Technical Documentation Version 6.2

Slots

Slots
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Slot Dialogs

Slots are variables, or the primary data storage containers on an object. In the **Open Object** dialog, the slots list shows all of the data that "resides" on the object. This includes both required input data, calculated output timeseries data, input tabular data, and input coefficients for the various physical process calculations. The list of slots may change depending on the User Methods that are selected.

The names of the slots are pre-defined in the object code for all objects except the Data Object, on which you can create and name your own slots. The list includes all slots which are currently "active;" i.e., associated with the object in general (for the selected controller) or associated with currently selected User Methods.

1. Slot Dialogs

To open a slot:

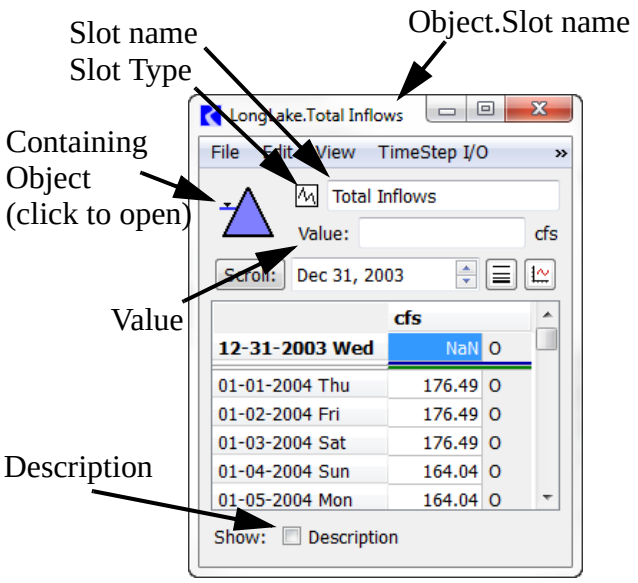
- in the **Open Object** Slots or Methods tab
  - double-click on the slot's row name
  - right click on a slot's row and use the **Open Slot...** context menu
  - highlight a slot's row and select **Slot ➥ Open Slot** from the command menu bar
  - highlight a slot's row and use the Ctrl-O accelerator
- from the main workspace, use the **Workspace ➥ Slots ➥ Open Slot** menu.

To close an **Open Slot** dialog,

- select **File ➥ Close Window**
- press Control-W when the window is active
- click on the red "X" button in the upper right corner of the dialog
- double click the white icon in the upper left corner of the dialog
- from the main workspace, use the **Workspace ➥ Slots ➥ Close All Slots** menu item to close all Open Slot dialogs.

1.1 Tour of the Open Slot Dialog

A sample Open Slot dialog for a series slot is shown to the right. Although other types of slots have different options, most of the slots have similar menus, look, and feel. This section first describes the general Open Slot layout and menu options. Then each individual type of slot is presented later with further information on type specific configuration options.



The open slot contains the following:

- The title of the Open Slot dialog is the Object.Slot name.
- The slot name is repeated in a text field below the menu bar. On data objects, the user can change the name of the slot by editing this text field.
- The type of slot is displayed by an icon. Click **HERE (Section 3)** for a list of the icons.
- The containing object's icon is shown. Clicking on this icon will open the object.
- The **Value** field shows the full precision of the highlighted cell and the units. The user can type a value directly in here or in the cell.
- The **Description** checkbox shows a text description of the slot. Click **HERE (Section 1.3)**.

1.2 Menus

Following is a general description of the menus for the open slot dialog and how it is used. Detailed description of each type of slot is presented **HERE (Section 3)**.

1.2.1 File Menu

The functionality available from the File menu depends on the slot type. In general, this menu is used to:

Import (fixed or resize) and Export (display or model precision): Large sets of data may be imported into, and exported from the Open Slot dialog. Exported data are written to a text file in tab-separated format. Imported data may be tab or space-separated. Exported values are written in the display units and either the precision currently specified in the **Open Slot** dialog (**Display Precision**) or the entire internal precision (**Model Precision**) Likewise, imported data are assumed to be in the same units as the **Open Slot** dialog. The entire precision of an imported value will be preserved, although only the selected display precision is shown. **Import Fixed Size** truncates incoming data if the data file contains more rows than the slot, and leaves existing data if the data file contains fewer rows than the slot. **Import Resize** automatically resizes the slot to match incoming data.

Plot: Open a new plot with the given slot.

Print Expression: On expression slots, print the expression.

SCT: Add the series slot to an existing SCT or create a new SCT with the slot.

Show Workspace: Bring the workspace to the top of the screen.

Close Window: Close the window.

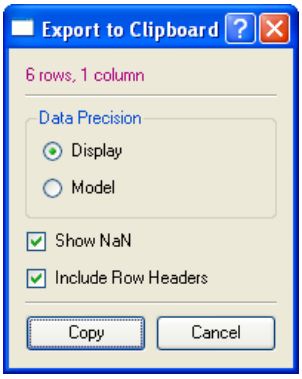
1.2.2 Edit Menu

The Edit menu is available on series, table, periodic and list slots and is used to change the number of rows or columns, and to change values in the slot.

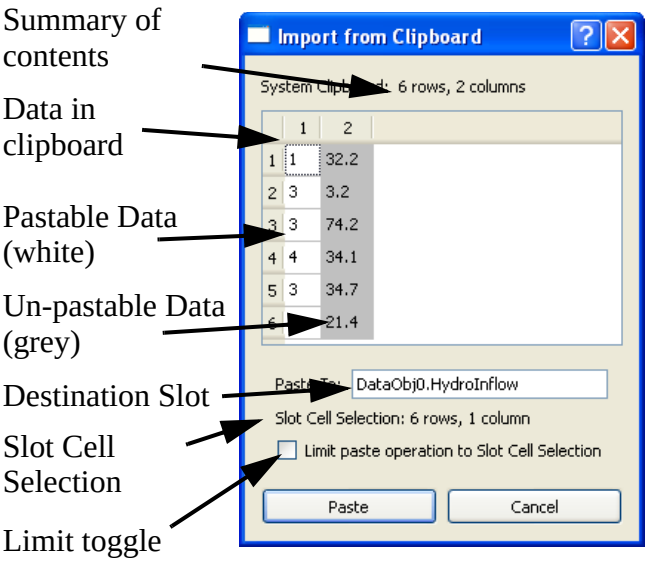
Cut/Copy/Paste: There are options to cut/copy/paste data from the highlighted cells. These use an "internal" clipboard and cannot be copied or pasted from other applications. See the Export Copy and Import Paste options below to use the system clipboard.

Paste as Input: Paste from the internal clipboard and set the Input flag.

Export Copy: The **Export Copy** menu option is used to export the selected data to the operating system's clipboard for use in other applications, like Excel. When the user clicks this option, an **Export to Clipboard** dialog opens as shown to the right. This dialog allows the user to choose the precision, either **Display** or **Model**, whether to **Show NaN** (or copy them as blanks) and whether to **Include the Row Headers**. It also provides information on the number of rows and columns that will be exported. Clicking **Copy** adds the selected data to the operating system's clipboard while **Cancel** stops the operation.

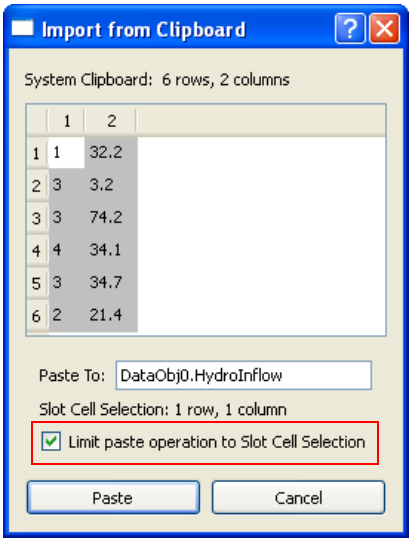


Import Paste: The **Import Paste** menu is used to paste data from the operating system's clipboard into the slot. For example, the user can copy a selection of cells from Excel or a column of data from a text file and **Import Paste** it directly into the slot. After copying the data, the user selects one or more cells of the slot and then selects **Import Paste**. An **Import from Clipboard** dialog similar to the following is shown. This dialog displays the contents of the system clipboard and provides options and information on the paste operation.



The contents of the clipboard will show pastable data (white) and un-pastable data (grey). Data is un-pastable if it does not fit in the content of the cell selection. For example, if the data in the clipboard has multiple columns and the cell is a single series slot, the second column of data is un-pastable as shown in the above screenshot.

Also, the user can choose to **Limit paste operation to Slot Cell Selection** using the check mark toggle. This limits the paste to only affect those cells in the slot that were selected. This selection is shown in the **Slot Cell Selection** line. For example, if only one cell in the slot is selected, but the clipboard contains two rows of data as above, all but the first cell are greyed out. In this example, shown to the right, only the value of 1 will be pasted. If the number of values in the clipboard is larger than slot selection, but the limiting operation is not checked, the paste will import all data and will add the necessary rows to the slot. Note, an import will not add columns to the slot.



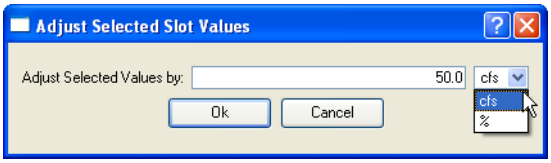
Insert/Append/Delete: The Edit menu contains options to Insert, Append, and/or Delete rows or columns from the slot, depending on the type and use of the slot.

Clear All Outputs: On series slots, this option can be used to clear all the Outputs. Note, all outputs are cleared at the beginning of a run.

Fill Values Below: The Fill Values Below option is used to copy and paste the selected cell to all rows below. This will overwrite any existing data after the confirmation menu is clicked.

Replace NaN's Below: The Replace NaNs Below option is used to replace only NaN with the selected values. Any existing data will not be overwritten.

Interpolate: The Interpolate option is used to interpolate between two known values within a column. It only works on a selection when the first and last value in the selection have values. The option will interpolate between the two values and change all the values to have the Input flag.



Slot Adjust Values: One or more values selected in a slot can be adjusted using the "Adjust Values..." item available from the Edit menu of slot dialogs. When the user selects "Adjust Values..." RiverWare opens a modal Adjust Slot Values dialog which allows the user to provide the amount by which the selected slot values should be adjusted. Values may be adjusted by a percentage, or if all of the values have the same units, by a fixed increment in user units. After entering the adjustment value the user then applies that value to the selected values by selecting the "Ok" button or cancels the operation by selecting the "Cancel" button.

The adjustment is equal to adding a certain amount to the existing value(s) or multiplying by a percentage. The user may specify a positive or negative quantity. Note that the percentage option increases the existing amount by adding a specified percentage of that amount.

For example if the values 10.0 and 100.0 acre-ft/month are selected and the user enters 10 acre-ft/month into the Adjust Slot Values Dialog and selects "Ok", then the values will be changed to 20.0 and 110.0. If the user enters 10%, the values will be changed to 11.0 and 110.0.

Note that it is easy to select all cells in a column by clicking on the header for that column.

Set Dimensions: On some table slots the user can set both the number or rows and columns using this menu option.

1.2.3 Row Menu

On table and periodic slots, the Row menu is used to configure the rows.

Edit Row Labels: Change the Row Label. All row labels can be configured at once in the dialog. The labels can also be set to object names using the **Set Label(s) to an Object Name** button.

Insert Copied Rows: Insert Copied Rows from the internal clipboard

Insert New Row: Insert a new row after the selected row

Append New Row: Append a new row at the bottom.

Delete Rows: Delete the selected rows

Delete Rows Below: Delete all rows below the selected row

1.2.4 Column Menu

On some table and periodic slots (such as on data objects), the user can add or delete columns to the table. The Column menu is used to do this and change column labels.

Edit Column Labels: Change the Column Label. All row labels can be configured at once in the dialog. The labels can also be set to object names using the **Set Label(s) to an Object Name** button.

Set Number of Columns: Set the number of columns.

Append Column: Add a column to the end.

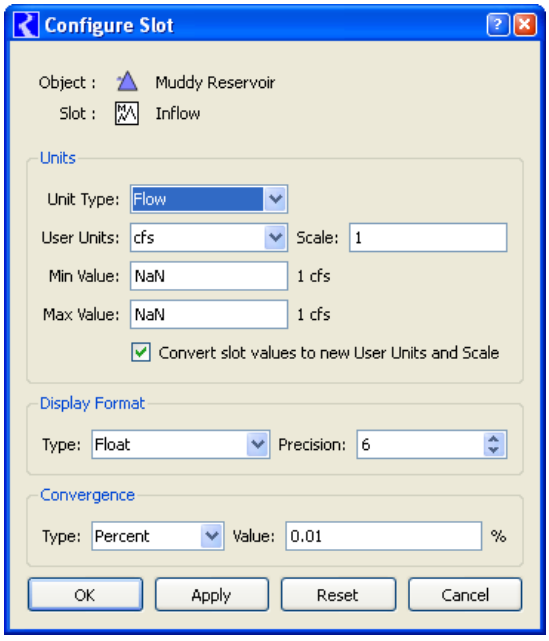
Delete Column: Delete the selected column

Delete Last Column: Delete the last column

Set Dimensions: Set the number of rows and column on the slot

1.2.5 View Menu - Slot Configuration Dialog

The view menu is used on all slot types to configure the slot. Following is a description of the general configuration menu. Detailed information is presented **HERE (Section 3)** for each slot type.



The **Configure Object.Slot** dialog is invoked by selecting **View ➥ Configuration** in the Open Slot dialog. This dialog is used to change units and specify the precision and display format of the values in the slot. Depending on the type of slot opened, the dialog could appear a slightly different. For example, the portion of the dialog showing the **Min Value** and **Max Value** portion is only displayed for Series Slots. Note, to configure multiple slots at one time, use the Configure Existing Slots dialog described **HERE (Section 2)**.

Specifying Units: RiverWare stores all slot values in RiverWare internal units and performs calculations in these units. When the object is first instantiated, the slots default to displaying the internal units, unless the Resource Database has been configured for a different default. The Resource Database file, riverwareDB, allows you to change the default display units to any unit of the specified unit type. More information on features and the syntax of the RiverWareDB file may be found in the reference section in the Units section of the documentation **HERE (Units.pdf, Section 3)**.

The display units, or User Units, are user-selectable for each RiverWare slot and slot column. They may be changed at any time through the slot Configuration menu. When data are displayed in the Open Slot dialog, their values are converted from the internal RiverWare units in which they are calculated and stored, to User Units for display and export. When data is entered or imported, the values are interpreted by the slot as being in the User Units and are automatically converted to RiverWare internal units for internal storage. This means that you must change the User Units to match the units of incoming data BEFORE entering or importing data. For more information on units click **HERE (Units.pdf, Section 1)**.

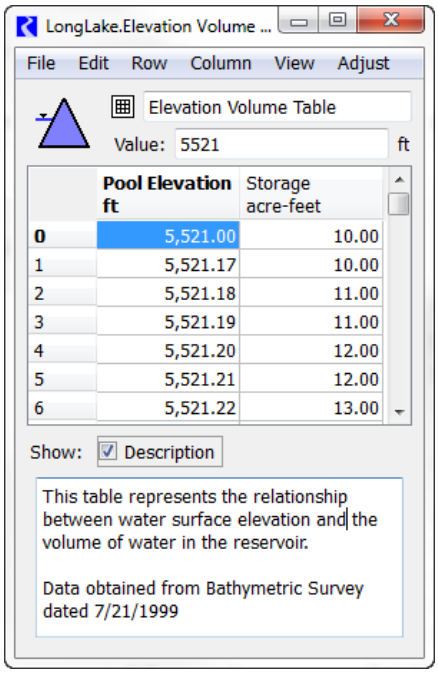
Setting Display Formats: This section points out the importance of choosing meaningful and readable units for display configurations. The **Unit Type** is set internally by RiverWare. All other parameters are configurable. The **Precision** of the display corresponds to the number of digits displayed beyond the decimal place, not the number of significant digits. Although more than 15 significant digits may be displayed, such values are beyond the machine epsilon of RiverWare calculations, and are not reliable.

Overriding Conversion: Changing units through the **Configure** menu results in conversion of the displayed slot values. This behavior may be overridden by turning off (unchecking) the default **Convert slot values to new User Units and Scale** toggle. This allows the units and/or scale to be changed, without converting the display values. The display values are assumed to be in terms of whichever new units and scale are selected. This feature can be used to correct data which were accidentally imported or entered with the wrong display units selected. Great care should be exercised when using this feature, so as not to corrupt data.

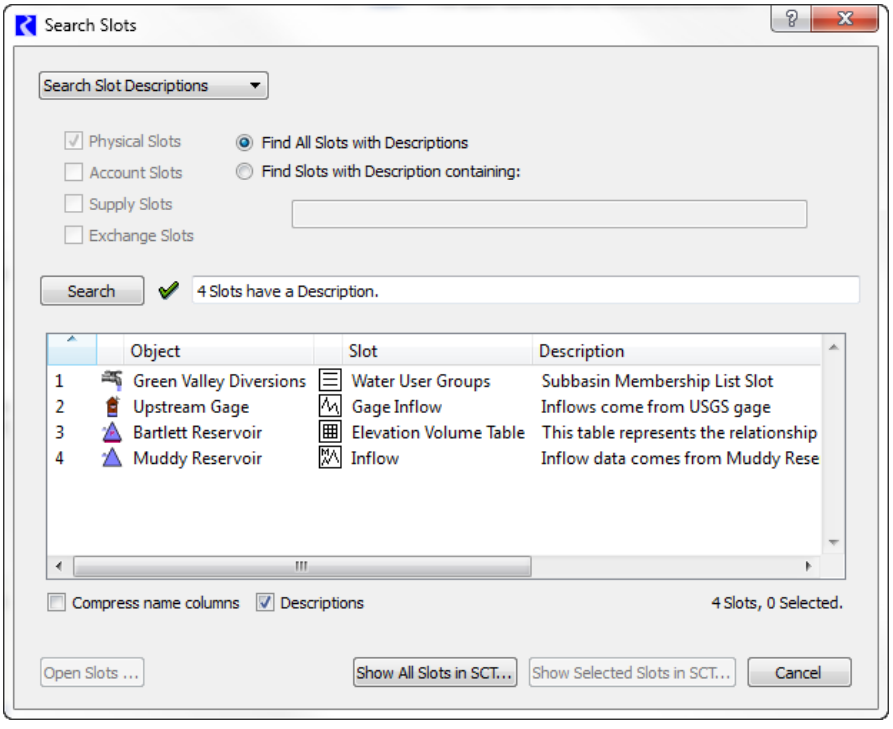
Note: **Show Commas in Numbers** - On slots, commas are shown by default as a thousands separator. This is a global setting that is specified from the **Workspace ➥ Show Commas in Numbers** menu on the workspace. More information is provided **HERE (Workspace.pdf, Section 5.7)**.

1.3 Slot Descriptions

On all slots, the user can specify a text description. The description is accessed from the **View ➥ Add/Show Description** menu or the **Description** checkbox on the Open Slot dialog. When this option is selected, a panel is added that provides a text box in which the user can type the description. For a series slot, the dialog would then look similar to the following screenshot



The **Search Slot Descriptions** utility can be used to find slots that have a description and/or slots that have a specific keyword(s) in their description. It is accessed from the RiverWare Workspace using the: **Workspace ➥ Slots ➥ Find Descriptions...** menu. The dialog shown to the right opens.



In this dialog, you can:

- **Find All Slots with Descriptions** - find any slot that has a description.
- **Find Slots with Descriptions containing** - find slots that have descriptions that contain the specified text. The search is not case sensitive.

You can limit the search to the specified types of slots including physical, account, supply or exchange slots. When any of the search input controls are changed, the Green Check icon turns into a Red “X”, and the search summary description is grayed out. Click the **Search** button to perform a new search.

This dialog has a **Descriptions** checkbox below the slot list. Turning on this checkbox replaces several slot attribute columns with a **Descriptions** column showing up to 150 characters of each Slot's description.

Turning on the **Compress name columns** checkbox replaces the distinct columns for object name, Account name and Slot name with a single “complete” slot name column.

Several context menu (right click) operations are available within the slot list:

- Open Slot -- Show the open slot dialog for the picked slot item.
- Open Object -- Show the open object dialog for the picked slot item (if applicable).
- Copy Slots -- Put the selected slot items into the slot clipboard, e.g. to paste into an output (manager) device slot list.

Buttons along the bottom of the dialog provide these functions:

- **Open Slots**: Separate open slot dialogs are shown for each of the selected items in the list. If more than four (4) slots are selected, then a query dialog box is shown confirming the operation with a message like this: “Do you want to show 421 Open Slot dialogs?”. Note that all shown open slot dialogs may be hidden with the **Workspace ➥ Slots ➥ Close All Slots**... menu operation.
- **Show All Slots in SCT**: All slots in the list (regardless of item selection) are shown in a new SCT dialog, and the dialog is closed.
- **Show Selected Slots in SCT**: Selected slots in the slot list are shown in a new SCT dialog, and the dialog is closed.
- **Cancel**: The dialog is closed.

The dialog can also be used to find input values on series slots as described **HERE (Section 3.1.4)**.

1.3.1 Adjust Menu

The Adjust menu, available on series and table slots, is used to change the display size of the columns in the slot. Users can manually resize columns by dragging the dividers between the column headers. The following five operations are also available in the View menu:

- **Set Column Widths**: set all data columns to the width of the single selected column.
- **Grow Columns to Fit Data**: expand (but don’t shrink) the columns to fit the widest numeric value displayed in the corresponding columns.
- **Fit Columns to Data:** resize all of the data columns to fit the widest numeric value displayed in the corresponding columns.
- **Fit Columns to Headers and Data:** resizes all of the data columns to fit the larger of the text in the corresponding column headers or the widest numeric value displayed in the corresponding columns.
- **Fit Columns to Headers:** resizes all of the data columns to fit the text in the corresponding column headers.

1.4 Creating and Configuring Slots on Data Objects

Data Objects are empty when first created. They are populated with slots based on user needs. The user can create various types of series, tables, periodic tables, statistical tables, scalar and expression slots. Click HERE (Section 3) to view a description of each type of slot. The user is NOT able to create Multi Slots, Table Series Slots or List Slots on Data Objects.

The main menu bar on the **Open Object** dialog for the Data Object has a pull-down **Slot** menu (or in the context-sensitive menu activated by right-clicking in the slot list area of the data object) which contains commands to:

- **Add Series Slot**
- **Add Series Slot with Expression**
- **Add Integer Indexed Series Slots**
- **Add AggSeries Slot**
- **Add Integer Indexed AggSeries Slot**
- **Add Table Slot**
- **Add Statistical Table Slot**
- **Add Periodic Slot, Text Headers**
- **Add Periodic Slot, Numeric Headers**
- **Add Scalar Slot**
- **Add Scalar Slot with Expression**
- **Add Mass Balance Summary (HERE (Section 3.13.1))**

There are also commands to

- **Delete Slot**
- **Copy Slot**
- **Paste Slot**
- **Open Slot**
- **Plot Slot**
- **Links to Slot**

After the slot is created, the following steps should be taken:

1. Open the newly created slot.

2. Rename the slot by typing directly in the Name field.

3. Use the configure menu option (and the subsequent dialog) to set the units, display format, and convergence criteria.

4. On series, consider revising the time series range, if necessary, prior to adding data into the series. On table slots, consider setting the number of rows and columns and changing the row or column labels.

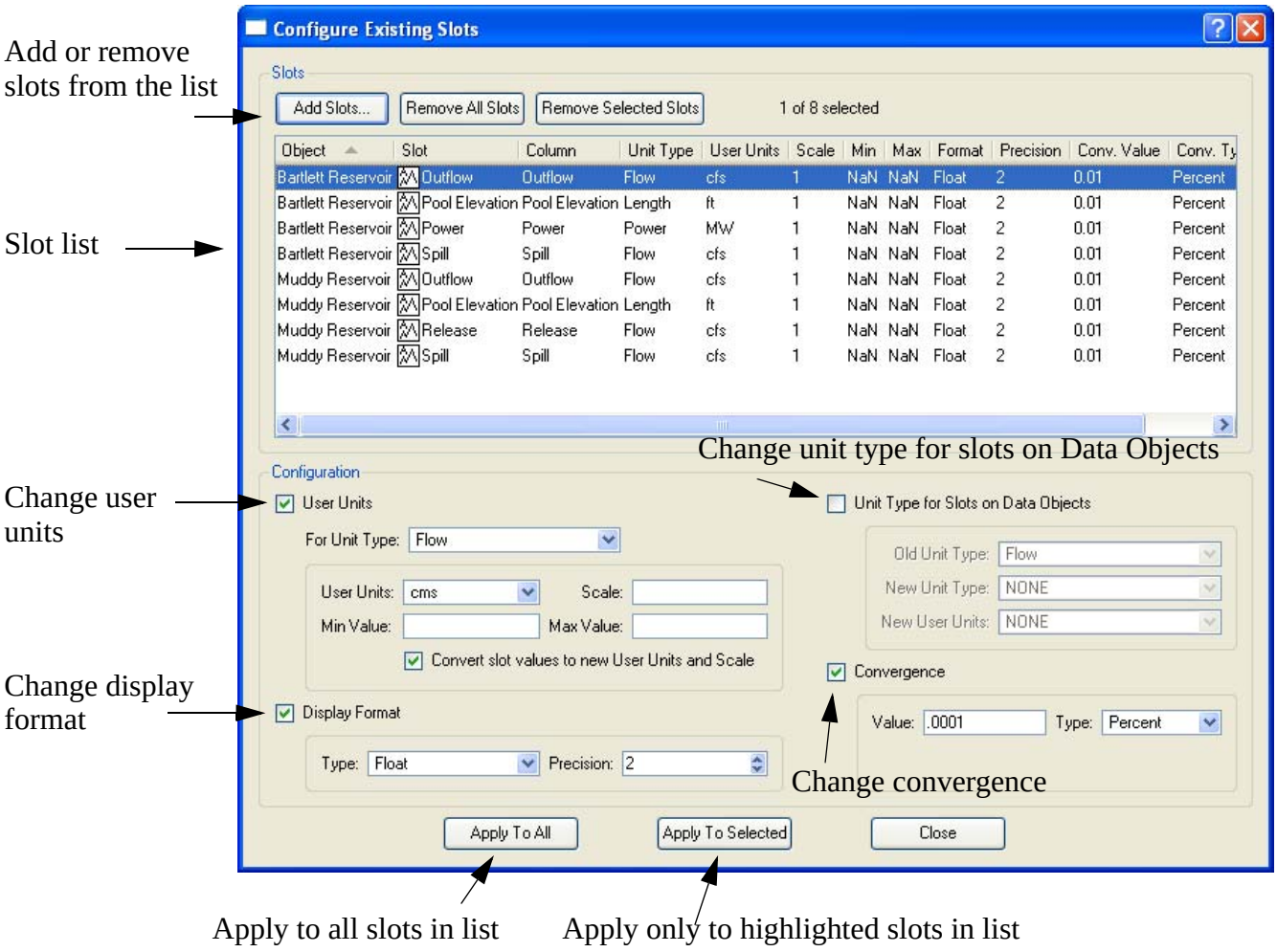
Global Slot Configuration

2. Global Slot Configuration

The **Configure Existing Slots** dialog enables multiple slots to be configured at the same time. The slots available do not include accounting slots as accounting slots are configured from the Accounting System Configuration. To access the **Configure Existing Slots** dialog, click the **Workspace ➥ Slots ➥ Configure Slots** menu item from the main workspace dialog in RiverWare. The dialog is used in the following general sequence as described in the following sections:

- Add slots to the list
- Select a new user unit, scale, min value, max value, display format, or convergence. Or, change the unit type and user units on data object slots.
- Select one or more of the slots from the list
- Apply the changes to all or selected slots.

Changes are immediate and are reflected in the dialog. Changes only apply to relevant slots, e.g. changes to flow user units only apply to slots that have Flow as the unit type. Below is a screenshot of the dialog with the main areas noted.

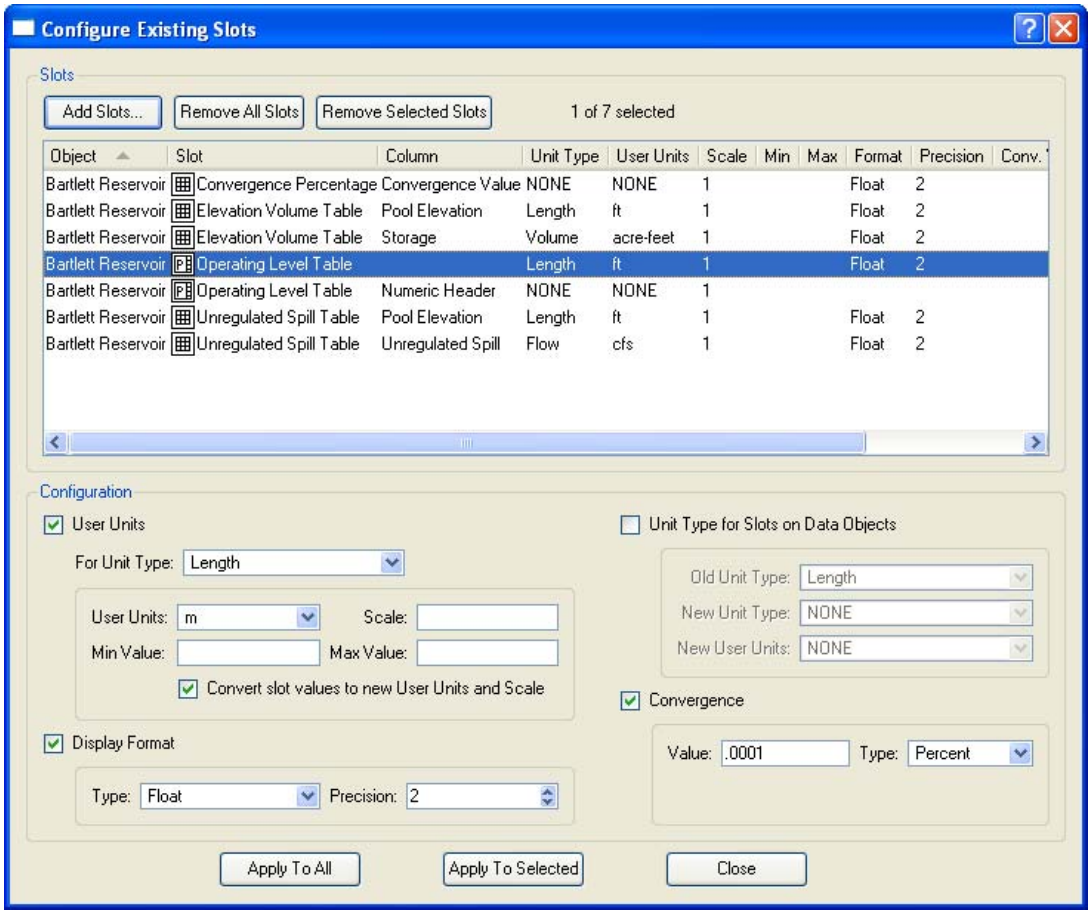


2.1 Selecting Slots

To select the slots for which you wish to make changes, you must add them to this dialog. To do this, click the **Add Slots** button or use the corresponding context menu item available with a right mouse click in the slot list. This opens RiverWare's slot selector. Click **HERE (Selector.pdf, Section 3)** for more information on using the selector. The Selector can be used to add all or a subset of the existing non-accounting slots in the current model.

After making a selection of one or more slots, those slots are added to the list view area of the dialog. These slots, or a subset, are the slots you wish to modify. Note that if a slot has multiple columns that can be configured independently, an entry is created in the list view for each column (see the example Elevation Volume Table Slot in the screenshot below). For tables, like the Periodic Slot, where data in any column must have the same units, only one list view item is created for this configuration. Periodic slots that have a second units dimension in the numeric headers of the columns get a second list view item to allow configuration of this dimension (see the Operating Level Table example slot). If some

configuration item, like convergence, is not applicable to an item, that column is left blank in the list view display.



To remove specific slots from the dialog, first select them. Note that the label above the list view indicates the number of items selected and the total number in the list. Then click the **Remove Selected Slots** button or use the corresponding context menu item available with a right mouse click in the slot list view. All slots can be removed using the **Remove All Slots** button or its corresponding context menu item. Double clicking an item in the slot's list view will bring up the Open Slot dialog for that slot.

2.2 Configuration Options

The configuration frame at the bottom of the dialog has check boxes for four types of configuration items; **User Units**, **Display Format**, **Convergence,** and **Unit Type for Slots on Data Objects**. By checking or unchecking these, any combination of the configuration options can be used. For example, if only convergence values are to be altered, only its check box can be selected, meaning that user units, unit type, and display format will not be modified by any applied changes.

Specifying User Units, Display Format, and Convergence: The items available for configuration appear much as they do in the configuration dialog for a single slot as described **HERE (Section 1.2.5)**.

To change user units, click the **User Units** check box. The **For Unit Type** pull down menu is used to specify for which unit type the user units will be modified. The new user units are specified in the **User Units** pull down menu. Specify a new **Scale**, **Min Value**, or **Max Value** and indicate whether to convert existing values to the new. To change the display format, click the **Display Format** check box and specify the new value. To change convergence, click the **Convergence** check box and enter a new value. Note, if any of the pull down menus or text boxes (**User Units, Scale, Min Value, Max Value**, display**Type**, convergence **Type**, or convergence **Value)** are left blank when these configurations are applied, no changes will be made to any slots for these items.

Specifying a new Unit Type on Data Objects: To change the unit type of a slot on a data object, click the **Unit Type for Slots on Data Objects** check box and specify an old unit type and the new unit type and user units. These changes only apply to slots on data objects as the user is not allowed to ever change the unit type of a slot on a simulation object.

Note: Show Commas in Numbers - In slot values, commas are shown by default as a thousands separator. This is a global setting that is specified from the **Workspace ➥ Show Commas in Numbers** menu on the workspace. More information is provided **HERE (Workspace.pdf, Section 5.7)**.

2.3 Applying the changes

When all desired configuration changes have been made, they can be applied in two ways, **Apply to Selected** or **Apply to All**. To apply changes only to selected items in the slot's list view, click the **Apply To Selected** button at the center bottom of the dialog. Note that the desired items should be selected before entering the configuration information because changing selections clears the configurations. This will change only those slots highlighted in the list view. Configuration changes can be applied to all slots in the slot list, whether selected or not, by clicking the **Apply To All** button at the left bottom of the dialog.

If changes are applied to a slot where they are not applicable, the changes will be ignored for that slot. For example, if convergence is configured to be changed and is applied to a slot that does not have convergence, it will be ignored. Similarly, if the user unit for flow is configured to be changed and a slot has a unit type of length, the user unit change will be ignored if applied to that slot.

2.4 Use Examples

Following are two examples of using the Configure Existing Slots.

Forgotten riverwareDB file: You just spent the last two hours building a model of a basin only to realize that you didn't have a riverwareDB file in place to give you the correct default units. Use the Configure Existing Slots dialog to change all of these slots using the following steps

- Open the dialog. From the main workspace, use the **Workspace ➥ Slots ➥ Configure Slots** menu.
- Select all slots in the model. Click the **Add Slots** button. In the selector, click **All** object types, **All** objects, **All** to select all slots and click **OK**. When finished processing, the list view in the Configure Existing Slots dialog should now have all of the slots in the model.
- Click the toggle to specify that you wish to change **User Units**.
- For one unit type in your model, select that unit type from the **For Unit Type** box, enter a new user unit and/or scale. Click the **Apply to All** button. Repeat for all unit types in your model.
- Change display format or convergence in a similar manner as desired

Changing configuration on specific slots: In this example, we have decided that for debugging purposes, we need all of the flow slots on specific reservoirs to be in acre-feet/day. There are two approaches we can use with the **Configure Existing Slots** dialog to make these changes.

- Add only the Reservoir flow slots to the list view using the slot selector to select the correct slots. A Unit Type filter can be applied in the selector to filter out non-flow slots. In the Configure Existing Slots dialog, we would then **Apply to All** to commit the changes.
- Add all of the reservoir slots to the listview. We would then highlight only the desired slots and make the desired changes. Then we would use the **Apply To Selected** button to make the changes.

Using the selector to choose the appropriate slots is more powerful and more elegant but you don't see the slots' configuration values before you make the selection. Selecting all slots, then choosing the desired slots in the list view allows you to see all of those slots' configuration before you modify them. For example, you see that reservoir Diversion slots (linked to a water treatment plant) have units set to "mgd" while all the others are set to "cfs". You may wish to change all the slots to acre-feet/day except the one with configured to be "mgd".

Types of Slots

3. Types of Slots

This section presents a brief description of the different types of slots and how they are used for representing different types of data. Click on the link to go to the section that further describes how to view, create, and edit that type of slot.

Name	Icon	Type	Description
Series Slot Go to Section 3.1		Series	A single timeseries of values. These slots may be linked with other Series Slot. Input data in Series Slots controls the simulation solution, and all simulation output data are written to Series Slots. For these reasons, Series Slots contain special functionality not found in table slots. Series Slots on a Data Object can be linked to any linkable slot on the workspace.
Series Slot with Expression Go to Section 3.5		Series	A specialized Series Slot whose value is computed from a user-defined arithmetic expression possibly containing other slot names as variables. They are used to calculate quantities such as “combined Storage of all Reservoirs.” Expression slots are available on Data objects and both Series slots and Scalar slots may contain expressions.
Integer Indexed Series Slot Go to Section 3.4		Series	A specialized series slot that is indexed by an integer number instead of a date.
Agg Series Slot Go to Section 3.2		Series	A specialized Series Slot that is an aggregation of one or more Series Slots which are independent of one another. They are used to group together similar series of data.
Integer Indexed Agg Series Slot Go to Section 3.4		Series	An agg series slot that is indexed by an integer number instead of a date.
Multi-Slot Go to Section 3.3		Series	A specialized Series Slot aggregating one or more Series Slots. The value in the first Series Slot column is the sum of the values in all of the other Series Slot columns (other slots to which they are linked). New Series Slot columns are automatically added when a link is made to the MultiSlot.

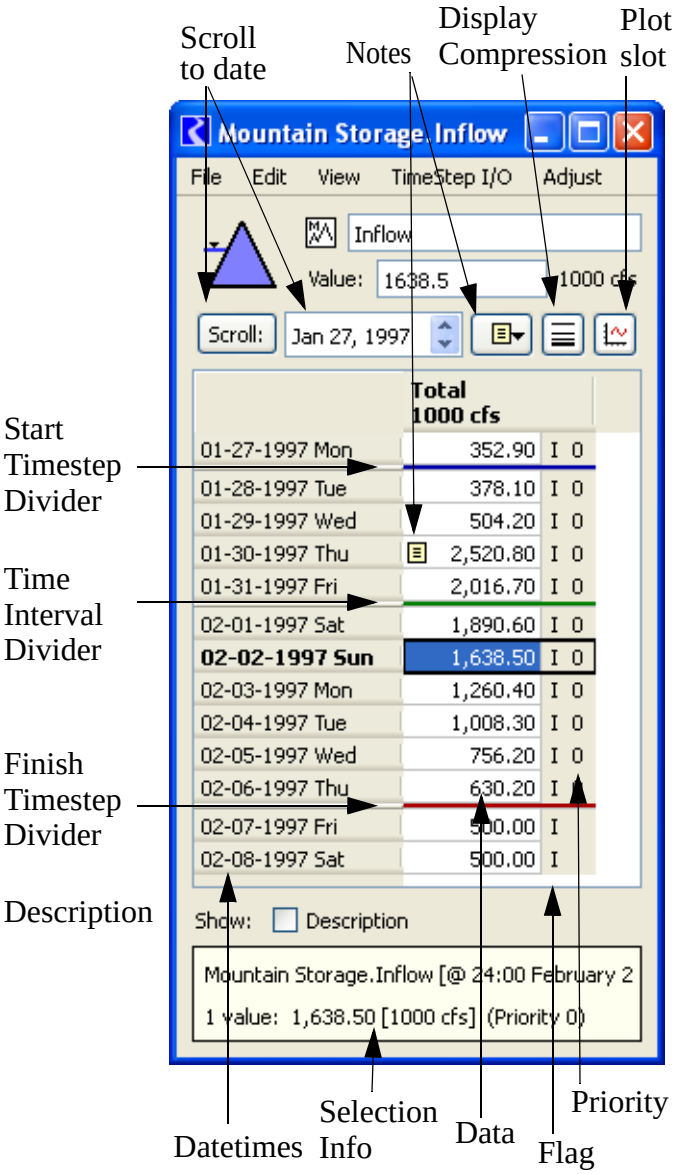
Name	Icon	Type	Description
Table Slot Go to Section 3.6		Table	A two or three-dimensional table of values for representing one or more functional relationships. Each column stores a variable with its own unit type and name. Rows are numbered beginning with 0. Both rows and columns can be referenced by using an index (0, 1, 2 . . . n) or using a label string. For a three-dimensional table lookup to be successful, column 1 must contain blocks of equal values which increase down the table, and column 2 must contain monotonically increasing values within each block of values from column 1. A two-dimensional table only requires monotonically increasing values in its first column. Table functionality includes accessing values beginning with the table indexes and accessing a column index beginning with row index and table value.
Table Series Slot Go to Section 3.7		Table	A specialized table slot whose rows correspond to time values. This slot contains limited timeseries functionality thus making it more efficient than Series Slots. It is commonly used for writing and reading large amounts of data. It is primarily used within object user methods; the user cannot create them on Data Objects.
Statistical Table Slot Go to Section 3.8		Table	A specialized table slot allowing the user to specify a statistical function, such as flow duration curve, which is computed at the end of a run using the data in specified model slot(s). This statistical analysis data can then be plotted or exported.
Periodic Slot Go to Section 3.9		Table	A specialized table slot, the periodic slot is used to hold data that repeats over a specified time period. For example, a set of monthly evaporation coefficients for a reservoir (the same every year), could be held in a periodic slot. The timeseries associated with the data can vary (hourly, daily, monthly, etc.) as well as the period over which the data repeats. The periodic slot can also handle irregular timeseries and can have either text or numeric column headings.
Scalar Slot Go to Section 3.10		Scalar	The scalar slot is used to hold a single piece of numeric data that will not vary with time. The scalar slot is a one-row, one-column table slot.

Name	Icon	Type	Description
Scalar Slot with Expression Go to Section 3.11		Scalar	A scalar slot whose value is computed from a user-defined arithmetic expression. The expression can contain values from other slots as variables. This slot resides on a Data Object only.
List Slot Go to Section 3.12		List	The list slot is used in certain user methods to specify a list of objects or slots associated with that method. The user cannot add List Slots to data objects
Mass Balance Summary Go to Section 3.13		Mass Balance Summary	The mass balance summary slot is a user-defined hierarchy of series slot collections used to check mass balance across many objects. This slot resides on a Data Object only.

Series Slot

3.1 Series Slot

There are several types of time series slots with various column configurations. Since all of these slot types contain rows which correspond to the series of data, they will be referred to collectively as series slots. Shown is a series slot with the key areas highlighted. There is a datetime spinner and scroll button used to scroll to the given date. Icon/buttons are used to show display compression, show notes, and to Plot the slot. The datetimes are shown as the row headings, the data values are shown in the cells, and each cell's value has a flag. Bold, green separators are automatically created based on the timestep of the slot. For example, in a daily slot, separators are placed between months. In 6-hour slot, days are separated. Also, there is a blue divider between the initial and start timestep. There is a red divider after the finish timestep.



Data: Time series data are displayed with one value per row where each row represents a timestep. A scroll bar along the right side of the field is used to view the entire set of data. Each row contains the full date and time, a status flag, and the slot value at that time. A slot value which shows **NaN** (Not a Number) represents an unsolved variable.

All RiverWare calculations are performed in internal RiverWare units. These are generally SI units such as: grams, meters, cms, hours, degrees Celsius, joules, megawatts, etc. The values which appear in the Open Slot dialog, however, may be displayed in one of various user-selectable units. The selected **User Units:** for a slot are indicated directly above the scrollable field. Simulation Output values are automatically converted to the User Units before being displayed in the Open Slot

dialog. Likewise, INPUT values which are entered and displayed in User Units are internally converted to RiverWare units for simulation calculations. This topic is covered in more detail **HERE (Units.pdf, Section 1)**.

Timesteps: Timesteps are reported chronologically. If the series is an Integer Indexed series, the rows are indexed by an integer number instead of a timestep.

Editing Slot Values: Conventional editing commands are available for all slots. They allow cutting, pasting, filling and clearing of data.

A **Delete** or **Cut** of any timestep except the first shifts data up to replace the lost cell, reassigning values to new timesteps. A **Delete** or **Cut** of the first timestep removes it completely from the series, essentially shifting the start date of the series.

Similarly, **Insert New Cell** or **Insert Copied Cells** when the first timestep is selected adds a new timestep to the beginning of the series. When any other timestep is selected, **Insert New Cell** or **Insert Copied Cells** shifts data down from the added cell, reassigning values to new timesteps.

Priority: In a Rulebased Simulation run, the dialog shows the priority of the slot at the given timestep. This can enable/disabled using the **View ➥ Show Priorities** menu.

Selection Info Area: Optionally, the **Selection Info Area** (also called the **Summary Area** or **Selection Statistics**) can be shown using the **View ➥ Show Selection Statistics**. This displays information on the selected cells in the Slot including the name or number of slots and then statistics on the selection. Statistics include Sum, Average, Median, Min, Max, Range, and Difference. All, some or none of these may be shown depending on the number of cells selected and the units of those cells. If a single value is selected and that value was solved for or set as a result of a rule in rulebased simulation, the Priority is also shown.

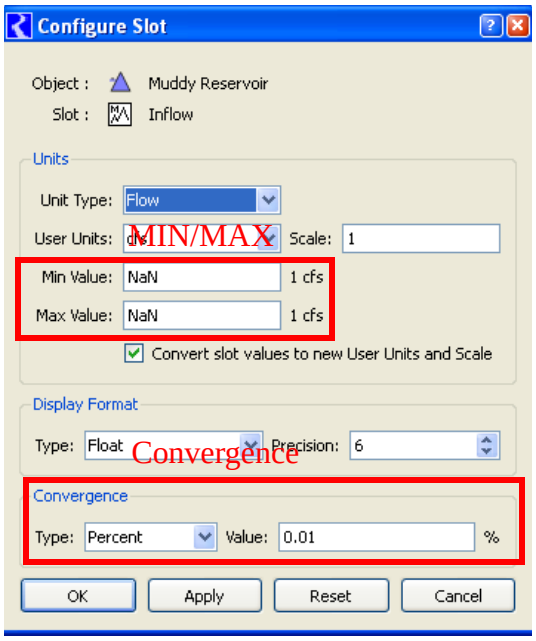
Global Time Scroll: The Open Slot dialog allows the concept of context sensitive right-mouse functions. One menu option is the Global Time Scroll which allows the user to move all dates in the model to the selected date. Any dialog that is open will move to that date. Any dialogs that are opened will open to that date.

3.1.1 Configuration

Following are configuration options specific to Series Slots. Further information on general configuration can be found **HERE (Section 1.2.5)**.

Setting Min/Max on a Series Slot: series slots have minimum and maximum values which can be entered through the **View ➥ Configure** dialog. In general these values are not used by the simulation. However, there are a few cases where a value can be used by the Object's User Methods. For example, a minimum Outflow on a Reach object is used to calculate the maximum allowable diversion. If no value is input, the total Inflow may be diverted.

On all series slots, if the simulation calculates a value or a value is INPUT which violates the specified minimum or maximum, a warning is issued in the diagnostics window, but the simulation continues.

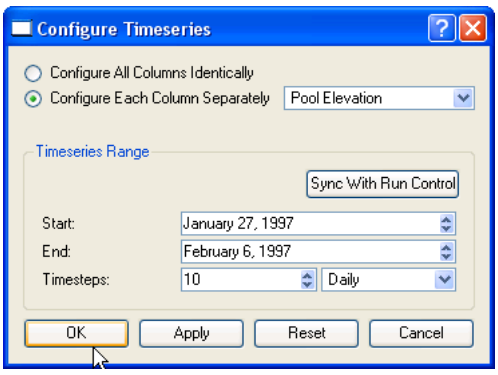


Setting Convergence and Max Iterations: Series slots have Convergence settings which can be edited in the lower portion of the **Configure** dialog. A slot can be reset if the new value is not within convergence of the old value and it has not been set more than the maximum number of times. The Set Value functionality is described **HERE (Simulation.pdf, Section 4.1)**. The following table describes the available convergence criteria:

Type	Units	Description	Convergence is reached:	Examples:
None	NA	No convergence. Any new value is considered different than the old value.	$Never$	Example of non-convergence: old = 100.0 cms new = 100.001 cms
Absolute	Internal (m, cms, m3, etc)	Absolute difference in internal units. The user enters the value in internal units. If old minus new (in internal units) is less than or equal to the convergence value, it is considered converged.	if $\|old - new\| \leq value$	Example of convergence: old = 100.0 cms new = 100.001 cms value entered = 0.001 cms Example of convergence old = 100.0 cfs new = 100.01 cfs value entered = 0.001 cms why? 100 cfs = 2.83168 cms 100.01 cfs = 2.83197 cms 2.83168 - 2.83197 = -0.00029 0.00029 < 0.001

Type	Units	Description	Convergence is reached:	Examples:
Percent	NA	Percent difference. The user enters the value as a percentage. If old minus new divided by the old value is less than or equal to the convergence value divided by 100, it is considered converged. If both old and new are zero, it is considered converged if old minus new is less than 1.1E-12	if $\frac{\lvert old - new \rvert}{old} \le \frac{value}{100}$ or If old or new is 0.0, then convergence is reached if $\lvert old - new \rvert \le 1.1X10^{-12}$	Example of convergence: old = 100.0 cms new = 100.001 cms value entered = 0.001 Example of **non**-convergence old = 10.0 cfs new = 10.01 cfs value entered = 0.001 why? $\frac{\lvert 10 - 10.01 \rvert}{10} > \frac{0.001}{100}$
Unit Percent	User Units specified for the slot	Absolute difference in user units. The user enters the value as a percentage in the specified user units, without considering scale. If old minus new (in user units) is less than or equal to the convergence value (in user units) divided by 100, it is considered converged.	if $\lvert old - new \rvert \le \frac{value}{100}$	Example of convergence: old = 100.0 cfs new = 100.001 cfs value entered = 0.1 %, cfs Example of **non**-convergence old = 10.0 cfs new = 10.1 cfs value entered = 0.1 %, cfs why? $\lvert 10 - 10.1 \rvert > \frac{0.1}{100}$

Time Series Range--Series Slot: The default start times and timestep are inherited from the Run Control settings when the object is instantiated. All series slots are initialized with one timestep to minimize model file size. Other rows are added by the user as needed for input or appended at run time when the slot's output values are calculated. You may change the time series range directly through the Time Series Range Dialog.



On Integer Indexed Series, the user is able to change the number of Values but the start, end, and timestep size configuration areas are disabled.

The time series range and timesteps can also be changed by selecting **Synch With Run Control** in the Time Series Range Dialog. This will update the time series range in the slot to match the time series range set in the **Run Control** dialog. The default start times and timestep are inherited from the Run Control settings when the object is instantiated. All series slots are initialized with one time.

Show Linked Slots: In the **View** menu, there is an option to **Show Linked Slots**. When selected, this shows all of the slots to which the given slot is linked.

Show Notes Column and Notes Group menu: The Show Notes Column and the Notes Group menu are used to display Notes that are associated with a timestep on a series slot. For more information on Notes on Series Slots, see the documentation **HERE (Section 5)**.

3.1.2 Series Display Compression

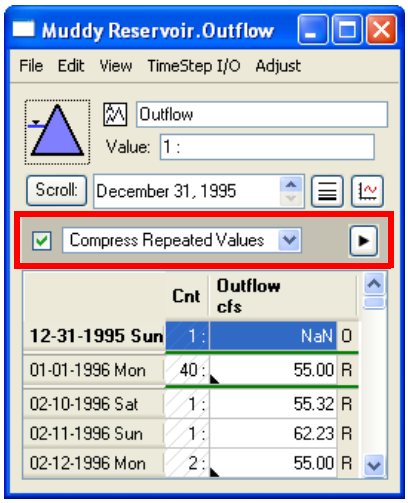
The Series Display Compression utility allows the user to "compress" or hide a particular value, NaNs, both, or any repeated values. This utility is useful for slots that hold data that is often the same value and the user only wishes to see any changes to this standard value. The functionality is available on Series Slots, Agg Series Slots, Multi Slots, and Table Series Slots.

3.1.2.1 Accessing Series Display Compression

Series Display compression can be accessed from

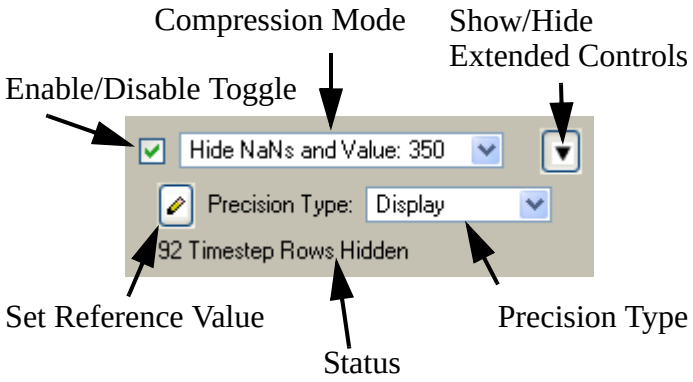
- the Open Slot dialog's **View ➥ Series Display Compression** menu
- the Series Display Compression icon on the Open Slot dialog

When either of these options are chosen, the Open Slot dialog adds the display compression area between the scroll area and above the column heading as shown.



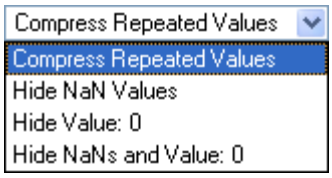
3.1.2.2 Configuring Compression

Following is a screenshot showing all of the configuration controls. Each option is then described in detail.

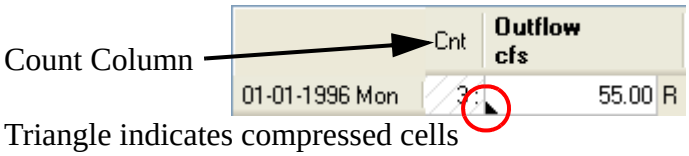


Enable/Disable Toggle: When **Series Display Compression** is first activated, there is a check mark in the toggle indicating that it is active. This toggle is used to toggle the compression on and off. Thus, the user can configure compression, then toggle it off to view or edit all the values, and then toggle it back on to re-enable compression

Compression Mode pull-down menu: When first activated, the **Compress Repeated Values** option is selected by default in the pull-down **Compression Mode** menu. The modes listed below are available for display compression:



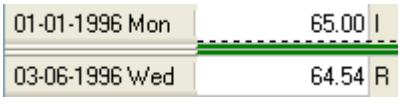
- **Compress Repeated Values**: Any values that are repeated will be compressed into one row. When this option is selected, the repeated values are all compressed into one cell and a count (**Cnt**) column is added. A small triangle is added to the lower corner of the cell to indicate that the cell represents repeated values. In the screenshot 3 values of 55cfs are repeated on 1/1/1996. These represent 1/1 through 1/3/1996.



- **Hide NaN Values**: All NaN values will be hidden and a dotted line is shown. For example, NaNs are hidden for 1/4 through 1/7/1996.

- **Hide Value: #**: All values matching the reference value will be hidden and a dotted line is shown. The user can change the value by clicking on the Reference Value icon and entering a new value.
- **Hide NaNs and Value: #**: All NaN values or values matching the reference value will be hidden and a dotted line will be shown. The user can change the reference value by clicking on the Reference Value icon and entering a new value.
- **Show Value: #**: All values that match the reference value are shown. NaNs are hidden. The user can change the reference value by clicking on the Reference Value icon and entering a new value.
- **Show NaNs and Value: #**: All NaNs and values that match the reference value are shown. The user can change the reference value by clicking on the Reference Value icon and entering a new value.
- **Show Values <= #**: All values less than or equal to the reference value are shown. NaNs are hidden. The user can change the reference value by clicking on the Reference Value icon and entering a new value
- **Show Values >= #** :All values greater than or equal to the reference value are shown. NaNs are hidden. The user can change the reference value by clicking on the Reference Value icon and entering a new value

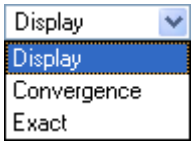
Note: The above text describes the options and how RiverWare represents each option on the screen. In each case, if the compressed/hidden range contains the automatic green datetime interval delineations (e.g. Monthly lines on a daily slot) those green lines will still be shown. In the example to the right, two green lines are shown representing the delineation before Feb. 1 and March 1 in this daily slot.



Show/Hide Extended Controls: To the right of the **Compression Mode** pull-down menu, the **Show/Hide Extended Controls** button  can be used to further refine how the compression is configured. When this button is clicked a further set of configuration options is presented and the arrow now points down.

Set Reference Value: When any of the "Hide Value" or "Show Value" compression modes are selected, the Set Reference Value icon  become active. Clicking this icon opens a dialog to allow the user to enter a value. This is the value that will be hidden. Once a new number is entered, the Compression Mode menu options will display that number in the menu.

Precision Type pull-down menu: Each of the above compression modes compares a value in a cell to some other value, either a reference value, NaN or the previous timestep's value. For more flexibility, value comparison can be based on either:



- **Display:** The display precision will be used; this is the default. If two numbers appear the same on the screen, they are considered the same.
- **Convergence:** The slot's convergence value will be used to compare the numbers. A number must be within convergence of the other number to be considered the same.
- **Exact**: The internally stored numbers will be compared.

Status information: The Status information will show the number of rows that are hidden or compressed.

3.1.2.3 Editing Compress/Hidden Values

On the Open Slot dialogs, the user can highlight a number of cells and type a new value that will be entered, as Input, into each selected cells. When **Series Display Compression** is enabled, the editing of values is treated a differently as follows:

Compressed Repeated Values: If the **Compress Repeated Values** is selected, editing of selected cells will edit any compressed cells. For example, if repeated 33 values are repeated and the user selects the repeated value, types in a new number, all 33 values will be set to that new number.

Hidden NaNs or Value: If any of the "Hide" options are selected, editing of selected cells will not affect hidden cells. Hidden values and NaN's will not be overwritten. But, any cells displayed and selected will be affected by the new value. Also, if the entire column is selected, edits will then apply to all values, whether hidden or not.

3.1.2.4 Multi-Column slots

On multi-column slots, (Agg Series, Multi Slots, Table Series Slots, and accounting slots), the Series Display Compression will only compress/hide a row if the compression is valid on all columns of the row. Following is a screenshot where the repeated value compression only applies to a subset of rows:

01-01-1996 Mon	1 :	1.00	I	NaN	O	NaN	O
01-02-1996 Tue	1 :	1.00	I	2.00	I	NaN	O
01-03-1996 Wed	4 :	1.00	I	2.00	I	3.00	I
01-04-1996 Thu	:	1.00	I	2.00	I	3.00	I
01-05-1996 Fri	:	1.00	I	2.00	I	3.00	I
01-06-1996 Sat	:	1.00	I	2.00	I	3.00	I
01-07-1996 Sun	4 :	NaN	O	2.00	I	3.00	I
01-08-1996 Mon	:	NaN	O	2.00	I	3.00	I
01-09-1996 Tue	:	NaN	O	2.00	I	3.00	I
01-10-1996 Wed	:	NaN	O	2.00	I	3.00	I
01-11-1996 Thu	1 :	NaN	O		O	3.00	I

Repeated Value Compression toggled Off

01-01-1996 Mon	1 :	1.00	I	NaN	O	NaN	O
01-02-1996 Tue	1 :	1.00	I	2.00	I	NaN	O
01-03-1996 Wed	4 :	1.00	I	2.00	I	3.00	I
01-07-1996 Sun	4 :	NaN	O	2.00	I	3.00	I
01-11-1996 Thu	1 :	NaN	O		O	3.00	I

Repeated Value Compression toggled On

Notice that only rows 1/3-1/6 and 1/7-1/10 are compressed because the repetition occurs across all columns. Similarly, on multi-column slots, if the user chooses to “Hide NaNs and Value”, it will only hide a row if all three columns have the reference value OR NaN.

3.1.3 Timestep I/O menu - Flags

On Series Slots, the Timestep I/O menu is used to change the status of the cell’s value by changing the flag. Possible flags vary by slot, but may include:

- INPUT (**I**),
- OUTPUT(**O**),
- DMI INPUT (**Z**),
- ITERATIVE MRM (**i**),
- TARGET BEGIN (**TB or tb**),
- TARGET (**T**),
- BEST EFFICIENCY (**B**),
- MAX CAPACITY (**M**),
- DRIFT (**D**),
- SURCHARGE RELEASE (**S**),
- REGULATION DISCHARGE (**G**),
- UNIT VALUES(**U**), and
- RULE (**R**).

User-input data are automatically flagged as INPUT, and may not be overwritten by simulation results. Certain values imported by an input DMI are flagged Z for DMI INPUT and are treated identically to INPUT (I) flags. Initialization Rules can also set values with the Z flag. OUTPUT (**O**) timesteps may contain values calculated during a previous run or toggled from INPUT status. These values are automatically cleared to NaN at the beginning of a simulation run. This guarantees that no previous solutions remain from one run to the next. Simulation results are written to timesteps flagged as

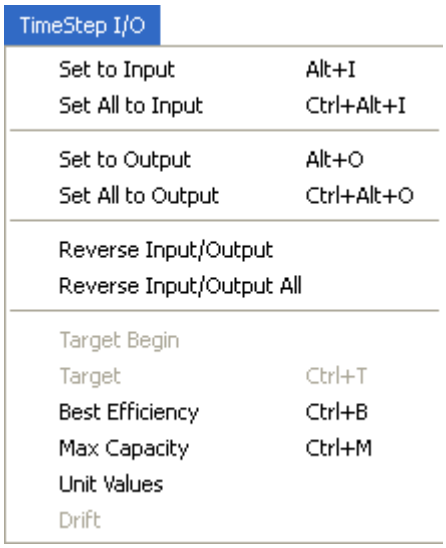
OUTPUT, TARGET BEGIN, BEST EFFICIENCY, MAX CAPACITY, SURCHARGE RELEASE, DRIFT and UNIT VALUES. Flags other than OUTPUT and INPUT are only available for certain series slots.

This section describes the use of special flags which may be set on SeriesSlot timesteps. The flags are typically set by the same mechanisms as INPUT and OUTPUT flags. But, unlike INPUT and OUTPUT flags, each type of special flag is only applicable to one or two slots. All SeriesSlots must have one of the following flags set for every timestep; each flag is indicated by its abbreviation:

- General flags available to all SeriesSlots.
  - **I** for **INPUT**
  - **O** for **OUTPUT**
  - **Z** for **DMI INPUT** - This flag indicates that the value was set by an input DMI. Click **HERE (DMI.pdf, Section 2.4)** for more information. In simulation, this flag behaves identically to the INPUT (I) flag.
  - **R** for **SET BY RULE -** This flag indicates that the value was set directly by a rule.
  - **i** for **ITERATIVE MRM -** This flag indicates that the value was set during iterative MRM by an MRM rule. Values with the “i” flag can be overwritten as though it is a “O” flag. Values with the “i” flag are cleared at the beginning of a single run and at the start of an MRM run, but are not cleared between each iterative MRM run. They are considered input during an iterative MRM run.
- Power calculation flags available to Energy slots.
  - **B** for **BEST EFFICIENCY**
  - **M** for **MAX CAPACITY**
- Maximum Outflow flag available to Outflow slots
  - **M** for **MAX CAPACITY**
- Target flags available to Storage and Pool Elevation slots.
  - **TB** or **tb** for **TARGET BEGIN**
  - **T** for **TARGET**
- Drift flag available to Regulated Spill and Bypass slots.
  - **D** for **DRIFT**
- Surcharge Release flag available to the Surcharge Release slot
  - **S** for **SURCHARGE RELEASE**
- Regulation Discharge flag available to the Regulation Discharge slot
  - **G** for **REGULATION DISCHARGE**
- Unit Values flag available to Turbine Release and Energy slots on power reservoirs with the Unit Power method selected:
  - **U** for **UNIT VALUES**

3.1.3.1 Setting Flags

Flags are set from the Open Slot dialog (or from the SCT). In the Open Slot dialog, a flag is set on the highlighted timestep by selecting the flag from the **Timestep I/O** menu. Flags which are unavailable for that slot will appear grayed-out in the menu.



The **Timestep I/O** menu has options to:

- **Set to Input**: Set selected cells to Input
- **Set All to Input**: Set all cells to Input
- **Set to Output**: Set selected cells to Output
- **Set All to Output**: Set all cells to Output
- **Reverse Input/Output**: Reverse the input and output flags on selected cells
- **Reverse Input/Output All**: Reverse the input and output flags on all the cells
- Set one of the special flags on the selected cells. The following sections describe many of the special flags.

3.1.3.2 Power Calculation Flags on Energy

BEST EFFICIENCY and **MAX CAPACITY** flags may be set on Energy timesteps instead of an **INPUT** Energy request value. These flags are used by the **getPlantPowerRelease** User Method to calculate the most efficient or maximum Energy generation possible for the flagged timestep.

The **getPlantPowerRelease** method uses tables to relate the current Operating Head to the most efficient Turbine Release or maximum allowable Turbine Release. The **MAX CAPACITY** flag is available for all power method except LCR Power Calc. The **BEST EFFICIENCY** flag is only valid for the following power methods:

- Plant Power Calc
- Plant Efficiency Curve
- Plant Power Equation
- LCR Power Calc
- Unit Power

The calculation of the best efficiency Energy generation or max possible Energy generation is an iterative solution. The Outflow required to produce the desired type of Energy affects Tailwater Elevation, which affects Operating Head, which affects the Outflow required to produce the desired Energy. For more information on these methods, click **HERE (Objects.pdf, Section 16.1.2)**.

When an energy value has been calculated using a **MAX CAPACITY** or **BEST EFFICIENCY** flag and it is set as a user input for a subsequent run, a warning may be posted that says “Energy request cannot be met on current iteration.” This is due to the way RiverWare solves. When two reservoirs are modeled in

series, the Tailwater Elevation of the lower reservoir affects the Operating Head of the upper reservoir. The Outflow of the upper reservoir, in turn, affects the Tailwater Elevation of the lower reservoir. This creates an iterative loop between the Outflow from the upper reservoir, the Tailwater Elevation of the lower reservoir, and the Operating Head of the upper reservoir. When an Energy value is set using either a **MAX CAPACITY** or a **BEST EFFICIENCY** flag, the reservoirs iterate over Outflow, Tailwater Elevation, and Operating Head until the values converge. If the Energy value is now set as an input and the model is run again, the Input Energy may not be possible given the Operating Head on the first iteration. If this happens a RiverWare warning is posted but the run does not abort, since the energy value MAY match the Operating Head at a later iteration. The Energy also MAY NOT match the Operating Head at a later iteration. If this occurs, the model will continue running even though the object did not solve. The run will NOT be aborted, but objects may not dispatch because required information was not propagated to them. The user must check the dispatch dialog if they receive the RiverWare warning message given above to make sure the model ran correctly.

3.1.3.3 Maximum Capacity Flag on Outflow

As demonstrated in the simulation exercise, this flag computes the maximum possible Outflow from a Reservoir on a given timestep. Setting the **MAX CAPACITY** flag on a Reservoir Outflow slot forces the Outflow to equal the sum of the maximum (Turbine) Release and the maximum Spill. This flag should be used with great care, as its effects may cause downstream reservoirs to exceed their operating ranges. The use of this flag also depends on having reliable and accurate input tables relating elevation to maximum release and spill.

The **MAX CAPACITY** flag is set by highlighting a simulation timestep on the Outflow slot of a Reservoir and selecting **Timestep I/O ➥ Max Capacity**. RiverWare places an **M** at the selected timestep to indicate that the flag is active. This flag is treated as an INPUT, but does not require a value. If a valid Outflow value is present at the flagged timestep, it is ignored in the simulation; a new Outflow value is calculated and displayed at that timestep. This behavior is similar to the Max Capacity and Best Efficiency flags of the Energy slot and the Drift flags of the Regulated Spill and Bypass slots. A Reservoir which has the Outflow Max Capacity flag set may dispatch under any of the “givenOutflow” dispatch methods:

- solveMB_givenOutflowHW for Level Power, Slope Power, and Storage Reservoirs.
- solveMB_givenOutflowStorage for Level Power, Slope Power, and Storage Reservoirs.
- solveMB_givenInflowOutflow for Level Power, Slope Power, and Storage Reservoirs.
- solveMB_givenOutflowInflow for Pumped Storage Reservoirs.

The Outflow Max Capacity flag may NOT be used on reservoirs when solving for Hydrologic Inflow, or when solving a Target Operation.

The Max Capacity solution is iterative. The exact sequence of calculations in each iterative loop is dependent on the type of Reservoir and the selected Spill Calculation Method. In all cases, the maximum Spill and maximum controlled Release are calculated individually, then summed. If the selected Spill Method includes Regulated Spill, the current or previous Pool Elevation is used to look up the maximum Regulated Spill from the Regulated Spill Table. This value is set in the Regulated

Spill slot, and the selected Spill Calculation Method is called. Any input Bypass and/or required Unregulated Spill are considered within the Spill Method. Next, the maximum release is calculated. If the Reservoir is a Power Reservoir, the selected Tailwater Calculation Method is executed to determine the Operating Head. This Operating Head or the Pool Elevation (in the case of Storage Reservoirs) is used to look up the maximum release from the Max Turbine Q table, Max Release table, Max Flow Through Turbines table, or Best Generator Flow table. Finally, the maximum release and the calculated Spill are added to determine the total maximum Outflow. This Outflow is used to mass balance the Reservoir. The iteration is repeated until Convergence is met or Max Iterations is exceeded.

3.1.3.4 Target Operation Flags

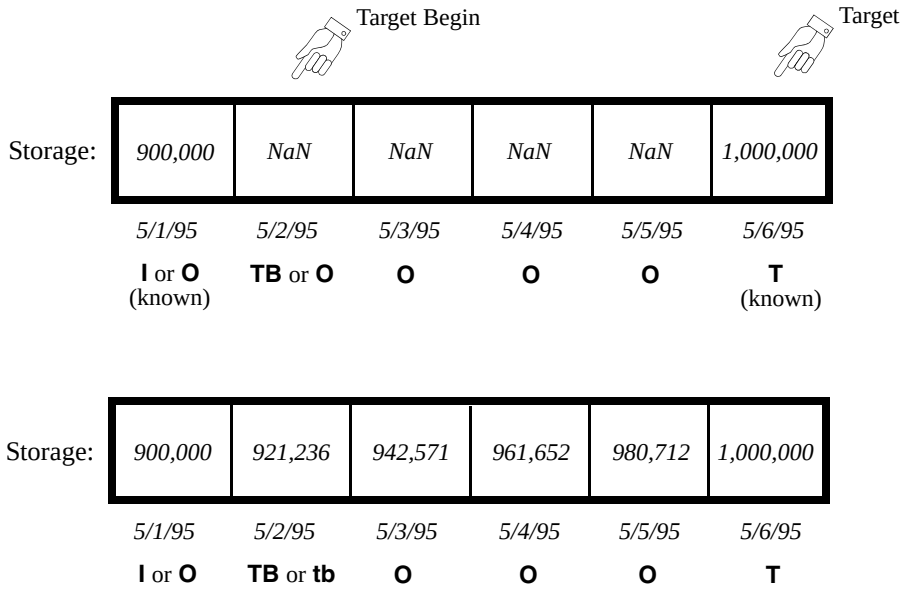
Target Operations are used to calculate a lumped mass balance across several timesteps, in order to exactly meet a user-input **TARGET** Pool Elevation or Storage value. Three conditions are necessary for a Target Operation to execute successfully:

- An initial value must be known at the timestep before the **TARGET BEGIN** timestep. This value may be **INPUT** or a known value at the time the Target Operation solves.
- A target Pool Elevation or Storage value must be specified at the **TARGET** timestep.
- Either Inflow or Outflow must be known for all timesteps in the target range.

Given these conditions, RiverWare calculates the unknown Inflows or Outflows for all of the timesteps within the Target Operation, such that the **TARGET** value is exactly met.

Timestep Range: When solving a target operation, RiverWare searches backwards from the **TARGET** time until it finds a valid **TARGET BEGIN** flag. The Target Operation is solved using the value from the timestep prior to the **TARGET BEGIN** flag as an initial condition. If the timestep prior to the **TARGET BEGIN** does not have a valid Storage or Pool Elevation, or a valid input value exists between the **TARGET BEGIN** and the **TARGET**, the simulation aborts with an error. Likewise, if the **TARGET BEGIN** or **TARGET** timestep already has enough information to dispatch with a different dispatch method, simulation aborts. If no **TARGET BEGIN** flag is specified, RiverWare searches backwards to the first valid value and solves the Target Operation with this initial condition.

When a beginning of target is assumed in this manner, RiverWare marks the timestep where the Target Operation actually begins with a **tb** (lowercase) flag in the Open Slot dialog. This flag is treated as an output, and is automatically cleared at the start of the next run. Setting a Target Operation from an SCT generates both the **TARGET** and **TARGET BEGIN** flags, and clears any previous Target Operations which overlapped with the new range.



Lumped Mass Balance: To calculate the unknown flow values, RiverWare performs a lumped mass balance over the target range. The required change in Storage is found by subtracting the storage just before the **TARGET BEGIN** (converted from Pool Elevation in the case of a Pool Elevation **TARGET**) from the **TARGET** value (also converted from Pool Elevation in the case of a Pool Elevation **TARGET**). All of the known Inflows and/or Outflows are then summed to calculate a side flow gain or loss of Storage over the target range. This volume of side flows is then subtracted from the change in Storage required to meet the **TARGET** value, and the remaining flow volume is distributed equally among the unknown Inflows or Outflows. The following equations represent the calculations discussed above:

$$\text{GainLoss} = \text{Storage(TB-1)} - \text{Storage(T)} + \sum(\text{Inflows} \times \Delta t) - \sum(\text{Outflows} \times \Delta t)$$

$$\text{Constant Inflow or Outflow} = \text{GainLoss} / (\text{Number of Undetermined Timesteps} \times \Delta t)$$

Redispatching: The setting of flow values on intermediate timesteps of the Target Operation forces the object onto the dispatch queue at those times. The timesteps dispatch with enough information to solve completely (Inflow and Outflow are known for all timesteps.) The only timestep which actually re-dispatches is the **TARGET** timestep, since a valid previous Storage value is now known.

3.1.3.5 Spill Drift Flags

Spill **DRIFT** is used to calculate the Regulated or Bypass Spill over a controlled gate as the reservoir Pool Elevation changes over time. The flag is always considered an input on any timestep where it is set but no value is initially set by the user. In this way, it is similar to the Energy **BEST EFFICIENCY** and **MAX CAPACITY** flags. Since **DRIFT** is considered an **INPUT**, it may affect over determination of Spill parameters.

The first timestep prior to initiating drift is used to determine a gate index called the Regulated (or Bypass) Drift Index. This index is interpolated from a 3-dimensional Regulated (or Bypass) Spill Index Table, which relates Pool Elevation to Spill for various gate indices. In all subsequent timesteps where the **DRIFT** flag is set, the same index is used to determine the new Spill. The gate index is maintained throughout the selected time period. At each timestep, the new value of Spill is calculated for the structure based on the current average Pool Elevation.

3.1.3.6 Surcharge Release Flag

The **SURCHARGE RELEASE** flag is used to calculate the surcharge or mandatory release from a reservoir during flood control operations. Surcharge releases are meant to evacuate water from that sits above the top of the flood pool. This flag can only be set on the Surcharge Release slot which is only available when the user has selected a Surcharge Release Calculation method. The flag is always considered an input on any timestep where it is set but no value is initially set by the user.

Although the **SURCHARGE RELEASE** flag may be set by selecting **Timestep I/O ➥ Surcharge Release** from the Surcharge Release slot, in practice it should only be set by a rule. When the **SURCHARGE RELEASE** flag is set, and the inflow to the reservoir is known, the reservoir can dispatch with the solveMB_givenInflowSurchargeRelease dispatch method. This dispatch method will calculate the forecasted surcharge releases and will set them on both the Surcharge Release and Outflow slots so that they may propagate downstream. The manner in which the forecasted surcharge releases are calculated depends on the method selected in the Surcharge Release Calculation category. If the user is interested in using one of the surcharge release methods, detailed information can be found **HERE (Objects.pdf, Section 22.1.15)** for the Storage Reservoir.

3.1.3.7 Regulation Discharge Flag

The **REGULATION DISCHARGE** flag is used to calculate the regulation discharge at a Control Point. Regulation discharge is used during flood control operations and is defined as the maximum allowable flow in the channel at the control point. This flag should only be set on the Regulation Discharge Calc slot on Control Points. This slot is only available when the user has selected a Flood Control method and a Regulation Discharge method. The flag is always considered an input on any timestep where it is set but no value is initially set by the user. Like the **SURCHARGE RELEASE** flag, the **REGULATION DISCHARGE** flag should only be set by a rule. If the user is interested in using one of the Regulation Discharge methods, detailed information can be found **HERE (Objects.pdf, Section 9.1.9)**.

3.1.3.8 Unit Values Flag

The **UNIT VALUES** (U) flag is used to indicate that the user is going to specify unit level values but would like to use those to drive the solution. The **UNIT VALUES** flag may be set on Energy or Turbine Release on power reservoirs that have the Unit Power (**HERE (Objects.pdf, Section 16.1.1.12)**) method selected. If the Unit Power method is not selected, an error is issued. This flag is considered a user input but does not require a value (similar to the **MAX CAPACITY** and **BEST EFFICIENCY** flag). At the beginning of the run any numeric values are cleared out. The flag can be set directly on the slot, from the SCT or from a Rule.

U Flag on Energy: Thus, if the U flag is set on Energy, one or more Unit Energy subslots must be specified by user input or a rule. When RiverWare runs, it sees that Energy has this flag which is considered an input. If it has enough other information (like Inflow, Storage, or PE), the reservoir will be able to dispatch one of the following methods:

- solveMB_givenEnergyInflow
- solveMB_givenEnergyStorage
- solveMB_givenEnergyHW

In addition, Energy can be flagged U, if the reservoir dispatches one of the following methods:

- solveMB_givenInflowOutflow
- solveMB_givenOutflowHW
- solveMB_givenOutflowStorage

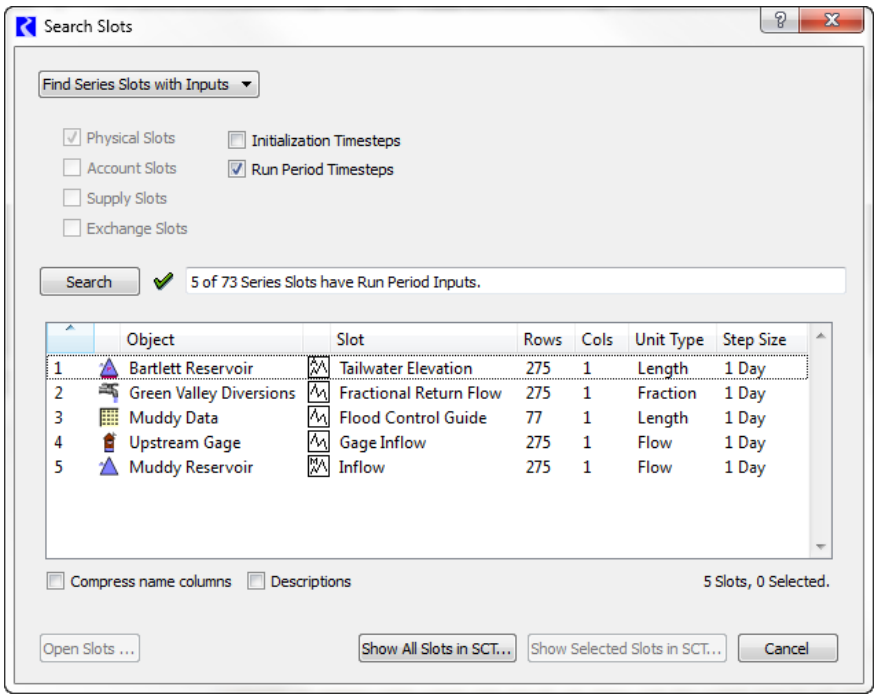
These methods do not require energy to be unknown.

U Flag on Turbine Release: Alternatively, if the U flag is set on Turbine Release, one or more Unit Turbine Release subslots must be specified as user input or by a rule. When RiverWare runs, it sees that Turbine Release has this flag which is considered an input. If it has an Inflow, the reservoir will be able to dispatch the solveMB_givenInflowRelease method.

Because this flag is specific to the Unit Power method, the full algorithm is described **HERE (Objects.pdf, Section 16.1.1.12)**.

3.1.4 Finding Inputs

The **Find Series Slots with Inputs** utility can be used to find values that are input in the model. It is accessed from the RiverWare Workspace using the: **Workspace ➥ Slots ➥ Find Inputs... menu.** The dialog shown to the right opens.



The user has options to filter on the types of series slots on which to look for input values. In a pure simulation model, this is only Physical Slots (i.e. Outflow, Inflow, etc.) If Accounting is enabled, the user may choose to search any or all of the following series slot “domains”:

- Physical Slots

- Account Slots
- Supply Slots
- Exchange Slots

The search may be limited to either **Initialization Timesteps** (before the Run Start timestep) or **Run Period Timesteps** (on or after the Run Start timestep). If both are checked, all series slots having any inputs are found, regardless of where (in time) those Input values are within the slots' time series.

The search operation is performed by clicking the **Search** push button. The number of series slots with Input-flagged timesteps, and the total number of series slots matching the checked “domains” are indicated in a status line to the right of the search button. If search criteria is changed (by clicking any of the check boxes at the top of the dialog), a green check icon  is displayed next to the search button indicating that a new search with the new criteria has yet to be performed. The green check icon is hidden upon performing another search.

The user has the option of showing the slots' object name and account name (if applicable) in separate columns. This is controlled by the **Compress columns** check box below the slot list. This is not available if supply slots or exchange slots are shown in the slot list,

Several context menu (right click) operations are available within the slot list:

- Open Slot -- Show the open slot dialog for the picked slot item.
- Open Object -- Show the open object dialog for the picked slot item (if applicable).
- Copy Slots -- Put the selected slot items into the slot clipboard, e.g. to paste into an output (manager) device slot list.

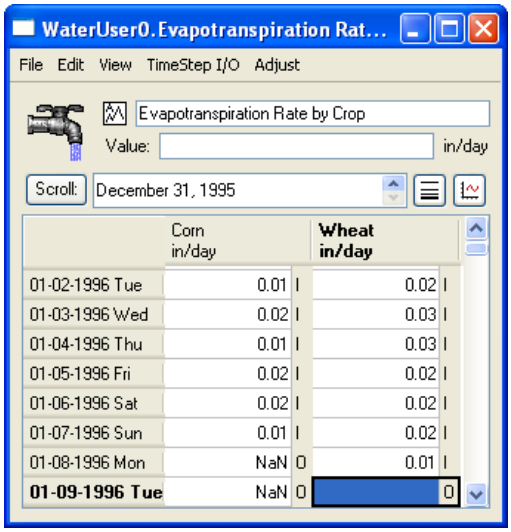
Buttons along the bottom of the dialog provide these functions:

- **Open Slots**: Separate open slot dialogs are shown for each of the selected items in the list. If more than four (4) slots are selected, then a query dialog box is shown confirming the operation with a message like this: “Do you want to show 421 Open Slot dialogs?”. Note that all shown open slot dialogs may be hidden with the **Workspace ➥ Slots ➥ Close All Slots**... menu operation.
- **Show All Slots in SCT**: All slots in the list (regardless of item selection) are shown in a new SCT dialog, and the **Find Series Slots with Inputs** dialog is closed.
- **Show Selected Slots in SCT**: Selected slots in the slot list are shown in a new SCT dialog, and the **Find Series Slots with Inputs** dialog is closed.
- **Cancel**: The **Find Series Slots with Inputs** dialog is closed.

The dialog can also be used to find slot descriptions as described **HERE (Section 1.3)**.

3.2 Agg Series Slots

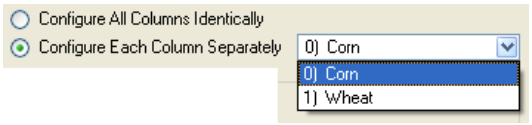
Aggregate Series Slots (Agg Series) are specialized Series Slot that group together one or more Series Slots which are independent of one another. They are used to group together similar series of data. Agg Series slots are essentially multiple individual series of data. The columns of an Agg Series Slot are often referred to as Sub Slots. The screenshot to the right shows the Evapotranspiration Rate by Crop for two different crops, Corn and Wheat.



3.2.1 Configuration

Following are configuration options specific to Agg Series Slots. Further information on general configuration can be found **HERE (Section 1.2.5)** and **HERE (Section 3.1.1)** for Series Slots.

Agg Series slots can be configured such that each column is configured identically or each is configured individually. In the Configuration dialog, there is a toggle to configure the columns identically or separately as shown:



3.2.2 Other Options

Because each column can be configured separately, the time range of each column can be configured to have different start and end dates. The two options allow the columns of the agg series to synch back together:

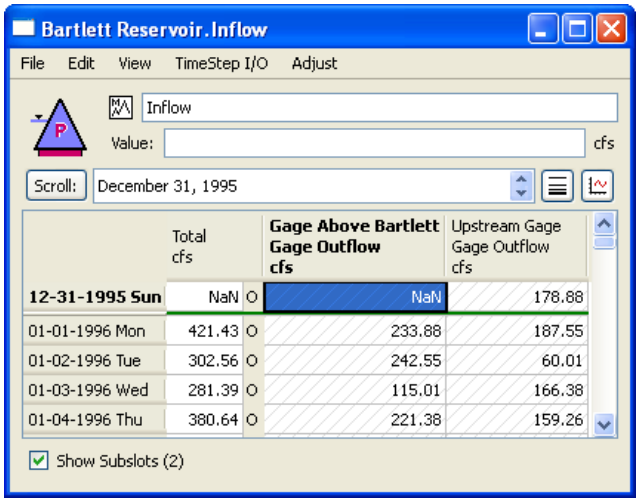
Max Synch: The **Edit ➥ Max Synch** option will synchronize each column to fully encompass the earliest and latest date displayed on any column of the slot. For example, if column 1 goes from Jan. 1, 1999 to June 1, 1999 and column 2 goes from Feb. 2, 1999 to July 23, 1999, a **Max Synch** will change the range of both columns to be Jan. 1, 1999 to July 23, 1999.

Synch to Column0: The **Edit ➥ Synch to Column0** option will synchronize each to column to match the first column (i.e. column 0). On the previous paragraphs example, a **Synch to Column0** will change the range of all columns to be Jan. 1, 1999 to June 1, 1999.

> **Note:** Many of the general slots in RiverWare, such as Outflow, Storage, and Pool Elevation are Agg Series slots. This is an artifact of how the original optimization system was designed. When enabled, optimization used the second and third columns in the solution. In the current controllers, these columns are never used and can be ignored. In this case, the user can think of a single column Agg Series as a normal Series Slot.

3.3 Multi Slots

Multi Slots are specialized series slots that automatically sum the values of the slots to which they are linked. In the screenshot, two series slots named **Gage Above Bartlett. Gage Outflow** and **Reach2.Outflow** are linked to the **Bartlett.Inflow** slot. Each of the linked slots appears in a column. The cells for these columns are grey hatched indicating that they are not directly editable from this view. The user should edit these values from the other end of the link. The sum of all linked columns is reported in the **Total** column. The columns of a Multi Slot are often referred to as Sub Slots. All of the sub slots must have the same unit type and user unit although the other end of the link can have a different user unit, conversion is automatic.

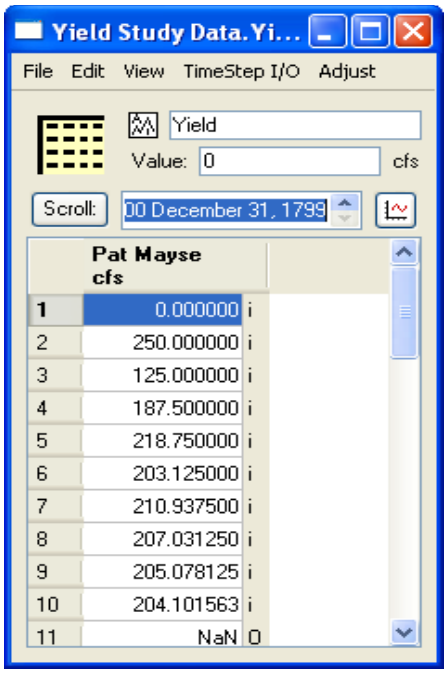


Configuration of Multi Slots is similar to Series Slots **HERE (Section 3.1.1)**. On Multi Slots there is a toggle at the bottom of the dialog that is used to hide or show the subslots. The check box is shown only if the MultiSlot has at least one subslot. It is initialized to OFF if the MultiSlot has exactly one subslot, otherwise, it is initialized to ON. This can be useful for subslots that only have one link, hence it really only represents one series of data.

3.4 Integer Indexed Series Slots and Agg Series

Integer Indexed Series Slots (and Integer Indexed Agg Series Slots) are a specialized type of series slots whose range is not associated with dates, rather just their order in the series. The indices are 1-based, i.e. the first value has index 1.

Configuration of Integer Indexed Series Slots is similar to Series Slots HERE (Section 3.1.1) but, because the series is incremented by integer, there are a few differences between this type of slot and a standard series slot. The **View** menu now has a **Series Range** menu instead of the standard **Timeseries Range** menu option. In the **Series Range** menu (the **Configure Series** dialog), the Begin, End, and timestep areas are disabled. The user can change the range only by changing the number of values.



> **Note:** Internally, the slot is actually a standard series slot with a 1 hour timestep starting on 24:00 December 31, 1799. This can be important because this date is shown in the date scroll area.

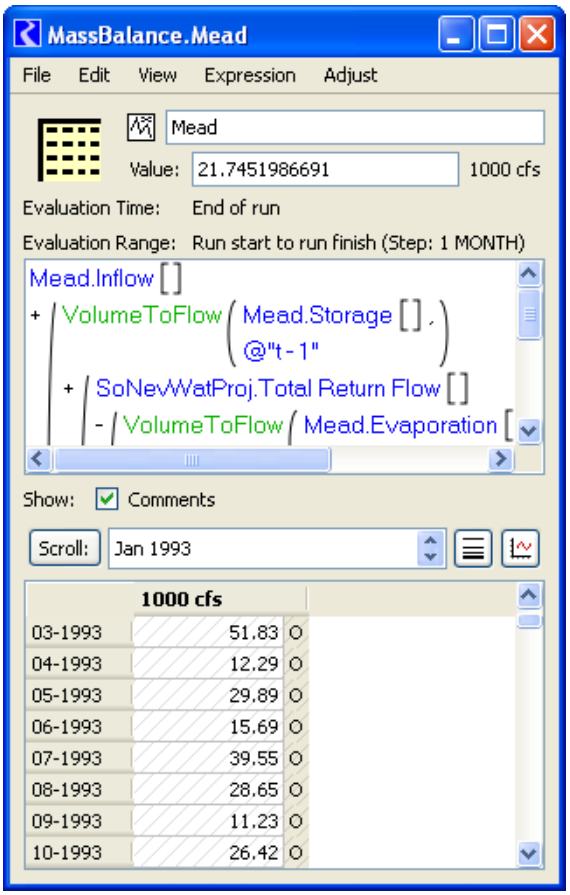
Integer Indexed Series slots can be used as a part of the following utilities:

- They are plotted with integer values with units of NONE for the x dimension.
- They can be accessed and set from the RiverWare Policy Language. Integer Indexed Slots are particularly useful in Iterative MRM mode as they can be used to store values for a particular run index.
- They can be displayed on a System Control Table (SCT). Note, the SCT can either show standard time series or integer indexed series, but not both.

3.5 Expression Slots - Series

Expression slots are computational expressions. The user can either create a **Series Slot with Expression** or a **Scalar Slot with Expression**. They are used to calculate quantities such as “combined Storage of all Reservoirs,” “weekly average Outflow of Hoover Dam,” “the ratio of Hydrologic Inflow to Reach Inflow at selected structures”, or any conceivable equation. Expression slots (both series and scalar) are available only on Data Objects. To add a Series slot with expression select **Slot ➥ Add Series Slot with Expression.**

Expression slots utilize the RiverWare Policy Language (RPL). RPL is computationally expressive language and has an associated structured editor. Because Expression slots utilize RPL (the same language in which RiverWare rules are written) they may contain simple expressions or complex logic and functions. Anything that may be expressed in a rule may also be evaluated in an Expression slot. The use of RPL also provides dimensional analysis to ensure that units are reconciled throughout the expression. It is important to make sure that the unit type of the slot is the same as the units to which the expression evaluate.



3.5.1 Configuration

Following is description of the configuration options available for expression slots.

3.5.1.1 File Menu

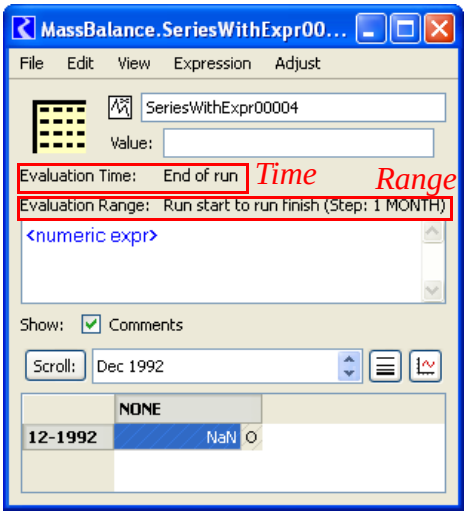
On the File menu, the Import options are not available as you cannot import or type data into the slot. The export options are available and can be used to export the calculated data out of the slot. A Print Expression menu option is available to print the expression. This uses the same printing mechanism as other RPL sets, described **HERE (RPLUserInterface.pdf, Section 3.1)**.

3.5.1.2 Edit Menu

On expression slots, the **Edit** menu has options to **Copy** (to the RiverWare clipboard) and **Export Copy** (to the system clipboard). Importing, pasting, and other data editing features are disabled as the expression slot is “output only”.

3.5.1.3 View Menu

The View Menu on expression slots show the following menu options:



Configuration: The configuration uses the standard series slot configuration dialog described HERE (Section 3.1.1).

Evaluation Range: By default, Expression slots are evaluated for each timestep in the model run (i.e., the range is synchronized with the run control). If you are only interested in the result of an expression for a reduced range of dates or for a different timestep, you may select **View ➥ Evaluation Range**, deselect **Always Synch with Run Control** and enter the date range in which you are interested.

> **Note:** An expression slot does not need to have the same timestep as the run control. If the user chooses to Always Synch with Run Control but uses a different timestep than the run, the slot will evaluate for only those timesteps that fall within the run dates.

Open RPL Set: The RPL set containing functions used by any expression slot can be opened by **View ➥ Open RPL Set.** All of the functionality associated with a RPL set can be utilized from this RPL set editor such as importing/exporting, analysis, search and replace, and creating utility groups of functions. Note, that only functions will be shown in the RPL set editor, the expressions on the slots themselves are the equivalent to the rules in a ruleset. Click HERE (RPLUserInterface.pdf, Section 1) for more information on RPL sets. From the RPL set, the user can control the layout using the **Set ➥ Layout...** menu. Click HERE (RPLUserInterface.pdf, Section 3.2) for more information on layouts.

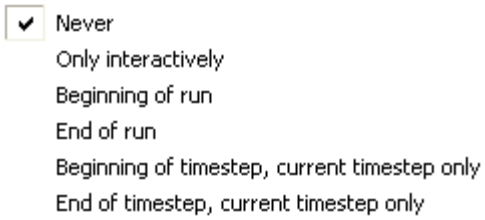
3.5.1.4 Expression Menu

Show Expression: This toggle is used to show or hide the expression. By default, the expression is shown.

Evaluate: The user can manually evaluate the expression from the **Expression ➥ Evaluate** menu.

Validate: The user can manually verify the expressions validity using the **Expression ➥ Validate** menu.

Evaluation Time: Expression slots can be evaluated at the beginning or end of each simulation run, at the beginning or end of each timestep, never, or interactively on demand. These options are particularly useful for performance when running large models and when evaluating a large number of expression slots. To select when an Expression slot is evaluated select **Expression ➥ Evaluation Time** from the Expression slot menu, and choose from the options shown to the right. A check mark will be shown next to the selected option.



The Expression menu is used to build expressions. There are options to **Cut**, **Copy**, **Paste**, **Delete**, and **Enable** and expression. **Undo** and **Redo** are available to go back or go forward when editing expressions. These are only available when a relevant expression is selected. Finally, there is a menu option to bring up the **Palette** open the **RPL Debugger** and open the **RPL set**.

Show Comments: The **Show Comments** menu allows you to hide or show inline RPL comments (added from the palette). There is also a toggle on the slot dialog below the RPL expression that hides/shows the comments (shown to the right). Comments are shown by default. If there are any comments defined, a box is shown around the toggle.

3.5.2 Building Expressions

Expression slots utilize the RPL palette to build expressions. The RPL palette provides a syntax-guided editor designed to assist in the construction of complex syntactically correct expressions within the RiverWare Policy Language environment. The editor works by maintaining a partially constructed expression and allowing the user to manipulate unfinished portions using the palette. Initially, the buttons in the palette are grayed out. When building an expression, the **palette** enables any buttons that could possibly go in a highlighted portion of the expression.

See the documentation **HERE (RPLUserInterface.pdf, Section 1)** on RPL and the palette for further information on any of the RPL topics described.

Note: For Expression Series Slots, the symbolic datetime specifications @"Start Timestep" and @"Finish Timestep" refer to the expression slot's evaluation range, not the controller's start or end dates. The predefined functions, RunStartDate() and RunEndDate(), **HERE (RPLPredefinedFunctions.pdf, Section 133)**, provide a reference to the controller's start and end dates, respectively

3.5.3 Diagnostics for Expression Slots

Diagnostics for expression slot evaluation can be configured in the **Diagnostics Manager** **HERE (Diagnostics.pdf, Section 1.2)**.

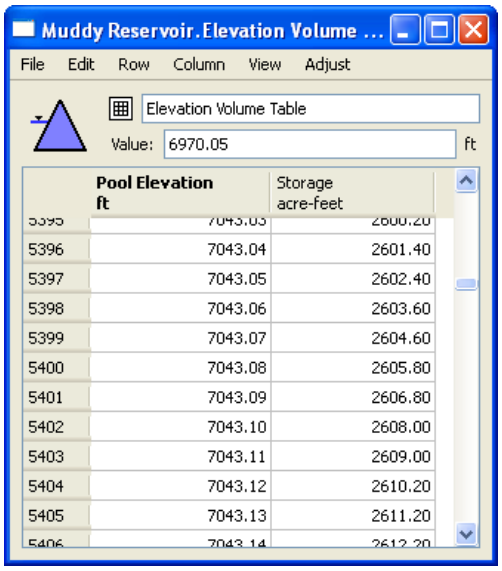
If expression slots are evaluated outside of a run, using the **Expression ➥ Evaluate** menu on the slot or the **Control ➥ Evaluate Expression Slots** menu from the workspace, then diagnostics must be set up using the Workspace diagnostics **HERE (Diagnostics.pdf, Section 5.1)**.

If expression slots are evaluate during a run, either beginning or end of timestep or beginning or end of run, then diagnostics must be set up using Simulation diagnostics **HERE (Diagnostic.pdf, Section 2.1)** or Rulebased Simulation diagnostics **HERE (Diagnostics.pdf, Section 3.1)**, depending on the selected controller. Within each of those diagnostics configurations, the **Expr. Slot Execution** and **Expr. Slot Function Execution** categories deal with expression slots.

Table Slots

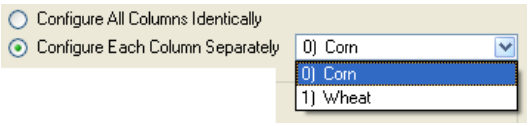
3.6 Table Slots

Table Slots are used to store any table of data. They can define a curve (2-Dimensional), a surface (3-Dimensional), or several unrelated sets. A 2-Dimensional table may require monotonically increasing values in its first column as shown in the Elevation Volume table.

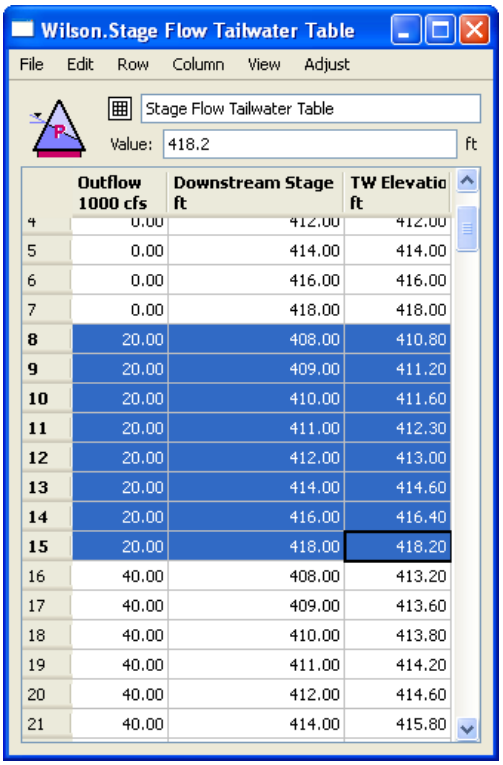


3.6.1 Configuration

The configuration of Table Slots is described in the general slot configuration section **HERE (Section 1.2.5)**. Each column of the table has both a Label and a Unit (user units are configurable). On simulation objects, the Rows are labeled by number unless defined otherwise. Both columns and rows are zero based, i.e. the first column is column 0. On Data Objects, the user is able to change both the Units, Display Format, Column Labels, and Row Labels. Table Slots can be configured such that each column is configured identically or each is configured individually. In the Configuration dialog, there is a toggle to configure the columns identically or separately as shown below:



A 3-Dimensional table requires that column 1 contain sets of equal values which increase down the table, and column 2 must contain monotonically increasing values within each set of values from column 1. Column 3 then contains the values to look up for columns 1 and 2. For example, the **Stage Flow Tailwater Table** is a 3-Dimensional table relating **TW Elevation** to the independent variables of reservoir **Outflow** and **Downstream Stage**. A set where Outflow is equal to 20,000 cfs is highlighted.



	Outflow 1000 cfs	Downstream Stage ft	TW Elevatio ft
4	0.00	412.00	412.00
5	0.00	414.00	414.00
6	0.00	416.00	416.00
7	0.00	418.00	418.00
8	20.00	408.00	410.80
9	20.00	409.00	411.20
10	20.00	410.00	411.60
11	20.00	411.00	412.30
12	20.00	412.00	413.00
13	20.00	414.00	414.60
14	20.00	416.00	416.40
15	20.00	418.00	418.20
16	40.00	408.00	413.20
17	40.00	409.00	413.60
18	40.00	410.00	413.80
19	40.00	411.00	414.20
20	40.00	412.00	414.60
21	40.00	414.00	415.80

Edit Row Configuration: The user is able to change the number of rows in most tables. This is done through the Row menu using the **Insert**/**Append**/**Delete** rows options.

Editing Column Configuration: Some Table Slots allow columns to be appended and deleted. This is done to store a variable number of data sets within a single slot. A "block" is defined as the number of columns which must be appended or deleted together. In the case of the Elevation Volume Table, the block size is 2, one column for Pool Elevation and one for Storage (although the user can't add blocks to this table). When appending or deleting columns from a Table Slot and its dependents, reconfiguring must be done in blocks. The minimum table size is 1 block. The user can change the number of columns using the **Set Number of Columns**, **Append Column**, **Delete Column**, **Delete Last Column**, and **Set Dimensions** menu options from the Column menu. The **Column ➥ Set Dimensions** can also be used to change the number of rows and columns at the same time.

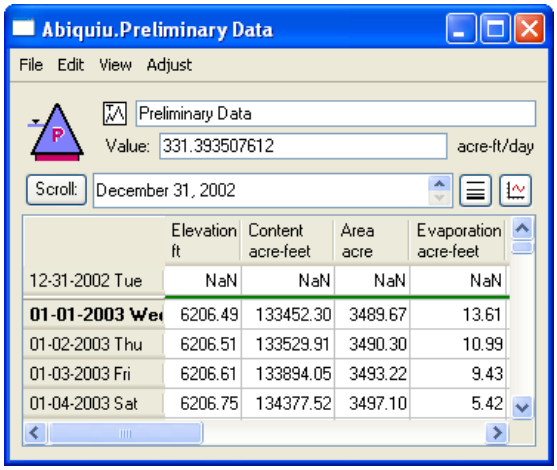
Show Column Sum Row: The user is able to show the sum of the column rows using the **View ➥ Show Column Sum** Row menu item. This option adds a special read-only SUM row to the bottom of the column that sums all of the values above (NaNs are assumed to be zero). This feature is especially useful when setting up routing coefficients or factors where the sum of the column must equal 1.0.

3.6.2 Source Slots

Some specific scalars and tables have a "Source" slot. When a slot has a source slot, the values are computed from the source slot's values. Thus, the destination slot becomes read-only and displays a cross hatch over the data. The slot also provides a note indicating the source slot used to compute the data. The source slot is typically set/un-set at beginning of run, so you must initialize the run to see the read-only status.

3.7 Table Series Slot

Table Series Slots are a specialized table slot whose rows correspond to time values. This slot contains limited timeseries functionality thus making it more efficient than Series Slots. It was created as a way to efficiently write and/or read large amounts of data. Table Series Slots are primarily used within object user methods such as the Muskingum Cunge hydraulic routing methods. These types of slots cannot be created on Data Objects.



3.8 Statistical Table Slots

Statistical table slots allow the user to specify a statistical function, such as a flow duration curve, which is computed at the end of a run using the data in specified model slot(s). This statistical analysis data can then be plotting or exported to another application.

This statistical analysis could be computed using Riverware's existing export or output manager functionality coupled with a third-party analysis application such as Excel. Statistical table slots provides this functionality inside Riverware to allow quick analysis at the end of a run without leaving the Riverware environment.

3.8.1 Creating a Statistical Table Slot

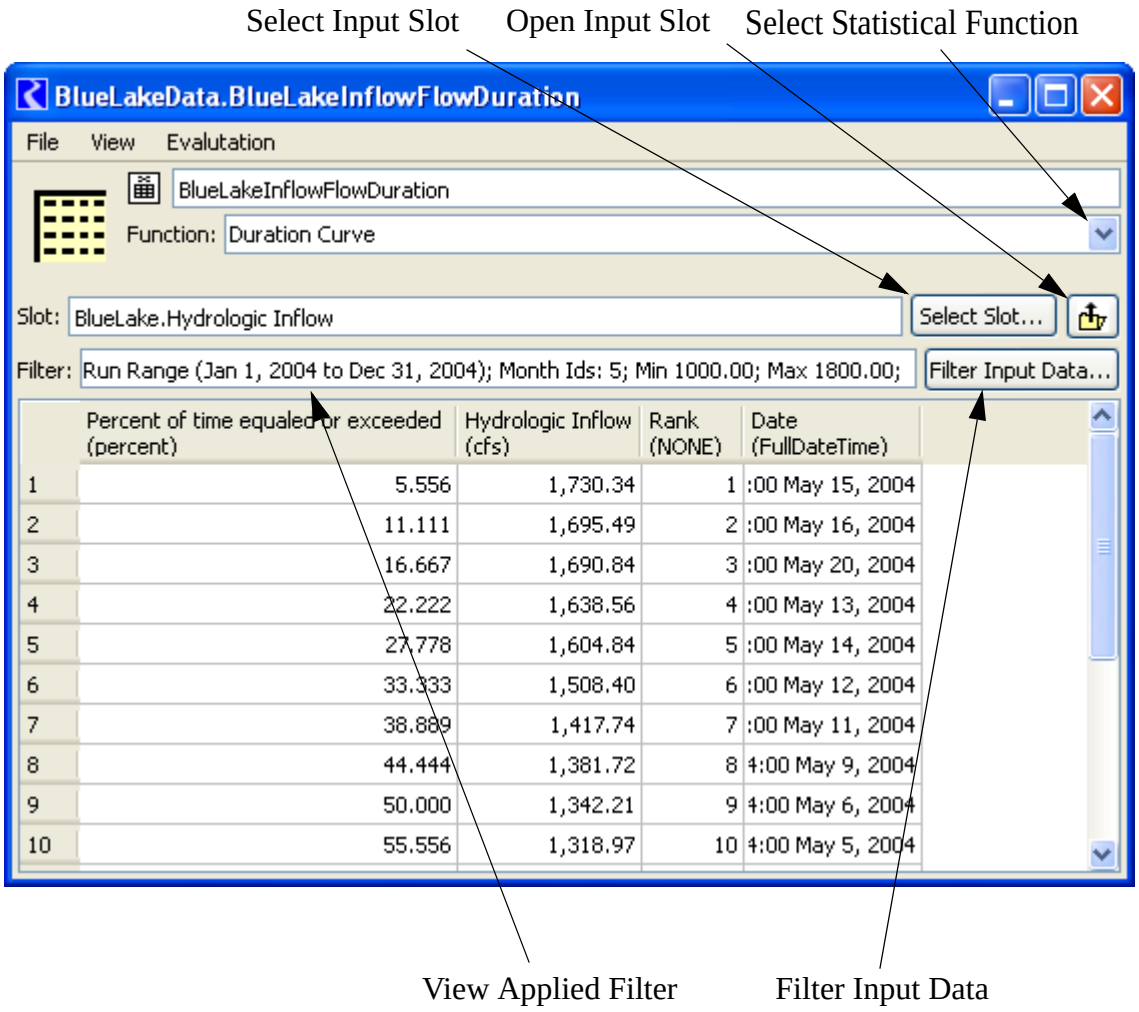
Statistical table slots can only be added to data objects. To create a statistical table slot, open the object dialog for a data object. From this dialog:

- Select **Slot ➥ Add Statistical Table Slot** from the data object's main menu bar.
- Right-click over the slots list and select **Add Slot ➥ Statistical Table Slot** from the context menu.

A statistical table slot will be displayed in the slot list with the slot icon:

3.8.2 Configuring a Statistical Table Slot.

A statistical table slot is configured and viewed using the Statistical Table Slot Dialog. Open this dialog by double-clicking on the statistical table slot in the data object dialog.



The basic steps in configuring a statistical table slot are:

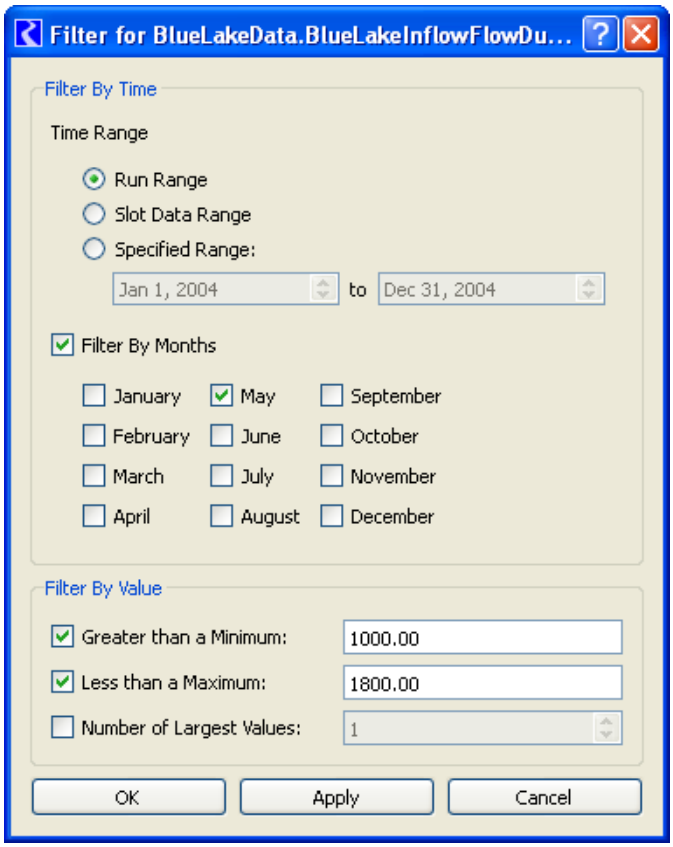
1. Select the desired statistical function from the **Function** pull-down list. The functions are described **HERE (Section 3.8.6)**.

2. Select the input slot for the statistical function by pressing the **Select Slot...** button. A selected input slot can then be opened by pressing the icon next to the **Select Slot...** button.

3. Select any desired filtering of the input data by pressing the **Filter Input Data...** button. Data can be filtered by:

- Time Range, select the **Run Range** (default), full **Slot Data Range**, or a **Specified Range**
- Months, choose the desired months
- Values **Greater than a Minimum**
- Values **Less than a Maximum**
- A specified **Number of Largest Values**

Multiple filters can be applied concurrently. A summary of any applied filtering can be viewed on the Statistical Table Slot Dialog in the Filter text window.



4. Specify the display units, scale, and precision for each column in the table by selecting **View ➥ Configure...** from the dialog's menu bar.

3.8.3 Evaluating a Statistical Table Slot

By default, all statistical table slots will be cleared at the beginning of the run and evaluated at the end of the run.

- To prevent a statistical table slot from being evaluated at the end of the run select **Evaluation ➥ Disabled** on the dialog's menu bar.

The contents of a statistical table slot can also be cleared and evaluated manually.

- To manually evaluate a statistical table slot select **Evaluation ➥ Evaluate (Alt+E)** from the slot dialog's menu bar.
- To manually clear the contents of a statistical table slot select **Evaluation ➥ Clear** from the slot dialog's menu bar.

3.8.4 Analyzing a Statistical Table Slot.

Snapshots can be made of statistical slots to easily preserve and compare their values from different runs.

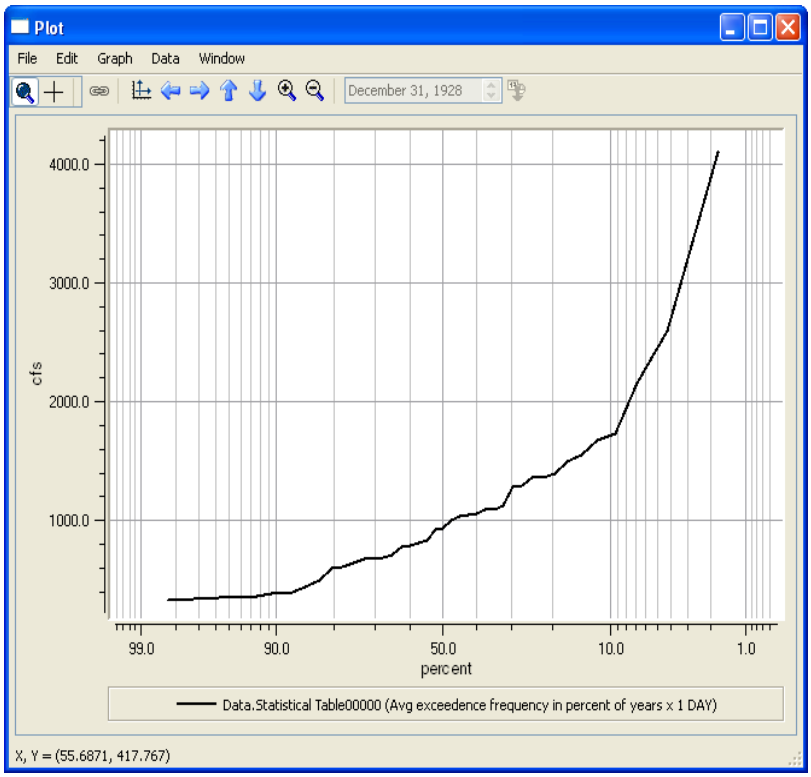
- To create a snapshot of the statistical slot select **View ➥ Snapshot Mgr (Alt+S)** from the slot dialog's menu bar.
- The snapshot manager dialog will be opened and the statistical slot and its input slot will be added to the manager's slot list if not already present.
- Taking a snapshot creates a data object with copies of all slots that are in the manager's list.

- To preserve the data, the snapshots of statistical slots have all functionality disabled that could change the values of the data in the slot.

3.8.5 Plotting a Statistical Table Slot

The contents of a statistical table slot can be plotted.

- To plot the contents of the statistical table slot select **File ➥ Plot (Ctrl+P)** from the slot dialog's menu bar.
- If the statistical slot has more than 2 columns, a dialog appears to allow specification of which columns to plot (some functions may present a check box option for plotting all the result data columns, for example to plot all duration columns from a value duration function). A typical choice would be percent exceedence probabilities versus values. In this case, the percent exceedences will, by default, be plotted on a probability scale as you would see on normal probability paper. On such a scale, normally distributed values will plot as a straight line. A sample is shown to the right.



- If desired, the probability axis can be changed to a linear scale by selecting **Edit ➥ Axis Configuration** from the plot dialog's menu bar, then choosing the X-Axis and changing the toggle.
- The axes of the generated plot can also be configured to be logarithmic by selecting **Edit ➥ Axis Configuration** from the plot dialog's menu bar. This can be used, for example, to plot a log-normal representation of the data.
- The configuration of the plot can be saved for quick access by using either the output manager or the **File ➥ Save As...** option on the plot dialog.

A statistical slot can be plotted with all of its snapshots.

- To plot the contents of the statistical table slot along with all of its snapshots, select **File ➥ Plot with Snapshots (Alt+P)** from the slot dialog's menu bar.

- If the statistical slot has more than 2 columns, a dialog appears to allow specification of which columns to plot (some functions may provide a check box option to plot all the result data columns). The selections are used for the slot as well as for all the snapshots.
- The slot's data and the data in all of its snapshots are plotted on the same graph to allow for an easy visual comparison.
- The axes of the generated plot can be configured to logarithmic scale by selecting **Edit ➥ Axis Configuration** from the plot dialog's menu bar.
- The configuration of this plot can be saved for quick access by using either the output manager or the **File ➥ Save As...** option on the plot dialog.

User data input to a table slot can be plotted with a statistical slot.

- Add a table slot to your data object by selecting **Slot ➥ Add Table Slot** from the data object's menu bar.
- A dialog will appear asking for the number of rows and columns you want in your table slot. You will probably want at least two columns to plot the slot.
- The new table slot with a default name will appear in the slot list of the data object's dialog. Double click on the new table slot in this list to bring up the table slot's dialog.
- Select **View ➥ Column Labels** from the table slot's dialog. Give the columns heading names in the new dialog that comes up and click OK.
- Now select **View ➥ Configure** from the table slot's dialog. Assign Unit Type and User Units to your columns by using the Configure Each Column Separately option.
- Enter the desired data into the cells of the table slot's dialog.
- From a plot of your statistical slot, select **Data ➥ Add Table Curve** from the plot's menu bar.
- From the resulting Curve Configuration dialog, click the **Select Table Slot** button and select the table slot you created above.
- The Curve Configuration dialog will allow you to select what columns you wish to plot on the x and y axes of the plot along with line styles and formats.
- Clicking OK on the Curve Configuration dialog will then add your user input data from the table slot onto the plot with the statistical slot.

The contents of the statistical table slot can also be exported to a text file for analysis using an external tool.

- To export the contents of the table slot select **File ➥ Export (Display Precision)** or **File ➥ Export (Model Precision)** from the slot dialog's menu bar.

3.8.6 Statistical Functions

The following statistical functions are provided on Riverware's statistical table slots.

3.8.6.1 Duration Curve

Name	Duration Curve
Input Slot(s)	1 series slot
Column 0	*Label:* Percent of time equaled or exceeded *Unit Type:* Fraction
Column 1	*Label*: [Name of input slot] *Unit Type:* [Unit type of input slot]
Column 2	*Label:* Rank *Unit Type:* None
Column 3	*Label:* Date *Unit Type:* DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Sort all n resulting values in decreasing order. 3. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m = n. 4. Compute the statistical exceedence percentage value (P) for each item using the formula: P = m / n. 5. The final output is the list of: P, the slot values in sorted descending order, rank, and date of the values.

3.8.6.2 Annual Max Frequency Curve

	Annual Max Frequency Curve
Input Slot(s)	1 series slot
Column 0	*Label:* Max exceedence frequency in percent of years *Unit Type:* Fraction
Column 1	*Label*: [Name of input slot] *Unit Type:* [Unit Type of input slot]
Column 2	*Label:* Rank *Unit Type:* None

	Annual Max Frequency Curve
Column 3	*Label:* Date *Unit Type:* DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Create a list of the maximum annual values for each year within the resulting data. 3. Sort all n annual values in decreasing order. 4. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 5. Compute the statistical exceedence percentage value (P) for each item using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on rank. 6. The final output is the list of: P, the max annual values in sorted descending order, rank, and date of the value.

3.8.6.3 Annual Min Frequency Curve

	Annual Min Frequency Curve
Input Slot(s)	1 series slot
Column 0	*Label:* Min exceedence frequency in percent of years *Unit Type:* Fraction
Column 1	*Label*: [Name of input slot] *Unit Type:* [Unit Type of input slot]
Column 2	*Label:* Rank *Unit Type:* None
Column 3	*Label:* Date *Unit Type:* DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Create a list of the minimum annual values for each year within the resulting data. 3. Sort all n annual values in increasing order. 4. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 5. Compute the statistical exceedence percentage value (P) for each item using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on rank. 6.The final output is the list of: P, the min annual values in sorted ascending order, rank, and date of the value.

3.8.6.4 Annual Avg Frequency Curve

	Annual Avg Frequency Curve
Input Slot(s)	1 series slot
Column 0	*Label:* Avg exceedence frequency in percent of years *Unit Type:* Fraction
Column 1	*Label*: [Name of input slot] *Unit Type:* [Unit Type of input slot]
Column 2	*Label:* Rank *Unit Type:* None

	Annual Avg Frequency Curve
Column 3	*Label:* Date *Unit Type:* DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Create a list of the average annual values for each year within the resulting data. 3. Sort all n annual values in decreasing order. 4. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 5. Compute the statistical exceedence percentage value (P) for each item using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on rank. 6. The final output is the list of: P, the avg annual values in sorted descending order, rank, and date of the value.

3.8.6.5 Monthly Maximums By Year

	Monthly Maximums By Year
Input Slot(s)	1 series slot
Column 0	*Label:* Year *Unit Type:* DateTime
Columns 1 - 12	*Label*: [Month} Max *Unit Type:* [Unit Type of input slot]
Column 13	*Label*: Annual Max *Unit Type:* [Unit Type of input slot]
Final Rows	*Labels*: Maximum, Minimum, Average (of the columns) *Unit Type:* [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Iterate the data and track and save the maximum value for each month and for each year. 3. Generate average maximum values for each month across all years and for the annual maximum across all years. 4. The final output is a row for each year and final rows for maximums, minimums, and averages across all the years. Columns are the date for the year, a column for each month's maximum, and an annual maximum column.

3.8.6.6 Monthly Minimums By Year

	Monthly Minimums By Year
Input Slot(s)	1 series slot
Column 0	*Label:* Year *Unit Type:* DateTime
Columns 1 - 12	*Label*: [Month} Min *Unit Type:* [Unit Type of input slot]
Column 13	*Label*: Annual Min *Unit Type:* [Unit Type of input slot]
Final Rows	*Labels*: Maximum, Minimum, Average (of the columns) *Unit Type:* [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Iterate the data and track and save the minimum value for each month and for each year. 3. Generate average minimum values for each month across all years and for the annual minimum across all years. 4. The final output is a row for each year and final rows for maximums, minimums, and averages across all the years. Columns are the date for the year, a column for each month's minimum, and an annual minimum column.

3.8.6.7 Monthly Averages By Year

	Monthly Averages By Year
Input Slot(s)	1 series slot
Column 0	*Label:* Year *Unit Type:* DateTime
Columns 1 - 12	*Label*: [Month} Avg *Unit Type:* [Unit Type of input slot]
Column 13	*Label*: Annual Avg *Unit Type:* [Unit Type of input slot]

	Monthly Averages By Year
Final Rows	*Labels*: Maximum, Minimum, Average (of the columns) *Unit Type:* [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Iterate the data and calculate and save the average value for each month and for each year. 3. Generate averages from the average values for each month across all years and for the annual average value across all years. 4. The final output is a row for each year and final rows for maximums, minimums, and averages across all the years. Columns are the date for the year, a column for each month's average, and an annual average column.

3.8.6.8 Monthly Totals By Year

Note that totals generated by this function may not make sense for some slots (i.e, flow or storage).

	Monthly Totals By Year
Input Slot(s)	1 series slot
Column 0	*Label:* Year *Unit Type:* DateTime
Columns 1 - 12	*Label*: [Month} Tot *Unit Type:* [Unit Type of input slot]
Column 13	*Label*: Annual Tot *Unit Type:* [Unit Type of input slot]
Final Rows	*Labels*: Maximum, Minimum, Average (of the columns) *Unit Type:* [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Iterate the data and track and save the total value for each month and for each year. 3. Generate average total values for each month across all years and for the annual total across all years. 4. The final output is a row for each year and final rows for maximums, minimums, and averages across all the years. Columns are the date for the year, a column for each month's total, and an annual total column.

3.8.6.9 Partial Duration Max Frequency Curve

	Partial Duration Max Frequency Curve
Input Slot(s)	1 series slot
Column 0	*Label:* Max exceedence frequency in percent *Unit Type:* Fraction
Column 1	*Label*: [Name of input slot] *Unit Type:* [Unit Type of input slot]
Column 2	*Label:* Rank *Unit Type:* None
Column 3	*Label:* Date *Unit Type:* DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. If user has specified a base value, use it in the call to the partial duration calculation and present all the results generated. 3. If not a user-supplied base value, sort the input values in decreasing order and assume a base equal to the value at position (number of years of input data plus one). Make successive calls to the partial duration calculation with decreasing base values until the number of results equals or exceeds the number of years of data in the input slot. 4. The partial duration calculation tabulates the largest values that are greater than the base value, which are separated by events less than the base value. 5. Sort all n result values in decreasing order. 6. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 7. Compute the statistical exceedence percentage value (P) for each item. For the top half of items, use the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others in the top half are interpolated between these two based on rank. For the bottom half of items, use the formula: $\frac{2m-1}{2n}$ 8. The final output is the list of: P, the max partial duration values in sorted descending order, rank, and date of the value.

3.8.6.10 Partial Duration Min Frequency Curve

	Partial Duration Min Frequency Curve
Input Slot(s)	1 series slot
Column 0	*Label:* Min exceedence frequency in percent *Unit Type:* Fraction

	Partial Duration Min Frequency Curve
Column 1	*Label*: [Name of input slot] *Unit Type:* [Unit Type of input slot]
Column 2	*Label:* Rank *Unit Type:* None
Column 3	*Label:* Date *Unit Type:* DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. If user has specified a base value, use it in the call to the partial duration calculation and present all the results generated. 3. If not a user-supplied base value, sort the input values in increasing order and assume a base equal to the value at position (number of years of input data plus one). Make successive calls to the partial duration calculation with increasing base values until the number of results equals or exceeds the number of years of data in the input slot. 4. The partial duration calculation tabulates the smallest values that are less than the base value, which are separated by events greater than the base value. 5. Sort all n result values in increasing order. 6. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 7. Compute the statistical exceedence percentage value (P) for each item. For the top half of items, use the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others in the top half are interpolated between these two based on rank. For the bottom half of items, use the formula: $\frac{2m-1}{2n}$ 8. The final output is the list of: P, the min partial duration values in sorted ascending order, rank, and date of the value.

3.8.6.11 Value Duration Max Frequency Curve

	Value Duration Max Frequency Curve
Input Slot(s)	1 series slot
Column 0	*Label:* Max exceedence frequency in percent of years *Unit Type:* Fraction
Columns 1 - N	*Label*: [Duration represented by column] *Unit Type:* [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Determine the durations to use in calculation based on timestep of input slot. Currently only implemented for day (1, 2, 3, 5, 7, 19, 15, 60, 90 and 365 day) and month (1, 2, 3, 4, 6 and 12 month) 3. Loop for each duration. 4. For each year, average the slot values over the duration starting with timestep 1, then starting with timestep 2, etc. to generate a set of values over this duration for the year. Take the maximum of this set of values and record this as the single result for the year. 6. Sort all the result values (one for each year) in decreasing order and present as a column of results for this duration. 7. Move on to the next duration. 4. Assign a rank to each row of results from 1 to n. 5. Compute the statistical exceedence percentage value (P) for each row using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on row rank. 6. The final output is the list of: P and a column of results for each duration used.

3.8.6.12 Value Duration Min Frequency Curve

	Value Duration Min Frequency Curve
Input Slot(s)	1 series slot
Column 0	*Label:* Min exceedence frequency in percent of years *Unit Type:* Fraction

	Value Duration Min Frequency Curve
Columns 1 - N	*Label*: [Duration represented by column] *Unit Type:* [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Determine the durations to use in calculation based on timestep of input slot. Currently only implemented for day (1, 2, 3, 5, 7, 19, 15, 60, 90 and 365 day) and month (1, 2, 3, 4, 6 and 12 month) 3. Loop for each duration. 4. For each year, average the slot values over the duration starting with timestep 1, then starting with timestep 2, etc. to generate a set of values over this duration for the year. Take the minimum of this set of values and record this as the single result for the year. 6. Sort all the result values (one for each year) in increasing order and present as a column of results for this duration. 7. Move on to the next duration. 4. Assign a rank to each row of results from 1 to n. 5. Compute the statistical exceedence percentage value (P) for each row using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on row rank. 6. The final output is the list of: P and a column of results for each duration used.

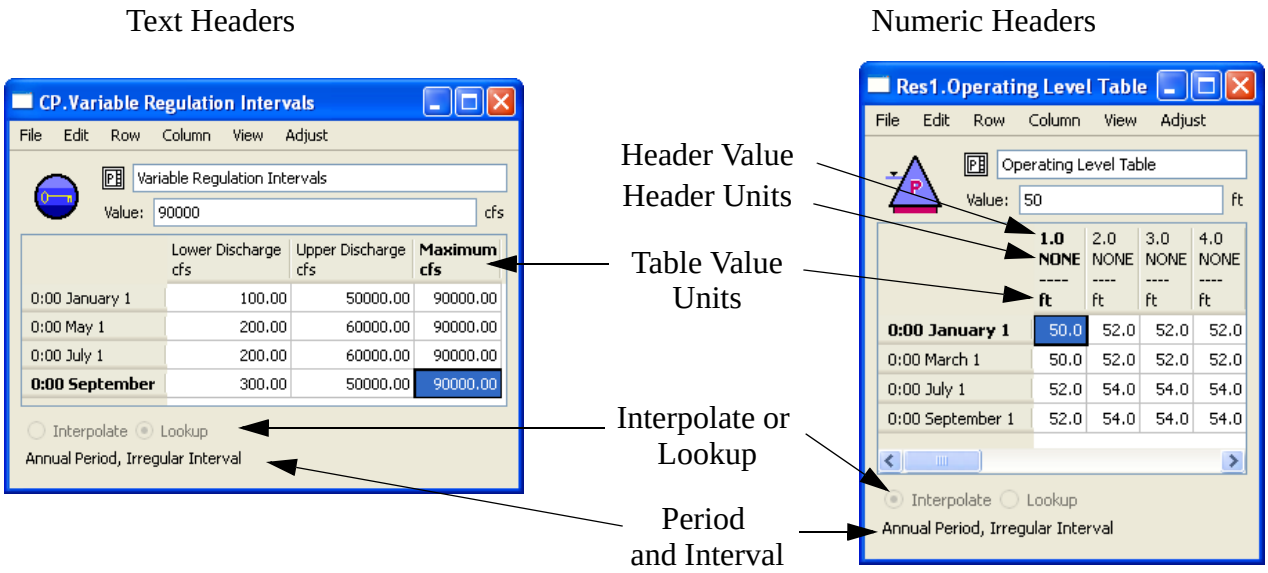
3.8.6.13 Value Duration Avg Frequency Curve

	Value Duration Avg Frequency Curve
Input Slot(s)	1 series slot
Column 0	*Label:* Avg exceedence frequency in percent of years *Unit Type:* Fraction
Columns 1 - N	*Label*: [Duration represented by column] *Unit Type:* [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Determine the durations to use in calculation based on timestep of input slot. Currently only implemented for day (1, 2, 3, 5, 7, 19, 15, 60, 90 and 365 day) and month (1, 2, 3, 4, 6 and 12 month) 3. Loop for each duration. 4. For each year, average the slot values over the duration starting with timestep 1, then starting with timestep 2, etc. to generate a set of values over this duration for the year. Take the average of this set of values and record this as the single result for the year. 6. Sort all the result values (one for each year) in decreasing order and present as a column of results for this duration. 7. Move on to the next duration. 4. Assign a rank to each row of results from 1 to n. 5. Compute the statistical exceedence percentage value (P) for each row using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on row rank. 6. The final output is the list of: P and a column of results for each duration used.

3.9 Periodic Slots

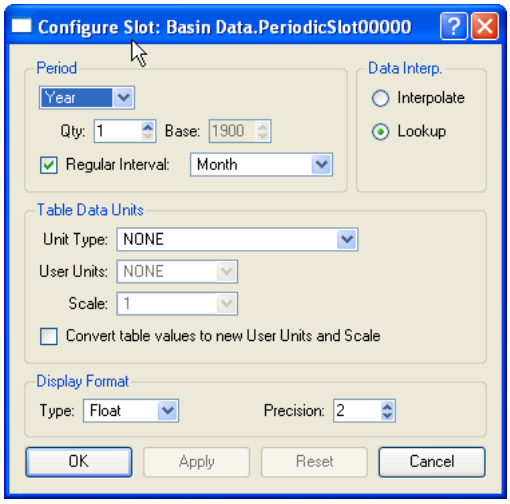
Periodic slots are tables used to represent periodic data which repeats at regular time interval. An example might be a set of evaporation coefficients for a reservoir. The rate of evaporation varies with such factors as temperature and wind speed, factors which vary seasonally. It is natural to assume that this variation is the same for each year. If this sort of data were entered into a series slot, then the same data would need to be repeated every year. This would be impractical and inconvenient for the user. On the other hand, if this data were entered in to a table slot, then the data would lose the time element

associated with each value. This would make it difficult to look up or interpolate values with respect to time. The periodic slot solves both of these problems.



3.9.1 Configuration Options

Periodic slots are configured like other slots using the **View ➥ Configure** menu.



The upper left portion of the **Configure Slot** dialog, under the **Period** section, is used to set the period and interval of the periodic slot. The period can range from 6-hours to several years while the interval depends on the period selected. If the period required is several years, the **Qty** value should be modified from 1 to the number of years and the **Base** year--the first year in the period--should be defined. Also notice the checkbox next to **Regular Interval**. If the data interval is not a consistent length of time, the user can de-select this option and the periodic slot would then have an irregular interval. The user is then free to configure the rows/timesteps in any fashion. Click **HERE (Section 3.9.1.1)** for more information.

The **Data Interp.** section located in the upper right portion of the **Configure Slot** dialog is used to specify whether or not data should be interpolated or looked up directly when accessing the table at a time that is not specifically listed as a row label. For example, the monthly data is shown for the beginning of each month. If we're in the middle of the month, should we use that same piece of data, or should we interpolate between the two months? This is a question that would need to be answered on a per model basis, however, the default behavior is a direct lookup.

> **Note:** Slots configured to **Lookup** use the value in the row that has a datetime less than or equal to the desired datetime and the datetime in the next row is greater than the desired datetime. Slots configured to **Interpolate**, perform a linear interpolation using values whose rows' datetimes bound the desired datetime.

Columns can be added/deleted by selecting a column and using the **Column** menu.

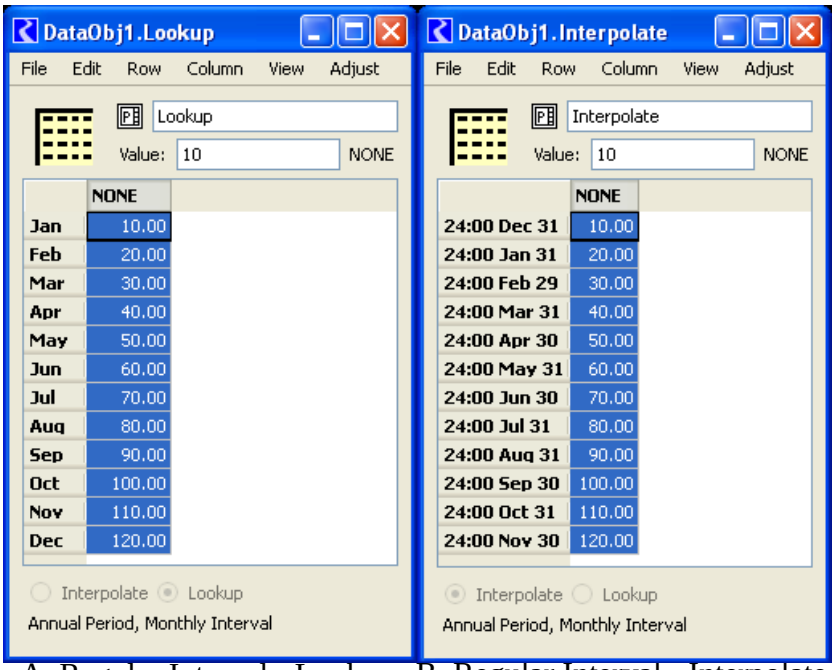
3.9.1.1 Display of Dates

The rows of a periodic slot represent dates and are displayed differently if the interval is Regular or Irregular. This distinction in dates is described below.

Regular Intervals: Regular Interval periodic slots only show enough information to identify the date. The display is different if the slot is configured to Lookup or Interpolate. When the slot is configured to **Lookup**, the rows only show the part of the date the changes from one row to the next. Thus, if it is a monthly interval, only the month is shown not the hour or day. If it is a daily interval with an annual period, only the day number is shown.

For periodic slots that are configured to **Interpolate**, the date represents an instant in time that corresponds to the end of a timestep. Thus, for a monthly interval, the dates are 24:00 Dec 31, 24:00 Jan1, etc... Note, Feb 29th is shown in this case but actually behaves as though it is 0:00 March 1.

The following figure shows screenshots of a periodic slot that has a Regular Interval and Monthly Interval. When a new periodic slot (Text Headers) is added to a data object, this is how they appear.The following table shows some sample results for the slots shown using the specified datetime.



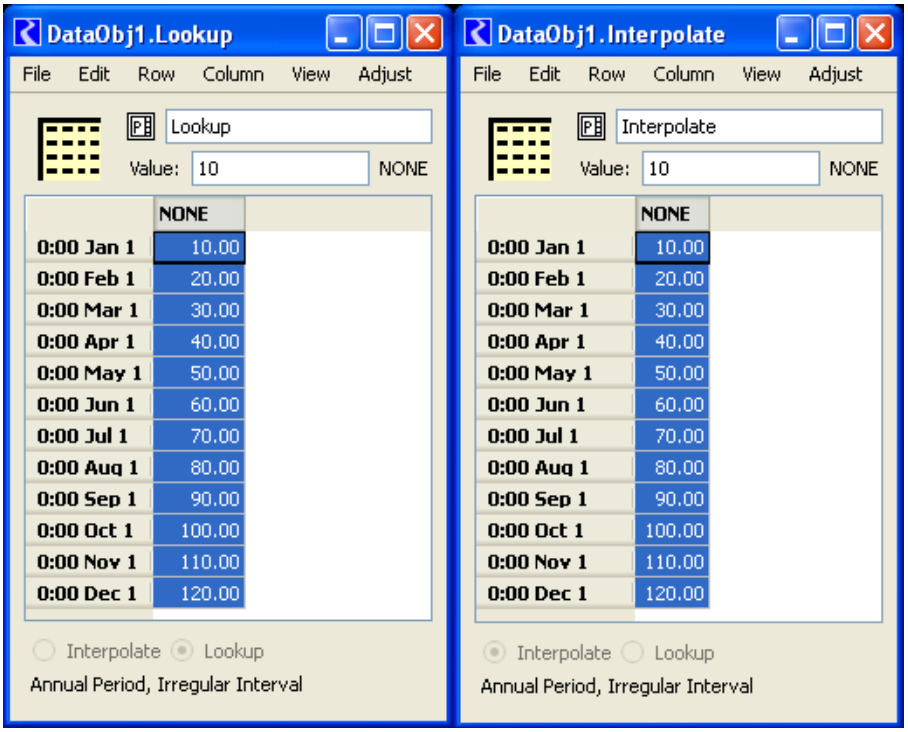
A. Regular Interval - Lookup B. Regular Interval - Interpolate

Datetime	A.Regular Interval - Lookup	B. Regular Interval - Interpolate
24:00 January 13, 2001	10	14.2
24:00 February 23, 2003	20	28.2
24:00 October 21, 2009	100	106.8

For Regular Intervals, the user cannot add or delete rows. The slot must be converted to an Irregular Interval first.

Irregular Intervals: For Irregular Intervals, the timestep displayed is an instant in time. The screenshot shows the same slots above converted to an Irregular Interval. Because they have the same rows (displayed differently), the A slots would behave the same and the B slots would behave the same.

The user can add or delete rows from periodic slots with an Irregular Interval using the **Row** menu.



A. Irregular Interval - Lookup B. Irregular Interval - Interpolate

3.9.2 Headers

The user can create two different types of periodic slots: with text headers for the columns or with numeric headers for the columns.

3.9.2.1 Text headers

In this mode, the periodic slot simply contains columns of data that may or may not be related. There can be no interpolation across columns.To add a periodic slot with Text Headers to a data object:

1. Append a periodic slot by selecting **Slots ➥ Add Periodic Slot, Text Headers**
2. If the columns are to be accessed using text, select **Column ➥ Set Column Label** to add a text header to each of the columns.

3.9.2.2 Numeric headers

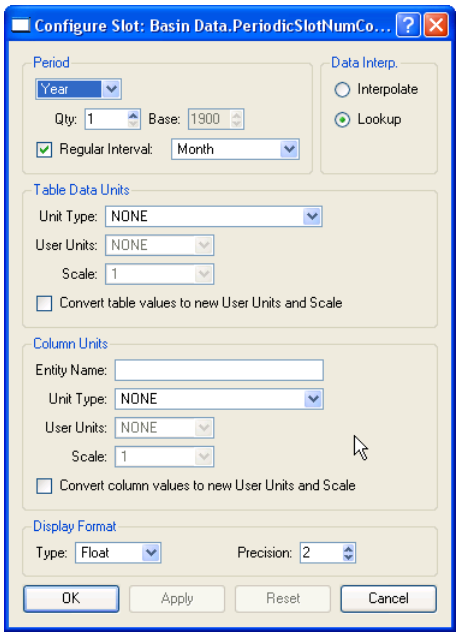
Consider a periodic slot containing loss coefficients. The periodic slot may contain loss coefficients that vary not only with time, but also with flow rate in a reach. RiverWare could then identify which coefficient to use by indexing the table row using the current time step and the table columns using a flow rate. The user could specify as many columns as necessary to sufficiently describe the variation of

loss coefficients as a function of flow rate. The periodic slot's **Column Units** would be configured to be flow, perhaps with units of 1000 cfs.

To add a periodic slot with Numeric Headers to a data object:

1. Append a periodic slot by selecting **Slots ➥ Add Periodic Slot, Numeric Headers.**

2. Select **View ➥ Configure** to configure the periodic slot

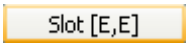


The dialog now has a **Column Units** section. This may be useful if the columns are indexed using numeric header values and the values have some physical (not simply descriptive) significance.

The periodic slot can be used backwards to work from the table values and date outward to define a value associated with the column(s). For example, suppose the periodic slot defines the various pools or phases in a reservoir. The conservation pool may be defined as phase 1 with the first column containing pool elevations defining the conservation pool throughout the year. This first column would have a header of 1.0, meaning phase 1. The flood pool may be phase 2.0 with a second column using 2.0 as its header. The surcharge pool may be phase 3.0, etc. Knowing the pool elevation at a given time, the periodic slot can be used to determine the current phase. Interpolating across columns, this outward lookup may determine that the current phase is 2.5 for a given pool elevation and date, meaning pool is halfway from the bottom of flood pool to the bottom of the surcharge pool.

3.9.3 Referencing Periodic Slots in RPL

In RPL, periodic slots are referenced using the Slot[E, E] syntax. Like other tables, this is a row by column reference. But, because it is a periodic slot, the row is a datetime: Slot[<Datetime>, E]. When referenced in RPL, the configuration of the slot will be used when accessing dates that are "between rows". That is, it will either interpolate or look up depending on the slot's configuration.



For periodic slots with **text headers**, the column specification is a text string matching a column or the zero-based column index. For periodic slots with **numeric headers**, the column specification is a numeric value with units. You can specify any number that falls within the min and max column values. That is, you don't have to specify an exact column's value, but can use numeric values that are "between columns" and it will linearly interpolate for you. For example, the following slot represents low flows that are based on reservoir levels. It is configured to lookup:

	5000 ft	5010 ft
Jan. 1	10 cfs	20 cfs
Feb 1	40 cfs	60 cfs
March 1	60 cfs	80 cfs

In RPL, to reference this slot on January 15th for reservoir elevation 5002ft, the following would be used:

```
Slot[@"January 15,2011", 5002 ft]
```

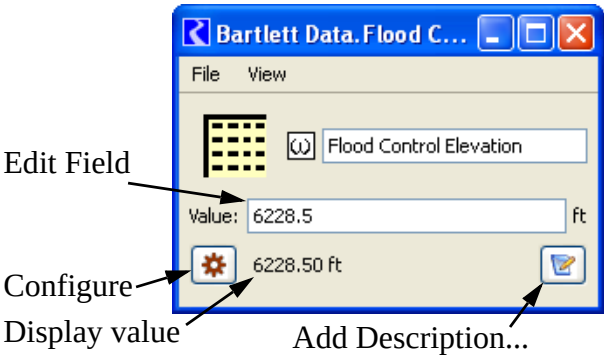
It would return:

```
12 cfs
```

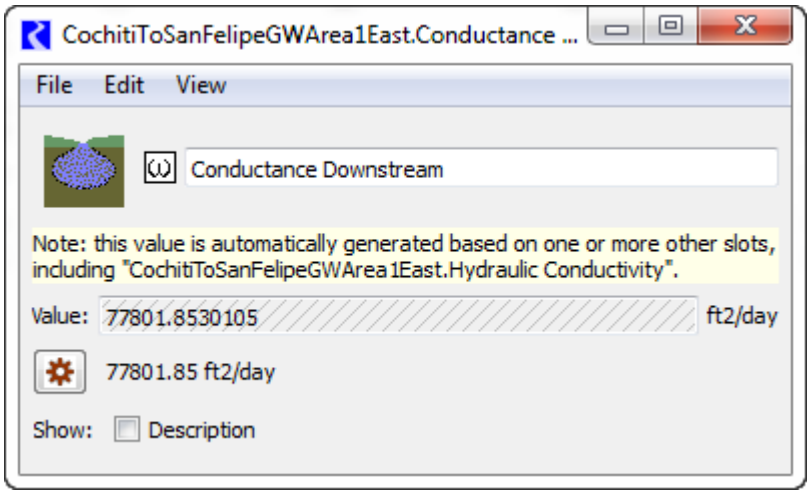
Scalar and List Slots

3.10 Scalar Slots

Scalar slots represent a single value. Configuration options include units and display format. Scalar slots are used only for input data parameters. The configuration of Scalar Slots is the same as the general slot configuration section **HERE (Section 1.2.5)**.

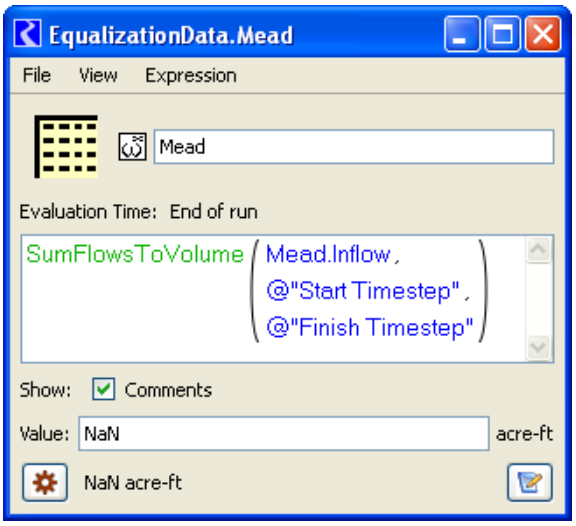


Some specific scalars and tables have a “Source” slot. When a slot has a source slot, the values are computed from other slot values. Thus, it becomes read-only and displays a cross hatch over the data. See screenshot. It also provides a note indicating the source slot used to compute the data. The source slot is typically set/un-set at beginning of run, so the user must initialize the run to see the read-only status.



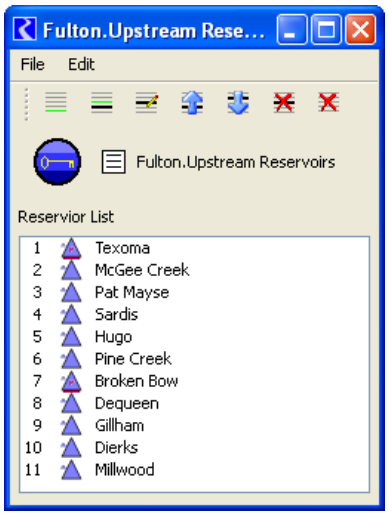
3.11 Expression Slots - Scalar

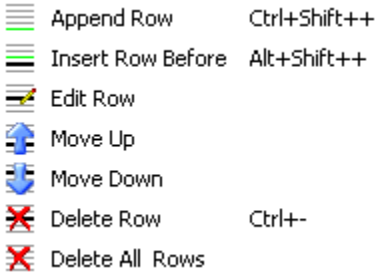
A **Scalar Slot with Expression** can be created on a data object. To add a Scalar slot with expression select **Slot ➥ Add Scalar Slot with Expression**. This slot, similar to the Series Slot with Expression, is used to evaluate an expression that evaluates to only one value, i.e. timestep independent. Click **HERE (Section 3.5)** for more information on **Series Slots with Expression** as that information is valid here too. The difference is that the scalar expression slot does not have an **Evaluation Range**, it will evaluate for the single value only. Like the series expression slot, the user can configure when it evaluates. Use the **Expression ➥ Evaluation Time** menu to choose.



3.12 List Slots

A List Slot is used to store a collection of non-numeric data, typically a group of objects. Shown to the right is a sample **Upstream Reservoirs** List Slot. This slot contains the Reservoirs that are upstream of the given control point. It is used in the Regulation Discharge and Flood Control algorithm to specify the reservoir which contribute to the flow at this control point. The following options are available from the **Edit** menu, from the toolbar icons, and from the right click context menu:





On a List Slot that contains either Objects, Slots, Accounts, or Supplies, when the user clicks on either the Append Row, Insert Row Before, or Edit Row, a selector will open allowing the user to choose the appropriate items.

Mass Balance Summary

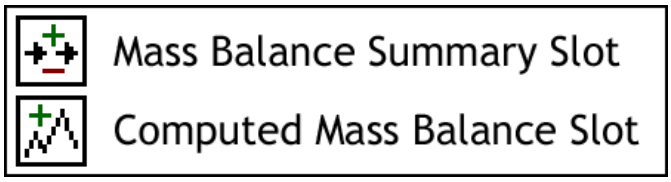
3.13 Mass Balance Summary

The Mass Balance Summary slot is a user-defined hierarchy of series slot collections used to check (i.e. sum) mass balance across many objects. The collections are themselves series slots representing the sum of the contained slots. These slots can be used within RPL expressions and any other place where series slots are used.

There are two levels of within a Mass Balance Summary slot:

- **Water Balance** -- the sum of one or more **Slot Sums**. For example, a water balance might represent all water flowing in/out of the main channel or all flows in the groundwater.
- **Slot Sum** -- the sum of one or more series slots. Slot sums are useful to summarize or classify different slots. For example, a **Slot Sum** might represent all the seepage, evaporation, diversions or return flow slots. The sum is represented as either the positive or negative sense. **Negative** Slot Sums are subtracted from their containing Water Balance. **Positive** Slot Sums are added in the containing Water Balance. Only flow or volume (unit type) series slots having the model run timestep size can be used. References to RPL expression slots are supported for entities not represented by slots on simulation objects.

The screenshot shows the icons for: (1) the Mass Balance Summary Slot, and (2) The Computed Mass Balance Slots (i.e. Water Balances and Slot Sums).



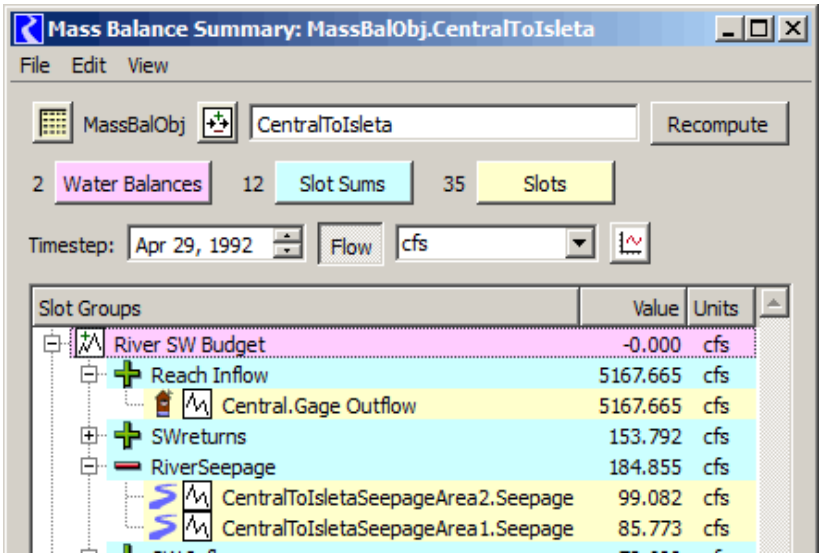
The Computed Mass Balance Slots are computed:

- On demand (by you) and/or
- At the end of a run, immediately after the evaluation of post-run RPL expression slots.

Also, a list of RPL expression slots to be evaluated after a Mass Balance Summary slot computation can be specified within the summary definition -- this can be used, for example, for annualization of mass balance summary results.

The screenshot shows the dialog for a **Mass Balance Summary Slot**. Colors are associated with the three collection levels:

	Collection Level	Backgrond Color
1	Water Balance	Pink
2	Slot Sum	Cyan
3	Slot Reference	Yellow



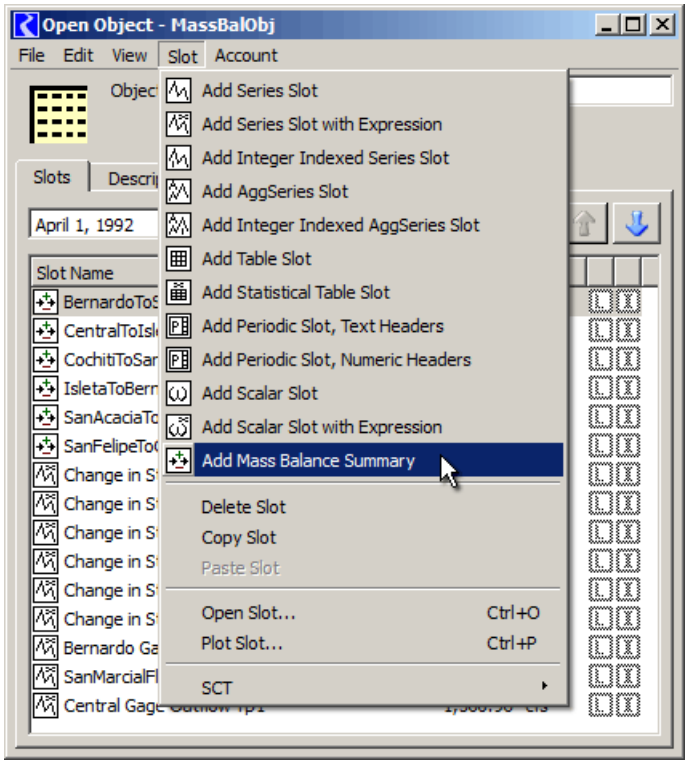
The three color buttons at the top of this dialog function as a “legend” for the three levels. Also, clicking on those buttons open the tree items in the list to the corresponding level. Also individual collection items can be opened and closed in the usual way -- by clicking on the tree controls.

Finally, the slots can be shown in any flow or volume units and plotted as needed.

3.13.1 Mass Balance Summary Slot Construction

Creating a Mass Balance Summary Slot: A **Mass Balance Summary Slot** can be created on any data object from the menu by selecting the **Add Mass Balance Summary** operation.

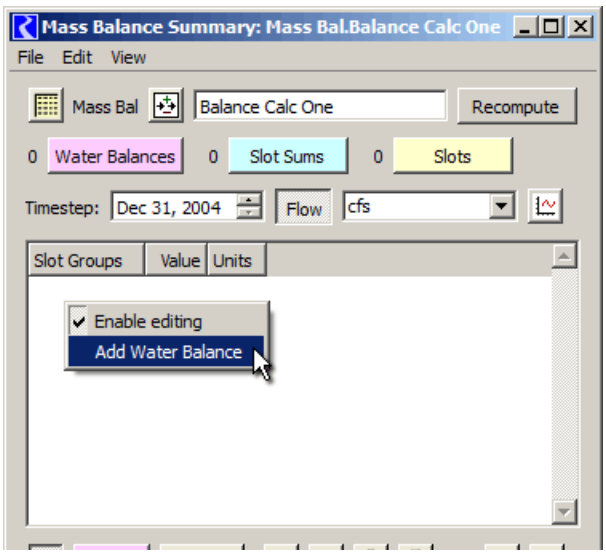
The name of the new Mass Balance Slot can be edited in it’s dialog. When the typed name is not valid, the text in the name entry field is shown in red.



Configuring a Mass Balance Summary Slot:

Editing the configuration of a **Mass Balance Summary Slot** can be enabled or disabled. It is initially enabled on a newly created slot. Editing can be enabled or disabled with the following controls:

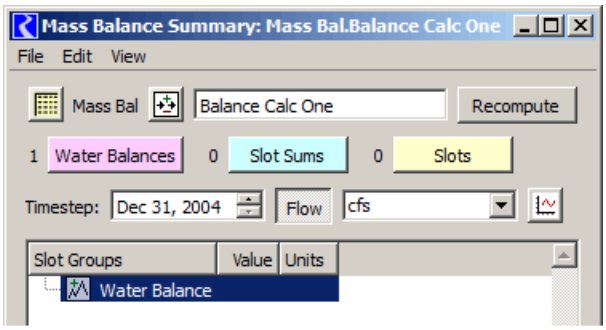
- The lock icon toggle button in the bottom left of the dialog. 
- The **Enable editing** item in the right-click context menu.
- The **Enable editing** item in the Edit menu.

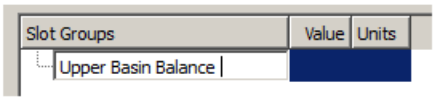


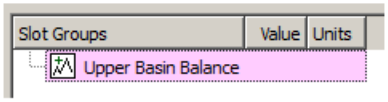
Right-clicking in the list outside of any defined items (e.g. when the list is empty) shows a simple context menu including the **Add Water Balance** operation.

The buttons along the bottom of the dialog are also context sensitive -- their operation and enabledness depends on the selection within the slot list. When no items are selected, the **New** button also adds a water balance to the list.

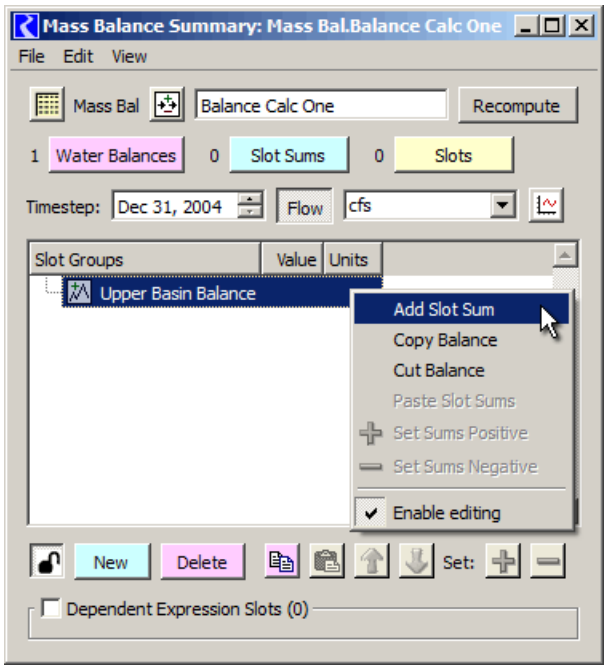
When new **Water Balances** or **Slot Sums** are created, they are given a unique default name. The name can be edited “inline” by double-clicking on the name.

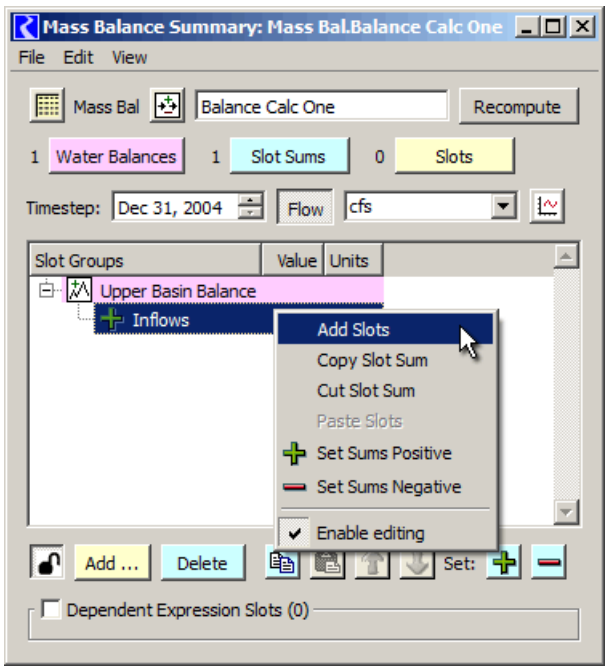




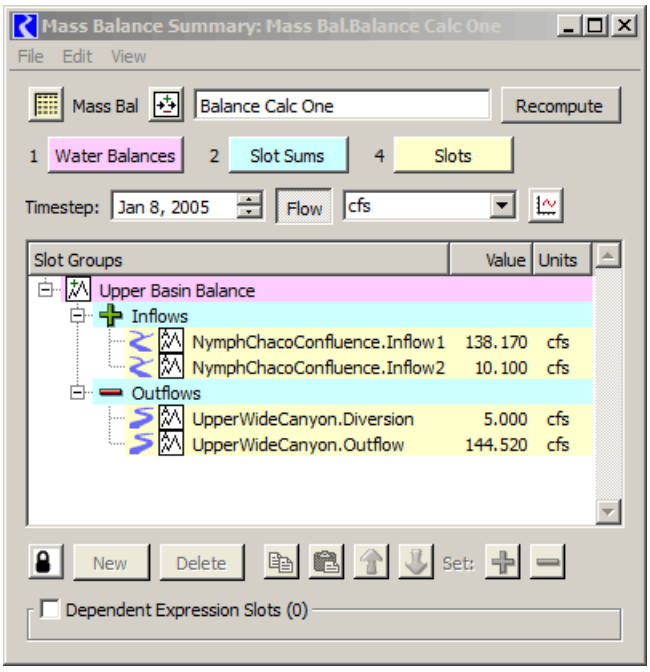


Slot Sums can be added to **Water Balances**, and **Slot References** can be added to **Slot Sums** using the **Add** context menu operation or the bottom context buttons.

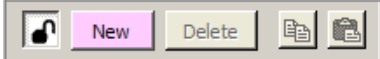
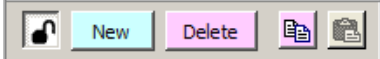
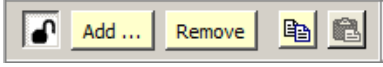




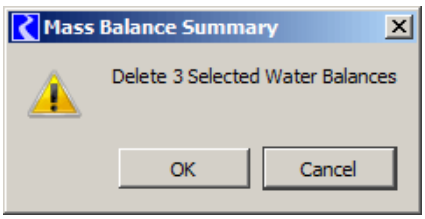
When adding Slots, the slot selector dialog is shown. This will allow the selection of only series slots. The slot selector's unit type filter will be shown, initialized to "Flow". It is also valid to select "Volume" slots which represent a non-static volume entity -- i.e. those which can be converted to "Flow" by dividing its value by the timestep interval (i.e. volume per time). (The computed results will be strange if a static volume slot, such as Reservoir Storage, is selected).



The following table illustrates the operations provided by the first several buttons, as a function of the selected item or items. Tooltips on these buttons provide additional information.

	Selected Item	Operations
	None	Create new Water Balance
	Water Balance	Create New Slot Sum; Delete / Copy Water Balance
	Slot Sum	Add Slot Reference; Delete / Copy Slot Sum
	Slot Reference	Add Slot Reference; Remove / Copy Slot Reference

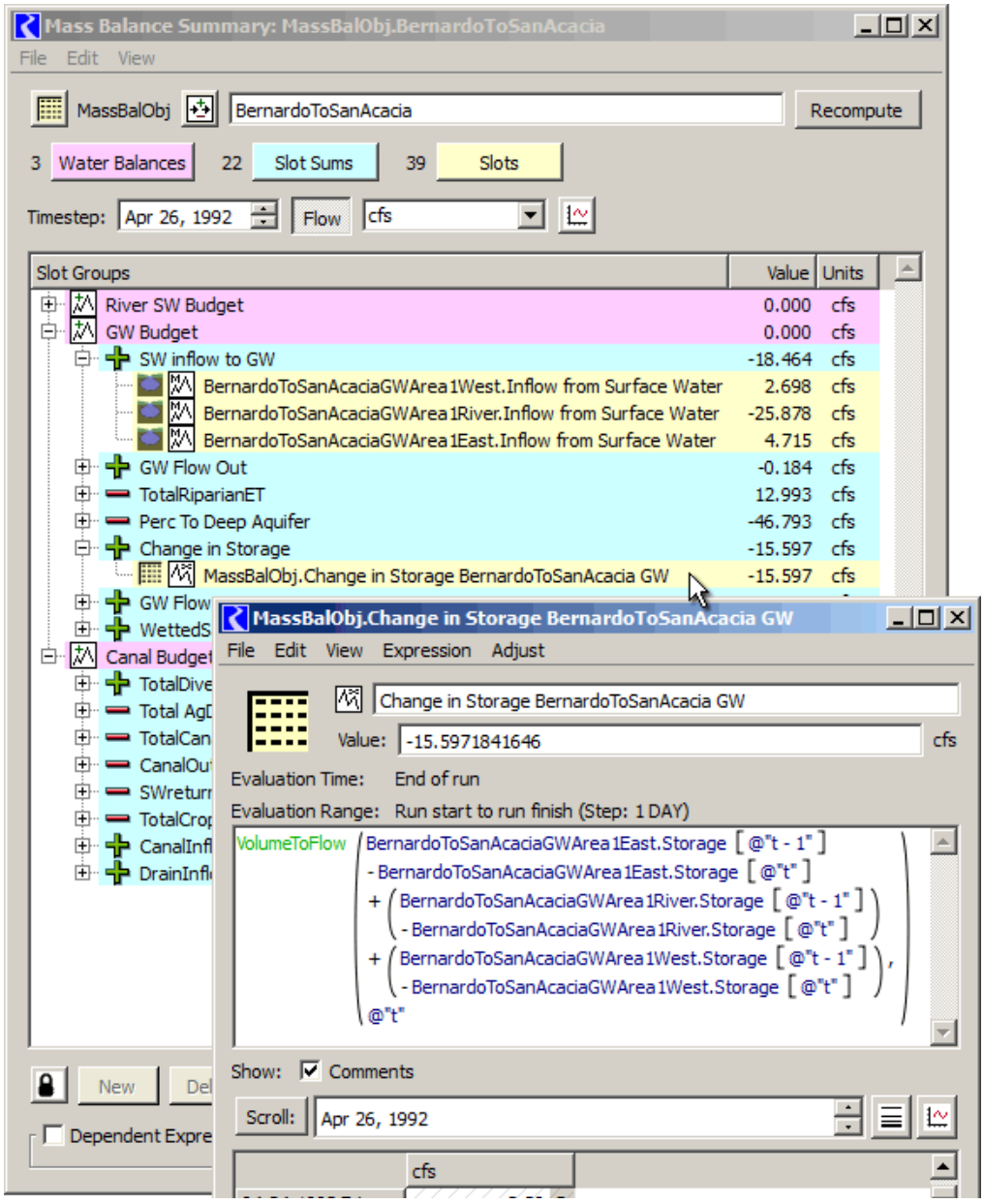
The **New** / **Add** and **Paste** operations are enabled only for single-item selections. The **Delete** / **Remove** and **Copy** operations are enabled on single or multiple selections when all selected items are at the same level. The enabledness of the **Paste** operation depends also on the type of items (Water Balances, Slot Sums, or Slot References) in the clipboard. You must confirm **Delete** / **Remove** operations.



The up and down arrows move the selected items up or down within the set of "sibling" items. They are enabled only when the selected items are all at the same level.

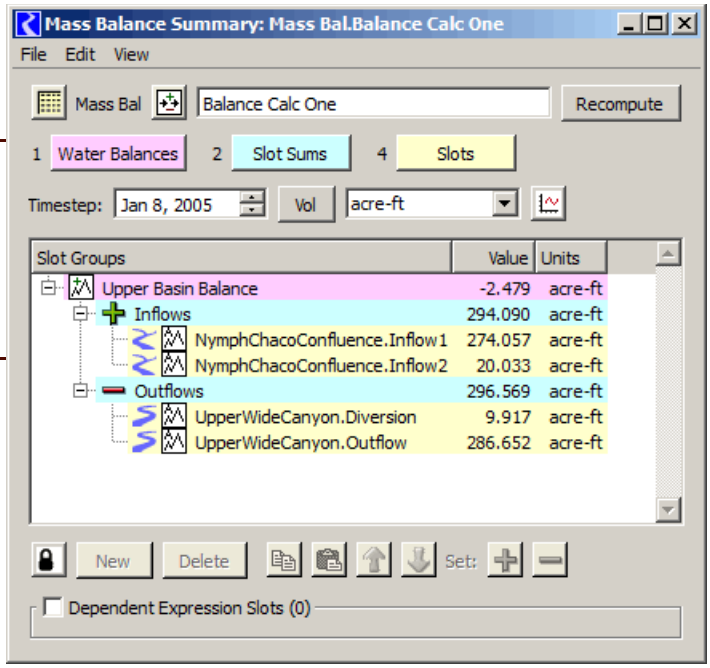
The  and  buttons affect the Slot Sums within the set of selected items. **When the mass balance summary is computed, the values of "positive" Slot Sums are added to the containing Water Balance; the values of "negative" Slot Sums are subtracted.**

RPL Expressions for Other Slots: For any value not provided as a RiverWare slot, you will need to define and refer to a RPL expression slot. Here is an example of the inclusion of a “change in storage” expression slot from the previous to the current timestep.



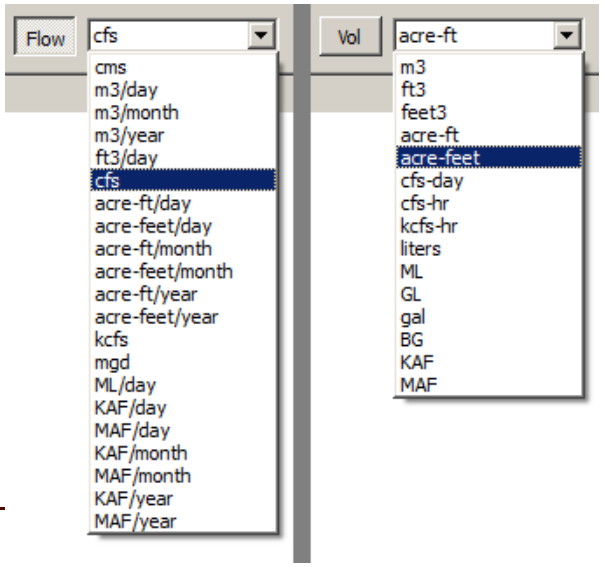
3.13.2 Mass Balance Summary Internal Display Operations

The **Mass Balance Summary Slot** dialog shows a single timestep value of all contained series slots.



> **Note:** All Water Balances, Slot Sums and series slot references must have the same timestep size as the model run. Water Balances and Slot Sums are computed for the model run interval (start to finish timesteps).

Units: Series values can be displayed in any Flow or Volume units in this dialog. Volume values are converted to flows by dividing by the timestep interval.

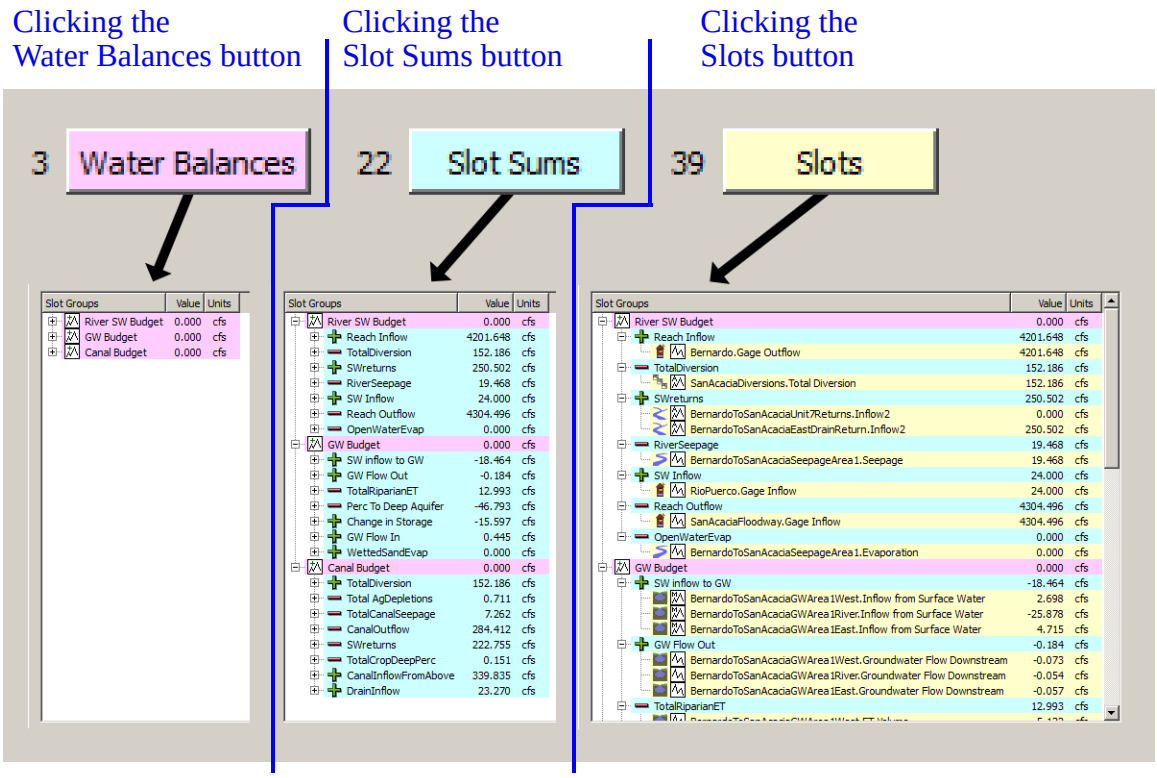


The individual settings for Flow and for Volume units are separately retained. That is, clicking the Flow and Volume toggle button switches between the last selected unit for those two unit types.

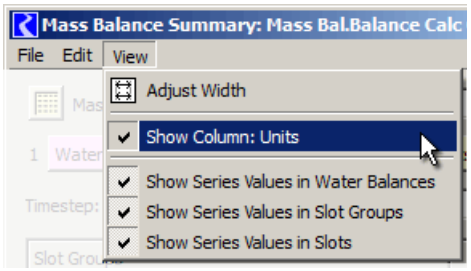
The selected unit type and unit is both a display setting and a configuration setting; when the mass balance summary is computed, the computed slots are reconfigured with these units.

> **Note:** When the computed results (Water Balances and Slot Sums) are referred to by RPL expressions, the units must work correctly or an error will be issued. Unit type incompatibilities will be reported by the RPL expression evaluation mechanism in the usual way.

Tree Display: As previously mentioned, the level "legend" buttons function to open the entire tree to the indicated level. Of course, individual tree items can be opened or closed by clicking on the standard tree controls.

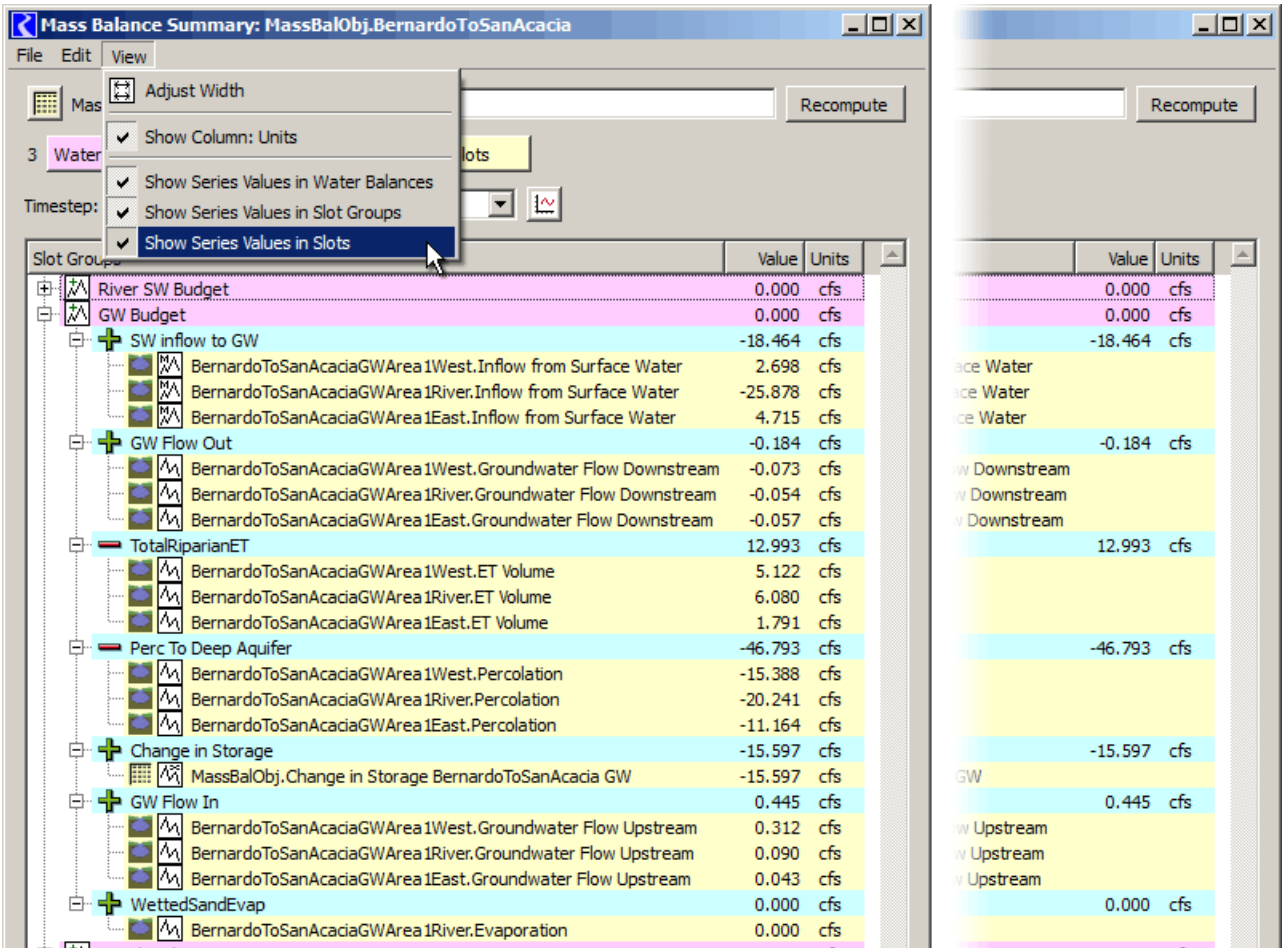


The **View** menu provides operations which effect data display within this dialog.



Show Column: Units: The units column in the slot list can be hidden. But, if slots having different unit types (other than flow and volume) are added to the list, units are unconditionally shown and the option to hide the units column is disabled.

Show Values: You may want to hide values at any of the levels, so that only comparable values (at the same level) are displayed. The three **Show Series Values** toggles in the **View** menus are used to show/hide the numeric values as illustrated on the following screenshot.



3.13.3 Mass Balance Summary External Display Operations

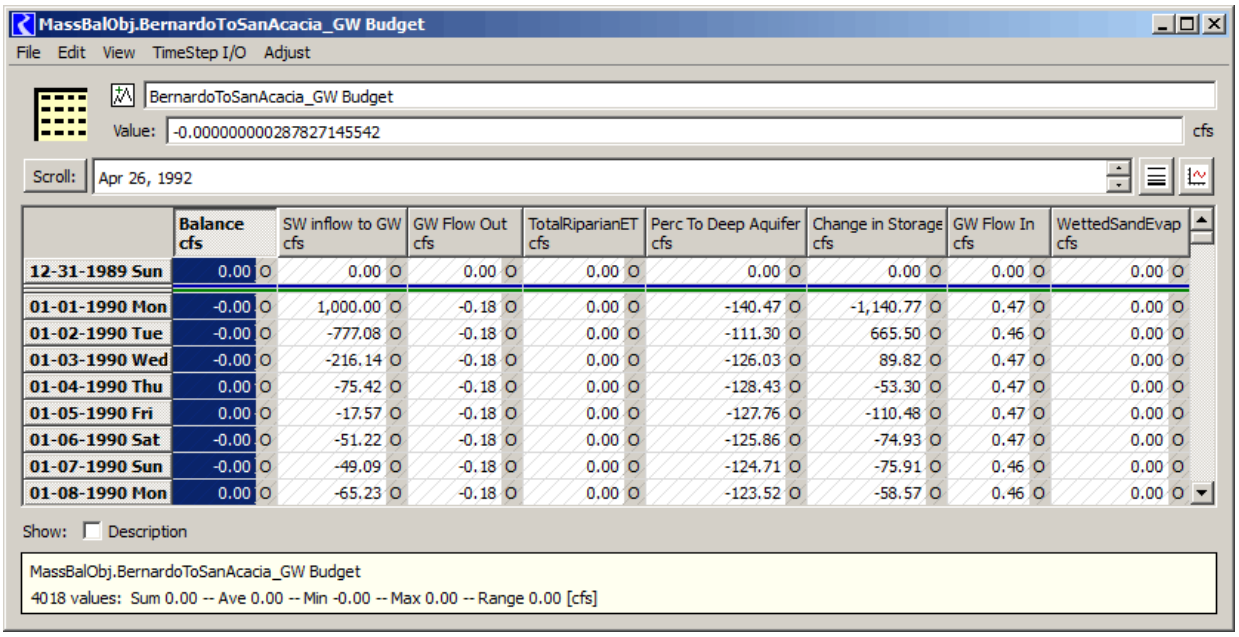
From the **Open Mass Balance Summary Slot** dialog, you can:

- Show selected slots in an open slot dialog.
- Show slots in a new SCT or in the single open SCT. You can show either the visible (in the tree), or only the selected slots.
- Plot the selected slots.
- Copy selected slots, e.g. to an Output Device or to the Snapshot Manager.

These options are described in the following sections:

Show Computed Slots in an Open Slot Dialog: As currently implemented, **Water Balances** are generated as aggregate series slots and each of the **Water Balance**'s **Slot Sums** are generated as series

slot columns on that aggregate. Use the **Open Slots... c**ontext menu to show the slot dialog for the selected component (editing disabled).



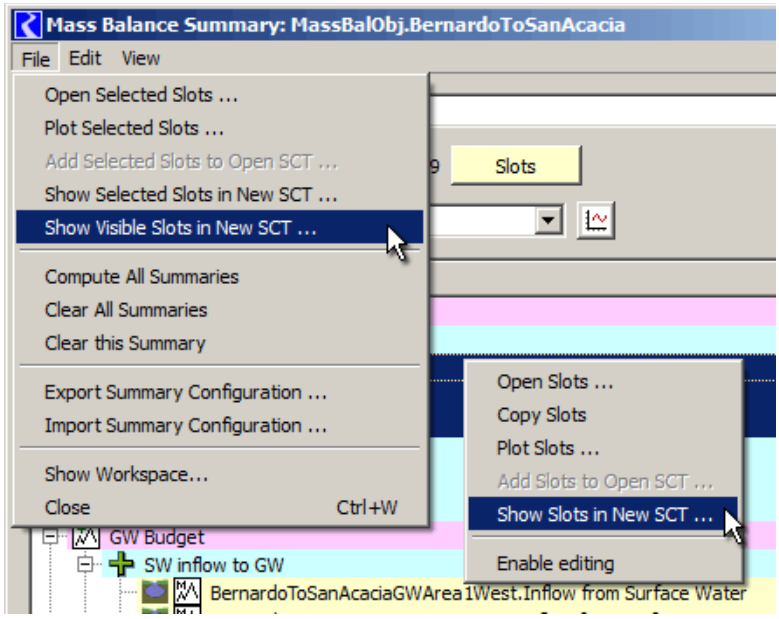
	Balance cfs	SW inflow to GW cfs	GW Flow Out cfs	TotalRiparianET cfs	Perc To Deep Aquifer cfs	Change in Storage cfs	GW Flow In cfs	WettedSandEvap cfs
12-31-1989 Sun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-01-1990 Mon	-0.00	1,000.00	-0.18	0.00	-140.47	-1,140.77	0.47	0.00
01-02-1990 Tue	-0.00	-777.08	-0.18	0.00	-111.30	665.50	0.46	0.00
01-03-1990 Wed	-0.00	-216.14	-0.18	0.00	-126.03	89.82	0.47	0.00
01-04-1990 Thu	0.00	-75.42	-0.18	0.00	-128.43	-53.30	0.47	0.00
01-05-1990 Fri	0.00	-17.57	-0.18	0.00	-127.76	-110.48	0.47	0.00
01-06-1990 Sat	-0.00	-51.22	-0.18	0.00	-125.86	-74.93	0.47	0.00
01-07-1990 Sun	-0.00	-49.09	-0.18	0.00	-124.71	-75.91	0.46	0.00
01-08-1990 Mon	0.00	-65.23	-0.18	0.00	-123.52	-58.57	0.46	0.00

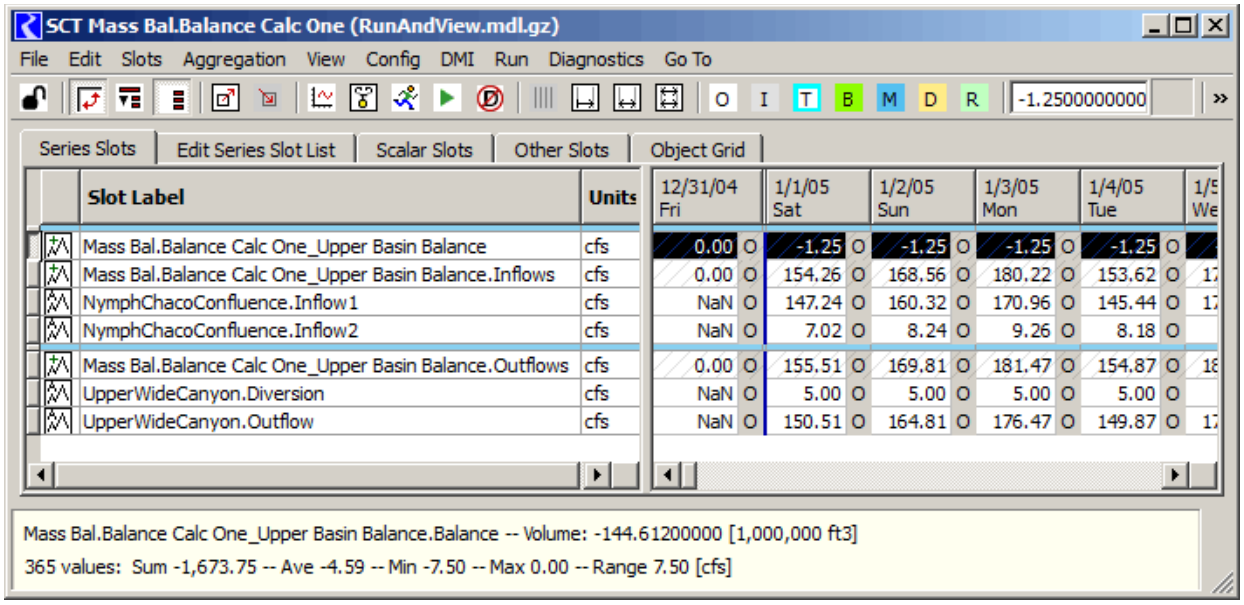
Note: There is currently no indication of the Slot Sums' "sense" being positive or negative.

Values are displayed with a crosshatch indicating that they are "read-only" (non-editable). Notice, in the image above, the not-quite-zero value in the "Value" line edit field from the single selected cell (upper left cell) -- this sort of value will be typical of actual computed Water Balance values (due to convergence). Enabling the display of the selection statistics (from the View menu) and selecting the first column provides a convenient way to determine whether or not the whole Water Balance series is zero.

Show Slots in an SCT: Computed summary and referenced slots can be shown in an SCT. If a single SCT is open, slots from the Mass Balance Summary dialog can be *added to* that SCT (the SCT must have the same timestep size as the model run).

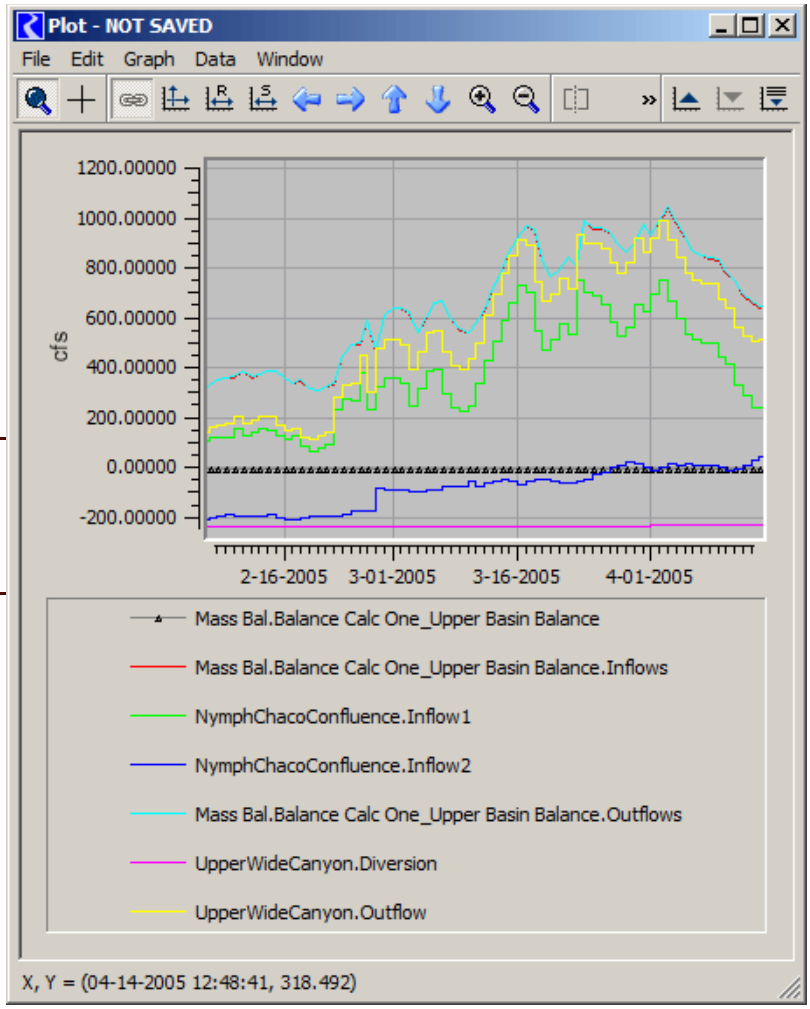
The **File** menu's **Show Visible Slots in New SCT** shows all slot items current visible in the slot list (i.e. excluding those hidden under a closed tree branch).





Note: Water Balance and Slot Sum slots are shown with the values and units set at the time of the most recent mass balance computation -- i.e. not necessarily the current unit setting in the Open Mass Balance Summary Slot dialog. If referenced slots are including in the "show in SCT" operation, they will be shown with their currently configured (or "active") units. And if they are editable slots, they will be editable in the SCT. (Notice the rows in the image above which are not cross-hatched -- those values are directly editable).

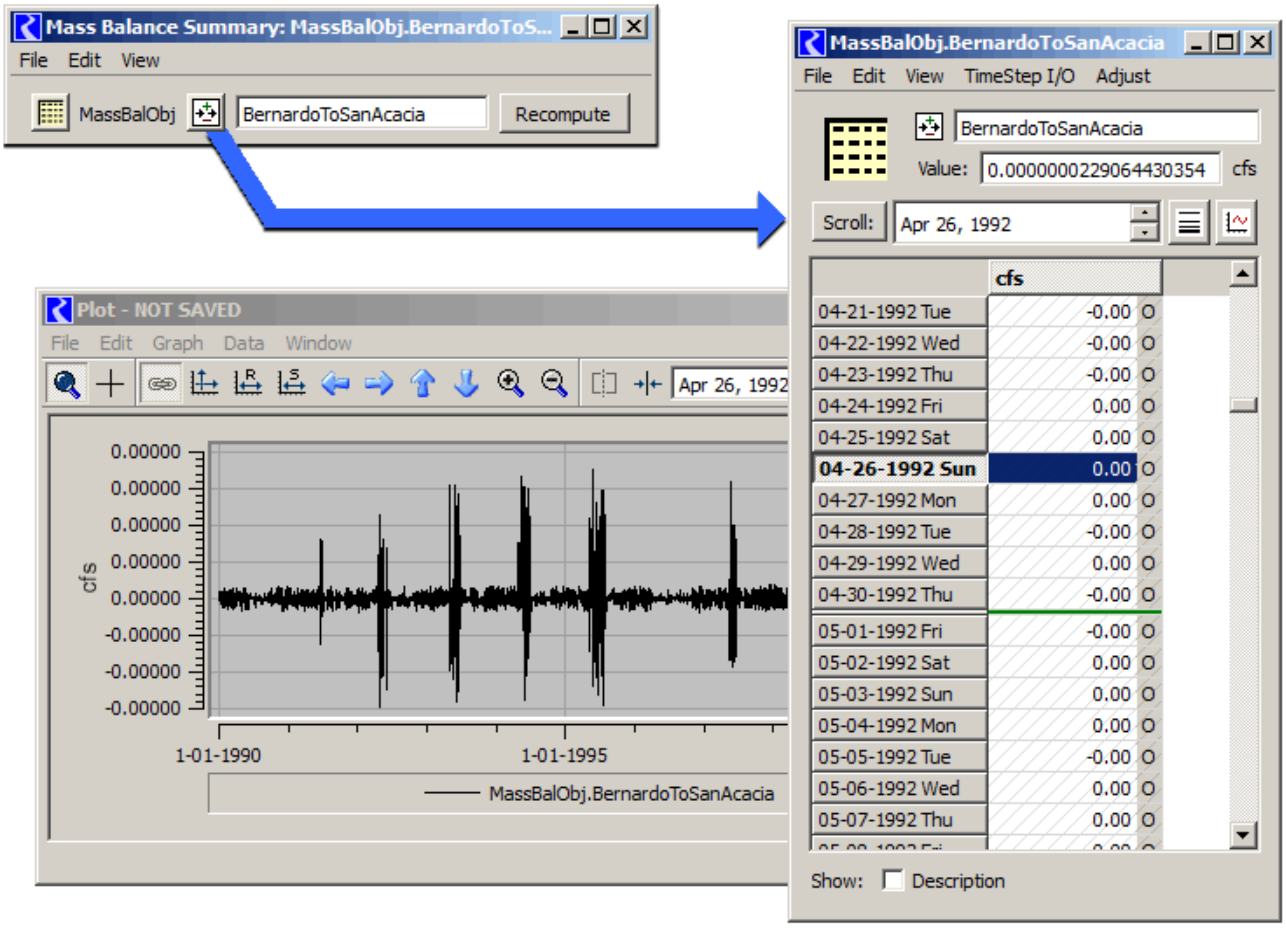
Plot Slots: Computed summary and referenced slots can be plotted in a single plot. Those operations are visible in the menus shown in the prior section. The note above regarding the active units of computed and referenced slots applies also to Plots -- i.e. the units used will not necessarily be those of the current settings in the Open Mass Balance Summary slot dialog.



> **Note:** All values are plotted in their positive (actual) sense -- values in negated Slot Sums are not shown as negated values.

Copy Slots: Computed summary and referenced slots can be copied to the RiverWare Slot Clipboard. From there, they can be pasted into various slot lists in RiverWare, including the general **Output Device** slot list and the **Snapshot Manager** slot list.

Examining the Mass Balance Summary Slot's Series: The Mass Balance Summary Slot is itself a series slot (contained on a data object) and can be examined by clicking on the Mass Balance Summary Slot icon button at the top of the dialog. (In a sense, a Mass Balance Summary Slot has two different "open slot" dialogs).



In the plot above, notice how all of the values represented on the vertical axis are zero (to a precision of five fractional decimal digits), in this example.

3.13.4 Dependent RPL Expression Slot Support

Mass Balance Summaries are designed in such a way that intermediate and final sum results (Slot Sums and Water Balances) are usable for custom user calculations implemented in RPL Expression Slots, such as annualization of values. In a run, the mass balance summary is computed after RPL Expression slots. To allow RPL expression slots to reference mass balance summary data, the **Dependent Expression Slot List** in a Mass Balance Summary is evaluated, in order, once, after each **Mass Balance Summary** is computed.

Dependent Expression Slot results will generally be incomplete when computing a Mass Balance Summary if the RPL Expression Slots in the list depends on sums from *multiple* mass balance summaries. The following provisions address this problem:

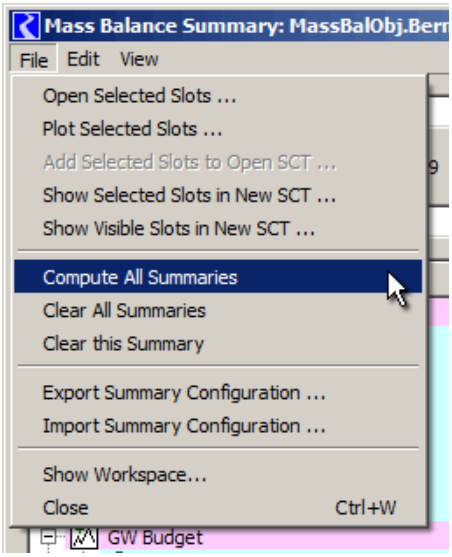
- The automatic “end-of-run” mass balance computations are performed in this order:

  1. The RPL Expression slots in the Dependent Expression Slot Lists in ALL Mass Balance Summaries are cleared.

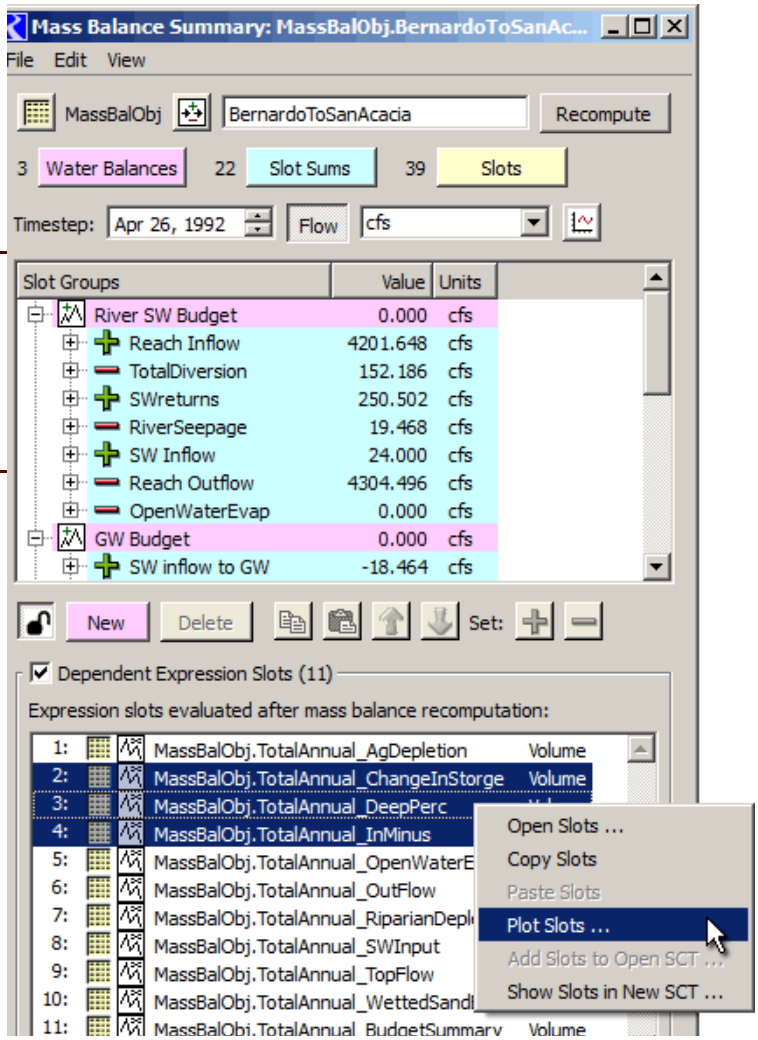
  2. All Mass Balance Summaries are computed.

  3. The RPL Expression slots in the Dependent Expression Slot Lists in ALL Mass Balance Summaries are evaluated.

- In addition, in the **File** menu, there is a **Compute All Summaries** option that perform this model-wide computation (the three steps in the prior item)



The Dependent Expression Slot panel at the bottom of the Open Mass Balance Summary Slot dialog implements editing and display operations similar to those of the main slot list.



> **Note:** If the dependent Expression Slots use a different from the model’s run timestep, they can’t be displayed in the same SCT as the computed summary slots and slot references.

Clicking the **Add** button opens the slot selector, initialized with **Has RPL Expression** and **Unit Type** (“Flow”) filters on by default.

3.13.5 Mass Balance Summary Computation

When computed, the timestep size and timestep range of each of the Mass Balance Summary and Slot Sums are set to the step size and range of the run controller. The unit type and configured display units are

set to those specified. For each timestep in the run time range, any of the contained slots having a valid value at that timestep contributes that value to the Slot Sum or Water Balance's value at that timestep. NaNs are ignored (effectively zero). The computed slots are set to be "read-only".

Limitations of the current Mass Balance Summary Computation:

- No "routed terms". A timestep offset cannot be applied to any slot reference within a Slot Sum, or to any Slot Sum within a Water Balance.
- No knowledge of "static volumes". The mechanism unconditionally converts all volumes to flows by dividing the volume by the timestep size (for each timestep). A RPL implementation of the "change in storage" calculation can be seen **HERE (RPL Expressions for Other Slots:)**.

Mass Balance Summary Computations are performed in these ways:

- By clicking the "Recompute" button in the Open Mass Balance Summary Slot dialog.
- By selecting the "Compute All Summaries" operation in the "File" menu of that dialog.
- Automatically, at the end of a run, immediately after the "end-of-run" RPL Expression Slots evaluation. This is performed unconditionally.

As a tool for debugging and testing Mass Balance Summary implementations (including user definitions), operations to **clear** an individual Mass Balance Summary, and all Mass Balance Summaries (including Dependent Expression Slots) is provided in the **File** menu.

3.13.6 Persistence

All Mass Balance Summary configuration information is stored on the Mass Balance Summary Slot. This is applied both in the RiverWare model file and in Export SimObj (data object) files.

A Mass Balance Summary Slot's computed slots are created as (effectively) invisible slots on the same data object. They do show up in the slot selector!

A Mass Balance Summary Slot's configuration can also be saved to, and read from a file using Export and Import operations in **File** menu.

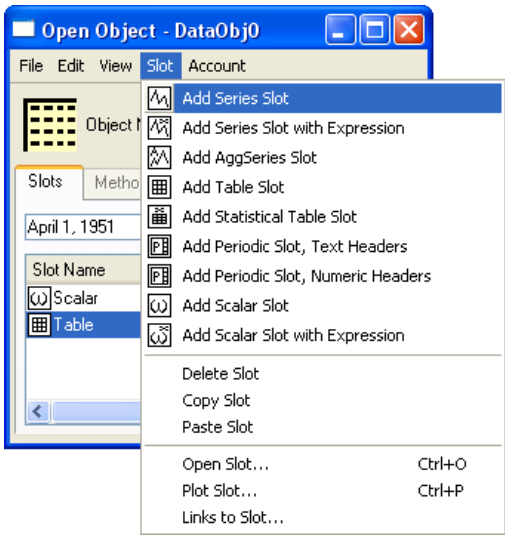
DateTime Values in Slots

4. DateTime Values in Slots

In addition to the standard unit types (Flow, Length, Volume, etc...) that can be configured on slots on data objects. It is now possible to add slots that have values in the slot that represents a DateTime. This is possible by configuring the slot to have a DateTime unit type. Following is a walk through describing how to add a slot with a DateTime value. Following that is a description of each of the date times and a description of how to use the values in RPL.

4.1 Walkthrough: Adding a Slot with DateTime Values to a Data Object

To introduce how DateTime Values exist on RiverWare Slots, this section walks the user through the process of creating a Series Slot with DateTime value on a Data Object.

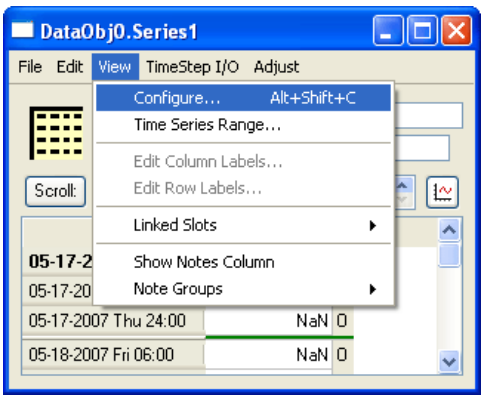


STEP 1. Create a Data Object and **Add a Series Slot,** or any of the following types of Slots. All of the following support DateTime values:

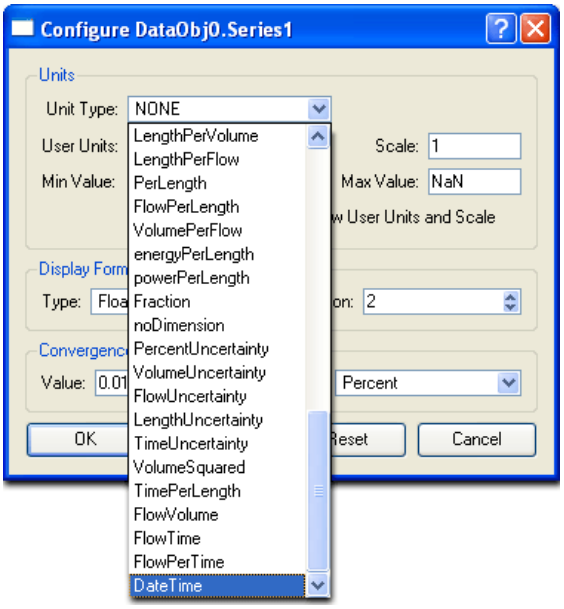
- Series Slot
- AggSeries Slot
- Table Slot
- Scalar Slot

STEP 2. From the Open Object Dialog, double click on your new Series Slot to show the Open Series Slot dialog.

STEP 3. From the Open Series Slot's **View** menu**,** select **Configure** to open the Series Slot Configuration dialog box...

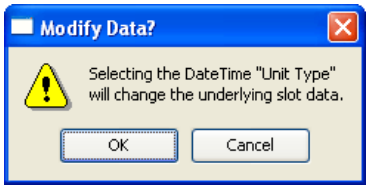


STEP 4. From the Series Slot Configuration dialog box, select the last item from the Unit Type option menu: **DateTime**.

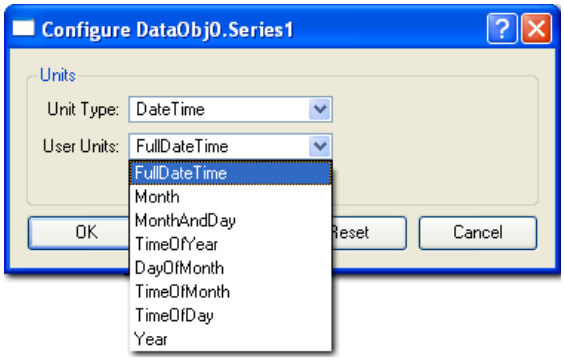


The "DateTime" Unit Type, and the eight supported DateTime User Units are special in RiverWare. These selections cause the Slot's values to be displayed and edited as DateTimes rather than as numeric values.

Unlike switching between ordinary Unit Types, switching to the "Date Time" Unit Type, and between the various DateTime "User Units" causes a change in the underlying Slot values. The user must confirm these changes with this popup dialog.



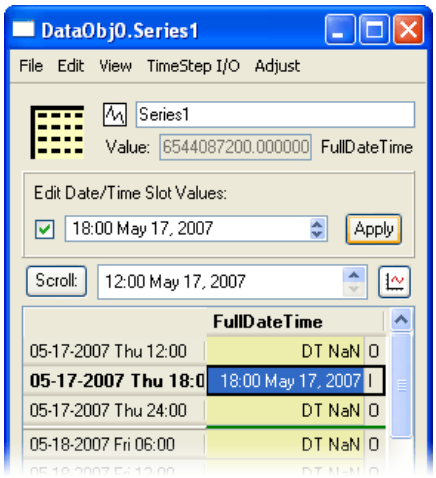
STEP 5. As a result of switching to the "DateTime" Unit Type, configuration properties associated with only numeric values are hidden (e.g. Min/Max values, Display Format, Convergence).



Notice the eight different "User Units" associated with the DateTime Unit Type. You can keep the default selection, "FullDateTime" ... **Click OK.**

Note: AggSeries Slots and Table Slots support independent Numeric / DateTime configuration on each column.

STEP 6. As a result of selecting a "DateTime" unit, the **Edit Date/Time Slot Values:** area is added to the Open Slot dialog.

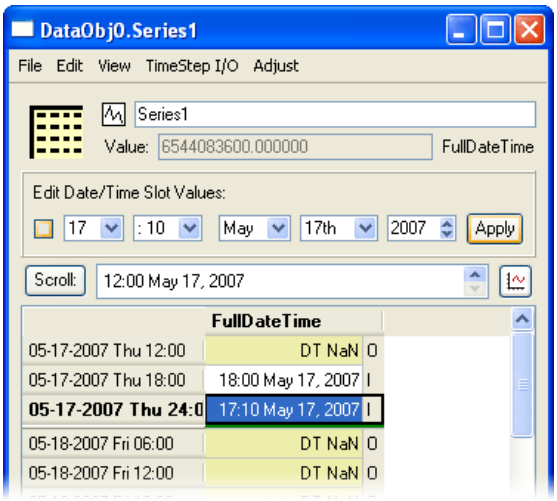


The entry and selection fields shown within the **Edit Date/Time Slot Values:** area depend on which DateTime "User Unit" selection was made. For the **FullDateTime** selection, two alternative entry modes are available, selectable with the checkbox on the left.

- **Timestep Spinner** -- for DateTimes on Timestep Boundaries. (first image).
- **Unconstrained Date/Times** -- for selection of any DateTime within the supported RiverWare date range. (second image) ....

Try making different Cell Selections, hitting the **Apply** button and repeating these steps with different DateTime entry values.

Notice that the **Value** field at the top of the Open Slot dialog is disabled (not editable, and shown with a gray background). This field shows the actual internal numeric value associated with the selected cell's DateTime value.



Double-clicking on a cell assigns the cell's value to the **Edit Date/Time Slot Values:** area.

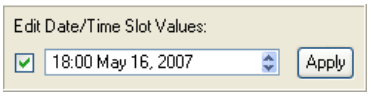
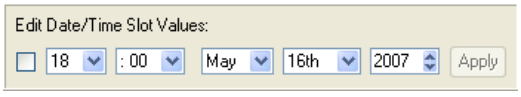
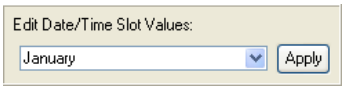
When a range of cells is selected with the first and last cell having valid values, interpolated DateTimes can be assigned to the intervening cells. Try: **Edit ➥ Interpolate** (not illustrated here).

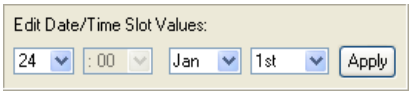
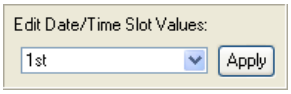
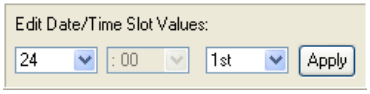
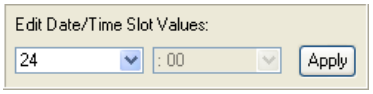
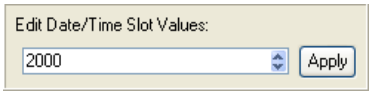
Plotting of DateTime value series is also supported. (Hit the Plot icon button on the right side of the dialog). DateTime coordinates are not shown on the axes, but relative DateTime "magnitudes" can be discerned.

DateTime values which don't conform to the Slot's (or Slot column's) configured DateTime "units" (Partial DateTime configuration) are shown with a yellow cell background. In addition, a value that is Not a Number (NaN) is shown with the syntax **DT NaN**.

4.2 Partial DateTime Editor

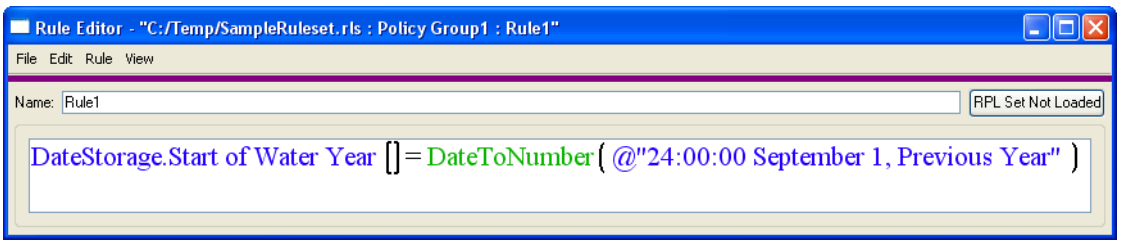
The Partial DateTime Editor in the Open Slot dialog also shows the applied DateTime. This page shows this dialog in standard numeric configuration and in the various Full and Partial DateTime configurations. The screenshots shown are for a Scalar slot but they are applicable to the other supported slots as well

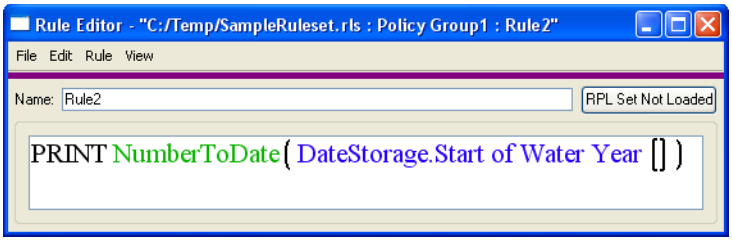
DateTime User Unit	Example	Selection Mechanism
Full DateTime	18:00 May 16, 2007	 Timestep Spinner or  Unconstrained Date/Times
Month	January	 Month pulldown menu

DateTime User Unit	Example	Selection Mechanism
Month and Day	January 1st	 Month and Day pulldown menu
Time of Year	24:00 Jan. 1	 Hour, Month, Day pulldown menu
Day of Month	1st	 Day of Month pulldown menu
Time of Month	24:00 1st	 Hour and Day of Month pulldown menu
Time of Day	24:00	 Hour pulldown menu
Year	2000	 Year Spinner

4.3 Access to DateTime values via RPL

RPL doesn't directly support DateTime Slot values as DateTimes. All Slot values are handled as numeric values. Two Predefined RPL Functions are used to convert the Slot DateTime values to and from RPL DateTimes values. The following illustration demonstrates the use of the **DateToNumber** and **NumberToDate** Predefined functions. The following two sections provide more information about these predefined functions.





The following links will take you to the appropriate documentation

- DateToNumber - This function converts a DateTime to the corresponding number. Click **HERE (RPLPredefinedFunctions.pdf, Section 23)** for more information.
- NumberToDate - This function converts a number to a corresponding DateTime. Click **HERE (RPLPredefinedFunctions.pdf, Section 114)** for more information

Notes on Series Slots

5. Notes on Series Slots

5.1 Introduction

Annotation of series slots using “Notes” allows the user to comment on data in a RiverWare model. The modeler may choose to document certain characteristics of input data such as filled values, storm events, etc. A run model saved with its results may include notes calling attention to certain operations, decisions, outcomes, etc. Other possible applications of this annotation functionality can be imagined. Notes are for documentation purposes; they do not affect the solution and they cannot be accessed (read or assigned) via RPL. In general, notes are available for all types of series (Series, Multi, Agg, Table Series, Series with Expression) and can be edited via the Open Slot dialogs, the SCT, and the Edit Account dialogs.

Notes are short text strings that are associated with one or more timesteps. Each note belongs to a “Note Group”. Each Note Group contains a list of associated slots and the timestep(s) to which they apply

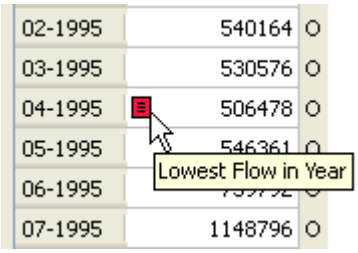
The “Note Group Manager” utility dialog facilitates creation and management of Note Groups. The display icon for each group can be assigned a color.

Currently notes can be imported and exported using old-style (non-direct-to-database) DMI functionality. Notes can be imported directly to a series slot through the slot edit dialog’s file menu but the export functionality on the same menu does not support notes.

Note: Support for text Notes on series slot timesteps (“Annotations” or just “Notes”) was redesigned in RiverWare 5.2. Notes are still organized within Note Groups, but notes are now directly applied to individual series slot timesteps rather than by associating their containing Note Groups with whole series slots. Additionally, multiple notes can be associated with a timestep on an individual series slot.

5.1.1 Notes

A Note is a text string that is associated with a series slot at a timestep and each note is associated with a **Note Group**. A Note has the following properties:

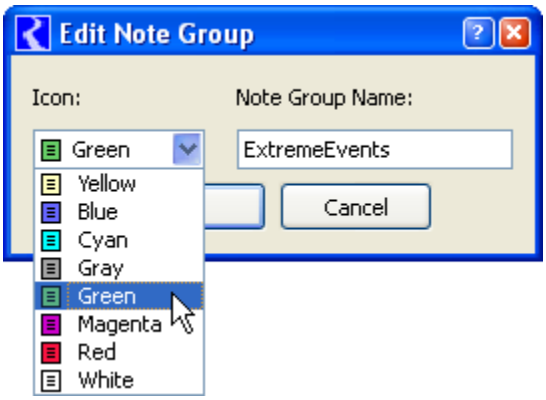


1. Note text: The text string that makes up the Note.
2. Note group membership: A note belongs to exactly one Note Group.

3. Slots and timesteps: A note has one or more series slots at specified timesteps

5.1.2 Note Groups

A **Note Group** is composed of three properties:

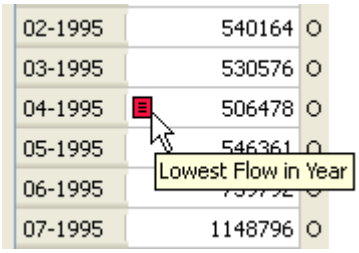


1. Name: a name is generally provided by the user.
2. Icon Color: A note group has one of eight basic colors.
3. Set of Notes: A Note Group has a set of one or more text **Notes**.

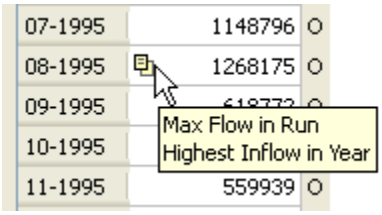
If the user wishes to change the note, the user does this in one location the **Note Group Manager**, with the changes propagating to all slots associated with the Note Group as described **HERE (Section 5.4.2)**.

5.2 Display and Editing of Notes

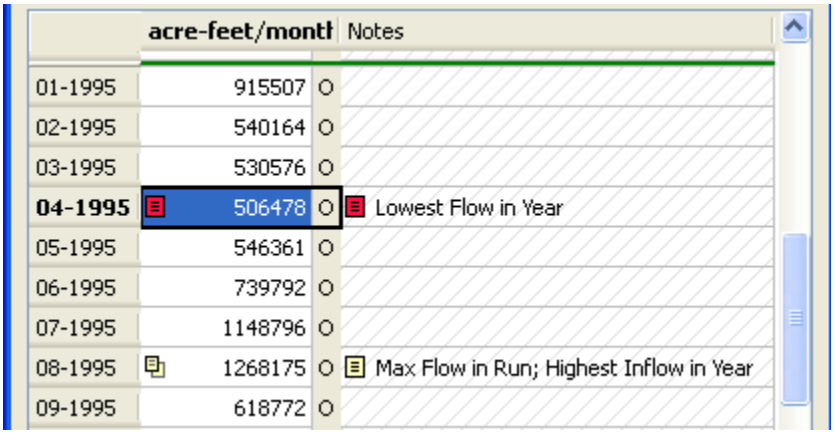
Note text can be seen and reviewed in the series slot dialogs. In the series slot dialogs (for Series Slots, Agg Series Slots, Multi Slots, Table Series Slots and Edit Account dialogs), the presence of a note is shown by a small icon to the left of the value. The color of the icon indicates the color of the note's Note Group. Mousing over the icon displays a tool tip with the Note's text.



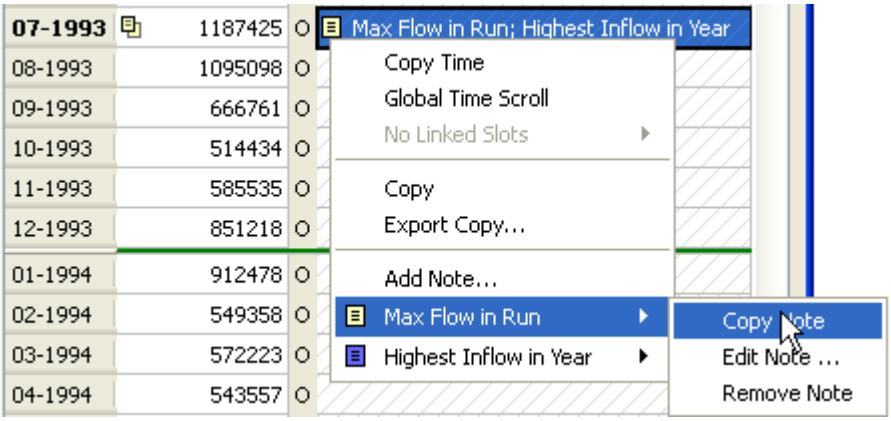
Cells having more than one note have a special icon suggesting one note stacked on the other. The tool tip lists each note, one per line. See image to the right.That icon is always yellow and does not reflect the color of any of the corresponding Note Groups.



The note text can be shown in a separate column using the **View ➥ [x] Show Notes Column** toggle menu item. If the Notes Column is visible and the open slot belongs to one and only one Note Group, a new note can be created by simply typing in the Notes Column. The Note will be created as a member of the slot's Note Group.

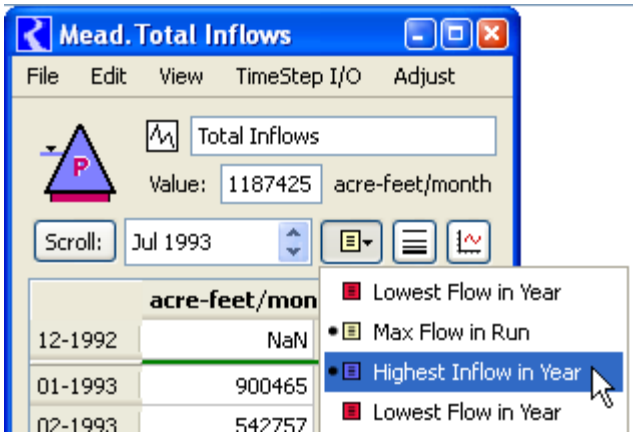


When one or more notes exist on a particular Slot/Timestep, the context menu (right-click) on the cell includes a submenu for each note. See the image below. The title of the submenu shows the Note Group icon and the Note Text. The submenu contains three operations:



- **Copy Note:** The **Copy Note** menu item copies a Note reference to the **Note Copy Buffer.** In the example shown to the right, the "Max Flow in Run" note would be copied to the buffer. The note can then be pasted in one or more cells using the **Paste Note** operations.
- **Edit Note:** The **Edit Note...** menu item shows the Note Group Manager Dialog, with the indicated Note pre-selected. The user may change the note text, or move the note to a different Note Group (potentially having a different Note Group icon).
- **Remove Note:** The **Remove Note** menu item removes the indicated note from the selected Slot/ Timestep (only). This does not effect the appearance of the same note at other timesteps on the same Slot, or on any other Slot.

The dialog can be scrolled to the timestep of a note on the Slot via the **Note Navigation** menu button**.** See the screenshot to the right Items in the **Note Navigation** menu having a bullet indicate that the timestep of the note matches that of the timestep spinner.



Holding down the Shift Key while selecting an item causes a Global Time Scroll (scrolling all open series-related dialogs to the corresponding timestep).

5.3 Creation of Notes

Following are three ways to create a note:

1. In an open series slot dialog, edit account dialog or SCT

- Right-click in a cell
- Select **Add Note...** from the context-sensitive pop-up menu. This will open the **Note Group Manager** which is described in detail **HERE (Section 5.4).**
- Choose or create a **Note Group**
- Choose or create the **Note** text.
- Choose the slots and timesteps to which the note should apply by clicking on the **Add Entry Using Context** button. This opens the **Apply Notes to Slots** dialog which is described **HERE (Section 5.5)**. The slot and timestep from which this right-click operation began are selected.
- Change/add slots or timesteps (if necessary) and click **Ok** to associate the Note with the slot/timestep.

2. From the main workspace:

- Choose the **Utilities ➥ Note Group Management...** menu. This opens the **Note Group Manager** dialog as described **HERE (Section 5.4)**
- Choose or create a **Note Group**.
- Choose or create the **Note** text.
- Click the **Add Slot Entries...** button to open the **Apply Notes to Slots** dialog which is described **HERE (Section 5.5)**.
- Click the **Add Slots...** button and choose the slots to which the note applies.
- Specify the timestep or range of timesteps to which the note applies.

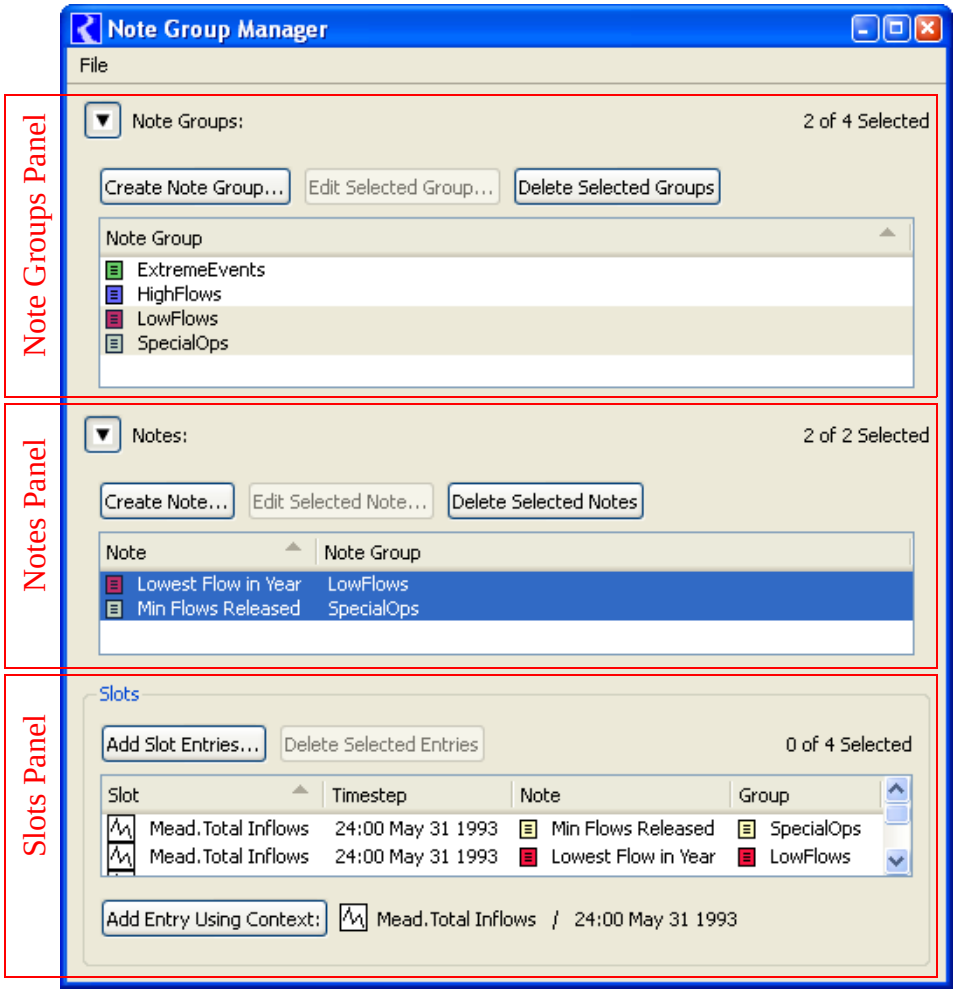
3. To create a note based upon an existing note (copy/paste of note). In an open series slot dialog, edit account dialog or SCT

- Right-click in a cell that has the desired noted.
- Select the note from the context-sensitive menu and choose **Copy Note.**

- Go to the destination slot and timestep and right-click in the cell.
- Choose **Paste Note: Name**.

5.4 Note Group Manager Dialog

The **Note Group Manager** and supporting sub-dialogs are used to maintain the set of notes on series slots.



This dialog is arranged vertically in three hierarchically defined panels as shown in the following figure: **Note Groups**, **Notes**, and **Slots**. The first two panels can show either a list or a combo box, controlled by the triangle arrow button in each panel. The combo boxes allow for the selection of a single item (Note Group or Note), or “All” items.

The panels are used in a top to bottom order. First you select (highlight) one or more **Note Groups**. Then the member **Notes** are displayed in the **Notes** panel. Then you select one or more **Notes** in the **Notes** panel and the member slots and timesteps are displayed in the **Slots** panel.

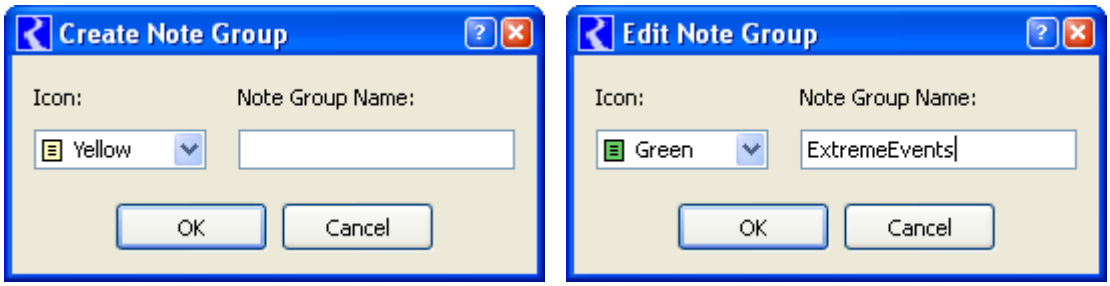
Following is a description of these three panels.

5.4.1 Note Groups panel:

The **Note Groups** panel shows all the defined Note Groups and supports three operations (buttons):

- Create Note Group...
- Edit Selected Group...
- Delete Selected Groups

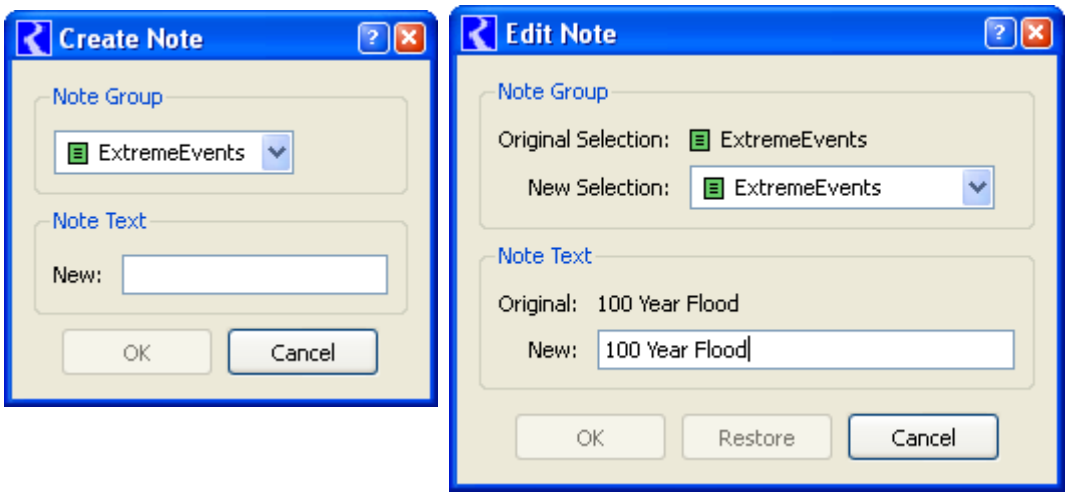
These buttons bring up dialogs for creating (define the name and icon color) or editing (changing the name and icon color), or confirming deletion of Note Groups as shown below:



5.4.2 Notes panel:

For the selected **Note Group** in the above panel, the **Notes** panel shows the notes that are a member of that group. It supports three operations (buttons):

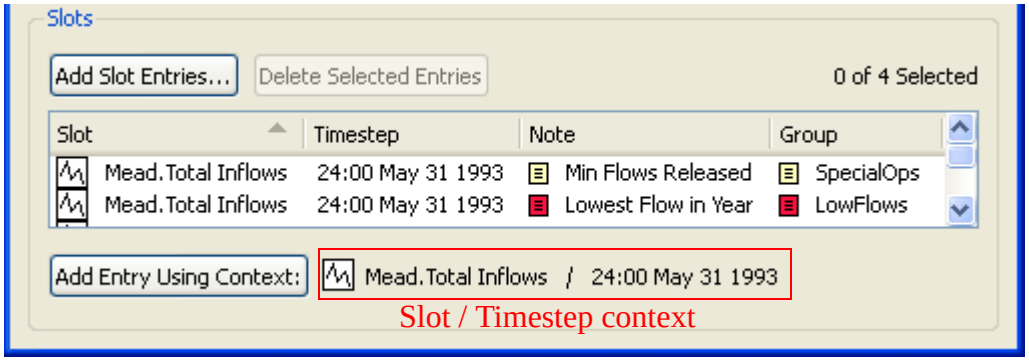
- **Create Note...**: Enter a new **Note** text and choose the **Note Group** to which it belongs.
- **Edit Selected Note...**: Edit existing **Note** text or change the **Note Group** to which it belongs.
- **Delete Selected Notes...**: Delete the selected **Note** after confirmation.



5.4.3 Slots:

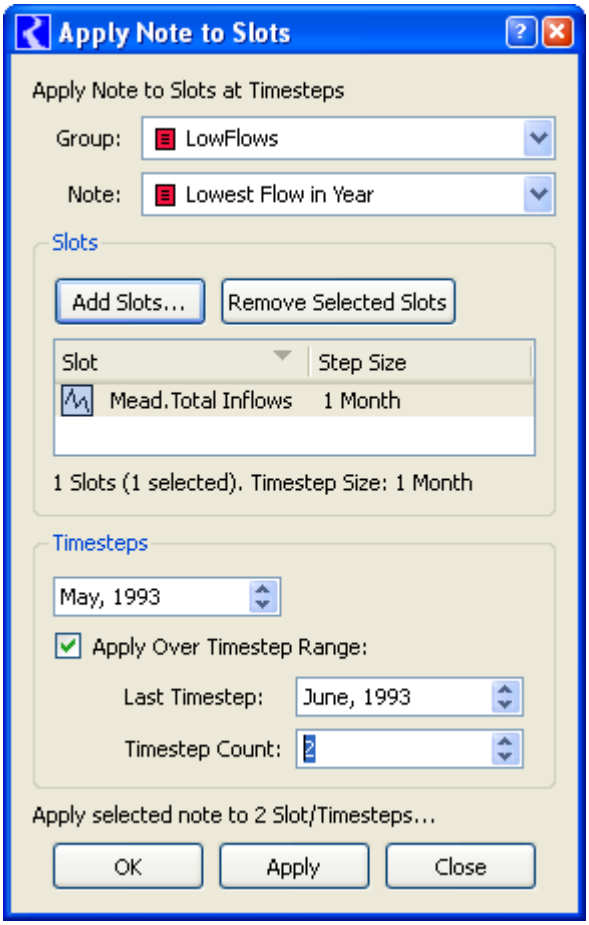
For the selected **Note**(s) in the middle panel, the **Slots** panel shows the slots and timesteps to which the note has been applied:

Both the **Add Slot Entries...** and **Add Entry Using Context:**



buttons bring up the **Apply Notes to Slots** dialog described in the next section. These differ only in the initial selections used in that dialog. The **Add Entry Using Context** button is available when the manager dialog is shown from the context of a particular slot and timestep, i.e. right clicking on a cell in a slot or SCT then choosing **Add** (or **Edit**) Note. The current context (Object.Slot and Timestep) is listed on the same line as the button.

5.5 Apply Note to Slots dialog



The **Apply Note to Slots** dialog allows the user to associate a particular note with one or more Slots at one or more contiguous timesteps.

The list of slots and the timestep selections are sometimes pre-selected, depending on how the **Apply Note to Slots** dialog is shown. These selections can be modified before creating the new Note/Slot/Timestep associations.

The Group and Note combo boxes can be modified to select a different note. Only one note can be selected at any one time.

Additional Slots can be added to the Slot List by clicking the **"Add Slots..."** button. This brings up the RiverWare Slot Selector.

Slots can be removed from the Slot List by selecting items in the list and clicking the **"Remove Selected Slots"** button. Doing so has no effect on any existing Note/Slot/Timestep associations.

In the **Timesteps** section, the user can choose one timestep or range of timesteps (continuous only) to which the note will apply.

The **OK** or **Apply** buttons are enabled only if the inputs specify a valid state representing Note/Slot/Timestep associations that are not yet existing. For one thing, all of the Slots in the Slot list must have the same timestep size. If enabled, the **OK** and **Apply** buttons create a Note/Slot/Timestep association for all of the Slots in the list (i.e. not just the selected Slot items).

Status lines under the Slot List and above the bottom buttons indicate the state of the inputs. Examples of the various messages shown in the bottom status line are as follows. (The OK and Apply buttons are enabled only in the 4th example):

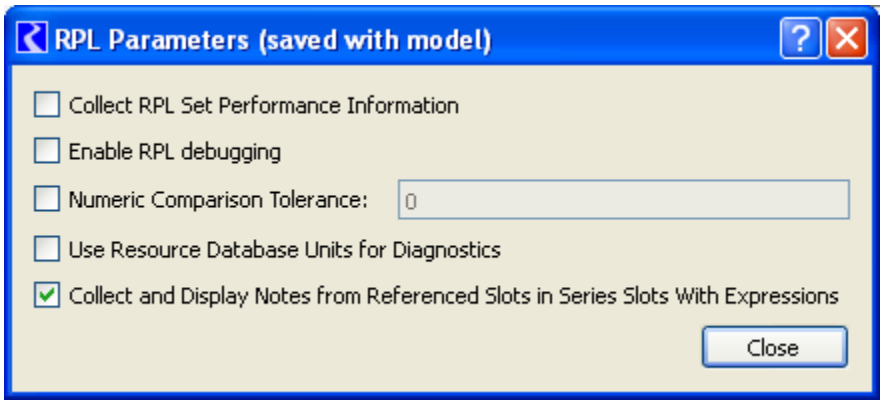
- No defined Note is selected.
- The Slot list is empty.

- The Slot list includes Slots having different timestep sizes.
- Apply selected note to 6 Slot/Timesteps... [enabled state]
- The selected note has been applied to 6 Slot/Timesteps.

5.6 Collected Notes on Expression Slots

Collected notes are a special type of note associated with series expression slots (i.e. **Series Slot with Expression)**. When the expression slot is evaluated, notes from the series slots referenced in its expression ("source" slots) are copied to corresponding timesteps in the expression slot. The source slots for providing notes are an accumulated list of the source slots referenced across the expression slot's evaluations at all timesteps. The notes from the source slots are collected and copied once at the end of the expression slot's evaluation. The collected notes are removed and re-collected each time the expression slot evaluates. In the context of a run, they are removed at the beginning of the run and collected at the end of the run, so if the run is paused or aborts in the middle, the collected notes will be absent.

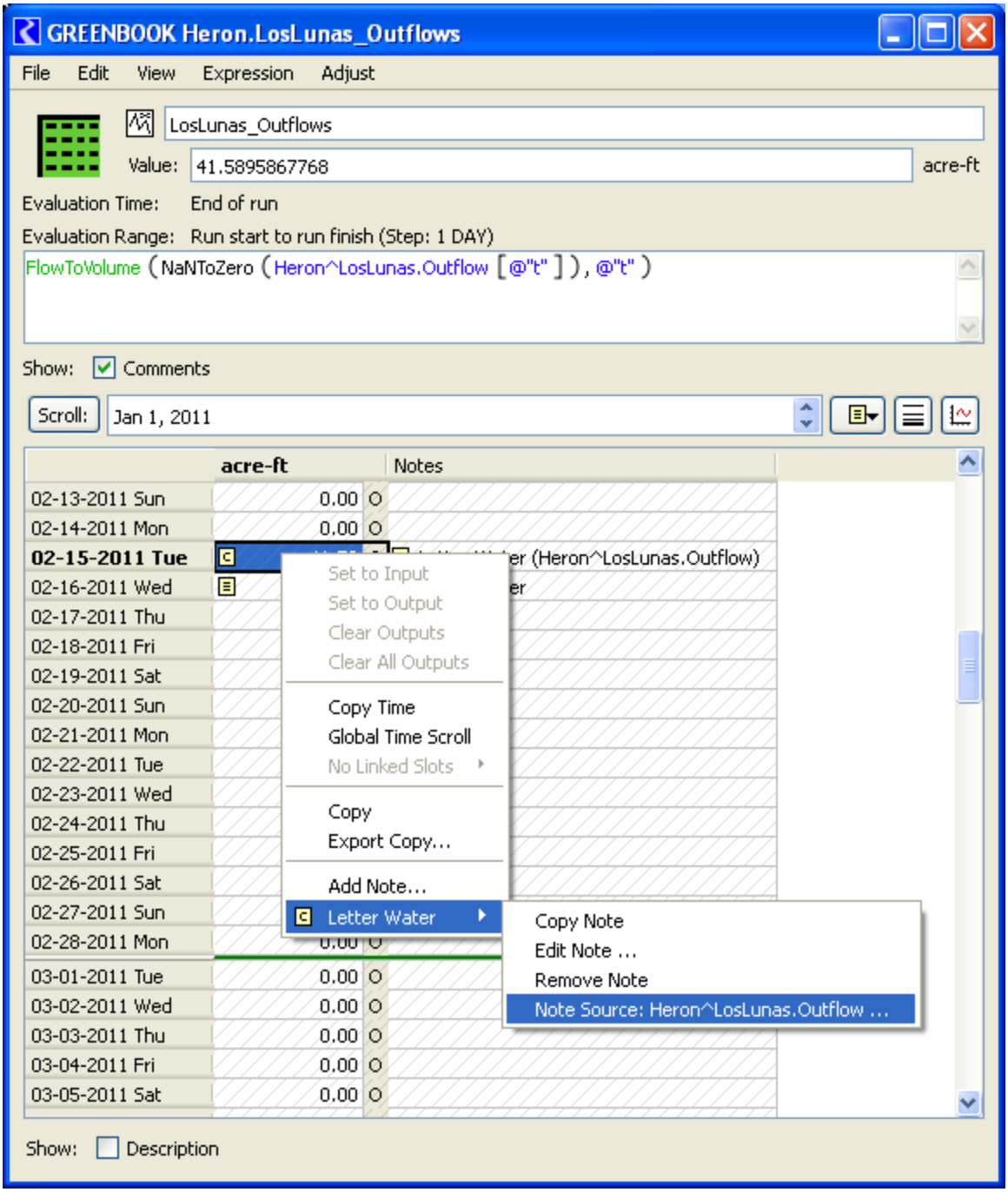
The collection of notes for series with expressions is optional and is controlled on a model-wide basis by a parameter selection in the **RPL Parameters** dialog. This dialog is available from the RiverWare workspace under the **Policy** menu.



In the places where notes for series can be displayed (Series Slot, SCT and Notes Group Manager dialogs), collected notes are differentiated by having a C in their icon. See the image below. The text of a collected note, where displayed in the notes column or in a tool tip when mousing over a note icon, will show the text of the note followed by the source slot name in parentheses.

Note: Note that if a note is propagated up through a number of expression slots, the slot where the note originated is maintained as the source slot for the note even though one expression slot may be picking it up from another expression slot that referred to the source slot.

The context menu (right-click) on a cell for a collected note in the series slot and SCT dialogs will have an additional menu entry showing the source slot of the collected note. Click the item to open the source slot's dialog. If a source slot is deleted from the model, the collected notes that refer to that source slot will also be deleted.


GREENBOOK Heron.LosLunas_Outflows
File Edit View Expression Adjust
LosLunas_Outflows
Value: 41.5895867768
acre-ft
Evaluation Time: End of run
Evaluation Range: Run start to run finish (Step: 1 DAY)
FlowToVolume (NaNToZero (Heron^LosLunas.Outflow [@"t"]), @"t")
Show: Comments
Scroll: Jan 1, 2011
acre-ft
Notes
02-13-2011 Sun 0.00 O
02-14-2011 Mon 0.00 O
02-15-2011 Tue
02-16-2011 Wed
02-17-2011 Thu
02-18-2011 Fri
02-19-2011 Sat
02-20-2011 Sun
02-21-2011 Mon
02-22-2011 Tue
02-23-2011 Wed
02-24-2011 Thu
02-25-2011 Fri
02-26-2011 Sat
02-27-2011 Sun
02-28-2011 Mon
03-01-2011 Tue 0.00 O
03-02-2011 Wed 0.00 O
03-03-2011 Thu 0.00 O
03-04-2011 Fri 0.00 O
03-05-2011 Sat 0.00 O
Set to Input
Set to Output
Clear Outputs
Clear All Outputs
Copy Time
Global Time Scroll
No Linked Slots
Copy
Export Copy...
Add Note...
Letter Water
Copy Note
Edit Note ...
Remove Note
Note Source: Heron^LosLunas.Outflow ...
Show: Description

5.7 DMI I/O

Notes can be output from RiverWare slots to data files using “old-style” DMI’s (i.e. DMI’s parameterized to use an external program and a control file as opposed to direct-connect database DMI’s). The control file keyword used to specify notes is as follows:

```
slot_anno = true
```

The default value for slot_anno is false, meaning no Notes will be written.

A line in RiverWare time series format (for DMI import or from DMI export) containing a note will be formatted as:

```
<value> anno {Storm Events} {4.3 Inches}
```

where <value> will be a numeric value, “anno” is a keyword, Storm Events defines the Note Group to which the note belongs and 4.3 Inches is the note itself. The “<“ and “>” will not exist in actual output. The “{“ and “}” do exist, delimiting the Note Group name from the note text itself.

Note: In the external RiverWare time series format, only one Note will be supported at one given timestep on any one SeriesSlot. That is, if a given SeriesSlot is a member of more than one (say, two) Note Groups, and if both of those Note Groups have a Note at the same timestep (say, 2-13-2007), then only ONE of those Notes will be preserved in the DMI operation.