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KYROM: A Drought Management Model for the Kentucky River Basin Users Manual

J. Herman
University of Kentucky Water Resources Research Institute

L. Ormsbee
University of Kentucky Water Resources Research Institute

KENTUCKY RIVER BASIN WATER SUPPLY ASSESSMENT STUDY

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A Drought Management Model for the Kentucky River Basin

User's Manual

J. Herman
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Prepared for:
The Kentucky River Authority

By:
The Kentucky Water Resource Research Institute
University of Kentucky
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Disclaimer

Although reasonable effort has been made to assure that the results obtained are correct, neither the authors, nor the KWRRI, assumes any responsibility for any results or any use made of the results obtained with the model. This software is provided "AS IS", and the user assumes all risks when using it.

KYROM User's Manual

Introduction

The **K**entucky **R**iver **O**peration and **M**anagement model is a computer application developed for the Kentucky River Authority by the Kentucky Water Resource Research Institute (KWRRI) for the purpose of simulating the Kentucky River Basin during drought periods. The model was developed as part of the KWRRI Kentucky River Basin Water Supply Assessment Study. This study was authorized by the KRA in a contract with the KWRRI dated April 1, 1995. Ownership of the model is exclusively that of the Authority and specific rules governing KYROM's distribution or license agreement may be applicable. It is strongly recommended the user contact the Authority concerning this matter before using the model.

System Requirements

To use the KYROM model, you need:

- An IBM® compatible machine with at least a 80486 processor or higher. A Pentium 100 MHz machine or higher is recommended.
- A CD-ROM optical drive.
- Approximately 7 megabytes of unused hard drive memory.
- A licensed copy of Microsoft® Excel.

How To Install

The KYROM model is comprised of two files (DMM1.XLS, DMM1E.XLS) which are located on the CD that was provided with this manual. These files must be copied onto your computer's hard drive into a directory entitled "KYROM1". If no KYROM1 directory exists, one must be created.

The procedure to make a KYROM1 directory and install the program files on your computer's hard drive is dependent upon the operating system of the computer. Follow the installation steps listed below for your operating system.

Windows 3.X

1. Go to the Windows File Manager. The File Manager is located in the Main program group.

2. In the left window select the "C:\" folder located at the top of the directory tree. (You may have to use the scroll bars.)

3. From the File Manager select "File" on the menu bar located at the top of the screen. Then select Create Directory from the File menu.

4. A pop-up window will appear prompting you to enter the directory name. Type "KYROM1" in the box provided. Then click the OK button to create the KYROM1 directory.

5. Next go to the CD drive by selecting it from the drive boxes located above the directory and file windows. The left window should now show two directories named "KYBASIN" and "KVDM".

6. Click the KVDM folder from the directory tree in the left window. The right window should now contain the two program files identified earlier.

7. Highlight both files with the mouse, then select Copy from the File menu located at the top of the screen. A pop-up window will appear prompting you to enter the destination of the copied files. Type "C:\KYROM" in the box provided and press the OK button.

8. The program is now installed on you hard drive. Select Exit from the File menu at the top of the screen to exit the File Manager.

Windows '95

1. Go to the Windows Explorer. The Explorer is usually the last item in the Programs menu. The Programs menu is displayed when you click on the Start button located at the bottom left-hand corner of the desktop.

2. In the left window of the Explorer highlight the hard drive (C:\) item in the directory tree. (The hard drive is usually located near the top of the tree.)

3. Next select "File" from the menu bar located at the top of the screen. Then select New from the menu. Another menu will appear, select Folder from the list.

4. A new directory will appear in the right window labeled "New Folder". Change the name of this folder to "KYROM1".

5. Next go to the CD drive by selecting it from the left window. The right window should now show two directories named "KYBASIN" and "KVDM".

6. Click the KVDM folder in the right window. The right window should now contain the two program files identified earlier.

7. Highlight the two files with the mouse. This is done by holding down the CTRL button on the keyboard and clicking on each file individually with the mouse. Once all the files have been selected, right-click the mouse on any of the highlighted files. A small menu will appear; select Copy.

8. Next right-click on the KYROM1 directory located in the left window. From the small menu that appears select Paste.

9. The program is now installed on you hard drive. Click on the ☒ located at the top right-hand side of your screen to exit the Windows Explorer.

Starting the Model

There are two ways to start the KYROM model. The first method is from the Excel program. To do this select Open from the File menu in Excel. At the common dialog box that appears, select the DMM1.XLS file (located in the C:\KYROM1 directory), then press the OK button and the model will be loaded.

The second method to start the KYROM model is from the Windows File Manager or Windows '95 Explorer. To do this, simply locate the file in the KYROM1 directory and double-click on it with the mouse. The computer will then open KYROM in the Excel environment for you.

The first method is recommended for those familiar with the Excel program. For those unfamiliar with Excel the second method is recommended. If your computer has severe memory restrictions, the first method is strongly recommended, since it does not require the File Manager/Explorer program to be open concurrently with the KYROM program.

Model Structure

The KYROM model is comprised of two Microsoft® Excel spreadsheet files. Only one file (DMM1.XLS) is accessed by the user directly. The other file is accessed automatically by the computer during run time. Figure 1 illustrates the interaction between the two files. The DMM1 file is the Input/Output Module (or IOM) for the KYROM model. The IOM is the sole interface between KYROM and the user. The IOM is where all user input is entered and model output is displayed. The DMM1E.XLS file is responsible for performing the calculations necessary to simulate the river for the 28-day analysis period. The DMM1E.XLS file is called by the computer when the user requests (from the IOM) a simulation to be performed.

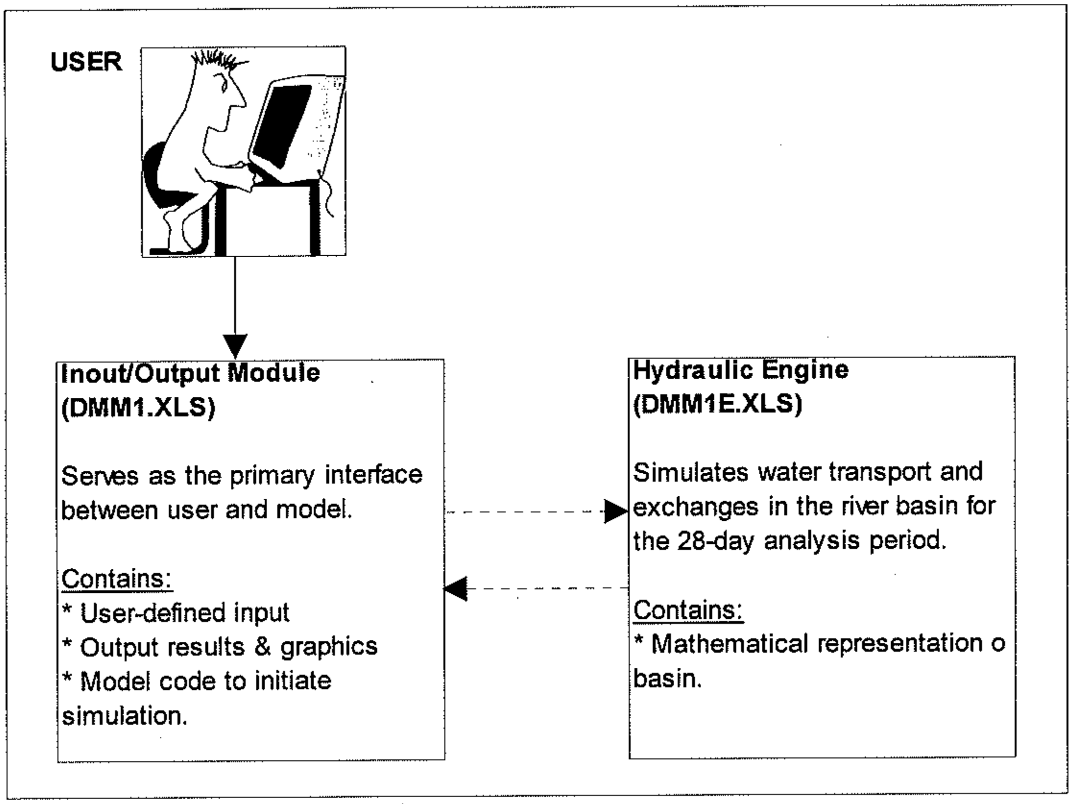

Figure 1: Flow chart of KYROM model structure

Model Overview

The Kentucky River Operation and Management (KYROM) model has been developed for the Ky. River Authority by the Ky. Water Resource Research Institute (KWRRI) for the purpose of assisting decision-makers in the short-term management of a severe drought in the Ky. River Basin. The model is intended as a tool, providing estimates for future deficits in the basin over a 28-day horizon. Potential deficit management measures can be evaluated by their impact on reducing predicted deficits. The model allows decision-makers to quickly determine the impact of changes in reservoir releases, valve release strategies, crest gate operation, and demand curtailment on predicted deficits. From this experience, decision-makers can develop an effective plan to manage water supply during a drought. Additionally, the model can assist in water supply planning negotiations between conflicting user groups by quickly illustrating the impact of potential management strategies, as opposed to relying on ad hoc hypotheses about the system response to these changes.

The KYROM model uses a similar hydraulic engine to that used by the KYBASIN model to simulate river behavior and predict deficits. A primary difference between the two models is their planning horizons. The KYROM model is intended to assist decision-makers at the time of a drought, whereas the KYBASIN model is intended to assist decision makers in preparing for a specific design drought. Consequently, the decision variables available in the KYROM model reflect drought management strategies/solutions that can be implemented immediately. KYROM decision variables do not include long-term structural changes to the river system as a means to manage the drought.

Output from KYROM is displayed in five output screens denoting weekly water levels, demand & deficit traces, river flows, low-level valve pool transfers, and reservoir releases. These screens provide information about the river basin necessary in evaluating potential management decisions on water supply.

Model Methodology

The KYROM model uses a similar calculation methodology to that used by the KYBASIN model. Differences in the two algorithms are limited to the number and frequency of input parameters. Consequently, much of the methodology used by the KYROM model is identical to that documented in the KYBASIN User's Manual (KWRRI, 1996) and the KWRRI Task III - Deficit Analysis Report (KWRRI, 1996) illustrated in Figure 2. As such, this information is not duplicated here. Instead, only that methodology particular to the KYROM model is discussed in this manual. Model assumptions and theory not discussed in this manual may be found in these two companion documents. Complete bibliographic information on these documents appears in the *References* section in the back of this report.

Portions of the methodology are included in this manual. This information is provided to inform users how certain data inputs will be interpreted by the model. This is necessary to ensure an accurate characterization of the river system by the user. This information is contained in the *How Do I ...* sections of the report.

KENTUCKY RIVER BASIN WATER SUPPLY ASSESSMENT STUDY

Task III Report - Deficit Analysis

L. Ormsbee
J. Herman

Prepared for:
The Kentucky River Authority

Prepared by:
The Kentucky Water Resource Research Institute
University of Kentucky
Lexington, Kentucky

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KENTUCKY RIVER BASIN WATER SUPPLY ASSESSMENT STUDY

KYBASIN

A Water Supply Assessment Model for the Kentucky River Basin

User's Manual

J. Herman
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Lexington, Kentucky

SEPTEMBER 1996
KWRRI 9607

Figure 2: KWRRI reports where additional KYROM methodology may be found.

What You Need To Do To Perform a Simulation

1. Become familiar with the menu system.

The KYROM menu system was designed to facilitate use of the model and was designed with simplicity in mind. As illustrated in the virtual tour, there are two menu systems: the main menu which is activated from clicking on the basin diagram and the menubar which is located at the top of the screen. The main menu is the primary menu system that is used by the user to perform simulations. It contains those items/data that the user will change frequently (i.e. municipal demands, reservoir releases, etc.). The menubar contains those items which will likely only be changed infrequently (i.e. stage-storage data, return flow percentages, etc.). All input data necessary to perform a simulation can be accessed from the main menu or menubar.

2. Enter input data.

The following data must be provided by the user in order to perform a realistic simulation.

- ☒ municipal demands
- ☒ irrigation demands
- ☒ dam crest elevations
- ☒ critical intake elevations
- ☒ initial lateral inflow estimates
- ☒ reservoir transmission losses
- ☒ crest gate locations (optional)
- ☒ low-level valve locations (optional)
- ☒ lock/dam leakages
- ☒ initial water levels
- ☒ minimum flow requirements
- ☒ maximum reservoir releases
- ☒ reservoir rule curves
- ☒ pulse reservoir releases (optional)
- ☒ crest gate strategy (optional)
- ☒ valve strategy (optional)

The input screens for the above data may be accessed through the main menu. The remaining data below has default databases that were generated by the KWRRI during the Kentucky River Basin Water Supply Assessment Study for the Authority in 1996. This data reflects KWRRI's "best guess" for these parameters and is largely reflective of the published Corps of Engineers data for these parameters at the time. The user may change these parameters by accessing them through the menubar located at the top of the screen.

- ☒ pool stage-storage data
- ☒ lock stage-discharge data
- ☒ reservoir stage-area data
- ☒ evaporation data
- ☒ pool stage-area data
- ☒ reservoir stage-storage data
- ☒ return flow percentages
- ☒ design drought inflow traces

Specific step-by-step instructions on how to enter/modify all of the above data items are provided in the *How Do I ...* sections in the back of this manual. These sections also provide a detailed description of each data item and identify the format in which they must be entered.

It should be noted that there may already be data entered in many of the input screens. This data is 'old' data remaining from a previous simulation. It is important to make sure you check all the input screens before performing a simulation, to ensure unwanted 'leftover' input does not apply to the current simulation.

3. Perform the simulation.

Once all input has been entered/verified into the computer, a simulation may be performed at any time by selecting it from the main menu. A simulation takes approximately 1 minute on a Pentium 166 MHz machine. Run times will vary depending upon machine type and configuration.

4. View output.

When a simulation is completed, a pop-up menu will appear informing the user that results have been generated. At this juncture the output may be reviewed. The Output Menu may be accessed by selecting *View Output* from the Main Menu or from the Output menu on the menubar. The Output Menu provides access to KYROM's five graphical output screens. The five output screens permit the user to view fluctuations in the following parameters over the 28-day analysis period: municipal demands and deficits, pool storages, river flows at lock locations, pool transfers, and reservoir levels and releases. With the exception of reservoir outputs, graphical output is displayed on a weekly-averaged basis over the 28-month analysis period. Storages reflect water levels in the impoundment at the end of the day. River flows denote both flow over and through locks and dams. Municipal demand and deficit values are not averaged; they represent weekly sums for the reach or impoundment.

Each of the five output screens has two controls that the user can use to change the output graph. The first control is a listbox which allows the user to select the desired week in the 28-day analysis period. The graph is updated automatically to reflect the current selection in the listbox. The listbox in the output screen for the major reservoirs is used to select the desired reservoir, since reservoir output is viewed daily. The second control on all output screens is the *View Other Output* button. This button allows the user to access the Output Menu directly.

Output may also be viewed in tabular format. To view output in tabular form the user can either use the menubar or the button provided on the graphical output screens. Tabular output is provided on a daily basis.

It is important to keep in mind that model output is static, reflecting input data at the time the simulation was performed, and changes in input parameters will not be reflected in the output until another simulation is requested.

*5. **Repeat if necessary.***

Once the output has been reviewed, subsequent simulations can be performed by repeating steps 2 - 4.

Calibrating the Model

The KYROM model must be calibrated before it can be used effectively. Calibration of the model involves determining the lateral inflows, those flows entering the river from the watershed as runoff or groundwater, for the river reaches. The river has been divided into nine macro reaches for lateral inflow computations. The lateral inflow for each macro reach is distributed among the individual pools in the reach by a proportion of watershed areas. Initial lateral inflow estimates for the macro reaches must be calibrated in order to properly estimate lateral inflows for the future 28-day analysis period.

The initial lateral inflow for a macro reach is defined by two flowrates that represent the lateral inflows into the macro reach that occurred over the two days prior to the simulation period. To calibrate the model, the user must specify estimates for these two lateral inflows (see *How Do I ... Specify lateral inflows?*). The basin conditions, demands, and reservoir operation for the last two days are entered into the model and a simulation performed. River flows predicted by the model for the two day period can then be compared with those estimated by the USGS. Properly calibrated estimates for the lateral inflows should result in a close match between actual USGS-recorded and KYROM-predicted flows at the gaged lock locations (#2, #6, #10, & #14) for the two day period.

Once lateral inflow estimates for the two days prior to the simulation have been properly calibrated, the user can begin to use the KYROM model to predict future water supply deficits. The model will calculate any future deficits under an assumption that future lateral inflows decay nonlinearly. The model remains calibrated until the first day of the analysis period changes.

The steps below demonstrate the calibration procedure.

Calibration Steps:

1. Obtain USGS recorded flows at locks #2, #6, #10, & #14 for the two days prior to the first day of the 28-day analysis period.

2. Complete all input tables necessary to describe the river system for the two day period prior to the first day of the analysis period. Initial water levels, municipal and irrigation demands, reservoir rule curves, and valve/crest gate operation for the two day period should all be identified.

3. From the main menu, access the lateral inflow pop-up window and make initial estimates for the lateral inflows for the macro reaches. Do not specify negative values for lateral inflows. In addition, place a check in the box labeled *Calibration run.*

4. Perform the simulation.

5. Access the raw output from the *Output* menu on the menubar. Compare the model-predicted river flows at the lock locations with the actual flows recorded by the USGS for the two-day period. In the raw output the first two days represent the two-day period of interest; the remaining 26 days of model-predicted river flows may be ignored.

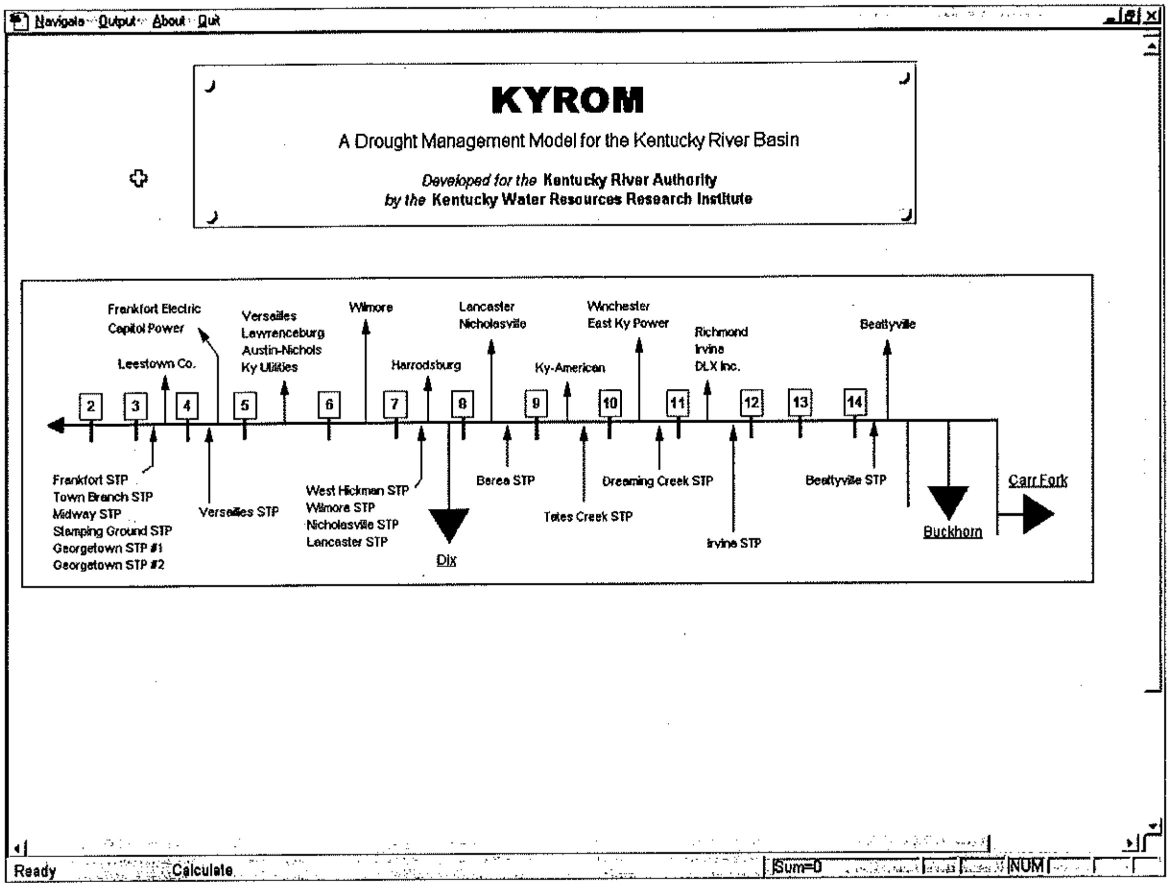
6. If there is a close match between actual and model-predicted river flows, then the lateral inflow estimates made in step #3 are calibrated. Use these laterals when performing simulations. Remember to change the values in the input tables (i.e. initial water levels, reservoir rule curve, etc.) used during calibration to reflect the conditions for the current analysis period. In addition, remove the check from the box labeled *Calibration run* on the lateral inflow pop-up window.

7. If a close match was not obtained in step #5, then steps #3 - #5 must be repeated until a satisfactory match is obtained. If model-predicted flows are less than actual flows, lateral inflow estimates should be increased in step #3. If actual river flows are smaller than those predicted by the model, lateral inflows estimates should be reduced.

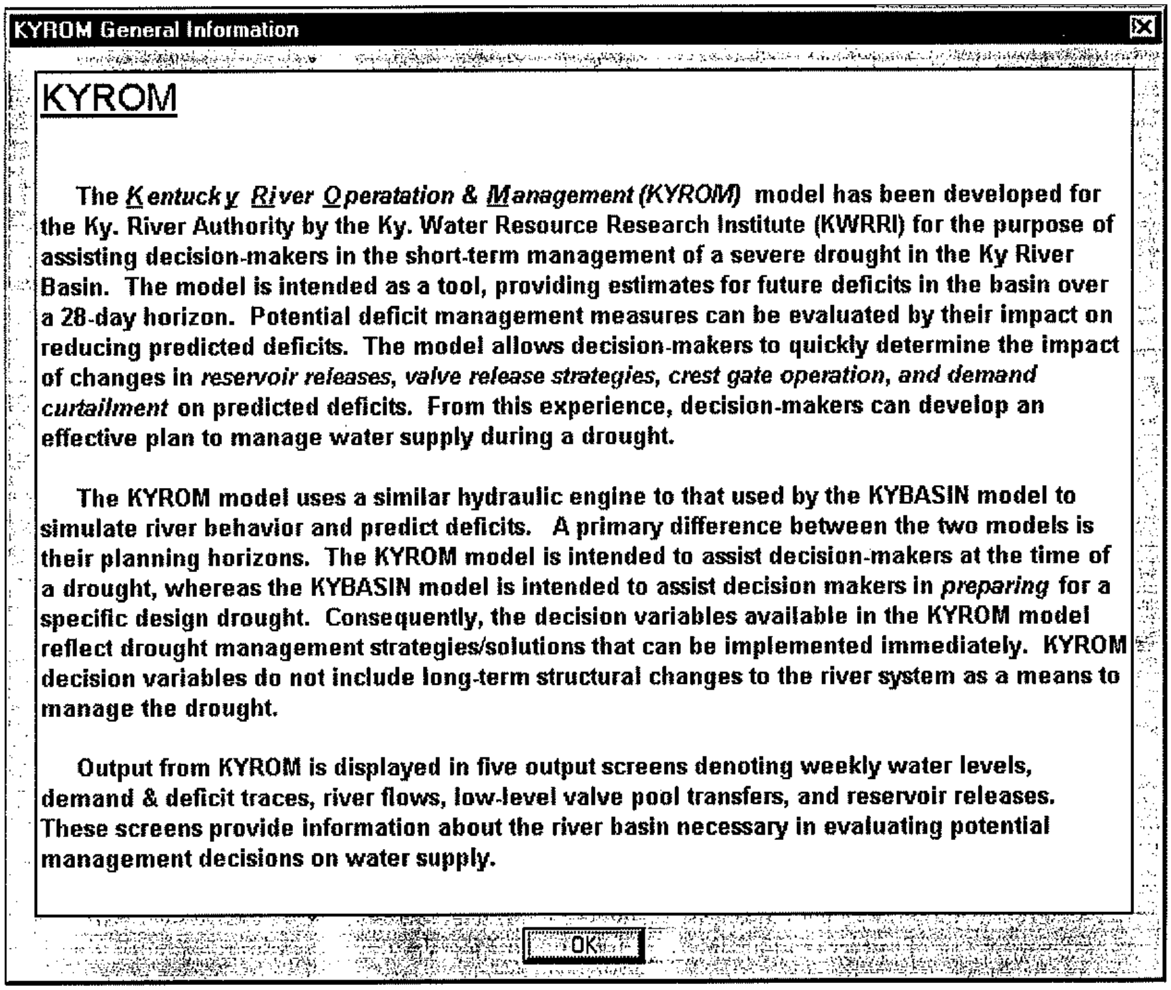
Visual Tour of KYROM

The following pages provide an illustrated look at the layout of the KYROM model. Illustrations of the menu systems, input screens, and pop-up windows are included to familiarize the user with the model environment. A brief textual description appears below each illustration.

Opening Screen Items

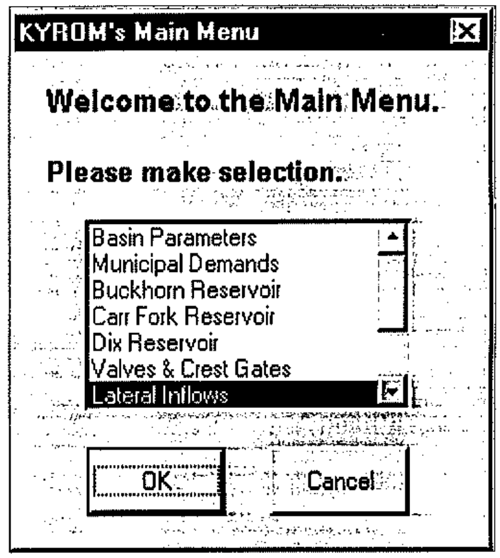


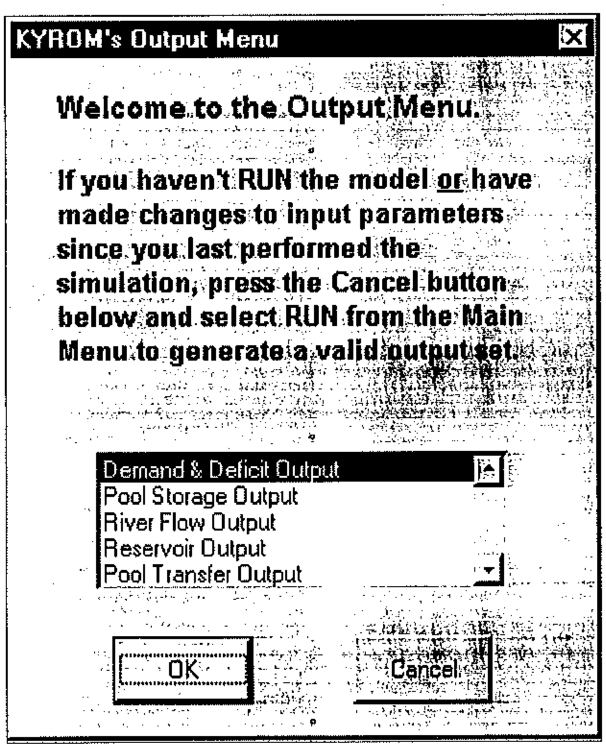
1. *Opening Screen.* The Opening Screen is automatically displayed when the user opens the KYROM model. Clicking on the basin schematic in the center of the screen activates the Main Menu (3).



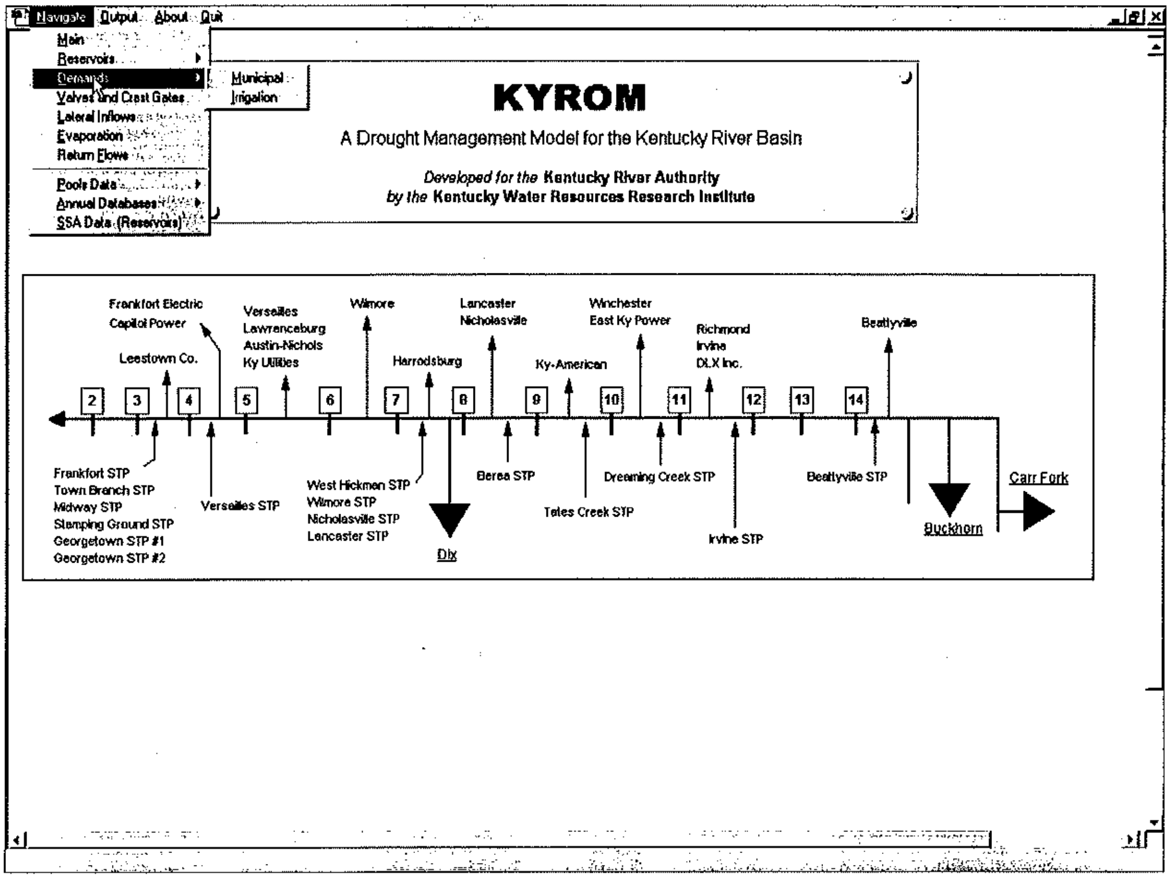
2. *General Information Box*. The General Information Box appears automatically when the model is first loaded. The General Information Box provides a brief overview of the model and its capabilities. Clicking the OK button will dismiss the box and allow the model to continue to load. The General Information Box may be viewed again by selecting the appropriate item from the About menu in the menubar located at the top of the screen.

3. *Main Menu.* The Main Menu may be viewed by clicking the right mouse button on the basin schematic located in the Opening Screen. Items in the Main Menu may be selected by right-clicking the item in the list and pressing the OK button to confirm the selection. The Main Menu is one of the KYROM model's two menu systems. The menu items in the Main Menu contain links to the most commonly used inputs that are needed when performing a simulation. Selection of an item in the Main Menu allows the user to edit the associated parameter (e.g. municipal demands, minimum flow requirements, etc.) or perform the listed action (e.g. perform the simulation, view output, etc.). The Main Menu may only be activated from the basin schematic on the Opening Screen.





4. *Output Menu.* The Output Menu can be accessed either by selecting *View Output* from the Main Menu or from the Output menu in the menubar. The Output Menu provides the user with links to KYROM's five output screens. An output screen may be accessed by selecting it from the Output Menu and pressing the OK button. The Output Menu may also be accessed from each of the five graphical output screens via the *View Other Output* button located on each output screen. The five output screens indicated in the Output Menu are illustrated in the Visual Tour under *Menubar Items - Output menu.*



5. *The Menubar*. The Menubar is located at the top of the screen and is available from all user input screens. The Menubar contains four menu items: Navigate, Output, About, and Quit. Each menu item represents a separate menu available to the user. The Navigate menu provides the user with links to user input tables. Some of the items listed in the Navigate menu are also listed in the Main Menu. The Output menu item provides the user with direct access to the Output menu and tabular results. The About menu allows the user to display the General Information Box or the model's version statement. The Quit menu may be used to exit the KYROM model.

Main Menu Items

Navigate Output About Quit

Initial Conditions

Lock & Dam	Beginning Water Level (ft)
Pool 14	635.4
Pool 13	618.9
Pool 12	601.1
Pool 11	584.1
Pool 10	566.7
Pool 9	549.6
Pool 8	532.24
Pool 7	514.1
Pool 6	498.2
Pool 5	484.54
Pool 4	469.53
Pool 3	455.33
Pool 2	442.02
Buckhorn	757
Carr Fork	1017
Dix Dam	720

Mininimum Flow Requirements

Lock & Dam	Mininum Flow Reqmt's (cfs) WEEK 1	WEEK 2	WEEK 3	WEEK 4
Pool 14	75	75	75	75
Pool 13	79	79	79	79
Pool 12	82	82	82	82
Pool 11	91	91	91	91
Pool 10	120	120	120	120
Pool 9	124	124	124	124
Pool 8	128	128	128	128
Pool 7	134	134	134	134
Pool 6	136	136	136	136
Pool 5	139	139	139	139
Pool 4	175	175	175	175
Pool 3	195	195	195	195
Pool 2	202	202	202	202
MF@T				
CF@Mouth				
NFJUSCFR				
NF@H				
NF@J				
SF@B				

Main Stem Characteristics

Lock & Dam	Dam Crest Elev (ft)	Lock/Dam Leakage (cfs)	Critical Intake Elev (ft)
Pool 14	634.4	50	630
Pool 13	617.9	50	607.9
Pool 12	600.1	50	590.1
Pool 11	583.1	50	575.7
Pool 10	565.7	50	557.1
Pool 9	548.6	50	540
Pool 8	531.24	50	529.1
Pool 7	513.1	50	502.8
[illegible]	[illegible]	[illegible]	[illegible]

Jacobson Characteristics

Begin Water Level (ft) =	967.2
Sediment Pool (mg) =	125.36
Max Withdrawal to KAWC (mgd) =	25

Ready Calculate Sum=0 NUM

6. *Basin Parameters Screen.* The Basin Parameters Screen is comprised of four user input tables which contain much of the lock and dam data that is necessary to perform a simulation. Lock and dam leakages, initial water levels, critical intake elevations, and dam crest elevations all must be identified in the Basin Parameters Screen. Additionally, weekly minimum flow requirements at river locations and Jacobson Reservoir characteristics are entered in the Basin Parameters Screen. The Basin Parameters Screen is accessed by selecting *Basin Parameters* from the Main Menu.

Navigate Output About Quit

Muncipal Demands

MAIN STEM AND HEADWATER DEMANDS

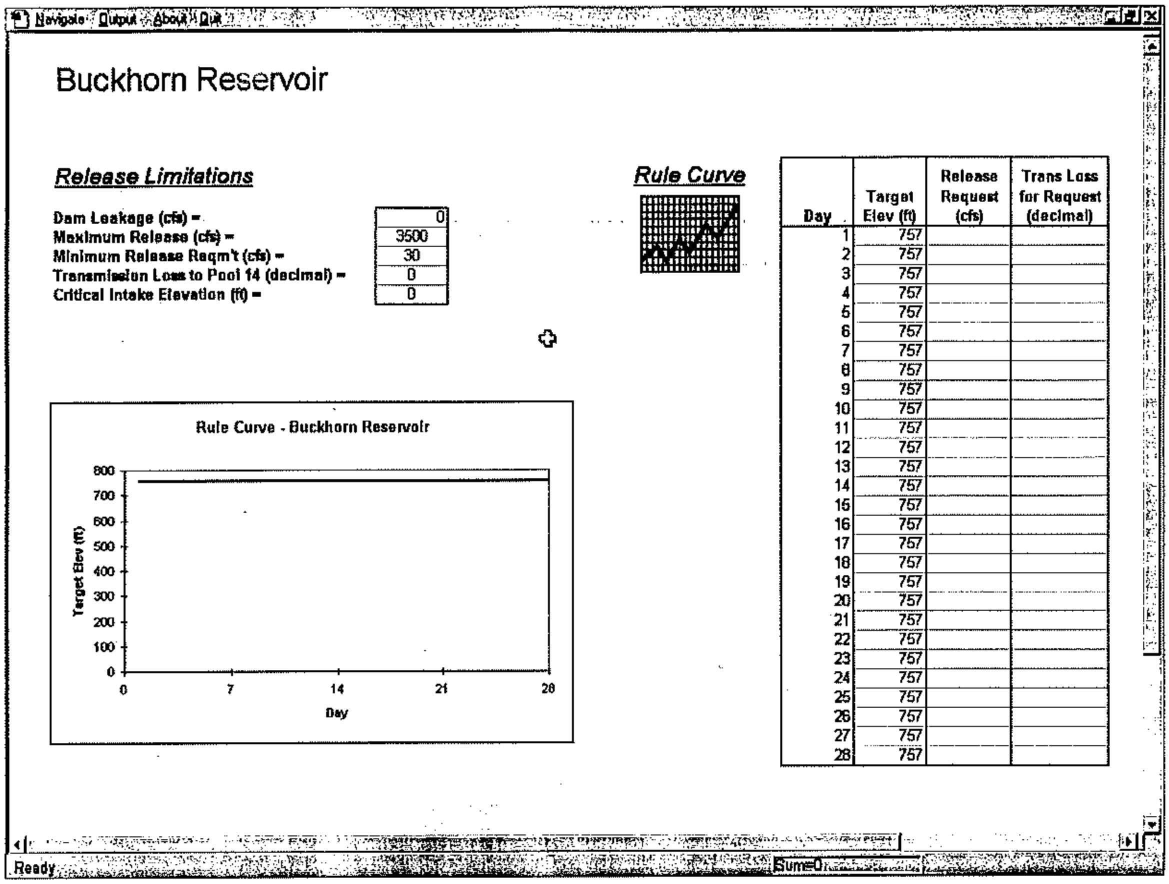
Reach Name	Permitted Withdrawer	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Pool 2	ADD2				
Pool 3	Leestown Co	0.208	0.208	0.208	0.208
	ADD3				
Pool 4	Frankfort Electric	7.950	7.950	7.950	7.950
	Capitol Power	2.652	2.652	2.652	2.652
	ADD4				
Pool 5	Versailles	2.686	2.686	2.686	2.686
	Lawrenceberg	2.104	2.104	2.104	2.104
	Austin-Nichols	0.693	0.693	0.693	0.693
	Ky-Utilities				
	ADD5				
Pool 6	Wilmore	0.654	0.654	0.654	0.654
	ADD6				
Pool 7	Harrodsburg	1.873	1.873	1.873	1.873
	ADD7				
Pool 8	Lancaster	1.296	1.296	1.296	1.296
	Nicholasville	2.451	2.451	2.451	2.451
	ADD8				
Pool 9	Ky-American	48.133	48.133	48.133	48.133
	ADD9				
Pool 10	Winchester	5.000	5.000	5.000	5.000
	East Ky Power Coop	0.008	0.008	0.008	0.008
	ADD10				
Pool 11	Richmond	5.209	5.209	5.209	5.209
	Irvine	1.283	1.283	1.283	1.283
	DLX, Inc.	0.142	0.142	0.142	0.142
	ADD11				
Pool 12	ADD12				
Pool 13	ADD13				
Pool 14	Beattyville	0.643	0.643	0.643	0.643
	ADD14				
Dix Dam	Danville	3.747	3.747	3.747	3.747
	Northpoint Center	0.191	0.191	0.191	0.191

TRIBUTARY DEMANDS

Reach Name	Permitted Withdrawer	WEEK 1	WEEK 2	WEEK 3	WEE
Pool 2	Owenton	1.205	1.205	1.205	1.2
Pool 3	Georgetown (2)	0.000	0.000	0.000	0.0
	Stamping Ground (2)				
	Ky-Fish/Wildlife	1.048	1.048	1.048	1.0
	Old Grand Dad Distilling	0.002	0.002	0.002	0.0
	Canewood Golf	0.000	0.000	0.000	0.0
	Longview Country Club	0.018	0.018	0.018	0.0
	Frankfort Country Club	0.119	0.119	0.119	0.1
	Players Club of Lexington	0.000	0.000	0.000	0.0
Pool 4	Old Crow Distil. (2)	0.018	0.018	0.018	0.0
	Wilson Landscaping	0.000	0.000	0.000	0.0
Pool 5	None				
Pool 6	None				
Pool 7	Andover Golf	0.065	0.065	0.065	0.0
	Lone Oak Country Club	0.047	0.047	0.047	0.0
	Connemara Golf	0.146	0.146	0.146	0.1
Pool 8	Berea College Utility	0.253	0.253	0.253	0.2
Pool 9	Arlington/EKU Golf	0.030	0.030	0.030	0.0
Pool 10	Clay City	0.283	0.283	0.283	0.2
	Stanton	0.000	0.000	0.000	0.0
Pool 11	Berea College Utility (2)	1.852	1.852	1.852	1.8
	Bluegrass Army Depot	0.197	0.197	0.197	0.1
Pool 12	None				
Pool 13	None				
Pool 14	None				
Jacobson	None				
Buckhorn	Hyden-Leslie Co Water	0.701	0.701	0.701	0.7
	Shamrock Coal (4)	1.065	1.065	1.065	1.0
	Leeco, Inc (2)	0.671	0.671	0.671	0.6
	Bit-Laurel Mining	0.000	0.000	0.000	0.0
	Cyprus Cumb Coal (4)	0.477	0.477	0.477	0.4
Carr Fork	None				

Ready Calculate Sum=0 NUM

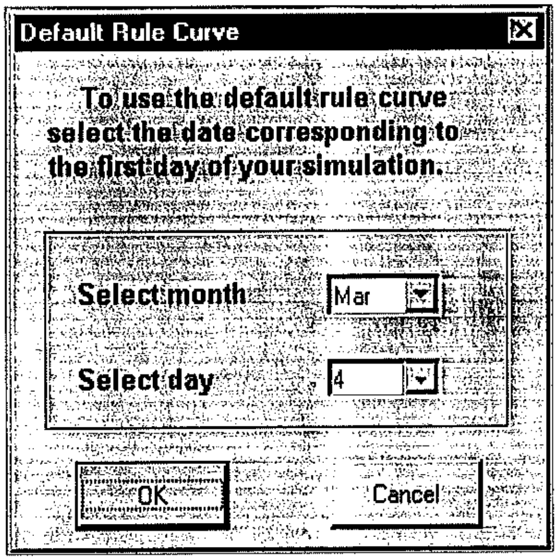
7. *Municipal Demand Database Screen.* Weekly municipal demands for all permitted surface water withdrawals from the river are identified in the Municipal Demand Database Screen. Municipal withdrawals are entered directly into the table for all permitted withdrawers. When performing evaluations involving demand curtailments, the original demand in the table is replaced with the restriction. The Municipal Demand Database Screen may be accessed by selecting *Municipal Demands* from the Main Menu or from the Navigate menu in the menubar.



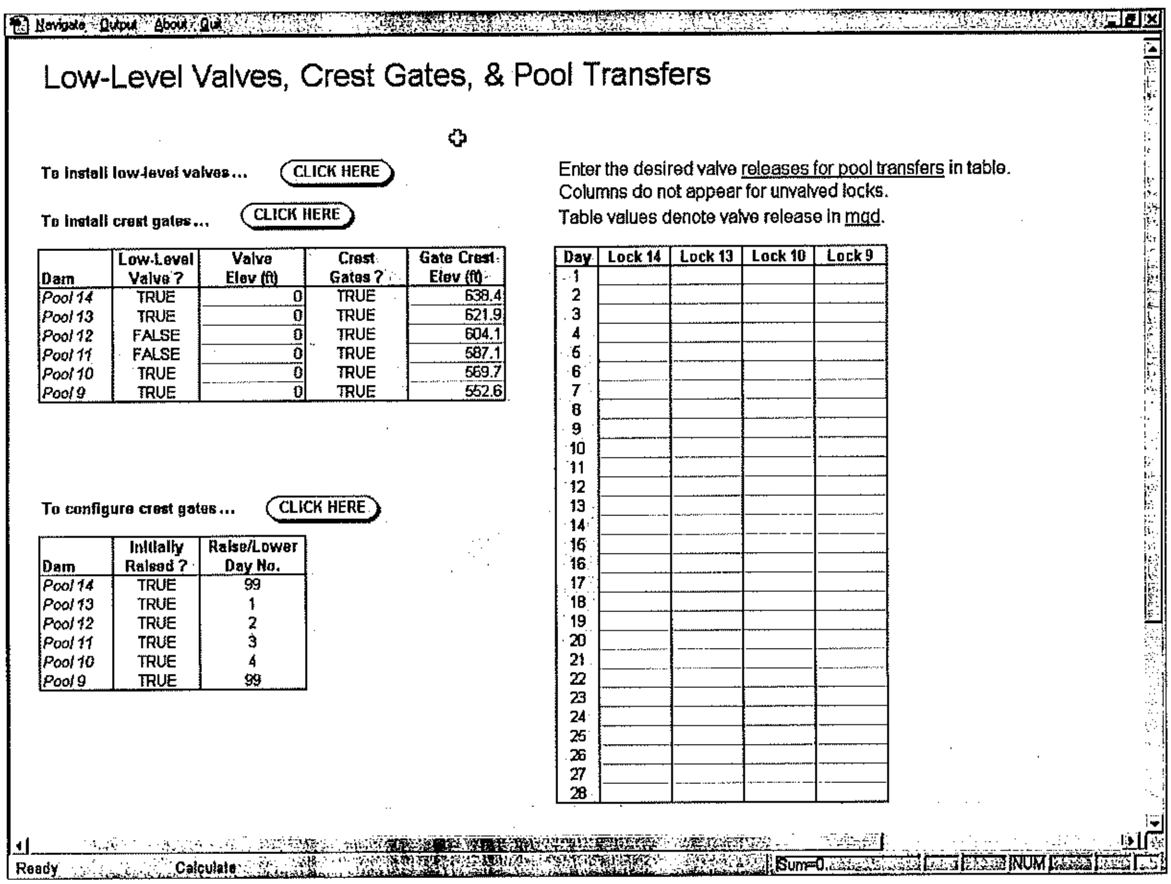
8. *Reservoir Screen (Buckhorn).* The critical intake elevation, dam leakage, release limits, and rule curve for each reservoir is identified on the Reservoir Screen. A separate Reservoir Screen exists for each of the three major reservoirs in the basin (e.g. Buckhorn, Carr Fork, and Dix). No Reservoir Screen exists for Jacobson Reservoir, because it is a pump storage facility with no downstream release policy. Transmission losses from a reservoir are also identified on its Reservoir Screen. Two transmission loss rates are used by the KYROM model, one for regular releases (those releases made to maintain the rule curve and satisfy minimum flow requirements) and one for user-defined release requests.

   Values on the Reservoir Screen are entered directly into the appropriate table. Reservoir rule curves may be entered directly in the table or the default rule curve may be used. The default rule curve is accessed by mouse clicking the graph icon to the left of the table (see #9). The graph in the lower left corner of the Reservoir Screen illustrates the rule curve currently in the table.

   The Reservoir Screen may be accessed by selecting the desired reservoir name from the Main Menu or from the Navigate menu in the menubar.

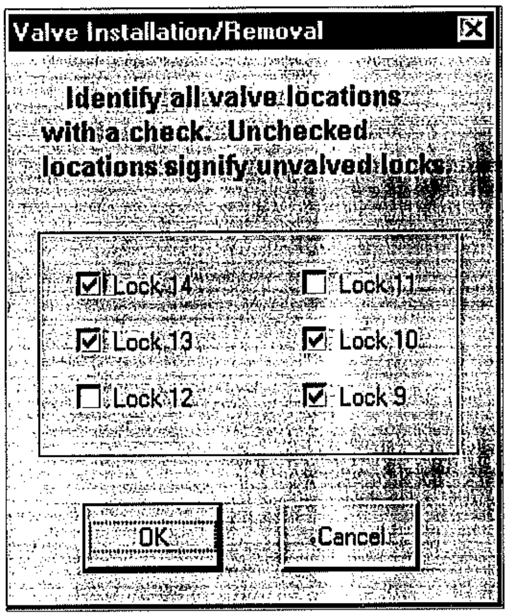


9. *Default Rule Curve Box.* The Default Rule Curve Box is displayed when the graph icon on a Reservoir Screen is selected. This pop-up window allows the user to load a 28-day fragment of the the reservoir's default rule curve into the table on the Reservoir Screen. The portion of the rule curve to be loaded into the table is selected by specifying the first day of the 28-day fragment.

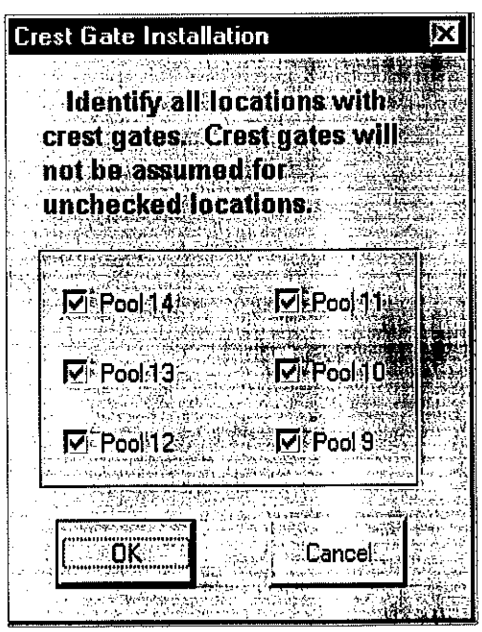


10. *Valve/Crest Gate Screen.* Low-level valve and crest gate locations are specified on the Valve/Crest Gate Screen. Three buttons are located on the screen to assist the user. These controls permit the user to install valves at lock and dam locations (see #11), install crest gates at lock and dam locations (see #12), and indicate the initial

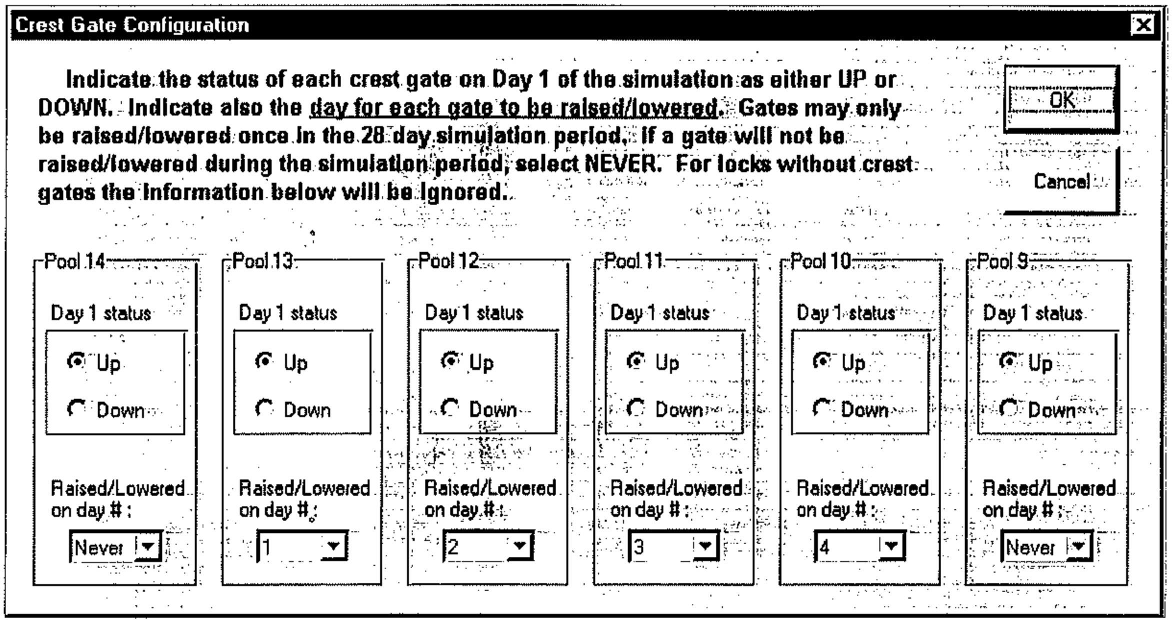
position of crest gates (see #13). Once valves or gates have been installed, the user must enter the elevation of the valve or gate in the white portion of the table. The gray portions of the table denote areas that are completed by the model. Pool transfers, water transferred by the low-level valves to satisfy downstream deficits, are specified in the Valve/Crest Gate Screen. Pool transfers are defined by the user-defined releases from the valves that are indicated in the table on the right of the screen. The table is automatically modified to include only those pools that have low-level valves installed. The Valve/Crest Gate Screen can be accessed by selecting *Valve & Crest Gates* from the Main Menu or the menubar.



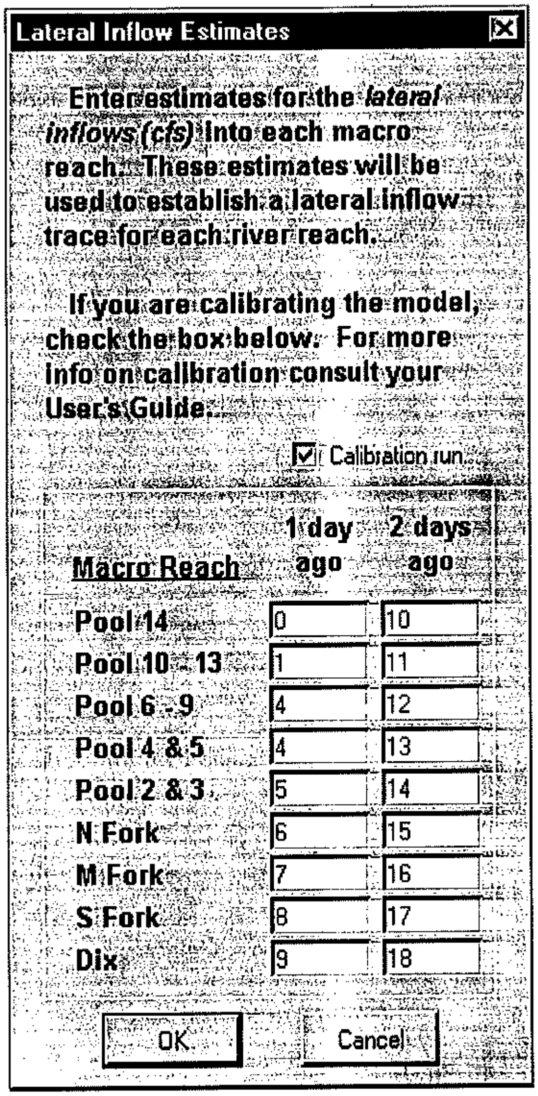
11. *Valve Installation Box.* The Valve Installation Box is displayed from the Valve/Crest Gate Screen by pressing one of the three user buttons located on that screen. The Valve Installation Box is used to install or remove low-level release valves in Ky. River locks and dams. Valves may only be installed in lock and dams #9 - #14. Pressing the OK button will install valves in those locks and dams marked with a ☑. No valve will be considered in the simulation for lock and dam locations that aren't marked. Current valve locations are automatically maintained in the table on the Valve/Crest Gate Screen.



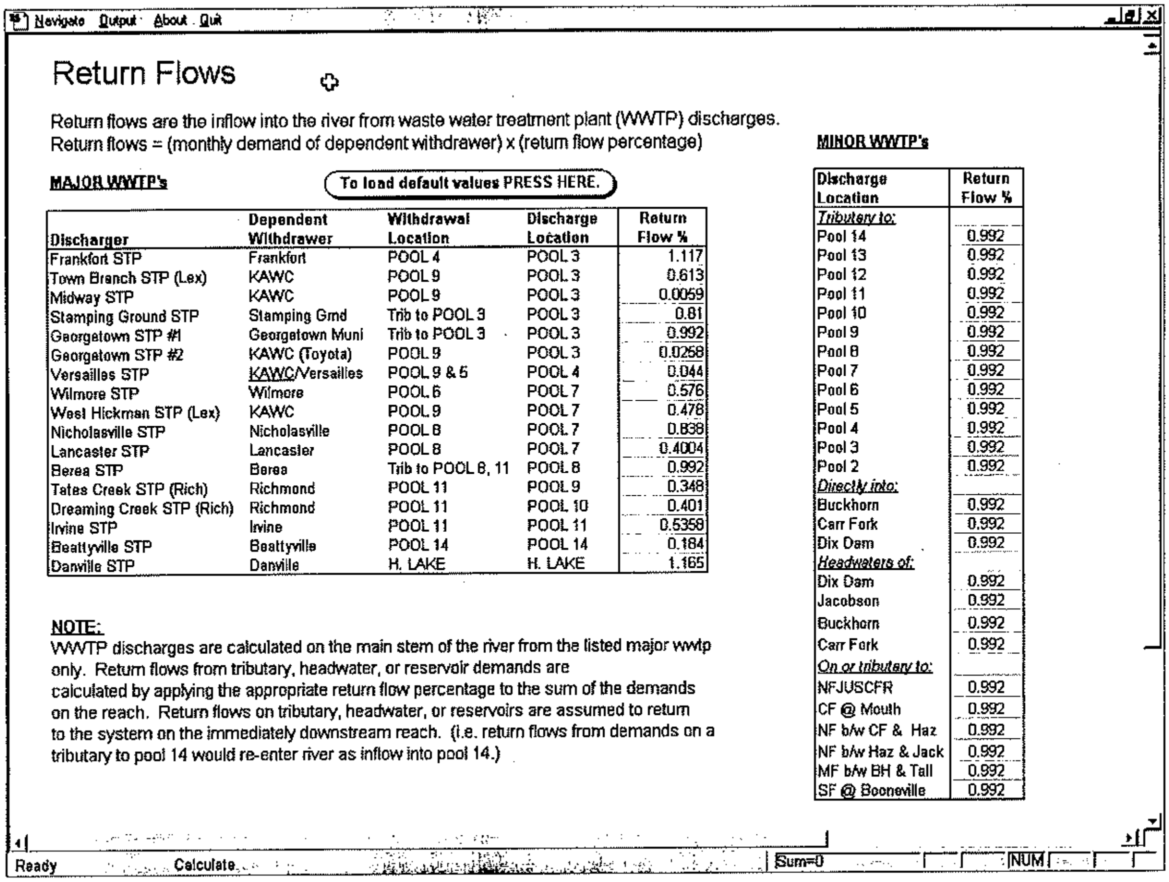
12. *Crest Gate Installation Box.* The Crest Gate Installation Box is displayed from the Valve/Crest Gate Screen by pressing one of the three user buttons located on that screen. The Crest Gate Installation Box is used to install or remove crest gates on Ky. River dams. Crest gates may only be installed on dams #9 - #14. Pressing the OK button will install crest gates at those lock and dams marked with a ☑. No crest gate will be considered in the simulation for dam locations that aren't marked. Current crest gate locations are automatically maintained in the table on the Valve/Crest Gate Screen.



13. *Crest Gate Configuration Box.* The Crest Gate Configuration Box is displayed from the Valve/Crest Gate Screen by pressing one of the buttons located on that screen. The Crest Gate Configuration Box is used to specify the initial position (up or down) of installed crest gates and the day they will be lowered/raised. The user may elect not to change the orientation of a crest gate by selecting *Never* for the raise/lower day. Information specified for dam locations that do not have a crest gate installed will be ignored by the model during simulations.



14. *Lateral Inflow Estimate Box.* Initial estimates for lateral inflows into river reaches are specified in the Lateral Inflow Estimate Box. Estimates for initial lateral inflows are refined during calibration of the model by changing the values on this pop-up window. Inflow estimates are required for the macro reaches indicated in the figure for the previous two days. Lateral inflows for the upcoming 28-day simulation period are determined from the initial estimates and assume a nonlinear decay relationship. A check mark next to the box labeled *Calibration run* indicates that the lateral inflows are being used to calibrate the model. This box should be unchecked by the user when the calibration is completed.



Navigate Output About Quit

Return Flows

Return flows are the inflow into the river from waste water treatment plant (WWTP) discharges.
Return flows = (monthly demand of dependent withdrawer) x (return flow percentage)

MAJOR WWTP's

To load default values PRESS HERE.

Discharger	Dependent Withdrawer	Withdrawal Location	Discharge Location	Return Flow %
Frankfort STP	Frankfort	POOL 4	POOL 3	1.117
Town Branch STP (Lex)	KAWC	POOL 9	POOL 3	0.613
Midway STP	KAWC	POOL 9	POOL 3	0.0059
Stamping Ground STP	Stamping Grnd	Trib to POOL 3	POOL 3	0.81
Georgetown STP #1	Georgetown Muni	Trib to POOL 3	POOL 3	0.992
Georgetown STP #2	KAWC (Toyota)	POOL 9	POOL 3	0.0258
Versailles STP	KAWC/Versailles	POOL 9 & 5	POOL 4	0.044
Wilmore STP	Wilmore	POOL 6	POOL 7	0.576
West Hickman STP (Lex)	KAWC	POOL 9	POOL 7	0.478
Nicholasville STP	Nicholasville	POOL 8	POOL 7	0.838
Lancaster STP	Lancaster	POOL 8	POOL 7	0.4004
Berea STP	Berea	Trib to POOL 8, 11	POOL 8	0.992
Tates Creek STP (Rich)	Richmond	POOL 11	POOL 9	0.348
Dreaming Creek STP (Rich)	Richmond	POOL 11	POOL 10	0.401
Irvine STP	Irvine	POOL 11	POOL 11	0.5358
Beattyville STP	Beattyville	POOL 14	POOL 14	0.184
Danville STP	Danville	H. LAKE	H. LAKE	1.165

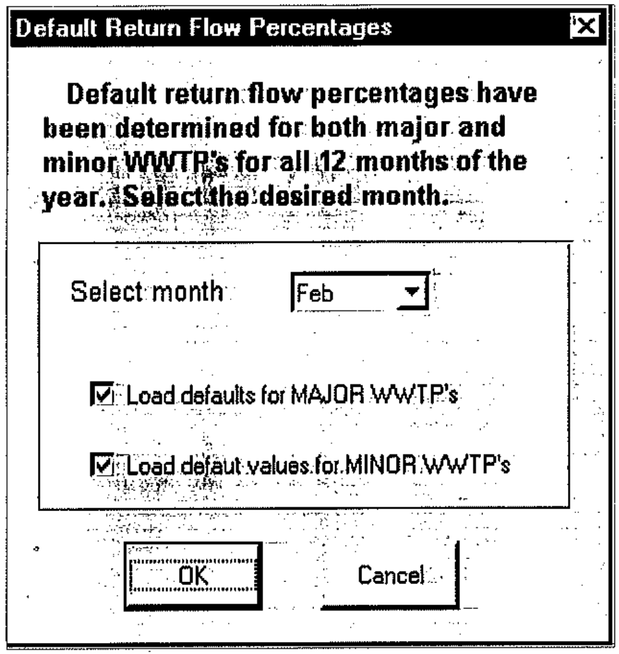
NOTE:
WWTP discharges are calculated on the main stem of the river from the listed major wwtp only. Return flows from tributary, headwater, or reservoir demands are calculated by applying the appropriate return flow percentage to the sum of the demands on the reach. Return flows on tributary, headwater, or reservoirs are assumed to return to the system on the immediately downstream reach. (i.e. return flows from demands on a tributary to pool 14 would re-enter river as inflow into pool 14.)

MINOR WWTP's

Discharge Location	Return Flow %
Tributary to:	
Pool 14	0.992
Pool 13	0.992
Pool 12	0.992
Pool 11	0.992
Pool 10	0.992
Pool 9	0.992
Pool 8	0.992
Pool 7	0.992
Pool 6	0.992
Pool 5	0.992
Pool 4	0.992
Pool 3	0.992
Pool 2	0.992
Directly into:	
Buckhorn	0.992
Carr Fork	0.992
Dix Dam	0.992
Headwaters of:	
Dix Dam	0.992
Jacobson	0.992
Buckhorn	0.992
Carr Fork	0.992
On or tributary to:	
NFJUSCFR	0.992
CF @ Mouth	0.992
NF b/w CF & Haz	0.992
NF b/w Haz & Jack	0.992
MF b/w BH & Tall	0.992
SF @ Booneville	0.992

Ready Calculate Sum=0 NUM

15. *Return Flows Screen.* The return flow rates for all major waste water treatment plants (WWTP) are indicated on the Return Flows Screen. A "reach rate" is used for the minor WWTPs in the basin. All minor WWTPs use the "reach rate" that corresponds to their discharge location. Return flow rates may be entered directly into the white portion of each table or the default return flow rate database may be used by clicking the sole button control on the screen.



16. *Default Return Flow Box.* The Default Return Flow Box is displayed by selecting the button control on the Return Flows Screen. Default values for major and minor WWTP return flow rates may be loaded into the Return Flows Screen with the Default Return Flow Box. Default rates for any month of the year may be selected. Default return flow rates are based on an analysis of historical rates from 1985 - 1994.

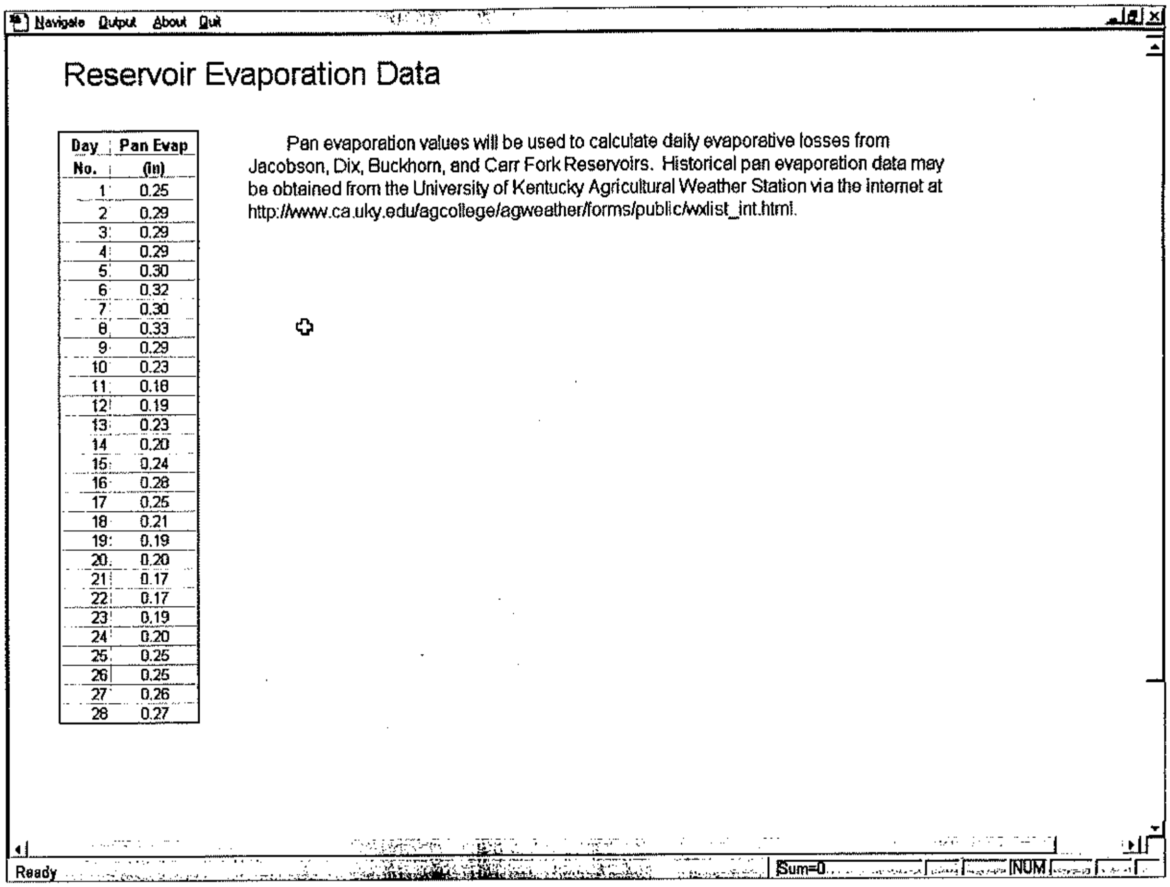
Navigate Output About Quit

Irrigation Demands

Reach Name	Average Daily Demands (MGD) WEEK 1	WEEK 2	WEEK 3	WEEK 4
Pool 14				
Pool 13				
Pool 12				
Pool 11				
Pool 10				
Pool 9				
Pool 8	1.000	1.000	1.000	1.000
Pool 7	1.000	1.000	1.000	1.000
Pool 6	1.000	1.000	1.000	1.000
Pool 5	1.000	1.000	1.000	1.000
Pool 4	1.000	1.000	1.000	1.000
Pool 3	1.000	1.000	1.000	1.000
Pool 2	1.000	1.000	1.000	1.000
Dix Dam				
Jacobson				
Buckhorn				
Carr Fork				
NFJUSCFR				
CF@Mouth				
NF@H				
NF@J				
MF@T				
SF@B				

Ready Calculate Sum=0 NUM

17. *Irrigation Demands Screen.* Direct withdrawals from the river for crop irrigation are located on the Irrigation Demands Screen. Values are entered directly into the table. The Irrigation Demands Screen is accessed by selecting *Irrigation* under *Demands* in the Navigate menu on the menubar.



Reservoir Evaporation Data

Day No.	Pan Evap (in)
1	0.25
2	0.29
3	0.29
4	0.29
5	0.30
6	0.32
7	0.30
8	0.33
9	0.29
10	0.23
11	0.18
12	0.19
13	0.23
14	0.20
15	0.24
16	0.28
17	0.25
18	0.21
19	0.19
20	0.20
21	0.17
22	0.17
23	0.19
24	0.20
25	0.25
26	0.25
27	0.26
28	0.27

Pan evaporation values will be used to calculate daily evaporative losses from Jacobson, Dix, Buckhorn, and Carr Fork Reservoirs. Historical pan evaporation data may be obtained from the University of Kentucky Agricultural Weather Station via the internet at http://www.ca.uky.edu/agcollege/agweather/forms/public/wxlist_int.html.

18. *Evaporation Data Screen.* The pan evaporation values for the 28-day analysis period are specified in the table on the Evaporation Data Screen. The pan evaporation data in the table is used to compute evaporative losses in Ky. River pools and all major reservoirs in the basin. The Evaporation Data Screen is accessed by selecting *Evaporation* from the Navigate menu in the menubar.

Navigate Output About Quit

Summary of Storage-Area Equations for Ky River Pools

All surface areas are in ***acres*** .

Pool #2, #3, #4

	Surf Area
Pool	@ dam crest
2	
3	
4	

Pool #5

Power of x	Coeff
5	0
4	-3.8E-11
3	2.28E-07
2	-0.0005
1	0.583221
0	67.86147

Pool #6

Power of x	Coeff
5	0
4	-9.4E-13
3	1.27E-08
2	-8E-05
1	0.311686
0	213.5345

Pool #7

Power of x	Coeff
5	0
4	-2.1E-12
3	2.5E-08
2	-0.00013
1	0.450016
0	87.69487

Pool #8

Power of x	Coeff
5	0
4	-3.1843E-11
3	2.37887E-07
2	-0.00065637
1	0.869308
0	0

Pool #9

Power of x	Coeff
5	8.72E-15
4	-9.9E-11
3	4.29E-07
2	-0.00089
1	0.97605
0	0

Pool #10

Power of x	Coeff
5	0
4	-2.1E-11
3	1.82E-07
2	-0.00057
1	0.907599
0	0

Pool #11

Power of x	Coeff
5	0
4	-3.7E-11
3	2.4E-07
2	-0.0006
1	0.796515
0	0

Pool #12

Power of x	Coeff
5	0
4	-3.7222E-11
3	2.45817E-07
2	-0.00061984
1	0.8231584
0	0.00E+00

Pool #13

Power of x	Coeff
5	0
4	0
3	4.3E-07
2	-0.00089
1	0.76556
0	0.00E+00

Pool #14

Power of x	Coeff
5	0
4	0
3	2.46E-07
2	-0.0007
1	0.71114
0	0.00E+00

Ready Calculate Sum=0 NUM

19. *Pool Stage-Area Screen.* The equations used to define the stage-area characteristics of each of the mainstem pools are located on the Pool Stage-Area Screen. These equations identify the surface area in a pool at any given depth. Coefficients for these third-order polynomial equations are identified in the tables under each pool name. Coefficients are not required for pools #2, #3, & #4. In lieu of the coefficients, the surface area of each pool at the dam crest elevation must be provided for these three pools. The Pool Stage-Area Screen is accessed by selecting *Stage-Area* under *Pools Data* in the Navigate menu on the menubar.

Navigate Output About Quit

Summary of Stage-Storage Equations for Ky River Pools

Listed crest elevations reflect actual existing crest elevations.

Pool #2
Crest elev = 441.02 ft

Power of x	Coeff
3	0
2	1.989832
1	-1628.203
0	332656

Pool #3
Crest elev = 454.33 ft

Power of x	Coeff
3	0
2	6.370275
1	-5516.69
0	1194128

Pool #4
Crest elev = 468.53 ft

Power of x	Coeff
3	0
2	3.198201
1	-2808.43
0	616363

Pool #5
Crest elev = 483.54 ft

Power of x	Coeff
3	0
2	2.418659
1	-2189.436
0	495496.44

Pool #6
Crest elev = 497.2 ft

Power of x	Coeff
3	0
2	4.465989
1	-4195.174
0	985428.6

Pool #7
Crest elev = 513.1 ft

Power of x	Coeff
3	0
2	4.672833
1	-4526.16
0	1095937

Pool #8
Crest elev = 531.24 ft

Power of x	Coeff
3	0
2	1.913717
1	-1867.26
0	454704

Pool #9
Crest elev = 548.6 ft

Power of x	Coeff
3	0
2	3.735004
1	-3886.498
0	1011388.6

Pool #10
Crest elev = 565.7 ft

Power of x	Coeff
3	0
2	6.71727
1	-7346.506
0	2.01E+06

Pool #11
Crest elev = 583.1 ft

Power of x	Coeff
3	0
2	2.857243
1	-3164.23
0	8.76E+05

Pool #12
Crest elev = 600.1 ft

Power of x	Coeff
3	-0.0478
2	88.4323
1	-54320.1
0	1.11E+07

Pool #13
Crest elev = 617.9 ft

Power of x	Coeff
3	6.24E-02
2	-111.0908
1	65950.96
0	-1.31E+07

Pool #14
Crest elev = 634.4 ft

Power of x	Coeff
3	0.0688418
2	-163.3798

Ready Calculate Sum=0 NUM

20. *Pool Stage-Storage Screen.* The equations used to define the stage-storage characteristics of the mainstem pools are located on the Pool Stage-Storage Screen. Coefficients for these third-order polynomial equations are identified in the tables under each pool name. The Pool Stage-Storage Screen is accessed by selecting *Stage-Storage* under *Pools Data* in the Navigate menu on the menubar.

Navigate · Output · About · Quit

Annual Return Flow Percentages Database

Return flows are the inflow into the river from waste water treatment plant (WWTP) discharges.
Return flow rates were determined from withdrawal and discharge data supplied by the Ky DOW and waste water treatment plants. Rates were derived by relating the withdrawal from the primary "customer" (dependent withdrawer) of the WWTP to the recorded discharge. Only dry weather data was used to eliminate the influence of stormwater intrusion into the sewer system.

Discharger	Dependent Withdrawer	Discharge Location	Return Flow % (as decimal) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Frankfort STP	Frankfort	POOL 3	0.553	1.117	0.775	0.571	0.609	0.629	0.571	0.598	0.652	0.576	0.659	0.793
Town Branch STP (Lex)	KAWC	POOL 3	0.474	0.613	0.528	0.449	0.383	0.235	0.407	0.408	0.368	0.412	0.445	0.462
Midway STP	KAWC	POOL 3	0.007	0.006	0.005	0.006	0.004	0.006	0.002	0.002	0.002	0.003	0.004	0.005
Stamping Ground STP	Stamping Grnd	POOL 3	0.810	0.810	0.522	0.490	0.283	0.654	0.672	0.517	0.446	0.252	0.341	0.445
Georgetown STP #1	Georgetown Muni	POOL 3	0.640	0.992	0.851	0.573	0.635	0.503	0.621	0.593	0.609	0.597	0.729	0.825
Georgetown STP #2	KAWC (Toyota)	POOL 3	0.022	0.026	0.024	0.023	0.021	0.016	0.018	0.018	0.019	0.021	0.023	0.024
Versailles STP	KAWC/Versailles	POOL 4	0.030	0.044	0.047	0.025	0.019	0.022	0.033	0.022	0.018	0.024	0.040	0.048
Wilmore STP	Wilmore	POOL 7	0.573	0.576	0.785	0.477	0.685	0.190	0.408	0.693	0.534	0.548	0.359	1.219
West Hickman STP (Lex)	KAWC	POOL 7	0.321	0.478	0.404	0.267	0.246	0.156	0.496	0.207	0.200	0.254	0.361	0.444
Nicholasville STP	Nicholasville	POOL 7	0.716	0.838	0.703	0.506	0.659	0.550	0.685	0.537	0.711	0.618	0.689	0.717
Lancaster STP	Lancaster	POOL 7	0.393	0.400	0.489	0.519	0.295	0.202	0.349	0.219	0.256	0.213	0.338	0.305
Berea STP	Berea	POOL 8	0.640	0.992	0.851	0.573	0.635	0.503	0.621	0.593	0.609	0.597	0.729	0.825
Tates Creek STP (Rich)	Richmond	POOL 9	0.253	0.348	0.371	0.311	0.274	0.347	0.189	0.363	0.420	0.382	0.393	0.322
Dreaming Creek STP (Rich)	Richmond	POOL 10	0.497	0.401	0.425	0.424	0.415	0.346	0.407	0.354	0.420	0.363	0.421	0.419
Irvine STP	Irvine	POOL 11	0.528	0.536	0.535	0.492	0.528	0.323	0.359	0.407	0.290	0.412	0.462	0.602
Beattyville STP	Beattyville	POOL 14	0.268	0.184	0.211	0.258	0.124	0.039	0.265	0.170	0.090	0.138	0.187	0.199
Danville STP	Danville	H. LAKE	0.609	1.165	0.965	0.575	0.591	0.396	0.544	0.439	0.581	0.468	0.675	0.761
	BASIN AVERAGE RATE =		0.640	0.992	0.851	0.573	0.635	0.503	0.621	0.593	0.609	0.597	0.729	0.825

Ready　Sum=0

21. *Annual Return Flows Database.* Default values for return flow percentages for all major and minor WWTP in the basin are identified in the Annual Return Flows Database. The percentages identified in the table are loaded into the Return Flows Screen from the button control located on that screen. The default database may be changed by overwriting the old values. The basin average rate is the default percentage that is applied to minor WWTPs. The Annual Return Flow Database is accessed from *Annual Databases* in the Navigate menu on the menubar.

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Annual Default Rule Curves for Buckhorn, Carr Fork, and Dix Reservoirs

BUCKHORN

Target elevations indicate desired water level (ft) in reservoir.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	757.00	757.00	757.00	757.00	782.00	782.00	782.00	782.00	782.00	773.76	765.24	757.00
2	757.00	757.00	757.00	757.83	782.00	782.00	782.00	782.00	781.73	773.48	764.97	757.00
3	757.00	757.00	757.00	758.67	782.00	782.00	782.00	782.00	781.45	773.21	764.69	757.00
4	757.00	757.00	757.00	759.50	782.00	782.00	782.00	782.00	781.18	772.93	764.42	757.00
5	757.00	757.00	757.00	760.33	782.00	782.00	782.00	782.00	780.90	772.66	764.14	757.00
6	757.00	757.00	757.00	761.17	782.00	782.00	782.00	782.00	780.63	772.38	763.87	757.00
7	757.00	757.00	757.00	762.00	782.00	782.00	782.00	782.00	780.35	772.11	763.59	757.00
8	757.00	757.00	757.00	762.83	782.00	782.00	782.00	782.00	780.08	771.84	763.32	757.00
9	757.00	757.00	757.00	763.67	782.00	782.00	782.00	782.00	779.80	771.56	763.04	757.00
10	757.00	757.00	757.00	764.50	782.00	782.00	782.00	782.00	779.53	771.29	762.77	757.00
11	757.00	757.00	757.00	765.33	782.00	782.00	782.00	782.00	779.25	771.01	762.49	757.00
12	757.00	757.00	757.00	766.17	782.00	782.00	782.00	782.00	778.98	770.74	762.22	757.00
13	757.00	757.00	757.00	767.00	782.00	782.00	782.00	782.00	778.70	770.46	761.95	757.00
14	757.00	757.00	757.00	767.83	782.00	782.00	782.00	782.00	778.43	770.19	761.67	757.00
15	757.00	757.00	757.00	768.67	782.00	782.00	782.00	782.00	778.15	769.91	761.40	757.00
16	757.00	757.00	757.00	769.50	782.00	782.00	782.00	782.00	777.88	769.64	761.12	757.00
17	757.00	757.00	757.00	770.33	782.00	782.00	782.00	782.00	777.60	769.36	760.85	757.00
18	757.00	757.00	757.00	771.17	782.00	782.00	782.00	782.00	777.33	769.09	760.57	757.00
19	757.00	757.00	757.00	772.00	782.00	782.00	782.00	782.00	777.05	768.81	760.30	757.00
20	757.00	757.00	757.00	772.83	782.00	782.00	782.00	782.00	776.78	768.54	760.02	757.00
21	757.00	757.00	757.00	773.67	782.00	782.00	782.00	782.00	776.51	768.26	759.75	757.00
22	757.00	757.00	757.00	774.50	782.00	782.00	782.00	782.00	776.23	767.99	759.47	757.00
23	757.00	757.00	757.00	775.33	782.00	782.00	782.00	782.00	775.96	767.71	759.20	757.00
24	757.00	757.00	757.00	776.17	782.00	782.00	782.00	782.00	775.68	767.44	758.92	757.00
25	757.00	757.00	757.00	777.00	782.00	782.00	782.00	782.00	775.41	767.16	758.65	757.00
26	757.00	757.00	757.00	777.83	782.00	782.00	782.00	782.00	775.13	766.89	758.37	757.00
27	757.00	757.00	757.00	778.67	782.00	782.00	782.00	782.00	774.86	766.62	758.10	757.00
28	757.00	757.00	757.00	779.50	782.00	782.00	782.00	782.00	774.58	766.34	757.82	757.00
29	757.00		757.00	780.33	782.00	782.00	782.00	782.00	774.31	766.07	757.55	757.00
30	757.00		757.00	781.17	782.00	782.00	782.00	782.00	774.03	765.79	757.27	757.00
31	757.00		757.00		782.00		782.00	782.00		765.52		757.00

CARR FC

Ready · Sum=0 · NUM

22. *Annual Reservoir Rule Curve Database*. The default rule curves for the three major reservoirs in the basin are located in the Annual Reservoir Rule Curve Database. The default rule curve elevations for each reservoir may be altered by overwriting the values in the appropriate table. The Annual Reservoir Rule Curve Database is accessed from *Annual Databases* in the Navigate menu on the menubar.

Navigate Output About Quit

Stage-Storage-Area Eqn's for Reservoirs

If changes in stage-storage-area equations are made, be sure to edit tabular data @ cells B37:I457.

Buckhorn Reservoir

Spillway crest = 820 ft
Reservoir bottom = 715 ft

Stage-Storage
x=elev (ft)
y=storage (MG)

power of x	coeff
3	0.021901
2	-46.2839
1	32610.22
0	-7660387

Stage-Area
x=elev (ft)
y=surf area (acres)

power of x	coeff
3	0.000383
2	-0.69499
1	414.2549
0	-80799.7

Carr Fork Reservoir

Spillway crest = 1055 ft
Reservoir bottom = 960 ft

Stage-Storage
x=elev (ft)
y=storage (MG)

power of x	coeff
3	0.002434
2	-5.53088
1	3891.175
0	-791569

Stage-Area
x=elev (ft)
y=surf area (acres)

power of x	coeff
3	0.000349
2	-1.02059
1	1005.918
0	-333521

Jacobson Reservoir

Spillway crest = 967.2 ft
Sediment pool = 587 ft
Reservoir bottom = 946 ft

Stage-Storage
x=elev
y=storage (MG)

power of x	coeff
3	0.028402
2	-79.7952
1	74720.13
0	-2.3E+07

Stage-Area
x=stor (mg)
y=surf area (acres)

power of x	coeff
4	-2.00E-09
3	3.00E-06
2	-0.0021
1	0.7849
0	12.532

Dix Dam Reservc

Spillway crest = 760 ft ft
Reservoir bottom = 517 ft

Stage-Storage
x=elev (ft)
y=storage (MG)

power of x	coeff
3	0.066308
2	-141.384
1	101168.3
0	-2.4E+07

Stage-Area
x=elev (ft)
y=surf area (acres)

power of x	coeff
3	0.014259
2	-30.9482
1	22408.98
0	-5411045

TABULATED SS DATA - needed for daily elev & evap loss calc's

BUCKHORN

Vol (MG)	Elev (ft)
-0.078	715
3.466	715.25
7.099	715.5

CARR FORK

Vol (MG)	Elev (ft)
-0.123	960
0.205	960.25
0.718	960.5

DIX DAM

Vol (MG)	Elev (ft)
84076	655
84400.07	655.25
84722.75	655.5

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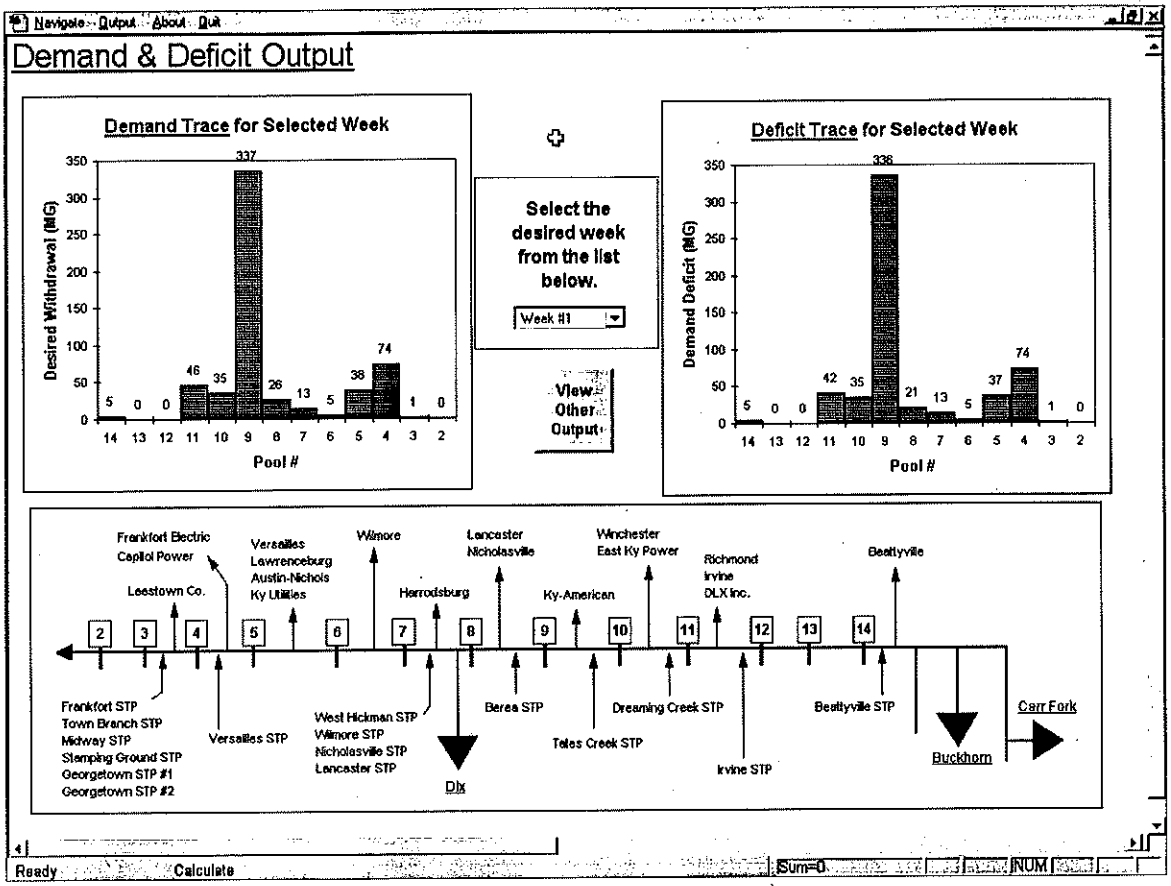
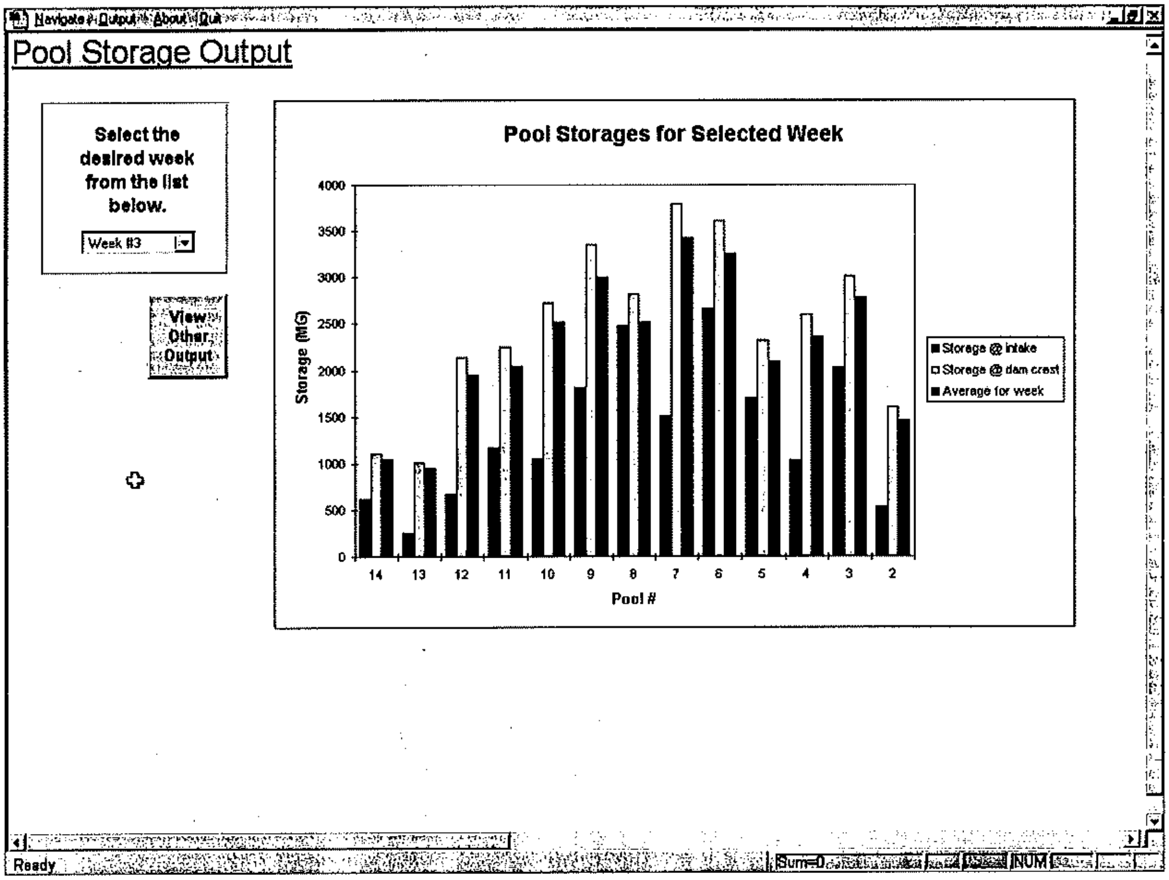
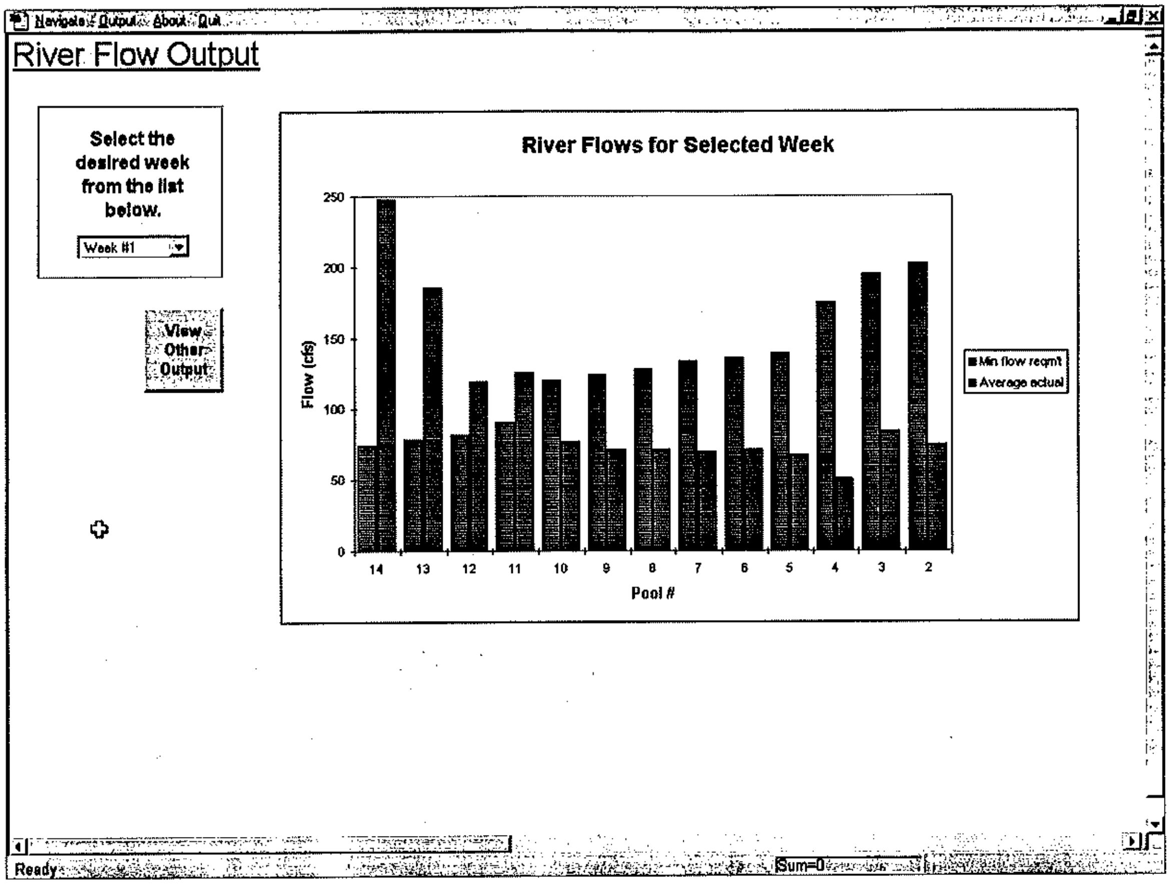
23. *Reservoir Stage-Storage-Area Screen.* The equations used to define the stage-storage-area characteristics of Buckhorn, Carr Fork, Dix, and Jacobson reservoirs are located on the Reservoir Stage-Storage-Area Screen. Coefficients for the third-order polynomial equations are identified in the tables under each reservoir name. The Reservoir Stage-Storage-Area Screen is accessed from the Navigate menu on the menubar.



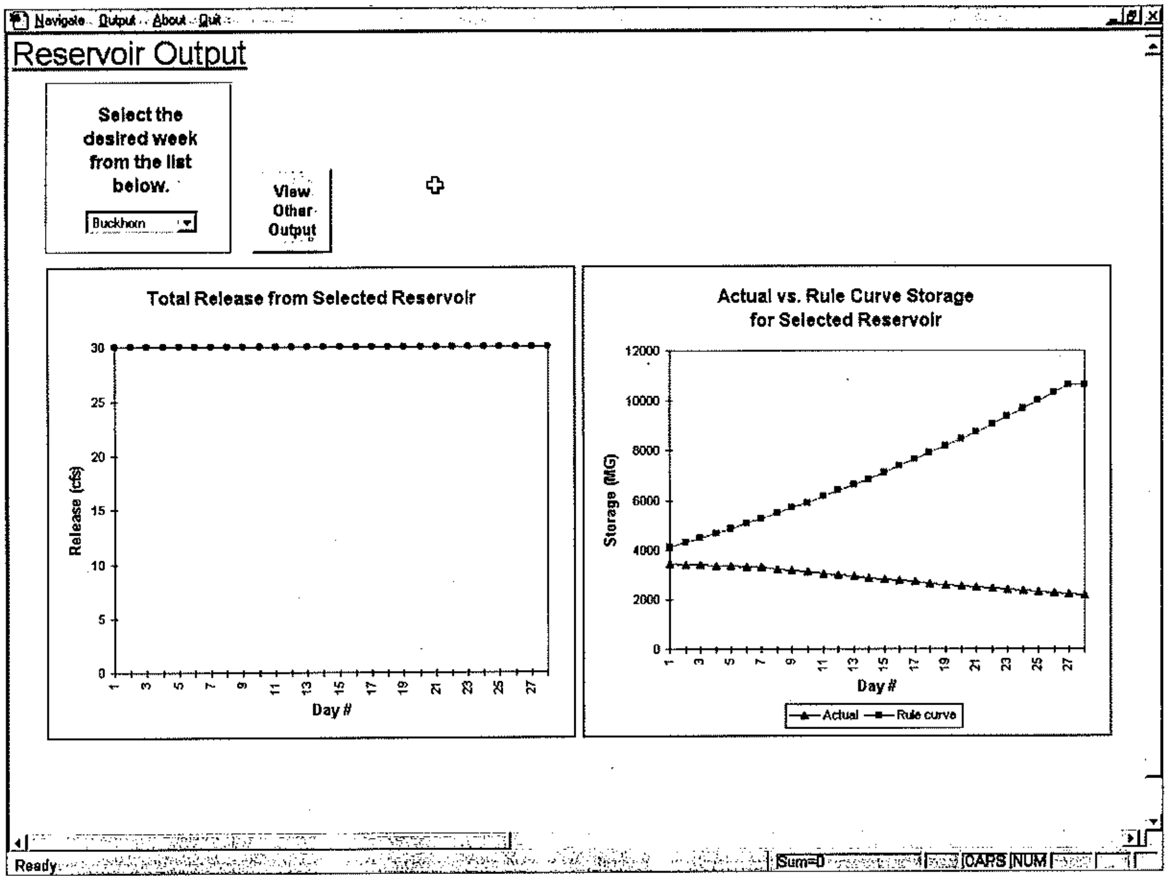
24. *Demand & Deficit Output Screen.* Daily municipal demands and deficits for each mainstem pool are summed weekly and illustrated in the Demand & Deficit Output Screen. The listbox control allows the user to select the desired week in the 4-week analysis period. The graphs are updated automatically to reflect listbox selections. The button control allows the user to access the Output Menu. The basin schematic is included to illustrate the location of municipal withdrawals and WWTP discharges on the river.



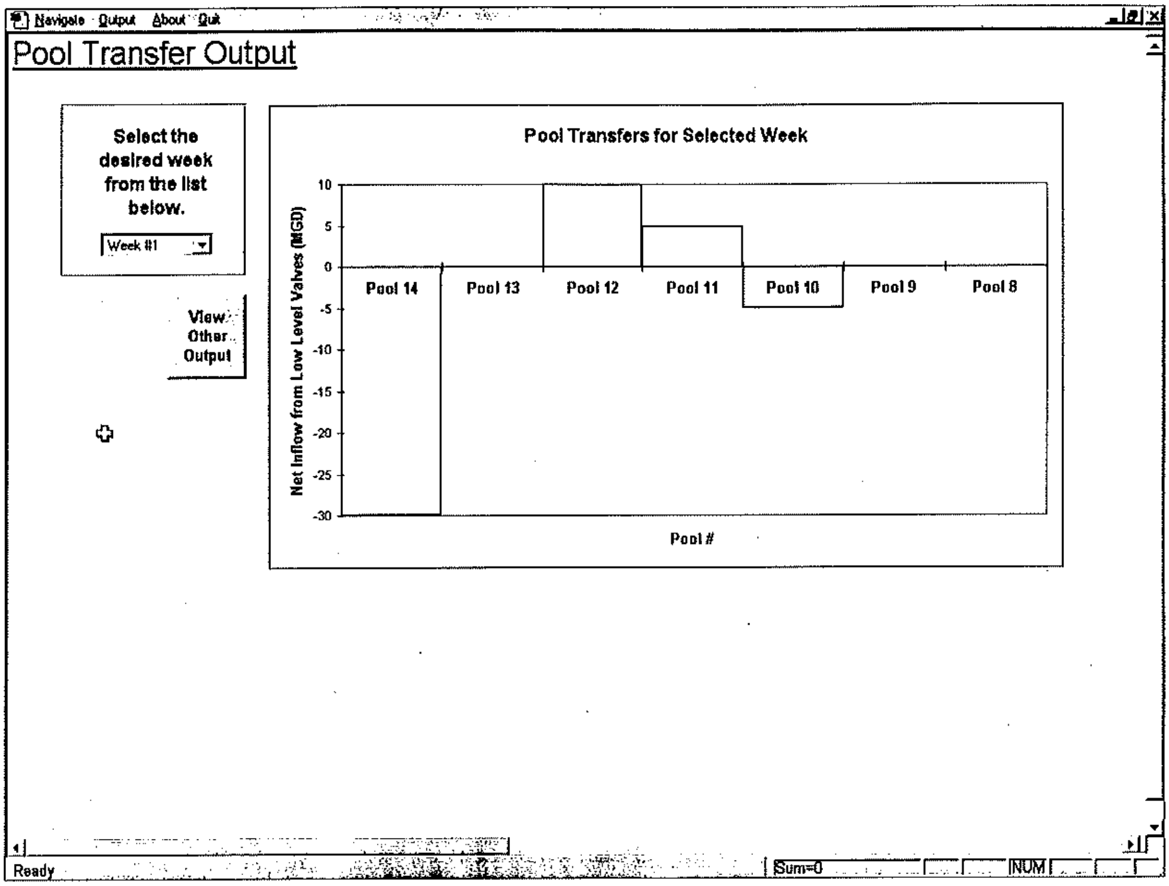
25. *Pool Storage Output Screen.* The average storage level in each main stem pool for each week of the 4-week analysis period is illustrated in the Pool Storage Output Screen. The storages corresponding to the critical intake level and dam crest elevation for each pool are also identified in the graph on this screen. The listbox control allows the user to select the week to be displayed in the output graph. The button control provides access to the Output Menu.



26. *River Flow Output Screen.* The average daily flow in the river at each lock and dam location for each week of the 4-week analysis period is illustrated in the River Flow Output Screen. The DOW minimum flow requirement at each lock and dam location is also identified in the graph on this screen. The listbox control allows the user to select the week to be displayed in the output graph. The button control provides access to the Output Menu.



27. *Reservoir Output Screen.* The daily releases, storages, and rule curve targets for each major reservoir are identified on the Reservoir Output Screen The listbox control allows the user to select the reservoir to be displayed in the output graphs on this screen. The button control provides access to the Output Menu.



28. *Pool Transfer Output Screen.* The low-level valve pool transfer policy used in the simulation is illustrated on the Pool Transfer Output Screen. Net transfers from each pool are shown on the bar graph on this screen. Negative values indicate pools in which water was depleted for downstream release. Positive values reflect transfers from upstream pools. Zero values indicate that there was no net gain/loss in the water level resulting from pool transfers. The listbox control allows the user to select the week to be displayed in the output graph. The button control provides access to the Output Menu.

Navigate Output About Quit

Output Blocks from Engine

DEFICITS (MG)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pool 14	0.643358	0.643358	0.643358	0.643358	0.643358	0.643358	0.643358	0.643358	0.643358	0.643358	0.643358	0.643358	0.643358	0.6433
Pool 13	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pool 12	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pool 11	6	6	6	6	6	6	6	6	6	6	6	6	6	
Pool 10	5	5	5	5	5	5	5	5	5	5	5	5	5	
Pool 9	48	48.	48	48	48	48	48	48	48	48	48	48	48	
Pool 8	3	3	3	3	3	3	3	3	3	3	3	3	3	
Pool 7	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.
Pool 6	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.
Pool 5	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	[illegible]
Pool 4	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	1
Pool 3	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.
Pool 2	0	0	0	0	0	0	0	0	0	0	0	0	0	

STORAGES (MG) - Beginning of day

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pool 14	1237.828	1225.45	1213.195	1201.063	1189.053	1177.162	1165.391	1153.737	1142.199	1130.777	1119.47	1108.275	1097.192	1086.
Pool 13	1127.056	1115.785	1104.628	1093.581	1082.646	1071.819	1061.101	1050.49	1039.985	1029.585	1019.289	1009.096	999.0054	989.01
Pool 12	2311.146	2288.034	2265.154	2242.502	2220.077	2197.877	2175.898	2154.139	2132.597	2111.271	2090.159	2069.257	2048.565	2028.
Pool 11	2423.48	2399.245	2375.253	2351.5	2327.985	2304.706	2281.658	2258.842	2236.253	2213.891	2191.752	2169.834	2148.136	2126.
Pool 10	2988.554	2958.669	2929.082	2899.791	2870.793	2842.085	2813.664	2785.528	2757.672	2730.096	2702.795	2675.767	2649.009	2622.
Pool 9	3565.205	3529.553	3494.267	3459.315	3424.722	3390.475	3356.57	3323.004	3289.774	3256.876	3224.308	3192.064	3160.144	3128.
Pool 8	2989.07	2959.18	2929.588	2900.292	2871.289	2842.576	2814.15	2786.009	2758.149	2730.567	2703.262	2676.229	2649.467	2622.
Pool 7	4061.417	4020.803	3980.595	3940.789	3901.381	3862.367	3823.744	3785.506	3747.651	3710.175	3673.073	3636.342	3599.979	3563.
Pool 6	3866.053	3827.392	3789.118	3751.227	3713.715	3676.578	3639.812	3603.414	3567.38	3531.706	3496.389	3461.425	3426.811	3392.
Pool 5	2477.49	2452.715	2428.188	2403.906	2379.867	2356.068	2332.508	2309.183	2286.091	2263.23	2240.598	2218.192	2196.01	2174.
Pool 4	2791.674	2763.757	2736.12	2708.758	2681.671	2654.854	2628.305	2602.022	2576.002	2550.242	2524.74	2499.492	2474.497	2449.7
Pool 3	3298.131	3265.15	3232.498	3200.173	3168.171	3136.49	3105.125	3074.073	3043.333	3012.899	2982.77	2952.943	2923.413	2894.1
Pool 2	1734.43	1717.086	1699.915	1682.916	1666.086	1649.425	1632.931	1616.602	1600.436	1584.432	1568.587	1552.901	1537.372	1521.

FLOWS (CFS) - Beginning of day

Ready Sum=0 CAPS NUM

29. *Raw Output Screen.* The output results generated by the KYROM Hydraulic Engine File (DMM1E.XLS) are stored in the Raw Output Screen. These results are copied to the Raw Output Screen automatically after a simulation is performed. Pool deficits, storages, and flows, as well as, reservoir releases, levels, and rule curves appear in separate tables in the Raw Output Screen. Output in these tables is given daily. The five output screens that appear in the Output Menu pop-up window access the data on the Raw Output Screen to generate their graphs. As with all the output screens, the values on this screen reflect results of the last simulation. Any changes to input parameters are not reflected in the output until they are simulated.

How Do I … ?

The following sections are designed as a quick-reference tutorial for the user. It is recommended the user review each section as he/she inputs data to ensure proper understanding of each parameter. Each section is devoted to a solitary task identified in the title. The following is a list of the sections.

Each section provides a step-by-step procedure to perform the task identified in its title. Included is a detailed definition of the input parameter and a brief explanation of its usage by the model. This is provided to ensure proper characterization of the river system by the user.

How Do I … Set initial water levels?

Parameter Definition: Initial water levels refer to the water levels in main stem pools or major reservoirs at the beginning of the 28-day simulation period. The initial water level is the water level in each impoundment on the day the simulation is performed. The initial water level should reflect the water level at the beginning of the day. An initial water level for each main stem pool must be specified. All elevations in the model use the National Geodetic Vertical Datum of 1929.

Model Usage: The model uses the initial water levels as a starting point for the hydraulic calculations.

Data Source: No default values for initial water levels are provided. This is a user-required input.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

❷ From the Main Menu select *Basin Parameters*.

❸ In the table that appears, enter the desired initial water level, in feet, for each main stem pool and major reservoir.

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: The white portions of data input tables denote user input areas. The gray portions of the table reflect row/column headings or input that is automatically entered by the model.

The initial water level for Jacobson Reservoir is specified on the Basin Parameters Screen (see How Do I … Define Jacobson Reservoir characteristics?).

How Do I … Set dam crest elevations?

Parameter Definition: The dam crest elevation, quite simply, refers to the elevation of the dam crest for a main stem lock and dam. The dam crest elevation should not include the increase in elevation resulting from a crest gate. Crest gate elevation increases are considered separately. Dam crest elevations must be specified for each main stem lock and dam location. All elevations in the model use the National Geodetic Vertical Datum of 1929.

Model Usage: The model uses the dam crest elevations to establish discharges over dam crests during the simulation.

Data Source: Default values for dam crest elevations were obtained from the Army Corps of Engineers.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu*.

❷ From the Main Menu select *Basin Parameters*.

❸ In the table that appears, enter the desired dam crest elevation, in feet, for each main stem pool. (You may have to use the vertical scroll bar to view the entire table.)

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Permanent increases in dam crest elevations can be evaluated by changing default values. Permanent increases that are more than 5' over existing (default) elevations may result in erroneous output. The error is due to insufficient stage-storage data at the higher elevations. It is recommended that the user make a careful observation of model output to assess its validity when attempting to simulate increases in dam crest elevations in excess of 5'over default values.

How Do I … Set critical intake elevations?

Parameter Definition: The critical intake elevation is defined in the model as the elevation in a pool below which withdrawal intakes can no longer function properly and municipal demand withdrawals must cease. Only one critical intake elevation is specified for each river reach, regardless of the number of intakes located in the reach. A critical intake elevation must be specified for each main stem pool prior to performing a simulation. All elevations in the model use the National Geodetic Vertical Datum of 1929.

Model Usage: The model uses the critical intake elevation in a pool to help establish whether municipal withdrawals are possible. When the water levels dip below the critical intake elevation a deficit is encountered equal to the total unsatisfied demand in the reach.

Data Source: The default values for critical intake elevations were obtained from the Authority and contact with individual municipal withdrawers. Default elevations reflect the invert elevations of intake pipes.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

❷ From the Main Menu select *Basin Parameters*.

❸ In the table that appears, enter the critical intake elevation, in feet, for each main stem pool. (You may have to use the vertical scroll bar to view the entire table.)

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: In many cases where minimum flow requirements are enforced, the critical intake elevation is irrelevant. This is true because municipal demands are prohibited when minimum flow requirements can no longer be met. For the default lock leakages and minimum flow requirements, this occurs at elevations slightly above the dam crest and presumably is considerably higher than the critical intake elevation.

The critical intake elevations for the major reservoirs may be found on the Reservoir Screens (see *Virtual Tour*, #20). Critical intake elevations for the major reservoirs are necessary for mass-balance computations only, and deficits for reservoir demands are not quantified.

How Do I ...Specify lock and dam leakages?

Parameter Definition: Lock and dam leakage is defined as the average daily flow that leaks through the dam structure of mainstem pools when the water level is equal to the dam crest elevation.

Model Usage: The model uses the inputted leakage values to assess reductions in pool storages during the simulation. The inputted leakage values are used to derive stage-leakage equations for the lock and dam structures. These relationships are based on a standard orifice equation, which predicates an exponential decrease in leakage as pool levels decrease.

Data Source: The default leakage value for all the mainstem locks and dams is 50 cfs. This value is considered a "best guess" and was extracted from previous studies of the river by the Army Corps of Engineers and Harza Engineering Co.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu*.

❷ From the Main Menu select *Basin Parameters*.

❸ In the table that appears, enter the lock and dam leakages, in cubic feet per second, for each main stem pool. (You may have to use the vertical scroll bar to view the entire table.)

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Lock and dam leakages are considered applicable towards satisfying minimum flow requirements.

How Do I … Set minimum flow requirements at river locations?

Parameter Definition: Minimum flow requirements are DOW-enforced minimum flowrates in the river that have been deemed necessary in order to preserve water quality. The DOW, through use of its withdrawal permits, currently enforces minimum flow requirements at select river locations. Minimum flows in the river are mandated to protect river ecosystems by providing adequate dilution to incoming pollution from waste water treatment discharges and agricultural runoff.

Current DOW policy states that the minimum flowrate specified at each river location must be allowed to pass downstream. Consequently, if inflow into a mainstem pool is less than the minimum flow requirement at the pool, then the entire inflow must be allowed to pass downstream (i.e. municipal withdrawals must cease).

Model Usage: Minimum flow requirements are treated as a demand on water supplies that is senior to municipal demands but junior to irrigation demands and natural losses. If minimum flow requirements cannot be met, then a deficit in the river pool is encountered equal to the municipal demand. In a valved river system, minimum flow requirement *policy* is met with the valves, but pool storage below crest is not used to augment deficient pool inflows to minimum flow requirement levels.

Data Source: Default values for the minimum flow requirements are present in the original model file. Minimum flow requirements for river locations were obtained from the DOW.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

❷ From the Main Menu select *Basin Parameters.*

❸ In the table that appears, enter weekly minimum flow requirements, in cubic feet per second, for each listed river location.

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Minimum flow requirements are specified weekly to provide the user with the flexibility to relax requirements in the event a state water emergency is declared. Relaxing minimum flow requirements designates more water eligible for municipal withdrawal.

How Do I ... Define Jacobson Reservoir characteristics?

Parameter Definition: The sediment pool elevation, initial water level, and maximum withdrawal rate must be identified for Jacobson Reservoir prior to performing a simulation. The sediment pool elevation is the elevation corresponding to the lowest possible level at which water is usable for demand withdrawal. Water levels below the sediment elevation contain too large a sediment loading to be suitable for withdrawal. The initial water level is the water level in the reservoir at the beginning of the first day of the 28-day simulation. The maximum withdrawal, as the name implies, corresponds to the maximum flowrate that can be withdrawn from the reservoir. The maximum withdrawal rate is dependent upon the size of the intake structure.

Model Usage: The model uses the sediment pool, initial water level, and maximum withdrawal rate to quantify usable/available water supply and ensure that the reservoir is operated within realistic bounds.

Data Source: The default sediment pool level and maximum withdrawal rate were obtained from Kentucky-American Water Co. There is no default value for the initial water level; this is a user-required input.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu*.

❷ From the Main Menu select *Basin Parameters*.

❸ In the table that appears, enter the sediment pool, initial water level, and maximum withdrawal rate for Jacobson Reservoir. The sediment pool and initial water level should be expressed in million gallons. The withdrawal rate should be given in million gallons per day.

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Jacobson withdrawals will be limited by the maximum withdrawal rate and by the amount of storage above the sediment pool level. Evaporative losses are still possible at elevations below the sediment pool.

There is no refilling algorithm for Jacobson Reservoir during the simulation.

How Do I ... Specify municipal demands?

Parameter Definition: Municipal demands are those withdrawals from the mainstem of the Ky. River and its tributaries used to satisfy residential, commercial, and industrial demands.

Model Usage: Municipal demands are withdrawn from the river after natural losses, irrigation demands, and minimum flow requirements have been withdrawn. If the remaining water supply is insufficient to satisfy the daily municipal demand for a pool, then a deficit is experienced equal to the unsatisfied demand. The water supply remaining after losses and available for municipal withdrawal is determined by the critical storage for the pool. Critical storage is the storage in a pool corresponding to the lowest level in the pool for which municipal demand withdrawal is still permitted. Water below the critical storage level is not available for municipal withdrawal. The critical storage level is dependent upon minimum flow requirements, pool stage-discharge relationships, low-level valve locations, and critical intake elevations.

Data Source: Municipal withdrawal locations were obtained from the Kentucky Division of Water surface water withdrawal permits. Municipal demands are a user-required input. Historical demands for all permitted demand withdrawals may be found on DOW surface water withdrawal permits.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

❷ From the Main Menu select *Municipal Demands.*

❸ In the Municipal Demand Screen, enter the average daily demand, in million gallons per day, for each week of the four-week analysis period. All the permitted municipal demand withdrawals on the mainstem are listed in the table on the left of the Municipal Demand Screen. Permitted tributary demands appear in the table on the right. Demands may be entered directly into the table.

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: To impose demand restrictions/curtailment, replace the desired demand withdrawal with the restriction in the appropriate table in the Municipal Demands Screen. This will reset the municipal demand equal to the restriction. Model output *will not* quantify the deficit that is a result of the reduction of the desired demand to the restricted amount. Deficits *will* be quantified when the restricted demand goes unsatisfied.

How Do I … Add an additional demand withdrawal on the river?

Parameter Definition: An additional demand withdrawal on the river is defined as a new municipal withdrawal. The model is equipped to accommodate new demand withdrawals on main stem river pools only. (Although you could lump a new demand withdrawal with an existing demand withdrawal). New demand withdrawals are referred to as the ADD# demand, where # refers to the pool where the withdrawal intake is located.

Model Usage: The KYROM model treats the ADD# demand as another municipal withdrawal from the # pool and is subject to the same limitations (e.g. junior to minimum flow requirements, prohibited at elevations below the critical intake elevation for the pool, etc.).

Data Source: No default values for additional demand withdrawals on mainstem river pools are provided. This is an optional input parameter.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

❷ From the Main Menu select *Municipal Demands*.

❸ In the Municipal Demand Screen locate the desired ADD# demand and enter the average daily demand, in million gallons per day, for each week of the four-week analysis period. ADD# are located on each mainstem pool in the table on the left of the Municipal Demand Screen.

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: No attempt is made by the model to increase local WWTP discharges to reflect the new demand withdrawal, since there is no guarantee that the new demand withdrawal would utilize an existing local WWTP. If it is likely return flows from the new demand will discharge into the withdrawal pool, then the magnitude of monthly demands for this withdrawal should be identified as the net withdrawal (i.e. equal to the consumptive loss only).

The ADD# demand can be useful in prolonging the utility of the KYROM model, as future withdrawals on the river can be modeled.

How Do I … Specify reservoir rule curves?

Parameter Definition: A reservoir rule curve is a schedule of daily desired, or target, elevations in the reservoir. A reservoir rule curve is usually determined based on a number of factors, including flood storage, water supply storage, hydropower potential, and recreation benefit. A rule curve must be specified for each of the three major reservoirs (Buckhorn, Carr Fork, and Dix) in the basin for a successful simulation. Rule curve elevations are given relative to the National Geodetic Vertical Datum of 1929.

Model Usage: The model uses a reservoir's rule curve to simulate reservoir operation. Reservoir releases are used to match reservoir levels to the rule curve. When reservoir levels are above daily rule curve targets, water is released to restore levels to rule curve levels, up to the maximum allowable release limit. When water levels are below daily rule curve targets, only the minimum release requirement, if applicable, is released.

Data Source: The default rule curves for the three major reservoirs were obtained from the Army Corps of Engineers (Buckhorn and Carr Fork) and Kentucky Utilities (Dix).

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

❷ From the Main Menu select the name of the desired reservoir.

❸ In the Reservoir Screen that appears, enter the desired daily rule curve target elevations for each day of the 4-week analysis period. Elevations may be entered directly into the *Target Elev* column in the table. Alternately, the default rule curve may be used. To load the default rule curve into the table, mouse-click on the small graph icon to the left of the table. A pop-up window will appear prompting the user to enter the first day of the 28-day default rule curve fragment to load into the table. Once the month and day have been selected, press OK to load the values into the table.

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: A rule curve must be specified for each of the three reservoirs (e.g. Buckhorn, Carr Fork, Dix). Opting to use the default rule curve only loads the default values into the table on the currently displayed Reservoir Screen. Rule curves must be specified for the other reservoirs individually.

Reservoir releases can significantly affect river flows. Care should be taken to obtain realistic rule curve data. The reservoir rule curve is a desired daily water level target for the reservoir. Specifying a reservoir rule curve does not guarantee that reservoir levels will equal the desired target levels, since precipitation (or the lack of) greatly influences reservoir levels. It is therefore recommended the user examine the reservoir output from the model to determine actual reservoir behavior.

The default reservoir rule curves for the entire year are located in the Annual Reservoir Rule Curves Screen. The default rule curve databases may be modified by the user (see *How Do I ... Modify the reservoir rule curve default database?*).

The graph in the lower left corner of the Reservoir Screen, illustrates the rule curve currently in the table. The graph is updated automatically by the model.

How Do I … Specify reservoir release limits?

Parameter Definition: Reservoir release limits refer to the maximum and minimum allowable releases from a reservoir. The maximum release limit may be equal to the spillway capacity or may be dictated by downstream flood potential. The minimum release requirement refers to the DOW-mandated release necessary to preserve downstream water quality.

Model Usage: The model uses reservoir release limits to ensure reservoir releases are operating within the realistic range.

Data Source: The default maximum release limits for the three major reservoirs were obtained from the Army Corps of Engineers (Buckhorn and Carr Fork) and Kentucky Utilities (Dix). Default minimum release requirements were obtained from the DOW.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu*.

❷ From the Main Menu select the name of the desired reservoir.

❸ In the Reservoir Screen that appears, enter the desired maximum and minimum release limits, in cubic feet per second, for the selected reservoir.

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: The minimum release limit for Buckhorn, Carr Fork, and Dix reservoirs is identical to the DOW's minimum flow requirement specified on the Basin Parameters Screen. Minimum release limits will be released from the reservoir every day, provided sufficient water exists in the reservoir.

How Do I ... Specify reservoir leakages?

Parameter Definition: Reservoir leakage is defined as the average daily flow that leaks through the dam structure of the reservoir at all water levels.

Model Usage: The model uses the inputted leakage value to assess reductions in reservoir storage during the simulation. Reservoir leakage is treated as a constant loss and is independent of the water level in the reservoir.

Data Source: No default leakage value is given for reservoir leakage.

Procedure:

1. Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

2. From the Main Menu select the desired reservoir.

3. In the Reservoir Screen that appears, enter the reservoir leakage, in cubic feet per second, for the selected reservoir.

4. Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Reservoir leakage is considered separate of release limits and dam leakage is not applied towards satisfying the minimum release requirement.

How Do I ... Specify transmission losses for reservoir releases?

Parameter Definition: Reservoir transmission loss refers to the reduction in reservoir releases that occurs as a result of groundwater recharge/ bank seepage in the river during downstream travel. Two transmission loss rates are specified in the model. The first is applied to regular reservoir releases; regular releases are those releases made to maintain the rule curve and satisfy minimum release requirements. The second is applied to additional release requests; additional release requests are additional releases from a reservoir beyond regular releases that are made for low flow augmentation purposes. Two rates are used to allow recognition of the differences in loss rates that can result due to the nature of the release (i.e. a constant discharge versus a large pulse).

The transmission loss rates for reservoir releases in the KYROM model apply for the reach between the reservoir and the next downstream mainstem pool. Thus, for Buckhorn and Carr Fork, the transmission loss rate reflects the transmission loss from the reservoir to pool 14 of the Ky. River.

The transmission loss rates are expressed as a percentage reduction in the total release (i.e. a transmission loss of 10% would signify a 10% reduction in reservoir releases during downstream travel). A single constant rate is applied to regular reservoir releases. For additional reservoir releases, a daily transmission loss rate is specified for each release request.

Model Usage: The model uses the transmission loss rates to assess reductions in reservoir releases. Transmission losses are subtracted immediately upon release from the reservoir and are treated as permanent losses to the system.

Data No default transmission loss rates are included in the model. Transmission loss rates must be provided by the user.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu*.

❷ From the Main Menu select the desired reservoir.

❸ In the Reservoir Screen that appears, enter the transmission loss rate for regular releases in cell provided below the reservoir release limits. Enter the transmission loss rates for additional release requests in the table to the right of the release request. Both transmission loss rates should be expressed as a decimal (e.g. 0.10 for a 10% loss rate).

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Transmission loss rates for release requests are provided to allow the user to better emulate the transmission losses that occur in the large pulse releases that are a common low flow augmentation practice.

How Do I ... Specify additional reservoir releases?

Parameter Definition: The user may elect for a reservoir to release more water than is needed to maintain its rule curve. This is termed as an additional reservoir release, or a release request, in the model. An additional reservoir release is usually a pulse release used for low-flow augmentation. Additional reservoir releases are an optional parameter in the model and are not required in order to perform a successful simulation.

Model Usage: In the model, additional reservoir releases are made on top of the release made to maintain the daily rule curve target. Total reservoir releases are compared with the maximum allowable release limit for the reservoir. If a total release exceeds the maximum limit, then the actual release made from the reservoir is restricted to the maximum limit.

Data Source: No default values for additional reservoir releases are provided. This is an optional input parameter.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu*.

❷ From the Main Menu select the desired reservoir.

❸ In the Reservoir Screen, enter the desired daily release requests, in cubic feet per second (cfs), for the reservoir. Note that releases will only be made if they do not violate the maximum release limit and there is sufficient water in the reservoir.

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: The reservoir release requests entered in the table are not guaranteed to be released, since this may cause the maximum release limit to be exceeded. It is therefore recommended the user examine the reservoir output from the model to determine actual reservoir behavior.

It should be noted that additional release requests are ambivalent to the rule curve, and release requests will be made (if maximum release limit is not violated and there is sufficient water in the reservoir) regardless of the reservoir water level. The effect of additional release requests on reservoir levels can be seen by examining reservoir output from the model.

Transmission losses for reservoir releases are specified in the column to the right of the release request in the table. *See How Do I ... Specify transmission losses for reservoir releases?* for a complete explanation on how to do this.

How Do I … Install low-level valves at lock and dam locations?

Parameter Definition: Low-level valves refers to gate valves that could be installed in lock and dam structures to permit controlled releases from a pool at water elevations below the dam crest. Such a valve has been installed in lock and dam #11 and is being considered by the Authority at other locations.

A valved system offers two distinct advantages over a non-valved system at reducing drought impacts. First, the valve can be used to maintain minimum flow requirement policy, permitting legal "mining" of river pools by municipal withdrawals. ("Mining" of a pool refers to the depletion of pool storage below the dam crest.) Recall, that if minimum flow requirements are enforced, municipal demands must cease when pool inflows are less than minimum flow requirements. A second advantage of the valved system is that valves permit the transfer excess capacity from upstream river pools to satisfy downstream deficits. This is referred to as a *pool transfer*.

Model Usage: The model permits the installation of low-level valves in lock and dams #9 through #14 only. Low-level valves are automatically used to satisfy the minimum flow requirement *policy*, if enforced. Valves are not used to deplete storage below dam crests to augment deficient pool inflows to minimum flow requirement levels. In a valved pool, storage below crest is eligible for municipal demand withdrawal, but is also still subject to natural losses, irrigation demands, and dam leakage. The model also permits pool transfers with the low-level valves. Pool transfers are discussed in *How Do I ... Specify pool transfers with low-level valves?*.

Data Source: No default settings for low-level valve locations or operation are provided. This is an optional input parameter.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu*.

❷ From the main menu select *Valves & Crest Gates.*.

❸ The Valve/Crest Gate Screen will appear. To install low-level valves, click on the button control beside the *To install low-level valves* caption.

❹ At the pop-up window that appears, check the lock and dam locations in which to install low-level valves. Press the OK button to confirm the installations.

❺ In the table on the Valve/Crest Gate Screen, you must enter the elevation (in NGVD) of all installed low-level valves in the *Valve Elev* column. Note that the model has automatically updated the values in the *Low-Level Valve?* column. A value of TRUE in this column indicates a valve is installed at the location.

❻ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: The capacity of the low-level valve is not computed by the model. Model users should check this manually to ensure that specified valve releases are possible.

In the model, valves may be located at any depth on the lock and dam structure. The user should exercise his/her engineering judgment as to whether valve elevations are practical.

The table on the right of the Valve/Crest Gate Screen is used for denoting pool transfers with the low-level valves. It is automatically sized to reflect installed valve locations. If a lock and dam location does not appear in this table then it does not currently have a low-level valve installed. Do not attempt to add a lock and dam location to this table. Following the procedure above for installing a low-level valve will automatically update the table.

As with all input tables in the KYROM model, white portions denote user input areas while gray areas are completed by the computer.

How Do I … Specify pool transfers with low-level valves?

Parameter Definition: Low-level valves may be used to transfer excess capacity from upstream river pools to satisfy downstream deficits. This is referred to as a *pool transfer*. A pool transfer loses effectiveness when it encounters an unvalved pool, since water exiting from the unvalved pool is severely limited at elevations below dam crest.

Model Usage: The model considers pool transfers independent of other flows in the river. As a consequence, water designated for pool transfer through a valve is not applied towards minimum flow requirements at the lock. Similarly, pool transfer water is not considered in establishing the pool inflow that must be allowed to pass downstream for the case when pool inflows are less than required minimums. Inflow into unvalved pools is not excluded from minimum flow requirements and withdrawal, regardless if the inflow was provided through an upstream pool transfer.

When a pool transfer is designated, the valves are opened to the setting which will permit the designated flow to pass. Consequently, pool transfers are not reduced by losses or demand withdrawal, since these losses will be absorbed by the pools themselves. The pool transfer algorithm is processed before withdrawals and losses are assigned to the pool to ensure the transfer is given the highest priority.

Pool levels are checked prior to transfer requests to ensure the water is available for transfer and that valves are submerged. Partial transfers may result if there is an insufficient storage in the pool or if water levels in the intermediate pools are below the valve elevation.

Data Source: No default settings for pool transfer requests are provided. This is an optional input parameter.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu*.

❷ From the main menu select *Valves & Crest Gates*..

❸ The Valve/Crest Gate Screen will appear. In the table on the right of the screen, enter the desired valve release settings, in million gallons per day, for each valved location. Valve settings denote the average daily release through the valve. Use the valve release settings to dictate the desired pool transfer strategy. Pools that do not have a valve installed are not displayed in the table.

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: The capacity of the low-level valve is not computed by the model. Model users should check this manually to ensure that specified valve releases are possible.

An effect of pool transfers is that water levels are reduced in the contributing pools. The reduced levels result in smaller discharges over the dam or in leakage flows. This can cause significant depletion of the immediately downstream pool due to the differential discharge/leakage rates in the upstream and downstream dams.

Pool transfers are requests for water and may not be honored if valves are exposed or there is insufficient water available. Model output should be reviewed to determine the actual water transferred.

To transfer water between non-adjacent pools, make sure that all intermediate valves are open to the desired flow-thru capacity. This may cause depletion of the intermediate pool if upstream release requests were not received and storage is available in the intermediate pool.

The table on the right of the Valve/Crest Gate Screen is used for denoting pool transfers with the low-level valves. It is automatically sized to reflect installed valve locations. If a lock and dam location does not appear in this table then it does not currently have a low-level valve installed. Do not attempt to add a lock and dam location to this table. Following the procedure identified for installing a low-level valve will automatically update the table.

How Do I … Install crest gates on mainstem dams?

Parameter Definition: Crest gates refer to mechanical gates that could be installed on existing mainstem dam structures which, when raised, would increase the dam crest elevation by the height of the gate. Crest gates can be raised before drought periods to increase the amount of water available in a river pool. Crest gates are usually lowered during wet periods to prevent unnecessary flooding of riparian land. Crest gates lose utility in drought periods if flow in the river is insufficient to fill up the increased storage capacity. Therefore, crest gate operation (i.e. determining raising/lowering times) is critical to its performance.

Model Usage: The model permits the installation of crest gates on mainstem dams #9 thru #14 only. The initial crest gates position at the beginning of the 4-week analysis period and the lower/raise strategy must be specified. Crest gates may be raised and lowered only once. No leakage is considered through the crest gate itself.

Data Source: No default settings for crest gate locations, sizes, or operation are provided. Crest gates are an optional input parameter.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

❷ From the main menu select *Valves & Crest Gates..*

❸ The Valve/Crest Gate Screen will appear. To install crest gates, click on the button control beside the *To install crest gates* caption.

❹ At the pop-up window that appears, check the lock and dam locations in which to install crest gates. Press the OK button to confirm the installations.

❺ In the table on the Valve/Crest Gate Screen, you must enter the elevation (in NGVD) of all installed crest gates in the *Crest Gate Elev* column. The crest gate elevation denotes the new elevation of the dam crest when the crest gate is in the raised position. Note that the model automatically updates the values in the *Crest Gates?* column. A value of TRUE in this column indicates a crest gate is installed at the location.

❻ Next, the crest gate position and operation must be specified. On the Valve/Crest Gate Screen, click on the button control beside the *To configure crest gates* caption.

❼ At the pop-up window that appears, indicate the initial position of each crest gate by clicking on the desired position. A black dot will appear next to the selected position. At the bottom of the pop-up window, select the day that the crest gate position will be changed from its initial position. Selecting *Never* will leave the crest gate in the initial position for the entire 28-day analysis period. Information entered in this pop-up window will be disregarded for locations that do not have a crest gate installed.

❽ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: In the model, crest gate heights may be set to any size. The user should exercise his/her engineering judgment as to whether these sizes are structurally feasible. Crest gate heights in excess of 5' may result in erroneous output. The error is due to insufficient stage-storage data at the higher elevations. It is recommended that the user make a careful observation of model output to assess its validity when attempting to simulate crest gate heights in excess of 5'.

How Do I … Specify lateral inflows for river reaches?

Parameter Definition: Lateral inflows for river reaches indicate the runoff and groundwater inflow into a reach from its watershed. Estimates of the lateral inflows for the two days prior to the simulation must be specified by the user. Generating these estimates is described in *Calibrating the Model.*

Model The model uses the calibrated lateral inflows for the two-day period prior to simulation to determine lateral inflows for the upcoming 28-day period. Lateral inflows are calculated by a nonlinear decay relationship using the previous two days' values.

Due to the calibration process and the need for measured streamflow data, the river was divided into nine macro reaches which are defined by USGS gaging stations. The calibrated lateral inflow estimates for the smaller computational reaches used by the model are computed as a percentage of the lateral of the macro reach. The percentage is based on the proportion of the smaller watershed area to the macro watershed.

Data Source: Initial lateral inflow estimates for the two-day period prior to the simulation period are user-required inputs. The decay relationship used by the model to generate future lateral inflow estimates was developed for exclusively the basin from historic streamflow data (Jain, 1994).

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

❷ From the main menu select *Lateral Inflows.*

❸ In the pop-up window that appears, enter the calibrated estimates for the lateral inflows, in cubic feet per second, for the two days prior to the simulation period. For more information on obtaining these estimates see *Calibrating the Model.*

❹ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Do not enter negative values for lateral inflow estimates. Entering negative values will result in negative lateral inflow predictions for laterals in the 28-day period. If positive lateral inflow estimates do not yield a good calibration, assume zero lateral inflows.

A zero lateral inflow estimate will result in no lateral inflows for the macro reach for the entire 28-day analysis period.

Evaporative losses from river reaches are calculated separate from lateral inflows.

How Do I ... Change return flow percentages?

Parameter Definition: Return flow percentage is defined as the percentage of municipal withdrawals that returns to the river as waste water treatment plant (WWTP) discharges. Return flow rates are computed by comparing the demand withdrawal to the associated WWTP discharge rates. A return flow percentage of 0.60 indicates that 60% of water withdrawn from the river for municipal demand is returned to the river by the WWTP or, conversely, that there is a 40% consumptive loss in water withdrawn for municipal demands. Default values for return flow percentages are provided in the model's default database.

Return flow rates are recognized for each major WWTP (identified by name) and for smaller WWTP's in the basin (identified by reach). The rates specified by reach apply to all WWTP's (other than major WWTP's) discharging into the listed reach.

Model Usage: Return flow rates are used in the model to assess river inflows from WWTP discharges. Each WWTP is associated with a municipal demand. WWTP discharges are computed by multiplying the associated municipal withdrawal times the return flow percentage.

Data Source: The default return flow rates for the major WWTP's were calculated by relating a select sample of 1986-1994 dry weather discharges to the corresponding withdrawals by the perceived primary municipal supplier. For more information on their derivation consult the *Task III Deficit Analysis* report (KWRRI, 1996)

Failure to provide a return flow rate will result in a 100% consumptive loss, or no return flows.

Procedure:

❶ Move the mouse over the basin schematic on the Opening Screen and click the right mouse button to bring up the *Main Menu.*

❷ From the main menu select *Return Flows.*

❸ The Return Flows Screen will appear. In the two tables enter the desired return flow percentages (in decimal) for the major and minor WWTP's in the basin.

❹ Default values may be used by pressing the button control. Pressing the button will display a pop-up window. In the pop-up window, select the desired month of the simulation. (This is necessary because default return flow rates have been developed for each month of the year.) Default values may be loaded for major, minor, or both WWTP's. Pressing the OK button will dismiss the pop-up window and automatically load the desired default return flow percentages into the table(s).

❺ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Return flow percentages reflect river inflows from WWTP's. Return flows are calculated by multiplying the percentage by the dependent withdrawal. The dependent withdrawer is the demand withdrawer who represents the largest single source of inflow for the WWTP.

Return flows are reduced during drought periods in proportion to deficits experienced by the dependent withdrawer. In other words, if only 50% of a municipality's demand is withdrawn from the river due to insufficient supply, then return flows are reduced by 50% for that period.

Return flows are lagged by a day to reflect travel time spent in the distribution and treatment systems.

How Do I ... Specify irrigation demands?

Parameter Definition: Irrigation demands are those withdrawals from the mainstem of the Ky. River and its tributaries used for watering crops and livestock. Individual irrigation demands on a river reach are lumped together to form a single irrigation demand for the reach.

Model Usage: Irrigation demands are subtracted from a river reach prior to municipal demands, but subsequent to natural losses (e.g. evaporation, groundwater recharge, etc.). It is assumed irrigation withdrawals may be taken at any depth in the river and regardless of minimum flow requirements.

Data Source: Irrigation demands for river reaches are a user input. No default database is available.

Procedure:

❶ Select *Irrigation Demands* from the *Navigate* menu on the menubar at the top of the screen.

❷ In the Irrigation Demands Screen, enter the desired irrigation demand for each river reach. Note that irrigation demands are given monthly and represent the average daily demand in million gallons per day (mgd) for every day in the month.

❸ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Unsatisfied irrigation demands are not included in deficit calculations. Irrigation demands do influence water available for withdrawal by municipal demands.

How Do I ... Specify evaporation data?

Parameter Definition: Evaporative losses reflect the water from an impoundment that is lost to the atmosphere. Evaporative losses are subtracted from mainstem pools and major reservoirs based on daily pan data supplied by the user.

Model Usage: Evaporative losses are senior to all river withdrawals and minimum flow requirements. Evaporative loss is calculated as 70% of the product of the daily pan evaporation value and the surface area of the impoundment.

Data Source: Pan evaporation data is a user input. Evaporation pan data is recorded by several weather agencies and monthly forecasts/predictions may be obtained.

Procedure:

❶ Select *Evaporation* from the *Navigate* menu on the menubar at the top of the screen.

❷ In the Evaporation Data Screen that appear, enter forecasted daily pan evaporation estimates for the 28-day analysis period. Pan evaporation data should be expressed in inches.

❸ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen.

Remarks: Evaporative losses account for a small portion of the total water budget in the river. While care should be taken to obtain accurate data, absolute accuracy in approximating this input is not as critical as it is for other user input data.

How Do I ... Change pool stage-area data?

Parameter Definition: The pool stage-area data refers to the equations developed for each pool which define the surface area in each pool at any given elevation. As with all elevation input data in the model, elevations are given in relation to the National Geodetic Vertical Datum of 1929.

Model Usage: The model uses the stage-area data to compute evaporative losses from mainstem pools. One equation is used for each mainstem river pool which completely describes the surface area of a river pool from its bottom to elevations well above the dam crest. Equations are in the form of third-order (or less) polynomials, where the independent variable is elevation (ft) and the dependent variable is surface area (acres).

Data Source: The default stage-area equations were developed by fitting a third-order (or less) curve to stage-area data obtained from the Army Corps of Engineers. The stage-area data was developed from USGS quadrangle maps with a 20' contour interval.

Procedure:

❶ Select *Stage-Area* from *Pools Data* in the *Navigate* menu on the menubar at the top of the screen.

❷ In the Pool Stage-Area Screen, enter the coefficients for the new stage-area curves. Equations must be of the form described in **Model Usage.** If a second-order polynomial is used, set the coefficient for the third-order term to zero.

❸ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen

Remarks: The stage-area equations are used exclusively for evaporative losses. This data is not used in any form for any other purpose.

How Do I … Change pool stage-storage data?

Parameter Definition: Pool stage-storage data refers to the equations developed for each pool which define the storage in each pool at any given elevation. As with all elevation input data in the model, elevations are given in relation to the National Geodetic Vertical Datum of 1929.

Model Usage: The model uses the stage-storage data extensively in the simulation calculations. One equation is used for each mainstem river pool which completely describes the storage potential of a river pool from its bottom to elevations well above the dam crest. Equations are in the form of third-order (or less) polynomials, where the independent variable is elevation (ft) and the dependent variable is pool storage (million gallons).

Data Source: The default stage-storage equations were developed by fitting a third-order (or less) curve to stage-storage data obtained from the Kentucky Geological Survey (KGS) and the Army Corps of Engineers. The stage-storage data was developed from USGS quadrangle maps with a 20' contour interval.

Procedure:

❶ Select *Stage-Storage* from *Pools Data* in the *Navigate* menu on the menubar at the top of the screen.

❷ In the Pool Stage-Storage Screen, enter the coefficients for the new stage-storage curves. Equations must be of the form described in **Model Usage.** If a second-order polynomial is used, set the coefficient for the third-order term to zero.

❸ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen

Remarks: The stage-storage equations have a profound impact on model results. Extreme care should be taken when making changes to this data.

How Do I ... Modify the return flow percentages default database?

Parameter Definition: Default values for waste water treatment plant (WWTP) discharges (termed return flows) are located in the Annual Return Flows Database. Return flows are expressed as a percentage of the dependent demand withdrawal, reflecting the amount of the demand withdrawal that is returned to the river. Return flow percentages are provided for each month of the year. Return flow percentages in the default database can be loaded into the user input table on the Return Flows Screen by using the button control on that screen (see *How Do I ... Change return flow percentages?*). Only values in the user input table on the Return Flows Screen will be used in simulations. The basin average rate is a weighted average rate of the major WWTP rates that is used as the default value for the minor WWTP's.

Model Usage: The annual default return flows database is not used by the model during simulation. The default database is only used during the data input process.

Data Source: The default return flow rates for the major WWTP's were calculated by relating a select sample of 1986-1994 dry weather discharges to the corresponding withdrawals by the perceived primary municipal supplier. For more information on their derivation consult the *Task III Deficit Analysis* report (KWRRI, 1996)

Procedure:

❶ Select *Return Flows* from *Annual Databases* in the *Navigate* menu on the menubar at the top of the screen.

❷ In the Annual Return Flows Database that appears, enter the new return flow percentages (in decimal) for the desired WWTP's.

❸ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen

Remarks: The annual return flow database is accessed by the model from the Return Flows Screen when the user requests default values be used. Changing default values in the annual database will cause the new values to be loaded as defaults for all new requests.

The user only needs to access this screen if they desire to change the permanent default database of return flow percentages. Temporary changes to return flow percentages for single simulations should be made on the Return Flows Screen.

How Do I ... Modify the reservoir rule curve default database?

Parameter Definition: Default reservoir rule curves for the three major reservoir (Buckhorn, Carr Fork, and Dix) are located in the Annual Reservoir Rule Curve Default Database. The default reservoir rule curves indicate the desired daily water levels for each reservoir for every day in the year. Fragments of the rule curve are loaded into the rule curve table on the Reservoir Screen by using the control located on that screen (see *How Do I ... Specify reservoir rule curves?*). Only values in the user input table on the Reservoir Screen will be used in simulations.

Model Usage: The Annual Reservoir Rule Curve Default Database is not used by the model during simulation. The default database is only used during the data input process.

Data Source: The default rule curves for the three major reservoirs were obtained from the Army Corps of Engineers (Buckhorn and Carr Fork) and Kentucky Utilities (Dix).

Procedure:

❶ Select *Rule Curves* from *Annual Databases* in the *Navigate* menu on the menubar at the top of the screen.

❷ In the Annual Reservoir Rule Curve Database that appears, enter the new reservoir rule curve levels (in feet and NGVD) for the desired reservoirs.

❸ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen

Remarks: The Annual Reservoir Rule Curve Database is accessed by the model from the Reservoir Screens when the user requests default values be used. Changing default values in the annual database will cause the new values to be loaded as defaults for all new requests.

The user only needs to access this screen if they desire to change the permanent default database of reservoir rule curves. Temporary changes to reservoir rule curves for single simulations should be made on the respective Reservoir Screens.

How Do I ... Change the stage-storage-area data of the major reservoirs?

Parameter Definition: Reservoir stage-storage and stage-area data define the storage and surface area in the reservoir at any given elevation. Elevations are given in feet and are based on the National Geodetic Vertical Datum of 1929. Reservoir storage and surface area are given in million gallons and acres, respectively.

Model Usage: The model uses the stage-storage data extensively in the simulating the major reservoirs. Reservoir stage-area data is used by the model to compute evaporation losses. Both equations are in the form of third-order polynomials, with elevation as the independent variable and storage/area as the dependent variable.

Data Source: Default stage-storage-area equations for the reservoirs were developed from data provided by the Army Corps of Engineers (Buckhorn and Carr Fork), Kentucky Utilities (Dix), and Kentucky-American Water Co. (Jacobson).

Procedure:

❶ Select *SSA Data (Reservoirs)* from the *Navigate* menu on the menubar at the top of the screen.

❷ In the Reservoir Stage-Storage-Area Screen that appears, enter coefficients for the new stage-storage-area curves. Equations must be of the form described in **Model Usage.** If a second-order polynomial is used, set the coefficient for the third-order term to zero.

❸ Click on *Main* in the *Navigate* menu on the menubar to return to the Opening Screen

Remarks: Accurate stage-storage equations are paramount to properly simulating reservoir behavior and available water supply. Extreme care should be taken when making changes to this data.

When reservoir stage-storage equations are changed, be sure to change the tables to the right of the coefficient data. These tables are located off-screen and you will have to use the right arrow key or scroll bars to locate them.

References

Jain, Ashu, 1994, Development of a Decision Support System for Drought Characterization and Management.

Kentucky Water Resource Research Institute (KWRRI), 1996, Task III - Deficit Analysis.

Kentucky Water Resource Research Institute (KWRRI), 1996, KYBASIN User's Manual.