社会開発調査部報告書

TUNISIAN REPUBLIC

MINISTRY OF THE WORKS AND HOUSING

FEASIBILITY STUDY FOR THE CONSTRUCTION OF A FIXED CROSSING BETWEEN RADES AND LA GOULETTE

EXECUTIVE SUMMARY

JANUARY 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Republic of Tunisia, the Japanese Government decided to conduct a study on the Construction of the Rades-La Goulette Connecting Facility and entrusted the study to the Japan International Cooperation Agency (JICA)

JICA sent to Tunisia a study team headed by Mr. Takeshi Nakayama, and composed of members from the Pacific Consultants International and Nippon Koei Co., Ltd., two times between August 1989 and December 1990.

The team held discussions with the concerned officials of the Government of the Republic of Tunisia, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

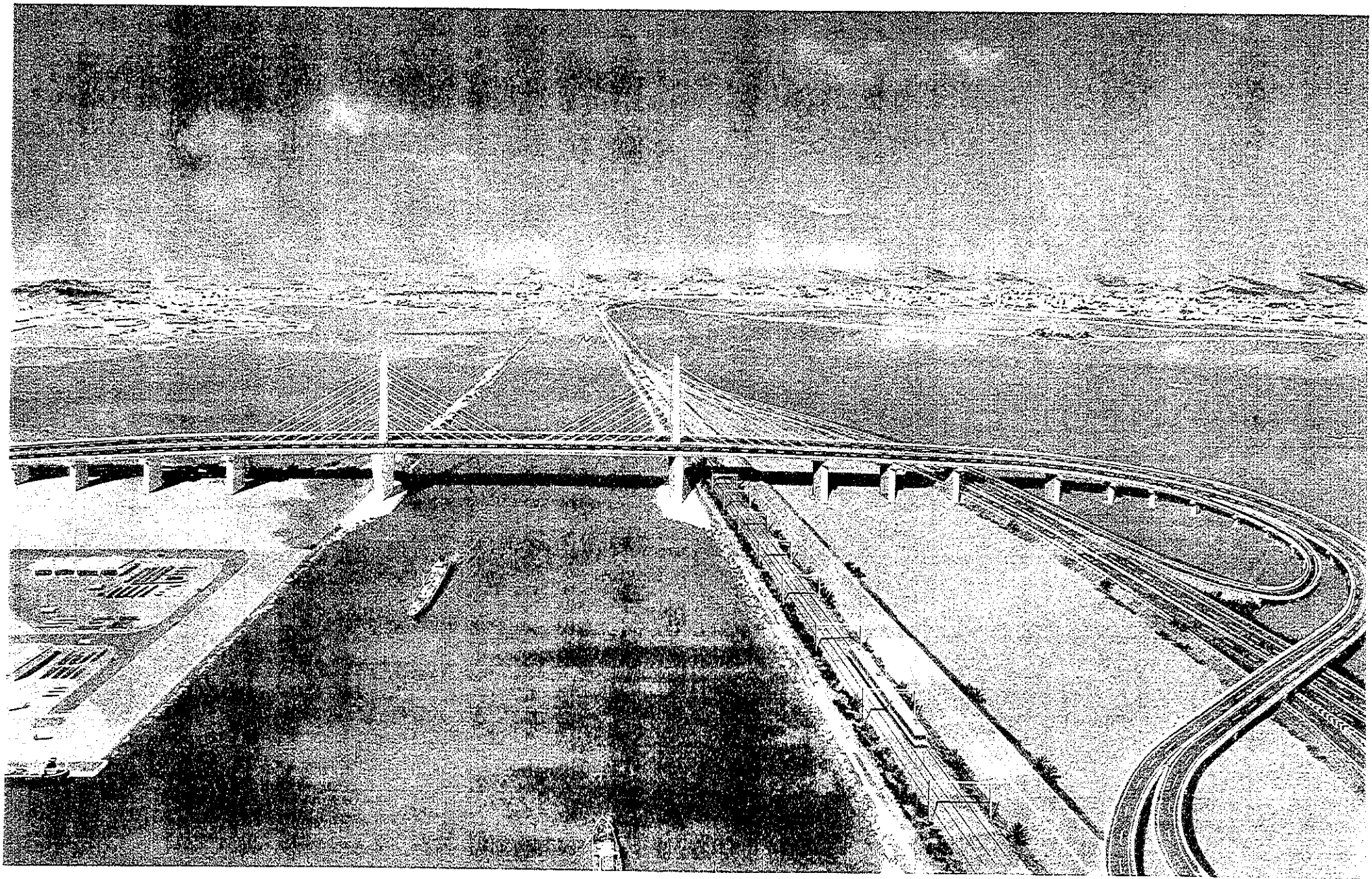
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Tunisia for their close cooperation extended to the team.

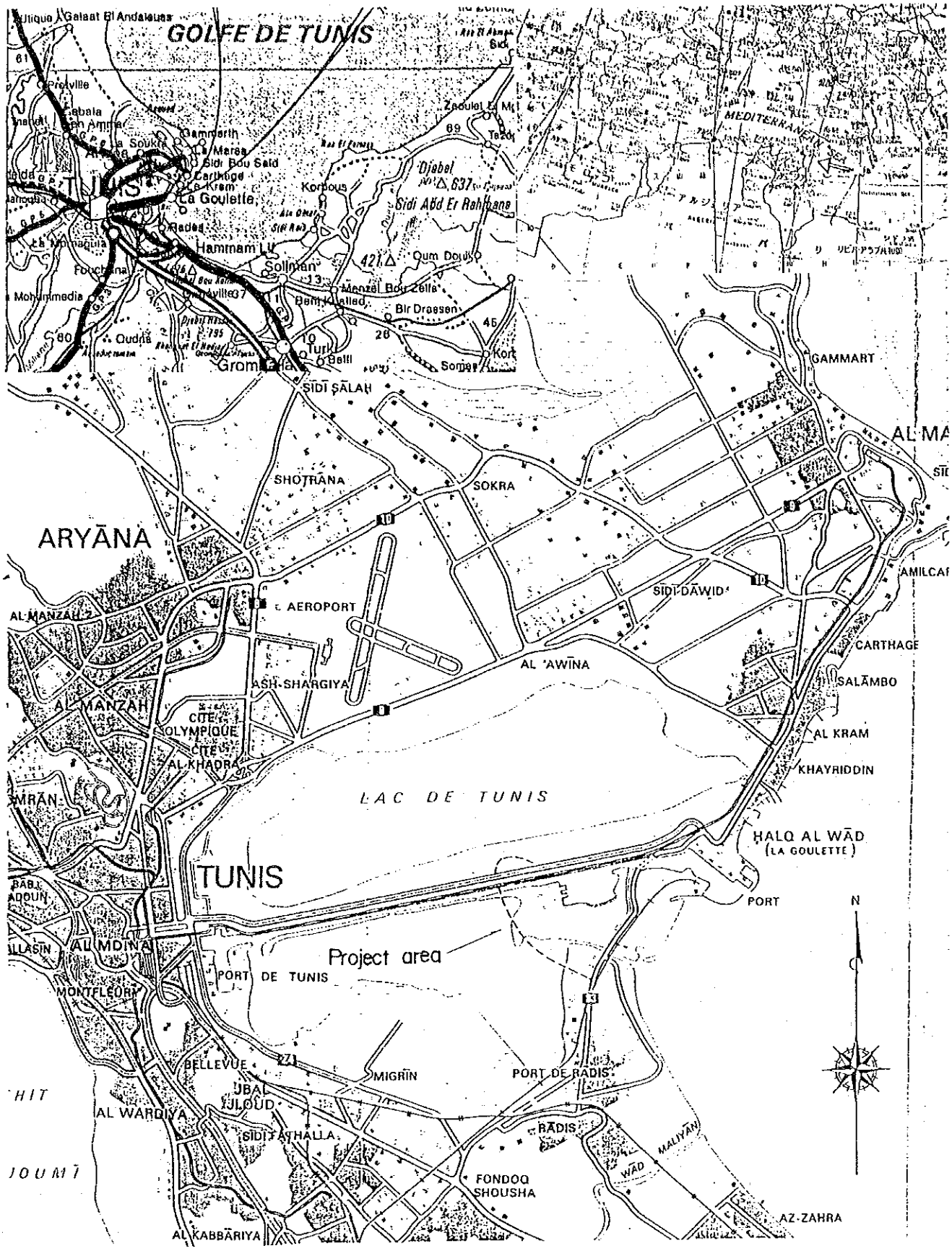
January 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



ETUDTE DE FAISABILITE SUR LA CONSTRUCTION D'UN OUVRAGE
DE FRANCHISSEMENT DU GOULET DE RADES-LA GOULETTE



PROJECT LOCATION MAP

Scale 1 : 100,000

EXECUTIVE SUMMARY

This section of the Report sums-up the general conclusions and recommendations of the feasibility study, for the construction of a fixed crossing over the Tunis Canal between Rades and La Goulette. This study commenced in September 1989.

1. GENERAL DESCRIPTION OF THE PROJECT AREA (See Figure 1)

The Tunis agglomeration, overlooks the Gulf of Tunis, covers an area of 160km^2, has a population in the region of 1.3 million, or about 17% of the national population (7.5 millions).

The Tunis Lake, about 10 km long with a depth of about 1m, is almost isolated from the Mediterranean by sand banks. The city of Tunis is situated at the western end of the lake. The Tunis Canal, formed by dredging the lake, runs in an East-West direction, over a length of about 10 km, which allows shipping to pass from the opening of the sand banks up to the Port of Tunis through the lake.

As the lake is divided into two parts, North and South by the Tunis Canal, the towns of Rades and La Goulette, which are on the Mediterranean Sea coast, are themselves separated by the same canal.

Transport across the canal between these two towns is presently provided by ferries. Although the volume of the various traffic between Rades and La Goulette grew in the last years, simultaneously and proportionally with the industrial development, these ferries are the only means of transport between these two zones. These ferries do not allow the transport of heavy loads, nor do they assure a good transport efficiency. More over, heavy vehicles increase the congestion in the city because routing around the lake, a fact that consequentially harms the urban environment. So it is imperative to build a structure to provide a direct service between these two towns, not only with the aim of relieving the traffic in the city-centre, but also to promote further development of the Tunis agglomeration.

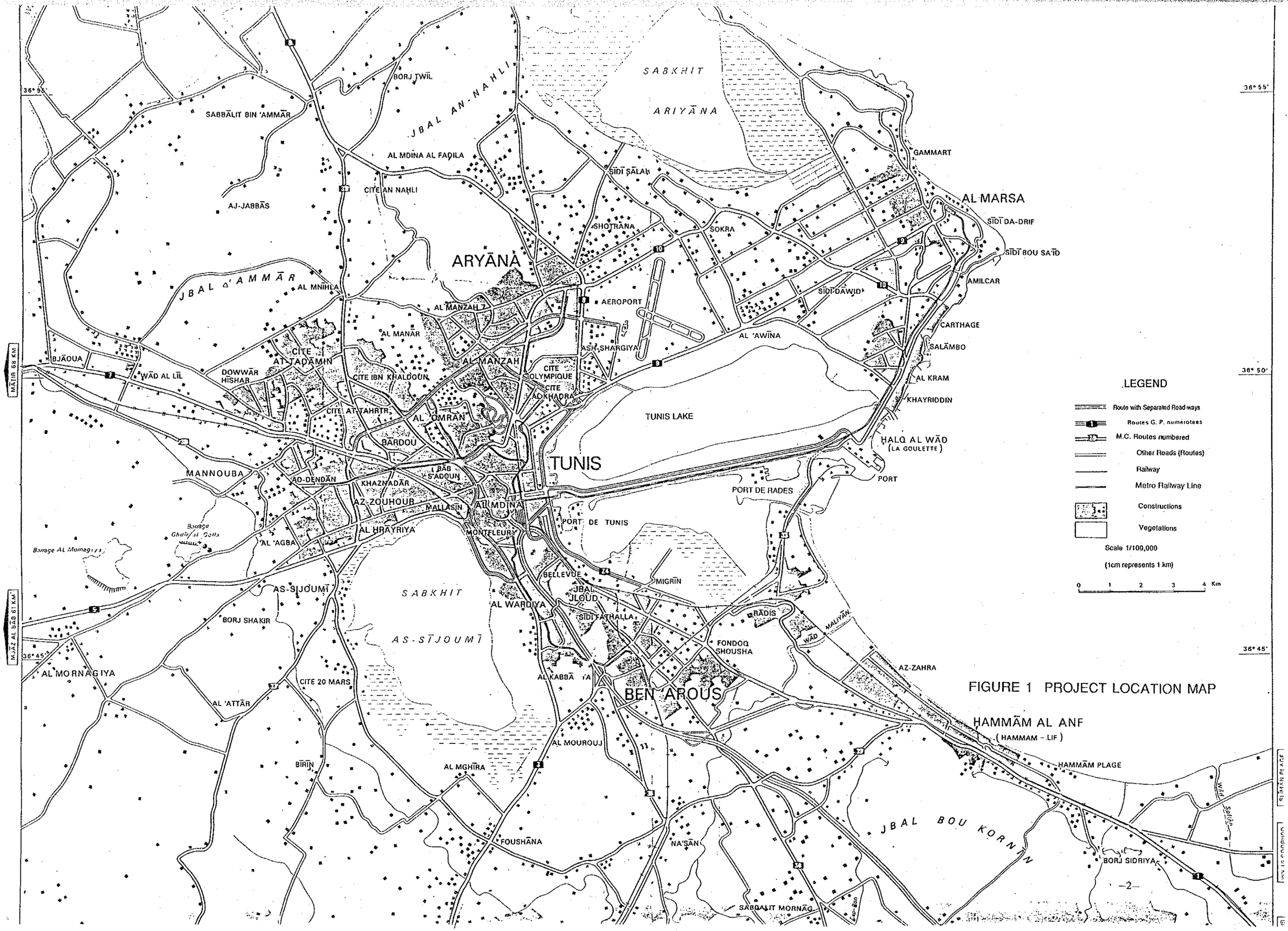


FIGURE 1 PROJECT LOCATION MAP

2 FUTURE PROJECTS IN THE TUNIS AGGLOMERATION

The rate of population growth of the whole country was 2% to 2.5% in the last 20 years, where as this rate is 3.2% in the Tunis agglomeration which undergoes a concentration of population as the Nation's Capital. The concerned Tunisian authorities have undertaken successfully some political measures to depress this rate of growth, but other problems are produced following the urban expansion. The same authorities report the following urban problems:

- Transportation
- Car parking
- Proliferation of squatters

Taking into account these maladjustments, which are currently observed in the agglomeration, the responsible authorities will determine the following options in order to re-establish the conditions of an equilibrium in the principal functions of the agglomeration:

(1) Establishing industrial zones in the West and in the South

(2) Development of urbanization in the South

(3) Restructuring the urban extensions to the North and to the South-West

(4) Development of urban centres in the South and in the West

(5) Necessary public works in the agglomeration and improved land-use,

Figure 2 shows the future projects in the Tunis agglomeration, which have been established by the responsible authorities.

3. STATUS OF THE ROADS RELATED TO THE PROJECT AND ROAD NETWORK IMPROVEMENT PLANS

The road network in the Tunis agglomeration has both a ring-shape and a radial form, including an incomplete ring road. The important roads have a large median strip and footpaths. The lesser roads carry two way traffic. The traffic problems in the city, are primarily due to congestion at cross-

DISTRICT OF TUNIS

Directing Plan

OF URBANISM

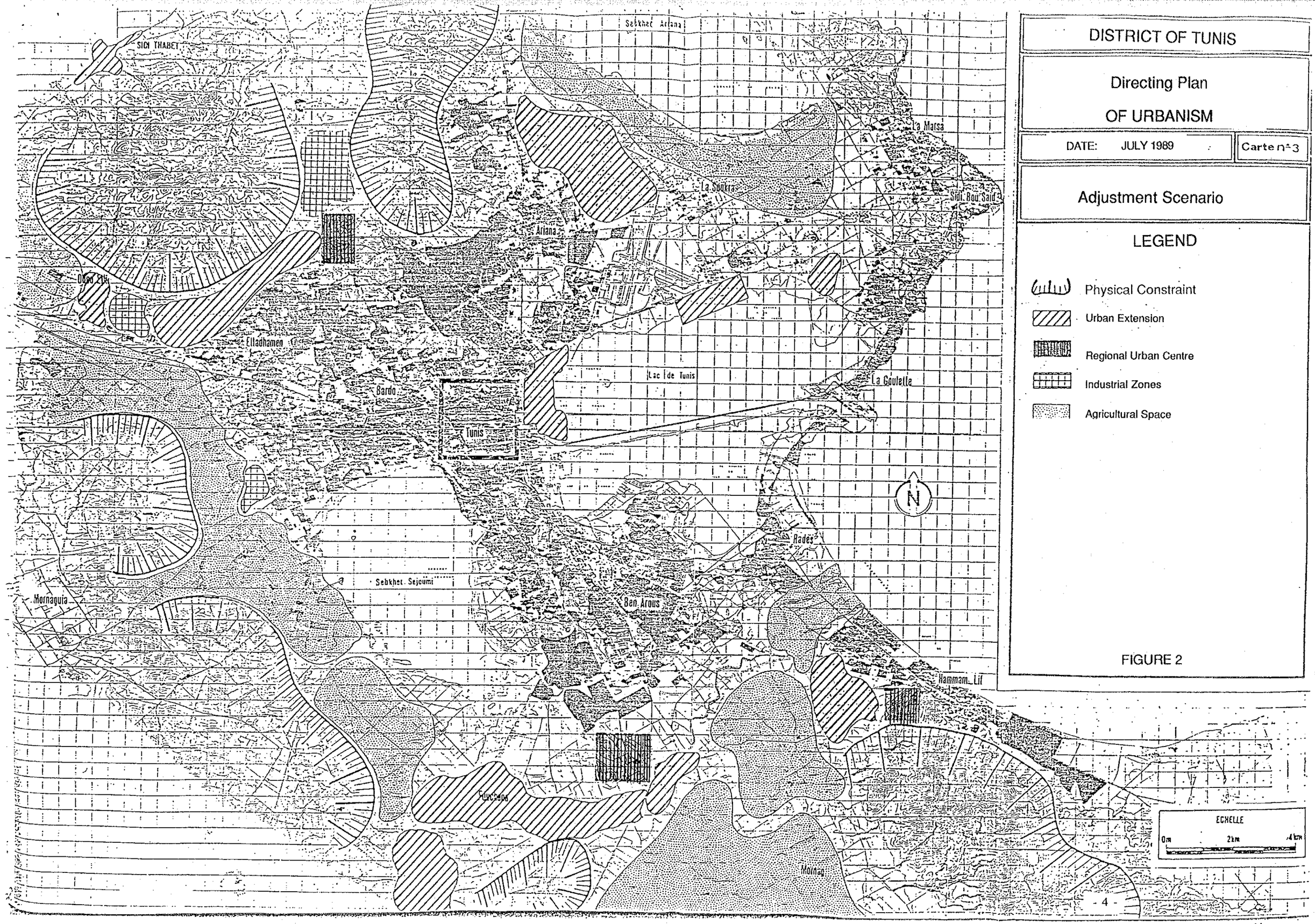
DATE: JULY 1989 | Carte n°3

Adjustment Scenario

LEGEND

- Physical Constraint
- Urban Extension
- Regional Urban Centre
- Industrial Zones
- Agricultural Space

FIGURE 2



roads, at the entry and exit to the city centre as well as in the city centre. On the principal thoroughfares, the rate of the traffic growth between 1982 and 1987 varies from 5% per year, (on the radial roads) to 15% (on certain sections). See Table 1.

This is the reason for which the responsible authorities are eager to make interchanges and to improve or construct roads. See Figure 3. The roads directly referring to the project are MC33 with its junctions, GP9 express-way, GP1, Z4, Motor-way (Tunis - Hammamet) and MC34 and MC39.

4. FUTURE TRAFFIC DEMAND ON THE PROJECT STRUCTURE

The traffic in future years on the project structure has been obtained on the basis of an "origin-destination" matrix at a future time extrapolated from the present matrix. The construction of the structure will start in 1992, the traffic is estimated below in relation to the years 1996 (when the bridge comes into service), 2006 and 2016.

Daily traffic	1996	2006	2016
(Calculated in units of private cars) U.P.C.	22,500	39,000	51,000

The traffic per direction (in the year 2006) are presented below:

- Traffic from the North-East direction towards the South: 20,774 (53%)
- Traffic from the North-East direction towards the South-West: 6,477 (17%)
- Traffic from the North direction towards the South: 5,968 (15%)
- Traffic from the West direction towards the South: 5,923 (15%)

Total: 39,142 (100%)

The traffic created per region (in the year 2006) are:

- Regions of Rades and La Goulette: 21,262 (27%)
- Regions North-East and North of La Goulette: 26,318 (34%)
- Regions to the West: 5,923 (8%)
- Regions to the South and the South West of Rades: 24,781 (32%)

Total 78,284 (=39,142 x 2)

Table 1 Traffic Volume (1987)

Road	Daily Traffic	Sector
Express Way	18,000	
GP-9	29,700	
GP-8	25,000	
GP-10	32,281	
X.2	19,124	NORTH
Lesseps	20,550	
X.4	16,625	
X.3	14,571	
MC-130	24,625	
MC-31	18,950	
Total North	219,426	54.6%
GP-7	15,501	
GP-5	21,200	
PVE539	15,400	West
West EXIT	14,528	
MC-37	7,530	
Total West	74,159	18.4%
GP-3	5,700	
South EXIT	41,218	
GP-1	39,878	
Z.4	21,818	
Total South	108,614	27%
Total Net	402,199	100%

Source: District of Tunis

DISTRICT OF TUNIS

REGIONAL DIRECTING PLAN OF TRANSPORTS

DATE: MARCH 1989 MAP-A3

Projects in the Course of Achievement and Projects Studied or being studied

LEGEND

Projects in the process of achievement

- Division and arrangement of routes
- Viaduct
- Interchange
- Creation of infrastructure

Projects studied or being studied

- Arrangement of roads
- New roads
- Arrangement of knots
- Planned interchanges

Figure 3

The following expressions mean:

- North-East : The North side of the bridge (La Goulette-Carthage-La Marsa etc...)
- North : Sidi Daoud, La Soukra, L'Ariana, Airport
- West : Tunis and the zones at the west side of the lake
- South-West: Ben Arous, Megrine
- South : South side of the bridge (Rades, Hammam-Lif, etc.)

(See Figure 4.)

Thus, the structure of the project will contribute not only to the regional traffic between Rades and La Goulette, but also to the through traffic from the North-East towards the South, and to the through traffic from the North-East towards the South-West and from the North towards the South.

This structure will relieve the city from the present North-South traffic, that is to say 33,219 vehicles (minus the traffic that uses the ferry and induced traffic). The traffic in the city will be relieved from congestion by this project and even the road users who do not use this structure will benefit from it.

In other words, this structure will play an important role as a principal thoroughfare in the Eastern region, and be integrated into the road nets of the Tunis agglomeration.

5. PLANNING OF PROJECTED ROAD ALIGNMENT AND STRUCTURE

(1) The design parameters for the road-way

The major conditions for the road-way on the project structure have been determined by referring to the French criteria of the roads, as agreed with the Tunisian authorities, taking into account: the functions which can contribute to the development of the Tunis agglomeration; the future traffic demand; the present and future projects for the existing express-way and MC33 which will provide the transport service to the project structure; the construction cost of the project; etc. The principal criteria are cited below:

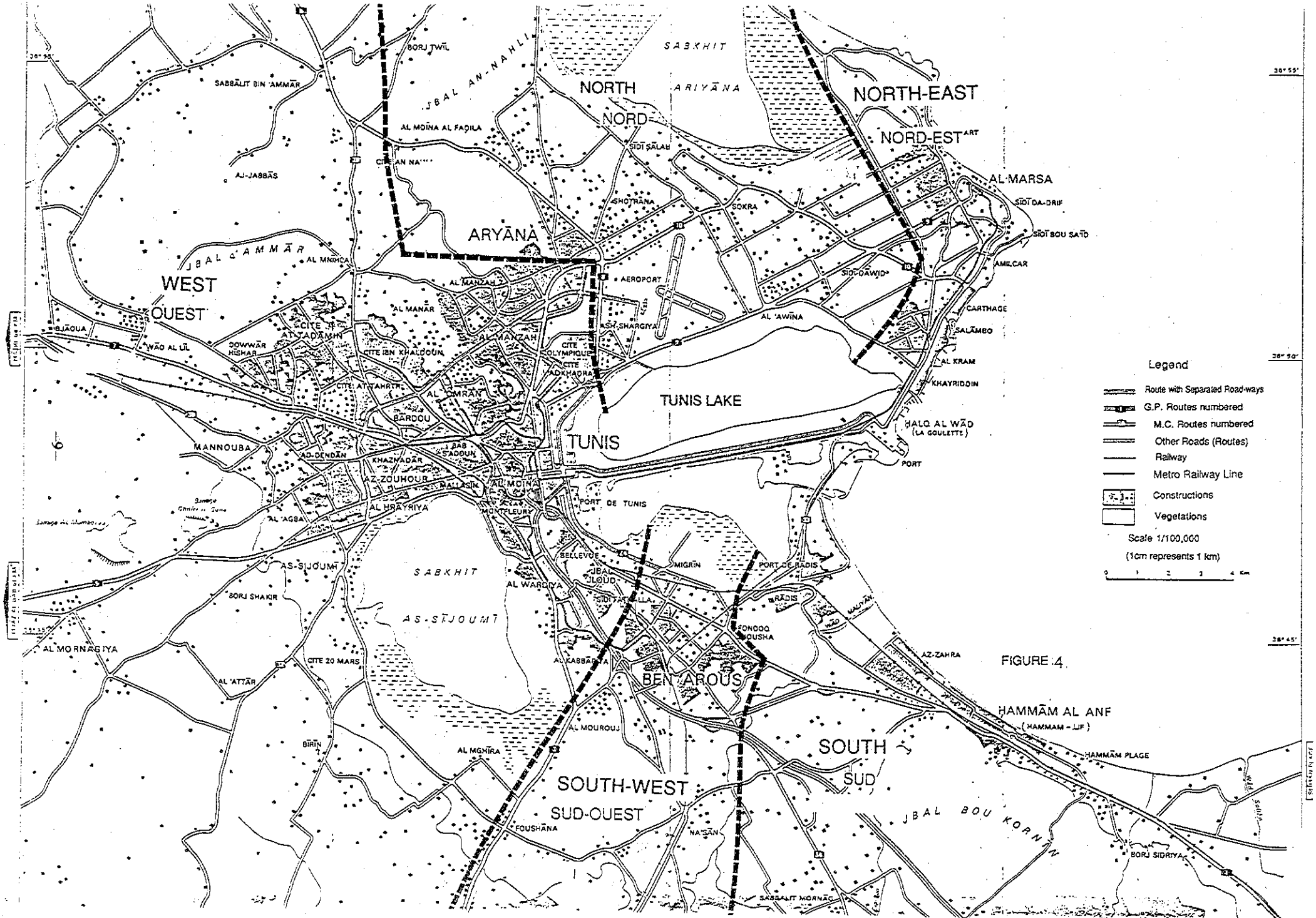

NORTH
NORD
ARYĀNA
NORTH-EAST
NORD-EST
AL-MARSA
WEST
OUEST
TUNIS
TUNIS LAKE
SOUTH
SUD
SOUTH-WEST
SUD-OUEST
BEN AROUS
HAMMĀM AL ANF
HAMMĀM PLAGE
MANNOUBA
AS-SIJOUMI
AL MORNAGIYA
SABKHIT ARIYĀNA
SABKHIT AS-SIJOUMI
JBAL AN-NAHLI
JBAL 'AMMĀR
JBAL BOU KORNIN
BORJ TWIL
SABBĀLIT BIN 'AMMĀR
AL MOINA AL FAQILA
AJ-JABBĀS
SIDI SALAH
SHOTRANA
SOKRA
AEROPORT
AL MANZAH
AL MANAR
AL 'AWINA
ASH-SHARGIYA
CARTHAGE
SALAMBO
AMILCAR
SIDI DAWID
SIDI DA-DRIF
SIDI BOU SA'ID
AL KRAM
KHAYRIDDIN
HALQ AL WĀD (LA GOULETTE)
PORT
BARDOU
AL MNIHLA
CITE AT-TADAMIN
CITE IBN KHALDOUN
CITE AT-TAHRIR
CITE OLYMPIQUE
CITE ADKHADRA
AL 'UMRAN
BAB SADOUN
KHAZNADAR
AD-DENDAN
AZ-ZOUHOUR
AL HRAYRIYA
AL 'AGBA
AL MOINA
PORT DE TUNIS
MONTFLEURY
BELLEVUE
JBAL JLOUD
SIDI FATALLA
AL WARDIYA
MIGRIN
PORT DE RADIS
RADIS
FONDOQ DJOUMA
AZ-ZAHRA
AL KABBARIYA
AL MOUROUJ
AL MGHIRA
BIRIN
FOUCHANA
NA'SAN
SABBALIT MORNAG
BORJ SIDRIYA
BORJ SHAKIR
CITE 20 MARS
AL 'ATTAR
Legend
Route with Separated Road-ways
G.P. Routes numbered
M.C. Routes numbered
Other Roads (Routes)
Railway
Metro Railway Line
Constructions
Vegetations
Scale 1/100,000
(1cm represents 1 km)

FIGURE :4

1) Design speeds

Throughway	:	60 km/h
Interchanges	:	40 km/h

2) Minimum horizontal radius

Throughway	:	250 m
Interchanges	:	50 m

3) Minimum vertical radius

Throughway, crest	:	3,000 m
sag	:	1,700 m
Interchanges, crest	:	1,200 m
sag	:	1,100 m

4) Maximum gradient : 6%

5) Standard cross-sections : See Figure-5

(2) Study alternatives and selection of the optimum solution

The study has compared numerous alternatives, which are described.

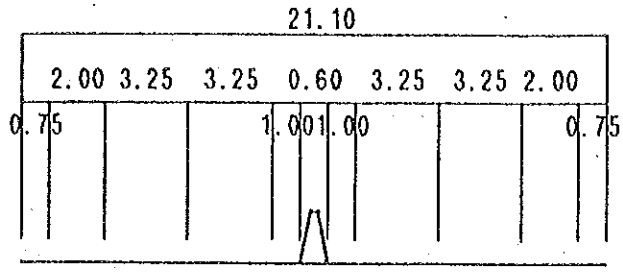
1) Comparative study between the crossing corridors: (3 alternative) (Figure-6)

2) Comparative study between the height-clearances per crossing corridor (2 or 3 alternative per corridors).

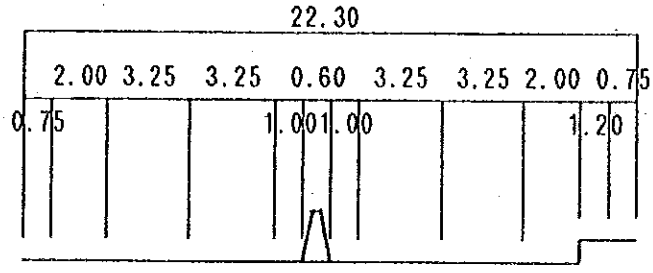
3) Comparative study between the structures per crossing corridor (alternatives between bridge and tunnel).

These alternatives present 28 combinations to be studied. For each of them, the influence on the passage of boats as well as on the harbour installations, the traffic demand forecast, the construction cost and the economic internal rate of return have been evaluated. The results of this estimate, for optimum solutions only, are presented in Table 2. Unsatisfactory alternatives have not been included.

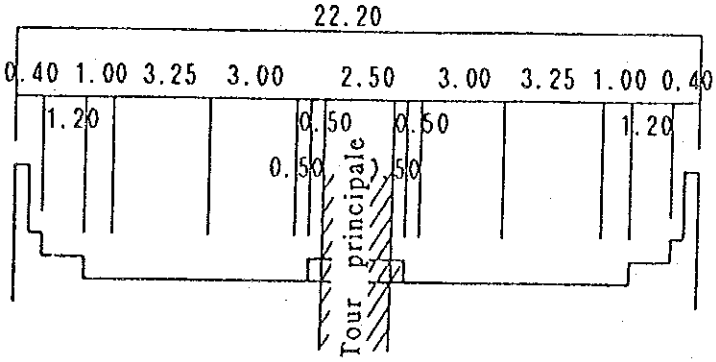
Throughway over Earth Platform (without footpaths)



Throughway over Earth Platform (with footpaths)



Throughway on Principal Structure (with footpaths)



Throughway on Access Viaduct (with footpaths)

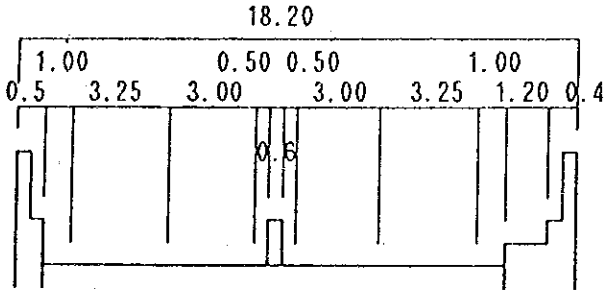


Figure 5 Cross Sections of Roadways

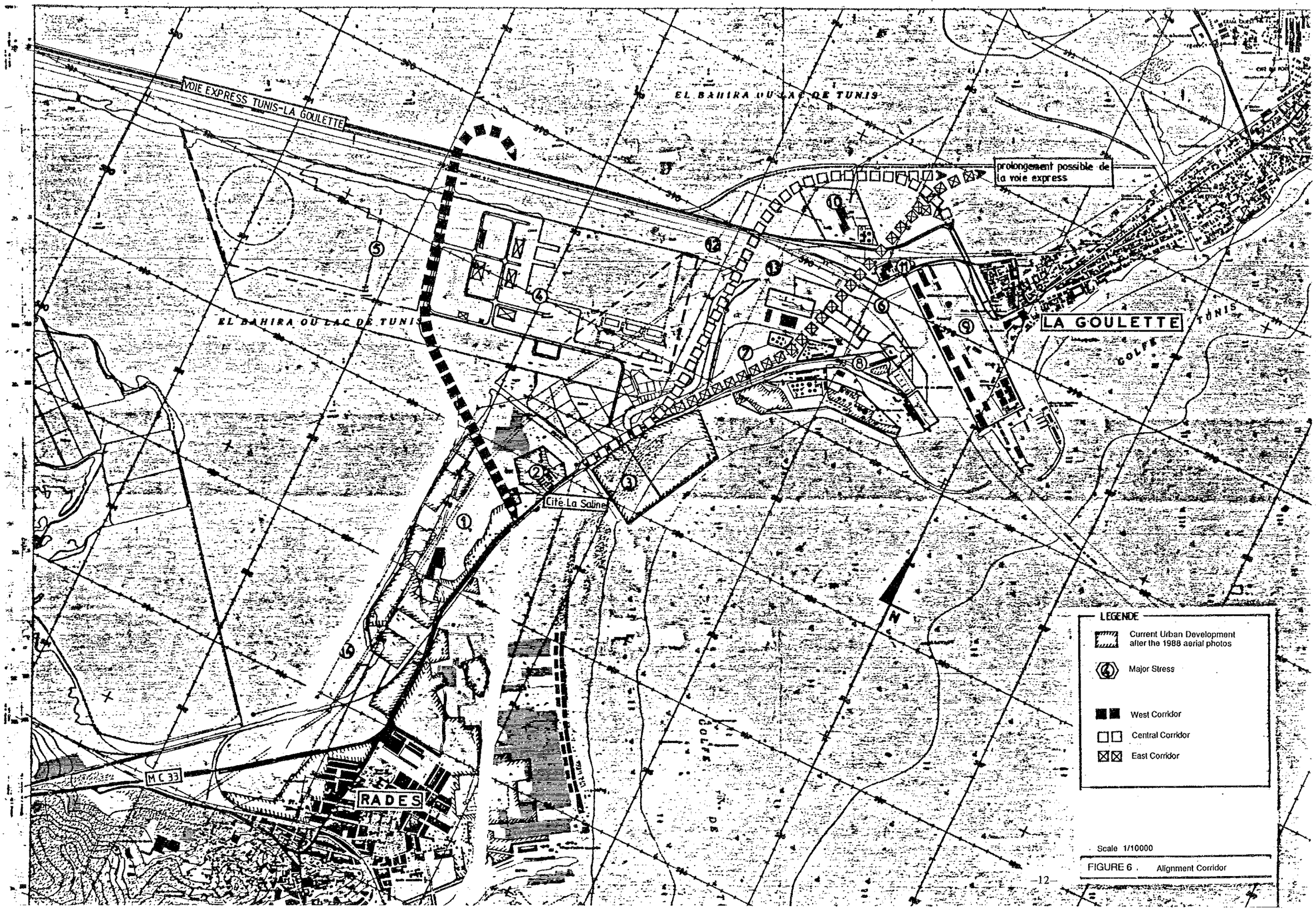


FIGURE 6 . Alignment Corridor

Table 2 Multi-Criteria Comparison of Corridors and Alternatives

Rades - La Goulette

Arrangement Alternative		East Corridor		Central Corridor			West Corridor				
		Bridge		Bridge		Tunnel	Bridge				Tunnel
1. General characteristics of the arrangement											
- Height clearance (bridge) (M)		55.0	45.7	55.0	45.7	-	45.7	30.0	15.0	Lifting	-
- Navigation clearance (tunnel) (M)		-	-	-	-	-13.0	-	-	-	-	-7.5
- Span of the crossing structure (M)		320	320	200	200	-	150	150	80	150	-
- Length of the viaducts/Interchanges (M)		2,330	2,180	2,270	1,970	-	1,890	1,370	540	590	-
- Total length of the alignment, for linking La Goulette - Rades (M)		4,565	4,565	4,610	4,610	4,665	6,860	6,745	6,745	6,745	6,370
- Approximate cost ratio		2.11	1.79	1.87	1.43	2.27	1.43	1	9.56	1.51	1.98
- Traffic forecast (1994) (Unit of private car)		21,853		24,160			19,887				
- (2004) U. P. C.		37,747		37,610			37,104				
- (2014)		45,579		48,137			48,478				
EIRR (%)	Normal	10.5	11.3	12.6	15.1	10.9	14.6	18.7	24.9	13.6	12.6
	Cost + 15% Advantage -15%	8.0	8.6	9.7	11.9	8.3	8.3	14.9	20.1	10.5	9.7

(Note) * The comparison of the construction costs is based on the West Corridor with a 30m height clearance (→ 1.0) The construction costs are calculated on the Optimum structure (the least costly) per alternative.

* The forecast of the traffic demand is only for the years 1994, 2004 and 2014 for this comparison.

* EIRR: economic internal rate of return

It appears from the previous data that:

1) The traffic volumes will not differ significantly between the corridor alternatives.

2) The tunnel alternatives will be more expensive than those of the bridge and they will be less suitable for the traffic technology, owing to the volume of the predicted traffic (problems of ventilation, security, etc.)

Identical height clearances for the bridge alternatives show that the Central Corridor will have less influence on the harbour function than the East Corridor, and the West Corridor less than the Central Corridor.

Thus, the optimum solution will depend on the choice of a height clearance for the bridge alternative on the West Corridor.

The choice of a height clearance has finally fallen on the 30 m alternative, after the decision by the Tunisian Government, to select the West Corridor.

For the principal structure, crossing the channel, a cable stayed concrete bridge of 150 m central span and a 30 m navigational clearance, has been chosen taking into account the conditions of the navigable passage, the aesthetic harmony with the environment, the bridge construction cost, its maintenance, etc.

6. ROAD DESIGN ON THE STRUCTURE

(1) General

This road over the structure crosses in a North-South direction, the channel which leads to Tunis Harbour on the west side and Rades New Harbour on the East, over a length of about 5.7 km which includes a deviation of about 2 km long of the express way. The road over the bridge and approach spans is about 1.6 km long, and other 4.1 km is on embankment.

The access viaducts will have concrete spans, considering the control conditions of the adjacent roads, the aesthetic similarity with the main structure, the bridge construction cost and, its maintenance costs, etc.

Concerning the linking into the existing roads, a trumpet type of interchange has been adopted at the North end to connect into the express way, while in the South a level intersection at grade with the MC33 has been adopted.

The general plan of the roads and the general elevation of the bridge structure are shown in Figures 7 and 8.

(2) The scope of the construction work for this project

As shown in Figure 7, the construction works for this project extend for a length of about 3.7 km between the express-way and the MC33 and on a length in the region of 2 km for the express-way deviation.

7. THE PROJECT COST AND THE EXECUTION PLAN

(1) Projected Programme - See Table-3.

(2) The project cost (In Tunisian Dinars) T.D.

Construction cost:	57,140,000.T.D.
Design and engineering cost:	5,714,000 T.D.
Land purchase and compensation costs:	500,000 T.D.
Administration costs of the Ministry of Works and Housing	570,000 T.D.
Contingencies:	9,588,000 T.D.
Total	73,508,000 T.D.

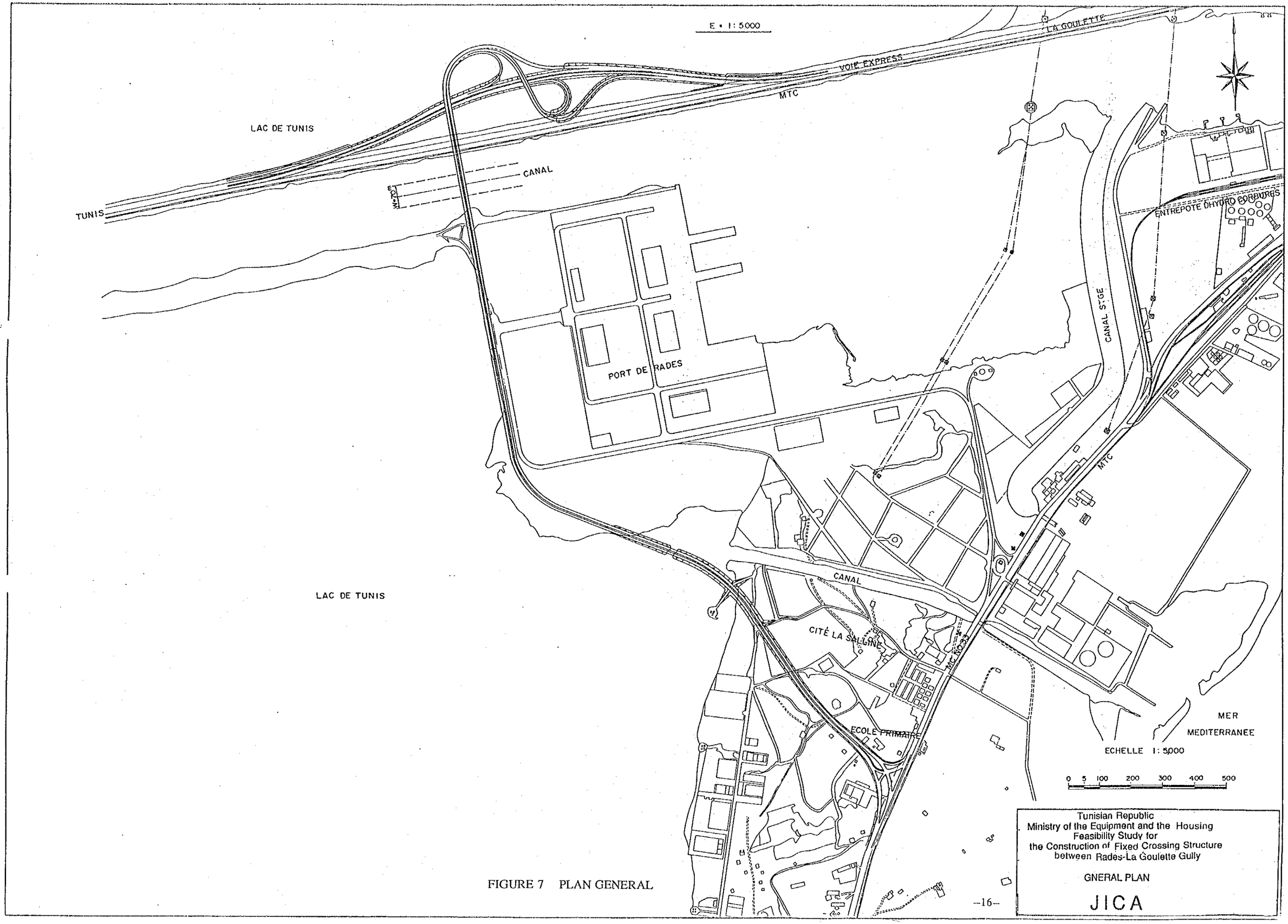


FIGURE 7 PLAN GENERAL

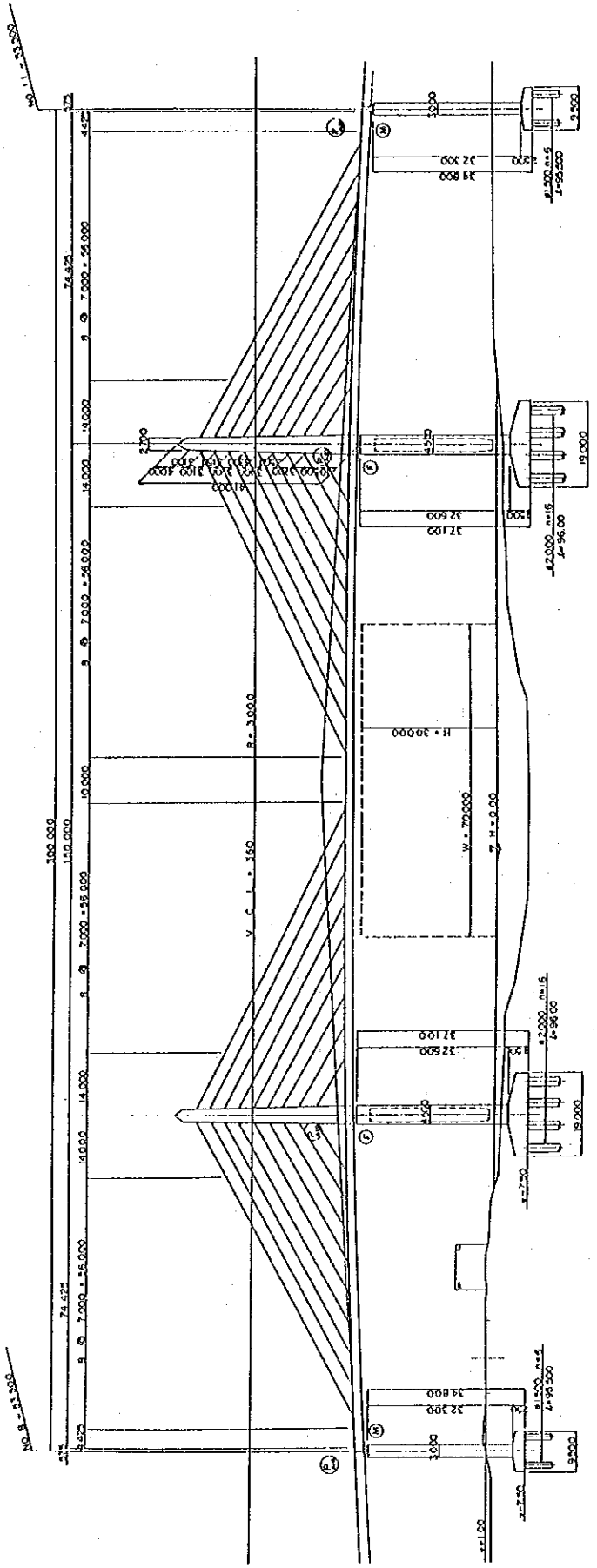
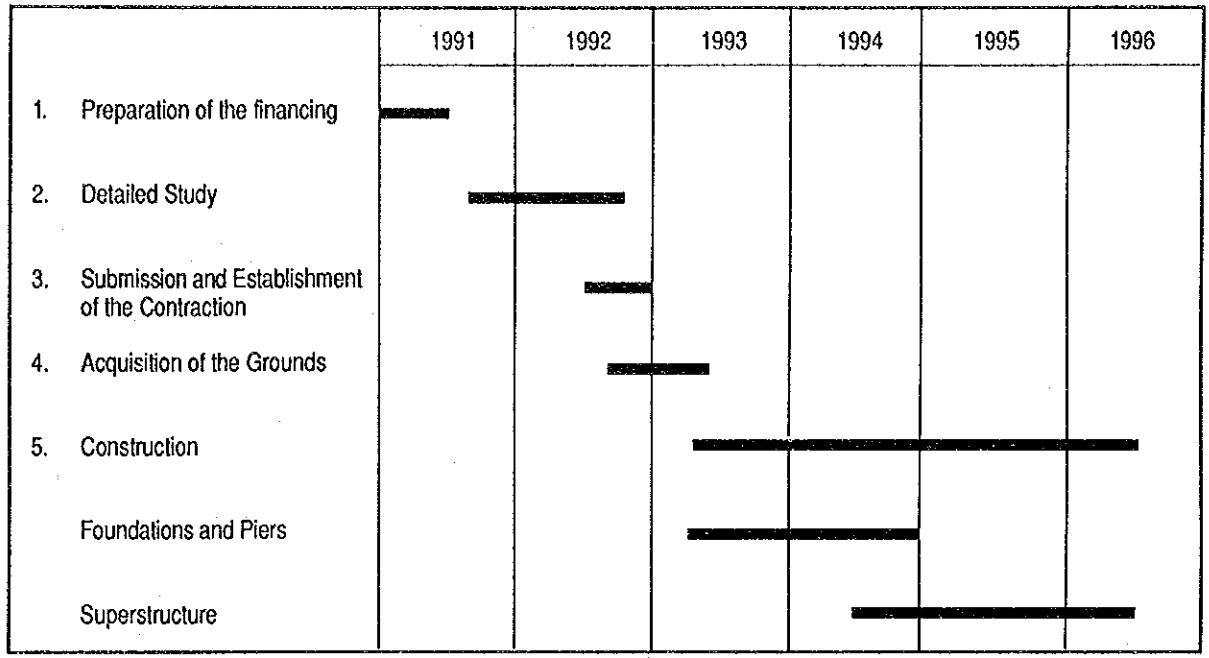


FIGURE 8 ELEVATION OF THE BRIDGE

Table 3 Execution Plan



8. ECONOMIC EVALUATION

The economic evaluation, which takes into consideration the project benefits and the analysis of the costs, has been carried out by taking into account the planned construction and the total cost of the project. The benefits involve transportation costs, time savings, the multiplying effect of the project investment, etc., but do not consider benefits arising from the regional development because of the difficulty of quantifying these intangible results.

The expediency cost of capital in Tunisia is in the region of 12%, whereas the economic internal rate of return for this project will be 18.7% in a normal situation and 14.9% should these be a 15% increase in construction cost, as well as a 15% reduction in benefits, so that this project is judged to be highly feasible.

9. RECOMMENDATION

As mentioned before, this project is feasible as far as the internal rate of return is concerned. Even if this fact is not taken into account, this project would be essential for a balanced development of the Tunis agglomeration. This bridge link is equivalent to the Golden Gate Bridge in San-Francisco, or the Bosphorus Bridge in Istambul. The feasibility study carried out in 1976 by the French company SETEC also, realized the feasibility and strategic value of this crossing. From the social and economic potential of this country this crossing should have been constructed long ago.

The economic effect caused by the completion of the project in the project zone, the economic gains during the construction period are beneficial, as is the effect of the investment on the whole economy. For these reasons, the Study Team recommends that the project is implemented as soon as possible.

10. FURTHER INVESTIGATIONS

(i) The forecast of the total traffic demand for this project supposes the completion of improvements to roads, relating to the project. It is imperative that these are carried out, so that the investment in this structure achieves the full potential that this study has indicated.

This study recorded that the existing traffic between the MC33 La Goulette-Carthage and the MC33-E3, is already at the limit of saturation. For this reason, in order to make this project efficient, the construction of the highway deviation around the town of La Goulette and its extension towards Carthage must be completed also by the time that this project is completed.

(ii) The project structure is linked up to the express-way on the South banks of the North lake of Tunis, in such a way that there will be an interchange and a deviation of the express-way.

On the East bank of Tunis North Lake, an extension of the expressway towards Carthage is planned.

In the area of these two sites, the Company for the Promotion of the Tunis Lake (C.P.L.T.) is carrying out improvements to the banks of the Tunis Lake.

So it is important that discussions between the Ministry of the Works and Housing and the C.P.L.T. take place as soon as possible to coordinate these two projects.

(iii) The project site comprises unconsolidated soils. It had been estimated before the geological study that the bearing strata for the foundation would be at a depth of about 50 m. The results of a boring to the anticipated bearing depth showed that the strata lay at a depth of about 100 m. This extra depth caused the number of boring sites to be reduced from 5 to 2 because of time-limits. Before detailed design for foundations can commence supplementary borings must be carried out to obtain more data and test results for the soils.

(iv) For the purposes of this study and to provide a conservative solution the piles have been considered to be 100 m long, which provides adequate load carrying capacity. It may be possible to reduce the length of the pile during detail design, but this must depend on the results of a detailed study following the additional boreholes and tests.