

TUTORIAL-4

CHANGE IN SPECIFIC TIME DURATION OF UH

Problems

(a) The ordinates of one hour unit hydrograph for the catchment No. 807/1 are given below

| | | | | | | | | | | |
|-------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| time (hrs) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| One hr U.H. (m^3/S) | 3.05 | 15.73 | 28.05 | 33.67 | 32.25 | 29.21 | 23.75 | 18.27 | 13.49 | 9.64 |
| time (hrs) | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | |
| One hr U.H. (m^3/S) | 6.72 | 4.58 | 3.07 | 2.03 | 1.32 | 0.85 | 0.55 | 0.35 | 0.22 | |
| time (hrs) | 20 | 21 | 22 | | | | | | | |
| One hr U.H. (m^3/S) | 0.14 | 0.08 | 0.05 | | | | | | | |

Find out the ordinates of 2-hour unit hydrograph.

(b) Find ordinates of two hour unit hydrograph for the catchment B.R. No. 807/1 are given below

| | | | | | | | | | |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|--|
| time (hrs) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| 2 hr UH (m^3/S) | 1.53 | 9.39 | 21.89 | 30.86 | 33.46 | 31.23 | 26.48 | 21.01 | |
| time (hrs) | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |
| 2 hr UH (m^3/S) | 15.88 | 11.57 | 8.18 | 5.65 | 3.83 | 2.55 | 1.68 | 1.09 | |
| time (hrs) | 17 | 18 | 19 | 20 | 21 | 22 | 23 | | |
| 2 hr UH (m^3/S) | 0.70 | 0.45 | 0.29 | 0.18 | 0.11 | 0.07 | 0.03 | | |

Find out the ordinates of 1 hour unit hydrograph.

(a) **Conversion of shorter duration unit hydrograph to longer duration unit hydrograph**

Any Unit Hydrograph can easily be converted to a longer duration unit hydrograph, provided the desired duration is a multiple of the original duration. The steps involved in computation of 2 hour unit hydrograph from known one hour unit hydrograph are given below (Ref. Table T 4.1)

- (i) Enter known one hour unit hydrograph ordinates in the Col. (2).
- (ii) Shift the ordinates of one hour unit hydrograph by one hour and enter in Col. (3).
- (iii) Add Col (2) and Col (1) and enter in Col. (4). It represents the runoff resulting due to 2mm excess rainfall in 2 hours.
- (iv) Divide the ordinates of the hydrograph, obtained from step (iii), by 2 and enter in the Col. (5).
- (v) The ordinates of the hydrograph derived from step (iv) represents the unit hydrograph of 2 hour duration.

Fig. T 4.1 shows the conversion of one hour unit hydrograph to 2 hour unit hydrograph graphically.

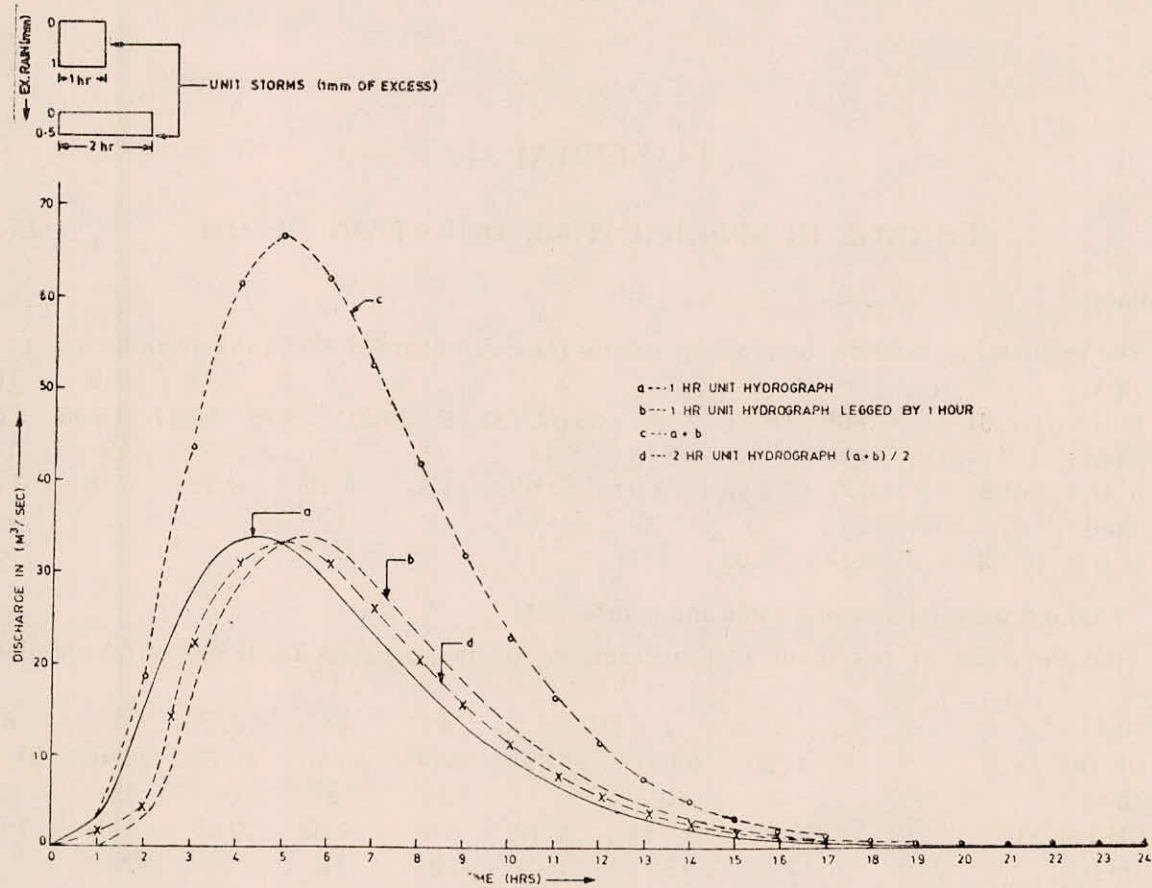


Fig. T 4.1—Conversion of 1—Hour Unit Hydrograph to 2—Hour Unit Hydrograph

(b) General technique for changing the unit hydrograph duration

A more general technique to convert unit hydrographs to different unit hydrograph durations is by use of S-curve hydrographs. In this example, one hour unit hydrograph is computed from the known 2 hour Unit Hydrograph. The steps are as follows (Ref. Table T 4.2).

- (i) Enter known two hour unit hydrograph ordinate in Col (3).
- (ii) Calculate S-curve additions and enter in Col (3).
- (iii) Addl. Col (2) and Col (3) and enter in Col (4). It represents the ordinate of S-curve hydrograph of intensity 0.5 mm/hr.
- (iv) Shift the ordinates of S-curve by desired duration of unit hydrograph i.e. one hour for this example and enter in Col (5).
- (v) Subtract Col (4) and Col (5) and enter it in Col (6). It represents the ordinates of the hydrograph resulting due to the rainfall of 0.5 mm/hr falling over the catchment for one hour.

- (vi) Multiply the ordinates of the hydrograph obtained from step (v) by 2 and enter it in Col (7).
- (vii) The hydrograph obtained from step (v) represents the Unit hydrograph of one hour duration.

Fig. T 4.2 shows the relation of Unit hydrograph to the S-curve.

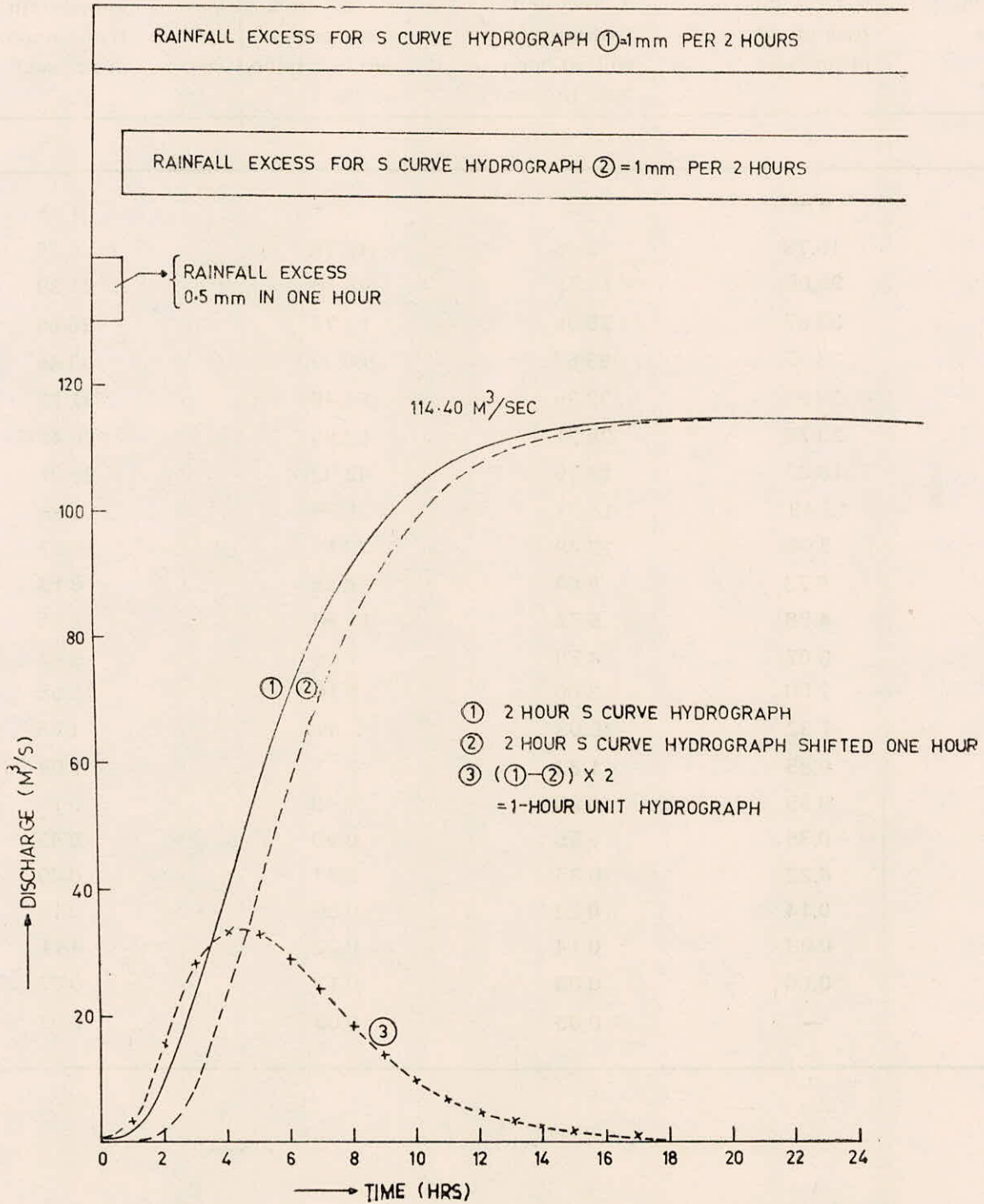


Fig. T 4.2 – Relation of Unit Hydrograph to S-Curve

(T-4/3)

Table T 4.1

Computation of 2-hour Unit Hydrograph from known One hour Unit Hydrograph

Catchment Area = 823.62 km³

| Time in Hours | 1-hour unit hydrograph in (m ³ /sec) | 1-hour unit hydrograph shifted one hour (m ³ /sec) | Runoff from 2 mm excess rain in 2-hours (m ³ /sec) | 2-hour unit Hydrograph in (m ³ /sec) |
|---------------|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 1 | 3.05 | — | 3.05 | 1.53 |
| 2 | 15.73 | 3.06 | 18.78 | 9.39 |
| 3 | 28.05 | 15.73 | 43.78 | 21.89 |
| 4 | 33.67 | 28.05 | 61.72 | 30.86 |
| 5 | 33.25 | 33.67 | 66.72 | 33.46 |
| 6 | 29.21 | 33.25 | 62.46 | 31.23 |
| 7 | 23.75 | 29.21 | 52.96 | 26.48 |
| 8 | 18.27 | 23.75 | 42.02 | 21.01 |
| 9 | 13.49 | 18.27 | 31.76 | 15.88 |
| 10 | 9.64 | 13.49 | 23.13 | 11.57 |
| 11 | 6.72 | 9.64 | 16.36 | 8.18 |
| 12 | 4.58 | 6.72 | 11.30 | 5.65 |
| 13 | 3.07 | 4.58 | 7.65 | 3.83 |
| 14 | 2.00 | 3.00 | 5.10 | 2.55 |
| 15 | 1.32 | 2.03 | 3.35 | 1.68 |
| 16 | 0.85 | 1.32 | 2.17 | 1.09 |
| 17 | 0.55 | 0.85 | 1.40 | 0.70 |
| 18 | 0.35 | 0.55 | 0.90 | 0.45 |
| 19 | 0.22 | 0.35 | 0.57 | 0.29 |
| 20 | 0.14 | 0.22 | 0.36 | 0.18 |
| 21 | 0.08 | 0.14 | 0.22 | 0.11 |
| 22 | 0.05 | 0.08 | 0.13 | 0.07 |
| 23 | — | 0.05 | 0.05 | 0.03 |

Table T 4.2

Computation of One-hour Unit Hydrograph from known 2-hour Unit Hydrograph by S-curve Method

Catchment Area = 823.62 km²

| Time (hrs) | 2hr Unit hydrograph (m ³ /S) | S-Curve addition | S-Curve | S-Curve lagged by one hr | | 1-Hour U.H. (m ³ /S) |
|------------|---|------------------|---------------|--------------------------|-------------|---------------------------------|
| (1) | (2) | (3) | (4)=(2) + (3) | (5) | (6)=(5)-(4) | (7)=(6) × 2/1 |
| 1 | 1.53 | — | 1.58 | — | 1.53 | 3.06 |
| 1 | 9.39 | — | 9.39 | 1.53 | 7.86 | 15.72 |
| 3 | 21.89 | 1.53 | 23.42 | 9.39 | 14.03 | 28.06 |
| 4 | 30.86 | 9.39 | 40.25 | 23.42 | 16.83 | 33.66 |
| 5 | 33.46 | 23.42 | 56.88 | 40.25 | 16.63 | 33.26 |
| 6 | 31.23 | 40.25 | 71.48 | 56.88 | 14.60 | 29.20 |
| 7 | 26.48 | 56.88 | 83.36 | 71.48 | 11.88 | 23.76 |
| 8 | 21.01 | 71.78 | 92.49 | 83.36 | 9.13 | 18.26 |
| 9 | 15.88 | 83.36 | 99.24 | 92.49 | 6.75 | 13.50 |
| 10 | 11.57 | 92.49 | 104.06 | 99.24 | 4.82 | 9.64 |
| 11 | 8.18 | 99.24 | 107.42 | 104.06 | 3.36 | 6.72 |
| 12 | 5.65 | 104.06 | 109.71 | 107.42 | 2.29 | 4.58 |
| 13 | 3.83 | 107.42 | 111.25 | 109.71 | 1.54 | 3.08 |
| 14 | 2.55 | 109.71 | 112.26 | 111.25 | 1.01 | 2.02 |
| 15 | 1.68 | 111.25 | 112.93 | 112.26 | 0.67 | 1.35 |
| 16 | 1.09 | 112.26 | 113.35 | 112.93 | 0.42 | 0.84 |
| 17 | 0.70 | 112.93 | 112.63 | 113.35 | 0.28 | 0.56 |
| 18 | 0.45 | 113.36 | 113.80 | 112.63 | 0.17 | 0.34 |
| 19 | 0.29 | 113.63 | 113.92 | 113.80 | 0.12 | 0.24 |
| 20 | 0.18 | 113.80 | 113.98 | 113.92 | 0.06 | 0.12 |
| 21 | 0.11 | 113.92 | 114.03 | 113.98 | 0.05 | 0.10 |
| 22 | 0.07 | 113.98 | 114.05 | 114.03 | 0.02 | 0.04 |
| 23 | 0.03 | 114.03 | 114.06 | 114.05 | 0.01 | 0.02 |
| 24 | — | 114.05 | 114.05 | 114.06 | 0.0 | 0.0 |

$$\begin{aligned} \text{S-curve equilibrium flow} &= \frac{0.2778 \times 823.62}{2} \\ &= 114.40 \text{ m}^3/\text{Sec.} \end{aligned}$$

(T-4/5)

