Problem: *Baseflow and Direct Runoff for a Watershed*

Statement:

For your chosen watershed (from the Project #1 assignment), use daily streamflow data to estimate the baseflow and direct runoff contributions to streamflow.

As part of this exercise, you will need to use the online Purdue Web-based Hydrograph Analysis Tools (WHAT) to perform baseflow separation for your chosen watershed. You access the online tool at:

https://engineering.purdue.edu/mapserve/WHAT/

For your chosen watershed, get its USGS stream-gage number and go to the Purdue WH AT web site. Click on *1) WHAT Using USGS Daily Flow Data*. Then click on *i) I will enter USGS gaging station number*. On the subsequent screen, enter the USGS station number and click on *i) Click here to read USGS flow data from USGS web Site*.

After a short wait, you can select a baseflow separation method. Use the default option *Recursive Digital Filter* and select an appropriate aquifer type; the default *Perennial streams with porous aquifers* should be fine for most locations (but if your watershed has very little baseflow might use other choices). Then click *Run WHAT for Monthly, Yearly Output*.

Now download the results as three separate CSV files:

Download Daily Flow, Runoff, Baseflow in CSV Format
Download Monthly Runoff in CSV Format
Download Monthly Baseflow in CSV Format

With these data files, do the following steps in your analysis:

a. Report the base flow index (BFI) for the watershed and create a graph showing the flow and baseflow hydrographs for a single year.

   Note: Open the *Daily Flow, Runoff, Baseflow in CSV Format* file in Excel. At the bottom on the Excel file, you will find a summary of the Flow, Direct Runoff, Baseflow, and Base Flow Index (BFI) [baseflow divided by flow]. From the daily flow record, pick a single year to plot (your choice, but I would go for a wet year rather than a dry year). For the chosen year, plot flow and baseflow (in cfs) versus time (date) on a single plot. Note that the different between the flow and baseflow is the direct runoff. From this graph, you should be able to see the low-frequency baseflow variations with the high-frequency storm-related direct runoff.

b. Compute the climatology of monthly baseflow and direct runoff for the 30-year period from 1981 to 2010. Report the results as a table and in graphical form.

Note: After you open the monthly data files in Excel, you will need to extract the data for the calendar years of 1981 to 2010 to compute 30-year averages. The data files are organized by water year. Therefore, the row with 1980~1981 in the first column contains the data for Oct-1980, Nov-1980, Dec-1980, Jan-1981, …, Sep-1981, and finally, the water year average. You need to delete the data for 1980 in this row, and all the data above (before 1981). Likewise, the row with 2010~2011 in the first column contains the data for Oct-2010, Nov-2010, Dec-2010, Jan-2011, …, Sep-2011, and finally, the water year average. You need to delete the data for 2011 in this row, and all the data below (after 2010). With the data for calendar years 1981 to 2010, compute the 30-year monthly averages.

Do this process for the Monthly Runoff and Monthly Baseflow data. Then create a table showing the month (Jan to Dec), the average runoff rate (or direct runoff) (in cfs), and the average baseflow rate (in cfs). Also add two columns to show direct runoff and baseflow as a depth (volume/area) (in inches) [by multiplying the average rate by the time in each month to get the volume, and by dividing by the watershed drainage area to get the depth].

Finally, create a graph with the table data showing bars for the baseflow (in inches) and direct runoff (in inches) versus month. Choose a *2-D Column Stacked Column* chart with baseflow on the bottom and direct runoff stacked on top (so the stacked columns together show streamflow depth).

Solution:

NOTE: I performed the assignment exercise in python. Please let me know if you'd like the supporting code for the figures and tables.