What is discharge?

- Discharge: The volume of water that flows past a certain point in a stream over a specific period of time
- a.k.a. FLOW = volume/time
- To solve flow you need:
  - area (ft²) & velocity (ft/s)
  - or
  - time (s) & volume (ft³)

Streamflow Cross-Section

Cross-Section Area (ft²):
Width of stream (ft) x depth of stream (ft)
Streamflow velocity (ft/s)

\[
Q = \frac{A}{t} \times V
\]

Important Units for Water - Flow

- cfs (ft³/s) – cubic feet per second
  - Often used for streamflow
- gpcd – gallons per capita per day
  - Residential use of water per person, per day
- gal/min – gallons per minute
  - Flow rates for household fixtures (showers, faucets, etc.)
- af/year – acre-feet per year (72,400 af/yr = 100 cfs)
  - Amounts of water for irrigation, water utilities & many quantified water rights (325,850 gal = 1 af)
- cms (m³/s) – cubic meters per second (1 cm³/s = 35.3 cfs)
  - Also used for streamflow

How do we calculate discharge or flow (aka Q)?

- What we have:
  - area (ft²) & velocity (ft/s)
  - time (s) & volume (ft³)
- How do we use these variables to get Q?

\[
Q = \frac{A}{t} \times V
\]

Calculating Flow (1)

- These problems are similar to “rate-type” problems where velocity is the rate.

- How long would it take to fill an Olympic swimming pool (~400,000 gal) if all you had was a garden hose (~5 gal/min)?

- How do we solve this problem?

Flow variables (1)

How long would it take to fill an Olympic swimming pool (~400,000 gal) if all you had was a garden hose (~5 gal/min)?

- What are our variables?
  - Know: Volume
  - Solve for: Time
- Which equation?

\[
Q = \frac{A}{t} \times V
\]
Flow Example (1)

How long would it take to fill an Olympic swimming pool (~400,000 gal) if all you had was a garden hose (~5 gal/min)?

\[
Q = \frac{\text{Volume(gal)}}{\text{Time(min)}}
\]

\[
Q = \frac{400000 \text{ gal}}{5 \text{ gal/min}} = 80,000 \text{ min} = 55.5 \text{ days}
\]

(assuming 60 min/hr x 24 hr = 1440 min)

Calculating Flow (2)

• How much water can a ditch carry per month if its cross-sectional area is 10 m² and the flow rate is 1 m/sec? Calculate the rate in both cms and cfs. Assume 35 cfs = 1 cms

\[
Q = \frac{\text{Area(m}^2\text{)} \times \text{Velocity} \text{ m/s}}{\text{Time(s)}} = \frac{10 \text{ m}^2 \times 1 \text{ m/s}}{\text{s}} = 10 \text{ m}^3/\text{s}
\]

Conversion: 10 m³/s x 35 cfs/cms = 350 ft³/s

Flow variables (2)

• How much water can a ditch carry per month if its cross-sectional area is 10 m² and the flow rate is 1 m/sec? Calculate the rate in both cms and cfs.

• What are our variables?
  – Know: Area, rate
  – Solve for: flow/mo

• Which equation?

\[
Q = \frac{A \times V}{s} \quad \text{OR} \quad Q = \frac{\text{Volume} \text{ m}^3}{\text{Time(s)}}
\]

Flow Example (2)

How much water can a ditch carry per month if its cross-sectional area is 10 m² and the flow rate is 1 m/sec? Calculate the rate in both cms and cfs.

\[
Q = \frac{\text{Area(m}^2\text{)} \times \text{Velocity} \text{ m/s}}{\text{Time(s)}} = \frac{10 \text{ m}^2 \times 1 \text{ m/s}}{\text{s}} = 10 \text{ m}^3/\text{s}
\]

Conversion: 10 m³/s x 35 cfs/cms = 350 ft³/s

Flood Freq: What is a 100-year Flood?

• The maximum level of flood water or flow that occurs, on average, once every 100 years.
• It seems simple, but...
• What is the probability that a 100-year flood will occur in any given year?
• 1% chance of a 100-year flood every year

\[
\frac{100\%}{100 \text{ years}} = \frac{1\%}{1 \text{ yr}}
\]

10-year and 500-year floods?

\[
\frac{100\%}{10 \text{ years}} = 10\% \text{ yr} \quad \frac{100\%}{500 \text{ years}} = 0.2\% \text{ yr}
\]

What is the problem with this statistical method?