



Stormwater Runoff and Pipe Flow

Use the rational method and the continuity equation to size a solution for a school parking lot.

Name _____ Date _____

Rational method: $Q = C i A$, where Q = peak runoff (ft^3/s), C = runoff coefficient, i = rainfall intensity (in/hr), A = area (acres).

Continuity: $Q = A v$, where A = pipe cross-sectional area (ft^2) and v = velocity (ft/s).

1. A 2.5-acre asphalt parking lot has $C = 0.90$. Find the peak runoff for a storm of 2.0 in/hr.

2. The school replaces 1.0 acre with permeable pavement and a rain garden ($C = 0.30$). Find the new area-weighted C and the new peak runoff.

3. By what percent did the redesign reduce peak runoff?

4. The original runoff drains to a 12-inch pipe. Calculate the flow velocity.

5. Would an 8-inch pipe carry the original flow within a guideline of 2 to 10 ft/s ? Show your calculation.

6. Describe one environmental and one economic benefit of the redesign for the watershed that feeds St. Louis's rivers.

7. Sketch the site plan showing flow paths, the rain garden, and the pipe outlet.



For teachers

Grade 11 Answer Key

Accept reasonable answers that are supported by evidence.

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1. $Q = 0.90 \times 2.0 \times 2.5 = \mathbf{4.5 \text{ ft}^3/\text{s}}$
2. $C = (0.90 \times 1.5 + 0.30 \times 1.0) \div 2.5 = \mathbf{0.66}$; $Q = 0.66 \times 2.0 \times 2.5 = \mathbf{3.3 \text{ ft}^3/\text{s}}$
3. $(4.5 - 3.3) \div 4.5 \times 100 \approx \mathbf{27\%}$
4. $A = \pi(0.5)^2 = 0.785 \text{ ft}^2$; $v = 4.5 \div 0.785 = \mathbf{5.7 \text{ ft/s}}$
5. $A = \pi(0.333)^2 = 0.349 \text{ ft}^2$; $v = \mathbf{12.9 \text{ ft/s}}$, too fast. The 12-inch pipe is the better choice.
6. Examples: less sediment and heat reaching streams, groundwater recharge; smaller pipes, lower flood damage and treatment costs.
7. Sketches vary.