### RiverWare 6.7 Development -- Output Canvas Flow Lines / Dec. 2014 Phil Weinstein, CADSWES -- edit 12-30-2014 / DRAFT

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# (1) Overview

This document describes the Output Canvas' Flow Line capabilities developed through December 2014. This is beyond the Output Canvas capabilities delivered with RiverWare 6.6 which includes Teacups and Teacup Legend, Text Items and Images.

This Flow Line development represents a subset of Flow Line features described in this design document:

RiverWare Output Canvas: Tea Cup and Flow Animations: Design 3 [31 pp.] R:\doc\Output\OutputCanvas\2014\OutputCanvD esign3-2014-08-25.docx

Basic features include:

- 1. Creation of multiple flow line groups and flow lines.
  - A set of flow lines can be created in a single operation using a GUS object selection.
  - Flow lines are initially placed within the canvas at a location based on the flow line's simulation object within the simulation view.
- 2. A flow line is a single line segment drawn on the output canvas.
  - Draggable "anchor point" icons are shown at each end when the flow line is selected.
  - The flow line itself is also draggable.



- Flow lines are currently always black.
- 3. Each flow line has a single slot references defined with:
  - a. a simulation object name defined within each flow line.
  - b. a local slot name defined within the flow line group, default: "Outflow".
- 4. Flow line *thickness* depicts the absolute magnitude of the slot (at the output canvas' reference timestep) relative to all flow lines within the group. The thickness is interpolated using these flow line group settings:
  - Minimum Value. Values at or below this value are drawn with the minimum thickness.
  - Minimum Thickness
  - o Maximum Value. Values at or above this value are drawn with the maximum thickness.
  - Maximum Thickness
- 5. In the Output Canvas configuration dialog, flow line tree items support these context menu operations: Copy/Cut/Paste/Delete, Move Up/Down, Open Object.
- 6. In the canvas (both the configuration preview and in the output canvas viewer), flow lines support these context menu operations: **Open Object, Open Slot, Plot Slot, Configure** -- PLUS the following operations on the all flow lines within the containing flow line group: **Show Slots in New SCT, Plot Slots, and Configure Group.**

"Design 3" flow line features which were NOT implemented include:

- 1. Flow line color and line style depicting magnitudes relative to each flow line's channel's "capacity" or a set of guide curves. The current design calls for user specification of lists of "flow intervals" with display attributes defined within the flow line group and "thresholds" defined within each flow line.
- 2. Attachment behaviors of flow line anchor points; snapping.

## (2) Flow Line Group Creation and Configuration

In an Output Canvas (output device) created from the RiverWare Output Manager dialog, a flow line group can be created in these two ways in the Output Canvas Configuration dialog:

- 1. With the "Flow Line Group" item selected in the "Add Item" option menu, click the green plus ("+") button, *or*:
- 2. With the context menu on the General Settings (top-most) tree item: Add Item >> Flow Line Group.

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Add Item: Teacup Group Output C Teacup Legend Teacup Marker Text Group Text Group Text Item Bounding Box Flow Line Group Flow Line Group	Add Item: Flow Line Group

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	Expand All Items
	Collapse All Items

Either of the operations above create a new Flow Line Group item. With that item selected within the Output Canvas Content list, the group's default settings are shown in the settings panel; *see image to the right*.

The slots associated with the flow lines within a flow line group must have the same unit type and local slot name (e.g. "Outflow"). These slots can be on different object types (e.g. Reservoirs and Reaches), as long as each of those object types have a slot with the specified local slot name.

Double clicking on the Unit Type value shows a unit type combo box for the selection of the desired unit type; generally "Flow" will be appropriate (the default).

Double clicking on the Slot Name value allows direct entry of a slot name. Also, an ellipsis button brings up a slot name selector with slot names represented within the existing slots of the model. Notice that the currently set slot name is shown in parenthesis after the flow line group's name in the Output Canvas Content tree.



Instead of basing a group's flow line's slot references on the main simulation object associated with the flow line, slots on associated *data objects* can instead be used. This is done by changing the Flow Line Group's Slot Reference Type from "Object / Slot Name" to "Data Object / Slot Name".

Setting	Value
Name	Flow Line Group
Show	Yes
Unit Type	Flow
Slot Reference Type	Object / Slot Name 📃 💌
Slot Name	Object / Slot Name
Minimum Value	Data Object / Slot Name

As mentioned in the overview, each flow line's **thickness** is computed as an interpolation based on minimum and maximum values and thicknesses. The maximum value should be devised in relationship to the maximum values (generally, flows) among all flow lines in the group.

- Note that there is no expectation that all encountered series values will be within the "Minimum / Maximum Value" range. It's just that flow line thickness for values outside that range will be "clipped" at the respective configured Minimum or Maximum Thickness.
- See also the subsequent section on Setting the Flow Line Group's Maximum Value.

## (3) Flow Line Creation and Configuration

Multiple flow lines can be created within any flow line group in these two ways in the Output Canvas Configuration dialog:

- 1. With the "Flow Line" item selected in the "Add Item" option menu, and a flow line group selected within the Output Canvas Content tree, click the green plus ("+") button, *or*:
- 2. With the context menu on a Flow Line Group tree item: Add Item >> Flow Line.



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		Expand All Items	
		Collapse All Items	

Either of the operations above shows the (GUS) Simulation Object selector. Multiple objects can be selected; a flow line item will be created for each selected object at a heuristically devised location (based on the location of the selected SimObj within the simulation view).

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File Edit View			
Add Item: Flow Line	• • = • •	Canvas Preview Log	1
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Flow Line: Powell:			
Setting	Value		
Label	Powell		
Reference Object	Powell		
Reference Data Object	PowellInflow		
End-1 X Position	80		
End-1 Y Position	88		
End-2 X Position	180	Lock Positions: Background Images	Other Items
End-2 Y Position	188	Apr 2011	
Generate		OK Apply	Cancel

Selecting a flow line either in the Output Canvas Content tree or within the canvas preview causes that flow line's anchor points to become visible. The flow line may be repositioned by dragging the anchor points or the flow line itself.

A flow line's Label setting is initialized to the name of the Reference Object (from which the flow line was created). The label can be changed by the user, but it is currently used only within the configuration dialog's Output Canvas Content tree; the label text does not currently appear in the Output Canvas.

The "Reference *Data* Object" in the flow line configuration is used only if "Data Object / Slot Name" is selected in the containing flow line group's Slot Reference Type setting; see the previous section. If that is used, the configured slot name is expected to be on the Reference Data Object instead of the Reference Object. A flow line's Reference Data Object setting is initialized to the name of a data object whose name starts with the name of the picked Reference Object, if one is found. Otherwise it is set to the Reference Object's name with "Data" appended (preceeded by a space character).

## (4) Flow Line Display Features

Flow lines are currently always drawn as solid black line segments. (Color and line style are being reserved for a future capability to convey a different value-quality than does line thickness). A flow line's thickness is computed from value and thickness interpolation settings defined within the containing flow line group, as described above.

25,971,400

A flow line's tooltip shows the name of the associated slot (generally a series slot, generally having "flow" units).

The single selected flow line has these ornaments:

- 1. A dotted bounding rectangle around the flow line.
- 2. (Only in the canvas preview, with item positions unlocked): donut dingbats with a transparent center around the flow line's two endpoints.

0 Powell 58.26% Full

Flow lines are drawn under teacups, images and canvas text items, though teacups and images can be partially transparent, in which case the flow line will "show through" those items. Flow line anchor points are always drawn on top; see the accompanying image.

There is currently no direct support for showing RiverWare simulation object icons at the ends of flow lines, but user-supplied image icons (with the possibility of those being the the normal object icons) can be used for this purpose. (Note that each image is stored as image data within the output device, inside the RiverWare model. So this approach does increase the model size).

Flow lines don't currently display any text -- neither their label or their current value. But text items can be independently created and placed near flow lines. See two examples of this below.



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# (5) Flow Line Operations

Flow lines support a context menu with the following operations.

- 1. **Open Object** -- show the open object dialog for the flow line's reference object.
- 2. Open Slot -- show the flow line's associated slot (generally a series slot).
- 3. **Plot Slot** -- show a new plot page with a
- single plot showing the flow line's associated slot.

... plus a "Flow Line Group" submenu with the following operations. These operations apply to all flow line's in the same flow line group (i.e. the clicked flow line's sibling flow lines).

4. Show Slots in new SCT -- show a new SCT with one column (or row, depending on the default SCT configuration) for each



flow line's series slot. See an example of this in the next section ("Setting the Flow Line Group's Maximum Value").

5. Plot Slots -- show a new plot page with a single plot showing all of the flow lines' associated slots. Note that, with the current RiverWare plot output device, there is limited support for a set of series slots having different units. Up to two different units can be represented, and those two units are mapped to the two vertical axis (left and right) -- even if those two units are of the same unit type (e.g. cfs and acre-feet/month -- both being "flow" units). So a plot generated from a set of flow lines will be misleading, and possibly incomplete, if the current unit scheme has different display units for the varous flow line slots. A warning message will be shown if more than two units are represented.

## (6) Setting the Flow Line Group's Maximum Value

As mentioned above, the flow line thickness is computed using interpolation settings including minimum and maximum slot values which are mapped to minimum and maximum flow line thicknesses (in pixels). A reasonable minimum value is 0.0. The maximum value should be chosen which exceeds *most* slot values among all flow lines in the flow line group in the full time series. One way to come up with a good maximum value for a flow line group is illusrated below. This involves these steps:

- 1. From a context menu on any of the flow lines within the flow line group, pick "Flow Line Group >> Show Slots in new SCT...".
- 2. In the resulting SCT, select all cells.
- 3. In the selection statistics along the bottom of the SCT, notice the "Max" value.
- 4. Enter a number somewhat less than that maximum value in the Flow Line Group's "Maximum Value" settings.

Note: When an SCTs selection includes values of more than one value, but only values of a single unit *type*, the selection statistics are shown in the first encountered unit. This worked out well in the example illustrated below because the first slot had the desired units ("1,000 acre-ft/month"). The user may have to move a slot

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of the desired units to the first slot position (SCT row or column) in order to show selection statistics in those units.

SCT Flow Line Group (24MoStudy-FlowLines.mdl.gz)							
File Edit Slots Aggregation View Config DMI Run Diagnostics Go To							
Series Slots Edit Series Slot List Scalar Slots Other Slots Object Grid							
Slot Label	Units	3/31/11 Thu	4/30/11 Sat	5/31/11 Tue	6/30/11 Thu	7/31/11 Sun	8/31 Wed
BlueMesa.Outflow	1.000 acre-ft/month	74.71	102.00	168,00	82,80	112.00	12
Crystal.Outflow	cfs	1,272	2,187	3,871	2,484	2,179	
FlamingGorge.Outflow	1,000 acre-ft/month	59.33	160.32	188.15	228.97	230.83	11
A Fontenelle.Outflow	cfs	945.36	1,920.00	3,500.00	4,700.00	2,650.00	1,70
A Havasu.Outflow	acre-ft/month	693,648	812,731	706,324	683,380	737,077	631
An Mead.Outflow	Mead.Outflow acre-ft/month		1,092,046	1,041,540	956,812	914,050	820
Mohave.Outflow acre-ft/month		976,146	1,066,698	1,009,028	952,938	902,978	792
MorrowPoint.Outflow	1,000 acre-ft/month	73.48	116.51	198.00	107.80	118.00	12
Powell.Outflow	1,000 acre-ft/month	1,033.24	966.00	1,103.00	1,179.00	1,255.00	1,19
Navajo.Outflow	1,000 acre-ft/month	30.95	29.75	58.51	120.00	39.07	4
An TaylorPark.Outflow	1,000 acre-ft/month	5.7	16.0	30.0	28.0	28.0	
Vallecito.Outflow	1,000 acre-ft/month	2.48	1.79	34.64	56.31	41.54	
	Þ	<u> </u>	]				•
12 Slots Volume: 115.1325	9 [1,000,000 acre-ft]						
372 values: Sum 115,132.59 Ave 309.50 Min 1.49 Max 1,255.00 Range 1,253.51 [1000 acre-ft/month]							
Flow Line Group:							
			L	Setting	Valu	•	
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Unit Type Flow

Maximum Thickness 32

Slot Name

Minimum Value 0 2 Minimum Thickness 2 Maximum Value 1,7

Slot Reference Type Object / Slot Name

Outflow

0 1000 acre-ft/month

1,200 1000 acre-ft/month

## (7) Some Possible Flow Line and Output Canvas Enhancements

### Flow Lines

- 1. Flow lines should be poly-lines. Currently, flow lines have just two points. (They are line segments). Additional vertices could be managed graphically (e.g. through context menus on the canvas flow line). Their persistence should no longer be implemented through rwSettings since rwSettings don't currently support arrays (and the user doesn't need to numerically see or edit vertex coordinates anyway).
- 2. Anchor point "attachment" behaviors / "snapping" are needed.
- 3. There seems to be a requirement for **more flexibility in flow line slot reference composition.** There are several ways of accomplishing this. (We look at some representative actual use cases).
- 4. We may want to devise a way of showing **simulation object icons** on the canvas -- in a way which is more convenient and efficient than using user-supplied image items.

### **Output Canvas**

- Remove explicit Slot Reference Type rwSettings -- i.e. "Object / Slot Name" vs. "Data Object / Slot Name". We could just automatically search both (when defined and valid) for the required slot name. (This is currently the most confusing setting type among the variuos output canvas configuration objects. And it's unnecessary). (Note, however, that we may want a "reference type" setting for a different reason: providing "immediate" value in each teacup for its "maximum" value).
- 2. **Multiple Item Selection,** both in the configuration object tree and the canvas. (The selections should be partially synchronized, as is the current single item selection). The copy/paste buffer (for output canvas configuration objects) should be expanded to support a *list* of objects. There are many potential use cases for this enhancement, including managing multiple versions of large numbers of output canvas objects.
  - The simplest thing to do for the **rwSetting panel** would be to display a rwSetting list *only when* exactly one canvas configuration node is selected. This would be equivalent to the current level of rwSettingTree support.
  - A more advanced approach is presenting only those settings which are common to multiple selected nodes, displaying a value only if it is common to all nodes, and setting all values to a common value upon entry. This would require enhancements to rwSetting and rwSettingTree.

### Teacups

- 1. It may be desirable to support the specification of a teacup's maximum value as a teacup setting.
  - The current default algorithm obtains the maximum storage (volume) value from the volume column in the last row of the object's Elevation Volume Table slot (if the object has such a slot, as do reservoirs). The problem with this is that, for numeric stability, that table is often significantly, arbitrarily extended.

- The practical alternative is to provide the object's maximum value in a user scalar slot on a data object associated with the object. That's a lot of work for the user, and unless there are other potential uses for that Max Storage value, it would be simpler for the user to configure that right in the teacup.
- Note that the maximum value *is* displayed in the teacup graphic, so its value can readily be confirmed by the user.
- Technical: A direct way to support this would require the rwSetting enhancement outlined below ("rwSetting conditioning should be extended to a parent node's rwSetting list").

### **Text Groups**

- 1. Text Groups could have an option to force all slot values to be displayed with the current unit scheme's default display attributes (units and precision) for the value's unit type -- instead of the display attributes specifically configured for the particular slot.
  - The lack of that option (or only implemented behavior) shows up in Reservoir Outflow flow lines in the 24 Month Study regression test example. Notice that there are <u>three different</u> <u>scale/units represented</u> in the text items shown in this screenshot -- cfs, acre-feet/month and 1000 acre-feet/month -- http://cadswes2.colorado.edu/~philw/2014/TeaCup/Dec2014/2014-12-26/FlowLinesText-24MonthStudy.png

#### rwSettings

1. **rwSetting conditioning should be extended to a parent node's rwSetting list** -- i.e. not just limited to the sibling settings within the same node. The rwSettingTree constructor could be passed a 2nd rwSetting list for rwSetting conditioning. It might be sufficient to pass just that 2nd list to rwSettingTree editor widget constructors, and to all rwSetting methods which take a "siblings" list.

Such conditioning is currently used for:

- conditionally showing an rwSetting, based on the value of a "sibling" rwSetting.
- o retrieving display attributes (units and precision), based on the value of a "sibing" rwSetting.

--- (end) ----