Name: _____ Laboratory Section: _____

Date: _____ Score/Grade: _____

Video
Exercise 22
Pre-Lab Video
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LAB EXERCISE

Recurrence Intervals for Natural Events

Lab Exercise and Activities

SECTION 1

Streamflow, Discharge, and Gage Height

Using the data provided in Table 22.1, answer the following questions and completion items.

1. **a)** The highest discharge recorded for the listed years: *3836*

   b) Year recorded: *1997*

   c) The lowest discharge recorded for the listed years: *46*

   d) Year recorded: *1931*

2. **a)** Average discharge (1984–2013): *1178 cms*

   b) Range of discharge (1984–2013): *3790 cms*

TABLE 22.1 Peak annual discharge (in cubic meters per second) and gage height (in meters above gage datum elevation) for the Red River of the North at Grand Forks, North Dakota, 1882–2016. (USGS National Water Information Service, NWIS, http://nwis.waterdata.usgs.gov/usa/nwis/peak)

1 Peak Discharge Date	2 Discharge (cms)	3 Gage at Peak	4 Rank	5 Recurrence Interval
April 18, 1997	3836	15.9	1	135.00
April 14, 2011	2450	15.2	2	*67.5*
April 10, 1897	2380	15.3	3	*45.0*
April 23, 1979	2296	14.8	4	*33.8*
April 1, 2009	2148	15.0	5	*27.0*
April 18, 1882	2100	14.6	6	*22.5*
April 6, 2006	2038	14.6	7	*19.3*
March 20, 2010	1761	14.0	8	*16.9*
April 21, 1996	1635	14.0	9	*15.0*
April 14, 2001	1618	13.7	10	*13.5*
April 13, 1989	1109	13.2	20	6.8
April 27, 1904	924	12.4	30	4.5
April 12, 1943	790	11.6	40	3.4
April 3, 1976	661	10.5	50	2.7
April 6, 1917	554	9.9	60	2.3
March 24, 1929	479	8.6	70	1.9
July 2, 1957	412	7.5	80	1.7
April 2, 1928	342	6.6	90	1.5
June 12, 1925	271	5.8	100	1.4
March 28, 1926	216	5.5	110	1.2
April 8, 1912	132	3.9	120	1.1
April 1, 1889	84	3.7	130	1.0
April 10, 1931	46	2.0	135	1.0

3. a) The highest gage at peak discharge: *15.9*

b) Year recorded: *1997*

c) The lowest gage at peak discharge: *2.0*

d) Year recorded: *1931*

4. Scan the *Discharge* (column 2) and *Gage at Peak* (column 3) data columns. As gage height at peak (stream depth) gets higher, what usually happens to the discharge?

Gage height usually increases with discharge.

5. In general, there is a direct relationship between discharge and width, depth (gage height), and velocity. A stream's **rating curve** relates stream discharge to the gage height. Figure 22.1 shows the gage height plotted against discharge. Note that the discharge axis is logarithmic.

a) We can use the graph in Figure 22.1 to read data from the chart. Use the **rating curve** to determine the gage height associated with the following discharges. (*Hint:* Use colored pencils to mark them on the graph first.)

100 cms [3.0 m]

500 cms ***9.0 m***

1000 cms ***11.7 m***

3000 cms ***17.0 m***

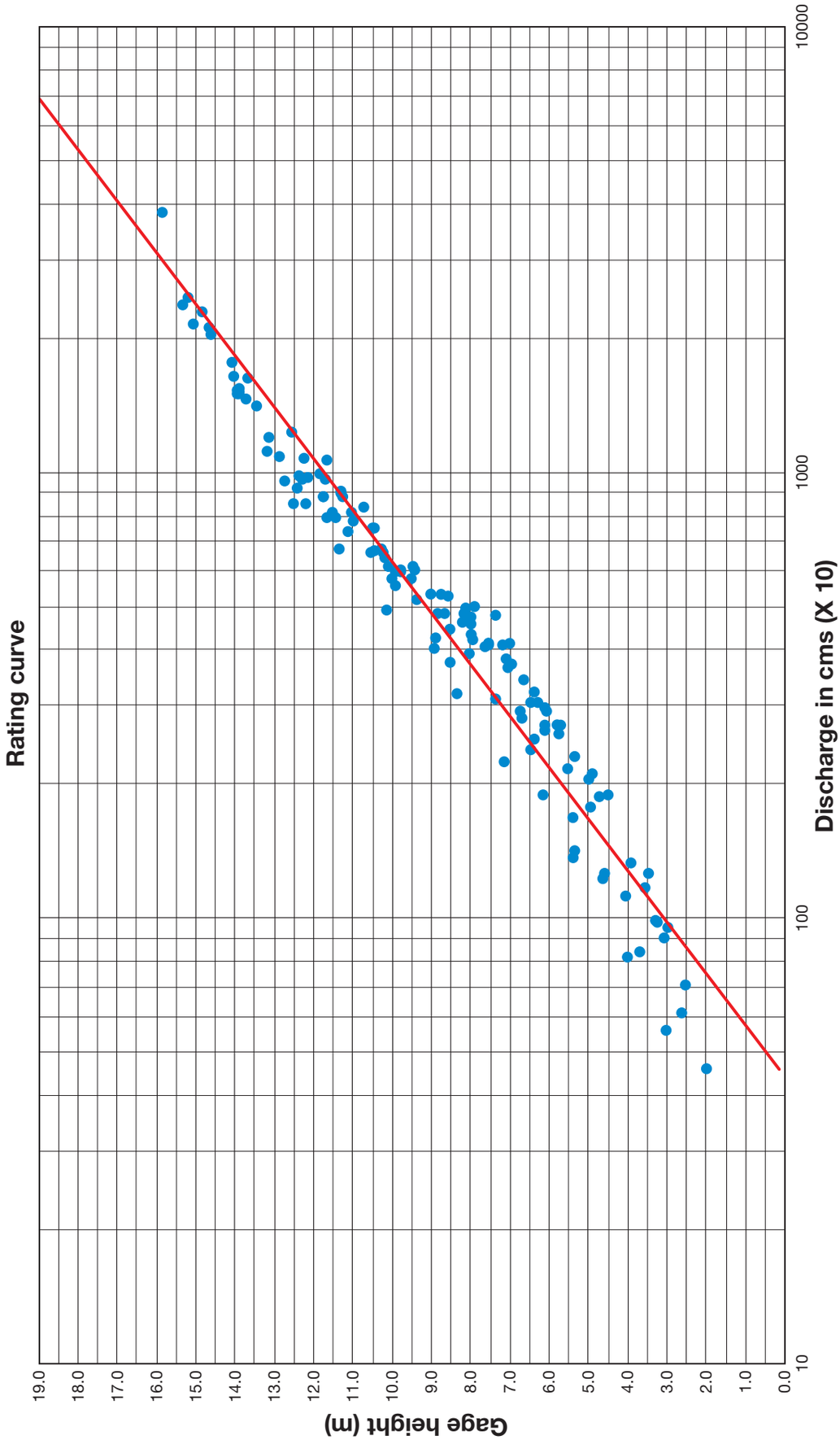
b) Determine the discharge associated with a gage height of

6 meters [225 cms]

9 meters ***500 cms***

12 meters ***1100 cms***

15 meters ***2250 cms***



▲ **Figure 22.1** Rating curve for the Red River

SECTION 2

Floods and Recurrence Intervals

1. Refer once again to Table 22.1 and at the far right locate columns 4 and 5, *Rank* and *Recurrence Interval*, which have not been used as yet. Rank the floods (using the gage height data in column 3), with the rank of 1 for the largest flood and continue in descending order to the smallest, entering your ranking numbers in column 5.

The recurrence interval (*RI*) is calculated using the following formula:

$$RI = \frac{n + 1}{m}$$

Where

RI = recurrence interval (in years)

n = number of years of record

m = rank of the flood

For example, the flood with a rank of 1 and 30 years of records would have a recurrence interval calculated as follows:

$$RI = \frac{30 + 1}{1} = 31$$

2. Calculate the rank and recurrence intervals for the gage heights and enter your results in column 5 of Table 22.1. Some (namely, flood ranks 1 and 10–116) have been done for you on the table to get started.

3. On the logarithmic paper in **Figure 22.2**, plot the recurrence (return) interval against the discharge. The sample points for flood ranks 1 and 11–116 have been plotted.

Once again you can use the graphs you created to obtain information about hypothetical discharges and recurrence intervals.

4. a) Using the **flood frequency curve** in Figure 22.2 (and colored pencils to mark on graph), estimate the recurrence interval of a flood of the following magnitudes:

200 cms ***less than 1 year***

1500 cms [10 years]

3000 cms ***110 years***

b) Estimate the discharge of the

50-year flood ***2500 cms***

100-year flood ***2800 cms***

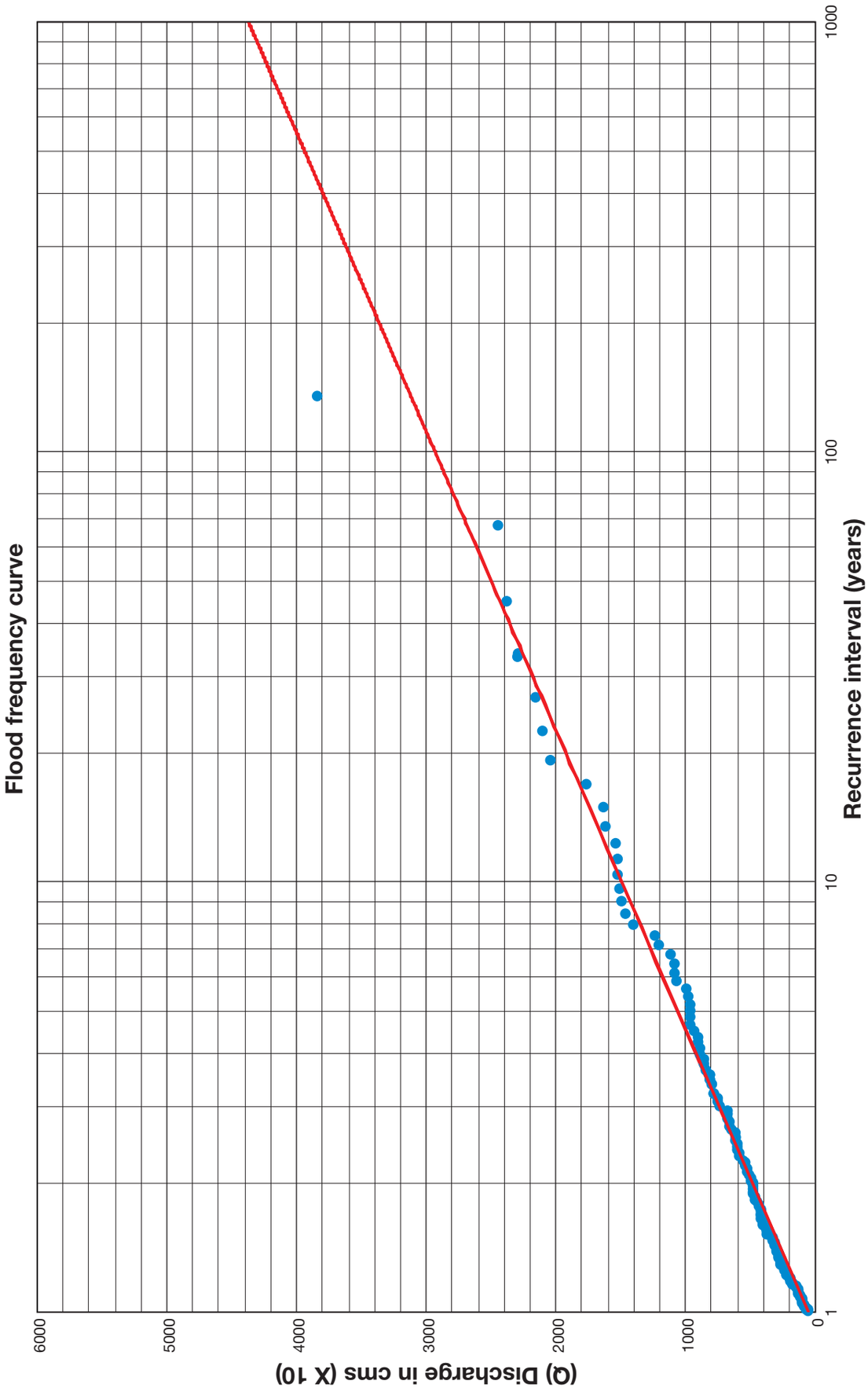
500-year flood ***3900 cms***

5. a) Use Figure 22.2 along with Figure 22.1 to determine the gage height of these flood frequencies. (Use the flood frequency curve in Figure 22.2 to obtain the discharge, and then use that discharge on the rating curve to determine the associated gage height.)

20-year flood ***14 m***

300-year flood ***16.6 m***

400-year flood ***16.7 m***



▲ **Figure 22.2** Flood frequency curve for the Red River

b) Now use both graphs (Figure 22.1 first, and then 22.2) to determine the recurrence interval of the gage height at

10 meters ___*2.5 yrs*___

12 meters ___*5.5 yrs*___

15 meters ___*33 yrs*___

6. How many times in a century would you expect the Red River to crest at a gage height of 13 meters?

10 times

What is the probability of a flood of that magnitude in any given year?

10%

7. According to the flood frequency curve, what is the return interval for a flood the magnitude of the spring 1997 flood?

400 year flood

SECTION 3

Probability, Prediction, and Risk Assessment

1. What is the recurrence interval for a flood the magnitude of the 1997 flood, based on your plotted line? ___[70 years]___

2. According to your charts, what is the recurrence interval for Grand Forks' peak gage height for that year?

400 years

3. What are the probabilities of floods of these magnitudes occurring in any given year?

April 18, 1997 (15.86 m) ___*0.9%*___

April 22, 1997 (16.56 m) ___*0.4%*___

4. What would be the recurrence interval for a flood to reach the top of the new levee? ___*+2000 years*___

5. How high above the gage datum would you want to locate a new house in Grand Forks to make certain it would be safe from a 30-year flood? ___*14.75 m*___