Education evenings 2016

Practical introduction to groundwater modelling

Computer exercises
03 01 RMA example model

1

Purpose

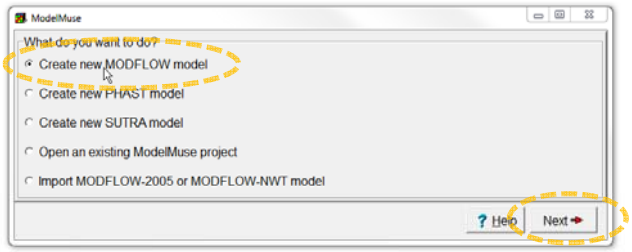
In this exercise, we will reconstruct the Rocky Mountain Arsenal model, which is one of the examples that come with ModelMuse. We will learn to

- ✓ import a map,
- ✓ import objects from a shapefile,
- ✓ generate the grid and
- ✓ use the CHD package.

2

Create new model

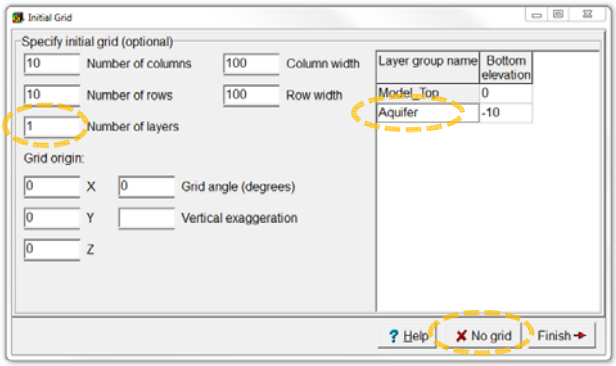
- ✓ Start ModelMuse by double-clicking on its icon.
- ✓ Choose **Create new MODFLOW model** and click **Next**.



3

Use a single layer

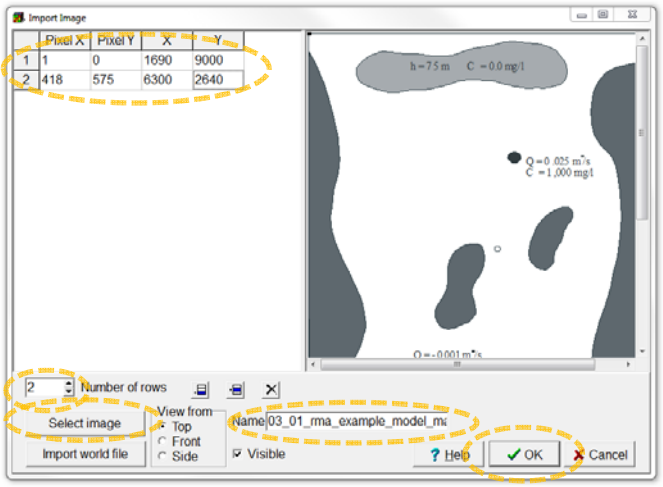
- ✓ Change the **Number of layers** to 1,
- ✓ set the **Layer group name** to “Aquifer”,
- ✓ and click the **No grid** button.



4

Import image

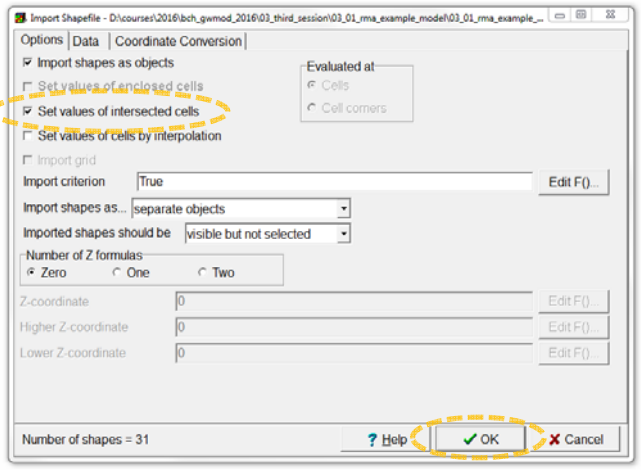
- ✓ Select **File|Import|Image…**,
- ✓ and use the **Select image** button to choose "03_01_rma_example_model_map.emf".
- ✓ Then increase the **Number of rows** to 2, and
- ✓ fill in the table as shown on the right to correctly georeference the image.
- ✓ Click **OK**.



5

Import objects (1/2)

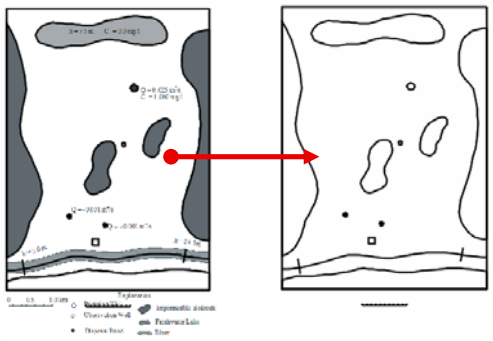
- ✓ Select **File|Import|Shapefile…**,
- ✓ and choose "03_01_rma_example_model_objects.SHP" in the **Open a Shapefile** dialog box.
- ✓ In the **Import Shapefile** dialog box, check the check box for **Set values of intersected cells**.
- ✓ We will only use the geometry of the shapes, so click **OK**.



6

Import objects (2/2)

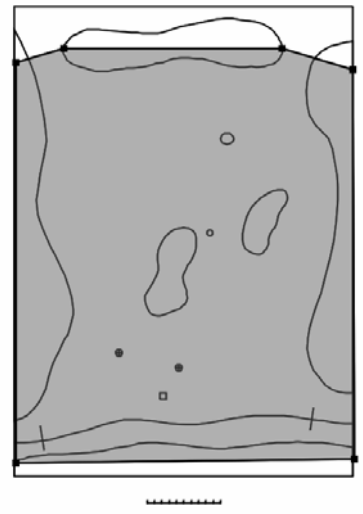
- ✓ Select **Edit|Show or Hide Image**, so we can focus on the objects.



7

Define model limits (1/2)

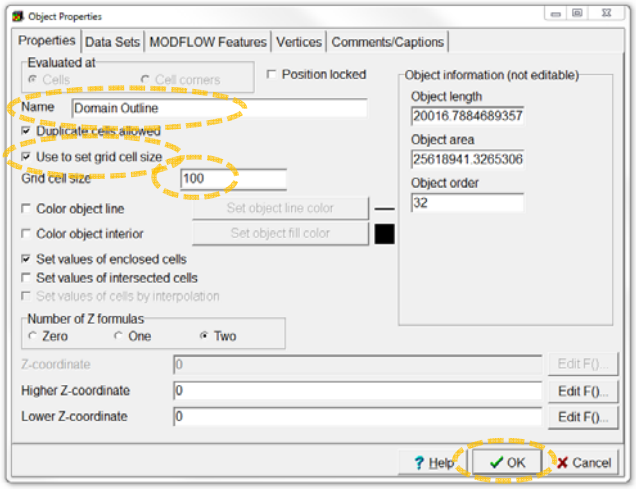
- ✓ Select **Object|Create|Polygon**, or use the corresponding button,
- ✓ and draw a polygon as shown on the right.
- ✓ Double click at the final point, to open the **Object Properties** dialog box.



8

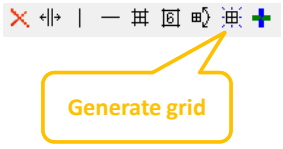
Define model limits (2/2)

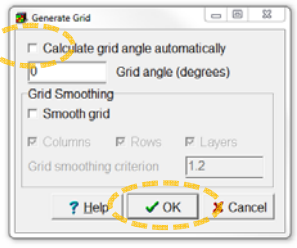
- ✓ Change the object **Name** to "Domain Outline",
- ✓ check the check box for **Use to set grid cell size**, and
- ✓ set the **Grid cell size** to 100.
- ✓ Then press **OK**.



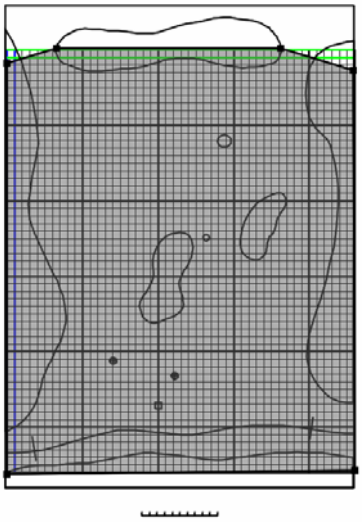
Generate the grid

- ✓ Select **Grid|Generate Grid…** or use the corresponding button.
- ✓ Uncheck the **Calculate grid angle automatically** check box, and
- ✓ click **OK**.





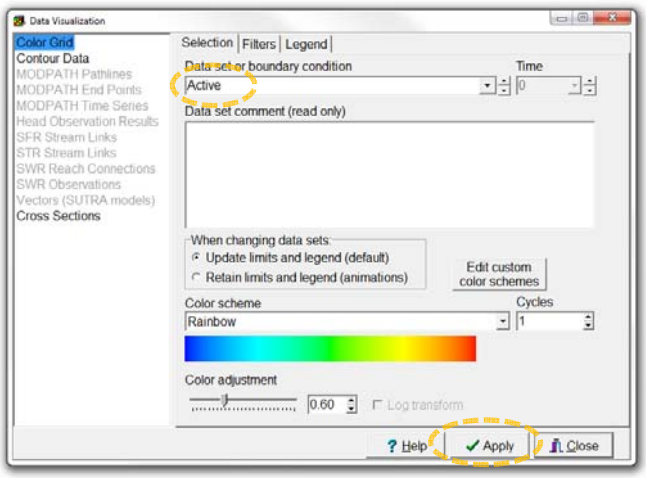
This is what you should get



11

Set active part of the grid (1/6)

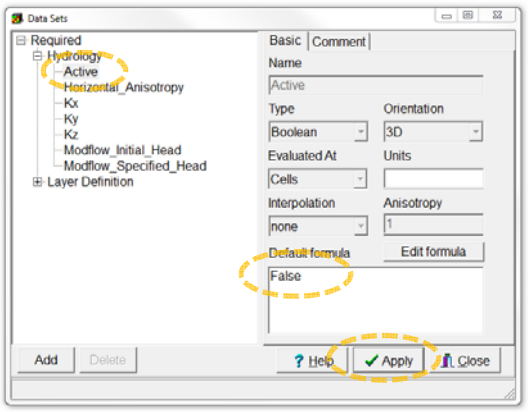
- ✓ First visualize the **Active** data set by selecting **Data|Data Visualization…** or using the corresponding button,
- ✓ expanding **Data Sets|Required|Hydrology**,
- ✓ and selecting **Active**.
- ✓ Then press **Apply**.



12

Set active part of the grid (2/6)

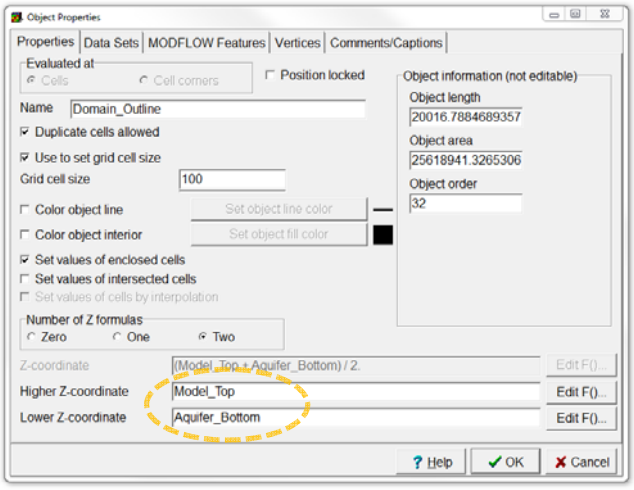
- ✓ Select **Data|Edit Data Sets…**,
- ✓ and choose the **Active** data set.
- ✓ Change its **Default Formula** to "False",
- ✓ and click **Apply**.



13

Set active part of the grid (3/6)

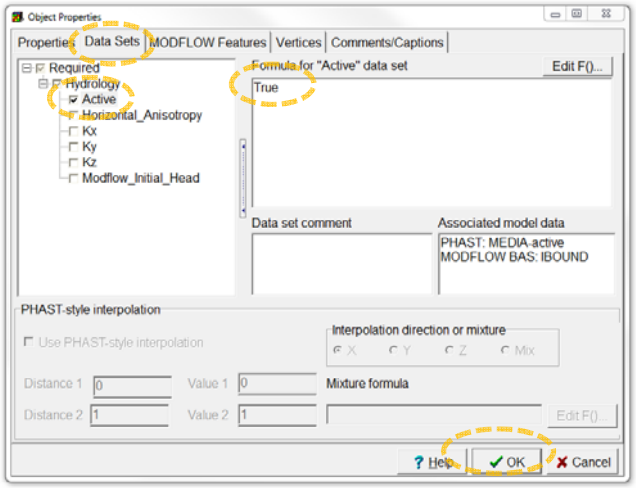
- ✓ Select the object that was used to define the domain outline, and double-click to open the **Object Properties** dialog box.
- ✓ Change the **Higher Z-coordinate** and **Lower Z-coordinate** to "Model_Top" and "Aquifer_Bottom" respectively.



14

Set active part of the grid (4/6)

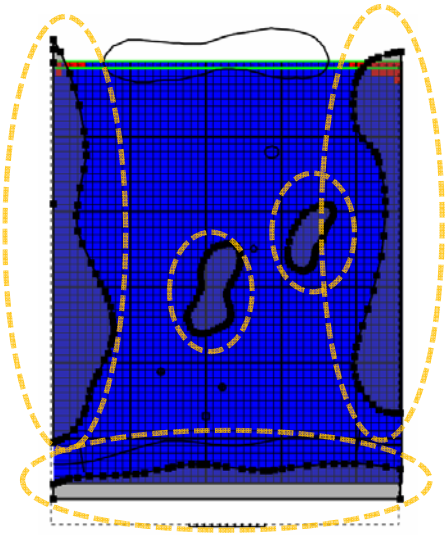
- ✓ Switch to the **Data Sets** tab,
- ✓ expand **Required|Hydrology**,
- ✓ and select **Active**.
- ✓ Change the formula to “True”.
- ✓ Then press **OK**.



15

Set active part of the grid (5/6)

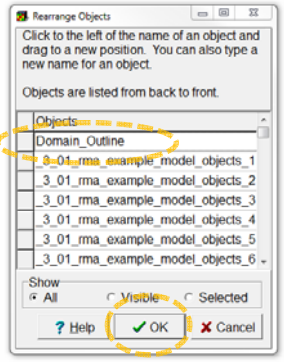
- ✓ Now repeat the procedure in the last two slides for the objects that are selected in the figure on the right, but set the **Active** data set to “False”.



16

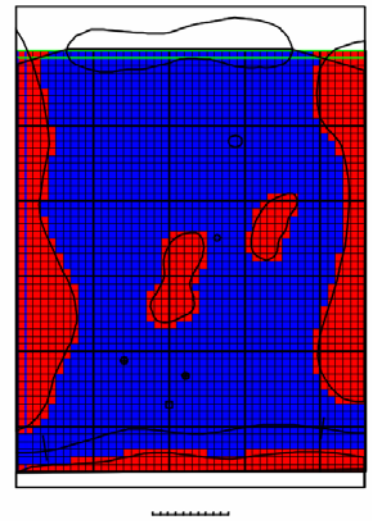
Set active part of the grid (6/6)

- ✓ Finally, select **Object|Edit|Rearrange Objects…**, and
- ✓ move the Domain_Outline object located at the bottom of the list to the top of the list.
- ✓ Then press **OK**.



17

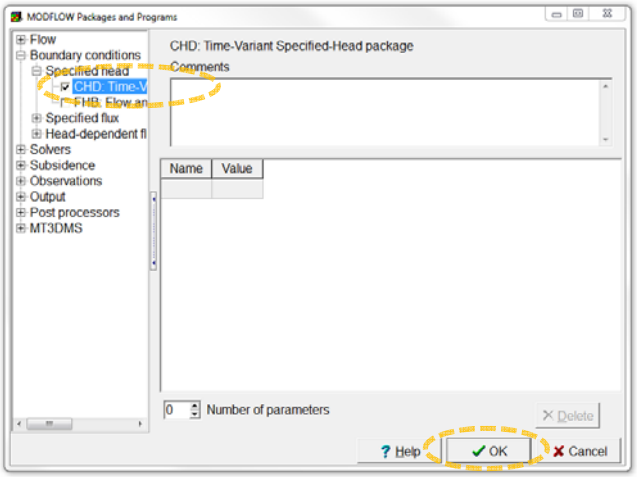
This is what you should get



18

Enable the CHD package

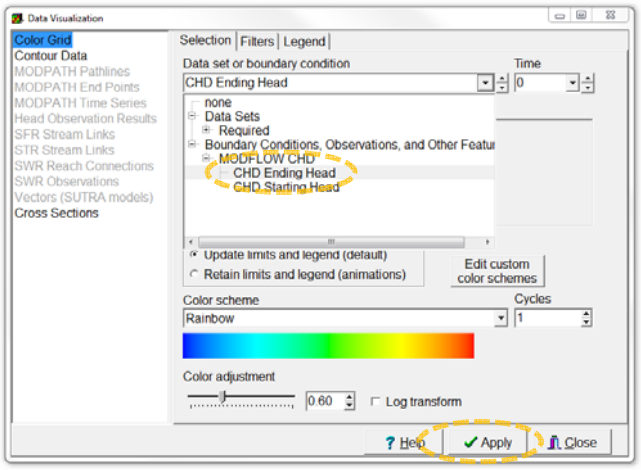
- ✓ Select **Model|MODFLOW Packages and Programs…**,
- ✓ expand **Boundary conditions|Specified head**,
- ✓ and select the **CHD** package.
- ✓ Then click **OK**.



19

Add specified head boundaries (1/6)

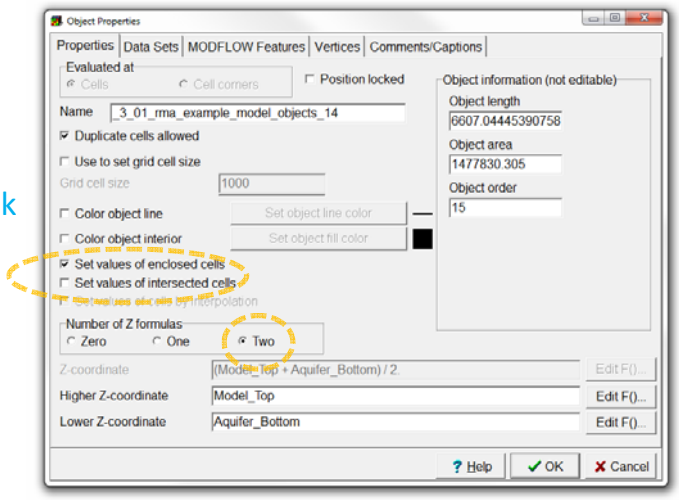
- ✓ We will model the lake and river as a specified head boundary.
- ✓ First select **Data|Data Visualization…** and select the **CHD Ending Head**.
- ✓ Then press **Apply**.



20

Add specified head boundaries (2/6)

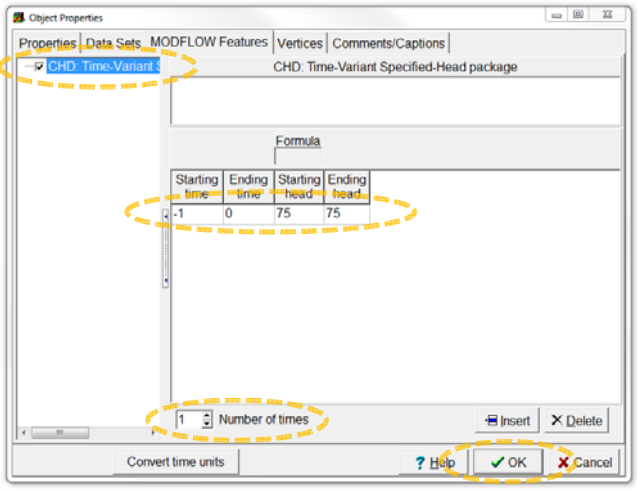
- ✓ Double-click the object that represents the lake.
- ✓ In the **Object Properties** dialog box, check **Set values of enclosed cells** and uncheck **Set values of intersected cells**.
- ✓ Change the **Number of Z formulas** to **Two**.



21

Add specified head boundaries (3/6)

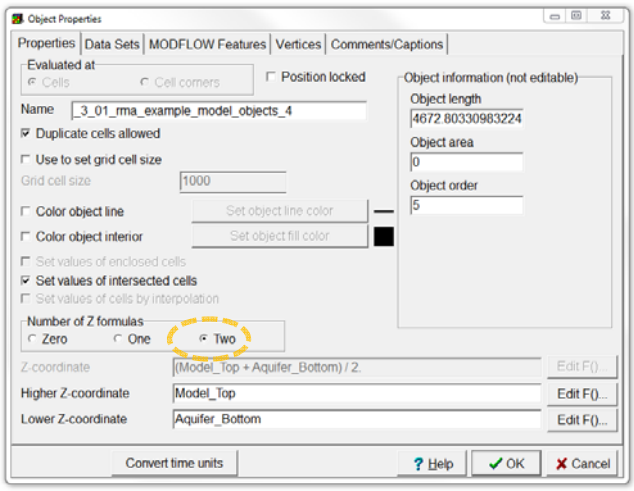
- ✓ Switch to the **MODFLOW Features** tab,
- ✓ select the **CHD** package,
- ✓ change the **Number of times** to 1,
- ✓ and set **Starting time**, **Ending time**, **Starting head**, and **Ending head** to -1, 0, 75 and 75.
- ✓ Then click **OK**.



22

Add specified head boundaries (4/6)

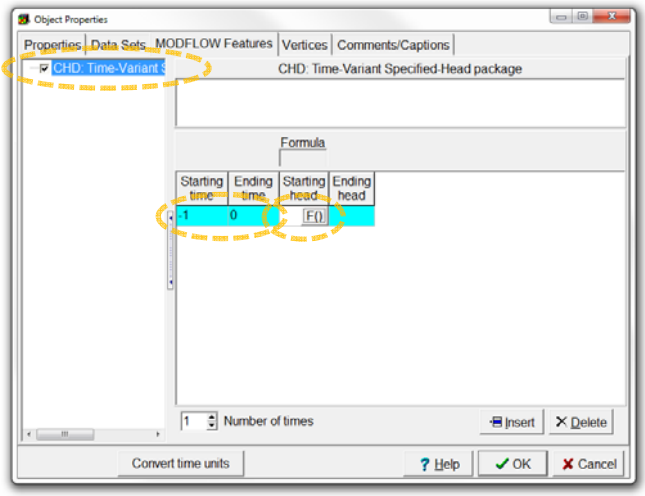
- ✓ Now double-click on the object that represents the river, to open the **Object Properties** dialog box.
- ✓ Change the **Number of Z formulas** to **Two**.



23

Add specified head boundaries (5/6)

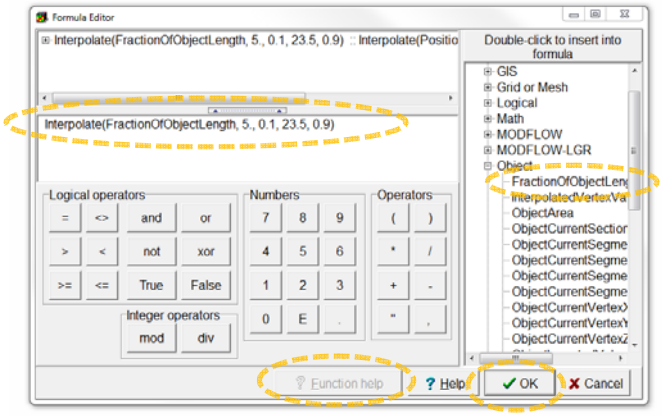
- ✓ Switch to the **MODFLOW features** tab,
- ✓ select the **CHD** package,
- ✓ set the **Starting time** and **Ending time** to -1 and 0,
- ✓ and click the button in the **Starting head** cell to open the **Formula Editor**.



24

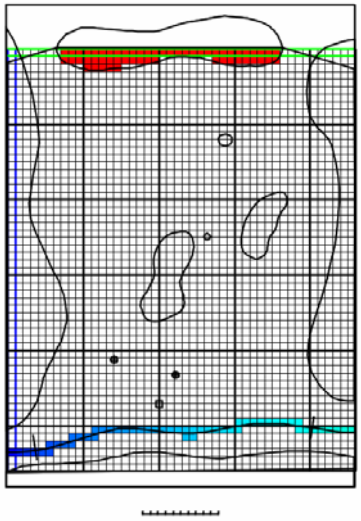
Add specified head boundaries (6/6)

- ✓ The head in the stream varies from 5 near the cross mark near the left end of the stream to 23.5 near the cross mark at the right end of the stream. The cross marks are at 10% and 90% of the length of the object representing the stream. Enter the formula "Interpolate(FractionOfObjectLength, 5, 0.1, 23.5, 0.9)"
- ✓ Check the **Interpolate** and **FractionOfObjectLength Function help** to see what these functions do, and click **OK**.
- ✓ Copy the Starting head formula to the **Ending head** cell, and press **OK**.



25

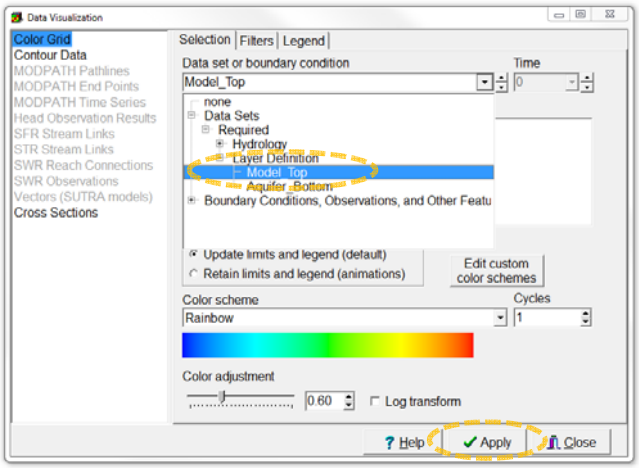
This is what you should get



26

Define aquifer geometry (1/9)

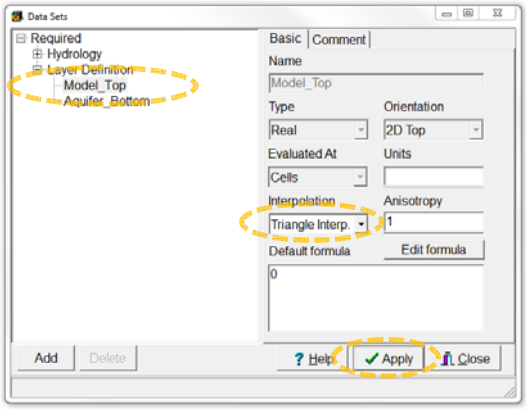
- ✓ The elevation of the top of the aquifer slopes gradually from approximately 71 at the north end of the model to 1 m above the stream at the south end of the model.
- ✓ First select **Data|Data Visualization…** and select the **Model_Top**.
- ✓ Then press **Apply**.



27

Define aquifer geometry (2/9)

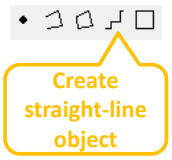
- ✓ Select **Data|Edit Data Sets…**,
- ✓ select **Model_Top**,
- ✓ for interpolation, select **Triangle Interp.**, and
- ✓ press **Apply**.

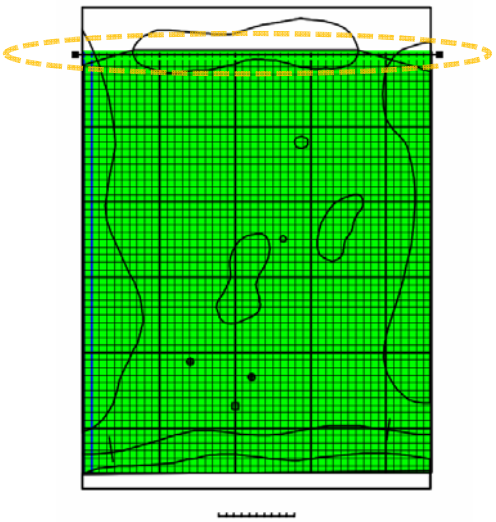


28

Define aquifer geometry (3/9)

- ✓ Select **Object|Create|Straight Line**, or use the corresponding button, and
- ✓ draw a straight east-west line at the north end of the model.

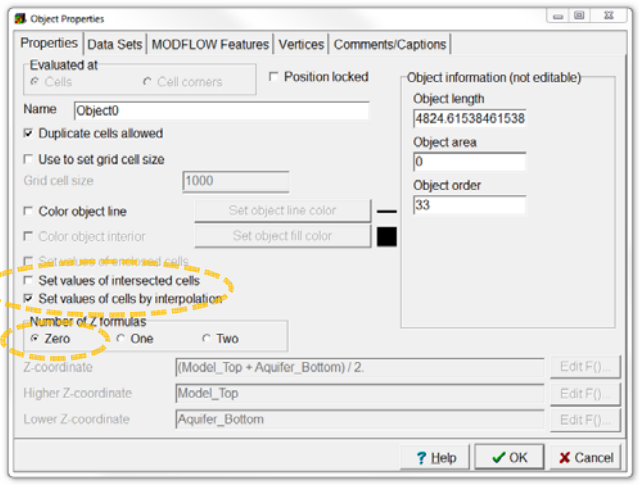




29

Define aquifer geometry (4/9)

- ✓ In the **Object Properties** dialog box, change the **Number of Z formulas** to **Zero**,
- ✓ uncheck **Set values of intersected cells**, and
- ✓ check **Set values of cells by interpolation**.

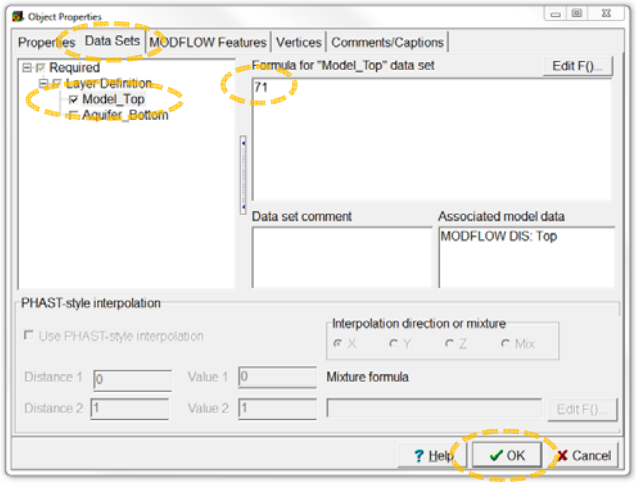


30

Define aquifer geometry (5/9)

- ✓ Switch to the **Data Sets** tab,
- ✓ select **Model_Top**, and
- ✓ change its formula to 71.
- ✓ Then click **OK**.

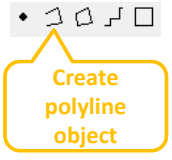
Because there are only two points in this object, nothing will change yet. At least 3 non-collinear points must be present for **Triangle Interp.** to be used.

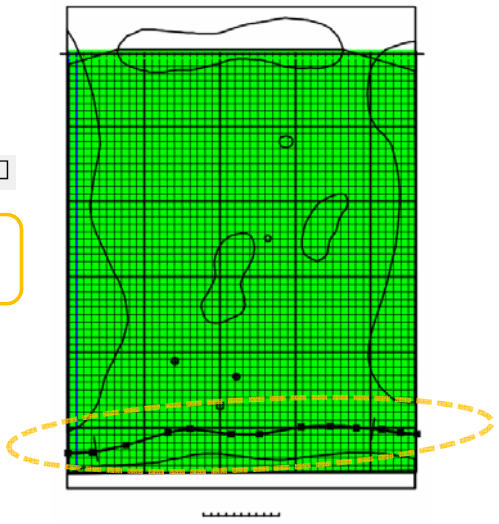


31

Define aquifer geometry (6/9)

- ✓ Select **Object|Create|Polyline**, or use the corresponding button, and
- ✓ draw a polyline at the location of the stream.
- ✓ The previous stream object can not be used for this because it must have two Z formulas and this one will need to have zero Z formulas.

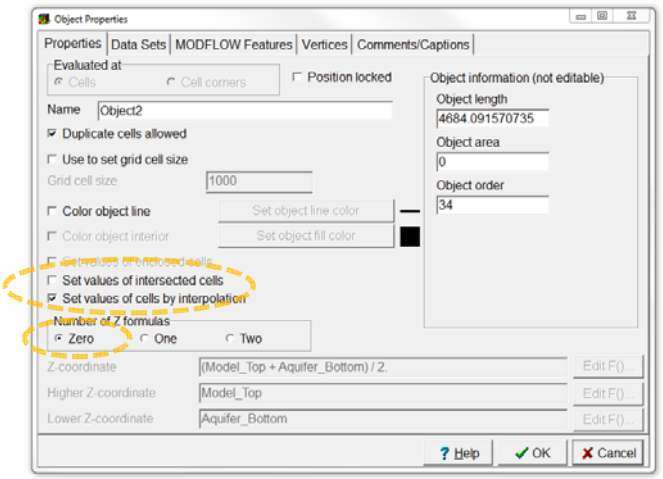




32

Define aquifer geometry (7/9)

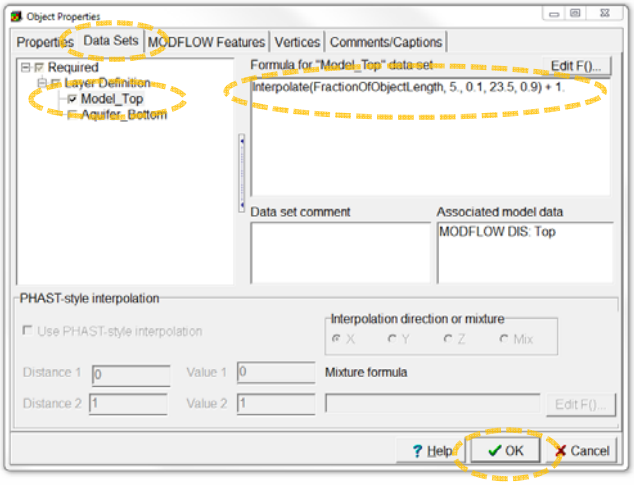
- ✓ In the **Object Properties** dialog box, change the **Number of Z formulas** to **Zero**,
- ✓ uncheck **Set values of intersected cells**, and
- ✓ check **Set values of cells by interpolation**.



33

Define aquifer geometry (8/9)

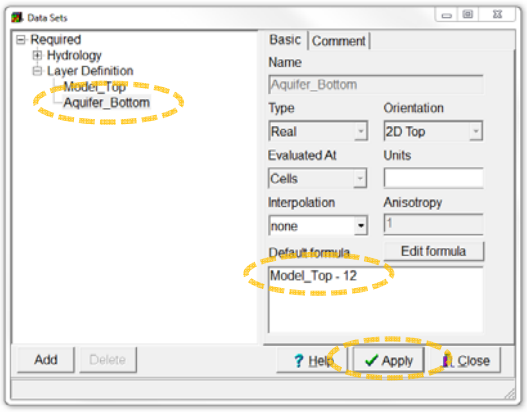
- ✓ Switch to the **Data Sets** tab,
- ✓ select **Model_Top**, and
- ✓ change its formula to "Interpolate(FractionOfObject Length, 5., 0.1, 23.5, 0.9) + 1".
- ✓ Then click **OK**.



34

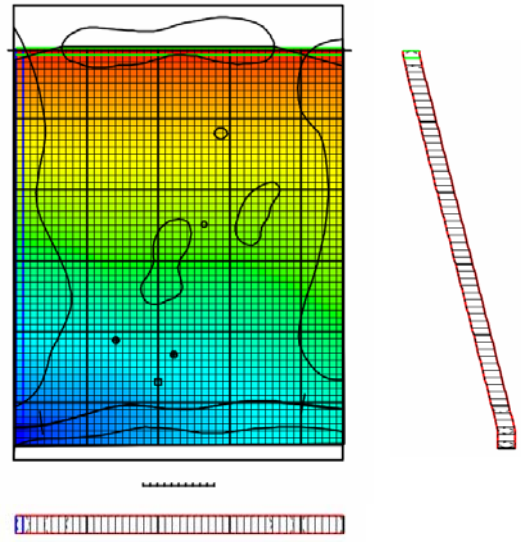
Define aquifer geometry (9/9)

- ✓ Finally, change the aquifer bottom elevation by selecting **Data|Edit Data Sets…**,
- ✓ selecting **Aquifer_Bottom**, and changing the **Default Formula** to "Model_Top - 12".
- ✓ Then click **Apply**.



35

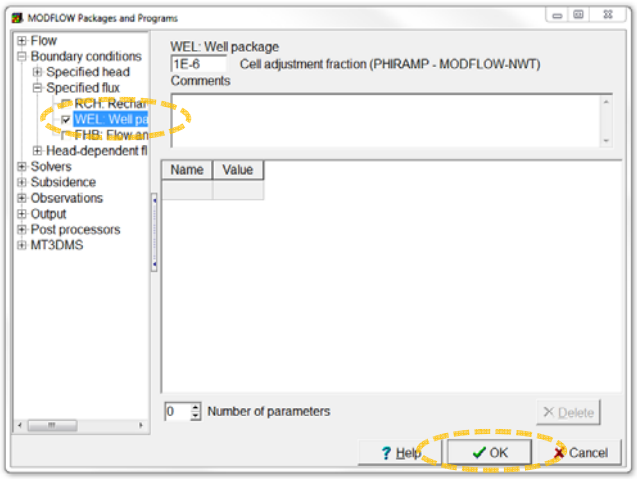
This is what you should get



36

Add wells (1/5)

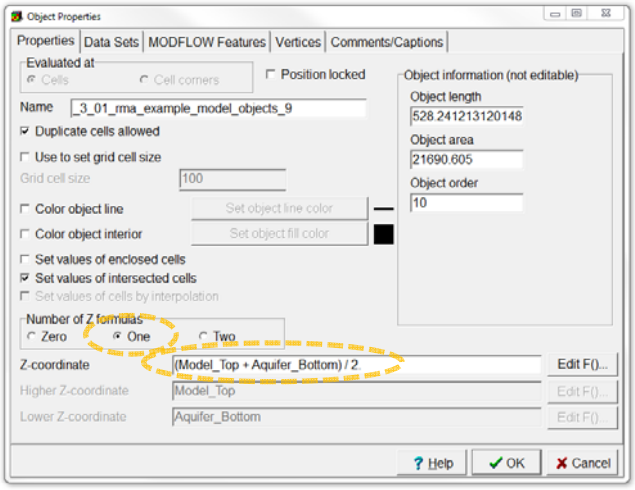
- ✓ Select **Model|MODFLOW Packages and Programs…**,
- ✓ expand **Boundary conditions|Specified flux**, and
- ✓ check the **Well Package**.
- ✓ Then click **OK**.



37

Add wells (2/5)

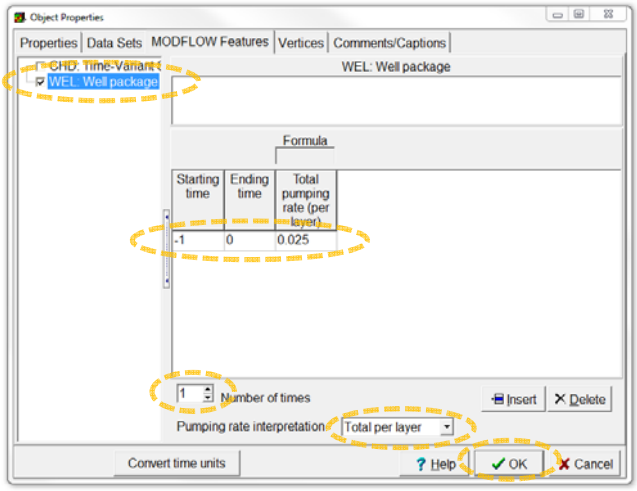
- ✓ Double click on the object that represents the disposal pond to open the **Object Properties** dialog box.
- ✓ Change the **Number of Z formulas** to **One** and make sure the formula is "(Model_Top + Aquifer_Bottom) / 2".



38

Add wells (3/5)

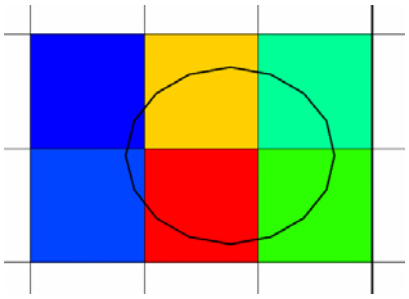
- ✓ Switch to the **MODFLOW Features** tab,
- ✓ check the **WEL** package,
- ✓ change the **Number of times** to 1,
- ✓ the **Pumping rate interpretation** to **Total per layer**,
- ✓ and set **Starting time**, **Ending time** and **Total pumping rate** to -1, 0, and 0.025.
- ✓ Then click **OK**.



39

Add wells (4/5)

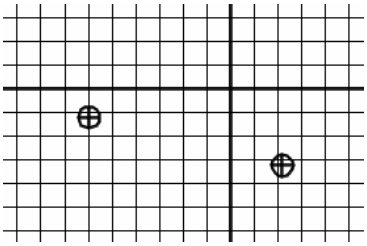
- ✓ Now colour the grid with the **Well pumping rate**,
- ✓ and check if the total is 0.025.



40

Add wells (5/5)

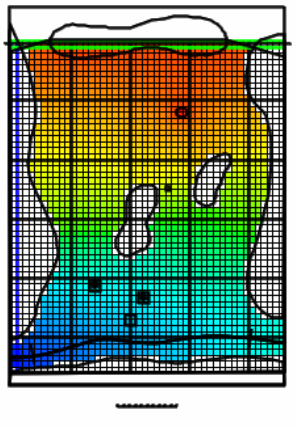
- ✓ To add the two pumping wells, create point objects at the center of the well symbols,
- ✓ check the **WEL** package,
- ✓ set the **Number of times** to 1,
- ✓ the **Pumping rate interpretation** to **Direct**,
- ✓ the **Starting** and **Ending time** to -1 and 0,
- ✓ and finally the **Pumping rate** to -0.001 and -0.002 for the western and eastern well respectively.



41

Run the model

- ✓ Now save the model as "03_01_rma_example_model.mmZLib" in folder "03_01_rma_example_model",
- ✓ run MODFLOW, and
- ✓ import the head results.
- ✓ You should get something similar to the figure on the right.



42

BELGIUM

Education evenings 2016

Practical introduction to groundwater modelling

Computer exercises
03 01 RMA example model

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

43