Water Supply and Sewerage Network

Environmental Engineering Department

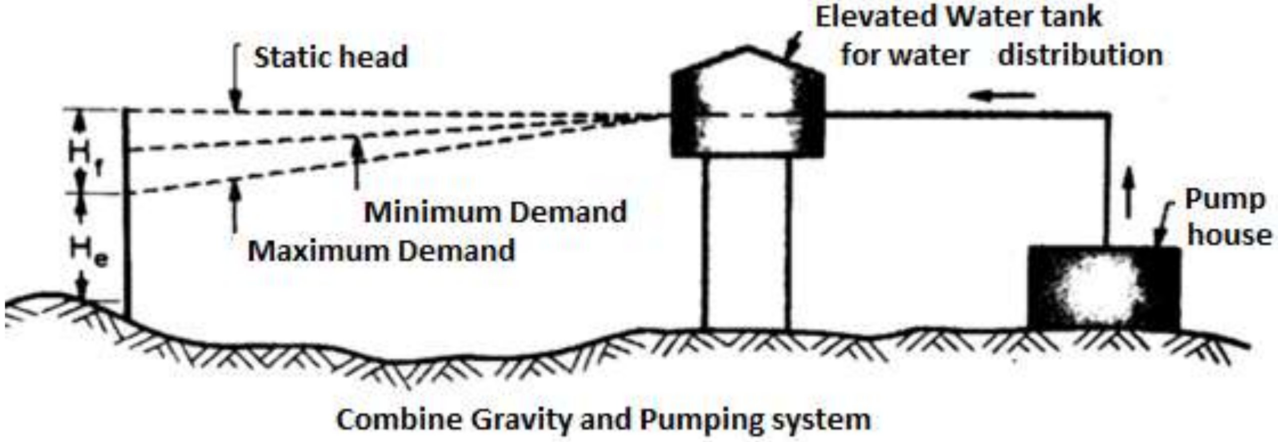
Tikrit University

Wesam Sameer Mohammed-Ali

Ph.D., P.E., M.ASCE, M.AWRA

Distribution System

This system must supply water with the required quantity & pressure. It includes pipes, storage tanks, pumps. hydrants. & valves.



Classification of distribution Systems

I. Gravity distribution

High level lake or reservoir supply water to the system. It is safe & reliable.

II. Direct pressure distribution

Water is pumped directly into system. Problems are due to failure in power-supply & pressure fluctuation.

III. Pumping & Storage System (Direct & Indirect system) (Dual or Combine system)

When the demand exceeds the pumping rate. the flow into the distribution system is from pumping station & elevated reservoir. When the pumping is more than the demand, the excess of water is stored in the reservoir. This system is economic & reliable. ft provides uniform pumping rate & the stored water is used for fire demands & pump breakdown.

Water Requirements

The amount of water required to fulfil the demand of the consumers. The water requirements depends on several factors

- *Size of city*
- *Climatic condition.*
- *Economical condition.*
- *Water quality.*
- *Water pressure.*
- *Commerce and Industries.*
- *Sewerage availability.*
- *Water flow metering.*
- *Natural of supply.*
- *Environmental education.*

Municipal Consumption of Water

1. **Domestic use** …… Houses & private buildings…. Uses: drinking, bathing, cooking, sanitation, etc.

2**. Industrial & Commercial Use** …. Offices, stores, hotels, factories, & refineries.

3. **Public Use** … Schools, colleges, hospitals, cinema, theatre, mosques, parks, gardens, fire fighting, sprinkling streets, public fountains, etc.

4. **Loss & Wastes** ….Bad plumbing, pipes breakage, unauthorized connections, etc.

PREDICTION OF POPULATION

Population can be predicted from known information of the city and its environment, commercial, industrial etc.

Prediction Methods

1. Uniform Growth Rate(Arithmetical Progression) A constant increment of growth is added periodically.

Example: If the population increased from 90,000 to 100,000 in a period of five years between 2000 and 2005, find the population in 2010.

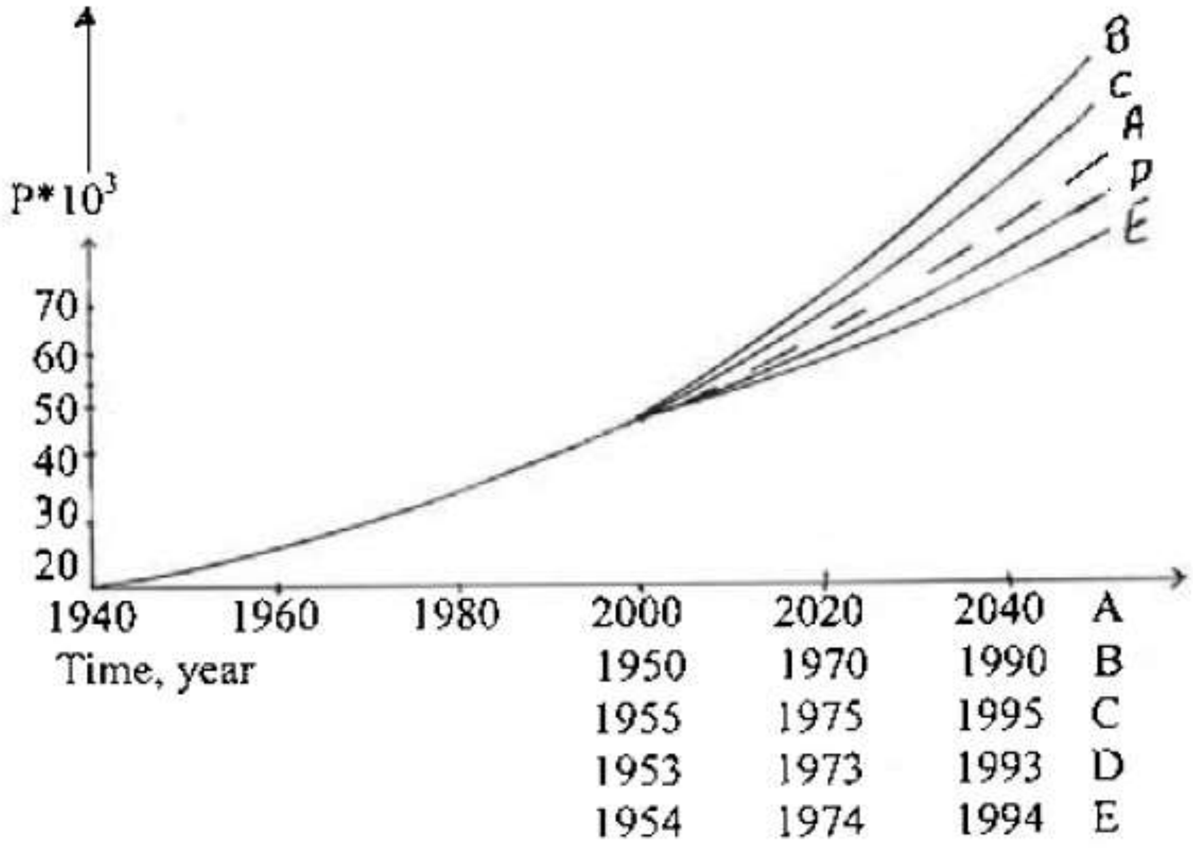
Solution:
At 2000 → 90,000
2005 → 100,000
Increment = 100,000 - 90,000 = 10,000
In 2010, the population = 100,000 + 10,000 = 110,000

2. Uniform Percentage Growth Rate A constant percentage of growth is assumed for equal periods of time.

Example: If the population increased from 100,000 to 110,000 during the decade of (1990 — 2000), find the population in 2010.

Solution:
At 1990 → 100,000
2000 → 110,000
Increment % = (110,000-100,000)/100,000 = 10 %
In 2010, the population = 100,000 *1.1= 121,000

3. Graphical Comparison (Modified Curvilinear) The population-time curve of the city is extended into the future based on a comparison with population-time curve of similar cities.



4. Empirical Method (Geometrical Progression)

Hardenberg equation, $\boxed{P_f = P_r(1+r)^n}$

Where:

P_f … future population, P_r … present population, r ….. rate of yearly increase, n ……number of years.

When the population data of the past years are available, then (r) can be computed, $\boxed{r = \sqrt[n]{P_f/P_r} - 1}$

Example: The population of a city was 124,000 in 1990 and 156,000 in 2000

a) What is the annual rate of increase?

b) What will be the population in 2010?

Solution:

$\boxed{r = \sqrt[n]{P_f/P_r} - 1} \rightarrow r = \sqrt[10]{156000/124000} - 1 \rightarrow r = 0.023 \quad = 2.3\%$

$\boxed{P_f = P_r(1+r)^n} \rightarrow P_{2010} = 156000(1+0.023)^{10} \qquad P_{2010} = 196{,}000$

What if we use 124,000 ? Check

Water Quantity Consumption

Average Daily Consumption : Mean daily usage during a one-year period.

Maximum Daily Consumption : Can be obtained from,

- Greatest total amount of water used during any 24h period in the past three years.
- Estimated from use in other cities of similar character & climate.
- Estimated from average daily consumption.

Max. Daily Consumption > 1.8 Average Daily Consumption.

Peak Hourly Consumption : Peak hour usage.

Use	L/person/d
Domestic	340
Administrative	35
Industrial	40
Net allocation	415
Losses 20%	85
Cross allocation	500

Variation in residential water consumption (L/person/d) in USA.

consumption	Range	Average
Yearly average	380 – 490	420
Mean winter	190 – 490	380
Mean summer	490 – 980	640
Maximum daily	600 – 1900	870
Maximum hourly	760 – 5000	1500

Note :-

- Intakes, transmission line, treatment plant, & pumping are designed for Maximum daily use, however, Hourly variations are handled by storage.
- Distribution mains designed for; Maximum Daily use + Fire Flow.

Fire Protection Requirements

The following equation is used to estimate the amount of water required to fulfil the demand of the fire.

$$\boxed{F = 3.7\, C \sqrt{A}}$$ **F** … the fire flow (L/s) **A** … the total floors area (m^2)

$$\boxed{F = 18\, C \sqrt{A}}$$ **F** … the fire flow (gpm) **A** … the total floors area (ft^2)

1 $Gallon$ = 3.87 $Litters$

1 m^2 = 10.76 ft^2

C ... coefficient of type of construction,

1.5 wood frame building
1.0 ordinary construction: brick & wood
0.8 noncombustible buildings
0.6 Asbestos calcium silicate board, & other new materials fire-resistive e.g- concrete buildings

<u>Max. fire flow for;</u>

Wood frame & ordinary construction	500L/s
Noncombustible construction & fire-resistive construction	380L/s
Normal one story building of any type	380L/s
-Min. fire flow	30L/s

<u>Pressure</u>

Min. pressure with pumpers = 140kPa
Without pumpers = 500kPa.

Fire Flow Duration

Fire Flow (L/s)	≥ 610	580	550	520	490	460	430	400	370	340	310	280	250	220	190	≤160
Duration (h)	10	9	9	8	8	7	7	6	6	5	5	4	4	3	3	2

Example (1)

A three-story wood frame building with a ground floor area of $680m^2$ is adjacent to a five-story building of ordinary construction with 900 m^2 per floor. Determine the fire flow & duration required for each building & the complex assuming the units are connected.

Solution:

Wood frame building: C=1.5

$F = 3.7\ C\ \sqrt{A} = 3.7 * 1.5 * \sqrt{680 * 3}$

F = 250L/s < 500 o.k.

From Table ++++ the duration = 4h

Ordinary construction building: C=1.0

$F = 3.7\ C\ \sqrt{A} = 3.7 * 1.0 * \sqrt{900 * 5}$

F = 248L/s < 500 o.k.

From Table ++++ the duration = 4h

For Two Buildings

The total area (A) = A1+A2 = (3*680 + 5*900) = 6540 m^2

% of Wood frame building = (3*680 / 6540) = 0.31 = 31%

% of Ordinary construction building = (5*900 / 6540) = 0.69 = 69%

$F = 3.7\ * \left(0.31 * 1.5 * \sqrt{6540} + 0.69 * 1.0 * \sqrt{6540}\right)$

F = 350L/s < 500 o.k.

From Table ++++ the duration = 5h

Example (2):

Estimate the fire flow for a 60,000m², single-story building of ordinary construction.

Solution:

$F = 3.7 \times 1.0\ \sqrt{60{,}000}$

$= 900$L/s

900 > Max. fire flow for one story = 380L/s

Choose → F = 380L/s.

<u>Example 3</u>: A community with population of 22000 person has an average consumption of 600 *lpcd* and the fire dictated by a building of ordinary construction with a floor area of 1000 m^2 and height of 6 stories, determine:-

1. The daily fire flow demand.
2. Maximum daily flow rate.
3. Total flow required during the day with 10 hours duration of fire.

Solution:

1. The daily fire flow demand.

$$\boxed{F = 18\, C\, \sqrt{A}} \quad = 18 * 1 * \sqrt{1000 * 6 * 10.76} = 4574\ gpm = 45874 * 3.78 \frac{l}{gal} * 1440 \frac{\text{min}}{\text{day}} = 24.92 * 10^6 \frac{l}{day}$$

2. Maximum daily flow rate.

$$Maximum\ daily\ flow\ rate = 22000\ Capita * 600 \frac{l}{capita * day} * 1.8 = 23.76 * 10^6 \frac{l}{day}$$

3. Total flow required during the day with 10 hours duration of fire.

$$Total\ Flow = 23.76 * 10^6 \frac{l}{day} + 24.92 * 10^6 \frac{l}{day} * \frac{10\ hr}{24\ hr} = 34.76 * 10^6 \frac{l}{day}$$

Water Supply and Sewerage Network

Environmental Engineering Department

Tikrit University

Wesam Sameer Mohammed-Ali

Ph.D., P.E., M.ASCE, M.AWRA