CE EN 431
Engineering Hydrology
Winter 1994
Section 1

Lab 7: Runoff Analysis--Snake River at King Hill, Idaho

Submitted to:
Dr. A. W. Miller

by
Christopher Smemoe
March 3, 1994

Contents

Introduction

This report uses streamflow records from King Hill, Idaho. King hill is located in south-west Idaho, and may be called the land of desolation. There is not much there. I have obtained the following information about the gaging station and watershed at King Hill, Idaho:

- **Location: 43 degrees latitude, 115 degrees, 12 minutes longitude**
- **Area of watershed above gaging station: 35,800 square miles**
- **Type of water stage measurement instrument: Water-stage recorder**
- **Reliability of record: Records are excellent. Record from 1909 to present**
- **Shape of watershed: See contour map in appendix C**
- **Size of watershed: Huge watershed, covering much of eastern and central Idaho**
- **Topography and elevation of watershed: Rugged, mean elevation of 6040 ft**
- **Other factors:** Flow in the Snake River at King Hill is regulated by American Falls Reservoir 168.4 miles upstream. Occasional fluctuation in the river is caused by hydroelectric plants upstream. At times, practically the entire flow is diverted at Milner (upstream) during irrigation season. Lots of the flow at King Hill is derived from springs and seepage entering below Milner. Diversions above the station irrigate about 2.45 million acres.

The purpose of this report is to analyze streamflow records from the Snake River at King Hill, Idaho. From these streamflow values, I used an assumed industry demand to determine the size of reservoir that would be required to supply industries in the King Hill area during a drought. I used data between the years of 1941 and 1970 to determine the size of the reservoir required.

Objectives/Procedure

For the objectives and procedure, I have included the lab handout. You can find the lab handout in the appendix.

Results

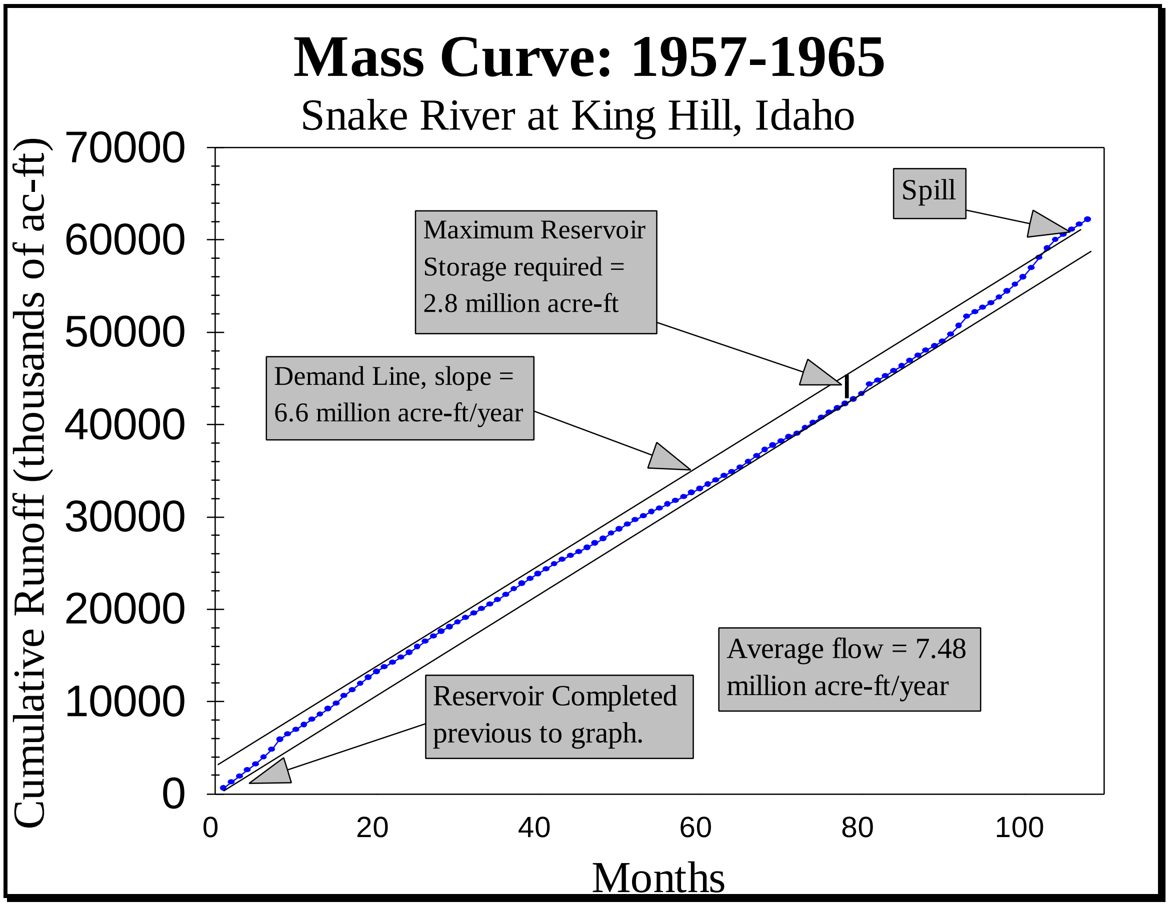

Figure 1: Mass curve created from values at the gaging station on the Snake River at King Hill, Idaho.

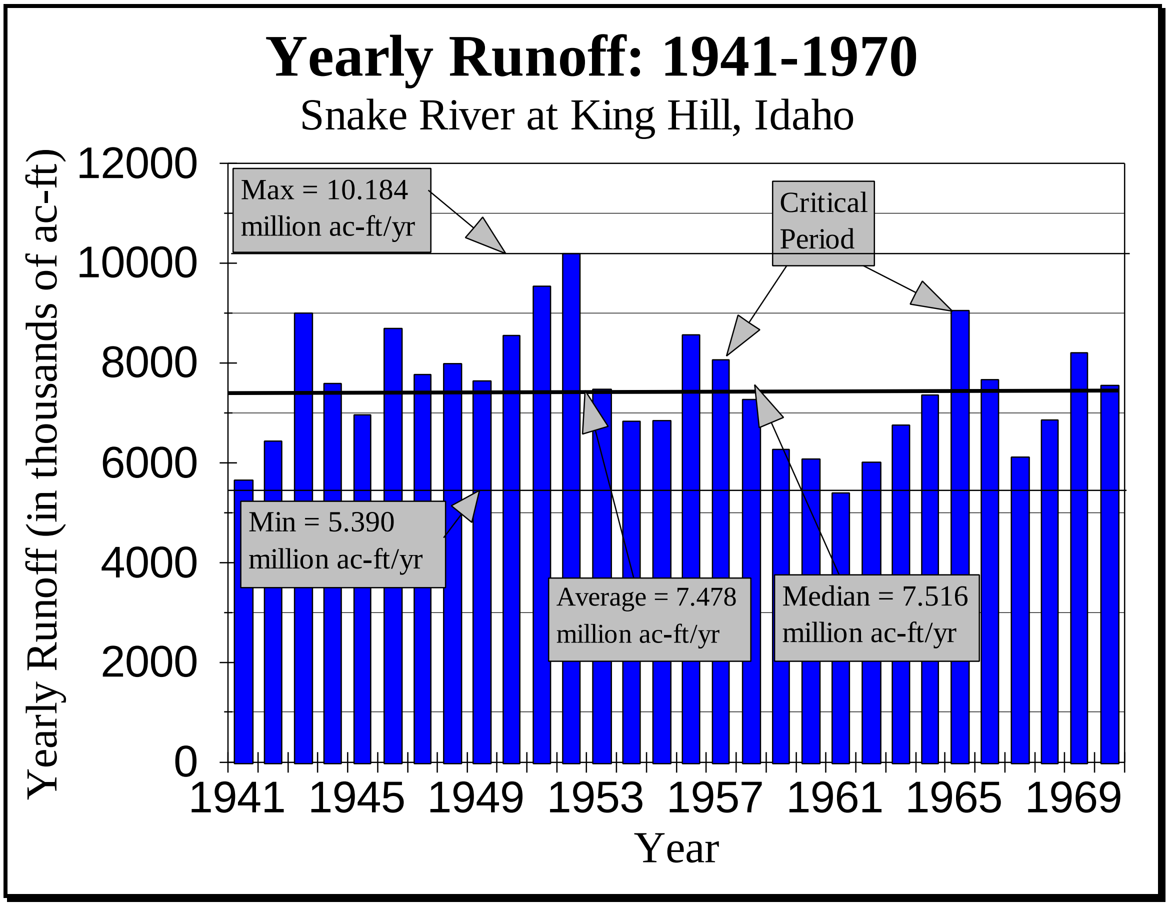

Figure 2: Yearly runoff in thousands of acre-ft between 1941 and 1970. Values taken from King Hill gaging station on Snake River in Idaho.

Table 1: Data for a proposed reservoir at King Hill, Idaho to supply industry demands.

Parameter	Value
Study Outlet	Snake River, King Hill, Idaho
Period of Analysis	1941-1970
Critical Dry Period	1957-1965
Average Yearly Runoff (million acre-ft/yr)	7.48
Minimum Yearly Runoff (million acre-ft/yr)	5.39 (1961)
Maximum Yearly Runoff (million acre-ft/yr)	10.18 (1952)
Median Yearly Runoff (million acre-ft/yr)	7.516 (ave. of 1953 and 1970)
Yearly Industry Demand (million acre-ft/yr)	6.6
Industry Demand (% of long-term average runoff rate)	88%
Reservoir is empty	April, 1963
Reservoir is full	April, 1958 (initial) and Feb, 1965 (post-drought)
Spill after first year (acre-ft)	1,200,000
Required Reservoir Storage Capacity (acre-ft)	2,800,000
Year to begin construction to avoid lack of water	Just before 1957 (not sufficient info)

Discussion

You can see the results in figures 1 and 2 and table 1.

Mass curve and runoff values over the 30-year study period. The mass curve for the data at King Hill is located in figure 1. I selected 1957 to 1965 to be the years that storage would be critical. 1961 had the lowest rainfall in the 30-year period between 1941 and 1970. During this year, only 5.39 million acre-feet of water flowed past the gaging station. During the average water year, over 7 million acre-feet of water flowed past the gaging station.

From the mass curve, I determined (using the demand line) the required storage capacity of the reservoir. Also, I was able to determine the amount of spill that would occur over a reservoir the year following a drought. Finally, from the slope of the demand line, I was able to determine the average assumed demand to be 6.6 million acre-feet per year. The average supply over the 30-year study period was 7.48 million acre-feet per year. Thus, the I calculated the industry demand to be precisely 88.24% of the total flow through King Hill, Idaho.

Other considerations (groundwater flows, evaporation losses, and a non-uniform rate of demand, and other cool stuff). When I determined the required reservoir storage, I did not take into consideration groundwater flows into and out of the reservoir, evaporation losses in the reservoir, and a non-uniform rate of demand by the industry. Groundwater flows out of the reservoir could be high in this part of Idaho. There could also be a large amount of evaporation. These two factors could require a larger reservoir volume than what I determined.

Also, in this problem, I assumed a uniform rate of demand. In a real-life project, the demands may not be uniform. I would have to take the seasonal fluctuations of demand into consideration.

Calculations

The calculations were fairly straightforward and involved tabulating the data, calculating the average value over the 30-year study period, and determining the minimum, maximum, and median years of runoff. *My calculations and data are located in Appendix C.*

To make the mass curve, I simply added up the monthly runoffs for the critical period between 1957 and 1965. I then graphed the cumulative runoff values.

Conclusions/Applications

In conclusion, determining the mass curve for flow through a gaging station over a study period is useful, exciting, and highly interesting. I would not have spent my Thursday night in any other way.

The mass curve is used by hydrologists and engineers to determine the volume of water required or the excess at any time in a river’s history. Using the mass curve, a hydrologist can size a reservoir. Also, a water resource engineer can use the mass curve to determine the flow over a spillway or through an outlet on a dam. The engineer can then size the spillway or outlet works to carry the required flow.

This lab was an exciting and rewarding experience for me. I thank you for the opportunity I had to learn about mass curves so I can use them after I grow up and become the Sanpete county hydrologist.

Appendix

Appendix A: References

- Wanielista, Martin. **Hydrology and Water Quantity Control**. John Wiley and Sons, Inc. 1990.
- United States Department of Interior, Geological Survey. **Water Supply Papers-Basin 13, 1940-1970 data (3 volumes)**.

The lab handout and my calculations are located on the following pages.

Appendix B: Lab Handout

Appendix C: Calculations and Data