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HEC-WAT
Watershed Analysis Tool

Quick Start Guide

Version 1.0
September 2017

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14. ABSTRACT
The HEC-WAT program provides an interface that will streamline and integrate the analytical process using the tools commonly applied by the multi-disciplinary teams of USACE offices so that more efficient and coordinated modeling and planning may be performed. This Quick Start Guide will lead a user through a test watershed and how to build an HEC-WAT study.

15. SUBJECT TERMS
HEC-WAT, program, interface, streamline, integrate, analytical process, tools, multi-disciplinary, teams, Corps, water resources study, CAP, Continuing Authorities Program, study, graphical user interface, GUI, HEC-HMS, HEC-SSP, HEC-RAS, HEC-ResSim, HEC-DSSVue, HEC-FIA, software, plug-in, concept, computations, framework, USACE, hydrologic, hydraulic, economic, social impact analyses, modeling, results, models, reporting, visualization, data, sharing, rainfall-runoff analysis, river hydraulics, reservoir system analysis, flood damage analysis, flood impact analysis, statistical analysis, ecosystem response analysis, measures, trade-off analyses, alternatives, simulations, analysis periods, events, schematic, map layers, map windows, program order, reservoirs, levees, common computation points, stream alignment, impact areas, model linking, Without Project Conditions, panes, tabs, toolbars

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Chapter 1

HEC-WAT (Watershed Analysis Tool)

1.1 Introduction

The U.S. Army Corps of Engineers (USACE) conducts water resources management studies. These studies begin with the definition of problems, issues, and opportunities and continue through the planning process by formulating, evaluating, and comparing alternatives with various analyses to determine impacts so that appropriate decisions may be made. The studies often require hydrologic, hydraulic, economic, and social impact analyses. In most cases, varying sections within a USACE office or through a Project Delivery Team (PDT) perform these impact analyses independently with the reporting and visualization of modeling results through independent models. For the project study, coordination, file/data sharing, logistics, reporting of modeling results, and status reporting are often a problem for the modeling teams as well as project management.

The Institute for Water Resources, Hydrologic Engineering Center (CEIWR-HEC) developed the Watershed Analysis Tool (HEC-WAT) to meet the USACE requirements of performing water resources studies in a comprehensive, systems based approach. Modeling teams will benefit because teams will be able to develop models in a closely coordinated manner using a shared schematic; track progress of other models; and, automatically retrieve results from previous model runs through the shared schematic, thus assuring a more efficient and coordinated result. A graphical user interface (GUI) would allow data and results sharing, common schematic assembly, definition and representation of alternatives, model setup, editing and implementation, and direct data and results visualization. The management team would benefit through the use of a tool that employs a common interface by being able to track project status through each modeling component and being able to display results during public and project status meetings.

For over two decades, USACE has required that all USACE planning processes address the Nation's water resources needs in a systems context while using risk analysis. From within USACE there is very little guidance and few tools to support this requirement. For this reason, HEC has added an option to HEC-WAT that will analyze complex riverine systems while implementing the flood risk management and systems requirements. The new compute option, Flood Risk Analysis (FRA), will allow a user to perform plan formulation or system performance analyses while incorporating risk analysis.

HEC-WAT provides a framework that streamlines and integrates tools commonly applied by USACE District and Division offices used when performing a water resources management study. The basic building block of the HEC-WAT framework is an HEC developed concept labeled "plug-in". By using the plug-in concept HEC-WAT incorporates individual pieces of software such as:

HEC-RAS - River Analysis System
HEC-HMS - Hydrologic Modeling System
HEC-ResSim - Reservoir Simulation
HEC-FIA - Flood Impact Analysis
HEC-SSP - Statistical Software Package
HEC-DSSVue -HEC Data Storage System (DSS) Visual Utility Engine

The plug-in allows the software to work together in a coordinated fashion so that water resources, and economic decisions can be made from the same interface.

1.2 Purpose

The purpose of the HEC-WAT software is to help USACE study teams perform the necessary hydrologic, hydraulic, and consequence planning analyses that is required for water resource studies. The HEC-WAT framework allows a multi-disciplinary PDT to perform water resources studies in a comprehensive, systems based approach by building, editing and running models commonly applied by multi-disciplinary teams and saving and displaying data and results in a coordinated fashion.

The terminology, analysis procedures, and output used by HEC-WAT are consistent with the requirements of USACE guidance and policy. HEC-WAT is designed to facilitate:

- The entry of the appropriate data into each of the individual modeling programs.
- Trade-off analyses as all study alternatives will eventually be created within the HEC-WAT using consistent schematics, data, and tools. Their results will be easier to compare and contrast thus making the trade-off analysis easier to perform.
- The analytical process and enhanced coordination among study team members, while producing more consistent results, and shared displays.
- The definition of alternatives through schematic representations, model identification and sequencing, and tabular formats.
- The study status by reviewing reports in the HEC-WAT. During any given study, the manager or any other member of the project delivery team (PDT) will be able to determine the study status.
- The reviewing of modeling results at all modeled locations without the direct knowledge of how any of the individual models develop those results. Those attending meetings will be able to see the results directly rather than reading the results from a few locations in a hard copy report or poster.

Chapter 2

Installing HEC-WAT

2.1 Requirements

- Installation - about 3 GB of hard disk space for HEC-RAS 5.0.3 and HEC-WAT; Russian River watershed data about 10 GB; HEC-WAT Russian River watershed about 3 GB
- Memory - 6 GB
- Operating System - Windows XP 64-bit, Windows 7, and Windows 10.
- Java - HEC-WAT runs Java 8, which is included and run under the HEC-WAT installation folder

2.2 Installation

- Install HEC-WAT using the self-extracting exe file (i.e., C:\Programs) - "*HEC-WAT_10_Portable.exe*".
- HEC- RAS Install - If HEC-RAS Version 5.0.3 has not been installed on your computer, located in *C:\Programs\....\HEC-WAT-10_Portable\apps*) is a shortcut. Double-click on the shortcut and the user will be directed to the HEC-RAS download webpage.
- Install the Russian River Watershed using the zip file - "*Russian_WAT.7z*".
- Install the Russian River folder using the zip file - "*RussianRiver_Data.7z*".

- To create an HEC-WAT shortcut, from the HEC-WAT directory, right click on "*wat.exe*" and drag to the desktop. Release, and from the shortcut menu click **Create shortcuts here**, an HEC-WAT shortcut will appear.

2.3 Starting HEC-WAT

When starting HEC-WAT, double-click the HEC-WAT icon (shortcut) on your desktop. The splash dialog box (Figure 2.1) for HEC-WAT will open and will appear for a few seconds, and then the main window of HEC-WAT will appear (Figure 2.2). HEC-WAT is now ready for use.

Figure 2.1 HEC-WAT Splash Dialog Box

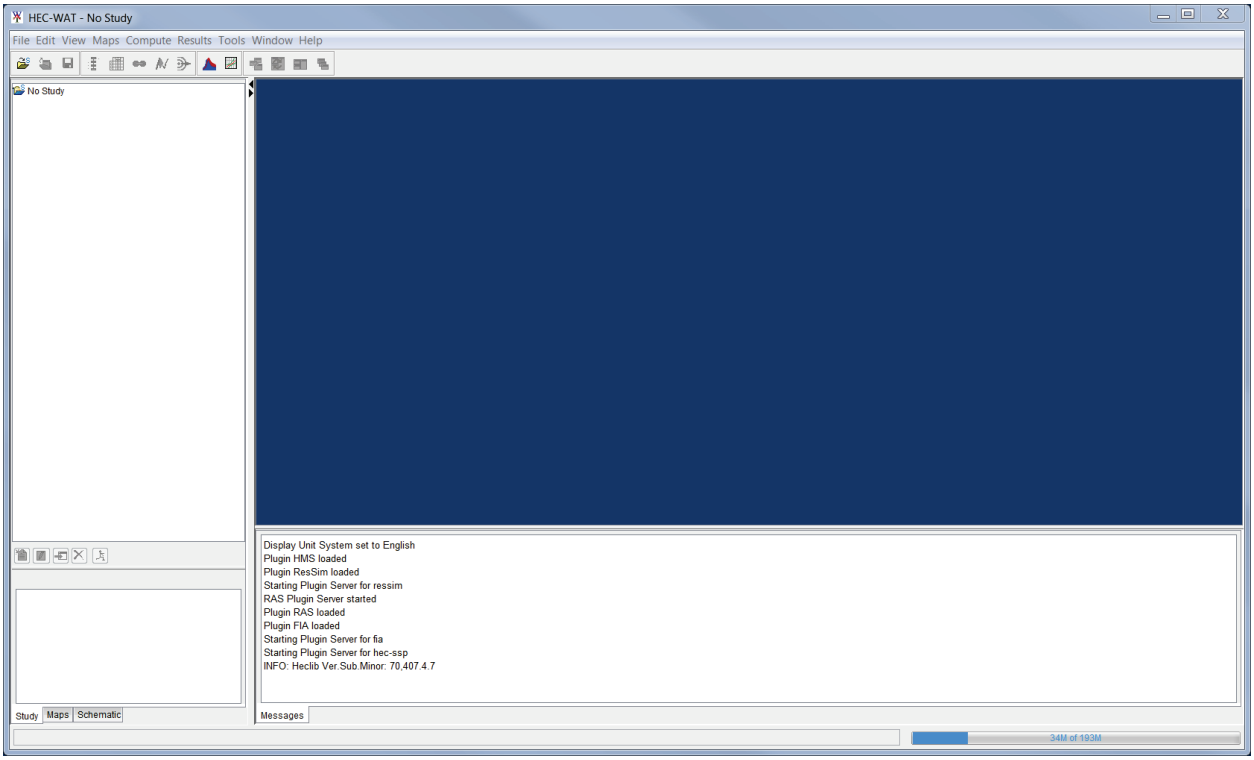


Figure 2.2 HEC-WAT Main Window

2.4 About the Quick Start Guide

Chapters 3 thru 5 provide the user with an overview of the HEC-WAT framework. Chapter 6 introduces the user to creating an HEC-WAT study from scratch. Chapters 7 thru 9 are standalone chapters that lead a user thru creating an HEC-WAT study by importing individual models (Chapter 7); importing a CWMS watershed (Chapter 8); and, creating an HEC-WAT study that incorporates a simple flood FRA compute.

Chapter 3

HEC-WAT Overview

HEC-WAT is software that orchestrates the building, editing, and running of a series of models to help perform water resources studies and address the requirements found in USACE guidance. The software provides flexibility to offices in the performance of water resources studies (Figure 3.1). The software can be used to perform small CAP (Continuing Authorities Program) studies or large comprehensive studies. The HEC-WAT interface streamlines and integrates the analytical process of water resource studies by using the tools commonly applied by multi-disciplinary teams. These tools include hydrologic, hydraulic, economic, and social impact assessments.

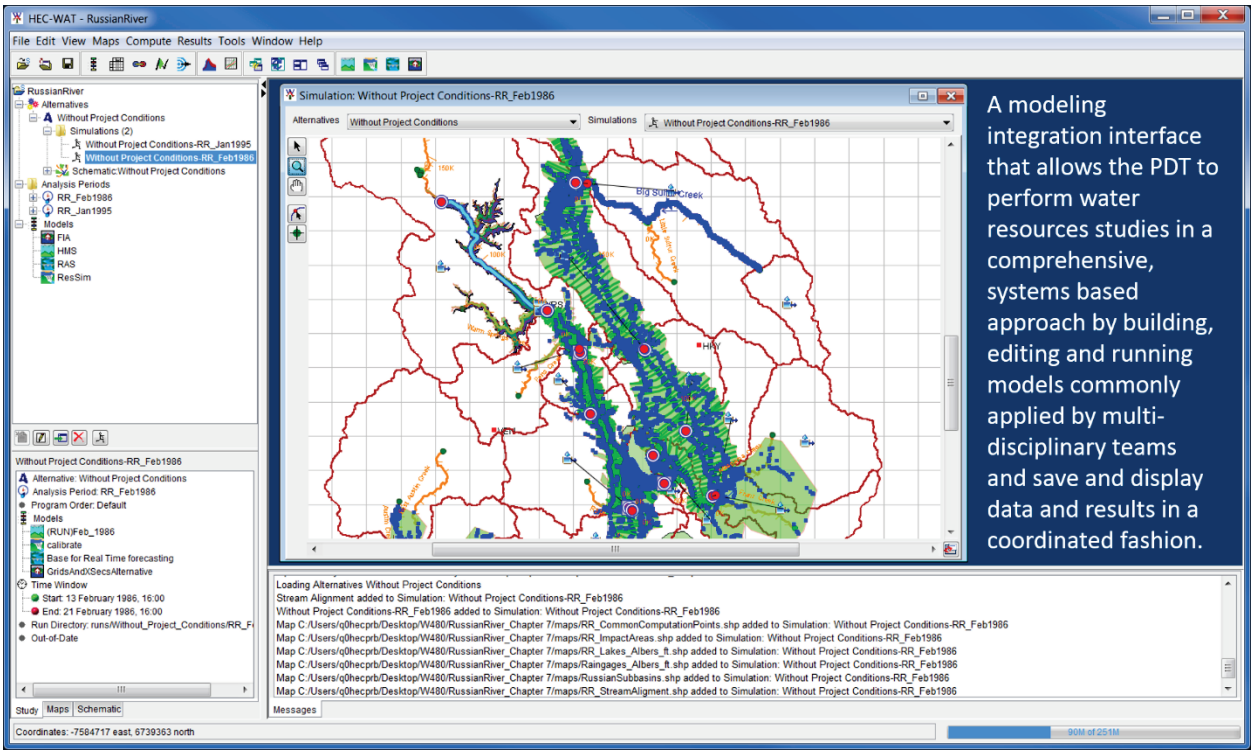


Figure 3.1 HEC-WAT Study

The HEC-WAT tool allows USACE and its partners and stakeholders to conduct their studies in a coordinated fashion. Coordination begins as each model uses the common schematic that is built within the HEC-WAT interface. The common schematic demands that each team use the same nomenclature for each of their models and alternatives. The individual models can be built and edited inside or outside the HEC-WAT and model results are viewed from HEC-WAT by selecting the elements found on the schematic. Once the models are located within HEC-WAT, the models can be run in sequence. The storage of data is organized by DSS and a simple DSS linking device is used to connect the models. The models themselves, the input data, and the results are all stored in the HEC-WAT's directory structure.

Therefore, all data and files used to make decisions are easily retrieved. Alternative analyses can be performed, and output from multiple alternatives can be viewed at the same time making alternative analyses and selection easier.

3.1 Identifying a Study

An issue at the beginning of any project study (i.e., reconnaissance, or feasibility) is the definition, study extent, and representation of alternatives, initially the without project, base year alternative. HEC-WAT helps to address this issue by allowing the project study team to jointly define alternatives through schematic representations, model identification and sequencing, and tabular formats.

The study team, under the direction of a Project Manager (PM), will start by meeting to acquaint the team with the location of the study to be conducted, and, then defining the problems and looking for opportunities. A typical study team could be composed of a PM, GIS (Geographic Information System) specialist, hydrologist, hydraulic engineer, water manager (reservoir), economist (flood damage and other consequence such as life loss), biologist (water quality), and planner.

After the location of the watershed, and the problems and opportunities of the study have been identified, the team will start the analytical process by determining what data or models already exist and what data and models will need to be built. Unlike the CWMS (Corps Water Management System) software that automatically extracts or copies data for a DSS file before a simulation is computed, HEC-WAT has no such requirements. Therefore, if the study requires the use of observed data, historical, or other model data, this data needs to be stored in DSS files. This requirement is based on the way HEC-WAT links model alternatives together and simulations are computed.

With a map in hand, the PM would lead the study team on choosing the study boundaries, identifying gage locations, sub-basin delineations, points where models would share data (common computation points), damage area centers, and location of measures (reservoirs, levees, etc.). Once this information has been identified then someone from the study team would be chosen to set up the base alternative (Without Project Conditions). This person should be someone with knowledge of the study area.

With the study area defined, the study team needs to identify any models that may already exist, what data is available, and what is the time window (analysis period) for the base alternative (Without Project Conditions). Once the base alternative is set the study team could identify, name, and gather information for additional alternatives. These alternatives could include the use of additional flood risk management measures, environmental features, or represent future conditions. The benefit of HEC-WAT is that each of the modeling teams will be able to use the identical schematic to perform their modeling and naming will be consistent across all models.

Each alternative will be tied to a given schematic. Therefore, the alternative definitions will be fully coordinated making for more consistent modeling and results.

3.2 Creating a Study

After the study team has identified the study area, an HEC-WAT study can be created (Figure 3.1). A **study**, in HEC-WAT is a combination of the data and models and events required to analyze a specific geographic area. The first step is to define the schematic for the base alternative, and then schematics for other defined alternatives.

A **schematic** is a physical representation of a stream alignment, and the flood risk management and environmental measures that will be modeled. One individual from the study team will build the schematic for the base alternative. The first basic item of an HEC-WAT schematic is the stream alignment; this is usually created from importing information from a map layer (shapefile). Once a stream alignment has been built, then using the drawing tools available from within HEC-WAT, common computation points, and existing flood control or restoration measures, can be added to the schematic that will be shared across all models. To aid in the placement of elements on the schematic, background maps of gage locations, reservoir locations, sub-basin delineations, study boundary areas, etc. could be added to the study.

By default, HEC-WAT creates the base alternative – Without Project Conditions first. The study team has probably defined other alternatives that can be created, as well. An **alternative** in HEC-WAT is a way to group a schematic with different operations and model parameters. Once an alternative is created, the next step is to create analysis periods. **Analysis periods** define the time window and events that could be associated with an alternative are generated using time window modifiers. An **event** is an occurrence of precipitation/snowmelt that leads to some sort of hydrologic response normally associated with a specific time period. The event can be historical or hypothetical or represent the upper limit of a precipitation runoff response.

Now that alternatives and analysis periods have been defined, existing models that have been identified can be brought into the HEC-WAT study either by importing or copying the files into the HEC-WAT directory structure. If models are to be built, the HEC-WAT provides two options. One is that the models can be created through HEC-WAT by accessing the individual pieces of software directly from the framework. The other option is to copy the files created by HEC-WAT to a computer, and then return the files to the HEC-WAT study (Chapter 4, Section 4.6) once the models are calibrated. For example, if the HEC-RAS model for a study needs to be built, from the HEC-WAT directory structure there is a HEC-RAS folder which contains the default HEC-RAS files for the study. Copy these files to a computer, create the HEC-RAS model, and then copy the files back to the HEC-WAT study.

Once all the models have been added to the HEC-WAT study, simulations can be created. A **simulation** is a combination of an analysis period and event(s) associated with an alternative. For each of these combinations, models will need to be selected, the simulation will be computed, and results will be reviewed. The process is then repeated for the other identified alternatives, and after several HEC-WAT simulations, alternative result comparisons can be reviewed.

3.3 Opening a Study

1. From the HEC-WAT main window (Figure 3.1), from the **File** menu, click **Open Study**. The **Open Study** Browser (Figure 3.2) will open.

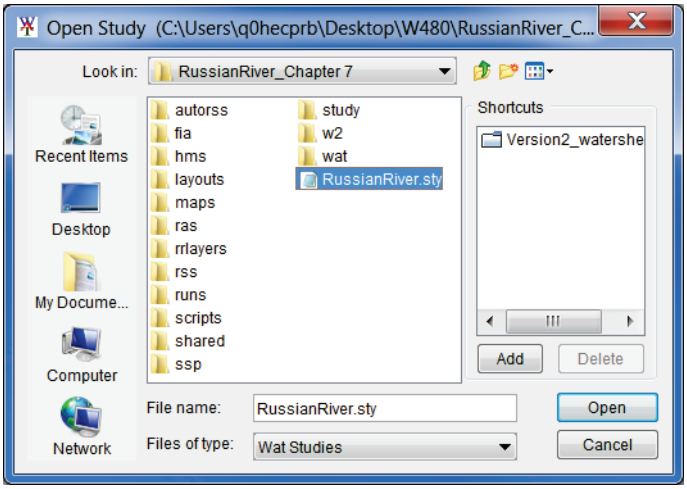


Figure 3.2 HEC-WAT - Open Study Browser

2. Browse to the location of the provided HEC-WAT study (i.e., *C:\Users\xxxxxxxx\Desktop\Russian_WAT*). The **Look in** list will show the location that is being chosen. Click on the .sty file - *RussianRiver.sty*. The **File Name** box will now contain the .sty file name. The **Files of Type** list should display *Wat Studies*.

3. Click **Open**, the **Open Study** Browser will close (Figure 3.2) and the HEC-WAT main window (Figure 3.3) will now display the selected study - *RussianRiver*.

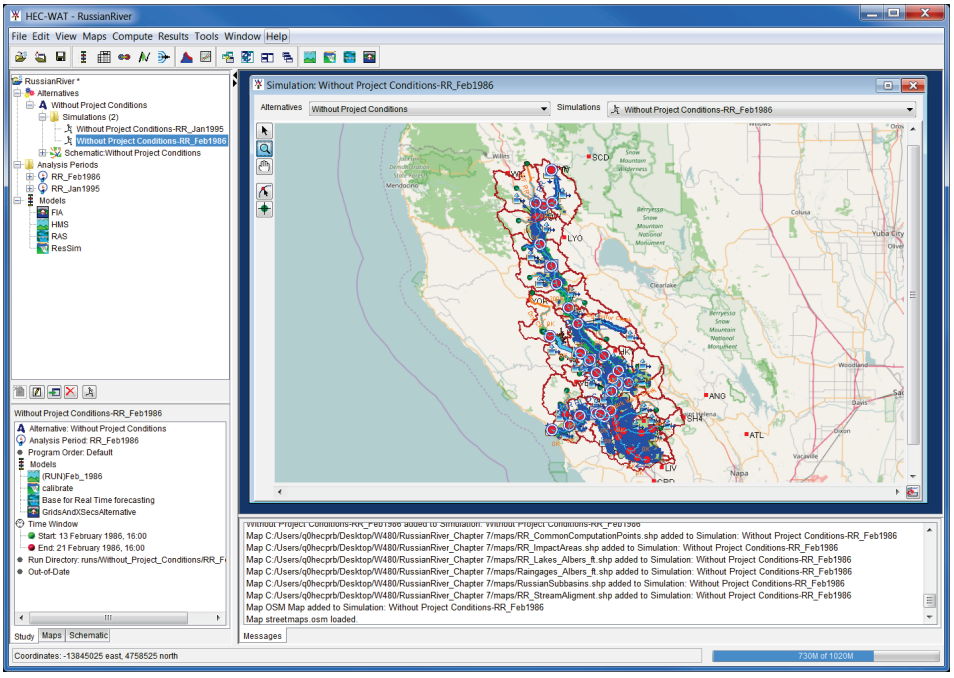


Figure 3.3 HEC-WAT Main Window - *RussianRiver* Study

Chapter 4

HEC-WAT Interface

The HEC-WAT main window (Figure 4.1) displays the framework for the HEC-WAT software that allows users to enter data, review data, create alternatives, run simulations, and view results. The **Title Bar** (Figure 4.1) displays the HEC-WAT study title. After a study is opened, the name of the study will appear here.

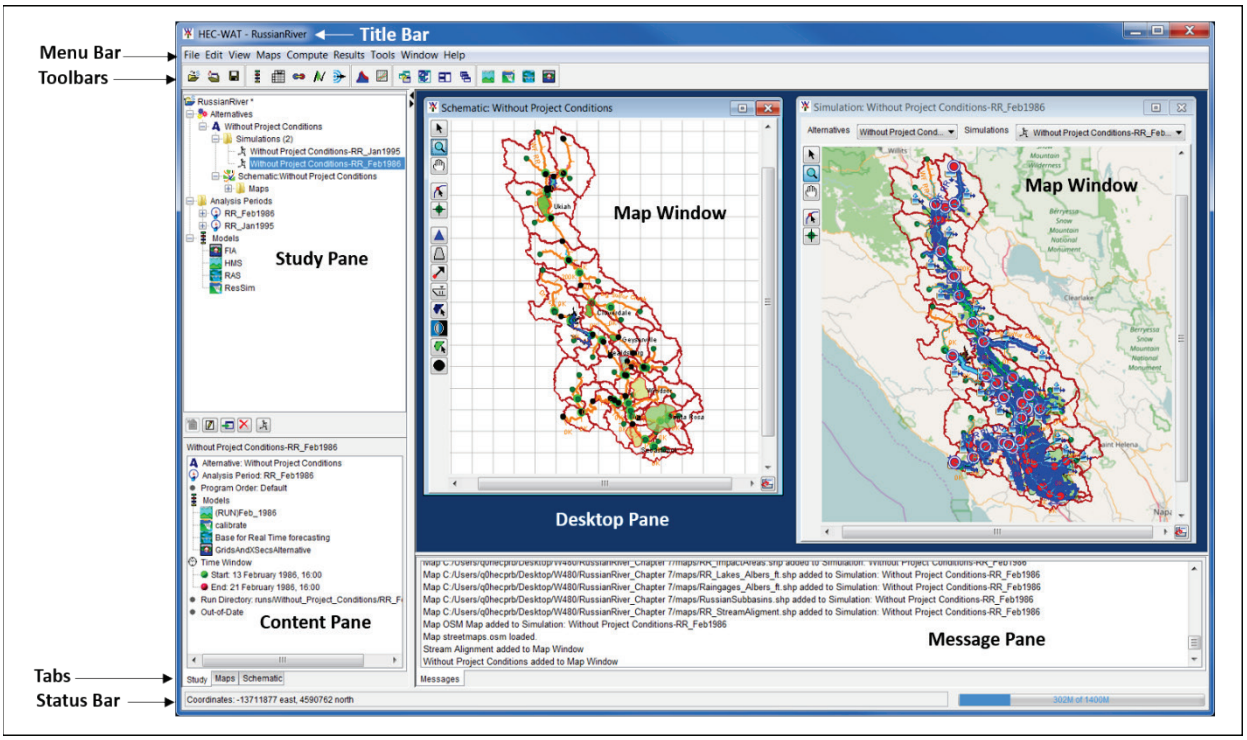


Figure 4.1 HEC-WAT Main Window

4.1 Panes

The HEC-WAT main window (Figure 4.1) is laid out in panes that allow the user to view HEC-WAT study data at the same time or to display different, yet simultaneous, views of the study data. The HEC-WAT main window has four main panes. The panes are:

Study Pane Provides an overview of items that have been defined for an HEC-WAT study (Figure 4.2). Based on the view (Section 4.2), the **Study Pane** can display information about alternatives; simulations; analysis periods; models that have been defined for the study; what map windows are actively open; the available schematics; stream alignments; measures; common computation points; and, impact areas.

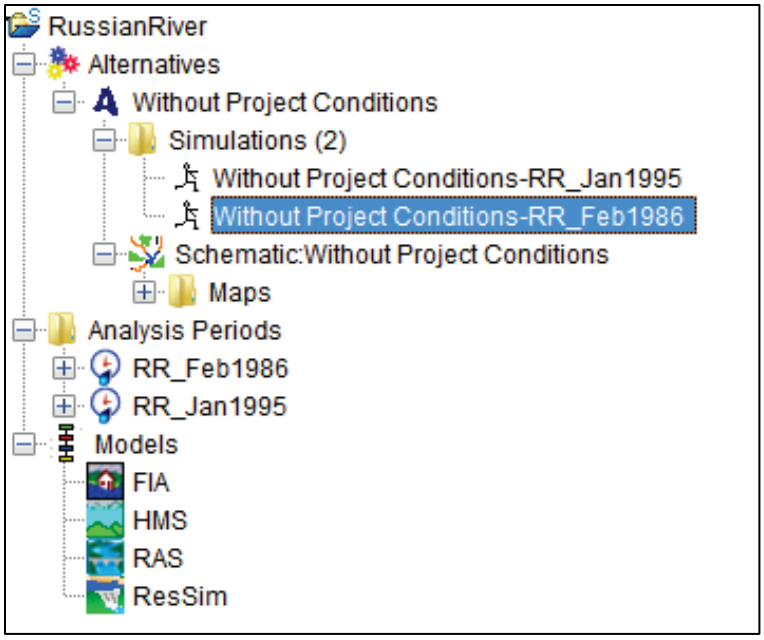


Figure 4.2 Study Pane - Study View

Content Pane This pane provides details on selected HEC-WAT components (Figure 4.3) in the **Study Pane** (available in the study, maps, and schematic views; see Section 4.2). For example, in Figure 4.3, for a study view, an HEC-WAT simulation has been selected – *Without Project Conditions-RR_Feb_1986*. The **Content Pane** displays the elements of the selected simulation. Information includes the alternative, the analysis period, the program order being used, the model alternatives that were run, the time window, the directory where the results from the simulation were written, and the status of the simulation. For a map view, the **Content Pane** displays the layers (map layers, primary layers) associated with the selected map windows listed in the **Study Pane**.

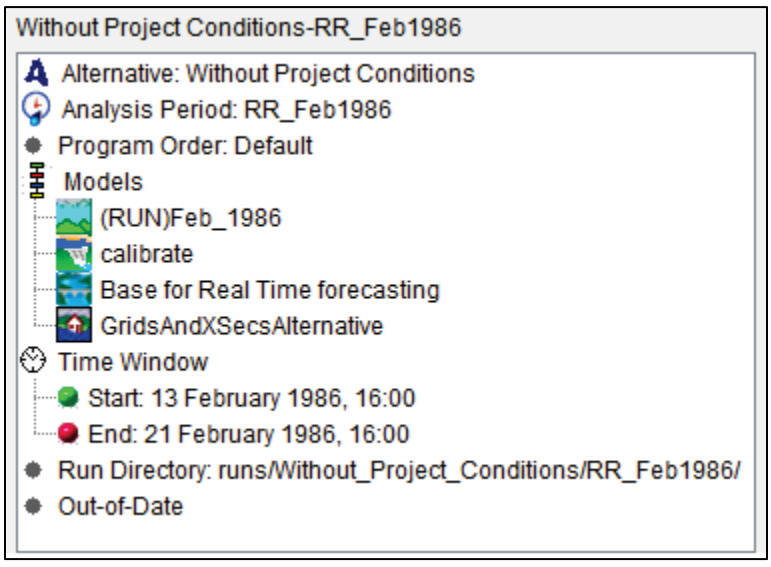


Figure 4.3 Content Pane - Study View

Desktop Pane The **Desktop Pane** (Figure 4.4) is where the different map windows available from HEC-WAT will display. For example, in Figure 4.4, the **Desktop Pane** contains a map window of a selected simulation and a map window of a selected schematic. These two map windows provide the user with a graphical representation of a simulation and a schematic, respectively.

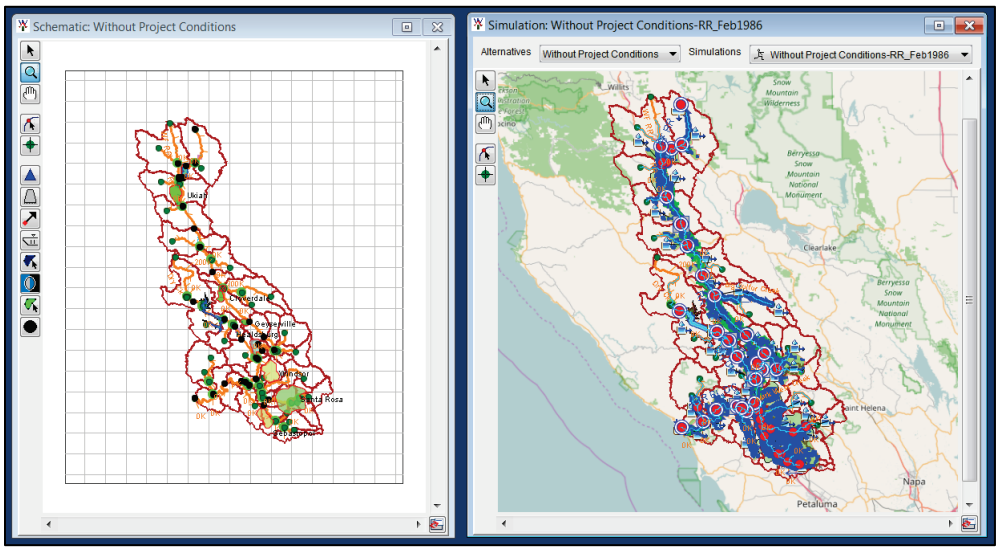


Figure 4.4 Desktop Pane

Message Pane The **Message Pane** (Figure 4.5) contains messages that the HEC-WAT software is providing for informational purposes. The information in the **Message Pane** is a record of HEC-WAT software activities, recording the opening of a study, opening map windows, accessing DSS, and many other HEC-WAT activities.

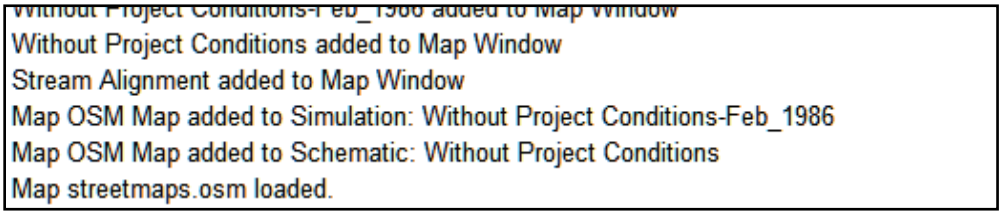
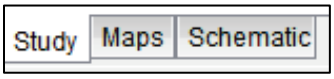


Figure 4.5 Message Pane

4.2 Tabs



HEC-WAT tabs provide different views of the available data in a study and users can perform certain operations for a study from the tabs. The tabs can change the layout of the menu bar; and, available information in the **Study** and **Content** panes can change. There are three tabs:

Study The default tab (Figure 4. 2) which provides a view of the study data in a tree (study tree) in the **Study Pane**. Also, from the **Study Tree** a user can create, edit, and delete alternatives, analysis periods, and simulations. From the **Content Pane** (Figure 4.3) the user can view detailed information about items

listed in the **Study Tree**. Also, this view affects the HEC-WAT menu bar (Section 4.3)

Maps This tab (Figure 4.6) provides a view (**Maps View**) of the map windows currently active in the **Desktop Pane** (Figure 4.4). The maps windows are displayed by type in the **Study Pane** portion. In the **Content Pane** portion (Figure 4.6) information about the layers for a selected map window are displayed. Also, from the **Content Pane** in the **Maps View** the user can turn layers on/off, adjust properties of the layers, and order the layers for viewing in the associated map window. When the user switches to the **Maps View** the HEC-WAT menu bar options will change.

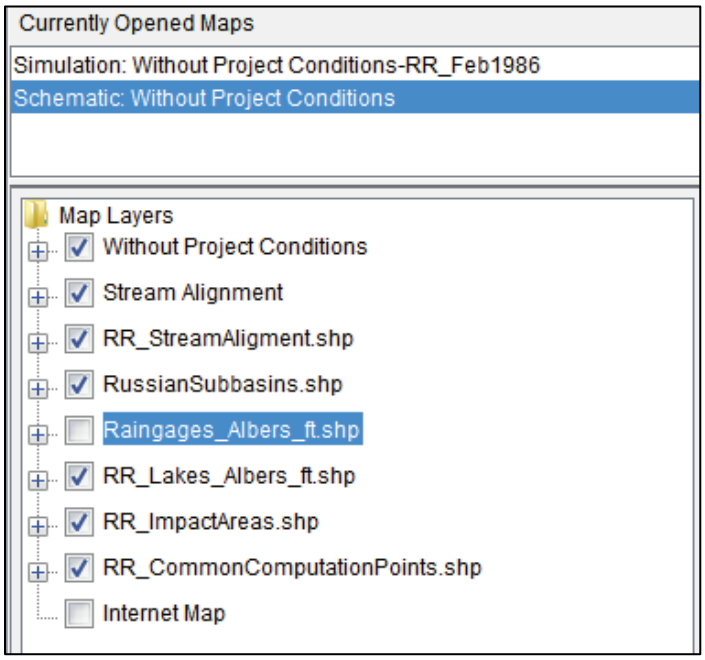


Figure 4.6 Maps Tab

Schematic From this tab (Figure 4.7), the user is provided with a view (a tree) in the **Study Pane** of the map layers that are available in the study, schematics that have been defined for the study, and, available components - stream alignments, measures (levees, reservoirs), common computation points, and impact areas that have been defined for the study. Also, from the study tree, the user can create, edit, delete, and modify the elements in the **Schematic View**. In the **Content Pane** further information is provided about elements in the **Schematic View**. When the user switches to the **Schematic View** the HEC-WAT menu bar options will change.

4.3 Menu Bar

The menu bar of HEC-WAT provides the user with many commands to perform various functions. For further details on each command for the available menus, review the HEC-WAT User's Manual. For this manual, an overview of each menu that is available in the HEC-WAT software is provided.

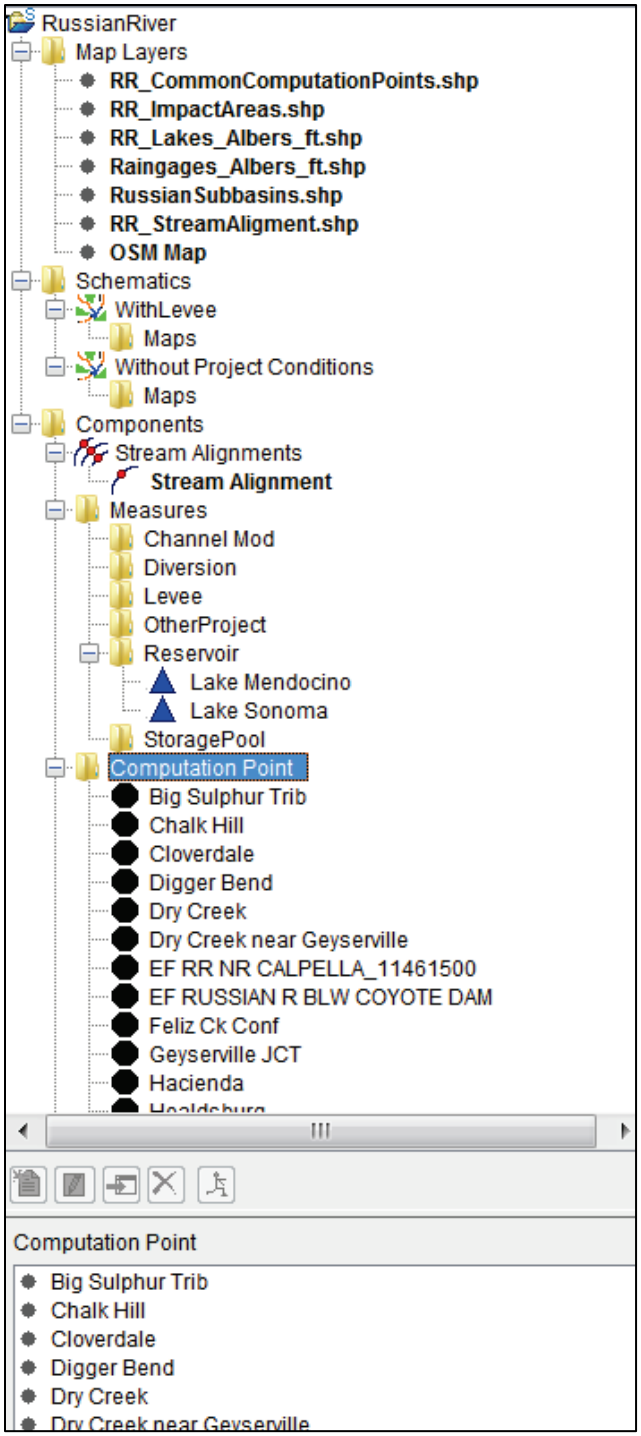


Figure 4.7 Schematic Tab

The **File** menu allows the user to perform study management functions such as creating, opening, closing, and saving an HEC-WAT study. Also, provides commands that will allow users to provide information about the study team; select the software applications or tools (plug-ins) that are needed for the study; import a CWMS watershed; import other HEC software application's model alternatives (HEC-HMS, HEC-ResSim, HEC-RAS, HEC-ResSim); open recently viewed HEC-WAT studies; and, exit the HEC-WAT software. This menu is available in all HEC-WAT views.

From the **Edit** menu, the HEC-WAT users can create/modify/edit items that are the building blocks of an HEC-WAT study. A user can manipulate alternatives and simulations; establish the program order for a study; link the individual models of a study; modify the look and feel of the common computation point layers (CCPs); provide aliases for defined stream segments in the HEC-WAT study; access available FRA editors; and, access editors from the individual application software and tools that are part of a study. This menu is available in all HEC-WAT views.

The **View** menu is where an HEC-WAT user can setup the HEC-WAT main window. The user can select which toolbars and panes to display and not display; set display units for plotting and tabulating; save layouts of the HEC-WAT framework; select which common computation point layer to view; and, review a report of the CCPs by common computation point layer in the HEC-WAT study. This menu is available in all HEC-WAT views.

From the **Maps** menu the user can setup map layers and map windows for the HEC-WAT study. Commands include setting up spatial properties; adding and removing map layers; manipulate map windows; add an Internet map; print a copy of the active map window in the **Desktop Pane** (Figure 4.4); and, import and export schematic elements (i.e., stream alignment, common computation points). This menu is available in all HEC-WAT views.

The **Compute** menu is used to compute individual simulations; compute multiple simulations; view a list of simulations for the watershed that have been computed; compute the active simulation or compute the individual models of the active simulation; and, view the compute log for the active simulation. This menu is only available in the **Study View**.

From the **Results** menu the user can view the simulation DSS file which contains data from a simulation; and, results from the software applications that are part of the active study. This menu is only available in the **Study View**.

The **Tools menu** provides access to DSS data (HEC-DSSVue); access to the Statistical Software Package (HEC-SSP); provides options for HEC-WAT startup, setting system properties, viewing threads, setup simulation and compute color, and plug-in information; view the log for HEC-WAT; view the logs that display DSS file activity and the logs of the applications software; monitor memory usage; what graphic elements HEC-WAT knows about from the other applications; information on how the different model alternatives are used for the study; and, setup for Distributed Computing. This menu is available in all HEC-WAT views.

From the **Window** menu the HEC-WAT user can control the appearance of the map windows in the **Desktop Pane** (Figure 3.1) of the HEC-WAT main window. This menu is available in all HEC-WAT views.

From the **Help** menu the user can access HEC-WAT documentation (i.e., HEC-WAT User's Manual, HEC-WAT Quick Start Guide), install the example study, connect to the HEC-WAT webpage, connect to the HEC website, and display current version information about HEC-WAT.

4.4 Map Windows

Map windows (Figure 4.4) in HEC-WAT provide a way to graphically display HEC-WAT components. Map windows are displayed in the **Desktop Pane** of the HEC-WAT interface. There are three types of map windows available in HEC-WAT - schematic, alternative, and simulation. The HEC-WAT User's Manual provides more detailed information on map windows.

4.5 Plug-Ins

The primary purpose of HEC-WAT is to streamline and integrate a water resources study using software commonly applied by multi-disciplinary teams. The integration of the models is accomplished through the use of a concept called a "**plug-in**". By using plug-ins, HEC-WAT can incorporate individual pieces of software (HEC-RAS, HEC-HMS, HEC-ResSim, HEC-FIA) into the HEC-WAT framework which allows the individual software applications to work together in a coordinated fashion so that water resources, and economic decisions can be made from the same interface. For further details on plug-ins, review the HEC-WAT Technical Reference Manual which will be available after the release of Version 1.0.

To view the HEC-WAT default plug-ins:

1. From the HEC-WAT main window (Figure 4.1), from the **Tools** menu, click **Options**.

2. The **Options** dialog box (Figure 4.8) will open. Click on the **Plug-ins** tab. The table that is displayed provides information on all of the current plug-ins that are available in HEC-WAT.

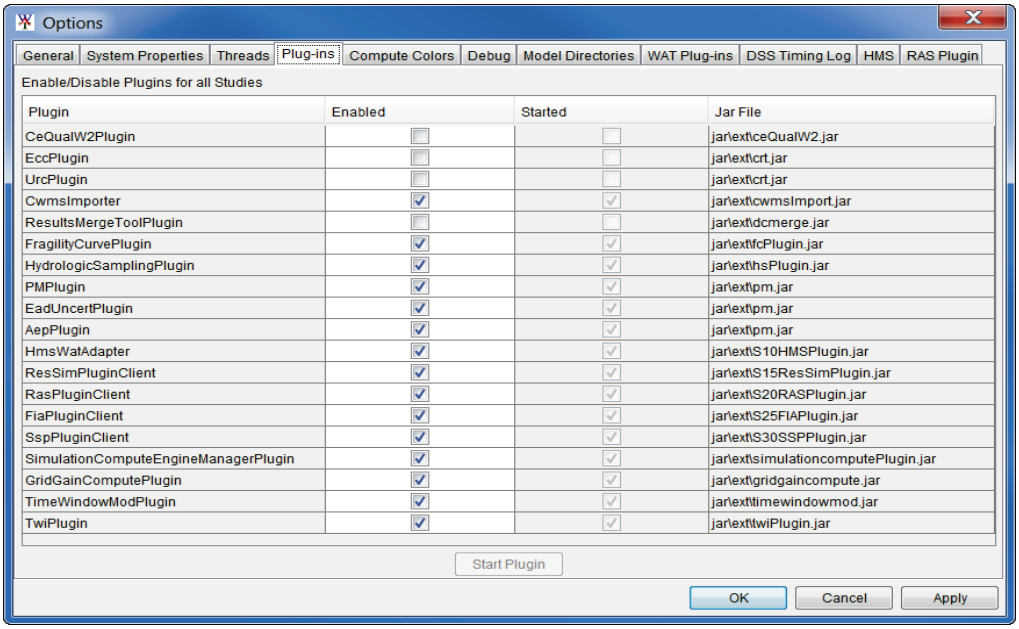


Figure 4.8 HEC-WAT - Options Dialog Box - Plug-ins Tab

4. Click **OK**, the **Options** dialog box will close (Figure 4.8).

To select the plug-ins for a study:

1. From the HEC-WAT main window (Figure 4.1), from the **File** menu, click **Study Details**.

2. The **Study Details** dialog box (Figure 4.9) will open. This dialog box provides information about the active study, allows the user to manipulate map windows; contact information for the study team; information on the model alternatives that make up the study; information about study simulations, and the plug-ins that are used by the study

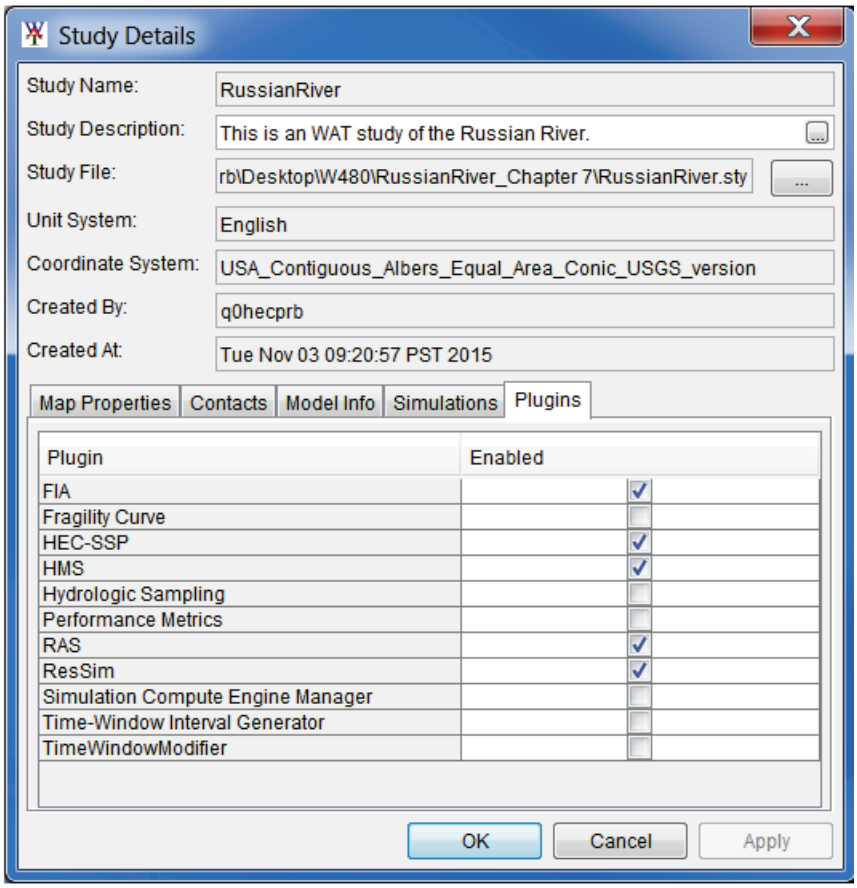


Figure 4.9 Study Details Dialog Box – Plugins Tab

3. Click on the **Plug-ins** tab. By enabling or disabling the plug-ins listed, the user will define what plug-ins will be used for the active study.

4. Click **OK**, the **Study Details** dialog box (Figure 4.9) will close.

4.6 Directory Structure

Once an HEC-WAT study has been created, a directory structure has been created at a location the user selected when creating a HEC-WAT study. Figure 4.10 is a snapshot that represents the HEC-WAT directory structure for the *RussianRiver* study. More information on this directory structure and the individual files is provided in Chapter 4 of the HEC-WAT User's Manual.

Name	Date modified	Type	Size
autorss	2/22/2016 5:37 PM	File folder	
fia	8/4/2016 9:05 AM	File folder	
hms	8/4/2016 9:05 AM	File folder	
layouts	8/4/2016 9:03 AM	File folder	
maps	8/3/2016 2:01 PM	File folder	
ras	5/2/2016 7:52 PM	File folder	
rrlayers	11/3/2015 9:34 AM	File folder	
rss	8/4/2016 9:03 AM	File folder	
runs	8/3/2016 8:20 AM	File folder	
scripts	11/3/2015 9:22 AM	File folder	
shared	6/27/2016 5:10 PM	File folder	
ssp	11/3/2015 9:48 AM	File folder	
study	7/8/2016 1:46 PM	File folder	
w2	7/17/2016 8:51 AM	File folder	
wat	5/13/2016 4:09 PM	File folder	
.forecast	11/3/2015 9:22 AM	FORECAST File	2 KB
.forecast.bak	11/3/2015 9:22 AM	BAK File	0 KB
contacts.xml	6/24/2016 6:23 PM	XML Document	1 KB
contacts.xml.bak	4/16/2016 8:31 PM	BAK File	1 KB
Correct_stream.align	11/3/2015 9:22 AM	ALIGN File	775 KB
Default.ag	11/3/2015 9:23 AM	AG File	1 KB
Default.ag.bak	11/3/2015 9:22 AM	BAK File	1 KB
modelAltInfo.xml	6/24/2016 6:23 PM	XML Document	3 KB
modelAltInfo.xml.bak	4/16/2016 8:31 PM	BAK File	2 KB
PrecipGrids.xml	11/3/2015 9:22 AM	XML Document	2 KB
PrecipGrids.xml.bak	11/3/2015 9:22 AM	BAK File	2 KB
RR_PrecipGrids.xml	11/3/2015 9:22 AM	XML Document	2 KB
RR_PrecipGrids.xml.bak	11/3/2015 9:22 AM	BAK File	2 KB
RR_ResSim_Model.wksp	11/3/2015 9:22 AM	WKSP File	4 KB
RR_ResSim_Model.wksp.bak	11/3/2015 9:22 AM	BAK File	4 KB
Russian_River.wksp	11/3/2015 9:22 AM	WKSP File	4 KB
Russian_River.wksp.bak	11/3/2015 9:22 AM	BAK File	4 KB
RussianRiver.log	8/4/2016 9:05 AM	Text Document	380 KB
RussianRiver.log.bak	8/4/2016 9:05 AM	BAK File	380 KB
RussianRiver.projection	8/3/2016 2:01 PM	PROJECTION File	1 KB
RussianRiver.projection.bak	8/3/2016 12:50 PM	BAK File	1 KB
RussianRiver.sty	8/3/2016 2:01 PM	STY File	9 KB
RussianRiver.sty.bak	8/3/2016 12:50 PM	BAK File	9 KB
RussianRiver.sty.projection	6/24/2016 5:52 PM	PROJECTION File	1 KB
RussianRiver.sty.projection.bak	6/24/2016 5:52 PM	BAK File	0 KB
RussianRiver.sty.sa.bak	6/24/2016 5:52 PM	BAK File	0 KB
RussianRiver.wksp	8/4/2016 9:03 AM	WKSP File	5 KB

Figure 4.10 HEC-WAT Example Directory Structure

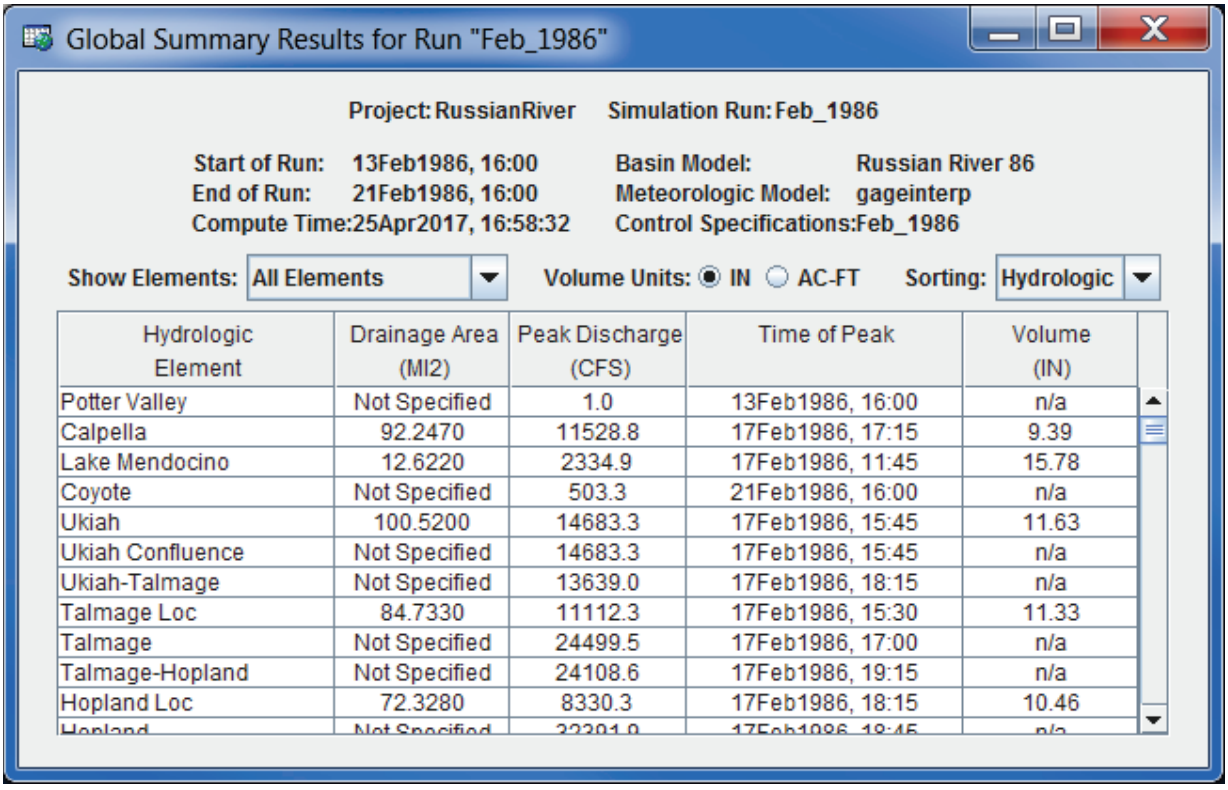
Chapter 5

Reviewing Results

To view model results in HEC-WAT, at least one simulation map window should be open in the **Desktop Pane**. Results will display for the active simulation map window by the model alternatives that are associated with the simulation. Results are available either from the HEC-WAT main window (Figure 4.1), from the **Study Tree** by simulation, from the **Content Pane**, or interactively from the schematic of the current simulation map window.

5.1 Results Menu

From the HEC-WAT **Results** menu the user can access reports from the different models. From the HEC-WAT main window (Figure 4.1), from the **Results** menu, the user will point to the model from which the user wants to view results for. For example, if the user points to **HMS**, points to the HEC-HMS model alternative (that is part of selected simulation), click on **Global Summary Table**, the **Global Summary Results for** report for that particular HEC-HMS run will display (Figure 5.1).



Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Potter Valley	Not Specified	1.0	13Feb1986, 16:00	n/a
Calpella	92.2470	11528.8	17Feb1986, 17:15	9.39
Lake Mendocino	12.6220	2334.9	17Feb1986, 11:45	15.78
Coyote	Not Specified	503.3	21Feb1986, 16:00	n/a
Ukiah	100.5200	14683.3	17Feb1986, 15:45	11.63
Ukiah Confluence	Not Specified	14683.3	17Feb1986, 15:45	n/a
Ukiah-Talmage	Not Specified	13639.0	17Feb1986, 18:15	n/a
Talmage Loc	84.7330	11112.3	17Feb1986, 15:30	11.33
Talmage	Not Specified	24499.5	17Feb1986, 17:00	n/a
Talmage-Hopland	Not Specified	24108.6	17Feb1986, 19:15	n/a
Hopland Loc	72.3280	8330.3	17Feb1986, 18:15	10.46

Figure 5.1 HMS - Global Summary Report

For HEC-RAS, from the **Results** menu, point to **RAS**, click **Plot XYZ 3-D**, the **X-Y-Z Perspective Plot** dialog box will open (Figure 5.2).

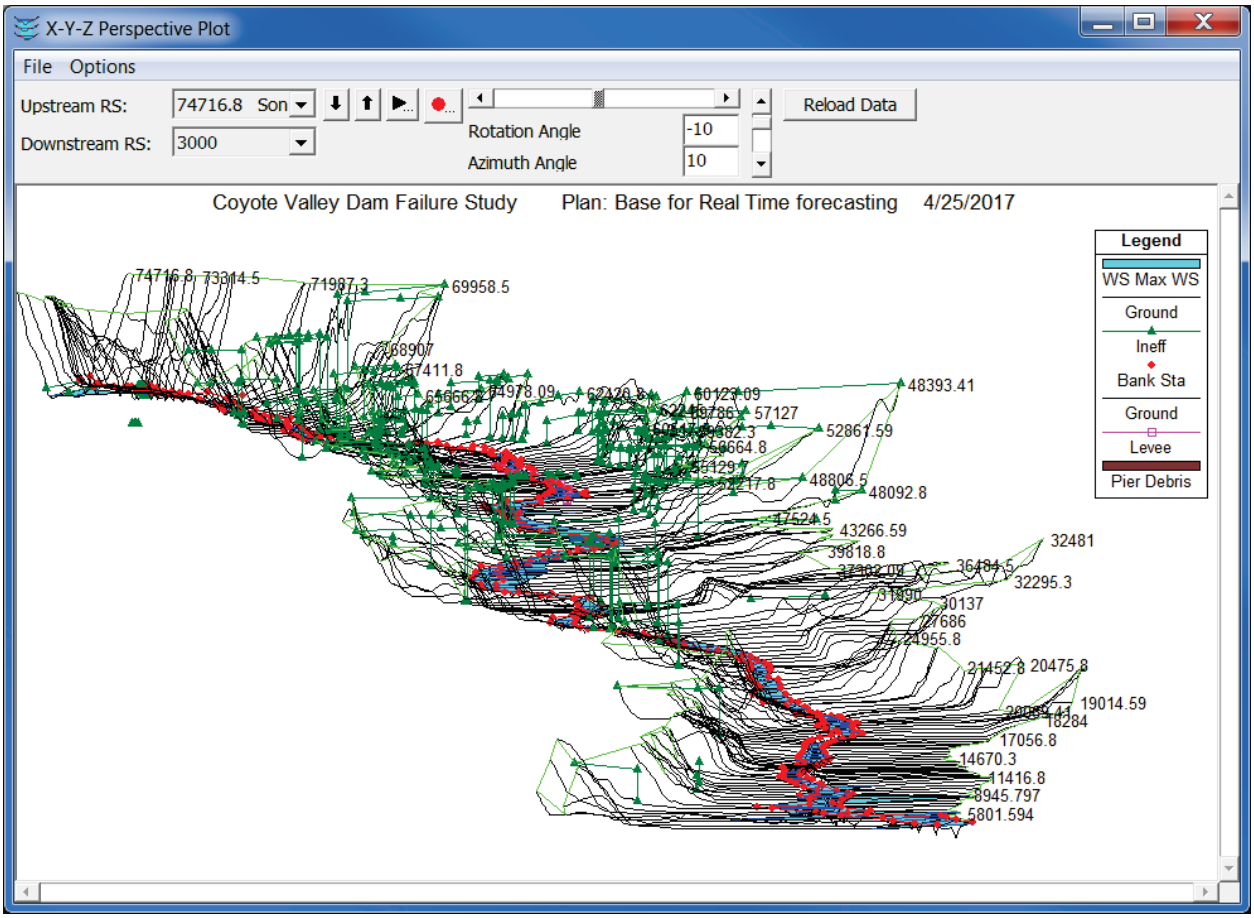


Figure 5.2 RAS - X-Y-Z Perspective Plot

5.2 Content Pane

Once a simulation has been computed, the user can also get the same reports that are available from the **Results** menu from the **Content Pane**. From the **Content Pane** right-click on one of the available models, from the shortcut menu (Figure 5.3), point to **Results**, click on the results that are available.

For example, in Figure 5.3, from the **Content Pane** right-click on the HEC-ResSim *calibrate* model, from the shortcut menu point to **Results**, click **Flow Summary**. The HEC-ResSim **Flow Summary Report** dialog box will open (Figure 5.4).

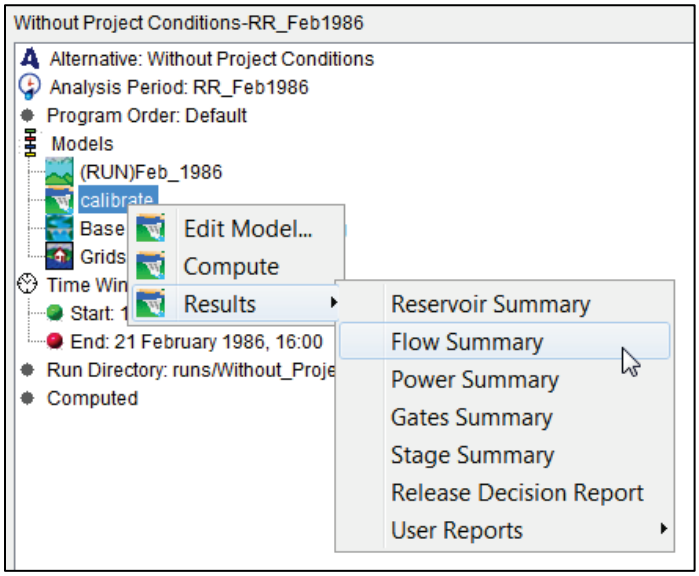
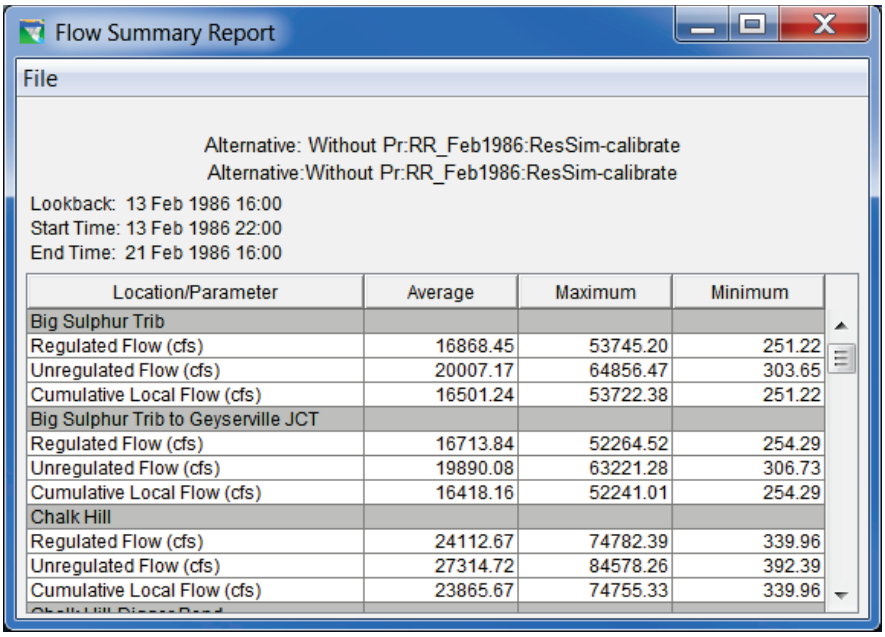


Figure 5.3 Content Pane - Shortcut Menu - Results



Flow Summary Report

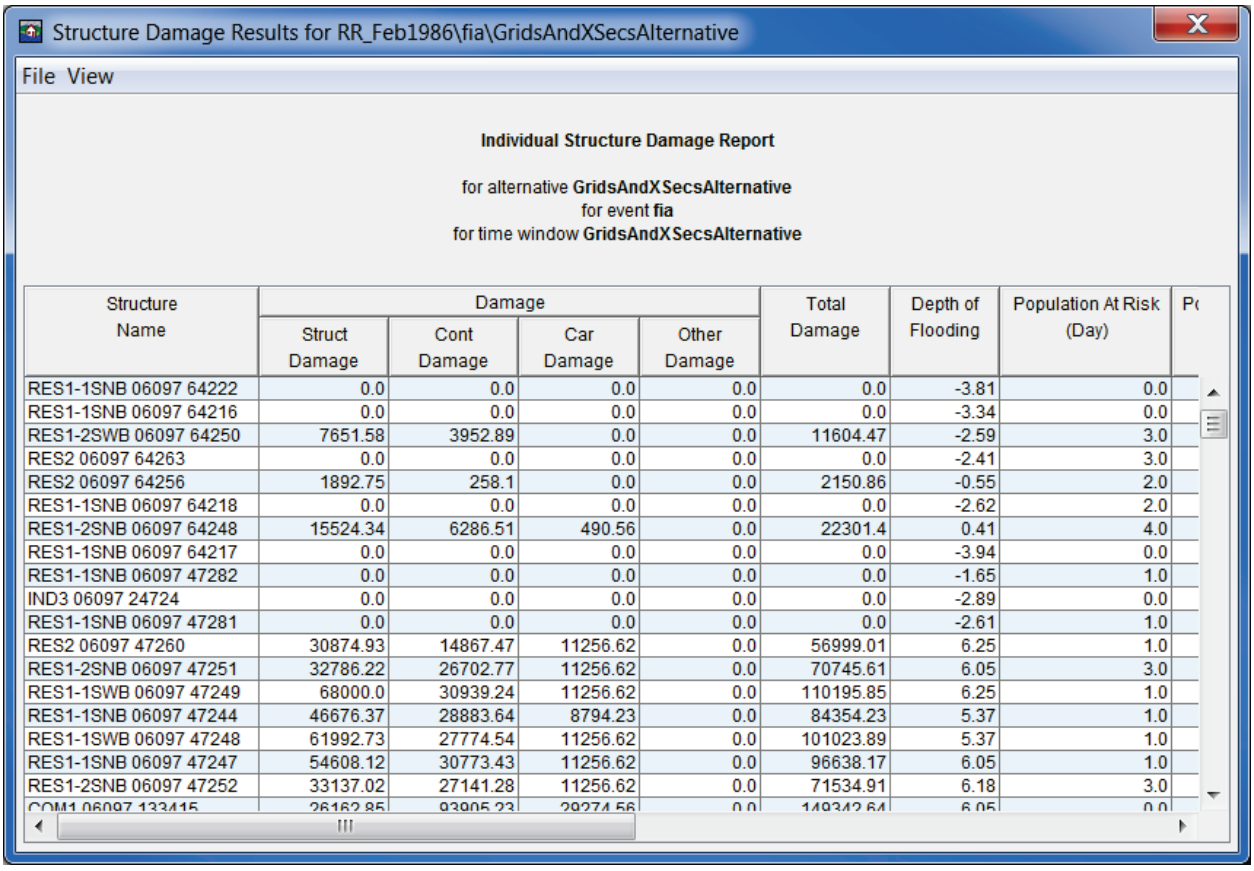
File

Alternative: Without Pr:RR_Feb1986:ResSim-calibrate
Alternative:Without Pr:RR_Feb1986:ResSim-calibrate
Lookback: 13 Feb 1986 16:00
Start Time: 13 Feb 1986 22:00
End Time: 21 Feb 1986 16:00

Location/Parameter	Average	Maximum	Minimum
Big Sulphur Trib			
Regulated Flow (cfs)	16868.45	53745.20	251.22
Unregulated Flow (cfs)	20007.17	64856.47	303.65
Cumulative Local Flow (cfs)	16501.24	53722.38	251.22
Big Sulphur Trib to Geyserville JCT			
Regulated Flow (cfs)	16713.84	52264.52	254.29
Unregulated Flow (cfs)	19890.08	63221.28	306.73
Cumulative Local Flow (cfs)	16418.16	52241.01	254.29
Chalk Hill			
Regulated Flow (cfs)	24112.67	74782.39	339.96
Unregulated Flow (cfs)	27314.72	84578.26	392.39
Cumulative Local Flow (cfs)	23865.67	74755.33	339.96

Figure 5.4 ResSim - Flow Summary Report - Russian River

For HEC-FIA results, right-click on the HEC-FIA *GridsAndXSecsAlternative* model, from the shortcut menu point to **Results**, click **Individual Structure Damage Report**. The HEC-FIA **Individual Structure Damage Report** will open (Figure 5.5).



Structure Damage Results for RR_Feb1986\fia\GridsAndXSecsAlternative

File View

Individual Structure Damage Report

for alternative **GridsAndXSecsAlternative**
for event **fia**
for time window **GridsAndXSecsAlternative**

Structure Name	Damage				Total Damage	Depth of Flooding	Population At Risk (Day)	P(
	Struct Damage	Cont Damage	Car Damage	Other Damage				
RES1-1SNB 06097 64222	0.0	0.0	0.0	0.0	0.0	-3.81	0.0	
RES1-1SNB 06097 64216	0.0	0.0	0.0	0.0	0.0	-3.34	0.0	
RES1-2SWB 06097 64250	7651.58	3952.89	0.0	0.0	11604.47	-2.59	3.0	
RES2 06097 64263	0.0	0.0	0.0	0.0	0.0	-2.41	3.0	
RES2 06097 64256	1892.75	258.1	0.0	0.0	2150.86	-0.55	2.0	
RES1-1SNB 06097 64218	0.0	0.0	0.0	0.0	0.0	-2.62	2.0	
RES1-2SNB 06097 64248	15524.34	6286.51	490.56	0.0	22301.4	0.41	4.0	
RES1-1SNB 06097 64217	0.0	0.0	0.0	0.0	0.0	-3.94	0.0	
RES1-1SNB 06097 47282	0.0	0.0	0.0	0.0	0.0	-1.65	1.0	
IND3 06097 24724	0.0	0.0	0.0	0.0	0.0	-2.89	0.0	
RES1-1SNB 06097 47281	0.0	0.0	0.0	0.0	0.0	-2.61	1.0	
RES2 06097 47260	30874.93	14867.47	11256.62	0.0	56999.01	6.25	1.0	
RES1-2SNB 06097 47251	32786.22	26702.77	11256.62	0.0	70745.61	6.05	3.0	
RES1-1SWB 06097 47249	68000.0	30939.24	11256.62	0.0	110195.85	6.25	1.0	
RES1-1SNB 06097 47244	46676.37	28883.64	8794.23	0.0	84354.23	5.37	1.0	
RES1-1SWB 06097 47248	61992.73	27774.54	11256.62	0.0	101023.89	5.37	1.0	
RES1-1SNB 06097 47247	54608.12	30773.43	11256.62	0.0	96638.17	6.05	1.0	
RES1-2SNB 06097 47252	33137.02	27141.28	11256.62	0.0	71534.91	6.18	3.0	
COM1 06097 133415	26162.85	93905.23	29274.56	0.0	149342.64	6.05	0.0	

Figure 5.5 FIA - Individual Structure Damage Report

5.3 Schematic

Results from the schematic are available by right-clicking on schematic elements and from the shortcut menu select result items (zooming in on an area is a good idea). From the map window click the **Pointer Tool**, right-click on a schematic element, a shortcut menu will appear (Figure 5.6). For example (Figure 5.6), right-click on a junction, the shortcut menu (Figure 5.6), besides providing information about the junction, HEC-WAT also provides information on schematic elements that are around the junction, like impact area, routing reaches, and cross sections.

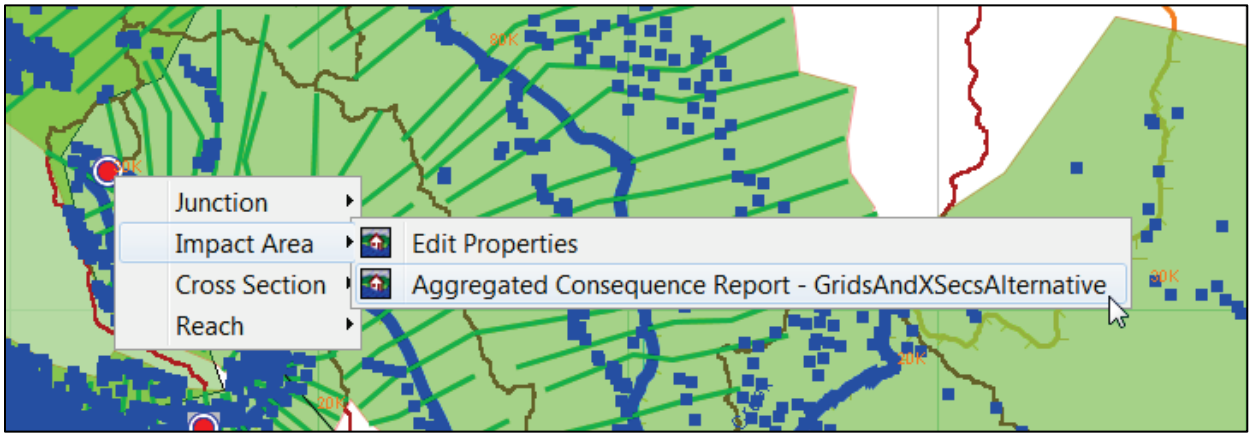
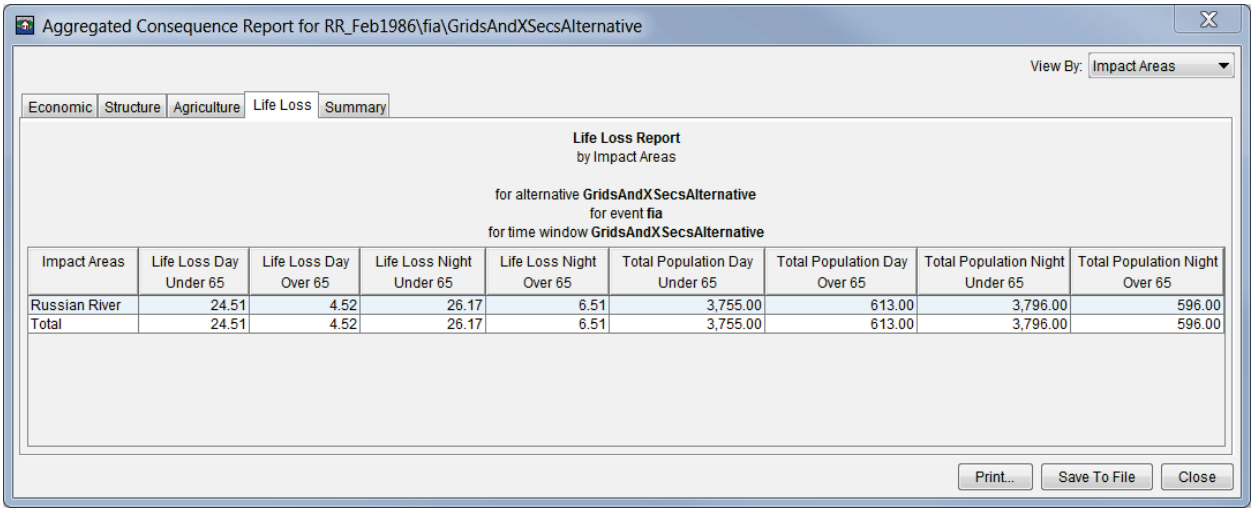


Figure 5.6 HEC-WAT Schematic Shortcut Menu

In the example (Figure 5.6), if the user right-clicks on a junction from the shortcut menu, point to **Impact Area**, click **Aggregated Consequence Report**, the HEC-FIA **Aggregated Consequence Report** will open (Figure 5.7). Click the **Life Loss** tab to get a **Life Loss Report** by impact areas.



Impact Areas	Life Loss Day Under 65	Life Loss Day Over 65	Life Loss Night Under 65	Life Loss Night Over 65	Total Population Day Under 65	Total Population Day Over 65	Total Population Night Under 65	Total Population Night Over 65
Russian River	24.51	4.52	26.17	6.51	3,755.00	613.00	3,796.00	596.00
Total	24.51	4.52	26.17	6.51	3,755.00	613.00	3,796.00	596.00

Figure 5.7 FIA - Aggregated Consequence Report - Life Loss Report

From the same location in Figure 5.6, from the shortcut menu point to **Reach**, click **Profile Plot**, and the HEC-RAS **Profile Plot** (Figure 5.8) is displayed.

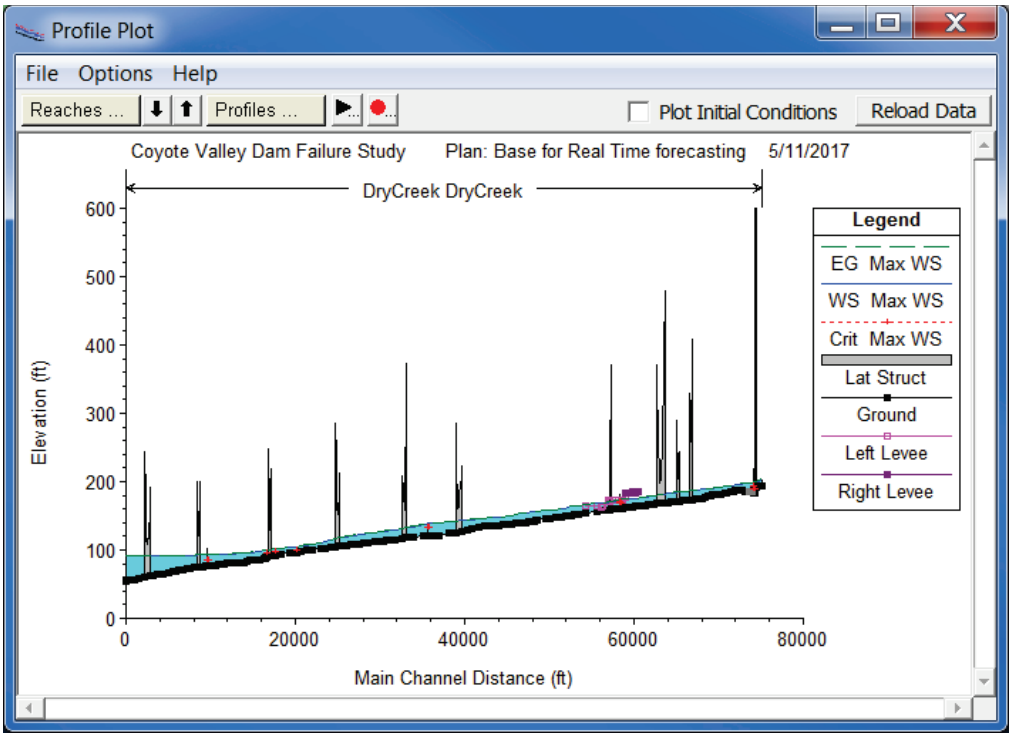


Figure 5.8 RAS - Profile Plot

Also at that location (Figure 5.6), from the shortcut point to **Reach**, click **Graph**, and the HMS graph for that HMS routing reach (Figure 5.9) is displayed.

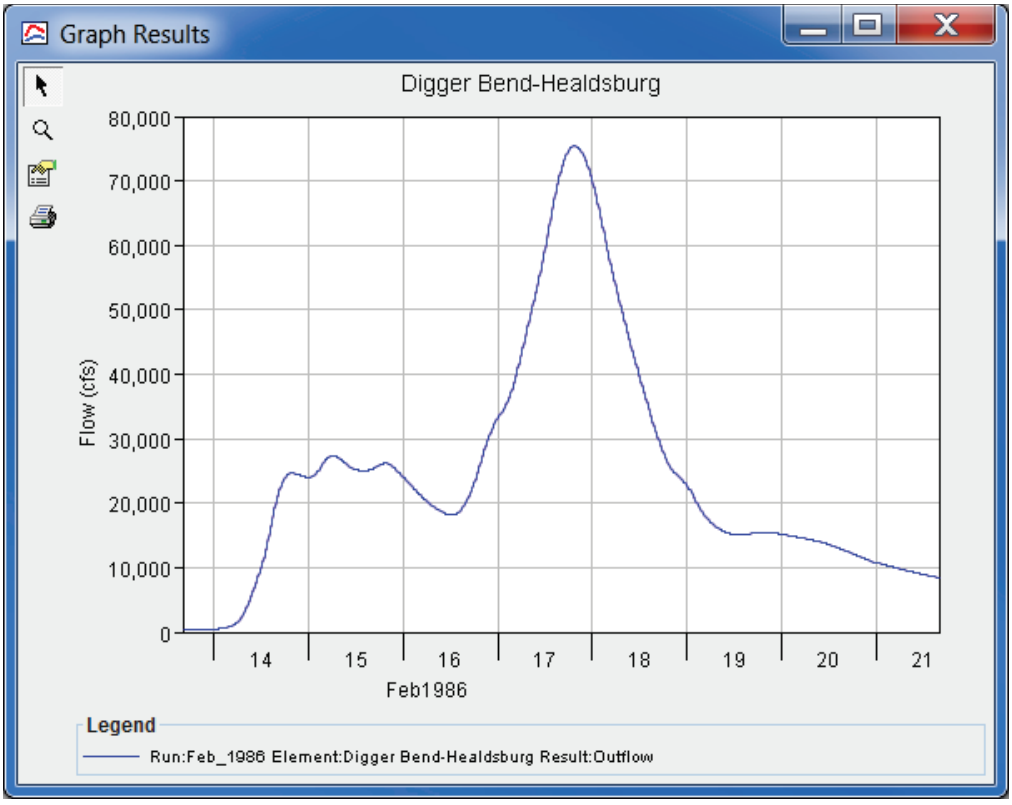


Figure 5.9 HMS - Graph of HEC-HMS Routing Reach

Chapter 6

Create an HEC-WAT Study from Scratch

Chapters 3 - 5 provided the user with an overview of the HEC-WAT framework. This chapter provides the user with instructions on creating an HEC-WAT study from scratch.

6.1 Create an HEC-WAT Study

To create a new study:

1. From the HEC-WAT main window (Figure 6.1), on the **File** menu, click **New Study**. The **Create New Study** dialog box (Figure 6.2) will open.

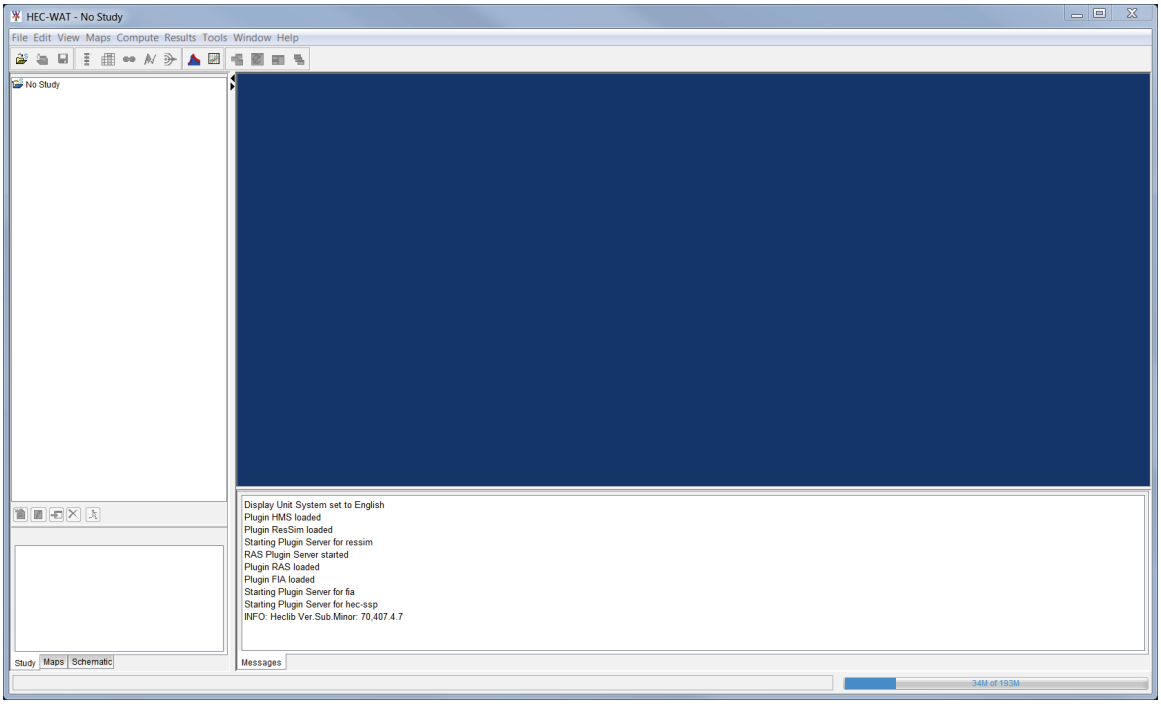


Figure 6.1 HEC-WAT Main Window

2. In the **Study Name** box (Figure 6.2), enter a name (*RussianRiver*), and in the **Description** box, enter a description (*Russian River water resources study*) for the new study.

3. In the **Directory** box (Figure 6.2), either enter the name of the directory where to store the HEC-WAT study, or click ..., and an **Open** browser (Figure 6.3) will open. Navigate to the directory where the HEC-WAT study will be stored, click **Open.** The **Open** browser (Figure 6.3) will close. On the **Create New Study** dialog box (Figure 6.2) in the **Directory** box the location will display.

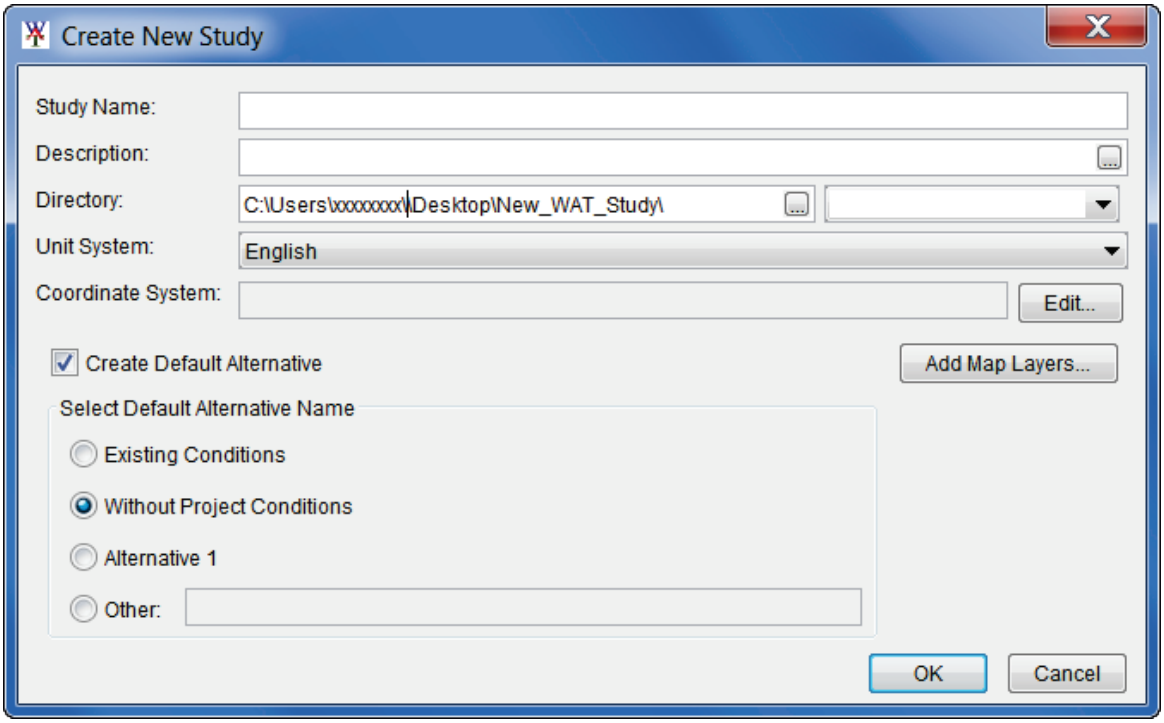


Figure 6.2 Create New Study Dialog Box

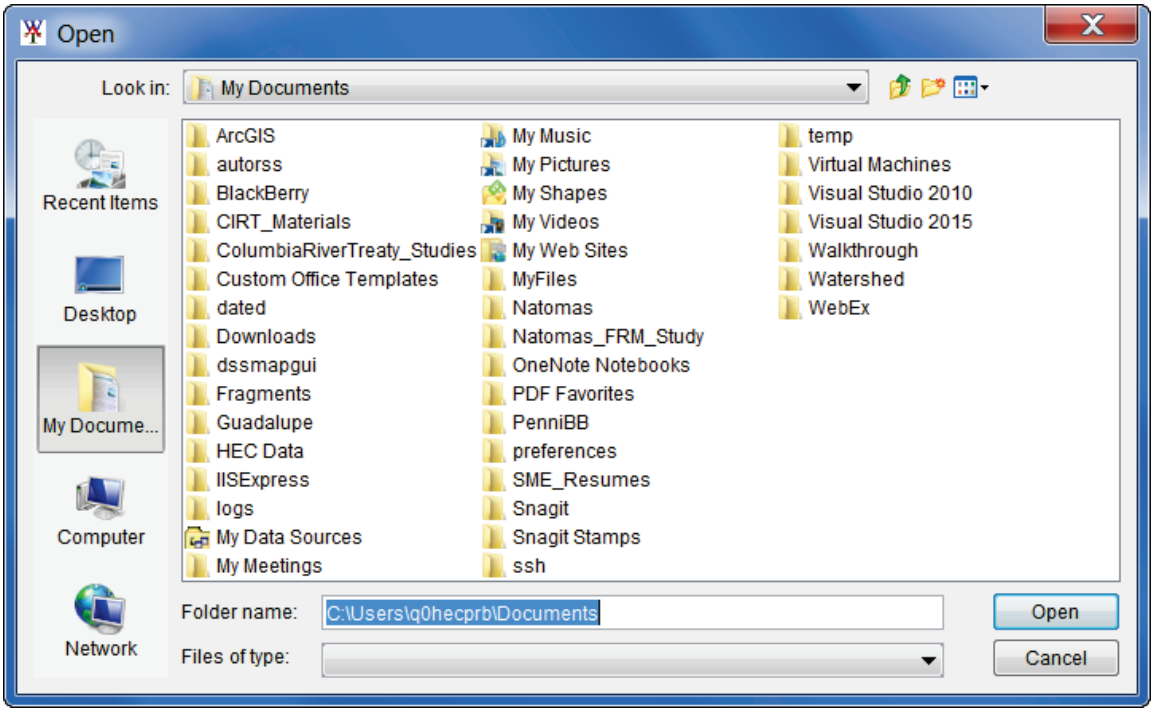


Figure 6.3 Open Browser

4. The **Unit System** (Figure 6.2) for the study defaults to **English** (which is correct for the *RussianRiver* study). The other choice from the list is **SI** (metric).

5. Next, the projected coordinate system of the study needs to be set. From the **Create New Study** dialog box (Figure 6.2), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure 6.4).

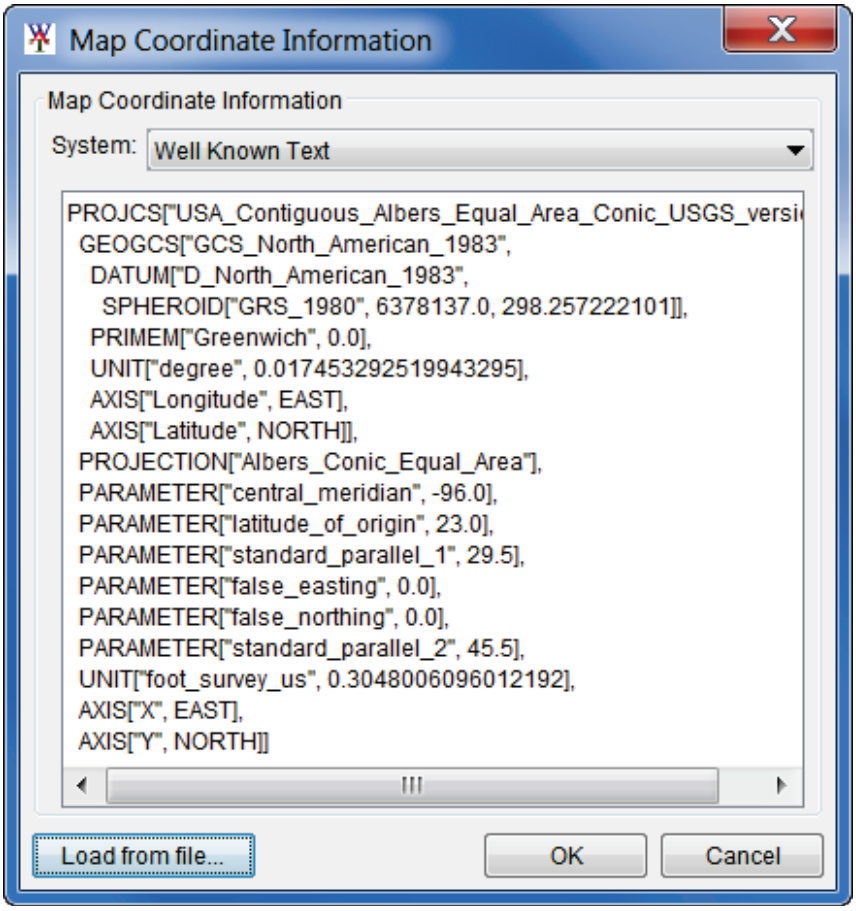


Figure 6.4 Map Coordinate Information Dialog Box with Study Projection Information

6. For the *RussianRiver* study the associated map layers have the correct projected coordinate system. So, one of those map layers can be used to set the projected coordinate system for the study. From the **Map Coordinate Information** dialog box (Figure 6.4), click **Load from file** (lower left corner of dialog box); an **Open** browser (Figure 6.3) will open. The map layers for the *RussianRiver* study are located in a folder titled *RussianRiver_Data* (double-click). In that folder, is a *MapLayers* (double click) folder, from that folder, click on ***RR_StreamAlignment.prj*** (any of the map layers will work). Click **Open**, now the **Map Coordinate Information** dialog box will contain information about the projected coordinate system (Figure 6.4). Click **OK**, the **Map Coordinate Information** dialog box will close (Figure 6.4). Now on the **Create New Study** dialog box the **Coordinate System** box (Figure 6.2) contains the name of the projected coordinate system (i.e., *USA_Continguous_Albers_Equal_Area_Conic_USGS_version*) for the study.

7. When creating the *RussianRiver* study the user can add map layers that the PDT team has gathered for defining the study area. From the **Create New Study** dialog box (Figure 6.2), click **Add Map Layers**. The **Select Map to Add** browser will open (Figure 6.5).

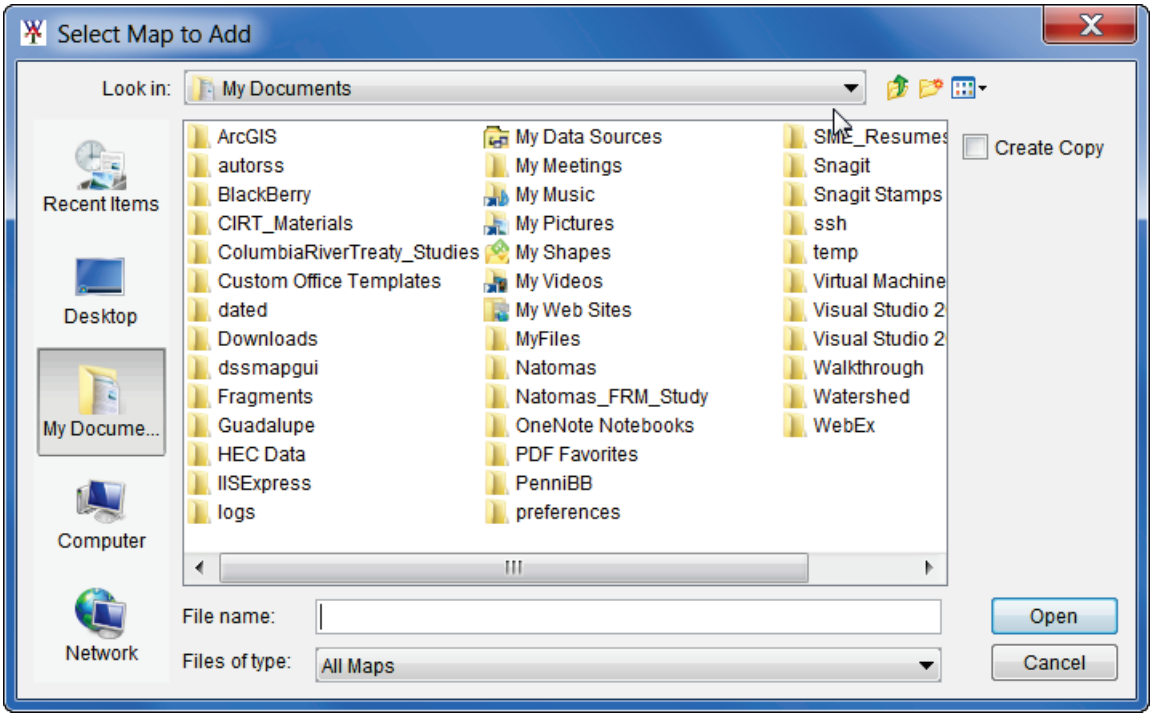


Figure 6.5 Select Map to Add Browser

To copy the map layers to the study directory area, from the **Select Map to Add** browser (Figure 6.5), select **Create Copy**. Browse to where the map layers are located (in the folder titled *RussianRiver_Data*, double-click on *Map Layers*). Select the following map layers:

- Find the map layer that represents the stream alignment - *RR_StreamAlignment.shp*
- Find the map layer the represents the subbasins - *RussianSubbasins.shp*
- Find the map layer which represents the stream gages - *Raingages_Albers_ft.shp*
- Find the map layer which represents the reservoirs - *RR_Lakes_Albers_ft.shp*
- Find the map layer which represents the impact areas - *RR_ImpactAreas.shp*
- Find the map layer which represents the CCPs - *RR_CommonComputationPoints.shp*

Click **Open**, the **Select Map to Add** browser will close (Figure 6.5). The **Create New Study** dialog box (Figure 6.6) appears.

8. HEC-WAT creates a default alternative - *Without Project Conditions*. If the user wants the default alternative to have a different name, several choices are available, including **Other** which allows the user to name the default alternative. For the *RussianRiver* study the default alternative is used.

9. Click **OK**, the **Create New Study** dialog box will close (Figure 6.6). The HEC-WAT main window will now have the name of the study (*RussianRiver*) on the title bar (Figure 6.7). A **Schematic Map Window** opens, which contains the map layers that were added to the study in Step 7.

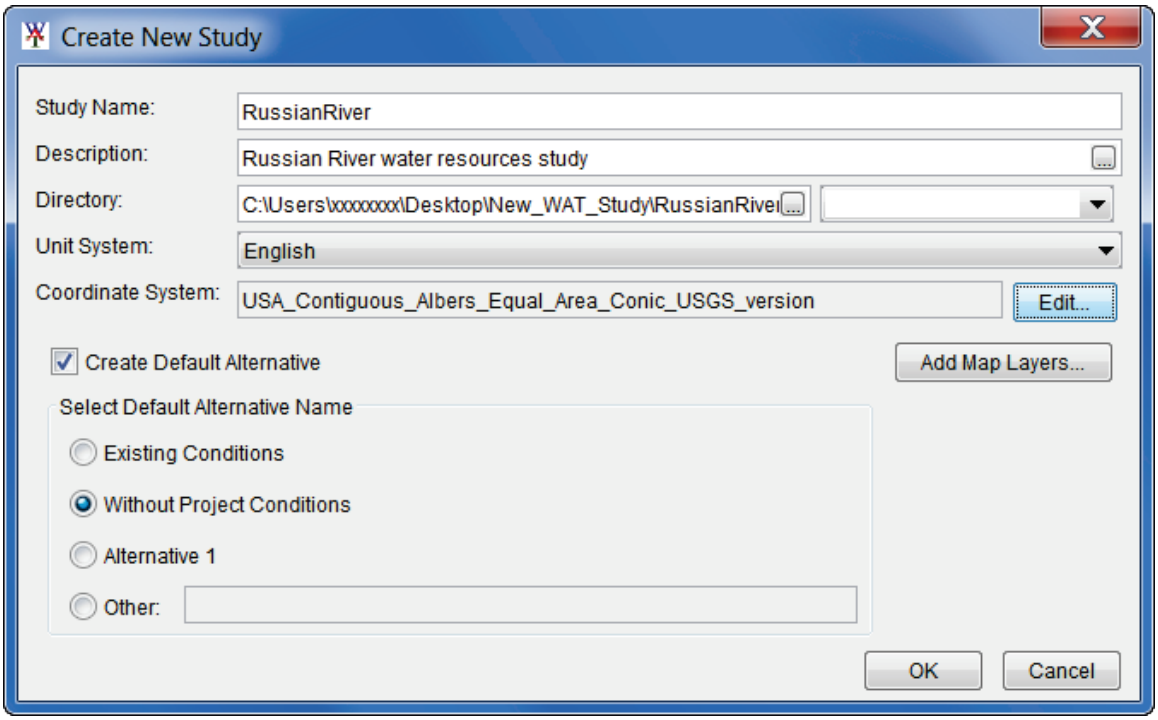


Figure 6.6 Create New Study Dialog Box - Completed

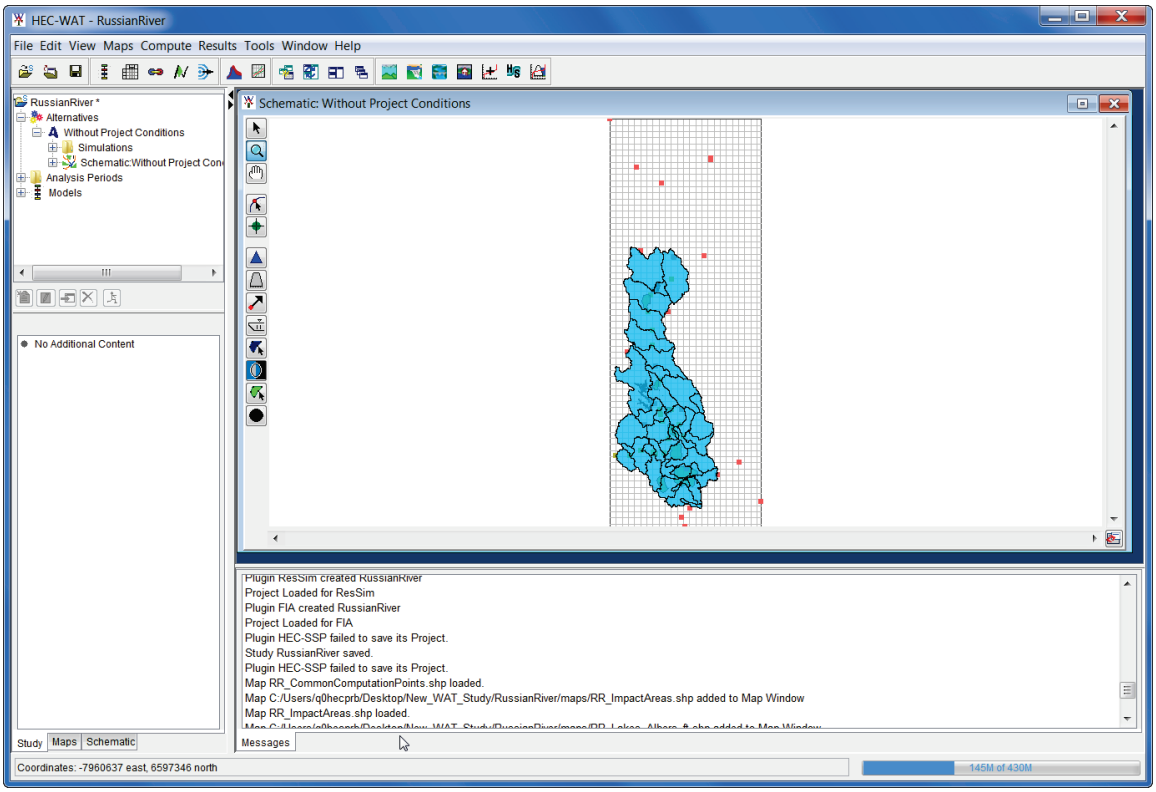


Figure 6.7 HEC-WAT Main Window - *RussianRiver* Study - Maps Tab

6.2 Building the Without Project Conditions Schematic

HEC-WAT by default will create a default alternative *Without Project Conditions* (see Section 6.1, step 8). From the HEC-WAT main widow (Figure 6.8), the **Schematic Map Window**, will contain the initial schematic for the *Without Project Conditions*. The next step is to build the schematic for the default alternative.

6.2.1 Adjust Map Layers

Once a map layer is in the HEC-WAT framework the user can make adjustments to the layer. Since the map layer that represents the subbasins for the *RussianRiver* study is a little bit in everyone's face, let's adjust that file - *RussianSubbasins.shp*.

From the HEC-WAT main window, click the **Maps** tab (Figure 6.7). Now the user can see which **Map Window** is currently active and what layers make up that **Map Window**. To change the color and the fill aspects of the *RussianSubbasins.shp* do the following:

1. From the **Map Layers** tree (Figure 6.8), right click on *RussianSubbasins.shp*. This is the shapefile shortcut menu. This shortcut menu allows the user to expand/collapse the *RussianSubbasins.shp* leaf; move the shapefile to different positions in the tree (**Move To Top/Move To Bottom, Move up/Move Down**); show the legend of the shapefile; change the label of the shapefile; edit the properties of the shapefile; set/remove scale factors; copy the map layer to another location; and open the attribute table of the shapefile.

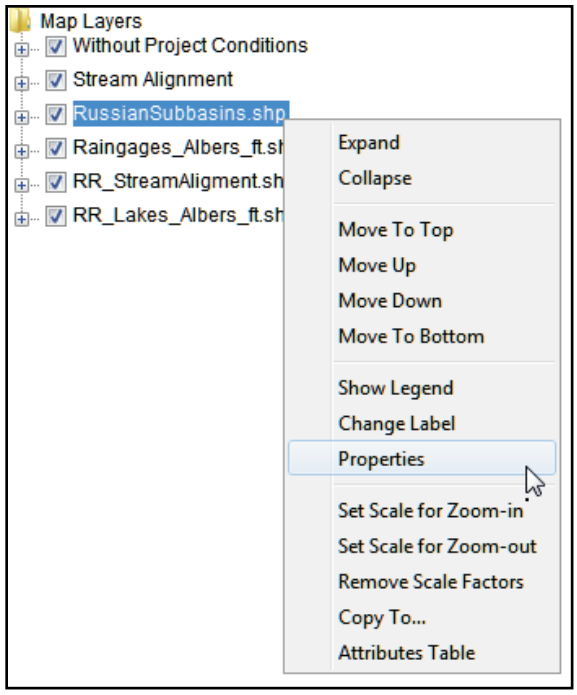


Figure 6.8 Map Layers Tree - Shortcut Menu

2. From the shapefile shortcut menu (Figure 6.8), click **Properties**, the **Edit Polygon Properties** dialog box will open (Figure 6.9). The *RussianSubbasins.shp* file is a polygon shapefile. To edit the fill of the active map layer, from the **Fill** tab, change the color or not have a fill. For the example in Figure 6.9, fill will be turned off. So click **Display Fill**, the check mark will clear, meaning that fill is turned off.

   To change the outline color of the subbasin layer, from the **Edit Polygon Properties** dialog box (Figure 6.9), click the **Border** tab. From the **Color** list, select a color ("darkred"). Click **OK**, the **Edit Polygon Properties** dialog box will close and the changes will appear in dark red in the **Map Window**.

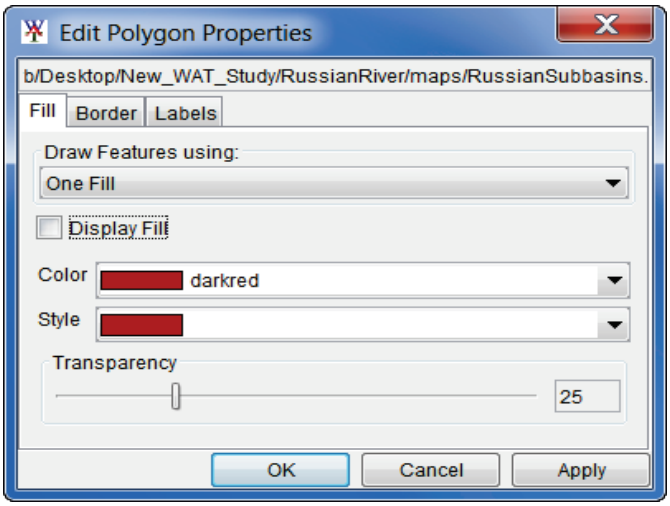


Figure 6.9 Edit Polygon Properties Dialog Box

3. To turn off a map layer - click in the checkbox by *Raingages_Albers_ft.shp*, the rain gages no longer appear on the map window.

4. To display the map window zoomed in, select the **Zoom Tool**  . Draw a box around the map layers that are displayed in the **Map Window**. From the **Maps** menu, click **Default Map Properties**, the **Default Map Properties for** dialog box will open (Figure 6.10). Click **Set Map Extents to Display**, click **OK**. The **Default Map Properties for** dialog box will close.

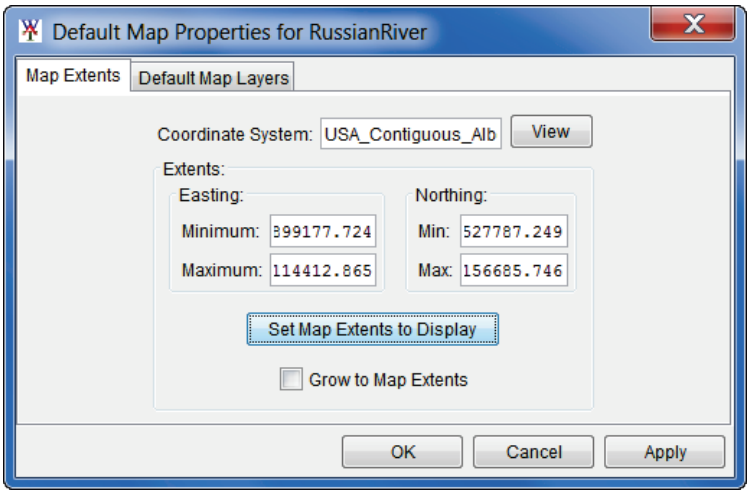


Figure 6.10 Default Map Properties for Dialog Box

This sets the extents for the **Map Window** so that when the study is opened the next time the **Map Window** will be zoomed in to the tighter area.

6.2.2 Create a Stream Alignment

The backbone of any schematic is the **stream alignment**, and is the starting point in creating a schematic. A stream alignment is a one-dimensional river coordinate system, which defines the natural downstream flow network. Also, from the stream centerline, stationing will be provided

relative to its global location and specific to the study. The alignment indicates where confluences and bifurcations occur and provides a sense of distance and scale. Stream alignments are composed of a series of streams, stream nodes, and stream junctions.

The PDT has discussed the extents of the main stem for the study and has included all of the tributaries that will be considered by all of the models in the study. The PDT has created a shapefile that contains all of the pertinent streams - *RR_StreamAlignment.shp*

To import a stream alignment:

1. From the **Map Layers** tree (Figure 6.8), right-click on *Stream Alignment*. From the shortcut menu, click **Import**. The **Import Stream Alignment** dialog box will open (Figure 6.11). The **Shapefile Name** list defaults to the first line shapefile it can find in the *maps* directory; which happens to be the shapefile that represents the stream alignment for the *RussianRiver* study - *RR_StreamAlignment.shp*.

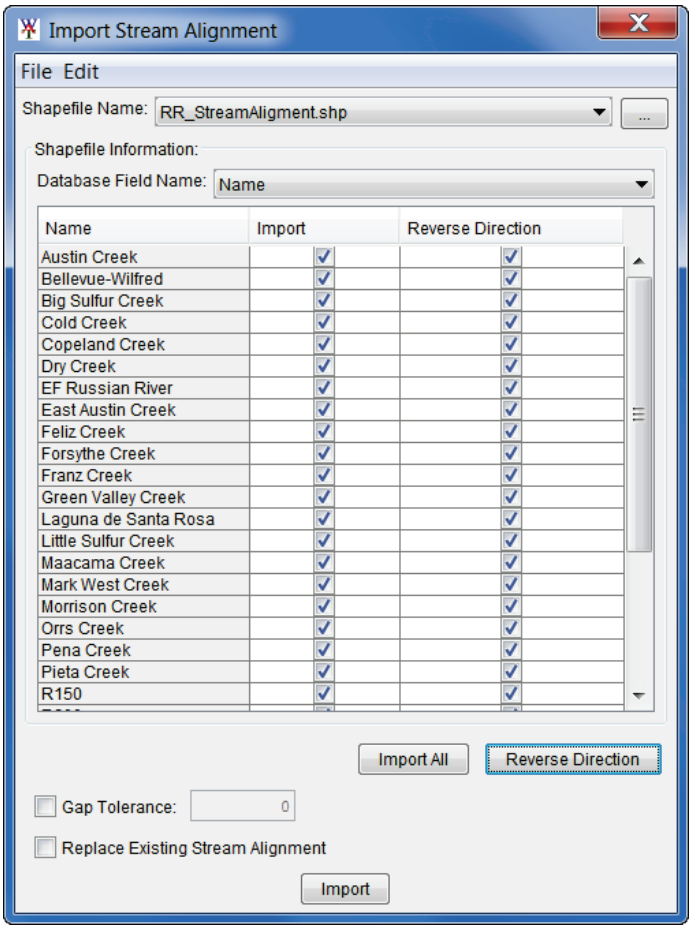


Figure 6.11 Import Stream Alignment Dialog Box

2. From the **Database Field Name** list (Figure 6.11), the user needs to select the field name in the attribute file that contains the names of the streams - ***Name***. Once a field name is selected, the table below will populate with the streams contained in the shapefile. If there is an issue with any of the stream segments the checkbox in the **Import** column

(Figure 6.11) will not be selected. This means the stream segment is not continuous and will not be imported.

3. Click **Reverse Direction** (Figure 6.11). The flow direction in the *RR_StreamAlignment.shp* shapefile is not correct. So instead of fixing the issue with ArcMap® (ESRI GIS software), by performing the **Reserve Direction** procedure the system of streams will have the correct flow direction.

4. Click **Import**, a message window will appear letting the user know that the stream alignment imported successfully. Click **OK**, the **Import Stream Alignment** dialog box will close (Figure 6.11). In the active **Map Window** the stream alignment appears (orange stream segments; green stream nodes and stream junctions).

6.2.3 Add the Background Internet Map

Knowing where the watershed is located in reference to known locations can be quite helpful when communicating with the PDT and stakeholders. From the **Maps** menu (Figure 6.12), point to **Add Internet Map**, from the available list select which internet map that would be a good background (i.e., *Open Street Map*) map for the watershed. The selected internet map will load and appear in the active **Map Window**.

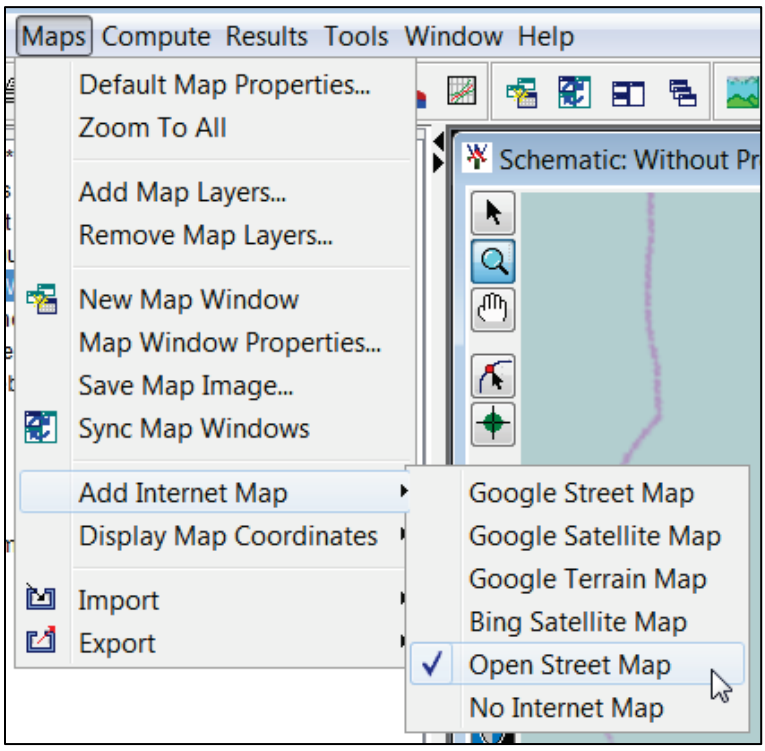


Figure 6.12 Maps Menu - Add Internet Map

This layer in the background might help with adding additional streams to the stream alignment; locations of reservoirs, levees, other projects, impact areas, and common computation points (CCPs). Based on the known extents of the study area, the layer provides a view of the watershed and surrounding area.

6.2.4 Adding CCPs

Common computation points (CCPs) are locations where one model can transfer data to another model, a location where results are needed for model development or alternative analysis, or locations where input boundary conditions are to be defined. CCPs need to be consistent for all models and should be placed on the stream alignment based on knowledge of possible study alternatives. The entire study team should be involved in the definition of the common computation points.

To import CCPs from a shapefile:

1. From **Maps** menu (Figure 6.12), point to **Import**, click **Computation Points**. The **Import Computation Points** dialog box will open (Figure 6.13). The **Shapefile Name** list defaults to the first point shapefile it can find in the *maps* directory; which happens to be the shapefile that represents the common computation points for the *Russian River* study - *RR_CommonComputationPoints.shp*.

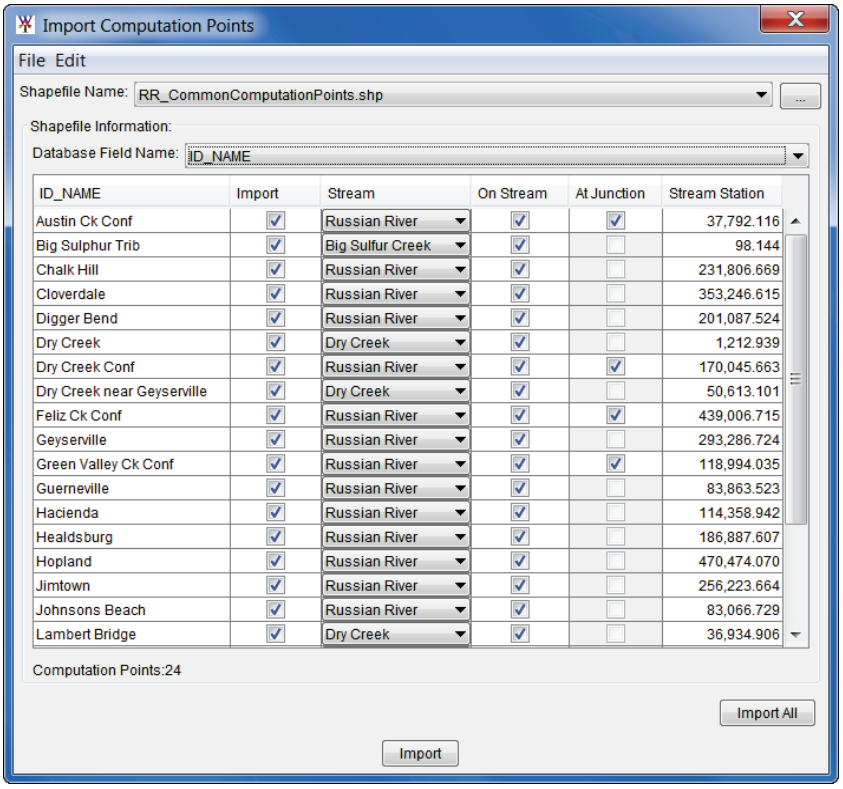


Figure 6.13 Import Computation Points Dialog Box

2. From the **Database Field Name** list (Figure 6.13), select the field name in the attribute file that contains the names of the CCPs - ***ID_Name***. Once a field name is selected, the table below will populate with the CCPs contained in the shapefile. If there is an issue with any of the CCPs the checkbox in the **Import** column will not be selected.

3. Click **Import**, the **Import Computation Points** dialog box will close (Figure 6.13). Once the import of the CCPs is completed, a message window will appear letting you

know that the CCPs have been imported successfully. In the active **Map Window** the CCPs appear as black circles.

A user can also add CCPs to the schematic manually by performing the following steps:

1. From the **Schematic Map Window**, find the location where a CCP needs to be added, press the **Computation Point Tool** .

2. Hold down the **CTRL** key and click on the stream alignment to place the common computation point.

3. The **Name New Computation Point** dialog box will open (Figure 6.14). Enter the new **Name** (required) and **Description** (optional, but recommended). Click **OK**, the **Name New Computation Point** dialog box will close.

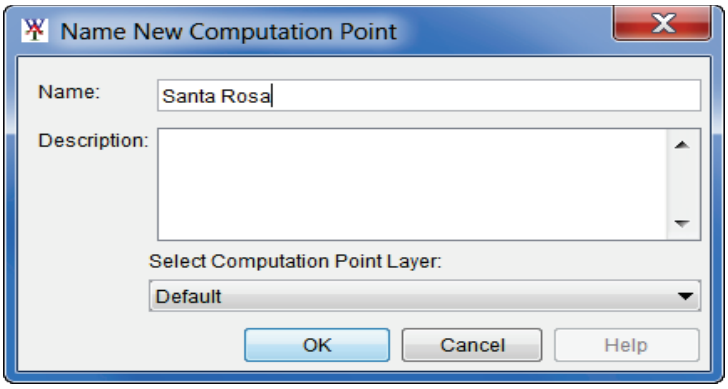


Figure 6.14 Name New Computation Point Dialog Box

4. The common computation point will now appear in the map window as a black circle.

5. If a CCP is added at a stream junction, a slightly different **Name New Computation Point** dialog box will open (Figure 6.15). Enter the new **Name** (required) and **Description** (optional, but recommended).

6. From the **Select the Placement of the Computation Point** list (Figure 6.15), determine exactly where the common computation point will be placed. Choices are to have the common computation point placed on the stream junction, along one of the streams that form the stream junction, or none of the above. For example, in Figure 6.15, the common computation point will be placed on the stream junction.

7. Click **OK**, the **Name New Computation Point** dialog box (Figure 6.15) will close. The common computation point will now appear in the display area as a black circle.

6.2.5 Adding a Reservoir

A **reservoir** is the impoundment created behind dams, or behind navigation locks and dams. For HEC-WAT a reservoir also includes the dam built on a stream to store water for uses such as flood risk management, hydroelectric power generation, recreation use, and water supply, etc.

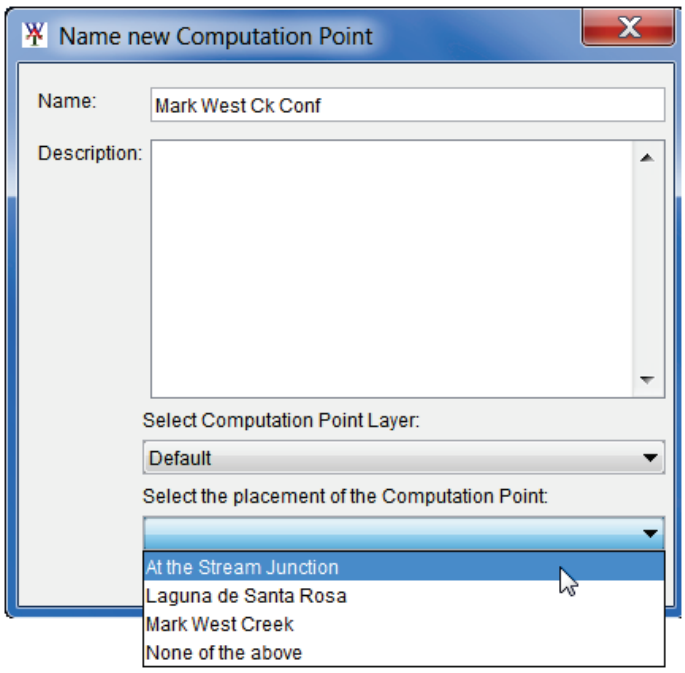


Figure 6.15 Name new Computation Point Dialog Box at a Stream Junction

To add a reservoir:

1. From the **Schematic Map Window**, find the location where a reservoir needs to be added, press the **Reservoir Tool** .

2. Hold down the **CTRL** key and click on the stream alignment to place the upstream end of the reservoir. Release the **CTRL** key; drag the mouse to the downstream end of the reservoir and click.

3. The **Name New Reservoir** dialog box will open (Figure 6.16). Enter the new **Name** (*Lake Mendocino*) and **Description** (optional, but recommended). Click **OK**, the **Name New Reservoir** dialog box will close.

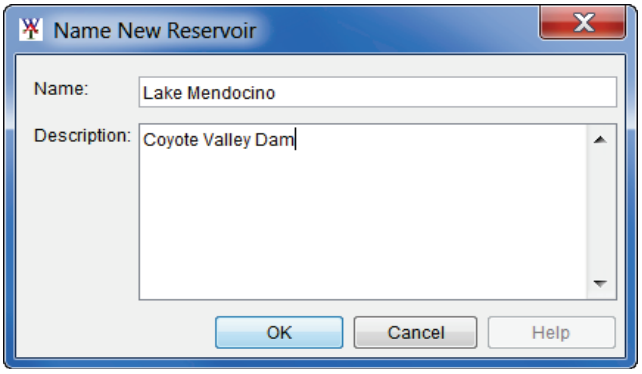


Figure 6.16 Name New Reservoir Dialog Box

4. The reservoir will now appear on the schematic as a cyan triangle (reservoir pool), a blue line (storage reach), a gray rectangle (dam), and two common computation points that represent the upstream and downstream ends of the reservoir.

5. The default representation of the reservoir pool is a triangle; the user can edit this triangle if a more detailed representation of the pool is desired. With the **Reservoir Tool** pressed, double-click on the reservoir. The triangle (Figure 6.17) will now be green with a blue outline color. Also, there are three vertex points (blue), and at the apex of the triangle is the reservoir label, which is represented by a yellow circle.

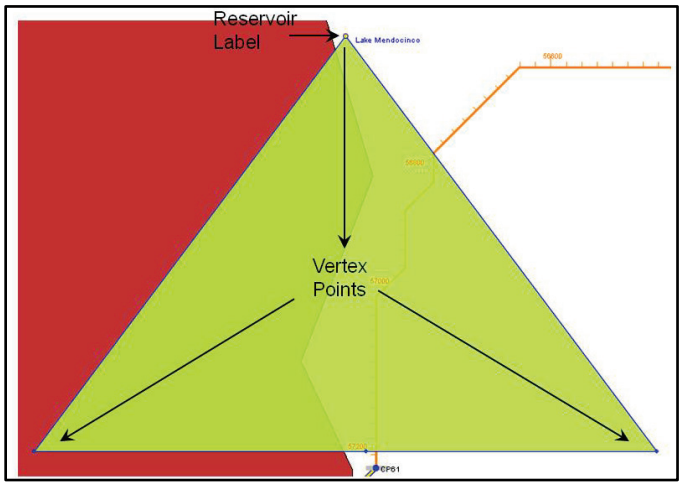


Figure 6.17 Reservoir Pool

6. When a reservoir is created there are two common computation points that are created with default names. It is recommended that the names of the two common computation points be changed. These two common computations points represent the inflow and outflow junctions of the reservoir and should be renamed accordingly.

7. To change the name of a common computation point, press the **Computation Point Tool** ●, right-click on one of the common computation points. From the shortcut menu, click **Rename Computation Point**; the **Rename Computation Point** dialog box will open (Figure 6.18). In the **Name** box, enter the new name, and in the **Description** box enter a description (optional, but recommended). For example, in Figure 6.18, the inflow junction for *Lake Mendocino* has been labeled *Lake Mendocino Inflow Jct*, and the outflow junction should be labeled *Lake Mendocino Outflow Jct*.

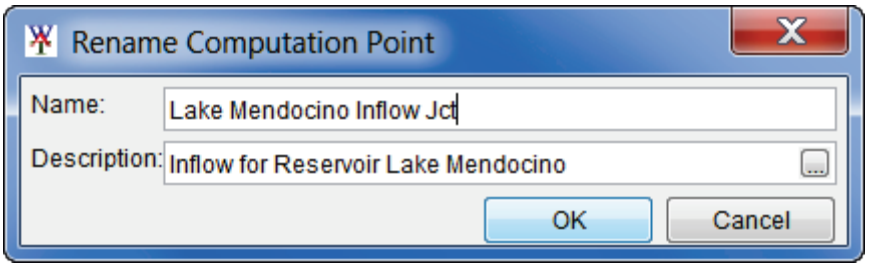


Figure 6.18 Rename Computation Point Dialog Box

8. Click **OK**, a **Confirm Rename** window will open, asking the user to be sure that the CCP is to be renamed. Click **Yes**, the **Rename Computation Point** dialog box will close (Figure 6.18) and the new name for the CCP will appear in the map window.

Repeat the steps above for the Lake Sonoma reservoir.

6.2.6 Adding Impact Areas

An **impact area** is any distinct portion of a study that is affected by rising or falling stage in a stream, river, lake, or reservoir. Impact areas are an optional element, and are only required when the user wants to compute impacts at damage area centers in the study area

To import impact areas from a shapefile:

1. From the **Maps** menu (Figure 6.12), point to **Import**, click **Impact Areas**. The **Import Impact Areas** dialog box will open (Figure 6.19). The **Shapefile Name** list figures out whether there are any polygon shapefiles available in the **maps** directory; from the list the shapefile that represents the impact areas for the *RussianRiver* study - *RR_ImpactAreas.shp*.

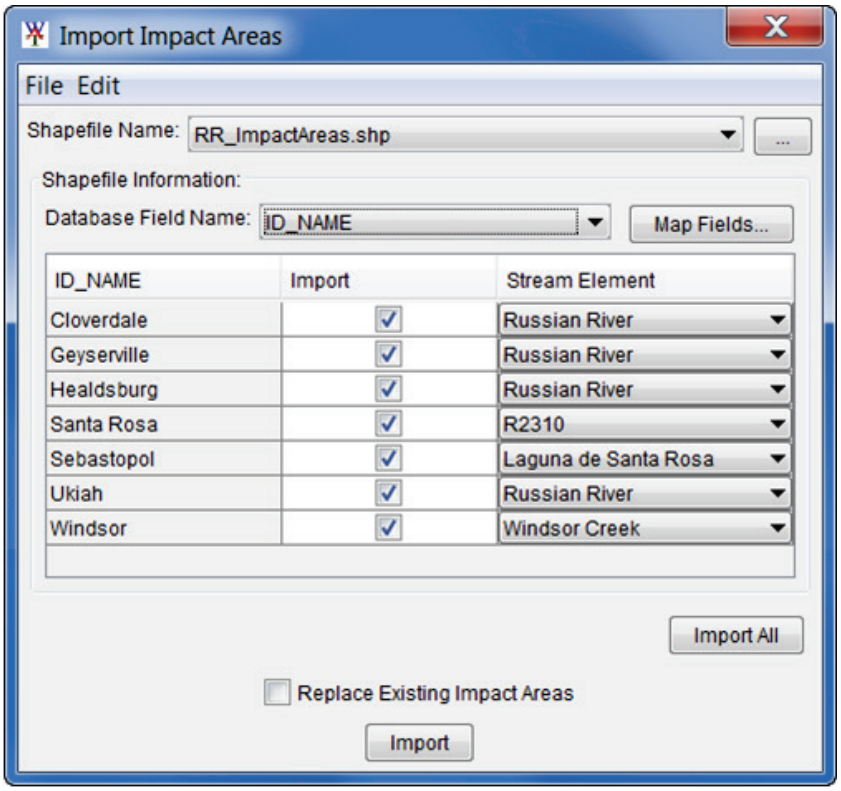


Figure 6.19 Import Impact Areas Dialog Box

2. From the **Database Field Name** list (Figure 6.19), the user needs to select the field name in the attribute file that contains the names of the impact areas - ***ID_Name***. Once a field name is selected, the table below will populate with the impact areas contained in the shapefile. If there is an issue with any of the impact areas the checkbox in the **Import** column will not be selected.

3. Click **Import**, the **Import Impact Areas** dialog box will close (Figure 6.19). Once the import of the impact areas is completed, a message window will appear letting the user know that the impact areas have been imported successfully. In the active **Map Window** the impact areas appear as green polygons.

A user can also add impact areas to the schematic manually by performing the following steps:

1. From the **Schematic Map Window**, find the location where an impact area needs to be added, press the **Impact Area Tool**  .

2. Hold down the **CTRL** key while clicking the mouse button. Each click creates a vertex point (Figure 6.20), which is the boundary of the polygon. When reaching the end point, release the **CTRL** key and click.

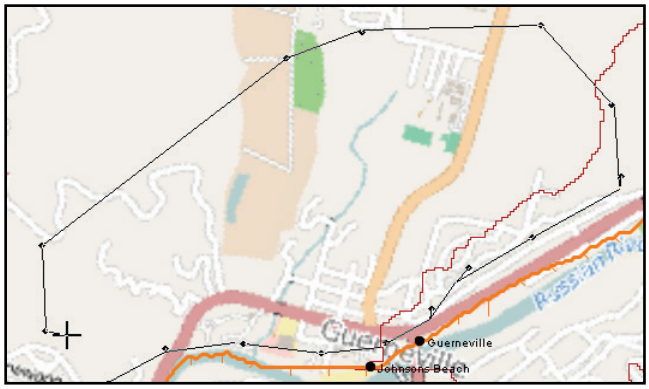


Figure 6.20 Draw an Impact Area

3. The **Name New Impact Area** dialog box will open (Figure 6.21). Enter a name (*Guerneville*), and if needed, enter a description. Click **OK**, the **Name New Impact Area** dialog box will close.

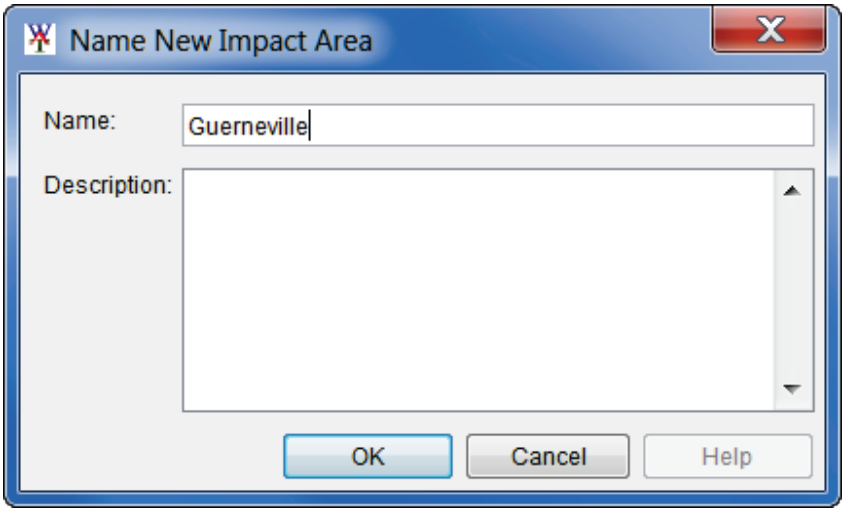


Figure 6.21 Name New Impact Area Dialog Box

4. The impact area will now appear in the display area as a green polygon with a name.

Following the steps in this chapter creates the basic schematic elements for an HEC-WAT watershed - stream alignment, common computation points, impact areas, and projects (reservoirs, levees). Now this basic schematic can be used by the models that are required for the watershed. The user will have choices at this point - to either build the individual models in

HEC-WAT or build individual models outside of HEC-WAT. If models are built outside of HEC-WAT, the user can import the individual models (Chapter 7) or if the models are the result of a Corps Water Management System (CWMS) watershed being available (Chapter 8).

Either choice using the basic schematic built in HEC-WAT promotes collaboration with customers, partners and stakeholders involved in water resource studies. Users will be able to perform studies in an integrated and systems based approach.

Chapter 7

Create an HEC-WAT Study from Existing Models

If the HEC-WAT study the user is building has existing model files, the user can build an HEC-WAT study from those models. For the *Russian River* example, the user can create an HEC-WAT study by importing individual model files (i.e., HEC-HMS, HEC-ResSim, HEC-RAS, HEC-FIA) that are available.

7.1 Create an HEC-WAT Study

To create a new study:

1. From the HEC-WAT main window (Figure 7.1), on the **File** menu, click **New Study**. The **Create New Study** dialog box (Figure 7.2) will open.

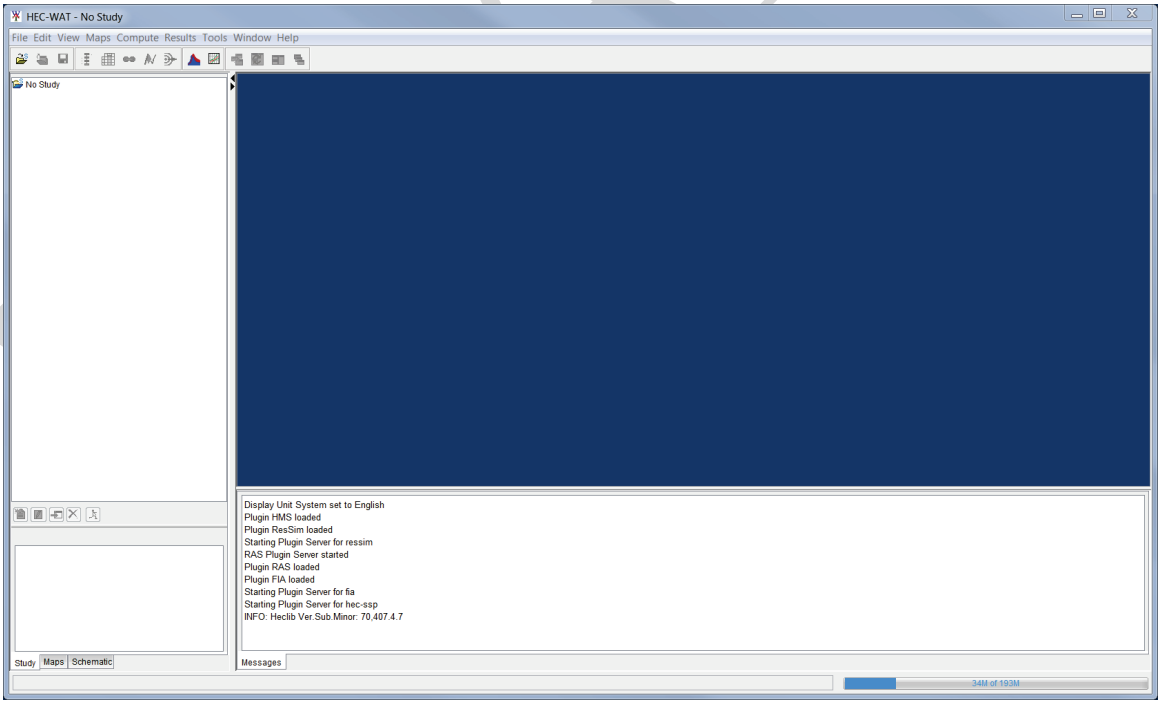


Figure 7.1 HEC-WAT Main Window

2. In the **Study Name** box (Figure 7.2), enter a name (*RussianRiver*), and in the **Description** box, enter a description (*Russian River water resources study*) for the new study.

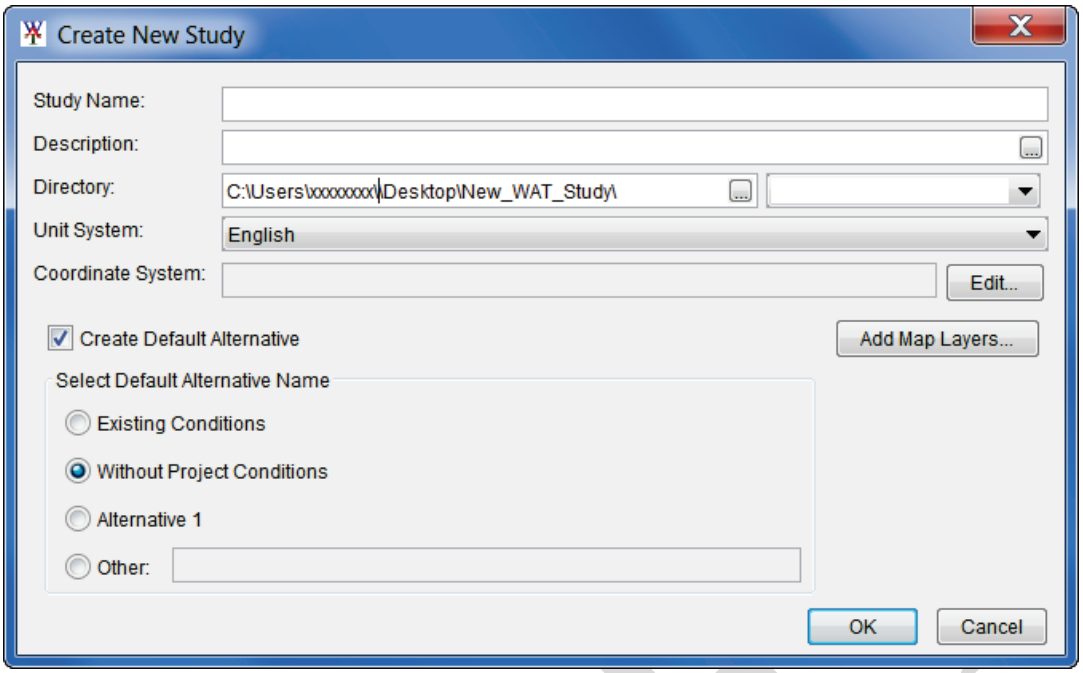


Figure 7.2 Create New Study Dialog Box

3. In the **Directory** box (Figure 7.1), either enter the name of the directory where the HEC-WAT study will be stored, or click ..., and an **Open** browser (Figure 7.3) will open. Navigate to the directory where the HEC-WAT study will be stored, click **Open**. The **Open** browser (Figure 7.3) will close. On the **Create New Study** dialog box (Figure 7.2) in the **Directory** box the location will display.

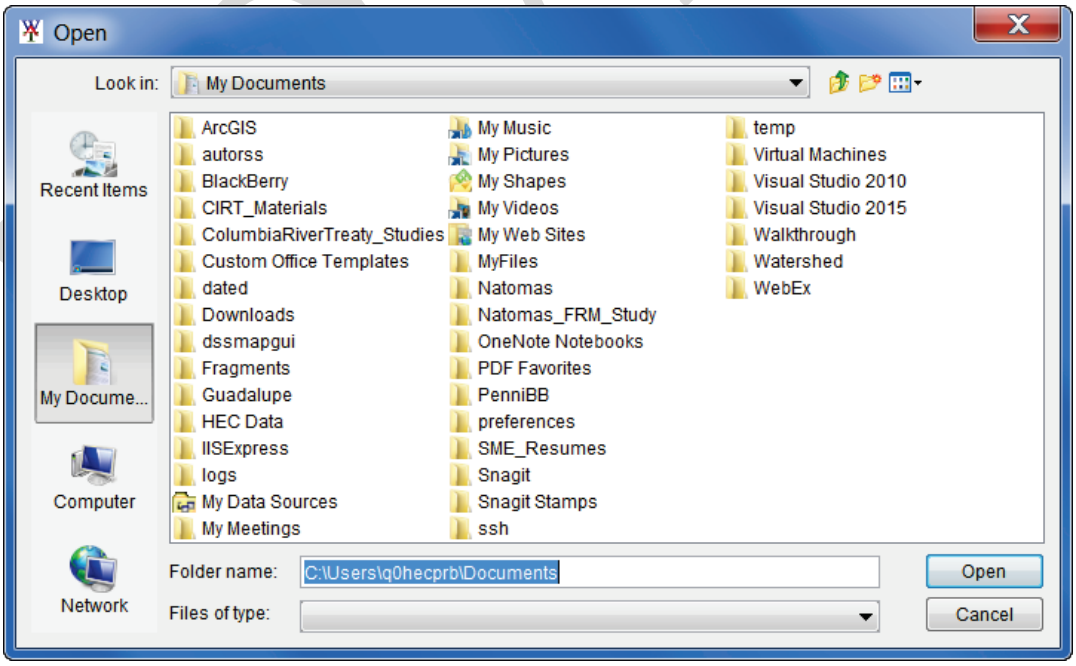


Figure 7.3 Open Browser

4. The **Unit System** (Figure 7.2) for the study defaults to **English** (which is correct for the *RussianRiver* study). The other choice from the list is **SI** (metric).

5. Next, the projected coordinate system of the study needs to be set. From the **Create New Study** dialog box (Figure 7.2), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure 7.4).

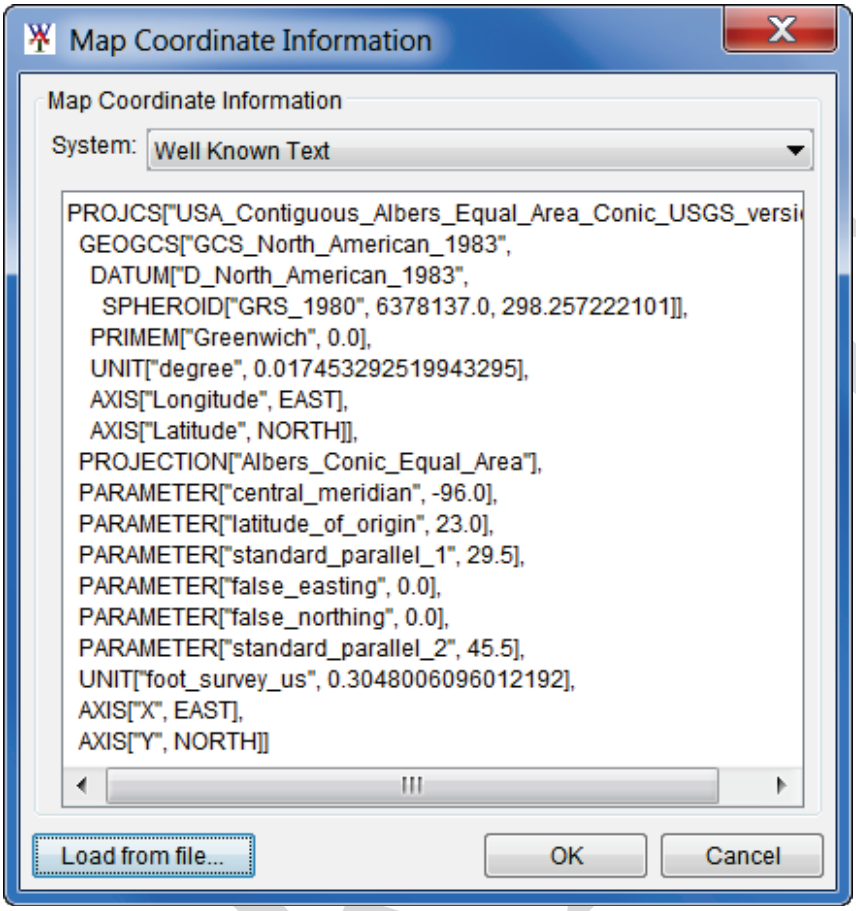


Figure 7.4 Map Coordinate Information Dialog Box with Study Projection Information

6. For the *RussianRiver* study, the associated map layers have the correct projected coordinate system. So, use one of those map layers to set the projected coordinate system for the study. From the **Map Coordinate Information** dialog box (Figure 7.4), click **Load from file** (lower left corner of dialog box); an **Open** browser (Figure 7.3) will open. The map layers for the *RussianRiver* study are located in a folder titled *RussianRiver_Data* (double-click). In that folder, is a *MapLayers* (double click) folder, from that folder, click on *RR_StreamAlignment.prj* (any of the map layers will work). Click **Open**, now the **Map Coordinate Information** dialog box will contain information about the projected coordinate system (Figure 7.4). Click **OK**, the **Map Coordinate Information** dialog box will close (Figure 7.4). Now on the **Create New Study** dialog box the **Coordinate System** box (Figure 7.2) contains the name of the projected coordinate system (i.e., *USA_Continguous_Albers_Equal_Area_Conic_USGS_version*) for the study.

7. Click **OK**; the **Create New Study** dialog box will close (Figure 7.2). The HEC-WAT main window will now have the name of the study (*RussianRiver*) on the title bar (Figure 7.5). A blank **Schematic Map Window** opens.

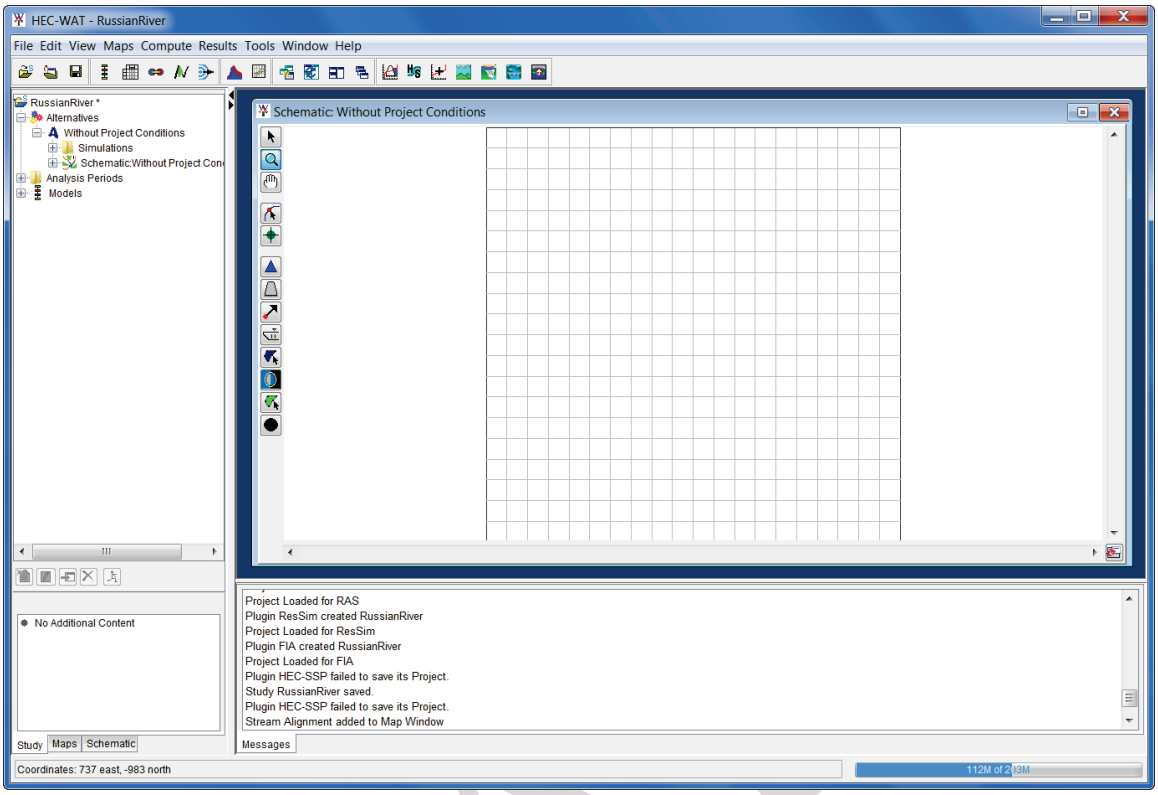


Figure 7.5 HEC-WAT Main Window - *RussianRiver* Study

7.2 Define Plug-Ins for a Study

To define the plug-ins for the *RussianRiver* study:

1. From the HEC-WAT main window (Figure 7.5), from the **File** menu, click **Study Details**.

2. The **Study Details** dialog box (Figure 7.6) will open. Click on the **Plug-ins** tab. The table that is displayed provides information on the plug-ins that are available in for the study.

3. For the *RussianRiver* study the following plug-ins should be enabled – *FIA, HEC-SSP, HMS, RAS,* and, *ResSim*.

4. Click **OK**, the **Study Details** dialog box will close (Figure 7.6), and the plug-ins for the study have been defined.

7.3 Import an HEC-ResSim Model

If there is an HEC-ResSim model available, the user should import that model first. Why? Because the HEC-ResSim model will contain a stream alignment, all of the common computation points (CCPs), and the reservoirs necessary to model the study area.

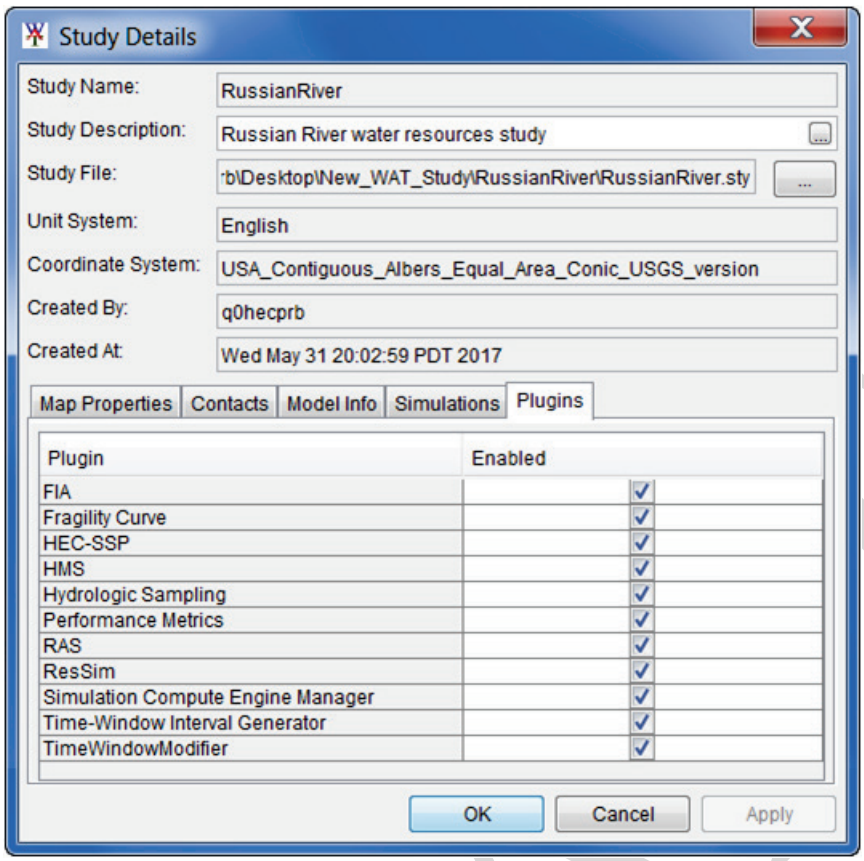


Figure 7.6 Study Details Dialog Box - Plugins Tab

1. From the HEC-WAT main window (Figure 7.5), from the **File** menu, point to **Import**, and click **ResSim**. An **Import Type** window (Figure 7.7) will open, click **Watershed**.

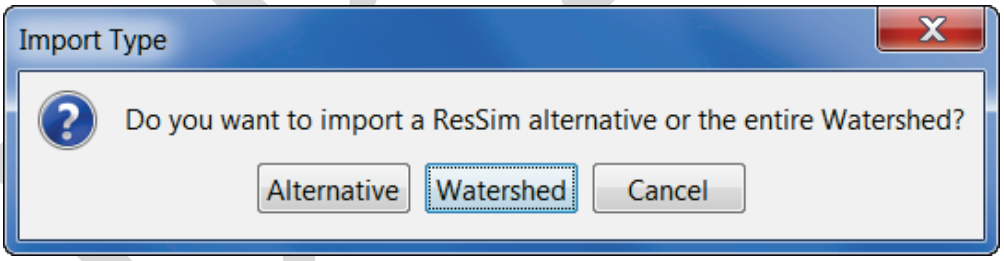


Figure 7.7 Import Type Window

2. The **Select Watershed File to Import From** (Figure 7.8) browser will open. Browse to the folder *RR_Models*; double click on the *base* folder; double-click on the *RR_ResSim_Model* folder. The **Files of Type** list should display **ResSim Watershed Files**; click *RR_ResSim_Model.wksp*; and, then click **Open.**

3. A **ResSim Import** window will open (Figure 7.9) showing the progress of the HEC-ResSim import.

4. The HEC-WAT **Schematic Editor** will open (Figure 7.10), from the **Measures** area of the **Schematic Editor**, click **Select All**. All of the reservoirs listed in the table are now selected. Click **OK**, the **Schematic Editor** will close (Figure 7.10).

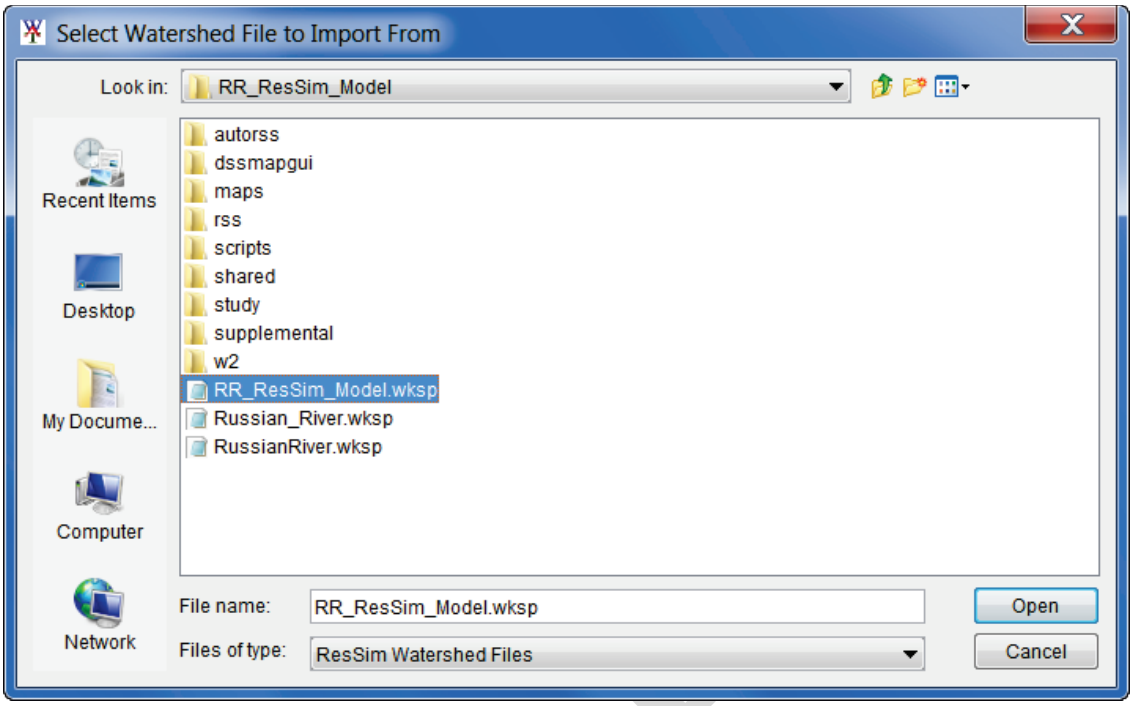


Figure 7.8 Select Watershed File to Import From Browser

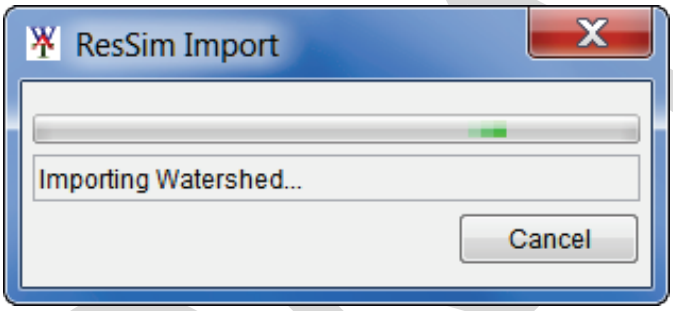


Figure 7.9 ResSim Import Window

5. The imported stream alignment, common computation points, reservoirs, and any available map layers from the HEC-ResSim model display in the HEC-WAT **Schematic Map Window** (Figure 7.11). For all of the map layers to appear, close the **Schematic Map Window,** from the message window click **Yes**. To re-open the **Schematic Map Window**, from the **Study Tree**, double-click on *Schematic: Without Project Conditions*, the **Schematic Map Window** will appear in the **Desktop Area** of the HEC-WAT main window (Figure 7.11).

6. The user has now completed the import of the *RussianRiver* HEC-ResSim model.

7.4 Import an HEC-HMS Model

1. From the HEC-WAT main window (Figure 7.5), from the **File** menu, point to **Import**, and click **HMS**. The HEC-HMS application will open with the **Select Project File** browser already open (Figure 7.12).

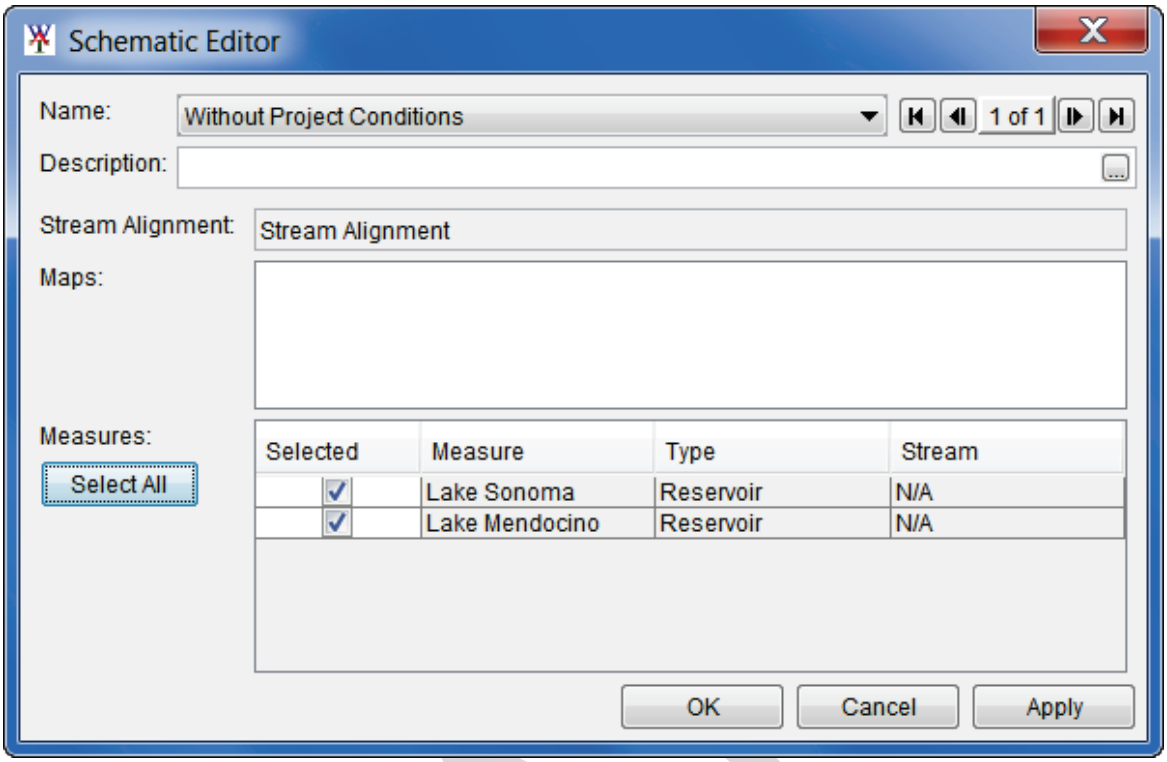


Figure 7.10 Schematic Editor

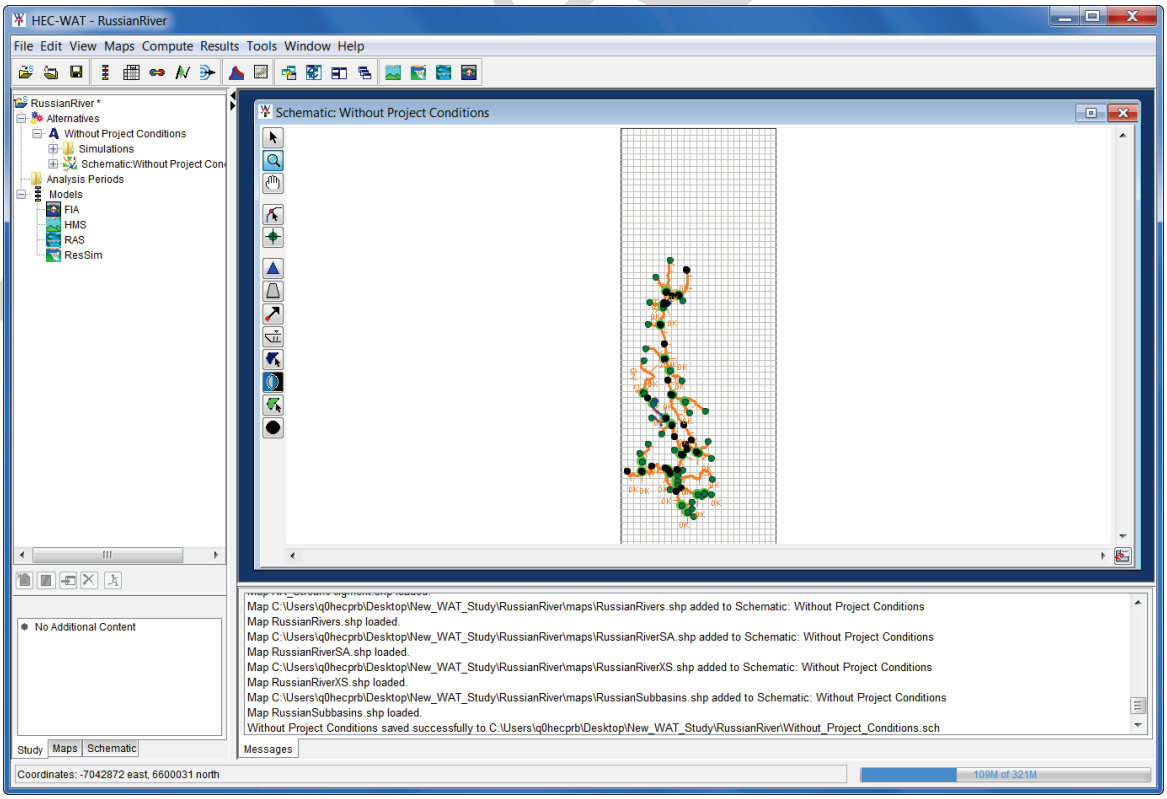


Figure 7.11 HEC-WAT Schematic Map Window After HEC-ResSim Import

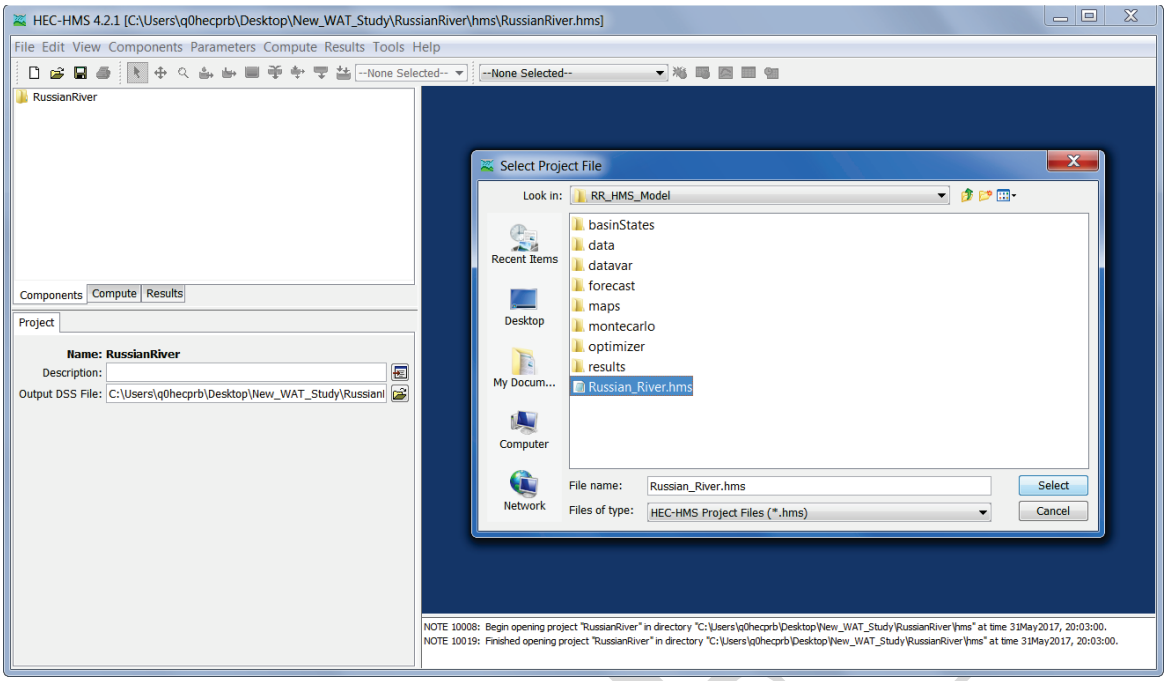


Figure 7.12 HEC-HMS Main Window and Select Project File Browser

2. Browse to the folder *RR_Models*; double click on the *RR_HMS_Model* folder, select *Russian_River.hms* and, then click **Select.**

3. When the HEC-WAT study is created an *hms* subfolder is created. In that subfolder are the default files that are generated when creating an HEC-HMS project. When the HEC-HMS import process finds that a project already exists, a warning window will appear (Figure 7.13). Click **Yes**, the warning window will close.

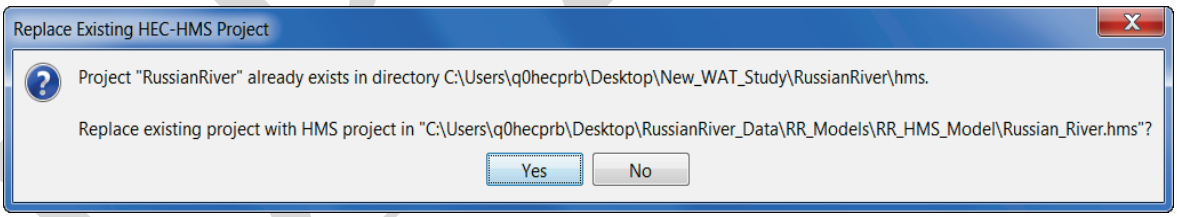


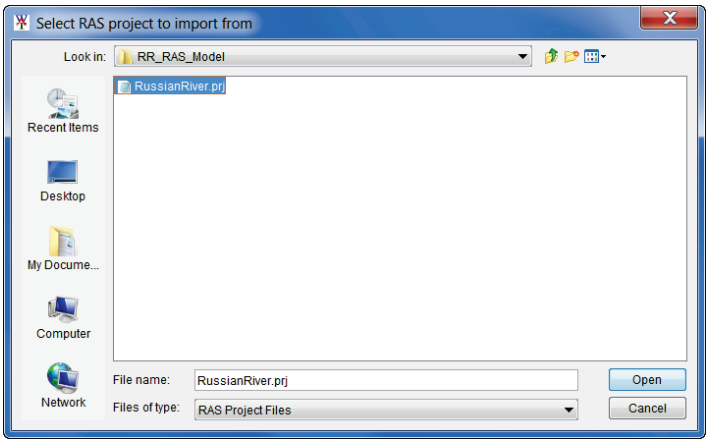
Figure 7.13 HEC-HMS Warning Window about HEC-HMS Project

4. The import process begins (patience this could take a few seconds), the import is finished when the study pane in the HEC-HMS main window contains a study tree. From the HEC-HMS main window (Figure 7.12), from the **File** menu, click **Exit**.

5. The user has now completed the import of the *RussianRiver* HEC-HMS model.

7.5 Import an HEC-RAS Model

1. From the HEC-WAT main window (Figure 7.5), from the **File** menu, point to **Import**, and click **RAS**. The **Select RAS project to import from** browser will open (Figure 7.14).



7.14 Select RAS project to import from Browser

2. Browse to the folder *RR_Models*; double click on the *RR_RAS_Model* folder, select *RussianRiver.prj* and, then click **Open.**

3. The **Select RAS project to import from** browser will close (Figure 7.15). An **Importing** window (Figure 7.15) will open; when the HEC-RAS model import is complete this window will close.

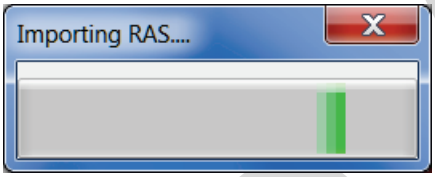


Figure 7.15 HEC-RAS Importing Window

4. The user has now completed the import of the *RussianRiver* HEC-RAS model.

7.6 Import an HEC-FIA Model

1. From the HEC-WAT main window (Figure 7.5), from the **File** menu, point to **Import**, and click **FIA**. The **Import Alternatives** dialog box will open (Figure 7.16).

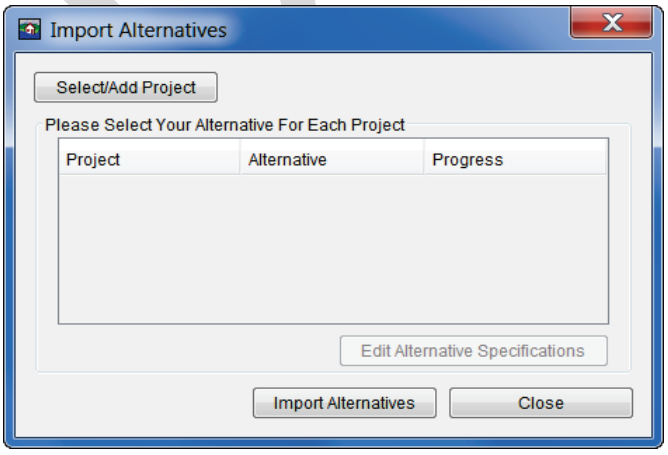


Figure 7.16 Import Alternatives Dialog Box

2. Click **Select/Add Project**, an **Open** browser will open (Figure 7.3). Browse to the folder *RR_Models*; double click on the *RR_FIA_Model* folder, select *Russian_River.prj* and, then click **Open.**

3. The table will now contain the name of the **Project** (*RussianRiver*). From the **Alternative** column (Figure 7.17), from the list, select the HEC-FIA alternative that will be imported (*GridsAndXSecsAlternative*).

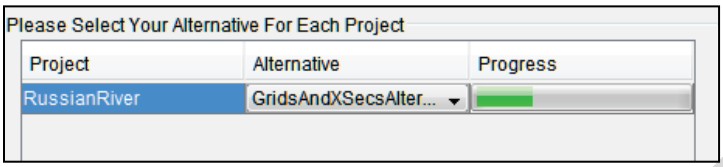


Figure 7.17 HEC-FIA Import Alternative Table

4. Click **Edit Alternative Specifications**, the **Alternative Specification** dialog box will open. Select **Copy Projection from project**, and click **OK**.

5. Click **Import Alternatives**, in the **Progress** column of the table (Figure 7.17) the cell will display the progress of the import with a green bar. When the import is complete an **Information** window will open, click **OK**.

6. From the **Import Alternatives** dialog box (Figure 7.17) click **Close**. A *RussianRiver* HEC-FIA model alternative has been imported.

7.7 Add Map Layers

Now that the base models are in the watershed lets add some map layers:

1. From the HEC-WAT main window (Figure 7.5), from the **Maps** menu, click **Add Map Layers**, the **Select Map to Add** browser will open (Figure 7.18). Click **Create Copy**. Browse to the folder *RussianRiver_Data*; double click on the *MapLayers* folder, select the following map layers:

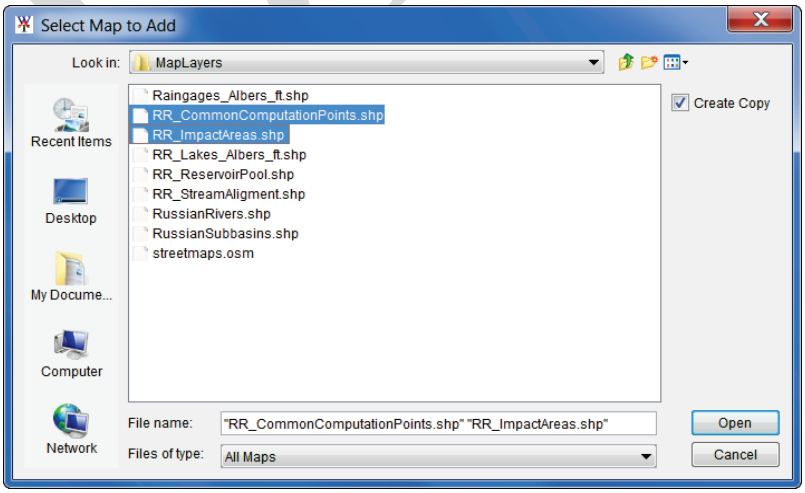


Figure 7.18 Select Map to Add Browser

- Find the map layer which represents the impact areas - *RR_ImpactAreas.shp*
- Find the map layer which represents the CCPs - *RR_CommonComputationPoints.shp*

2. Click **Open**, the **Select Map to Add** browser will close (Figure 7.18). The HEC-WAT **Schematic Map Window** (Figure 7.19) will now display the added map layers.

3. The user can now make adjustments to the map layers. From the HEC-WAT main window (Figure 7.5), click the **Maps** tab. From the **Map Layers** tree:

   - Right-click on the **Stream Alignment** layer, from the shortcut menu, click **Move to Top**.
   - Right-click on the **Without Project Conditions** layer, from the shortcut menu, click **Move to Top**.
   - Un-check the ***Raingages_Albers_ft.shp*** map layer (this will cause the map layer to no longer display in the active map window).
   - Right-click on the ***RR_ImpactAreas.shp*** map layer, from the shortcut menu, click **Properties**. The **Edit Polygon Properties Editor** will open (Figure 7.20). From the **Fill** tab, change the color to "lightgreen", click **OK**. The impact areas on the active map window will now display in "lightgreen".

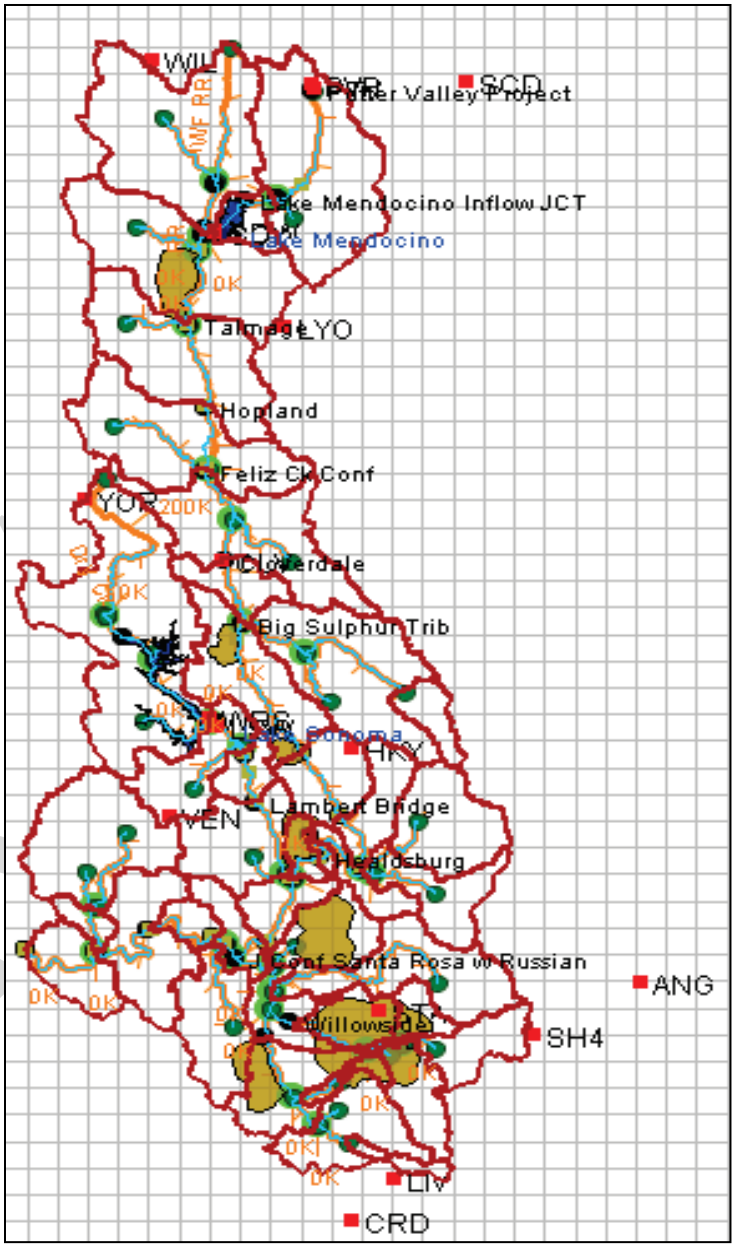


Figure 7.19 Map Layers Added to Watershed

4. The user can adjust the view of the study area in the active map window. Using the **Magnifier Tool**, zoom the study area in the active map window to the appropriate area that the user would like displayed. From the HEC-WAT main window (Figure 7.5), from the **Maps** menu, click **Default Map Properties**, the **Default Map Properties for** dialog

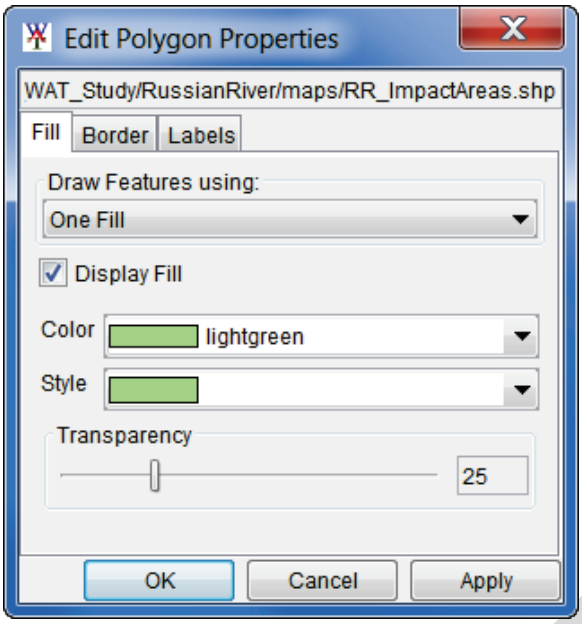


Figure 7.20 Edit Polygon Properties Editor

box will open (Figure 7.21). Click **Set Map Extents to Display**, click **OK**. The **Default Map Properties for** dialog box will close.

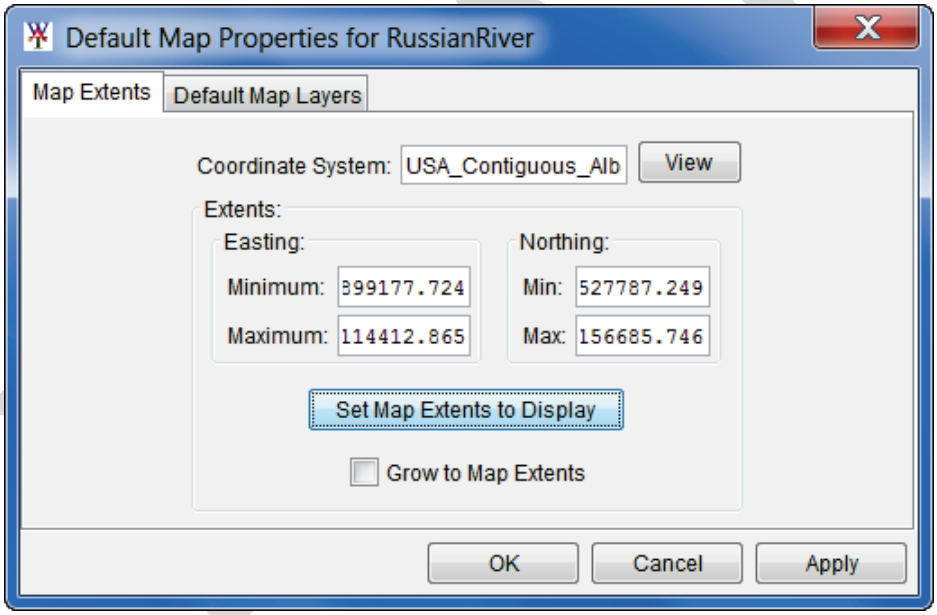


Figure 7.21 Default Map Properties for Dialog Box

This sets the extents for the **Map Window** so that when the study is opened the next time the **Map Window** will be zoomed in to the tighter area.

7.8 Create an Analysis Period

An HEC-WAT compute requires an HEC-WAT alternative, an analysis period, a program order, and model alternatives.

To create an analysis period:

1. From the HEC-WAT main window (Figure 7.5), from the **Study Tree**, right-click on the **Analysis Periods** folder (Figure 7.22). From the shortcut menu click **New**.

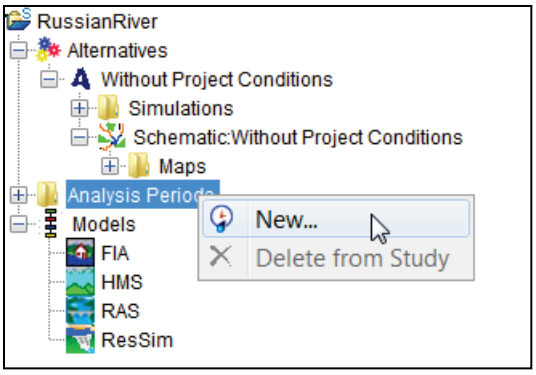


Figure 7.22 Analysis Period Shortcut Menu

2. The **Create New Analysis Periods** dialog box will open (Figure 7.23). In the **Name** box enter a name (*RR_Feb1986*). In the **Time Window** box enter the information required for the time window.

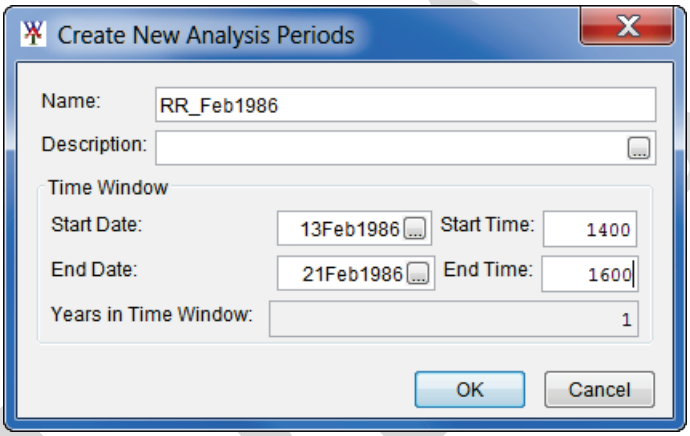


Figure 7.23 Create New Analysis Periods Dialog Box

3. For the **Start Date** and **End Date**, enter in the format ddmmmyyyy. The **Start Time** and **End Time** should be entered as military time - e.g. 0000, 0600, 1300 (1 p.m.), 2400 (midnight).

4. Click **OK**, the **Create New Analysis Periods** dialog box will close (Figure 7.23). On the HEC-WAT main window (Figure 7.6), from the **Study Pane**, under the **Analysis Periods** folder, the new analysis period name will appear.

7.9 Setup Lookback Window – HEC-ResSim

The time window for an HEC-ResSim simulation has two parts, a "lookback period" and a "simulation or forecast period". The lookback period is used by HEC-ResSim to "warm up" a HEC-ResSim model alternative. During this period, routing of flows through the river and

reservoir network are performed but no release decisions are made nor are any mass balance computations evaluated. The user should think of the lookback period as the time to establish the state of the river network and the starting conditions of the reservoirs. The simulation period is the portion of the time window during which HEC-ResSim simulates reservoir operations, and makes release decisions based on the operation scheme defined by the user. Releases are then routed through the river network, combining with local inflows along the way.

Since HEC-WAT and most of the models treat the analysis period as a single, continuous time window, a setup step is required for each HEC-ResSim alternative in an HEC-WAT study. The setup step lets each HEC-ResSim model alternative know how much of the analysis period to use for the lookback period.

To setup the lookback period:

1. From the HEC-WAT main window (Figure 7.5), from the **Edit** menu, point to **ResSim,** click **Lookback Window** (Figure 7.24).

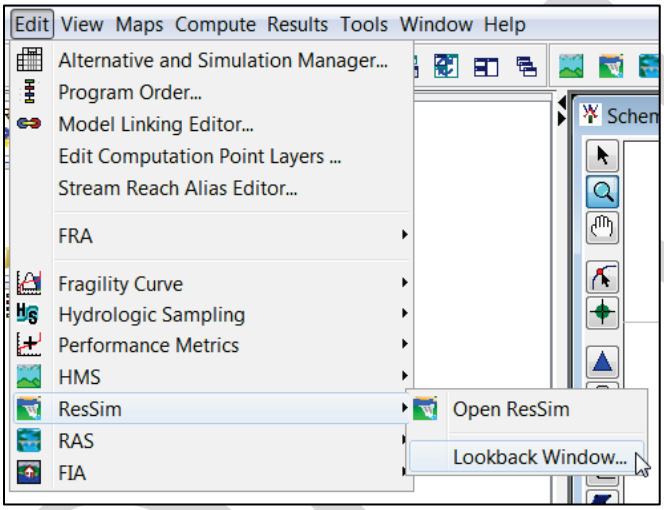


Figure 7.24 Edit Menu – ResSim – Lookback Window

2. The **Lookback Window** dialog box (Figure 7.25) will open.

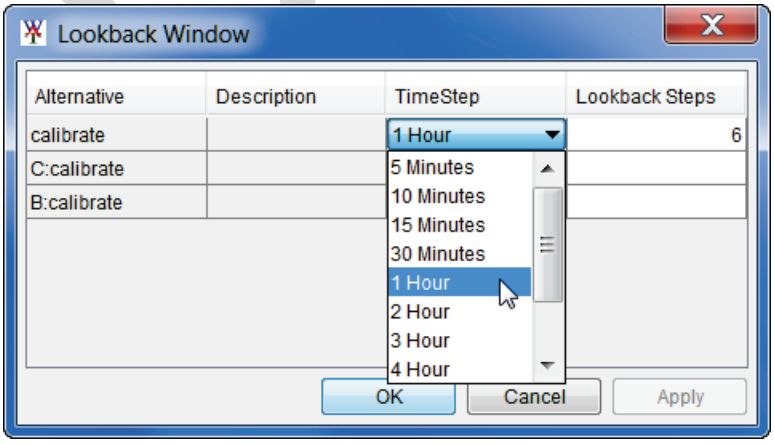


Figure 7.25 Lookback Window Dialog Box

3. The table displays the HEC-ResSim alternatives that are available in the HEC-WAT study. Each alternative that is being used in an HEC-WAT simulation will need to have a lookback window set. For example, in Figure 7.25, the HEC-ResSim alternative *calibrate* has a **TimeStep** of 1 hour and **Lookback Steps** of 6.

4. The time step can be selected from the **TimeStep** column, in each cell there is a list of available time steps for the user to choose from. The selected time step has to match the time step that was specified for the HEC-ResSim alternative as part of the alternative's original run control data (which is located in the HEC-ResSim Alternative Editor). The number of lookback steps must be entered in a cell in the **Lookback Steps** column. At least one lookback time step is required for a HEC-ResSim alternative to compute, however more lookback steps may be needed, depending on a variety of factors in the HEC-ResSim alternative's operating scheme. The HEC-ResSim modeler should be consulted to determine the minimum lookback window needed by each alternative.

5. Click **OK**, a **Missing Lookback Info** window (Figure 7.26) will open. This message window is letting the user know that lookback information for the other HEC-ResSim alternatives have not been set. For this example, the user is only using the *calibrate* alternative, click **OK**. The **Missing Lookback Info** window (Figure 7.26) and the **Lookback Window** dialog box (Figure 7.25) will both close.

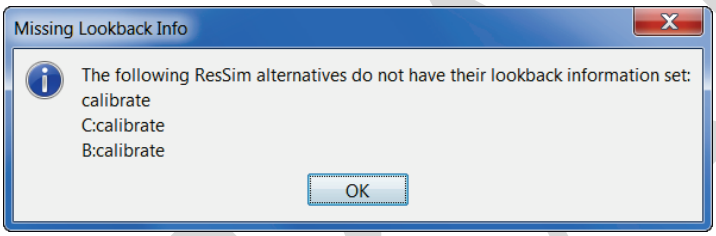


Figure 7.26 Missing Lookback Info Window

7.10 Program Order

HEC-WAT allows for a flexible set of programs, computation order, and data flow through the establishment of a program order. Once a program order has been chosen for an HEC-WAT study, changes should not be made to the program order as this could cause a disruption in the flow of data and invalidate any existing work.

Currently in HEC-WAT Version 1.0 the default program order is - HMS, ResSim, RAS, FIA. This is the correct program order for the example watershed that is being used, so no adjustment is necessary. For further details on **Program Order**, review Chapter 11 (Section 11.1) of the HEC-WAT User's Manual.

7.11 Create an HEC-WAT Simulation

Now that all of the building blocks have been configured (alternative, analysis period, program order, models), the user can now create an HEC-WAT simulation. To create an HEC-WAT simulation:

1. From the HEC-WAT main window (Figure 7.5), from the **WAT Tools** toolbar, click the **Alternative and Simulation Manager** button .

2. The **Alternative and Simulation Manager** will open (Figure 7.27). From this dialog box the user can create/modify alternatives, analysis periods, simulations, program orders, link models, and make runs.

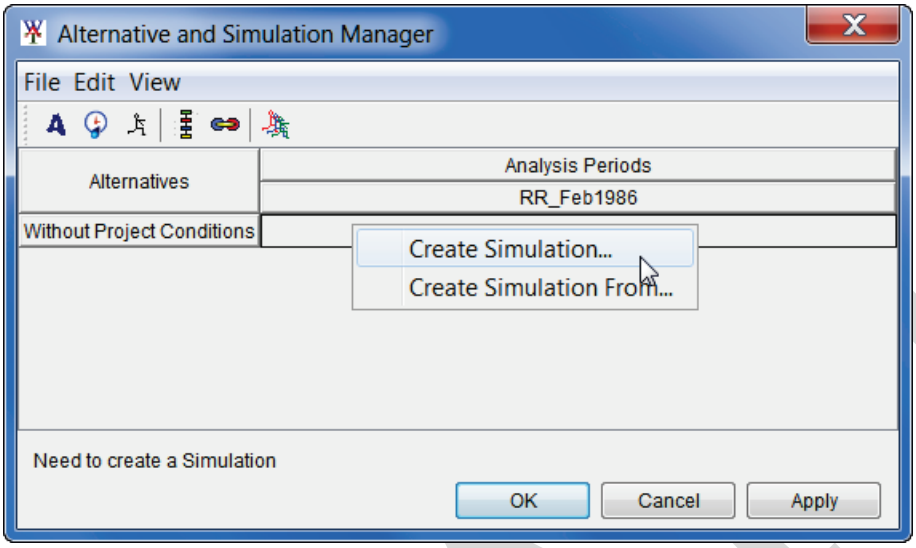


Figure 7.27 Alternative and Simulation Manager

3. To create a simulation, from the table right-click on the intersection of an alternative and analysis period. From the shortcut menu click **Create Simulation**. The **Create New Simulation** dialog box will open (Figure 7.28).

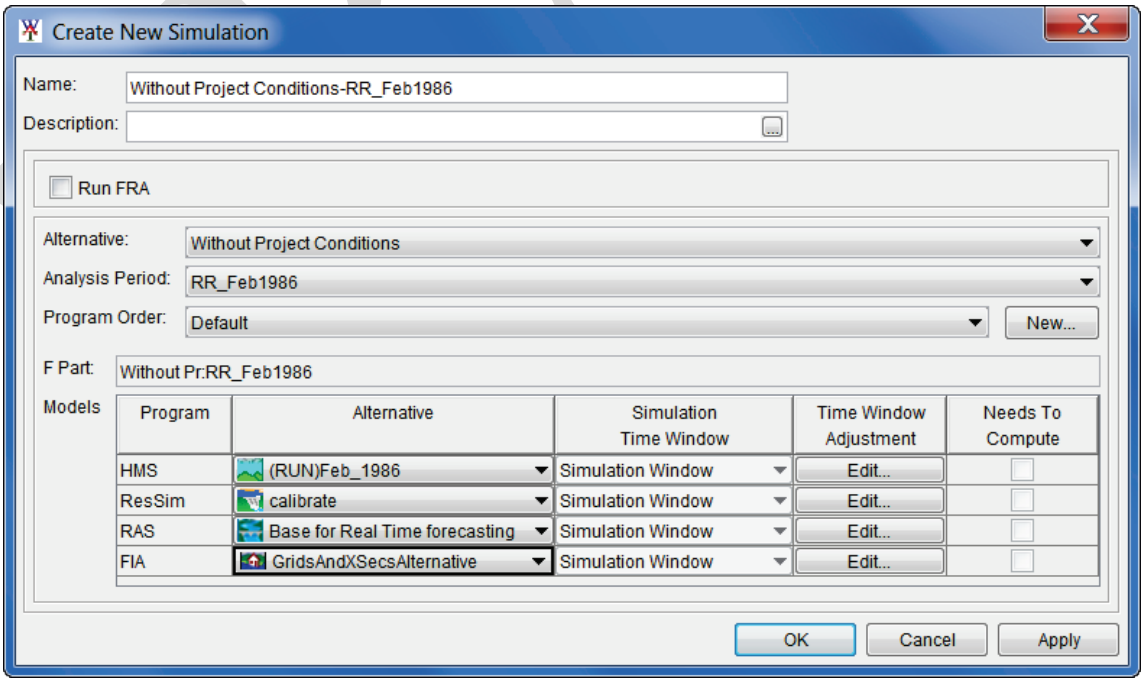


Figure 7.28 Create New Simulation Dialog Box

4. HEC-WAT has defined a default name for the simulation (*Without Project Conditions-RR_Feb1986*) in the **Name** box (Figure 7.28). The name is a combination of the HEC-WAT alternative name and analysis period name, where the intersection was in the table (name can be changed). Also, in the **Alternative** and **Analysis Period** lists (Figure 7.28) the selections have already been made based on the intersection in the table. The selected **Alternative** cannot be changed, but the selected **Analysis Period** can be changed.

5. The program order is *Default*.

6. In the **F Part** box (Figure 7.28), a default **F Part** is displayed that was generated by HEC-WAT based once again on the alternative and analysis period names. The user can edit the item, but it is not advised.

7. In the **Programs** table (Figure 7.28), the software applications that were defined in the program order appear in the order they were selected. Now the user must select the appropriate model alternatives (plan, run) for each software application. From the **Alternative** column, from the list for **HMS** (Figure 7.29), select the appropriate HMS model alternative (*(RUN)Feb_1986*). Repeat the process for the other software applications. Below is the list of the appropriate model alternatives for the *RussianRiver* study:

   HMS - (RUN)Feb_1986
   ResSim - calibrate
   RAS - Base for Real Time forecasting
   FIA – GridsAndXSecsAlternative

Models

Program	Alternative	Simulation Time Window	Time Window Adjustment	Needs To Compute
HMS	(RUN)Feb_1986	Simulation Window	Edit...	
ResSim	calibrate	Simulation Window	Edit...	
RAS	Base for Real Time forecasting	Simulation Window	Edit...	
FIA	GridsAndXSecsAlternative	Simulation Window	Edit...	

Figure 7.29 Selection of Model Alternatives - Create New Simulation Dialog Box

8. Now that all of the model alternatives have been selected, click **OK**. The **Create New Simulation** dialog box will close (Figure 7.29). On the **Alternative and Simulation Manager** (Figure 7.30), the intersection of an HEC-WAT alternative and analysis period now provides information about the simulation.

9. Click **OK**; the **Alternative and Simulation Manager** will close (Figure 7.30). From the HEC-WAT main window (Figure 7.5), the created simulation appears on the **Study Tree**, under the **Simulations** folder (Figure 7.31).

10. The **Content Pane** (Figure 7.32) displays information about the selected simulation.

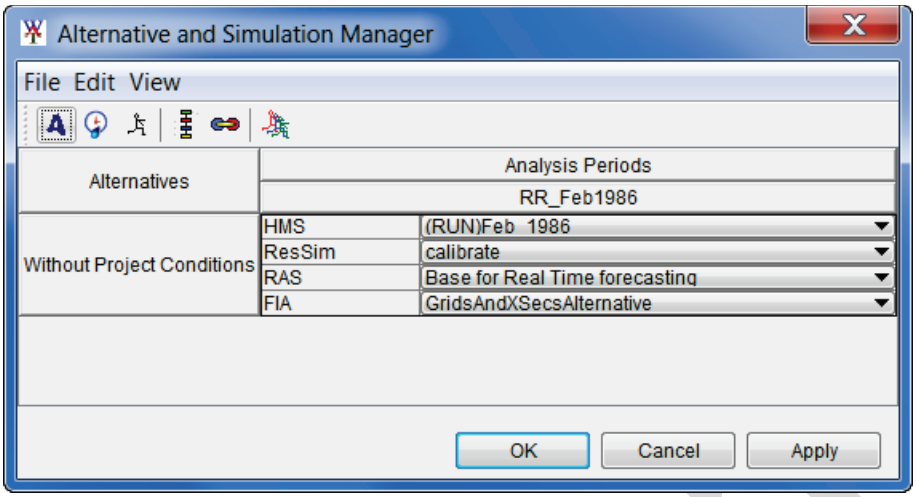


Figure 7.30 Alternative and Simulation Manager - Completed Simulation

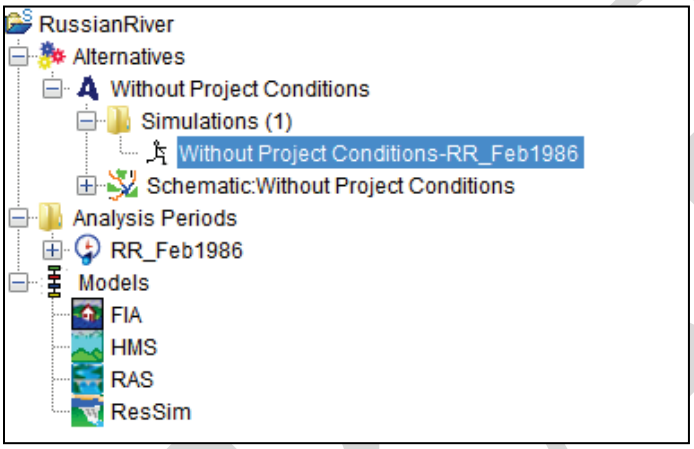


Figure 7.31 Study Tree with Created Simulation

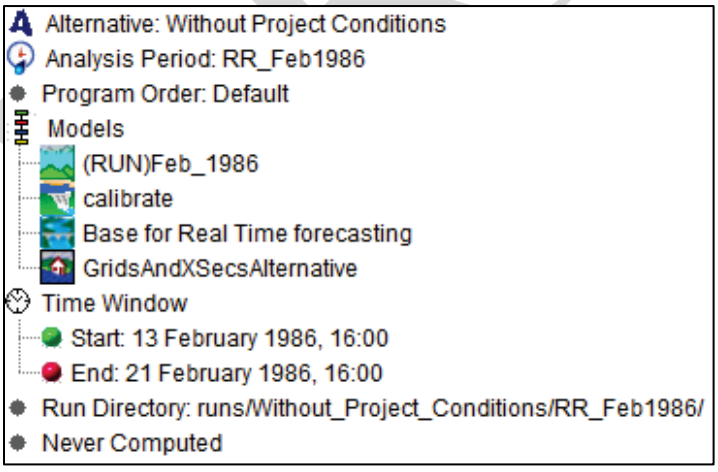


Figure 7.32 Content Pane

11. Double click on the simulation name (*Without Project Conditions-RR_Feb1986*), a **Select Map** dialog box will open. Click **New Map Window**, click **OK**. The **Select Map** dialog box will close. The new map window will contain the schematic elements that represent the simulation (Figure 7.33).

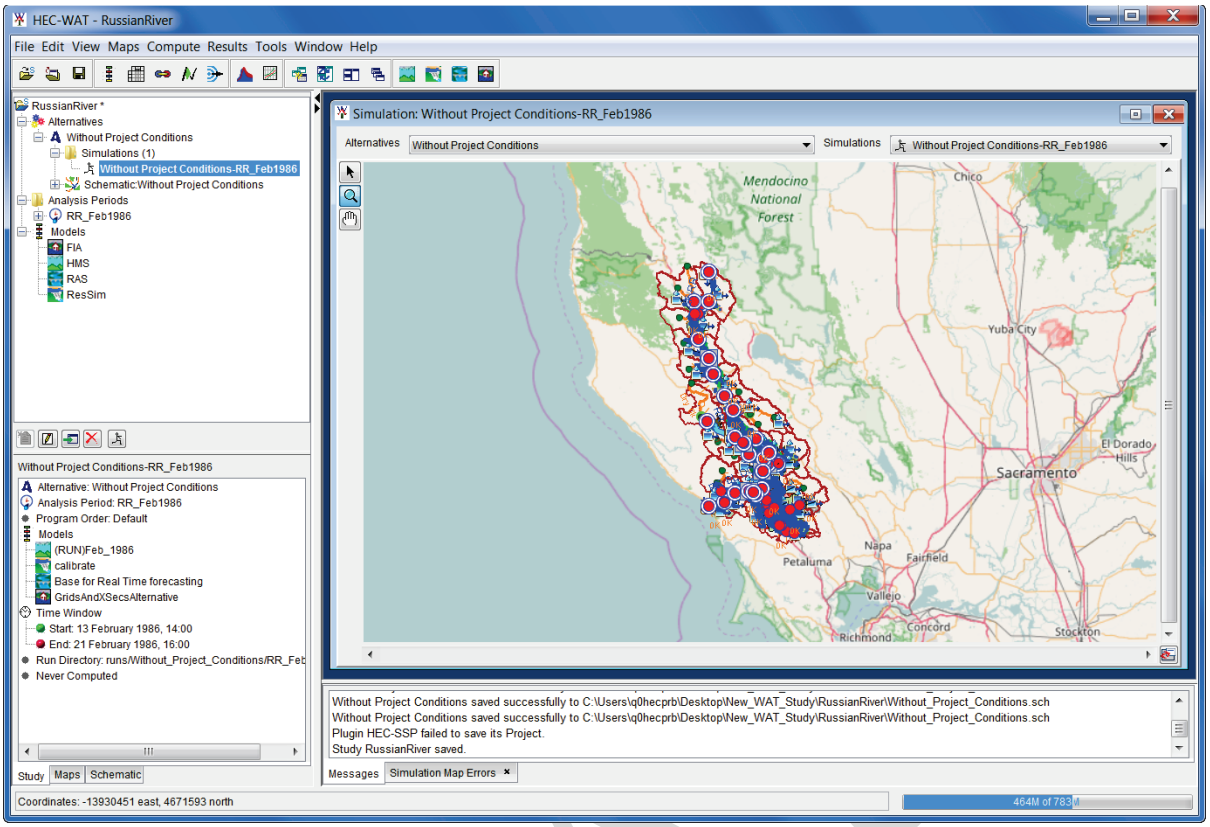


Figure 7.33 Map Window - Schematic of Current HEC-WAT Simulation

7.12 Linking

The next step is to have the models of a simulation communicate with each other. This is accomplished by linking (DSS mapping) the models thru DSS and using a simulation name. From HEC-WAT, the **Model Linking Editor** (Figure 7.34) provides an easy way to link models including observed data, and provides a mechanism where the linking will have to be done once per alternative.

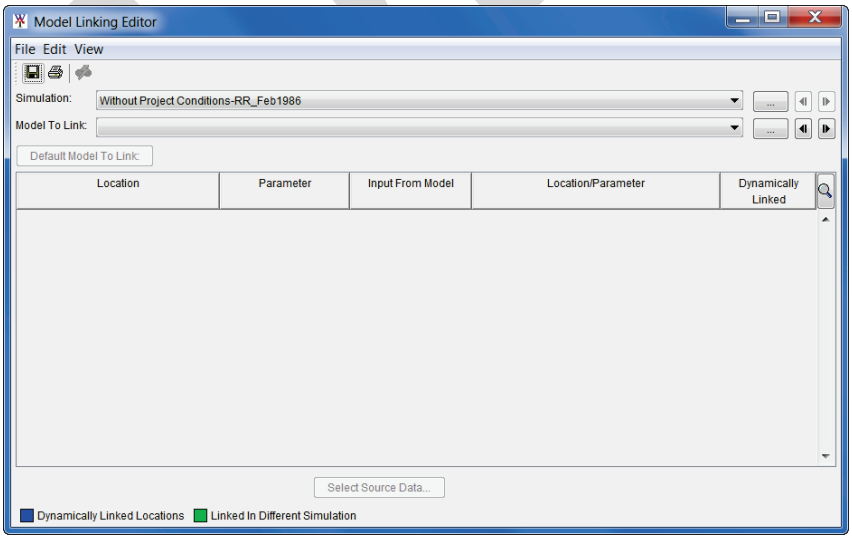


Figure 7.34 Model Linking Editor

1. From the HEC-WAT main window (Figure 7.33), from the **WAT Tools** toolbar, click the **Model Linking Editor** button .

2. The **Model Linking Editor** will open (Figure 7.34). From the **Simulation** list the user will need to select a simulation. For this example the user will be selecting the *Without Project Conditions-RR_Feb1986* (default) simulation.

3. Now let's link the individual model alternatives that are part of the selected simulation.

7.12.1 Linking the HMS Model Alternative

1. From the **Model Linking Editor**, from the **Model to Link** list select *HMS-(RUN)FEB_1986* (Figure 7.34). The **Model Linking Editor** table (Figure 7.35) will now contain all of the locations for the HMS model alternative.

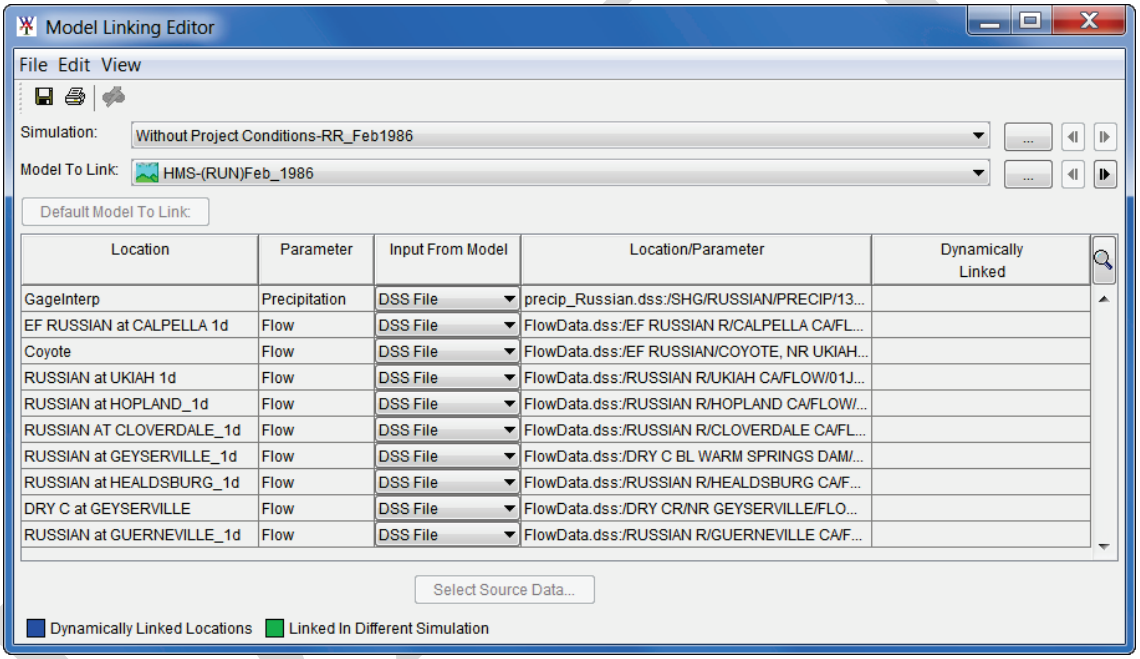


Figure 7.35 Model Linking Editor – HMS Model Alternative

2. Since HEC-HMS wants precipitation and flow data that is not provided by another software application, HEC-WAT reads the linking from the HMS model alternative and displays that linking in the **Model Linking Editor** table (Figure 7.35).

3. The table displays the linking from a DSS file for the HMS model alternative which is the correct linking.

7.12.2 Linking the ResSim Model Alternative

1. From the **Model Linking Editor**, from the **Model to Link** list select *ResSim-calibrate* (Figure 7.35). The **Model Linking Editor** table (Figure 7.36) will now contain all of the locations for the ResSim model alternative that need to be linked.

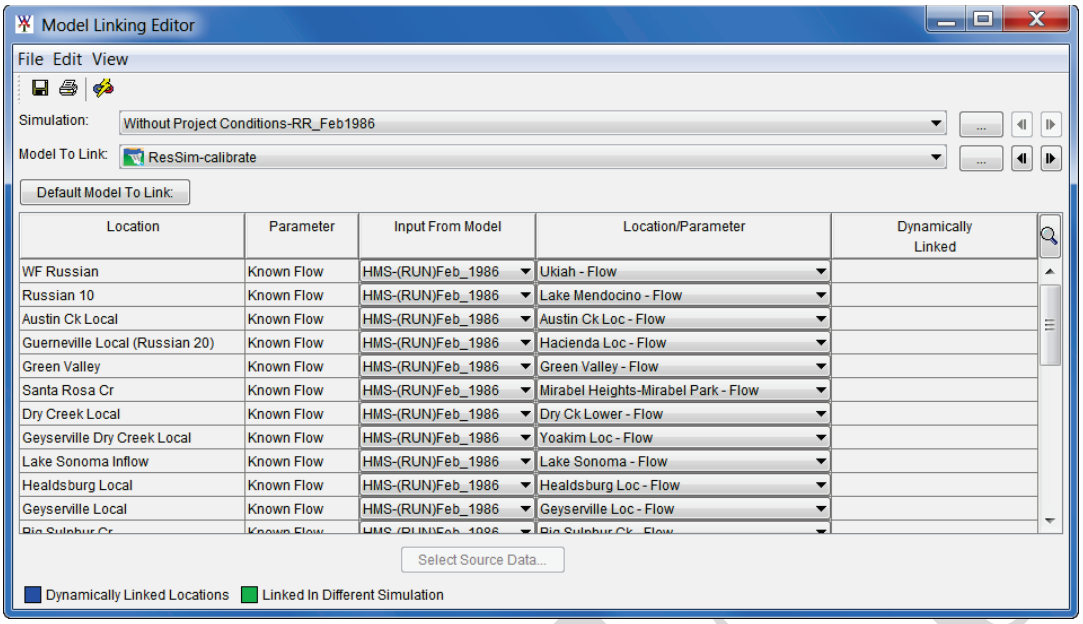


Figure 7.36 Model Linking Editor – ResSim Model Alternative

2. The current linking (Figure 7.37) that is displayed for the ResSim model alternative is correct, so the linking does not need to be done.

7.12.3 Linking the RAS Model Alternative

1. From the **Modeling Linking Editor**, from the **Model to Link** list select *RAS-Base for Real Time forecasting* (Figure 7.36). The **Model Linking Editor** table (Figure 7.37) contains all of the locations for the RAS model alternative that need to be linked. The current linking (Figure 7.37) that is displayed is the HEC-RAS linking for the standalone model.

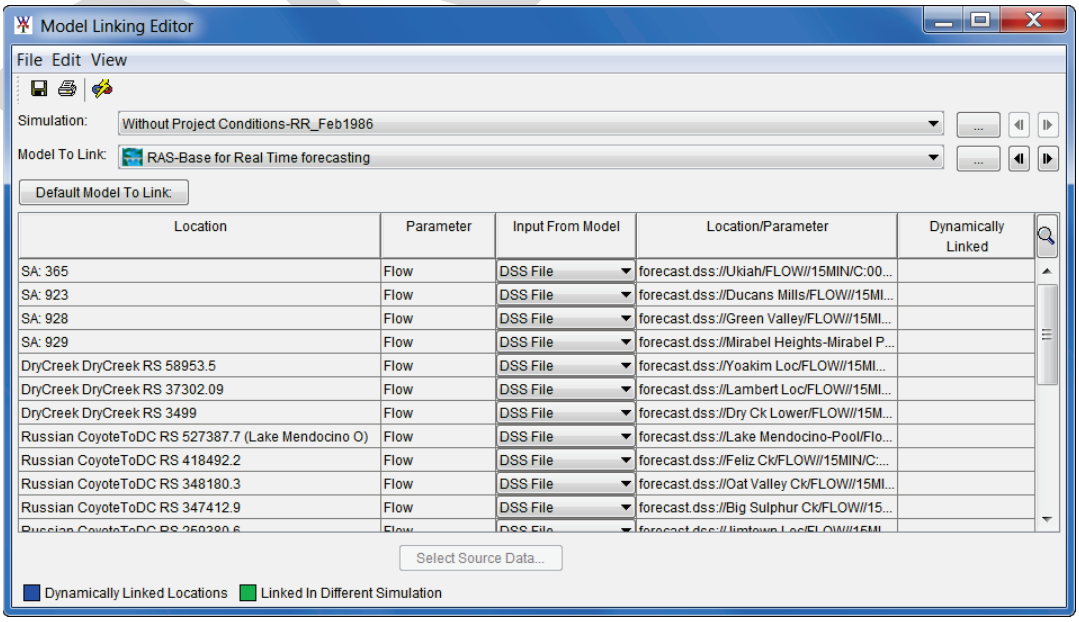


Figure 7.37 Model Linking Editor - RAS Model Alternative Unlinked

2. RAS model alternative linking will be the results from the HMS and ResSim model alternatives.

3. From the **Model Linking Editor** (Figure 7.37), click **Default Model to Link**. The **Select Default Model to Link** dialog box will open (Figure 7.38). From the **Default Model to Link** list, select *HMS-(RUN)Feb_1986*. Click **OK**, the **Select Default Model to Link** dialog box will close (Figure 7.38).

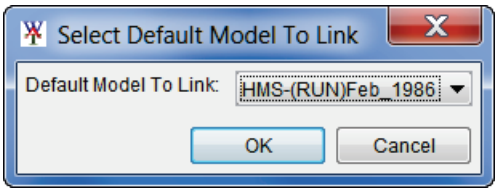


Figure 7.38 Select Default Model to Link Dialog Box

4. A **Confirm Input from the "Input From Model" changing to** window (Figure 7.39) will appear. Basically the window is asking the user to be sure before proceeding, click **Yes**. The **Confirm Input from the "Input From Model" changing to** window closes, and the **Model Linking Editor** now displays the linking for the RAS model alternative (Figure 7.40).

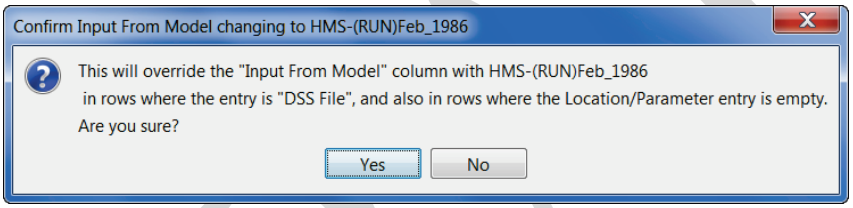


Figure 7.39 Confirm Input from Model changing to Window

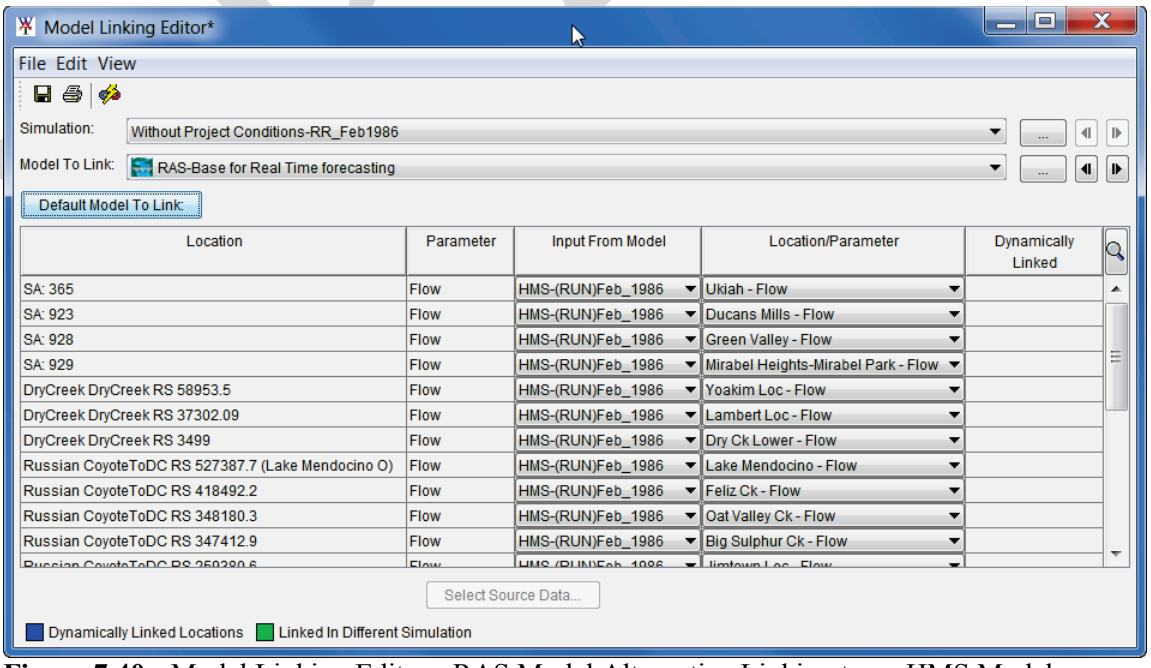


Figure 7.40 Model Linking Editor - RAS Model Alternative Linking to an HMS Model Alternative

5. There are two locations in the RAS linking that need to be linked to the ResSim model alternative. From the **Model Linking Editor** table (Figure 7.40) for the *DryCreek DryCreek RS 74716.8 (Sonoma Outflow J)* row, from the **Input Model** column (Figure 7.40), select *ResSim-calibrate*. HEC-WAT tries to find a match, *Lake Sonoma-Pool - Outflow*. From the **Location/Parameter** column list, select *Lake Sonoma Outflow JCT - Flow*.

6. Repeat Step 5 for the *Russian CoyoteToDC RS 527387.7 (Lake Mendocino O)* row (*Lake Mendocino-Pool - Outflow*) from the **Location/Parameter** column list, select *Lake Mendocino Outflow JCT - Flow*.

7. Refer to the printout (*RussianRiverLinking.pdf;* located in a folder titled *RussianRiver_Data*) for the linking for each of the model alternatives. Once the linking is finished for the RAS model alternative, from the **Model Linking Editor** (Figure 7.41) click , this will save the linking.

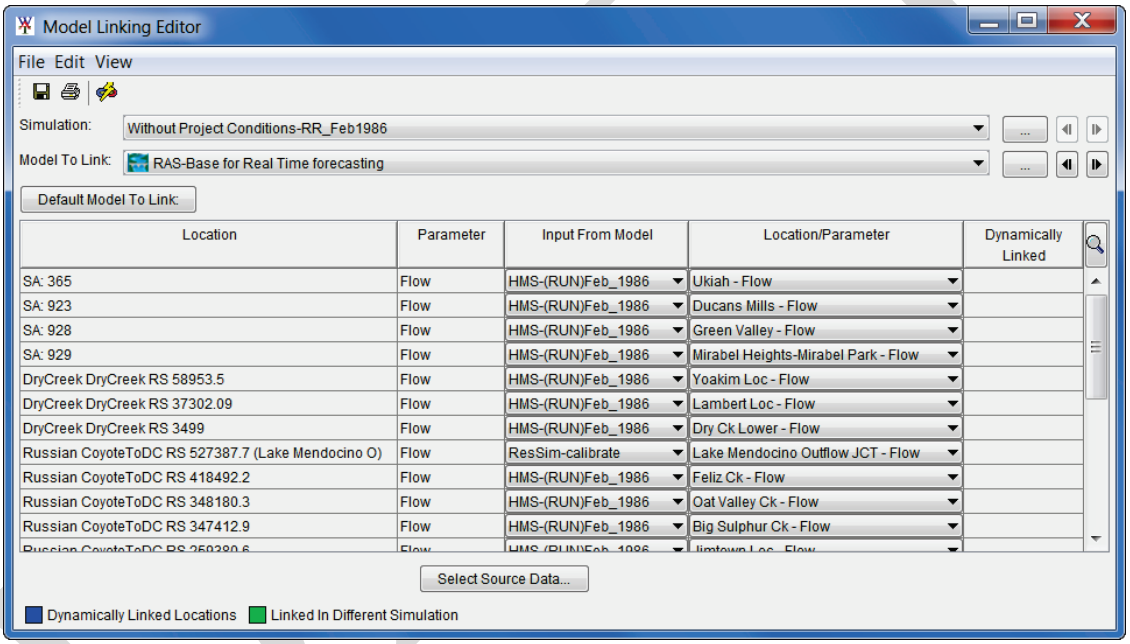


Figure 7.41 Model Linking Editor - Completed RAS Model Alternative Linking

8. That completes the linking for the RAS model alternative.

7.12.4 Linking the FIA Model Alternative

1. From the **Model Lining Editor**, from the **Model to Link** list select *FIA-GridsAndXSecsAlternative* (Figure 7.41). The **Model Linking Editor** table (Figure 7.42) will now contain all of the locations for the FIA model alternative that need to be linked.

2. For the FIA model alternative, the linking will be results from the RAS model alternative.

3. From the **Model Linking Editor** (Figure 7.42), click **Default Model to Link**. The **Select Default Model to Link** dialog box will open (Figure 7.38). From the **Default**

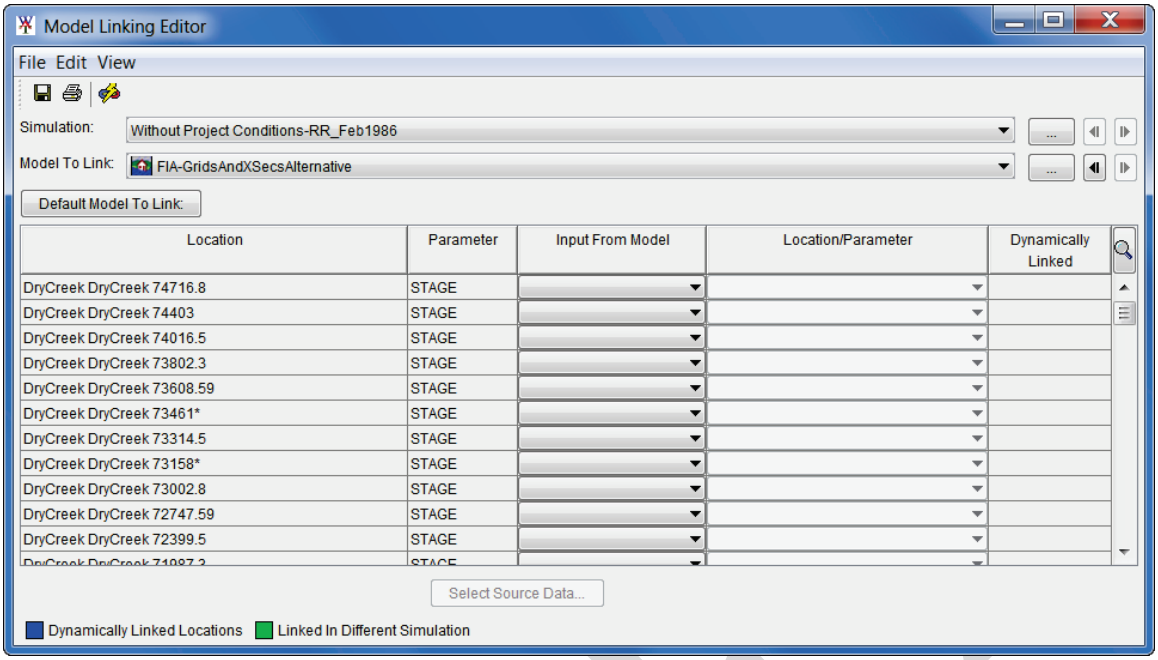


Figure 7.42 Model Linking Editor - FIA Model Alternative Unlinked

Model to Link list, select *RAS-Base for Real Time forecasting*. Click **OK**, the **Select Default Model to Link** dialog box will close (Figure 7.38).

4. A **Confirm Input from the "Input From Model" changing to** window (Figure 7.39) will appear. Basically the window is asking the user to be sure before proceeding, click **Yes**. The **Confirm Input from the "Input From Model" changing to** window closes, and the **Model Linking Editor** now displays the linking for the RAS model alternative (Figure 7.43).

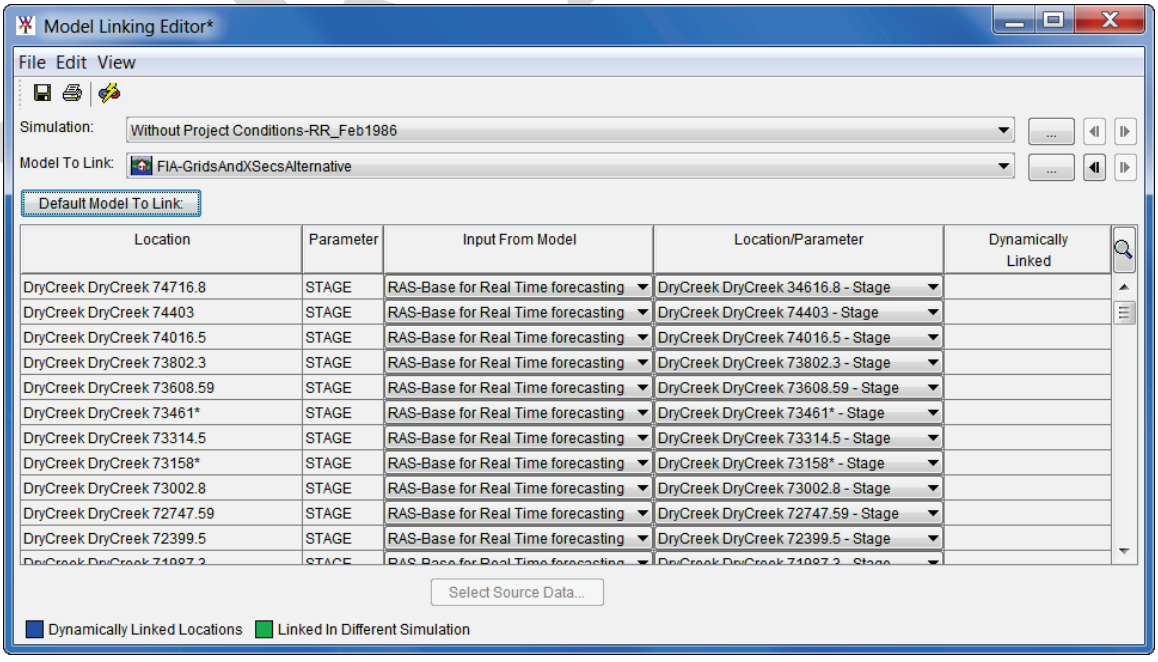


Figure 7.43 Model Linking Editor - FIA Model Alternative Linking to RAS Model Alternative

5. The user will need to adjust two rows for the FIA linking; HEC-WAT did not choose the correct locations. In Figure 7.43, for the first row (*DryCreek DryCreek 74716.8*), change the **Location/Parameter** column to *DryCreek Dry Creek 74716.8 (Sonoma Outflow J) - Stage*. Repeat for the row *Russian CoyoteToDC 527387.7* and change the **Location/Parameter** column to *Russian CoyoteToDC 527387.7 (Lake Mendocino O) - Stage*.

6. Refer to the printout (*RussianRiverLinking.pdf;* located in a folder titled *RussianRiver_Data*) for the linking for each of the model alternatives. Once the linking is finished for the RAS model alternative, from the **Model Linking Editor** (Figure 7.44) click , this will save the linking.

7. That completes the linking for the FIA model alternative.

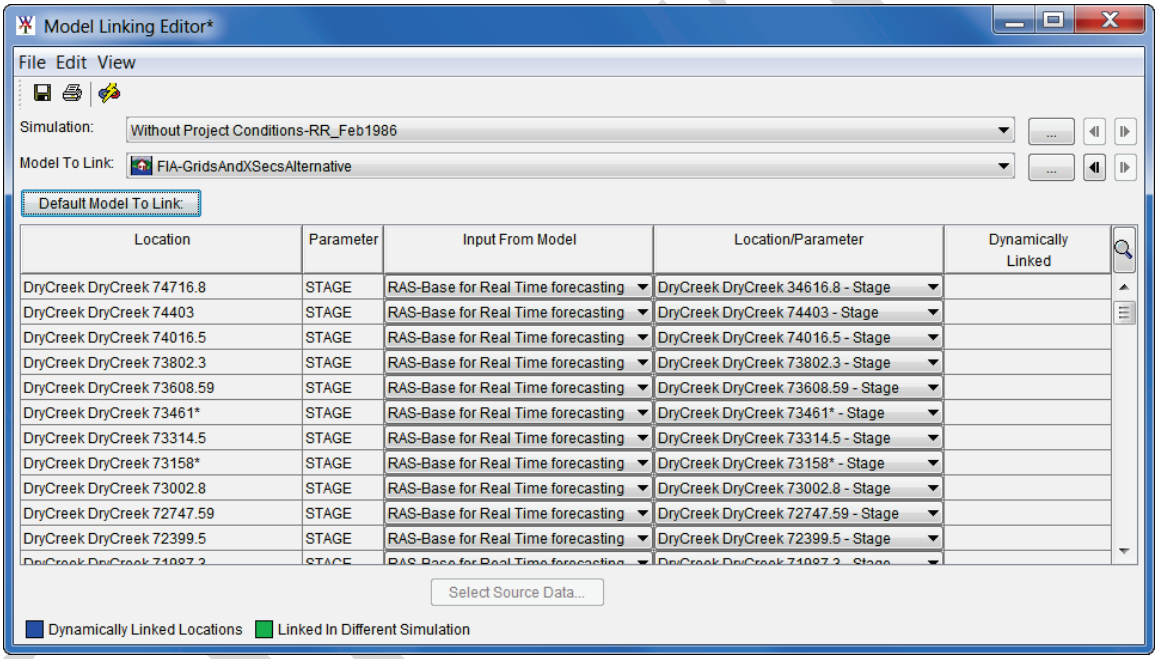


Figure 7.44 Model Linking Editor – Completed FIA Model Alternative Linking

7.13 Compute and Results

Now that a simulation has been defined, the linking of model alternatives has been completed for the simulations, and model alternatives have been imported into HEC-WAT, the user is now ready to compute the Russian River watershed.

1. From the HEC-WAT main window (Figure 7.45), from the **Study Tree**, from the **Simulations** folder, right-click **Without Project Conditions-RR_Feb1986**. From the shortcut menu (Figure 7.45) point to **Compute**, hold down the **Ctrl** key, click **Simulation**.

2. The **Compute Progress** dialog box will open (Figure 7.46). The compute for the Russian River study takes about 20 minutes.

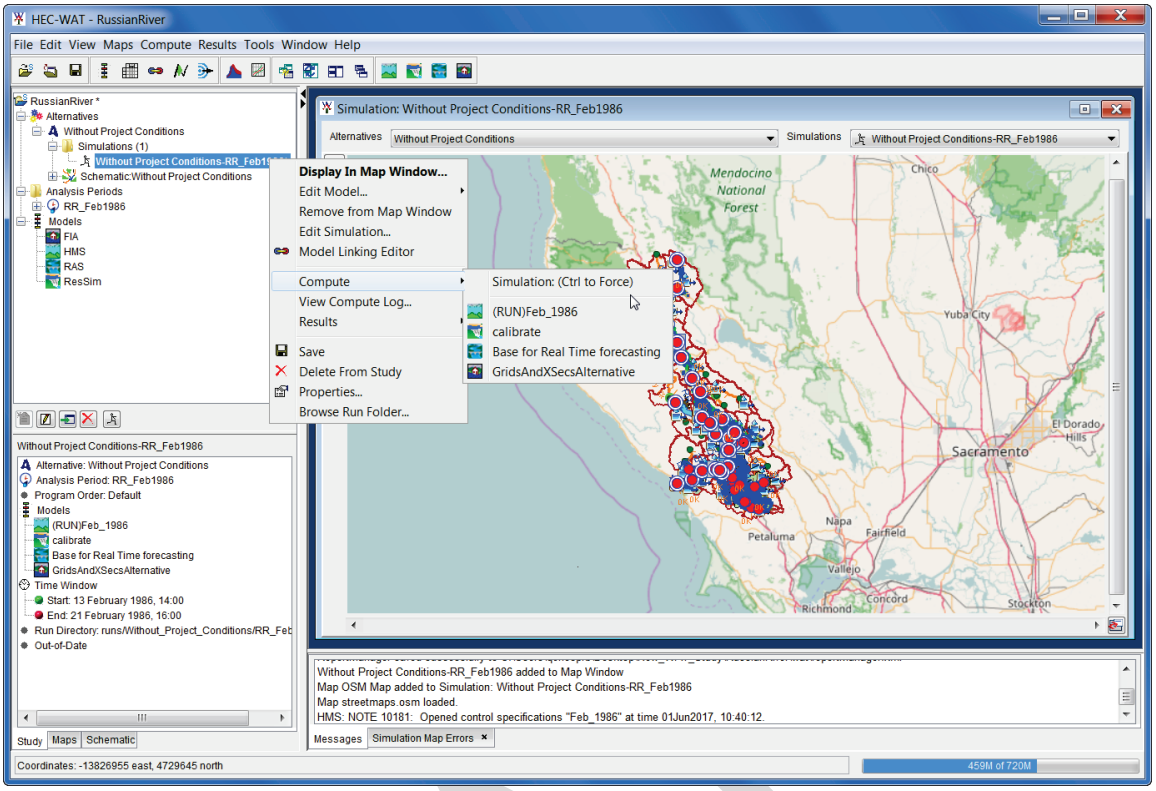


Figure 7.45 HEC-WAT Main Window - Compute

3. When the compute is finished, click **Close,** the **Compute Progress** dialog box will close (Figure 7.46).

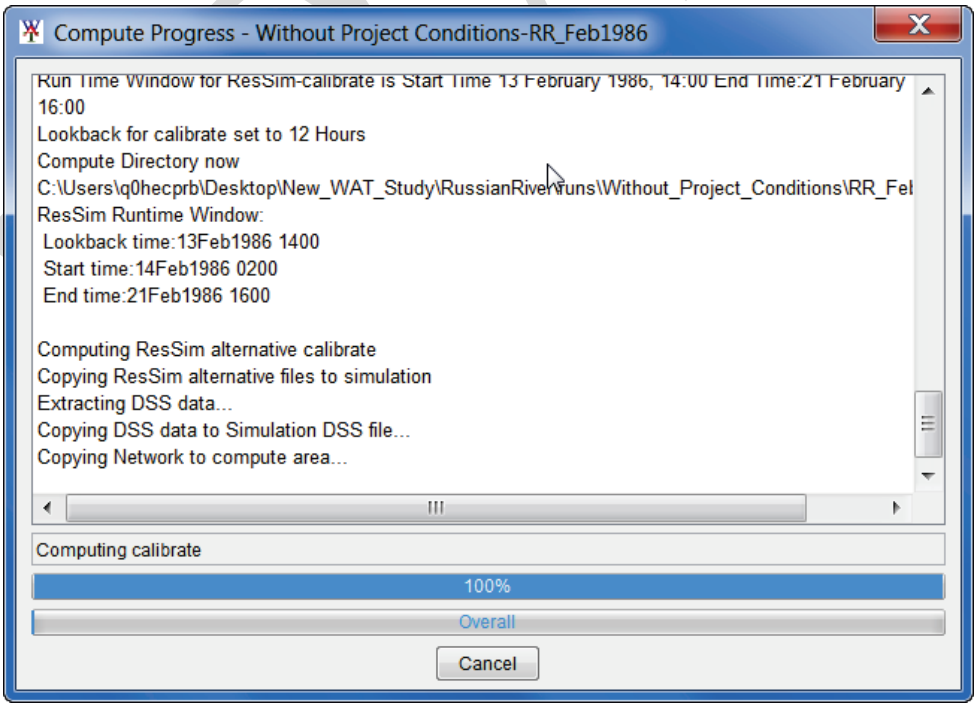


Figure 7.46 Compute Progress Dialog Box

Chapter 8

Create an HEC-WAT Study from a CWMS Watershed

If the HEC-WAT study the user is building already has been built in the Corps Water Management System (CWMS) software, an HEC-WAT study can be created from the CWMS watershed. For the *Russian River* example, the user can create an HEC-WAT study by importing the available CWMS watershed.

8.1 Create an HEC-WAT Study

To create a new study:

1. From the HEC-WAT main window (Figure 8.1), on the **File** menu, click **New Study**. The **Create New Study** dialog box (Figure 8.2) will open.

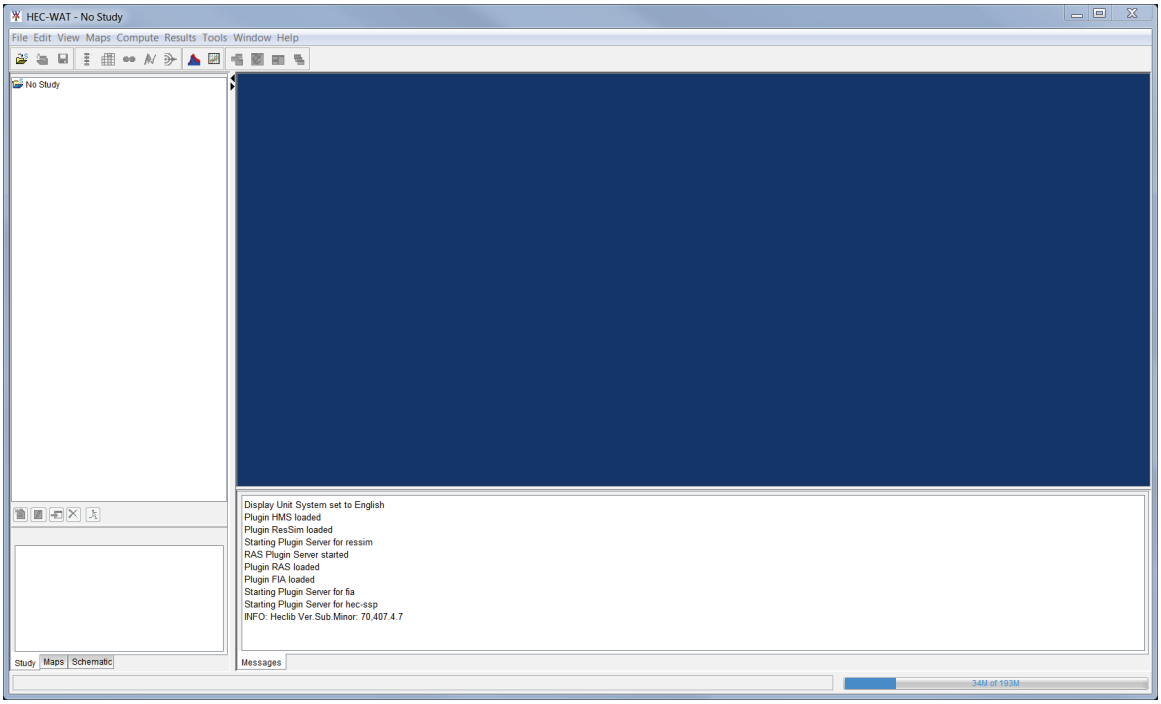


Figure 8.1 HEC-WAT Main Window

2. In the **Study Name** box (Figure 8.2), enter a name (*RussianRiver*), and in the **Description** box, enter a description (*Russian River water resources study*) for the new study.

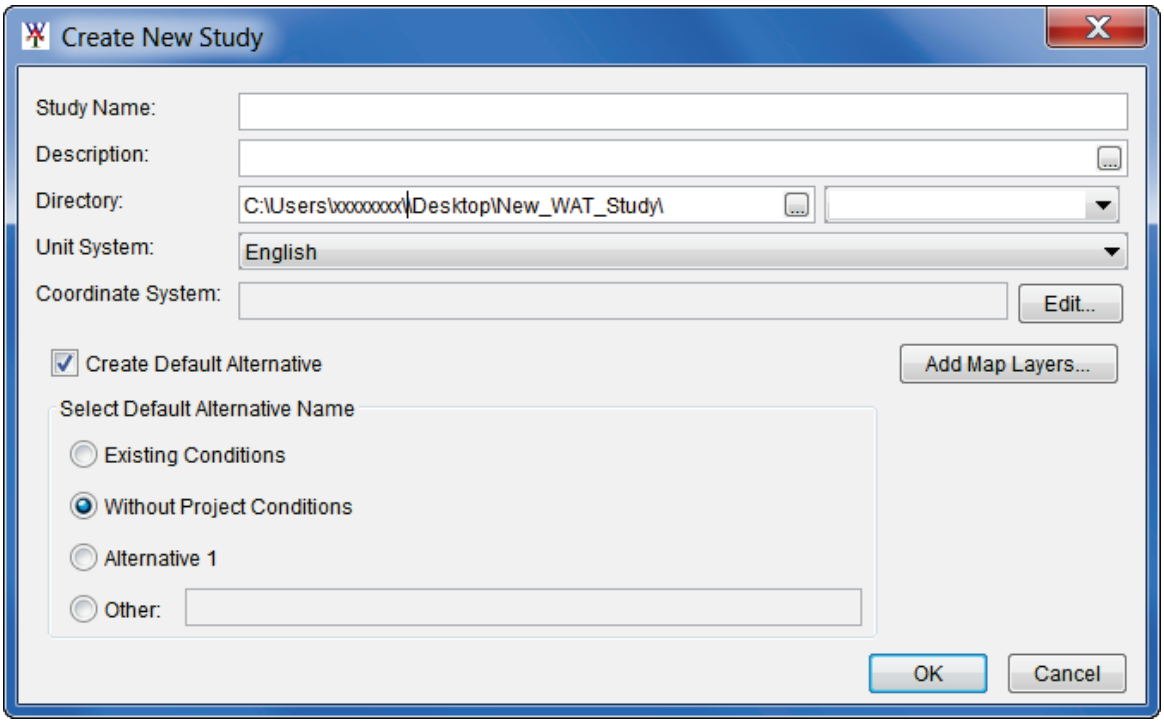


Figure 8.2 Create New Study Dialog Box

3. In the **Directory** box (Figure 8.1), either enter the name of the directory where the HEC-WAT study will be stored, or click ..., and an **Open** browser (Figure 8.3) will open. Navigate to the directory where the HEC-WAT study will be stored, click **Open**. The **Open** browser (Figure 8.3) will close. On the **Create New Study** dialog box (Figure 8.2) in the **Directory** box the location will display.

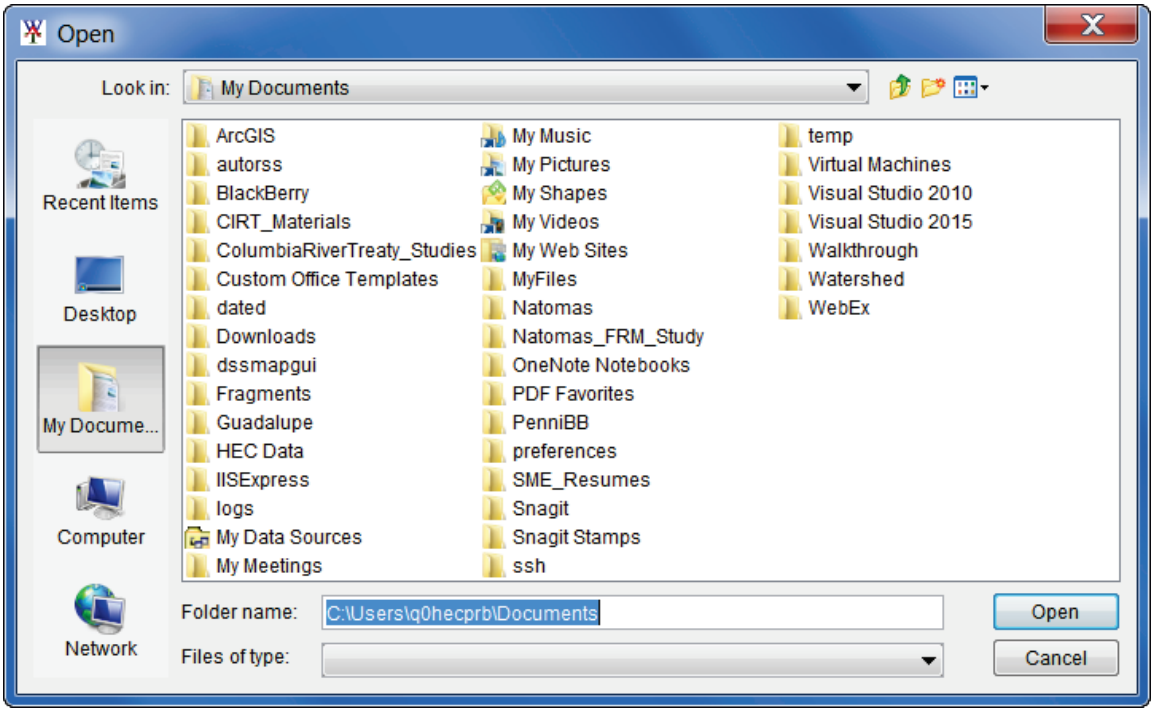


Figure 8.3 Open Browser

4. The **Unit System** (Figure 8.2) for the study defaults to **English** (which is correct for the *RussianRiver* study). The other choice from the list is **SI** (metric).

5. Next, the projected coordinate system of the study needs to be set. From the **Create New Study** dialog Box (Figure 8.2), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure 8.4).

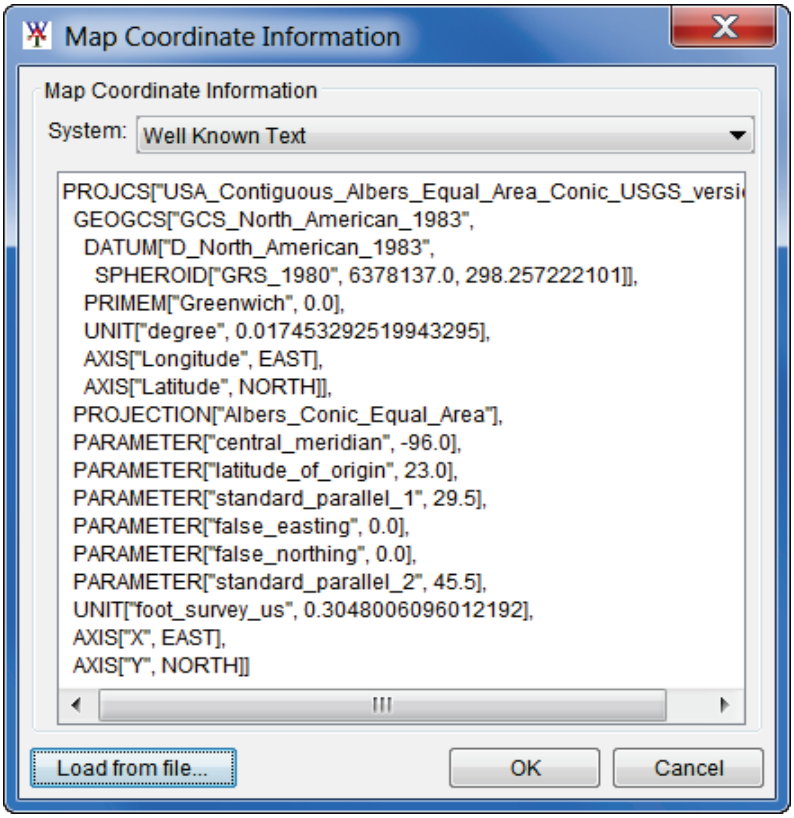


Figure 8.4 Map Coordinate Information Dialog Box with Study Projection Information

6. For the *RussianRiver* study, the associated map layers have the correct projected coordinate system. So, use one of those map layers to set the projected coordinate system for the study. From the **Map Coordinate Information** dialog box (Figure 8.4), click **Load from file** (lower left corner of dialog box); an **Open** browser (Figure 8.3) will open. The map layers for the *RussianRiver* study are located in a folder titled *RussianRiver_Data* (double-click). In that folder, is a *MapLayers* (double-click) folder, from that folder, click on *RR_StreamAlignment.prj* (any of the map layers will work). Click **Open**, now the **Map Coordinate Information** dialog box will contain information about the projected coordinate system (Figure 8.4). Click **OK**, the **Map Coordinate Information** dialog box will close (Figure 8.4). Now on the **Create New Study** dialog box the **Coordinate System** box (Figure 8.2) contains the name of the projected coordinate system (i.e., *USA_Continguous_Albers_Equal_Area_Conic_USGS _version*) for the study.

7. Click **OK**; the **Create New Study** dialog box will close (Figure 8.1). The HEC-WAT main window will now have the name of the study (*RussianRiver*) on the title bar (Figure 8.5). A blank **Schematic Map Window** opens.

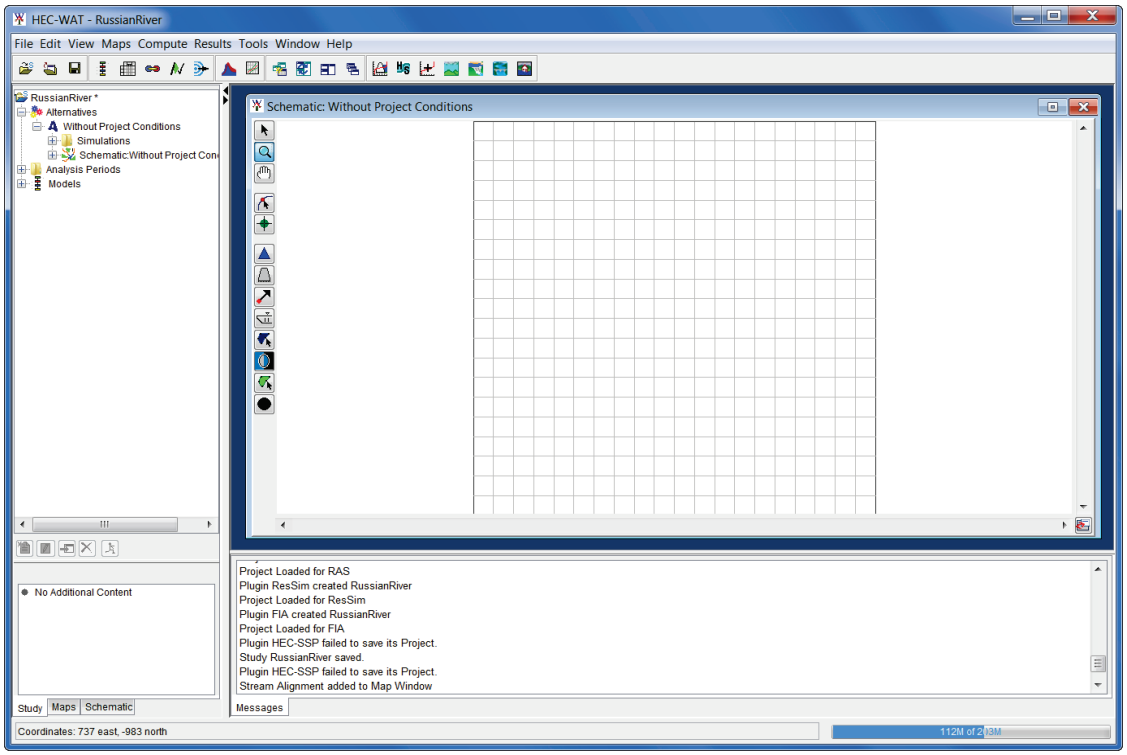


Figure 8.5 HEC-WAT Main Window - *RussianRiver* Study

8.2 Import a CWMS Watershed

To import a CWMS watershed:

1. From the **File** menu, point to **Import**, click **CWMS Watershed**. The **Import CWMS Watershed** dialog box will open (Figure 8.6).

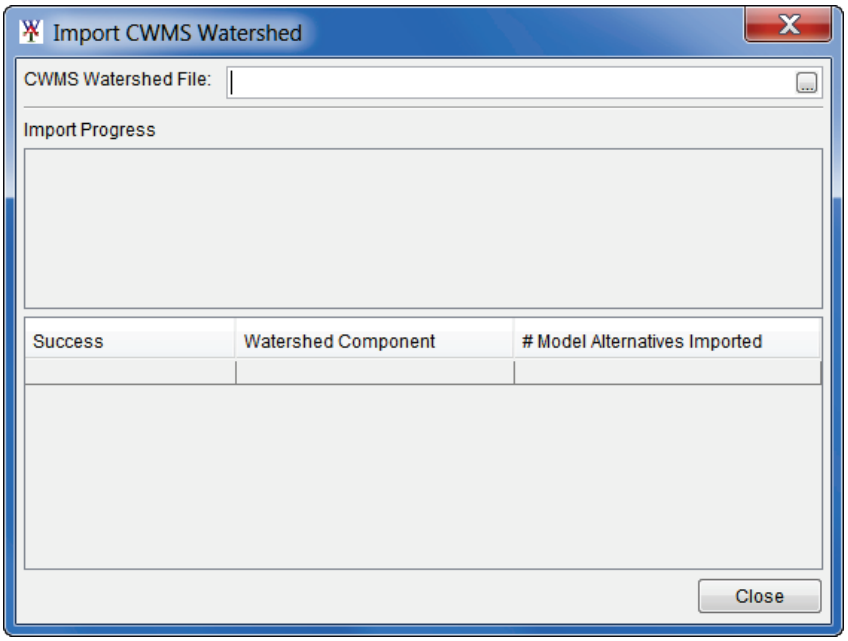


Figure 8.6 Import CWMS Watershed Dialog Box

2. Now select the *RussianRiver* CWMS watershed file. From the **CWMS Watershed File** box, click ..., and the **Select Workspace File** browser (Figure 8.7) will open. Browse to the directory (*C \Desktop\RussianRiver_Data\CWMS_Watershed/RussianRiver*) and select *RussianRiver.wtrshd*. Click **Import**, the **Select Workspace File** browser will close (Figure 8.7).

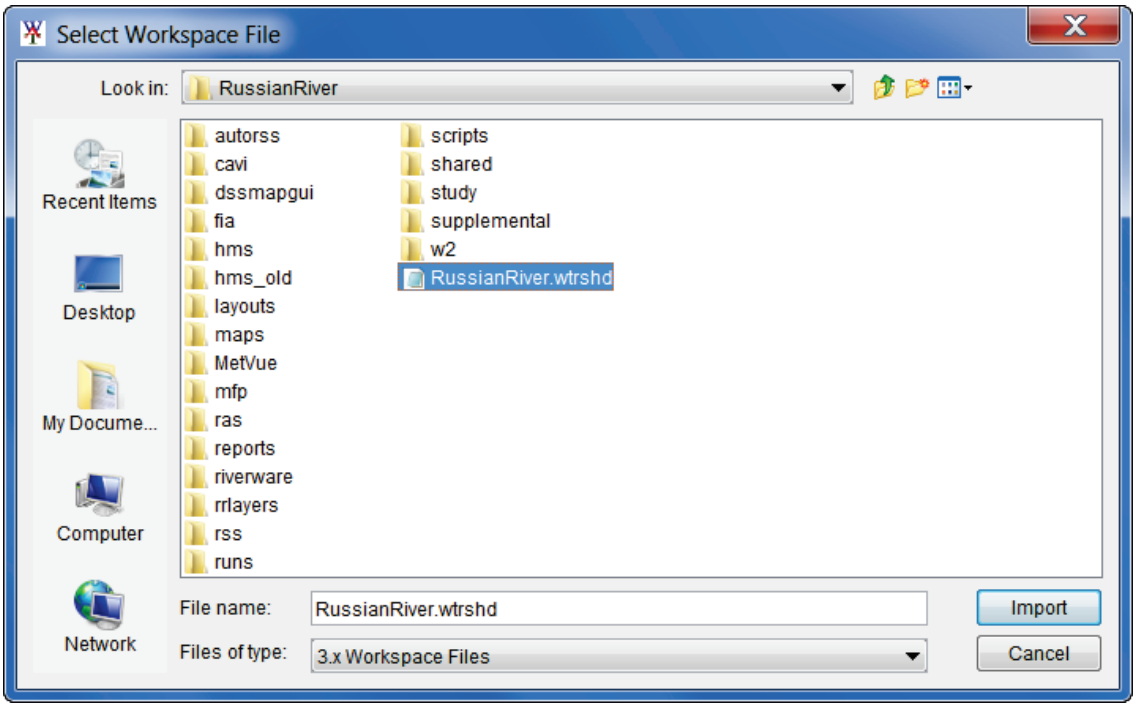


Figure 8.7 Select Workspace File Browser

3. A **Continue Import?** window will open (Figure 8.8). This window is warning the user that the import process will overwrite any existing data in the watershed. Click **Yes**, the **Continue Import?** window will close (Figure 8.8)

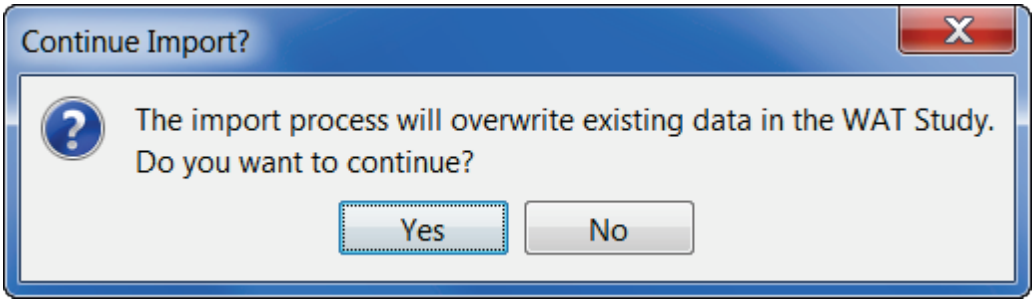


Figure 8.8 Continue Import? Window

4. The **Import CWMS Watershed** dialog box (Figure 8.9) will now display the name of the CWMS watershed file in the **CWMS Watershed File** box (Figure 8.9). As the import proceeds, the **Import Progress** box on the **Import CWMS Watershed** dialog box (Figure 8.9) will display what is happening during the import. The table on the **Import CWMS Watershed** dialog box (Figure 8.9) will display which CWMS watershed components have finished, whether the import was successful or not, and the number of model alternatives that were imported.

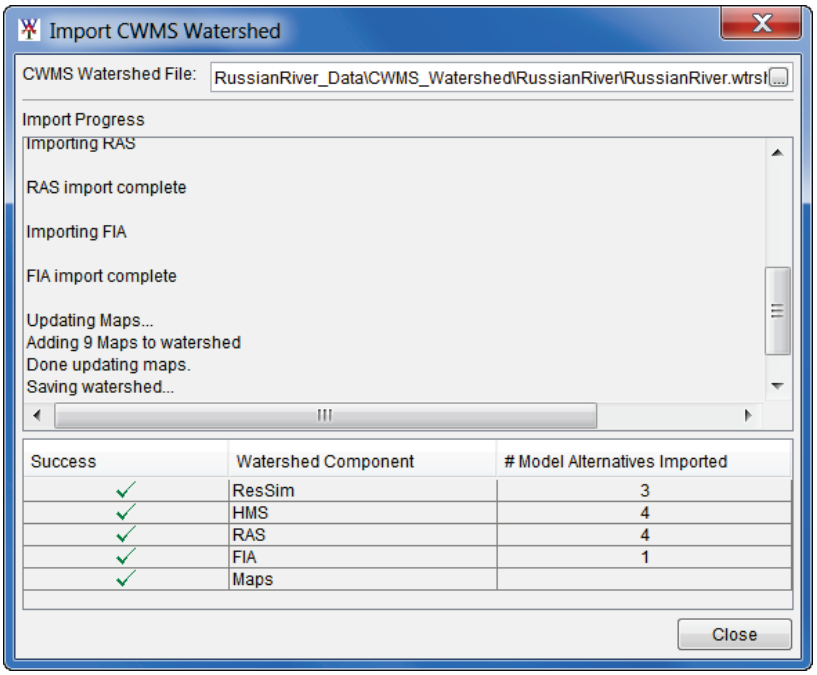


Figure 8.9 Importing *RussianRiver* CWMS Watershed

5. When the HEC-WAT study is created an *hms* subfolder is created. In that subfolder are the default files that are generated when creating an HEC-HMS project. When the HEC-HMS import process finds that a project already exists, a warning window will appear (Figure 8.10; this warning window can open behind the HEC-WAT main window). Click **Yes**, the warning window will close.

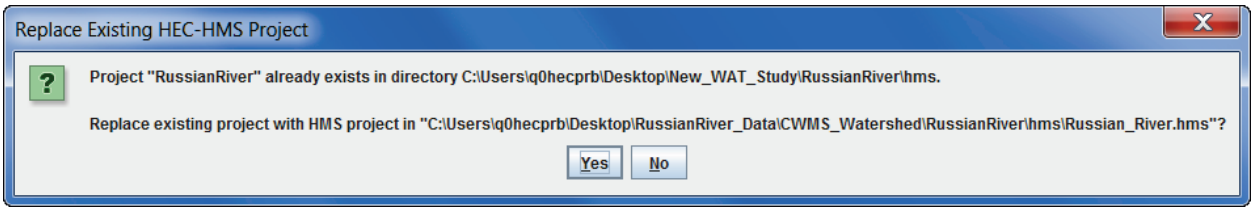


Figure 8.10 HEC-HMS Warning Window about HEC-HMS Project

6. If the HEC-HMS model was created using Version 4.0/4.1, a **Convert HEC-HMS Project** window (Figure 8.11) will open. This window is letting the user know that the HEC-HMS model will be converted to a Version 4.2 HEC-HMS model. Click **Convert Project**, the **Convert HEC-HMS Project** window (Figure 8.11) will close, and the import of the watershed will continue.

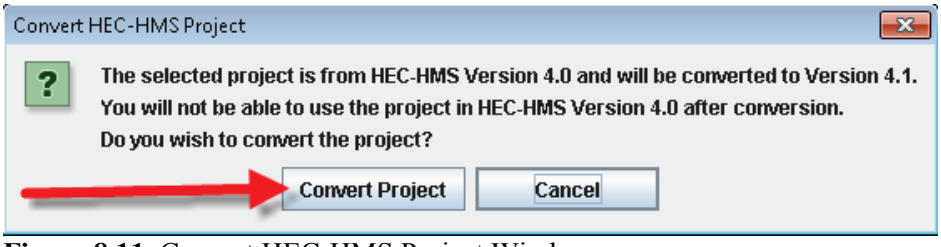


Figure 8.11 Convert HEC-HMS Project Window

7. Once the import process is finished from the **Import CWMS Watershed** dialog box (Figure 8.9) click **Close**. The **Import CWMS Watershed** dialog box (Figure 8.9) will close, and the HEC-WAT main window (Figure 8.12) will display the map layers and the stream alignment of the imported CWMS watershed.

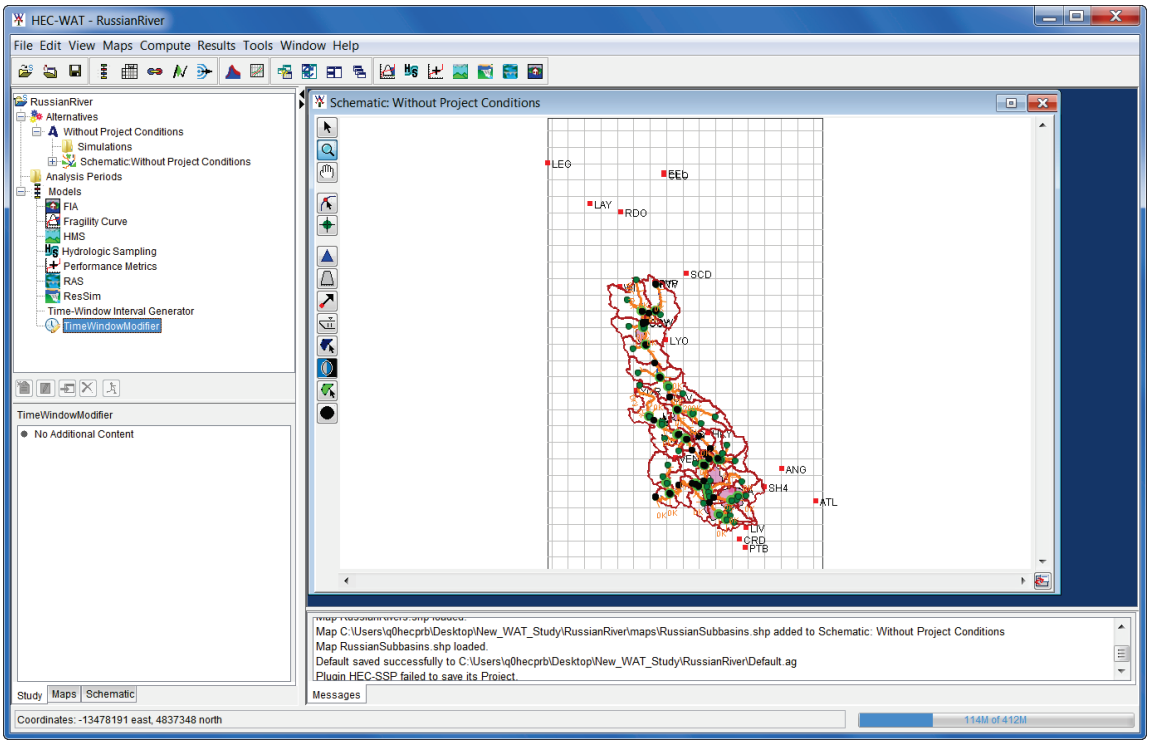


Figure 8.12 HEC-WAT Main Window - *RussianRiver* Study - Map Layers & Stream Alignment

7. From the **File** menu, click **Save Study**.

8.3 Adjust Schematic - Reservoir Displays

The reservoir elements from the HEC-ResSim model, do not automatically display on the HEC-WAT **Schematic Map Window**. From the **Study Pane**, from the **Study Tree** under the **Simulations** folder, right-click *on Schematic:Without Project Conditions*. From the shortcut men, click **Edit**. The **Schematic Editor** (Figure 8.13) will open, under **Measures**, click **Select All**. Click **OK**, the **Schematic Editor** will close, and the HEC-ResSim reservoir elements will appear on the HEC-WAT **Schematic Map Window**.

8.4 Adjust Map Layers

Part of the CWMS import, includes importing map layers for the HEC-WAT study. Now the user can make adjustments to the map layers.

1. From the HEC-WAT main window, click the **Maps** tab (Figure 8.12). Now the user can see which **Map Window** is currently active and what layers make up that **Map Window**. The user can now make adjustments to the map layers, from the **Map Layers** tree:

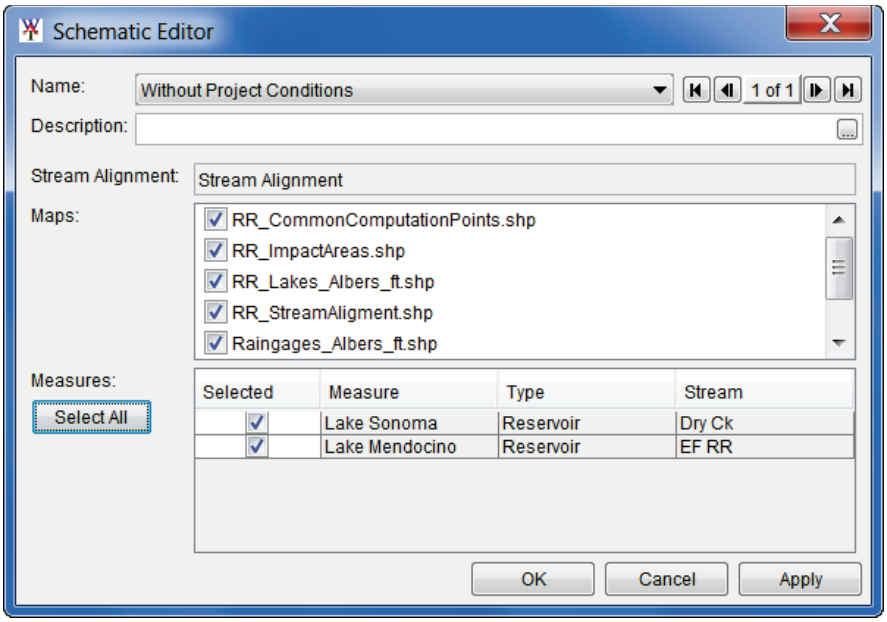


Figure 8.13 Schematic Editor

- Un-check the ***Raingages_Albers_ft.shp*** map layer (this will cause the map layer to no longer display in the active map window).

- Right-click on the ***RR_ImpactAreas.shp*** map layer, from the shortcut menu, click **Properties**. The **Edit Polygon Properties Editor** will open (Figure 8.14). From the **Fill Tab**, change the color to "lightgreen", click **OK**. The impact areas on the active map window will now display in "lightgreen".

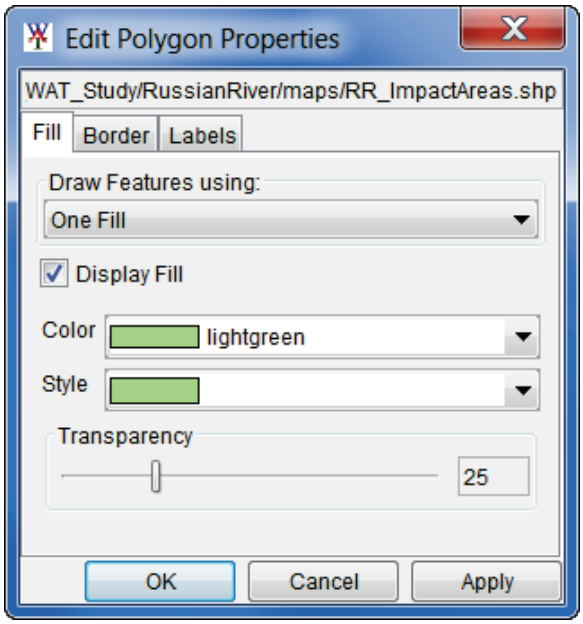


Figure 8.14 Edit Polygon Properties Editor

2. The user can adjust the view of the study area in the active map window. Using the **Magnifier Tool**, zoom the study area in the active map window to the appropriate area that the user would like displayed. From the HEC-WAT main window (Figure 8.12),

from the **Maps** menu, click **Default Map Properties**, the **Default Map Properties for** dialog box will open (Figure 8.15). Click **Set Map Extents to Display**, click **OK**. The **Default Map Properties for** dialog box will close.

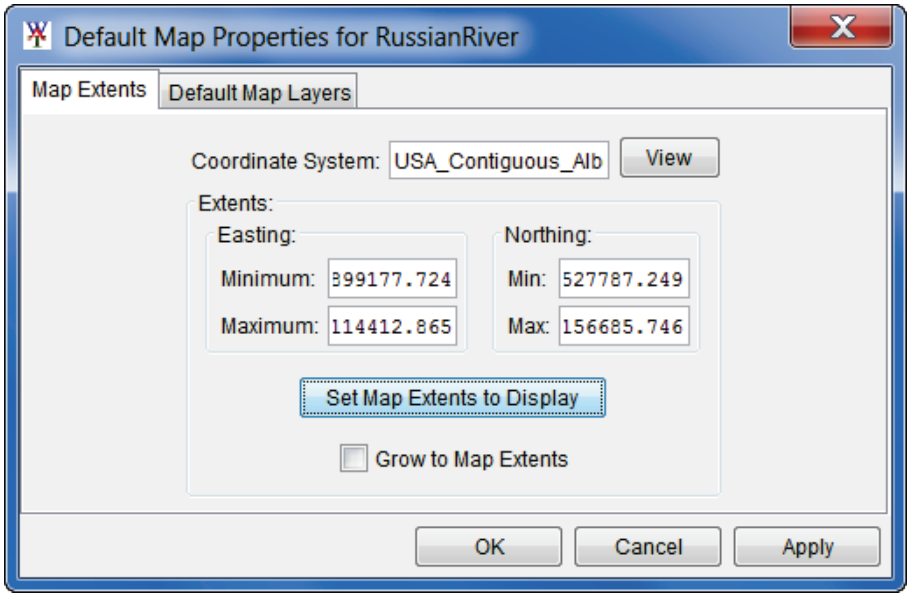


Figure 8.15 Default Map Properties for Dialog Box

This sets the extents for the **Map Window** so that when the study is opened the next time the **Map Window** will be zoomed in to the tighter area.

8.5 Define Plug-Ins for Study

To define the plug-ins for the *RussianRiver* study:

1. From the HEC-WAT main window (Figure 8.12), from the **File** menu, click **Study Details**.

2. The **Study Details** dialog box (Figure 8.16) will open. Click on the **Plug-ins** tab. The table that is displayed provides information on the plug-ins that are available for the study.

3. For the *RussianRiver* study the following plug-ins should be enabled – *FIA, HEC-SSP, HMS, RAS,* and, *ResSim*.

4. Click **OK**, the **Study Details** dialog box will close (Figure 8.16), and the plug-ins for the study have been defined

8.6 Create an Analysis Period

An HEC-WAT compute requires an HEC-WAT alternative, an analysis period, a program order, and model alternatives.

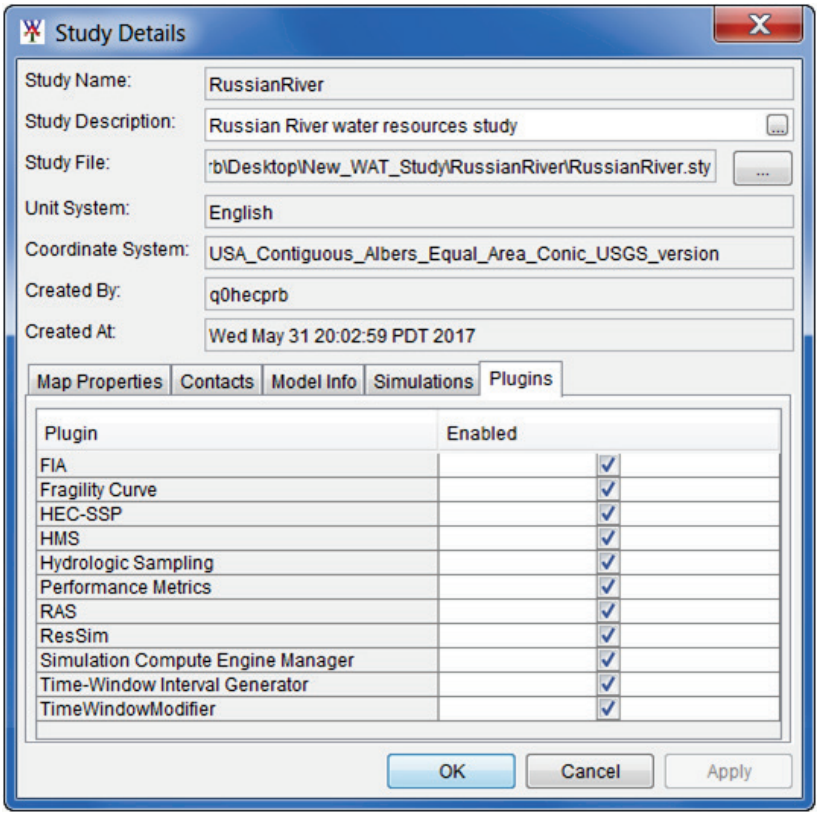


Figure 8.16 HEC-WAT – Study Details Dialog Box - Plugins Tab

To create an analysis period:

1. From the HEC-WAT main window (Figure 8.12), from the **Study Tree**, right-click on the **Analysis Period** folder (Figure 8.17). From the shortcut menu click **New**.

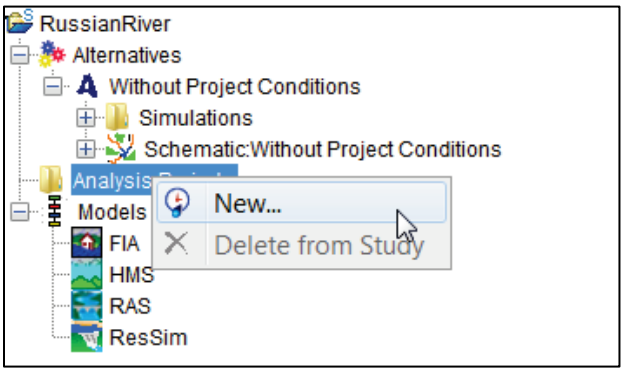


Figure 8.17 Analysis Periods Shortcut Menu

2. The **Create New Analysis Periods** dialog box will open (Figure 8.18). In the **Name** box enter a name (*RR_Feb1986*). In the **Time Window** box enter the information required for the time window.

3. For the **Start Date** and **End Date**, enter in the format ddmmmyyyy. The **Start Time** and **End Time** should be entered as military time - e.g. 0000, 0600, 1300 (1 p.m.), 2400 (midnight).

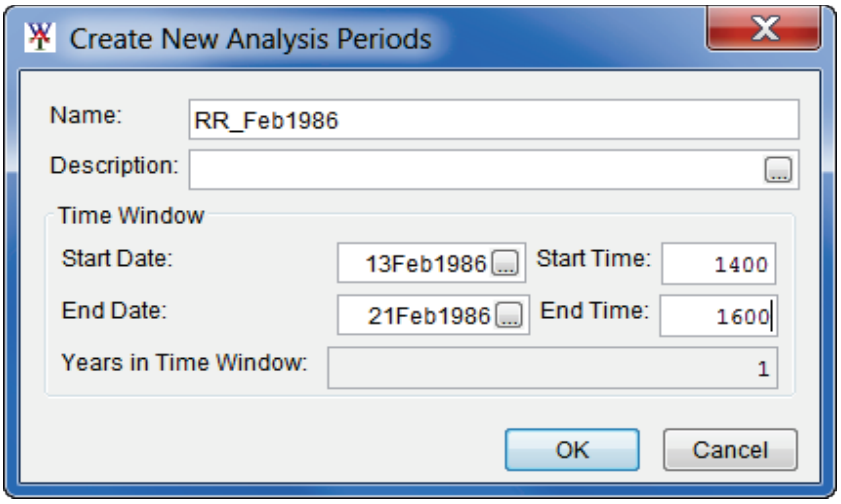


Figure 8.18 Create New Analysis Periods Dialog Box

4. Click **OK**, the **Create New Analysis Periods** dialog box will close (Figure 8.18). On the HEC-WAT main window (Figure 8.12), from the **Study Pane**, under the **Analysis Periods** folder, the new analysis period name will appear.

8.7 Setup Lookback Window – HEC-ResSim

The time window for an HEC-ResSim run has two parts, a "lookback period" and a "simulation or forecast period". The lookback period is used by HEC-ResSim to "warm up" a ResSim model alternative. During this period, routing of flows through the river and reservoir network are performed but no release decisions are made nor are any mass balance computations evaluated. The user should think of the lookback period as the time to establish the state of the river network and the starting conditions of the reservoirs. The simulation period is the portion of the time window during which HEC-ResSim simulates reservoir operations, and makes release decisions based on the operation scheme defined by the user. Releases are then routed through the river network, combining with local inflows along the way.

Since HEC-WAT and most of the models treat the analysis period as a single, continuous time window. For this reason a setup step is required for each HEC-ResSim alternative in an HEC-WAT study. The setup step lets each HEC-ResSim alternative know how much of the analysis period to use for the lookback period.

To setup the lookback period:

1. From the HEC-WAT main window (Figure 8.12), from the **Edit** menu, point to **ResSim,** click **Lookback Window** (Figure 8.19).

2. The **Lookback Window** dialog box (Figure 8.20) will open.

3. The table displays the ResSim model alternatives that are available in the HEC-WAT study. Each model alternative that is being used in an HEC-WAT simulation will need to have a lookback window set. For example, in Figure 8.20, the ResSim model alternative *calibrate* has a **TimeStep** of 1 hour and **Lookback Steps** of 6.

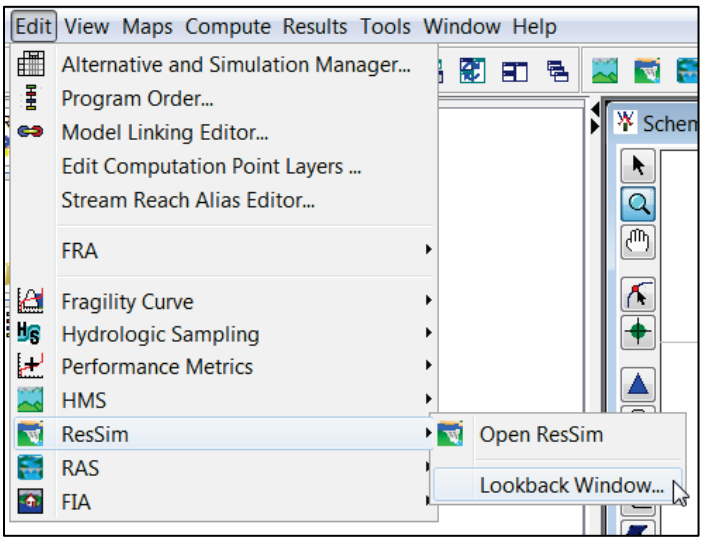


Figure 8.19 Edit Menu – ResSim – Lookback Window

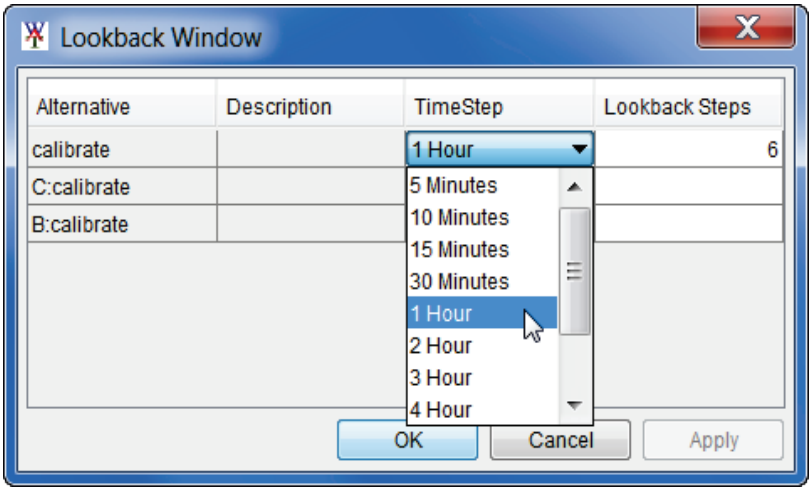


Figure 8.20 Lookback Window Dialog Box

4. The time step can be selected from the **TimeStep** column, in each cell there is a list of available time steps for the user to choose from. The selected time step has to match the time step that was specified for the ResSim model alternative as part of the alternative's original run control data (which is located in the HEC-ResSim Alternative Editor). The number of lookback steps must be entered in a cell in the **Lookback Steps** column. At least one lookback time step is required for a ResSim model alternative to compute, however more lookback steps may be needed, depending on a variety of factors in the ResSim model alternative's operating scheme. The HEC-ResSim modeler should be consulted to determine the minimum lookback window needed by each alternative.

5. Click **OK**, a **Missing Lookback Info** window (Figure 8.21) will open. This message window is letting the user know that lookback information for the other ResSim model alternatives have not been set. For this example, the user is only using the *calibrate* model alternative, click **OK**. The **Missing Lookback Info** window (Figure 8.21) and the **Lookback Window** dialog box (Figure 8.20) will both close.

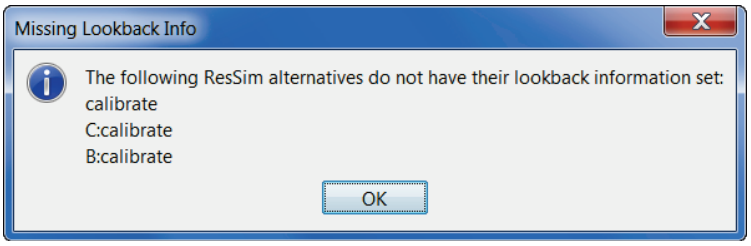


Figure 8.21 Missing Lookback Info Window

8.8 Program Order

HEC-WAT allows for a flexible set of programs, computation order, and data flow through the establishment of a program order. Once a program order has been chosen for an HEC-WAT study, changes should not be made to the program order as this could cause a disruption in the flow of data and invalidate any existing work.

Currently in HEC-WAT Version 1.0 the default program order is - HMS, ResSim, RAS, FIA. This is the correct program order for the example watershed that is being used, so no adjustment is necessary. For further details on **Program Order**, review Chapter 11 (Section 11.1) of the HEC-WAT User's Manual.

8.9 Create an HEC-WAT Simulation

Now that all of the building blocks have been configured (alternative, analysis period, program order, models), the user can now create an HEC-WAT simulation. To create an HEC-WAT simulation:

1. From the HEC-WAT main window (Figure 8.12), from the **WAT Tools** toolbar, click the **Alternative and Simulation Manager** button .

2. The **Alternative and Simulation Manager** dialog box will open (Figure 8.22). From this dialog box the user can create/modify alternatives, analysis periods, simulations, program orders, link models, and make runs.

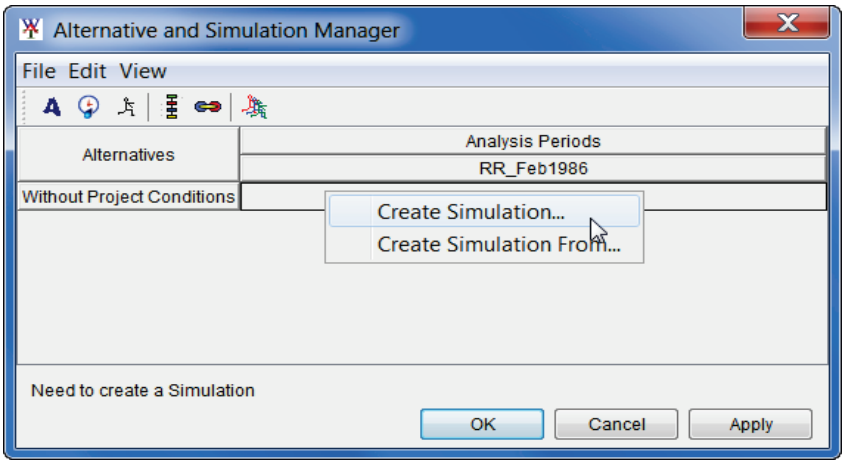


Figure 8.22 Alternative and Simulation Manager Dialog Box

3. To create a simulation, from the table right-click on the intersection of an alternative and analysis period. From the shortcut menu click **Create Simulation**. The **Create New Simulation** dialog box will open (Figure 8.23).

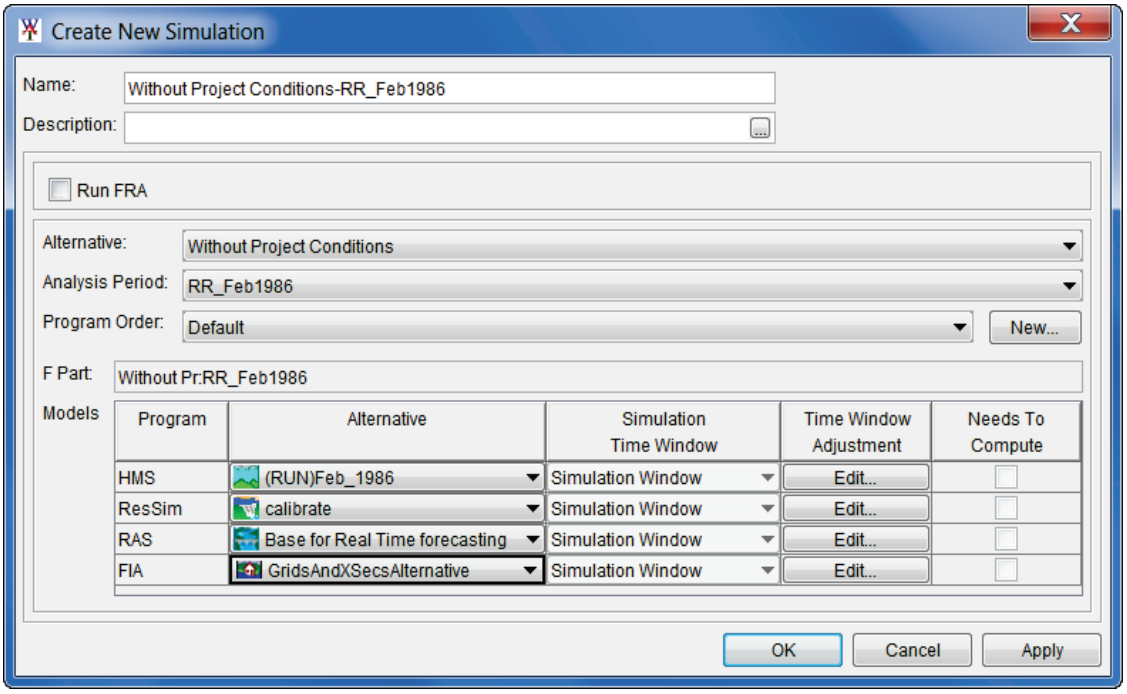


Figure 8.23 Create New Simulation Dialog Box

4. HEC-WAT has defined a default name for the simulation (*Without Project Conditions-RR_Feb1986*) in the **Name** box (Figure 8.23). The name is a combination of the HEC-WAT alternative name and analysis period name, where the intersection was in the table (name can be changed).

5. A program order needs to be selected. From the **Program Order** list (Figure 8.23) make sure *Default* is selected as the program order.

6. In the **F Part** box (Figure 8.23), a default **F Part** is displayed that was generated by HEC-WAT based once again on the alternative and analysis period names. The user can edit the item, but it is not advised.

7. In the **Programs** table (Figure 8.23), the software applications that were defined in the program order appear in the order the software applications were selected. Now the user must select the appropriate alternative (plan, run) for each software application. From the **Alternative** column, from the list for **HMS** (Figure 8.24), select the appropriate HMS run (*(RUN)Feb_1986*). Repeat the process for the other software applications. Below is the list of the appropriate alternatives for the *RussianRiver* study:

   HMS - (RUN)Feb_1986
   ResSim - calibrate
   RAS - Base for Real Time forecasting
   FIA - GridsAndXSecsAlternative

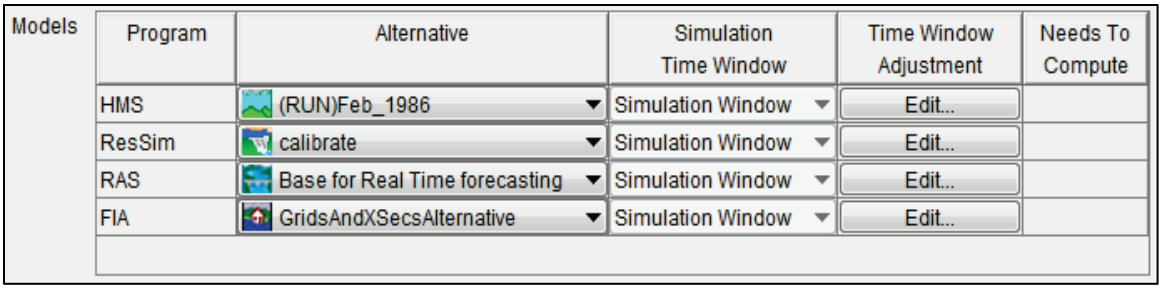


Figure 8.24 Selection of Model Alternatives - Create New Simulation Dialog Box

8. Now that all of the model alternatives have been selected, click **OK**. The **Create New Simulation** dialog box will close (Figure 8.23). On the **Alternative and Simulation Manager** (Figure 8.25) dialog box, the intersection of the WAT alternative and analysis period now provides information about the simulation.

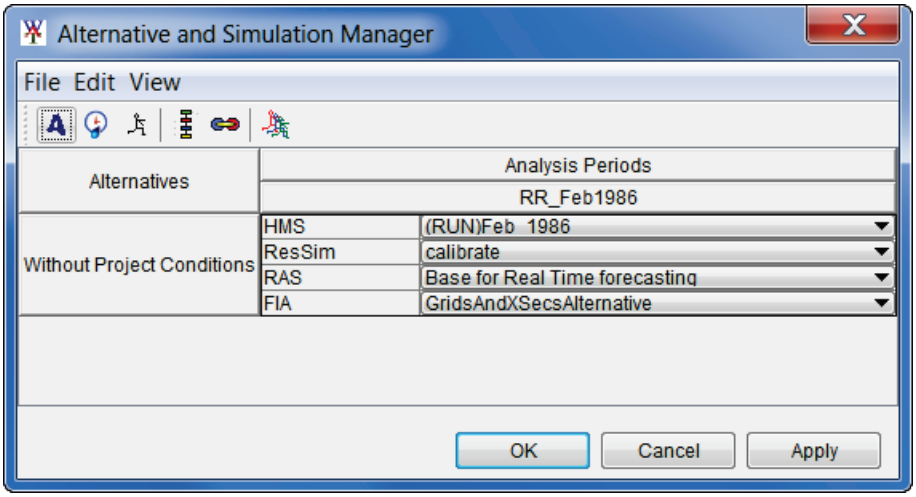


Figure 8.25 Alternative and Simulation Manager - Completed Simulation

9. Click **OK**; the **Alternative and Simulation Manager** dialog box will close (Figure 8.25). From the HEC-WAT main window (Figure 8.12), the created simulation appears on the **Study Tree**, under the **Simulations** folder (Figure 8.26), click on the simulation.

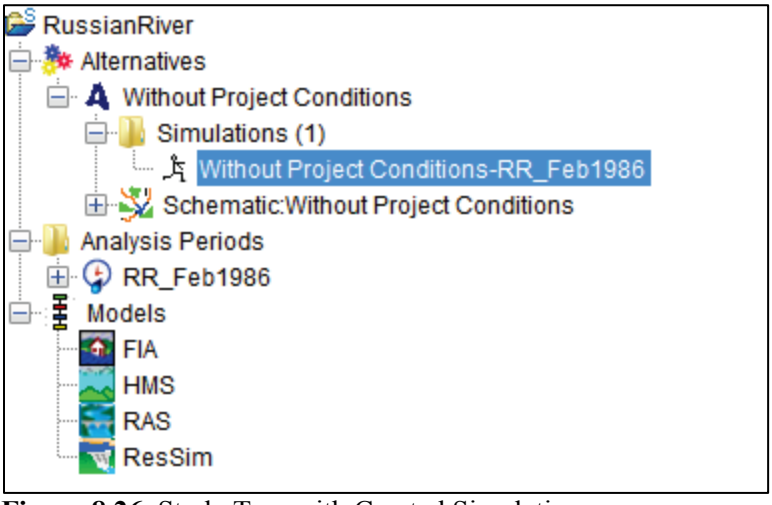


Figure 8.26 Study Tree with Created Simulation

10. The **Content Pane** (Figure 8.27) displays information about the selected simulation.

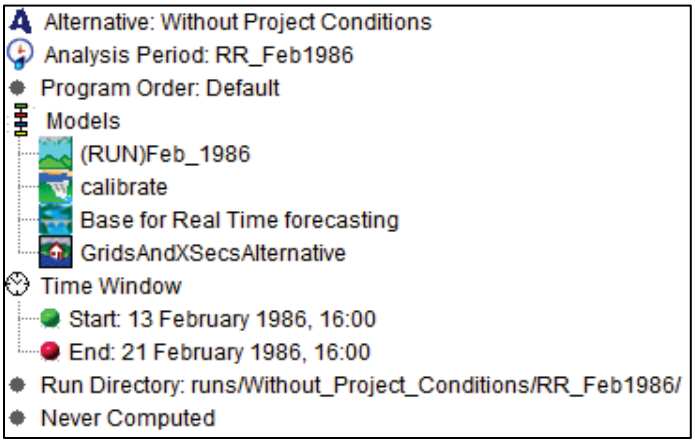


Figure 8.27 Content Pane

11. Double click on the simulation name (*Without Project Conditions-RR_Feb1986*), a **Select Map** dialog box will open. Click **New Map Window**, click **OK**. The **Select Map** dialog box will close. The new map window will contain the schematic elements that represent the simulation (Figure 8.28).

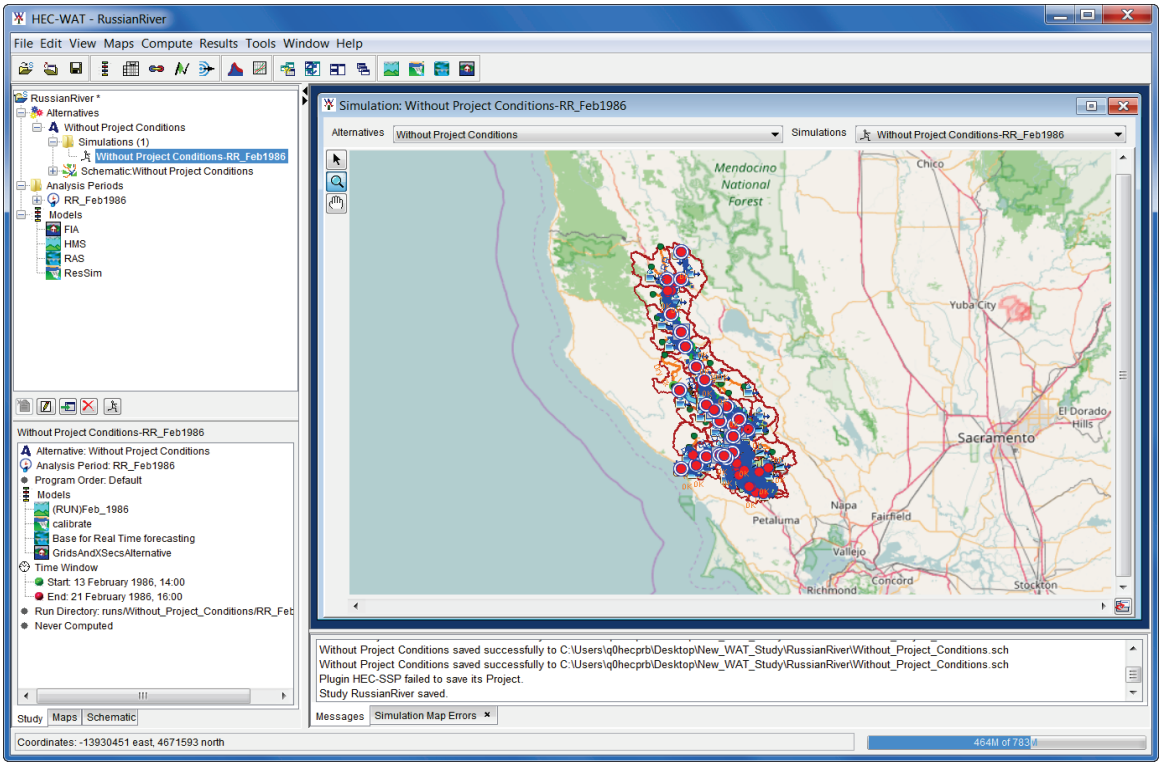


Figure 8.28 Map Window - Schematic of Current HEC-WAT Simulation

8.10 Linking

The next step is to have the models of a simulation communicate with each other. This is accomplished by linking (DSS mapping) the models thru DSS and using a simulation name.

From HEC-WAT, the **Model Linking Editor** (Figure 8.29) provides an easy way to link models including observed data, and provides a mechanism where the linking will have to be done once per alternative.

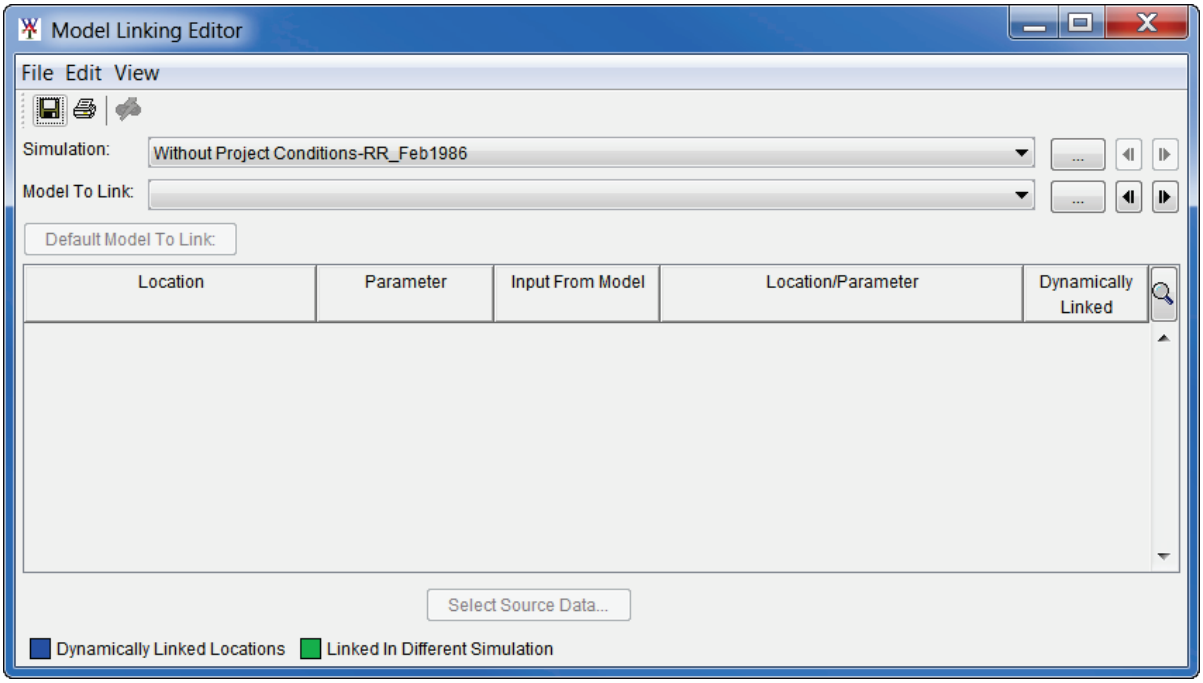


Figure 8.29 Model Linking Editor

1. From the HEC-WAT main window (Figure 8.28), from the **WAT Tools** toolbar, click the **Model Linking Editor** button .

2. The **Model Linking Editor** will open (Figure 8.29). From the **Simulation** list the user will need to select a simulation. For this example the user will be selecting the *Without Project Conditions-RR_Feb1986* (default) simulation.

3. Now let's link the individual model alternatives that are part of the selected simulation.

8.10.1 Linking the HMS Model Alternative

1. From the **Model Linking Editor**, from the **Model to Link** list select *HMS-(RUN)FEB _1986* (Figure 8.29). The **Model Linking Editor** table (Figure 8.30) will now contain all of the locations for the HMS model alternative.

2. Since HEC-HMS wants precipitation and flow data that is not provided by another software application, HEC-WAT reads the linking from the HMS model alternative and displays that linking in the **Model Linking Editor** table (Figure 8.30).

3. The table displays the linking from a DSS file for the HMS model alternative which is the correct linking.

4. That completes the linking for the HMS model alternative.

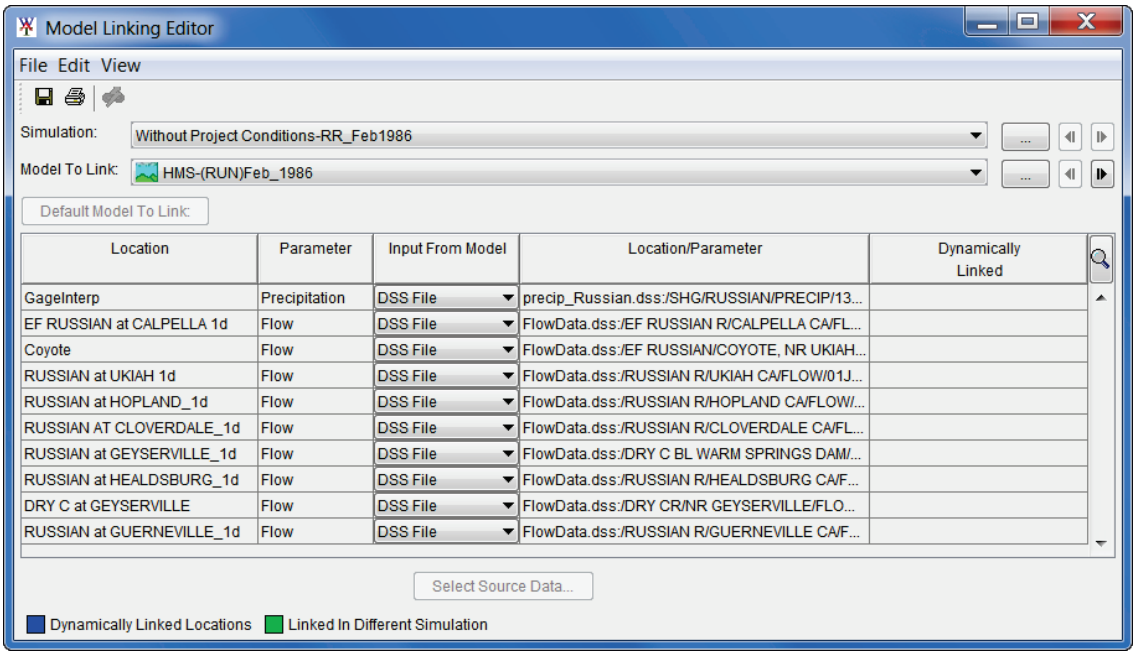


Figure 8.30 Model Linking Editor – HMS Model Alternative

8.10.2 Linking the ResSim Model Alternative

1. From the **Model Linking Editor**, from the **Model to Link** list select *ResSim-calibrate* (Figure 8.30). The **Model Linking Editor** table (Figure 8.31) will now contain all of the locations for the ResSim model alternative that needs to be linked.

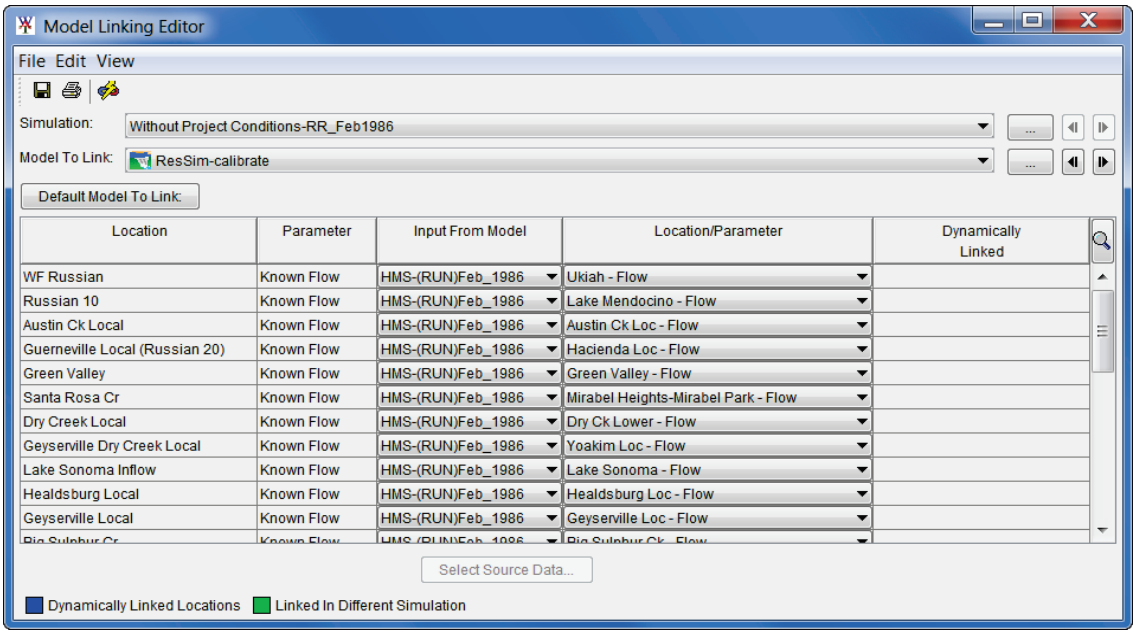


Figure 8.31 Model Linking Editor – ResSim Model Alternative

2. The current linking (Figure 8.31) that is displayed for the ResSim model alternative is correct, so the linking for the ResSim model alternative does not need to be done.

8.10.3 Linking the RAS Model Alternative

1. From the **Model Linking Editor**, from the **Model to Link** list select *RAS-Base for Real Time forecasting* (Figure 8.31). The **Model Linking Editor** table (Figure 8.32) will now contain all of the locations for the RAS model alternative that need to be linked. The current linking (Figure 8.32) that is displayed for the RAS model alternative is the linking for the standalone model.

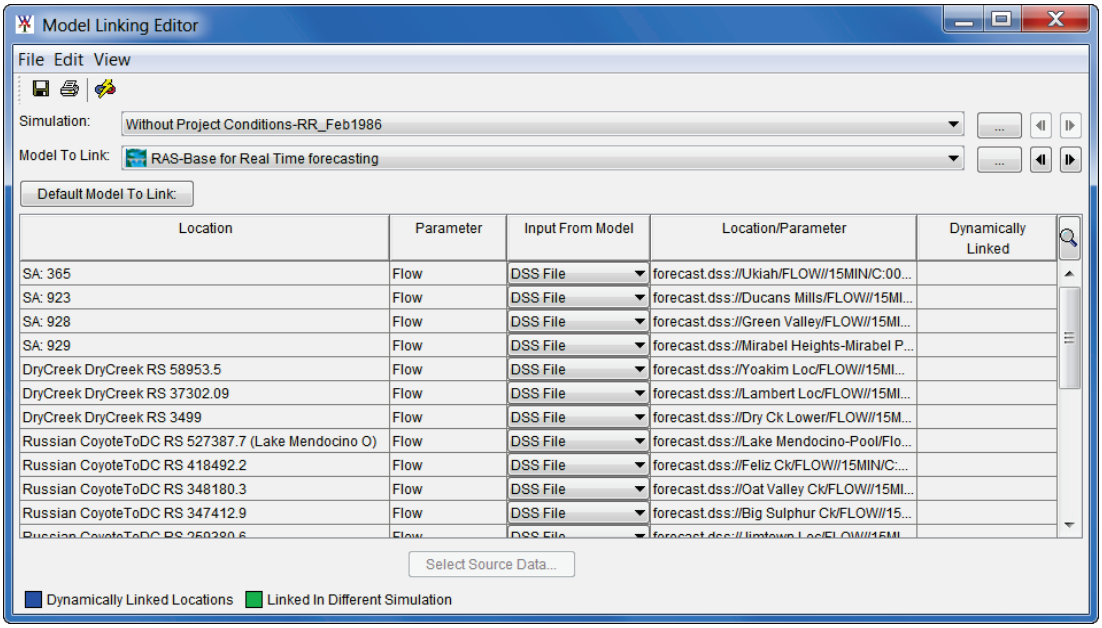


Figure 8.32 Model Linking Editor - RAS Model Alternative Unlinked

2. RAS linking will be results from the HMS and ResSim model alternatives. The printout (*RussianRiverLinking.pdf*) of the linking for each of the model alternatives is located in a folder titled *RussianRiver_Data*.

3. From the **Model Linking Editor** (Figure 8.32), click **Default Model to Link**. The **Select Default Model to Link** dialog box will open (Figure 8.33). From the **Default Model to Link** list, select *HMS-(RUN)Feb_1986*. Click **OK**, the **Select Default Model to Link** dialog box will close (Figure 8.33).

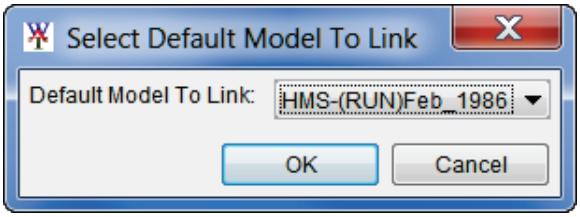


Figure 8.33 Select Default Model to Link Dialog Box

4. A **Confirm Input From Model changing to** window (Figure 8.34) will appear. Basically the window is asking the user to be sure before proceeding, click **Yes**. The **Confirm Input From Model changing to** window closes, and the **Model Linking Editor** now displays the linking for the RAS model alternative (Figure 8.35).

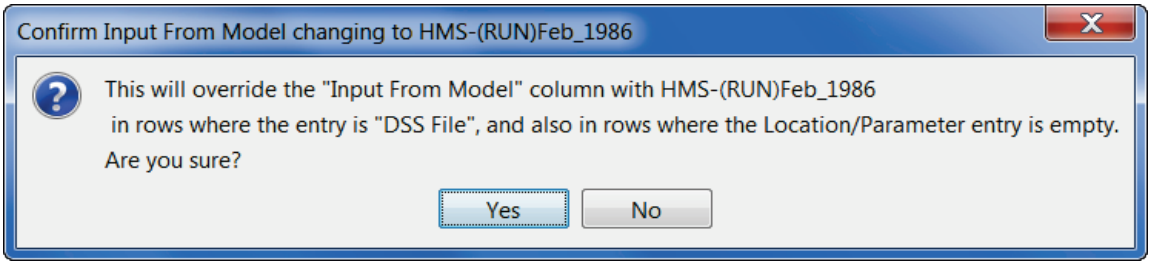


Figure 8.34 Confirm Input From Model changing to window

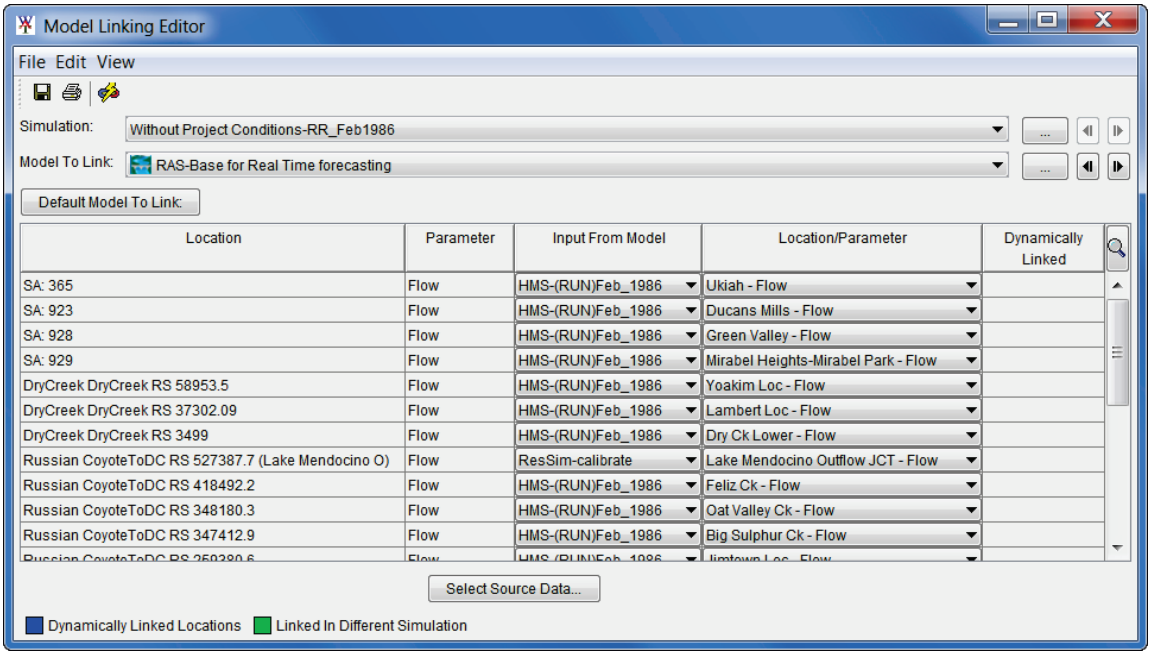


Figure 8.35 Model Linking Editor - Completed RAS Model Alternative Linking

5. There are two locations in the RAS linking that need to be linked to the ResSim model alternative. From the **Model Linking Editor** table (Figure 8.35) for the *DryCreek DryCreek RS 74716.8 (Sonoma Outflow J)* row, from the **Input Model** column (Figure 8.35), select *ResSim-calibrate*. HEC-WAT tries to find a match, *Lake Sonoma-Pool - Net Inflow*. So from the **Location/Parameter** column list, select *Lake Sonoma Outflow JCT - Flow*.

6. Repeat Step 5 for the *Russian CoyoteToDC RS 527387.7 (Lake Mendocino O)* row (*Lake Mendocino - Flow*) to *Lake Mendocino Outflow JCT - Flow*.

7. The printout (*RussianRiverLinking.pdf*) of the linking for each of the model alternatives is located in a folder titled *RussianRiver_Data*. Once the linking is finished for the RAS model alternative, from the **Model Linking Editor** (Figure 8.35) click , this will save the linking.

7. That completes the linking for the RAS model alternative.

8.10.4 Linking the FIA Model Alternative

1. From the **Model Linking Editor**, from the **Model to Link** list select *FIA-GridsAndXSecsAlternative* (Figure 8.35). The **Model Linking Editor** table (Figure 8.36) will now contain all of the locations for the FIA model alternative that needs to be linked.

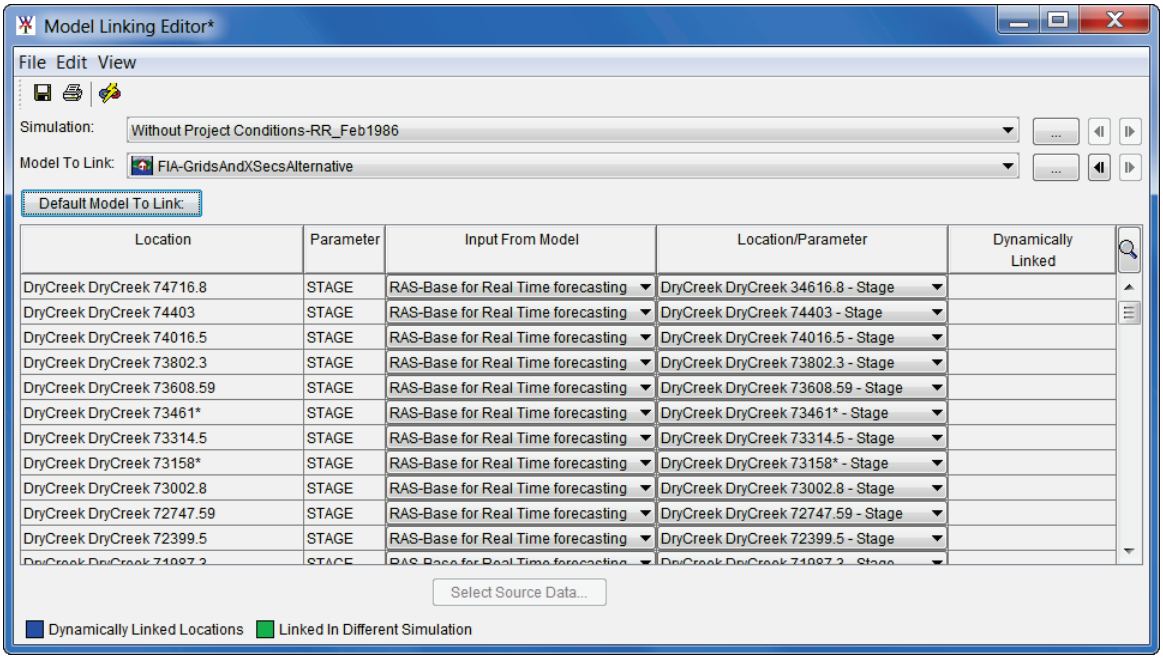


Figure 8.36 Model Linking Editor - Completed FIA Model Alternative Linking

2. For FIA the linking will be results from the RAS model alternative. The printout (*RussianRiverLinking.pdf*) of the linking for each of the model alternatives is located in a folder titled *RussianRiver_Data*.

3. As the user can see the linking for the FIA model alternative in this study is already completed. This is because the RAS and FIA model alternatives have already been linked in standalone mode.

4. For this example, the user will need to adjust two rows for the FIA linking; HEC-WAT did not choose the correct locations. In Figure 8.36, for the first row (*DryCreek DryCreek 74716.8*), change the **Location/Parameter** column to *DryCreek Dry Creek 74716.8 (Sonoma Outflow J) - Stage*. Repeat for the row *Russian CoyoteToDC 527387.7* and change the **Location/Parameter** column to *Russian CoyoteToDC 527387.7 (Lake Mendocino O) - Stage*.

5. Once the linking is finished for the FIA model alternative, from the **Model Linking Editor** (Figure 8.36) click , this will save the linking.

6. That completes the linking for the FIA model alternative.

8.11 Compute and Results

Now that a simulation has been defined, the linking of model alternatives has been completed for a simulation, and model alternatives have been imported into HEC-WAT, the user is now ready to compute the Russian River study.

1. From the HEC-WAT main window (Figure 8.37), from the **Study Tree**, from the **Simulations** folder, right-click ***Without Project Conditions-RR_Feb1986***. From the shortcut menu (Figure 8.37) point to **Compute**, hold down the **Ctrl** key, click **Simulation**.

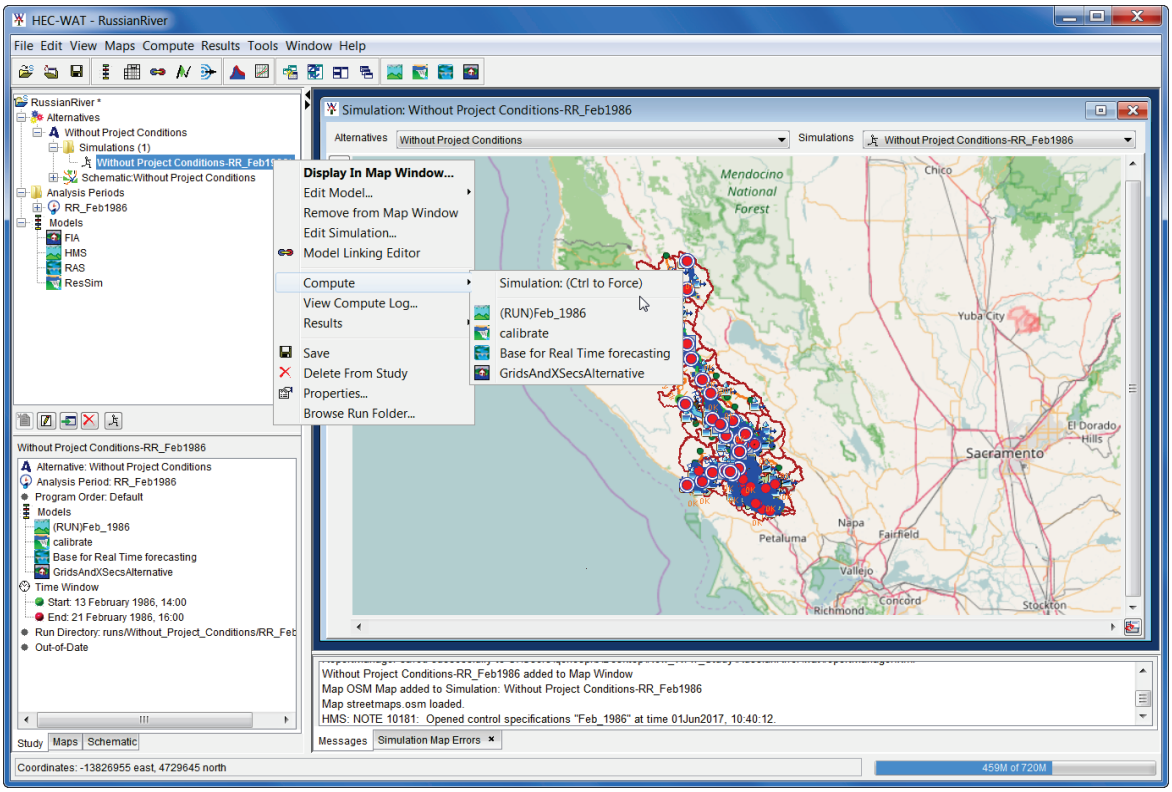


Figure 8.37 HEC-WAT Main Window - Compute

2. The **Compute Progress** dialog box will open (Figure 8.38) and the compute starts. Since the user is taking a watershed that was built for real-time forecasting (CWMS) and creating a planning study (HEC-WAT) from those models, the user may need to do some work on getting the models to compute successfully.

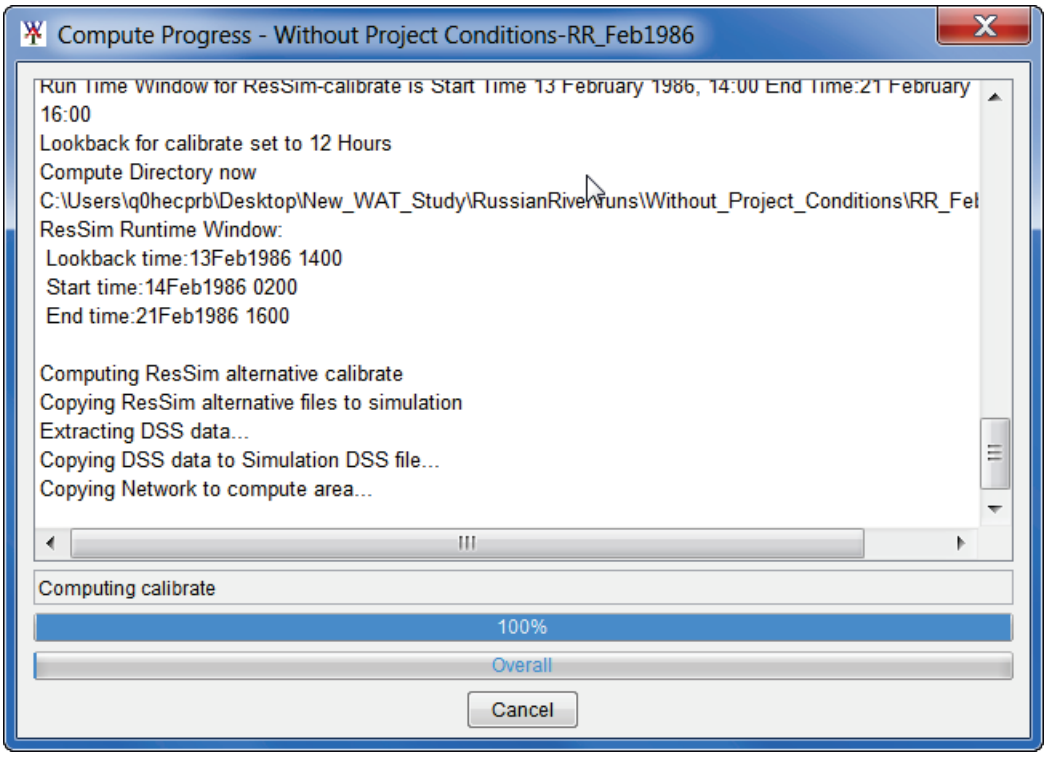


Figure 8.38 Compute Progress Dialog Box

Chapter 9

Flood Risk Analysis (FRA) Compute Option

USACE flood risk management (FRM) policy requires that USACE analytical processes include methods and tools that employ integrated, comprehensive, systems and life-cycle based approaches and risk-based concepts in planning, design, construction, operations and major maintenance. These USACE methods need to incorporate systems response of projects when considering load distribution and failure possibilities. USACE policy also states that project performance needs to consider the system reaction to flood loading and how those loadings are distributed across the watershed.

HEC-WAT includes an option that will analyze complex riverine systems while implementing the flood risk management and systems requirements. The compute option, Flood Risk Analysis (FRA), allows a user to perform plan formulation or system performance analyses while incorporating risk analysis.

9.1 Create an HEC-WAT Study

To create an HEC-WAT study by importing from individual models, the first step is to create an HEC-WAT study:

1. From the HEC-WAT main window (Figure 9.1), on the **File** menu, click **New Study**. The **Create New Study** dialog box (Figure 9.2) will open.

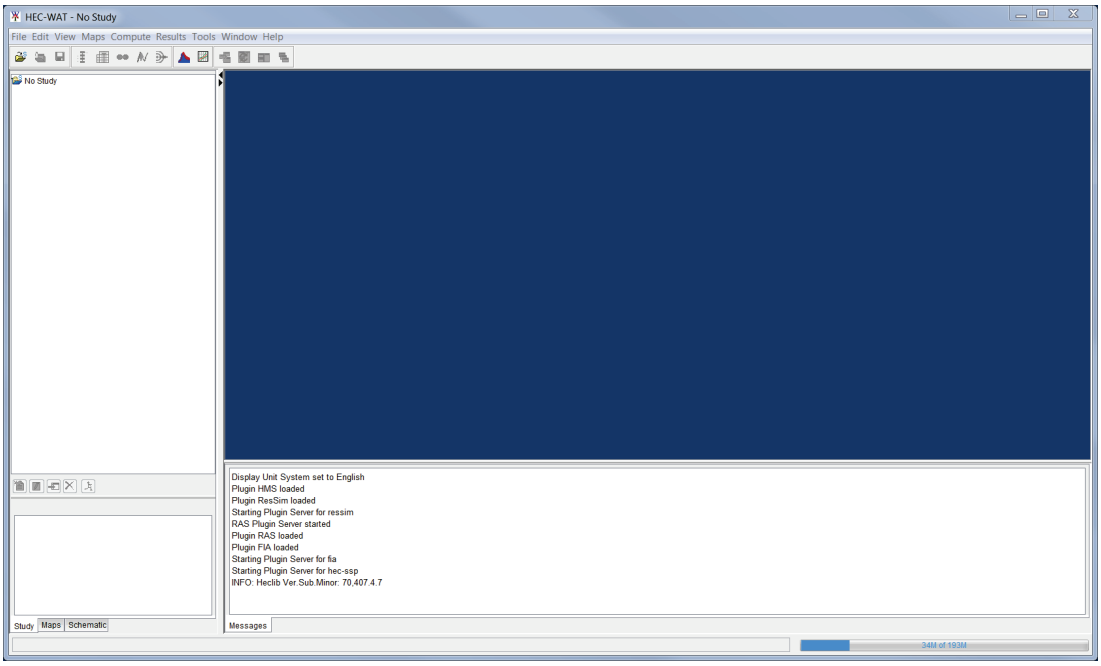


Figure 9.1 HEC-WAT Main Window

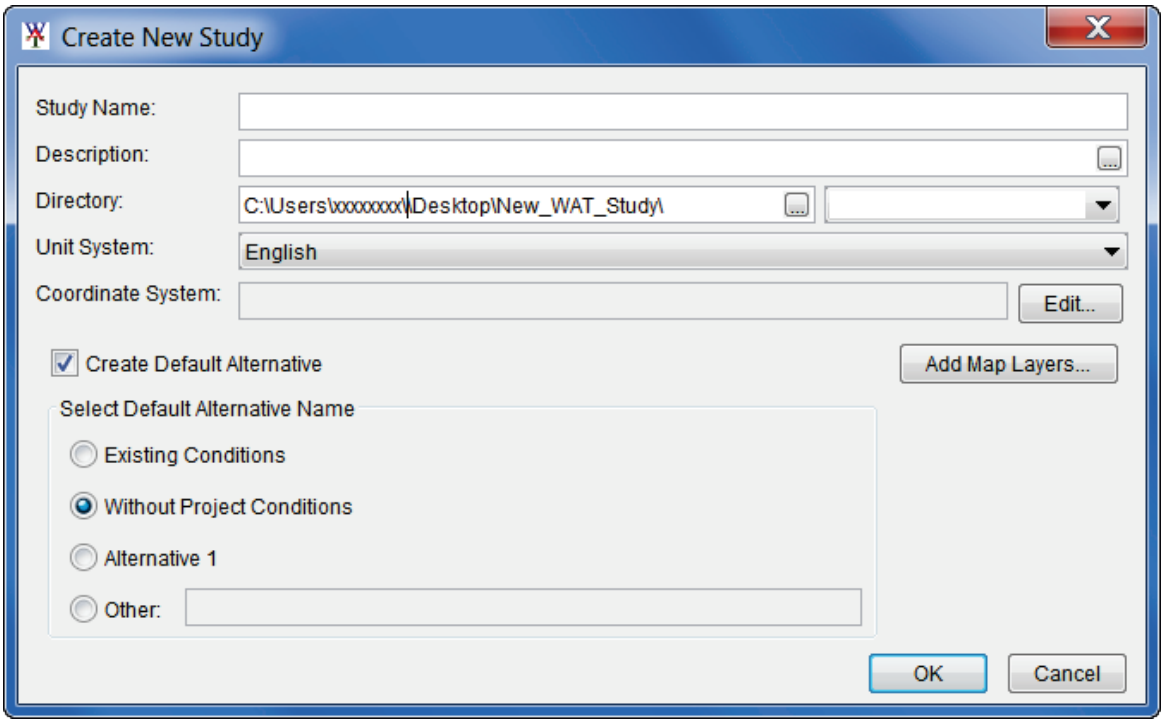


Figure 9.2 Create New Study Dialog Box

2. In the **Study Name** box (Figure 9.2), enter a name (*RussianRiver*), and in the **Description** box, enter a description (*Russian River water resources study - FRA*) for the new study.

3. In the **Directory** box (Figure 9.2), either enter the name of the directory where the HEC-WAT study will be stored, or click ..., and an **Open** browser (Figure 9.3) will open. Navigate to the directory where the HEC-WAT study will be stored.

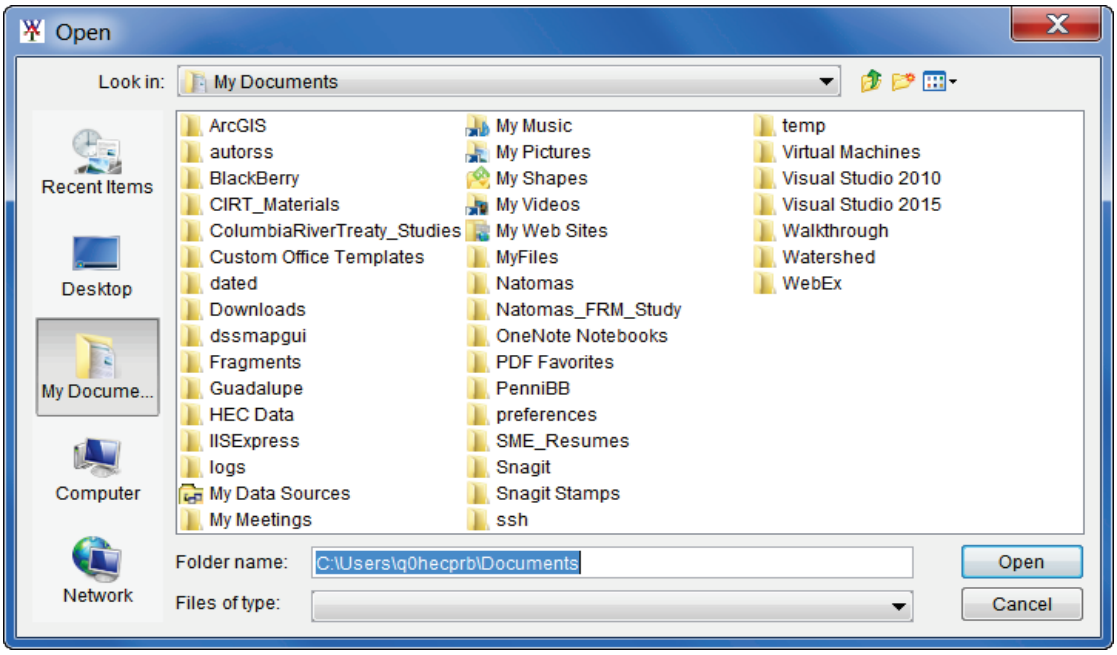


Figure 9.3 Open Browser

4. The **Unit System** for the study defaults to **English** (which is correct for the *RussianRiver* study). The other choice from the list is **SI** (metric).

5. Next, the projected coordinate system of the study needs to be set. From the **Create New Study** dialog box (Figure 9.1), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure 9.4).

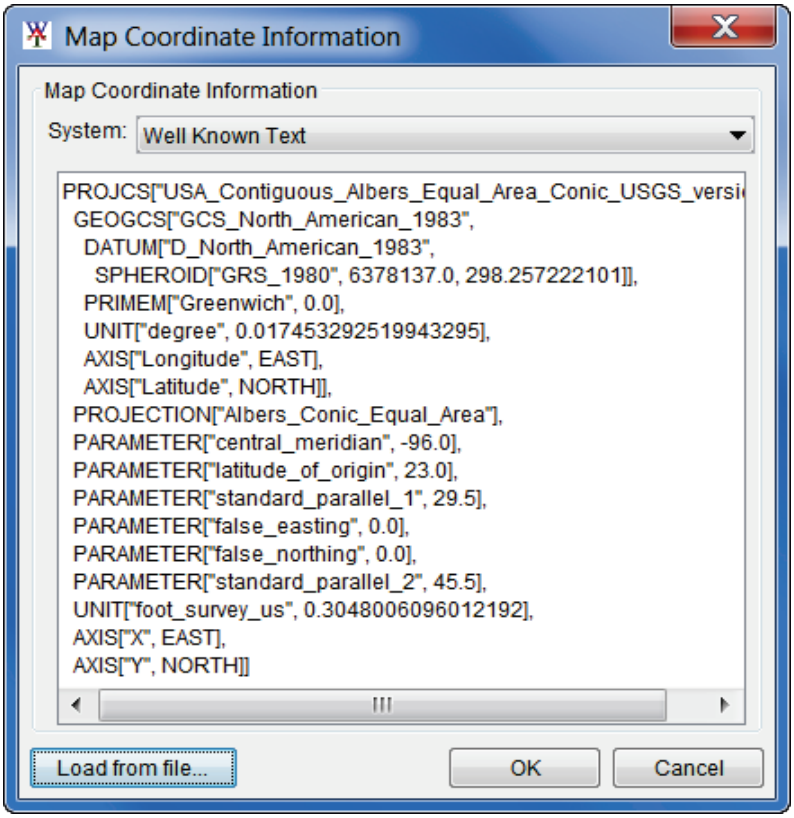


Figure 9.4 Map Coordinate Information Dialog Box

6. For the *RussianRiver* study, the associated map layers have the correct projected coordinate system. So, use one of those map layers to set the projected coordinate system for the study. From the **Map Coordinate Information** dialog box (Figure 9.4), click **Load from file** (lower left corner of dialog box); an **Open** browser (Figure 9.3) will open. The map layers for the *RussianRiver* study are located in a folder titled *RussianRiver_Data* (double-click). In that folder, is a *MapLayers* (double click) folder, from that folder, click on *RR_StreamAlignment.prj* (any of the map layers will work). Click **Open**, now the **Map Coordinate Information** dialog box will contain information about the projected coordinate system (Figure 9.4). Click **OK**, the **Map Coordinate Information** dialog box will close (Figure 9.4). Now on the **Create New Study** dialog box the **Coordinate System** box (Figure 9.2) contains the name of the projected coordinate system (i.e., *USA_Continguous_Albers_Equal_Area_Conic_USGS_version*) for the study.

7. Click **OK**; the **Create New Study** dialog box will close (Figure 9.1). The HEC-WAT main window will now have the name of the study (*RussianRiver*) on the title bar (Figure 9.5). A blank **Schematic Map Window** opens.

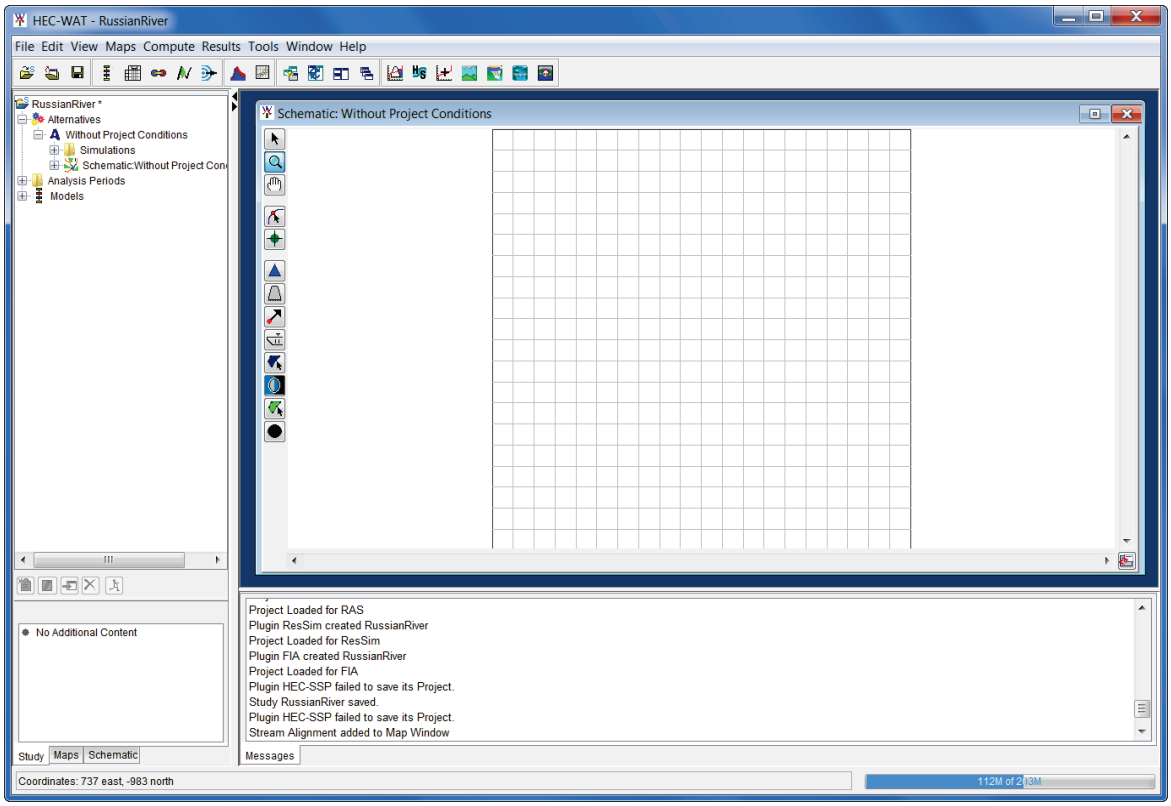


Figure 9.5 HEC-WAT Main Window - *RussianRiver* Study

9.2 Import an HEC-ResSim Model

If there is an HEC-ResSim model available, the user should import that model first. Why? Because the HEC-ResSim model will contain a stream alignment, all of the common computation points (CCPs), and the reservoirs necessary to model the watershed.

1. From the HEC-WAT main window (Figure 9.5), from the **File** menu, point to **Import**, and click **ResSim**. An **Import Type** window (Figure 9.6) will open. Since the *RussianRiver* study being built does not have any of the basic building blocks that are covered in Chapter 6, click **Watershed**.

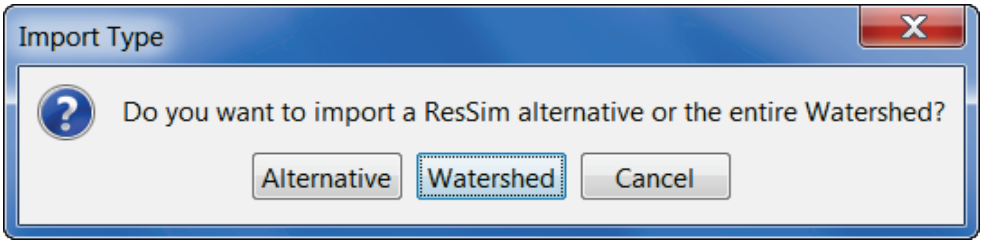


Figure 9.6 Import Type Window

2. The **Select Watershed File to Import From** (Figure 9.7) browser will open. Browse to the folder *FRA_RR_Models*; double click on the *base* folder; double-click on the *RR_ResSim_Model* folder. From the **Files of Type** list, select **ResSim Watershed Files**; click *RussianRiver.wksp*; and, then click **Open.**

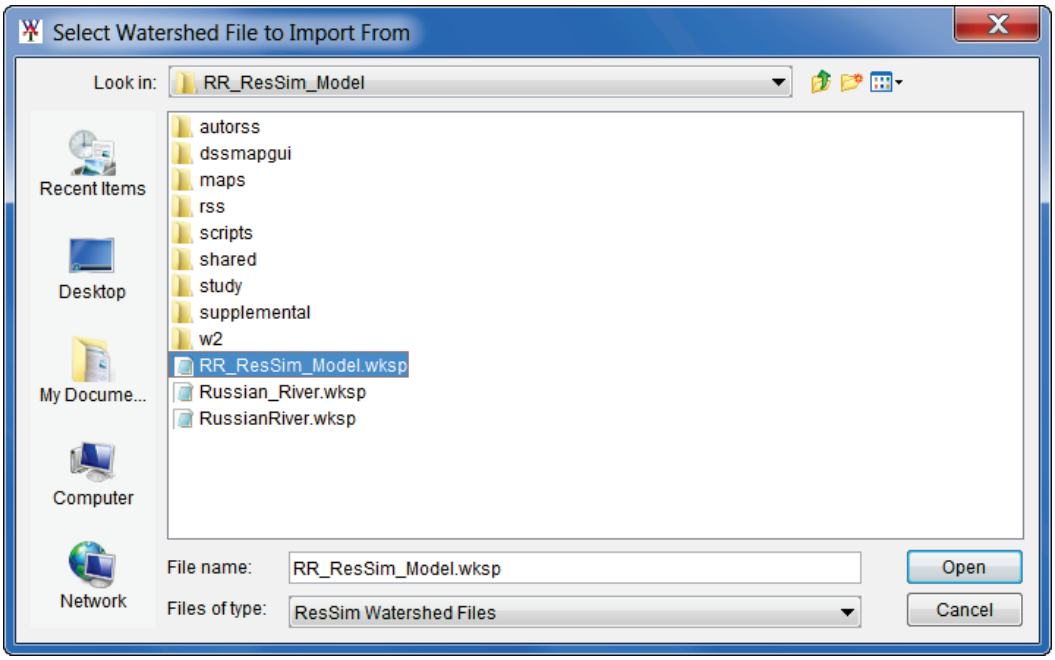


Figure 9.7 Select Watershed File to Import From Browser

3. A **ResSim Import** window will open (Figure 9.8) showing the progress of the HEC-ResSim import.

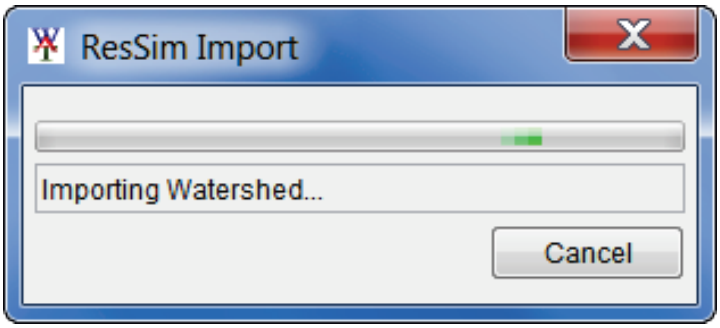


Figure 9.8 ResSim Import Window

4. The HEC-WAT **Schematic Editor** will open (Figure 9.9), from the **Measures** area of the **Schematic Editor**, click **Select All**. All of the reservoirs listed in the table are now selected. Click **OK**, the **Schematic Editor** will close (Figure 9.9).

5. The imported stream alignment, common computation points, reservoirs, and any available map layers from the HEC-ResSim model display in the HEC-WAT **Schematic Map Window** (Figure 9.10). For all of the map layers to appear, close the **Schematic Map Window,** from the message window click **Yes**. To re-open the **Schematic Map Window**, from the **Study Tree**, double-click on S*chematic: Without Project Conditions*, the **Schematic Map Window** will appear in the **Desktop Area** of the HEC-WAT main window (Figure 9.10).

6. The user has now completed the import of the *RussianRiver* HEC-ResSim model.

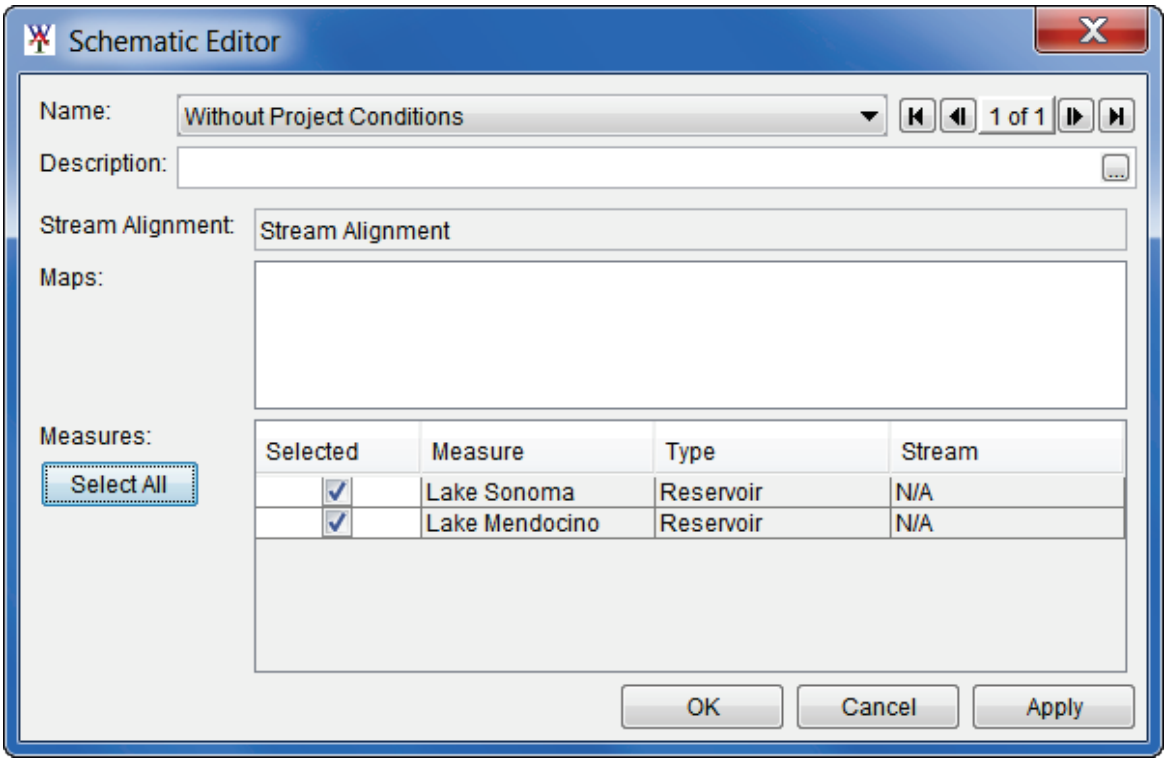


Figure 9.9 Schematic Editor

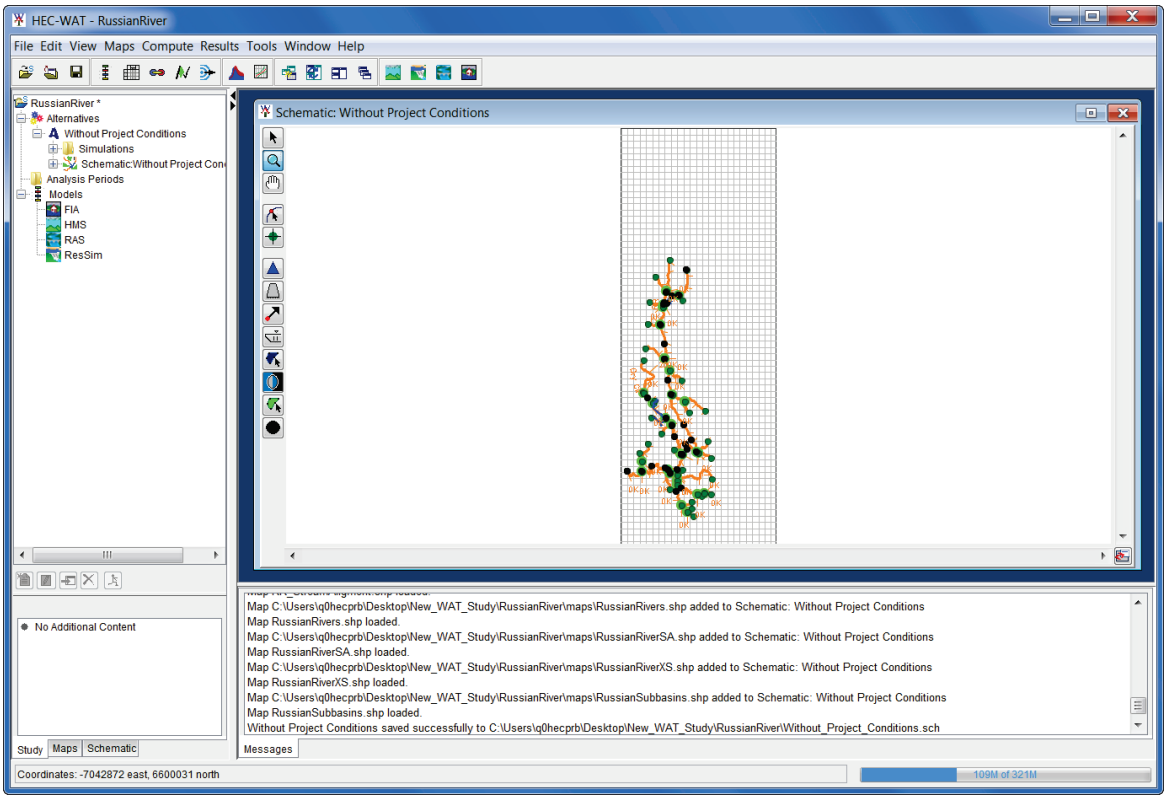


Figure 9.10 HEC-WAT Schematic Map Window After HEC-ResSim Import

9.3 Import an HEC-HMS Model

1. From the HEC-WAT main window (Figure 9.5), from the **File** menu, point to **Import**, and click **HMS**. The HEC-HMS application will open along with the **Select Project File** browser (Figure 9.11).

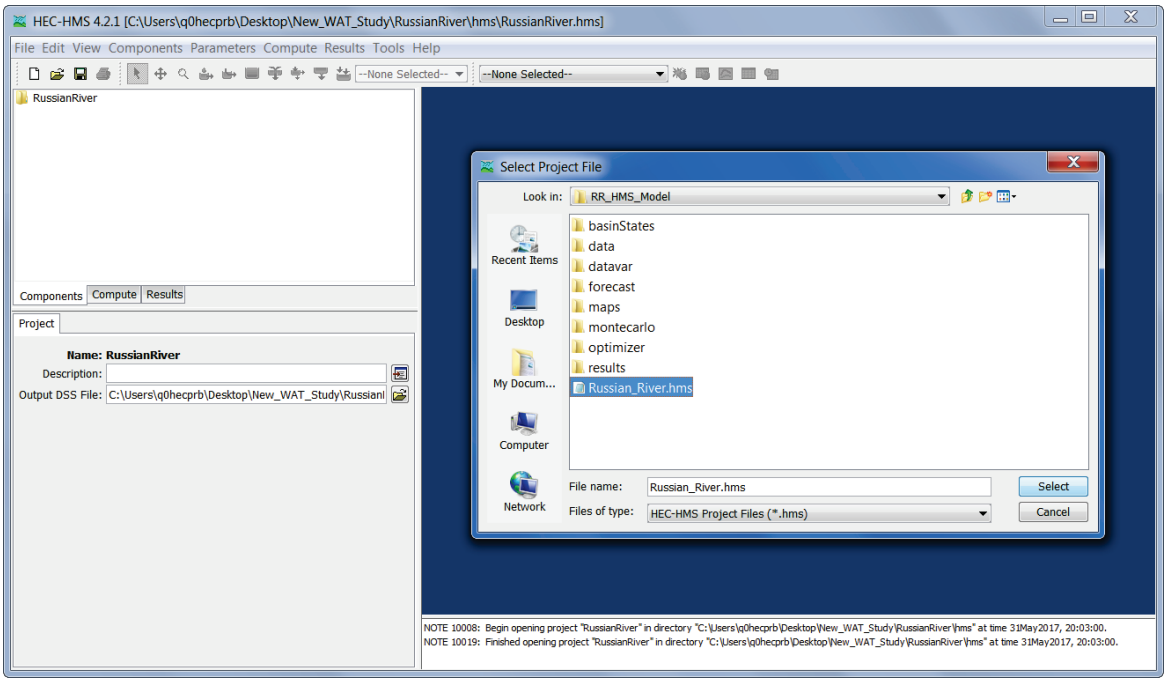


Figure 9.11 HEC-HMS Main Window and Select Project File Browser

2. Browse to the folder *FRA_RR_Models*; double click on the *RR_HMS_Model* folder, select *Russian_River.hms* and, then click **Select.**

3. When the HEC-WAT study is created an *hms* subfolder is created. In that subfolder are the default files that are generated when creating an HEC-HMS project. When the HEC-HMS import process finds that a project already exists, a warning window will appear (Figure 9.12). Click **Yes**, the warning window will close.

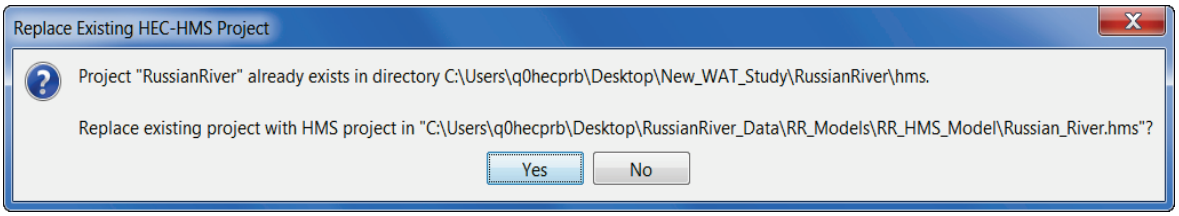


Figure 9.12 HEC-HMS Warning Window about HEC-HMS Project

4. The import process begins (patience this could take a few seconds), the import is finished when the study pane in the HEC-HMS main window contains a study tree. From the HEC-HMS main window (Figure 9.11), from the **File** menu, click **Exit**. The HEC-HMS model import is completed.

9.4 Import an HEC-RAS Model

1. From the HEC-WAT main window (Figure 9.5), from the **File** menu, point to **Import**, and click **RAS**. The **Select RAS project to import from** browser open (Figure 9.13).

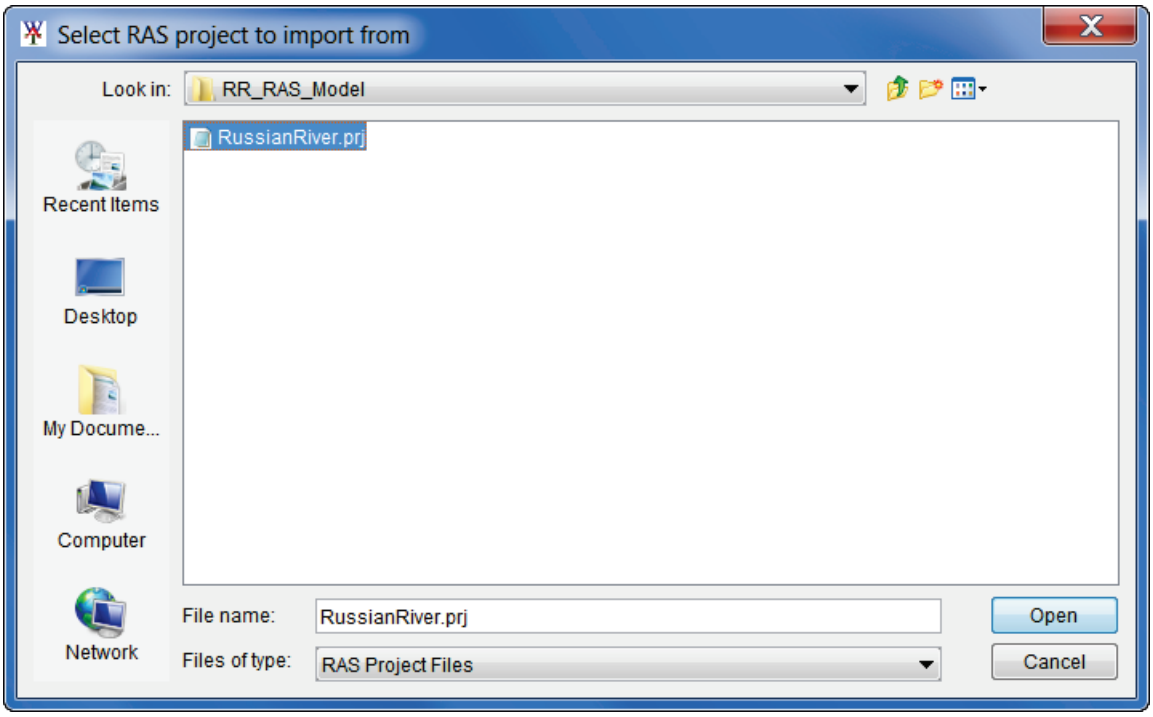


Figure 9.13 Select RAS project to import from Browser

2. Browse to the folder *FRA_RR_Models*; double click on the *RR_RAS_Model* folder, select *RussianRiver.prj* and, then click **Open.**

3. The **Select RAS project to import from** browser will close (Figure 9.13). An **Importing** window (Figure 9.14) will open; when the HEC-RAS model import is complete this window will close. The HEC-RAS model import is completed.

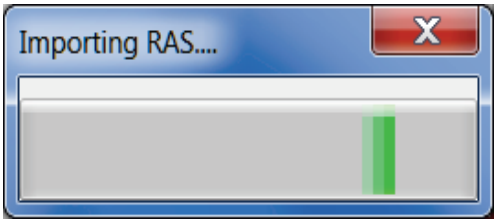


Figure 9.14 HEC-RAS Importing Window

9.5 Import an HEC-FIA Model

1. From the HEC-WAT main window (Figure 9.5), from the **File** menu, point to **Import**, and click **FIA**. The **Import Alternatives** dialog box will open (Figure 9.15); this dialog box can open behind the HEC-WAT main window.

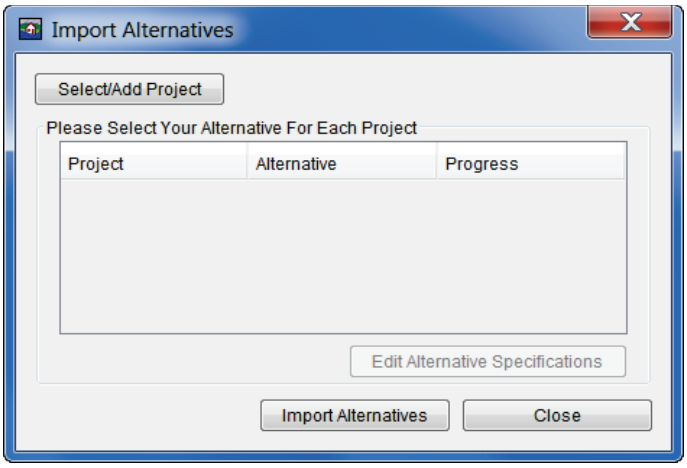


Figure 9.15 Import Alternatives Dialog Box

2. Click **Select/Add Project**, an **Open Browser** will open (Figure 9.3). Browse to the folder *FRA_RR_Models*; double click on the *RR_FIA_Model* folder, select *RussianRiver.prj* and, then click **Open.**

3. The table will now contain the name of the **Project** (*RussianRiver*). From the **Alternative** column (Figure 9.16), from the list select the HEC-FIA alternative that will be imported (*GridsAndXSecsAlternative*).

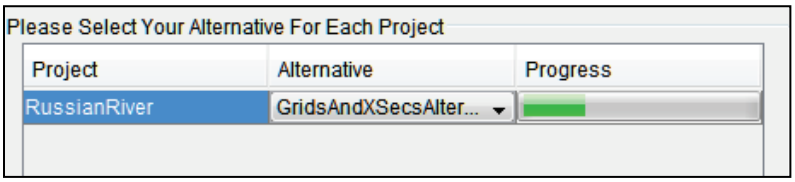


Figure 9.16 HEC-FIA Import Alternative Table

4. Click **Edit Alternative Specifications**, the **Alternative Specification** dialog box will open. Select **Copy Projection from project**, and click **OK**.

5. Click **Import Alternatives**, in the **Progress** column of the table (Figure 9.16) the cell will display the progress of the import with a green bar. When the import is complete an **Information** window will open, click **OK**.

6. From the **Import Alternatives** dialog box (Figure 9.15) click **Close**. The HEC-FIA model alternative has been imported.

9.6 Add Map Layers

Now that the base models have been imported into the study lets add some map layers:

1. From the HEC-WAT main window (Figure 9.5), from the **Maps** menu, click **Add Map Layers**, the **Select Map to Add** browser will open (Figure 9.17). Click **Create Copy**. Browse to the folder *RussianRiver_Data*; double click on the *MapLayers* folder, select the following map layers:

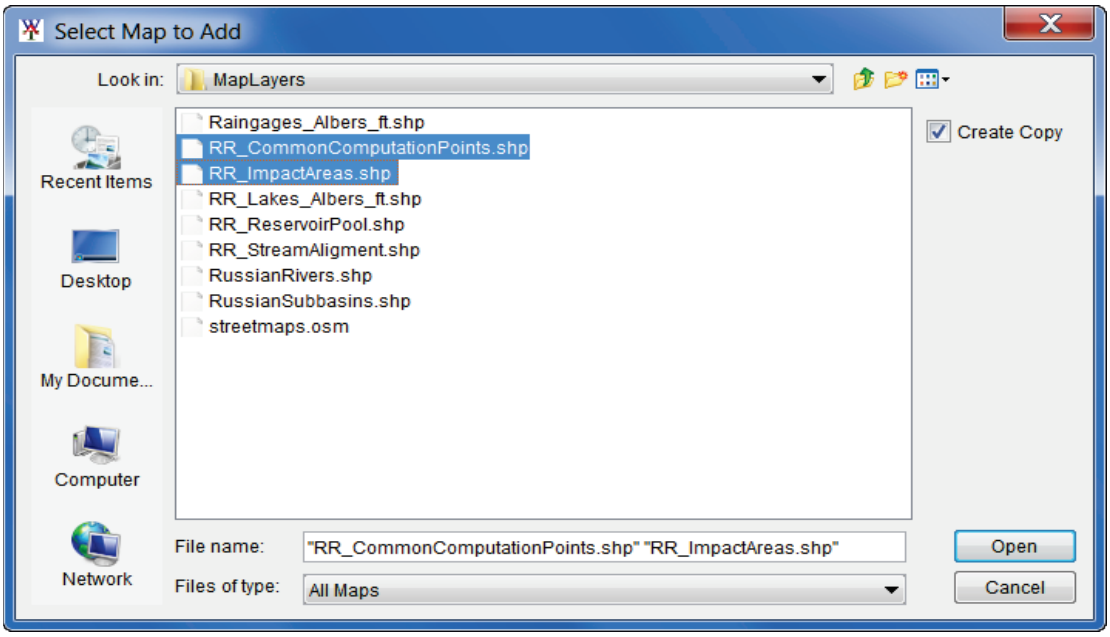


Figure 9.17 Select Map to Add Browser

- Find the map layer which represents the impact areas - *RR_ImpactAreas.shp*
- Find the map layer which represents the CCPs - *RR_CommonComputationPoints.shp*

2. Click **Open**, the **Select Map to Add** browser will close (Figure 9.17). The HEC-WAT **Schematic Map Window** (Figure 9.18) will now display the added map layers.

3. The user can now make adjustments to the map layers. From the HEC-WAT main window (Figure 9.5), click the **Maps** tab. From the **Map Layer**s tree:

   - Right-click on the **Stream Alignment** layer, from the shortcut menu, click **Move to Top**.

   - Right-click on the **Without Project Conditions** layer, from the shortcut menu, click **Move to Top**.

   - Un-check the *Raingages_Albers_ft.shp* map layer (this will cause the map layer to no longer display in the active map window).

   - Right-click on the *RR_ImpactAreas.shp* map layer, from the shortcut menu, click **Properties**. The **Edit Polygon Properties Editor** will open (Figure 9.19). From the **Fill Tab**, change the color to "lightgreen", click **OK**. The impact areas on the active map window will now display in "lightgreen".

4. The user can adjust the view of the study area in the active map window. Using the **Magnifier Tool**, zoom the study area in the active map window the appropriate area that the user would like displayed. From the HEC-WAT main window (Figure 9.5), from the **Maps** menu, click **Default Map Properties**, the **Default Map Properties for** dialog box will open (Figure 9.20). Click **Set Map Extents to Display**, click **OK**. The **Default Map Properties for** dialog box will close.

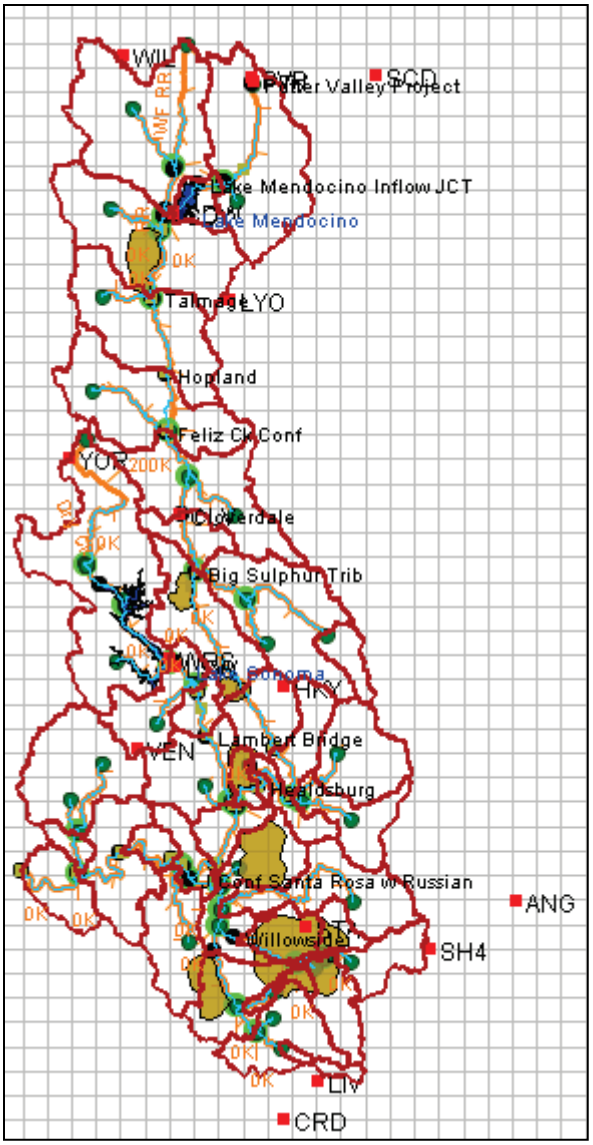


Figure 9.18 Map Layers Added to Watershed

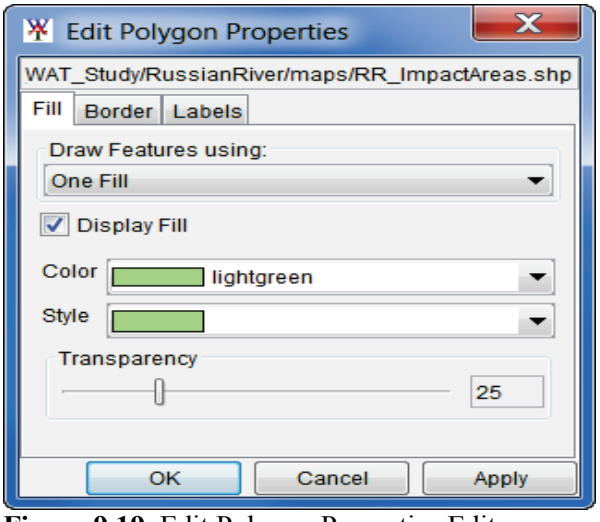


Figure 9.19 Edit Polygon Properties Editor

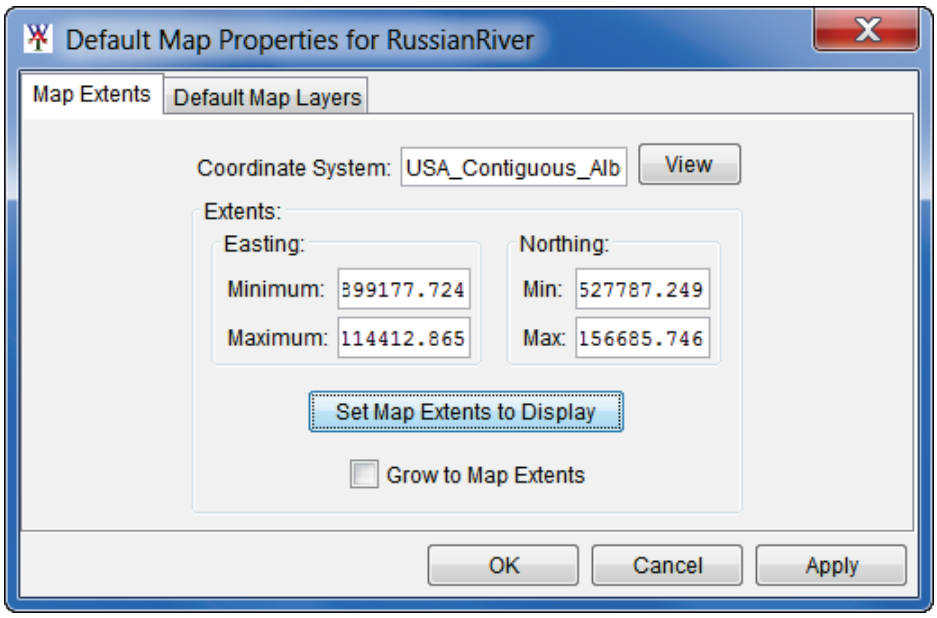


Figure 9.20 Default Map Properties for Dialog Box

This sets the extents for the **Map Window** so that when the study is opened the next time the **Map Window** will be zoomed in to the tighter area.

9.7 Define Plug-Ins for an FRA Study

To define the plug-ins for the *RussianRiver* study:

1. From the HEC-WAT main window (Figure 9.5), from the **File** menu, click **Study Details**.

2. The **Study Details** dialog box (Figure 9.21) will open. Click on the **Plug-ins** tab. The table that is displayed provides information on the plug-ins that are available in for the study.

3. For an FRA study, all plug-ins should be selected. Click **OK**, the **Study Details** dialog box will close (Figure 9.21).

9.8 Hydrologic Sampling

The first step in an FRA compute (Monte Carlo analysis) is the sampling of the hydrology to create perhaps thousands of realizations of a hydrologic sequence. Because FRA is an event-based model, the hydrology information is needed as time series of flow or precipitation to be routed through the system under study. Life-cycle analysis requires each realization of hydrology to consist of a full analysis period, for example fifty years, although a single year analysis period is also possible. Realizations may be formed as flow hydrographs, or may be formed as precipitation hyetographs, with hydrographs generated by HEC-HMS within each FRA sub-compute. Each realization of the analysis period will only be populated by the flood events, and not the low flow periods between flood events.

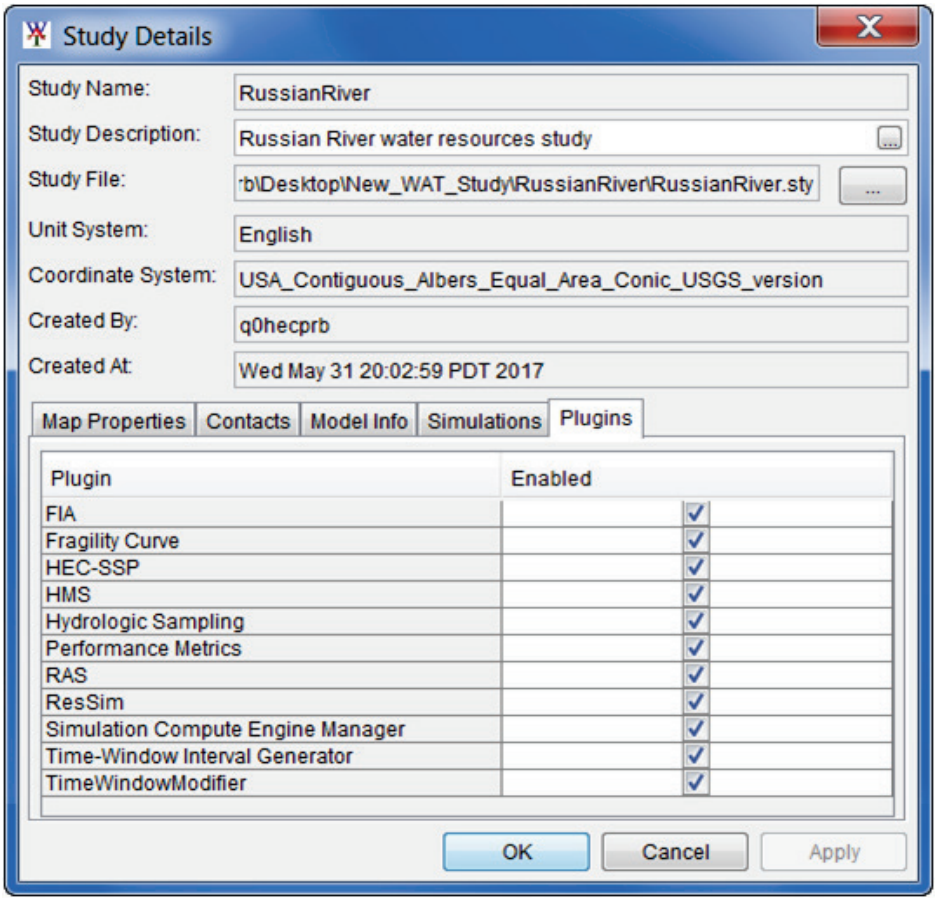


Figure 9.21 HEC-WAT – Study Details Dialog Box - Plugins Tab

Hydrologic Sampling generates the hydrologic sequences required for the sampling of the hydrology. Then hydrologic information such as flow or precipitation frequency curves, cross correlations between curves, and hydrograph or hyetograph shapes, or historical and synthetic event hydrographs is stored. The Hydrologic Sampling then generates pseudo random numbers to sample the hydrology to generate as many realizations of the life-cycle hydrologic sequence as necessary. Each generated sequence is made available to the other software applications available in the HEC-WAT program sequence.

9.8.1 Creating a Hydrologic Sampling Alternative

The following is for creating a simple hydrologic sampling alternative from a hydrologic sampling alternative that has already been created. For further details review the HEC-WAT User's Manual.

9.8.2 Copying a Hydrologic Sampling Alternative

1. With the HEC-WAT software closed, from the user's computer, locate the HEC-WAT directory for the watershed. From the *FRA_RR_Models* folder, copy the *RR_hs* folder to the HEC-WAT directory that contains the study. Rename that folder to *hs*.

2. Open HEC-WAT, and open the *RussianRiver* study.

3. From the **Study Pane** (Figure 9.22), expand **Models**. There should be a **Hydrologic Sampling** node, click on it. In the **Content Pane** (below the **Study Pane**), there should be a Hydrologic Sampling Alternative - *RR_Precip2*.

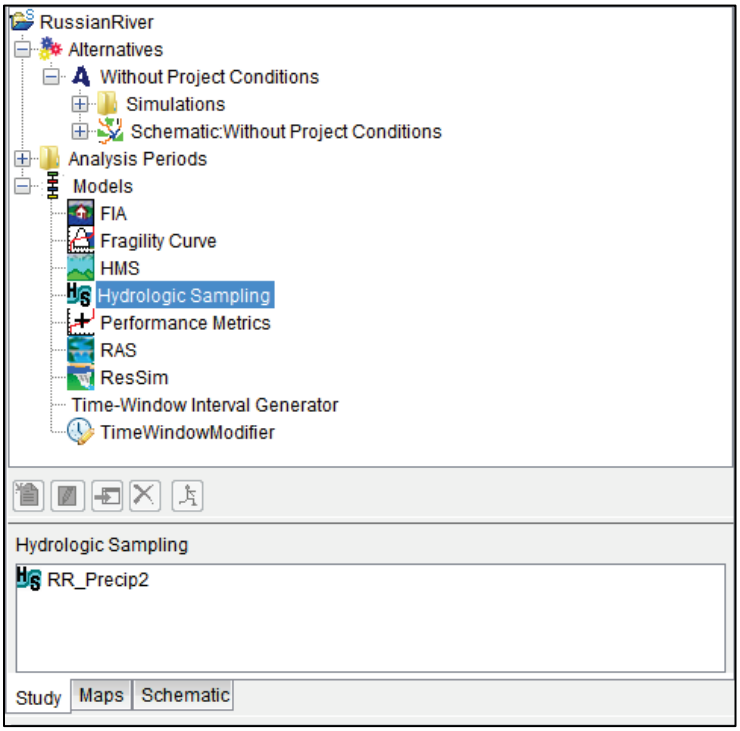


Figure 9.22 Study and Content Panes

4. Right-click on *RR_Precip2*, from the shortcut menu click **Edit**. The **Hydrologic Sampling Editor** will open (Figure 9.23).

5. *RR_Precip2* is a hydrologic sampling alternative that was previously built for the *Russian River* study. This alternative is setup to sample precipitation data. How do we know that (besides the name)? From the **Data to be Sampled** list on the **Hydrologic Sampling Editor** (Figure 9.23), **Precipitation Sampling** has been selected. The other choice is **Flow Sampling**. For **Precipitation Sampling** there is one sampling method available (**Sampling Method** list, Figure 9.23), **Basin Average Frequency Curve**.

6. For **Flow Sampling**, there are two sampling choices (**Sampling Method** list, Figure 9.23) - **Basin Average Frequency Curve** (which is the selection for *RR_Precip2*) and **Historical Basin-wide Events**. Each of these choices are the mechanisms that generate a hydrologic sequence.

   - **Basin Average Frequency Curve** - generates an event hydrograph for each location by sampling a peak flow from a flow frequency curve and combining that peak with a hydrograph shape (for further details see HEC-WAT User's Manual and Applications Guide).

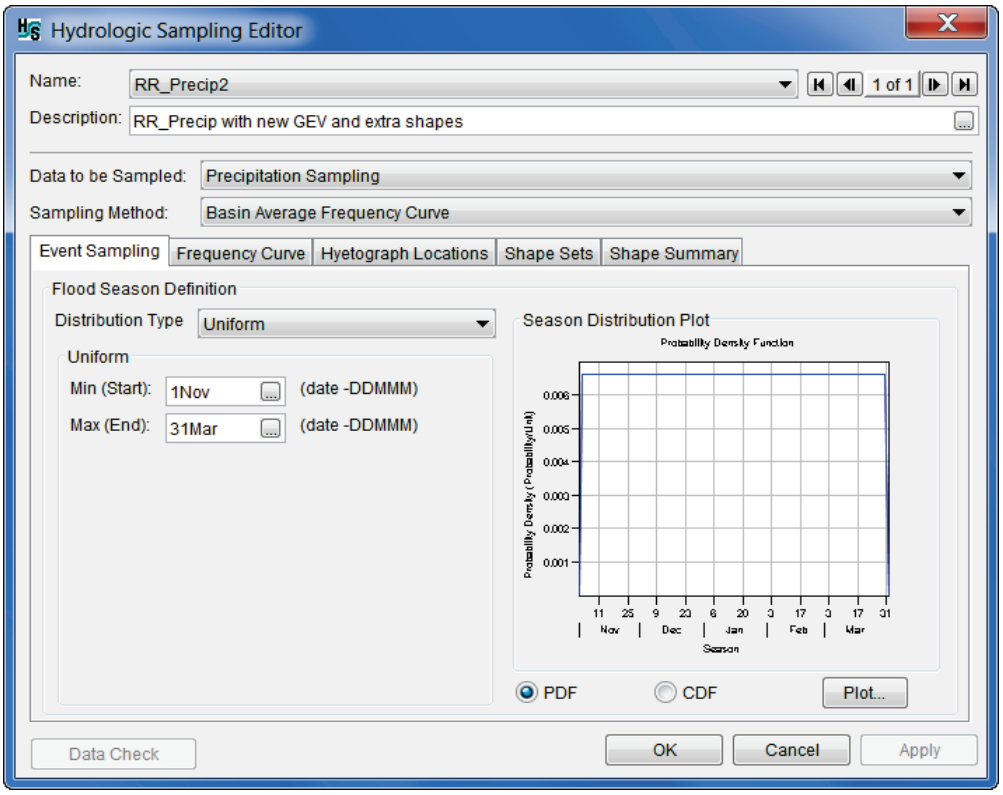


Figure 9.23 Hydrologic Sampling Editor - Event Sampling Tab

- **Historical Basin-wide Events** - the period-of-record of actual events plus an array of synthetic events are put into a "flood bucket" and repeatedly re-sampled to provide basin-wide sets of hydrographs (for further details see HEC-WAT User's Manual and Applications Guide).

9.9 Create an Analysis Period

An FRA compute requires an HEC-WAT alternative, an analysis period, a program order, and model alternatives.

To create an analysis period:

1. From the HEC-WAT main window (Figure 9.5), from the **Study Tree**, right click on the **Analysis Periods** folder (Figure 9.24). From the shortcut menu click **New**.

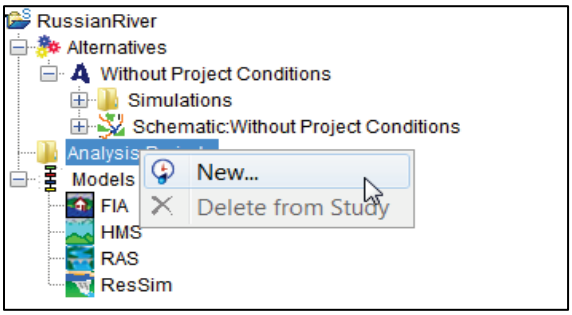


Figure 9.24 Analysis Period Shortcut Menu

2. The **Create New Analysis Periods** dialog box will open (Figure 9.25). In the **Name** box enter a name (*FRA_TW*). In the **Time Window** box enter the information required for the time window.

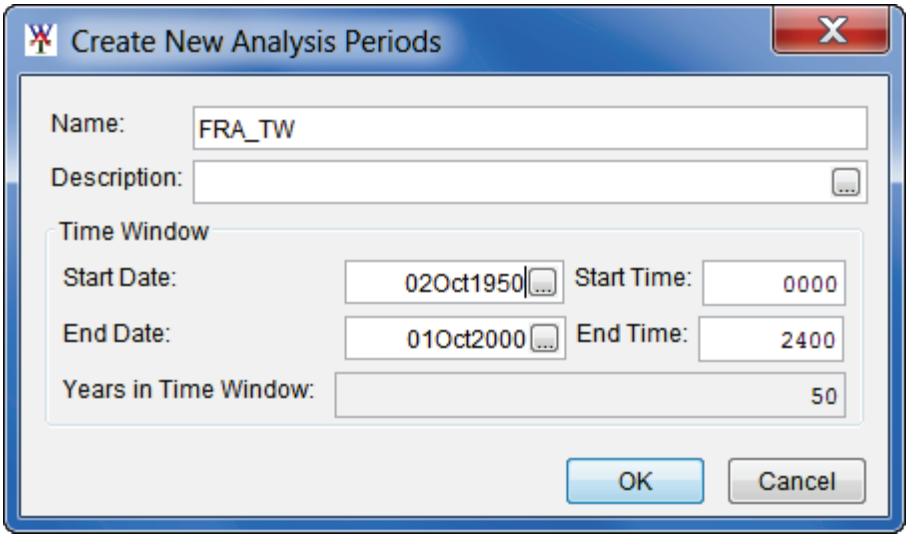


Figure 9.25 Create New Analysis Periods Dialog Box

3. For the **Start Date** and **End Date**, enter in the format ddmmmyyyy. The **Start Time** and **End Time** should be entered as military time - e.g. 0000, 0600, 1300 (1 p.m.), 2400 (midnight)

.

4. Click **OK**, the **Create New Analysis Periods** dialog box will close (Figure 9.26). On the HEC-WAT main window (Figure 9.5), from the **Study Pane**, under the **Analysis Periods** folder, the new analysis period name will appear.

9.10 Setup Lookback Window – HEC-ResSim

The time window for an HEC-ResSim run has two parts, a "lookback period" and a "simulation or forecast period". The lookback period is used by HEC-ResSim to "warm up" a ResSim model alternative. During this period, routing of flows through the river and reservoir network are performed but no release decisions are made nor are any mass balance computations evaluated. The user should think of the lookback period as the time to establish the state of the river network and the starting conditions of the reservoirs. The simulation period is the portion of the time window during which HEC-ResSim simulates reservoir operations, and makes release decisions based on the operation scheme defined by the user. Releases are then routed through the river network, combining with local inflows along the way.

Since HEC-WAT and most of the models treat the analysis period as a single, continuous time window. For this reason a setup step is required for each HEC-ResSim alternative in an HEC-WAT study. The setup step lets each ResSim model alternative know how much of the analysis period to use for the lookback period.

To setup the lookback period:

1. From the HEC-WAT main window (Figure 9.5), from the **Edit** menu, point to **ResSim,** click **Lookback Window** (Figure 9.26).

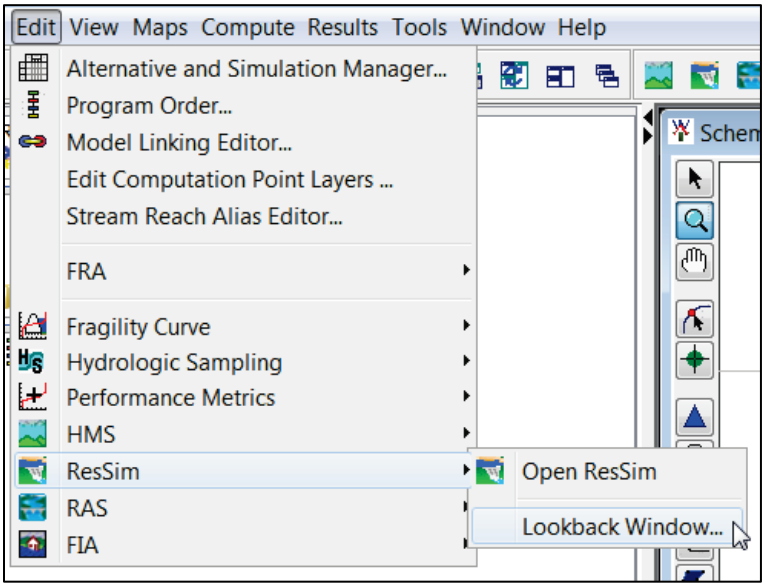


Figure 9.26 Edit Menu – ResSim – Lookback Window

2. The **Lookback Window** dialog box (Figure 9.27) will open.

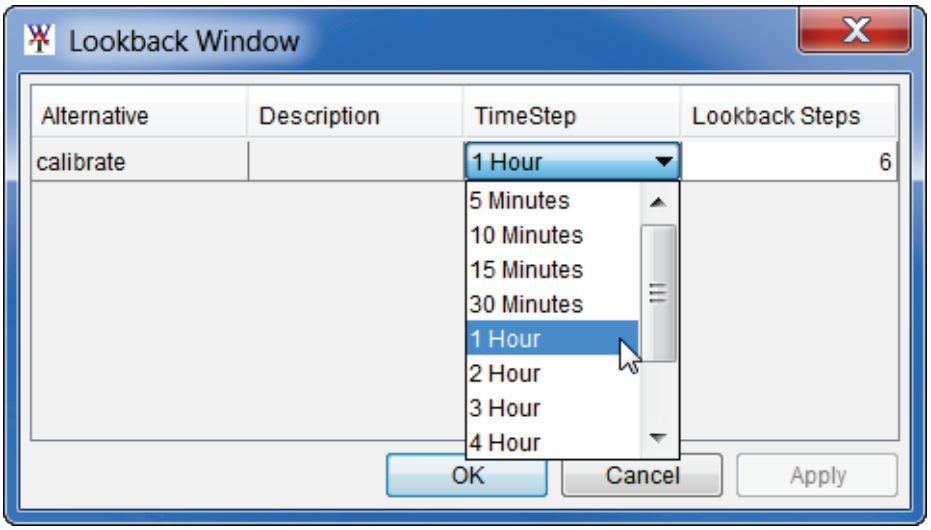


Figure 9.27 Lookback Window Dialog Box

3. The table displays the ResSim model alternative that are available in the HEC-WAT study. Each model alternative that is being used in an HEC-WAT simulation will need to have a lookback window set. For example, in Figure 9.27, the HEC-ResSim alternative *calibrate* has a **TimeStep** of 1 hour and **Lookback Steps** of 6.

4. The time step can be selected from the **TimeStep** column, in each cell there is a list of available time steps for the user to choose from. The selected time step has to match the time step that was specified for the ResSim model alternative as part of the alternative's

original run control data (which is located in the HEC-ResSim Alternative Editor). The number of lookback steps must be entered in a cell in the **Lookback Steps** column. At least one lookback time step is required for a ResSim model alternative to compute, however more lookback steps may be needed, depending on a variety of factors in the ResSim model alternative's operating scheme. The HEC-ResSim modeler should be consulted to determine the minimum lookback window needed by each alternative.

9.11 Program Order

HEC-WAT allows for a flexible set of programs, computation order, and data flow through the establishment of a program order. Once a program order has been chosen for an HEC-WAT study, changes should not be made to the program order as this could cause a disruption in the flow of data and invalidate any existing work.

Currently in HEC-WAT Version 1.0 the default program order is - HMS, ResSim, RAS, FIA. This is the correct program order for the example watershed that is being used, so no adjustment is necessary. For further details on **Program Order**, review Chapter 11 (Section 11.1) of the HEC-WAT User's Manual.

9.12 Create an HEC-WAT FRA Simulation

Now that all of the building blocks have been configured, the user can now create an HEC-WAT FRA simulation. To create an HEC-WAT FRA simulation:

1. From the HEC-WAT main window (Figure 9.5), from the **WAT Tools** toolbar, click the **Alternative and Simulation Manager** button .

2. The **Alternative and Simulation Manager** dialog box will open (Figure 9.28). From this dialog box the user can create/modify alternatives, analysis periods, simulations, program order, link models, and make runs.

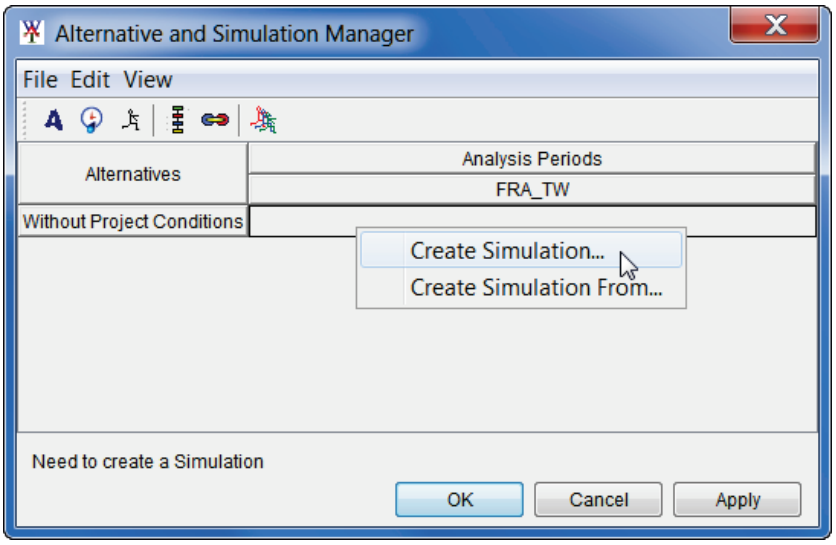


Figure 9.28 Alternative and Simulation Manager Dialog Box

3. To create a simulation, from the table right-click on the intersection of an alternative and analysis period. From the shortcut menu click **Create Simulation**. The **Create New Simulation** dialog box will open (Figure 9.29).

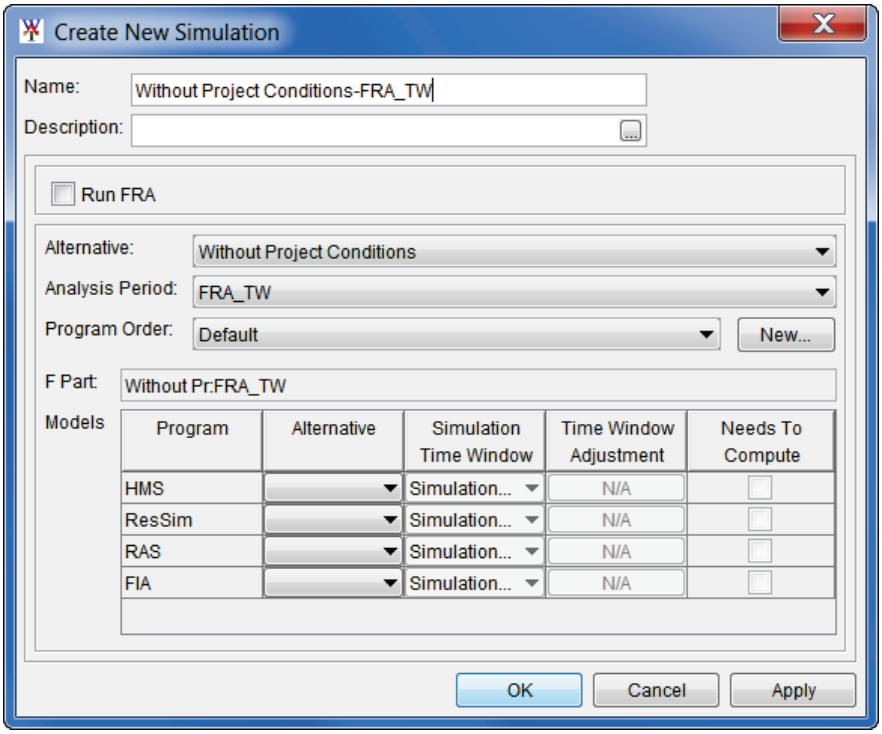


Figure 9.29 Create New Simulation Dialog Box

4. HEC-WAT has defined a default name for the simulation (*Without Project Conditions-FRA_TW*) in the **Name** box (Figure 9.29). The name is a combination of the HEC-WAT alternative name and analysis period name, where the intersection was in the table (name can be changed). Also, in the **Alternative** and **Analysis Period** lists (Figure 9.29) the selections have already been made based on the intersection in the table. The selected **Alternative** cannot be changed, but the selected **Analysis Period** can be changed.

5. In the **F Part** box (Figure 9.29), a default **F Part** is displayed that was generated by HEC-WAT based once again on the alternative and analysis period. The user can edit the item, but it is not advised.

6. To create an FRA simulation, select **Run FRA** (Figure 9.30). The options for setting up an FRA simulation are now available.

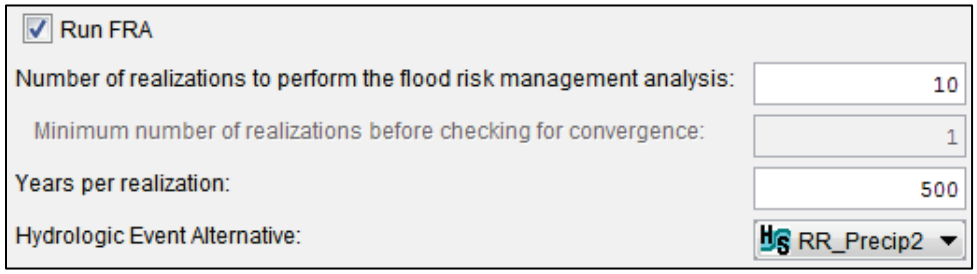


Figure 9.30 FRA Setup - Create New Simulation Dialog Box

- **Number of realizations to perform the flood risk management analysis** - enter the maximum number of realizations (e.g., *10*) that are needed to perform the FRA analysis; number must be equal to or larger than the simulation time window.

- **Years per realization** - default is 500; number can be increased.

7. From the **Hydrologic Event Alternative** list (Figure 9.30) select the appropriate Hydrologic Sampling Alternative (*RR_Precip2*).

6. A program order needs to be selected. From the **Program Order** list (Figure 9.30) select the *Default* program order.

8. In the **Programs** table (Figure 9.31), the software applications that were defined in the program order appear in the order the software applications were selected. Now the user must select the appropriate alternative (plan, run) for each software application. From the **Alternative** column, from the list for **HMS** (Figure 9.31), select the appropriate HMS run (*(MCA)DCL_WAT*). Repeat the process for the other software applications. Below is the list of the appropriate alternatives for the *RussianRiver* study:

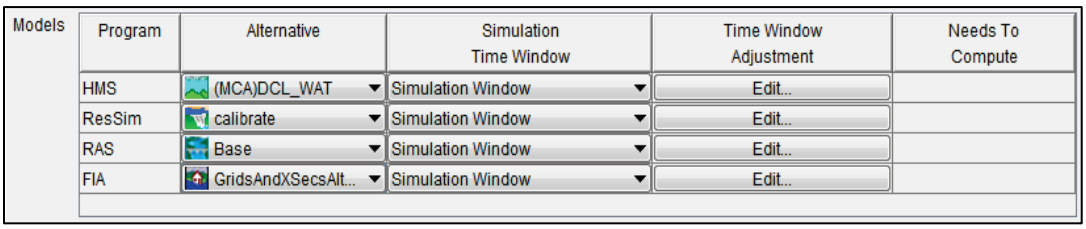


Figure 9.31 Selection of Model Alternatives - Create New Simulation Dialog Box

HMS - (MCA)DCL_WAT
ResSim - calibrate
RAS - Base
FIA - GridsAndXSecsAlternative

9. Now that all of the alternatives have been selected, click **OK**. The **Create New Simulation** dialog box will close (Figure 9.28). On the **Alternative and Simulation Manager** (Figure 9.32) dialog box, the intersection of the alternative and analysis period now provides information about the simulation.

10. Click **OK**; the **Alternative and Simulation Manager** dialog box will close (Figure 9.32). From the HEC-WAT main window (Figure 9.5), the created simulation appears on the **Study Tree**, under the **Simulations** folder (Figure 9.33).

11. Click on the simulation in the **Study Tree** (Figure 9.33), the **Content Pane** (Figure 9.34) displays information about the selected simulation.

12. Double-click on the simulation name (*Without Project Conditions-FRA_TW*), a **Select Map** dialog box will open. Click **New Map Window**, click **OK**. The **Select Map** dialog box will close. The new map window will contain the schematic elements that represent the simulation (Figure 9.35).

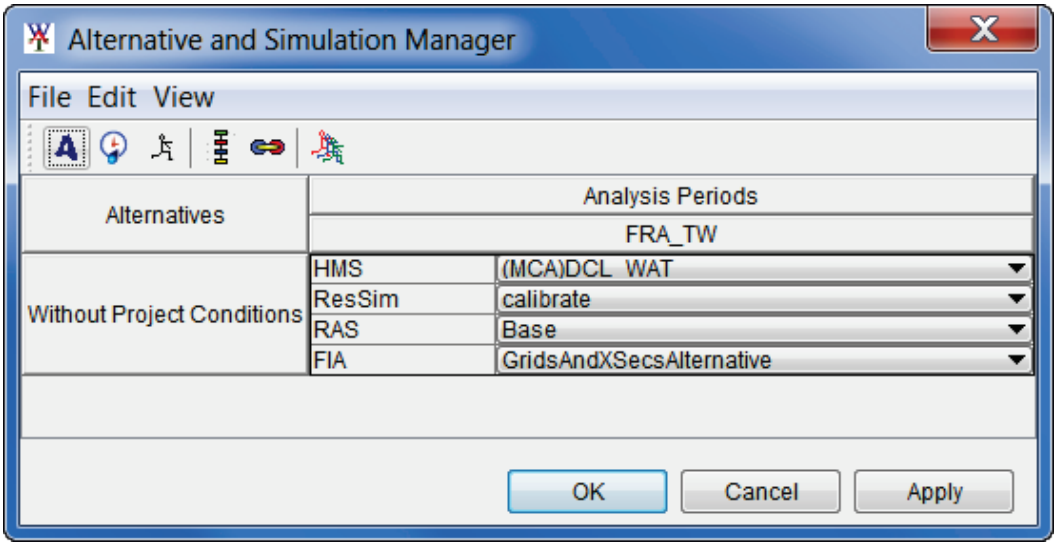


Figure 9.32 Alternative and Simulation Manager - Completed Simulation

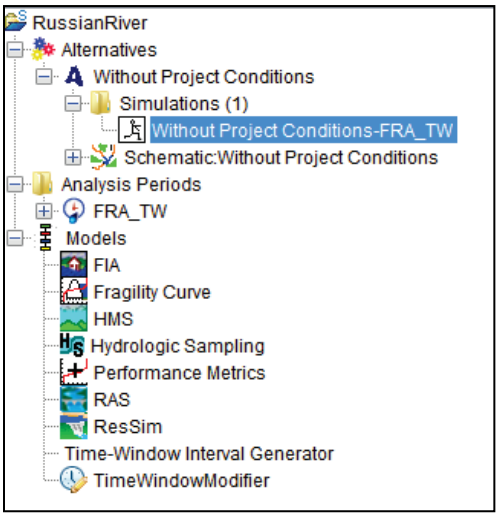


Figure 9.33 Study Tree with Created Simulation

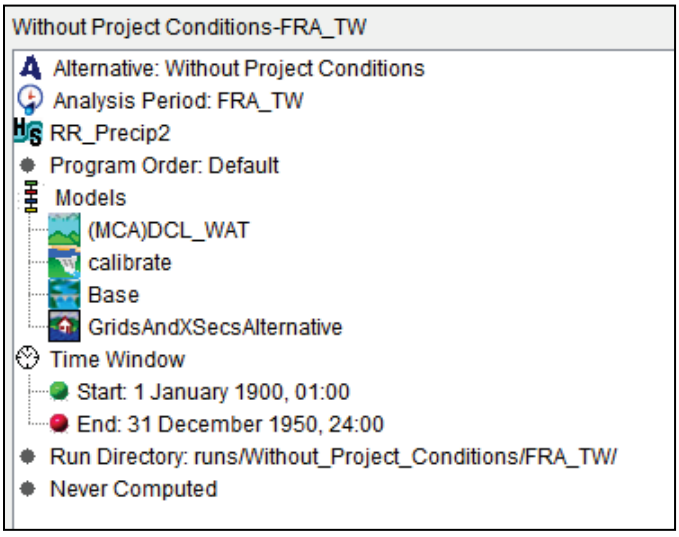


Figure 9.34 Content Pane

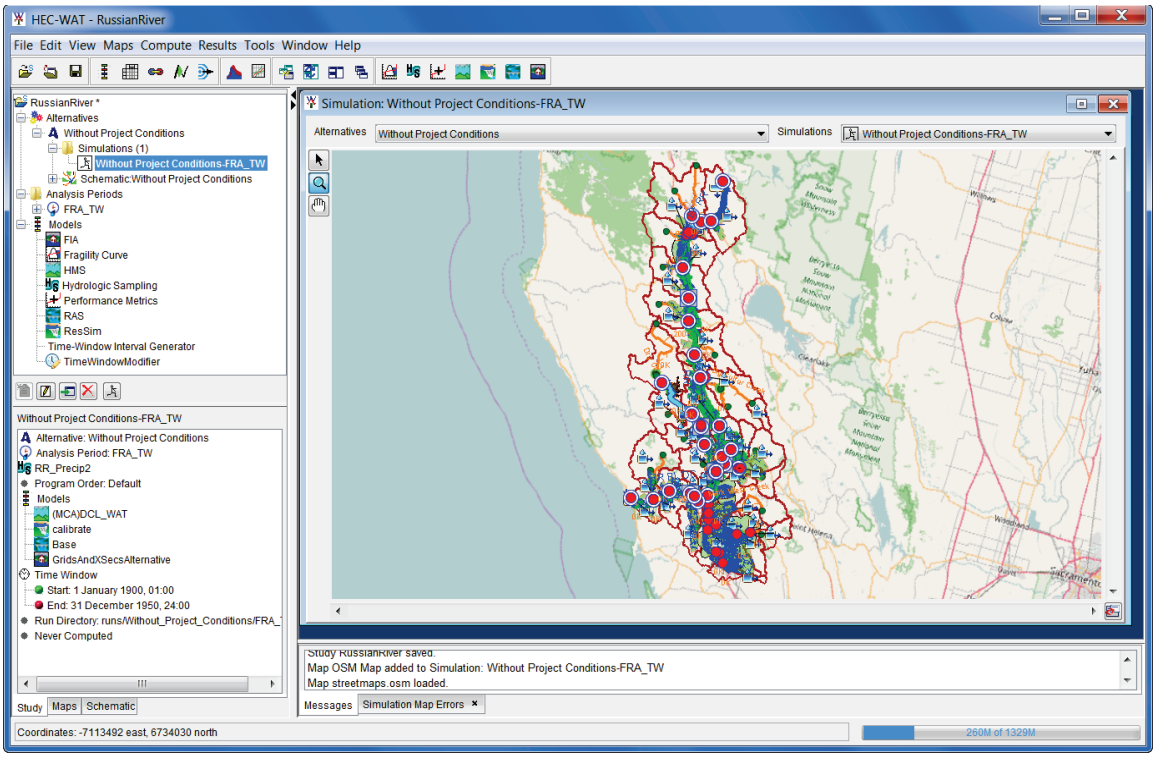


Figure 9.35 Map Window - Schematic of Current HEC-WAT Simulation

9.13 Linking

The next step is to have the models of a simulation communicate with each other. This is accomplished by linking (DSS mapping) the models thru DSS and using a simulation name. From HEC-WAT, the **Model Linking Editor** (Figure 9.36) provides an easy way to link models including observed data, and provides a mechanism where the linking will have to be done once per alternative.

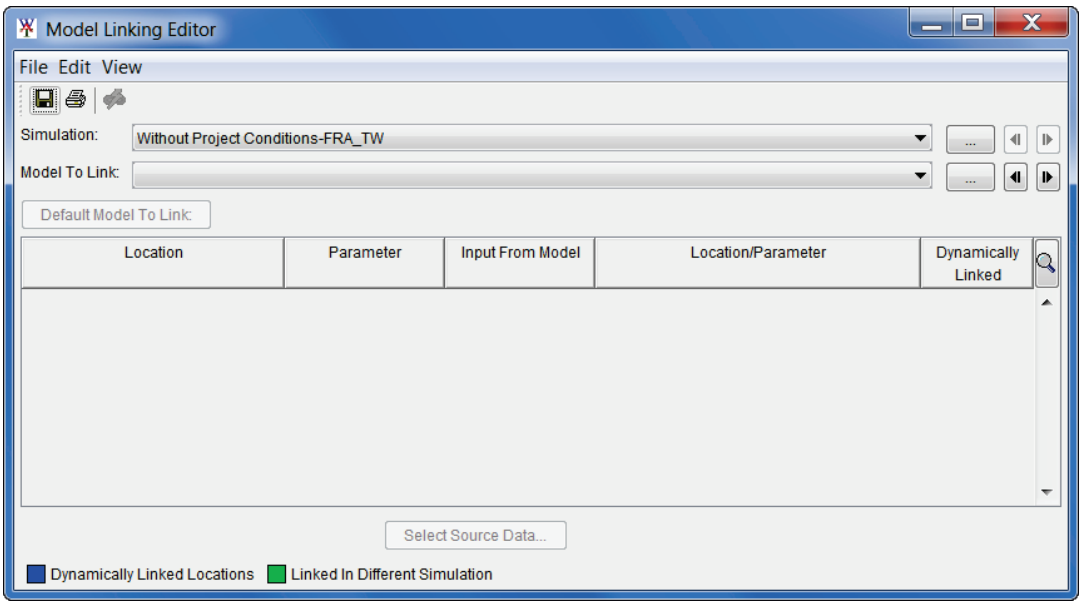


Figure 9.36 Model Linking Editor

1. From the HEC-WAT main window (Figure 9.35), from the **WAT Tools** toolbar, click the **Model Linking Editor** button .

2. The **Model Linking Editor** will open (Figure 9.36). From the **Simulation** list the user will need to select a simulation. For this example the user will be selecting the *Without Project Conditions-FRA_TW* (default) simulation.

3. Now let's link the individual model alternatives that are part of the selected simulation.

9.13.1 Linking the HMS Model Alternative

1. From the **Model Linking Editor** (Figure 9.36), from the **Model to Link** list select *HMS-(MCA)DCL_WAT* (Figure 9.37). The **Model Linking Editor** table will now contain all of the locations for the HEC-HMS model that need to be linked.

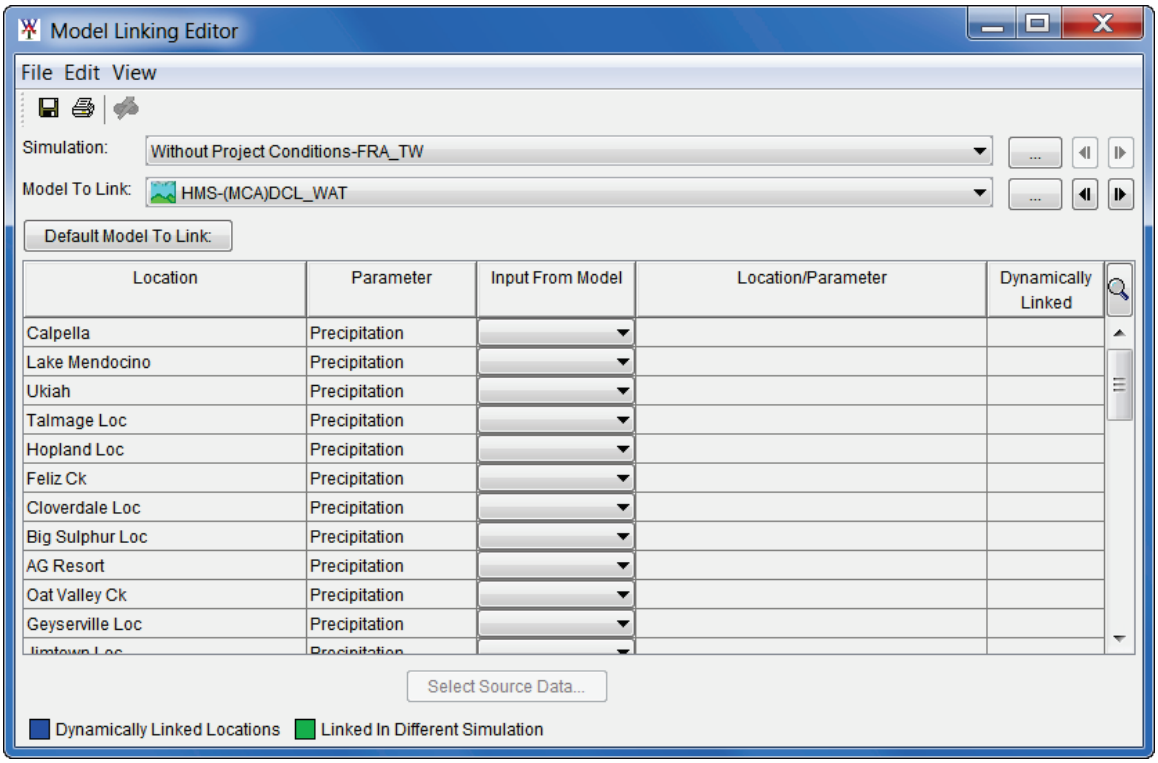


Figure 9.37 Model Linking Editor - HMS Model Alternative Unlinked

2. For HEC-HMS the linking will be results from the Hydrologic Sampling alternative. The printout (*RussianRiverLinking.pdf*) of the linking for each of the model alternatives is located in a folder titled *RussianRiver_Data*.

3. Does every row in the table have to be done? Yes, but, since all of the linking will be to the Hydrologic Sampling alternative, click **Default Model to Link**. The **Select Default Model to Link** dialog box will open (Figure 9.38). From the **Default Model to Link** list, select *HydrologicSampling-RR_Precip2*. Click **OK**, the **Select Default Model to Link** dialog box will close (Figure 9.38).

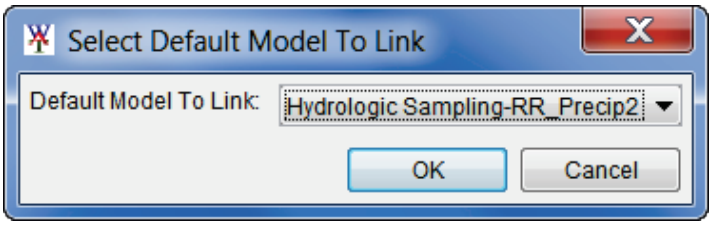


Figure 9.38 Select Default Model To Link Dialog Box

4. A **Confirm Input From Model changing to** window (Figure 9.39) will appear. Basically the window is asking the user to be sure before proceeding, click **Yes**. The **Confirm Input From Model changing to** window closes, and the **Model Linking Editor** now displays the linking for the HEC-HMS model (Figure 9.40).

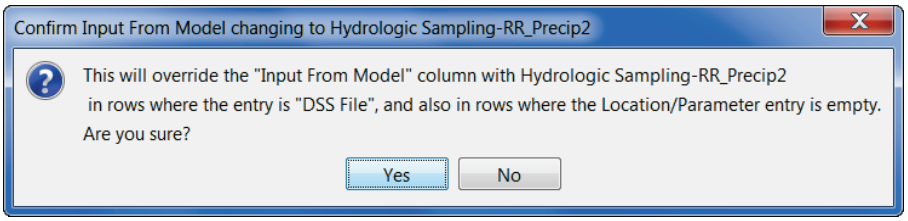


Figure 9.39 Confirm Input From Model changing to Window

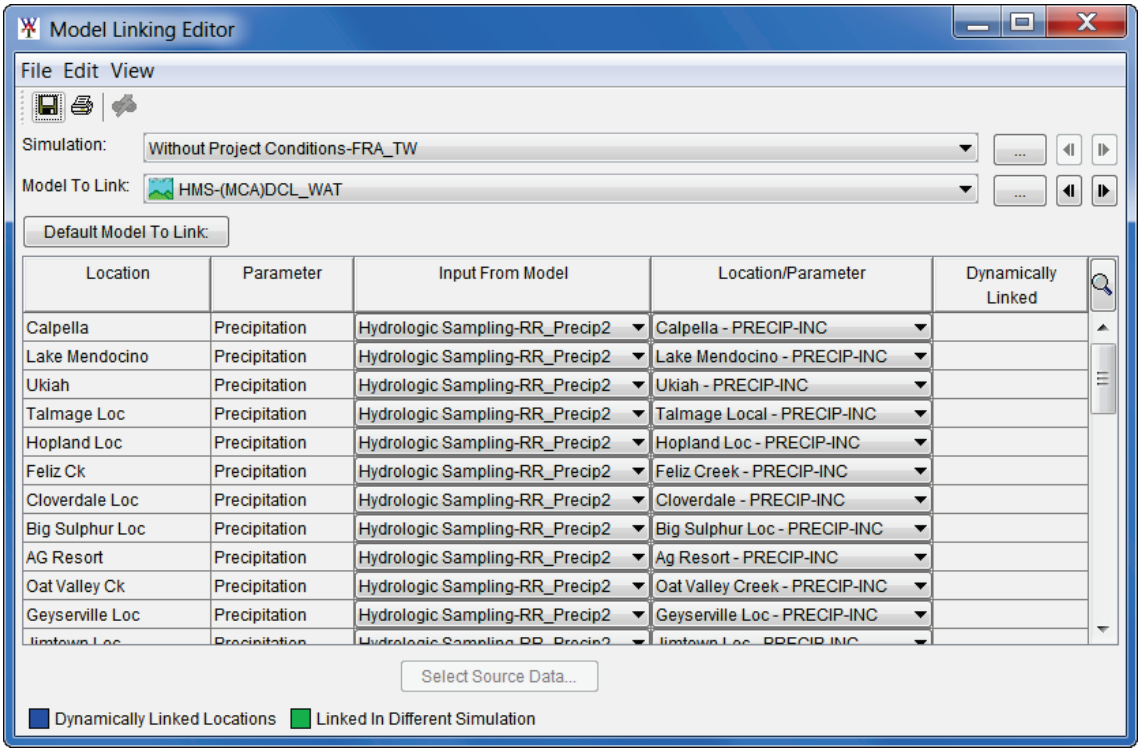


Figure 9.40 Model Linking Editor - Completed HMS Model Alternative Linking

5. Once the linking is finished for the HMS model alternative, from the **Model Linking Editor** (Figure 9.40) click , this will save the linking.

6. That completes the linking for the HMS model alternative.

9.13.2 Linking the ResSim Model Alternative

1. From the **Model Linking Editor** (Figure 9.40), from the **Model to Link** list, select *ResSim-calibrate*. The **Model Linking Editor** table (Figure 9.41) will now contain all of the locations for the ResSim model alternative that needs to be linked.

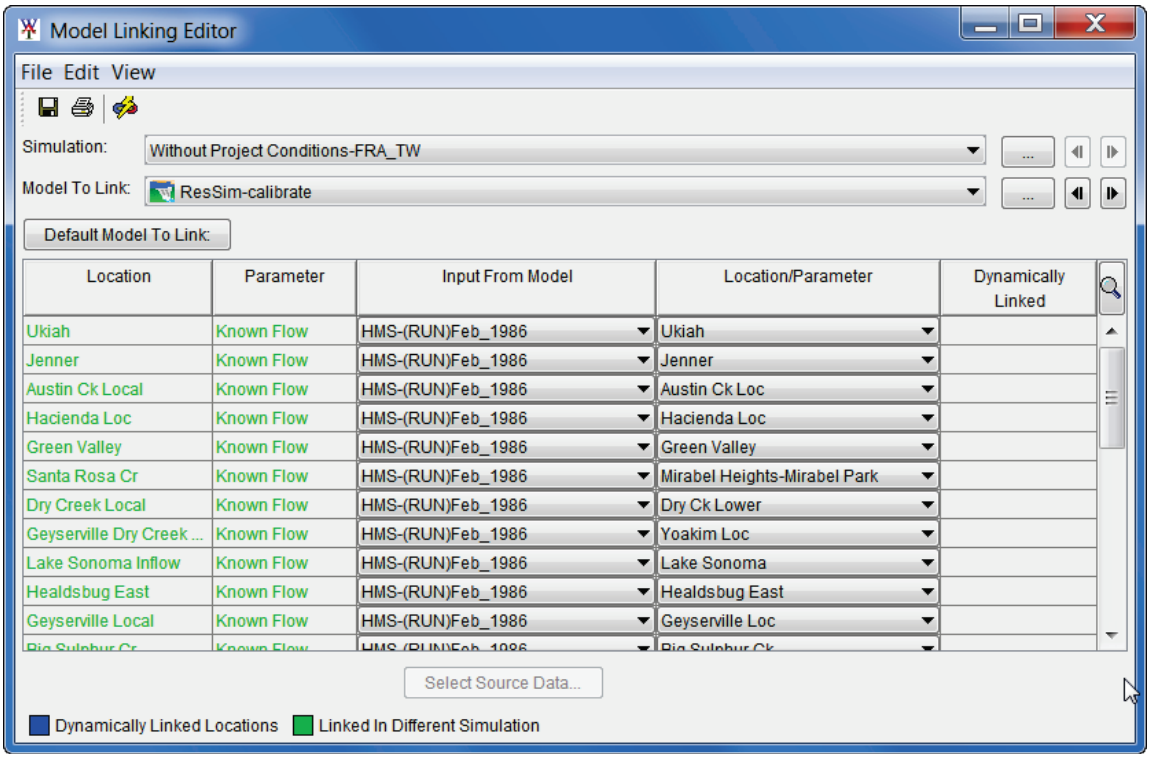


Figure 9.41 Model Linking Editor - ResSim Model Alternative Unlinked

2. For ResSim the linking will be the results from the HMS model alternative. Well, this looks like it is already linked. Well, yes and no. The HEC-ResSim model was already part of another HEC-WAT study. The model was modified to include parameter sampling. So the **Model Linking Editor** is reading the ResSim linking and it's reporting that this HEC-ResSim model alternative is already linked to an HMS model alternative that HEC-WAT knows about and it was linked to a different HEC-WAT simulation.

3. Does every row in the table have to be done? Yes, but, since all of the linking will be to the HMS model alternative, click **Default Model to Link**. The **Select Default Model to Link** dialog box will open (Figure 9.38). From the **Default Model to Link** list, select *HMS-(MCA)DCL_WAT*. Click **OK**, the **Select Default Model to Link** dialog box will close (Figure 9.38).

4. A **Confirm Input From Model changing to** window (Figure 9.39) will appear. Basically the window is asking the user to be sure before proceeding, click **Yes**. The **Confirm Input From Model changing to** window closes, and the **Model Linking Editor** now displays the linking for the ResSim model alternative (Figure 9.42).

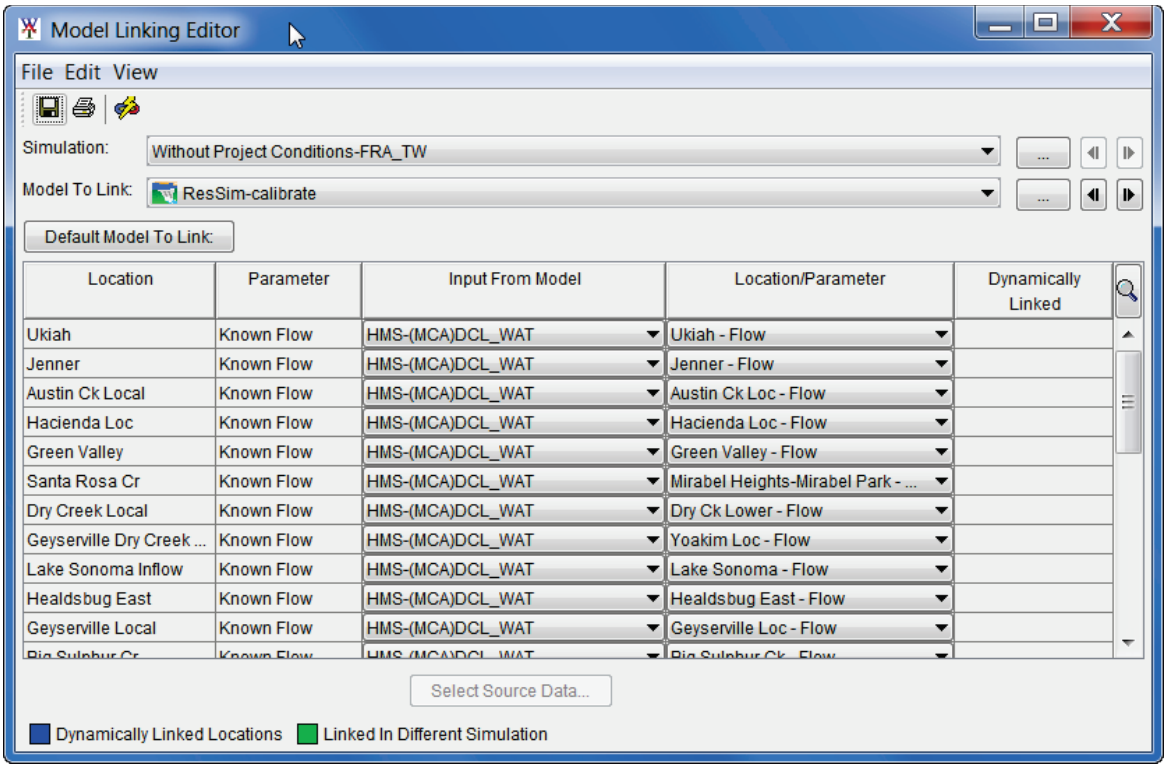


Figure 9.42 Model Linking Editor - Completed ResSim Model Alternative Linking

5. Once the linking is finished for the ResSim model alternative, from the **Model Linking Editor** (Figure 9.42) click , this will save the linking.

6. That completes the linking for the ResSim model alternative.

9.13.3 Linking the RAS Model Alternative

1. From the **Model Linking Editor** (Figure 9.42), from the **Model to Link** list, select *RAS-Base*. The **Model Linking Editor** table (Figure 9.43) will now contain all of the locations for the RAS model alternative that needs to be linked.

2. For the RAS linking, results from the HMS and ResSim model alternatives will be used. The printout (*RussianRiverLinking.pdf*) of the linking for each of the model alternatives is located in a folder titled *RussianRiver_Data*.

3. From the **Model Linking Editor** (Figure 9.43), click **Default Model to Link**. The **Select Default Model to Link** dialog box will open (Figure 9.38). From the **Default Model to Link** list, select *HMS-(MCA)DCL_WAT*. Click **OK**, the **Select Default Model to Link** dialog box will close (Figure 9.38).

4. A **Confirm Input From Model changing to** window (Figure 9.39) will appear. Basically the window is asking the user to be sure before proceeding, click **Yes**. The **Confirm Input From Model changing to** window closes, and the **Model Linking Editor** now displays the linking for the RAS model alternative (Figure 9.44).

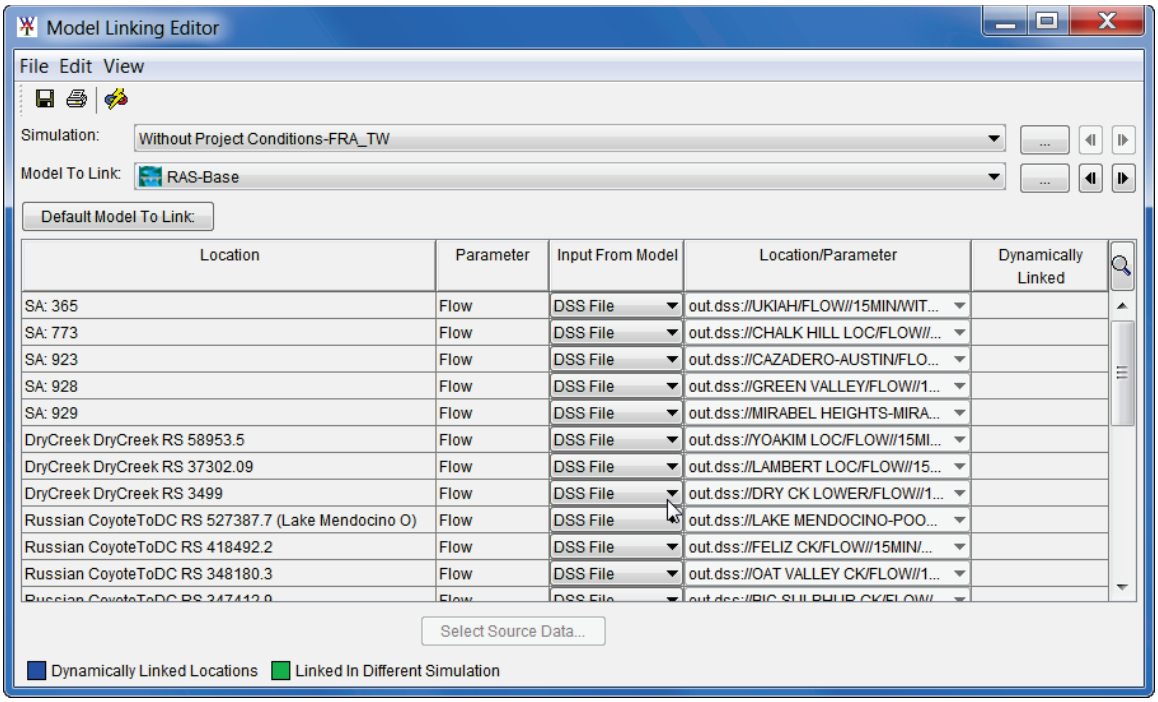


Figure 9.43 Model Linking Editor - RAS Model Alternative Unlinked

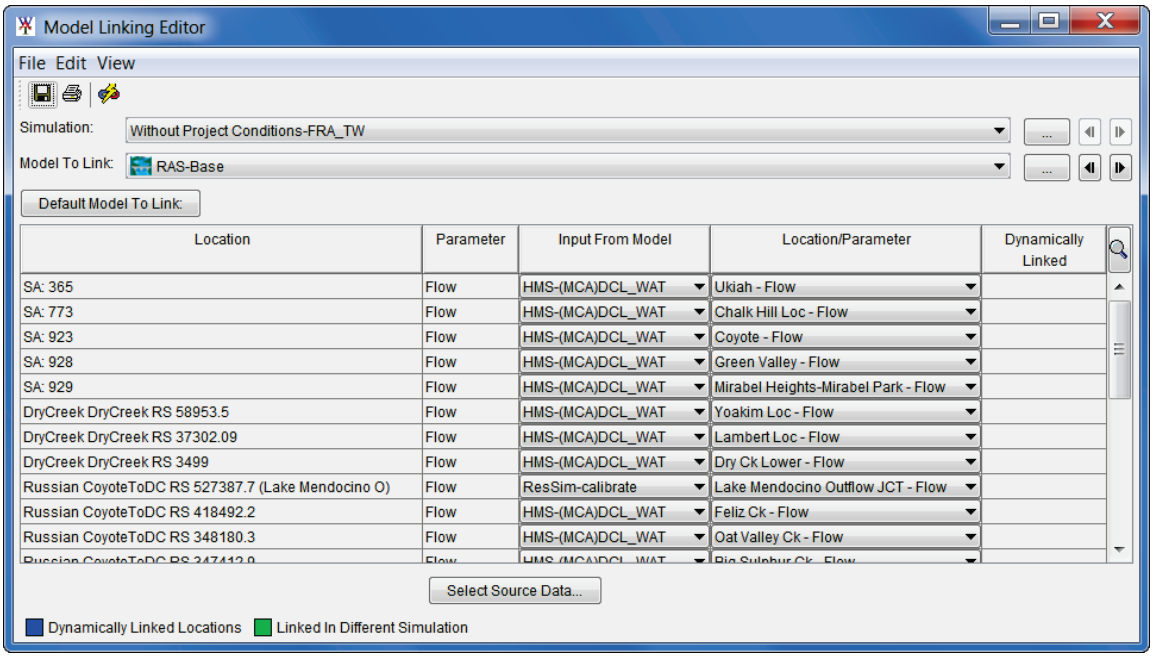


Figure 9.44 Model Linking Editor - Completed RAS Model Alternative Linking

5. There are two locations in the RAS linking that needs to be linked to the ResSim model alternative. From the **Model Linking Editor** table (Figure 9.43) for the *DryCreek DryCreek RS 74716.8 (Sonoma Outflow J)* row, from the **Input Model** column (Figure 9.43), select *ResSim-calibrate*, select *Lake Sonoma Outflow JCT - Flow*.

6. Repeat Step 5 for the *Russian CoyoteToDC RS 527387.7 (Lake Mendocino Outflow JCT - Flow)* row.

7. Once the linking is finished for the RAS model alternative, from the **Model Linking Editor** (Figure 9.44) click , this will save the linking.

8. That completes the linking for the RAS model alternative.

9.13.4 Linking the FIA Model Alternative

1. From the **Model Linking Editor**, from the **Model to Link** list select *FIA-GridsAndXSecsAlternative* (Figure 9.44). The **Model Linking Editor** table (Figure 9.45) will now contain all of the locations for the FIA alternative model that needs to be linked.

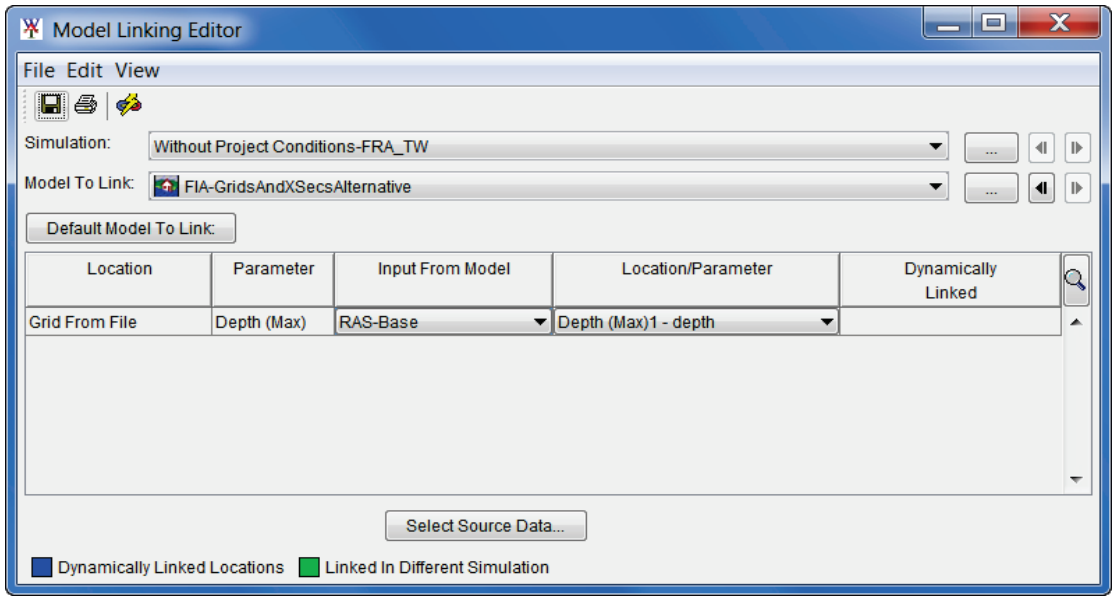


Figure 9.45 Model Linking Editor - Completed FIA Model Alternative Linking

2. For FIA, the linking will be the results from the RAS model alternative. Specifically depth grids that have been created by the RAS Mapper Tool available from HEC-RAS.

3. From the **Model Linking Editor** (Figure 9.45), from the **Input From Model** column, from the model list, select *RAS-Base*. In the **Location/Parameter** column, HEC-WAT has identified what it thinks is the correct item - *Depth (Max)1 - depth* and HEC-WAT is correct.

4. Once the linking is finished for the FIA model alternative, from the **Model Linking Editor** (Figure 9.47) click , this will save the linking.

5. That completes the linking for the FIA model alternative.

9.14 Output Variables

The user must choose at least one output variable from the model alterantives in the compute sequence or tell the FRA simulation to compute without an output variable being chosen before computing an FRA simulation (Section 9.15). For a "production" simulation where output is

required, the user should choose all appropriate output variables before running the simulation. Why is it a good idea for the user to choose at least one output variable? In most cases, the desired type of output from a WAT/FRA simulation will include the maximum (or minimum) value from a time-series record. For example, the maximum stage from a reservoir time-series could be extracted to build a reservoir stage frequency curve. Saving time-series information from many thousands of events, at many locations, for many alternatives could overwhelm the available storage on a computer. However, maximum values (scalars) do not require much disk space. From the **Output Variable Editor** (Figure 9.46), a user can select any available output variables from the models that are part of the selected HEC-WAT simulation and get summary information (e.g., maximum flows, maximum stage, etc.) for each event in the FRA compute.

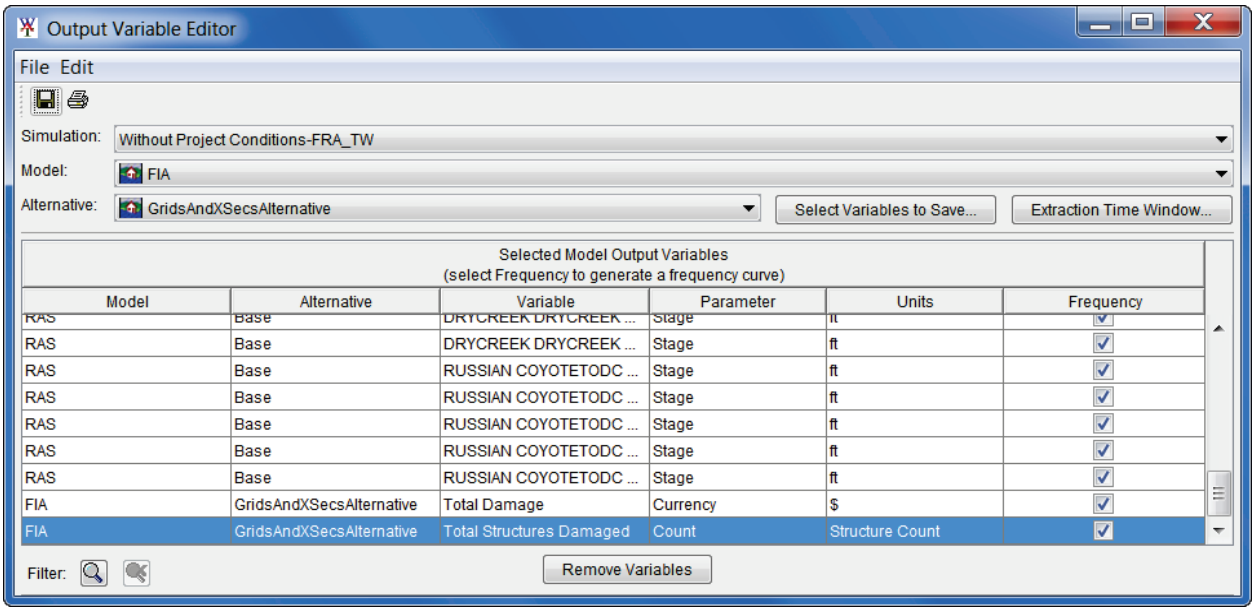


Figure 9.46 Output Variable Editor

1. From the HEC-WAT main window (Figure 9.35), from the **WAT Tools** toolbar, click  .

2. The **Output Variable Editor** will open (Figure 9.46). From this editor, the user can select variables from the model alternatives that are part of a selected HEC-WAT simulation. Currently, the maximum value for each of the output variables selected will be saved to the *simulation.dss* file and if the user wants to generate a frequency curve for a selected output variable, the user must select **Frequency** from the **Output Variable Editor** (Figure 9.46).

3. From the **Simulation** list, select an HEC-WAT simulation (only FRA simulations will be available); next from the **Model** list select the appropriate software application; and, then from the **Alternative** list select the appropriate model alternative.

4. Next click **Select Variables to Save**, the **Select *model alternative*** selector will open (Figure 9.47).

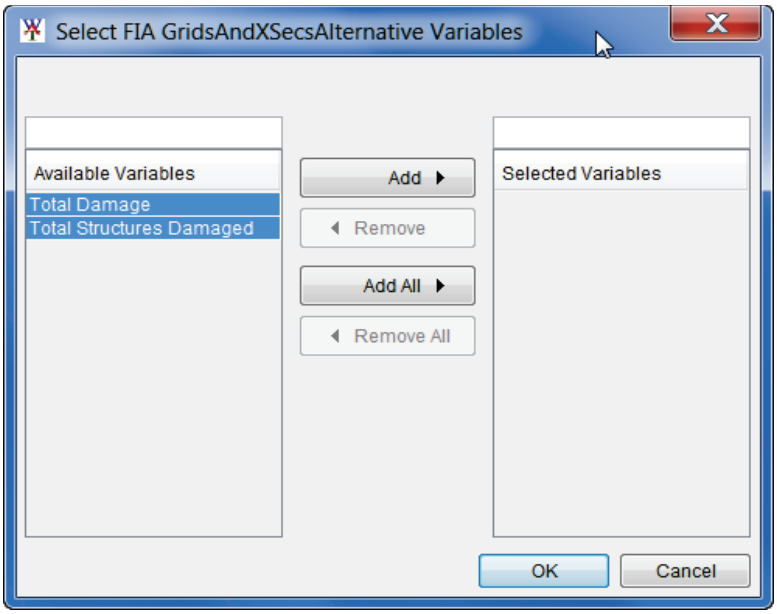


Figure 9.47 Select *model alternative* Selector

5. A list of the model alternative's available output variables is listed in the **Available Variables** list. To select one, highlight, and then click **Add**. The selected variable is moved to the **Selected Variables** list. Click **OK**, the **Select *model alternative*** selector (Figure 9.47) closes and the selected output variables appear on the **Output Variable Editor** (Figure 9.46).

6. From the **File** menu, click **Save**. Close the **Output Variable Editor** (Figure 9.46).

9.15 Compute and View Results

Now that a simulation has been defined, the linking of model alternatives has been completed for a simulation, and model alternatives have been imported into HEC-WAT, the user is now ready to compute the Russian River study.

1. From the HEC-WAT main window (Figure 9.35), from the **Study Tree**, from the **Simulations** folder, right-click *Without Project Conditions-FRA_TW*. From the shortcut menu (Figure 9.48) point to **Compute**, click **Simulation**.

2. The **Run FRA Simulation** dialog box will open (Figure 9.49). In the **Name** box is the name of the simulation that will be computed (*Without Project Conditions-FRA_TW*). The number of realizations (*10*) that will be computed is provided in the **Max. Number of Realizations** box. Other options are:

   - **Start at Lifecycle 1** - default starting point of an FRA compute

   - **Run specified** - by selecting this option the user can choose whether to run from a specific lifecycle or realization. From the **Run Specified List** (Figure 9.49) the user can select lifecycle or realization. In the text box the user will then enter the number of the specific lifecycle or realization to start the FRA compute from.

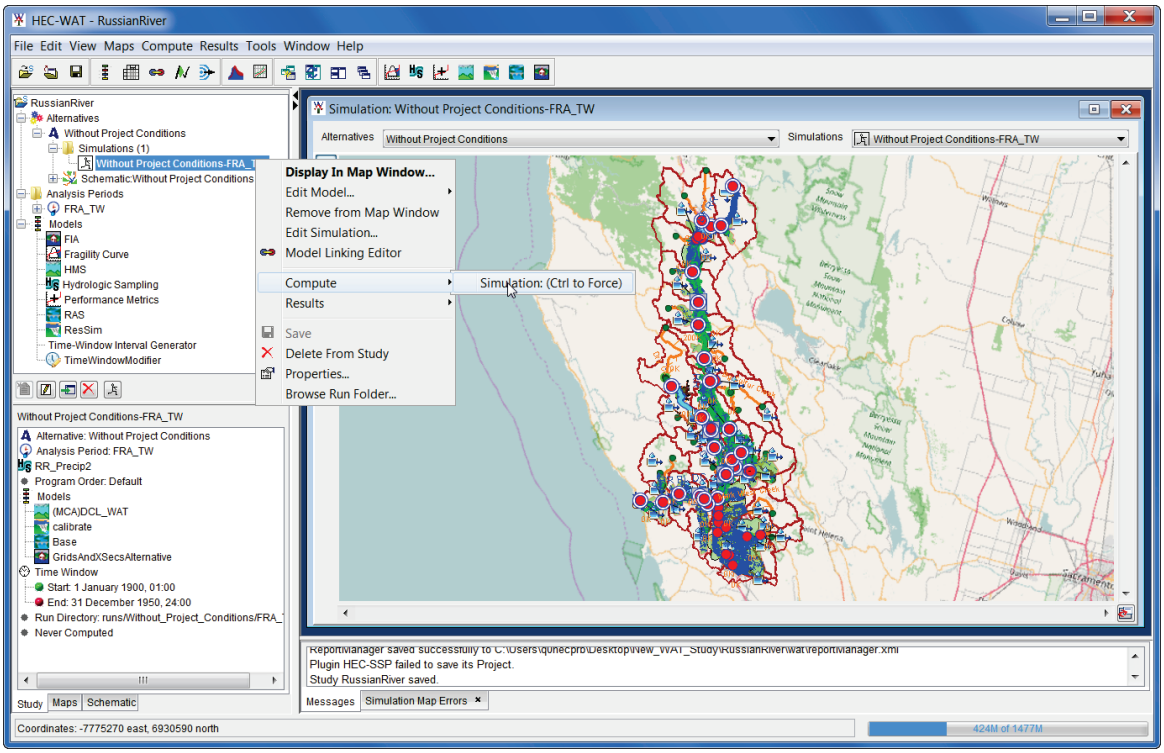


Figure 9.48 HEC-WAT Main Window – FRA Compute

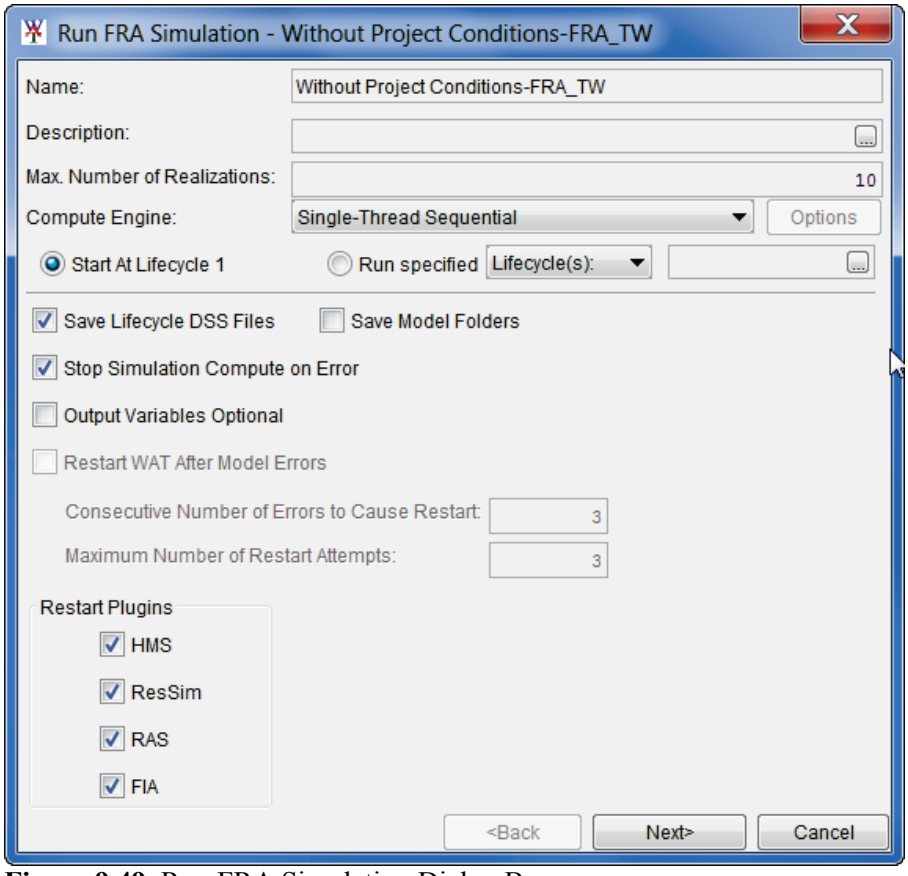


Figure 9.49 Run FRA Simulation Dialog Box

- **Save Lifecycle DSS Files** - when the user makes this choice all FRA results are saved. If the only results the user wants saved are by realization and lifecycle then the user should choose **Delete Event Folders** (Figure 9.49) to make sure results by events are not saved.

- **Save Model Folders** – results by events are not saved by default; if the user wishes to save all information, **Save Model Folders** (Figure 9.49) must be selected

- **Stop Simulation Compute on Error** - selecting this option will make the FRA compute stop when any kind of error is detected during the simulation (compute)

- **Output Variables Optional** – by default an FRA compute requires that at least one output variable be selected; if **Output Variables Optional** is selected then output variables are not required for the FRA compute

- **Restart WAT After Model Errors** – if **Stop Simulation Compute on Error** has not been selected, this option becomes available. If this option is selected, the user can set the consecutive number of errors that will make HEC-WAT restart and the maximum number of restarts.

- **Restart Plugins** - this allows the user to decided which programs to stop and re-start during the FRA compute. This needs to be used when there are memory issues with the individual software applications during an FRA compute.

3. Click **Next**, the **Run FRA Simulation Information** dialog box (Figure 9.50) will open. This dialog box provides information about the FRA simulation that is about to be computed. Information includes the time window, when the simulation will be stopped, whether results will be saved, lifecycles that will be run, convergence information, model sequence information, variables for convergence, time window modifiers; and output variable time windows.

4. Click **Compute**, the **Compute Progress** dialog box will open (Figure 9.51). When the compute is finished, click **Close,** the **Compute Progress** dialog box will close (Figure 9.51).

5. Since the user is taking a study that was built for a non-flood risk analysis, the user may need to do some work on getting the models to compute successfully.

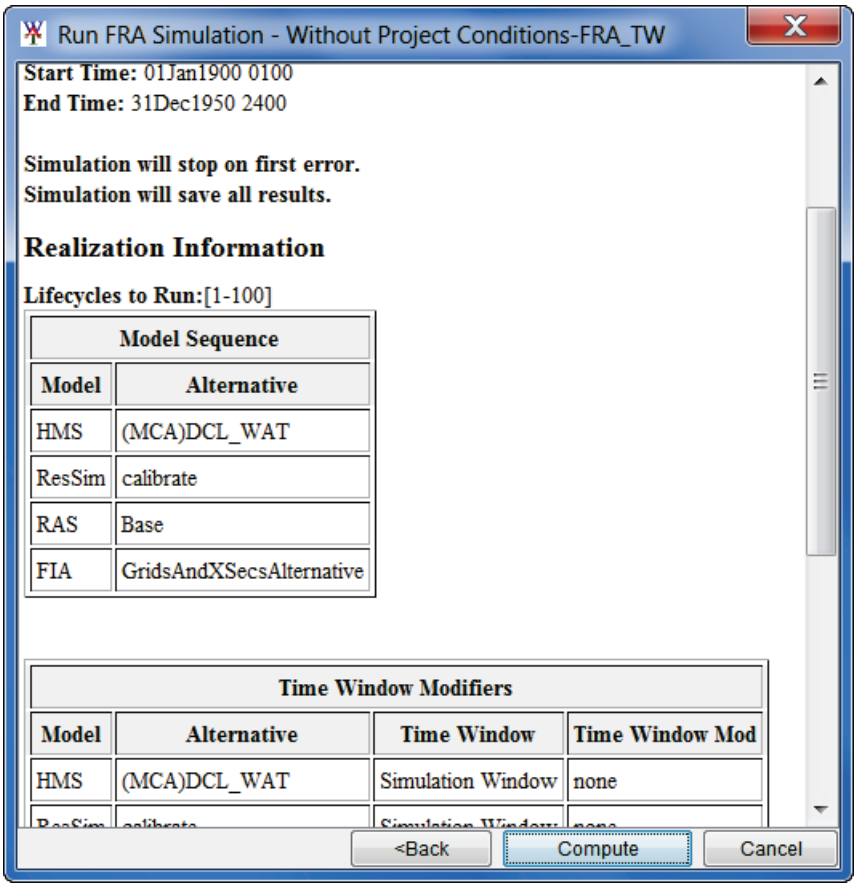


Figure 9.50 Run FRA Simulation Information Dialog Box

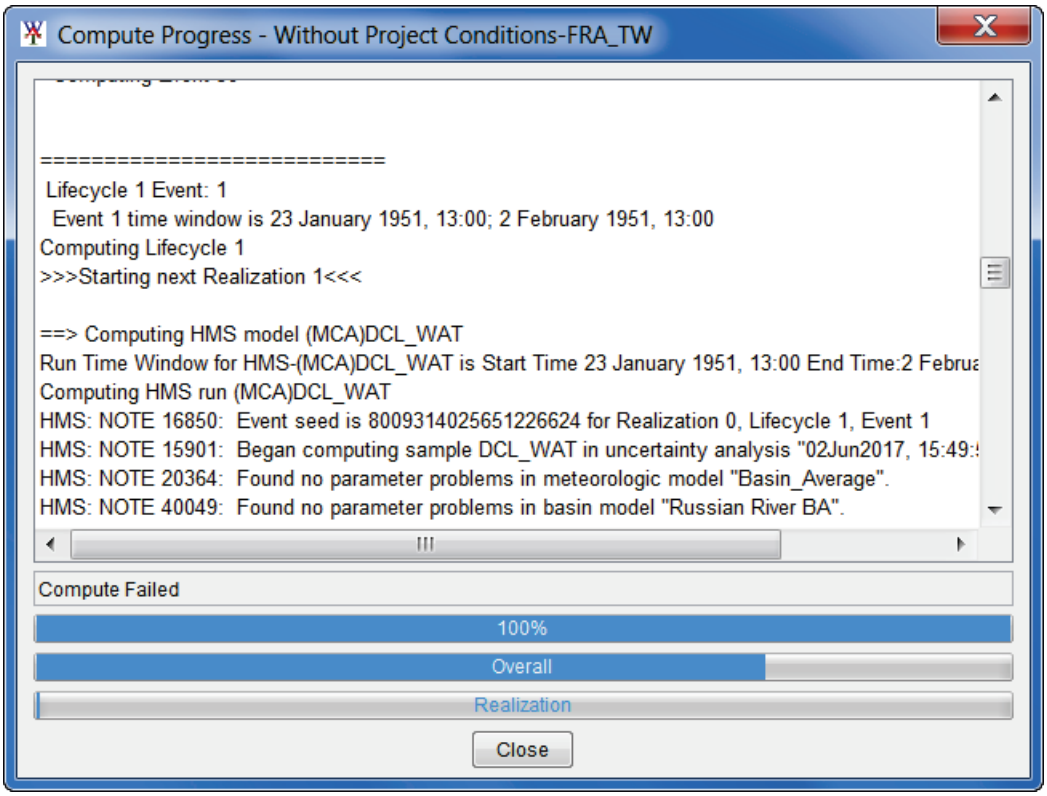


Figure 9.51 Compute Progress Dialog Box - FRA Compute