

Lesson 21: Hydrograph Analysis

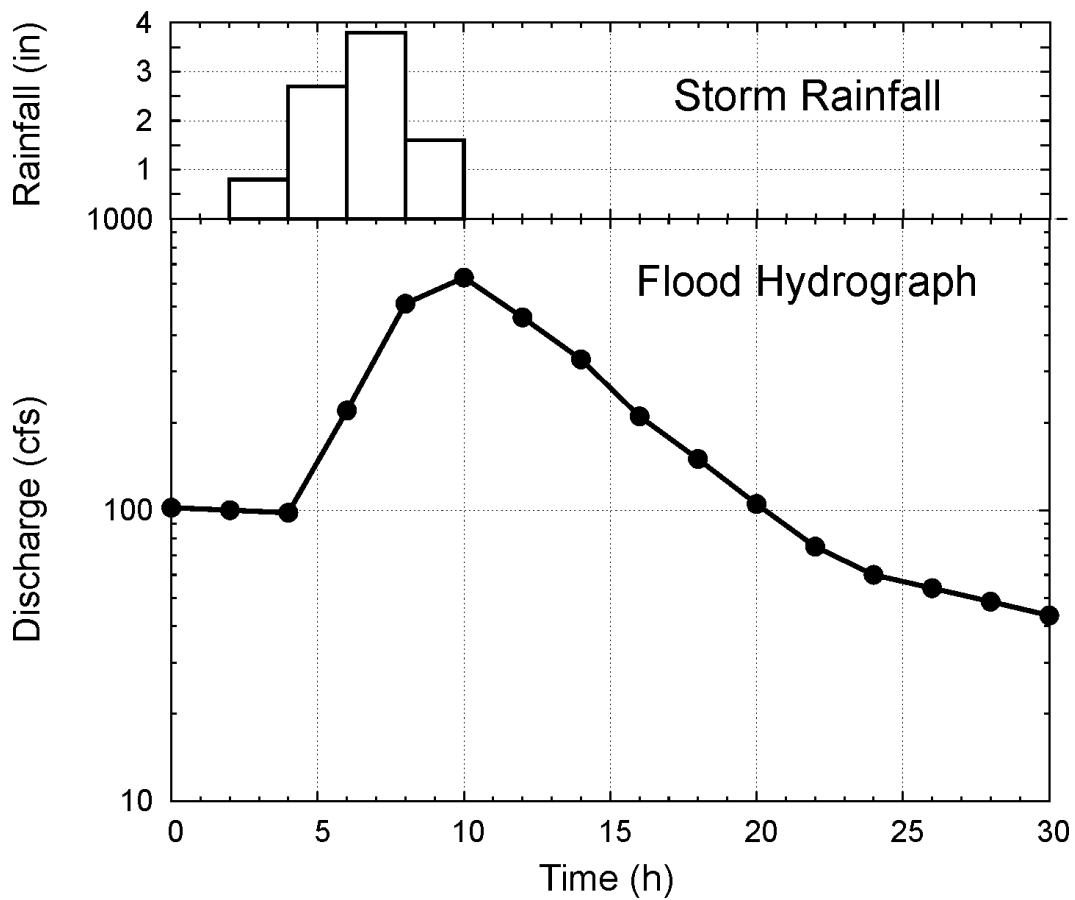
Determine the Direct Runoff and Rainfall Excess for a Flood Event

Given

- Incremental rainfall hyetograph
- Streamflow Hydrograph
- Watershed area $A = 2.4 \text{ mi}^2$

Find

- Baseflow (by a separation method)
- Direct runoff hydrograph (V_d and r_d also)
- Rainfall excess (P_e) hyetograph



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Baseflow Separation (Straight-Line Method B) and Direct Runoff Hydrograph

	(Given)	SL-B	
Time	Q	Q_b	DRH
(hr)	(cfs)	(cfs)	(cfs)
0	102.0	102.0	--
2	100.0	100.0	--
4	98.0	98.0	0
6	220.0	94.2	125.8
8	512.0	90.4	421.6
10	630.0	86.6	543.4
12	460.0	82.8	377.2
14	330.0	79.0	251.0
16	210.0	75.2	134.8
18	150.0	71.4	78.6
20	105.0	67.6	37.4
22	75.0	63.8	11.2
24	60.0	60.0	0.0
26	54.0	54.0	--
28	48.5	48.5	--
30	43.5	43.5	--
		ΣDRH	1981.0 cfs
		V_d	327.4 ac-ft
		r_d	2.56 inches

Direct runoff

$$V_d = \Sigma DRH \cdot \Delta t = (1981.0 \text{ cfs})(2 \text{ h}) \times \frac{3600 \text{ s}}{\text{h}} \times \frac{\text{ac}}{43560 \text{ ft}^2} = 327.4 \text{ ac - ft}$$

$$r_d = \frac{V_d}{A} = \frac{327.4 \text{ ac - ft}}{2.4(640 \text{ ac})} \times \frac{12 \text{ in}}{\text{ft}} = 2.56 \text{ in}$$

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Rainfall Excess Using the ϕ -Index Method

	(Given)			
Time	P	i	i_e	P
(hr)	(inches)	(in/hr)	(in/hr)	(inches)
0	--	--	--	--
2	0.8	0.40	0.00	0.00
4	2.7	1.35	0.37	0.73
6	3.8	1.90	0.92	1.83
8	1.6	0.80	0.00	0.00
10				
ϕ	0.985 in/hr		ΣP_e	2.56 in
			ΣP	8.90 in
			C	0.288

Determine ϕ -index for storm (given r_d)

If $\phi > 1.35$ in/hr:

$$r_d = 2.56 \text{ in} = (1.90 - \phi)(2 \text{ h})$$

$$\phi = 1.90 - \frac{2.56 \text{ in}}{2 \text{ h}} = 0.62 \text{ in/hr} < 1.35 \text{ in/hr [Not OK - try again]}$$

If $\phi > 0.80$ in/hr:

$$r_d = 2.56 \text{ in} = (1.90 - \phi)(2 \text{ h}) + (1.35 - \phi)(2 \text{ h})$$

$$2\phi = 1.90 + 1.35 - \frac{2.56 \text{ in}}{2 \text{ h}}$$

$$\phi = \frac{1}{2}(1.90 + 1.35 - 1.28) = 0.985 \text{ in/hr} > 0.8 \text{ in/hr [OK!]}$$

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Rainfall Excess Hyetograph and Direct Runoff Hydrograph

