Riverware

Technical Documentation Version 7.3

Model Run Analysis

Center for Advanced Decision Support for
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Model Run Analysis
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1. Model Run Analysis - Simulation

The **Model Run Analysis** utility provides post-run diagnostics regarding object dispatching and known values of dispatching slots at every timestep of the simulation. The **Model Run Analysis** dialog is invoked by selecting **Model Run Analysis** from the **Utilities** menu heading or by clicking on the Run Analysis shortcut button on the toolbar.

The **Model Run Analysis** tool provides dispatch information at two levels of detail. At the workspace level, the dispat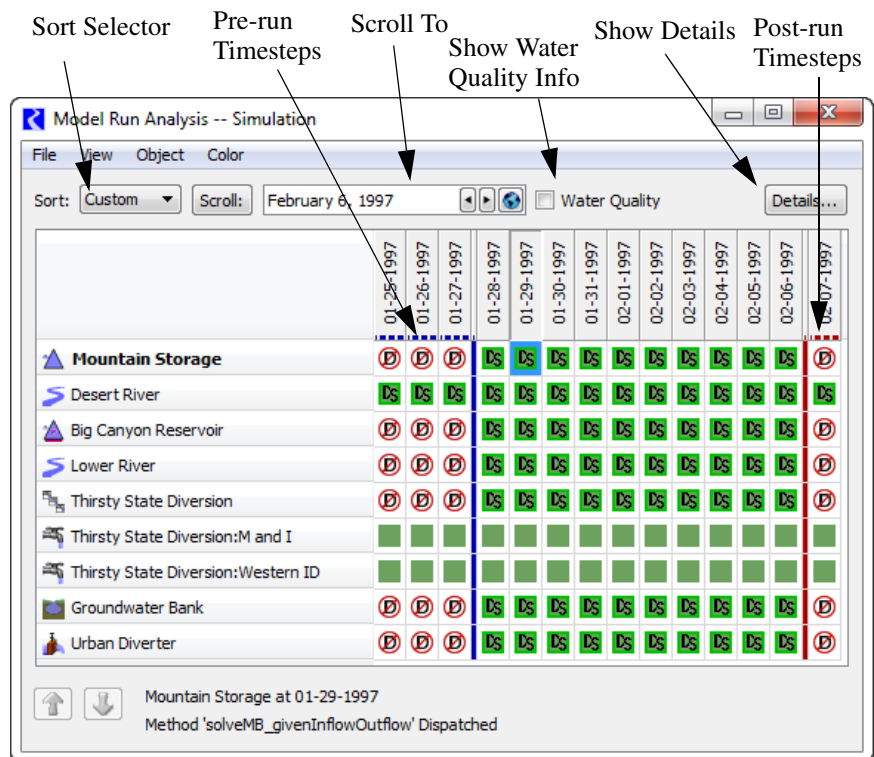ch state of each object for each timestep of the model run is visible. At a more detailed level, the tool allows an object's dispatch methods and known slot values at the end of each timestep to be viewed. A sample **Model Run Analysis** dialog is shown below:

The **Model Run Analysis -- Simulation** dialog displays the workspace-level view of dispatch conditions. This dialog consists of a two-dimensional matrix with workspace objects on one axis and model run timesteps on the other axis. The left-most part of the matrix, separated by a blue vertical line, indicates pre-run timesteps. Post-run timesteps (when configured) are shown separated by a red line. Each cell in the matrix shows the dispatch state of an object at the indicated timestep. Dispatches are registered automatically during model runs; dispatch information is displayed when available. Because they never dispatch, Data Objects and Snapshot Objects are not included in the list of Objects.

An Object has one of four possible dispatch states:

Object has not dispatched. The known and unknown slots for the timestep did not meet the requirements of any method on the dispatch table for the Object.

Object has dispatched but not solved. Conditions of a single method on the dispatch table were met; the method dispatched, but the Object did not solve completely. (in yellow)

Object has fully dispatched. Conditions of a single method on the dispatch table were met; the method dispatched, and the Object solved.

Object has no dispatch conditions. The Object has no entries on its dispatch table, the Object has no dispatch conditions (e.g. Gage Object or Thermal Object), or the model has not been run.

1.1 Dialog Tour

Following is a tour of the model run analysis dialog:

1.1.1 Sorting

The object list can be sorted using a variety of methods including the pull-down menu and the up and down arrows.

Sort menu: The order in which Objects appear in the dialog may be rearranged from its original alphabetical order. The Sort pull down menu allows the user to sort the objects by:

- Custom - The user may define a custom order using the **Up** and **Down** arrow buttons as described in the following section. Note, initially, the objects are arranged by the internal ordering of the objects in the model file as defined by the order in which objects were created.
- Name - Alphabetical
- Type - Arrange by the object's type. The types are then arranged alphabetically.
- Position - Arrange using the workspace layout to arrange the objects top to bottom based on y-coordinate (This assumes objects in the basin go top to bottom and the Run Analysis tool is displayed "Time on Top")
- Custom from Workspace - Use the custom order created on the Workspace **Object List** described **HERE (Workspace.pdf, Section 3.5)**.

Move Object Up/Down buttons: The **Up** and **Down** arrows are used to move one or more selected objects up or down in the list. These buttons are only available for the **Custom** sort order. When using any of the other sort orders (**Name**, **Type**, **Position**) the **Set Order** button is displayed and active. This button sets the currently displayed order as the new **Custom** order, switches the sort menu to **Custom**, and enables the **Up** and **Down** buttons. A warning message dialog is presented to alert the user that the custom order will be overwritten. This functionality allows the user to first sort by one of the common approaches, save the order as custom,

then make detailed changes using the **Up** and **Down** arrow buttons. Any further changes to the **Custom** order are saved automatically.

1.1.2 Scroll To

The **Scroll To** button allows the user to enter a date or use the datetime spinner to select a date. Clicking **Scroll** moves the dialog to that date.

1.1.3 Water Quality Dispatch Information

When water quality is enabled, as described **HERE (WaterQuality.pdf, Section 2)**, the Water Quality toggle is displayed on the main grid dialog and the WQ toggle is shown on Dispatch Details dialogs. When checked, the water quality dispatch information is shown instead of the water quantity dispatch information. More information on this can be found **HERE (WaterQuality.pdf, Section 3.2)**.

1.1.4 Time on Top/Time on Side

The Model Run Analysis tool can be shown with either time on the top or time down the side. In the view menu, the chosen option will have a check mark next to it.

1.1.5 Rules Grid

Even for a simulation model, the user can select to show the **Rules Grid** from the **View** menu. This can be useful when switching between the simulation and rulebased simulation controllers. Showing the Rules Grid provides additional information on the priority of the rules that set slots. Click **HERE (Section 2.1)** for more information.

1.1.6 Show Object Icons

In the **View** menu, the user can select to **Show Object Icons**. When checked, the icon for each simulation object is shown in on the tool. This option is only available when shown in the **Time on Top** configuration. For the **Time on Side** configuration, object icons are never shown.

1.1.7 Update After Every Timestep

In the **View** menu, the user can select to **Update After Every Timestep**. If this option is checked on, the utility, when opened, will be updated after every timestep. For models with a lot of objects or a large number of timesteps, this processing can be very time consuming and lead to adverse performance. For large models, it is advisable to turn this option off or keep the Model Run Analysis utility closed until the model has stopped running. Note, the utility is always updated when the run stops. For small models, this option can remain checked.

1.1.8 Fonts

The fonts used in the Model Run Analysis dialog can be changed from the **View ➡ Select Fonts menu**. Once a non-default font is configured, it is preserved as the "selected font." Using the **View ➡ Use**

Default Font and **View ➡ Use Selected Font**, the user can switch between the default and specified font.
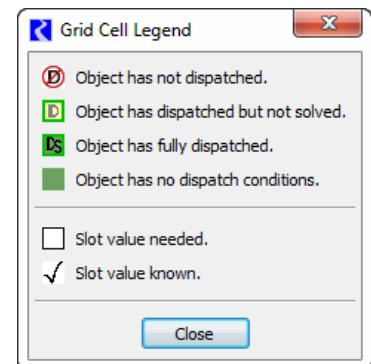
1.1.9 Pre-Run timesteps

Timesteps before the start timestep are displayed with a blue dotted line below/right of the timestep label. Also, there is a blue separator line between the initial and start timestep. Only certain objects (reaches, confluences, control points, and stream gages) dispatch during pre-run timesteps,. Thus, most objects indicate they have not dispatched during the pre-run period.

1.1.10 Post-Run timesteps

Timesteps after the finish timestep are displayed with a red dotted line below/right of the timestep label. Also, there is a red separator line after the finish timestep. Post-Run dispatching is enabled on the run control parameters **HERE (RunControl.pdf, Section 2.1)**.

1.1.11 Legend

A legend used in the Model Run Analysis can be displayed using the **View ➡ Grid Cell Legend** menu as shown in following screenshot.

1.1.12 Dispatch State

Clicking on an Object/timestep cell displays its dispatch state in text form at the bottom of the Dispatch Information dialog. If the Object dispatched at that timestep, then the name of the method under which it dispatched is also displayed.

1.1.13 Right Click Context Menus

On the Model Run Analysis, right-click context menus are available to **Show Dispatch Behavior Details..., Show Special Results Details..., Open Object..., Disable Dispatching, Copy Time**, and **Global Scroll**.

1.1.14 Disabling Dispatching

The **Model Run Analysis** dialog may be used to disable or enable dispatching for individual Objects. Disabling dispatching prevents the object from dispatching at any timestep, regardless of what slots are known. The Object's Beginning of Run behavior, however, may never be disabled. This functionality is useful to debug models. To disable dispatching for an Object, click on its name and select **Object ➡ Disable Dispatching** from the Model Run Analysis dialog menu bar. The Object name is shaded with red diagonal lines to indicate that it will no longer dispatch. To re-enable dispatching, click on the name of the Object for which dispatching has been disabled and select the **Object ➡ Enable Dispatching**.

1.2 Details Dialogs

From the model run analysis tool, you can see additional information for any object at any timestep. The information available depends on the model's controller and other selections. Following are the available details:

1.2.1 Dispatch Behavior Details Dialogs

The **Dispatch Behavior Details** dialogs allow the entries in the dispatch table and the known slots at the end of each timestep to be viewed for each object. To open a **Dispatch Behavior Details** dialog, double-click on a cell in the **Model Run Analysis** dialog which represents the desired object and timestep.
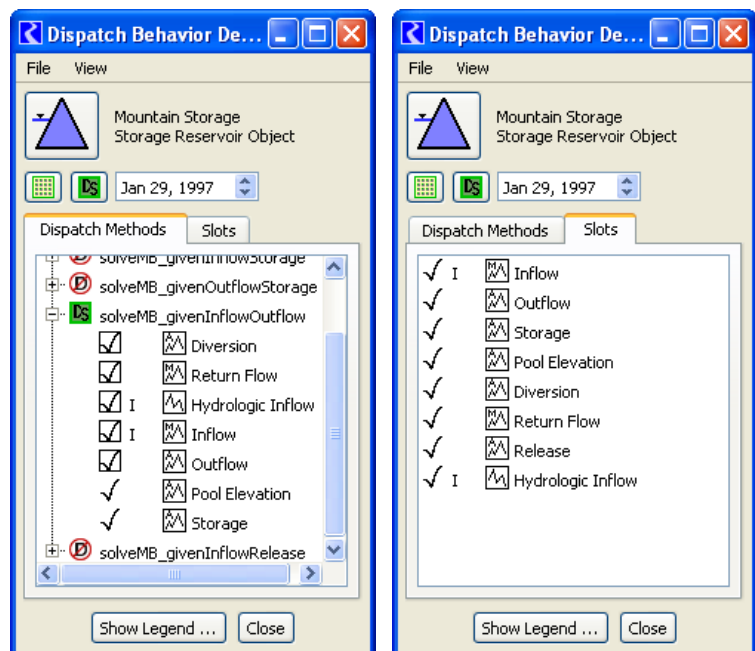
The **Dispatch Behavior Details** dialog has two views. The default view depends on the dispatch state of the selected object/ time. A sample of each view is shown:

If the Object *has no dispatch* conditions, or the model has not yet been run, a blank dialog is shown.

If the Object *did not dispatch* during the selected timestep, the **Dispatch Behavior Details** dialog appears showing the slots tab. Each of the displayed slots is a required known and/or a required unknown for one of the Object's dispatch methods. The checkmarks indicate which slots were known at the end of the selected timestep.

To view the entries in the dispatch table (possible dispatch methods) for this object,

select the **Dispatch Methods** tab. The **Dispatch Methods** view shows all of the methods in the Object's dispatch table, each marked with a symbol indicating whether the method dispatched. Clicking on the tree view to the left of a dispatch method name opens a list of its dispatch conditions. Slots in the list with a box to their left are required knowns for the method to dispatch. Slots with no box are required unknowns. Checkmarks indicate which slots were known at the end of the timestep.
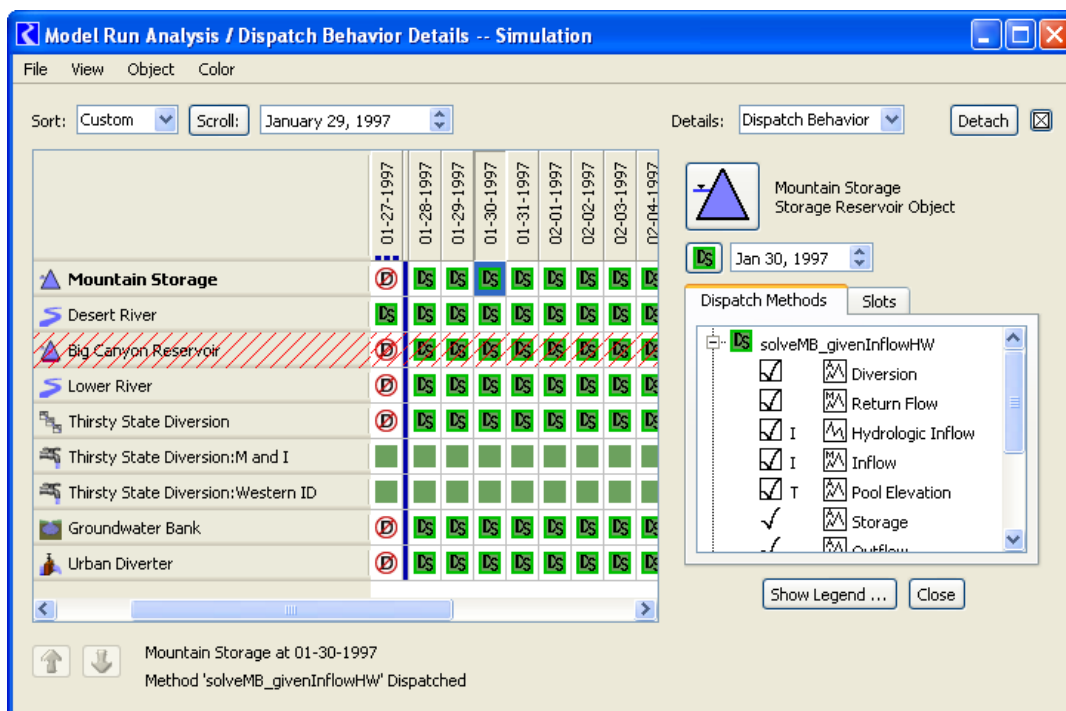
If the object *did dispatch* during the selected timestep, the **Dispatch Behavior Details** dialog opens in the **Dispatch Methods** view. The method which dispatched at the selected timestep is marked with the dispatched symbol and is opened to show its dispatch conditions. Notice that all of the slots are checked as known, even those required to be unknown. This occurs because the object solved correctly for all slots, making them known by the end of the timestep. We know that the dispatch conditions requiring unknowns were met at the time of dispatching because the method could not have dispatched otherwise. This may seem slightly confusing, but remember that the known/unknown status of particular slots is

truly of interest only if the object failed to dispatch at the selected timestep. If the object did indeed dispatch, all of the conditions must have been met.

The **Dispatch Behavior Details** dialog contains a date spinner which moves the detail view forward and backward in time. This is useful to determine how the set of known slots changes from timestep to timestep.

The **Dispatch Behavior Details** dialog can also be docked in the **Model Run Analysis** dialog. From the **Model Run Analysis** dialog, click the **Details** button. This adds the **Dispatch Behavior Details** dialog to the same window as the **Model Run Analysis** dialog, as shown.

When docked, the dialogs can be separated using the **Detach** button. When in stand alone mode, the **Dispatch Behavior Details** dialog can be docked from its **File ➥ Dock in Model Run Analysis** menu.

In the **Dispatch Behavior Details** dialog, clicking on the Object icon brings up the Open Object dialog. Similarly, Clicking on the icon ▦ brings up the Model Run Analysis and docks the **Dispatch Behavior Details** dialog.

1.2.2 Rule Effects Details Dialog

The **Rule Effects Details** dialog displays the names of all rules and whether each rule succeeded at the selected timestep. More information is available **HERE (Section 2.5)**.

1.2.3 Special Results Details Dialogs

The **Special Results Details** dialogs provide access to results for certain algorithms and computations. Currently the implemented special results are for USACE Methods. Click **HERE (USACE_SWD.pdf, Section 5.5)** for more information.

2. Model Run Analysis - Rulebased Simulation

A modified version of the **Model Run Analysis -- Simulation** dialog, which is available when the Simulation controller is active, is available when the Rulebased Simulation controller is active. The Rulebased Simulation version of the **Model Run Analysis -- Simulation** dialog is called the **Model Run Analysis -- Rulebased Simulation** dialog. It provides important information regarding slot priorities, determination of dispatch methods, and propagation of the effects of rules across a model. It is a diagnostic tool to be used in conjunction with the regular diagnostics to debug rules and verify that a run has solved as expected.

2.1 Main Analysis Dialog

The **Model Run Analysis -- Rulebased Simulation** dialog is opened by selecting **Model Run Analysis** from the **Utilities** menu or clicking on the model run analysis toolbar button.

For each object at each timestep, the cells provide information about the dispatch state of the object. The five possible dispatch states and their icons are:

Not Dispatched - The known and unknown slots for the timestep did not meet the conditions of any method on the dispatch table for the object.

Dispatched But Did Not Solve - Conditions of a single dispatch method were met, the method dispatched, but the object did not solve completely (background is yellow).

Dispatched and Solved Based Entirely on User Input Values - Conditions of a single method were met from user input; the method dispatched, and the object solved completely.

No Dispatch conditions - The object has no entries on its dispatch table; the object has no dispatch conditions (e.g., Thermal Object), or the model has not been run.

Dispatched and Solved Based on Highest Priority Known Values - Conditions of a single method were met by prioritizing the slots, the method dispatched, and the object solved completely.

The first four dispatch states are identical to those in the **Model Run Analysis -- Simulation** dialog **HERE (Model Run Analysis - Simulation)**. The last dispatch state is specific to the **Model Run Analysis -- Rulebased Simulation** dialog. It provides information about the priorities of the governing slots for a dispatched object. The priorities and possible **R** flags of the governing slots are a good way to verify the solution of a Rulebased Simulation run.

Recall that Reservoir objects have two governing slots, selected from the list of potential governing slots. Reservoirs may solve downstream due to Inflow and Storage or Inflow and Elevation, upstream due to Outflow (or Energy or Release) and Storage or Outflow (or Energy or Release) and Elevation, or it may solve for its ending Storage and Pool Elevation due to Inflow and Outflow (or Energy or Release). The intersection of the required knowns of the dispatch method and the potential governing slots of the object determine the governing slots. The governing slots shown in the **Model Run Analysis -- Rulebased Simulation** dialog show us the direction of the solution.

When an object/timestep cell is clicked on, a box at the lower left corner of the **Model Run Analysis** dialog displays its dispatch state in text form. If the selected object dispatched at the selected timestep, the box shows the name of the method with which it dispatched and the names and priorities of the governing slots.

The arrows next to the priorities in the cells represent the direction of water flow through the slot. Outflow is a downstream link to other objects in the model; it is marked by a down arrow. Inflow is an upstream link to other objects in the model; it is marked by an up arrow. The absence of an arrow next to some of the governing slots indicates that they are not topologically relevant. These are slots like Storage and Pool Elevation which are neither linked upstream nor downstream.

Example:

Consider the two cells shown to the right. They describe two reservoir objects which are linked. The upstream reservoir is shown above the downstream reservoir. Can you reconstruct how this model solved?

Answer:

The upper reservoir dispatched given the following slots:

> Inflow (there is an "upstream linkable" arrow next to the slot priority)
> > which was set as a user input (the priority is **0**).
> Storage or Pool Elevation (there is no arrow next to the slot priority)
> > which was set by Rule #2 (the priority is **2R**).

So, the upper reservoir must have solved for its Outflow at priority 2; Rule #2 must have been the last successful rule at the time the upper reservoir got enough information to solve.

The lower reservoir dispatched given the following slots:

> Inflow (there is an "upstream linkable" arrow next to the slot priority)
> > which was set as a result of the upper reservoir's dispatch
> > at priority 2 (the priority is **2**).
> Outflow (there is a "downstream linkable" arrow next to the slot priority)
> > which was set by Rule #3 (the priority is **3R**).

So, the lower reservoir must have solved for its Storage and Pool Elevation at priority 2 or 3. We cannot be sure of the priority of Storage and Pool Elevation from the information given. If Rule #2 made its assignment first, the last successful rule to fire before the lower reservoir's dispatch must have been Rule #3; Storage and Pool Elevation would have a priority of 3. If, however, Rule #3 made its assignment first, the last successful rule to fire before the lower reservoir's dispatch must have been Rule #2 (which would cause the lower reservoir's Inflow to be known); Storage and Pool Elevation would have a priority of 2.

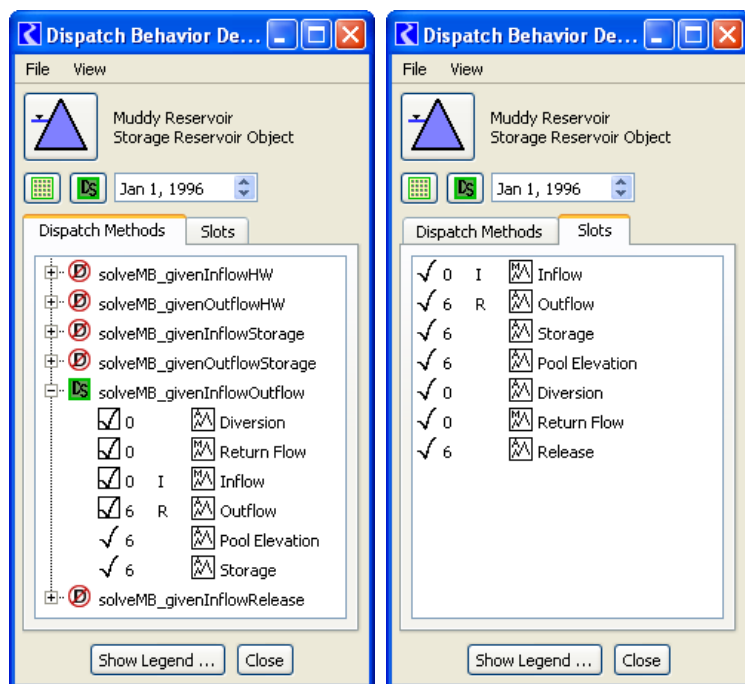The directional arrows may be turned on or off by clicking in the **Show Slot Link DIrections** box under the dialog's **View** menu. In the same menu, you can turn on or off the automatic updating which occurs every timestep by clicking in the **Update After Every Timestep** box. Turning off the updating may save some time if you are running a long model with the **Model Run Analysis** dialog open.

2.2 Dispatch Behavior Details Dialog

The **Dispatch Behavior Details** dialog is similar to the one in the **Model Run Analysis -- Simulation** dialog, but contains additional information. In both the **Dispatch Methods** view and the **Slots** view, the priorities and flag status of slots is displayed as well as their known/unknown status. The slot priorities and flags, along with knowledge about how objects select a dispatch method, allow the user to understand why each object solved the way it did.

In using the **Dispatch Behavior Details** dialog to determine why an object solved using a particular dispatch method, it is important to recognize that the display only shows the post-dispatch information. This is different from the information before the dispatch. After the dispatch, all slots which are solved for have the priority equal to the controller priority at the time of the dispatch.

If, however, the dispatch of an object fails due to a priority conflict, the **Dispatch Behavior Details** dialog will still show the original priorities and **R** flags of the slots. This can be helpful in debugging an aborted run.

2.3 Transient vs. Final Information

An important difference between the diagnostics messages and the **Model Run Analysis -- Rulebased Simulation** dialog is their handling of transient information. Diagnostics messages are generated continuously throughout the run, while the **Model Run Analysis -- Rulebased Simulation** dialog updates its information at the end of each timestep. Diagnostics messages provide a trace of the run execution, including all intermediate states within a timestep. The **Model Run Analysis -- Rulebased Simulation** dialog, however, provides a snapshot of the most recent execution details from the perspective of the end of the timestep. Any intermediate states of dispatching, slot values, and priorities which existed before the solution was finalized for the timestep are unavailable.
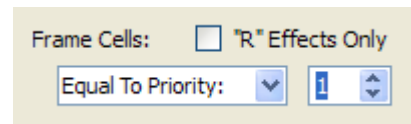
2.4 Governing Rules

In addition to displaying dispatch information and slot priorities, the **Model Run Analysis -- Rulebased Simulation** dialog allows you to trace the effects of rules across a model. When a rule sets a value which triggers a dispatch, the dispatch may calculate a new value which will propagate to another object. This object will then redispatch, possibly setting a value which will propagate to yet

another object. In this fashion, the effect of a rule may propagate well beyond the object on which it sets a value. Ultimately, it is the highest-priority, successfully-executed rule(s) which determine the model solution. The priority of these rules is reflected in the governing slots for each object's last dispatch. The priority of the governing slots identifies the governing rules.

> GOVERNING RULES
>
> The governing rules for an object are the rules whose priorities are responsible for the values on the object's governing slots.

In the lower-right corner of the **Model Run Analysis -- Rulebased Simulation** dialog, an area called **Frame Cells With Effects:** allows the user to show which rules govern the solution. For example, changing the **Option** menu from **None** to **Equal To (==)** and entering a **1** in the spinner box, puts a box around all object/timestep pairs that are governed by this priority.
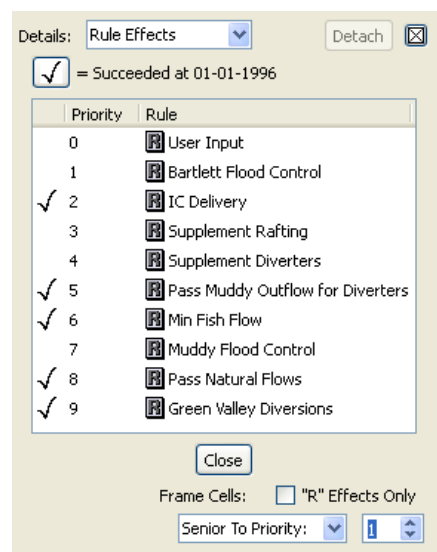
The **Effects** box also has a toggle for selecting **"R" Effects Only**. As the name indicates, turning on this toggle will only mark the cells of the proper priorities which were also set directly by a rule.

2.5 Rule Effects Details Dialog

The same ability to mark cells which meet priority criteria is also available in the **Rule Effects Details** dialog. This dialog also displays the names of all rules and whether each rule succeeded at the selected cell's object and time. Finally, this dialog allows you to color-code governing rules for a strong graphical way of tracking their effects across a model. A sample is shown on the following page. Note that this dialog is always docked within the **Model Run Analysis -- Rulebased Simulation** dialog.

- The **Rule Effects** dialog is shown by Selecting **View ➥ List Rules / Set Rule Colors...** from the **Model Run Analysis -- Rulebased Simulation** dialog or, if a **Details** dialog is currently docked in that dialog, selecting **Rule Effects** for the details type.

The same commands which are in the **Model Run Analysis -- Rulebased Simulation** dialog's **Effects** box are in the bottom of the **Rule Effects** dialog. Making a selection in this dialog automatically has effect in the other dialog. Governing rules may be selected by name rather than priority number by clicking on their name in the top of the dialog. The check marks to the left of each rule indicate whether or not the rule fired successfully on the timestep reported in the middle of the dialog. Clicking on each timestep's cell in the **Model Run Analysis -- Rulebased Simulation** dialog lets you see the successful rule firings for that timestep.

To assign colors to governing rules, select a rule in the **Rule Effects** dialog and select **Color ➡ Edit...**. This brings up a color chooser for assigning a color to portions of any cells in which this is a governing rule.

Rule Colors can be toggle on and off using the **View ➡ Show Rule Color** menu.