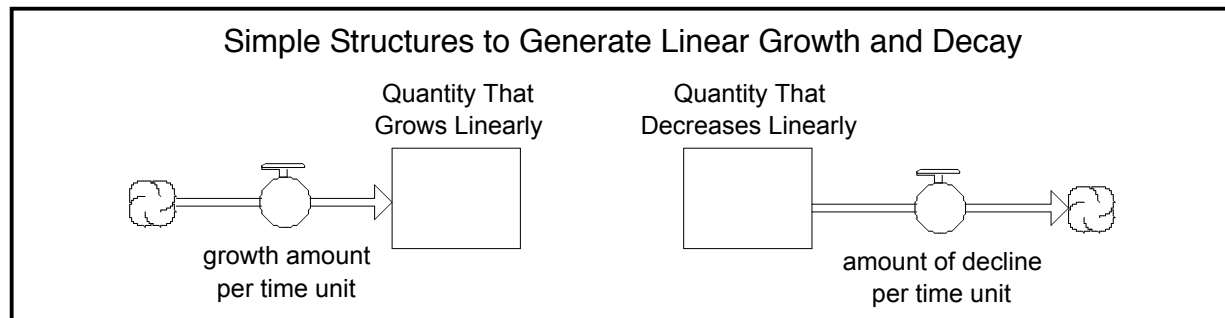


# Water in a Lake Model



To access the free version of the Stella Online software please create an account by going to the location: [publish.iseesystems.com](http://publish.iseesystems.com).

The Stella diagrams shown here can be used to model a system that varies linearly with time. Login to the Stella Online software. Since we want to build simulations we want to make sure we are in the Modeling mode (designated by the icon  $x^2$  in the top tool bar of the Stella Online software) and not in the Map mode (designated by the icon ).

## The Water in a Lake Model

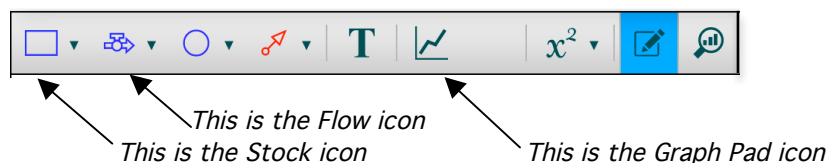
Suppose you know of a lake that is filled with continuous runoff from small streams. We want to keep track of the amount of water in the lake each year. The water in the lake will start at 100 kilo-acre-feet (KAF) and the streams are flowing water in at 5 KAF per year.

In this problem there are three important components: the volume of water in the lake, the amount of water that flows in per year, and time. We will determine how to identify which Stella building block should be used to represent each component. Time will not be represented using a building block. It is automatically included in all Stella models when we run them. That leaves only the water in the lake and water flowing in to consider. Then...

**1(a)** Ask yourself: What (amount of water in the lake or amount of water from streams) is increasing or decreasing with time?

You will define that component to be the stock. To do so, select the stock icon from the tool bar by clicking on it once, then release your click. Now click to place the icon in the model window. Be sure to name the stock: make sure the name bar above the box is selected (click on the box once to select it, if necessary), then type a name. Use your answer from 1(a) as the name.

Stella Online Toolbar



Finally set a beginning value for the stock: double-click inside the box and type (in the properties panel at the right) the number that is the beginning value. For this problem we will start with 100, so enter the value 100 (we will not worry about specifying the units in the computer for this problem). Also, remove the check mark at the top of the panel next to the words “Non-negative.” This check mark should ALWAYS be removed from all stocks. You will notice that the stock icon in your model now has a little +/- symbol in the lower right-hand corner to indicate that the non-negative check mark has been removed. Finally, click on the little triangle that is in the leftmost part of the panel, about half-way down the panel. (Clicking on the triangle closes the panel.) Notice that the yellow warning box in the stock disappears.

**1(b)** Next ask yourself: Is the stock value increasing or decreasing with time?

You will use the flow icon to represent the increase or decrease in the stock value per time. The flow icon represents the concept that “causes” the stock value to change (or can be thought of as the rate at which the stock value changes). So, should the flow be defined as amount of water in the lake or amount of water from the streams?

Select the flow icon from the tool bar by clicking on it once. Release the click. Decide if the stock is increasing or decreasing with this flow.

If *increasing*: place the flow cursor to the left of the stock (about 2 inches) click-and-drag it into the stock (the stock should turn blue if you have made a good connection).

OR

If *decreasing*: place the flow cursor **inside the stock**, click-and-drag the cursor out of the stock (to the right, about two inches).

Be sure to label the flow icon (the name bar below the flow ball must be selected) and set its value (by double-clicking on the ball part of the flow and typing in the value for the flow, in the panel at the right). Recall the water flow is 5 {KAF per year}. Click on the little triangle on the left of the panel to close the panel. Notice again that the warning symbol in the flow disappears when the value is set.

**1(c)** From the first sentence of the problem, determine (mentally) how much water should be in the lake after 4 years.

Finally, define a graph in Stella to see if your model gives you the same result.

To create a graph click on the Graph Pad icon in the toolbar. Click to place it in the diagram window and a new “blank” graph pad will open up. Once the graph pad opens double click on it so the graph pad properties panel opens. Notice that the word “Series 1” is in the Series List box. This is a placeholder for us to identify a variable we want to graph. Go to the Variable drop-down menu bar that contains the word “Choose...” Select the variable *Amount of Water in the Lake* (or whatever you named your stock).

While the graph pad properties panel is still open let’s make two other changes. Slide down the graph pad properties panel to “Graph Options.” Across from the Legend Position click “Bottom.” Then slide down the graph pad properties panel some more to the section labeled “Grid Options.” Click in the check box next to Grid Options (to activate this option). Type in 5 for the X Grid Lines and 5 for the Y Grid Lines.

Now press the Play button (the triangle at the far left of the bottom menu bar) to run this model.

**1(d)** Click-and-drag the cursor, left and right, on the graph page to determine approximately when the lake contains 122.5 KAF of water. (Drag your cursor across the graph until *Amount of Water in the Lake* approximately equals 122.5 (look under the graph at the legend and find the values for "Amount of Water in Lake" to the right of or below its name). Read off the associated time value (look at the changing time value, centered below the graph).

Opps, there is a problem. The water volume value only shows whole KAFs. We need the value shown to allow decimal parts of a KAF to be displayed. Double click the Water in Lake stock to open its Properties panel. At the bottom of the panel click on the formatting symbol (#) button. Change Precision to 0.1 and Scale by to "none."

But it appears the time variable is months not years. This is just a label change issue. To fix the time label double-click on a blank space in the modeling window. The Model Settings panel will open up. This is where you can change the simulation time label. Change the time units to years instead of months. Rerun the model and the time units should now be listed as years.

Record the time (interval) the lake will contain 122.5 gallons in the box below. Be sure to write units after your answer.

**1(e)** The Model Settings panel allows us to change some other important model simulation settings.

To change the length of time the simulation will run, double click on a blank space in the modeling desktop to open the model's Settings panel. Set the Stop Time number at 10 and set DT to 0.1. The DT specifies how often within each time unit to calculate model values for each variable. A DT of 0.1 will calculate variable values each 1/10 of a year. Change the Time Units to years.

Now press Play to run the simulation.

**1(f)** How much water is in the lake at 4.8 years?

How many years will it take for the lake to fill to 130 KAF?

**1(g)** Wait! This lake is going to flood the entire area eventually if there is no way for it to lose water. Suppose the people in a nearby village remove 2 KAF of water each year for all of their needs. Modify the previous diagram to include this new information. Rerun the simulation. Now, how much water will be in the lake in 4.8 years?

**1(h)** To exit the modeling software notice the button in the top right of the Stella window. If you want to download the model it will appear on your computer desktop. You can save it for a later time but it is also saved in your account with isee systems, inc. You also have the option of signing out of the software.