Example 2.2 Water Budget

During a particular 30-day period, the streamflow flowing into a reservoir averaged 5.0 m^3/s. Water supply withdrawals from the reservoir averaged 136 mgd. The only other outflow from the reservoir was 9.4 cm of evaporation from the reservoir water surface. The average water surface area of the reservoir during the 30 days was 3.75 km^2. The reservoir had 12,560 ac-ft of water in storage at the beginning of the 30-day period. Determine the storage content at the end of the 30 days alternatively in units of m^3 and ac-ft.

Solution End-of-period storage S_2 is determined as a function of beginning-of-period storage S_1, inflow I, water supply withdrawal W, and evaporation E based on the following water budget equation with all terms expressed in consistent units.

$$S_2 = S_1 + I - W - E$$

$$S_1 = (12{,}560 \text{ ac-ft})\left(43{,}560 \frac{\text{ft}^3}{\text{ac-ft}}\right)\left(0.02832 \frac{\text{m}^3}{\text{ft}^3}\right) = 15{,}494{,}300 \text{ m}^3$$

$$I = \left(5.00 \frac{\text{m}^3}{\text{s}}\right)(30 \text{ days})\left(\frac{86{,}400\text{s}}{\text{day}}\right) = 12{,}960{,}000 \text{ m}^3$$

$$W = \left(136{,}000{,}000 \frac{\text{gal}}{\text{day}}\right)\left(0.003785 \frac{\text{m}^3}{\text{gal}}\right)(30 \text{ days}) = 15{,}442{,}800 \text{ m}^3$$

$$E = (3.75 \text{ km}^2)(9.4 \text{ cm})\left(1{,}000{,}000 \frac{\text{m}^2}{\text{km}^2}\right)\left(0.01 \frac{\text{m}}{\text{cm}}\right) = 352{,}500 \text{ m}^3$$

$$S_2 = 15{,}494{,}300 + 12{,}960{,}000 - 15{,}442{,}800 - 352{,}500 \text{ m}^3 = 12{,}659{,}000 \text{ m}^3$$

$$S_2 = (12{,}659{,}000 \text{ m}^3)\left(\frac{\text{ac-ft}}{1{,}234 \text{ m}^3}\right) = 10{,}260 \text{ ac-ft}$$