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Flow Rate Activity Worksheet

Objective: The main objective for this activity is to understand how flow rate is measured and to compare the average flow rate of a stream to low flow and peak flow rate values for that stream.

Background: The flow rate is the volume of fluid which passes per unit time. It is represented by the symbol Q and its units are length cubed per time or $[L]^3/[T]$. The flow rate of a stream is directly related to the amount of water moving from the watershed into the stream. It is affected by weather and can change seasonally and after major weather events. Knowing a stream's peak and low flow rates are necessary to predict flooding and to monitor impacts of pollutants and sediment movement in a stream. This is very important for urban planning around streams.

Procedure:

An easy method to determine flow rate in a stream is to place a buoyant object on the water surface and time how long it takes for the object to float a measured distance. The measured distance divided by the time gives an approximate surface velocity of the stream. Note: Surface velocity is not representative of the average velocity throughout the stream. Therefore, this value will be adjusted by multiplying the surface velocity by 0.85 to make it more representative of the whole stream. The average velocity multiplied by the average cross-sectional area of the stream gives a flow rate. Determine the flow rate of this stream using the following method. Record measurements and calculations in the data chart below.

Flow Rate Measurements:

Step 1: Choose a stream length (ft) to perform this activity on, measure the width (ft) and the depth(ft) of the section of stream that you have chosen. The section of the stream you choose will not affect the calculations. Flow rate values are constant throughout the stream even though individual measurements will change.

Step 2: Place the buoyant object (leaf, pinecone, water bottle) on the stream surface at the starting location you have chosen.

Step 3: Measure the time(s) it takes for the object to float to the ending point you have chosen (stream length).

Step 4: Estimate cross-section area (A), by multiplying the stream width (ft) by the depth (ft).

Step 5: Calculate the velocity at the surface ($V_{surface}$) by dividing length by time.

Step 6: Calculate mean velocity: $V_{mean} = (0.85) * (V_{surface})$

Step 7: Calculate flow rate: $Q = A*V_{mean}$

(Summary Equation: $Q = VA = (0.85 \times \frac{ft}{s})(w \times d)$)

Data Table

Length (ft)	Width (ft)	Depth (ft)	$V_{surface}$ (ft/s)	V_{mean} (ft/s)	Area (ft^2)	Q (ft^3/s)

USGS StreamStats:

1. On the computer, go to https://streamstats.usgs.gov/ss/

   Delineate the watershed for the stream you were in.

   a. Type in your location to zoom into the map.
   b. Click the state or region of study.
   c. Zoom into your creek.
   d. Click the delineation button.
   e. Click on a spot on your creek.
   f. Wait for the application to delineate the watershed.
   g. Choose the blue continue button on the left- hand side of the screen.
   h. Choose the peak flow statistics and low flow statistics buttons. (You can choose other basin characteristics that you are interested in as well.
   i. Click continue. It will build a report for you.
   j. On the report, scroll down to see the peak flood values and the range for low flow.

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Analysis:

1. What is your calculated flow rate value (from the data table)? _____

2. Reflecting on this activity, do you think that this method was the most accurate way to measure the flow rate? Why or why not?

3. What are suggestions for improving your measurements and calculations?

4. What were the conditions when you measured flow rate in the stream today? (rain, drought, normal?)

5. From the USGS StreamStats site, what is the 2-year low flow value? _____

6. From the USGS StreamStats site, what is the 2-year peak flood value (a flood that has a 50% chance of occurring)? _____

7. From the USGS StreamStats site, what is the 200-year peak flood value (a flood that has a 0.5% of occurring)? _____

8. How does your flow rate value compare to these flood values?

9. What are some events that may cause values to be different?

10. With 100-year and 200-year floods happening more frequently in today's climate, what are some ways that you think that people could address this issue?

11. How do you think engineers can help with this problem?

12. If there is damage due to this amount of flooding or if new infrastructures need to be built to prevent further flooding, who do you think should be responsible for paying? (Homeowner, taxpayers…)