Hydrologic Analysis Part A

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Hydrograph computed at outlet of each subarea

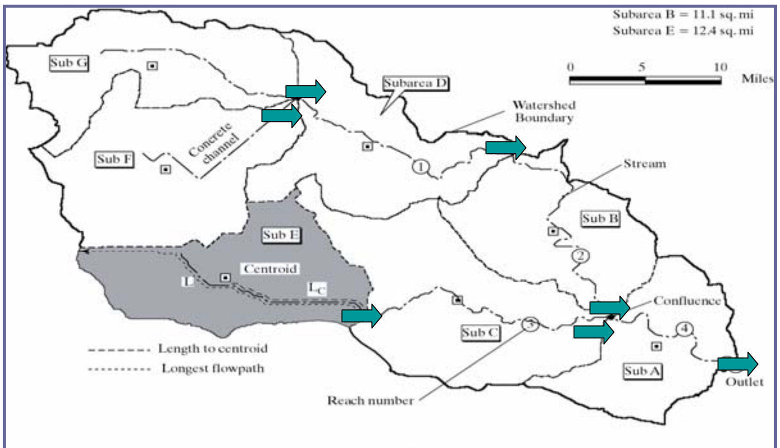

Figure 2.1a
Typical watershed area.

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Hydrographs routed to the outlet of the watershed

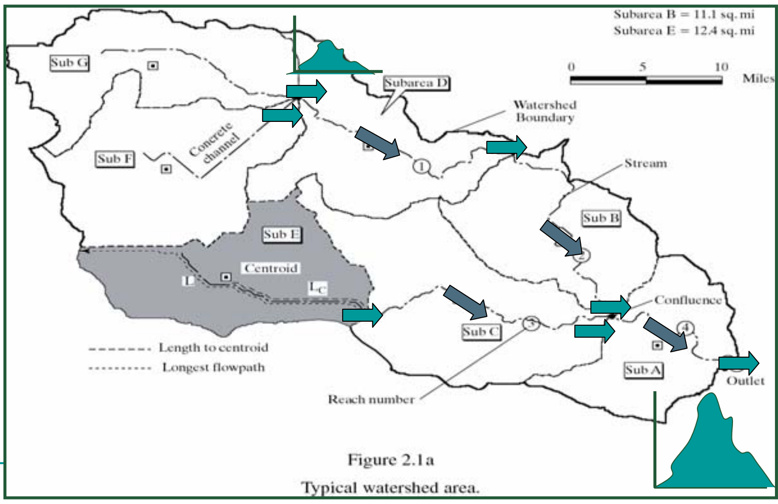
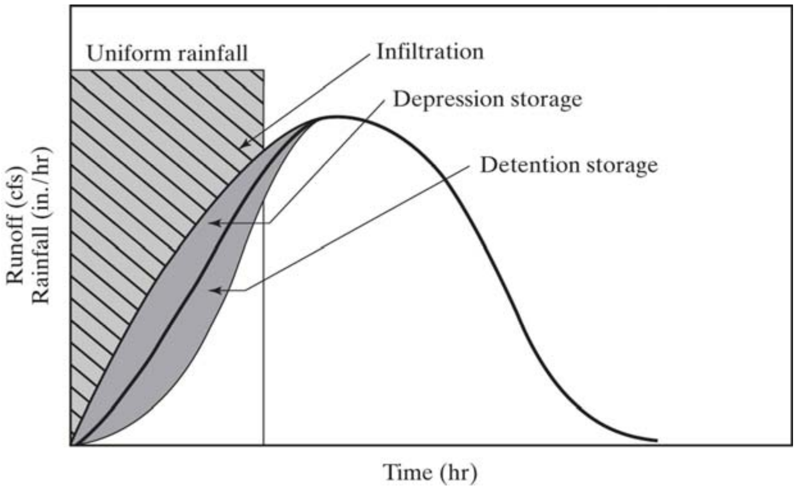


Figure 2.1a
Typical watershed area.

Factors affecting the shape of hydrograph

- **Relief or gradient of the area:** The steeper the slopes, the lower the rate of infiltration and faster the rate of run-off
- **Geology, rock type and soil type:** Run-off will occur quickly where impermeable rocks are exposed. The deeper the soil the more water can be absorbed.
- **Presence of vegetation:** A high amount of vegetation will intercept rainfall, and reduce initial surface flow. Evergreen plants are able to transpire throughout the year (assuming temperatures are high enough and moisture is available - not frozen).
- **Land use (Urbanization):** Impermeable road surfaces, sloping roofs, guttering, and underground sewer and drainage systems help transfer water in an urban area to rivers quickly.
- **Water use:** Dams and reservoirs slow down the rate of discharge at peak times.
- **Drainage density:** This ratio is the length of river course per area of land. The larger the amount of streams and rivers per area the shorter distance water has to flow and the faster the rate of response.
- **Precipitation:** The rate and intensity of the rainfall will directly affect the amount and rate of overland flow.
- **Time of year/season:** In the summer, evapotranspiration rates are higher, reducing the amount of surface runoff.

Rainfall distribution in a watershed



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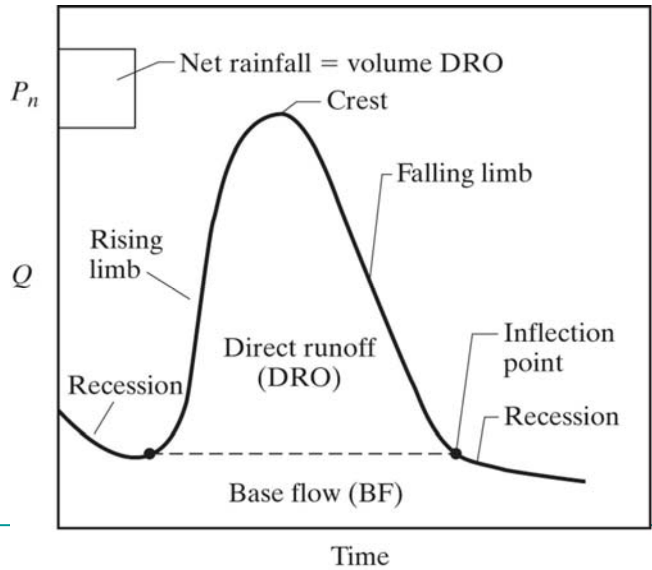
Components of a Hydrograph



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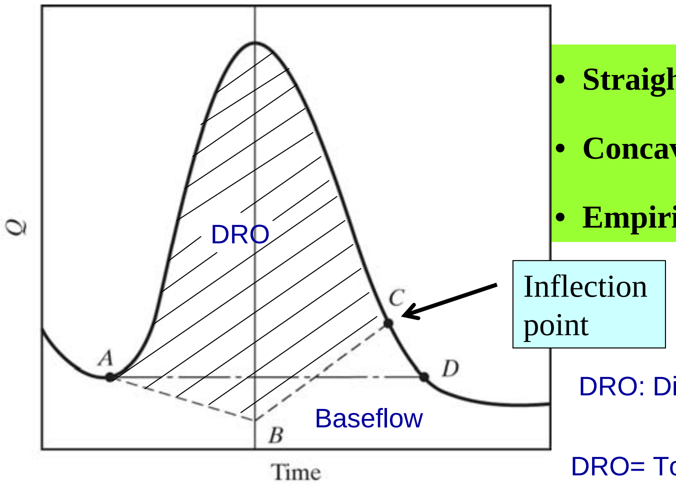
Base Flow Separation

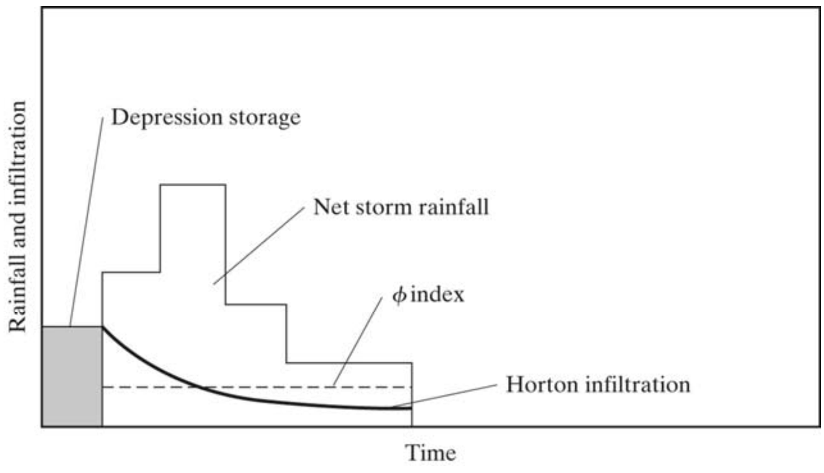


- **Straight Line method**
- **Concave method**
- **Empirical method**

DRO: Direct Runoff

DRO= Total Q - Baseflow

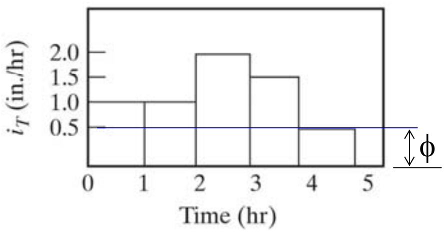
Infiltration Loss Curves

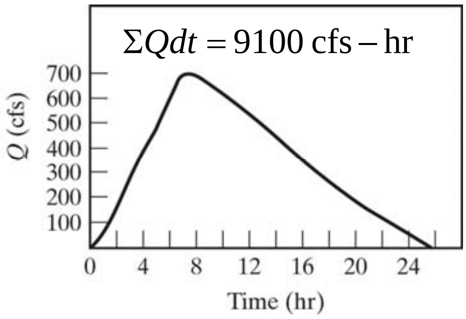


Example 2-1. Watershed Response to a Rainfall

Given:
ϕ= 0.5 in/hr
Excess rainfall = 0.5*2+1.5*1+1*1= 3.5in

DRO= 9100 cfs-hr = 9100/43560*3600*12 = 9024.8 ac-in
Area of the watershed= DRO/Excess rainfall = 9024.8/3.5= 2578.5 ac





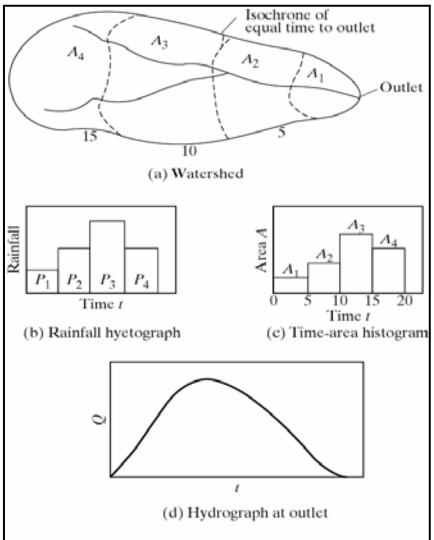


Figure 2.6
Time-area method.

Time-Area Method

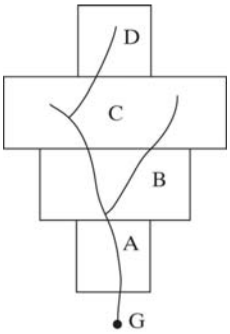
$$Q_n = R_i A_1 + R_{i-1} A_2 + \cdots + R_1 A_j$$

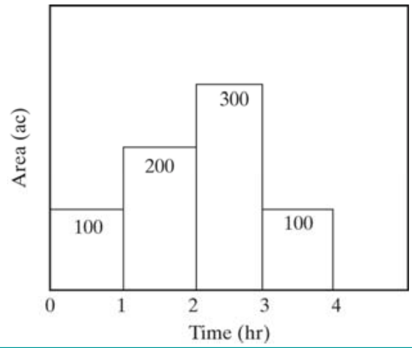
Q_n= hydrograph ordinate at time n (length^3/time)
R_i= excess rainfall ordinate at time i (length/time)
A_j = time-area histogram ordinate at time j (length^2)

Example 2-2: Time Area Hydrograph

Given: Constant Rainfall = 0.5 in/hr for a period of 5 hours

	A	B	C	D
Area (ac)	100	200	300	100
Time to gauge (hr)	1	2	3	4





$$Q_1 = 0.5(\text{in/hr}) \times 100(\text{ac}) = 50\text{ac} - \text{in/hr} \approx 50\text{cfs}$$
$$Q_2 = 0.5 \times 100 + 0.5 \times 200 = 150$$
$$Q_3 = 0.5 \times 100 + 0.5 \times 200 + 0.5 \times 300 = 300$$

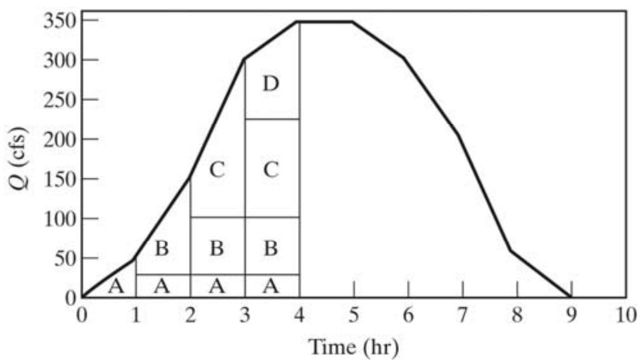
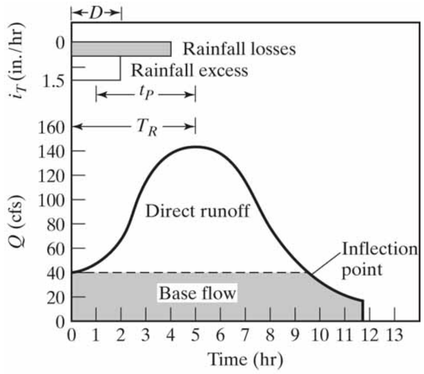


Table E2–2. Excel Spreadsheet Calculations

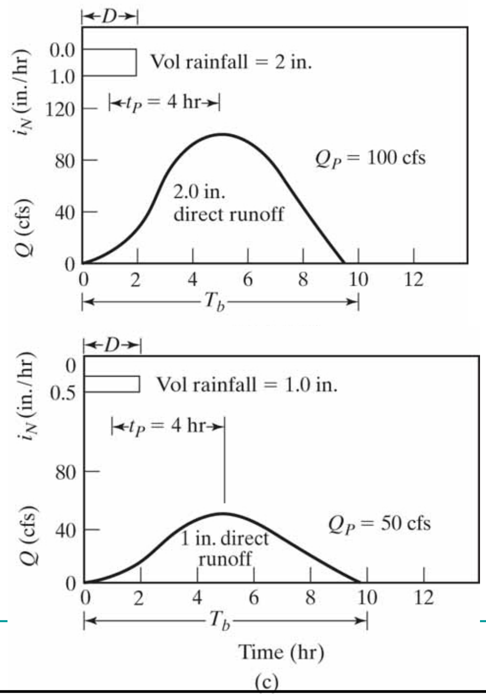
Time (hr.)	Hyetograph Ordinate R1:Rn	Basin No.	Time to Gage	Basin Area A1:An (ac)	R1*An	R2*An	R3*An	R4*An	R5*An	Storm Hydrograph
0					Lag by time to gage, T					**0.0**
1	0.5	A	1	100	R1*A1=50.0					**50.0**
2	0.5	B	2	200	R1*A2=100.0	50.0				**150.0**
3	0.5	C	3	300	R1*A3=150.0	100.0	50.0			**300.0**
4	0.5	D	4	100	R1*A4=50.0	150.0	100.0	50.0		**350.0**
5	0.5					50.0	150.0	100.0	50.0	**350.0**
6							50.0	150.0	100.0	**300.0**
7								50.0	150.0	**200.0**
8									50.0	**50.0**
9										**0.0**

Unit Hydrograph

Basin response from 1 inch (or 1 cm) of uniform rainfall of given duration, D



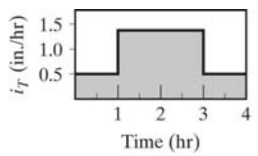
(a)



Example 2-3 Derivation of a UHG

Given: Constant ϕ = 0.5 in/hr, Constant Baseflow =100cfs

Determine: UHG ordinates, t_p and T_b



Tutorial:

1. Problem 2.6

2. Rework Example 2-3 with ϕ= 1 in/hr