Example Problem

Obtain a Unit Hydrograph for a basin of 315 km^2 of area using the rainfall and stream flow data tabulated below.

Stream flow data

Time (hr)	Observed hydrograph(m^3/s)
0	100
1	100
2	300
3	700
4	1000
5	800
6	600
7	400
8	300
9	200
10	100
11	100

Rainfall data

Time (hr)	Gross PPT (GRH) (cm/h)
0-1	0.5
1-2	2.5
2-3	2.5
3-4	0.5

Example Problem Contd…

- Empirical unit hydrograph derivation separates the base flow from the observed stream flow hydrograph in order to obtain the direct runoff hydrograph (DRH). For this example, use the horizontal line method to separate the base flow. From observation of the hydrograph data, the stream flow at the start of the rising limb of the hydrograph is 100 m^3/s
- Compute the volume of direct runoff. This volume must be equal to the volume of the effective rainfall hyetograph (ERH)

$$V_{DRH} = (200+600+900+700+500+300+200+100)\ m^3/s\ (3600)\ s = 12'600{,}000\ m^3$$

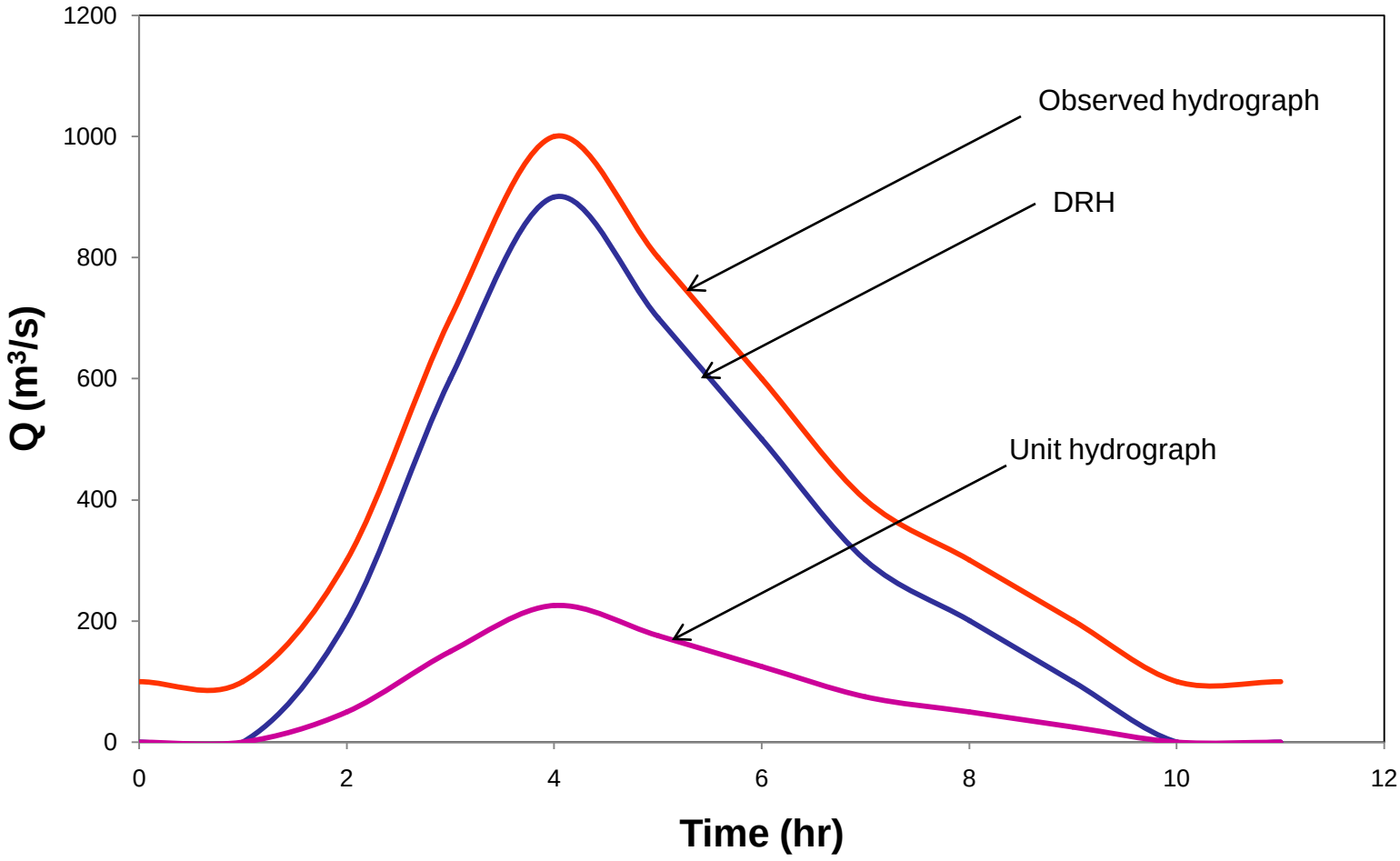
- Express V_{DRH} in equivalent units of depth:

$$V_{DRH} \text{ in equivalent units of depth} = V_{DRH}/A_{basin} = 12'600{,}000\ m^3/(315000000\ m^2) = 0.04\ m = 4\ cm$$

Obtain a Unit Hydrograph by normalizing the DRH. Normalizing implies dividing the ordinates of the DRH by the V_{DRH} in equivalent units of depth

Time (hr)	Observed hydrograph(m^3/s)	Direct Runoff Hydrograph (DRH) (m^3/s)	Unit Hydrograph ($m^3/s/cm$)
0	100	0	0
1	100	0	0
2	300	200	50
3	700	600	150
4	1000	900	225
5	800	700	175
6	600	500	125
7	400	300	75
8	300	200	50
9	200	100	25
10	100	0	0
11	100	0	0

Example Problem Contd…



Example Problem Contd…

- Determine the duration D of the ERH associated with the UH obtained in **4**. In order to do this:

1. Determine the volume of losses, V_{Losses} which is equal to the difference between the volume of gross rainfall, V_{GRH}, and the volume of the direct runoff hydrograph, V_{DRH} .
   $V_{Losses} = V_{GRH} - V_{DRH}$ = (0.5 + 2.5 + 2.5 +0.5) cm/h 1 h - 4 cm = 2 cm

2. Compute the *f*-index equal to the ratio of the volume of losses to the rainfall duration, t_r. Thus,
   ø-index = V_{Losses}/t_r = 2 cm / 4 h = 0.5 cm/h

3. Determine the ERH by subtracting the infiltration (*e.g.*, ø-index) from the GRH:

Example Problem Contd…

Time (hr)	Effective precipitation (ERH) (cm/hr)
0-1	0
1-2	2
2-3	2
3-4	0

As observed in the table, the duration of the effective rainfall hyetograph is 2 hours. Thus, D = 2 hours, and the Unit Hydrograph obtained above is a 2-hour Unit Hydrograph.