GOVERNMENT OF THE REPUBLIC OF INDONESIA

FEASIBILITY STUDY FOR JAKARTA-MERAK HIGHWAY PROJECT

FINAL REPORT

VOLUME I ; TEXT

JULY 1974

OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN

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Preface

The Government of Japan, in response to the request of the Government of the Republic of Indonesia, carried out a survey on the Jakarta-Merak Highway Project, the study begin assigned to the Overseas Technical Cooperation Agency.

The Agency, fully aware of the importance of the effect that the completion of the Jakarta-Merak Highway Project will have on the social and economic development of the Republic, despatched a survey team composed of experts on highway planning and highway economics to Jakarta for the survey, starting from September, 1973. While in Indonesia, the full cooperation of various Government departments had made it possible for the survey to be carried out very smoothly. Subsequent works in Japan are now duly completed and this report is the product of the survey.

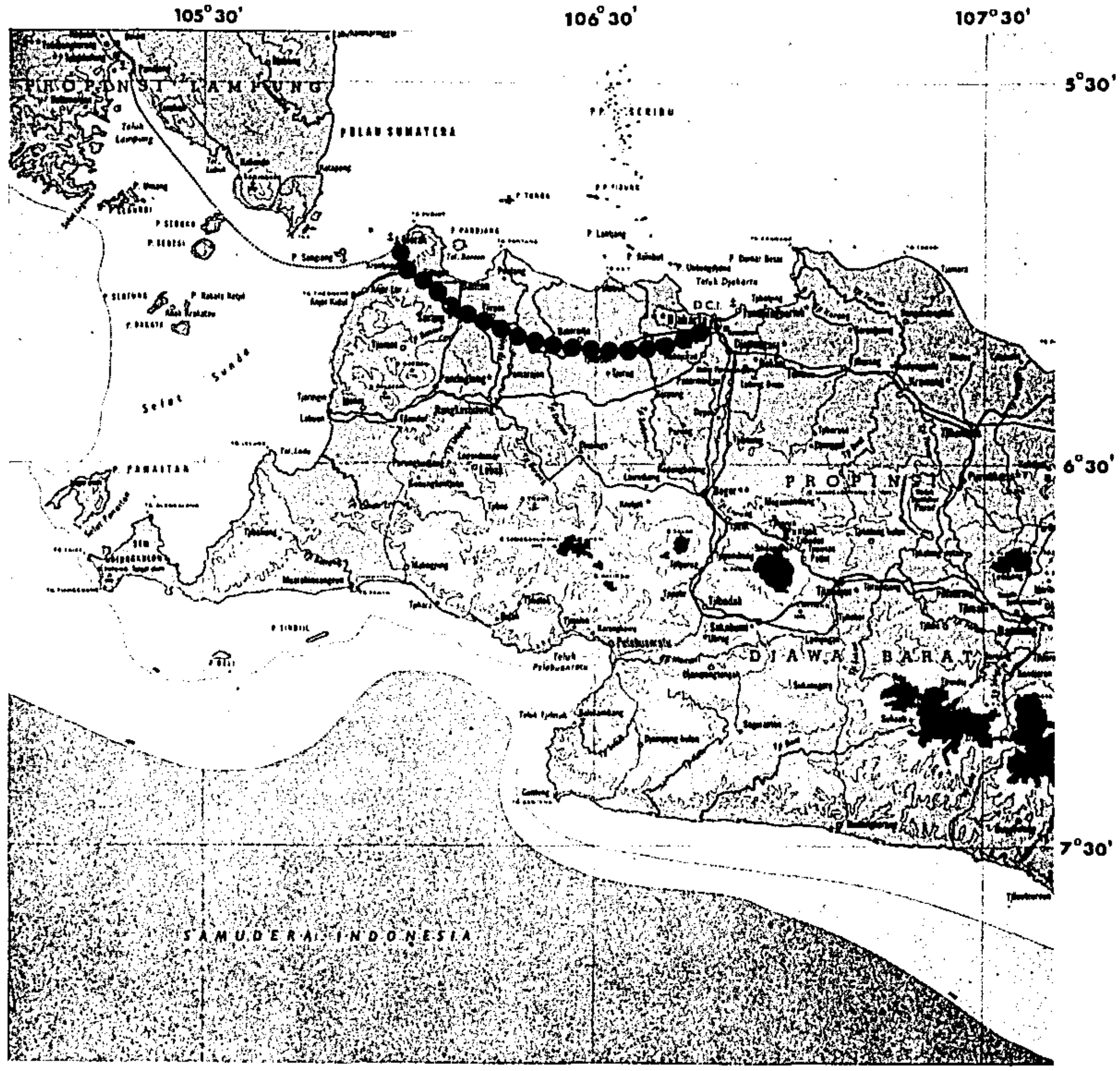
This report covers the route selection, traffic estimation, preliminary engineering design and economic evaluations as well as the estimation of the construction cost of the Jakarta-Merak Highway, a highway of about 102 km in length, planned as a part of the overall highway development plan of the Republic, for the purpose of ensuring the efficient transportation of the expanding economic influence sphere of the Metropolitan of Jakarta, and of attaining a planned economic development of the nation.

It is our fervent wish that the results of the survey will contribute towards the development of the Province of West Java and towards the promotion of international friendship between Japan and the Republic of Indonesia.

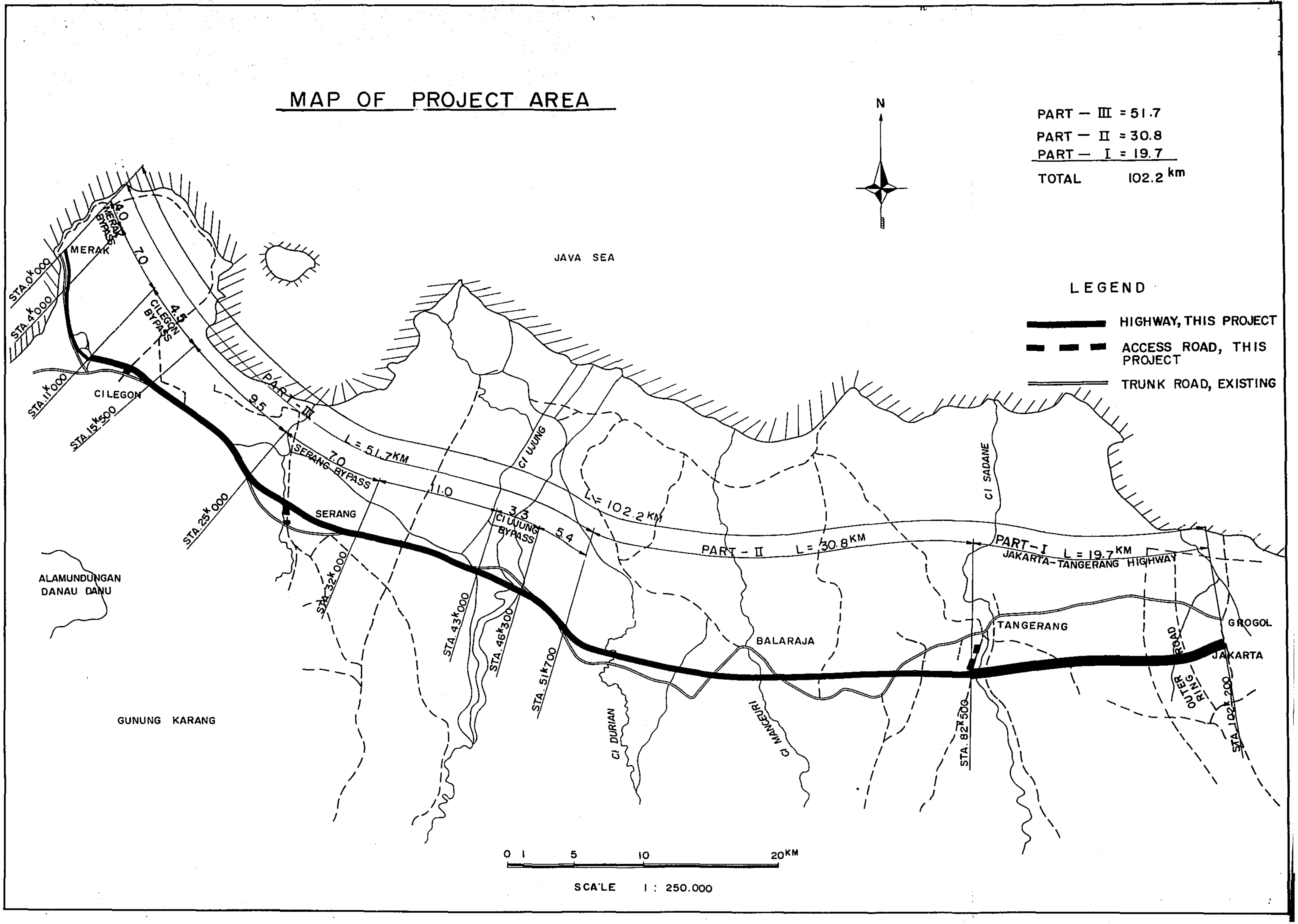
July, 1974

Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

PROJECT LOCATION MAP



PROJECT ROUTE



MAP OF PROJECT AREA
PART — III = 51.7
PART — II = 30.8
PART — I = 19.7
TOTAL 102.2 km
N
JAVA SEA
LEGEND
HIGHWAY, THIS PROJECT
ACCESS ROAD, THIS PROJECT
TRUNK ROAD, EXISTING
MERAK
MERAK BYPASS
CILEGON
CILEGON BYPASS
SERANG
SERANG BYPASS
CI UJUNG
CI UJUNG BYPASS
CI SADANE
PART - III
L = 51.7KM
L = 102.2KM
PART - II L = 30.8KM
PART - I L = 19.7KM
JAKARTA-TANGERANG HIGHWAY
TANGERANG
GROGOL
JAKARTA
BALARAJA
OUTER RING ROAD
ALAMUNDUNGAN DANAU DANU
GUNUNG KARANG
CI DURIAN
CI MANCEURI
STA.0k000
STA.4k000
STA.11k000
STA.15k500
STA.25k000
STA.32k000
STA.43k000
STA.46k300
STA.51k700
STA.82k500
STA.102k200
SCALE 1 : 250.000

SUMMARY AND CONCLUSIONS

A) Summary

The existing Jakarta-Merak Highway has, since the past, been serving as the connecting route from the Metropolitan of Jakarta to the west right up to the western tip of the Island of Java, and then further connected by ferry service to the Island of Sumatra. Due to the recent increase in vehicle traffic demand accompanying the development of the region along the highway, traffic on this only link to the Island of Sumatra has greatly increase, and the necessity arises of providing improvement to this route. Especially in the section between Jakarta and Tangerang, congestion occurs at certain hours of the day, and urgent steps of remedy are necessary.

In the determination of the alignment for a new Jakarta-Merak Highway, three alternatives were studied from the economic and the technical points and a conclusion was reached that the Alternative II was most favourable, and further studies were carried out in this alternative, and the results are as follows:

(1)	Total length:	102.2 km
(2)	Width of road way:	
	Part I	42.50 m
	Part II	35.00 m
	Part III	27.00 m
	Part III (Merak Bypass)	16.00 m
(3)	Final number of traffic lanes:	
	Part I	6 lanes
	Part II	4 lanes
	Part III	4 lanes
	Part III (Merak Bypass)	2 lanes

(4) Width of right of way:

Part I	70 m
Part II	60 m
Part III	50 m
Part III (Merak Bypass)	30 m

(5) Width of traffic lane:

Part I	3.75 m
Part II	3.75 m
Part III	3.50 m
Part III (Merak Bypass)	3.50 m

(6) Design speed:

Part I	120 km/h
Part II	120 km/h
Part III	100 km/h
Part III (Merak Bypass)	80 km/h

(7) Estimated future traffic volumes (at representative cross section):

Jakarta-Tangerang section		
	1980	21,500 veh/day
	1990	45,200 veh/day
Ci Ujung Bypass		
	1980	10,200 veh/day
	1990	21,000 veh/day
Serang Bypass		
	1980	10,300 veh/day
	1990	21,300 veh/day
Cilegon Bypass		
	1980	5,600 veh/day
	1990	12,000 veh/day

(8) Total project cost (in Mar. 1974 price)

Part I	Construction cost	US$21,821 thousand
	Land acquisition	US$ 7,955 thousand
	Total	US$29,776 thousand

Part II	Construction cost	US$21,685 thousand
	Land acquisition	US$ 7,689 thousand
	Total	US$29,374 thousand
Part III	Construction cost	US$38,130 thousand
	Land acquisition	US$ 9,292 thousand
	Total	US$47,422 thousand

(9) Project cost for the stage-1 construction (in Mar. 1974 price):

Cilegon Bypass

Construction cost	US$ 3,082 thousand
Land acquisition	US$ 1,433 thousand
Total	US$ 4,515 thousand

Serang Bypass

Construction cost	US$ 4,924 thousand
Land acquisition	US$ 2,142 thousand
Total	US$ 7,066 thousand

Ci Ujung Bypass

Construction cost	US$ 2,453 thousand
Land acquisition	US$ 803 thousand
Total	US$ 3,256 thousand

Jakarta-Tangerang Highway

Construction cost	US$14,425 thousand
Land acquisition	US$ 7,955 thousand
Total	US$22,380 thousand

(10) Project cost for the stage-1 construction including escalation allowance:

Cost escalation has shown an acceleration in recent years, and the indications are strong that escalation rate will assume even greater in the years ahead.

In case of this project, it will take serveral years before all construction will be completed, since construction entails selection of consultant, detailed engineering design and land acquisition and compensation.

To ensure the most appropriate project cost, the project cost for the stage-1 construction in Mar. 1974 prices has been revised to take into account the escalation allowance. Cost escalation from Mar. 1974 has been estimated at 10% per annum.

Thus the revised project cost resulted to US$50,600,000 which includes about 36% of total escalation allowance to the original project cost at Mar. 1974 price.

(11) Estimated benefits

The benefits for the principal years were estimated as follows:

1980	US$14,544 thousand
1990	US$29,533 thousand

(12) Economic analysis

With due consideration for the stage construction program, economic analysis was carried out and the resultant benefit/cost ratios and internal rate of return are as follows:

At a discount rate of 15%	B/C = 1.51
At a discount rate of 12%	B/C = 2.03
At a discount rate of 10%	B/C = 2.36
Internal rate of return	23.2%

From the results of the economic analysis and of the estimated future traffic volumes, it is evident that the construction of the proposed Jakarta-Merak Highway is highly justifiable. Especially for several of the sections included in the first stage of the stage construction program, traffic congestion will be inevitable in the near future without the implementation of the proposed project. The implementation of the first stage program is therefore of an utmost urgency.

B) <u>Conclusion</u>

The following recommendations are made basing on the overall results of analysis made in this study.

(1) It is recommended that the implementation of the following items of the first stage program of the project be effected at an earliest date possible.

a) The new construction of four lane highway for the Jakarta-Tangerang section.

b) The construction of new bypasses of the existing road for the towns of Serang and Cilegon.

c) The construction of a new bridge over Ci Ujung River and of the access roads to the bridge.

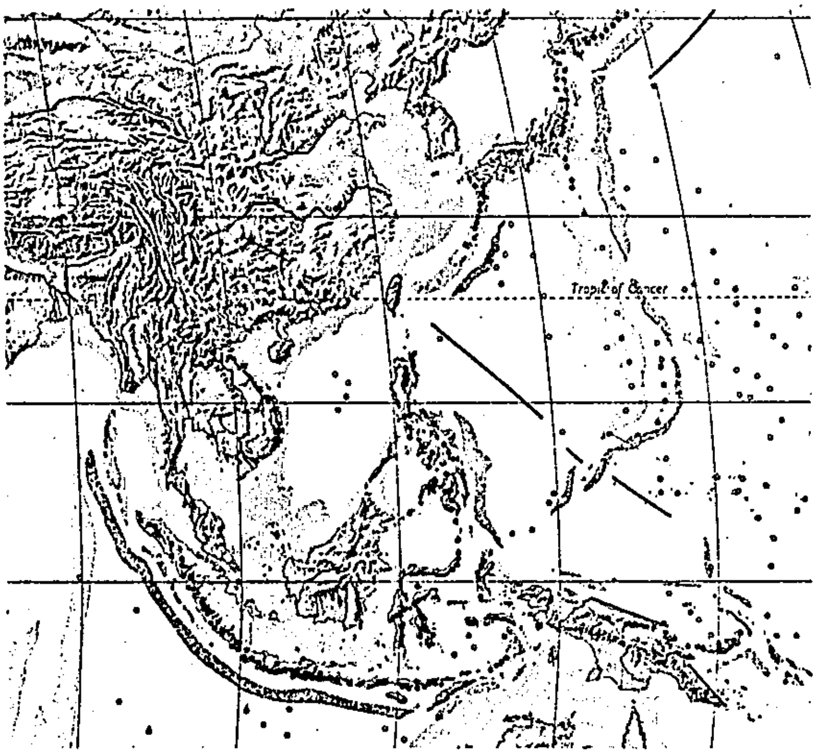
(2) The Tangerang-Balaraja section is recommended for implementation in the second stage. However, if it is financially possible, the implemetation of this section should be effected as soon as possible.

(3) To ensure maximum economic effects for the project, the improvement and completion of the feeder road network should be implemented in conjunction with the construction of new Jakarta-Merak Highway.

C O N T E N T S

Chapter I

INTRODUCTION



1. INTRODUCTION

1.01 Objectives

The purpose of this Study is to determine the technical and economic feasibility of, and to prepare an optimum program for, reconstructing or improving about 110 km of road linking Jakarta and Merak. The Study also aimed identification of the access and feeder roads that will be connected to and support the investment made for the construction of the main trunk highway. Figure 1-1 shows the roads to be included in the project.

1.02 Scope of Work

It will be performed all works necessary to attain the objectives set out above, including field investigations, and engineering, traffic and economic studies.

To determine the technical and economic feasibility of reconstructing or improving all or part of the existing highways, the Study will be divided into two phases. The first phase will include selection of the most feasible alternative solutions for the trunk highway and identification of access and feeder roads strengthening, on the basis of traffic forecasts, reconnaissance field surveys, magnitude cost estimates and preliminary economic analysis. The second phase will include preliminary engineering and final economic analysis. For selected solutions, route surveys and soil investigations will then be conducted, and the economic analysis will be refined based on the resulting revised construction cost estimates.

1.03 Conduct of the Study

The execution of the Study was carried out by experts from the Pacific Consultants International under the supervision of a Supervisory Committee compsoing of experts from various departments of the Japanese Government. The study team despatched by the consultants spent 46 days (from 20 September to 9 October, 1973, from 14 January to 8 February, 1974) in Jakarta, Merak and the vicinities, starting from 20 September 1973, for

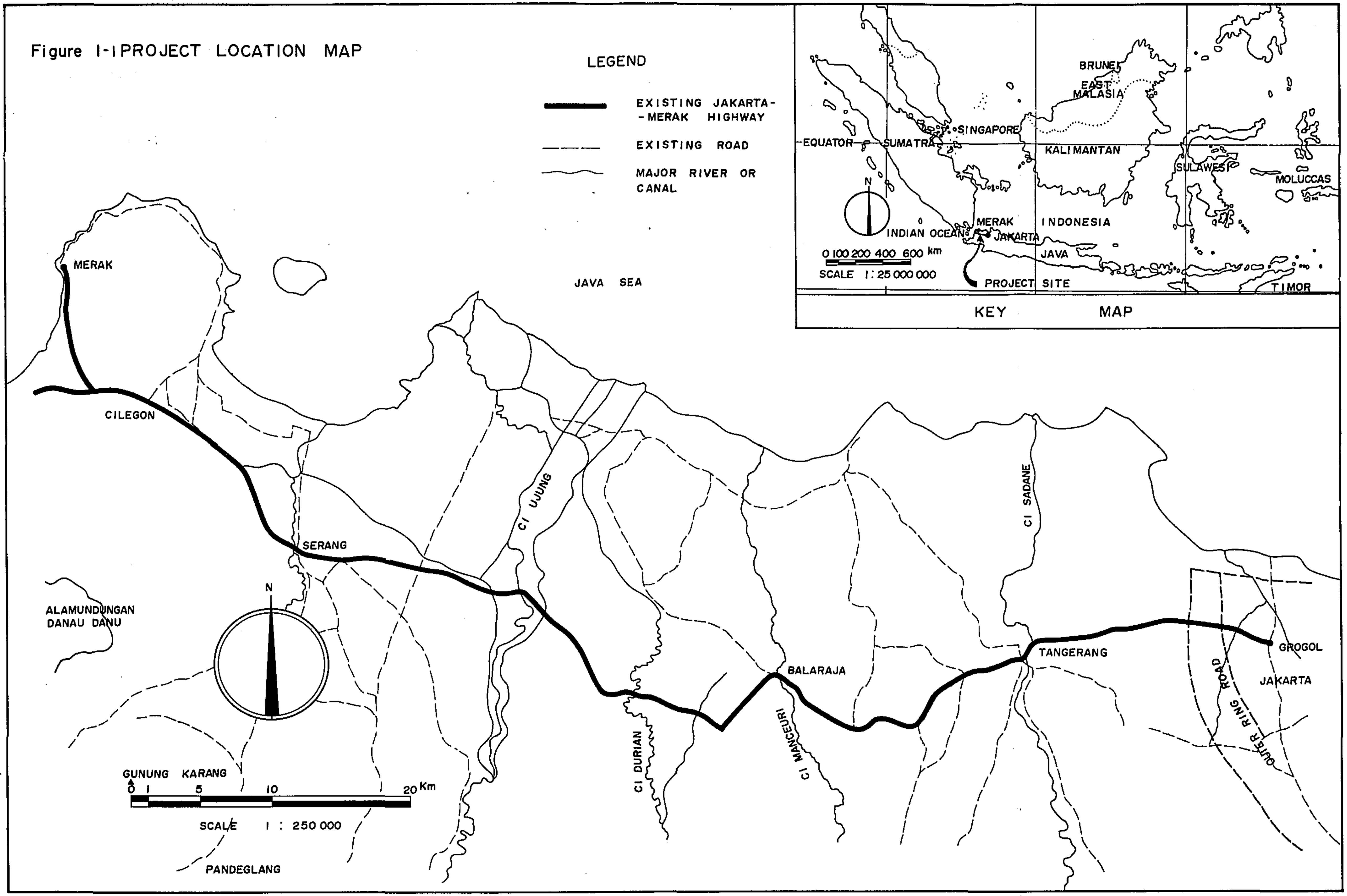


Figure I-1 PROJECT LOCATION MAP
LEGEND
EXISTING JAKARTA-MERAK HIGHWAY
EXISTING ROAD
MAJOR RIVER OR CANAL
MERAK
JAVA SEA
CILEGON
SERANG
CI UJUNG
CI SADANE
ALAMUNDUNGAN DANAU DANU
N
BALARAJA
TANGERANG
GROGOL
JAKARTA
OUTER RING ROAD
CI DURIAN
CI MANCEURI
GUNUNG KARANG
0 1 5 10 20 Km
SCALE 1 : 250 000
PANDEGLANG
BRUNEI
EAST MALASIA
SINGAPORE
EQUATOR
SUMATRA
KALIMANTAN
SULAWESI
MOLUCCAS
INDIAN OCEAN
MERAK
JAKARTA
INDONESIA
JAVA
0 100 200 400 600 km
SCALE 1 : 25 000 000
PROJECT SITE
TIMOR
KEY MAP

fact finding, data collection and discussion with officials of various relevant Departments of Government of the Republic of Indonesia. Subsequent works were carried out in the Pacific Consultants International's Head Office in Tokyo whereby the full support of the whole engineering staff of the consultants as well as the consultants' electronic computer facilities was thrown in. The representatives of the supervisory committee made two separate visists for a total of 33 days to Jakarta during the study team's working period for confirmation of essential points of decision with Bina Marga.

A team of a member each from both the Supervisory Committee and the consultants was despatched again to Jakarta in April, 1974 for draft final report and discussion on the final findings of the study.

1.04 <u>Organization of the Study Team</u>

The full list of the study team and Supervisory Committee is as follows:

A. <u>Supervisory Committee</u>

Chairman

Mr. Shinichiro Asai
Director, Planning Div., Road Bureau,
Ministry of Construction, Japan

Highway Engineer

Mr. Haruo Yoshikoshi
Deputy Director, Planning Div., Road Bureau,
Ministry of Construction, Japan

Highway Construction Specialist

Mr. Masanobu Takami
Technical Investigator, Secretariat, Ministry of Construction, Japan

Rigional Planner

Mr. Mitsuhiro Sasanuma
Special Grade Engineer, International Cooperation Office,
Planning Bureau,
Ministry of Construction, Japan

Structural Engineer

Mr. Jun Wada
Chief, Highway Construction Section, Highway Department,
Hokuriku Regional Construction Bureau,
Ministry of Construction, Japan

Highway Engineer

Mr. Shunichiro Kamijo
Chief, Aichi National Highway Construction Office,
Chubu Regional Construction Bureau,
Ministry of Construction, Japan

B. Study Team of Pacific Consultants International

Project Manager:	Chisato Hirotani
Deputy Project Manager & Highway Engineer:	Akira Shikichi
Highway Engineer:	Takashi Miyakoshi
Highway Engineer:	Kengo Ueda
Structural Engineer:	Itaru Mae
Transportation Engineer:	Fan Kai-Chang
Transportation Economist:	Hitoshi Takahashi

1.05 Assistance from the Government Department & Other Bodies in Indonesia

In the course of the study, much valuable assistance, advice, opinions, and conveniences were received by the team from various governments departments and public and private bodies in Indonesia. We would like to express our appreciation to all, without whom, the study could not be carried out so smoothly and successfully. A full list will be too long to be included here. So only the major bodies will be mentioned hereunder:

Badan Perencanaan Pembangunan Nasional (BAPPENAS)

Directorat Jenderal Bina Marga, Ministry of Public Works and Power

Provincial Government of West Java

Provincial Police Department of West Java

D.K.I. Municipal Planning Board

Office of Jakarta Metropolitan Area Transportation Study

Indonesian State Railway

Krakatau Steel Corporation

1.06 Report Procedure

A. Guide Lines

This report is divided into chapters that are numbered consecutively with Arabic numerals.

The chapters are divided further into sections, sub-sections, and articles. Sections are denoted by the use of two decimal figures, sub-sections by capital Latin letters.

All tables and figures have been numbered with Arabic numerals. Tables normally contain substantially all the necessary basic data for the conclusion arrived at in the report.

B. Report Outline

Chapter 1 introduces the objectives and scope of work of the Study, as well as, the geography, demography and economy of the project area.

Chapter 2 describes the existing situation of the influence area.

Chapter 3 describes economic base studies and traffic forecasting.

Chapter 4 contains an aspect of the initial engineering studies including the geometric standard recommended.

Chapter 5 gives the calculated preliminary construction costs for each alternative solution.

Chapter 6 describes the economic analysis and evaluation of alternatives.

Chapter 7 contains the preliminary engineering.

Chapter 8 gives construction cost estimates for selected alternative solution, and Chapter 9 shows the final economic analysis which is developed using the results of the refined construction cost estimates.

1.07 Project Area Descriptions

A. Geography

The project region is located at an area northwest of West Java. One terminal of the projected highway is Jakarta, the capital and largest city in Indonesia, which is originally founded as a port town in the 7th century. The other terminal of the projected highway is Merak, gateway to Sumatra.

The natural border of the region to the north is the Java sea, to the west the Sunda Strait, and to the south the Indonesian ocean. Please see Fig. 1-1 for the project location map.

B. Topography

The topography of the project region is dominated by the lowland and is traversed by several rivers running from the mountains in south to the Java sea in north. The southern part of the project region consists of mountainous area reaching altitude of 2,000 meters.

The general terrain configuration concerning projected highway will be described along the proposed alternative routes that will link Jakarta and Merak. Please refer to Chapter 4 for further descriptions.

C. Climate

The projected region is located between 6 and 8 degrees south of the equator and consequently has a tropical climate. The seasons are influenced by the monsoons which blow in a general direction from the southeast from April to September and from the northwest or west from October to March.

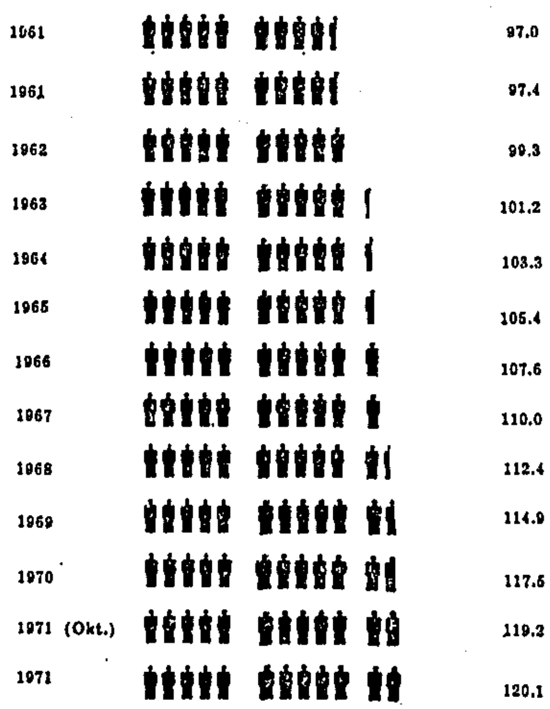
During the southeast monsoon the average rainfall in Jakarta is around 75 mm per month with July usually the dryest. The northwest monsoon brings heavy rainfalls which average over 220 mm per month. The heaviest rainfalls occur mostly in February and averaged about 390 mm during the period from 1966 to 1970. The average total yearly rainfall in Jakarta is approximately 1,800 mm. For the whole projected region, rainfall is varying with the altitude, total yearly rainfall from 1,000 mm to 2,000 mm in lowland, from 2,000 mm to 3,000 mm in highland and more than 3,000 mm in mountainous region.

The maximum yearly average temperature in Jakarta exceeds 30°C and the minimum yearly average marks around 23.5°C.

Relative humidity varies very little through the year. During the period of the northwest monsoon, in Jakarta, the maximum monthly average relative humidity comes up to about 81.5%.

Chapter 2

THE EXISTING SITUATION OF THE INFLUENCE AREA



2. THE EXISTING SITUATION OF THE INFLUENCED AREA

2.01 Administrative Division

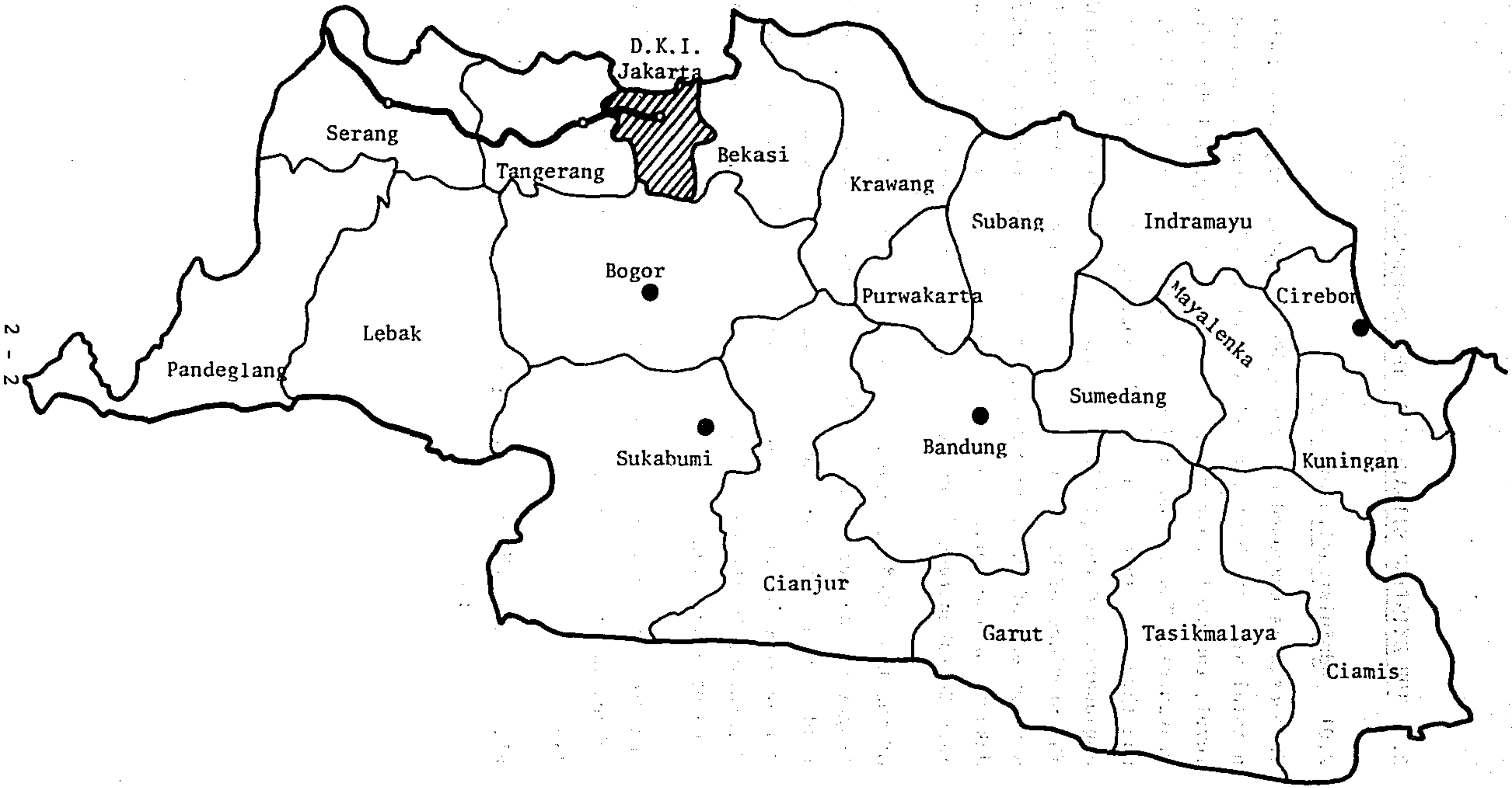
Indonesia is composed of over 3,000 islands, large and small, and has a total area of about two million square kilometers. At the national level, the whole country is divided into two special districts and 24 provinces. The island of Java is composed of two special districts and three provinces, namely, the Special District of Jakarta and Jogjakarta and the provinces of East Java, Central Java and West Java. The province of West Java, in which the proposed road lies, is on the western end of the Island Java, enclosing the Special District of Jakarta on the north. The Province of West Java is further divided into 20 Kabupatens (counties) and 4 Kotamadya (cities).

Of the Kabupatens in the Province of West Java, the Kabupatens of Tangerang and Serang come under the primary influence of the proposed road. Kabupatens are further divided into Kecamatans (towns and villages) which are the smallest administrative units. There are 17 Kecamatans in the Kabupaten of Tangerang and 26 Kecamatans in the Kabupaten of Serang.

The Province of West Java has a total area of 49,118 km^2 of which the Kabupaten of Tangerang has 1,282 km^2 while the Kabupaten of Serang has 1,850 km^2.

Fig. 2-1 shows the administrative division of the Province of West Java and Jakarta.

Fig.2-1 ADMINISTRATIVE DIVISION OF THE PROVINCE OF WEST JAVA AND JAKARTA



2.02 Population

According to past census the population of the Republic of Indonesia was 97,019,000 in 1961, and 119,232,000 in 1971, showing an annual growth rate of 2.1% during the ten years period. The population of the Islands of Java and Madura was 62,993,000 in 1961 and 76,102,000 in 1971, for an annual growth rate of 1.9%, which is lower than the national growth rate. Consequently, Java's share of the national population has dropped from 64.9% in 1961 to 63.8% in 1971. At the province level, the Province of West Java has a population growth rate of 2.1%, while that for the Special District of Jakarta was 4.6%. However, for the last 5 years, the growth rate of Jakarta has been dropping drastically. In the Kabupaten level, Tangerang had an annual growth rate of 2.3% while Serang had an annual growth rate of 1.8%. The total population of Tangerang was 1,067,000 in 1971, for a density of 832 persons/km^2, while that of Serang was 855,000, for a density of 474 persons/km^2. As the density of the whole Java Island for the same year was 565 persons/km^2, Tangerang had a density higher than the average of the whole island, while that of Serang was below average.

Past Trend in Increase of Population

		Population (in 1,000 persons) 1961	1971	Annual growth rate	Density (persons/Km^2)
1.	Indonesia	97,019	119,232	2.1	59
2.	Java	62,993	76,102	1.9	565
3.	Prov. of West Java	17,615	21,633	2.1	440
4.	Jakarta City	2,907	4,574	4.6	7,941
5.	Kab. Tangerang	848	1,067	2.3	832
6.	Kab. Serang	716	855	1.8	474
7.	Kab. Pandeglang	439	573	2.7	261

* Source: Population census

2.03 Registered Number of Vehicle

The total registered number of motor vehicle (excluding two-wheel vehicles) for the Republic of Indonesia was about 400 thousands in the year 1971, which gives a very low rate of ownership of about 3.3 vehicles per 1,000 population. The comparative rate of ownership was 3.6 vehicles for the Island of Java, 2.3 vehicles for the Province of West Java and 26.8 vehicles for the Special District of Jakarta. The rate of vehicle ownership was very much higher in Jakarta, which accounted for about 30% of the total national registered number of vehicles.
Although the rate of ownership of vehicles for the Province of West Java was slightly higher than 2.1 vehicle/1,000 persons, which was the rate of ownership for the Island of Java excluding Jakarta, the difference is so small that we may safely say that when Jakarta was excluded, the rate of ownership was almost uniform for the whole of the Island of Java.

It is difficult to obtain accurate data on the Kabupaten level. However, with the limited data available, we had computed the rate of ownership for Tangerang to be 0.9 veh./1,000 persons, and for Serang to be 0.6 veh./1,000 persons, much lower that the Province average of 2.3 vehicles, showing that motorization was almost non-existing for these Kabupatens.

Table 2-1 shows the existing status of vehicle ownership for the past years.

Table 2-1-1 REGISTERED NUMBER OF VEHICLES (1971)

	Passenger cars	Buses	Trucks	Total	veh/ 1,000 persons
1. Indonesia	259,282	22,797	115,082	397,161	3.3
2. Java	197,719	11,898	67,516	277,133	3.6
3. Prov. of West Java	36,698	2,162	11,749	50,609	2.3
4. Jakarta City	95,077	5,834	21,935	122,846	26.8
5. Kab. Tangerang	247	30	663	940	0.9
6. Kab. Serang	408	22	84	514	0.6
7. Kab. Pandeglang	142	9	82	233	0.4

* Source: 1) Statistics from Bappenda.
2) Statistics from Provincial Police Department, West Java.

Table 2-1-2 RATE OF INCREASE IN NUMBER OF VEHICLES

	Indonesia		Banten District	
Year	No. of Vehicles	Rate of increase (%)	No. of Vehicles	Rate of Increase (%)
1968	314,770	-	1,725	-
1969	332,298	5.6	1,777	3.0
1970	364,730	9.8	1,883	6.0
1971	397,161	8.9	1,960	4.1

* Source: Same as previous table.

** Banten district includes the 4 Kabupatens of Tangerang, Serang, Pandeglang and Lebak.

Table 2-1-3 TREND OF CHANGE IN COMPOSITION BY TYPES OF VEHICLE FOR INDONESIA

Year	No. of Vehicles	veh/ 1,000 persons	Composition (%) Passenger car	Buses	Trucks
1963	243,599	2.4	58.8	9.5	31.7
1964	260,586	2.5	60.4	7.5	32.1
1965	269,905	2.6	61.8	6.8	31.4
1966	291,969	2.7	61.5	6.7	31.8
1967	296,856	2.7	62.7	6.2	31.1
1968	314,770	2.8	64.1	6.2	29.7
1969	332,298	2.9	65.9	5.8	28.3
1970	364,730	3.1	65.5	6.5	28.0
1971	397,161	3.3	65.3	5.7	29.0

* Source: Statistical Year Book, Indonesia

2.04 Traffic Volume on the Existing Jakarta-Merak Highway

Regular traffic volume counts have been taken on 5 points along the existing Jakarta-Merak Highway. Table 2-2 shows the results of the traffic counts for the year 1969 - 1971. It may be seen that generally the traffic volume on the existing route is small. The Jakarta-Tangerang section registered the highest traffic volume of over 5,000 vehicles per day in 1971. The traffic volume rapidly diminished from east to west, and at the extreme west traffic count station, the volume was only about 10% of the Jakarta-Tangerang section. Despite the low traffic volume, the road is congested in many sections (especially for the section east of Tangerang) due to the heavy volume of two-wheel vehicles, bechas and animal drawn vehicles.

Table 2-2 PAST TRAFFIC VOLUMES ON EXISTING JAKARTA-MERAK HIGHWAY

Year	Section / Vehicle type	Jakarta -Tangerang	Tangerang - Balaraja	Balaraja - Serang	Serang - Cilegon	Cilegon - Merak
	Passenger cars	1,462	416	520	462	331
	Buses	115	63	132	70	23
	Trucks	804	142	246	194	74
1969	SUBTOTAL	2,381	621	898	726	428
	2, 3 wheelers	238	47	67	88	31
	Bicycles	648	230	400	527	276
	Animal drawn carts	31	41	91	71	119
	Passenger cars	3,250	927	483	524	262
	Buses	272	111	130	83	31
	Trucks	1,679	1.061	292	232	116
1970	SUBTOTAL	5,207	2,099	905	839	409
	2, 3 wheelers	966	199	151	248	83
	Bicycles	1,636	N.D.	1,630	286	451
	Animal drawn carts	85	188	175	37	138
	Passenger cars	3,547	1,681	1,167	737	539
	Buses	427	329	341	89	77
	Trucks	1,442	481	353	238	139
1971	SUBTOTAL	5,416	2,491	1,861	1,064	755
	2, 3 wheelers	1,436	624	521	531	257
	Bicycles	1,126	485	675	525	217
	Animal drawn carts	40	36	197	67	247

* Source: Results of annual traffic counts on highways, Bina Marga.

2.05 Travel Speed on the Existing Jakarta-Merak Highway

The whole route of the existing route is of paved surface and the surface condition is generally fairly good, improvement works being underway in some sections. Running along flat land, steep gradients and sharp curves are rare. Although the major portion of the road traverses rural areas, intermittent building up along both sides of the road breaks the monopoly, and the existence of bechas as means of local transportation for major towns and villages tends to impede the smooth flow of vehicles.

A travel time survey was carried out in a passenger sedan to verify the travel speed along the existing route, and the results show that the average travel speed for the whole route was 48.8 kph. However, the section between Tangerang and Grogol (Jakarta) had a much lower average travel speed of 34.8 kph, due to the relatively heavy traffic volume, the dense building up along the roadside and the large number of bechas and pedestrians in this section of the route. The travel speed through the town centres is much lower than the rural sections, and registered about 25 kph, 30 kph, 30 kph respectively for Tangerang, Serang and Cilegon. The details of the travel time survey results are presented in Table 2-3.

Table 2-3 RESULTS OF TRAVEL TIME SURVEY

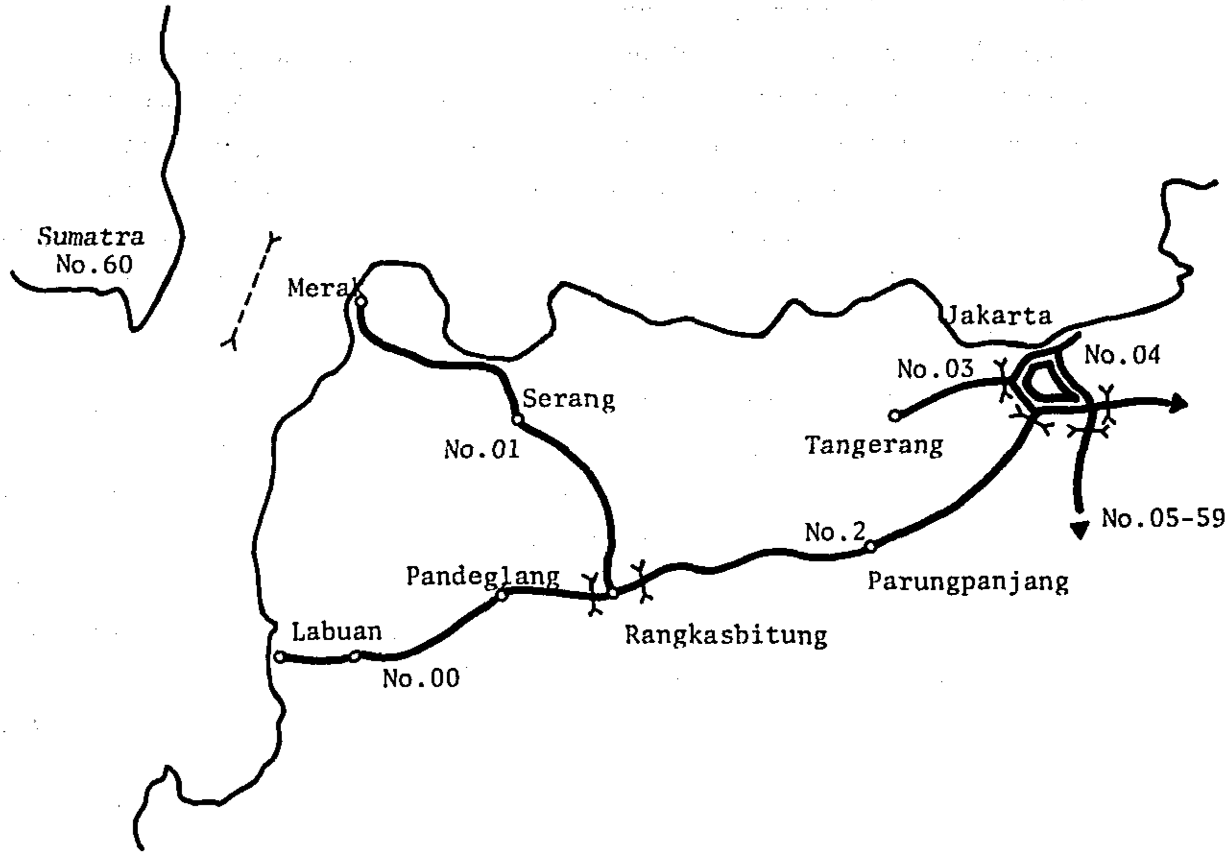
Section	Distance (Km)	Travel Time (Minutes)	Average Travel Speed (Km/h)
1. Grogol - Tangerang	18.7	32.2	34.8
(Tangerang City)	(2.6)	(6.6)	(24.6)
2. Tangerang - Balaraja	24.0	25.6	56.2
3. Balaraja - Serang	42.7	49.9	51.3
(Serang City)	(3.7)	(7.8)	(28.3)
4. Serang - Cilegon	16.0	16.7	57.4
(Cilegon City)	(1.4)	(2.4)	(31.2)
5. Cilegon - Merak	13.9	17.6	47.2
WHOLE ROUTE	115.3	141.8	48.8

2.06 Existing Railway Traffic

There is no directly competing railway line along the existing Jakarta-Merak Highway. The railway to the west of Jakarta runs from Jakarta in a southwest direction until Rangkasbitung, where it branches off into two lines, one going to Labuan in the east and the other to Merak via Serang. Only the Serang-Merak section runs generally parallel to the existing highway. A short branch line connects Jakarta and Tangerang.

Statistical data on the quantity of goods and passenger conveyed within this railway network was available for the year 1971.
The data show that the total goods movement was a meagre 485,711 tons/year or an average of 1,330 tons/day, while the total passengers movement was 2,731,258 passengers/year or an average of 7,480 passengers/day. The major portion of the railway traffic movement was composed of short distance intra-regional movements. The quantity of movement between Jakarta and Serang Region came to only about 20% of the total, i.e. 530,465 persons/year or 1,450 persons/day in passenger traffic and 108,708 tons/year or 300 tons/day in goods traffic. For the branch line between Jakarta and Tangerang, the goods traffic was 23,640 tons/year (60 tons/day) and the passenger traffic was 22,633 persons/year (60 persons/day).
Fig. 2-2 and Table 2-4 show the movement of goods and passengers by railway in the year 1971.

Fig.2-2 EXISTING RAILWAY NETWORK IN WEST JAVA



The above shows the railway network in the western part of Java. For the purpose of O-D Table compilation, the network is grouped into zones shown below.

1.	No. 00	Labuan - Warunggnung
2.	No. 01	Merak - Rangkasbitung
3.	No. 02	Citeras - Palmerah
4.	No. 03	Tangerang - Pesing
5.	No. 04	Within the loop of Jakarta City
6.	No. 05-59	Beyond Jakarta
7.	No. 60	Sumatra

Table 2-4-1

Interzonal flow of passengers by railway (1971)

Unit: Person/Year

DESTINATION / ORIGIN	00	01	02	03	04	05~59	60	TOTAL
00	165.639	54.847	11.461	0	28.760	641	115	261.463
01	46.158	508.488	110.657	0	130.089	2.712	248.768	1.046.872
02	11.324	121.973	335.069	0	184.422	166	0	652.954
03	0	5	9	979	22.491	35	0	23.519
04	22.161	140.483	195.065	29			43.693	401.431
05~59	319	5.509	528	78			28	6.462
60	0	314.978	50	0	23.299	230		338.557
TOTAL	245.601	1.146.283	652.839	1.086	389.061	3.784	292.604	2.731.258

* Source: Statistical Department, Indonesian State Railway

Table 2-4-2

Interzonal flow of goods by railway (1971)

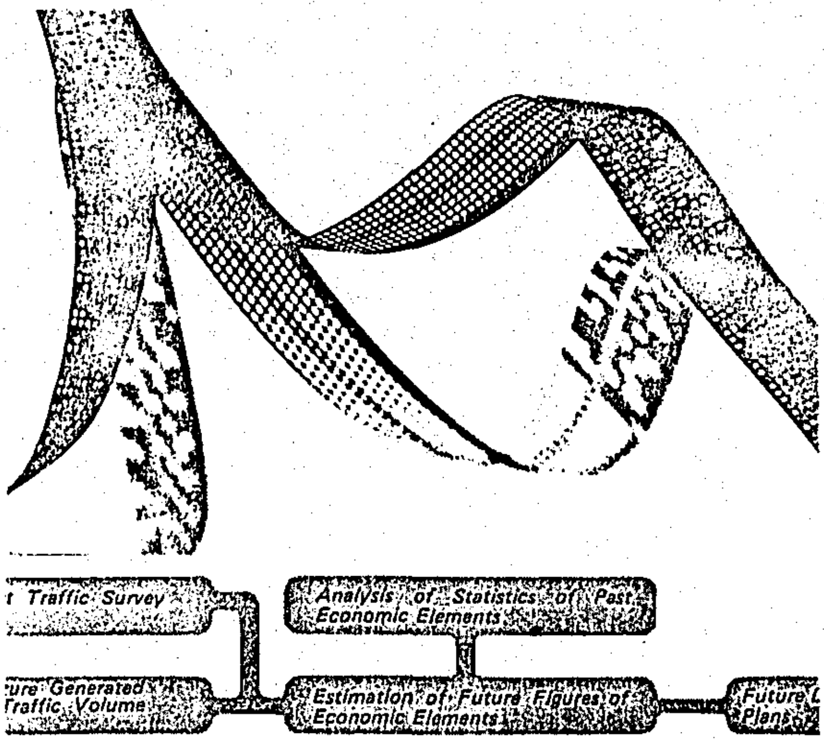
Unit: Ton/Year

DESTINATION / ORIGIN	00	01	02	03	04	05~59	60	TOTAL
00	20		682	473	3 288	4 112	683	9 258
01	20	132	1 906	1 216	11 918	5 333	676	21 201
02	80	423	236 461	35 811	36 433	22 026		331 234
03						876		876
04	486	2 251	35	312			63 862	66 946
05~59	657	5 627	4 971	22 452			36	33 743
60		2 285	487		19 618	63		22 453
TOTAL	1 263	10 718	224 542	60 264	71 257	32 410	65 257	485 711

* Source: Statistical Department, Indonesian State Railway

Chapter 3

FORECAST OF FUTURE TRAFFIC VOLUME



3. FORECAST OF FUTURE TRAFFIC VOLUME

3.01 Zone Division

The proposed road starts from Jakarta and ends in Merak traversing over the Kabupatens of Tangerang and Serang. In the forecast of future traffic volume, it is necessary to divide these two Kabupatens, which form the primary influence area, into small zones.

In the process of zone division, points of heavy concentration of population along the route, as well as the points of traffic counts were consulted, and the final zones decided were that Jakarta was as one zone, the Kabupaten of Tangerang divided into two zones of Tangerang and Balaraja, while the Kabupaten of Serang was divided into three zones of Serang, Cilegon and Merak, the administrative boundaries being adopted as boundaries of zones. The Kabupaten of Pandeglang, to the south of Serang, forms another zone. The rest of the Island to the east were combined into one single external zone.

Fig.3-1 shows the zone division while Table 3-1 presents the zone code list for the zones.

Fig.3-1 ZONE DIVISION

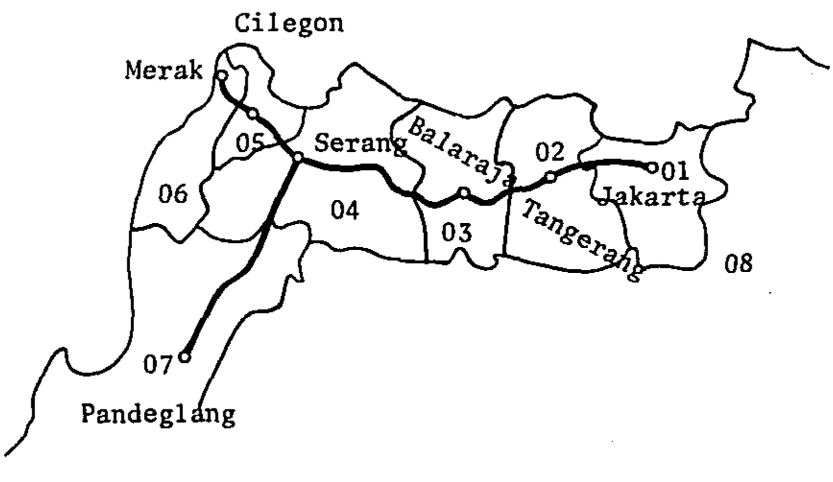


Table 3-1 ZONE CODE LIST

ZONE NO.	ZONE CODE	KABUPATEN	KETJAMATAN
01	JAKARTA		
02	TANGERANG	TANGERANG	Tangerang Batuceper Teluk Nega Serpong Ciputat Ciledug Curug Legok Sepatan
03	BALARAJA		Cikupa Balaraja Tigalareya Kresek Kronjo Mauk Rajeg Pasartamn
04	SERANG	SERANG	Baros Kasemen Kopo Kragilan Pabuaran Padarincang Pamarayan Petir Pontang Serang Taktakan Tirtayasa Carenang Cikande Cikeusal Ciomas Ciruas Walantaka
05	CILEGON		Bajonegara Kramatwatu Mancak Cilegon Waringin kurung
06	MERAK		Anyer Pulomerak Cinangka
07	PANDEGLANG	PANDEGLANG	
08	WEST JAWA		

3.02 Estimation of Population by Zone

Data were scarce for the projection of future population and projection by time trend was the chief method adopted. In other words, for most of the zone, the annual growth rate of population from 1961 to 1971 was assumed to remain unchanged for most of the zones, and from this trend the population for years 1980 and 1990 computed.

However, some deviation from the above method was made for the zones of Jakarta (No. 1), Cilegon (No. 5) and Merak (No. 6). The annual growth rate of the population of Jakarta was a high 4.6% for the 10 year period from 1961 to 1971. However, in the Jabotabek Report (The Planning of the Jakarta-Bogor-Tangerang-Bekasi Metropolitan District), taking the government's policy of curbing population increase into consideration, the natural growth rate was estimated at 2.8% for the period 1971 - 1980. With social increase, the total growth rate was estimated at 4.0%. For the years 1980 - 2000 the annual growth rate was estimated at 1.8% for natural increase and at 2.8% for total increase including social increase. These estimated growth rates were adopted in this study for the estimation of the future population of Jakarta.

In the Cilegan-Merak region, there is a plan for the establishment of a large scale steel industry complex, and the increase of population due to this development has to be taken into consideration. The main points of the steel industry complex plan are summarized as follows:

(i) Target year: 1979

(ii) Target quantity of production (iron and steel): 2.5 million tons

(iii) Number of Employees:

Iron and Steel factories	14,000	persons
Related Industries	7,000	"
Ancillary Services	21,000	"
Total	42,000	"

(iv) Planned Population: 250,000

(Employees x 5 + population for suburban agriculture, construction etc.)

(v) Planned Area

Area for iron and steel factories	250 ha
Area for related industries	300 "
Reserved land	500 "
Area for port facilities	200 "
Area for residential and commercial use	1000 "
Total	about 2200 ha

(vi) Cargo Movements

Quantity on inflow of materials	5.0 million tons/year
Quantity of outflow of products	2.5 million tons/year
Average daily quantity of flow	20,000 tons/day
Between new port and steel complex	15,000 tons (rail)
Between Jakarta and steel complex	5,000 tons
of which	2,500 tons by rail
	2,500 tons by road

From the above plan for the steel industry complex, it is evident that the population will be distributed into the zones of Cilegon and Merak. It is therefore necessary to estimated the number of persons to be imigrated from other districts to these two zones.

While the target year is 1979, it is difficult to imagine that all related industries and ancillary services will be fully developed by 1980. Assuming that all the target employees for steel industries and 50% of the employees for related industries and ancillary services will be employed by 1980, and that the total target is reached by 1990, the number of skilled labours, which will have to be imported from outside the two zones of Cilegon and Merak, is estimated to be 3,500 for 1980 and 4,200 for 1990. The number of employees may thus be summarized as follows:

	1980	1990
Steel factories	14,000	14,000
Related industries	3,500	7,000
Ancillary services	10,500	21,000
Total	28,000	42,000
(of which locally employed)	24,500	37,800

As a large number of employees will be locally employed, it is necessary to check the possible supply from these two zones. The rate of employment for the Cilegon-Merak district is at present 38.5%. If this rate remains unchanged, there will be an increase of labour supply of 34,000 persons for 1980 and 78,000 persons for 1990. This increase is sufficient to fill the demand of unskilled labours by the steel complex. The social increase may therefore be limited to only the skilled labour required by the complex. The skilled labours, with their dependents, are assumed to reside in the two zones in equal number.

The zone code and the results of the estimated future population are summarized on Table 3-2.

Table 3-2

Population by zone

	1971	1980	1990
01. Jakarta	4.574.056	6.509.000	9.069.000
02. Tangerang	657.925	829.000	1.072.000
03. Balaraja	408.770	484.000	585.000
04. Serang	612.877	713.000	845.000
05. Cilegon	127.170	158.000	189.000
06. Merak	115.126	152.000	192.000
07. Pandeglang	572.628	728.000	950.000
08. West Jawa	19.138.188	23.025.000	28.283.000

3.03 Estimation of Future Registered Number of Vehicles

Here again data in hand are not sufficient for accurate estimate of the future number of vehicles, and the method of estimating the rate of ownership of vehicles in relation to the per capita income of the population was adopted.

A. Estimation of the Per Capita National Income

There were no data available regarding the per capita income in the Kabupaten level and it was assumed that the per capita income of Tangerang and Serang was the same as the national average. The estimations for Jakarta were separately made from past statistics. The per capita income for Jakarta and for the Republic for the past years are as follows.

		1966	1967	1968	1969	1970	1971
Indonesia	in rupiah	--	--	16,399	20,649	24,542	26,292
	in US$	--	--	40	50	59	64
Jakarta	in rupiah	5,800	14,500	30,600	37,700	51,800	56,400
	in US$	14	35	74	91	125	136

In both cases, the increase show linear trends on analysis, and the trends are found to be represented by the following curves.

Whole nation $Y = 10.11\ (X - 1960) - 43.12$

$Y = 25.54\ (X - 1960) - 138.07$

where Y : per capita income in US$

X : calendar year

From the above curves, the future per capita incomes are estimated as follows:

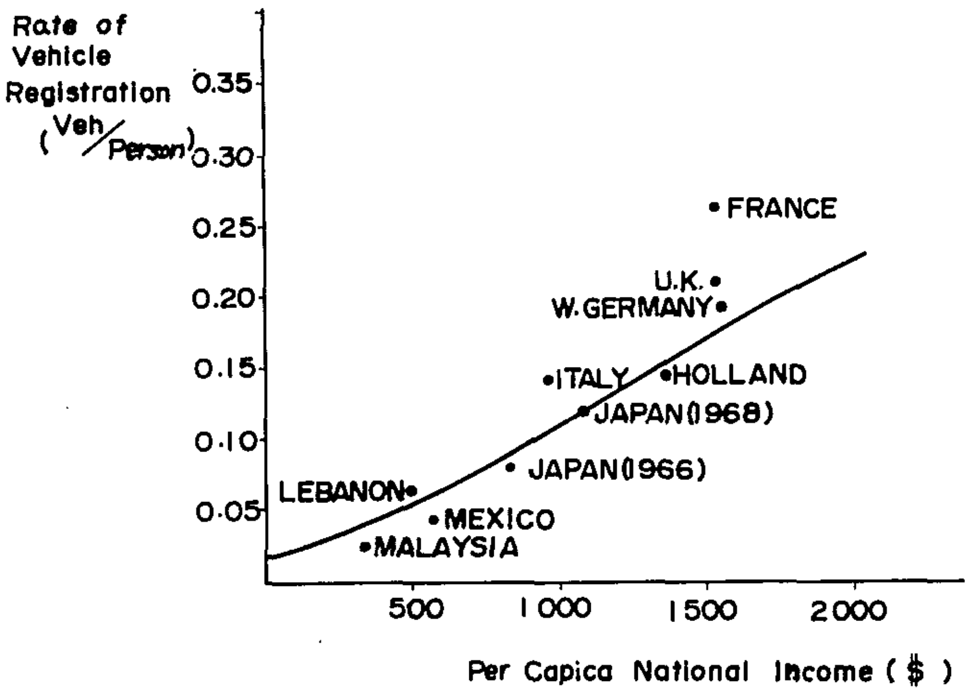
	1980	1990
whole nation	159 US$	260
Jakarta	373 US$	628

As compared to the per capita income for 1971, the national figure shows that by 1990 the income will increase to 4.1 times, at an annual growth rate of 11.5%, while in Jakarta for the same period, the income will be increased to 4.6 times, at an annual rate of 11.7%. While it may be too rash to determine the future per capita income through projection of the past trend, there are, at the time of the study, no data on any official estimates in this regard, and the figures calculated above are adopted in the estimation of traffic volume.

B. Relation Between Rate of Vehicle Ownership and per Capita Income

Analysis of the relation between rate of vehicle ownership and per capita income using data from various countries of the world shows that the two factors are closely related and may be expressed by the curves $y = 0.4\ (0.050754)^{0.999177^x}$, as may be seen from Fig. 3-2, and this curve is used in subsequent estimations.

Fig. 3-2 Relation between Per Capita Income & Rate of Vehicle Registration



C. The Determination of Rate of Ownership of Vehicle in the Influenced Area

The curve established above was made applicable with the per capita income of 1971 to check the theoretical rate of ownership against the actual figures. Calculation shows a theoretical rate of ownership in 1971 of 0.029 veh./person for Jakarta, which compares very favorably against the actual rate of 0.027 veh./person. As for the national rate of ownership in 1971, the theoretical figure of 0.024 veh./person is considerably higher than the actual figure of 0.003 veh./person. This is due to the fact that when the per capita income is low, the theoretical curve tends to give a higher rate than reality, the lower limit being 0.0020 veh./person. However, it can be expected that with the increase in per capita income, the national rate of ownership should gradually reach the international theoretical figures obtained from the graph. In this study, it is assumed that by 1990, when the estimated national per capita income exceeds the existing per capita income for Jakarta, the theoretical figure from the curve is made applicable, while national rate of ownership for 1980 is obtained through the interpolation of the theoretical 1990 figure and the actual 1971 figure. Assuming the rate of ownership of the Kabupatens of Tangerang and Serang to be the same as that for the whole nation, the future rates of ownership are determined as follows:

unit: veh./person

	1971 (actual)	1980	1990
Jakarta	0.027	0.045	0.067
Kabupatens	0.003	0.019	0.036

D. Estimation of the Number of Vehicles for the Traffic Zones

The future population of the traffic zones had been estimated in previous sections. The multiplication of the population with the rate of vehicle ownership per capita will produce the estimated total number of vehicles for the traffic zones. The number of vehicles thus determined for the year 1980 and 1990 are as follows.

		1980		1990	
Zone No.	Name of Zone	Population	Vehicles	Population	Vehicles
1	JAKARTA	6,509,000	292,905	9,069,000	607,623
2	TANGERANG	829,000	15,751	1,072,000	38,592
3	BALARAJA	484,000	9,196	585,000	21,060
4	SERANG	713,000	13,547	845,000	30,420
5	CILEGON	158,000	3,002	189,000	6,804
6	MERAK	152,000	2,888	192,000	6,912
7	PANDEGLANG	728,000	13,832	950,000	34,200
8	WEST JAWA	23,025,000	437,475	28,283,000	1,018,188

E. Estimation of Number of Vehicles by Types of Vehicle

In this study, the motor vehicle are classified into three types, viz. passenger vehicles, buses and trucks.

To estimate the numbers of vehicle by types, the composition percentage of each type of vehicle was determined and the total numbers of vehicle previously determined were divided accordingly. For the Kabupaten zones, the composition was derived from analysis of the past trend of change of vehicle composition in the national level and the future composition established. As for Jakarta, the composition of vehicle had remained virtually unchanged for the past several years, and the 1971 composition was assumed to be maintained in future. The following table shows the results of the analysis.

		Passenger cars	Buses	Trucks	Total
	1971	65.3	5.7	29.0	100.0
Nation	1980	69.5	5.4	25.1	100.0
	1990	74.3	4.6	21.1	100.0
Jakarta		77.4	4.7	17.9	100.0

The number of vehicle by types of vehicles for the traffic zone accordingly as below:

unit: vehicles

Zone No.	Name of Zone	1980 Passenger Cars	1980 Buses	1980 Trucks	1990 Passenger Cars	1990 Buses	1990 Trucks
1	JAKARTA	226,708	13,767	52,430	470,300	28,558	108,765
2	TANGERANG	10,947	851	3,953	28,674	1,775	8,143
3	BALARAJA	6,391	497	2,308	15,647	969	4,444
4	SERANG	9,415	732	3,400	22,602	1,399	6,419
5	CILEGON	2,086	162	754	5,055	313	1,436
6	MERAK	2,007	156	725	5,136	318	1,458
7	PANDEGLANG	9,613	747	3,472	25,411	1,573	7,216
8	WEST JAWA	304,045	23,624	109,806	756,514	46,837	214,837

3.04 The Estimation of Future Traffic Volume between Jakarta and Merak

A. The Determination of present O-D Matrices

The limited past traffic survey data are inadequate for obtaining a full picture of the overall past traffic pattern in the influence area, and to verify the present traffic pattern in the area, theoretical O-D matrices were established and checked against traffic volume counts made along the existing route.

The gravity model was employed in the preparation of the theoretical matrices, the population of the zones being used as the attracting element and the time distance between zones adopted as resistance element.

The model is as follows:

$$Tij = Ti \times Tj \times \frac{k}{Dijn}$$

where Tij = distributed traffic volume between i and j

Dij = resistance element between i and j (time distance)

Ti,Tj= attraction element of i. j, (population)

n, k,= coefficient

The coefficient were derived through analysis of the results of cordon traffic survey made in the Metropolitan Area Traffic Planning Study and the coefficient was found to be 1.5, a typical parameter for an urban area. Since the proposed highway traverse through rural area, for which the coefficient is in most cases bigger than the urban area, careful check was made before the parameter was adopted. For the purpose of comparison, calculations were made with the three cases of coefficients of 1.5, 1.7 and 2.0, and the results from the empirical value of 1.5 reflected the actual traffic pattern best, and its adoption for this study was decided.

The resultant theoretical O-D matrices by types of vehicles for 1971 are as shown in Table 3-3.

On assigning the traffic of the theoretical O-D matrices to the existing road network, the theoretical traffic volumes at various sections are shown in the table below, and in Fig.3-3 whereby the actually surveyed traffic volumes were also listed for comparison. It is clearly seen that the theoretical volumes compare very favorably with the actual volumes, although the actual volumes for the low traffic-volume sections were higher than the theoretical figures. Nevertheless it was considered that the general pattern of the theoretical O-D matrices sufficiently expressed the actual traffic pattern and the model was therefore adopted for the forecast of future traffic volumes.

CROSS-SECTION TRAFFIC VOLUMES, 1971

Section	Passenger car		Bus		Truck		Total	
	theo-retical	actual	theo-retical	actual	theo-retical	actual	theo-retical	actual
Jakarta-Tangerang	3,484	3,547	556	427	1,202	1,442	5,242	5,416
Tangerang-Balaraja	2,041	1,681	327	329	705	481	3,073	2,491
Balaraja-Serang	1,214	1,167	192	341	419	353	1,825	1,861
Serang-Cilegon	620	737	118	89	216	238	954	1,064
Cilegon-Merak	322	539	63	77	113	139	498	755

Table 3-3-1

INTERZONAL ACTUAL AND TIME DISTANCES

Interzonal actual distance

	02	03	04	05	06	07	08
01	26	55	93	105	113	143	180
02		24	67	79	87	117	206
03			43	50	58	88	235
04				12	20	50	273
05					8	67	285
06						70	293
07							270

unit : km

Interzonal time distance

	02	03	04	05	06	07	08
01	45	71	121	134	142	196	216
02		26	76	89	97	151	261
03			50	63	71	125	287
04				13	21	(75)	337
05					8	88	350
06						96	358
07							540

unit : minute

Table 3-3-2 **Theoretical O−D matrices** - 1971

1971 − Passenger cars

	02	03	04	05	06	07	08	T
01	1.445	454	306	54	45	138	(3.998)	6.440
02		293	88	14	11	29	433	2.313
03			103	15	11	24	233	1.133
04				240	106	(78)	275	1.196
05					92	13	54	482
06						10	47	322
07							(127)	

1971 − Buses

	02	03	04	05	06	07	08	T
01	329	103	70	12	10	32	(910)	1.466
02		67	20	3	3	7	—	429
03			23	3	3	6	—	205
04				55	24	(18)	—	210
05					21	3	—	97
06						2	—	63
07								

1971 − Trucks

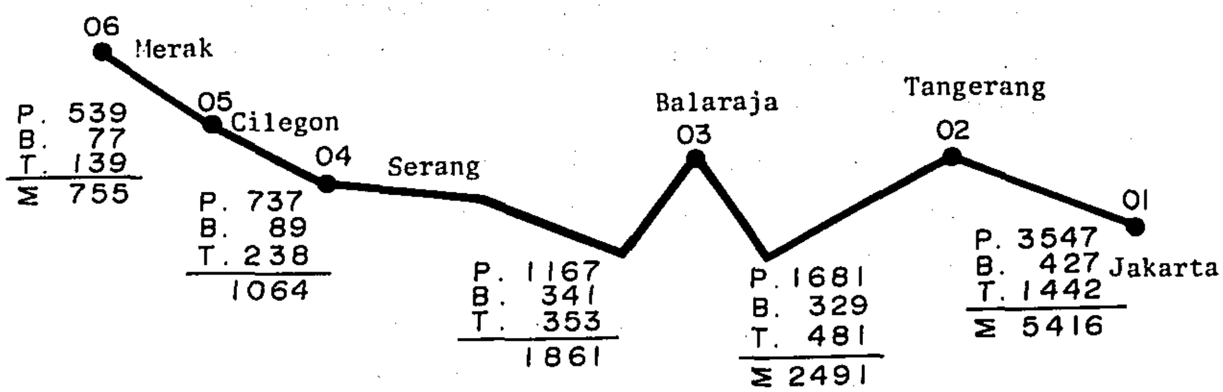
	02	03	04	05	06	07	08	T
01	498	156	105	19	16	48	(1.379)	2.221
02		101	30	5	4	10	149	797
03			35	5	4	8	81	390
04				83	37	(27)	95	412
05					32	4	19	167
06						4	16	113
07							(44)	

1971 − All vehicles

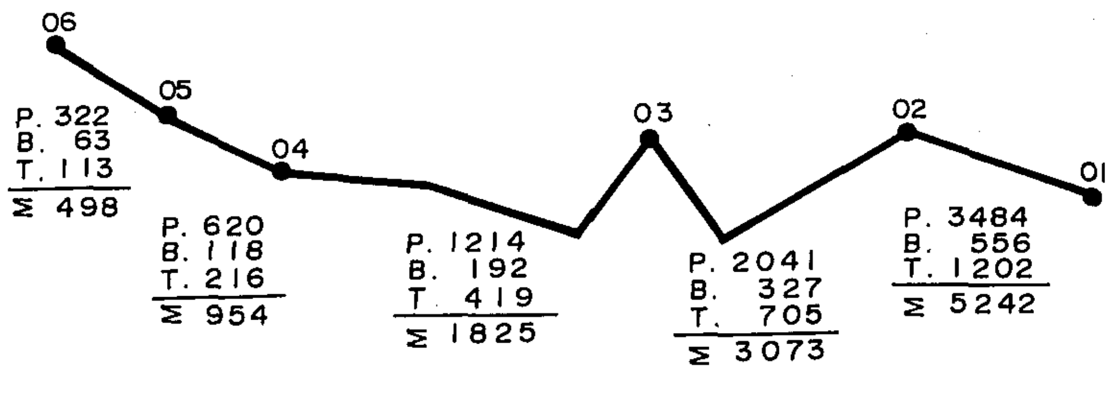
	02	03	04	05	06	07	08	T
01	2.272	713	481	85	71	218	(6.287)	10.127
02		1.174	138	22	18	46	582	3.539
03			161	23	18	38	314	1.728
04				378	167	(123)	370	1.818
05					145	20	73	746
06						16	63	498
07							(171)	

Table 3-3-3

Surveyed traffic volume - 1971



Theoretical traffic flow chart - 1971



B. Establishment of Future O-D Matrices

(i) Determination of number of trips for vehicle per day in the influence area

To determine the number of trip per vehicle, the number of trips in the present O-D matrices was divided by the estimated number of vehicles making the trips on the route, and the results are as follows:

Passenger car	:	2.6 trips/veh. day
Bus	:	11.3 trips/veh. day
Truck	:	2.5 trips/veh. day

It was assumed that no drastic changes would occur in the future number of trips per vehicle and the above figures were made applicable in the estimation of future traffic volumes.

(ii) Calculation of volume of traffic generation

The total volume of traffic generation for the traffic zones were derived through multiplying the number of vehicles of each zone to the estimated trip ends (= 2 x trips/veh.day) per vehicle.

(iii) Future O-D matrices

The future natural growth traffic O-D matrices were determined with the gravity model, and the results are as in the Table 3-4.

Table 3-4-1

O-D Matrices for natural increase traffic - 1980

1980 - Passenger cars

	02	03	04	05	06	07	08	T
01	4.171	2.846	2341	731	766	657	(19.026)	30.538
02		147	66	19	20	69	1.023	5.515
03			132	35	34	87	841	4.122
04				482	316	(307)	1.081	4.725
05					408	52	218	1.945
06						58	273	1.875

1980 - Buses

	02	03	04	05	06	07	08	T
01	1.351	779	554	90	117	177	(5.021)	8.089
02		308	119	18	22	30	-	1.848
03			196	27	33	40	-	1.383
04				322	262	(136)	-	1.589
05					178	20	-	655
06						20	-	632

1980 - Trucks

	02	03	04	05	06	07	08	T
01	1.150	656	434	89	106	147	(4.232)	6.814
02		244	88	16	19	24	355	1.896
03			144	24	27	29	295	1.419
04				277	206	(107)	376	1.632
05					175	16	77	674
06						23	92	648

1980 - All vehicles

	02	03	04	05	06	07	08	T
01	6.672	4.281	3.329	910	989	981	28.279	45.441
02		699	273	53	61	123	1.378	9.259
03			745	86	94	156	1.136	6.924
04				1.081	784	550	1.457	7.946
05					761	88	295	3.274
06						101	365	3.155

Table 3-4-2

O-D Matrices for natural increase traffic — 1990

1990 — Passenger cars

	02	03	04	05	06	07	08	T
01	10.451	4.860	4.661	1.215	1.454	1.362	(39.472)	63.475
02		591	311	75	87	179	2679	14.373
03			419	92	102	165	1.606	7.835
04				1.479	1.106	(736)	2.594	11.306
05					1.190	127	527	4.705
06						148	698	4.785

1990 — Buses

	02	03	04	05	06	07	08	T
01	3.058	1.263	1.190	203	281	366	(10.417)	16.778
02		431	221	34	46	63	—	3.853
03			262	37	48	62	—	2.103
04				593	511	(260)	—	3.037
05					360	39	—	1.266
06						41	—	1.287

1990 — Trucks

	02	03	04	05	06	07	08	T
01	2.584	1.065	941	202	257	306	(8.779)	14.134
02		324	156	31	38	49	731	3.913
03			186	33	39	44	443	2.134
04				495	393	(202)	710	3.083
05					348	31	146	1.286
06						46	185	1.306

1990 — All vehicles

	02	03	04	05	06	07	08	T
01	16.093	7.188	6.792	162	1.992	2.034	58.668	94.387
02		1.346	688	140	171	291	3.410	22.139
03			867	162	189	271	2.049	12.072
04				2.567	2.010	1.198	3.304	17.426
05					1.898	197	673	7.257
06						235	883	7.378

3.05 Development Traffic

The traffic volume so far estimated had been largely natural growth traffic volume. However, should any large scale developments be planned along the route following the construction of the highway, the developed traffic will have to be accounted for. The western half of the proposed route follows the existing alignment and new routes are proposed only for the Jakarta - Tangerang section. Except for the Cilegon steel complex, no plans are at present in hand for any large scale development along the route, since the region is at present already fully engaged in agricultural activities. As for the steel complex, the additional traffic due to the increase in population had been taken into consideration. Therefore, in this section on developed traffic, only the traffic of trucks to transport materials and products between Jakarta and the steel complex will be taken into consideration.
The movements of goods between Jakarta and the Cilegon steel complex by road is, as shown in the previous section, estimated to be 2,500 tons/day in both direction. Assuming that 10 ton trucks will be employed for the goods movement and assuming an average load coefficient of 0.75, the volume of traffic will be 330 trucks/day between Cilegon and Jakarta.

3.06 Ferry Boat Traffic

Plans are underway to strengthen the interinsular traffic between the islands of Sumatra and Java through the provision of a ferry link between Bakauhuni (Sumatra) and Merak (Java). The consultants ENEX from New Zealand had, in the feasibility study of the ferry link, made detailed estimations of the future vehicles traffic utilizing this ferry service. The Java end of the ferry service being Merak, there is no doubt that the arriving and departing vehicles at Merak will use the proposed Jakarta-Merak Highway on the Java end. In this study no new efforts had been made in estimating the ferry boat traffic but that the figures estimated by ENEX were adopted and added to the natural growth traffic volumes. Although the ENEX report did not analyze the origin or destination of the ferry boat traffic, it can be safely presumed that being the largest distributing and collecting center of

goods in West Java, Jakarta will be the traffic end of most of the ferry boat traffic. In this report, it was assumed that one of the ends of all the ferry boat traffic would be Jakarta, and the traffic volume on the Jakarta-Merak Highway adjusted accordingly.
The estimated traffic volumes for the key years are as follows:

	Passenger Cars	Buses	Trucks	Total
1980	63	150	120	333 vehicles/day
1990	160	409	292	861 "

3.07 Other Possible Traffic Source

Considerations were also made on the possibility of traffic generation of the following sources, but it was eventually decided against their inclusion for the various reasons to be separately related below.

A. Diversion from the Railway

The statistical data for the railway traffic of 1971 showed that the volume of traffic which may be considered for diversion to the new highway is small. The diversion of a portion of this traffic would not substantially alter the traffic pattern of the highway. It was decided therefore, that for a conservative estimate, the diversion from the railway would not be taken into consideration.

B. Generated Traffic

In estimating the traffic on a new highway consideration for the traffic which would be generated purely due to the completion of the new highway would have to be made. In the case of this study, only the section between Jakarta and Tangerang is of a completely new alignment, running closely parallel to the existing route. The traffic volume is not very large and the road surface condition of the existing route is fairly good so that any suppression of existing traffic demand is inconceivable. The totally new traffic generation due to the completion of the new highway will be extremely small if in existance at all. It was decided, therefore, that no accounts were taken of the generated traffic due to the implementation of the project under study.

C. Tourist Traffic

The beach at Merak is one of the preciously few beaches which form the recreation resorts in West Java and should any large scale efforts be made towards tourist promotion, the effects on the traffic volume will be great. However, in-situ investigation shows that the size of the beach is too small for any large scale development, and large scale expansion of the tourist industry cannot be expected. In this study, it is considered therefore that other than the existing tourist traffic which is included in the natural growth traffic, no further considerations be made for traffic from tourist development.

D. Traffic from the New International Airport

A new international airport is planned at the coastal area northeast of Tangerang, and studies were made to ascertain its effects on the traffic volume on the proposed route. It was found that a new road connecting the new airport and the town center of Jakarta had been planned so that airport users would not need to make use of the proposed highway.

3.08 Total Distributed Traffic

The total traffic volumes between relevant zones are summed up from the above natural growth traffic, development traffic and ferry boat traffic and the results for the key years 1980 and 1990 are as in Table 3-5.

Table 3-5-1

O-D Matrices for all traffic -1980

1980 – Passenger cars

	02	03	04	05	06	07	08	T
01	4.171	2.846	2.341	731	829	657	(19.026)	30.538
02		147	66	19	20	69	1.023	5.515
03			132	35	34	87	841	4.122
04				482	316	(307)	1.081	4.725
05					408	52	218	1.945
06						58	273	1.938

1980 – Buses

	02	03	04	05	06	07	08	T
01	1.351	779	554	90	267	177	(5.021)	8.089
02		308	119	18	22	30	–	1.848
03			196	27	33	40	–	1.383
04				322	262	(136)	–	1.589
05					178	20	–	655
06						20	–	782

1980 – Trucks

	02	03	04	05	06	07	08	T
01	1.150	656	434	419	226	147	(4.232)	6.814
02		244	88	16	19	24	355	1.896
03			144	24	27	29	295	1.419
04				277	206	(107)	376	1.632
05					175	16	77	1.004
06						23	92	768

1980 – All vehicles

	02	03	04	05	06	07	08	T
01	6.672	4.281	3.329	1.240	1.322	981	(28.279)	45.441
02		699	273	53	71	123	1.378	9.259
03			472	86	94	156	1.136	6.924
04				1.081	784	(550)	1.457	7.946
05					761	88	295	3.604
06						101	365	3.488

Table 3-5-2

O-D Matrices for all traffic -1990

1990 – Passenger cars

	02	03	04	05	06	07	08	T
01	10.451	4.860	4.661	1.215	1.614	1.362	(39.472)	63.475
02		591	311	75	87	179	2.679	14.373
03			419	92	102	165	1.606	7.835
04				1.479	1.106	(736)	2.594	11.306
05					1.190	127	527	4.709
06						148	698	4 945

1990 – Buses

	02	03	04	05	06	07	08	T
01	3.058	1.263	11.90	203	690	366	10.417	16.778
02		431	221	34	46	63	—	3.853
03			262	37	48	62	—	2.103
04				593	511	(260)	—	3.037
05					360	39	—	1.266
06						41	—	1.696

1990 – Trucks

	02	03	04	05	06	07	08	T
01	2.584	1.065	941	532	549	306	(8 779)	14.134
02		324	156	31	38	49	731	3.913
03			186	33	39	44	443	2.134
04				495	393	(202)	710	3.083
05					348	31	146	1.616
06						46	185	1.598

1990 – All vehicles

	02	03	04	05	06	07	08	T
01	16.093	7.188	6.792	1.950	2.853	2.034	(58.668)	94.387
02		1.346	688	140	171	291	3.410	22.139
03			867	162	189	271	2.049	12.072
04				2.567	2.007	1.198	3.304	17.426
05					1.898	197	673	7.587
06						235	883	8.239

3.09 Estimation of Traffic Volume on the New Route

In the sections of the Jakarta-Merak Highway with upgrading of the existing route, no considerations are necessary for the splitting of the traffic volumes between different routes. However, in the sections where new alignments are proposed, calculations will have to be made of the volumes of traffic that will be diverted from the existing route to the new route. The probably density method, in the form of the equation $P_1/100 = 1 - 2\left(\frac{T_1}{T_2} - \frac{1}{2}\right)^2$, was employed. In this equation, P_1 in % is the percentage of traffic volume that will utilize the shorter (in time distance) of the two competing routes, while T_1 and T_2 are respectively the time distance of the shorter and the longer routes. This equation shows that when both routes are of the same time distance, the traffic volume will be evenly split, and when one route is half in time distance of the other, all traffic will utilize only the shorter route. (Fig.3-3)

This calculation, however, was only applicable to the sections with new routes, where diversion occurs between the new routes and the existing highway. For the sections where improvement of the existing route is proposed, it is evident that 100% of the traffic will remain on the same route and diversion calculation was not necessary.

Calculations were made for all the zone pairs and the results of the traffic assignment for the various alternatives are as in Table 3-6 and Fig. 3-4. The results show that in all cases, almost the total volumes of the inter-zonal traffic will shift to the new route leaving only localized intra-district traffic on the existing route.

The year by year traffic volumes for the various alternatives, converted into passenger car units, are listed in Table 3-7.

Fig.3-3-1 DIVERSION CURVE

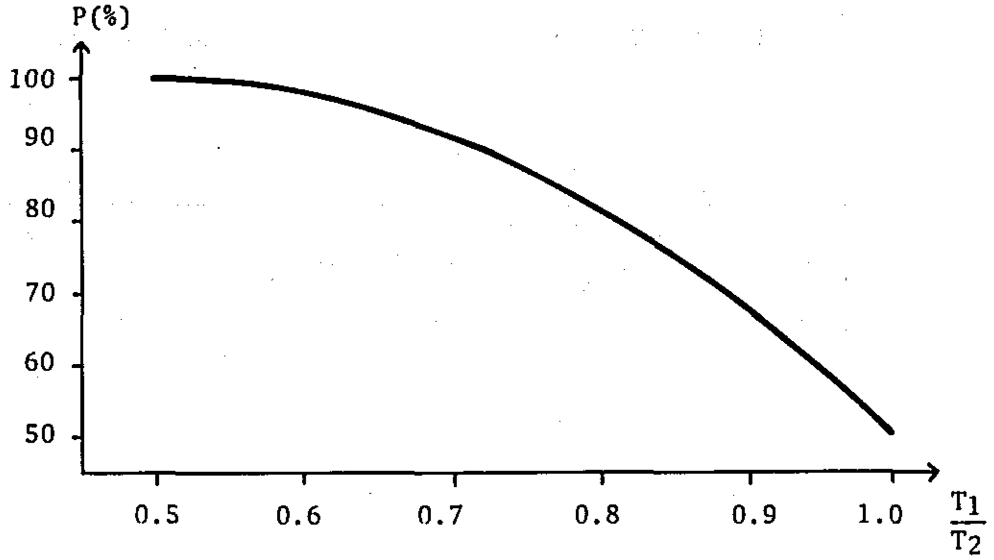


Fig.3-3-2 SKETCH OF RELATIVE POSITION OF THE ALTERNATIVES

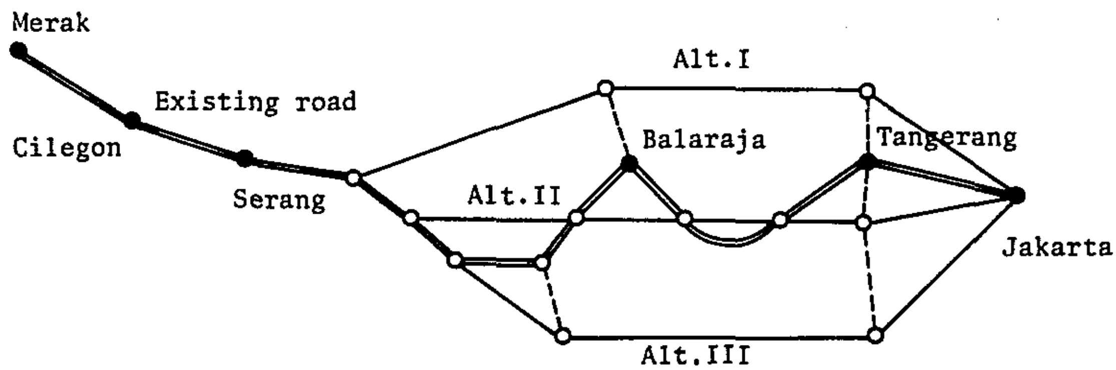


Table 3-6-1

DIVERTED TRAFFIC O-D TABLE (1980) - ALTERNATIVE I

Passenger Cars

	02	03	04	05	06	07	08
01	3,937	2,641	2,313	722	819	649	( )
02		119	66	19	20	69	966
03			132	35	34	87	780
04				482	316	( )	1,068
05					408	52	215
06						58	270

Buses

	02	03	04	05	06	07	08
01	1,275	723	547	89	264	174	( )
02		250	119	18	22	30	-
03			195	27	33	40	-
04				322	262	( )	-
05					178	20	-
06						20	-

Trucks

	02	03	04	05	06	07	08
01	1,086	609	429	414	223	145	( )
02		198	88	16	19	24	335
03			144	24	27	29	274
04				277	206	( )	371
05					175	16	76
06						23	91

Total

	02	03	04	05	06	07	08
01	6,298	3,973	3,289	1,225	1,306	968	( )
02		567	273	53	61	123	1,301
03			471	86	94	156	1,054
04				1,081	784	( )	1,439
05					761	88	291
06						101	361

Table 3-6-2

DIVERTED TRAFFIC O-D TABLE (1980) - ALTERNATIVE II

Passenger cars

	02	03	04	05	06	07	08
01	3,937	2,596	2,320	724	822	651	( )
02		131	65	19	20	68	966
03			125	33	32	82	767
04				482	316	( )	1,071
05					408	52	216
06						58	271

Buses

	02	03	04	05	06	07	08
01	1,275	710	549	89	265	175	( )
02		275	117	18	22	29	-
03			185	25	31	38	-
04				322	262	( )	-
05					178	20	-
06						20	-

Trucks

	02	03	04	05	06	07	08
01	1,086	598	430	415	224	146	( )
02		218	86	16	19	24	335
03			136	23	25	27	269
04				277	206	( )	373
05					175	16	76
06						23	91

Total

	02	03	04	05	06	07	08
01	6,298	3,904	3,299	1,228	1,311	972	( )
02		624	268	53	61	121	1,301
03			446	81	88	147	1,036
04				1,081	784	( )	1,444
05					761	88	292
06						101	362

Table 3-6-3

DIVERTED TRAFFIC O-D TABLE (1980) - ALTERNATIVE III

Passenger cars

	02	03	04	05	06	07	08
01	3,420	2,459	2,304	719	816	646	( )
02		5	44	13	13	46	839
03			66	18	17	44	727
04				482	316	( )	1,064
05					408	52	216
06						58	269

Buses

	02	03	04	05	06	07	08
01	1,108	673	545	89	263	174	( )
02		11	79	12	15	20	-
03			98	14	17	20	-
04				322	262	( )	-
05					178	20	-
06						20	-

Trucks

	02	03	04	05	06	07	08
01	943	567	427	412	222	145	( )
02		9	58	11	13	16	291
03			72	12	14	15	255
04				277	206	( )	370
05					175	16	76
06						23	91

Total

	02	03	04	05	06	07	08
01	5,471	3,699	3,276	1,220	1,301	965	( )
02		25	181	36	41	82	1,130
03			236	44	48	79	982
04				1,081	784	( )	1,434
05					761	88	292
06						101	360

Table 3-6-4

DIVERTED TRAFFIC O-D TABLE (1990) - ALTERNATIVE I

Passenger cars

	02	03	04	05	06	07	08
01	9,866	4,510	4,605	1,200	1,595	1,346	( )
02		479	310	75	87	179	2,529
03			418	92	102	165	1,490
04				1,479	1,106	( )	2,563
05					1,190	127	521
06						148	690

Buses

	02	03	04	05	06	07	08
01	2,887	1,172	1,176	201	682	362	( )
02		350	220	34	46	63	-
03			261	37	48	62	-
04				593	511	( )	-
05					360	39	-
06						41	-

Trucks

	02	03	04	05	06	07	08
01	2,439	988	930	526	542	302	( )
02		263	156	31	38	49	690
03			185	33	39	44	411
04				495	393	( )	701
05					348	31	144
06						46	183

Total

	02	03	04	05	06	07	08
01	15,192	6,670	6,711	1,927	2,819	2,010	( )
02		1,092	686	140	171	291	3,219
03			864	162	189	271	1,901
04				2,567	2,010	( )	3,264
05					1,898	197	665
06						235	873

Table 3-6-5

DIVERTED TRAFFIC O-D TABLE (1990) - ALTERNATIVE II

Passenger cars

	02	03	04	05	06	07	08
01	9,866	4,432	4,619	1,204	1,599	1,350	( )
02		528	305	74	85	176	2,529
03			396	87	96	156	1,465
04				1,479	1,106	( )	2,571
05					1,190	127	522
06						148	692

Buses

	02	03	04	05	06	07	08
01	2,887	1,152	1,179	201	684	363	( )
02		385	217	33	45	62	-
03			247	35	45	59	-
04				593	511	( )	-
05					360	39	-
06						41	-

Trucks

	02	03	04	05	06	07	08
01	2,439	971	933	527	544	303	( )
02		289	153	30	37	48	690
03			176	31	37	42	404
04				495	393	( )	704
05					348	31	145
06						46	183

Total

	02	03	04	05	06	07	08
01	15,192	6,555	6,731	1,932	2,827	2,016	( )
02		1,199	675	137	167	286	3,219
03			819	153	178	257	1,869
04				2,567	2,010	( )	3,275
05					1,898	197	667
06						235	875

Table 3-6-6

DIVERTED TRAFFIC O-D TABLE (1990) - ALTERNATIVE III

Passenger cars

	02	03	04	05	06	07	08
01	8,570	4,199	4,586	1,196	1,588	1,340	( )
02		21	206	50	58	118	2,197
03			210	46	51	83	1,388
04				1,479	1,106	( )	2,552
05					1,190	127	519
06						148	687

Buses

	02	03	04	05	06	07	08
01	2,508	1,091	1,171	200	679	360	( )
02		16	146	23	30	42	-
03			131	19	24	31	-
04				593	511	( )	-
05					360	39	-
06						41	-

Trucks

	02	03	04	05	06	07	08
01	2,119	920	926	523	540	301	( )
02		12	103	21	25	32	599
03			93	17	20	22	383
04				495	393	( )	699
05					348	31	144
06						46	182

Total

	02	03	04	05	06	07	08
01	13,197	6,210	6,683	1,919	2,807	2,001	( )
02		49	455	94	113	192	2,796
03			434	82	95	136	1,771
04				2,567	2,010	( )	3,251
05					1,898	197	663
06						235	869

Fig. 3-4-1

Assigned traffic volume — 1980

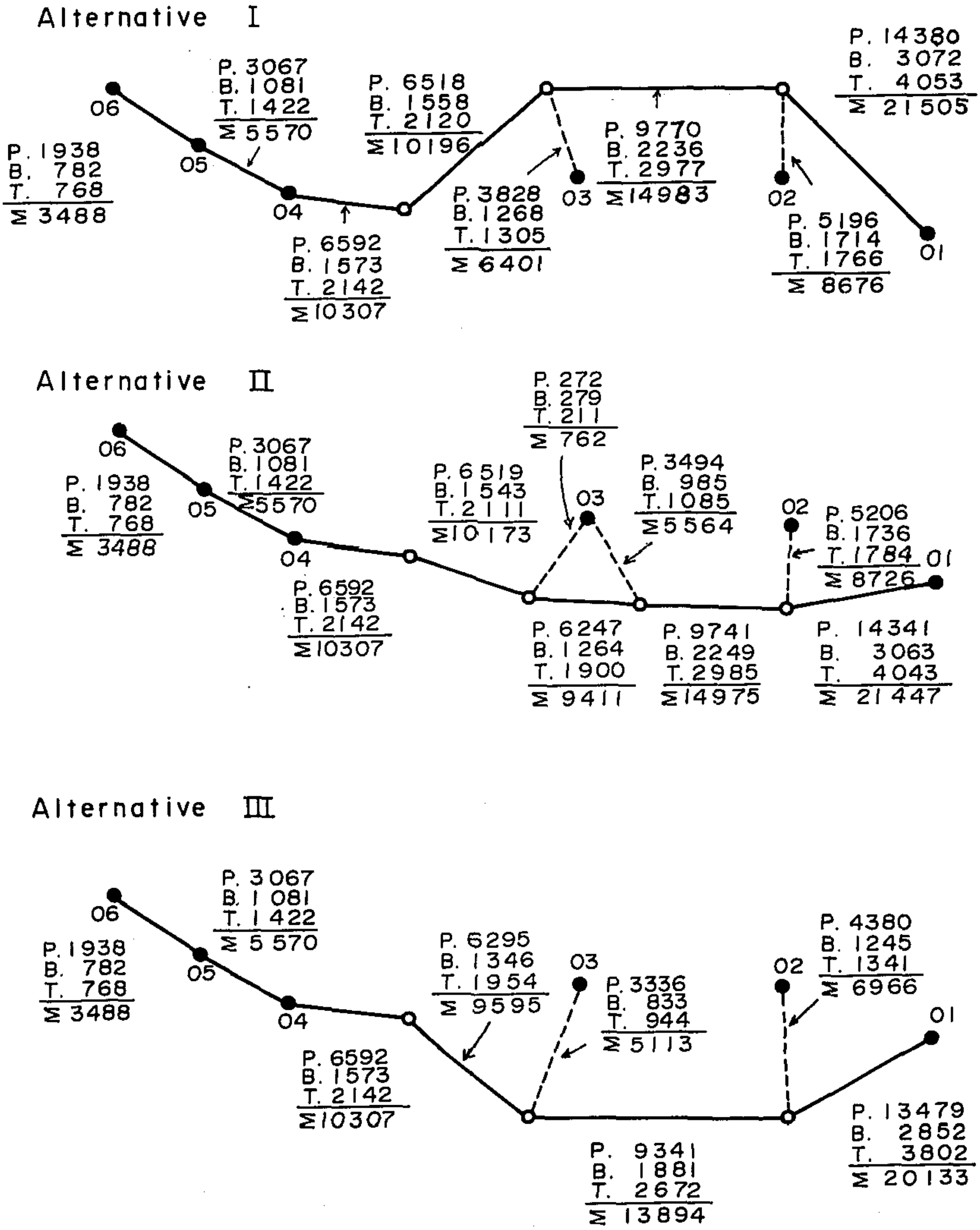


Fig. 3-4-2

Assigned traffic volume — 1990

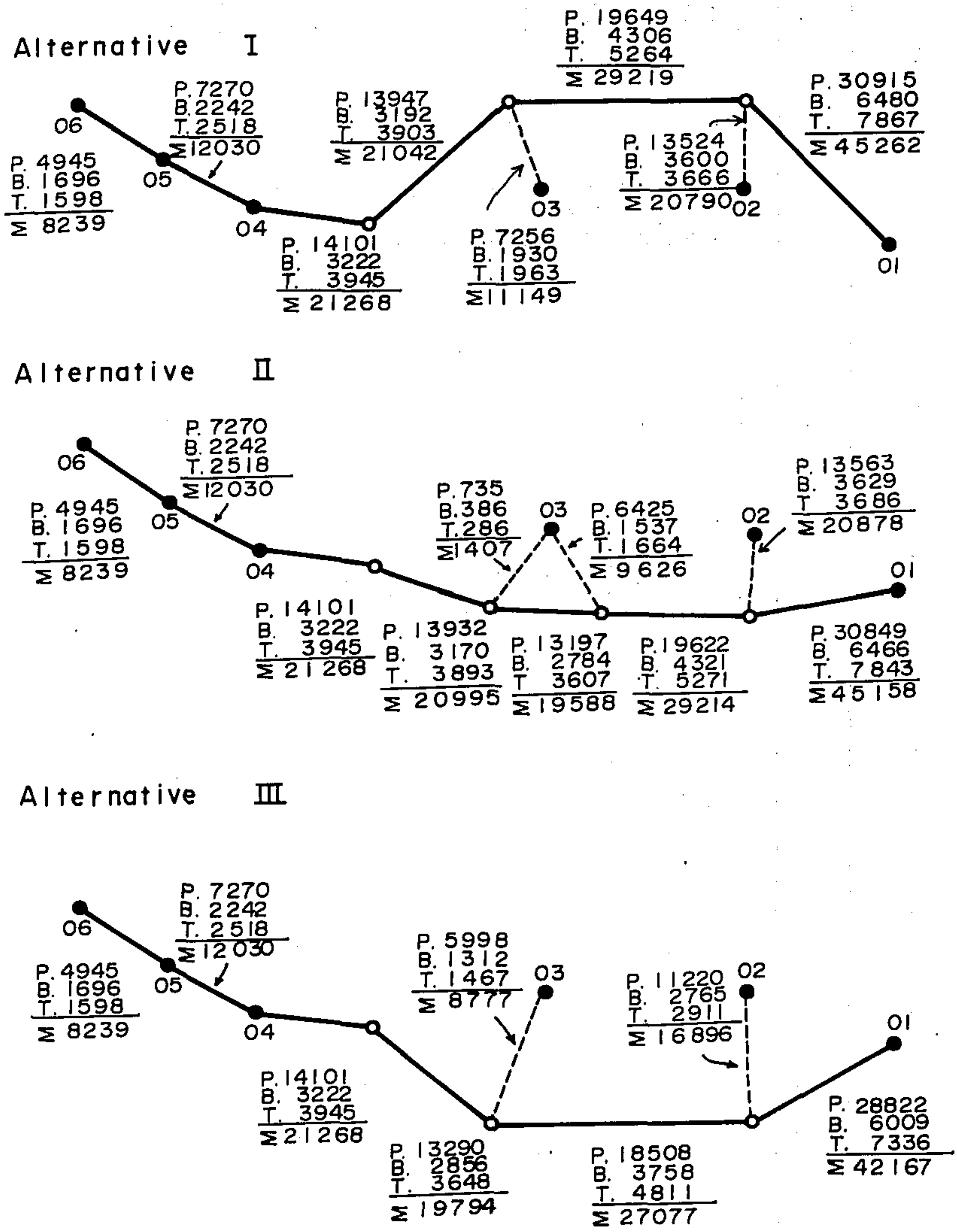


Table 3-7-1

Alternative I Annual Road Section Traffic Volumes in Passenger Car Unit Unit: PCU

Section / Year	I-a	I-b	I-c	I-d	I-e	I-f
1977	3,090	5,458	9,698	9,959	14,631	19,324
78	3,739	6,330	11,139	11,021	16,489	22,432
79	4,389	7,201	12,581	12,448	18,348	25,530
80	5,038	8,073	14,022	13,874	20,206	28,628
81	5,688	8,945	15,463	15,300	22,064	31,726
82	6,337	9,816	16,905	16,727	23,923	34,824
83	6,987	10,688	18,346	18,153	25,781	37,922
84	7,636	11,560	19,787	19,579	27,639	41,020
85	8,286	12,432	21,229	21,006	29,498	44,119
86	8,935	13,303	22,670	22,432	31,356	47,217
87	9,585	14,175	24,111	23,858	33,214	50,315
88	10,234	15,047	25,552	25,284	35,072	53,413
89	10,884	15,918	26,994	26,711	36,931	56,511
90	11,533	16,790	28,435	28,137	38,789	59,609
91	12,183	17,662	29,876	29,563	40,647	62,707
92	12,832	18,533	31,318	30,990	42,506	65,805
93	13,482	19,405	32,759	32,416	44,364	68,903
94	14,141	20,277	34,200	33,842	46,222	72,001
95	14,781	21,149	35,642	35,269	48,081	75,100
96	15,430	22,020	37,083	36,695	49,939	78,198
97	16,080	22,892	38,524	38,121	51,797	81,296
98	16,729	23,764	39,965	39,547	53,655	84,394
99	17,379	24,635	41,407	40,974	55,514	87,492
2000	18,028	25,507	42,848	42,400	57,372	90,590
01	18,678	26,379	44,289	43,826	59,231	93,688
02	19,327	27,250	45,731	45,253	61,089	96,786
03	19,977	28,122	47,172	46,679	62,947	99,884
04	20,626	28,994	48,613	48,105	64,805	102,982
05	21,276	29,866	50,055	49,532	66,664	106,081
06	21,925	30,737	51,496	40,958	68,522	109,179

Table 3-7-2

Alternative II Annual Road Section Traffic Volumes in Passenger Car Unit Unit: PCU

Section / Year	II-a	II-b	II-c	II-d	II-e	II-f,g,h	II-i
1977	3,090	5,458	9,698	9,558	8,554	14,630	19,279
78	3,739	6,330	11,139	10,981	9,894	16,490	22,370
79	4,389	7,201	12,581	12,404	11,235	18,349	25,462
80	5,038	8,073	14,022	13,827	12,575	20,209	28,553
81	5,688	8,945	15,463	15,250	13,915	22,069	31,644
82	6,337	9,816	16,905	16,673	15,256	23,938	34,736
83	6,987	10,688	18,346	18,086	16,596	25,788	34,827
84	7,636	11,560	19,787	19,519	17,937	27,648	40,919
85	8,286	12,432	21,229	20,943	19,277	29,508	44,010
86	8,935	13,303	22,670	22,366	20,617	31,367	47,101
87	9,585	14,175	24,111	23,789	21,958	33,227	50,193
88	10,234	15,047	25,552	25,212	23,298	35,087	53,284
89	10,884	15,918	26,992	26,635	24,639	36,946	56,376
90	11,533	16,790	28,435	28,058	25,979	38,806	59,467
91	12,183	17,662	29,876	29,481	27,319	40,666	62,558
92	12,832	18,533	31,318	30,904	28,660	42,525	65,650
93	13,482	19,405	32,759	32,327	30,00[illegible]	44,385	68,741
94	14,131	20,277	34,200	33,750	31,341	46,245	71,833
95	14781	21,149	35,642	35,174	32,681	48,105	74,925
96	15,430	22,020	37,083	36,597	34,021	49,964	78,015
97	16,080	22,892	38,524	38,020	35,362	51,824	81,107
98	16,729	23,764	39,965	39,443	36,702	53,684	84,198
99	17,379	24,635	41,407	40,866	38,043	55,543	87,290
2000	18,028	25,507	42,848	42,289	39,383	57,403	90,381
01	18,678	26,379	44,289	43,712	40,723	59,263	93,472
02	19,327	27,250	45,731	45,135	42,064	61,122	96,564
03	19,977	28,122	47,172	46,558	43,404	62,982	99,655
04	20,626	28,994	48,612	47,981	44,745	64,842	102,747
05	21,276	29,866	50,055	49,405	46,085	66,702	105,838
06	21,925	30,737	51,496	50,828	47,425	68,561	108,929

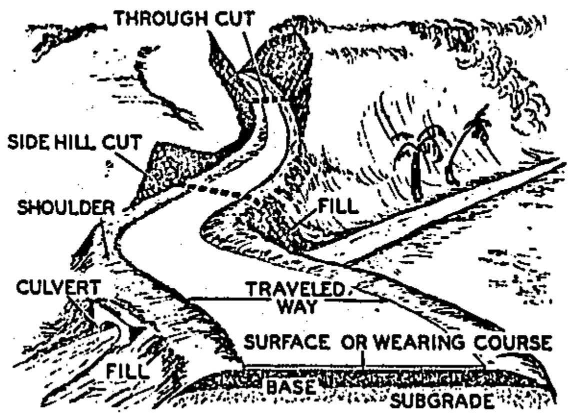
Table 3-7-3

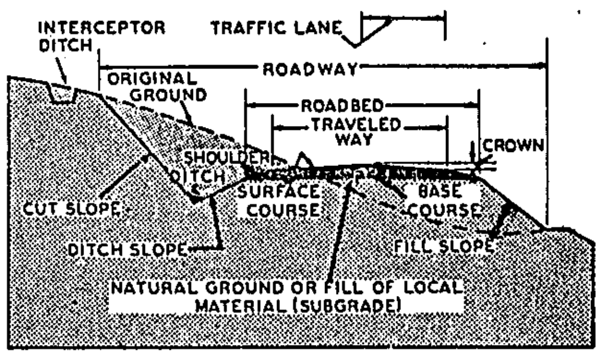
Alternative III Annual Road Section Traffic Volumes in Passenger Car Unit Unit: PCU

Section / Year	III-a	III-b	III-c	III-d	III-e	III-f
1977	3,090	5,458	9,698	8,874	13,287	18,170
78	3,739	6,330	11,139	10,214	15,007	21,042
79	4,389	7,201	12,581	11,555	16,727	27,915
80	5,038	8,073	14,022	12,895	18,447	26,787
81	5,688	8,945	15,463	14,235	20,167	29,660
82	6,337	9,816	16,905	15,576	21,887	32,532
83	6,987	10,688	18,346	16,916	23,607	35,405
84	7,636	11,560	19,787	18,256	25,327	38,277
85	8,286	12,432	21,229	19,597	27,047	41,150
86	8,935	13,303	22,670	20,937	28,766	44,022
87	9,585	14,175	24,111	22,277	30,486	46,895
88	10,234	15,047	25,552	23,617	32,206	49,767
89	10,884	15,918	26,994	24,958	33,926	52,640
90	11,533	16,790	28,435	26,298	35,646	55,512
91	12,183	17,662	29,876	27,638	37,366	58,385
92	12,832	18,533	31,318	28,979	39,086	61,257
93	13,482	19,405	32,759	30,319	40,806	64,130
94	14,141	20,277	34,200	31,659	42,526	67,002
95	14,781	21,149	35,642	33,000	44,246	69,875
96	15,430	22,020	37,083	34,340	45,965	72,747
97	16,080	22,892	38,524	35,680	47,685	75,620
98	16,729	23,764	39,965	37,020	49,405	78,492
99	17,379	24,635	41,407	38,361	51,125	81,365
2000	18,028	25,507	42,848	39,701	52,845	84,237
01	18,678	26,379	44,289	41,041	54,565	87,110
02	19,327	27,250	45,731	42,382	56,285	89,982
03	19,977	28,122	47,172	43,722	58,005	92,855
04	20,626	28,994	48,613	45,062	59,725	95,727
05	21,276	29,866	50,055	46,403	61,445	98,600
06	21,925	30,737	51,496	47,743	63,164	101,472

Chapter 4

INITIAL ENGINEERING STUDIES





4. INITIAL ENGINEERING STUDIES

4.01 Studies of Alternatives

The project highway will be located in the Daerah Khusus Ibukota Jakarta Raya, Kabupaten Tangerang and Kabupaten Serang.

Three main alternative routes were studied including reconstruction, improvement or rehabilitation of all or part of the existing highways.

In this study, the technical investigations were carried out in sufficient detail to provide a basis for the selection of a single alternative between Jakarta and Merak.

A. Description of Alternatives

The location of the alternative routes are shown on Figure 4-1.
The three alternative routes, which were compared on the basis of overall cost and anticipated benefits, are described as follows:

(i) Alternative I

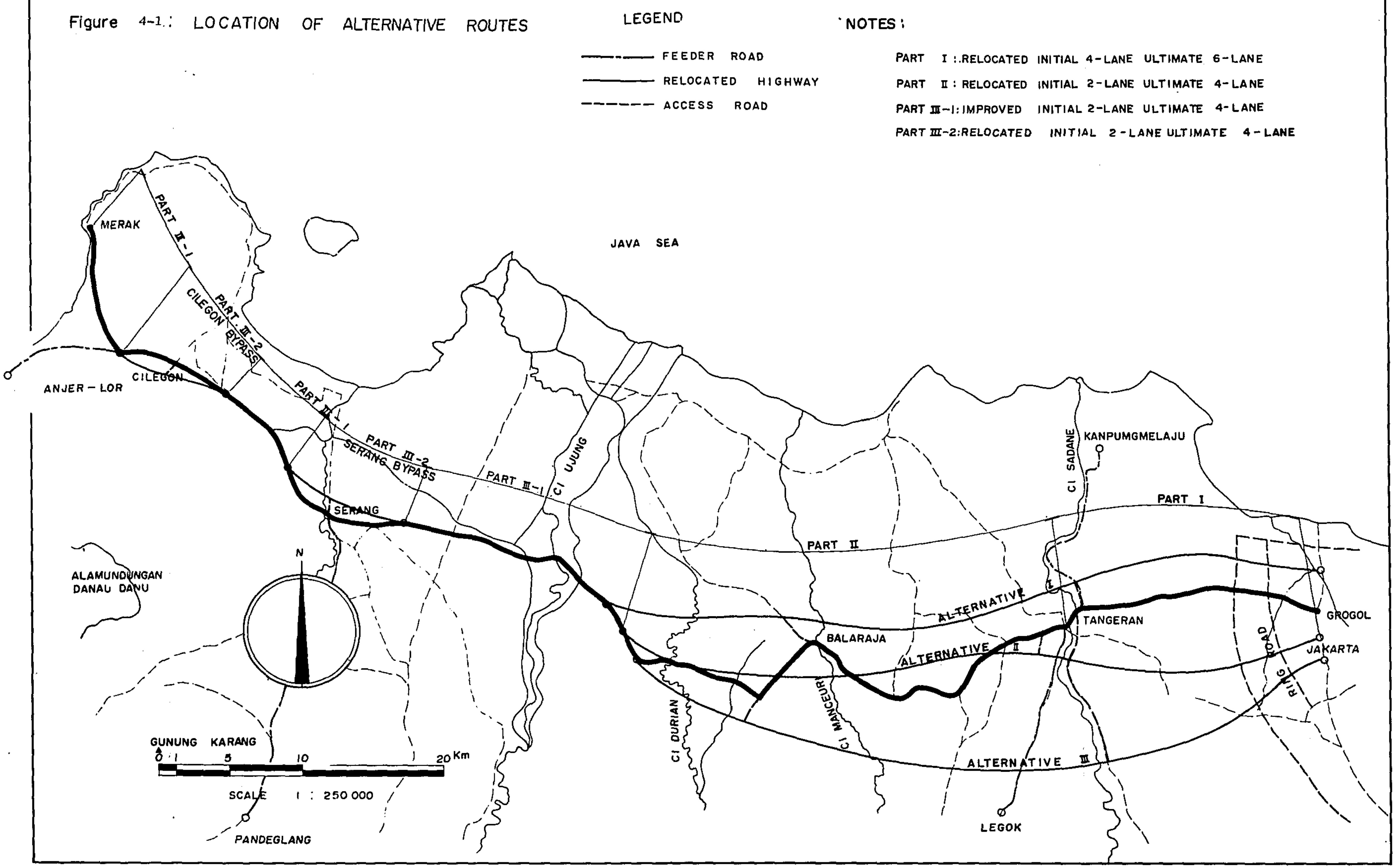
This alternative will consist of reconstruction and improvement of existing road. A new connection starts at a street intersection at Jalan Jembatan Tiga in Jakarta, and runs to the west parallel to the existing road.

A bridge across the Ci Sadane is proposed about 1.2 kilometers downstream of existing bridge,
The total span of new bridge is estimated to be approximately 150 meters. The next 35 kilometers passes through flat terrain, the area is of highly developed rice paddy and is starred with numerous Rawa and swampy areas.

Another major river crossing is over Ci Ujung. A bridge having a total span of 120 meters will have to be built adjacently to the existing bridge.

From the point about 4 kilometers east of the said river crossing, primarily improvement of existing road was provided. The topography along the existing road between said point and Merak is predominantly flat to rolling. The proposed alignment was designed to by-pass the cities of

Figure 4-1.: LOCATION OF ALTERNATIVE ROUTES



Serang and Cilegon.

The approximate total length of this alternative route will be 105.1 kilometers.

(ii) <u>Alternative II</u>

This alternative route was selected with same concept to the alternative I in mind, and will consist of reconstruction and improving sections. A new connection starts at planned street intersection on Jalan Let. Jen. S. Parman which is the extension of Jalan Jembatan Tiga.

At Tangerang, the proposed new alignment passes the Southern fringe of the city taking enough space for future expansion.

The total bridge span length for Ci Sadane is estimated to be about 120 meters, which is 30 meters shorter than that for the Alternative I.

The proposed new alignment will intersect with the existing national road at about 6 kilometers west of the river crossing, and runs toward directly west by-passing village of Cikupa and Balaraja.

From the village of Cangkudu primarily the construction will consist of improvement of existing road, including by-pass of the cities of Serang and Cilegon. The bridge location for Ci Ujung is identical to the Alternative I.
The approximate total length of this alternative route will be 107.8 kilometers.

(iii) <u>Alternative III</u>

This alternative differs from the other two primarily planned in that instead of choosing flat terrain, rather slightly rolling and dry areas were chosen for the sub-corridor of the proposed new alignment, considering the following factors:

- Easy embankment for roadway
- Better continuation to the Trans-Java highway

A new connection starts at planned street intersection on Jalan Let. Jen. S. Parman which is located about 2 kilometers south of highway terminus for the alternative II.

The route will head southwest from the said street intersection for about 10 kilometers where it will turn gently the direction and follow a course due west through the flat-rolling area until it intersects the Ci Manceuri.

Near the Ci Manceuri crossing, the proposed alignment will change the direction to west northwest and runs through flat terrain and will be connected to the existing national road about 10 Km east of Ci Ujung.

From said connection point, the same route was selected as stated in (ii) Alternative II. The approximate total length of this alternative route will be 114.4 kilometers.

4.02 Design Criteria

A. Terrain Conditions

Most of the project's relocated routes pass through flat area except a portion of alternative III that passes through a terrain varying flat to rolling.

Table 4-1 presents terrain conditions encountered for each section of the Alternatives.

Table 4-1

TERRAIN CONDITIONS

Alternative	Section	Terrain
I	A (Relocated)	Flat
	B (Improved)	Flat/ Rolling
II	A (Relocated)	Flat
	B (Improved)	Flat / Rolling
III	All through (Relocated/Improved)	Flat / Rolling

B. Road Design Criteria

Because flat terrain is predominant, major deviations from current Government design standards are unlikely for all alternatives. Brief notes for each item of geometrical design criteria, and the reasons for making certain modifications to the current Indonesian Government geometric standards are presented below:

(i) Design Speeds

The design speed adopted for the relocated trunk highways in alternative I thru III are 120 km/h and 100 km/h for the flat and the rolling areas respectively except 80 km/h was used for the Merak bypass. These speeds were set to the greatest degree possible to satisfy the needs of nearly all users throughout the road's life. Since the terrain is favorable, a high volume, high speed highway can be constructed at a reasonable cost.

For improved trunk highways in alternatives I thru III, 100 km/h for the flat terrain and 80 km/h for rolling terrain were adopted, considering lower traffic volumes.

For access roads, providing a facility with design speeds meeting class IIA of the Government standard will result in excessively heavy earthwork. Considering the function of an access road, its function may be to serve relatively light transport of goods, the reduced design speed is therefore recommended.

(ii) Reserve R.O.W. Width

Right-of-way width assigned to the project should anticipate all practical future expansion. A fixed width proposed for each class of highway is as follows:

Table 4-2

PROPOSED RESERVE WIDTH

Designation	Lane	Reserve R.O.W. Width in Meters
Relocated trunk highway	4 lane initial and 6 lane ultimate construction	70
Relocated trunk highway	2 lane initial and 4 lane ultimate construction	60
Relocated/improved trunk highway	2 lane initial and 4 lane ultimate construction	50
Access road	2 lanes	30

(iii) Pavement Width

No modifications or changes were made to the current Government standard. Table 4-3 presents proposed pavement widths for each class highway in this project.

Table 4-3

PROPOSED PAVEMENT WIDTHS

Designation	Lane	Pavement Width in Meters
Relocated trunk highway	4 lane initial and 6 lane ultimate construction	2 x (2 x 3.75) & 2 x (3 x 3.75)
Relocated trunk highway	2 lane initial and 4 lane ultimate construction	2 x 3.75 & 2 x (2 x 3.75)
Relocated/improved trunk highway	2 lane initial and 4 lane ultimate construction	2 x 3.50 & 2 x (2 x 3.50)
Access road and Merak bypass	2 lanes	2 x 3.50

(iv) Shoulder Width

4 Lane Initial and 6 Lane Ultimate Construction

A 3.5 meters wide usable exterior shoulder for rural area and 3.0 meters for urban area are recommended. As for the usable interior shoulders, a width of 1.5 meters were recommended. All usable shoulders will be treated for full widths.

4 Lane Ultimate Construction

A 3.5 meters wide usable exterior shoulders were recommended for the entire stretch of the Part II section. In the Part III section, these widths were reduced to 3.0 meters (flat area) and 2.5 meters (rolling area) according to the terrain condition.

As for the usable interior shoulders, a constant width of 1.5 meters was recommended.

All usable shoulders will be treated for full widths.

2 Lane Merak Bypass Construction and Access Roads

A 3.0 meters width for flat terrain and a 2.5 meters width for rolling terrain were recommended as a usable shoulder. Since a larger number of cycles are in use, a 1.0 meter wide treated cycle path will be provided in these shoulders on both sides of trunk highways and access roads.

(v) Median Width

Since it was found that a land acquisition cost is rather high in the urban area, a conservative median width of 5 meters was recommended.

However, favorable site conditions in the other areas permitted adoption of a same median width as which specified in the Government standards.

(vi) Cross Slope of Pavement

It is considered that a 2 percent cross slope is sufficient.

(vii) Cross Slope of Shoulders

It should be noted that excessive cross slope for treated shoulders in 2 lane road designed as cycle paths is adversary.
A value of 2 percent for cycle paths and 4 percent for other shoulders is recommended.

(viii) Maximum Superelevation

The outside edge of the road will be rotated with respect to the inside edge in the horizontal curves. On the area subject to flood, care must be taken so that the lowest elevation of the roadway will keep the required freeboard above the water surface.

The lower value of superelevation is recommended to ensure more comfortability to users in trunk highway.

(ix) Minimum Horizontal Radii

The largest radius of curvature compatible with the topographic conditions should be used whenever possible. In view of easy terrain being predominant, larger minimum horizontal radii are recommended for the trunk road. All recommended minimum horizontal radii are corresponding to the maximum superelevation of 8 percent.

Tables 4-4 thru 4-7 present recommended design criteria applicable for varying terrain conditions and the corresponding Government standards. Where feasible, higher values than the minimum listed in the tables will be utilized.

Table 4-4

HIGHWAY GEOMETRIC DESIGN CRITERIA
6-LANE ULTIMATE CONSTRUCTION
(APPLICABLE FOR PART I SECTION)

Item	Unit	Recommended Design Criteria		*Government Standard	
Terrain	-	Flat	Rolling	Flat	Rolling
Design speed	km/h	120	100	120	100
Reserve R.O.W. width	Meter	70	70	60	60
Pavement width	Meter	2 x (3 x 3.75)		2 x (3 x 3.75)	
Shoulder width	Meter	3.5(3.0)	3.5	3.5	3.0
Median width	Meter	10 (8)	10 (8)	10	10
Cross slope of pavement	%	2	2	2	2
Cross slope of shoulder	%	4	4	4	4
Type of pavement	-	Asphaltic concrete (hot-mix)		Asphaltic concrete (hot-mix)	
Maximum superelevation	%	6	6	10	10
Minimum radii	Meter	880	640	560	350
Maximum gradient	%	3	5	3	5
Stopping sight distance	Meter	225	165	225	165
Minimum vertical curve length	Meter	In accordance with Fig. 4-2		In accordance with Fig. 4-2	

*Relocated highways will be classified as class I in current Government standards, please refer to the Government's "Standard Specifications for Geometric Design of Rural Highways" for descriptions.

Table 4-5

HIGHWAY GEOMETRIC DESIGN CRITERIA

4 LANE ULTIMATE CONSTRUCTION
(APPLICABLE FOR PART II SECTION)

Item	Unit	Recommended Design Criteria		*Government Standard	
Terrain	-	Flat	Rolling	Flat	Rolling
Design speed	km/h	120	100	120	100
Reserve R.O.W. width	Meter	60	60	60	60
Pavement width	Meter	2 x (2 x 3.75)		2 x (2 x 3.75)	
Shoulder width	Meter	3.5	3.5	3.5	3.0
Median width	Meter	10	10	10	10
Cross slope of pavement	%	2	2	2	2
Cross slope of shoulder	%	4	4	4	4
Type of pavement	-	Asphaltic concrete (hot-mix)		Asphaltic concrete (hot-mix)	
Maximum superelevation	%	6	6	10	10
Minimum horizontal radii	Meter	880	640	560	350
Maximum gradient	%	3	5	3	5
Stopping sight distance	Meter	225	165	225	165
Minimum vertical curve length	Meter	In accordance with Fig. 4-2		In accordance with Fig. 4-2	

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*Relocated highways will be class I in current Government standard when traffic volume will exceeds 20,000 passenger car unit, please refer to the Government's Standard Specifications for Geometric Design of Rural Highways" for descriptions

Table 4-6

HIGHWAY GEOMETRIC DESIGN CRITERIA

4 LANE ULTIMATE CONSTRUCTION

(APPLICABLE FOR PART III SECTION)

Item	Unit	Recommended Design Criteria		*Government Standard	
Terrain	-	Flat	Rolling	Flat	Rolling
Design speed	km/h	100	80	100	80
Reserve R.O.W. width	Meter	50	50	40	40
Pavement width	Meter	2 x (2 x 3.50)		2 x (2x 3.50)	
Shoulder width	Meter	3.0	2.5	3.0	2.5
Median width	Meter	4.0	4.0	1.5	1.5
Cross slope of pavement	%	2	2	2	2
Cross slope of shoulder	%	4	4	4	4
Type of pavement	-	Asphaltic concrete (hot-mix)		Asphaltic concrete (hot-mix)	
Maximum superelevation	%	8	8	10	10
Minimum horizontal radii	Meter	480	330	350	210
Maximum gradient	%	4	6	4	6
Stopping sight distance	Meter	165	115	165	115
Minimum vertical curve length	Meter	In accordance with Fig. 4-2		In accordance with Fig. 4-2	

*Relocated/improved highways will be classified as class IIA in current Government standard when traffic volume will fall between 6,000 and 20,000 in passenger car unit, please refer to the Government's "Standard Specifications for Geometric Design of Rural Highways" for descriptions.

Table 4-7

HIGHWAY GEOMETRIC DESIGN CRITERIA

2 LANE MERAK BYPASS/ACCESS ROAD

Item	Unit	Recommended Design Criteria		*Government Standard	
Terrain	-	Flat	Rolling	Flat	Rolling
Design speed	km/h	80	60	60	60
Reserve R.O.W. width	Meter	30	30	30	30
Pavement width	Meter	2 x 3.50		2 x 3.50	
Shoulder width	Meter	3.0	2.5	2.5	2.5
Cross slope of pavement	%	2	2	2	2
Cross slope of shoulder	%	6	6	6	6
Type of pavement	-	Asphaltic concrete		Penetration macadam	
Maximum superelevation	%	10	10	10	10
Minimum horizontal radii	Meter	210	115	210	115
Maximum gradient	%	7	7	7	7
Stopping sight distance	Meter	115	115	75	75
Minimum vertical curve length	Meter	In accordance with Fig. 4-2		In accordance with Fig. 4-2	

*Access roads will be classified as class IIB in current Government standards, please refer to the Government's "Standard Specifications for Geometric Design of Rural Highways" for descriptions.

Fig. 4-2-1 LENGTH OF VERTICAL CURVE (CRESTS)

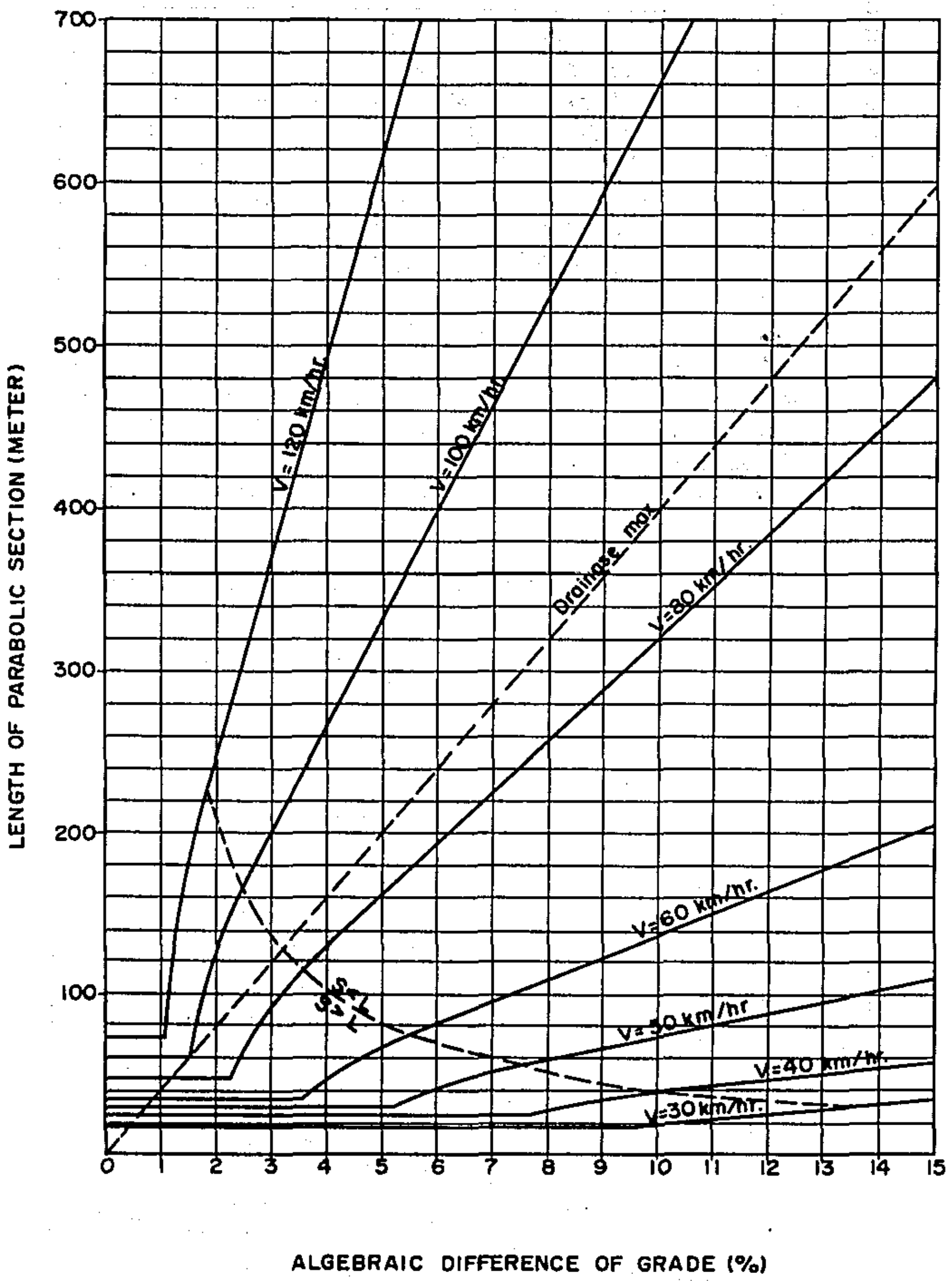
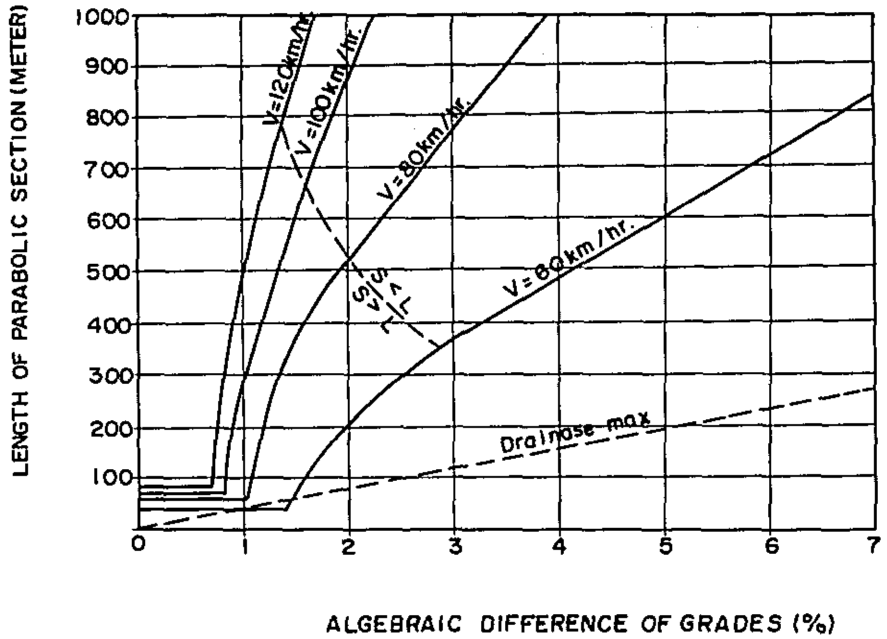


Fig. 4-2-2 LENGTH OF VERTICAL CURVE (CRESTS)
- FOR TWO LANE PRIMARY ROAD -



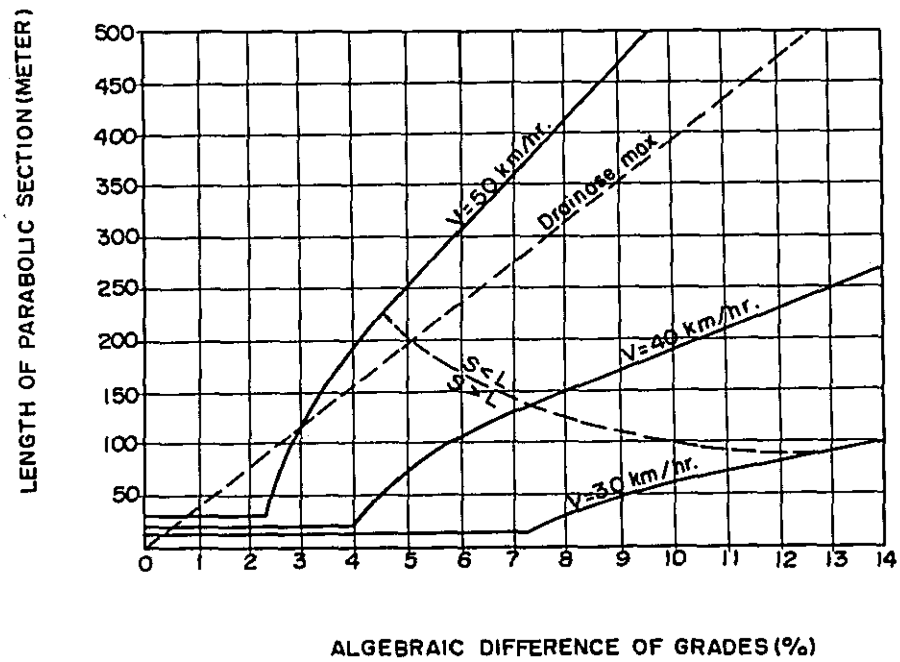


Fig. 4-2-3 LENGTH OF VERTICAL CURVE (SAG)

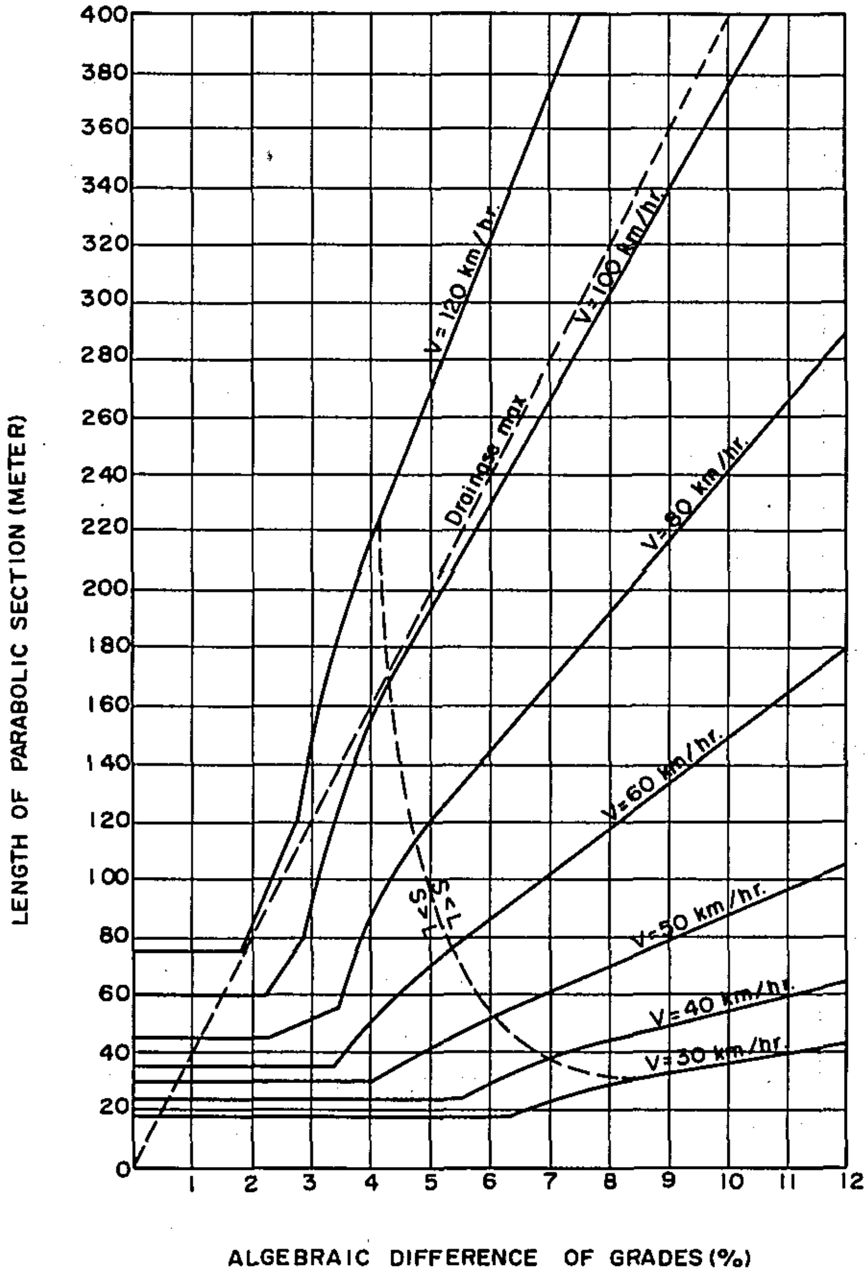
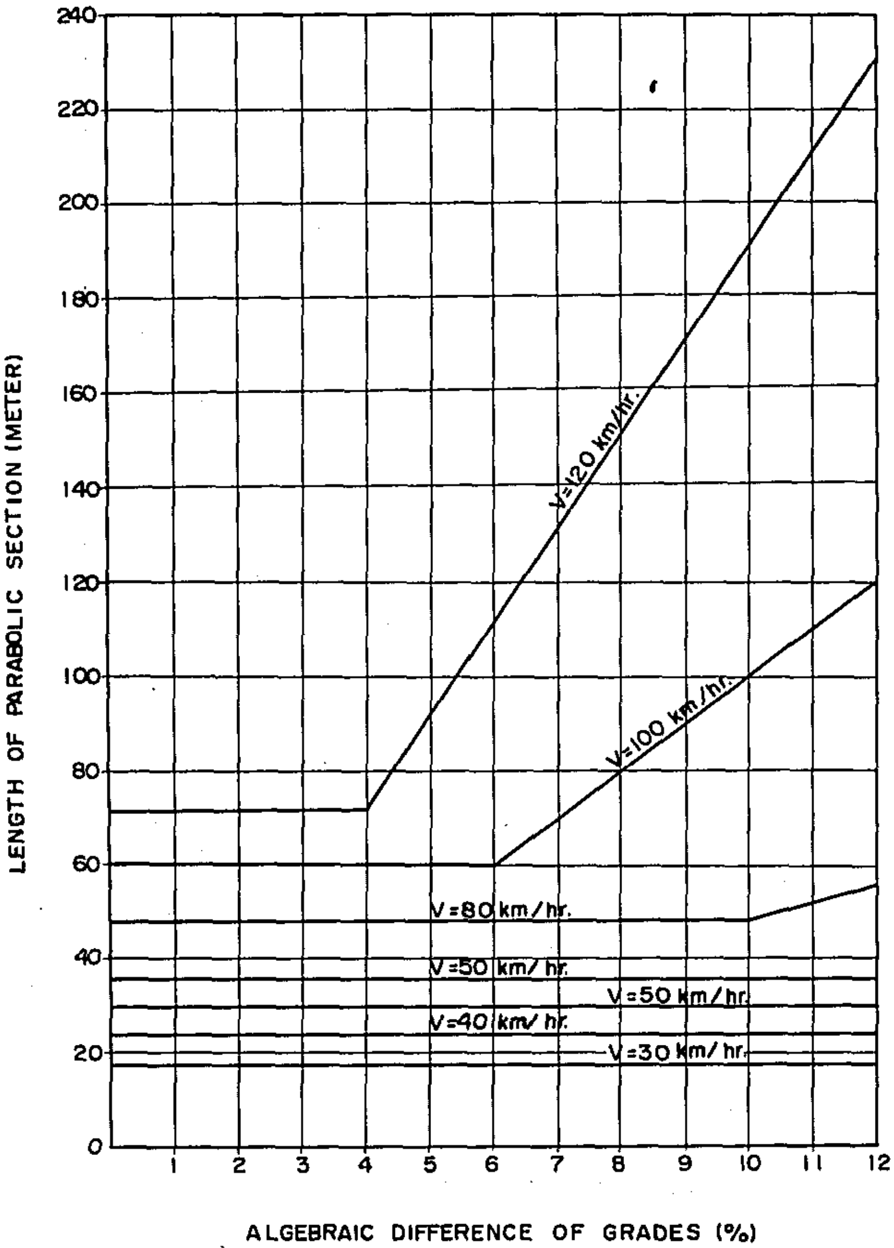


Fig. 4-2-4 LENGTH OF VERTICAL CURVE(SAG)



C. Bridge Design Criteria

Government standards for design of bridges are currently in use throughout Indonesia.

According to the Government standards, live loads by standard vehicles are classified in two ways i.e., "T" loads, which load the entire carriageway and "D" loads, which load the traffic lane.

"T" Loading:

For the calculations of floor design or the carriageway system design, a 10 ton wheel load will be used.

"D" Loading:

For the calculations of girder design, a 12 ton knife edge load and uniform load of "P" ton per meter of lane length stipulated will be used.

For those aspects of design not covered by the Government standards, AASHO (American Association of State Highway Officials) standard specifications for highway bridges will be used.

Earthquakes are to be expected in regions of this project. An earthquake coefficient of 0.14 - 0.28 will be used as specified in the Government standards.

D. Drainage Criteria

The rational method with peak flow curves will be used in the preliminary studies.

A design storm frequency of 50 years is recommended for bridges and 25 years for culverts.

Recommended clearances above design floor levels for various types of drainage structures are presented in Table 4-8.

Table 4-8

RECOMMENDED CLEARANCE ABOVE DESIGN FLOOD LEVELS

Structure Type	Clearance in Meter
Major Bridges	2.0
Bridges	1.5
Large Box Culverts	0.5
Pipe Culverts	Nil
Minor Culverts	Headwater limited to 1.2 times height to inlet opening

4.03 Design Features

All of the procedures used to evaluate the alternatives from a technical aspect are described in this chapter.

A. Number of Lanes

Ultimately, the trunk highway running along the proposed alignment will consist of a divided 6-lane highway between Jakarta and Tangerang and a divided 4-lane highway between Tangerang and Cilegon.
In all sections of this trunk highway smaller number of lanes are required initially, so staged construction is recommended.

B. Intersections

There are relatively few roads crossing or connecting with the trunk highway. It is recommended that intersections with these roads be made at grade in each alternative route with the exception of Jakarta terminal junction and intersections with primary roads. At the present, an outer ring road for Jakarta is being studied. Therefore, a fully directional grade separated interchange will ultimately be required, and should be provided studies in the detailed design phases of both ring road and this projects. For the purposes of this study, interchanges with grade separation structures are proposed.

C. Pavement Design

A bituminous pavement is recommended as the most practical and economical for the project, considering maintenance costs during the design life of the road.

In an initial study the bituminous pavement design is based on the "Shell" design method which is authorized by the ECAFE standards. Checks have been made using the U.S. Army, Corps of Engineers Manual.

Subgrade strength was estimated by a visual investigation of the soil conditions encountered in the project sites.

Because of the relatively poor quality of soils found along the route of the proposed highway, a CBR value of 5% was used for pavement design.

The selected pavement design consists of asphaltic concrete binder and surface courses, a stabilized aggregate base course, and a granular subbase course which is constructed on a subgrade compacted to 95% of maximum density.

To delay capital expenditures to the maximum extent, the bituminous paving is designed to permit stage construction. Ultimate requirements for an asphaltic concrete surface course may be met by a later stage resurfacing operation.

For initial construction, a 6 centimeters asphaltic concrete surface course is proposed. Resurfacing, consisting of a 7.5 centimeters overlay, will be required for the entire length of the road at the ultimate stage.

D. Bridge and Culvert Design

In selecting the type of superstructures of bridges, the followings are deemed generally to be preferable from economical and technical points of view:

- long span bridges over Ci Sadane and Ci Ujung shall be of steel type of bridges.

- Intermediate long span bridges ranged approximately from 20 m to 30 m shall be of prestressed concrete type of bridges.
- Short span bridges ranged approximately from 7 m to 20 m shall be of reinforced concrete type of bridges.
- Reinforced concrete box culverts shall be used in minor rivers and canals whose widths are less than 7 m. In proportion to the widths it shall be selected so as to be of mono-opening type or multi-openings type.

  To make a grade separation for the existing railway, prefabricated prestressed concrete beam shall be adopted as an overpass bridge.

4.04 Stage Construction

This project needs a large scale of construction work so that it should not be preferable both technically and economically to construct the whole cross section of the highway at one time through the whole proposed route. Therefore, a construction program on a staged basis has to be planned in order to optimize the investment-benefit relation.

Describing hereafter are recommendable divisions for the construction of this project when stage construction will be carried out.

A. Division for Design Standard

The whole route is to be divided into three major parts according to the design standard dominated by the traffic volume forecast, viz. Part I of the eastern part (Jakarta-Tangerang), Part II of the middle part (Tangerang-Ci Ujung), and Part III of the western part (Ci Ujung-Merak).

B. Division for Stage Construction

Each construction part divided as mentioned above is to be constructed on a staged basis as below:

(i) Part I; where a relocated 6-lane road is envisaged for the ultimate stage, construction work may start with

4-lane initially and be widened to 6-lane ultimately.

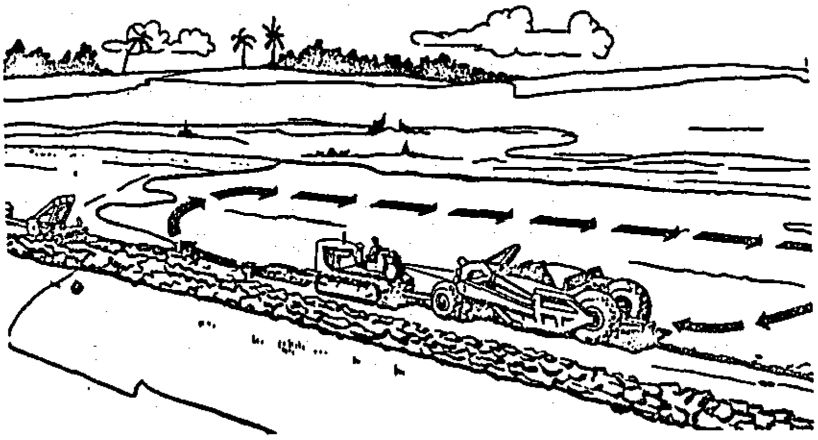
(ii) Part II; where a relocated 4-lane road is envisaged for the ultimate stage, construction work may start with 2-lane initially and be widened to 4-lane ultimately.

(iii) Part III; this part will be subdivided into Part III-1 and Part III-2, where applied to the part of improving the existing highway and the part of by-passes relocated at Serang and Cilegon, respectively. In the Part III-1, minor improving works for pavement, alignment, etc. may start on the existing highway initially and be widened to 4-lane ultimately including major improving of the existing highway, while in the Part III-2, construction work may start with 2-lane initially and be widened to 4-lane ultimately.

Whole section of the access road will be completed at the initial stage as shown in Figure 4-1.

Chapter 5

CONSTRUCTION COST FOR EACH ALTERNATIVE



5. CONSTRUCTION COST FOR EACH ALTERNATIVE

5.01 General

For the purposes of this study, the cost estimates presented were based on the assumption that international open tender would be adopted for the construction of all the necessary works of this project.

Cost estimates undertaken hereafter aimed to carry out cost-benefit calculation for this project. The estimates are based upon current construction costs, but they do not include any allowance for future price escalation.

5.02 Construction Cost Estimates

The followings are construction cost estimates prepared for alternative route study, among which tables 5-1 thru 5-3 present construction cost estimates for each alternative, Table 5-4 presents construction cost estimates for initial and ultimates stages, and Table 5-5 presents construction cost estimates for access roads.

Table 5-1

CONSTRUCTION COST ESTIMATE FOR ALTERNATIVE I (IN SEP. 1973 PRICE)

Unit : US$

Item	Unit	PART I JAKARTA - TANGERANG (Relocated 4-Lane Initial/ 6-Lane Ultimate)			PART II TANGERANG - UJUNG RIVER (Relocated 2-Lane Initial/ 4-Lane Ultimate)			PART III UJUNG RIVER-MERAK (Relocated/Improved 2-Lane Initial/4-Lane Ultimate)		
		Quantity	Unit Cost	Total	Quantity	Unit Cost	Total	Quantity	Unit Cost	Total
A. HIGHWAY CONSTRUCTION										
1. Clearing and Grubbing										
(a) Rice paddy or removal of topsoil	M^2	827,200	0.15	124,080	1,180,480	0.15	177,072	233,858	0.15	35,079
(b) Cultivated area	M^2	148,050	0.10	14,805	221,340	0.10	22,134	310,200	0.10	31,020
(c) Rubber plantation	M^2	39,480	0.20	7,896	59,024	0.20	11,805	45,662	0.20	9,132
(d) Demolition	M^2	9,870	2.00	19,740	14,756	2.00	29,512	74,832	2.00	149,664
2. Excavation										
(a) Common	M^3	0	1.50	0	0	1.50	0	327,652	1.50	491,478
(b) *Borrow for fill or* embankment	M^3	1,457,940	3.00	4,373,820	2,248,080	3.00	6,744,240	508,641	3.00	1,525,923
(c) Rock	M^3	0	8.60	0	0	8.60	0	0	8.60	0
3. Fill Select Material for Soft Ground Treatment	M^3	98,700	4.00	394,800	147,560	4.00	590,240	19,471	4.00	77,884
4. Drainage Structures										
(a) Multi-openings RC box culvert with head walls	M	225	1,200	270,000	660	1,200	792,000	315	1,200	378,000
(b) R.C. culvert with head walls	M	900	720	648,000	2,640	720	1,900,800	1,260	720	907,200
5. Bridges										
(a) Short span bridge	M^2	1,770	480	849,600	4,900	480	2,352,000	2,200	480	1,056,000
(b) Intermediate span bridge	M^2	1,475	600	885,000	3,430	600	2,058,000	1,100	600	660,000
(c) Long span bridge	M^2	0	840	0	3,675	840	3,087,000	2,640	840	2,217,000
6. Pavement										
(a) Subgrade preparation	M^2	712,520	0.05	35,626	1,305,600	0.05	65,280	839,250	0.05	41,963
(b) Subbase course	M^3	160,082	4.00	640,328	258,128	4.00	1,032,512	183,074	4.00	732,296
(c) Base course	M^3	88,134	6.30	555,244	142,800	6.30	899,640	102,991	6.30	648,843
(d) *Bituminous prime* coat	M^2	423,000	0.18	76,140	765,000	0.18	137,700	986,200	0.18	177,516
(e) Asphaltic concrete surface course	Ton	131,374	14.80	1,944,335	158,440	14.80	2,344,912	211,518	14.80	3,130,466
(f) Bituminous surface treatment	M^2	376,000	0.25	94,000	340,000	0.25	85,000	347,700	0.25	86,925
7. Establishment of Turf										
(a) Spot sodding with overseeding	M^2	376,000	0.20	75,200	442,000	0.20	88,400	513,600	0.20	102,720

Item	Unit	PART I JAKARTA - TANGERANG (Relocated 4-Lane Initial/ 6-Lane Ultimate)			PART II TANGERANG-UJUNG RIVER (Relocated 2-Lane Initial/ 4-Lane Ultimate)			PART III UJUNG RIVER-MERAK (Relocated/Improved 2-Lane Initial/4-Lane Ultimate)		
		Quantity	Unit Cost	Total	Quantity	Unit Cost	Total	Quantity	Unit Cost	Total
8. Stone Protection	M^2	23,312	3.00	69,936	42,160	3.00	126,480	35,588	3.00	106,764
9. Guard Rail	M	2,256	15.00	33,840	4,080	15.00	61,200	5,826	15.00	87,390
10. Center Line and other Markings	M	75,200	0.60	45,120	68,000	0.60	40,800	125,300	0.60	75,180
11. Traffic Signs										
(a) Regular size	EA	75	36.00	2,700	136	36.00	4,896	170	36.00	6,120
12. Maintenance and Protection of Traffic	Lump Sum			111,602			226,516			127,346
13. Mobilization	Lump Sum			558,011			1,132,581			636,728
14. Interchange and Grade Separation Structure	Lump Sum			3,835,946			-			1,802,484
TOTAL CONTRACT COST (ITEMS 1 THROUGH 14)	15,665,769 + 24,010,720 + 15,301,121 = 54,977,610									
CONTINGENCY	54,977,610 x 0.15 = 8,246,642									
FINAL ENGINEERING SUPERVISION & ADMINISTRATION	63,224,252 x 0.10 = 6,322,425									
TOTAL	US$ = 69,547,000									
B. LAND ACQUISITION & COMPENSATION										
1. Land Acquisition										
(a) Town	M^2	31,700	12.05	381,985	20,400	7.23	147,492	49,460	3.23	357,596
(b) Other area	M^2	1,414,400	1.21	1,711,424	2,019,600	1.21	2,443,716	1,630,740	1.21	1,973,195
2. Compensation for Buildings and Crops										
(a) Brick building	M^2	21,200	36.15	766,380	20,400	24.10	491,640	29,410	24.10	708,781
(b) Wooden building	M^2	81,598	16.87	1,376,558	76,500	7.23	553,095	59,450	7.23	429,824
(c) Shed	M^2				38,250	2.41	92,183	30,225	2.41	72,842
(d) Crops	M^2	303,772	8.68	2,636,741	428,400	8.68	3,718,512	356,575	8.68	3,095,071
TOTAL LAND ACQUISITION & COMPENSATION COST	6,873,088 + 7,446,638 + 6,637,309 = 20,957,035									
CONTINGENCY	20,957,035 x 0.15 = 3,143,555									
CADASTRAL SURVEY, PREPARATION OF R. O. W. PLAN & ADMINISTRATION	24,100,590 x 0.10 = 2,410,059									
TOTAL	US$ 26,510,649 ≑ 26,511,000									

Table 5-2

CONSTRUCTION COST ESTIMATE FOR ALTERNATIVE 2 (IN SEP. 1973 PRICE).

Unit US$

Item	Unit	PART I JAKARTA - TANGERANG (Relocated 4-Lane Initial/ 6-Lane-Ultimate)			PART II TANGERANG-UJUNG RIVER (Relocated 2-Lane Initial/ 4-Lane Ultimate)			PART III UJUNG RIVER-MERAK (Relocated/Improved 2-Lane Initial/4-Lane Ultimate)		
		Quantity	Unit Cost	Total	Quantity	Unit Cost	Total	Quantity	Unit Cost	Total
A. <u>HIGHWAY CONSTRUCTION</u>										
1. Clearing and Grubbing										
(a) Rice paddy or removal of topsoil	M^2	472,500	0.15	70,875	646,443	0.15	96,967	244,658	0.15	36,699
(b) Cultivated area	M^2	472,500	0.10	47,250	646,443	0.10	64,644	321,000	0.10	32,100
(c) Rubber plantation	M^2	52,500	0.20	10,500	71,827	0.20	14,365	46,862	0.20	9,372
(d) Demolition	M^2	52,500	2.00	105,000	71,827	2.00	143,654	77,712	2.00	155,424
2. Excavation										
(a) Common	M^3	313,800	1.50	470,700	429,936	1.50	644,904	336,334	1.50	504,501
(b) Borrow for fill or embankment	M^3	749,960	2.50	1,874,900	802,543	2.50	2,006,358	523,228	2.50	1,308,070
(c) Rock	M^3	0	8.60	0	0	8.60	0	0	8.60	0
3. Fill Select Material for Soft Ground Treatment	M^3	26,260	4.00	105,040	35,914	4.00	143,656	20,071	4.00	80,284
4. Drainage Structures										
(a) Multi-openings RC box culvert with head walls	M	180	1,200	216,000	600	1,200	720,000	315	1,200	378,000
(b) R. C. culvert with head walls	M	720	720	518,400	2,400	720	1,728,000	1,260	720	907,200
5. Bridges										
(a) Short span bridge	M^2	1,475	480	708,000	3,675	480	1,764,000	2,200	480	1,056,000
(b) Intermediate span bridge	M^2	1,180	600	708,000	2,940	600	1,764,000	1,100	600	660,000
(c) Long span bridge	M^2	0	840	0	2,940	840	2,469,000	2,640	840	2,217,600
6. Pavement										
(a) Subgrade preparation	M^2	758,000	0.05	37,900	1,271,040	0.05	63,552	862,770	0.05	43,139
(b) Subbase course	M^3	170,300	4.00	681,200	251,295	4.00	1,005,180	189,189	4.00	756,756
(c) Base course	M^3	93,760	6.30	590,688	139,020	6.30	875,826	106,519	6.30	671,070
(d) Bituminous prime coat	M^2	450,000	0.18	81,000	744,750	0.18	134,055	1,036,600	0.18	186,588
(e) Asphaltic concrete surface course	Ton	139,760	14.80	2,068,448	154,246	14.80	2,282,841	222,625	14.80	3,294,850
(f) Bituminous surface treatment	M^2	400,000	0.25	100,000	331,000	0.25	82,750	362,100	0.25	90,525
7. Establishment of Turf										
(a) Spot sodding with overseeding	M^2	400,00	0.20	80,000	397,200	0.20	79,440	542,400	0.20	108,480

Item	Unit	PART I JAKARTA - TANGERANG (Relocated 4-Lane Initial/ 6-Lane Ultimate)			PART II TANGERANG-UJUNG RIVER (Relocated 2-Lane Initial/ 4-Lane Ultimate)			PART III UJUNG RIVER-MERAK (Relocated/Improved 2-Lane Initial/4-Lane Ultimate)		
		Quantity	Unit Cost	Total	Quantity	Unit Cost	Total	Quantity	Unit Cost	Total
8. Stone Protection	M^2	24,800	3.00	74,400	41,044	3.00	123,132	37,076	3.00	111,228
9. Guard Rail	M	2,400	15.00	36,000	3,972	15.00	59,580	6,112	15.00	91,680
10. Center Line and Other Markings	M	80,000	0.60	48,000	66,200	0.60	39,720	132,500	0.60	79,500
11. Traffic Signs										
(a) Regular size	EA	80	36.00	2,880	132	36.00	4,752	179	36.00	6,444
12. Maintenance and Protection of Traffic	Lump Sum			86,352			163,104			127,855
13. Mobilization	Lump Sum			431,759			815,519			639,276
14. Interchange and Grade Separation Structure	Lump Sum			3,835,946			-			1,802,484
TOTAL CONTRACT COST (ITEMS 1 THROUGH 14)	12,989,230 + 17,288,999 + 15,355,125 = 45,633,354									
CONTINGENCY	45,633,354 x 0.15 = 6,845,003									
FINAL ENGINEERING SUPERVISION & ADMINISTRATION	52,478,357 x 0.10 = 5,247,836									
TOTAL	US$ 57,726,193 ≑ 57,726,000									
B. LAND ACQUISITION & COMPENSATION										
1. Land Acquisition										
(a) Town	M^2	33,500	12.05	403,675	19,860	7.23	143,588	51,860	7.23	374,948
(b) Other area	M^2	1,496,600	1.21	1,810,886	1,966,140	1.21	2,379,029	1,676,340	1.21	2,028,371
2. Compensation for Buildings and Crops										
(a) Brick building	M^2	22,400	36.15	809,760	19,860	24.10	478,626	30,610	24.10	737,701
(b) Wooden building	M^2	81,064	16.87	1,367,550	69,510	7.23	502,557	61,130	7.23	441,970
(c) Shed	M^2				34,755	2.41	83,760	31,065	2.41	74,867
(d) Crops	M^2	324,912	8.68	2,820,236	422,025	8.68	3,663,177	366,775	8.68	3,183,607
TOTAL LAND ACQUISITION & COMPENSATION COST	7,212,107 + 7,250,737 + 6,841,464 = 21,304,308									
CONTINGENCY	21,304,308 x 0.15 = 3,195,646									
CADASTRAL SURVEY, PREPARATION OF R.O.W. PLAN & ADMINISTRATION	24,499,954 x 0.10 = 2,449,995									
TOTAL	US$ 26,949,949 ≑ 26,950,000									

Table 5-3

CONSTRUCTION COST ESTIMATE FOR ALTERNATIVE 3 (IN SEP. 1973 PRICE)

Unit US$

Item	Unit	PART I JAKARTA - TANGERANG (Relocated 4-Lane Initial/ 6-Lane-Ultimate)			PART II TANGERANG-UJUNG RIVER (Relocated 2-Lane Initial/ 4-Lane Ultimate)			PART III UJUNG RIVER - MERAK (Relocated/Improved 2-Lane Initial/4-Lane Ultimate)		
		Quantity	UnitCost	Total	Quantity	Unit Cost	Total	Quantity	Unit Cost	Total
A. HIGHWAY CONSTRUCTION										
1. Clearing and Grubbing										
(a) Rice paddy or removal of topsoil	M^2	201,600	0.15	30,240	333,312	0.15	49,997	254,108	0.15	38,116
(b) Cultivated area	M^2	604,800	0.10	60,480	999,936	0.10	99,994	330,450	0.10	33,045
(c) Rubber plantation	M^2	151,200	0.20	30,240	249,984	0.20	49,997	47,912	0.20	9,582
(d) Demolition	M^2	50,400	2.00	100,800	83,328	2.00	166,656	80,232	2.00	160,464
2. Excavation										
(a) Common	M^3	946,560	1.50	1,419,840	831,283	1.50	1,246,925	343,987	1.50	515,981
(b) Borrow for fill or embankment	M^3	190,080	2.50	475,200	665,011	2.50	1,662,528	535,992	2.50	1,339,980
(c) Rock	M^3	0	8.60	0	0	8.60	0	0	8.60	0
3. Fill select Material for Soft Ground Treatment	M^3	0	4.00	0	0	4.00	0	20,596	4.00	82,384
4. Drainage Structures										
(a) Multi-openings RC box culvert with head walls	M	180	1,200	216,000	600	1,200	720,000	315	1,200	378,000
(b) R. C. culvert with head walls	M	720	720	518,400	2,400	720	1,728,000	1,260	720	907,200
5. *Bridges*										
(a) Short span bridge	M^2	1,475	480	708,000	3,675	480	1,764,000	2,200	480	1,056,000
(b) Intermediate span bridge	M^2	1,180	600	708,000	2,940	600	1,764,000	1,100	600	660,000
(c) Long span bridge	M^2	0	840	0	2,940	840	2,469,000	2,640	840	2,217,600
6. Pavement										
(a) Subgrade preparation	M^2	727,680	0.05	36,384	1,436,160	0.05	71,808	883,350	0.05	44,168
(b) Subbase course	M^3	163,488	4.00	653,952	281,549	4.00	1,126,196	194,540	4.00	778,160
(c) Base course	M^3	90,010	6.30	567,063	155,520	6.30	979,776	109,606	6.30	690,518
(d) Bituminous prime coat	M^2	432,000	0.18	77,760	864,000	0.18	155,520	1,080,700	0.18	194,526
(e) Asphaltic concrete surface course	Ton	134,170	14.80	1,985,761	178,944	14.80	2,648,371	232,344	14.80	3,438,691
(f) Bituminous surface treatment	M^2	384,000	0.25	96,000	345,600	0.25	86,400	374,700	0.25	93,675
7. Establishment of Turf										
(a) Spot sodding with overseeding	M^2	384,000	0.20	76,800	460,800	0.20	92,160	567,600	0.20	113,520

Item	Unit	PART I JAKARTA - TANGERANG (Relocated 4-Lane Initial/ 6-Lane Ultimate)			PART II TANGERANG-UJUNG RIVER (Relocated 2-Lane Initial/ 4-Lane Ultimate)			PART III UJUNG RIVER-MERAK (Relocated/Improved 2-Lane Initial/4-Lane Ultimate)		
		Quantity	Unit Cost	Total	Quantity	Unit Cost	Total	Quantity	Unit Cost	Total
8. Stone Protection	M^2	23,808	3.00	71,424	47,616	3.00	142,848	38,378	3.00	115,134
9. Guard Rail	M	2,304	15.00	34,560	4,608	15.00	69,120	6,366	15.00	95,490
10. Center Line and other Markings	M	76,800	0.60	46,080	76,800	0.60	46,080	138,800	0.60	83,280
11. Traffic Signs										
(a) Regular size	EA	77	36.00	2,772	154	36.00	5,544	188	36.00	6,768
12. Maintenance and Protection of Traffic				79,157			175,949			130,523
13. Mobilization				395,786			879,746			652,614
14. Interchange and Grade Separation Structure	Lump Sum			3,835,946			-			1,802,484
TOTAL CONTRACT COST (ITEMS 1 THROUGH 14)	12,226,600 + 18,650,615 + 15,637,903 = 46,515,118									
CONTINGENCY	46,515,118 x 0.15 = 6,977,268									
FINAL ENGINEERING SUPERVISION & ADMINISTRATION	53,492,386 x 0.10 = 5,349,239									
TOTAL	US$ 58,841,625 ≑ 58,842,000									
B. LAND ACQUISITION & COMPENSATION										
1. Land Acquisition										
(a) Town	M^2	32,300	12.05	389,215	23,040	7.23	166,579	53,960	7.23	390,131
(b) Other area	M^2	1,441,800	1.21	1,744,578	2,280,960	1.21	2,759,962	1,716,240	1.21	2,076,650
2. Compensation for Buildings and Crops										
(a) Brick building	M^2	21,600	36.15	780,840	23,040	24.10	555,264	31,660	24.10	763,006
(b) Wooden building	M^2	78,124	16.87	1,317,952	80,640	7.23	583,027	62,600	7.23	452,598
(c) Shed	M^2				40,320	2.41	97,171	31,800	2.41	76,638
(d) Crops	M^2	313,012	8.68	2,716,944	489,600	8.68	4,249,728	375,700	8.68	3,261,076
TOTAL LAND ACQUISITION & COMPENSATION COST	6,949,529 + 8,411,731 + 7,020,099 = 22,381,359									
CONTINGENCY	22,381,359 x 0.15 = 3,357,204									
CADASTRAL SURVEY, PREPARATION OF R. O. W. PLAN & ADMINISTRATION	25,738,563 x 0.10 = 2,573,856									
TOTAL	US$ 28,312,419 ≑ 28,312,000									

Table 5 - 4

CONSTRUCTION COST ESTIMATES FOR INITIAL AND ULTIMATE STAGES (IN SEP. 1974 PRICE)

Unit : 1, 000 US$

Item	Alternative 1				Alternative II				Alternative III			
	Length	Initial Stage	Ultimate Stage	Total	Length	Initial Stage	Ultimate Stage	Total	Length	Initial Stage	Ultimate Stage	Total
PART I	Km 18.8	19, 168	7, 743	26, 911	Km 20.0	20, 049	8, 082	28, 131	Km 19.2	20, 420	8, 378	28. 798
PART II	Km 34.0	29. 446	11, 188	40, 634	Km 33.1	22, 936	8, 119	31, 055	Km 38.4	25, 335	8, 756	34, 091
PART III	Km 52.3	24, 605	3, 908	28, 513	Km 54.7	22, 183	3, 307	25, 490	Km 56.8	21, 151	3, 114	24, 265
TOTAL	Km 105.1	73, 219	22, 839	96, 058	Km 107.8	65, 168	19, 508	84, 676	Km 114.4	66, 906	20, 248	87, 154

NOTE:

PART I : JAKARTA - TANGERANG

PART II : TANGERANG - UJUNG RIVER

PART III : UJUNG RIVER - MERAK

Table 5 - 5

CONSTRUCTION COST ESTIMATES FOR ACCESS ROADS (IN SEP. 1973 PRICE)

Unit US$

Item	Alternative I		Alternative II		Alternative III	
	Length	Cost	Length	Cost	Length	Cost
Tangerang 1	1.0 Km	38,000	- Km	-	- Km	-
" 2	-	-	3.3	125,000	3.3	125,000
" 3	-	-	-	-	9.0	324,000
Balaraja	4.0	152,000	-	-	-	-
Congkudu	-	-	-	-	2.6	754,000
Serang	0.7	27,000	0.7	27,000	0.7	27,000
Cilegon	0.5	19,000	0.5	19,000	0.5	19,000
TOTAL	6.2	236,000	4.5	173,000	16.1	1,249,000

Chapter 6

ECONOMIC ANALYSIS

Year	11	12	13	14	15	16	17
1	0.900901	0.892857	0.884956	0.877193	0.869565	0.869969	0.8547
2	0.811622	0.797194	0.783147	0.769468	0.756144	0.743163	0.73051
3	0.731191	0.711780	0.693050	0.674972	0.657516	0.640658	0.6243
4	0.658731	0.635518	0.613319	0.592080	0.571753	0.552291	0.533
5	0.593451	0.567427	0.542760	0.519369	0.497177	0.476113	0.456
6	0.534641	0.506631	0.480319	0.455587	0.432328	0.410442	0.389
7	0.481658	0.452349	0.425061	0.399637	0.375937	0.353830	0.333
8	0.433926	0.403883	0.376160	0.350559	0.326902	0.305025	0.2847
9	0.390925	0.360610	0.332885	0.307508	0.284262	0.262953	0.2434
10	0.352184	0.321973	0.294588	0.269744	0.247185	0.226684	0.20803
11	0.317283	0.287476	0.260698	0.236617	0.214943	0.195417	0.1778
12	0.285841	0.256675	0.230706	0.207559	0.186907	0.168463	0.15197
13	0.257514	0.229174	0.204165	0.182069	0.162528	0.145227	0.1298
14	0.231995	0.204620	0.180677	0.159710	0.141329	0.125195	0.111
15	0.209004	0.182696	0.159891	0.140096	0.122894	0.107927	0.094
16	0.188292	0.163122	0.141496	0.122892	0.106865	0.093041	0.081
17	0.169633	0.145634	0.125218	0.107800	0.092926	0.080207	0.0693
18	0.152822	0.130040	0.110812	0.094561	0.080805	0.069144	0.0592
19	0.137678	0.116107	0.098064	0.082948	0.070225	0.059617	0.05063
20	0.124034	0.103667	0.086782	0.072762	0.061100	0.051385	0.0432

6. ECONOMIC ANALYSIS

6.01 Vehicle Operating Cost for Representative Vehicles

In the past studies made for highway feasibility in Indonesia, the Kampsax had compiled basic data on the operating cost of vehicles on Indonesian highways. These costs, both with and without taxes, were formulated for representative passenger car and truck/bus. In this study, therefore, these data were made applicable to the proposed project, after having made any necessary modifications to up-date the figures for adoption in the base year 1973.

The breakdown of the operating costs are as shown in Table 6-1 the summary of the operating costs are as follows:

(1) Average total cost per kilometer at speed of 80 km/hr for a representative passenger car on level tangent paved road = 34.4 rupiah (total costs) or 14.7 rupiah without taxes

(2) Average total cost per kilometer at speed of 72 km/hr for a representative truck/bus on level tangent paved road = 33.2 rupiah (total cost) or 26.0 rupiah without taxes.

6.02 dL - Values

The dL-values due to the various road characteristics are shown in Table 6-2. These were adopted from the Kampsax report with the following additions:

(1) dL for undivided road of narrow traffic lane
Even if a road section should be level, tangent and paved, if the road is undivided and the traffic lane narrow, the travel speed on the road section will be considerably reduced. The major part of the existing Jakarta-Merak Highway is with a traffic lane width of 3 m or below. Travel time surveys carried out by the study team shows that for some paved level and practically tangent road section, the average travel speed recorded ranges from 52.0 km/hr to 69.8 km/hr for an average

of 64.1 km/hr. Besides the dL due to road surface condition, the friction due to narrow traffic lane can be deduced to be about 0.1 km/km. In this study, therefore, a dL-value of 0.1 km/km is adopted for the whole route of the existing road.

(2) dL- for existing of becha (trishaws)

Along many sections of the existing road where building up along the road is heavy, many bechas are found running along the route. These bechas greatly impede the travelling of automobiles and special considerations should be made. During the travel time survey, it was found that while traversing through road sections with continuous becha traffic the travel speed generally fell to 50 - 60% of that for the preceding or the subsequent road sections. In this report, a dL-value of 0.50 km/km is therefore used for the road sections of becha concentration, the sections having been identified during the travel time survey.

Table 6-1-1 OPERATING COST OF A REPRESENTATIVE CAR ON A TANGENT LEVEL PAVED ROAD (ALL COSTS EXCLUDE TAXES)

a) Basic data

1. Vehicle cost : 900,000 rupiah
2. Cost of one set of tyres : 33,000 rupiah
3. Average vehicle lift : 14 years
4. Average tyre life : 50,000 km
5. Average annual mileage : 22,000 km

b) Fixed cost per annum

Depreciation	Rp.	65,000
Interest		108,000
Insurance		17,000
Total		190,000
Fixed cost per km	Rp.	8.65

c) Running cost per kilometer

Fuel	Rp.	2.44
Oils		0.13
Tyres & Tubes		0.67
Maintenance		2.80
Total	Rp.	6.04

d) Total cost per kilometers $8.65 + 6.04 = $ Rp. 14.7

(*1) Annual mileage = 365 days x 60 km/day ≑ 220,000 km

Table 6-1-2 OPERATING COST OF A REPRESENTATIVE TRUCK/BUS ON A TANGENT LEVEL PAVED ROAD (ALL COSTS EXCLUDE TAXES)

a) Basic data

1. Vehicle cost :	Rp.	1,920,000
2. Cost of tyre :	Rp.	137,000
3. Average vehicle lift :		10 years
4. Average tyre life :		70,000 Km
5. Average annual mileage : (*1)		75,000 Km

b) Fixed cost per annum

Depreciation	Rp.	192,000
Interest		231,000
Insurance		64,000
Driver & assistant		310,000
Overheads etc.		215,000
Total		1,012,000
Fixed cost per Km	Rp.	13.49

c) Running cost per Km

Fuel		3.86
Oils		0.17
Tyres & tubes		1.90
Maintenance		6.58
Total	Rp.	12.51

d) Total cost per kilometer : 13.49 + 12.54 = Rp. 26.0

(*1) Annual mileage = 300 days/year x 250 km/day = 75,000 km

Table 6-2-1 THE CALCULATION OF DL VALUES IN KM/KM

1. ROAD SECTION (I): GROGOL - TANGERANG (TOTAL LENGTH : 18.7 KM)

Road Element	Description	Road Length	dL - Values Cars Unit	Cars Total	Trucks & Buses Unit	Trucks & Buses Total
Road Surface & Condition	Paved, Fair	18.7	0.15	2.81	0.25	4.68
Narrow traffic lane	-	18.7	0.10	1.87	0.10	1.87
Gradient	0 - 3%	18.7	0	-	0	-
	0 - 5%	0	0.15	-	0.20	-
	5 - 7%	0	0.35	-	0.45	-
	7 %	0	0.65	-	0.80	-
Narrow Bridges	-	0	0	-	0	-
Sharp Curves	-	0	0	-	0	-
Roadside Friction	Light	2.90	0	-	0	-
	Medium	3.20	0.18	0.58	0.18	0.58
	Heavy	12.60	0.32	4.03	0.32	4.03
Concentration of Becha	-	15.8	0.50	7.90	0.50	7.90
Total	-	18.7		17.19		19.06
Equivalent distance	-	18.7		35.89		37.76
Theoretical average travel speed	-	-		41.7 kph		35.6 kph

Table 6-2-2

2. ROAD SECTION (2) : TANGERANG - BALARAJA (TOTAL LENGTH : 24.0 KM)

Road Element	Description	Road Length	dL - Values			
			Cars		Trucks & Buses	
			Unit	Total	Unit	Total
Road Surface & Condition	Paved, Fair	24.00	0.15	3.60	0.25	6.00
Narrow traffic lane	-	24.00	0.10	2.40	0.10	2.40
Gradient	0 - 3%	22.9	0	-	0	-
	3 - 5%	1.0	0.15	0.15	0.20	0.20
	5 - 7%	0	0.35	-	0.45	-
	7 %	0.1	0.65	0.07	0.80	0.08
Narrow Bridges	-	0	0	-	0	-
Sharp Curves	-	0	0	-	0	-
Roadside Friction	Light	7.95	0	-	0	-
	Medium	12.70	0.18	2.29	0.18	2.29
	Heavy	3.35	0.32	1.07	0.32	1.07
Concentration of becha	-	5.60	0.50	2.80	0.50	2.80
Total	-	24.0		12.38		14.84
Equivalent distance	-	24.0		36.38		38.84
Theoretical Travel	-	-		52.8 kph		44.5 kph

Table 6-2-3

3. ROAD SECTION (3) : BALARAJA - SERANG (TOTAL LENGTH : 42.7 KM)

			dL - Values			
			Cars		Trucks & Buses	
Road Elements	Description	Road Length	Unit	Total	Unit	Total
Road Surface & Condition	Paved, Fair	42.7	0.15	6.41	0.25	10.68
Narrow traffic lane	-	42.7	0.10	4.27	0.10	4.27
Gradient	0 - 3%	41.8	0	-	0	0
	3 - 5%	0.9	0.15	0.14	0.20	0.18
	5 - 7%	0	0.35	-	0.45	-
	7 %	0	0.65	-	0.80	-
Narrow Bridges	-	0	0	-	0	-
Sharp Curves	-	0	0	-	0	-
Roadside Friction	Light	24.20	0	-	0	-
	Medium	14.80	0.18	2.66	0.18	2.66
	Heavy	3.70	0.32	1.18	0.32	1.18
Concentration of becha	-	6.20	0.50	3.10	0.50	3.10
Total	-	42.7		17.76		22.07
Equivalent distance	-	42.7		60.46		64.77
Theoretical average speed	-	-		56.5 kph		47.5 kph

Table 6-2-4

4. ROAD SECTION (4) : SERANG -CILEGON (TOTAL LENGTH : 16.0 KM)

Road Element	Description	Road Length	dL - Values Cars Unit	Cars Total	Trucks & Buses Unit	Trucks & Buses Total
Road Surface & Condition	Paved, Fair	16.0	0.15	2.40	0.25	4.00
Narrow traffic lane	-	16.0	0.10	1.60	0.10	1.60
Gradient	0 - 3%	15.0	0	-	-	-
	3 - 5%	1.0	0.15	0.15	0.20	-
	5 - 7%	0	0.35	-	0.45	-
	> 7 %	0	0.65	-	0.80	-
Narrow Bridges	-	0		-		-
Sharp Curves	-	0		-		-
Roadside Friction	Light	10.00	0	-	0	-
	Medium	5.00	0.18	0.90	0.18	0.90
	Heavy	1.00	0.32	0.32	0.32	0.32
Concentration of becha	-	2.60	0.50	1.30	0.50	1.30
Total	-	16.0		6.67		8.32
Equivalent distance	-	16.0		22.67		24.32
Theoretical Travel Speed	-	-		56.5 kph		47.4 kph

Table 6-2-5

5. ROAD SECTION (5) : CILEGON - MERAK (TOTAL LENGTH : 13.9 KM)

Road Element	Description	Road Length	dL-Values Cars Unit	Cars Total	Trucks & Buses Unit	Trucks & Buses Total
Road Surface & Condition	Paved, Fair	13.9	0.15	2.09	0.25	3.48
Narrow traffic lane	-	13.9	0.10	1.39	0.10	1.39
Gradient	0 - 3%	12.95	0	-	0	-
	3 - 5%	0.70	0.15	0.11	0.20	0.14
	5 - 7%	0.25	0.35	0.09	0.45	0.11
	> 7 %	0	0.65	-	0.80	-
Narrow Bridges	-	0	0	-	0	-
Sharp Curves	-	5	0.10	0.50	0.04	0.20
Roadside Friction	Light	7.40	0	-	0	-
	Medium	5.60	0.18	1.01	0.18	1.01
	Heavy	0.90	0.32	0.29	0.32	0.29
Concentration of becha	-	1.80	0.50	0.90	0.50	0.90
Total	-	13.9		6.38		7.52
Equivalent Distance	-	13.9		20.28		21.42
Theoretical Travel Speed	-	-		54.8 kph		46.7 kph
Total equivalent distance for whole route				175.68		187.11
Average speed for whole route				52.5 kph		44.4 kph

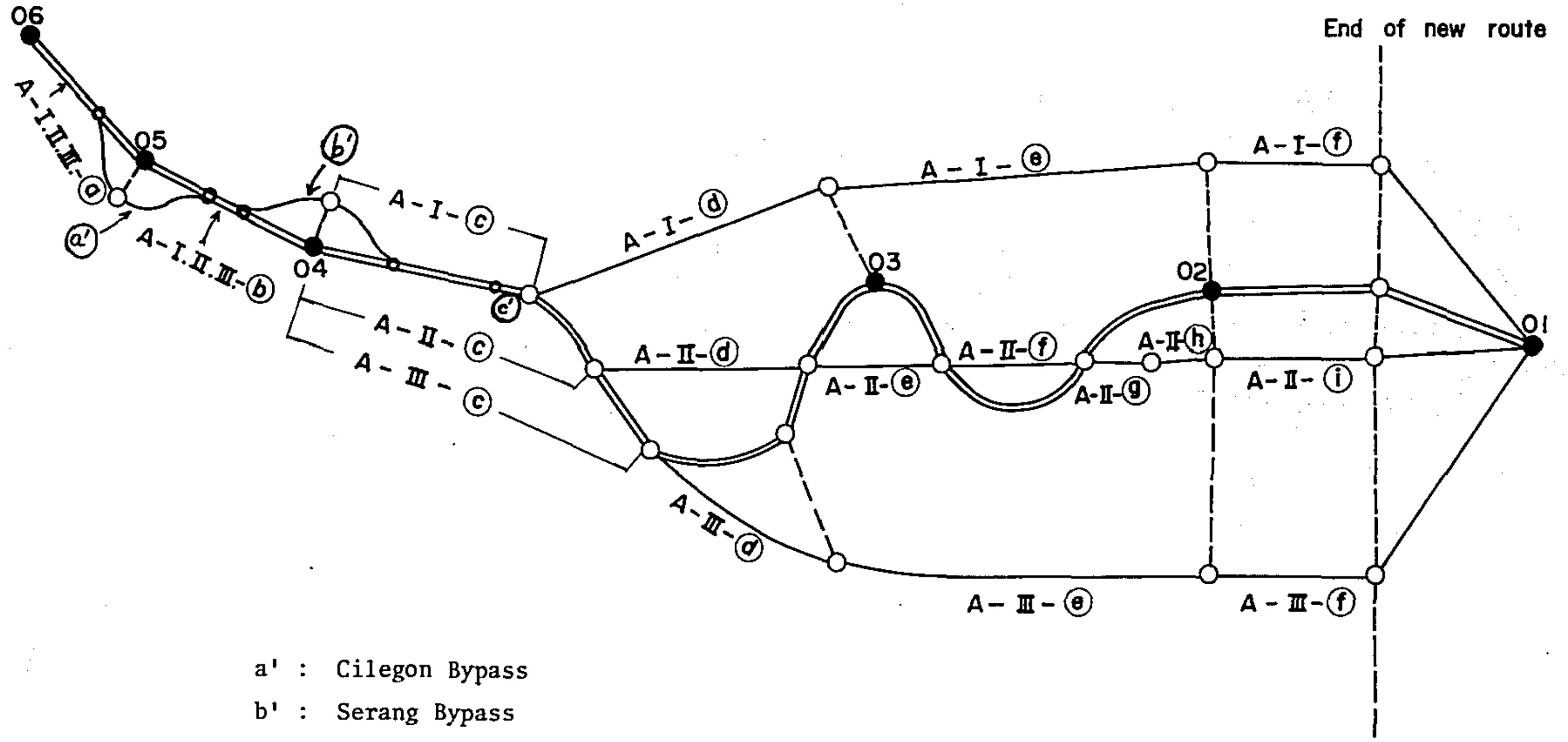
6.03 Calculation of Equivalent Distance for Existing Jakarta-Merak Highway

The proposed route include new alignment for certain sections. The calculation of the dL alone will not be sufficient for the purpose of benefit calculation. The dL for various road sections are computed and added to the actual length of road section to obtain the equivalent distance of the road sections. The resultant equivalent distance by section are as in Fig. 6-2 and Table 6-3, and only the summary of the results are shown below together with the theoretical average travel speed of vehicles. The results of the travel time survey are also given for comparison. It is seen that while minor differences are seen, the dL calculations are considerably closed to the actual surveyed results. It should be noted that the theoretical travel speed is generally higher than the actual survey results due probably to the fact that during the travel time survey, many sections of the existing road were under construction or improvement and this factor is not taken into consideration in dL calculation.

Road Section	Actual distance (km)	Equivalent distance for cars (Km)	Theoretical Travel Speed	Actual Travel Speed	Equivalent distance for truck/bus (Km)	Theoretical Travel Speed
Grogol - Tangerang	18.70	35.89	41.7 kph	34.8 kph	37.76	35.6 kph
Tangerang-Balaraja	24.00	36.38	52.8	56.2	38.84	44.5
Balaraja-Serang	42.70	60.46	56.5	51.3	64.77	47.5
Serang-Cilegon	16.00	22.67	56.5	57.4	24.32	47.4
Cilegon-Merak	13.90	20.28	54.8	47.2	21.42	46.7
Whole route	115.30	175.68	52.5	48.8	187.11	44.4

Fig. 6-1-1

Section Division for the Alternative Routes



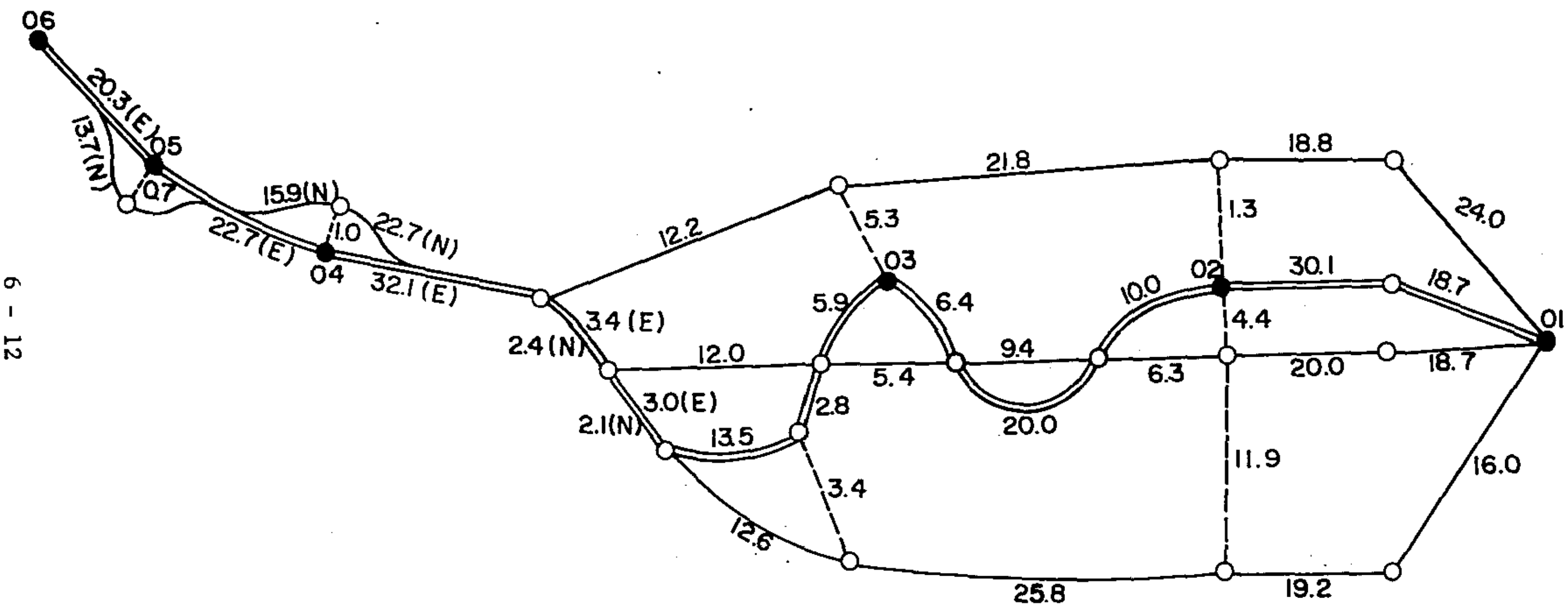
a' : Cilegon Bypass

b' : Serang Bypass

c' : Ci Ujung Bridge

Fig. 6-1-2

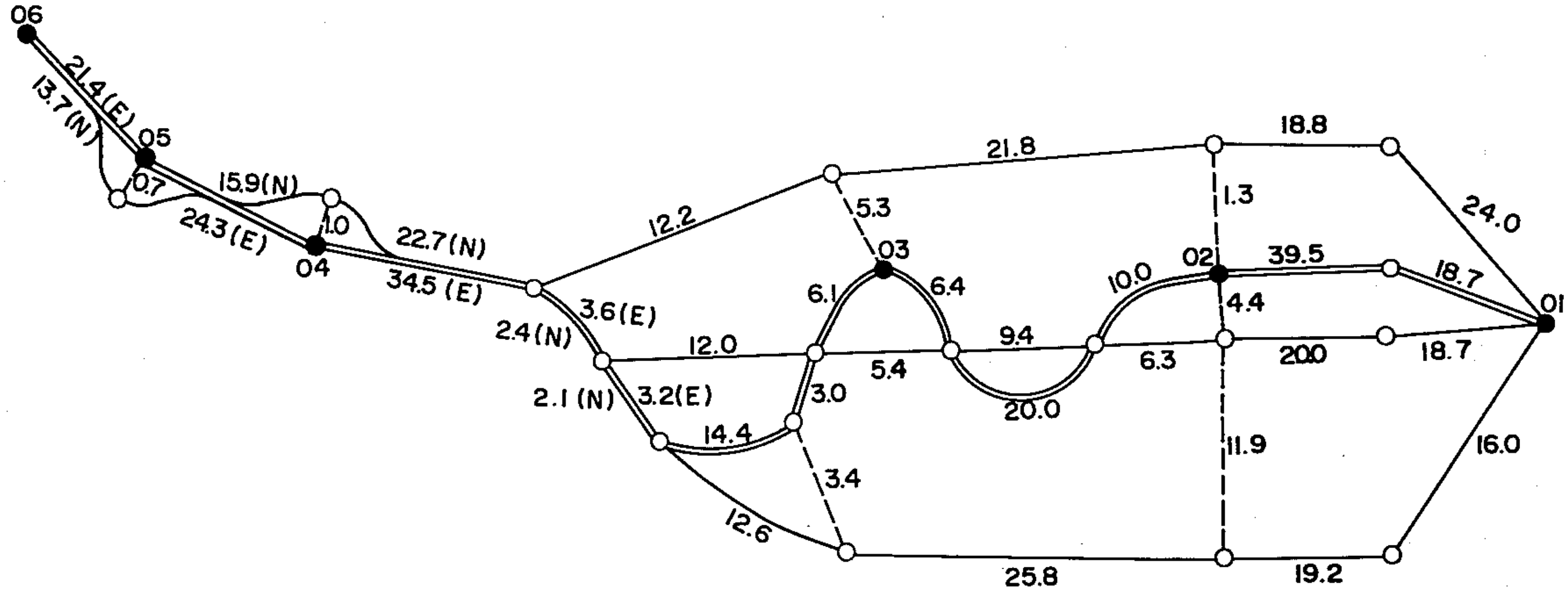
Equivalent distance by Section – Passenger car



E : Existing route
N : New route

Fig. 6-1-3

Equivalent distance by Section - Bus, Truck



E : Existing route

N : New route

Table 6-3 Interzonal equivalent distance

Alt I

	02	03	04	05	06	07	08
01	44.1	69.9	100.5	116.1	129.1	200.5	(288)
02		28.4	59.0	74.6	87.6	159.0	332.1
03			41.2	56.8	69.8	141.2	357.9
04				17.6	30.6	(100)	388.5
05					14.4	117.6	404.1
06						130.6	417.1

Alt II

	02	03	04	05	06	07	08
01	43.1	61.1	97.9	110.5	126.5	197.9	(288)
02		27.6	63.6	79.2	92.2	163.6	331.1
03			44.5	60.1	73.1	144.5	349.6
04				17.6	30.6	(100)	385.9
05					14.4	117.6	398.5
06						130.6	414.5

Alt III

	02	03	04	05	06	07	08
01	47.1	74.0	102.8	118.4	130.4	202.8	
02		55.1	83.9	99.5	111.5	183.9	335.1
03			47.4	63.0	82.4	147.4	362.0
04				17.6	30.6	(100)	390.8
05					14.4	117.6	406.4
06						130.6	418.4

EXITING ROAD Passenger car / Bus.Truck

	02	03	04	05	06	07	08
01	61.1 / 63.5	97.5 / 99.9	158.0 / 164.7	180.7 / 189.0	201.0 / 210.4	258.0 / 264.7	(288 / 288)
02		36.4 / 36.4	96.9 / 101.2	119.6 / 125.5	139.9 / 146.9	196.9 / 201.2	349.1 / 351.5
03			60.5 / 64.8	83.1 / 89.1	103.4 / 110.5	160.5 / 164.8	385.5 / 387.9
04				22.7 / 24.3	43.0 / 45.7	(100 / 100)	446 / 452.7
05					20.3 / 21.4	122.7 / 124.3	468.7 / 477.0
06						143.0 / 145.7	489 / 498.4

6.04 The Evaluation of Direct Benefit

In the calculation of direct benefits derived through saving in operating cost and time, the total operating cost of the vehicles on the existing road as well as the new route(s) were calculated through multiplying the equivalent distance with the cost per vehicle kilometer, the difference between the total costs on the existing road and that on the new route being the benefit for the route.

It was computed that should the whole project be completed, the direct benefits at current price for the years 1980 and 1990 would be as follows:

	1980	1990	Growth rate
Alternative I	13,447 x 10^3\$	27,523 x 10^3\$	7.4%
Alternative II	14,544 x 10^3\$	29,533 x 10^3\$	7.4%
Alternative III	12,242 x 10^3\$	25,529 x 10^3\$	7.6%

The above benefits for the whole route are the accruments of the benefits derived from the various individual sections, which vary from section to section. Table 6-4 shows the annual benefits at current prices for the individual sections, which may be expected independent of all other road sections.

It was pointed out in Chapter 3 that the region along the Jakarta Merak highway being relatively highly developed, the volume of development traffic and induced traffic after the completion of the proposed project will be small enough to be considered negligible without serious by affecting the findings of the study. Nevertheless, even if the traffic volume is small, the benefit accumulated over the years, may come to be considerable in the form of indirect benefit. Also, other indirect benefits as the reduction of accident,reduction in damage to goods transported, reduction in investment on storage facilities for goods, and many others may also be expected. However, the quantification of indirect benefits is difficult without ample past data, and computations will have to be based on many uncertain assumptions so that the results of the calculations may be wanting in precision. In this study, it was decided that the indirect benefits be omitted and only the direct benefits be considered in that the cost benefit analysis. Any indirect benefits generated will therefore serve to further boost the economic feasibility of the project.

Table 6-4-1

Alternative: I

ANNUAL ROAD SECTION BENEFITS

Unit: 1,000 US$

Section / Year	a	a'	b	b'	c	d	e	f
1977	207.8	266.8	295.7	907.8	1,014.1	1,957.9	2,167.8	2,406.1
78	251.2	341.2	342.1	1,046.0	1,163.8	2,250.0	2,466.8	2,770.5
79	294.5	415.5	388.6	1,184.1	1,313.6	2,542.0	2,765.9	3,134.9
80	337.9	489.8	435.1	1,322.3	1,463.3	2,834.1	3,064.9	3,499.3
81	381.3	564.1	481.6	1,460.5	1,613.1	3,126.2	3,363.9	3,863.7
82	424.6	638.4	528.1	1,598.6	1,762.8	3,418.2	3,663.0	4,228.1
83	468.0	712.7	574.5	1,736.8	1,912.6	3,710.3	3,962.0	4,592.5
84	511.4	787.1	621.0	1,874.9	2,062.3	4,002.3	4,261.0	4,956.9
85	554.8	861.4	667.5	2,013.1	2,212.1	4,294.4	4,560.1	5,321.4
86	598.1	935.7	714.0	2,151.3	2,361.8	4,586.5	4,859.1	5,685.8
87	641.5	1,010.0	760.5	2,289.4	2,811.6	4,878.5	5,158.1	6,050.2
88	684.9	1,084.4	806.9	2,427.6	2,661.3	5,170.6	5,457.1	6,414.6
89	728.2	1,158.7	853.4	2,565.7	2,811.1	5,462.6	5,756.2	6,779.0
90	771.6	1,233.0	899.9	2,703.9	2,960.8	5,754.7	6,055.2	7,143.4
91	815.0	1,307.3	946.4	2,842.1	3,110.6	6,046.8	6,354.2	7,507.8
92	858.3	1,381.6	992.9	2,980.2	3,260.3	6,338.8	6,653.3	7,872.2
93	901.7	1,456.0	1,039.3	3,118.4	3,410.1	6,630.9	6,952.3	8,236.6
94	945.1	1,530.3	1,085.8	3,256.5	3,559.8	6,922.9	7,251.3	8,601.0
95	988.5	1,604.6	1,132.3	3,394.7	3,709.6	7,215.0	7,550.4	8,965.5
96	1,031.8	1,678.9	1,178.8	3,532.9	3,859.3	7,507.1	7,849.4	9,329.9
97	1,075.2	1,753.2	1,225.3	3,671.0	4,009.1	7,799.1	8,148.4	9,694.3
98	1,118.6	1,827.6	1,271.7	3,809.2	4,158.8	8,091.2	8,447.4	10,058.7
99	1,161.9	1,901.9	1,318.2	3,947.3	4,308.6	8,383.2	8,746.5	10,423.1
2000	1,205.3	1,976.2	1,364.7	4,085.5	4,458.3	8,675.3	9,045.5	10,787.5
01	1,248.7	2,050.5	1,411.2	4,223.7	4,408.1	8,967.4	9,344.5	11,151.9
02	1,292.0	2,124.8	1,457.7	4,361.8	4,757.8	9,259.4	9,643.6	11,516.3
03	1,335.4	2,199.2	1,504.1	4,500.0	4,907.6	9,551.5	9,942.6	11,880.7
04	1,378.8	2,273.5	1,550.6	4,638.1	5,057.3	9,843.5	10,241.6	12,245.1
05	1,422.2	2,347.8	1,597.1	4,776.3	5,207.1	10,135.6	10,540.7	12,609.6
06	1,465.5	2,422.1	1,643.6	4,914.5	5,356.8	10,427.7	10,839.7	12,974.0

Table 6-4-2

Alternative II

ANNUAL ROAD SECTION BENEFITS

Unit: 1,000 US$

Section / Year	a	Cilegon Bypass a'	b	Serang Bypass b'	c	d	e	f	g, h	i
1977	207.8	266.8	295.7	907.8	1,143.7	922.9	727.8	1,880.6	585.4	3,109.0
78	251.2	341.2	342.1	1,046.0	1,312.7	1,059.9	842.2	2,121.6	659.8	3,569.7
79	294.5	415.5	388.6	1,184.1	1,481.6	1,196.9	956.6	2,362.7	734.3	4,030.5
80	337.9	489.8	435.1	1,322.3	1,650.5	1,333.9	1,071.0	2,603.7	808.7	4,491.2
81	381.3	564.1	481.6	1,460.5	1,819.4	1,470.9	1,185.4	2,844.8	883.1	4,951.9
82	424.6	638.4	528.1	1,598.6	1,988.3	1,607.9	1,299.8	3,085.8	957.6	5,412.7
83	468.0	712.7	574.5	1,736.8	2,157.3	1,744,9	1,414.2	3,326.9	1,032.0	5,873.4
84	511.4	787.1	621.0	1,874.9	2,326.2	1,881.9	1,528.6	3,567.9	1,106.5	6,334.1
85	554.8	861.4	667.5	2,013.1	2,495.1	2,018.9	1,643.0	3,809.0	1,180.9	6,794.9
86	598.1	935.7	714.0	2,141.3	2,664.0	2,155.9	1,757.3	4,050.0	1,255.3	7,255.6
87	641.5	1,010.0	760.5	2,289.4	2,832.9	2,292.9	1,871.7	4,291.1	1,329.8	7,716.3
88	684.9	1,084.4	806.9	2,427.6	3,001.9	2,439.9	1,986.1	4,532.1	1,404.2	8,177.0
89	728.2	1,158.7	853.4	2,565.7	3,170.8	2,566.9	2,100.5	4,773.2	1,478.7	8,637.8
90	771.6	1,233.0	899.9	2,703.9	3,339.7	2,703.9	2,214.9	5,014.2	1,553.1	9,098.5
91	815.0	1,307.0	946.4	2,842.1	3,508.6	2,840.9	2,329.3	5,255.3	1,627.5	9,559.2
92	858.3	1,381.6	992.9	2,980.2	3,677.5	2,977.9	2,443.7	5,496.3	1,702.0	10,020.0
93	901.7	1,456.0	1,039.3	3,118.4	3,846.5	3,114.9	2,558.1	5,737.4	1,776.4	10,480.7
94	945.1	1,530.3	1,085.8	3,256.5	4,015.4	3,251.9	2,672.5	5,978.4	1,850.9	10,941.4
95	988.5	1,604.6	1,132.3	3,394.7	4,184.3	3,388.9	2,786.9	6,219.5	1,925.3	11,402.2
96	1,031.8	1,678.9	1,178.8	3,532.9	4,353.2	3,535.9	2,901.2	6,460.5	1,999.7	11,862.9
97	1,075.2	1,753.2	1,225.3	3,671.0	4,522.1	3,662.9	3,015.6	6,701.6	2,074.2	12,323.6
98	1,118.6	1,827.6	1,271.7	3,809.2	4,691.1	3,799.9	3,130.0	6,942.6	2,148.6	12,784.3
99	1,161.9	1,901.9	1,318.2	3,947.3	4,860.0	3,936.9	3,244.4	7,183.7	2,223.1	13,245.1
2000	1,205.3	1,876.2	1,364.7	4,085.5	5,028.9	4,073.9	3,358.8	7,424.7	2,297.5	13,705.8
01	1,248.7	2,050.5	1,411.2	4,223.7	5,197.8	4,210.9	3,473.2	7,665.8	2,371.9	14,166.5
02	1,292.0	2,124.8	1,457.7	4,361.8	5,366.7	4,347.9	3,587.6	7,906.8	2,446.4	14,627.3
03	1,335.4	2,199.2	1,504.1	4,500.0	5,535.7	4,484.9	3,702.0	8,147.9	2,520.8	15,088.0
04	1,378.8	2,273.5	1,550.6	4,638.1	5,704.6	4,621.9	3,816.4	8,388.9	2,595.3	15,548.7
05	1,422.2	2,347.8	1,597.1	4,776.3	5,873.5	4,758.9	3,930.8	8,630.0	2,669.7	16,009.5
06	1,465.5	2,422.1	1,643.6	4,914.5	6,042.4	4,895.9	4,045.1	8,871.0	2,741.1	16,470.2

Table 6-4-3

Alternative III ANNUAL ROAD SECTION BENEFITS Unit: 1,000 US$

Section / Year	a	a'	b	b'	c	d	e	f
1977	207.8	266.8	295.7	907.8	1,261.6	139.8	2,065.5	3,111.2
78	251.2	341.2	342.1	1,046.0	1,447.9	161.5	2,430.2	3,564.8
79	294.5	415.5	388.6	1,184.1	1,634.3	183.3	2,794.9	4,018.4
80	337.9	489.8	435.1	1,322.3	1,820.6	205.0	3,159.6	4,472.0
81	381.3	564.1	481.6	1,460.5	2,007.0	226.7	3,534.3	4,925.6
82	424.6	638.4	528.1	1,598.6	2,193.3	248.5	3,889.0	5,379.2
83	468.0	712.7	574.5	1,736.8	2,379.7	270.2	4,253.7	5,832.8
84	511.4	787.1	621.0	1,874.9	2,566.0	292.0	4,618.4	6,286.4
85	554.8	861.4	667.5	2,013.1	2,752.4	313.7	4,983.1	6,740.0
86	598.1	935.7	714.0	2,151.3	2,938.7	335.4	5,347.7	7,193.6
87	641.5	1,010.0	760.5	2,289.4	3,125.1	357.2	5,712.4	7,647.2
88	684.9	1,084.4	806.9	2,427.6	3,311.4	378.9	6,077.1	8,100.8
89	728.2	1,158.7	853.4	2,565.7	3,497.8	400.7	6,441.8	8,554.4
90	771.6	1,233.0	899.9	2,703.9	3,684.1	422.4	6,806.5	9,008.0
91	815.0	1,307.3	946.4	2,842.1	3,870.5	444.1	7,171.2	9,461.6
92	858.3	1,381.6	992.9	2,980.2	4,056.8	465.9	7,535.9	9,915.2
93	901.7	1,455.9	1,039.3	3,118.1	4,243.2	487.6	7,900.6	10,368.8
94	945.1	1,530.3	1,085.8	3,256.5	4,429.5	509.4	8,265.3	10,822.4
95	988.5	1,604.6	1,132.3	3,394.7	4,615.9	531.1	8,630.0	11,276.0
96	1,031.8	1,678.9	1,178.8	3,532.9	4,802.2	552.8	8,994.6	11,729.6
97	1,075.2	1,753.2	1,225.3	3,671.0	4,988.6	574.6	9,359.3	12,183.2
98	1,118.6	1,827.6	1,271.7	3,809.2	5,174.9	586.3	9,724.0	12,636.8
99	1,161.9	1,901.9	1,318.2	3,947.3	5,361.3	618.1	10,088.7	13,090.4
2000	1,205.3	1,976.2	1,364.7	4,085.5	5,547.6	639.8	10,453.4	13,544.0
01	1,248.7	2,050.5	1,411.2	4,223.7	5,734.0	661.5	10,818.1	13,997.6
02	1,292.0	2,124.8	1,457.7	4,361.8	5,920.3	683.3	11,182.8	14,451.2
03	1,335.4	2,199.2	1,504.1	4,500.0	6,106.7	705.0	11,547.0	14,904.8
04	1,378.8	2,273.5	1,550.6	4,638.1	6,293.0	726.8	11,912.2	15,358.4
05	1,422.2	2,347.8	1,597.1	4,776.3	6,479.4	748.5	12,276.9	15,812.0
06	1,465.5	2,422.1	1,643.6	4,914.5	6,665.7	770.2	12,641.5	16,265.6

6.05 Summary of Preliminary Cost Estimates

The preliminary construction costs estimates for the various alternatives are made in the subsequent sections. The results are summarised as follows:

Construction Costs including Land Acquisition

Alternative I:	96,058	thousand US$
Alternative II:	84,676	" "
Alternative III:	87,154	" "

The annual maintenance costs for the alternatives are estimated as follows:

Alternative I:	480	thousand US$
Alternative II:	423	" "
Alternative III:	436	" "

The preliminary estimates of construction and maintenance costs by road sections for the alternatives are as shown in Table 6-5.

Table 6-5 PRELIMINARY ESTIMATES OF CONSTRUCTION AND MAINTENANCE COSTS BY ROAD SECTIONS

	Alternative I			Alternative II			Alternative III	
Road Section	Construction Cost	Maintenance Cost	Road Section	Construction Cost	Maintenance Cost	Road Section	Construction Cost	Maintenance Cost
I-a	3,203	16	II-a	3,203	16	III-a	3,203	16
a'	5,455	27	a'	5,455	27	a'	5,455	27
b	2,775	14	b	2,775	14	b	2,775	14
b'	6,769	34	b'	6,769	34	b'	6,769	34
c	8,709	43	c	9,929	50	c	10,596	53
d	12,295	61	d	10,060	50	d	9,869	49
e	28,339	142	e	4,525	23	e	24,222	121
f	28,513	143	f	7,875	39	f	24,265	122
		480	g, h	8,595	43			
			i	25,490	127			
Total	96,058	480		84,676	423		87,154	436

6.06 Preliminary Benefit/cost Analysis

A preliminary economic evaluation is made for the three alternatives for the case whereby the whole project should be implemented from the initial stage without consideration for the advantages of stage construction.

Calculations were made on the assumption that the construction period will be four years (1975 - 1978) so that the road will be open to traffic in 1979. Assuming a redemption period of 20 years, and a discount rate of 15% the benefit/cost ratio for the alternatives, with year 1973 as the base year, are as follows:

1) Alternative I: B/C = 1.00
2) Alternative II: B/C = 1.21
3) Alternative III: B/C = 1.00

The above calculation show that economically, all the three alternatives are feasible even if the implementation of the whole route should be carried out at the initial stage. Also, according to this calculation, the Alternative II shows to be the most favourable of the three alternatives. However, this calculation can only provide an indication as to the economic feasibility of the projects and further detailed analysis will have to be made. The main reason is that the assumption that the whole route be implemented at the initial stage usually does not provided a most economical solution. The traffic demand is forecast for the further target years twenty years ahead, and the number of traffic lanes planned to cater for the future demand. The completion of the final plan in the initial stage will be redundant and excessive.

Also, the simultaneous implementation of such a big project will have to be planned with due considerations for the financial resources, the supply of materials and of labour, besides the traffic demand. For this reason, stage construction considerations are made in order to provide an optimum project implementation program.

6.07 Stage Construction Considerations

Stage construction considerations are made both for the road section and for the number of traffic lanes. The construction of a road section may be deferred if the traffic demand can be sufficiently served by the existing highway. When construction is implemented, a smaller number of traffic lanes may be constructed first and further traffic lanes provided at a later date.

Preliminary trial calculation shows that deferment of the initial year of implementation results in better economic feasibility due to the low rate of increase in annual benefit as compared to the discount rate, and purely from an economic point of view, delay of implementation as much as possible is favourable. However, traffic demand does not allow infinite deferment and the program of stage construction depends very greatly on the traffic demand.

The Section 7.04 in the subsequent chapter shows the traffic capacity of the existing highway and the proposed new highway. To maintain a service level "B" for the existing highway, the section from Tangerang to Merak has a capacity of 12,000 PCU/day, while the section from Tangerang to Grogol, where bechas and heavy building up impede smooth traffic flow, the capacity drops to 9,500 PCU/day. As for the proposed route, when only two lanes are provided, the capacity will be 20,000 PCU/day for flat terrain and 15,000 PCU/day for rolling terrain, and 12,500 PCU/day for the section between Cilegon and Merak, where a lower standard is planned. On expansion of the two lane highways to multi-lanes, the capacity for four lanes will be 44,000 PCU/day and six lanes will be 65,000 PCU/day.

To derive maximum economic effect, it is decided in this study to allow traffic demand to surpass the capacity, which is set at a comparatively comfortable service level, before implementation of the project, and the limit of tolerance is set at twenty percent above the traffic capacity of the road sections.

With reference to the Table 3-7 where future traffic volumes for all road sections are shown, the necessary program for implementation may be summarized as follows.

(a) Alternative I

i) Section a: A two lane new highway should be completed by 1990 and the expansion to four lanes completed by 2000

ii) Section b: Two lanes new highway by 1988, and four lanes by 1995

iii) Section c, d: Two lanes by 1981 and four lanes by 1985

iv) Section e: Four lanes by 1981

v) Section f: Four lanes from the beginning and six lanes by 1995

(b) Alternative II

i) Sections a,b: Same as Alternative I

ii) Section c,d,e: Two lanes by 1981 and four lanes by 1985

iii) Section f,g,h: Four lanes by 1981

iv) Section i: 4 lanes from the beginning and 6 lanes by 1993

(c) Alternative III

i) Sections a,b,c: Same as Alternative I

ii) Section d: Two lanes by 1982 and four lanes by 1986

iii) Section e: Four lanes by 1982

iv) Section f: Four lanes from the beginning and six lanes by 1995

It will be seen from the above observation that the section that requires most urgent implementation is the section joining Tangerang and Jakarta for which a four lane highway will be necessary from the beginning. This is followed by the section between Tangerang and Balaraja, whereby a four lane construction two years later is called for. Construction of all other road sections may be deferred to a later stage. However, although through traffic volumes of the western part of the proposed route are not big enough to warrant implementation, the sections of the existing route that pass through the town centres of Serang and Cilegan are even today rather congested due to the simultaneous existence of local traffic. Bypasses are planned at the outskirts of these two towns. From the point of congestion due to local traffic, it is recommended that although the main route of the western half may be deferred in implementation, the construction of the bypasses should be initiated right from the beginning. Also, the condition of the existing bridge over Ci Ujung is poor and early replacement is physically necessary. The construction of the new bridge therefore is also included in Stage I.

6.08 Economic Evaluation for Stage Construction Program

Reevaluation of the economic feasibility of the proposed route is made for the alternatives with the construction program staged into three stages as follows:

i) Stage I: The constructions which will have to be implemented immediately and the preparation of which has to be started from now. This includes the construction of four lanes for the Tangerang - Jakarta section and the construction of the bypasses for Serang and Cilegon and the Ci Ujung Bridge. With preparation beginning from this year, it is anticipated that effective implementation will be started from 1975 and the construction completed by 1978.

ii) Stage II: The implementation of the sections which call for completion by 1981.

iii) Stage III: The remaining construction works to complete the plan.

According to this program, the annual amount of investment will be as shown in Table 6-6, while the annual maintenance cost will be as in Table 6-7, and the benefits which may be expected for the various years are summarized in Table 6-8.

Traffic analysis shows that traffic demand for the Stage I portion of the highway will be very big. Especially for the section between Tangerang and Jakarta, the 1980 traffic demand will be over 250% the capacity of the existing highway. It is strongly recommended therefore that the implementation of the Stage I portion should be carried out immediately.

Table 6-6-1

Alternative I

PRELIMINARY ANNUAL INVESTMENT PROGRAM

Unit: 1,000 US$

Section / Year	a	(Cilegon Bypass) a'	b	(Serang Bypass) b'	c, d	e	f	Total for Stage I	Total for Stage II	Total for Stage III	Grand Total
1975		228		275			1230	1733			1733
76		1141		1375			6151	8667			8667
77		1826		2201	703	1417	9842	13869	2120		15989
78		1370		1650	3513	7085	7382	10402	10598		21000
79					5620	11335			16955		16955
80					4512	8502			12717		12717
81											-
82											-
83				507	2781					3288	3288
84				761	4172					4933	4933
85											-
86			461							461	461
87			692							692	692
88	950									950	950
89	1425									1425	1425
90											-
91											-
92							1563			1563	1563
93		356	649				2345			3350	3350
94		534	973							1507	1507
95											-
96											-
97	331									331	331
98										497	497
99											-
Total	3203	5455	2775	6769	21004	28339	28513	34671	42390	18997	96058

Table 6-6-2

Alternative II

PRELIMINARY ANNUAL INVESTMENT PROGRAM

Unit: 1,000 US$

Section / Year	a	(Cilegon Bypass) a'	b	(Serang Bypass) b'	c,d	e	f,g,h	i	Total for Stage I	Total for Stage II	Total for Stage III	Grand Total
1975		228		275				1109	1612			1612
76		1141		1375				5546	8062			8062
77		1826		2201	685	168	824	8873	12900	1677		14577
78		1370		1650	3423	839	4117	6655	9675	8379		18054
79					5477	1342	6588			13407		13407
80					4107	1006	4941			10054		10054
81												-
82												-
83				507	2519	468					3494	3494
84				761	3778	702					5241	5241
85												-
86			461								461	461
87			692								692	692
88	950										950	950
89	1425										1425	1425
90												-
91								1323			1323	1323
92								1984			1984	1984
93		356	649								1005	1005
94		534	973								1507	1507
95												-
96												-
97	331										331	331
98	497										497	497
99												
Total	3203	5455	2775	6769	19989	4525	16470	25490	32249	33517	18910	84676

Table 6-6-3

Alternative III

PRELIMINARY ANNUAL INVESTMENT PROGRAM

Unit: 1,000

Year \ Section	a	a' (Cilegon Bypass)	b	b' (Serang Bypass)	c, d	e	f	Total for Stage I	Total for Stage II	Total for Stage III	Grand Total
1975		228		275			1058	1561			1561
76		1141		1375			5288	7804			7804
77		1826		2201	697	1211	8460	12487	1908		14395
78		1370		1650	3486	6055	6345	9365	9541		18906
79					5578	9689			15267		15267
80					4184	7267			11451		11451
81											–
82											–
83				507	2608					3115	3115
84				761	3912					4673	4673
85											–
86			461							461	461
87			692							692	692
88	950									950	950
89	1425									1425	1425
90											–
91											–
92											–
93		356	649				1246			2251	2251
94		534	973				1868			3375	3375
95											–
96											–
97	331									331	331
98	497									497	497
99											
Total	3203	5455	2775	6769	20465	24222	24265	31217	38167	17770	87154

Table 6-7

PRELIMINARY ANNUAL MAINTENANCE COSTS UNDER STAGE CONSTRUCTION

Unit: 1,000 US$

Year \ Alternative	Alternative I	Alternative II	Alternative III
1975	-	-	-
76	-	-	-
77	52	48	47
78	132	121	119
79	247	212	213
80	322	279	290
81	385	329	347
82	385	329	347
83	385	329	347
84	402	346	362
85	426	373	386
86	426	373	386
87	429	375	388
88	432	378	392
89	437	383	396
90	444	390	404
91	444	390	404
92	444	397	404
93	452	407	404
94	469	412	415
95	476	419	432
96	476	419	432
97	476	419	433
98	478	421	433
99	480	423	436

Table 6-8

ANNUAL BENEFITS UNDER STAGE CONSTRUCTION

Unit: 1000 US$

Alternative / Year	Alternative I	Alternative II	Alternative III
1979	4734.5	5630.1	5618.0
80	5311.4	6303.3	6284.1
81	13991.4	15180.1	11708.2
82	15309.2	16589.1	13947.0
83	16626.9	17998.2	15185.9
84	17944.6	19407.2	16424.7
85	19262.3	20816.3	17663.6
86	20580.1	22225.1	18902.5
87	21897.8	23634.1	20141.3
88	24022.4	25850.1	22187.1
89	25386.7	27305.7	23472.5
90	27522.5	29532.7	24220.7
91	28930.1	31031.6	25529.4
92	30337.7	32530.4	26858.1
93	31745.2	34029.3	28186.8
94	33152.8	35528.1	29515.5
95	34560.4	37027.0	30844.2
96	35968.0	38525.9	32173.0
97	37375.6	40024.7	34830.4
98	38783.1	41523.6	36159.1
Total	483442.7	520692.6	440852.1

6.09 Benefit/cost Ratio and Internal Rate of Return Calculation

Again assuming a redemption period of 20 years after the completion of the first phase, the results of economic evaluation are as follows:

i) Alternative I

At a discount rate of 15%	B/C =	1.24
At a discount rate of 12%	B/C =	1.55
At a discount rate of 10%	B/C =	1.83
Internal rate of return	=	18.2%

ii) Alternative II

At a discount rate of 15%	B/C =	1.54
At a discount rate of 12%	B/C =	1.93
At a discount rate of 10%	B/C =	2.26
Internal rate of return	=	21.4%

iii) Alternative III

At a discount rate of 15%	B/C =	1.29
At a discount rate of 12%	B/C =	1.58
At a discount rate of 10%	B/C =	1.87
Internal rate of return	=	18.8%

The above results show that on a stage construction program, the benefit/cost ratio of all the alternatives increase very substantially with the alternative II remaining most favourable, while the other two alternatives show almost identical results. Alternative II is also the only alternative which gives an internal rate of return of over 20%.

6.10 Decision on the Choice of Final Route

While the results of the economic evaluation are the major factors for making a decision on the final choice of the route, other non-economical factors are also fully taken into consideration. All the factors point to the fact that the alternative II is the most favourable alternative in every way. The following list the main factors that are taken into consideration.

A) Economic considerations

1) Benefit/cost Ratio: Alternative II has the highest benefit/cost ratio.

2) Internal rate of return: Alternative II is the only alternative with an IRR of over 20%.

3) Total construction cost: The total construction cost of the Alternative II is the lowest of the alternatives.

4) Benefits: The accumulated benefits over twenty years is highest for Alternative II.

B) Other considerations

1) The alignment of Alternative II closely follows the existing route and intersects with the existing route several times so that at the construction stage, the existing route may be used as a construction road, thus facilitating the transportation of construction materials, and saving construction time.

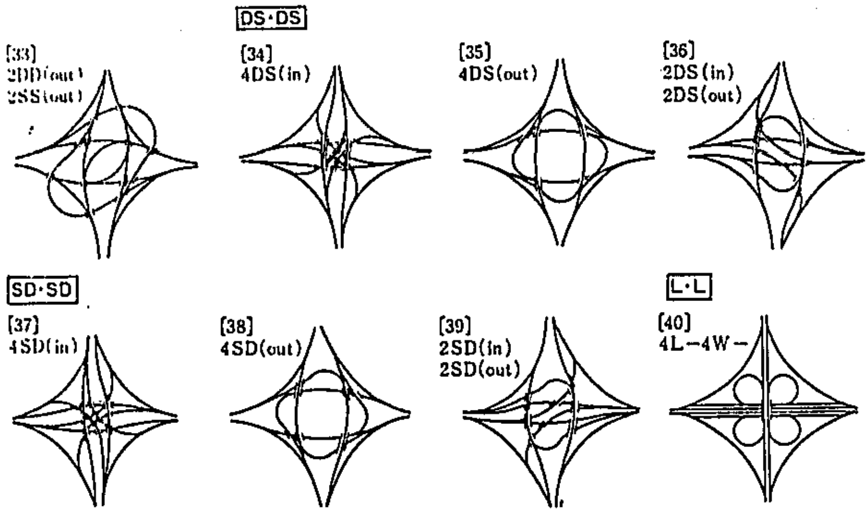
2) The Alternative II is adjacent to existing built-up area and will provide easy access for a larger number of future road users.

3) The intersection of the Alternative II route with the existing highway naturally divides the proposed route into many short sections,the implementation of which may be carried out independently. Thus the stage construction plan may be easily adjusted to suit the actual situation, should the implementation at a large scale be difficult.

With full considerations on all factors made, it is recommended that the Alternative II should be adopted as the best alternative. Subsequent engineering works in greater details will thus the carried out on the Alternative II only.

Chapter 7

PRELIMINARY ENGINEERING



7. PRELIMINARY ENGINEERING

7.01 Introduction

The study is concerned with the work undertaken for the preliminary design of the reconstruction of the Jakarta Merak Highway, and deals only with the engineering aspects of the project. The economic feasibility of reconstructing or improving about 110 Km of said roads was detailed in the previous chapters.

The aim of the study is to carry out the Preliminary Engineering to a degree of accuracy that will permit estimates of principal quantities of construction with an accuracy of ±20% of final quantities. The principal quantities of construction will include common excavation, rock excavation, base and sub-base material, surfacing material, number and size of principal drainage structures, bridges, and major structures. Preliminary engineering design of major bridges and other major structures also included determination of the approximate spans, types of superstructure, and types of foundations.

Field investigations including aerial survey were undertaken by the Team, and soil investigations are under way by the Bandung Institute of Soils and Highway Research at the expense of Bina Marga.

Using as imput the refind construction cost estimates from the preliminary engineering design, together with other data and costs modified as necessary, a complete review of the economic analysis were undertaken. In addition to the recalculation of the cost benefit ratio, the project was subdivided into appropriate divisions for separate economic analysis, including cost benefit ratios to determine the optimum priorities of staged construction. For those studies and tests which cover the refinement of economic analysis using detailed cost estimate, please refer to Chapter 9. Final Economic Analysis.

7.02 Basic Data

A. Aerial Mosaics

Aerial photo of the project area flown in 1973, to a contact scale of 1 : 25,000 and working mosaics of the area enlarged from the above to a scale of 1 : 10,000 were mainly used in this study. The designing works were performed utilizing also the plan and profile (Scale of 1 : 2,000 horizontal and 1 : 200 vertical) of the existing Jakarta-Merak road which was provided by Bina Marga.

B. Soils and Materials Investigation

Soil sampling was conducted by the Bandung Institute of Soils and Highway Research along the alignment approved by Bina Marga for further investigations, after review of the Interim Report submitted during December, 1973.

Soil sampling for roadway and pavement design was accomplished by means of auger boring at appropriate intervals. A boring log recording the depths and thickness of strata encountered and physical characteristics of each soil, was prepared for each boring location.

Samples were collected and marked for laboratory identification and selected soil samples were tested in the laboratory.

At each bridge site, sub-surface conditions were investigated by drilling with standard penetration tests, including the taking of undisturbed samples. The investigation was made to depths adequate to prepare a preliminary foundation design.

C. Right-Of-Way

The prices for land acquisition and compensation which prevails in the project area were based on the information given by Bina Marga.
To identify existing land use of the area, aerial photo and site maps available were used.

The given land price list did not cover all of the project area. Therefore, in such a case, the price for similar area listed was applied.

7.03 Design Standard

A. General

Geometric standard of highway design and bridge design standard as well as drainage criteria applicable to the proposed highway were established in the Interim Report, which is compiled in Chapter 4 in this report. The previously determined criteria will be used, unless otherwise noted below.

The highway between Jakarta and Tangerang was planned as a full access controlled facility at the ultimate stage, with access permitted only at designated interchanges.
However, in Tangerang-Merak section, a highway with partial control of access has been planned because of economic considerations.

The principal operational or functional difference between a highway with and one without control of access is in the degree of interference with through traffic by other vehicles entering, and crossing the highway and by pedestrians. While the initial cost may be high, controlled access highways are often economical in the long run. From this stand point of view, low cost interchanges were recommended for each major intersections in the rural district.

B. Pavement Design

The criteria previously used in the alternative design were amended to use AASHO method in accordance with the recommendation made by Bina Marga.

The method for the flexible pavement design in this Chapter is based on the "AASHO INTERIM GUIDE FOR DESIGN OF PAVEMENT STRUCTURES, 1972," the element of design used in this method are the value of soil support, traffic, the serviceability of pavement, and regional factor.

C. Lighting

Roadway lighting is proposed for the interchange areas only. The criteria will be based on policies of "AN INFORMATIONAL GUIDE FOR LIGHTING CONTROLLED ACCESS HIGHWAYS (AASHO)."

Full illumination system will be adopted at each interchange including ramps, through lanes, and crossing structures.

Design lighting levels and uniformity ratios will be in accordance with those specified in an Informational Guide For Lighting Controlled Access Highways (AASHO).

D. Signing

Fabrication and erection of signs and delineators will be, in principle, in accordance with AASHO standard.

Guide signs are to be clearly prominent and large size boards are necessary for drivers who are driving at high speed in heavy traffic flow. The destination will be shown apparently in fewest number of letters as possible.

Regulatory sign and warning sign will be in accordance with the Government standard.

7.04 Analysis of the Highway Capacity

The concepts and methodology used to develop the highway capacity analysis of the proposed highway are based on the Highway Capacity Manual of Highway Research Board, U.S.A. However a minor adjustment was made to reflect local conditions, based on the results of studies accomplished by Highway Research Board, Japan, because a lot of resemblances are found in operating conditions, type and size of vehicles between Indonesia and Japan.

Capacities for all basic highway types for uninterrupted flow under ideal conditions are summarized in the following table.

UNINTERRUPTED-FLOW CAPACITIES
UNDER IDEAL CONDITIONS

Highway Type	Capacity (Passenger Vehicles per Hour)
Multilane	2,000 per lane
Two-lane, two-way	2,000 total both directions

To compute the capacity/volume relationship, the peaking characteristics of traffic are taken into account. They are expressed in terms of the peak-hour factor. For freeways this ratio is based on the maximum 5-min rate of flow within the peak hour. Generally, the highest 5-min rate of flow within the peak hour on urban freeways is 1.05 to 1.15 times the peak-hour volume in larger metropolitan areas. This range is equivalent to a peak-hour factor ranging from 0.95 to 0.87.

On each section, average daily truck volumes, reduced for anticipated peak hour composition is translated into passenger car equivalents on the basis of generalized terrain values. Truck adjustment factors (Tc) are then determined. Also lateral clearance and lane width adjustment factors (Wc) are used with discretion in freeway capacity computations where required.

Table 7-1 shows the methods used to determine Volume/Capacity ratios on the facility during the peak hour in given year.

Examination indicates that in Tangerang - Bojong section the two-lane highway provides as apparently low level of service prior to complete the Phase II constructions.

Table 7-1 CAPACITY AND LEVEL OF SERVICE DETERMINATION

Phase	Section	Number of Lanes 1/	Year	A D T	Trucks % of ADT	Trucks % of DHV 2/	Passenger Car Equivalent (Et) 3/	Tc 4/	Wc 5/	Capacity (Mixed-vehicles/Hr/Dir.)	D H V	Design Volume to Capacity Ratio	Level of Service
I	I (Jakarta-Tangerang)	4	1980	21,447	33	26	1.7	0.85	1.0	3,400/Dir.	1,670 6/	0.49	D
I	III (Ciujung-Serang)	2	1980	10,307	36	29	2.0	0.78	1.0	1,560	1,240	0.79	D
	" (Serang-Cilegon)	2	1980	5,570	45	36	1.9	0.76	1.0	1,520	670	0.44	D
II	I (Jakarta-Tangerang)	6	1990	45,158	32	26	1.7	0.85	1.0	5,100/Dir.	3,520 6/	0.69	D
II	II (Tangerang-Bojong)	2	1980	14,975	35	28	2.0	0.78	1.0	1,560	1,797	1.15	F
II	III (Cilegon-Merak)	2	1980	3,488	44	35	1.9	0.76	1.0	1,520	420	0.28	C
II	" (")	2	1990	8,239	40	32	1.9	0.78	1.0	1,560	990	0.63	D

1/ Total number of lanes for both directions.

2/ The percentage of trucks during the design hour is reduced to reflect the future peak hour traffic composition.

3/ ET = Passenger Car Equivalents of Trucks - Values are given based on Japanese standard.

4/ Tc = Truck Factor at Capacity = $\frac{100}{100 - P_T + E_T \times P_T}$

in which

P_T = percentage of trucks

E_T = passenger car equivalents of trucks

5/ Wc = Adjustment for Lane Width and Lateral Clearance.

6/ Design Hourly Volume for Heavy Direction

= ADT x 12% x 0.65 (Directionality factor)

7.05 Preliminary Designs

A. Alignment Studies

Extensive field reconnaissance and aerial photo and map studies were made to establish the most effective yet economical geometric characteristics of the proposed alignment. Actual ground observation of the sites tentatively selected from the preliminary study formed the basis for the final decision of the highway location.

On the basis of findings made during the study and ground observation, the alignment proposed in the Interim Report was modified as indicated in the detailed descriptions.

(i) Control Point

The actual deliberate ground reconnaissance was preceded by a thorough study of maps and aerial photographs of the region through which the highway is to be located. The following steps were executed in the study:

- Note and mark the terminal points of the highway as well as any intermediate points through which the highway must pass. These are called as "primary control points."
- Observe those marshes (Rawa), river bent, and similar obstacles which the highway cannot cross, and either lightly sketch or visualize the most direct remaining route for the highway. These obstacles, too, are considered to be primary control features. Soils map available was studied for areas of unsuitable soils of low bearing capacity, such as deep organic soils in marshes and swamps.
- Observe the rivers which must be crossed, noting particularly the nature of any possible approaches to them. Select potential crossing points which seem most suited to good road building. These points are secondary control features.

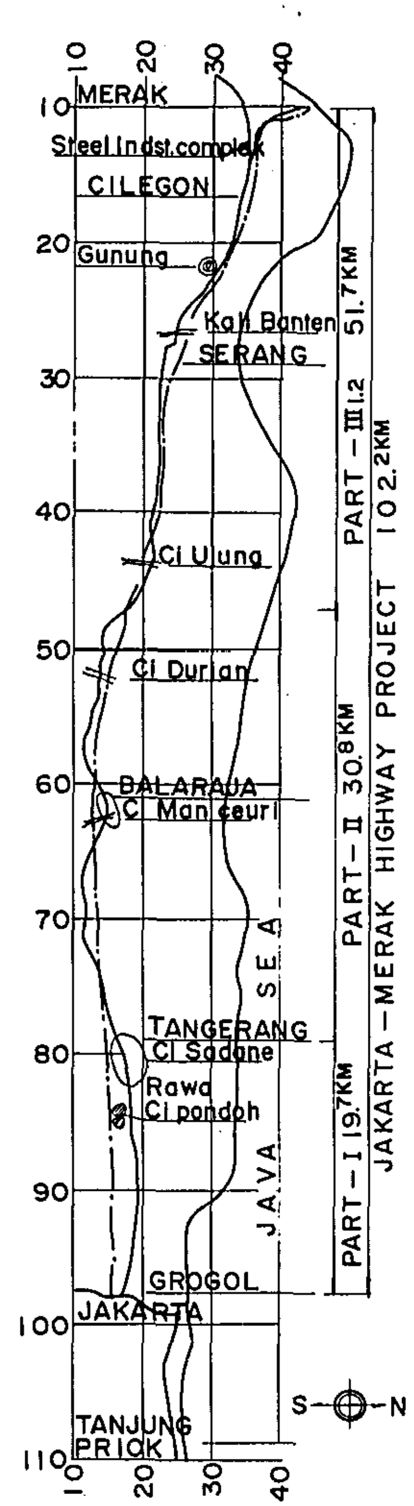
- Note general contour directions within each small valley or pocket and observe where the road can best be located to follow these general contour directions. These become control features of the third order.

Table 7-2 shows major control points considered in the study.

CONTROL POINTS FOR SELECTED HIGHWAY ALIGNMENT

Table 7-2

LOCATION / DIVISION



PART	STATION	FUTURE AVERAGE DAILY TRAFFIC (ADT) 1980	FUTURE AVERAGE DAILY TRAFFIC (ADT) 1990	MAJOR CONTROL POINTS CONSIDERED IN ALIGNMENT STUDIES
PART III.2	0 – 4	P 1.938 B 782 T 768 Σ = 3.488	P 4.945 B 1.696 T 1.598 Σ = 8.239	Merak Terminal; Narrow space between coastal line and G. Merak; Merak Beacl Hotel.
	4 – 6			
	6 – 9			Numerous houses along the existing road.
	9 – 11			Cilegon steel complex; Potential junction with major highway.
	11 – 15.5	P 3.067 B 1.081 T 1.422 Σ = 5.570	P 7.270 B 2.242 T 2.518 Σ = 12.030	Cilegon steel complex; Potential railway crossing; Expansion of Cilegon City.
	15.5 – 25			
	25 – 32			Serang City (by-passing regulred); Potential railway crossing.
	32 – 43	P 6.592 B 1.573 T 2.142 Σ = 10.307	P 14.101 B 3.222 T 3.945 Σ = 21.268	Potential Ciujung crossing point; Adverse soil condition near existing brick yard.
	43 – 46.3			
	46.3 – 51.7			Higher ground water table.
PART II	51.7 – 57	P 6.519 B 1.543 T 2.111 Σ = 10.173	P 13.932 B 3.170 T 3.893 Σ = 20.995	Swampy spot.
	57 – 62.9			Potential junction with existing national road; Villages.
	62.9 – 68.5			Irrigation channel; Potential junction with existing national road.
	68.5 – 77.3	P 9.741 B 2.249 T 2.985 Σ = 14.975	P 19.622 B 4.321 T 5.271 Σ = 29.214	Irrigtion channel; Potential junction with existing national road.
	77.3 – 82.5			Army base; Potential Cisadane crossing point.
PART I	82.5 – 90	P 14.341 B 3.063 T 4.043 Σ = 21.447	P 30.849 B 6.466 T 7.843 Σ = 45.158	Future expansion of Tangerang city; Rawa Cipondoh
	90 – 102.2			Grogol Terminal.

(ii) Recommended Alignment for Part III Section

Sta. No.0 - Sta. No.4

The topography in this section is characterized by a small mountain chain including Mts. Merak, Keket and Ompang, of which altitude is about 150 to 200 m. To the west, it directly slopes down to the sea for the most part, and is composed of exposed hard rocks.

Existing road is located along the shoreline with very low geometric standard in parallel with the railway.

Under the site conditions mentioned above, construction of new 4-lane highway by improving the existing road will result in a very expensive proposition involving considerable seawall construction and an effort required for the relocation of the hotel.

After due consideration of the control factors mentioned above, route for proposed 2-lane highway is selected to pass through the mountain-side as shown in Figure 7-1.

Grade separation for the existing railway was planned to be made at Station No.1, entrance of Merak city.

Sta. No.4 - Sta. No. 6

In this section the existing road runs through the rice paddy area with a fair route alignment, but in some part, existing roadway grade seems to be too low compared with the rice paddy level.

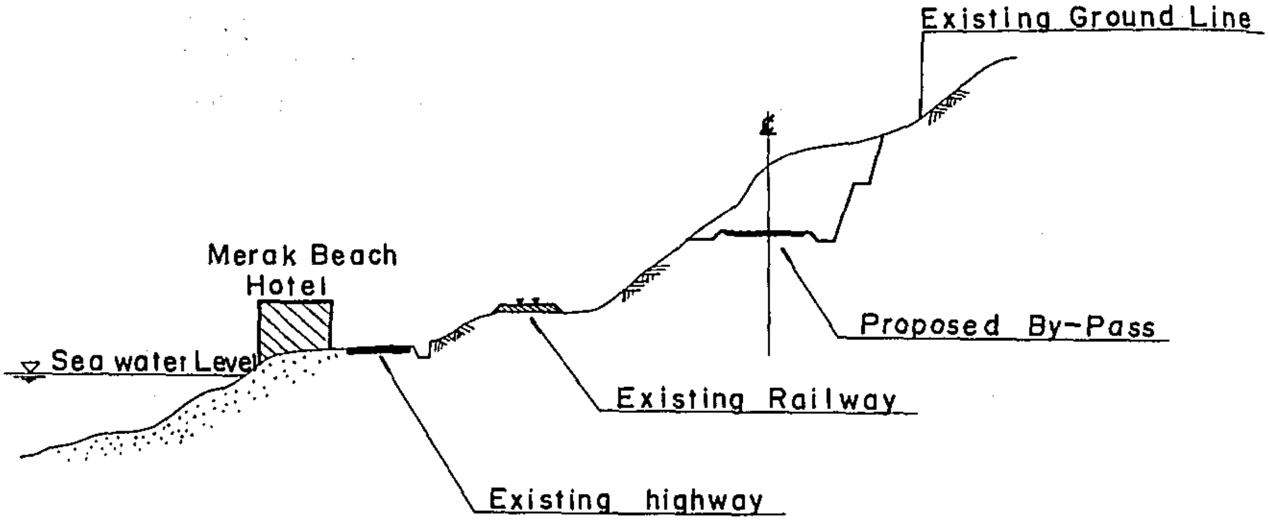
In order to improve the existing drainage condition of the road, proposed highway shall be constructed by raising the roadway grade for about 1 meter.

Sta. No. 6 - Sta. No. 9

There are many small houses in the existing roadside. The horizontal alignment of the existing road is rather fair, however, the vertical alignment of it is in very poor state.

Figure 7-1

SECTIONAL VIEW AT MERAK BEACH HOTEL



New highway construction will be accomplished by the betterment of existing road, and this will entail the relocation of some houses.

Sta. No.9 - Sta. No.16

The existing road detours the golf course with adverse S-shaped alignment, instead of an old national road used to pass through the Cilegon city with a straight alignment.

Proposed highway is planned as a 4-lane freeway type road from the Cilegon junction to Tangerang.

In selecting the alignment, consideration was made for the future plans of steel complex, favorable location to overpass existing railway, traffic control at Cilegon junction, and the connection to the access road to Anyer and so forth.

Route selection will be largely governed by the future plan of the steel complex. Whether Cilegon bypass should be on the north or on the south of the city is a primary matter, however, in this report preparation stage, a bypass on the north of Cilegon city, alternative "A" in the following comparison was adopted considering the advantage in grade-separation with the existing railway and an accessibility to the road to Anyer. Please refer Figs. 7-2 and 7-3 in the following pages.

Sta. No.16 - Sta. No.25

In the most stretch, the existing road passes through rice paddy and small villages are scattered along the road.

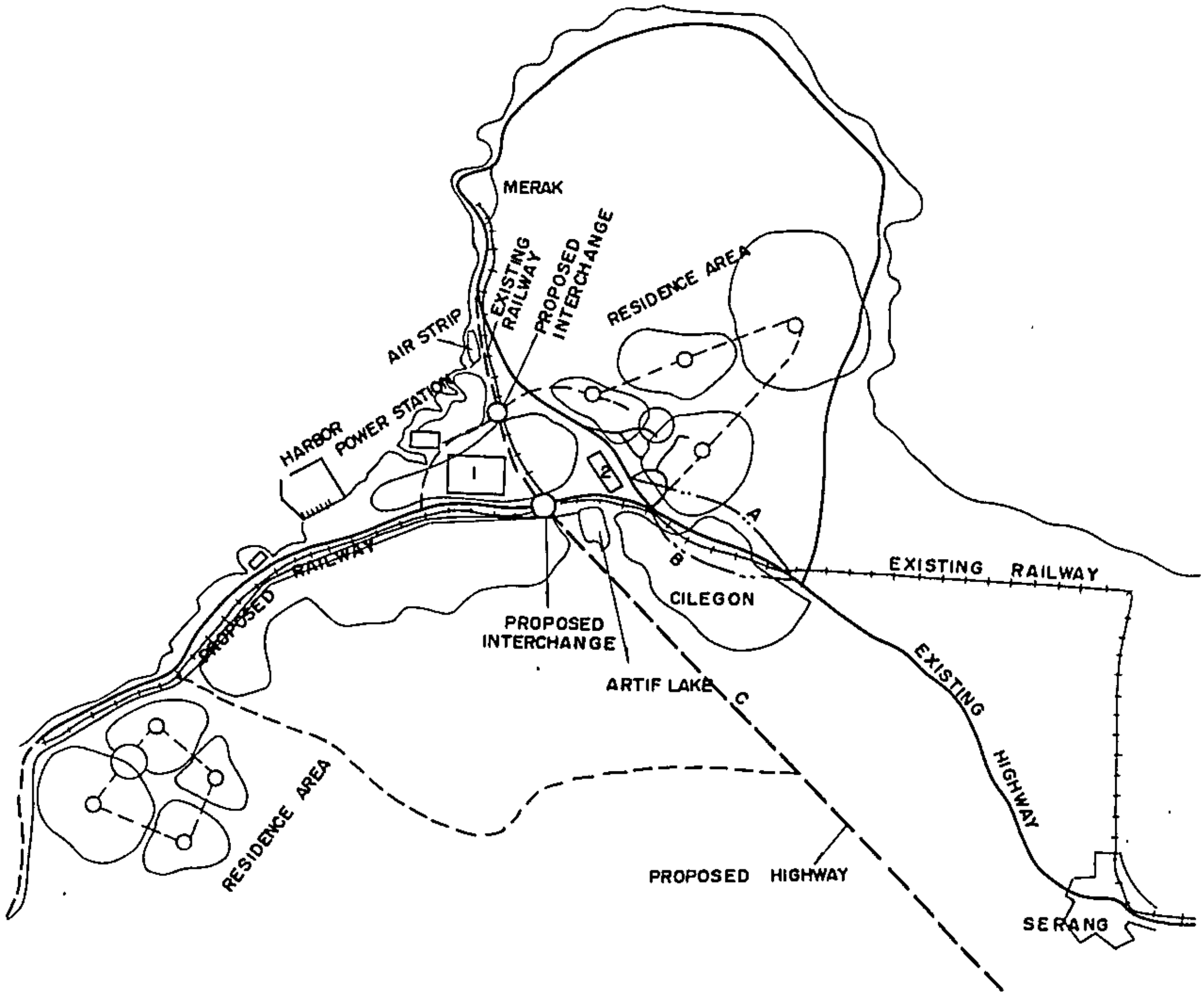
Because of an excellent roadway alignment of existing road, proposed highway construction can be done by an "improvement." Necessary widening will be made on the northern-side of existing roadway, except in the rolling area between Stas. 18 and 20, where widening to the southern-side will result in better alignment and in provision of more embankment materials.

Figure 7 - 2

AERIAL PHOTO SHOWING CILEGON STEEL COMPLEX

S = 1/25 000

Figure 7 - 3



PLANED CILEGON STEEL COMPLEX

SCALE 1 : 200,000

Between Station No. 21 and 25, improvement of existing profile of the roadway will be necessary to satisfy the geometrical requirement of higher standard road.

Sta. No.25 - Sta. No.32

Proposed alignment in this section was selected as to provide a bypass route for Serang city. Existing national road turns to the right near the center of the city and immediately turns to the left at the next street intersection.

Considering the future expansion of Serang city, as well as existing road and railway to be overpassed, the location of interchange was selected at about 1.0 Km north of the existing national road clearing existing stadium.

Sta. No.32 - Sta. No.43

The existing road in this section is a newly rehabilitated two-lane highway having a carriage width of 7 to 8 meters, which mainly passes through rice paddy. The roadside trees giving an attractive scenery of country-side and are harmonizing with scattered small villages along the road.

Only minor improvement seemed to be necessary to obtain ideal geometrical standard, however, the proposed roadway grade must be raised for some extent to cut the ground water. Thus, planned profile was so designed to get about 1.5 meter higher than that of existing highway grade.

In the vicinity near Station No.41, there are a lot of brick-yards. Taking an account of the fact that the area is predominantly covered with grayish clay, 0.5 meter thick sand mat was proposed for the replacement of embankment foundations.

Sta. No.43 - Sta. No.47

Ciujung bridge, the largest river crossing in this project, is located at Sta. No.45 + 800. A steel truss bridge is in being on the existing national road, however, its width and loading capacity are deemed to be quite insufficient even to serve for the present traffic. Furthermore, horizontal alignment of the existing approach road on both sides of the bridge are in very poor situation to improve them, since the built-up area of villages of Kragilan and Kerenggen are covering the site.

In the light of abovementioned site condition, new bridge location was selected at 2.0 kilometers upstream of the existing bridge location providing a steel box girder bridge with a total span of 121.0 meter.

Sta. No.47 - Sta. No.52

This section is a rice paddy area spread out on the rolling terrain, where a horizontal alignment of the existing highway is composed of many S-shaped small radii curves. Existing roadway grade in this section is lower than the rice paddy level for the most stretch and pavement conditions seems to be very poor.

Taking an advantage of an outstanding general alignment of the existing highway, an improvement technique was exercised in this study.

(iii) Recommended Alignment for Part II Section

Reconstruction technique was utilized in this Part, because general route of existing highway is considered to be disadvantageous to improve.

In selecting the alignment, care was taken upon the river crossing at Ci Durian and Ci Manceuri, junction location for the existing national road, terrain and soil conditions surrounding general route of proposed highway.

Sta. No.52 - Sta. No.57

This section mainly consists of rubber plantation, rice paddy and grass-land. General site condition in the area is rather rolling at an altitude range of 5 - 20 meters.

To make an embankment height as low as possible in the depressed areas near Station No.53, proposed roadway grade was maintained rather low, and larger cutting of hills are planned to obtain the embankment materials required in the section between Station Nos.54 - 57.

The site for Ci Durian river crossing was selected at 400 m downstream of the existing bridge, taking account of hydrological conditions and the alignment of the approach roads.

<u>Sta. No.57 - Sta. No.63</u>

Throughout the whole of this section, it is covered with the highly cultivated rice paddies. A number of short span bridges and culverts were necessitated to cross a lot of irrigation channels.

The pavement condition of the existing highway seems to be considerably damaged because of the higher ground water table and insufficient depth of pavement structure. Therefore, the finished grade of the proposed highway was planned 1.5 to 2.0 m higher than the existing general ground level, taking account of proper drainage and possible higher ground water tables.

<u>Sta. No.63 - Sta. No.69</u>

As the existing national road is making detour to pass Balaraja village, the proposed alignment was so selected as to make a short cut.

In the existing ground level, an altitude of 25 meter approx. is observed near Ci Manceuri, and 5 meter at low-land.

In the hilly area many small villages are scattered with coconut and banana plantation,and in low-land,rice paddy is being cultivated utilizing irrigation systems.

Proposed alignment was determined based on such control points as irrigation channels and existing streams have to be crossed, and the location of junctions for the existing national road.

As for the junctions, at-grade intersection was recommended for the facility provided near station No.63 and diamond type interchange for the facility near station No.68 + 500, considering the future traffic volumes to be served by them.

Sta. No.69 - Sta. No.77

The alignment of proposed highway was selected on the north of the existing highway within a distance of 1.0 to 2.0 Km. In this area, rice paddy was found even at the high spots at a altitude of 20 to 25 m.

The horizontal alignment of the proposed highway was so determined as to coincide with terrain conditions by using S-shaped curves of large radii of curvature such as 3000 to 9000 m.

At the vicinity where the proposed highway intersects with the existing highway, various factories have been built and forming a modern built-up area.

An intermediate size diamond type interchange was provided at said intersection, to allow that it will form a western gateway to the future greater Tangerang.

Sta. No.77 - Sta. No.84

In the first half of this stretch, an alignment selection was made to avoid the existing army camp which will be near the Station No. 79. In the other half, the location was mainly governed by the selection of potential crossing point of Ci Sadane which seem most suited to the excellent highway building.

Selected alignment is containing three large radius curves of 3,000 m, 10,000 m and 6,000 m and a deflection angle provided at each intersectional point was determined as small as possible.

Between Station Nos. 78 and 79 + 500, vertical and horizontal curves must be provided simultaneously. In general rule, when vertical and horizontal curves occur in combination or in close proximity to each other, the ideal solution may be proposed by the vertical curve wholly within or wholly outside the horizontal curve. To design a flowing alignment, following the terrain and merging itself harmoniously into the surrounding countryside without sharp discontinuities, planned vertical curve was provided wholly within the horizontal curve.

For further discussion of the interchange provided at Sta. No.82 + 500, please refer to paragraph 7.05. B. Interchange.

(iv) Recommended Alignment for Part I Section

Sta. No.84 - Sta. No.90

In this area many small villages are scattered on the numerous number of heights, and the proposed highway passes by a large marsh named Rawa Cipondoh.
Junction with the existing road located at Station No.90 was planned by a larger size diamond type interchange.

The terrain conditions are so easy, alignment selection was made without major difficulties to meet the requirement of geometric criteria for the design speed of 120 Km/hr.

Sta. No.90 - Sta. No.102 + 200

This part is now developing as the suburbs of Jakarta city and includes a planned outer ring road of Jakarta at near station No. 97. Area between Station No.100 to the existing ring road named Jalan, Let. Jen. S. Parman, where proposed Jakarta-Merak highway terminated, has been developed as the residential area of Jakarta city.

Route alignment in this area was made taking account of the site conditions of the terminal interchange at Jl. Let. Jen. S. Parman, and the roadside development. The horizontal alignment of the proposed highway was so determined as to coincide with terrain conditions by using S-shaped curves of large radius of curvature such as 3000 to 6000 m. Cross sectional arrangement in this part was determined considering separation of the lanes for fast and slow moving vehicles.

For further discussion of the Jakarta Interchange, please see paragraph 7.05. B. Interchange.

B. Interchange

(i) General

Interchange design is generally developed under the integrated considerations of traffic requirement, site conditions, design controls and criteria established for the interchange legs and turning roadways, and economy.

The greater number of the interchange sites of the project highway is located in such expensive land as the highly developed area or the fringe of the city where immediate development have been promised. Therefore, a selection of the type of interchange which can save the right-of-way cost will be a matter of primary concern.

Each type of interchange has its own advantages and disadvantages. The principal disadvantages of the cloverleaf are the extra travel distance required for right-turning traffic, the weaving maneuvers inevitable, and the relatively large right-of-way area needed for it. The travel distance on a loop as compared with that of a direct right-turn at grade increases rapidly with an increase in design speed. Even this design speed is limited to a 40 - 50 Km/hr, the turning radius on a loop will call for 50 - 60 meters, and this requirement is directly connected to an extra travel time and an increasing of the right-of-way acquisition cost. Moreover, collector - distributor roads will be necessary along the highway as stated below:

- Although it depends on the traffic volume in the through carriageway, a capacity of looped ramp is about 950 - 500 v.p.h. of merging and less than 800 v.p.h. for diverging.
- When the total of traffic on two adjoining loops amounts to approximately 1,000 v.p.h., interference mounts rapidly and the speed of through traffic is reduced.
- To increase the above mentioned capacity to 1,200 - 1,300 v.p.h., a continuous additional lane is required to accommodate deceleration, acceleration and weaving between the on and off ramps.

In partial cloverleaf interchange with diagonal slip roads in four quadrants, two looped ramps in more important quadrants will be provided diagonally opposite each to accommodate traffic. The arrangement has the advantage that the additional ramps eliminate direct right-turns from the cross-road. Comparing the partial cloverleaf, however, with diamond, it will be found out no difference in number of at-grade crossings and traffic handling capacity in those crossings. Taking an extra travel distance required by the loop into consideration, no advantage is considered to be found over diamond in traffic handling capacity. In the event that heavy traffic volume through the loop is anticipated this type will be recommendable, since the greater traffic capacity and the decreasing of number of accident in the at-grade crossing can be expected. However, the cost for acquisition of the right-of-way as well as for construction will naturally be more than that of diamond type.

A full diamond interchange is formed when a one-way diagonal ramp is provided in each quadrant. Diamond interchange can be characterized of simplicity, compactness and clearness, and is also the lowest in cost, logical in type. . Thus this type is widely used in both rural and urban areas. The type is adaptable to major - minor road or street and is employed to handle the traffic efficiently accompanying neither hazard nor difficulty.

The following reveals the advantages inherent to diamond interchanges over a complete cloverleaf or partial cloverleaf type.

- On the projected highway, the ramps can be provided very easily with respect to a grade separation structure to form diamond interchange.
- All traffic can enter and leave the projected highway at a high speed through the simple straight ramps, without using a loop which requires long travel distance as in a cloverleaf type.

- Only a narrow band of right-of-way is necessitated this may be able to reduce the land acquisition cost to about 30% of that of cloverleaf type.

Although some traffic channelization and signal control devices are necessary usually at the intersection, when such incidental devices are introduced a diamond interchange will display a excellency in its simplicity and safety of operation, and provide sufficient function and enough capacity to cater for the anticipated traffic.

Thus the maximum use of diamond is recommended for interchanges in rural district to minimize the costs of construction and right-of way acquisition.

Table 7-3 shows an outline of characteristics of each type of interchanges.

Table 7-3

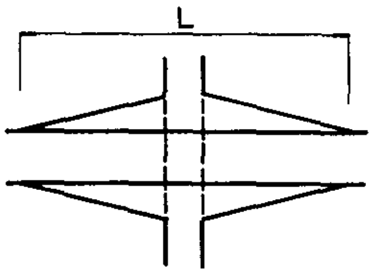
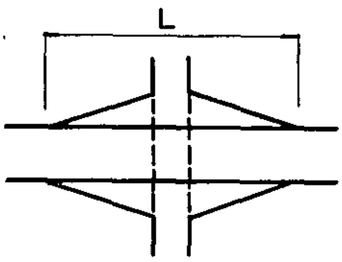
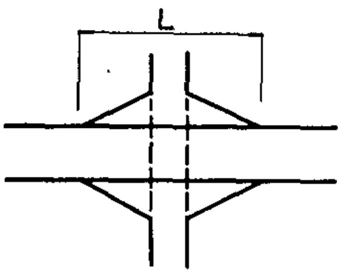
COMPARISON OF CHARACTERISTICS OF EACH TYPE OF INTERCHANGE

Type of Interchange	Construction Cost (index)	Required Right-of-way Area	Traffic Capacity	Traffic Safety	Travel Time
Cloverleaf	3.3	100,000 m^2 Approx.	Large	Good	Longer travel time at loops
Partial Cloverleaf	2.3	60,000 m^2 "	Comparatively large	Fair: Hard to reduce accident rate	Same as above
Diamond	1.0	22,500 m^2 "	Comparatively large: Channeli-zation for at-grade intersections will provide more capacity	Fair: Signal control results in lower accident rate	Shorter travel distance: There is a little time loss in the at-grade inter-sections

(ii) Standard Size Diamond Type Interchanges.

The diamond type interchanges are adopted for 6 intersections as shown in Volume II, 3 being in Part III, 3 in Part II and Part I. In this plan the ramps for the interchange at the Serang Bypass becomes comparatively long due to the necessity to pass over the railway line at the same time. For the other five locations, the interchanges are planned according to the standard sizes as shown in Table 7-4 and Figure 7-4.

Table 7-4

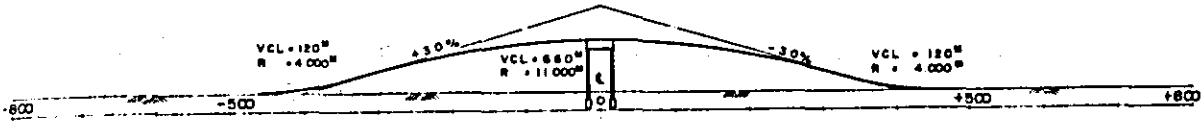
Item / Part	Type	L	Approx. Construction Cost (U.S $)	
PART-I	 TYPE A	1 600m	Grade Separation Structure	1 200 000
		*	Pavement	250 000
			Earthworks	60 000
			Total	1 500 000
PART-II	 TYPE B	1 300m	Grade Separation Structure	800 000
		*	Pavement	220 000
			Earthworks	50 000
			Total	1 070 000
PART-III	 TYPE C	1 000m	Grade Separation Structure	8 00 000
		*	Pavement	1 30 000
			Earthworks	30 000
			Total	9 60000

* Construction cost does not include the paving cost of thru lanes

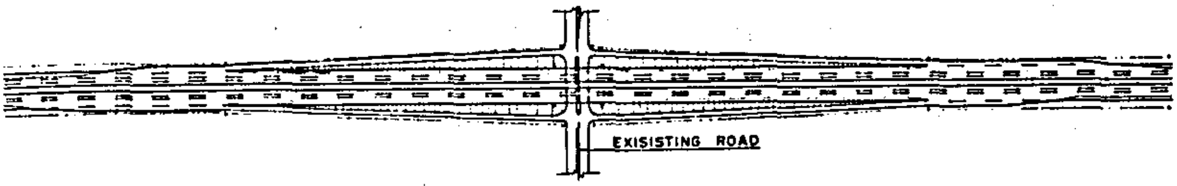
Figure 7-4

TYPICAL DIAMOND INTERCHANGES

SCALE 1:10 000 = H
1: 1 000 = V



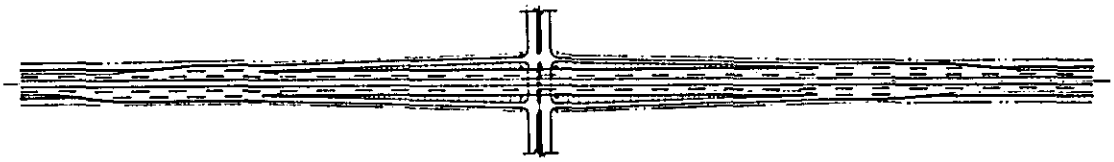
SECTION



PLAN

TYPE A – DIAMOND INTERCHANGE

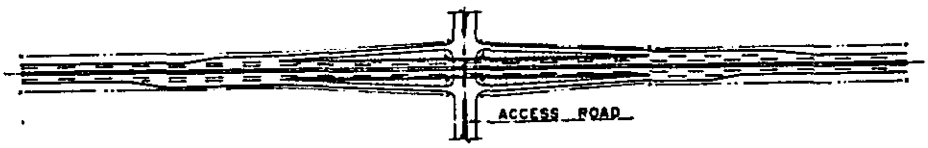
SECTION



PLAN

TYPE B – DIAMOND INTERCHANGE

SECTION



PLAN

TYPE C – DIAMOND INTERCHANGE

(iii)Tangerang Interchange

The Tangerang interchange is planned at a location 19.7 Km from the Jakarta terminus.

The urban district of Tangerang develops centering around Ci Sadane, and the Ci Sadane Bridge becomes a bottle neck causing disruption of traffic between Jakarta and Tangerang.

For this reason, the Tangerang Interchange is planned at the west of Ci Sadane (on the Merak Side), and connection with centre of Tangerang made through access road.

In this region, the existing roads at Sta. No.82 + 600 is about 2 m higher than the river bank of Ci Sadane. It is therefore not favourable to design a bridge of high clearance at Ci Sadane in order that the Jakarta-Merak Highway will overpass said road.

With consideration that the type of interchange should be such that it will be adaptable to any future development at the surrounding, and that the Ci Sadance Bridge should not be adversely affected by the ramps of the interchange the type as shown in Table 7-5 is adopted.

Table 7-5 COMPARISON OF ALTERNATIVE TYPES OF TANGERANG INTERCHANGE

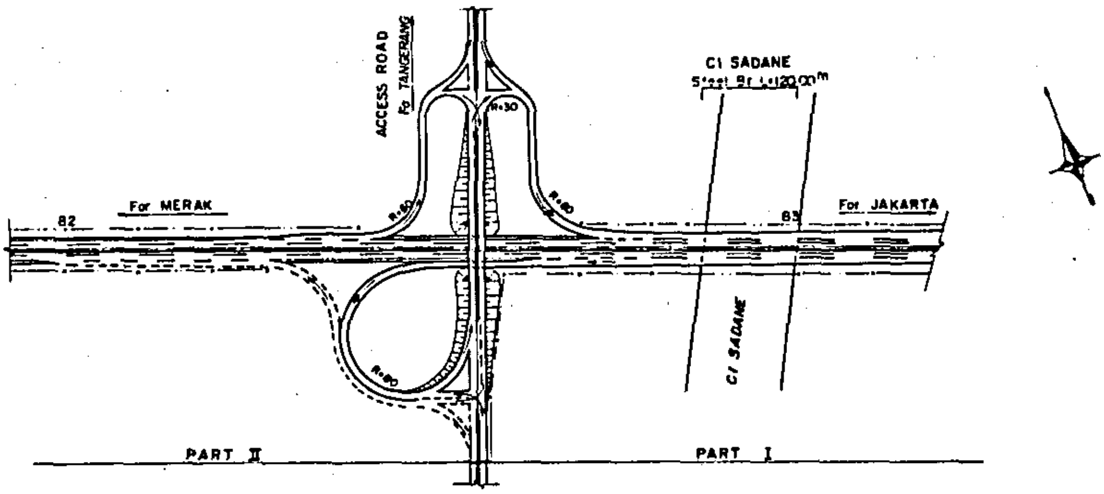
Description	Comparison	
	*Alternative A	*Alternative B
Traffic movement	The major direction of traffic (Jakarta-Tangerang) travels in a loop	Major direction Traffic is catered for by direct ramps
Right-of-way required	Small and compacted	Not small, and irregular form
Adaptability to future development of vicinity land	It will be easy to provid additional ramps for new directions	Major structure construction works will be necessary to provided new loop-ramps
Ci Sadane Bridge	The speed change lanes of the highway will not extend to Ci Sadane Bridge	Same as Alt. A
Transition between Part II (4 lanes) and Part I (6 lanes)	Smooth transition is possible through the entrance and exit of the ramps	Same as Alt. A
Number of grade separation structure required	1 EA	2 EA
Construction cost	Low	High

* Note: Please refer to Fig. 7-5 for the plan of interchange of each alternative.

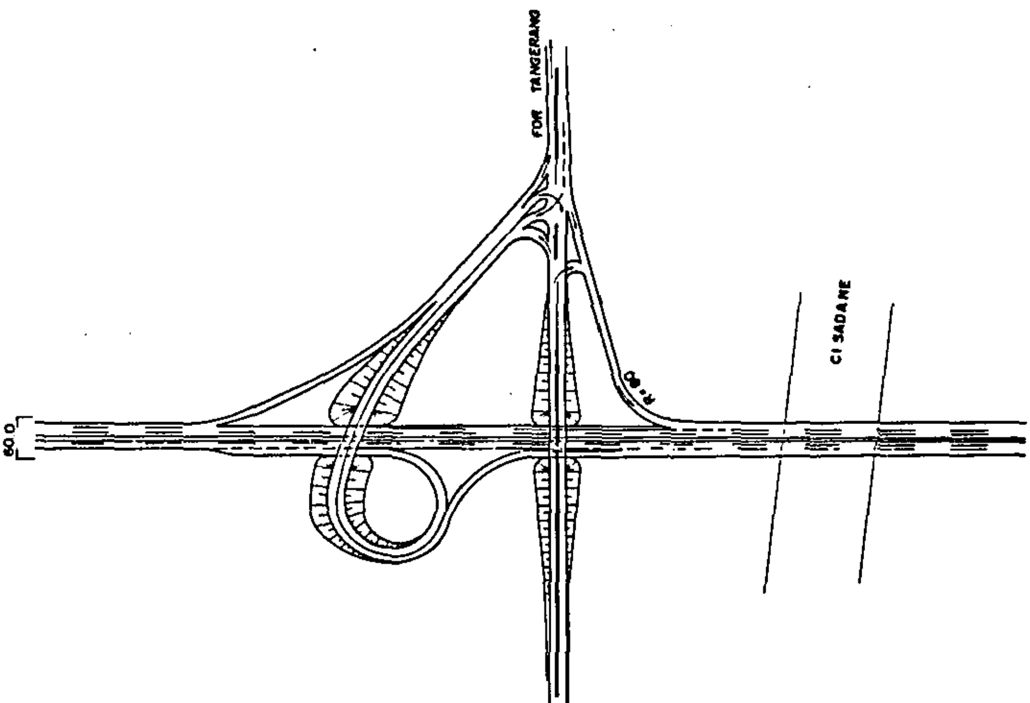
Figure 7-5

TANGERANG INTERCHANGE

SCALE 1 : 10 000



ALTERNATIVE "A"



ALTERNATIVE "B"

(iv) Interchange At The Future Ring Road

The Ring Road plan is not yet in the construction implementation stage, and the exact alignment is not yet known. In this study, it is assumed that the interchange between the Jakarta-Merak Highway and the Ring Road will be located at the small tableland at Sta. 98 + 500.

At this area, paddy fields are found at low land of 7 - 8 m in ground level, while residential houses are spotted at higher land of 10 - 13 m in ground level.

With consideration for provision of fill material required for the Jakarta Merak Highway, the finished grade at the interchange is planned at 9 - 10 m.

In this case, the future Ring Road will pass above the Jakarta-Merak Highway and the decision on the Type of interchange is made accordingly. Either a full-clover type or a double-trumpet type will serve the purpose, and a recommendation for a full clover type is made after comparisons made as shown in Table 7-6.

Table 7-6 COMPARISON OF ALTERNATIVE TYPES OF RING ROAD INTERCHANGE

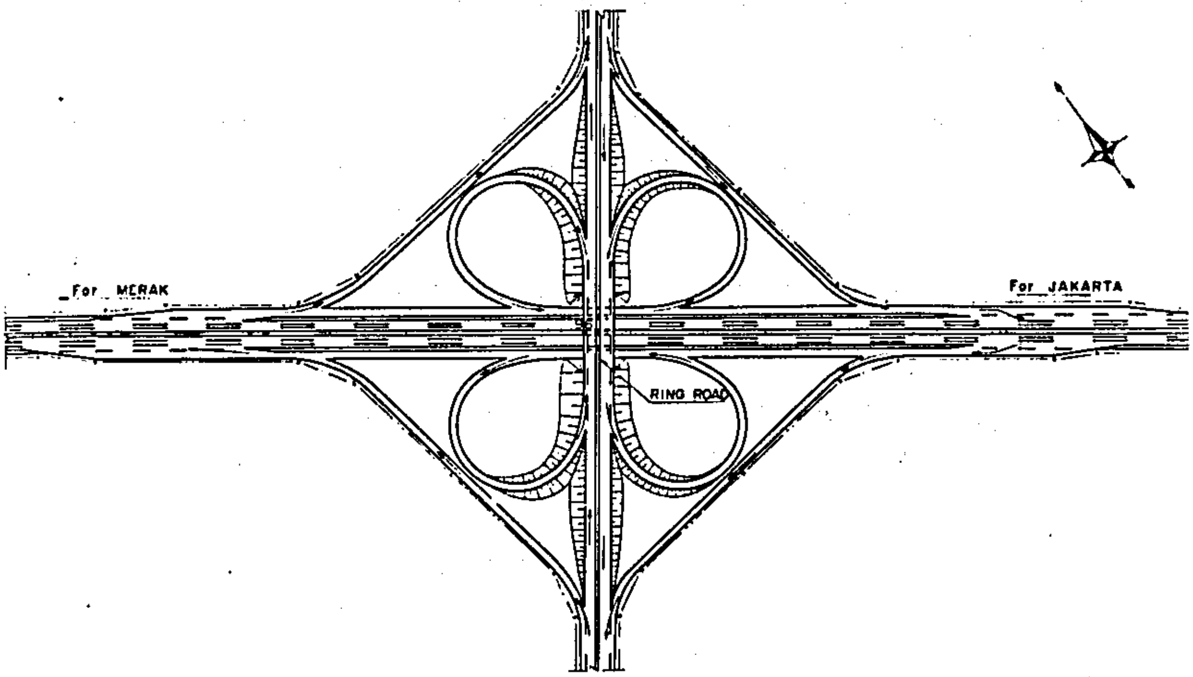
Description	Comparison	
	*Alternative A	*Alternative B
Location and land use	The traffic facilities are concentrated at one point and is favourable from the point of land use	The interval between this interchange and adjacent interchanges is only 2 - 3 Km, so that the design of trumpet will receive some restrictions
Number of structures required	1 EA	3 EA
Traffic movement	Weaving occurs on the collector and distributor lanes of the trunk road	Weaving takes place on the ramp section
Others	-	Should the type be used on a toll road, this type will be advantageous for placing of toll gate

* Note: Please refer to Fig. 7-6 for the plan of interchange of each alternative.

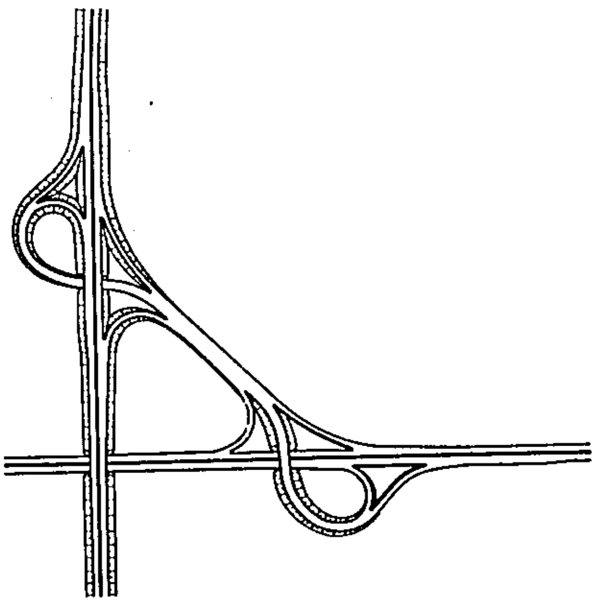
Figure 7-6

RING ROAD INTERCHANGE

SCALE 1 : 10 000



ALTERNATIVE "A"



ALTERNATIVE "B"

(v) <u>Jakarta Interchange</u>

The existing Jalan Let Jen. S. Parman serves as the existing outer ring road for Jakarta City. It is a divided 4 lane road and can be expanded to 6 lanes in future. The intersection with Jakarta-Merak highway occurs at a terrace which drops at the west to the ground level of 5 - 7 meter.

The alignment of Jalan Let Jen. S. Parman runs in a curve along the terrace. The west part of the road is a depressed area, while permanent buildings are found dotted along the east side of the road.

The conditions to be considered in the planning of the interchange are as follows:

- The possibility of the Jakarta-Merak highway being extended beyond this point into the city of Jakarta has to be considered.
- The plan has to be made within the limit of the existing physical conditions without having to demolish many permanent buildings or facilities such as an antenna site.

The above conditions, as well as the construction cost and the ease in construction work well fully taken into consideration and the final choice of Alt. A from Table 7-7 was made.

Although the possibility of a complete interchange with three level structure may be worth studying, however, considering that the Jalan Let Jen. S. Parman is provided with only at grade intersections with existing roads for its entire stretch, the interchange with a two level structure allowing for channelization or weaving was finally determined.

Table 7-7 COMPARISON OF ALTERNATIVE TYPES OF JAKARTA INTERCHANGE

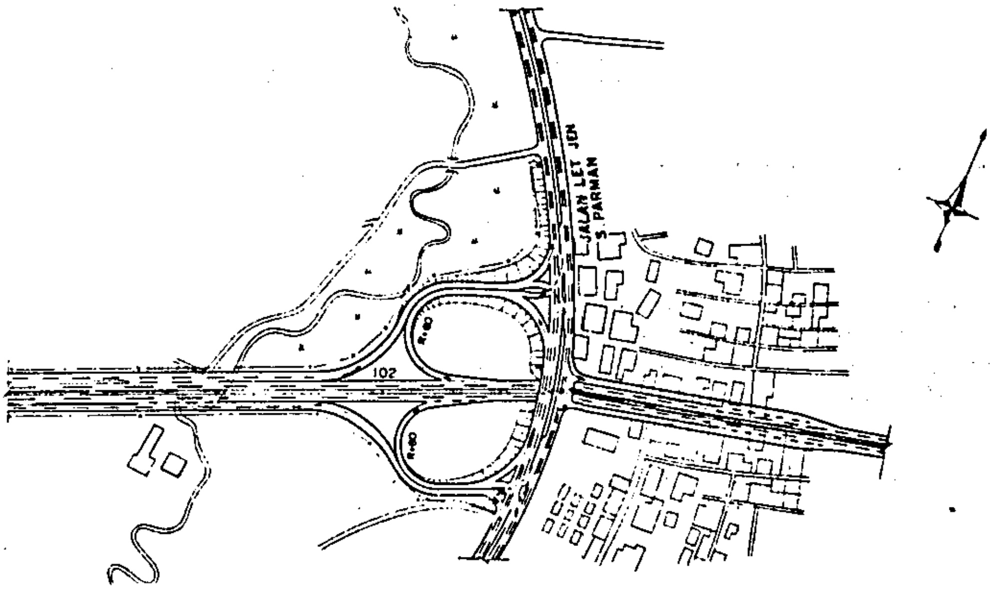
Description	Comparison: *Alternative A	Comparison: *Alternative B
Traffic movement	Channelization is necessary at two locations on the existing road	Traffic movement may be carry out only through weaving
The adaptability to future extension of the highway into the center of city	Connection on the Jakarta side may be effected by forming a diamond type interchange	Same as Alt. A
Land requirement	The interchange may be planned within undeveloped land	Requires larger land area than Alt. "A" and demolition of some buildings is necessary
Ease in construction	The interchange may be easily connected to the existing road with minor modification of medians	More gradė separation structures are necessary, and traffic flow on the existing road will be affected during the construction
Construction cost	Low	High

* Note: Please refer to Fig. 7-7 for the plan of interchange of each alternative.

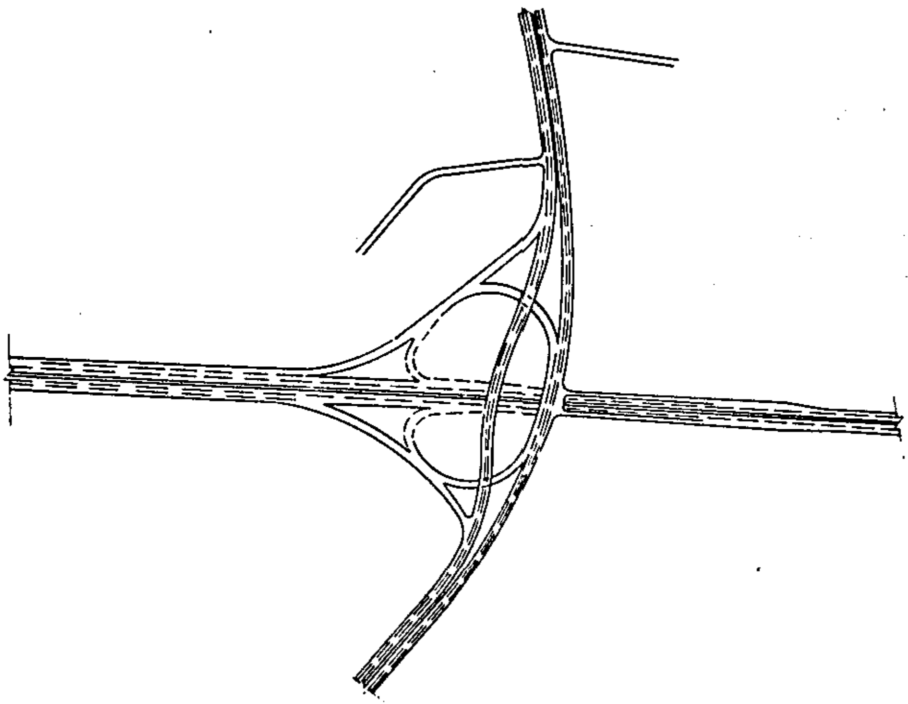
Figure 7-7

JAKARTA INTERCHAGE

SCALE 1 : 10 000



ALTERNATIVE "A"



ALTERNATIVE " B "

C. Bridges

(i) General

The preliminary study for structures described hereinafter is aimed at obtaining a magnitude of construction cost for structures having a type and dimensions determined refering to the existing data of similar-natured structures and/or taking account of the data obtained from site investigations.

Therefore, prior to the commencement of detail design, the following investigations and comparative designs shall be needed in determining final type, dimensions, span length, etc.;

- Hydrological study pertaining to the rivers, including the highest flood level, ordinary flood level and low water level, shape and slope of rivers, intensity and frequency of heavy rainfall in the catchment area, etc.
- Geological exploration at the spots of structures, including machine borings with undisturbed soils sampling, standard penetration tests, and if possible, measurements of lateral bearing force of soils.
- Topographical surveying and observation of current velocities.
- Other relevant investigations, including means of transport for materials, erection method, navigation clearance, availability of materials, etc.

(ii) Site Investigations

For the purpose of studying alternative routes, preliminary site investigation was conducted during September 28 to 30, 1973. After the final alternative route was selected and approved, the site investigation along the selected alternative route was carried out during January 22 to 29, 1974, to obtain the data necessary in preliminary engineering.

Through the above mentioned investigations, the general informations for the sites were gathered, and the following major points were revealed for the structural studies.

- There are two major rivers to cross in the project area, namely Sadane river which flowing in Tangerang city, and Ujung river which is located about 16 Km east of Serang city. Both rivers have an approximate width of 100 meters and water depth and discharges of them are as described in paragraph 7.05 E. As for the river flow state, Sadane river has more steady natures owing to the river relief provided at the downstream of the existing bridge location, while Ujung river has comparatively high value of flowing velocity.
- Besides the above two rivers, there are two medium rivers between Tangerang and Serang cities, namely Durian and Manceuri rivers, of which widths are about 50 m and their discharge and flowing velocity are seemed to be comparatively large and high. Other rivers or channels are minor one, having width of less than 30 m.
- Selected alignment crosses the existing railway at the points near the cities of Serang, Cilegon and Merak. To provide grade separations for these railway, overpass bridges are required.

Normally, these overpass bridges never necessitates longer span than about 20 meters. Therefore, it is considered advantageous to adopt prefabricated prestressed concrete beams for superstructures.

Among the said overpass bridges, the one at Serang bypass will become such a large scale of viaduct having a total length of 300 m, because it will be necessary to overpass the existing highway simultaneously.

- As a number of interchanges were provided for the proposed highway, grade separation structures will also be necessary.

(iii) Study of Type of Structures

Culvert

Since project route is located in highly cultivated paddy area, a lot of irrigation channels are found along the route. From the past experience, we know that concrete box or pipe culverts will offer the most economical solutions when the span length is smaller than about 7 m. By the necessary span length, the type of culvert will be determined as follows:

Span length	Type
below 1.5 m	R.C. pipe culvert
1.5 m to 3.0 m	" mono-opening box culvert
3.0 m to 7.0 m	" multi-openings box culvert

Bridge Superstructures

Generally speaking, the following points shall be taken into consideration in determining the type of bridge superstructures.

- Appropriate span length subject to the river and/or terrain conditions at the bridge sites.
- Optimum span length to minimize the total construction cost.
- Technical and economical advantages in construction of sub-structures and erection of superstructures.
- Esthetic points of view.

As for the soil conditions at the aforesaid major rivers, soil investigation data which were obtained from Bina Marga, show that a soft alluvial clayish stratum exists up to about 25 m below the river bed. Therefore, construction costs of substructures and foundation will comparatively be a large amount so that a prestressed concrete bridge may not be economical when its span length exceeds 30 m.

In the light of the points mentioned above, the following type of super-structures are adopted in this preliminary study stage according to the necessary span length.

Span length	Type
below 20 m	R.C. T-shape beam bridge
20 m to 30 m	P.C. "
above 30 m	Steel girder bridge

The rivers to which steel girder type of superstructures will be advantageously applied from technical and economical viewpoints, are Ujung and Sadane rivers.

As for type and span length, 3-span continuous box girders bridge with spans of 35m + 50m + 35m = 120 m is planned for Ujung river, considering possibility to adopt cantilever erection method, and for Sadane river, simply-supported composite plate girders bridge with span of 30 m, is planned because Sadane river is more steady and water velocity/ discharge at a peak may not be so much as those in Ujung river.

The main reasons to use steel bridge in the above mentioned major two river crossings are;

- Light dead load compared to R.C. or P.C. beams will result in less vertical and horizontal forces on substructures and foundations during an earthquake, which may mean reduction of construction cost as a whole bridge.
- Partial or full cantilever erection method without using temporary stagings can be adopted, which is advantageous if temporary stagings could not be easily constructed.
- Quality control and technics needed in construction will be easier than that of long-span P.C. bridge, and construction period can be shortened.

In recent years, in Indonesia, steel bridges have come to being used. However,their number and scale seem to be still small. In order to make a progress in bridge engineering,steel bridges, not limited to minor beam or composite beam bridges, shall be used insofar as practicable and economical, even though steel materials must be imported for the time being.

The existing fabricators in Bandung and Surabaya can fabricate a small scale of rivetted steel girders but it seemed to be questionable whether they have a capability to fabricate new type of welded bridges using high-tensile steel materials. However, steel bridges shall be fabricated in Indonesia if such local fabricators can be found who will be capable to fabricate such a new type of bridges under the conditions that they would be furnished steel materials and technical assistance. Otherwise, steel bridges must be imported in prefabricated knock-down condition, and assembled and erected at site.

Substructures and Foundation

As aforementioned soil conditions at the major river crossings seem to be not so good, being so soft to a depth of about 25 m below the river bed that cast-in-place reinforced concrete or steel piles foundation, or caisson foundation should be needed to set the foundation of structures on the firm stratum.

Considering the recent progress of pile foundation techniques in both equipment and construction method, it may be recommendable to use cast-in-place concrete or steel pile foundation with diameters larger than 1 m.

In case of cast-in-place concrete pile, there are several construction methods in accordance with the type of using equipment. However, the reverse circulation drill method may be considered most suitable, because it has such excellent characteristics as below in operations;

- Suitable for working in the water
- Need smaller construction yard
- Rapid excavation by continuous operation of the equipment

When it is found difficult to construct footing of piers under the river bed due to a large water depth and/or high water velocity as a result of further investigation, foundation system in which footing is set above water level being supported with piles shall be adopted. In this case, however, lateral force resistance of piles shall be carefully studied.

Regarding the type of foundations for minor bridges and culverts, if necessary, precast reinforced concrete piles may be suitable when spread type of footing cannot be used because hard stratum enough to bear the forces transmitted exists at the deeper portion.

(iv) Others Points of Care in Design

Specifications

Loading conditions and other necessary matters shall be conformed to the requirements of the specifications of Bina Marga as listed below; unless otherwise specified in Bina Marga's specifications, AASHO and ASTM specifications shall be used;

- Loading Specifications for Highway Bridges
- Standard Specification for Composite Beam of Highway Bridges
- Specifications and Standards for Reinforced Concrete Slab Highway Bridges.
- Standard Specifications for Highway Construction

AASHO : The American Association of State Highway Officials
ASTM : The American Society for Testing and Materials

Earthquake-proof Design

According to the above Loading Specifications for Highway Bridges, project area falls under the area I or II stipulated in earthquake distribution map (Daerah Genpa di Indonesia), that is, area I covers almost from Merak to Tangerang cities and area II covers Jakarta city area. When using foundation types except spread footing foundation, horizontal seismic coefficient to be designated in each area I or II is as follows:

Area I : 0.28
Area II : 0.14

Therefore, it is necessary to design almost all bridges using seismic coefficient of 0.28. In order to design earthquake-proof bridges, seismic consideration shall be made not only relating to the strength of structures but to the permissible displacement of structures.

Stage Construction

As a result of feasibility study, Jakarta-Merak Highway shall be constructed on the stage construction basis and Stage I described below:

Stage I :

1) 4-lane between Jakarta and Tangerang
   (as for bridges, 6-lane will be constructed)
2) 2-lane of short cut at Ujung river
   (as for bridges, 2-lane will be constructed)
3) 2-lane of bypasses at Serang and Cilegon

When designing the bridges at Serang and Cilegon bypasses, staged construction shall be duly taken account of in designing substructures and foundations.

Grade Separation for Railway

Before establishing design criteria for overpass bridges to the existing railway, negotiation shall be made with Indonesian State Railways concerning future improvement programme and other relevant matters to design the bridges.

D. Pavement

(i) Pavement Design Method

The method for the flexible pavement design for the project highway is based on the "AASHO INTERIM GUIDE FOR DESIGN OF PAVEMENT STRUCTURES, 1972" as recommended by the Bina Marga.

The element of design used in this method are the value of soil support, traffic, the serviceability of a pavement and regional factor.

Checks were made on this design, using other two methods developed by "Shell" and the Corps of Engineer, U.S. Army.

(ii) SELECTION OF PAVEMENT TYPES

For comparison purposes, pavement thickness design was made for varying thickness of surface, base and subbase courses.

The descriptions, recommendable uses and advantages of the various types of pavement are as follows:

Hot-Mix Bituminous Concrete Pavement

Dense-graded hot-mix bituminous concrete mixtures are particularly suited for paving heavy-duty-traffic roads and streets. These types of mixtures will be preferable for paving roads and streets having volumes of 3,000 vehicles or more per day, although, considering the lack of a central mixing plant and the rather high mobilization cost of a new plant for the site, selection of this pavement type will require cost comparison studies.

Cold-Laid Bituminous Concrete, Plant Mix

Where hot-mix bituminous concrete mixtures are not economically available, cold-laid bituminous concrete mixtures are used to pave roads and streets. These mixtures composed of well-graded aggregate containing either tar, asphalt cement with a liquefier, or hard asphalt with flux oil used for paving all such areas. Normally, cold-laid bituminous mixtures containing cut-back asphalt or emulsified asphalt are limited to paving roads and streets having traffic volumes of 3,000 vehicles and less. However, the cost of this pavement types will still be high because of the mobilization involved.

Penetration Macadam

Penetration macadam is basically limited to small paving projects located in remote areas where hot or cold-plant bituminous mixtures are not economically available. However, when carefully built over a satisfactory base, penetration macadam is durable and will stand up under all but the heaviest wheeled traffic. Very little equipment is needed and construction is rapid. The requirements are a good base, good coarse crushed stone aggregate, good weather, and careful spreading and rolling.

Surface Treatment

The use of single bituminous surface treatment as original surfacing is usually limited to stabilization of shoulders and similar areas. Multiple bituminous surface treatments are normally limited to original surfacing for roads, and streets having a traffic volume of approximately 100 vehicles per day. They may also be used as the original surfacing of a parking area where pavement markings are not required for parking control. Double surface treatments will provide a satisfactory temporary surfacing for any pavements subjected to a low daily traffic volume. Surface treatments provide interim surfaces for roads and streets being constructed in stages. These treatments are overlaid with higher grade bituminous surface when traffic requires a better surfacing.

Gravel and Crushed-Rock Surfaces

Gravel or crushed rock is used only for low-traffic volume roads or for stabilizing shoulders and similar areas. The minimum thickness of the surfacing material is 10 centimeters, and its minimum CBR at its maximum expected water content must be at least around 50.

(iii) Material Sources

Subgrade conditions, borrow areas, and sources of materials for (a) subbase course, (b) base course, and (c) paving aggregates were investigated.

Subbase Course

Several types of materials are available for subbase course construction at the site. The major sources of the materials for this project shall be the Sadane and Ujung rivers. Access can be gained to acceptable deposits at numerous locations by barges.

Design CBR values for the subbase course are to be finally selected after completion of comprehensive investigations including laboratory testing. A careful cost comparison would be needed to establish the most economical design.

For the purpose of preliminary studies, the following maximum permissible values were assumed:

			Maximum Permissible Value Gradation Requirements, % Passing			
Material	Maximum Design CBR	Size Cm	2mm Sieve	0.074mm Sieve	Liquid Limit	Plasticity Index
Subbase, coral	40	5	80	15	25	5
Subbase, gravelly sand	40	5	80	15	25	5
Subbase, silty sand	15	3	--	--	35	12

Base Course

Experience has shown that only good-quality materials should be used in base courses for heavy-duty flexible pavements.
Limerock, and stabilized aggregate will be suitable for use in the construction.

The quarry map indicates several pits of igneous rocks. They are generally found in the form of gravel, pebble, cobble and boulders in large deposits along rivers. They are easily excavated, crushed, screened and washed as necessary. Once processed, they can be hauled to the site by trucks and barges.

A privately owned large quarry exist in the vicinity of Merak port. The current production is negligible because of a lack of plant. However unquarried rock is available in quantities far in excess of that required for the use of this project.

(iv) Design Examples

In the Interim Report, examples of the pavement thicknesses design were presented for the "SHELL" DESIGN METHOD and the U.S. ARMY, CORPS OF ENGINEERS METHOD. To compare the AASHO METHOD with these design methods, the same highway section selected in the Interim Report was chosen.

It is assumed that a projected trunk highway between Jakarta and Tangerang is to be constructed on a subgrade having a CBR of 5, and it is expected that the traffic volume will be approximately 21,400 vehicles per day in average ADT. A design period of 20 years is adapted.

a. Determination of Equivalent 18-Kip Single Axle Loads

Traffic volume and truck weights by vehicle type will be taken into account by calculating 18-Kip rates per truck type.

From Figure 3-2-1 Assigned Traffic Volume - 1980 in the Interim Report, an average ADT for a 20-year design period in both directions is 21,400 vehicles.

Average 20-year ADT in one direction $= \frac{21,400}{2} = 10,700$ vehicles

The average number of trucks per day in one direction for the 20-year design period will be 19% trucks x 10,700 vehicles = 2,140 trucks

Assume $\frac{1}{2}$ of the number of trucks would travel in the design lane.

$2{,}140 \text{ trucks} \times \frac{1}{2} = 1{,}070 \text{ trucks}$

For this example it is assumed that an 18-Kip rate per 1,000 for all trucks = 600

The average number of equivalent 18-Kip single axle load applications per day in the design lane

$$= \frac{1{,}070 \times 600}{1{,}000} = 642$$

b. Soil Support Value

The soil support values for the subgrade, embankment material, or other layer in question were determined by conversion from CBR.

Material	Soil Group	Design CBR	Soil Support Value
Compacted Subgrade	CH	5	4.5
Subbase, Sandy Gravel	--	35	8
Base, Crushed Stone	--	80	9.5

c. Structural Layer Coefficients

$$SN = a1\ D1 + a2\ D2 + a3\ D3$$

where:

a1, a2, a3 = coefficients of relative strength.

D1 = thickness of bituminous surface course, inches.

D2 = thickness of base course, inches.

D3 = thickness of subbase, inches.

Using Table C.4-1. AASHO INTERIM GUIDE FOR DESIGN OF PAVEMENT STRUCTURES, 1972, the following values are obtained.

Pavement Component	Structural Layer Coefficients Proposed by AASHO Committee on Design
Surface Course, Plantmix, High Stability	0.44
Base Course, Crushed Stone	0.14
Subbase Course, Sandy Gravel	0.11

d. Regional Factor

Considering the adverse conditions, such as during a period of strength loss of the roadbed materials which may occur during rainy season, a regional factor of 1.5 was assumed in this design.

e. Pavement Thickness for Various Construction

The required structural number (SN) over the roadbed soil will be determined from the Figure II-I, ASSHO INTERIM GUIDE, for the major highways having a terminal serviceability index (pt) 2.5.

For the soil support value (=4.5) with the total 18-Kip equivalent single-axle applications of 642 daily and the assumed regional factor of 1.5, the resulting weighted structural number (SN) is 4.4.

Three possible alternate designs which satisfy the minimum structural number (SN) of 4.4 are as follows:

DETERMINING THICKNESS OF LAYER

Alternate	Component	Thickness, Inches		Layer Coefficient	SN
1	A.C Surfacing	5	(14 cm)	0.44	2.42
	Aggregate Base	4	(10 cm)	0.14	0.56
	Aggregate Subbase	12	(32 cm)	0.11	1.38
		22	(56 cm)		4.4
2	A.C surfacing	5	(14 cm)	0.44	2.42
	Aggregate Base	6	(15 cm)	0.14	0.84
	Aggregate Subbase	10	(27 cm)	0.11	1.16
		22	(56 cm)		4.4
3	A.C surfacing	4	(12 cm)	0.44	1.98
	Aggregate Base	8	(20 cm)	0.14	1.12
	Aggregate Subbase	12	(30 cm)	0.11	1.32
		24	(62 cm)		4.4

(v) "SHELL" Design Method Example

Both magnitude and load repetitions are significant parameters in this method. Followings are design examples for pavement thicknesses. To illustrate the design procedure more definitely, a certain portion of trunk highway was chosen.

A projected trunk highway between Jakarta and Tangerang, is to be constructed on a subgrade having a CBR of 5. It is expected that the traffic volume will be approximately 10,000 axile loads per day per lane. A 20 year design life is assumed.

(a) Traffic Requirements

The expected axle-load distribution in one lane will be found based on the projection of traffic.

(b) Axle-Load Distribution

The expected axle-load in the lane is:

Less than 3.50 ton	72%
3.50 - 7.25 "	24%
7.25 - 9.00 "	3%
9.00 - 10.00 "	1%
	100%

(c) Load Distribution Factor (LDF)

The load distribution factor (LDF) is obtained from Chart 2. Shell's "1963 Design Charts for Flexible Pavements."

Table 7-8

LOAD DISTRIBUTION FACTOR

Axle Load Group	Percentage	Contribution to LDF
Less than 3.5	72	0.4
3.5 - 7.25	24	2.1
7.25 - 9.00	3	1.2
9.00 - 11.00	1	0.9
		4.6

(d) Modulus of Subgrade and Design Number of Equivalent 10-ton Axle Load

The modulus (E) of the subgrade is obtained using Chart 1 in Shell's Design Charts which shows that for a CBR of 5, $E=500\ kg/cm^2$.

The design number of equivalent 10-ton axle load (N) is obtained from Chart 3, using an LDF of 4.6 as computed before.

$$N = 3.5 \times 10^6$$

(e) Pavement Thickness for Various Construction

Using Chart 5 for $E = 500\ kg/cm^2$ and $N = 3.5 \times 10^6$, the following alternative constructions are obtained.

Table 7-9

ALTERNATIVE PAVEMENT CONSTRUCTION

Construction	Total Thickness of Dense Asphalt Layers (cm)	Total Thickness of Granular Layers (cm)	Overall Thickness (cm)
1	23.0	21.0	44.0
2	19.0	29.0	48.0
3	13.5	41.0	54.5

(f) Designed Pavement Thicknesses

The design thickness of each layer of materials for subbase and base courses will depend upon the CBR design value of each material.

Table 7-10 shows two possible combinations which have been chosen in this design, using alternative construction of 3 in previous page.

Table 7-10

POSSIBLE PAVEMENT DESIGN

Recommended Design

Dense Asphalt Surface Course	6 cm
Dense Asphalt Binder Course	7.5 cm
Total Thickness of Dense Asphalt Layers	13.5 cm
Base Course with Minimum CBR80	10 cm
Subbase Course with Minimum CBR40	31.0 cm
Total Thickness of Granular Layers	41.0 cm
OVERALL THICKNESS	54.5 cm

Alternative Design

Dense Asphalt Surface Course	6 cm
Dense Asphalt Binder Course	7.5 cm
Total Thickness of Dense Asphalt Layers	13.5 cm
Base Course with Minimum CBR80	15.0 cm
Sub base Course with Minimum CBR40	26.0 cm
Total Thickness of Granular Layers	41.0 cm
OVERALL THICKNESS	54.5 cm

(vi) Check Design by the U.S. Army, Corps of Engineers Method

Pavement thicknesses based on the "Shell" design method will be checked using the U.S. Army, Corps of Engineers Method. Generally, several designs are possible for a specific site, and the most practicable design can be selected.

(a) Design Index

The design of flexible pavement for the road will be based on a "Design Index." The design index represents all traffic expected to use a flexible pavement during its life. Considering traffic composition and volumes the design is to be prepared for a road that will require a design index of 6.

(b) Total Thickness

The total thickness of subbase, base and pavement will be governed by the CBR of the compacted subgrade and the selected design index. From the flexible pavement design curves the required total thickness above the compacted subgrade (CBR of 5) is 22" = 55 cm.

(vii) Variation of Subgrade Strength and Project Phasing

Since available data on which to base a design are limited at this report stage, a conservative CBR value of 5% for the subgrade is assumed for the cost estimates of pavement construction. More extensive soils testing may result in selection of a higher CBR value for final pavement design with a corresponding saving in the pavement structure thicknesses.

The pavement design is based on the average traffic volume anticipated during the 20-year study period for the project. However, consideration to staging construction of the asphaltic concrete surface course is considered to be especially important.

(a) Variation of Subgrade Strength

For example, use of a design CBR of 7% would result in a saving of about 10 cm in overall thickness of pavement which is minor amount in total pavement construction cost.

(b) Project Phasing

Ultimate requirements for a 14.0 cm asphaltic concrete pavement may be met by a one stage overlaying operation. For initial construction, a 5 cm asphaltic concrete surface is proposed. The overlaying operation will be made about 5 years after the initial pavement construction.

E. Hydrology

(i) Site Investigations

This investigation is aimed at establishing a design criteria for bridges and drainage structures on the proposed road and roadside, and aimed as determining the lowest safe finished grade in the embankment sections where the ground is inundated with water.

To learn more about the existing hydrological data, survey team have also made field investigations in October 1973 and January 1974, and the characteristics of the area affected were investigated carefully.

(ii) Rainfall

Since the project area has a typical equatorial heavy rainfall special attention was payed to the frequent short-duration and high-intensity storms.

The average mean annual rainfall in the project area is about 1,800 mm and the maximum rainfall occuring in the late afternoon and early evening. This type of rainfall is characterized by heavy showers over a limited area, for periods of one to two hours. In such a shower the rate of precipitation may reach about 200 mm at maximum 24-hour rainfall of 20-years frequency, and reach about 60 mm maximum 1-hour storm of the same.

(iii) Influence of Topography and Character of Ground

Most of the rain that falls on rocky or bare, impervious slopes, or pavements runs off quickly. At the other extreme, only a small percentage of that falling onto cultivated area or heavy forest may run off at a slow rate. Slope and surface moisture at the time of rainfall introduce added variables.

The terrain over which project road passes is generally flat, and the vegetation varying from rubber tree plantations to paddy and average grass. According to the careful field investigations and considerations for the future development of the area, the factors affecting overland flow time and runoff coefficients were selected to determine the runoffs.

Fig. 7-8 will give reasonable values for the time of overland flow for various conditions of cover, slope, and length. When the particular overland flow area consits of several types of surfaces, the time of overland flow may be determined by adding together the respective computed for flow over the lengths of the various surfaces from the most remote point to the inlet.

(iv) Runoff Estimation

The rational formula was used in the preliminary design for estimating peak storm runoff for determining capacities of minor drainage structures.

The runoff in cubic meters per second from smaller drainage areas will relate to the rainfall intensity, "i" in millimeters per hour, the area of watershed, "A" in square meters, and the runoff coefficient, "C", in the rational formula (logical approach),

$$Q = \frac{1}{3.6 \times 10^6} . C \cdot I \cdot A$$

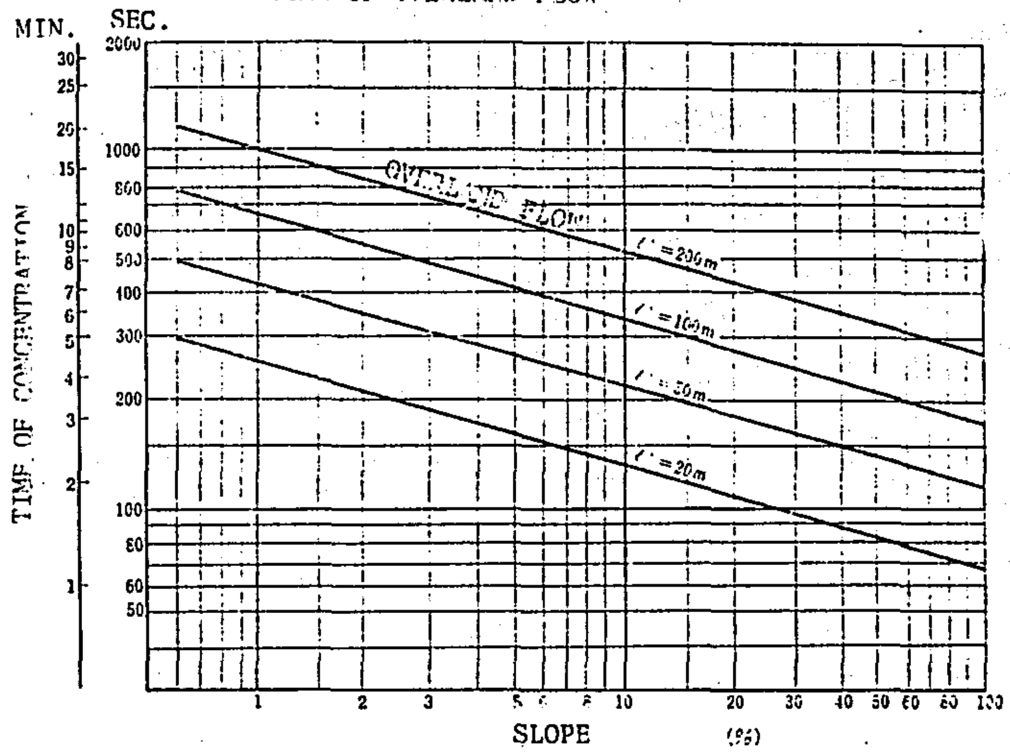
(v) River Flow Records and Runoff Observations

River flow records on a major rivers in the project area are available and those data were taken into consideration for the determination of bridge heights. The most common and safe criteria for highway bridge waterway determination is to fix the bottom of beams on a specified minimum clearance above the highest flood water level ever recorded.

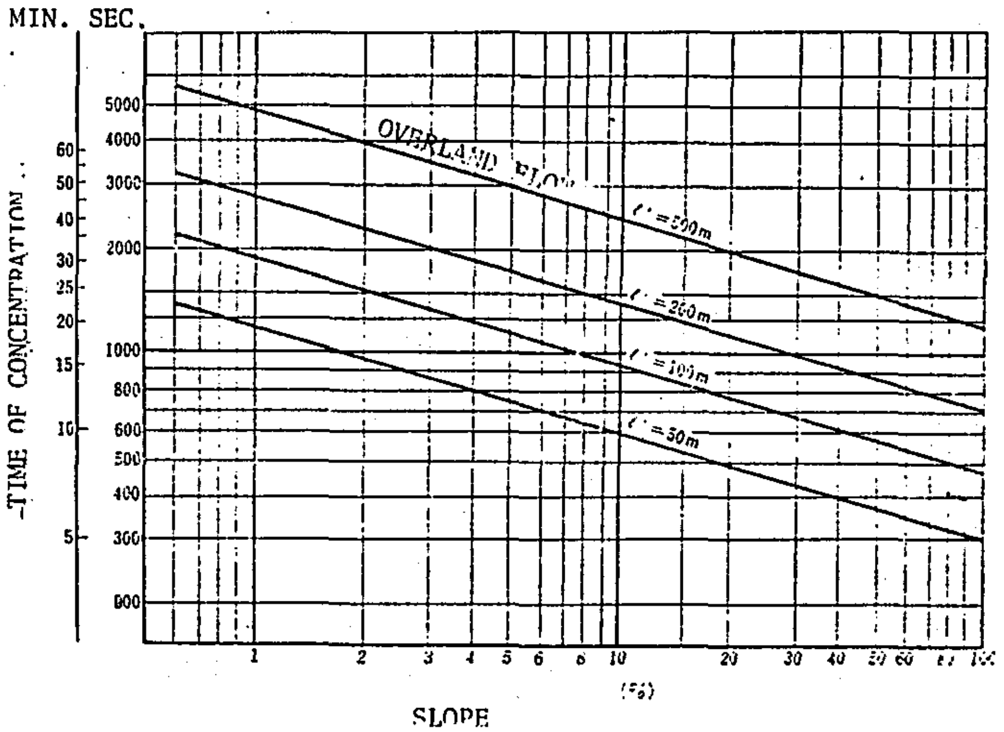
Table 7-11 summarizes the river records of the Sadane, Ujung and Durian Rivers.

Fig. 7-8

TIME OF OVERLAND FLOW



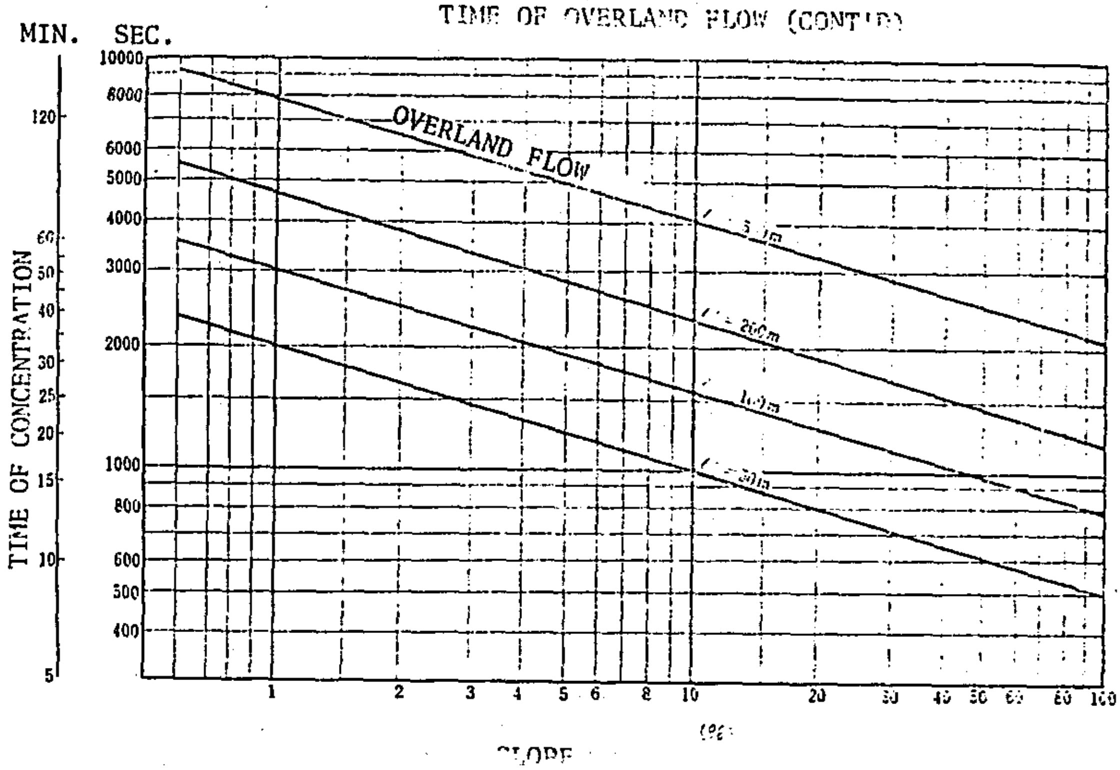
SMOOTH PAVEMENT



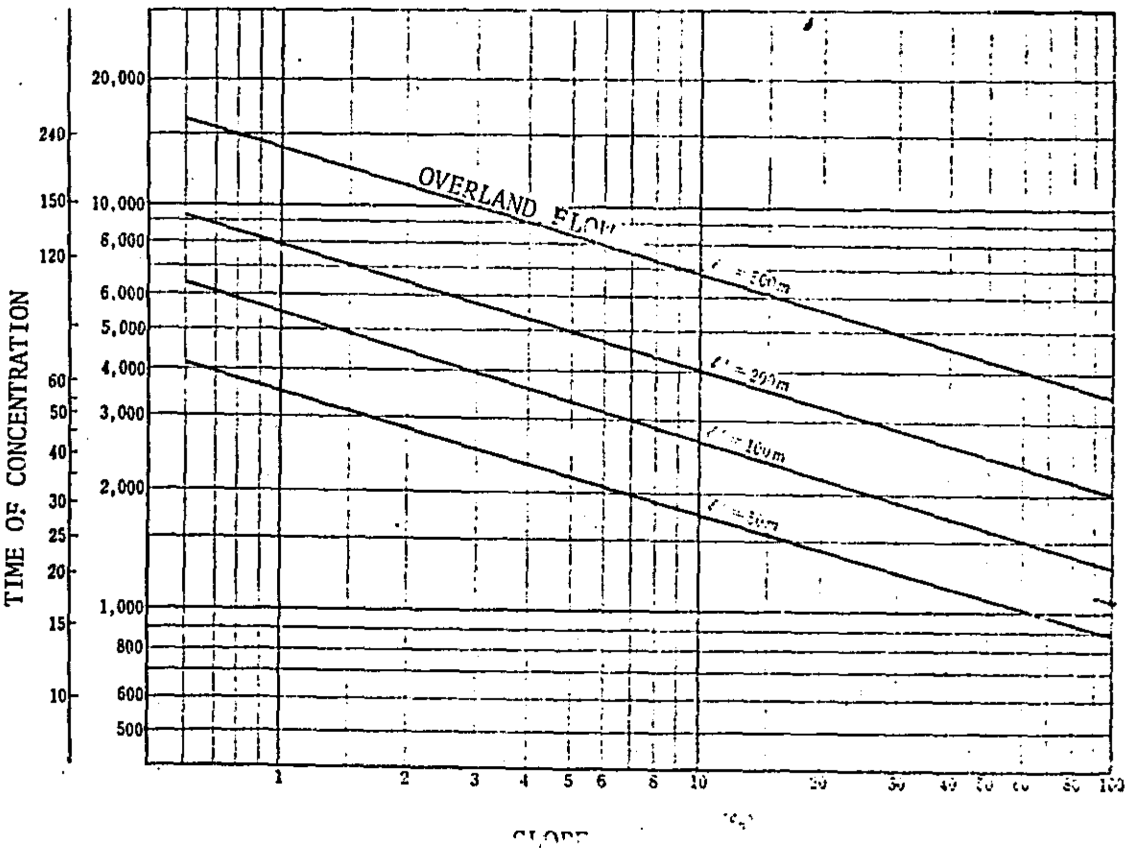
BARE SOIL

Fig. 7-8

TIME OF OVERLAND FLOW (CONT'D)



POOR TURF



AVERAGE TURF

Table 7-11

RIVER FLOW RECORDS

River : Ci Sadane
Gaging Station : Batu-beulah
Watershed Area : 840.7 km^2

Date	Maximum Stage (m)	Maximum Discharge (m^3/sec.)
3, Nov. '69	3.41	---
30, Apr. '70	3.74	585
14, Aug. '71	5.11	---
10, Dec. '72	4.29	747

River : Ci Ujung
Gaging Station : Rangkas Bitung
Watershed Area : 1,363.9 km^2

Date	Maximum Stage (m)	Maximum Discharge (m^3/sec.)
23, Apr. '70	5.80	643
24, Apr. '72	4.68	464

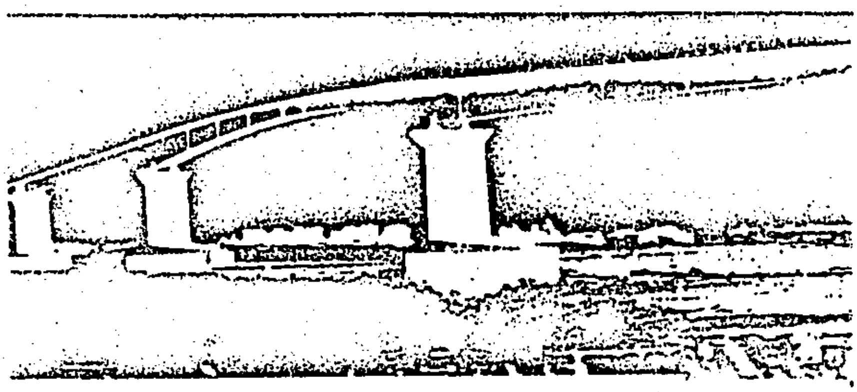
River : Ci Durian
Gaging Station : Parigi
Watershed Area : 648.7 km^2

Date	Maximum Stage (m)	Maximum Discharge (m^3/sec.)
16, Jun. '70	4.96	169
6, Jun. '70	4.96	169
--- '72	4.86	---

* Source : Observation record by Bureau of investigation of Water Resources, Bandung

Chapter 8

CONSTRUCTION COST ESTIMATE FOR SELECTED ALTERNATIVE SOLUTION



8. CONSTRUCTION COST ESTIMATE FOR SELECTED ALTERNATIVE SOLUTION

8.01 Study of Land Acquisition Costs

Through the cooperation and assistance of Bina Marga, information for the prices of land acquisition and compensation that prevails the project area were furnished.

Representative values are as shown below.

LAND ACQUISITION AND COMPENSATION

Type and Location	Present Value
a. Area between Jakarta - Tangerang, outside the municipal city of Jakarta	
Land	
- along the existing main road	Rp. 5,000/m^2
- about 5 Km off the main road	Rp. 500/m^2
Buildings	
- permanent houses along the main road	Rp.15,000/m^2
- semi permanent houses along the existing road	Rp. 7,000/m^2
b. Area between Tangerang - Merak, along the main road	
Land	
- in the cities	Rp. 3,000/m^2
- cultivated land outside the cities	Rp. 500/m^2
Buildings	
- permanent houses in the cities	Rp.10,000/m^2
- semi permanent houses in the cities	Rp. 5,000/m^2
- permanent houses outside the cities	Rp. 3,000/m^2
- semi permanent houses outside the cities	Rp. 1,000/m^2

8.02 Construction Cost Estimates

Construction quantities were determined in accordance with results of the preliminary design of this project.

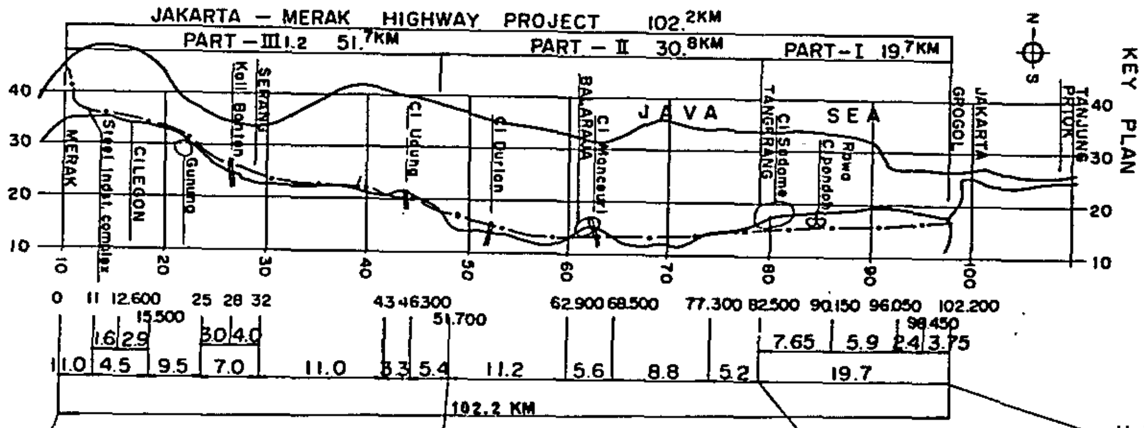
Table 8-1 thru 8-3 presents construction quantities and estimated costs for all section of the work in this project, by each different construction phase. For the purposes of determining project cost, a contingency allowance of 15% and an engineering, supervision and administration costs totaling 10% have been added to the total contract costs.

The unit costs shown in the table indicate all contract costs including contractor's field overhead, general overhead and profit.

The estimates are based on the current construction cost after the oil crisis, but they do not include Indonesian Government taxes and duties on materials and equipment or any allowance for future price escalation.

Table 8-1

CONSTRACTION COST ESTIMATE - IN MAR. 1974 PRICE



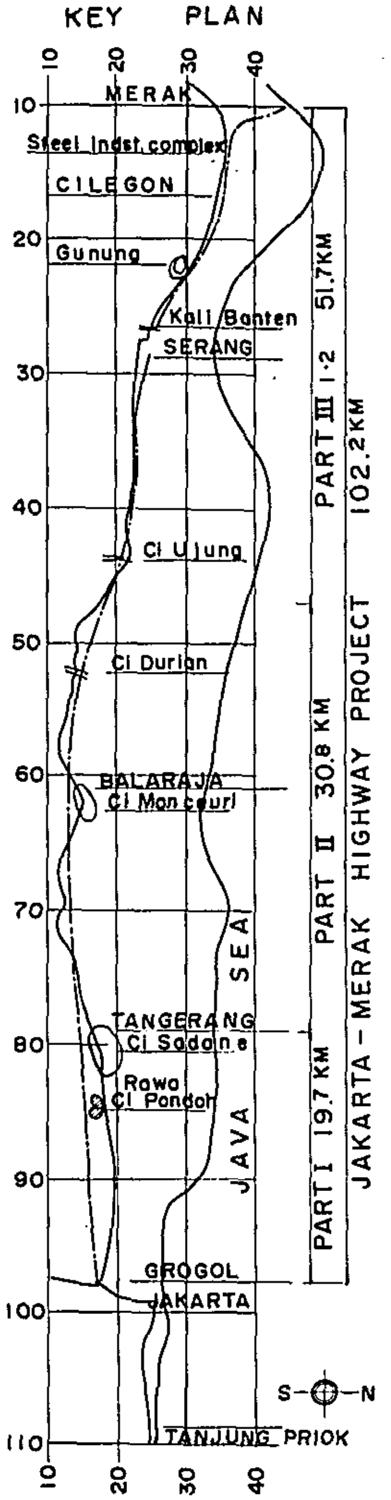
Unit US $

		Item	Unit	Unit Cost	PART – III Quantity Phase I	PART – III Quantity Phase II	PART – III Quantity Total	PART – III Total US $	PART – II Quantity Phase I	PART – II Quantity Phase II	PART – II Quantity Total	PART – II Total US $	PART – I Quantity Phase I	PART – I Quantity Phase II	PART – I Quantity Total	PART – I Total US $
A		HIGHWAY CONSTRUCTION														
		Clearing and Grubbing														
1	a	Rice paddy or removal of topsoil	M²	0.15	772.200	236.700	1 008.900	151.335	676.000	517.000	1 193.000	178.950	407.000	151.000	558.000	83.700
	b	Cultivated area	〃	0.10	315.400	69.200	384.600	38.460	78.400	60.400	138 800	13.880	353.000	133.000	486.000	48.600
	c	Rubber plantation	〃	0.20	106.200	14.300	120.500	24.100	78.000	61.600	139.600	27.920	—	—		
	d	Demolition	〃	2.00	35.500	207.200	242.700	485.400	—	—	—		42.000	14.000	56.000	112.000
		Excavation														
2	a	Common	M³	1.50	217.000	66.000	283.000	424.500	310.000	233.000	543.000	814.500	600.000	175.000	775.000	1162.500
	b	Borrow for fill or embankment	〃	2.50	697.400	267.200	964.600	2411.500	407.000	359.000	766.000	1915.000	360.000	200.000	560.000	1400.000
	c	Rock	〃	8.60	77.000	—	77.000	662.200		—	—		—		—	
3		Fill select Material for Soft Ground Treatment	M³	4.0	23.000	6.900	29.900	119.500	19.900	15.500	35.400	141.600	13.000	4.500	17.500	70.000
		Drainage Structure														
4	a	Multi-openings Rc box culvert with head wall	M	1200.00	280	80	360	432.000	40	40	80	96.000	100	—	100	120.000
	b	Rc-box culvert with head walls	M	700.00	160	—	160	112.000	100	100	200	140.000	150	—	150	105.000
	c	Rc P culvert 1.5m ø	M	80.00	120	40	160	12.300	190	190	380	30.400	450		450	36.000
		Bridges														
5	a	Short span bridge L<15	M²	480.00	1.770	1.360	3.130	1502.400	510	640	1.150	552.000	580	—	580	278.400
	b	Intermediate span bridge 16~40	〃	600.00	8.840	5.390	14.230	8538.000	1.580	1.580	3.160	1896.000	—	—	—	
	c	Long span bridge 50~	〃	900.00	1.380	1.380	2.760	2484.000	3.000	—	3.000	2700.000	5.200	—	5.200	4680.000
		Pavement														
6	a	Subgred preparation	M²	0.15	612.400	481.600	1 094.000	164 100	348 000	348.000	696.000	104.400	543.000	168 000	710.000	106.650
	b	Subbase course	M³	4.80	162.500	128.500	291.000	1396.800	107.200	107.200	214.400	1029.120	148.000	44.800	192.800	925.440
	c	Base Course	〃	7.60	101.500	80.300	181.800	1381.680	70.800	70.800	141.600	1076.160	89.000	24.600	113.600	863.360
	d	Bituminous prime coat	M²	0.25	413.300	326.900	740.200	185.050	264.800	264.800	529.600	132.400	355.000	168.000	523.000	130.750
	e	Asphaltic Concrete Surface Course	Ton	18.00	67.700	176.600	244.300	4397.400	30.900	143.800	174.700	3144.600	43.000	141.100	184.100	3313.800
	f	Bituminous surface treatment	M²	0.90	499.700	980.700	1480.300	1332.360	264.800	796.600	1 061.400	955.260	355.000	781.800	1136.800	1 023 120
7		Establishment of Turf spot sodding with overseeding	M²	0.20	526.300	298.900	825.200	165 040	336.000	445.500	781.500	156.300	400.000	232.000	632.000	126400
8		Stone Protection	M²	3.60	1.200	800	2.000	7 200	2.000	2.000	4.000	14.400	3.000	3.000	6.000	21.600
9		Guard Rail		18.00	15.700	5.200	20.900	376.200	4.500	2.250	6.750	121.500	2.500	16.500	19.000	342000
10		Center Line and other Markings	M	0.60	119.800	189.600	309.400	185.640	71.700	143.400	215.100	129.060	93.800	150.000	243.800	146.280
11		Concrete curb stone	M	6.00			—				—			18.000	18.000	108.000
12		Side Walk	M²	5.75			—				—			48.000	48.000	276.000
13		Trafic Sings Regular	El	70.00	208	—	208	14.560	123	—	123	8.610	80	—	80	5.600
		〃 Guide	〃	2000.00	130		130	260.000	60		60	120.000	40		40	80.000
		〃 Lighting	〃	2160.00	360		360	777.600	160		160	345.600	150		150	324.000
14		Interchanges	Lump Sum					380.000				320.000				385.400
15		Maintenance and Protection of Traffic	Lump Sum					284.219				161.637				162.746
16		Mobilization	Lump Sum					1435.307				816.265				813.730
17		Contingency						4521.218				2571.234				2587.661
18		Final Engineering Supervision & Administration						3466.267				1971.279				1983.874
		TOTAL			38.128.936 + 21 684.075 + 21 822.611 = 81 635.622						US $ 81 636.000					
B		LAND ACQUISITION & COMPENSATION		P-I P-II P-III												
1		Land Acquisition						2 439.070				1726.428				2 376.570
	a	Town	M²	12.05 7.23	50.000			361.500					70.000			843.500
	b	Village	〃	1.21 1.21	333.500			2077.570	150.000			1 726.428	252.000			1 533.070
	c	Rice field	〃		1195.500				1078.800				679.000			
	d	Rubber coconut plantation	〃		133.000				174.000				—			
	e	Cultivated area	〃		55.000				24.000				336.000			
2		Compensation for Buildings and Crops						4906.329				4351.789				3911.845
	a	Brick building	M²	36.15 24.10	5.500			132.550	500			12.050	6.800			245.820
	b	Wooden building	〃	16.87 7.23	18.900			136.647	4.500			32.535	8.400			141.706
	c	Shed	〃	2.41 2.41	12.000			28.920	4.400			10.604	3.700			8.917
	d	Crops	〃	8.68 8.68	530.900			4608.212	495.000			4296.600	405.000			3515.400
		Sub Total						7345.399				6078.217				6 288.415
3		Contingency						1 101.810				911.733				943.262
4		Cadastral Survey, preparation of R.O.W Plan & Administration						844.721				698.995				723.168
		TOTAL			9 291.930 + 7 688.945 + 7 954.344 = 24 935.719						US $ 24 936.000					

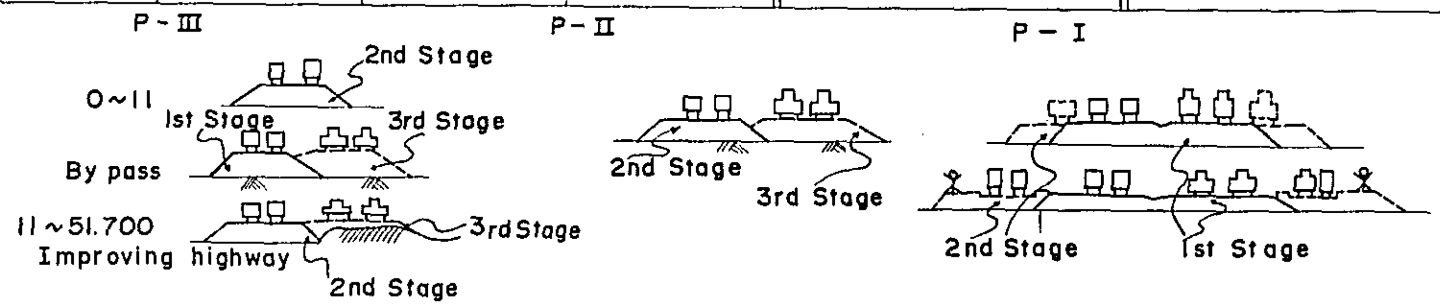
Table 8-2

PROJECT COST ESTIMATE (PHASED CONSTRUCTION) - IN MAR. 1974 PRICE

Unit 1000 US$

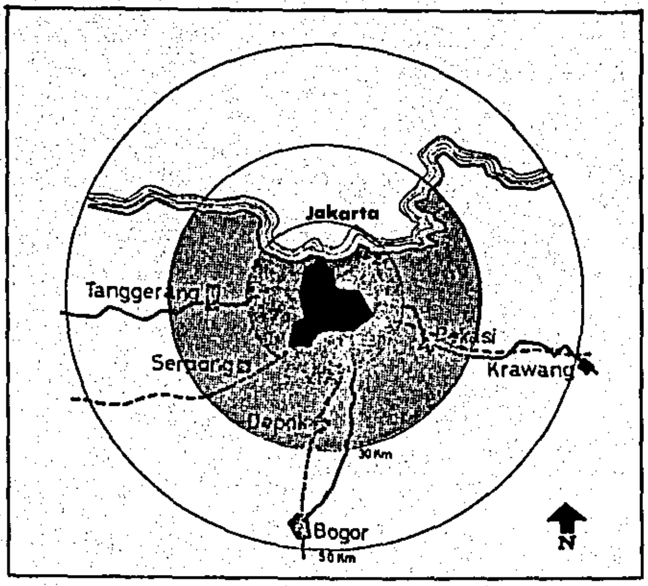


PART	STA. NO.	Distance	HIGHWAY CONSTRUCTION Phase I 1st Stage	Phase II 2nd Stage	Phase II 3rd Stage	TOTAL	LAND ACQUISITION COMPENSATION TOTAL	Land Ac	Compensation	TOTAL
PART - III (51.7 KM)	0 - 11	11.0		5 444		5 444	1 139			6 583
	11 - 15.500	4.5	3 082	——	2 509	5 591	1 433			7 024
	15.500 - 25	9.5	——	2 214	2 248	4 462	1 406			5 868
	25 - 32	7.0	4 924	——	5 100	10 024	2 142			12 166
	32 - 43	11.0	——	2 498	2 766	5 264	1 600			6 864
	43 - 46.300	3.3	2 453		2 413	4 866	803			5 669
	46.300 - 51.700	5.4		1 155	1 324	2 479	769			3 248
	Sub TOTAL		10 459 (21 770)	11 311	16 360	38 130	9 292	3 066	6 226	47 722
PART - II (30.8)	51.700 - 62.900	11.2	——	4 170	3 436	7 606	3 789			11 395
	62.900 - 68.500	5.6	——	3 631	1 940	5 571	1 695			7 266
	68.500 - 77.300	8.8	——	2 464	3 058	5 522	399			5 921
	77.300 - 82.500	5.2	——	1 368	1 618	2 986	1 806			4 792
	Sub TOTAL		11 633		10 052	21 685	7 689	2 153	5 536	29 374
PART-I (19.7)	82.500 - 102.200	19.7	14 425	7 396	——	21 821	7 955			29 776
	Sub TOTAL		21 821				7 955	3 023	4 932	
	TOTAL		24 884	30 340	26 412	81 636	24 936	8 242	16 694	106 572



Chapter 9

FINAL ECONOMIC ANALYSIS



9. FINAL ECONOMIC ANALYSIS

9.01 Refinement of Economic Evaluation

The engineering works in greater detail for the Alternative II which is the final alternative adopted, results in an increase of the construction costs. Modifications in design and alignment are some of the minor reasons. But the major factor is the increase in unit cost of many items in construction, adjusted to suit the recent world trend in increase in price of commodities and materials after the petroleum crisis. This increase affects all the three alternatives, and will in no way upset the priority of the three alternatives decided in previous economic evaluation.

Here a reevaluation is made for Alternative II to determine the effect of increase in construction cost on the economic viability of the alternative. The recent petroleum crisis will naturally affect the operating cost of vehicles. However, detailed analysis on the operating cost is not possible at this stage due to lack of time. Instead, calculations will also be made on the assumption that the operating cost is increased by (1) 10% and (2) 20%.

The following are the results of the reevaluation of the economic effects, under the new estimates for construction cost, invested under the stage construction program as shown in Table 9-1, and the stage maintenance expenditure shown in Table 9-2.

a) Assuming that the per unit vehicle operating cost remains the same,

At a discount rate of 15%	B/C = 1.26
At a discount rate of 12%	B/C = 1.69
At a discount rate of 10%	B/C = 1.97
Internal rate of return	= 18.7%

b) Assuming an increase of 10% in vehicle operating cost,

At a discount rate of 15%	B/C = 1.39
At a discount rate of 12%	B/C = 1.86
At a discount rate of 10%	B/C = 2.17
Internal rate of return	= 20.8%

c) Assuming an increase of 20% in vehicle operating cost,

At a discount rate of 15%	B/C =	1.51
At a discount rate of 12%	B/C =	2.03
At a discount rate of 10%	B/C =	2.36
Internal rate of return	=	23.2%

It will be seen that in all cases, the results of the economic analysis show that the project remains highly feasible despite a considerable upward revision of the construction cost items. Also, it is worthy of special note that, as has been described in section 6.04, the benefits accounted for in the analysis include only the direct benefit items which are easily quantifiable and do not include various indirect benefits which are not readily quantifiable. These indirect benefits, therefore, will serve as a safety factor for the economic analysis, and should they be included in the accrued benefits, the economic feasibility will be greatly enhanced.

Table 9-1 Final Annual Investment Program

Unit: 1,000 US$

Section / Year	a	(Cilegon Bypass) a'	b	(Serang Bypass) b'	c	(Ci Ujung Bridge) c'	d	e	f,g,h	i	Total Stage I	Total Stage II	Total Stage III	Grand Total
1975		226		353		163				1,119	1,861	-		1,861
76		1,129		1,767		814				5,595	9,305	-		9,305
77		1,806		2,826	300	1,302	397	266	536	8,952	14,886	1,499		16,385
78		1,354		2,120	1,506	977	1,990	1,332	2,678	6,714	11,165	7,506		18,671
79					2,409		3,184	2,130	4,285			12,008		12,008
80					1,807		2,388	1,598	3,214			9,007		9,007
81														
82														
83				2,040	1,636	965	1,374	776					6.791	6,791
84				3,060	2,454	1,448	2,062	1,164					10.188	10,188
85														
86			1,448										1.448	1,448
87			2,172										2,172	2,172
88	2,633												2,633	2,633
89	3,950												3,950	3,950
90														
91										2,958			2,958	2,958
92										4,438			4,438	4,438
93		1,004	899										1,903	1,903
94		1,505	1,349										2,854	2,854
95														
96														
97														
98														
99														
Total	6,583	7,024	5,868	12,166	10,112	5,669	11,395	7,266	10,713	29,776	37,217	30,020	39,335	106,572

Table 9-2

Final Annual Maintenance Cost

Year	Maintenance Costs in 1,000 US$
1977	57
78	140
79	234
80	293
81	337
82	337
83	337
84	371
85	422
86	422
87	429
88	440
89	453
90	473
91	473
92	486
93	505
94	514
95	529
96	529
97	529
98	529

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4.	Standard Specification for Geometric Design of Rural Highway, No. 13/1970	"
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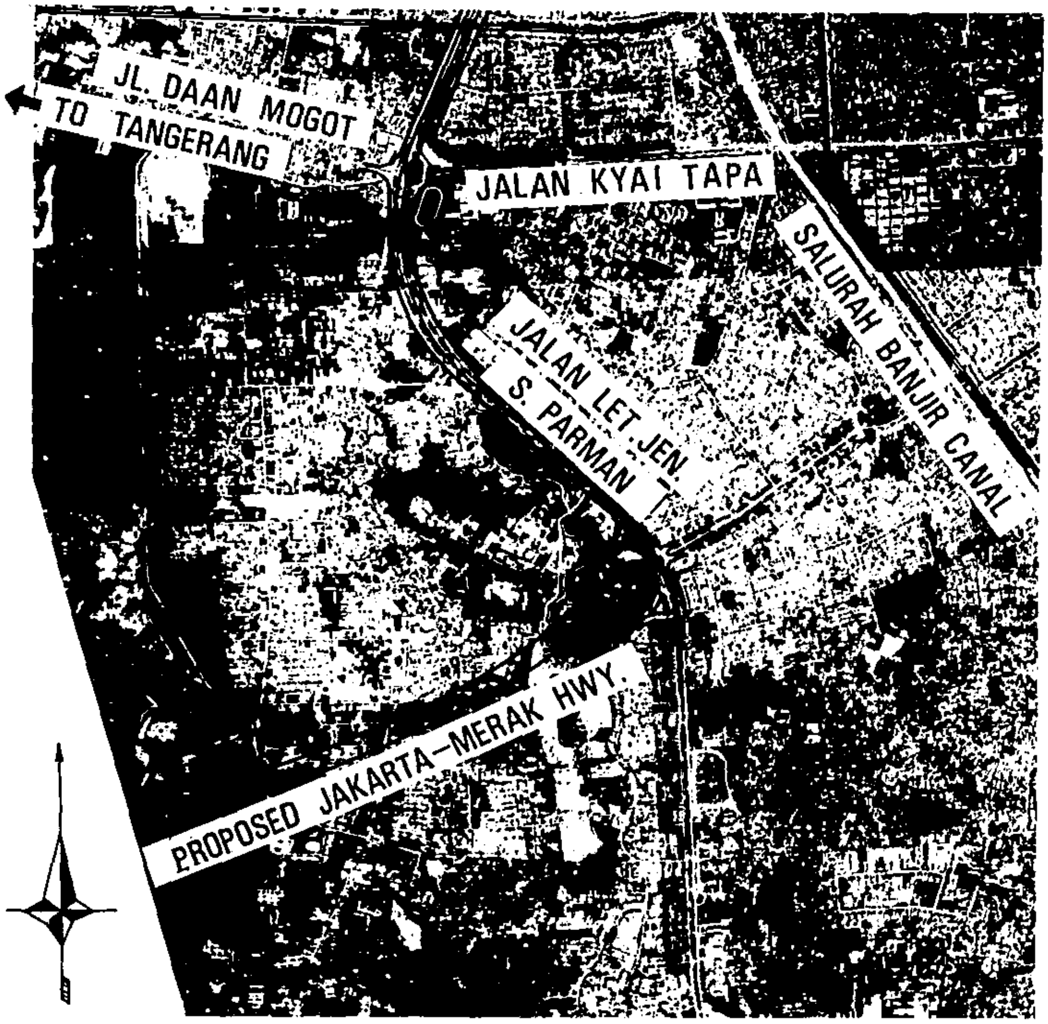
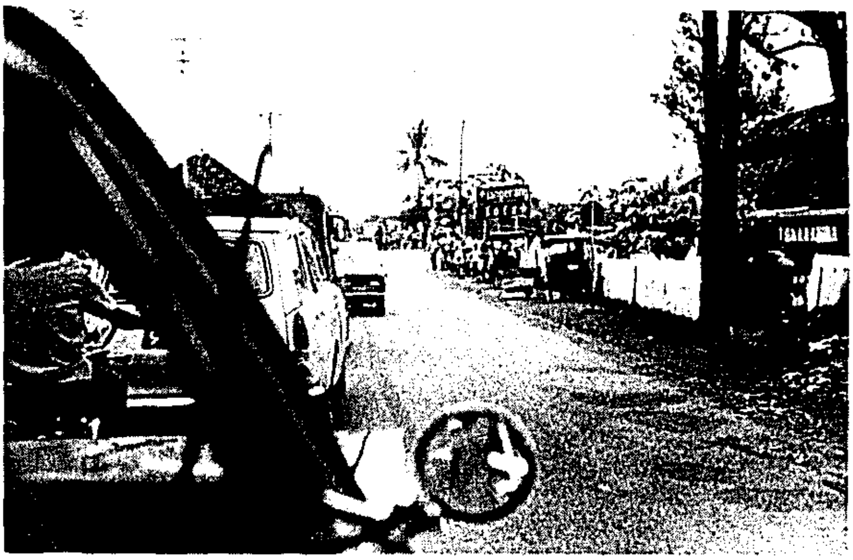
11.	MS-1 Thickness Design	Asphalt Institute
12.	1973 Annual Book of ASTM Standards	American Society for Testing and Materials
13.	Geometric Design Standards for Highways Other than Freeways	American Association of State Highway Officials
14.	AASHO Interim Guide for Design of Pavement Structures,1972	"
15.	Peta Djalan Raja Seluruh, Indonesia	Departmen Pekerdjaan Vmum Dan Tenaga
16.	Report on Urban O-D Surveys	Ministry of Construction, Japan

17.	Highway Capacity Manual	Bureau of Public Roads U.S.
18.	Ordinance on Highway Structure	Ministry of Construction, Japan
19.	Report on the Feasibility Study of the Bangkok-Thonburi Ring Road Project Part II	Overseas Technical Cooperation Agency
20.	The Explanation and Application for Geometric Design Standards	Japan Highway Association
21.	Earth Work Manual for Highways	"
22.	Manual for Bituminous Pavement	"
23.	Highway Design Standard	Japan Highway Public Corporation
24.	Hasil Perhitungan Lalu-Lintas Rutin Klas, A, B, C Tahun 1971	Dinas Perancang Dit. Espran Dit. Jen Bina Marga
25.	Rencana Pembangunan Jawa Barat	Directorate General of Housing, Building Planning and Urban Development
26.	Jabotabek	"
27.	Data Processing Origin-Destination Survey August-September,1969	Dit. Espran Dit. Jen Bina Marga
28.	Outline of the Principles and Proposals for the 5-year Program of Jakarta Metropolitan Area Transportation Study	
29.	Proyeksi Penduduk Indonesia 1971-1981	Biro Pusat Statistik
30.	Feasibility Study Trans-Java Highway	Lyon Associates, Inc.
31.	Pendapatan Nasional Indonesia National Income of Indonesia 1968-1971	Biro Pusat Statistik
32.	Survey Sosial Ekonomi Nasional Tahap Keempat (Oktober 1969-Desember 1969)	"
33.	Report on the Survey for the Development of Iron and Steel Industry in Indonesia	Overseas Technical Cooperation Agency

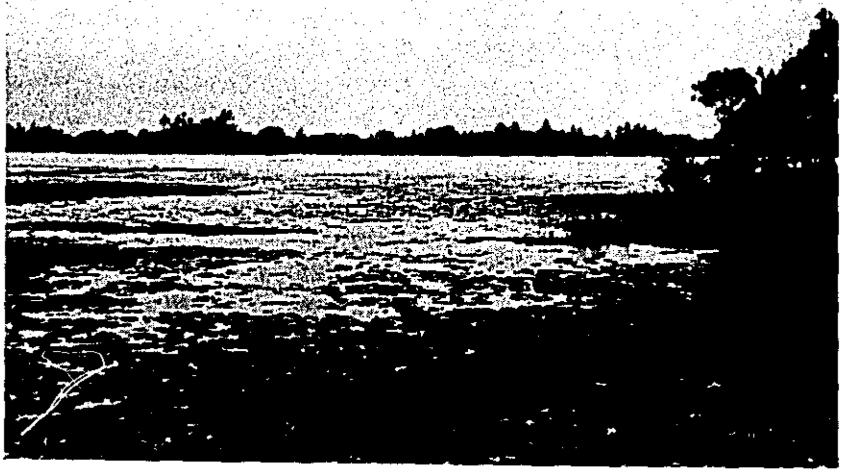


Aerial photograph showing Grogol area and a junction for proposed Jakarta-Merak highway

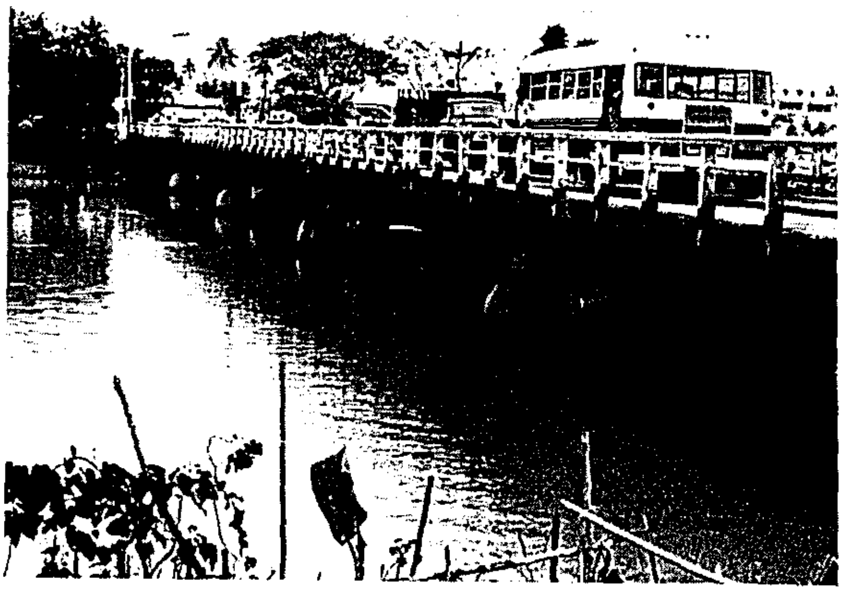
Existing Grogol intersection



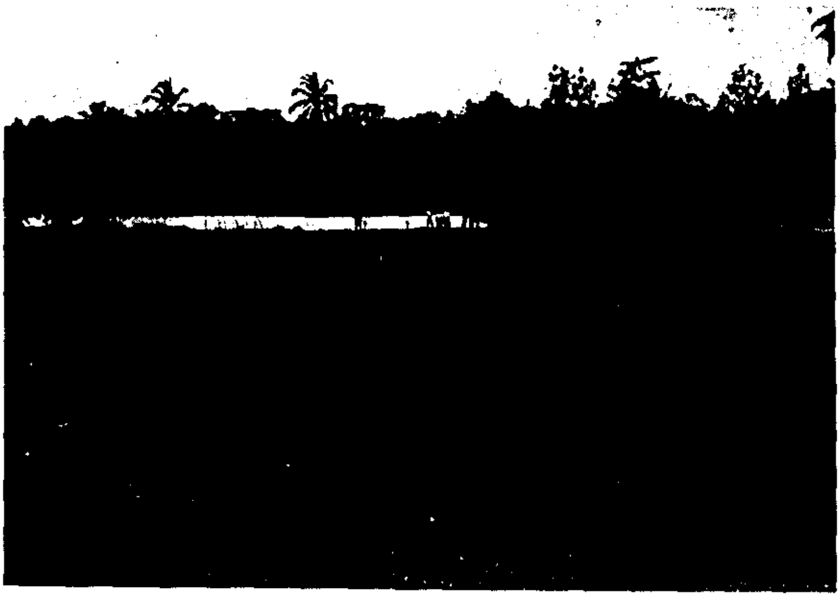
Existing road section between Jakarta
and Tangerang



Rawa Cipondoh



Existing Ci Sadane bridge: The Tangerang city develops centering around Ci Sadane river



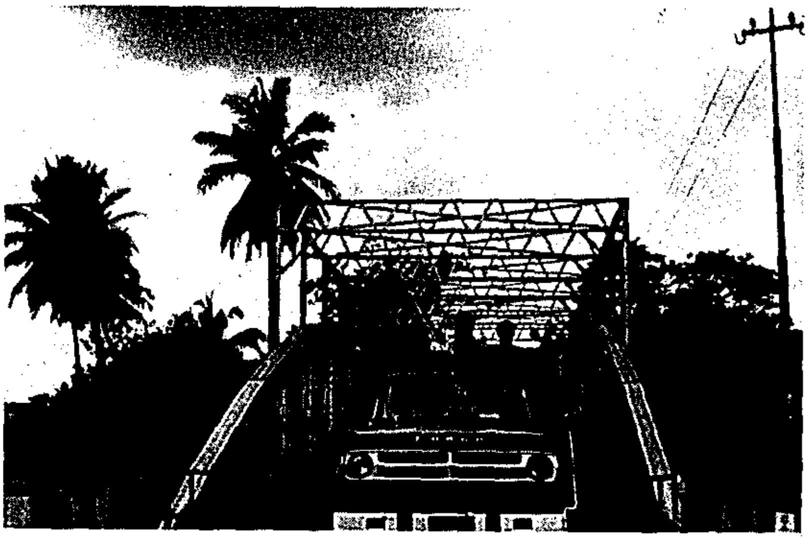
Proposed bridge site over Ci Sadane river
for alternative II

The walls of an old brick house recording
the past flood level

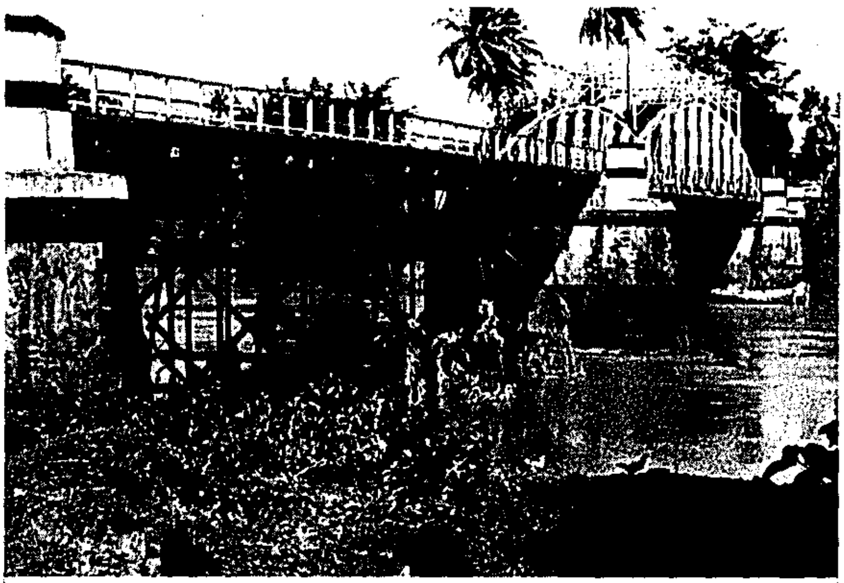
In alternative I, a bridge site for the Ci Sadane river is proposed about 1.2 kilometer downstream of existing bridge

After crossing the Ci Sadane river the proposed route passes through flat terrain which is starred with numerous Rawa and swampy areas: Gregarious nipa plants showing the one of those swamps

A view of existing road in the improvement section



Existing Ci Ujung bridge



Same above

Proposed Ci Jung bridge site (Alternative II)

Existing road section to be relocated

A section of national road in Serang city: many Becas are found running along the existing route and impede the flow of vehicles

Congested street in Cilegon city