

Education evenings 2016

*Practical introduction
to groundwater modelling*

Computer exercises
01 04 Adding features to our model

Purpose

In this exercise, we will

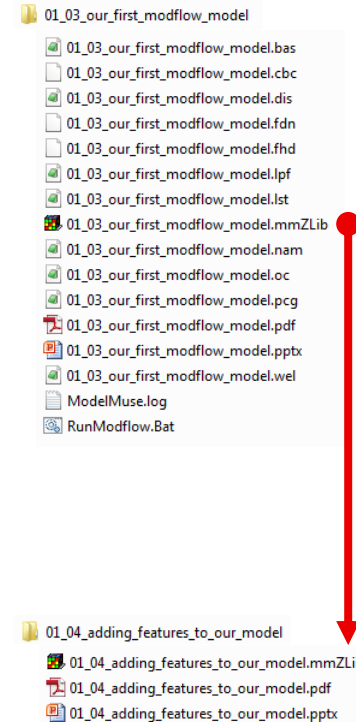
- ✓ add a river,
 - ✓ a drain,
 - ✓ and constant head boundaries
- to our model.

We will also

- ✓ visualize the fluxes from/to these model features.

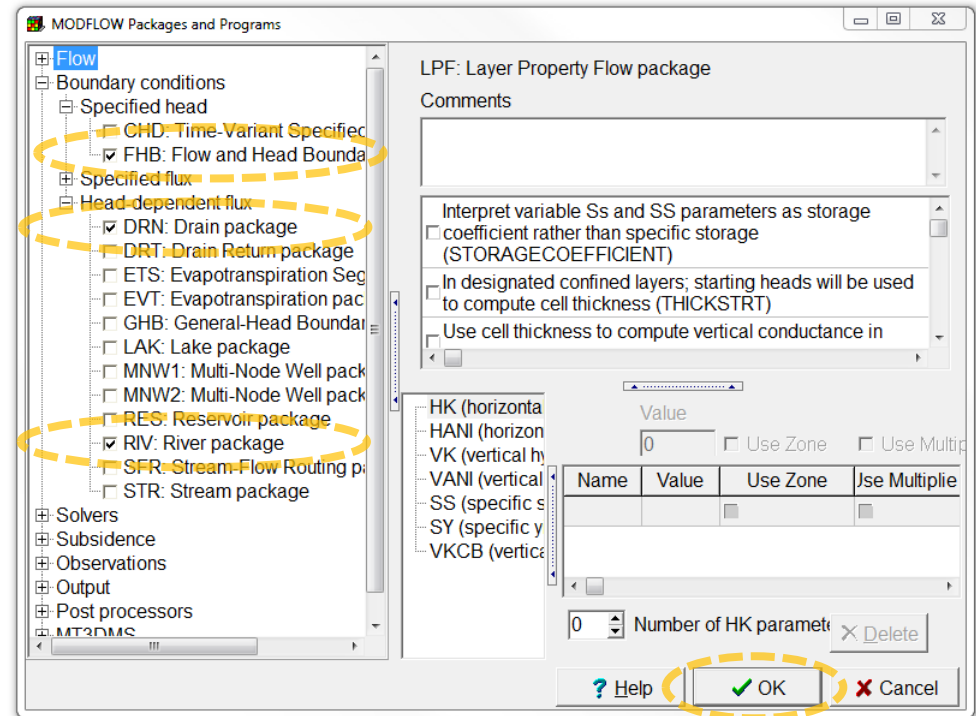
Copy file previous exercise

- ✓ Copy file
“/01_03_our_first_modflow_model
/01_03_our_first_modflow_model.
mmZLib”
to folder “/01_04_adding_features_
to_our_model/”
- ✓ Change the file name to
“01_04_adding_features_
to_our_model.mmZLib”,
- ✓ and open the file in ModelMuse.



Enable MODFLOW packages

- ✓ Select **Model | MODFLOW Packages and Programs...**,
- ✓ and mark the checkboxes of the **Flow and Head Boundary, Drain, and River** packages.
- ✓ Then press **OK**.

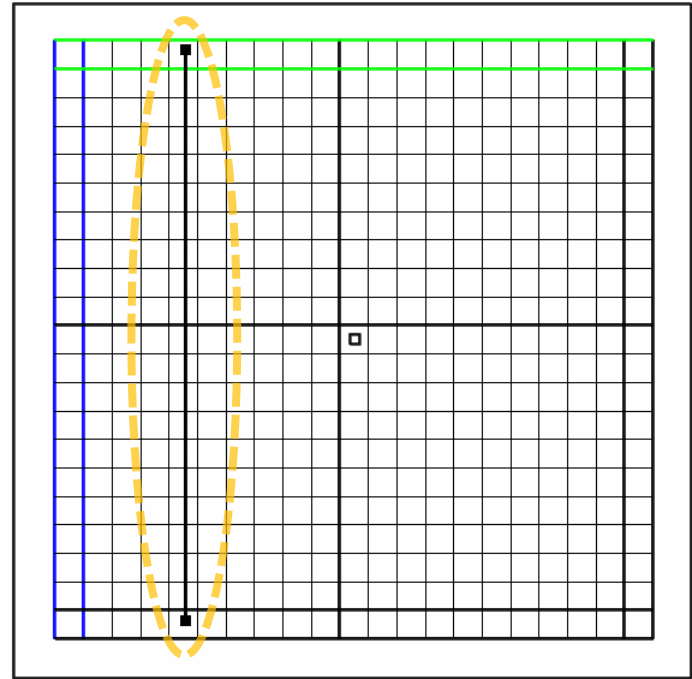


Add a river (1/3)

- ✓ Select **Object | Create | Straight Line** or use the corresponding button,
- ✓ and draw a straight river in the fifth column, going from the first to the last row.

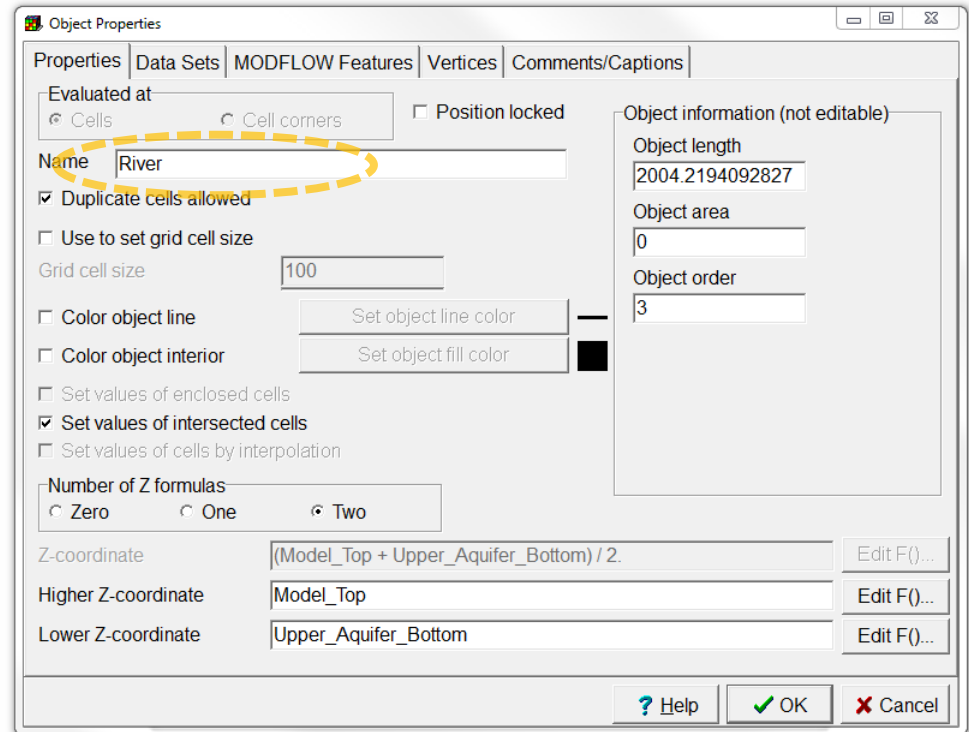


Create
straight-line
object



Add a river (2/3)

- ✓ In the **Object Properties** dialog box, change the object name to “River”.



The screenshot shows the 'Object Properties' dialog box with the 'Name' field set to 'River'. A yellow dashed circle highlights the 'Name' field and the 'Duplicate cells allowed' checkbox. The dialog box has several tabs: 'Properties', 'Data Sets', 'MODFLOW Features', 'Vertices', and 'Comments/Captions'. The 'Properties' tab is active. It contains various settings for the object, including evaluation options, grid cell size, and color settings. On the right, there is a section for 'Object information (not editable)' showing details like length, area, and order. At the bottom, there are buttons for 'Help', 'OK', and 'Cancel'.

Object Properties

Properties | Data Sets | MODFLOW Features | Vertices | Comments/Captions

Evaluated at
☒ Cells ☐ Cell corners ☐ Position locked

Name River

☒ Duplicate cells allowed

☐ Use to set grid cell size
Grid cell size

☐ Color object line

☐ Color object interior

☐ Set values of enclosed cells
☒ Set values of intersected cells
☐ Set values of cells by interpolation

Number of Z formulas
☐ Zero ☐ One ☒ Two

Z-coordinate

Higher Z-coordinate

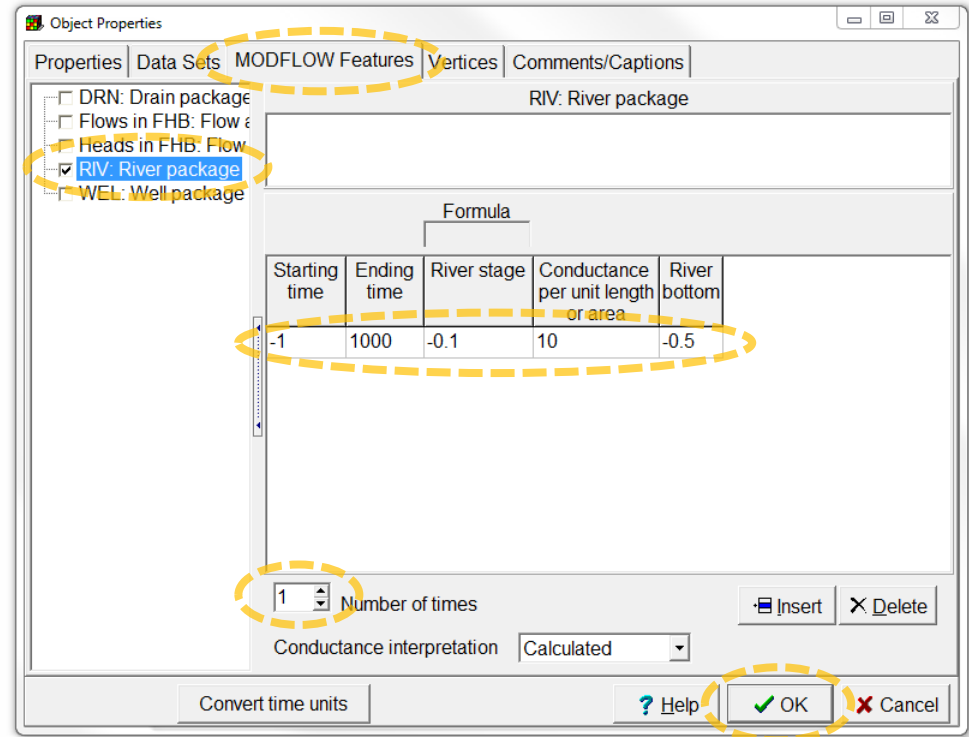
Lower Z-coordinate

Object information (not editable)
Object length
Object area
Object order

? Help OK Cancel

Add a river (3/3)

- ✓ Switch to the **MODFLOW Features** tab, and
- ✓ check the **River package**.
- ✓ Change **Number of times** to 1,
- ✓ and fill in the **Starting time**, **Ending time**, **River stage**, **Conductance**, and **River bottom** with, respectively, -1, 1000, -0.1, 10, -0.5.
- ✓ Then press **OK**.

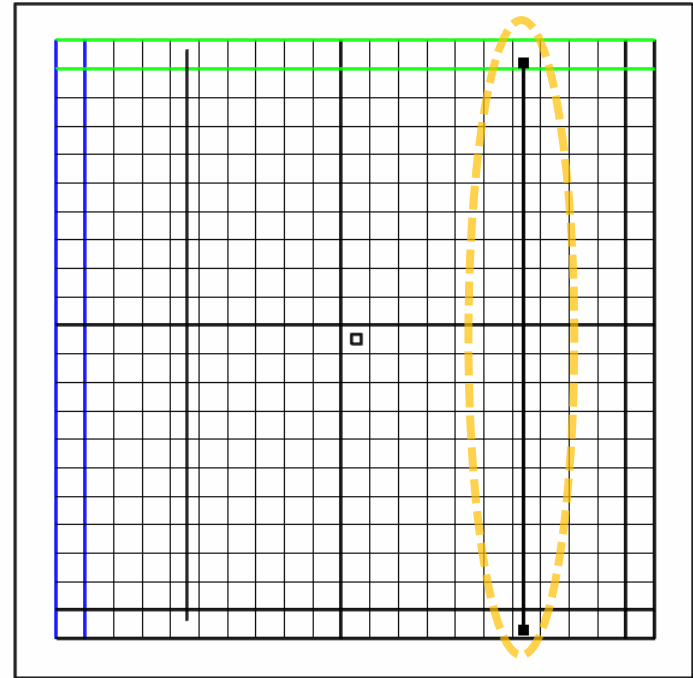


Add a drain (1/3)

- ✓ Select **Object | Create | Straight Line** or use the corresponding button,
- ✓ and draw a straight drain in the 17th column, going from the first to the last row.



Create
straight-line
object



Add a drain (2/3)

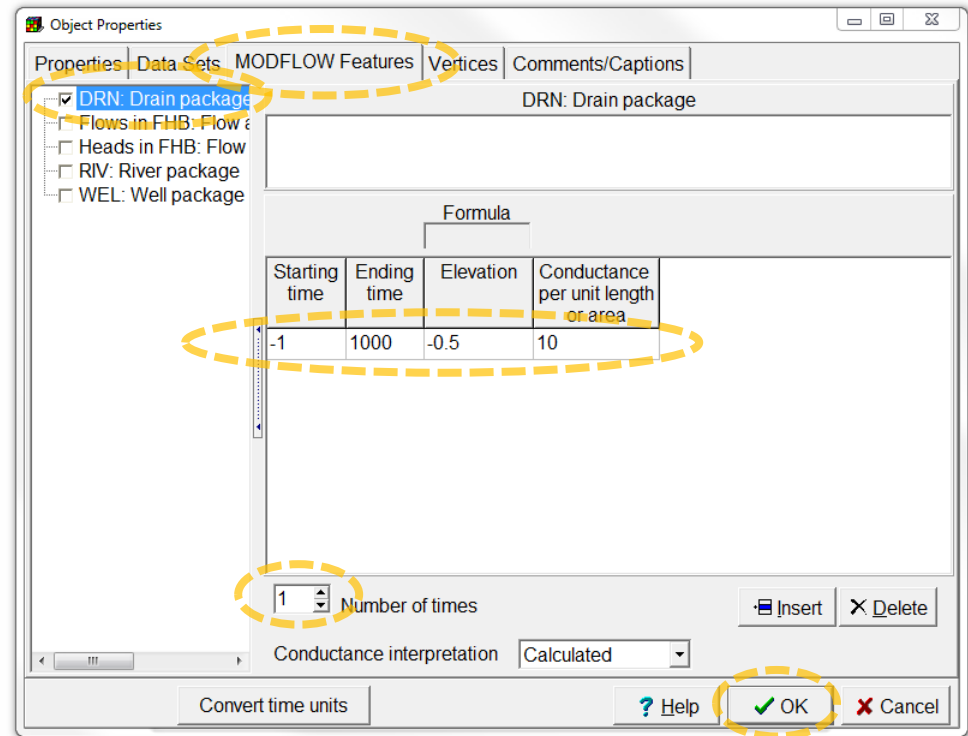
- ✓ In the **Object Properties** dialog box, change the object name to “Drain”.

The screenshot shows the 'Object Properties' dialog box with the 'Name' field set to 'Drain'. A yellow dashed circle highlights the 'Name' field. The dialog box has several tabs: 'Properties', 'Data Sets', 'MODFLOW Features', 'Vertices', and 'Comments/Captions'. The 'Properties' tab is active. It contains various settings for the object, including 'Evaluated at' (Cells), 'Position locked' (unchecked), 'Duplicate cells allowed' (checked), 'Use to set grid cell size' (unchecked), 'Grid cell size' (100), 'Color object line' (unchecked), 'Color object interior' (unchecked), 'Set values of enclosed cells' (unchecked), 'Set values of intersected cells' (checked), 'Set values of cells by interpolation' (unchecked), 'Number of Z formulas' (Two), 'Z-coordinate' ((Model_Top + Upper_Aquifer_Bottom) / 2), 'Higher Z-coordinate' (Model_Top), 'Lower Z-coordinate' (Upper_Aquifer_Bottom), and 'Object information (not editable)' (Object length: 1991.5611814346, Object area: 0, Object order: 4). At the bottom, there are buttons for 'Convert time units', 'Help', 'OK', and 'Cancel'.

Property	Value
Name	Drain
Duplicate cells allowed	Checked
Grid cell size	100
Set values of intersected cells	Checked
Number of Z formulas	Two
Z-coordinate	(Model_Top + Upper_Aquifer_Bottom) / 2
Higher Z-coordinate	Model_Top
Lower Z-coordinate	Upper_Aquifer_Bottom

Add a drain (3/3)

- ✓ Switch to the **MODFLOW Features** tab, and
- ✓ check the **Drain package**.
- ✓ Change **Number of times** to 1,
- ✓ and fill in the **Starting time**, **Ending time**, **Elevation** and **Conductance** with, respectively, -1, 1000, -0.5 and 10.
- ✓ Then press **OK**.

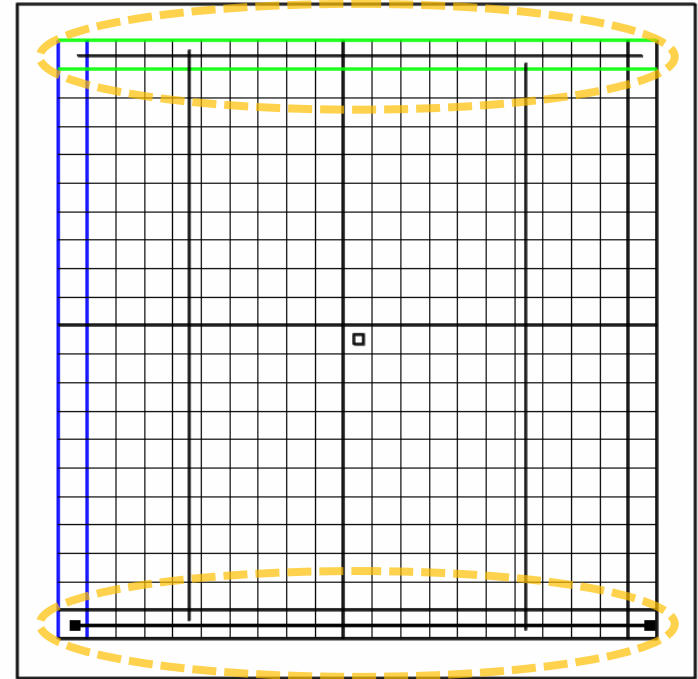


Add constant head boundaries (1/3)

- ✓ Select **Object | Create | Straight Line** or use the corresponding button,
- ✓ and draw a straight line in the first row, going from the first to the last column.
- ✓ Go through the next 2 slides and then repeat the steps for the last row.

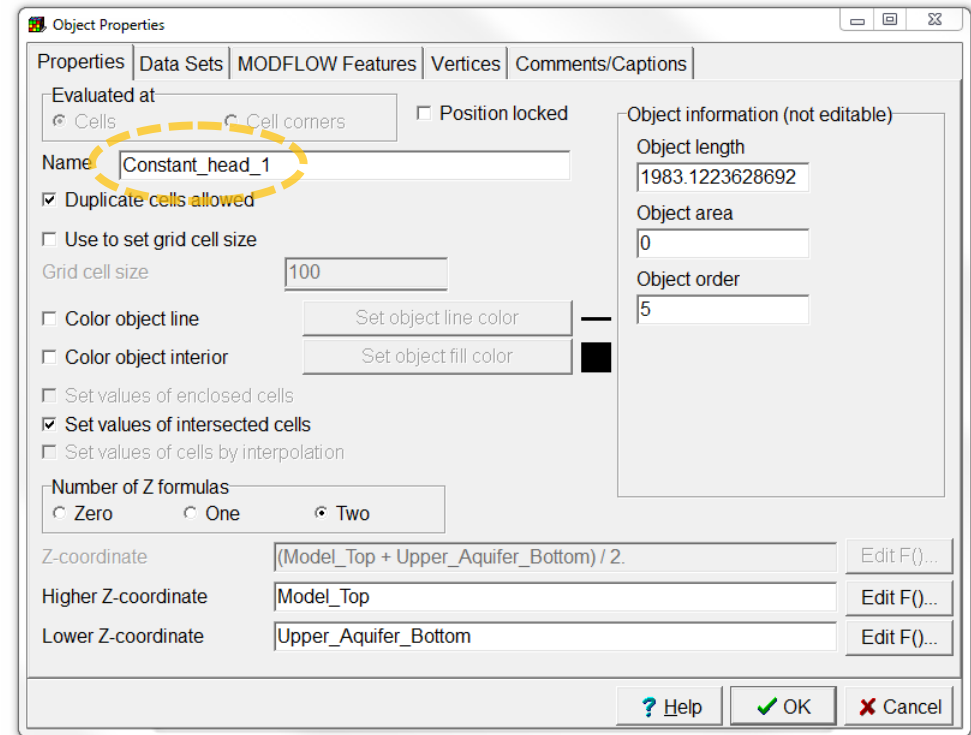


Create
straight-line
object



Add constant head boundaries (2/3)

- ✓ In the **Object Properties** dialog box, change the object name to “**Constant_head_1**” or “**Constant_head_2**”.

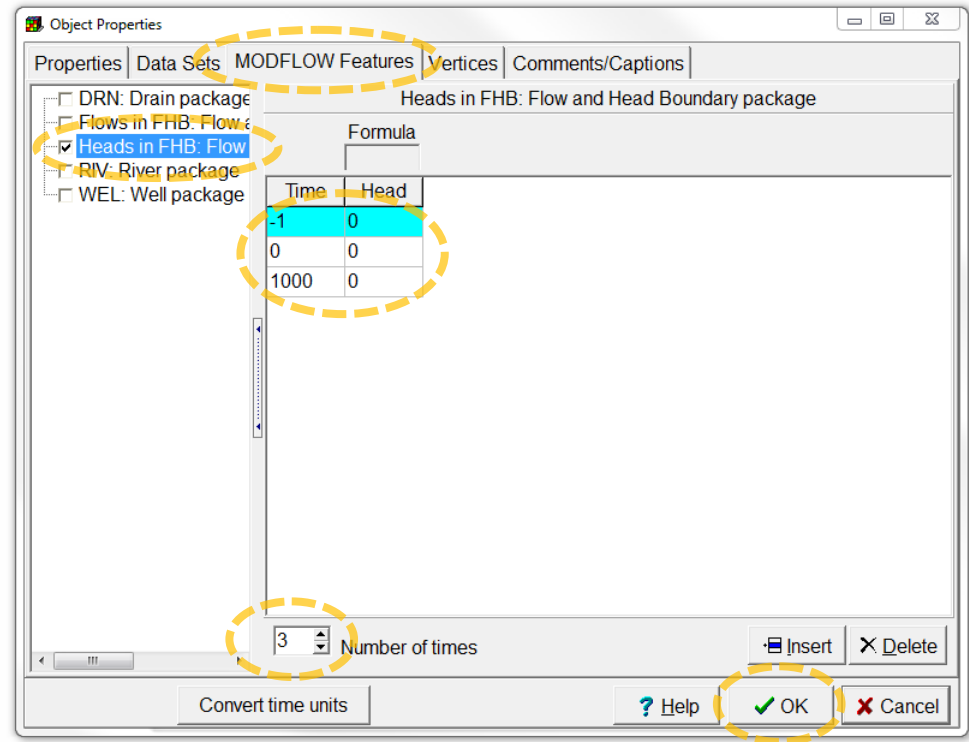


The screenshot shows the 'Object Properties' dialog box with the 'Properties' tab selected. A yellow dashed circle highlights the 'Name' field, which contains the text 'Constant_head_1'. The 'Evaluated at' section has 'Cells' selected. The 'Duplicate cells allowed' checkbox is checked. The 'Grid cell size' is set to 100. The 'Number of Z formulas' section has 'Two' selected. The 'Z-coordinate' field contains the formula $(\text{Model_Top} + \text{Upper_Aquifer_Bottom}) / 2$. The 'Higher Z-coordinate' field contains 'Model_Top' and the 'Lower Z-coordinate' field contains 'Upper_Aquifer_Bottom'. The 'Object information (not editable)' section on the right shows 'Object length' as 1983.1223628692, 'Object area' as 0, and 'Object order' as 5. The 'OK' button is highlighted with a green checkmark.

Properties	Data Sets	MODFLOW Features	Vertices	Comments/Captions
Evaluated at <input checked="" type="radio"/> Cells <input type="radio"/> Cell corners <input type="checkbox"/> Position locked				
Name: <input type="text" value="Constant_head_1"/>				
<input checked="" type="checkbox"/> Duplicate cells allowed				
<input type="checkbox"/> Use to set grid cell size Grid cell size: <input type="text" value="100"/>				
<input type="checkbox"/> Color object line <input type="button" value="Set object line color"/>				
<input type="checkbox"/> Color object interior <input type="button" value="Set object fill color"/>				
<input type="checkbox"/> Set values of enclosed cells				
<input checked="" type="checkbox"/> Set values of intersected cells				
<input type="checkbox"/> Set values of cells by interpolation				
Number of Z formulas <input type="radio"/> Zero <input type="radio"/> One <input checked="" type="radio"/> Two				
Z-coordinate: <input type="text" value="(Model_Top + Upper_Aquifer_Bottom) / 2"/> <input <="" td="" type="button" value="Edit F()..."/>				
Higher Z-coordinate: <input type="text" value="Model_Top"/> <input <="" td="" type="button" value="Edit F()..."/>				
Lower Z-coordinate: <input type="text" value="Upper_Aquifer_Bottom"/> <input <="" td="" type="button" value="Edit F()..."/>				
<input type="button" value="Help"/> <input checked="" type="button" value="OK"/> <input type="button" value="Cancel"/>				

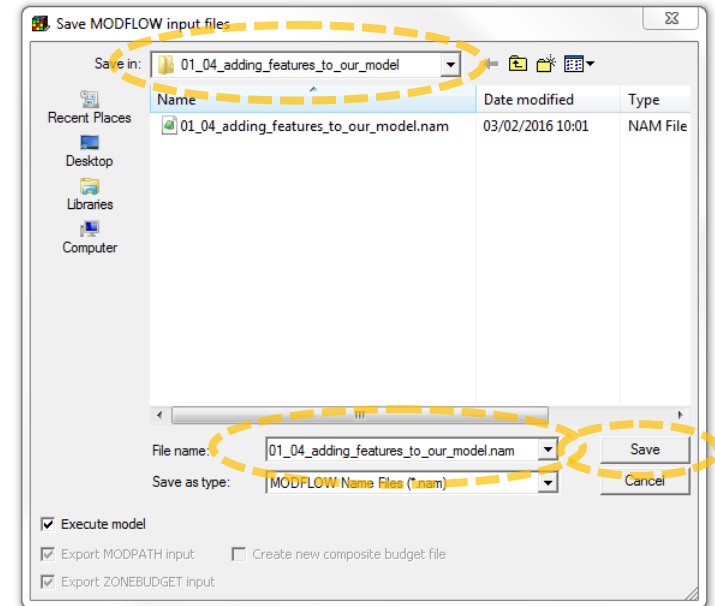
Add constant head boundaries (3/3)

- ✓ Switch to the **MODFLOW Features** tab, and
- ✓ check the **Flow and Head Boundary** package.
- ✓ Change **Number of times** to 3,
- ✓ and fill in the **Time** column with -1, 0, 1000, and the **Head** column with 0, 0, 0.
- ✓ Then press **OK**.
- ✓ Make sure you defined two constant head boundaries!



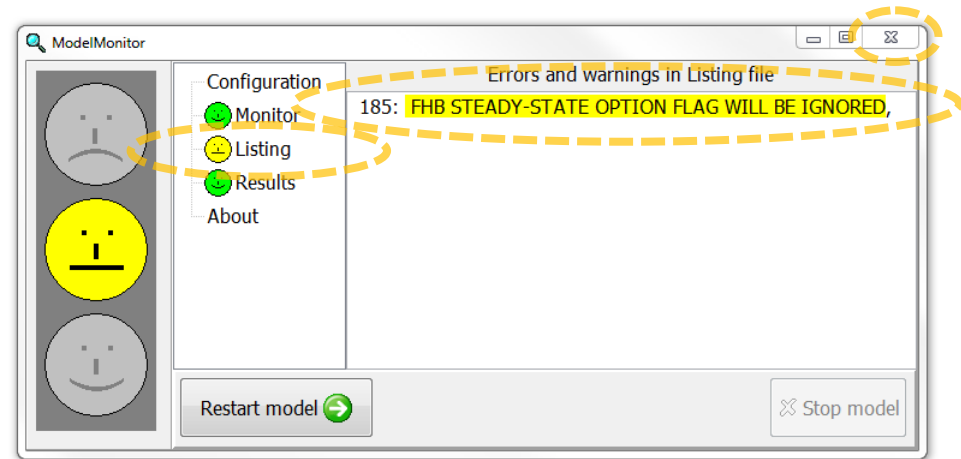
Run model (1/2)

- ✓ Select **File | Export | MODFLOW Input Files**,
- ✓ specify the file name
“/01_04_adding_features_to_our_model/
01_04_adding_features_to_our_model.nam”, and
- ✓ click **Save**. ModelMuse will create the MODFLOW input files and start running MODFLOW.



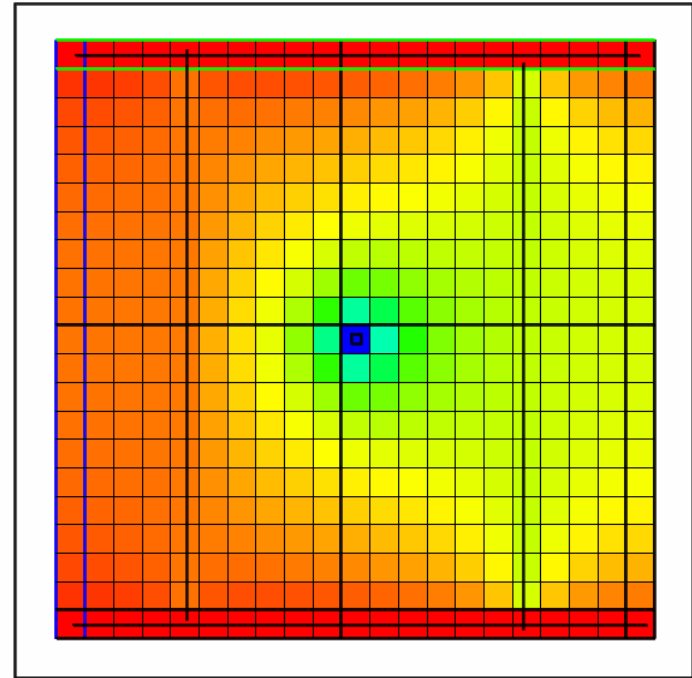
Run model (2/2)

- ✓ ModelMonitor found a warning in the Listing file, but this is normal when using the **Flow and Head Boundary package** with transient stress periods.
- ✓ Close ModelMonitor,
- ✓ the listing file,
- ✓ and the command line window.



Visualize simulated heads

- ✓ Color the grid with the simulated heads like we did during the previous exercise.

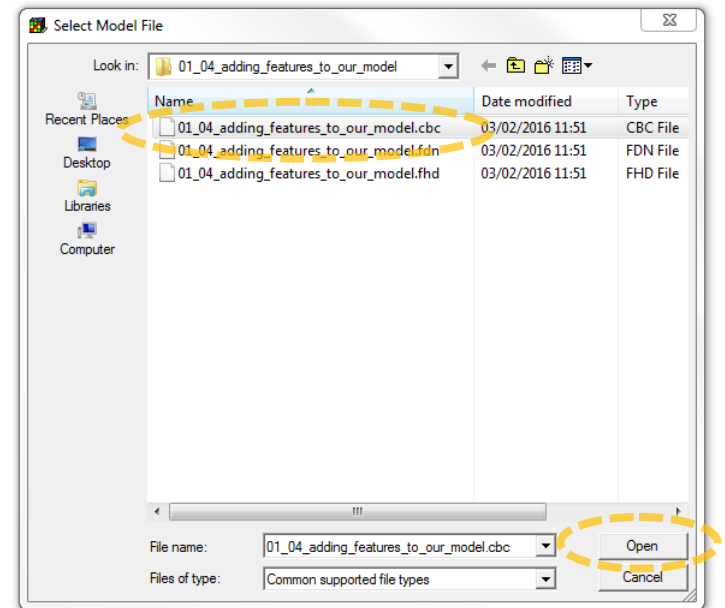


Import flow data (1/2)

- ✓ Select **File | Import | Model Results...** or use the corresponding button,
- ✓ select the binary flow file
“01_04_adding_features_to_our_model.cbc”, and
- ✓ click **Open**.

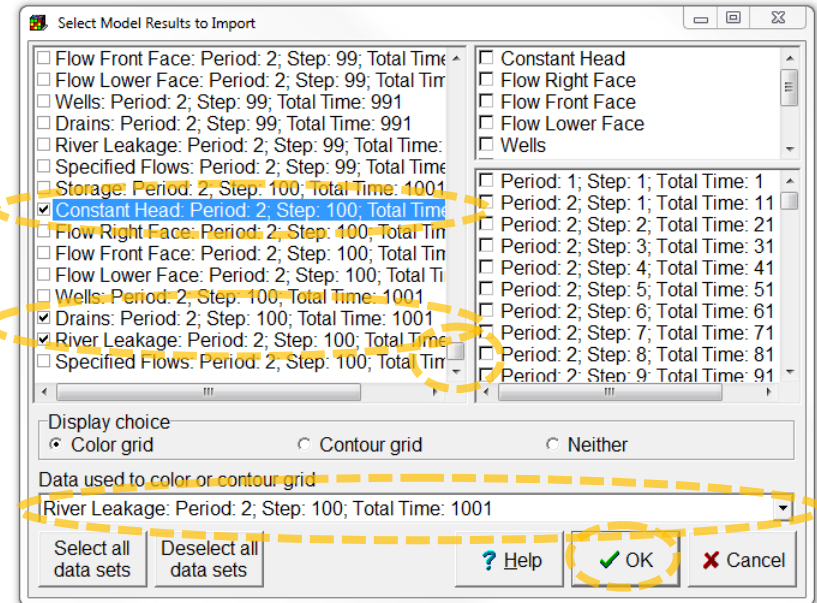


Import and
display model
results



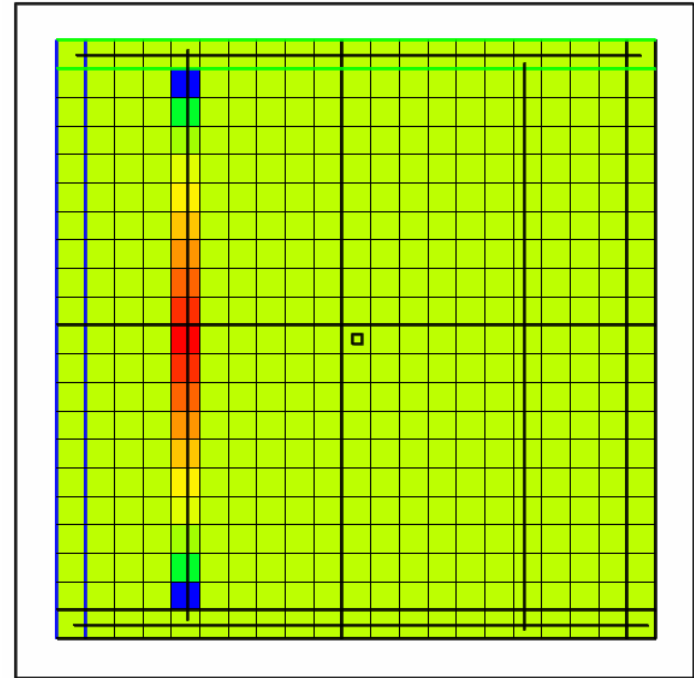
Import flow data (2/2)

- ✓ In the **Select Model Results to Import** dialog box, scroll down to the bottom, and
- ✓ select **Constant Head, Drains, and River Leakage for Period: 2; Step: 100.**
- ✓ Also, choose to color the grid with the **River Leakage** flows.
- ✓ Then click **OK**.



Check fluxes from/to the river

- ✓ Check the values of the fluxes from/to the river using the status bar, or **Data | Show Grid or Mesh Values**.
- ✓ Is the river gaining water from, or losing water to the aquifer?

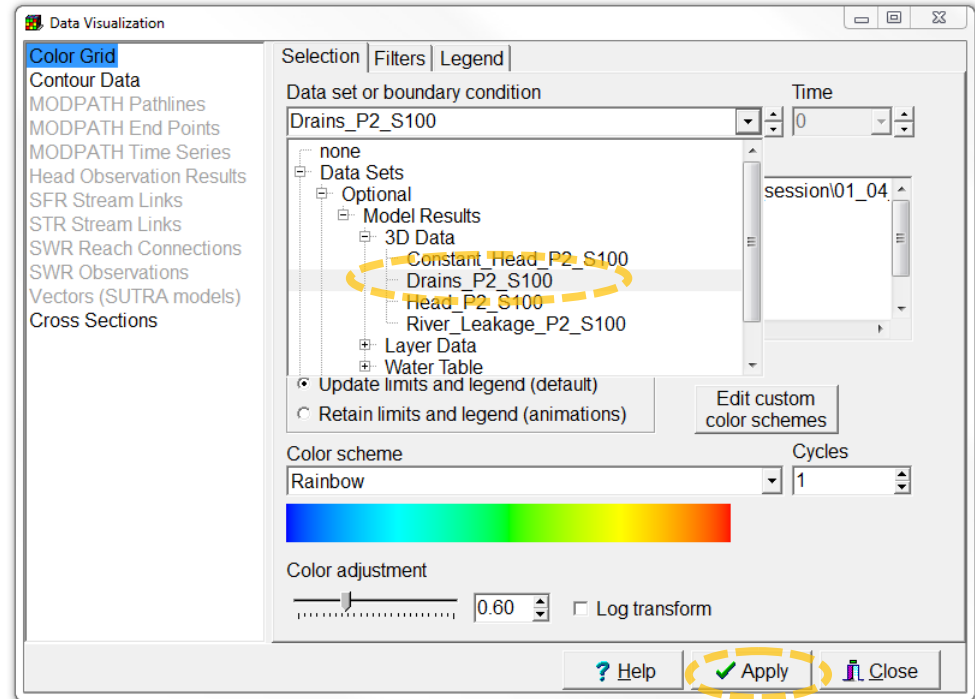


Check fluxes to the drain (1/2)

- ✓ Now color the grid with the Drain flows, by selecting **Data | Data visualization**, or using the corresponding button,
- ✓ changing the data set to **Drains_P2_S100**,
- ✓ and pressing **Apply**.

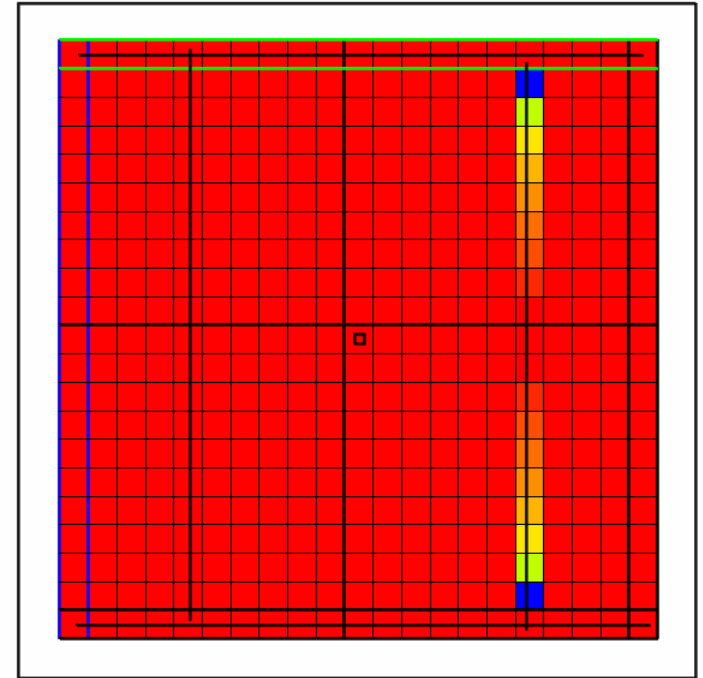


Data
visualization



Check fluxes to the drain (2/2)

- ✓ Check the values of the fluxes to the drain using the status bar, or **Data | Show Grid or Mesh Values**.
- ✓ Is the drain active over its entire length?

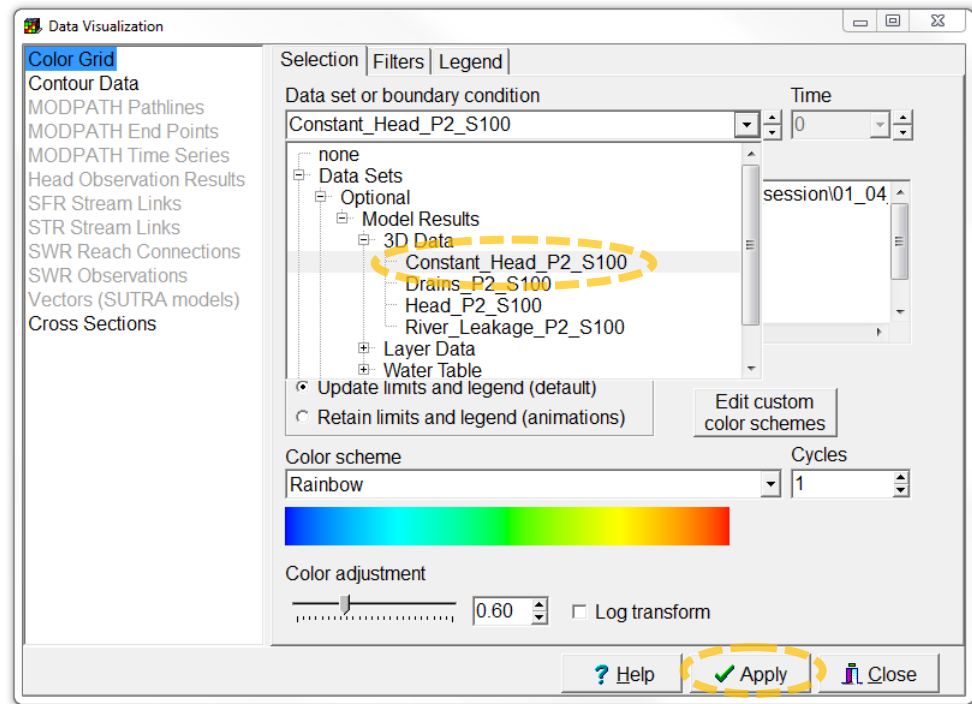


Check fluxes from/to the constant head boundaries (1/2)

- ✓ Now color the grid with the Constant Head flows, by selecting **Data|Data visualization**, or using the corresponding button,
- ✓ changing the data set to **Constant_Head_P2_S100**,
- ✓ and pressing **Apply**.

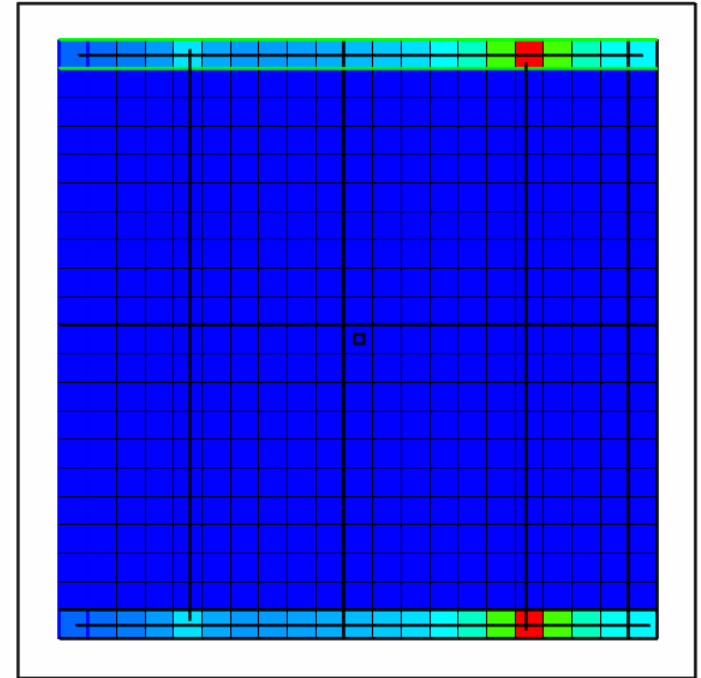


Data
visualization



Check fluxes from/to the constant head boundaries (2/2)

- ✓ Check the values of the fluxes to the Constant Head cells using the status bar, or **Data | Show Grid or Mesh Values**.
- ✓ Why are the largest values located at the drain?



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Computer exercises
01 04 Adding features to our model

*Questions? Found an error?
Please contact B. Rogiers at brogiers@sckcen.be.*