

Please copy & return 1/6
ASAP

Problem Set #3
ERS 100

Ch. 5 all
Ch. 6 all

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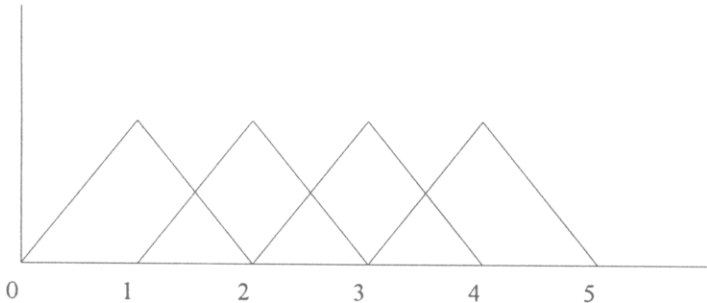
1A). What is the effective ppt of the hydrograph?

The hydrograph is a triangle with a baselength of 2 hours and a peak after 1 hour of 1.4 mm/hr. Area under the triangle is equal to:

$$\frac{1}{2} * 2 * 1.4 = 1.4 \text{ mm}$$

B) What is the base length of a 4 hour unit hydrograph?

The four hour unit hydrograph for this basement can be constructed by adding the unit hydrograph for 1 hour four times, each time with a 1 hour time lag. However, by adding four UHG for 1 hour, the total volume under the graph will be 4 mm. We want this to be a unit hydrograph, and have to divide by 4 to obtain the 4 hour Unit Hydrograph. To create the UHG for a 1 hour rainstorm, we can take the hydrograph from part A) and divide the area (and ordinates) by 1.4 to obtain a 1 mm UHG.

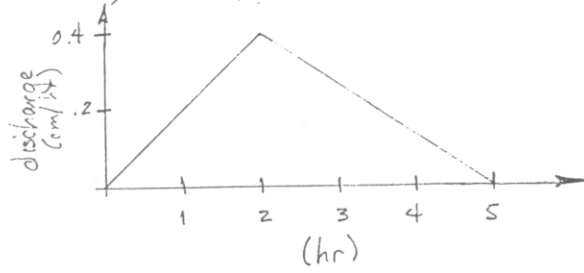



The base length will be 5 hours (see drawing)

C) What is the peak discharge intensity for a 2.1 mm/hr storm of a two hour duration?

First we should create a UHG for a 2 hour storm. We can do this by adding two UHG from part A) together, resulting in a hydrograph for a two hour storm with a 2 mm effective rainfall depth. To obtain the UHG for the two hour storm, we divide the total area by 2. The storm causing this UHG as runoff will have an intensity of 1mm over 2 hours, or 0.5 mm/hr. To obtain a hydrograph for a 2.1 mm/hr intensity, we multiply the UHG by 4.2 (2.1 / 0.5). Another way of looking at it is that the total storm depth for the 2.1 mm/hr intensity storm will be 4.2 mm (it took 2 hours), thus we have to multiply the area of the UHG by 4.2.

2. A 2-hour, $\frac{1}{2}$ cm/hr storm results in a UHG of 5-hour duration.

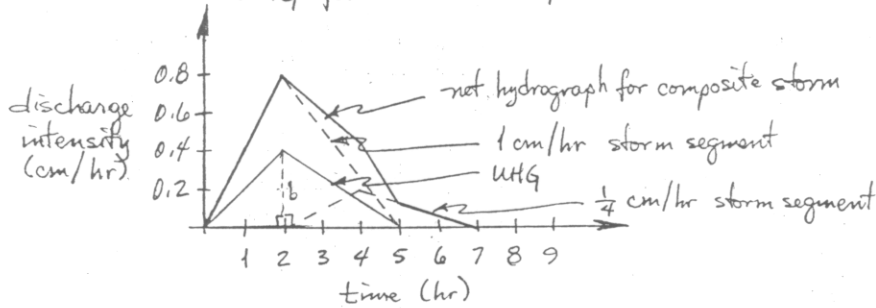


From geometry we have -  where the A of both Δ 's = 1

$$A = 1 = \frac{1}{2} b(2) + \frac{1}{2} b(3) = b + \frac{3}{2} b \quad \text{or } b = \frac{2}{5} = \underline{\underline{0.4 \text{ cm/hr}}}$$

2 explanations \rightarrow

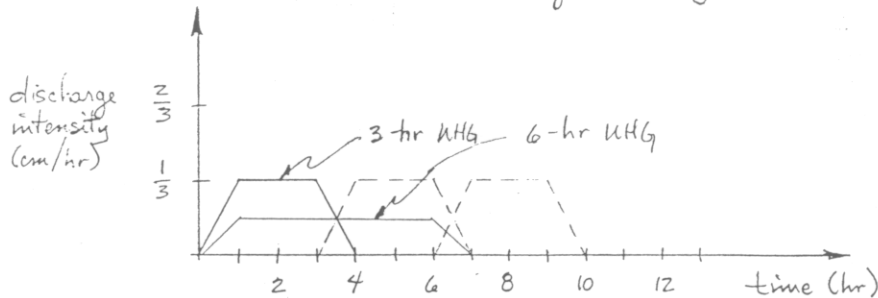
2. The 2-hour UHG for this 0.5 cm/hr storm has a 5-hour runoff duration.



The area below the UHG must = 1 cm and is composed of two right Δ 's

$$A = 1 \text{ cm} = \frac{1}{2} b(2 \text{ hr}) + \frac{1}{2} b(3 \text{ hr}) = b + \frac{3}{2} b \Rightarrow b = \frac{2}{5} = \underline{\underline{0.4 \text{ cm/hr}}}$$

4. Given the 3-hr UHG below; determine h , the rainfall intensity, runoff duration for 9-hr UHG and max discharge intensity for 6-hr UHG.



(a) Area of UHG = 1 cm = $2 \cdot \frac{1}{2} (1 \text{ hr})(h) + (2 \text{ hr})h = 3h$ or $h = \underline{\underline{\frac{1}{3} \text{ cm/hr}}}$

(b) Rainfall intensity = $1 \text{ cm} / (\text{UHG storm duration} - 3 \text{ hr}) = \underline{\underline{\frac{1}{2} \text{ cm/hr}}}$

(c) Runoff duration of 9-hr UHG = 10 hr (see construction above)

(d) 6-hr UHG max discharge intensity = $\frac{1}{2}$ of the max for 3-hr UHG = $\frac{1}{6} \text{ cm/hr}$

3) What is the UHG for a storm taking 2 hours?

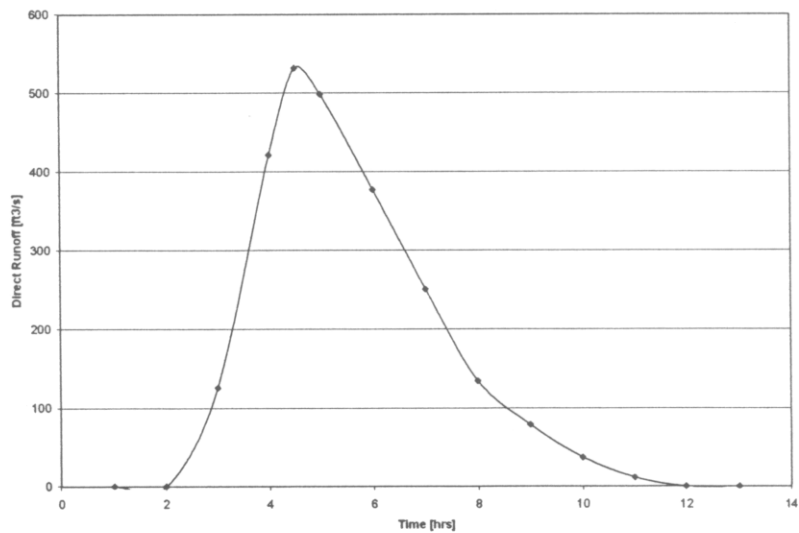
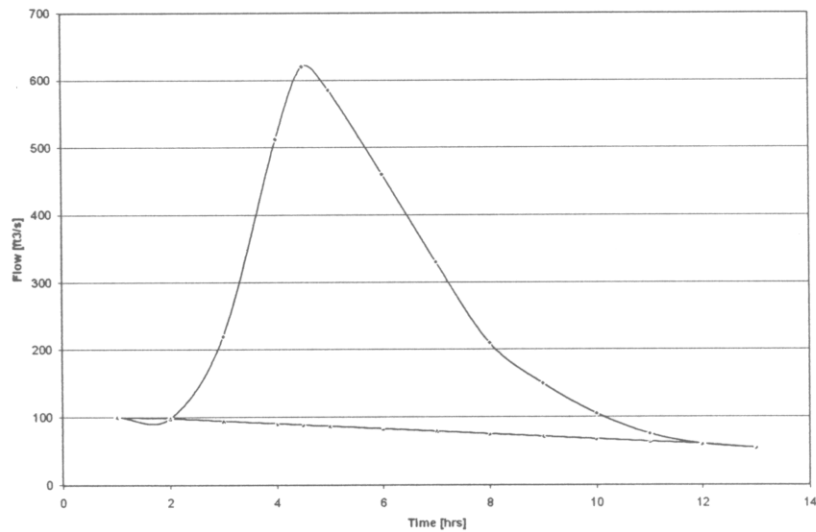
The hydrograph shown is for a 1 hour storm. The total area under the triangle is

$$\left(\frac{1}{2} * 1 * \frac{2}{3}\right) + \left(\frac{1}{2} * 2 * \frac{2}{3}\right) = 1 \text{ cm}$$

Which is correct, because it is a unit hydrograph. The two hour UHG will be the 1 hour UHG added to another with a 1 hour lag. However, total volume will then be 2 cm, thus this hydrograph needs to be divided by 2.

The peak occurs after 2 hours at an intensity of 1 cm/hr.

5)



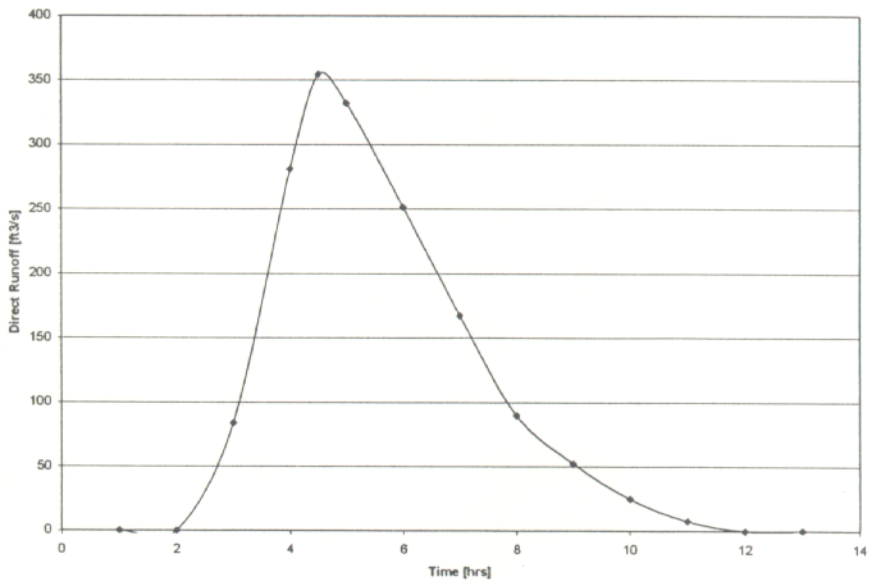
| TIME | Discharge | Baseflow | D.R. | VOLUME |
|------|-----------|----------|-------|-----------|
| 1 | 100 | 100 | 0 | 0 |
| 2 | 98 | 98 | 0 | 226440 |
| 3 | 220 | 94 | 125.8 | 985320 |
| 4 | 512 | 90 | 421.6 | 857790 |
| 4.5 | 620 | 89 | 531.5 | 926910 |
| 5 | 585 | 87 | 498.4 | 1576080 |
| 6 | 460 | 83 | 377.2 | 1130760 |
| 7 | 330 | 79 | 251 | 694440 |
| 8 | 210 | 75 | 134.8 | 384120 |
| 9 | 150 | 71 | 78.6 | 208800 |
| 10 | 105 | 68 | 37.4 | 87480 |
| 11 | 75 | 64 | 11.2 | 20160 |
| 12 | 60 | 60 | 0 | 0 |
| 13 | 54 | 54 | 0 | 0 |
| | | | | T 7098300 |

A total volume of $7.1 \times 10^6 \text{ ft}^3$ was measured as direct runoff. This must represent an equivalent depth of 1.5 inch. Since $\text{depth} = \text{Volume} / \text{Area}$,

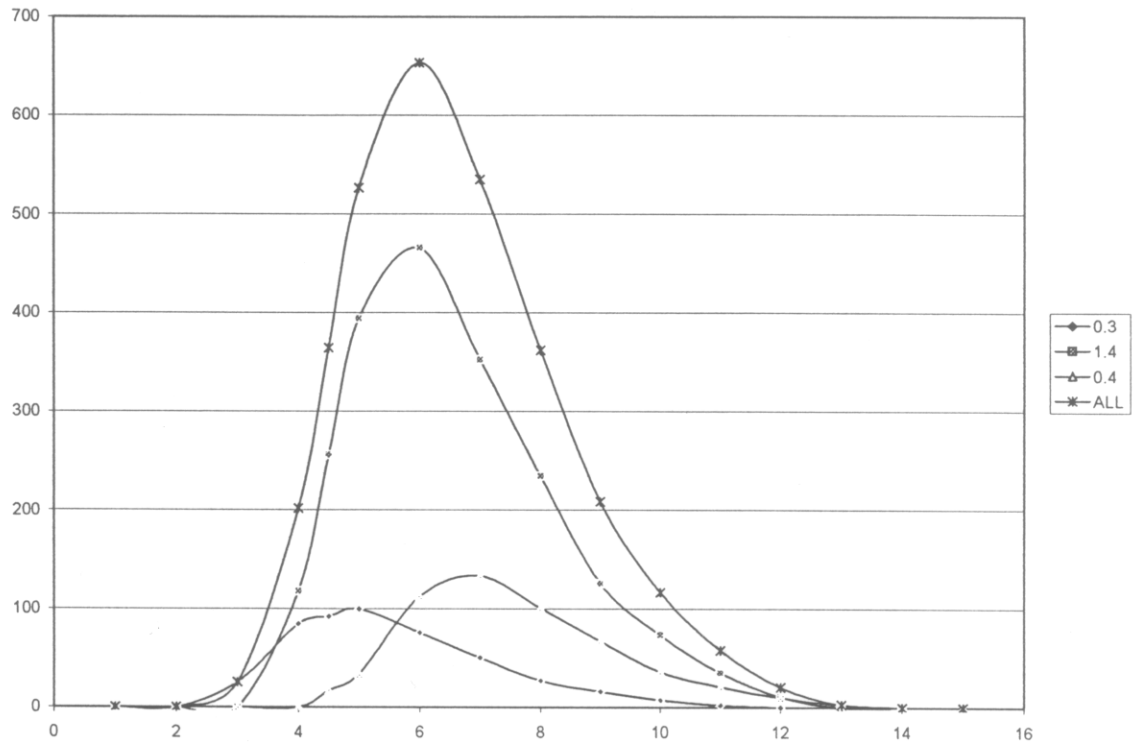
$$0.125 \text{ ft} = 7.1 \times 10^6 \text{ ft}^3 / \text{Area}$$

$$\text{Area} = 56.8 \times 10^6 \text{ ft}^2 = 1.8 \text{ mi}^2$$

The UHG is similar to the HG but divided by 1.5



The composite hydrograph looks similar (but not exactly) like the figure below...



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1).

- Silver color will reflect more radiation, thus less energy uptake by the plant, thus less evapotranspiration
- More turbulent wind will cause a higher vapor gradient, thus higher evapotranspiration
- Stomata closure results in higher resistance through the leaf thus lower evapotranspiration

2).

Lake capacity (volume) is $3.69 * 10^{10} \text{ m}^3$

Lake area = 40,000 acres

Lake temp = 50 Fahrenheit

Air temp = 75 Fahrenheit

RelHum = 25%

Windspeed = 15mph

Evaporation from the lake can be calculated using the equation:

6/
$$E = C \left(1 + \frac{w}{10} \right) (e_o - e_a)$$

The saturated vapor pressure and air vapor pressure can be read from table 6.1. We are looking for units of [inches of mercury].

$$e_o = 0.36$$

$$e_a = e_s * RH = 0.89 * 0.25 = 0.22$$

$$\text{Total evaporation [in inches]} = 0.36 * (1+1.5) * (0.36-0.22) = 0.126 \text{ in/day}$$

For 1 year over 40,000 acres, this would be a volume of

$$0.126 \text{ in/day} * 0.0254 \text{ m/in} * 40,000 \text{ ac} * 0.4 \text{ ac/ha} * 10000 \text{ m}^2/\text{ha} = 512 * 10^3 \text{ m}^3/\text{day}$$

$$\text{Water use rate for city is } 1.2 * 10^6 * 0.4 = 480 * 10^3 \text{ m}^3/\text{day}$$

$$\text{Total water use per day is ET + consumption} = 992 * 10^3 \text{ m}^3/\text{day}$$

Divide the lake volume by the water consumption to obtain the number of days:

$$3.69 * 10^{10} \text{ m}^3 / 9.92 * 10^5 \text{ m}^3 = 3.72 * 10^4 \text{ days} = \underline{102 \text{ years !!}}$$

There are many reasons why not to feel too confident in this estimate.....

Serrano chapter 3