4.3 STORAGE ESTIMATION

4.3.1 RESERVOIR MASS CURVE AND STORAGE

During high flows, water flowing in a river has to be stored so that a uniform supply of water can be assured, for water resources utilisation like irrigation, water supply, power generation, etc. during periods of low flows of the river.

A mass diagram is a graphical representation of cumulative inflow into the reservoir versus time which may be monthly or yearly. A mass curve is shown in Fig. for a 2-year period. The slope of the mass curve at any point is a measure of the inflow rate at that time.

Required rates of draw off from the reservoir are marked by drawing tangents, having slopes equal to the demand rates, at the highest points of the mass curve. The maximum departure between the demand line and the mass curve represents the storage capacity of the reservoir required to meet the demand. A demand line must intersect the mass curve when extended forward, otherwise the reservoir is not going to refill. The vertical distance between the successive tangents represent the water wasted over the spillway. The salient features in the mass curve of flow in Fig. are:

a-b: inflow rate exceeds the demand rate of x cumec and reservoir is overflowing

b: inflow rate equals demand rate and the reservoir is just full

b-c: inflow rate is less than the demand rate and the water is drawn from storage

c: inflow rate equals demand rate and S1 is the draw off from the reservoir (mm3)

c-d: inflow rate exceeds demand rate and the reservoir is filling

d: reservoir is full again

d-e: same as a-b e:

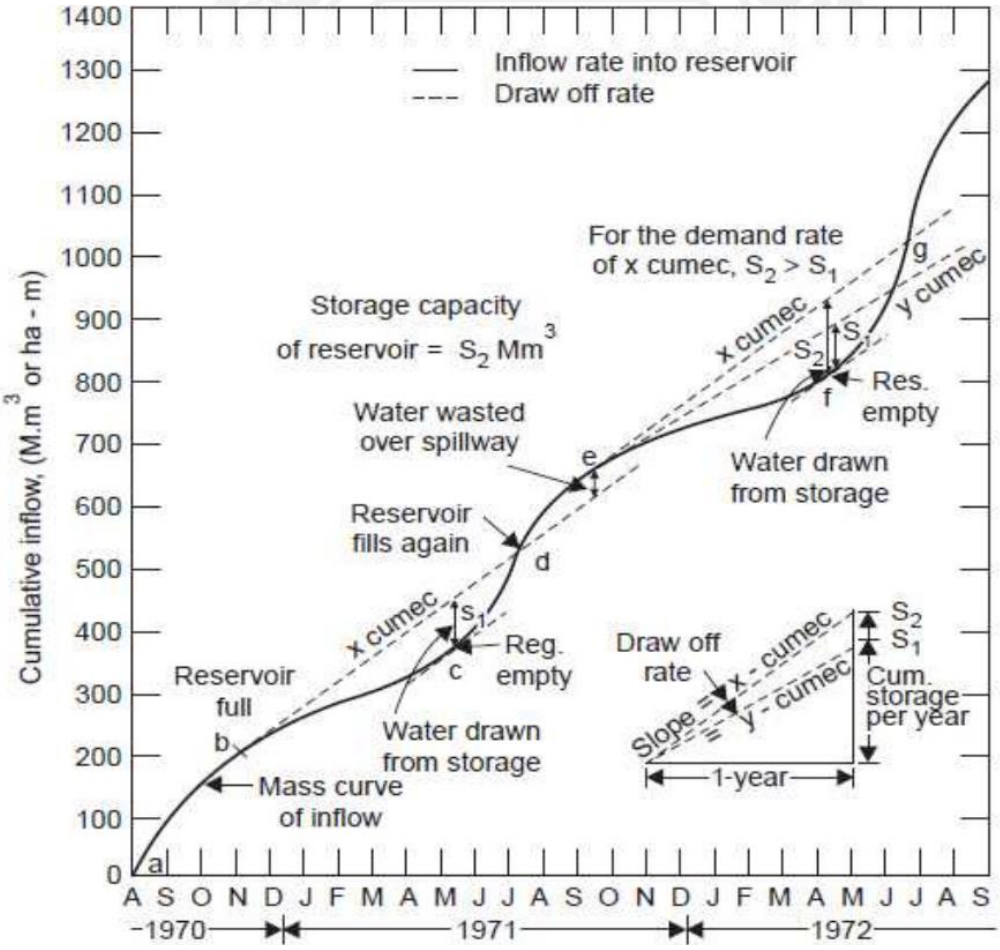
similar to b

e-f: similar to b-c

f: inflow rate equals demand rate and S2is the draw off from the reservoir

f-g: similar to c-d

To meet the demand rate of x cumec the departure S2 > S1; hence, the storage capacity of the reservoir is S2 mm3. If the storage capacity of the reservoir, from economic considerations, is kept as S1 mm3, the demand rate of x cumec can not be maintained during the time e-f and it can be at a lesser rate of y cumec (y < x).



Storage capacity of reservoir from mass curve

The use of mass curve is to determine:

(i) the storage capacity of the reservoir required to meet a particular withdrawal rate.

(ii) the possible rate of withdrawal from a reservoir of specified storage capacity.

The observed inflow rates have to be adjusted for the monthly evaporation from thereservoir surface, precipitation, seepage through the dam, inflow from adjacent basins, re- quired releases for downstream users, sediment inflow, etc. while calculating the storage ca- pacity of the reservoir.

The average flow figures for the site of a proposed dam are collected for about 10 years.

From this record the flow figures for the driest year are used for drawing the mass flow curve.

Graphical analysis is enough for preliminary studies. Final studies are made by tabular computation. If tangents are drawn to the crest and trough of the mass curve such that the departure of the lines represents the specified reservoir capacity, the slope of the tangent at the crest gives the continuous flow that can be maintained with the available storage capacity. From this the greatest continuous power output for the available fall at the site for a given plant efficiencyand load factor can be determined.

From the daily flow data a hydrograph or a bar graph is drawn for the maximum flood during the period of 10 years and the spillway capacity to pass this flood with the available storage capacity is determined. Thus, the power and the flood control potentialities of the site are investigated.

The mass curve of water utilisation need not be a straight line. The dashed curve in Fig. shows the cumulative requirements of water use in different months as compared with monthly cumulatively inflow. The maximum draft in the reservoir (i.e., maximum departure of the water use and inflow curves) occurs by the end of April. The reservoir again be- comes full by the end of September when the two curves intersect

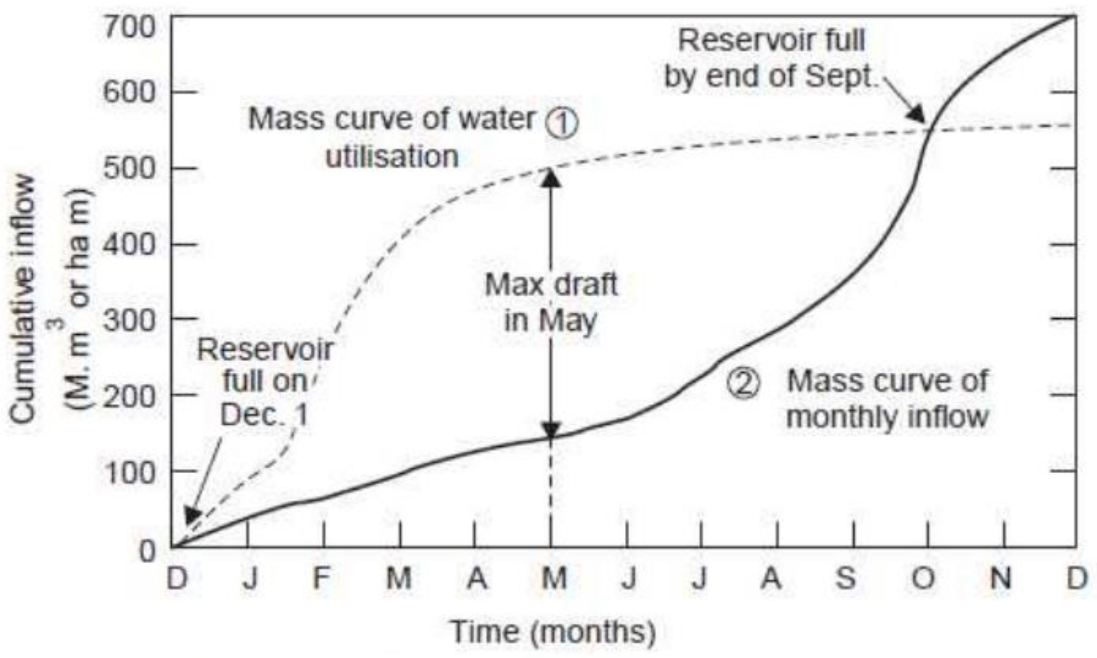


Fig. 10.2 Mass curves of water utilisation and monthly inflow

4.3.2 FLOW DURATION CURVES

Flow duration curves show the percentage of time that certain values of discharge weekly, monthly or yearly were equalled or exceeded in the available number of years of record. The selection of the time interval depends on the purpose of the study. As the time interval increases the range of the curve decreases, Fig. 10.4. While daily flow rates of small storms are useful for the pondage studies in a runoff river power development plant, monthly flow rates for a number of years are useful in power development plants from a large storage reservoir. The flow duration curve is actually a river discharge frequency curve and longer the period of record, more accurate is the indication of the long term yield of a stream. A flat curve indicates a river with a few floods with large ground water contribution, while a steep curve indicates frequent floods and dry periods with little ground water contribution.

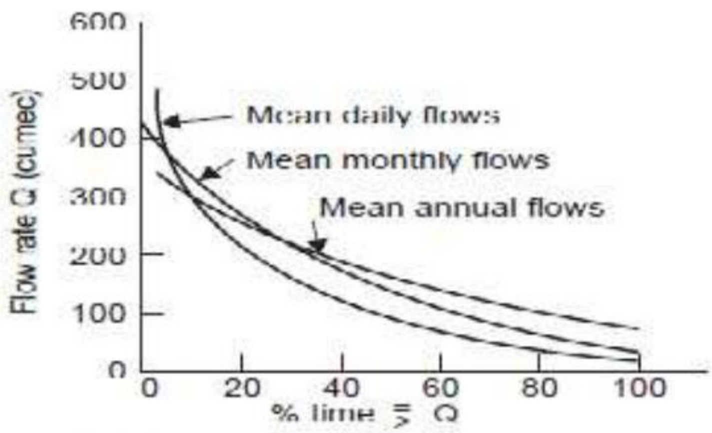


Fig. 10.4 Flow duration curves—effect of observation period

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