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THE HASHEMITE KINGDOM OF JORDAN

FEASIBILITY STUDY
OF
RING ROADS CONSTRUCTION PROJECT
IN IRBID CITY

FINAL REPORT

SUMMARY AND RECOMMENDATIONS

FEBRUARY 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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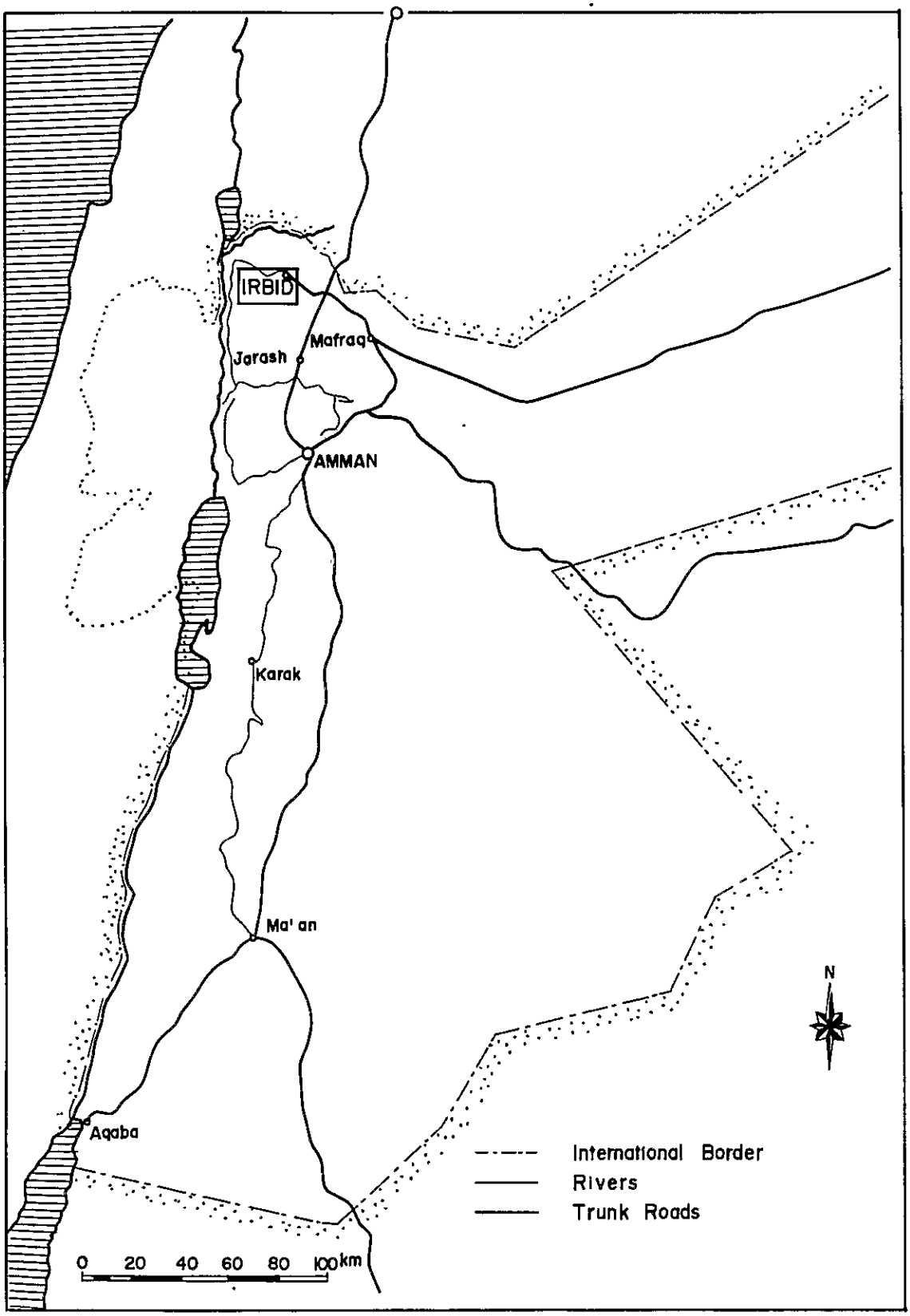
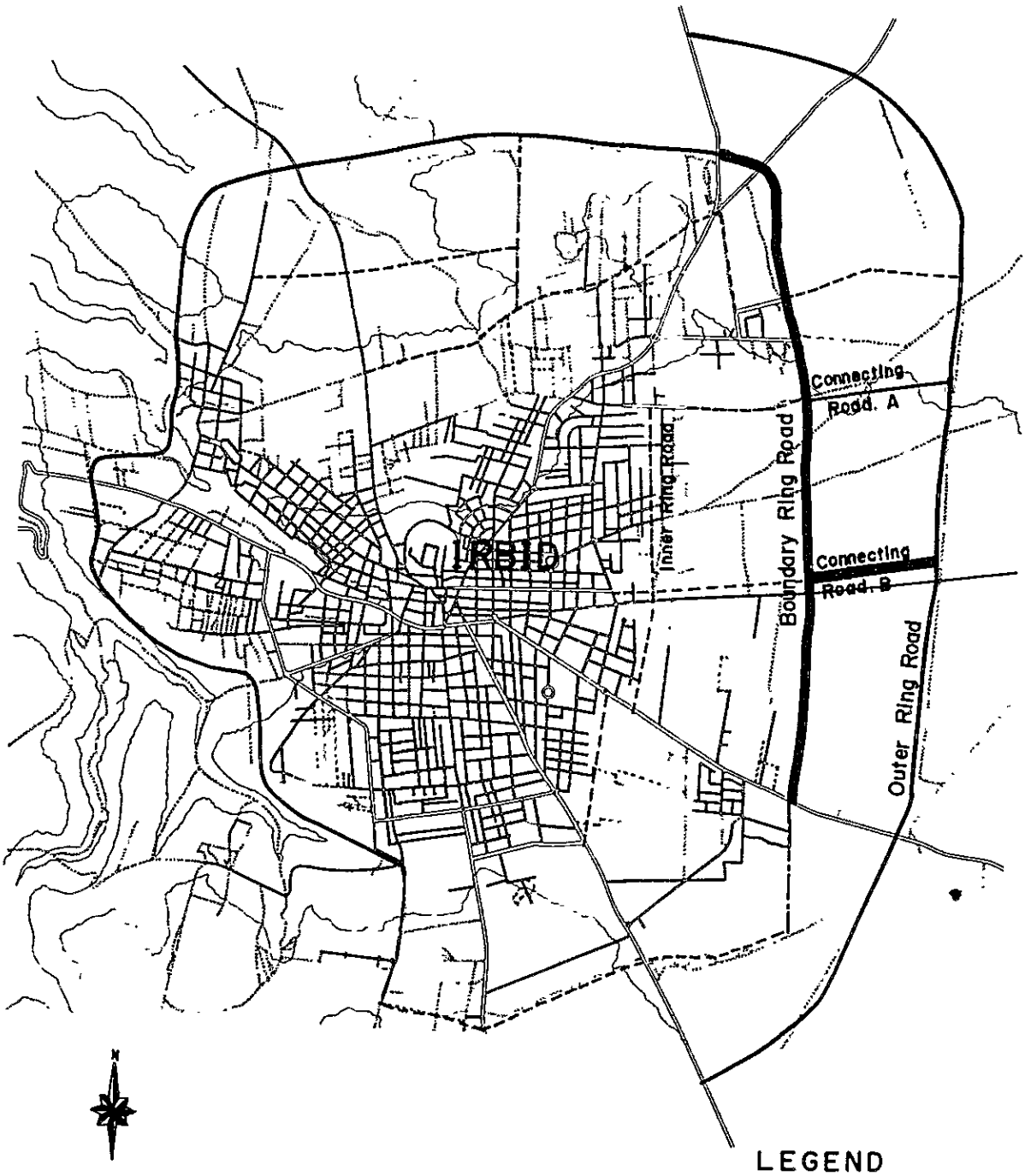
GENERAL MAP OF JORDAN



PROJECT LOCATION MAP



LEGEND

- 4-Lane 2-Way road
- 2-Lane 2-Way road
- Roads planned by the City
- Ideal Routes

Scale
S = 1:40,000

0 1.0 2.0 Km

PROJECT LOCATION MAP

Table of Contents

Summmary and Recommendations

SUMMARY AND RECOMMENDATIONS

1. Necessity and Significance of the Project

At the present time, Irbid is the largest city in northern Jordan. It is not only the administrative centre of the Irbid Governorate, but also serves as the major centre for diversified economic activities and education.

In Irbid, the most serious traffic problems involve the road network since all the main roads form a radial pattern converging at the city center. Hence intra-city traffic, inter-regional traffic and through traffic all mix together and create congestion. During the next 20 years, the population of Irbid Expanded is expected to increase almost 2.3 times, while total trip ends of cars and trucks are forecast to increase almost 3.2 times.This will put more pressure on the urban center of Irbid which is also the center of the road network. For these reasons and as part of the re-adjustment planning of the agricultural lands to be assigned as residential areas, the road network of the City of Irbid has been under study since 1970 by the Municipality of Irbid.

Consequently, the Ring Road project for the City of Irbid is part of a program of infrastructure improvement for the purpose of promoting development of various urban functions. The project includes construction of a Boundary Ring Road (BRR) and Outer Ring Road (ORR) with average radius of about 2.5 km and of about 3.5 km respectively from the urban center. The Ring Roads extend for a distance of about 24 km (including Connecting Roads of about 2 km) and connect to the existing radial Roads at the periphery of the City of Irbid. The Ring Roads will form the backbone for planning the future City of Irbid, and serve as an arterial street for intra-city and inter-regional traffic and as a by-pass for through traffic.

2. Background of the Project

In 1977, the Hashemite Kingdom of Jordan requested the Japanese Government to cooperate in planning integrated regional development of the northern region of the country centering around Irbid City. The Japanese Government, through Japan Inrernational Cooperation Agency

(JICA), dispatched missions to Jordan in 1978 and 1979, and an Integrated Regional Development plan was formulated which recommended three projects: namely, Irbid Industrial Estate, Irbid Ring Roads and Irbid Tourism Project. After performing preliminary feasibility studies of Irbid Industrial Estate and Irbid Ring Roads, this feasibility study of Irbid Ring Roads was started by JICA at the request of the Government of Jordan in order to achieve the following objectives:

i. To mitigate traffic congestion in the center of Irbid City by diverting traffic to ring roads.

ii. To contribute to the development of less-developed areas by providing more efficient traffic facilities.

iii. To prevent disorderly sprawling growth of the urbanized areas by planning the framework for appropriate land use.

3. Existing Road Network

According to the Municipality of Irbid, the total length of roads in the municipality was approximately 130 km as of March 1981, and about 15% of the total road network is unpaved gravel road. Most arterial roads in the City which are part of the national road network are radial roads passing through the centre of Irbid.

These national roads are Route 11 and Route 16 (primary roads) and Route 23 (secondary road).

Hashimi Street is Irbid City's broadest street and passes through the centre of the City dividing the City into northern and southern parts.

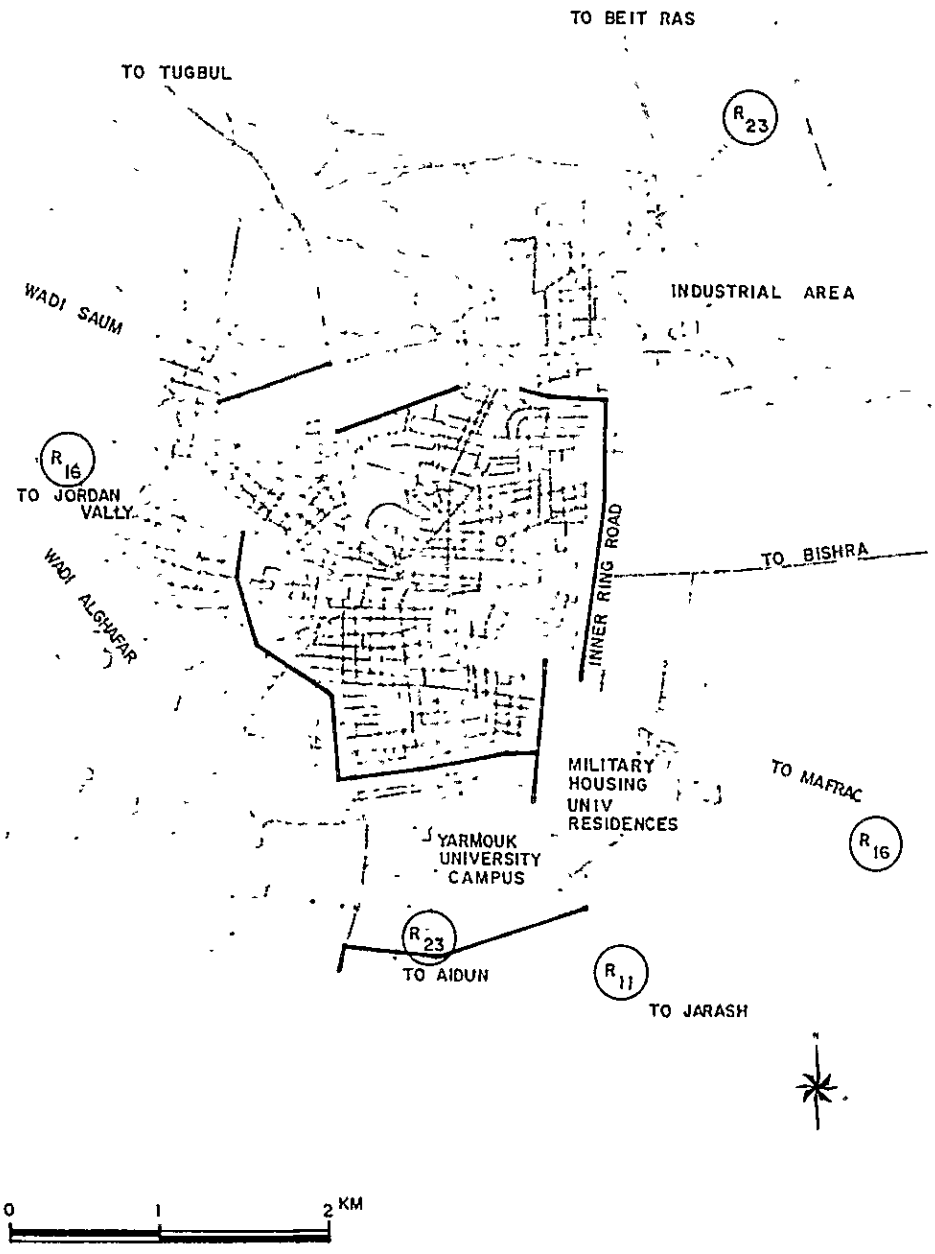
Other radial roads are Bishra Road, 6 m in width and running parallel to the east and about 50 m south of Hashimi Street, and a road in the northwest running towards Tugbul. All main roads have a right-of-way width of about 20 - 30 m., and their intersections are rotary system type, especially the main intersections.

The Inner Ring Road, located at about 1.0 to 1.5 km from the City centre, has a total length of about 8 kms, of which 4.3 km of the southwest and southern sections is open to traffic; the 2.5 km eastern section is now under construction. However, this eastern section,

planned by the Municipality, does not smoothly link up at the intersection of Route 16 to Mafraq. At present, the Inner Ring Road is not joined at its northwest section, and construction has been stopped, due to an established residential area.

Two small parts of the Boundary Ring Road (500 m in the southern part and 200 m crossing Wadi Saum in the eastern part) are now under construction.

ROAD NETWORK IRBID, 1980



4. Scoio-Economic & Land-Use Plan

As one of the bases for planning the road network for Irbid City, a land use plan for the growth of Irbid City and its surrounding areas (called Irbid Expanded) was developed. The land use plan took into consideration the topographic situation of Irbid City (which is physically limited in the west and southwest by steep wadis), the land use regulation plan and development plans of the City, and urban planning concepts.

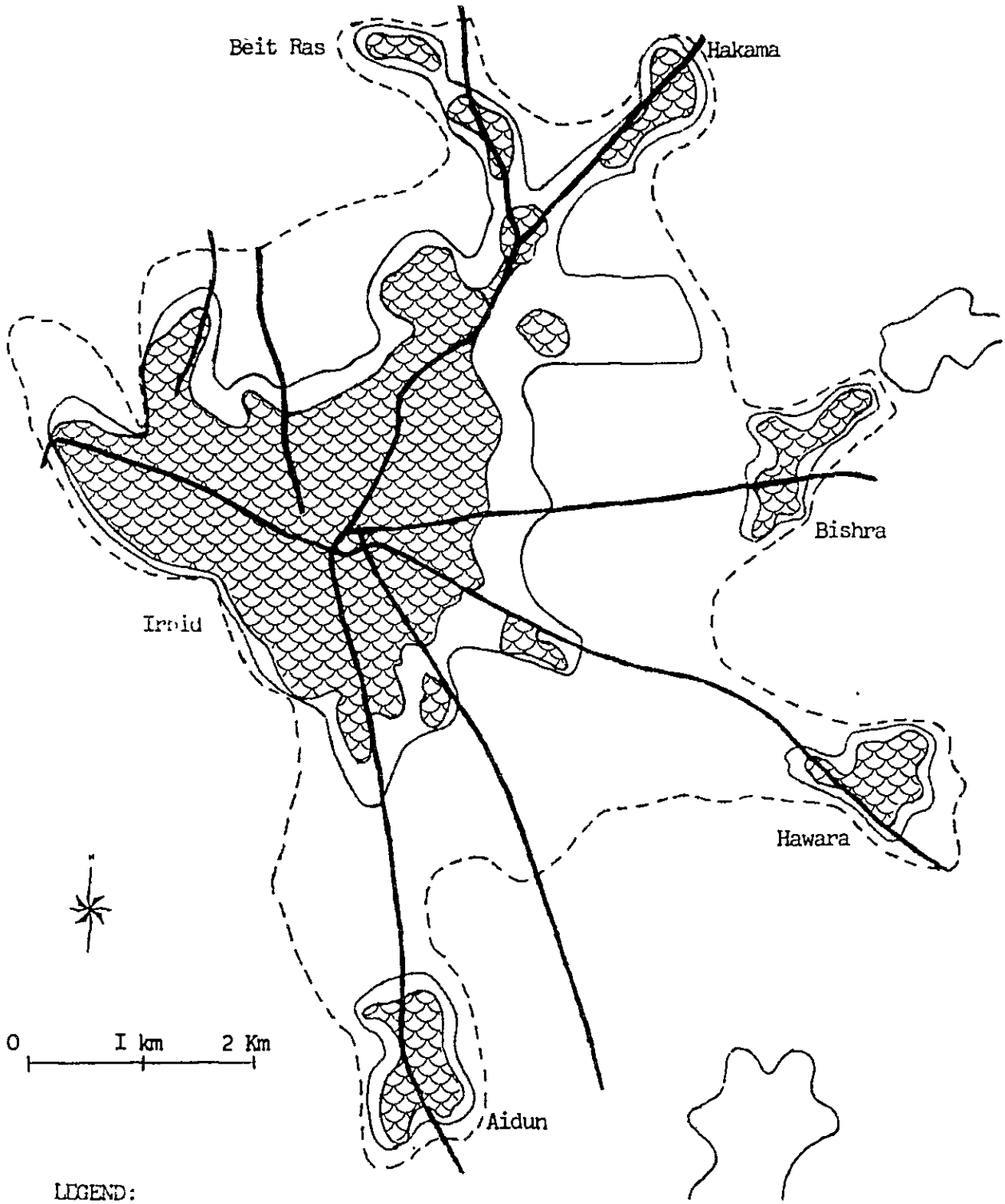
The frame of future land use in Irbid expanded is summarized by the Table below and by the following Figure which outlines the Growth of the Urban Area. In total, the plan for the year 2000 recommends tripling the used land area to accommodate and redistribute the 2.3-fold increase in population.

Estimated Frame of Future Land-Use in Irbid Expanded

	1980	1985	2000
Population (1,000 persons)	139	173	322
Population in Residential Area (1,000 persons)	111	138	258
Employed Population (1,000 persons)	27.8 (20%)	38.9 (22.5%)	96.6 (30%)
Sector 11 Population (1,000 persons)	4.2 (15%)	7.0 (18%)	24.2 (25%)
Residential Area (ha) Gross Density	967 (115 persons/ha)	1,247 (111 persons/ha)	2,576 (100 persons/ha)
Commercial & Business Area (ha) gross	139 (10 m^2/person)	190 (11 m^2/person)	419 (13 m^2/person)
Industrial area (ha) Gross Density of workers	42 (100 persons/ha)	73 (96 persons/ha)	284 (85 persons/ha)
Large-scale Green (ha) Gross Area Required	69 (5.0 m^2 person)	111 (6.4 m^2/person)	354 (11 m^2/person)
Urban Area (ha) Density (person/ha)	1,217 114	1,654 106	3,637 89

Ref. Table 3-14.

FUTURE URBAN AREA IN IRBID EXPANDED



The recommendations of the land-use plan are outlined below and shown in the following Figure.

Most of the area inside the Inner Ring Road excluding central commercial and business area should be assigned as a mixed area of linear commercial area and residential area.

In Irbid City, the wind blows from the west all through the year, so it is quite reasonable to locate the industrial area at the northeast fringe of the city. Inside the area, a manufacturing distribution center is recommended to be located.

If the industrial area is concentrated in one place, traffic also will be concentrated, so a simple service industry is better located in the existing sub-station area and along Fouara Street.

The existing central market place is very suitable for an agricultural distribution centre, since it is located along the Inner Ring Road, which connects Palestine Road and Baghdad Road.

A large scale green area (Recreation Area) should be located in the northern and eastern boundary areas. The value of recreation areas will be increased as urbanization proceeds and as the standard of living level rises. The hill area of the city centre should be developed as a green park.

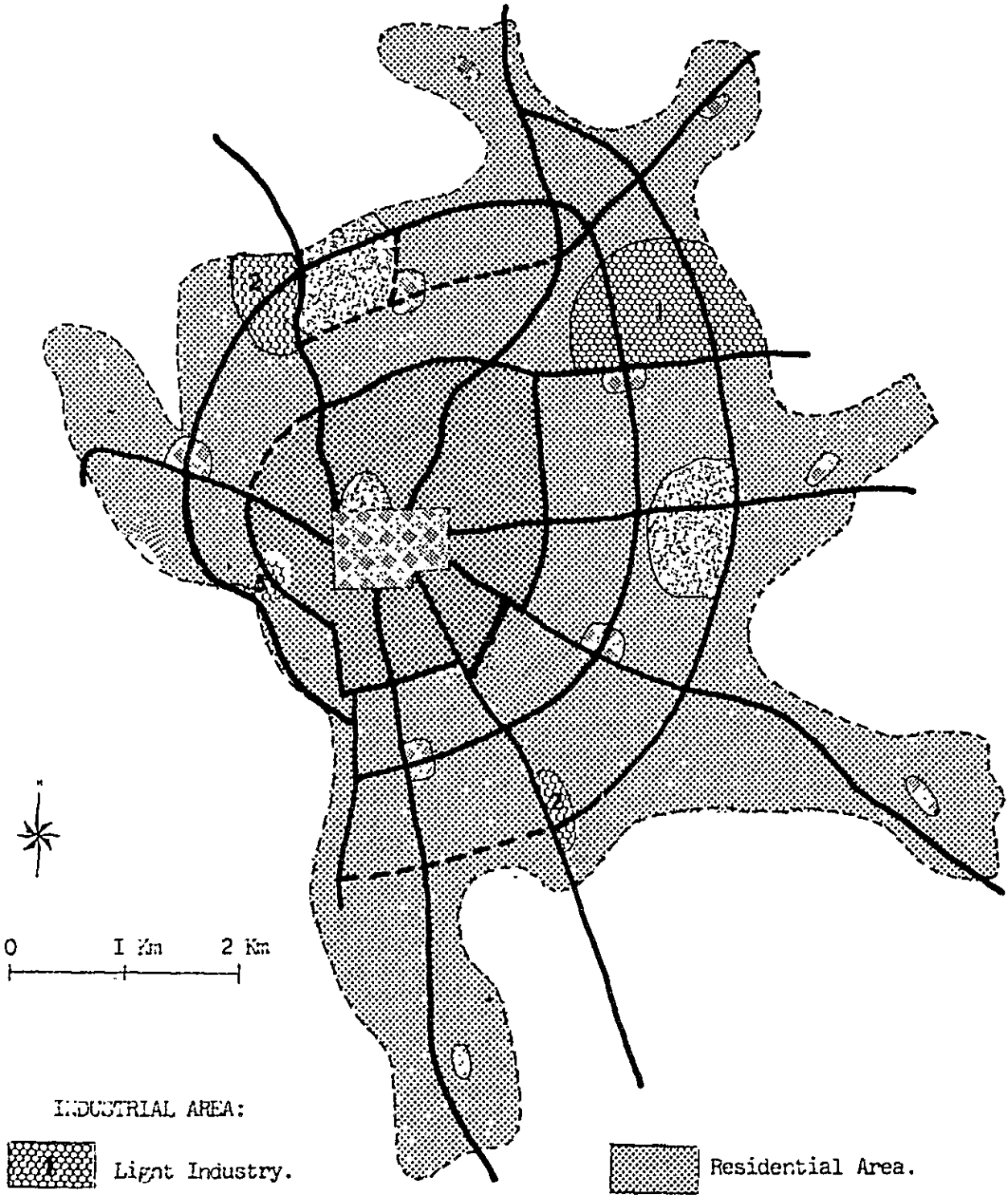
The centers of Residential Areas (commercial areas) should be arranged along the Boundary Ring Road. It is very important to promote district centers in Irbid City, since they are very effective in preventing the concentration of the traffic flow to the city centre.

Since the size of an ideal neighbourhood is approximately 1 km x 1 km, it is desirable to arrange the Boundary Ring Road and Outer Ring Road at 1 km intervals from the Inner Ring Road.

It is very important to improve the Inner Ring Road as a smooth circle, in order to solve the present congestion of traffic in the city centre. After the Inner Ring Road is improved in a smooth circle, it is necessary to prohibit through traffic inside the Inner Ring Road.

After the population of Irbid Expanded exceeds 250,000, a subcentre should be developed and Irbid Expanded should be upgraded to a multi-core city. The desirable position of the sub-center is on Baghdad Street, approximately 6 km from the existing urban centre.

LAND USE PLAN IN IRBID EXPANDED (in 2000)



INDUSTRIAL AREA:

- Light Industry.
- Service Industry.
- Distribution Center. for Sector 1
- Arterial Road.
- Residential Area.
- Commercial Area.
- Commercial and Residential Area.
- Industrial Area.
- Green Area.

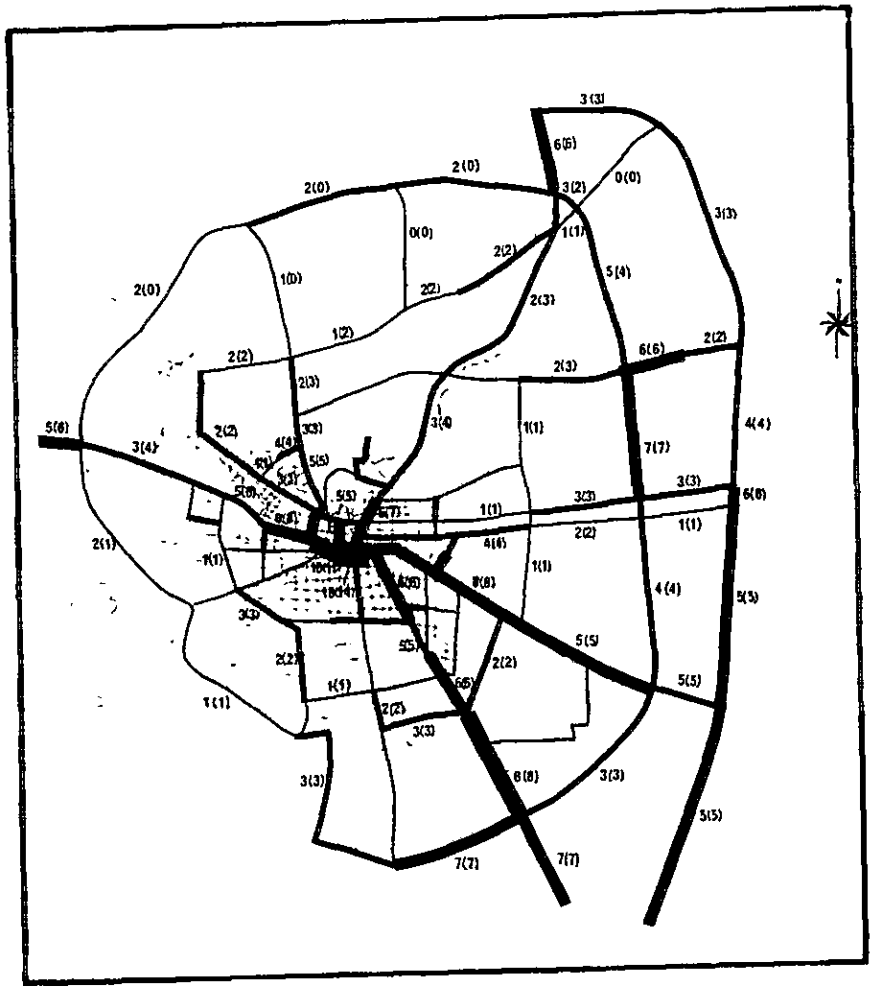
5. Surveyed and Forecast Traffic Situation

The existing traffic situation was determined by an Owner Interview Survey emphasizing traffic within the City Area and a Cordon Line Survey emphasizing traffic entering and leaving the City Area. Using this information together with data regarding the road network, socio-economic characteristics on population, vehicle ownership, etc., simulation of the traffic network by computer was used to assign and forecast attracted and generated trip volumes for the existing traffic situation as of 1981 and traffic in the project target years of 1985 and 2000. In all simulation, vehicles were classified into two types: "cars" (including passenger cars, vans & pick-ups, buses and taxis) and "trucks" (including medium-size trucks, heavy trucks and other vehicles).

The results which are shown in the Figure and Tables which follow are summarized below.

- The total daily number of trips is 48,634 in 1981. This is forecast to grow 1.3 times by 1985 to 64,331 or 3.2 times by the year 2000 to 154,935.
- The largest part of this traffic is inter-regional (53%) at present, but this is expected to decline (40% in the year 2000).
- The second largest part of the traffic is intra-city (39%) at present, and this is forecast to increase (51% in the year 2000).
- Through traffic presently accounts for 8% of the total and is expected to rise only slightly to 9% in the year 2000.
- The ratio of cars to trucks is 9:1 at present and almost the same in the year 2000.
- The distribution of traffic flows is relatively constant to/from all zones of the city as shown by desire lines.

RESULT OF TRAFFIC ASSIGNMENT (1985)



LEGEND :

1. RING ROAD TRAFFIC VOLUME (1000 VEHICLES / DAY) 7(6) ALTERNATIVE(2) ALTERNATIVE(1)

2. 10000 8000 5000 2000 (VEHICLES / DAY)

RESULT OF TRAFFIC ASI

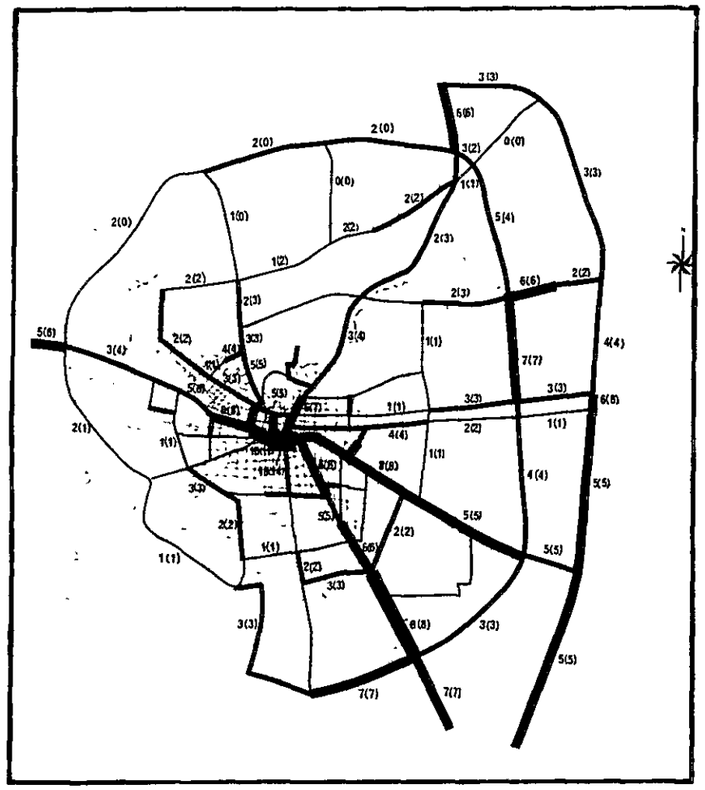
2

LEGEND :

1. RING ROAD TRAFFIC VOLUME (1000 VEH

2. 20 000 15 000 10 000 5 000 (VEHICLES / DA

RESULT OF TRAFFIC ASSIGNMENT (1985)



LEGEND ;

1. RING ROAD TRAFFIC VOLUME (1000 VEHICLES / DAY) 7(6) ALTERNATIVE(2) / ALTERNATIVE(1)

2. 10000 8000 5000 2000 (VEHICLES / DAY)

RESULT OF TRAFFIC ASSIGNMENT

2000 (WITH)

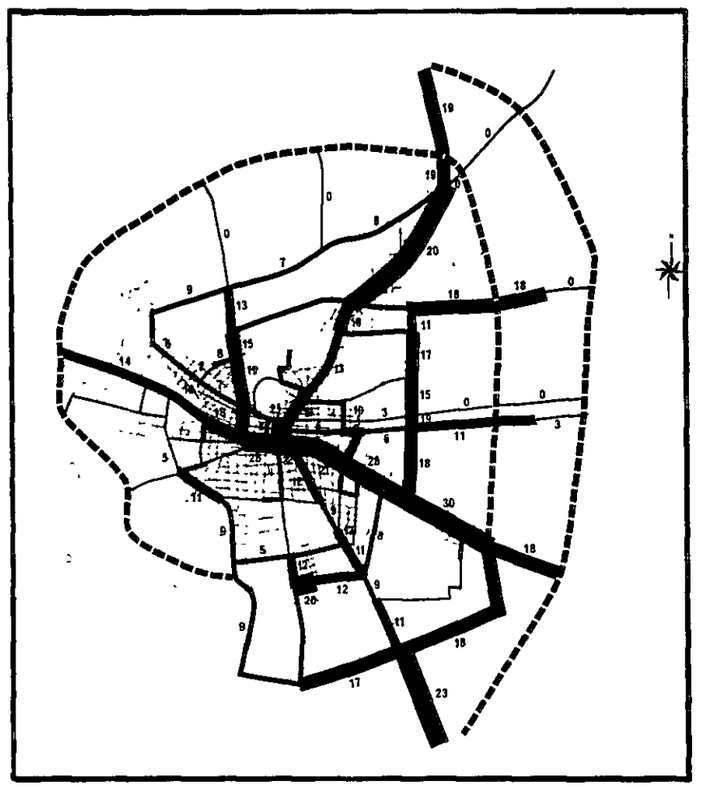
LEGEND ;

1. RING ROAD TRAFFIC VOLUME (1000 VEHICLES / DAY)

2. 20 000 15 000 10 000 5 000 (VEHICLES / DAY)

RESULT OF TRAFFIC ASSIGNMENT

2000 (WITHOUT)

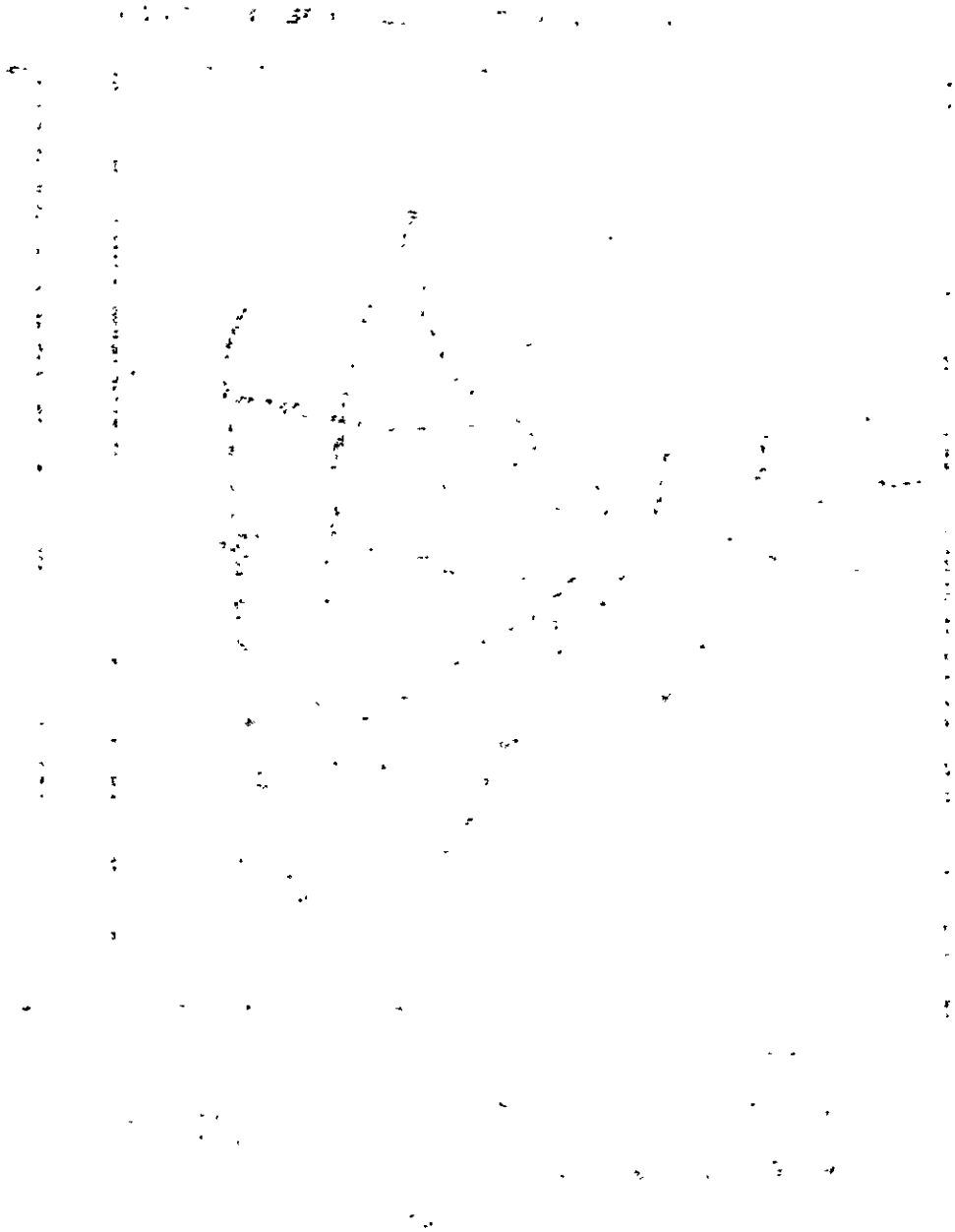


LEGEND ;

1. RING ROAD TRAFFIC VOLUME (1000 VEHICLES / DAY)

2. 20 000 15 000 10 000 5 000 (VEHICLES / DAY)

3. PROPOSED RING ROAD



Surveyed and Forecasted Daily Traffic Volume and Composition
Vehicle (1981, 1985, 2000)

(Unit: % trips/day)

		Intra-city	Inter-regional	Through traffic	Total
1981	Car	37.6	45.9	6.2	89.2
	Truck	1.5	6.8	2.1	10.4
	Total	39.1	52.7	8.3	100.0
1985	Car	44.0	37.0	8.7	89.6
	Truck	2.8	5.2	2.4	10.4
	Total	46.8	42.2	11.1	100.0
2000	Car	48.0	36.1	7.5	91.6
	Truck	2.9	4.1	1.4	8.4
	Total	50.9	40.2	8.9	100.0

Growth Index of Daily Traffic Volume

(Base Year 1981 = 1.0)

		Intra-city	Inter-regional	Through traffic	Total
1985	Car	1.5	1.1	1.9	1.3
	Truck	2.5	1.0	1.5	1.3
	Total	1.6	1.1	1.8	1.3
2000	Car	4.1	2.5	3.9	3.3
	Truck	6.3	1.9	2.2	2.6
	Total	4.2	2.4	3.4	3.2

6. Preliminary Design of the Project Roads

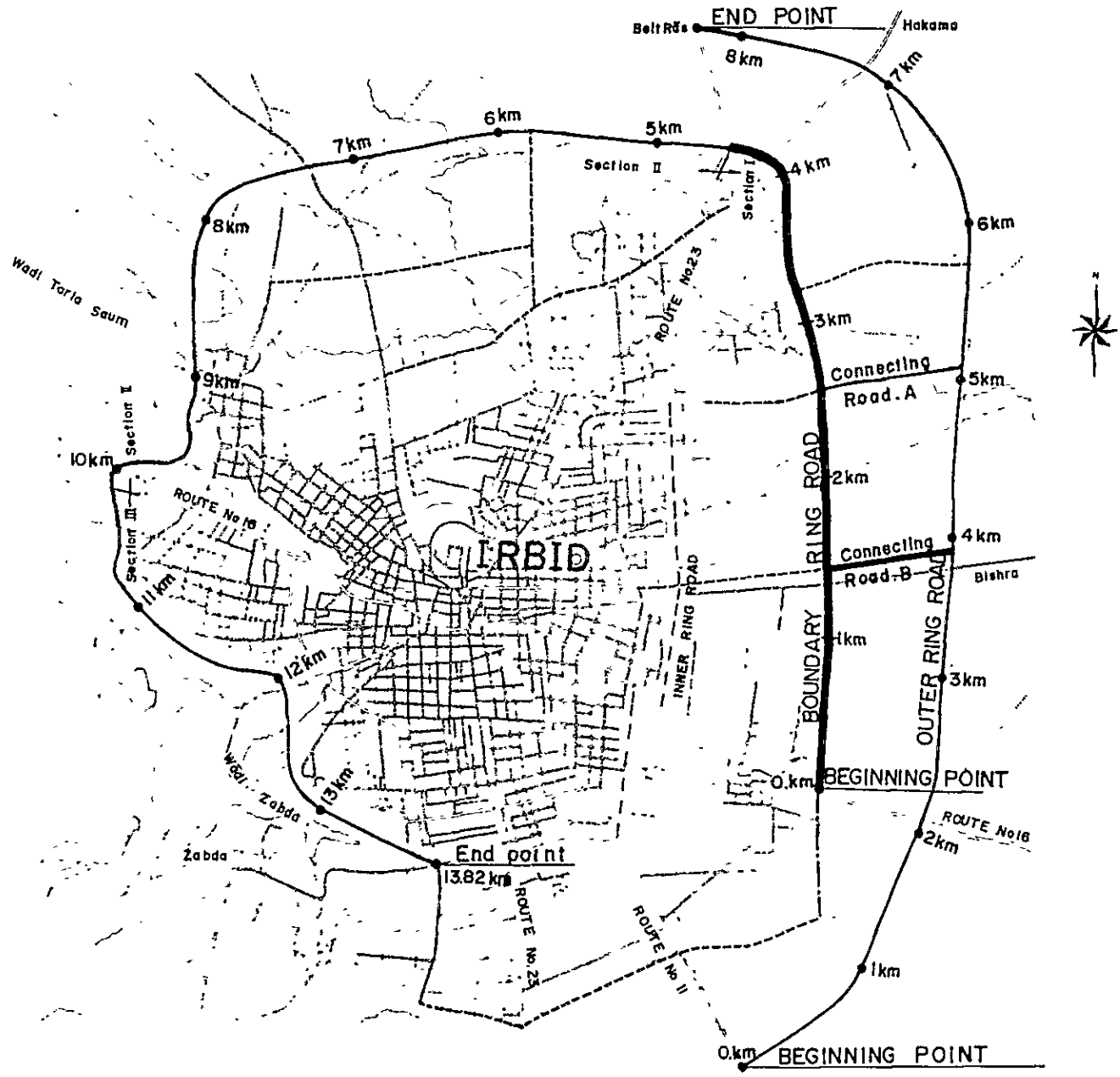
The routing of the Boundary Ring Road (BRR) is based on the plan by the Irbid Municipality for the Adustment of Land for Redidential Use. Separated by a distance of about 1 km, the Outer Ring Road (ORR) runs almost parrallel to Section 1 of the BRR around the eastern outskirts of the city. Connecting Road-A (CR-A) has been planned to extend a road now proposed by the City Municipality and Connecting Road-B (CR-B) has been planned to extend a road now under construction. CR-A is close to an industrial area and CR-B runs closely parallel to Bishra Street. The total length of the route is approximately 24 km with breakdown of Sections as follows:

Route Section	Length (km (%))		Construction Area (m^2)		Over-lay Area (m^2)	
BRR - Section 1	4.4	(18.4)	66,000		45,980	
Section 2	5.78	(24.1)	115,600	(21.7)	76,300	(21.4)
Section 3	3.64	(15.2)	72,800	(13.7)	48,800	(13.5)
(Subtotal BRR)	(13.82)	(57.7)	(320,400)	(60.3)	(216,260)	(20.7)
Outer Ring Road	8.34	(34.8)	166,800	(31.4)	110,000	(30.9)
Connecting Road-A	0.95	(4.0)	19,000	(3.6)	12,500	(3.5)
Connecting Road-B	0.85	(3.5)	25,500	(4.8)	17,800	(5.0)
Total	23.96	(100.0)	531,700	(100.0)	356,560	(100.0)

The features and location of the Sections of the BRR are as follows:

BRR Section	Starting Point (distance from BP)	Ending Point (distance from BP)	Topography	Land-Use
1	Baghdad St. (0.0)	Beit Ras St. (4.4)	Flat	Agriculture
2	Beit Ras St. (4.4)	Palestine St. (10.18)	Hilly/Rolling	Agri., olive orchards, residential
3	Palestine St. (10.18)	Bab Al-Wadd St. (13.82)	Mountainous Wadi Slopes	Scattered houses

LOCATION OF THE PROJECT ROADS



LEGEND

- 4 – Lane 2 – Way road
- 2 - Lane 2 – Way road
- Roads Planned by the City
- Ideal Routes

Scale
S = 1: 40,000
0 10 20

Based on the most appropriate routes, a detailed horizontal alignment study was made. A general description of the route of each road segment is outlined below:

BRR Alignment

The BRR begins from Route No. 16. The alignment for the BRR was designed taking into account control points such as the community and terrain etc..

From the Beginning Point up to the 7 km point, the route alignment traces the route of the Irbid City Road. For the rest of the extension, because of the mountanious terrain, the alignment was determined to minimize earth works.

Four at-grade intersections with signals are planned at the junctions with existing roads. Five culverts are also planned: 4 to cross the valley, and 1 for an existing road.

ORR Alignment

The route for the ORR was determined so as to run parallel with the BRR. In the main, this route traces the route of the City Road planned by Irbid.

Two at-grade intersections with signals are to be provided.

Basic requirements controlling the engineering aspects of the vertical alignment study were as follows:

- In the Flat and Rolling area, the finished level of the roadway will be maintained 0.2 - 0.6 m above the natural ground as far as possible taking into consideration the land-use after development
- A minimum gradient of 0.3% will be adopted for roadway surface drainage
- Flatter vertical gradients and a larger length of vertical curve will be adopted near the intersections as much as possible
- In the mountainous area, vertical alignment was determined to minimize earth works
- The minimum vertical clearance for grade separation structures will be minimum 5.0 m.
- A combination of horizontal and vertical alignments will be considered

- A maximum gradient of 6.0% will be adopted in consideration of heavy trucks

In addition to the basic requirements mentioned above, the following primary control points for BRR and ORR were considered for the determination of vertical alignment.

- Seven at-grade intersections to be provided as listed below:

  Signals for traffic control shall be set up at all intersections except No. 3 where the volume of traffic does not justify signalization.

No.	Intersection with BRR
1	Baghdad St. (Rt-16)
2	Bishra St.
3	Hakama St.
4	Beit Ras St. (Rt-23)
5	Palestine St. (RT-16)
	Intersection with ORR
6	Jarash St. (Rt. 11)
7	Baghdad St. (Rt. 16)

- Grade-separation structures to be provided at:

  Sta. 8 + 820 (Existing road south of Factory)

- Four Wadis to be considered at:

  Sta. 7 + 700
  Sta. 8 + 830
  Sta. 9 + 480
  Sta.12 + 120

Preliminary engineering study was carried out to develop roadway designs that would permit estimates of principal quantities for construction with an accuracy of ±20% of the final quantities. The recommended design criteria for the Ring Roads are listed in the Table below:

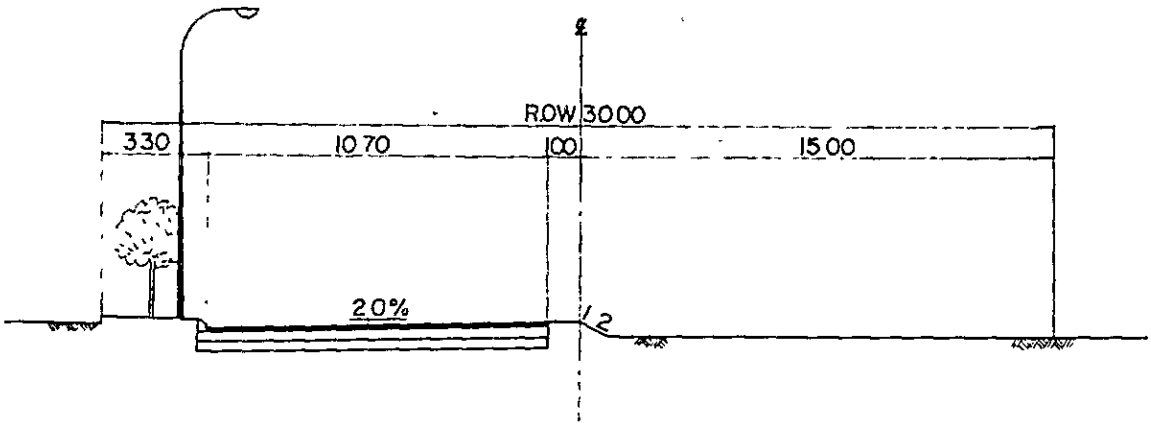
Design Element	Unit	BRR-Sec.1 (B.P∿4.3 km)	BRR-Sec.2 (4.3∿7.2 km)	BRR-Sec.2 (7.2∿10.2 km)	BRR-Sec.3 (10.2∿E.P)	ORR CR-A	ORR CR-B
Design Speed	km/h	80	80	80	60	80	80
R.O.W.	m	30	30	20 (MIN)	20 (MIN)	30	30
Lene Width	m	3.6	3.6	3.6	3.6	3.6	3.6
Lane Number	lane	4	2	2	2	2	4
Mediam Width	m	2.5	0	0	0	0	2.5
Shoulder Width (Left)	m	0.5	3.0	3.0	3.0	3.0	0.5
(Right)	m	3.0	3.0	3.0	3.0	3.0	3.0
Sidewalk	m	3.3	3.4	3.4	0	3.4	3.3

Based on the above design criteria, typical cross sections for the Ring Roads were drawn as shown in the following Figures.

TYPICAL CROSS SECTION OF RING ROAD IN IRBID CITY

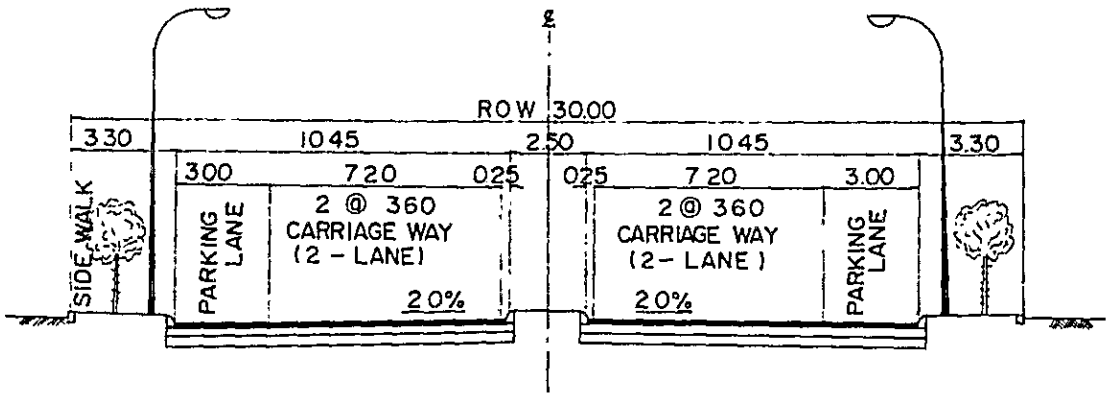
BOUNDARY RING ROAD SECTION I
(BAGHDAD STREET TO BEIT RAS STREET)

STAGE - I



BOUNDARY RING ROAD SECTION I
STAGE - 2 AND

CONNECTING ROAD - B



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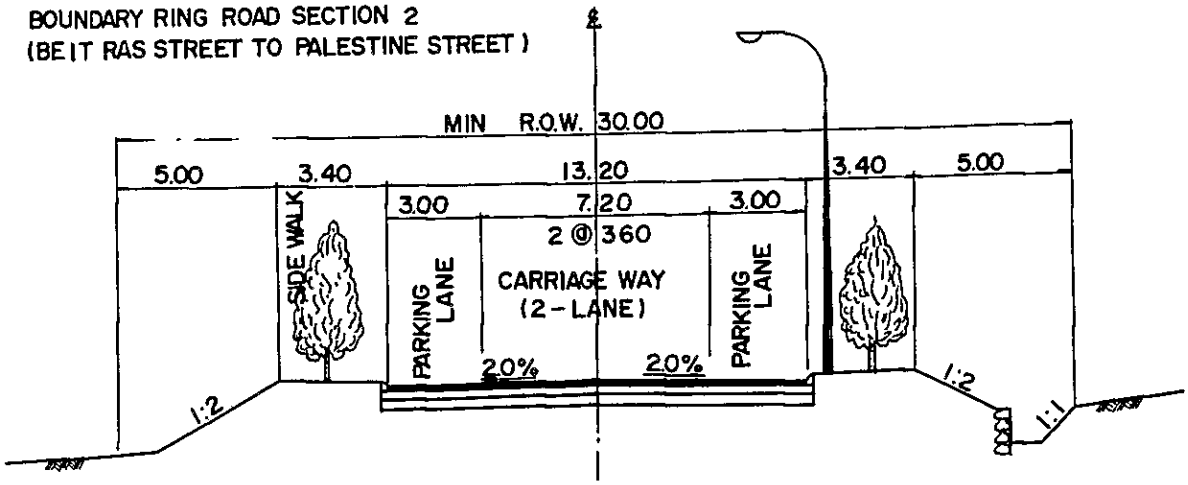
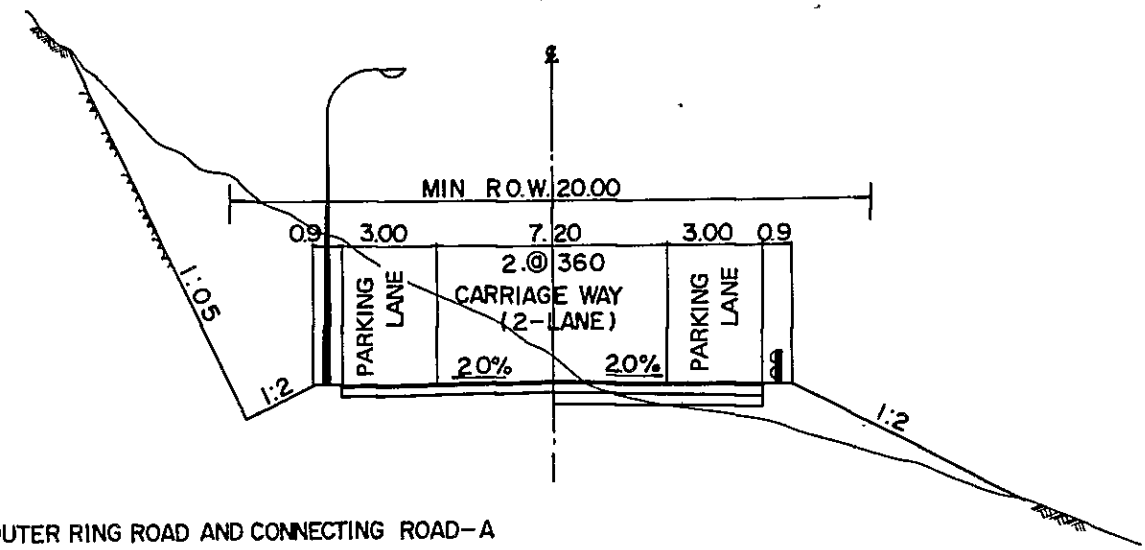
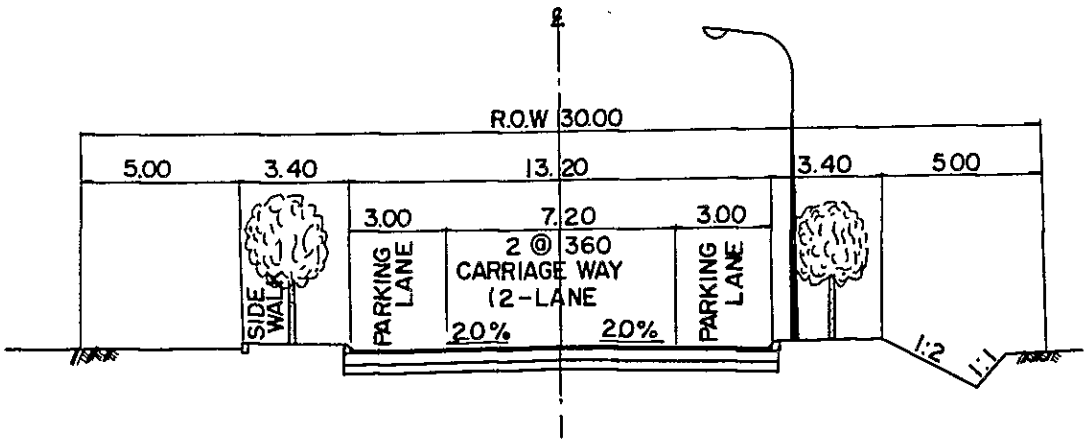
BOUNDARY RING ROAD SECTION 2
(BEIT RAS STREET TO PALESTINE STREET)



BOUNDARY RING ROAD SECTION 3
(PALESTINE STREET TO BAB AL-WADD STREET)



OUTER RING ROAD AND CONNECTING ROAD-A



7. Staged Construction

Since the construction of the Ring Roads requires a large investment and in order to obtain maximum economic benefits a staging of construction is adopted. The eastern part of the Boundary Ring Road (Section 1) and Outer Ring Road have priority to be constructed in an early stage taking into consideration the large traffic demand due to planned the industrial estate, truck terminal and housing project in the eastern part of Irbid City.

On the other hand, in order to mitigate the traffic congestion on Route 16 in the center of Irbid City, the construction of the northern part of the BRR (Section 2) and the southern part (Section 3) is necessary, although Section 3 is the more important of the two.

Consequently, two alternative construction completion schedules were proposed for BRR Section 2 as follows:

Alternative I - BRR Section 2 in 1985
Alternative II - BRR Section 2 in 1990

For all other sections of the ring roads, only one construction completion schedule is proposed; namely:

1985 - BRR Section 1 (Stage 1 : Two lanes)
BRR Section 3 (Two lanes)
Outer Ring Road (Two lanes)
Connecting Road - A (Two lanes)
Connecting Road - B (Four lanes)

1995 - BRR Section 1 (Stage 2: widening to four lanes)

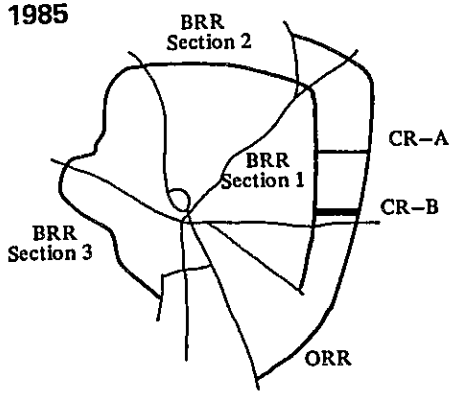
2 lane

4 lane

STAGED CONSTRUCTION

Alternative I

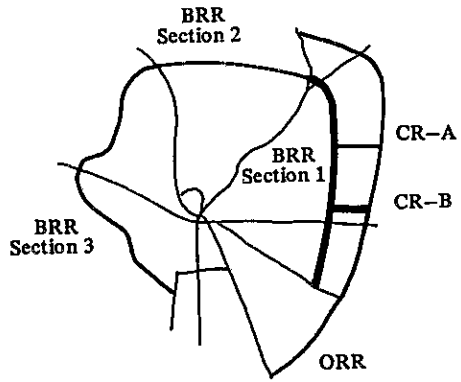
1985



1990

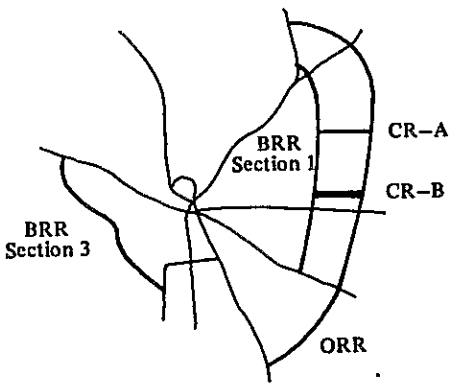
Same as 1985

1995

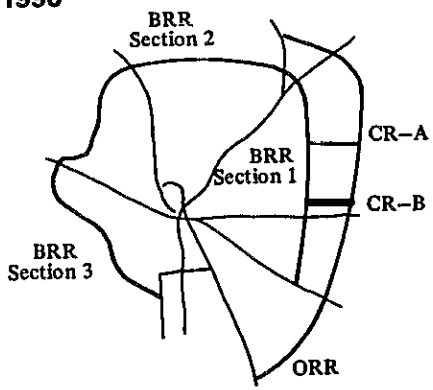


Alternative II

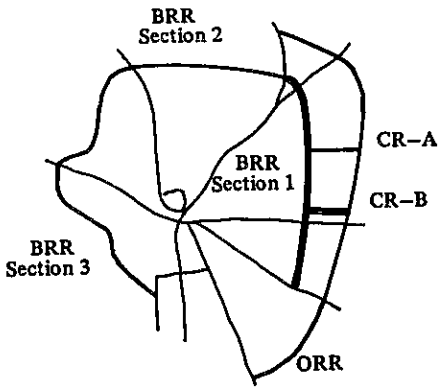
1985



1990



1995



8. Project Costs

The unit price of each work item was obtained by accumulating the labour cost, equipment cost, material cost, in Sept. 1981 in Northern Jordan, and informed opinions on various specific items secured in interviews with individual Ministry of Public Works' engineers and local contractors. The results were checked against recent actual figures for the construction work in Jordan.

Although the design of the pavement is for a target of 20 years, to prevent excessive thickness and to reduce initial investment cost, construction will be staged so that the initial thickness meets traffic requirements of the first 10 years. Subsequently, it will be overlaid to meet future requirements.

In order to estimate the actual economic cost of the project to the Jordan, duties were deducted from the estimated financial costs and the results were used in the benefit cost analysis.

Total project cost in financial and economic terms for the major expense categories of construction, land acquisition, compensation, contingencies and engineering supervision and also project costs for each road segment are listed in tables which follow.

Total Project Cost by Major Expense Category

(Unit : JD (%))

	Financial Cost			Economic Cost	
	Total		L.C	F.C	
Total Construction Cost	4,338,666	(57.4)	2,028,549	2,310,117	3,886,617 (56.9)
Land Acquisition	1,598,300	(21.1)	1,598,300	-	1,470,436 (21.5)
Compensation	544,500	(7.2)	410,700	133,800	599,940 (7.3)
Contingencies	648,147	(8.6)	403,755	244,392	585,999 (8.6)
Engineering Supervisor	433,867	(5.7)	202,855	231,012	388,862 (5.7)
Total Project Amount	7,563,489	(100.0)	4,644,159	2,919,321	6,834,854 (100.0)

Note: L.C : Local Currency F.C : Foreign Currency

1 JD ≒ 2,941 US$

Total Project Cost by Route Section
(Financial Basis)

(Unit : JD (%))

Route Section	Total Construction Cost			
	Total		L.C	F.C
BRR-Section 1 (Stage-1)	790,602	(10.5)	511,649	278,953
Section 1 (Stage-2)	690,517	(9.1)	466,173	224,344
Section 2	1,915,764	(25.3)	1,146,283	769,481
Section 3	1,742,144	(23.1)	1,160,909	581,235
(Subtotal BRR)	(5,139,027)	(68.0)	(3,285,014)	(1,854,013)
Outer Ring Road	1,507,963	(19.9)	905,394	602,569
Connecting Road-A	124,097	(1.6)	62,894	61,203
Connecting Road-B	233,943	(3.1)	158,642	75,301
Asphalt-Concrete Over-lay	558,454	(7.4)	232,214	326,240
Total	7,563,480	(100.0)	4,644,158	2,919,321

Note: L.C : Local Currency
F.C : Foreign Currency
1 JD ≒ 2,941 US$

Ref. Tables 9.6 ∿ 9.14

9. Project Benefits

When the ring roads are completed ("with project"), vehicles will be able to travel faster, and therefore, vehicle operating costs and travel time will decrease, in comparison with the do-nothing situation (i.e. "without project"). Project benefits were calculated from the cost savings, realized "with project". Quantified Project benefits were calculated for the two alternative cases of the ring roads project in terms of total vehicle movement (Vehicle-km and Vehicle-hrs), vehicle operating costs and time cost.

If the ring roads are constructed, vehicles which would otherwise pass through the center of the city will travel along the ring roads because vehicles can be driven faster. Therefore, vehicle-km in the "with project" case is more than the "without project" case in 1985 (except Alternative II where the Ring Road is not fully operational until 1990) and 2000.

On the other hand, vehicle operating costs in the "with project" case are less than the "without project" case because vehicles can be driven faster due to the decrease of congestion in the center of the city. Vehicle operating costs become higher as the speed goes down; however, since vehicles can be driven faster in the "with project" case compared

to the "without project" case, time cost is reduced by construction of the ring roads. As shown in the following table, operating costs saving are estimated at about JD 1,500 per day in 1985 and JD 4,000 per day in 2000.

In addition, time savings are estimated at about JD 500 per day in 1985 and JD 5,000 per day in 2000.

Since the ring roads will be constructed by the end of 1985, project benefits will be obtained starting from 1985. Assuming the project life to be 25 years, total undiscounted project benefits were estimated at about JD 62 million.

Net Vehicle Movements and Cost Savings 1/

	1985		2000
	Alternative I	Alternative II	
Vehicle-Km per day 2/	-3,498	36	-36,571
Vehicle-Hr per day 3/	4,419	4,158	45,085
Operating Costs Saving (JD per day)	1,464	1,457	4,029
Time Cost Saving (JD per day)	517	487	5,275

Ref. Table 5.19

Notes: 1/ Net total = "Without Project" minus "With Project"

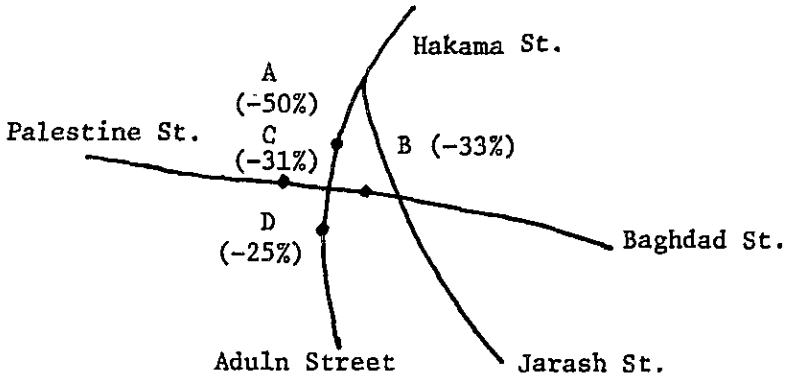
2/ Cars and trucks

3/ Cars only

In addition, because of the ring roads, traffic can easily be detoured away from the city center and the traffic congestion in the urban center will be reduced as shown in the Figure of Traffic Assignment Results. At the same time, the environment of the urban center will be improved with the reduction of noise and air pollution. It is forecast that as of the year 2000, the traffic volume of arterial roads in the

urban center will be reduced 25 - 50% with this project compared to "without project" as measured by the decrease in traffic volume around the cross point of Palestine St. and Baghdad St. as shown below. Thus it can be considered that the effect of the Ring Road will be very strongly-felt for the road network system in Irbid.

Effect of Project to Release Traffic Congestion as of the year 2000.



Ref. Table 10.1

Note: ( ) show decrease in traffic volume "with project"

Other Non-quantified Project Benefits include the following:

- For the area along the ring road which will be developed as a residential area, the ring roads will be important as the arterial roads inside the residential district. The Boundary and Outer Ring Roads will become the arterial road of approximately 780 ha and 430 ha of residential area, respectively. This is the largest benefit independent of growth in the volume of traffic.
- Since residential area will be established along the ring roads, the urban areas inside the inner city having a high population density will decrease.
- District Centers (commercial areas) developed beside intersections of the Boundary Ring Road and the existing radial arterial road will be very effective in preventing a concentration in the traffic flow to the urban centers.
- Access to the industrial area will become easier and the absolute value of the Industrial land will increase. The truck terminal, which is planned to be located along the Outer Ring Road inside the industrial area will function effectively with the ring road.

10. Project Evaluation

Economic cost and benefits of the project were discounted at the rate of 10 percent (the discount rate suggested by the Ministry of Public Works) for the two alternatives. The results presented in the Table below indicate that both alternatives are economically feasible since benefits are expected to be twice the amount of costs (Alternative I B/C = 2.23 and Alternative II B/C = 2.42) and since the Internal Rates of Return are almost twice the discount rate (Alternative I IRR = 18.1% and Alternative II IRR = 19.7). Although total project costs are about 6 percent less in the case of Alternative I, Alternative II was selected as being more recommendable in terms of return on investment.

Summary of Economic Analysis (Discounted at 10% using 1981 Prices)

(Unit: 1000 JD)

	Alternative I	Alternative II
Total Discounted Costs	4,977	4,563
Total Discounted Benefits	11,082	11,044
Net Present Value (B-C)	6,105	6,481
Cost-Benefit Ratio (B/C)	2.23	2.42
Internal Rate of Return (IRR)	18.1%	19.7%

A comparison was made of the Cost-Benefit Ratios, in Alternative II for each section of the ring roads as shown in the Table below in order to examine the importance of each section based on the estimated vehicle-km by section. The results reconfirm the recommendation to delay the construction of BRR Section 2 by 5 years in order to reduce costs since its B/C ratio is low. Although BRR Section 3 also has low B/C ratio, its construction is not delayed since its function to reduce through traffic in the road network is felt to be more significant.

Cost-Benefit Ratios by Section
(Discounted at 10% using 1981 prices, 1000 JD)

	Costs (1000 JD)	Benefits (1000 JD)	B/C
BRR Section 1 (including CR-A)	1,007	3,718	3.69
BRR Section 2	1,006	1,633	1.62
BRR Section 3	1,260	955	0.76
ORR (including CR-B)	1,290	4,738	3.67
Total	4,563	11,044	2.42

Other considerations which support the selection of Alternative II are as follows:

- Alternative I is a little more effective than alternative II from the viewpoint of reducing traffic congestion faster and improving the urban environment.
- On the other hand, in Alternative I, investment will be concentrated in one period, and accordingly, land prices will increase in one period. The negative impact of Alternative I will be larger than that of Alternative II.
- Furthermore, since the investment period of Alternative II is longer than that of Alternative I, it can be financed a little more easily.

11. Implementation Schedule

The implementation schedule for the recommended Alternative II is shown in the Table below. Some of the noteworthy schedule details are as follows:

- The detailed design including a review of the Feasibility Study will commence in the beginning of 1982 and, consequently, tender documents for construction are to be prepared.
- Modification of the land readjustment plan to match with the proposed Ring Roads should be urgently started.
- Land acquisition and compensation will commence in the beginning of 1982.
- When land acquisition and compensation are completed, the contract for construction can be approved and awarded.
- Mobilization for construction can begin after the contract has been awarded.
- Widening Boundary Ring Road Section 1 to four lanes should be completed by the end of 1995.
- Over-lay of asphalt surface should be performed after 10 years of road use.

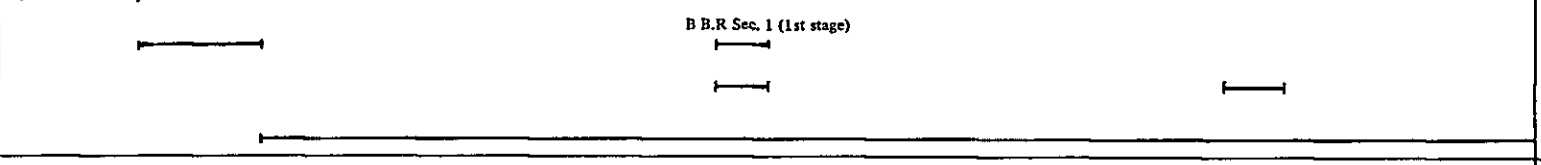
Executing Agency for Construction

The Municipality of Irbid is the agency responsible for the execution for road construction. The necessary land acquisition and compensation for the land and property within the proposed right-of-way should be undertaken prior to the start of construction by this agency.

Other concerned government agencies are the Ministry of Municipal, Rural and Environmental Affairs, the Ministry of Public Works and the Ministry of Finance.

The proposed project organization structure for execution of the Ring Roads is shown in the following Figure.

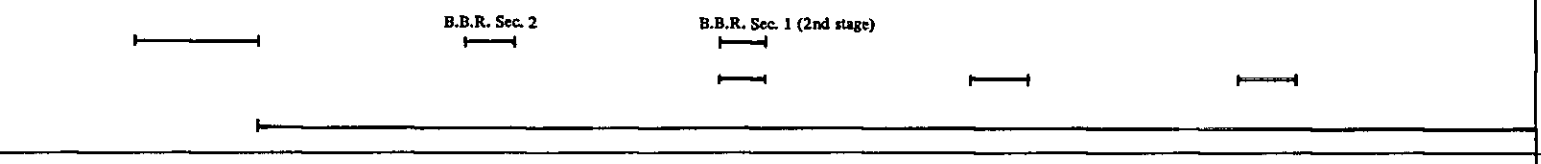
Implementation and Investment Schedule (Alternative I)



Item \ Year	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	1	2	3	4	5	6	7	8	9	10	Total
Detailed Design and Tender																														
Land Acquisition and Compensation																														
Construction																														
Over-lay of Asphalt Surface																														
Maintenance																														
Engineering, Supervision and Administration	85	85	92	91									35	40										6						454
Land Acquisition and Compensation	1,179	1,178																												2,357
Construction			1,940	1,940										380																4,260
Over-lay of Asphalt Surface														446										66						512
Maintenance					3.6	3.6	3.6	3.6	108.7	3.6	3.6	3.6	3 6	108.7	4.3	4.3	4.3	124.8	4.3	4.3	4.3	124.8	4 3	4.3	108.7	4.3	4 3	124.8	4.3	776 6
Total	1,264	1,263	2,032	2,031	3.6	3.6	3.6	3.6	108.7	3.6	3.6	3.6	38 6	974.7	4.3	4.3	4.3	124.8	4.3	4.3	4.3	124 8	4.3	76.3	108.7	4.3	4.3	124 8	4.3	8,339.6

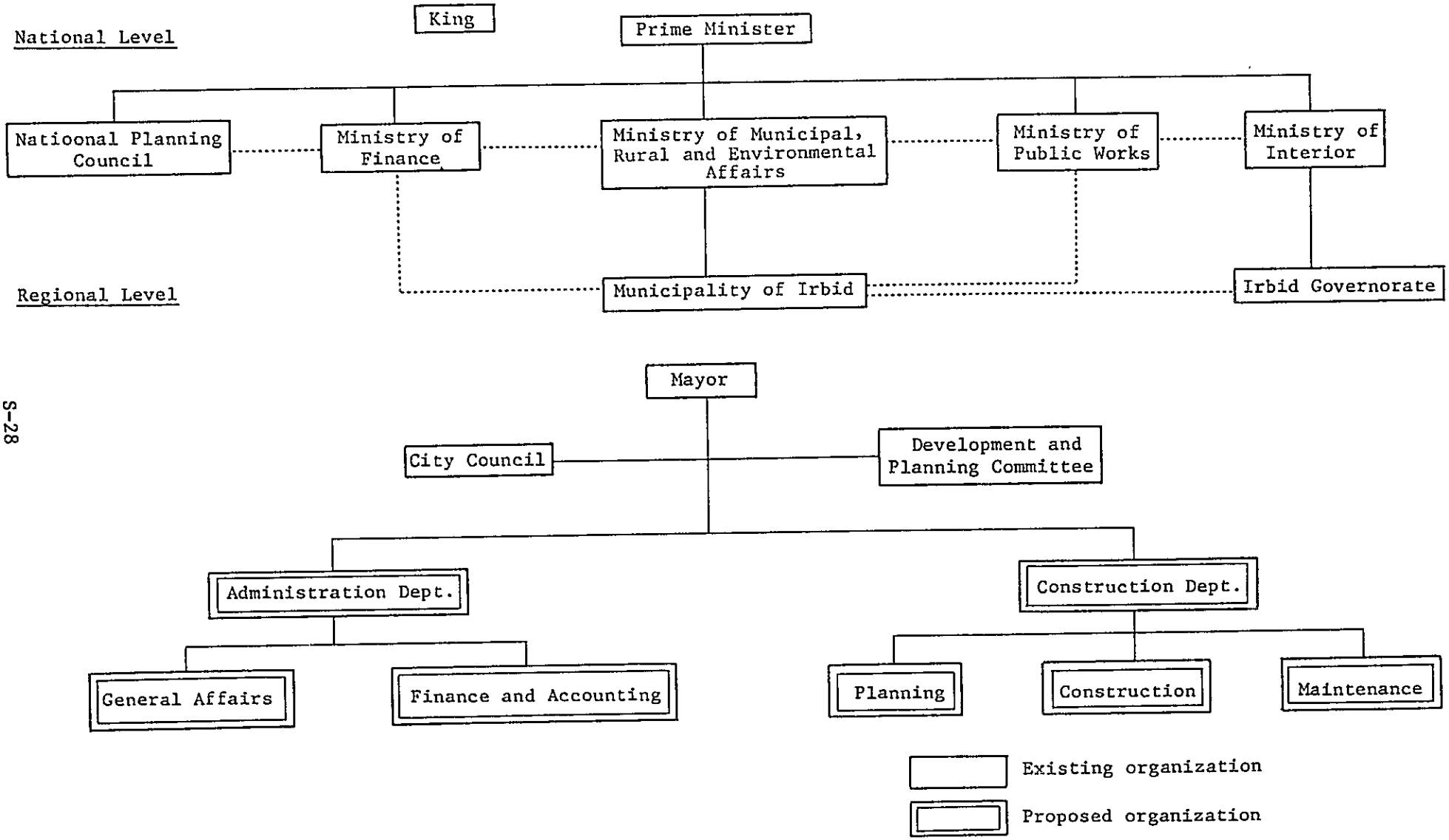
Implementation and Investment Schedule (Alternative II)

(Unit: 1,000 JD)



Item \ Year	1982	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	1	2	3	4	5	6	7	8	9	10	Total
Detailed Design and Tender																														
Land Acquisition and Compensation																														
Construction																														
Over-lay of Asphalt Surface																														
Maintenance																														
Engineering, Supervision and Administration	55	55	61	60				55	67				30	35					10					6						434
Land Acquisition and Compensation	1,179	1,178																												2,357
Construction			1,271	1,271					1,338					380																4,260
Over-lay of Asphalt Surface														337					109					66						512 .
Maintenance					2.7	2.7	2.7	2.7	82	3.6	3.6	3.6	3.6	108.7	4.3	4.3	4.3	108.7	4.3	4.3	4.3	124.8	4.3	4.3	108.7	4.3	4.3	124.8	4.3	730.2
Total	1,234	1,233	1,332	1,331	2.7	2.7	2.7	57.7	1,487	3.6	3 6	3.6	33.6	860.7	4.3	4.3	4.3	108.7	123.3	4.3	4.3	124.8	4.3	76 3	108.7	4.3	4.3	124.8	4.3	8,293.2

Organization Structure



12. Conclusion and Recommendations

In conclusion, the ring roads are very important for the urban function of Irbid City. Characteristics of soil at the site are acceptable and soil materials can be compacted with optimum water content by drying during road construction. There are no complicated structures. Technically, there are no problems.

Jordanian contractors should be able to execute the ring roads without any difficulty. Construction materials such as aggregates, cement, asphalt and steel bars are all locally available in acceptable quality and in sufficient quantities.

Of the two alternatives, Alternative II is more recommendable. The project is not very sensitive to cost increases since it was calculated that a 10 percent increase in costs only decrease IRR by about one percent. Even in the case where cost increases to 110% and the time saving benefit is excluded (ie, benefits are reduced about 58%), the project is still feasible since IRR is reduced to 12%.

Hence, the project is considered to be technically and economically feasible.

- The section of the Boundary Ring Road between its intersections with Bab Al-Wadd Street and Baghdad Street, and the roads from the urban center joining Connecting Roads A and B are not included in this project since they are planned to be constructed by Irbid Municipality. However, since the roads planned in this project will be completed by 1985, interfacing city roads should be completed before 1985.
- The design standard of a part of the Boundary Ring Road which Irbid Municipality will plan should be equal to that of the project Roads. Reference to the future traffic volume and vehicle composition in the Study should be made.

- The Ring Roads have a large effect on reducing the traffic volume in the center area of Irbid City. However, certain fundamental traffic related problems still remain, such as traffic safety, vehicle parking, pedestrian ways so on. Therefore, in order to solve the overall traffic problems, it will be necessary to make up a master transportation plan in Irbid. This master plan should include traffic control and regulation plan, intersections improvement plan, public transportation network plan, parking area plan etc.

- At the present time, a reajustment plan on most of the land for the proposed roads has been carried out by Irbid Municipality, accordingly, it is necessary to urgently modify the readjustment plan to match with the proposed Ring Roads.

- The budget for the construction of Ring Roads is insufficient. Consequently, strong financial support by the Government of Jordan and loans from foreign countries are needed and should be arranged as soon as the project is approved. It is necessary to establish appropriate organization in Irbid municipality for execution of the Ring Roads.