Exercise 5. HEC-HMS Modeling using data from GIS Data Services Extension

GIS in Water Resources, Fall 2015

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Purpose

The purpose of this extension to exercise 5 is to develop and run your own HEC-HMS model for Onion Creek.

1. Preparation

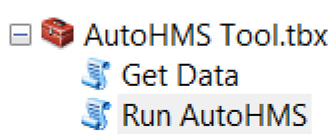
This extension assumes you have already done Exercise 5 at http://www.caee.utexas.edu/prof/maidment/giswr2015/Ex5/Ex52015.pdf and have an Ex5.mxd map document and Onion_HEC.gdb from having run AutoHMS -> GetData. Make sure that ArcMap has been saved, closed and re-opened before proceeding because the Run AutoHMS tool sometimes gives errors if this has not been done.

Onion_HEC.gdb is in http://www.neng.usu.edu/cee/faculty/dtarb/giswr/2015/Ex5Data.zip for students who are unable to use the ArcGIS services through an organizational account.

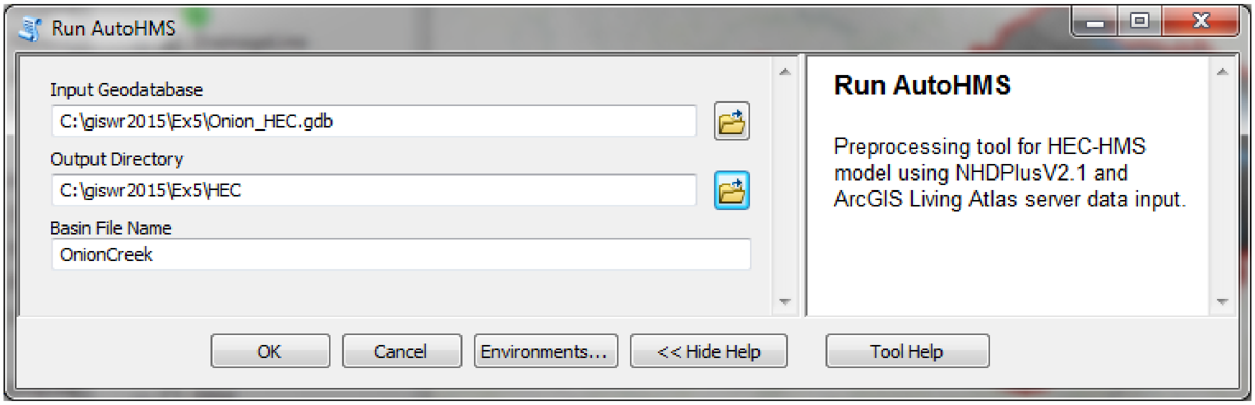
2. Prepare HEC-HMS basin file

Use this data downloaded in Exercise 5 in AutoHMS to create a .BASIN file, which is an ASCII text file used by HEC-HMS to populate the software with hydrologic elements and their respective attributes (i.e. downstream connectivity, loss parameters, routing parameters, basin area).

1) Open ArcMap and locate the Run AutoHMS tool in the AutoHMS Tool.tbx toolbox. This should be in Ex5tools in the project folder where you initially unzipped http://www.neng.usu.edu/cee/faculty/dtarb/giswr/2015/Ex5tools.zip
2) Select the *Run AutoHMS* script from the toolbox.

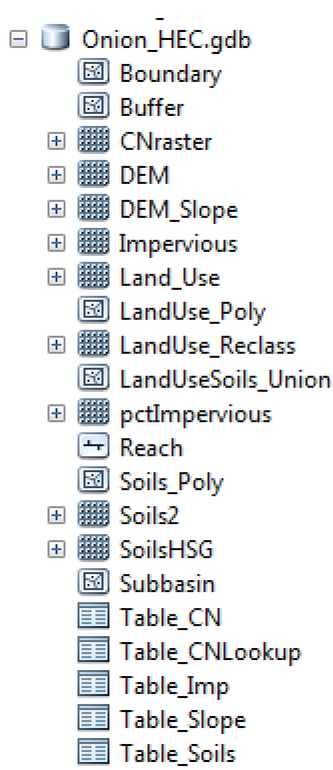


3) Input the geodatabase created with the *Get Data* script (Onion+HEC.gdb).
4) Select an output directory where the HEC-HMS .BASIN file will be saved.
5) Input a name for the .BASIN file (i.e. *OnionCreek*).
6) Select *OK*. This process should take approximately 1 minute to complete.



Note that this function sometimes gives errors if the layers it is working on are open in ArcMap, so if you get an error, remove all layers from Onion_HEC.gdb from your map, save, close and reopen and try again.

You should now have much more data in Onion_HEC.gdb and the file OnionCreek.BASIN that specifies the basin model for HEC-HMS.



The basin file OnionCreek.BASIN is a text file that you can open in a text editor (e.g. Wordpad) to view the input properties computed from the GIS information. You should not edit information in this file unless you really know what you are doing.

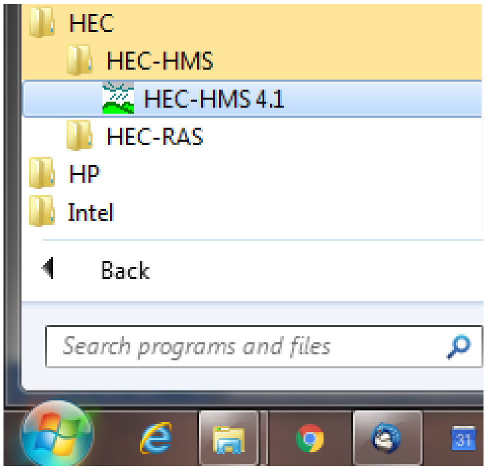
Name	Date modified	Type	Size
OnionCreek.BASIN	10/26/2015 10:54 ...	BASIN File	29 KB

```
Basin: OnionCreek
     Last Modified Date:  26 October 2015
     Last Modified Time:  22:54:16
     Version 3.5
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Allow Blending: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Junction: Junction-J2
     Canvas X: -167820.293892
     Canvas Y: -1141769.96992
     Downstream: Flowline-2
End:

Junction: Junction-J5
     Canvas X: -159223.955437
     Canvas Y: -1145511.5417
     Downstream: Flowline-10
End:
```

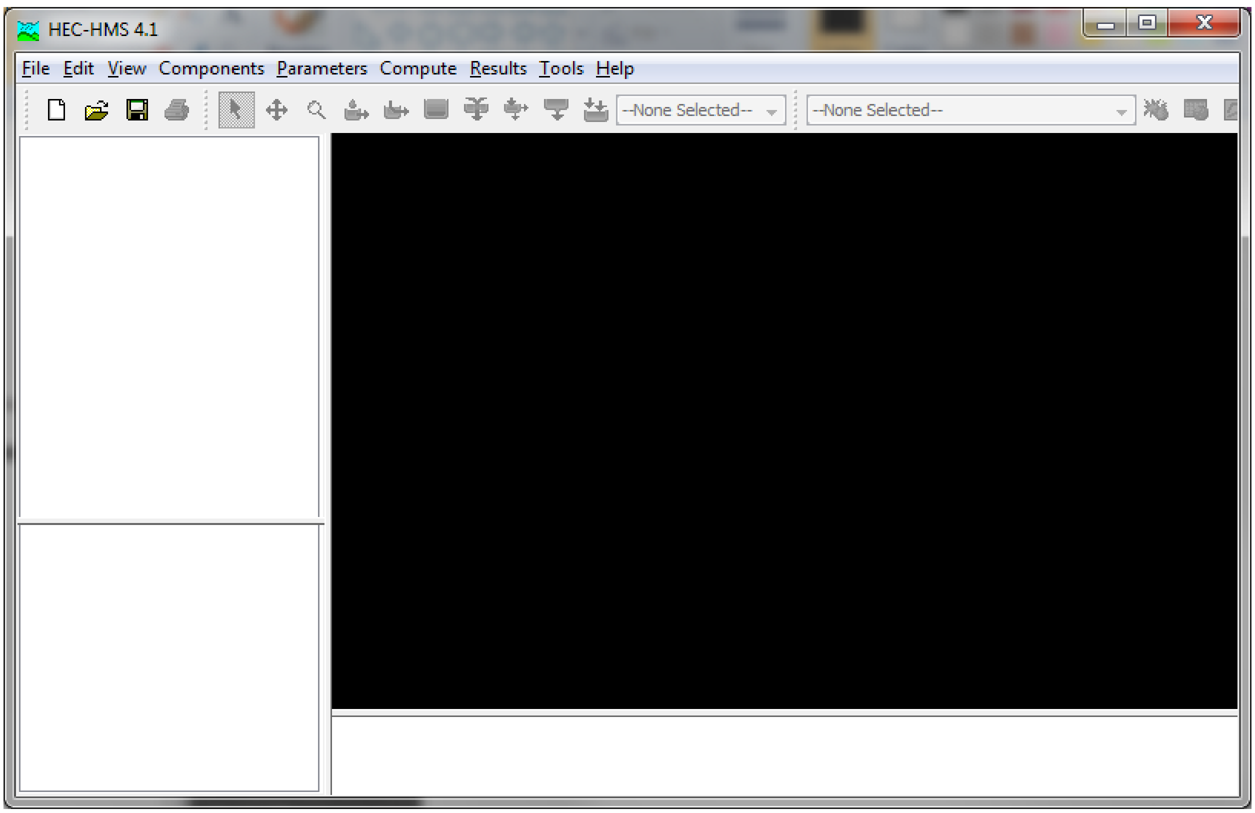
To turn in: Open the attribute table for the Subbasin feature class in Onion_HEC.gdb. For the largest subbasin (Note that Subbasin in HEC corresponds to Catchments we delineated earlier) report the slope and percentage imperviousness (Imp column). Compare these values to the values you calculated above using zonal statistics.

3. Prepare other inputs and run HEC-HMS

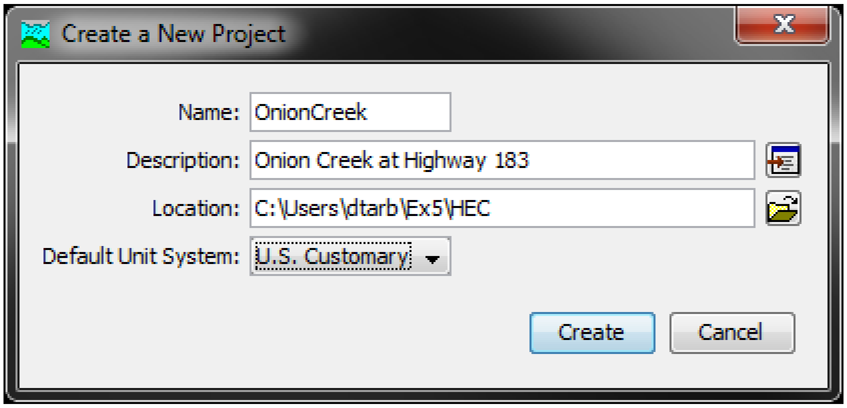
Start HEC-HMS from the start button or desktop icon.



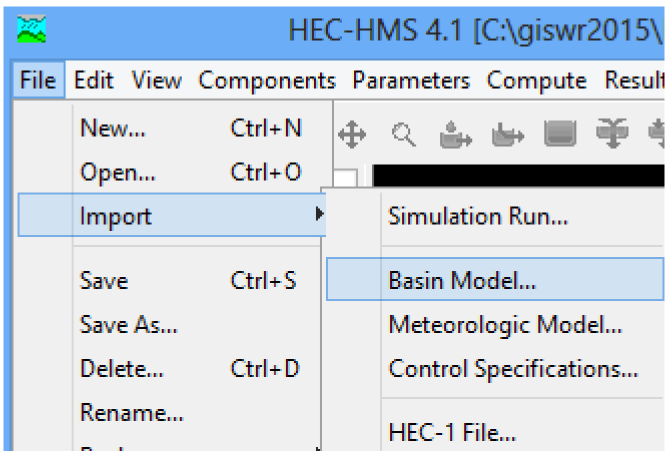
Initially you get this blank screen



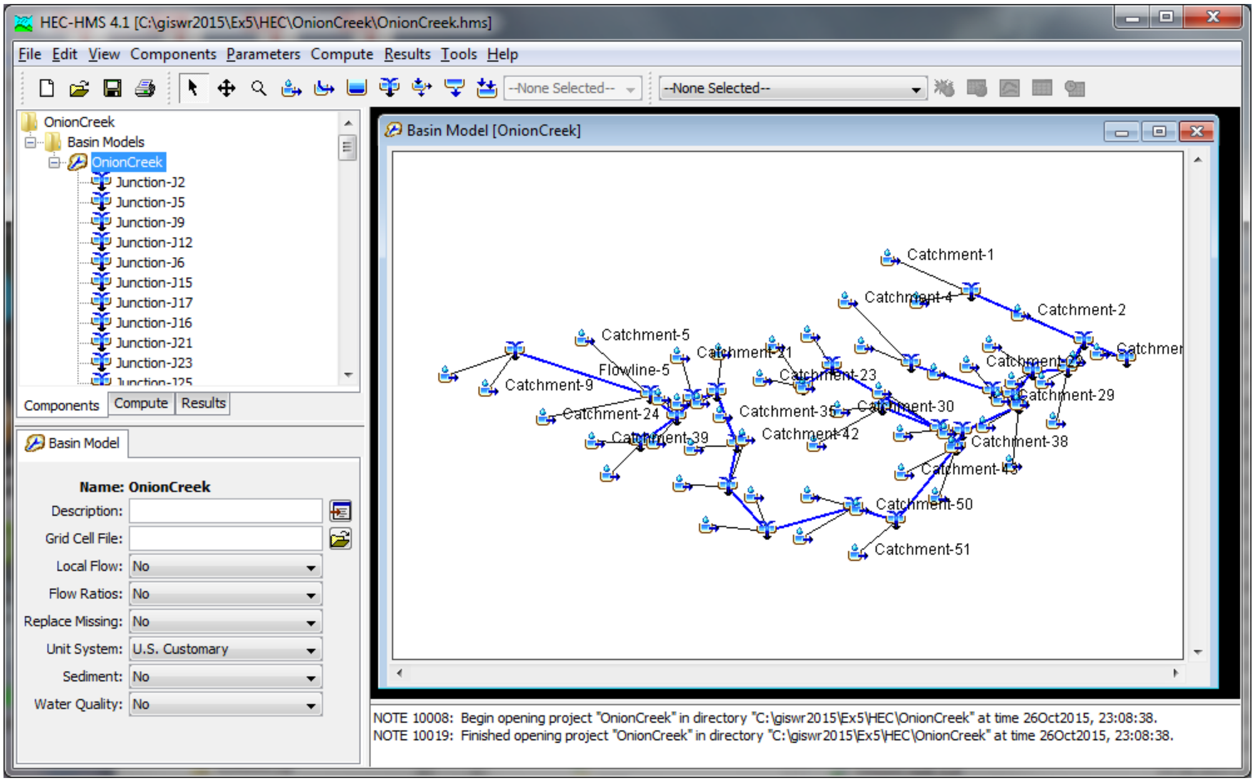
From the File menu (or icon) select New and set a name, location and U.S. Customary units and click Create.



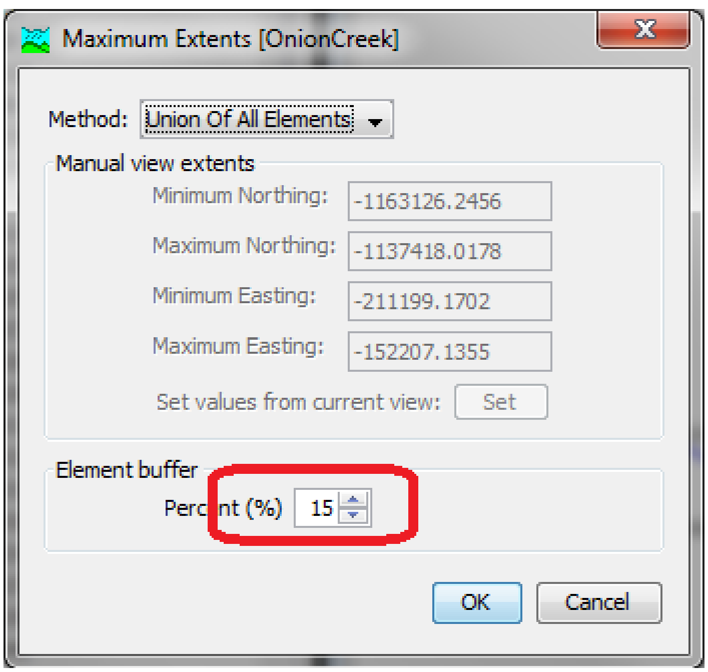
A new folder with the Name given will be created in the location you designate. Click File -> Import -> Basin Model and select the OnionCreek.BASIN file produced by ArcGIS.



In the components panel on the left you should see OnionCreek under Basin Models. Click on this to see the Basin Model window. Note that a Basin, in HEC Jargon has been created for each catchment in the Catchments polygon provided to the HEC-HMS data preparation scripts. This is a detailed distributed representation of the Onion Creek watershed that would have been tedious and error prone to set up by hand. Pretty cool!



Note that you may need to select View -> Maximum Extents and adjust the Element buffer to see the most downstream elements in the Basin Model View



In addition to basin properties, HEC needs meteorological information to determine a design storm. The City of Austin provides precipitation depth-duration frequency information at https://www.municode.com/library/tx/austin/codes/drainage_criteria_manual?nodeId=APXBDERAFRINRAFRAUTRCOTE

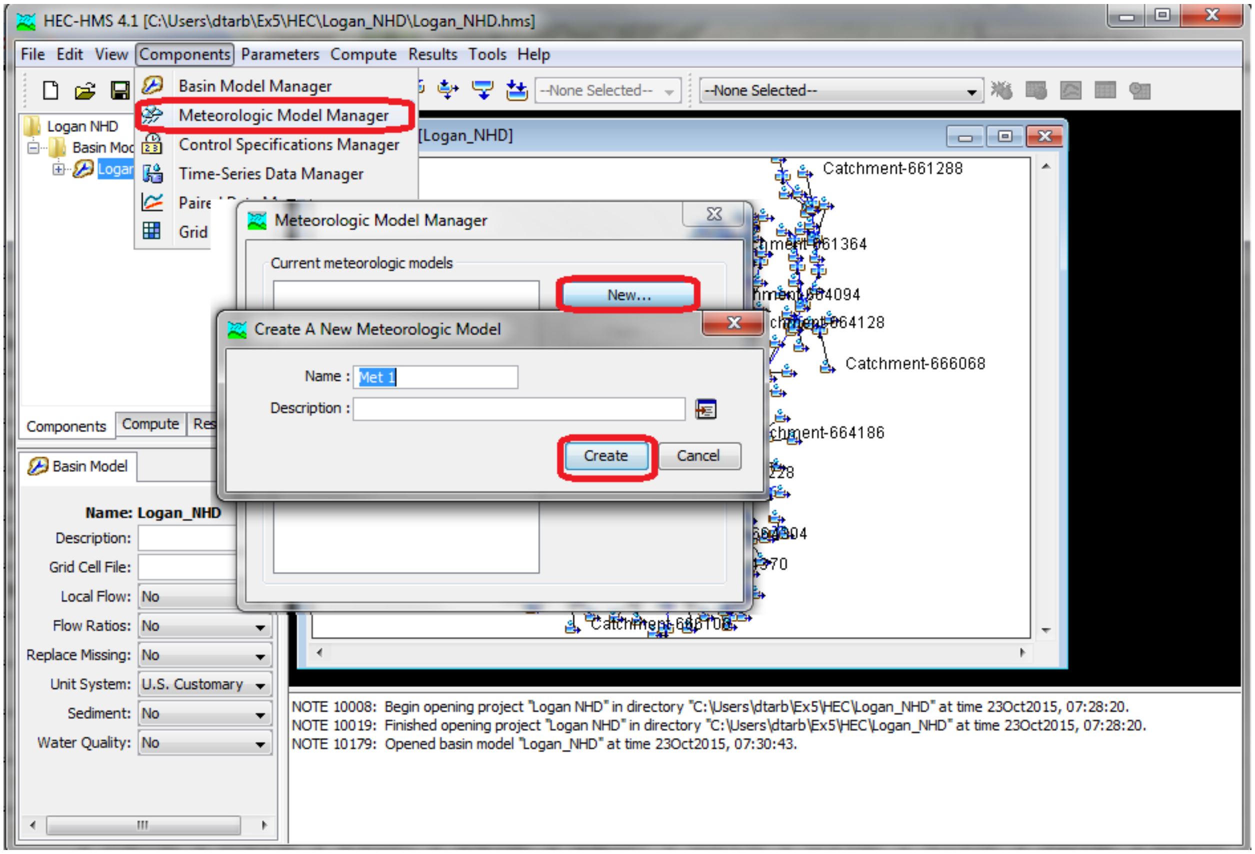
The values circled are for a 100 year storm

Table 1. Depth-duration frequency of precipitation for Austin and Travis County, Texas

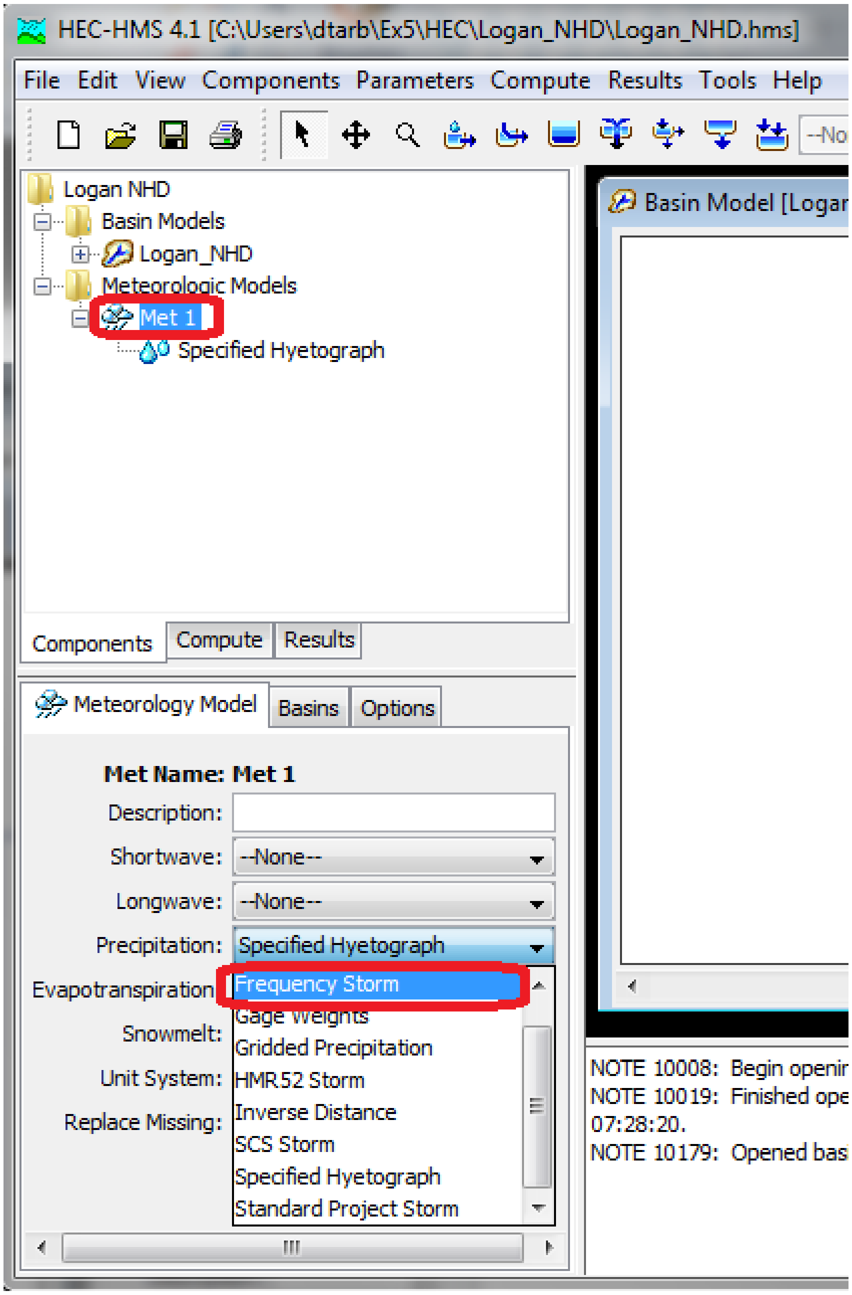
[Note: Values in table derived from Asquith (1998). The location used to define the parameters of the precipitation distribution was Tom Miller Dam on the Colorado River near the center of the Austin area located at latitude 30°17′39″ and longitude 97°47′12″. min., minutes; hr, hours; in., inches]

Annual non-exceedance probability (percent)	Recurrence interval (years)	Precipitation depth and duration											
		15 min (in)	30 min (in)	1 hr (in)	2 hr (in)	3 hr (in)	6 hr (in)	12 hr (in)	1 day (in)	2 day (in)	3 day (in)	5 day (in)	7 day (in)
0.500	2	0.98	1.32	1.72	2.16	2.32	2.67	3.06	3.44	3.81	4.04	4.30	4.57
.600	2.5	1.05	1.42	1.86	2.35	2.53	2.91	3.33	3.84	4.28	4.51	4.81	5.08
.700	3.33	1.14	1.54	2.04	2.58	2.79	3.19	3.64	4.33	4.84	5.08	5.43	5.70
.800	5	1.26	1.71	2.28	2.89	3.13	3.56	4.07	4.99	5.60	5.85	6.26	6.53
.900	10	1.47	1.98	2.68	3.42	3.71	4.21	4.81	6.10	6.88	7.14	7.65	7.91
.960	25	1.76	2.36	3.28	4.20	4.55	5.14	5.90	7.64	8.63	8.91	9.53	9.75
.980	50	2.01	2.68	3.79	4.88	5.28	5.94	6.86	8.87	10.0	10.3	11.0	11.2
.990	100	2.29	3.04	4.37	5.66	6.11	6.85	7.96	10.2	11.5	11.8	12.6	12.7
.996	250	2.73	3.57	5.26	6.86	7.38	8.24	9.67	12.0	13.6	13.9	14.7	14.8
.998	500	3.11	4.02	6.06	7.94	8.51	9.47	11.2	13.5	15.2	15.6	16.5	16.5

In HEC-HMS click on Components -> Meteorologic Model Manager and Click New. Accept the default name and click Create.

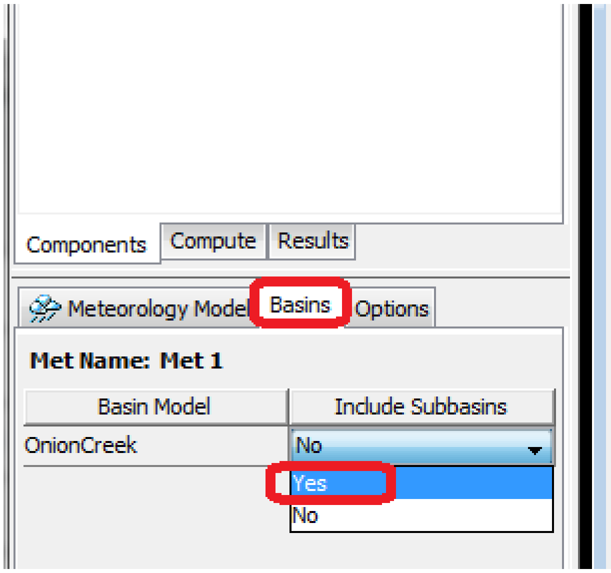


Close the Meteorologic Model Manager using the red X. Your components listing now includes a Meteorologic Model. Click on Met-1, and then in the panel for setting properties at the bottom left switch from a Specified Hyetograph to **Frequency Storm**.



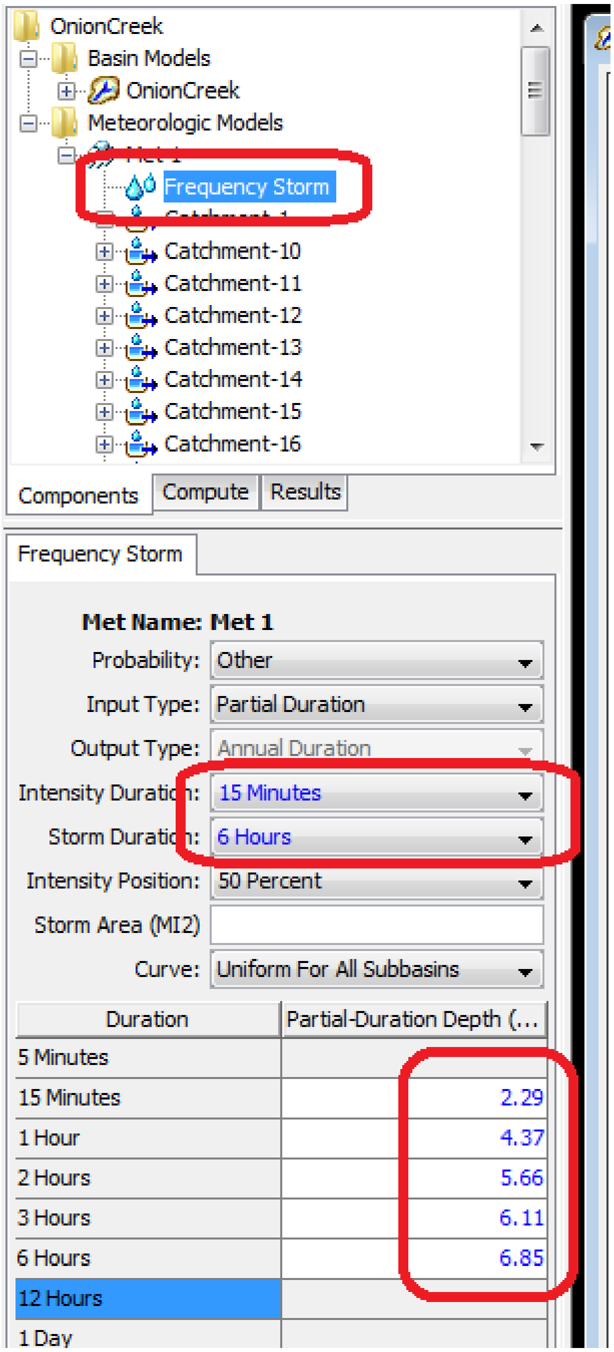
Click Yes to the warning about losing data. We have not entered any data for a specific Hyetograph that we would be in danger of losing. Note that above the detail under the Met-1 Meteorology Model changes to Frequency Storm.

Click on Basins next to the Meteorology Model tab and under Include Subbasins, toggle from No to Yes.

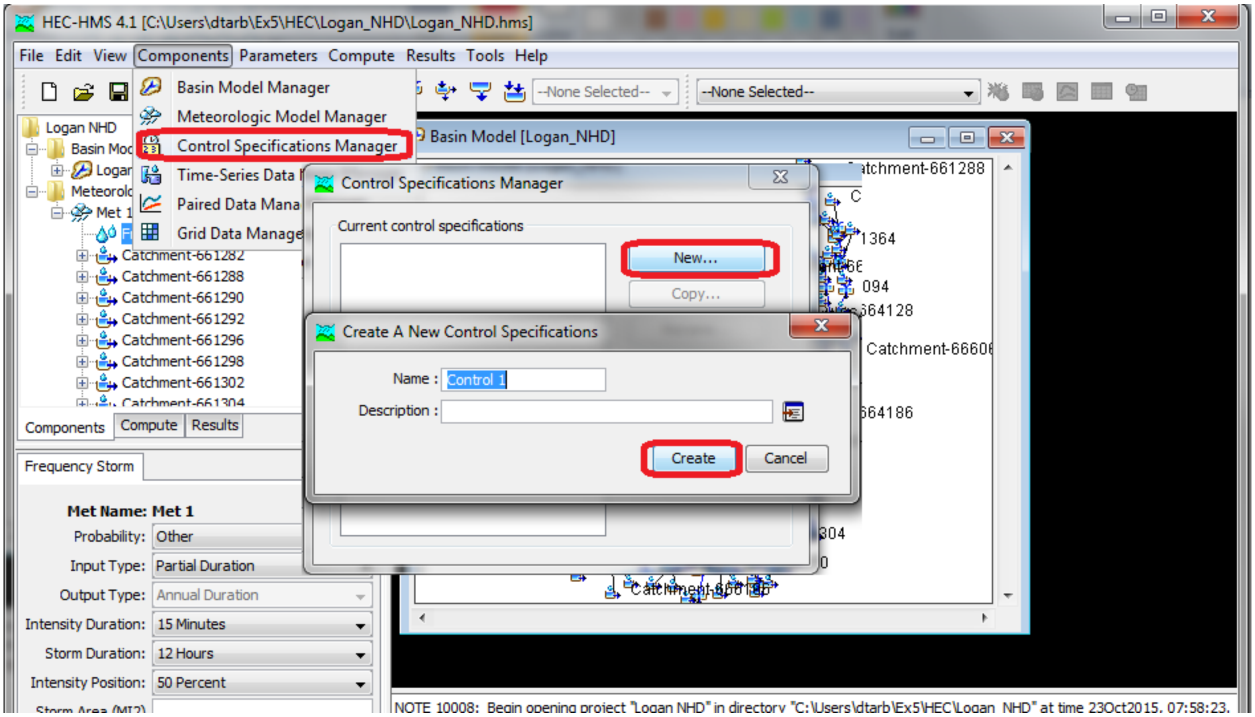


You should then see that in the table of components each catchment is listed below the Frequency storm indicating the association of the Frequency Storm with each Catchment.

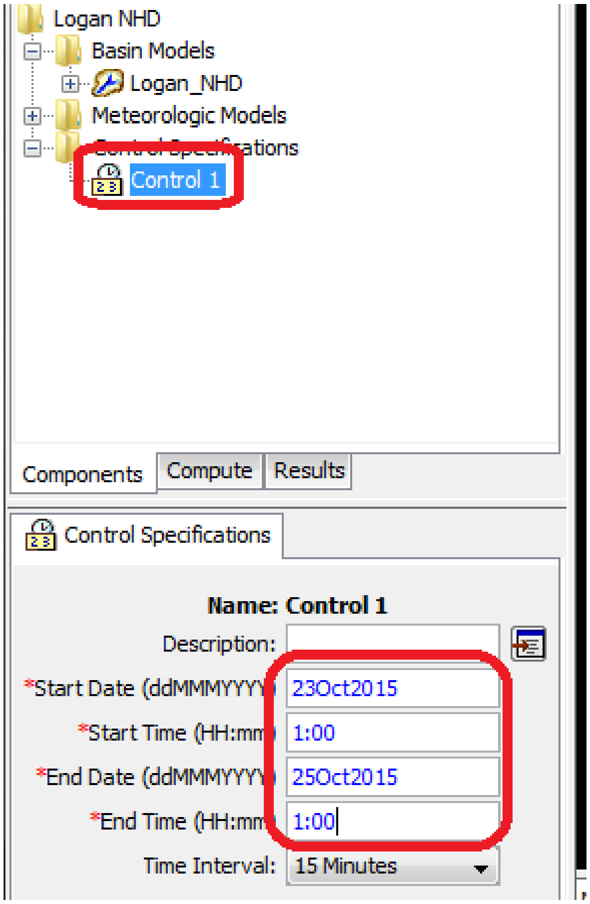
Click on Frequency Storm so that its parameters are displayed in the bottom left panel. Change the settings indicated. Note that what is displayed in blue is unsaved. If you click save in the top bar the data will be saved to the project file and display switch to black. You should do this periodically.



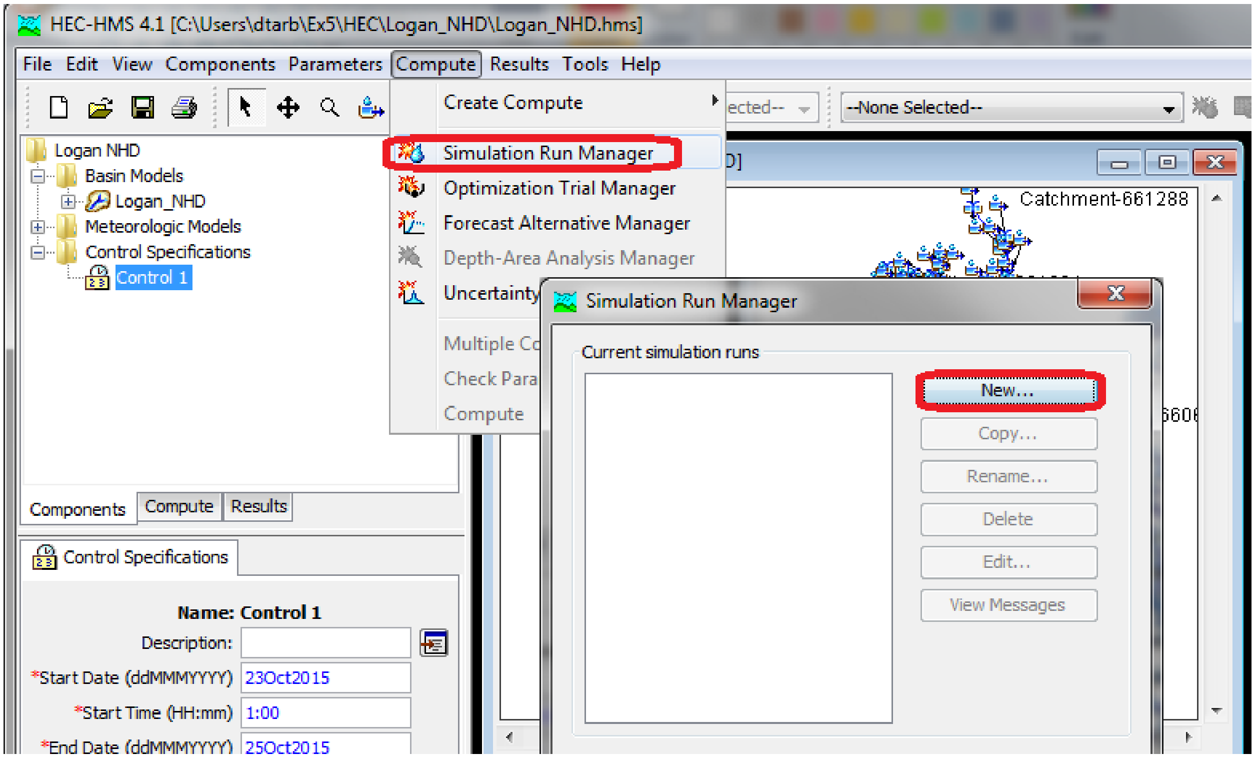
Next click Components -> Control Specifications Manager and New and Create, leaving the default name Control-1.



In the components panel on the left collapse Meteorologic models and expand Control Specifications and click on Control-1. Set start and end date and times as indicated. These are arbitrary. We are looking for 2 days of simulation and a 6 hour storm.

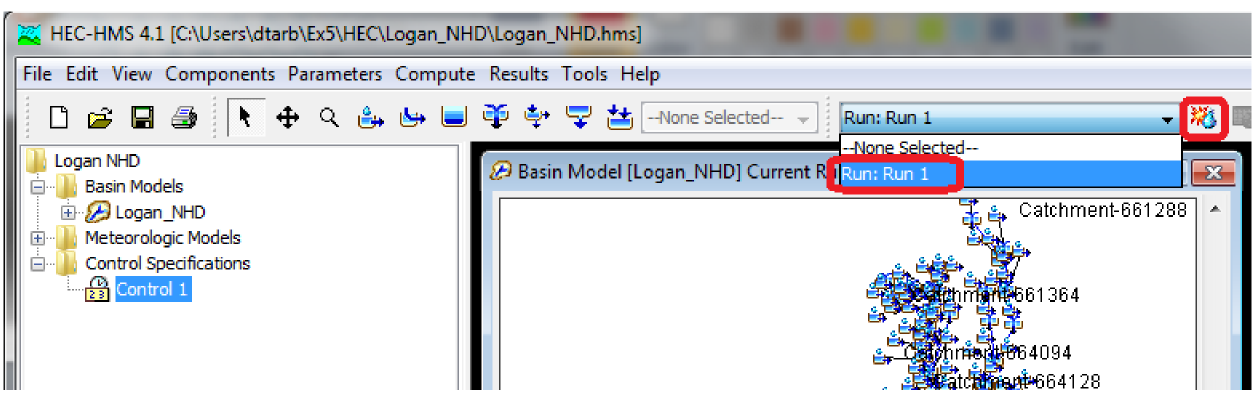


Now we are ready to set up a model run. Click Compute -> Simulation Run Manager and select New

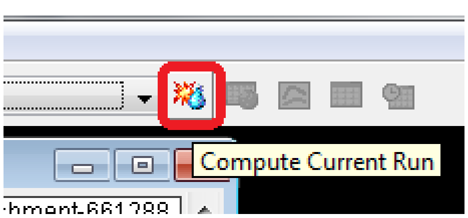


Accept the default name Run 1 and click Next. At step 2, accept the single choice of OnionCreek as the Basin Model and click Next. At step 3, accept Met 1 as the single choice of Meteorologic Model and click Next. At step 4, accept Control 1 as the single choice of Control Specifications and click Finish. Close the Simulation Run Manager.

On the top menu bar select Run 1.

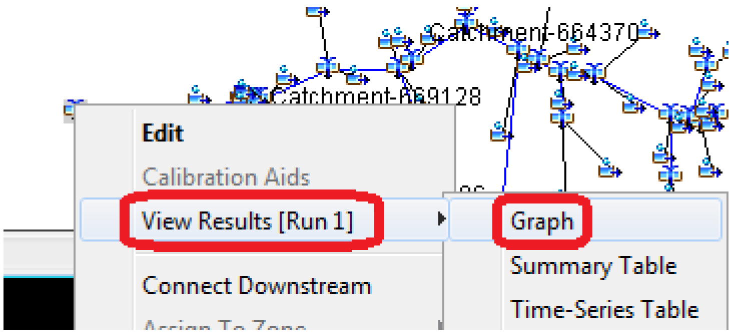


The model should now be ready to run with the "Compute Current Run" button activated

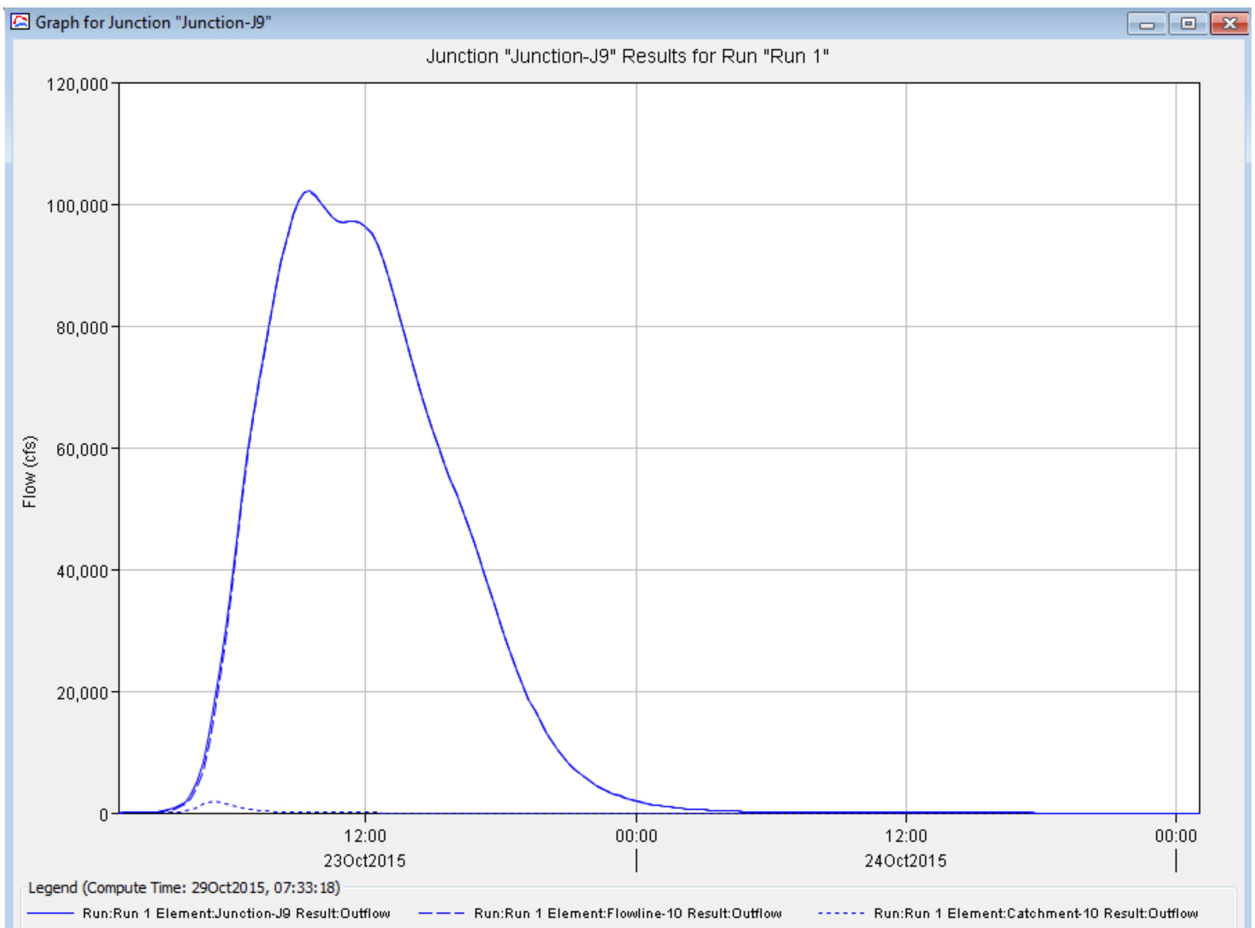


Click this button. The model should now run. You will see a number of warnings and a progress bar. You can ignore the warnings for this exercise (though if doing this professionally you should check each).

You can right click on elements in the Basin Model window to view results at that location in Graph or Table form.



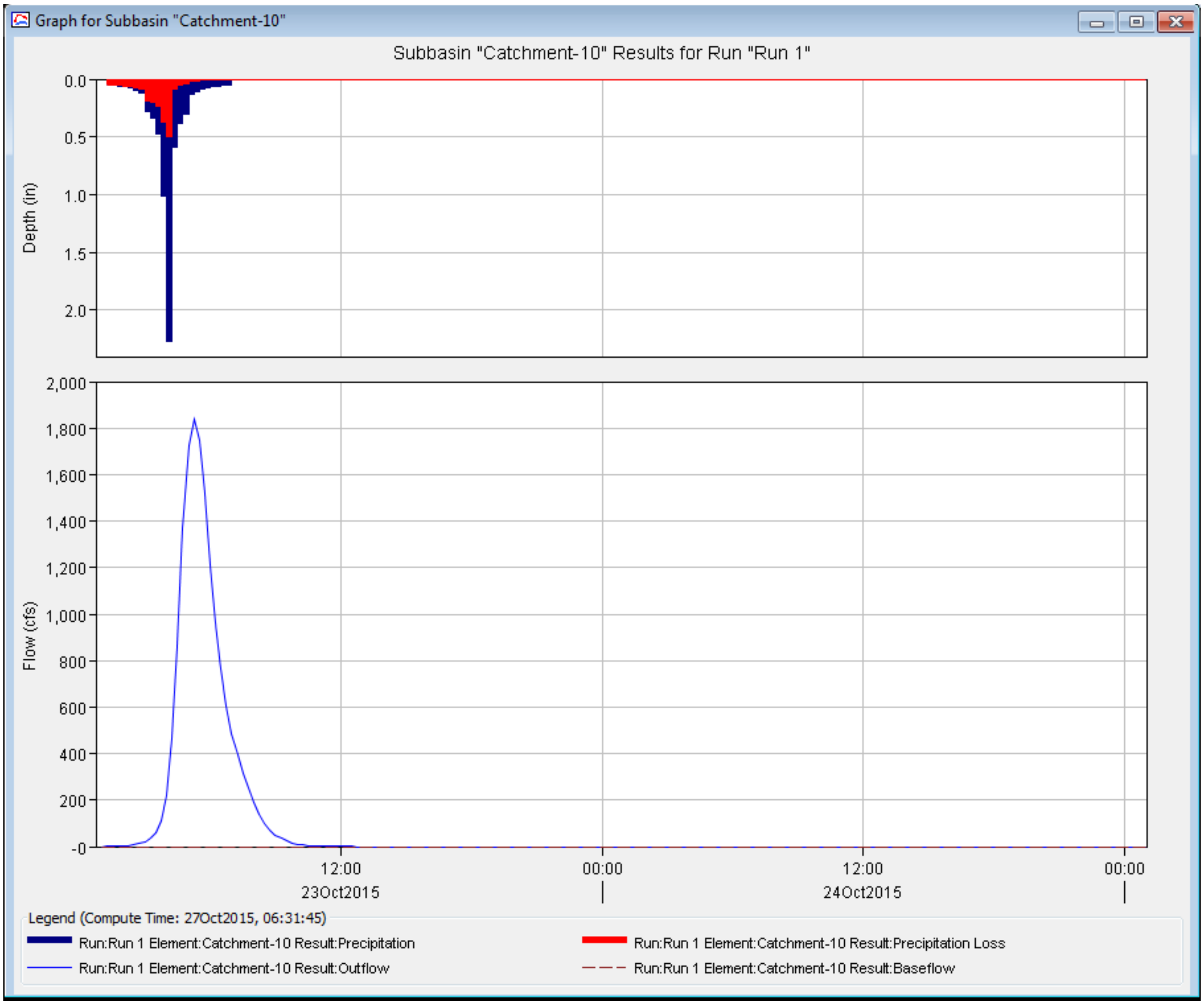
Here is the graph of flow at the outlet.



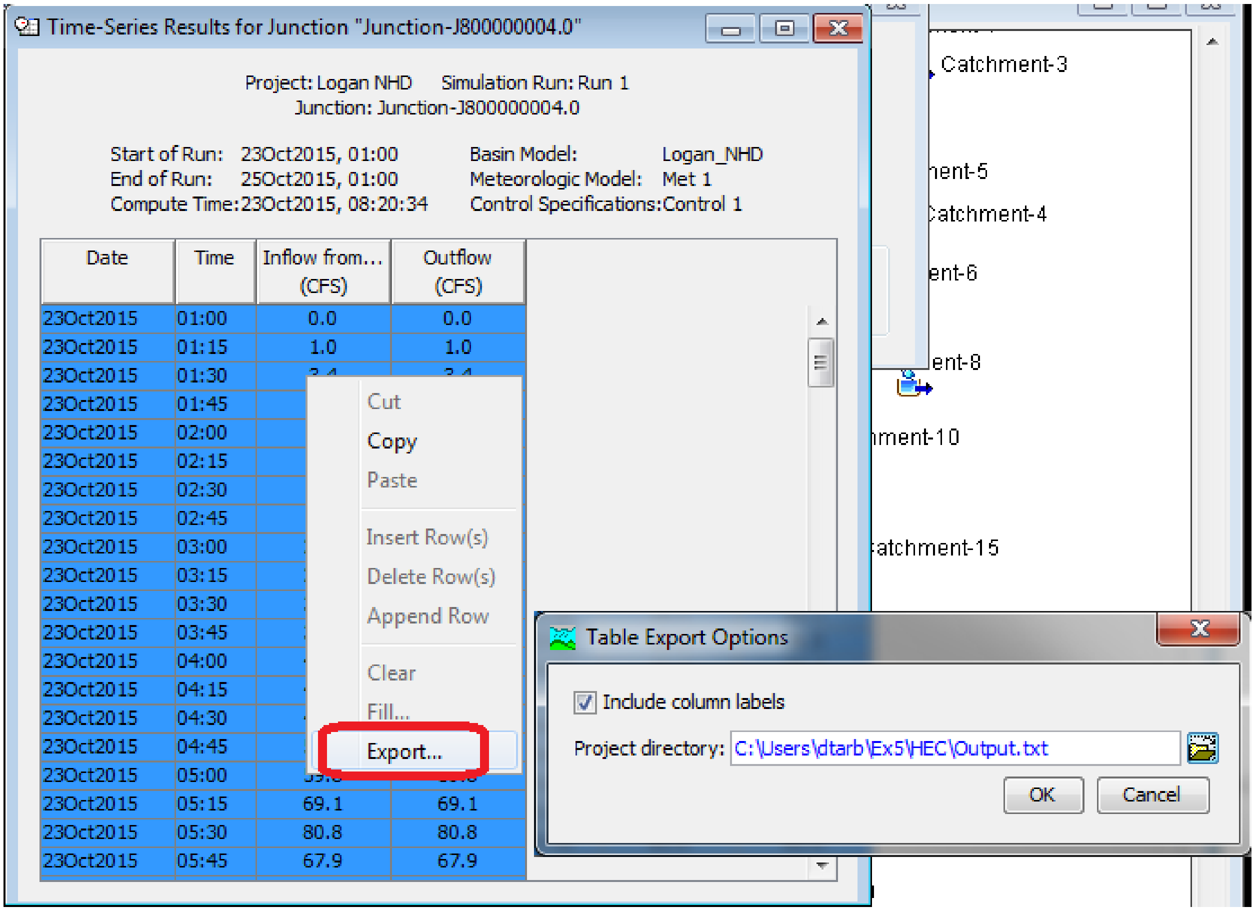
Note a flow just over 100,000 cfs. Do you think this is realistic?

Go to the USGS NWIS site for this watershed
http://waterdata.usgs.gov/nwis/inventory/?site_no=08159000 and check peak streamflow at this location.

If you click on the results for the subbasins, you can see the storm being applied to each. This is plotted top down. The storm lasts for 6 hours but has a peak near the center that reflects high intensities following the intensity-duration data that we inserted from City of Austin website.



Note that when displaying a time series table you can select the data and right click to export to a text file.



This is a convenient way to export the data to Excel for making comparative plots.

Prepare graphs where you show HEC-HMS hydrographs at the outlet and at an illustrative locations about 1/2 of the way up Onion Creek from the outlet to the source. Prepare a map where you indicate the locations where you have done these comparisons. These should show how the peak of the hydrograph increases as one moves downstream and the basin area gets larger.

To turn in: Prepare a short report where you give the Hydrograph from HMS at the outlet and one other location (about half way up from the outlet). Include a layout where you show these locations. Interpret the graphs/results that you present. Include in your report at least one catchment where you show the precipitation, precipitation loss and runoff.

OK. You are done!

Summary of Items to turn in.

1. *Open the attribute table for the Subbasin feature class in Onion_HEC.gdb. For the largest subbasin (Note that Subbasin in HEC corresponds to Catchments we delineated earlier) report the slope and percentage imperviousness (Imp column). Compare these values to the values you calculated above using zonal statistics.*

2. *Prepare a short report where you give the Hydrograph from HMS at the outlet and one other location (about half way up from the outlet). Include a layout where you show these locations. Interpret the graphs/results that you present. Include in your report at least one catchment where you show the precipitation, precipitation loss and runoff.*