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 (ft^2) & velocity (ft/s)

  or
  - time (s) & volume (ft^3)

Streamflow Cross-Section

Cross-Section Area (ft^2):

Width of stream (ft) x depth of stream (ft)

Streamflow velocity (f/s)

$$Q\left(\frac{ft^3}{s}\right) = \text{Area}\,(ft^2) \times \text{Velocity}\left(\frac{ft}{s}\right)$$

Important Units for Water - Flow

- cfs (ft^3/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 (m^3/s) – cubic meters per second (1 cms = 35.3 cfs)
  - Also used for streamflow

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

- What we have:
  - area (ft^2) & velocity (ft/s)
  - time (s) & volume (ft^3)
- How do we use these variables to get Q?

$$Q\left(\frac{ft^3}{s}\right) = \text{Area}\,(ft^2) \times \text{Velocity}\left(\frac{ft}{s}\right) \quad \textbf{OR} \quad Q\left(\frac{ft^3}{s}\right) = \frac{\text{Volume}\,(ft^3)}{\text{Time}\,(s)}$$

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?

$$Q\left(\frac{ft^3}{s}\right) = Area\,(ft^2) \times Velocity\,\frac{ft}{s} \quad \textbf{OR} \quad Q\left(\frac{ft^3}{s}\right) = \frac{Volume\,(ft^3)}{Time\,(s)}$$

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)?

$$Q\left(\frac{gal}{\min}\right) = \frac{Volume(gal)}{Time(\min)}$$

$$Q\left(\frac{5gal}{\min}\right) = \frac{400000(gal)}{time(\min)}$$

Time(min) = 80,000 min = 55.5 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 m^2 and the flow rate is 1 m/sec? Calculate the rate in both cms and cfs. Assume 35 cfs = 1 cms
- How do we solve this problem?

Flow variables (2)

- How much water can a ditch carry per month if its cross-sectional area is 10 m^2 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?

$$Q\left(\frac{ft^3}{s}\right) = Area(ft^2) \times Velocity\frac{ft}{s}$$ **OR** $$Q\left(\frac{ft^3}{s}\right) = \frac{Volume(ft^3)}{Time(s)}$$

Flow Example (2)

How much water can a ditch carry per month if its cross-sectional area is 10 m^2 and the flow rate is 1 m/sec? Calculate the rate in both cms and cfs.

$$Q\left(\frac{m^3}{s}\right) = Area(m^2) \times Velocity\frac{m}{s}$$

$$Q\left(\frac{m^3}{s}\right) = 10(m^2) \times 1\frac{m}{s}$$

Flow(cms) = 10 m^3/s

Conversion: 10 m^3/s x 35 cfs/cms = 350 ft^3/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

$$\frac{100\%}{100\,years} = 1\frac{\%}{yr}$$

10-year and 500-year floods?

$$\frac{100\%}{10\,years} = 10\frac{\%}{yr} \qquad \frac{100\%}{500\,years} = 0.2\frac{\%}{yr}$$

What is the problem with this statistical method?