

Annexure 12.1: Capacity of Service Reservoir

Example 1: Find the capacity of a newly proposed service reservoir serving OZ having a demand of 2 MLD. The supply hours are 22 hours, and the supply shall shut down during the 21st and 22nd hours. The hourly multiplying factors are shown in Figure 1. The initial water elevation is 100 m and the maximum water elevation in the tank is 104 m.

It is required to compute the capacity of the service reservoir.

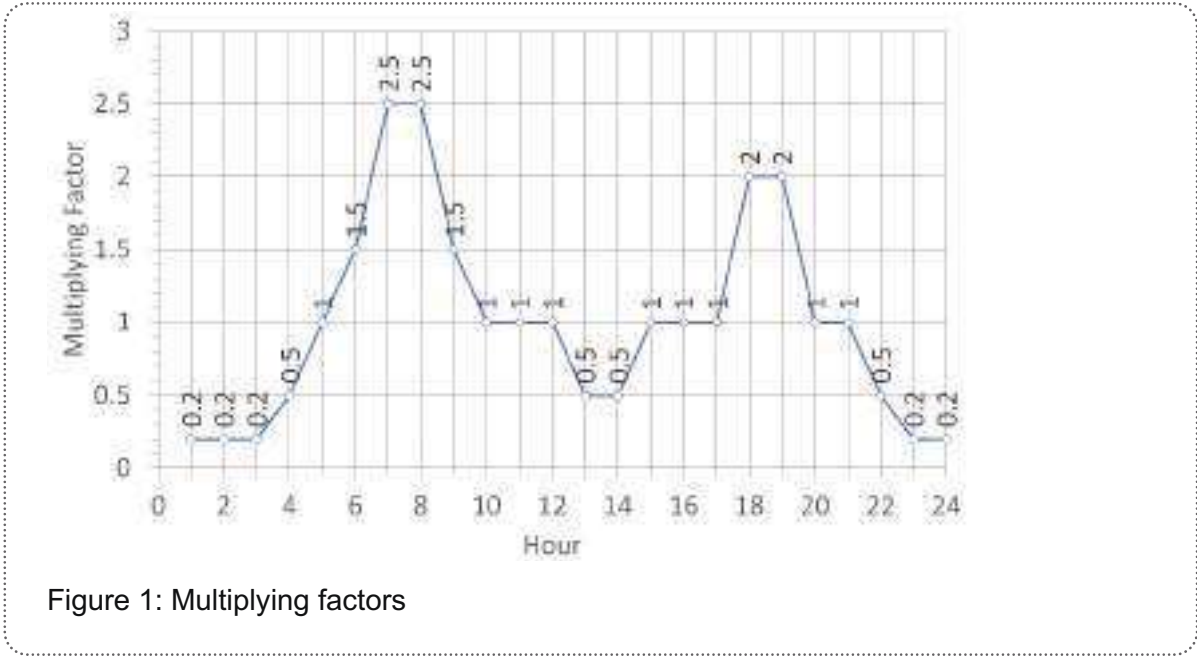


Figure 1: Multiplying factors

Solution: Average inflow = $2 \times 1000 / 24 = 83.33 \text{ m}^3/\text{h}$, since supply hours = 22, Hourly inflow = $2 \times 1000 / 22 = 90.909 \text{ m}^3/\text{h}$ which are shown in Col. 2 of Table 1. Multiplying factors are shown in Column 4. Hourly out flow = Multiplying factor \times Average inflow which are computed in Col 5. Difference between cumulative inflow and cumulative outflow are shown in Col. 7. The computation in Table 1 is carried out with the assumption of initial water elevation of 1.35m.

Table 1: Mass balance

Time from Start (hours)	Inflow		Multiplying factors	Outflow		Cumulative. Inflow-Cumulative. Outflow (m ³ /h)
	Inflow (m ³ /h)	Cumulative Inflow (m ³ /h)		Outflow (m ³ /h)	Cumulative Outflow (m ³ /h)	
1	2	3	4	5	6	7
0	90.9	0.0	0.2	16.7	0.0	0.0
1	90.9	90.9	0.2	16.7	16.7	74.2
2	90.9	181.8	0.2	16.7	33.3	148.5
3	90.9	272.7	0.2	16.7	50.0	222.7
4	90.9	363.6	0.5	41.7	91.7	272.0
5	90.9	454.5	1	83.3	175.0	279.5
6	90.9	545.5	1.5	125.0	300.0	245.5
7	90.9	636.4	2.5	208.3	508.3	128.0
8	90.9	727.3	2.5	208.3	716.7	10.6
9	90.9	818.2	1.5	125.0	841.7	-23.5
10	90.9	909.1	1	83.3	925.0	-15.9
11	90.9	1000.0	1	83.3	1008.3	-8.3
12	90.9	1090.9	1	83.3	1091.7	-0.8
13	90.9	1181.8	0.5	41.7	1133.3	48.5
14	90.9	1272.7	0.5	41.7	1175.0	97.7
15	90.9	1363.6	1	83.3	1258.3	105.3
16	90.9	1454.5	1	83.3	1341.7	112.9
17	90.9	1545.5	1	83.3	1425.0	120.5
18	90.9	1636.4	2	166.7	1591.7	44.7
19	90.9	1727.3	2	166.7	1758.3	-31.1
20	90.9	1818.2	1	83.3	1841.7	-23.5
21	0.0	1818.2	1	83.3	1925.0	-106.8
22	0.0	1818.2	0.5	41.7	1966.7	-148.5
23	90.9	1909.1	0.2	16.7	1983.3	-74.2
24	90.9	2000.0	0.2	16.7	2000.0	0.0

The graph of Cumulative Inflow and Cumulative Outflow with time is shown in Figure 2.

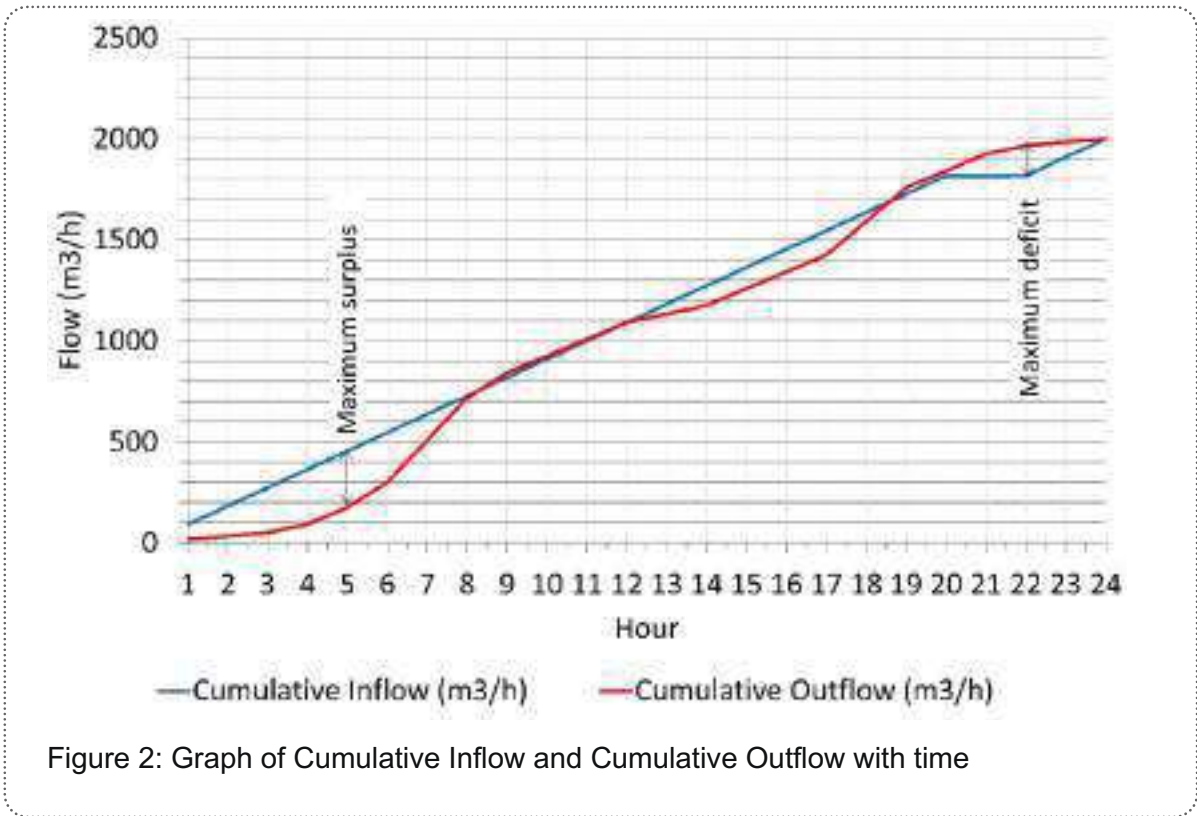


Figure 2: Graph of Cumulative Inflow and Cumulative Outflow with time

Capacity: For the assumed initial water elevation of 1.35 m, it is observed that the values of cumulative inflow are more than those of the cumulative outflow till eight hours and their difference is maximum at five hours (Figure 2). This means the surplus water is maximum at five hours. It can also be seen that reservoir will be full when the surplus is maximum and it will be empty when the deficit is maximum, which is at 22 hours.

The values of cumulative outflow are more than cumulative inflow from eight hours to 12 hours. This means that the water levels in the tank are decreasing. It may also be observed that the values of cumulative inflow are more than cumulative outflow from 12 hours till 18 hours, which means that the water level in the tank are increasing. Beyond 18 hours, cumulative outflow is more than that of the cumulative inflow.

Thus, for balancing the variation in the water levels (decreasing/ increasing), some buffer capacity should be provided which is given by,

$$\text{Capacity of tank} = \text{Maximum surplus storage} + \text{Maximum deficit} \tag{Eq. 1}$$

The maximum surplus from Col 7 of Table 1 = 279.5 and maximum deficit = 148.5 m³. Hence,

$$\text{Capacity of tank} = 279.5 + 148.5 = 428 \text{ m}^3.$$

For 24×7 water supply, the service reservoir should neither get empty nor overflow. This is achieved by properly maintaining initial water level in the tank, which is given by,

$$\text{Initial water level in the tank} = \frac{\text{Maximum deficit volume}}{\text{Area of cross section}} \tag{Eq. 2}$$

In above case, maximum deficit = 148.5 (Col 7 of Table 1), hence,

$$\text{Initial water level in the tank} = \frac{148.5}{0.7854(12*12)} = 1.31, \text{ Say } 1.35 \text{ m. Hence, assumption of}$$

initial water level of 101.35 is in order.

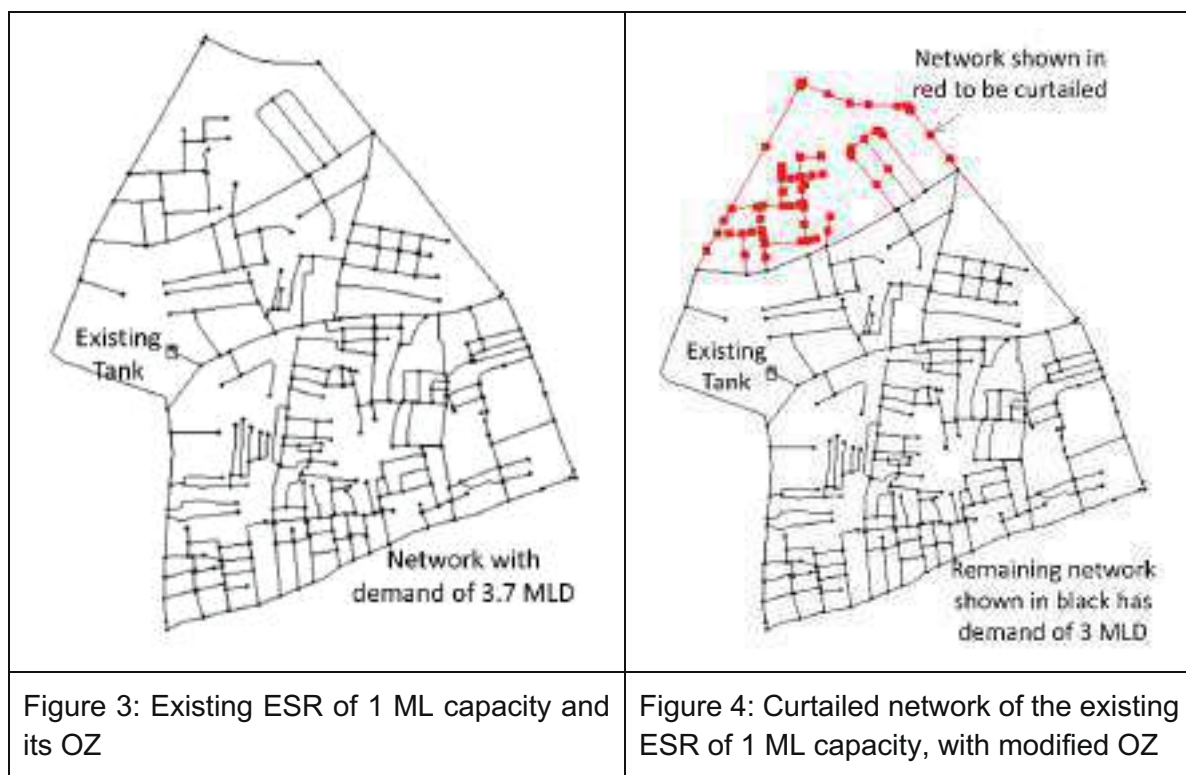
Capacity as per demand/3 Rule:

$$\text{Demand} = 2 \text{ MLD, hence the capacity} = 2*1000/3 = 666.67, \text{ say } 667 \text{ m}^3$$

Though the capacity computed by the mass balance is 428 m^3 , the capacity by the demand/3 rule is 667 m^3 . Hence, the capacity to be adopted is 667 m^3 .

Example2: Check extent of the pipe network of the existing service reservoir whose capacity is 1 ML. The pipe network of the existing tank is shown in Figure 3.

Solution:



From Figure 3, it is observed that the demand of all the nodes of the existing tank is 3.7 MLD. If the network is allowed to be served by the existing tank, then the required capacity of the tank would be $3.7/3$, i.e., 1.23 ML and the tank will get empty. This can be avoided by making retrofitting of the original network and some part of the network should be removed as shown in Figure 4. The removed part of this existing tank shall be then attached with the adjoining OZ of another tank.

In some of the cases, due to lesser supply hours (due to non-availability of electricity), the required capacity of the existing tank shall be computed using mass balance method and it might be larger than 33%. In such situation, the extent of the network shall be suitably curtailed/adjusted. In any case, demand of all nodes serving existing tank shall not exceed three times capacity of tank.