Watershed & Hydrogeometric Parameters

- Geometry
  - Width and Depth
  - Slope
- Hydrology
  - Velocity and Flow
  - Mixing characteristics (dispersion)
- Drainage Area
- Dams, Reservoirs & flow diversions
- Geographical location of basin
Assessing Hydrogeometry

- Point Estimates vs. Reach Estimates
- Flow
  - often requires velocity
  - May use stage
    - USGS gaging stations

\[ Q = UA_c \]

\[ U = \frac{Q}{A_c} \]

- Velocity
  - Current Meter
  - Weighted Markers or Dye

Current Meters

- Price
- Pygmy

http://advmnc.com/Rickly/currmet.htm  
http://www.swoffer.com/2200.htm
Electromagnetic sensors

- Hach FH950 flow meter

Images: [www.hach.com](http://www.hach.com)

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Principles of electromagnetic sensing

- Under Faraday's law of induction, moving conductive liquids inside of a magnetic field generates an electromotive force (voltage) in which the pipe inner diameter, magnetic field strength, and average flow velocity are all proportional. In other words, the flow velocity of liquid moving in a magnetic field is converted into electricity. \( E \) is proportional to \( V \times B \times D \)

From: [www.keyance.com](http://www.keyance.com)
Current Meter Deployment

- Current meter and weight suspended from a bridge crane
- Wading rod and current meter used for measuring the discharge of a river

Current Meter Method

- Divide stream cross section into transects
- Measure velocity in each with meter
  - at 60% depth in shallow water (<2ft)
  - or 20% and 80% depth in deep water
Deployment cont.

- Crane, current meter, and weight used for measuring the discharge of a river from a bridge

From: U.S. GEOLOGICAL SURVEY CIRCULAR 1123; on the www at:

Moving Marker Methods

- Best for low velocity (<0.2 ft/s)
- Several types
  - Drogues (current at depth)
  - Dye (mixing too)
  - Surface objects (Oranges, Frisbees)
- Velocity from change in location with time

\[
U_{avg} = \frac{\Delta x}{t} \quad \text{Time of travel}
\]

\[
Q_{avg} = U_{avg} \left( \frac{A_1 + A_2}{2} \right)
\]
Drogues

- Designed to move with the current at a specific depth
- Surface float with a plastic underwater sail set at a predetermined depth

Dye studies

USGS Gaging Stations

- Hardware & telemetry

Stage vs Discharge

- Sections of stage-discharge relations for the Colorado River at the Colorado--Utah State line

Note: Present relation began October 1, 1993
Annual Hydrograph

Perennial flow regime
• 52 mi² drainage area
- 631 mi² drainage basin

Ephemeral River
• 289 mi² drainage area

Snow melt
• 1260 mi² drainage area
USGS Data Sources

- For “real time” data see:
- For “historical” data see:

![Sampling Date](image)
Other resources

- There are two WQN publications available from the USGS:
  - The CD-ROMs are published in a 2-disc set as USGS Digital Data Series DDS-37, entitled "Data from Selected U.S. Geological Survey National Stream Water-Quality Monitoring Networks (WQN)" by R.B. Alexander, J.R. Slack, A.S. Ludtke, K.K. Fitzgerald, and T.L. Schertz. The cost is $42 plus shipping and handling costs.

- To order, write or call:
  - U.S. Geological Survey
    Branch of Information Services
    Box 25286
    Denver, Colorado 80225-0286
    1-800-435-7627
Summary

- Natural conditions that affect hydrograph
- Anthropogenic factors
  - impoundments
  - urbanization and channelization
    - quick runoff
  - human water use

Other uses and calculations

- Interpolation between measurement sites
- Dispersion, longitudinal and lateral
  - Driven by flow velocity and stream geometry
  - Determines distance to complete mixing
- Low flow analysis
  - Important for “design conditions”
Interpolating Flow Measurements

- For estimating flow between gaging stations
- Develop log-log relationship

\[ \frac{Q_1}{Q_2} = \left( \frac{A_{D1}}{A_{D2}} \right)^y \]

Longitudinal Dispersion

- From Fischer et al., 1979

\[ E = 0.011 \frac{U^2 B^2}{H U^*} \]

Where the Shear Velocity is:

\[ U^* = \sqrt{g HS} \]
Lateral Mixing

- Lateral or transverse dispersion coefficient for a stream:
  \[ E_{lat} = 0.6HU \]

- Length required for complete mixing:
  - Side discharge:
    \[ L_m = 0.40U \frac{B^2}{E_{lat}} \]
  - Center discharge:
    \[ L_m = 0.10U \frac{B^2}{E_{lat}} \]

Low Flow Analysis

- Generally the design condition
- \(7Q_{10} = \) minimum 7-day flow that would be expected to occur every 10 years.
- Calculation
  - determine the minimum 7-day flow for each year of record (usually summer period)
  - list years in ascending order, assigning a rank (m)
  - Then probability or occurrence is:
    - Determine 10% probability flow from graph on probability paper
      \[ p = \frac{m}{N+1} \]
Low Flow Analysis: Data Table

- 33 years of data from: Schuylkill River @ Philadelphia

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Low Flow Analysis: Graph

- 7Q10 Graphical Solution: Schuylkill River @ Philadelphia

- Thomann & Mueller, pg. 39-40
- Chapra, pg. 243-244
• **To next lecture**