

# WATER CONSERVATION IN PALESTINE

AN INTEGRATED APPROACH  
TOWARDS PALESTINIAN WATER RESOURCES MANAGEMENT

Ramallah - Palestine

March 1994



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## PREFACE

This Report has been prepared with the objective of contributing to the ongoing efforts aiming at addressing the issues and problems associated with water scarcity in the Middle East, in general, and the River Jordan basin, in particular. Although the ideas presented in the Report address the particular requirements of Palestine, it is hoped that the recommended water conservation measures and practices will be implemented by all regional parties in order to safeguard and allow the equitable and sustainable use of the available and potential water resources.

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# EXECUTIVE SUMMARY

## Introduction

One of the primary concerns of the people of Palestine is having sufficient water to assure their economic and social development both now and in the future. Palestine, along with Israel, Jordan, and most other mid-eastern countries have very limited water resources and future populations will place severe demands on already fragile reserves. There are numerous studies and plans for expanding water resource supplies through various schemes including water transfers from other basins and desalination. These schemes are expensive in most cases and also have daunting logistical and political barriers to overcome. Recognizing the scarcity of water and inevitable population growth in the region, the conservation of existing water sources is imperative. There are numerous conservation measures and approaches that may be utilized to maximize the efficient and effective use of water resources which will expand and sustain their use.

While water conservation is seen as a necessary endeavor in consideration of the limited resources available in the region, it is equally necessary to ensure the availability of water supply to meet the basic requirements of the Palestinian people.

The introduction of water conservation is based on the assumptions that, firstly, water is being used inefficiently and secondly, actual demand is exceeding available supply. The first assumption may be true in certain places and situations in Palestine, but the second at this moment is certainly not valid for Palestine as a whole.

The Palestinian demand for water, both in the domestic and agricultural sectors, is kept artificially low due to direct restrictions and suppression of the Palestinian economy by the Israeli occupation authorities over the last 27 years. The potential water resources available to the Palestinian people under an equitable sharing of regional water supplies greatly exceed the present low water demand and in this sense the urgency for water conservation may be less acute in the short and medium term.

However, responsible government takes a view to the long term, when the population will have increased considerably as a result of natural growth and the return of refugees and other Palestinians, after an acceptable peace agreement is reached. Water conservation measures initiated in the short term shall have taken full effect by the time they are actually needed to provide for the needs of a growing population, but they have to be introduced parallel to an accelerated expansion of the water supply, in volume and coverage, to meet the real water demand, both in the domestic and agricultural sectors.

Furthermore, water conservation measures can be desirable from an economic and financial point of view, as increased water use efficiency results in higher production and reduction of water losses reduces costs.

Presently, the average Palestinian domestic consumption (after deducting losses) is only about 50 liters/person/day (18 cm<sup>3</sup>/c/yr) as compared to about 250 liters/person/day (91 cm<sup>3</sup>/c/yr) for Israel (World Bank, 1993). It is proposed that a minimum water requirement be established for all domestic and industrial water users in order to assure the legitimate human and social needs of all citizens in the region. In order to achieve the minimum water requirement for the domestic sector and also to maintain the agricultural economy which is critical to the region, water conservation must become an integral component of all water development in the future.

The purpose of this report is to;

- provide a review of the existing water resource sector including the natural resources (water and land), the institutions and human resources, and the infrastructure devoted to the sector,
- describe potential water conservation measures and practices applicable to Palestine, and
- recommend investment and technical assistance priorities.

It has been recognized that institutional development with attendant human resource development is a necessary undertaking in Palestine. Sustaining water resource development can only be achieved with strong and capable institutions devoted to managing natural resources and protecting the environment for future generations. Establishing these institutions and equipping them with adequate resources is a necessary precondition to employing conservation approaches and must be considered a top priority.

### **Water Sector Background**

The only available Palestinian surface water resources are the Jordan River flow and the flash floods in the ephemeral streams flowing west, north and eastward from the central highlands of the inland region of Palestine (West Bank). Groundwater in the inland region and coastal regions (Gaza Strip) is abstracted from two entirely different aquifers. The Mountain Aquifer, underlying the inland region with three main flow directions, west, north and east has an estimated safe yield of about 700 MCM/YR (million cubic meters per year). Two thirds of the total water used is abstracted by wells, whereas about two fifths are supplied from springs. The water quality of the Mountain Aquifer flowing in western and northern direction is very good; however, in some areas spring flow or groundwater abstracted from aquifers in the Jordan Valley is brackish and not suitable for potable/domestic water supply.

Some studies indicate that the coastal aquifer has an annual recharge of 50 to 70 MCM/YR, but according to a more conservative assessment it is only 35 MCM/YR. At present, coastal groundwater is grossly over-exploited by an annual abstraction of about 95 MCM/YR. The quality of the groundwater is poor and deteriorating as a result of over-abstraction during the past several decades. Infiltration of sewage and

irrigation runoff carrying agriculture chemicals adds to that problem. The situation is also aggravated by Israeli water withdrawals within the coastal region itself (about 5-6 MCM annually) and by wells along the eastern border of the inland region that intercept the westward groundwater flow before it crosses the border.

After occupying the Palestinian territories in 1967 the Israeli authorities have severely restricted the Palestinians in developing their water resources in the inland region, whereas Israel continued its use of western and northern flows of the shared Mountain Aquifer, both in Israel as well as for the Jewish settlements established in the Occupied Palestinian Territory (OPT). The eastern flow of the Mountain Aquifer which is not shared was also utilized by Jewish settlements and the Israeli military. In the coastal region overdrafting has always been a major concern. Recently, abstraction has accelerated at a rate essentially threatening the viability of the entire aquifer system. Indeed, delays in the implementation of the broader political agreement are detrimental to the implementation of a remedial action which can be affected by the Palestinian authority.

At present, the Palestinian people are allowed to abstract only about 15 to 20 percent of the water originating in the inland region, whereas the Israelis use over three quarters of the yield of the Mountain Aquifer. The abstractions from this aquifer have reached the safe yield and most probably have gone beyond that limit during recent years. An equitable and workable solution to the management of the regional water resources is a fundamental objective of ongoing water negotiations.

Some studies and data collection of the water resources in the region have been carried out, but access to existing data is restricted and, as a result, one will find different estimates of the available renewable water resources in the area. A regional survey and establishment of a data bank is needed to provide a complete assessment of the regional water situation.

Presently, the demand in the domestic and industrial sectors is comparatively low and it will take time to upgrade the deficient infrastructure and institutions to a level where the effective demand can be met. This would leave sufficient water for irrigation in the short and medium term in the inland region. In the coastal region the situation is already very critical and here serious attempts will have to be made to control and reduce abstraction rather than allow it to increase even further. However, as population growth and reconstruction and development of the Palestinian state continues, the domestic and industrial sectors will claim an increasing share of the good quality water resources. Water conservation measures will play a cost effective role in deferring the implementation of high cost alternatives. Assuming that meeting the water demand of the domestic sector has preference over the agricultural sector, and economic pricing of the water would work in the same direction, farmers will be forced to increase their water use efficiency and at the same time look for alternative sources of water of lower quality such as brackish water and treated wastewater.

## **Institutions and Human Resources**

In the short term the Palestinian government will have to take important decisions on the allocation of water resources required for development of the different sectors of the economy. The present deplorable situation in the water sector with regard to the position and performance of the institutions responsible for management and operation of the public services is a direct result of 27 years of occupation. All infrastructure plans were directed towards serving the new Jewish settlements with limited effort towards the improvement of the Palestinian water sector.

The end of the occupation should have a prompt and positive effect on rebuilding the basic Palestinian infrastructure, including the water and sewerage networks. However, unless there is a comprehensive integrated national plan that addresses questions of appropriate size, organizational structure, administrative and technical standards in integrating the water and sewerage systems, there will be a number of uncoordinated, segregated systems.

There are several constraints identified in the water sector institutional structure. They are: discriminatory policies applied by the Israeli authorities in the pricing of domestic water, limited investment and finance sources, poor financial accounting systems and procedures applied in water undertakings, high percentage of water losses, ineffective fee collection practices, and inadequate pricing policies and cost recovery.

In some cities sewage collection networks are available but in most cases sewage is just discharged into a nearby wadi, creating serious public health hazards. Few waste water treatment facilities exist but none work properly.

In rural areas only about half of the Palestinian communities have access to safe drinking water from protected sources. After the occupation in 1967 the Israeli authorities have destroyed a large number of wells in the Jordan Valley used for irrigation water supply and farmers were denied access to their lands. Although some of these wells and lands are still being used by Jewish settlers or by the Israeli army, the reclamation of the Jordan Valley using the groundwater from the Eastern Aquifer will require a considerable investment in drilling of new wells, development of spring flows, and installation of new pumps and distribution systems.

## **Institutional Development**

The development of an institutional structure to plan, develop, and manage the nation's water resources is an essential step in implementing effective conservation activities. Given that Palestinian institutions are in the process of being developed or reorganized under new leadership, it is clear that institutional development in this sense is probably the single most important conservation measure considered in this report. Since the proposed Palestinian water institutional structure will be the primary vehicle to carry out conservation activities (or cause to be carried out through laws,

regulations, policies or some other administrative action), its importance can not be overstated.

In building the proper institutional framework which will suit the requirements and conditions of independent Palestine, it is believed that several issues are paramount. The new structure should provide for the creation of a national water authority that is responsible for all water planning and oversight, the integration of water and sewerage services, and the creation of autonomous regional utilities. A possible arrangement for the water sector institutional structure is proposed to consist of four types of organizations; National Water Council, National Water Supply and Sewerage Authority, Regional Water Supply and Sewerage Utilities, and Water Supply and Sewerage Services Company.

- \* The National Water Council would be responsible for policy, planning, international agreements and water transfer. It will also be responsible for the management of national water resources and the monitoring and regulation of the services provided. It will set standards and monitor for any discrepancies on the part of the implementing agencies.
- \* The National Water Supply and Sewerage Authority will manage the allocation of national water resources and distribute and sell water to the regional utilities. Implementing the transfer of water from outside of Palestine (e.g., Israel) will be coordinated and controlled through this authority. All regional coordination, joint projects and activities with neighboring countries regarding water and wastewater management will be carried out by this authority. Various licensing and other related procedures will also be within the framework of this authority's responsibility.
- \* The Regional Water Supply and Sewerage Utilities for the major regions of Palestine may be patterned after the Jerusalem Water Undertaking. Each regional utility will assume the full responsibility for all water and sewerage services in the region. The regional utilities will be run as non-profit public utilities. It must be emphasized that each utility will be financially and administratively independent. The regional utilities will be run by a board of directors representing the general assembly. The general assembly would include representatives from all sectors serviced in the region as well as representatives of community based non-government organizations, environmental groups, industrialists, etc. In this manner, the regional utility will be fully accountable to the community which it serves.
- \* The Water Supply and Sewerage Services Company will provide the regional water and sewerage utilities with services which each individual utility would not be able to support on a regional level. These services may include design, planning, large-scale development and construction contracts, heavy-vehicle and machinery maintenance, rehabilitation and calibration of large diameter water meters as well as human resources development. The company should include a vocational school for the education and training of technicians for

various vocations in the regional water and sewerage utilities. The company may also provide contractual services, like well drilling and rehabilitation, to the National Water Supply and Sewerage Authority, as well as to other customers.

There are several important considerations recognized as requiring immediate attention by the new institutional body. Training is needed in modern techniques and processes for managing water utilities. Special attention is needed for establishing proper accounting systems that underline the financial autonomy of the utilities. Tariff schedules must be adopted that ensure full cost recovery and guarantee financial autonomy and accountability. Increased emphasis must also be placed on improving tariff collection efficiency.

### **Conservation Measures and Practices**

Water conservation takes many forms. It is helpful to differentiate between conservation measures (the software of water management) and practices (the hardware of water management). Measures may be direct, such as regulatory controls or economic incentives related to water use, or indirect, such as through the use of price or persuasion of the public by awareness campaigns carried out in the mass media. Measures are largely the direct responsibility of a central water authority. Practices, on the other hand, are typically investments carried out by the supplier or the water user often because of measures introduced by the water authority. Practices typically require the use of technologies to reduce losses from leaks, reduce evapotranspiration, reduce demand for fresh water by substituting water of lesser quality, or increase the recharge.

The various approaches to conservation addressed in this report include; reducing water losses, investments in reducing water demand, substituting for fresh water, institutional and regulatory approaches, economic incentives, and education and persuasion.

Reducing water losses begins with municipal unaccounted-for-water. A comparison of volumes of water supplied and water delivered to the consumer clearly indicates significant unaccounted-for water in existing Palestinian municipal networks. Losses are estimated to range from 25 to 55 percent of actual supply. Within the existing municipal networks there is a high percentage of water losses originating from leaks owing to deteriorated network conditions. Extensive repair and replacement of the existing networks is a major conservation priority.

In the agricultural sector there are several recommended practices to reduce water losses such as lining earthen canals. In Palestine wadis typically convey large volumes of water for short periods from rainfall events of short duration. Collection dams and water spreading terraces to agricultural fields or canals to ground water recharge basins are viable conservation techniques in Palestine. Injection wells to facilitate groundwater recharge is also a promising technique in some locations.

In some areas of the inland region there are most impressive examples of terracing, drought resistant olive and almond trees, and intercropping with a variety of other crops. This conservation practice conserves both soil and water and should be replicated wherever farming is practiced on steep slopes.

Reducing user demand in the agriculture sector can be achieved through the increased investment in technologies such as drip irrigation. Major improvements on national water resources such as watershed management and spring development, should be the responsibility of the Palestinian government, leaving end-user investments in the agricultural sector to be made by the private sector, cooperatives and individual farmers. Improved credit to farmers is needed to encourage and increase the use of water conservation technologies.

Household water conservation devices include water saving toilets, dual wastewater systems and flow regulators. Many industrial processes such as cooling and stone cutting can use water of lesser quality or recycled water.

Two substitutes for fresh water, wastewater and brackish water, offer important conservation practices. Wastewater offers particular advantages as a substitute for freshwater. Municipalities with sewer systems and treatment plants may recover high percentages of their water supplies. As much as 65 percent of municipal water supplies may be available for reuse with adequate and efficient infrastructure. Treatment of sewerage is necessary for safe reuse. The treatment process should be determined by the end use for which the reclaimed water is to be used. Palestine presently has only a few treatment plants but none are working properly. More treatment plants are being planned but technical and management issues need to be addressed prior to further expansion of this sub-sector.

Brackish water, estimated at around 200 MCM, occurs primarily in the coastal region and the eastern parts of the inland region. The expanded use of brackish water has particular merit in the Jordan Valley and the coastal region. Careful management is needed but recent advances in crop science makes this an attractive conservation option.

Regulatory measures expected to be implemented by the new water and sewerage utilities include water extraction licensing, applying standards of service, water quality monitoring, plumbing and appliance restrictions, restrictions on water use during droughts, and penalties for non compliance.

Regulatory measures need to be complemented by economic incentives to encourage compliance and water conservation. Graduated tariffs can be designed to moderate demand while safeguarding the basic requirements of the poor. Discrimination in pricing between water supplies of different qualities and integration of sewage charges with water tariffs are other conservation mechanisms.

Education and persuasion is thought to be a very important tool to instill a conservation ethic in water users. The water and sewerage utilities will carry out

public awareness campaigns which will raise the level of understanding regarding water resource limits and persuade citizens to adopt recommended conservation practices.

### **Project Recommendations**

In summary, the conservation measures and practices described above offer great potential to conserve national water resources and direct available and potential water supplies to the most beneficial use.

Based on the relevancy of the conservation approach, recommendations on projects have been formulated. Those projects which have immediate need and impact on water conservation are indicated as short term priorities. Medium term projects are those which primarily require preliminary studies to be carried out, while long term projects are those dependent on the completion of feasibility studies.

#### **Short Term**

1. Assistance in Institutional Development
2. Municipal Water Supply Network Rehabilitation
3. Regional Data Collection
4. National Water Policy and Planning
5. Well and Spring Survey
6. Tariff Reform
7. Pilot Project for Irrigation with Wastewater and Brackish Water

#### **Medium Term**

8. Training of Regional Water and Sewerage Utility Staff
9. Commodity Procurement for New Water and Sewerage Utilities
10. Well Rehabilitation
11. Dam Siting and Design
12. Public Awareness Campaigns
13. Rehabilitation of Waste Water Treatment Plants

#### **Long Term**

14. Dam Construction
15. Municipal Network Extension
16. Credit Program for Improving Irrigation Efficiencies



# 1 GENERAL BACKGROUND

## 1.1 HISTORICAL OVERVIEW

The partition plan for Palestine, outlined in the UN General Assembly Resolution 181 of November 1947, called for the establishment of an Arab state and a Jewish state in Palestine. However, the actual borders of the Jewish State of Israel as declared in 1948 exceeded the borders outlined in the partition plan, and all contact between what is now known as the West Bank and the Gaza Strip was completely severed. The West Bank was incorporated into Jordan and the Gaza Strip came under Egyptian control. In 1967 both regions came under Israeli military occupation.

On November 15, 1988 the Palestine National Council (PNC) announced the Declaration of Palestinian Independence which proclaimed the establishment of the State of Palestine, with Jerusalem its national capital. The Palestinian State has been recognized by over 100 members of the United Nations and granted varying levels of status and representation in various international organizations and agencies. Within the framework of the peace process which was initiated in November 1991, representatives of the State of Palestine are participating as full partners in negotiating future regional arrangements.

Among the issues which are discussed by the participants in the negotiation process, water is clearly one of the most central. One of the multi-lateral working groups is entirely dedicated to the issue of regional water resources management and distribution. The groups on the environment, economic development and the refugees will most likely have to allocate a substantial proportion of their discussions to the issue of regional water distribution and utilization and the constraints to progress in all three areas arising from the scarcity and deteriorating quality of available water resources. At the same time, the question of arms control is unlikely to be settled until the potential of conflicts over water between regional riparian states is reduced.

Although scarcity and maldistribution of water resources constitute the two most common riparian problems in the Middle East, the Jordan basin best represents the model of scarcity with attendant problems of overpopulation, insufficient financial resources, poor management and imbalance of power among its riparians.

At the heart of the issues which characterize the conflict potential among the Jordan basin's riparians is the lack of agreement on riparian issues. The Palestinian and Jordanian view is that Israel has preempted their water rights and impeded their development while exploiting the water resources of the OPT either directly for the Jewish colonies or by extracting from the aquifer extensions within Israel. It is estimated that Israel currently satisfies up to 40 percent of its water needs from water seen as Palestinian. About 87 percent of the current OPT's water supply is consumed by Israelis.

## 1.2 GEOGRAPHY

The proposed State of Palestine, comprising the inland region known as the "West Bank", the coastal region known as the "Gaza Strip" and the proposed "corridor" connecting the inland and coastal regions through Idna and Beit Hanoun, has a land area of 6183 square kilometers. The inland region, including the "No Man's Land" zones around Jerusalem and the Latrun area, extends over an area of 5682 square kilometers (excluding the 210 square kilometers comprising the surface area of the Dead Sea within the State's boundaries). The inland region has a maximum length of 137 kilometers along the longitudinal axis between Zububa in the north and the southern-most boundary line south of Al Samu. Its width varies from 31 kilometers along the latitude connecting Jerusalem with the northern tip of the Dead Sea, to 58 kilometers along the latitude starting from Qalqilia along the western boundary and intersecting the Jordan River north-east of Zubeidat.

The coastal region extends over an area of 365 square kilometers. It has an average maximum length of 45 kilometers between the boundary near Beit Hanoun in the north, and Rafah on the Palestinian-Egyptian border in the south. Its width varies from 6 kilometers along the line transversing through Deir El-Balah in the center, to 13 kilometers along the Palestinian-Egyptian boundary in the south.

The proposed connecting "corridor", which is essential to ensure territorial integrity and viable socio-economic integration, has an area of around 136 square kilometers and extends from Idna in the south-west of the inland region to Beit Hanoun in the north-east of the coastal region. It has a total length of about 35 kilometers and an average width of 4 kilometers.

The State is tentatively divided into four major development regions, along the pre 1967 administrative boundaries of the districts of Nablus, Al Quds (Jerusalem), Al Khalil (Hebron) and Gaza. The State's general location is shown in Figure 1.1.

## 1.3 LAND USE

Land use and development are generally influenced by the prevailing soil characteristics, topography, climate, population distribution and density, availability of water and other natural resources and the type and level of economic activity.

In addition to these factors, land use development in Palestine has been affected by the restrictions imposed by the military occupation on the use of land and the utilization of other available and potential natural resources. The confiscation of Palestinian land, the construction of Jewish colonies and related infrastructure and the severe restrictions imposed by the occupation authorities on all aspects of Palestinian development have constrained the proper development of land use in accordance with the social and economic needs of the Palestinian people, and have resulted in obvious deleterious environmental and ecological effects.

Of the total land area within the State's boundaries, it is estimated that about 2300 square kilometers (37%) are easily cultivable, about 2250 square kilometers (37%) have a limited capacity for cultivation but may be reclaimed, while some of the remaining areas which are not suitable for cultivation may be developed into good grazing lands. By 1990 the major land use components were estimated shown in Table 1.1.

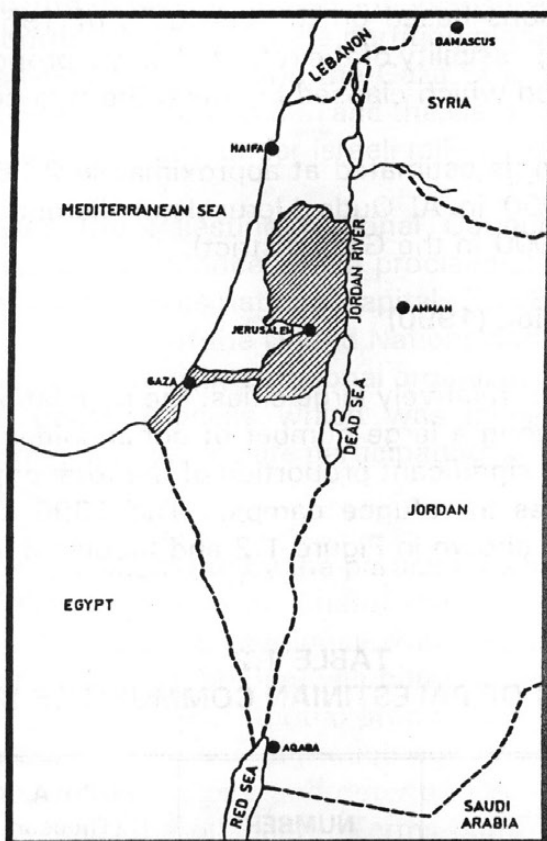


Figure 1.1 General Location of the State of Palestine

TABLE 1.1  
LAND USE COMPONENTS IN OPT, 1990

LAND USE	AREA (Sq. Km.)	PERCENT
Cultivated Lands	1945	31.5
Forests	30	0.5
Built-up Areas		
Palestinian Communities	200	3.2
Jewish Colonies	70	1.1
Roads	10	0.2
Grazing and Desert	3928	63.5
<b>TOTAL</b>	<b>6183</b>	<b>100.0</b>

## 1.4 POPULATION AND DEMOGRAPHY

Obviously, reliable information on the State's base population and its demographic characteristics can be obtained only through a census conducted by the Government of Palestine after all those who were citizens of the "West Bank" and the "Gaza Strip" prior to the 1967 war are given the opportunity to return. In the meantime, and for the purpose of this study, the total population and its distribution will be estimated as an average of projections based on the censuses of 1961 and 1967. These estimates account for the possibility of the return of only a proportion of all those who emigrated during the period which elapsed between the two censuses.

The total 1990 population is estimated at approximately 2.265 million (669000 in the Nablus district, 584000 in Al Quds (Jerusalem) district, 239000 in Al Khalil (Hebron) district and 773000 in the Gaza district).

### 1.4.1 Population Distribution (1990)

With the exception of a few relatively large cities, the population of the four districts is generally distributed among a large number of communities with relatively small populations. In addition, a significant proportion of the total population, especially in the Gaza district, still lives in refugee camps. The 1990 spatial distribution of Palestinian communities is shown in Figure 1.2 and tabulated in Table 1.2.

TABLE 1.2  
THE DISTRIBUTION OF PALESTINIAN COMMUNITIES BY SIZE, 1990

COMMUNITY TYPE	NUMBER	POPULATION (Thousands)	PERCENT
District Cities	4	> 70	25
Other Cities & Towns	9	20 - 70	14
Small Towns	50	5 - 20	19
Villages	70	2.5 - 5	10
Small Villages	376	< 2.5	15
Refugee Camps	28	1 - 60	17
<b>TOTAL</b>	<b>537</b>		<b>100</b>

### 1.4.2 Urbanization

In many developing countries "urbanization" has been due to massive population movement from the rural towns and villages to the major urban cities. In Palestine, such urbanization has been precluded as a result of the maldistribution of resources, employment opportunities and services, and the complexity of the political, social and economic conditions. Instead, urbanization in Palestine has generally been characterized by the natural growth of urban cities and a gradual transformation of some towns and villages to semi-urban communities. The latter communities

generally tend to acquire increasing urban functions while maintaining a predominantly traditional life style. Furthermore, a significant number of the Palestinian people had been forced to leave their original communities and live in refugee camps as a result of the expanding occupation of Palestinian lands by Israel since its establishment in 1948.

Thus, for the purpose of identifying possible urbanization trends, communities in Palestine are divided into four categories on the basis of population size, functional role and dominant life style. It is important to note that while the proposed categorization allows for the analysis of the present community structure and facilitates the assessment of future community development requirements, the four categories exhibit definite overlapping characteristics which makes it difficult to draw the dividing lines between them with absolute accuracy. The four categories are urban, semi-urban, rural and refugee communities.

- \* Urban communities include all communities which have a definite urban role, and which clearly perform administrative, commercial and services functions. This category may be divided into three groups, the traditional urban centers, a number of urban towns and several sub-urban communities.
- \* Semi-urban communities include rural towns and villages which are increasingly acquiring urban characteristics due to their functional role, location and economic activity.
- \* Rural communities are those which are predominantly active in agriculture and have no significant administrative, commercial or services function. Communities within this category are all those which are not included in the above two categories, excluding the refugee camps. This category also includes a small number of Bedouin communities, which are scattered mainly in the southern parts of the inland and coastal regions.
- \* Refugee communities include all refugee camps. Members of these communities generally work outside the camps, in neighboring towns or in Israel. The refugee population resides in 20 camps in the inland region and 8 camps in the coastal region.

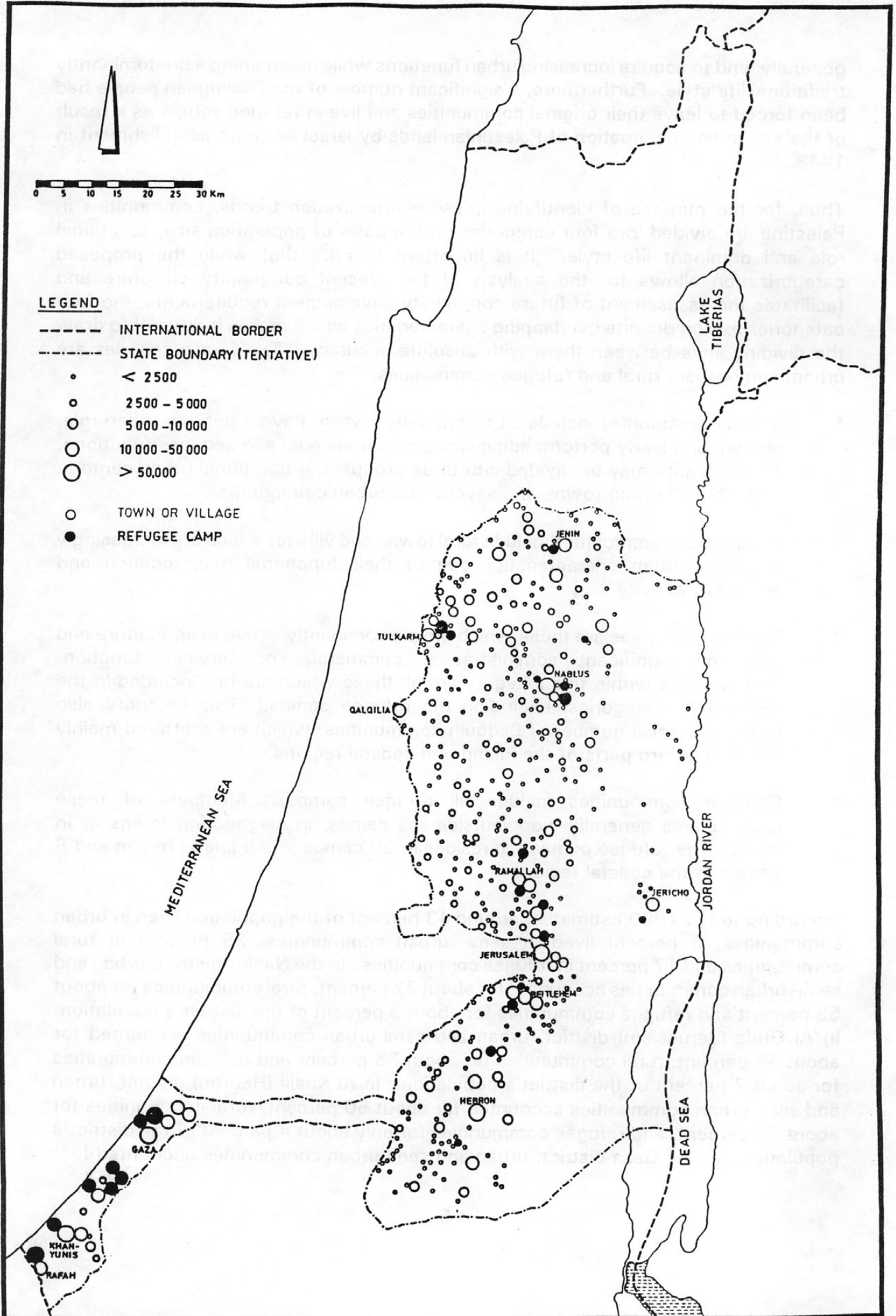
According to the 1990 estimates, around 43 percent of the population lived in urban communities, 5 percent lived in semi-urban communities, 35 percent in rural communities and 17 percent in refugee communities. In the Nablus district, urban and semi-urban communities accounted for about 32 percent, rural communities for about 59 percent and refugee communities for about 9 percent of the district's population. In Al Quds (Jerusalem) district, urban and semi-urban communities accounted for about 58 percent, rural communities for about 35 percent and refugee communities for about 7 percent of the district's population. In Al Khalil (Hebron) district, urban and semi-urban communities accounted for about 50 percent, rural communities for about 46 percent, and refugee communities for only about 4 percent of the district's population. In the Gaza district, urban and semi-urban communities accounted for



0 5 10 15 20 25 30 Km

**LEGEND**

- INTERNATIONAL BORDER
- - - - - STATE BOUNDARY (TENTATIVE)
- < 2500
- 2500 - 5000
- 5000 - 10000
- 10000 - 50000
- > 50,000
- TOWN OR VILLAGE
- REFUGEE CAMP



MEDITERRANEAN SEA

JORDAN RIVER

DEAD SEA

LAKE  
TIBERIAS

TULKARH

JENIN

NABLUS

GALQILIA

RAMALLAH

JERICO

JERUSALEM

BETLEHEM

HEBRON

GAZA

KHAN-YUNIS

RAFAH

about 56 percent, refugee communities for about 35 percent, and rural communities for only about 9 percent of the district's population. The estimated 1990 population distribution according to district and type of community is presented in Table 1.3.

**TABLE 1.3**  
**POPULATION DISTRIBUTION, 1990**  
**(THOUSANDS)**

Type of Community	Region									
	State		Nablus District		Jerusalem District		Hebron District		Gaza District	
	Population	%	Population	%	Population	%	Population	%	Population	%
Urban	978	43	157	23	319	55	95	40	407	53
Semi-Urban	125	5	60	9	19	3	24	10	22	3
Rural	782	35	395	59	205	35	110	46	72	9
Refugee	380	17	57	9	41	7	10	4	272	35
<b>TOTAL</b>	<b>2265</b>	<b>100</b>	<b>669</b>	<b>100</b>	<b>584</b>	<b>100</b>	<b>239</b>	<b>100</b>	<b>773</b>	<b>100</b>

## 1.5 CLIMATE

Palestine has a Mediterranean climate characterized by long, hot, dry summers and short, cool, rainy winters, which are modified locally by altitude and latitude. The climate is determined by Palestine's location between the subtropical aridity of Egypt and the subtropical humidity of the eastern Mediterranean. January is the coldest month, with temperatures ranging from 5°C to 10°C, and August is the hottest month, with temperatures ranging from 18°C to 38°C.

About 70 percent of the average rainfall in Palestine falls between November and March. The months of June through August are generally rainless. Rainfall is unevenly distributed, generally decreasing to the south and east and varies from season to season and from year to year. Precipitation is often concentrated in violent storms, causing flooding and erosion. During January and February, it may take the form of snow at the higher elevations of the central highlands, especially around Jerusalem.

Climate in the Jordan Valley zone is characterized by hot summers and warm winters with an annual rainfall ranging from 350 millimeters in the north to 100 millimeters in the south. The Eastern Slopes zone suffers from aridity and erosion with an average annual rainfall of around 250 millimeters. The Central Highlands zone enjoys good rainfall ranging from 700 millimeters in the mountains to 400 millimeters at the foothills annually. The Semi-Coastal zone has relatively high rainfall ranging from 500 millimeters to 600 millimeters annually. The Coastal zone has an average annual rainfall ranging from 400 millimeters around Gaza in the north to 200 millimeters around Rafah in the south. The mean number of rainy days per year ranges from 55 in the mountain range to 25 in the Jordan Valley and the coastal zones.

## 1.6 SOILS

Soil physiognomy is affected by parent rock and the local climate. Parent and climatic conditions can contribute to the formation of a wide range of soil types. Most similar to the parent rock in composition are young soils. In mature or old soils, climatic and other environmental factors are decisive while the origin of the rock is hardly identifiable. Soils mature in central and northern Palestine and due to relatively high temperatures are intermediate while in the Naqab and lower Jordan Valley desert soils prevail.

Highly important in farming is the ratio between the formation of new soil and its disappearance by erosion. In the mountainous areas, the topsoil is washed off faster than new soil can form from the bedrock beneath. The young soil usually has no chance to mature and grow old, therefore most soils in these areas are classed as young.

In Tulkarm and part of the Jenin sub-districts, soils are characterized by heavy terra rossa and alluvial types. Most of these soils are suitable for farming.

Most of the remaining soils in the inland region are light gray to grayish brown soils. These soils are not particularly fertile but they may be enriched by manure and chemical fertilizers.

In the coastal region, besides the barren dune belt along the shore, are the coarse-grained, hamra soils, which are adaptable to farming because of the fine textured cover of mineral on each grain.



## **2 OVERVIEW OF THE REPORT**

### **2.1 WATER SECTOR ISSUES**

One of the primary concerns of the Palestinian people is having sufficient water to assure their economic and social development both now and in the future. Palestine, along with Israel, Jordan, and most other mid-eastern countries have very limited water resources and future population projections will place severe demands on already fragile reserves. There are numerous studies and plans for expanding water resource supplies through various schemes including water transfers from other basins and desalination. These schemes are expensive in most cases and also have daunting logistical and political barriers to overcome. Recognizing the scarcity of water and inevitable population growth in the region, the conservation of existing water sources is imperative. There are numerous conservation measures and approaches that may be utilized to maximize the efficient and effective use of water resources which will expand and sustain their use.

### **2.2 GUIDING PRINCIPLES**

In order to define efficient and effective use, several principles of development must be addressed in the context of Palestine. A joint Palestinian/Israeli report (Assaf et al, 1993) proposed several necessary principles for water development including the need to establish a minimum water requirement (MWR) in order to assure the legitimate human and social needs of all citizens in the region. It was recommended that the MWR be set at 100 CM/person/yr (cubic meters per person per year) corresponding to 274 l/c/d for domestic/urban/industrial demands. This figure recognizes the present low per capita consumption for Palestinians with a piped water supply (not including losses) of 18 CM/person/yr (50 l/c/d) and the obvious need to raise Palestinian water consumption to levels comparable to other countries in the region. An additional 25 CM/person/yr (68 l/c/d) is added to the MWR for utilization for household and small scale gardening which is of cultural importance to the Palestinian people who often grow crops near their houses for self-consumption. The resulting total MWR of 125 CM/person/yr (342 l/c/d) is proposed as an equitable apportionment standard for domestic water resource allocations in the entire region. This MWR is understood to also apply to Palestinian refugees and other Palestinians who return to Palestine as a result of the peace negotiations.

The authors further propose that, once the MWR has been satisfied, all remaining fresh water should be used for agricultural purposes. In view of the limited fresh water resources available, domestic and industrial/commercial use of water is seen as the priority. During the short and medium term stages of nation-building and developing the new State of Palestine, the Palestinian agricultural sector would continue to utilize at least existing extractions from irrigation, and be encouraged to develop and utilize flowing springs, and be aided in the planning and construction of rainwater runoff detention dams, plus be allocated the remaining water that is not utilized in the national domestic MWR per capita allocations for the Palestinian

population as a whole. In the future, water of lesser quality, brackish water and treated wastewater, could be used for agricultural purposes. It was pointed out that through recycling and with the installation of efficient infrastructure, about 65 percent of Palestinian wastewater in urban areas can be reclaimed and provided to support a significant portion of the water requirements in the Palestinian agricultural sector in the long term. Thorough, comprehensive and inter-disciplinary planning is required in order to coordinate future treated wastewater availability and suitable land for its use and appropriate cropping patterns.

- \* The first guiding principle of this report is, therefore, raising the domestic/industrial consumption levels of fresh water to minimum standards while maintaining the agriculture sector at its present level with the added buffer of unused spring water and rainfall runoff which can be accomplished through a series of water conservation measures.
- \* A second guiding principle is the recognition that institutional development with attendant human resource development is a necessary undertaking in Palestine. Sustaining water resource development can only be achieved with strong and capable institutions devoted to managing natural resources and protecting the environment for future generations. Establishing these institutions and equipping them with adequate resources is a necessary precondition to employing conservation approaches and must be considered a top priority.
- \* A third guiding principle is the need to recognize that water is an economic good which, subject to social considerations, should be allocated to optimize economic development.
- \* A fourth guiding principle is the necessity to view water as a renewable resource to be developed within the context of a safe yield established for each watershed or aquifer on a regional basis. Environmental protection must be considered as a necessary approach to maintain water quantity and quality and associated habitats for not only human concerns but also animal and plant life. Conjunctive use of water resources multiplies the benefits and justifies investments that may be uneconomical when viewed singularly.

### **2.3 REPORT PURPOSE**

In light of these principles the purpose of this report, then, is to;

- provide a review of the existing water resource sector including the natural resources (water and land), the institutions and human resources, and the infrastructure devoted to the sector,
- describe potential water conservation measures and practices applicable to Palestine, and
- recommend investment and technical assistance needs and strategies.

Most conservation measures or practices can be carried out, or cause to be carried out, only by capable institutions with a mandate for action, capable staffs, and adequate resources. The establishment of such institutions becomes the first priority for the water sector in the newly emerging State of Palestine. Conservation activities described herein are proposed to take place within the purview of such institutions to be established in the near future.

It is perhaps necessary to note that water conservation takes many forms. It is helpful to differentiate between measures (the software of water management) and practices (the hardware of water management). Measures may be direct, such as regulatory controls placed on water use, or indirect, such as through the use of price or persuasion of the public by awareness campaigns carried out in the mass media. Measures are largely the direct responsibility of a water authority. Practices, on the other hand, are typically investments carried out by the supplier or the water user often because of measures introduced by the water authority. Practices often involve the use of technologies to reduce losses from leaks, reduce evapotranspiration, reduce demand for fresh water by substitution with water of lesser quality, or increase the recharge. These distinctions provide the basis for the organization of this report.

In Chapter 3, "Water Sector Background" a description is provided of the sector including existing water resources, institutions, and infrastructure. Chapter 4, "Institutional Development" provides a proposed reorganization plan for the water sector to include a National Water Council, a National Water Supply and Sewerage Authority, several regional Water and Sewerage Utilities, and a Water Supply and Sewerage Services Company. In Chapter 5, "Conservation Measures and Practices," various approaches and technologies are described along with the expected benefits that could accrue from their adoption. A rationale for selecting among the various conservation approaches based on short, medium, and long term perspectives, is outlined in chapter 6, "Ranking of Project Priorities". Draft profiles of recommend projects are provided in Appendix A.

### **3 WATER SECTOR BACKGROUND**

The availability of reliable supplies of water in sufficient quantity and adequate quality for domestic, agricultural and industrial uses is essential for the continued livelihood of Palestine, and its sustained socio-economic development activities. It is a fact that the Palestinian people have been deprived of the opportunity to develop their potential and available national water resources. Moreover, they have been excluded from almost all riparian arrangements for the distribution and allocation of the Jordan River Basin waters. As a result, the quantities of water which have been available to the Palestinian people in the Occupied Palestinian Territory during the past 27 years represents only a small fraction of their water rights. Immediately upon independence, the State of Palestine will have to identify its water rights and make every possible effort to secure access to its water resources through regional and bilateral arrangements. In addition, the State of Palestine will have to adopt and encourage the rational utilization of available resources in order to affect a balance between the rates of consumption and natural replenishment of the water sources.

The growing scarcity of water in the Middle East in general and in Jordan, Israel and Palestine in particular makes water conservation measures a mandatory part of any water management plan irrespective of the outcome of the bilateral and multilateral negotiations. The competing demands by the agricultural sector on one hand and the domestic and industrial sectors on the other hand are both likely to increase considerably and would require a policy to guarantee an adequate supply, both in volume and quality, for the domestic and industrial sectors. An increasing part of the agricultural water demand will eventually have to be covered by springs, rainfall runoff, brackish water and treated municipal and industrial wastewater. Water conservation measures will have to be tuned to those developments.

Despite the distinctly adverse conditions posed by the Israeli occupation, some Palestinian institutions are showing a remarkable performance. However, the Palestinian authorities still have to set up the institutional and regulatory capability to plan, guide and implement the major developments in the water sector that are now due to take place and simultaneously introduce the necessary water conservation measures.

The poor condition or absence of water infrastructure is a major constraint to the prudent use of scarce water resources. Water conservation efforts will be only fully effective after the population and the farmers have been provided with both an adequate water supply and wastewater handling systems. However, even at the current low levels of service, significant savings of water can be achieved.

#### **3.1 WATER RESOURCES, SUPPLY AND DEMAND**

Rainfall is the source of almost all water supply in Palestine. Rainfall decreases from north to south and from west to east with annual averages ranging from around 650 millimeters in the Central Highlands zone to 200 millimeters or less in the Jordan Valley and coastal zones.

The average total amount of rainfall on the land area comprising the State of Palestine is estimated at 3030 million cubic meters (MCM) (approximately 130 MCM in the coastal region and 2900 MCM in the inland region). Evaporation and surface run-off account for about 2135 MCM. The resulting average renewable water balance is approximately 895 million cubic meters (60 MCM in the coastal region and 835 MCM in the inland region). However, of this amount only about 760 MCM are estimated to be easily usable. In addition, Palestine's riparian share of the Jordan River Basin's waters has been estimated at 320 MCM annually (250 MCM from the Jordan River and 70 MCM from the Yarmuk River). Thus, the total potential annual renewable water sources available to Palestine are estimated at 1080 MCM.

Rainwater which falls over the Central Highlands flows to the east and west following the natural slopes of the mountain range. As the western slopes are gentler than the eastern slopes and enjoy more rainfall, the western groundwater aquifers have a higher recharge rate. Rainfall on the steep eastern slopes, however, feeds the springs along the eastern escarpment and the deep seated aquifers along the Jordan Valley. In the coastal region the balance of rainfall remaining after evapotranspiration and run-off infiltrates the sandy soil and recharges the groundwater aquifers.

### **3.1.1 Surface Water**

Rainfall becomes available as surface water to the extent that it is able to run-off into rivers rather than evaporate or infiltrate into the ground. The amounts of surface water run-off and the rate of infiltration into the ground depend on many factors related to climate, topography, geology and soil characteristics.

The only permanent source of surface water within the boundaries of the State of Palestine is the Jordan River. Surface run-off water resulting from high-intensity rainfall is generally intermittent and does not occur in any wadi every year. Therefore, surface water storage schemes based on run-off or flood flows may not give a reliable yield, or retain sufficient quantities of water for direct summer abstraction. However, such schemes would be excellent for artificial recharge of the underground aquifer system especially in the Jordan Valley and coastal zones.

Sea water is available only in the Dead Sea in the east and the Mediterranean along the coastal region in the west.

Most of the usable surface water is available through some 300 springs and seeps which drain the various groundwater basins at the foot of the mountain range in the western inland region. Only about 120 of these springs and seeps have permanent discharge, while the rest flow only in the winter season and dry up in the summer.

The total annual discharge of all springs and seeps is estimated at 90-110 million cubic meters. Of this amount, fresh water annual discharge is estimated at 50-60 million cubic meters. The remaining 40-50 million cubic meters are brackish water discharged through springs and seeps located along the northern and western shores of the Dead Sea. About 3-4 million cubic meters of the fresh spring water are used

for domestic purposes, while the rest is utilized for irrigation. Brackish water is partially utilized for irrigation of palm trees and for recreation in sites along the western shore of the Dead Sea. No spring water is available in the coastal region.

Due to upstream development in Israel, the wadi flows in the coastal region are negligible at present. In the inland region the Palestinians have not been able yet to utilize the inland region wadi flash floods by either spreading the water for agriculture or retaining it for groundwater recharge. The present Jordan River flow (about 210 MCM/yr) comprises brackish base flow from return flows and flood flows from Yarmouk and other side wadies. The base flow includes the Israeli diversion of saline spring water which previously drained into Lake Tiberias. The fresh water flow is all tapped from Lake Tiberias by Israel to feed their National Water Carrier. The Johnston Plan envisaged an annual supply of 320 MCM good quality water to the inland region, taken from the Jordan River and originating from the Yarmouk river. This plan has never been comprehensively implemented and in any case the Palestinians have currently no access at all to the Jordan River water. This is subject of ongoing negotiations with the aim to establish the Palestinian share of all the regional water resources, surface water and groundwater.

### **3.1.2 Groundwater**

#### ***Inland Region***

Groundwater in Palestine is abstracted from two entirely different aquifer systems. The Mountain Aquifer, underlying the inland region with three main flow directions, west, north and east, has an estimated average safe yield of about 600-800 MCM/yr (See Table 3.2). Two thirds of the total water used by the Palestinian people is abstracted by wells, whereas about two fifths come from springs. The total annual abstraction for domestic use in the inland region in the period 1988 to 1992 ranged between 22.5 and 28.4 MCM, comprising 18.8 - 23.8 MCM pumpage from wells and 3.1 to 5.2 MCM flow from springs (1992), as may be seen from Appendix B.1.

The water quality of the Mountain Aquifer flowing in western and northern direction is generally very good; the eastern aquifer needs further study and development. It is known, however, that water from the springs near the Dead Sea and the groundwater abstracted from the shallow aquifers in the southern part of the Jordan Valley is brackish and not suitable for potable/domestic water supply. At a few places in Palestine the nitrate content of the groundwater has increased considerably due to infiltration of sewage.

After occupying the Palestinian territories in 1967, the Israeli authorities have severely restricted the Palestinians in developing their water resources both in the inland region and in the coastal region, whereas Israel continued to increase its use of the shared Mountain Aquifer underlying the inland region both in Israel as well as for the Jewish settlements established in the Occupied Palestinian Territory (OPT). At present, the Palestinian people abstract only about 15 percent of the water originating in the inland region, whereas the Israelis use over three quarters of the safe yield of the Mountain

aquifer. The abstractions from this aquifer have reached the safe yield and most probably have gone beyond that limit during recent. Unless the very skewed distribution resulting from these historic developments is rectified, a satisfactory and workable solution to the management of the regional water resources is not attainable.

The inland region contains six major aquifers as shown in Table 3.1.

- \* The Pleistocene aquifer consists of unconsolidated sands and gravels of varying sizes separated by impermeable layers of saline marls. It extends along most of the Jordan Valley between Jericho in the south and Marj Na'ja and lower Wadi Fara'a in the north. This aquifer is believed to be fully exploited through some 100 pumping wells extracting about 15 mcm annually with chloride contents ranging from 100 mg per liter to over 200 mg per liter. Further exploitation would increase the salinity levels and may destroy the fresh water zone in the Jordan Valley unless fresh water artificial recharge is introduced.
- \* The Neogene aquifer consists of well-cemented conglomerates containing relatively small quantities of fresh water. It is situated at the northern part of the Jordan Valley near Bardala and Ein El Bayda. This aquifer is also believed to be fully exploited through two pumping wells extracting about 7 million cubic meters annually with relatively low chloride content.
- \* The Eocene aquifer is composed of thin limestone layers with chalk and marl intercalations. It is located in the north-western part of the inland region around Jenin and upper Wadi Fara'a. Due to its limited thickness and extension, the storage capacity and utilization of this aquifer is directly affected by rainfall. It is believed to be fully exploited by some 60 pumping wells extracting 3-4 million cubic meters annually.
- \* The Turonian aquifer is composed of massive, locally interbedded limestones and dolomites. It extends over a large area in the Tulkarm sub-district. It is only partially exploited through some 50 pumping wells extracting 8-9 million cubic meters of good quality water annually.
- \* The Upper Cenomanian aquifer is shallow and composed mainly of interbedded dolomites and chalky limestones. It is located in the Qalqilia area. It is only partially exploited through some 70 pumping wells extracting 5-6 million cubic meters of good quality water annually.
- \* The Lower Cenomanian aquifer consists mainly of limestones. It is deep-seated with very large extension in the central and southern parts of the inland region, on both sides of the mountain ridge, thus enjoying a massive recharge from rainfall. It is only partially exploited by 8 wells extracting around 8 million cubic meters annually.

**TABLE 3.1**  
**MAJOR AQUIFERS IN THE INLAND REGION**

Main Area	Aquifer	No. of Palestinian Existing Wells	Estimated Extraction (mcm)
Jordan Valley & Wadi Fara'a	Pleistocene	100	15
North West and Jordan Valley	Neogene	2	7
North West and Wadi Fara'a	Eocene	60	3 - 4
West of Tulkarm Area	Turonian	50	8 - 9
Qalqilia Area	Upper Cenomanian	70	5 - 6
Central & Southern Areas	Lower Cenomanian	8	8

### ***Coastal Region***

The source of groundwater in the coastal region is the aquifer which is composed of sub-aquifers made up mainly of sand, sandstone and pebbles. The sub-aquifers overlay each other in certain places and are separated by impervious and semi-impervious clayey layers. The upper aquifer lies closest to the sea and extends up to two kilometers inland, at a depth mainly below sea level. Middle sub-aquifers are situated below the upper aquifer near the coastline, but rise in an eastward direction according to the general slope of the geological layers. The lower sub-aquifers extend further inland. Total thickness of the aquifer ranges from 120 meters near the coast to 10 meters in the east, where it has relatively higher salinity. The top of the aquifer consists of sand dunes in the west and of finer continental deposits, interbedded with paleosols in the east. Deeper permeable strata are present at depths of 200-300 meters and consist of carbonates and sandstones, with salinity levels reaching around 2000 mg per liter.

In the coastal region restrictions to development and use of the groundwater by the Palestinian people are imposed by the Israeli authorities, similar to those in the inland region. This has resulted in unacceptably low levels of water supply and sanitation services to the towns, villages and refugee camps, that have among the highest population densities in the world. The Jewish settlements apparently do not face these restrictions and reportedly the Israeli water company Mekorot is selling about the same amount of water to the coastal region as is being abstracted by the Jewish settlers.

From a water resources management point of view the situation in the coastal region is different from the inland region. Some studies indicate that the coastal region aquifer has an annual recharge of 50 to 70 MCM/yr, but according to a more



conservative assessment this is only 35 MCM/yr. Current groundwater abstractions of about 95 MCM/yr create an annual deficit of 25 to 45 MCM and according to more conservative estimates as much as 60 MCM. The situation is also aggravated by Israel's water withdrawals within the coastal region itself (about 5 - 6 MCM annually) and by wells along the eastern border of the coastal region that intercept the westward groundwater flow before it crosses the border.

Measurements on water samples show that the salinity of the groundwater is steadily increasing. This is a result of intrusion and upconing of saline water at locations where over-abstraction is taking place. The water quality in the central part of the coastal region generally is rather poor, with chloride content between 200 mg/l and 1,000 mg/l and values over 1,000 mg/l in the east; nitrate levels are around or above the 50 mg/l maximum standard established by the European Community. This problem is compounded by the increasing pollution of the aquifer by chemicals used in agriculture (e.g. pesticides, herbicides and chemical fertilizers).

Very recent observations seem to indicate that delaying the establishment of Palestinian authority, coupled with the depressed economic situation appears to be leading to a proliferation of newly drilled wells for agricultural and other uses which may inflict irreversible damage to the aquifer as a result of saline intrusion. (Reportedly, over 500 new shallow wells were dug since September 13th 1993). This is unacceptable and it is urgent that measures should be taken by the Palestinian authority to control the situation and to protect the aquifer.

**TABLE 3.2  
OCCUPIED PALESTINIAN TERRITORIES; ANNUALLY RENEWABLE WATER (\*)**

	WBDP	UN	HADDAD	ESCWA	Society for Austro-Arab Relations	Jad Isaac	Assaf et al. FW(BW)*
West Bank							
Northern Aquifer	140	140				140	61(70)
Western Aquifer	335	335				335	310(40)
Eastern Aquifer	105	125				125	81(70)
<b>TOTAL</b>	<b>580</b>	<b>600</b>	<b>720</b>	<b>700(easily exploitable from a total of 835)</b>	<b>830</b>	<b>600</b>	<b>452(180)</b>
Gaza Aquifer	50-60	50-80 (Various sources quoted)	52-72	60	50-60	70	60(or 35)
Jordan River		120 (currently used by Israel)		320 (estimated Palestinian Share)			210 (Lower Jordan River)

\* FW = Fresh Water; (BW) = Brachium Water (not included in Fresh Water).

Source: West Bank data Base Project, Agriculture and Water Resources in the West Bank, The Jerusalem Post/Westview Press, 1987.

UN: Water Resources of the Occupied Palestinian Territory, United Nations, 1992.

ESCWA: Land and Water Resources in the Occupied Palestinian Territory, the Center for Engineering and Planning, Report for ESCWA, 1992.

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Jad Isaac: Impact of the Prolonged Israeli Occupation on Water And Environment in the Palestinian Occupied Territories, The Hague, 1992.

Assaf et al.: A proposal for the Development of a Regional Water Master Plan, IPCRI, 1993.

Adapted from: World Bank: Development the Occupied Territories; An Investment in Peace; 1993.

### 3.1.3 Demand

Some studies and data collection of the water resources and water use in Palestine is carried out but access to existing data is restricted and as a result one will find different estimates of the available renewable water resources in the area (See Table 3.1 and 3.2). Also definitions used by the various authors differ and are not always clear, which adds to the difficulties in comparing the different estimates.

A joint Palestinian/Israeli research team reviewed currently available information and made an assessment of the regional water resources and use, pertaining to Palestine.

Table 3.3 presents an estimate of the total annual availability of water, fresh and brackish, for the Jordan basin and their current use by the riparian parties. Additional supply of varying quality would have to come from more costly sources, like treated wastewater, desalinated brackish water or seawater, or transboundary water transfers from the Nile, from Lebanon or from Turkey.

**TABLE 3.3**  
**THE ESTIMATED WATER POTENTIAL AND CURRENT USE OF THE SHARED**  
**REGIONAL WATER RESOURCES (FRESH & BRACKISH)**

Resource	TOT Avail MCM/Yr	Currently Used By			Unused
		Israel MCM/Yr	Palestine MCM/Yr	Jor(Syr) MCM/Yr	
1. Mountain Aquifer	632**	463*	110	-	59***
2. Gaza Aquifer	60(or 35)	4	90	-	(minimum deficit)-34
3. Jordan + Yarmouk Basin	1,060	640	-	150(170)	100
4. Lower Jordan	210	-	-	-	100****
<b>TOTALS</b>	<b>1,962</b>	<b>1,107</b>	<b>200</b>	<b>320</b>	<b>225</b>
* Including an estimated 50 MCM/Yr used by Jewish settlements built after 1967 in the inland region. ** Includes an estimated 180 MCM/Yr of brackish water. *** Mainly brackish water, some of which could be diverted upstream as fresh water or desalinated for domestic. **** Mainly irregular brackish return irrigation flows and from saline springs with particularly low flow in summer, which could be desalinated for domestic/urban use.					

From: Assaf *et al.*: A Proposal for the Development of an Regional Water Master Plan, IPCRI, 1993.

The team also introduced the concept of an annual minimum water requirement for domestic and industrial use of 100 CM per person, increased by 25 CM for domestic food production. This adds up to a total annual Minimum Water Requirement (MWR) of 125 CM/person/yr, that should be met by the available resources as a priority supply.

The Palestinian people in the OPT have not yet reached this level of consumption because their economic and social development has been forcibly curtailed over the last 27 years, as was explained above. After the establishment of the Palestinian government, major efforts shall be made in developing and building the institutions, human resource base and infrastructure of Palestine. The accelerated development of the domestic and industrial sectors will bring the actual demand to the level of the MWR of 125 CM/person/yr in the foreseeable future. With further economic growth, the real annual water demand can be expected to increase beyond this level.

Taking account of the expected increase of the Palestinian population through natural growth and return of refugees and other Palestinians means that water is going to be increasingly scarce in the future (Figure 3.1). Not only Palestine will be facing water shortages but the other countries in the region as well. Henceforth, choices will have to be made regarding the distribution of existing and potential water resources between various sectors of the economy.

The demand in the domestic and industrial sectors of Palestine is still low and it will take time to upgrade the totally deficient infrastructure and institutions to a level where the effective demand can be met. This would leave sufficient water for irrigation in the inland region in the short and medium term; in the coastal region the situation is already very critical and here serious attempts will have to be made to control and reduce abstraction rather than allow it to increase even further. However, as population growth and reconstruction and development of the Palestinian state continues the domestic and industrial sectors will claim an increasing share of the good quality water resources. (Figures 3.2 and 3.3).

Assuming that meeting the minimum water demand of the domestic sector has preference over the agricultural sector and economic pricing of the water would work in the same direction, farmers will be forced to increase their water use efficiency and at the same time look for alternative sources of water, for which they still can compete. Within thirty years not only will the agricultural sector depend on brackish and treated wastewater, but also part of the water demand of the domestic and industrial sector may have to be covered by desalination of brackish water and perhaps even purification of wastewater (Figure 3.3). Therefore, in view of the long-term water resources perspective, a careful development of irrigated agriculture seems warranted. (Figures 3.2 and 3.4).

The irrigated area may be retained at the present level or perhaps increased somewhat if farmers would further increase their irrigation water use efficiency or develop spring flows and utilize runoff (Figure 3.4). The Palestinian government will need a national water master plan prepared on the basis of a thorough study of the available and potential water resources and of the different sectors of the Palestinian economy, in order to be able to decide on a sound allocation of the scarce water resources.

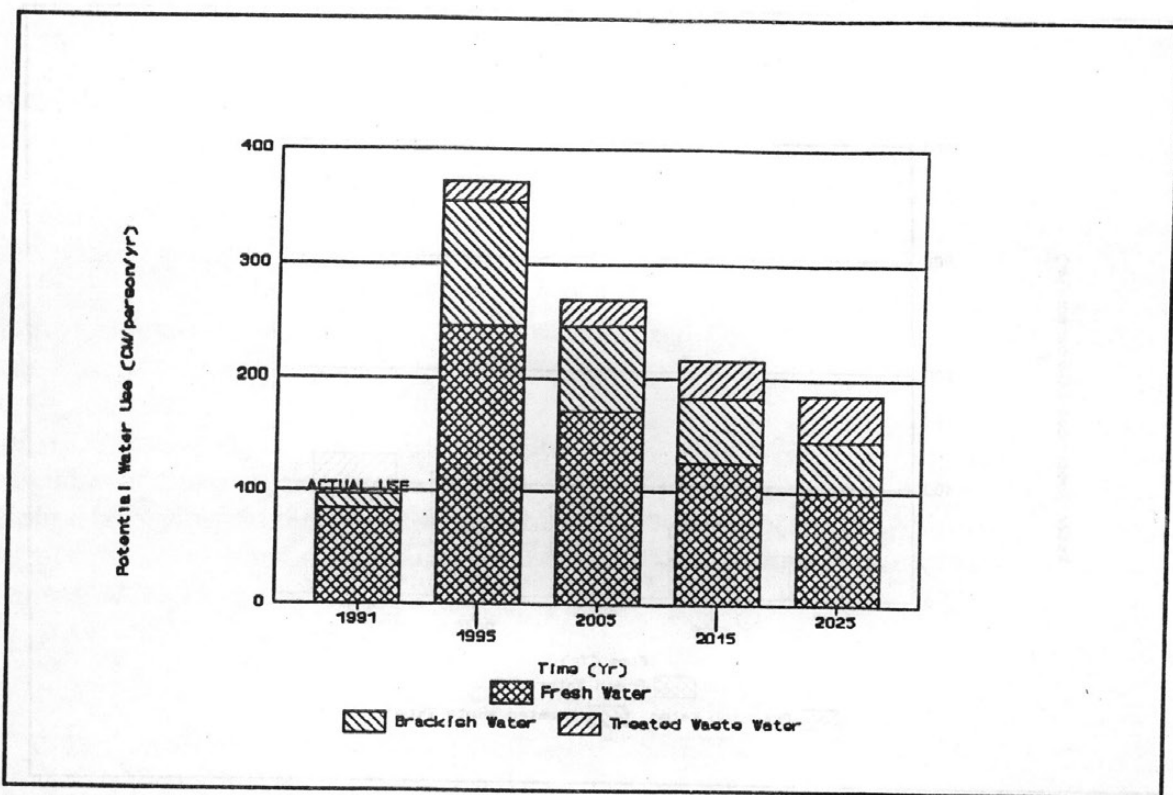


Figure 3.1 Potential Available Water Based on Proposed Palestinian Water Rights

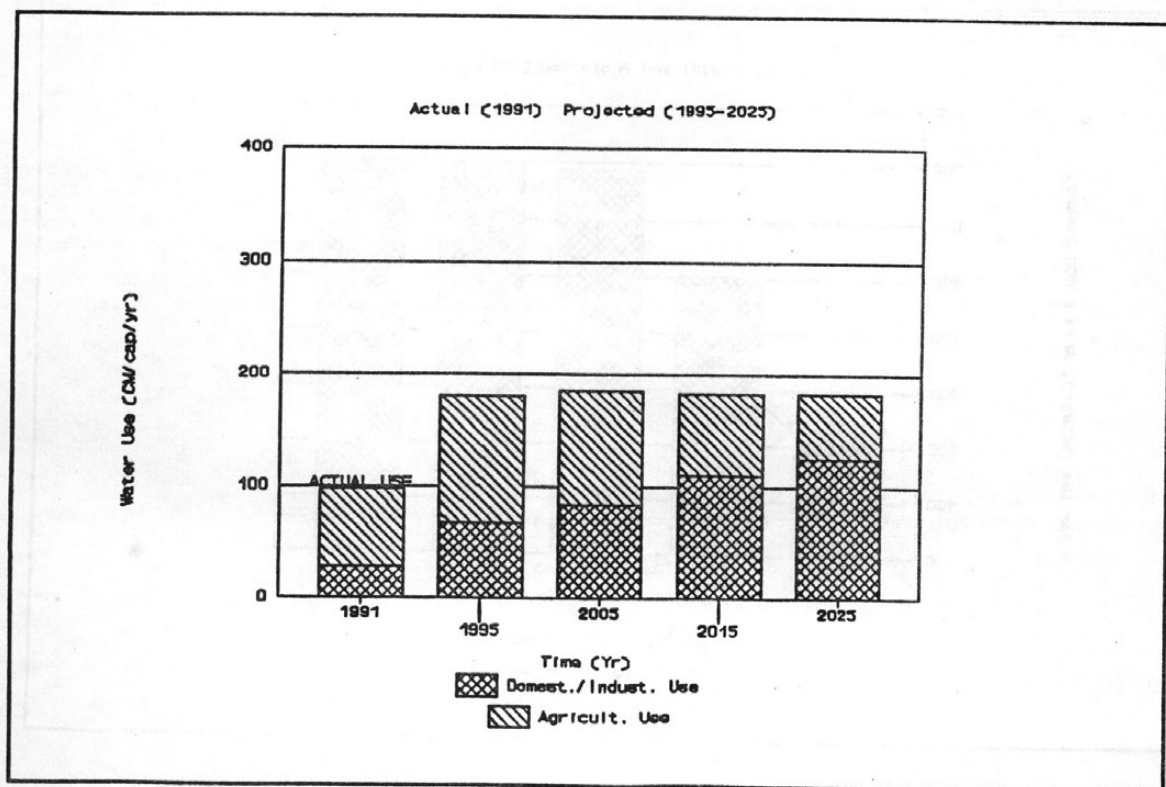


Figure 3.2 Projected Water Use by Sector to Achieve the Minimum Water Requirement (MWR)

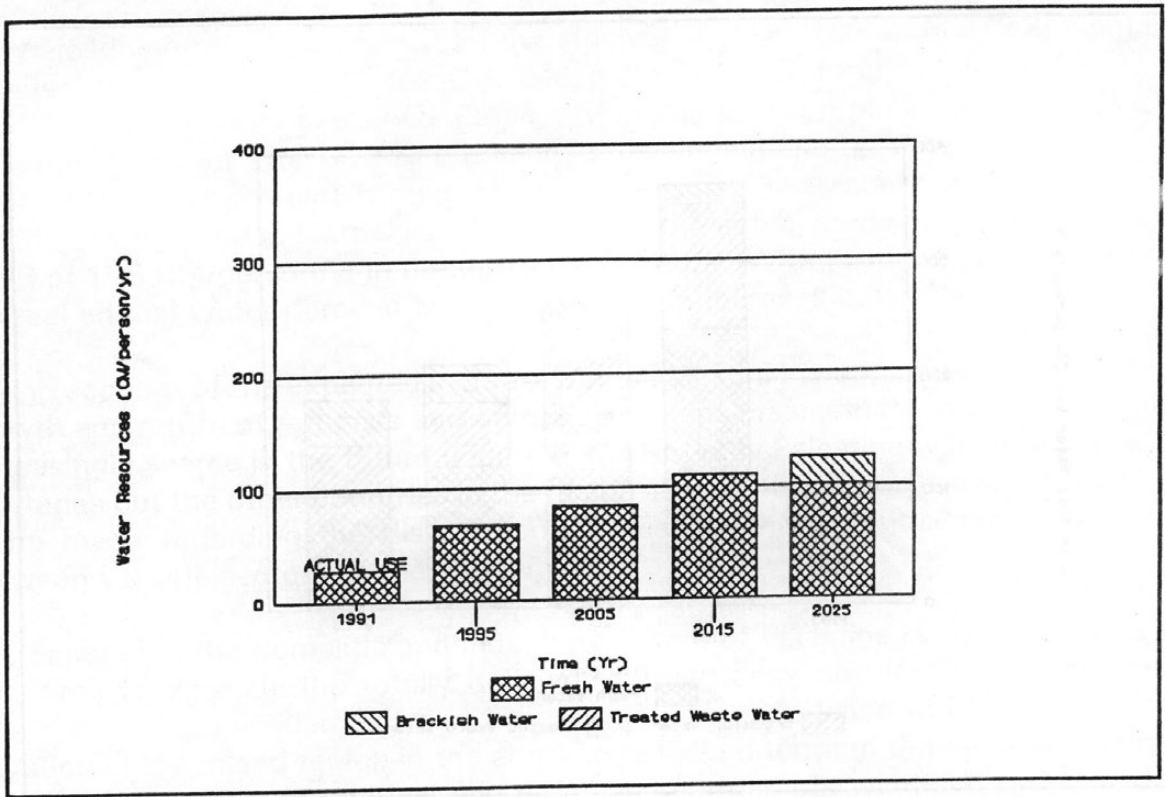


Figure 3.3 Projected Water Resources for Domestic and Industrial Use

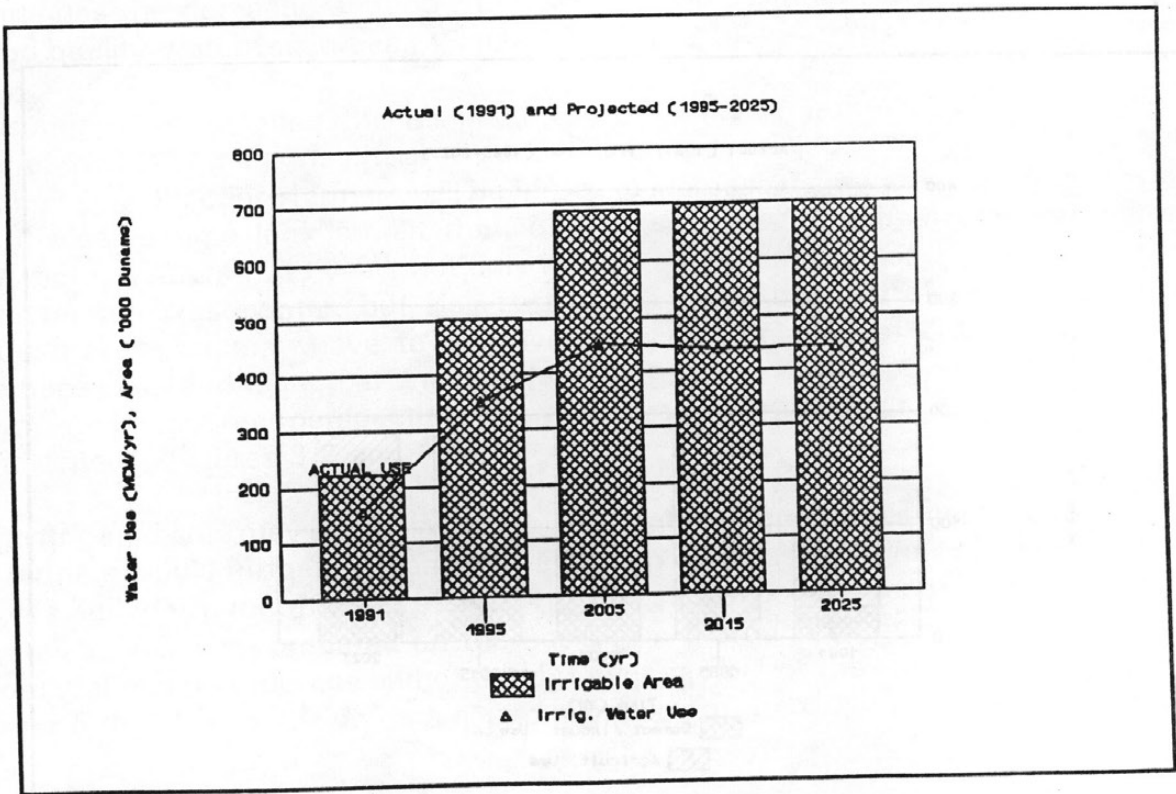


Figure 3.4 Projected Irrigation Water Use and Irrigated Area

## ***Domestic Water***

The current domestic water supply to the Palestinian people taking into account leakage and unaccounted-for-losses is about 50 l/c/d (18 cm/c/yr) as compared to 250 l/c/d (91 cm/c/yr) for Israelis, which means a significant demand restriction. The Palestinian water utilities are not allowed to drill and exploit the number of wells or tap the springs necessary to meet their need. As a result they have to purchase part of the water they distribute to their customers from the Israeli water company, Mekorot. This results in higher costs and an irrational lay-out and hence higher costs of the required infrastructure. Appendix B presents an overview of all wells and springs in the inland and coastal regions used for domestic water supply and irrigation including location and average annual yield.

Only the groundwater in the northern and southern parts of the coastal region meets drinking-water standards. Bringing water of an acceptable quality to the places where it is needed requires strong government and extra investments in infrastructure. In Deir Al Balah, in the coastal region, a brackish water desalination plant for drinking water supply with a capacity of a 400,000 CM/yr was commissioned recently. In general, groundwater abstraction beyond the safe yield of the aquifer should not be allowed for any purpose and thus also not for desalination of brackish water to produce drinking water. This criterion alone seems to disqualify introduction of desalination plants for brackish groundwater in the coastal region as a feasible solution to the water scarcity. Besides, these high-tech and high energy consuming plants would leave the Palestinian government with the burden of large operation and maintenance costs.

In rural areas of the inland region about fifty percent of the population is not provided with piped water supply. They depend largely on water from nearby springs, rainwater collection from rooftops and purchase from water trucks. The latter option is very expensive for the consumers and is proven to be health hazardous as water transported by trucks often gets contaminated before it is delivered to the houses.

## ***Irrigation Water***

The Israeli occupation authorities have limited access to groundwater from wells and springs for irrigation for Palestinian farmers to no more than 90 percent of their average 1970-1973 use. Partly due to this measure farmers have increased their irrigation water use efficiency significantly, by using piped water conveyance and localized irrigation methods. The distribution of the irrigated land over the OPT is presented in Table 3.4.

In the Jordan Valley water supply as well as access to land for irrigated agriculture has been severely restricted by the Israeli authorities. Whereas irrigation by Jewish settlers and the Israeli army is ostensibly taking place, the water use by the Palestinian people is much lower than before.

**TABLE 3.4**  
**RAINFED AND IRRIGATED CULTIVATED LAND**  
**( Number of dunams (1 dunum = 0.1 ha) by District (1982-1990)**

DISTRICT	1982		1990	
	RAINFED	IRRIGATED	RAINFED	IRRIGATED
Jenin	349,000	10,440	279,965	9,707
Tulkarm	316,860	28,000	264,776	15,667
Nablus	242,330	2,790	269,465	3,257
Ramallah and Bethlehem	317,320	1,450	259,724	1,272
Hebron	288,810	900	345,295	543
Jordan Valley	6,770	34,640	4,500	29,468
<b>Inland Region (TOTAL)</b>	<b>1,587,000</b>	<b>93,720</b>	<b>1,423,725</b>	<b>59,904</b>
<b>Coastal Region</b>	<b>70,890</b>	<b>78,750</b>	<b>58,000</b>	<b>110,000</b>
<b>TOTAL</b>	<b>1,657,890</b>	<b>172,470</b>	<b>1,481,725</b>	<b>169,904</b>

1982 Source: ASIR, Food Security in the West Bank and Gaza Strip, ESCWA/AOAD, October 1985, pp. 34-36,43.

1990 Source: ASIR Data Bank, 1992, in Assaf, et al, A proposal for the Development of a Regional Water Master Plan, IPCRI, 1993, p. 133, (printing errors corrected).

Agriculture in the coastal region depends almost entirely on groundwater irrigation and although the area under high water demanding citrus cultivation has decreased over recent years, the remaining dunums of citrus still account for a considerable part the water consumption. Unfortunately, little progress is made towards motivating the farmers to use treated wastewater as an alternative to groundwater for irrigation. Also, financial and other incentives are still missing for introduction of options like using low-quality brackish water in combination with rainwater collected in ground storage tanks.

Apart from recharging the aquifers and producing surface runoff, rainfall accounts for up to 1.7 million dunams of rainfed agriculture (1 dunam = 0.1 ha), not including grazing land, of which about 70,000 dunams are in the coastal region. However, yields are low as rainfall is highly irregular and consequently the farmers are unwilling to take the risk of substantial investment in improving their cultivation practices, like the introduction of new drought-resistant crop varieties and costly land preparation, without assistance from the government. Over the last years rainfed agriculture did not witness an increase in the level of technology similar to that in irrigated agriculture and, given adequate support and improvements, the production level of rainfed agriculture can still be increased.

### 3.2 INSTITUTIONS AND HUMAN RESOURCES

With the occupation in 1967 Israel has assumed by force the authority and control over all sectors of the Palestinian economy and society. Only in some sectors at



lower levels in the administrative system the Israeli Army represented by the Israeli Civil Administration (CA) allowed Palestinian institutions to continue to function. However, these institutions do not form a coherent institutional framework and responsibilities and authority of Palestinian officials are restricted and can be overridden indiscriminately by the CA at any time. Besides, the financial basis of Palestinian institutions is very weak.

The status of the institutions in the water sector is no exception to this generally bleak picture. The CA does not allow the Palestinian people to manage their own water resources. The set up of an authority for planning and management of the Palestinian water resources should be a first priority of the Palestinian government. Palestinians have managed and operated regional and municipal water utilities though with very restricted authority and very limited funds. Despite these limitations some utilities have managed to improve their performance and efficiency over the years and they have developed models and ideas that can be instrumental in rebuilding the institutions of the Palestinian water and sewerage sector.

The Palestinian institutions in the agricultural sector are hardly functioning or have completely ceased to exist. Agricultural research, training and extension organizations that persist, like the Arab Development Society in Jericho and Khadouri Institute in Tulkarm, are being hampered in their operations by the CA. To promote water conservation both in rainfed and irrigated agriculture existing organizations have to be strengthened, but at the same time a strong agricultural extension service will have to be set up, supported by agricultural research.

### **3.2.1 Water Resources Planning and Regulation**

In the short term the Palestinian government will have to take important decisions on the allocation of water resources required for development of the different sectors of the economy. Large investments depend on these decisions. However, no Palestinian water resources planning agency exists as yet. The establishment under the UNDP umbrella of a Palestinian Water Task Force, supervised by a Steering Committee, including some leading Palestinians in the water sector may be a first important step towards that goal.

National water resources planning and management can only be done on the basis of a sound natural resources and environmental database and a national water master plan for Palestine. Data on the Palestinian natural resources, including surface water and aquifers are still missing and existing data are not accessible to Palestinian scientists and planners and a comprehensive water master plan has still to be made. It is clearly in the interest of all countries of the region to make data on their shared water resources available and jointly manage these resources including planning, decision-making and operation and monitoring according to agreed rules. Only this arrangement would assure the most efficient and economic use of the regional water resources and the supply of a minimum water requirement to all at an affordable cost.

### **3.2.2 Management of Public Services in the Water Sector**

The present deplorable situation of the Palestinian water sector with regard to the position and performance of the institutions responsible for management and operation of the public services is a direct result of 27 years of occupation. All infrastructure plans implemented by the Israeli occupation authorities were directed towards serving the new Jewish settlements in the OPT with limited effort towards the improvement of the Palestinian water sector other than by Palestinian water authorities and NGO's.

The most important field in which this problem was manifested was that of water resource management and infrastructure. Added to the Jewish settlements' needs in this field was the importance of the inland region's water resources and their effect on the existing Israeli resources and future needs. On this basis, and very early after the occupation, the Israeli authorities enacted many military orders and bylaws restricting the development of water resources and their management by the Palestinian people and institution. As a result, only 20 wells were drilled in the inland region since 1967 for the supply of drinking water and domestic requirements, and 3 for irrigation for Palestinian use. In addition, two old wells for domestic use and 10 for agricultural use were replaced by new ones. This control is clearly apparent when considering that about 50 percent of the total Palestinian domestic water requirements are supplied by bodies and corporations under the direct authority of the Israeli military administration.

At present, only 290 out of 537 Palestinian communities (towns and villages) have piped water supply, but lack sewerage networks. There are more than 200 localities that have neither drinking water nor sewerage networks. In all, there is a very limited number of sewerage systems in the OPT and only four treatment plants. Plans exist to start construction of a number of sewerage systems in cities and villages of Palestine. These plans, however, lack an integrated framework of technical, environmental, administrative and economic dimension at a national level. The current situation requires much needed institutional and infrastructural building to create a solid foundation for water and wastewater management in the Palestinian state.

The end of the occupation should have a prompt and positive effect on rebuilding the basic infrastructure of Palestine, including the water and sewerage networks. However, unless there is a comprehensive integrated national plan that addresses questions of appropriate size, organizational structure, administrative and technical standards in integrating the water and sewerage systems, there will be a number of uncoordinated, segregated systems.

### **3.2.3 Water Utilities in the Occupied Palestinian Territory**

Since the occupation in 1967, the Israeli authorities subjected all works and projects pertaining to water and water resources to its direct supervision and control through Military Order No. 92/1967. This order prevented any Palestinian organization or undertaking from the execution of any work connected with the running,

management, maintenance or development of water services or resources without the prior approval and licensing from the Israeli military authorities.

The utilities in Palestine dealing with the management of daily water services or in the development of its infrastructure may be divided into four main groups:

**(a) Municipal Water Departments**

Most existing municipalities were established before 1967. They were either combined water and sanitary departments or separate water departments. These departments dealt with the planning, development, management and maintenance of drinking water networks, sewerage networks and other water resources development. Since the occupation, the role of these departments was limited to the operation and maintenance of the water and sewerage networks.

These departments suffer from a multitude of constraints which render their service inefficient and limits the possibility for improvements. Being integral parts of the organizational structure of the municipalities and having their budgets within the municipal budget subjects these departments to all the bureaucratic deficiencies inherent in the existing municipal system, and consequently limits their effectiveness.

**(b) Administratively Independent Utilities**

Some municipalities joined hands in certain areas to overcome the shortcomings of the separate municipal departments. In the Ramallah area, the Jerusalem Water Undertaking (JWU) was established to serve the Ramallah District including cities of Ramallah, El-Bireh, Deir Debwan, Silwad, Beit Hanina, Beitonina and currently some forty villages and refugee camps. In Bethlehem, the Water Department serves Bethlehem, Beit Jala, Beit Sahour and a number of villages and refugee camps.

These water utilities are administratively and financially independent and each of them has its own board of directors. JWU has been successful in dealing with the requirements of growth, development and financial independence and others can be upgraded.

**(c) Local Committees and Village Councils**

About one quarter of all Palestinian villages have village councils. These local bodies manage and develop public services in the village including the supply of domestic water, energy and sanitary services. Local committees are formed when there is no council. The councils and the committees are generally unqualified from a technical, administrative and financial viewpoint, resulting in overall inefficient management.

**(d) Department directly connected with the occupation "Civil Administration"**

The "West Bank" Water Department which was originally part of the Jordan Natural Resources Authority is now under the direct supervision and control of the officer for

water affairs of the "Civil Administration" of the occupation authorities. Its main tasks include:

- preliminary studies, design, preparation of tender specification as well as the supervision of execution of projects in the inland region of Palestine. It collects bulk water bills from municipalities and village councils and designs networks, reservoirs and other secondary works.
- monitoring domestic and irrigation wells and springs, rendering services and technical advice to all water departments and utilities, the operation and maintenance of all water plants and conveyance pipes including village internal nets which belong to the Water Department.

The Israeli water company Mekorot was granted the right to manage the water resources in the OPT. All engineering works related to the utilization and development of the water resources, other than those run by the institutions described above, are entrusted to Mekorot. This company applies Israeli governmental policies regarding water resources management with special attention to the Jewish settlements in the OPT.

In the coastal region UNWRA supplies water to 20 percent of the refugee population, while the remainder is supplied by a large number of different suppliers, including municipal and village councils and private enterprises, which results in a large variety in standards of service, quality of water and charges.

In addition to these weaknesses of the institutional arrangements, other constraints to the proper functioning of the water utilities include:

- The "Civil Administration" generally does not make information available nor does it allow Palestinian municipal officers and NGO's to participate in comprehensive planning.
- Water treatment is minimal and of dubious quality. There is also minimal leakage detection, insufficient replacement of faulty meters and lack of proper control of illegal connections.
- Sewerage utilities have no clear responsibilities for operation and are characterized by poor funding, inadequate training of operators, lack of adequate revenue collection and enforcement, and no clear responsibility for the proper disposal of sewage.
- Revenue collection for all public services is lumped into one account with no separate accounts for water and sewerage. Revenue collection has been increasingly difficult since the start of the Intifada.
- The tariff system is not affordable by low-income consumers which leads to illegal connections and non-payment of bills.

### **3.3 MAIN CONSTRAINTS IN THE WATER INSTITUTIONS**

The Palestinian water sector suffers from several constraints which if resolved would surely increase the efficiency of the organizations operating in this sector. These problem areas have developed over the last 27 years of Israeli occupation and are the cause of the deteriorated state of the infrastructure in the Palestinian water sector.

#### **3.3.1 Institutional and Human Resources Constraints**

As previously indicated, most water utilities are managed as departments within municipalities or local councils governed by municipal regulations and laws. These utilities suffer from organizational, technical and administrative weaknesses, lack of flexibility and bureaucratic limitations. The lack of coordination and cooperation between these individual departments and utilities has a negative effect on the overall efficiency of the water services in Palestine as a whole.

Organizational and administrative duties, activities and objectives are undefined for the institution as a whole and also for the employees. The salary scales are unjust and little if any incentives to work are available. Due to excessive unemployment during the years of occupation, particularly during the period of the Intifada, and due to increased strikes and work stoppages, these institutions were obliged to hire extra labour for the same activities. This practice resulted in inefficiency, over employment and high salary rates relative to the total expenses.

In villages, one or two employees look after the water networks. They are responsible for maintenance, new extensions and collecting water bills. These employees are usually unqualified and untrained for such work. In the municipalities the conditions are better with graduate civil or mechanical engineers responsible for the department. However, the number of these engineers is limited and they usually begin work with little prior or subsequent training in the water field. The same applies to the administrative and financial staff in these utilities.

During the last few years some of the international organizations have financed technical training programs such as water quality testing which were financed by SCF, and management of water networks for engineers which was financed by Canada Fund. Next spring Birzeit University in cooperation with EEC and Delft institution will organize study and training courses for engineers in the water and sanitation field.

Except for these activities and programs, training on an adequate scale remains an unfulfilled requirement that needs particular attention. Inter-utility coordination and exchange of information and experiences are also very rare and should be encouraged.

As a result of the financial difficulties of the utilities there is usually a lack of adequate office space, stores, workshops, meeting rooms, tools, laboratory equipment and transportation facilities.

### 3.3.2 Financial Constraints

The first three categories of water organizations in Palestine suffer, as do most Palestinian organizations and corporations, from severe financial deficits and lack of funds, which limit both development and extent and quality of delivered services.

Financial constraints may be divided into two main groups:

- Constraints due to the occupation and are related to discriminatory pricing policies and the lack of financial resources.
- Shortcomings inherent in the structure of the Palestinian water utilities and departments related to accounting, costing, bill collection and other internal financial procedures and systems.

#### 1) Discriminatory policies applied by the Israeli occupation authorities in the pricing of domestic water

As previously indicated, about 50 percent of the Palestinian domestic water consumption comes from sources directly controlled by the occupation authorities including the "West Bank" Water Department, Mekorot and the Jerusalem Municipality. In some cases, the "West Bank" Water Department facilitates activities between Mekorot and some water utilities in the inland region. The Department services the water invoices from Mekorot, adds 50 percent to their prices, and presents the new bills for collection. At present, the Water Department charges a flat rate of 1.8 NIS (US\$ 0.60) per cubic meter. The result has been that the Palestinian utilities and ultimately the consumers are paying a highly unfair price to the occupation authorities. This resulted in the inability of the water utilities to generate sufficient revenue to cover all their operating and maintenance expenses and left nothing for extension and development of distribution or main water networks. The drastic reduction in the margin of profit for Palestinian utilities has negatively affected the extension of their services, particularly to villages and unserved localities, as well as their maintenance and development plans for the networks.

For example, the Jerusalem Municipality purchases water from Mekorot (1992) at NIS 0.70 per cubic meter and sells it at an average price of 3.00 NIS. This gives a margin of 328 percent compared with only 55 percent for the Jerusalem Water Undertaking which purchases water from the municipality at NIS 1.92 /m<sup>3</sup> and sells it at the same average rate of NIS 3.00. (exchange rate: US\$ 1 = NIS 3). This short fall in revenue directly impacts the utility's ability to finance new works and conservation measures.

The variable cost for the production of one cubic meter of water from sources owned by Palestinian utilities is only NIS 0.75. The Palestinian utilities are obliged, due to lack of developed own sources, to purchase water from occupation controlled sources at a cost between NIS 1.80-2.20 per cubic meter. The Civil Administration's reluctance to issue the necessary licenses for drilling of wells to the water utilities has

led to the increased dependence of these utilities on the purchased water from occupation controlled sources.

## 2) Lack of Adequate Financing

Due to the lack of a central or national body for planning or coordination, the Palestinian water utilities work individually, each according to its circumstances and initiative in procuring financial resources. UN and other donor agencies operating in the OPT as well as several NGOs offer financial and technical aid to the Palestinian people. Water is one of the fields where such aid was directed, mainly for constructing new networks, and reservoirs. In the last twenty years about 140 water projects were executed, mostly in the rural areas of the inland region.

As mentioned earlier, and in light of the absence of a central planning body, the priorities of the individual water departments were not set as part of a national plan. The lack of coordination among donors coupled with the lack of a Palestinian input into masterplanning caused a fragmented infrastructure development in the water sector. Nevertheless, financial support helped in constructing many networks in the rural areas and in rehabilitating part of the existing facilities.

## 3) Inadequate Financial Accounting Systems

Modern accounting systems are rarely implemented in the water departments of the municipalities and water committees in villages, nor do these departments have the qualified staff for this purpose. Usually the water departments use the single entry method and work in accordance with an estimated budget for expenses and revenues. They do not generate balance sheets, profit and loss accounts, cost accounting, depreciation arrangements or reserves. The final accounts of these departments are usually not precise and therefore cannot be utilized for managerial or financial policy making.

## 4) High Percentage of Losses

Water losses, which are the difference between produced or purchased quantities and sold quantities, vary between 25 percent and 55 percent of the total water supply. These extremely high losses are a clear indication of the deteriorated state of the water networks. This is basically due to the failure to maintain and upgrade the networks.

In order to determine unrecorded losses from faulty meters JWU installed standard main meters and compared the measurements with those of private meters. A difference of 11.3 percent was found which adds to the water losses total. Other reasons for the high losses are the unsuitable water meters and the black losses.

In addition to these losses, illegal connections or unidentified misappropriation (black losses) have increased in the last six years also due to the depressed economy. The

percentage of these losses vary between areas depending upon social and economic circumstances of the population.

#### 5) Ineffective Fee Collection Practices

The prevailing social and political conditions and the inefficiency of the postal and banking services in the OPT compelled the water institutions to distribute their water bills to customers directly by hand. Attempts have been made to apply modern methods of billing and fee collection through the banking system, but without success. Out of those who pay their bills regularly, only 7 percent of the consumers pay their bills through the banks, 41 percent pay at the main offices of the water institutions and the majority of 52 percent pay directly to collectors who call on them at their homes. The outstanding balances of water bills exceed 60 percent in certain areas. In sewerage schemes fee collection is even worse due to the limited practical and effective measures against bad debtors.

The efficiency of the independent water utilities in bill collection is, however, much higher. This is due to the special staff allocated specifically for this purpose as well as the consumer's sense of obligation towards payment since the utilities control the service and have the right to disconnect it if necessary. An exemplary case is the Jerusalem Water Undertaking in Ramallah District which has thus far provided very effective water service and has achieved the highest rate in collecting outstanding bills reaching approximately 98 percent.

#### 6) Inconsistent Pricing Policies and Cost Recovery

The various water utilities currently implement different water tariffs. The tariffs, in general, are graduated to enable the low income consumers to benefit from a reduced price for the first 5-10m<sup>3</sup> per month and to encourage large volume consumers to save water. There are also reduced prices for bulk consumers (Israeli army camps, Jewish settlements, and Palestinian villages).

The methods of calculating unit costs and prices are not standardized. Direct costs are sometimes taken into consideration in calculating the prices, but no consideration is made for future investments. For example, the average rate paid for water by consumers in Nablus in 1990 was US\$ 0.676/m<sup>3</sup>, covering approximately 40 percent of the operation and maintenance (O&M) cost of delivered water, while in the Ramallah area the consumers paid 158 percent of the O&M cost of delivered water.

In the sewerage section, the implemented fees and tariffs barely reach 20 percent of the actual O&M cost of these schemes. The El-Bireh Municipality serves approximately 40,000 people in the city of El-Bireh itself and surrounding refugee camps. This municipality is considered to be one of the most successful and efficient in providing various municipal services including sewerage services. Despite this, the El-Bireh Municipality also faces great difficulties in running its sewerage system as shown in figure 3.5.



**Tariff Structure:**

A minimum charge of US\$ 7.1 is charged for residential, commercial and industrial establishments with areas not exceeding 50 square meters. Each additional square meter of space is charged an additional US\$ 0.14 annually.

	US\$
<b>Revenues:</b>	
Revenues collected in 1993	14,705
Uncollected debts (1992 and 1993)	48,841
<b>Total Revenue</b>	<b>39,126</b>
<b>Costs and Expenses:</b>	
Maintenance for Network and Pumping Stations	13,167
Power for Pumping Stations	4,584
Salaries of Pumping Station Attendants	9,720
End of Service Reserves for Station Attendants	810
Wages for maintenance workers	10,000
End of Service Reserves for Maintenance Workers	833
Depreciation of Sewerage Network - total estimated value of US\$ 3,092,333 (@ 2.5% annually for 40 years)	77,308
Depreciation of Pumping Stations - total estimated value of US\$ 860 thousands (@ 10% annually for 10 years)	86,000
<b>Total Costs</b>	<b>202,422</b>

**Figure 3.5 El-Bireh Municipality Sewerage Collection System Costs and Revenues**

From these figures, it can be seen that the annual revenues of El-Bireh sewerage system cover only 19.3 percent of the costs and expenses. Only approximately 37 percent of these billable revenues are actually collected. These figures do not take into account the operation of a treatment plant which is planned to be built at a capital cost of approximately US\$ 3.0 million. Thus, the establishment of the treatment plant, although important to reduce negative impacts on the environment, will only increase the negative financial condition of the sewerage network as run by the municipality.

### **3.3.3 Institutions in the Agricultural Sector**

Policy making and regulating water resources for the agricultural sector are firmly in the hands of the Israeli authorities and administration is limited to control and enforcement of regulations and no services, like extension are provided by the CA. Other public funding and support to farmers through services is extremely meager. Generally, the policies and related regulations seem to reflect broad Israeli interests with regard to the occupied Palestinian Territory, exemplified by restrictions for the expansion of land under active permanent cultivation, like olives and grapes, and promotion of seasonal crops like vegetables in rainfed areas or in greenhouses in the

last 10 years. This practice goes against the long-term objective of land and water conservation through permanent rainfed tree crop cultivation. Israelis maintain a firm control over the water resources which prohibits Palestinian planning and utilization of the water resources in a rational way with a view to long-term sustainability.

More specifically policies and regulations appear to be guided ad-hoc by the developments and interests of the Israeli agricultural sector. This lack of stability discourages investments and restricts development in the Palestinian agricultural sector, resulting among other things in a very low priority for water conservation. The only factor that caused the introduction of efficient water use technology in irrigation in the Occupied Palestinian Territory, was the Israeli restriction on water volume (i.e. well pumpage quotas) available for irrigation.

The only services currently provided to the agricultural sector are delivered by non-formal cooperatives and NGO's - such as the introduction and distribution by ASIR of rainfed, draught resistant fruit-producing evergreen trees, such as grafted olives and jojoba in the northern parts of the inland region; CRS and ICC which assisted in constructing agricultural roads and fencing and the Arab Studies Society Land Research Center which is active in land reclamation and tree distribution. Restrictive administrative conditions and inadequacy of funding are not conducive to effective coordination of these efforts and to bringing these services anywhere near the required level and coverage. The role of formal cooperatives has declined over the years since occupation and at present most are inoperative.

Water conservation measures in agriculture such as introducing efficient water use irrigation techniques or construction of water spreading terraces and water retention dams require medium and long-term investments. Institutional credit for end-user investments is hardly available to the Palestinian farmers and the Palestinian authority should be responsible for larger scale improvement on watersheds.

### **3.4 INFRASTRUCTURE**

#### **3.4.1 Domestic and Industrial Sector**

The water utilities have serious problems to meet the demand of their customers because of the bad state of repair of pumps and distribution networks, faulty water meters or absence of meters, lack of buffer-reservoirs, resulting in water supply in rotation by force, low pressure, system leakages, illegal connections, and unaccounted-for losses. Furthermore, Palestine lacks coherent and integrated supply and conveyance networks. Such networks exist in some regions, but in most cases communities are supplied from local sources. Water quality can not be maintained as contamination enters the system during drops in pressure when the utilities have to deliver the water in rotation. The major components of the existing supply and conveyance networks are shown in Figure 3.6.

Limited sewage and wastewater collection and disposal also restricts demand, as customers will use less water if they can not easily get rid of the wastewater.

In many villages and small towns and in the rural areas sewage and wastewater is disposed of through septic tanks.

In some cities sewage collection networks are available, in other cities, like Bethlehem and surrounding villages, they are being constructed with international funding; in most cases sewage is just discharged in a nearby wadi, creating serious public health hazards and losing the opportunity for a very important water conservation practice - the reuse of wastewater for irrigation and possibly other uses.

In rural areas only about half of the villages have access to safe drinking water from protected sources. In many places the disposal of untreated sewage is a direct threat to the groundwater resources which are being tapped for drinking water. Figure 3.7 shows the Palestinian communities which have piped water distribution networks.

Real demand for water is high and actual demand will increase, where wastewater collection and disposal is improved and rehabilitation and expansion of the water supply networks allow for a better and more reliable service; in the future the demand of industries will also increase.

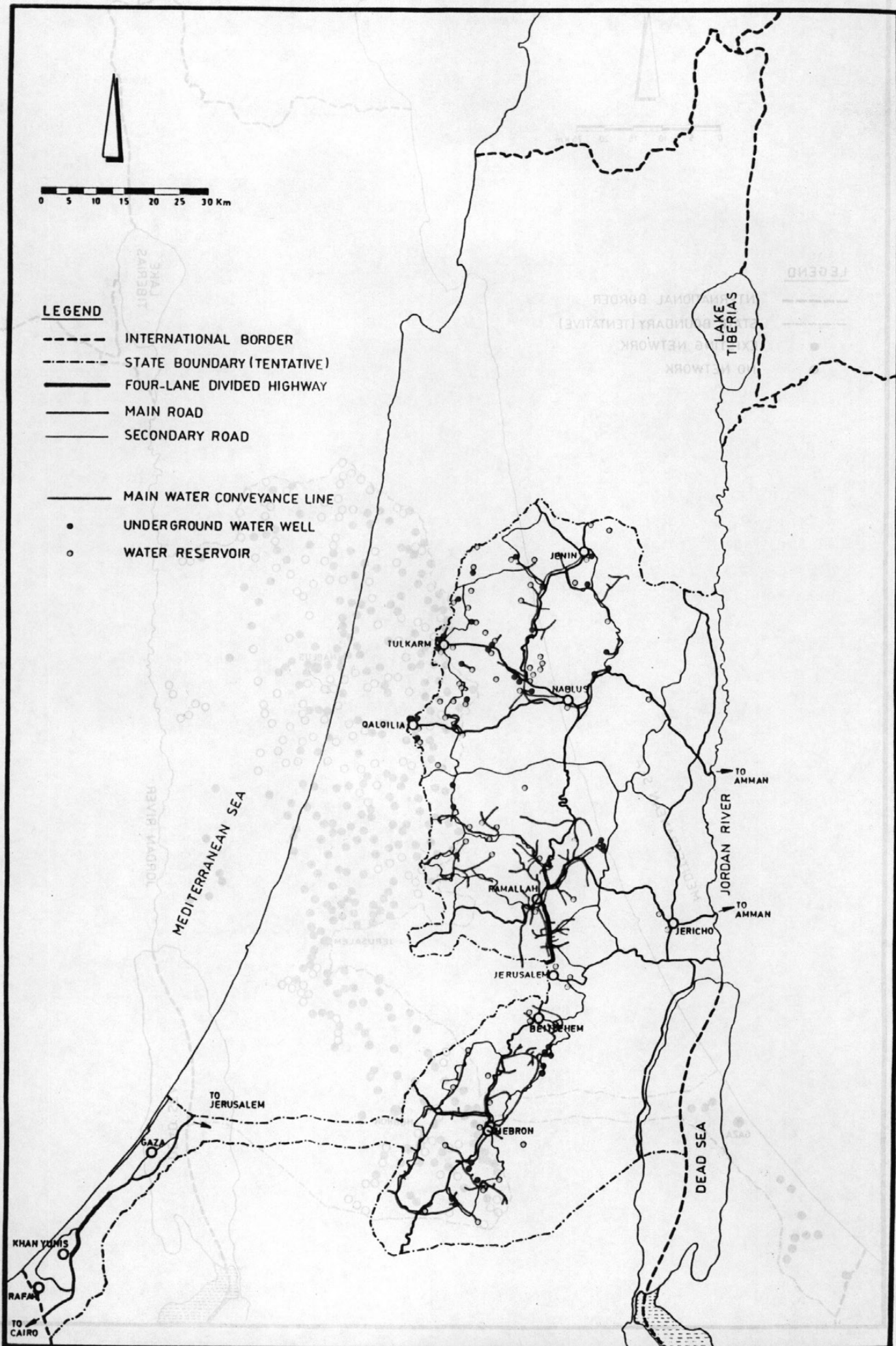
Rehabilitation and repair of leaking and inadequate water supply networks is impeded by a lack of funds and human resources, political hurdles and by the often difficult physical circumstances, which are a result of haphazard physical planning in the urban areas. Lack of physical planning also hampers industrial development and makes it difficult to meet industry's specific water demands in terms of quantity and quality. Provided restrictions by the Israeli authorities are lifted the availability of water resources should not be a problem.

Only few wastewater treatment facilities exist so far, in Ramallah, in Tulkarm, in Beit Lahia and Gaza; new treatment facilities are being planned for Nablus, Jenin, El-Bireh, Rafah, Tulkarm, Salfet and Silet Al Dhaher. Recently, feasibility studies commissioned by UNRWA for sewerage and drainage of Beach Camp (Gaza Town area) and Rafah and for stormwater collection and disposal for Jabalia Camp were completed. The study for Beach Camp recommends the establishment of a pilot project for irrigation using effluent from the Gaza treatment plant. Feasibility studies on the immediate rehabilitation of the wastewater treatment plant of Gaza City is being carried out and also a feasibility study for locating stormwater and sewage collection and treatment for Middle Camp Area (6 villages and camps) where disposal of raw sewage is posing a direct threat to public health have first priority for establishment of a sewage and wastewater treatment plant. Although reuse of treated wastewater is rather a medium-to long-term issue, it is advisable to include this aspect in the early stages of planning and designing these facilities, as introduction of the idea of reuse to the population involved needs time and an approach of gradual awareness and habituation.

### 3.4.2 Agricultural Sector

After the occupation in 1967 the Israeli authorities have destroyed a large number of wells in the Jordan Valley used for irrigation water supply and farmers were denied access to their lands and water rights along the banks of the Jordan River. Although some of these wells and lands are still being used by Jewish settlers or by the Israeli army the reclamation of the Jordan Valley using the underdeveloped groundwater from the Eastern Aquifer and spring flow will require a considerable investment in drilling of new wells, spring development and installation of new pumps and distribution systems. The Palestinian authorities should be responsible for major improvements on national water resources leaving end-user investments in the agricultural sector to be made by the private sector, cooperatives and individual farmers. They require, however a politically and administratively stable environment and should be supported by public agricultural services, like research and extension. They also should be planned in accordance with a national water master plan to adapt the expansion of irrigation to the long-term availability of water for agriculture.

At various places farmers are using raw sewage for irrigation of vegetables. Very little is done yet on the provision of treated sewage and wastewater to farmers and where attempts were made, like in the coastal region, they were met by the farmers with little enthusiasm. Farmers seem to perceive that where the use of treated sewage becomes institutionalized this will affect the marketability of their crops.



**Figure 3.6 Main Water Supply and Conveyance Networks**

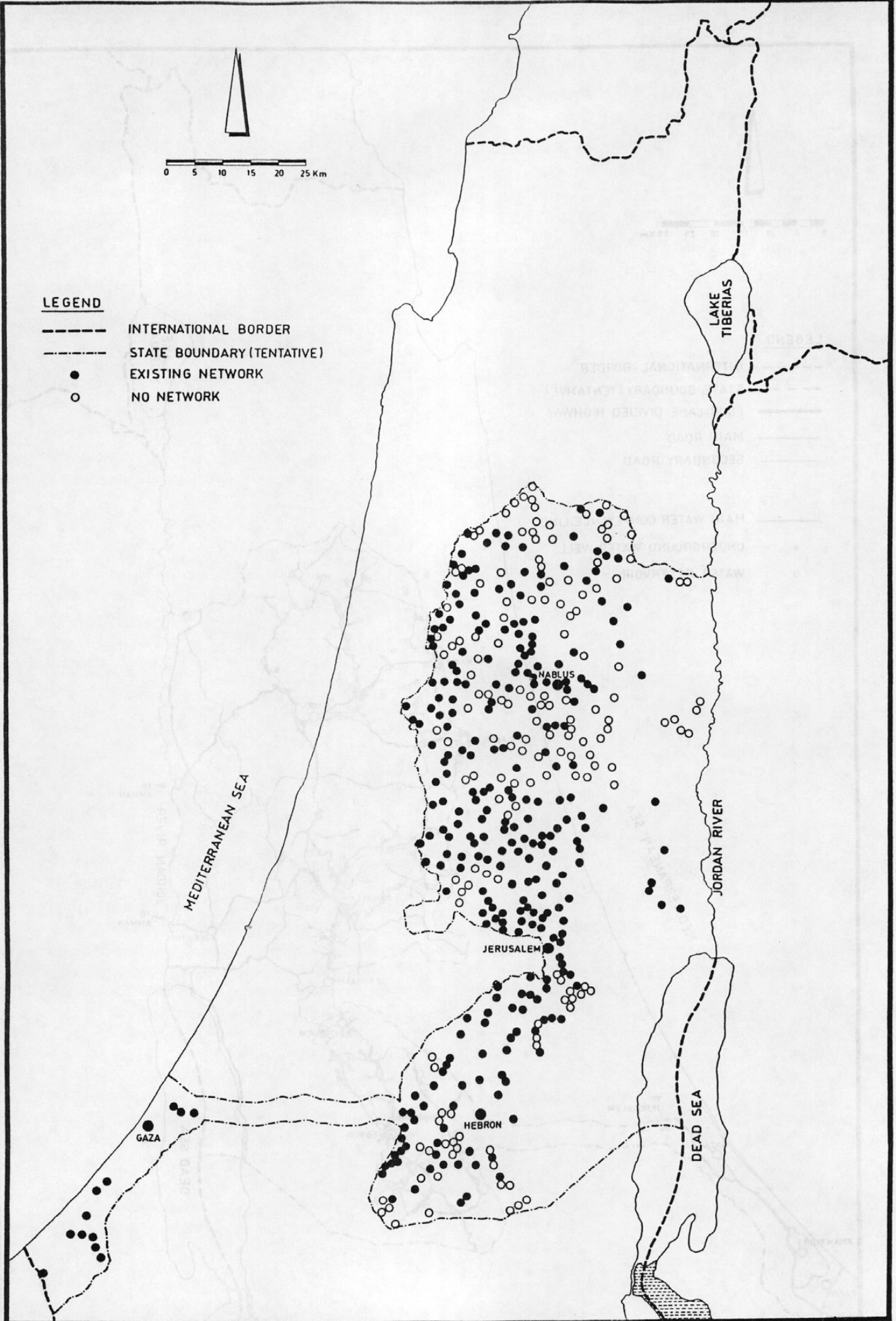


Figure 3.7 Existing Piped Water Distribution Networks

## **4 INSTITUTIONAL DEVELOPMENT**

The development of an institutional structure to plan, develop, and manage the nation's resources is an essential step in implementing effective conservation activities. Given that Palestinian institutions are in the process of being developed or reorganized under new leadership, it is clear that institutional development in this sense is probably the single most important conservation measure to be considered in this report. Since the new water authority will be the primary vehicle to carry out conservation activities (or cause to be carried out through laws, regulations, policies or some other administrative action), its importance can not be overstated.

In the preceding chapter, section 3.2, a description of the existing water sector institutional structure was provided along with an outline of the problems and issues they are facing. This section provides a recommended plan for a national water institution in Palestine including the necessary organizations and associated departments. This is however only one option. A study to evaluate the various options within the Palestinian setting is therefore a priority activity.

### **4.1 REORGANIZATIONAL ISSUES**

In building the proper institutional framework which will suit the requirements and conditions of Palestine, various issues must be considered including privatization, integration of water and sewerage services, regionalization, utility autonomy, and national level policy, planning, monitoring, and regulatory functions.

#### **4.1.1 Privatizing the Water Sector**

In order to choose a suitable institutional model for the water sector, the privatization model must be considered in order to decide the applicability of this model given the present and future circumstances in Palestine. Many countries have chosen various types of private sector management in recent years and it has proven to have positive effects on the quality of services, self sufficiency and financial returns. However, it is important to first review the unique case of the existing water sector in Palestine.

- 1) The infrastructure of most of the municipal water supply sector is disrepaired. It will be necessary to begin rehabilitation and replacement of assets from the starting point. It is unlikely that private investors will be willing to undertake the large investments required.
- 2) The donors ready for rebuilding this sector will be reluctant to give grants to private investors and loans to private investors will also be costly.
- 3) The low standard of living and the social hardships of the population will not help investors (in the short term) to set prices and tariffs covering full O&M costs plus a return on the capital investment.

- 4) The high expectations of the population and the sensitive situation during the transitional period do not encourage privatization of public utilities at this point.

In spite of these constraints, participation by the private sector should continue to be considered as an option for the future after the infrastructure is improved to a level which is compatible with the interests of consumer and potential investors.

#### **4.1.2 Integration of Water and Sewerage Services**

It is envisioned that the water and sewerage functions will be integrated at all levels. Integration is expected to improve the efficiency of both functions by avoiding unnecessary overlap and lack of coordination which occur when independent bodies manage each of the functions separately. Some problems currently observed include possible waste seepage into the underground water supply network, uncontrolled discharge into wadis, inefficient methods employed by municipalities for charging sewage fees (based upon size of structure rather than water consumption) and ineffective methods of collecting fees which could be done by one service. It is proposed that in the future wastewater be treated and recycled for agricultural and other uses. Integrating the two services would facilitate the conjunctive use approach and assure the quality standards needed for specified uses.

#### **4.1.3 Unification of Services under Regional Utilities**

Presently, in some parts of Palestine large areas are served by a single water utility. The more common arrangement is that water services are fragmented and supplied by a number of small weak institutions. It is, therefore, recommended to divide the country into several major regions, each of which would be served by a single water and sewerage utility. The existing small scale water management schemes serving individual villages and small areas have losses in water networks exceeding 50 percent and their accounting and administrative methods are also very ineffective. The integration of these schemes into regional organizations managing all water supplies and networks in the area together with sewerage facilities would reduce inefficiency in the use of water resources and the lack of coordinated planning.

The integration and unification of these services will also have a positive effect on water treatment costs since the capital investment and operating costs in treatment plants are prohibitive on a small scale and cannot be considered feasible unless serving a reasonably large region. Another advantage in this respect is the ability of the responsible utility to control the effluent from treatment plants to downstream areas and thus allow improved cost recovery. In the current situation, treatment plants owned by individual municipalities are unable to recover their costs due to their lack of jurisdiction over downstream villages.

It is suggested that four regional water and sewerage utilities would be established to cover the three main districts of the inland region (Nablus, Jerusalem, and Hebron) and the coastal region. However, a national master plan is needed to determine the



most effective allocation based on existing networks, future extensions to the networks, water sources, and wastewater reuse applications.

#### **4.1.4 Continuation and Reinforcement of the Utility Autonomy**

Although most of the existing water utilities in Palestine are public service institutions, they are not incorporated into the governmental structure. This semi-autonomous nature should be maintained and strengthened under the coming Palestinian administration in order to allow these utilities to develop freely and avoid the complications of incorporating these utilities into governmental departments. Thus it will be easy and harmonious to unify and integrate these departments in the proposed new regional institutional setup.

The water departments in the larger municipalities such as Nablus, Hebron, Ramallah and Gaza are expected to form the nucleus of the proposed regional utilities. However, the present state of these departments does not demonstrate the capability and sufficient level of efficiency and development to carry the future integrated regional responsibility. Major assistance is needed to reform and develop the administrative, technical, financial and human resources capabilities in these departments. Concentrated efforts for a period between one to two years is needed to improve these departments.

Utility autonomy will require a solid understanding on the part of management and staff regarding the rights and responsibilities of each. A review of personnel policies is needed including salary, benefits, promotion schedules, and training opportunities. In order to hire and retain competent personnel and compete with the private sector for their services, the utilities management will necessarily adopt flexible approaches to deal with rapidly changing economic and labor conditions.

#### **4.1.5 National Level Planning and Monitoring**

Although the financial and administrative autonomy of the water and sewerage utilities is deemed highly necessary to assure that local needs are met, it is equally important to establish a national water council which will plan and monitor the overall water resources and assure that regional utilities meet national standards of service. This body would establish policies related to standards and specifications, water quality control, environmental impact, and monitor for overall performance of the utilities. Implementation of major national water projects and effective distribution among the various regional utilities would be carried out by a newly established water supply and sewerage authority.

#### **4.1.6 Water, Supply and Sewerage Service Company**

The small-scale of the regional water and sewerage utilities in Palestine makes it unfeasible to invest in some large-scale services, capabilities and equipment. The establishment of a Water Supply and Sewerage Services Company would solve this problem by providing these capabilities (large-scale construction, maintenance, design

and planning, training, etc.) to the regional utilities as well as the national water and sewerage authority in an efficient manner. The company would be established by the regional utilities as a cooperative company which will subsequently sell its services to each of these utilities and to other customers in the commercial sector.

## **4.2 INSTITUTIONAL STRUCTURE**

Taking all of these factors into consideration, the general framework for water and sewerage management in Palestine has been designed. As indicated above, it comprises four different types of institutions:

- **National Water Council**
- **National Water Supply and Sewerage Authority**
- **Regional Water and Sewerage Utilities**
- **Water Supply and Sewerage Services Company**

Figure 4.1 shows the relationship between these institutions.

### **4.2.1 The National Water Council**

The proposed organizational structure for the National Water Council is shown in the organizational chart in Appendix C1. The structure shows all the possible divisions which may be required to carry out the functions of this organization. However, despite the definition of these divisions, it is expected that the organization will be built up and developed gradually with the establishment of the sub-divisions as necessary.

The general function of this council is the monitoring and regulation of the services provided by the National Water Supply and Sewerage Authority, the Regional Water Supply and Sewerage Utilities and the Water Supply and Sewerage Services Company. The Council will set standards and monitor for any discrepancies on the part of the national authority, regional utilities or the company. It will also be responsible for international agreements and transfer from outside Palestine.

### **4.2.2 The National Water Supply and Sewerage Authority**

This governmental body will plan and develop the national water resources and ensure effective distribution among the various regional utilities. It will be responsible for monitoring water resources run by the regional utilities. All regional and joint projects for implementing international agreements with neighboring countries regarding water and wastewater management will be carried out by this authority. National projects such as dams, large-scale treatment plants, national awareness programs, etc. will

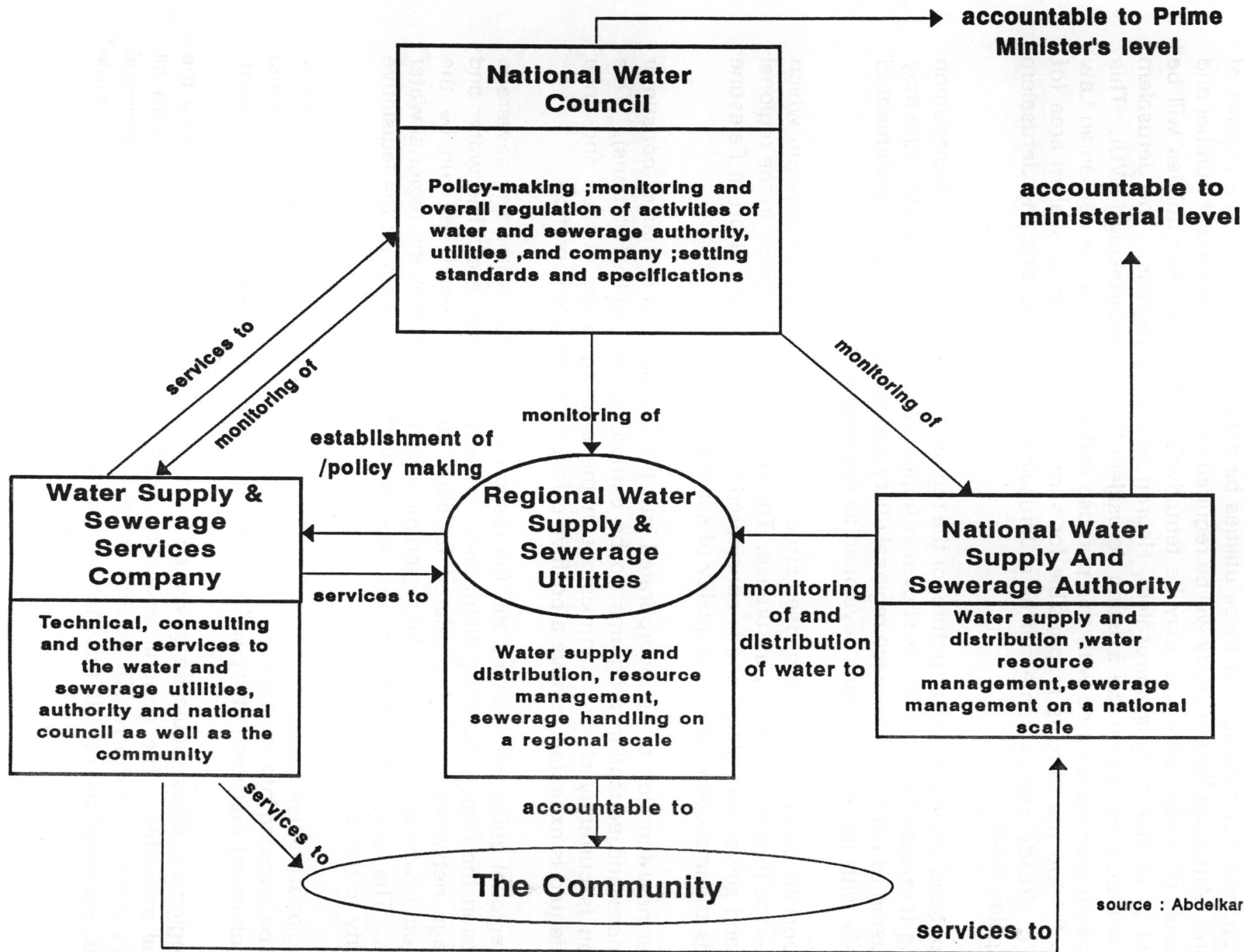


Figure 4.1 RELATIONSHIPS BETWEEN PROPOSED RESPONSIBLE BODIES IN THE WATER SECTOR

also be carried out by this department. Various licensing and other related procedures will also be within the framework of this department's responsibilities. The proposed organizational structure for the National Water Supply and Sewerage Authority is given in Appendix C2.

#### **4.2.3 Regional Water Supply and Sewerage Utilities**

It is proposed that a number of these utilities be established in the major regions of Palestine. Although further study will be required to determine the exact number and boundaries of these utilities, it may be tentatively stated that four utilities will be required to service Nablus, Jerusalem, Hebron and Gaza regions. The Jerusalem region will be serviced by the existing Jerusalem Water Undertaking (JWU). This undertaking was established with this purpose and according to the Jordanian Law No. 9 of 1966 the JWU is responsible for servicing the entire Jerusalem area (of which it already serves some northern Jerusalem areas) including the Jerusalem municipality itself.

The proposed organizational structure for the regional utilities, which was based upon the long-term plan for the JWU, is shown in Appendix C3. This model structure may be adjusted as necessary for each regional utility and is expected to be implemented gradually with the sub-divisions developed as necessary.

An important division in the proposed structure is the quality affairs division which includes the function of quality assurance. This function is a necessity in the regional water and sewerage utilities and is considered to be a pioneering effort in Palestine towards the improvement of the quality of service.

Another new function to be incorporated into the organization is that of consumer awareness and education programs (to be carried out by Public Relations). This function is currently almost non-existent in the existing water utilities and once implemented is expected to have a positive effect on water conservation.

Each regional utility will assume the full responsibility for all water and sewerage services in the region including distribution, collection, billing, etc. The water and sewerage networks and other related facilities currently owned and run by the individual towns and villages in the region must be transferred to the regional water utilities. The appropriate laws and regulations must be drawn up by the legislative authority to this effect.

The regional utilities would be operated as non-profit public utilities. Excess revenues would be invested into the improvement of the utility's facilities and services. It must be emphasized that each utility will be financially and administratively independent.

The regional utilities would be governed by a board of directors representing the general assembly. The general assembly would include representatives from all sectors serviced in the region as well as representatives of NGOs, environmental groups, industrialists, etc. In this manner, the regional utility will be fully accountable

to the community which it serves. Thus, although the direct responsibility for delivering water and sewerage services will be transferred from the individual municipal authorities, their right to be consulted concerning the manner in which these services are performed will be preserved. The transfer of assets and liabilities of these utilities to the proposed regional body will be carried out under suitable legislation regulating the transfer.

The make up of the general assembly and board of directors would be established by the appropriate laws and regulations to be issued by the Palestinian legislative body within the context of a national water master plan. The members of the general assembly may be nominated by the beneficiaries or by the municipal body in each region. The number of representatives in the general assembly from each region and organization may be determined by the number of beneficiaries and the amount of water consumption in the represented region as well as other considerations. The mechanism used to determine and choose the members of the general assembly and board of directors is vital to the preservation of the community's direct participation in the regional utilities. Thus, a detailed study which utilizes the experience of other countries in this respect is recommended.

#### **4.2.4 Water Supply and Sewerage Services Company**

The main function of this institution would be to provide the regional water and sewerage utilities with services which each individual utility would not be able to support on a regional level. These services may include large-scale development and construction contracts, heavy-vehicle and machinery maintenance, rehabilitation and calibration of large diameter water meters as well as human resources development. The company should include a vocational school for the education and training of technicians for various vocations in the regional water and sewerage utilities. The company may also provide contractual services to the regional water and sewerage utilities such as well drilling and rehabilitation as well as to other customers. It should be noted that the above mentioned services, as well as other services, are currently provided to the Palestinian water utilities by Israeli companies as no Palestinian companies offer these services.

It is envisioned that this company will be established as a joint project by the various regional utilities. The board of directors of the company will include representatives from all the regional utilities involved. Any excess revenues realized by this company will either be reinvested into the company or distributed among the regional utilities according to their initial investments. The proposed organizational structure for the company is shown in Appendix C4. This is a tentative structure and, as with the previously proposed structures, is not expected to be fully implemented upon the establishment of the company but rather built up gradually according to necessity.

The primary budget items for establishing the previous four types of institutions are listed in Appendix C5.

### **4.3 HUMAN RESOURCES IMPROVEMENTS**

The critical ingredient of any institution is staffing with qualified individuals. The following are recommended actions to improve human resources:

- 1) Cooperation between universities and research institutions and the proposed water and sewerage utilities should be increased. Universities are expected to start teaching water resources management courses and operation and maintenance of public utilities.
- 2) A number of regional training facilities should be established within the regional utilities. These facilities are expected to satisfy the training needs of the surrounding localities. The trainees should get theoretical and practical on-the-job training. The centers need to be fully equipped for the dual purpose of providing training as well as assisting the individual utility in its maintenance programs.
- 3) A technical school providing training for technicians in the water sector should be established. This school may be incorporated in to the Water Supply and Sewerage Service Company and supported by the regional utilities.
- 4) Short term training courses abroad in certain fields will provide necessary training to the water utilities in areas that are unavailable locally. Candidates should be selected and sent to attend appropriate training sessions abroad whenever such training is necessary. There is an immediate need for training in water administration and management specifically for the middle management level. This is one area of training that is unavailable on the local level.
- 5) A possible source of qualified staff needed for the various water institutional entities could come from Palestinians returning from abroad. Recruitment of these individuals could be stimulated by announcements of employment in the water sector trade journals. The Committee for the Reemployment of Returnees can also assist as they have collected data on such individuals.

### **4.4 ACCOUNTING SYSTEMS**

Improved accounting systems and approaches are needed to assure effective operations. Accounting systems and financial statements adopted by water utilities should conform to commercial accounting methods used in the private sector. The activities of each water utility should be categorized to different costing centers, expenses related to each cost center must be transferred and borne by the related center.

At the end of each financial year, a production account, profit and loss account (surplus and deficiency account) and a balance sheet showing the financial results

should be prepared and submitted to the responsible bodies (general assembly and board of directors).

Allocations and provisions for depreciation and for the "investment fund" must be taken into consideration in order to establish a revolving fund for capital reinvestment, thus laying solid bases for financial self-sufficiency in this sector.

#### **4.5 FINANCIAL AUTONOMY AND COST RECOVERY**

The cost of water supply and sanitation services must be borne by the beneficiaries to ensure adequate recovery of operation and maintenance costs as well as the expansion of services and facilities. Cost recovery is a crucial step towards the financial viability and the eventual autonomy of sector agencies.

Full cost recovery involves recuperation of investment costs as well as those for O&M (operations and maintenance). This method will enable water supply and sanitation systems to establish among themselves a revolving fund for reinvestment in the sector and will gradually reduce dependency on grants provided by international agencies. In order to achieve full cost recovery, there must be appropriate regulations, penalties, and provisions for procedures to enforce the laws pertaining to non payment of bills, illegal connections, and other violations. It is expected that full cost recovery will require a gradual approach beginning with recovery of O&M costs and part of the capital cost. Feasibility studies are needed to determine willingness to pay and establish appropriate revenue streams based on graduated tariffs.

A sample cost statement is presented in Appendix C6.

#### **4.6 COLLECTION POLICIES**

The integration of water and sewerage systems and the establishment of the regional autonomous water and sewerage bodies will help in raising the collection rates by allowing these bodies to use practical methods to ensure collection from bad debtors since water schemes and sewerage schemes are not at present run by the same institutions in most of the cases.

The ability of raising awareness among the consumers to abide by the rules and pay their outstanding balances will be more effective and comprehensive if carried out by the integrated regional bodies. The excellent results achieved by the Jerusalem Water Undertaking (JWU) in this field should be studied for implementation in other utilities. Experiences of the different undertakings and departments in other sectors should also be examined as examples and drawn on as appropriate.

#### **4.7 WATER SECTOR INTEGRATION**

The institutional structure described in this chapter applies to the water sector. Obviously, there are water users outside of the municipal setting. Agriculture, in particular, is presently the largest water user in Palestine. As the individual

consumption rises to meet the minimum water requirement for domestic and industrial uses, then close collaboration will be needed with agricultural (and all other water users such as mining, recreation or wildlife habitat) to optimize water resource management. An appropriate institutional body will be needed to assure water sector integration. The completion of a national water master plan is needed to give direction to the integration task. As a precondition to completing such a master plan, an information gathering task needs to be carried out to collect all pertinent data in Palestine, Jordan, and Israel related to water resources and uses and to establish a regional data bank. In the long term a regional system of information exchange is needed to continuously update the data bank.



## **5 CONSERVATION MEASURES AND PRACTICES**

Most conservation measures and practices can be carried out (or cause to be carried out) only by a capable institution with a mandate for action, a capable staff, and adequate resources. The establishment of a water institutional authority becomes a top priority for the water sector in the newly emerging State of Palestine. The preceding chapter provided a recommended plan for a national water institutional structure including key organizations with requisite departments to be established immediately upon independence. Conservation activities described in this chapter are proposed to take place within the purview of such an institution.

Water conservation takes many forms. It is helpful to differentiate between conservation measures and practices. Measures may be direct, such as regulatory controls or economic incentives related to water use, or indirect, such as through persuasion of the public by awareness campaigns carried out in the mass media. Measures are largely the direct responsibility of a central water authority. Management practices, on the other hand, are typically carried out by the water user often because of measures introduced by the water authority. Practices typically require the use of technologies to reduce losses from leaks, reduce evapotranspiration, reduce demand for fresh water by substituting for water of lesser quality or increase of water recharge.

The various approaches to conservation addressed herein are the following:

- Reducing Water Losses
- Investments in Reducing User Demand
- Substituting for Fresh Water
- Institutional and Regulatory Approaches
- Economic Incentives
- Education and Persuasion

### **5.1 REDUCING WATER LOSSES**

#### **5.1.1 Municipal Unaccounted-for-Water**

Unaccounted-for-water is a troublesome component of municipal water systems world wide. It is helpful to distinguish between two methods of evaluating unaccounted-for-water. One method considers the difference between the value of water which enters the system and the revenues collected. A second method measures the volume of water entering the system in comparison to the volume delivered to the customer as

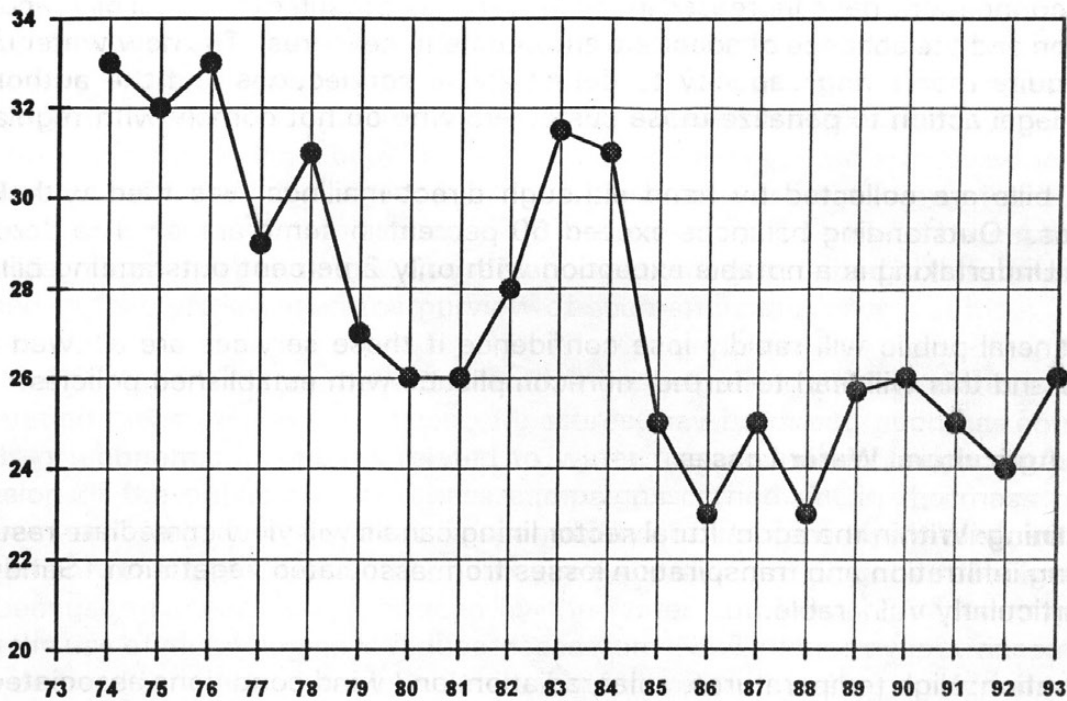
measured by meters. Both methods reveal the magnitude of the problem but it is often difficult to distinguish between the various possibilities for water losses. The most prominent cause for water losses is leaks in pipes, connections, or valves but other factors include illegal connections, unpaid bills, and faulty meters. Determining the exact problem is often a difficult undertaking but where done effectively can lead to large savings in water and finances.

A comparison of volumes of water supplied and water delivered at the consumer level clearly indicates significant unaccounted-for water in existing Palestinian municipal networks. Losses are reported to range from 25 to 55 percent of the supplied quantities. Within the existing municipal networks there are large water losses originating from leaks in the pipe networks due to their deteriorated condition. Even a casual inspection of most of the older urban systems suggests significant losses from leaks. The systems are operating far below acceptable standards since many utilities do not have an accurate or regular measurement of losses, and assistance is needed for conducting systematic water audits.

Losses in networks can be traced and decreased by:

- 1) Raising public awareness by campaigns directed to the public to motivate them to immediately inform the water utility about leakages.
- 2) Installing main water meters in each locality and comparing the total consumption in these meters with the total consumption of the individual consumers' meters. Thus areas with a high loss percentage will be identified and dealt with on a priority basis.
- 3) Performing a general survey using electronic leak detectors in localities suspected of excessive or repetitive leakage.
- 4) Replacing deteriorated networks according to a priority plan.

Figure 5.1 shows the variations in water losses at JWU from 1974 to 1993. The drastic decrease in losses between 1984 and 1986 is due mainly to the replacement of 10 km of a 6-inch main line supplying the Beit Hanina area (north of Jerusalem) with a 10-inch line at a total cost of US\$ 500,000. The rate of return for this investment was about 17 percent. This relatively high rate shows that the replacement policy is clearly feasible and beneficial.



**Figure 5.1 The Variation in Water Losses at JWU from 1974 to 1993**

Unaccounted for water losses related to inaccurate water meters could be monitored and reduced by:

- 1) Using volumetric type water meters instead of velocity meters in areas where customers have installed rooftop tanks (pressure breaking) because of low pressure or irregular flows. In addition, meters suspected of false readings should be checked and calibrated regularly and replaced as required.
- 2) Improving the efficiency and competence of maintenance workshops.
- 3) Constant monitoring and comparison of both the average and the recorded consumption of each consumer in order to quickly identify irregular consumption rates.
- 4) Improving work procedures in new installations and in the maintenance of pipes to eliminate the introduction of soil and other substances that may negatively effect the accuracy of the water meters.
- 5) Providing reduced tariffs for consumers with no water reserve tanks on their roofs since tanks cause an under reporting of flow. This, however, can only be affected after continuous piped supply is provided.

Illegal connections have increased in recent years as a result of the declining economic situation and the absence of adequate enforcement measures. The new water utilities will require monitoring capacity to detect illegal connections and the authority to evoke legal action to penalize those customers who do not comply with regulations.

Water bills are collected by hand although direct mailings was tried with limited success. Outstanding balances exceed 60 percent in some areas. The Jerusalem Water Undertaking is a notable exception with only 2 percent outstanding bills.

The general public will rapidly lose confidence if these services are allowed to fall behind and this will lead to further non-compliance with established policies.

### **5.1.2 Agricultural Water Losses**

**Canal lining:** Within the agricultural sector lining canals will yield immediate results by reducing infiltration and transpiration losses from associated vegetation. Sandy soils are particularly vulnerable.

**Evaporation:** High temperatures, solar radiation, and wind conditions associated with the local climate produce high evaporation rates. Measuring these parameters could be carried out through the establishment of a network of meteorological stations in appropriate sites throughout Palestine.

**Transpiration:** Transpiration losses may equal evaporation losses where vegetation cover is dense. Techniques for reducing transpiration include:

- substituting crops that are drought resistant,
- covering crops in a greenhouse fashion to collect transpired water vapor and thus reduce the evaporation rate
- planting windbreaks or intercropping with taller plants to reduce wind movement

Many crops already grown in Palestine are drought resistant including almonds, olives, jojoba, barley, vetch, and lentils. Increasing emphasis on these crops in rainfed areas is an appropriate conservation strategy.

### **5.1.3 Water Collection**

Rainwater runoff represents an important part of the hydrologic cycle. Most rainfall, particularly on sandy soils with little vegetative cover, enters the groundwater system. However, stream flow that continues outside of areas where it can be effectively used represents a water loss. In arid zones wadis typically convey large volumes of water for short periods from rainfall events of short duration. Collection dams and water spreading terraces to agricultural fields or canals directed to ground water recharge

basins can reduce these losses. Injection wells to facilitate groundwater recharge is also a promising technique in some locations.

Water recharge is thought to be particularly appropriate in the coastal region, the Auja and Wadi Kilt areas in the Jericho district and Wadi Fara'a in the Nablus region. Also the excessive runoff in the Jenin wadis during heavy rains could be exploited.

In some areas of the inland region there are most impressive examples of terracing, drought resistant olive and almond trees, and intercropping with a variety of other crops. This conservation practice conserves both soil and water and should be replicated wherever farming is practiced on steep slopes.

Rooftop collection systems may have merit for households to supplement water supplies. While rooftop collection systems are most popular in higher rainfall zones with short season dry periods there are examples of this technology in Palestine. The cost of constructing a storage basin is usually the limiting factor. Buildings with large roofs such as schools and other public institutions are often good sites.

## **5.2 INVESTMENT IN REDUCING USER DEMAND**

User demand may be influenced in several ways. The software measures of regulation, economic incentives, and education are discussed below in this chapter. This section reviews the potential practices and technologies appropriate to water conservation in the agricultural, municipal and industrial sectors.

### **5.2.1 Agricultural Sector**

For most countries, and especially in the Middle East, agriculture is by far the biggest water user. Irrigation development has made possible crop production in dry areas where rainfed production would be precarious or impossible. Reducing water consumption while maintaining food production for local consumption and supplying an export market are major challenges to the sector. With increasing competition from the domestic and industrial sectors, agriculture is faced with dwindling water supply opportunities and/or increased costs to purchase water.

It is estimated that the agricultural sector currently accounts for about 73 percent of total water consumption, while the domestic and industrial sectors account for 25 and 2 percent, respectively. Clearly conservation measures will need to focus on agriculture if significant gains are to be made.

It should be noted that only about 5 percent of all cultivated land in the inland region is under irrigation. In the coastal region the ratio increases to about 67 percent. Conservation efforts in the agricultural sector can, therefore, be applied to only a limited scope at present, but would have to be expanded as larger areas of cultivated land came under irrigation.

Rainfed agriculture could also benefit from water conservation techniques as effective use of rainfall runoff in this sector potentially contributes to ground water recharge.

On farm irrigation technologies consist of three types; surface irrigation, sprinkler irrigation and micro irrigation. Improvements in surface irrigation is achieved primarily from improved land levelling thus enabling a uniform and minimal application of water over the field. Piping technologies include plastic syphons from head ditches to secondary furrows, flexible pipes to distribute water, and buried PVC pipes with riser mains. Sprinkler irrigation allows savings on uneven or hilly terrain where levelling is impractical. The largest savings occur from the use of drip irrigation systems.

Comparisons between furrow or sprinkler and micro systems show a savings of 50 percent for tomatoes and eggplant and 109 percent for bananas in various locations (World Bank, 1993). Drip irrigation not only saves water but also increases production by several fold for many crops by assuring a continuous supply of water to the root zone. Fruit trees, vineyards and vegetable crops are the most common applications. It is important to note that in order to be effective improved farm technologies must be matched with the experience, investment capacity, and managerial abilities of the farmers who will employ them.

Improved irrigation technologies including drip irrigation is already used by many Palestinian farmers especially in the Jordan Valley, Jenin and Tulkarm districts, and throughout the coastal region. However, lack of investment funds and limited affordability prohibit the wide application of these technologies. If the problem of credit can be solved, this approach could represent a significant conservation effort.

### **5.2.2 Municipal Sector**

The municipal sector includes residential, commercial, transportation and institutional uses. Residential water use is the highest but this varies considerably between households depending primarily on income levels. Water taps, showers, clothes washers, and toilets are devices that can be replaced or modified with water saving substitutes. The challenge is to introduce devices that pose a minor inconvenience to the user.

Given the objective of equitable distribution to increase per capita consumption in order to achieve the MWR and raise the standard of living of the Palestinian people, it would appear that reducing demand is counter to the goal. However, it is important to assure that water is not needlessly wasted. This approach will become more relevant as the economy and public awareness grow.

### **5.2.3 Industrial Sector**

Consumptive water use in the Palestinian industrial sector is relatively small compared to the agricultural and municipal sectors and therefore potential water savings will be small. However, water audits of industrial washing, transportation, and cooling uses

will lead to improved technologies which use less water in manufacturing. Many industrial processes can use recirculated water.

In the Middle East significant savings may be obtained by the recirculation of cooling water from thermal power generating plants (World Bank, 1993). In Egypt the power sector accounts for 79 percent of industrial water consumption. Future feasibility studies of energy cooling systems should consider the marginal costs of closed circuit systems and/or substituting brackish or other water of less quality in open systems.

Although significant reduction in industrial water consumption will only become meaningful after a substantial growth of the Palestinian industry, campaigns to instill awareness of water saving technologies and their economic relevancy to individual users are most appropriate.

## **5.3 SUBSTITUTING FOR FRESH WATER**

### **5.3.1 Wastewater Reuse**

Wastewater offers particular advantages as a substitute for freshwater. Municipalities with sewer systems and treatment plants may recover high percentages of their water supplies. As much as 65 percent of municipal water supplies may be available, with efficient collection and treatment facilities, for reuse (Assaf, 1993). Treatment of sewerage is necessary for safe reuse. The treatment process should be determined by the end use for which the reclaimed water is to be used. The use of untreated wastewater is a common but dangerous practice in many parts of the world because of transmission of waterborne diseases. Wastewater offers large advantages, as compared to fresh water, for use in agriculture by partially supplying needed nutrients at a lower price. For agricultural purposes and many industrial purposes treatment costs are relatively low. More expensive treatment processes may produce water of quality suitable for human consumption.

Several countries are reusing large quantities of wastewater. Mexico City recycles 100 percent of its sewerage for agriculture after sedimentation and partial treatment. Many cities irrigate fodder crops for animal feed. Israel is aiming to utilize more than 80 percent of its total wastewater, primarily in agriculture (World Bank, 1993).

In Palestine only 10 cities have extensive sewage collection networks. These include East Jerusalem, Nablus, El Bireh, Hebron, Ramallah, Tulkarm, and Jenin in the inland region. In the coastal region they include Gaza, Beit Lahia, Jablia village and camp and Tal El Sultan in Rafah. The extent of coverage varies from 20 percent to 75 percent. The remaining urban areas and most rural areas depend on septic tanks, percolation pits, latrines, or open drains. Most of the urban wastewater collection systems combine sewer connections with street drains.

Ramallah and Tulkarm are the only cities with wastewater treatment facilities in the inland region. Two treatment facilities have been constructed in the coastal region

but none are operating properly. Wastewater flows from the cities by gravity into neighbouring wadis and is often used by farmers for irrigation.

At the household level some use is made of grey water, wastewater from kitchen sinks and washing machines, for watering gardens. Expanding this practice is recommended.

Wastewater reuse offers high potential as a conservation measure that should be exploited. Expanding the coverage of sewers and adding treatment facilities is a necessary precondition.

### **5.3.2 Brackish Water**

Brackish water is commonly available in arid climates especially in the Middle East. With careful management brackish water can be utilized for many crops. Advances in soil and plant sciences have shown that some crops tolerate specific salinity levels and that these levels may vary during the growth cycle. Substituting moderately saline water or mixing fresh water with brackish water can be utilized effectively for selected crops and result in substantial savings of fresh water.

For some crops very high salinity levels are tolerated. For example, in Abu Dhabi forest plantations on sandy soils have been irrigated with brackish water of 10,000 ppm of soluble salts (World Bank 1993).

Assaf (1993) estimates that there is about 180 MCM of brackish water in the inland region of which at least 55 MCM are currently available for Palestinian use in the lower Jordan Valley. Much of this water is derived from springs at low elevations along the Dead Sea. There is also significant brackish water in the coastal region. The expanded practice of using brackish water has particular merit in the Jordan Valley region where suitable agricultural land is available.

### **5.3.2 Dual Distribution Systems**

Fresh water is, of course, required for drinking, food preparation, and some industrial purposes. Much fresh water is nonetheless used for purposes requiring only lower quality water such as cleaning, fire hydrants, garden watering, stock watering, and industrial processing. For the latter uses, brackish water or treated waste water may be considered if a dual distribution system is constructed. The second system would be primarily for outdoor uses, and selected household and industrial uses.

There is relatively little experience world-wide in the use of dual distribution systems. In Hong Kong about 20 percent of total demand is supplied by sea water which is distributed primarily for toilet flushing. In Eilat in Israel, which uses expensive desalinated water for drinking, a dual system is used for urban irrigation and fire fighting.



Given the higher costs of installing dual distribution systems the technology is generally rated moderate for Palestine although cost benefit studies will be needed to verify this assumption. The acute water quality situation in the coastal region may, however, offer possibilities for implementation of this conservation practice.

#### **5.4 INSTITUTIONAL AND REGULATORY APPROACHES**

A recommended water sector institutional structure was described in Chapter 4. The proposed organizations and their departments are intended to carry out many functions which are directly related to conservation measures and practices. The new institution will of course be empowered by law to carry out regulatory measures. Enlightened laws, regulations, and standards can contribute much to conserving water or directing it to the most effective use. Regulatory activities related to water conservation should include:

- water extraction licensing (for surface and groundwater)
- standards of service
- water quality monitoring
- plumbing and appliance restrictions
- drought restrictions
- penalties for non-compliance

Licensing or the granting of permits for water development (wells, springs, dams) is a necessary function of the water authority if water resources are to be rationally extracted and utilized in a sustained manner. Groundwater, in particular, requires proper application and regulation of safe yield values for each well.

Varying standards of service are necessary to satisfy the needs of the various of water users (customers) including domestic, commercial, institutional, industrial, and agricultural users. Within each category it will be necessary to establish and regulate standards of service related to quantity, pressure, and quality of water delivered. Optimizing the system to provide levels of service within a conjunctive use formula is a challenging regulatory function. For example, applying standards which establish the chemical or bacteriological content of wastewater to be applied for agriculture will do much to assure the safe use of water in the interest of preserving public health.

Water quality monitoring is, of course, necessary to assure safe potable water for domestic and commercial consumers. In consideration of the proposed strategy to conserve fresh water and substitute water of various qualities (wastewater and saline water) for agriculture and some industrial and stone mining uses, minimum standards of acceptance for each use must be carefully controlled. In addition, wastewater from

municipal sewers, drains, and treatment facilities must be managed in a sound manner to avoid negative environmental impacts on surface waters and related animal and plant ecosystems.

Plumbing and appliance regulations are necessary to assure the use of materials and appliances that are conservation sensitive. Plumbing standards related to such items as pipes, valves, fixtures, and water tanks are necessary both to regulate the flow and to also minimize the possibility of leaks from inferior products or installations. Appliance labelling to identify items such as toilets which have low water use requirements are necessary.

In arid climates which typically have large annual variations in rainfall, regulating water use during droughts is a required and significant regulatory function. Controlling non essential uses such as lawn or park watering and car washing can have significant effects on water consumption.

Finally, all of the above regulatory conservation measures must be supported by penalties for non-compliance. Illegal connections, tampering with meters, and refusal to pay bills are typical acts which call for the application of penalties. Penalties may include cutting of service, fines, or both. The circumstances of application and the size of fines will have to be addressed by each utility in accordance with societal norms. Even-handed enforcement is critical to the success of laws, standards, and regulations. Regulations which are intelligently established, widely disseminated, and equitably applied will be more willingly accepted by the general public.

The application of the above described regulatory measures is highly recommended. Some of the measures are, of course, already being practiced to a limited degree but increased utilization under the new institutional structure should produce a significant impact on water conservation. This underlines the priority need to establish and empower the new Palestinian institutional structure as quickly as possible.

## **5.5 ECONOMIC INCENTIVES**

The institutional structure proposed in Chapter 4 provided for regional utilities that would be financially and administratively autonomous. The first objective of tariff policy must therefore be to ensure full cost recovery so as to establish the regional utilities on a financially autonomous basis.

Besides cost recovery, however, pricing policy can perform a powerful conservation function through the incentives they provide to end-users. In principle, water prices should reflect the full economic value of water so that users reflect this value in their consumption decisions. In practice, however, it is seldom feasible to increase prices to the extent warranted except over a period of time. Moreover, poorer consumers need to be protected so that they can satisfy their basic needs at a cost they are able to afford. And tariffs for commercial, institutional and industrial users must be designed to take into account the adverse impact they might potentially have on economic development.

In view of these considerations, pricing policies should be designed carefully to complement other conservation practices and measures in ways that encourage efficient levels of water use while safeguarding basic needs. Among the options that can be considered are:

1. Graduated block tariffs to reflect the amount of water consumed. Present tariff schedules provide for very little difference between one price group and another, with the result that they have limited impact on end-user demands. For instance, in Hebron Municipality, the present water tariff schedule is as follows:

-	From 0-10 cubic meters/month:	US\$ 0.82/cubic meter
-	From 11-15 cubic meters/month:	US\$ 0.85/cubic meter
-	From 16 cubic meters and above:	US\$ 0.89/cubic meter

Substantially steeper block tariffs need to be considered, and these could have a significant impact on residential water use.

2. Discrimination between different qualities of water to encourage use of lower quality wastewater, grey water and saline water for appropriate industrial, residential and agricultural purposes. The feasibility of differential charges depends on the physical infrastructure available and the marginal costs incurred over-and-above those necessary to meet approved environmental standards.
3. Incorporation of sewerage charges along with those for water. Although it is true that not all sewerage costs are directly dependent on the volume used, many costs (eg. those for treatment) are. Therefore, tying sewerage charges to water tariffs also provides an important additional disincentive to over consumption. Given the dual objectives of water tariffs for cost recovery and conservation, and the need to safeguard the poorer sections of the community, care must be taken in designing tariff structures. A tariff study which also assess willingness to pay and the potential water savings to be gained from alternative schedules will provide a useful input into the conservation effort.

## **5.6 EDUCATION AND PERSUASION**

### **5.6.1 Need for Public Education**

In order to ensure maximum attention to the proper utilization, protection and conservation of water in Palestine, it is of utmost importance that all Palestinian users be made aware of fundamental matters relating to water. For that reason, dissemination of information programs and educational programs and curricula must be set up. Grassroots education of proper water utilization and conservation should be included in school curricula starting from the elementary school level up to high school, and including college. Research programs should be supplemented by the provision of extension services for dissemination of broad information to the public, with special focus on domestic users as well as specialized information for the

agriculture and industrial sectors. Effective public information aims at the creation of a general as well as personal responsibility for the crucial water issues that face the Palestinian people. Given a general feeling of responsibility for the local resources, the Palestinian people will be aware of the importance of the protection and conservation of water for their future economic development and domestic comforts.

As the Palestinian people become more in charge of their own destiny, all citizens and water users will be interested in the rational use and conservation of water. All sectors of the Palestinian public should be involved at all levels in support of decisions made regarding the allocation and conservation of Palestinian water resources. The Palestinian public should also be informed about the problems and solutions for water use and conservation. Appropriate sectors of the Palestinian public should participate at all stages of study, development and planning of water use and conservation, as the public can make significant contributions both to the identification of targets and to the development, adoption and implementation of the proposed plans. A program for a defined dissemination of information which may be called, "Palestinian Waters - Use and Conservation," should be developed.

### **5.6.2 Obstacles to Overcome**

It is important to recognize several obstacles to public education relating to water conservation that must be overcome.

First, to many Palestinians groundwater is "out of sight, out of mind" and there is a low level of awareness. However, the importance of the need for water in the area has made the issue of water rights a priority to decision makers and even the general public as a political issue. The obstacle to overcome is to make the general Palestinian public believe that they can personally contribute to alleviating part of this water resource scarcity problem.

Second, people often have a mystical view of groundwater as springing or issuing from the ground at a point or at a well without connecting it to what is happening on the surrounding land. This obstacle has to be overcome by educating the general public and specifically the agriculturalists and industrialists that whatever substances they put on the ground or discharge in the water onto the ground could and probably will eventually affect the quality of the groundwater supplies in Palestine.

Third, groundwater is regarded by the general public as being automatically pure and wholesome. There is little realization that groundwater may look, smell and taste pure while in fact it is polluted and cause a serious risk to health. This obstacle is especially important in the rural areas of the inland region as well as near the cities (e.g. Nablus and Jenin) and all areas of the coastal region.

Fourth, farmers, land-users and agriculture production planners have little or no knowledge about the hydrological cycle and the importance of using drought-resistant crops and trees in Palestine. Agricultural economists should be involved in disseminating information with regard to pricing agricultural produce considering the

amount of water used and its cost to the farmer. The concept of limited Palestinian water reserves along with the availability of waters of varying qualities must be considered for each crop to be produced.

Lastly, professionals in the area of water resources have little training or experience in interdisciplinary cooperation and communications. Water resources planners in Palestine need to obtain appropriate and timely consultations from water scientists and agricultural, industrial and urban planning specialists. The water planners must learn to take account of ways of presenting simple and clear concepts about water to inform non-specialist decision makers about groundwater utilization, protection and conservation issues.

### **5.6.3 Steps in Awareness Building**

Public awareness building in the area of water resources conservation, if done effectively, will lead to a dialogue in which the Palestinian community can express its basic needs and at the same time learn to help itself. Dissemination of information is most effective when it involves the combined use of various forms of communications accompanied by practical measures and supported by local institutions which should be responsible for long-term implementation of the suggested water conservation measures. Since water resources management should be of a multi-sectorial nature (water, economic development including agriculture and industry, health and hygiene, information systems, and community and urban development), all relevant institutions must be identified by region in Palestine and their performance capacity analyzed.

Awareness building takes time and so do changes in behavior. The effectiveness of any dissemination of information measures or educational programs will be lessened if the Palestinian public is unable to turn to a responsible institution for help when it is needed. It is therefore essential that any public awareness campaign be set up in parallel with more than one local institution in order that they can provide active support if needed by the public. No single institution alone can muster an overall effective public awareness program. Cooperation between existing institutions and local water authorities must be encouraged by donor agencies in order for such a dissemination of information program to be effective.

Public information campaigns should be carried out to present alternative concepts and procedures for raising the level of public awareness. Information regarding water resources and their proper utilization and discharge into the environment should be presented to the public in understandable language and presented in an appealing manner in order to emphasize priorities in water conservation and utilization.

The most commonly utilized forms of communication for awareness building are provision of information by means of mass media and talks with local groups accompanied by the use of audiovisual aids. The news media would probably be the most effective with not only public service advertisements but also newspaper and magazine articles. After the establishment of the Palestinian government, the media

of Palestinian radio and television may also be available. Public awareness advertisements in the Palestinian press and in the future through the Palestinian Broadcasting Authority radio and television stations on proper water use and conservation should be supported by the Palestinian government.

Direct mail contact can also be achieved through water bill inserts promoting domestic water conservation with consumer advice, as well as simple pamphlets and leaflets, water utility newsletters, household maintenance handbooks, and even the American style of public relation message buttons and bumper stickers for cars. Colorful message carrying posters can also be effective when displayed in public buildings and commercial centers.

Public awareness of the issues involved in public participation in water conservation can also be carried out by personal contact. This is most effective by water consumer assistance by the water utility or administration institution responsible. However, other ways are through speaker programs by water professionals, slide shows at open workshops illustrating specific water problems, and even booths at exhibitions of any kind. Special events can also be planned at schools and in the community centers. Children can become involved through slogan and poster contests. In the agricultural sector, farmers producing drought resistant crops may be supported or given yearly awards.

Most importantly is the creation of public awareness for using appropriate technologies and traditional systems in solving water utilization and conservation problems (i.e., household rainwater catchment as a backup water supply, terracing, rainfed agricultural development, control of rainwater runoff for crops, adaptability of earth dams in rural areas, tree crop development for soil conservation and water retention).

The use of education and persuasion as a practice to create a public conservation ethic should become a permanent component of the new institutional authority in the Palestinian water sector. Creating the message and selecting the medium to disseminate the message is a necessary first step that should be carried out as soon as the new authority is in place.

## 6 RANKING OF PROJECT PRIORITIES

The preceding chapters have described the existing Palestinian water sector, outlined problems related to the sector, and suggested a range of possible solutions related to water conservation activities. Building an appropriate institutional structure was indicated as being of utmost importance. This chapter identifies projects (or components of projects) that are recommended to be undertaken on a priority basis. The projects are ranked on the basis of short, medium, and long term considerations. Projects to be started in the short term are defined as those that need immediate implementation because the need and benefit related to water conservation is unmistakably clear and the impact will be immediately felt. In several cases these projects will continue into the medium and long terms. Medium term projects in most cases follow on activities stemming from short term projects or studies to design and determine the magnitude of intervention needed. Long term projects are action programs responding to designs completed in the short and medium term.

The recommended projects are at a preliminary stage of identification and in many cases overlap with activities proposed in other contexts. Further work will therefore be required before some of these projects can be adopted for implementation and to ensure that coordination exists with other on-going programs. Data sheets containing additional details of most of the recommended projects are given in Appendix A. It should be recognized, however, that the cost estimates are only very tentative and that the data sheets are only an indicative guide.

### SHORT TERM

#### 1. Assistance in Institutional Development

A possible institutional structure for the Palestinian water sector was described in Chapter 4. A detailed study of this proposal is suggested as a basis for implementing major institutional reforms. However, support for the Jerusalem Water Undertaking need not await the outcome of such a study since proposals for its further strengthening are well advanced and the experience of the JWU would provide important lessons to be extended to the other regional utilities.

A short term project is proposed comprising two components: (i) immediate technical assistance support to the Jerusalem Water Undertaking (JWU) in areas including administration and managerial reforms, policy, planning, commercial cost accounting systems, willing-to-pay and tariff policies, regional master plans, and legal reforms for the water and sewerage departments; and (ii) a study of the overall institutional framework and the creation of additional regional water utilities.

In the medium term, the project would be extended to provide technical assistance support to the proposed regional water utilities in order to facilitate their establishment.

## **2. Municipal Water Supply Network Rehabilitation**

The rehabilitation of existing water networks will have immediate paybacks by reducing water loss from leaks. The percentage of leakage in water networks that were laid thirty years ago or more in the municipalities can exceed 50 percent. Municipal network rehabilitation needs should have already been prepared for some priority works. A water audits program is required to form the basis for longer term rehabilitation programs.

A short term project is proposed comprising two components: (i) a systematic program of water audits as a basis for preparing a longer term program; and (ii) implementation of priority network rehabilitation works where detailed designs are already available.

The project of network rehabilitation would continue in the medium term and long term as further priorities are established and as designs and estimates are prepared.

## **3. Regional Data Collection**

There is much water data that is not presently available to the Palestinian people. This includes data covering hydrology (both surface and groundwater) and water use in both Israel and systems in areas in Palestine controlled by Israel. The development of a regional data bank available for shared use is needed. Water planning cannot be adequately carried out without access to the relevant information.

In the short term, a study team should be commissioned to set up the data bank and assure that all needed information is made available as quickly as the data can be assembled and provision made for continued up-dates in the medium term and long term. In the short term studies should be made on: (i) establishment of a hydrological and meteorological network in Palestine and (ii) prototype projects for small earth dams for runoff retention including reconnaissance study for large storage dams. Also in the medium and long term studies and consulting contracts should be commissioned to enable the Palestinian water authority to both generate raw data as well as check and monitor ongoing data collection systems.

## **4. National Water Policy and Planning**

Concurrent with the establishment of a data bank, and the necessary analytic studies of the data, work should start on: (i) defining national water sector policy, (ii) developing a strategy based on the policy, and (iii) formulating an action plan to put the strategy into effect. The plan would form the basis for future water resource development in Palestine by quantifying the resource base and proposing how it should be effectively used. The plan would be expected to provide the basis for optimizing water resources exploitation, set standards for conjunctive water use, implement strategies for water conservation activities, and assure sustainable environment protection. The development of such a plan is an iterative process,



covering the stages of policy, strategy and plan formulation allowing, at each stage, time for public review, debate, and subsequent revision.

In the short term, a project is proposed which would develop guidelines for defining water sector policy principles and initiating the planning process.

In the medium term, following the creation of the Palestine Water Council, the major planning process should get under way with the definition of national water policies for the development of strategies to implement these policies and to plan formulation. Input from representative sectors of the Palestinian people should be a key strategy for assuring acceptance of the process.

In the long term, policies and strategies would be periodically reviewed and the plan would be updated.

## **5. Well and Spring Survey**

Well rehabilitation in the agricultural sector is of top priority since all future water management policies will have to take into consideration existing and functioning wells in the area. Most agricultural wells were drilled before 1967; 55 percent between 1960-1967, 40 percent between 1951-1959 and 5 percent before 1950.

The age of existing pumps and engines is comparable. Thirty-five percent of the pumps and 25 percent of the diesel engines in agricultural wells are more than thirty years old. It has been estimated that upgrading the overall efficiency of pumping equipment would save at least US\$ 0.5 million in fuel consumption. Only 20 percent of agricultural wells are over 120 meters deep, with 60 percent being between 51 and 120 meters and 20 percent less than 50 meters.

The survey should evaluate rehabilitation needs of municipal wells as first priority and irrigation wells as second priority.

This short term project would develop criteria, procedures, and guidelines for the rehabilitation of wells used for both municipal and agricultural purposes.

A spring development survey should be carried out in parallel with the well survey as above with emphasis placed on economic returns of water utilization, land-use in the proximity of the spring or well and cropping patterns.

An action plan will be developed in the medium term based on the well and spring survey with well rehabilitation efforts being carried out in both the medium and long term.

## **6. Tariff Reform**

Economic incentives to reduce wasteful consumption and put the regional utilities on a sound financial footing can be accomplished through tariff reform. The present

tariffs bear little resemblance to financial investments and are not sufficiently graduated to influence consumption patterns and attitudes.

A tariff study is therefore proposed which would make recommendations in the light of alternative options in the design of tariffs so as to (i) ensure financial sustainability and (ii) influence consumer demand in ways that reduce unnecessary consumption. Based on an assessment of willingness to pay, it is envisaged that this would lead to a progressive tariff structure.

The tariff study should be completed in the short term and presented to the regional utilities by the proposed National Water Council.

New tariff schedules would be implemented in the medium term in the context of institutional reforms and the creation of the proposed new regional utilities. Technical assistance and hardware procurement for implementation of the tariff reform would be both a medium and long term project.

#### **7. Pilot Projects for Irrigation with Wastewater and Brackish Water**

The conservation concept of substituting water of different qualities for different purposes will require a measured approach in order to overcome skepticism. In order to improve understanding of this concept, pilot projects are needed to demonstrate the feasibility of irrigating certain crops with either brackish water or treated wastewater. Treatment processes need to be designed in accordance with the end use of the treated water. Water quality must be matched with the agriculture crop or other end use. Projects are needed at selected locations in both the inland and coastal regions of Palestine.

In the short term, demonstration plots should be set-up in both the inland and coastal region utilizing brackish water for crop production. In the medium and long term, pilot projects utilizing wastewater will be implemented in parallel with the construction of wastewater treatment facilities.

#### **8. Training of Regional Water and Sewerage Utility Staff**

To complement the activities of project # 1, "Assistance in Institutional Development", training at the regional utility level is proposed. Training would cover the indicated subjects and also include technical subjects such as leak detection methods, use of visual inspection equipment, laboratory quality control of water emphasizing bacteriological water testing, proper maintenance of domestic water meters, and setting-up of test benches. Both on-the-job training and study tours are envisioned. This is a continuing process.

#### **9. Commodity Procurement for New Water and Sewerage Utilities**

To upgrade the technical capacity of the regional water and sewerage utilities various pieces of equipment are needed. This includes electronic leak detection instruments,

cameras for pipe inspection, X-ray equipment for welding joint inspections, and water meter repair stations.

In the short term, equipment will be purchased and placed under the management of the JWU with the understanding that certain items may in the future be transferred to the proposed Water Supply and Sewerage Services Company. In the medium and long term, the technical units of all regional utilities will be either set-up or upgraded.

## **MEDIUM TERM**

### **10. Well Rehabilitation**

Based on the results of the well survey, it is expected that virtually all wells in the agricultural sector would need rehabilitation (repair or replacement) of both well casing and pumps. The wells would be returned to production based on their sustained yield capacities and the beneficial needs of the irrigation sector. Rehabilitation of wells and supplying the domestic water sector should have priority.

### **11. Dam Siting and Design**

The percentage of rainfall runoff is very high in the inland region during seasons of even average rainfall. Based on this fact, it is a priority that watershed development be encouraged and pilot projects should be implemented utilizing earth dams as water retention structures to hold water not only for irrigation but for artificial groundwater recharge. Wadi Kilt in the Jericho district and Wadi Fara'a in the Nablus district all the way down to the Jordan Valley are examples where such a project would be both effective and serve as an example for replication on a smaller scale in other areas.

In the short term pilot demonstration projects should be initiated for small scale earth dams for runoff retention for agricultural use and/or recharge. A feasibility study to determine the sites, design, cost, benefits, and environmental impact of large dams is a necessary step that should be carried out in the medium term. Groundwater recharge is an important conservation measure to minimize runoff losses.

### **12. Public Awareness Campaigns**

Public awareness campaigns should be started by setting-up pilot programs in existing water authorities for the initiation of water awareness among consumers especially related to conservation practices. This project should include at the outset a poster and brochure campaign specifically with regard to reporting leaks and maintenance of home piping systems. With regard to the agricultural sector, brochures and site visits should be made to agricultural cooperatives and Palestinian farmers in the field. Emphasis should be placed on rainwater collection and the potential uses of treated wastewater in areas where appropriate. Cropping patterns should also be addressed.

In the short term there should be preparation of prototype materials such as service messages for the upcoming Palestinian radio and television stations, bill inserts, leaflets, posters, bumper stickers and teaching materials for school curricula.

In the medium term the proposed material would be utilized and disseminated in a pilot project at JWU.

The long term project would be the implementation of a "Palestinian Water - Use and Conservation", public awareness program at national and regional levels.

It is expected that the pilot program would be revised based on lessons learned in the medium term and continued in the long term as a permanent component of the water sector development program.

### **13. Rehabilitation of Wastewater Treatment Plants**

In consideration of the need to eliminate the unhealthy conditions created by the untreated sewerage piped into wadis and the need to begin using wastewater for beneficial purposes, rehabilitation of treatment plants is needed. None of the existing wastewater treatment plants operate at design efficiencies. Both design and operation standards need to be reviewed and steps taken to upgrade these facilities.

This project needs considerable study and coordination with local utilities as well as other on-going projects.

## **LONG TERM**

### **14. Dam Construction**

Based on the results of the dam siting and design feasibility study, dam construction would be carried out at appropriate sites to serve as models of the applicability of this practice.

### **15. Municipal Network Extension**

Based on fresh water saved through leakage reduction in Project # 2 (Water Supply Network Rehabilitation), tariff adjustments, and other conservation measures, the municipal water supply network should be extended to those areas which are presently unserved and also upgraded to meet the demands of existing under-served customers in the domestic and industrial sectors in order to reach the minimum water requirement goal.

### **16. Credit Program for Improving Irrigation Efficiencies**

In view of the constraints identified for investments by farmers in water saving irrigation equipment, a credit program is needed. The increased use of drip irrigation equipment, for example, can be expected to have significant and immediate water conservation benefits.

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# APPENDIX A

## DATA SHEETS FOR RECOMMENDED PROJECTS

Appendix A/1	Replacement/Rehabilitation of Water Distribution Networks
Appendix A/2	Assistance in Institutional Development
Appendix A/3	Well Rehabilitation or Substitution
Appendix A/4	Regional Water Resources Data Collection
Appendix A/5	Training of Regional Water Utility Staff
Appendix A/6	Tariff Reform Study
Appendix A/7	Demo plots for Irrigation by Brackish and Treated Wastewater
Appendix A/8	Credit for Improving Irrigation Efficiency
Appendix A/9	Small Water Retention Dams Pilot Project
Appendix A/10	Rehabilitation of Waste Water Treatment Plants
Appendix A/11	Designing an Awareness Program
Appendix A/12	Well And Spring Inventory
Appendix A/13	Commodity Procurement for the Water and Sanitation Sector

**I. Replacement/Rehabilitation of Water Distribution Networks /Infrastructure**
**II. DESCRIPTION, OBJECTIVE AND BENEFITS**
**Location:** Inland and Coastal Regions of Palestine

**Works:** Rehabilitation or replacement of water supply networks especially of municipalities and villages whose networks are more than 25 years old and show high losses including. unaccounted for water. The works would typically comprise replacement of pipes, meters, regulators, valves, buffer tanks, booster pumps and civil works as and when necessary.

**Executor(s):**

- Local contractors for the major works
- Technicians of regional and municipal water utilities for the minor works

**Benefits:**

- Reduction of losses; regular supply; expansion of services; no pressure drops and hence less contamination; improved metering, facilitating better cost recovery.

**III. COST ESTIMATE (US\$)**

Total: 26.0 million Investments: 25.0 million Techn. Ass. 1.0 million)

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- Project assessment/studies/tendering: **PECDAR** advised by the Water Task Force Steering Committee, under auspices of UNDP and assisted by a Palestinian consulting engineering firm.
- Studies: Regional and municipal utilities
- Project execution: Regional and municipal utilities
- Project end users: Regional and municipal utilities

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Responsibilities for operation/management of networks shall be clear and explicit
- Standards for rehabilitation/replacement shall be agreed upon during the project formulation phase by all parties involved.

**VI. PREPARATION REQUIREMENTS**

- Preparation of a ToR for the project preparation
- Description and siting of networks to be rehabilitated and standards to be met; tentative quantities; ToR for consulting engineering services for preparation of contract documents.
- Preparation of contract documents (per network) and assistance to PECDAR in tender evaluation
- General supervision of execution of works by Palestinian consulting engineering firm, for major rehabilitation/replacement works.

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- Training of technicians of utilities
- Establishment of a regional servicing unit/leak deatction and monitoring service in order to maintain a high standard of service and cost recovery
- Adequate operation and maintenance budget.

VIII. TIME DURATION (month)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• ToR for project preparation	**									
• Project preparation Studies	**	**	**	**	**	**				
• Preparation Contract Docs					**	**				
• Tendering/Award Contracts					**	**				
• Execution of Contracts							****	****	****	**



## Appendix A/2

### I. Assistance in Institutional Development / Institution Building

#### II. DESCRIPTION, OBJECTIVE AND BENEFITS

**Location:** Ramallah district, Palestine

**Works:** Upgrading of the institutional capabilities of the Jerusalem Water Undertaking, Ramallah District (JWU) and other utilities that operate or are destined to operate at a regional level through:

- review of current cost accounting system; preparation of guidelines and recommendations for water supply and sanitation sector in general
- assessment of in-house JWU study on job description and evaluation; salary scales; merit rating system etc.
- preparation of standards and specifications and procurement manuals for the water supply sector in general;
- establishment of a technical library
- operationalisation of a remote control and monitoring system at JWU
- Operationalization of GIS System at JWU

The project would start with the JWU, which is already prepared to absorb and utilize the technical assistance in capacity building; this will be followed by an interim evaluation in order to adapt the approach and methodology for the other existing and envisaged regional authorities like Nablus, Hebron and Gaza.

**Executor(s):** Local and International expert(s) on water supply administration and management.

**Benefits:** Improved performance and efficiency; reduction of losses; improvement in level of services for all existing and envisaged regional utilities.

#### III. COST ESTIMATE (US\$)

Total: (725,000)      Investments: (350,000\*)      Techn. Ass.: (375,000)  
 \* procurement, installation and commissioning of remote control and monitoring equipment

#### IV. RESPONSIBLE PALESTINIAN ORGANIZATION

- Project formulation/implementation/evaluation: Representatives of the regional and municipal water utilities

#### V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION

- Procurement of a water supply network remote control and monitoring system for JWU

#### VI. PREPARATION REQUIREMENTS

- Preparation of a ToR in close consultation with utilities involved

#### VII. RECOMMENDATIONS FOR FUTURE ACTION

- Thorough post-evaluation of the project, providing recommendations for further institution building in the water sector

VIII. TIME DURATION (month)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• Prep. tender remote control equipm.	**									
• Procurement of equipment		**	**	**						
• Preparation of ToR Instit. Build.	**									
• Institution Building JWU				**	**	**				
• Interim evaluation						**				
• Institution building other Utilities							***			
• Post evaluation								**		

**I. Well Rehabilitation or Substitution / Infrastructure**

**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Inland and Coastal regions of Palestine

**Works:** Rehabilitation of wells, pumps and related equipment for domestic water supply as pPriority 1; and agricultural wells are priority 2; substitution of obsolete wells by drilling of new wells as and when necessary. Total number of wells and installations to be rehabilitated or replaced is estimated at 25.

**Executor(s):** Local and/or international contractors

**Benefits:** Meeting real domestic and industrial water demand; reducing energy costs for pumping; ensuring minimum water quality standards.

**III. COST ESTIMATE (US\$)**  
 Total: 20 million      Investments: 18 million      Techn. Ass.: 2 million

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- Inventory: Palestine's Water Department and Water Utilities involved assisted by an expert to make a ToR for preparation of contract/procurement documents
- Study/execution: Relevant Regional or Municipal Water Utilities assisted by a Palestinian consulting engineering firm.

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Responsibilities for operation/management of the wells shall be clear and explicit.
- Standards for rehabilitation and substitution shall be agreed upon during the inventory stage by all parties involved.
- Tender procedures and guidelines shall be available and endorsed by PEC DAR

**VI. PREPARATION REQUIREMENTS**

- Inventory of wells to be rehabilitated/replaced and sites for new wells by an ad-hoc task force comprising members of all the water utilities involved; (Note: The WBWD has prepared a comprehensive report on the status of the wells in the Inland region (Nasseruddin, 1993)); ToR for the preparation of contract/procurement documents.
- Preparation of contract documents for works and procurement of goods. Tendering and contract awards.
- Supervision of installation/execution.

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- Continious monitoring of well performance

VIII. TIME DURATION (month)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• Inventory and ToR for Preparation Contract Docs	**	**								
• Preparation Contract Docs			**	**						
• Tendering/Award Contracts					**					
• Execution of Contracts						**	****	****	****	** *

**I. Regional Water Resources Data Collection/Institutional Development**

**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Region Palestine, Jordan and Israel.

**Works:** Collection and analysis of regional surface and groundwater resources data, with the aim to provide a comprehensive and sound base for Palestinian water resources planning and management by the future Palestinian authorities.

**Phase 1:**

- Collection, testing, organizing and systematically storing of all available geological, hydrological (including quality), geo-hydrological, climatological data relevant to Palestine into a computer database (or with the aim to establish a computer water resources data-base in a following phase).
- Feasibility study for the establishment of a hydrological and meteorological network in Palestine.
- Reconnaissance study for large storage dams in Wadi Fa'ra and Wadi Kilt and prototype for the demonstration of the benefits of smaller earth dams for runoff retention in water sheds near agricultural lands.

**Phase 2:** Inventory of all water related infrastructure; setting up of a Geographical Information System taking into account the need to also service water supply and wastewater management (domestic, agricultural and industrial).

**Executors:** Study team headed by a Palestinian, dJordanian and an Israeli water resources specialists and an international expert/water resources planner, assisted by experts in the field of hydrology, hydrogeology, GIS, computer dataprocessing applications, with Palestinian counterparts.

**Benefits:** A comprehensive and accessible database on the regional water resources will allow planners to prepare a sound water master plan for the region and for Palestine in particular. A basis for environmentally balanced economic development and growth.

**III. COST ESTIMATE (US\$)**

Total: 400,000                      Investments:                      Techn. Ass.: 400,000\*  
 \*excluding operational costs.

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- PECDAR advised by the Palestinian Steering Committee on Water (Task Force under UNDP auspices) with both international and local input.

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Coordinate with UNDP regarding proposed project 'Socio-Economic Planning for Development in the West Bank and Gaza Strip.'

**VI. PREPARATION REQUIREMENTS**

- Preparation of a ToR for the study by or in coordination with the Steering Committee of the Water Task Force.

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- A parallel step should be the preparation of a water master plan for Palestine.
- Follow-up on recommendations for
  - the establishment of a hydro- and meteorological network and
  - the ToR for construction of large storage dams in Wadi Fa'ra and Wadi Kilt

VII. TIME DURATION (months)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
● Preparation of the ToR	**									
● Recruitment of experts		**	**							
● Execution of the study				**	**	**	***	**	**	

**Appendix A/5**

**I. Training of Regional Water Utility Staff / Institutional Development**

**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Inland and Coastal regions of Palestine

**Works:** Training of middle level and top administrators in the Regional Water Supply Sewerage Utilities in technical and financial techniques applicable to medium-sized water utilities, covering both water supply and sanitation. Both on-the-job training and study tours to water utilities in other countries.

**Executor(s):** International and local training expert(s)

**Benefits:** Improved performance of the staff, resulting in higher operations and cost efficiency and a generally higher level of services.

**III. COST ESTIMATE (US\$)**

Total: 300,000      Investments:      Techn. Ass.: 300,000 (including costs of study tours)

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- Project preparation: Regional and Municipal Water Utilities
- Project execution: Regional and Municipal Water Utilities

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Institution building project for the water utilities shall have been completed and evaluated, before the training program is started.

**VI. PREPARATION REQUIREMENTS**

- Preparation of ToR

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- The need for further training and refresher courses should be regularly checked.
- Formation of training unit in the National Water Supply and Sewerage Service Company

VIII. TIME DURATION (months)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
● Preparation of ToR	**									
● Recruitment of training expert(s)		**	**							
● Project execution				**	**	**	**	**	**	
● Post evaluation								**	**	

**I. Tariff Reform Study; Water and Sanitation Sector Institutional Development**
**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Inland and Coastal region of Palestine

**Works:** Carrying out a tariff reform study, including a consumers' survey in the Palestinian water and sanitation sector, with the aim to establish tariff that shall be based on the principle of full cost recovery, including depreciation and investments and shall induce water conservation by the consumers and at the same time ensure an affordable water price for the lowest income groups.

**Executor(s):** Local organization/consultancy firm assisted by an international expert and in cooperation with the regional utilities and other related Palestinian officials and representatives of interest groups.

**Benefits:** Independent and cost-effective operation of the water and sanitation utilities; increased consumer's awareness of the economic value of water, resulting in conservation measures at the household and community level.

**III. COST ESTIMATE (US\$)**

Total: 150,000      Investments:      Techn. Ass.: 150,000

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- Regional and Municipal Water Utilities

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Establish coordination between all water utilities.

**VI. PREPARATION REQUIREMENTS**

- Preparation of ToR

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- Introduction of improved tariff system by all water utilities
- Regular analysis of financial performance of utilities in order to update tariffs
- Consumer awareness

VIII. TIME DURATION (months)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• Preparation of ToR	**									
• Engagement of organization/firm		**	**							
• Tariff study				**	**	**	***			

**I. Demo plots for Irrigation by Brackish and Treated Wastewater / Agriculture**

**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Ramallah, Tulkarm and Gaza districts

**Works:** (Ref also to *Rehabilitation of Waste Water Treatment Plants*)

- Establishment of pilot demonstration plots for irrigation with brackish water mixed with harvested rainwater, in combination with other water use reducing techniques like plastic tunnels, drip irrigation,...etc.
- Establishment of pilot demonstration plots for irrigation with treated waste water downstream of waste water treatment plants.

**Executor(s):** NGOs, agricultural research organisations, Colleges of Agriculture (Nablus, Hebron), Arab Development Society, Jericho

**Benefits:** Water conservation; provision of access to affordable water resources to farmers; use of nutritious value of waste water.

**III. COST ESTIMATE (US\$)**

Total: 500,000                      Investments: 450,000                      Techn. Ass.: 50,000

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- NGOs, executing organisations in cooperation with the water utilities (in case of treated waste water)

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Demo plots shall be easily accessible

**VI. PREPARATION REQUIREMENTS**

- Project formulation study

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- Systematic evaluation of the demonstration project with the aim of expanding the activity.

VIII. TIME DURATION (month)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• Project formulation study	**	**	**							
• Implementation				**	**	**	***	****	***	

**I. Credit for Improving Irrigation Efficiency / Agriculture**

**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Inland and Coastal regions of Palestine

**Works:** Establishment of a credit scheme for investments by private farmers and farmers' cooperatives in water saving technologies: piped conveyance, drip-, bubbler- and sprinkler irrigation, storage reservoirs.

**Executor(s)** Institutionalised cooperatives and banks

**Benefits:** Increased water use efficiencies in agriculture

**III. COST ESTIMATE (US\$)**

Total: 5,500,000

Investments: 5,000,000

Techn. Ass.: 500,000

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- PECDAR / Palestine Department of Agriculture

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Establishment of viable agricultural credit programs. Watershed management is not an individual private sector endeavor or responsibility. Major improvement on antional water source should be the responsibility of the Palestinian Authority leaving only end-user investments to the individual farmer or cooperatives in the agricultural sector.

**VI. PREPARATION REQUIREMENTS**

- Preparation of ToR for study
- Project formulation and design

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- Regular monitoring of performance of the outstanding loans

VIII. TIME DURATION (months)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• Project of ToR	**									
• Proj. form & design		**	**	**						
• Implementation					**	**	***	**	**	

**I. Small Water Retention Dams Pilot Project / Infrastructure**

**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Wadis in the Inland region; 10 locations  
**Works:** Construction of small water/earth retention dams in the upper reaches of the wadis, to retain water during flash floods for infiltration and recharge of the local aquifer. The dams would, in the course of 5 - 15 years, gradually fill up with sediments and be used for terraced, hillslope-runoff based agriculture. A combination of earthfill and gabion boxes should be used for the construction of 1 - 3 meter high dams across the wadis. A fuse plug may be applied in areas noted for heavy and destructive flashfloods.

**Phase 1:** Reconnaissance, hydrological and 'sociological' assessment, site selection, topo survey, design and costing; procurement of materials and equipment (prudent shopping).

**Phase 2:** Construction • direct execution with local labour and local contractors • procurement of materials

**Phase 3:** Operation and maintenance; monitoring performance; environmental impact assessment with a view to wider scale introduction of these small dams. (5 year contract)  
 Formulation of a follow-up project, comprising a full reconnaissance survey aiming at systematic implementation of small water/earth retention dams through participation of the local population at viable locations.

**Executor(s):** Local contractors.

**III. COST ESTIMATE (US\$)**

Total: US\$ 800,000 Investments: US\$ 700,000 Techn. Ass.:US\$ 100,000

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- Steering Committee on Water (Task Force on Water under UNDP auspices)

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Consultations with the Palestinian authority for preliminary site identification

**VI. PREPARATION REQUIREMENTS**

- Preparation of ToR
- Reconnaissance survey (hydrologist and rural sociologist)
- Topographic survey
- Design & quantities, specifications/instructions

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- Implementation of similar small earth and water retention dams at viable locations in the inland and coastal regions and preparation of Terms of Reference for large scale storage dams in Wadi Kilt and Wadi Fara'a, ...etc.

VIII. TIME DURATION (month)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• Preparation of ToR	**									
• Reconnaissance survey		**	**		**					
• Topographic survey				**	**					
• Design & tender documents						**	***		****	****
• Construction								****	****	****



## I. Rehabilitation of Waste Water Treatment Plants/Infrastructure

### II. DESCRIPTION, OBJECTIVE AND BENEFITS

**Location:** Coastal region and Tulkarm district in inland region

**Works:** Rehabilitation and re-commissioning of waste water treatment plants in:

- Gaza (north: serving villages and refugee camps and south: serving Gaza City)
- Tulkarm  
with the aim to provide at acceptable quality treated wastewater to irrigated agricultural demonstration plots to be established downstream of the plants.  
(Note: Rehabilitation of the Ramallah sewage treatment plant is recently undertaken by USAID)

**Executor(s):** Local Palestinian contractors

**Benefits:** Experience will be gained on treatment of sewage and waste water for irrigation and the techniques and requirements of the re-use in irrigated agriculture. Re-use in future will provide a significant additional waste resource for agriculture and contribute to the conservation of good quality fresh water resources.

### III. COST ESTIMATE (US\$)

Total: 6.1 million      Investments: 6 million      Techn. Ass.: 100,000

### IV. RESPONSIBLE PALESTINIAN ORGANIZATION

- Palestinian utilities in charge of the treatment facilities

### V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION

- Training of management and technical staff responsible for the operation of plants.

### VI. PREPARATION REQUIREMENTS

- Project formulation study, setting quality standards and preparing contract documents

### VII. RECOMMENDATIONS FOR FUTURE ACTION

- Experience gained in Ramallah, Gaza and Tulkarm shall be used in the design and operation of waste water treatment plants in other locations.

VIII. TIME DURATION (months)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• Project formulation study	**	**	**							
• Prepare tender documents				**	**	**				
• Implementation							***	****	****	**

**I. Designing an Awareness Program / Education**

**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Country-wide Campaign

**Works:** Design and produce awareness program packages containing the following components: • direct mail: pamphlets, leaflets, posters, bill inserts, newsletters, handbooks, buttons, bumper stickers etc.. • news media: radio & television ads, video movie, radio announcements, news paper and magazine articles • personal contact: speaker program, slide show, booths at exhibits, customer assistance • special events: school talks, slogan/poster contests, posters around town, displays, reminder items, decals, district fairs  
Throughout the design process the end-users of the products will be consulted on a regular basis.

**Executor(s)** Governmental departments and local N.G.O, providing expertise (including technical input, education linkages, public relations, desktop publishing, Video- and Slideshow production, graphical design, copy writing), equipment, materials for drafting and designing education/ information materials

**Benefits:** The end-users, water utilities and other institutions in the water sector will have at their disposal materials to conduct their awareness campaigns.

**III. COST ESTIMATE (US\$)**

Total: 150,000      Investments:      Techn. Ass.: 150,000 (including equipment and materials)

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- Steering Committee on Water (Water Task Force)
- Palestinian regional and municipal water utilities
- Palestine Ministries of Water and Agriculture

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

**VI. PREPARATION REQUIREMENTS**

- Preparation of ToR

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- Providing the results of the project to school organisations and institutions for use in awareness and public education campaigns.

<b>VIII. TIME DURATION (month)</b>	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• Preparation of ToR	**									
• Implementation	**	**	**	**	**	**	*	*		

**I. Well And Spring Inventory / Water Resources Management**

**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Inland and coastal regions of Palestine

**Works:** Inventory of all wells and springs (domest. and agric. supply): type, position, elevation, depth, year of establishment, condition, static waterdepth, yield, water quality, data on wateruse, operation etc.  
 For clusters of wells: type, position, elevation and condition for all wells and the additional data for a representative sample of 10 - 25% of the total number of wells.  
 Presenting data in a format suitable for entry into a computer database, for further data processing and analysis.

**Executor(s):** Local organisations experienced in carrying out field surveys, and data management.

**Benefits:** A sound data base on groundwater abstraction that will allow the Palestinian Water Council and the Palestinian Ministry of Agriculture to monitor and manage water resources with the aim to optimize water use under safe yield conditions. Facilitates water conservation and protection of the environment.

**III. COST ESTIMATE (US\$)**

Total: 180,000 Investments: Techn. Ass.: 180,000

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- Steering Committee of the Water Task Force and Palestine National Water Council

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Collection of 1:50,000 or 1:20,000 topographic maps to be provided to the executor (exist at Land Unit / Arab Studies Society).
- Procurement of handheld GPS equipment and groundwater level sounding devices (100 and 200m length), and computer equipment to be used by the executor.
- Definition of data to be collected, including data format, coding etc.

**VI. PREPARATION REQUIREMENTS**

- Preparation of ToR for well and spring Inventory

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- Regular monitoring of a selected number of wells by the concerned water authority

VII. TIME DURATION (months)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
• Preparation of ToR	**									
• Engagement of consulting firm		**								
• Execution of well inventory			**	**	**	**	*			

**I. Commodity Procurement for the Water Supply & Sanitation Sector/Institutional Development**

**II. DESCRIPTION, OBJECTIVE AND BENEFITS**

**Location:** Inland and coastal regions of Palestine

**Works: A** Procurement of goods and equipment for the proposed Regional Water Supply and Sewerage Utilities including: ● workshop and testbench for small diameter domestic water meters ● bacteriological laboratory for water quality testing

**B** Procurement of goods to Jerusalem Water Undertaking (JWU) technical unit (eventually this equipment shall be administered by a national water and sewerage company): ● electronic leak detection equipment, both manually operated and mounted mobile unit ● visual inspection equipment for water and sewage pipes, manhole and borehole surveys to determine state of casing, blockages, leakage etc. for priority repairs ● X-ray equipment to check metals and welded joints etc. ● workshop and testbench for large diameter water meters (N.B. the contract would be for supply, installation, commissioning and training) ● insulation equipment to check coordination of insulation on pipes before covering them with sand

**Executor(s):** Jerusalem Water Undertaking (JWU) and other water utilities

**Benefits:** Reduction of leakage losses, energy losses, increased efficiency, improved metering and cost recovery, increased lifetime of assets

**III. COST ESTIMATE (US\$)**

Total: 720,000

Investments: I: 370,000  
II: 330,000

Techn. Ass.: 20,000

**IV. RESPONSIBLE PALESTINIAN ORGANIZATION**

- Jerusalem Water Undertaking (JWU) and other water utilities

**V. PRECONDITIONS TO BE MET FOR IMPLEMENTATION**

- Establishment of the Technical Unit in the JWU for temporary management of the purchased equipment It is understood that this technical unit will provide services to all other water utilities.

**VI. PREPARATION REQUIREMENTS**

- Preparation of procurement documents

**VII. RECOMMENDATIONS FOR FUTURE ACTION**

- Establishment of a national Water Supply and Sewerage Services Company

VIII. TIME DURATION (months)	1	2	3	4	5	6	7-12	13-18	19-24	25-32
● Preparation of procurement documents	**	**								
● Tender and award of contract			**							
● Installation/Commis./Training				**	**	**	***			

## **APPENDIX B**

### **MAJOR WELLS AND SPRINGS IN PALESTINE**

<b>Appendix B1</b>	<b>Annual Pumpage from Wells in the Inland Region for Domestic Use</b>
<b>Appendix B2</b>	<b>Annual Flow of Springs in the Inland Region for Domestic Use</b>
<b>Appendix B3</b>	<b>Annual Pumpage from Wells in the Inland Region for Irrigation</b>
<b>Appendix B4</b>	<b>Annual Flow of Fresh Water Springs in the Inland Region</b>
<b>Appendix B5</b>	<b>Annual Discharge of Major Wells for Domestic Use in the Coastal Region</b>
<b>Appendix B6</b>	<b>Annual Discharge of Major Irrigation Wells in the Coastal Region</b>

APPENDIX B1

ANNUAL PUMPAGE FROM WELLS IN THE INLAND REGION FOR DOMESTIC USE 1983-1992

No.	Well-Owner	Coordinates	Discharge m <sup>3</sup> /hr	Annual Pumpage For Domestic Use (1000m <sup>3</sup> )									
				1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	Tubas Water Project	182.30/189.65	60	-	-	265	222	287	310	235	201	214	207
2	Bethan Well No. 1	180.15/185.40	196	-	-	1002	1579	1005	1011	1134	1118	1106	990
3	Bethan Well No. 2	182.15/185.75	312	-	-	-	-	1105	1865	1477	2016	1855	1200
4	Arrabeh Well	171.35/201.075	100	448	668	891	407	873	369	378	456	222	125
5	Qabatiya Well	178.91/201.47	96	710	706	586	600	845	595	474	203	199	211
6	Jenin Municipality	178.50/207.40	138	843	550	302	332	536	636	289	479	364	1020
7	Qafin Village Council	158.14/204.28	90	111	138	146	153	163	204	194	230	260	218
8	Zeita Village Council	155.00/199.00	120	32	33	31	36	41	50	41	77	112	108
9	Deir Ghusin Village	157.50/195.45	75	-	-	65	103	104	148	121	274	283	103
10	Tulkarm Municipality	152.30/190.95	85	-	-	300*	296	417	558	585	658	800	819
11	Tulkarm Municipality	152.45/191.10	80	-	-	600*	630	740	896	643	717	727	574
12	Tulkarm Municipality	152.92/191.84	78	660	667	648	538	629	714	614	674	654	657
13	Anabta Municipality	161.10/190.40	55	-	-	0	0	0	0	0	0	0	0
14	Anabta Municipality	161.50/190.85	74	120	128	132	146	135	168	135	167	1194	180
15	Deir Sharaf Well No.2	166.55/184.75	55	-	-	0	0	0	0	0	0	0	0
16	Deir Sharaf Well No.3	166.75/184.75	70	0	0	0	0	0	0	0	0	0	0
17	Beit Iba	169.00/183.00	230	833	762	1200	1126	1132	971	938	1136	1185	996
18	Azzoun Village Council	154.70/177.00	60	70	78	32	93	126	126	84	120	127	184
19	Qalqilia Municipality	146.90/177.30	318	472	496	564	557	535	524	457	608	552	359
20	Qalqilia Municipality	148.40/177.45	277	367	419	500	511	689	583	446	649	880	1042
21	Hableh Village Council	147.92/174.64	174	78	93	109	114	166	163	154	180	180	202
22	Zawiya Well	154.15/166.15	20	557	339	470	418	378	130	20	57	2	2

**APPENDIX B1 (Continued)**  
**ANNUAL PUMPAGE FROM WELLS IN THE INLAND REGION FOR DOMESTIC USE 1983 - 1992**

No.	Well-Owner	Coordinates	Discharge m <sup>3</sup> /hr	Annual Pumpage For Domestic Use (1000m <sup>3</sup> )									
				1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
23	Shibteen Well No.5	154.35/161.75	90	UNKNOWN, OPERATED BY MEKOROT									
24	Shibteen Well No.4	155.00/153.00	85	218	50*	199	89	190	509	517	624	593	632
25	Ein Samia Well No.1			-	-	293	293	578	742	426	395	599	1223
26	Ein Samia Well No.3/Irrig	182.10/154.00	50	-	-	326	270	203	262	136	255	244	282
27	Ein samia Well No. 5	181.55/155.25	168	-	-	1027	1398	1379	1444	1136	1454	1187	1212
28	Herodion Well No.1	170.90/118.30	87	460	586	597	428	524	351	287	434	351	379
29	Herodion Well No.2	170.92/119.33	420	2821	2776	2528	2880	2731	2923	2117	2070	2613	2797
30	Herodion Well No.3		420	1231	1191	1275	3220	2695	3334	2794	3567	2931	3230
31	Herodion Well No.4	169.46/114.08	300	-	-	-	-	270	106	821	1521	1753	847
32	Beit Fajjar No. 1	169.6./115.10	270	811	69	863	703	739	1058	721	1132	985	1284
33	Fawwar Well No. 1	156.12/098.41	54	-	-	-	-	-	258*	320*	280*	300*	350*
34	Fawwar Well No. 3	156.12/098.45	25	-	-	-	-	-	125*	160*	130*	140*	170*
35	Rihiya Well		57	-	-	-	-	86	256	231	323	238	232
36	Simia Well/Samu'	153.46/092.26	54	317	343	397	419	426	280	264	353	354	268
37	Sanur Well	169.46/193.41	186	-	-	-	-	-	-	470	1206	1184	934
38	Kufr Zibad Village council	156.80/181.20	81	-	-	-	-	-	-	20	35	67	91
39	Shofah Water Coop.	155.50/188.50	54	-	-	-	-	-	-	-	23	35	44
40	Ya'bed Municipality	167.10/207.00	27	-	-	-	-	-	-	-	-	-	-
	Total			11159	10092	15348	17561	19727	21696	18839	23822	23490	23172
	From Springs For Domestic Usage			2841	2213	1904	3825	3823	3823	3640	3788	3094	5197
	Final Total			14000	12305	17252	21386	23550	25519	22479	27610	26584	28369

\* Estimation

APPENDIX B2

ANNUAL FLOW OF SPRINGS IN THE INLAND REGION UTILIZED FOR DOMESTIC USAGE (1000 m<sup>3</sup>)

No.	Name of Spring	Coordinates	Location	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
1	El Asal	174.54/180.34	Nablus	139	95	89	152	152	163	187	147	212	242
2	Dafna	175.90/180.30	Nablus	142	110	79	142	148	163	181	121	168	489
3	Ras El Ein	174.31/180.21	Nablus	438	221	183	612	498	457	462	363	352	364
4	Qaryoun	174.68/180.60	Nablus	368	273	198	612	533	523	583	434	489	508
5	Beit El Ma	173.50/181.84	Nablus	505	392	284	665	687	675	600	473	652	635
6	Shamiya	166.76/165.84	Salfit	47	42	37	55	81	72	50	54	123	124
7	Matwi	162.38/165.50	Salfit	77	63	49	63	95	86	79	63	252	234
8	Kfar Farat	169.19/184.60	Deir Sharaf	39	29	22	66	66	47	46	35	103	89
9	Haroun	169.41/185.78	Naqoura + Sabestiya	126	108	89	208	284	172	178	126	499	261
10	Sharqia	171.10/187.79	Nisf Jubeil	33	23	19	58	56	60	41	32	114	60
11	Muwaziya	170.9./187.90	Beit Imrin	45	30	22	189	112	106	85	42	210	148
12	Ijnesinya	170.58/186.32	Ijnesiny	15	11	10	35	44	35	18	15	317*	67
13	Burqa	166.70/189.70	Burqa	74	63	37	100	95	81	115	66	143	115
14	Barta'a	159.88/209.35	Barta'a	100	69	73	79	121	100	107	88	208	163
15	Delbeh + Liqtan	156.94/159.16	Abud	113	79	63	116	142	112	129	124	399	263
16	Sultan	192.20/141.95	Jericho	580	605	650	673	709	788	867	911	956	1004
	Total			2841	2213	1904	3825	3823	3640	3788	3094	5197	4766



APPENDIX B3

ANNUAL PUMPAGE FROM WELLS IN THE INLAND REGION FOR IRRIGATION/1988-1992 (1000 m<sup>3</sup>)

NO.	DISTRICT	PUMPING WELLS	1988	1989	1990	1991	1992
1.	Jericho	42	5184.3	3587.0	4115.4	3847.8	4438.3
2.	Auja	8	484.4	729.6	1580.6	1464.1	48.3
3.	Jiftlik/W. Fari'a	35	4609.4	3408.2	5190.4	3649.5	1823.3
4.	Marj Na'ja	11	1277.2	1130.4	1363.5	1372.4	1348.3
5.	Bardala	8	2372.7	1562.6	2326.6	1864.1	2176.3
6.	Ras Fari'a/Bethan	24	2744.7	277.2	2725.0	2776.2	2304.6
7.	Jenin/Sanur	58	3397.2	3680.7	4039.4	3689.3	4413.8
8.	Tulkarm	53	9934.9	8633.1	9724.0	9385.8	8992.3
9.	Qalqilia	70	6166.4	6294.2	6890.8	6052.5	5911.2
	<b>Total</b>	<b>309</b>	<b>36151.2</b>	<b>31803.0</b>	<b>37433.7</b>	<b>34101.7</b>	<b>31456.4</b>

Note: Pumpage in Jericho does not include the pumpage from the 15 Wells of the Arab Development Project.

## APPENDIX B4

ANNUAL FLOW OF FRESH WATER SPRINGS IN THE INLAND REGION 1987 - 1992 (1000 m<sup>3</sup>)

NO.	DISTRICT	NUMBER OF SPRINGS	1987/88	1988/89	1989/90	1990/91	1991/92
1.	Jericho	6	25.952	19.231	19.354	16.679	46.276
2.	Auja/Fasayil	2	11.692	10.284	8.697	2.984	16.115
3.	W. Maleh/Ein Beida	5	367	453	373	263	2.447
4.	Lower W. Fari'a	3	1.477	1.503	973	725	2.595
5.	Ras Fari'a/Bethan	8	13.302	10.638	8.154	6.037	33.403
6.	Nablus/Naqoura	28	4.125	3.249	3.340	2.429	7.086
7.	Jenin/Burqa	8	235	271	300	246	731
8.	Salfit	2	176	158	84	86	281
9.	Ramallah/Abud	27	1.637	1.354	1.742	1.458	4.164
10.	Jerusalem/Bethlehem	15	1.577	1.139	1.215	1.070	2.408
11.	Hebron	10	220	222	193	221	930
	Total	114	60.760	48.502	44.425	32.198	116.436

Note: The above table shows the total annual Flow of the 114 measurable springs with minimum flow of 0.1 lit/sec. (0.36m<sup>3</sup>/hr).

**APPENDIX B5**

**LOCATION AND PUMPING RATES OF MAJOR MUNICIPAL AND  
OTHER WELLS FOR DOMESTIC USE IN THE COASTAL REGION (1990)**

<b>LOCATION</b>	<b>NUMBER OF TOTAL WELLS</b>	<b>NUMBER OF OPERATIONAL WELLS</b>	<b>AVERAGE ANNUAL DISCHARGE (mcm)</b>
Beit Hanoun	3	2	0.50
Beit Lahia	4	3	1.30
Jabalia/Nazla	7	6	1.40
Gaza	24	18	13.50
Khan Yunis	7	6	3.90
Deir El Balah	6	3	0.20
Bani Suhaila	2	2	0.10
Abasan	3	2	0.10
UNRWA (Camps)	11	7	0.60
<b>Sub-Total</b>	<b>67</b>	<b>49</b>	<b>21.60</b>
Israeli Water Company (Mekorot)			5.00
<b>TOTAL</b>		<b>49</b>	<b>26.52</b>

APPENDIX B6

LOCATION AND DISCHARGE RATES OF MAJOR IRRIGATION  
WELLS IN THE COASTAL REGION (1990)

LOCATION	TOTAL NUMBER OF WELLS	OPERATIONAL WELLS	AVERAGE ANNUAL DISCHARGE (mcm)
Beit Lahia	188	179	5.50
Dumra	25	25	1.30
Beit Hanoun	145	137	5.50
Nazla	67	60	1.90
Jabalia	163	153	4.40
Gaza, NE	73	68	2.50
Gaza, NW	276	240	4.00
Gaza, SW	199	191	4.50
Abu Middin	49	47	0.80
Nusseirat	95	89	2.50
Deir El Balah	156	142	3.60
Northern Saba'	68	63	2.20
Eastern Saba'	44	42	1.00
Southern Saba'	8	3	0.10
Smeiri	15	15	0.60
Khan Yunis	179	162	5.00
Rafah	146	138	6.20
Bani Suhaila	11	11	0.20
Abasan	24	23	0.40
Khuza'a	5	3	0.10
<b>Sub-Total</b>	<b>1936</b>	<b>1791</b>	<b>52.30</b>
Shallow Wells (Mawasi) in Khan Yunis and Vicinity		275	8.00
<b>TOTAL</b>		<b>2066</b>	<b>60.30</b>

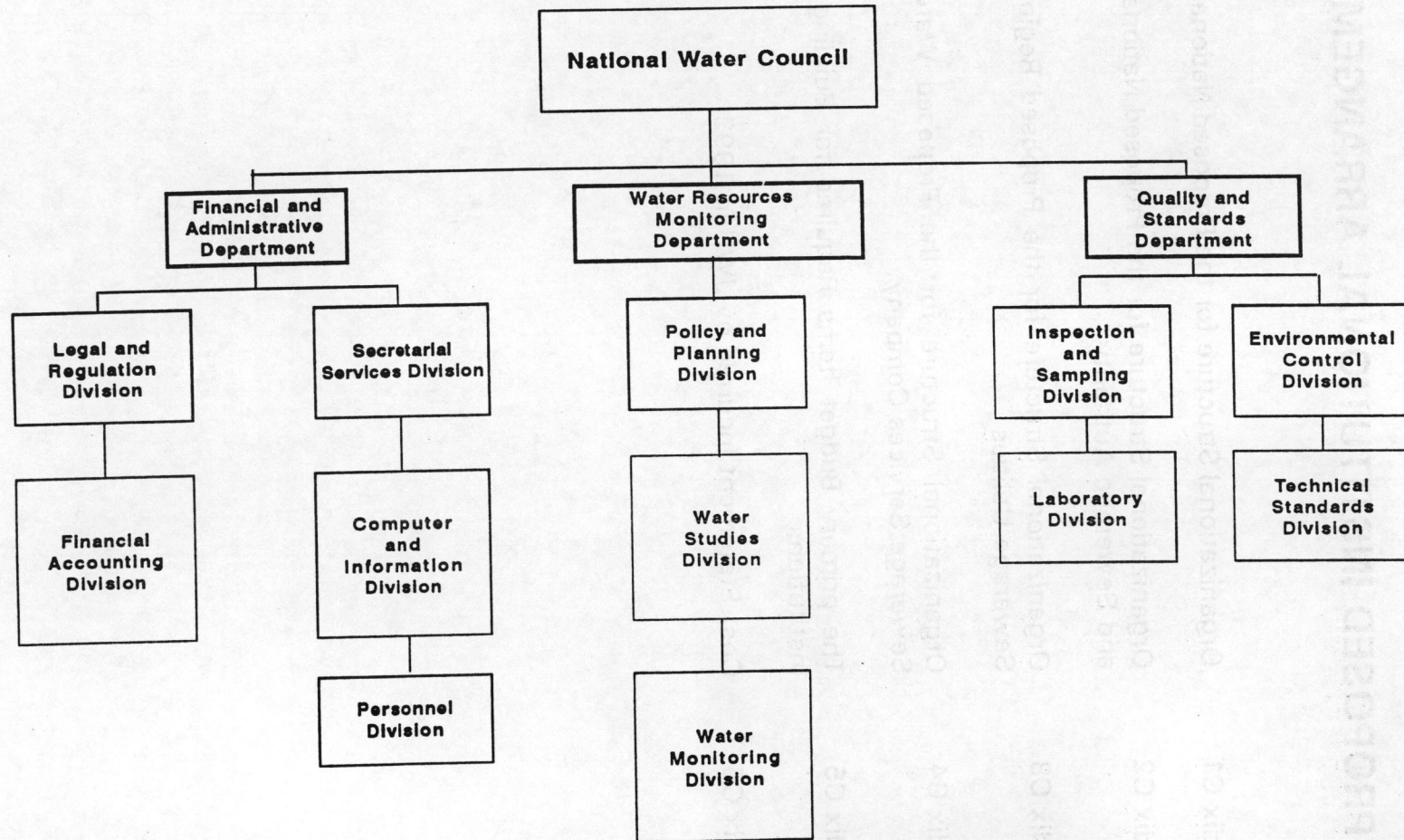
# APPENDIX C

## PROPOSED INSTITUTIONAL ARRANGEMENTS

- Appendix C1      Organizational Structure for the Proposed National Water Council
- Appendix C2      Organizational Structure for the Proposed National Water supply and Sewerage Authority
- Appendix C3      Organizational Structure for the Proposed Regional Water and Sewerage Utilities
- Appendix C4      Organizational Structure for the Proposed Water Supply and Sewerage Services Company
- Appendix C5      The primary Budget Items Required for Building the Proposed Institutions
- Appendix C6      Cost Statement Incurred by JWU in 1993

## APPENDIX C1

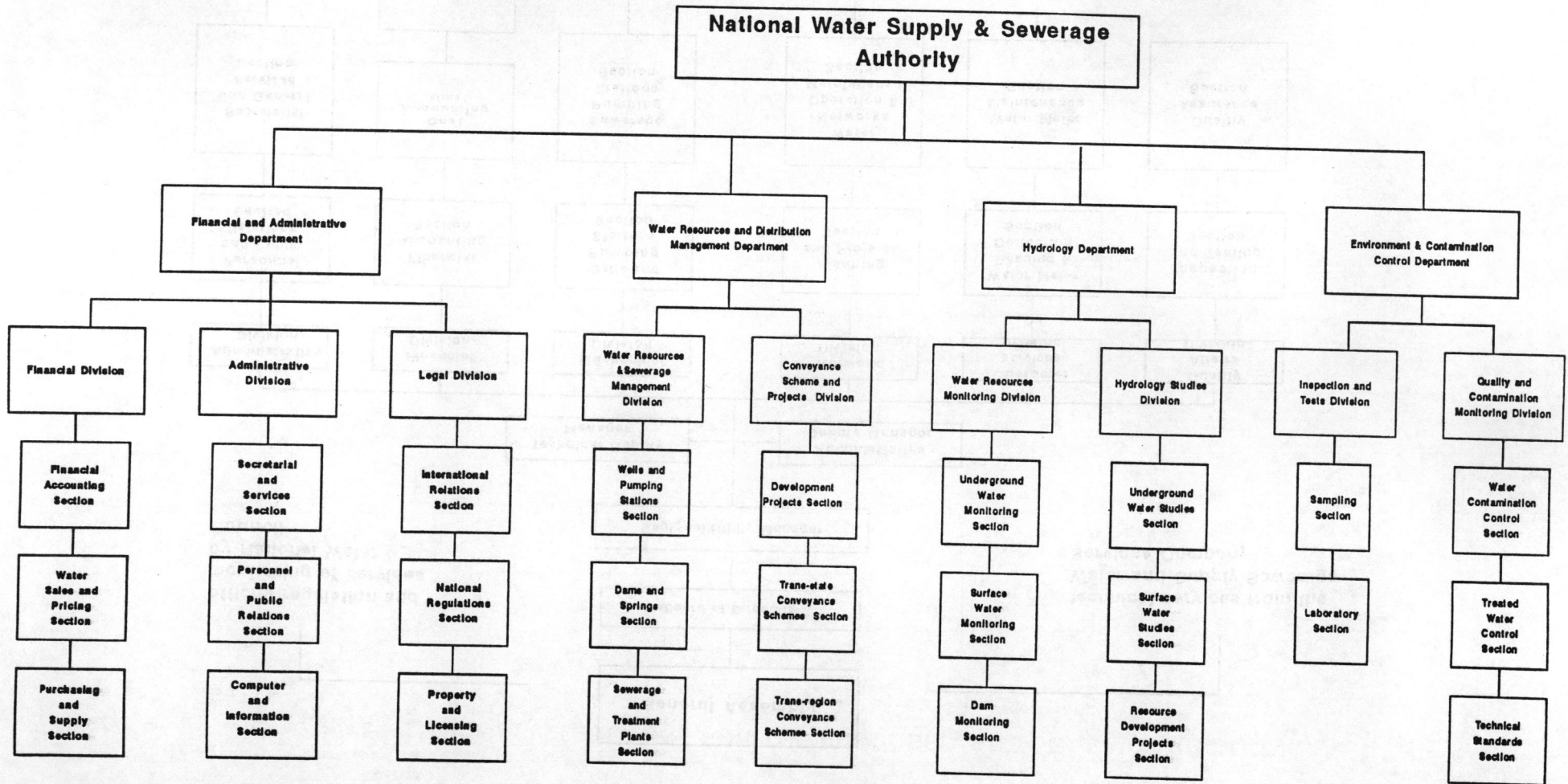
### ORGANIZATIONAL STRUCTURE FOR THE PROPOSED NATIONAL WATER COUNCIL



Source : Abdelkarim Asa'd/JWU

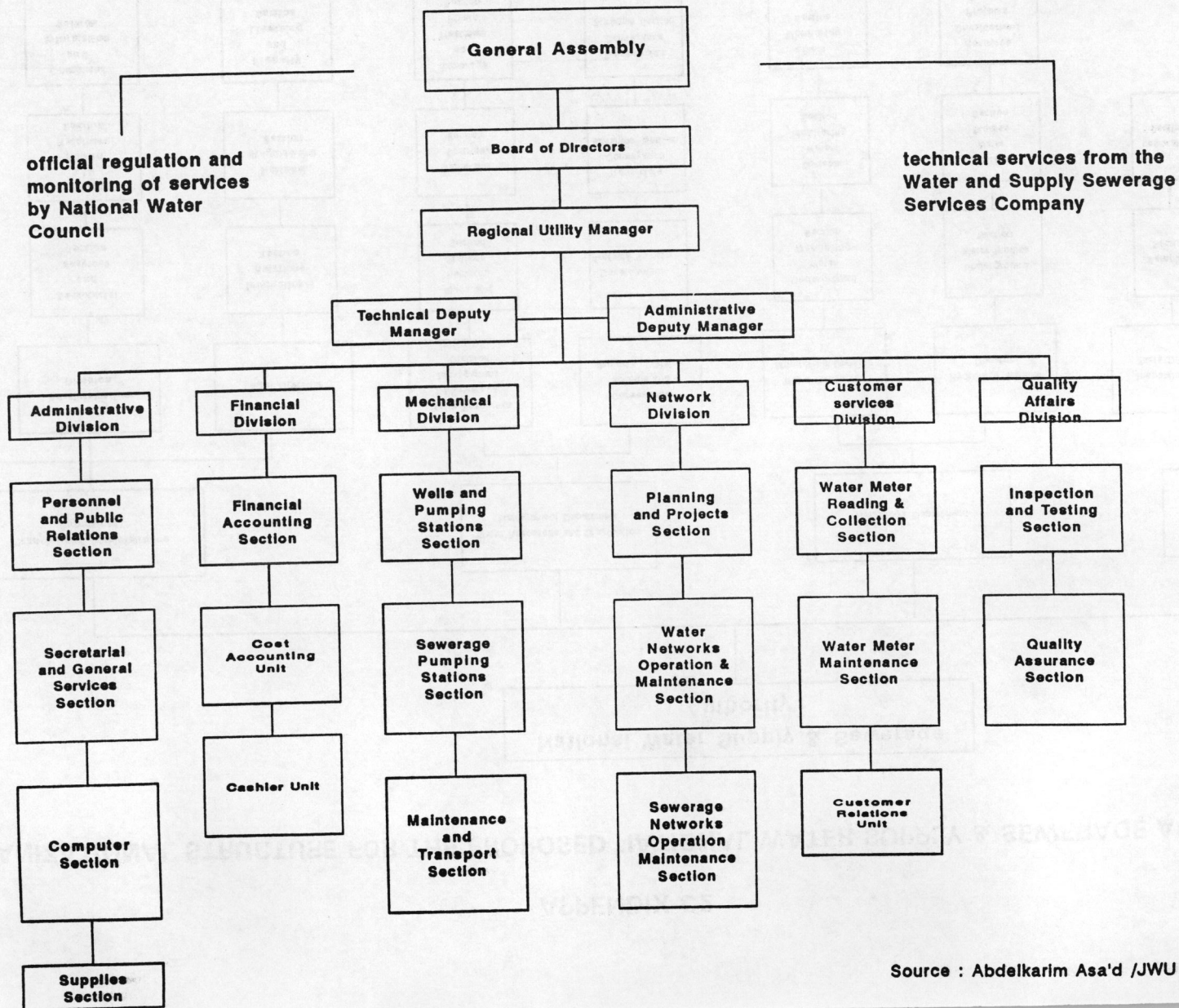
## APPENDIX C2

# ORGANIZATIONAL STRUCTURE FOR THE PROPOSED NATIONAL WATER SUPPLY & SEWERAGE AUTHORITY



## APPENDIX C3

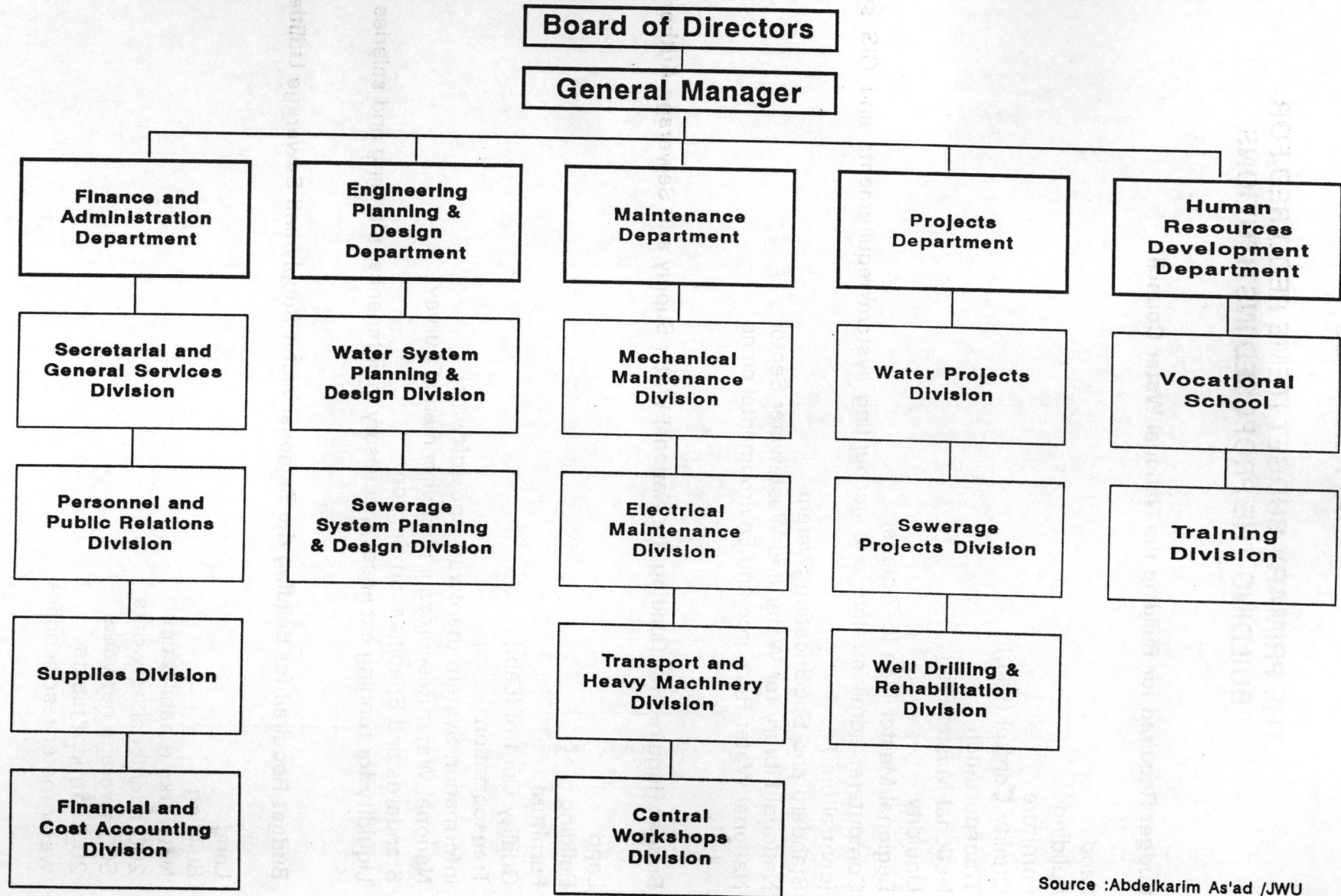
### ORGANIZATIONAL STRUCTURE FOR THE PROPOSED REGIONAL WATER AND SEWERAGE UTILITIES





# APPENDIX C4

## ORGANIZATIONAL STRUCTURE FOR THE PROPOSED WATER SUPPLY AND SEWERAGE SERVICES COMPANY



Source :Abdelkarim As'ad /JWU

## APPENDIX C5

### THE PRIMARY BUDGET ITEMS REQUIRED FOR BUILDING THE PROPOSED INSTITUTIONS

#### **Budget Required for Building the National Water Council**

Land  
Building  
Furniture  
Quality Control (Lab.)  
Transportation  
National Master Plan  
Liquidity  
Regional Master Plan (5-7 plans)  
Computers, administrative and accounting system requirements and GIS system  
(central unit)  
Standard and Specification System  
National Library for Water and Wastewater Sector  
National Water Resource and Environmental plans

#### **Budget Required for Building the National Water Supply and Sewerage Authority**

Land  
Building  
Furniture  
Quality Control (Lab.)  
Transportation  
Information System (hardware and software)  
National Water Resources and Environmental Survey  
Standards and Specification Section  
Liquidity for running expenses, necessary maintenance, planning and salaries

#### **Budget Required for Building the Regional Water Supply and Sewerage Utilities**

Land  
Building  
Networks rehabilitation  
200 additional networks  
50 sewerage networks  
20 treatment plants  
water meter test benches

## APPENDIX C5 CONT'D

25 additional wells for existing networks

25 additional wells for new networks

Vehicles

20 reservoirs 1000 m3

10 reservoirs 2000 m3

50 pumping stations (additional)

1 awareness campaign

workshops: • equipment  
 • welding machine  
 • compressors  
 • tools

Geographic Information System

Computers

### Budget Required for Building the Regional Water Supply and Sewerage Utilities

Land

Building

- Administrative
- Mechanical workshop
- Electrical workshop
- General services workshop
- School building

Equipment

- Mechanical
- Electrical
- Furniture
- Training equipment
- Drilling equipment
- Transportation vehicles
- Tools, leak detection unit, compact system for video inspection of bore holes, sewerage pipes and water distribution pipes.

Working Capital

- Electrical materials and spare parts
- Mechanical materials and spare parts
- Cash for salaries and various expenses

**APPENDIX C6**  
**COST STATEMENT INCURRED BY JWU IN 1993**

Cubic Meters Sold = 5,526,571	Amount NIS*	Subtotal NIS	NIS/m <sup>3</sup> sold
<b>Production Cost</b>		<b>12,253,788.57</b>	<b>2.2172</b>
Labor Cost	768,452.59		0.1390
Material Cost	102,584.82		0.0186
Other Expenses	281,938.07		0.0510
Power	2,787,206.41		0.5043
Water Purchased (if any)	8,123,573.13		1.4699
Depreciation	190,033.58		0.0344
<b>Distribution Cost</b>	<b>4,579,891.39</b>	<b>16,833,679.96</b>	<b>0.8287</b>
Labor Cost	3,230,066.18		0.5845
Material Cost	784,883.00		0.1420
Other Expenses	233,224.31		0.0422
Depreciation	331,717.90		0.0600
Administrative Cost	1,728,631.74	18,562,311.70	0.3128
Labor Cost	1,237,433.96		0.2239
Other Expenses	412,250.24		0.746
Depreciation	78,947.54		0.0143
<b>Less End - Starting Inventory</b>	<b>(220,000.00)</b>	<b>18,782,311.70</b>	
Cost of Revolving Grant Fund (@ US\$ 6 million to be recovered at 8.33% annually over 12 years)	1,499,400.00	20,281,711.70	0.2713
<b>Gross Cost</b>		<b>20,281,711.70</b>	<b>3.6699</b>
Less Miscellaneous Returns ** (meter rental, pipe laying, etc.)	3,441,527.39	16,840,184.31	0.6227
<b>Net Costs</b>		<b>16,840,184.31</b>	<b>0.6227</b>

\* 1 USD = 3 NIS

\*\* this item is included to eliminate the effect of other revenues on the unit price.

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