Water Facilities Master Plan for Nablus City

Preparing a strategic plan for water facilities was the main purpose of this study, to be able to sustain continuous development in water network during the development in city parts over the plan years.

This plan will be for 15 years starting from year 2012 and ending by year 2027 including all facilities of the network like resources, wells, conveyance lines and the local distribution network.

Water network in Nablus have many main problems which affect the quality of the service and make consumers unhappy, these problems are:

1. Intermittent water supply: there is no zone in Nablus takes continuous water supply because of the low capacity of the network which takes time to fill the storage facilities.
2. High percent of losses: in year 2012 the average percent of losses in the city rich about 38% which is a high percent.
3. The gap between demand and supply: due to the population growth over years and because of the limited access to water resources.

By studying these problems and the available data we were able to define some of the suitable solutions, so, by implementing this plan we expect to have the following results:

1. Continuous water supply: by increasing the capacity of the system which makes it capable to refill within very acceptable time.
2. Better control and loss detection: by taking into consideration the current project that is implementing by Nablus Municipality, this project called “Implementation of Water Loss Reduction Program for Nablus Municipality” we expect to minimize the losses and save water as much as possible.
3. Fill the gap between demand and supply: by adding new resources to the network and having better management in the network.
4. Prepare cash flow for the proposed projects and distribute them over the planning years to make them feasible.

To have better description of the study area, Nablus City has a unique location as it connects the southern and northern parts of the west bank and also because it is an economical and cultural centre. This city is one of the largest cities in Palestine because it has a total area of 29 Km2 with a built up area of 8.7 km2. The population in year 2012 was 182,615 capita distributed over all parts of the city with concentration in the old city and in refugee camps.

Nablus city has topography like wade as it's located between Eibal and Gerzem mountains with a moderate climate. The city has unique social environment because it contains the main three religions: Islam, Christianity and Judaism.

The city was divided into six main pressure zones by Nablus Municipality in year 2012, these zones are: Central, North Western, North Eastern, Southern, Western and Eastern. These zones are divided into 27 distribution areas by taking into consideration the differences in elevation not to be higher than 100m and length of the distribution area, we have to mention that all parts of the city are covered by water network and all used water comes from Palestinian wells. Losses in the network were 38% in average in year 2012.

Describing the existing components of the current water network, there are the following components:

1. Resources: all from ground water, the city mainly have six wells which are: Albadan, Alfar'a, Dier Sharaf, Sabastia, Audala and Roujeb and five springs: Qaryoun and Qwarien, Ras El-ein, Ein Alasal, Ein Dafna and Ein Biet Elma'a. Total amount of water conveyed from wells is 7.7 Mm3/yr and total amount comes from springs is 2.5 Mm3/yr.
2. Conveyance lines: used to convey water from resources to storage facilities.
3. Storage Facilities: mainly the city has 10 storage facilities distributed over the city with total storage capacity of 16,900 m3.
4. Local Distribution Network: to provide water to consumers.

Water losses in the city were divided into three main components, these components are:

1. Physical losses: means the losses due to connection losses and leakage in other parts of the network.
2. Black Losses: defined as the amount of water that can be consumed without being paid for.
3. Meter Losses: It is the losses due to meters misreading or some problems in meters.

The 38% of losses in year 2012 these losses can be divided into 11% losses in conveyance lines, 5% losses in reservoirs and the rest of losses (22%) existed in the following part of the network after reservoirs.

Water inters to the city in year 2012 equal to 9.042 Mm3/yr to all parts of the city with total water consumption in average equal to 81.3 Lpcd. Consumption in the pressure zones is like the following:

Pressure zone Name	Total consumption (m^3/month)	Consumption rate (Lpcd)
NE (North eastern)	39543.7	61
W (Western)	152324.7	99.8
S (Southern)	68900.1	95.8
E (Eastern)	97851.6	60.4
NW (North Eastern)	29042.6	111
C (Central)	61207.2	86.9

And to be able to find the demand we assumed that we have 38% of water losses also domestic water use equal to 90% from municipal water use.

Future Water Characteristics of the network:

In this plan we divided the planning years into 3 stages each stage with a period of five years as following:

1. Stage 1: 2012-2017
2. Stage 2: 2017-2022
3. Stage 3: 2022-2027

Using the following design criteria to determine the appropriate projects:

1. Sustain 120 Lpcd as domestic water consumption in all pressure zones.
2. Sustain continuous water supply by locating reservoirs in elevated places to provide water by gravity
3. Make pressure zone operate separately and having their own reservoirs and control
4. To use one day average demand to determine reservoir size
5. To do rehabilitation in the network to make it able to handle the demand in the following 15 years.

In this plan we eliminate springs from being used as water resources because of its high variability as resources. Four wells were proposed in the plan according to Palestinian Water Authority in 2011. These wells are:

Name	Productivity Rate Mm3/year	Productivity Rate M3/h	Elevation	Construction Year
Sabastia 2	2.1	300	260	2016
Sabastia 3	2.1	300	260	2021
Dier Sharaf 2	2.5	350	265	2023
Hesba	1.05	150	485	2025

To store the provided amounts of water from wells we propose 6 reservoirs as following

Name	Pressure Zone	Capacity m^3	Elevation masl	Construction Year	Coordinates	
					E	N
WR1	Western	3500	770	2014	35°13'59.835"	32°12'58.869"
NER1	North-Eastern	3500	820	2014	35°16'16.127"	32°13'23.977"
ER1	Eastern	5000	610	2015	35°18'28.197"	32°11'54.012"
NWR1	North-Western	2500	705	2019	35°14'55.635"	32°14'10.393"
ER2	North-Eastern	3000	670	2025	35°17'25.735"	32°13'34.866"
WR2	Western	3000	670	2023	35°13'34.133"	32°13'5.882"

To design conveyance lines we take two main criteria velocity to be between 0.6-3 m/s and pressure to be between 3-10 bars.

And to design the pumps we depend on energy equation to determine the KWh of each pump.

To prepare a financial study we take some criteria into consideration as follows:

1. Reservoirs comes before wells
2. Well needs two years to be ready
3. Reservoir needs one year to be ready
4. Smooth cash flow for each stage

And the following cost were used in the plan:

Element Name	Unit Cost Estimation
Reservoir	100 $/$m^3$ [3]
Wells: drilling and equipping	1000 $/m [4]
Pipe: 8"	130 $/m [5]
Pipe: 16"	180 $/m [6]
Pumps	1000 $/KWh [7]

By dividing all the proposed projects over the planning years we were able to determine the cost of each stage and each years, from this we a cash flow was generated.