Baseflow Program

As described in:

Arnold, J.G., P.M. Allen, R. Muttiah, and G. Bernhardt. 1995. Automated base flow separation and recession analysis techniques. Ground Water 33(6): 1010-1018.

Arnold, J.G. and P.M. Allen. 1999. Automated methods for estimating baseflow and ground water recharge from streamflow records. Journal of the American Water Resources Association 35(2): 411-424.

Using the baseflow program:

Step one: download daily streamflow data from USGS

USGS provides several options for the date format when downloading the stream data. You ***must*** select YYYYMMDD (the last one in the list) for the date format.

Step two: format streamflow data properly

USGS allows the user to download the data in tab delimited format. However, the baseflow program doesn't like tabs. To delete the tabs, import the streamflow data into EXCEL or some other spreadsheet software and export the stream data in space delimited format.

In addition to converting the tabs, all of the header information that USGS places at the top of the data file must be deleted. The baseflow program assumed the first line in the file is used for header information. All other lines should contain the date and daily streamflow value.

The format of the data lines is:

YYYYMMDD *flowvalue*

There must be no spaces in the date portion (YYYYMMDD) of the line. The date must be separated from the flow value by at least one space. Any units may be used for the flow values. (Keep in mind that SWAT outputs flow only in metric units)

An example data file is included in the download (08099500.flw)

Step three: create master input file

Create a text file named “file.lst”. The program will look for a file by this name.

The format of the master input file is provided in Appendix A.

Step four: run program

Copy the streamflow data files, the master input file, and bflow.exe (from the download) into the same directory. Open a DOS prompt window and move to the directory containing all the files. At the command prompt, type: **bflow.exe**

When a new command prompt appears, the program is finished.

Step five: view output

Output from the baseflow filter program will be listed in the text file “baseflow.dat”. The format and explanation of information in this file is provided in Appendix B.

If IPRINT was set to 1 in the master input file, daily filter data is printed also. An explanation of the daily filter data file is provided in Appendix C.

Appendix A: Master Input File (file.lst)

Variables in file:

Variable Name	Description
NDMIN	Minimum number of days used to calculate the value for alpha in the groundwater recession equation. (see the article for a discussion of this value) The default setting for NDMIN is 10.
NDMAX	Maximum number of days used to calculate the value for alpha in the groundwater recession equation. (see the article for a discussion of this value) The default setting for NDMAX is 300.
IPRINT	Print code for daily output: Summary values for baseflow fractions, alpha and baseflow days are automatically printed out. In addition to the standard output, the user may choose to print the filtered values for baseflow for the three passes made by the program. This variable governs printing of the daily data. 0 Do not print daily values 1 Print daily values If IPRINT is set to 1, the output file name FLWFILE_OUT ***must*** be defined. The default setting for IPRINT is 0.
FLWFILE	The name of the file containing the daily streamflow data. The file name can contain up to 15 characters. An unlimited number of streamflow data files can be processed at the same time.
FLWFILE_OUT	The name of the file to which daily filter results are written. Required only if IPRINT = 1. The file name can contain up to 15 characters. A different daily output file name must be given for every streamflow data file.

An example master input file:

```
!!Input for baseflow program:
     10 !NDMIN: minimum number of days for alpha calculation
    300 !NDMAX: maximum number of days for alpha calculation
      0 !IPRINT: daily print option (0-no; 1-yes)

!!Daily stream data files
08099500.flw     08099500.out
```

The format of the lines in the master input file is:

Variable name	Line #	Position	Format	F90 Format
Comment line	1	Space 0-80	NA	NA
NDMIN	2	NA	integer	free
NDMAX	3	NA	integer	free
IPRINT	4	NA	integer	free
Comment line	5	Space 0-80	NA	NA
Comment line	6	Space 0-80	NA	NA
FLWFILE	7-end	space 1-15	character	a15
FLWFILE_OUT	7-end	space 17-31	character	a15

For the variables on lines 2-4, the program doesn't require the numbers to be in a certain position on the line. However, the number must be the first thing on the line and it must be followed by a space to separate it from anything else written on the line.

Appendix B: Primary Output File (baseflow.dat)

The primary output file lists seven types of information for each streamflow data file processed. The information is:

Variable Name	Description
Gage file	Name of streamflow data file
Baseflow Fr1	Fraction of streamflow contributed by baseflow that is estimated in first pass.
Baseflow Fr2	Fraction of streamflow contributed by baseflow that is estimated in second pass.
Baseflow Fr3	Fraction of streamflow contributed by baseflow that is estimated in third pass.
NPR	Number of individual baseflow recessions used to calculate master recession curve.
Alpha Factor	Baseflow recession constant
Baseflow days	Baseflow days. Number of days for the baseflow recession to decline through one log cycle.

Using output information to calibrate a SWAT simulation.

In general, the fraction of water yield contributed by baseflow should fall somewhere between the value for Baseflow Fr1 and Baseflow Fr2. (If baseflow in your watershed is not from aquifers recharged by precipitation falling the watershed, things get more complicated and this rule may not apply.)

The groundwater file variable, ALPHA_BF, can be set to the value calculated for Alpha Factor.

Appendix C: Daily Filter Data File (FLWFILE_OUT)

The daily filter data file lists the following information:

Variable Name	Description
Date	Date formatted as YYYYMMDD
Streamflow	Streamflow value for day from streamflow data file.
Bflow Pass1	Baseflow value for day that is estimated in first pass.
Bflow Pass2	Baseflow value for day that is estimated in second pass.
Bflow Pass3	Baseflow value for day that is estimated in third pass.