LAB 2

WATER BUDGET OF MONO LAKE: RUNOFF, STORAGE, AND GROUNDWATER FLOW

PURPOSE: Familiarize you with components of the hydrologic cycle, data sources, and techniques for data analysis.

OBJECTIVES: Determine runoff, change in storage, and solution of the continuity equation to determine groundwater flow into Mono Lake.

PROBLEM: Determine the average groundwater flow into Mono Lake, CA.

APPROACH: Write the general continuity equation for the water budget of Mono Lake, indicating all possible inputs and outputs.

RUNOFF

Determine the average annual runoff (m^3) from all streams flowing into Mono Lake.

1. Three large streams flow into Mono Lake, all from the Sierra Nevada (Fig. 1.2). These streams are gaged by the Los Angeles Department of Water and Power (DWP), and have the following average annual runoff.

Lee Vining Creek	87.3 cfs (cubic feet per second)
Rush Creek	44.8 cfs
Mill Creek	37.0 cfs

   What is the combined average annual runoff of these three streams, in m^3?

2. The Los Angeles DWP has been diverting water from Lee Vining, Rush, and Mill Creeks (below the gaging stations) for many years, running the diverted water through the Owens Valley aqueduct to Los Angeles. These diversions average 105, 305 acre-ft per year.

   Taking into account these diversions, what is the average annual flow into Mono Lake from these three streams, in m^3?

3. Two small streams, not gaged, were measured with simple weirs to determine their runoff.

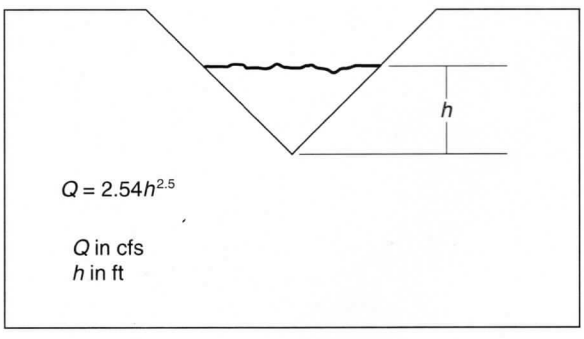
   The smallest stream, Andy Thompson Creek, was measured with a 90° triangular-notch weir. This type of weir is most useful for discharges of less than 1 cfs. The formula for a weir with this geometry is

   $$Q = 2.54\, h^{5/2}$$

   where Q is in cfs and h is in ft.

   The measurement, taken after flow is stabilized, showed the water surface 6.9 inches above the notch. Determine runoff (m^3/yr).

Triangular-notch Weir (90°)

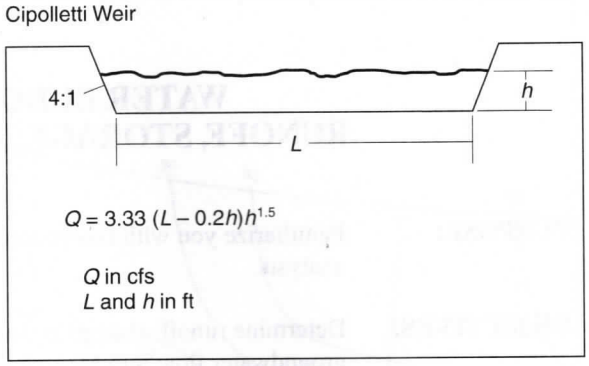


4. The larger stream required a larger weir, so a 3-foot Cipolletti weir was used. This type of weir is useful for flows of a few cfs. The Cipolletti formula is

$$Q = 3.33(L - 0.2h)h^{3/2}$$

where Q is in cfs, and L and h are in ft.

The flow stabilized at a height of 3.5 inches. Calculate discharge (m^3/yr).



5. Numerous springs discharge along the shoreline of Mono Lake. All significant springs were monitored by weirs, and their average total flow is 5530 gpm (gallons per minute), which should be considered surface flow, or runoff.

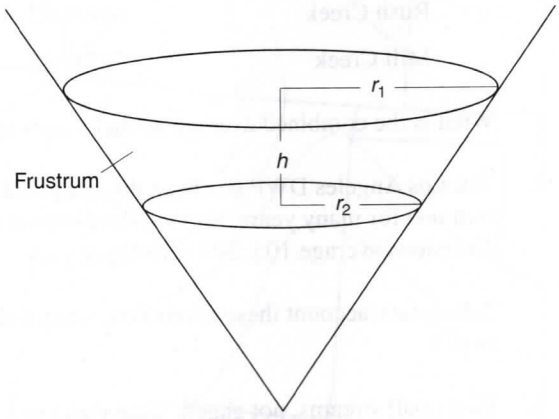
Convert spring runoff to m^3/yr.

6. Summarize the average annual runoff into Mono Lake.

STORAGE

1. Mono Lake is more or less elliptical in map view, but morphometric studies of the lake have determined that its volume can be approximated well by the volume of a cone, as though the lake were circular with a uniformly sloping bottom. Thus, any change in storage can be calculated simply by determining the volume of the frustrum of a cone, as shown in the diagram.

From the data recorded by the Los Angeles DWP, Mono Lake stood at 6406.9 ft in June 1954, and it had fallen to 6391.2 ft by June 1964. Surface area of the lake in June 1954 was 89.4 mi^2, while the area in June 1964 was 77.0 mi^2.



Assuming that the lake is about circular, determine the respective radii of the lake in 1954 and in 1964.

Calculate the change in storage of Mono Lake over the ten-year period from June 1954 to June 1964.

2. What was the average annual change in storage over this period (m^3)?

GROUNDWATER FLOW

1. Using all the data presented so far, solve the continuity equation for average annual groundwater flow. Base this value on data from the period from June 1954 to June 1964. For precipitation, use the value of 40,000,000 m^3/yr (determined from an isohyetal analysis), and for evaporation, use the value 215,000,000 m^3/yr.

2. To arrive at this estimate, what assumptions have you made about any other elements of the water budget? Refer back to the continuity equation you wrote at the beginning of the lab.

WATER BUDGET

1. Summarize the annual water budget for Mono Lake, using the table that follows. Take care to report only significant figures.

ANNUAL WATER BUDGET FOR MONO LAKE (1954–1964)			
Inflow (m^3/yr)		**Outflow + Change in Storage (m^3/yr)**	
Runoff		Evaporation	
Precipitation			
Groundwater Flow		Change in Storage	
Total Inflow		**Total Outflow + Change in Storage**	

2. Discuss briefly the possible sources of error in the annual water budget.

3. Which element of the water budget probably contains the largest error? Why?