Table 6.2 Definition of Soft Ground Layer

Layer of Soils	Natural Water Content (%)	Unconfined Compression (kg/cm^2)	Number of Blows (N)
	more than	less than	less than
Organic Soils Layers	100	0.5	4
Cohesive Soils Layers	50	0.5	4
Sand or Sandy Soils Layers	30	-	10

Based on the results of geological investigations, it was judged that soft ground areas exist in the following two locations along the Toll Road route.

Location	Total Length	Layer Thickness
1. Near Surabaya river crossing (Sta.9+000 - 13+500)	4.5 km	16 m
2. Near Mas river crossing (Sta. 34+000 - 38+300)	4.3 km	24 m

6.3.4 Soft Ground Treatment Study

(1) Conditions for Treatment Analysis

a) Embankment Design Conditions

- Embankment Material
  - Wet density : γ_t = 1.80 t/m^3
  - Cohesion : c = 2.00 t/m^2
  - Internal friction angle : ø = 10 degree
  - Design CBR : 5%
  - Plasticity index : Ip = 22.2
- Embankment Slope : 1 : 2
- Progress of Embankment : 5 cm height per day

b) Target for Settlement and Stability

- Remaining Settlement : 10 cm at maximum after completion of embankment

- Safety factor for sliding : $F_X > 1.25$

(2) Result of Soft Ground Treatment Study

a) Treatment Method

There are several soft ground treatment methods available for embankment construction, among which the vertical sand drains method with sand mat was selected from the practical and economical viewpoint. The thickness of sand mat layer on the ground is 1.0 m in consideration of trafficability of heavy equipment. The diameter of sand drains is 40 cm.

b) Results of Soft Ground Treatment Study

The results of soft ground treatment study are summarized in Table 6.3.

Table 6.3 Results of Soft Ground Treatment Study

Descriptions	Soft Ground Area	
	Surabaya River Area (Sta. 11+500)	Mas River Area (Sta. 37+400)
Sand drains	ø 400 mm @ 2.5 m	ø 400 mm @ 2.5 m
Sand mat	1.0 m thickness	1.0 m thickness
Remaining Settlement after 30 days retention	5.6 cm < 10 cm	8.7 cm < 10 cm
Safety factor for sliding	$1.27 > F_X = 1.25$	$1.26 > F_X = 1.25$
Limited embankment height	7.2 m	7.3 m
Ultimate settlement for 7.0 m embankment height	1.75 m	2.20 m

6.3.5 Embankment and Other Materials

Location of sources of materials is shown in Fig. 6.4.

a) Embankment Materials

Laterite soils with CBR of approximately 5-6 are available at several potential borrow areas in the southeast of Mojosari. Small scale potential borrow areas were found in the north of the Surabaya river (i.e. silty sand, tuffaceous clay and weathered tuff, with CBR ranging from 5 to 24), but available volume is very limited (approximately 500,000 m^3 in total).

b) Subbase Materials

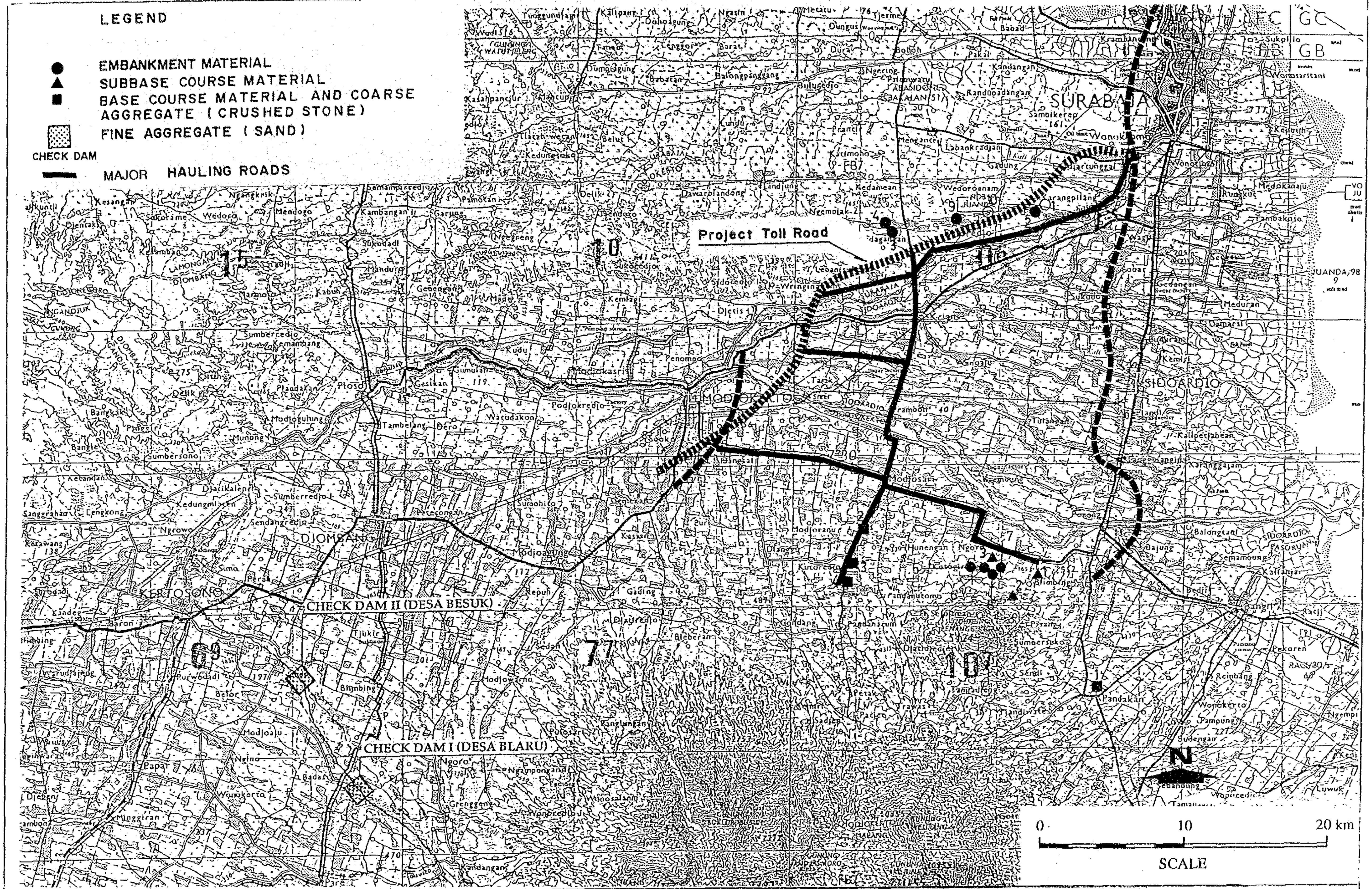
Subbase materials of fine to coarse sand, with CBR of approximately 30, are available at several potential borrow areas in the southeast of Mojosari. These materials are not suitable as fine aggregate for concrete due to their grain size distribution characteristics but are highly advantageous for the embankment construction to reduce the total thickness of pavement structure.

c) Coarse Aggregate Materials

The main source of coarse aggregate materials is river gravel (i.e. andesite rocks) from the borrow pits in the south of Mojosari. The quality test showed a satisfactory result for utilization in the Toll Road construction.

d) Fine Aggregate Materials

Abundant fine aggregate materials sources exist in the south of Jombang, sand deposit from eruption of Mount Kelud. Estimated volume of deposits is approximately 5, million m^3. Test results generally passed the grading requirement of fine aggregate.



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 6.4 Location Map of Material Sources

6.4 Hydrological Survey

6.4.1 Site Survey and Data Collection

A site survey was carried out to investigate the hydrological conditions in the Project Area, including river system, irrigation canal network and flood condition. Data of rainfall, flood control schemes and irrigation schemes were collected from such agencies as the regional irrigation offices of Sidoarjo and Mojokerto regencies and the Brantas River Basin Development Execution Office. The data collected were analyzed to prepare a sound basis for the route selection and preliminary design.

6.4.2 Flood Conditions

(1) Flood Control

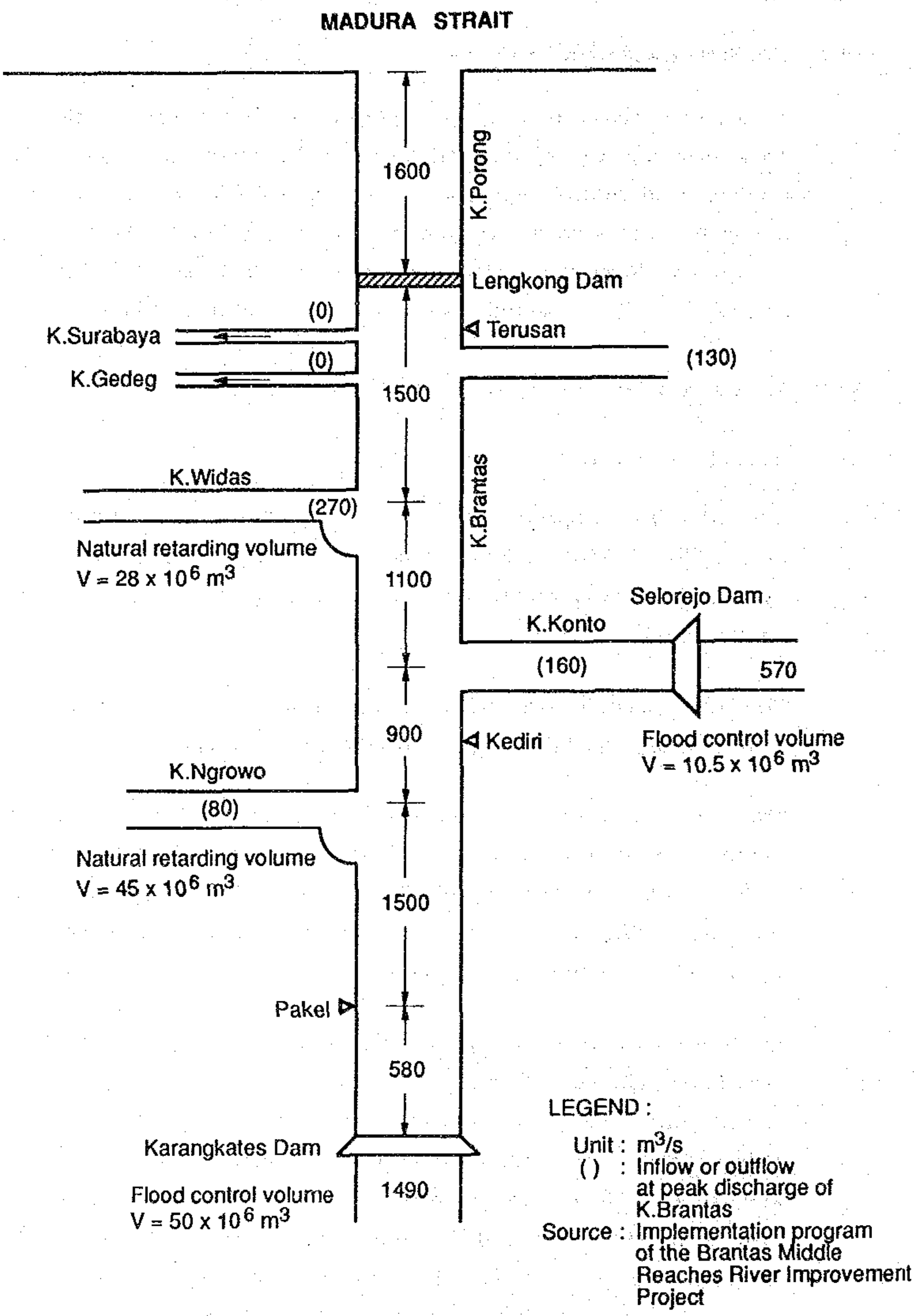
Since the first comprehensive development plan of the Brantas river basin was formulated in 1961, several sizable projects of water resources development for hydroelectric power generation, flood control and water supply were successively implemented.

The present flood control scheme of the Brantas river is formulated in accordance with the design flood discharge of 50 years return period as illustrated in Fig. 6.5.

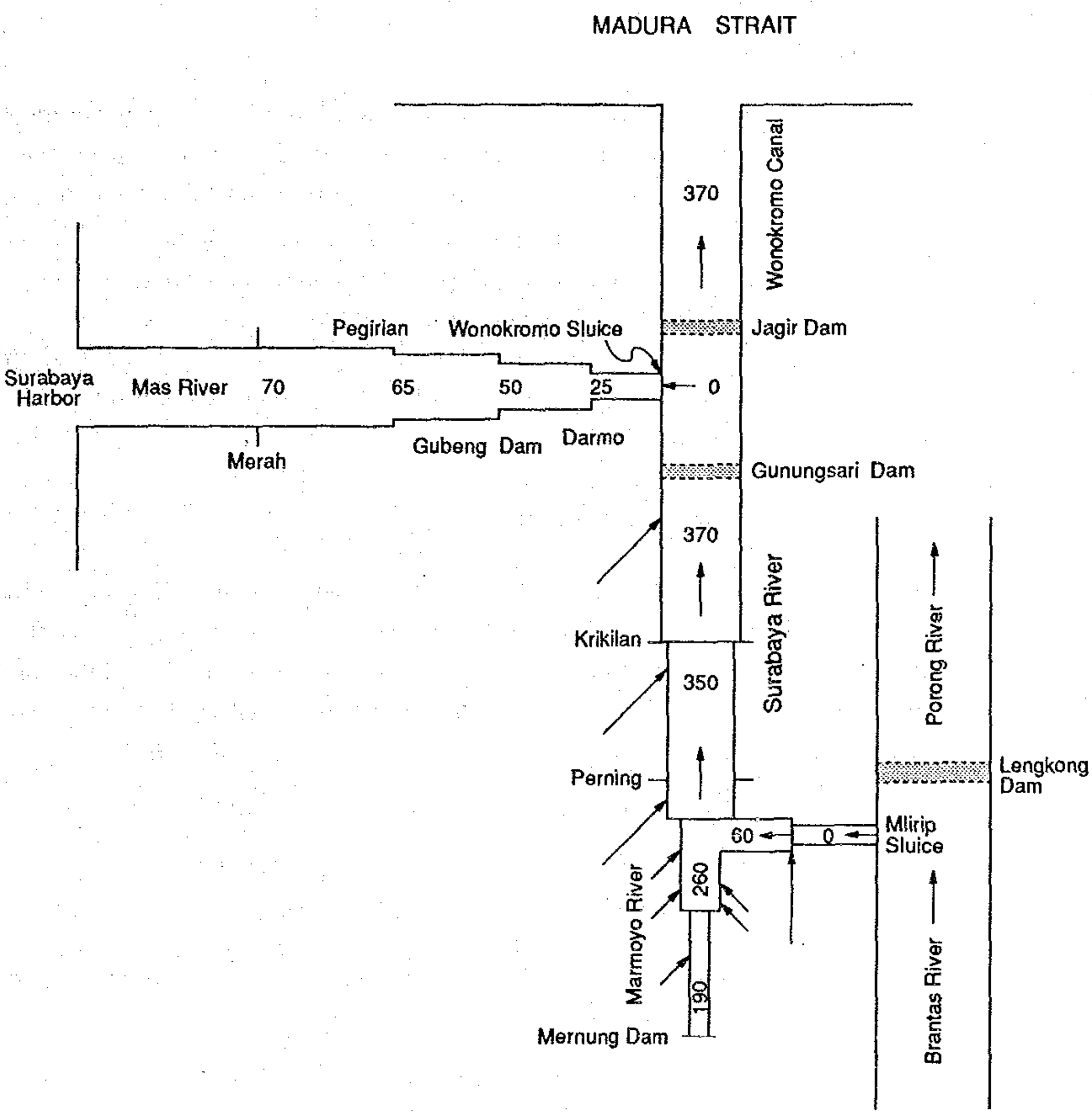
The Porong river, the main drainage of the Brantas river, has a levee system at both banks. Recently, the existing levee height was examined in view of securing 1.0 m freeboard above the design high water level. Though it was found that there are some portions having insufficient freeboard downstream, the existing levee height upstream is compatible to the minimum freeboard of 1.0 m.

In the overall development plan of the Brantas river system, flood of the Brantas river is not allowed to flow into the Surabaya river by gate operation of Mlirip and Gedeg sluice. The flood control scheme of the Surabaya river is formulated independently of the Brantas scheme. The design flood discharge of the basin was estimated for 50 years return period as illustrated in Fig. 6.6. The Surabaya river also has a levee system at both banks. Present levee height exceeds the design levee height after the completion of the Surabaya River Improvement Project (1981) and the Surabaya River Improvement Project Stage II (1988).

Under such situation, no special considerations against flood will be required for both the Porong and Surabaya rivers if the Toll Road passes over the existing levees



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 6.5 Brantas River Basin Flood Control Scheme



Remarks.
Design discharge : m^3/s
Source : Survey and Study Report for the Kali Surabaya River Improvement Project. Aug. 1976

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 6.6 Design Flood Discharge of Surabaya River

securing sufficient headroom for vehicle traffic on the inspection roads on river banks.

(2) Flood experience

The Brantas Delta has had no experience of flooding in the recent decade after implementation of the Porong River and the Surabaya River Improvement Projects. According to the information given by the Sidoarjo Regional Irrigation Office, there are still some small retained water areas, 40 cm depth in maximum, for 2-3 days after heavy rain. Locations of these occasional retained water areas are illustrated in Fig.6.7. These occur because of depressed terrain conditions.

According to the hearing survey at Mojokerto regency, this region also has no flood experience in recent decades.

6.4.3 Irrigation System in the Brantas Delta

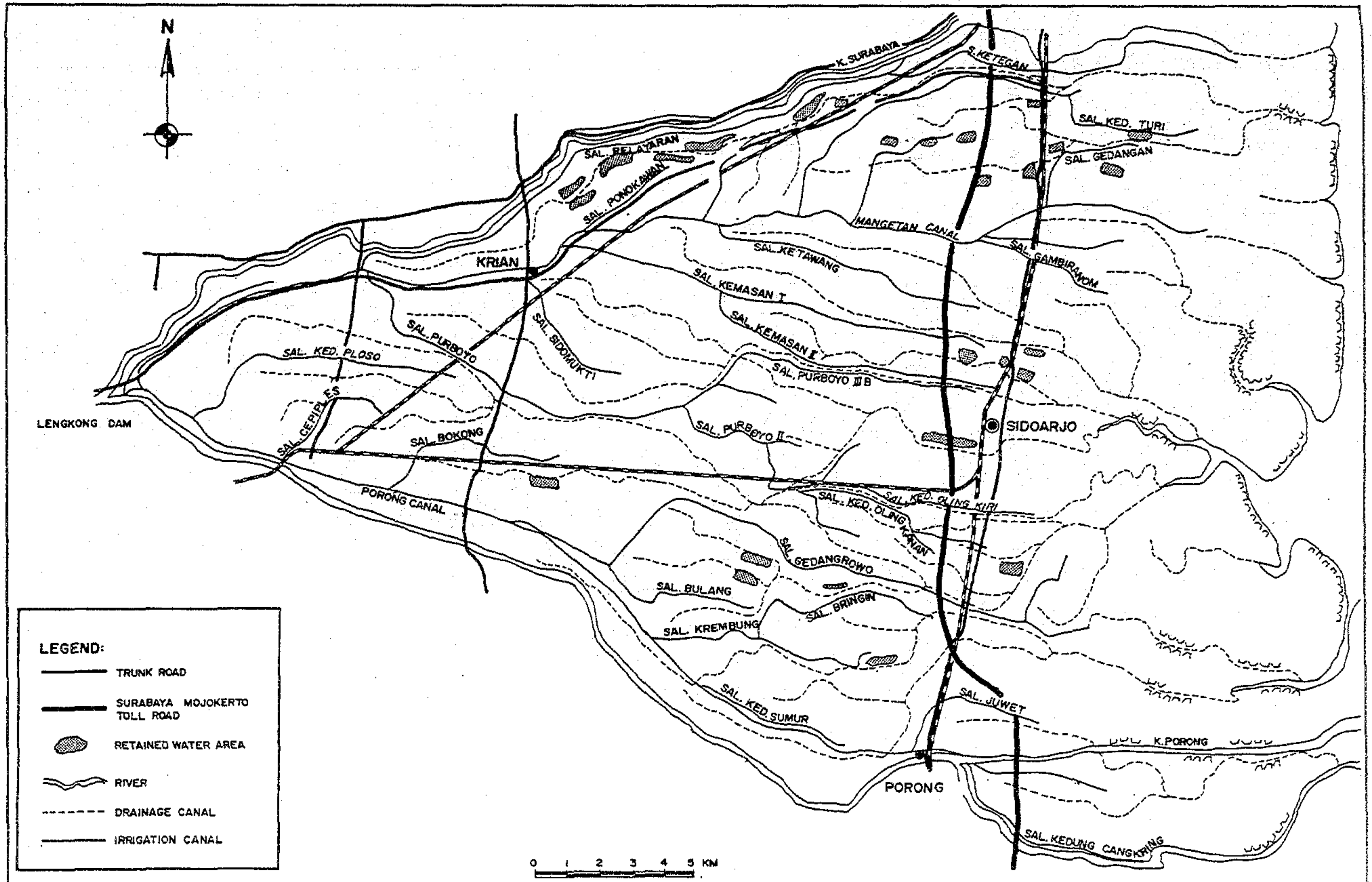
Surrounded by the Surabaya river, the Porong river and the Madura Strait, the Brantas Delta is one of the most developed irrigation areas as illustrated in Fig. 6.8. This irrigation area is maintained by the Sidoarjo Regional Irrigation Office of DPU in the Kabupaten Sidoarjo. It forms a Technical Irrigation Network in the area of 28,851 ha, covering the following areas.

1)	Voor Canal Irrigation Area	663 ha
2)	Mangetan Canal Irrigation Area	15,986 ha
3)	Porong Canal Irrigation Area	12,202 ha

Irrigation Water is taken from the Lengkong Dam (Brantas River) using the following facilities.

1)	Voor Canal as a sedimentation pond	1,300 m
2)	Main Canal (Mangetan/Porong)	75,350 m
3)	Intake Structure	432 numbers
4)	Secondary Canal	297,690 m
5)	Tertiary Canal	838,724 m

Voor Canal Irrigation Area will not be affected by the Toll Road. Mangetan Canal and Porong Canal Irrigation Areas, the former in particular, will be directly affected by the Toll Road when the southern route is selected. Normally, major irrigation



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 6.7 Location of Retained Water Area canals are provided with an inspection road which should remain after the construction of the Toll Road.

6.4.4 Rainfall Analysis

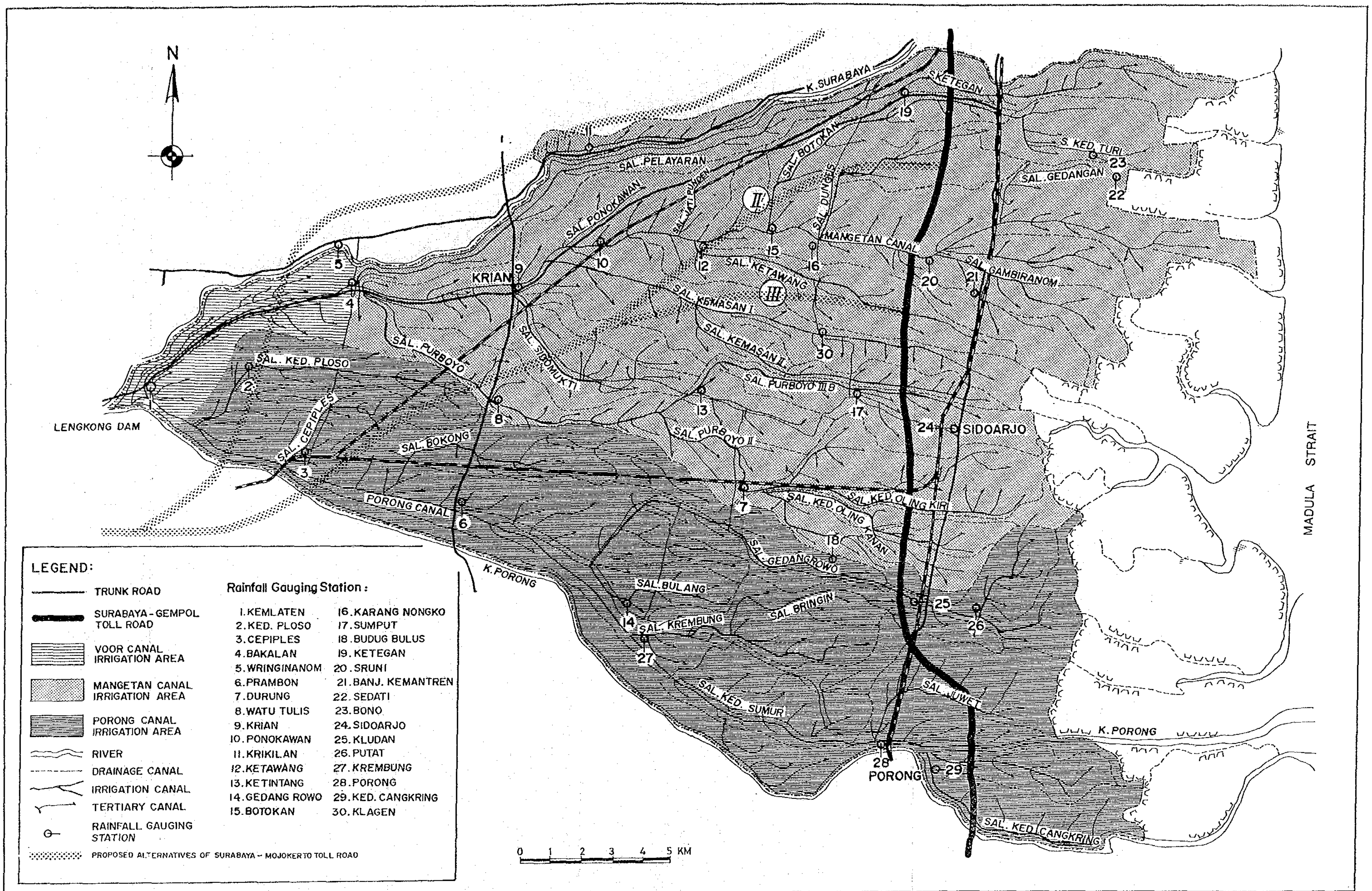
(1) Rainfall Data

Rainfall data was collected from the Sidoarjo Regional Irrigation Office, the Mojokerto Regional Irrigation Office and the Brantas River Basin Development Execution Office. Fig. 6.9 shows locations of rainfall gauging stations in the Project Area.

For the rainfall analysis, the following 11 rainfall stations having 20 years daily rainfall data were selected.

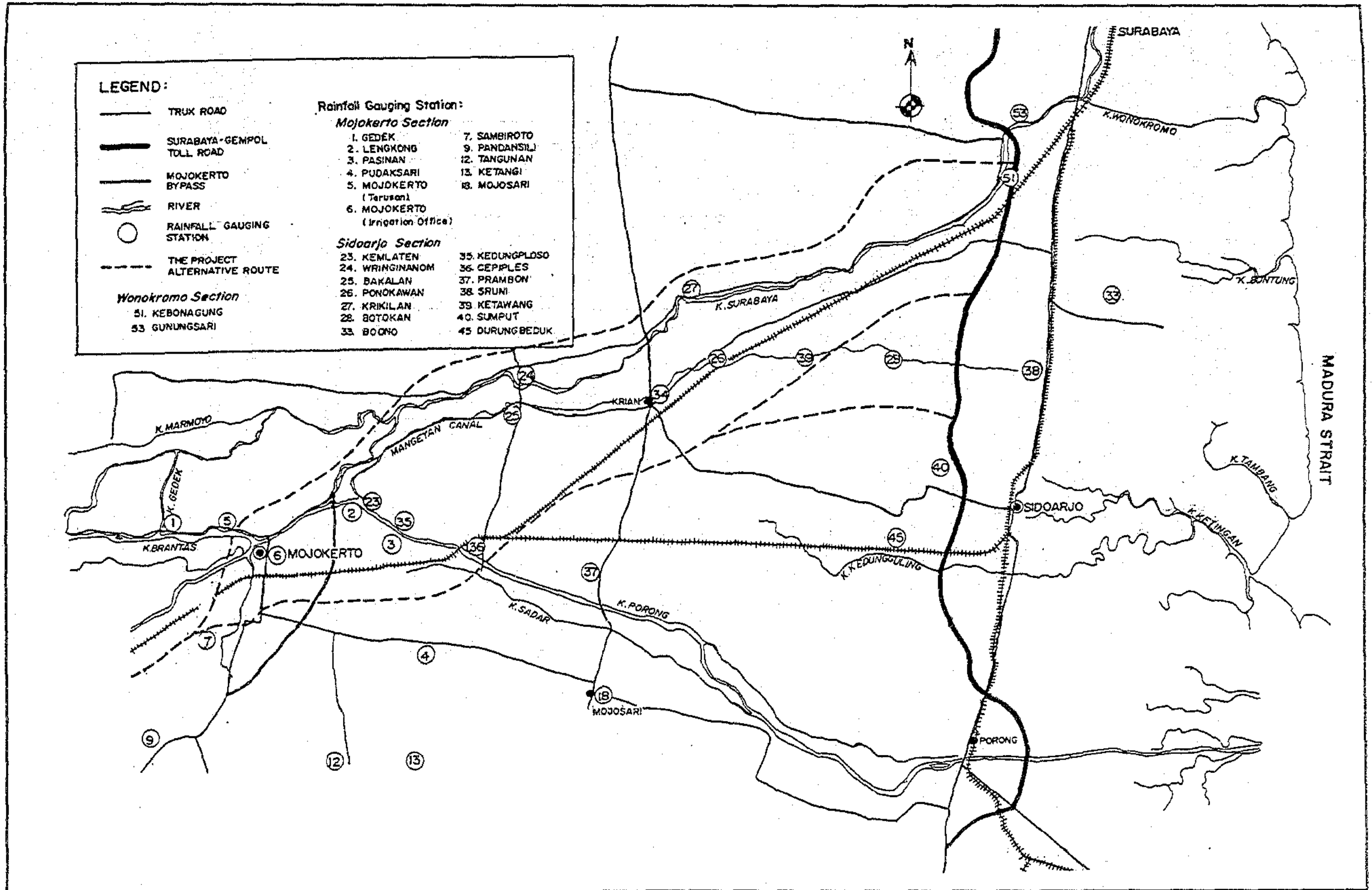
No.	Station Name
2	Lengkong
5	Mojokerto (Terusan)
7	Sambiroto
25	Bakalan
27	Krikilan
28	Botokan
34	Krian
36	Cepiples
37	Prambon
38	Sruni
53	Gunungsari

Mean monthly rainfall and average number of monthly rainy days are shown in Appendices A-6.5 and 6.6.



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 6.8 Canal Network System in the Brantas Delta



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 6.9 Location of Rainfall Gauging Stations

(2) Design Rainfall Intensity

Probable daily rainfall of the following return periods are calculated (refer to Subsection 9.2.4) applying Gumbel Method in order to estimate design rainfall intensity.

Return period	Apply to
25 years	Tributaries of the Porong and Surabaya rivers
5 years	Neighboring basin
3 years	Surface water drainage

Table 6.4 shows the calculation result of probable daily rainfall for the said return periods (maximum daily rainfall per annum for 20 years of each rainfall gauging station is shown in Appendix A-6.7).

Table 6.4 Probable Daily Rainfall

No.	Station Name	Return Period		
		3 years	5 years	25 years
2	Lengkong	90.65	104.68	144.56
5	Mojokerto (Terusan)	92.01	102.73	133.24
7	Sambiroto	104.47	119.07	160.59
25	Bakalan	111.12	128.95	179.67
27	Krikilan	90.60	102.42	136.03
28	Botokan	100.55	107.24	126.26
34	Krian	108.60	119.24	149.49
36	Cepiples	93.31	102.93	130.29
37	Prambon *	111.19	130.62	185.89
38	Sruni	94.72	103.82	129.68
53	Gunungsari	107.38	124.67	173.85

Referring to the calculated result, values of Prambon station are adopted for the rainfall intesity analysis. Design rainfall intensity (mm/hr) is expressed as follows applying Dr. Mononobe's formula.

$$r_t = \frac{R_{24}}{24}\left(\frac{24}{t}\right)^{2/3}$$

where. r_t : Mean rainfall intensity in "t" hours (mm/hr)
R_{24} : Daily rainfall (mm)
t : Time of concentration (hour)

$$t = t_i + \frac{Lc}{60 \times V}$$

t_i : Inlet time of surface runoff from the farthest point of a basin to river channel
Lc : River channel length
V : Mean velocity of flow in a channel

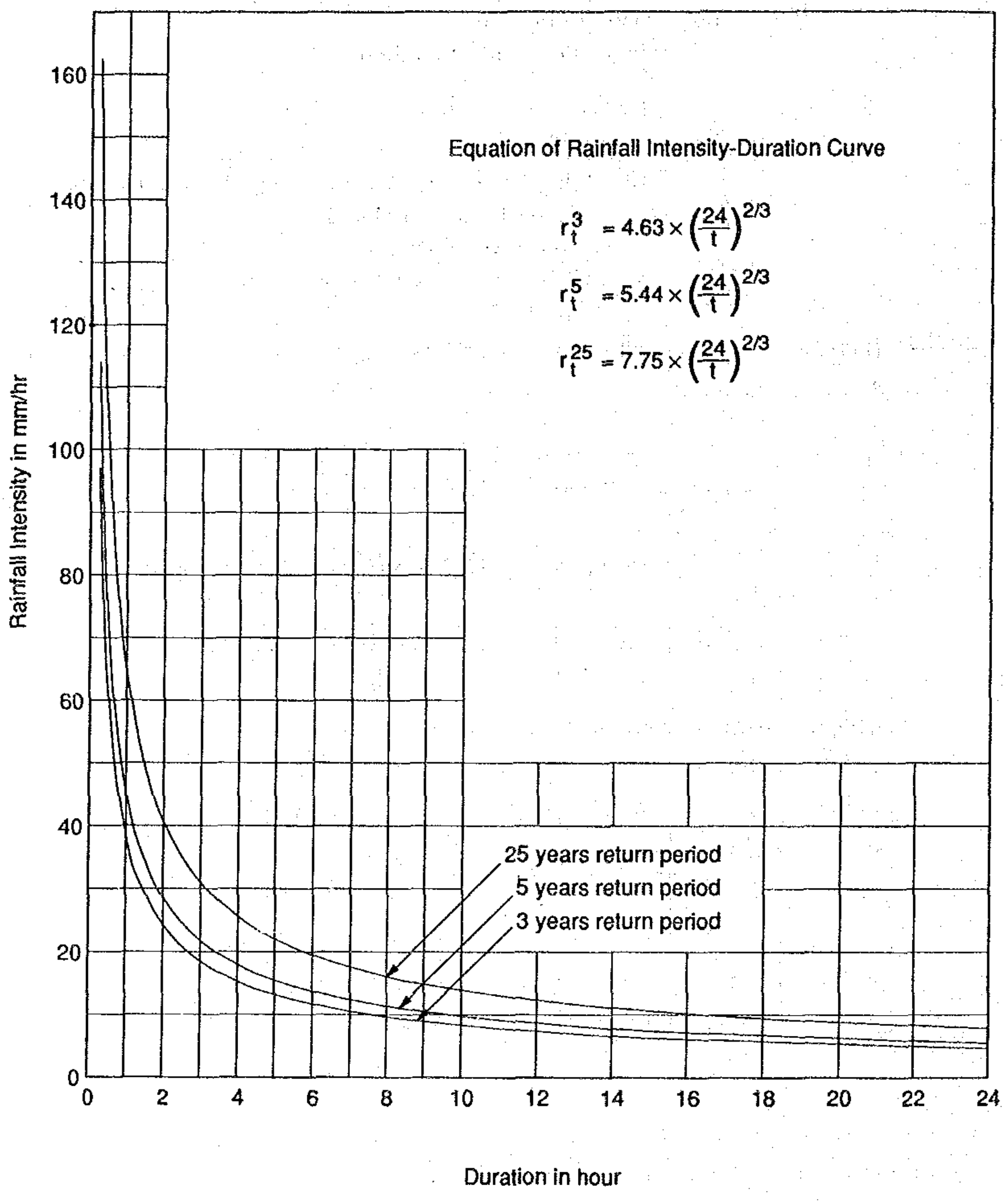
Therefore design rainfall intensity for 3 years, 5 years and 25 years return period is derived as follows.

3 years return period $r_t^3 = 4.63\left(\frac{24}{t}\right)^{2/3}$

5 years return period $r_t^5 = 5.44\left(\frac{24}{t}\right)^{2/3}$

25 years return period $r_t^{25} = 7.75\left(\frac{24}{t}\right)^{2/3}$

Design rainfall intensity-duration curve is presented in Fig. 6.10.



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	**Fig. 6.10** **Design Rainfall Intensity -Duration-Frequency Curve**

Chapter 7

ROUTE SELECTION

CHAPTER 7

ROUTE SELECTION

7.1 Establishment of Route Alternatives and Screening

7.1.1 General

This Section describes the results of the initial route study which aimed i) to pick up all the possible route alternatives taking into account the socio-economic, environmental and physical conditions in the Project Area and ii) to narrow them down through comparative study to short-listed alternatives.

Such short-listed alternatives were then compared in Section 7.2 in more detail based on the results of traffic demand forecast, preliminary cost estimates and preliminary economic analysis to select an optimum route.

7.1.2 Basic Policies for Route Location

The objectives of the Project are understood as follows:

- To strengthen the road network between Surabaya and Mojokerto to dissolve traffic congestion on the existing national and provincial roads connecting these two cities by adding a high-standard road link of full access control; and
- To constitute a part of the Trans Java Tollway System which will realize high-capacity and high-speed vehicular transport in Java Island.

Taking such objectives in mind, the following basic policies were exercised in locating the alternative routes.

a) To facilitate the future extension of the Toll Road for the formation of the entire Trans Java Tollway System, as well as westward extension from

Mojokerto and eastward connection to Pasuruan and Probolinggo via Gempol.

b) To locate the route to enable the construction of the interchanges at the most efficient places for road users. To this end, the route should be selected at the shortest possible distance from the city center of Surabaya, Krian and Mojokerto, which are the major points of traffic generation and attraction in the corridor.

c) To locate the route coordinating with the landuse plan and road network development plan of the regencies of Surabaya, Gresik, Sidoarjo and Mojokerto.

d) To locate the route which attains to low cost road structures.

e) To pay attention to such primary controls as existing roads, railway lines, large rivers/canals and electric power transmission lines to be crossed.

f) To avoid public facilities such as schools, hospitals, mosques, governmental offices, military facilities, as well as monuments having cultural/historical values.

g) To avoid as much as possible large factories and housing complexes.

h) To minimize severance of villages and well-developed farmland.

7.1.3 Review of Past Studies

To check the consistency with recent development plans and concepts, the following past studies were reviewed in the route locating process:

- Trans Java Highway Feasibility Study
- Investment Opportunities : Tollroads in Indonesia
- Pre-Feasibility Study for the Surabaya-Mojokerto-Kediri Toll Road
- Alternative Routes of the Surabaya-Mojokerto Toll Road indicated by the Government of East Java Province
- GKS Study (i.e. Urban Development Planning Study on Surabaya Metropolitan Area)

- IUIDP (i.e. Integrated Urban Infrastructure Development Project)

(1) Trans Java Highway Feasibility Study

The first idea of the Trans Java Tollway System dates back to the Trans Java Highway Feasibility Study conducted by Lyon Associates, Inc. in 1973. The Trans Java Highway intended to connect Jakarta and Surabaya via Semarang by a high-standard new road link.

The recommended route in the Semarang-Surabaya section in the study was the southern route connecting such cities as Surakarta, Madiun, Jombang and Mojokerto (refer to Fig. 7.1). The alignment in Nganjuk-Surabaya section generally passes south of major cities along the route corridor. It passes 2 km south of Nganjuk, 5 km south of Kertosono, then turns slightly to the north, and passes 4 km south of Jombang, 5 km south of Mojoagung, then turns northerly passing Mojokerto 3 km to the east of the city. The alignment then crosses the Porong river, turns easterly and then northeasterly, passing 3 km south of Krian and terminates 1 km south of Waru (refer to Fig. 7.2).

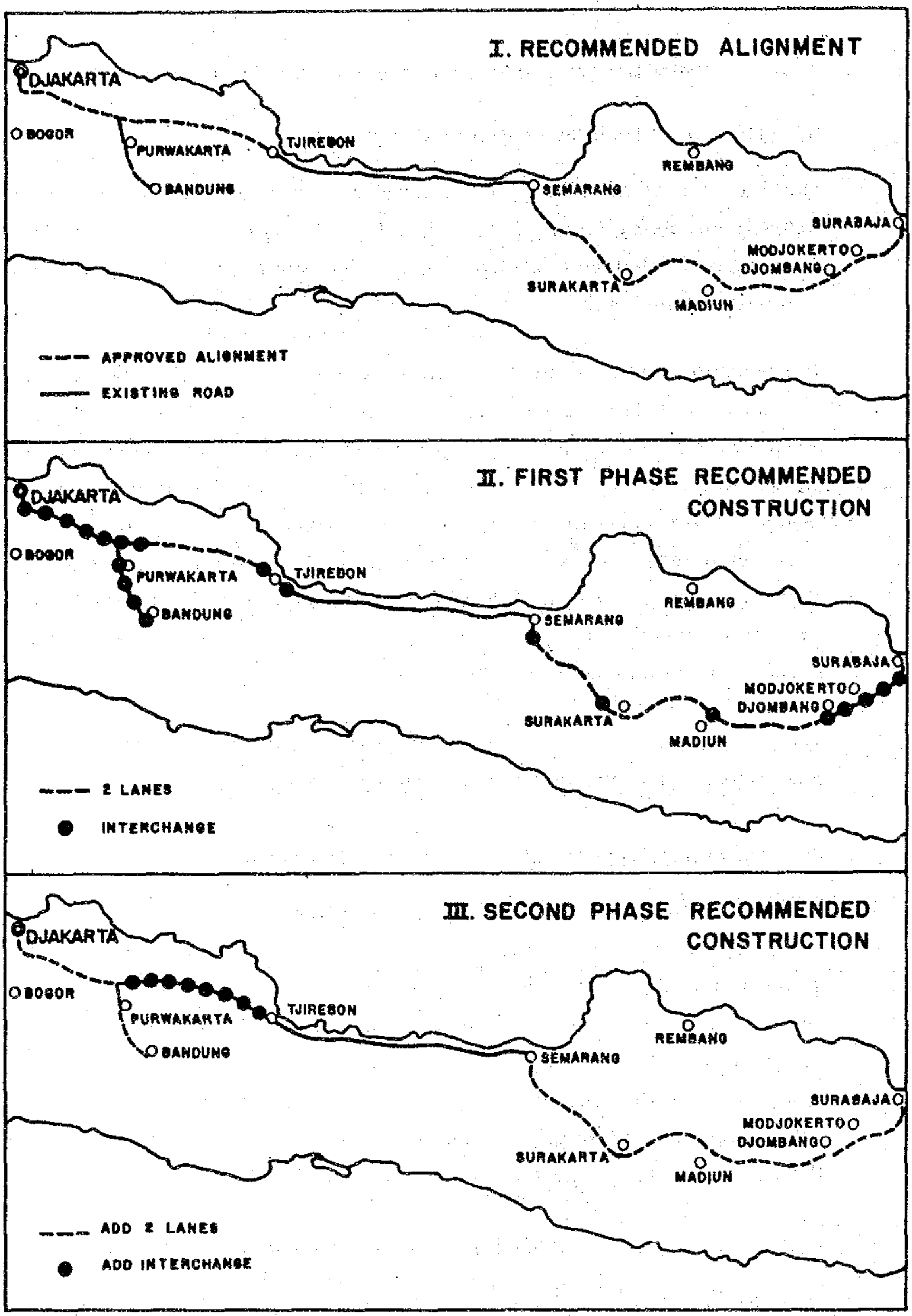
The design in the Jombang-Surabaya section was 2-lane road with all intersections grade-separated for the optimum opening year of 1980.

(2) Investment Opportunities : Tollroads in Indonesia

The idea of the Trans Java Highway has been refined into the Trans Java Tollway System incorporating the progress of toll road development in the vicinity of Jakarta and Surabaya, which is described in the pamphlet of "Investment Opportunities: Tollroads in Indonesia" prepared by P.T. Jasa Marga in 1988. The general route follows the recommended corridor in the Trans Java Highway Study. The Surabaya side terminus is planned near Sidoarjo Interchange (IC) on the existing Surabaya-Gempol Toll Road. The eastward extension from Gempol to Pasuruan appears in the pamphlet (refer to Fig. 7.3).

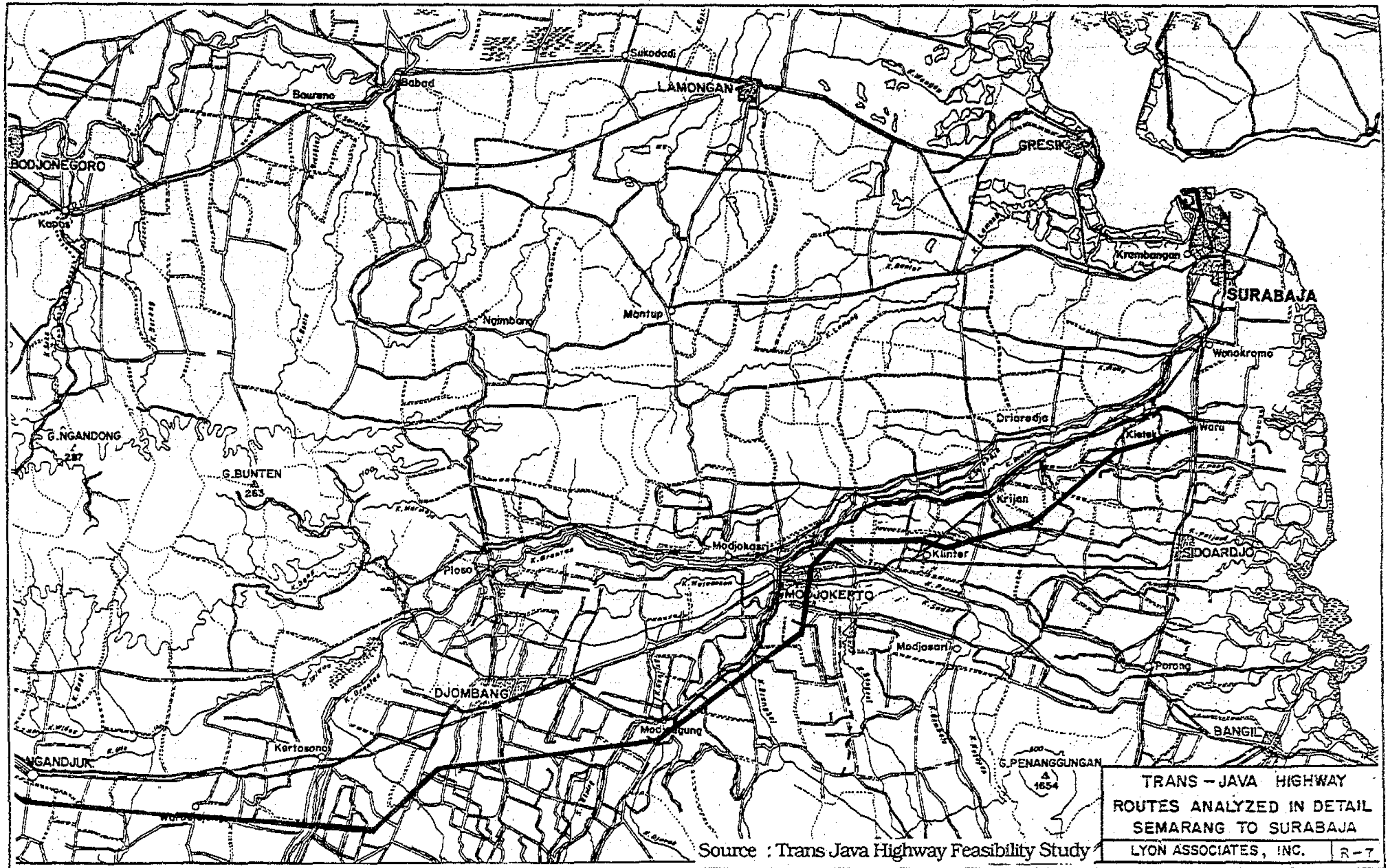
(3) Pre-Feasibility Study for the Surabaya-Mojokerto-Kediri Toll Road

The pre-Feasibility Study for the Surabaya-Mojokerto-Kediri Toll Road was conducted in 1989 by the Civil Engineering Faculty of the Institut Teknologi Sepuluh Nopember, Surabaya. After the comparison of three alternative routes, the southern route which starts from Waru IC of the Surabaya-Gempol Toll Road and passes south of Krian, Mojokerto, Jombang and Kertosono was selected as the recommended route



Source : Trans Java Highway Feasibility Study

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 7.1 Recommended Route by Trans Java Highway Feasibility Study (1)

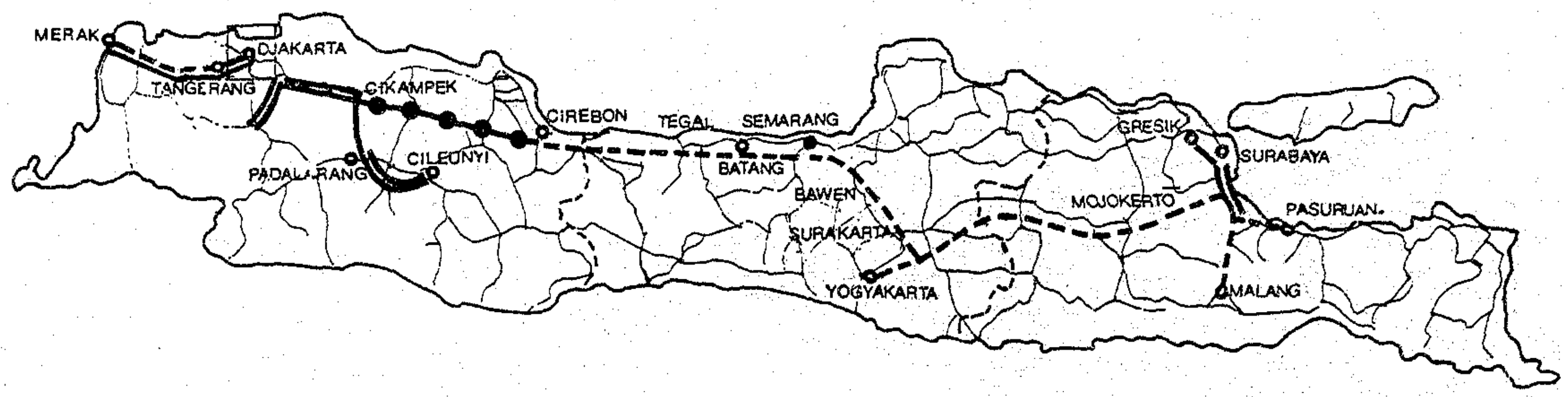


Source : Trans Java Highway Feasibility Study

SURABAYA - MOJOKERTO TOLL ROAD PROJECT

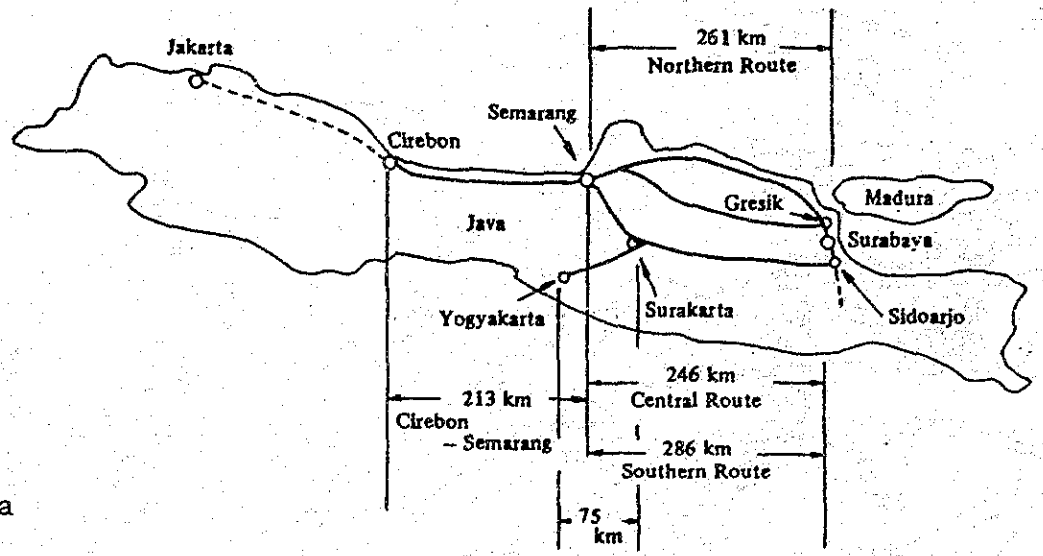
Fig. 7.2 Recommended Route by Trans Java Highway Feasibility Study (2)

TRANS JAVA TOLLWAY SYSTEM



STATUS AS OF AUGUST 1991

: In Operation
: Under Construction
: Detailed Design Stage
: Feasibility Study
: Pre-Feasibility Study



Source : Investment Opportunities : Tollroads in Indonesia

SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 7.3 Route Shown in Investment Opportunities : Tollroads in Indonesia (refer to Fig. 7.4). The advantages of direct connection with the Surabaya-Gempol Toll Road at Waru IC were explained as i) high accessibility to Juanda airport, ii) support to the development planning of Surabaya inter-city public transport pole of Bungurasih (planned new bus terminal), iii) integration with the plan of the East Surabaya Outer Ring Road and iv) support to the industrial activities in the southern part of Surabaya (Rungkut and Waru areas) and to Sidoarjo regency, though probable difficulties were anticipated in the modification of the layout of Waru IC.

(4) Alternative Routes of the Surabaya-Mojokerto Toll Road indicated by the Government of East Java Province

Two alternative routes were explained by the East Java Provincial Government in the discussion with the Preliminary Study Team of JICA in November 1989. One alternative route runs north of the provincial road and is connected to the Surabaya-Gempol Toll Road at Kota Satelite IC. The other runs south of the national road and is connected to the Surabaya-Gempol Toll Road at Waru IC. Both routes start from the northern end of the existing Mojokerto Bypass (refer to Fig. 7.5).

(5) GKS Study

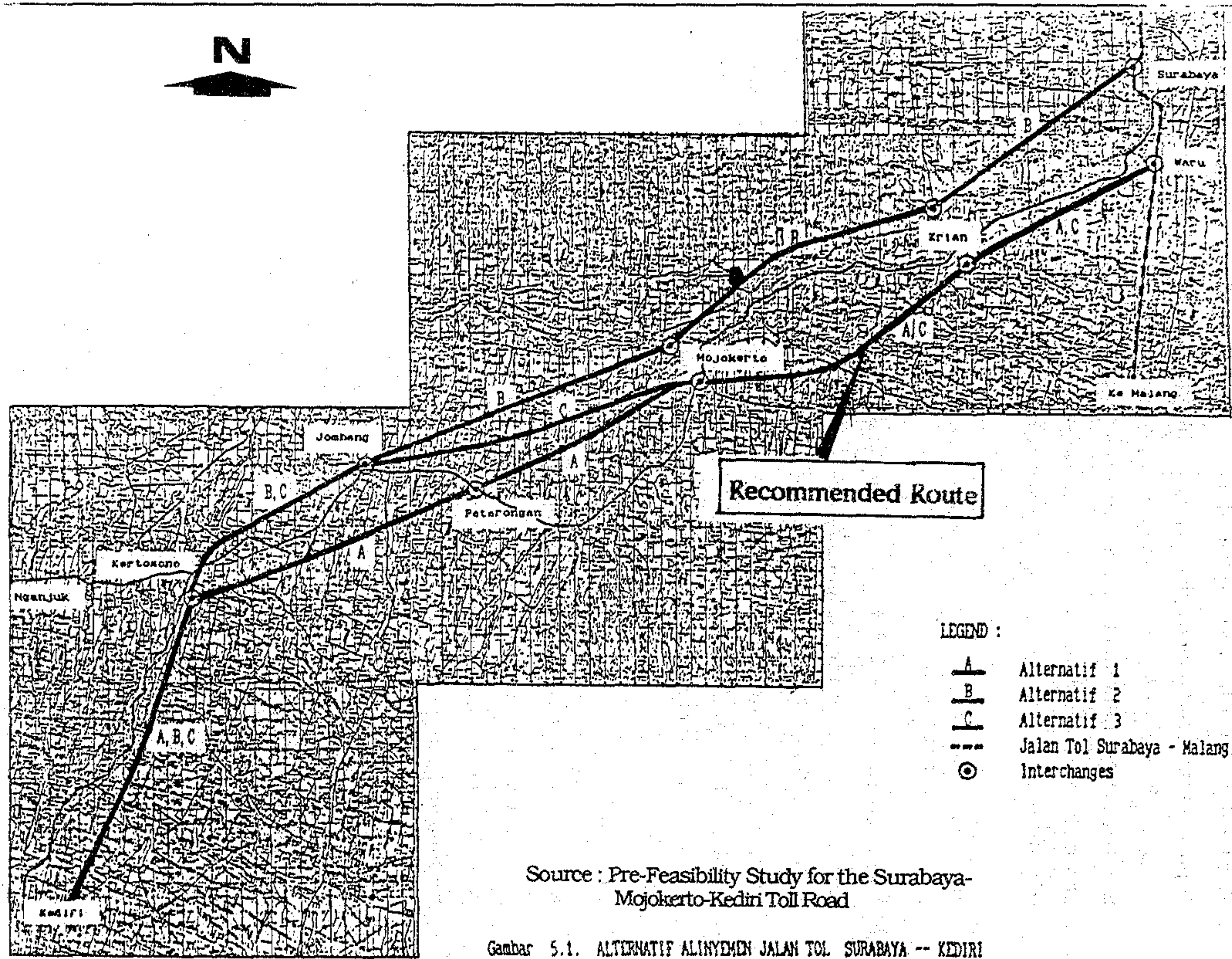
In 1983, the Urban Development Planning Study on Gerbangkertosusila (GKS, Surabaya Metropolitan Area) was conducted by JICA, which formulated a master plan for the comprehensive development of Surabaya Metropolitan Area and recommended short-term and long-term sectorial development programs.

Regarding the road network development in the long-term program, the study recommended the development of an arterial ring roads system together with radial roads. The proposed ring road system consisted of three ring roads, the Inner Ring Road linking Tandes, Karang Pilang, Waru and Sukolilo, the Middle Ring Road from Gresik to the south of Juanda airport and the Outer Ring Road linking Cerme, Krian and south of Sidoarjo (refer to Fig. 7.6).

The toll road network recommended in the Surabaya Metropolitan Area consists of the Surabaya-Gempol Toll Road and the Surabaya-Gresik Toll Road, but the toll road linkage between Surabaya and Mojokerto was not indicated in the GKS Study.

(6) IUIDP

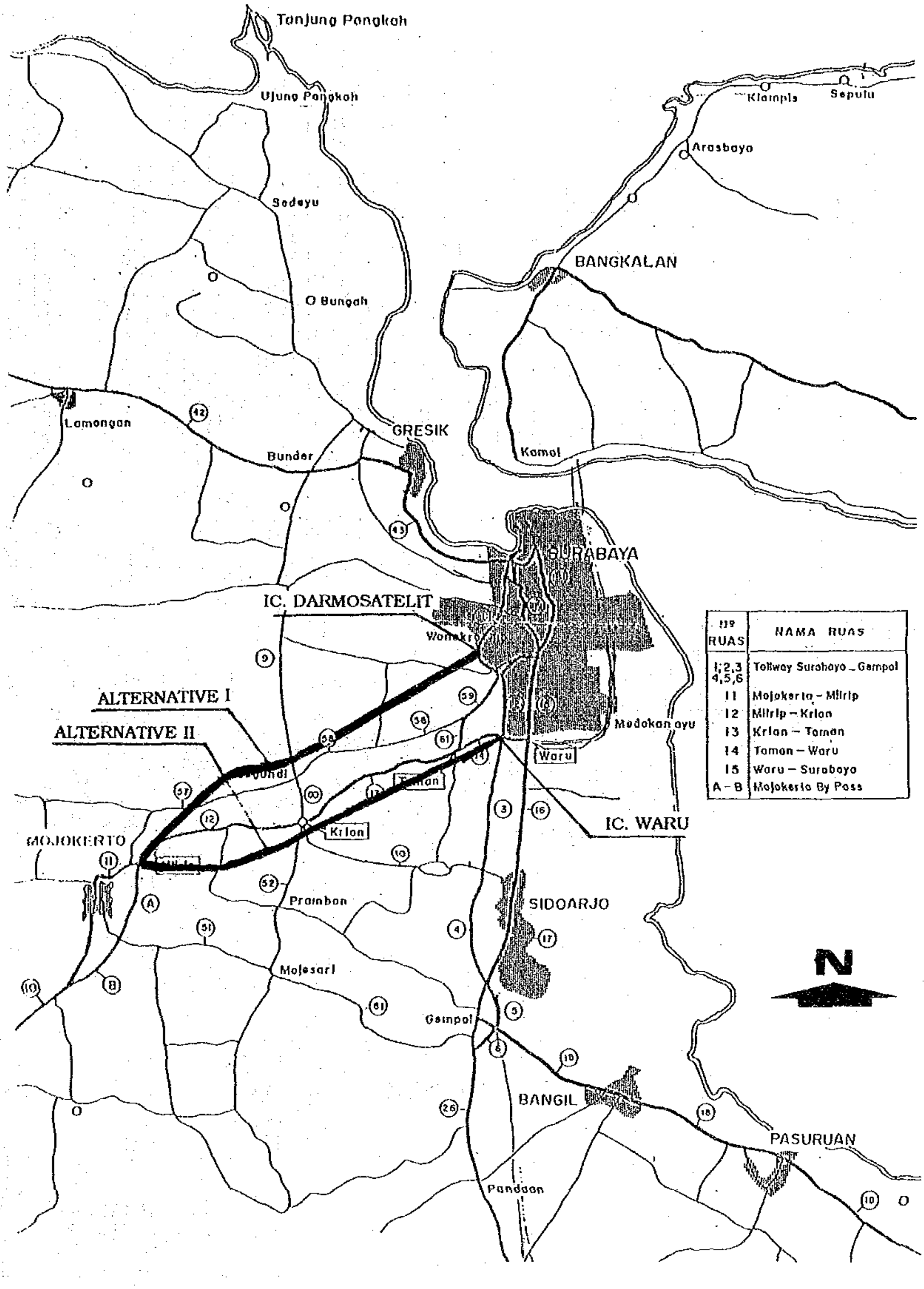
The study of the Integrated Urban Infrastructure Development Project (IUIDP) in Surabaya municipality has been executed under the financial assistance of IBRD



Source : Pre-Feasibility Study for the Surabaya-Mojokerto-Kediri Toll Road

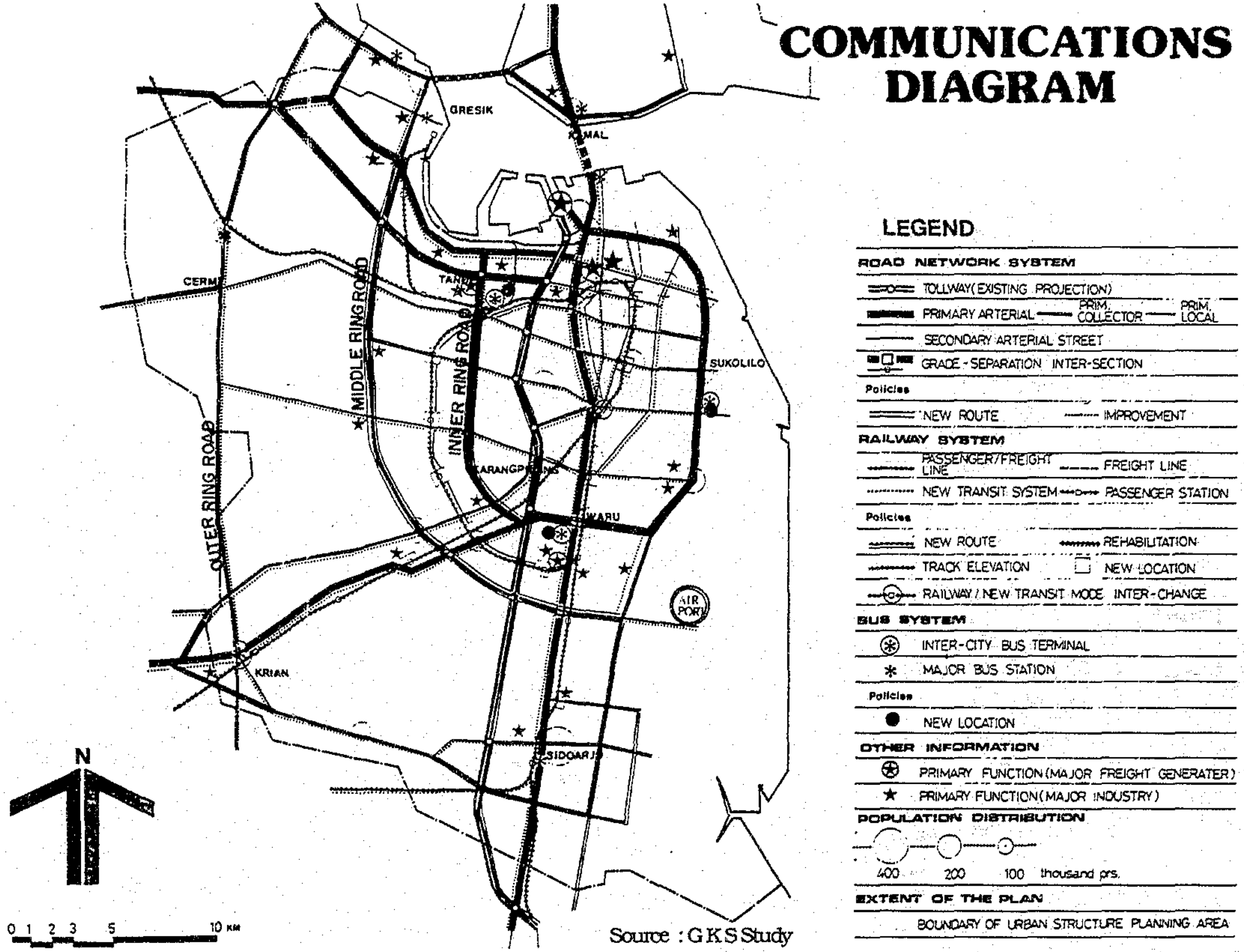
Gambar 5.1. ALTERNATIF ALINYEMEN JALAN TOL SURABAYA -- KEDIRI

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 7.4 Recommended Route by Pre-Feasibility Study for Surabaya-Mojokerto-Kediri Toll Road



Source : Alternative Routes of the Surabaya-Mojokerto Toll Road indicated by the Goverment of East Java Province

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 7.5 Route Alternatives of East Java Provincial Government



Source : G K S Study

SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 7.6 Ring Roads System Proposed in GKS Study since 1988, which focuses on the infrastructure development with the target year of 1994. The route of the Inner Ring Road (called as the western outer ring road and the eastern outer ring road in the IUIDP) is shown more definitely than the above GKS study (refer to Fig. 7.7), and will be incorporated in the road network development plan of Surabaya municipality in the Pelita VI period.

7.1.4 Bases of Route Study and Clarifications

(1) Observations of the Local Governments concerning Route Location

The opinion of the East Java Provincial Government (TK.I) about the route of the Toll Road was explained in the discussion with the Preliminary Study Team, and is as described in Subsection 7.1.3 (4).

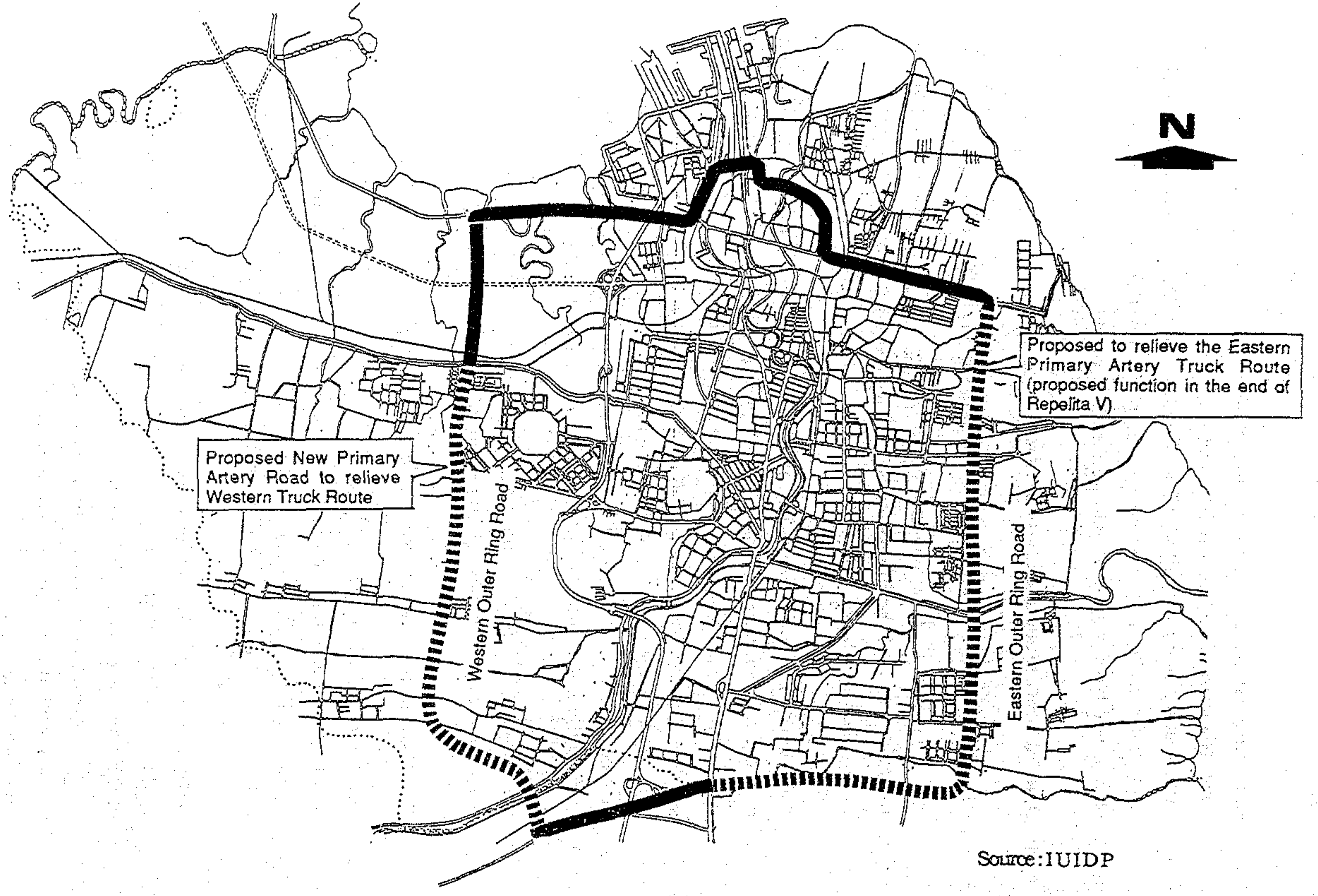
The related local governments (TK. II) were also interviewed for their opinions about the route of the Toll Road. Gresik regency prefers the route passing the areas north of the provincial road in expectation of support to its planned industrial and housing developments in these areas. While, Sidoarjo regency pointed out the possible difficulties for the route passing through its areas on the south of the national road in respect of the loss of well-developed farmland and adverse effects on socio-economic environment such as severance of villages and farmland.

There was no specific opinion from Surabaya (Kotamadya) and Mojokerto (Kabupaten and Kotamadya) regencies about the proposed route.

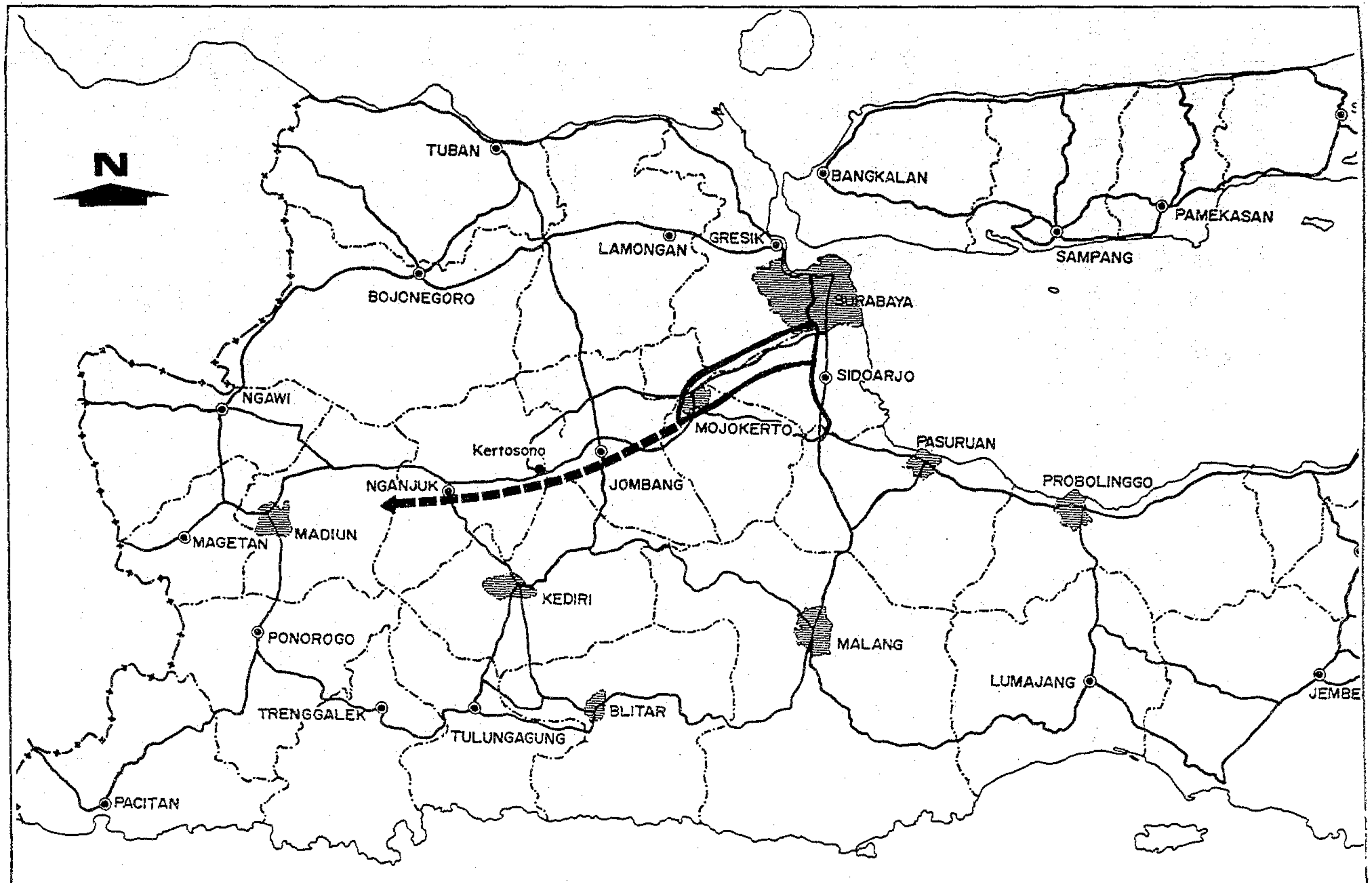
(2) Extension of the Toll Road in the West of Mojokerto

For the future extension of the Toll Road westward from Mojokerto, a general route is understood to follow the route of the existing national road connecting Jombang, Kertosono, Nganjuk and Madiun, keeping the locations of interchanges close to these cities.

In the Jombang-Kertosono-Nganjuk corridor, it is natural to consider that the route of the Trans Java Tollway System will be located south of these cities, since large cities such as Kediri, Tulungagung and Blitar are all located on the south of the national road, while there is no center of large traffic generation and/or attraction in the northern area. This concept is identical to the recommended routes in the past studies (refer to Fig. 7.8).



SURABAYA - MOJOKERTO TOLL ROAD PROJECT | Fig. 7.7 Inner Ring Road Recommended in IUIDP



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 7.8 Basic Route in the West of Mojokerto

The alternative route passing north of Mojokerto city (northern route) will, therefore, join the other alternative route which passes south of the city (southern route) in the section between Mojokerto and Jombang. The northern route from the east will turn to the southwest near Mojokerto city for a shorter route in connection with the crossing of the Brantas river, since the river is in the east-west direction while Jombang city is situated southwest of Mojokerto city. Based on this consideration, it was presumed that both routes meet at about 4.5 km southwest of Mojokerto city, which is the Mojokerto side terminus for route comparison.

(3) Traffic Condition

When the route study was initiated, only the traffic survey including roadside OD survey and traffic count survey was completed and the present OD matrix was still under preparation. The following were the outline of the existing traffic situation according to the preliminary compilation of the above survey results.

- The total traffic in the east-west direction is about 40,000 vehicles/day except motorcycle.
- About 25,000 vehicles/day, 65% of the total, is long trip traffic which has trip ends in Mojokerto or its western areas.
- About 75% of the above long-trip traffic is to and from Surabaya and the remaining to and from the south and the east of Surabaya (Sidoarjo, Gempol, Malang, Pasuruan, Probolinggo etc.).

Judging from the above results, it was envisaged that a shorter route in general direction to Surabaya is advantageous for long trip users.

(4) Design Speed of the Toll Road

A 120 km/hr design speed was applied taking into account the role of the Trans Java Tollway System and terrain condition (regional toll road in flat area). This design speed is the same as those applied for the existing Jakarta-Tangerang Toll Road, the Jakarta-Cikampek Toll Road and the planned Cikampek-Cirebon Toll Road, all of which will constitute parts of the entire Trans Java Tollway System. The corresponding minimum radii of curvature were adopted for the examination of the horizontal alignment of alternative routes.

7.1.5 Basic Data for Route Study

(1) Working Aerial Photo Mosaics

Working aerial photo mosaics to an approximate scale of 1:20,000 newly prepared by the Study Team (3 courses were flown for the purpose of preparation of working mosaics in September 1990) was used as a bases for preliminary route study. The aerial photo mosaic along the Surabaya river to a scale of 1:5,000 obtained from the Brantas River Basin Development Execution Office (BRBDEO) of the Department of Water Resources was also used to supplement the above working mosaics.

(2) Topographical maps

Current topographical maps to a scale of 1:50,000 were used to proceed with the route location in the context of the total road network in the Project Area, to check the topographic condition along the corridor and to measure the route length of each alternative. The important control points were checked and confirmed directly by on-the-ground investigations.

(3) Geological Maps and Existing Soils and Materials Data

Geological map of the Study Area to a scale of 1:100,000 (Urban Geologic Map of Surabaya-Sidoarjo-Krian and Surrounding Areas, East Jawa, 1986) was used for geological study. Soils and materials data from the construction of the Surabaya-Gempol Toll Road and several boring logs data from the projects of bridge construction and river improvement (Wonokromo, Kedurus, Ngrame, Turi, New Lengkong Dam, Mojokerto and Watudakon) were also made use of for the soils and materials study.

(4) Hydrological Survey

A hydrological survey was conducted by the Study Team to check the river system, flood situation and irrigation systems in the Project Area.

7.1.6 Consideration for Environmental Impact

Environment as used herein refers to the totality of the surroundings of the population: social, man-made, physical and natural. Environmental impact is normally discussed dividing it into two categories: i) Favorable Impact and ii) Adverse Impact (refer to Table 7.1). It is essential that the Toll Road be considered as

Table 7.1 Environmental Conditions in the Project Area

Human's Surroundings	Favorable Impact	Adverse Impact
Social • Population	- Creation of employment opportunities Better Population distribution	Residents displacement and Right-of-Way acquisition - -
• Economic activity /transport	Direct benefit and time cost saving Reduction of commodities price Alleviation of traffic congestion	- - -
• Landuse	Increase of landuse potentiality Better transport mobility and accessibility Increased agricultural & industrial output Urban renewal	- - Loss of agricultural land -
Man-made • Irrigation System	-	Disturbance of irrigation systems (mitigation measures to be provided)
• Public Facilities	Interrelation with the existing highway network, railway lines, electric power transmission lines, military facilities and housing/industrial areas should be studied carefully.	
• Development plans	Given full consideration	-
Physical • Air & water	-	Temporary pollution during construction
• Drainage	-	Careful measures should be provided against hydrological problems
Natural • Natural ecosystem (estuary, mud flat and marine)	N/A	N/A
• Preserved forest	N/A	N/A
• Important vegetation and wildlife	N/A	N/A
• Fish pond Culture	N/A	N/A

an element of the total environment. The Toll Road can and should be located to complement its environment and serve as a tool for environmental improvement.

The Study Team places the environmental impact as the top priority in the planning and route location process of the Toll Road. Environmental impact has been dealt with as a supplemental study in many past road projects, however, this kind of study approach will be abandoned entirely in the Study.

The area surrounding each alternative route has an inherent interrelated system of social, man-made and physical variables. Improvement in one variable within this system sometimes can not be attained without some adverse effect on other variables. Some of the adverse impacts may be negligible, but others may have a strong and lasting adverse impact on the environment, including the quality of human life. Refer to Section 12.4 in Chapter 12 for the description of the environmental background in the Study Area (i.e. direct influence zone).

7.1.7 Major Control Factors for Route Location

(1) Topographic Condition

The terrain condition in the Project Area is favorable and offers no difficulty for locating the route of the Toll Road. Refer to Subsection 6.1.1 for further descriptions.

(2) Geological Condition

In the eastern region from Krian, the north - south axis is covered by predominant soft ground areas. In case of the Surabaya-Gempol Toll Road, for the designed embankment of 2 m, the total settlement was estimated at 70 cm with 2 m preloading for 1.5 years. The same kind of treatment should be designed where the route is selected to pass such soft ground areas.

According to existing data, the thickness of the soft ground layer ranges widely from 4 m to the largest encountered of 23-50 m at Kedurus. The data also indicate that the existence of a soft ground layer is not found or limited in the west of Krian. Judging from these data, the soft ground area is assumed to extend generally from the coastal area to the east of Krian, though local soft ground areas exist in the Krian-Mojokerto area as the geology of the Alluvium Formation is rather variable, not orderly stratified. The bearing strata for the construction of pile foundations for bridge structures is situated at 20-30 m deep from the existing ground level, in the delta area.

The hilly area is mainly of Pusangan and Kabuh Formation in Middle to Lower Pleistocene Age. The soils in the Pucangan Formation are composed of clay, tuffaceous clay and tuffaceous sandy clay classified as CH according to the AASHTO soil classification. This soil is unsuitable as an embankment material because of its expansive nature. If the route is selected to cross hilly areas having such soils, excavated earth/soft rock should be wasted, subgrade layer replaced with suitable materials and cut slope flatter than 1:4.

The sources for embankment materials are found in the hilly areas from the south of Gempol to Mojoagung. Excavation of the deposits along the Surabaya river and the Porong river is not allowed. Both rivers are under the control of the Brantas River Basin Development Execution Office (BRBDEO). Since the sources for embankment materials are situated in the hilly areas which spread out to the south of Gempol, the southern route has an advantage of shorter hauling distance.

(3) Hydrological Condition

No flood is recorded in recent decades because flood control is developed in the Brantas Delta. However, disturbance of the existing irrigation system is a major problem for route location.

The Porong river and the Surabaya river have a levee system on both sides of the rivers. The proposed route of the Toll Road is anticipated to cross the upstream part of the Porong river near Mojokerto, and the Surabaya river in case of the northern alternative route. Consideration is to be given to allow enough clearances for the inspection roads which are provided for the maintenance of a levee system.

There are recorded occasional retained water areas in limited locations of the Brantas Delta. Refer to Subsection 6.4.2 for further descriptions of the hydrology.

(4) Irrigation Canals

The Brantas Delta is the most highly developed irrigation area in the region, and utmost attention must be paid to this situation. Sidoarjo regency occupies the major part of the Brantas Delta and Sidoarjo Regional Irrigation Office maintains the entire irrigation systems in the Delta.

In case that the Toll Road will pass through Sidoarjo regency where numerous irrigation canals exist, construction of many bridges are required keeping clearance for inspection road on the bank of canals. Each irrigation canal and its irrigated area in Brantas Delta is shown in Table 7.2 (refer to Fig. 6.8 in Subsection 6.4.3 for the canal network in the Brantas Delta).

Table 7.2 Irrigated Main Paddy Field in the Brantas Delta

VOOR CANAL IA 663 ha		MANGETAN CANAL IA 15,986 ha		PORONG CANAL IA 12,202 ha	
Irrigation Canal	Area (ha)	Irrigation Canal	Area (ha)	Irrigation Canal	Area (ha)
Lengkong Canal	258	Mangetan I	742	Porong I	417
Kemlaten Canal	405	Mangetan II	1,712	Porong II	534
		Mangetan III	787	Porong III	522
		Mangetan IV	496	Porong IV	724
		Purboyo I	1,020	Kd. Ploso	930
		Purboyo II	452	Cepiples	445
		Purboyo IIIA	262	Bokong	1,141
		Purboyo IIIB	788	Ged. Rowo	2,000
		Kemasan I	1,423	Bulang	265
		Kemasan II	489	Kebaron	286
		Ketawang	924	Krembung	870
		Jati Punden	203	Bringin	472
		Botokan	421	Rawan	158
		Kedung Turi	402	Tambakrejo	140
		Sidomukti	1,053	Kedungsemur	603
		Dungus	400	Juwet	867
		Gambir Anom	798	Pejarakan	481
		Sruni	418	Kd. Cangkring	830
		Gedangan	200	Putat	517
		Pelayaran	871		
		Ketegan	126		
		Bandilan	133		
		Kd.Uling Kanan	1,030		
		Kd.Uling Kiri	836		

Note : IA = Irrigation Area

(5) Existing Road Network

The pattern of the road network in the Project Area is not complicated as far as the route location of the Toll Road is concerned. The connections with the existing national and provincial roads are given full consideration to enhance regional development as well as to improve the long-term and short-term viability of the Toll Road.

The road network in the Project Area consists of national roads, provincial roads and kabupaten/desa/city roads. The existing national and provincial road links which are important in the route selection are shown below.

Important Road Links in the Route Locating

Category	Road Link
National Road	• Taman-Sidoarjo-Gempol
	• Waru-Krian-Mojokerto-Gemekan-Jombang
Provincial Road	• Wonokromo-Driyorejo-Legundi-Mlirip
	• Mojokerto-Gedeg-Ploso
	• Legundi-Krian-Mojosari

At Mojokerto city, there is a bypass to the national road, which facilitates a toll bridge. Another bypass to the national road is under planning for Krian city (refer to Fig. 7.9). As explained in Subsection 7.1.3, Surabaya Metropolitan Area has a ring roads plan. All of these road links are taken into account in the interchange planning of the Toll Road.

(6) Railway Line

The Surabaya-Madiun Line is the only railway line in operation which will be crossed by the Toll Road. There is a line connecting Sidoarjo and Tarik which is abandoned at present but the Railway Authority has a plan to resume operation in future (A long-span bridge over this line was constructed for the Surabaya-Gempol Toll Road for future resumption of the railway operation).

There are many sugarcane railway (trolley) lines constructed in the Dutch colonial period, most of which have been abandoned. But, there are several lines still in use, mainly in Sidoarjo regency.

(7) Electric Power Transmission Lines

There are eight electric power transmission lines which will be crossed by the alternative routes. Two parallel lines are running in a northeast to southwest direction which pass about 1 km northwest of Krian city. Three other parallel lines

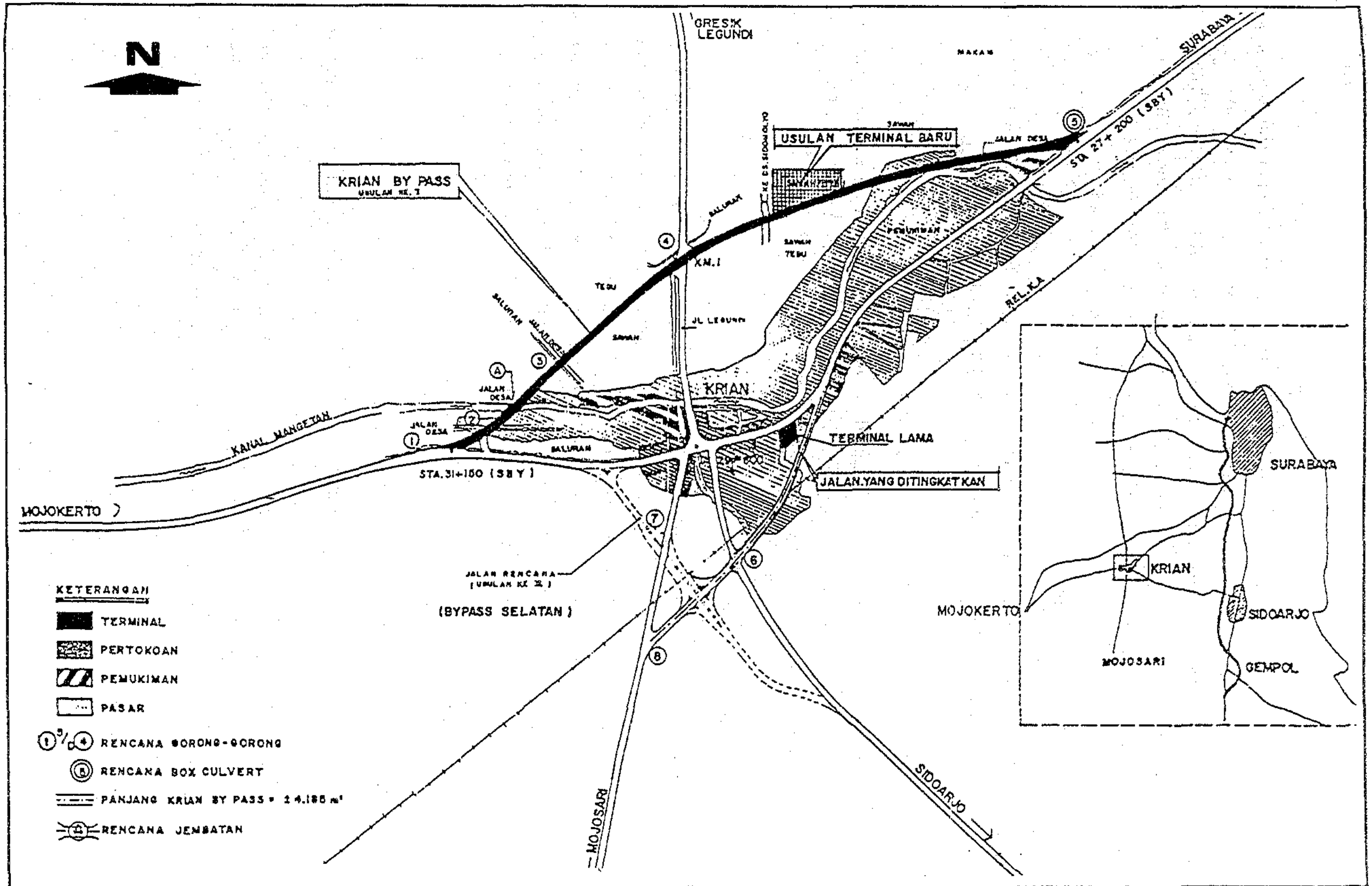


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Fig. 7.9 Proposed Krian Bypass

are running in a north-south direction along the Surabaya-Gempol Toll Road on its western side north of Waru and after crossing Waru IC on its eastern side south of Waru. Another three parallel lines are running in the south of Mojokerto. The route will be selected so as to avoid or minimize the relocation/diversion of the pylons of these electric power transmission lines.

(8) Military Facilities

There exist military facilities including a maneuvers field near the southwestern boundary of Surabaya municipality, which should be avoided.

(9) Housing Development Area

Development of a new town is planned at Driyorejo in Gresik regency as a satellite town of Surabaya city. The total planned area is 1,000 ha, 200 ha of which has a definitive plan approved by the Governor of the regency.

(10) Industrial Development Areas

Industrial estates are planned at Jetis (750 ha) and at Ngoro (southeast of Mojosari, 2,000 ha) in Mojokerto regency. Gresik regency has a macro-scale landuse map for future industrial estates development which designates the areas in the north of the provincial road (Wonokromo-Driyorejo-Legundi), though there has been no definite plan yet. In addition to these, a numbers of individual operators are developing factories along the existing provincial road in the north of the Surabaya river.

7.1.8 Interchange Study

(1) Important Governing Factor

Location of Junctions (i.e. tollway-to-tollway interchange) and Interchanges (i.e. tollway-to-artery interchange) is one of the major governing factors in locating the Toll Road route. Along the corridor, the Junction with the Surabaya-Gempol Toll Road and the interchanges for Krian and Mojokerto are the major locations of interchanges. Once the locations of interchanges are determined, the general route alignment of the Toll Road is almost fixed.

(2) Junction with the Surabaya-Gempol Toll Road

The eastern end of the Toll Road is the Junction with the existing Surabaya-Gempol Toll Road. The suitable locations were examined between Kota Satelit IC (northernmost proposed location which is indicated in the alternative of East Java Provincial Government) and Sidoarjo IC (southernmost proposed location which is indicated in the pamphlet of Investment Opportunities).

There are two basic considerations. One is to connect the Toll Road directly to the existing interchange (tollway-to-artery interchange) on Surabaya-Gempol Toll Road adding the function as the Junction and the other is to connect in the stretches between the existing interchanges.

However, direct connection to the existing interchange is not recommended. For direct connection, it is necessary to modify the existing layout possibly to a full cloverleaf type or double trumpet type. Among 4 interchanges, Kota Satelit IC and Sidoarjo IC having single trumpet type layout and Gunung Sari IC having half cloverleaf type layout (refer to Fig. 7.10) have little room for such modification without large reconstruction works disturbing the existing traffic.

Waru IC in double trumpet type layout has some possibility of such modification to remodel it to a Junction, since the approach to the national road (Taman-Sidoarjo-Gempol) was originally intended as a link of full access control and the opening of the flyover bridge over the national road (Waru-Krian-Mojokerto) has spare space to accommodate an additional 4-lane road.

However, judging from the traffic situation at Waru, it is not recommended to connect the Toll Road at this point. At present, most of the traffic in the Surabaya-Mojokerto direction uses the approach to Waru IC via the roundabout at the Rungkut intersection with the national road (Taman-Sidoarjo-Gempol). In the roundabout, traffic jams are occurring in the morning and evening peak hours due to the serious concentration of the traffic. A worse situation is predicted after relocation of the bus terminal from Wonokromo to Waru. In addition, there is a plan for the Inner Ring Road to pass Waru as mentioned in Subsection 7.1.3. Under such circumstances, this location is not recommended for the Junction since it will cause further concentration of traffic in the future.

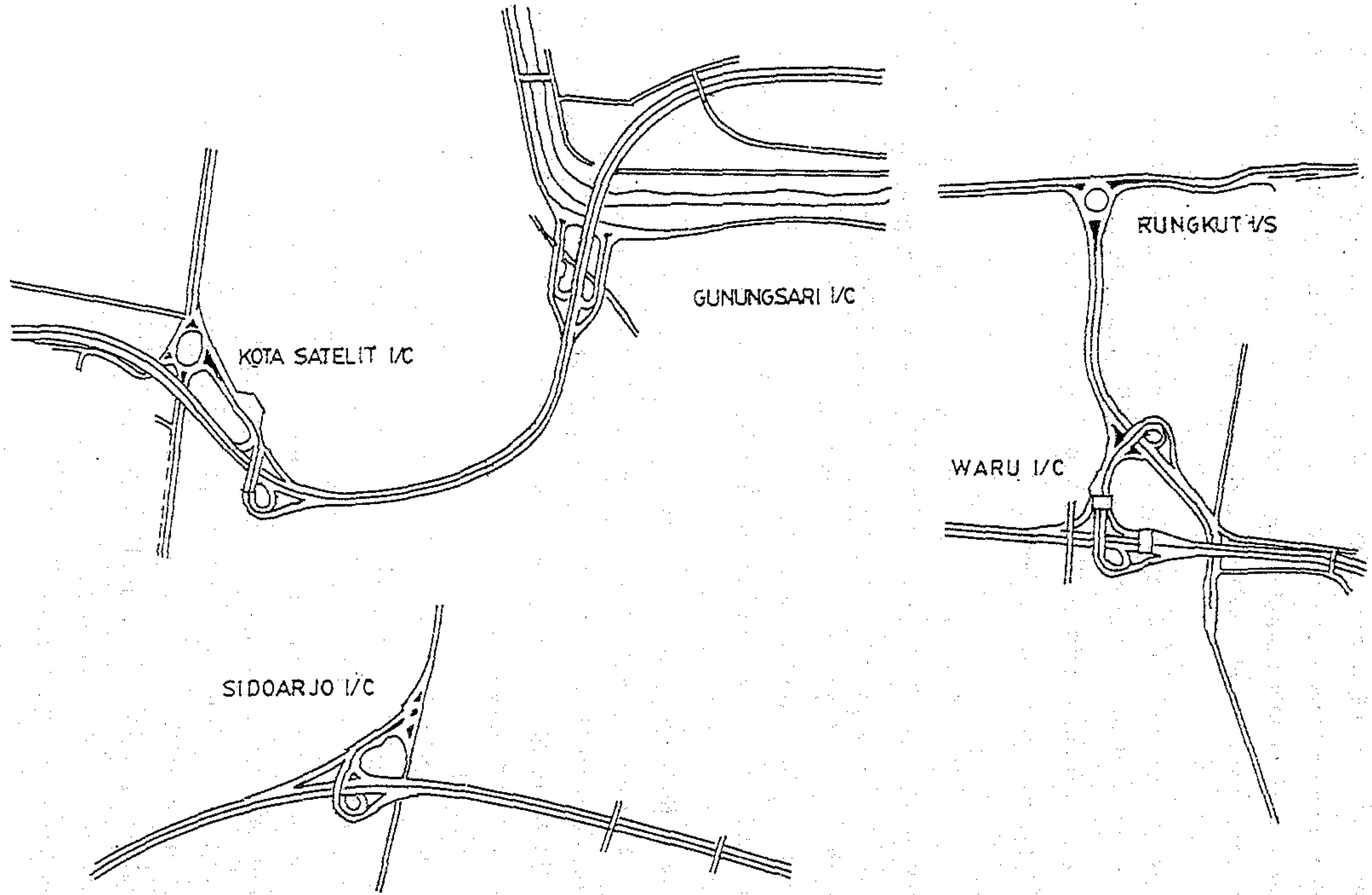

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Fig. 7.10 Interchanges on the Surabaya-Gempol Toll Road

Other problems relating to the direct connection at Waru IC are as follows:

- A frontage road is required on both sides of the existing toll road approach from Rungkut intersection if the said approach is incorporated into the tollway system of full access control.
- The route of the Toll Road must pass through a heavily inhabited area for some 2 km on the west of Waru IC.
- The horizontal curve of the approach near the intersection with the national road (Waru-Krian-Mojokerto) is very small (192 m in radius) which is insufficient as the alignment of the Toll Road. It can be allowed only when a toll barrier is planned near the Junction and speed can be controlled.

Based on the above considerations, it was concluded that the location of the Junction should be sought in between the existing interchanges on the Surabaya-Gempol Toll Road. The following factors were taken into account in evaluating the possible locations of the Junction.

1) Alignment of the Surabaya-Gempol Toll Road

For traffic safety, better alignment than the normal section is required in the vicinity of the Junction. For a design speed of 100 km/hr in the northern stretch and for a design speed of 120 km/hr in the southern stretch of Waru IC, the alignment of the Surabaya-Gempol Toll Road was checked with the following criteria.

Description	Design Speed (km/hr)	
	120	100
Horizontal Alignment		
Min. Radius (m)	2,000 (1,500)	1,500 (1,000)
Vertical Alignment		
Max Gradient (%)	2	2
Min. Radius of Curve (m)		
Crest	45,000 (23,000)	25,000 (15,000)
Sag	16,000 (12,000)	12,000 (8,000)

Note : Figures in parentheses show the criteria for absolute minimum.

2) Structures on the Surabaya-Gempol Toll Road

The location of the Junction is to be selected without causing the reconstruction of the existing throughway bridges and overbridges on the Surabaya-Gempol Toll Road.

3) Distance between the Junction and the existing interchange

Distance from the adjoining interchange should be sufficient for maneuver of vehicles and to allow safe weaving. A minimum distance of 2 km is to be secured.

4) Relation with the Ring Road Plan

The location of 5 km south of Waru IC satisfies the above conditions of 1) to 3). However, this location is near to the planned Middle Ring Road according to the GKS Study as described in Subsection 7.1.3. In order to keep flexibility for the planning of the Middle Ring Road, it is recommended to select other locations.

As a result of the evaluation, the following 3 sites were selected as the proposed locations of the Junction with the Surabaya-Gempol Toll Road.

a.	2 km north of Waru IC	Gunung Sari IC - Waru IC
b.	3 km south of Waru IC	Waru IC - Sidoarjo IC
c.	3 km north of Sidoarjo IC	Waru IC - Sidoarjo IC

Except for the location of a. in the above, it is possible to extend the ramps of the Junction eastward to connect with the national road (Taman-Waru-Sidoarjo-Gempol), depending on the traffic demand. The location of a. in the above has little possibility of such extension because available land is limited and the adjoining interchanges are located a short distance from the proposed Junction.

(3) Interchange for Krian City

At Krian, there are three alternative locations of the interchange, all of which will be connected to the provincial road (Legundi-Krian-Mojosari). The first alternative is in the north of the Surabaya river (3.5 km north of Krian city) and the second alternative is between the Surabaya river and the national road (2 km north of Krian city) just to the north of the planned Krian Bypass. These two locations are intended to serve Krian city and the industrial development area on the north of the Surabaya river in Gresik and Mojokerto regencies. The third alternative is 3 km south of Krian city, which is intended to serve Krian and Mojosari. Service to the industrial development area on the north of the Surabaya river is limited.

For the second alternative, careful route locating is required taking into account the planned Krian Bypass and the existing electric power transmission lines running the area.

(4) Interchange for Mojokerto City

It is recommended to consider the Mojokerto Bypass as a future connecting road for the interchange.

Direct connection to the existing Mojokerto Bypass or use of the bypass incorporating it into the tollway system for future extension is not recommended, because of the following reasons:

1) The bypass is incorporated in the road network in Mojokerto area connected with the provincial road and local roads. In case that this bypass is incorporated into the tollway system of full access control, costly reconstruction for raising the vertical alignment to cross over the national and provincial roads and railway line, which are at-grade crossing at present, will be required. In addition, widening of the tollway portion (the present bypass is of 2-lane, 2-way) and provision of frontage roads along the tollway portion for local service will become necessary.

2) The toll bridge has a cross section of 4 lanes, having 14.0 m wide carriageways, 1.0 m wide sidewalk on both sides and a 1.0 m wide raised median, which is smaller than the standard width of throughway bridge of a 4-lane toll road.

There are two alternatives of route locations whether the route passes north or south of Mojokerto city. For the northern route alternative, the connecting road is the national road and the interchange will be located north of the Surabaya river. It is difficult to locate the interchange on an extension of the alignment of the bypass, because the bypass joins the national road with a very skew angle and there is no room to plan an intersection because the road is on the bank of the Surabaya river.

The possible location of the interchange was examined taking the following conditions into account:

- There should be enough space between the national road and the Surabaya river to design an intersection.
- The alignment of the national road near the intersection should be favorable to secure sufficient sight distance.
- The distance between the interchange and the Surabaya river should be sufficient to accommodate toll gate facilities.
- The interchange is to be located east of Mojokerto bypass for a smooth connection particularly for long trip users who will continue to use Mojokerto Bypass, before the westward extension of the tollway from Mojokerto is realized.

The selected site of the interchange is some 5.5 km northwest of Mojokerto city. The approach of the interchange will be connected to the national road about 1 km east from the intersection with the bypass.

One of the significant problems related to the location of the interchange on the northern route is that an additional interchange might be required in the south of Mojokerto after the westward extension of the Toll Road. The interchange selected above can not serve properly the traffic from/to Mojokerto to/from the western area, forcing travel of extra distance.

For the southern route alternative, the connecting road is the Mojokerto Bypass. The interchange is located about 1 km north of the provincial road (Mojokerto-Mojosari) near the existing bus terminal.

(5) Other Interchanges

In case that the route is selected to pass north of the Surabaya river and is connected to the Surabaya-Gempol Toll Road north of Waru IC, it crosses the planned Inner and Middle Ring Roads. The connections with these ring roads are other proposed locations to plan additional interchanges.

7.1.9 Description of Alternative Routes

A total of 6 route alternatives, divided into 4 basic route alternatives designated Alternative-A, -B, -C and -D, have been established for comparison in the preliminary route study as shown in Fig. 7.11. The following is a brief description of each route alternative (explained in the direction from Mojokerto to Surabaya).

(1) Alternative-A

This alternative is basically identical to the northern alternative route of the East Java Provincial Government which runs on the north of the Surabaya river. It aims at less adverse impact on the existing socio-economic environment and passes through undeveloped areas and is characterized as the route which proceeds directly to Surabaya city.

Starting at the Mojokerto terminus, 4.5 km southwest of Mojokerto city, the route runs northerly on the west side of the city and crosses a railway line, an irrigation canal and the Brantas river. Thereafter the route turns to the northeast, runs along an irrigation canal and crosses two provincial roads and the Marmoyo river. The route then gradually turns easterly to pass through the edge of a gentle hill area along the Surabaya river and reaches the northernmost proposed location of the interchange to Krian city, 3.5 km north from the city.

After Krian, the route turns slightly to the northeast along the Surabaya river passing through a flat area, then turns again easterly to pass through the edge of a gentle hills on the south of the planned new town of Driyorejo. It turns to the northeast to avoid the military area then turns again easterly, crosses the provincial road and the Surabaya river and reaches the Surabaya-Gempol Toll Road 2 km north from Waru IC.

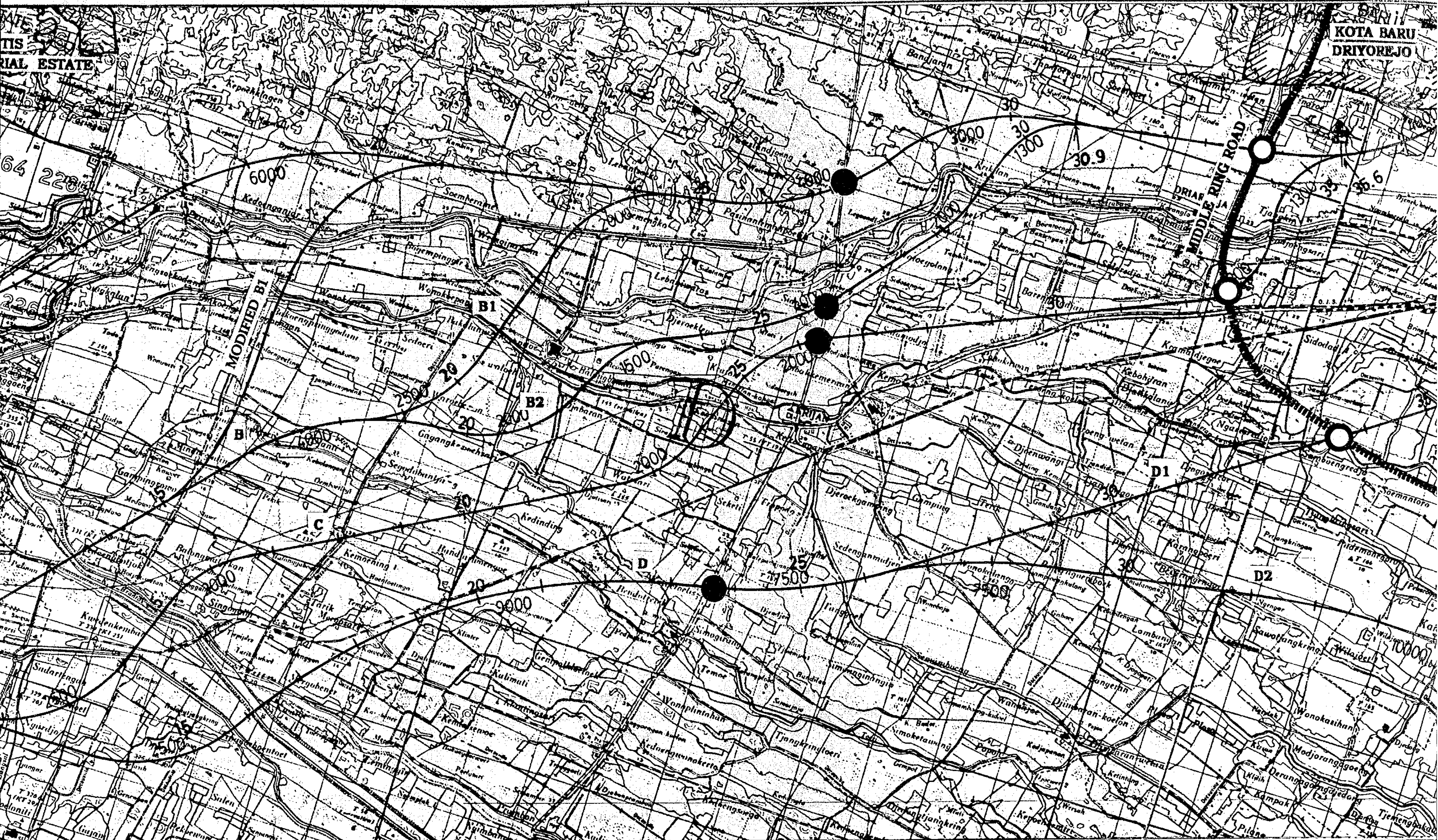
The points of issue in this alternative are:

- The location of the interchange to Mojokerto city is less suitable than the southern route as discussed in Subsection 7.1.8 (4).

- The route has to cross the geologically unfavorable area in Gresik regency.

There is no subsidiary alternative to connect to the southern location of the proposed interchange to Krian.

JETIS
INDUSTRIAL ESTATE
MODIFIED B1
MOJOKERTO BYPASS
A
B
C
6000
3000
2500
5000



KOTA BARU DRIYOREJO
MIDDLE RING ROAD
MODIFIED B1
B1
B2
B
C
D
D1
D2
6000
3000
1300
30.9
35.6
2500
2000
1500
7500
9000
10000

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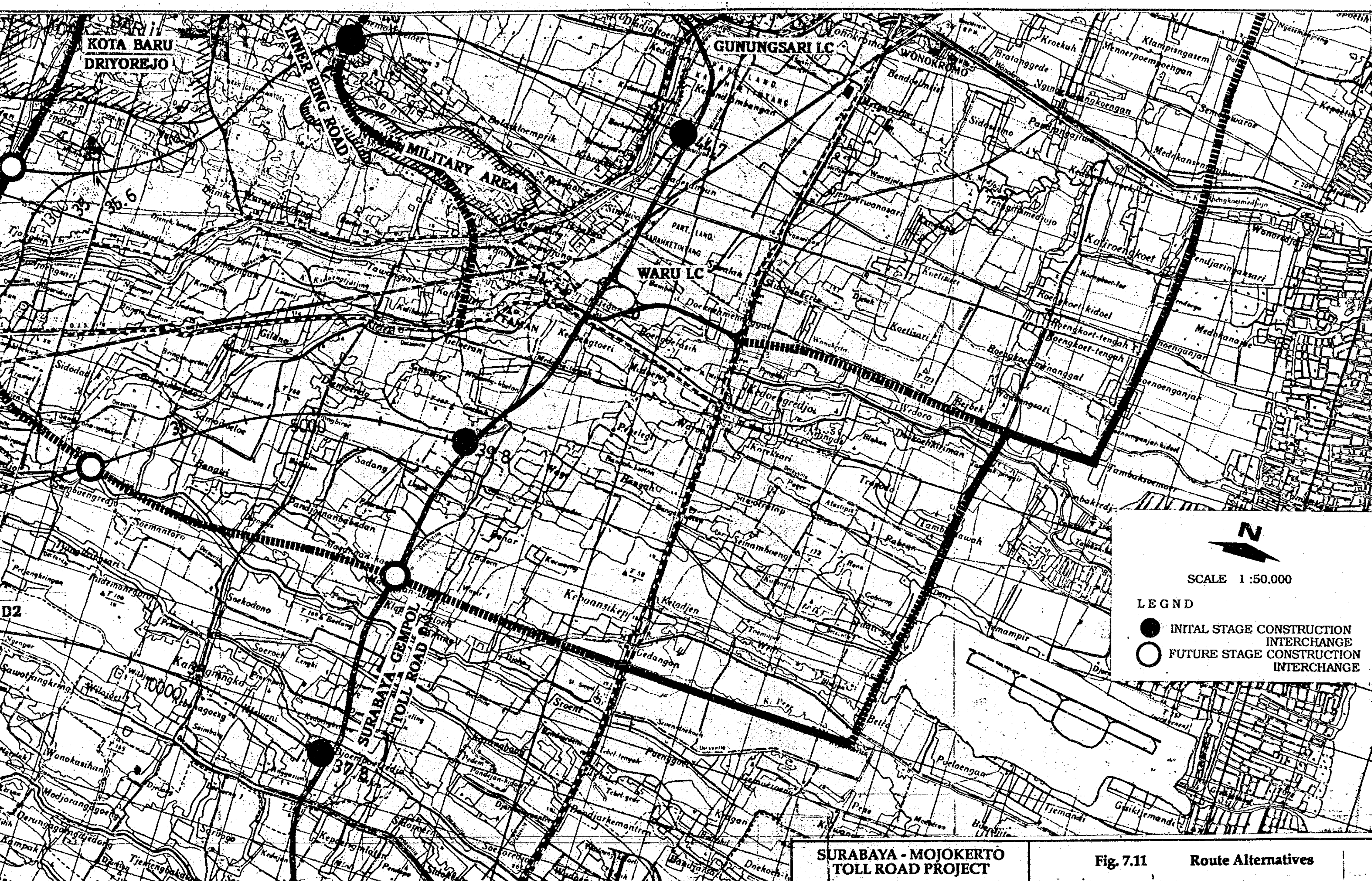
Fig. 7.



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 7.11 Route Alternatives