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Palestinian Water Authority

Program funded by the

U.S. Agency for International Development

assisted by

CDM/Morganti

Water Resources Program

Task 45
Environmental Assessment for the Nablus Area Water Supply System

Draft Environmental Assessment

14 June 1997

USAID Contract No. 294-C-00-96-90560-00
Contractor: Camp Dresser & McKee International Inc.
Deliverable 45a.03

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Preface

The Water Resources Program, funded by the U.S. Agency for International Development (USAID), will contribute to implementation of water-related aspects of the Israeli-Palestine Liberation Organization Peace Accords of 1993.

USAID has entered into a three-year contract with Camp Dresser & McKee International Inc. (CDM) to provide comprehensive services under USAID's Municipal Services Project in the West Bank and Gaza. These services are being provided by CDM through a team of firms referred to as **CDM/Morganti**. Under the contract, **CDM/Morganti** will provide data collection, investigations, planning, design, training, institutional support, commodity procurement, and construction services.

All contract funds are being administered by **CDM/Morganti** which, working under the direction of USAID and in close collaboration with the Palestinian Water Authority (PWA) and the Joint Water Committee (Israeli-Palestinian), will coordinate the provision of U.S. Government assistance for the supply of water to Palestinian consumers. **CDM/Morganti** is implementing the Water Resources Program consistent with the USAID/West Bank and Gaza Mission's Strategy.

Of primary, though not exclusive, concern are the Trilateral Committee (U.S.-Israeli-Palestinian) activities. These activities focus on the development of water systems in the Eastern Aquifer basin of the West Bank consistent with the Water Agreement known as "Article 40" between the Government of Israel and the Palestinians. The Joint Water Committee will identify and present to the Trilateral Committee activities for consideration. To date, the Joint Water Committee has identified: 1) a major water supply and transmission system to serve the Hebron-Bethlehem Area and 2) a water supply and transmission system to serve the Jenin Area as priority projects. It is anticipated that at least one other water supply system and transmission system will be identified by the Joint Water Committee for consideration under USAID-financed program. It is envisaged that USAID will contribute limited funds to construct essential elements of two or more major projects consistent with the provision of Article 40. **CDM/Morganti** will assist the PWA in packaging unfunded activities for presentation to other donor agencies.

Work under the contract began on 1 July 1996 and is expected to be completed by 30 June 1999. This report is the third of a series of environmental impact assessment reports for the Nablus service area. The principal preparer of this assessment is Dr. Iyad Abumoghli, assisted by Lane Krahl.

EXECUTIVE SUMMARY

One component of the Water Resources Program is a water supply facility master plan to serve the Nablus municipal area. The service area for the facility master plan encompasses only about 17 percent of the total area in the Nablus District, but 64 percent of the population of the district lives inside the service area. The area includes the city of Nablus, with a current population of 102,462, and 37 other communities ranging in size from 319 to 8,904 inhabitants. The plan will focus on development of water supply sources, transmission, pumping, treatment, and storage for the years 2000, 2010 and 2020. This activity was identified by USAID/West Bank and Gaza as requiring an environmental assessment (EA).

Purpose and Objective

The purpose of the Water Resources Program of the West Bank Municipal Services Project is to provide greater access to and more effective use of scarce water resources. The objective of the program in the Nablus service area is to provide the necessary guidance to systematic improvement, renovation, and expansion of water supply facilities for the year 2000 through the year 2020.

Significant Issues

The EA team, after conducting a scoping session, identified seven significant issues: increase of wastewater generation, sustainability of groundwater resources, induced development, land use and acquisition, improved hygiene, energy requirements, and destruction of archaeological resources. The impacts of implementation of the facility master plan on these seven issues are assessed in the EA.

Proposed Action and Alternatives

Facility master plan alternatives were developed to meet the objective of supplying adequate water to all of the residents in the Nablus service area through the year 2020. The **CDM/Morganti** team developed a proposed action and three action alternatives to meet this need with specific targets for the years 2000, 2010, and 2020. The alternatives differ from the proposed action primarily in their sources of water. The proposed action and its alternatives are summarized in Table ES.1. The EA team also assessed the impact of the no action alternative.

Table ES.1
SUMMARY OF THE FACILITY MASTER PLAN PROPOSED ACTION AND ALTERNATIVES

Item	Year	Proposed Action	Alternative 1	Alternative 2	Alternative 3
Sources of Increased Water	2000	Northeastern Aquif. 3 wells 4.65 Mcm/yr Western Aquifer 1 wells 2 Mcm/yr Mekoroth 0.95 Mcm/yr	Northeastern Aquif. 3 wells 4.65 Mcm/yr Western Aquifer 1 wells 2 Mcm/yr Mekoroth 0.95 Mcm/yr	Northeastern Aquif. 1 wells 1.8 Mcm/yr Western Aquifer 4 wells 7.4 Mcm/yr Mekoroth Eliminate 1.6 Mcm/yr	Northeastern Aquif. 1 wells 1.8 Mcm/yr Mekoroth 5.8 Mcm/yr
	2010	Western Aquifer 9 wells 14.35 Mcm/yr Mekoroth Eliminate 2.55 Mcm/yr	Northeastern Aquif. 3 wells 5 Mcm/yr Western Aquifer 2 wells. 4 Mcm/yr Mekoroth 2.8 Mcm/yr	Western Aquifer 6 wells 11.8 Mcm/yr	Mekoroth 11.8 Mcm/yr
	2020	Western Aquifer: 7 wells 13.9 Mcm/yr	Western Aquifer 3 wells 7 Mcm/yr reated Wastewater 6.9 Mcm/yr	Western Aquifer 7 wells 13.9 Mcm/yr	Multi-national Desalinization Project 41.7 Mcm/yr Mekoroth Eliminate 19.2 Mcm/yr
New Pipelines	2000	44 km main 24 km branch	44 km main 24 km branch	47 km main 24.5 km branch	34 km main 22 km branch
	2010	55.5 km main 19 branch	38.5 km main 17.5 branch	55.5 km main 19 branch	18 km main 17.5 km branch
	2020	33 km main 0 km branch	75 km main 2.5 km branch 30 km main for wastewater	33 km main 0 km branch	11.5 km main 2.5 km branch
New Storage Reservoirs	2000	1 regional 11 local	1 regional 11 local	1 regional 10 local	1 regional 11 local
	2010	3 regional 25 local	1 regional 25 local	3 regional 26 local	1 regional 25 local
	2020	1 regional 28 local	3 regional 28 local	1 regional 28 local	1 regional 28 local
New Pump Stations	2000	3	3	9	6
	2010	7	0	1	0
	2020	0	10 3 for wastewater	0	2

Mitigation Measures

Ten mitigation measures were developed, applicable to all alternatives.
Development of an Archaeological Resource Protection Program
Adoption of Design Standards to Minimize the Intrusive Character of Proposed Facilities
Adoption of Design Standards to Minimize Noise in Residential Areas
Development of a Construction Control Program to Avoid Undue Disruption of Access and Services
Development of a Construction Control Program to Avoid Undue Destruction of Cesspits
Adoption of Design Standards to Minimize Soil Erosion and Destruction of Vegetation
Avoid Groundwater Overdraft
Adoption of Design Standards to Prevent Releases of Chlorine Gas and Minimize Potential Impacts
Adoption of Design Standards to Prevent or Contain Fuel Releases at Well Sites and Pump Stations
Shallow Groundwater Impact Assessment

These mitigation measures eliminate or minimize the potential impacts of implementation of the facility master plan on some of the significant issues. Some of the mitigation measures also address issues which were identified as nonsignificant, but in the absence of mitigation may become significant.

Affected Environment

The Nablus service area covers 265 square kilometers in the north central portion of the Nablus District. The service area is mountainous and straddles the watershed divide between the eastern slopes and western slopes. Elevation within the service area ranges from 300 to 900 meters above mean seal level. The area is characterized by its hot, dry summers and moderate, rainy winters. Annual mean rainfall is 664 mm, most of which occurs between December and March.

The total estimated population in the Nablus service area in 1996 was 185,209. Fifty-five percent of the residents of the service area live in the city of Nablus. The population of the service area is expected to grow to 423,240 by the year 2020. Most of the economic assets of the West Bank are concentrated in Nablus city. Major industrial activities in the area include aggregate quarrying, stone and marble cutting, and a wide range of manufacturing and processing industries.

The Nablus service area is underlain by the Northeastern Aquifer Basin, but it is also served by groundwater from the Western Aquifer Basin. Recharge of these aquifers has not been fully studied. Estimates of recharge range from 140 to 200 Mcm/yr for the Northeastern Aquifer and 350 to 360 Mcm/yr for the Western Aquifer. Schedule 7 of Article 40 of the Interim Oslo Peace Accords identifies both of the aquifers as being fully assigned.

All but 11 of the 38 communities in the service area are served by piped water systems. The 11 communities without water systems represent 10 percent of the population. They rely primarily upon rainwater collected in cisterns for their domestic water. The piped water systems are currently supplied with 8.4 Mcm/yr from four wells (4.6 Mcm/yr), five spring systems (2.2 Mcm/yr), and water purchased from Mekoroth (1.6 Mcm/yr). Current average domestic consumption (accounting for other uses and system losses) is estimated at 48 L/c/d.

The only sewer in the service area is in the city of Nablus. It serves 90 percent of the city population. There are no wastewater treatment plants connected to the sewer, so it discharges

untreated wastewater to two wadis. Some of the wastewater is used illegally for agricultural irrigation. All of the other communities in the service area dispose of wastewater in cesspits or septic tanks.

Nablus city was built by the Canaanites on the remains of a Stone Age city. Excavations have uncovered remains from the Chalcolithic to Roman periods, including city walls, towers, and temples. Sixty-one archaeological sites have been identified in the Nablus service area.

Environmental Consequences

Assessing the environmental impacts of the facility master plan is not as straight forward as assessing the impacts of a proposed action where exact locations and activities are well defined. Most of the proposed facilities will not be constructed for many years. The exact locations of these facilities are not known, making site specific determinations of impact impossible. Therefore, most of the assessment is necessarily general, particularly in assessing the impacts of the proposed facilities for the year 2020.

If the mitigation measures presented in section 2.7 of this EA are implemented at the time of design and construction, the facilities should cause no significant impacts on the environment. The greatest potential impacts are associated with increasing wastewater flows. These impacts will need to be addressed in the future through wastewater management. The other potential impact of most concern is unsustainable use of the groundwater resource. This issue can only be addressed with development and implementation of a regional water exchange scheme involving all of the parties currently using the three aquifers under the West Bank. The regional scheme should include economically efficient exchanges of desalinated seawater for groundwater. A regional solution, in combination with implementation of the groundwater monitoring program proposed in the EA, should eliminate the potential for overdraft of the aquifer.

Monitoring Plans

The EA proposes monitoring programs to provide continual feedback on the design, construction and operation of the system, and to suggest strategies for dealing with the issues of concern where warranted. The areas of specific focus for the monitoring programs are:

- The development of a water resource monitoring plan, focused on the relationship of local demand for water and local sources of supply.
- The development of a domestic water quality monitoring program to ensure that the water systems are not contaminated by wastewater.
- The development of a monitoring program that ensures the implementation of the proposed mitigation measures.

DRAFT ENVIRONMENTAL ASSESSMENT OF THE MASTER PLAN FOR THE NABLUS SERVICE AREA

Abbreviations

ARIJ	Applied Research Institute, Bethlehem
CDM	Camp Dresser & McKee International Inc.
CDM/Morganti	Consortium of Camp Dresser & McKee International Inc. and the Morganti Group with other Palestinian and International Firms.
m^3	cubic meters
EA	Environmental Assessment
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Technical Office)
JWC	Joint Water Committee (Israeli - Palestinian)
JWU	Jerusalem Water Undertakings
km	kilometers
L/c/d	liters per capita per day
m	Meters
Mcm	Million cubic meters
mmsl	Meters above mean sea level
NGO	Non-Governmental Organization
PWA	Palestinian Water Authority
UFW	Unaccounted-for-water
UNRWA	United Nations Relief and Works Agency
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WBWD	West Bank Water Department
WHO	World Health Organization

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DRAFT ENVIRONMENTAL ASSESSMENT OF THE MASTER PLAN FOR THE NABLUS SERVICE AREA

1. INTRODUCTION

The United States Agency for International Development (USAID) is funding the Water Resources Program of the West Bank Municipal Services Project. The program is being implemented by a team (**CDM/Morganti**) led by Camp Dresser & McKee International Inc. and including the Morganti Group Inc., Associated Consulting Engineers - Palestine, Center for Engineering and Planning - Palestine, Chemonics International Inc., and Harza Environmental Services in close cooperation with the Palestinian Water Authority (PWA) and under the auspices of the Joint Water Committee (Israeli-Palestinian). Under the program, **CDM/Morganti** coordinates the provision of U.S. Government assistance for water resource management and the supply of water to Palestinian consumers consistent with the USAID/West Bank and Gaza Mission's strategy.

One component of the Water Resources Program is a water supply facility master plan to serve the Nablus municipal area. The service area for the facility master plan (Figure 1.1) encompasses only about 17 percent of the total area in the Nablus District, but 64 percent of the population of the district lives inside the service area. The area includes the city of Nablus, with a current population of 102,462, and 37 other communities ranging in size from 319 to 8,904 inhabitants. The plan will focus on development of water supply sources, transmission, pumping, treatment, and storage for the years 2000, 2010 and 2020. This activity was identified by USAID/West Bank and Gaza as requiring an environmental assessment (EA).

This EA addresses significant environmental issues for the facility master plan. It assesses potential environmental impacts and identifies necessary mitigation measures for each of the plan alternatives. The assessment of the environmental impacts of the facility master plan has been closely coordinated with the facility master planning team to ensure that environmental concerns have been considered in the development and selection of planning alternatives. Once an alternative is selected, the facility master planning team will prepare a comprehensive implementation plan. This plan will include the mitigation measures developed in the environmental assessment.

The Environmental Assessment is organized as follows. Section 1 presents the purpose and objectives of the project, identifies the significant issues which are addressed in the EA, and describes the criteria which will be used to make the assessments. Section 2 presents a description of the proposed action and alternatives and the required mitigation measures. Section 3 describes the environment which will affect and/or be affected by the project. Section 4 presents the environmental consequences associated with the proposed action and each alternative. Section 5 contains the proposed monitoring plans, and Section 6 lists the preparers, persons contacted, and references consulted throughout the preparation of the assessment.

1.1 PURPOSE AND OBJECTIVES

The purpose of the Water Resources Program of the West Bank Municipal Services Project is to provide greater access to and more effective use of scarce water resources. The objective of the program in the Nablus service area is to provide the necessary guidance to systematic improvement, renovation, and expansion of water supply facilities for the year 2000 through the year 2020.

1.2 SIGNIFICANT ISSUES

The **CDM/Morganti** EA team held a scoping session in Nablus on December 2, 1996. Prior to the scoping session, the EA team prepared a draft scoping session handout and a participant list which were reviewed by USAID and PWA. During the scoping session, 33 issues were identified by the participants as being potentially significant. The EA team grouped similar impacts and used criteria on the relevance, magnitude, extent, duration, and uncertainty of the potential impacts associated with each issue to identify 7 significant issues for the Nablus area (Table 1.1).

The scoping report for the Nablus service area, submitted on 23 December 1996 and approved by USAID on 13 February 1997, contains explicit explanation and justification for the identification of significant issues.[1] USAID's approval of the scoping report was contingent upon consideration of two issues: social and cultural impacts and roads.

Social and cultural impacts and roads were identified by scoping session participants as potentially significant issues. Subsequent analysis by the EA team, however, indicated that they were nonsignificant issues. Some participants at the scoping session were concerned that providing houses with water will minimize social gatherings around springs, however, ninety percent of the population in the service area is served by piped water systems. Those people do not rely upon gatherings at the springs for social interaction. Apparently there are many other existing opportunities for social gatherings. Cultural impacts could also be associated with presence of foreign employees during construction of the systems. However, because of the touristic nature of the West Bank, the residents of Nablus are already exposed to tens of thousands of foreigners every year. In addition, for the last 30 years the residents of the area have been connected and exposed to the Israeli culture, which is very different than the Palestinian culture. Implementation of the facility master plan, therefore, is unlikely to have significant social or cultural impacts.

The only road construction which may be associated with implementation of the facility master plan is short (50 to 200 meter) access roads to well and reservoir sites, limited to use by maintenance and operation personnel. Proposed pipelines and pump stations for all alternatives are located within existing road rights-of-way, requiring no new construction. There are no forests in the region which would suffer from deforestation due to construction of the short access roads. Any potential impacts from road construction will be minimized by implementation of the soil erosion mitigation measures in section 2.7 of this EA.

Some of the nonsignificant environmental issues were considered to be so when they are associated with the mitigation measures prepared for the other service areas (Jenin and Hebron-

[1]Deliverable 45b.02

Bethlehem) being assessed by the same environmental team in the West Bank.[2] These mitigation measures have been included in in section 2.7 of this EA. Although, the **CDM/Morganti** team will not implement the Nablus facility master plan, it did prepare design specifications for facility development in other areas of the West Bank which should serve as guiding tools for the implementation of this plan.

Table 1.1
IDENTIFICATION OF SIGNIFICANT ISSUES

Issue	Significant	Nonsignificant
Increase of Wastewater Generation	✔	
Land Use and Acquisition	✔	
Destruction of Archaeological Resources	✔	
Rare and Endangered Species		✔
Traffic Disruptions		✔
Improved Hygiene	✔	
Energy Requirements	✔	
Noise and Dust		✔
Architectural Treatment of Facilities		✔
Increased Cost on Water Users		✔
Sustainability of Water Resources (Quantity and Quality)	✔	
Induced Development	✔	
Public Awareness for Conservation		✔
Cultural and Social Impacts		✔
Roads		✔
Maintenance and Operation of Storage Tanks (Flooding and Washout)		✔
Earthquakes		✔
Vegetation Cover		✔
Impacts on Neighboring Countries		✔

1.3 ASSESSMENT CRITERIA

For each of the significant issues, the EA team developed assessment criteria to be used in measuring the impacts. To the extent possible, the team developed criteria which could be quantitatively measured. These criteria are described in this section.

[2]These issues include: aesthetic impact of the facilities, noise, traffic, disruption of access and services during construction, destruction of cesspits during construction, soil erosion, destruction of vegetation, and releases of chlorine gas and fuel.

Increase of Wastewater Generation

Increased wastewater generation may contaminate groundwater resources and cisterns which may cause adverse health impacts. The criteria for assessing this issue are current and projected water supply and subsequent wastewater generation, wastewater collection and disposal methods, depth of groundwater resources, surface discharges and seepages, final disposal site of wastewater and pumpage from cesspits, and effluent quality.

Sustainability of Groundwater Resources

The criteria for assessing the impacts of the alternatives on sustainable use of groundwater are projected withdrawals and estimates of safe yield, including water use assignments in Article 40 of the Interim Agreement.

Improved Hygiene

Increase of water supply will improve public health and the standard of living in the project area. The assessment criterion for this issue is per capita water consumption. Current and projected per capita consumption rates are evaluated using the WHO design recommendation for minimum per capita consumption for in-house piped systems.

Induced Development

Implementation of the facility master plan may sufficiently increase water availability to stimulate economic development in the area, including industrial development which could result in long-term negative environmental impacts such as generation of toxic waste and air pollution. Induced development might also be associated with positive impacts such as creation of job opportunities, promotion of tourism, and the use of water for recreational purposes. Induced development may also impact cultural and social structures in the planning area. The impact of induced development is assessed by analyzing economic growth with and without implementation of the plan. The assessment uses existing information on projected economic growth, rather than producing project specific economic growth models.

Land Use and Acquisition

Facility construction will require land acquisition and cause irreversible changes in land use. These impacts can be mitigated by ensuring adequate compensation for any irreversible commitments. These impacts are assessed by determining land use and land ownership at proposed facility sites.

Energy Requirements

The provision of electrical power for pumping is an indirect impact of the project. Additional electricity may be required to operate the proposed facilities, raising concerns about the environmental impacts associated with power generation and transmission. The assessment criteria for this issue are energy requirements and current and projected energy sources and availability. The energy requirements are compared to energy availability to determine if there is an energy deficit. If a deficit exists, the potential impacts of required energy sources are assessed.

Destruction of Archaeological Resources

Destruction of archaeological resources may result in irreversible negative long-term impacts. To the extent possible, the project should be implemented in such a way to avoid irreversible impacts. Discovery of new archaeological resources may also be associated with this project and may result in both negative and positive impacts. Potential destruction or discovery of archaeological resources will be evaluated on the basis of maps produced through literature surveys that will be conducted in the early stages of the assessment. Walk over surveys are not applicable in this case, since the master plan does not identify specific facility locations, but such surveys are included as mitigation measures.

Figure 1-1
General Location Map

2. PROPOSED ACTION AND ALTERNATIVES

The project team reviewed several system component options and identified the proposed action and reasonable alternatives for the facility master plan. This chapter describes the process used for screening and evaluating component options, presents the no action alternative, and presents the proposed action and reasonable alternatives.

2.1 ALTERNATIVE DEVELOPMENT PROCESS

The facility master plan elements are those structural measures that can be taken to satisfy the water supply needs for the years 2000, 2010, and 2020. The plan elements are source development, transmission mains, pump stations, and storage reservoirs. Alternative sources of water are: a) the Northeastern Aquifer; b) the Western Aquifer; c) Mekoroth (trading, exchanging or purchasing water from the Israelis); d) reuse of treated wastewater (either directly, or in exchange for other fresh water); and e) unconventional sources, such as desalinated water imported into the region, or treated water from the Jordan River. Alternatives for routing and storage are somewhat limited by locations of sources of supply, demand centers, and existing infrastructure including existing road systems and associated rights-of-way, but some variations in routing were evaluated, especially where topography dictated the need for seeking less costly routes with respect to pumping needs. Staged development is an integral part of the master plan, and assumptions are made regarding the rates at which it is practical for construction to proceed within this area. Target years of 2000, 2010, and 2020 mean that it is anticipated that the facilities will be constructed by these target years, or as closely as possible to this schedule to satisfy forecast water supply needs.

All alternatives use the same projections of future water demands. In developing water demand projections for the planning area, the planning team assumed that per capita consumption would increase over the planning period to the WHO average rate for house connections in small communities (150 L/c/d).[3] The WHO rate is for household consumption only, so the team increased the rate to account for public, livestock, and commercial/industrial water use, based on historical trends, allowing for slight increases in future public and commercial/industrial uses. The team also accounted for leakage, wastage, meter losses, and other unaccounted-for water. In doing so the team used historic loss rates, but assumed that they would decrease as new systems came on line. Water use projections and the assumptions upon which they are based are presented in Table 2.1.

Three alternatives were prepared for the three stages of development, years 2000, 2010, and 2020. The three alternatives are based upon the use of different sources of water and associated differences in pipeline, storage, and pumping needs. The Preliminary Report of the Water Supply Facility Master Plan for the Nablus Service Area (Deliverable 44a.01) contains a detailed description of each of the alternatives.

Using components of these three alternatives, a tentative proposed action has been identified. The tentative proposed action is an understanding between the planning team and the PWA engineers. It has not been adopted by PWA. Table 2.2 summarizes the proposed action and the action alternatives.

---

[3]WHO, 1993.

Table 2.1
WATER DEMAND PROJECTIONS AND ASSUMPTIONS

Component		2000	2010	2020
Service Area Population		258,292	330,635	423,240
Domestic Consumption Rate (L/c/d)		75	126	158
Public Water Consumption Rate (L/c/d)		7	9	12
Livestock Consumption Rate (L/c/d)		13	13	13
Commercial/Industrial Consumption Rate (L/c/d)		7	13	20
Overall Loss (%)[a]		40	30	25
Total	(L/c/d)	170	230	270
	(Mcm/yr)	16.0	27.8	41.7

[a]Includes leakage, wastage, meter losses, and other unaccounted-for water.

2.2 NO ACTION

The no action alternative continues the use of the existing water supply and distribution system serving the Nablus area (Figure 2.1), with the addition of 1.8 Mcm/yr which will come from the new well in the Northeastern Aquifer and transmission line being funded by GTZ. Currently, the total amount of water supplied to the service area is 8.4 Mcm/yr, with 1.2 Mcm/yr from the Western Aquifer, 3.4 Mcm/yr from the Northeastern Aquifer, 2.2 Mcm/yr from springs, and 1.6 Mcm/yr purchased from Mekoroth. The new well will bring the total to 10.2 Mcm/yr.

2.3 PROPOSED ACTION

The proposed action contains portions of both alternative 1 and alternative 2. Like alternative 1, it draws additional water from the Northeastern and Western aquifers and from Mekoroth to meet the demand in the year 2000. Similar to alternative 2, it shifts exclusively to the Western Aquifer in the year 2010. It also eliminates reliance upon water from Mekoroth in the year 2010.

Year 2000

By the year 2000, water demand in the Nablus service area will be 16 Mcm/yr, requiring an additional supply of 7.6 Mcm/yr. The additional water will come from three new wells producing 4.65 Mcm/yr in the Northeastern Aquifer, one well producing 2 Mcm/yr in the Western Aquifer, and the purchase of 0.95 Mcm/yr from Mekoroth. The wells in the Northeastern Aquifer will be located at Odala,[4] Iraq Burin, and Beit Dajan. The Western Aquifer well will be drilled at the Deir Sharaf well field. Additional pipelines will be introduced into the system to convey the new water supplies to the areas needed. These new pipelines will include 44 km of main lines and 24 km of branch lines. Three new pump stations, one 10,000 m^3 regional storage reservoir, and 11 local reservoirs ranging in size from 200 to 1,000 m^3 will be constructed.

[4]The new well funded by GTZ.

Year 2010

In the year 2010, nine new wells will be developed in the Western Aquifer at the Deir Sharaf well field to supply 14.35 Mcm/yr. This new water will meet the increased need of 11.8 Mcm/yr and allow the system to eliminate its dependence on Mekoroth. New main lines totaling 55.5 km in length and branches lines totaling 19 km in length will be added to the system. Seven new pump stations, one 10,000 m^3 and two 5,000 m^3 regional reservoirs, and 25 local reservoirs with capacities of from 200 to 2,000 m^3 will also be added to the system.

Year 2020

In the year 2020, seven new wells at the Deir Sharaf well field in the Western Aquifer will provide an additional supply of 13.9 Mcm/yr. Thirty-three kilometers of new main lines, one 5,000 m^3 regional reservoir, and 28 new local reservoirs, with capacities of from 100 to 1,000 m^3, will be added to the system.

2.4 ALTERNATIVE 1

Alternative 1 (Figure 2.2) meets increased demand with a combination of sources, including the Northeastern Aquifer, the Western Aquifer, Mekoroth, and reuse of treated wastewater.

Year 2000

In the year 2000, additional water will come from three new wells producing 4.65 Mcm/yr in the Northeastern Aquifer, one well producing 2 Mcm/yr in the Western Aquifer, and the purchase of 0.95 Mcm/yr from Mekoroth. The wells in the Northeastern Aquifer will be located at Odala, Iraq Burin, and Beit Dajan. The Western Aquifer well will be drilled at the Deir Sharaf well field. Additional pipelines will be introduced into the system to convey the new water supplies to the areas needed. These new pipelines will include 44 km of main lines and 24 km of branch lines. Three new pump stations, one 10,000 m^3 regional storage reservoir, and 11 local reservoirs ranging in size from 200 to 1,000 m^3 will be constructed.

Year 2010

In year 2010, alternative 1 will obtain 5 Mcm/yr additional supply from the Northeastern Aquifer with three new wells, one each at Odala, Iraq Burin, and Beit Furik. Another two wells will be drilled in the Deir Sharaf well field in the Western Aquifer, which will provide an additional 4 Mcm/yr. The remaining need of 2.8 Mcm/yr will be purchased from Mekoroth. New pipelines will be added to the system, including 38.5 km of main lines and 17.5 of branch lines. A 10,000 m^3 regional reservoir and at 25 local reservoirs, ranging in size from 200 to 2,000 m^3, will also be constructed.

Year 2020

In year 2020, alternative 1 develops an additional 7 Mcm/yr in three new wells in the Western Aquifer near Salfit. The other 6.9 Mcm/yr of increased need will be met with treated wastewater -- 3 Mcm/yr in exchange for an equal amount of spring water used for agriculture, and 3.9 Mcm/yr for applicable commercial and industrial uses. To deliver the water from the wells, 75.5 km of main lines and 2.5 km of branch lines will be constructed, ten new pump stations will be

added to the system. The municipal water system will also require three new 5,000 m^3 regional reservoir and 28 local reservoirs ranging in size from 100 to 1,000 m^3.

Reuse of wastewater will require construction of two tertiary wastewater treatment plants, one which will produce the 3 Mcm/yr for exchange for agricultural use, and the other to produce the 3.9 Mcm/yr for commercial and industrial uses. To deliver the water to the users, the 3 Mcm/yr plant will require a pump station, a power station, 15 km of conveyance lines, and storage reservoirs. The 3.9 Mcm/yr plant will require two pump stations and 15 km of conveyance lines.

2.5 ALTERNATIVE 2

The concept of Alternative 2 is to develop all the future water supply needs of the service area from the Northeastern and Western aquifers, and eliminate reliance on Mekoroth for any supplies after the year 2000. Alternative 2 is shown in Figure 2.3.

Year 2000

In the year 2000, one well will be developed in the Northeastern Aquifer at Odala to produce 1.8 Mcm/yr. Four new wells capable of producing 7.4 Mcm/yr will be developed in the Western Aquifer at the Deir Sharaf well field. This will supply a total of 9.2 Mcm/yr, 7.6 of which will meet the increased need, and 1.6 which will allow the system to eliminate its reliance upon Mekoroth. New pipelines will be introduced into the system to convey the new supplies. These will include about 47 km of main lines and 24.5 km of branch lines. Nine pump stations will be added to the system, as well as one new 10,000 m^3 regional reservoir and 10 local reservoirs with capacities of from 200 to 1,000 m^3.

Year 2010

In the year 2010, six new wells will be developed in the Western Aquifer at the Deir Sharaf well field to supply the necessary 11.8 Mcm/yr. New main lines totaling 55.5 km in length and branches lines totaling 19 km in length will be added to the system. One new pump station, one 10,000 m^3 and two 5,000 m^3 regional reservoirs, and 26 local reservoirs with capacities of from 200 to 2,000 m^3 will be added to the system.

Year 2020

In the year 2020, seven new wells at the Deir Sharaf well field in the Western Aquifer will provide an additional supply of 13.9 Mcm/yr. Thirty-three kilometers of new main lines, one 5,000 m^3 regional reservoir, and 28 new local reservoirs, with capacities of from 100 to 1,000 m^3, will be added to the system.

2.6 ALTERNATIVE 3

Alternative 3 meets future demand through purchased water from Mekoroth up to year 2020. Beginning in the year 2020, the water supply system will rely entirely upon desalinated water imported to the service area, coming from a multi-national project. Alternative 3 is shown in Figure 2.4.

Year 2000

In year 2000, the additional 7.6 Mcm/yr needed to satisfy the projected water use will come from the new well in the Northeastern Aquifer at Odala (1.8 Mcm/yr) and from Mekoroth (5.8 Mcm/yr). Additions to the existing pipeline networks will include 34 km of main lines and 22 km of branch lines. Six new pump station will be installed, and one 10,000 m^3 regional reservoir will be constructed. Eleven local reservoirs, ranging in size from 200 to 1,000 m^3, will be added to the system.

Year 2010

In year 2010, an additional supply of 11.8 Mcm/yr will be purchased from Mekoroth. New pipelines added to the system will include 18 km of main lines and 17.5 km of branch lines. A new 10,000 m^3 regional reservoir and 25 local reservoirs, ranging in size from 200 to 2,000 m^3, will be added to the system.

Year 2020

In year 2020, the system will begin to receive the entire projected water need of 41.7 Mcm/yr from a new multi-national desalinization project. New pipelines (not including the pipeline delivering the water to the service area) will include 11.5 km of main lines and 2.5 km of branch lines. Two new pump stations, one new 5,000 m^3 regional reservoir, and 28 local reservoirs, with capacities of from 100 to 1,000 m^3, will be added to the system.

Table 2.2
SUMMARY OF THE FACILITY MASTER PLAN PROPOSED ACTION AND ALTERNATIVES

Item	Year	Proposed Action	Alternative 1	Alternative 2	Alternative 3
Sources of Increased Water	2000	Northeastern Aquif. 3 wells 4.65 Mcm/yr Western Aquifer 1 wells 2 Mcm/yr Mekoroth 0.95 Mcm/yr	Northeastern Aquif. 3 wells 4.65 Mcm/yr Western Aquifer 1 wells 2 Mcm/yr Mekoroth 0.95 Mcm/yr	Northeastern Aquif. 1 wells 1.8 Mcm/yr Western Aquifer 4 wells 7.4 Mcm/yr Mekoroth Eliminate 1.6 Mcm/yr	Northeastern Aquif. 1 wells 1.8 Mcm/yr Mekoroth 5.8 Mcm/yr
	2010	Western Aquifer 9 wells 14.35 Mcm/yr Mekoroth Eliminate 2.55 Mcm/yr	Northeastern Aquif. 3 wells 5 Mcm/yr Western Aquifer 2 wells. 4 Mcm/yr Mekoroth 2.8 Mcm/yr	Western Aquifer 6 wells 11.8 Mcm/yr	Mekoroth 11.8 Mcm/yr
	2020	Western Aquifer: 7 wells 13.9 Mcm/yr	Western Aquifer 3 wells 7 Mcm/yr Treated Wastewater 6.9 Mcm/yr	Western Aquifer 7 wells 13.9 Mcm/yr	Multi-national Desalinization Project 41.7 Mcm/yr Mekoroth Eliminate 19.2 Mcm/yr
New Pipelines	2000	44 km main 24 km branch	44 km main 24 km branch	47 km main 24.5 km branch	34 km main 22 km branch
	2010	55.5 km main 19 branch	38.5 km main 17.5 branch	55.5 km main 19 branch	18 km main 17.5 km branch
	2020	33 km main 0 km branch	75 km main 2.5 km branch 30 km main for wastewater	33 km main 0 km branch	11.5 km main 2.5 km branch
New Storage Reservoirs	2000	1 regional 11 local	1 regional 11 local	1 regional 10 local	1 regional 11 local
	2010	3 regional 25 local	1 regional 25 local	3 regional 26 local	1 regional 25 local
	2020	1 regional 28 local	3 regional 28 local	1 regional 28 local	1 regional 28 local
New Pump Stations	2000	3	3	9	6
	2010	7	0	1	0
	2020	0	10 3 for wastewater	0	2

2.7 MITIGATION MEASURES

Mitigation measures are actions taken to address adverse impacts associated with project alternatives in order to resolve them wherever possible. This is performed by identifying those important issues associated with each alternative that, if modified in some fashion, make the project more acceptable.

For this project, issues requiring mitigation were identified using the concerns expressed during the environmental scoping sessions and the experience of the project team in other assignments. Mitigation measures for some issues identified as nonsignificant for the facility master plan are included to provide guidance for implementation of the plan and to make sure that they remain nonsignificant.

2.7.1 Mitigation Measures Common to All Alternatives

The following mitigation measures are common to all alternatives. They should be incorporated into the facility master plan operational requirements and action plan, and into technical specifications during subsequent design and construction.

(a) Development of an Archaeological Resource Protection Program

Since the exact location of the proposed facilities cannot be known until detailed designs are prepared, and because this environmental assessment considers only the master plan phase, no walk over surveys were conducted for this EA. When facility designs are developed, however, the following mitigation measures should be implemented. They should proceed in a step-wise fashion, each step involving greater detail over smaller areas to insure that resources are identified, assessed, and protected in an appropriate fashion. The work begins with literature searches followed by field surface surveys of proposed project sites by trained professionals to determine the likely presence of important resources. The specific mitigation measures are as follows:

<u>During the planning and design phases</u>

Research the literature and contact archaeologists working in or familiar with the area to ensure that known archaeological sites are incorporated into the planning process.

Conduct reconnaissance surface surveys for all facility sites and pipe alignments that are not in roadways previously disturbed by construction. These walkover surveys are conducted for the purpose of determining if an area is likely to contain significant resources. If any such resources are noted, then decisions will need to be made whether to adjust the alignment and locations, or to conduct intrusive investigations.

Where warranted, qualified archaeologists should conduct intrusive investigations consisting of field excavations, and appropriate specimen collection, recording, and preservation.

Where intrusive investigations indicate the need to preserve the site in some manner, authorities should be consulted to determine if the facility should be relocated, or the site fully documented prior to construction.

During the construction phase

Immediate notification of appropriate authorities of the discovery of previously undocumented artifacts.

Retain services of a qualified archaeologist to assess unforeseen circumstances.

The application of these measures will vary in intensity with different types of facilities. For example, since the location of water transmission and distribution mains can be adjusted to account for obstacles, the detailed examination of the routes of these alignments for archaeologically important resources will be conducted at the time of final design, when adjustments can be made to avoid important resources, without significantly altering the overall water system design. On the other hand, since major facilities, such as well sites, pump stations, treatment plants, and reservoirs, cannot be moved without corrupting the overall plan, it is important to conduct a more comprehensive assessment in the planning stage.

(b) Adoption of Design Standards to Minimize the Intrusive Character of Proposed Facilities

Water supply system facilities can be economically and efficiently designed using buildings and landscaping that are of an industrial character; however, many of the communities in the service area still have the special characteristics of traditional Palestinian villages. These characteristics must be protected from introducing exotic designs. Therefore, design standards should be adopted to complement the local setting, rather than detract from it.

(c) Adoption of Design Standards to Minimize Noise in Residential Areas

During construction, noise in residential areas will be unavoidable, but it can be minimized through scheduling. Construction of facilities in residential areas should not be undertaken from sundown to sunrise.

Some of the facilities associated with water systems (e.g., pumps and generators) can cause irritating noise for nearby residents. These facilities should be located as far from residential areas as possible. Where facility noise may adversely impact nearby residents, noise attenuation systems should be required, as appropriate to the setting of the specific facility.

(d) Development of a Construction Control Program to Avoid Undue Disruption of Access and Services

The installation of the water pipelines may entail major construction in close proximity to homes and businesses, raising the potential that abutters to the system could be unduly inconvenienced for a prolonged length of time. There will undoubtedly be some short term inconvenience and traffic disruption. To avoid undue inconvenience, the construction program should include the following:

Contract provisions that detail the sequence for construction of pipelines, such that local inconvenience is avoided to the maximum extent feasible.

Contract provisions that specify the method of construction in certain highly congested areas which will minimize disruption of access, such as trench-to-truck construction and provision of road plates to provide access over trenches.

Contract provisions that require the contractor to secure approval of construction staging and lay down areas.

(e) *Development of a Construction Control Program to Avoid Undue Destruction of Cesspits*

The installation of the water supply system facilities, especially pipelines, may entail destruction of cesspits constructed within private land and in the rights-of-way of the roads. To avoid negative consequences, the construction program should include the following:

Residents should be notified to empty their cesspits prior to construction in the vicinity of these cesspits.

The contract should have provisions for reconstruction of destroyed cesspits after project completion and provision of alternative disposal methods during construction, such as connecting to nearby cesspits, provision of mobile wastewater storage tanks, or provision of portable latrines.

(f) *Adoption of Design Standards to Minimize Soil Erosion and Destruction of Vegetation*

Construction of pipelines, water supply facilities, and associated access roads, will disturb surface soil and vegetation and create the potential for soil erosion. To avoid excessive soil erosion, facility designs should provide for adequate runoff and drainage control during and following construction. Design standards should be adopted which:

Require the contractor to replace domestic and agricultural vegetation destroyed during construction.

Require the contractor to restore trench surfaces to a condition at least equal to that existing before work began.

Require that any road construction use best standard engineering practices to control drainage and runoff and prevent erosion.

(g) *Avoid Groundwater Overdraft*

Water resources should be managed so that withdrawals do not result in overdraft of available groundwater sources. The facility master plan relies on the current available information on the safe yield of the Northeastern and Western aquifers and on data available on the current extraction rates. However, developing groundwater models for these aquifers is essential to fully understand their hydrogeologic characteristics and yield potentials. Mitigation of overdraft is proposed via water exchange, development of a

groundwater monitoring program, and development of groundwater models for the Northeastern and Western aquifers. These measures are detailed in the monitoring section of this EA, Chapter 5.

(h) *Adoption of Design Standards to Prevent Releases of Chlorine Gas and Minimize Potential Impacts*

Chlorine gas is a poisonous gas. It will be used to chlorinate water at the wellheads before it enters the transmission mains. To prevent potentially serious threats to human health, design standards should be adopted which require that:

Chlorine gas systems operate under vacuum to prevent gas leakage.

Chlorinators be constructed entirely of materials resistant to the corrosive attack of chlorine gas.

Chlorine gas leak detectors with automatic alarm systems be installed inside the chlorination facilities.

(I) *Adoption of Design Standards to Prevent or Contain Fuel Releases at Well Sites and Pump Stations*

Many of the well sites and pump stations proposed for this project will require power from diesel generators. On-site storage tanks for diesel fuel should be fully contained.

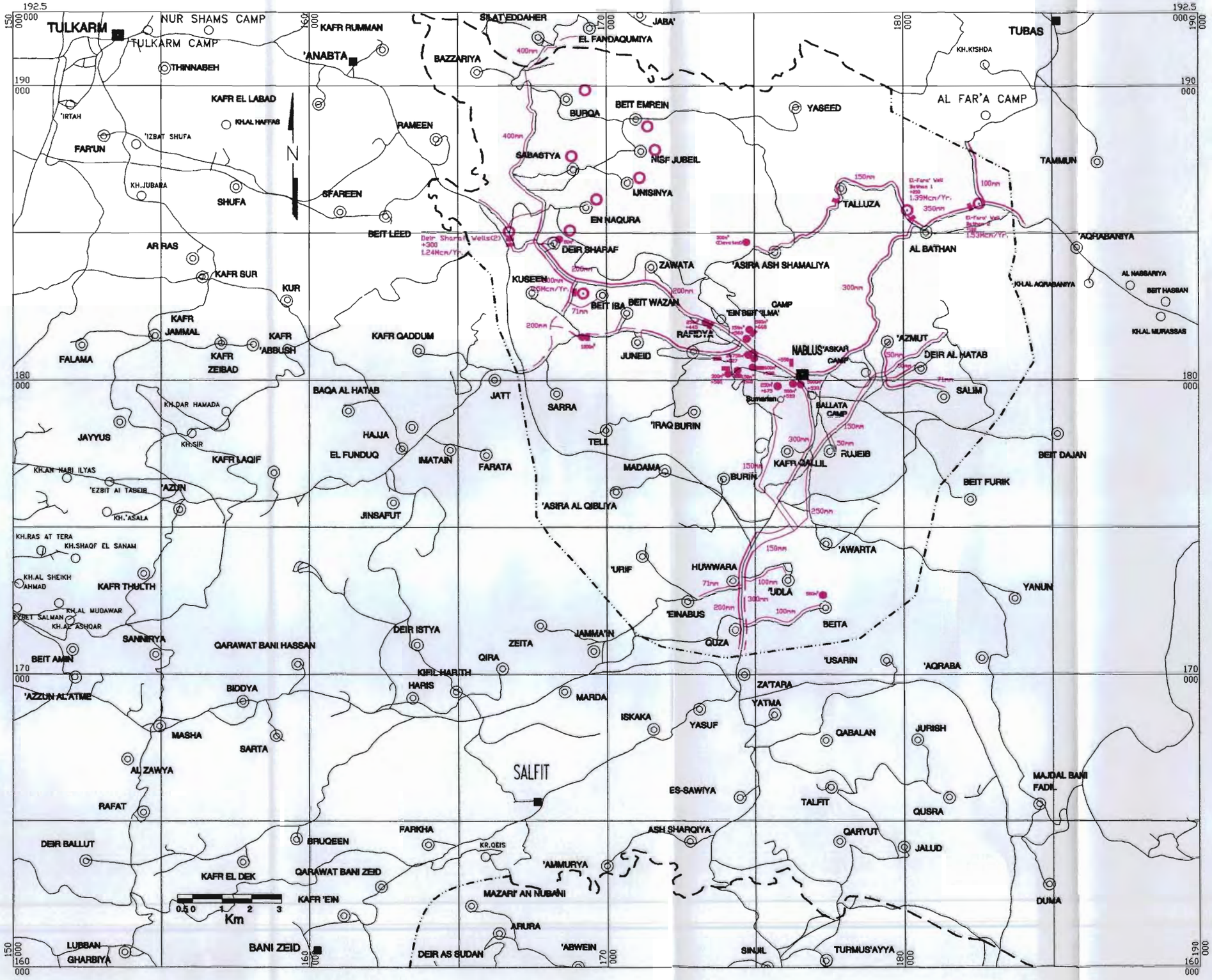
(j) *Shallow Groundwater Impact Assessment*

The potential for implementation of the facility master plan to increase the contamination of shallow groundwater is a major but complex issue. There is general consensus that significant increases in the volume of water available for use will result in increased wastewater streams. There is also consensus that in the long-term, in the Nablus area, the answer to shallow groundwater contamination is the construction and operation of functioning wastewater treatment plants. There is no consensus, however, about the nature, distribution, magnitude and consequences of the impact -- if any -- that implementation of the plan may have.

For this reason, the quality of shallow groundwater should be monitored for fecal contamination and nitrates, to identify and respond to impacts from wastewater contamination.

2.7.2 Mitigation Measures Implementation Responsibilities

The mitigation measures in this EA have been designed to prevent significant impacts. For them to be effective, they must be implemented. For the facility master plan activities, PWA shall be responsible for implementation, although it may share the responsibility with donor agencies and their contractors.



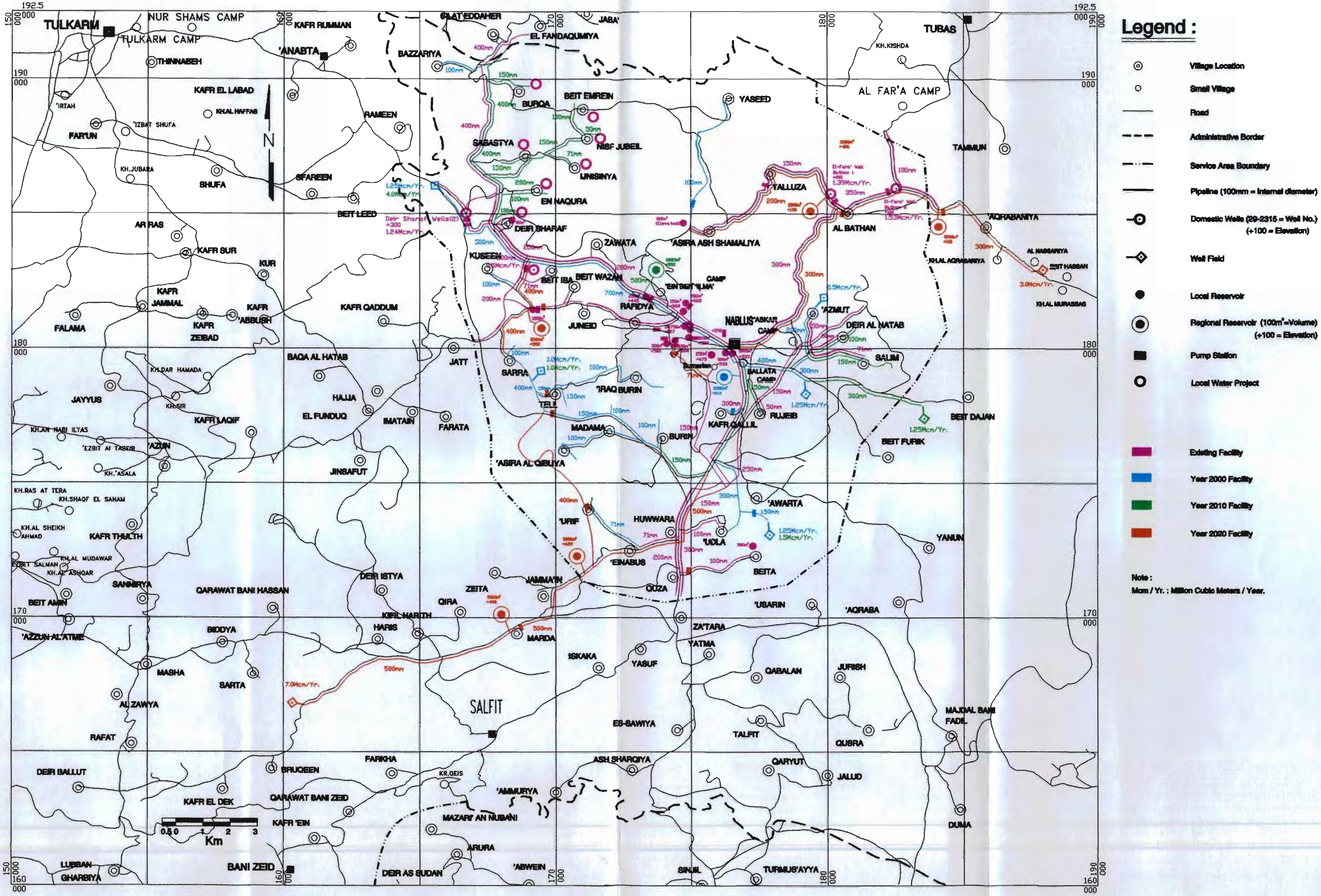
Legend :

- Village Location
- Small Village
- Road
- Administrative Border
- Service Area Boundary
- Pipeline (100mm = Internal diameter)
- Domestic Wells (29-2315 = Well No.) (+100 = Elevation)
- Well Field
- Local Reservoir
- Regional Reservoir (100m³=Volume) (+100 = Elevation)
- Pump Station
- Local Water Project
- Existing Facility

Note :
Mcm / Yr. : Million Cubic Meters / Year.

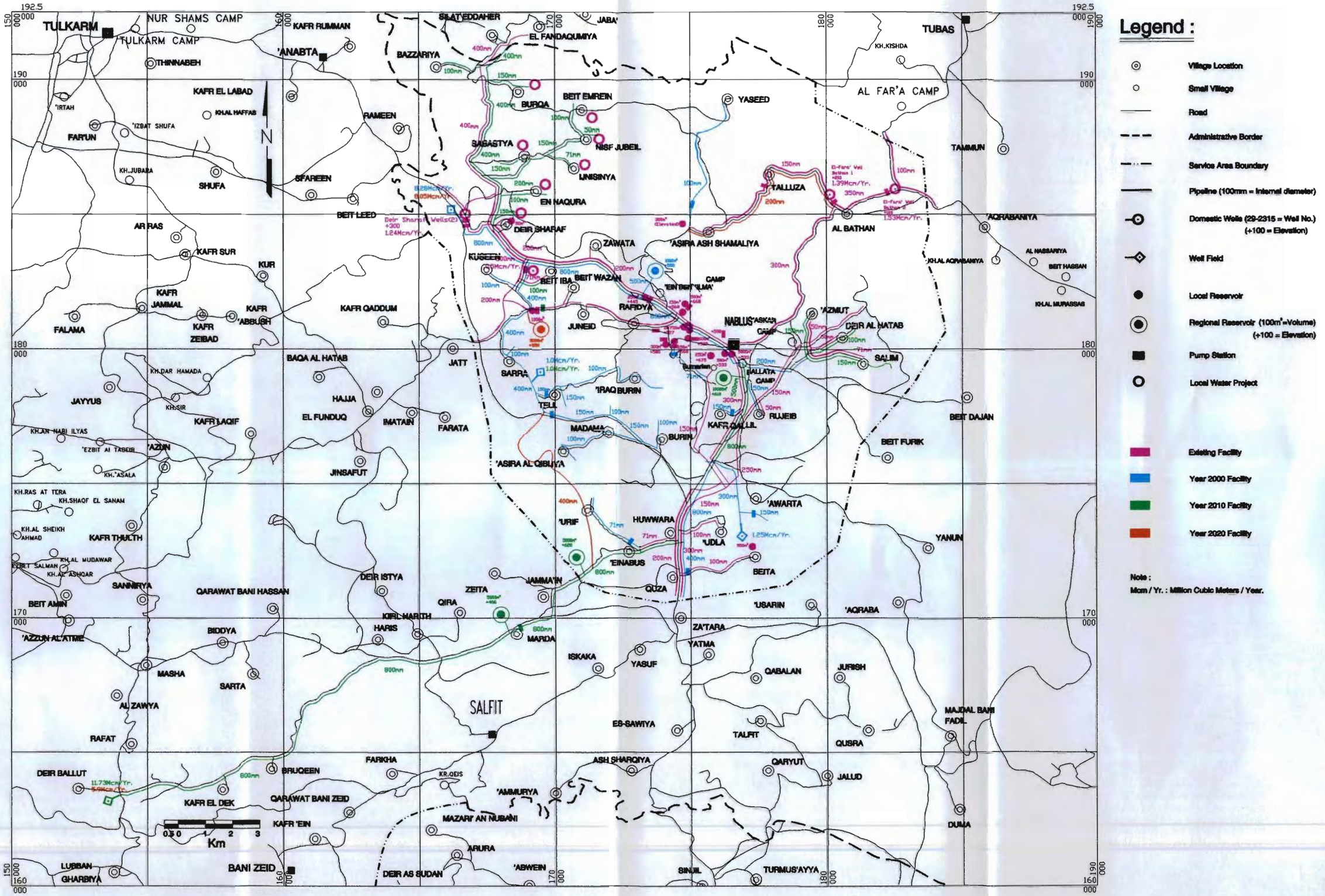
CDM/Morganti

Figure 2-1
Existing Water Supply in the Nablus Service Area



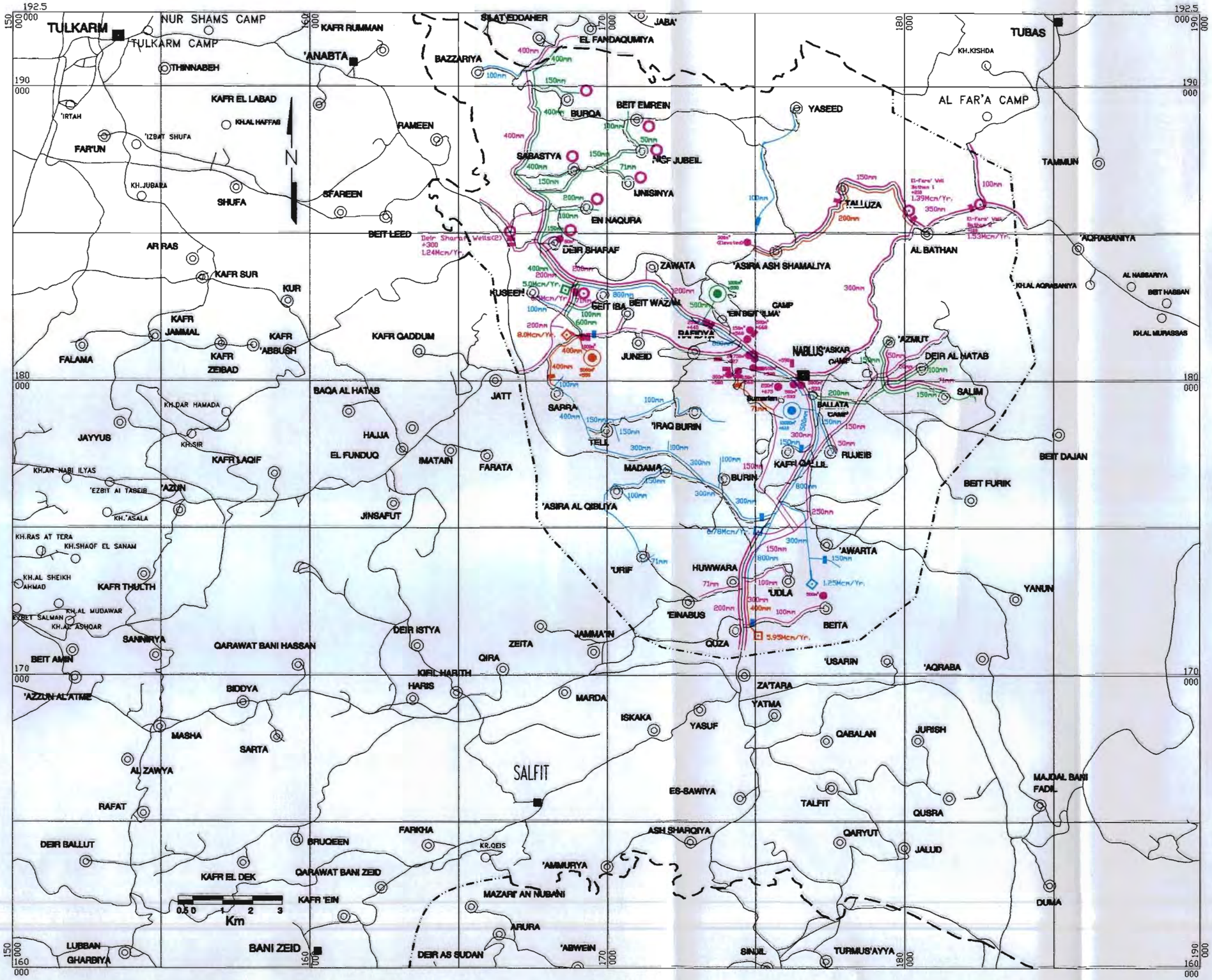
CDM/Morganti

Figure 2-2
Alternative 1 Water Supply Facilities



CDM/Morganti

Figure 2-3
Alternative 2 Water Supply Facilities



Legend :

- Village Location
- Small Village
- Road
- Administrative Border
- Service Area Boundary
- Pipeline (100mm = Internal diameter)
- Domestic Wells (29-2315 = Well No.) (+100 = Elevation)
- Well Field
- Local Reservoir
- Regional Reservoir (100m³=Volume) (+100 = Elevation)
- Pump Station
- Local Water Project
- Existing Facility
- Year 2000 Facility
- Year 2010 Facility
- Year 2020 Facility

Note :
Mcm / Yr. : Million Cubic Meters / Year.

CDM/Morganti

Figure 2-4
Alternative 3 Water Supply Facilities

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3. AFFECTED ENVIRONMENT

The description of the affected environment is based on field surveys, discussions with municipal personnel and consultants working on other projects in the same area, and literature reviews. The principal supplier of information was the Applied Research Institute (ARIJ) in Bethlehem. ARIJ has recently published an Environmental Profile for the Nablus District.[5]

3.1 PHYSICAL AND NATURAL ENVIRONMENT

3.1.1 Geography

The Nablus service area covers 265 square kilometers in the north central portion of the Nablus District (17 percent of the total land area of the district). Nablus District is located in the northern part of the West Bank. It is bounded by Jenin and Israel from the north, Tulkarm and Israel from the west, Ramallah and Jericho from the south, and the Jordan River from the east. The service area, however, does not extend into the Jordan River Valley or to the borders with Israel and Ramallah.

The Nablus service area straddles the watershed divide between the eastern slopes and western slopes. The eastern slopes are steep and drain to the Jordan River. The western slopes are more gentle than the eastern slopes, and drain to the Mediterranean Sea. Elevation within the service area ranges from 300 to 900 meters above mean seal level.

3.1.2 Climate

The Nablus service area is characterized by its hot, dry summers and moderate, rainy winters. The prevailing wind is southwest in winter and northwest in summer. This area experiences the Khamaseen desert conditions during late spring. January is the coldest month with an average maximum temperature of 13 °C and an average minimum temperature of 6 °C. August is the hottest month with an average maximum temperature of 29 °C and an average minimum temperature of 20 °C.

The mean annual relative humidity of the Nablus area is 62 percent. Evaporation rates are particularly high in summer and can reach 238 mm/month in July, while in winter it reaches only 49 mm/month in December. The rainy season begins in October and ends in May. The annual mean rainfall is 664 mm, most of which occurs between December and March.

3.1.3 Soil and Geology

The geologic formations in the Nablus District are described briefly as follows:

1. Jurassic Rocks: Exposed in wadi Maleh, and composed mainly of limestone. Jurassic rocks are divided into Lower Maleh formation and Upper Maleh Formation.

[5] ARIJ 1996

2. Cretaceous Rocks are divided into Ramali Formation, Lower Beit Kahil Formation, Upper Beit Kahil Formation, Yatta Formation, Hebron Formation, Bethlehem Formation, and Jerusalem Formation.
3. Rocks of the Cretaceous-Tertiary Transition Chalk with Chert
4. Tertiary Rocks consisting of the Jenin subseries and Bayda Formation.
5. Quaternary rocks which are divided into Lisan formation, Alluvium, Nari formation, and Igneous rocks

The major soil associations found in Nablus District are illustrated in Table 3.1. The most common soils in the service area are the terra rossas and brown and pale rendzinas.

3.1.4 Water Resources Quality, Quantity, and Systems

The Nablus service area is underlain by the Northeastern Aquifer Basin, but it is also served by groundwater from the Western Aquifer Basin. These basins are composed of two major fresh water aquifers: the upper and lower Cenomanian. They are located in the limestone of the Judean Group of the Cenomanian Stage of the Upper Cretaceous Series. The geologic formations in which the aquifers are located are complex, with significant folding, faulting, and fracturing.

Recharge of the Northeastern and Western aquifers has not been fully studied. Estimates of recharge range from 140 to 200 Mcm/yr for the Northeastern Aquifer and 350 to 360 Mcm/yr for the Western Aquifer.[6] Schedule 7 of Article 40 of the Interim Oslo Peace Accords identifies the Western and Northeastern aquifers as being fully assigned (no water remains for development), with Palestinians withdrawing 22 Mcm/yr from the Western Aquifer and 42 Mcm/yr from the Northeastern Aquifer. The Interim Report of the Comprehensive Master Plan for Water Resources in the West Bank and Gaza Strip,[7] identified slightly different Palestinian groundwater withdrawal amounts than did Article 40 (Table 3.2), indicating that the Palestinians are using 10 Mcm/yr less than Article 40 allocates for the Northeastern Aquifer. This surplus, however, is for the entire Northeastern Aquifer, and must be balanced against the estimated 2 Mcm/yr overdraft in the Western Aquifer identified in the same report.

All but 11 of the 38 communities in the service area are served by piped water systems. The 11 communities without water systems represent 10 percent of the population. They rely primarily upon rainwater collected in cisterns for their domestic water.

There are five spring systems in the service area (Nablus, Sabastya, Far'a, El Badan, and Miska) providing about 2.2 Mcm/yr of water in the piped water systems. These springs are the sole source of water for six communities -- Burqa, Beit Imrin, Nisf Jbeil, Sabastya, Ajansinya, and An-Naqura -- and supplement the supplies to Nablus city and Deir Sharaf.

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[6]Deliverable 4.02

[7]Ibid.

Table 3.1
SOIL TYPES AND CHARACTERISTICS OF THE NABLUS AREA

Soil Association	Area (ha)	Location	Parent Material	Natural Vegetation	Rain-fall (mm)
Grumusols	9,461	Smooth to gently sloping.	Fine textural alluvial or aeolien sediments	Prosopis farcata-Scolymus maculatus	300-700
Terra rossa, brown and pale rendzinas	78,409	Central mountains. Small plateau of the mountains	Dolomite and hard limestone.	Quercus, calliprinos, Pistacia palaestina and Pistacia lentiscus. Pistacia atlantica, Amygdalus korschinski and Pistacia palaestina.	400-700
Brown & pale rendzinas	35,884	Hilly slopes	Soft calk and marl.	Pinus halepensis and Pistacia palaestina.	600-700
		Valleys and depressions	Marl and chalk.	Quercus ithaburensis, Pistacia lentiscus, Ceratonia siliqua and Ballotetalia undulatae.	300-700
Brown lithosols & loessial arid brown soils	5,052	Eastern slopes	Loessial sediments.	Ballotetalia undulatae, Artemisietea herbae-albae.	200-350
Regosols	11,427	Along terrace escarpments in the Jordan Valley	Sands, clays and loess.	Anabasis articulata, Salsola vermiculata and Salsola tetrandra	150-200
Dark Brown soils	5,642	Slope areas	Aeolian sediments, calcareous sandstone and medium-fine textured alluvial.	Prosopis farcata - Scolymus maculatus	350-500
Alluvial Arid Brown soils	3,148	Alluvial fans and plains	Formed as a result of erosion of calcareous silty and clay.	Herbaceous of desert annual halophytes and glycophytes	150-200
Loessial Arid Brown soils	311	Sloping plateau and dissected plateau	Conglomerate and chalk.	Achilleetum santolinae	150-250
Calcareous serozems	4,571	Flood plains	Limestone, chalk and marl.	Salsoletum villase	100-400
Solonchalk	3,148	Drainage valleys and shallow closed basins	Recent alluvial deposits.	Tamarix, Suaeda and Nitraria	50
Pale Rendzinas	325	Jammain, Orif and Sabastya (hilly slopes)	Soft chalk and marl	Pinus halepensis	600-700

Table 3.2
GROUNDWATER WITHDRAWALS FROM WELLS AND SPRINGS IN THE WESTERN AND NORTHEASTERN AQUIFERS

Western Aquifer		Northeastern Aquifer	
Location and Type of Withdrawal	Amount (Mcm)	Location and Type of Withdrawal	Amount (Mcm)
Schedule 7 of Article 40			
Palestinian	22.00	Palestinian	42.00
Israel	340.00	Israel	103.00
TOTAL	362.00	TOTAL	145.00
Comprehensive Master Plan for Water Resources[a]			
Hebron, Agriculture	0.19	Jenin, Municipal and Industrial	2.80
Bethlehem, Agriculture	0.48	Jenin, Agriculture	5.84
Jenin, Municipal and Industrial	0.11	[b]Nablus, Municipal and Industrial	2.28
Tulkarm, Municipal and Industrial	6.40	[b]Nablus, Agriculture	20.98
Tulkarm, Agriculture	16.00	TOTAL	31.90
Ramallah, Municipal and Industrial	0.85		
Ramallah, Agriculture	0.51		
TOTAL	25.54		

[a]Deliverable 4.02, Table 2.8
[b]Entire Nablus District, including areas outside of the service area

Most of the water in the existing systems comes from four wells (Table 3.3), three operated by the Municipality of Nablus and one operated by the West Bank Water Department (WBWD). These wells produce around 4.6 Mcm/yr. The Nablus municipal wells supply the municipality of Nablus and eight surrounding communities. The WBWD well supplies the municipality of Nablus, Beit Iba, Beit Wazan, and Qusin. Water purchased from Mekoroth (1.6 Mcm/yr) supplies the municipality of Nablus and eight other communities. Current average domestic consumption (accounting for other uses and system losses) is estimated at 48 L/c/d.

According to a water quality study conducted by ARIJ, most of the water used for domestic consumption in the Nablus District is of good quality. The Far'a and El Badan spring systems have good water quality in the upstream areas, but downstream at the conjunction of wadi El Far'a and wadi El Badan, the water is mixed with untreated wastewater from the municipality of Nablus, thus subjecting it to pollution.

The Nablus city water system is by far the largest water system in the service area. The system serves almost 100 percent of the city, with a total length of approximately 20 km. The system was constructed in 1930. Rehabilitation of parts of the network started two years ago. Nablus Municipality has 10 storage reservoirs with a total capacity of 9,000 cubic meters.

Table 3.3
MUNICIPAL SUPPLY WELLS IN THE NABLUS SERVICE AREA

Well	Owner	Coordinates	Total Depth (m)	Static Water Level (m)	Aquifer	Capacity (Mcm/yr)
Bethan 1	Nablus Mun.	180.15/185.40	748	189	Northeastern	1.4
Bethan 2	Nablus Mun.	182.75/185.75	413	93	Northeastern	1.5
Deir Sharaf	Nablus Mun.	166.75/184.75	670	206	Western	1.2
Beit Iba	WBWD	169.00/183.00	595	241	Northeastern	0.5
Source: Deliverable 44a.01						

At the present time, a variety of projects are underway or planned within the Nablus service area. The German Technical Assistance (GTZ) has just finished drilling a new well which will add 1.8 Mcm/yr to the Nablus municipal system. They are also constructing a main transmission line from the well to Nablus. Recently, a project funded by USAID and executed by the United Nations Development Programme (UNDP) rehabilitated all the piping and fittings in the old city of Nablus, and installed about 2,500 new water meters. Another recently completed UNDP project in Nablus involved training for leakage detection. Additional training under this project will be conducted in the near future for use of special equipment in tapping pipelines under pressure.

A World Bank project for reconstruction of the Jerusalem Road was recently completed, which also rehabilitated the existing water systems affected by the road construction, including main and branch lines. The UNDP is working on a water supply project in the village of Bazarya, within the Nablus service area, to construct a new source of water for the village, to be supplied from the Mekoroth system. The Palestinian Economic Council for Development and Reconstruction is funding a water supply project in the village of Beitta to provide a local storage reservoir of 500 m^3 for the village system. Austrian assistance may soon become available to prepare water system plans for villages within the Nablus service area.

3.1.5 Wastewater Quantity, Collection, and Treatment

Almost ninety percent of the municipality of Nablus is connected to a sewer system which serves all domestic, industrial, and commercial uses. The sewer is a combined system for both sewage and rainwater except in two newly built areas. This causes floods and contamination of domestic water supply in some areas of the city during rainy days as is the case in the Al-Badan area. There are no wastewater treatment plants connected to the sewers, so untreated wastewater is discharged into two wadis. About 40 percent of the waste is discharged to the west of the city through Wadi Zimar. The remaining 60 percent is discharged to the east through Wadi Sajour. Both wastewater streams are being illegally used for unrestricted irrigation causing threats to public health. Approximately 66 percent of wastewater that flows in the wadis from the sewerage network, in addition to 4.4 percent of the wastewater pumped from the cesspits, is used for irrigation purposes, particularly for growing vegetables.

A recent groundwater quality study of domestic and irrigation wells near Wadi Zimar and downstream from the Nablus wastewater discharge point, revealed chloride and nitrate contamination in several wells. Given the shallow depth to groundwater in the area, the natural groundwater chemistry, and the high transmissivity of the overlying geology, the report concluded that the probable source of the contamination was sewage.[8]

The Nablus sewer serves about 50 percent of the population in the service area. The other communities have no sewers. They depend on other disposal methods including cesspits, septic tanks, and open channels. Open channels are commonly used in refugee camps. Far'a camp is a good example, where the wastewater is collected in two open channels. The wastewater flows toward the southern part of the camp to 'Ein Shibli where it meets the wastewater discharged from Nablus city. At that location, the raw wastewater flows outside the camp boundaries to be used for irrigating various crops. Because the channels are uncovered, overflow of the drains is likely to occur during the rainy season.

Most of the main industries in Nablus district, such as detergents, shoe making, and food processing, are located in Nablus city and the villages. Two communities in the service area (Beit Iba and Deir Sharaf) are suffering from wastewater effluent discharges from the industrial factories adjacent to them.

A major investment project for wastewater treatment and disposal of Nablus sewage has been initiated by the GTZ and funds are expected to be provided by the German government through Kreditanstalt fur Wiederaufbau. A conceptual Master Plan for sewage treatment and disposal is currently under preparation and the project is expected to be completed by the year 2000. The plan calls for the construction of two treatment plants, one located 5 km east of the city and the other located 10 km west of the city. A pilot wastewater treatment plant was constructed by the GTZ and is run by An-Najah University.

3.1.6 Ecological Resources

There is no specific information available on ecological resources for the Nablus service area. The West Bank, however, is characterized by a diversity of wildlife. The number of plant species in the West Bank is estimated at around 2,500. There are estimated to be 470 bird species in 206 genera. There is no comprehensive study on endangered or threatened species in the West Bank. Some endangered or threatened species are mentioned sporadically in the literature, but they have not been officially registered.

A new project, approved for funding by the UNDP, will conduct a comprehensive survey on biodiversity and to prepare a country report describing biodiversity resources. The same project will prepare a national strategy and action plan for the protection of biodiversity resources in the West Bank.

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[8] Aliewi et al. 1997

3.2 THE BUILT ENVIRONMENT

3.2.1 Historical and Archaeological Heritage

Nablus is a Palestinian city located between Mount Gerizim and Mount 'Ibal. It is the site of an ancient city which was continuously occupied from Bronze Age until the present. Nablus city was built by the Canaanites on the remains of a Stone Age city. Its name was derived from the Canaanite word Shekheim, which means a hilly area. Ruins of ancient Shekheim have been found on Tell Balata. Excavations have uncovered remains from the Chalcolithic to Roman periods, including city walls, towers, and temples.

A review of the literature identified 61 archaeological sites in the Nablus service area. Table A.1, in Appendix A, lists all of the known archaeological sites in the service area. Figure A.1 shows the locations of these sites.

3.2.2 Land Use

The Nablus service area occupies only 17 percent of the total district, but 64 percent of the population of the district lives in the service area. The largest city in the service area (and the district) is the municipality of Nablus.

There is no specific information available on land use in the Nablus service area. Although much of the area is municipal, it also contains some of the prime agricultural land in the district. Most of the agricultural land is rainfed, but some areas are irrigated, including the use of wastewater from the Nablus sewer.

3.3 SOCIO-ECONOMIC ENVIRONMENT

3.3.1 Economy and Population

The population of the Nablus service area in 1996 was estimated at 185,209 and it is expected to increase to 258,292, 330,635, and 423,240 in 2000, 2010, and 2020, respectively. Most of the economic assets of the West Bank are concentrated in Nablus city. What distinguishes Nablus city from other Palestinian cities is the type of land ownership. In Nablus, many families hold large tracts of land, while land is fragmented into small lots in the other cities. Major industrial activities in Nablus District include aggregate quarrying, stone and marble cutting, and a wide range of manufacturing and processing industries. Processing and manufacturing industries include food products, clothing, leather products, furniture, printing, workshop fabrication, mixed concrete, terrazzo tiles, and cement blocks. These industries are found in Nablus municipal industrial zones.

The unemployment rate in Nablus District for 1994 was approximately 23 percent. Due to the Israeli closures of the West Bank and the limited opportunities for employment in the West Bank, unemployment has increased significantly in recent years. Approximately 60 percent of the employed persons have permanent jobs, 20 percent have seasonal jobs, and 20 percent have part-time jobs.

3.3.2 Public Health

Health care services are provided by the Palestinian Ministry of Health, the United Nations Relief and Works Agency (primarily to refugees), nongovernmental organizations, and private entrepreneurs. Primary health care in the area is operated by public health offices. These offices supervise and are responsible for preventive health services in urban and rural areas. There are 53 primary health care clinics, four hospitals, and four rehabilitation centers in the Nablus District. The district possesses the highest number per capita of medical and health care professionals in the West Bank.

4. ENVIRONMENTAL CONSEQUENCES

This section presents the environmental consequences associated with no action, the proposed action, and the alternatives for the facility master plan. The assessment of consequences is based on the significant issues and their associated criteria.

Assessing the environmental impacts of the facility master plan is not as straight forward as assessing the impacts of a proposed action where exact locations and activities are well defined. Most of the proposed facilities will not be constructed for many years. The exact locations of these facilities are not known, making site specific determinations of impact impossible. Therefore, most of the following assessment is necessarily general, particularly in assessing the impacts of the proposed facilities for the year 2020.

4.1 NO ACTION

The greatest impact of no action is on the hygiene of current users of the water system. Current average domestic consumption in the service area is 48 L/c/d. Even with the additional 1.8 Mcm/yr from the new well, average domestic consumption is expected to decline to 38 L/c/d by the year 2000, because population growth. This consumption level is well below the WHO recommendation of 100 L/c/d for piped water connections.[9] The lack of adequate water means that there is insufficient water for sanitation needs, which poses risks to public health.

Because no action involves no development of new water supply facilities, it will not increase wastewater generation. However, because of the low water consumption rates in the Nablus service area, wastewater collection pipelines, where they exist, suffer frequent blockage and flooding causing maintenance problems and public health hazards.

No action will not impact the sustainable use of groundwater resources. The only new water supply in the no action alternative is the new well in the Northeastern Aquifer, which according the **CDM/Morganti** analysis has some water available for development.[10]

The no action alternative will not induce planned or unplanned development, therefore it will not impose a stress on the available water resources, increase demand on power generation, or cause other environmental impacts associated with development. By the same token, no action will not impose any impacts on land use and availability, cause destruction of archaeological sites, or increase power demand.

4.2 PROPOSED ACTION

The proposed facility master plan will provide an average of 75 L/c/d to the residents of the area in the year 2000, 126 L/c/d in 2010, and 158 L/c/d by 2020. This is a significant increase over the amount of domestic water supplied under the no action alternative, and, except in the year 2000, is higher than the WHO minimum. The provision of more water will improve hygiene and public health in the area.

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[9]WHO, 1993

[10]Deliverable 4.02

Providing more water will generate more wastewater. It is estimated that 80 percent of water delivered to the tap will become wastewater. Current wastewater flows are estimated at 4.9 Mcm/yr, with 50 percent being discharged into sewers and 50 percent being discharged into cesspits or septic tanks. By the year 2000 wastewater flows will increase by around 57 percent to 7.7 Mcm/yr, with a similar division between sewers and cesspits. If the proposed action is implemented, wastewater flows will increase to 15.6 Mcm/yr by the year 2010, and they could reach 25 Mcm/yr by the 2020.

The impact of increased wastewater flows will depend upon the type and condition of wastewater collection and treatment. Wastewater from the Nablus city sewer system is already suspected of contaminating groundwater. It is also used for irrigation, which poses public health problems. If the current GTZ program is fully implemented, the potential for contamination from the Nablus sewers should be eliminated, or greatly reduced. It would also greatly reduce the potential health problems associated with current reuse of the wastewater.

Even with construction of the wastewater treatment plants, 50 percent of the wastewater generated in the service area will still be discharged to cesspits or septic tanks. Increased flows into cesspits and septic tanks will either increase seepage into the underlying aquifer, cause increased surface seepage, or cause increased cesspit and septic tank pumping. Wastewater pumped from cesspits and septic tanks are often disposed of in nearby wadis, creating the potential for direct human contact and groundwater contamination. These potential problems can only be addressed by improved cesspit and septic tank design and management or by regional wastewater planning.

Table 4.1 presents current and projected Palestinian groundwater withdrawals and Article 40 assignments for the portions of the three aquifers which underlie the West Bank. As the table indicates, implementation of the proposed action will contribute to overdraft of the Western and Northeastern aquifers beginning in the year 2000.

The overdraft can be avoided by implementing a regional exchange scheme whereby desalinated seawater or imported water is introduced into the Israeli national system, which is thereby enabled to supply water to communities currently dependent upon groundwater. This would reduce the pressure on the aquifers and free up water for use by the Palestinians. The unit cost of delivering desalinated seawater or imported water to the proposed Nablus water system would be higher than delivery to the Israeli water system.[11] It would be most economically efficient, therefore, to exchange desalinated seawater or imported water to be used in the Israeli system for groundwater to be used in the proposed Nablus water system.

Current estimates of groundwater recharge and withdrawals are based on limited information. To improve this situation and enable better groundwater management, the groundwater monitoring program described in section 5.1.2 of this EA should be implemented.

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[11]The Israeli communities dependent upon the and Western Aquifer and the transmission system which serves them are generally nearer to the sea, both in elevation and linear distance, than the Palestinian communities and the proposed Nablus transmission system.

Table 4.1
PROJECTED GROUNDWATER SURPLUSES OR SHORTAGES FOR THE WEST BANK AQUIFER SYSTEMS

Type of Withdrawal	Current Withdrawals[a]	Withdrawal Projections[b]		
		2000	2010	2020
Eastern Aquifer System				
Municipal and Industrial				
Hebron-Bethlehem	12.40	37.00	49.00	49.00
Nablus, Other	3.00	0.00	0.00	0.00
Ramallah, FMP Service Area	2.60	5.50	5.50	5.50
Jericho	1.10	2.47	4.37	6.27
Agriculture	41.89	41.89	41.89	41.89
Total Palestinian	*60.99*	*86.86*	*100.76*	*102.66*
Article 40 Interim Assignment				
Palestinian	54.00			
Israeli	40.00	40.00	40.00	40.00
To be developed	78.00			
Total	172.00	172.00	172.00	172.00
Surplus or (Deficit) Without Exchange[c]	**71.01**	**45.14**	**31.24**	**29.34**
Surplus or (Deficit) With Exchange[d]	**111.01**	**85.14**	**71.24**	**69.34**
Western Aquifer System				
Municipal and Industrial				
Hebron-Bethlehem	0.00	0.00	16.00	40.00
Jenin	0.11	0.00	8.30	21.80
Tulkarm	6.40	15.32	27.46	39.60
Nablus, FMP Service Area	0.00	3.20	17.55	31.45
Nablus, Other	0.00	9.02	15.62	23.46
Ramallah, FMP Service Area	0.85	0.00	19.40	37.00
Ramallah, Other	0.00	6.14	10.64	16.00
Agriculture	17.18	17.18	17.18	17.18
Total Palestinian	*24.54*	*50.86*	*132.15*	*226.49*
Article 40 Interim Assignment				
Palestinian	22.00			
Israeli	340.00	340.00	340.00	340.00
Total	362.00	362.00	362.00	362.00
Surplus or (Deficit) Without Exchange[c]	**(2.54)**	**(28.86)**	**(110.15)**	**(204.49)**
Surplus or (Deficit) With Exchange[d]	**337.46**	**311.14**	**229.85**	**135.51**
Northeastern Aquifer System				
Municipal and Industrial				
Jenin	2.80	14.50	17.00	19.00
Nablus, FMP Service Area	2.28	8.05	8.05	8.05
Agriculture	26.82	26.82	26.82	26.82
Total Palestinian	*31.90*	*49.37*	*51.87*	*53.87*
Article 40 Interim Assignment				
Palestinian	42.00			
Israeli	103.00	103.00	103.00	103.00
Total	145.00	145.00	145.00	145.00
Surplus or (Deficit) Without Exchange[c]	**10.10**	**(7.37)**	**(9.87)**	**(11.87)**
Surplus or (Deficit) With Exchange[d]	**113.10**	**95.63**	**93.13**	**91.13**

Type of Withdrawal	Current Withdrawals[a]	Withdrawal Projections[b]		
		2000	2010	2020
Total				
Palestinian Use	*117.43*	*187.09*	*284.78*	*383.02*
Article 40 Interim Assignment				
Palestinian	118.00			
Israeli	483.00	483.00	483.00	483.00
To be developed	78.00			
Total	679.00	679.00	679.00	679.00
Surplus or (Deficit) Without Exchange[c]	**78.57**	**8.91**	**(88.78)**	**(187.02)**
Surplus or (Deficit) With Exchange[d]	**561.57**	**491.91**	**394.22**	**295.98**

[a]From Deliverable 4.02, Table 2.8.

[b]Projection Assumptions:

Municipal and Industrial withdrawals for Bethlehem, Jenin, and the Nablus and Ramallah Facility Master Plan (FMP) Service Areas are from the facility master plans (Deliverables 25.02, 34.02, 44a.01, and 44b.01).

Municipal and Industrial withdrawals for Tulkarm and Jericho are from Deliverable 4.02.

Municipal and Industrial withdrawals for Nablus Other and Ramallah Other are extrapolations for the portions of the districts outside the FMP service areas using information from Deliverable 4.02 and assuming that future demand will be met with water from the Western Aquifer.

For this analysis, agricultural withdrawals and the Article 40 assignments are assumed to remain constant at existing levels.

[c]Total Assignment - Israeli Assignment - Palestinian Use. These are not necessarily physical surpluses or deficits, but merely represent comparisons between estimated uses and Article 40 assignments.

[d]Total Assignment - Palestinian Use. This is a check of whether the Palestinian demands exceed West Bank groundwater availability, indicating whether an exchange scheme is feasible.

Because of the rich history in the Nablus area, the potential exists for destruction of archaeological resources during construction of water facilities. The exact location of future facilities is not known, therefore, field examinations have not been conducted. To protect archaeological resources and mitigate any potential impacts, the Archaeological Resource Protection Program, described in section 2.7 of this EA, should be implemented.

Implementation of the facility master plan will provide more water to the area, which in turn will stimulate and sustain increased development. Increased development will improve the economic well being of the area residents, but it may also cause urban pollution, including air pollution, water pollution, solid waste disposal, and urban sprawl onto agricultural lands. These problems can be prevented or mitigated through urban planning and the development of environmental protection programs. The Palestinian Authority is striving to meet these needs, and should be encouraged and supported in their efforts.

Because the exact location of proposed future facilities is not known, the exact impacts on land use and acquisition cannot be assessed. During the construction of wells, pump station, storage tanks, and transmission mains, the proposed action will disturb around 17 hectares of land in the year 2000, around 23 hectares in 2010, and about 12 hectares in 2020. Almost 70 percent of the total disturbed area over the life of the project will be for pipelines within existing road rights-of-way, which should have no impact on land acquisition, and little or no impact on land use. The remaining area required for facilities is small compared to the total area of the service area, so the land use impacts are likely to be insignificant. Any land acquisition, however, should be accompanied by just and fair compensation for land owners.

Energy requirements for the proposed action are relatively modest. Energy will be required to operate four wells and three pump stations in the year 2000, an additional nine wells and seven

pump stations in 2010, and an additional seven wells in 2020. This energy most likely will be provided by on-site diesel generators. Even if the power comes from the power grid, the amount of energy required by implementation of the facility master plan will be small compared to that required for future domestic and industrial needs. One potential problem associated with diesel generators is fuel leaks. The design standards to prevent or contain fuel releases at well sites and pump stations (described in section 2.7 of this EA) should be implemented to mitigate this potential impact.

4.3 ALTERNATIVE 1

Alternative 1 will have virtually the same environmental impacts as the proposed activity, except in the areas of groundwater sustainability, public health and land use. This alternative calls for meeting some of the demand in the year 2020 by exchanging 3 Mcm/yr of treated wastewater for fresh water from existing springs currently used for irrigation, and by reusing 4 Mcm/yr of treated wastewater for commercial and industrial uses. To deliver this water to the users, the plan calls for 30 kilometers of pipelines and three pump stations.

Implementation of the facility master plan will generate enough wastewater to meet the reuse needs of alternative in the year 2020. Reuse of this wastewater will lessen the potential impacts on the aquifer systems, particularly if an exchange scheme is not implemented. Reuse of wastewater, however, is dependent upon development of wastewater treatment systems and conveyances to deliver the treated wastewater to irrigators or other users. If the new wastewater treatment plants are built for the municipality of Nablus, then reuse in agriculture will be a possibility, if conveyance systems are constructed. Reuse for commercial and industrial uses will require additional tertiary treatment, as well as construction of conveyance systems.

Wastewater reuse increases the potential for human health problems through contact with the water or through consumption of the crops grown with the water. Wastewater quality standards should be developed and implemented to mitigate these problems. Guidelines should also be developed for proper use of treated wastewater, depending on its quality, the potential for human contact, and for agricultural reuse, the type of crop grown.

Construction of the wastewater treatment and conveyance facilities will increase the amount of land which will be disturbed by this alternative, which will create the potential for more land use conflicts than the proposed action. Implementation of the alternative will also require strong institutional capabilities to prohibit illegal water or sewer connections to the conveyance lines.

4.4 ALTERNATIVE 2

The concept of Alternative 2 is to depend on the Western Aquifer and to stop water purchase from Mekoroth beginning in the year 2000. Therefore, impacts on the sustainability of groundwater resources under Alternative 2 will be higher in the short term, but only in one aquifer, the Western Aquifer. Otherwise, the impacts of this alternative are similar to those of the proposed action.

4.5 ALTERNATIVE 3

Alternative 3 has the same environmental impacts as the proposed action, except that it avoids any potential impacts on groundwater resources beginning in the year 2020. This alternative

relies upon water supplies from Mekoroth until a major multi-national project can be brought on line in 2020. By the year 2020, any potential impact on groundwater resources will therefore be eliminated. Prior to 2020, however, the water provided by Mekoroth will most likely come from the Western Aquifer, and alternative 3 will have the same groundwater impacts as the proposed alternative.

4.6 SUMMARY

Although it is impossible to fully quantify the potential impacts of the facility master plan or to even adequately describe them qualitatively, if the mitigation measures presented in section 2.7 of this EA are implemented at the time of design and construction, the facilities should cause no significant impacts on the environment. The greatest potential impacts are associated with increasing wastewater flows. These impacts will need to be addressed in the future through wastewater management. The other potential impact of most concern is unsustainable use of the groundwater resource. This issue can only be addressed with development and implementation of a regional water exchange scheme involving all of the parties currently using the three aquifers under the West Bank. The regional scheme should include economically efficient exchanges of desalinated seawater for groundwater. A regional solution, in combination with implementation of the groundwater monitoring program proposed in the EA, should eliminate the potential for overdraft of the aquifer.

5. MONITORING PLANS

Implementation of the facility master plan will raises a number of issues that are important to the successful functioning of these systems including the long-term adequacy of local water supply sources and adequate control and treatment of wastewater. These issues will have to be addressed in the basic design of the system, however, they warrant special monitoring programs to assure that they do not compromise the water supply systems. Monitoring is also necessary to ensure implementation of mitigation measures.

The purposes of the monitoring programs are to provide continual feedback on the design, construction and operation of the system, and to suggest strategies for dealing with issues of concern where warranted. These plans complement the standard operating practices of the PWA by integrating concerns unique to the Nablus area into routine operations. The plans supplement the basic design of the systems, and are intended to address conditions which cannot be fully understood at present, or which may arise in the future.

The areas of specific focus for the monitoring programs are as follows:

- The development of a water resource monitoring plan, focused on the relationship of local demand for water and local sources of supply.
- The development of a domestic water quality monitoring program to ensure that the water systems are not contaminated by wastewater.
- The development of a monitoring program that ensures the implementation of the proposed mitigation measures.

5.1 WATER RESOURCES MONITORING

The project aims to provide sufficient water to meet demands through the year 2020. The increases in the water demands are driven by a combination of increases in serviced population, increased per capita consumption of the serviced population (to raise the quantities of water supplied to the residents of the area to acceptable international standards), and increased usage associated with economic activities. The purpose of this monitoring plan is to consolidate all variables associated with the development of future supplies into a single, cohesive plan. The component parts of the plan include monitoring changes in demand patterns and monitoring resource sustainability.

5.1.1 Monitoring Changes in Demand Patterns

Future demand forecasts are predicated on increases in demand patterns for various sectors of the economy and decreases in leakage and unaccounted for losses. The purpose of monitoring demand patterns is to compare actual changes in demand to forecasts so that adjustments can be made to projections. The monitoring program will track demand patterns over time by producing a report that accounts for the total use of water by component, using pumping records, meter readings, and other available data. Trends should be tracked by component, to account for total usage, and at selected domestic accounts to monitor changes in per capita usage patterns. An example of a form that can be used to record the information is presented in Table 5.1. This form should be produced on a quarterly basis, to provide constant feedback on system operations, and

to develop data that provides information on quarterly consumption patterns. In filling the form out, it will be necessary to estimate certain factors, such as the population connected to the system, in order to compute factors comparable to those used in design.

Table 5.1
WATER USE RECORD OF INFORMATION

Summary Report on Water Uses for the Period __ to __				
	Number of Accounts	**Total Usage**	**Average Usage[1]**	**Design Usage**
Metered Uses				
Domestic				
Actual				
Estimated				
Commercial				
Actual				
Estimated				
Industrial				
Actual				
Estimated				
Agricultural				
Actual				
Estimated				
Total Metered				
Unmetered Uses				
Flushing				
Hydrant				
Other				
Total Unmetered				
Total Accounted				
Total Pumpage				
Estimated Losses				
Notes: 1. Per capita usage based on xx people served per meter.				

On an ongoing basis the data contained in the forms can be plotted and used to guide management decisions. The following are a few examples of how the data could be used to respond to system changes and enhance operational effectiveness:

If the percentage of pumpage attributed to leakage and unaccounted for losses does not decline over time, this indicates a need for either additional sources of supply beyond those included in the plan, or the institution of an aggressive leak detection and repair program, or improved metering.

If the per capita usage of the domestic sector does not increase at the rate projected, then it may be possible to reallocate planned domestic demand to other sectors or reduce source development.

If overall demand is not increasing as projected, it may be possible to slow development of new sources.

5.1.2 Monitoring Groundwater Quantity and Quality

The master plan calls for providing an increase of 33.3 Mcm/yr of water by the year 2020. The planned sources of this water -- the Western and Northeastern Aquifers -- are currently at or near safe yield.[12] The estimate of safe yield for these aquifers, however, is based on limited information. The actual safe yield may be greater or lesser than the current estimate. PWA should implement a groundwater modeling and monitoring program for the Western and Northeastern Aquifers. The program should be based on the modeling and monitoring plan being developed by **CDM/Morganti** for the Eastern Aquifer.[13]

The purposes of the groundwater monitoring program should be to monitor groundwater levels, to determine the effect of pumping on the aquifers, to identify new areas for potential well field development, to provide data for modeling safe yield, and to monitor water quality in the aquifer. The PWA should identify wells in the aquifer which can be used as monitoring wells. At each well samples of abstraction, water table, and water quality should be taken. Abstraction and water table measurements should be taken monthly. The type and interval for water quality measurements are presented in Table 5.2.

The data collected in the monitoring plan should be screened, processed, and analyzed using the United Nations Groundwater for Windows package, which is currently used by PWA. The results should be disseminated in the form of bulletins and reports to interested agencies. The results should also be used, along with abstraction and water table data from other wells, to model safe yield. The PWA should be able to draw upon the work being done by **CDM/Morganti** in development of the Eastern Aquifer Groundwater Models to assist it in modeling the Western and Northeastern Aquifers. The results from the model should be used by PWA to update the master plan.

Since the Israelis as well as the Palestinians are using these aquifers, data from both sides must be included in the model. The JWC should oversee that required measures are taken for the joint monitoring of the aquifer.

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[12]Deliverable 4.02.

[13]Deliverables 20.01 and 20.02.

Table 5.2
WATER QUALITY SAMPLING AT GROUNDWATER MONITORING WELLS

Quarterly Field Measurements		
Electrical Conductivity Temperature pH	Odor Color	Redox Potential Dissolved Oxygen
Quarterly Laboratory Parameters and Major Ions		
pH Electrical Conductivity Total Hardness Total Dissolved Solids Alkalinity	Sodium Potassium Calcium Magnesium Bicarbonate Carbonate	Sulphate Chloride Nitrate Nitrite Ammonia Phosphate
Semiannual Biological Analyses		
Fecal Coliform	Total Coliform	

5.2 DOMESTIC WATER QUALITY MONITORING

The improper release of treated wastewater to the environment, either through agricultural reuse, malfunctioning cesspits, or planned or incidental discharge to a wadi, could raise public health concerns. Although the wastewater systems are not part of this project, they will have an impact on the proposed water supplies. The facility master plan has been developed with this concern in mind, by incorporating the possible increase in wastewater flows, the possible destruction of cesspits, and the improper disposal of wastewater.

The continued effectiveness of the water supply systems is, however, dependant on the provision of potable water. This will require an ongoing program of sampling and analysis of water supplies to assure that the system is not affected by the wastewater flows. This will entail:

The use of chemical and biological analyses, at the tap as well as at production wells, to ensure that the quality of the water supplies has not been contaminated by wastewater flows. The parameters should include odor, nitrate, fecal coliform, and total coliform.

The posting of signs and routine patrolling of the area adjacent to the water supply facilities to ensure that wastewater is not being dumped in areas that could lead to groundwater contamination.

Working with other parties and donor agencies to ensure that wastewater collection, treatment, and disposal receive proper attention and have high priority.

5.3 MONITORING IMPLEMENTATION OF MITIGATION MEASURES

Many of the potential impacts of the proposed action are considered to be insignificant because of mitigation. It is therefore imperative that the mitigation measures be implemented. To this end, all mitigation measures in the EA should become contractual obligations of project implementation. The PWA should incorporate the proposed mitigation measures into the

contract documents and specifications and should also inspect construction sites to ensure that the mitigation measures are implemented as it begins to implement the facility master plan.

5.4 SUMMARY OF MONITORING RESPONSIBILITIES

The responsibilities for implementing the monitoring programs are summarized in Table 5.3. This EA has proposed mitigation measures and monitoring programs which should ensure that the proposed actions will not significantly impact the environment. It has also identified responsibilities for their implementation.

To facilitate the implementation of these mitigation measures and monitoring plans USAID should work with other donor agencies and institutions to strengthen the capacity of PWA to establish a continuous monitoring system. In addition, other institutions responsible for the protection of the environment (e.g., Directorate of the Environment of the Ministry of Planning) must be given responsibilities and capacity to monitor the environmental impacts of the project once it is in operation.

Table 5.3
SUMMARY OF THE MONITORING PLANS AND RESPONSIBILITIES

Monitoring Program	Facility Master Plan		
	Responsibility	Time Frame	Funds
Water Resources Monitoring			
Changes in Demand Patterns	PWA	Over the life of the resource	PWA in house
Groundwater Quantity and Quality			
Sampling and Analysis	PWA	Over the life of the resource	PWA in house
Aquifer Modeling	PWA	Over the life of the resource	PWA in house
Cooperation between Israelis and Palestinians in monitoring shared aquifers	JWC	Over the life of the resource	JWC in house
Domestic Water Quality			
Sampling and Analysis, Sign Posting and Patrolling	PWA & Local water authorities	Over the life of the resource	PWA in house Local in house
Working With Other Agencies for Construction of Wastewater Systems	PWA	As soon as possible	PWA in house & International Donors
Implementation of Mitigation Measures	PWA	Over the life of the resource	PWA in house & International Donors

6. RESOURCES

6.1 LIST OF PREPARERS

Principal Preparer:

Dr. Iyad Abumoghli	Environmental Assessment Task Manager, 14 years of experience in environmental impact assessment, water resources management, and water quality modeling.
Mr. Lane Krahl	Environmental Assessment Specialist, 20 years of experience in environmental impact assessment, natural resource management, environmental economics, and environmental planning.

Contributions Received From:

Mr. Alan Schultz	Consulting Civil Engineer, 35 years of experience in water resources planning and hydraulic engineering..
Mr. Farouk Ghosheh	Mechanical Engineer, 34 years of experience in water resources planning, design and supervision.
Dr. Marwan Abu-Khalaf	Senior Archaeologist, 18 years of experience in archaeological research and investigations.

6.2 LIST OF CONTACTS

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Anan Masri	Municipality of Nablus
Adnan Amudi	Municipality of Nablus
Nadeem Milhim	GTZ
Ernst Doring	GTZ
Naser Abu-Halaweh	JWC
Ala-Eddin Milhim	Ministry of Industry
Suhair Al-Qadi	Ministry of Tourism

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APPENDIX A

DESCRIPTION OF ARCHAEOLOGICAL RESOURCES IN THE PROJECT AREA

Nablus is a city located between Mt. Gerzim and Mt. 'Ibal. It is an ancient site occupied from the Bronze age until the present. Its builders named it "Shekaim," which means a hilly area. It was mentioned in the letters of tell al-Amarneh, and the ruins of the ancient site have been found on Tell Balata on the outskirts of Nablus. Table A.1 lists the known archaeological sites in the Nablus service area. Figure A.1 shows their locations.

Table A.1
ARCHAEOLOGICAL RESOURCES IN THE NABLUS SERVICE AREA

No	Site	Location	Description
1	Balata	East of Nablus	An Ancient Site Occupied from the Early Bronze Age until Present. Several Excavations Took Place on the Site, Which Produced Several Types of Discoveries: Pottery, Walls, Gates Fortifications Etc.
2	Khirbat Dhiyab	South East of Balata	Foundation, Old Stones
3	Khirbat Al - 'Uqud	North of Balata	Destroyed Khan (Caravan Serial), Arches, Ruins of Buildings, rock cut reservoirs.
4	Tell Al - Ras	South West of Balata	Ruins of Rectangular Building, Tunnel
5	'Askar	East of Nablus and North East of Balata	Tombs, Rock Cut Tunnels, Reservoir
6	Khirbat Miska	North East of Dair Al - Hatab	Remains of Pottery Shards, Glass, Remains of Old Scattered Stones.
7	Tell Al - Fukhar	Between Miskat and Dair Al - Hatab	Remains of Buildings and Reservoirs
8	Al - Kharabeh	Close to the Village of Dair Al Hatab	Foundations, Wall, Reservoirs, Rock Cut Pool and Old Road
9	Salim	East of Jerusalem	Foundation, Reservoirs, Rock Cut Tombs. South of the Village There Is Khirbat al-Sheik Nasrallah,which contains: Foundations, Reservoirs, Tombs.
10	Khirbat Salim	North of Salim	Remains of Buildings
11	'Awarta	South East of Nablus	The Can'anite "Jab' Finjas" and in the Roman Period it Had the Same as the Present Name " Awarta". There Main. The Tombs of Ali'azar the Son of Harum; Finjas Son of Ali'azar Who Was Known by al - shaikh al-Mansuri;the Ibtamar, the Brother of Ali'zar.
12	Khirbat Al - Ras	Close to 'Awarta	Foundation, Walls, Rock out Reservoirs

No	Site	Location	Description
13	Khirbat Hayya	East of 'Awarta	Ruins of Buildings
14	Khirbat Al - Shararba	North East of 'Awarta	Ruins and Remains of Buildings
15	Khirbat Rujan	East of Baita	Ruins of Buildings
16	Khirbat 'Ulim	North East of Baita	Remains of Buildings
17	Al - Junaid	West of Nablus	Remains of Tower, Fortification, Tomb of Al - Junaid
18	Khirbat Al - Shaikh Ghanem	Close to Kafr Qallil	Mausoleum on the Summit of Mt. Gerzim.
19	Khirbat Al Qasr (Sarin)	The Village of Kafr Sarin	Foundation, Walls, Destroyed Vaults, Rock Cut Tombs.
20	Burin	South Nablus	Rock Cut Tombs and Presses, Basins, Walls.
21	Khirbat Makhna	East of Burin	Remains of Buildings, Tombs
22	Khirbat 'Amra	East of Khirbat Makhna	Remains of Buildings Reservoirs
23	Khirbat Kafroor	West of the Village Tel	Scattered Stones and Buildings
24	Khirbat Al - Suratain	North of Tel	Remains of Tower
25	Khirbat 'Ufar	North West of Burin	Remains of Buildings, Wells
26	Khirbat Sur	West of 'Irag Burin	Remains of Walls Foundations
27	Qusin	South of Dair Sharaf	Tower, Reservoirs, Press
28	Khirbat 'Atarud	West of the Village Quza	Tell of Ruins, Buildings, Pottery Shards, Foundations, Caves, Reservoirs
29	Bab, Beit Al - Khirba	Close to Hawwara	Rock Cut Pool, Reservoirs, Caves
30	Khirbat Sarisya	West of 'Ainabus	Scattered Stones, Rock Cut Reservoirs and Tombs
31	Khirbat Dair Ha'mid	Between Zawata and 'Arsira Al - Shamaliya	Remains of Walls Foundation
32	Khirbat Al - Duweir	West of Dair Sharaf	Foundation, Rock Cut Reservoirs, Tower, Lintel
33	Khirbat Kafr Farat	East of Dair Sharaf	Walls, Scattered Stones
34	Khirbat Qabuba	Close to Dair Sharaf	Walls, Pool, Reservoirs, Caves
35	Bir Al - Qatran	North West of Dair Sharaf	
36	Beit Jdiyya	West of Dair Sharaf	
37	Sabastya	North West of Nablus	Remains of a Tower, Church, Tombs.
38	Khirbat Al - Luza	South of Sabastya	Destroyed Walls, Canal, Pottery, Shards
39	Khirbat Shu'la.	South East of Sabastia	Remains of Old Buildings

No	Site	Location	Description
40	Nisf Jubail	North West of Nablus	Foundations, Arch, Tunnel
41	Khirbat Al - Shrai'm	West of Nisf Jubail	Foundations, Reservoirs, Reservoirs, Rock-cut Caves
42	Beit 'Amin	North West of Nablus	Walls Remains, Basins
43	Burqa	North West Nablus	Remains of Buildings, Rock Cut Caves
44	Al - Qubaibat	North of Burqa	It Is a Mausoleum Located on the Summit of the Mount
45	Bay Zid (Abu Zaid)	East of Burqa	Mausolaeum of One Room, for Abu Zaid Al-bustami
46	Khirbat Al-minya	Close to the Village of Bazzarya	Foundations, Buildings, Rock Cut Reservoirs, Pottery Shards Mosaic
47	Khirbat Baitita	Between Bazzaria and Kafr Al - Labed	
48	'Asira Al - Shanaliyya	North of Nablus	Remains of a Village, Rock Cut Reservoirs, Tombs, Caves, Mosaic
49	Khirbat Al - Hawa	East of Asira Al - Shamaliyya	Remains of Buildings Ruins
50	Khirbat Al - Kuz	South of Khirbat Al - Hawa	Remains and Ruins of Buildings
51	Khirbat Al - Sayyad	North of 'Asira Al - Shamaliyya	Ruins and Archaeological Remains
52	Khirbat Filayya	North of Khirbat Al - Sayyad	Archaeological Remains
53	Khirbat Neib	North of 'Asira Al - Shamaliyya	Ruins and Archaeological Remains
54	Talluza	North East of Nablus	Foundations, Remains of Buildings, Towers, Tombs, Reservoirs, Harun Mausoleum, Maqam Al - Arba'in (Shrine)
55	Khirbat Sumait	East of Talluza	Remains of Walls and a Dome
56	Khirbat 'Utfur	Close to Talluza	Foundations, Rock Cut Reservoirs, Tombs
57	Khirbat Al - 'Aqd	Close to Talluaza	Remains of Buildings
58	Al - Babhan	South east of Talluza	Its site is known today as (Khirbat al - Frwa. Its remains composed of remains of walls, foundation, columns pieces, well dressed stones, caves, old road.
59	Yasid	North East of Nablus	Destroyed Mosque, vaulted buildings. Minaret with insription. Reservoirs, rock cut Tombs.
67	Khirbat kufr Baita	North west of Beit Furik	remains of Buildings and a niche
122b	Khirbat al-Dair	North of Jamma'iu	Foundations, walls

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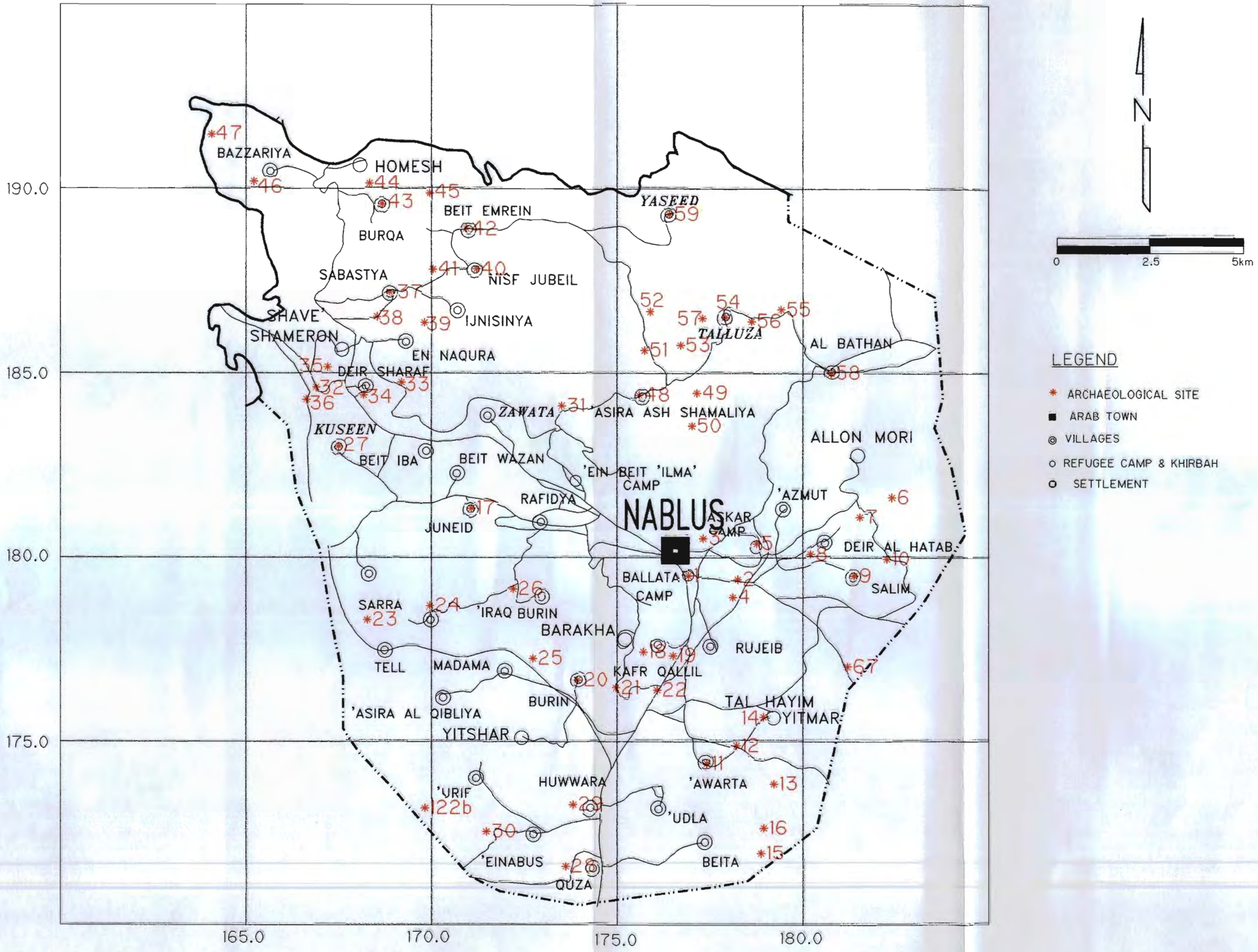

Figure A.1
Archaeological Sites in the Nablus Master Plan Service Area