

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

WATER AUTHORITY OF JORDAN
MINISTRY OF WATER AND IRRIGATION
THE HASHEMITE KINGDOM OF JORDAN

**THE STUDY
ON
THE IMPROVEMENT
OF
THE WATER SUPPLY SYSTEM
FOR
THE ZARQA DISTRICT
IN
THE HASHEMITE KINGDOM OF JORDAN**

FINAL REPORT

SUPPORTING REPORT

JULY 1996

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**TOKYO ENGINEERING CONSULTANTS
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**THE STUDY ON
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FOR THE ZARQA DISTRICT**

SUPPORTING REPORTS

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PART-I

LONG TERM DEVELOPMENT PLAN

A. WATER RESOURCES

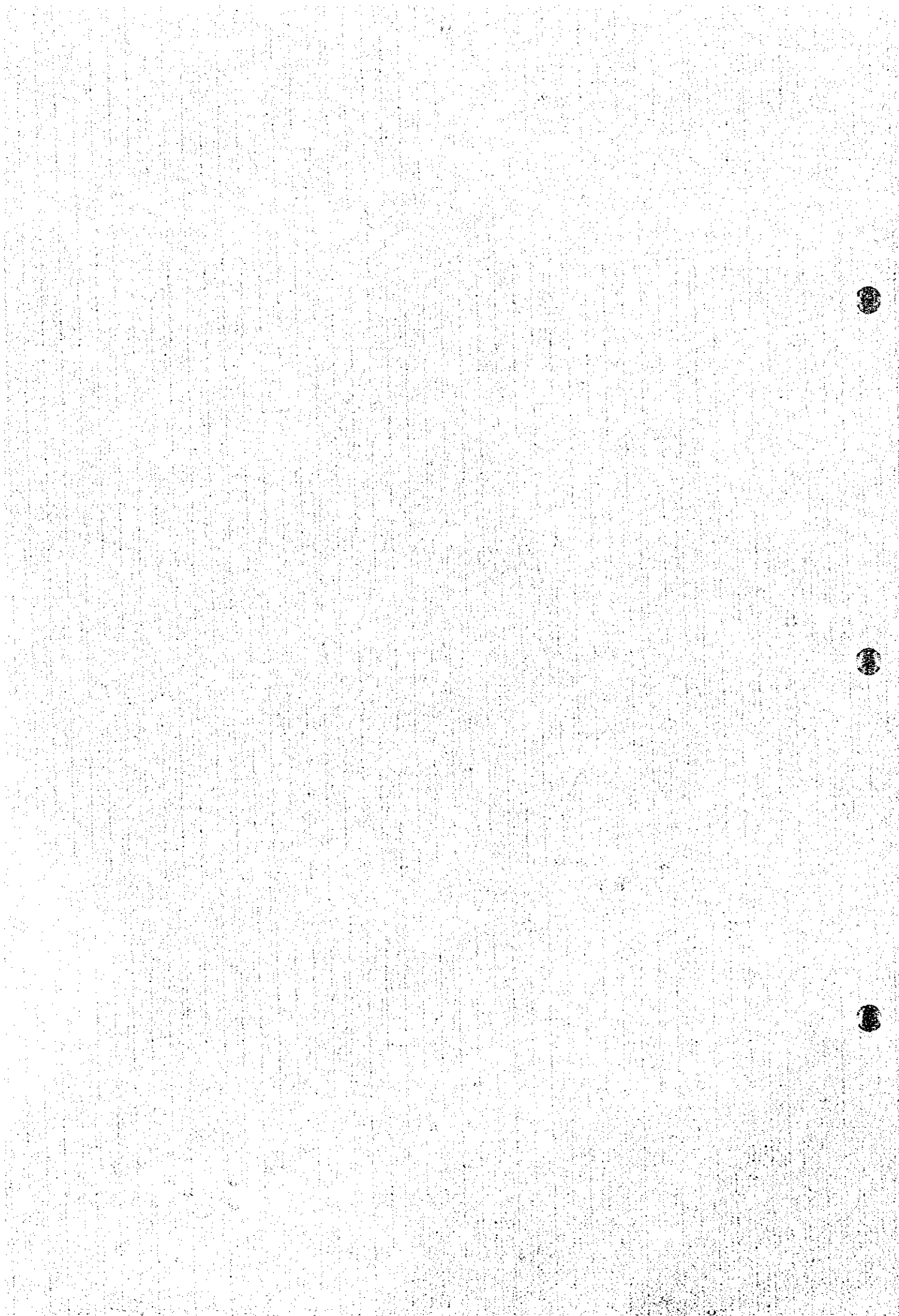


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Part A HYDROGEOLOGY

1 General

Two groundwater basins, located within Zarqa governorate, are hydrogeologically known as Amman- Zarqa and Azraq Basins, as shown in Fig.- A1. About 50% of the water wells in Jordan are distributed in these two basins around 1000 well. These wells are mainly used for agriculture and industry. Only small portion of these wells (41 wells) are used for the water supply purposes of Zarqa district and main part of Amman governorate.

In order to identify the ground water resources status of these important basins, discussion takes place about the geology and hydrogeology of the area concerned.

2 General Geology

Geological succession of North Jordan is presented in Table-A1.

2.1 Amman-Zarqa Basin

The deepest and oldest geological unit is the Zarqa group of Triassic - Jurassic age in the study area. This group is divided into two formations, Z1 the main formation of Triassic age and the Azab formation Z2 of Jurassic age. The Kurnub group of Lower Cretaceous age overlays the Zarqa group. This group is divided into two units, the Subeihi formation (K2), which is the upper part of the group, and Aarda formation (K1) the lower part of the group.

All outcropping formations in the study area are of Upper Cretaceous - lower Tertiary age, belonging to the younger Ajlun and Belqa groups. Ajlun group of Upper Cretaceous age consists of seven stratigraphic units A1 - A7 and overlays the Kurnub group. The younger Belqa group of Upper Cretaceous - lower Tertiary age overlays the Ajlun group and consist of three stratigraphic units in the study area.

Table - A1 GEOLOGICAL SUCCESSION OF NORTH JORDAN

PERIOD	EPOCH	GROUP	FORMATION	CODE
Quaternary	Recent	Alluvial	& Aeolian Rocks	
Tertiary	Pliocene	Plateau	Azraq	
	Pliocene		Sirhan	
	Miocene	Volcanics	Upper Basalt	
	Oligocene		Basalt Tuff	
			Middle Basalt	
			Lower Basalt	
	Eocene	Beqaa	Wadi Shallala	B5
	Paleocene		Rijam	B4
	Maestrichtian		Muwaggar	B3
Upper Cretaceous	Campian	Ajlun	Amman	B2
	Santonian		Wadi Chudran	B1
	Turonian		Wadi Sir	A7
	Cano-manian	Ajlun	Shueib	A5-6
			Hummar	A4
			Fueis	A3
			Haur	A1-2
Lower Cretaceous			Subeifi	R2
			Aarda	R1
Jurassic		Zarqa	Azab	Z2
Triassic			Ilain	Z1

2.2 Al- Azraq Basin

The major geological feature within the study area is Al Azraq depression. It is of tectonic origin consisting of a narrow asymmetric basin formed between fault zones and separated from Sirhan by a gentle arch. Within Al Azraq basin, a large sequence of sediments (> 3000m thick) has accumulated since the Paleozoic.

The Kurnub sandstone group of Lower Cretaceous represents the lower part of the sequence. This group is overlain by a very thick sequence of carbonate rocks limestone, sandy limestone and marl mainly, with some phosphate, bituminous and cherts.

This sequence is divided into two groups, Ajlun group of Upper Cretaceous age (A1 - A7) in Al Azraq and the younger Belqa group of Upper Cretaceous - Lower Tertiary age (B1 - B5) in Al Azraq.

The recent Oligocene - Quaternary consist of volcanic rocks basalt and tuff interbedded with sandy limestone, marl and gypsum of the Sirhan and Azraq formations.

3 Amman-Zarqa Basin Aquifer System

The geological and structural conditions of the study area have a major effect and control on the hydrogeological condition of the basin.

Previous studies carried out by Parker 1970, H. H 1983, Hsi 1991, indicate the presence of five groundwater units in the basin: Basalt aquifer, Amman - Wadi Sir (B2/A7) aquifer, Hummar (A4) aquifer, Naur (A1-2) aquifer and Kurnub (K) aquifer. These units are classified into upper, middle and lower aquifer systems.

3-1 Upper Aquifer System

This system consists of three aquifers; alluvial aquifer, Basalt aquifer and Amman - Wadi Sir (B2/A7) aquifer.

(1) Alluvial aquifer

The Sukhna gravel forms a small alluvial aquifer along Seil Zarqa area. This aquifer overlies and hydraulically connected with the underlying Hummar limestone aquifer. Its saturated thickness is about 20 m and the water levels are a few meters below surface, with an average well yield of 2 l/s to 10 l/s. The aquifer has been polluted as a result of irrigation return flow and infiltration from the poor quality Seil Zarqa flows.

(2) Basalt aquifer

This aquifer covers most of wadi Dhuleil and northeastern desert areas, recharging from the north Syrian territory as an under flow to the northeast desert of Jordan. It consists mainly of basalt interbedded with clay beds and volcanic ashes. basalt thickness in wadi Dhuleil area ranges between 20m to 110m, and becomes thicker towards north and northwest.

There is a hydraulic connection between this aquifer and the B2 aquifer. Below it, where in the pumping test analysis, these two aquifers were considered as one unit.

(3) Amman - Wadi Sir (B2/A7) Aquifer

This aquifer outcrops in the western highlands and southern escarpment. It is considered as the major productive aquifer within the basin.

Geologically it comprises two formations; Amman (B2) and Wadi Sir (A7). The B2 formation consists of limestone and marl as well as phosphatic layers interbedded with chert, outcropping extensively in the area, with a thickness ranging between 2m to 150m. The older A7 formation consists of thinly bedded crystalline limestone and chalky limestone with some chert layers. As a result, this aquifer is characterized by good joints and fissures system as well as solution channels and karstic feature.

Along the Zarqa river (Seil Zarqa), this aquifer is overlain by wadi - fill deposits, ranging in thickness from 10m - 15m at Ruseifa to 1m - 20m at Zarqa. In the area between Zarqa and Sukhna, this aquifer is absent and the wadi deposits rest on the Hummar formation directly.

As for the type of the aquifer, it is mainly considered as a water table aquifer, but in some locations, where it is tapped by the B1 clay, this aquifer can be considered as confined. The base of this aquifer is defined by the Shueib marls, and the average thickness of this aquifer is about 180m in Amman and Ruseifa areas. According to WAJ Team-1989, the transmissivity of this aquifer ranges between 9 m²/day to > 900 m²/ day.

3-2 Middle Aquifer System

This system comprises two aquifers; Hummar formation (A4) and Naur formation (A1 - 2).

(1) Hummar (A4) aquifer

This formation consists of dolomitic limestone. It outcrops in the northern part of the upper Amman - Zarqa basin, but generally it occurs at depths through most of the basin. This

aquifer is characterized by a good jointing system and karstification features. Its base is the Fuheis marl (A3) and confined by Shuib marls (A5 - 6).

According to Parker, 1979 transmissivity and permeability values for this aquifer range between 230 - 28,000 m²/day and 0.5 - 60 m/day respectively.

(2) Naur (A1 - 2) Aquifer

This aquifer consists of limestone interbedded with marl. Its base is the A1 marl and separated from the A4 aquifer by a thick sequence of A3 marls.

3-3 Lower Aquifer System

The Kurnub aquifer outcrops along the Sweilih anticline, north of upper Amman- Zarqa basin, while it occurs at depths about 450 m south of Amman and at 500 -500m depths near Zarqa. This aquifer is considered as confined, separated from A1-2 aquifer by thick layers of shale and clay. According to Howard Humphreys, 1978, transmissivity values range between 2-1,700 m²/day, with an average of 200 m²/day.

4 Al-Azraq Basin Aquifer System

The aquifer system in this basin is divided into three sub systems:

- upper aquifer system: including the Basalt, Wadi shallala/sirhin and Rifam aquifers.
- middle aquifer system: including Amman (B2), Wadi Chudran (B1) and Wadi Sir (A7) aquifers. This system is separated from the upper aquifer by thick marl sequence of Muwaqqar (B3) formation.
- lower aquifer system: This system is represented by the Kurnub sandstone aquifer of Lower Cretaceous age. The whole Ajlun series A1- A6 consisting mainly of limestone and marls, separates this aquifer system from the middle one.

Our discussion in this part is concentrated on the WAJ well field aquifer system; that is the upper aquifer system.

Evaluation of the previous studies, interviews with WAJ officers and site investigations indicate that the major source for groundwater in Al Azraq basin is the shallow aquifer system due to water quality condition and economical considerations.

(1) Basalt Aquifer

This aquifer is considered as the main aquifer system. It is composed of basalt mainly intercalated with limestone and sandstone of Oligocene - Pleistocene age. It outcrops in the

northern part of the Azraq basin, and considered generally to be hydraulically connected with the underlying Rijam aquifer.

Within the WAJ well field, the saturated thickness of this aquifer ranges between 40m to 50m and the depth to water level ranges between 5m to 40m. This heterogeneous unconfined aquifer is characterized by high permeability value, and high transmissivities average between 270 m²/d to 65,000 m²/d.

(2) Wadi shallala (B5) Aquifer

This formation underlies the Basalt aquifer in the well field area, consisting of marl, marly limestone and clay of Eocene age, with an average thickness of 70m. South of the well field area, this formation is replaced by Sirhan formation of Pliocene age, which consists of sandstone and marl mainly. Within the well field, shallal formation is considered as a low permeability aquifer, separating Basalt aquifer from Rijam aquifer.

(3) Rijam (B4) Aquifer

This aquifer consists of limestone, marly limestone and marl of Upper Cretaceous - lower Eocene age, outcropping within the Azraq basin.

In north Azraq, this aquifer is underlain by the B3 formation of very low permeability and overlain by the Basalt aquifer. So this aquifer can be considered as unconfined with an average saturated thickness of 60m and a water level range of between 20m to 40m.

Pumping test carried out by WAJ indicates that transmissivities vary between 6m²/day to 230m²/day and a permeability range between 0.5 m/day to 60 m/day.

Part B WAJ WELL FIELD

This section presents and discusses water abstraction condition within the governorate. This discussion includes presentation and evaluation of major water resources, and groundwater level condition as well as abstraction and consumption rates.

1 GENERAL

Zarqa governorate depends totally on groundwater to cover its water demand. This water is abstracted from Amman-Zarqa and Azraq basins, which are considered as the major productive groundwater basins in Jordan.

1-1 Amman-Zarqa Basin

This basin has an area of 3,900 km². Recharge sources to this basin are natural and artificial types. Natural recharge sources are the lateral flow of groundwater from the western highlands, percolation of surface and rain water. Return flow of domestic water through leakage from the water supply system forms a non-negligible part of recharge to this basin as an artificial source, where it was estimated by WAJ Team-1989 to be about 10 MCM. Major abstraction in this basin is from the upper and middle aquifer systems. The total number of active groundwater wells within this basin is 670 wells. Table -A2 presents the number of governmental and private active wells and its uses within this basin.

**Table - A2 NUMBER OF GOVERNMENT AND PRIVATE WELL
IN AMMAN AND ZARQA BASIN**

as of 1994

Purpose	Government Well	Private Well	Total
Domestic	109	11	120
Irrigation	5	457	462
Industry	-	46	46
Water Sale	-	2	2
Total	114	516	630

Total recharge to this basin is 88 MCM, according to salameh. etl-1993 while the total consumption from this basin is 190.2 MCM, according to WAJ yearly report -1993. This consumption is divided to:

- 65 MCM for domestic use
- 117.6 MCM for agricultural use
- 7.5 MCM for industrial use

This consumption equals to about 216% of the total recharge to the basin, causing high depletion of the basin.

Several observation wells monitor the water level condition of the groundwater well field in this basin. Data collected from these wells show a gradual water level depression in Dhulail, Zarqa, Awajan and Ruseifa areas. Well location map of these wells is shown in Fig.- A1.

Water level condition for each of the above mentioned areas are discussed according to the available data.

(1) Dhulail Area

Regional depressions in water levels were recorded in this area, where the major drawdown in water level occurred in the B2-A7 aquifer. The water level condition in five observation wells in this area, as shown in Fig.- A2, is as follows:

- TW-15: about 12 m (about 1m/year) of drop in water table were recorded between the years 1970 to 1993.
- TW-6: about 14 m drop within the last 10 years.
- DP-4: about 18 m drop within the last 10 years.
- TW-5: about 5 m drop within the last 10 years.

(2) Zarqa, Awajan Hashemeyeh and Ruscifa Areas

Most of the wells in these areas as presented in Fig.- A3 show a rising condition in water level. This condition can be referred to the return flow from the house cesspools as well as the recharge from Es-Samura wastewater treatment plant, causing a severe pollution for the groundwater source in these areas.

1-2 Azraq Basin

The area of this basin is 12,710 km². Recharge sources for this basin are the lateral flow of ground and surface water from the Syrian mountains. The total number of active groundwater wells within this basin is 583. Table -A3 presents the number of governmental and private wells and its uses within this basin.

Table -A3 NUMBER OF GOVERNMENT AND PRIVATE WELL,
IN AL AZRAQ BASIN

as of 1994

Purpose	Government Well	Private Well	Total
Domestic	35	-	35
Irrigation	6	540	546
Industry	-	2	2
Total	41	542	583

In this basin, major consumption of water is concentrated on the upper aquifer system. Recharge to this basin is about 25 MCM while the total abstraction is about 50.6 MCM, (WAJ yearly report-1993) and divided into :

- 25.4 MCM for domestic use pumped to Aminan and Zarqa areas.
- 25 MCM for agricultural use
- 0.187 MCM for industrial use

This basin is highly depleted, where its total consumption equals about 202% of the total recharge.

Water level records for 4 observation wells in the area show a drop in water level ranging between 1m to 7 m, as presented in Fig.- A3. These observation wells are monitoring the B5/B4 aquifer, which is connected with the overlain Basalt aquifer

2 Water Supply System

Following are the major wells and well fields supplying the governorate with its domestic water demand. It must be taken into consideration that a non-negligible amount of this water is pumped into Amman and Mafraja governorates.

(1) Azraq Well field

This well field includes a total number of 15 water wells under production. Depths of these wells range between 61m to 210m, and vary in pumping rate between 60 m³/hr to 220 m³/hr. Table -A4 presents depth and pumping rate for each well in this field, where total yearly pumping rate is 22.8 MCM.

Table -A4 DEPTH AND DISCHARGE RATE IN AL-AZRAQ FIELD

Well No.	Well Depth (m)	Discharge Rate (m ³ /hr)
Azraq-1	203	170
Azraq-2	212	270
Azraq-3	210	180
Azraq-4	206	170
Azraq-5	204	60
Azraq-6	206	150
Azraq-7	204	170
Azraq-8	202	180
Azraq-9	204	170
Azraq-10	203	180
Azraq-11	61	220
Azraq-12	209	170
Azraq-13	205	170
Azraq-15	210	170
Azraq-18	171	170

Source; WAJ File 1994

(2) Khaldieh & Za'attari Well field

Khaldieh well field is composed of seven wells, pumping with a total rate of 1,200 m³/hr, and the Za'attari wells yield a total rate of 300 m³/hr. These two well fields are supplying Khaw station with a total yearly volume of 13.14 MCM.

(3) Hallabat Well field

This well field is composed of eight wells, where seven are under operation. The depth of these wells range between 132 m to 160 m, and pumping rates range between 25m³/hr to 150 m³/hr. Table -A5 presents depth and present pumping rate for each well within this field. Total yearly pumping rate from this field is 5.14 MCM.

(4) Hashmeyeh Well field

This field consist of four productive wells. These wells range in depth between 103 m to 128 m, and varies in discharge rate between 15 m³/hr to 180 m³/h. Well depth and discharge rate within this field are also presented in Table -A5. The total yearly pumping rate is 3.2 MCM

(5) Awajan Well field

This field is composed of three wells, ranging in depth between 148 m to 184 m, with a pumping rate varying between 100 m³/hr to 300 m³/hr. The total yearly pumping rate is 4.2 MCM, supplying Awajan tank.

(6) Murhib Well field

This field consists of four wells. These wells range in depth between 140 m to 255 m, with a present pumping rate ranging between 10 m³/hr to 40 m³/hr. Total yearly pumping is 0.74 MCM, supplying Awajan tank.

(7) Ruseifa Area Wells

Six groundwater wells are located within Ruseifa area. These wells supply different sectors of the area with their water demand. Total yearly pumping rate is 3.92 MCM.

(8) Unpiped Water Supply

Four groundwater wells were identified within the governorate selling water to the public, especially in summer time. In summer, pumping rate from these wells is about 60 m³/hr., with a duration between 15 hr. to 20 hr. per well. In winter, pumping rate from these wells is also about 60 m³/hr with duration between 8 hr to 10 hr per well.

**Table -A5 DEPTH AND DISCHARGE RATE IN HALLABAT,
HASHEMEYEII, AWAJAN AND MURHIB FIELD**

Well No.	Well Depth (m)	Discharge Rate (m3/hr)
Hallabat-3	na (not available)	0
Ha-3A	132	62
Ha-3B	na	150
Ha-5	160	25
Ha-6	156	90
Ha-7	na	90
Ha-8	137	120
Ha-10	na	50
Hashemeyeh-1	na	15
Hm-2	128	70
Hm-3	103	180
Hm-4	106	100
Awajan-21	148	150
AJ-22	184	100
AJ-23	151	300
Murhib-1	255	10
Mr-2	217	40
Mr-3	140	20
Mr-4	217	15

Source; WAJ File 1994

PART C WATER RESOURCES FUTURE STATUS

1. General

It is clear from the previous presentation that the two major ground water basins supplying the governorate with its water demand are highly exploited. The total consumption is more than twice the recharge (or safe yield) rate. Total yearly water supply to Zarqa area for domestic purpose where the consumption rate increased from 9.39 MCM/year in 1985 to 25.56 MCM in 1993. In this period, two sharp consumption peaks are observed; the first in the period 1989-1990, where the consumption increased from 17.15 MCM to 21.76 MCM,

while the second is in the period 1992-1993, where the consumption increased from 22.75 MCM to 25.56 MCM.

The increase in water demand is normal, as a result of population increase as well as the development and extending of both agricultural and industrial sectors which consume high amounts of water not considered in this study.

The information presented in this part is derived from interviews with the senior staff of MOWI, evaluation of both the recent studies conducted on Jordan groundwater resources and WAJ data bank reports.

In the near future, present water sources will not be enough, and new supplementary sources must be obtained to cover the increasing water demand. Several choices and/or alternatives can be considered to eliminate or at least decrease this problem. These choices and/or alternatives are presented to save water shortage problem all over Jordan, depending on the use of natural water resources and the conservation of these sources.

2. Use Of Natural Water Resources

(1) Disi water supply project: Production from Disi/Muddawara wellfield is expected to start in the year 2000. This project will supply greater Amman area with its water demand for ten years period. The estimated total storage of groundwater in this field is about 100 MCM. After production starts from this project, the total quantity of about 25 MCM water pumped from Azraq wellfield to cover both Amman and Zarqa can be concentrated to cover only for Zarqa.

(2) Yarmouk river water: Since four decades ago, several dam construction projects were proposed to collect the Yarmouk river water, like Maqarin, Mukheiba and Unity dams with capacities of 350 MCM, 200 MCM and 200 MCM respectively. Unfortunately, none of the projects were carried out due to the political complications with other riparian. In 1987 an agreement was signed with Syria for constructing the Unity dam. This dam would bring additional 100 MCM/year of water and partly relieve the increasing domestic water deficiencies. This project, however, stopped in 1989. In the near future within ten years, the Unity dam will be needed to meet the increasing demand.

(3) Peace treaty water: The peace treaty between Jordan and Israel was ratified and concluded in November 1994. The treaty is understood to bring a total of 215 MCM water to Jordan through the following steps:

- Jordan will receive 55 MCM water immediately.

Probably after five years, an additional 70 MCM will be brought to Jordan by constructing a diversion dam in adassiya and several storage dams on Yarmouk river and the Jordan river.

- On the long term period, probably after ten years or even more, the remaining 90 MCM of water will be brought to Jordan by rehabilitation of Jordan river water.

(4) Artificial recharge: This technique can be used as a method of improving the groundwater quality in the highly exploited basins such as Amman-Zarqa and Azraq basins.

(5) Use of brackish water: Recent studies on brackish water resources in Jordan indicate the presence of high amounts of water with a salinity range from 1,500 to 5,000 mg/l. This water can be used in irrigating semi-tolerant and tolerant crops, saving huge amounts of fresh water used for irrigating these crops. Also, by using simple desalinating facilities, this water can replace a non negligible amounts of fresh water used to cover some domestic and industrial demands.

Latest study carried out by JICA in 1994 on brackish water desalination in Jordan valley, shows that about 121 MCM are available for abstraction under safe yield condition from Zarqa aquifer system only. As a result of this study, it is under consideration to construct a desalination center at Al-Kafrein village in the Jordan valley. The center will desalinate about 5 MCM/year of brackish water in the first stage and will be increased in the future.

3. Water Conservation

(1) Wastewater treatment and reuse: The increasing consumption of water for domestic and industrial sectors will result in producing huge quantities of wastewater. Using modern and high standards treatment technique, this waste water can be used for irrigation and industrial demand.

(2) Serious actions should be taken to reduce water consumption for different demands. These actions include:

- Through the media, wise use of water inside the house for different purposes must be presented
- Convince people to carry regular check on the house water connections.
- Convince the farmers to use modern irrigation methods.

FIG.- A1

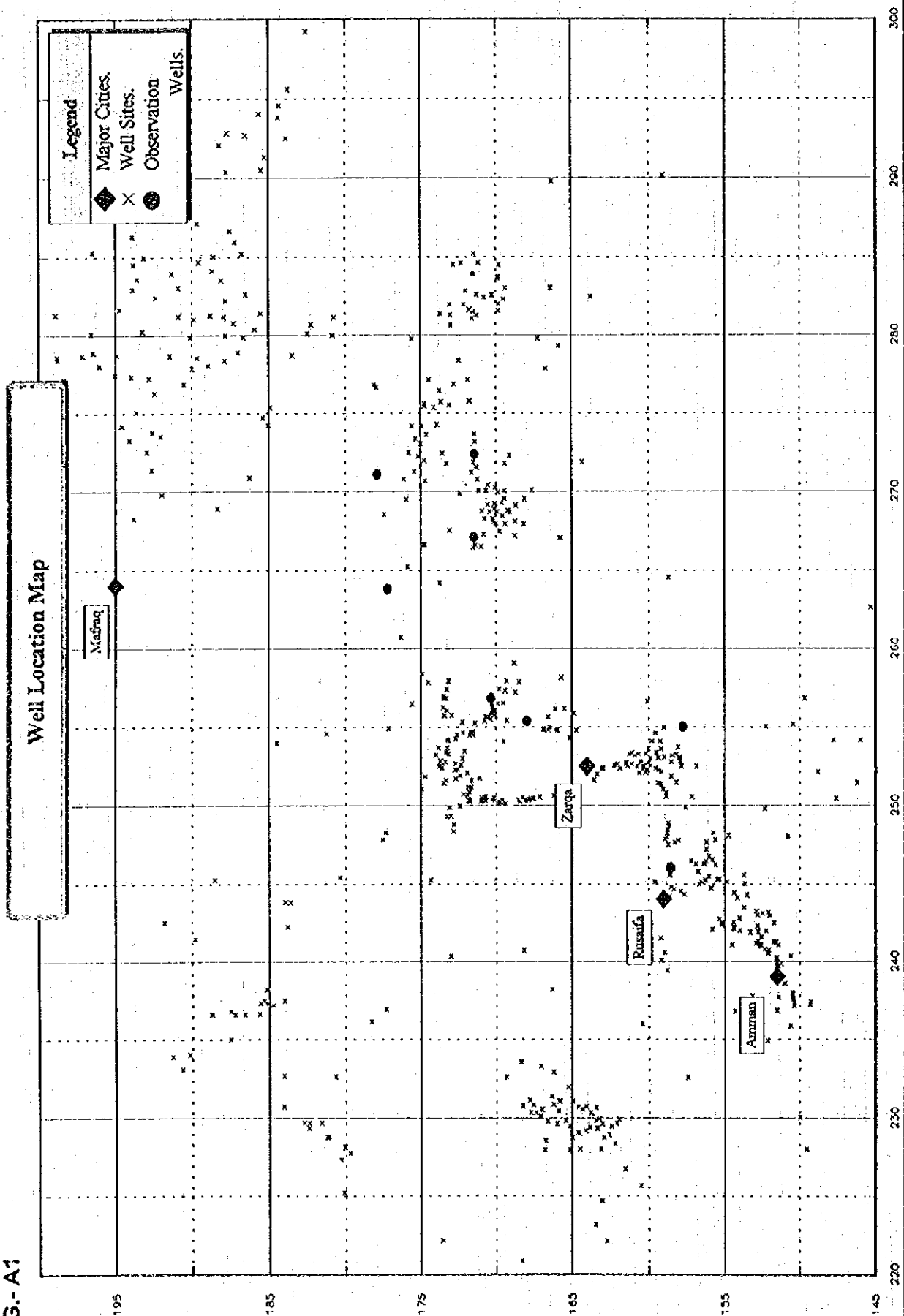


FIG.- A2 (A) WADI DHULAIL BASIN

Source : G.W. Monitoring Sec, MOWI

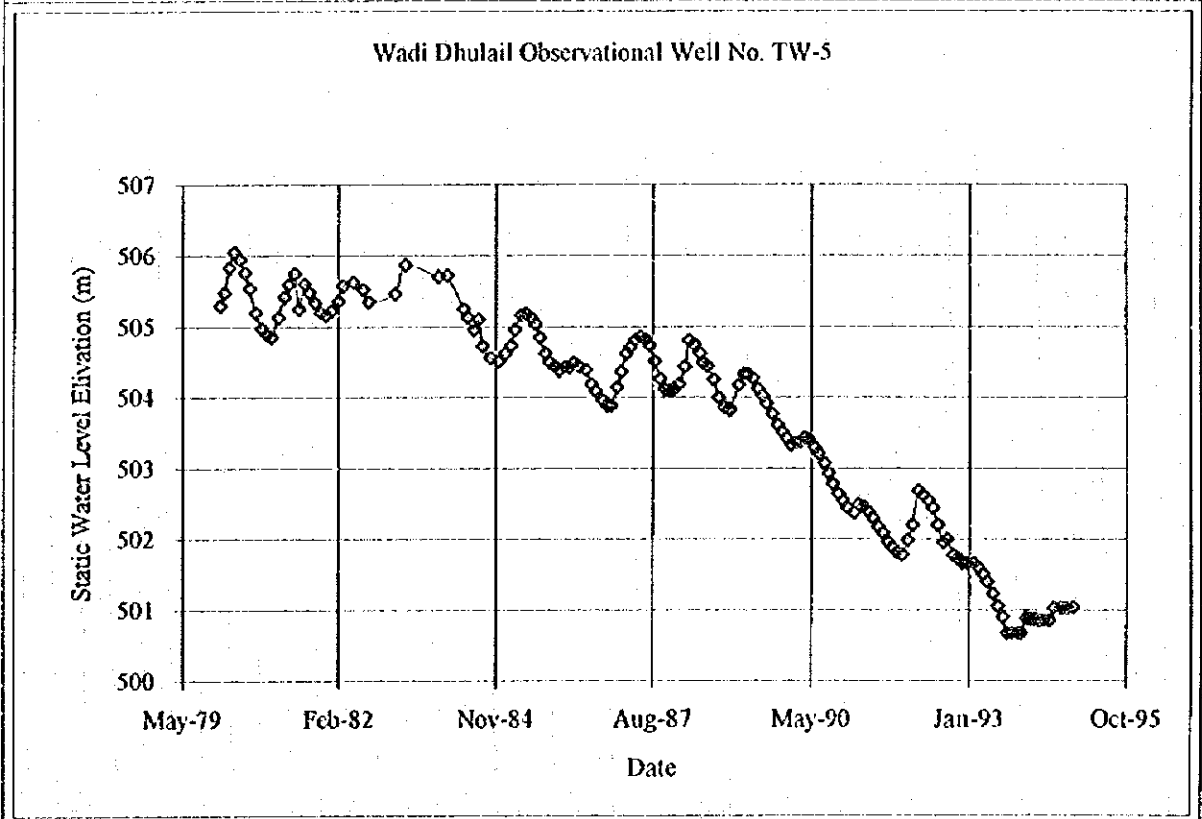
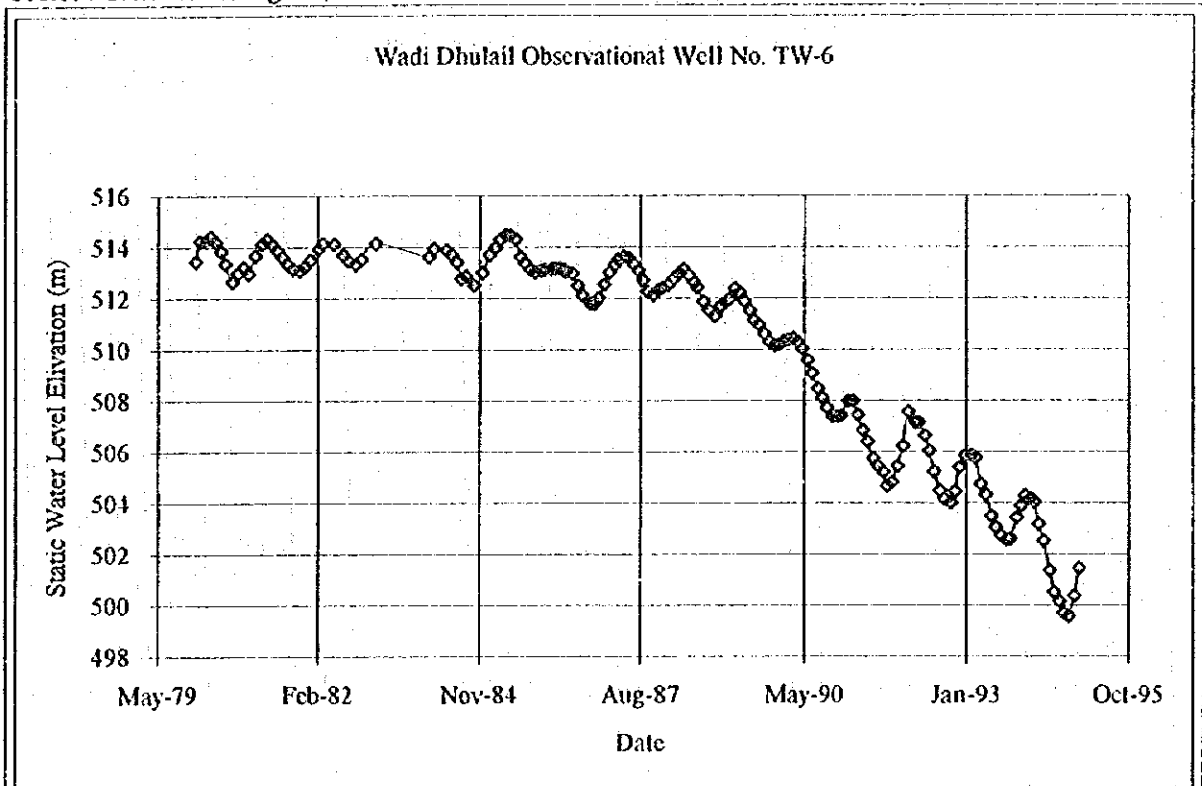


FIG.- A2 (B) WADI DHULAIL BASIN

Source : G.W. Monitoring Sec, MOWI

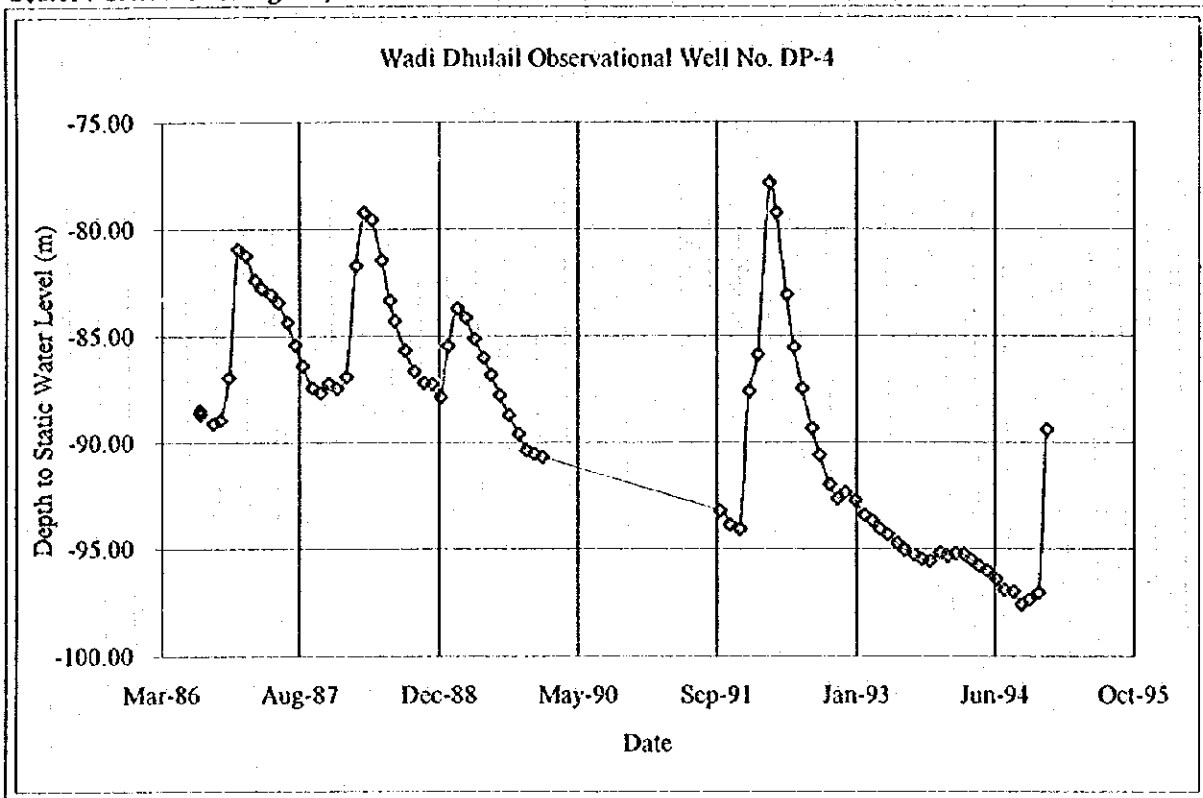


FIG.- A2 (C) WADI DHULAIL BASIN

Source : G.W. Monitoring Sec, MOWI

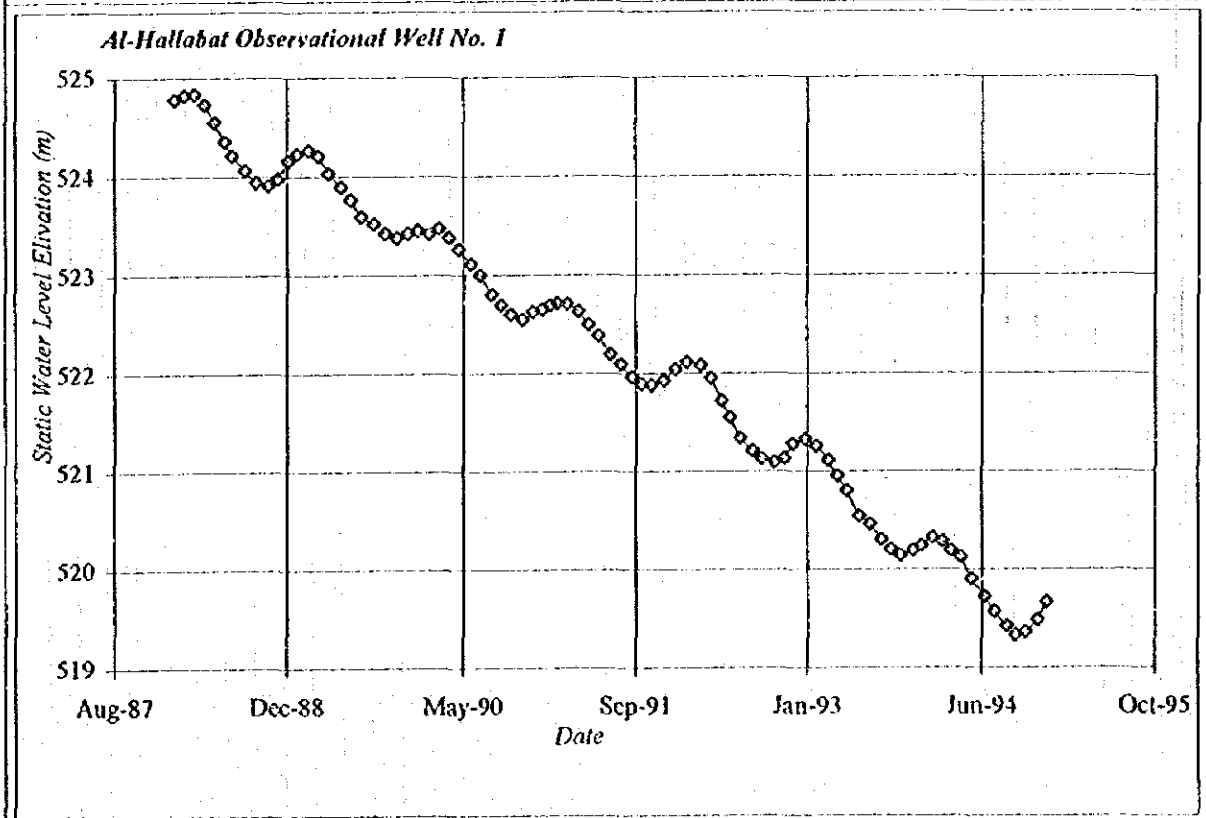
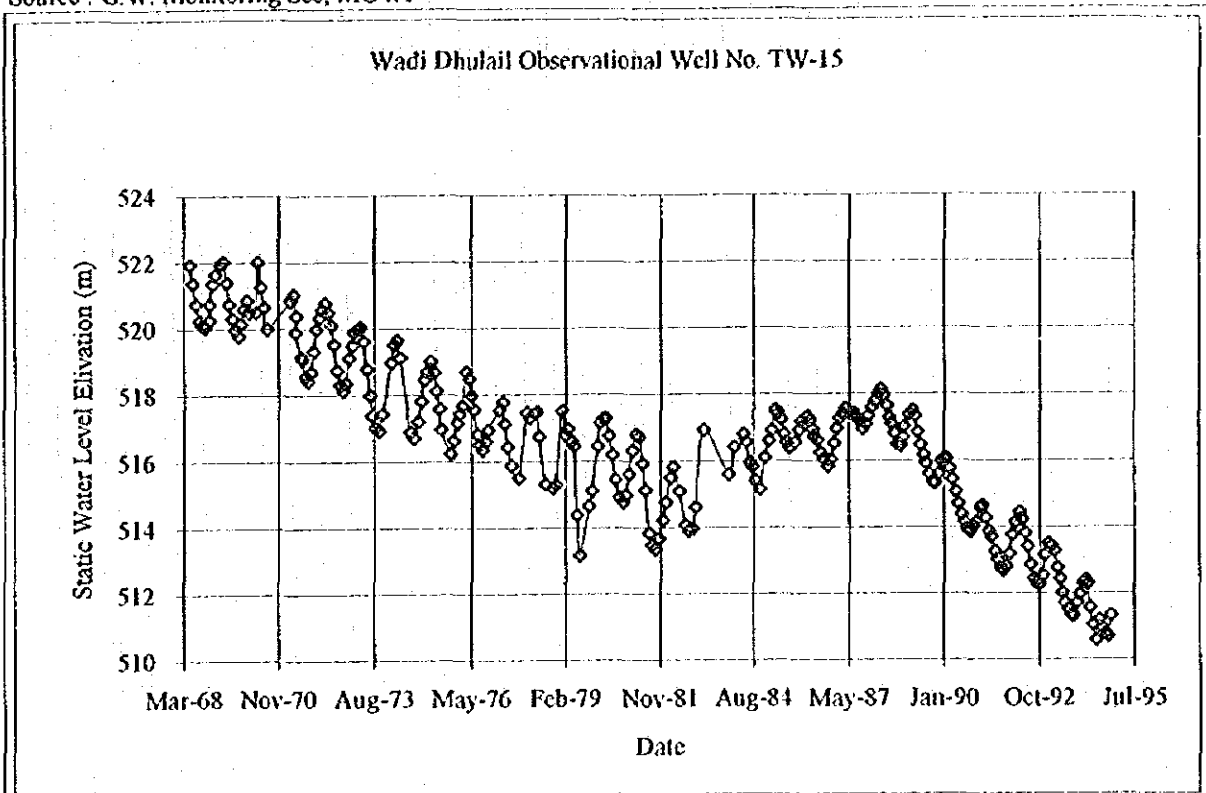


FIG.- A3 (A) ZARQA BASIN

Source : G.W. Monitoring Sec, MOWI

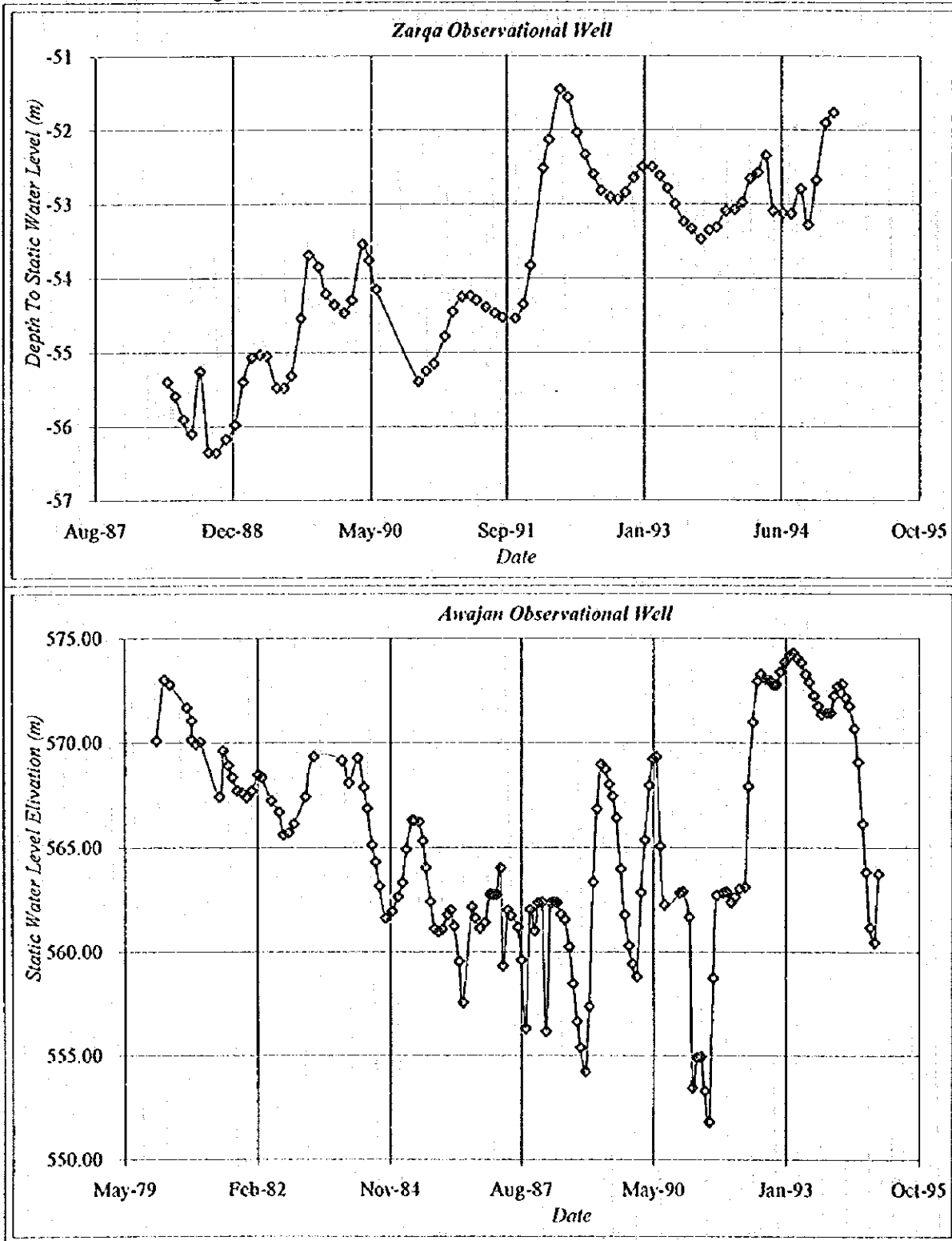


FIG.- A3 (B) ZARQA BASIN

Source : G.W. Monitoring Sec, MOWI.

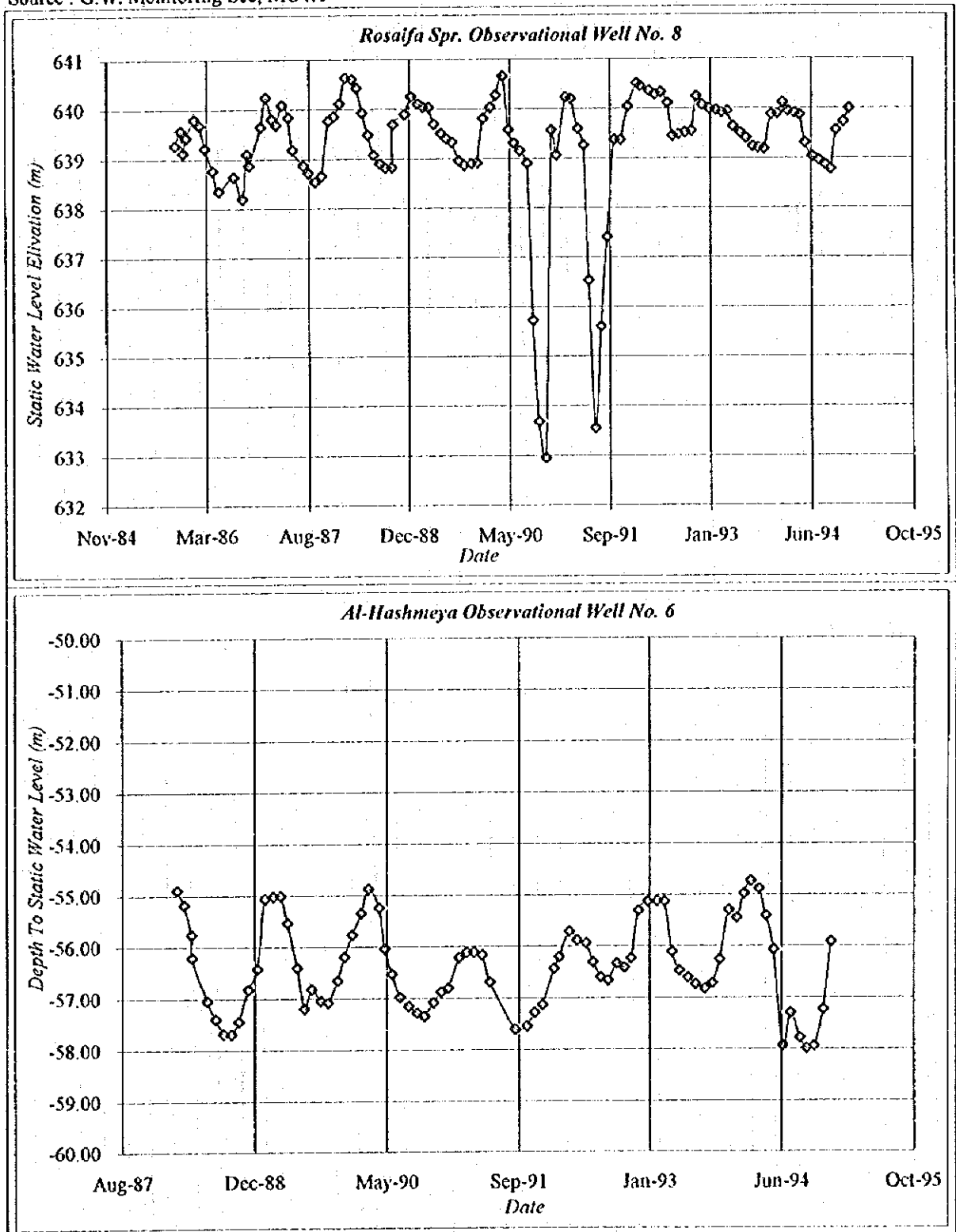


FIG.- A4 (A) AZRAQ BASIN

Source : G.W. Monitoring Sec, MOWI

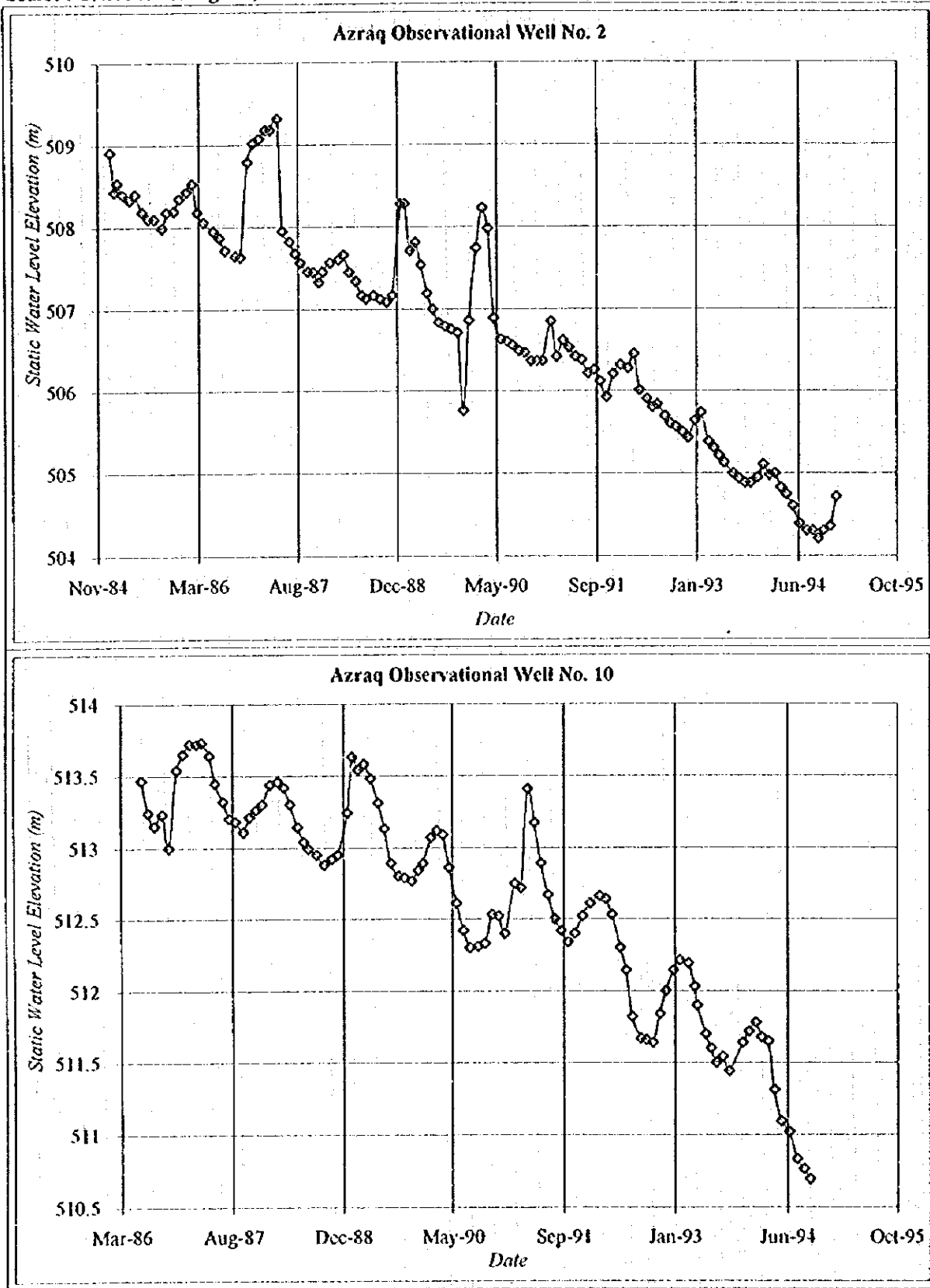
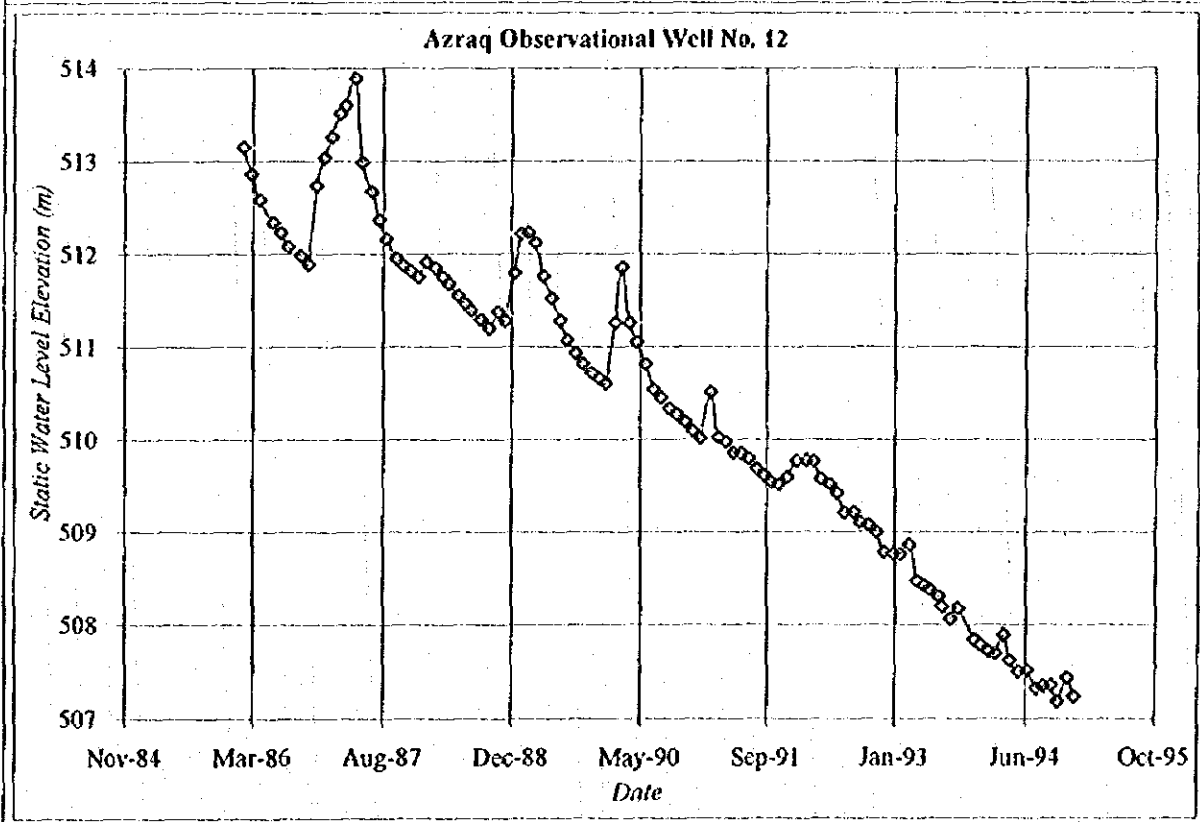
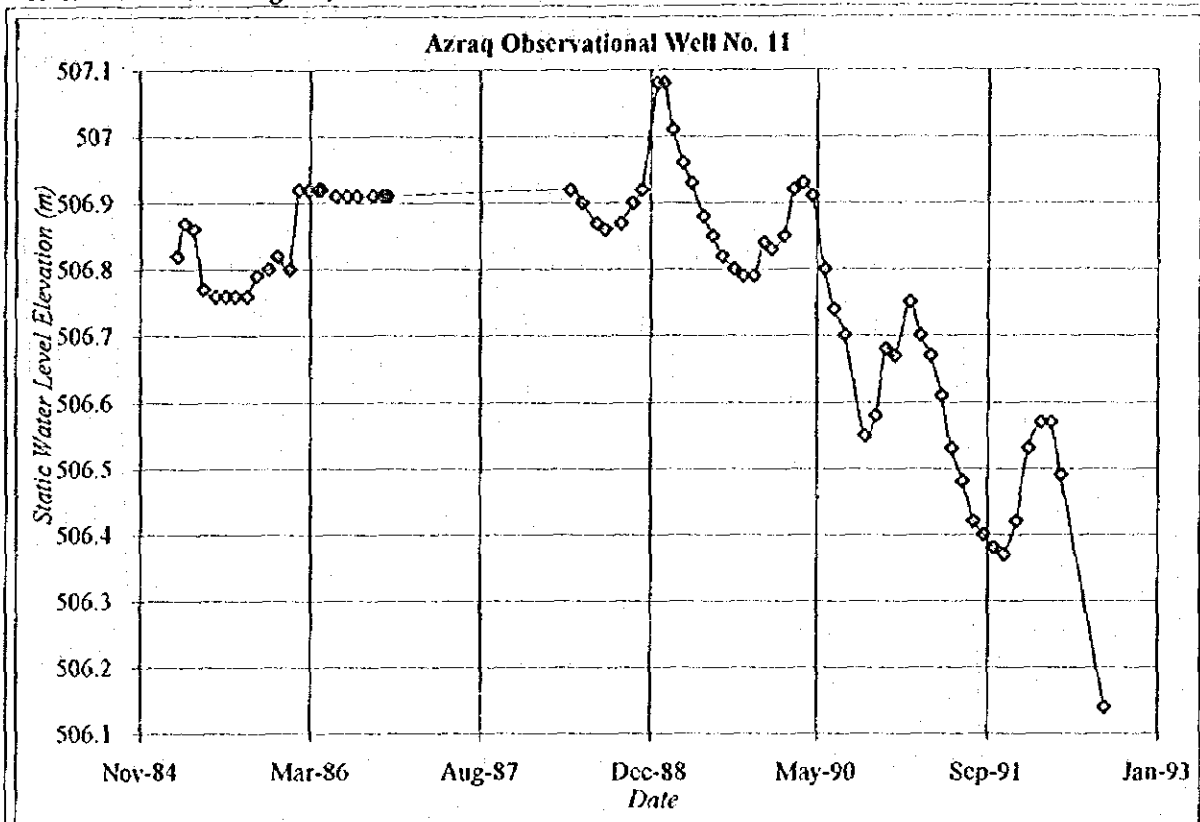


FIG.- A4 (B) AZRAQ BASIN

Source : G.W. Monitoring Sec, MOWI



B. SOCIO-ECONOMY

Appendix B
- Socio-Economy -

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1. NATIONAL ECONOMY AND DEVELOPMENT PLAN

1.1 National Economy

The gross domestic product (GDP) of Jordan was JD 3,882 million in 1993 at current price and the per-capita income is estimated at about JD 970 (US\$1,385). During the past two decades the economy of Jordan experienced a high growth in the earlier part and drastic slow down in the latter part. From 1973 to 1984 Jordan enjoyed unprecedented economic growth. The GDP grew at 11.1 % p.a. during 1973 - 1979 and 9.9 % during 1980 - 1985. However, drastic economic slow down started from 1985 and continued up to 1989. The average growth rate of GDP was -1.2 % p.a. during that period. The recovery of the Jordan economy commenced from 1990 and relatively steady economic growth continued upto now. (The average growth rate of GDP is 6.0 % during the period of 1989 - 1993). Past trend of GDP is presented in Tables B.1 and B.2.

The economic structure of Jordan is explained by the sector share of GDP as presented below.

Sector Share of GDP (1993)

Agriculture and Forestry	10.3 %
Mining and Quarrying	4.1 %
Manufacturing	17.0 %
Construction *1	12.2 %
Wholesale, Retail, Hotel and Restaurant	11.8 %
Transport, Storage and Communication *2	22.2 %
Finance and Real Estate	22.4 %
Total	100.0 %

Source: Department of Statistics

*1 includes electricity and water

*2 includes social service

As indicated above, the share of manufacturing sector is relatively small of 17 %. The share of the secondary industry including manufacturing and construction sector accounts for less than 30 %, while that of services sectors accounts for 56 %.

In 1993 total exports including re-exports were JD 865 million, while total imports were JD

2,414 million. The resulting trade balance was JD +1,589 million. During the past decade (1983 - 1993) the exports increased at a high growth rate of 15.6 % p.a., while the imports grew at a moderate rate of 8.3 % p.a. However, the characteristics of this trade balance has never been changed and the imbalance increased year by year. The trade imbalance is being offset by non-trade balance and foreign assistance. (Historical trend of exports and imports is presented in Table B.3).

The export import structure of Jordan economy is presented in the following table.

Structure of Trade (Based on the year 1992)

	Exports	Imports
Food & Beverage	15.3 %	19.2 %
Crude Materials (Phosphate, Potash)	34.4 %	2.1 %
Mineral, Fuel	-	13.7 %
Chemicals	31.1 %	11.0 %
Manufactured Goods	10.6 %	20.1 %
Machinery & Transport Equipment	1.9 %	24.6 %
Others	6.7 %	9.3 %
Total	100.0 %	100.0 %

Source: Statistical Year Book, 1993

In 1993, the revenue of the Jordan government was JD 1,368 million. The expenses was JD 1,341 million and the resulting budget surplus was JD 27 million. For the capital expenditure about JD 574 million was allocated in 1993, which is equivalent to 14.8 % of GDP.

During the period of 1988 - 1991 consumer price increased at a high rate of 16.4 % p.a. on an average. After 1991, the consumer price went down to the steady increase (4.4 % p.a. during 1991 - 1993) and its trend continues upto today.

The exchange rate of JD has been relatively stable during the past 5 years as presented below.

Exchange of JD against US\$*

1989	1990	1991	1992	1993
0.577	0.665	0.682	0.681	0.694

Source: Statistical Year Book

* Average of the year (selling price)

1.2 Economic Development Plan

National economic development plan was prepared for the target year of 1993 - 1997 by the Ministry of Planning.

The most important basic principles of the plan are as follows:

- (1) Liberalization of the economy, elimination of distortions and development of an appropriate investment climate.
- (2) Development of natural resources, particularly water & energy.
- (3) Development of the export sector.
- (4) Striving for balance between human and economic resources.
- (5) Creation of further employment opportunities in the various production sectors.

Under the basic principles mentioned above, the target of the 5-year plan is set as follows:

- (1) GDP (1991 constant price) is planned to increase from JD 3,452 million in 1992 to JD 4,147 million in 1997 at an average growth rate of 6 % p.a.
- (2) Population is projected to increase at 3.2 % during the plan period and the per-capita GDP (1991 constant price) is planned to increase at an average growth rate of 2.7 %.
- (3) Inflation rate is projected at 4 - 5 % p.a. during the plan period to correct structural imbalance and to achieve fiscal and monetary stability.
- (4) Unemployment rate is planned to reduce to 9.6 % in 1997 (from the current 18 %)

The projected GDP and per-capita GDP during the plan period are presented in the following table.

Projected GDP and Per-capita GDP

	1992	1993	1994	1995	1996	1997	Annual Growth Rate
GDP (1991 constant price, JD million)	3,069	3,288	3,472	3,681	3,905	4,147	6.0 %
Population (1,000)	3,954	4,082	4,214	4,351	4,492	4,638	3.2 %
Per-capita GDP (1991 constant price)	783	805	824	846	869	894	2.7 %

Source: Economic and Social Development Plan 1993 - 1997

For attaining the above target, the amount of the total investment (gross fixed capital formation) is planned to be JD 5,242 million during the period of 1993 - 1997, of which JD 1,874 million or 36 % is planned to be financed by public sector.

The public sector investment program consists of the following three groups.

Infrastructure	:	JD 890 million (48 %)
Social sector	:	JD 810 million (43 %)
Productive sector	:	JD 174 million (9 %)

Among the infrastructure sector, particular attention is paid to key facilities such as water, electricity, roads and telecommunication.

For the water and irrigation sector, the following sector policies are clearly mentioned in the 5-year plan:

- (1) Optimum utilization and conservation of water resources. (includes setting a pricing policy that would ensure rationalization of their use)
- (2) Regulating the use of water for various purposes.
- (3) Improving the efficiency of water carrying system and reducing water loss.
- (4) Increasing water resources and utilizing flood water.
- (5) Improving the quality of water produced by treatment plants for the purposes of irrigation.
- (6) Raising irrigation efficiency at the farm.

- (7) Regulating the extraction of groundwater.

2. SOCIO-ECONOMY

2.1 Administrative Boundary and Population

2.1.1 Administrative Boundary

The Zarqa Governorate, located in the northern region of the country, is one of the eight governorates in Jordan. The Zarqa Governorate consists of one district called the Zarqa district and two nahias, namely the Azraq nahia and the Birain nahia. The Zarqa district is further divided into eight municipalities and other localities, while the Azraq nahia and the Birain nahia are divided into several municipalities.

Total area of the Zarqa Governorate is about 5,201 km², which is equivalent to 6 % of the country total (89,000 km²).

The Study Area is located in the Zarqa district of the Zarqa Governorate and consists of urban areas, namely the Zarqa municipality, the Rusaifa municipality, the Hashmeyeh municipality, the Sukhna municipality and the Shennuler refugee camp. Total area of the Study Area is 90.5 km² or about 1.7 % of the Zarqa Governorate.

The administrative boundary of each municipality in the Study Area was obtained by each municipality and is presented in Fig. 2.1.

2.1.2 Population

According to the National Population and Housing Census conducted in 1994 by the Department of Statistics, total population of the Zarqa Governorate was 623,943, which is equivalent to 14.8 % of the national population. From 1979 to 1994, the population of Zarqa Governorate increased at an annual growth rate of 4.3 %. The population of the Study Area was 534,674 in 1994 and grew at 3.9 % per year on an average during 1979 - 1994, which indicates relatively lower growth rate during the same period compared to that of the Governorate total.

The areas and population of the Zarqa Governorate and the Study Area both in 1979 and 1994

are presented in the following table. (Population density of the Study Area in 1994 is presented in Fig. 2.2.)

Area and Population

Study Area	Area (km ²)	1979	1994	Average Growth Rate (%)
Zarqa Municipality *1	58.9	219,344	344,524	3.06
Sukhna Municipality	5.6	4,390	9,764	5.47
Hashmeyeh Municipality	6.2	4,148	13,038	7.93
Rusaifa Municipality	18.9	49,885	131,130	6.65
Schinneler Camp	0.9	23,261	36,218	3.00
Study Area Total	90.5	301,028	534,674	3.90
Other Areas	5,110.5	32,032	89,269	7.07
Total Zarqa Governor	5,201.0	333,060	623,943	4.27

Source: Department of Statistics

*1 Includes new Zarqa and Awajan

*2 High increase rate during 1979 - 1994 is due to the returnees from the Gulf countries.

2.2 Socio-Economic Conditions in the Study Area

Located at about 20 km (on road) north east of Amman, Zarqa is the third largest Governorate in Jordan. Rapid population growth has been due to an inflow of refugees from Palestine (particularly after 1948 and 1967) and immigration from rural areas (since the military base was established). The most recent increase of the population was caused by the Jordanian returnees from the neighboring Arabic Countries after the Gulf War. (1990 - 1991). South part of Zarqa has been developed as an industrial city and attracted factory laborers from rural areas.

With respect to education, about 70 % the residents complete primary and/or secondary education. (74 % for the male and 66 % for the female). The percentage of non-education is high of 18 % for the female, while that is less than 10 % for the male in Zarqa. The educational background in Zarqa Governorate is summarized in the following table.

Educational Background (ZARQA)

	Male	Female
Non-education	8.2 %	18.6 %
Primary education	32.5 %	33.0 %
Secondary education (High school)	41.4 %	33.4 %
More than secondary	10.8 %	7.5 %
Missing	7.2 %	7.5 %
Total	100.0 %	100.0 %

Source: Jordan Population and Family Health Survey, 1991

As indicated in the historical development, the study Area has been growing as the main industrial and urban area in Jordan. From Rusaifa to Zarqa municipalities, about 45 major factories are operating, which include mining, dairy products, paper, iron and steel product, ceramic, breweries and distilleries. In Hashmeyeh two key industrial plants in the nation are operating, namely, a petroleum refinery plant and a thermal power plant. Names of the major factories and the water consumption are presented in Table B.1.

Though agriculture is not a predominant sector in the Study Area, the area along the Zarqa river is being used mainly for vegetable production. Animal husbandry including chicken farming is also being conducted in the suburban area.

There is no available statistics regarding regional production in Zarqa Governorate. But the Regional Gross Domestic Product (RGDP) is roughly estimated at around JD 590 million in 1993 based on the population statistics.

2.3 Public Health and Hygiene

In Zarqa Governorate there are one governmental hospital (and one more under construction), six private hospitals and one army hospital. In addition, there are two comprehensive health centers being operated under which about 15 secondary health centers are established. There exist 22 mother and child centers and 14 dental clinics.

The doctor/population ratio in Zarqa is 1/1500 and the bed/population ratio is 1/976. The above

figures indicate that the environment of health care in Zarqa Governorate is equal or slightly better than the national average.

Infrastructure for the public hygiene has relatively been well installed. For the domestic water supply about 99 % of the household are being provided by WAJ pipe system. (According to the household survey conducted by us in December 1994, 96 % of the households use WAJ pipe system, 3 % use WAJ water tanks and 1 % use wells). However, rationing of the water supply is being conducted in some areas, particularly, during summer season and installation of roof tank/ground reservoir and purchasing domestic water from private water tanks are required for the residents. Deterioration of the water quality caused by waste water intrusion to the wells is an important problem for the regional hygiene.

About 58 % of the residents have public sewerage system and the remaining 42% still use septic tank in Zarqa Governorate which indicates relatively high installation ratio compared to other developing countries. However, the sewerage volume exceeds the capacity of the treatment plant installed at As Samura by more than two times, which results in discharging half-treated water into rivers and deteriorate living environment in Zarqa. The sewerage water is being used for agriculture production which causes deterioration of public hygiene.

Other unfavorable aspects for the public hygiene in the Study Area are rapid urbanization and industrialization. Increased traffic and discharges from major factories installed along Ruscifa - Zarqa municipalities cause problems of air pollution and water contamination. According to our factory survey, some factories are dumping the industrial wastes and sludge into the public sewer lines or directly into Zarqa river without proper treatment.

With respect to solid waste, all the wastes from factories and households in the Study Area are being collected by trucks and dumped at designated disposal site for land reclamation. The site is located at Rusaifa, a few hundred meters east from Zarqa - Amman Highway.

For the liquid waste, the land near the boundary of Rusaifa and Amman is allocated for disposal site. The liquid waste is being collected by tanks with the capacity of 10m³ and dumped into a waste water pond for evaporation. However, the contaminated water might be flushed out into the tributary of the Zarqa river during winter season.

Though the living environment has not been improved so much in total, statistics show that

number of patients of typical water-borne diseases in Zarqa Governorate tend to decrease, in general, as presented below.

No. of Registered Patients of Waterborne Diseases

Name of Diseases	Average No. of Patients (1978 - 1979)	Average No. of Patients (1991 - 1993)
Typhoid	44	4
Para/Typhoid	14	2
Infectious Hepatitis	31	94
Dysentery	1	7

Source: Zarqa Governorate

Beside the above, enteritis and diarrhea are more common in Zarqa. In 1993, 11,030 persons are reported to be infected by diarrhea and 402 persons are hospitalized.

2.4 Household Economy

Average number of family per household is 7.1 in Zarqa. Based on the population of 534,674, about 75,300 households live in the Study Area.

Though detailed information on the economic activity of household in Zarqa or the Study area is not available, about 25 % of the residents are considered to be involved in industrial and construction sectors, while about 70 % in the service sectors. Agriculture sector absorbs very limited percentage of the residents. The employment structure of the household is summarized in the following table.

Employment Structure in Jordan

Sector	% of employment
Agriculture	4.0
Mining & Industry	13.8
Construction	11.3
Trade, Retail	20.4
Transportation	12.0
Services including Finance	38.5
Total	100.0

Source: Household Expenditure and Income Survey, 1992

Average household income in 1992 is JD 4,003 per year in Zarqa Governorate, which is relatively lower than that of Jordanian average (JD 4,607). Based on the average family size of 7.1 per household, per-capita income is estimated at JD 559 in Zarqa.

Distribution of household income is as presented below

Income Distribution in Zarqa/Jordan

Income Range (JD)	Zarqa	Jordan
I < 1,200	5.6 %	7.6 %
1,200 < I < 2,400	28.4 %	27.1 %
2,400 < I < 3,600	25.8 %	22.6 %
3,600 < I < 4,800	16.1 %	14.6 %
4,800 < I < 6,000	10.2 %	9.8 %
6,000 < I < 7,200	5.0 %	5.8 %
I > 7,200	8.9 %	12.5 %
Total	100.0 %	100.0 %

Source: Household Expenditure and Income Survey, 1992

As indicated in the above, about 50 % of the households get annual income ranging JD 1,200 - 3,600 both in Zarqa and Jordan (this figures roughly coincide with the results of our household survey). The percentages of the household with income less than JD 1,200 are only 6 - 7 %, while those with income more than JD 7,200 are 9 - 12 %. According to the household survey

conducted by JICA Team, household income of Zarqa municipality is larger than that of Rusaifa municipality.

Total household expenditure is estimated at JD 4,197 per year on an average in Zarqa Governorate. (The household expenditure in overall Jordan is JD 4,562). Out of the total expenditure, about 38 % is allocated for food and beverages, 23 % for housing and 11 % for transportation. The allocated amount for fuel, electricity and water is only JD 200 (JD 16,7/month/hh) or 5 % of the total expenditure. Contents of the household expenditure both for Zarqa and Jordan are presented in the following table.

Annual Household Expenditure

Item	(JD)	
	Zarqa	Jordan
Food & Beverages	1,580.5	1,849.2
Housing & Furnishing	981.3	998.0
Transportation	466.3	509.6
Cloth	369.4	372.3
Recreation	259.4	248.3
Fuel, Electricity, Water	199.8	229.2
Education	142.8	160.2
Health	117.9	102.1
Others	80.5	93.8
Total	4,197.9	4,562.7

Source: Household Expenditure and Income Survey, 1992

3. URBAN DEVELOPMENT AND LAND USE

3.1 Historical Development

Initially, 2 - 300 Bedouin people lived in the Study Area. In 1908, Hijazi Railway was constructed to connect Damascus in Syria with Zarqa and Māan in Jordan. After construction of this railway, Zarqa was further developed as a commercial center supplying essential goods for the local community and travelers passing through Zarqa. Development of housing and commercial establishments was first observed around this time. The first immigrants of the

Chechenyan came to settle down in Zarqa in 1905, and then established their housing and developed their agricultural lands at fertile lands along the Zarqa river. Combined the newcomer of the Chechenyan with local Bedouin tribe of the Bani Hassan, the number of total population in Zarqa reached a thousand in 1910's.

In 1927, the military camp in Sarafand was transferred to Zarqa. With relocation of the military camp, most employees of the camp moved to Zarqa with their families. Furthermore, a large number of commercial establishments were installed in Zarqa to supply essential goods to the camp and the local community. The number of total population reached at around 6,000 in 1930's. The fundamental urban structure of Zarqa was formed during this time.

Substantial urban development occurred after the World War II, which was caused by the following three major factors. The first one is a mass influx of an international migration such as the Palestinian refugees resettled in three refugee camps in Schunneler, Zarqa, and Sukhna after the Middle East Wars in 1948 and 1967, and the Jordanian returnees from the neighboring Arabic countries after the Gulf War in 1991. This brought a large number of people into the Study Area. Most refugees and returnees are, however, considered as permanent residents in the Study Area at present, while it was initially conceived as temporary residents. The second factor is the progress of industrialization in the Study area, particularly in Rusaifa and Zarqa. Two major industrial plants were constructed in the Study Area, namely, a petroleum refinery plant and a thermal electricity power plant constructed in Hashmeyeh in 1958 and 1973, respectively. This industrialization contributed to generating a large number of local employment in the Study Area. The third factor is a large number of rural-urban internal migration to the Study Area caused by its rapid urban growth.

Through the above developments, the Study Area has become the second highest populated and most industrialized area in Jordan.

3.2 Present Urban Development and Land Use

3.2.1 Present Urban Development

Present situation of the urban development in the Study Area can be explained by the following three different development categories:

Residential development

Considering rapid urbanization observed in the Study Area, the most important factor is the residential development.

Present residential development has been based on the present zoning regulations which do not meet actual local housing demands. Since most land in the urban areas is zoned as large residential plot of 500m² or more, most of middle to low income people cannot afford to acquire the land. Therefore, most of the houses are located in crowded and mixed residential areas with commercial areas in downtown of Zarqa and in urban center of Rusaifa. People also find their houses at outside of the urban center as well. Under this circumstance, many people, especially poorer ones, tend to ignore administrative systems and zoning regulations to get their houses, which resulted in an illegal and disorder development of residential lands in the Study Area. At present, there are ten on-going public housing projects in the Study Area, providing 5,307 plots /buildings for the estimated served population of 82,080. In terms of the served population, a half of the on-going projects are located in Zarqa and another half are in Rusaifa. These projects are designed to provide houses for those of middle-income or low-income. (On - going public housing projects are presented in Fig. 3.1).

Industrial development

The Study Area has been recognized as the most industrialized area in Jordan, and major industrial establishments such as a petroleum refinery plant and a thermal electricity power plant are concentrated around this area. In addition, most major industrial establishments for food, chemical, beverage, basic metal, textile, leather and nonmetallic mineral products are located in the Study Area, particularly along the Zarqa-Rusaifa corridor from the south of Zarqa to the east of Rusaifa. Recently, government agencies have guided to locate new industrial establishments on upland areas at the south of Zarqa so as to be served by the Amman-Zarqa highway. The location of major industrial establishments are presented in Fig. 3.2.

According to the planning agencies of local municipalities, no major industrial development is planned for the Study Area at present.

Refugee camp development

In the Study Area, three Palestinian refugee camps are located, namely, the Shennuler camp, the Zarqa camp, and the Sukhna camp, each of which was established in 1968, 1948, and 1968, respectively. The number of total population in each camp in 1994 was 36,218 in the Shennuler camp, 19,000 in the Zarqa camp, and 5,750 in the Sukhna camp, totally accounting for 60,968

(about 11 % of total population in the Study Area). The location and characteristics of the camps are summarized in Fig. 3.3. Since the official boundary of each camp was fixed, population density in the camps became higher as population increased. At present, population density is 395 persons / ha in the Shennuler camp, 1,056 persons / ha in the Zarqa camp and 821 persons / ha in the Sukhna camp. Population in the camps seems to have already saturated except Shennuler camp. However, regarding the Shennuler camp, population density in reality seems to be much higher (654 persons / ha) since the present population in Shennuler camp is reported at around 60,000 according to the Ministry of Palestinian Affairs.

Incorporating all the above, present urban development in the Study Area is summarized as presented in Fig. 3.4.

3.2.2 Present Land Use

On the basis of the available aerophotoes, results of field survey and the preliminary results of the Greater Zarqa Comprehensive Development Plan, present land use in the Study Area is prepared by the JICA Study Team as presented in Fig.3.5. A brief description of the present land use is as follows:

Overview

The composition of land use in the Study Area is presented below.

Major Land Use	Land Area (km ²)	
Residential Area	29.0	32.0 %
Mixed Area	11.2	12.4 %
Industrial Area	7.2	8.0 %
Agricultural Area	3.7	4.1 %
Public Area	1.9	2.1 %
Open Space Area	1.4	1.5 %
Refugee Camp	0.8	0.9 %
Vacant Land	35.3	39.0 %
Total	90.5	100.0 %

The characteristics of land use in the Study Area are as following:

- (1) As shown in Fig. 3.5, most of the steep land located at west side of the Study Area is vacant land which dominates the highest share of 39% with the land area of 35.3 ha.
- (2) Residential area extends towards north and south - west direction from Zarqa city and has the second highest share of 32%.
- (3) Mixed area, which is defined as the mixed land use area of high density residential with commercial shares 12% of the Study Area. This area is located mainly in Zarqa and Rusafa along the highway.
- (4) Industrial area has relatively high share of 8%, which is located at southeast of Zarqa, west of Rusafa and south of Hashemeyeh.
- (5) Agricultural area is relatively small sharing 4% of the Study Area, which extends along the Zarqa river.
- (6) The remaining areas are shared by public, open space (bus stop, park, etc.) and refugee camp, which account for about 5% in total.

Zarqa

As presented in Fig. 3.6, one of the characteristics of the land use in Zarqa is that the residential area intermingled with commercial area occupies the center of the municipality. This mixed area is divided into two parts. One part is a central area developed as downtown of Zarqa, where multi-storied residences with intensive commercial activities are predominant. The other part is a surrounding area developed as residential area, where multi-storied residences with less intensive commercial activities are observed. In the north of Zarqa, new residential area called "New Zarqa" is being developed recently. In New Zarqa, new residential development (with high standard) and public housing development are predominant. In the west of Zarqa, housing is also being developed along the roads to Beirein. Industrial areas are concentrated on upland area at the south of Zarqa, which is close to the Amman-Zarqa highway running from the north to the south. Agricultural lands are found only in the limited area along the Zarqa river running from the south to the north.

Rusafa

As illustrated in Fig. 3.7, some industrial development is observed along the Zarqa river, which extends to industrial areas of Zarqa in the south. Residential areas are being developed mainly along major roads. Some residential areas in urban center are intermingled with commercial areas. As observed in Zarqa, commercial area is found at downtown area in urban center alongside the road connecting Amman to Zarqa. Some agricultural lands exist along the Zarqa

river running from the west to the east. Most of the vacant land are not suitable for housing development due to the geographical conditions.

Hashemeyeh

Compared to Zarqa and Rusaifa, land use in Hashemeyeh is simple as presented in Fig. 3.8, since the economic activities in Hashemeyeh depend on two major industrial establishments; a petroleum refinery plant and a thermal electricity power plant. Almost a half of the built area is occupied by two industrial plants, and the rest is taken up by residential area with some agricultural area. Commercial areas are observed along the main road running from the northwest to the southeast.

Sukhna

As presented in Fig. 3.9, Sukhna is the least developed area in the Study Area with the total population of only about 9,800 at present. Residential and commercial areas are concentrated around urban center and other areas including agricultural lands are spread out outside the urban area. Some residential areas have been newly developed at relatively steep areas in the south of Sukhna. However, the number of population living in this area is small.

3.3 Future Urban Development

3.3.1 Development Constraints

Through the investigation and study, several development constraints for the Study Area are identified which can be explained as follow:

Physical constraints

On the basis of topographical maps and aerial photographs, the following physical constraints are identified in the Study Area.

- Existence of the military camp located in Zarqa, which limits further development towards the east of Zarqa,
- Steep land laid down around Zarqa, which limits further development towards the west and the north of Zarqa, and
- Existing industrial plants such as oil refinery and power plants in Hashemeyeh.

Given physical constraints stated above, the Study Area has limitation to further development, especially housing development in absorbing an increasing population in the future.

Institutional constraints

The following institutional constraints are perceived in the Study Area, according to interviews to local municipal officers and review of reports on housing strategy.

- Limited capabilities of local planning agencies for enforcing planning and zoning regulations and preparing city development plans, which consequently created existence of informal transfer of land ownership and unregistered land title by individuals particularly observed in Zarqa-Rusaifa area.
- Poor control over land use and transactions which leads to illegal and improper land development.

3.3.2 City Development Plan

In the Study Area, in spite of being the second highly populated and urbanized area in Jordan, there has been no regional development master plan prepared for the Zarqa Governorate. However, facing rapid urban development and industrial development, Zarqa municipality and Greater Amman municipality have jointly launched on preparing " Greater Zarqa Comprehensive Development Plan (Master Plan)" since October 1994.

The Study Area of the Master Plan is about 400 km² and covers the following five municipalities and the Shennuler refugee camp:

- Zarqa municipality,
- Rusaifa municipality,
- Hashmehyeh municipality,
- Sukhna municipality,
- Graisa municipality, and
- Schennuler refugee camp.
- Qura Bani Hashem Municipality

The target year of the Master Plan is set at the year 2010, and the main contents of the Master Plan are as follows:

- Preparation of urban land use plan,
- Preparation of urban transportation plan,
- Preparation of regional development scenario, and
- Preparation of information system.

The main objective of the Master Plan is to formulate a comprehensive development plan for the Greater Zarqa Area to have well balanced living environment with industrial development and residential development. In the Master Plan, a regional development scenario will be prepared with proposed development projects for main roads, special zoned areas and housing.

The final results of the Master Plan was not available for our Study as of August, 1995, since preparation of the Master Plan has been delayed due to the unexpected situation. However, some preliminary results are used for our planning.

3.3.3 Development Scenario and Future Land Use

On the basis of the analysis on spatial development using topographic map and aerial photographs (one in 1992 and the other in 1984), and referring preliminary results of the Master Plan, a development scenario for the Study Area is prepared as follows.

- (1) Due to the physical constraints, future development of the Study Area will mainly be directed to west and north of Zarqa city. One of the major development axis (mainly residential and partly residential/commercial mixed development) runs towards north of Zarqa, where density of the existing housing is still low and potential lands for further development are available. Another major development axis runs toward west (northwest and southwest) of Zarqa. In the northwest of Zarqa, the residential development extends along the road connecting Zarqa to Beirein. Potential land for future residence exists in this area where the terrain is relatively flat and the population density is low. Southwest of Zarqa is also potential residential development area where public housing projects are underway at present. Residential area and mixed commercial area will, thus, be expanded to west and north of Zarqa in the future.
- (2) No substantial increase of the industrial area is expected in the Study Area. But, expansion of production capacities in the existing industries will be made along Zarqa - Amman corridor. Establishment of new factories is also expected producing mainly consumer goods in the northern part of the Study Area, though the number of new

establishment is limited.

- (3) The area for agriculture land will not change so much in the future. In the urban area, the existing agriculture land may be transformed to residential land and would reduce its size. Due to the limited availability of the water resources, further extension of the agriculture land in the suburban area is rather unrealistic.
- (4) The area for public use will expand a little corresponding to the growth of residential development.
- (5) The area for the refugee camp is assumed to remain unchanged, though redevelopment by restoring its legal status and provision of infrastructure will be facilitated.
- (6) As a whole, the residential and mixed residential area will expand to west and north-west directions and cover most of the relatively flat terrain area of the Study Area, while the vacant land will decrease correspondingly.

Based on the development scenario explained above, development direction and the future land use of the Study Area are projected as presented in Figs. 3.10 and 3.11. The future land use is summarized in the following table :

Future Land Use in the Study Area (2015)

Major Land Use	Area (km ²)	
Existing Residential Area	29.0	(32.0%)
Mixed Area	11.2	(12.4%)
Future Residential Area	10.2	(11.3%)
Industrial Area	8.0	(8.8%)
Agricultural Area	3.4	(3.8%)
Public Area	2.2	(2.4%)
Open Space Area	1.6	(1.8%)
Refugee Camp	0.8	(0.9%)
Vacant Land	24.1	(26.6%)
Total	90.5	100.0%

Though the military camp area located at east side of Zarqa city is excluded from our Study Area

and considered as a constraint of the future city development, the area might be incorporated in the urban area if proposal for Greater Zarqa development is legally accepted. If materialized, this area will be used for administrative, commercial and residential as well as parks and social facilities. At present, thousands of military and its related people live in the area that will increase to 50,000 to 75,000 in around 2015 under that situation.

4. POPULATION PROJECTION

Population projection in the Study Area is made on the basis of the analysis on the historical trend and future development potential in the following manner.

4.1 Frame of Total Population Growth

The population of the Study Area increased at 3.9% p.a. during the period of 1979 - 1994. The population increase includes the considerable number of returnees from the Gulf countries, which is approximately estimated at around 60,000. Excluding this factor, natural population growth is estimated at 3.1% during this period.

Another indicative figure for future population projection of total population frame would be the planned population growth rate set up in "Economic and Social Development Plan of Jordan, 1993 - 1997. The projected figure is 3.2% p.a. during the plan period.

Based on these figures, total population growth of the Study Area is estimated, which will be used as the total population frame in the whole Study Area to be projected.

Period	Frame of Total Population Growth In The Study Area
1995 - 2000	3.2% p.a.
2000 - 2005	2.8% p.a.
2005 - 2015	2.4% p.a.

During 1995 - 2000, a little bit higher rate than the past trend is applied in due consideration of the socio - economic effect of the Peace Treaty. But, the high growth rate will go down after the year of 2000 as the household income increase and the living standard improve.

4.2 Population Projection for Sub - Areas

The population census conducted in 1994 contains the population data for 67 sub - areas (see Fig. J.2) in the Study Area. Based on the data, population densities for the sub - areas are calculated and the sub - areas are grouped into G1, G2, G3 and G4 according to the densities as presented in Fig. 4.1.

Future population increase for each group is estimated in due consideration of the present population density and future potential development in the Study Area within the projected total population frame.

By applying the different growth rates, population of each sub-area is estimated as presented in Table 4.1. (population distribution in each sub-area is summarized in Fig. 4.2.). Projected population in each municipality and in the Study Area are presented below:

Projected Population in the Study Area

Municipality	1994	1995 - 2000	2000	2000 - 2005	2005	2005 - 2015	2015
	Population	GR	Population	GR	Population	GR	Population
Zarqa	340,261	2.8%	406,600	2.5%	460,000	2.3%	577,500
Sukhna	9,764	4.4%	12,600	3.9%	15,300	3.0%	20,600
Hashmeyeh	13,936	4.7%	17,200	4.0%	20,900	3.2%	28,600
Rusaifa	134,495	4.0%	165,900	3.3%	195,200	2.6%	252,300
Schennuler	36,218	2.7%	42,500	2.4%	47,900	2.2%	59,500
Total	534,674	3.2%	644,800	2.8%	739,300	2.4%	938,500

Source: JICA Study Team

As presented above, total population in the Study Area will be 644,800 in 2000, 739,300 in 2005 and 938,500 in 2015.

Tables

Table B.1 Gross National Product at Current Prices

	1993	1992	1991	1990	1989	1988	1987
1) Industries	2,653.5	2,401.6	2,045.6	1,878.3	1,702.4	1,550.1	1,503.0
- Agriculture, Hunting, Forestry and Fishing	274.3	246.9	213.5	187.8	139.8	134.5	137.8
- Mining and Quarrying	110.3	130.5	124.9	148.8	154.5	82.4	66.9
- Manufacturing	451.0	406.3	343.7	345.3	254.7	197.0	213.6
- Electricity and Water	70.7	66.6	62.0	53.9	52.7	50.6	48.5
- Construction	251.9	215.3	125.7	105.6	101.5	112.9	120.0
- Wholesale and Retail Trade, Restaurants and Hotels	312.1	278.7	254.7	216.8	180.7	254.9	269.2
- Transport, Storage and communication	495.0	450.0	382.7	362.0	359.1	294.5	277.4
- Finance, Insurance, Real Estate and Business Services	593.3	520.4	472.2	407.0	413.8	377.2	329.3
- Community, Social and Personal Services	94.9	86.9	66.2	51.1	45.6	46.1	40.3
2) Producers of Govt. Services	643.5	554.7	474.4	449.1	431.3	418.9	388.0
3) Producers of Private Non-Profit Services to Households	42.9	39.2	34.0	30.8	25.2	21.5	20.4
4) Domestic Services of Households	7.8	7.2	5.3	6.2	6.0	5.6	5.9
Total (1+2+3+4)	3,347.7	3,002.7	2,559.3	2,364.4	2,164.9	1,996.1	1,917.3
Less: Imputed Bank Service Charge	-46.4	-41.8	-53.7	-39.9	-55.3	-49.5	-39.3
= G.D.P. at Factor Cost	3,301.3	2,960.9	2,505.6	2,324.5	2,109.6	1,946.6	1,878.0
+ Indirect Taxes Less Subsidies	581.1	532.1	349.5	343.8	262.5	317.8	330.6
= G.D.P. at Producer's Prices	3,882.4	3,493.0	2,855.1	2,668.3	2,372.1	2,264.4	2,208.6
+ Net Factor Income From Abroad	-149.1	-186.2	-221.1	-239.5	-191.4	-88.5	-50.2
= G.N.P. at Market Price	3,733.3	3,306.8	2,634.0	2,428.8	2,180.7	2,175.9	2,158.4

Source : Department of Statistics

(1) : Recently revised data by the Department of Statistics (1987-1992).

(2) : Revised preliminary estimates in accordance with the new series.

Table B.2 Gross Domestic Product at Constant Prices

	1993	1992	1991	1990	1989	1988	1987
1) Industries	1,587.3	1,493.8	1,322.7	1,279.0	1,339.3	1,493.5	1,523.4
- Agriculture, Hunting, Forestry and Fishing	230.6	209.6	178.7	163.1	124.4	164.7	124.2
- Mining and Quarrying	52.1	53.5	54.1	63.6	77.4	70.0	75.5
- Manufacturing	268.9	253.7	220.7	224.0	204.4	164.8	203.6
- Electricity and Water	61.1	58.7	56.2	53.3	96.4	63.1	64.7
- Construction	155.2	138.6	89.2	80.7	86.1	108.3	132.7
- Wholesale and Retail Trade, Restaurants and Hotels	70.0	65.4	59.0	57.7	77.1	226.2	263.4
- Transport, Storage and communication	292.4	278.5	255.1	270.2	279.9	288.8	290.4
- Finance, Insurance, Real Estate and Business Services	405.5	386.2	369.6	335.5	363.8	367.5	331.1
- Community, Social and Personal Services	51.5	49.6	40.1	30.9	29.8	40.1	37.8
2) Producers of Govt. Services	440.2	415.3	392.6	386.1	388.2	405.0	381.1
3) Producers of Private Non-Profit Services to Households	26.7	25.3	23.1	22.0	20.1	20.7	20.5
4) Domestic Services of Households	4.3	4.2	3.1	3.6	4.0	5.3	6.0
Total (1+2+3+4)	2,058.5	1,938.6	1,741.5	1,690.7	1,751.6	1,924.5	1,931.0
Less: Imputed Bank Service Charge	-28.3	-27.0	-36.5	-28.5	-44.1	-47.7	-39.6
= G.D.P. at Factor Cost	2,030.2	1,911.6	1,705.0	1,662.2	1,707.5	1,876.8	1,891.4
+ Indirect Taxes Less Subsidies	354.5	343.5	237.8	245.8	209.1	306.4	333.0
= G.D.P. at Producer's Prices	2,384.7	2,255.1	1,942.8	1,908.0	1,916.6	2,183.2	2,224.4

Source : Department of Statistics

(1) : Recently revised data by the Department of Statistics (1987-1992).

(2) : Revised preliminary estimates in accordance with the new series.

Table B.3 External Trade During 1966-1993

YEAR	TRADE BALANCE	EXPORTS			IMPORTS
		RE-EXPORTS	DOMESTIC	TOTAL	
1966	-57,812.4	1,640.5	8,758.6	10,399.1	68,211.5
1967	-43,720.9	1,342.4	9,984.4	11,326.8	55,047.7
1968	-43,229.2	2,090.7	12,171.8	14,262.5	57,491.7
1969	-53,003.2	2,832.9	11,915.7	14,748.6	67,751.8
1970	-53,712.2	2,853.0	9,316.8	12,169.8	65,882.0
1971	-65,186.1	2,623.6	8,817.3	11,440.9	76,627.0
1972	-78,304.2	4,399.4	12,606.5	17,005.9	95,310.1
1973	-89,263.4	4,974.2	14,010.3	18,984.5	108,247.9
1974	-106,854.7	10,314.9	39,437.5	49,752.4	156,607.1
1975	-185,074.3	8,799.5	40,138.9	48,938.4	234,012.7
1976	-270,049.5	19,893.0	49,552.2	69,445.2	339,494.7
1977	-372,417.9	21,810.8	60,289.1	82,099.9	454,517.8
1978	-368,031.5	26,781.2	64,129.9	90,911.1	458,942.6
1979	-464,758.8	38,348.1	82,559.3	120,907.4	585,666.2
1980	-544,401.8	51,468.5	120,107.0	171,575.5	715,977.3
1981	-804,872.7	73,606.7	169,025.8	242,632.5	1,047,505.2
1982	-877,965.9	78,946.3	185,581.2	264,527.5	1,142,493.4
1983	-892,735.7	50,490.0	160,084.7	210,574.7	1,103,310.4
1984	-780,682.8	29,602.7	261,054.6	290,657.3	1,071,340.1
1985	-763,557.7	55,541.9	255,345.8	310,887.7	1,074,445.4
1986	-594,171.1	30,413.0	225,615.1	256,028.1	850,199.2
1987	-599,845.7	66,935.6	248,773.4	315,709.0	915,554.7
1988	-640,395.9	55,552.7	325,718.1	381,270.8	1,021,666.7
1989	-597,154.9	98,828.8	534,158.7	632,987.5	1,230,142.4
1990	-1,019,741.0	93,834.6	612,252.5	706,087.1	1,725,828.1
1991	-939,718.6	172,117.6	598,626.7	770,744.3	1,710,462.9
1992	-1,384,699.6	195,548.1	633,754.5	829,302.6	2,214,002.2
1993	-1,588,963.2	173,379.9	691,281.7	864,661.6	2,453,624.8

Source: Department of Statistics

Table 2.1 Major Factories in the Study Area

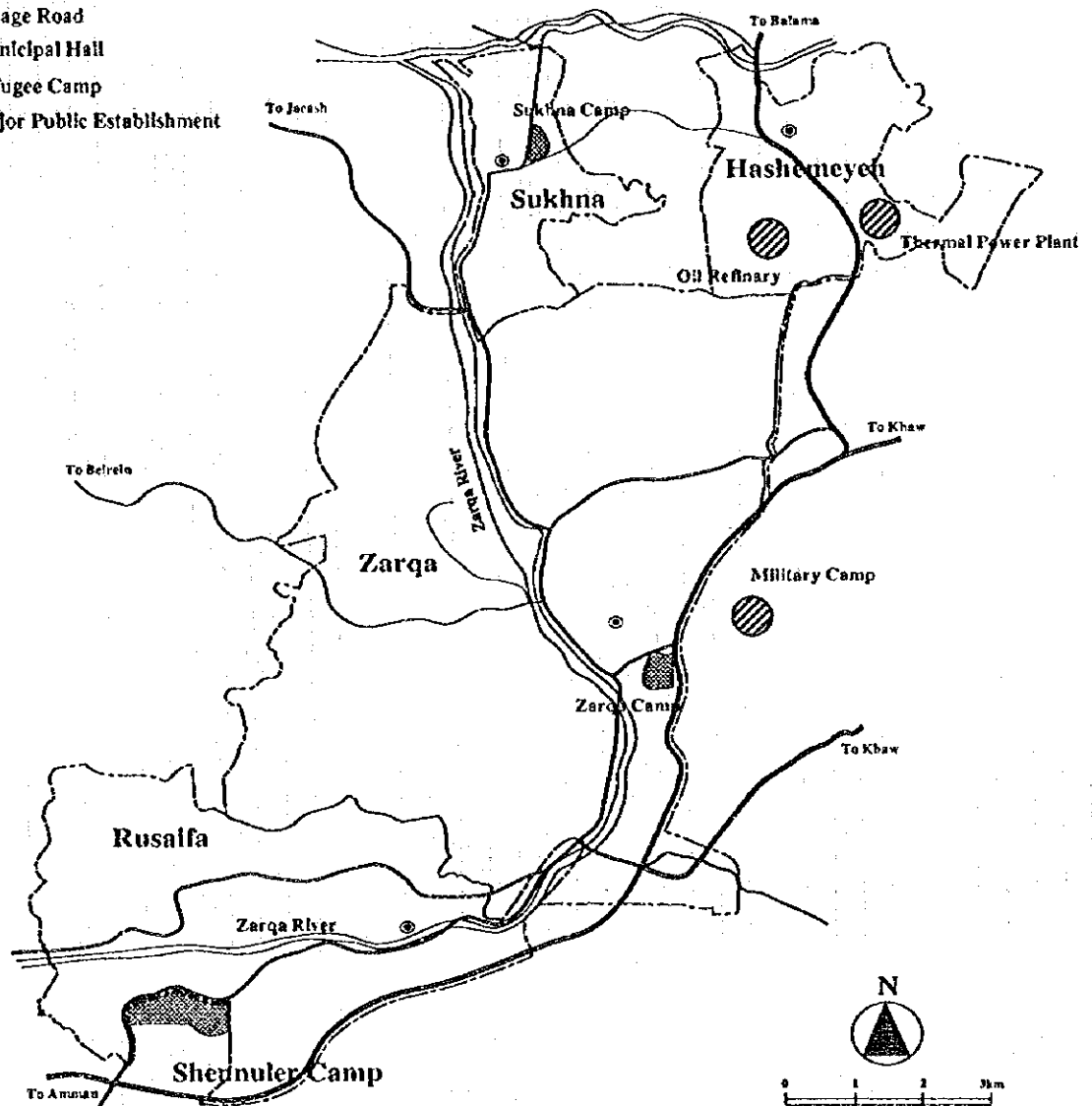
Name	Location	Water Consumption (m ³ /month)
<u>Zarqa Area:</u>		
Sheep and Poultry Co.	Hashmeyeh	515
Jaber Fawzi Zeidan	Zarqa - Ruseifa	475
Niqoula Jaber Zeidan	Zarqa - Ruseifa	460
Talhouni Mill	Zarqa - Ruseifa	325
Jawad Bakery	-	275
Petroleum Refinery	Hashmeyeh	252,000
Thermal Electric Power Plant	Hashmeyeh	180,000
Jordan Tanning Co.	Aminan - Zarqa	7,500
Tissue Paper Factory	Sukhna	6,000
Pulp and Mill Factory	Amman - Zarqa	6,000
Sulphochemicals	Osh Valley	4,500
Eagle Distilleries	Zarqa - Ruseifa	3,600
Jordanian Beer Co.	Zarqa - Ruseifa	2,250
Jordan Pipes Co.	Hashmeyeh	2,100
Spinning and Weaving Co.	Hashmeyeh	1,800
<u>Ruseifa Area:</u>		
Jordan Worsted Mill Co.	General St.	194
Jordan Insulation Materials	General St.	180
Pepsi Cola Co.	Amman - Zarqa	45,000
Jordanian Yeast Co.	Bassatein	12,750
ICA Co.	Zarqa - Ruseifa	9,000
Jordan Dairy	Zarqa - Ruseifa	3,900
Jordan Worsted	Zarqa - Ruseifa	5,100
Jordan Mineral Exploration Co.	Zarqa - Ruseifa	2,250

Source: WAJ Zarqa

Figures

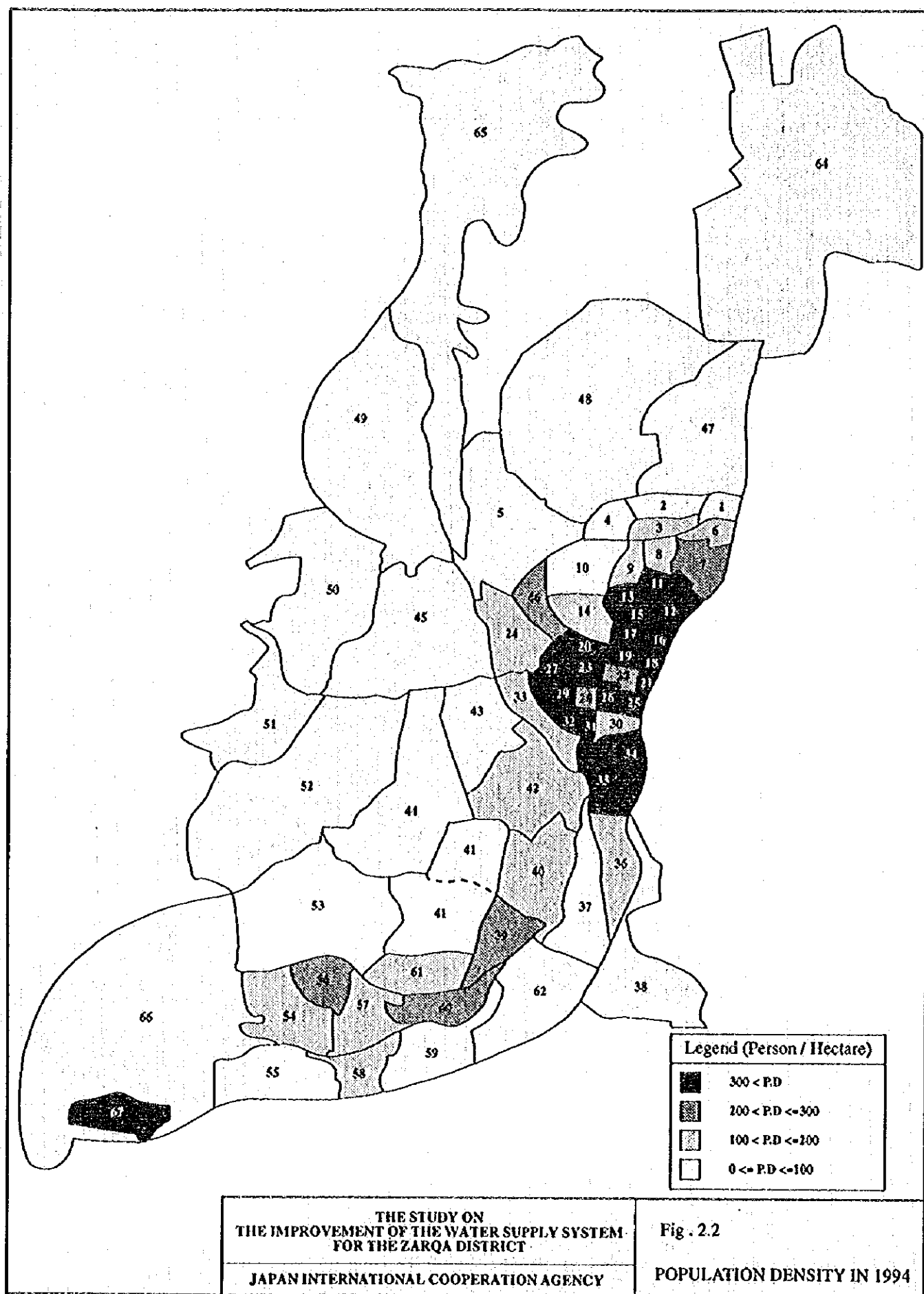
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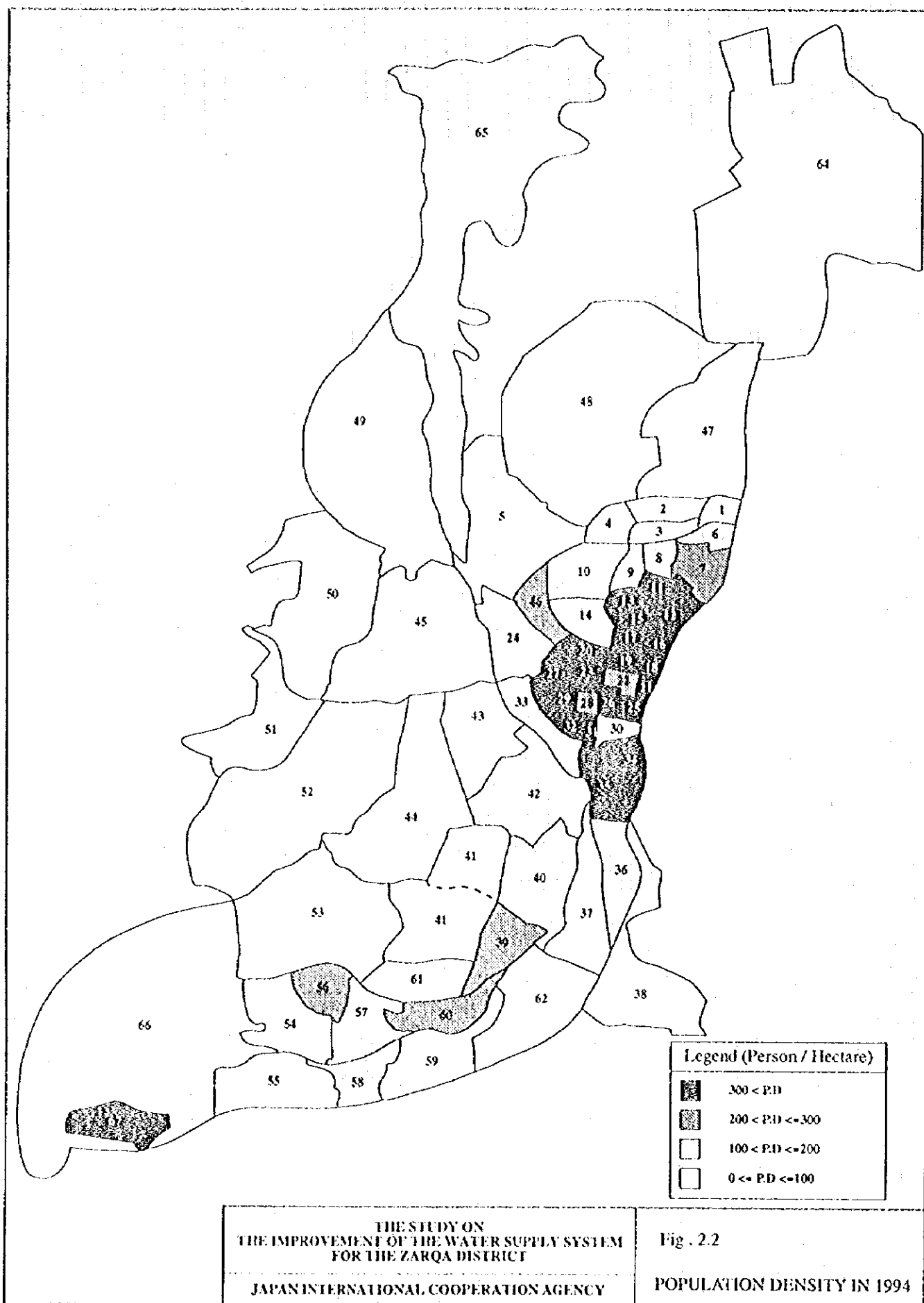
- Municipal Boundary
- == Highway
- Primary Road
- Secondary Road
- Village Road
- ⊙ Municipal Hall
- ▨ Refugee Camp
- ▤ Major Public Establishment



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JAPAN INTERNATIONAL COOPERATION AGENCY

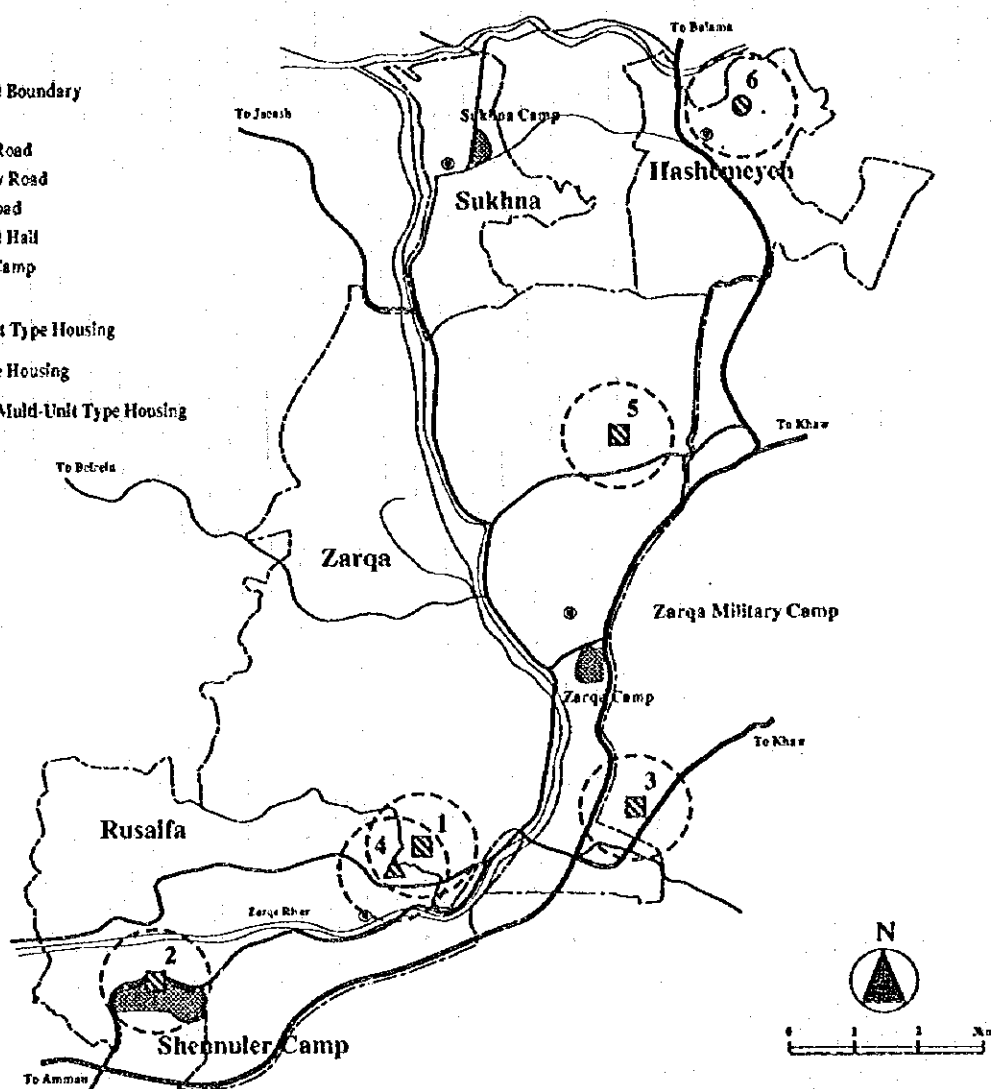
Fig. 2.1
ADMINISTRATIVE
BOUNDARY IN THE
STUDY AREA





LEGEND

- Municipal Boundary
- ==== Highway
- Primary Road
- Secondary Road
- Village Road
- ⊙ Municipal Hall
- ⊙ Refugee Camp
- ▨ Multi-Unit Type Housing
- ⊙ Villa Type Housing
- △ Villa and Multi-Unit Type Housing



Site No	Project Name	Project Location	Project Area	Type of Housing	No of Plots / Bldgs	No of Stories / Flats	No of Served Pop
1	Rusaifa 1	Rusaifa	307 ha	Multi-Unit Bldg	941	2	13,550
1	Rusaifa 2	Rusaifa	220 ha	Multi-Unit Bldg	622	2	8,957
1	Rusaifa 3	Rusaifa	204 ha	Multi-Unit Bldg	480	2	6,912
1	Rusaifa 4	Rusaifa	102 ha	Multi-Unit Bldg	330	2	4,752
2	Rusaifa Extension	Rusaifa	013 ha	Multi-Unit Bldg	50	2	720
3	Zarqa 1, 2, 3	Zarqa	424 ha	Multi-Unit Bldg	1,550	3	33,480
4	Amr Talal	Zarqa	-	Villa	204	1	1,469
4	Amr Talal	Zarqa	-	Multi-Unit Bldg	57	6	2,462
5	Patrawe	Zarqa	-	Multi-Unit Bldg	57	6	2,462
6	Hashemeyeh	Hashemeyeh	-	Villa	1,016	1	7,315
-	Total	-	-	-	5,307	-	82,080

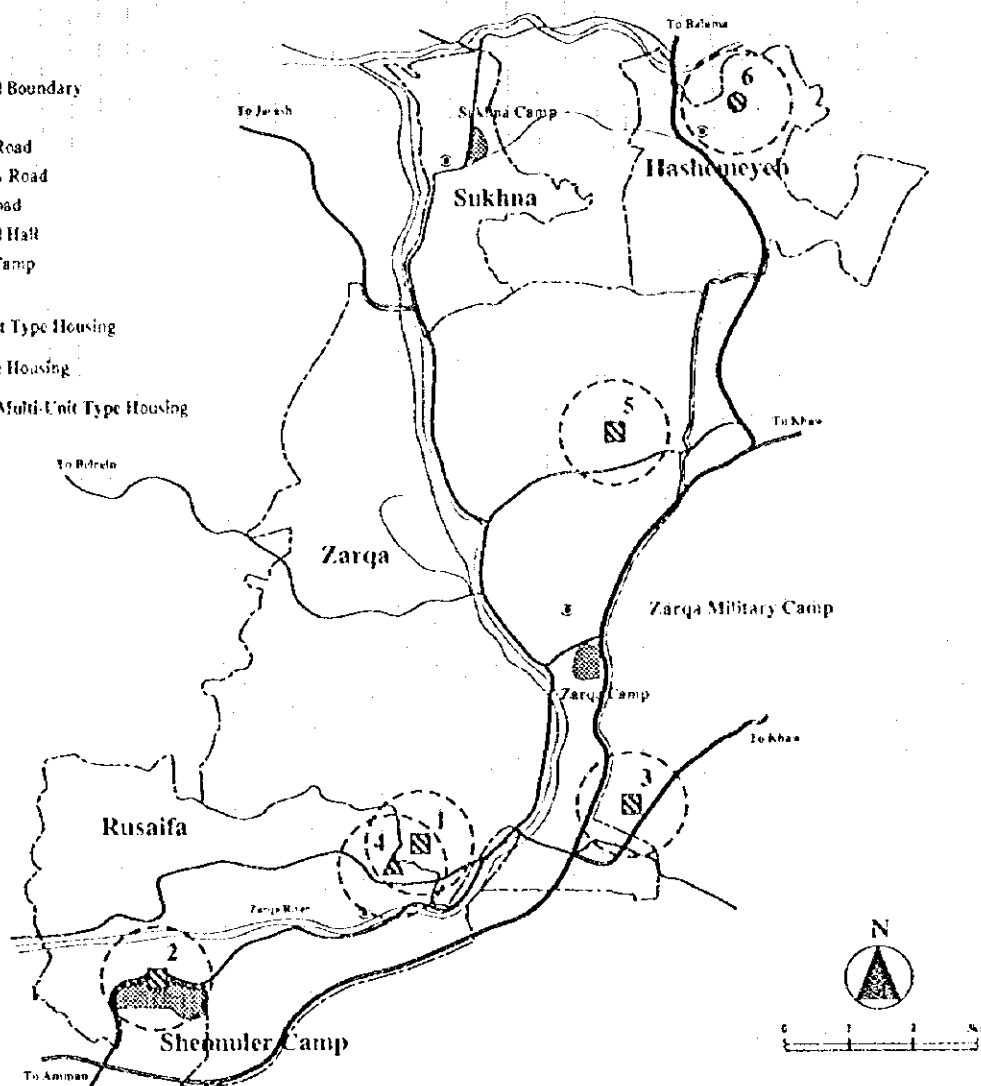
Source: Housing and Urban Development Corporation

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Fig. 3.1
ON-GOING PUBLIC HOUSING
PROJECTS IN THE STUDY AREA

LEGEND

- Municipal Boundary
- == Highway
- Primary Road
- Secondary Road
- Village Road
- ⊙ Municipal Hall
- ⊙ Refugee Camp
- ▨ Multi-Unit Type Housing
- ⊙ Villa Type Housing
- △ Villa and Multi-Unit Type Housing



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3	Zarqa 1, 2, 3	Zarqa	424 ha	Multi-Unit Bldg	1,550	3	33,480
4	Amr Talal	Zarqa	-	Villa	204	1	1,469
4	Amr Talal	Zarqa	-	Multi-Unit Bldg	57	6	2,462
5	Patrawe	Zarqa	-	Multi-Unit Bldg	57	6	2,462
6	Hashmehyeh	Hashmehyeh	-	Villa	1,016	1	7,315
-	Total	-	-	-	5,307	-	82,080

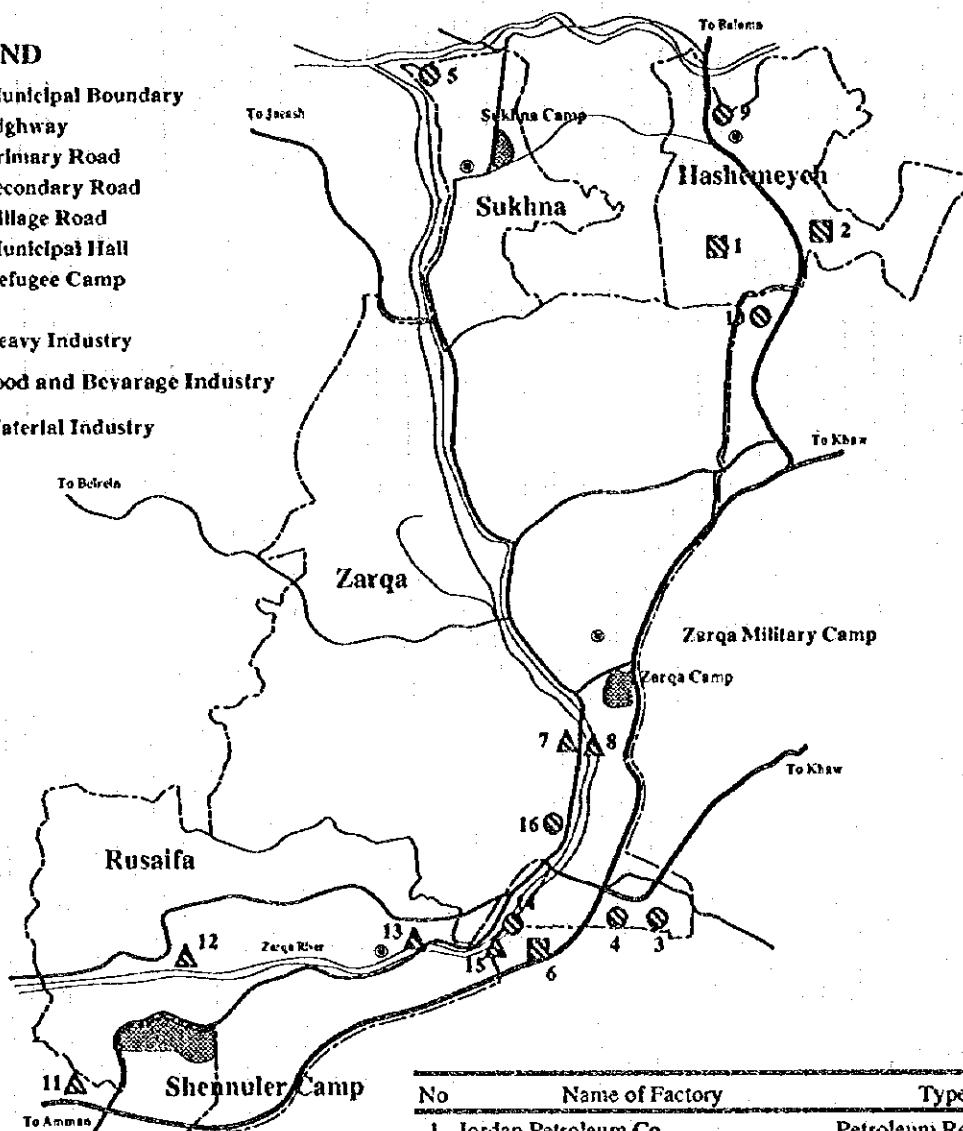
Source: Housing and Urban Development Corporation

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Fig. 3.1
ON-GONIG PUBLIC HOUSING
PROJECTS IN THE STUDY AREA

LEGEND

- Municipal Boundary
- == Highway
- Primary Road
- Secondary Road
- Village Road
- ⊙ Municipal Hall
- Refugee Camp
- ▨ Heavy Industry
- ▴ Food and Beverage Industry
- ⊗ Material Industry



No	Name of Factory	Type of Industry
1	Jordan Petroleum Co.	Petroleum Refineries
2	Thermal Electricity Power Station	Electricity
3	Paper and Cardboard Paper Co.	Paper Products
4	Jordan Tanning Co.	Leather Products
5	Tissue Paper Factory	Paper Products
6	Sulpochemicals Co.	Chemical Products
7	Eagle Distilleries	Beverage Industries
8	Jordanian Beer Co.	Beverage Industries
9	Jordan Pipes Co.	Basic Metal Products
10	Spinning and Weaving Co.	Textile Manufacturing
11	Pepsi Cola Co.	Beverage Industries
12	Jordanian Yeast Co.	Food Manufacturing
13	I.C.A. Co.	Food Manufacturing
14	Jordan Worsted Co.	Textile Manufacturing
15	Jordan Dairy	Food Manufacturing
16	Jordan for Mineral Explorant Co.	Nonmetallic Mineral Products


Source: Zarqa Governorate Administration of Water Authority

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FOR THE ZARQA DISTRICT

JAPAN INTERNATIONAL COOPERATION AGENCY

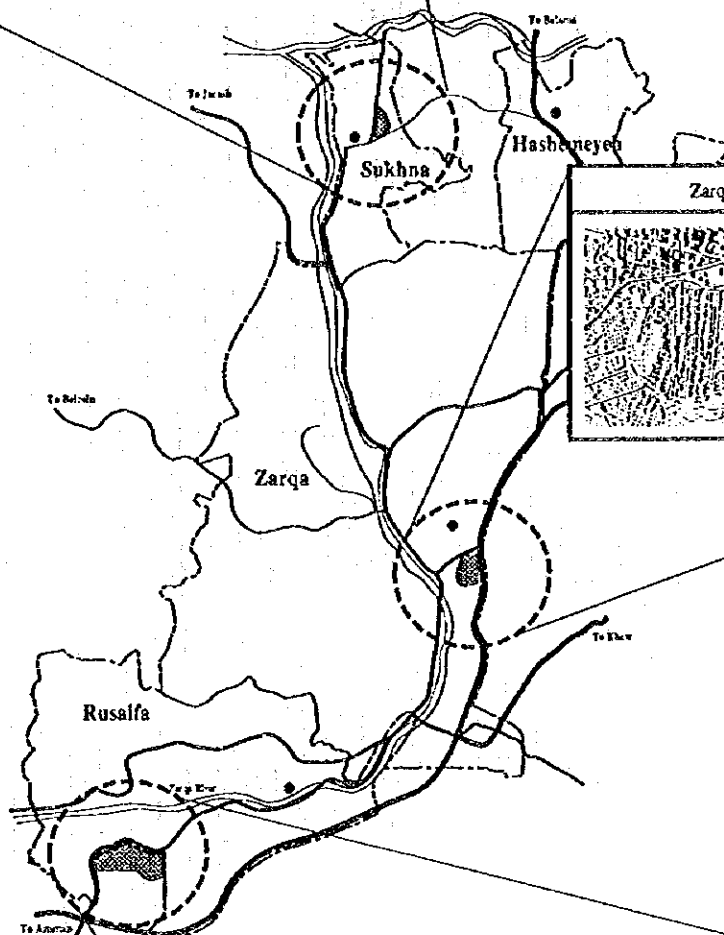
Fig. 3.2


MAJOR FACTORIES IN THE
STUDY AREA


Sukhna Refugee Camp (1995)	
	Year Established: 1968 Land Area: 7.0 ha Population: 5,750 Population Density: 821 / ha Number of Households: 680 Average Number of Households: 8.5

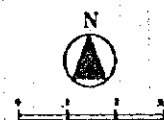
LEGEND

- Municipal Boundary
- == Highway
- Primary Road
- Secondary Road
- Village Road
- ⊙ Municipal Hall
- Refugee Camp



Zarqa Refugee Camp (1995)	
	Year Established: 1948 Land Area: 18.0 ha Population: 19,000 Population Density: 1,056 / ha Number of Households: 2,325 Average Number of Households: 8.2

Schneller Refugee Camp (1995)	
	Year Established: 1968 Land Area: 91.7 ha Population: 36,218 Population Density: 395 / ha Number of Households: 7,650 Average Number of Households: 7.8



Source: Department of Palestinian Affairs
Department of Statistics

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FOR THE ZARQA DISTRICT

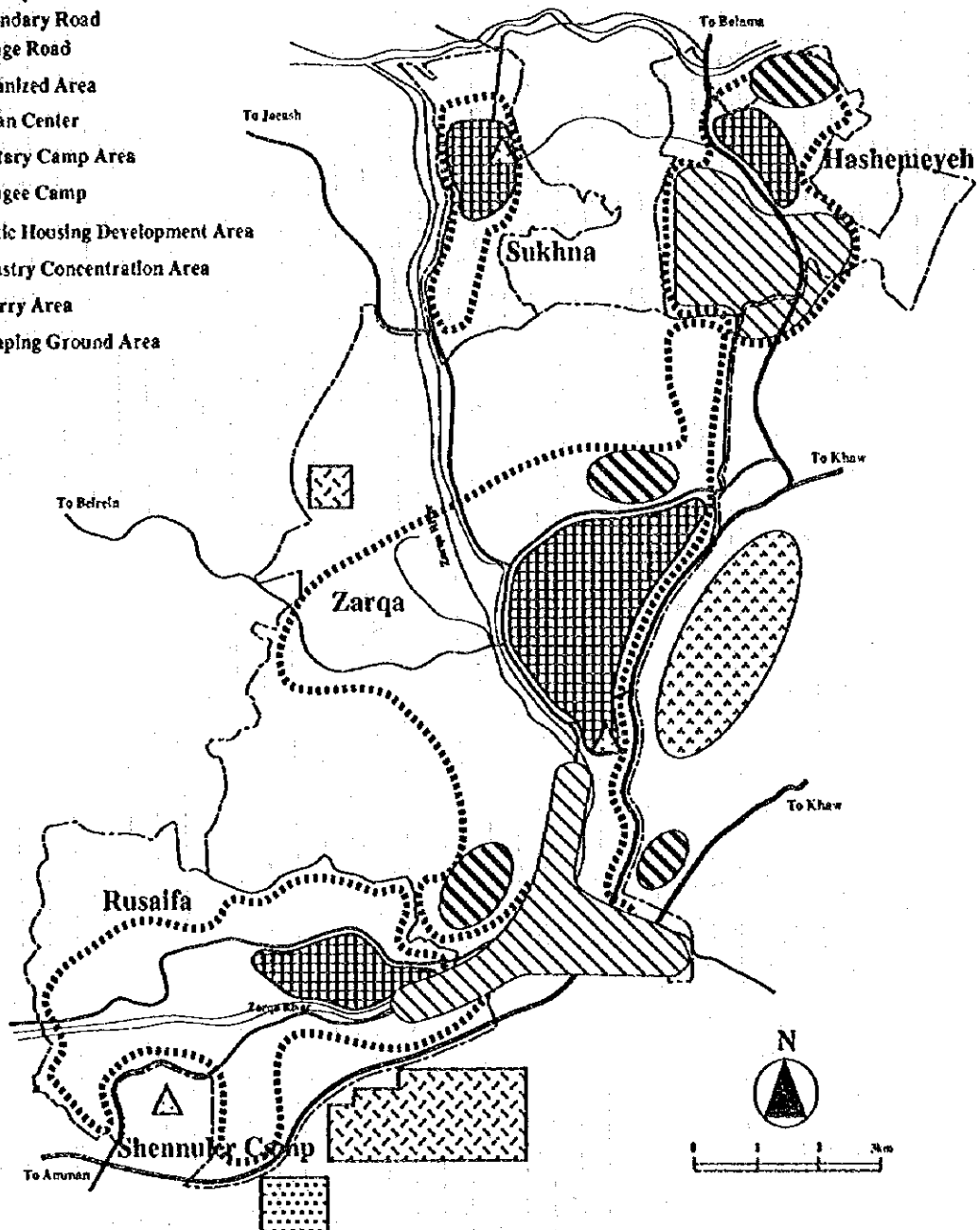
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3

REFUGEE CAMPS IN THE
STUDY AREA

LEGEND

- Municipal Boundary
- == Highway
- Primary Road
- Secondary Road
- Village Road
- ⊙ Urbanized Area
- ⊞ Urban Center
- ⊗ Military Camp Area
- △ Refugee Camp
- ▨ Public Housing Development Area
- ▧ Industry Concentration Area
- ▩ Quarry Area
- ▤ Dumping Ground Area

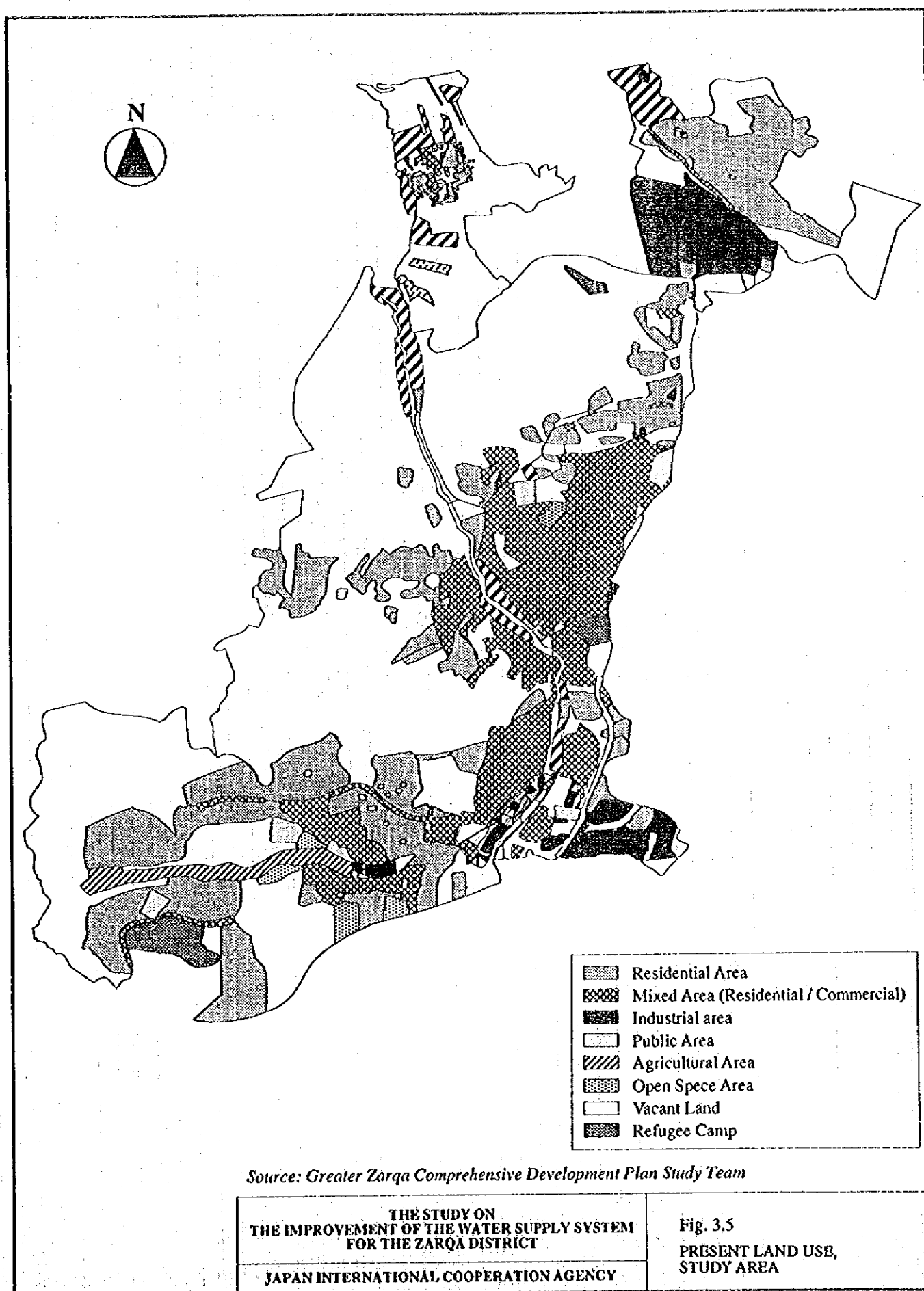


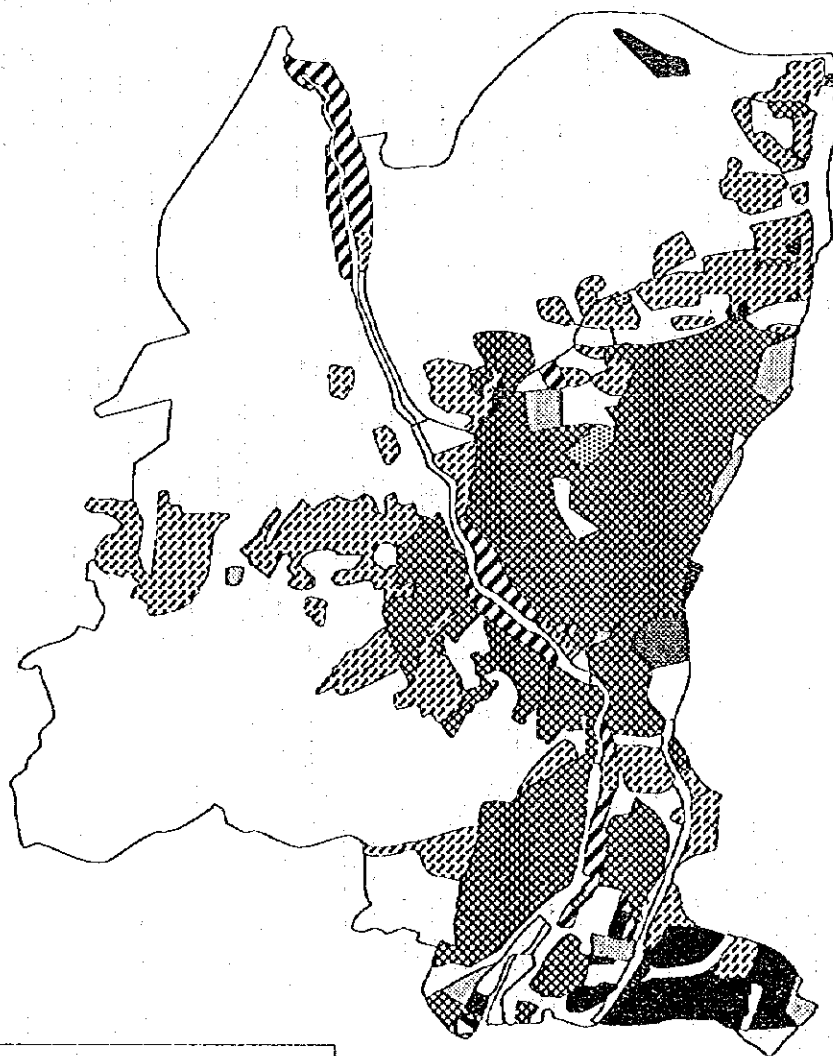
THE STUDY ON
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FOR THE ZARQA DISTRICT









JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.4

PRESENT URBAN
DEVELOPMENT IN
THE STUDY AREA





-  Residential Area
-  Mixed Area (Residential / Commercial)
-  Industrial area
-  Public Area
-  Agricultural Area
-  Open Spece Area
-  Vacant Land
-  Refugee Camp



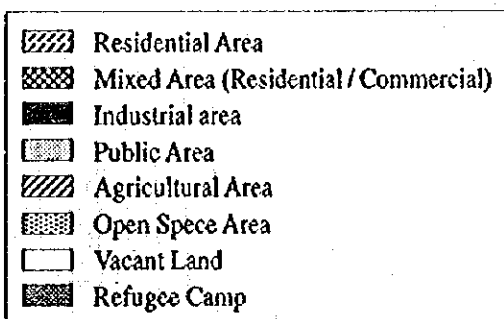
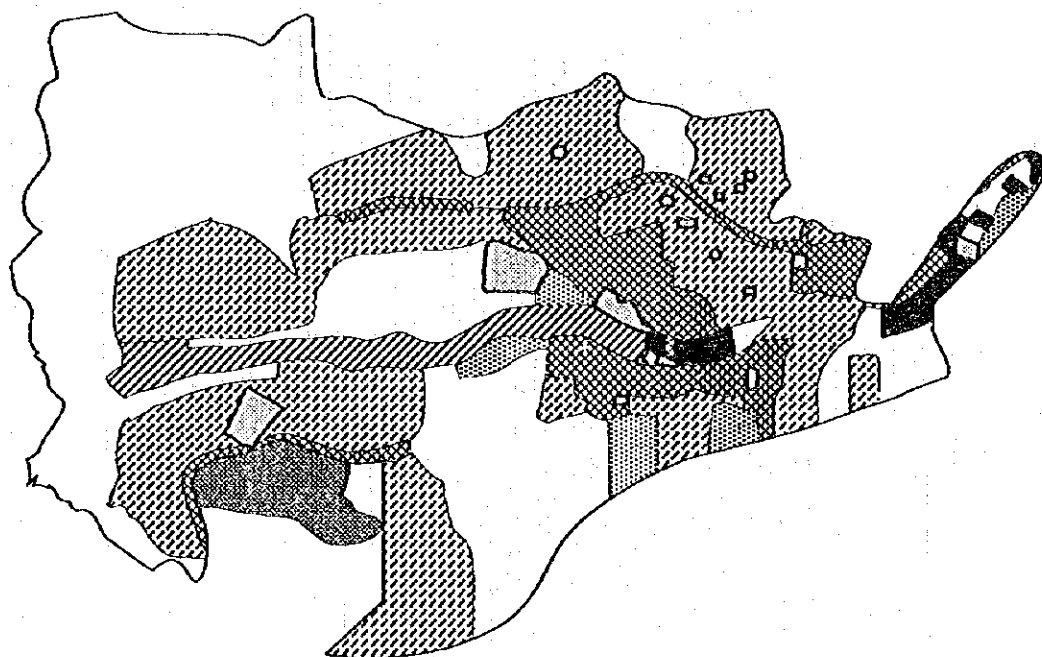
Source: Greater Zarqa Comprehensive Development Plan Study Team

THE STUDY ON
THE IMPROVEMENT OF THE WATER SUPPLY SYSTEM
FOR THE ZARQA DISTRICT

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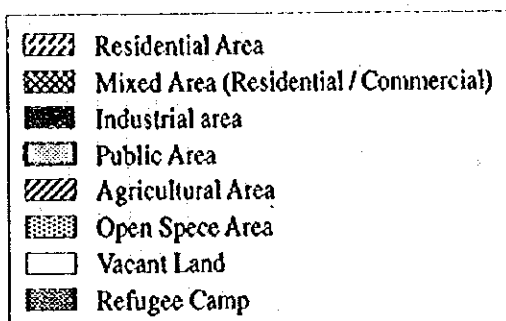
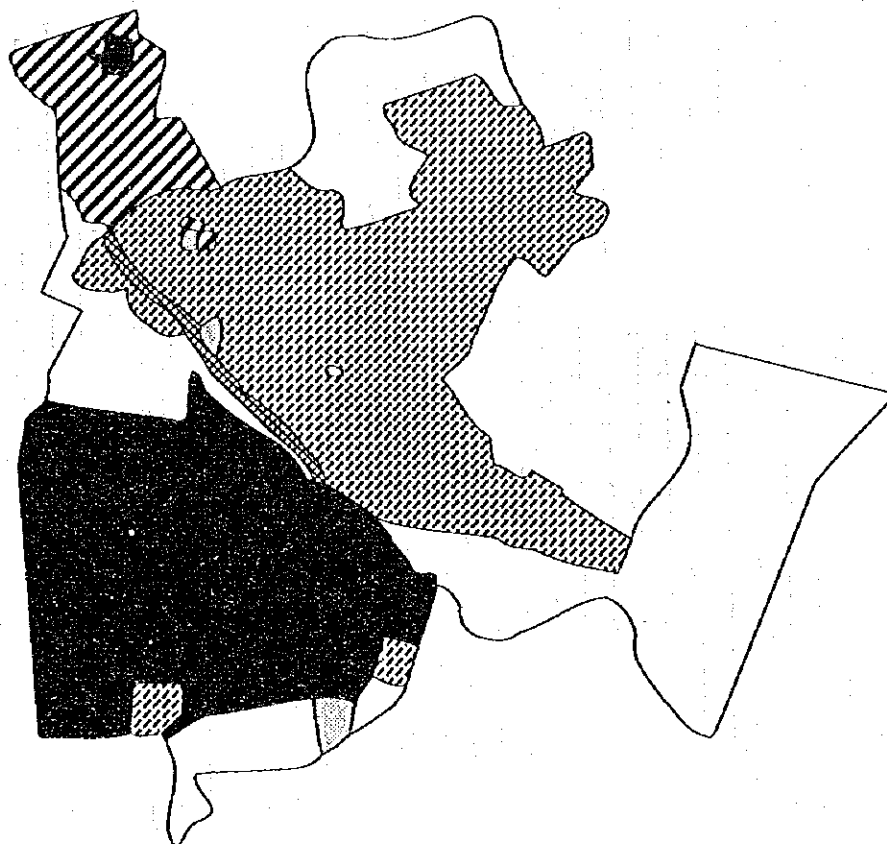
Fig. 3.6

PRESENT LAND USE, ZARQA



Source: Greater Zarqa Comprehensive Development Plan Study Team

<p align="center">THE STUDY ON THE IMPROVEMENT OF THE WATER SUPPLY SYSTEM FOR THE ZARQA DISTRICT</p>	<p align="center">Fig. 3.7</p>
<p align="center">JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p align="center">PRESENT LAND USE, RUSAIIFA</p>



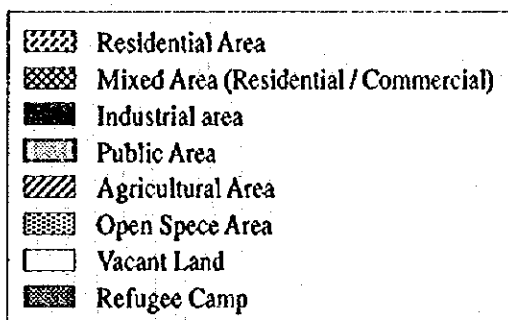
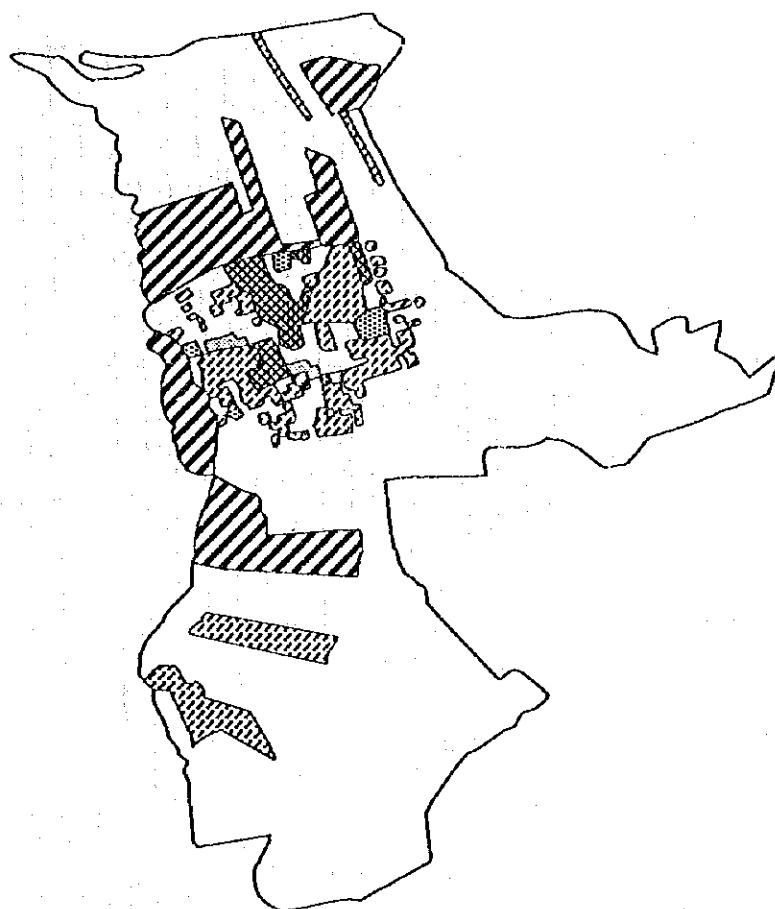
Source: Greater Zarqa Comprehensive Development Plan Study Team

THE STUDY ON
THE IMPROVEMENT OF THE WATER SUPPLY SYSTEM
FOR THE ZARQA DISTRICT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8

PRESENT LAND USE,
HASHEMEYEH



Source: Greater Zarqa Comprehensive Development Plan Study Team

THE STUDY ON
THE IMPROVEMENT OF THE WATER SUPPLY SYSTEM
FOR THE ZARQA DISTRICT

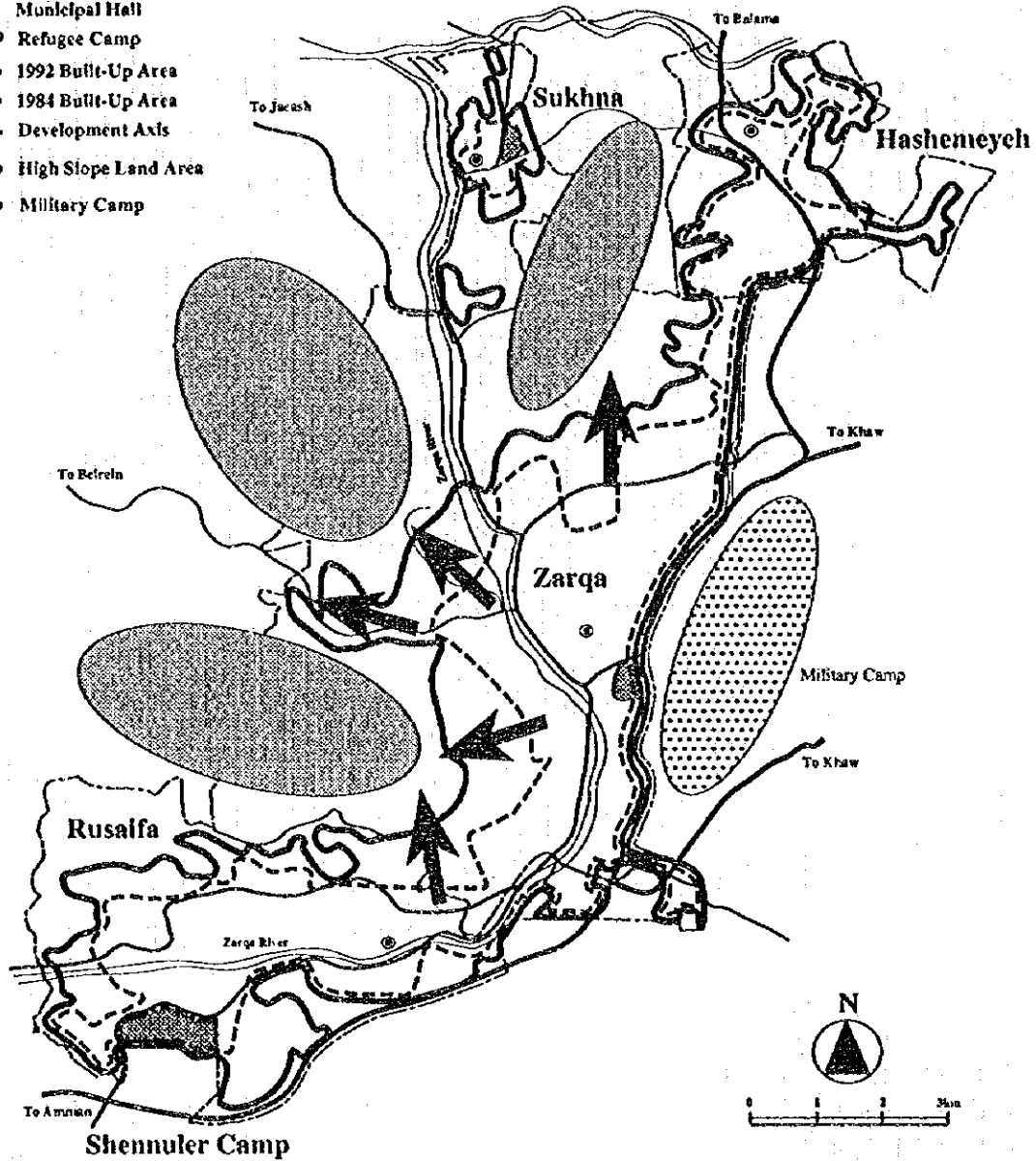
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Fig. 3.9

PRESENT LAND USE, SUKHNA

LEGEND

- Municipal Boundary
- == Highway
- Primary Road
- Secondary Road
- Village Road
- ⊙ Municipal Hall
- Refugee Camp
- 1992 Built-Up Area
- 1984 Built-Up Area
- Development Axis
- ▨ High Slope Land Area
- ⊙ Military Camp



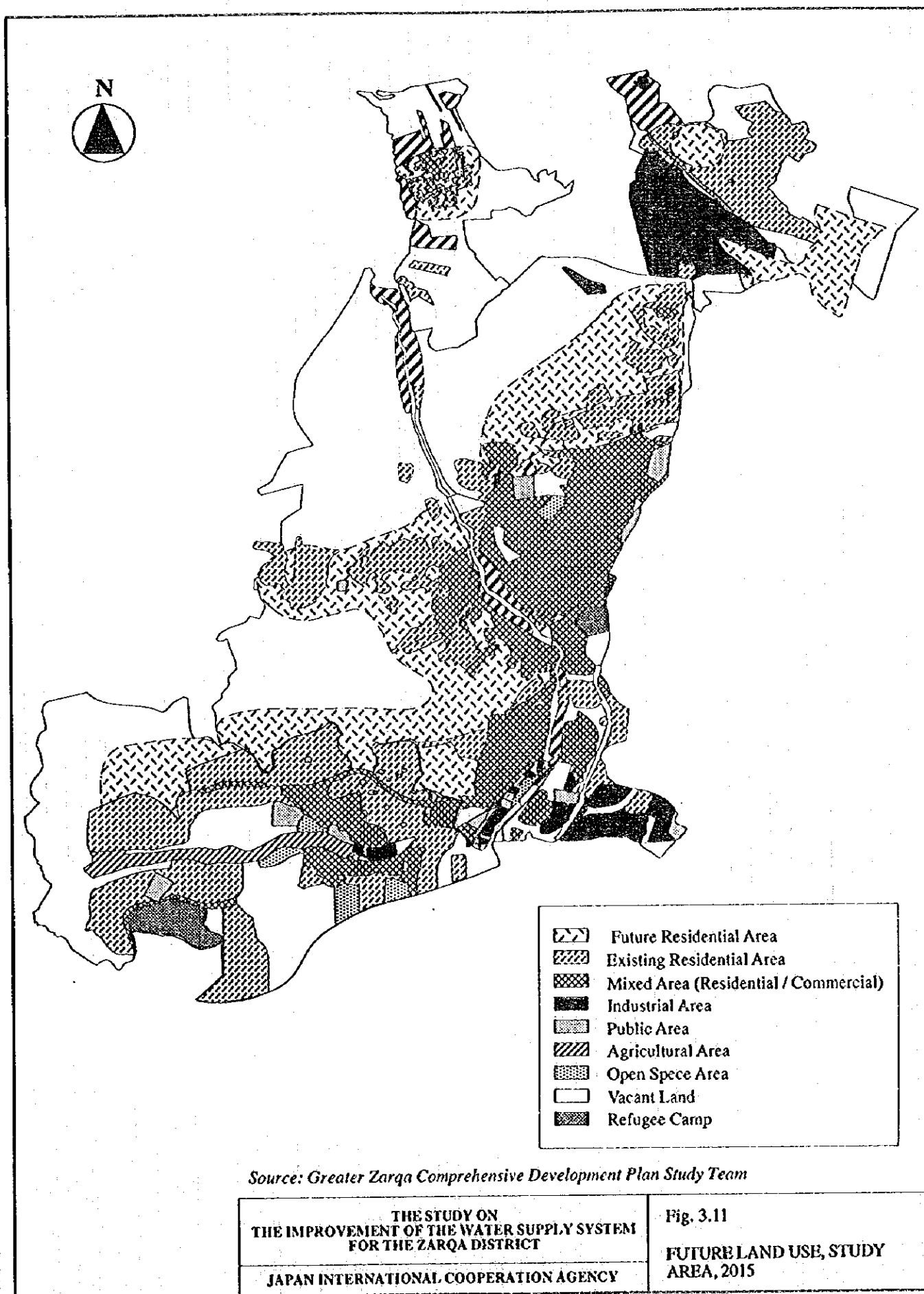
Sources: Aerial Photographs Taken in 1985 and 1992, and Topographic Maps by Royal Jordanian Geographic Center

THE STUDY ON
THE IMPROVEMENT OF THE WATER SUPPLY SYSTEM
FOR THE ZARQA DISTRICT

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Fig. 3.10

DEVELOPMENT DIRECTION
IN THE STUDY AREA



C. HOUSEHOLD SURVEY

Appendix C
- HOUSEHOLD SURVEY -

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1. GENERAL

To formulate water supply improvement plan, detailed information on water consumption, water use pattern, customers' behaviour and response to WAJ services are imperative. From that point of view, a household survey was conducted focusing on domestic water, since this category dominates others as can be seen in Table - C1. Procedures and results of the survey are described in the following sections.

In WAJ Zarqa, there isn't enough accurate data and information about water consumption, and behavior of subscribers to supplement future comprehensive planning. This is mainly due to 1) a rapid and unexpected population growth in the area and 2) a somewhat delayed and unroutined data recording and compilation system although computerization is recently adopted in WAJ Zarqa. In addition, past studies and analyses in this engineering field are a little and mostly out of dated. It is therefore intended that the current survey may provide information on consumers' water usage pattern and their living environment, replenishing the insufficiency of data and inputs to the current water supply improvement plan up to 2015.

In general, water consumption percapita closely relates to a family size, job, living standard, water supply conditions, etc. Public understanding and cooperation are key issues for formulating a long-term water supply planning. Water tariff shall be within consumers' capability to pay. These basic information are incorporated to future water demand forecast, system network analysis and financial analysis of the Study.

2. ORGANIZATION OF SURVEY

2.1 Data Collection Method

Out of several methods generally applied for the survey, finally selected is an "interview" by WAJ staff (bill collectors) both in Zarqa and Rusaifa offices. This is considered most effective and accurate as compared to others such as mailing, telephone, and their combination. Followings are considered in the selection:

1) Interviewees are not always responsive for the inquiries. In case of their misunderstanding, interviewers could immediately point out in a tete-a-tete, asking them a correct answer. Thus, this method minimizes misunderstandings of interviewees, resulting in an increase of response rate.

2) Topographical maps are not available in a sufficient scale to locate subscribers in their exact addresses. Further, interviewers should have basic information on water supply system in the area. In this sense, bill collectors from Rusaifa and Zarqa offices were considered most appropriate for organizing survey team as interviewers. This organization substantially reduces time required for the interview.

3) Other methods generally applied may have following advantages and disadvantages:

Method	Advantage	Disadvantage
Mailing	-Simple	-Frequent misunderstanding -Less response rate to each inquiry -Requiring a longer period
Telephone	-Reply to be immediately obtained	-Miscommunication in case of a number of inquiries
Combination of mailing & interview	-Accurate	-Considerable time required

2.2 Sample and Questionnaire Design

1) Sample Size

Sample size was determined 255 samples to be representative of 534,674 population (1994 Census Data) of Zarqa District. The survey basically adopts unstratified, single-staged sampling method.

2) Sampling

It is recommended to apply random sampling for the current survey. Statistically, it is hard to attain the random sampling. To seek a practical solution, following moderate procedures are undertaken:

- Whole study area was grouped into 4 sub-areas, namely, 1) Zarqa (inclusive of New Zarqa, Awajan), 2) Rusaifa (inclusive of Schneller), 3) Hashemeyeh and 4) Sukhna. Then, sample size was determined in proportion to the 1994 Census Population for each sub-area as given in Table - C2.

- On the topographical map with a scale of 1/25,000, 200-meter width mesh as shown in Fig. - C1 was provided. According to the required number of the meshed zones, the random sampling was then made.

- From each selected meshed zone, 5 samples are allocated for the interview. The selected blocks were numbered basically from north to south and from west and east. (See also Fig.- C1)

2.3 Questionnaire

Prior to developing a questionnaire form, a series of reconnaissance surveys was made at the study area. A draft questionnaire was then prepared by the Team for further discussions with WAJ officials and Jordanian residents. These aim to reflect subscribers' behavior into the questionnaire. The questionnaire form was thus elaborated, specifically for the current survey both in English and Arabic. The form finally developed in English version is given in Attachment - C1.

The questionnaire consists of three categories: 1) Mode and standard of living, 2) Water usage, and 3) General views on WAJ's services.

1) Mode and standard of living

- Occupation, household size, religion, structure type of houses
- Income level
- Type of sewerage services

2) Water usage

- Water storage, filter, treatment for drinking
- Water consumption

3) General view on WAJ's services

- Water pressure
- Payment for water
- Satisfaction, reason for unsatisfaction

The above inquiries were arranged in the form to flow smoothly and not to give any misunderstanding to the households.

2.4 Data Processing

Data entry started early January, 1995 immediately after the questionnaire survey at the field was completed. Editing and cleaning was made simultaneously with Excel software program.

Since Zarqa and Rusaifa offices manage and operate the water distribution system separately, all sample data are further conglomerated into two: 1) 'Zarqa' including Hashemeyeh, Sukhna, New Zarqa, Awajan, and 2) 'Rusaifa' including Schneller.

In the course of data review and editing, the results were found to eventually contain some incomplete data. They are:

- 1) Replies for monthly electricity charge contain figures per three months or four months. Accordingly, these data shall be canceled from further analysis.
- 2) Daily water consumption data obtained from the interviewees are not necessarily accurate. These should be replaced by the latest meter reading records of WAJ.

Following the data review and editing, data processing for cross tabulation was carefully made, in due consideration of the above.

3 RESULTS OF HOUSEHOLD SURVEY

3.1 Primary Data

Table - C3 presents primary data obtained from the household survey. As shown in the table, the data indicate high response rate except inquiries on 'water consumption' and 'reason for unsatisfaction'. As noted in the foregoing section, all water consumption data have been replaced by meter reading records (third quarter, 1994) of WAJ. Monthly payments for electricity and sewerage, however, are incomplete and shall be canceled from further analysis.

3.2 Processed Data with Cross Tabulation

The data were carefully processed with Excel software program for the purpose of the cross tabulation. Following paragraphs brief major results of the household survey which are also given in

Tables - C4 to C14 and Figs.- C2 to C10.

1) Mode and standard of living

- More than half of the households rely on the tertiary sector (commerce and service) for their lives. It was also assumed that an average unemployment ratio in the area is around 20%. (See Fig.- C2)
- Average number of household members is 9.2 as shown in Table - C4, much larger than 6.9 members obtained from the Jordan Population and Family Health Survey 1990. This is due to the fact that several families used to live together in one household. The above 1990 Survey also suggests 29% of families are living with ever-married and unmarried relatives, while the remaining 71% are a nuclear family (parents and children).
- The survey also revealed that the average household in Rusaifa has a large family members of 11.3 as compared to 8.0 in Zarqa. (See also Table - C4)
- The majority of the households (95%) is Islam and the remainings (5%) are Christians. (See Table - C5)
- Houses made of concrete/stone exceed others with a high percentage of 97%. This explains extremely low occurrence of "fire" recorded in the area. (See Table - C6)
- Most residents depend on WAJ water although some have alternative sources. (See Table - C7)
- Public sewerage services cover built-up areas of Rusaifa, Zarqa and Hashemeyeh. There are some percentage of residents in the built-up areas, who cannot afford to be served by public sewerage system mainly because of slightly high sewer tariff. According to WAJ Zarqa, these population account for 25% in the sewered area. The majority of residents in the outskirts of the area still depend on private sector services and conventional methods. (See Table - C8)
- Monthly income of more than half of households falls between 100JD/month and 200JD/month with an average percapita income of around 17JD/month. (See Fig. - C3)

2) Water usage

- Entire households have water storage facilities (roof tanks and other means) without exception. (See Table - C9)
- Majority of the households (95%) are not accustomed to boil water before drinking although some (5%) are practicing. (See Table - C10)
- Only a small number (8%) of households are using filters at their house taps for purification purpose. Households who have filters and boil water before drink are much small in percentage (2%). They are keen about the quality of WAJ water. (See Tables - C11 to C12)
- Although water pressure is not major problems for customers, 16% of Zarqa subscribers answered high, which may result in an increase of leakage from the distribution pipe network. In Rusaifa this value drops to only 4%. (See Fig.- C4)
- Unit water consumption in Rusaifa is smaller than that in Zarqa as presented in Fig.- C5. They are 72 lpcd and 52 lpcd respectively. This is because of the rationing frequently practiced in Rusaifa as seen in Fig.- C6. Further, Fig.- C5 also illustrates seasonal change in unit water consumption during rainy and dry seasons. Seasonal change in Zarqa is larger than that in Rusaifa. Rusaifa people consume less water throughout the year. Further detailed discussions on unit water consumption are made in Section 3.3 which follows.
- Fig.- C7 illustrates actual needs for water. As far as questionnaires are concerned, most of them (89%) expressed their satisfaction in terms of quantity. In view of the present suppressed water use by subscribers, this is hardly believable. In this background, more serious problems may lie or they became accustomed to the present situation. This issue will be discussed further in Section VII of the Main Report.

3) General view on WAJ's services

- As regards water pressure, most household (77%) expressed their impression as average, while 11% of the households clearly stated as low. (See Fig. - C4)
- Average monthly payment for water and sewerage is 2.4 % of the household income, within an allowable level of 3.0%. (See Fig.- C8)

- One third of households are not satisfied with water supply services by WAJ as enumerated in Table - C13. Major reasons for the unsatisfaction may lie in a slightly heavy burden for water charge payment as compared to their income. (See Table - C14)

3.3 Unit Water Consumption vs. Household Type

To look into far more detail of households behaviour, analyses are made on unit water consumption in relation with household size and type of sewer services.

As regards household size, Fig.- C9 was prepared with plotted data of the 203 samples. As seen on this figure, it is apparent that water consumption percapita (in summer season) relates to the household size. To obtain magnitude of this relationship in numerical figure, a correlation coefficient was computed. The value obtained was as high as 0.414 against 203 samples. Further, a single regression model that explain the relation between the water consumption percapita (Y) and the household size (X) was developed as follows:

$$Y = 67.3 + 1774.3 \exp(-X)$$

whereas,

Y : unit water consumption percapita (lpcd)

X : household members (person)

For water demand forecast, the above equation will be helpfull. From the equation, it can be assumed that one (1) member decline in the higher range of the average family size, 7 - 10, may be equivalent to one (1) lpcd increase of the unit water consumption at most. In the lower range of 5 - 7 average household members, however, the decline tends to be comparatively large, 3 - 8 lpcd decrease per member.

Apart from the household size, the relation between unit water consumption and the type of sewer services are also brought into focus. As seen in Fig.- C10, the unit water consumption does not relate to the sewer service types. To the contrary, subscribers connected to the public sewers use less water than those not sewerred. WAJ staff/engineers explained most residents in the study area depend on Arabian type of the pour-flush toilet which do not require much water. Due to their burden for sewer tariff, they usually tend to save water.