CE 3354 Engineering Hydrology Exam 2, Fall 2014[1]

1. Figure 1 is a flood frequency curve for somewhere in Texas. Using the curve answer the following questions:

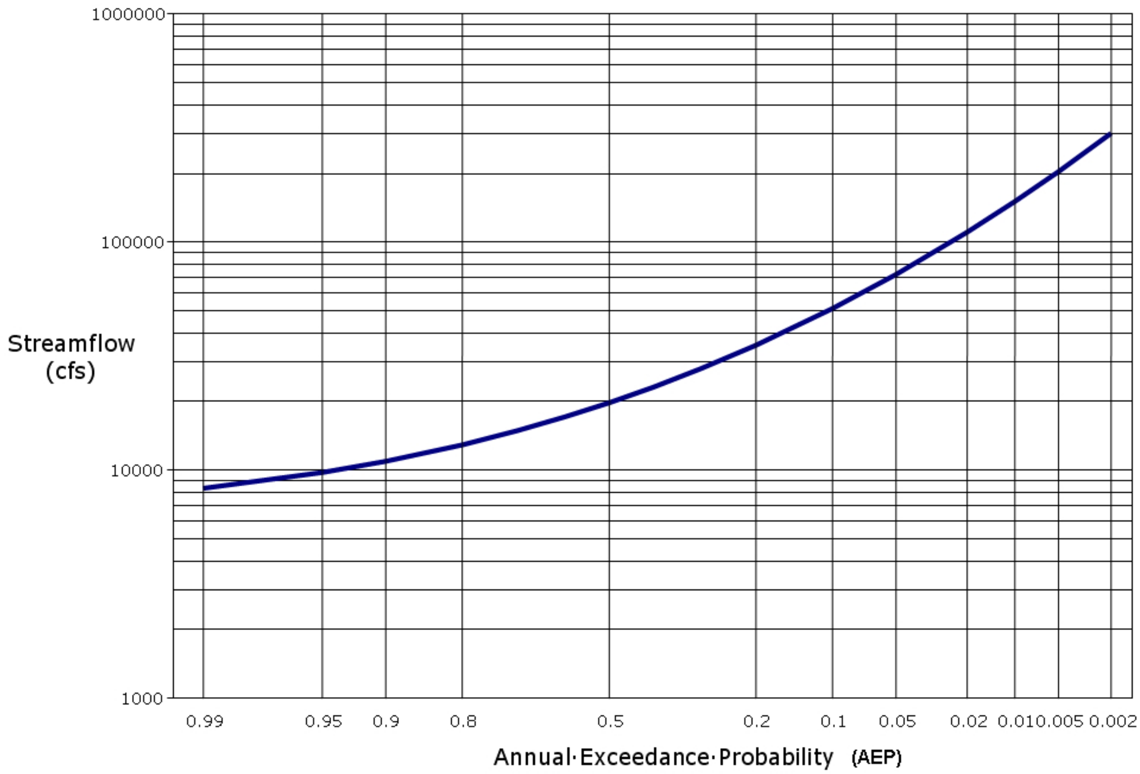

Figure 1: Flood frequency curve for a gaging station

   (a) What is the median (50% probability) streamflow magnitude indicated by the curve?

   (b) What is the probability of observing a discharge of magnitude of $10,000$ CFS or **more** indicated by the diagram?

   (c) What is the probability of observing a discharge of magnitude $40,000$ CFS or **less** indicated by the diagram?

[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 2 is a topographic map of a small drainage basin. The drawn contour interval is 20 feet. Many of the contours are labeled.

   A stormwater detention structure (dam) is to be is built on the Eastern portion of the basin, near the outlet shown on Figure 2. The purpose of the detention structure is to reduce the peak discharge downstream of the structure.

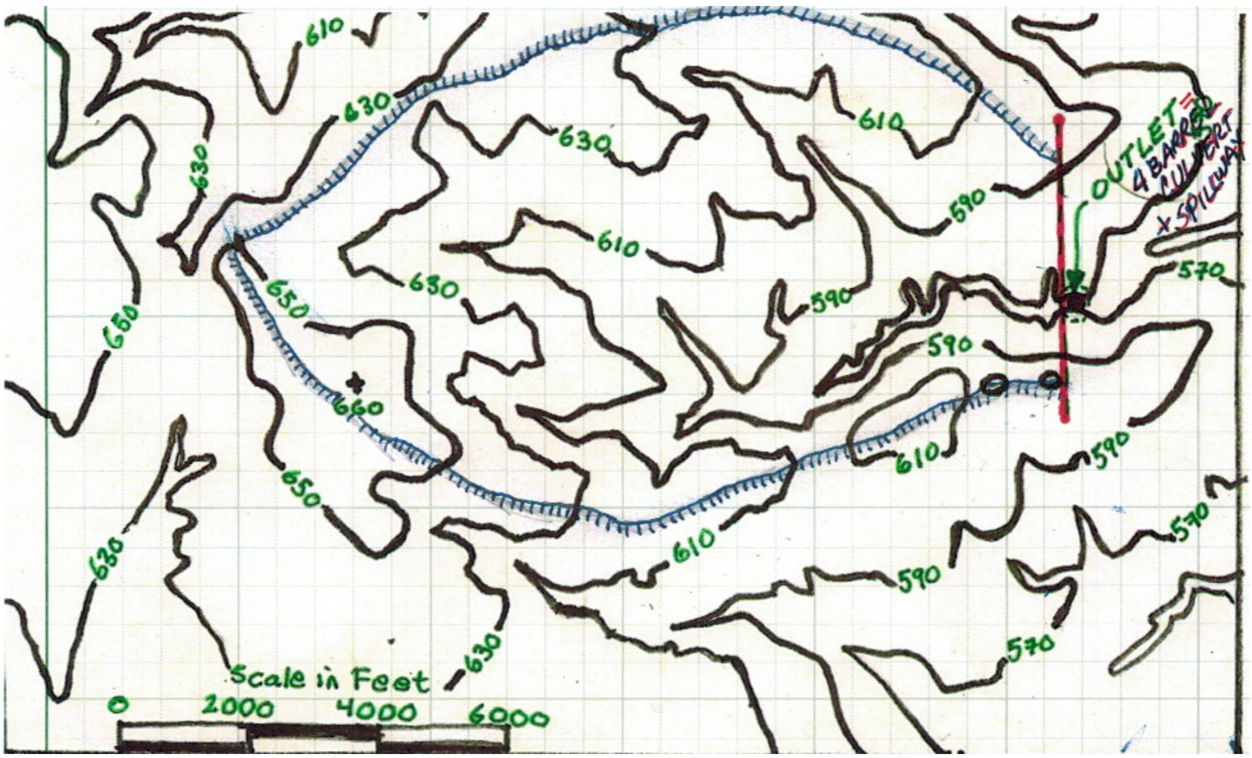

Figure 2: Topographic Map of a portion of the Earth. Elevations and linear distances are in *feet*. North (by convention) is up.

The dam spillway crest (elevation at which water will go over the top of the dam) is 595 *feet*. The dam also has 4 parallel, 2-foot diameter, 100-foot long culverts at its base to drain the detention structure, this culvert system is similar in appearance as the system depicted in Figure 3 The culverts are laid on a slope of 0.005. Manning's n for each culvert is 0.013. The entrance and exit coefficients are unity (1). The alignment of the dam is depicted by the vertical dashed line segment next to the outlet.

(a) Estimate the drainage area in square feet of the drainage basin. The boundary is already drawn on the map.

Figure 3: Multiple-barrel outlet structure

(b) Convert the drainage area from square feet into acres.

(c) Convert the drainage area from acres into square miles.

(d) The water surface area when the dam impounds water to a water surface elevation of 565 $feet$ is assumed to be essentially zero. Sketch an elevation (side) view of the reservoir and outlet works – indicate elevations on the sketch of the base of the dam, the spillway crest, the culvert inlet elevation, and culvert outlet elevation.

(e) Estimate the water surface area when the dam impounds water to a water surface elevation of 570 *feet*.

(f) Estimate the water surface area when the dam impounds water to a water surface elevation of 580 *feet*.

(g) Estimate the water surface area when the dam impounds water to a water surface elevation of 590 *feet*.

(h) Estimate the water surface area when the dam impounds water to a water surface elevation of 600 *feet*.

(i) Use these estimates to complete the Elevation-Area Function Table in Figure 4 below

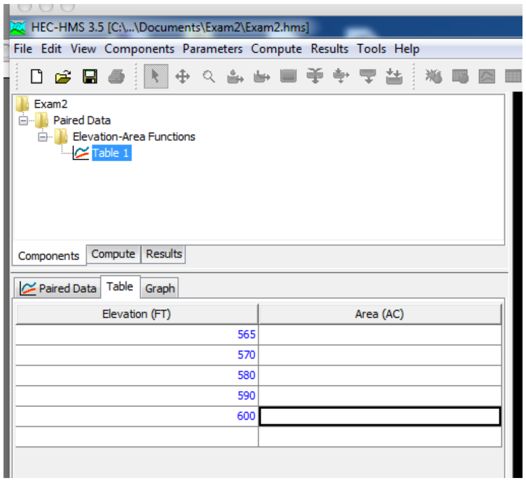

Figure 4: Elevation-Area Function Data Entry Dialog from HEC-HMS

3. Figure 5 is a tabulation of an observed storm and runoff for the drainage area depicted by the map in Figure 2 before installation of the detention facility.

TIME-HOURS	ACC-RAIN-INCHES	OBSERVED-FLOW-CFS
0	0.000	0
1	0.000	0
2	0.000	0
3	0.000	0
4	0.000	0
5	0.000	0
6	0.000	0
7	0.000	0
8	0.091	1.42466349
9	0.096	0.31660086
10	0.101	0.3165874
11	0.105	0.31660086
12	0.110	0.3165874
13	0.110	0.403656
14	0.140	0.403656
15	0.740	25.161224
16	2.740	600.236472
17	2.930	825.207416
18	3.020	157.42584
19	3.020	96.608336
20	3.020	28.121368
21	3.080	36.867248
22	3.200	20.048248
23	3.259	7.1447112
24	3.259	0

Figure 5: Cumulative rainfall for a 24-hour period on watershed determined for Figure 2

(a) Estimate the total **volume** of runoff in cubic feet from the storm.

(b) Convert the estimate of runoff volume from cubic feet into watershed inches.

(c) Using the runoff volume in watershed inches, estimate the value of S in the SCS equation (8.6.5 in Textbook);

$$P_e = \frac{(P - 0.2S)^2}{P + 0.8S} \tag{1}$$

(d) Using the value of S just computed, estimate the value of CN in the CN equation (8.6.6 in Textbook);

$$S = \frac{1000}{CN} - 10 \tag{2}$$

(e) Use the estimate to complete the data entry dialog depicted in Figure 6 below:

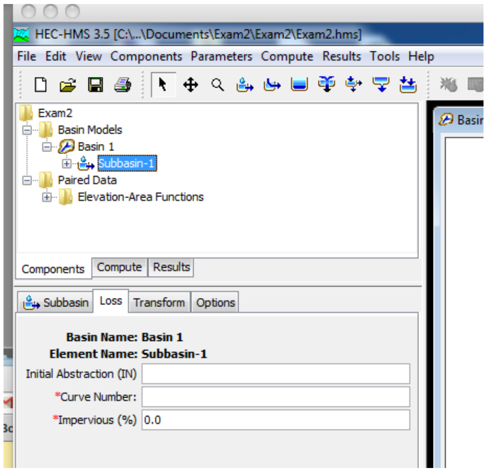

Figure 6: Loss Model Data Entry Dialog from HEC-HMS

(f) Describe how to estimate basin lag time from the observation time series and use your estimate to complete the data entry dialog depicted in Figure 7 below:

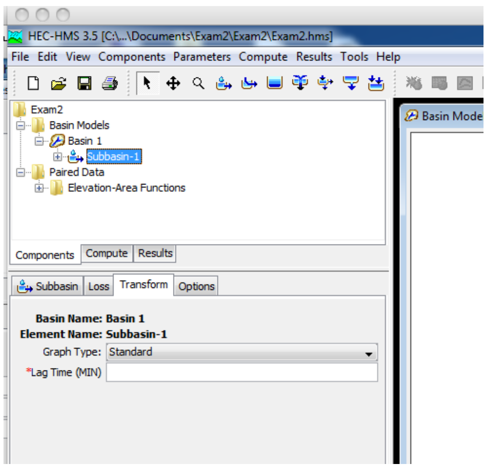

Figure 7: Transform Model Data Entry Dialog from HEC-HMS

4. A HEC-HMS model must have three components to run. Circle the three components required for any HEC-HMS model to run in Figure 8

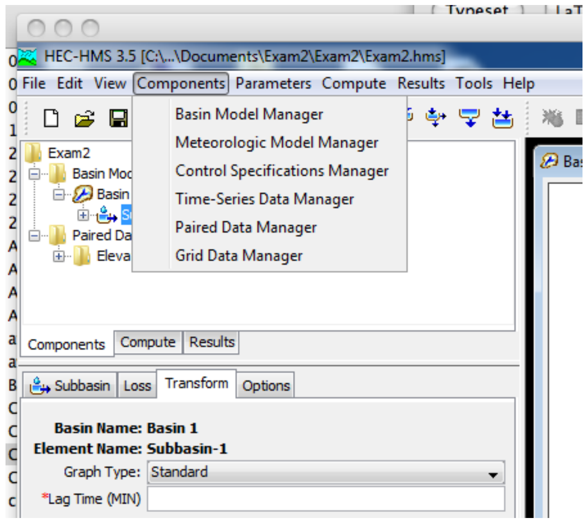

Figure 8: Components pull-down menu in HMS

5. A connectivity diagram of a HEC-HMS model of the drainage basin depicted in Figure 2 **before** the installation of the detention facility is best represented by which figure below?

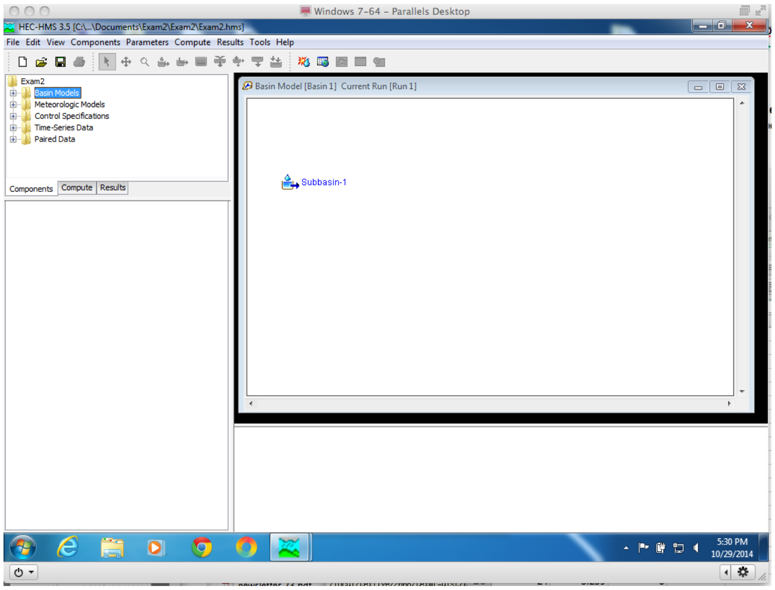

Figure 9: Model A

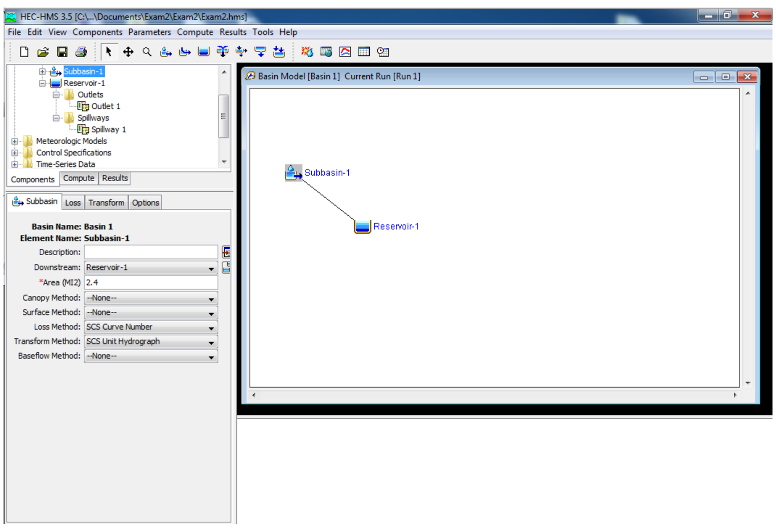

Figure 10: Model B

6. A connectivity diagram of a HEC-HMS model of the drainage basin depicted in Figure 2 **after** the installation of the detention facility is best represented by which figure below?

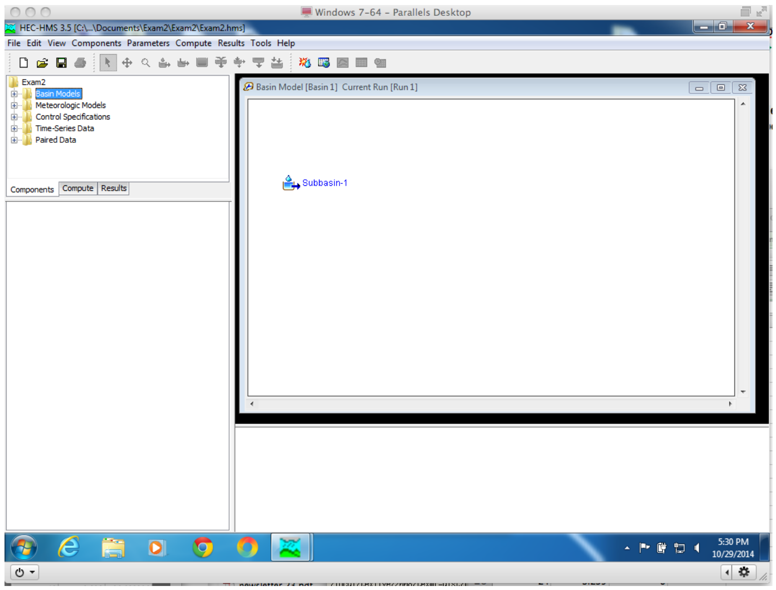

Figure 11: Model A

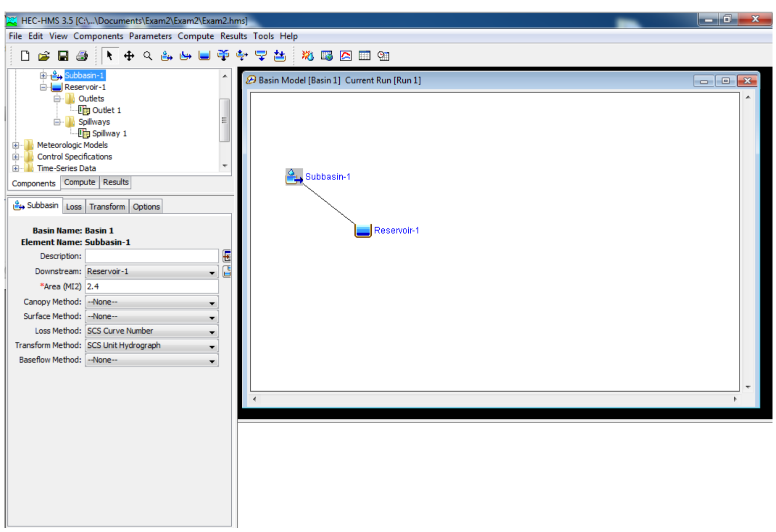

Figure 12: Model B

7. Build the HEC-HMS model depicted as Model B. Use the estimates to parameterize the model and simulate the observed storm. Adjust CN and Lag Time so that the peak discharges in the simulated and observed time series are within 15 percent of each other. Adjust the overall simulation time (Control Specifications) so that the reservoir drains completely (2 days should be sufficient with the outlet works described earlier.).

   (a) What is the observed peak discharge at the outlet from the watershed (inlet to the reservoir) in cubic feet per second?

   (b) What is the simulated peak discharge at the outlet from the watershed (inlet to the reservoir) in cubic feet per second?

   (c) When is the time to peak in your model at the outlet from the watershed (inlet to the reservoir) for the observed discharges?

   (d) When is the time to peak in your model at the outlet from the watershed (inlet to the reservoir) for the simulated discharges?

   (e) What is the simulated peak discharge at the outlet of the reservoir in cubic feet per second?

   (f) When is the simulated peak discharge at the outlet of the reservoir?

   (g) What is the maximum pool elevation of the reservoir for the storm?

   (h) How much is the peak discharge reduced by the reservoir?