Calculations: Flow Rate Fundamentals

Part 1: Real-World Performance vs. Theoretical Design

Formula to determine velocity = V=Q/A as feet per second

- Flow rate Q = 17.5 cfs (cubic feet per second, ft^3/s)
- Channel width (b): 3 ft
- Measured depth (y): 1.1 ft

Step 1: Cross-Sectional Area (A) - For a rectangle: A = b * d = 3ft * 1.1 ft = 3.3 ft^2

Step 2: Flow Velocity (V) - V= Q/A = 17.5 cfs/3.3 ft^2 = 5.5 ft/s

Step 3: Time to travel 10 feet - V = 5.5 ft/s; 10 ft = 1.8 seconds

Factors that influence flow rate and therefore velocity of flow in an open channel include not only capacity but the slope and the type of surface. These are considered in Manning's Equation as follows:

- Q=VA=1.49nAR2/3S1/2
- n = Roughness Coefficient
- S = Slope

Once built the only variable in this formula for the channel is the quantity of water depending on storm size and the depth of flow. If we consider what would happen in the same size storm where the flow rate Q must stay the same, then the depth is the only variable and must increase if the velocity slows by half (i.e. object takes twice as long):

V = 10 ft/ 3.6 s = 2.8 ft/s and Q = V(b*y) = 17.5 cfs with Channel width (b) = 3 ft

y=Q/Vb = 17.5 cfs/2.8 ft/s3 ft = 2.1 ft

The depth of flow would be greater than the channel height of 1.5 ft.

Part 2: On-Site Rainfall Measurement & Localized Flow

Rainfall recorded: 1 inches in 20 minutes

Step 1: Convert this rainfall to inches per hour - (1 inches / 20 minutes) x 60 min/hr = 3 in/hr
Step 2: Convert to feet per second: 3 in/hr x 0.08 ft/in x .0003 hr/s = 0.000072 ft/s
Step 3: Use the Rational Method (described in Lesson Plan 5): Q = C x A x I = 1.32 cfs

- Runoff Coefficient for Paved Areas (C) = 0.9
- Drainage Area (A) = 20,419 ft^2
- Storm Intensity (I) = 0.000072 ft/s (calculated above)

With a max flow rate capacity of 26 cfs the channel is well equipped to handle the calculated quantity of runoff produced by this size of storm.

Water Quality Monitoring Sampling Hazard Analysis

Step/Task	Hazards	Hazard Controls
Site Access	• Crossing streets and freeways • Wet and rainy conditions • Overgrown vegetation • High traffic area • Confined spaces	• Wear sunscreen and bug spray as needed • Check traffic before crossing roads and getting out of the vehicle, if stopped on the shoulder • Don't enter manholes or pipes • Always take someone else with you • Know where the nearest hospital is • Survey conditions before entering site • Stay away from pipe openings during storm events • Be aware of surroundings and people around you
Sample Collection	• Wet and rainy conditions	• Do not sample in the rain • Check surroundings before opening and touching the equipment • Wear gloves and wash hands after handling samples • Keep wipes and hand sanitizer readily available