Analysis Techniques: Annual Analysis Tutorial

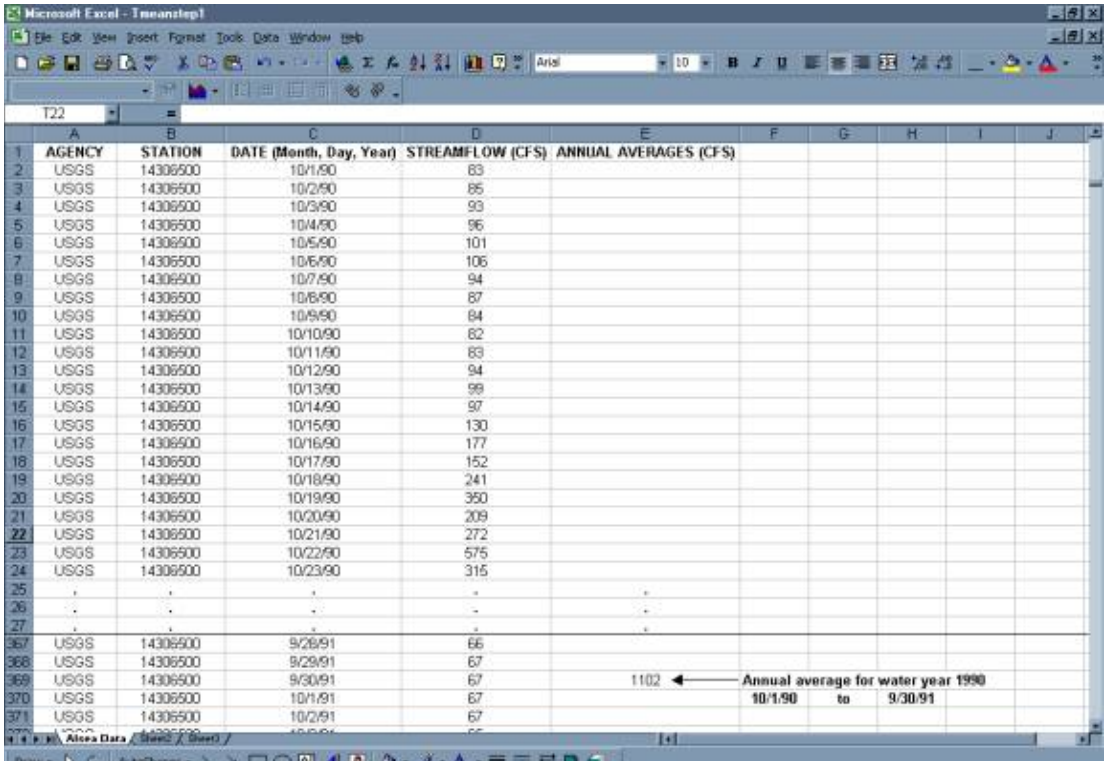
Information to get started:

- The lesson below contains step-by-step instructions and "snapshots" of what each step looks like when carried out in a Microsoft Excel workbook. Blue shading of information in the Excel illustrations denotes changes made from the previous step. Dots placed in three consecutive rows indicate that a portion of data is hidden from sight.
- You can download an Excel workbook containing the complete data set by clicking on the "Download Data" link below. It contains each calculation step on a separate worksheet. To move between steps, click on the tabs at the bottom of the excel window.
- When you download the file, it may open in your browser window. You may wish to use the "save as" function to save the file to a local drive and then reopen it in Excel. This will make it easier to flip between the online lesson and the example workbook.
- Finally, we want to remind you that the techniques explained on this site are statistically based; therefore results must be viewed as predictions and not as facts. Please use the techniques and the information obtained from them responsibly!

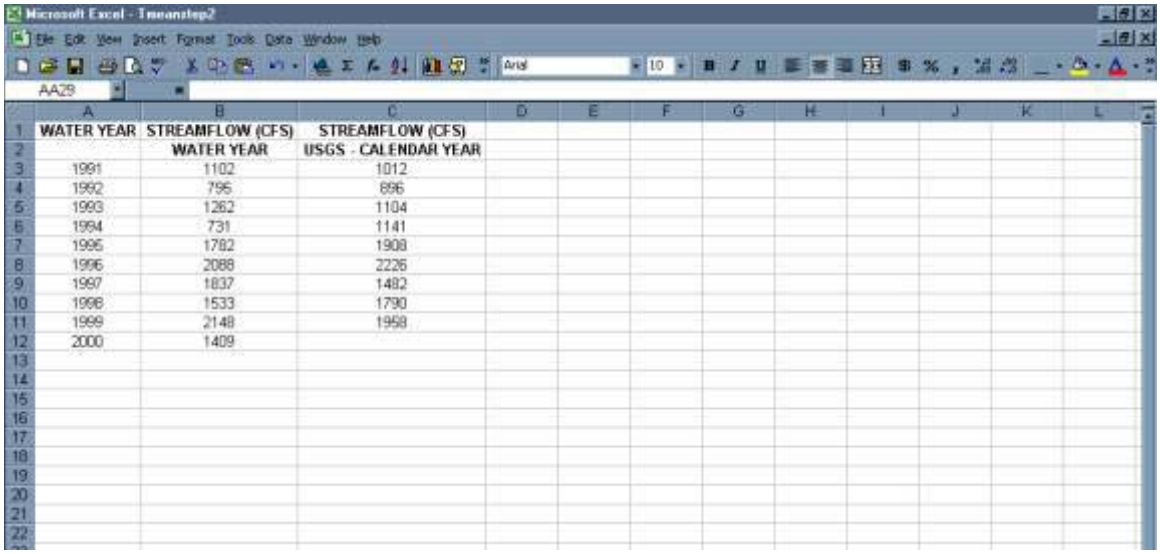
Download Data

Step 1: Calculating Mean Annual Flow

- You can use the average function in Excel to obtain the average streamflow for each water year in the period of record. The averaging will involve 365 or 366 daily values in each water year (366 days accounts for leap year). See the **Data Manipulation** section for a more detailed explanation of how to obtain data and to calculate mean annual flow.



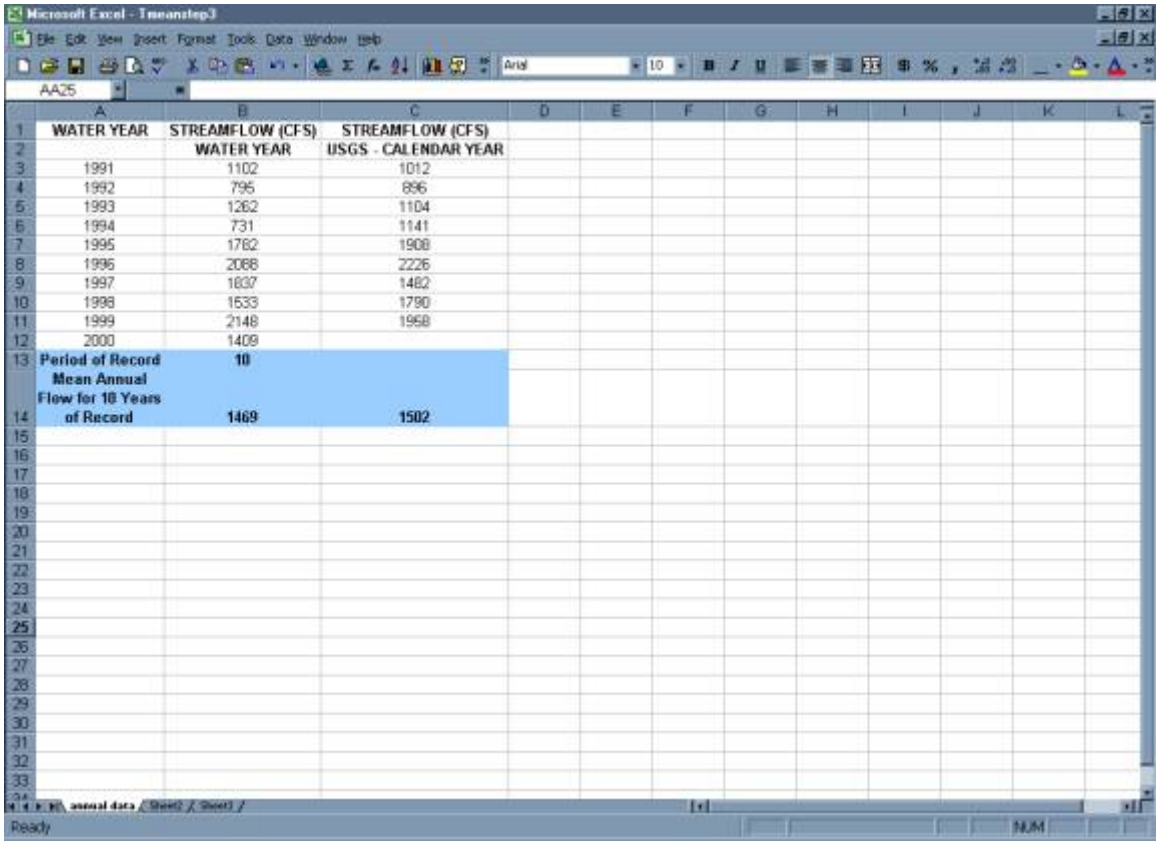
- Copy your mean flow for each year into a new table.



	A	B	C
1	WATER YEAR	STREAMFLOW (CFS) WATER YEAR	STREAMFLOW (CFS) USGS - CALENDAR YEAR
3	1991	1102	1012
4	1992	795	896
5	1993	1262	1104
6	1994	731	1141
7	1995	1782	1908
8	1996	2088	2226
9	1997	1837	1482
10	1998	1533	1790
11	1999	2148	1958
12	2000	1409	

Step 2: Calculating the Mean Annual Flow for Period of Record

- Use the average function to calculate the mean annual flow for the period of record. For this example, the period of record is 10 years.
- Column C in the table below contains the mean annual flow for "calendar years". It is interesting to compare how the value changes when the mean is calculated for "calendar years" instead of "water years".



	A	B	C
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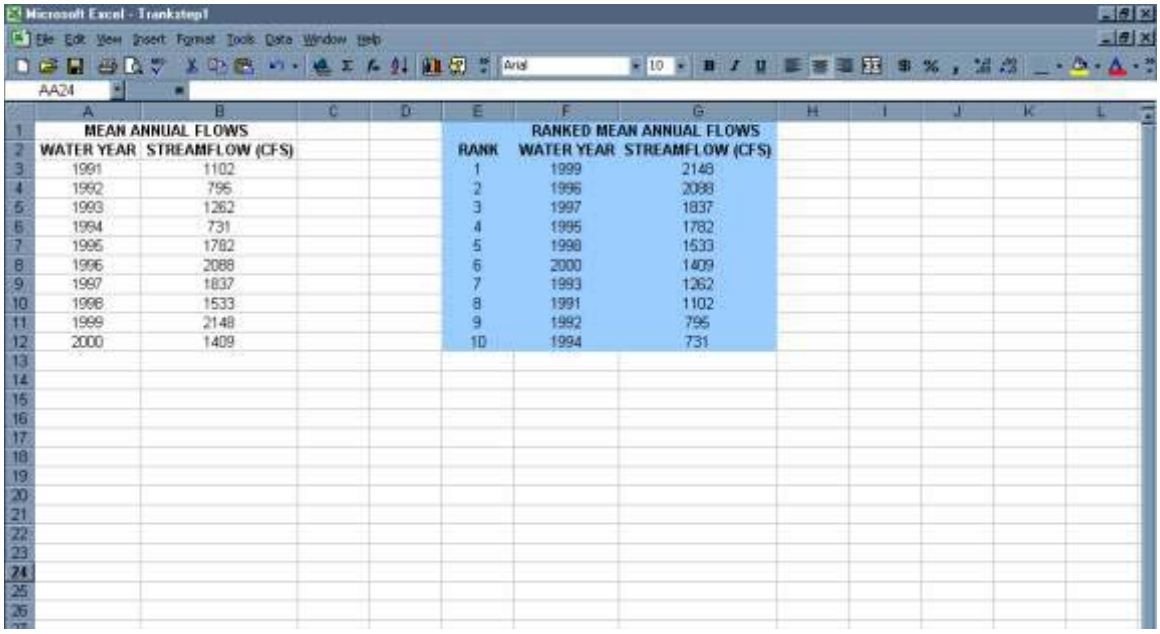
7	1995	1782	1908
8	1996	2088	2226
9	1997	1837	1482
10	1998	1533	1790
11	1999	2148	1958
12	2000	1409	
13	Period of Record	10	
14	Mean Annual Flow for 10 Years of Record	1469	1502

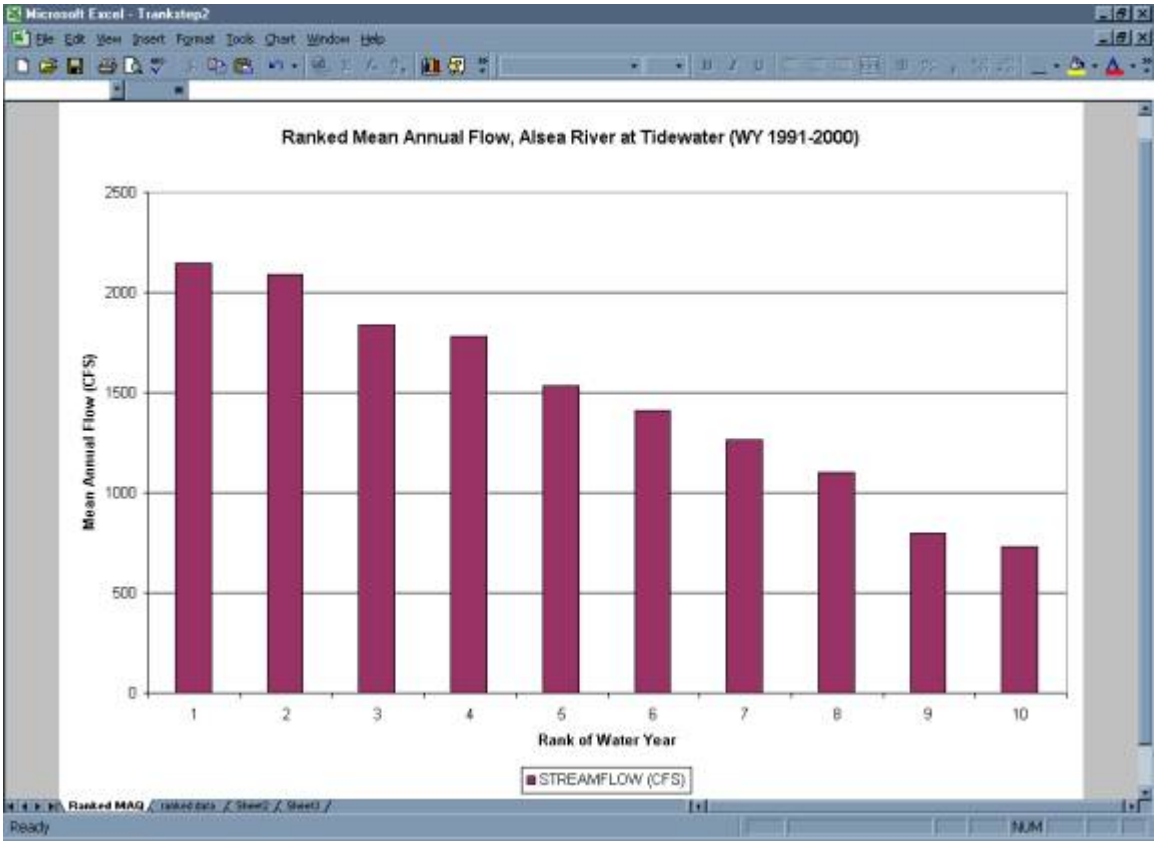
Step 3: Ranked Annual Flow

- Use the sort option (under the Data menu) to sort mean annual flows in descending order.



MEAN ANNUAL FLOWS			RANKED MEAN ANNUAL FLOWS		
WATER YEAR	STREAMFLOW (CFS)		RANK	WATER YEAR	STREAMFLOW (CFS)
1991	1102		1	1999	2148
1992	795		2	1996	2088
1993	1262		3	1997	1837
1994	731		4	1995	1782
1995	1782		5	1998	1533
1996	2088		6	2000	1409
1997	1837		7	1993	1262
1998	1533		8	1991	1102
1999	2148		9	1992	795
2000	1409		10	1994	731

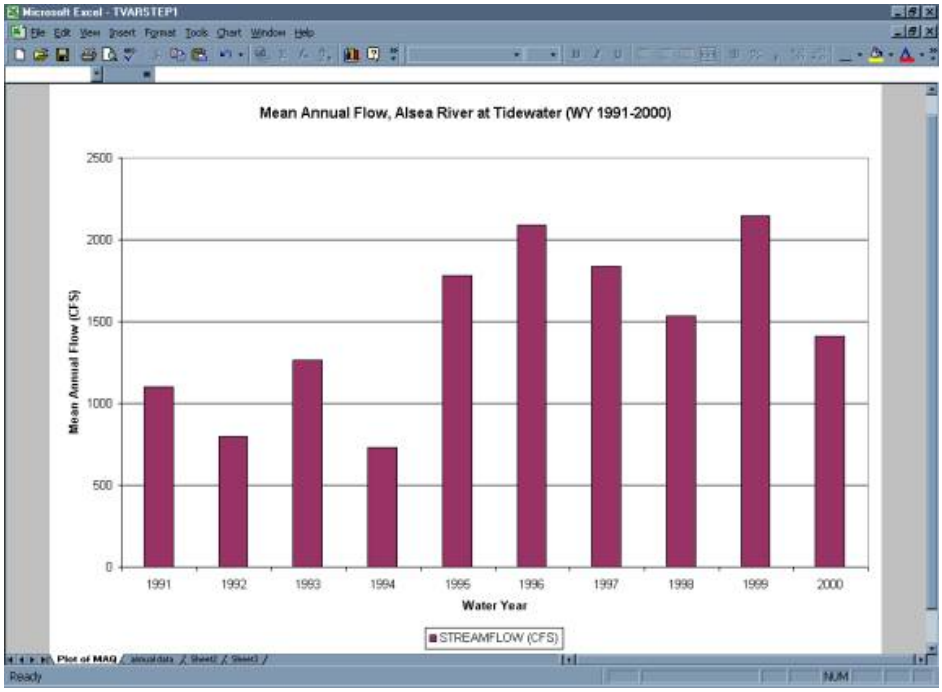
- Plot ranked data.



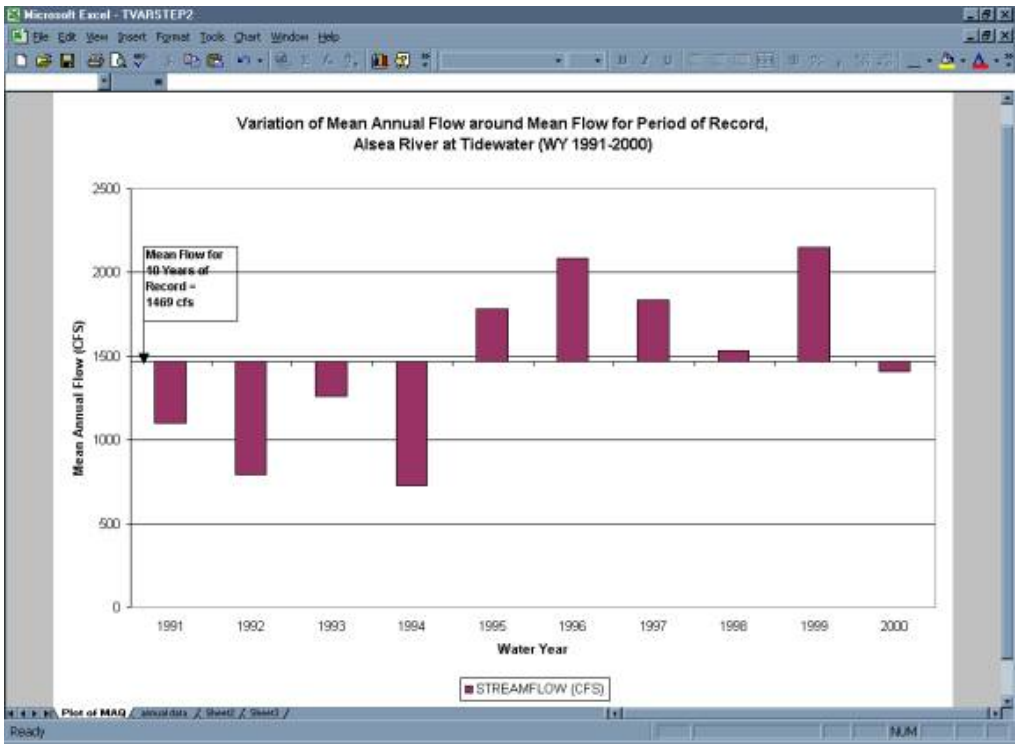
Step 4: Pattern Analysis

Step 4a: Variation of Mean Annual Flow around Mean Flow for Period of Record

- Plot mean annual flow vs. water year.

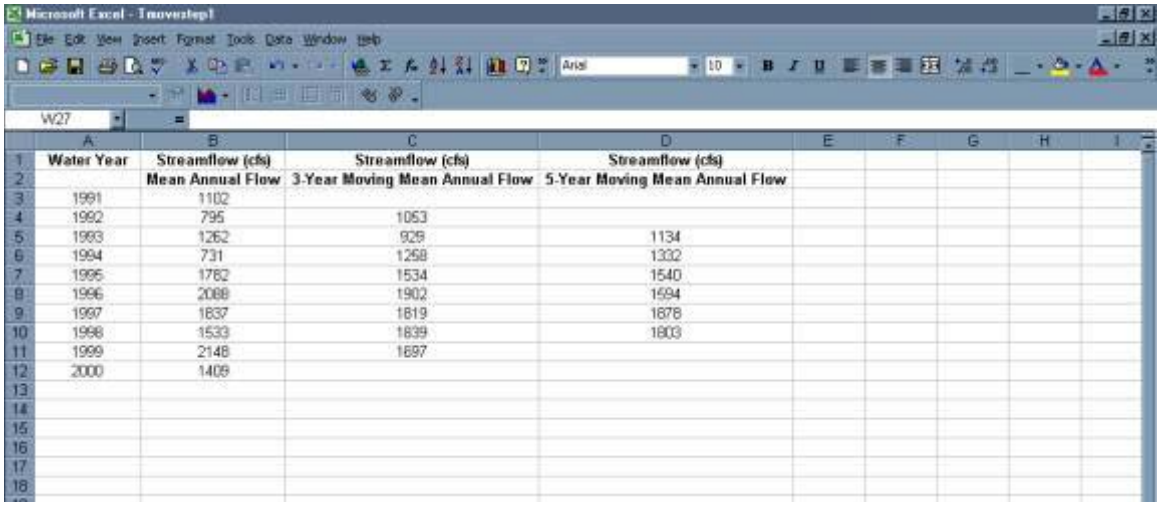


- Set the Y-axis to intersect the X-axis at the value for the mean flow for the period of record.



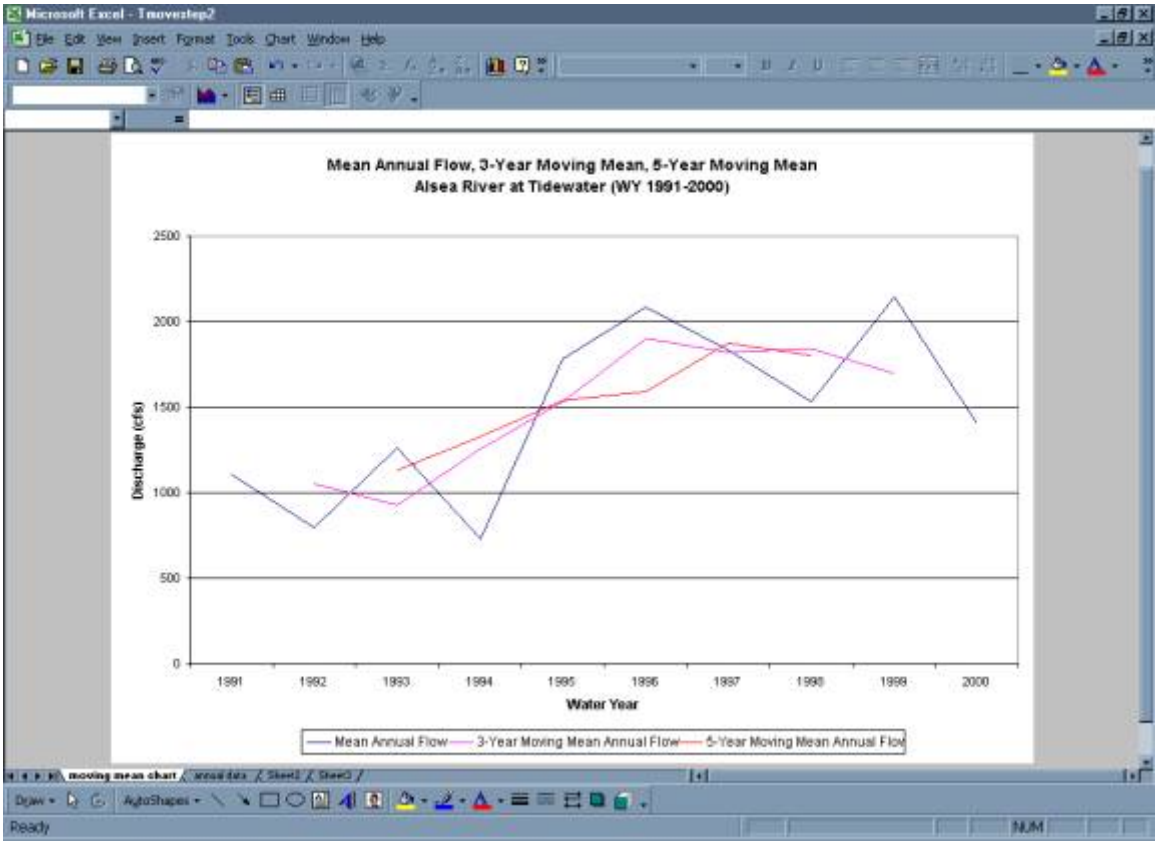
Step 4b: 3-Year and 5-Year Moving Mean

- Starting with the 2nd and 3rd year of the period of record, use the average function in Excel to calculate the mean annual flow of the surrounding 3 (yr 1 to yr 3) and 5 (yr 1 to yr 5) years. Copy these formulas down the columns to calculate the mean annual flow for 3-year and 5-year intervals for the entire period of record. Note that there will be no entry for the last year in the record for the 3-year moving mean and no entry for the last two years in the record for the 5-year moving mean.



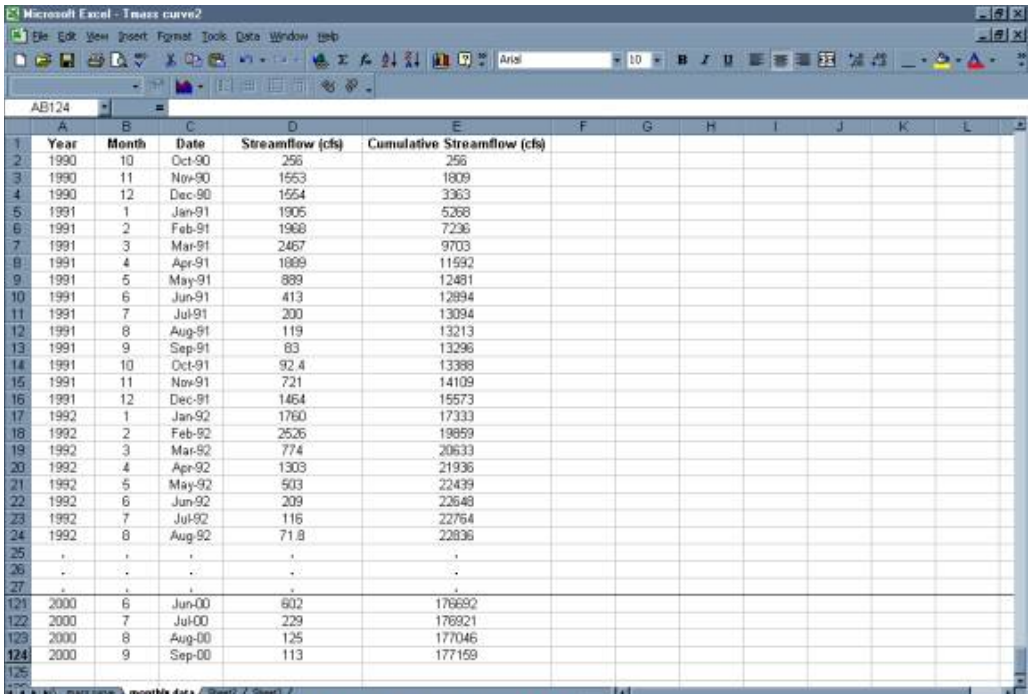
	A	B	C	D
1	Water Year	Streamflow (cfs)	Streamflow (cfs)	Streamflow (cfs)
2		Mean Annual Flow	3-Year Moving Mean Annual Flow	5-Year Moving Mean Annual Flow
3	1991	1102		
4	1992	795	1053	
5	1993	1262	929	1134
6	1994	731	1258	1332
7	1995	1782	1534	1540
8	1996	2088	1902	1694
9	1997	1837	1819	1878
10	1998	1533	1839	1803
11	1999	2148	1697	
12	2000	1409		

- Plot the Average mean annual flow, the 3-year moving mean annual flow, and the 5-year moving mean annual flow.



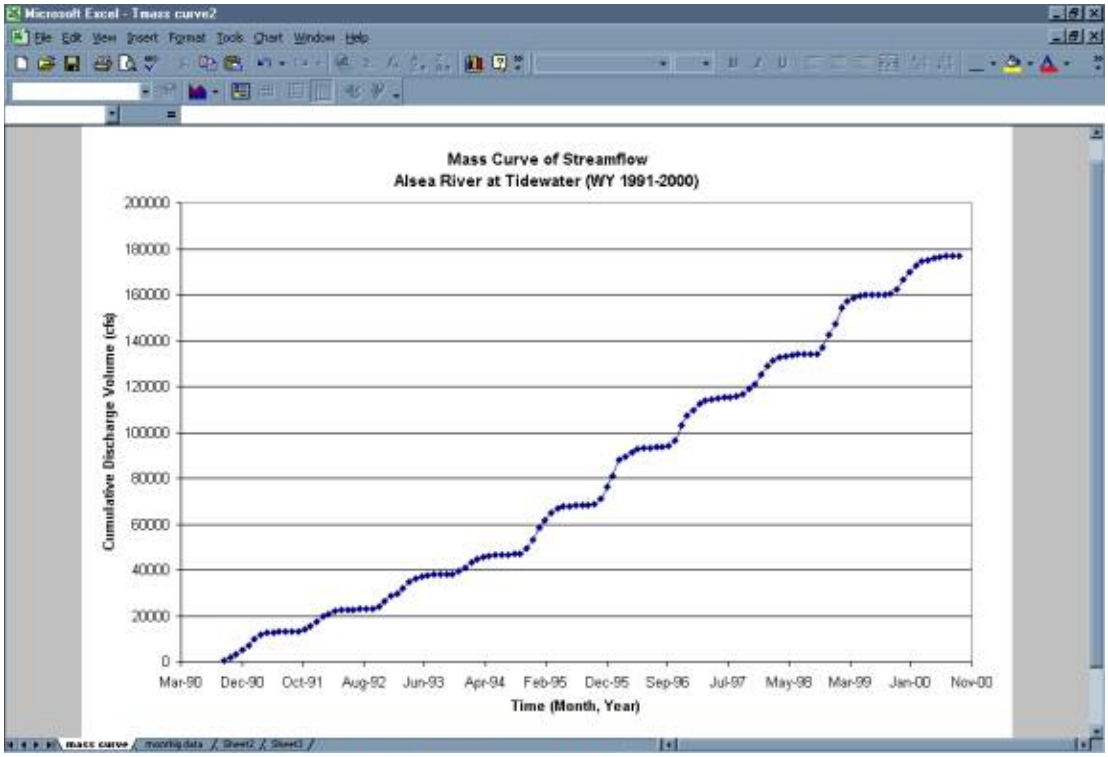
Step 4c: Mass Curve Method

- Calculate cumulative quantity of streamflow for the period of record using average monthly flows. See the **Data Manipulation** section for a more detailed explanation of how to calculate average monthly flows.



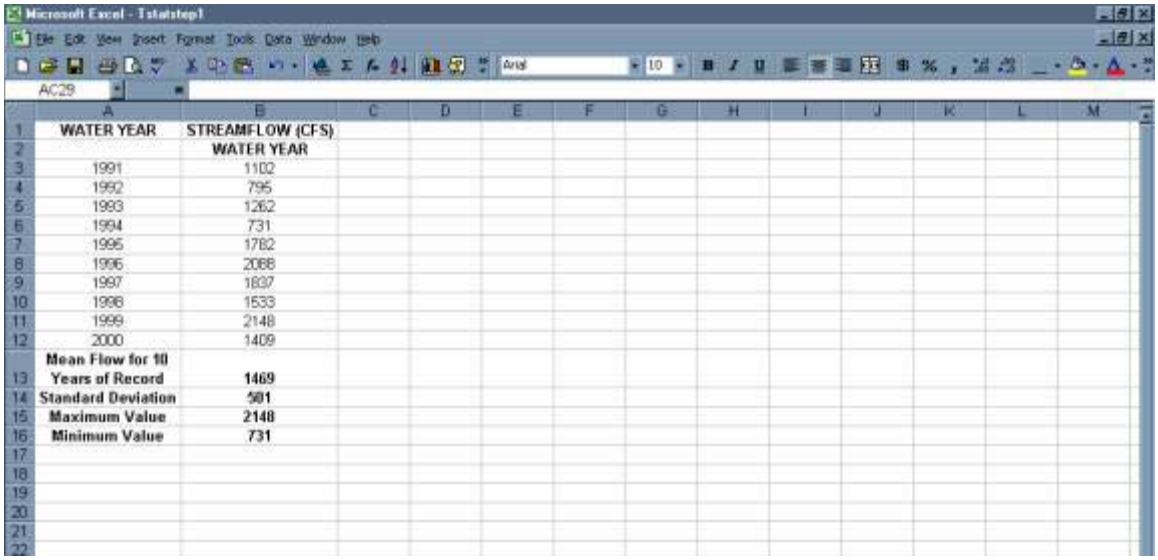
	Year	Month	Date	Streamflow (cfs)	Cumulative Streamflow (cfs)
2	1990	10	Oct-90	256	256
3	1990	11	Nov-90	1553	1809
4	1990	12	Dec-90	1554	3363
5	1991	1	Jan-91	1905	5268
6	1991	2	Feb-91	1968	7236
7	1991	3	Mar-91	2467	9703
8	1991	4	Apr-91	1889	11592
9	1991	5	May-91	889	12481
10	1991	6	Jun-91	413	12894
11	1991	7	Jul-91	200	13094
12	1991	8	Aug-91	119	13213
13	1991	9	Sep-91	83	13296
14	1991	10	Oct-91	92.4	13388
15	1991	11	Nov-91	721	14109
16	1991	12	Dec-91	1464	15573
17	1992	1	Jan-92	1760	17333
18	1992	2	Feb-92	2526	19859
19	1992	3	Mar-92	774	20633
20	1992	4	Apr-92	1303	21936
21	1992	5	May-92	503	22439
22	1992	6	Jun-92	209	22648
23	1992	7	Jul-92	116	22764
24	1992	8	Aug-92	71.8	22836
121	2000	6	Jun-00	602	176892
122	2000	7	Jul-00	229	176921
123	2000	8	Aug-00	125	177046
124	2000	9	Sep-00	113	177159

- Plot cumulative streamflow versus time.



Step 5: Calculate Simple Statistics

- Excel functions can be used to perform these calculations.
    - Mean -- use the AVERAGE function.
    - Standard Deviation -- use the STDEV function.
    - Maximum Value -- use the MAX function.
    - Minimum Value -- use the MIN function.



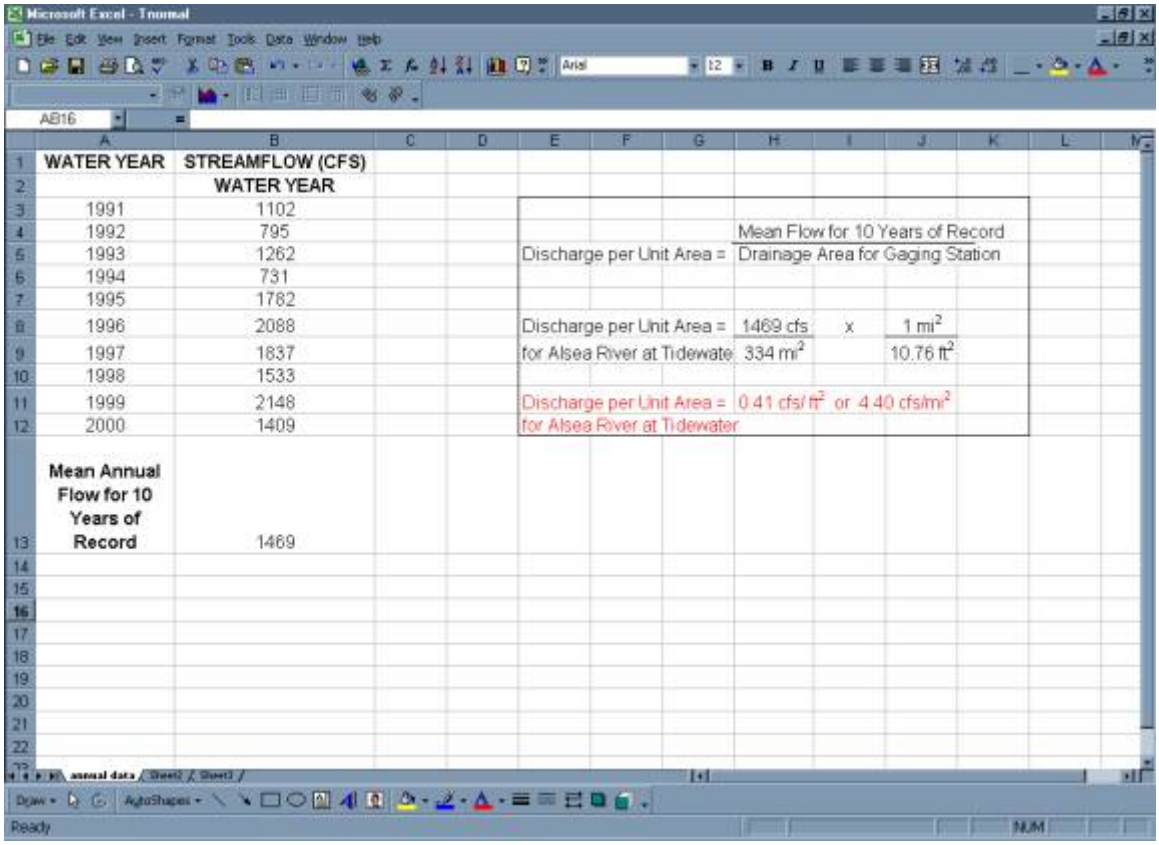
	A	B
1	WATER YEAR	STREAMFLOW (CFS)
2		WATER YEAR
3	1991	1102
4	1992	795
5	1993	1262
6	1994	731
7	1995	1782
8	1996	2088
9	1997	1837
10	1998	1533
11	1999	2148
12	2000	1409
13	Mean Flow for 10 Years of Record	1469
14	Standard Deviation	501
15	Maximum Value	2148
16	Minimum Value	731

Step 6: Normalization of Mean Annual Flow (Discharge per Unit Area)

- Calculate Discharge Per Unit Area.
    - To do this, you need the Station Description provided by the USGS web page. It includes the drainage area for the gage.

Show Me (this will open in a separate browser window)

- Mean flow for the Period of Record is divided by the Drainage Area for the gage.



	A	B
1	WATER YEAR	STREAMFLOW (CFS)
2		WATER YEAR
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12	2000	1409
13	Mean Annual Flow for 10 Years of Record	1469

Discharge per Unit Area = Mean Flow for 10 Years of Record / Drainage Area for Gaging Station

Discharge per Unit Area = 1469 cfs / 334 mi^2 x 1 mi^2 / 10.76 ft^2

Discharge per Unit Area = 0.41 cfs/ft^2 or 4.40 cfs/mi^2 for Alsea River at Tidewater