Name: ____________
Lab Section: ________
each person turns in one lab

GEOSCIENCE 001 LAB: STREAMFLOW AND FLOODING OF SPRING CREEK

Materials: notebooks, calculators, meter sticks, tape measures, stopwatches, a couple of oranges, **clothing appropriate for working in a stream on a cold day.**

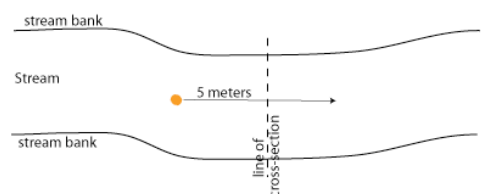
In this lab, we're going to study the stream flow and the size of boulders in Spring Creek near Houserville, just a couple of miles NE of campus, with the goal of understanding some things about stream behavior and the history of flooding. We will divide ourselves into groups of 4; 2 people will measure the channel cross-section, the others will measure the velocity and measure the largest clast size in your section of the river.

For this lab, you need to come prepared to get a bit wet — there is no other way to study streams! We have some waders, but you should nevertheless bring old shoes or sandals that can get wet and wear some pants that can be rolled up so that you can wade out into the stream. Bring plenty of warm clothing for the parts of you that are not wet. Our time at the stream is short enough that no one needs to worry about hypothermia.

Measuring Discharge

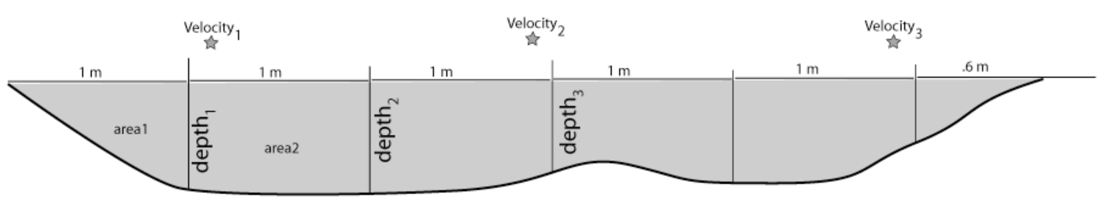
Part of this lab will involve using data collected at a US Geological Survey stream monitoring gauge near Houserville; this gauge monitors the stream depth, which can be converted through the use of a rating curve, into the discharge of the stream — the volume of water moving through the channel over a given time period (usually expressed in cubic feet per second). We will use these data to calculate the 100 year flood, which is planners use to dictate where people should and should not build near a stream.

In order to gain a better understanding of what discharge means, we're going to make some measurements of our own. This requires doing two things: measuring the cross-sectional profile of the stream, and then measuring the velocity at a few points along the cross-section. The details of this are shown in the figure below.



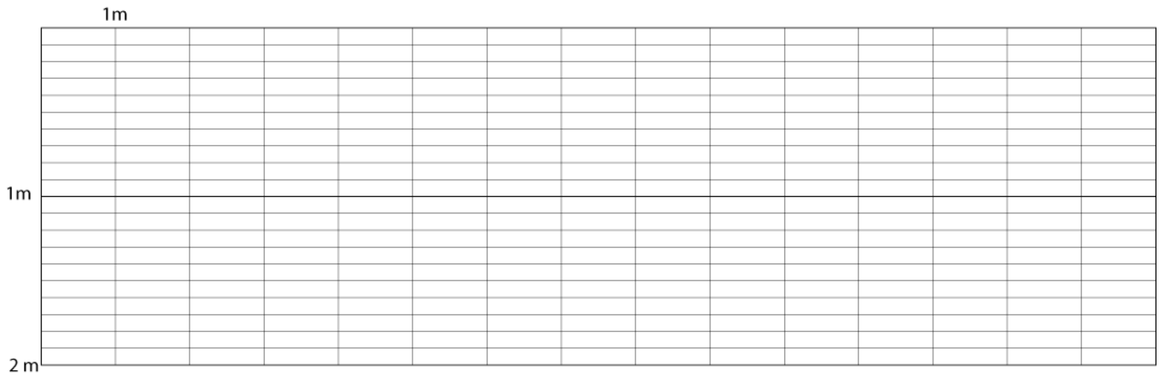
Measure the velocity along a 5 meter distance above and below your line of cross-section. Find the velocity in 3 - 5 different positions across the channel; at each position, make 2 measurements and take the average. The path along which you measure the velocity should be chosen so that there are no abrupt changes in gradient — pick a section of the channel where the flow appears to be relatively consistent.

Measure the stream cross-section in 1 meter increments, getting a depth measurement every meter, as shown below. The stars represent approximate locations along the channel where a velocity measurement was made.



treat each of the areas as either a triangle or a trapezoid, then multiply the area of each box with the nearest velocity measurement to give a discharge for that section of the stream, then sum these partial discharges to get the total discharge.

Plot your cross-section on the graph below, showing the velocity measurements as well.



area															
v * 0.7															
Disch-arge															

Note: you take 70% of the surface velocity in order to approximate the average velocity from the surface to the bed of the stream (where the velocity diminishes).

Sum the discharge boxes and write the total discharge here (don't forget the units):_______.

Estimating Maximum Flood From Clast Sizes

The other task while in the field will be to measure the largest clast size in the portion of the stream where you measured your cross-section. You may have to look 5 meters upstream or downstream to get what appears to be the biggest clast. You need to be a bit careful here because large boulders have been brought to the channel to make small dams or to try to prevent bank erosion — you want to measure something that has definitely been transported by the river. Once you've located the biggest clast, measure the intermediate dimension, imagining that it is approximately some kind of rectangular cube that would have three mutually perpendicular dimensions.

Write your clast size here in mm:____________________

Below are some data that show the relationship between shear stress and clast size for a range of values. Either graph these data and use a best-fitting line to project the shear stress inferred by your largest clast size, or use the data to make an equation for a line, then apply that equation to the clast size you measured.

Clast Name	Int. Diam (mm)	τ_{crit} (Pa)
Boulders	256	248.976
Cobbles	64	62.244
Very Coarse Gravel	32	29.686
Coarse Gravel	16	15.322
Medium Gravel	8	7.661
Fine Gravel	4	3.352
Very Fine Gravel	2	1.412
Very Coarse Sand	1	0.589
Coarse Sand	0.5	0.259
Medium Sand	0.25	0.174
Fine Sand	0.125	0.147
Very Fine Sand	0.0625	0.123

Write your shear stress(inferred by the largest clast) here:______________

Then, use the formula relating critical shear stress (the shear stress at the stream bed needed to initiate movement) to water depth to estimate the water depth implied by the clast.

$$\tau = \rho g h \sin\alpha$$

where τ is shear stress (in units of Pascals, which are Newtons/m^2), ρ is density (for water, 1000 kg/m^3), g is the acceleration of gravity (9.8 m/sec^2), h is the water depth (in meters) and α is the slope (in degrees) of the stream, which here has a drop of 20′ over a distance of 5100′.

Write your clast-inferred water depth here:____________________

Is this a maximum or minimum water depth? (think about what would happen if you had a stream bed that simply had no large boulders and there was a huge flood that could easily have transported clasts larger than anything present in the stream bed).

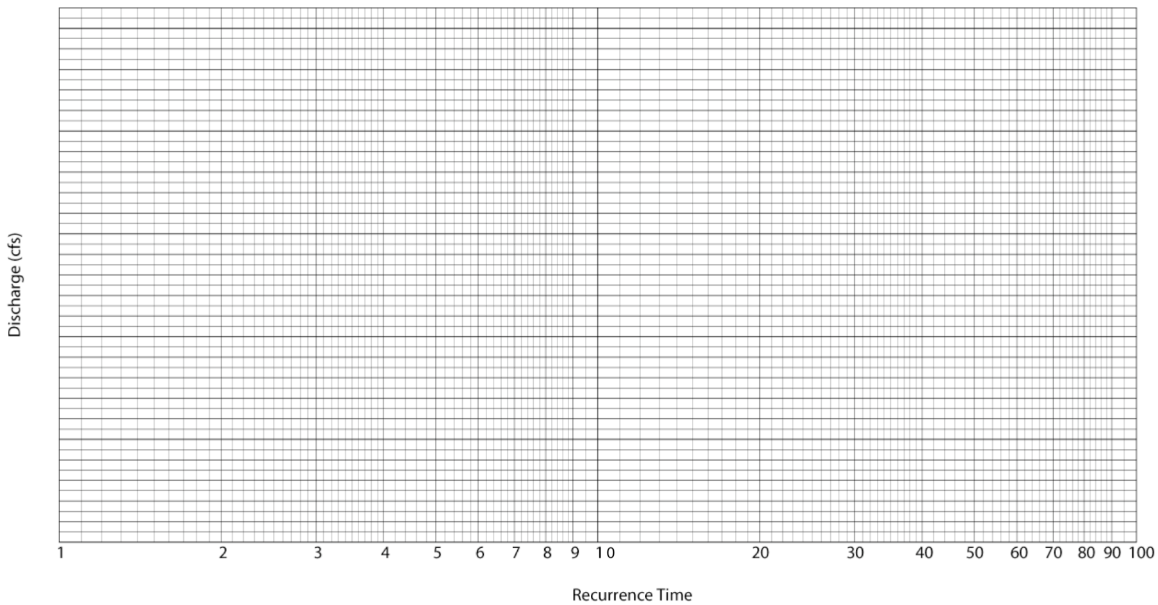
Next, we move on to consider how this water depth compares with the 100-year flood. This is work to be done outside of the lab period.

Analysis of Historical Streamflow Data from Houserville

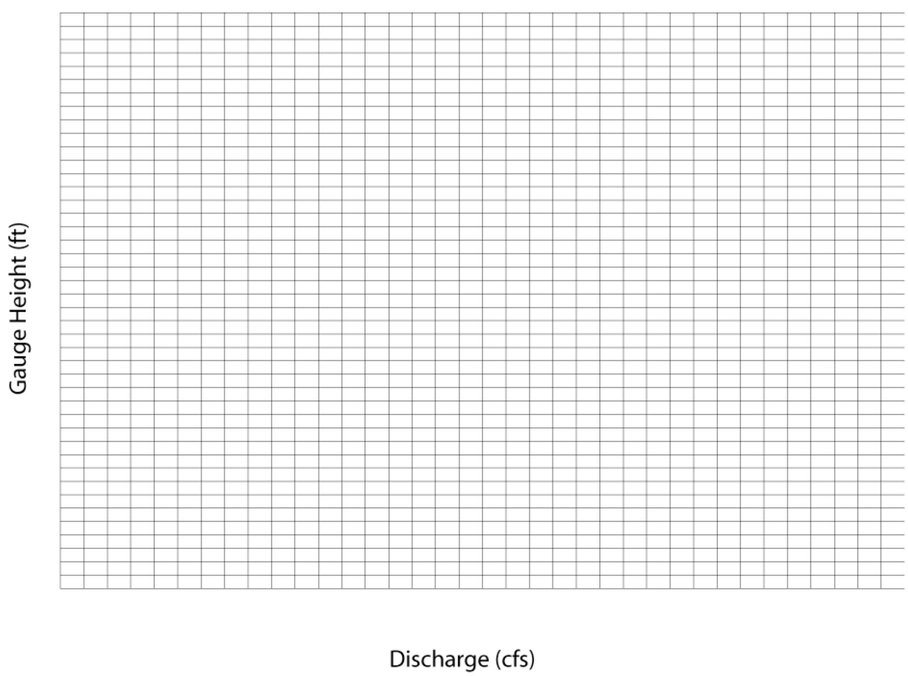
Estimate the 100-year flood **discharge and gauge height** for Spring Creek in Houserville using the data provided. First, calculate the Rank (1 being the flood with the greatest discharge) and Recurrence Time, using the formula RT=(n+1)/m (n is the number of yearly peak flood data — 20 in this case, and m is the rank of the peak discharge), filling in the results for the table below.

Year	Date	Gauge Height (ft)	Discharge (cfs)	Rank	Recurrence Time
1985	Feb. 12, 1985	4.93	318		
1986	Mar. 15, 1986	6.79	687		
1987	Apr. 04, 1987	5.54	440		
1988	Aug. 29, 1988	4.98	351		
1989	Jun. 21, 1989	5.62	476		
1990	Jun. 09, 1990	5.05	364		
1991	Oct. 23, 1990	5.62	476		
1992	Dec. 03, 1991	4.55	269		
1993	Apr. 01, 1993	7.14	835		
1994	Mar. 25, 1994	7.02	800		
1995	Jan. 20, 1995	5.55	466		
1996	Jan. 19, 1996	10.05	2,370		
1997	Oct. 19, 1996	6.79	748		
1998	Apr. 09, 1998	6.14	599		
1999	Jan. 24, 1999	7.13	832		
2000	Jun. 15, 2000	5.09	363		
2001	Aug. 19, 2001	5.36	423		
2002	Jun. 06, 2002	6.98	795		
2003	Aug. 03, 2003	6.89	772		
2004	Sep. 18, 2004	9.76	2,110		

Next, plot the data on the semi-log graph below, and extrapolate to the 100-year event by using a best-fit straight line. Note that this must be done with logarithmic scale for the x-axis.



Then, use the gauge height and discharge data to construct another graph that will enable you to extrapolate to the gauge height of the 100-year flood.



Write your results here:

100-yr discharge:________________

100-yr flood height:______________

How does your clast-inferred flood height compare with the 100 year flood? Use the graphs above to estimate the discharge and recurrence time of the clast-moving flow event:

Clast-Inferred Discharge______________________

Clast-Inferred Recurrence Time ________________________