CE 3354 Engineering Hydrology Exam 1, Fall 2014[1]

1. Provide short answers to the following questions:

   a) What is a "watershed?"

   b) What is "excess precipitation ?"

   c) What is "a hyetograph?"

   d) What is "a hydrograph?"

   e) What is "an intensity-duration-frequency curve?"

[1]Students should write their name on all sheets of paper. Students are permitted to use Laptops, Tablets, and smart phones for **browsing** the internet to help answer questions. Students are permitted to use their own notes and the textbook to help answer questions.

2. Figure 1 is a hand-drawn topographic map of somewhere in Texas. The drawn contour interval is 20 feet. Most of the contours are labeled — the South-East corner is at elevation $\approx 550ft$. The North-West corner is at elevation $\approx 650ft$.

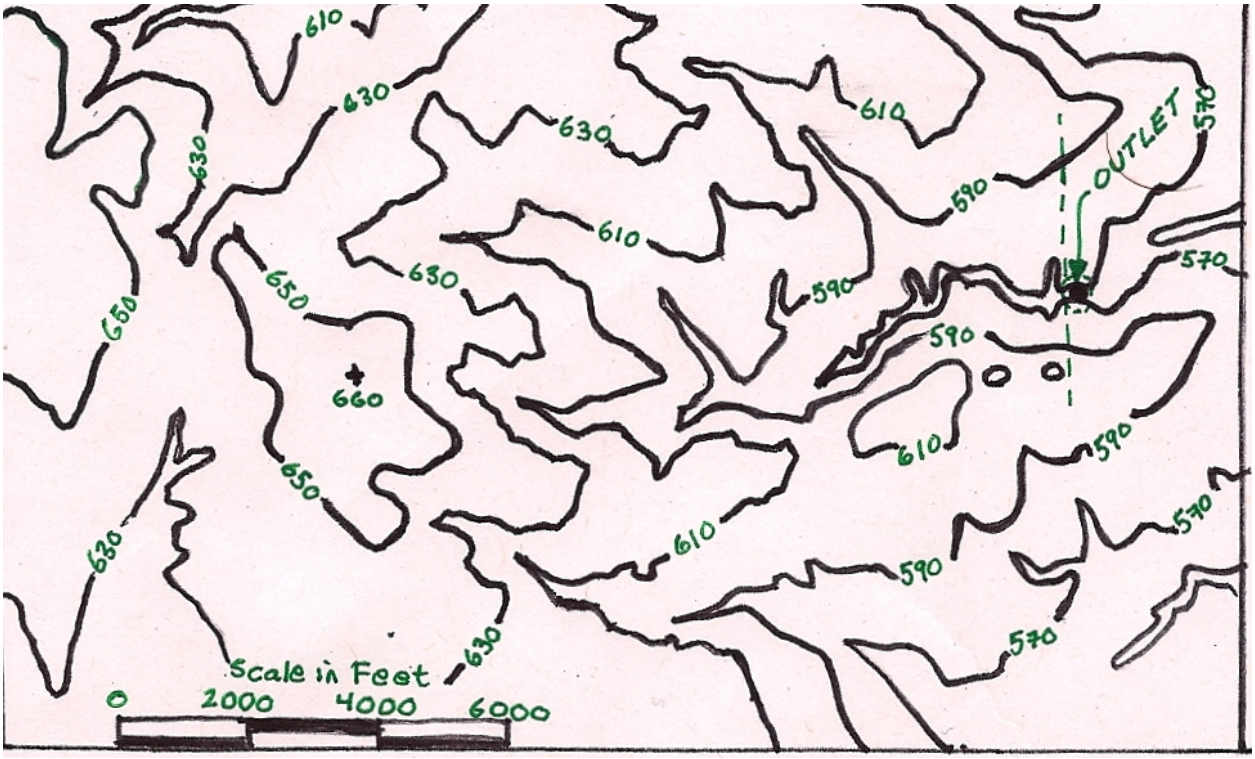


Figure 1: Topographic Map of a portion of the Earth. Elevations and linear distances are in $feet$. North (by convention) is up.

Useful unit conversions:

- 43560 $ft^2 = 1$ $acre$
- 640 $acres = 1$ $square\ mile$
- 5280 $feet = 1$ $mile$

a) What is the area in ft^2, $acres$, and mi^2 depicted by the map [2] on Figure 1 ? Explain by sketch or words how you computed the area.

b) Locate the highest point depicted on the map. Circle this point.

c) What is the numerical value of elevation in feet of this location (read from map)?

d) What is the numerical value of the contour line that encloses this location (read from map — the point is higher than this contour, but the point is entirely enclosed by a contour).

e) Lightly shade the area within the contour.

f) Determine the area in in ft^2, $acres$, and mi^2 of the shaded region. Again explain by sketch or words how you computed the area.

[2] The area of the whole rectangle

g) Delineate the watershed that drains to the location labeled "OUTLET" on the map.

h) Determine the drainage area in in ft^2, $acres$, and mi^2 of the watershed you delineated. Show any relevant calculations below. Describe how you estimated the drainage area.

i) Draw three different flow paths from the highest elevation portion of the watershed to the outlet. Determine the length in ft of these paths.

j) Determine the slope (dimensionless) of the longest path.

3. The watershed in Figure 1 is located in Brown County, Texas. Figure 2 is a map of counties in Texas. Figures 3 and 4 are excerpts from the Texas DDF Atlas.

   a) Circle Brown county on Figure 2.

   b) Circle Brown county on Figure 3.

   c) Circle Brown county on Figure 4.

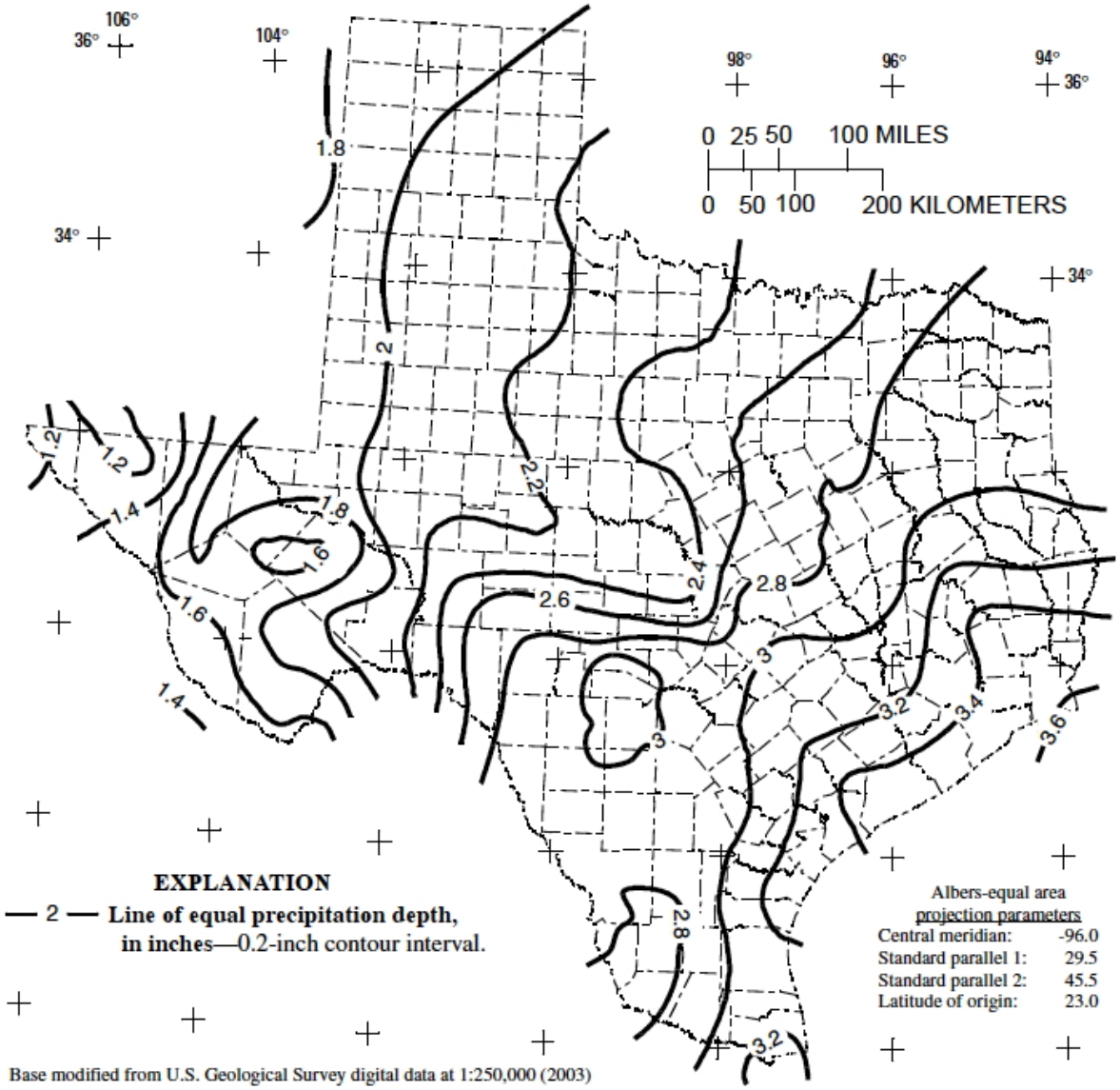
   d) Write the formula that converts the Annual Exceedence Probability (AEP) into an Annual Recurrence Interval (ARI).

   e) Estimate the precipitation depth in Brown county for a 2 hour storm with an Annual Exceedence Probability (AEP) of 0.2 (20 %).

   f) Write the formula that converts the depth of rain into an average intensity for a storm with a duration of T_c.

   g) Estimate the average rainfall intensity in Brown county for a 2 hour storm with an Annual Exceedence Probability (AEP) of 0.2 (20 %)

Figure 2: Map of Texas counties



Depth of precipitation for 5-year storm for 2-hour duration in Texas.

Figure 3: Excerpt from DDF Atlas

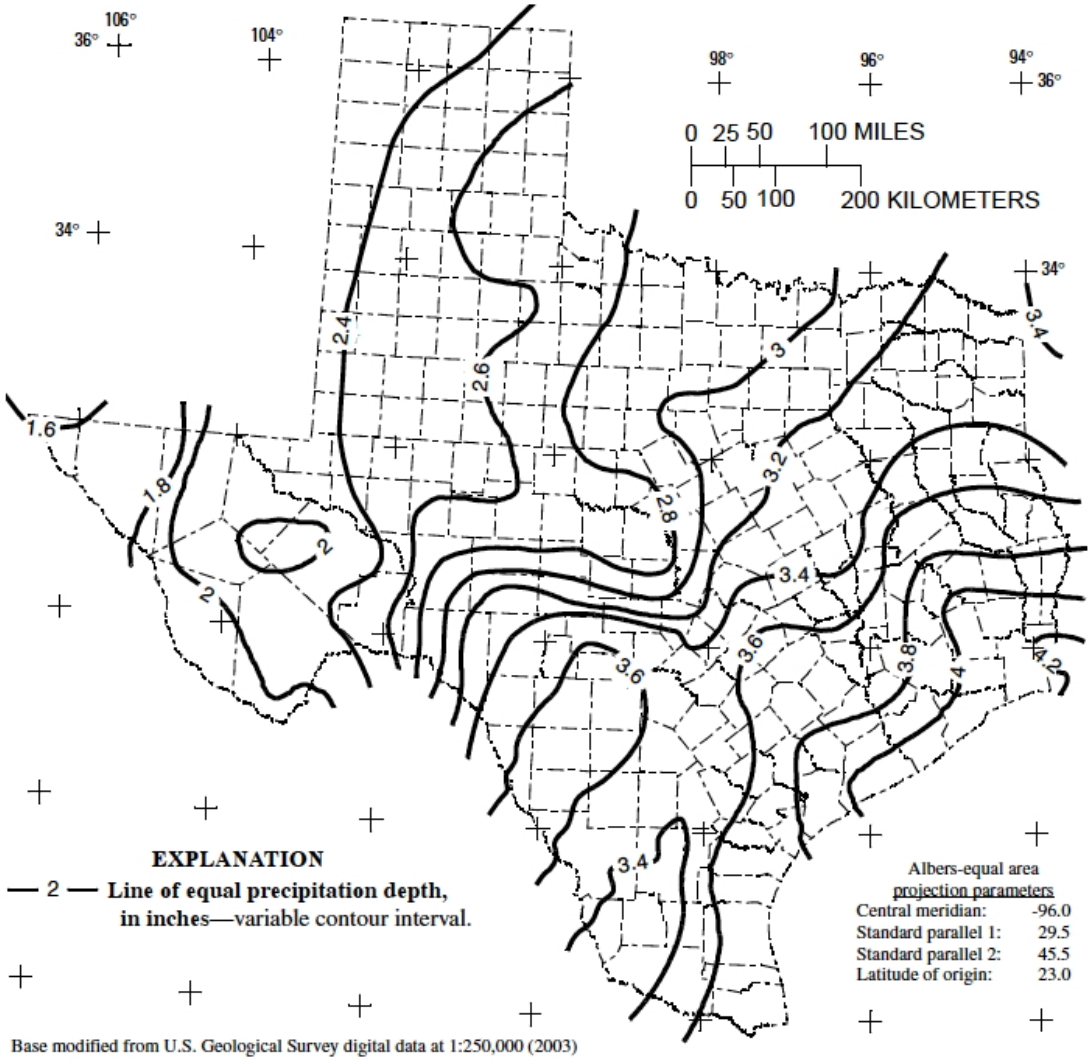


Figure 31. Depth of precipitation for 10-year storm for 2-hour duration in Texas.

Figure 4: Excerpt from DDF Atlas

4. Figure 5 is a table of mean monthly air temperatures for Brown county, Texas. Figure 6 is a table of fraction of annual daytime hours by latitude (p) for the Blaney-Criddle formula.

   a) Write the Blaney-Criddle formula.

   b) Identify the column (outline the column) on Figure 5 that lists the mean monthly air temperature.

   c) Estimate the latitude of Brown county. Describe how you made the estimate.

   d) Identify the row (underline) in Figure 6 that corresponds to the latitude estimate.

e) Estimate the evaporation depths for Brown county using the Blaney-Criddle formula and complete the table below.

Month	Evapo-transpiration (inches)
January	
Febuary	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

Monthly Averages for
Brownwood, TX
[English | Metric]

Monthly Averages | Table Display | Graph Display

Month	Avg. High	Avg. Low	Mean	Avg. Precip	Record High	Record Low
Jan	15°C	-1°C	7°C	34.3 mm	32°C (2006)	-18°C (1973)
Feb	17°C	2°C	9°C	63.0 mm	37°C (2009)	-18°C (1951)
Mar	21°C	6°C	13°C	68.1 mm	36°C (1967)	-12°C (1980)
Apr	26°C	10°C	18°C	58.7 mm	40°C (2012)	-3°C (1987)
May	30°C	16°C	23°C	95.2 mm	42°C (1967)	3°C (1979)
Jun	33°C	19°C	27°C	114.0 mm	44°C (2011)	9°C (1964)
Jul	36°C	21°C	28°C	51.1 mm	43°C (1964)	12°C (1990)
Aug	36°C	21°C	28°C	56.9 mm	44°C (1964)	11°C (1992)
Sep	32°C	17°C	24°C	74.4 mm	43°C (2000)	3°C (1989)
Oct	27°C	11°C	19°C	78.0 mm	39°C (1951)	-6°C (1993)
Nov	21°C	5°C	13°C	42.7 mm	34°C (2010)	-11°C (1979)
Dec	16°C	0°C	8°C	39.1 mm	32°C (1954)	-21°C (1989)

Figure 5: Mean monthly temperature data

Table 4: Blaney-Criddle p values by latitude

Lat (N) / Lat (S)	Jan / Jul	Feb / Aug	Mar / Sep	Apr / Oct	May / Nov	Jun / Dec	Jul / Jan	Aug / Feb	Sep / Mar	Oct / Apr	Nov / May	Dec / Jun
60	.15	.20	.26	.32	.38	.41	.40	.34	.28	.22	.17	.13
55	.17	.21	.26	.32	.36	.39	.38	.33	.28	.23	.18	.16
50	.19	.23	.27	.31	.34	.36	.35	.32	.28	.24	.20	.18
45	.20	.23	.27	.30	.34	.35	.34	.32	.28	.24	.21	.20
40	.22	.24	.27	.30	.32	.34	.33	.31	.28	.25	.22	.21
35	.23	.25	.27	.29	.31	.32	.32	.30	.28	.25	.23	.22
30	.24	.25	.27	.29	.31	.32	.31	.30	.28	.26	.24	.23
25	.24	.26	.27	.29	.30	.31	.31	.29	.28	.26	.25	.24
20	.25	.26	.27	.28	.29	.30	.30	.29	.28	.26	.25	.25
15	.26	.26	.27	.28	.29	.29	.29	.28	.28	.27	.26	.25
10	.26	.27	.27	.28	.28	.29	.29	.28	.28	.27	.26	.26
5	.27	.27	.27	.28	.28	.28	.28	.28	.28	.27	.27	.27
0	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27

Figure 6: Blaney-Criddle "p" values by latitude.

5. List three infiltration models mentioned in the textbook.

   i)

   ii)

   iii)

6. Consider the Green-Ampt infiltration model expressed in equation 7.4.29b in the textbook. ($f \approx K\frac{\Psi+L}{L}$).

   (a) What does "K" correspond to in the model?

   (b) What does "L" correspond to in the model?

   (c) What does "f" correspond to in the model?

   (d) A large time, what is the magnitude of $L >> \Psi$. Using this observation, what is the estimated infiltration rate ?

7. Figure 7 is a hydrograph.
   a) Locate the peak discharge (draw a circle around the peak).
   b) What is the value of peak discharge?

   c) What is the time to peak indicated by the hydrograph?

   d) What is the time base of the hydrograph ?

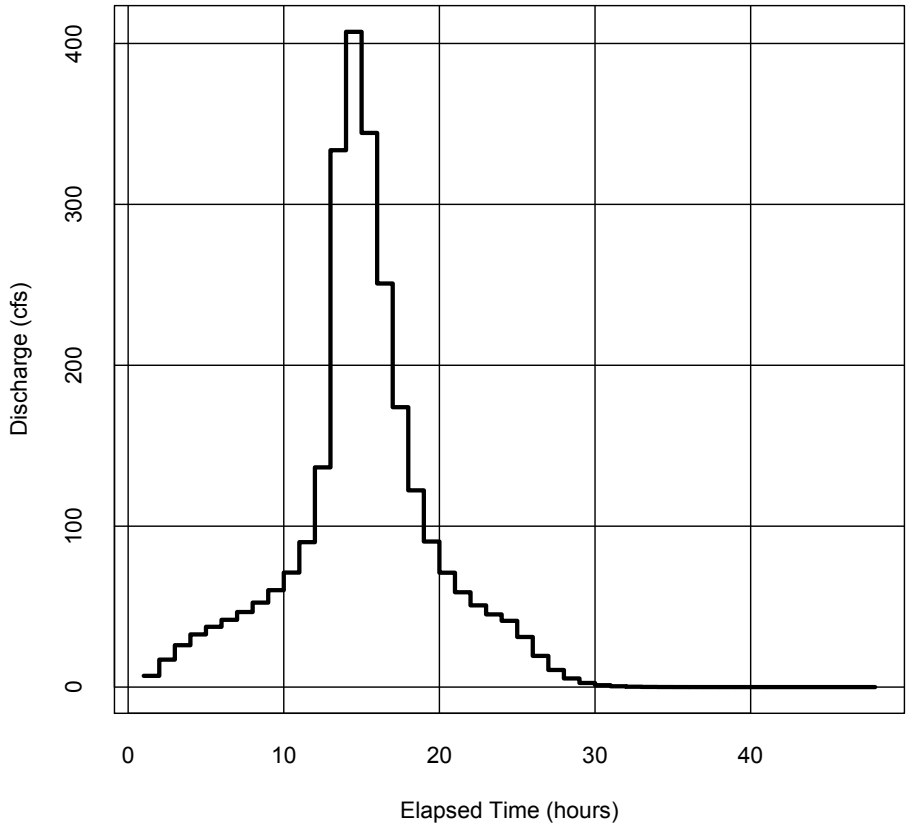


Figure 7: Inter-basin input hydrograph.

8. A dam is to be is built on the Eastern portion of the valley, near the outlet shown on Figure 1. The dam spillway crest (elevation at which discharge over the dam is uncontrolled) is 595 $feet$. The alignment of the dam is depicted by the vertical dashed line segment next to the outlet.

   Estimate the volume of water stored when the dam impounds water to a water surface elevation of 590 $feet$