Chapter 3 National Water Control System

Chapter 4 Municipal Water Network Rehabilitation

Chapter 5 Wehda-Irbid Water Supply

4.4 Rehabilitation and Restructuring Plan

4.4.1 Summary of Rehabilitation and Restructuring Plan

(1) Rehabilitation Plan

The rehabilitation plan for 5 study areas has been examined and formulated taking into account the current situation of water supply system in the study areas and the criteria for rehabilitation. The results of the examination are summarized in Table 4.4.1-1.

Table 4.4.1-1 Summary of Rehabilitation Plan

Study Area	Replacement of Distribution Pipe (m)			Total (m)	Replacement of House Connection (nos.)
	Dia. 25mm	Dia.50mm	Dia. 75mm		
South Amman	1,524	95,644	17,689	114,857	4,000
Madaba City	---	---	28,476	28,476	5,800
Karak City	---	7,268	8,620	15,888	3,200
Tafilah City	21,392	7,230	10,147	38,769	5,400
Ma'an City	18,222	3,123	13,323	34,668	4,500

The material for distribution pipes and service pipes of house connection to be replaced shall be of high density polyethylene (HDPE).

(2) Restructuring Plan

In order to reduce the physical loss in the distribution pipelines, water distribution system shall be reviewed taking into account high pressure zone due to the directly pumped system to the service areas as well as aging of the pipelines. The results of the examination are summarized in Table 4 4.1-2.

Table 4.4.1-2 Summary of Restructuring Plan

Study Area	Water Reservoir	Water Distribtution Pump Station (PS)		
		No. of PS	Lifting Capacity (per 1 PS)	Head
South Amman	$2000m^3$ x 2 units	2 units	$260m^3/h$	40m
Madaba City	(No restructuring is required)			
Karak City	$2000m^3$ x 1 unit	Not required (by gravity)		
Tafilah City	(No restructuring is required)			
Ma'an City	(No restructuring is required)			

The rehabilitation/restructuring plan and quantity for each study area are described in detail hereinafter.

4.4.2 South Amman

(1) Rehabilitation Plan

The study area is located adjacent to the boundary of the Project for Restructuring and Rehabilitation of Greater Amman Water Network now under implementation by PMU.

The study area has an area of 128 km^2 and a subscriber of 6,660 in the year 2000.

The total length of distribution pipeline in the area is about 227 km with diameters from 25mm to 800mm. The age of pipelines is less than 30 years for steel pipes and 50 years for ductile iron pipes. Therefore, in accordance with the criteria for rehabilitation, the existing pipelines with diameters of 25mm to 75mm of galvanized steel shall be replaced by HDPE pipes.

The rehabilitation plan drawing is shown in Fig. 4.4.2-1 and 4.4.2-2.

(2) Restructuring Plan

The topography of the area is generally flat and wide, so that water has to be distributed by pumps with a high pressure. This will bring a high pressure of the pipelines near the pump station and lead to water leakage on the pipelines.

In order to avoid a water leakage caused by a high internal water pressure, one water distribution station will be constructed in each center of the two distribution areas with the lifting capacity and head shown in Table 4.4.1-2.

(3) Bill of Quantities for Rehabilitation

All the distribution pipelines in the study area are listed in Table 4.4.2-1. For rehabilitation, the pipelines of galvanized steel with diameters of 25 to 75mm will be replaced by new HDPE pipes. As shown in Table 4.4.2-2, the length of pipeline to be replaced is expected as about 115 km or 51 % of the total length of distribution pipeline in the study area.

Table 4.4.2-1 Distribution Pipeline in the Study Area

Diameter (mm)	Material	Length (m)	Diameter (mm)	Material	Length (m)
25	G	1,524	100	G	13,879
32	PE	80	100	ST	23,062
50	G	95,644	100	PE	564
63	PE	3,431	100	DI	1,028
75	G	17,689	150	ST	16,287
			200	ST	13,614
			300	ST	7,161
			400	ST	14,624
			600	ST	6,217
			800	ST	12,462
Total (25～75mm)		118,368	Total (100mm or over)		108,898
Grand Total			227,266		

[Pipe Material] G : Galvanized Steel
PE : Polyethylene
ST : Steel
DI : Ductile Iron

Table 4.4.2-2 Pipeline Length for Rehabilitation (South Amman)

Diameter (mm)	Material	Length (m)
25	G	1,524
50	G	95,644
75	G	17,689
Total		114,857

4.4.3 Madaba City

(1) Rehabilitation Plan

The study area covers the most densely populated area of Madaba City with an area of 5.0 km^2 and a subscriber of 8,235 in 2000. The total length of distribution pipelines in the area is about 47 km with diameters of 80 to 450 mm.

Pipe materials are mostly of galvanized steel and black steel with an age of less than 30 years. Therefore, in accordance with the criteria for rehabilitation, the existing pipelines of 80 mm of galvanized steel shall be replaced by HDPE pipes.

The rehabilitation plan drawing is shown in Fig. 4.4.3-1.

(2) Restructuring Plan

In the study area, water is supplied by force main from Madaba pump station and by gravity from elevated water tanks. Since the served area is relatively small as 5.0 km^2 and topographically flat, the internal water pressure of pipeline is less than 5.0 kg/cm^2 or 50 m as water head. The capacity of water reservoir is now 7,000m^3, which is more than the required capacity of 5,500m^3 in 2010. Therefore, it is considered that restructuring is not required for Madaba City.

(3) Bill of Quantities for Rehabilitation

As shown in Table 4.4.3-1, the length of pipeline to be replaced is expected as about 29 km or 60 % of the total length of distribution pipeline in the study area.

Table 4.4.3-1 Pipeline Length for Rehabilitation (Madaba City)

Pipe Diameter (mm)	Pipe Length (m)
80	28,476
100	12,285
150	1,510
200	2,357
250	160
300	470
350	1,380
450	715
Total	47,353
For Rehabilitation	
75	28,476
Total	28,476

4.4.4 Karak City

(1) Rehabilitation Plan

The study area covers the most densely populated area of Karak City with an area of 4.0 km^2 and a subscriber of 4,500 in 2000. The total length of distribution pipelines in the area is about 37 km with diameters of 50 to 300 mm.

Pipe materials are mostly of galvanized steel and black steel with an age of less than 30 years. Therefore, in accordance with the criteria for rehabilitation, the existing pipelines of 50 and 75 mm of galvanized steel shall be replaced by HDPE pipes.

The rehabilitation plan drawing is shown in Fig. 4.4.4-1.

(2) Restructuring Plan

In the study area, water is supplied by gravity from two water reservoirs located on the hilly area. The whole city area is supplied by one water reservoir with a capacity of 1,000m^3, which is not sufficient against the required amount of 3,000 m^3.

Both reservoirs are located at the height of 1,070m above sea level while the elevation of the city ranges from 950 to 1020 m. In order to reduce a high internal pressure in the pipelines, pressure relief valves are installed on the pipelines. Therefore, as a restructuring plan, the extension of water reservoir of 2,000m^3 at the location of existing reservoir of 1,000 m^3 shall be considered in this study.

(3) Bill of Quantities for Rehabilitation

As shown in Table 4.4.4-1, the length of pipeline to be replaced is expected as about 16 km or 43 % of the total length of distribution pipeline in the study area.

Table 4.4.4-1 Pipeline Length for Rehabilitation (Karak City)

Pipe Diameter (mm)	Pipe Length (m)
50	7,268
75	8,620
100	9,802
150	3,058
200	3,563
250	3,756
300	659
Total	36,726
For Rehabilitation	
50	7,268
75	8,620
Total	15,888

4.4.5 Tafielah City

(1) Rehabilitation Plan

The study area covers the most densely populated area of Tafielah City with an area of 5.0 km^2 and a subscriber of 6,776 in 2000. The total length of distribution pipelines in the area is about 53 km with diameters of 20 to 250 mm.

Pipe materials are mostly of galvanized steel and black steel with an age of less than 30 years. Therefore, in accordance with the criteria for rehabilitation, the existing pipelines of 20 to 75 mm of galvanized steel shall be replaced by HDPE pipes.

The rehabilitation plan drawing is shown in Fig. 4.4.5-1.

(2) Restructuring Plan

In the study area, there are two existing water reservoirs of a capacity of 4,500 m^3 and 1,000m^3 (total capacity of 5,500m^3), which is sufficient to the required capacity of 3,500m^3 in 2010. Water is served by gravity from these two reservoirs. Therefore, no restructuring is required in this area.

(3) Bill of Quantities for Rehabilitation

As shown in Table 4.4.5-1, the length of pipeline to be replaced is expected as about 39 km or 73 % of the total length of distribution pipeline in the study area.

Table 4.4.5-1 Pipeline Length for Rehabilitation (Tafielah City)

Pipe Diameter (mm)	Pipe Length (m)
20	7,830
25	13,562
50	7,230
75	10,147
100	8,189
150	1,240
200	2,757
250	2,275
Total	53,230
For Rehabilitation	
25	21,392
50	7,230
75	10,147
Total	38,769

4.4.6 Ma'an City

(1) Rehabilitation Plan

The study area covers the most densely populated area of Ma'an City with an area of 8.9 km^2 and a subscriber of 5,600 in 2000. The total length of distribution pipelines in the area is about 35 km with diameters of 20 to 350 mm.

Pipe materials are mostly of galvanized steel and black steel with an age of less than 30 years. Therefore, in accordance with the criteria for rehabilitation, the existing pipelines of 20 to 75 mm of galvanized steel shall be replaced by HDPE pipes. As shown in Table 4.4.8, the length of pipeline to be replaced is expected as about 35 km or 71 % of the total length of distribution pipeline in the study area.

The rehabilitation plan drawing is shown in Fig. 4.4.6-1.

(2) Restructuring Plan

In the study area, water is supplied by one existing water reservoir of a capacity of 5,000 m^3, which is sufficient to the required capacity of 3,000m^3 in 2010. Water is served by gravity from this reservoir. There will be no such a high pressure zone as the internal water pressure becomes more than 5.0 kg/cm^2. Therefore, no restructuring is required in this area.

(3) Bill of Quantities for Rehabilitation

As shown in Table 4.4.6-1, the length of pipeline to be replaced is expected as about 35 km or 71 % of the total length of distribution pipeline in the study area.

Table 4.4.6-1 Pipeline Length for Rehabilitation (Ma'an City)

Pipe Diameter (mm)	Pipe Length (m)
20	12,888
25	5,334
50	3,123
75	9,050
80	4,273
100	6,740
150	4,230
200	2,106
250	347
300	457
350	510
Total	49,058
For Rehabilitation	
25	18,222
50	3,123
75	13,323
Total	34,668

SOUTH AMMAN (1/2) S=1 : 40,000

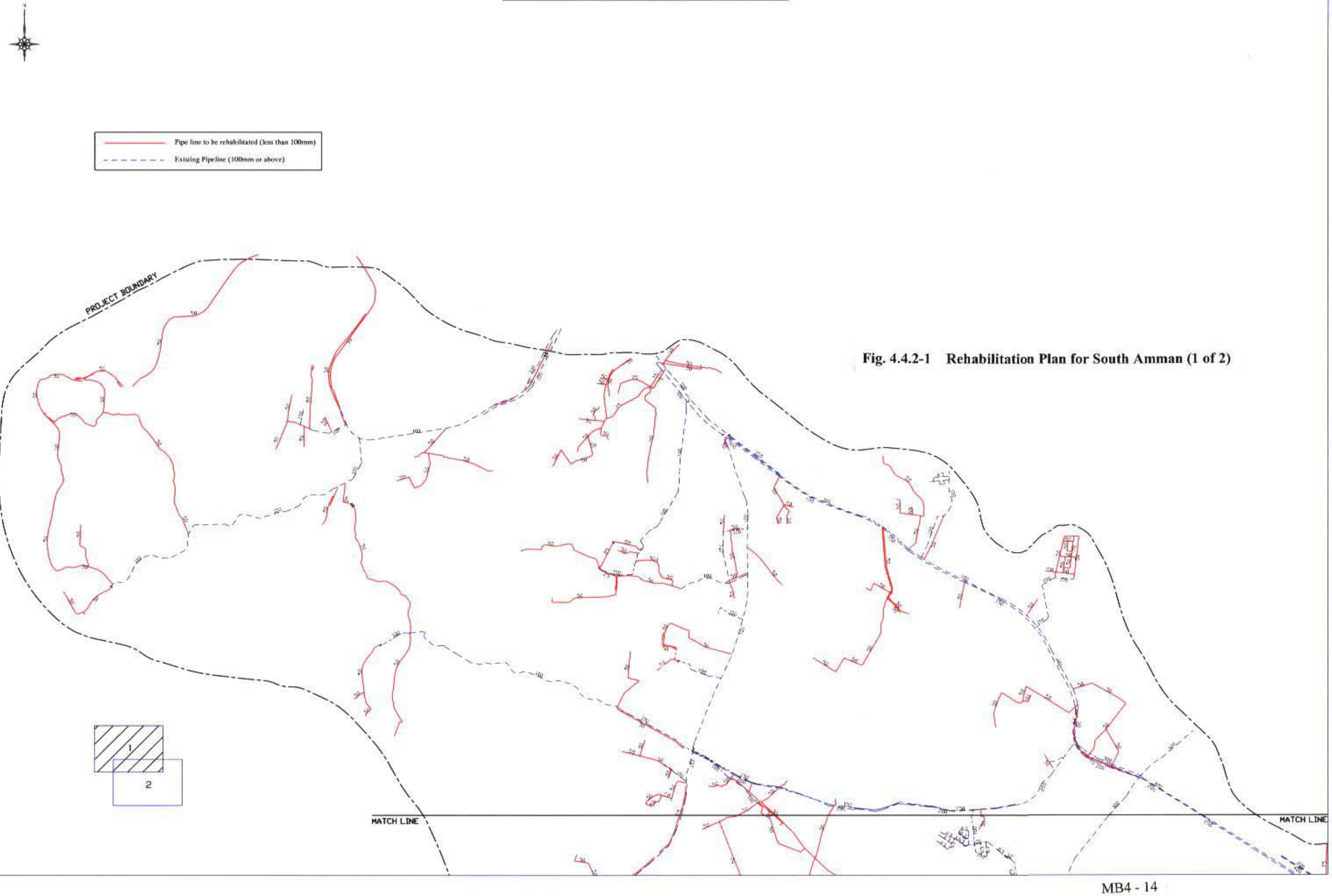

Fig. 4.4.2-1 Rehabilitation Plan for South Amman (1 of 2)

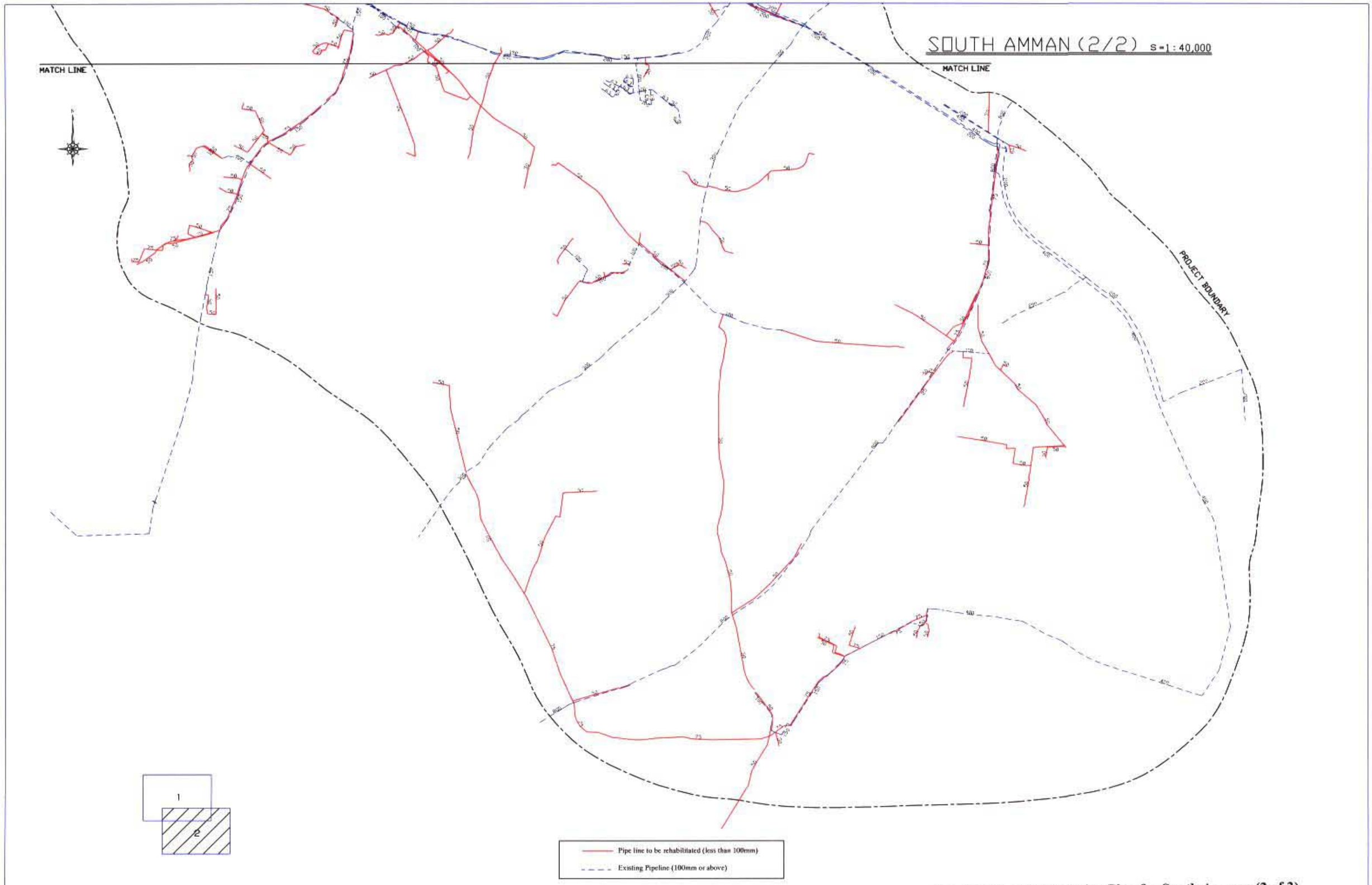

Fig. 4.4.2-2 Rehabilitation Plan for South Amman (2 of 2)

MADABA S=1:10,000

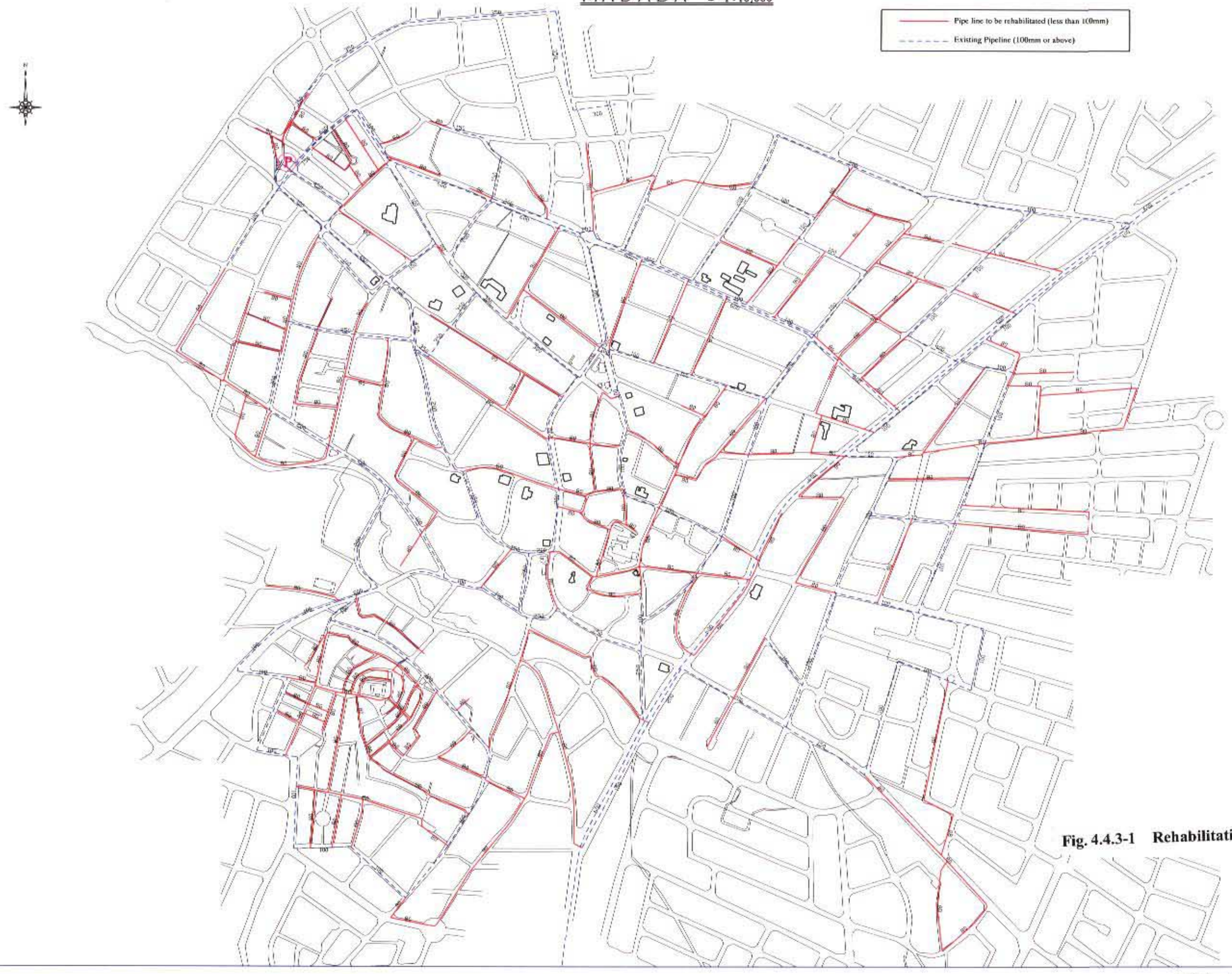

Fig. 4.4.3-1 Rehabilitation Plan for Madaba City

KARAK S=1:10,000

Fig. 4.4.4-1 Rehabilitation Plan for Karak City

TAFILAH S=1:10,000

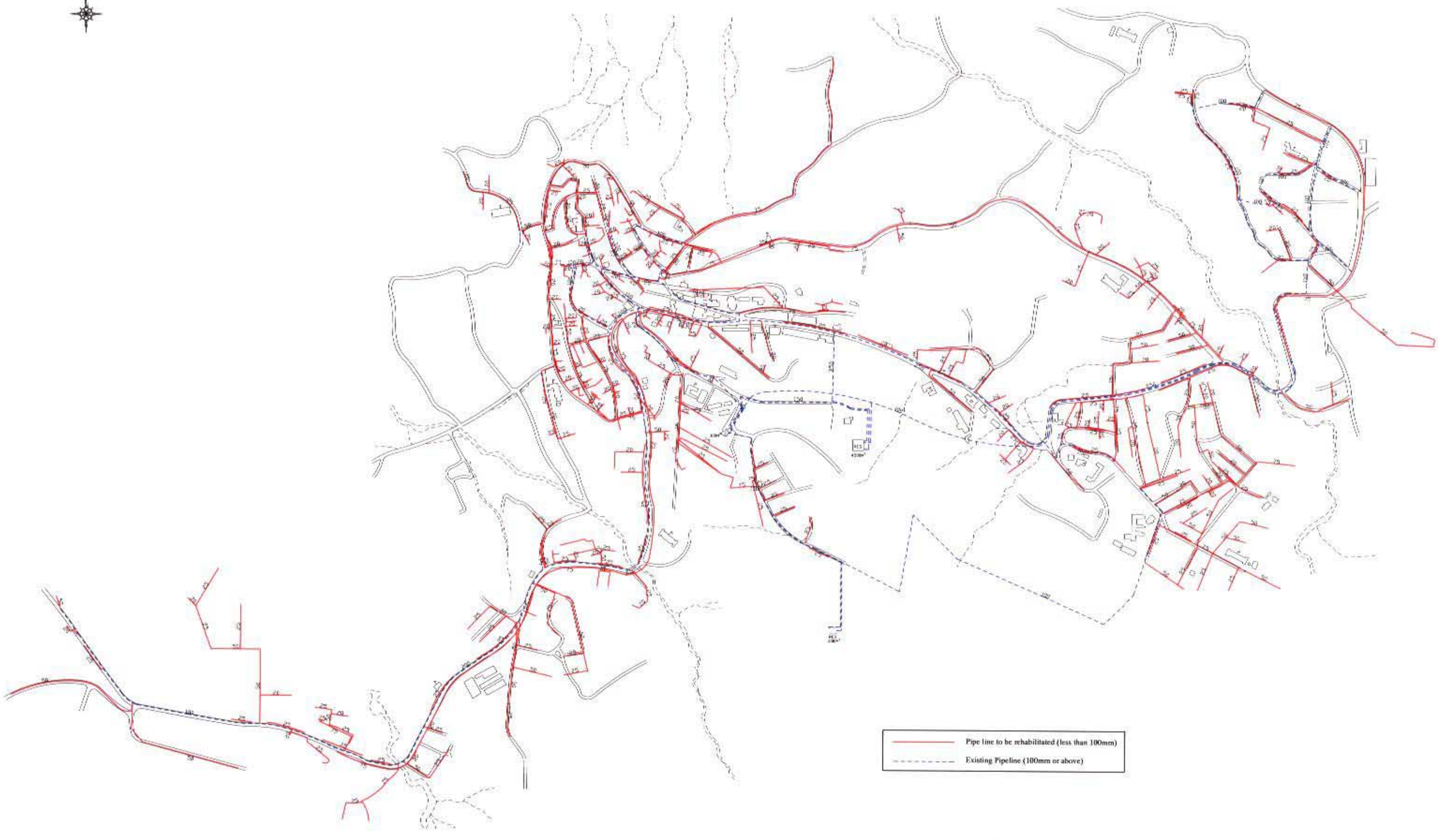

Fig. 4.4.5-1 Rehabilitation Plan for Tafilah City

MA' AN S=1:10,000

FROM WATER RESERVOIR (5,000m3)

Pipe line to be rehabilitated (less than 100mm)

Existing Pipeline (100mm or above)

Fig. 4.4.6-1 Rehabilitation Plan for Ma'an City

4.5 Cost Estimate

4.5.1 Unit Prices for Construction Cost Estimate

The adopted unit prices for construction cost estimate are established based on the following information and documents:

- Several previous study reports of MOWI
- Latest price list of Ministry of Public Works and Housing, version 1999 (The Government Tender Directorate Annual Report)
- Quotation and consultation with local contractors and manufactures
- Experience of the Consultant

Unit prices include all the costs for construction works with belongings and all indirect prices except owner's administration cost, engineering cost and physical contingencies. The prices given in the previous study reports of MOWI mentioned above are converted into the prices of the year 2001 taking into account the annual escalation ratio of 3% per annum.

Table 4.5.1-1 shows the basic construction cost for civil works taking into account the unit price estimation. Table 4.5.1-2 summarizes unit prices for the estimate of base construction cost for water distribution network, water reservoir and distribution pump station. Fig. 4.5.1-1 shows the estimated base construction cost for distribution pump station. Unit prices in these tables are based on prices of the year 2001.

Table 4.5.1-1 Basic Construction Cost for Civil Works (1/2)

Item	Unit	Unit price (JD/ unit)
Land acquisition		
North Jordan Valley	ha	16,000
Middle and south Jordan Valley	ha	12,000
Others	ha	8,000
Earth work		
Site leveling	m^2	2.0
Excavation Common	m^3	3.5
Rock	m^3	8.5
Backfill	m^3	2.5
Concrete		
Lean concrete	m^3	45.0
Mass concrete	m^3	70.0
Reinforced concrete	m^3	140.0

Table 4.5.1-1 Basic Construction Cost for Civil Works.(2/2)

Item	Unit	Unit price (JD/ unit)
Steel		
Steel bar	t	520
Steel structure	t	1,570
Building		
High quality	m^2	350
Middle quality	m^2	200
Low quality	m^2	160
Road pavement	m^2	9.5
Fence and gate	m	25

Table 4.5.1-2 Unit Prices for Water Distribution Facilities

Component	Unit	Unit Price (JD/unit)
Distribution HDPE pipe		
DN 25	m	20
DN 50	m	22
DN 75	m	24
Water Reservoir		
1,000m^3	m^3	121
2,000m^3	m^3	99
3,000m^3	m^3	90

Note : HDPE means High Density Polyethylene.

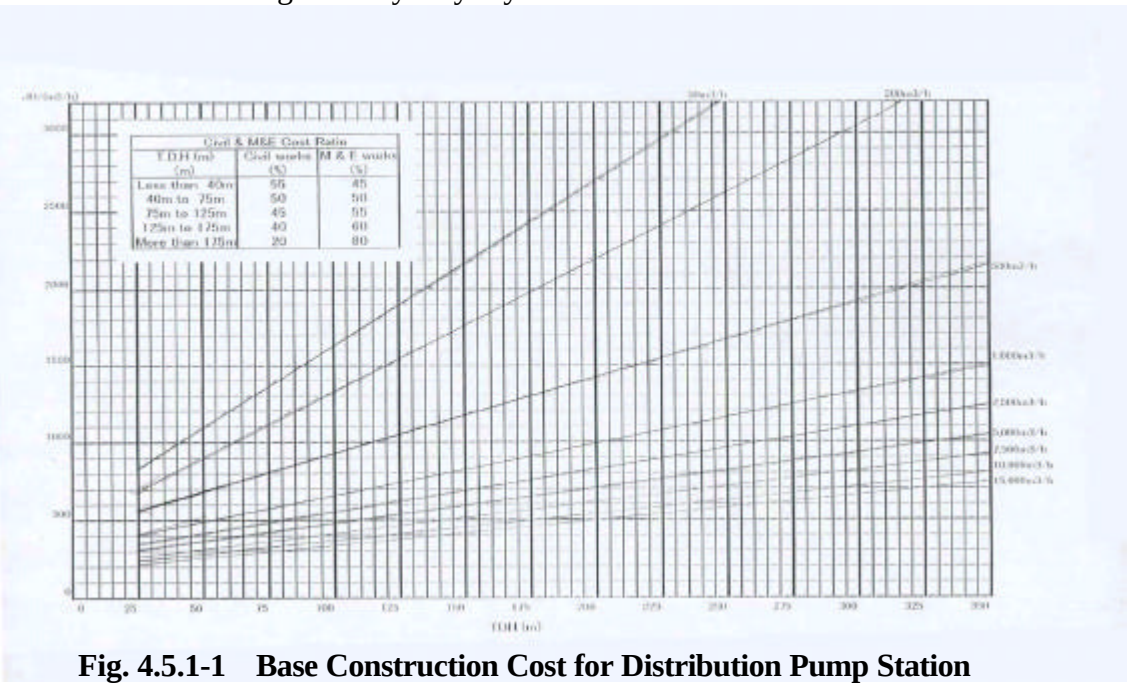

Fig. 4.5.1-1 Base Construction Cost for Distribution Pump Station

4.5.2 Estimation of Investment Cost

For preliminary estimates of investment cost, it was divided into base construction cost, administration cost, engineering cost and physical contingencies as described below.

(1) Basic design assumptions for base construction cost estimation
Costs shall be estimated for the rehabilitation works of municipal water network in five study areas (South Amman, Madaba city, Karak city, Tafilah city and Ma'an city).

Base construction cost estimate considers the water distribution pipeline, water reservoir and distribution pump station.

The unit pipeline cost shown in Table 4.5.1-2 is estimated with a condition that pipes are laid under asphalt paved roads.

For distribution pipes, ductile iron pipes shall be adopted for the diameters of not less than 100mm and HDPE pipes for less than 100mm.

(2) Cost for administration, engineering and physical contingencies
Administration costs include the cost for the administrative works such as internal planning and budgeting, the administration of engineering and construction contracts, legal services, and liaison with funding agencies etc. The administrative costs are assumed to be about 5% of the base construction costs.

Engineering costs include the cost for the engineering services such as surveys, planning, designs, site supervision etc. These services are estimated as 10% of the base construction costs according to the experience of the consultant.

The physical contingencies are estimated as 10% of the total of base cost, administration cost and engineering cost.

4.5.3 Unit Cost for Operation and Maintenance

Operation costs have been estimated for the staff cost, power cost and maintenance cost.

(1) Staff cost
The following criteria are applied to estimate required staff for operation and maintenance of pumping stations.

Criteria	Required staff
Transmission volume of pump station <5,000m^3/d Transmission volume of pump station 5,000 to 20,000m^3/d	1 2
Transmission volume of pump station 20,000m^3/d or more	3

The estimate of personnel costs are based on current salaries paid including all overhead costs (e.g. allowances, pension fund etc.) Average annual cost for one

staff member is estimated to be 3,500JD/a based on the data from Department of Statistic Data Bank 1998.

(2) Maintenance cost
Annual maintenance costs are calculated as a 0.5% of the base construction costs. This percentage is based on experience and is widely accepted as representative of typical conditions.

(3) Power cost
Electrical energy is consumed by transmitting water by pumps to water reservoir and booster pump station. Power consumption is calculated according to the transmission volume and pumping height and an efficiency of 70% is assumed. The present average compound rate per kWh for water supply sector is 0.034JD.

4.5.4 Results of Cost Estimate and Implementation Plan

The results of cost estimate for network rehabilitation and restructuring of five study areas are shown in Table 4.5.4-1.

Table 4.5.4-1 Cost Estimate for Network Rehabilitation and Restructuring

Study Area	Investment Cost (JD)		Total Investment Cost (JD)	O & M Cost (JD)
	Rehabilitation	Restructuring		
South Amman	3,219,000	1,025,000	4,244,000	49,900
Madaba City	865,000	0	865,000	3,400
Karak City	484,000	250,000	735,000	2,800
Tafilah City	1,050,000	0	1,050,000	4,200
Ma'an City	952,000	0	952,000	3,800
Total	6,570,000	1,275,000	7,845,000	64,100

The expected implementation schedule for network rehabilitation and restructuring is as shown in Fig. 4.5.4-1.

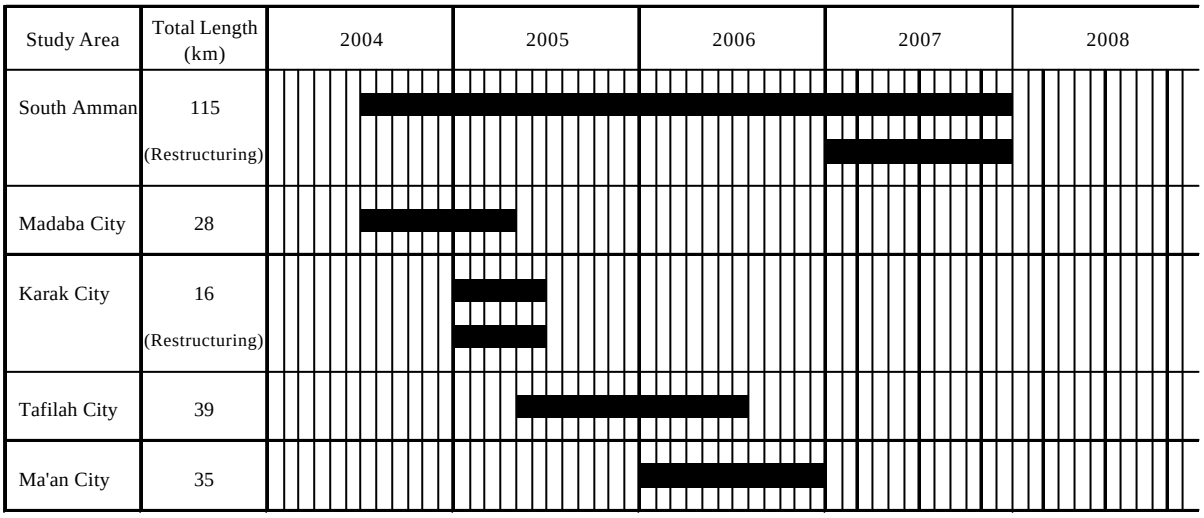

Fig. 4.5.4-1 Proposed Implementation Schedule for Network Rehabilitation and Restructuring

4.6 Economic and Financial Analysis

4.6.1 Socio-Economic Conditions

(1) South Amman

1) Population

Population and its Growth in the Past

Item	1979 Census	1994 Census	Inter-Censual Growth Rate/a
Jordan	2,149,177	4,139,458	4.5%
Amman Governorate	795,675	1,576,238	4.7%
South Amman			
Um Qusair & Muqablin	3,970	19,900	11.3%
Kirbet Al-Suq	3,481	20,791	12.7%
Sahab	11,974	32,153	6.8%
Juwaideh	2,987	16,780	12.2%
Jawa	980	8,492	15.5%
Al-Yadudeh	403	10,933	24.6%
Abu-Alanda	4,202	24,208	12.4%
Queismeh	14,862	25,885	3.8%
Jizeh & Talbieh-R. Camp	3,504	7,924	5.6%
Total	46,363	167,066	8.9%

Source: Department of Statistics

The so-called South Amman consists of 9 localities. The 1994 population of South Amman was 167,066. It accounted for 11% of the governorate population. It grew during the inter-censual 15 years 1979 to 1994 at the average annual rate of 8.9%, which was nearly twice as high as the governorate average, and also almost twice as high as the national average as shown in the above table.

2) Employment

Employment

Item	Employment, 1997	Population, 1997	Employment/1,000 Population
Jordan	410,136	4,600,000	89
Amman Governorate	269,499	1,751,680	154

Source: Statistical Yearbook of Jordan 1998, Department of Statistics

The employment includes that for all the establishments employing 5 persons or more, in both public and private sectors for all economic activities, with the exception of the agricultural sector, armed forces, public security and civil defense.

Employment in the Amman Governorate was 269,499, accounting for 66% of the national total in 1997 in contrast to its population share of 38%. The employment per 1,000 population was 154, which was by far higher than the national average of 89. All of this shows that the economic activities are concentrated in this governorate.

(2) Madaba

1) Population

Population and its Growth in the Past

Item	1979 Census	1994 Census	Inter-Censual Growth Rate/a
Jordan	2,149,177	4,139,458	4.5%
Madaba Governorate	54,560	107,321	4.6%
Madaba City	28,236	55,749	4.6%

Source: Department of Statistics

The 1994 population of Madaba City was 55,749. It accounted for 52% of the governorate population. It grew during the inter-censual 15 years 1979 to 1994 at the average annual rate of 4.6%, which was equal to the governorate average, and slightly higher than the national average as shown in the above table.

2) Employment

Employment

Item	Employment, 1997	Population, 1997	Employment/1,000 Population
Jordan	410,136	4,600,000	89
Amman Governorate	269,499	1,751,680	154
Jordan (excl. Amman Governorate)	140,637	2,848,320	49
Madaba Governorate	5,096	119,140	43

Source: Statistical Yearbook of Jordan 1998, Department of Statistics

Employment per 1,000 population was 43 in the Madaba Governorate in comparison with its outside Amman Governorate average of 49 in 1997. It shows that the economy of this governorate is less active than the rest of the country excluding the Amman Governorate.

(3) Karak

1) Population

Population and its Growth in the Past

Item	1979 Census	1994 Census	Inter-Censual Growth Rate/a
Jordan	2,149,177	4,139,458	4.5%
Karak Governorate	95,268	169,770	3.9%
Karak City	11,941	18,633	3.0%

Source: Department of Statistics

The 1994 population of Karak City was 18,633. It accounted for 11% of the governorate population. It grew during the inter-censual 15 years 1979 to 1994 at the average annual rate of 3.0%, which was noticeably lower than the governorate average of 3.9%, and also markedly lower than the national average of 4.5% as shown in the above table.

2) Employment

Employment

Item	Employment, 1997	Population, 1997	Employment/1,000 Population
Jordan	410,136	4,600,000	89
Amman Governorate	269,499	1,751,680	154
Jordan (excl. Amman Governorate)	140,637	2,848,320	49
Karak Governorate	10,738	188,600	57

Source: Statistical Yearbook of Jordan 1998, Department of Statistics

Employment per 1,000 population was 57 in the Karak Governorate in comparison with its outside Amman Governorate average of 49 in 1997. It shows that the economy of this governorate is more active than the rest of the country excluding the Amman Governorate.

(4) Ma'an

1) Population

Population and its Growth in the Past

Item	1979 Census	1994 Census	Inter-Censual Growth Rate/a
Jordan	2,149,177	4,139,458	4.5%
Ma'an Governorate	39,433	79,670	4.8%
Ma'an City	11,284	22,989	4.9%

Source: Department of Statistics

The 1994 population of Ma'an City was 22,989. It accounted for 29% of the governorate population. It grew during the inter-censual 15 years 1979 to 1994 at the average annual rate of 4.9%, which was slightly higher than the governorate average, and also considerably higher than the national average as shown in the above table.

2) Employment

Employment

Item	Employment, 1997	Population, 1997	Employment/1,000 Population
Jordan	410,136	4,600,000	89
Amman Governorate	269,499	1,751,680	154
Jordan (excl. Amman Governorate)	140,637	2,848,320	49
Ma'an Governorate	6,748	88,320	76

Source: Statistical Yearbook of Jordan 1998, Department of Statistics

Employment per 1,000 population was 76 in the Ma'an Governorate in comparison with its outside Amman Governorate average of 49 in 1997. It shows that the economy of this governorate is much more active than the rest of the country excluding the Amman Governorate.

(5) Tafielah

1) Population

Population and its Growth in the Past

Item	1979 Census	1994 Census	Inter-Censual Growth Rate/a
Jordan	2,149,177	4,139,458	4.5%
Tafielah Governorate	35,545	62,783	3.9%
Tafielah City	12,493	20,881	3.5%

Source: Department of Statistics

The 1994 population of Tafielah City was 20,881. It accounted for 33% of the governorate population. It grew during the inter-censual 15 years 1979 to 1994 at the average annual rate of 3.5%, which was considerably lower than the governorate average of 3.9%, and also markedly lower than the national average of 4.5% as shown in the above table.

2) Employment

Employment

Item	Employment, 1997	Population, 1997	Employment/1,000 Population
Jordan	410,136	4,600,000	89
Tafielah Governorate	7,466	69,920	107

Source: Statistical Yearbook of Jordan 1998, Department of Statistics

Employment per 1,000 population was 107 in the Tafielah Governorate in comparison with its all country average of 89. It shows that the economy of this governorate is more active than the rest of the country.

4.6.2 Economic and Financial Analysis

(1) Methodology

1) Financial Analysis

(a) Preparation of cost benefits streams

a) Project life for financial analysis was set at 30 years.

b) Preparation of cost streams

The estimated initial cost of the project was spread over the implementation period. Also, the annual recurrent cost for the operation and maintenance (O & M) of the facilities was entered annually after the implementation up to the end of the project life.

c) Estimation of water stream

The quantity of municipal water to be annually supplied after the implementation up to the end of the project life was estimated.

d) Estimation of UFW reduction in the with project case

The ratio of UFW in the without project case was estimated by dividing the quantity of municipal water billed by that of municipal water supplied in recent years.

Out of it, the fraction attributable to the physical loss was estimated.

Finally, out of the fraction, the extent to which the physical loss will be reduced through the implementation of the rehabilitation project was estimated.

e) Estimation of water stream to be saved and billed in the with project case

From items c) and d), the quantity of municipal water to be annually saved in the with project case was determined up to the end of the project life.

Then, the estimated administrative loss of water was annually subtracted from the quantity of water to be saved. This way, the quantity of water to be saved and billed was annually determined up to the end of the project life.

f) Estimation of the unit value of water

The financial value of the unit quantity of municipal water was estimated based on the existing water tariff and future needs for raising it.

g) Preparation of benefits stream

From items e) and f) the benefits stream was worked out up to the end of the project life.

(b) Calculation of Financial Criteria and Financial Evaluation

a) The discount rate was assumed as 5%.

b) Using the cost benefits streams, FIRR, NPV and the water price were calculated.

c) Based on the values of financial criteria, taking into consideration qualitative factors as well, the judgment on the financial feasibility of the project was passed.

2) Economic Analysis

(a) Preparation of cost benefits streams

a) Project life

(Same as in financial analysis)

b) Preparation of cost streams
The estimated initial cost was divided into foreign and local components. The standard conversion factor was applied to the local components, except land acquisition cost, which was annualized based on land rent.
The initial cost of the project was spread over the implementation period. Also, the annual recurrent cost for the operation and maintenance (O & M) of the facilities was entered annually after the implementation up to the end of the project life.

c) Estimation of water stream
(Same as in financial analysis)

d) Estimation of UFW reduction in the with project case
(Same as in financial analysis)

e) Estimation of water stream to be saved in the with project case
From items c) and d), the quantity of municipal water to be annually saved in the with project case was determined up to the end of the project life.

f) Estimation of the unit value of water
The economic value of the unit quantity of municipal water was estimated based on the affordability of a household to pay for water supply and the water demand per household.

g) Preparation of benefits stream
From items e) and f) the benefits stream was worked out up to the end of the project life.

(b) Calculation of Economic Criteria and Economic Evaluation

a) The opportunity cost of capital was assumed as 10%.

b) Using the cost benefit streams, EIRR, NPV and the water price were calculated.

c) Based on the values of economic criteria, taking into consideration qualitative factors as well, the judgment on the economic feasibility of the project was passed.

(2) Common Preconditions

Section Nos. 1) and 3) are applied commonly to all the water networks rehabilitation projects.

1) Depreciation Period: 30 years

2) Standard Conversion Factor: 0.9664

3) Land Rent: 35 fils/dunum

(3) South Amman

1) Preconditions

(a) Expected Reduction of Physical Loss (Unit: m^3/year)

Year	2010
Reduction of Physical Loss	440,400

(b) Investment Costs (Unit: JD)

Investment Costs	Local Components		Foreign Components	
4,243,399	90%	3,831,414	10%	411,985

(c) Implementation Schedule

2003	2004	2005	2006	2007	2008

(d) O & M Costs (Unit: JD)

Year	2010
O & M Costs	49,875

(e) Water Tariff (Unit: Fils/m^3)

2004	2005	2006	2007	2008	2009	2010
411	423	436	449	463	476	491

Starting in 2005, the average wastewater tariff per m^3 was assumed to be increased at the annual rate of 3% up to 2010.

(f) Unit Benefits of Municipal Water: 735 Fils/m^3

2) Results of Financial Analysis

FIRR	NPV (JD)	Unit Water Price (Fils)
-0.7%	-1,964,352	899

Note: Discount Rate=5%

3) Results of Economic Analysis

EIRR	NPV (JD)	Unit Water Price (Fils)
3.8%	-1,513,262	1,299

Note: Discount Rate=10%

4) Evaluation

This project is financially not feasible with the FIRR of –0.7%, NPV of –1,964,352 JD and the unit water price of 899 fils per m^3. It is also economically not feasible with the EIRR of 3.8%, NPV of –1,513,262 JD and the unit water price of 1,299 fils per m^3.

The project is placed 5th in terms of both financial and economic feasibility out of the 5 projects concerned. The value of FIRR is negative, and the value of EIRR is low. Therefore, the project can be judged to be a candidate for a grant or soft loan.

(4) Madaba City

1) Preconditions

(a) Expected Reduction of Physical Loss (Unit: m^3/year)

Year	2010
Reduction of Physical Loss	603,950

(b) Investment Costs (Unit: JD)

Investment Costs	Local Components		Foreign Components	
864,531	100%	864,531	0%	0

(c) Implementation Schedule

2003	2004	2005	2006	2007	2008

(d) O & M Costs (Unit: JD)

Year	2010
O & M Costs	3,417

(e) Water Tariff (Unit: Fils/m^3)

2004	2005	2006	2007	2008	2009	2010
294	303	312	321	331	341	351

Starting in 2005, the average wastewater tariff per m^3 was assumed to be increased at the annual rate of 3% up to 2010.

(f) Unit Benefits of Municipal Water: 735 Fils/m^3

2) Results of Financial Analysis

FIRR	NPV (JD)	Unit Water Price (Fils)
20.4%	1,801,469	111

Note: Discount Rate=5%

3) Results of Economic Analysis

EIRR	NPV (JD)	Unit Water Price (Fils)
49.5%	2,753,842	159

Note: Discount Rate=10%

4) Evaluation

This project is financially remarkably feasible with the FIRR of 20.4%, NPV of 1,801,469 JD and the unit water price of 111 fils per m^3. It is also economically conspicuously feasible with the EIRR of 49.5%, NPV of 2,753,842 JD and the unit water price of 159 fils per m^3.

The project is placed 1st in terms of both financial and economic feasibility out of the 5 projects concerned. The value of FIRR is more than four times the discount rate, the value of EIRR is nearly five times the OCC, and the financial unit water price is less than a half of the current level. Therefore, the project can be judged to be most worthwhile and suitable for early implementation.

(5) Karak City

1) Preconditions

(a) Expected Reduction of Physical Loss (Unit: m^3/year)

Year	2010
Reduction of Physical Loss	321,150

(b) Investment Costs (Unit: JD)

Investment Costs	Local Components		Foreign Components	
734,682	89%	652,027	11%	82,655

(c) Implementation Schedule

2003	2004	2005	2006	2007	2008

(d) O & M Costs (Unit: JD)

Year	2010
O & M Costs	2,824

(e) Water Tariff (Unit: Fils/m^3)

2004	2005	2006	2007	2008	2009	2010
294	303	312	321	331	341	351

Starting in 2005, the average wastewater tariff per m^3 was assumed to be increased at the annual rate of 3% up to 2010.

(f) Unit Benefits of Municipal Water: 735 Fils/m3

2) Results of Financial Analysis

FIRR	NPV (JD)	Unit Water Price (Fils)
13.1%	816,235	181

Note: Discount Rate=5%

3) Results of Economic Analysis

EIRR	NPV (JD)	Unit Water Price (Fils)
28.8%	1,195,743	261

Note: Discount Rate=10%

4) Evaluation

This project is financially remarkably feasible with the FIRR of 13.1%, NPV of 816,235 JD and the unit water price of 181 fils per m^3. It is also economically remarkably feasible with the EIRR of 28.8%, NPV of 1,195,743 JD and the unit water price of 261 fils per m^3.

The project is placed 2nd in terms of both financial and economic feasibility out of the 5 projects concerned. The value of FIRR is more than 2 times the discount rate, the value of EIRR is nearly 3 times the OCC, and the financial unit water price is less than two thirds the current level. Therefore, the project can be judged to be very much worthwhile and suitable for early implementation.

(6) Tafielah City

1) Preconditions

(a) Expected Reduction of Physical Loss (Unit: m^3/year)

Year	2010
Reduction of Physical Loss	256,200

(b) Investment Costs (Unit: JD)

Investment Costs	Local Components		Foreign Components	
1,050,491	100%	1,050,491	0%	0

(c) Implementation Schedule

2003	2004	2005	2006	2007	2008

(d) O & M Costs (Unit: JD)

Year	2010
O & M Costs	4,152

(e) Water Tariff (Unit: Fils/m^3)

2004	2005	2006	2007	2008	2009	2010
294	303	312	321	331	341	351

Starting in 2005, the average wastewater tariff per m^3 was assumed to be increased at the annual rate of 3% up to 2010.

(f) Unit Benefits of Municipal Water: 735 Fils/m^3

2) Results of Financial Analysis

FIRR	NPV (JD)	Unit Water Price (Fils)
5.4%	45,098	331

Note: Discount Rate=5%

3) Results of Economic Analysis

EIRR	NPV (JD)	Unit Water Price (Fils)
15.7%	464,017	486

Note: Discount Rate=10%

4) Evaluation

This project is financially feasible with the FIRR of 5.4%, NPV of 45,098 JD and the unit water price of 331 fils per m^3. Also, it is economically substantially feasible with the EIRR of 15.7%, NPV of 464,017 JD and the unit water price of 486 fils per m^3.

The project is placed 4th in terms of both financial and economic feasibility out of the 5 projects concerned. The value of FIRR is above the discount rate, and the value of EIRR is by more than 50% higher than the OCC. Therefore, the project can be judged to be sufficiently worthwhile and suitable for implementation.

(7) Ma'an City

1) Preconditions

(a) Expected Reduction of Physical Loss (Unit: m^3/year)

Year	2010
Reduction of Physical Loss	331,100

(b) Investment Costs (Unit: JD)

Investment Costs	Local Components		Foreign Components	
952,416	100%	952,416	0%	0

(c) Implementation Schedule

2003	2004	2005	2006	2007	2008

(d) O & M Costs (Unit: JD)

Year	2010
O & M Costs	10,764

(e) Water Tariff (Unit: Fils/m^3)

2004	2005	2006	2007	2008	2009	2010
294	303	312	321	331	341	351

Starting in 2005, the average wastewater tariff per m^3 was assumed to be increased at the annual rate of 3% up to 2010.

(f) Unit Benefits of Municipal Water: 735 Fils/m3

2) Results of Financial Analysis

FIRR	NPV (JD)	Unit Water Price (Fils)
9.8%	556,247	249

Note: Discount Rate=5%

3) Results of Economic Analysis

EIRR	NPV (JD)	Unit Water Price (Fils)
23.2%	986,240	348

Note: Discount Rate=10%

4) Evaluation

This project is financially solidly feasible with the FIRR of 9.8%, NPV of 556,247 JD and the unit water price of 249 fils per m^3. Also, it is economically remarkably feasible with the EIRR of 23.2%, NPV of 986,240 JD and the unit water price of 348 fils per m^3.

The project is placed 3rd in terms of both financial and economic feasibility out of the 5 projects concerned. The value of FIRR is almost twice the discount rate, the value of EIRR is more than double the OCC, and the financial unit water price is considerably lower than the current level. Therefore, the project is judged to be very much worthwhile and suited for early implementation.

(8) 5 Water Networks Rehabilitation Projects Combined

1) Preconditions

(a) Expected Reduction of Physical Loss (Unit: m^3/year)

Year	2010
Reduction of Physical Loss	1,952,800

(b) Investment Costs (Unit: JD)

Investment Costs	Local Components		Foreign Components	
7,845,519	94%	7,350,879	6%	494,640

(c) Implementation Schedule

2003	2004	2005	2006	2007	2008

(d) O & M Costs (Unit: JD)

Year	2010
O & M Costs	71,032

(e) Water Tariff (Unit: Fils/m^3)

2004	2005	2006	2007	2008	2009	2010
320	330	339	350	360	371	382

Starting in 2005, the average wastewater tariff per m^3 was assumed to be increased at the annual rate of 3% up to 2010.

(f) Unit Benefits of Municipal Water: 735 Fils/m^3

2) Results of Financial Analysis

FIRR	NPV (JD)	Unit Water Price (Fils)
6.3%	1,009,217	334

Note: Discount Rate=5%

3) Results of Economic Analysis

EIRR	NPV (JD)	Unit Water Price (Fils)
17.2%	3,886,581	465

Note: Discount Rate=10%

4) Evaluation

The results of financial and economic analysis of the five water networks rehabilitation projects combined are that they are financially feasible with the FIRR of 6.3%, NPV of 1,009,217 JD and the unit wastewater price of 334 fils per m^3. It is also economically solidly feasible with the EIRR of 17.2%, NPV of 3,886,581 JD and the unit wastewater price of 465 fils per m^3.

The project is financially feasible on conditions that the municipal water tariff be raised at the annual rate of 3% since 2005 up to 2010. As a result, the tariff will go up to 371 fils per m3 on average in 2010 from the current 320 fils per m^3.

The FIRR of 6.3% is better than the assumed discount rate of 5%, and also the EIRR of 17.2% is much better than the OCC of 10%. As a conclusion, these projects are judged as a whole to be sufficiently worthwhile and suitable for implementation.

4.6.3 Preparation of Projected Financial Statements

(1) Preconditions

The projected financial statements, namely the income statement, the funds statement and the balance sheet were prepared.

In preparing projected financial statements, the following preconditions were set:

Item	Values, etc.
Financing resources	80% : External; 20%: Local
Financing terms	Repayment period: 30 years
	Grace period: 5 years
	Annual interest rate: 4%
Inflation rate	2%/a
Executing Entity	Public
Corporate Tax	0%

(2) Evaluation of Projected Financial Statements

The financial statements for the five water networks rehabilitation projects combined shown in Table 4.6.3-1 are summarized by the representative managerial indices as follows:

(Unit: %)

Projects	Profit/ Revenues	Working Capital/ Revenues	Profit/ Liabilities and Capital
	Up to 2020	Up to 2020	Up to 2020
Water Networks Rehabilitation	25.7	19.4	2.6

For the sake of comparison analysis, it can be stated that the standard level would be 10% for the profit to revenues ratio, 10% for the working capital to revenues ratio, and 5% for the profit to liabilities and capital ratio.

Regarding the profit to revenues ratio, the five water networks rehabilitation projects combined have been found to be perfectly OK with the calculated value more than 2.5 times the standard level. With regard to the working capital to revenues ratio also, the projects are highly sustainable with almost two times the value compared with the desired level.

With respect to the profit to liabilities and capital ratio, the projects would not be up to the standard level. However, this point should not be overemphasized because these undertakings of social nature are essentially not profit-oriented and, therefore, the estimated values should be regarded as acceptable.

In conclusion, it can be stated that the projects concerned would be financially highly sustainable under the afore-mentioned preconditions.

Table 4.6.3-1 Financial Statements of 5 Water Network Rehabilitation Projects Combined

(Unit: JD at Current Prices)

Item	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(1) Income Statement																	
Revenues	0	229,899	402,098	447,586	639,119	714,203	798,281	798,281	798,281	798,281	798,281	798,281	798,281	798,281	798,281	798,281	798,281
O & M Cost	0	11,883	22,545	22,996	78,686	80,260	81,865	81,865	81,865	81,865	81,865	81,865	81,865	81,865	81,865	81,865	81,865
Depreciation	0	0	0	0	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693
Interest Payment	134,930	247,954	299,773	351,591	351,591	351,591	337,527	323,463	309,400	295,336	281,273	267,209	253,145	239,082	225,018	210,954	196,891
Expenditures	134,930	259,838	322,318	374,587	693,970	695,544	683,085	669,022	654,958	640,894	626,831	612,767	598,704	584,640	570,576	556,513	542,449
Profit Before Tax	-134,930	-29,939	79,780	72,999	-54,851	18,659	115,196	129,259	143,323	157,386	171,450	185,514	199,577	213,641	227,705	241,768	255,832
Tax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Profit After Tax	-134,930	-29,939	79,780	72,999	-54,851	18,659	115,196	129,259	143,323	157,386	171,450	185,514	199,577	213,641	227,705	241,768	255,832
	(up to 2020)																
Average Profit Before Tax to Revenues Ratio	17.8%																
Average Profit After Tax to Revenues Ratio	17.8%																
(2) Funds Statement																	
Profit After Tax	-134,930	-29,939	79,780	72,999	-54,851	18,659	115,196	129,259	143,323	157,386	171,450	185,514	199,577	213,641	227,705	241,768	255,832
Loans+Budget	3,373,249	2,825,608	1,295,455	1,295,455	0	0	0	0	0	0	0	0	0	0	0	0	0
Depreciation	0	0	0	0	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693	263,693
Sources	3,238,319	2,795,669	1,375,235	1,368,454	208,842	282,352	378,889	392,952	407,016	421,079	435,143	449,207	463,270	477,334	491,398	505,461	519,525
Capital Works	3,373,249	2,825,608	1,295,455	1,295,455	0	0	0	0	0	0	0	0	0	0	0	0	0
Payment of Principal	0	0	0	0	0	351,591	351,591	351,591	351,591	351,591	351,591	351,591	351,591	351,591	351,591	351,591	351,591
Working Capital	-134,930	-29,939	79,780	72,999	208,842	-69,239	27,298	41,361	55,425	69,489	83,552	97,616	111,680	125,743	139,807	153,870	167,934
Applications	3,238,319	2,795,669	1,375,235	1,368,454	208,842	282,352	378,889	392,952	407,016	421,079	435,143	449,207	463,270	477,334	491,398	505,461	519,525
	(up to 2020)																
Average Working Capital to Revenues Ratio	10.7%																
(3) Balance Sheet																	
Liabilities	2,698,599	4,676,525	5,583,344	6,490,163	6,490,163	6,138,572	5,786,981	5,435,390	5,083,800	4,732,209	4,380,618	4,029,027	3,677,437	3,325,846	2,974,255	2,622,665	2,271,074
Capital	539,720	1,357,464	1,825,880	2,287,515	2,232,664	2,251,323	2,366,518	2,495,777	2,639,100	2,796,486	2,967,936	3,153,450	3,353,027	3,566,668	3,794,373	4,036,141	4,291,973
Liabilities and Capital	3,238,319	6,033,988	7,409,224	8,777,678	8,722,826	8,389,894	8,153,499	7,931,168	7,722,900	7,528,695	7,348,555	7,182,478	7,030,464	6,892,514	6,768,628	6,658,806	6,563,047
Current Assets	-134,930	-164,869	-85,089	-12,090	196,751	127,513	154,810	196,172	251,597	321,086	404,638	502,254	613,933	739,677	879,484	1,033,354	1,201,288
Fixed Assets	3,373,249	6,198,857	7,494,313	8,789,768	8,526,075	8,262,382	7,998,689	7,734,996	7,471,303	7,207,610	6,943,917	6,680,224	6,416,531	6,152,838	5,889,145	5,625,452	5,361,758
Assets	3,238,319	6,033,988	7,409,224	8,777,678	8,722,826	8,389,894	8,153,499	7,931,168	7,722,900	7,528,695	7,348,555	7,182,478	7,030,464	6,892,514	6,768,628	6,658,806	6,563,047
	(up to 2020)																
Average Profit Before Tax to Liabilities and Capital Ratio	1.8%																

4.7 IEE for Municipal Water Networks Rehabilitation

(1) Project Components and Activities

The target areas for the Pre-feasibility study include the following:
- South Amman
- Madaba city
- Karak city
- Tafilah city
- Ma'an city

The component of the project will mainly be replacement of aged pipes where water losses are identified.

(2) Environmental Impacts Screening

The project areas for the above five area and cities are within the residential areas. Because of the similarity of environmental conditions in these areas and the common project activity, Table 4.7.1-1 is used for a screening of the environmental impacts instead of an environmental examination matrix.

Table 4.7.1-1 Environmental Impacts Screening

Environmental Elements		Negative Impacts		
		Significant	Moderate	None
Social Environment	Resettlement			○
	Economic Activity		○	
	Traffic & Living Facilities		○	
	Community Separation			○
	Archaeological & Cultural Properties			○
	Water Right / Right of Common			○
	Public Health & Sanitation			○
	Solid Waste		○	
	Risk of Disaster			○
Natural Environment	Topography & Geography			○
	Soil Erosion			○
	Groundwater			○
	Lake and Rivers			○
	Coastal Area			○
	Flora & Fauna			○
	Meteorology			○
	Landscape			○
Environmental Pollution	Air Pollution			○
	Water Pollution			○
	Soil Pollution			○
	Noise & Vibration		○	
	Ground Subsidence			○
	Offensive Odor			○
	Hazardous Substances			○

Because the construction work for the project will be within the area served by existing

water supply system, and new pipelines will be laid at the original places to replace the old ones, the project will be somewhat of the nature of repair work for the pipelines. Therefore, some factors such as land acquisition, construction site preparation will not be involved. Considering this, no impacts are anticipated on the natural environment elements, as well as some social environmental elements as resettlement, community separation, and archaeological property.

It goes without saying that the positive impacts of the project on the social environment will be significant because it will bring about a remarkable improvement of the water supply condition in the project areas. With the decrease of water losses after the network rehabilitation, water can be more adequately and safely supplied to the consumers. The direct impact is positive on public health and sanitation.

On the other hand, the rehabilitation work will involve excavation and other jobs using machineries. This will more or less disturb the normal life of residents near the work site and cause hindrance of traffic condition. Certain impacts are also anticipatable on economical activity, e.g. shops near the work site. Solid wastes will be unavoidably generated during the rehabilitation work.

Regarding the environmental pollution factors, noise and vibration may be a problem from the project especially in the densely populated area. Other pollutions are not likely to occur during the rehabilitation work.

(3) Consideration on Impacts Mitigation

From Table 4.7.1 and the above discussion, possible negative impacts are identified on four environmental items - economic activity, traffic and living facility, solid waste, noise and vibration. During a construction work in the city area, it may be difficult to erase completely such impacts, but certain measures can be taken to mitigate the impacts as far as possible. For instance, before the excavation and construction of a pipeline, the condition in the related area should be well investigated to identify the locations where the impacts may be significant. Then the work should be well planned and organized so that the period of the work at these locations can be shortened.

4.8 Project Evaluation

In performing financial analysis, it was premised first of all that the average municipal water tariff would be raised gradually every year from the current 294 fils per m^3 finally to 351 fils in 2010 outside the Amman Governorate. In the Amman Governorate the tariff would be increased from the current 411 fils per m^3 ultimately to 491 fils in 2010.

In performing financial analysis also, the discount rate was assumed as 5% in anticipation of the provision of a kind of soft loans for the implementation of the projects.

The summary of the economic and financial analysis of the 5 projects concerned is as follows:

Economic/Financial Criteria

Municipal Water Network Rehabilitation Projects	FIRR (%)	Unit Water Price	EIRR (%)
South Amman	-0.7	899	3.8
Madaba	20.4	111	49.5
Karak	13.1	181	28.8
Tafielah	5.4	331	15.7
Ma'an	9.8	249	23.2
Total	6.3	334	17.2

Note: Discount Rate: Financial=5%, Economic=10%

Managerial Indices (Unit: %)

Project	Profit/Revenues*	Working Capital/Revenues**	Profit/Liabilities and Capital***
Municipal Water Network Rehabilitation Projects	25.7	19.4	2.6

Note: Standard Levels:*=10%, **=10%, ***=5%

As the above table shows, the four projects excepting the South Amman project have turned out to be financially as well as economically sufficiently feasible with their FIRR's and EIRR's exceeding the assumed discount rates. Especially, both Madaba and Karak projects are excellent with markedly high FIRR's and EIRR's on one hand, and with conspicuously low unit water prices on the other. When the five projects are combined together, it is revealed that both FIRR and EIRR are at a reasonably high level compared with discount rates, and also the unit wastewater price is substantially low compared with the set level. In terms of managerial indices, both profitability and liquidity are excellent, attesting to the high financial sustainability of the projects as a whole.

In conclusion, the 5 municipal water network rehabilitation projects combined are found to be financially as well as economically feasible from every angle, and therefore recommended as a solid candidate for implementation.

For the environmental evaluation, it is pointed out by IEE (Chapter 4.7) that no serious negative environmental impacts will not occur by the implementation of the rehabilitation Works.