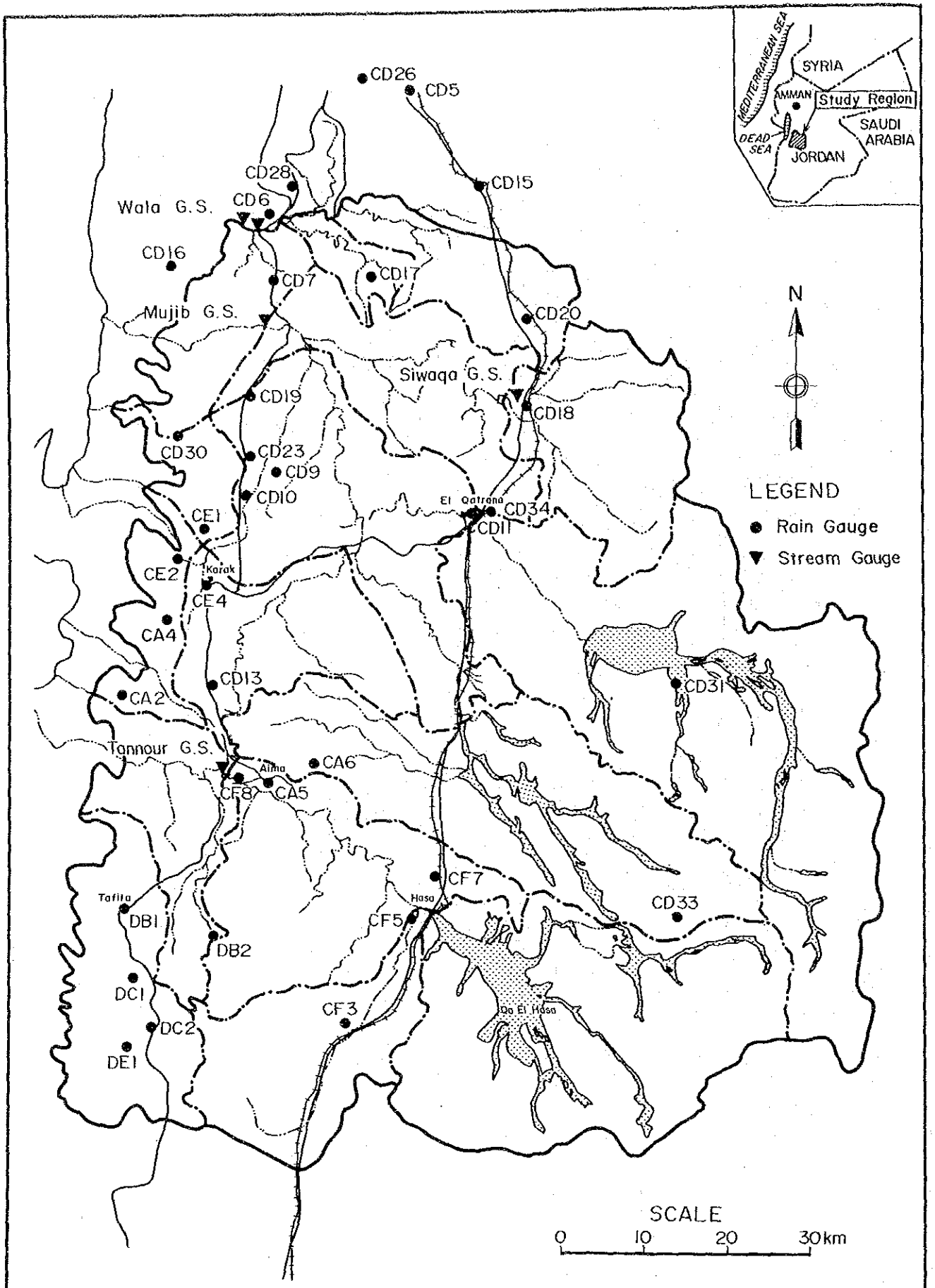

Fig. A-2 Rainfall and Stream Gauging Stations in the Study Area

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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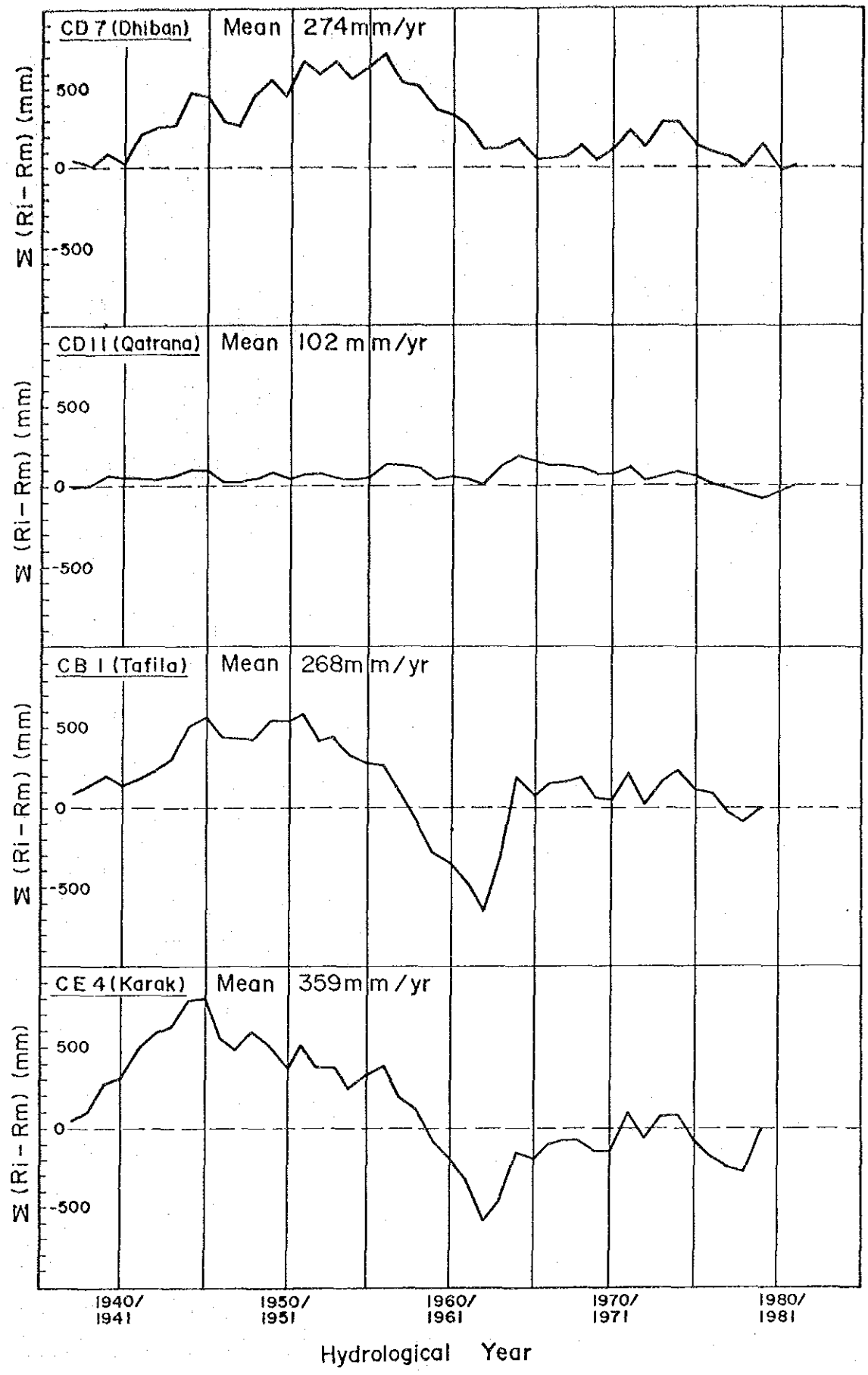

Fig. A-3 Rainfall Masscurve

THE HASHEMITE KINGDOM OF JORDAN
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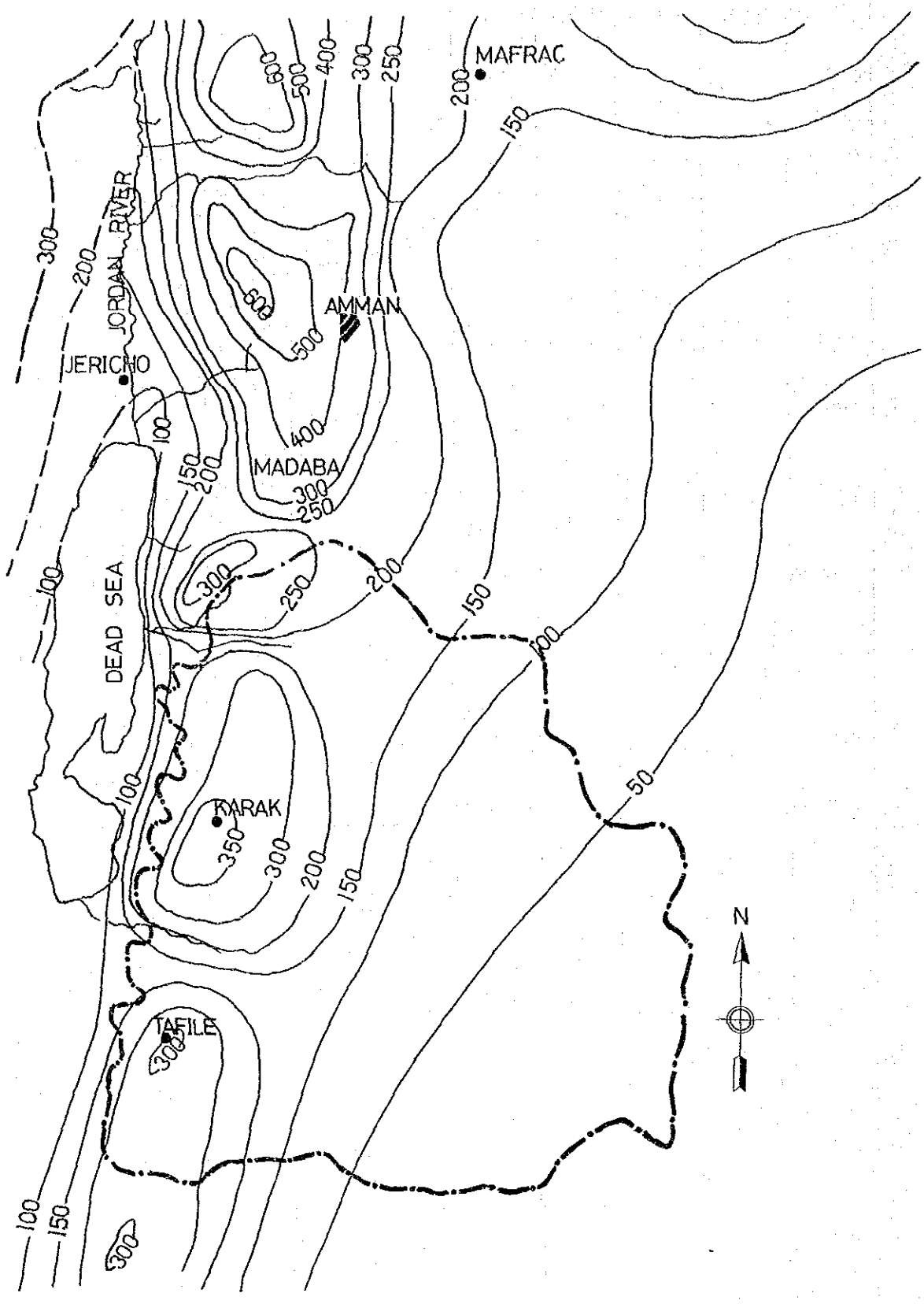

Source: National Water Master Plan, 1977

Fig. A-4 Isohyet for Normal Year

THE HASHEMITE KINGDOM OF JORDAN
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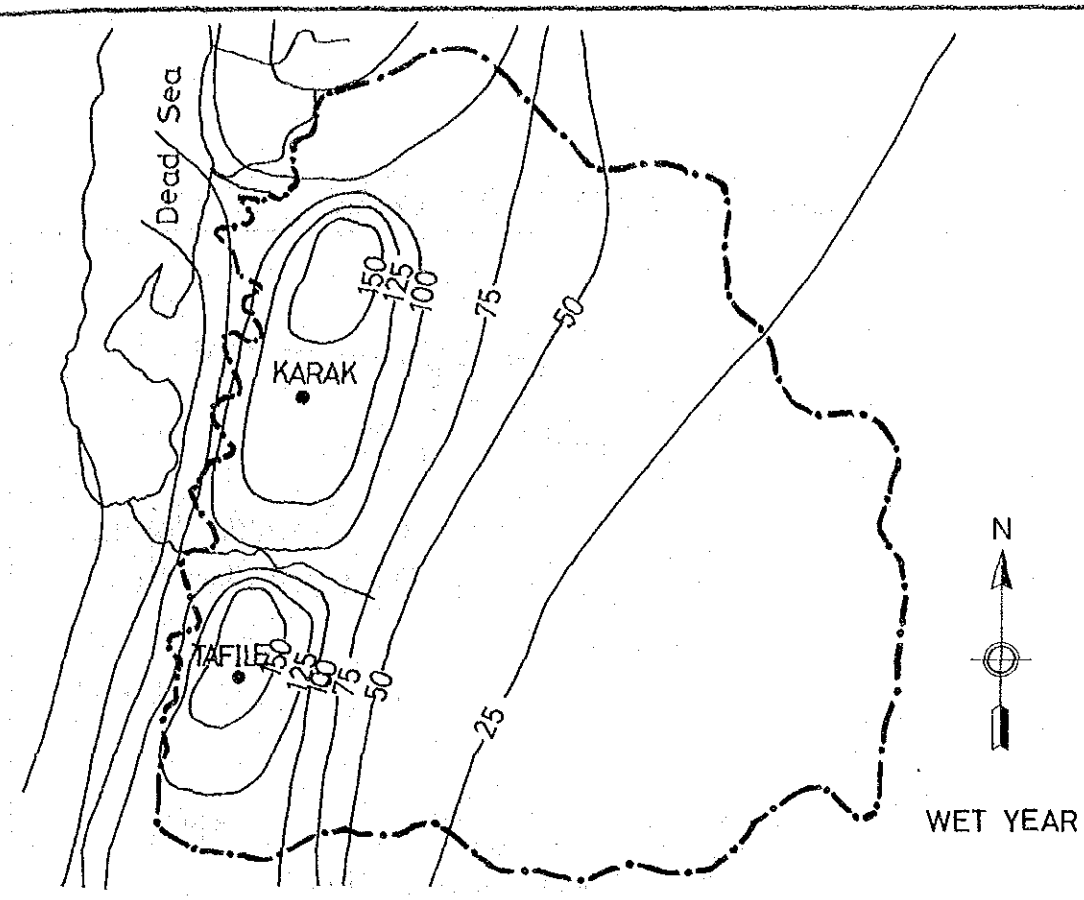

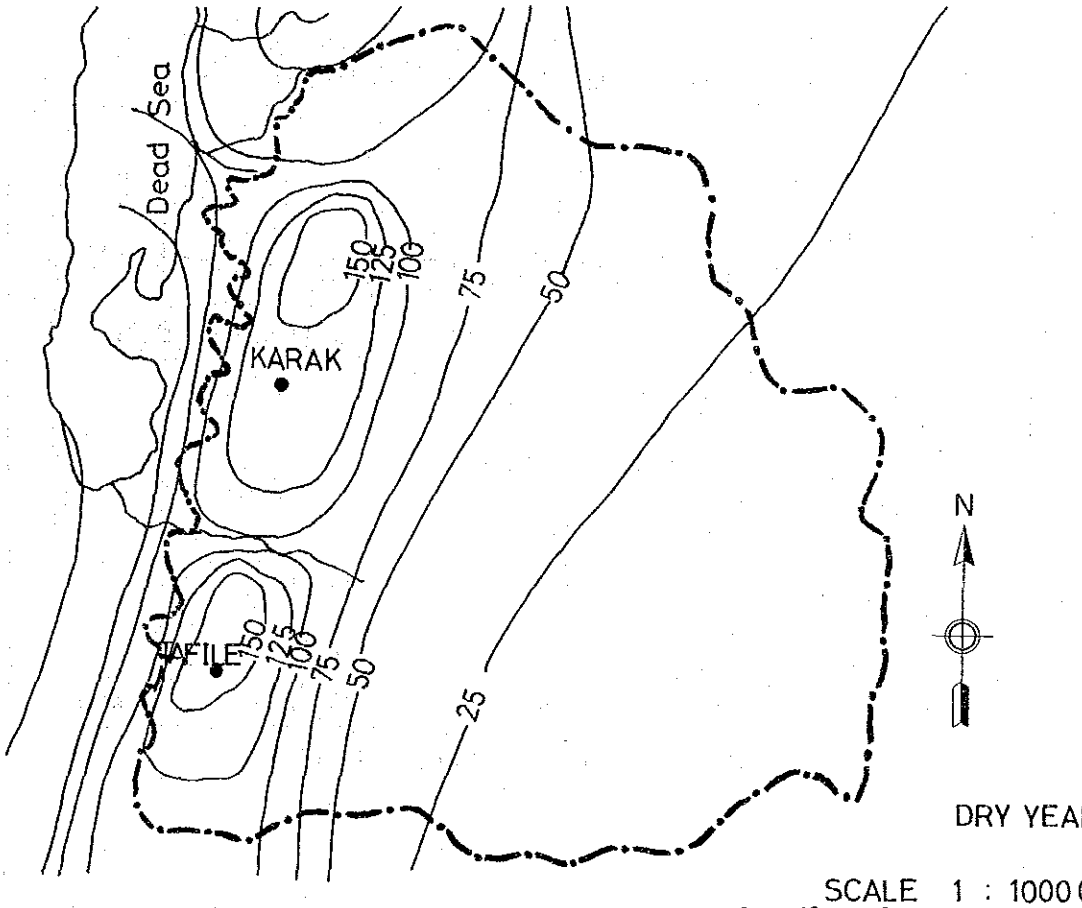

SCALE 1 : 1000 000
0 10 20 30 40 50 Km

Source: National Water Master Plan, 1977

Fig. A-5 Isohyets for Wet and Dry Years

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THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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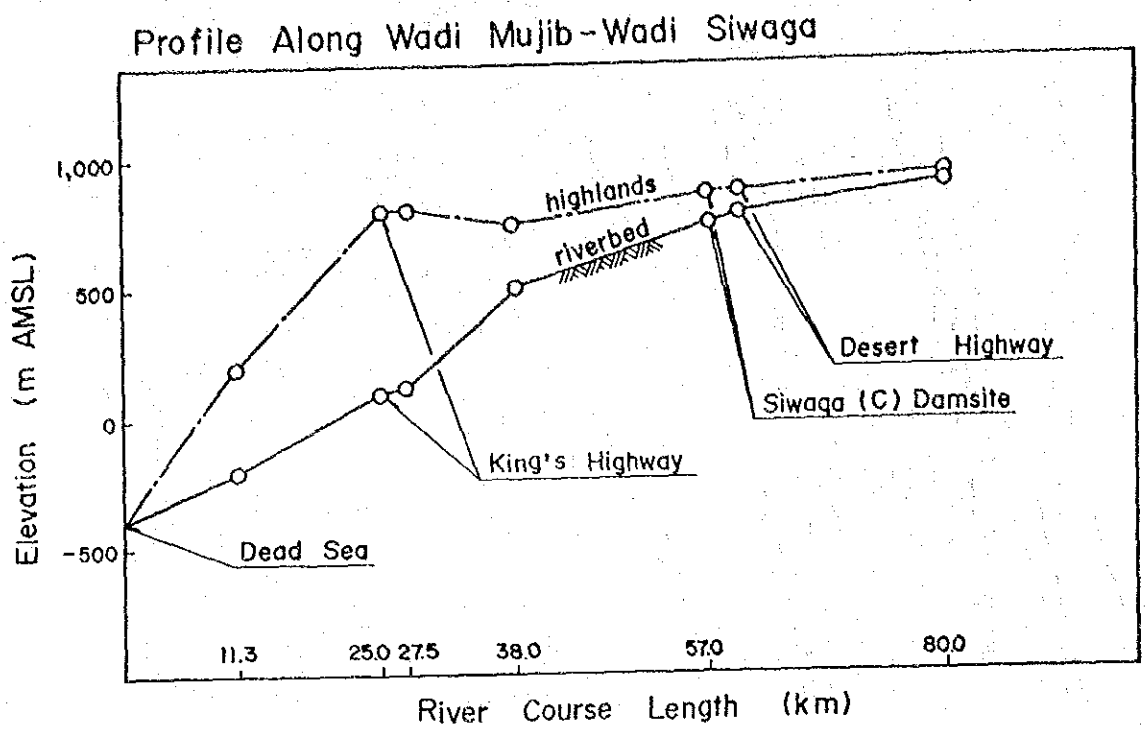

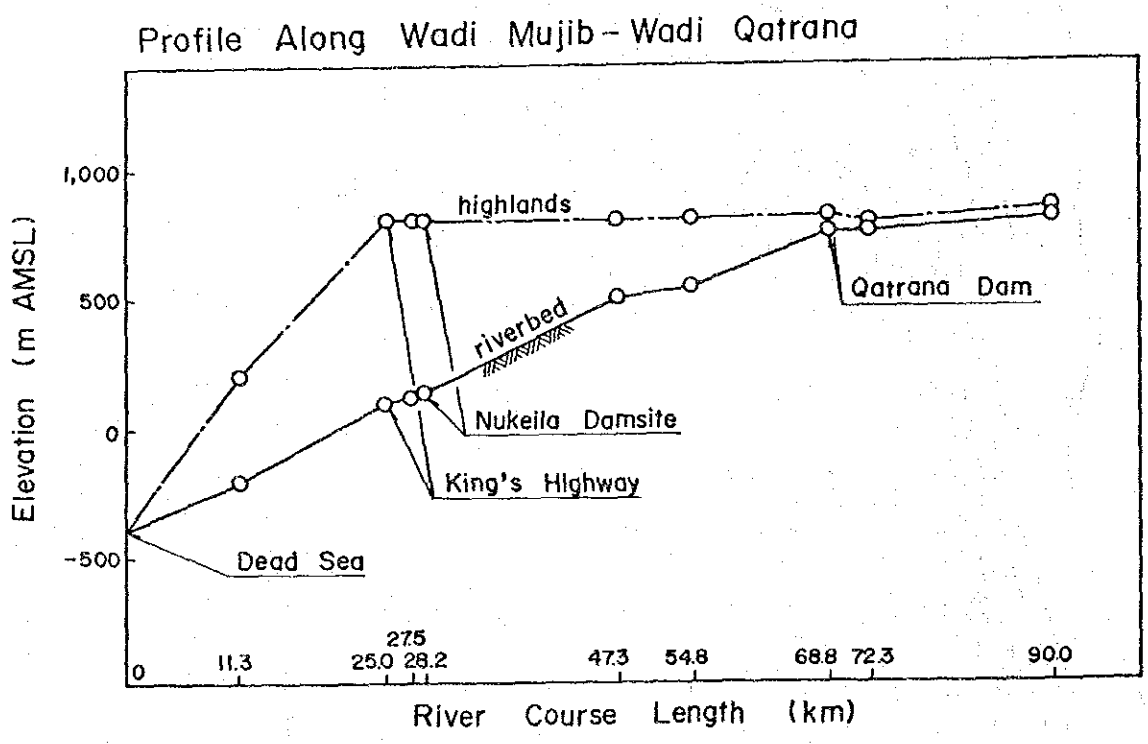

Fig. A-6 Profiles of Principal River Courses (1/2)

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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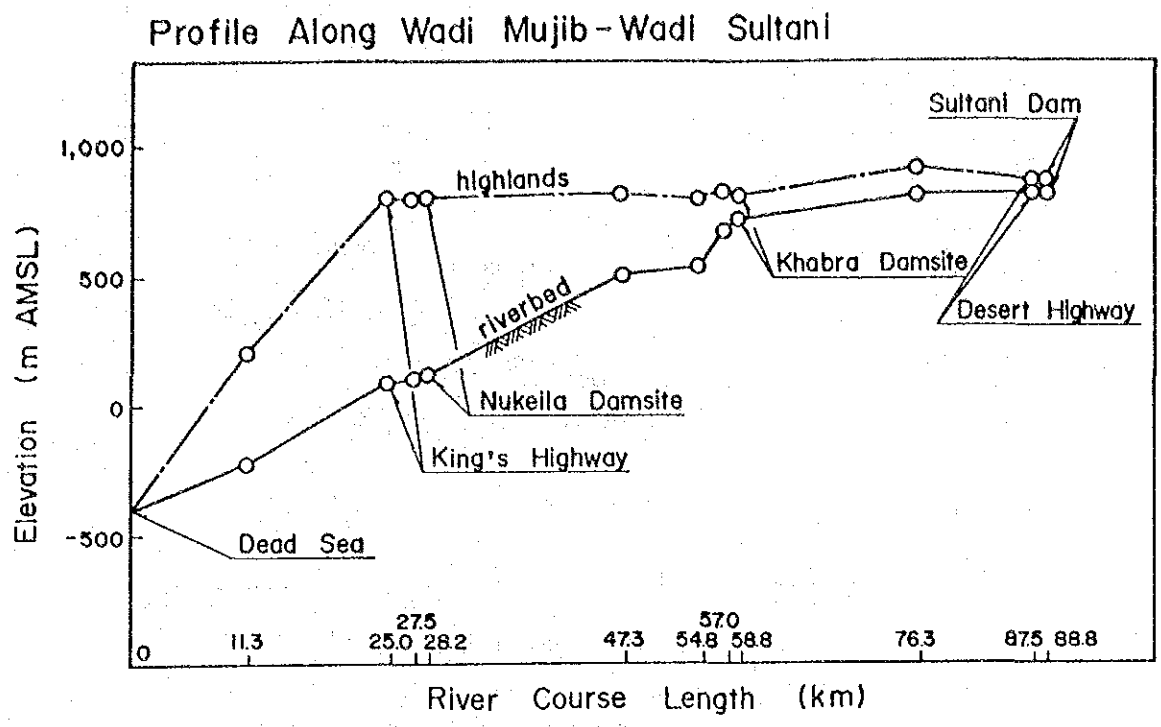

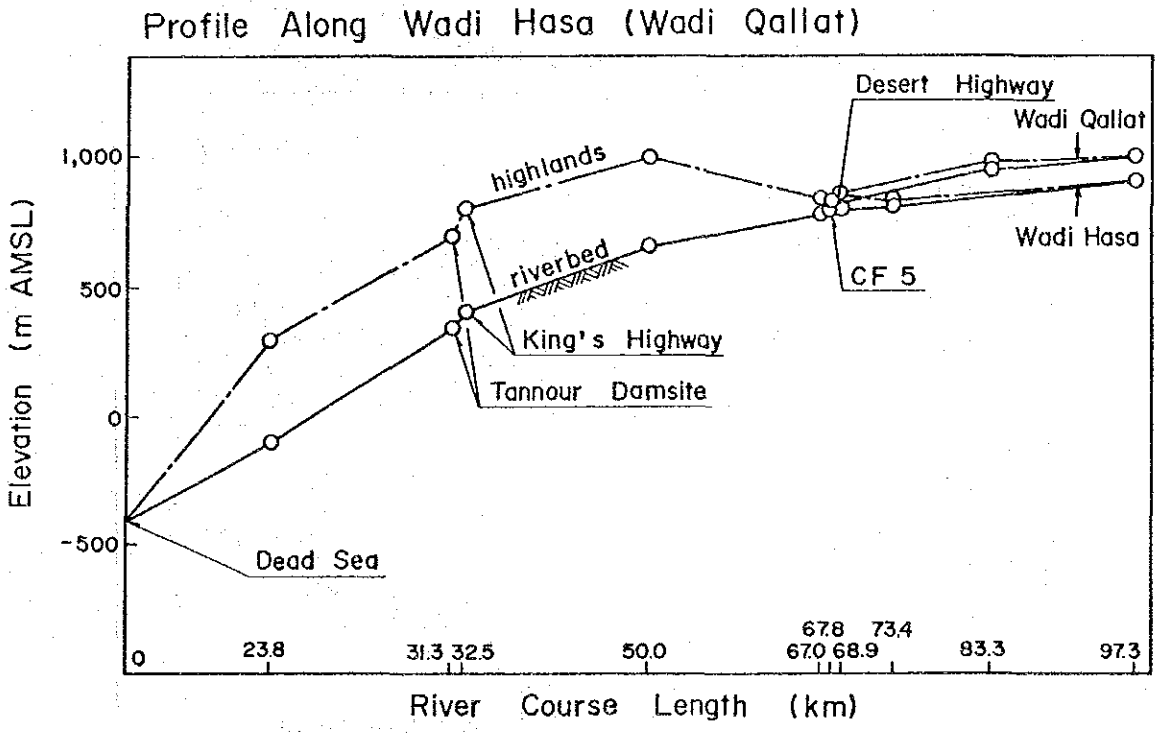

Fig. A-6 Profiles of Principal River Courses (2/2)

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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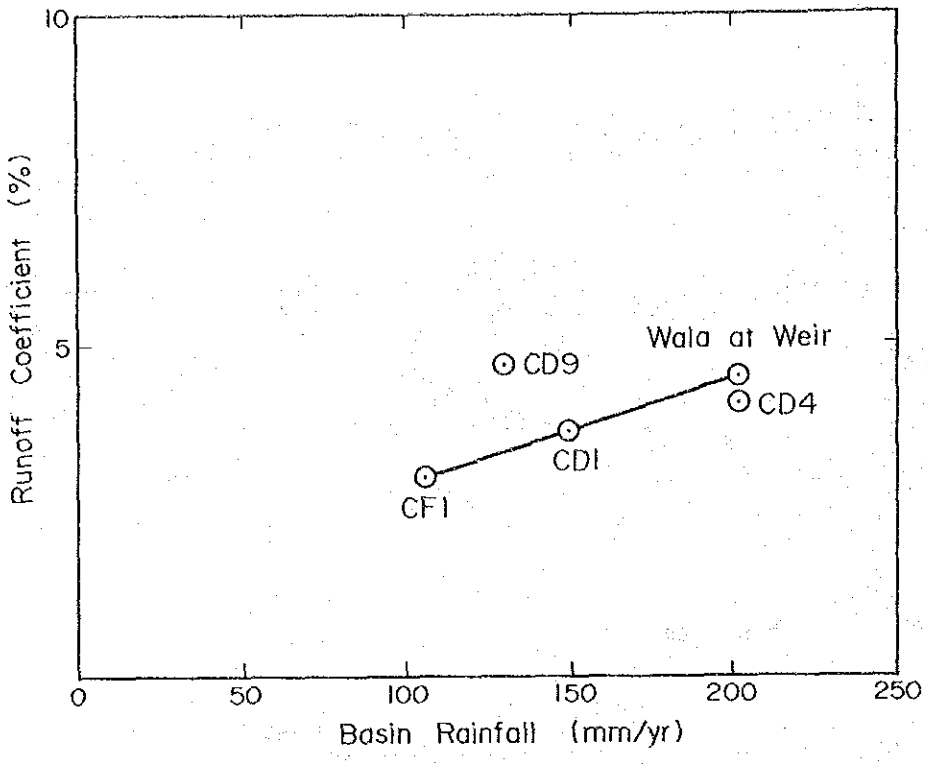

Fig. A-7 Runoff Coefficient at Stream Gauging Stations

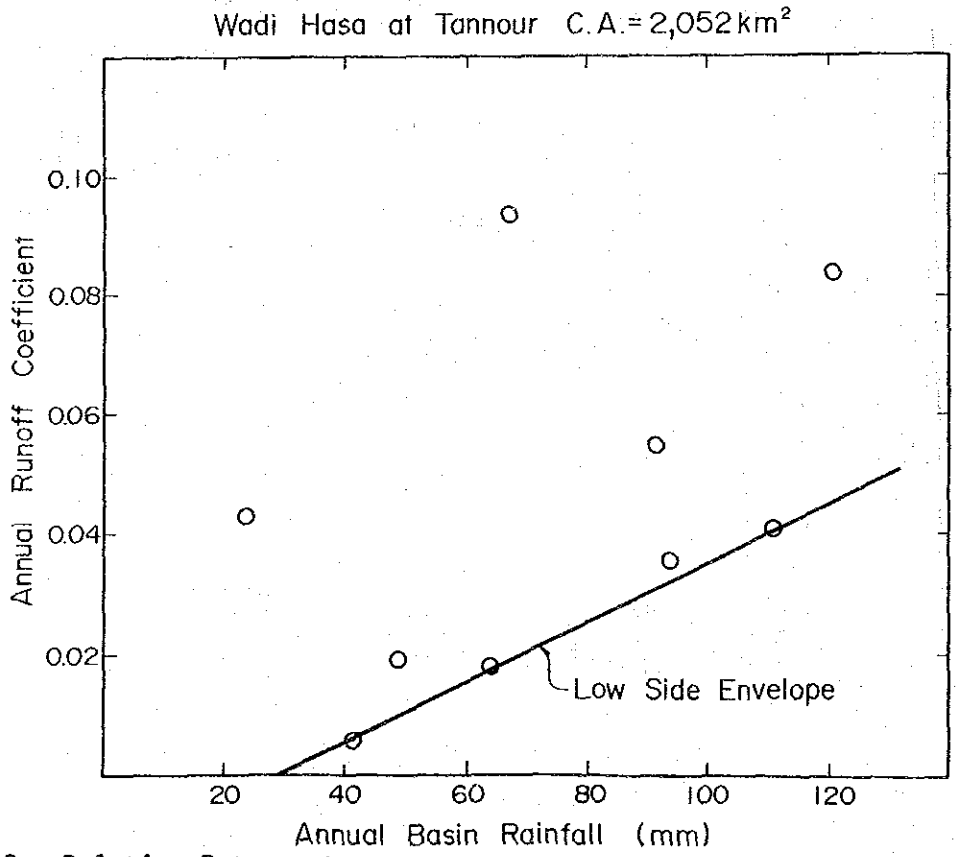

Fig. A-8 Relation Between Annual Basin Rainfall and Runoff Coefficient at Tannour on Wadi Hasa

Fig. A-7, Fig. A-8

THE HASHEMITE KINGDOM OF JORDAN
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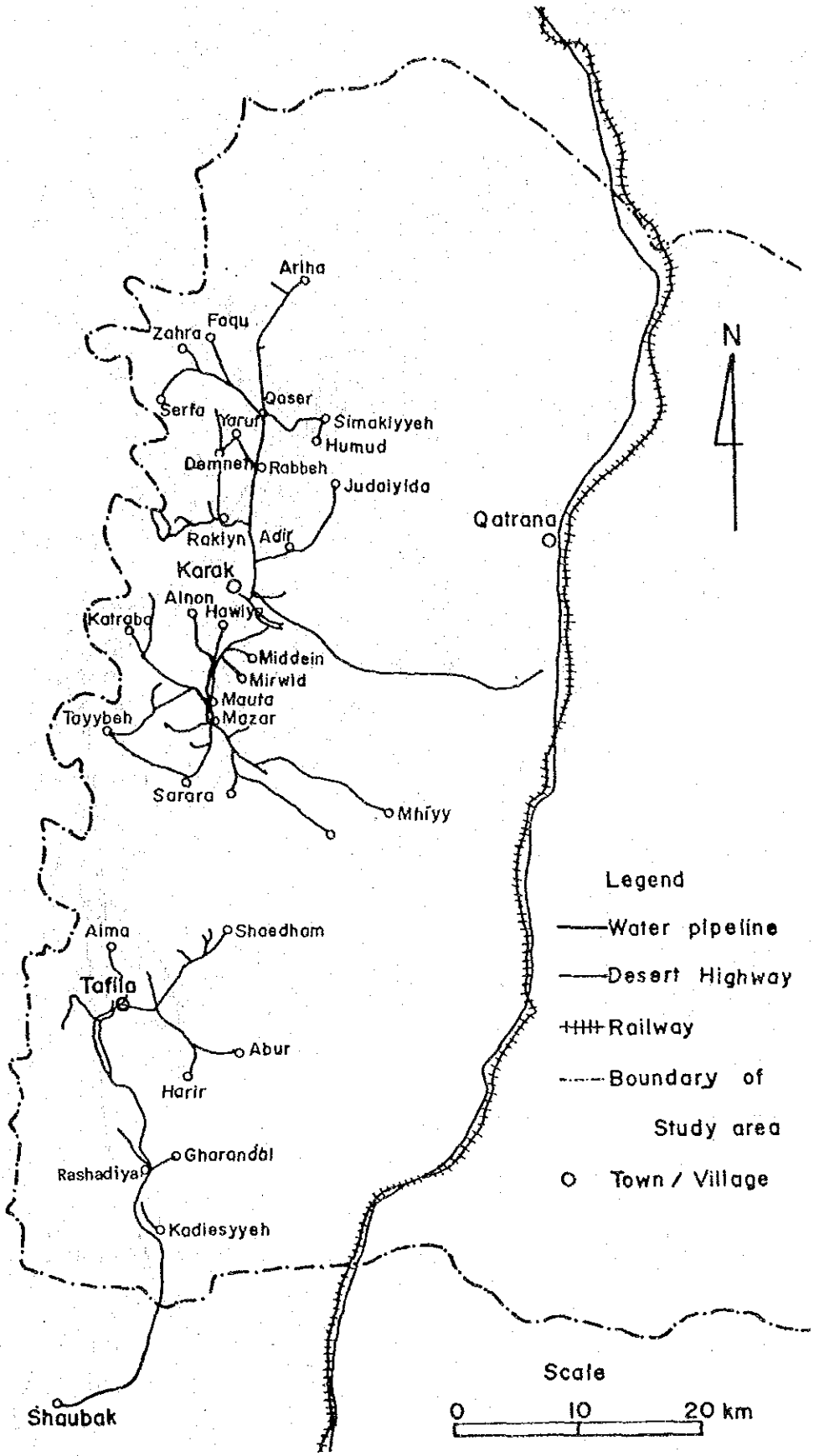

Fig. A-9 Karak and Tafila Water Networks

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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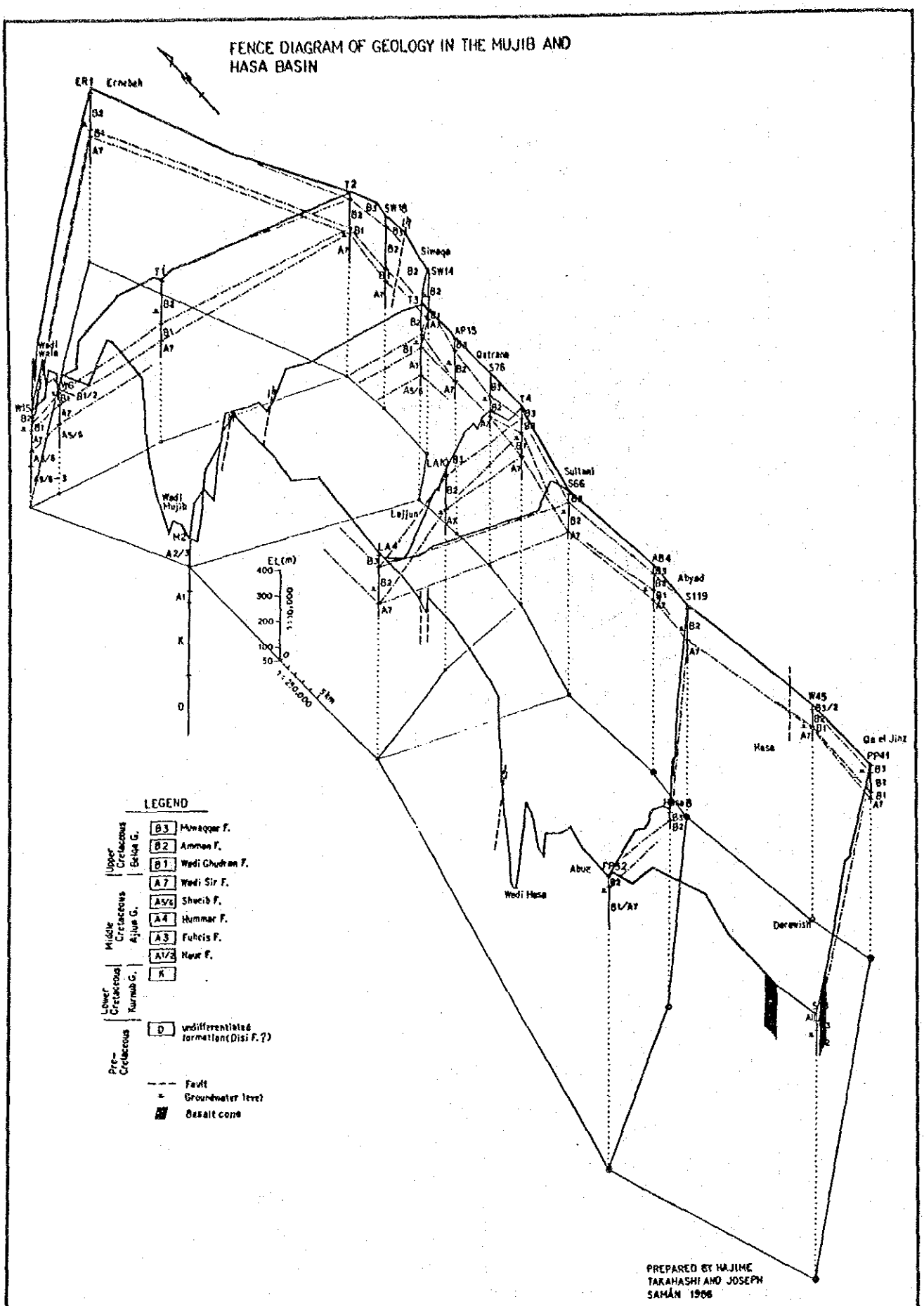

Fig. A-10 Fence Diagram of Geology

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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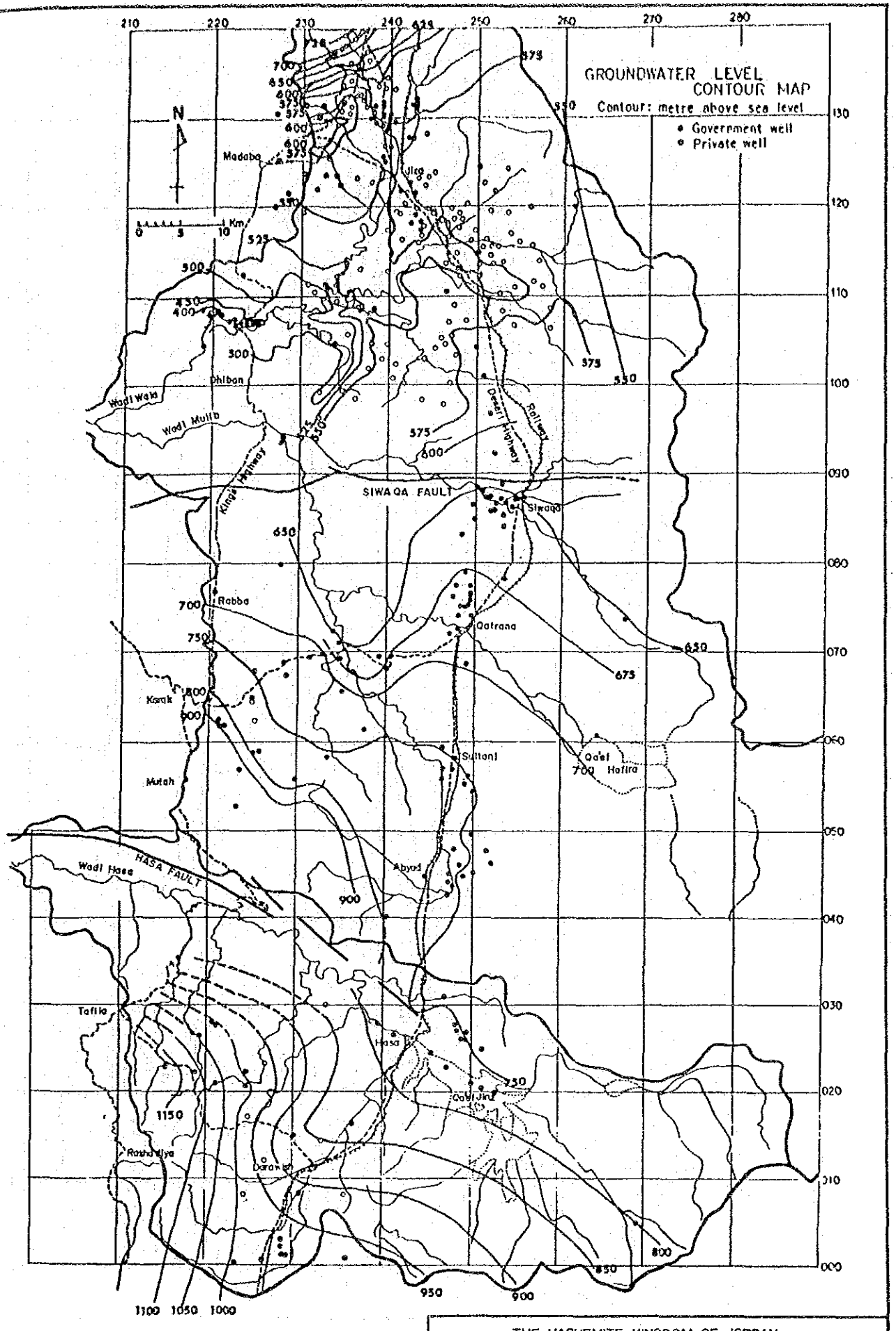

Fig. A-11 Groundwater Level Contour Map

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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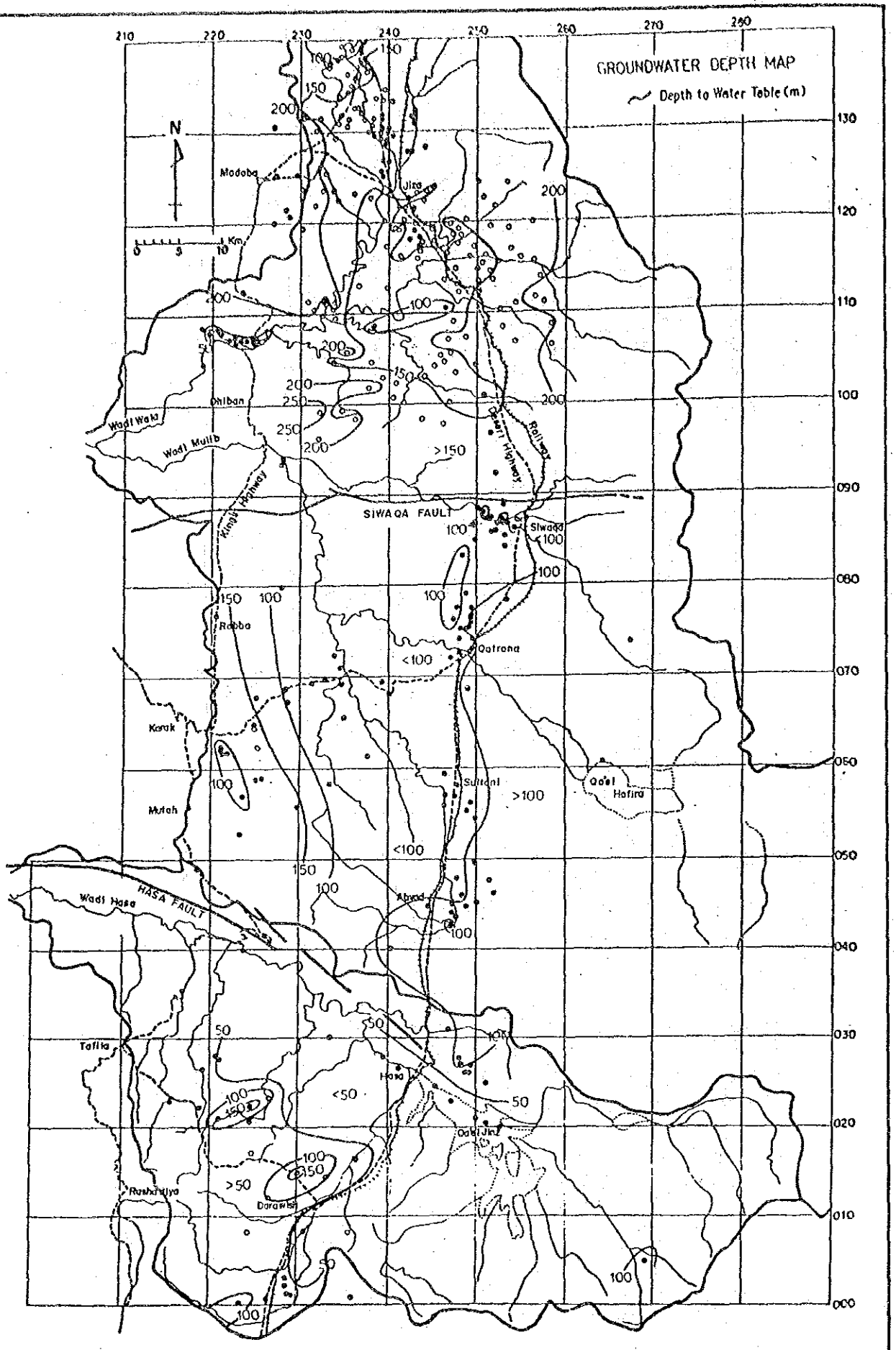

Fig. A-12 Groundwater Depth Map

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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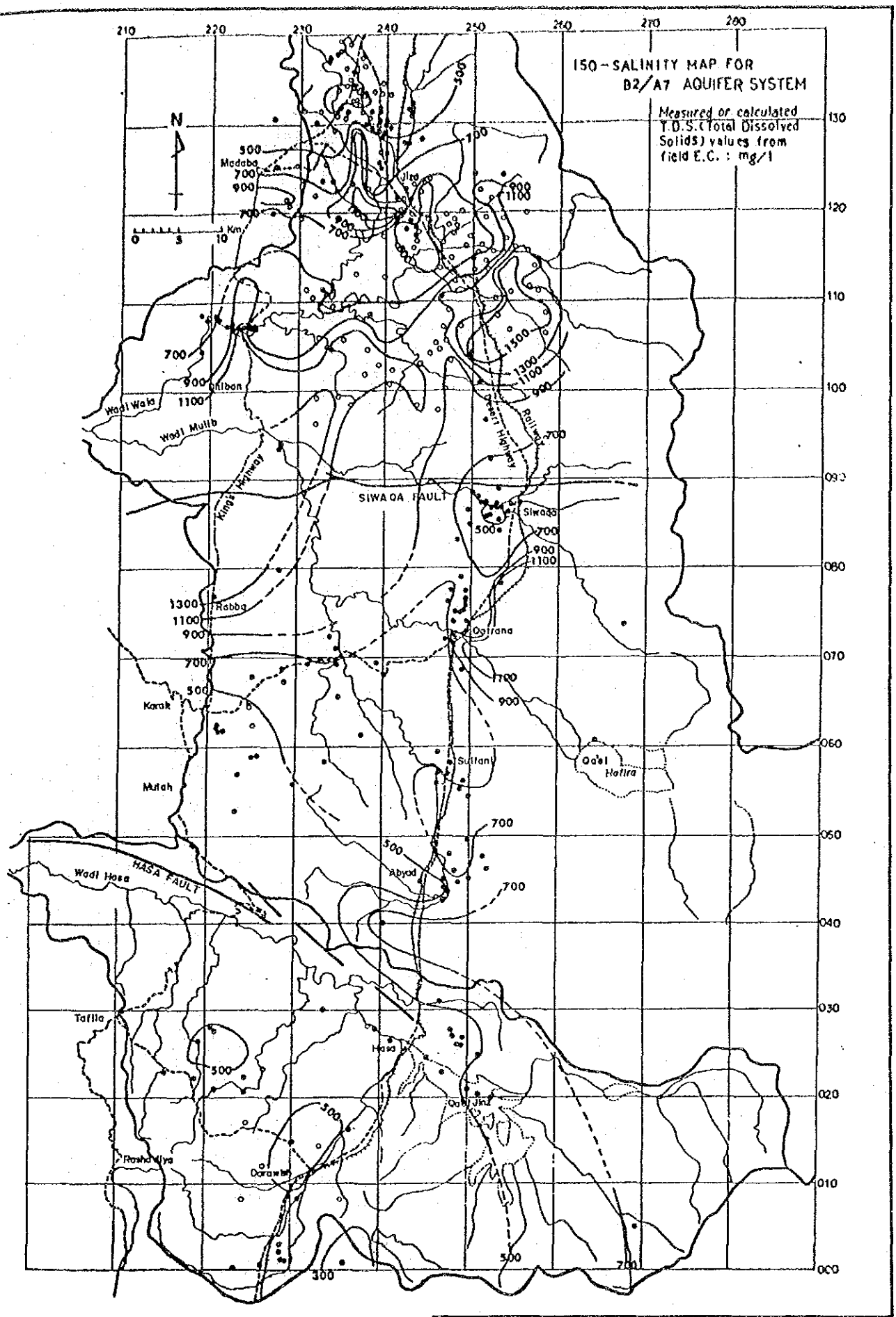

Fig. A-13 Iso-salinity Map of Groundwater

THE HASHEMITE KINGDOM OF JORDAN
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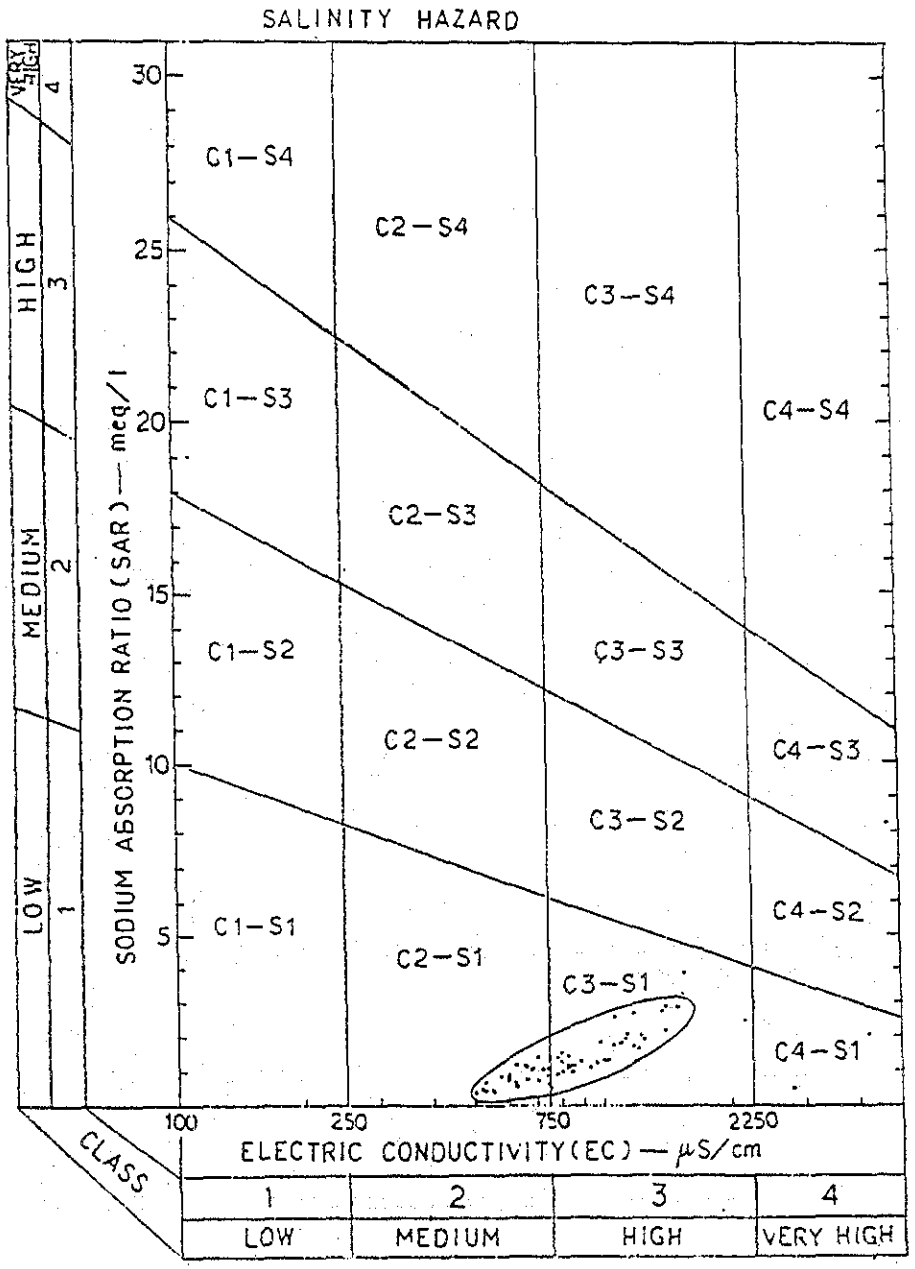

IRRIGATION WATER CLASSES OF GROUNDWATER IN B2/A7 AQUIFER SYSTEM

Note · Water in groups C1–S2, C1–S1 and C2–S1 should cause no problems.

· Water in groups C1–S3, C2–S2 and C3–S1 should also be suitable.

· Calculated T.D.S. : EC 100 μs/cm to 64 mg/

250	160
750	480
2250	1440

Fig. A-14 Groundwater Quality for Irrigation

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION
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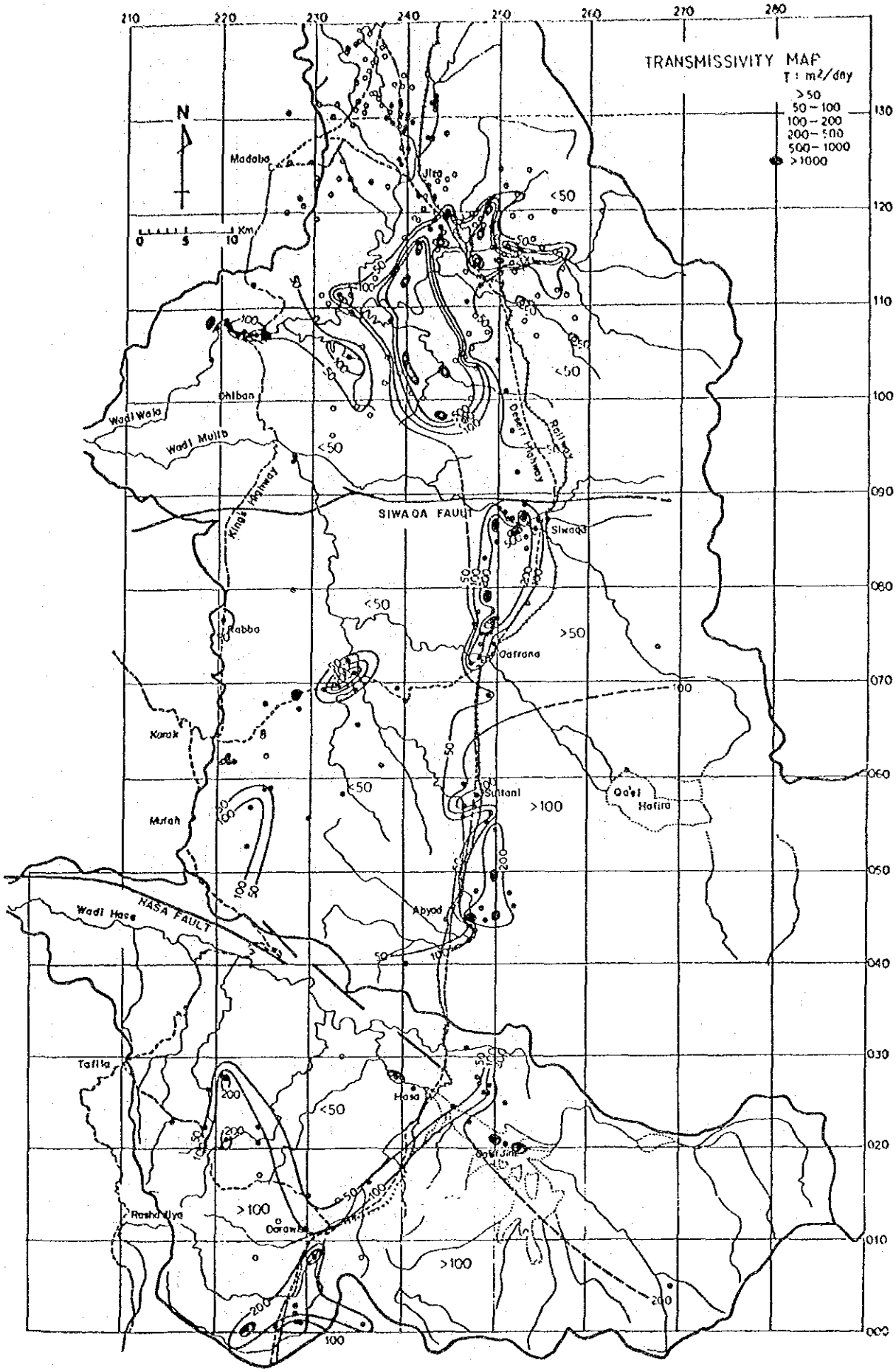

Fig. A-15 Transmissivity Map

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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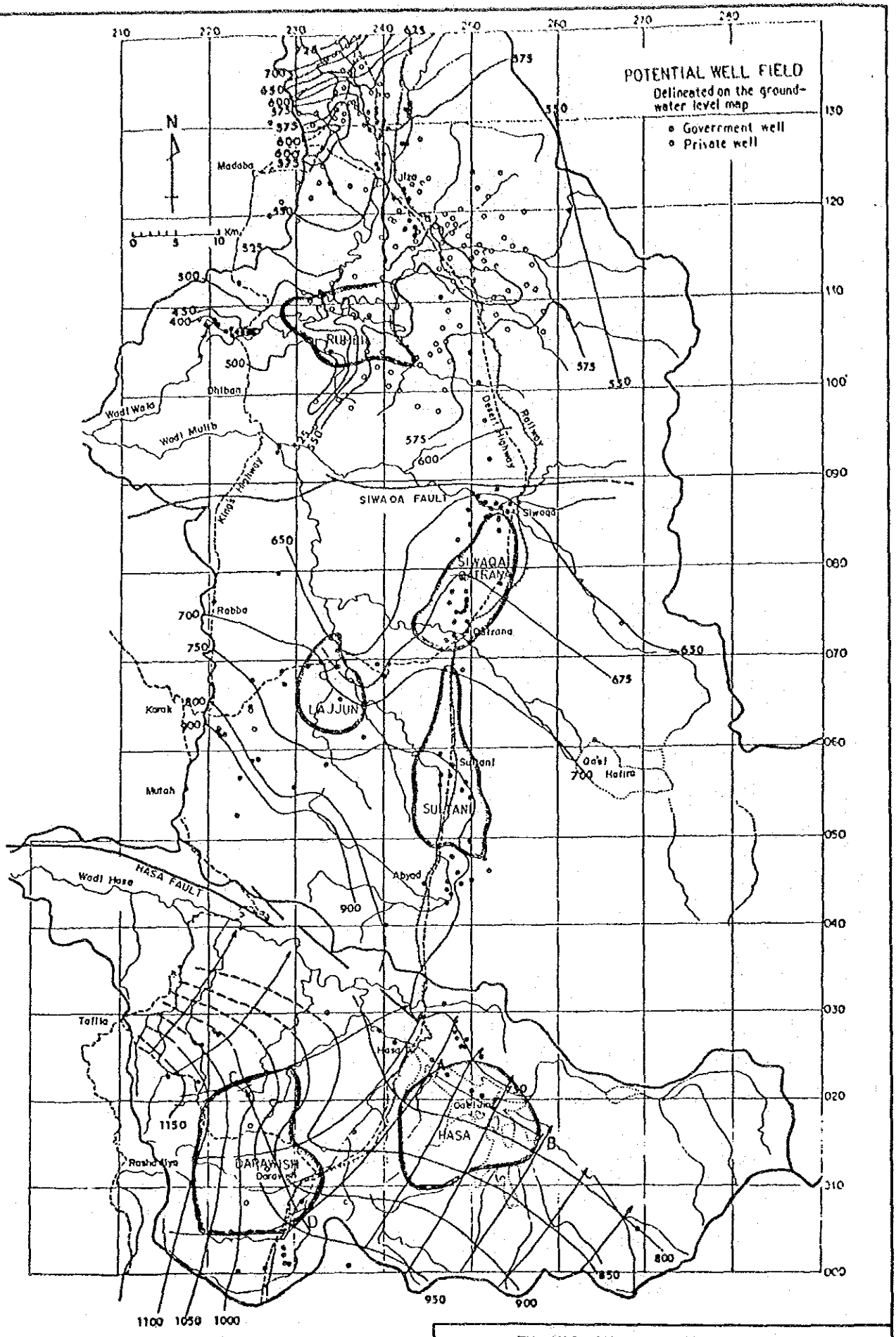

Fig. A-16 Prospective Groundwater Well Fields

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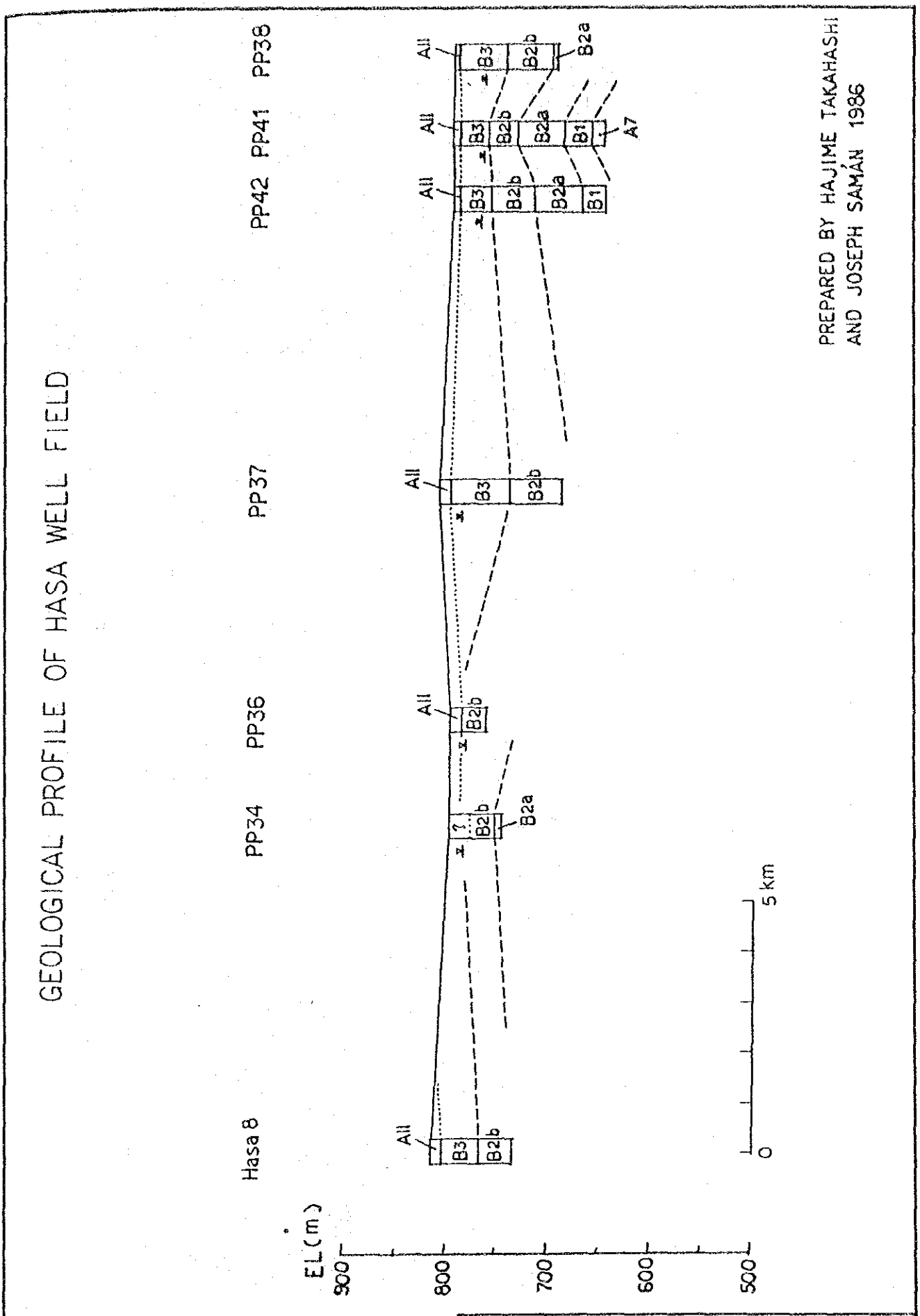

Fig. A-17 Geological Profile of Existing Hasa Well Field

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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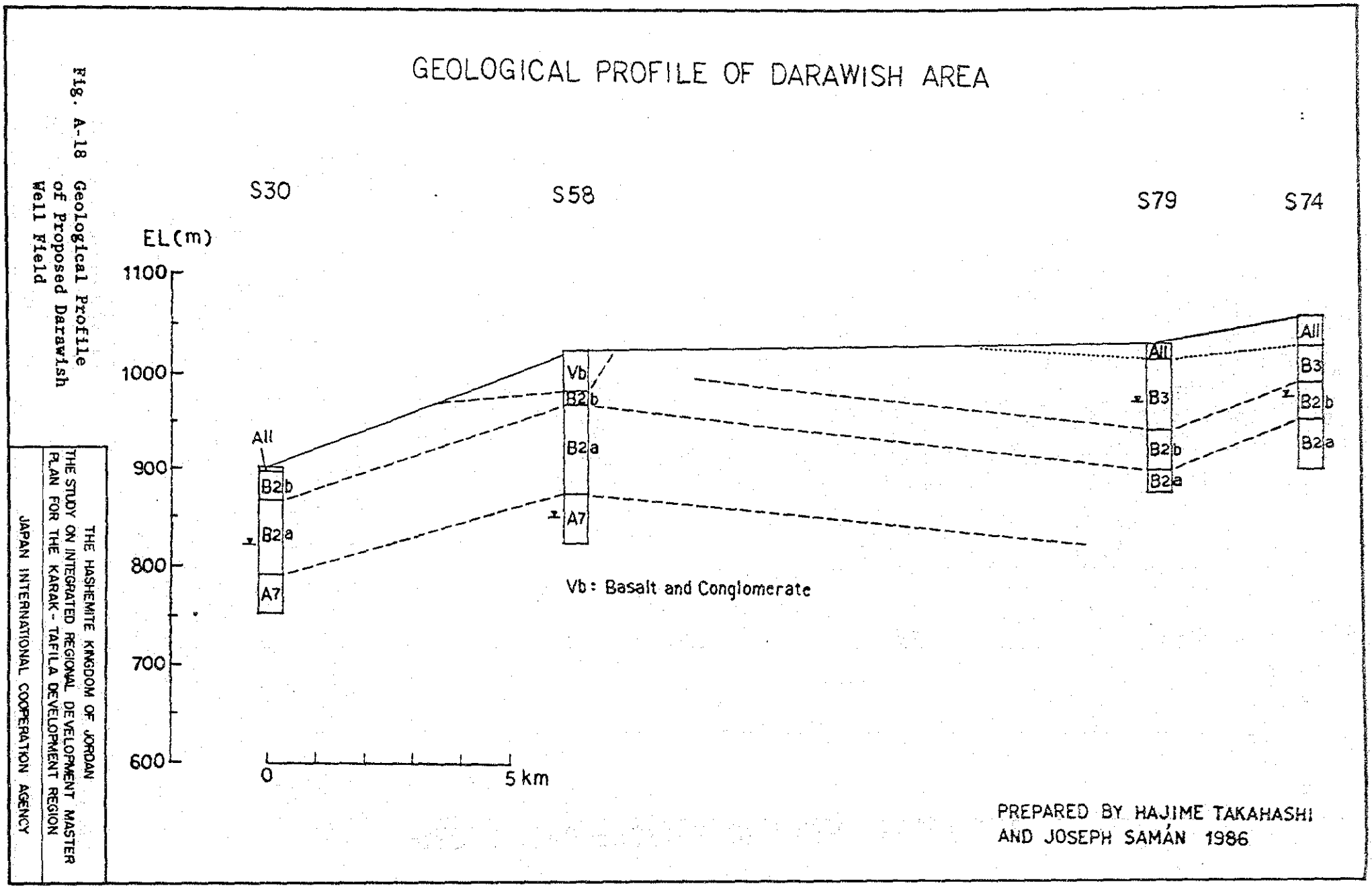

Fig. A-18 Geological Profile of Proposed Darawish Well Field

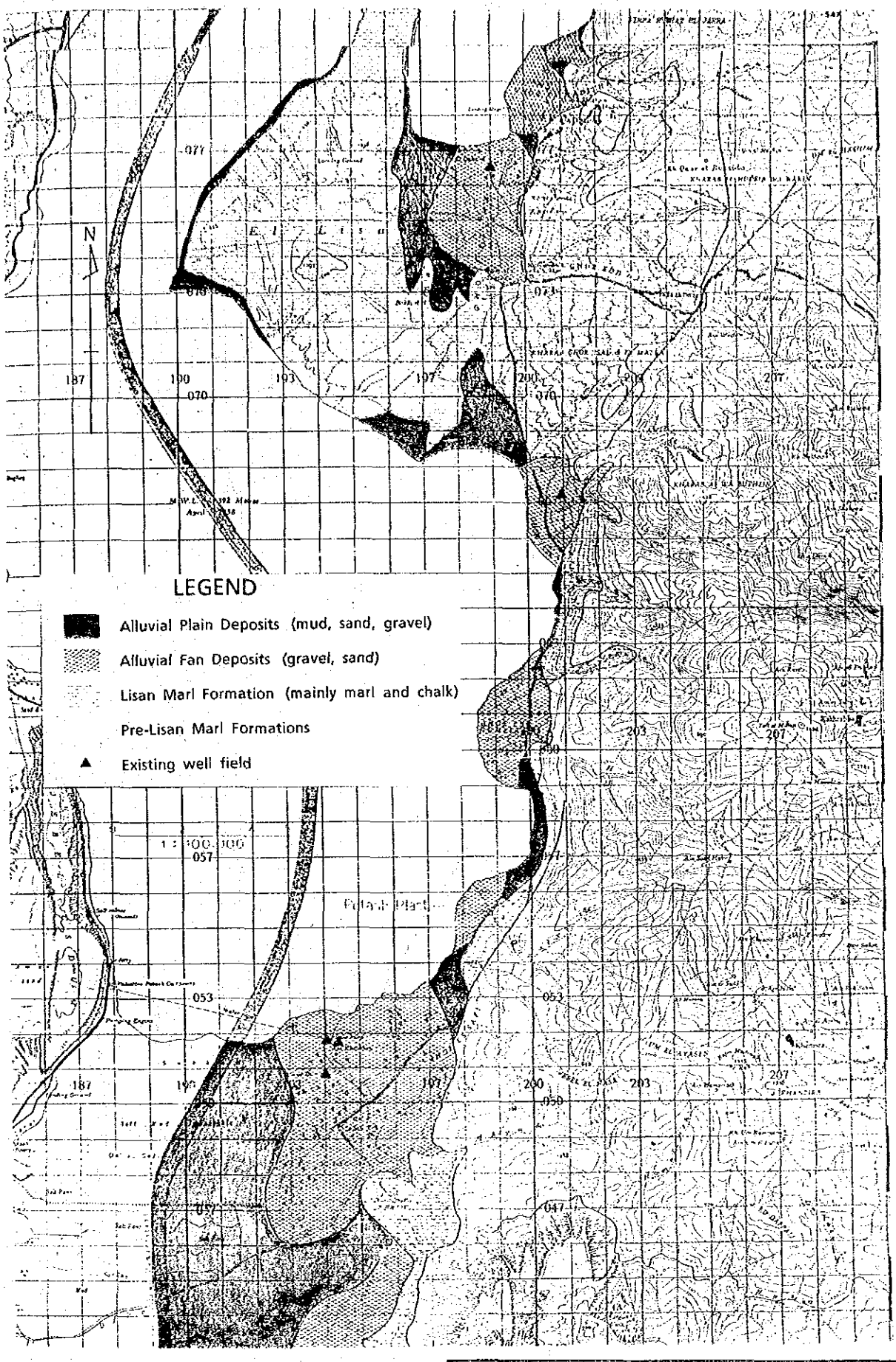

Fig. A-19 Geological Map of Southern Ghor

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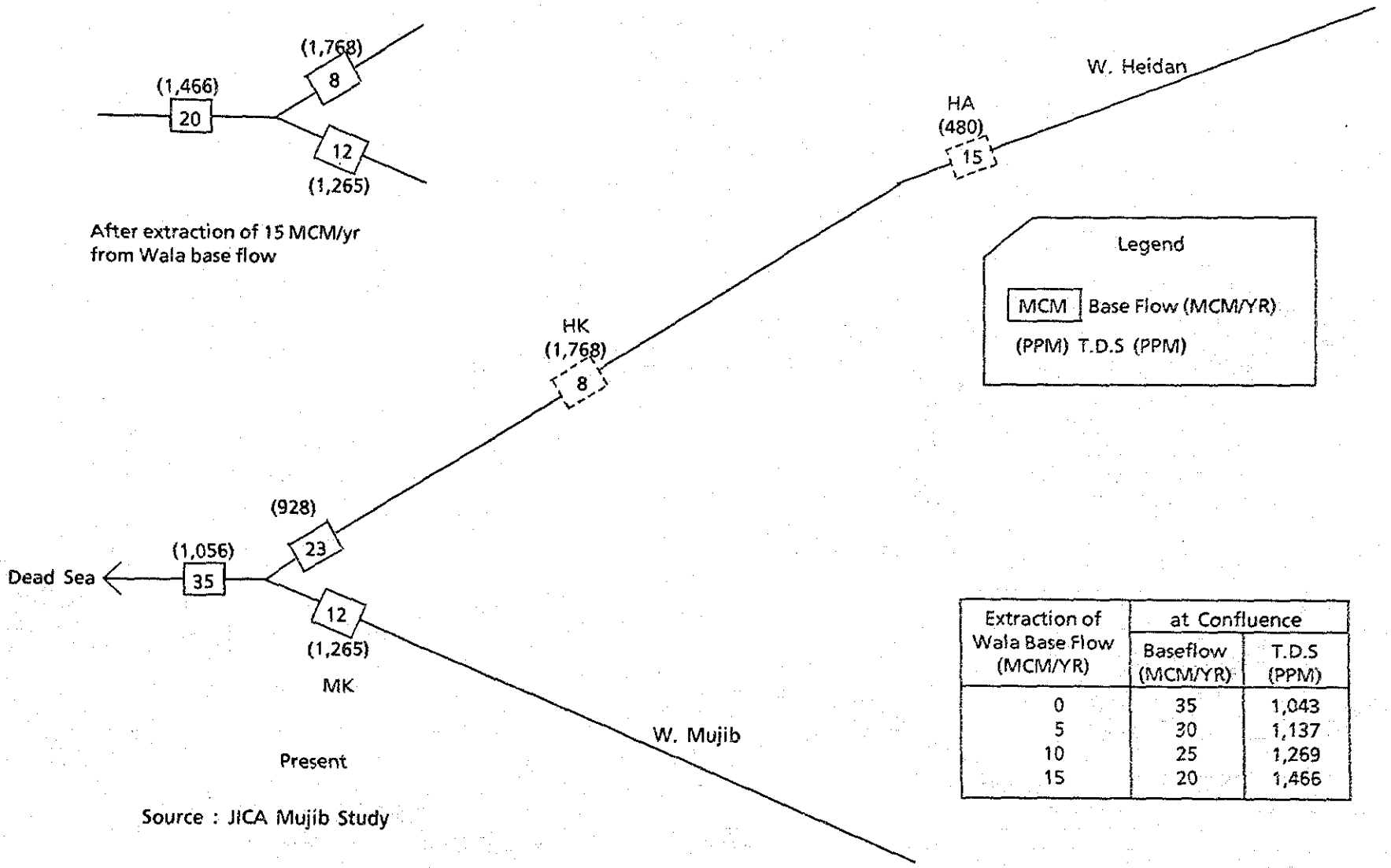
Fig. A-20 TDS of Base Flow of Wadi Wala and Wadi Mujib



Extraction of Wala Base Flow (MCM/YR)	at Confluence	
	Baseflow (MCM/YR)	T.D.S (PPM)
0	35	1,043
5	30	1,137
10	25	1,269
15	20	1,466

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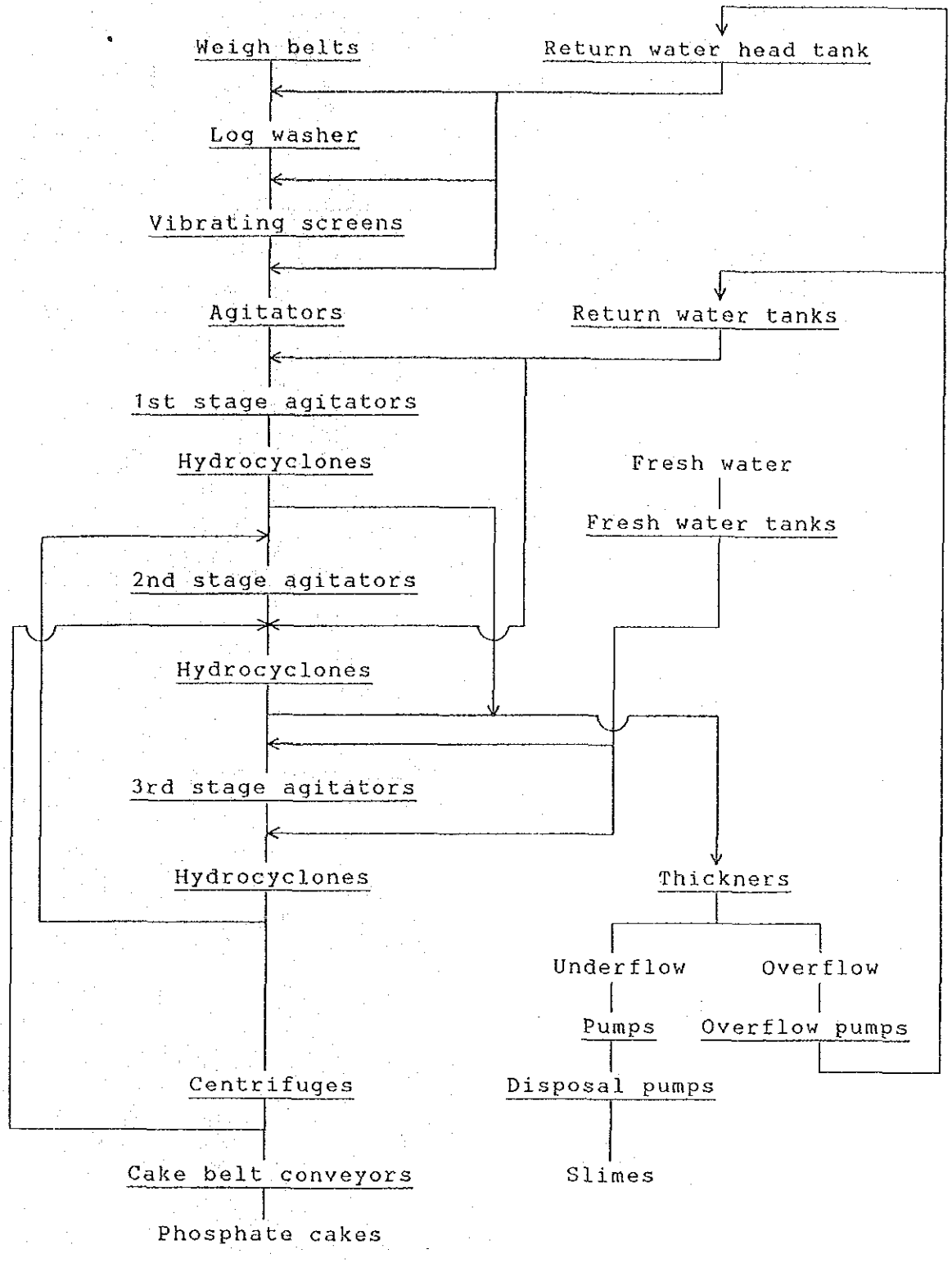

Fig. A-21 Simplified Flow Sheet of Beneficiation Plant of El-Hassa Phosphate Mine

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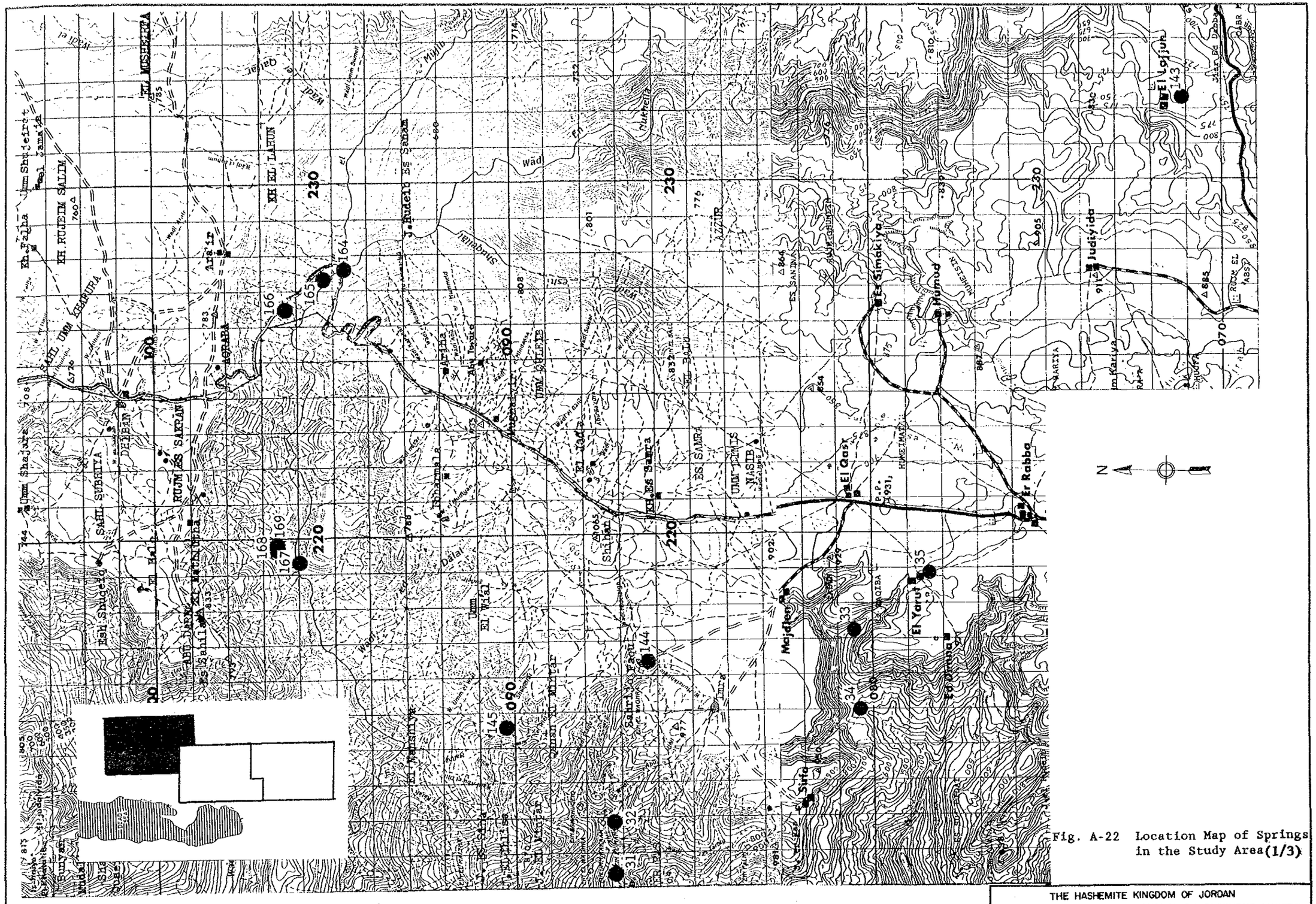

Fig. A-22 Location Map of Springs in the Study Area (1/3)

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THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION
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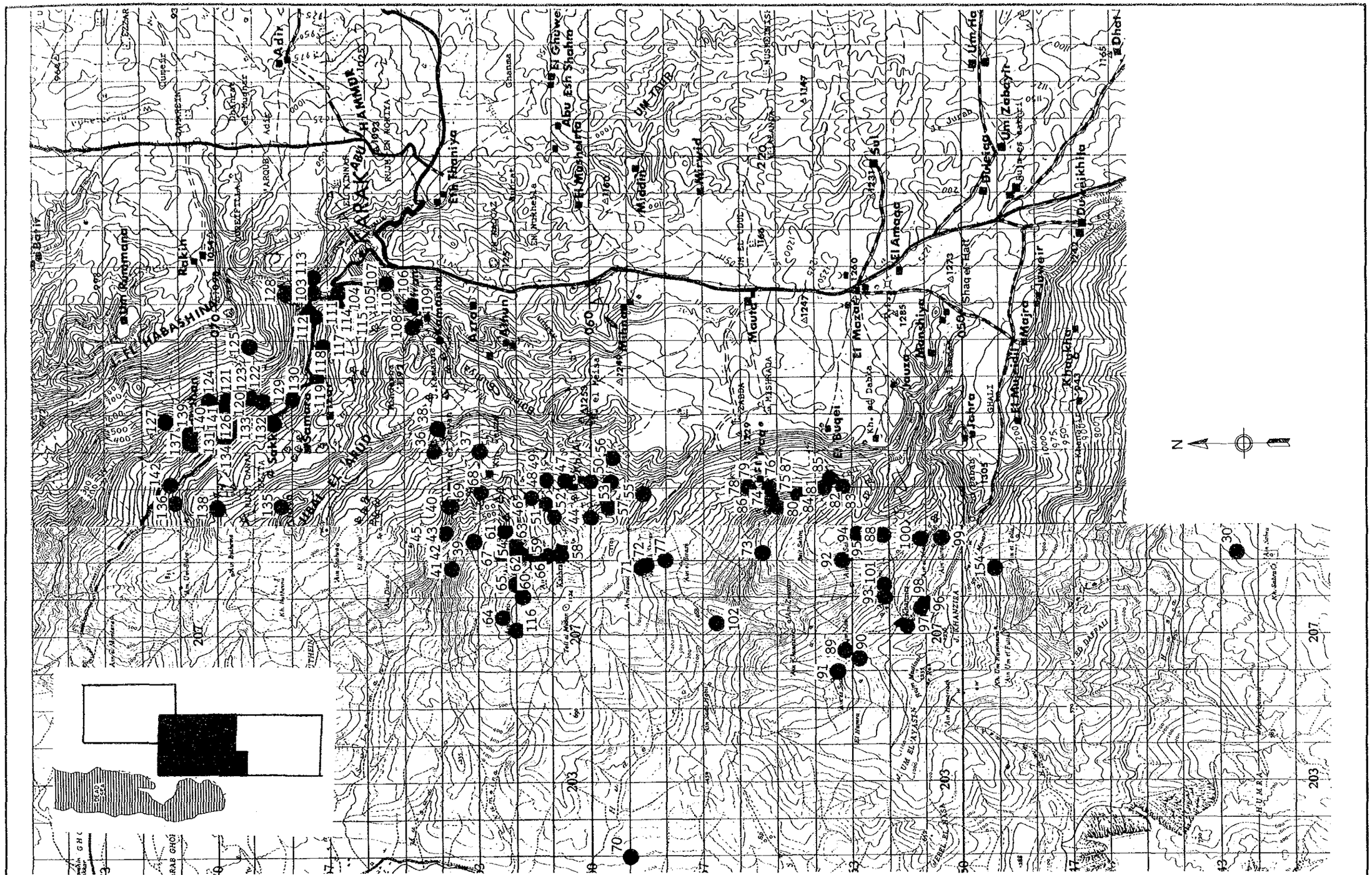

Fig. A-22 Location Map of Springs in the Study Area (2/3)

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK-TAFILA DEVELOPMENT REGION
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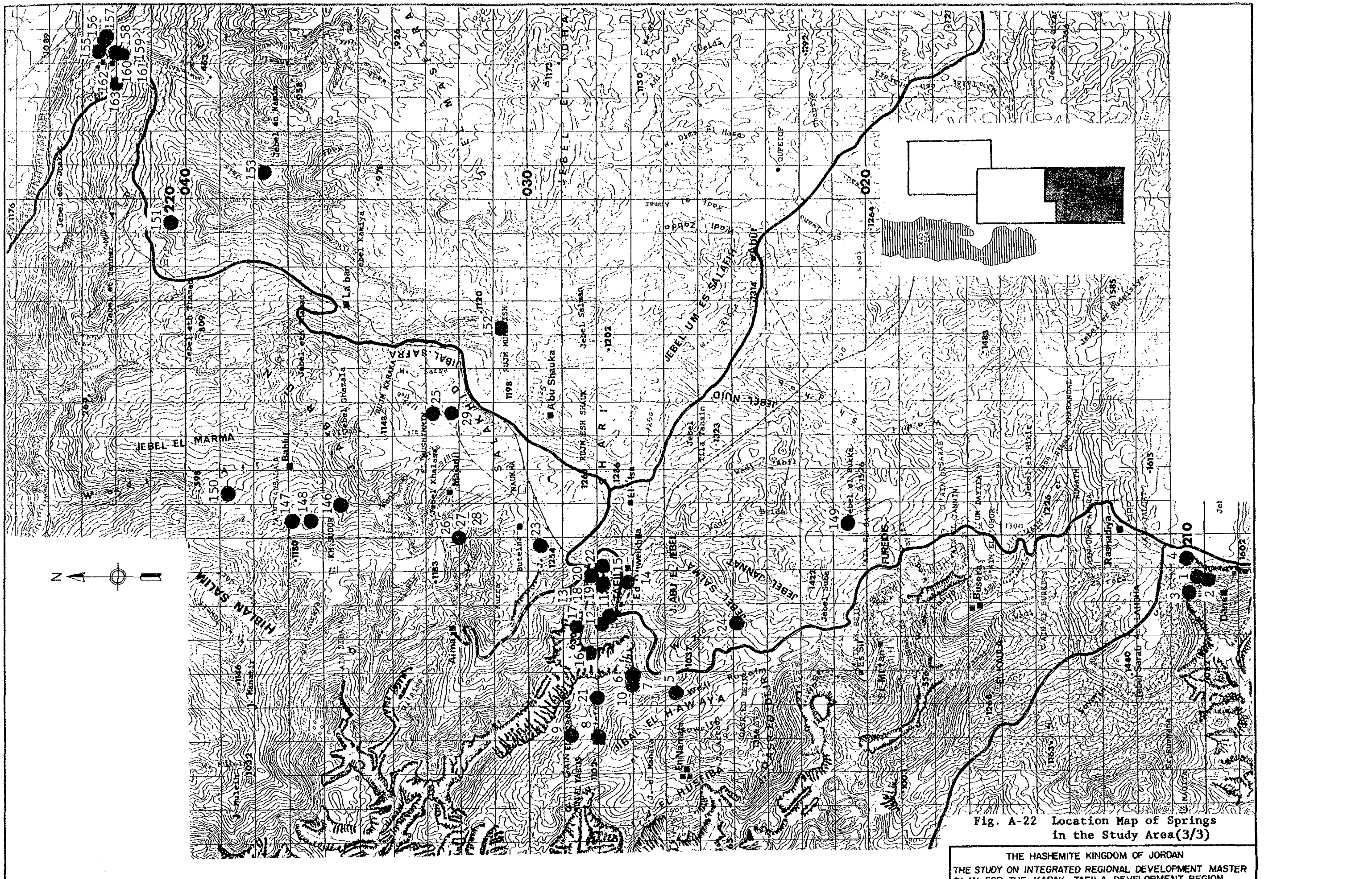

Fig. A-22 Location Map of Springs in the Study Area(3/3)

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THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK-TAFILA DEVELOPMENT REGION
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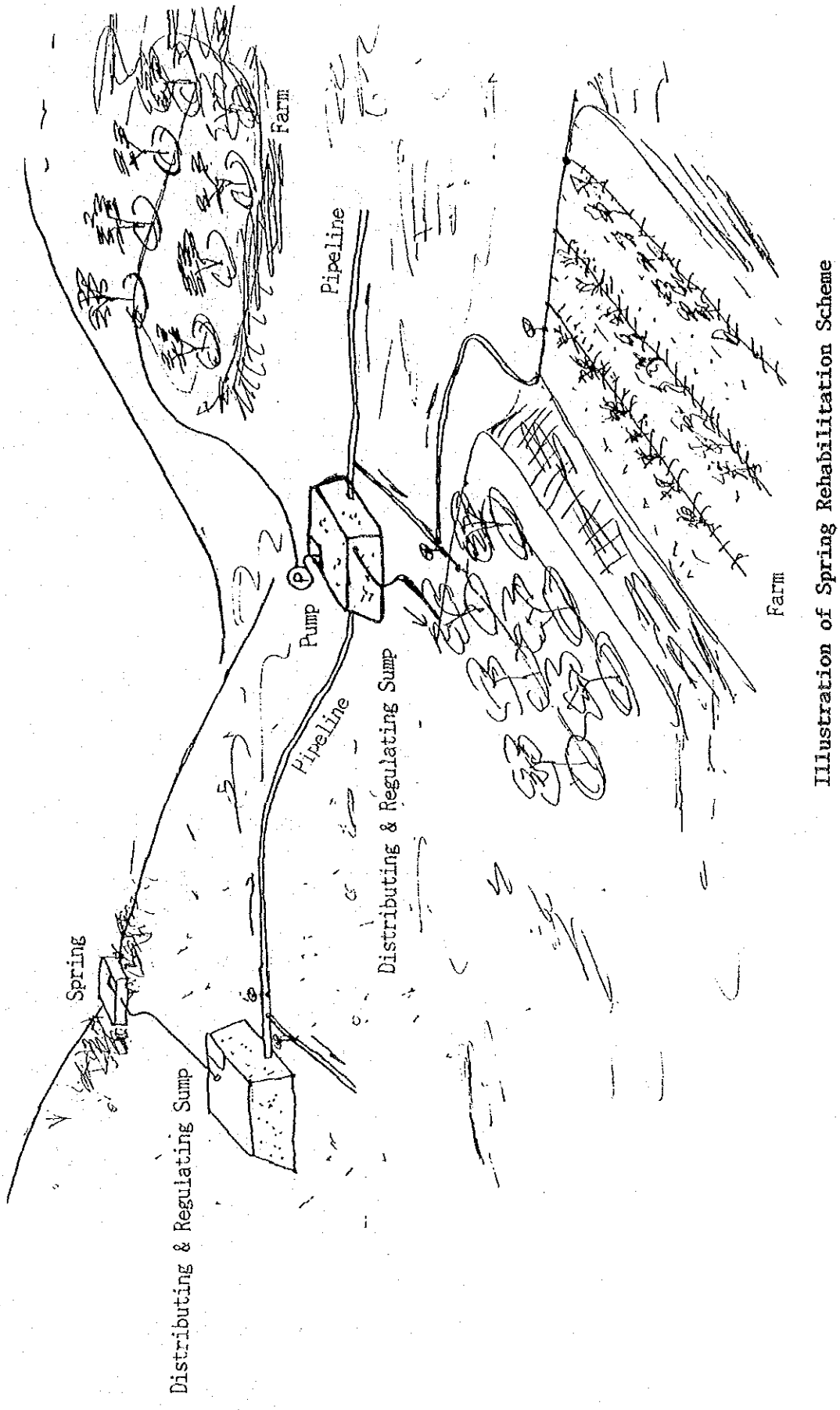

Illustration of Spring Rehabilitation Scheme

Fig. A-23 Illustration of Spring Rehabilitation Scheme

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

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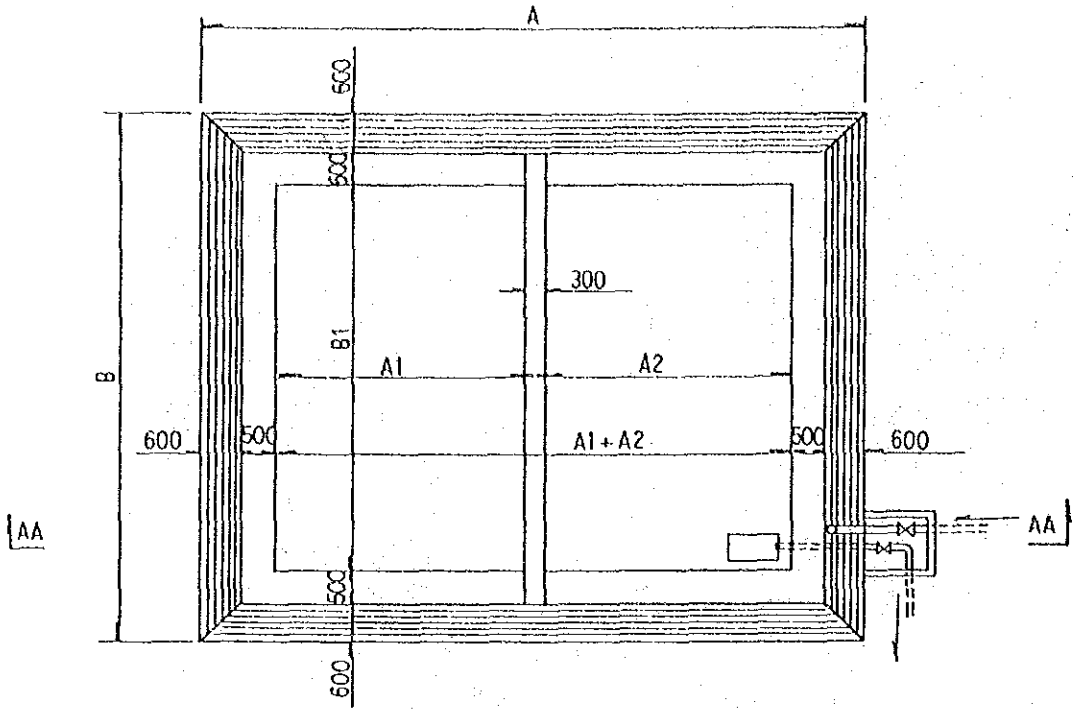

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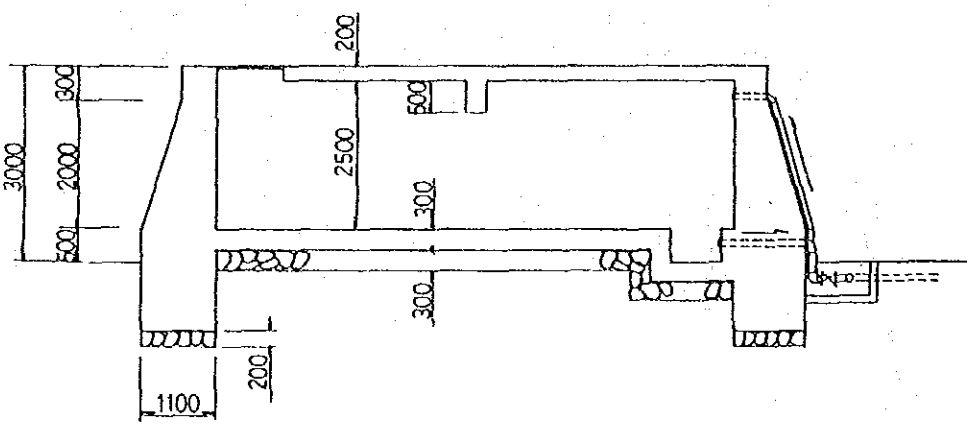

AA — AA

DIMENSION

	A	A1	A2	B	B1
50 m^3	7.200	2.500	2.500	7.200	5.000
100 m^3	10.200	4.000	4.000	8.200	6.000
200 m^3	14.700	6.250	6.250	10.200	8.000

Fig. A-24 Distribution and Regulating Sump for Spring Rehabilitation Scheme

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION
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ANNEX-B AGRICULTURE

THE STUDY ON
INTEGRATED DEVELOPMENT MASTER PLAN
FOR THE KARAK - TAFILA DEVELOPMENT REGION

VOLUME 4: SUPPORTING REPORTS

ANNEX-B AGRICULTURE

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LIST OF FIGURES

1. INTRODUCTION

This is Annex B on agriculture for the study on the integrated development for the Karak-Tafila development region and consists of chapters for identification of existing agricultural conditions including development potentials and constraints, and chapters for the agricultural development plans.

The present study was prepared in collaboration with experts from the Ministry of Municipal and Rural Affairs and the Environment, the Ministry of Planning, the Ministry of Agriculture, and Karak and Tafila Governorates.

2. AGRICULTURE IN JORDAN

Jordan with a total area of about 9 million ha is estimated to have arable land of about 364,000 ha, which corresponds to 4 per cent of the total area.

The Kingdom can be broadly divided into three parts; the Jordan Valley (the Ghor area), Highlands and Desert to the east.

The climate is predominantly of the Mediterranean type; hot and dry in summer, and cool and wet in winter.

The agricultural sector produced about 8.2 per cent of the GDP and shared about 17.1 per cent of Jordan's commodity exports in 1985.

The total number of farm-household in 1985 is estimated at about 58,000 of which 7,000 are in the Jordan Valley where intensive irrigated agriculture is operated.

Of the total arable land, about 200-250 thousand ha (55-69 per cent) are planted yearly with cereal crops, 30-50 thousand ha (8-14 per cent) with vegetables. Fruit trees cover 40-50 thousand ha (11-14 per cent) and about 40 thousand ha (11 per cent) are planted with forest trees. Some 100 thousand ha (27 per cent) are estimated to be used as range for livestock, mainly sheep and goats.

The annual average agricultural production in the last five years (1981-1985) reported by the Ministry of Agriculture was as follows:

Cereals	99,000 tons	Red meat	9,500 tons
Vegetable	628,000 tons	Milk	49,000 tons
Fruits	101,000 tons	White meat	37,000 tons
Olives	40,000 tons	Eggs	402,000,000 eggs

The irrigated agriculture in the Jordan Valley rapidly developed in the past few years and now provides about 85 per cent of Jordan's

agricultural exports.

Recognizing the over-reliance of agriculture on irrigation, the Government is promoting development of rainfed agriculture in the Highlands and of range in more arid areas under the Third Five-Year Plan which envisages 7.8 per cent of annual increase rate with allocating 10 per cent of development budget to the agricultural sector.

3. PRESENT CONDITIONS OF AGRICULTURE IN THE STUDY AREA

3.1 Position of Agriculture in the Study Area

Agriculture is minor in GRDP of the Study Area covering only about 10 per cent of the GRDP. The biggest industry is mining and manufacturing producing about 49 per cent of the GRDP. In terms of employment the agriculture is very important absorbing about 17 per cent of the total employment in the Study Area.

3.2 Landuse and Soil Conditions

3.2.1 Methodology of Landuse Study

A survey of the present landuse in the Study Area was carried out to identify the present land inventory. Two data sources were used: one is the aerial photographs taken in September 1984 with a scale of 1:25,000; and the other is the National Village Survey made in 1984. Photograph interpretation was conducted by the Study Team, and the results were drawn in topographic maps prepared in 1959 with a scale of 1:50,000. Final results were transcribed in a 1:250,000 maps with the grid method (see Fig. 4 of Volume 1).

An individual cell is 1.0 km x 1.0 km. A predominant landuse in each cell was identified by photographs and drawn in the map. Minor parts of the landuse were not necessarily shown in the map.

In respect to areas of irrigated vegetables, fruit trees and forest, there are some discrepancy between the results of photograph interpretation and the National Village Survey. Generally, figures derived from photograph interpretation are smaller than those of the National Village Survey, because of the two reasons: (A) areas with small plants are difficult to be identified by photograph interpretation; and (B) the irrigated vegetable areas are, in most cases, small and were neglected in the photograph interpretation. So, areas of irrigated vegetable, fruit trees and forest are taken from the figures of the National Village Survey.

A land slope map and an isohyetal map of the Study Area were also prepared for the agricultural land classification based on the topographic map scaled 1:50,000 and the National Water Master Plan, 1977 (Figs. B-3 and B-4).

3.2.2 Soil Conditions

According to the Soil of East Jordan by F. Moormann (FAO), 1979, soils in the area were grouped into 5 soil associations as follows and these distributions are shown in Fig. B-2.

	Area (km^2)	Extent (%)
Red Mediterranean Soils	910	11
Yellow Mediterranean Soils	550	7
Yellow Soils	1,770	22
Gray Desert Soils	4,800	59
Saline Soils in Mudflats	70	1
Total	8,100	100

The red Mediterranean soils develop in the Highlands with annual rainfall of more than 350 mm. The parent rocks are limestone, basalt and sandstone. The soil profile has A, B, C horizons, however, the A and B horizons can not be clearly differentiated by colour. Clay content of B horizon is larger than A horizon. The soils are the best in Jordan having comparatively higher fertility.

The yellow Mediterranean soils occur in areas with annual rainfall of 250 to 350 mm, covering the narrow zone between the cultivated Highlands and the steppe regions. The soil profile has A, B, C horizons but difference between B and C horizons is obscure. The soils have hard consistency. The dominant present landuse of the soils is grazing.

The yellow soils is the typical steppe soils with the annual rainfall of 100 to 200 mm. Profile development is very weak having C horizon and very thin A horizon. The soils are very hard and their permeability is poor.

The gray desert soils occur in areas with annual rainfall of less than 100 mm. This soils are very shallow in depth and their surface is covered by flint and basalt gravels. They have little agricultural potential except wadi beds.

The saline soils are found in wadi beds with poor drainage. Agricultural utilization of the soils is difficult without leaching of salts. Some soil samples were analyzed of their physical and chemical properties in the JVA laboratory, and the results are shown in Table B-11.

3.2.3 Present Landuse

Aerial photographs taken in September 1984 show that 100,200 ha have signs of cultivation of field crops, 500 ha of vegetables and 1,800 ha of fruit trees as shown below:

RESULT OF PHOTO-INTERPRETATION

Landuse	Area (ha)	(%)
Field crops/fallow	100,200	12.3
Irrigated vegetables	500	0.1
Fruit trees	1,800	0.2
Forest	5,700	0.7
Built-up area	1,900	0.2
Grazing/unarable area	702,100	86.5
Total	812,200	100.0

While agricultural statistics show that only 29,000 ha is cultivated annually for crop production. The balance is thought to be left fallow due to lack of proper economic incentive, cultivation methods, irrigation facilities and/or meager and erratic rainfall. When suitable crops are grown in areas of proper climatic and soil conditions with proper methods, the agricultural production can be significantly increased utilizing under-utilized rainwater and soils.

In conclusion, the present landuse is identified as follows taking into consideration that small parts of land are difficult to be identi-

fied by the photograph interpretation:

PRESENT LANDUSE

Landuse Category	Area (ha)	(%)
Fallow	75,800 1/	9.3
Field crops	24,400	3.0
Irrigated vegetables	900	0.1
Fruit trees	3,600	0.4
Forest	17,800	2.2
Built-up area	1,900	0.2
Mineral reserve/quarry	71,500	8.8
Grazing/unarable area	616,300	75.9
Total	812,200	100.0

1/: Estimated based on the total land area of field crops/fallow

In the Study Area, there are three wildlife reserves. Their names and respective areas are:

- Mujib Wildlife Reserve: 2,400 ha
- Abu Rukbah Wildlife Reserve: 41,000 ha
- Dhana Wildlife Reserve: 5,100 ha

3.3 Agricultural Population and Land Tenure

The total population in the Study Area is estimated at about 143 thousands as shown in Table B-1. According to a Statistical Year Book 1985, the share of rural population was 80.23 per cent in Karak, and 61.13 per cent in Tafila. An average number of family per farm household was 8.1 in Karak and Tafila in the Agricultural Census, 1983. Based on these figures, farm population and the number of farm household in the Study Area are estimated at about 106,000 and 13,000 respectively as shown in Table B-1.

Average farm size in terms of arable land, cultivated area and number of livestock are estimated as follows:

	Arable Land (ha)	Cultivated Area (ha)				Sheep (heads)	Goats (heads)
		Field Crops	Vege-tables	Fruits	Total		
The Study Area	62,500	24,420	980	3,600	29,000	185,000	158,000
Per farm house-hold	4.76	1.86	0.07	0.27	2.21	14.0	12.0

According to the Agricultural Census 1983, 99 per cent of holders directly manage their land in Karak. About 20 per cent of land is managed by tenant farmers under sharecropping system. This means most of the farmers are owner-farmers and about 16 per cent of the farmers are owner-cum tenant-farmers.

3.4 Crop Production

The main crops in the Study Area are wheat and barley. Cultivated areas of wheat and barley are about 16,000 ha and 6,000 ha respectively. Total of both areas occupied about 90 per cent of the cultivated area of cereal crops as shown in Table B-2.

As for the yearly variation of cultivated area during the past 10 years, the maximum and minimum areas of field crops cultivation were 44,100 ha in 1978 and 11,400 ha in 1984 respectively as shown in Table B-3. The difference between the maximum and minimum areas was 32,700 ha. This huge difference is considered to be caused mainly by the differences in time and amount of rainfall.

The production of these crops largely fluctuates year by year. Average unit yield of each field crops is very low: 0.67 ton/ha for wheat; 0.52 ton/ha for barley; 0.64 ton/ha for lentil; which show the yield of each crop is strongly affected by erratic rainfall (Table B-2). Total rainfall in the Study Area is less than that in the northern Highlands. The rainfall becomes less to the south. The Study Area is located in the marginal area for rainfed agriculture in Jordan.

Other than the climatological reasons, these low yields can be attributed to:

- misuse in landuse: cultivation of crops in areas with too low rainfall and too shallow soils
- improper crop husbandry such as low adoption rate of improved varieties, little application of fertilizers, insufficient control of weeds
- negligence in crop rotation etc.

Main wheat varieties are Hourani Nawari and F-8, which are the traditional varieties in Jordan. Main barley varieties are Deir Alla 106 and ACSAD 176. Replacement of cereal seeds by farms is seldom practiced in Jordan resulting in yield decline. To redress this situation, JCO has been implementing the certified seed multiplication project since 1980. In Karak 1,486 dunums of land were devoted to production of certified wheat seeds in 1986/1987.

Fertilizers and herbicides are seldom applied to cereal crops due to high risk inherent to low rainfall of the areas. Fertilizers are applied to vegetables and tobacco. Pesticides are applied to vegetables.

Pesticides are rarely applied to cereal crops. Ploughing is done by tractors in most cases.

In hilly areas animal ploughing is adopted. Sowing is due by broadcasting seeds by hand for cereal crops and weeding after germination is rarely practiced. Harvesting is done by combine harvesters in flat areas. In steep areas, harvesting is carried out by hand. Custom services of ploughing and harvesting by agricultural machinery are widely practiced by JCO and private companies. Harvested cereal crops by hand are threshed by threshers.

In Jordan there are several irrigation projects, of which the irrigation projects in the Jordan Valley are largest. The irrigation projects in the Study Area are Qatrana (North, South) and Wadi-Abiad

irrigation projects for the settlement of Bedou and increment of farm income. These are summarized below:

IRRIGATION PROJECTS IN JORDAN

No.	Name of Project	Name of Sub-Project	Irrigation Area (ha)
1.	Jordan Valley Irrigation Project	Jordan Valley	23,800
		South Ghors	2,500
			26,300
2.	Dhuleil Irrigation Project		360
3.	Al-Samra Irrigation	(A main objective is to plant trees and fruit trees using wastewater from the sewerage treatment plant for the cities of Amman and Zarqa)	
4.	Bedouin Settlement Project		
		Arja	120
		Woheda	171
		Abu-Lisan	1,170
		Tell-Burma	120
		Wadi-Abiad	53
		Qatrana (North)	100
		Qatrana (South)	65

Source: Irrigation Projects in Jordan-Water Authority, Irrigation Department

The approximate locations of these projects are shown in Fig. B-1.

In the Study Area, main sources of irrigation water are springs and deep wells. However along wadis in the lower parts of the basin, narrow strips of irrigated areas are found. These areas are extremely small. Water sources of these areas are base flow of rivers. Water is pumped up for 50 to 100 m in head and distributed.

Moreover there are two small dams in the Study Area: one is the Qatrana Dam (the reservoir capacity is 2.0 MCM); and the other is the Sultani Dam (the reservoir capacity is presently nominal). The purposes of these dams constructed in 1962 were irrigation for forage production,

livestock water supply, and groundwater recharge. The Qatrana and Sultani Dams have outlet works for irrigation of downstream areas. But the irrigation systems are not being used at present (1986).

In the Study Area, the irrigated area is as follows:

THE IRRIGATED AREA

(ha)

Source of Information	Vegetables	Trees	Field Crops	Total
National Water Master Plan in 1977	440	1800	240	2480
The Agricultural Census in 1983	900	2300		3200

In the Study Area there are about 169 springs, of which about 140 springs are used for irrigation.

The quantity of water supply for irrigation is estimated at 5-10 MCM/yr and the irrigated area is at more than 2,000 ha.

Crops irrigated are fruit trees and vegetables.

In the Study Area there are about 130 existing wells of which about 30 wells are used for irrigation, domestic uses and stock holds. Each well is 200 to 300 m deep with pumping head of 100 to 150 m, yields 20 to 30 litre/s of water and commands about 40 ha at most.

The total area irrigated by wells is estimated at about 500 ha. Crops grown are generally fruit trees and vegetables.

Most of the fields in the Study Area are not equipped with farm drains. Water logging damage for crops is seldom reported in the area except wadi beds because the groundwater table is generally deep. On the other hand, the fields are susceptible to soil erosion caused by runoff water.

3.5 Livestock

Animal production is more popular than cereal production in the Study Area.

The most important livestock in the Study Area is sheep and goats. Present livestock population in the Study Area is estimated at about 185,000 for sheep and 158,000 for goats which occupied about 16 per cent and 32 per cent of those of whole Jordan respectively as shown in Tables B-4 and B-5. The average stock of sheep and goats per farmer is varied by sub-region. Most of the farmers raise 26 sheep and goats per farmer on an average in the Study Area.

According to the Agricultural Census in 1983, total number of chicken farms in Karak and Tafila was 77 of which 64 were broiler farms and 13 were laying farms. These farms are mostly newly invested and capital intensive.

3.6 Agricultural Support System

3.6.1 Agricultural Extension

There are three kinds of organization engaged in the agricultural extension in Jordan; formal, parastatal, and private organizations.

The formal organization for the agricultural extension is the Ministry of Agriculture through the Agricultural Directorate. The extension section of the Agricultural Directorate is one of many organizations of the Directorate and plays minor role in the Directorate. The number of personnel for the extension section in the Agricultural Directorate is 7 for Karak in the total staff number of 108, and 2 for Tafila in 117. Extension services are hampered by the insufficiency of transportation means. Numbers of vehicles available for the extension services are 10 for Karak and 4 for Tafila. However, these vehicles are shared with other sections. Fuel allocated to each vehicle is about 400 litres per month. In these circumstances, extension services are apt to concentrate in progressive large farms especially of fruit and poultry.

As the parastatal organization, the Jordan Cooperative Organization (JCO) extends agricultural extension services on production inputs, marketing and credit to members of the cooperatives. In 1986 there were 21 agricultural cooperative societies in Karak Governorate and 9 in Tafila Governorate, composed of 1,924 and 291 members respectively. JCO's branch officers are stationed in Karak and Tafila. Numbers of employees of these in 1985 were 24 in Karak and 7 in Tafila.

Private traders and manufacturers dealing in agricultural inputs, machinery and equipment also play an important role in providing farmers with technical information on crop and animal husbandry. According to "The Agricultural Sector of Jordan" by A. B. Zahlan, there were 60 agricultural trading and manufacturing companies in Jordan in 1983. The number of agricultural engineers employed by these companies was 116. These engineers are considered to be more motivated and activated by higher salaries and by provision of company transport means, than formal extension workers.

3.6.2 Agricultural Research

Agricultural research is not so old in Jordan. The first agricultural research station was built in 1952 at Deir Alla in the Jordan Valley. There are 2 formal institutions for the agricultural research in Jordan: the National Centre for Agricultural Research and Technology Transfer (NCARTT); and the Faculty of Agriculture of the University of Jordan (FAUT).

NCARTT has 6 agricultural stations over the Kingdom. Names of stations and their major activities are:

Deir Alla Station:	Experiments on irrigated wheat, vegetables in field, and under plastic and forages, and production of seedlings of trees and fruit trees
Shaubak Station :	Experiments on fruit trees and legumes, and production of fruit tree seedlings (stone and pome fruits)
Hassain Station :	Experiments on fruit trees, and production of fruit tree seedlings (olives and stone fruits)

Rabba Station	:	Experiments on rainfed cereals and legumes
Madaba Station	:	Multiplication of cereal seeds (wheat), and experiments on cereals
Wadi Yabis Station:		Experiments on fruit trees, irrigated vegetables and cereals

FAUT is situated in Jubeiha, suburb of Amman and its research activities cover experiments on cereals, legumes, poultry and sheep. FAUT has another farm in the central Jordan Valley, where experiments on irrigated vegetables under plastic as well as in the fields are carried out. Budgets allocated from 1976 to 1982 to the agricultural researches in Jordan was so scarce as covering only 0.4 to 0.7 per cent of the total agricultural GDP generated in each year.

3.6.3 Agricultural Credit

There are several sources of agricultural credit in the Study Area: Agricultural Credit Corporation (ACC); Jordan Cooperative Organization (JCO); and Private such as landlords and middlemen.

As shown by the Agricultural Census 1983 in Table B-6, biggest source beside farmers themselves is landlords followed by formal agricultural credit institutions (ACC, JCO).

ACC provides three kinds of loans to farmers: seasonal loans (up to 2 years); medium-term loans (2 to 10 years); and long-term loans (more than 10 years) through regional offices in Karak and Tafila.

JCO has different loan periods. The seasonal loans extend to 14 months. The medium-term loans cover 14 months to 7 years, and the long-term loans cover more than 7 years. The interest rates depend on kind of loan and amounts, and vary between 6 to 8 per cent per year, but are not compounded. Mortgages are required for the loan application and do not exceed 75 per cent of the value of properties. Every farmer can access to ACC loans but normally members of the cooperative societies can borrow from the JCO bank.

3.7 Agricultural Marketing System

Local markets play a very important role in marketing of agricultural production in the Study Area. According to the Agricultural Census 1983, 59 per cent of the agricultural households in Karak and Tafila Governorates sell their products to small local market only, 16 per cent on farm gates only, and 12 per cent to central wholesale market only (Table B-7). Sale to export and on roadsides only covers negligibly small portion.

Most of the agricultural households do not have their own vehicles. So, agricultural produces are transported by hired pick-ups or hired trailers attached to tractors in most cases (Table B-8). Fourteen per cent of the agricultural households sell all their produces on the farm gate.

The Government has strong enforcement of agricultural policies through import monopoly of major imported foodstuff such as wheat, rice, sugar, meat and vegetable oil, through daily price control of foodstuff especially of fruits and vegetables and through the control of landuse and cropping patterns. The Ministry of Agriculture is in charge of the control of landuse and cropping patterns. The Ministry of Supply is in charge of the control of prices and import of foodstuff.

4. AGRICULTURAL DEVELOPMENT POLICY

4.1 National Agricultural Development Policy

In the Third Five-Year Plan (1986-1990), an annual growth rate in agricultural production is set at 7.8 per cent. This target is planned to be achieved through:

- Expansion of irrigated areas
- Crop diversification from vegetables to other crops
- Expansion of fruit tree planting, and forage production
- Improvement in field crop yields by introduction of modern techniques, through research finding and intensive agricultural extension services
- Development in post-harvest facilities such as slaughter houses, grading centers, cold stores

4.2 Regional Agricultural Development policy

(1) Karak Governorate: This gives the highest priority to the agricultural sector in the regional development and plans to increase the agricultural production through increment in planted areas and in unit yields, and through further exploitation of water resources.

(2) Tafila Governorate: This also gives the highest priority to the agricultural sector in the regional development plan 1986-1990 and will invest 20.2 per cent (6.06 millions JD) of the total development funds to the agricultural sector.

Particular objectives of the agricultural development plan are:

- Expansion of planted areas of field crops by 10,000 dunum/yr
- Expansion of fruit tree areas by 5,000 dunum/yr
- Expansion of vegetable planted areas by 1,000 dunum/yr
- Making available the necessary agricultural inputs (seedlings, seeds), loans and machinery services to the farmers all over the Governorates
- Development of grazing area by constructing grazing station in appropriate areas

- Development of animal industry by making available required fodder and increasing the veterinary care and guidance services
- Encouragement of agricultural multi-purpose cooperative movements for the agricultural development offering farmers necessary services and loans.

5. DEVELOPMENT PLAN FOR AGRICULTURE IN THE STUDY AREA

5.1 Development Constraints

(1) Poor agricultural resources, especially agricultural land and water

Scanty rainfall is the most serious constraint of the regional agriculture. The average annual rainfall of the Study Area is calculated at 158 mm. The distribution of the area by annual rainfall is shown in the table below:

Annual rainfall (mm/yr)	Area (km^2)	Extent (%)
25-100	3,980	49
100-150	1,360	17
150-200	990	12
200-250	700	9
250-300	460	6
300-350	610	7
Total	8,100	100

Source: MMRAE (1984)

Efficient utilization of the rainfall and land favoured by higher rainfall is thought to be the key of the agricultural development of the Study Area.

Soil erosion by water or wind is also the major problem of the regional agriculture. The following causes can be attributed to the soil erosion.

(A) Over-grazing in the marginal rainfall areas

(B) Inappropriate usage of land such as planting of field crops in hilly areas

(C) Inappropriate farming practice such as planting of crops in the direction of gradient, and deep plowing in hilly areas.

(D) Lack of vegetation in denuded areas; shortage of afforestation

(E) Lack of structure to prevent erosion such as terraces, check dams

(2) Fragmentation of agricultural land in gradient direction by equal inheritance among heirs, making contour cultivation and economic utilization of farm machinery difficult

(3) Low agricultural income is one of the reasons for migration of rural people, especially of young generation, to urban areas. Excessive concentration of population in cities, especially in Greater Amman, caused various problems such as shortage of houses and water, traffic congestion in cities, reduction of vitality in rural areas.

5.2 Basic Development Concept

(1) Objectives: Taking the existing constraints mentioned in Section 5.1 and objectives of the Five-Year Plan (1986-1990) for agriculture into account, objectives of the agricultural development are set as follows:

(A) To increase the agricultural products and productivity with making full use of such natural resources as rainfall and soils, to afford better living to farmers so that they remain in their farms and their villages

(B) To increase the food security by substituting domestic food produce for imported food

(C) To create more job opportunities in rural areas through intensification of farm production

(D) To conserve basic agricultural resources; soils and water

(E) To promote the export of agricultural produce and to reduce the trade deficit of the Kingdom

(2) Strategies applied in the agricultural development are as follows:

(A) Full utilization of under-utilized natural resources; water, soils

(B) Application and guidance of a principle; proper crops growing in proper land

(C) Extension of water harvesting through microcatchments and contour furrowing

(D) Winter irrigation using water from reservoirs or intake weirs

5.3 Future Landuse Plan

The Study Team proposes the following agricultural land classification criteria:

PROPOSED AGRICULTURAL LAND CLASSIFICATION CRITERIA

Present Land Use	Land Slope %	Annual Rainfall (mm) 350-300	300-200	200-100	100-0
Field crops/ Fallow	0- 8	Field crops	Field crops	Fruit trees	Grazing
	8-25	Fruit trees	Fruit trees	Fruit trees	Grazing
	25-	Forest	Forest	Grazing	Grazing
Vegetables	-	Vegetables	Vegetables	Vegetables	Vegetables
Fruit trees	-	Fruit trees	Fruit trees	Fruit trees	Fruit trees
Forest	-	Forest	Forest	Forest	Forest
Built-up areas	-	Built-up area	Built-up area	Built-up area	Built-up area
Others	0-25	Grazing	Grazing	Grazing	Grazing
	25-	Forest	Forest	Grazing	Grazing

Based upon the above land classification criteria with some allowances for built-up areas and for irrigable area in Hasa (about 300 ha), the future landuse plan is proposed as shown in Fig. 5 of Volume 1.

5.4 Development Plan for Agriculture

Sixteen projects are recommended. Of them, the following projects are newly proposed by the Study Team while the rest are the existing projects planned by the Government.

5.4.1 New Projects

(1) The Water Harvesting Development Project: Crops can thrive even under meager rainfall, say 100 mm/yr, when the meager rainfall is collected sufficiently for growing. This method is called water harvesting and its adaptability to arid climate is successfully demonstrated in Pakistan and Negev. Runoff coefficient becomes larger for smaller watershed but too small watershed causes smaller runoff coefficient. The peak runoff coefficient of as high as 41 per cent was

obtained for a watershed area of 500 m^2 in the case of 12 mm rainfall as shown in the table below:

RUNOFF COEFFICIENT FOR DIFFERENT SIZES OF WATERSHED

Area of Watershed (m^2)	Runoff Coefficient for 12 mm Rainfall(%)
1000	36
500	41
250	34
125	25
62.5	27

Source: Michael Evenari (1971), Negev

When deep soil, say, more than 1.0 m, is guaranteed, a rainfall of 100 mm/yr can keep a fruit tree with conditions: a plot size is 500 m^2; water consumption by a fruit tree is 13 m^3/yr; and runoff coefficient is 41 per cent. Artificial watersheds made of embankments can prevent soil erosion and can conserve rain water. The water harvesting will increase agricultural production such as fruit trees, forage crops making use of extensive under-utilized land and rainfall in the Study Area.

The Water Harvesting Development Project is formulated for 45,200 ha for the fruit tree growing, and 22,200 ha for the fodder shrub growing. Main leverages applied are construction of microcatchments or contour furrows, reservoirs and weirs.

Recommendable fruit trees are apple, peach, apricot, pomegranate, olive and grapevines. Expected yields of fruit trees are estimated as follows based on experimental results in Negev and agricultural production data of Jordan. The yields are very low due to inclusion of rain collecting area in the unit area:

400 kg/ha	for apple	540 kg/ha	for pomegranate
880 kg/ha	for peach	40 kg/ha	for olive
640 kg/ha	for apricot	470 kg/ha	for grapes

The fodder shrub development project will cover about 22,000 ha. Promising kinds and varieties are:

Atriplex	halimus
Atriplex	dimor
Atriplex	nummularia
Salsola	foetida
Ziziphus	nummularia
Propopis	cineraria, etc.

Microcatchments or contour furrows will also be applied for growing fodder shrubs. Experiments of the microcatchments, which were conducted in the Negev Desert under a rainfall condition of about 100 mm/yr, showed a yield of 650 kg/ha/yr in fresh weight of Atriplex halimus. This amount can support 0.3 heads of ewe per hectare.

(2) The Greenhouse (plastic house) Horticulture Project is planned for Afra hot springs. With natural energy supply from the hot springs, various kinds of vegetables, flowers and fruits can be grown and supplied to consumers at low costs even in the winter season. Cucumber, tomato, strawberry, egg plant, pimento, netted melon, carnation, rose and so forth are thought to be suitable for intensive cultivation in greenhouses (plastic houses). Plastic houses of about 0.45 ha will be constructed for experiments, demonstration and training of fruit growing.

In relation to the afforestation project planned by the Government, the followings are proposed by the Study Team:

(3) The Afforestation Project is envisaged for 57,100 ha in the Study Area. Three species suitable in arid climate to soil conservation, food and livestock feed are recommended; Acacia tortilis, Albizia levek, and Proposis pallida. Acacia tortilis withstands extremely arid and alkaline condition and grows fast producing leaves and pods which are eaten by sheep, goats and wildlife. A tree of Albizia levek could produce one fourth of the annual feed required by a cow in a year.

5.4.2 Existing Projects

The following are the list of projects formulated in the current Five-Year Plan for the Karak and Tafila Development Regions:

(1) The Lamb Fattening Center Project is consisting of construction of a cooperative farm of Awassi sheep breeding and five lamb fattening units (7,500 heads per annual each), by JCO under the technical assistance of West-Germany. The total cost will be loaned by EEC.

Total Amount	1,085	10^3JD	100.0%
Karak	155	10^3JD	14.3
Tafila	155	10^3JD	14.3
Sub-Total	310	10^3JD	28.6

(2) The Rangeland Reservation Project: MOA will construct four new rangeland reservation at Al-Yutum Valley, Azraq and the sloping Ghor margins. The total area is 15,000 ha.

Total Amount	2,803	10^3JD	100.0%
Tafila	215	10^3JD	7.7

(3) The Fodder Shrubs Planting Project: JCO carries out his project through agricultural cooperatives in Ma'an, Tafila Karak and Madaba governorates covering total 4,700 ha. Seventy-six per cent of the total cost will be granted by WFP.

Total Amount	628	10^3JD	100.0%
Karak	90	10^3JD	14.3
Tafila	90	10^3JD	14.3
Sub-Total	180	10^3JD	28.6

(4) The Introducing Forage Crops into Farming Cycle Project: JCO implements this project covering 4,800 ha in total, with self-finance at 78.7 per cent of the total cost and the rest will be assisted by WFP.

Total Amount	752	10^3JD	100.0%
Karak	50	10^3JD	6.6
Tafila	97	10^3JD	12.9
Sub-total	147	10^3JD	19.5

(5) The Introducing Legumes into Farming Cycle Project is implemented in the rainfed area less than 250mm/yr by JCO under the co-operation with MOA and Faculty of Agriculture, University of Jordan. Technical assistance will be given by Australia.

Total Amount	582	10^3JD	100.0%
Karak	42	10^3JD	7.2
Tafila	54	10^3JD	9.3
Sub-total	96	10^3JD	16.5

(6) The Veterinary Clinics Project aims at up-grading and expanding quarantine service by constructing three quarantine clinics and seven veterinary clinics which are expected at Satha, Kura, Jiza, Ajlun, Bseira and Ghor Safi.

Total Amount	600	10^3JD	100.0%
Karak	50	10^3JD	8.3
Tafila	50	10^3JD	8.3
Sub-total	100	10^3JD	16.6

(7) The Highland Farming Development Project is consisting of establishment of a national agricultural research center to plan and coordinate agricultural research and extension services in the Highlands, and four extension centers in Ramtha, Mushaqqar, Rubbeh and Shaubak to expand modern technique to the farmers. Technical financial assistance is given by USAID.

Total Amount	19,290	10^3JD	100.0%
Karak	3,000	10^3JD	15.6
Tafila	1,430	10^3JD	7.4
Sub-total	4,430	10^3JD	23.0

(8) The Certified Seeds Production Project aims to improve and multiply main gramineous legume seeds by producing foundation seeds and certified seeds and distributing them to farmers through cooperative societies. Technical assistance is given by West Germany.

(A) Production of foundation seeds

Total Amount	373	10^3JD	100.0%
Karak	124	10^3JD	33.2

(B) Production of certified seeds

Total Amount	400	10^3JD	100.0
Karak	80	10^3JD	20.0

(9) The Mechanized Agricultural Service Project aims to develop the two Cooperative Organization machine stations in Irbid and Madaba and construct four additional stations to help increase field crops, especially wheat and alfalfa. The necessary cost is granted by West Germany.

Total Amount	1,195	10^3JD	100.0%
Karak	238	10^3JD	19.9

(10) The Fruit Tree Seedling Production Project will produce 5.8 million fruit tree seedlings at the nurseries and stations of MOA during the plan period.

Total Amount	5,726	10^3JD	100.0%
Karak	230	10^3JD	4.0
Tafila	520	10^3JD	9.1
Sub-total	750	10^3JD	13.1

(11) The Soil Conservation and Fruit Tree Planting Project has been implemented since 1972 under the assistance of WFP for soil and water conservation in the sloping areas and planting these areas with fruit trees. About 12,500 ha will be planted during the plan period.

Total Amount	9,950	10^3JD	100.0%
Karak	398	10^3JD	4.0
Tafila	895	10^3JD	9.0
Sub-total	1,293	10^3JD	13.0

(12) The Forest Protection Project consists of a comprehensive survey of forest and rangeland, construction of forest roads and of observation towers. Technical assistance is given from West Germany.

Total Amount	3,789	10^3JD	100.0%
Karak	317	10^3JD	8.4
Tafila	218	10^3JD	5.7
Sub-total	535	10^3JD	14.1

(13) The Annual Afforestation Project consists of planting 25,000 ha/yr and providing forest trees seedlings required for afforestation under the technical assistance of West Germany.

Total Amount	9,914	10^3JD	100.0%
Karak	650	10^3JD	6.6
Tafila	450	10^3JD	4.5
Sub-total	1,100	10^3JD	11.1

6. PREPARATORY STUDY ON PRIORITY PROJECTS

6.1 Water Harvesting Project

6.1.1 Basic Concept

The water harvesting project is formulated for:

- 45,200 ha for fruit production and
- 22,200 ha for fodder shrub production

(1) Objectives of the water harvesting project coincide with the objectives of agricultural development in the Study Area, mentioned in Section 5.2:

(A) to increase the agricultural production, productivity and income making full use of natural under-utilized resources such as rainfall and soils

(B) to increase the food security substituting domestic food produce for imported food

(C) to generate new job opportunities in the rural areas through increase of agricultural production

(D) to conserve basic agricultural resources, soils and water

(E) to promote agricultural export in order to mitigate the trade deficit of the Kingdom

(2) Strategy: Major leverages to be applied to the water harvesting project are:

(A) Application of water harvesting measures, such as microcatchments, contour furrows, winter irrigation (runoff farming) to agricultural production

(B) Introduction of deep rooted crops such as fruit trees and fodder shrubs to the water harvesting project

(C) Adoption of phased development in order to mitigate risk and to lessen financial burden of the project. The project will start with construction of a pilot scheme of about 2,270 ha to collect basic technological and financial information about water harvesting.

(D) Establishment of a financially, administratively autonomous body for the project management

(E) Provision of agricultural soft loan to farmers who plan to grow crops by water harvesting, for construction of structures necessary for farm operation

6.1.2 Pilot Scheme

(1) Basic concept: Technical and economic viability of the water harvesting has not been fully demonstrated in Jordan. The pilot scheme of the water harvesting has the following objectives:

(A) to identify the most suitable methods of water harvesting to respective slopes, soils and rainfall conditions

(B) to confirm the economic viability of the agricultural development by water harvesting

(C) to demonstrate the economic performance of the water harvesting to farmer's as well as to government officials

(D) to train the agricultural extension workers in design, construction of water harvesting measures and in crop husbandry using water harvesting

A proposed site of the pilot scheme is situated 6 km west from the Desert Highway along El Huseiniya Abiad road. The site was selected based on the following merits of the site:

(A) to have the typical meteorological condition of the marginal areas of the Study Area i.e. situated at almost center of semi-desert areas (the Badia) of the Study Area, (annual rainfall is about 150 mm). Results of trials can be applied to other semi-desert areas of the Study Area.

(B) to have good access to the site provided with a paved El Huseiniya Abiad road even in the rainy season

(C) to have moderate slopes and deep soils (more than 1 m in depth), which are essential for successful implementation of the trials. Results of chemical analysis of soils are shown in Table B-11. Soils are thought to be suitable without severe salinity and alkalinity.

(D) to be situated in the Government land without crop cultivation or buildings

A preliminary layout of the pilot scheme is shown in Fig. B-5. The definite layout of the scheme should be determined based on the detailed topographic maps and detailed soil maps.

Cultivable areas for respective water harvesting methods are tentatively determined as:

- 56 ha for winter irrigation by gravity
- 82 ha for micro-catchments

(2) Experiments: Three kinds of experiments will be carried out to obtain the basic technological and economical information of the water harvesting:

(A) Water harvesting method tests such as on:
  (a) micro-catchments for different slopes, sizes, soils, covers, soil depths
  (b) runoff farming (irrigation)
  (c) contour furrows for different slopes, soil depths, soil covers
  (d) pitcher irrigation

(B) Crop suitability tests using the following crops under water harvesting:
  (a) Wheat, barley, alfalfa, sunflower, peas, hardy grass
  (b) Olive, grapes, apples, pistachio nuts, beans, peach, fig, almond, apricot, pomegranate
  (c) Atriplex halimus, Atriplex dimor, Atriplex nummularia, Propopis cineraria
  (d) Onion, Artichokes, Asparagus

(C) Fertilizer application amount tests to find optimum amounts of fertilizers, under water harvesting

In these tests, meteorological condition, crop water consumption and salt movement should be monitored together with crop productions.

(3) Training are and extension: In the course of the experiments, in-service training of agricultural extension workers of the project office mentioned afterward should be carried out.

(4) Construction cost: Irrigable area by the winter irrigation from the weir is estimated conservatively at 56 ha assuming that runoff with a return period of less than 10 years could be used for irrigation. About 15 ha will be able to be planted for perennial crops, and the rest for annual crops when winter rainfall is abundant (Table B-9).

Direct construction cost of the winter irrigation system is estimated at 125,900 JD with the following breakdown:

Intake weir	8,900 JD
Distribution channels	39,300
Distribution pipes	12,200
Farm development	33,400
Farm road	11,200
Others	76,300
	181,300

More detailed breakdown of the direct costs is shown in Table B-10.

Construction cost of the microcatchment is calculated based on a basic plot size of 500 m^2 (22.3 x 22.3 m) and its water collecting basin size of 4.0 x 4.0 x 0.15 m.

The height of the bund of a plot is 15 cm, and the length of the bases is 30 cm. The height of the bund of a basin is 30 cm and the base length is 60 cm. Construction of plots and ploughing of basins can be done by a disc plough drawn by a tractor. Shaping of basin will be done manually. The construction cost of the microcatchment is estimated at 15 JD/ha; 1 JD/ha for construction of bunds, 2 JD/ha for ploughing of basins, 12 JD/ha for shaping of basins.

Eighty-two ha of land with gentle slopes and without foreign drainage are selected for the microcatchments.

Total construction cost of the pilot scheme is estimated with the following breakdown:

Direct Costs		
Construction of the winter irrigation system	:	181,300 JD
Construction of the microcatchments	:	1,200
		182,500
Engineering & Administrative costs (10% of the above)	:	18,000
Contingency (10% of the above)	:	20,000
Total		220,500

6.1.3 Agricultural Development by Water Harvesting

As mentioned in the preceding sections, the Study Area has extensive under-utilized arable land and under-utilized water resources. This might be mainly due to the existence of more profitable job opportunities in the oil producing countries in the middle east than in agriculture in Jordan. The economic boom in the Gulf countries would not last forever as shown in the recent economic decline in the Gulf. Full utilization and preservation of natural resources such as soils and water for agricultural development is prerequisite for improvement in food security as well as for economic development and socioeconomic stabilization of the Kingdom.

Fruit trees and fodder shrubs were selected as target crops because they:

- have long root systems, which are essential for survival under semi-desert areas without irrigation
- have possibility of import substitution because large volumes of these, about 38,000 tons of apple and about 50,000 tons of meat for example are imported every year

As mentioned in Section 5.3 the target areas are estimated at 45,200 ha for fruit trees and 22,200 ha for fodder shrubs. Various water harvesting methods will be adopted to different slopes, soil depths and rainfall.

The microcatchments are thought to be most promising, among others, for its simple structure and low construction costs. Their economic performance has already been demonstrated in experiments at Sapha, 30 km east of Mafraq, under annual rainfall of about 150 mm and altitude of about 600 m by Mr. Jehad Abu Mushref, the Ministry of Agriculture. Sites for the microcatchments have to be free from foreign drainage and to have deep soils.

Check-dam cum terraced land i.e. runoff farming, also is thought to be promising. Pioneering works of check-dam cum terraced land are found in a wadi 17 km south of the Roman Pond near the international airport (QAIA) along the Desert Highway. These were built by a Bedou, named Zaal Daas in around 1965. Olive trees and grapevines are grown well without irrigation. Olive trees started bearing fruit in 1983. Grapevines are 7 years old. They showed good harvests. Wadi bottoms with deep soils and free from large floods are suitable for construction of check-dam cum terraced land. But these suitable areas might be limited.

Contour furrows will be applied to steep areas with deep soils and long uniform slopes free form foreign drainage.

Recommendable fruit trees and fodder shrubs for water harvesting are:

Apple	Atriplex halimus
Peach	Atriplex dimor
Apricot	Atriplex nummularia
Pomegranate	Salsola foetida
Olive	Ziziplus nummularia
Grape	Propopis cineraria

Apple, among recommended fruit trees, is thought to be most promising for its high demands and short supply and high durability in storage.

The following varieties of apple are available in the government nurseries:

- Jonathan
- Starking
- Golden Delicious
- Super Starking Delicious
- Summer Champion
- Fuji
- Gray Smith
- Spartan
- Topred
- Super Red Delicious
- Spurs red
- Tsugaru

Expected yield of apple is 20 kg/tree/yr.

Atriplex halimus (North African Salt Bush) is the most recommendable fodder shrub for its high adaptability to desert or semi-desert environments, its prominent productivity even in dry season, its self-seeding characteristic and its high palatability to sheep and goats.

Under the annual rainfall of 100 mm, Atriplex halimus might be able to produce 650 kg/ha/yr of fresh fodder, which can support 0.3 head of ewe, if deep soils are guaranteed.

Definitive selection of suitable water harvesting methods and their proper designs to respective topographical and geological conditions should be made after collection of basic technological and economic information about water harvesting in the pilot scheme.

The following criteria is assumed for the preliminary estimate of the construction cost of the water harvesting project:

Slope (%)	Suitable Water Harvesting Method
0-12	Microcatchments
12-	Contour furrows

The same design criteria and unit costs as that of the pilot scheme is applied to the microcatchments for the main project. Construction of the contour furrows will have to be done by hands or by animals due to steep slopes of the areas applied. The depth of the U-shaped furrows is assumed at 30 cm and width at 36 cm. Unit construction cost of the con-

tour furrows is estimated at 40 JD/ha as follows:

- Excavation of furrows by hand, 0.3 m x 0.3 m x 3.0 JD/m^3	= 0.32 JD/m
- Shaping	= 0.08 JD/m
Total	0.40 JD/m

Assuming an interval between furrows to be 6.0 m, the length of furrows per hectare is calculated at 1,666 m.

The direct construction cost of the water harvesting project is estimated as follows:

Crops	Slope (%)	Water Harvesting Method	Area (ha)	Unit Cost (JD/ha)	Cost (JD)
Fruit trees	0-12	Microcatchments	28,400	15	426,000
	12-	Contour furrows	16,000	666	11,188,800
Fodder Shrub	0-12	Microcatchments	20,700	15	310,500
	12-		1,500	666	999,000
			67,400		12,924,300

Engineering, administrative and contingency costs are estimated at about 21 per cent of the direct cost.

So, the total construction cost of the water harvesting project is estimated at about JD 15.6 million.

6.1.4 Project Management

Organization for the project management is formulated taking the following points into account:

(1) Creation of a new organization for the project management will increase financial burden to the Government. Existing organizations should be utilized as much as possible reinforcing deficient parts of the existing organizations.

(2) Farmer's initiative, participation and decisions should be respected and be given first priority because the proposed project is a kind of agricultural credit project, in which major parts of risk

involved in the project will be taken by farmers.

(3) Diffusion of authority and responsibility in implementing the project should be avoided. Financial and administrative autonomy including the right to make contracts for loans, services, etc. should be guaranteed for the executing authority.

(4) Promotion of the cooperative movements and of economic activities by the the private sector

Jordan Cooperative Organization (JCO) was selected as the executing organization of the project based on the following reason:

(1) JCO is an independent legal body with administrative and financial autonomy, which is essential for performing strong leadership in the project management.

(2) JCO is thought to have strong support and familiarity of farmers.

(3) JCO is run by a Board of Directors, in which representatives from MOA, MOP and CBJ as well as from cooperative societies are present. Coordinating functions will be assured in this Board.

Special project section in Cooperative and Project Department will be in charge of the project as in the case of the fodder shrub project.

6.2 Afra Greenhouse Horticulture Project

6.2.1 Basic Concept

The Jordan Valley is blessed with plentiful geothermal energy though its substantial exploitation has just started in Zarqa Ma'in for tourism development. Geothermal energy can also be utilized for agricultural purposes such as greenhouse (plastic house) horticulture, food processing, cold storage and air conditioning of livestock sheds. The Afra Greenhouse Project is the pioneering project in utilization of geothermal energy for greenhouse (plastic house) horticulture and has the following specific objectives:

- to find suitable crops to the greenhouse (plastic house) horticulture utilizing geothermal energy
- to develop suitable cropping methods to the greenhouse (plastic house) horticulture

- to develop suitable building structures for the greenhouse (plastic house) horticulture
- to demonstrate model farms of the greenhouse (plastic house) horticulture to farmers and the Government officials
- to train extension workers and farmers in the greenhouse (plastic house) horticulture

It is proposed that this project be operated as a pilot project by the Jordan Cooperative Organization at their own costs and risk.

6.2.2 Site Condition

There are 2 major hot springs in Afra. Their discharges and its temperatures were measured on February 3 and August 7, 1987. The results are shown in the table below:

DISCHARGES AND TEMPERATURE OF AFRA HOT SPRING

Site	Discharge	Water Temperature	Date
Upper spring	16.0 l/sec	48° C	Feb. 3,1987
Lower spring	2.5 l/sec	45° C	Feb. 3,1987
Wadi upstream	23.3 l/sec	43° C	Feb. 3,1987
Wadi downstream including the above	126.0 l/sec	47° C	Aug. 7,1987

The average spring water temperature in winter is calculated at 45°C. A site for the project is chosen from 2 alternatives: the left bank of Wadi Afra; and the left bank of Wadi Hasa near Burbeita. The first alternative is omitted because hot water has to be pumped up about 200 m in static head making the operation cost expensive and because the construction of pipeline is rather difficult due to the fragile rock wall on which pipeline is to be constructed. The second alternative has a good road from the hot springs and the required lift of water is only about 40 m. The distance between the hot springs and the proposed site is about 3 km. The site is being cultivated.

Air temperature at the site is estimated as follows based on data from a nearby station, Tafila:

ESTIMATED AIR TEMPERATURE AT THE SITE

Temperature	Winter (January)	Summer (July, August)
Average Daily Maximum	17° C	35° C
Average Daily Minimum	5° C	18° C

6.2.3 Project

Hot spring water of 20 litre/sec will be transmitted to the site. The rest of the hot water will be used for existing users of the hot water, further development of hot water in the future, and for tourism development.

Making a water temperature of drainage water from the heating at 34° C, the floor area of the greenhouse that can be heated is estimated at 0.45 ha based on the following formula:

$$A = B \times C / (D \times (E - F))$$
$$= 0.5 \times 720{,}000 / (5.3 \times (15 - 0))$$
$$= 4{,}528\ m^2 = 0.45\ ha$$

Where: A : Floor area (m^2)
B : Floor area/covering material area = 0.5
C : Transmitted heat (kcal/hr)
D : Greenhouse heat radiation coefficient ($kcal/m^2.hr.C^o$)
E : Air temperature inside of a greenhouse (C^o)
F : Air temperature outside of a greenhouse (C^o)

This area is calculated so as to meet the coldest winter temperature.

Many kinds of vegetables, flowers and fruit trees can be tested under greenhouses or plastic covers. However considering the overproduction of vegetables under plastic covers and greenhouses in Jordan, priority should be given to fruit trees such as grapes, oranges, papaya. The fruit tree growing under plastic covers is the new technology in Jordan and in the experimental stage. With the high living standard of

the Kingdom, demands of high quality fruits in the off-season must be strong. As in the case of vegetable production under plastic covers, there will be great possibility of development in fruits production under covers because it can assure farmers of:

- early harvesting (3 months earlier than ordinary methods for grapes in the case of Japan)
- higher prices
- longer harvesting period
- stable yields
- higher utilization rate of family labour by staggering the growing seasons

Construction cost of plastic houses for the pilot scheme is estimated at as follows:

Plastic houses	: 0.45 ha x 20,000 JD/ha =	9,000 JD
Irrigation system	: 0.45 ha x 1,000 JD/ha =	450 JD
Heating system by plastic pipes (dia. 5 cm)	: 11,600m x 0.45 JD/m =	5,200 JD
Direct cost sub-total		14,650 JD
Engineering, contingency (21 % of the above)		3,077 JD
Total		17,727 JD

6.2.4 Project Management

The fruit growing under plastic covers is the new technology in Jordan. Some experimental trials are being carried out by Jordan University in the Jordan Valley but not in the experimental stage. This technology has already been put to practical use in Japan, and in 1983, about 6,000 ha of fruit trees were grown under greenhouse (plastic houses). The technology has already been completed, and with some modifications Japanese experience could be applied to Jordan. The project would be managed by JCO with technical assistance of Japanese experts.

7. CONCLUSIONS AND RECOMMENDATIONS

The present study revealed the enormous potentiality of the area in the further agricultural development blessed with extensive under-utilized land and water resources. With introduction of proper technologies such as water harvesting, improved crop husbandry, substantial increment in agricultural production and creation of new job opportunities can be anticipated.

Adoption of new technologies by individual farmers will be difficult without success in experimental farms or farmer's fields and without proper financial and technological assistance to farmers given by the Government.

For full utilization of natural and human resources for the agricultural development of the Study Area, the following actions should be taken as early as possible:

(1) Implementation of a feasibility study of the Water Harvesting Development Project in the Study Area, including detailed social survey of the area
(2) Detailed design, construction and operation of the Pilot Scheme for the water harvesting development
(3) Strengthening of the existing agricultural extension system through reinforcement of personnel and introduction of motorcycles
(4) Introduction of the remote-sensing for estimation of crop production and for assessment of desertification which can be utilized for monitoring of agricultural policies, such as extension services. The remote-sensing for agricultural purposes will be able to be demonstrated in the feasibility study for the water harvesting development.

REFERENCES

B-1 Five-Year Plan for Economic and Social Development, 1986-1990, MOP, 1986

B-2 Agricultural Census, 1983

B-3 Statistical Year Book, DOS, 1984

B-4 Statistical Year Book, DOS, 1985

B-5 Multipurpose Household Sample Survey, DOS, 1975

B-6 National Village Survey, MOP, 1984

T A B L E S

Table B-1 FARM HOUSEHOLD AND POPULATION BY SUB-REGION (1985)

Sub-Reg.	Population	Total Household	Farm Population	Farm Household
Karak	37,838	4,678	30,360	3,750
Qasr	18,439	2,280	14,790	1,830
Mazar	26,729	3,305	21,440	2,650
Ayy	10,560	1,306	8,470	1,050
Qatrana	2,744	339	2,200	270
Sub-Total	96,310	11,908	77,260	9,550
Tafila	24,391	3,016	14,910	1,840
Bseira	8,456	1,046	5,170	640
Hasa	4,524	559	2,770	340
Sub-Total	37,371	4,621	22,850	2,820
Jizen	2,917	360	2,280	280
Dhiban	6,283	776	3,960	490
Sub-Total	9,200	1,136	6,240	770
Grand Total	142,881	17,665	106,350	13,140

/1 Estimated by 8.1 families per household from Agricultural Census 1983
/2 Rate of rural population; 80.23 % in Karak, 61.13 % in Tafila.

Table B-2 PLANTED AREA AND PRODUCTION OF FIELD CROPS IN THE STUDY AREA (AVERAGE OF 1981-1985)

	Cultivated Area (ha)	(%)	Production (ton)	Unit Yield (ton/ha)
Wheat	16,019	65.6	10,694	0.67
Barley	5,790	23.7	3,006	0.52
Lentil	1,246	5.1	803	0.64
Chick Pea	573	2.3	271	0.47
Other Crops	793	3.3	348	0.44
Total	24,421	100.0	15,122	0.62

Source: Ministry of Agriculture

Table B-3 PLANTED AREA IN THE STUDY AREA BY CROP AND BY YEAR

(ha)

	Wheat	Barley	Lentil	Chick Pea	Others	Total
1976	23,457	9,159	5,115	274	909	38,914
1977	24,942	8,702	3,644	423	741	38,452
1978	25,430	11,885	5,167	665	958	44,105
1979	25,063	13,703	3,362	643	1,315	44,086
1980	23,340	10,208	2,927	493	1,300	38,268
1981	20,564	7,135	2,375	381	1,288	31,743
1982	15,510	6,020	958	772	1,035	24,295
1983	23,414	8,941	1,869	974	1,153	36,351
1984	7,680	3,364	196	131	41	11,412
1985	18,750	7,270	377	1,088	684	28,169

Source: Ministry of Agriculture

Table B-4 LIVESTOCK POPULATION IN THE STUDY AREA

	Sheep		Goats		Cattle		Poultry		Sheep+ Goat per farm
	Head	%	Head	%	Head	%	Head	%	Head
Karak	29,162	15.8	26,740	17.0	118	36.4	446,000	14.1	14.9
Qasr	23,803	12.9	25,952	16.5	65	20.1	1,037,000	32.7	27.2
Mazar	55,612	30.1	43,282	27.5	31	9.6	515,000	16.2	37.3
Ayy	2,700	1.5	8,503	5.4	0	-	667,500	21.0	10.7
Qatrana	11,210	6.1	6,046	3.8	0	-	0	-	63.9
Sub-Total	122,487		110,523		214		2,665,500		24.4
Tafila	25,360	13.7	26,218	16.6	23	7.1	481,600	15.2	28.0
Bseira	10,855	5.9	6,805	4.3	2	0.6	700	0.0	27.6
Hasa	2,570	1.4	8,130	5.2	1	0.3	21,400	0.7	31.5
Sub-Total	38,785		41,153		26		503,700		28.3
Jizen	19,750	10.7	3,501	2.2	15	4.6	1,300	0.0	82.5
Dhiban	3,748	2.0	2,415	1.5	69	21.3	1,700	0.1	12.6
Sub-Total	23,498		5,916		84		3,000		38.1
Grand Total	184,770	100	157,592	100	324	100	3,172,200	100	26.0

Source : National Village Survey, 1984

Table B-5 NUMBER OF HEAD OF LIVESTOCK IN JORDAN

(1,000 heads)

	1981	1982	1983	1984	1985
Sheep	1,073	990	980	960	1,121
Goats	529	590	442	419	490
Total	1,602	1,580	1,422	1,379	1,611
Slaughtered Sheep	296	314	444	295	251
Slaughtered Goats	174	191	51	114	85
Total	470	505	495	409	336

Source: Animal Production and Health Department, Ministry of Agriculture

Table B-6 NUMBER AND AREA OF HOLDINGS BY SOURCE OF FINANCE IN KARAK AND TAFILA GOVERNORATES IN 1983

Sources	Area (dunum)	Area (%)	No. of Holdings (No.)	No. of Holdings (%)
Holder Himself	489,904	80	7,874	91
Landlord	34,159	6	380	5
Middleman	7,030	1	74	-
Agricultural Credit Corporation	28,075	5	134	2
Jordan Cooperative Organization	23,611	4	124	2
City and Village Development Bank	2,054	-	7	-
Farmer's Union	328	-	4	-
Other Government Sources	22,378	3	15	-
Private Sources	7,607	1	35	-
Other Non-Government Sources	683	-	31	-
Total	615,829	(100)	8,678	(100)

Source: 1983 Agricultural Census

Table B-7 NUMBER AND AREA OF HOLDINGS BY PLACE OF PRODUCTS SALE IN KARAK AND TAFILA GOVERNORATES

Place	Area (dunum)	Area (%)	Household (No.)	Household (%)
Central wholesale market only	38,604	10	536	12
On the roadside only	1,994	-	51	1
Small local market only	239,202	59	2,665	59
Exported only	2,311	1	7	-
On the farm gate only	70,707	17	722	16
Other market only	18,134	5	238	5
More than one market	33,783	8	318	7
Total	404,735	100	4,537	100

Source: Agricultural Census 1983

Table B-8 NUMBER OF HOLDINGS BY TRANSPORT MEANS OF PRODUCTS IN KARAK AND TAFILA GOVERNORATES

Means	No. of Household	%
Holding sold all products on the farm gate	722	14
By owned pick-up	292	6
By hired pick-up	1,987	39
By owned trolley attached to tractor	242	5
By hired trolley attached to tractor	973	19
By hired animal	561	11
By other means of transport	304	6
Total	5,081	100

Source: Agricultural Census 1983.

Table B-9 RUNOFF VOLUME IN PILOT PROJECT AREA

Item	Return Period (year)							
	1.01	1.25	2	5	10	25	50	100
Wadi Abiad Intake Weir Site (Catchment area = 110.5 km^2)								
Runoff Volume (MCM/yr)	0.040	0.300	0.840	2.200	3.520	5.710	7.810	10.100
Expected Yield (MCM/yr) 1/	0.012	0.090	0.252	0.660	1.056	1.710	2.340	3.030
Irrigable Area (ha) 2/	2.3	17.3	48.5	126.9	203.1	328.8	450.0	582.7
Wadi Abiad Water Spreading Site (Catchment area = 8.9 km^2)								
Runoff volume (MCM/yr)	0.004	0.024	0.068	0.176	0.284	0.460	0.629	0.815
Expected Yield (MCM/yr) 3/	0.004	0.024	0.068	0.176	0.284	0.460	0.629	0.815

1/: Expected yield is estimated at 30 % of runoff volume.

2/: Water demand of a fruit tree is estimated at 13 m^3/yr.
Planting space is 25 m^2/tree.

3/: Expected yield is estimated at 100 % of runoff volume.

Source: The Study Team

Table B-10 WINTER IRRIGATION SYSTEM CONSTRUCTION COST (1/2)

Stage No.	Farm Area (ha)	Work	Unit Rates		Construction Cost	
			Unit	Rate (JD)	Quantity	Cost (1000JD)
1st Year	15.3	Intake weir	Set	8,900.0	1.0	8.9
		Distribution channel	m	10.2	700.0	7.1
		Distribution pipe	m	3.6	970.0	3.5
		Farm Development	ha	598.0	15.3	9.1
		Farm Road	m	2.0	700.0	1.4
		Sub-Total (1)				30.0
		Other Work (1) x 20%				6.0
		Total				36.0
2nd Year	5.4	Intake weir	Set	-	-	-
		Distribution channel	m	10.2	1,870.0	19.0
		Distribution pipe	m	3.6	330.0	1.2
		Farm Development	ha	598.0	5.4	3.2
		Farm Road	m	2.0	1,900.0	3.8
		Sub-Total (1)				27.2
		Other Work (1) x 20%				5.4
		Total				32.6
3rd Year	18.6	Intake weir	Set	-	-	-
		Distribution channel	m	10.2	630.0	6.4
		Distribution pipe	m	3.6	1,090.0	3.9
		Farm Development	ha	598.0	18.6	11.1
		Farm Road	m	2.0	630.0	1.3
		Sub-Total (1)				22.7
		Other Work (1) x 20%				4.5
		Total				27.2

Table B-10 WINTER IRRIGATION SYSTEM CONSTRUCTION COST (2/2)

Stage No.	Farm Area (ha)	Work	Unit Rates		Construction Cost	
			Unit	Rate (JD)	Quanti-ty	Cost (1000JD)
4th Year	16.8	Intake weir	Set	-	-	-
		Distribution channel	m	10.2	630.0	6.4
		Distribution pipe	m	3.6	1,909.0	3.9
		Farm Development	ha	598.0	16.8	10.0
		Farm Road	m	2.0	2,330.0	4.7
		Sub-Total (1)				25.1
		Other Work (1) x 20%				5.0
		Total				30.1
Total	56.1	Intake weir				8.9
		Distribution channel				39.3
		Distribution pipe				12.2
		Farm Development				33.4
		Farm Road				11.2
		Other Work				20.9
		Water spreading				55.4
		Total				181.3

Source: The Study Team

Table B-11 SOIL ANALYSES

Site No.	1			2			3			4			5	6		7			8			9
Area	Maghar			Maghar			Jinz			Jinz			Jinz	Siwaqa		Hasa			Ruweiha			Afra
Location (P. Grid Y)	5.6			5.1			23			2.4			Hasa	9.1		7.2			29			4.3
(P. Grid X)	28.1			28.7			24.7			24.8			Mine	26.4		23.9			23.6			26.9
Sampling Date	13/10 1986	13/10 1986	13/10 1986	13/10 1986	13/10 1986	13/10 1986	13/10 1986	13/10 1986	13/10 1986	13/10 1986	13/10 1986	13/10 1986	13/10 1986	5/2/ 1987	9/2/ 1987	9/2/ 1987	9/2/ 1987	10/2/ 1987	10/2/ 1987	10/2/ 1987	2/2/ 1987	
Relief	Wadi Slope	Wadi Slope	Wadi Slope	Wadi	Mud Flat	Mud Flat	Mud Flat	Wadi Slope	Wadi Slope	Wadi Slope	Slime			Wadi	Wadi	Wadi	Wadi	Wadi	Wadi	Wadi	Depres-sion	
Depth (cm)	0-10	30-40	50	0-10	0-5	30-40	65-70	0-5	30-40	65-70	-			0-5	0-5	30	70	0-5	25	60	0-5	
Soil Analysis	SCL	CL	SIL	L	SiCL	SiL	-	SL	SCL	CL	C			SiL	SiL	SiL	SiL	L	L	SiL	SiL	
Texture (USDA System)																						
Clay (%)	21.2	38.2	17.9	26.7	33.6	24.5	-	12.7	22.1	30.3	45.2			17.0	26.7	49.4	57.6	9.4	13.5	12.1	15.3	
Silt (%)	26.6	36.2	14.1	49.9	52.2	66.4	-	199	22.2	31.8	38.5			61.1	72.3	49,6	41.9	43.1	44.7	51.1	58.1	
Sand (%)	52.2	25.6	68.0	23.4	14.2	9.1	-	67.4	55.7	37.9	16.3			21.9	1.0	1.0	0.5	47.5	41.7	36.8	26.6	
$CaCo_3$ (%)	39.90	46.09	48.75	37.92	42.47	44.39	41.58	4733	45.26	33.78	11.20			26.90	42.85	44.99	46.92	38.39	0.01	36.27	38.72	
Total Nitrogen (%)	0.02	0.03	0.01	0.03	0.08	0.02	0.05	0.03	0.02	0.02	0.01			0.07	0.02	0.03	0.02	0.03	10.68	0.02	0.12	
ECE (meq/100 gr)	10.78	14.48	9.92	15.64	15.84	15.24	14.82	6.50	10.36	15.90	12.32			14.26	16.14	18.12	18.52	9.80	-	12.92	14.50	
Available K (meq/100 gr)	0.98	0.39	0.35	1.25	0.98	0.23	0.25	0.59	0.19	0.24	0.20			-	-	-	-	-	-	-	-	
Giypsum Content (%)	0.31	0.26	-	0.67	1.23	18.23	26.90	0.58	-	-	2.45			0.06	16.00	0.13	0.06	0.02	21.40	0.06	-	
PH H_2O (1:2.5)	9.99	8.18	9.98	9.48	8.61	8.44	8.36	8.86	8.79	8.73	8.59			8.49	7.28	7.24	7.44	9.25	7.97	7.50	8.24	
P.C. Saturated extract	859	7.51	-	8.26	8.35	7.86	8.07	7.60	7.55	7.55	7.84			7.82	7.08	7.01	7.36	8.65	7.88	7.89	7.93	
EC (mmos/cm)	1.06	13.34	-	12.01	1.24	2.56	2.78	14.96	24.3	33.2	6.42			1.30	42.6	10.0	26.5	2.06	24.4	26.2	0.96	
EC (1:2.5) (mmos/cm)	0.52	2.98	0.39	0.61	0.38	2.66	2.75	1.76	3.96	5.67	2.45			-	-	-	-	-	-	-	-	
Exchangable Na (meq/L)	0.2	1.02	0.2	1.86	0.03	0.40	0.04	0.01	1.46	3.04	1.46			0.98	0.29	0.38	0.51	1.95	2.08	2.13	0.22	
Exchangable K (meq/L)	-	-	-	-	-	-	-	-	-	-	-			1.30	0.30	0.30	0.34	0.89	0.30	0.26	0.59	
Exchangable Ca (meq/L)	-	-	-	-	-	-	-	-	-	-	-			14.63	14.88	8.75	8.00	6.50	10.25	22.25	10.25	
Exchangable Mg (meq/L)	-	-	-	-	-	-	-	-	-	-	-			1.78	6.32	3.29	2.83	1.33	3.39	2.09	1.61	
Exchangable Sodium Percents	1.85	7.04	2.02	0.21	11.89	2.62	0.24	0.15	14.09	19.12	11.85			6.9	1.8	2.1	2.8	19.9	19.5	16.5	1.5	

Source: The Study Team

F I G U R E S

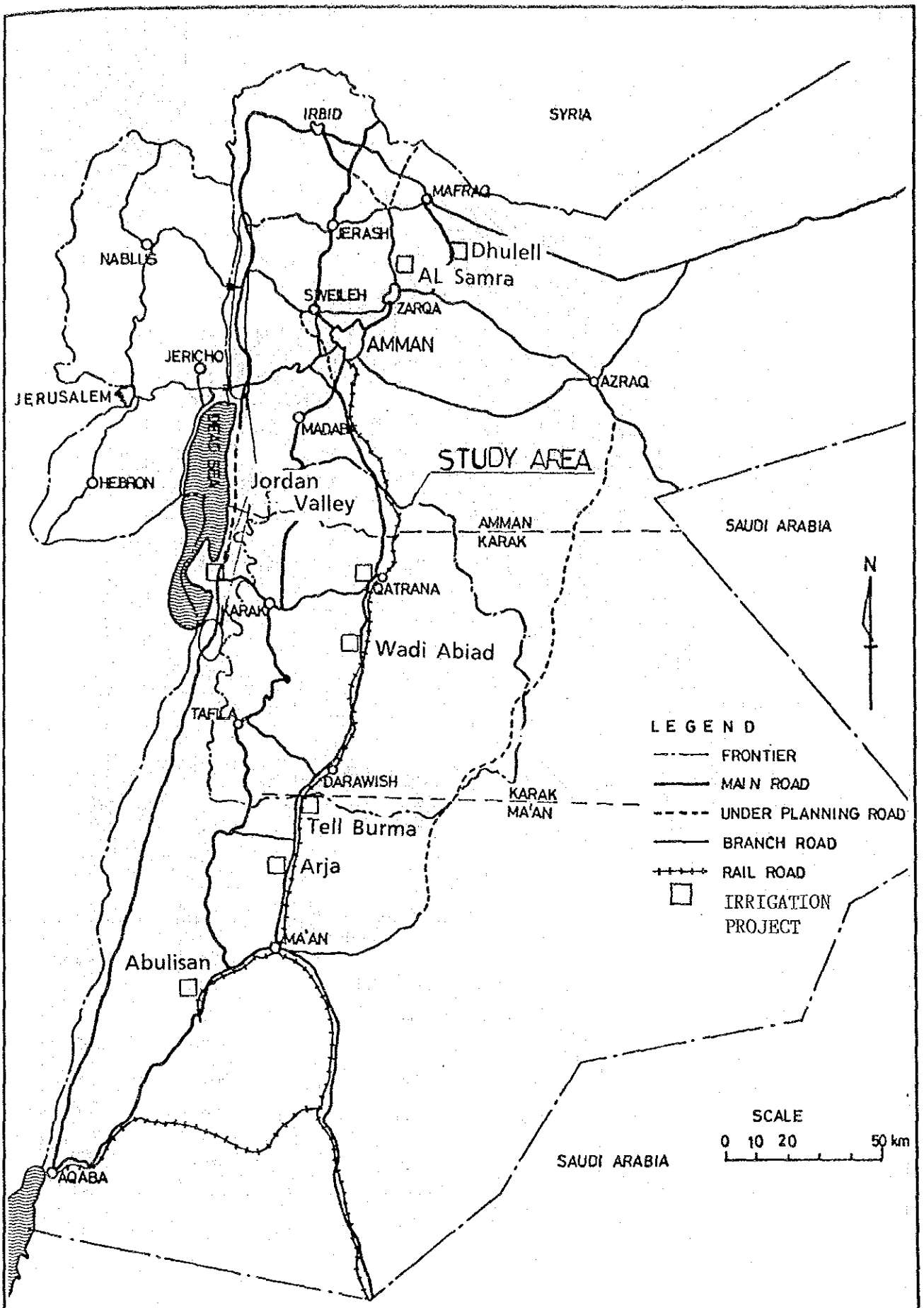
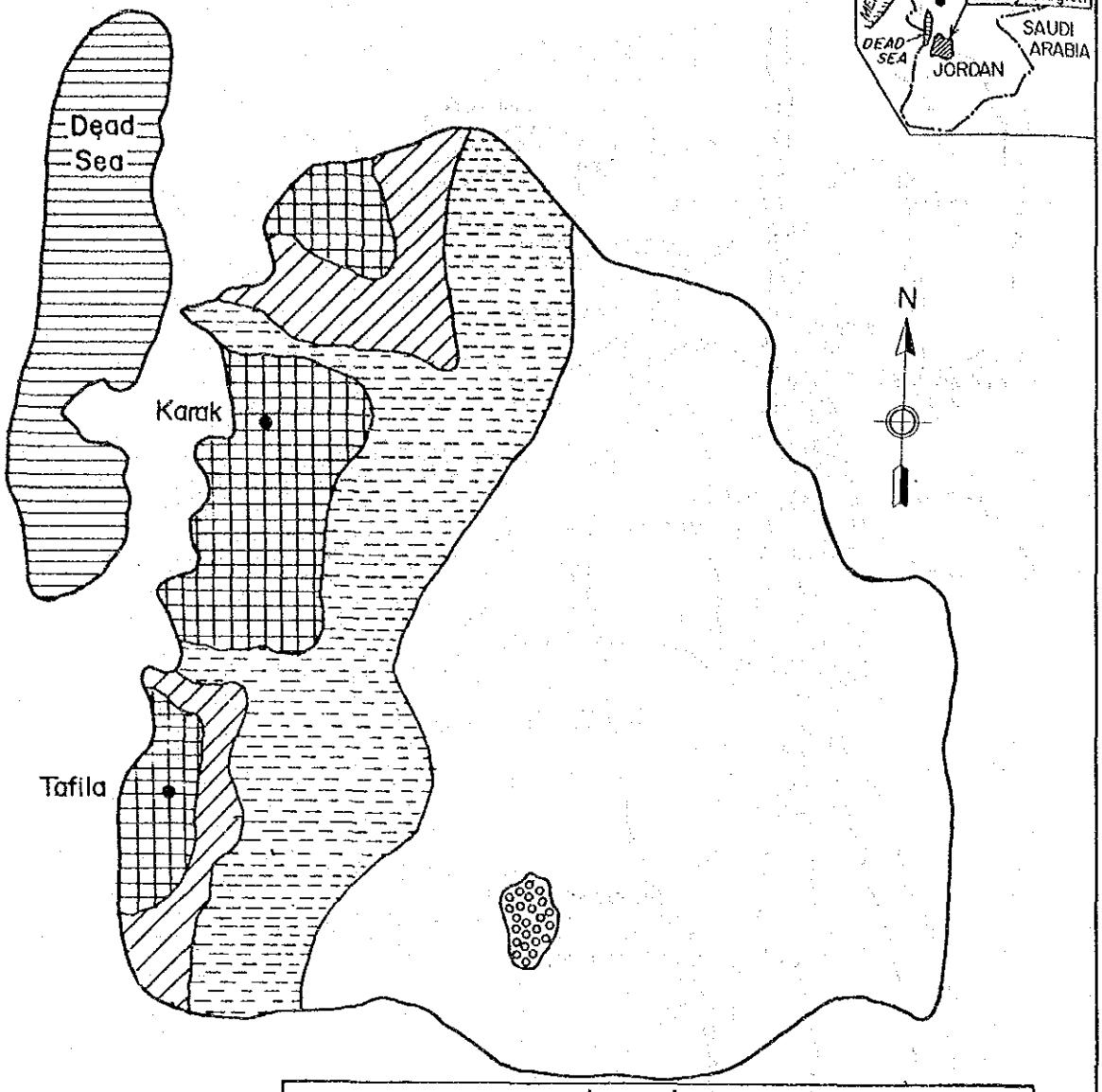


Fig. B-1 Location of Existing Irrigation Projects

THE HASHEMITE KINGDOM OF JORDAN
THE STUDY ON INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE KARAK - TAFILA DEVELOPMENT REGION

JAPAN INTERNATIONAL COOPERATION AGENCY



Legend	Area (km)	Extent %
Red Mediterranian Soils	910	11
Yellow Mediterran Soils	550	7
Yellow Soils	1770	22
Gray Desert Soils	4800	59
Saline Soils Mudflats	70	1
	8100	100

Fig. B-2 Soil Map

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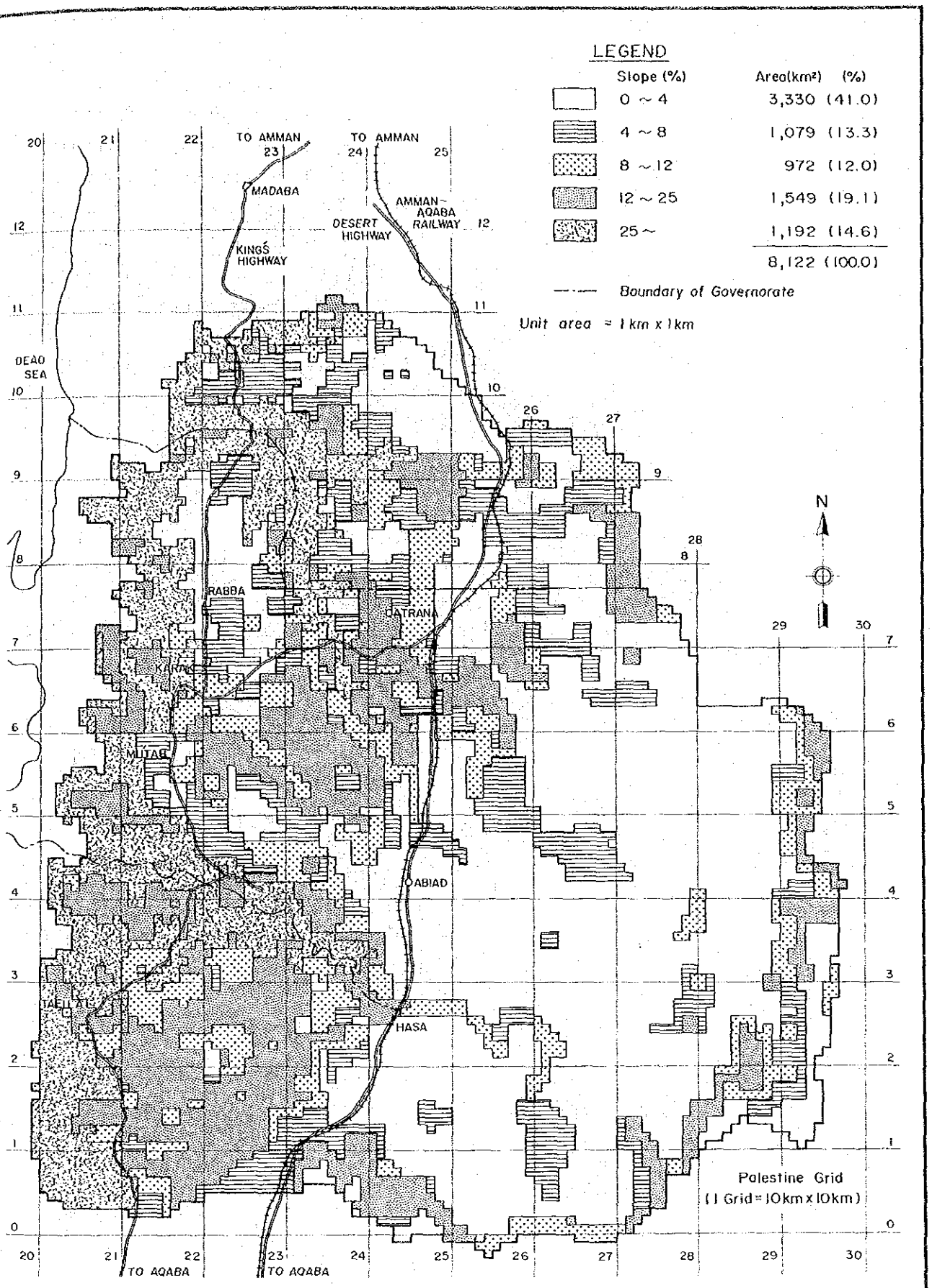

Fig. B-3 Land Slope Map

THE HASHEMITE KINGDOM OF JORDAN
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