QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS IN THE AQUATIC ENVIRONMENT

by

R. Riggins
E. Herricks
M. J. Sale

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# QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS IN THE AQUATIC ENVIRONMENT

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This report describes the development of a rigorous set of analysis procedures useful for identifying significant effects resulting from Army activities on aquatic ecosystems. Application guidelines and examples of these procedures are provided. The analysis procedures include techniques for organizing pertinent environmental information, simulation of spatial and temporal variations in water quality, and prediction of impact significance.
FOREWORD

This study was performed for the Directorate of Military Programs, Office of the Chief of Engineers (OCE) under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities"; Task A, "Environmental Impact Monitoring, Management, Assessment, and Planning"; Work Unit 022, "Water Quality Model System". The work was performed by personnel in the Civil Engineering Department of the University of Illinois, under Contract DACA 88-78-R-006, for the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL). Mr. Paul Carmichael, DAEN-MPE-T, was the OCE Technical Monitor.

The work was performed by the Environmental (EN) Division of the U.S. Army Construction Engineering Research Laboratory (CERL). Mr. R. E. Riggins was the CERL Principal Investigator. Dr. R. K. Jain is Chief of CERL-EN.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.
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<td>25</td>
</tr>
</tbody>
</table>
1 INTRODUCTION

Background

During the first decade of legislated environmental assessment of governmental activities, there have been changes in approaches and attitudes toward the National Environmental Policy Act (NEPA), as well as implementation of new legislation and administrative guidelines requiring new forms of environmental planning. New terminology, such as "scoping," "fate and effect," "hazard evaluation," etc., has appeared, and new methodologies have been developed for environmental planning and management. Unfortunately, legislative acts and rhetoric tend to grow faster than do the tools to carry them out. As a result, quantifying and measuring the significance of environmental impacts still remains an elusive target during planning, and flexible and efficient tools are needed to predict, evaluate, and mitigate these impacts. To meet this need, the U.S. Army Construction Engineering Research Laboratory (CERL) has developed a prototype package of computerized impact evaluation procedures called the Rational Impact Assessment System (RIAS) which use site-specific quantification routines to answer such questions as, "How bad will the impact be?" or "Will the impact be significant?"

Objective

The objective of this report is to document the development of RIAS as an impact evaluation tool.

Approach

Because the mechanisms of environmental impacts can be extremely complex and varied, it is difficult to construct one comprehensive simulation tool for predicting them. For this reason, the computer software developed to support RIAS consists of a series of independent modules which can be used either as separate programs or together as subroutines within a larger control program. The number of modules used depends entirely on the decision-maker's needs and the types of impacts identified through initial scoping.

Data collection, processing, and impact simulation carried out in RIAS proceed through the use of three general procedures: Filter Questions (FQUES), Water Quality Simulation (SIMWQ), and Rational Threshold Value Test (RTVTEST) (see Figure 1). Appendix C provides program listings for these three systems. FQUES collects and organizes relevant environmental setting and project information data through a computerized format of filter questions. SIMWQ simulates primary impacts on the physical/chemical attributes of
the aquatic receiving system over both temporal and spatial dimensions. RTVTEST is a set of rational threshold values (RTV) models which predict the significance of the primary and secondary impacts listed by SIMWQ. This series of analyses simulates the impact chain of events and provides a uniform method for environmental data handling.

Chapters 2 and 3 document the development of RIAS as an impact significance evaluation tool, describing these three supporting modules and providing user information for application of RIAS to the quantitative assessment of impacts on aquatic ecosystems. Four example applications of RIAS (Chapter 4) and user information for data collection and organization are presented (Chapter 5).

Mode of Technology Transfer

The information in this report will be issued as a DA Pamphlet in the 200 series and as the module called RIAS in the remote terminal ADP system entitled Environmental Technical Information System (ETIS).

Figure 1. General design and information flow for the RIAS.
2 FILTER QUESTIONS

FQUES has been developed to execute a program which asks a series of questions about a specific project's environmental setting and organizes the information obtained into a data file. The data file is then used as input for simulations and other evaluation protocols.

FQUES can be used to set up a new data file or to revise an existing data file. Output from FQUES stores data related to such things as number of stream reaches, number of conservative and nonconservative water quality attributes, tributary inputs, point source discharges, hydraulic rating parameters, boundary conditions, and biological parameters.
WATER QUALITY SIMULATIONS (SIMWQ)

The development of SIMWQ has been restricted to one-dimensional, non-dispersive, steady-state, plug flow models for receiving streams. Whenever possible, rate equations have been limited to first-order reaction kinetics. This results in linear rate equations which provide analytical solutions. In addition, it avoids the necessity of using complicated numerical solution techniques for sets of differential equations and produces a much more usable model.

SIMWQ considers two types of sources or sinks for water quality constituents. First-order decay or accumulation terms, similar to the form of the Streeter-Phelps equation, are used to represent most biological activity in the stream. These terms can also be used for distributed sources or sinks which affect the stream equally along a longitudinal gradient. Examples of these terms are benthic oxygen demand or nonpoint source runoff. The receiving watershed is represented by a series of stream reaches within which all model parameters are constant. At the end of each reach, new model parameters are calculated, based on local environmental data and point source inputs. These results are combined with upstream values based on conservation of mass and assuming complete mix. This modeling approach is not new; however, it is an efficient, flexible system for tracing changes in water quality.

One major addition to the computer program which is the basis for SIMWQ is the capability to handle branched watersheds. This required coding the boundary conditions for reaches rather than a modification of the analytical solutions.

Figure 2 shows the general conceptual design of SIMWQ and the variables it can analyze. Tables 1 and 2 define the model's variables and parameters, respectively. Table 3 presents the rate equations which represent the heart of the model. Table 4 lists the analytical solutions derived from the equations provided in Table 3. These solutions assume time-constant model parameters and apply only within reaches. Tributaries and any applicable point source inputs between reaches are accounted for by Eq 1:

\[ C = \frac{Q_1 C_1 + Q_2 C_2}{Q_1 + Q_2} \]  

[Eq 1*]

where \( C \) denotes concentration, \( Q \) is flow, and subscripts 1 and 2 refer to the different flows being combined.

Several simplifying assumptions were used to reduce the system of rate equations to the desired forms, including:

1. Algae concentrations will be relatively constant for a given reach and a given season of the year.

2. Higher organisms, such as fish and invertebrates, do not significantly affect the rate of concentration change for any of the attributes considered.

*Variables for all equations in text are defined in Table 2.
3. For the purpose of SIMWQ, certain water quality attributes can effectively be considered conservative substances (e.g., TDS, hardness, pH, total alkalinity).

These, and other assumptions involved with steady-state and nondispersive models, must be reevaluated in each application of SIMWQ.

Figure 2. Conceptual organization of interactions between water quality attributes within each stream reach in SIMWQ.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALK</td>
<td>Total alkalinity as CaCO₃</td>
<td>mg/l</td>
</tr>
<tr>
<td>C</td>
<td>Total dissolved inorganic carbon</td>
<td>mg/l</td>
</tr>
<tr>
<td>CDET</td>
<td>Carbon content of detritus in water column</td>
<td>mg/l</td>
</tr>
<tr>
<td>CO₂</td>
<td>Dissolved carbon dioxide</td>
<td>mg/l</td>
</tr>
<tr>
<td>COLI</td>
<td>Coliform bacteria concentration</td>
<td>#/100 mL</td>
</tr>
<tr>
<td>CONSi</td>
<td>iᵗʰ additional conservative water quality constituent</td>
<td>mg/l</td>
</tr>
<tr>
<td>D</td>
<td>Dissolved oxygen saturation deficit</td>
<td>mg/l</td>
</tr>
<tr>
<td>HARD</td>
<td>Water hardness as CaCO₃</td>
<td>mg/l</td>
</tr>
<tr>
<td>Li</td>
<td>Biochemical oxygen demand (BOD₅)</td>
<td>mg/l</td>
</tr>
<tr>
<td>NCONi</td>
<td>iᵗʰ additional nonconservative water quality constituent</td>
<td>mg/l</td>
</tr>
<tr>
<td>NDET</td>
<td>Nitrogen content of detritus</td>
<td>mg/l</td>
</tr>
<tr>
<td>NH₃</td>
<td>Total ammonia nitrogen</td>
<td>mg/l</td>
</tr>
<tr>
<td>NO₂</td>
<td>Nitrite nitrogen</td>
<td>mg/l</td>
</tr>
<tr>
<td>NO₃</td>
<td>Nitrate nitrogen</td>
<td>mg/l</td>
</tr>
<tr>
<td>O₂</td>
<td>Dissolved oxygen</td>
<td>mg/l</td>
</tr>
<tr>
<td>PDET</td>
<td>Phosphorus content of detritus</td>
<td>mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>pH of surface water (-log₁₀ [H⁺])</td>
<td>--</td>
</tr>
<tr>
<td>PO₄</td>
<td>Phosphate-phosphorus</td>
<td>mg/l</td>
</tr>
<tr>
<td>TW</td>
<td>Temperature of water</td>
<td>°C</td>
</tr>
<tr>
<td>TSS</td>
<td>Total suspended solids</td>
<td>mg/l</td>
</tr>
<tr>
<td>TDS</td>
<td>Total dissolved solids</td>
<td>mg/l</td>
</tr>
</tbody>
</table>
Table 2
SIMWQ Parameter Listing

<table>
<thead>
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<th>Symbol</th>
<th>Definition</th>
<th>Values</th>
<th>Sources*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Distributed Sources/Sinks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_L$</td>
<td>Scour/runoff of BOD$_5$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_{NCONi}$</td>
<td>Nonpoint sources of non-conservative pollutants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_{NH3}$</td>
<td>Surface runoff of NH$_3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_{NO3}$</td>
<td>Surface runoff of NO$_3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_{SO2}$</td>
<td>Daily mean net $1^0$ production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_{PO4}$</td>
<td>Surface runoff of PO$_4$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_{SSOD}$</td>
<td>Sediment oxygen demand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_{SS}$</td>
<td>Scour/erosional inputs of suspended solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_T$</td>
<td>Natural heat inputs from atmosphere</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Reaction Rates</td>
<td>($k_i^T = o_i^{T-2} \cdot k_i^{20^\circ C}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_{ANH3}$</td>
<td>Algal uptake of NH$_3$</td>
<td>0.1 to 4.0</td>
<td></td>
</tr>
<tr>
<td>$T_{ANO3}$</td>
<td>Algal uptake of NO$_3$</td>
<td>0.1 to 4.0</td>
<td>White &amp; Dracup</td>
</tr>
<tr>
<td>$T_{AP04}$</td>
<td>Algal uptake of PO$_4$</td>
<td>0.005 to 0.5</td>
<td>White &amp; Dracup</td>
</tr>
<tr>
<td>$T_{L}$</td>
<td>Decomposition of BOD$_5$</td>
<td>0.01 to 2.5</td>
<td>HEC, Zison</td>
</tr>
<tr>
<td>$T_{LS}$</td>
<td>Bottom exchange of BOD$_5$</td>
<td>0.0 to 2.0</td>
<td></td>
</tr>
</tbody>
</table>

*See References, pp 32-33.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
<th>Values</th>
<th>Sources*</th>
</tr>
</thead>
<tbody>
<tr>
<td>$k_{NCNi}$</td>
<td>Biodegradation/decay of ith nonconservative pollutant</td>
<td>attribute dependent</td>
<td></td>
</tr>
<tr>
<td>$k_{NDET}$</td>
<td>Mineralization/dissolution of nitrogen portion of detritus</td>
<td>0.001 to 0.02</td>
<td>HEC</td>
</tr>
<tr>
<td>$k_{NH3}$</td>
<td>Microbial conversion of NH$_3$</td>
<td>0.01 to 2.5</td>
<td>Zison, pp 188-197, HEC</td>
</tr>
<tr>
<td>$k_{NO2}$</td>
<td>Microbial conversion of NO$_2$</td>
<td>0.020 to 0.5</td>
<td>Miller &amp; Jennings, White &amp; Dracup, HEC</td>
</tr>
<tr>
<td>$k_{NO3}$</td>
<td>Microbial conversion of NO$_3$</td>
<td>$= 0.001$</td>
<td>Miller &amp; Jennings</td>
</tr>
<tr>
<td>$k_{PDET}$</td>
<td>Mineralization/dissolution of phosphorus portion of detritus</td>
<td>0.001 to 0.02</td>
<td>HEC</td>
</tr>
<tr>
<td>$k_{P04}$</td>
<td>Decay of phosphates due to microbial uptake/conversion</td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>$k_R$</td>
<td>Reaeration of dissolved oxygen</td>
<td>$k^{20}_R = a^{b} H^c$</td>
<td>Covar</td>
</tr>
<tr>
<td>$k_{SS}$</td>
<td>Decay of suspended solids (mineralization/biotic breakdown)</td>
<td>0.001 to 0.02</td>
<td>HEC</td>
</tr>
<tr>
<td>$k_{SSS}$</td>
<td>Settling of suspended solids</td>
<td>0 to 2.0</td>
<td>HEC</td>
</tr>
</tbody>
</table>

*See References pp 32, 33.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
<th>Values</th>
<th>Sources*</th>
</tr>
</thead>
<tbody>
<tr>
<td>$k_T$</td>
<td>Heat exchange with atmosphere</td>
<td>(See Temp. Model in the Computer Listing)</td>
<td></td>
</tr>
<tr>
<td>$k_{TSS}$</td>
<td>Overall decay of suspended solids</td>
<td>$k_{SS} + k_{SSS}/\text{depth}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>((k_{TSS} = k_{SS} + k_{SSS}/\text{depth}))</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*See References pp 32, 33.*
Table 3
SIMWQ Rate Equations*

Rate Equations (within reaches, excluding point sources)

1. Temperature

\[ \frac{dT}{dt} = S_T - k_T T_t \]

2. BOD

\[ \frac{dL}{dt} = -(k_L^T + k_{LS}^T) L_t + S_L \]

3. Suspended Solids

\[ \frac{dTSS}{dt} = -k_{TSS}^T \cdot TSS_t + SSS = -(k_{SS}^T + \frac{k_{SS}^T}{\text{depth}}) TSS_t + SSS \]

4. Phosphate-Phosphorus

\[ \frac{dP04}{dt} = -k_{P04}^T \cdot P04_t + k_{PDET}^T \cdot PDET_t + S04 + k_{APO4}^T \cdot A \]

5. Ammonia-Nitrogen

\[ \frac{dNH3}{dt} = -k_{NH3}^T \cdot NH3_t + k_{NDET}^T \cdot NDET_t + SNH3 + k_{ANH3}^T \cdot A \]

6. Nitrite-Nitrogen

\[ \frac{dNO2}{dt} = -k_{NO2}^T \cdot NO2_t + k_{NH3}^T \cdot NH3_t \]

* Equation variables are defined in Table 2.
Table 3 (Cont'd)

7. Nitrate-Nitrogen

\[
\frac{dN_{\text{NO}_3}}{dt} = k_{\text{NO}_2} \cdot \text{NO}_2 - k_{\text{NO}_3} \cdot \text{NO}_3 + S_{\text{NO}_3} + k_{\text{ANO}_3} \cdot A
\]

8. Dissolved Oxygen Deficit

\[
\frac{dD}{dt} = -k_L \cdot L_t + k_{\text{NH}_3} \cdot L_{\text{NH}_3} + k_{\text{NO}_2} \cdot L_{\text{NO}_2} - k_R \cdot D_t - S_{O_2} + S_{\text{SO}_2}
\]

9. Conservative Constituents

\[
\frac{dC_{\text{ON}_i}}{dt} = 0
\]

10. Nonconservative Constituents

\[
\frac{dN_{\text{ON}_i}}{dt} = -k_{\text{NCON}_i} \cdot N_{\text{ON}_i} + S_{\text{NCON}_i}
\]
Table 4

Analytical Solutions to Table 3*
(These equations apply only within stream reaches which have constant model parameters.)

<table>
<thead>
<tr>
<th>Equation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Biochemical Oxygen Demand (L)</strong></td>
<td></td>
</tr>
<tr>
<td>[ L_t = (L_0 - \frac{L}{K_1}) \exp(-(k_L^T + k_{LS}^T)t) + \frac{L}{K_1} ]</td>
<td></td>
</tr>
<tr>
<td>where [ K_1 = \frac{S_L}{(k_L^T + k_{LS}^T)} ]</td>
<td></td>
</tr>
<tr>
<td><strong>2. Total Dissolved Solids (TSS)</strong></td>
<td></td>
</tr>
<tr>
<td>[ TSS_t = (TSS_0 - \frac{TSS}{K_1}) \exp(-(k_{SS}^T + \frac{k_{SSS}^T}{depth})t) + \frac{TSS}{K_1} ]</td>
<td></td>
</tr>
<tr>
<td>where [ K_1 = \frac{S_{SS}}{(k_{SS}^T + k_{SS}^T + k_{SSS}^T)_{depth}} ]</td>
<td></td>
</tr>
<tr>
<td><strong>3. Suspended Solids Portioning</strong></td>
<td></td>
</tr>
<tr>
<td>[ CDET_t = PC(TSS_t) ]</td>
<td></td>
</tr>
<tr>
<td>[ NDET_t = PN(TSS_t) ]</td>
<td></td>
</tr>
<tr>
<td>[ PDET_t = PP(TSS_t) ]</td>
<td></td>
</tr>
<tr>
<td><strong>4. NH3</strong></td>
<td></td>
</tr>
<tr>
<td>[ NH3_t = (NH3_0 - \frac{NH3}{K_1} - \frac{NH3}{K_2}) \exp(-k_{NH3}^T_t) + \frac{NH3}{K_1} \exp(-k_{SS}^T_t) + \frac{NH3}{K_2} ]</td>
<td></td>
</tr>
</tbody>
</table>

* Equation variables are defined in Table 2.
Table 4 (Cont'd)

\[ \frac{n}{K_1} = \frac{[k^T_{\text{NDE}} \cdot P_n(TSS_0 - K_1)]}{(k^T_{\text{NH3}} - k^T_{\text{SS}})} \]

\[ \frac{n}{K_2} = (k^T_{\text{NDE}} \cdot P_n \cdot \frac{TSS}{K_1} + S_{\text{NH3}} - k_{\text{ANH3}})/k^T_{\text{NH3}} \]

5. NO2

\[ \text{NO2}_t = (\text{NO2}_0 - N_1 - N_2 - N_3) \exp(-k^T_{\text{NO2}} t) + N_1 \exp(-k^T_{\text{NH3}} t) \]

\[ + N_2 \exp(-k^T_{\text{SS}} t) + N_3 \]

where \[ N_1 = \frac{k^T_{\text{NH3}} \left( \text{NH3}_0 - \frac{n}{K_1} - \frac{n}{K_2} \right)}{K^T_{\text{NO2}} - k^T_{\text{NH3}}} \]

\[ N_2 = \frac{k^T_{\text{NH3}} K_1}{k^T_{\text{NO2}} - k^T_{\text{SS}}} \]

\[ N_3 = \frac{k^T_{\text{NH3}} K_2}{k^T_{\text{NO2}}} \]

6. NO3

\[ \text{NO3}_t = \text{NO3}_0 + \frac{\text{NO}_1}{K_1} - \frac{\text{NO}_2}{K_2} \exp(-k^T_{\text{NO2}} t) - \frac{\text{NO}_3}{K_3} \exp(-k^T_{\text{NH3}} t) - \frac{\text{NO}_4}{K_4} \exp(-k^T_{\text{SS}} t) \]
Table 4 (Cont'd)

where \( K_{1}^{\text{no}} = (k_{\text{NO}_2}^{T} N_3 + S_{\text{NO}_3} - k_{\text{ANO}_3} A) t \)

\[ K_{2}^{\text{no}} = \text{NO}_2 - N_1 - N_2 - N_3 \]

\[ K_{3}^{\text{no}} = \frac{k_{\text{NO}_2}^{T}}{k_{\text{NH}_3}} N_1 \]

\[ K_{4}^{\text{no}} = \frac{k_{\text{NO}_2}^{T}}{k_{\text{SS}}} N_2 \]

7. \( \text{PO}_4 \)

\[ \text{PO}_4 t = (\text{PO}_4 - K_{1}^{\text{P}} - K_{2}^{\text{P}}) \exp(-k_{\text{PO}_4}^{T} t) + K_{1}^{\text{P}} \exp(-k_{SS}^{T} t) + K_{2}^{\text{P}} \]

where \( K_{1}^{\text{P}} = \frac{k_{\text{PDET}}^{T} (PP(TSS_{0} - K_{1}^{T}))}{k_{\text{PO}_4}^{T} - k_{SS}^{T}} \)

\[ K_{2}^{\text{P}} = \frac{k_{\text{PO}_4}^{T} \cdot PP \cdot K_{1}^{T} + S_{\text{PO}_4} - k_{\text{APO}_4} \cdot A}{k_{\text{PO}_4}^{T}} \]

8. Dissolved Oxygen (\( \text{O}_2 \))

\[ O_2 t = 02_{\text{SAT} t}^{T} - O_t \]

\[ L_{\text{NH}_3} t = 3.43 \cdot \text{NH}_3 t \]
\[ l_{NO2}^T = 1.14 \cdot NO2_t \]

\[ D_t = (D_0 - \frac{K_1}{K_1} - \frac{K_2}{K_3} - \frac{K_4}{K_4} - \frac{K_5}{K_5}) \exp(-k_R^T t) \]

\[ \begin{align*}
&\quad D \\
&+ \frac{K_1}{K_1} \exp(-(k_L^T + k_{L5}^T)t) + \frac{D}{K_2} \exp(-k_{NH3}^T t) \\
&+ \frac{D}{K_3} \exp(-k_{NO2}^T t) + \frac{D}{K_4} \exp(-k_{SS}^T t) \\
&+ \frac{D}{K_5}
\end{align*} \]

Where \[ \frac{K_1}{K_1} = \frac{k_L^T (L_0 - \frac{L}{K_1})}{k_R^T - (k_L^T + k_{LS}^T)} \]

\[ \frac{D}{K_2} = \frac{3.43 k_{NH3}^T (NH3_0 - \frac{n}{K_1} - \frac{n}{K_2}) + 1.14 k_{NO2}^T N_1}{k_R^T - k_{NH3}^T} \]

\[ \frac{D}{K_3} + \frac{1.14 k_{NO2}^T (NO2_0 - N_1 - N_2 - N_3)}{k_R^T - k_{NO2}^T} \]

\[ \frac{D}{K_4} = \frac{3.43 k_{NH3}^T K_1 + 1.14 k_{NO2}^T N_2}{k_R^T - k_{SS}^T} \]
Table 4 (Cont'd)

\[
\frac{D}{k_0} = (k_L^{T} k_{L-1} + 3.43 k_T^{T} k_{NH32}^{n} + 1.14 k_T^{T} N_{NO2}^{N3} - S_{O2}^{T} + S_{SOD}^{T})/k_R^{T}
\]

9. Conservative Attributes

\[\text{CONSi}_t = \text{CONSi}_0\]

10. Nonconservative Attributes

\[\text{NCONi}_t = (\text{NCONi}_0 - \frac{S_{\text{NCONi}}}{k_{\text{NCONi}}^{T}}) \exp\left(-\frac{k_{\text{NCONi}}^{T}}{k_{\text{NCONi}}} t\right) + \frac{S_{\text{NCONi}}}{k_{\text{NCONi}}}\]

11. Temperature

\[T_t = (T_0 - K_T) \exp(-k_T t) + K_T\]

where

\[k_T = 1.17 \times 10^{-3} + \rho L(a + bV)(\beta_j + 6.1 \times 10^{-4} P)\]

\[K_T = (q_{SN} + q_{at} - 7.36 \times 10^{-2} - \rho L(a + bV)(\alpha_j - e_a - 6.1 \times 10^{-4} P \cdot AT)/k_T)\]
An analytical approach such as that provided by RIAS requires measurable indicators of impact significance. To determine such significance, threshold values must be established. Therefore, it is necessary to develop concepts for using RTVs to measure the significance of impacts within the aquatic environment. The RTVTEST models used to develop RIAS are a subset of available models. Impacts can be analyzed at three levels of effect by applying one or more of the following tests:

1. WQRTV -- Assessment of the extent of predicted violation of existing ambient water quality standards.

2. SIRTV -- Assessment of the effect of organic pollution on the microbial community.

3. TURTV -- Assessment of the expected concentrations of toxic compounds on overall environmental toxicity of receiving system (species-specific).

The flexibility of RIAS allows these RTVTESTs to be used singly or in conjunction with each other.

**Water Quality Standard Assessments (WQRTV)**

This RTVTEST quantifies the magnitude of water quality violations which will be caused by the impacts of the project being evaluated. This test is relatively straightforward, comparing existing stream standards to the output of pertinent SIMWQ attributes. Impact is quantified in terms of the degree of violation (mg/l) at specific points in the WQ (i,j,k) profile, the spatial extent of violations (mg/l/miles), and the temporal extent of violations. The RTV level in this case is the existing water quality standard.

**Saprobic Indices (SIRTV)**

This system was developed as an empirical relationship between aquatic organisms and organic water pollution. This relationship has been termed the Saprobian system and uses the concept of an indicator species. The application of the empirical relationships of the Saprobian system in a quantitative index was introduced by Pantle and Buck and expanded by Sladecek. They

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describe the Saprobic index S as ranging between 1 and 4 and 1 and 8, respectively. Other literature has shown the relationship between the Saprobic index and BOD5 in the stream. Table 5 gives the relative values of S and BOD5. Saprobic indices have generally been used as a classification scheme in Europe, but have not been widely used in the United States.

The Saprobic index can easily be calculated using BOD5 concentrations provided by SIMWQ:

\[
SI(i,k) = \frac{1.075(L(i,k)) - 0.473}{0.218(L(i,k)) + 0.904}
\]

\[
= \frac{0.0189(L(i,k)) - 7.938}{0.0021(L(i,k)) - 1.882}
\]

if \(0 \leq L(i,k) \leq 50 \text{ mg/l}\)

if \(L(i,k) > 50 \text{ mg/l}\)

where \(SI(i,k)\) is the Saprobic index in \(i\)th point in space and \(k\)th point in time.

The values of \(SI(i,k)\) can then be used to interpret the impact of organic effluents on the community structure of the receiving stream. For example, RTV levels can be set at \(SI(i,k) < 2.0\) for no significant impact and at \(2 < SI(i,k) < 3\) for minimal impact; then the output from the SIRTV routine can be used to quantify the extent of temporal and spatial impacts within the aquatic environment.

Environmental Toxicity (TURTV)

The toxicity unit concept has proven to be a useful tool for integrating biological response to both primary toxicants and modifying factors (e.g., dissolved oxygen [DO], temperature, pH, etc.). This index has been used successfully to assess the biological significance of water pollution impacts. A toxic unit of a specific pollutant is simply a concentration equal to the

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6 V. Sladecek, "The Measures of Saprobity"; and "System of Water Quality from the Biological Point of View."

7 V. Sladecek and F. Tucek, "Relation of the Saprobic Index to BOD5."


96-hour LC50 for a target organism.* Toxic units are calculated as the ratio of simulated ambient concentrations of an attribute divided by its LC50. This ratio is also analogous to a pollutant's application factor,10 and a threshold level can be specified to ensure protection for target organisms (e.g., requiring a toxic unit < 0.01 would be equivalent to an application factor of 100, which is used for many chlorinated hydrocarbons). Toxic units can also be accumulated (summed) for all potential toxicants to obtain an overall index of environmental toxicity. Experience has indicated acceptable levels of total toxicity units,11 but one must remember that this index is just a first approximation of biological response.

The problems involved with measuring environmental toxicity include adjusting for the effects of environmental modifiers and predicting synergistic effects of various pollutant combinations. Information on the effects of combinations of toxicants is available for only a few species, but more data are being collected daily. However, despite these limitations, the toxic unit model is still the best general model now available for impact assessment. When toxicity data are available at multiple trophic levels, the toxic units can also be used at various levels to measure the sensitivity of aquatic communities.

* LC50 is a measure of the concentration level of the toxic material that will kill 50 percent of the species being used in the test within a given time interval (e.g., 96 hours).

10 Quality Criteria for Water (U.S. Environmental Protection Agency [USEPA], 1976).


Table 5

<table>
<thead>
<tr>
<th>Degree</th>
<th>S</th>
<th>L</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katharobity</td>
<td>-0.5</td>
<td>0.0</td>
<td>Purest water</td>
</tr>
<tr>
<td>Zernosaprobity</td>
<td>0.5</td>
<td>1.0</td>
<td>Very clean</td>
</tr>
<tr>
<td>Oligosaprobity</td>
<td>1.5</td>
<td>2.5</td>
<td>Clean</td>
</tr>
<tr>
<td>Beta-mesosaprobity</td>
<td>2.5</td>
<td>5.0</td>
<td>Mild pollution</td>
</tr>
<tr>
<td>Alpha-mesosaprobity</td>
<td>3.5</td>
<td>10.0</td>
<td>Pollution</td>
</tr>
<tr>
<td>Polysaprobity</td>
<td>4.5</td>
<td>50.0</td>
<td>Heavy pollution</td>
</tr>
<tr>
<td>Isosaprobity</td>
<td>6.5</td>
<td>400.0</td>
<td>Sewage</td>
</tr>
<tr>
<td>Metasaprobity</td>
<td>6.5</td>
<td>700.0</td>
<td>Septic</td>
</tr>
<tr>
<td>Hypersaprobity</td>
<td>7.5</td>
<td>2,000.0</td>
<td>Putrefaction</td>
</tr>
<tr>
<td>Ultrasaprobity</td>
<td>8.5</td>
<td>120,000.0</td>
<td>Lifeless liquors</td>
</tr>
</tbody>
</table>

This chapter provides a series of application scenarios which demonstrate the utility of RIAS. Appendices A and B provide sample output of the RIAS system application. These examples concentrate on problems pertinent to current Army activities, but are not meant to be exhaustive. The role of RIAS or a similarly designed methodology in improving impact planning will become apparent in this discussion.

The general framework for decision-making using RIAS should be envisioned as an iterative process using the three computerized procedures -- FQUES, SIMWQ, and RTVTEST -- as the central tools. Adequate methods for impact scoping presently exist in the form of matrix methodology such as the Environmental Impact Computer System (EICS), a computerized system to help environmental planners identify and mitigate impacts of proposed Army projects or activities. However, a shortcoming of matrix methodology is that it is not a data-handling tool and provides little, if any, quantification potential. This is the purpose of developing secondary algorithms like RIAS for impact assessment. While computer-based matrix methodologies work well for specifying a project's potential impacts, they cannot detect small changes in project specifications which may mean the difference between significant or nonsignificant impacts. RIAS, which has this capability, uses quantitative procedures to integrate impacts according to changes in project specifications. Environmental setting data are used to predict impact magnitudes. Subsequent to initial use of these procedures, project specifications can be changed, allowing impact assessment of various alternatives to be done easily and inexpensively. In this way, the RIAS methodology provides a truly quantitative tool for impact management.

Besides quantification, another major advantage of RIAS is standardization. The computer-based algorithms define the organization of environmental information and specify its use in a consistent, repeatable protocol. At this time, the links between primary-level impact assessment (i.e., scoping activities like EICS) and secondary procedures such as RIAS should be via paper ties only. This could be in the form of RAMIT (ramification/mitigation) statements output from EICS, descriptor package writeups, and user manuals such as the appendices to this report. Ultimately, if a system such as RIAS received broad-based support, data sets specifying environmental setting could be assembled for all Army bases, providing "off the shelf" assessment capability whenever new missions altered base operations. Since the goals of impact modeling should be flexibility and easily usable prediction tools coupled to readily available data sets, RIAS can be seen as a design prototype for this type of methodology.

The following sections provide examples of how RIAS can be applied to assessing environmental impacts resulting from Army projects.

Example 1

The impacts occurring in aquatic receiving systems which are the most frequently studied originate from point source discharges of domestic sewage effluents. This type of effect must be considered in environmental impact statements and/or assessments of Army activities. Receiving stream impacts caused by organic pollution occur when mission changes alter sewage treatment plant loadings or treatment efficiencies or when old sewage treatment plants are upgraded. RIAS provides an assessment tool for analyzing these situations. The BOD/DO models within RIAS are only a subset of a more general model. The outputs from both WQRTV and SIRTV quantify these types of impacts and place impact predictions in easily understandable terms. (See Appendix B, Part 3.)

Example 2

Waste discharges from many Army industrial or laboratory activities contain toxic components which can adversely affect aquatic biota. The magnitude and spatial extent of these impacts are largely a function of environmental setting, such as watershed dilution capacity, ambient water quality, and local target species. The TURT routine in RIAS provides a consistent method of considering such information and quantifying impact magnitude using the toxic unit concept. (See Appendix A, Part 3, Section C.)

Example 3

Vehicle maintenance activities account for point source discharges of many potentially harmful water quality attributes, including suspended solids, detergents, oils and greases, and general BOD. While washrack facilities are being redesigned and relocated, the impacts of these facilities within a watershed context could be evaluated using the RTVTESTs in RIAS. Thus, site-specific design activities could be made more efficient by considering the watershed assimilation capacity of sensitivity (Appendix B, Part 3) as shown by RIAS.

Example 4

Impacts from landfill leachate are increasingly affecting the aquatic environment. The significance of these impacts depends on many factors, including the water body's assimilative capacity and the sensitivity of biota in the receiving watershed. RIAS is an excellent tool for evaluating the severity of these impacts. If leachate rates and initial concentrations can be estimated and isolated in a watershed, a simulated point source discharge can be created to represent leachate inputs. (See Appendix B, Part 3.)
Organization of Information Inputs

The first step in using the RIAS computer routines for an impact assessment is organizing the data sources and describing the problem. This requires several stages of data collection and organization, including: (1) identification of the control parameters for simulation and assessments, (2) collection of data on boundary conditions for the analysis, and (3) estimation of kinetic rate coefficients and source/sink terms for the water quality simulations.

The first step is determining the impact types to be considered and the geometric description of the watershed to be analyzed. Potential impacts must have already been identified by some type of scoping procedure (e.g., EICS). Physical and chemical water quality attributes are required at this point, as well as environmental modifiers which might be important in weighing impact significance. This information is used to specify the attributes to be modeled in SIMWQ. The watershed description consists of identifying reach lengths, drainage areas upstream from the top of each stream reach, tributary and effluent locations, and bifurcation structure. (Chapter 2 provides criteria for specifying reaches.) Drainage areas are calculated using standard U.S. Geological Survey maps.

The technique to be used for numbering reaches, bifurcations, tributaries, and effluents is:

1. Numbering reaches: Number reaches beginning at the top of the most upstream minor branch of the stream to be modeled. Proceed downstream until a confluence is encountered. Skip to the top of the next most upstream minor branch and continue downstream to the next confluence. When no more minor branches remain, proceed down the main branch from upstream to downstream.

2. Numbering bifurcations: Each channel bifurcation (confluence location) is designated by a real number consisting of digits in the tens, ones, tenths, and hundredths places. For example, for "10.05," the whole number part of the indicator ("10" in this example) represents the receiving reach downstream of the confluence. The fractional part of the indicator ("5" in this example) represents the last reach of the minor branch which is entering a higher-order stream.

3. Numbering tributary inputs: Using the numbering system described above, number upstream tributaries first, doing the more minor branches first. This convention is not critical, but will provide more consistency. Remember that the inputs at the top reach of each branch must be designated as a tributary in order to set boundary conditions for the simulation model. The index of each tributary designates the stream reach into which it empties, not simply its number.
4. Numbering effluent inputs: Using the numbering system described above, number effluents in an upstream to downstream manner. As with tributaries, the index number of an effluent represents the number of the reach into which it empties, not the number of the effluent.

The second stage of data organization is specifying boundary conditions of water quality attributes at tributaries and effluents within the watershed. Techniques for doing mass balances on Army installations are available which are adequate for describing effluents. Another source of effluent information is the National Pollutant Discharge Elimination System (NPDES) permits for point source discharges. Many sources are available that describe information on tributary inputs. However, when no information on boundary conditions is available, field data must be collected.

The last stage of data organization is specifying the kinetic terms in SIMWQ equations. This is the most important requirement for ensuring accurate impact assessment. The structure used in SIMWQ takes advantage of a class of widely used simulation models (steady-state, plug flow) whose parameters are well understood. The review of Zison, et al., is a good primary source of information on the state of the art of estimating these model parameters. Table 2 provides a range of values experienced for all model terms and references to previous modeling work in which they were used.

Example Problem

To illustrate the use of all the RIAS routines, Appendix B provides an example impact assessment. Figure 3 shows the layout of a hypothetical Army post where the potential impacts from four point sources of pollutants on aquatic receiving systems will be analyzed. Pre-analysis information has already been organized, and the example begins as FQUES is executed to build up the project specification/environmental setting data base. All user responses in the computer output have been underlined.

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Figure 3. Physical layout for example problem.
CONCLUSION

This report has described the framework and demonstrated the utility of RIAS, a computerized technique which uses the concept of rational threshold values to determine impact significance. This system uses a rigorous set of analysis procedures to identify significant effects resulting from Army activities on aquatic ecosystems.
REFERENCES


Quality Criteria for Water (U.S. Environmental Protection Agency [USEPA], 1976).


UNCITED REFERENCES


APPENDIX A:
ANALYTICAL SOLUTIONS USED IN SIMWQ

The general solution used in the SIMWQ equations is demonstrated here for a simple steady-state situation of coupled water quality attributes.* The equations developed here are used only within a stream reach in which all model parameters are constant. Implicit assumptions are:

1. Nondispersive, plug flow
2. Temporal steady-state conditions at all upstream loading points, source/sink terms, and stream discharge
3. First-order reaction kinetics.

The initial system of coupled reaction is given by:

\[
\frac{dA_t}{dt} = -k_1A_t + S_A \tag{Eq A1}
\]

\[
\frac{dB_t}{dt} = -k_2B_t + k_3A_t + S_B
\]

where:

\[A_t = \text{concentration of attribute A at time } t\]
\[B_t = \text{concentration of attribute B at time } t\]

The general solution is:

\[
A_t = S_Ak_1 + (A_0 - \frac{S_A}{k_1}) \exp(-k_1t) \tag{Eq A2}
\]

\[
B_t = \left[\frac{k_3S_A}{k_1k_2} + \frac{S_B}{k_2}\right] + \left[\frac{k_3S_A}{k_1(k_2 - k_1)} - \frac{k_3A_0}{k_2 - 1} + \frac{k_3S_A}{k_1k_2} - \frac{S_B}{k_2}\right] \exp(-k_2t) + \left[\frac{k_3A_0}{k_2 - k_1} - \frac{k_3S_A}{k_1(k_2 - k_1)}\right] \exp(-k_1t)
\]

* A more detailed discussion of this type of equation development can be found in Chapters 4 and 5 of R. V. Thomann, Systems Analysis and Water Quality Management (McGraw-Hill, 1972).
Generally, this type of solution takes on the form:

\[ C_t = \alpha + \sum_{i=1}^{n} B_i \exp(-\gamma_i t) \]  \[ \text{[Eq A3]} \]

where \( \alpha, \beta_i, \) and \( \gamma_i \) are constants within a reach which can be calculated from data inputs, and \( C_t \) is the concentration of any attribute at time \( t \).

In some cases, this analytical solution degenerates; i.e., if \( k_2 \) is input as zero or if \( k_2 = k_1 \), the result will be an illegal arithmetic operation. Therefore, contingencies have been made in the FORTRAN code to avoid this type of solution breakdown. Using the coupled system defined initially, four conditions can be identified which cause a breakdown:

1. \( k_1 = 0, k_2 \) nonzero
2. \( k_2 = 0, k_1 \) nonzero
3. \( k_1 = k_2 = 0 \)
4. \( k_2 = k_1 \neq 0 \).

The solutions used to avoid blowup in SIMWQ can be derived as follows:

**Condition 1** \((k_1 = 0, k_2 \neq 0):\)

\[ A_t = a_0 + S_{At} \]  \[ \text{[Eq A4]} \]

\[ B_t = \left[ \frac{k_3 A_0}{k_2} + S_B \right] + \left( B_0 - \frac{k_3 A_0}{k_2} \right) \exp(-k_2 t) + \frac{1}{2} k_3 S_{At} t^2 \]

**Condition 2** \((k_2 = 0, k_1 \neq 0):\)

\[ A_t = \frac{S_A}{k_1} + \left( A_0 - \frac{S_A}{k_1} \right) \exp(-k_1 t) \]  \[ \text{[Eq A5]} \]

\[ B_t = \left[ \frac{S_A}{k_1} - k_3 A_0 \right] \exp(-k_1 t) + [S_B + \frac{k_3 S_A}{k_1}] t \]

**Condition 3** \((k_1 = k_2 = 0):\)

\[ A_t = A_0 + S_{At} \]  \[ \text{[Eq A6]} \]

\[ B_t = B_0 + S_{Bt} \]
Condition 4 \((k_1 = k_2 \neq 0)\):

\[
A_t = \frac{S_A}{k_1} + (A_0 - \frac{S_A}{k_1}) \exp(-k_1t) \tag{Eq A7}
\]

\[
B_t = \left(\frac{k_3S_A}{k_1k_2} + \frac{S_B}{K_2}\right) + (B_0 - \frac{k_3S_A}{k_2k_1} - \frac{S_B}{k_2} \exp(-k_2t))

+ k_3 \left(A_0 - \frac{c_A}{k_1}\right)t \exp(-k_1t)
\]

This same type of logic and equation formulation is applied to all sets of coupled equations in SIMWQ. Because of the additional terms compounded in \(t\), the form of the general solution is expanded to

\[
C = \alpha + \sum_{i=1}^{n} \beta_i \exp(-\gamma_i t) + \delta t + \epsilon t \exp(\rho t) \tag{Eq A8}
\]

As before, all the constant terms, \(\alpha, \beta, \gamma, \delta, \epsilon, \rho\), can be calculated based on input for each reach and \(C\) could be the concentration of any attribute. These terms are all calculated in the subprogram APARAM, which also includes the logic to avoid unnecessary breakdowns in the computer software codes. This logic increases the usability of the final product and requires a minimum of user expertise.
APPENDIX B:

RIAS USE EXAMPLE

Part 1: New Data File Creation

---

TERMINAL: 257
79/12/18. 10.32.43.
UNIVERSITY OF ILLINOIS CYBER 175. NOS 1.3 - 485/485.

SIGNON: 341947562
PASSWORD: ********
TERMINAL: 257, TTY
RECOVER/ CHARGE: bill.cea..ps7770
LAST RECORDED SIGNON AT 10:23 12/18/79
/-fques

THIS PROGRAM ALLOWS
THE USER TO BUILD UP A NEW
DATA FILE OR TO REVISE AN OLD DATA
FILE FOR SUBSEQUENT CONTROL AND
INPUT FOR WATER QUALITY SIM-
ULATIONS UNDER 'RIAS'

DO YOU WISH TO BEGIN CREATING A NEW DATA FILE
(ANS: YES OR NO) ? Y

TIME INVARIANT PARAMETERS

I) TYPE IN THE NAME OF THE DATA SET
? example no. 1

---
II) ANSWER THE FOLLOWING QUESTIONS ABOUT SIMULATION CONTROL PARAMETERS.

HOW MANY REACHES (ANS: 1-20) ? 4

HOW MANY TIME PERIODS (ANS: 1-27) ? 2

HOW MANY ADDITIONAL CONSERVATIVE WATER QUALITY ATTRIBUTES BEYOND THE CORE ATTRIBUTES (ANS: 0-2) ? 0

HOW MANY ADDITIONAL NONCONSERVATIVE ATTRIBUTES (ANS: 0-4) ? 2

INPUT THE NAMES OF THESE ADDITIONAL PARAMETERS.

CONSERVATIVE ATTRIBUTES:
ATT. NO. 9) ? **
ATT. NO. 10) ? **
ATT. NO. 11) ? **

NONCONSERVATIVE ATTRIBUTES:
ATT. NO. 12) ? **
ATT. NO. 13) ? **

INPUT THE MODELING CODES FOR THE EIGHT CORE ATTRIBUTES (ANS: 0 OR '1')
? 0 0 1 1 0 0 0 0

III) INPUT THE PARAMETERS DESCRIBING THE WATERSHED STRUCTURE FOR THIS SIMULATION.

HOW MANY TRIBUTARY INPUTS ? 5

INPUT CODES:
1) 1
2) 2
3) 3
4) 4
5) 5

HOW MANY POINT SOURCE DISCHARGES ? 4

INPUT CODES:
1) 1
2) 2
3) 3
4) 4

HOW MANY MAIN BRANCH BIFURCATIONS ? 5

BIFURCATION CODES:
1) 5, 0
2) 1, 4
3) 2, 3
4) 5
5) 3

1) 3.2, 1.8
2) 4.1, 3
3) 2.5, 4.2
4) 2.2, 0.3
5) 3.5, 1.1
6) 2.1, 1.0
7) 5.7, 1.2
8) 20, 390

IV) INDICATE HOW YOU WISH TO MODEL STREAM HYDRAULICS.

0) MEAN DEPTH AND VELOCITY SPECIFIED FOR EACH REACH AND TIME PERIOD.
1) HYDRAULIC WATING PARAMETERS USED FOR EACH REACH.

(ANS: USE EITHER 0 OR '1') 0
ZERO TIME VARIANT PARAMETERS FIRST (X OR Y) ?  n

*************************************************************
TIME VARIANT PARAMETERS FOR TIME PERIOD NO. 1
*************************************************************

I) HYDRAULIC PARAMETERS.

INPUT MEAN VELOCITIES FOR EACH REACH.
? 0.24, 0.17, 0.23, 0.25, 0.29, 0.3, 0.34, 0.9

INPUT MEAN DEPTHS FOR EACH REACH.
? 0.19, 0.14, 0.12, 0.22, 0.25, ...

< ERROR, RETYPE RECORD AT THIS FIELD
? 0.25, 0.33, 0.8

II) BOUNDARY CONDITIONS AT TRIBUTARIES.

INPUT AMBIENT WATER QUALITY CONDITIONS FOR TRIBUTARIES 1 THROUGH 5

<table>
<thead>
<tr>
<th>TEMP.</th>
<th>BODS</th>
<th>TSS</th>
<th>NH3</th>
<th>NO2</th>
<th>NO3</th>
<th>PO4</th>
<th>DO</th>
<th>HARD.</th>
<th>PH</th>
<th>ZN</th>
<th>CL2</th>
<th>COLI.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.1</td>
<td>0.5</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>20.2</td>
<td>0.5</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>20.3</td>
<td>0.5</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>20.4</td>
<td>0.5</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>20.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

MEAN DISCHARGE? 0.03, 0.09, 0.05, 5.28

III) BOUNDARY CONDITIONS AT EFFLUENT DISCHARGES.

INPUT AMBIENT WATER QUALITY CONDITIONS FOR EFFLUENTS 1 THROUGH 4

<table>
<thead>
<tr>
<th>TEMP.</th>
<th>BODS</th>
<th>TSS</th>
<th>NH3</th>
<th>NO2</th>
<th>NO3</th>
<th>PO4</th>
<th>DO</th>
<th>HARD.</th>
<th>PH</th>
<th>ZN</th>
<th>CL2</th>
<th>COLI.</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.5</td>
<td>5.3</td>
<td>3.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>25.4</td>
<td>5.3</td>
<td>3.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>22.2</td>
<td>5.3</td>
<td>3.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>22.5</td>
<td>5.3</td>
<td>3.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

MEAN DISCHARGE? 0.03, 0.09, 0.05, 5.28

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### MEAN DISCHARGE

#### IV) REACTION RATE COEFFICIENTS.

**Input the indicated rate coefficient for reaches 1 through 8**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_{\text{NH}_3}$</td>
<td>$0.05, 0.05, 0.05, 0.05, 0.05, 0.05, 0.05, 0.05$</td>
</tr>
<tr>
<td>$K_{\text{NO}_3}$</td>
<td>$0.05, 0.05, 0.05, 0.05, 0.05, 0.05, 0.05, 0.05$</td>
</tr>
<tr>
<td>$K_{\text{PO}_4}$</td>
<td>$0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02$</td>
</tr>
<tr>
<td>$K_{\text{PO}_4}$</td>
<td>$0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02$</td>
</tr>
<tr>
<td>$K_{\text{SiO}_2}$</td>
<td>$0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01$</td>
</tr>
<tr>
<td>$K_{\text{CaO}}$</td>
<td>$0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00$</td>
</tr>
<tr>
<td>$K_{\text{CO}_3}$</td>
<td>$0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00$</td>
</tr>
<tr>
<td>$K_{\text{SSS}}$</td>
<td>$0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00$</td>
</tr>
<tr>
<td>$K_{\text{SS}}$</td>
<td>$0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00$</td>
</tr>
<tr>
<td>$K_{\text{MgO}}$</td>
<td>$0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00$</td>
</tr>
</tbody>
</table>

#### V) DISTRIBUTED SOURCE/SINK PARAMETERS.

**Input the indicated source/sink term for reaches 1 through 8**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_{\text{NH}_3}$</td>
<td>$0.05, 0.05, 0.05, 0.05, 0.05, 0.05, 0.05, 0.05$</td>
</tr>
<tr>
<td>$K_{\text{NO}_3}$</td>
<td>$0.05, 0.05, 0.05, 0.05, 0.05, 0.05, 0.05, 0.05$</td>
</tr>
<tr>
<td>$K_{\text{PO}_4}$</td>
<td>$0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02$</td>
</tr>
<tr>
<td>$K_{\text{PO}_4}$</td>
<td>$0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02$</td>
</tr>
</tbody>
</table>
Part 2: Data File Revision

This program allows the user to build up a new data file or to revise an old data file for subsequent control and input for water quality simulations under 'Rias'.

Do you wish to begin creating a new data file (ANS: YES or NO) ? [Y]

Do you wish to review and/or revise the existing data file (ANS: YES or NO) ? [Y]

The current contents of your data file have the title:

Example No. 1

This data set specifies simulation of the following water quality attributes:

**TEMP**  **BOD5**  **TSS**  **NH3**  **NO2**
**NO3**  **PO4**  **D.O.**  **HARD.**  **PH**
**IN**  **CL2**  **COLI.**

Simulations will be run for 2 time periods for a total of 5 stream reaches.
THE SPECIFIED WATERSHED STRUCTURE IS AS FOLLOWS:

<table>
<thead>
<tr>
<th>REACH NO.</th>
<th>LENGTH (MI.)</th>
<th>DRAINAGE AREA (SQ. MI.)</th>
<th>INPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.200</td>
<td>1.500</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>0.800</td>
<td>1.300</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2.500</td>
<td>4.900</td>
<td>**</td>
</tr>
<tr>
<td>4</td>
<td>2.200</td>
<td>6.300</td>
<td>**</td>
</tr>
<tr>
<td>5</td>
<td>3.500</td>
<td>11.100</td>
<td>**</td>
</tr>
<tr>
<td>6</td>
<td>2.100</td>
<td>13.000</td>
<td>**</td>
</tr>
<tr>
<td>7</td>
<td>5.700</td>
<td>32.000</td>
<td>**</td>
</tr>
<tr>
<td>8</td>
<td>20.000</td>
<td>990.000</td>
<td>**</td>
</tr>
</tbody>
</table>

...NUMBER OF MAJOR BIFURCATIONS OF THE MAIN CHANNEL OF THIS RECEIVING STREAM IS 1

BRANCH NO. 1 INCLUDES REACHES 1 TO 1

THE MAIN CHANNEL INCLUDES REACHES 2 TO 8

HYDRAULIC MODELING WILL BE DONE USING MEAN VELOCITIES AND DEPTHS FOR EACH REACH AND TIME PERIOD.

NONE OF THE ABOVE PARAMETERS CAN BE ALTERED WITHOUT CREATING A TOTALLY NEW DATA SET (I.E., BY STARTING OVER WITH "QUES").

DO YOU WANT TO CONTINUE (ANS: YES OR NO)?

WHICH TIME PERIOD DO YOU WANT TO REVIEW?

INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)

1) HYDRAULIC PARAMETERS
2) INITIAL CONDITIONS IN TRIBUTARIES
3) INITIAL CONDITIONS IN EFFLUENTS
4) KINETIC PARAMETERS
5) DISTRIBUTED SOURCE/SINK PARAMETERS
6) BIOLOGICAL PARAMETERS

INDICATE THE INDEX NUMBER OF THE KINETIC PARAMETER YOU ARE INTERESTED IN REVIEWING

1) KANH3
2) KAO3
3) KAP04
4) KL
5) KL3
6) KHD3
7) KHN3
8) KHO2
9) KNO3
10) KPDET
11) KPO4
12) KR
13) KSS
14) KSS3
15) KT
16) KTS3
17) KNC3
18) KNC2

WHICH ONE?
THE VALUES CURRENTLY SPECIFIED FOR YACA2 WILL BE LISTED BELOW BY REACH. TO CHANGE A VALUE, RESPOND TO THE TRAILING "?" WITH THE NEW VALUE.

1) 0.7 .002
2) 0.7 .003
3) 0.7 .003
4) 0.7 .002
5) 0.7 .003
6) 0.7 .002
7) 0.7 .003
8) 0.7 .003

REVIEW ANOTHER RATE COEFFICIENT (ANS: YES OR NO)?

CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)?

REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO)?

WHICH TIME PERIOD DO YOU WANT TO REVIEW?

INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)

1) HYDRAULIC PARAMETERS
2) INITIAL CONDITIONS IN TRIBUTARIES
3) INITIAL CONDITIONS IN EFFLUENTS
4) KINETIC PARAMETERS
5) DISTRIBUTED SOURCE/SINK PARAMETERS
6) BIOLOGICAL PARAMETERS

INDICATE THE INDEX NUMBER OF THE DISTRIBUTED SOURCE/SINK TERM YOU WISH TO REVIEW

1) SL
2) SNO3
3) SO2
4) SPO4
5) SSOD
6) SSS
7) ST
8) SAT1
9) SAT2
10) SAT3
11) SAT4
12) SAT5
13) SAT6

THE VALUES CURRENTLY SPECIFIED FOR SSOD WILL BE LISTED BELOW BY REACH. TO CHANGE A VALUE, RESPOND TO THE TRAILING "?" WITH THE NEW VALUE.

1) 0.7 .6
2) 0.7
3) 0.7
4) 0.7 .6
5) 0.7
6) 0.7 .6
7) 0.7
8) 0.7 .6

REVIEW ANOTHER SOURCE/SINK TERM (ANS: YES OR NO)?

CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)?

REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO)?

WHICH TIME PERIOD DO YOU WANT TO REVIEW?

43
INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)
1) HYDRAULIC PARAMETERS
2) INITIAL CONDITIONS IN TRIBUTARIES
3) INITIAL CONDITIONS IN EFFLUENTS
4) KINETIC PARAMETERS
5) DISTRIBUTED SOURCE/SINK PARAMETERS
6) BIOLOGICAL PARAMETERS

INDICATE THE INDEX NUMBER OF THE DISTRIBUTED SOURCE/SINK TERM YOU WISH TO REVIEW
1) SL
2) NH3
3) NO3
4) SO2
5) PO4
6) SSOD
7) SS
8) ST
9) SAT1
10) SAT2
11) SAT3
12) SAT4
13) SAT5

THE VALUES CURRENTLY SPECIFIED FOR SSOD WILL BE LISTED BELOW BY REACH. TO CHANGE A VALUE RESPOND TO THE TRAILING ‘?’ WITH THE NEW VALUE.
1) 0.?
2) 0.?
3) 0.?
4) 0.76
5) 0.72
6) 0.76
7) 0.73
8) 0.72

REVIEW ANOTHER SOURCE/SINK TERM (ANS: YES OR NO)?

CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)?

REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO)?

YOUR DATA SET IS STORED IN THE FILE ‘TAPE9’. REMEMBER TO SAVE OR REPLACE IT IF YOU WANT TO USE IT IN A LATER SESSION.

NOTE. If
/replace_tape9

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Part 3: RTV Test Using Data File Created and Revised

SIMULATIONS HAVE BEEN STARTED USING THE FILE 'TAPE33' AS CONTROL INPUT.

SIMULATED WATER QUALITY PROFILES HAVE BEEN OUTPUT TO 'TAPE33' FOR 2 TIME PERIOD(S) FOR THE FOLLOWING WATER QUALITY ATTRIBUTES:

1) TEMP.
2) BOD5
3) TSS
4) NH3
5) NO2
6) NO3
7) PO4
8) D.O.
9) HARD.
10) PH
11) ZN
12) CL2
13) COLI.

WATER QUALITY SIMULATIONS COMPLETE. YOU MAY NOW PROCEED TO RTV TESTING. REMEMBER TO SAVE OR REPLACE 'TAPE33' IF YOU PLAN TO USE IT IN LATER SESSIONS.

NOTE:!!
/replace,tape33
/-wqrtv

LOADER INFORMATION:
MAP OPTIONS = OFF
GLOBAL LIBRARY SET IS - GC3ALPH

-------------------------------------------------------------------------------------
* THIS RTV ROUTINE TESTS FOR VIOLATIONS OF AMBIENT WATER QUALITY STANDARDS AND QUANTIFIES THE SPACIAL EXTENT OF THESE VIOLATIONS

-------------------------------------------------------------------------------------

EXAMPLE NO. 1

------------------------------------------------------------------

...ICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE TO BE ANALYZED.

1) TEMP. 5) NO2
2) BOD5 6) NO3
3) TSS 7) PO4
4) NH3 8) D.O.
   9) HARD.
   10) PH
   11) ZN
   12) CL2
   13) COLI.

RESPOND WITH THE TOTAL NUMBER OF ATTRIBUTES FOLLOWED BY THE APPROPRIATE INDEX NUMBERS

? 5,2,3,4,8,13

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Section A: Violation Test

---

**INPUT LOCAL AMBIENT WATER QUALITY STANDARDS**

---

**WE PERIOD NO. ?**

BOD5
UPPER LEVEL STANDARD ? 10
LOWER LEVEL STANDARD ?

TSS
UPPER LEVEL STANDARD ? 12
LOWER LEVEL STANDARD ?

NH3
UPPER LEVEL STANDARD ? 1.5
LOWER LEVEL STANDARD ?

D.O.
UPPER LEVEL STANDARD ?
LOWER LEVEL STANDARD ?

ZN
UPPER LEVEL STANDARD ? 1.0
LOWER LEVEL STANDARD ?

STANDARDS CONSTANT OVER TIME (Y OR N) ? Y

---

**REPORT ON WATER QUALITY VIOLATIONS**

---

**1) TOTAL RIVER MILES IN VIOLATION OF STANDARDS.**

<table>
<thead>
<tr>
<th>ATTRIBUTE</th>
<th>TIME PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>------------</td>
<td>---</td>
</tr>
<tr>
<td>BOD5</td>
<td>33.5</td>
</tr>
<tr>
<td>TSS</td>
<td>33.5</td>
</tr>
<tr>
<td>NH3</td>
<td>16.7</td>
</tr>
<tr>
<td>D.O.</td>
<td>0.0</td>
</tr>
<tr>
<td>ZN</td>
<td>3.2</td>
</tr>
</tbody>
</table>

DO YOU WANT A GRAPHICAL OUTPUT FOR ANY ATTRIBUTE PROFILES (ANS: YES OR NO)? Y

---

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PLOT BODS FOR ANOTHER TIME PERIOD? y

PLOT ANOTHER WATER QUALITY ATTRIBUTE? y

ATTRIBUTE NUMBER? 1

TIME PERIOD? 1

TSS: TIME PERIOD NO. 1

TIME PERIOD? 2

TSS: TIME PERIOD NO. 2

DISTANCE DOWNSTREAM (MILES)
PLOT TSS FOR ANOTHER TIME PERIOD? n

PLOT ANOTHER WATER QUALITY ATTRIBUTE? y

ATTRIBUTE NUMBER? 4

TIME PERIOD? 2

NH3: TIME PERIOD NO. 1

DISTANCE DOWNSTREAM (MILES)

NH3: TIME PERIOD NO. 2
PLOT NH3 FOR ANOTHER TIME PERIOD? Y
PLOT ANOTHER WATER QUALITY ATTRIBUTE? Y
ATTRIBUTE NUMBER? 8
TIME PERIOD? 1 D.O.: TIME PERIOD NO. 1

4.5 8
C7.5 =0 0000000000000000000000000000000000000000000
0 7. =0 0 0
N6.5 =0
C 6. .................................
5.5 =0
4.5 0
( 4. 0
M3.5 0
G 3. 0
L2.5 0
L1.5 0
1. +
5 +
0. .................................
0 4 8 12 16 20 24 28 32 36 40
DISTANCE DOWNSTREAM (MILES)

PLOT D.O. FOR ANOTHER TIME PERIOD? Y
TIME PERIOD? 2 D.O.: TIME PERIOD NO. 2

3.5 8
C8.5 =0 0000000000000000000000000000000000000000000
3. +0 0 0 0000000000000000000000000000000000000000000
C6.5 0
6. .................................
5.5 +
(4.5 +
M4. +
G3.5 +
L2. +
L1.5 +
5 +
0. .................................
0 4 8 12 16 20 24 28 32 36 40
DISTANCE DOWNSTREAM (MILES)
PLOT D.O. FOR ANOTHER TIME PERIOD? Y
PLOT ANOTHER WATER QUALITY ATTRIBUTE? N
ATTRIBUTE NUMBER? 1
TIME PERIOD? 1

T14E PERIOD IN TIME PERIOD NO. 1

```
| Distance Downstream (Miles) | 0  | 2  | 4  | 6  | 8  | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 |
|-----------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                             | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
|                             | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
|                             | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
```

PLOT ZN FOR ANOTHER TIME PERIOD? Y
TIME PERIOD? 2

DISTANCE DOWNSTREAM (MILES)

```
| Distance Downstream (Miles) | 0  | 2  | 4  | 6  | 8  | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 |
|-----------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                             | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
|                             | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
|                             | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
```

PLOT ZN FOR ANOTHER TIME PERIOD? Y
PLOT ANOTHER WATER QUALITY ATTRIBUTE? N

THIS CONCLUDES "QRTV". YOU MAY EXECUTE MORE
RTV ROUTINES NOW. BEGIN A MITIGATION
LOOP ON SIJHOFF.

2.943 CP SECONDS EXECUTION TIME
Section B: Saprobic Index Analysis

******************************************************************************
SAPROBIC INDEX ANALYSIS FOR EXAMPLE NO. 1
******************************************************************************

WATER QUALITY DESIGNATION RIVER MILES IN TIME PERIOD
               1  2   3   4   5   6
Purest Water    0.0  0.0
Clean Water     3.2  26.5
Mild Pollution  2.5  0.0
Polluted        5.8  0.0
Heavily Polluted 14.3  0.4
Raw Sewage      13.3  2.7
Septic Condition 0.0  0.0

DO YOU WANT FURTHER QUANTIFICATION OF THIS (ANS: YES OR NO) ? Y

INPUT TIME PERIOD OF INTEREST ? 1

THIS SECTION ISN'T OPERATIONAL YET, BUT THE OUTPUT WILL BE LOCATIONS OF ZONES IN EACH WATER QUALITY DESIGNATION FOR THE SPECIFIED TIME PERIOD.
.038 CP SECONDS EXECUTION TIME
Section C: Environmental Toxicity

/ -turtv

LOADER INFORMATION:
MAP OPTIONS = OFF
GLOBAL LIBRARY SET IS - GC3ALPH

**********************************************************************
** THIS RTV ROUTINE TESTS ENVIRONMENTAL TOXICITY                  **
**********************************************************************
EXAMPLE NO. 1

Specify which water quality attribute(s) are to be analyzed for their toxic effects.
1) TEMP.
2) BOD5
3) TSS
4) NH3
5) NO2
6) NO3
7) PO4
8) D.O.
9) HARD
10) PH
11) ZN
12) CL2
13) COLI.

Respond with the total number of toxicants followed by the appropriate index numbers.
? 3, 4, 11, 12

Specify target species:

Designate stream type (W=WARM WATER, C=COLD WATER) ? W

Representative species list:
1) Fathead Minnow
2) Carp
3) Bluegill
4) Channel Cat
5) Largemouth Bass

Respond with number of target species desired and with their appropriate index number(s).
? 1, 3

Input the 96 hour LC50’s for the following species and potential toxicants:

Bluegill

NH3 ? 0.6
ZN ? 0.3
CL2 ? 0.2

Specify time period of interest ? 1
### REPORT ON TOXICITY IMPACTS IN TIME PERIOD

**MAXIMUM AND MEAN (IN PARENTHESES) TOXICITY UNITS**

<table>
<thead>
<tr>
<th>TARGET SPECIES</th>
<th>TOTAL</th>
<th>NH3</th>
<th>ZN</th>
<th>CL2</th>
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<td>BLUEGILL</td>
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<td>(4.272)</td>
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<td>(2.903)</td>
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**DO YOU WANT A GRAPHICAL OUTPUT FOR TOXICITY UNITS VS. LOCATION DOWNSTREAM (ANS: YES OR NO)?**

YES

**INPUT TOXICANT NUMBER?**

1) NH3  
2) ZN  
3) CL2

**INPUT TARGET SPECIES INDEX?**

BLUEGILL

**TIME PERIOD (T=TOTAL T.U.'S; T.T.U.'S FROM SPECIFIED ATT.)**

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**PLOT TOXICITY IMPACTS FROM NH3 FOR ANOTHER TARGET SPECIES?**

NO

**PLOT FOR ANOTHER TOXICANT?**

YES
INPUT TOXICANT NUMBER ? 2
INPUT TARGET SPECIES INDEX ? 1

BLUEGILL ; CL2 ; TIME PERIOD 1
(T=TOTAL T.U.'S; *=T.U.'S FROM SPECIFIED ATT.)

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PLOT TOXICITY IMPACTS FROM Zn
FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? y
INPUT TOXICANT NUMBER ? 3
INPUT TARGET SPECIES INDEX ? 1

BLUEGILL ; CL2 ; TIME PERIOD 1
(T=TOTAL T.U.'S; *=T.U.'S FROM SPECIFIED ATT.)

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</table>
DO YOU WANT TO CONTINUE ANALYSES FOR ANOTHER TIME PERIOD (ANS: Y OR N) ? Y

SPECIFY TIME PERIOD OF INTEREST ? 2

REPORT ON TOXICITY IMPACTS IN TIME PERIOD 2

MAXIMUM AND MEAN (IN PARENTHESES) TOXICITY UNITS

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DO YOU WANT A GRAPHICAL OUTPUT FOR TOXICITY UNITS VS. LOCATION DOWNSTREAM (ANS: YES OR NO) ? Y

INPUT TOXICANT NUMBER ? 1

INPUT TARGET SPECIES INDEX ? 1

BLUEGILL ; NH3 ; TIME PERIOD 2
(T=TOTAL T.U.'S; *T.U.'S FROM SPECIFIED ATT.)

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PLOT TOXICITY IMPACTS FROM NH3 FOR ANOTHER TARGET SPECIES ? N
PLOT FOR ANOTHER TOXICANT ? Y
INPUT TOXICANT NUMBER ? 3
INPUT TARGET SPECIES INDEX ? 1

BLUEGILL ; CL2 ; TIME PERIOD 2
(T=TOTAL T.U.'S; *=T.U.'S FROM SPECIFIED ATT.)

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35. . T TT
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DISTANCE DOWNSTREAM (MILES)

PLOT TOXICITY IMPACTS FROM ZN
FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? n

INPUT TOXICANT NUMBER ? 3
INPUT TARGET SPECIES INDEX ? 1

BLUEGILL ; CL2 ; TIME PERIOD 2
(T=TOTAL T.U.'S; *=T.U.'S FROM SPECIFIED ATT.)

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7.5 . T
2.5 .

DISTANCE DOWNSTREAM (MILES)

PLOT TOXICITY IMPACTS FROM CL2
FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? n

57
DO YOU WISH TO CONTINUE ANALYSES FOR ANOTHER TIME PERIOD (ANS: X OR N) ? n

******************************************************************************
THIS CONCLUDES 'TURTU'. YOU MAY EXECUTE MORE RTU ROUTINES NOW, BEGIN A MITIGATION LOOP OR SIGNOFF.
******************************************************************************
2.004 CP SECONDS EXECUTION TIME

bye

3KVN9R5 COSTS: 690.570 SRUS AT $.0068 = $4.70
APPENDIX C:
RIAS SOURCE PROGRAMS

type rias/g

------------------------------------------

WELCOME TO THE
RATIONAL IMPACT EVALUATION SYSTEM
U.S. A.E.
CONSTRUCTION ENGINEERING RESEARCH
LABORATORY

VERSION 1.2
NOVEMBER 1979

------------------------------------------

THIS COMPUTER BASED IMPACT ASSESSMENT SYSTEM
CAN BE ACTIVATED BY EXECUTING A SERIES OF
PROCEDURE FILES WHICH ARE DESCRIBED BELOW:

1) -FQUES

THIS PROC FILE EXECUTES A PROGRAM WHICH ASKS
A SERIES OF QUESTIONS ABOUT THE ENVIRONMENTAL
SETTING FOR A SPECIFIC PROJECT AND ORGANIZES
THE INFORMATION OBTAINED INTO A DATA FILE
WHICH IS USED AS INPUT FOR SIMULATIONS AND
OTHER EVALUATION PROTOCOLS. 'FQUES' CAN BE
USED TO SETUP A NEW DATA FILE OR TO REWRITE
AN EXISTING DATA FILE. OUTPUT FROM 'FQUES'
IS TO A MASS STORAGE FILE CALLED 'TAPE9'.

2) -SIMWQ

THIS PROC FILE EXECUTES A WATER QUALITY
SIMULATION MODEL WHICH PREDICTS PRIMARY
PHYSICAL AND CHEMICAL IMPACTS IN THE AQUATIC
ENVIRONMENT BASED ON THE ENVIRONMENTAL
SETTING AND PROJECT SPECIFICATION INFORMA-
TION STORED IN THE OUTPUT FROM 'FQUES'.
OUTPUT FROM 'SIMWQ' IS TO A MASS STORAGE
FILE CALLED 'TAPE33'.

3) -RTVS

THIS PROC CALLS A LISTING OF A SERIES OF
PROGRAMS WHICH QUANTIFY ENVIRONMENTAL IMPACTS
IN THE AQUATIC ECOSYSTEM. THE USER CAN
THEN CHOOSE WHICH RTV MODELS ARE APPLICABLE
AND CAN EXECUTE EACH WITH THE APPROPRIATE
PROC CALL. ALL RTV MODELS REQUIRE INPUT
FROM 'TAPE9' AND/OR 'TAPE33'.

******** YOU MAY BEGIN **********
type,-fques/g

GET,BFQUES/ID=341447562.
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BFQUES.
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YOUR DATA SET IS STORED IN THE FILE 'TAPE9'.
NOTE.!! REMEMBER TO SAVE OR REPLACE IT IF YOU WANT TO
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BTURTV.
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ype *DEL*
type, sturtv/g

type, wqrtv/g

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GRAB, GCSALPH/F.
RWF.
WQRTV.
/

type, sirtv/g

GET, BSIRTV/ID=341447562.
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BSIRTV.
/
PROGRAM FILTERQ(INPUT,OUTPUT,TAPE1=INPUT,TAPE2=OUTPUT,TAPE9)
COMMON/NAMES/TITLE(d),CNAME(20),SNAMES(20),KNAME(20)
COMMON/CNTL/NR,NTP,NWQC,NE,IT(15),IE(15),ICODE,
+ HCODE(8),NCWQC,NCWQC,NTWQC,NS,NK
COMMON/TWQ/(15,20),EQW(15,20),TQ(15),EQ(15)
COMMON/KDATA/K20(20,20)
COMMON/SDATA/S20(20,20)
COMMON/MDATA/LR 20,DA(20)
COMMON/BDATA/A(20)
INTEGER TITLE,CNAME,HCODE,KNAME,NNAME.E.:
INTEGER DINDEX(125),CNTLRS(8)
REAL LR,K20
DATA (CNAME(I),I=1,8)/"TEMP","BOD5","SS","NH3","NO2","NO3",
+ "P04","D.O.",/
DATA (KNAME(I),I=1,20)/"KANH3","KANO3","KAP04","KL","KLS",
+ "KND3","KUH3","KUO2","KUO3","KPD3","KPO4","KR","KSS",
+ "KSSS","KT","KSS","KNC1","KNC2","KNC3","KNC4"/
DATA (SMAME(I),I=1,20)/"SL","SUM3","SN03","SO2","SP04",
+ "SS03","SS0","ST","SAT1","SAT2","SAT3","SAT4","SAT5","SAT6",
+ "SA7","SA7","SA7","SA7","SA7","SA7",/PRINT*," 
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PRINT*," I) TYPE IN THE NAME OF THE DATA SET" 
READ(1,911) (TITLE(I),I=1,8)
IF(EOF(1)) 20,21
PRINT*." "
PRINT*." " II) ANSWER THE FOLLOWING QUESTIONS ABOUT SIMULATION*
PRINT*., " CONTROL PARAMETERS."
PRINT*., " HOW MANY REACHES (ANS:1-20) ",
READ(1,*) NR
IF(EOF(1)) 30,31
PRINT*., " HOW MANY TIME PERIODS (ANS:1-12) ",
READ(1,*) NTP
IF(EOF(1)) 31,32
PRINT*., " HOW MANY ADDITIONAL CONSERVATIVE WATER QUALITY*
PRINT*., " ATTRIBUTES BEYOND THE CORE ATTRIBUTES" *(ANS: 0-12) ",
READ(1,*) NCWQC
IF(EOF(1)) 32,33
PRINT*., " HOW MANY NONCONSERVATIVE ATTRIBUTES" *(ANS: 0-4) ",
READ(1,*) NNWQC
IF(EOF(1)) 33,34
NTWQC=6*NCWQC+NNWQC
NWQC=8
NS=NTWQC
IF(NTWQC.LE.8) GO TO 70
PRINT*., " INPUT THE NAMES OF THESE ADDITIONAL PARAMETERS."
IF(NWQC.LT.1) GO TO 51
PRINT*., " CONSERVATIVE ATTRIBUTES:"
DO 50 I=1,NCWQC
49 PRINT*., " ATT. NO. ",I+8,"
READ(1,913) CNAME(8+I)
IF(EOF(1)) 49,50
CONTINUE
IF(NNWQC.LT.1) GO TO 51
PRINT*., " HOWCONSERVATIVE ATTRIBUTES:"
DO 59 I=1,NNWQC
59 PRINT*., " ATT. NO. ",I+8*NCWQC," 
READ(1,913) CNAME(8*NCWQC+I)
IF(EOF(1)) 59,60
CONTINUE
70 PRINT*., " INPUT THE MODELING CODES FOR THE EIGHT CORE"
PRINT*., " ATTRIBUTES (ANS: 0 OR 1) ",
READ(1,*) (MCODE(I),I=1,8)
IF(EOF(1)) 70,71
PRINT*., " III) INPUT THE PARAMETERS DESCRIBING THE WATERSHED"
PRINT*., " STRUCTURE FOR THIS SIMULATION."
PRINT*., " HOW MANY TRIBUTARY INPUTS ",
READ(1,*) HIT
IF(EOF(1)) 100,101
101 IF(HIT.LT.1) GO TO 120
PRINT*., " INPUT CODES:" 
DO 110 I=1,HIT
110 PRINT*., 
READ(1,') IT(I)
IF(EOF(1)) 110,111
CONTINUE
120 PRINT*., " HOW MANY POINT SOURCE DISCHARGES ",
READ(1,') DIE
IF(EOF(1)) 120,121
121 IF(NIE.LT.1) GO TO 141
PRINT*., " INPUT CODES:" 
63
DO 140 I=1,NIE
   PRINT*,"I1,",IE(I)
   IF(EOF(1)) 130,140
140 CONTINUE
141 PRINT*,"HOW MANY MAIN BRANCH BIFURCATIONS ",NIE
   READ(1,*),NB
   IF(EOF(1)) 141,142
142 IF(NB.LT.1) GO TO 151
143 CONTINUE
145 PRINT*,"BIFURCATION CODES:
   READ(1,*),HCODE(I)
   IF(EOF(1)) 145,150
150 CONTINUE
151 PRINT*,"INPUT THE LENGTH OF EACH REACH AND THE DRAINAGE AREA UPSTREAM FROM THE TOP OF EACH REACH (ANS: MILES AND SQUARE MILES)."
152 PRINT*,"INPUT THE LENGTH OF EACH REACH AND THE DRAINAGE AREA UPSTREAM FROM THE TOP OF EACH REACH (ANS: MILES AND SQUARE MILES)."
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189 PRINT*,"INPUT THE LENGTH OF EACH REACH AND THE DRAINAGE AREA UPSTREAM FROM THE TOP OF EACH REACH (ANS: MILES AND SQUARE MILES)."
190 CONTINUE
191 PRINT*,"IV) INDICATE HOW YOU WISH TO MODEL STREAM HYDRAULICS.
   PRINT*,"0) MEAN DEPTH AND VELOCITY SPECIFIED FOR EACH REACH AND TIME PERIOD.
   PRINT*,"1) HYDRAULIC RATING PARAMETERS USED FOR EACH REACH.
   PRINT*,"(ANS: USE EITHER 0 OR 1)."
192 READ(1,194) HCODE
   IF(EOF(1)) 192,190
193 IF(HCODE.GT.0) GO TO 221
194 PRINT*,"INPUT THE HYDRAULIC RATING PARAMETERS FOR EACH REACH; RESPOND WITH FOUR PARAMETERS IN THE FOLLOWING ORDER: AV,BV,AD,BD.
   DO 190 I=1,NR
195 PRINT*,"I") HYDRAULIC PARAMETERS.
   DO 190 (VEL(II),II=1,NR)
196 IF(EOF(1)) 196,211
197 PRINT*,"INPUT MEAN DEPTHS FOR EACH REACH.
198 PRINT*,"READ(1,*),HAD(I),HBD(I)
   IF(EOF(1)) 189,190
199 CONTINUE
200 PRINT*,"CALL LOADTIP(ITP)
   DO 450 ITP=1,NTP
201 PRINT*,"TIME VARIANT PARAMETERS FOR TIME PERIOD NO. " ITP
202 PRINT*,"HYDRAULIC PARAMETERS.
   IF(HCODE.GT.0) GO TO 221
203 PRINT*,"INPUT MEAN VELOCITIES FOR EACH REACH.
   READ(1,*),(VEL(II),II=1,NR)
   IF(EOF(1)) 210,211
204 PRINT*,"INPUT MEAN DEPTHS FOR EACH REACH."
220 PRINT*, "II) BOUNDARY CONDITIONS AT TRIBUTARIES."
221 PRINT*, "...T AMBIENT WATER QUALITY CONDITIONS FOR" 
222 PRINT*, "TRIBUTARIES 1 THROUGH \"NIT" 
223 DO 225 IC=1,NTWQC
224 PRINT*, "",CNAME(IC),": ", 
225 READ(1,*) (TWQ(IIT,IC),IIT=1,NIT) 
226 IF(EOF(1)) 225,227
227 PRINT*, "III) BOUNDARY CONDITIONS AT EFFLUENT DISCHARGES."
228 PRINT*, "...T AMBIENT WATER QUALITY CONDITIONS FOR" 
229 PRINT*, "EFFLUENTS 1 THROUGH \"NIE" 
230 DO 235 IC=1,NTWQC
231 PRINT*, "",CNAME(IC),": ", 
232 READ(1,*) (EQ(IIE,IC),IIE=1,NIE) 
233 IF(EOF(1)) 235,236
234 PRINT*, "MEAN DISCHARGE:" 
235 PRINT*, "",CNAME(IC),": ", 
236 READ(1,*) (EQ(IIE,IC),IIE=1,NIE) 
237 IF(EOF(1)) 236,238
238 PRINT*, "IV) REACTION RATE COEFFICIENTS."
239 PRINT*, "INPUT THE INDICATED RATE COEFFICIENT FOR" 
240 PRINT*, "REACHES 1 THROUGH \"NR" 
241 PRINT*, "DO 250 IK=1,NK
242 PRINT*, "",KNAME(IK), 
243 READ(1,*) (K20(IR,IK),IR=1,NR) 
244 IF(EOF(1)) 244,245
245 PRINT*, "V) DISTRIBUTED SOURCE/SINK PARAMETERS."
246 PRINT*, "INPUT THE INDICATED SOURCE/SINK TERM FOR" 
247 PRINT*, "REACHES 1 THROUGH \"NR" 
248 PRINT*, "DO 260 IS=1,NS
249 PRINT*, "",SNAME(IS), 
250 READ(1,*) (S20(IR,IS),IR=1,NR) 
251 IF(EOF(1)) 250,251
252 PRINT*, "VI) BIOLOGICAL PARAMETERS."
253 PRINT*, "INPUT ESTIMATED ALGAL BIOMASS FOR REACHES" 
254 PRINT*, "1 THROUGH \"NR" 
255 PRINT*, "DO 270 IR=1,NR
256 PRINT*, "",A(IR),IR=1, NR) 
257 IF(EOF(1)) 271,450
258 CALL LOADVPS(ITP) 
CALL CLOSEHS(9)

65
DO YOU WISH TO REVIEW AND/OR REVISE THE EXISTING DATA FILE?
(ANS: YES OR NO)

READ(1,901) IANS2
IF(EOF(1)) 510,511
IANS2.EQ."*" .AND. IANS2.NE."*" ) GO TO 510
IF(IANS2.EQ."*") GO TO 998
CALL OPENMS(9,DINDEX,125,0)
519 CALL UNLOAD(ITP)
520 PRINT*,
600 CALL DSUM
901 FORMAT(1A1)
902 FORMAT(1I1)
903 FORMAT(8A10)
911 FORMAT(9A10)
913 FORMAT(1A5)
914 FORMAT(1I1)
915 FORMAT(1F5.2)
923 FORMAT(8F10.3)
898 CONTINUE
999 STOP

* INDEX FOR ALL VARIABLES AND PARAMETERS USED IN 'SIMWQ'

A(IR) ALGAL CONCENTRATIONS IN REACH 'IR' (MG/L)
ALPHA(IC) PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)
ATT KEY FOR MASS STORAGE OF WQ VECTOR
BCODE(IB) BIFURCATION CODE DEFINING WATERSHED BRANCHES
BETA(IC,I) PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)
BQ(IB) DISCHARGE AT MINOR TRIBUTARY AT IB'TH BIFURCATION (FT*3/SEC)
BWQ(IBIC) WQ VECTOR AT MINOR TRIBUTARY AT IB'TH BIFURCATION
CNAME(IC) ALPHABETIC NAMES OF WATER QUALITY ATTIBUTES
CCTRLS(8) ARRAY HOLDING SIMULATION CONTROL PARAMETERS FOR TRANSFER TO AND FROM MASS STORAGE (NH,NTP,NWQC,ETC.)
DA(IR) DRAINAGE AREA UPSTREAM FROM IR'TH REACH (MILES**2)
DELTIC,I) PARAMETER FOR ANALYTICAL WQ SOLUTION
DEPTH(IR) MEAN DEPTH OF IR'TH REACH (FEET)
DINDEX(I) MASTER INDEX FOR MASS STORAGE OF SIMULATION DATA
EPSLIC,I) PARAMETER FOR ANALYTICAL WQ SOLUTION
EQE(I) DISCHARGE AT I'E'TH POINT SOURCE EFFLUENT INPUT (FT*3/SEC)
EQV(I,EIC) WATER QUALITY VECTOR AT IE'TH EFFLUENT INPUT
GAMMA(I,EIC) PARAMETER FOR ANALYTICAL WQ SOLUTIONS
HAD(IR) HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS
HAV(IR) HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES
HBD(IR) HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS
HAV(I) HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES
HCODE SWITCH FOR SPECIFYING MODELING CHOICE FOR DEPTH VEL
IATT ATTRIBUTE INDEX (1 TO 20)
I3 BIFURCATION INDEX (1 TO 5)
IC WQ CONSTITUENT INDEX (1 TO 20); SAME AS IATT
IE(IIE) EFFLUENT INPUT INDEX (1 TO 15)
INUM INDEX FOR SPECIFICATION OF RECORD KEY FOR MASS STORAGE OF WQ VECTORS
IP SAME AS IPP
INDEX OF PROFILE POINT IN SIMULATION RESULTS (1 TO 200)

INDEX OF REACH (1 TO 20)

INDEX FOR MASS STORAGE OUTPUT OF WQ VECTOR

INDEX OF RECEIVING REACH (DOWNSTREAM) OF 18TH BIFURCATION

INDEX SPECIFYING TOP OF SUPERIOR CHANNEL BRANCHES

INDEX OF TIME PERIOD (1 TO 12)

INDEX OF WATER QUALITY CONSTITUENTS (1 TO 20)

TEMPERATURE ADJUSTED KINETIC RATE COEFFICIENT (1/DA)

RATE COEFFICIENT AT 20 DEGREES (1/DA)

LENGTH OF 18TH REACH (MILES)

MODELING CODE FOR 18TH ATTRIBUTE

NUMBER OF WQ ATTRIBUTES

NUMBER OF BIFURCATIONS OF STREAM CHANNEL (0<4<5)

NUMBER OF CONSERVATION WQ CONSTITUENTS (0<4QC<12-4NCQC)

NUMBER OF POINT SOURCE EFFLUENT INPUTS (0<NS<15)

NUMBER OF TRIBUTARY INPUTS (1<NT<15)

NUMBER OF NON-CONSERVATION WQ CONSTITUENTS

NUMBER OF PROFILE POINTS IN SIMULATION OF CURRENT

NUMBER OF REACHES IN CURRENT SIMULATION (1<NR<2)

NUMBER OF SOURCE/SINK TERMS IN SIMULATION (0<NSS<12)

NUMBER OF TIME PERIODS IN SIMULATION RUN (1<NT<12)

NUMBER OF TOTAL WQ CONSTITUENTS IN SIMULATION (NTWQC<20)

NUMBER OF CORE WATER QUALITY CONSTITUENTS IN SIMULATION

PERCENT OF NITROGEN IN SUSPENDED SOLIDS (/1000)

PERCENT OF PHOSPHORUS IN SUSPENDED SOLIDS (/100)

STREAM DISCHARGE AT IPP TH POINT OF OUTPUT PROFILE (FT**3/SEC)

DISCHARGE INPUT FROM BIFURCATION TO CURRENT REACH (CF)

DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CF)

MASTER INDEX FOR MASS STORAGE OF SIMULATED WQ PROFILES

DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CF)

DISCHARGE AT TOP OF CURRENT REACH AFTER SOLUTIONS (CF)

TEMPERATURE CORRECTION FACTOR FOR IKTH RATE COEFFICIENT

TEMPERATURE CORRECTION FACTOR FOR IS_TH SOURCE/SINK TERM

TEMPERATURE CORRECTED SOURCE/SINK TERM FOR 18TH REACH

SINK TERM AT 20 DEGREES C (MG/DA)

WATER TEMPERATURE (DEGREES C)

SIMULATION NAME

TOTAL LENGTH OF STREAM TO BE SIMULATED (MILES)

DISCHARGE IN IT TH TRIBUTARY (GFS)

TOTAL TIME OF TRAVEL WITHIN CURRENT REACH (DAYS)

WATER QUALITY VECTOR FOR IT TH TRIBUTARY INPUT

MEAN VELOCITY IN IT TH REACH (MILES/DA)

WATER QUALITY VECTOR FOR IPP TH POINT IN SIMULATION

WATER QUALITY VECTOR FOR 18TH BIFURCATION INPUT

WATER QUALITY VECTOR FOR IT TH EFFLUENT INPUT

WATER QUALITY VECTOR FOR IT TH TRIBUTARY INPUT

WATER QUALITY VECTOR AT TOP OF CURRENT REACH AFTER

INCREAS BETWEEN PROFILE POINTS IN SIMULATION OUTPUT

INDEX OF LOCATION IN TERMS OF STREAM REACH

DISTANCE AT TOP OF CURRENT REACH

DISTANCE FROM TOP OF CURRENT REACH

PARAMETER FOR ANALYTICAL WQ SOLUTION

END
SUBROUTINE DSM

COMMON /MNAME/I(8),CHNAME(20),SNAME(20),KNAME(20)
COMMON /CNAME/I(8),CHNAME(20),SNAME(20),KNAME(20)
COMMON /NAME/I(4),CHNAME(20),SNAME(20),KNAME(20)
COMMON /MCODE/I(15),NCODE/I(15),WQC/I(15),EQ/I(15)
COMMON /EQQC/I(15),EQ/I(15),EQ/I(15),EQ/I(15)
COMMON /KDATA/I(20,20)
COMMON /SDATA/I(20,20)
COMMON /MDATA/I(20,20)
COMMON /BDATA/I(20)
REAL K20,L20
INTEGER TITLE,CHAME,KNAME,SNAME
INTERGER TITLE,CHAME,KNAME,SNAME

PRINT*, "THE CURRENT CONTENTS OF FOUR DATA FILE HAVE THE"
PRINT*, "TITLE:"
PRINT*, "", (TITLE(I),I=1,5)
PRINT*, "", (TITLE(I),I=6,8)
PRINT*, "" THIS DATA SET SPECIFIES SIMULATION OF THE"
PRINT*, " FOLLOWING WATER QUALITY Attributes:"
PRINT*, "", (CNAME(I),I=1,5)
PRINT*, "", (CNAME(I),I=6,10)
IF(NTWQC.LT.11) GO TO 10
PRINT*, "", (CNAME(I),I=11,15)
IF(NTWQC.LT.16) GO TO 10
PRINT*, "", (CNAME(I),I=16,20)

PRINT*, " SIMULATIONS WILL BE RUN FOR ",NTP," TIME PERIODS"
PRINT*, " F= TOTAL OF ",NR," STREAM REACHES."
CALL WAIT
PRINT*, " THE WATERSHED STRUCTURE IS AS FOLLOWS:"
PRINT*, " R= LENGTH DRAINAGE INPUTS"
PRINT*, " WO. (MI.) (SQ.MI.) EFF. TRIB."
DO 30 IR=1,NR
EINPUT="!
DO 23 IIT=1,NIT
CONTINUE
DO 26 IIE=1,NIT
CONTINUE
30 PRINT(1,900) IR,LR(IR),DAC(IR),EINPUT,TINPUT
900 FORMAT(7X,112,3X,2(1F10.3,2X),7X,112,3X,112)

PRINT*, " THE NUMBER OF MAJOR BIFURCATIONS OF THE MAIN"
PRINT*, " CHANNEL OF THIS RECEIVING STREAM IS ",NB
IF(NB.LE.0) GO TO 40
START=1
PRINT*, "!
DO 39 INB=1,NB
IEND=CODE(INB)+100-IFIX(CODE(INB))
39 CONTINUE
DO 39 INB=1,NB
IEND=CODE(INB)+100-IFIX(CODE(INB))
PRINT*, "BRANCH NO. ",INB," INCLUDES REACHES ",START," TO ",
+ IEND
THE MAIN CHANNEL INCLUDES REACHES ".START," TO ".NR.

HYDRAULIC MODELING WILL BE DONE USING MEAN "

VELOCITIES AND DEPTHS FOR EACH REACH AND TIME" PERIOD.

HYDRAULIC MODELING WILL BE DONE USING HYDRAULIC "

RATING PARAMETERS RELATING MEAN VELOCITIES AND "

DEPTHS TO DISCHARGE IN A REACH."

NONE OF THE ABOVE PARAMETERS CAN BE ALTERED WITHOUT" 

CREATING A TOTALLY NEW DATA SET (I.E., BY" 

STARTING OVER WITH "FQUES")."

DO YOU WANT TO CONTINUE (ANS: YES OR NO)

WHICH TIME PERIOD DO YOU WANT TO REVIEW

INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU" 

WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)"

1) HYDRAULIC PARAMETERS"

2) INITIAL CONDITIONS IN TRIBUTARIES"

3) INITIAL CONDITIONS IN EFFLUENTS"

4) KINETIC PARAMETERS"

5) DISTRIBUTED SOURCE/SINK PARAMETERS"

6) BIOLOGICAL PARAMETERS"

THIS DATA SET USES HYDRAULIC RATING PARAMETERS" 

THERFORE NO MEAN VALUES FOR VELOCITY" 

OR DEPTH ARE NEEDED." 

THE CURRENT VALUES FOR MEAN VELOCITIES AND DEPTHS" 

FOR EACH REACH DURING TIME PERIOD ",ITP." ARE" 

LISTED BELOW. TO CHANGE THE CURRENT VALUES" 

RESPOND TO TRAILING "?" BY THE NEW VALUES." 

(NO. REACH,VELOCITY,DEPTH)"

DO 170 IR=1,NR

,IR,)," 

VEL(IR),DEPTH(IR)

CONTINUE

CONTINUE
GO TO 500
PRINT*, " INDICATE WHICH WATER QUALITY ATTRIBUTE YOU ARE"
PRINT*, " INTERESTED IN:
PRINT*, "",IC, ")",CNAME(IC)
PRINT*, "",NTWQC+1,") DISCHARGE"
PRINT*, "",IWQC
READ(1,*) IWQC
IF(ZOF(1)(1)) 211,212
IF(IWQC.EQ.NTWQC+1) GO TO 230
PRINT*, " THE VALUES FOR "CNAME(IWQC), " FOR TIME PERIOD 
PRINT*, "",ITP," ARE LISTED BELOW BY TRIBUTARY."
PRINT*, " TO CHANGE A VALUE RESPOND TO THE TRAILING '?'
PRINT*, " WITH THE NEW VALUE."
DO 220 IIT=1,NIT
PRINT*, ",IIT,"",TWQ(IIT,IWQC),
READ(1,*) TWQ(IIT,IWQC)
IF(EOF(1)) 220,219
219 CONTINUE
220 CONTINUE
PRINT*, " GO TO 241
PRINT*, " THE VALUES FOR TRIBUTARY DISCHARGE FOR TIME PERIOD",
PRINT*, "",ITP," ARE LISTED BY TRIBUTARY BELOW. TO"
PRINT*, " CHANGE A VALUE RESPOND TO THE TRAILING '?' BY"
PRINT*, " THE NEW VALUE."
DO 240 IIT=1,NIT
PRINT*, ",IIT,"",TWQ(IIT),
READ(1,*) TWQ(IIT)
IF(EOF(1)) 240,239
239 CONTINUE
240 CONTINUE
241 PRINT*, " REVIEW ANOTHER TRIBUTARY ATTRIBUTE (ANS: YES OR NO)",
READ(1,901) IANS
IF(EOF(1)) 241,242
242 IF(IANS.NE."H".AND.IANS.NE."Y") GO TO 241
IF(IANS.EQ."N") GO TO 500
PRINT*, " WHICH ATTRIBUTE",
READ(1,*) IWQC
IF(EOF(1)) 243,244
244 IF(IWQC.LT.1.OR.IWQC.GT.NTWQC+1) GO TO 209
GO TO 212
250 PRINT*, " INDICATE WHICH WATER QUALITY ATTRIBUTE YOU ARE"
PRINT*, " INTERESTED IN:
PRINT*, "",IC, ")",CNAME(IC)
PRINT*, "",NTWQC+1,") DISCHARGE"
PRINT*, "",IWQC
READ(1,*) IWQC
IF(EOF(1)) 261,262
262 IF(IWQC.EQ.NTWQC+1) GO TO 280
PRINT*, " THE VALUES FOR "CNAME(IWQC), " FOR TIME PERIOD 
PRINT*, "",ITP," ARE LISTED BELOW BY EFFLUENT."
PRINT*, " TO CHANGE A VALUE RESPOND TO THE TRAILING '?'
PRINT*, " WITH THE NEW VALUE."
DO 270 IIE=1,NIE
PRINT*, "",IIE,"",EWQ(IIE,IWQC),
READ(1,*) EWQ(IIE,IWQC)
IF(EOF(1)) 270,269
269 CONTINUE
270 CONTINUE
PRINT*, " GO TO 291
THE VALUES FOR EFFLUENT DISCHARGE FOR TIME PERIOD * 
* ITP, * ARE LISTED BELOW. TO * 
* CHANGE A VALUE RESPOND TO THE TRAILING '?' BY * 
* THE NEW VALUE.

DO 290 IIE=1,NIE 
PRINT*, "",IIE,"",EQ(IIE), 
READ(1,*),EQ(IIE) 
IF(EOP(1)) 289,290 
289 CONTINUE 
290 CONTINUE 
291 PRINT*, " REVIEW ANOTHER EFFLUENT ATTRIBUTE (ANS: YES OR NO)", 
READ(1,901) IANS4 
IF(EOP(1)) 291,292 
292 IF(IANS4.NE."N".AND.IANS4.NE."Y") GO TO 291 
IF(IANS4.EQ."N") GO TO 500 
293 PRINT*, " WHICH ATTRIBUTE", 
READ(1,*),IWAR 
IF(EOP(1)) 293,294 
294 IF(IWAR.LT.1.OR.IWAR.GT.NWAR) GO TO 259 
GO TO 262 
300 PRINT*, " INDICATE THE INDEX NUMBER OF THE KINETIC PARAMETER" 
PRINT*, " YOU ARE INTERESTED IN REVIEWING" 
309 DO 310 IK=1,NK 
310 PRINT*, "",IK,"",KNAMES(IK) 
311 PRINT*, "", 
READ(1,*),IX 
IF(EOP(1)) 311,312 
312 IF(IX.LT.1.OR.IX.GT.NX) GO TO 309 
PRINT*, " THE VALUES CURRENTLY SPECIFIED FOR "KNAMES(IK)," WILL" 
PRINT*, " BE LISTED BELOW BY REACH, TO CHANGE A VALUE" 
PRINT*, " RESPOND TO THE TRAILING '?' WITH THE NEW" 
PRINT*, " VALUE.

DO 320 IR=1,NR 
PRINT*, "",IR,"",K20(IR,IX), 
READ(1,*) K20(IR,IX) 
IF(EOP(1)) 319,320 
319 CONTINUE 
320 CONTINUE 
321 PRINT*, " REVIEW ANOTHER RATE COEFFICIENT (ANS: YES OR NO)", 
READ(1,901) IXANS 
IF(EOP(1)) 321,322 
322 IF(IANS5.NE."N".AND.IANS5.NE."Y") GO TO 321 
IF(IANS5.EQ."N") GO TO 500 
330 PRINT*, " WHICH ONE", 
READ(1,*),IX 
IF(EOP(1)) 330,331 
331 IF(IX.LT.1.OR.IX.GT.NX) GO TO 309 
GO TO 313 
350 PRINT*, " INDICATE THE INDEX NUMBER OF THE DISTRIBUTED" 
PRINT*, " SOURCE/SINK TERM YOU WISH TO REVIEW" 
359 DO 360 IS=1,NS 
360 PRINT*, "",IS,"",SNAMES(IS) 
361 PRINT*, "", 
READ(1,*),IS 
IF(EOP(1)) 361,362 
362 IF(IS.LT.1.OR.IS.GT.NS) GO TO 361 
363 PRINT*, " THE VALUES CURRENTLY SPECIFIED FOR "SNAMES(IS)," WILL" 
PRINT*, " BE LISTED BELOW BY REACH, TO CHANGE A VALUE" 
PRINT*, " RESPOND TO THE TRAILING '?' WITH THE NEW" 
PRINT*, " VALUE."
DO 370 IR=1,NR
PRINT*,"",IR,"",S20(IR,IS),
READ(1,*) S20(IR,IS)
IF(EOF(1)) 369,370
369 CONTINUE
370 CONTINUE
PRINT*," REVIEW ANOTHER SOURCE/SINK TERM (ANS: YES OR NO)",
READ(1,901) IANS6
IF(EOF(1)) 371,372
372 IF(IANS6.NE."N".AND.IANS6.NE."Y") GO TO 371
370 CONTINUE
PRINT*," WHICH ONE",
READ(1,*) IS
IF(EOF(1)) 380,381
381 IF(IS.LT.1.OR.IS.GT.NS) GO TO 359
GO TO 363
400 PRINT*," THE CURRENT VALUES FOR MEAN ALGAL CONCENTRATIONS",
PRINT*," ARE LISTED BELOW BY REACH AND FOR TIME PERIOD",
PRINT*,"",".ITP.". TO CHANGE A VALUE RESPOND TO THE",
PRINT*," TRAILING '?' BY THE NEW VALUE."
DO 410 IR=1,NR
PRINT*","",IR,"",A(IR),
READ(1,901) A(IR)
IF(EOF(1)) 409,410
409 CONTINUE
410 CONTINUE
PRINT*,""
500 PRINT*," CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)",
501 READ(1,901) IANS1
IF(EOF(1)) 501,502
502 IF(IANS1.NE."Y".AND.IANS1.NE."N") GO TO 501
501 CONTINUE
PRINT*,""
508 PRINT*," INDICATE PARAMETER TYPE ",
READ*,IPARAM
IF(EOF(1)) 508,509
509 IF(IPARAM.LT.0.OR.IPARAM.GT.6) GO TO 113
GO TO (150,200,250,300,350,400),IPARAM
510 PRINT*,""
511 PRINT*," REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO)",
512 READ(1,901) IANS2
IF(EOF(1)) 511,512
512 CALL LOADVPS(ITP)
IF(IANS2.NE."Y".AND.IANS2.NE."N") GO TO 511
RETURN
END
SUBROUTINE LOADTIP(ITP)

COMMON/NAMES/TITLE(8),CNAME(20),SHAME(20),ENAME(20)
COMMON/NCTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+MCODE(8),NCWQC,NNCWQC,NTMWC,NS,NK
COMMON/TWQC/TWQ(15,20),EYQ(15,20),TQ(15),EQ(15)
COMMON/KDATA/K20(20,20)
COMMON/SDATA/S20(20,20)
COMMON/MDATA/LR(20)

REAL LR,K20
INTEGER TITLE,HCODE,CNAME
INTEGER DINDEX(125),CNTRLS(8)
DATA (CNAM4E(t),I:1,8)/"rEMP.", "BOD5", "TSS", "NH3", "NO2-", "NO3",
+"F04", "D.O."

CALL WRITMS(9,TITLE,8,1,-1)
CALL WRITMS(9,NCTRLS,8,2,-1)
CALL WRITMS(9,NCTRLS,8,3,-1)
CALL WRITMS(9,CNAME,8,4,-1)

IF(NAATTS.LE.0) GO TO 570
CALL WRITMS(9,BCODE,8,5,-1)
CALL WRITMS(9,IT,NIT,6,-1)
CALL WRITMS(9,LH,NR,7,-1)
CALL WRITMS(9,DA,NR,8,-1)
IF(HCODE.EQ.O) GO TO 580
CALL WRITMS(9,HAV,NR,10,-1)
CALL WRITMS(9,HBV,NR,11,-1)
CALL WRITMS(9,HAD,NR,12,-1)
CALL WRITMS(9,HBD,NR,13,-1)

RETURN

ENTRY LOADVPS
.*TWQC=NTMWC=NNCWQC
NX=15+NCWQC
NS=MTWQC
II=13+*(ITP-1)*9
IF(HCODE.EQ.0) GO TO 585
INUM=II+1
CALL WRITMS(9,VEL,NR,INUM,-1)
INUM=II+2
CALL WRITMS(9,DEPTH,NR,INUM,-1)

NUM=NIT*TWQC
INUM=II+1
CALL WRITMS(9,TWQ,300,INUM,-1)
INUM=II+4
CALL WRITMS(9,TQ,300,INUM,-1)
INUM=II+5
CALL WRITMS(9,EWQ,300,INUM,-1)
INUM=II=6
CALL WRITMS(9,EQ,NIE,INUM,-1)
NUM=NN=NR
INUM=II=7
CALL WRITMS(9,K20,400,INUM,-1)
NUM=NS=NR
INUM=II=8
CALL WRITMS(9,S20,400,INUM,-1)
INUM=II=9
CALL WRITMS(9,A,MR,INUM,-1)
RETURN
END

SUBROUTINE UNLOAD(ITP)

COMMON/NAMES/TITLE(8),CHAME(20),SNAME(20)
COMMON/CTRL/HR,KT,MC,QC,MR,NIE,IT(15),IE(15),MCQ,
+ NCQ,MCWQC,MNCWQC,MTWQC,MS,MR
COMMON/INQC/TWQ(15,20),NIE(15,20),TQ(15),EQ(15)
COMMON/KDATA/K20(20,20)
COMMON/SDATA/S20(20,20)
COMMON/IDATA/I15(20,20)
COMMON/SDATA/LR(20)
REAL LR
INTEGER NAME,NAME
INTEGER INDEX(125),CNTLRS(8)

C-----> UNLOAD DATA FROM MASS STORAGE FILE
CALL READMS(9,TITLE,8,1)
CALL READMS(9,CNTLRS,8,2)
MR=CNTLRS(1)
MTP=CNTLRS(2)
MCQ=CNTLRS(3)
MCQ=CNTLRS(4)
MCQ=CNTLRS(5)
NR=CNTLRS(6)
NIE=CNTLRS(7)
NS=CNTLRS(8)
MCWQC=MR
MCWQC=MCWQC+MCWQC
MCWQC=MCWQC+MCWQC
CALL READMS(9,MCQ,MNCWQC,NCWQC)
IF(MCQ.LE.0) GO TO 570
CALL READMS(9,TITIE,NTWQC,4)
CALL READMS(9,MCQ,MB,5)
CALL READMS(9,MCQ,NR,6)
CALL READMS(9,MCQ,NR,7)
CALL READMS(9,LR,NR,8)
CALL READMS(9,DA,NR,9)
IF(MCQ.EQ.0) GO TO 580
CALL READMS(9,HAV,MR,10)
CALL READMS(9,HBV,MR,11)
CALL READMS(9,HAD,MR,12)
CALL READMS(9,HBD,MR,13)

570 RETURN

74
ENTRY UNLTVPS
II=13*(ITP-1)*9
IF(HCODE.EQ.1) GO TO 585
INUM=II=1
CALL READMS(9,VEL,MR,INUM)
INUM=II+2
CALL READMS(9,DEPTH,MR,INUM)
NUM=NIT*NTQBC
INUM=II+3
CALL READMS(9,TWQ,300,INUM)
INUM=II+4
CALL READMS(9,TQ,NIT,INUM)
NUM=NIE*NTQBC
INUM=II+5
CALL READMS(9,EWQ,300,INUM)
INUM=II+6
CALL READMS(9,EQ,NIE,INUM)
NUM=NIE*NR
INUM=II+7
CALL READMS(9,K20,400,INUM)
INUM=II+8
CALL READMS(9,K20,400,INUM)
INUM=II+9
CALL READMS(9,NS,MR,INUM)
RETURN
END

SUBROUTINE WAIT
READ*, DUMMY
IF(EOF(1))1,2
1 GO TO 2
2 DO 3 I=1,5
3 PRINT*, " 
RETURN
END
SOURCE LISTING OF SIMWQ

PROGRAM WQMAIN(OUTPUT,TAPE4=OUTPUT,TAPE9,TAPE33)
COMMON/NAMES/TITLE(4),CNAME(20)
COMMON/CTRL/AB,ABP,WQ,W4,WQC,WE,ITW,IFT(15),ITW(15),M4CDE,
+ M4CDE(8),IR,IB,IPP,WQC,WQC,WQC,WQC,WQC,NPP
COMMON/WQ/WQ(15,20),WQ(15,20),TQ(15),SQ(15),
+ SQ(5,20),BQ(5)
COMMON/KDATA/K20(20,20),KTF(20)/QDATA/Q10K(20),Q10S(20)
COMMON/SDATA/S20(20,20),ST(20)
COMMON/CDATA/DA(20),DEP(20),VEL(20),BCODE(5),
+ HAY(20),HRV(20),HAD(20),HBD(20)
COMMON/BDATA/PN,PP,A(20)
COMMON/PARAM/ALPHA(20),BETA(20,5),GAMMA(20,5),D3LTA(20),
+ EPSIL(20,5),ZETA(20)
DIMENSION WQ(200,200),Q(200),X(200,3)
REAL K20,KT,,LR
INTEGER TITLE,HCODE,CHANCE,DINDEX(125)
DATA (CNAME(I),I:1,B)/"TEMP","TSS","BOD","NH3","NO3", "AO2", "N03",
+ "PO4","N04","/"
C------> INPUT DATA FROM 'TAPE9'
C
CALL QOPENMS(9,DINDEX,125,0)
CALL LOADDAT(1TP)
C------> BEGIN SIMULATIONS FOR DISCRETE TIME PERIODS
C
DO 100 ITP=1,LTP
C
CALL LOADTVPC(1TP)
C
C------------> WATER QUALITY SIMULATIONS
C
CALL SIMWQ(WQ,Q,X)
C
C--> OUTPUT RESULTS
C
CALL WQOUTMS(WQ,Q,X,1TP)
100 CONTINUE
C
PRINT", "%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
PRINT", " SIMULATED WATER QUALITY PROFILES HAVE BEEN"
PRINT", " OUTPUT TO 'TAPE33' FOR " ,ITP," TIME PERIOD(S) FOR THE FOLLOWING WATER"
PRINT", " QUALITY ATTRIBUTES:"
PRINT", " "
DO 200 IATT=1,NTWQC
200 PRINT", ",IATT," ," ,CNAME(IATT)
PRINT", " %
PRINT", "%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
CALL QCLOSEMS(9)
STOP
**INDEX FOR ALL VARIABLES AND PARAMETERS USED IN "S1MQ"**

- **A(IR)**: Algal Concentrations (mg/L)
- **ALPHA(IC)**: Parameter for Analytical WQ Solution (mg/L)
- **ATT**: Key for Mass Storage of WQ Vector
- **BCODE(IB)**: Bifurcation Code Defining Watershed Branches
- **BETA(IC,L)**: Parameter for Analytical WQ Solution (mg/L)
- **BQ(IB)**: Discharge at Minor Tributary at IB'th Bifurcation (ft³/sec)
- **BWQ(IBIC)**: WQ Vector at Minor Tributary at IB'th Bifurcation
- **CNTRL(S,9)**: Array Holding Simulation Control Parameters for Mass Storage Transfer to and from mass storage (HR, NT, AT, WQ, etc.)
- **CNTRLS,8)**: Array Holding Simulation Control Parameters for Mass Storage of Simulation Data (HR, NT, AT, WQ, etc.)
- **DA(IR)**: Drainage Area Upstream from IR'th Reach (Miles²)
- **DELT(ICA,I)**: Parameter for Analytical WQ Solution
- **DEP(IR)**: Mean Depth of IR'th Reach (Feet)
- **DIJ(A)**: Master Index for Mass Storage of Simulation Data
- **EQ(IE)**: Discharge at IE'th Point Source Effluent Input (ft³/sec)
- **EWQ(I,IC)**: Water Quality Vector at IE'th Effluent Input
- **GAMA(IZ,:)**: Parameter for Analytical WQ Solutions
- **HAD(IR)**: Hydraulic Rating Parameter for Mean Depths
- **HAV(IR)**: Hydraulic Rating Parameter for Mean Velocities
- **HSD(IR)**: Hydraulic Rating Parameter for Mean Depths
- **HBV(IR)**: Hydraulic Rating Parameter for Mean Velocities
- **HCODE**: Switch for Specifying Modeling Choice for Depth Vel
- **IATT**: Attribute Index (1 to 20)
- **IB**: Bifurcation Index (1 to 5); Same as IATT
- **IC**: WQ Constituent Index (1 to 20); Same as NWQC
- **IE(IE)**: Effluent Input Index (1 to 15)
- **INUM**: Index for Specification of Record Key for Mass Storage of WQ Vectors
- **IP**: Same as IPP
- **IPP**: Index of Profile Point in Simulation Results (1 to 200)
- **IR**: Index of Reach (1 to 20)
- **IREC**: Record Key Index for Mass Storage Output of WQ Vector
- **IRECIP**: Index of Receiving Reach (Downstream) of IB'th Bifurcation
- **IT(IIT)**: Index of Input Location of Tributaries
- **ITOP**: Index Specifying Top of Superior Channel Branches
- **ITP**: Index of Time Period (1 to 12)
- **IWQC**: Index of Water Quality Constituents (1 to 20)
- **K**: Temperature Adjusted Kinetic Rate Coefficient (1/day)
- **K20**: Kinetic Rate Coefficient at 20 Degrees C (1/day)
- **LR(IR)**: Length of IR'th Reach (Miles)
- **MCODE(IC)**: Modeling Code for IC'th Attribute
- **MAATS**: Number of WQ Attributes
- **NB**: Number of Bifurcations of Stream Channel (0<NB<5)
- **NCWQC**: Number of Conservation WQ Constituents (0<NCWQC<12-NCWQC)
- **NW**: Number of Point Source Effluent Inputs (0<NW<15)
- **NWIT**: Number of Tributary Inputs (1<NWIT<15)
- **NWQC**: Number of Rate Coefficients Necessary for Simulation
- **NWQC**: Number of Non-Conservation WQ Constituents
- **NPP**: Number of Profile Points in Simulation of Current
- **NR**: Number of Reaches in Current Simulation (1<NR<20)
- **NS**: Number of Source/Sink Terms in Simulation (0<NS<20)
- **NTP**: Number of Time Periods in Simulation Run (1<NTP<12)
- **NWQC**: Number of Total WQ Constituents in Simulation (4NWQC<20)
- **NWQC**: Number of Core Water Quality Constituents in Simulation
- **PN**: Percent of Nitrogen in Suspended Solids (%/100)
- **PP**: Percent of Phosphorus in Suspended Solids (%/100)

77
SUBROUTINE ASOLN(TTWR,WQ)

COMMON/CNTRL/NR,MT,P,NWCQ,MB,N1,E,IT(I5),IE(I5),MCODE,
+ MCODE(8),IC,IB,IPP,NWCQ,NWCQ,NWCQ,NPP
COMMON/AR/ALPHA(20),BETA(20,5),GAMMA(20,5),DELTA(20),
+ EPSIL(20,5),FA(20)
DIMENSION NE(20),WQ(200,20)
DATA (NE(I),N1,2,203,2,5,1201/)
+ 0.00007774*TEMP**3

C----- DOWNSTREAM PROFILE CALCULATION OF WATER QUALITY

DO 899 J=1,NTWQC
WQ(IPP,J)=ALPHA(J)+DELTA(J)*TTWR-ZETA(J)*TTWR**2
+ EPSIL(J)
DO 799 K=1,II
WQ(IPP,J)=WQ(IPP,J)+BETA(J,K)*EXP(-GAMMA(J,K)*TTWR)
WQ(IPP,J)=WQ(IPP,J)+EPSIL(J,K)*TTWR*EXP(-GAMMA(J,K)*TTWR)
799 CONTINUE
899 CONTINUE
WQ(IPP,1)=DOSAT(WQ(IPP,1))=WQ(IPP,1)
RETURN
END
SUBROUTINE DILUTE(WQ, QO, Q0)

COMMON/CONTML/HR, ITP, NWQC, HB, NTU, IT(I), IT(15), IT(15), BCODE.
  + CODE(E), NR, EB, IPF, NWQC, HBWQC, NTQ, HPP
COMMON/ITWQC/MTQ(15, 20), ETQ(15, 20), TQ(15), EQ(15).
 + EWQ(3, 30), BQ(5),
COMMON/SDATA/LD(20), DA(20), DEPTH(20), VEL(20), BCODE(5),
 + HAY(20), HBV(20), HAD(20), HBD(20)
DIMENSION WQE(20), WQT(20), WQB(20), WQ(200, 20), QO(20), Q0(20)
REAL LR

C----- ZERO TRIBUTARY AND EFFLUENT INPUTS

101 QT=0.0
QQ=0.0
QB=0.0
DO 102 I=1, NTUQC
WQ(I)=0.0
WQE(I)=0.0
102 WQ(I)=0.0

C----- SELECT TRIBUTARY INPUTS FOR CURRENT REACH

DO 110 I=1, NTUQC
IF(IT(I).NE.IR) GO TO 110
QT=QT(I)
DO 105 J=1, NTUQC
105 WQT(I,J)=TWQ(I,J)
GO TO 111
110 CONTINUE

C----- SELECT POINT SOURCE EFFLUENT INPUTS FOR CURRENT REACH

DO 120 I=1, NTUQC
IF(IT(I).NE.IR) GO TO 120
QE=QE(I)
DO 115 J=1, NTUQC
115 WQE(J)=EWQ(I, J)
GO TO 121
120 CONTINUE

C----- SELECT INPUTS FROM BIFURCATIONS

DO 130 I=1, NB
IRECIP=INT(BCODE(I))
IF(IRECIP.NE.IR) GO TO 130
QB=BQ(I)
DO 125 J=1, NTUQC
125 WQB(J)=WQ(I, J)
GO TO 131
130 CONTINUE

C----- DILUTE WATER QUALITY VARIABLES

IF(I(R).EQ.1) GO TO 140
DO 135 I=1, NB
ITOP=BCODE(I)*100.-INT(BCODE(I))*100+1
IF(ITOP.EQ.IR) GO TO 140
135 CONTINUE
PRINT*, 'NO INPUTS AVAILABLE FOR THIS REACH' 
GO TO 150
140 QO(IR)=QE+QT
DO 145 K=1, NTUQC
145 WQO(K)=WQE(K)*QT*WQT(K)/QO(IR)
GO TO 150
150 QO(IR)=WQO(K)
DO 145 K=1, NTUQC
145 WQO(K)=WQE(K)*QT*WQT(K)/QO(IR)
GO TO 150
150 QO(IR)=QO(IR)+WQO(K)
GO TO 150
145 CONTINUE
RETURN
END
**SUBROUTINE LOADDAT(ITEM)**

C**--------------------------------------------------------------------------**
REAL LR,K(20)
COMMON/NAMES/TITLE(d),CNAME(20)
COMMON/CTRLS/NR,NTP,JWQC,DB,IT15),IE(15),HCODE,
  + HAV(15),HA(15),IPQ,JAVQC,JNWCQC,NWQC,JPP
COMMON/SDATA/LR(20),DA(20),IT(20)
COMMON/MDATA/LR(20),DA(20),DEPHT(20),VEL(20),B CODE(5),
  + HAV(20),HA(20),HAD(20),HBD(20)
COMMON/BDATA/PN,PP(20)
INTEGER TITLE, UCODE, CNAME, DINDEX(125),CNTRLS(3)

C---> UNLOAD DATA FROM MASS STORAGE FILE
CALL READMS(9,TITLE,8,1)
CALL READMS(9,CNAME,8,2)
NR=CNTRLS(1)
NTP=CNTRLS(2)
JWQC=CNTRLS(3)
NCWQC=CNTRLS(4)
HCODE=CNTRLS(5)
DB=CNTRLS(6)
IT=CNTRLS(7)
DA=CNTRLS(8)
JWQC=8
NR=16+JWQC
NS=8+NCWQC+NWQC
NWQC&=8+NCWQC+NWQC
CALL READMS(9,HCODE,8,9)
HAATTS=NCWQC+NWQC
IF(HAATTTS.LE.0) GO TO 570
CALL READMS(9,CNAME,NWQC,4)
570 CALL READMS(9,BCODE,NB,5)
CALL READMS(9,IT,NIT,6)
CALL READMS(9,IE,ND,7)
CALL READMS(9,LH,NR,8)
CALL READMS(9,DA,NR,9)
IF(HCODE.EQ.0) GO TO 580
CALL READMS(9,HAV,HR,10)
CALL READMS(9,HBV,HR,11)
CALL READMS(9,HAD,HR,12)
CALL READMS(9,HBD,HR,13)
580 RETURN
ENTRY LOADTYP
II=13*(ITEM-1)+9
IF(HCODE.EQ.1) GO TO 585
    H=II+1
CALL READMS(9,VEL,NR,INUM)
INUM=II+2
CALL READMS(9,DEPHT,NR,INUM)
INUM=II+3
CALL READMS(9,TWQ,300,INUM)
INUM=II+4
CALL READMS(9,TQ,NIT,INUM)
INUM=II+5
CALL READMS(9,EOQ,300,INUM)
INUM=II+6
CALL READMS(9,EOQ,NIT,INUM)
INUM=II+7
CALL READMS(9,K20,400,INUM)
INUM=II+8
CALL READMS(9,K30,400,INUM)
INUM=II+9
CALL READMS(9,A,INUM)
CONTINUE
RETURN
END
C--------------------------------------------
C/ROUTINE FCALC (:Q0)
C--------------------------------------------

COMMON/PARAM/ALPHA(20),BETA(20,5),GAMMA(20,5),DELTAL(20),
                   EPSIL(20,5),ZETA(20)
COMMON/Cctl/IR,IP,NQO,QBC,NIT,NAV,I(15),L(15),MCODE,
                   MCODZ(4),L(15),ZP,PNQO,HPNEW,HQF,APP
COMMON/CTDATA/KX20(20,20),K(20)/QDATA/K10K(20),Q10S(20)
COMMON/SDATA/S20(20,20),ST(20)
COMMON/SDATA/P,F,P,A(20)
COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BODE(5),
                   HAR(20),HBV(20),HAD(20),HBO(20)
DIMENSION QO(20)
REAL KT,KT20,LR
DATA (DELTAL(I),I=1,20)/20*0.0/
DATA ((EPSIL(1,J),I=1,20),J=1,5)/100*0.0/
DATA (ZETA(I),I=1,20)/20*0.0/
DOSAT(TEMP)=14.652-3.41022*TEMP-0.007991*TEMP**2
   -0.00007774*TEMP**3

C---- TEMPERATURE PARAMETERS
C
100 GAMMA(1,1)=KT(15)
   IF(GAMMA(1,1).EQ.0.0) GO TO 150
   ALPHA(1)=ST(5)/GAMMA(1,1)
   BETA(1,1)=QO(1)-ALPHA(1)
   GO TO 200
150 DELTA(1)=ST(5)
   ALPHA(1)=QO(1)
   BETA(1,1)=0.0
C
C---- BOD PARAMETERS
C
200 GAMMA(2,1)=KT(4)-KT(5)
   IF(GAMMA(2,1).EQ.0.0) GO TO 220
   ALPHA(2)=ST(1)/GAMMA(2,1)
   BETA(2,1)=QO(2)-ALPHA(2)
   GO TO 300
220 DELTA(2)=ST(1)
   ALPHA(2)=QO(2)
   BETA(2,1)=0.0
C
C---- TOTAL SUSPENDED SOLIDS PARAMETERS
C
300 GAMMA(3,1)=KT(13)
   IF(DEPTH(IR),ST(1)).GT(0.0) GAMMA(3,1)=GAMMA(3,1)*KT(14)/DEPTH(IR)
   IF(GAMMA(3,1).EQ.0.0) GO TO 340
310 ALPHA(3)=ST(7)/GAMMA(3,1)
   BETA(3,1)=QO(3)-ALPHA(3)
   GO TO 400
340 DELTA(3)=ST(7)
   ALPHA(3)=QO(3)
   BETA(3,1)=0.0
C
C---- AMMONIA PARAMETERS
C
400 GAMMA(4,1)=GAMMA(3,1)
   GAMMA(4,2)=KT(7)
   IF(GAMMA(4,1).EQ.0.0) GO TO 430
   (GAMMA(4,2).EQ.0.0) GO TO 460
   ALPHA(4)=(KT(6)*PN*ALPHA(3)+ST(2)-KT(1)*A(IR))/GAMMA(4,2)
   IF(GAMMA(4,1).EQ.0.0) GO TO 410
   BETA(4,1)=(KT(6)*PN*DATA(4,1))/GAMMA(4,2)-GAMMA(4,1))
   GO TO 490
410 BETA(4,1)=0.0
   EPSIL(4,1)=KT(6)*PN*ALPHA(3)
   GO TO 490

81
430 IF GAMMA(4,1),EQ,GAMMA(4,2) GO TO 440
ALPHA(4)=KT(5)*PP*ALPHA(3)+ST(2)-KT(1)*A(I'R))/GAMMA(4,2)
BETA(4,1)=0.0
ZETA(4)=KT(6)*PN*ST(7)/2
GO TO 440
440 BETA(4,1)=KT(6)*PN*ALPHA(3)/GAMMA(4,1)
ALPHA(4)=0.0
DELTA(4)=ST(2)-KT(1)*A(I'R)+(KT(6)*PN*ST(7))/GAMMA(3,1)
GO TO 450
450 DELTA(4)=ST(2)
ALPHA(4)=WQO(4)
BETA(4,1)=0.0
BETA(4,2)=0.0
GO TO 470
470 BETA(4,2)=WQO(4)-ALPHA(4)-BETA(4,1)
C---- NITRITE PARAMETERS
C
500 GAMMA(5,1)=GAMMA(3,1)
GAMMA(5,2)=GAMMA(4,2)
GAMMA(5,3)=KT(6)
IF(GAMMA(5,3),EQ,0.0) GAMMA(5,3)=0.0001
ALPHA(5)=GAMMA(4,2)*ALPHA(4)/GAMMA(5,3)
IF(GAMMA(5,3),EQ,GAMMA(5,1)) GO TO 510
BETA(5,1)=GAMMA(4,2)*BETA(4,1)/(GAMMA(5,3)-GAMMA(5,1))
510 BETA(5,1)=0.0
EPSIL(5,1)=WQO(4)*BETA(4,1)
GO TO 520
520 BETA(5,2)=0.0
EPSIL(5,2)=GAMMA(5,2)*BETA(4,2)
GO TO 502
C---- NITRATE PARAMETERS
C
600 GAMMA(6,1)=GAMMA(3,1)
GAMMA(6,2)=GAMMA(4,2)
GAMMA(6,3)=KT(6)
IF(GAMMA(6,3),EQ,0.0) GAMMA(6,3)=0.0001
ALPHA(6)=GAMMA(4,2)*ALPHA(4)/GAMMA(6,3)
ALPHA(6)=WQO(5)
BETA(6,1)=GAMMA(5,2)*BETA(5,1)/GAMMA(6,1)
BETA(6,2)=GAMMA(5,2)*BETA(5,2)/GAMMA(6,2)
BETA(6,3)=BETA(5,3)
DELTA(6)=KT(8)*ALPHA(5)+ST(3)-KT(1)*A(I'R)
C---- PHOSPHATE PARAMETERS
C
700 GAMMA(7,1)=GAMMA(3,1)
GAMMA(7,2)=KT(11)
IF(GAMMA(7,1),EQ,0.0) GO TO 730
IF(GAMMA(7,2),EQ,0.0) GO TO 760
ALPHA(7)=(KT(10)*PP*ALPHA(3)+ST(5)-KT(3)*A(I'R))/KT(11)
IF(GAMMA(7,1),EQ,GAMMA(7,2)) GO TO 710
BETA(7,1)=(KT(10)*PP*BETA(3,1))/(GAMMA(7,2)-GAMMA(3,1))
GO TO 790
710 BETA(7,1)=0.0
EPSIL(7,1)=ZETA(10)*R*ALPHA(3)
GO TO 790
730 IF(GAMMA(7,1),EQ,GAMMA(7,2)) GO TO 730
ALPHA(7)=(KT(10)*PP*ALPHA(3)+ST(5)-KT(3)*A(I'R))/KT(11)
BETA(7,1)=0.0
ZETA(7)=KT(10)*PP*ST(7)/2
GO TO 790
C--- PHOSPHATE PARAMETERS
C
800 GAMMA(8,1)=GAMMA(3,1)
GAMMA(8,2)=GAMMA(4,2)
GAMMA(8,3)=KT(6)
IF(GAMMA(8,3),EQ,0.0) GAMMA(8,3)=0.0001
ALPHA(8)=GAMMA(4,2)*ALPHA(4)/GAMMA(8,3)
ALPHA(8)=WQO(5)
BETA(8,1)=GAMMA(5,2)*BETA(5,1)/GAMMA(8,1)
BETA(8,2)=GAMMA(5,2)*BETA(5,2)/GAMMA(8,2)
BETA(8,3)=BETA(5,3)
DELTA(8)=KT(8)*ALPHA(5)+ST(3)-KT(2)*A(I'R)
C---- NITRATE PARAMETERS
C
PARAMETERS

\[ \begin{align*}
\alpha(\theta) &= \alpha(\theta) + \beta(\theta) + \gamma(\theta) + \delta(\theta) + \epsilon(\theta) \\
\beta(\theta) &= \beta(\theta) + \gamma(\theta) + \delta(\theta) + \epsilon(\theta) \\
\gamma(\theta) &= \gamma(\theta) + \delta(\theta) + \epsilon(\theta) \\
\delta(\theta) &= \delta(\theta) + \epsilon(\theta) \\
\epsilon(\theta) &= \epsilon(\theta)
\end{align*} \]

\[ \begin{align*}
\alpha(\theta) &= \alpha(\theta) \\
\beta(\theta) &= \beta(\theta) \\
\gamma(\theta) &= \gamma(\theta) \\
\delta(\theta) &= \delta(\theta) \\
\epsilon(\theta) &= \epsilon(\theta)
\end{align*} \]

\[ \begin{align*}
\alpha(\theta) &= \alpha(\theta) \\
\beta(\theta) &= \beta(\theta) \\
\gamma(\theta) &= \gamma(\theta) \\
\delta(\theta) &= \delta(\theta) \\
\epsilon(\theta) &= \epsilon(\theta)
\end{align*} \]

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\delta(\theta) &= \delta(\theta) \\
\epsilon(\theta) &= \epsilon(\theta)
\end{align*} \]

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\end{align*} \]

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\epsilon(\theta) &= \epsilon(\theta)
\end{align*} \]

\[ \begin{align*}
\alpha(\theta) &= \alpha(\theta) \\
\beta(\theta) &= \beta(\theta) \\
\gamma(\theta) &= \gamma(\theta) \\
\delta(\theta) &= \delta(\theta) \\
\epsilon(\theta) &= \epsilon(\theta)
\end{align*} \]
SUBROUTINE RACLC(IHP)

COMMON/CTRL/YR, HTP, IWQC, NR, HIT, NIE, IT(15), IE(15), HCODE,
MCODE(3), IR, IFP, ICWQC, NNCWQC, TACT, APP
COMMON/KDATA/LR(20, 20), KT(20), QDATA/Q10(20), Q10S(20)
COMMON/MDATA/S20(20, 20), ST(20)
REAL K20, KT

C------ Q10 CONVERSIONS OF RATE CONSTANTS

NK=16+NNCWQC
NS=6+NCWQC-NNCWQC
DO 100 I=1,NK
100 ST(I)=S20(IR, I)*Q10S(I)**(TEMP-20)
DO 200 I=1,NS
200 ST(I)=S20(IR, I)*Q10S(I)**(TEMP-20)
C RETURN
END

SUBROUTINE SIMWQ(WQ, Q, X)

COMMON/CTRL/YR, HTP, IWQC, NR, HIT, NIE, IT(15), IE(15), HCODE,
MCODE(8), IR, IFP, ICQAC, WACQ, HTACQ, NPP
COMMON/YDATA/LR(20), DA(20), DEPTH(20), VEL(20), BCODE(5),
+ HAV(20), HBV(20), HAD(20), HBD(20)
COMMON/MDATA/IWQC15,20), EWQ(15, 20), TQ(15), EQ(15),
+ BWQ(5, 20), BQ(5)
DIMENSION WQO(20), WQ(200, 20), QO(20), Q(200), X(200, 3)
REAL LH
INTEGER HPCODE

C------ CALCULATE DISTANCE BETWEEN PROFILE POINTS FOR OUTPUT

TLR=0.0
DO 10 IR=1, NR
10 TLR=TLR+LR(IR)
XINC=0.1
DO 20 I=1, NS
20 XINC=I*0.5
C------ CALCULATE WATER QUALITY PROFILE FOR A FIXED TIME PERIOD

IP=0
II=NR
XLAST=0.0
DO 100 IR=1, NR
100 XIR=IR
XWR=0.0
IPP=IPP+1
C CALL DILUTE(WQ, WQO, QO)
C
DO 110 IWQC=1, NTWQC
110 WQ(IPP, IWQC)*WQO(IWQC)
Q(IPP)=QO(IR)
X(IPP, 1)=XLAST
X(IPP, 2)=XIR
X(IPP, 3)=XIR
C IF(HPCODE.LT.1) GO TO 150
VEL(IR)*HAV(IR)*QO(IR)*HBV(IR)
DEPTH(IR)*HAD(IR)*QO(IR)*HBD(IR)
C 150 CALL RACLC(WQO(1))

84
CALL PCALC(I4Q)

200   IPP=IPP+1
       X='XWR+XIR
       IF(X['XWR,3].LE.(IR)) GO TO 300
       X(I'PP,1)=XLAST+XIR
       X(I'PP,2)=XIR
       X(I'PP,3)=XIR
       Q(I'PP)=QO(IR)
       TTWR=XWR/VEL(IR)

C CALL ASOLN(TTWR,WQ)
C Q(I'PP)=QO(IR)
   GO TO 200
300   X['XRL(IR)
       X(I'PP,1)=XLAST+XIR
       X(I'PP,2)=XIR
       X(I'PP,3)=XIR
       Q(I'PP)=QO(IR)
       TTWR=XWR/VEL(IR)

C CALL ASOLN(TTWR,WQ)

3 IF(WB.LT.1.0.OR.XIB.EQ.0.) GO TO 500
   DO 400 IC=1,NR
       XIB=XIB+1
   400   CONTINUE
   GO TO 200
   DO 350 IC=1,NWQC
650   BWQ(IC)=WQ(IPP,IC)
      CONTINUE
500   XLAST=X(I'PP,1)
       RETURN
END

C******************************************************************************
C ROUTINE WQOUTHS(QW,Q,X,ITP)
C******************************************************************************

      ITP=ITP+1
      CALL QOUTHS(33,QINDEX,277,0)
500   IREC=23*(ITP-1)+1
      CALL WRITEMS(13,ITP,1,IREC)
      IREC=23*(ITP-1)+2
      CALL WRITEMS(13,X,600,IREC)
      IREC=23*(ITP-1)+3
      CALL WRITEMS(13,Q,IREC)
      DO 30 IC=1,NWQC
         DO 20 IPP=1,NPP
            ATT(IPP)=QW(IC,IPP)

20   CONTINUE
30   CONTINUE
   IF(ITP.LT.I0P) GO TO 500
   CALL CLOSEHS(33)
      RETURN
END
PROGRAM WQTEST(INPUT,OUTPUT,TAPE3=INPUT,TAPE4=OUTPUT, + TAPE9,TAPE33)
COMMON/NAMES/TITLE(8),CNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NITNIE,IT(15),IE(15), + MCODD(8),NCWQC,NNCWQC,NTWQC,NPP
COMMON/MDATA/LR(20),DA(20),DCODE(15)
DIMENSION X(200,3),WQ(240),PTS(2),IWQSV(20,12),UWQS(20,12), + LWQS(20,12),XX(240),IATTS(20)
REAL LR,LWQS,LS
INTEGER TITLE,CNAME
DATA (CNAME(I),I=1,8)/"TEMP.","BOD5","TSS","NH3","NO2","NO3", + "PO4","D.O."
DATA XWQSV/240'0.0/',UWQS/240'9999.',LWQS/240'0.0/',IOPEN/O/
PRINT*,"+@++++T++++T++T+++++++V+++++
PRINT*,"THIS RTV ROUTINE TESTS FOR VIOLATIONS OF AMBIENT +
PRINT*,"WATER QUALITY STANDARDS AND QUANTIFIES THE +
PRINT*,"SPACIAL EXTENT OF THESE VIOLATIONS +
PRINT*,"+----------------------------------------------------------
C-----> READ DATA FROM 'TAPE9'
CALL DATINMS
C-----> DESIGNATE ATTRIBUTES OF INTEREST
PRINT*,"----------------------------------------------------------
PRINT*,"indle WHICH WATER QUALITY ATTRIBUTE(S) ARE TO BE ANALYZED."
DO 40 I=1,4
40 PRINT*,",(CNAME(I),I=I,8)
IF(NTWQC.LE.8) GO TO 45
DO 42 I=9,NTWQC
42 PRINT*,",(CNAME(I)
PRINT*,"RESPOND WITH THE TOTAL NUMBER OF ATTRIBUTES "
PRINT*,"FOLLOWED BY THE APPROPRIATE INDEX NUMBERS"
45 PRINT*,",READ(3,*)IATTS,(IATTS(I),I=1,NATTS)
IF(EOr(3)) 56,56
46 IF(NATTS.GT.NTWQC) GO TO 45
PRINT*,"+----------------------------------------------------------
C-----> SPECIFY EXISTING WATER QUALITY STANDARDS
PRINT*,"----------------------------------------------------------
PRINT*,"INPUT LOCAL AMBIENT WATER QUALITY STANDARDS "
PRINT*,"
PRINT*,"ITP=1
52 PRINT*,"TIME PERIOD NO. ",ITP
DO 59 IC=1,NATTS
IWQC=IATTS(IC)
PRINT*,",CNAME(IWQC)
PRINT*,"UPPER LEVEL STANDARD ",READ(3,*),UWQS(IWQC,ITP)
IF(EOr(3)) 56,56

86
**LOWER LEVEL STANDARD**, READ(3,.) LWQS(IWQC,ITP)
IF(EOF(3)) 59,59

CONTINUE
IF(ITP.EQ.1) GO TO 60
ITP=ITP+1
IF(ITP.GT.NTP) GO TO 69
GO TO 52

PRINT*, "STANDARDS CONSTANT OVER TIME (F OR N)", READ(3,940) IANS
IF(EOF(3)) 60,61

DO 66 IC=1,NATTS
UWQS(IWQC,ITP)=UWQS(IWQC,1)
LWQS(IWQC,ITP)=LWQS(IWQC,1)
66 CONTINUE
C----- READ DATA FROM 'TAPE33'

DO 100 ITP=1,NTP
DO 99 IC=1,NATTS
IWQC=IATTS(IC)
CALL INWQMS(IWQC,ITP,X,WQ,NPP)
DO 90 IPP=1,NPP
IF(WQ(IPP).LT.UWQS(IWQC,ITP).AND.WQ(IPP).GT.LWQS(IWQC,ITP)) + GO TO 90
XWQSV(IC,ITP)=XWQSV(IC,ITP)*(X(IPP,1)-X(IPP-1,1))
90 CONTINUE
99 CONTINUE
100 CONTINUE

1) TOTAL RIVER MILES IN VIOLATION OF STANDARDS.

DO 300 IC=1,NATTS
IWQC=IATTS(IC)
CNAME(IWQC),(XWQSV(IC,J),J:1,NEND)
300 CONTINUE

IF(NTP.LE.6) GO TO 399

PRINT*, "TIME PERIOD* "
DO 400 IC=1,NATTS
IWQC=IATTS(IC)
CNAME(IWQC),(XWQSV(IC,J),J:6,NTP)
400 CONTINUE

CALL PAUSE

PRINT*, "ATTRIBUTE  7  8  9  10  11  12"
C-----> ASK FOR GRAPHICAL OUTPUT
399 PRINT*, "" PRINT*., "" PRINT*., "" PRINT*., "" DO YOU WANT A GRAPHICAL OUTPUT FOR ANY ATTRIBUTE"
400 PRINT*, "" PRINT*., "" PROFILES (ANS: YES OR NO)"
READ(3,940) IANS
IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 400
IF(IANS.EQ."N") GO TO 999
CALL USTART
410 CALL UBEELL
PRINT*, "" PRINT*, "" ATTRIBUTE NUMBER ",
READ(3,*) IWQC
IF(EOF(3)) 410,411
411 IF(IWQC.GT.NTWQC) GO TO 410
420 PRINT*, "" PRINT*, "" TIME PERIOD ",
READ(3,*) ITP
IF(EOF(3)) 420,421
421 IF(ITP.GT.NTP) GO TO 420
CALL INWQMS(IWQC,ITP,X,WQ,NPP)
DO 430 IC=1,NATTS
IF(IATTSCIC).NE.IWQC) GO TO 430
US2UWQS(IWQC,ITP)
LSaLWQS( IWQC, ITP)
GO TO 431
430 CONTINUE
431 IF(US.LT.9999.) GO TO 460
WQ(NPP+1)=US
WQ(NPP+2)=US
GO TO 470
460 WQ(NPP+1)=LS
WQ(NPP+2)=LS
GO TO 470
470 DO 479 I=1,NPP
479 XX(I)=X(I,1)
XX(NPP+1)=0.0
XX(NPP+2)=XX(NPP)
PTS(1)=NPP
PTS(2)=2
PRINT(4,910) CNAME(IWQC),ITP
CALL GOPLOT1(XX,WQ,PTS,IWQC)
PRINT*, "" PRINT*, "" PRINT*, "" PRINT*, "" PRINT*, "" PLOT ",CNAME(IWQC)," FOR ANOTHER TIME PERIOD ",
480 READ(3,940) IANS
IF(EOF(3)) 480,481
481 IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 480
IF(IANS.EQ."Y") GO TO 410
CALL VEND
940 FORMAT(1A1)
910 FORMAT(25X,1A5,": TIME PERIOD NO. ",1I2)
930 FORMAT(4X,1A5,9X,6(1F5.1,2X))
899 PRINT*, "" PRINT*, "" PRINT*, "" PRINT*, "" PRINT*, "" THIS CONCLUDES 'WQRTV'. YOU MAY EXECUTE MORE
PRINT*, "" RTV ROUTINES NOW. PEGIN A MITIGATION"
PRINT*, "" LOOP OR SIGNOFF."
PRINT*, "" STOP
END
SUBROUTINE DATAMS
COMMON/NAMES/TITLE(8),CNAME(20)
COMMON/CNTRL/RR,NTP,HWQGC,NB,NIT,NIE,IT(15),IE(15),
+ HCODE(8),HCWQC,NWCWQC,NTWQC,XP
COMMON/NDATA/LR(20),DA(20),BCODE(15)
REAL LR
INTEGER TITLE,HCODE,CNAME
INTEGER DINDEX(125),CNTRLS(8)
C------> UNLOAD DATA FROM MASS STORAGE FILE
CALL OPENMS(9,DINDEX,125,0)
CALL READMS(9,TITLE,8,1)
CALL READMS(9,CNTRLS,8,2)
NR=CNTRLS(1)
NTP=CNTRLS(2)
HWQGC=CNTRLS(3)
NWCWQC=CNTRLS(4)
HCODE=CNTRLS(5)
NB=CNTRLS(6)
NIT=CNTRLS(7)
NIE=CNTRLS(8)
NWC=0
NR=NR+1
NWCWQC=NR
NWCQ=-NWCWQC
NTQ=NR+NWCQ+NWCWQC
NAA=M=0.25
IF(NAATTLE.0) GO TO 570
CALL READMS(9,CNAME,MTWQC,4)
570 CALL READMS(9,BCODE,NB,5)
CALL READMS(9,IE,NIT,6)
CALL READMS(9,IE,NIE,7)
CALL READMS(9,DA,NR,9)
CALL READMS(9,DA,NR,9)
RETURN
END
SUBROUTINE GOPLOT(X,Y,PTS,IWQC)
COMMON/NAMES/TITLE(8),CNAME(20)
INTEGER TITLE,CNAME,OPTS(2)
DIMENSION X(240),Y(240),PTS(2)
DATA OPTS/'LO,,DS'/
CALL UDIMEN(7..5.25)
CALL USET("EDGEAXES")
CALL USET("CHARACTER",IIA)
CALL USET("X BOTH")
CALL USET("Y BOTH")
CALL USET("X LABEL","DISTANCE DOWNSTREAM (MILES);")
CALL USET("Y LABEL","CONC. (MG/L);")
CALL UHELL
CALL UPL0T(X,Y,2.,PTS,OPTS)
CALL UFLUSH
CALL UPAUSE
CALL UERASE
RETURN
END
SUBROUTINE PAUSE
PRINT*,"CONTINUE",
READ(3,*) SUM
IF(EOF(3))10,10
10 CONTINUE
RETURN
END
SUBROUTINE INWQMS(IATT, ITP, X, ATT, NPP)
DIMENSION WQ(200), X(200,3)
INTEGER QINDEX(277)
IF(IOPEN.GT.0) GO TO 10
CALL OPENMS(33, QINDEX, 277, 0)
10 IREC1=23*(ITP-1)+1
CALL READMS(33, NPP, 1, IREC1)
IREC2=23*(ITP-1)+2
CALL READMS(33, X, 600, IREC2)
IREC3=23*(ITP-1)+3+IATT
CALL READMS(33, ATT, NPP, IREC3)
IOPEN=1
RETURN
END

/ type, ssirtv/g
PROGRAM SIMATN(INPUT, OUTPUT, TAPE1: INPUT, TAPE2: OUTPUT, RAPef, RAP33)

COMMON NAME, TITLE(8), CNAME(20)
COMMON NTH, NTWC, NTH, NLE, NTR(15), ILE(15), IMMT(5), IMMT(5), NTWC, NPP
COMMON NTH, NTWC, NTH, NLE, NTR(15), ILE(15), IMMT(5), IMMT(5), NTWC, NPP

DIMENSION X(200, 3), BODS(200), SI(200, 12), XSI(10, 12), SIT(7)

INTEGER TITLE, CNAME, SNAM3E(7, 2)

DATA XSI/120'0.0', SIT/-.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5/

CALL DATAMMS
DO 100 ITP=1, NTP
CALL INWQMS(2, ITP, X, BODS, NPP)
DO 90 IPP=1, NPP
IF( (BODS(ITP).GT.50.) ) GO TO 20
SIF(ITP, ITP)=(1.0747*BODS(ITP)-0.4729)/(0.9014*0.218*BODS(ITP))
GO TO 21
20 SIF(ITP, ITP)=(0.0189*BODS(ITP)-7.938)/(1.882-0.0021*BODS(ITP))
21 IF(IPP.EQ.1) GO TO 90
DO 50 IPP=1, NPP
IF(SIT(ITP).GT.SFR(I)) GO TO 50
XSI(I, ITP)=XSI(I, ITP)-X(IPP-1, 1)
GO TO 90
50 CONTINUE
90 CONTINUE
100 CONTINUE

PRINT*, "**************************************************************************"
PRINT*, "SAPROBIC INDEX ANALYSIS"
PRINT*, "FOR*
PRINT*, ",(TITLE(I), I=1, 4)
PRINT*, ",(TITLE(I), I=5, 8)
PRINT*, "**************************************************************************"
PRINT*, "**************************************************************************"
PRINT*, "WATER QUALITY RIVER MILES IN TIME PERIOD"
PRINT*, "DESIGNATION 1 2 3 4 5 6*"
PRINT*, "--- ---- ---- ---- ---- ----
PRINT*, ".cut*
PRINT*, "Do 150 I=1, 7
PRINT*(2,901) (SNAM3E(I, J), J=1, 2), (XSI(I, ITP), ITP=1, NEND)
150 CONTINUE
PRINT*, "**************************************************************************
PRINT*, "WATER QUALITY RIVER MILES IN TIME PERIOD"
PRINT*, "DESIGNATION 7 8 9 10 11 12*
PRINT*, "--- ---- ---- ---- ---- ----
PRINT*, "cut*
PRINT*, "Do 160 I=1, 7
PRINT*(2,901) (SNAM3E(I, J), J=1, 2), (XSI(I, ITP), ITP=1, NEND)
160 CONTINUE

91
200 CONTINUE
PRINT*, "DO YOU WANT FURTHER QUANTIFICATION OF THIS"
PRINT*, "(ANS: YES OR NO)",
READ(1,902) IANS
IF (EOF(1)) 201, 202
202 IF (IANS .NE. "M" .AND. IANS .NE. "Y") GO TO 201
IF (IANS .EQ. "M") GO TO 300
PRINT*, "DO YOU WANT FURTHER QUANTIFICATION OF THIS",
PRINT*, "(ANS: YES OR NO)",
READ(1,902) IANS
IF (EOF(1)) 201, 202
202 IF (IANS .NE. "N" .AND. IANS .NE. "Y") GO TO 201
IF (IANS .EQ. "N") GO TO 300
PRINT*, "INPUT TIME PERIOD OF INTEREST ",
READ(1,*) ITP
IF (EOF(1)) 210, 211
211 IF (ITP .GT. NTP) GO TO 210
PRINT*, "THIS SECTION ISN'T OPERATIONAL YET, BUT THE"
PRINT*, "OUTPUT WILL BE LOCATIONS OF ZONES IN EACH"
PRINT*, "WATER QUALITY DESIGNATION FOR THE SPECIFIED"
PRINT*, "TIME PERIOD."
300 CONTINUE
STOP
E=ND

C-----------------------------
SUBROUTINE DATINMS
C-----------------------------
COMMON / NAMES/TITLE(8), CNAME(20)
COMMON / CNTRL/ NR, NTP, NWCQ, NB, NIT, NIE, IT(15), IE(15),
+ MCODE(8), NCWQC, HNCWQC, NTWQC, NPP
COMMON / MDATA/ L(20), DA(20), BCODE(15)
REAL LR
INTEGER TITLE, HCODE, CNAME
INTEGER DINDEX(125), CNTRL8(8)
C------> UNLOAD DATA FROM MASS STORAGE FILE
CALL OPENMS(9, DINDEX, 125, 0)
CALL READMS(9, TITLE, 8, 1)
CALL READMS(9, CNTRL3, 8, 2)
NR=CNTRL8(1)
NTP=CNTRL8(2)
NWCQ=CNTRL8(3)
HNCWQC=CNTRL8(4)
NCWQC=CNTRL8(5)
NB=CNTRL8(6)
NIT=CNTRL8(7)
NIE=CNTRL8(8)
NPP=CNTRL8(9)
NWK=16-NWCQ
MS=8+HNCWQC-NWCQ
NTWQC=8+NCWQC-HNCWQC
MAATTS=HNCWQC+HNCWQC
IF (MAATTS .LE. 0) GO TO 570
CALL READMS(9, CNAME, NTWQC, 4)
570 CALL READMS(9, BCODE, NB, 5)
CALL READMS(9, IT, NIT, 6)
CALL READMS(9, IE, NIE, 7)
RETURN
END
SUBROUTINE INWQMS(IATT,ITP,X,ATT,NP)

C

DIMENSION WQ(200),X(200,3)
INTEGER QINDEX(277)
IF(ITP.GT.1) GO TO 10
CALL OPENMS(33,QINDEX,277,0)
10 IREC1=23*(ITP-1)+1
CALL READMS(33,NPP,1,IREC1)
IREC2=23*(ITP-1)+2
CALL READMS(33,X,600,IREC2)
IREC3=23*(ITP-1)+3+IATT
CALL READMS(33,ATT,NPP,IREC3)
RETURN
END
PROGRAM TEST(INPUT,OUTPUT,TAPE3=INPUT,TAPE4=OUTPUT,
+ TAPE9,TAPE33)
COMMON/NAME3,TITLE(3),CNAME(20)
COMMON/CTRL/NR,WQ,WQQC,WQQC,NWQC,WQQC,NWQC,NWQC,NWQC
COMMON/MRDATA/LR(20),DA(20),BCODE(5)
DIMENSION X(200,3),WQ(200),PTS(2),TU('0,5,200),MAXTU(10,5),
+ MEANTU('0,5),SPNAME('0,2),NAME('19),XX(400),LC50(10,5),
+ TDX('10),IS(10),C(400),TOTTU(5,200),ISO(10)
REAL LR,LC50,MAXTU,MEANTU,MAXTU(5),MEANTU(5)
LITERAL TITLE,CNAME,NAME,SPNAME
DATA (CNAME(I),I=1,3)/"TEMP","BOOS","TSS","NH3","NO2","NO3",
+ "PO","O","/
DATA (SPNAME(I,1),I=1,2)/"FATHEAD MI","N"/NOW "/
DATA (SPNAME(2,1),I=1,2)/"CARRP",""/
DATA (SPNAME(3,1),I=1,2)/"BLUEGILL",""/
DATA (SPNAME(4,1),I=1,2)/"CHANNEL CAT","T"/
DATA (SPNAME(5,1),I=1,2)/"LARGEMOUTH","BASS"/
DATA (SPNAME(6,1),I=1,2)/"BROOK TROUT","T"/
DATA (SPNAME(7,1),I=1,2)/"RAINBOW TR","OUT"/
DATA (SPNAME(8,1),I=1,2)/"COHO SALMO","N"/
DATA TOTTU/100000.0/
PRINT*,"/
PRINT*,"
PRINT*,"
PRINT*,"
PRINT*,"
PRINT*,"==================================================================================================================================="
PRINT*,"THIS RIV ROUTINE TESTS ENVIRONMENTAL TOXICITY"
PRINT*,"==================================================================================================================================="
PRINT*,"
C-----> READ DATA FROM 'TAPE9'
CALL DATIMS
C-----> DESIGNATE ATTRIBUTES OF INTEREST
PRINT*,"--------------------
PRINT*,"),(TITLE(I),I=1,8)
PRINT*,"--------------------
PRINT*,"INDICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE TO BE ANALYZED FOR THEIR TOXIC EFFECTS."
DO 10 I=1,4
PRINT*,"",",CNAME(I)=",CNAME(I),"",",N=",CNAME(I=4)
IF(NTWQC.LE.8) GO TO 15
DO 12 I=9,NTWQC
12 PRINT*,"",",CNAME(I)
PRINT*,"RESPOND WITH THE TOTAL NUMBER OF TOXICANTS"
PRINT*,"FOLLOWED BY THE APPROPRIATE INDEX NUMBERS"
15 PRINT*,""
READ(1,*) NTOX,(ITOX(I),I=1,NTOX)
IF(SOF(3)) 999,6
16 IF(NTOX.GT.NTWC) GO TO 15
DO 18 I=1,NTOX
18 NAME(I)=CNAME(ITOX(I))
PRINT*,"BAD INPUT; TRY AGAIN!"
GO TO 15
20 PRINT*,""
PRINT*, "SPECIFIC TARGET SPECIES:"
PRINT*, "DESIGNATE STREAM TYPE (W:WARM WATER, C: COLD WATER) ".
READ(3,940) ISTRM
IF(EOF(3)) 2,22
2 IF(ISTRM.EQ."C".AND.ISTRM.NE."W") GO TO 2
2 SPECIFICATION OF TARGET SPECIES
PRINT*, "REPRESENTATIVE SPECIES LIST:"
DO 25 I=1,8
   IF(I.EQ.15) GO TO 25
   IF(I.EQ.29) GO TO 25
25 CONTINUE
PRINT*, "RESPOND WITH NUMBER OF TARGET SPECIES DESIRED AND"
PRINT*, "WITH THEIR APPROPRIATE INDEX NUMBER(S)."
26 PRINT*, "SPECIFY LC50'S FOR TARGET SPECIES"
PRINT*, "INPUT THE 96 HOUR LC50'S FOR THE FOLLOWING SPECIES"
PRINT*, "AND POTENTIAL TOXICANTS:"
DO 35 IS=1,NSP
   PRINT*, "("SPNAME(IS),1).J=1,2)
35 CONTINUE
CALL USTART
PRINT*, "SPECIFY TIME PERIOD OF INTEREST ".
70 READ(3,*) ITP
IF(EOF(3)) 70,71
71 IF(ITP.GT.NTP) GO TO 70
PRINT*, "SUMTU=O.O
SUMTU=O.O
MAXTU(IT,IS)=O.
CALL IWQS(IS,ITP,X,WQ,NPP)
DO 90 IPP=1,NPP
   TU(IT,IS,IPP)=WQ(IPP)/LC50(IT,IS)
   TU(IT,IS,IPP)=TU(IT,IS,IPP)+TU(IT,IS,IPP)
   MAXTU(IT,IS)=MAXTU(IT,IS,IPP)
   MEANTU(IT,IS)=SUMTU/IPP
90 CONTINUE
PRINT*, "REPORT ON TOXICITY IMPACTS IN TIME PERIOD ".ITP
PRINT*, "MAXIMUM AND MEAN (IN PARENTHESES) TOXICITY UNITS"
PRINT*, "TOXICANT"
NEED=5
IF(NTOX.LT.5) NEND=NTOX
PRINT(3,911) (ITNAME(IT),IT=1,NEND)
DO 300 IS=1,NSP
PRINT(4,930) (SPNAME(ISP(IS),J),J=1,2),MAXTU(IS),
   *(MAXTU(IS),I=1,NEND)
PRINT(4,931) MEANTU(IS),(MEANTU(IS),I=1,NEND)
300 CONTINUE
PRINT*, "---"
PRINT*, "ASK FOR GRAPHICAL OUTPUT"
355 PRINT*, "DO YOU WANT A GRAPHICAL OUTPUT FOR TOXICITY UNITS"
400 PRINT*, "VS. LOCATION DOWNSTREAM (ANS: YES OR NO)"
READ(3,940) IANS
IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 400
IF(IANS.EQ."N") GO TO 899
410 CALL UBELL
PRINT*, "INPUT TOXICANT NUMBER ",
READ(3,411) IT
IF(EOF(3)) 412,411
411 IF(IT.LE.NTOX) GO TO 420
412 DO 415 IT=1,NTOX
   PRINT*, "",IT,"",ITNAME(IT)
415 PRINT*, "",IT "","",ITNAME(IT)
READ(3,411)
420 PRINT*, "INPUT TARGET SPECIES INDEX ",
READ(3,421) IS
IF(EOF(3)) 422,421
421 IF(IS.LE.NSP) GO TO 449
422 DO 425 IS=1,NSP
   PRINT*, "",IS,"",SPNAME(ISP(IS),J),J=1,2)
   PRINT*, "",IS "",SPNAME(ISP(IS),J),J=1,2)
   READ(3,421)
425 IF(IS.GT.NSP) GO TO 420
426 DO 449 IPP=1,NPP
   XX(IPP)=X(IPP,1)
   C(IPP)=TU(IT,IS,IPP)
   XX(IPP+NPP)=X(IPP,1)
   C(IPP+NPP)=TOTTU(IS,IPP)
449 PTS(1)=NPP
PTS(2)=NPP
PRINT*, ""
PRINT*, ""
PRINT*, ""
PRINT(4,910) (SPNAME(ISP(IS),J),J=1,2),ITNAME(IT),ITP
PRINT*, "(T=TOTAL T.U.'S; *T.U.'S FROM SPECIFIED ATT.)"
CALL GOPLOT1(XX,C,PTS)
PRINT*, ""
PRINT*, ""
PRINT*, "PLOT TOXICITY IMPACTS FROM ",ITNAME(IT)
PRINT*, "FOR ANOTHER TARGET SPECIES ",
IF(--JF(3)) 480.46d
 IF(LA.NE.,AN.-I.AS.-NE.-"N")
 GO TO 4JO
 IZ(IANs.7Q."
 GO TO 420
 PRINT*," PLOT FOR ANOTHER TOXICANT ",
 IF(ANS.EQ."Y") GO TO 490
 PRINT*," DO YOU WISH TO CONTINUE ANALYSES FOR ANOTHER TIME?"
 PRINT*," PERIOD (ANS: I OR N)",
 READ(3,940)
 IF(EOF(3)) 490,491
 IF(LAUS.NE.,IN.AND."
 GO TO 490
 IF(IANS.EQ,"") 30
 TO 40
 PRINT*,"," DO YOU WISH TO CONTINUE ANALYSES FOR ANOTHER TIME?"
 PRINT*," PERIOD (ANS: Y OR N)", 500
 READ(3,940)
 IF(EOF(3)) 500,501
 IF(IANS.NE,"Y".AND.IANS.NE,"N") GO TO 500
 PRINT*," THIS CONCLUDES "TVTV". YOU MAY EXECUTE MORE" PRINT*," RTV ROUTINES NOW, BEGIN A MITIGATION"
 PRINT*," LOOP OR SIGNOFF."
 STOP
 END
 SUBROUTINE DATINMS
 COMMON/TITLE(8),CNAME(20)
 COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,
 MCODE(8),NCWQC,NNCWQC,NTWQC,NPP
 COMMON/MDATA/LR(20),DA(20),BCODE(15)
 REAL LR
 INTEGER TITLE,HCODE,CNAME
 INTEGER DINDEX(125),CNTRLS(8)
 C------ UNLOAD DATA FROM MASS STORAGE FILE
 CALL OPEN3M(9,DIINDEX,125,0)
 CALL READMS(9,TITLE,8,1)
 CALL READMS(9,CNTRLS,8,2)
 NR=CNTRLS(1)
 NTP=CNTRLS(2)
 NCWQC=CNTRLS(3)
 NNCWQC=CNTRLS(4)
 HCODE=CNTRLS(5)
 NB=CNTRLS(6)
 NIT=CNTRLS(7)
 NIE=CNTRLS(8)
 NWQC=8
 MX=40-NCWQC
 X3=8-NNCWQC-XCQC
 NTQC=4+XCQC+NCWQC
 NAATS=NCWQC-NNCWQC
 IF(NAATS.LE.0) GO TO 570
 CALL READMS(9,CNAME,NTQC,4)
 CALL READMS(9,BCODE,NB,5)
 CALL READMS(9,IT,NIT,6)
 CALL READMS(9,IE,NIE,7)
CALL READMS(9,LR,WR,8)
CALL READMS(9,DA,WR,9)
RETURN
END
SUBROUTINE GOPLOT1(X,Y,PT3)
INTEGER TITLE,NAME,OPTS(2)
dimension X(400),Y(400),PTS(2)
data OPTS("L","LT")
call UDIMEN(7,5,5,20)
call USET("EDGEAXES")
call USET("CHARACTER",""")
call USET("XBOOTH")
call USET("YBOOTH")
call USET("XLABEL","DISTANCE DOWNSTREAM (MILES)")
call USET("YLABEL","TOX. UNITS")
call UBELL
call UPLTO(X,Y,2,PTS,OPT3)
call UFLUSH
CALL UPAUSE
return
end
SUBROUTINE PAUSE
PRINT*, "CONTINUE",
READ(3,*), DUM;
IF(EOF(NF))10, 10
end
SUBROUTINE INQM1S(RATT,ITP,X,ATT,NPP)
DIMENSION X0(200),X(200,3)
integer QINDEX(277)
if(IOpen.GT.0) go to 10
call OPENMS(33,QINDEX,277,0)
10 irec1=3*(ITP-1)+1
call READMS(33,NPP,1,IREC1)
irec2=3*(ITP-1)+2
call READMS(33,X,600,IREC2)
irec3=3*(ITP-1)+3+ ATT
call READMS(33,ATT,NPP,IREC3)
ope=1
return
eend
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USA Japan (USSA)
Ch. FE Div, AER-FE 9634A
AEC Eng (Honshu) 9634A
Fac Eng (Okinawa) 9634A

ATM

US Navy Academy 1099
ATTN: Facilities Engineer
ATTN: Dept of Geography &
Computer Science

USMC

MCRP 30-8

ATN: MCRL

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Chief of Engineers
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US Army Engineer District
New York 10007
ATTN: Chief, ENN-E
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ATTN: Chief, Engr Div Philadelphia 19106
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ATTN: Chief, Engr Div Norfolk 23510
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ATTN: Chief, Engr Div Savannah 31402
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ATTN: Env. Res. Br. Nashville 37202
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ATTN: Chief, Engr Div Louisville 40201
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ATTN: Chief, Engr Div Little Rock 72203
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ATTN: Chief, SWCO-D
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North Pacific 97208
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ATTN: AKFB-LU-E
6th US Army 94129
ATTN: AFB-EK-E
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ATTN: Learning Resources Center
ATTN: ATSE-TD-TL (2)
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