

Γεφυρα Ριον – Αντιριον
Rion - Antirion Bridge



ENVIRONMENTAL INTEGRATION

Prepared by Equipement et Environnement

GEFYRA GROUP
October 1995

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Γεφύρα Ριον-Αντιρίου

Rion-Antirion Bridge

Environmental integration

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1- CHRONOLOGICAL ACCOUNT OF THE PROJECT

The idea of a fixed link, connecting Northern Greece to Peloponesus over the strait between Rion and Antirion, dates back a long time. The strategic importance of this site, since antiquity, is confirmed by the Byzantine fortifications that appear there (integrating even older elements).

It was not until the end of the 20th century and the development of new construction techniques that a link over the Gulf of Corinth could even be considered.

After the preliminary studies were carried out by the Greek government, the initial invitations to tender were sent out in 1985. Various solutions were investigated but none actually suited the government's requirements. At the same time, detailed environmental studies were conducted in accordance with the procedure outlined in the attached diagram and, following technical studies, another call for tender went out in 1993.

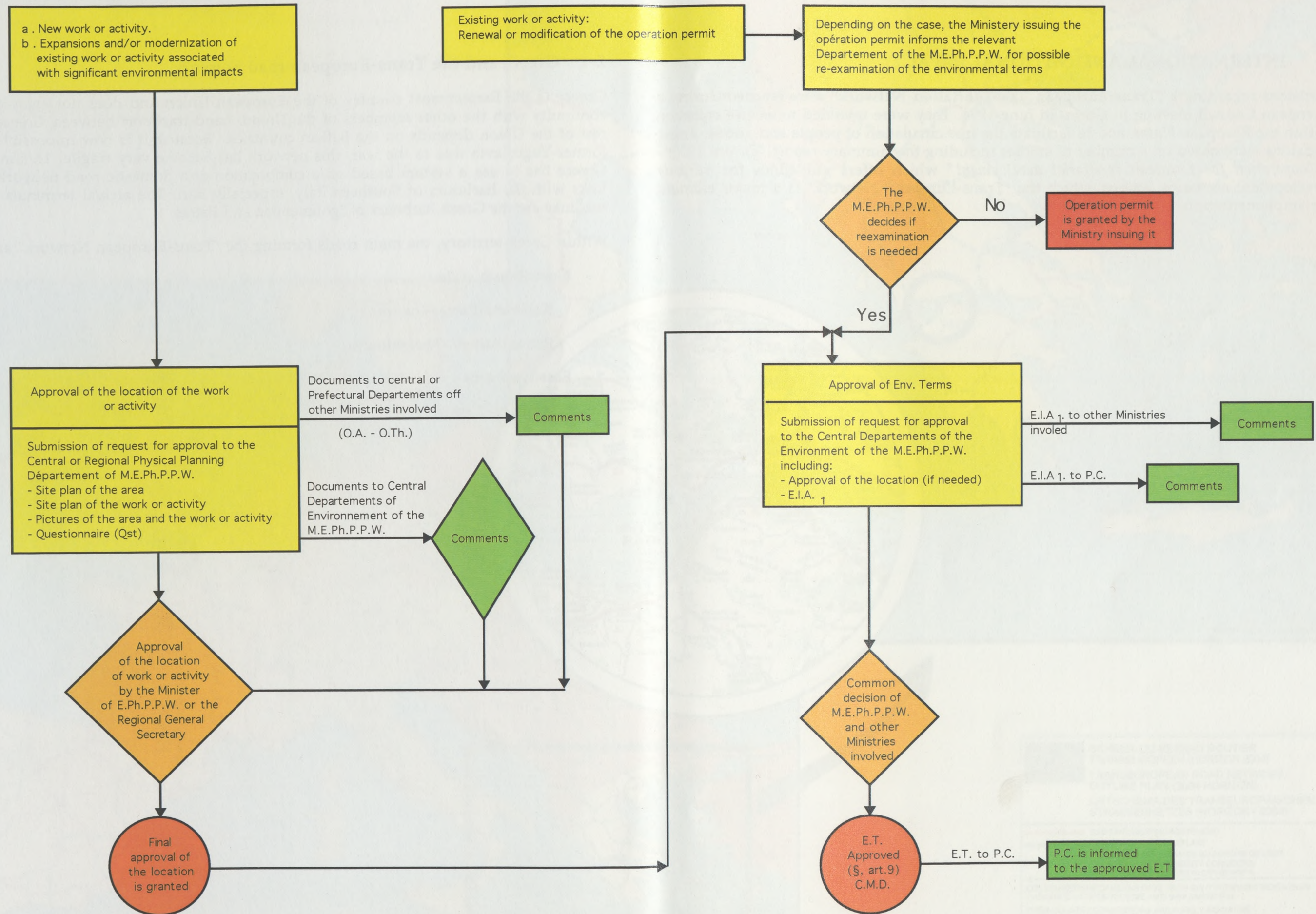
The government's decisions were put to local authorities and to the inhabitants of the area using the following methods : the Environmental Design Direction submitted the EIA (Environmental Impact Assessment) to the Prefectural Board of Achaia and Etoloarkanania, which were involved in the project. The Prefectural Board subsequently published all relevant information concerning the EIA in the local press and posted it on the bulletin boards of the Prefectures, setting a reasonable deadline for the submittal of proposals by any interested parties. Finally, the Prefectural Boards met in public to examine the EIA and communicated the Minutes of their meetings concerning the issue at hand and the proposals of the citizen bodies on to the Environmental Design Department.

Based on this information, the Environmental Design Department reached its decision under # 67731/15-9-93 approving environmental criteria regarding the project.

The present document summarizes the findings of the Government's impact study.

M.E.Ph.P.P.W.	Ministry of the Environment, Physical Planning and Public Works
E.T.	Environmental Terms
E.I.A ₁	Environmental Impact Assessment for works or activities of Class A ₁ (Tab. 1 C.M.D.)
Qst.	Questionnaire (Tab.2 C.M.D.)
O.A.	Organization of Athens
O.Th	Organisation of Thessaloniki
P.C.	Prefectural Council
CMD	Common Ministerial Decision

ENVIRONMENTAL PROCEDURES Class 1



2- INTERNATIONAL AND NATIONAL IMPACT

Decisions regarding a "Trans-European Transportation Network" were reached during a European Council meeting in Corfu, in June 1994. They were intended to ensure cohesion within the European Union and to facilitate the free circulation of people and goods. These decisions were based on a number of studies including the summary report "Europe 2000 + / Cooperation for European territorial development" which offers guidelines for various development scenarios, among which the "Trans-European Network" is a major element for implementation.

2-1 Greece and the Trans-European road network

Greece is the Easternmost country of the European Union and does not enjoy territorial continuity with the other members of the Union. Land transport between Greece and the rest of the Union depends on the Balkan countries. Because it is now impossible to cross former-Yugoslavia due to the war, this network has become very fragile. This means that Greece has to use a system based on a combination of a domestic road network and sea links with the harbours of Southern Italy, especially Bari. The arrival terminals for these sea links are the Greek harbours of Igoumenitza and Patras.

Within Greek territory, the main roads forming the "Trans-European Network" are :

- North-South Axis :

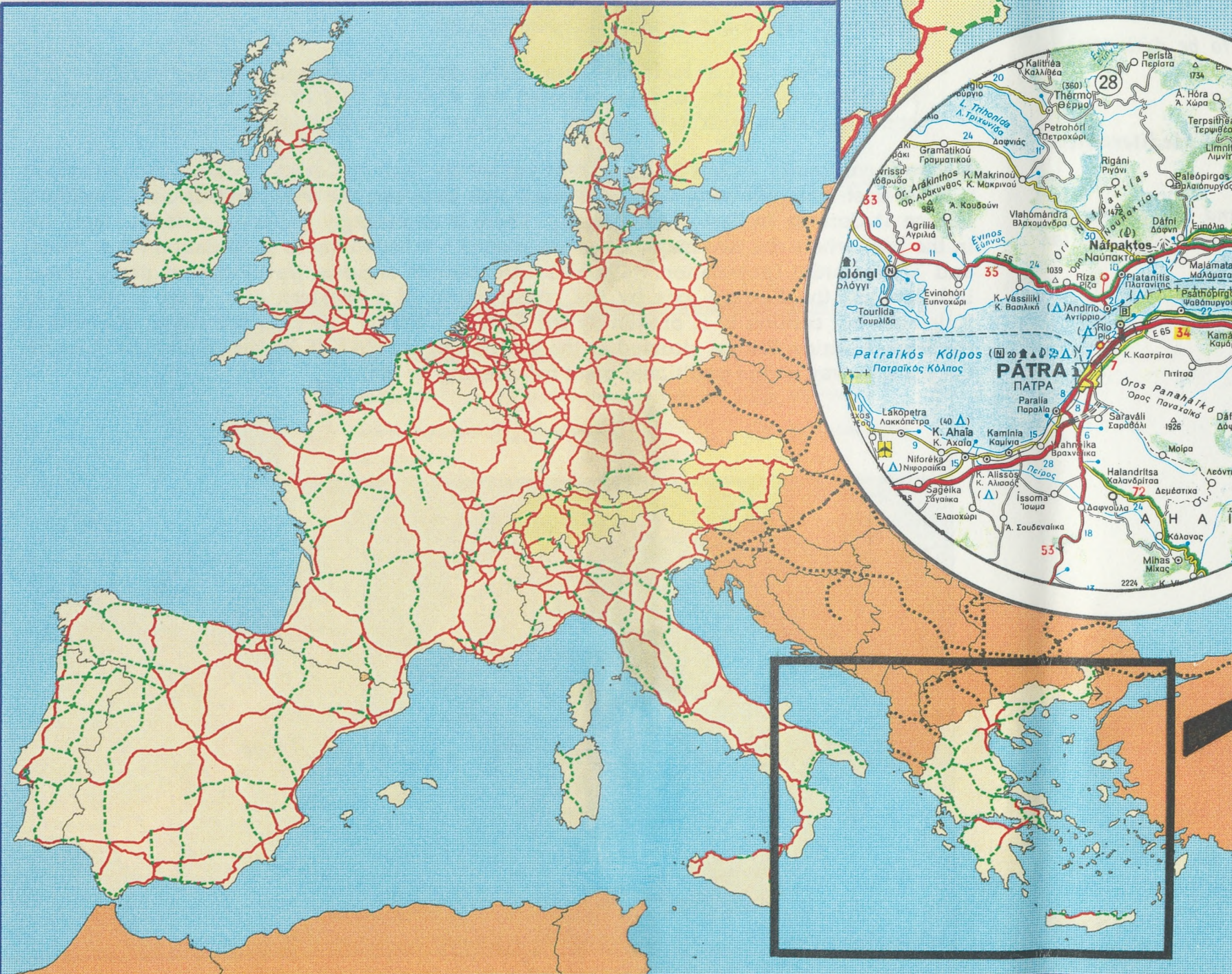
Kalamata-Patras-Ioannina

Patras-Athens-Thessaloniki

- East-West Axis :

Antirion-Lamia.

TRANSEUROPEAN ROAD NETWORK (2004 horizon)



SCHEMA DU RESEAU ROUTIER
TRANSEUROPEEN (HORIZON 2004)
TRANSEUROPEAN ROAD NETWORK
OUTLINE PLAN (2004 HORIZON)
LEITSCHHEMA DES TRANSEUROPAISCHEN
STRASSENNETZES (HORIZONT 2004)

— EXISTANT/EXISTING/BESTEHEND
— PLANIFIE/PLANNED/GEPLANT
— CORRIDORS PRIORITAIRES EN EUROPE DE L'EST
— EASTERN EUROPE PRIORITY CORRIDORS
— PRIORITÄRE KORRIDORE IN OST-EUROPA

LES CONNEXIONS DANS LES PAYS TIERS SONT PUREMENT INDICATIVES
LIAISONS DANS L'EX-YOUGOSLAVIE SEULEMENT P.M.
THIRD COUNTRY CONNECTIONS ARE PURELY INDICATIVE
LINKS IN FORMER YUGOSLAVIA P.M. ONLY
VERBINDUNGEN MIT DRITTLÄNDERN NUR HINWEISEND
VERBINDUNGEN IN FRÜHEREN YUGOSLAWIEN NUR P.M.

2-2 Greece as part of the Central Mediterranean

In its study of the Mediterranean regions, the "Europe 2000 +" report stresses the imbalance in the Greece's national development and the weakness of the infrastructure network (0.09 km highway/100 sq. km for 1.45 in the European Union and 31 km roads/100 sq. km for 159 in the European Union).

This study stresses that *"if current trends continue, the Central Mediterranean region is likely to continue to be fragmented, especially if conflicts in neighbouring countries persist, so greatly limiting the scope for economic cooperation."*

In order to overcome the problems arising from the continuation of current trends, there are three major issues that require action:

- *the fragmenting of the region and the weakness of its economy have to be dealt with ;*
- *any further deterioration of the environment must be prevented ;*
- *trade and other relations with the other parts of the Union and the Mediterranean must to be strengthened.*

... in Greece, improved connections are needed between the Peloponesus and the rest of the country (via the Rion-Antirion bridge), opening up the western coast, and improving the Rome-Naples-Bari-Igoumenitza-Thessaloniki-Alexandropolis road...."

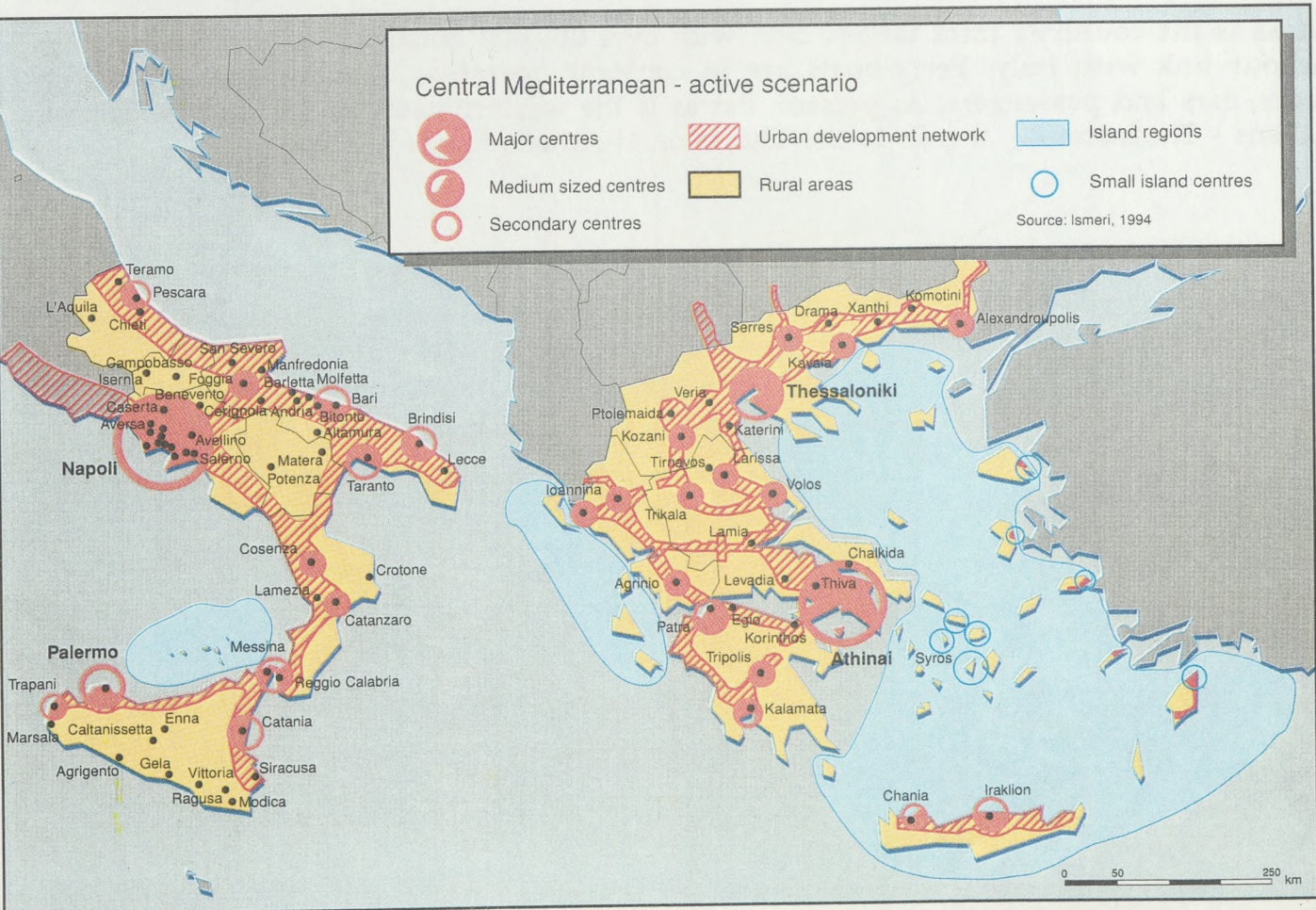
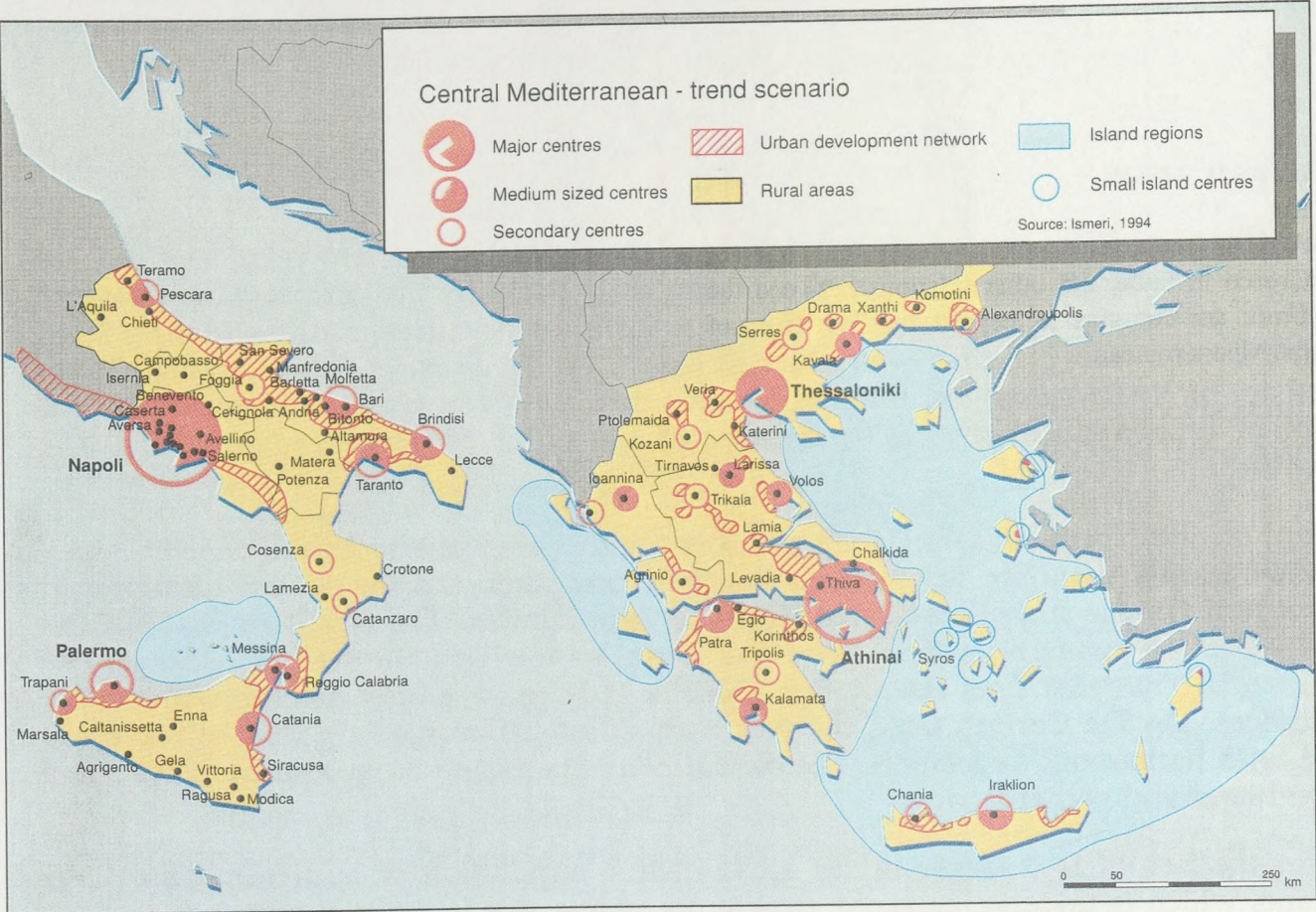
2-3 Greek Road "Master plan"

The Greek Government's intention up to the year 2010 were set down in a Master Plan based on the outline determined previously. The National Highway network is based on three axes :

- Patras-Athens-Thessaloniki (PATHE) highway (779 km), the key element of the infrastructure development, crossing regions and towns where 60 % of the population live. A beltway around Athens is part of the project, designed to skirt around the city center.
- The "Egnatia" highway crossing the above-mentioned highway (872 km), linking Igoumenitza, the Western gate of Greece, and the Turkish and Bulgarian borders, ensuring Middle-East-bound European transit.
- The Western Greece highway, from Kalamata to the Albanian border (462 km), the key element for the development of the Western part of the country and for its communication with Italy and the rest of the European Union.

Network continuity within the country is cut by the Gulf of Corinth, penetrating inland on a West-East line, allowing only one road link between the Peloponesus and Northern Greece at Corinth, in East of the country. There is accordingly a disproportionate land use in the East where the two major cities are located : Athens-Piraeus (population : 2 millions) and Thessaloniki (population : 400,000). Streamlined regional development presupposes imbalancing the Eastern axis by the construction of a Western axis from Ioannina to Kalamata but continuity is broken by the Gulf of Corinth. The key element of this axis is the Rion-Antirion Bridge, situated at the junction of the PATHE highway and the Western Greece highway, at the traditional point for crossing by sea.

CENTRAL MEDITERRANEAN DEVELOPMENT SCENARIOS



3- THE SITE

The Rion strait is the dividing line between Gulf of Corinth in the East, and Gulf of Patras in the West, the latter opening on to the Ionian sea. The narrowest neck of this strait is only 2,500 m, and the maximum water depth is 70 m.

3-1 Urban areas

This strait has been an easy crossing point since ancient times and two small towns were founded on its banks, Antirion in the North, and Rion in the South. The strategic importance of the site is borne out by the presence of ancient fortifications (dating from Byzantine times), incorporating even older elements, on the far side of both towns. These vestiges are of limited aesthetic interest because they have not been well conserved, but they are of high architectonic value because of the older elements embodied in their construction.

Antirion, on the Northern bank, is a small town with under one thousand inhabitants, a convenient transit point for fast vehicle transit to and from the towns and harbours in Northwestern Greece such as Agrinion, Ioanina, Igoumenitza. The Northern coast of the Patras Gulf is a growing residential area, due to the somewhat unhurried development of tourist resorts. The relief rises steeply (Mt Klokoba 1 038 m) to a hilly outcrop with visible rock surfaces. On the Corinth Gulf, the Northern Coast is bordered by vast empty areas covered with herbaceous vegetation. The coastal plain leading to Nafpaktos includes some cultivated land and orchards.

Rion, in the South, is a larger urban area, with a population of approximately 3,000 inhabitants which is undergoing rapid growth. In reality, this is a suburb of Patras and the town center is only ten or so kilometers to the Southwest. The traditional occupation on the coast, as at Antirion, was confined to a fort and a few shops near the landing stage. The old residential center is at Saint-Georges, approximately 1 km inland.

Patras is the country's third largest city (with over 200.000 inhabitants). It is the leading harbour link with Italy. Ferry-boats are in constant operation, loading and unloading trucks, cars and passengers. At present, Patras is the western gateway for Eastern Greece (Athens - Thessaloniki), thanks to the Thessaloniki-Athens-Patras highway.

RION - ANTIRION STRAIT



0 500 2000m

The coastal plain, between Patras and Rion, is being rapidly urbanized and olive groves, between the highway and the coast, are being sold off as building sites. This urbanization process is being reinforced by the creation of a regional hospital and the huge campus of the University of Patras on the Southern side of the highway.

On the South coast of the Gulf of Corinth, urbanization dates back even further but it still increasing (Aghios Vassilios). Oil storage depots are located along this shore, just a few hundred meters from Rion. Three kilometers further East is a cementery facing the sea.

The Athens-Patras railway runs approximately 1 km from the shore. Industrial areas are being developed along the Southern part of the highway, pushing the cultivated land back to the slopes of the mountains.

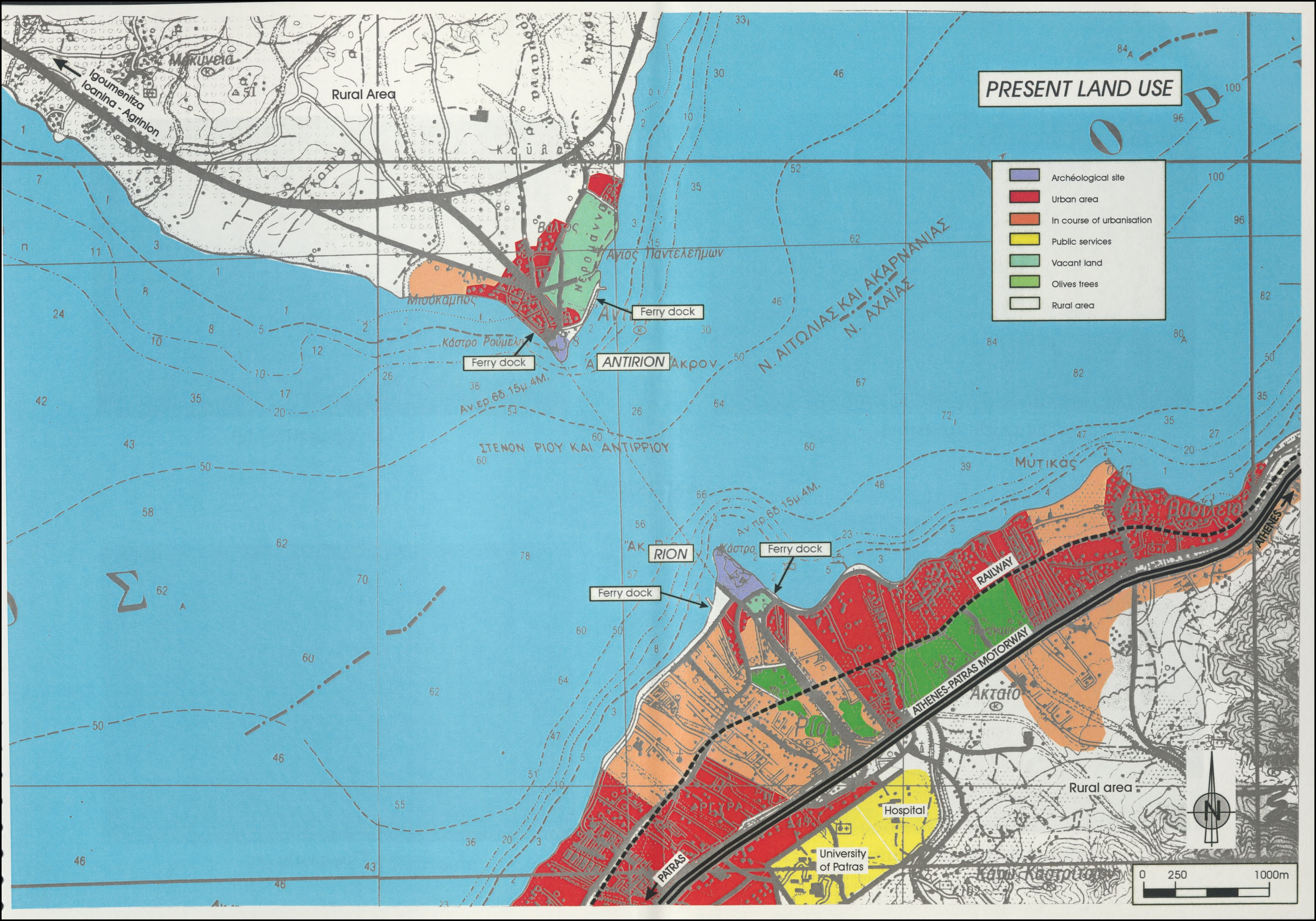
3-2 Crossing the strait today

The crossing between Rion and Antirion is serviced by 30 ferryboats. They are well equipped for rapid loading and unloading of vehicles (trucks, buses, and cars) but the entire process (loading, crossing and unloading) requires about 30 to 45 minutes.

The boats are barges with a front door lowered to form a ramp giving access to an internal platform where the vehicles park. The average ferry load consists of fifty cars, 4 or 5 semi-trailers and an equal number of buses. The cabin and passenger deck are generally located aft, above the vehicle platform.

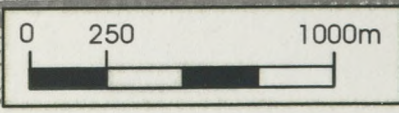
The ferries operates in shifts, with ten or so on stand-by, ready to provide a rapid response to a momentary traffic peak.

On-shore installations are simple : they consist of vast parking areas with a dock where the ferries moor at right angles and the access ramp is lowered. The length of the quay allows some ten boats to operate simultaneously. These parking areas and quays are located to the West and East of each of the built-up area, to be able to land to leeward at any time. The traffic demand has increased significantly and steadily over the last twenty years and the service level provided by the ferries, sensitive to weather conditions, is felt less and less appropriate to the growing importance of this link.



PRESENT LAND USE

- Archéological site
- Urban area
- In course of urbanisation
- Public services
- Vacant land
- Olives trees
- Rural area



ANTIRION

RION

Hospital

University of Patras

Ferry dock

Ferry dock

Ferry dock

RAILWAY

ATHENS-PATRAS MOTORWAY

PATRAS

ATHENS

Rural Area

Rural area

Igoumeniza
Ioannina - Agrinion

Makynia

Μησούκαμπος

Κάστρο Ρούμελης

Αν. Ερ. 65.15μ. 4Μ.

ΣΤΕΝΟΝ ΡΙΟΥ ΚΑΙ ΑΝΤΙΠΠΙΟΥ

Κάστρο

Αν. Πτο 65.15μ. 4Μ.

ΜΥΤΙΚΟΣ

Ακταίο

Αγίος Παντελεήμων

Ν. ΑΙΤΩΛΙΑΣ ΚΑΙ ΑΚΑΡΝΑΝΙΑΣ
Ν. ΑΧΑΪΑΣ

RION



The castle (outside)



The castle (inside)

ANTIRION



General view of Antirion



The castle



Ferries



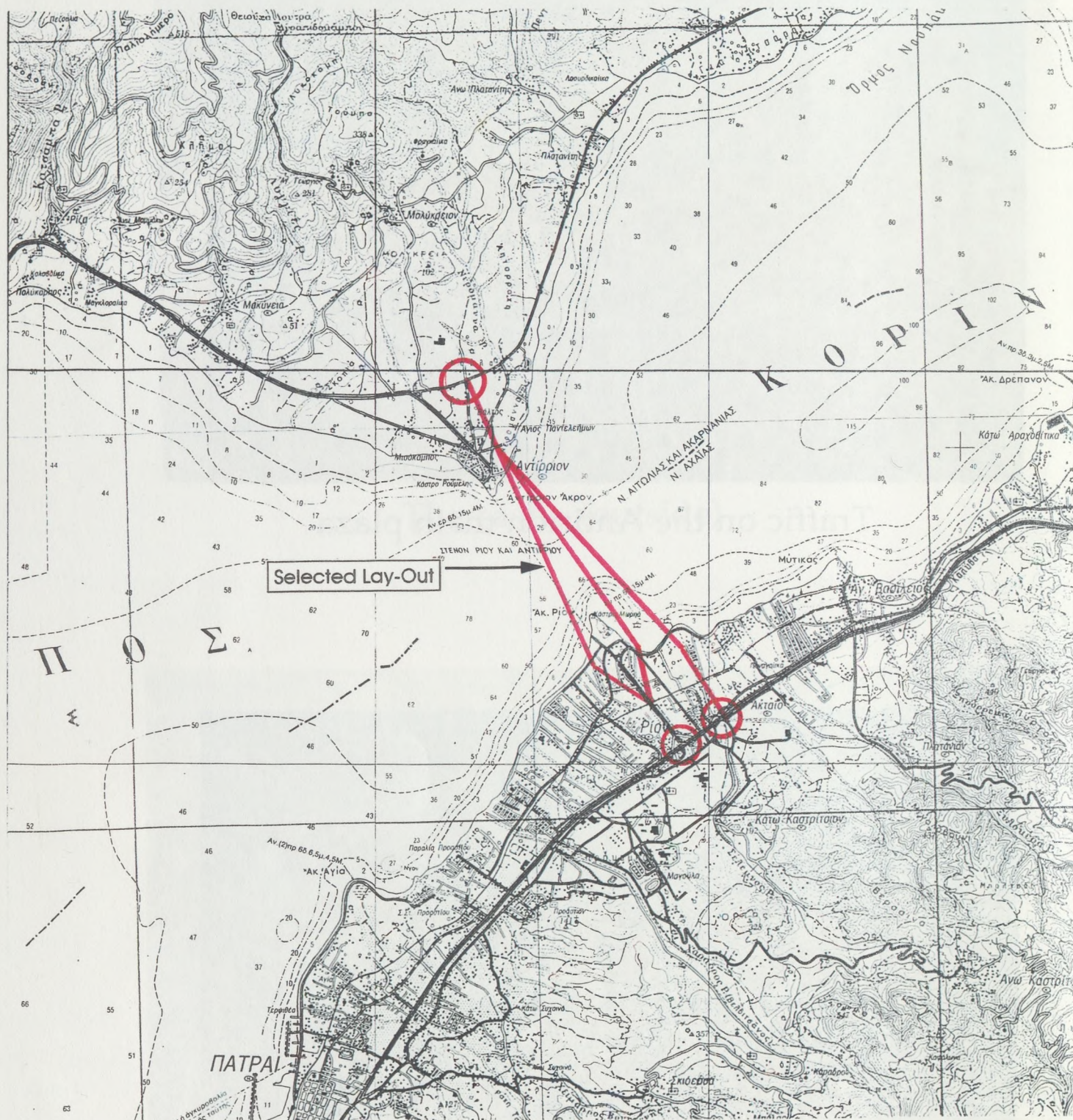
Traffic on the Antirion main plaza



Project area on Rion side



Project area on Antirion side



4- THE PROJECT

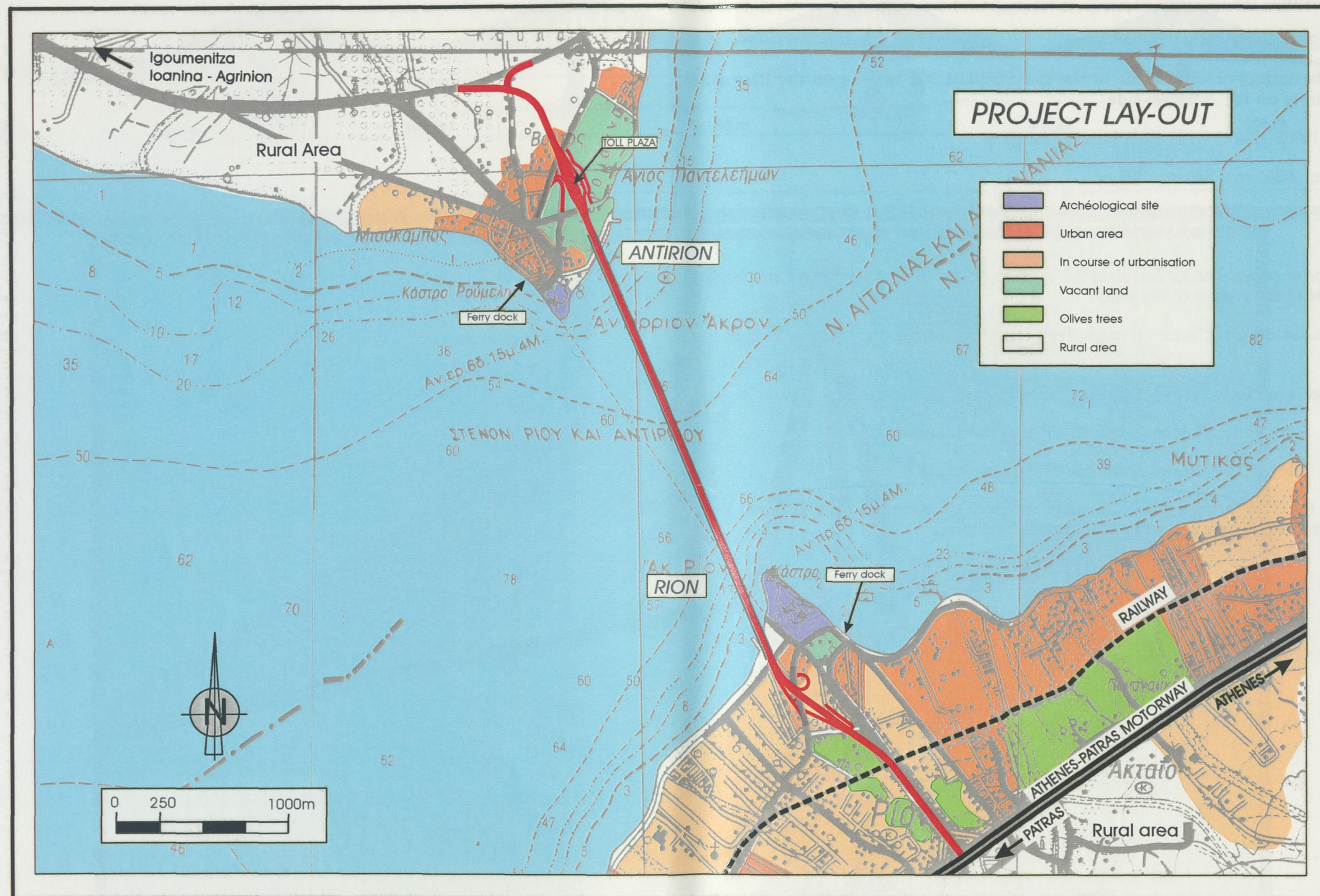
4-1 The alternative links and lay-outs

The EIA has considered environmental impact for the different types of links mentioned below :

- Fixed bridge ;
- Floating bridge ;
- Bored tunnel ;
- Sea-bed tunnel ;
- Submarine floating tunnel.

All the different types of tunnels were rejected. The two types of bridges, the fixed and floating bridges, were found to be environmentally equivalent. The choice finally went to the link that minimized the project's impact on the environment.

In parallel with the various types of links, a number of lay-outs have been studied. It soon became apparent that the Northern end of the project should be to the East of Antirion where there is a vast vacant area. The choice of site was more difficult at Rion. It first appeared desirable to build the bridge to the East of the castle, as on the Northern bank. More thorough studies revealed the drawbacks of such a solution. Finally, for reasons exposed in 8-1 hereafter, a lay-out west of the castle was chosen.



4-2 Project technical data

The bridge consists of :

- a main bridge, 2,290 m long ;
- an approach viaduct on either side of the main bridge, 378 m long on the Rion side and 252 m long on the Antirion side.

The main bridge has 5 spans, with the following lengths:

305 m / 560 m / 560 m / 560 m / 305 m.

This is a multi-cable stayed bridge, supported by 4 piers upon sturdy foundations, resting on the sea bed.

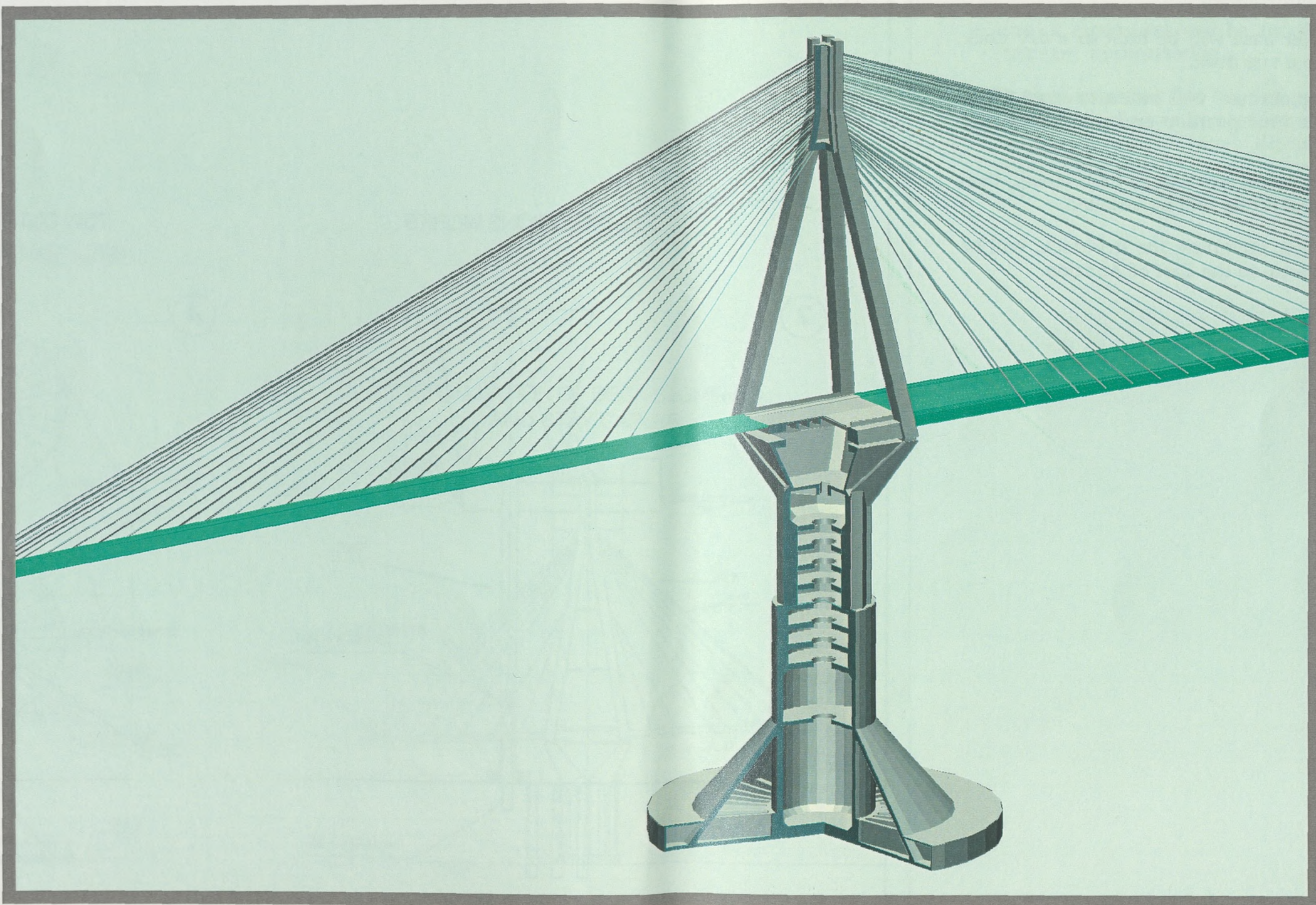
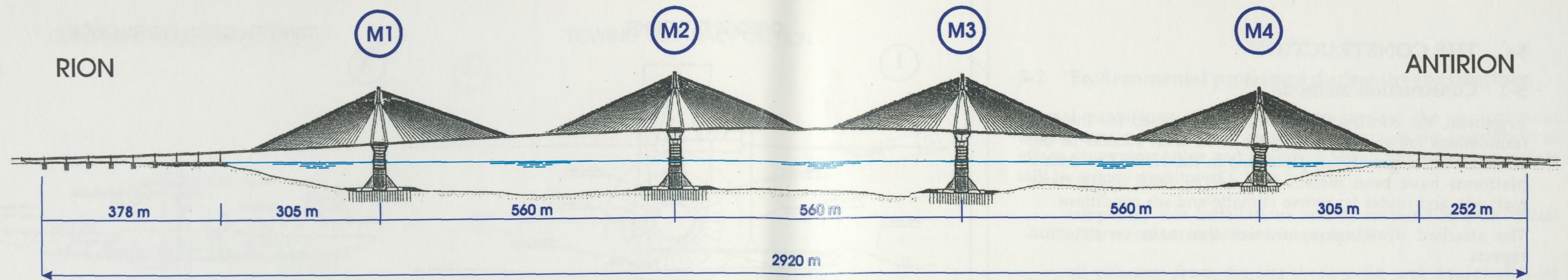
The deck is a slender composite girder, situated at 50 m above the sea level, and suspended by means of cables to the pylons of the piers.

Each pylon is made of 4 inclined concrete legs, meeting at the top, where cables are anchored.

So the main bridge assembles two exceptional construction techniques :

- concrete off shore platforms for its foundations,
- long cable-stayed spans for its superstructure.

On both sides of the main bridge, viaducts allow the deck to reach the ground level. They consist of 42 m concrete spans, almost entirely located on shore.



5- THE CONSTRUCTION

5-1 Construction methods

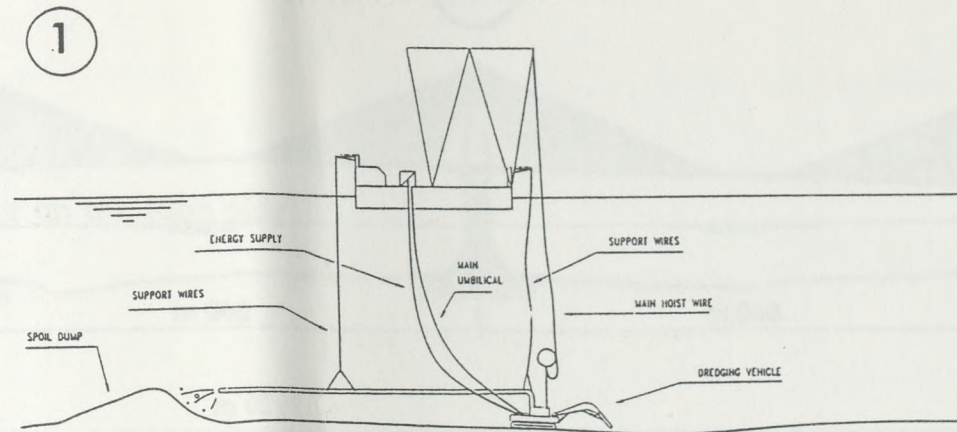
In general, the construction methods to be used for the pier foundations are the same as those used with success in the construction of gravity oil platforms in the North Sea. Many platforms have been installed in deeper seas, using these methods, and under far worse climatic and sea conditions.

The attached drawings synthesize the main construction aspects.

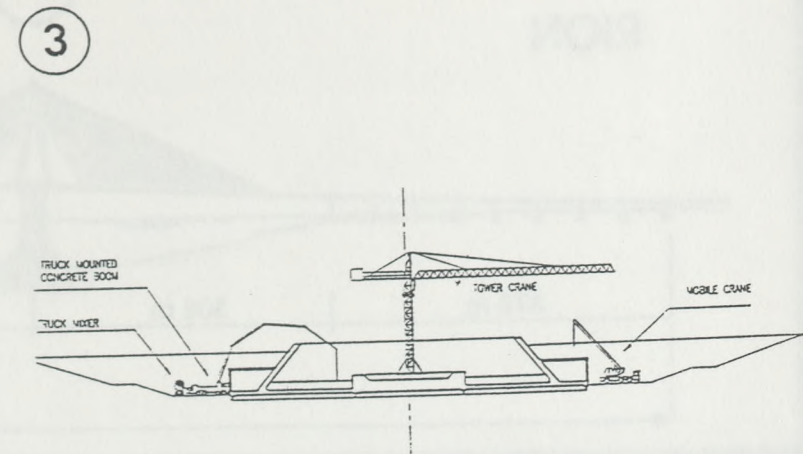
- 1-2 Preparation of sea bed for foundations : sea bed levelling and reinforcement.
- 3-4 Pier base : the pier base will be built in a dry dock, then towed out to a wet dock.
- 5-6 Pier shaft : the pier shaft will be constructed afloat then towed to its final position and sunk there onto the sea bed.
- 7-8 Pylon and deck : pylon legs will be built in-situ, then deck segments and cables will be installed.

The main site installations, including the dry dock, will be sited on the vast vacant area, to the East of Antirion.

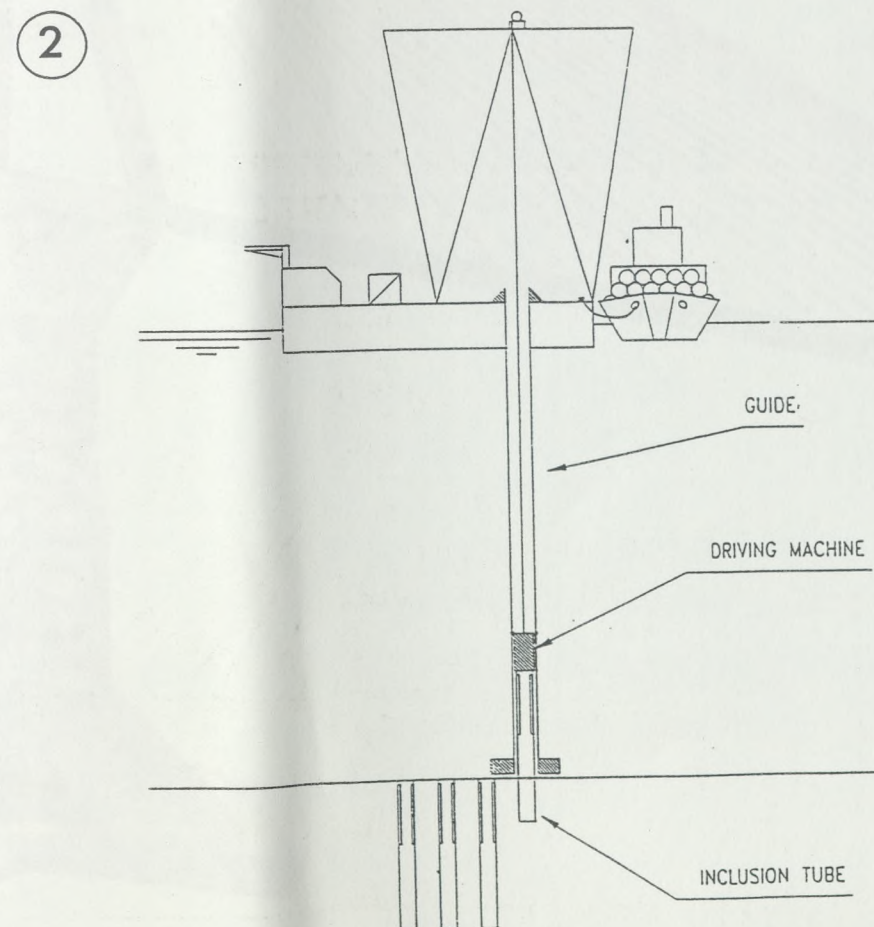
DREDGING WORKS



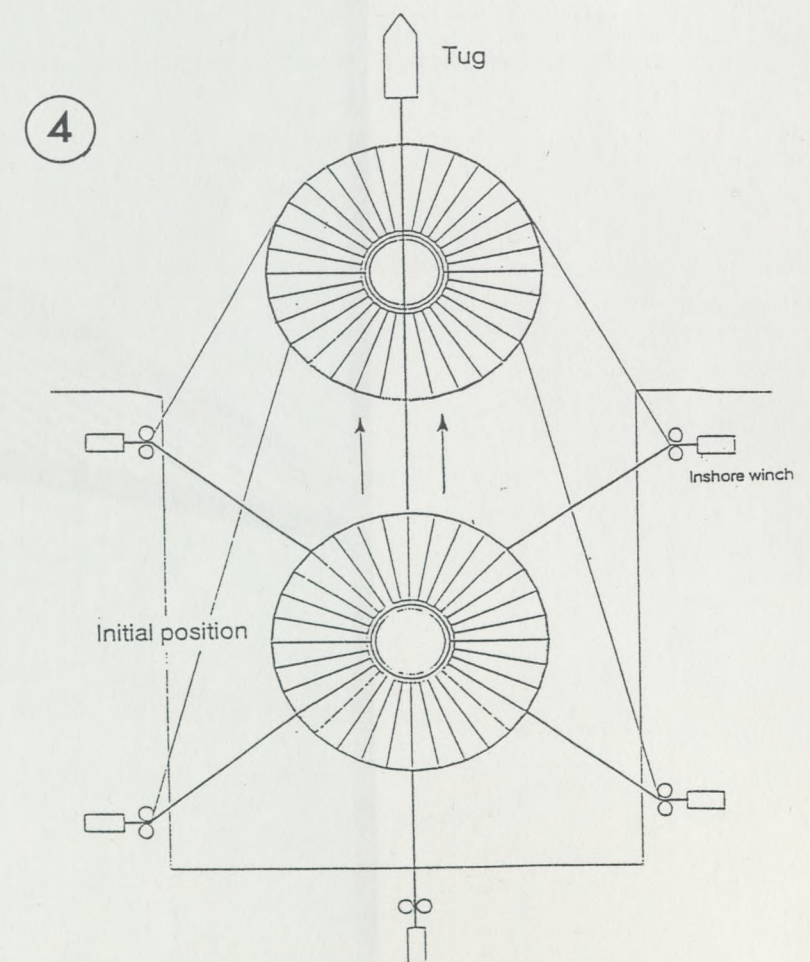
CONSTRUCTION IN DRY DOCK



SOIL INCLUSIONS WORKS

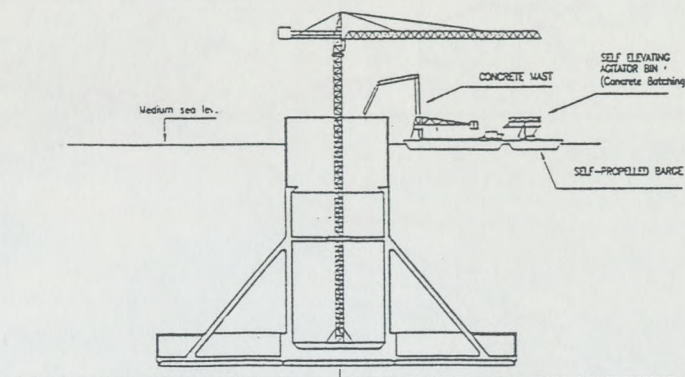


TOW OUT FROM DRY DOCK



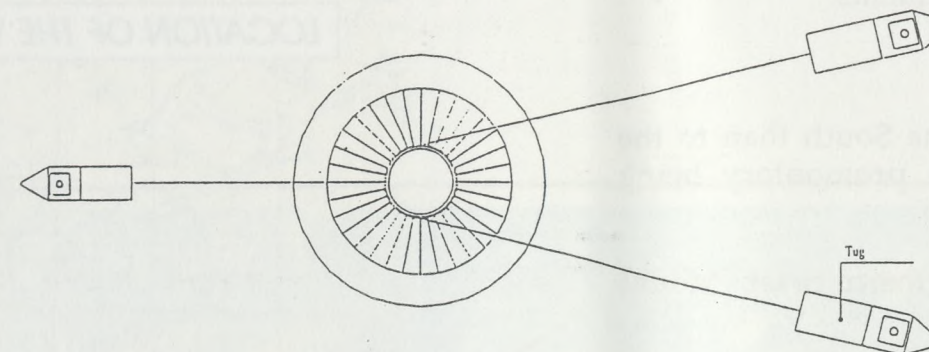
CONSTRUCTION AFLOAT ST 2

5



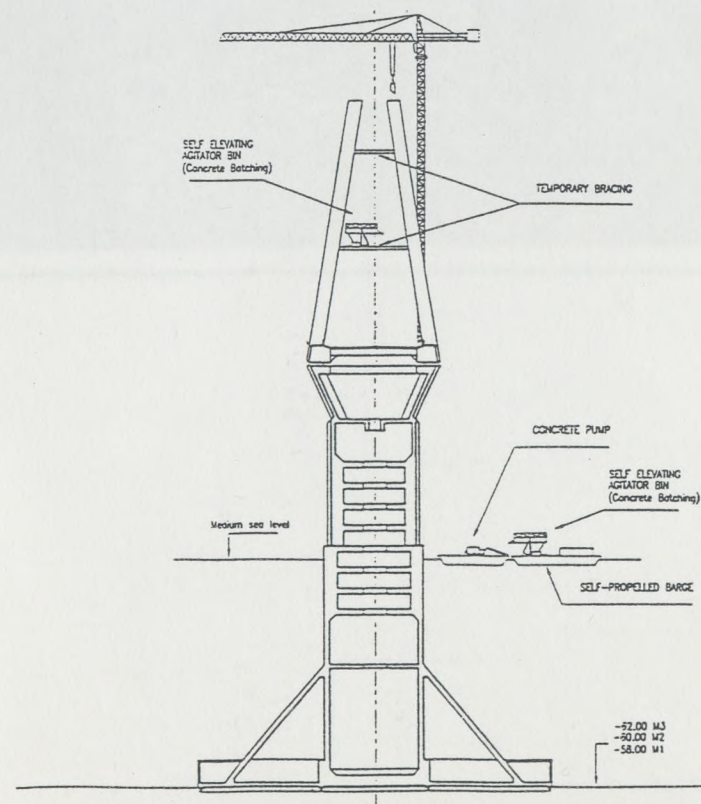
TOWING TO FINAL POSITION

6



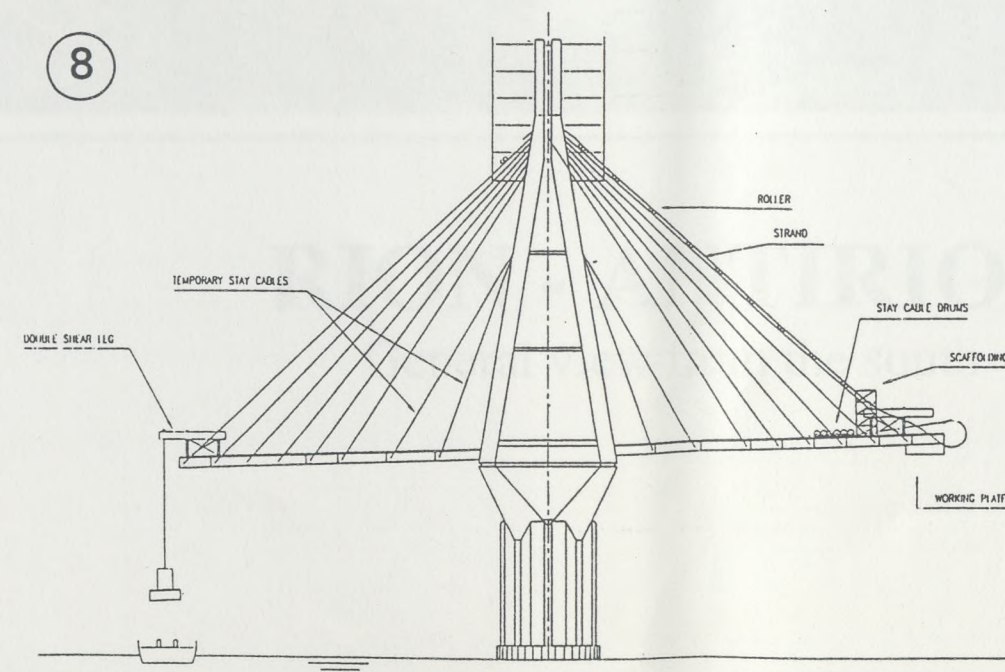
CONSTRUCTION OF TOWER LEGS

7



INSTALLATION OF DECK SEGMENTS AND STAY CABLES

8



5-2 Environmental protection during the construction

Special provisions will be made to protect the environment during construction. Apart from application of the legislation in effect, governing noise and pollution levels, the following points will be strictly monitored :

- temporary site installations will be restored to their initial state when construction is completed
- all effluents from the site (both solid and liquid) will be collected and discharged to sites selected by the authorities.
- use of explosives will be strictly restricted and subject to relevant authorization.

It must be noted that the design of the foundations and the flatness of the sea bed will minimize spoil from dredging and, therefore, any disturbance to the marine environment.

6- INTEGRATION INTO THE LANDSCAPE

The landscape into which this bridge is to fit consists of three main elements:

- the strait between the two promontories ;
- on each of the banks, the coastal plain which is narrower to the South than to the North, forming a promontory either side of the strait, each promontory being highlighted by the ancient fortifications.
- the mountainous slopes to the west of Antirion on the Northern coast, Mount Klokoba reaching an altitude of 1 037 m.

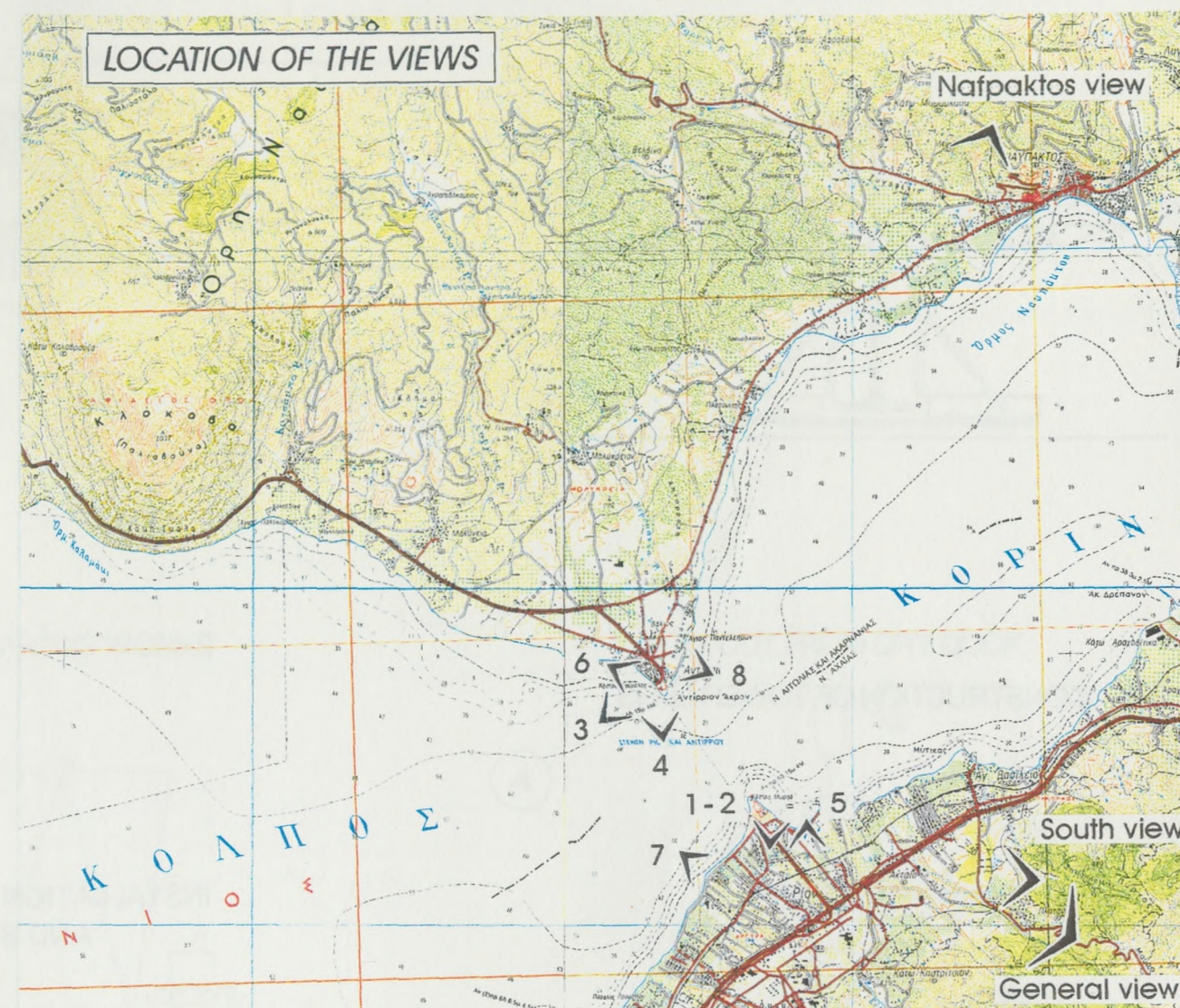
The mountainous slopes close the landscape to the North and South. They are covered with bushes and herbaceous plants but bare rock often appears between them. The steepness of the slope provides spectacular views, in particular from the South (cf. photo : general view from the South).

Views towards the East (Gulf of Corinth) are closed at a distance of ten or so kilometers by the narrowing of the area between the plain of the Mornos River to the North and the Drepanon peak to the South. On this side, the most distant point of view on the site is the Nafpaktos Castle.

Conversely, to the West, the opening onto the Gulf of Patras widens very quickly into a vast seascape closed at the horizon, more than 30 km away, by Cape Araxos.

On this site, where the field of view angles are measured in kilometers, despite the 2.5 km long bridge, and its maximum height of 150 m above sea level, there will be no disparity of scale. Its architecture has been specially designed by an expert in large bridge constructions, Berdj Mikaelian.

Better than words, the attached photographs show the scale of the landscape and how well the bridge fits in, both from a distance and close up.





RION - ANTIRION

General view from the south

7- MAJOR RISK PREVENTION

7-1 Seismic risks

The bridge design takes seismic risks into consideration. The structure is designed to resist very high earthquake levels, combined with tectonic movements.

7-2 Navigation risks

According to statistical data supplied by the Patras port authorities, an average of 10 vessels per day sail the Rion-Antirion strait. Most of them are coasters. The biggest ships are cargo or bulk carriers (40 to 80,000 dwt), but there are only 55 of them each year. No very large vessels, such as tankers, use the strait.

The navigation channel will be positioned in the middle of the strait, where a clear height of 50 m will be provided below the bridge deck.

The bridge piers will create little obstruction to navigation thanks to their limited size near sea level. They are designed to sustain the impact of a tanker.

The collision of a ship and the bridge could only result from an unexpected combination of factors : the crew loses control of the vessel which, left to itself, drifts up against the bridge. Special studies have been carried out showing that the risk of such an event is very low.

To prevent collision, not only is it intended to install a beaconing and light-signalling system during the construction period and when the bridge is operational, but, in addition, during construction, a specific system will be installed to monitor navigation, able to detect any abnormal behaviour of a ship and to take the necessary measures to prevent an accident.



RION - ANTIRION BRIDGE

VIEW FROM NAFFAKTOS CASTLE

8- LOCAL IMPACT AND PROTECTION

8-1 The Byzantine castles

On these two sites, Rion and Antirion, there are Byzantine castles in a commanding position above the shore, highlighting the strategic importance of the location. The proximity of the project was considered special grounds for investigation to avoid any undesirable overshadowing or visual disturbance. The project site was therefore chosen after assessing many alternative lay-outs, based upon minimizing the environmental impact. The alternatives were also put to the Central Archaeological Board which gave its opinion, and the Ministry of Culture issued its decision regarding the acceptable lay-out for the project. This decision, based exclusively on the criterion of environmental protection for the castles, preferred, in its principle, a lay-out to the East of the castle on the Rion side, downstream of the Selemnos stream. The lay-out terminating on the Rion side, West of the castle, and at least 100 m from it, was proposed as an alternative.

It was considered in these environmental studies (regardless of the construction cost which were obviously going to be higher because of the greater length of the marine portion of the project) that such a lay-out, East of the castle, downstream of the Selemnos stream :

- would lead to greater disturbance in the residentially-developed Aghios Vassilios region,
- comes into contact with the TEXACO installations for the storage of petroleum products, meaning risks for the traffic, for the project and also for the region in general.

The lay-out terminating East of the castle on the Rion side, but a short distance from it, according to the studies, will generate:

- more undesirable overshadowing by the castle,
- greater disturbance to the ferries which now connect the trunk roads of Western Greece.

Therefore, the lay-out that was finally adopted terminates on the Rion side, over 100 m to the West of the Castle. In this lay-out :

- the imposing atmosphere and the characteristic profile of the two castles are maintained,
- a favourable system of unimpeded road access to the link project is secured without disturbing local traffic, facilitated even further by the construction of the project.

The 6th Curator of Byzantine Antiquities, with headquarters in Patras, also agreed to the above-mentioned lay-out.

Today, the Byzantine castles are in a poor state of repair. The refurbishing of their surroundings and their restoration during the construction of the bridge will enhance the site in general. An information center could be installed in the Rion castle to provide information about the history of the site and the new bridge, thus highlighting the obvious continuity of the strategic importance of the strait for the development of Western Greece.

8-2 Disturbance to housing

The chosen lay-out is obviously bound to create problems for properties belonging to Rion residents who will have to be expropriated. This concerns approximately 20 houses and all new building in the project area will have to be stopped. Expropriations will be conducted by the government authorities using the normal legal procedures, before work begins. On the Antirion side, no house expropriation is really needed.

But the main permanent hindrance for housing will result from the increased traffic generated by the commissioning of the bridge and the correlated increase in noise levels.

It should be noted that at present, traffic passes through two built-up areas causing considerable interference with local life. Average traffic is 7,000 vehicles per day and can reach 20,000 vehicles per day during the summer peak period. The noise generated by this traffic substantially exceeds tolerable levels, local traffic safety is obviously precarious and traffic congestion in the built-up areas makes life difficult there in the summer. The opening of the bridge will relieve the urban centers of the through traffic and recreate more agreeable living conditions.

In-situ observations of the sound level will be made so as to have a basis of comparison between the current situation and the new one. A permanent observation network of sound levels will be set up as soon as the bridge is opened. These observations will quantify the hindrance caused by the new situation so that noise protection can be set up when the sound levels caused by traffic using the bridge reach the maximum threshold of 65 dB(A). As soon as work begins on site, protective measures will be applied to the noisier sectors.

8-3 Social acceptance of project

The bridge project between Rion and Antirion has aroused many favorable opinions both among the local inhabitants and the Greek people in general. The construction of this large bridge, on the European scale, is a reason for the inhabitants to feel proud. The expected consequences on the development of the Western front of Greece and the fact that it offers a better connection with the other countries of the European Union are particularly well understood. This project of large magnitude and high technology is felt to create dynamism in the country.



RION - ANTIRION BRIDGE

VIEW FROM THE SOUTH

