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SWRRBWQ Windows Interface User's Guide
DRAFT

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1. INTRODUCTION

The U.S. Department of Agriculture's (USDA) Simulator for Water Resources in Rural Basins-Water Quality (SWRRBWQ) was developed to simulate hydrologic, sedimentation, and nutrient and pesticide transport in a large, complex rural watershed. The model operates on a continuous time-scale and allows for subdivision of basins to account for differences in soils, land use, rainfall, etc. It can predict the effect of management decisions on water, sediment, and pesticide yield with reasonable accuracy for ungaged rural basins throughout the United States.

The SWRRBWQ Windows interface was developed to assist the user in data input and model execution and to make a complex model user-friendly. The Windows interface was developed for the Office of Science and Technology, Standards and Applied Sciences Division of the U.S. Environmental Protection Agency to assist them with the Total Maximum Daily Load (TMDL) program. This user's guide provides guidance on the use of the SWRRBWQ interface and illustrates its use with three example runs. The Windows interface also contains special buttons that are designed to access the climate and Soils-5 databases. The database support comes with search functions that make finding the data that you want as simple as possible, as well as detailed help messages and error checking. There are also additional buttons that bring up tables of crop information and pesticide information that may be selected by the user. A brief discussion of the SWRRBWQ model and its input and output structures is provided first in order to facilitate further discussions.

This Windows implementation also contains two graphics options: (1) the graphics option that comes with the SWRRBWQ model, and (2) a graphics options that allows you to control the variables that you would like to graph.

When you first access the SWRRBWQ interface, you will be presented with two choices: the Windows interface option and the Manual Run option. The Manual Run option allows you to access the UTIL text editor or the NOTEPAD editor to manually edit existing input files and submit edited input files to the model for processing. This option is there so that experienced personnel can edit the input files directly and so that existing files created previously under DOS can be edited under Windows.

This user's guide is divided into seven sections. Section 2 gives you a technical summary on the SWRRBWQ model, and the technical background of the model. Section 3 details the input requirements of the model and Section 4 details the output requirements of the model. Section 5 provides you with minimum system requirements and loading information for the Windows SWRRBWQ. Section 6 provides you with all the information necessary to use the SWRRBWQ Windows interface, including:

? How to access an existing file or opening a new file
? File-Naming Conventions
? Saving Input Files
? Setting Up a Default Editor for Viewing Output Files
? Running the SWRRBWQ Model
? SWRRBWQ output graphics
? SWRRBWQ commands and function keys
? Using the Manual Run option

Section 7 contains three examples runs that highlight important aspects of both user entry and the model. Appendix A provides you with a detailed layout of every prompt in the Windows Interface, the ranges, the SWRRBWQ variable name that is equivalent to the Windows Interface name, and other important information on the model.

2. TECHNICAL SUMMARY AND BACKGROUND

The model was developed by J.G. Arnold, J.R. Williams, N.B. Sammons of the U.S. Department of Agriculture, Agriculture Research Service and R.H. Griggs of the Texas Agricultural Experiment Station (Arnold *et al.* 1990, Williams, *et al.* 1985). SWRRBWQ has been tested on 11 large watersheds from eight Agricultural Research Service (ARS) locations throughout the United States. The results show SWRRBWQ can realistically simulate water and sediment yields under a wide range of soils, climate, land-use, topography, and management conditions (Arnold and Williams, 1987). SWRRBWQ should provide a versatile and convenient tool for use in planning and designing water resources projects.

SWRRBWQ includes five major components: weather, hydrology, sedimentation, nutrients, and pesticides. Processes considered include surface runoff, return flow, percolation, evapotranspiration, transmission losses, pond and reservoir storage, sedimentation, and crop growth. A weather generator allows precipitation, temperature, and solar radiation to be simulated when measured data is unavailable. The precipitation model is a first-order Markov chain model, while air temperature and solar radiation are generated from the normal distribution. Sediment yield is based on the Modified Universal Soil Loss Equation (MUSLE). Nutrient yields were taken from the EPIC model (Williams et al., 1984). The pesticide component is a modification of the CREAMS (Smith and Williams, 1980) pesticide model. SWRRBWQ allows for simultaneous computations on each subbasin and routes the water, sediment, nutrients, and pesticides from the subbasin outlets to the basin outlet.

Surface runoff volume is predicted using the SCS curve number (USDA, 1972) as a function of daily soil moisture content. Return flow is calculated as a function of soil water content and return flow time. Return flow travel times can be calculated from soil hydraulic properties or user-inputs.

The percolation component uses a storage routing model combined with a crack-flow model to predict flow through the root zone. Evapotranspiration is estimated using Ritchie's ET model. Transmission losses in the stream channel are calculated as a function of channel dimensions, flow duration, and effective hydraulic conductivity of the channel bed. Pond storage is based on a water balance equation that accounts for inflow, outflow, evaporation, and seepage. The reservoir water balance component is similar to the pond component except that it allows flow from the principal and emergency spillways. Peak runoff rate predictions are based on a modification of the Rational Formula. Sediment yield is computed for each subbasin with the modified Universal Soil Loss Equation (MUSLE). The channel and floodplain sediment routing model is composed of two components operating simultaneously (deposition and degradation). Degradation is based on Bagnold's stream power concept, and deposition is based on the fall velocity of the sediment particles. Sediment is also routed through ponds and reservoirs. The crop growth model computes total biomass each day during the growing season as a function of solar radiation and leaf area index (LAI). LAI is computed for each day from the maximum LAI and total above ground biomass. The ET component uses LAI to compute plant evaporation. Water and temperature stress factors are used as growth constraints.

SWRRBWQ simulates crop growth for both annual and perennial plants. Annual crops grow from planting date to harvest date or until the accumulated heat units equal the potential heat units for the crop. Perennial crops maintain their root systems throughout the year.

Lake water quality simulation can be applied when a single reservoir is simulated at the basin outlet. The lake water quality computes the toxic balance and the phosphorus mass balance in the lake, the equations for which come from Chapra (1983) and from Thomann and Mueller (1987), respectively. The major processes in the toxic balance are loading, outflow, reactions, volatilization, settling, diffusion, resuspension, and burial, while in the phosphorus balance, the balances are loading, outflow, and settling. The model tracks the fate of pesticides from their initial applications on the land to their final fate in the lake. This allows decision makers to directly predict the influence of upland agricultural management decisions on lake water quality (Arnold et al., 1991).

3. GENERAL INPUT REQUIREMENTS

The following paragraphs briefly describe the type of data required by SWRRBWQ. Input data requirements for running SWRRBWQ can be divided into five components: general simulation control, weather data, pesticide, entire basin data, and subbasin data, as shown in Table 3.1.

3.1 General Simulation Control

The control variables must be defined for a SWRRBWQ run. They control the total simulation length, number of subbasins and pesticides, which type of simulation to be included in a run, and output printout option. Three types of simulation options are available: groundwater, pond, and reservoir. For reservoir simulations, the user can have either reservoirs for each subbasin but not at the basin outlet or a single reservoir simulated at basin outlet with all subbasins draining into it. If the latter one is selected, lake water quality can be simulated. These variables determines the complexity of the watershed simulation.

3.2 Weather Data

The weather data are essential inputs to SWRRBWQ. The variables necessary for driving SWRRBWQ are precipitation, air temperature, and solar radiation. If daily precipitation and/or temperature data are available, they can be entered directly to SWRRBWQ. If not, SWRRBWQ can stochastically generate daily rainfall, maximum and minimum air temperatures, and solar radiation. One set of weather variables may be simulated for the entire basin, or the variables can be simulated for each subbasin. The SWRRBWQ user must supply statistical weather variables for the raingage of interest from the weather database, which can be retrieved from the SWRRBWQ interface. The statistical values were calculated from data recorded over 20 years for most of the first-order National Weather Service stations (Nicks, et. al, 1990). Input for the model must include monthly probabilities of receiving precipitation, a random number (0-1), and monthly maximum 0.5 h for the period of record from the weather database. If wet-dry probabilities are not available, the average monthly number of rainy days may be substituted. The monthly mean precipitation for an event, the monthly standard deviations of daily precipitation, the monthly skew coefficients are also required. Inputs for generating temperature and solar radiation are monthly maximum/minimum air temperatures, coefficient of variation, and monthly solar radiation.

Table 3.1 Screen Input Sequence in SWRRBWQ Interface

Data Component	Description of Input Data	Content		SWRRBWQ	
				Line No.	File N
1	General Simulation Control	Title, simulation length, # of subbasins (max=10)		1-3,4	*.DAT
		Water and sediment file		4	*.STA
		Type of simulation	Groundwater, Pond & Reservoir	4	*.DAT
			Lake water quality		
			# of Pesticides	39	
		Print control and output files		4	
2	Weather Data	Raingage Station		3	
		User input daily data file	Precipitation		*.PCP
			Temperature		*.TMP
		Statistics weather data		8-19	*.DAT
		Temperature data (subbasin # 2-10)		20-37	
3	Pesticide (max=10)			40	
4	Entire Basin Data	Physical representation of the basin/Groundwater variables		5,6,38	
5	Subbasin Data	Basin data		50,51	
		Centroid coordinates		6,7	
		Routing data		52,5	
		Pond and Reservoir		53,54-55	
		Pesticide		56-65	
		Soil		67-76	
		Crop and Nutrient (up to 3 crops)		66,77-78,81	
		Treatment (up to 5 applications)		82-97	
		Lake water quality (reservoir) at the basin outlet		1-10	*.LWI

3.3 Pesticide

When pesticide is applied, the amount of pesticide reaches the ground or plants, losses from the surface soil zone, and in the runoff water are computed by the model. Data associated with pesticide simulation are soil partition coefficient, washoff fraction, half-life application efficiency factor, and solubility. Up to ten pesticides can be simulated.

3.4 Entire Basin Data

This data describes physical representation of the basin, such as the total drainage area, basin slope, fraction of field capacity, etc. If groundwater flow simulation is considered, five additional parameters are required.

3.5 Subbasin Data

Subbasin data are further divided into the following categories:

1. Basin data that gives a physical representation of the subbasin, i.e., the fraction of the basin, the average main channel width, slope, length, Manning's n, and effective hydraulic conductivity. The channel length is the distance along the channel from the subbasin outlet to the most distant point in the subbasin. In general, the values can be obtained from topographic maps. Other variables are the runoff curve number, soil albedo, and initial water content of snow.

2. Centroid coordinates are the input for the X and Y centroid coordinates for each subbasin only if rainfall is simulated for multiple subbasins.

3. Routing data provides the average channel depth, width, slope, length and Manning's n, from the subbasin outlet to the basin outlet. It should be noted that the definition of the channel length in the basin data and routing data is different. The channel length here may be zero when applied to the subbasin where the subbasin outlet coincides with the entire basin outlet. Both channel lengths are used to calculate transmission losses. The first length occurs within the subbasin, while the other length is from the subbasin outlet to the basin outlet.

4. Pond and reservoir are optional to SWRRBWQ. The fraction of each subbasin that flows into ponds/reservoirs must be given. The total surface area of all ponds/reservoirs, runoff volume applied, initial volume, seepage through dam, initial and normal sediment concentrations, and hydraulic conductivity for ponds/reservoirs. In addition, the total surface area at principle spillway, runoff required to fill to principle spillway, and average principle release rate are also required for reservoir simulation.

5. Pesticide data include initial concentration on foliage, initial concentration on

ground, and enrichment ratio for the pesticide.

6. Soil data are required for each subbasin. The number of different soil series is entered by the user. More than one subbasin could use the same soil series or each subbasin could have a different series. Most of the soil data for SWRRBWQ can be taken from the Soil Conservation Service (SCS) Soils-5 database. The database is compiled from the SCS Soils-5 Interpretation Records, prepared by SCS staff, which provide information on the characteristics and interpretive properties of all soils series identified in the United States. The data contains the properties and characteristics of more than 14,000 soils. The soils data required for input to SWRRBWQ are number of layers, erosion factor K, depth, density, water capacity, conductivity, clay content, initial NO3 concentration, maximum rooting depth, and particle size distribution.

7. Crop and nutrients require identifying number of crops in rotation, planting and harvest dates and curve numbers. The user has to make selections on vegetation types and tillage operations. Other inputs are potential heat units, biomass conversion factor, water stress yield factor, harvest index, average annual C factor, maximum LAI, and initial residue cover.

8. Treatment data specify the dates and the amount of nitrogen, phosphorus, and/or pesticides that are applied to each subbasin for five applications. If irrigation is applied, the date and the amount of irrigation, or the water stress and irrigation runoff ratio should be supplied based on the type of irrigation selected by the user.

9. Lake water quality can be applied only when a single reservoir is simulated at basin outlet. There are two sets of data needed for the lake water quality: fifteen single variables and five monthly values. The variables are initial concentrations, reaction coefficients, several velocities, such as settling, resuspension, etc., and lake volume, depth, and temperature. Monthly values of wind speed, effluent flow, temperatures of effluent and natural inflow, and dewpoint temperature should also be included.

4. SWRRBWQ OUTPUT FILE DESCRIPTION

Once you have created an input file and have submitted the input file to the SWRRBWQ model, SWRRBWQ will process the input file and create an output file. The output will consist of the following items in the order that they are presented in the output file:

1. A listing of all the input variables for inspection. These include:

   ? Random number generator seeds at the start of simulation
   ? Groundwater variables
   ? Rainfall and temperature input options and monthly rainfall generator parameters
   ? Basin hydrology and sedimentation inputs. Also included are pond and reservoir inputs and routing data.
   ? Soils data for each subbasin starting with subbasin number one. Included are the sediment size distribution of the detached sediment for each subbasin.
   ? Crop data

2. A table reports 18 values printed by day, month, or year based on the selection made by the user. There are two sets of variables that are printed: flow in millimeters and loading in kilogram/hectares. The first set includes predicted precipitation, surface runoff, subsurface flow, water yield, percolation, transmission losses, ET, soil water content, reservoir volume, groundwater flow, and groundwater height. The second one shows sediment yield, organic nitrogen, organic phosphorus, nitrate (NO_3-N) in surface runoff, soluble phosphorus, nitrate in crops, lateral surface flow, and percolation. The values are basin composite values and are weighted by subbasin data.

3. Soil water values are printed for each subbasin at the end of simulation. Following the soil water values is a listing of pond and reservoir water volumes and sediment concentrations at the end of the simulation. The final composite pond and reservoir storage are basin values weighted by subbasin area. Average annual irrigation data for each subbasin, including number of applications and irrigation water applied, are printed for user inspection. The soil, pond, and reservoir water balance and pond and reservoir sediment balance are also produced. Values significantly different from zero may indicate unaccounted water and sediment entering or exiting the system.

4. Subbasin average annual values for rainfall, surface runoff, subsurface flow, sediment yield, and total biomass are reported. Next, average monthly basin values for rainfall, snowfall, surface runoff, subsurface flow, water yield, ET, and sediment yield area listed. Finally, selected miscellaneous basin statistics are shown. Standard deviation of rainfall are in mm. The mean CN is for the entire basin while the maximum and minimum are for individual subbasins. Basin peak flow statistics are listed along with the mean and standard deviation of monthly basin water yields.

5. Average annual basin values are weighted by subbasin areas and most definitions and

units are self-explanatory. Total subbasin sediment yield is the sum of the subbasin yields. Basin sediment yield is the total sediment yield reaching the basin outlet. The units of the variables in the pond and reservoir water budget are in mm over the area draining into the ponds and reservoirs. The yield loss from ponds and reservoirs is the amount of water and sediment the ponds and reservoirs trapped from going downstream.

6. Measured and predicted water yields are compared on monthly and annual water statistics table. Monthly error is absolute error while annual error is percent error. The data set was developed to demonstrate several input options and not describe the system. Consequently, measured and predicted values may not compare well. Monthly measured and predicted means and standard deviations, regression line slope, and R2 values are also included. Next, average monthly measured and predicted water yields are listed to determine if the model is overpredicting or underpredicting seasons of the year.

7. Finally, similar statistical analysis for sediment yields is performed as used for water yields. Measured and predicted sediment yields are shown at the end of the output.

5. MINIMUM SYSTEM REQUIREMENTS AND SYSTEM LOADING

5.1 Minimum System Requirements

The system runs under Microsoft Windows. The minimum system requirements are provided below:

- ? Windows Version 3.0
- ? 80386 Processor
- ? 4 Megabytes RAM
- ? 10 Megabytes hard disk space

NOTE: A math co-processor is recommended but not required.

5.2 Loading the System

STEP 1. Go to DOS and create a directory on the hard disk: **MD\SWRRB.**

NOTE: You must have 10 Megabytes of space on the hard disk drive on which you are installing SWRRBWQ.

STEP 2. Place the disk marked **SWRRBWQ Disk #1** in either drive A: or drive B:. Go to the directory that you created (**CD\PROUTE**) and enter the following command from that directory:

A:INSTALL A:
or
B: INSTALL B:(if the disk is in drive B:)

STEP 3: Follow the instructions for copying.

STEP 4. Next, create an icon in the Windows Main Menu using the NEW option in the FILE menu under the program manager. There are three Windows executables for which you may create icons:

Executable Name	**Description**
SWRRBFS.EXE	This is the SWRRBWQ executable that displays the interfaces available: the Windows Interface and the Manual Run interface, and allows you to select the one that you want. This is the executable that you should access if you plan to have only one icon for SWRRBWQ.

SWRRB.EXE	This is the main Windows Interface for SWRRBWQ. This executable creates the input file through a series of screens that are user-friendly, provide detailed help, and allow the user to call up and search the Climate and Soils-5 database.
MSWRRB.EXE	This executable allows you to edit existing SWRRBWQ files using the SWRRBWQ UTIL program. You may also submit the files to the model after editing.

You may choose to have SWRRBWQ be a separate group under the Program, have it as one of the items in the STARTUP menu so that it is available whenever you log into the Windows or make it an item under the MAIN MENU so that you can access it when you wish to use. Refer to your Windows Manual for information on creating an icon for SWRRBWQ.

NOTE: The working directory option should be the one containing the executables since SWRRWQ requires certain table files in order to create the input files.

STEP 5. You are now ready to use SWRRBWQ.

6. USING THE SWRRBWQ INTERFACE

Once you have finished loading the software, you will be ready to access the SWRRBWQ Windows Interface and Manual Run interface. This section details how to use these interfaces.

This section will describe the following:

? How to access an existing file or opening a new file in the Windows Interface
? File-Naming Conventions
? Saving Input Files in the Windows Interface
? Setting Up a Default Editor for Viewing Output Files
? Running the SWRRBWQ Model in the Windows Interface
? SWRRBWQ output graphics
? SWRRBWQ Windows Interface commands and function keys
? Using the Manual Run option

6.1 Accessing an Existing File or Opening a New File in the Windows Interface

When you first enter the SWRRBWQ Interface, you will be automatically assigned a new file. The new file name and number will appear at the top of the screen in parentheses.

To **access an existing file**, click on the **F**<u>**I**</u>**LE** option on the very top line, select the <u>**O**</u>**PEN** option and select the file that you want from the list that appears. When you click on the **FILE** option, you will be asked to verify that you actually wish to open a new file. This is to remind you that calling a new file will overwrite all the values contained in the file that you are in presently.

NOTE: The input files must be in the same location as the *.EXE files (the SWRRBWQ executable files). If you elect to read in an existing file from a different directory, the directory that the file is in becomes the default directory for SWRRBWQ. All the data files for SWRRBWQ must exist in the default directory. So we strongly recommend that you do not save input files in any location other than the SWRRBWQ directory.

If you have selected an existing file to edit, when you choose to save the file, the existing file will be rewritten with the new values unless you choose the SAVE AS option and assign a new file name. Please remember, if you are assigning a new name to a file, to follow the naming conventions followed by SWRRBWQ explained in the next subsection.

6.2 SWRRBWQ File Naming Conventions

All files created by SWRRBWQ in Windows have a file naming convention as explained below:

1. They will have the word SWRRBWQ in the beginning of the file name, followed a three-digit number that is sequentially assigned depending on the number of that type of file that currently exist in the default directory (the direction where the SWRRBWQ model resides).

2. The file extension will indicate the type of file. This is explained below:

File Names	Description of the file
SWRRB###.INP	SWRRBWQ Windows Interface Model Input This file is created by the Windows Interface

The following input files are generated by the SWRRBWQ Windows Interface when you choose to submit the SWRRB###.INP file to the model for execution. These files may be accessed independently through the Manual Run option. These files will be in your directory.

SWRRB###.DAT	Standard SWRRBWQ input file
SWRRB###.STA	Measured water yield and sediment
SWRRB###.PCP	Daily precipitation input file
SWRRB###.TMP	Daily temperature input file
SWRRB###.LWI	Lake water quality input file

Output Files
These files are generated by the SWRRBWQ model.

SWRRB###.OUT	Standard SWRRBWQ Output File
SWRRB###.RFO	Measured/generated rainfall output File
SWRRB###.TMO	Measured/generated temperature output file
SWRRB###.PST	Pesticide output file
SWRRB###.GRI	Graphics File

6.3 Saving Input Files

SWRRBWQ will ask you whether you wish to save the input file when you exit the program or when you reach the last file. However, if you have accessed an existing file and made all the changes before reaching the last screen, you may save the input file by proceeding to the FILE option and selecting the SAVE option. Once you have completed an input file, you may submit it to the SWRRBWQ model for execution. When you submit the input file to the model, the input file will be validated by the SWRRBWQ interface. If any errors are detected during the validation, you will be informed of them and brought to the incorrect entry so that you might effect the change immediately.

6.4 Setting Up a Default Editor for Viewing Output Files

The default editor for viewing and editing SWRRBWQ output files is the NOTEPAD program in Windows. You may choose any other editor for viewing the output by selecting the **UTILITIES** option on the second line of the screen. Click on **SETUP OUTPUT FILE VIEWER.** You will then be required to enter the location and name of the output file editor.

6.5 Running the SWRRBWQ Model in the Windows Interface

When you have completed the input file, select the RUN button to run the model with the input file you created. When you select the RUN option, all the entries in the file will be validated. If any errors are detected during the validation, SWRRBWQ will put up a message informing you of the type of error detected and will then take you to the prompt that is incorrect. Once all the values are valid, the file is submitted to the SWRRBWQ model for execution. When the processing of the input file is complete and the output results, SWRRBWQ will ask whether you wish to view them. If you indicated that you did wish to view the output file, SWRRBWQ will show them using a data editor allowing you to annotate the results if you so choose. To exit from the Data File Editor, press the ALT and F4 function keys simultaneously.

The model output is explained in Section 4.

6.6 SWRRBWQ Output Graphics

You have two output options for graphics in SWRRBWQ. There are the actual SWRRBWQ output graphics that are created during the processing of the input file. This graphics automatically appears on the screen when you submit an input file to the SWRRBWQ using the RUN button.

The second type of graphics is available under the Utilities option on the top line of the Windows Interface. This graphics option allows you overlay any variable over any other variable, instead of the fixed type of graphics that are available when you select the RUN option. The graphics option will be one of two items available under the Utilities selection. When you first click on this graphics option, SWRRBWQ will verify if there are output graphics files with the number as the SWRRBWQ input file that you are in when you select the graphics option. If a graphics file exists with the same file number, it will show a list of variables from which you may select as many as ten variables that you would like to plot on the same graph. To select an option, click on the variable name.

If no graphics file exists with same file number as the input file, the window will contain no variables. Press CANCEL to bypass this window and the next window will allow you to select the graphics file that you would like to graph. To select a graph, select the <u>G</u>raph option at the top of the screen. Next select the <u>O</u>pen option. When you have selected a file, you will see another window with all the variables names displayed. Select all the variables that you would like to overlay. When you have completed selecting the variables, the graph will be drawn on the screen. You may print the graph to the default printer selected in Windows by selecting the Printer option under the Graph option. To change any of the settings on the default printer temporarily for the printing of this output graph, select the PRINTER SETUP option.

6.7 SWRRBWQ Windows Interface Commands and Function Keys

SWRRBWQ has a series of "buttons" designed to make using the system as easy as possible. These buttons and the commands they represent are accessible in three ways: (1) click on the button with the mouse key to access the function that button represents, (2) press the ALT along with the underlined letter in the button title (e.g. ALT/H for Help), or (3) select the TOOL option and select the option under there from the list presented.

The buttons and the commands they represent are explained below:

The NEXT Button This option allows you to move to the next screen in SWRRBWQ. If there are incorrect values on the screen that you are in currently and you attempt to move to another screen, SWRRBWQ will inform you of the error and allow you the option of going back (and correcting the error at a later time) or correcting the error. The cursor will blink at the prompt with the incorrect entry, if you elect to correct the error before moving on.

The BACK button This button allows you to move back one screen. If there are incorrect values on the screen that you are in currently and you attempt to move to another screen, SWRRBWQ will inform you of the error and allow you the option of going back (and correcting the error at a later time) or correcting the error. The cursor will blink at the prompt with the incorrect entry, if you elect to correct the error before moving on.

The INDEX Function Instead of moving backwards and forwards through the screens, you may use the INDEX feature to hop back and forth between screens. To access this feature, move your cursor over the INDEX button and click with the mouse button, or enter ALT, N. All the screens available in this option will be displayed with the screen title and the screen numbers. **Certain screens will be grayed out. This indicates that these screens are not accessible due to selections made on other screens. The screen that you were in when you selected the INDEX button will be**

highlighted in blue text

If you wish to see the prompts that appear on each screen, press the EXPAND button at the bottom of the INDEX screen. The screen names and numbers will then include all the prompts contained in the screens. You may contract the screen again to the normal display of just the screen names and number by clicking on the CONTRACT button.

To move to the screen that you want, move your cursor over the screen number of any non-gray screen and click the left mouse button. You are taken immediately to that screen. To exit the INDEX screen and return to the previous screen, click on the CANCEL button.

The HELP Button This option allows you access help information on SWRRBWQ. You have two different types of help: **Prompt-Level Help** which contains information on the specific prompt that your cursor is on or on which you are entering data and **General Help** which contains a general description of the SWRRBWQ system.

To access the **General Help**, move your cursor over to the toolbar and the select the HELP option, or enter ALT, H from the keyboard. A menu will appear showing the various types of help. Select the HELP INDEX option or enter I from the keyboard.

To access **Prompt-Level Help**, move your cursor over to the prompt on which you would like information and press either the **F1** function key or move your cursor over to the HELP button and click.

A window will appear in either case displaying broad help or prompt-specific help. If you are accessing prompt-specific help, you may browse through the helps for all the additional prompts that are related to the prompt you are on by accessing the forward and backward BROWSE keys.

If you are accessing **General Help**, all sentences that are in green and underlined have further information on them. Move your cursor over the phrase you would like further information and click. You will be taken to that option.

There is a search function within the HELP functions that allows you to type in a word and find all the help available on the word that you typed. To access this, select the SEARCH key in the HELP window and follow instructions.

When you are through viewing help, exit the help window by either entering ALT, F4 from the keyboard or by moving the cursor over to the icon on the top left corner of the window and double clicking the left mouse button. You will be returned to the screen that you were in previously.

The CALC Button This option allows you to access the Calculator Function within Windows, should you require the use of a calculator at any screen in SWRRBWQ.

The TOP Button This option allows you to move to the first screen in SWRRBWQ from any screen without having to use the INDEX function.

The RUN Button This option allows you to submit an input file that you have created to the SWRRBWQ model for execution. If you have incorrect entries in the file when you click on this button, SWRRBWQ will inform you that you have incorrect values and take you to the appropriate prompt so that you may correct the value and resubmit the file.

The RESTORE Button This option allows you to restore the default values that were in the file before you started making changes for this screen. This is an option that allows you to start again without having to exit the system or go back to every variable that you changed.

6.8 Manual Run Option

This option is one of two main option available to you in the SWRRBWQ main menu. This option allows you to edit input files either using the SWRRBWQ DOS Utility program or using the Windows NOTEPAD editor (for those files not supported by the SWRRBWQ Utility program). This option requires some expertise in SWRRBWQ, so we recommend that you use the Windows interface option to familiarize yourself with the SWRRBWQ Model prior to using this option. You should also have access to the SWRRBWQ Utility User's Guide.

You have two options for the SWRRBWQ Input files:

EDIT You may edit any of the SWRRBWQ input files directly. Once you have selected a file, this button will either call up the SWRRBWQ DOS UTIL program or the NOTEPAD editor to allow you to edit the file selected.

RUN This option is only available for the SWRRB*.INP files. After you have edited the SWRRBWQ input file, you may submit it to the SWRRBWQ model for execution by selecting this button. This button will be grayed out for all other types of files showing that it cannot be selected.

The USDA provides the UTIL (Universal Text Integration Language) text editor to assist users for creating or editing. UTIL is designed to edit data files with a fixed variables and fixed format. Each variable or field with UTIL come with a description, the range limits for the variable and an interactive help message that explains that variable's usage. Weather data and soil data may be brought in within UTIL using the GETWEAT and GETSOIL command. Weather data are stored in 54 ASCII files, while soil database can be retrieved from an executable file (RUNHIQ.EXE). The user must run the RUNHIQ file to retrieve a soil from the database. One soil file will be created each time the RUNHIQ is run. Pesticide and crop data can be obtained from a pick list.

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7. EXAMPLE RUNS

This section contains three example runs to illustrate how to best use the SWRRBWQ Windows interface. The example runs are selected in an attempt to exercise all the major portions of the SWRRBWQ interface. The SWRRBWQ applications with three example runs are shown in Table 7.1. The SWRRBWQ application includes number of subbasins, weather generator, simulation type, four special buttons, nutrients, treatment, and statistical analysis. Each example run is designed to highlight portions of the model and is explained below.

The first example simulates water, sediment yields, pesticides, and nutrients under relatively uniform soil and rainfall conditions. A reservoir option and lake water quality are included in the simulation. The second example demonstrates how the basin is subdivided based on a wide range of soils, land use, tillage operations, rainfall, etc. A map of the basin showing the divisions is included. This example also shows how the SWRRBWQ interface incorporates available precipitation, temperature, and sediment data as the input files to SWRRBWQ. The last run simply contains one basin pesticide simulation including a reservoir routing and lake water quality option.

Three examples were obtained from the USDA and used the applications of the SWRRBWQ, LAKEWQ, RAIN, TEMP along with UTIL in the SWRRBWQ model. It should be noted that some of the values in example input files have been changed in order to produce reasonable results.

7.1 Example 1

Summary of scenario

A watershed is located in Waco, TX with an area of 74 km^2, a channel length of 1.55 km, and an average channel slope of 0.0001. The entire watershed is divided into four subbasins because of differences in land use and topography. A single reservoir and lake water quality are simulated at the basin outlet with all subbasins draining into it. Two pesticides, Paraquat and Bladex, and nutrients are also simulated. Each subbasin uses the same soil series, i.e., Houston Black, which contains three layers. This example was originally provided by USDA and distributed with the SWRRBWQ model. The USDA example input file is called RIESEXAM.DAT. It should be noted that the channel lengths for subbasin 2 and subbasin 3 in the routing data have been modified for this SWRRBWQ Windows so that the transmission losses from the subbasin outlet to the basin outlet could be estimated properly.

Thus, the output of this example will be different from the one (i.e., RIESEXAM.OUT) given by USDA. The sample run is for three years, January 1, 1970 to December 31, 1972.

Table 7.1 Example Run Matrix for SWRRBWQ Windows Interface

SWRRBWQ Application			Sample Run		
			Example 1	Example 2	Example 3
# of subbasins			4	4	1
Weather Generator	Raingage ID	User defined		Chickasha, OK	
		System defined	Waco, TX		Coleman, TX
	Precipitation	Simulated	?		?
		Measured		WASHITA.PCP*	
	Temperature	Simulated	?		?
		Measured		WASHITA.TMP*	
Simulation Type	Groundwater		?		
	Pond			?	
	Reservoir	Each subbasin		?	
		Basin outlet	?		?
	Lake Water Quality		RIESEXAM.LWÎ		SHOP.LWÎ
PESTICIDE ID	# of pesticides		2		1
SOIL ID	# of soils		1	4	1
CROP ID	# of crops		3	1	1
Nutrients			?		?
Treatment	N & P applied		?		N only
	Pesticide applied		?		?
	Irrigation				
Statistical Analysis	Measured Water Yield			WASHITA.STA*	
	Measured Sediment Yield			WASHITA.STA*	

* Input files supplied by USDA

The entry process will be explained in a series of steps meant to take you step-by-step through the process of editing or viewing the input file for this example run.

STEP 1. Select the SWRRBWQ Windows Interface by clicking on the Windows Interface button once you have selected the SWRRBWQ option.

STEP 2. Select an existing file called SWRRB001.INP in the SWRRBWQ interface by clicking on the File option at the main menu. There are a total of 14 screens available to you when you click on the INDEX button that illustrates the overall structure of the input file (the other screens are grayed out due to choices made in the sample run). Normally, SWRRBWQ requires you to provide information on number of subbasins for the simulation, drainage area, weather statistical data based on Raingage ID, simulation type, soil, and crop. Since you are retrieving an existing input file, you will not be required to do this.

STEP 3. You should examine the input file in detail and familiarize yourself with it by using the NEXT and BACK buttons to move through the screens and the HELP button to obtain general and detailed information about the interface and specific prompts. Areas that you should focus on are given below:

How to retrieve weather statistical data:
You retrieve weather statistical data from the weather database. This is done in the second screen of the Windows Interface. This screen and the subsequent screen that contains the statistical data is shown below in Figure 6.1. To select a different station in the same state, click on the Raingage station option and a list of all the stations will come up. Move your cursor to the option that you want and press ENTER and this option will be the new station. Keep in mind that you should restore the station to the WACO station option when you submit the file to the SWRRBWQ model.

How to access the Pesticide Table, the Soils-5 database, and the Crop Table:
This information is available through the PESTICIDE ID button, the SOIL ID button, and CROP ID button. These buttons will appear on the screens where you are required to enter information about pesticides, the soils, and crops. Refer to the HELP function for information on these buttons.

How to enter your own lake water quality data:
In the Windows Interface, you are given the option of entering your lake water quality data. This is done in Screen 5. In this example run, an USDA Lake Water Quality File exists (it is called RIESEXAM.LW1) and is accessed through the Lake Water Quality File entry option on Screen 5.

STEP 4. Once you have examined the input file and are familiar with it, you should submit it to the SWRRBWQ executable for processing. To do this, press the RUN button. SWRRBWQ will validate all the input data in the file when you press this button. If you have any errors, it will bring you to the incorrect entries. When you submit the input file to the model , the Windows interface will generate the input files required by the model, including the SWRRB####.LW1, which is the lake water quality file containing the input data from RIESEXAM.LW1.

STEP 5. A graph showing eight plots will appear on the screen while the model is running. Once the processing is complete, the output file will be shown using the NOTEPAD editor in Windows. The output will not be shown.

STEP 6. You may also use the SWRRBWQ Windows Graphic Utility Program to plot a different graph than the one you saw when the model was running, once you have run the model. This utility is available through the Utility item on the top of the screen. When you select this option, a list of variables in the dataset will appear on the screen. You may select up to ten variables to plot against each other in a single graph. An example of this graph is provided in Figure 7.2.

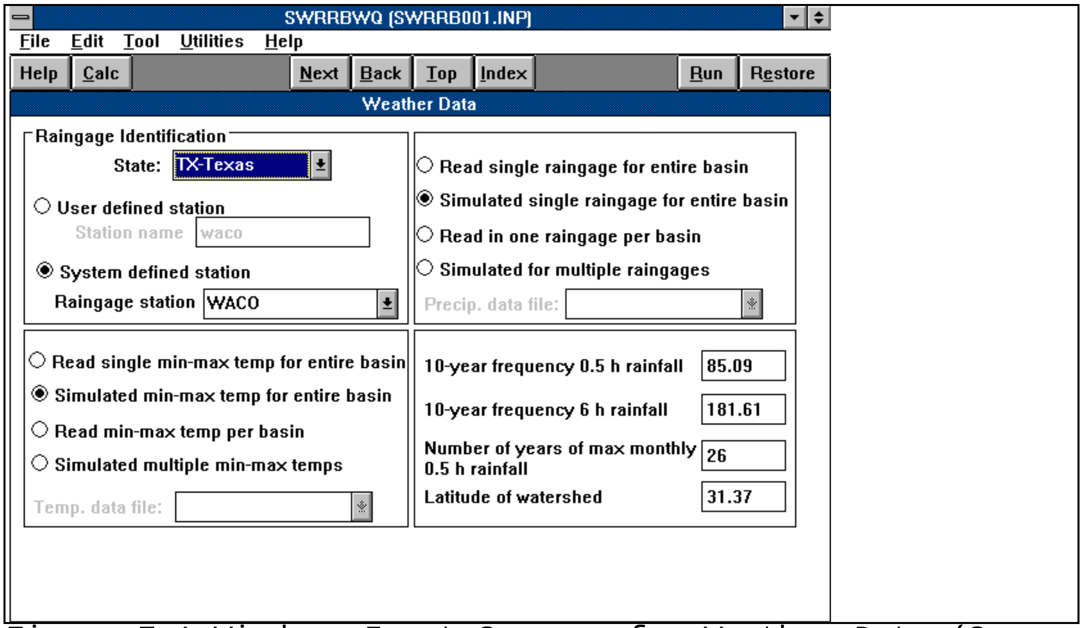
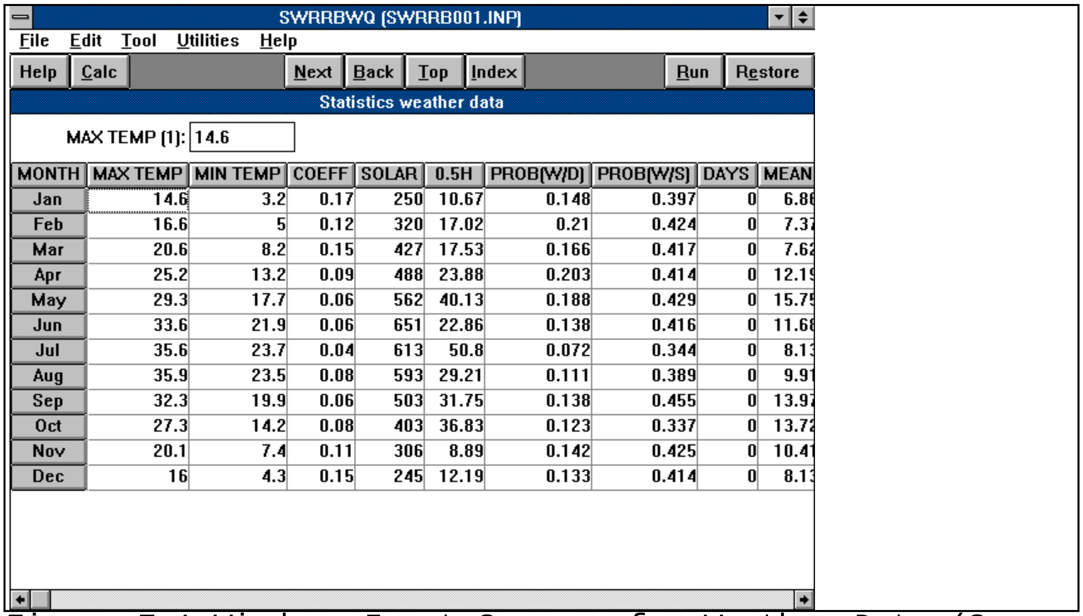


Figure 7.1 Windows Input Screens for Weather Data (Screen 1)



MONTH	MAX TEMP	MIN TEMP	COEFF	SOLAR	0.5H	PROB(W/D)	PROB(W/S)	DAYS	MEAN
Jan	14.6	3.2	0.17	250	10.67	0.148	0.397	0	6.8
Feb	16.6	5	0.12	320	17.02	0.21	0.424	0	7.3
Mar	20.6	8.2	0.15	427	17.53	0.166	0.417	0	7.6
Apr	25.2	13.2	0.09	488	23.88	0.203	0.414	0	12.1
May	29.3	17.7	0.06	562	40.13	0.188	0.429	0	15.7
Jun	33.6	21.9	0.06	651	22.86	0.138	0.416	0	11.6
Jul	35.6	23.7	0.04	613	50.8	0.072	0.344	0	8.1
Aug	35.9	23.5	0.08	593	29.21	0.111	0.389	0	9.9
Sep	32.3	19.9	0.06	503	31.75	0.138	0.455	0	13.9
Oct	27.3	14.2	0.08	403	36.83	0.123	0.337	0	13.7
Nov	20.1	7.4	0.11	306	8.89	0.142	0.425	0	10.4
Dec	16	4.3	0.15	245	12.19	0.133	0.414	0	8.1

Figure 7.1 Windows Input Screens for Weather Data (Screen 2)

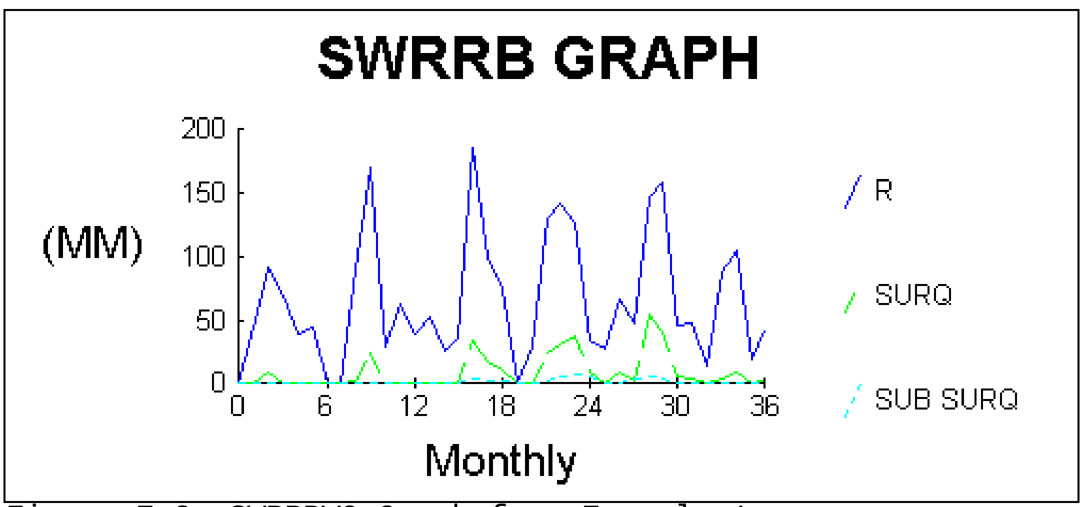


Figure 7.2 SWRRBWQ Graph from Example 1

7.2 Example 2

Summary of scenario

The little Washita River Watershed covers 538.2 square kilometers and is a tributary of the Washita River in southwest Oklahoma. The watershed is in the southern part of the Great Plains of the United States, which was one of seven watersheds chosen across the Nation for the Model Implementation Project (MIP) by USDA. The climate is classified as moist and subhumid, and the average annual rainfall was 29.42 inches for the 24 years of data collection by the ARS. Much of the annual precipitation and most of the large floods occurs in the spring and fall. The average temperature is degrees Fahrenheit.

Surveys of the soils in the watershed have been made by the SCS and published (Bogard et al. 1978, Moffatt 1973, Mobley et al. 1967). In these surveys, 64 different soil series were defined for the watershed, and 162 soil phases were mapped within these soil series to reflect differences in surface soil textures, slopes, stoniness, degree of erosion, and other characteristics that affect land use. These survey publications also provide information associated with each soil series, such as depth to bedrock, typical texture found at each depth, permeability, available water capacity, pH, and suitability for use in model inputs. Soil in the watershed were grouped into one of four hydrologic groups, groups A through D, on the basis of their soil properties that are known to influence runoff. These soil properties included depth to the water table, infiltration rate, and low permeability of subsurface soil layers. Hydrologic group B is predominant, covering 73.3 percent of the watershed. Scattered areas of shallow soil in the western end of the watershed have high runoff potential. There are a few areas with high runoff potential in the eastern end of the watershed because the soils have very low permeability. Scattered throughout the central portion of the watershed are areas with very low runoff potential because the soils are predominantly sandy and, thus, have a high infiltration rate and have flatter profiles.

Except for a few rocky, steep hills near Cement, OK, the upland topography is gently to moderately rolling. Maximum relief in the watershed is only about 600 feet. The channel system is well developed throughout the watershed and extends practically to the drainage divide in most areas, so the watershed is well drained except for a few alluvial areas.

The watershed first is divided into four subbasins and a map of the divisions is shown in Figure 7.3 (Arnold *et. al*, 1990). Actually, subbasin 4 is defined as an alluvium channel carrying the flow from three other subbasins to the basin outlet. Subbasin characteristics are shown in Table 7.2. Notice that channel length in routing data for subbasin 4 is zero because the subbasin outlet for subbasin 4 coincides the entire basin outlet.

Figure 7.3 Watershed 522 at Chickasha, Oklahoma
(After Arnold *et al*. 1990)

This example shows how the interface reads in measured precipitation and temperature data when the option selected is READ IN SINGLE RAINGAGE FOR ENTIRE BASIN. Also, when measured water yield and sediment data are available, the model will perform statistical analysis to compare the predicted and measured water and sediment yields. The data set was developed to demonstrate several input options. It is not meant to describe the system. Consequently, measured and predicted values may not compare well.

STEP 1. Select the SWRRBWQ Windows Interface by clicking on the Windows Interface button once you have selected the SWRRBWQ option.

STEP 2. Select an existing file called SWRRB002.INP in the SWRRBWQ interface by clicking on the File option at the main menu. There are a total of 16 screens available to you when you click on the INDEX button that illustrates the overall structure of the input file (there are normally 22 screens; however, a certain number will be grayed out depending on the selections for this example). Normally, SWRRBWQ requires you to provide information on number of subbasins for the simulation, drainage area, weather statistical data based on Raingage ID, simulation type, soil, and crop. Since you are retrieving an existing input file, you will not be required to do this.

STEP 3. You should examine the input file in detail and familiarize yourself with it by using the NEXT and BACK buttons to move through the screens and the HELP button to obtain general and detailed information about the interface and specific prompts. Areas that you should focus on are given below:

How to prepare the Water and Sediment Yield File, the Precipitation Data File, and the Temperature Data File (.STA, .PCP, and .TMP files):
These files are ASCII files and must be in a certain format. For this example, you will have the following existing files: WASHITA.STA, WASHITA.PCP, and WASHITA.TMP. You must select these files at the Water and Sediment Input File option, the Precipitation Data File option, and the Temperature Data File option. You may use the NOTEPAD editor to view these files outside SWRRBWQ. The help messages for the variables requiring entry of these file names will provide you with the format as well as other useful information.

STEP 4. Once you have examined the input file and are familiar with it, you should submit it to the SWRRBWQ executable for processing. To do this, press the RUN button. SWRRBWQ will validate all the input data in the file when you press this button. If you have any errors, it will inform you of this and bring you to the incorrect entries.

Table 7.2 Washita Watershed Subbasin Characteristics

Input Variables	Subbasin				Entire Basin
	1	2	3	4	
SUBBASIN DATA (from the subbasin outlet to the most distant point in the subbasin)					
Fraction of basin in subbasin	.297	.564	.085	.054	1
SCS runoff curves number	77	75	77	77	
Soil albedo	.15	.15	.15	.15	
Water content of snow (mm)	0	0	0	0	
Main channel length (km)	14.2	11.7	6.8	27.1	41.2
Average channel slope (m/m)	.0038	.0038	.0076	.0114	.0019
Average main channel width (m)	9	11	11	13	
Effective hydraulic conductivity of channel alluvium (mm/hr)	10.0	10.0	10.0	10.0	
Channel N value	.05	.05	.05	.05	.05
Overland flow N value	.05	.05	.05	.05	.05
Return flow travel time (days)	0	0	0	0	
Sediment concentration in return flow (ppm)	750	750	750	750	
USLE erosion factor P	1.0	1.0	1.0	1.0	
Average slope length (m)	55	55	50	100	60
Average slope steepness (m/m)	.08	.09	.08	.01	.08
ROUTING DATA (from subbasin outlet to basin outlet)					
Average channel width (m)	9.0	9.0	11.0	0	
Average channel depth (m)	3.0	3.0	3.5	0	
Channel slope (m/m)	.011	.011	.011	0	
Channel length (km)	27.1	13.3	3.1	0	
Channel N value	.05	.05	.05	0	
Effective hydraulic conductivity of channel alluvium (mm/hr)	10.0	10.0	10.0	0	
USLE soils K factor for channel	.305	.305	.305	0	
USLE C factor for channel	1.0	1.0	1.0	0	

STEP 5. A graph showing eight plots will appear on the screen while the model is

running. Once the processing is complete, the output file will be shown using the NOTEPAD editor in Windows. The output will not be shown since it takes up more than 20 pages.

STEP 6. You may also use the SWRRBWQ Windows Graphic Utility Program to plot a different graph than the one you saw when the model was running, once you have run the model. This utility is available through the Utility item on the top of the screen. When you select this option, a list of variables in the dataset will appear on the screen. You may select up to ten variables to plot in a single graph.

7.3 Example 3

Summary of scenario

This is a screening level example: a watershed without subdivision, one pesticide (Banvel) applied to corn field was simulated for the watershed and lake water quality. The watershed is located in Coleman, TX, with an area of 101.1 km^2, a channel length of 1.55 km, and an average channel slope of 0.001. Since there is one subbasin, only the subbasin data is required for computing transmission loss and performing sediment routing. Routing variables has been skipped. The input file called SHOP.DAT, which was provided by USDA, has been modified. The subbasin channel length supplied in SHOP.DAT was changed from 0.55 to 1.55 km. The average main channel width is 3.5 km instead of 0.01 km. The total simulation length for this example run is for three years: January 1, 1970 to December 31, 1972.

STEP 1. Select the SWRRBWQ Windows Interface by clicking on the Windows Interface button once you have selected the SWRRBWQ option.

STEP 2. Select an existing file called SWRRB003.INP in the SWRRBWQ interface by clicking on the File option at the main menu. There are a total of 18 screens available to you when you click on the INDEX button that illustrates the overall structure of the input file. Normally, SWRRBWQ requires you to provide information on number of subbasins for the simulation, drainage area, weather statistical data based on Raingage ID, simulation type, soil, and crop. Since you are retrieving an existing input file, you will not be required to do this.

STEP 3. You should examine the input file in detail and familiarize yourself with it by moving through the screens and using the help button to assist you on prompts.

STEP 4. Once you have examined the input file and are familiar with it, you should submit it to the SWRRBWQ executable for processing. To do this, press the RUN button. SWRRBWQ will validate all the input data in the file when you press this button. If you have any errors, it will bring you to the incorrect entries.

STEP 5. A graph showing six plots will appear on the screen while the model is running. Once the processing is complete, the output file will be shown using the NOTEPAD editor in Windows.

STEP 6. You may also use the SWRRBWQ Windows Graphic Utility Program to plot a different graph than the one you saw when the model was running, once you have run the model. This utility is available through the Utility item on the top of the screen. When you select this option, a list of variables in the dataset will appear on the screen. You may select up to ten variables to plot in a single graph.

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APPENDIX A: SWRRBWQ WINDOWS INTERFACE DESIGN

When you select the Windows Interface option, you have the option of either using the Windows' interface to SWRRBWQ or using the SWRRBWQ DOS UTIL program to edit existing input files. We will focus only on the Windows Interface portion of SWRRBWQ in this appendix. For information on the SWRRBWQ UTIL program, refer to the SWRRBWQ Model Technical Manual (Arnold *et al.* 1991).

The SWRRBWQ Windows interface is designed to be as user-friendly to the user as possible. It does this through the combination of handling all the input variables, accessing two databases, and managing five input files required for a SWRRBWQ run. Four special buttons have been developed to assist the user to simplify accessing the data. These four IDs are Raingage, PESTICIDE, SOIL, and CROP. The Raingage and SOIL ID serve the same function as GETWEAT and GETSOIL used in UTIL. The PESTICIDE and CROP ID perform a pick list function, where the user is presented with a list of choices and picks an option.

There are a total of twenty-two screens in the SWRRBWQ Windows interface. The screen input sequence (see Table 3.1) reflects an overall structure of the SWRRBWQ model. Screen numbers are assigned to cover all the general input requirements discussed previously. Table 3.1 also shows the relationship between the screen numbers in the interface and the corresponding line numbers written in the SWRRBWQ input files. Furthermore, a spreadsheet (see Table A.1) is generated to identify the controls (variables) for each screen. This table defines the following for SWRRBWQ:

1. variable name in SWRRBWQ,
3. the description of the variable,
3. line number of SWRRBWQ input file,
4. screen number,
5. control number,
6. control type, item, range, default, and unit.

Each variable has a unique control number on a particular screen in the interface. For example if you refer to the first page of Table A1, a variable <u>LU</u> is defined as Number of

Subbasins, which is the seventh control on the first screen. The <u>LU</u> is written at the third value of the forth line in the SWRRBWQ input file (*.DAT). The <u>LU</u>'s type is integer, up to ten subbasins can be specified, and the default should be 1.

There are a total of five input files that may be needed for a SWRRBWQ run. The interface will generate and edit two input files, i.e., .DAT and .LWI. Three other input files (i.e., .STA, .PCP, and .TMP) can only be read in through the interface. However, they can be edited through the SWRRBWQ Manual Run option. All the variables in the .DAT and .LWI files are included in the interface, while the .STA, .PCP, and .TMP files are treated as separate inputs to the interface. The input files must have the appropriate format that are required by SWRRBWQ.

The **Raingage ID** is designed to retrieve statistical weather data for the raingage of interest from weather database. The weather database contains four single variables and eleven monthly variables for more than 1200 raingage stations, which are used for generating daily precipitation, temperature, and solar radiation. The interface first ask the user to select the State, and then allows the user to have a option for selecting either a user defined station or a system defined station on Screen No. 3. If a system defined station is used, the raingage stations available to the State will show on the list. Once a raingage station is selected, the weather data are directly loaded into the fields reserved for receiving weather variables. If a user defined station is checked, the user must enter the statistical weather values.

The **PESTICIDE ID** button brings up a list of 76 pesticides that are contained in SWRRBWQ and displays the pesticides and pesticide parameters on the screen. Once the user selects a pesticide, all the values on the same line with the pesticide name will be loaded into the row of the pesticide screen.

The **SOIL ID** button was developed to retrieve a soil directly from the soil database, which contains 8 single variables and seven variables for the layer (up to ten layers) for 14,000 soil series. The user should provide one or more letters of the soil; the values for the soil are then loaded into appropriate fields by the interface.

The **CROP ID** button is similar to the PESTICIDE ID. It reads a list of 22 crops that are currently supplied in SWRRBWQ and displays the crops and crop parameters on the screen. Once the user selects a crop, all the values on the same line with the crop name will be loaded into the row of the crop screen.

Table A.1 Variable Input Sequence in SWRRBWQ Interface

APPENDIX B: REFERENCES

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