waste sludge flow (GPD)
F_a = actual waste sludge flow (GPD)
MLSS= mixed liquor suspended solids (mg/l)
RSS = return sludge suspended solids (mg/l)

Volumetric air supply:

$$VAS = \frac{(AV)(1000)(7.481)}{(24)(60)(V)}$$

AV = volume of air delivered (1000 ft^3/day)
V = aeration basin volume (1000 gal)

Organic air supply:

$$OAS = \frac{(AV)(1000)}{(BOD)(F)\ (8.34)}$$

AV = volume of air delivered (1000 ft^3/day)
BOD = primary effluent BOD (mg/l)
F = plant flow (MGD)

Volumetric power supply:

$$VPS = \frac{7.481\ HP}{V}$$

HP = total aerator horsepower (HP)
V = aeration basin volume (1000 gal)

Organic oxygen supply:

$$OAS = \frac{(N)(HP)(HR)}{(BOD)(F)(8.34)}$$

N = oxygen transfer rate (lb O_2/HP-hr)
HP = total aerator horsepower (HP)
HR = hours of aerator operation (hr/day)
BOD = primary effluent BOD (mg/l)
F = plant flow (MGD)

$$N = (2.5)\ \frac{CS-C}{9.17}\ (1.024)\ T-20\ (0.8)$$

CS = D.O. saturation in aeration basin (mg/l)
C = D.O. conc. in aeration basin (mg/l)
T = plant effluent temperature (°C)

A basic assumption made in the organic oxygen supply formulation is that the mechanical aerators employed are rated at 2.5 lb O_2/HP-hr under standard conditions as defined in [7]. Also assumed is an alpha

value for the wastewater of 0.8. If the engineer has the actual values of these parameters for the system being investigated, the model should be changed accordingly.

BOD removal efficiency:

$$E = \frac{BOD_i - BOD_o}{BOD_o} * 100.$$

BOD_i = primary effluent BOD (mg/l)
BOD_o = plant effluent BOD (mg/l)

Secondary Clarifier

For the secondary clarifier, the flow to the clarifier depends on whether it is part of a trickling filter or activated sludge type system. For the trickling filter system, the flow to the clarifier is equal to the plant flow plus the recycle to the filter minus the recycle from the filter effluent. For the activated sludge system, the flow to the clarifier is equal to the plant flow plus the recycle sludge flow.

Detention time:

$$DT = \frac{V}{1000\ F/24}$$

V = clarifier volume (1000 gal)
F = flow to clarifier (MGD)

Surface settling rate:

$$SSR = \frac{F * 10^6}{A}$$

F = flow to clarifier (MGD)
A = clarifier surface area (ft^2)

Weir overflow rate:

$$WOR = \frac{F * 10^6}{L}$$

F = flow to clarifier (MGD)
L = weir length (ft)

Solids loading rate:

$$SL = \frac{(SS)(F)(8.34)}{A}$$

SS = aeration basin or trickling filter effluent suspended solids (mg/l)
F = flow to clarifier (MGD)

Solids removal efficiency:

$$E = \frac{SSI - SSO}{SSO} * 100$$

SSI = aeration basin or trickling filter effluent suspended solids (mg/l)
SSO = plant effluent suspended solids (mg/l)

Data Input

The indicator model is designed to use data that is available prior to a survey's implementation and also the data generated by the survey. Design data needed should, of course, always be available. Operational data required will be available from the daily and monthly operation logs as required by Technical Manual 5-665, and then from the data generated by the survey. (If the value of any parameter is not available, it should be replaced by - 1.0 in the appropriate columns for the data input.) A listing of the data input necessary to implement the indicator model

follows:

Trickling Filter Type Plant

Card 1

Column 1: Plant type; 1 for trickling filter type plant.

Columns 2-41: Name of installation e.g. Fort Ord, CA
(Should be centered)

Card 2 - Primary Clarifier

Columns 1-8: Total volume (1000 gal)
(2 clarifiers @ 4000 gal ea. = 8.0)

Columns 9-16: Total surface area (Ft^2)
(2 clarifiers @ 200 Ft^2 ea. = 400.)

Columns 17-24: Total weir length (Ft)
(2 clarifiers @ 500 Ft ea. = 1000.)

Columns 25-32: Design flow rate (MGD)

Columns 33-40: Design detention time (Hrs)
If not readily available, calculate

$$DT = \frac{\text{Total Vol (1000 gal) X 0.024}}{\text{Design flow (MGD)}}$$

Columns 41-48: Design surface settling rate (GPD/Ft^2)
If not readily available, calculate

$$SSR = \frac{\text{Design flow (MGD) X } 10^6}{\text{Total surface area } (Ft^2)}$$

Columns 49-56: Design weir overflow rate (GPD/Ft)
If not readily available, calculate

$$WOR = \frac{\text{Design flow (MGD) X } 10^6}{\text{Total weir length (Ft)}}$$

Card 3 - Trickling Filter

Columns 1-8: Design flow rate (MGD)

Columns 9-16: Design organic loading (Lb BOD/Acre-Ft/Day)

Columns 17-24: Total volume (Acre-Ft)
(2 filters @ 3 acre-ft ea. = 6.)

Columns 25-32: Total area (Acres)
(2 filters @ .75 acres ea. = 1.5)

Columns 33-40: Total design recycle per day (MG)
If not readily available, calculate

R = Design percent recycle X 100. X Design flow (MGD)

Card 4 - Secondary Clarifier

Columns 1-8: Total volume (1000 Gal)
(2 clarifiers @ 4000 gal ea. = 8.0)

Columns 9-16: Total surface area (Ft_2^2)
(2 clarifiers @ 200 Ft^2 ea. = 400.)

Columns 17-24: Total weir length (Ft)
(2 clarifiers @ 500 Ft ea. = 1000.)

Columns 25-32: Design flow rate (MGD)

Columns 33-40: Design detention time (Hrs)
If not readily available, calculate

$$DT = \frac{\text{Total Vol (1000 gal) X 0.024}}{\text{Design flow (MGD)}}$$

Columns 41-48: Design surface settling rate (GPD/Ft^2)
If not readily available, calculate

$$SSR = \frac{\text{Design flow (MGD) X } 10_2^6}{\text{Total surface area } (Ft^2)}$$

Columns 49-56: Design weir overflow rate (GPD/Ft)
If not readily available, calculate

$$WOR = \frac{\text{Design flow (MGD) X } 10^6}{\text{Total weir length (Ft)}}$$

Columns 57-64: Design solids loading (Lb SS/Ft^2-Day)

Card 5 - General Operations

Columns 1-8: Peak flow (influent) (MGD)

Columns 9-16: Total daily flow (influent) (MG)

Columns 17-24: BOD (influent) (mg/l)

Columns 25-32: Suspended solids (influent) (mg/l)

Columns 33-40: BOD (effluent) (mg/l)

Columns 41-48: Suspended solids (effluent) (mg/l)

Card 6 - Process Operations

Columns 1-8: Primary clarifier effluent BOD (mg/l)

Columns 9-16: Primary effluent suspended solids (mg/l)

Columns 17-24: Trickling filter effluent BOD (mg/l)

Columns 25-32: Filter effluent suspended solids (mg/l)

Columns 33-40: Total recycle to filter (MGD)

Columns 41-48: Total recycle from filter effluent (MGD)

Columns 49-56: Recycle from secondary clarifier (MGD)

Activated Sludge Type Plant

Card 1

Column 1: Plant type; 2 for activated sludge type plant.

Columns 2-41: Same as for trickling filter type plant.

Card 2 - Primary Clarifier

Same as for trickling filter type plant.

Card 3 - Aeration Tanks

Columns 1-8: Total tank volume (1000 Gal)
(2 tanks @ 50,000 gal ea. = 100.)

Columns 9-16: Design flow rate (MGD)

Columns 17-24: Design detention time (Hrs)
If not readily available, calculate

$$DT = \frac{\text{Total Vol (1000 Gal)} \times 0.024}{\text{Design flow (MGD)}}$$

Columns 25-32: Design organic loading (Lb BOD/day/1000 Ft^3)

Columns 33-40: Design mixed liquor suspended solids (mg/l)

Columns 41-48: Number of aerators or compressors

Columns 49-56: Total aerator or compressor horsepower
(2 aerators @ 50 HP ea. = 100.)

Card 4 - Secondary Clarifier

Same as for trickling filter type plant.

Card 5 - General Operations

Same as for trickling filter type plant with the exception of:

Columns 49-56: Average temperature of plant effluent (C)

Columns 57-64: D.O. saturation in aeration basin (mg/l)

Card 6 - Process Operations

Columns 1-8: Primary clarifier effluent BOD (mg/l)

Columns 9-16: Primary effluent suspended solids (mg/l)

Columns 17-24: Mixed liquor suspended solids (mg/l)

Columns 25-32: Volume of air delivered (1000 ft^3/day)

Columns 33-40: Average mech. aerator operating time (hrs/day)
This should be computed by multiplying the time of operation of each aerator by its horsepower and summing to get the total. This horsepower-hour total should then be divided by the total aerator horsepower.

Columns 41-48: Recycle sludge volume (MGD)

Columns 49-56: Recycle sludge suspended solids (mg/l)

Columns 57-64: Wasted sludge volume (GPD)

Columns 65-72: Average aeration basin dissolved oxygen (mg/l)

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APPENDIX A

Listing of Treatment System Model

MAIN - MAIN reads in the predicted future influent data. Then, it routes the logic to either TFILT or ACTS depending on whether the simulation is for a trickling filter or activated sludge type system. Finally, MAIN prints out the estimated future effluent conditions returned to it by the subprograms.

TFILT - Subroutine TFILT first calls PCLAR which is the primary clarifier subroutine. Then, TFILT reads in the trickling filter data and, using the output from PCLAR as input to the filter, claculates the filter output. If required, subroutine TFNIT is called to calculate the filter nitrification. The output from the filter is then passed to subroutine TFSEC (the secondary clarifier subroutine) and the systems final effluent is determined and returned to MAIN.

TFNIT - Subroutine TFNIT takes the data passed from TFILT, determines the filter nitrification and returns this to TFILT.

TFSEC - Subroutine TFSEC takes the data passed to it from TFILT. Then, it reads in the secondary clarifier data, calculates the plant's final effluent and returns this to TFILT.

ACTS - Subroutine ACTS first calls PCLAR which is the primary clarifier subroutine. Then, ACTS reads in the aeration basin data and, using the output from PCLAR as input to the basin, calculates the basin output. If required, subroutine ACTNIT is called to calculate the basin nitrification. The output from the basin is then passed to subroutine ACTSEC (the secondary clarifier subroutine) and the systems final effluent is determined and returned to MAIN.

ACTNIT - Subroutine ACTNIT takes the data passed from ACTS, determines the aeration basin nitrification and returns it to ACTS.

ACTSEC - Subroutine ACTSEC takes the data passed from ACTS. Then, it reads in the secondary clarifier data, calculates the plant's final effluent and returns it to ACTS.

PCLAR - Subroutine PCLAR may be called by either TFILT or ACTS. PCLAR takes the plants influent data passed to it by one of these subroutines. It then reads in the primary clarifier data, calculates the clarifier output and returns it to the subroutine that called it.

```
C
C
C
C  STEADY STATE TREATMENT PLANT MODEL
C  MODEL TO SIMULATE TRICKLING FILTER
C  OR ACTIVATED SLUDGE TYPE PLANT
C
      DIMENSION TYP(4,2)
      REAL NH3,NO3
      COMMON FLOW
      DATA TYP(1,1),TYP(2,1),TYP(3,1),TYP(4,1)
     1  /'TRIC','KLIN','G FI','LTER'/,
     2  TYP(1,2),TYP(2,2),TYP(3,2),TYP(4,2)
     3  /'ACTI','VATE','D SL','UDGE'/
      READ(1,100)ITYP,FLOW,BOD,SS,NH3,NO3,TEMP
      WRITE(3,110)(TYP(I,ITYP),I=1,4)
      WRITE(3,115)FLOW,BOD,SS,NH3,NO3,TEMP
      GO TO (10,20),ITYP
   10 CALL TFILT(BOD,SS,NH3,NO3,TEMP,&30)
   20 CALL ACTS(BOD,SS,NH3,NO3,TEMP,&30)
   30 WRITE(3,120)BOD,SS,NH3,NO3
      STOP
  100 FORMAT(I1,6F8.0)
  110 FORMAT(1H1,//'  ESTIMATE OF PLANT PERFORMANCE AFTER ',
     1  'INSTALLATION EXPANSION'/16X,4A4,' TYPE PLANT'//
     2  5X,'PREDICTED FUTURE INFLUENT CONDITIONS'/)
  115 FORMAT(10X,'FLOW RATE=',T30,F8.2,2X,'(MGD)'/
     1  10X,'BOD=',T30,F8.2,2X,'(MG/L)'/
     2  10X,'SUSPENDED SOLIDS=',T30,F8.2,2X,'(MG/L)'/
     3  10X,'AMMONIA=',T30,F8.2,2X,'(MG/L)'/
     4  10X,'NITRATE=',T30,F8.2,2X,'(MG/L)'/
     5  10X,'TEMPERATURE=',T30,F8.2,2X,'(DEGREES C)')
  120 FORMAT(///5X,'ESTIMATED FUTURE EFFLUENT CONDITIONS'/
     2  10X,'BOD=',T30,F8.2,2X,'(MG/L)'/
     3  10X,'SUSPENDED SOLIDS=',T30,F8.2,2X,'(MG/L)'/
     4  10X,'AMMONIA=',T30,F8.2,2X,'(MG/L)'/
     5  10X,'NITRATE=',T30,F8.2,2X,'(MG/L)')
      END
```

```
C
C
C
      SUBROUTINE TFILT(BOD,SS,NH3,NO3,TEMP,*)
      COMMON FLOW
      REAL NH3,NO3,K20,NN
      DATA YTFSS /0.2/
      CALL PCLAR(BOD,SS)
      READ(1,110)V,A,R1,R2,K20,NN
      WRITE(3,120)V,A,R1,R2,K20,NN
      W=BOD*FLOW*8.34
      R=R1/FLOW
      F=(1.0+R)/(1.0+.1*R)**2
      E=1.0/(1.0+0.0085*(W/(V*F))**.5)
      E=E*1.038**(TEMP-20.)
      IF(E .GT. .95)E=.95
      E=1.-E
      SS=SS+YTFSS*(BOD*8.34*FLOW-E*BOD*8.34*(FLOW+R1))/(8.34*(FLOW+R1))
      BOD=BOD*E
      Q=(FLOW+R1)/A
      D=V/A
      IF(NH3 .GT. 0.)CALL TFNIT(NH3,NO3,TEMP,K20,NN,D,Q)
      CALL FTSEC(SS,R1,R2)
      RETURN1
  110 FORMAT(6F8.0)
  120 FORMAT(//1CX,'TRICKLING FILTER CHARACTERISTICS'/
     1  15X,'TOTAL FILTER VOLUME=',T40,F8.2,2X,'(ACRE-FT)',/
     2  15X,'TOTAL FILTER AREA=',T40,F8.2,2X,'(ACRES)',/
     3  15X,'RECYCLE TO FILTER=',T40,F8.2,2X,'(MGD)',/
     4  15X,'RECYCLE FROM FILTER=',T40,F8.2,2X,'(MGD)'/
     5  15X,'MEDIA COEFFICIENT (K)=',T40,F8.2/
     6  15X,'MEDIA COEFFICIENT (N)=',T40,F8.2)
      END
```

```
C
C
C
      SUBROUTINE TFNIT(NH3,NO3,TEMP,K20,NN,D,Q)
      COMMON FLOW
      REAL NH3,NO3,K20,K20,NN
      K20=K20*1.07**(TEMP-20.)
      E=EXP(-K20*D/Q**NN)
      NO3=NO3+NH3-NH3*E
      NH3=NH3*E
      RETURN
      END
```

```
C
C
C
      SUBROUTINE TFSEC(SS,R1,R2)
      COMMON FLOW
      READ(1,10)A
      WRITE(3,100)A
      FLO=FLOW+R1-R2
      RF=(1.0-0.82*EXP(-FLO /(2780.0*A)))/(1.0-0.00205*EXP(-FLO /
     1  (2780.0*A)))
      SS=SS*RF
      RETURN
   10 FORMAT(F8.0)
  100 FORMAT(//10X,'SECONDARY CLARIFIER CHARACTERISTICS'/
     1  15X,'AREA=',T40,F8.2,2X,'(ACRES)')
      END
```

```
C
C
C
      SUBROUTINE ACTS(BOD,SS,NH3,NO3,TEMP,*)
      COMMON FLOW
      REAL MLSS,NH3,NO3
      CALL PCLAR(BOD,SS)
      READ(1,100)VOL,MLSS,R,YN
      WRITE(3,120)VOL,MLSS,R,YN
      PLI=BOD*FLOW/(MLSS*VOL)
      IF(PLI .GT. 0.4)WRITE(3,130)PLI
      THETA=1.0/(YN*PLI)
      FLOWR=FLOW+R
      BOD=BOD-MLSS*VOL/(YN*THETA*FLOWR)
      SS=MLSS
      IF(NH3 .GT. 0.)CALL ACTNIT(NH3,NO3,FLOWR,VOL,THETA,TEMP)
      CALL ACTSEC(SS,FLOWR)
      RETURN1
  100 FORMAT(4F8.0)
  120 FORMAT(//1CX,'ACTIVATED SLUDGE CHARACTERISTICS'/
     1  15X,'TOTAL AERATION BASIN VOLUME=',T50,F8.2,2X,'(MG)'/
     2  15X,'MIXED LIQUOR SUSPENDED SOLIDS=',T50,F8.2,2X,'(MG/L)'/
     3  15X,'TOTAL SLUDGE RECYCLE=',T50,F8.2,2X,'(MGD)'/
     4  15X,'NET YIELD=',T50,F8.2,2X,'(LBS SOLIDS PRODUCED/'/
     5  T62,'LB BOD UTILIZED)')
  130 FORMAT(/5X,10('*'),'PLI=',F5.2/
     1  15X,'THIS PLI MAY CAUSE POORLY SETTLING SLUDGE'/
     2  15X,'AND INABILITY TO MAINTAIN ESTIMATED MLSS')
      END
```

```
C
C
C
      SUBROUTINE ACTNIT(NH3,NO3,FLOWR,VOL,THETA,TEMP)
      COMMON FLOW
      REAL NH3,NO3,NKS,NKR
      DATA Y,NKS/0.05,1.0/
      R1=FLOWR-FLOW
      TEMP1=VOL/THETA
      NKR=0.33*1.123**(TEMP-20.)
      DT=VOL/FLOWR
      X21=Y*FLOW*NH3*THETA/VOL
      XLOW=0.
      XUP=2.*X21
      IX=0
   10 S21=.5*NH3
      SLOW=0.
      SUP=NH3
      IS=0
   15 S22=S21+(NKR*S21*X21*DT)/(Y*(NKS+S21))
      X22=X21-(NKR*S21*X21*DT)/(NKS+S21)
      S17=(S22*FLOWR-NH3*FLOW)/R1
      X17=X22*FLOWR/R1
      DS2=S21-S17
      IF(ABS(DS2)-0.01)29,29,22
   22 IF(IS-20)24,29,29
   24 IF(DS2)27,27,25
   25 SLOW=S21
      S21=S21+0.5*(SUP-SLOW)
      IS=IS+1
      GO TO 15
   27 SUP=S21
      S21=S21-0.5*(SUP-SLOW)
      IS=IS+1
      GO TO 15
   29 X1=FLOWR*X21
      X2=FLOWR*X22
      X2=(X1-X2)/X21
      DX2=TEMP1-X2
      IF(ABS(DX2)-0.1)50,50,30
   30 IF(X21-0.001)40,40,32
   32 IF(IX-20)31,40,40
   31 IF(DX2)37,37,35
   35 XUP=X21
      X21=X21-0.5*(XUP-XLOW)
      IX=IX+1
      GO TO 10
   37 XLOW=X21
      X21=X21+0.5*(XUP-XLOW)
      IX=IX+1
      GO TO 10
   50 NO3=NO3+NH3-S21
      NH3=S21
   40 CONTINUE
      RETURN
      END
```

```
C
C
C
      SUBROUTINE ACTSEC(SS,FLOWR)
      COMMON FLOW
      READ(1,100)A
      WRITE(3,110)A
      A=A*4047.
      SSF=SS*FLOWR*3.785/24./A
      SS=4.5+8.6*SSF
      RETURN
  100 FORMAT(F8.0)
  110 FORMAT(//10X,'SECONDARY CLARIFIER CHARACTERISTICS'/
     1  15X,'AREA=',T40,F8.2,2X,'(ACRES)')
      END
```

```
C
C
C
      SUBROUTINE PCLAR(BOD,SS)
      COMMON FLOW
      READ(1,10)A
      WRITE(3,100)A
      RF=(1.0-0.82*EXP(-FLOW/(2780.0*A)))/(1.0-0.00205*EXP(-FLOW/
     1  (2780.0*A)))
      SS=SS*RF
      BOD=0.3*BOD+0.7*BOD*RF
      RETURN
   10 FORMAT(F8.0)
  100 FORMAT(//10X,'PRIMARY CLARIFIER CHARACTERISTICS'/
     1  15X,'AREA=',T40,F8.2,2X,'(ACRES)')
      END
```

APPENDIX B

Output From Treatment System Model Program

ESTIMATE OF PLANT PERFORMANCE AFTER INSTALLATION EXPANSION
TRICKLING FILTER TYPE PLANT

PREDICTED FUTURE INFLUENT CONDITIONS

FLOW RATE=	14.60	(MGD)
BOD=	148.00	(MG/L)
SUSPENDED SOLIDS=	163.00	(MG/L)
AMMONIA=	0.0	(MG/L)
NITRATE=	0.0	(MG/L)
TEMPERATURE=	15.00	(DEGREES C)

PRIMARY CLARIFIER CHARACTERISTICS

AREA=	0.84	(ACRES)

TRICKLING FILTER CHARACTERISTICS

TOTAL FILTER VOLUME=	4.56	(ACRE-FT)
TOTAL FILTER AREA=	1.52	(ACRES)
RECYCLE TO FILTER=	0.0	(MGD)
RECYCLE FROM FILTER=	0.0	(MGD)
MEDIA COEFFICIENT (K)=	0.23	
MEDIA COEFFICIENT (N)=	2.36	

SECONDARY CLARIFIER CHARACTERISTICS

AREA=	0.43	(ACRES)

ESTIMATED FUTURE EFFLUENT CONDITIONS

BOD=	39.10	(MG/L)
SUSPENDED SOLIDS=	6.69	(MG/L)
AMMONIA=	0.0	(MG/L)
NITRATE=	0.0	(MG/L)

ESTIMATE OF PLANT PERFORMANCE AFTER INSTALLATION EXPANSION
TRICKLING FILTER TYPE PLANT

PREDICTED FUTURE INFLUENT CONDITIONS

FLOW RATE=	2.00	(MGD)
BOD=	250.00	(MG/L)
SUSPENDED SOLIDS=	500.00	(MG/L)
AMMONIA=	20.00	(MG/L)
NITRATE=	0.0	(MG/L)
TEMPERATURE=	15.00	(DEGREES C)

PRIMARY CLARIFIER CHARACTERISTICS

AREA=	0.50	(ACRES)

TRICKLING FILTER CHARACTERISTICS

TOTAL FILTER VOLUME=	5.00	(ACRE-FT)
TOTAL FILTER AREA=	0.75	(ACRES)
RECYCLE TO FILTER=	2.00	(MGD)
TOTAL RECYCLE FROM FILTE	2.00	(MGD)
MEDIA COEFFICIENT (K)=	0.23	
MEDIA COEFFICIENT (N)=	2.36	

SECONDARY CLARIFIER CHARACTERISTICS

AREA=	0.50	(ACRES)

ESTIMATED FUTURE EFFLUENT CONDITIONS

BOD=	78.78	(MG/L)
SUSPENDED SOLIDS=	15.66	(MG/L)
AMMONIA=	19.58	(MG/L)
NITRATE=	0.42	(MG/L)

APPENDIX C

Listing of Indicator Model Program

```
C  BOX 5718                                                          00000010
C  ROGER R. SMITH                                                    00000020
C                                                                    00000030
C                                                                    00000040
C                                                                    00000050
      DIMENSION PLDES(4,2),UNIT(4,4)                                 00000060
      COMMON A(9,6),PLANT(10)                                        00000070
      DATA PLDES(1,2),PLDES(2,2),PLDES(3,2),PLDES(4,2)               00000080
     1  /'ACTI','VATE','D SL','UDGE'/,                               00000090
     2     PLDES(1,1),PLDES(2,1),PLDES(3,1),PLDES(4,1)               00000100
     3  /'TRIC','KLIN','G FI','LTER'/                                00000110
      DATA UNIT(1,1),UNIT(2,1),UNIT(3,1),UNIT(4,1)                   00000120
     1  /'PRIM','ARY ','SETT','LING'/,                               00000130
     2     UNIT(1,2),UNIT(2,2),UNIT(3,2),UNIT(4,2)                   00000140
     3  /' AER','ATIO','N TA','NKS '/,                               00000150
     4     UNIT(1,3),UNIT(2,3),UNIT(3,3),UNIT(4,3)                   00000160
     5  /'FINA','L CL','ARIF','IER '/                                00000170
      DATA UNIT(1,4),UNIT(2,4),UNIT(3,4),UNIT(4,4)                   00000180
     1  /'TRIC','KLIN','G FI','LTER'/                                00000190
C                                                                    00000200
C                                                                    00000210
C                                                                    00000220
      READ(1,901) NPTYP,PLANT                                        00000230
      WRITE(3,902)                                                   00000240
      WRITE(3,908)PLANT                                              00000250
      WRITE(3,905)(PLDES(I,NPTYP),I=1,4)                             00000260
      WRITE(3,903)                                                   00000270
C         DETERMINE PROCESS TYPE                                     00000280
      GO TO (90,80),NPTYP                                            00000290
C                                                                    00000300
C  ACTIVATED SLUDGE TYPE PLANT                                       00000310
C                                                                    00000320
   80 READ(1,906)(A(I,1),I=1,7)                                      00000330
C                                                                    00000340
C         PRIMARY CLARIFIER                                          00000350
C     A(1,1)=TOTAL TANK VOLUME (1000 GAL)                            00000360
C     A(2,1)=TOTAL SURFACE AREA (FT2)                                00000370
C     A(3,1)=TOTAL WEIR LENGTH (FT)                                  00000380
C     A(4,1)=DESIGN FLOW RATE (MGD)                                  00000390
C     A(5,1)=DESIGN DETENTION PERIOD (HRS)                           00000400
C     A(6,1)=DESIGN SURFACE SETTLING RATE (GPD/FT2)                  00000410
C     A(7,1)=DESIGN WEIR OVERFLOW RATE (GPD/FT)                      00000420
C                                                                    00000430
      WRITE(3,904)(UNIT(I,1),I=1,4)                                  00000440
      IF(A(1,1) .LT. 0.0)WRITE(3,910)                                00000450
      IF(A(2,1) .LT. 0.0)WRITE(3,911)                                00000460
      IF(A(3,1) .LT. 0.0)WRITE(3,912)                                00000470
      IF(A(4,1) .LT. 0.0)WRITE(3,913)                                00000480
      IF(A(5,1) .LT. 0.0)WRITE(3,914)                                00000490
      IF(A(6,1) .LT. 0.0)WRITE(3,915)                                00000500
      IF(A(7,1) .LT. 0.0)WRITE(3,916)                                00000510
C                                                                    00000520
      READ(1,906)(A(I,2),I=1,7)                                      00000530
C                                                                    00000540
C         AERATION BASIN                                             00000550
C     A(1,2)=TOTAL TANK VOLUME (1000 GAL)                            00000560
C     A(2,2)=DESIGN FLOW RATE (MGD)                                  00000570
C     A(3,2)=DESIGN DETENTION PERIOD (HRS)                           00000580
```

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C      A(4,2)=DESIGN ORGANIC LOADING (LB BOD/DAY/1000 FT3)                    00000590
C      A(5,2)=DESIGN MLSS (MG/L)                                              00000600
C      A(6,2)=NUMBER OF AERATORS OR COMPRESSORS                               00000610
C      A(7,2)=TOTAL AERATOR OR COMPRESSOR HORSEPOWER                          00000620
C                                                                             00000630
       WRITE(3,904)(UNIT(I,2),I=1,4)                                          00000640
       IF(A(1,2) .LT. 0.0)WRITE(3,920)                                        00000650
       IF(A(2,2) .LT. 0.0)WRITE(3,921)                                        00000660
       IF(A(3,2) .LT. 0.0)WRITE(3,922)                                        00000670
       IF(A(4,2) .LT. 0.0)WRITE(3,923)                                        00000680
       IF(A(5,2) .LT. 0.0)WRITE(3,924)                                        00000690
       IF(A(6,2) .LT. 0.0)WRITE(3,925)                                        00000700
       IF(A(7,2) .LT. 0.0)WRITE(3,926)                                        00000710
C                                                                             00000720
       READ(1,906)(A(I,3),I=1,8)                                              00000730
C                                                                             00000740
C          FINAL CLARIFIER                                                    00000750
C      A(1,3)=TOTAL TANK VOLUME (1000 GAL)                                    00000760
C      A(2,3)=TOTAL SURFACE AREA (FT2)                                        00000770
C      A(3,3)=TOTAL WEIR LENGTH (FT)                                          00000780
C      A(4,3)=DESIGN FLOW RATE (MGD)                                          00000790
C      A(5,3)=DESIGN DETENTION PERIOD (HRS)                                   00000800
C      A(6,3)=DESIGN SURFACE SETTLING RATE (GPD/FT2)                          00000810
C      A(7,3)=DESIGN WEIR OVERFLOW RATE (GPD/FT)                              00000820
C      A(8,3)=DESIGN SOLIDS LOADING (LB SS/DAY/FT2)                           00000830
C                                                                             00000840
       WRITE(3,904)(UNIT(I,3),I=1,4)                                          00000850
       IF(A(1,3) .LT. 0.0)WRITE(3,910)                                        00000860
       IF(A(2,3) .LT. 0.0)WRITE(3,911)                                        00000870
       IF(A(3,3) .LT. 0.0)WRITE(3,912)                                        00000880
       IF(A(4,3) .LT. 0.0)WRITE(3,913)                                        00000890
       IF(A(5,3) .LT. 0.0)WRITE(3,914)                                        00000900
       IF(A(6,3) .LT. 0.0)WRITE(3,915)                                        00000910
       IF(A(7,3) .LT. 0.0)WRITE(3,916)                                        00000920
       IF(A(8,3) .LT. 0.0)WRITE(3,917)                                        00000930
C                                                                             00000940
       GO TO 103                                                              00000950
C                                                                             00000960
C                                                                             00000970
C  TRICKLING FILTER TYPE PLANT                                                00000980
C                                                                             00000990
   90  READ(1,906)(A(I,1),I=1,7)                                              00001000
C                                                                             00001010
C          PRIMARY CLARIFIER                                                  00001020
C      A(1,1)=TOTAL TANK VOLUME (1000 GAL)                                    00001030
C      A(2,1)=TOTAL SURFACE AREA (FT2)                                        00001040
C      A(3,1)=TOTAL WEIR LENGTH (FT)                                          00001050
C      A(4,1)=DESIGN FLOW RATE (MGD)                                          00001060
C      A(5,1)=DESIGN DETENTION PERIOD (HRS)                                   00001070
C      A(6,1)=DESIGN SURFACE SETTLING RATE (GPD/FT2)                          00001080
C      A(7,1)=DESIGN WEIR OVERFLOW RATE (GPD/FT)                              00001090
C                                                                             00001100
       WRITE(3,904)(UNIT(I,1),I=1,4)                                          00001110
       IF(A(1,1) .LT. 0.0)WRITE(3,910)                                        00001120
       IF(A(2,1) .LT. 0.0)WRITE(3,911)                                        00001130
       IF(A(3,1) .LT. 0.0)WRITE(3,912)                                        00001140
       IF(A(4,1) .LT. 0.0)WRITE(3,913)                                        00001150
       IF(A(5,1) .LT. 0.0)WRITE(3,914)                                        00001160
```

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      IF(A(6,1) .LT. 0.0)WRITE(3,915)                                    00001170
      IF(A(7,1) .LT. 0.0)WRITE(3,916)                                    00001180
C                                                                        00001190
      READ(1,906)(A(I,2),I=1,5)                                          00001200
C                                                                        00001210
C         TRICKLING FILTER                                               00001220
C     A(1,2)=DESIGN FLOW RATE (MGD)                                      00001230
C     A(2,2)=DESIGN ORGANIC LOAD (LB BOD/ACRE-FT DAY)                    00001240
C     A(3,2)=TOTAL FILTER VOLUME (ACRE-FT)                               00001250
C     A(4,2)=TOTAL FILTER AREA (ACRES)                                   00001260
C     A(5,2)=TOTAL RECYCLE TO FILTER (MGD)                               00001270
C                                                                        00001280
      WRITE(3,904)(UNIT(I,4),I=1,4)                                      00001290
      IF(A(1,2) .LT. 0.0)WRITE(3,940)                                    00001300
      IF(A(2,2) .LT. 0.0)WRITE(3,941)                                    00001310
      IF(A(3,2) .LT. 0.0)WRITE(3,942)                                    00001320
      IF(A(4,2) .LT. 0.0)WRITE(3,943)                                    00001330
      IF(A(5,2) .LT. 0.0)WRITE(3,944)                                    00001340
C                                                                        00001350
      READ(1,906)(A(I,3),I=1,8)                                          00001360
C                                                                        00001370
C         FINAL CLARIFIER                                                00001380
C     A(1,3)=TOTAL TANK VOLUME (1000 GAL)                                00001390
C     A(2,3)=TOTAL SURFACE AREA (FT2)                                    00001400
C     A(3,3)=TOTAL WEIR LENGTH (FT)                                      00001410
C     A(4,3)=DESIGN FLOW RATE (MGD)                                      00001420
C     A(5,3)=DESIGN DETENTION PERIOD (HRS)                               00001430
C     A(6,3)=DESIGN SURFACE SETTLING RATE (GPD/FT2)                      00001440
C     A(7,3)=DESIGN WEIR OVERFLOW RATE (GPD/FT)                          00001450
C     A(8,3)=DESIGN SOLIDS LOADING (LB SS/DAY/FT2)                       00001460
C                                                                        00001470
      WRITE(3,904)(UNIT(I,3),I=1,4)                                      00001480
      IF(A(1,3) .LT. 0.0)WRITE(3,910)                                    00001490
      IF(A(2,3) .LT. 0.0)WRITE(3,911)                                    00001500
      IF(A(3,3) .LT. 0.0)WRITE(3,912)                                    00001510
      IF(A(4,3) .LT. 0.0)WRITE(3,913)                                    00001520
      IF(A(5,3) .LT. 0.0)WRITE(3,914)                                    00001530
      IF(A(6,3) .LT. 0.0)WRITE(3,915)                                    00001540
      IF(A(7,3) .LT. 0.0)WRITE(3,916)                                    00001550
      IF(A(8,3) .LT. 0.0)WRITE(3,917)                                    00001560
C                                                                        00001570
      GO TO 105                                                          00001580
C                                                                        00001590
  103 CALL ACT(&200)                                                     00001600
  105 CALL TFILT(&200)                                                   00001610
  200 CONTINUE                                                           00001620
      STOP                                                               00001630
  901 FORMAT(I1,10A4)                                                    00001640
  902 FORMAT(1H1///T41,50('*')/                                          00001650
     1  T41,'*          PLANT DESIGN AND OPERATION CHECK          *',    00001660
     2  /T41,50('*'))                                                   00001670
  903 FORMAT(//T20,'DESIGN INFORMATION NOT AVAILABLE'/                   00001680
     1  T20,32('*'))                                                    00001690
  904 FORMAT(/T18,'**',4A4,'**')                                         00001700
  905 FORMAT(T52,4A4,'  TYPE PLANT')                                     00001710
  906 FORMAT(8F8.0)                                                      00001720
  908 FORMAT(T46,10A4)                                                   00001730
  910 FORMAT(T20,'TOTAL VOLUME')                                         00001740
```

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  911 FORMAT(T20,'TOTAL SURFACE AREA')                                  00001750
  912 FORMAT(T20,'TOTAL WEIR LENGTH')                                   00001760
  913 FORMAT(T20,'FLOW RATE')                                           00001770
  914 FORMAT(T20,'DETENTION TIME')                                      00001780
  915 FORMAT(T20,'SURFACE SETTLING RATE')                               00001790
  916 FORMAT(T20,'WEIR OVERFLOW RATE')                                  00001800
  917 FORMAT(T20,'SOLIDS LOADING')                                      00001810
  920 FORMAT(T20,'TOTAL TANK VOLUME')                                   00001820
  921 FORMAT(T20,'FLOW RATE')                                           00001830
  922 FORMAT(T20,'DETENTION PERIOD')                                    00001840
  923 FORMAT(T20,'ORGANIC LOADING')                                     00001850
  924 FORMAT(T20,'MLSS')                                                00001860
  925 FORMAT(T20,'NUMBER OF AERATORS OR COMPRESSORS')                   00001870
  926 FORMAT(T20,'TOTAL AERATOR OR COMPRESSOR HORSEPOWER')              00001880
  940 FORMAT(T20,'FLOW RATE')                                           00001890
  941 FORMAT(T20,'ORGANIC LOADING')                                     00001900
  942 FORMAT(T20,'TOTAL FILTER VOLUME')                                 00001910
  943 FORMAT(T20,'TOTAL FILTER AREA')                                   00001920
  944 FORMAT(T20,'FILTER RECYCLE')                                      00001930
      END                                                               00001940
```

```
      SUBROUTINE ACT(*)                                                    00001950
      COMMON A(9,6),PLANT(10)                                              00001960
C                                                                          00001970
C  READ IN OPERATIONS DATA                                                 00001980
C                                                                          00001990
      READ(1,901)(A(I,5),I=1,8)                                            00002000
C                                                                          00002010
C         GENERAL OPERATIONS                                               00002020
C     A(1,5)=PEAK FLOW (INFLUENT) (MGD)                                    00002030
C     A(2,5)=TOTAL DAILY FLOW (INFLUENT) (MG)                              00002040
C     A(3,5)=BOD (INFLUENT) (MG/L)                                         00002050
C     A(4,5)=SUSPENDED SOLIDS (INFLUENT) (MG/L)                            00002060
C     A(5,5)=BOD (EFFLUENT) (MG/L)                                         00002070
C     A(6,5)=SUSPENDED SOLIDS (EFFLUENT) (MG/L)                            00002080
C     A(7,5)=AVERAGE TEMPERATURE (EFFLUENT) (DEG C)                        00002090
C     A(8,5)=D.O. SATURATION IN AERATION BASIN (MG/L)                      00002100
C                                                                          00002110
      WRITE(3,909)                                                         00002120
      WRITE(3,910)                                                         00002130
      IF(A(1,5) .LT. 0.0)WRITE(3,911)                                      00002140
      IF(A(2,5) .LT. 0.0)WRITE(3,912)                                      00002150
      IF(A(3,5) .LT. 0.0)WRITE(3,913)                                      00002160
      IF(A(4,5) .LT. 0.0)WRITE(3,914)                                      00002170
      IF(A(5,5) .LT. 0.0)WRITE(3,915)                                      00002180
      IF(A(6,5) .LT. 0.0)WRITE(3,916)                                      00002190
      IF(A(7,5) .LT. 0.0)WRITE(3,917)                                      00002200
      IF(A(8,5) .LT. 0.0)WRITE(3,918)                                      00002210
C                                                                          00002220
      READ(1,901)(A(I,6),I=1,9)                                            00002230
C                                                                          00002240
C         PROCESS OPERATIONS                                               00002250
C     A(1,6)=PRIMARY EFFLUENT BOD (MG/L)                                   00002260
C     A(2,6)=PRIMARY EFFLUENT SUSPENDED SOLIDS (MG/L)                      00002270
C     A(3,6)=MIXED LIQUOR SUSPENDED SOLIDS (MG/L)                          00002280
C     A(4,6)=VOLUME OF AIR DELIVERED (1000 FT3/DAY)                        00002290
C     A(5,6)=HOURS OF OPERATION OF MECHANICAL AERATORS (HRS/DAY)           00002300
C     A(6,6)=RETURN SLUDGE VOLUME (MGD)                                    00002310
C     A(7,6)=RETURN SLUDGE SUSPENDED SOLIDS (MG/L)                         00002320
C     A(8,6)=WASTE SLUDGE VOLUME (MGD)                                     00002330
C     A(9,6)=AVERAGE AERATION BASIN DISOLVED OXYGEN (MG/L)                 00002340
C                                                                          00002350
      WRITE(3,920)                                                         00002360
      IF(A(1,6) .LT. 0.0)WRITE(3,921)                                      00002370
      IF(A(2,6) .LT. 0.0)WRITE(3,922)                                      00002380
      IF(A(3,6) .LT. 0.0)WRITE(3,923)                                      00002390
      IF(A(4,6) .LT. 0.0)WRITE(3,924)                                      00002400
      IF(A(5,6) .LT. 0.0)WRITE(3,925)                                      00002410
      IF(A(6,6) .LT. 0.0)WRITE(3,926)                                      00002420
      IF(A(7,6) .LT. 0.0)WRITE(3,927)                                      00002430
      IF(A(8,6) .LT. 0.0)WRITE(3,928)                                      00002440
      IF(A(9,6) .LT. 0.0)WRITE(3,929)                                      00002450
C                                                                          00002460
      WRITE(3,902)                                                         00002470
      WRITE(3,903)PLANT                                                    00002480
      WRITE(3,904)                                                         00002490
C                                                                          00002500
C  OPERATIONS AND DESIGN CHECK                                             00002510
C                                                                          00002520
```

```
C  PRIMARY CLARIFIER                                                    00002530
C                                                                       00002540
C  DETENTION TIME                                                       00002550
      IF(A(1,1) .LT. 0.)GO TO 101                                       00002560
      XA=A(1,1)/(A(2,5)*1.0E03/24.)                                     00002570
      XP=A(1,1)/(A(1,5)*1.0E03/24.)                                     00002580
      WRITE(3,930)A(5,1),XA,XP                                          00002590
C                                                                       00002600
C  SURFACE SETTLING RATE                                                00002610
  101 IF(A(2,1) .LT. 0.)GO TO 102                                       00002620
      XA=A(2,5)*1.0E06/A(2,1)                                           00002630
      XP=A(1,5)*1.0E06/A(2,1)                                           00002640
      WRITE(3,931)A(6,1),XA,XP                                          00002650
C                                                                       00002660
C  WEIR OVERFLOW RATE                                                   00002670
  102 IF(A(3,1) .LT. 0.)GO TO 103                                       00002680
      XA=A(2,5)*1.0E06/A(3,1)                                           00002690
      XP=A(1,5)*1.0E06/A(3,1)                                           00002700
      WRITE(3,932)A(7,1),XA,XP                                          00002710
C                                                                       00002720
C  SOLIDS LOADING                                                       00002730
  103 IF(A(4,5) .LT. 0.  .OR.  A(2,1) .LT. 0.)GO TO 104                 00002740
      XA=A(4,5)*A(2,5)*8.34/A(2,1)                                      00002750
      WRITE(3,933)XA,XP                                                 00002760
C                                                                       00002780
C  EFFICIENCY                                                           00002790
  104 IF(A(4,5) .LT. 0.  .OR.  A(2,6) .LT. 0.)GO TO 105                 00002800
      EFF=((A(4,5)-A(2,6))/A(4,5))*100.                                 00002810
      WRITE(3,934)EFF                                                   00002820
C                                                                       00002830
C  AERATION BASIN                                                       00002840
C                                                                       00002850
C  DETENTION TIME                                                       00002860
  105 IF(A(1,2) .LT. 0.)GO TO 106                                       00002870
      IF(A(6,6) .LT. 0.)GO TO 106                                       00002880
      XA=A(1,2)/((A(2,5)+A(6,6))*1.0E03)*24.                            00002890
      XP=A(1,2)/((A(1,5)+A(6,6))*1.0E03)*24.                            00002900
      WRITE(3,940)A(3,2),XA,XP                                          00002910
C                                                                       00002920
C  VOLUMETRIC LOADING                                                   00002930
  106 IF(A(1,6) .LT. 0.  .OR.  A(1,2) .LT. 0.)GO TO 107                 00002940
      XA=A(1,6)*A(2,5)*8.34/A(1,2)*7.481                                00002950
      XP=A(1,6)*A(1,5)*8.34/A(1,2)*7.481                                00002960
      WRITE(3,941)XA,XP                                                 00002970
C                                                                       00002980
C  PROCESS LOADING INTENSITY                                            00002990
      IF(A(3,6) .LT. 0.)GO TO 107                                       00003000
      XA=A(1,6)*A(2,5)*8.34/(A(3,6)*A(1,2)*1.0E-03*8.34)                00003010
      XP=A(1,6)*A(1,5)*8.34/(A(3,6)*A(1,2)*1.0E-03*8.34)                00003020
      WRITE(3,942)XA,XP                                                 00003030
C                                                                       00003040
C  AVERAGE SLUDGE AGE                                                   00003050
  107 IF(A(3,6) .LT. 0. .OR. A(1,2) .LT. 0.)GO TO 108                   00003060
      IF(A(8,6) .LT. 0. .OR. A(7,6) .LT. 0.)GO TO 108                   00003070
      IF(A(6,5) .LT. 0.)GO TO 108                                       00003080
      XA=(A(3,6)*A(1,2)*1.0E-03*8.34)/((A(8,6)*1.E-06*A(7,6)*8.34)+     00003090
     1  ((A(2,5)-A(8,6)*1.E-06)*A(6,5)*8.34))                          00003100
```

```
      WRITE(3,943)XA                                                    00003110
C                                                                       00003120
C  DIFFUSED AERATION                                                    00003130
C  VOLUMETRIC AIR SUPPLY                                                00003140
  108 IF(A(4,6) .LT. 0.0) GO TO 110                                     00003150
      IF(A(1,2) .LT. 0.)GO TO 109                                       00003160
      XA=A(4,6)*1000.*7.48052/(A(1,2)*24.*60.)                          00003170
      WRITE(3,944)XA                                                    00003180
C                                                                       00003190
C  ORGANIC AIR SUPPLY                                                   00003200
  109 IF(A(1,6) .LT. 0.)GO TO 112                                       00003210
      XA=A(4,6)*1000./(A(1,6)*A(2,5)*8.34)                              00003220
      WRITE(3,945)XA                                                    00003230
      GO TO 112                                                         00003240
C                                                                       00003250
C  MECHANICAL AERATION                                                  00003260
C  VOLUMETRIC POWER SUPPLY                                              00003270
  110 IF(A(7,2) .LT. 0.0  .OR.  A(1,2) .LT. 0.0)GO TO 112               00003280
      XA=A(7,2)/A(1,2)*7.48052                                          00003290
      WRITE(3,946)XA                                                    00003300
C                                                                       00003310
C ORGANIC OXYGEN SUPPLY                                                 00003320
  111 IF(A(9,6) .LT. 0. .OR. A(1,6) .LT. 0.)GO TO 112                   00003330
      IF(A(5,6) .LT. 0. .OR. A(8,5) .LT. 0.)GO TO 112                   00003340
      ON=2.5*((A(8,5)-A(9,6))/9.17)*1.024**(A(7,5)-20.)*0.8             00003350
      XA=ON*A(7,2)*A(5,6)/(A(1,6)*A(2,5)*8.34)                          00003360
      WRITE(3,947)XA                                                    00003370
C                                                                       00003380
C  EFFICIENCY                                                           00003390
  112 IF(A(1,6) .LT. 0. .OR. A(5,5) .LT. 0.)GO TO 113                   00003400
      EFF=(A(1,6)-A(5,5))/A(1,6)*100.                                   00003410
      WRITE(3,948)EFF                                                   00003420
C                                                                       00003430
C  SECONDARY CLARIFIER                                                  00003440
C                                                                       00003450
C  DETENTION TIME                                                       00003460
  113 IF(A(1,3) .LT. 0.)GO TO 114                                       00003470
      IF(A(6,6) .LT. 0.)GO TO 117                                       00003480
      XA=A(1,3)/((A(2,5)+A(6,6))*1.0E03)*24.                            00003490
      XP=A(1,3)/((A(1,5)+A(6,6))*1.0E03)*24.                            00003500
      WRITE(3,950)A(5,3),XA,XP                                          00003510
C                                                                       00003520
C  SURFACE SETTLING RATE                                                00003530
  114 IF(A(2,3) .LT. 0.)GO TO 115                                       00003540
      XA=((A(2,5)+A(6,6))*1.0E06)/A(2,3)                                00003550
      XP=((A(1,5)+A(6,6))*1.0E06)/A(2,3)                                00003560
      WRITE(3,951)A(6,3),XA,XP                                          00003570
C                                                                       00003580
C  WEIR OVERFLOW RATE                                                   00003590
  115 IF(A(3,3) .LT. 0.)GO TO 116                                       00003600
      XA=(A(2,5)+A(6,6))*1.0E06/A(3,3)                                  00003610
      XP=(A(1,5)+A(6,6))*1.0E06/A(3,3)                                  00003620
      WRITE(3,952)A(7,3),XA,XP                                          00003630
C                                                                       00003640
C  SOLIDS LOADING                                                       00003650
  116 IF(A(2,3) .LT. 0.)GO TO 117                                       00003660
      IF(A(3,6) .LT. 0.)GO TO 118                                       00003670
      XA=A(3,6)*(A(2,5)+A(6,6))*8.34/A(2,3)                             00003680
```

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      XP=A(3,6)*(A(1,5)+A(6,6))*8.34/A(2,3)                                00003690
      WRITE(3,953)A(8,3),XA,XP                                             00003700
C                                                                          00003710
C  EFFICIENCY                                                              00003720
  117 IF(A(6,5) .LT. 0.)GO TO 118                                          00003730
      EFF=(A(3,6)-A(6,5))/A(3,6)*100.                                      00003740
      WRITE(3,954)EFF                                                      00003750
C                                                                          00003760
C  PLANT BOD EFFICIENCY                                                    00003770
  118 IF(A(3,5) .LT. 0. .OR. A(5,5) .LT. 0.)GO TO 119                      00003780
      E=(A(3,5)-A(5,5))/A(3,5)*100.                                        00003790
      WRITE(3,960)E                                                        00003800
C                                                                          00003810
C  PLANT SUSPENDED SOLIDS EFFICIENCY                                       00003820
  119 IF(A(4,5) .LT. 0. .OR. A(6,5) .LT. 0.)GO TO 120                      00003830
      E=(A(4,5)-A(6,5))/A(4,5)*100.                                        00003840
      WRITE(3,961)E                                                        00003850
C                                                                          00003860
  120 CONTINUE                                                             00003870
      RETURN1                                                              00003880
  901 FORMAT(10F8.0)                                                       00003890
  902 FORMAT(1H1///,T41,50('*')/                                           00003900
     1  T41,'*         PLANT DESIGN AND OPERATION CHECK          *',      00003910
     2  /T41,50('*'))                                                     00003920
  903 FORMAT(T46,10A4)                                                     00003930
  904 FORMAT(//T30,'PARAMETER',T74,'DESIGN',T88,'AVERAGE',T106,'PEAK'/     00003940
     1          T30,'*********',T74,'******',T88,'*******',T106,'****'/)  00003950
  909 FORMAT(/T20,'OPERATIONS INFORMATION NOT AVAILABLE',                  00003960
     1  /T20,36('*'))                                                     00003970
  910 FORMAT(/T18,'** GENERAL OPERATIONS **')                              00003980
  911 FORMAT(T20,'PEAK FLOW')                                              00003990
  912 FORMAT(T20,'TOTAL DAILY FLOW')                                       00004000
  913 FORMAT(T20,'AVERAGE INFLUENT BOD')                                   00004010
  914 FORMAT(T20,'AVERAGE INFLUENT SUSPENDED SOLIDS')                      00004020
  915 FORMAT(T20,'AVERAGE EFFLUENT BOD')                                   00004030
  916 FORMAT(T20,'AVERAGE EFFLUENT SUSPENDED SOLIDS')                      00004040
  917 FORMAT(T20,'AVERAGE EFFLUENT TEMPERATURE')                           00004050
  918 FORMAT(T20,'D.O. SATURATION IN AERATION BASIN')                      00004060
  920 FORMAT(/T18,'** PROCESS OPERATIONS **')                              00004070
  921 FORMAT(T20,'PRIMARY EFFLUENT BOD')                                   00004080
  922 FORMAT(T20,'PRIMARY EFFLUENT SUSPENDED SOLIDS')                      00004090
  923 FORMAT(T20,'MIXED LIQUOR SUSPENDED SOLIDS')                          00004100
  924 FORMAT(T20,'VOLUME OF AIR DELIVERED')                                00004110
  925 FORMAT(T20,'HOURS OF OPERATION OF MECHANICAL AERATORS')               00004120
  926 FORMAT(T20,'RETURN SLUDGE VOLUME')                                   00004130
  927 FORMAT(T20,'RETURN SLUDGE SUSPENDED SOLIDS')                         00004140
  928 FORMAT(T20,'WASTE SLUDGE VOLUME')                                    00004150
  929 FORMAT(T20,'AVERAGE AERATION BASIN DISOLVED OXYGEN')                 00004160
  930 FORMAT(/T10,'PRIMARY CLARIFIER DETENTION TIME (HRS)',T70,F10.3,T85   00004170
     1  ,F10.3,T100,F10.3)                                                00004180
  931 FORMAT(/T10,'PRIMARY CLARIFIER SURFACE SETTLING RATE (GPD/FT2)',     00004190
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                   00004200
  932 FORMAT(/T10,'PRIMARY CLARIFIER WEIR OVERFLOW RATE (GPD/FT)',         00004210
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                   00004220
  933 FORMAT(/T10,'PRIMARY CLARIFIER SOLIDS LOADING RATE (LB SS/FT2',      00004230
     1  '-DAY)',T85,F10.3,T100,F10.3)                                     00004240
  934 FORMAT(/T10,'PRIMARY CLARIFIER SOLIDS REMOVAL EFFICIENCY',           00004250
     1  T120,F5.1,' %')                                                   00004260
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  940 FORMAT(/T10,'AERATION BASIN DETENTION TIME (HRS)',                    00004270
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00004280
  941 FORMAT(/T10,'AERATION BASIN VOLUMETRIC LOADING ',                     00004290
     1  '(LB BOD/1000 FT3-DAY)',T85,F10.3,T100,F10.3)                       00004300
  942 FORMAT(/T10,'PROCESS LOADING INTENSITY (LB BOD/LB MLSS-DAY)',         00004310
     1  T85,F10.3,T100,F10.3)                                               00004320
  943 FORMAT(/T10,'AVERAGE SLUDGE AGE (DAYS)',T85,F10.3)                    00004330
  944 FORMAT(/T10,'VOLUMETRIC AIR SUPPLY (CFM/1000 FT3)'                    00004340
     1  ,T85,F10.3)                                                         00004350
  945 FORMAT(/T10,'ORGANIC AIR SUPPLY (FT3/LB BOD)',                        00004360
     1  T85,F10.3)                                                          00004370
  946 FORMAT(/T10,'VOLUMETRIC POWER SUPPLIED (HP/1000 FT3)',                00004380
     1  T85,F10.3)                                                          00004390
  947 FORMAT(/T10,'ORGANIC OXYGEN SUPPLY (LB O2/LB BOD)',                   00004400
     1  T85,F10.3)                                                          00004410
  948 FORMAT(/T10,'AERATION BASIN BOD REMOVAL EFFICIENCY',T120,F5.1,         00004420
     1  ' %')                                                               00004430
  950 FORMAT(/T10,'SECONDARY CLARIFIER DETENTION TIME (HRS)',               00004440
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00004450
  951 FORMAT(/T10,'SECONDARY CLARIFIER SURFACE SETTLING RATE (GPD/',        00004460
     1  'FT2)',T70,F10.3,T85,F10.3,T100,F10.3)                              00004470
  952 FORMAT(/T10,'SECONDARY CLARIFIER WEIR OVERFLOW RATE (GPD/FT)',        00004480
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00004490
  953 FORMAT(/T10,'SECONDARY CLARIFIER SOLIDS LOADING RATE (LB SS/FT2',     00004500
     1  '-DAY)',T70,F10.3,T85,F10.3,T100,F10.3)                             00004510
  954 FORMAT(/T10,'SECONDARY CLARIFIER SOLIDS REMOVAL EFFICIENCY',          00004520
     1  T120,F5.1,' %')                                                     00004530
  960 FORMAT(/T10,'OVERALL PLANT BOD REMOVAL EFFICIENCY',                   00004540
     1  T120,F5.1,' %')                                                     00004550
  961 FORMAT(/T10,'OVERALL PLANT SOLIDS REMOVAL EFFICIENCY',                00004560
     1  T120,F5.1,' %')                                                     00004570
      END                                                                   00004580
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      SUBROUTINE TFILT(*)                                                00004590
      COMMON A(9,6),PLANT(10)                                            00004600
C                                                                        00004610
C  READ IN OPERATIONS DATA                                               00004620
C                                                                        00004630
      READ(1,901)(A(I,5),I=1,6)                                          00004640
C                                                                        00004650
C         GENERAL OPERATIONS                                             00004660
C     A(1,1)=PEAK FLOW (INFLUENT) (MGD)                                  00004670
C     A(2,5)=TOTAL DAILY FLOW (INFLUENT) (MG)                            00004680
C     A(3,5)=BOD (INFLUENT) (MG/L)                                       00004690
C     A(4,5)=SUSPENDED SOLIDS (INFLUENT) (MG/L)                          00004700
C     A(5,5)=BOD (EFFLUENT) (MG/L)                                       00004710
C     A(6,5)=SUSPENDED SOLIDS (EFFLUENT) (MG/L)                          00004720
C                                                                        00004730
      WRITE(3,909)                                                       00004740
      WRITE(3,910)                                                       00004750
      IF(A(1,5) .LT. 0.0)WRITE(3,911)                                    00004760
      IF(A(2,5) .LT. 0.0)WRITE(3,912)                                    00004770
      IF(A(3,5) .LT. 0.0)WRITE(3,913)                                    00004780
      IF(A(4,5) .LT. 0.0)WRITE(3,914)                                    00004790
      IF(A(5,5) .LT. 0.0)WRITE(3,915)                                    00004800
      IF(A(6,5) .LT. 0.0)WRITE(3,916)                                    00004810
C                                                                        00004820
      READ(1,901)(A(I,6),I=1,8)                                          00004830
C                                                                        00004840
C     PROCESS OPERATIONS                                                 00004850
C                                                                        00004860
C     A(1,6)=PRIMARY EFFLUENT BOD (MG/L)                                 00004870
C     A(2,6)=PRIMARY EFFLUENT SUSPENDED SOLIDS (MG/L)                    00004880
C     A(3,6)=FILTER EFFLUENT BOD (MG/L)                                  00004890
C     A(4,6)=FILTER EFFLUENT SUSPENDED SOLIDS (MG/L)                     00004900
C     A(5,6)=RECYCLE TO FILTER (MGD)                                     00004910
C     A(6,6)=RECYCLE FROM FILTER (MGD)                                   00004920
C     A(7,6)=RECYCLE FROM SECONDARY CLARIFIER (MGD)                      00004930
C                                                                        00004940
      WRITE(3,920)                                                       00004950
      IF(A(1,6) .LT. 0.0)WRITE(3,921)                                    00004960
      IF(A(2,6) .LT. 0.0)WRITE(3,922)                                    00004970
      IF(A(3,6) .LT. 0.0)WRITE(3,923)                                    00004980
      IF(A(4,6) .LT. 0.0)WRITE(3,924)                                    00004990
      IF(A(5,6) .LT. 0.0)WRITE(3,925)                                    00005000
      IF(A(6,6) .LT. 0.0)WRITE(3,926)                                    00005010
      IF(A(7,6) .LT. 0.0)WRITE(3,927)                                    00005020
C                                                                        00005030
      WRITE(3,902)                                                       00005040
      WRITE(3,903)PLANT                                                  00005050
      WRITE(3,904)                                                       00005060
C                                                                        00005070
C  OPERATIONS AND DESIGN CHECK                                           00005080
C                                                                        00005090
C  PRIMARY CLARIFIER                                                     00005100
C                                                                        00005110
C  DETENTION TIME                                                        00005120
      IF(A(1,1) .LT. 0.)GO TO 100                                        00005130
      XA=A(1,1)/(A(2,5)*1.0E03/24.)                                      00005140
      XP=A(1,1)/(A(1,5)*1.0E03/24.)                                      00005150
      WRITE(3,930)A(5,1),XA,XP                                           00005160
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      C                                                                 00005170
      C  SURFACE SETTLING RATE                                          00005180
        100 IF(A(2,1) .LT. 0.)GO TO 101                                 00005190
            XA=A(2,5)*1.0E06/A(2,1)                                     00005200
            XP=A(1,5)*1.0E06/A(2,1)                                     00005210
            WRITE(3,931)A(6,1),XA,XP                                    00005220
      C                                                                 00005230
      C  WEIR OVERFLOW RATE                                             00005240
        101 IF(A(3,1) .LT. 0.)GO TO 102                                 00005250
            XA=A(2,5)*1.0E06/A(3,1)                                     00005260
            XP=A(1,5)*1.0E06/A(3,1)                                     00005270
            WRITE(3,932)A(7,1),XA,XP                                    00005280
      C                                                                 00005290
      C  SOLIDS LOADING                                                 00005300
        102 IF(A(4,5) .LT. 0. .OR. A(2,1) .LT. 0.)GO TO 103             00005310
            XA=A(4,5)*A(2,5)*8.34/A(2,1)                                00005320
            XP=A(4,5)*A(1,5)*8.34/A(2,1)                                00005330
            WRITE(3,933)XA,XP                                           00005340
      C                                                                 00005350
      C  EFFICIENCY                                                     00005360
        103 IF(A(4,5) .LT. 0. .OR. A(2,6) .LT. 0.)GO TO 104             00005370
            EFF=((A(4,5)-A(2,6))/A(4,5))*100.                           00005380
            WRITE(3,934)EFF                                             00005390
      C                                                                 00005400
      C  TRICKLING FILTER                                               00005410
      C                                                                 00005420
      C  HYDRAULIC LOADING                                              00005430
        104 IF(A(4,2) .LT. 0.)GO TO 106                                 00005440
            IF(A(5,6) .LT. 0.)GO TO 106                                 00005450
            XA=(A(2,5)+A(5,6))/A(4,2)                                   00005460
            XP=(A(1,5)+A(5,6))/A(4,2)                                   00005470
        105 XD=(A(1,2)+A(5,2))/A(4,2)                                   00005480
            IF(A(1,2) .LT. 0. .OR. A(5,2) .LT. 0.)XD=-1.                00005490
            WRITE(3,940)XD,XA,XP                                        00005500
      C                                                                 00005510
      C  ORGANIC LOADING                                                00005520
        106 IF(A(1,6) .LT. 0. .OR. A(3,2) .LT. 0.)GO TO 107             00005530
            XA=(A(2,5)*A(1,6)*8.34)/A(3,2)                              00005540
            XP=(A(1,5)*A(1,6)*8.34)/A(3,2)                              00005550
            WRITE(3,941)A(2,2),XA,XP                                    00005560
      C                                                                 00005570
      C  RECIRCULATION RATIO                                            00005580
        107 IF(A(5,6) .LT. 0.)GO TO 108                                 00005590
            XA=A(5,6)/A(2,5)                                            00005600
            XP=A(5,6)/A(1,5)                                            00005610
        108 XD=A(5,2)/A(1,2)                                            00005620
            IF(A(5,2) .LT. 0. .OR. A(1,2) .LT. 0.)XD=-1.                00005630
            WRITE(3,942)XD,XA,XP                                        00005640
      C                                                                 00005650
      C  EFFICIENCY                                                     00005660
        109 IF(A(1,6) .LT. 0. .OR. A(5,5) .LT. 0.)GO TO 110             00005670
            E=(A(1,6)-A(5,5))/A(1,6)*100.                               00005680
            WRITE(3,943)E                                               00005690
      C                                                                 00005700
      C  SECONDARY CLARIFIER                                            00005710
      C                                                                 00005720
      C  DETENTION TIME                                                 00005730
        110 IF(A(1,3) .LT. 0.)GO TO 111                                 00005740
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      IF(A(5,6) .LT. 0. .OR. A(6,6) .LT. 0.)GO TO 114                    00005750
      XA=A(1,3)/((A(2,5)+A(5,6)-A(6,6))*1.0E03)*24.                      00005760
      XP=A(1,3)/((A(1,5)+A(5,6)-A(6,6))*1.0E03)*24.                      00005770
      WRITE(3,950)A(5,3),XA,XP                                           00005780
C                                                                        00005790
C  SURFACE SETTLING RATE                                                 00005800
  111 IF(A(2,3) .LT. 0.)GO TO 112                                        00005810
      XA=(A(2,5)+A(5,6)-A(6,6))*1.0E06/A(2,3)                            00005820
      XP=(A(1,5)+A(5,6)-A(6,6))*1.0E06/A(2,3)                            00005830
      WRITE(3,951)A(6,3),XA,XP                                           00005840
C                                                                        00005850
C  WEIR OVERFLOW RATE                                                    00005860
  112 IF(A(3,3) .LT. 0.)GO TO 113                                        00005870
      XA=(A(2,5)+A(5,6)-A(6,6))*1.0E06/A(3,3)                            00005880
      XP=(A(1,5)+A(5,6)-A(6,6))*1.0E06/A(3,3)                            00005890
      WRITE(3,952)A(7,3),XA,XP                                           00005900
C                                                                        00005910
C  SOLIDS LOADING                                                        00005920
  113 IF(A(4,6) .LT. 0.)GO TO 115                                        00005930
      IF(A(5,6) .LT. 0. .OR. A(6,6) .LT. 0.)GO TO 114                    00005940
      IF(A(2,3) .LT. 0.)GO TO 114                                        00005950
      XA=(A(2,5)+A(5,6)-A(6,6))*A(4,6)*8.34/A(2,3)                       00005960
      XP=(A(1,5)+A(5,6)-A(6,6))*A(4,6)*8.34/A(2,3)                       00005970
      WRITE(3,953)A(8,3),XA,XP                                           00005980
C                                                                        00005990
C  EFFICIENCY                                                            00006000
  114 IF(A(6,5) .LT. 0.)GO TO 115                                        00006010
      E=(A(4,6)-A(6,5))/A(4,6)*100.                                      00006020
      WRITE(3,954)E                                                      00006030
C                                                                        00006040
C  PLANT BOD EFFICIENCY                                                  00006050
  115 IF(A(3,5) .LT. 0. .OR. A(5,5) .LT. 0.)GO TO 116                    00006060
      E=(A(3,5)-A(5,5))/A(3,5)*100.                                      00006070
      WRITE(3,960)E                                                      00006080
C                                                                        00006090
C  PLANT SUSPENDED SOLIDS EFFICIENCY                                     00006100
  116 IF(A(4,5) .LT. 0. .OR. A(6,5) .LT. 0.)GO TO 117                    00006110
      E=(A(4,5)-A(6,5))/A(4,5)*100.                                      00006120
      WRITE(3,961)E                                                      00006130
C                                                                        00006140
  117 CONTINUE                                                           00006150
      RETURN1                                                            00006160
  901 FORMAT(9F8.0)                                                      00006170
  902 FORMAT(1H1///T41,50('*')/                                          00006180
     1  T41,'*         PLANT DESIGN AND OPERATION CHECK         *',     00006190
     2  /T41,50('*'))                                                   00006200
  903 FORMAT(T46,10A4)                                                   00006210
  904 FORMAT(//T30,'PARAMETER',T74,'DESIGN',T88,'AVERAGE',T106,'PEAK'/   00006220
     1         T30,'*********',T74,'******',T88,'*******',T106,'****'/) 00006230
  909 FORMAT(/T20,'OPERATIONS INFORMATION NOT AVAILABLE',                00006240
     1  /T20,36('*'))                                                   00006250
  910 FORMAT(/T18,'** GENERAL OPERATIONS **')                            00006260
  911 FORMAT(T20,'PEAK FLOW')                                            00006270
  912 FORMAT(T20,'TOTAL DAILY FLOW')                                     00006280
  913 FORMAT(T20,'AVERAGE INFLUENT BOD')                                 00006290
  914 FORMAT(T20,'AVERAGE INFLUENT SUSPENDED SOLIDS')                    00006300
  915 FORMAT(T20,'AVERAGE EFFLUENT BOD')                                 00006310
  916 FORMAT(T20,'AVERAGE EFFLUENT SUSPENDED SOLIDS')                    00006320
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  920 FORMAT(/T18,'** PROCESS OPERATIONS **')                                00006330
  921 FORMAT(T20,'PRIMARY EFFLUENT BOD')                                     00006340
  922 FORMAT(T20,'PRIMARY EFFLUENT SUSPENDED SOLIDS')                        00006350
  923 FORMAT(T20,'FILTER EFFLUENT BOD')                                      00006360
  924 FORMAT(T20,'FILTER EFFLUENT SUSPENDED SOLIDS')                         00006370
  925 FORMAT(T20,'RECYCLE TO FILTER')                                        00006380
  926 FORMAT(T20,'RECYCLE FROM FILTER')                                      00006390
  927 FORMAT(T20,'RECYCLE FROM SECONDARY CLARIFIER')                         00006400
  930 FORMAT(/T10,'PRIMARY CLARIFIER DETENTION TIME (HRS)',                  00006410
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00006420
  931 FORMAT(/T10,'PRIMARY CLARIFIER SURFACE SETTLING RATE (GPD/FT2)',       00006430
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00006440
  932 FORMAT(/T10,'PRIMARY CLARIFIER WEIR OVERFLOW RATE (GPD/FT)',           00006450
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00006460
  933 FORMAT(/T10,'PRIMARY CLARIFIER SOLIDS LOADING RATE (LB SS/FT2'         00006470
     1  ,'-DAY)',T85,F10.3,T100,F10.3)                                      00006480
  934 FORMAT(/T10,'PRIMARY CLARIFIER SOLIDS REMOVAL EFFICIENCY',             00006490
     1  T120,F5.1,' %')                                                     00006500
  940 FORMAT(/T10,'TRICKLING FILTER HYDRAULIC LOADING (MGAD)',               00006510
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00006520
  941 FORMAT(/T10,'TRICKLING FILTER ORGANIC LOADING (LB BOD/ACRE-'           00006530
     1  ,'FT-DAY)',T70,F10.3,T85,F10.3,T100,F10.3)                          00006540
  942 FORMAT(/T10,'FILTER RECIRCULATION RATIO (RECIRCULATION/INFLUENT)',     00006550
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00006560
  943 FORMAT(/T10,'FILTER BOD REMOVAL EFFICIENCY',                           00006570
     1  T120,F5.1,' %')                                                     00006580
  950 FORMAT(/T10,'SECONDARY CLARIFIER DETENTION TIME (HRS)',                00006590
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00006600
  951 FORMAT(/T10,'SECONDARY CLARIFIER SURFACE SETTLING RATE (GPD/FT2)',     00006610
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00006620
  952  FORMAT(/T10,'SECONDARY CLARIFIER WEIR OVERFLOW RATE (GPD/FT)',        00006630
     1  T70,F10.3,T85,F10.3,T100,F10.3)                                     00006640
  953 FORMAT (/T10,'SECONDARY CLARIFIER SOLIDS LOADING RATE (LB SS/FT2',     00006650
     1  '-DAY)',T70,F10.3,T85,F10.3,T100,F10.3)                             00006660
  954 FORMAT(/T10,'SECONDARY CLARIFIER SOLIDS REMOVAL EFFICIENCY',           00006670
     1  T120,F5.1,' %')                                                     00006680
  960 FORMAT(/T10,'OVERALL PLANT BOD REMOVAL EFFICIENCY',                    00006690
     1  T120,F5.1,' %')                                                     00006700
  961 FORMAT(/T10,'OVERALL PLANT SOLIDS REMOVAL EFFICIENCY',                 00006710
     1  T120,F5.1,' %')                                                     00006720
      END                                                                    00006730
```

APPENDIX D

Output From Indicator Model Program

****
* PLANT DESIGN AND OPERATION CHECK *
****

FORT ORD, CA
TRICKLING FILTER TYPE PLANT

DESIGN INFORMATION NOT AVAILABLE
****

PRIMARY SETTLING
TOTAL WEIR LENGTH
WEIR OVERFLOW RATE

TRICKLING FILTER
FILTER RECYCLE

**FINAL CLARIFIER **
SOLIDS LOADING

OPERATIONS INFORMATION NOT AVAILABLE
****

** GENERAL OPERATIONS **

** PROCESS OPERATIONS **
FILTER EFFLUENT SUSPENDED SOLIDS

****
* PLANT DESIGN AND OPERATION CHECK *
****
FORT ORD, CA

PARAMETER	DESIGN	AVERAGE	PEAK	
PRIMARY CLARIFIER DETENTION TIME (HRS)	2.500	5.280	3.314	
PRIMARY CLARIFIER SURFACE SETTLING RATE (GPD/FT2)	701.670	340.000	541.667	
PRIMARY CLARIFIER SOLIDS LOADING RATE (LB SS/FT2-DAY)		1.009	1.608	
PRIMARY CLARIFIER SOLIDS REMOVAL EFFICIENCY				19.1 %
TRICKLING FILTER HYDRAULIC LOADING (MGAD)	-1.000	7.446	9.607	
TRICKLING FILTER ORGANIC LOADING (LB BOD/ACRE-FT-DAY)	1973.300	981.553	1563.750	
FILTER RECIRCULATION RATIO (RECIRCULATION/INFLUENT)	-1.000	1.044	0.655	
FILTER BOD REMOVAL EFFICIENCY				61.0 %
SECONDARY CLARIFIER DETENTION TIME (HRS)	1.700	3.498	2.196	
SECONDARY CLARIFIER SURFACE SETTLING RATE (GPD/FT2)	950.000	461.762	735.650	
SECONDARY CLARIFIER WEIR OVERFLOW RATE (GPD/FT)	6130.000	2970.296	4732.090	
OVERALL PLANT BOD REMOVAL EFFICIENCY				75.7 %
OVERALL PLANT SOLIDS REMOVAL EFFICIENCY				69.1 %