CE40460: Groundwater Hydrology

Homework 1 – The Hydrologic Cycle

Due: September 6, 2018

(1) Precipitation and Evaporation

The standard US Class A evaporation pan has an inside diameter of 47.5 inches and a depth of 10 inches.

(a) Calculate the surface area of water in the pan in square meters

(b) Calculate the volume of the pan in cubic meters

(c) If the initial volume of water in the pan is 11.5 US gallons, what is the depth of the water in millimeters?

(d) If after a 24 hour period with no precipitation the volume of water in the pan is measured and found to be 10.2 US gallons., what is the evaporation rate in millimeters/days?

(e) What would be the depth of water in millimeters

(f) During the succeeding day there was a 3 hour period of precipitation at a constant rate of 5mm/hour. Assuming that the 24 hours evaporation rate calculated in (d) also occurs during this 24 hour period, what would be the depth of water in the pan?

(g) If there is no further rain, and no water is added to the pan, how long would it take for the water in the pan to totally evaporate, using the constant 24 hour evaporation rate of step (d)?

(2) Infiltration

An infiltration capacity curve has the following parameters:

fc, the equilibrium infiltration capacity is 17 mm/hr
fo, the initial infiltration is 123 mm/hr
k, the rate constant is 0.4 hr^{-1}

Two rainstorms pass over identical basins of area 80 km^2 with the above characteristics. The first storm has a continuous rainfall of 50 mm/hr for 6 hours.

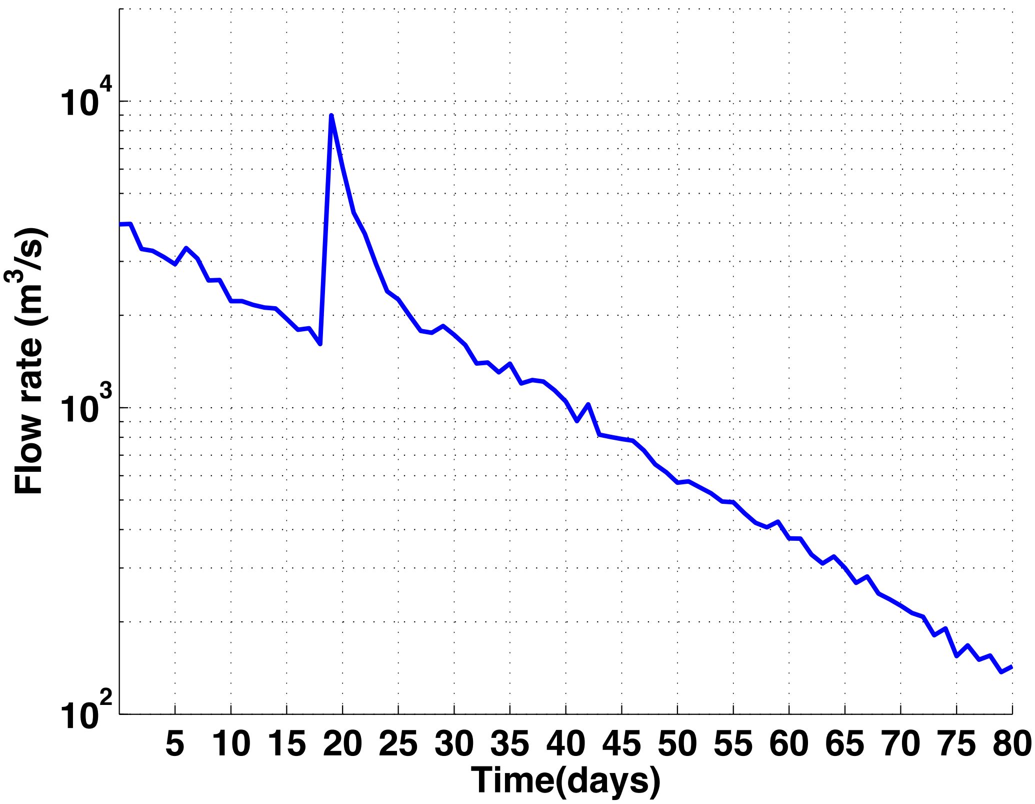
The second storm has a rainfall of 75mm/hr for 1 hour, followed by 25 mm/hr for 1hour, followed by 75 mm/hr for 1hour, followed by 25 mm/hr for 1 hour, followed by 75 mm/hr for 1hour, followed by 25 mm/hr for 1 hour also for a total of six hours.

Calculate the volume of infiltrated water **(in m^3)** over the first hour, over the first four hours, and over the total six hours. Do so for each of the storms.

Comment and try to explain any similarity or difference in the answers for the two storms.

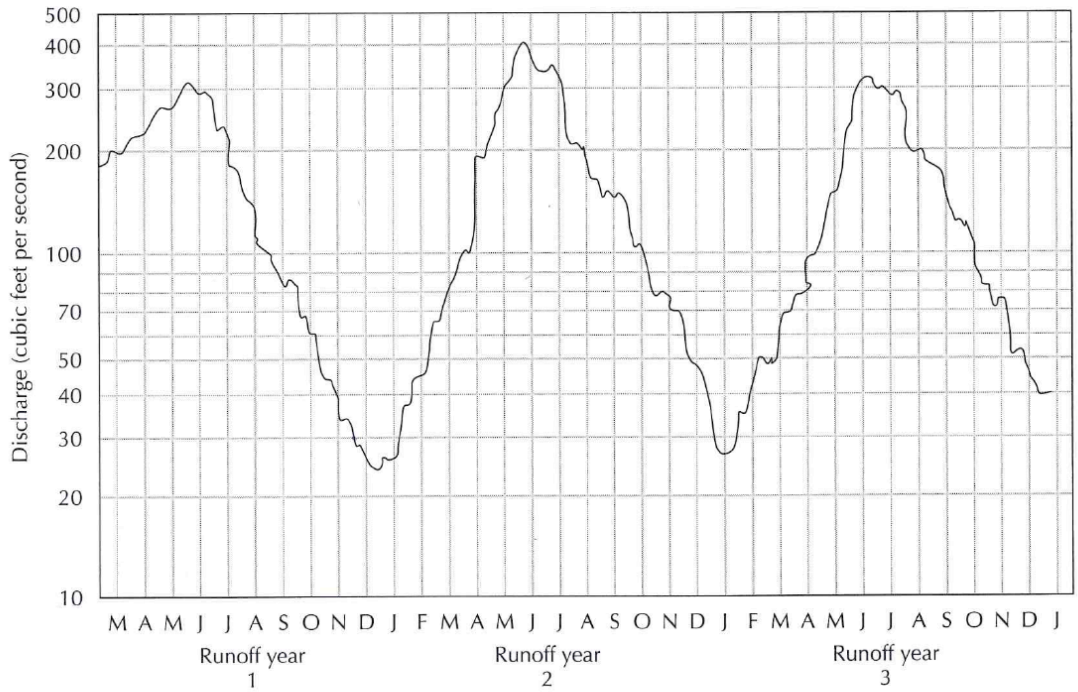
(3) Recession Curve Displacement method

Consider the baseflow recession curve portrayed below. Apply the recession curve displacement method to calculate the amount of recharge that happened during the storm event where there is a spike in the river flow rate.



(4) Fetter, Problem 2.15 (Seasonal Recession Method)

See figure 2.28 on the following page. It is the hydrograph of a river with a long summer baseflow recession. Compute the volume of annual recharge that occurs between runoff year 1 and runoff year 2 using the seasonal recession method.



▲ FIGURE 2.28
Hydrograph for Problem 2.15.

(5) Open Channel Flow

A natural stream with little vegetation has two sections carrying equal amounts of water. You can assume each cross section can be modeled as a rectangle. The first segment (upstream) of the stream has a width of 2m and water depth of 0.5m. The stream bed drops 10m over a distance of 500m.

(a) What is the velocity of the water flowing?
(b) What is the flow rate?

The flow rate in the second part of the stream is the same as the first, but now the stream has a width of 2.5m and a depth of 0.6m

(c) What is the velocity of the stream (assuming there has been no change in flow rate from section 1 to 2 – what is required for this assumption to be true?)
(d) If this section of the stream is also a natural stream with little vegetation what is the energy gradient in this region of the stream?

There is a proposal to try and slow the stream by planting some vegetation in the stream (like weeds). If this was done in the first section of the stream and everything else remains unchanged

(e) How would this affect the flow speed in the first section?
(f) What would now change in the second section given that the width, Manning coefficient and energy gradient of this section will not change. Calculate how anything that would change changes?