**Exercise 5a. Nutrient Load Calculation of San Marcos Basin**

GIS in Water Resources  
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# Goals of the Exercise

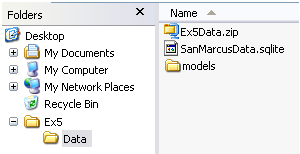
The HydroModeler is a modeling extension of HydroDesktop that adds the capability for a user to process data that was harvested using the HydroDesktop search mechanism. This exercise will show you how to construct a model using the HydroModeler, process data, and reload the results back into HydroDesktop to visualize them. To illustrate the usage of this extension a model will be constructed to calculate the nitrogen loading at two gauge stations within the San Marcos basin. The model will consist of several HydroModeler components that have been previously developed, and will be driven by nitrogen concentration and streamflow measurements.

## Computer and Data Requirements

Version **1.1 Beta 294** (Fri Oct 22 2010) or later of HydroDesktop must be installed on the computer. It is available at [www.HydroDesktop.org](http://www.HydroDesktop.org).

# Procedure for the Assignment

Logon to the computer of your choice and make a directory in your workspace for this exercise. The required files can be downloaded from the class website. Use Windows Explorer to create a folder called **Ex5** and within this location create a folder called Data. Unzip “**Ex5Data.zip**” in this folder.

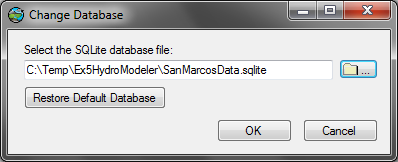


You should see a file called **SanMarcosData.sqlite.** This database contains streamflow and total nitrogen concentration at one USGS gauge location within the San Marcos basin, named San Marcos Rv at Luling, TX. This was downloaded for you using the HydroDesktop search feature. You will also see a folder called **models**. This folder contains some model components that will be used to perform a nitrogen loading calculation.

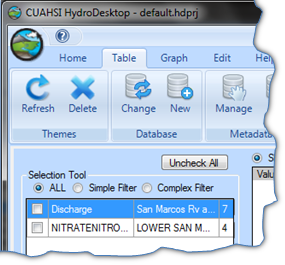
## Loading Data into HydroDesktop

Launch HydroDesktop. In order to use the data stored in the **SanMarcosData.sqlite** database, it must first be loaded into HydroDesktop. To do this, select the **Table** ribbon tab and under the **Database** category, click the **Change** button.

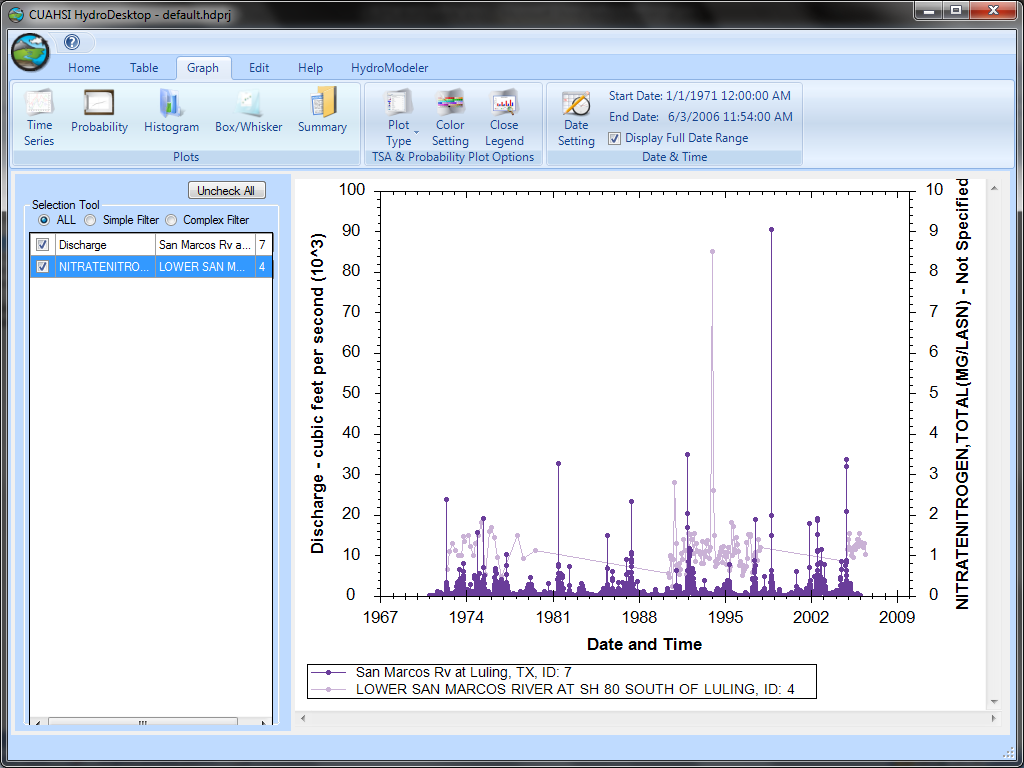
A new window will appear. Navigate to the path where the **SanMarcosData.sqlite** was saved and click **OK**.



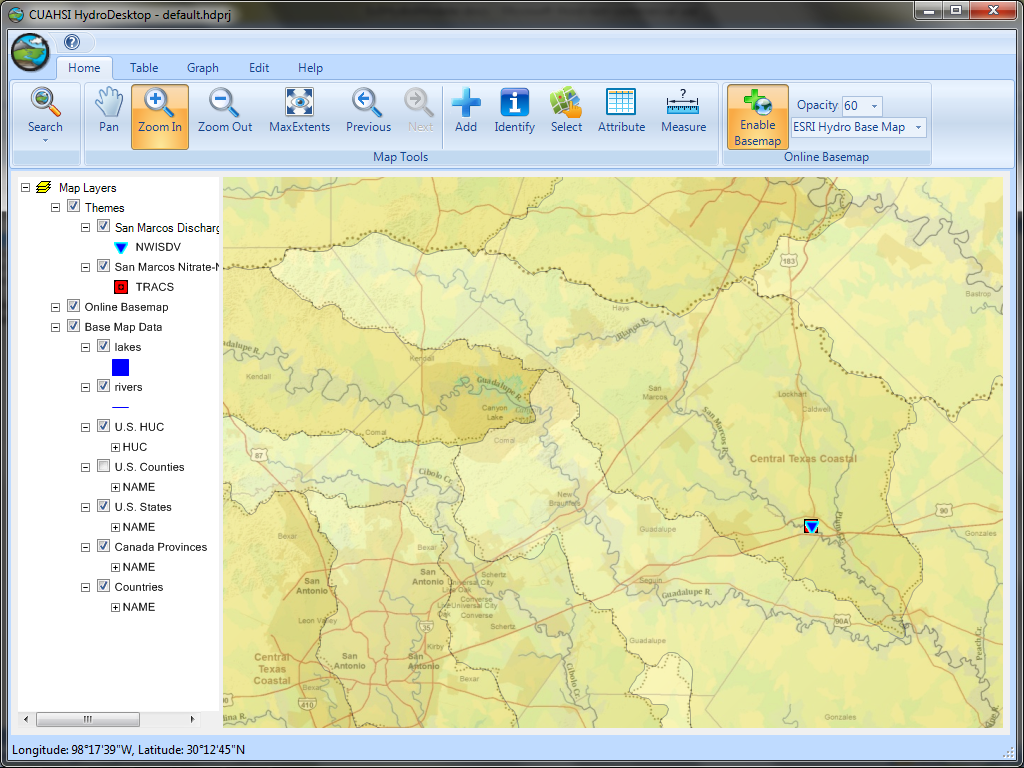
You should now see 2 data series (see below).



The actual values of these data series can be visualized by selecting the **Graph** ribbon tab. Check the boxes next to the **Flow rate** and **Total nitrogen** quantities for each site id. You can see that data is available at each site, although not always at the same time. Keep patient when Discharge data is loading.

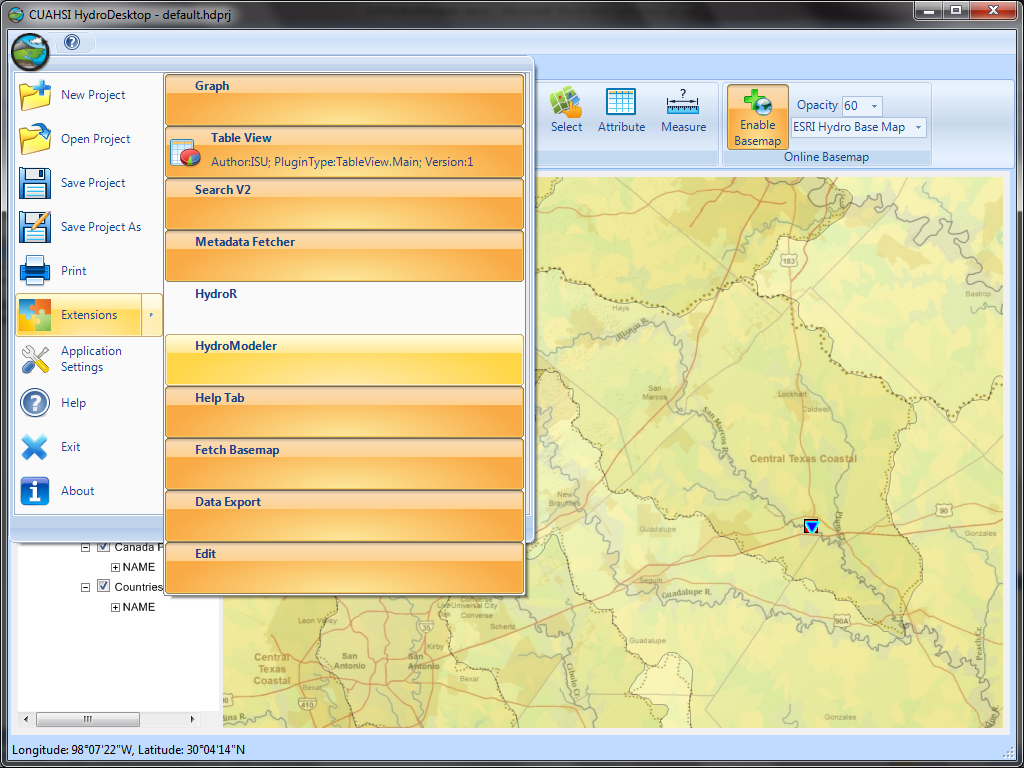


Navigate back to the **Home** ribbon tab to spatially visualize this data. Here we can see where the gauge exists in the San Marcos basin. Using the Basemap tool learned in Exercise 1, you can get the following fancy map showing the actual location of San Marcos Rv at Luling, TX.



## Loading the HydroModeler Extension

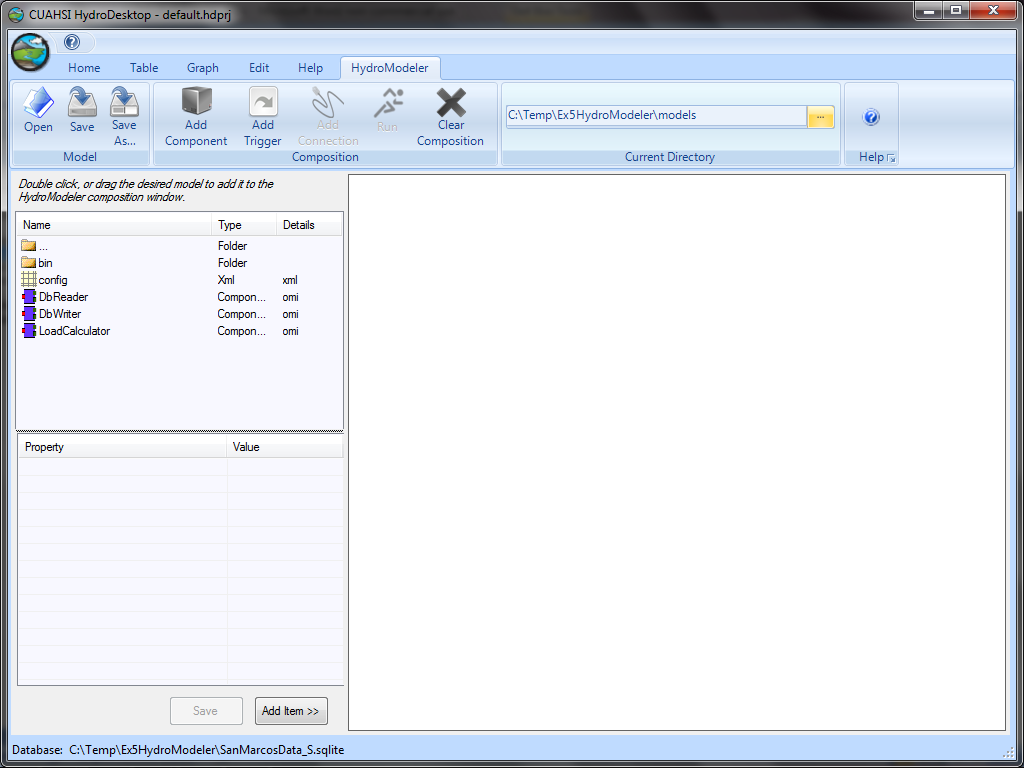
**HydroModeler** is an extension for HydroDesktop that provides a hydrologic modeling environment. This will be used to perform a nutrient loading calculation at the selected site, but only when both “Flow rate” and “Total nitrogen” exist at the same time. To do this, the HydroModeler extension must first be added by clicking on the **Orb** located in the top left corner of the HydroDesktop application, then selecting **Extensions**, and finally selecting **HydroModeler**.



**Click the Orb**

**Select HydroModeler**

The HydroModeler extension will automatically launch and you should see something like this (see below). There are three main components to HydroModeler: **File Browser** window, **Properties** window, and **Composition** window. The **File Browser** window is used to navigate and find “model components”. These “model components” are individual computations that can be loaded into the **Composition** window to form a “model composition”. The **Properties** window is used to display and modify the properties of a “model component” that is selected in the File Browser window.



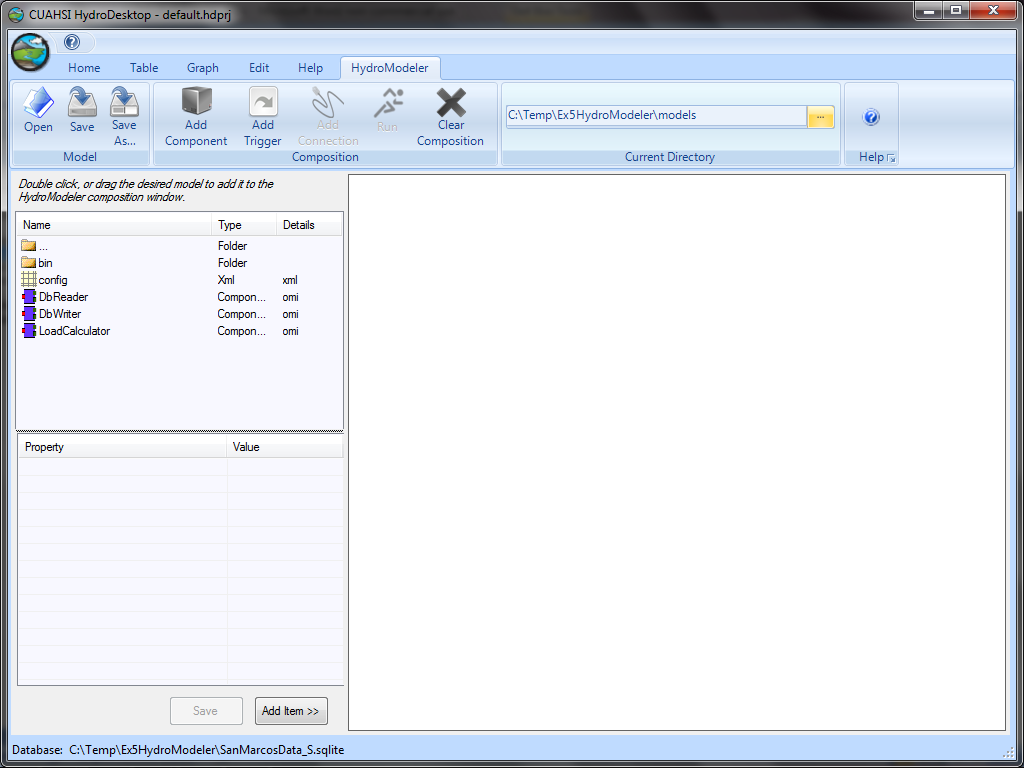
**File Browser**

**Composition Window**

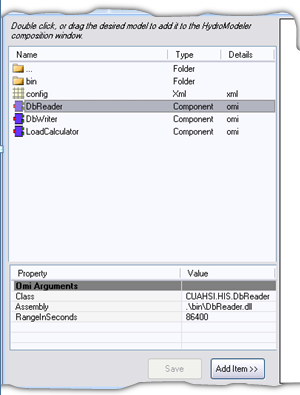
**Properties Window**

## Adding Model Components

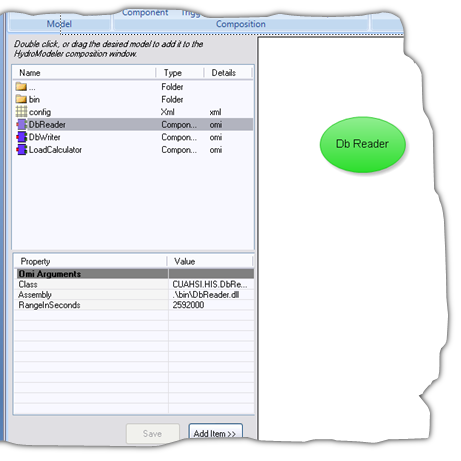
Navigate to the folder where you saved the exercise data and then into the **models** folder. You can do this using the **File Browser** window or by changing path in the **Current** **Directory** textbox.



Next, you should see a file named DbReader in the **File Browser** window. This is a model component designed to read data from the HydroDesktop database. Click once on the **DbReader** component to populate its attributes in the Properties window.

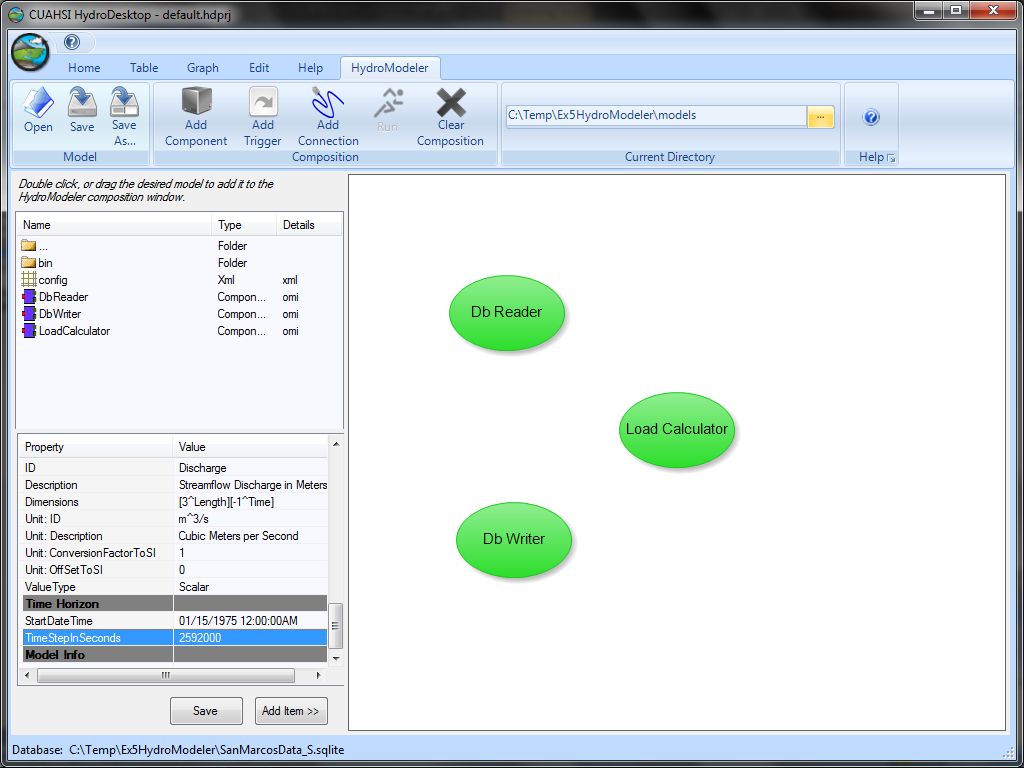


The values listed in the Properties window can tell us a little about the DbReader model component such as its class name, where the assembly is located, and an argument called **RangeInSeconds**. This argument allows the modeler to specify a search window to look for data. For instance, the current value of 86400 states that the DbReader will search for data within a 24 hour time window of all requested times. This is helpful if calculations are being performed on two different data series having different (or inconsistent) measurement intervals. Of course, there remains the possibility that more than one data value is found within the specified search window. In this case, the DbReader will average all of the values it finds. Since the stream flow data series contains daily recorded data and the nitrogen series contains values recorded every ~15 days, we must choose an appropriate RangeInSeconds as to not waste computational time. Click on **86400** and change its value to **2592000** (30 days), press **Enter** and then select **Save**. Next load the **DbReader** component by simply dragging it from the **FileBrowser** and dropping it into the **Composition** window.



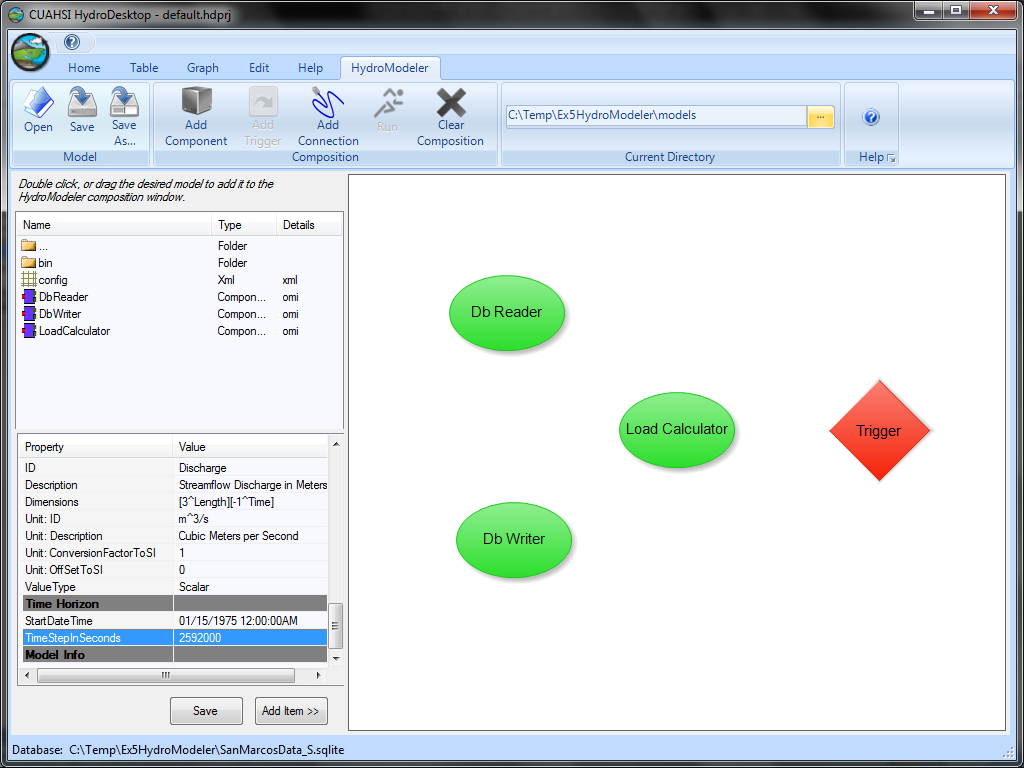
Next, add the **DbWriter** component to the Composition Window. This component is responsible for extracting time series data from the HydroModeler and saving it in the HydroDesktop database. The **IgnoreValue** argument, shown in the properties window, allows the modeler to specify which (if any) value will be ignored and thereby NOT saved to the database. For now, leave this as -1.

Next, locate the **LoadCalculator.** Click on the **LoadCalculator** model component once to see its attributes in the **Properties** window. You should see various arguments that describe the model. These arguments can be modified to resemble the desired study area. Scroll all the way to the way down and change **TimeStepInSeconds** to **2592000**. Next, we need to adjust this component’s start time by changing **StartDateTime** to **01/15/1975 12:00:00**.



Finally, **Save** these changes and add the **LoadCalculator** component to the model composition.

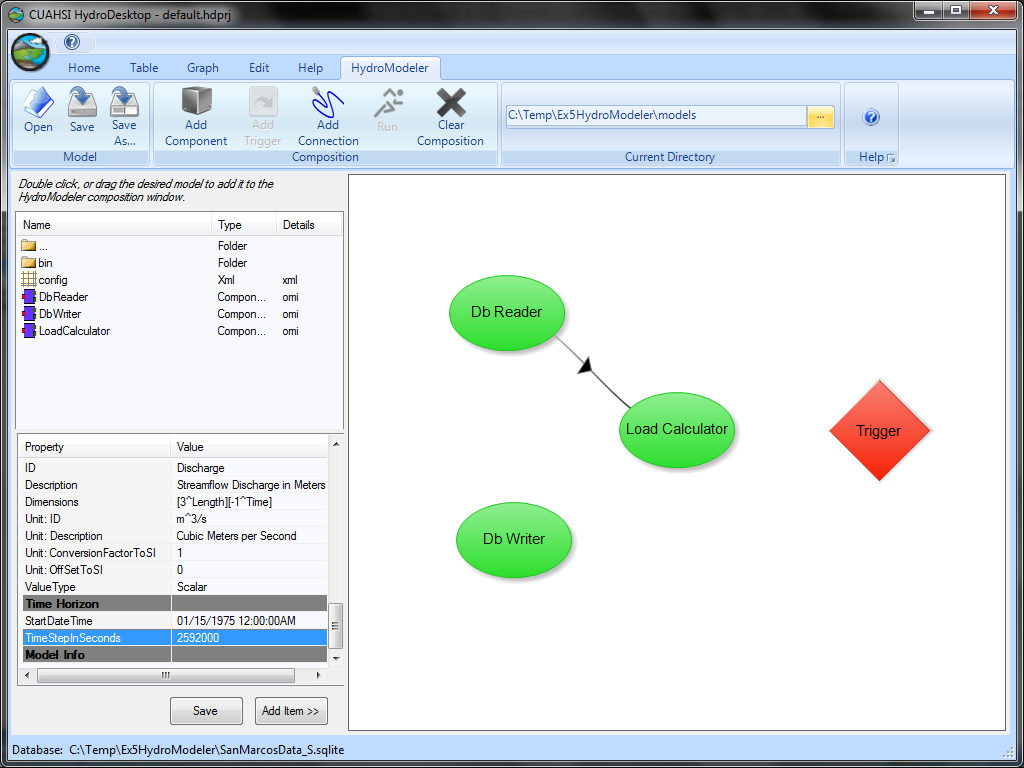
Lastly, add a **Trigger** to the composition by clicking the **Add Trigger** ribbon button at the top of the screen.



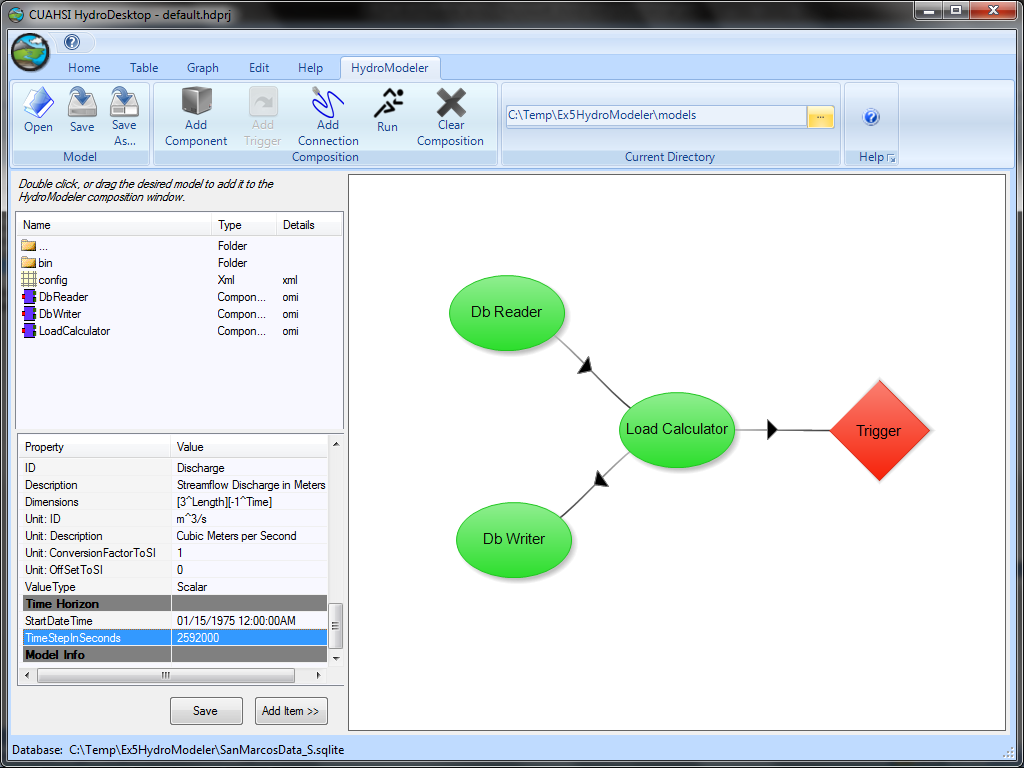
Now we have all the necessary model components to read the data from the database, perform a load calculation on the data, and then write the data back into the database. The **Trigger** is a mechanism that defines the end of the model, and is used behind-the-scenes to moderate the simulation run.

## Creating Links between Model Components

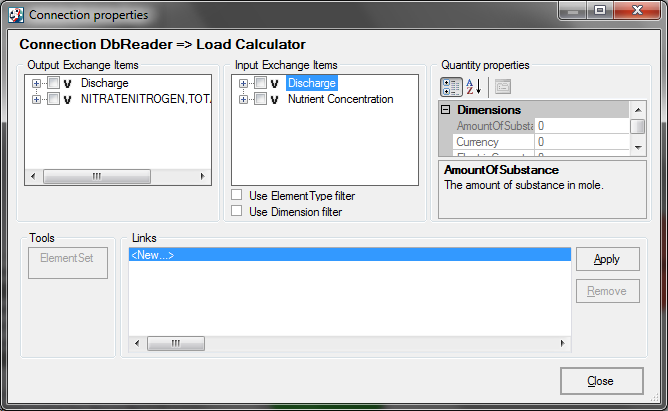
The next thing to do is create connections between the individual model components. These connections represent the pathways for data to flow between components. To add a link, click the **Add Connection** ribbon button then click the desired “source” model component followed by the desired “target” model component. For example, to create a linkage between the DbReader and LoadCalculator, click the **DbReader** component then the **LoadCalculator** component.



Repeat this to draw links from the **LoadCalculator** to the **DbWriter**, and the **LoadCalculator** to the **Trigger**. The model composition should look like this.

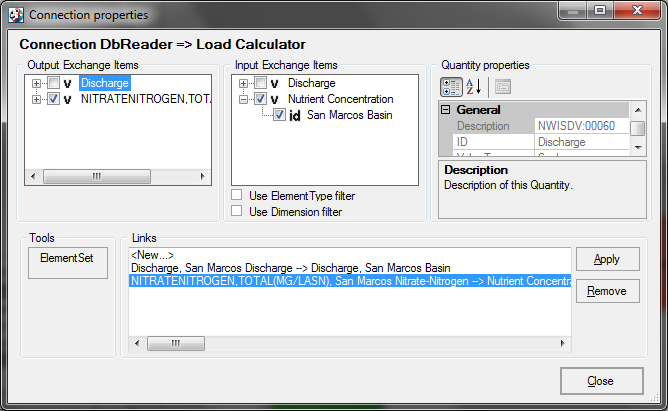


Next, we need to define the data that will travel across each link. Click on the **Arrow** between the DbReader and LoadCalculator, you should see the following window.

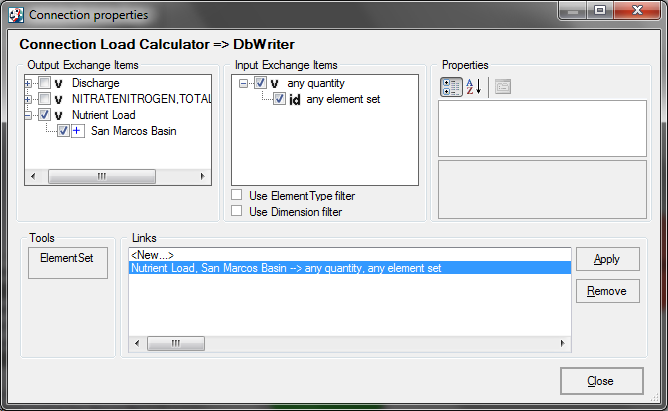


Click on the plus sign next to the **Discharge** item and **check the box** next the **San Marcos Discharge**. Then click the plus sign next to **Discharge** and **check the box** next to **San Marcos Basin**. Finally click the **Apply** button. This action tells HydroModeler that the “Flow rate” from the DbReader will be supplied as “Discharge” to the LoadCalculator during the simulation. Repeat this to define a linkage between **NitrateNitrogen,Total** and **Nutrient Concentration** as well.

**NOTE:** Be patient as this step may take a few extra seconds to complete.



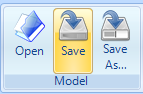
Close this window and **repeat these steps** for the link between the **LoadCalculator** and **DbWriter**, only this time choose **Nutrient Load** and **any quantity**.



Finally, click the link between the LoadCalculator and the Trigger. Specify **Discharge** and **San Marcus Discharge** to **TriggerQuantityID** and **TiggerElementID**.

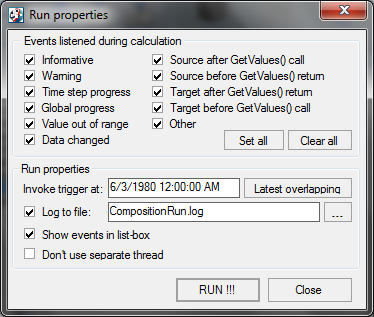


Save the model composition by clicking the **Save** ribbon button.

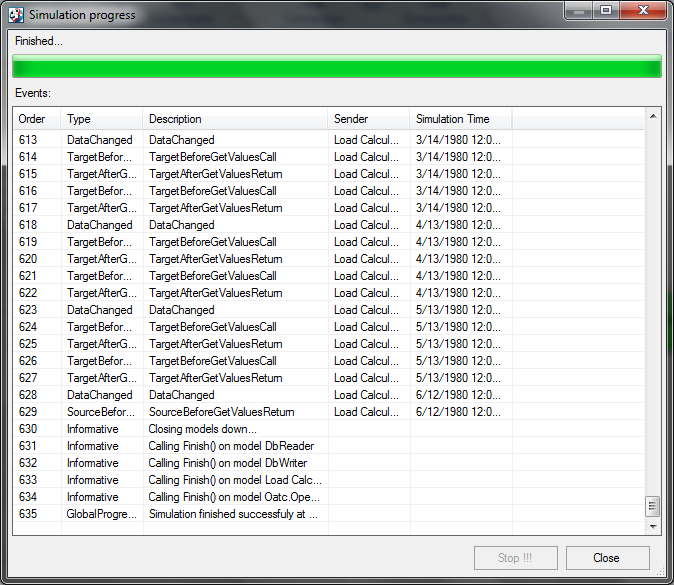


## Executing a Model Composition

Click the **Run** ribbon button to open the “Run properties” dialog.



Click the **Set all** button to turn all model notifications on. HydroModeler will automatically select the end time by based on the time horizons of all the components if “Latest overlapping”is clicked. Since model the entire series of data will take a significant amount of time, we can instead manually specify the model end time by changing **Invoke Trigger At**  to **6/3/1980 12:00:00 AM**. Finally select **RUN !!!** Model simulation should about 3 minutes. When it’s finished the dialog box should look like this.



Close this window, and select **Yes** at the next dialog window to reload the model components.

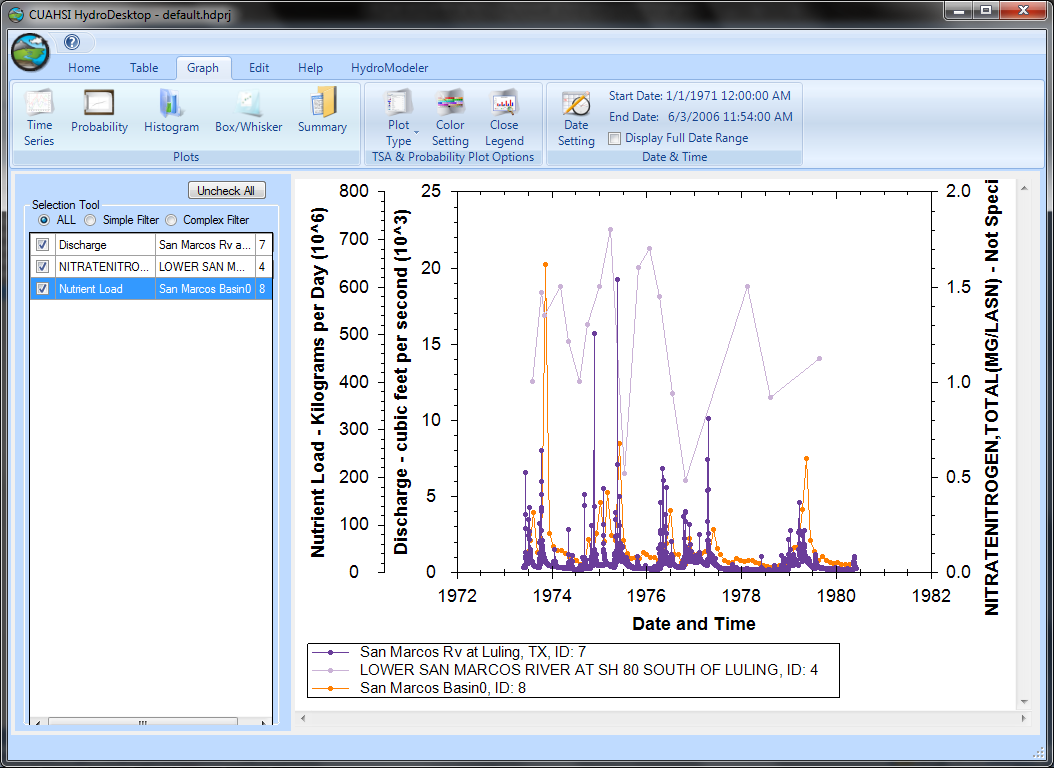
**NOTE:** Be patient as this step will take a few extra seconds to complete because each model will be reloaded.

## Viewing Simulation Results

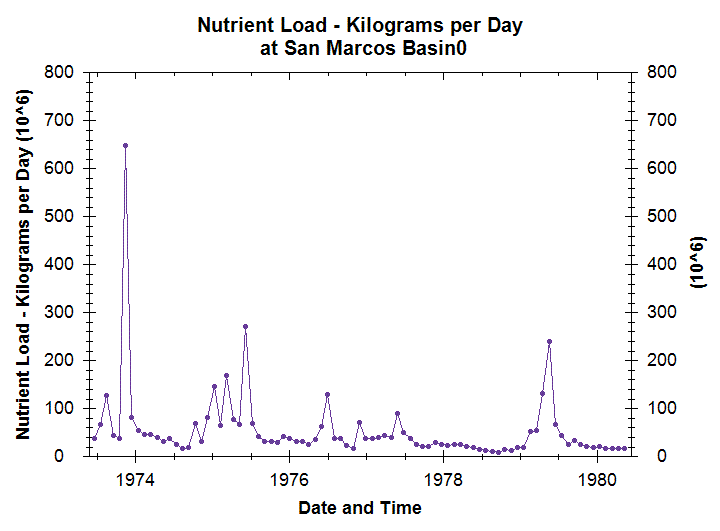
To view simulation results, first select the **Table** ribbon tab and click the **Refresh** button. You should see one new data series labeled **Nutrient Load**.

To view the series values, click the **Graph** ribbon tab and choose the desired series.

Here are the streamflow (dark purple line), nitrate-nitrogen concentration (light purple), and the nitrogen loading (orange line) for San Marcos Rv at Luling, TX all on a single plot. You can select **Date Setting** option to specify the date range so that only data during the dates that were simulated are shown in the plot.



Here is the exported graph of nitrogen loading that was calculated.



That’s the end of our procedure. You have successfully performed a simple nitrogen loading calculation. This model can be adjusted to fit different data by modifying the DbReader’s **RangeInSeconds** argument and/or the LoadCalculator’s **TimeStepInSeconds** argument.