

Calculation of Flood Hydrograph due to a known ERH of example 6.

Time	Ordinates of UH	DRH due to 2 cm ER Col. 2 $\times 2.0$	DRH due to 2 cm ER Col. 2 $\times 6.0$	DRH due to 4 cm ER Col. 2 $\times 4.0$	Ordinates of final DRH (Col. 3 + 4 + 5)	Base Ordinates flow (m ³ /s) hydrograph (m ³ /s) (Col. 6 + 7)	
		(Advanced by 6 h)		(Advanced by 12 h)			
1	2	3	4	5	6	7	8
0	0	0	0	0	0	15	15
3	25	50	0	0	50	15	65
6	50	100	0	0	100	15	115
9	85	170	150	0	320	15	335
12	125	250	300	0	550	17	567
15	160	320	510	100	930	17	947
18	185	370	750	200	1320	17	1337
(21)	(172.5)	(345)	960	340	1645	(17)	1662
24	160	320	1110	500	1930	19	1949
(27)	(135)	(270)	(1035)	640	1945	19	1964
30	110	220	960	740	1920	19	1939
36	60	120	660	640	1420	21	1441
42	36	72	360	440	872	21	893
48	25	50	216	240	506	23	529
54	16	32	150	144	326	23	349
60	8	16	96	100	212	25	237
66	(2.7)	(5.4)	48	64	117	25	142
69	0	0	—	—	—	—	—
72		0	16	32	48	27	75
75		0	0	—	—	—	—
78		0	0	(10.8)	(11)	27	49
81				0	0	27	27
84						27	27

Note: Due to the unequal time intervals of unit hydrograph ordinates, a few entries, indicated in parentheses have to be interpolated to complete the table.

Derivation of Unit Hydrograph

The flood hydrograph used in the analysis should be selected to meet the following

- The storm must be isolated storm occurring individually.
- The rainfall should be fairly uniform through the duration over the entire catchment.
- The duration of rainfall ranged from $(\frac{1}{5} - \frac{1}{3})$ of the basin lag.
- The rainfall excess of the selected storm should be high (1-4 cm).

في 4-6 ايام لا تزيد عن 250 مم
في 2-3 ايام لا تزيد عن 250 مم

Example 7

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The following are the ordinates of storm hydrograph of a catchment area 423 km^2 due to 6-hr isolated storm. Derive the 6-h unit hydrograph for this catchment.

Time from start of storm (h)	-6	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102
Discharge (m^3/s)	10	10	30	87.5	115.5	102.5	85.0	71.0	59.0	47.5	39.0	31.5	26.0	21.5	17.5	15.0	12.5	12.0	12.0

Solution

From Fig (17) which the flood hydrograph was plotted on :-

A = beginning of DRH $\rightarrow t=0$

B = end of DRH $\rightarrow t=90 \text{ h}$

P = Peak of DRH $\rightarrow t=20 \text{ h}$

assuming base flow varied linearly from 10 at $t=6$ to 12.5 at $t=90 \text{ h}$

$$\frac{12.5-10}{90} = 0.026 \text{ (20.5 each 18 hrs.)}$$

Checking of position B:

$$N = 0.83(423)^{0.2} = 2.78 \text{ day}$$

from observation $= 90 - 20 = 70 \text{ h} = 2.91 \text{ day}$

However $N = 2.91$ days is adopted here.

From table below (col. 4) volume of DRH is equal to $= 587 \times 6 \times 60 \times 60 = 12.68 \times 10^6 \text{ m}^3$

$$\text{depth} = \frac{12.68 \times 10^6}{423 \times 10^6} \times 100 = 3 \text{ cm}$$

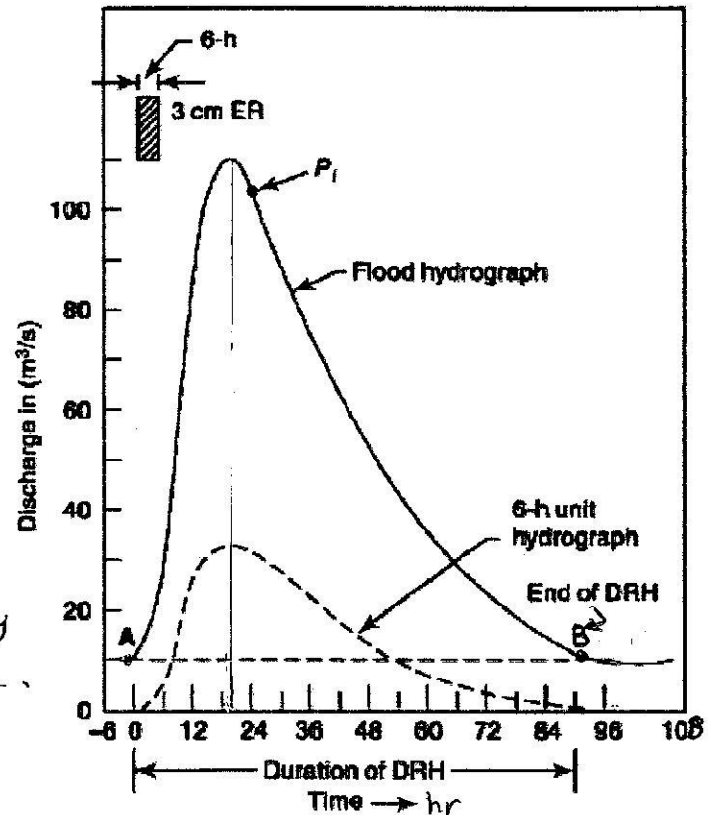


Fig.17 Derivation of UH from a flood Hydrograph

Time from beginning of storm (h)	Ordinate of flood hydrograph (m^3/s)	Base Flow (m^3/s)	Ordinate of DRH (m^3/s)	Ordinate of 6-h unit hydrograph (Col. 4)/3
1	2	3	4	5
-6	10.0	10.0	0	0
0	10.0	10.0	0	0
6	30.0	10.0	20.0	6.7
12	87.5	10.5	77.0	25.7
18	111.5	10.5	101.0	33.7
24	102.5	10.5	92.0	30.7
30	85.0	11.0	74.0	24.7
36	71.0	11.0	60.0	20.0
42	59.0	11.0	48.0	16.0
48	47.5	11.5	36.0	12.0
54	39.0	11.5	27.5	9.2
60	31.5	11.5	20.0	6.6
66	26.0	12.0	14.0	4.6
72	21.5	12.0	9.5	3.2
78	17.5	12.0	5.5	1.8
84	15.0	12.5	2.5	0.8
90	12.5	12.5	0	0
96	12.0	12.0	0	0
102	12.0	12.0	0	0
sum=			587	195.7

HW

(a) The peak of flood hydrograph due to a 3-h duration isolated storm in a catchment is $270 \text{ m}^3/\text{s}$. The total depth of rainfall is 5.9 cm. Assuming an average infiltration loss of 0.3 cm/h and a constant base flow of $20 \text{ m}^3/\text{s}$, estimate the peak of the 3-h unit hydrograph (UH) of this catchment.

(b) If the area of the catchment is 567 km^2 determine the base width of the 3-h unit hydrograph by assuming it to be triangular in shape.

Unit Hydrograph for Different Durations

(18)

الهيدروغراف لامتدادات مختلفة

Two methods are available for developing a unit Hydrograph for different durations:

1. Superposition method
2. S-curve method

Superposition method طريقة الانطباق

If a D-h hydrograph (UH) is available, and it is desired to develop a unit hydrograph of nD-h where n is an integer, one can use this method.
 شرط الطريقة ان يكون الهيدروغراف القياسي المعروف في اسبقية هو لامتدادته فقط (n*D) حيث n عدد صحيح موجب و n اقل من 1.
 الهيدروغراف الناتج يتكون من الاستيفاء. وعليه فان هذه الطريقة لا يمكن استخدامها في الهيدروغراف القياسي ذو امتدادته اقل من 1.
 في التوضيح - اني

Example 8: Given UH - 4 hrs, Derive UH - 12 hr.

Time (h)	0	4	8	12	16	20	24	28	32	36	40	44
Ordinate of 4-h UH	0	20	80	130	150	130	90	52	27	15	5	0

Solution:

Time (h)	Ordinates of 4-h UH (m ³ /s)			DRH of 3 cm in 12-h (m ³ /s) (Col. 2+3+4)	Ordinate of 12-h UH (m ³ /s) (Col. 5)/3
	A	B Lagged by 4-h	C Lagged by 8-h		
1	2	3	4	5	6
0	0	—	—	0	0
4	20	0	—	20	6.7
8	80	20	0	100	33.3
12	130	80	20	230	76.7
16	150	130	80	360	120.0
20	130	150	130	410	136.7
24	90	130	150	370	123.3
28	52	90	130	272	90.7
32	27	52	90	169	56.3
36	15	27	52	94	31.3
40	5	15	27	47	15.7
44	0	5	15	20	6.7
48		0	5	5	1.7
52			0	0	0

From table of example 8- the procedure is:

- ① Col. 1 and col. 2 are given.
- ② Col. 3 is generated by lagged col. 2 D-hr (4hr)
- ③ Col. 4 is generated by lagged col. 2 2D-hr (8hr)
- ④ Col. 5 is obtained by Adding col. 2, col. 3 & col. 4.
- ⑤ Divide col. 5 by 3 cm to get UH-12 hrs.

$$1 - \frac{\text{استجابة المطوب}}{\text{استجابة المطبوع}} = \text{عدد مراتب الترخيف}$$

$\frac{12}{4} - 1 = 2$ أي أن عدد مراتب الترخيف كما راعى في الجدول التالي هو 2
 (عدد مراتب توليد المحطة = 2 إضافة 1) العود لإصلاح Col. 2
 كما موضح في الشكل رقم (18).

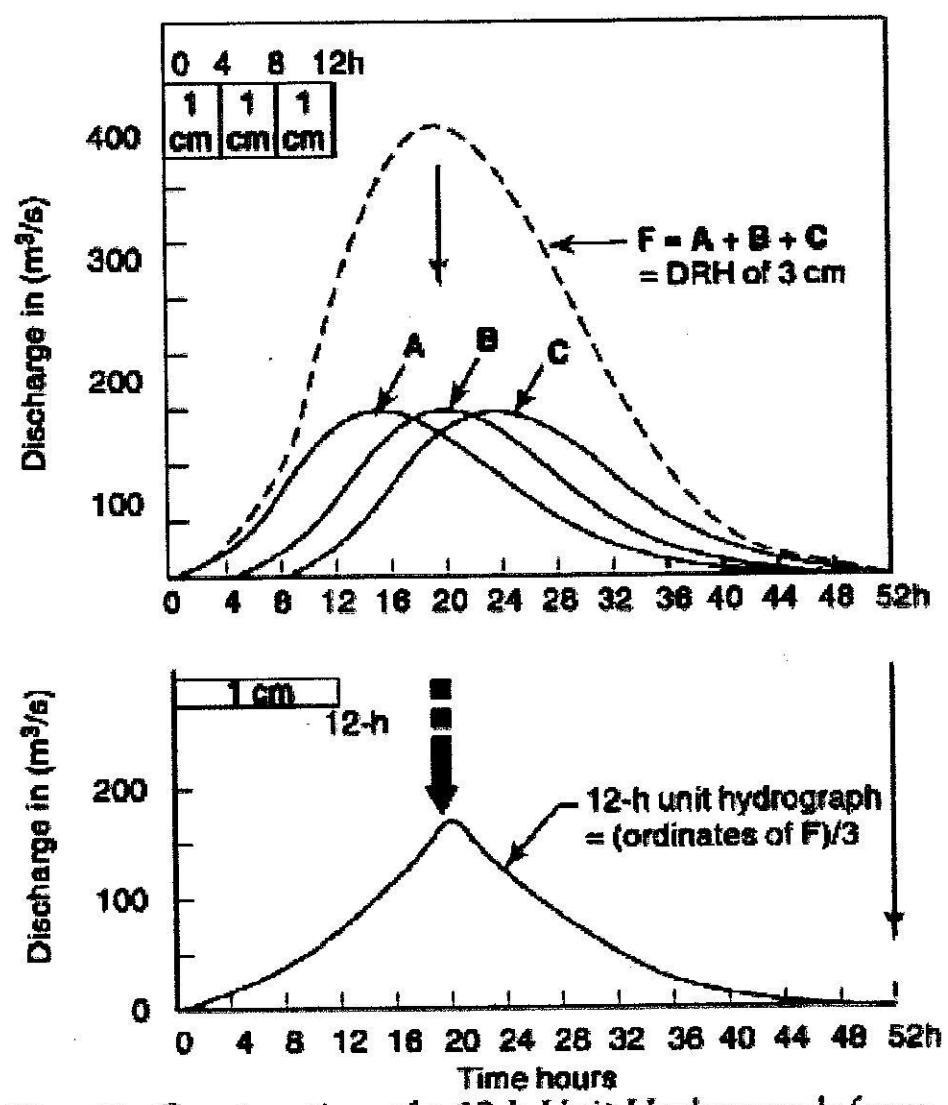


Fig. 18 Construction of a 12-h Unit Hydrograph from a 4-h Unit Hydrograph – Example 8