Hydrologic Analysis
Part B

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Change UH Duration

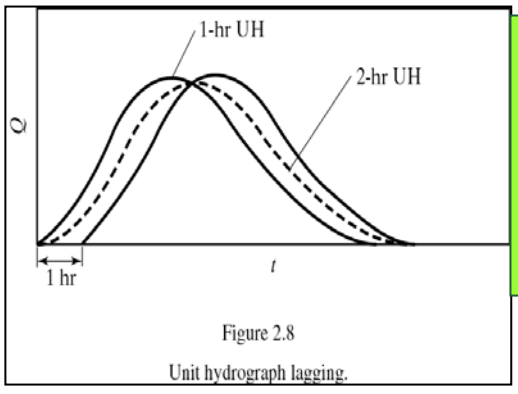


Figure 2.8
Unit hydrograph lagging.

Consider 1 hr UH
Add and Lag two UH by one hour
Sum and divide by 2
Results in 2 hr UH

S-Curve

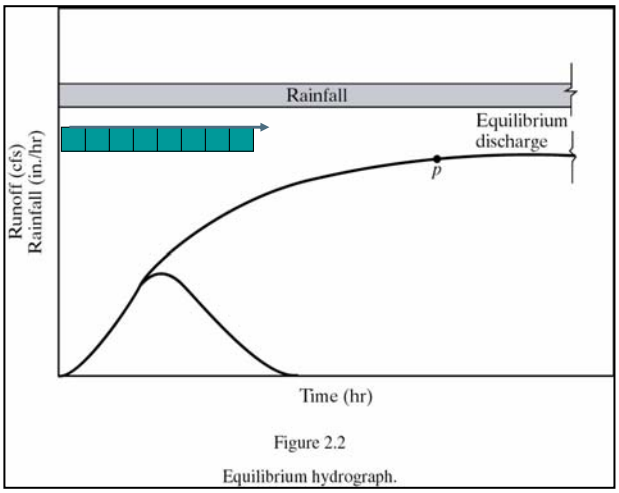
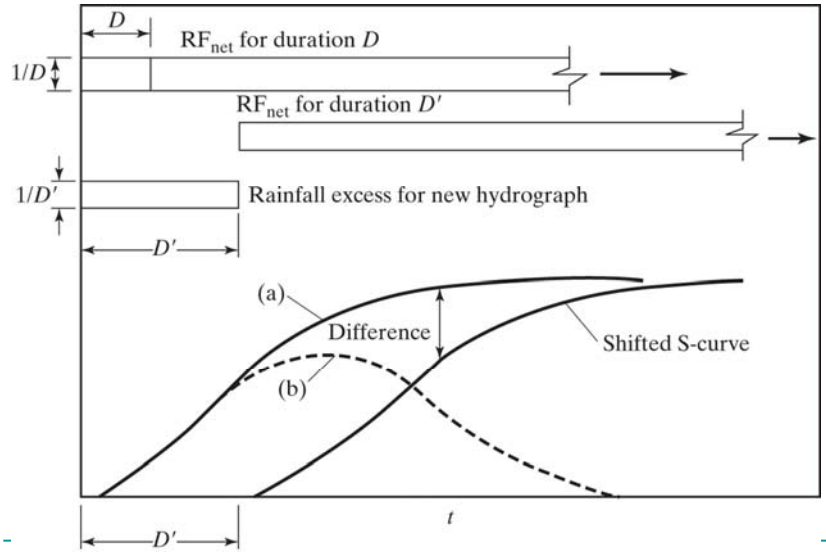


Figure 2.2
Equilibrium hydrograph.

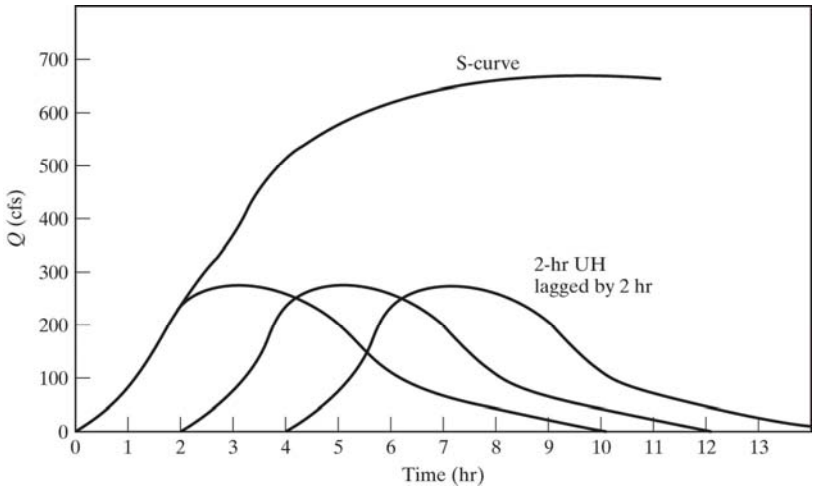
3

S-Curves for UH



4

Example 2-4: S-Curve method



5

Lag S Curves in time, subtract them, and multiply by D/D'

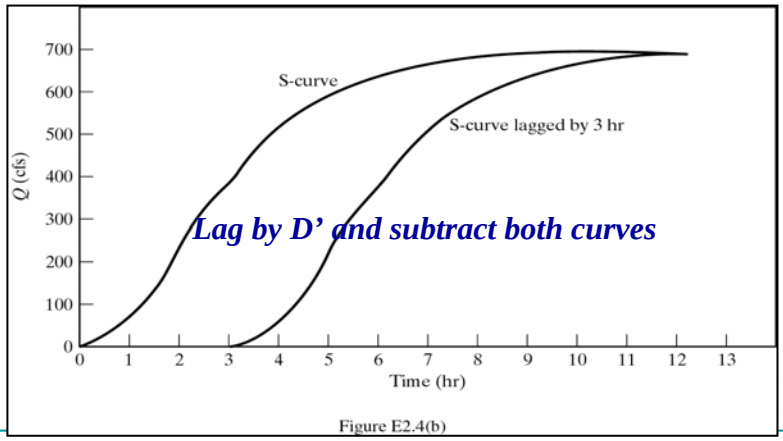


Figure E2.4(b)

6

3 hr. UH from a 2 hr. UH (D/D')

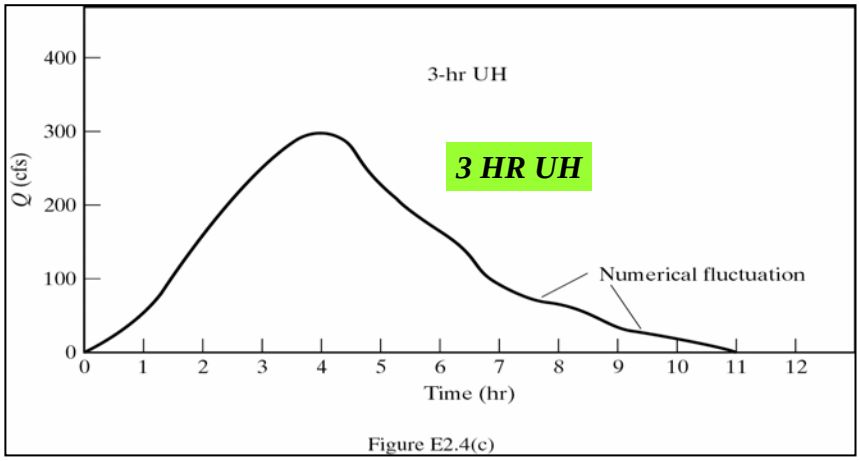
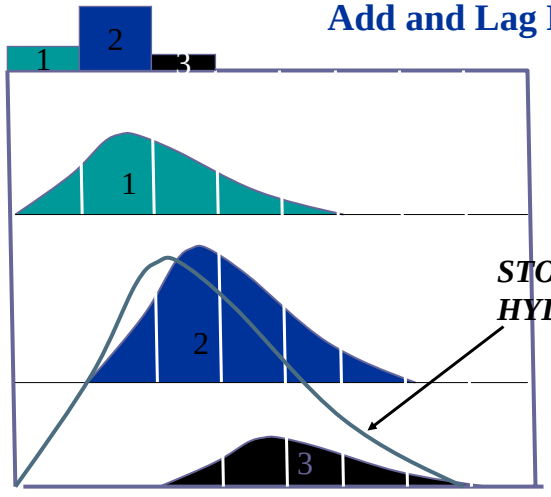


Figure E2.4(c)

7

Hydrograph Convolution

Add and Lag Method



Add up the ordinates of all three to produce storm hydrograph

8

Convolution Equation

$$Q_n = \sum_{i=1}^{n} P_i U_{n-i+1}$$

or

$$Q_n = P_n U_1 + P_{n-1} U_2 + P_{n-2} U_3 + \cdots + P_1 U_j$$

9

Example 2-5 Storm Hydrograph from UH

Given: P_n = (0.5, 1.0, 1.5, 0.0, 0.5) in
U_n = (0, 100, 320, 450, 370, 250, 160, 90, 40, 0) cfs

Determine: Storm hydrograph ordinates

10

Table E2–5.

Time (hr)	P_1U_n	P_2U_n	P_3U_n	P_4U_n	P_5U_n	Q_n
0	0					**0**
1	50	0				**50**
2	160	100	0			**260**
3	225	320	150	0		**695**
4	185	450	480	0	0	**1115**
5	125	370	675	0	50	**1220**
6	80	250	555	0	160	**1045**
7	45	160	375	0	225	**805**
8	20	90	240	0	185	**535**
9	0	40	135	0	125	**300**
10		0	60	0	80	**140**
11			0	0	45	**45**
12				0	20	**20**
13					0	**0**

11

Determining UH from multi-period excess rainfall

Given: Storm hydrograph ordinates; Q_1, Q_2, Q_3……..

Determine: Unit hydrograph ordinates, U_1, U_2, U_3…..

$$Q_1 = P_1U_1 \Rightarrow U_1 = Q_1 / P_1$$

$$Q_2 = P_2U_1 + P_1U_2 \Rightarrow U_2 = (Q_2 - P_2U_1) / P_1$$

$$Q_3 = P_3U_1 + P_2U_2 + P_1U_3 \Rightarrow U_3 = (Q_3 - P_3U_1 - P_2U_2) / P_1$$

…

…

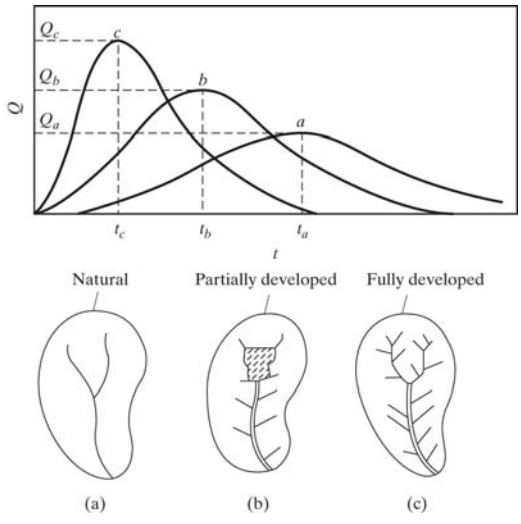
12

Tutorial:

Problem 2.7

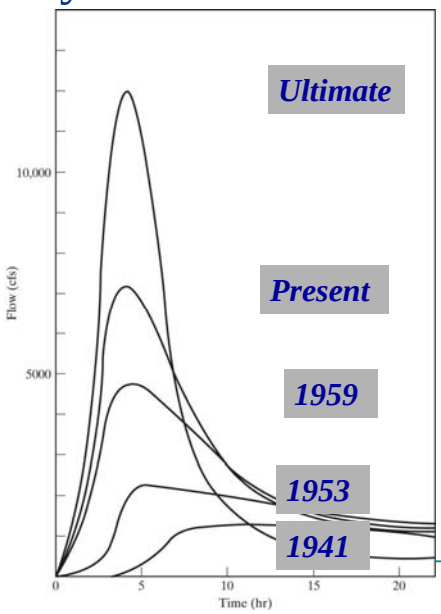
13

Effects of Development on UH



14

Synthetic UH



- Developed for basins that were ungaged
- Based on data from similar gauged basins
- Most methods are very similar in nature
- Revolutionized ability to predict hydrograph response

15

Synthetic UH Methods

- Snyder's Method (1938)
- Clark Method (1945)
- Nash (1959)
- SCS (1964, 1975)
- Kinematic Wave (1970s)

16

Example 2-7: Snyder's Method

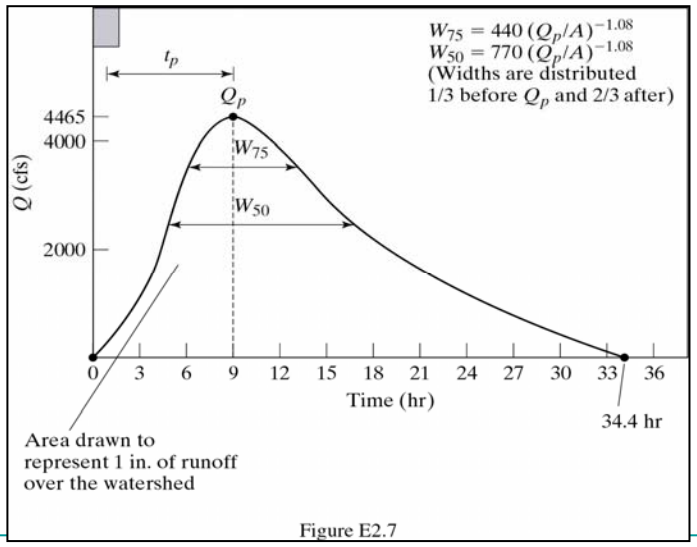
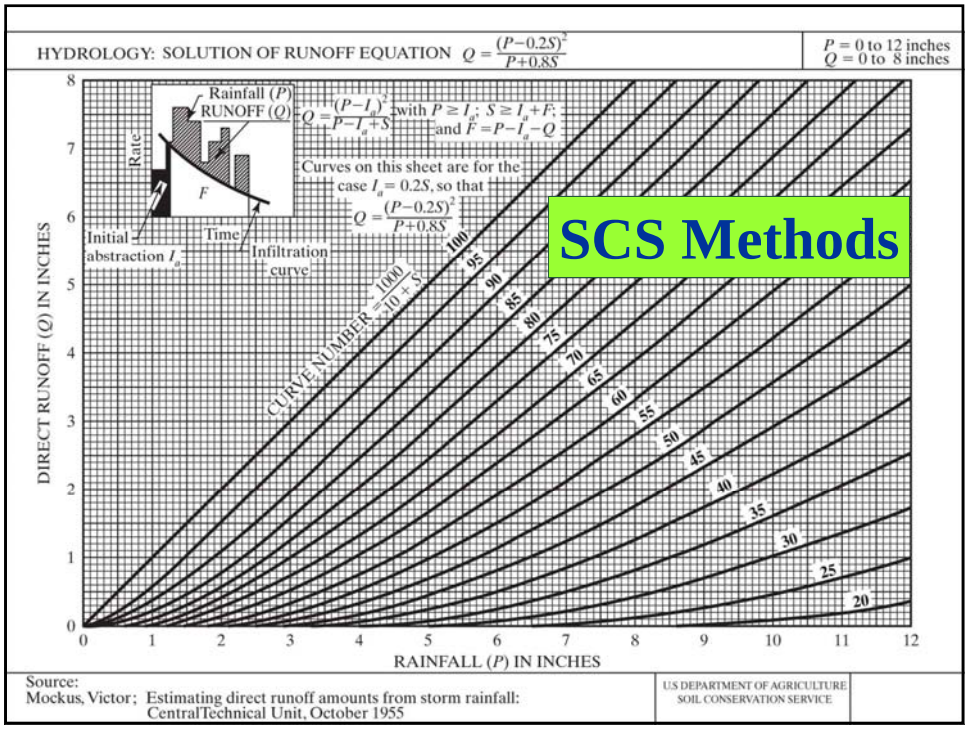
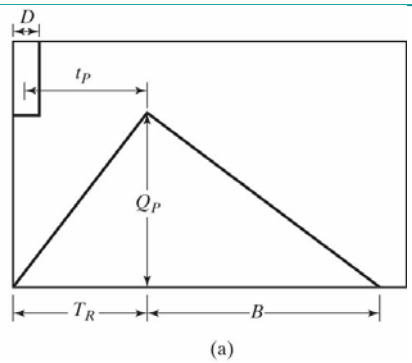


Figure E2.7

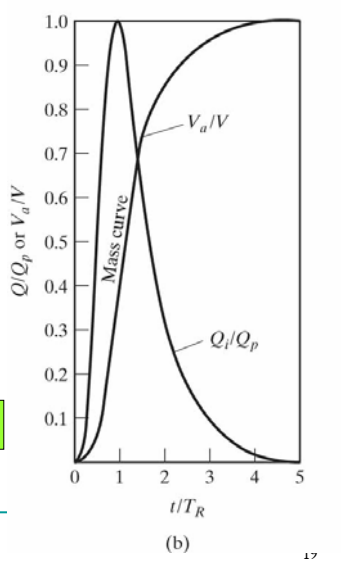
17



SCS Methods

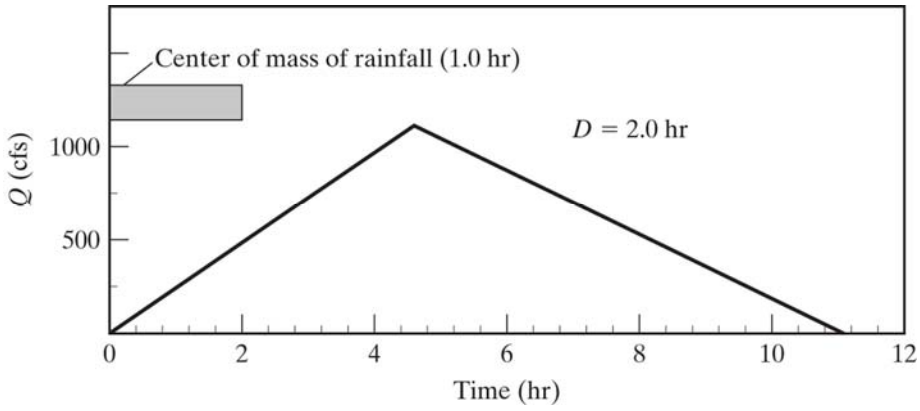


Triangular UH



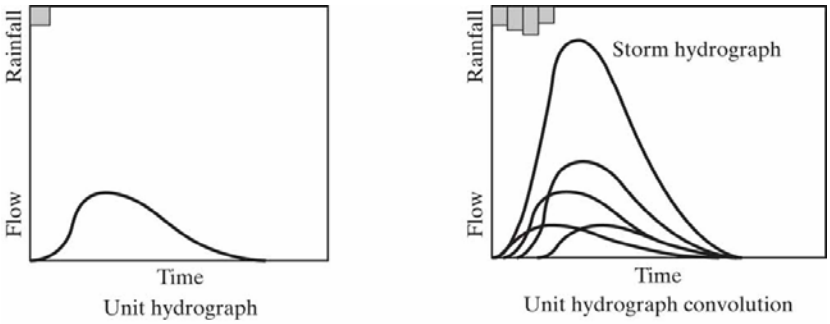
Dimensionless UH

Example 2-9: SCS Triangular UH



Unit Hydrograph Applications

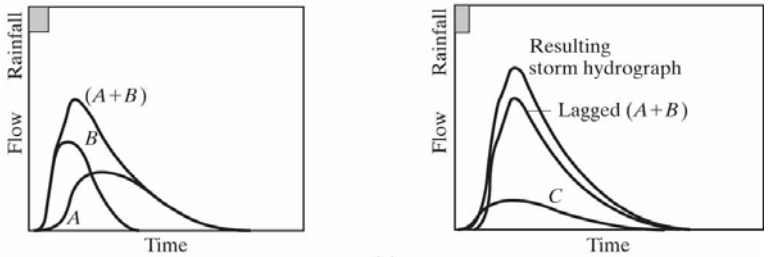
Multi-period Storms



(a)

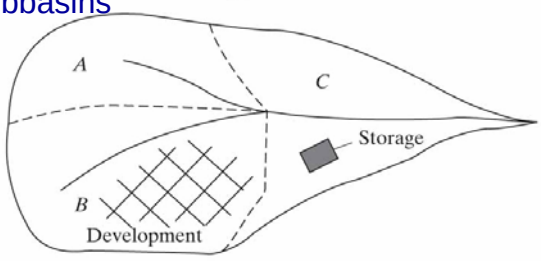
21

Unit Hydrograph Applications



(b)

Storm over subbasins



(b)

22

Tutorial:

1. Problem 2.4
2. Problem 2.11