Sanitary Engineering

Water supply
Sewerage system

Preliminary studies of water supply

1- Sources of water.
2- Design period (20 – 50 years).
3- Population (present and future)
4- Water consumption.
5- Water quality. (physical, chemical, bacteriological).

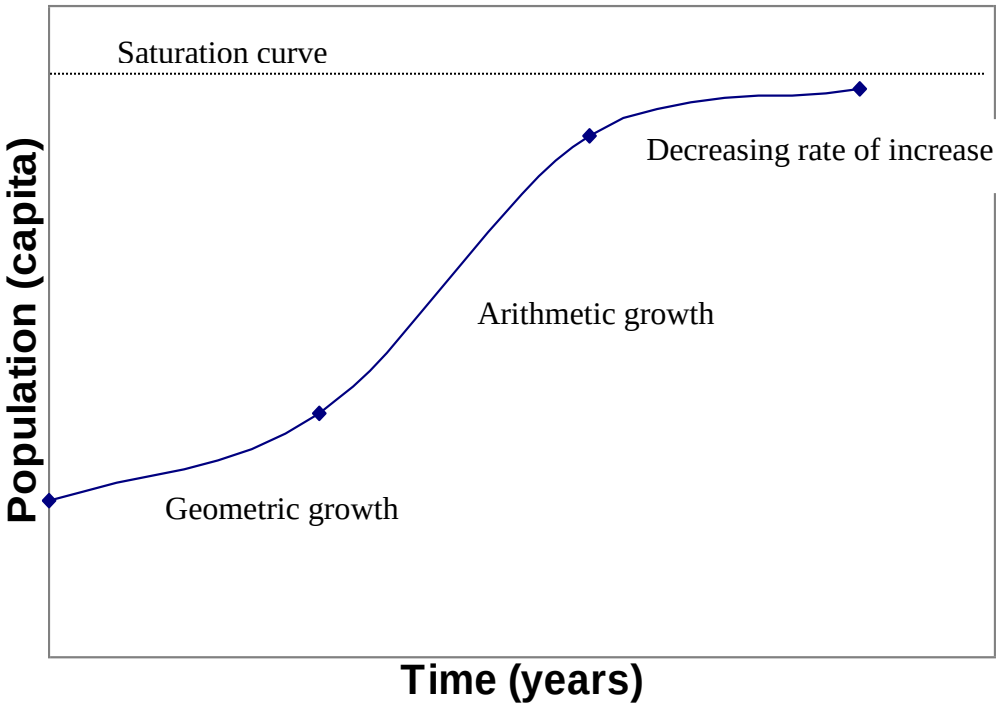
1-Sources of water:

- Rain
- Surface water
- Ground water.
- Brackish water.

3-Population

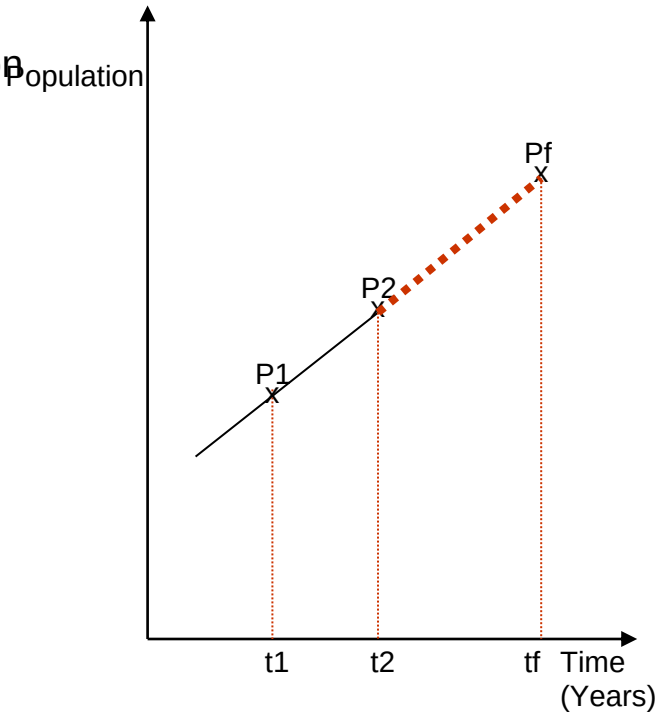
Factors affecting population increase:
1-Industrial and commercial activity.
2-Transportation facilities.
3-War and diseases.
4-Immigration.

Curve of population growth



1- Arithmetic method:

- This method depends on the linier increase of population.
- $P_f = P_i + K_a (T_f - T_i)$
- P_f : the population in future.
- P_i : the population in present.
- T_f : the design year.
- T_i : the year of known



Example:

Fined the population at year 2030.

Time (years)	P (capita)
1980	20500
1990	22000
2000	26000
2005	29000

Solution:

Time (years)	P	Δp	Δt	$\frac{\Delta p}{\Delta T}$
1980	20500			
1990	22000	1500	10	150
2000	26000	4000	10	400
2005	29000	3000	5	600

$$Ka = \frac{1}{n}\sum \frac{\Delta p}{\Delta T}$$

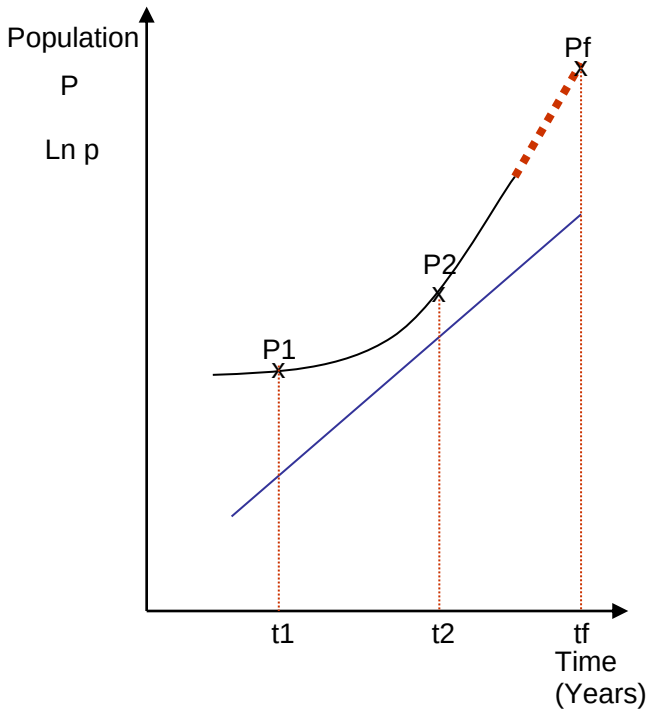
$$Ka = \frac{1150}{3} = 383.33$$

Pf = Pi + Ka (Tf –Ti)
P2030 = 29000 + 383.33 (2030 –2005) = 38583.25 ~ 38584 capita

2- Geometric method:

- This method depends on the linier increase of the logarithm of population.
- $\ln P_f = \ln P_i + K_g (T_f - T_i)$
- P_f : the population in future.
- P_i : the population in present.
- T_f : the design year.
- T_i : the year of known

$$Kg = \frac{1}{n}\sum \frac{\Delta \ln p}{\Delta T}$$



Example:
For the last example find the population at year 2030 using the geometric method.

Solution;

Time (years)	p	Δt	$\ln p$	$\Delta \ln p$	$\frac{\Delta \ln p}{\Delta T}$
1980	20500		9.928		
1990	22000	10	9.998	0.07	0.007
2000	26000	10	10.166	0.17	0.017
2005	29000	5	10.275	0.11	0.022

$$Kg = \frac{1}{n}\sum \frac{\Delta \ln p}{\Delta T}$$

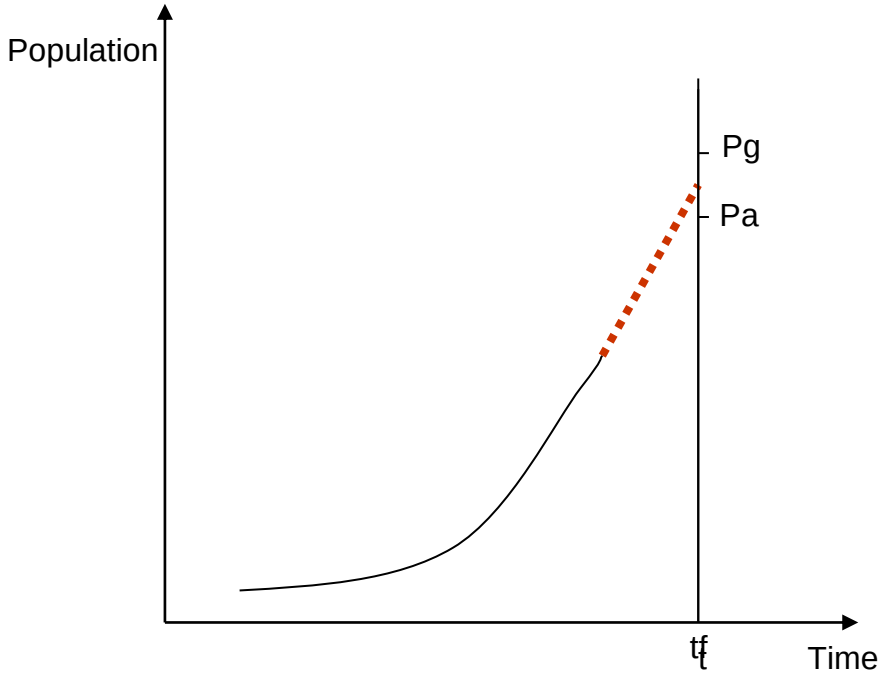
$$Kg = \frac{0.046}{3} = 0.015$$

$\ln P_f = \ln P_i + K_g (T_f - T_i)$

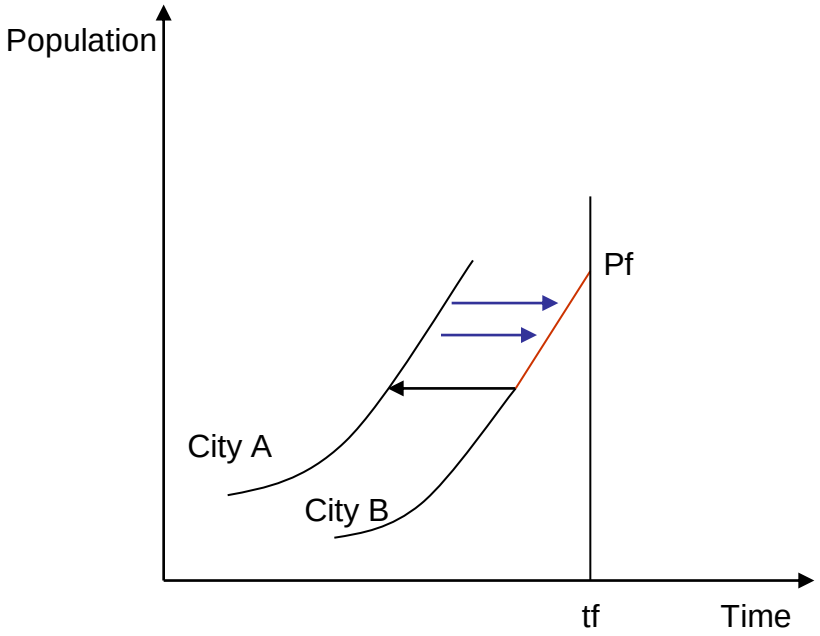
$\ln P_f = \ln 29000 + 0.015 (2030 - 2005)$

$P_f = 42194.75 \sim 42195$ capita

3- Graphical method



4- Comparison method



5- Increasing factor method

$$p_f = p_i(1+\frac{x}{100})^{(t_f - t_i)}$$

X: increasing factor = 2.4 % - 2.6 %

Example:

Predict the population of a city at year 2026 using increasing factor methodif the population at 1996 was 39000 capita.

Solution:

$$p_f = 39000(1+\frac{2.5}{100})^{(2026-1996)}$$

= 81805.14 ~ 81806 capita.

4- Water consumption

Unite of water consumption Liter/ capita/ day
q = total consumption per year/365 x population

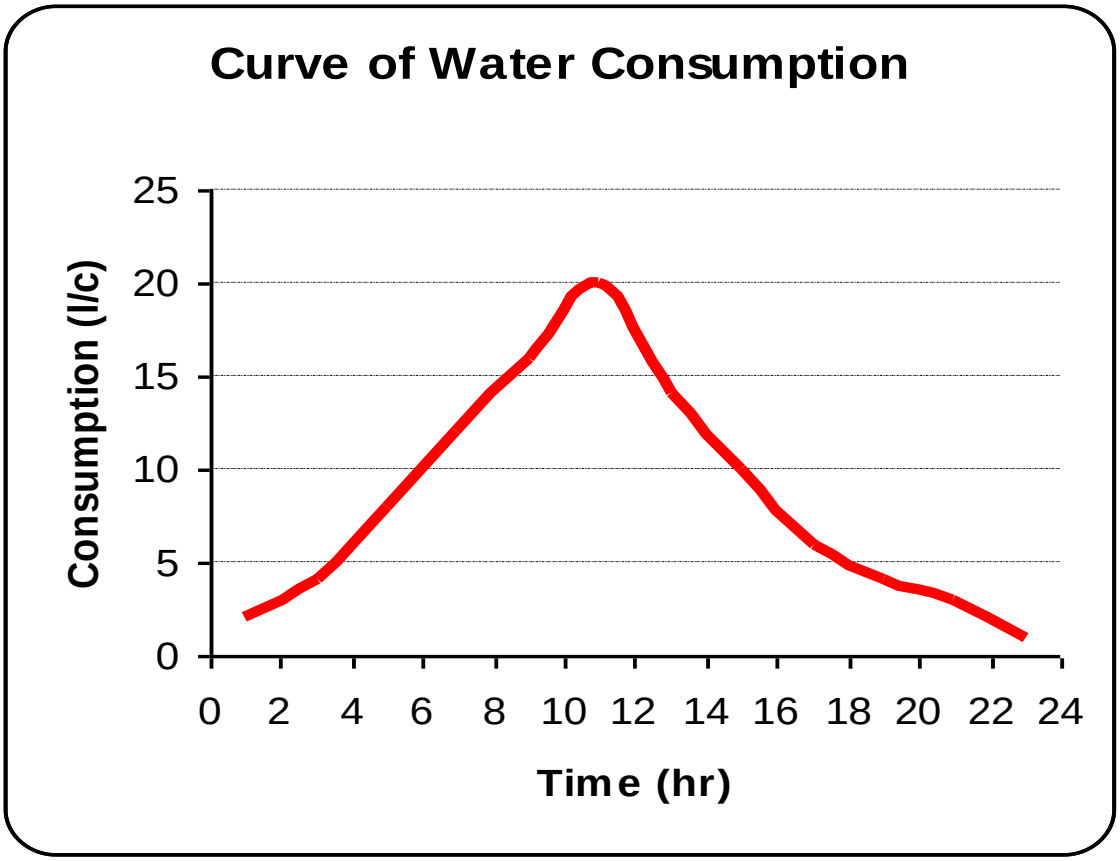
Factors affecting the rate of water consumption:

1- Size of community (population).
The per capita use of water increase by 1/10 the percentage increase in population.
2- Climate.
3- Standard of living.
4- Water pressure.
5- Quality of water.
6- Cost of water.
7- Sewerage system.

Consumption for various purposes:

1- Domestic consumption. 50%
2- Industrial consumption. 15%
3- Commercial consumption. 15%
4- Public use. 10%
5- Losses and waste 10%.

Fluctuation in water consumption



The area under the curve represent the total daily water consumption.

qmax monthly = 1.5 qave
qmax daily = 1.8 qave
qmax hourly = 2.5 qave
qmin = 0.7 qave

$$Q_{ave} = \frac{population \times q_{ave}}{1000 \times w.p \times 60 \times 60} = m^3 / s$$

Qmax monthly = 1.5 Qave
Qmax daily = 1.8 Qave
Qmax hourly = 2.5 Qave
Qmin = 0.7 Qave

5- Water quality:

Physical characteristics of water:

1- Temperature.
2- Odor , taste, color.

3- Turbidity < 5 NTU (nephelometric instrument).
4- Total dissolved solids 500 – 1000 mg/l.
5- Clarity. (potable , palatable).

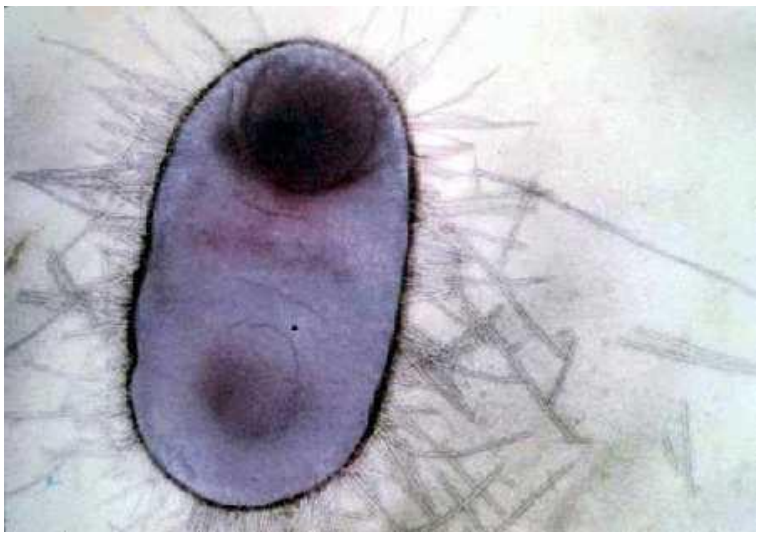
Chemical characteristics of water:

1- pH 6.5 – 8.5.
2- Iron ≤ 0.3 mg/l.
3- Manganese ≤ 0.1 mg/l.
4- Hardness. (CaCO3 > 150 mg/l)

5- Fluoride 0.5 – 1.5 mg/l.
6- Nitrate ≤ 45 mg/l.

Biological characteristics of water:

Fecal coli forms, total coli forms, E.coli.
The existence of any of coli form bacteria indicates a recent contamination of water.



A microscopic photo of E.Coli bacteria