7.2 Physical Condition Survey

7.2.1 Inventory for Existing Roads and Bridges

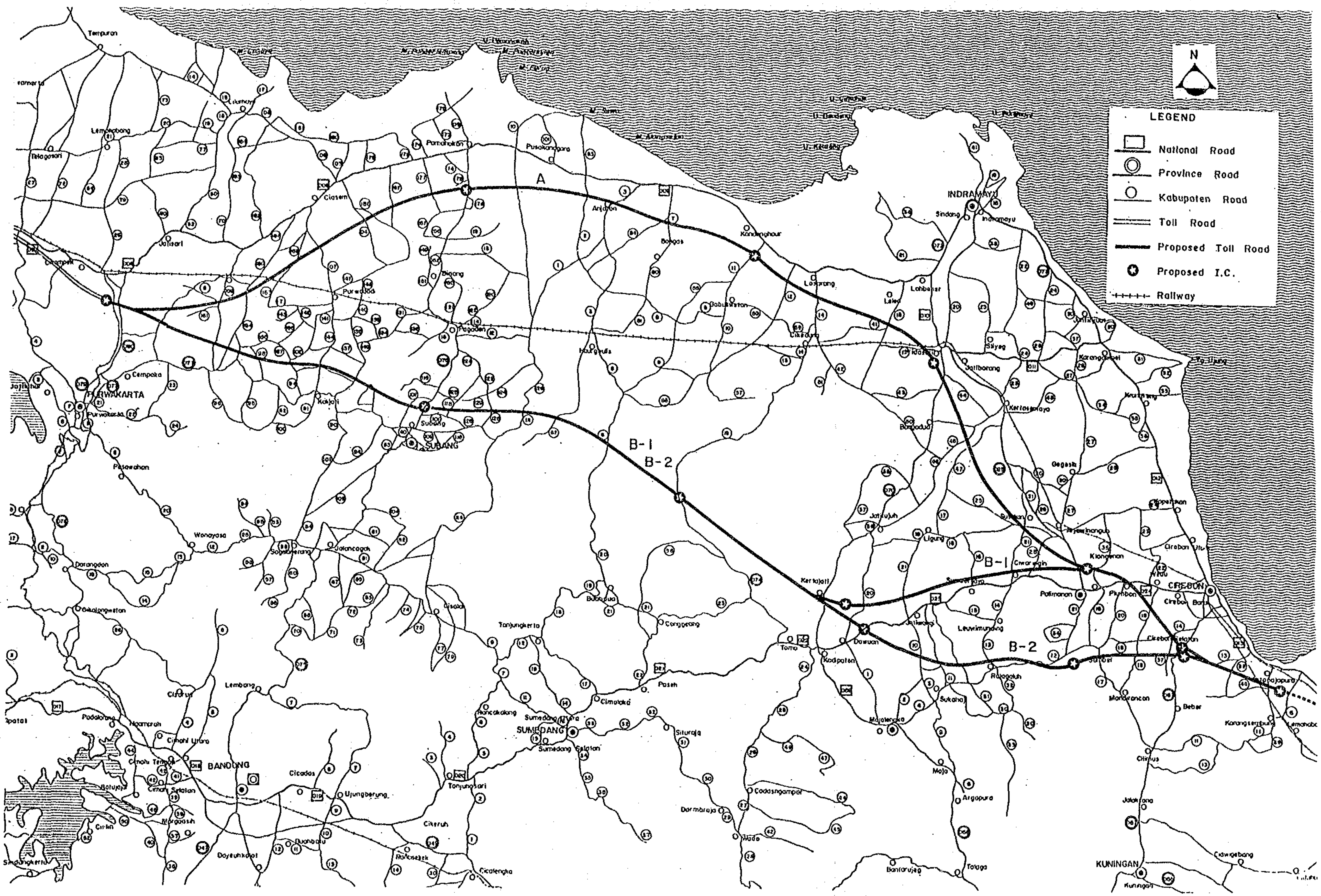
The existing (year 1987) inventory of national and provincial roads and bridges was found to be satisfactorily completed.

The inventory includes the classification of road, width of each component, pavement and drainage conditions. However, the existing inventory of Kabupaten roads only include the description for pavement type and route number.

The existing road network in the study area is shown on Fig. 7.2.1.

Based on the above records, field surveys were made on the existing roads, mainly at locations for crossing and connection points and at places close to possible alternative routes.

After any necessary corrections arising from the field survey, the inventory of crossing and connecting roads with interchanges were compiled as shown in Table 7.2.1 to Table 7.2.4.



Feasibility Study on Cikampek - Cirebon Tollway Project | Fig. 7.2.1 Road Map

Table 7.2.1 Inventory of Crossing and Connecting Road
National and Provincial Road (Route A)

Route No.	Classification: Status	Function	Roadway: Width (m)	Type of Pavement	Condition	L.Shoulder: Width (m)	Condition	R.Shoulder: Width (m)	Condition	Total Road Width	Remarks	Location
												Cikampek
080	Provincial	Arterial	6.0	Nacas	good	2.0	good	2.0	good	10.0	cross	
												Pamanukan
076	Provincial	Collector	6.0	PM-2	fair	2.0	good	2.0	good	10.0	cross	
												Kandanghaur
												Jatibarang
070	Provincial	Local	4.0	PM-2	good	1.0	fair	0.0	-	5.0	cross	
025	Provincial	Arterial	7.0	Laston	good	3.0	good	2.0	good	12.0	cross	
												Palimanan
024	National	Arterial	8.0	Butas	good	2.0	good	2.0	good	12.0	cross	
												Cirebon
067	Provincial	Collector	6.0	PM-2	good	2.0	fair	2.0	fair	10.0	cross	
												Cirebon
013	National	Arterial	7.0	Laston	good	2.0	good	2.0	god	11.0	connect	Timur
											with I/C	

Table 7.2.2 Inventory of Crossing and Connecting Road
National and Provincial Road (Route B-1)

Route No.	Classification		Roadway			L.Shoulder		R.Shoulder		Total Road Width	Remarks	Location
	Status	Function	Width (m)	Type of Pavement	Condition	Width (m)	Condition	Width (m)	Condition			
												Cikampek
080	Provincial	Arterial	6.0	Nacas	good	2.0	good	2.0	good	10.0	cross	
												Suban
076	Provincial	Collector	6.0	PM-2	fair	2.0	good	2.0	good	10.0	cross	
												Cikedung
070	Provincial	Local	6.0	PM-2	good	1.0	good	1.0	good	8.0	cross	
												Dawuan
023	National	Arterial	6.0	PM-2	good	2.0	good	2.0	good	10.0	connect	
025	Provincial	Arterial	7.0	Lastn	good	3.0	good	2.0	good	12.0	cross	
												Palimanan
024	National	Arterial	8.0	Butas	good	2.0	good	2.0	good	12.0	cross	
												Cirebon
067	Provincial	Collector	6.0	PM-2	good	2.0	fair	2.0	fair	10.0	cross	
												Cirebon
013	National	Arterial	7.0	Lastn	good	2.0	good	2.0	good	10.0	connect	Timur
											with I/C	

Table 7.2.3 Inventory of Crossing and Connecting Road

National and Provincial Road (Route B-2)

Route	Classification		Roadway			L.Shoulder		R.Shoulder		Total		
No.	Status	Function	Width (m)	Type of Pavement	Condition	Width (m)	Condition	Width (m)	Condition	Road Width	Remarks	Location
												Cikampek
080	Provincial	Arterial	6.0	Nacas	good	2.0	good	2.0	good	10.0	cross	
												Suban
076	Provincial	Collector	6.0	PM-2	fair	2.0	good	2.0	good	10.0	cross	
												Cikedung
070	Provincial	Local	6.0	PM-2	good	1.0	good	1.0	good	8.0	cross	
												Dawuan
023	National	Arterial	6.0	PM-2	good	1.0	good	1.0	good	8.0	cross	
												Sumber
067	Provincial	Collector	6.0	PM-2	good	2.0	fair	2.0	fair	10.0	cross	
												Cirebon
013	National	Arterial	7.0	Lastn	good	2.0	good	2.0	good	11.0	connect	Cirebon
											with I/C	Timur

Table 7.2.4 Inventory of Crossing and Connecting Road

Kabpaten Road

Location	Route A		Route B-1		Route B-2	
Kabpaten	No.	Pave.type	No.	Pave.type	No.	Pave.type
Suban	168	earth	05	asphalt	05	asphalt
Suban	159	earth	97	earth	97	earth
Suban	160	earth	98	earth	98	earth
Suban	163	earth	94	gravel	94	gravel
Suban	07	asphalt	07	asphalt	07	asphalt
Suban	04	earth	89	earth	89	earth
Suban	185	earth	87	earth	87	earth
Suban	186	earth	85	earth	85	earth
Suban	177	earth	107	earth	107	earth
Suban	11	asphalt	118	earth	118	earth
Suban	190	gravel	128	earth	128	earth
Suban	189	earth	111	earth	111	earth
Indramayu	02	earth	52	gravel	52	gravel
Indramayu	03	asphalt	06	asphalt	06	asphalt
Indramayu	54	gravel	15	asphalt	15	asphalt
Indramayu	07	asphalt	-	-	-	-
Indramayu	11	asphalt	-	-	-	-
Indramayu	12	asphalt	-	-	-	-
Indramayu	14	asphalt	-	-	-	-
Indramayu	16	asphalt	-	-	-	-
Indramayu	17	asphalt	-	-	-	-
Indramayu	45	asphalt	-	-	-	-
Indramayu	47	asphalt	-	-	-	-
Majalenka	-	-	20	asphalt	20	asphalt
Majalenka	-	-	21	asphalt	10	asphalt
Majalenka	-	-	16	asphalt	13	asphalt
Majalenka	-	-	-	-	12	asphalt
Cirebon	25	asphalt	31	asphalt	17	asphalt
Cirebon	31	asphalt	28	asphalt	15	asphalt
Cirebon	28	asphalt	36	asphalt	37	gravel
Cirebon	36	asphalt	18	asphalt	38	asphalt
Cirebon	18	asphalt	14	asphalt	09	asphalt
Cirebon	14	asphalt	37	gravel	-	-
Cirebon	37	gravel	38	asphalt	-	-
Cirebon	38	asphalt	09	asphalt	-	-
Cirebon	09	asphalt	-	-	-	-
Number of crossing		32		26		24

7.2.2 Soil Condition

1) Soil Investigation

A soil investigation for the proposed tollway was executed along the potential alignment in order to obtain the necessary data for preliminary design and cost estimation.

The soil investigation mainly consisted of:

a) Boring with Standard Penetration Test

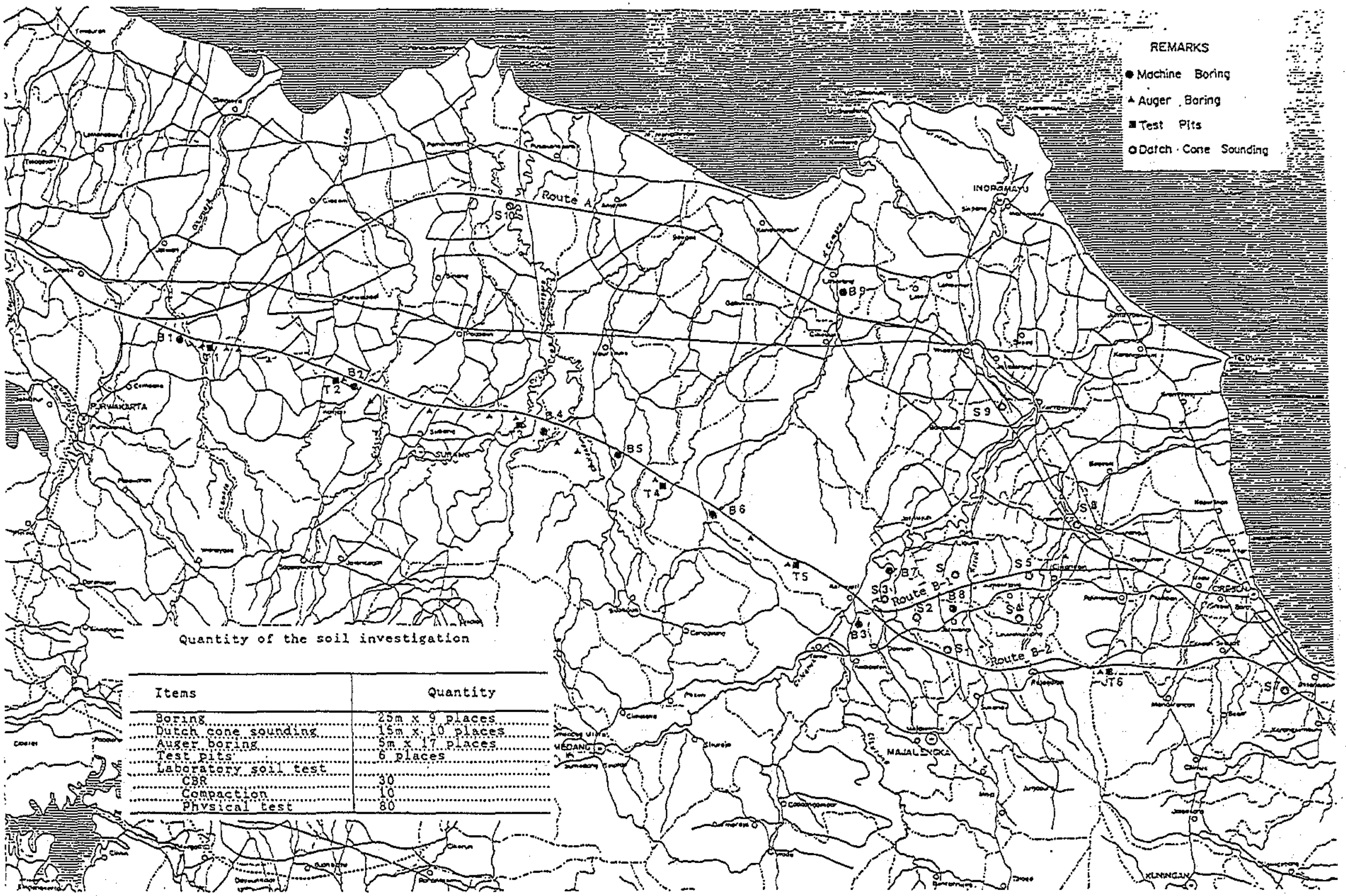
To clarify the condition of bearing layer for bridge foundations.

b) Auger Boring and Test Pits

To clarify the sub-surface condition and characteristics of the subgrade and borrow material.

c) Dutch Cone Sounding

To explore the existence of soft subsoil stratum and its thickness. The location of the soil investigation positions are shown in Fig. 7.2.2.



Quantity of the soil investigation

Items	Quantity
Boring	25m x 9 places
Dutch cone sounding	15m x 10 places
Auger boring	5m x 17 places
Test pits	6 places
Laboratory soil test	
CBR	30
Compaction	10
Physical test	80

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Fig. 7.2.2 Location Map of Soil Investigation

2) Soil Profile

a) Alternative Route A

One machine boring and three dutch cone soundings were executed around the alternative route A for the purpose of clarifying the existence of soft subsoil layer. Fig. 7.2.3 shows the results of boring and dutch cone sounding.

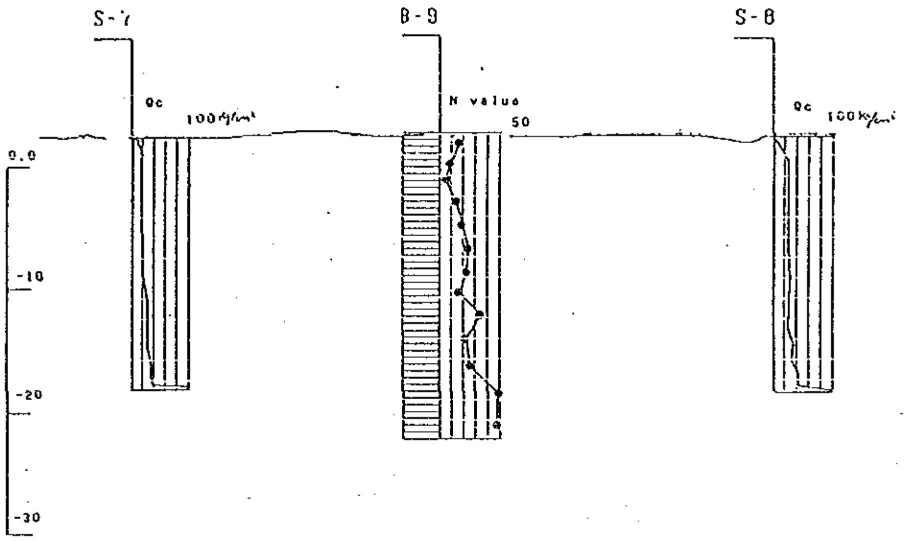

Fig. 7.2.3 Boring and Dutch Cone Sounding Results

Most sections of the alternative route A are planned to pass over alluvial plain; however, no soft subsoil strata which may require subsoil stabilization for consolidation settlement or for slip failure of the road embankment was found. The bearing layer for pile foundation was found at a depth of 20 m at the only one boring taken along this route.

b) Alternative Route B

Along the alternative route B, machine boring at 8 locations, auger boring at 17 locations and dutch cone sounding at 8 locations were executed. Fig. 7.2.4 shows the findings of the field soil investigation. According to the results of soil investigation, the subsoil strata along the alternative route B is composed of residual soil with highly weathered material of tuffaceous stone and secondary sedimentation whose materials mainly consist of clayey soil, however some deep portions of the stratum has tuffaceous sand clay and silt.

Result of Soil Investigation

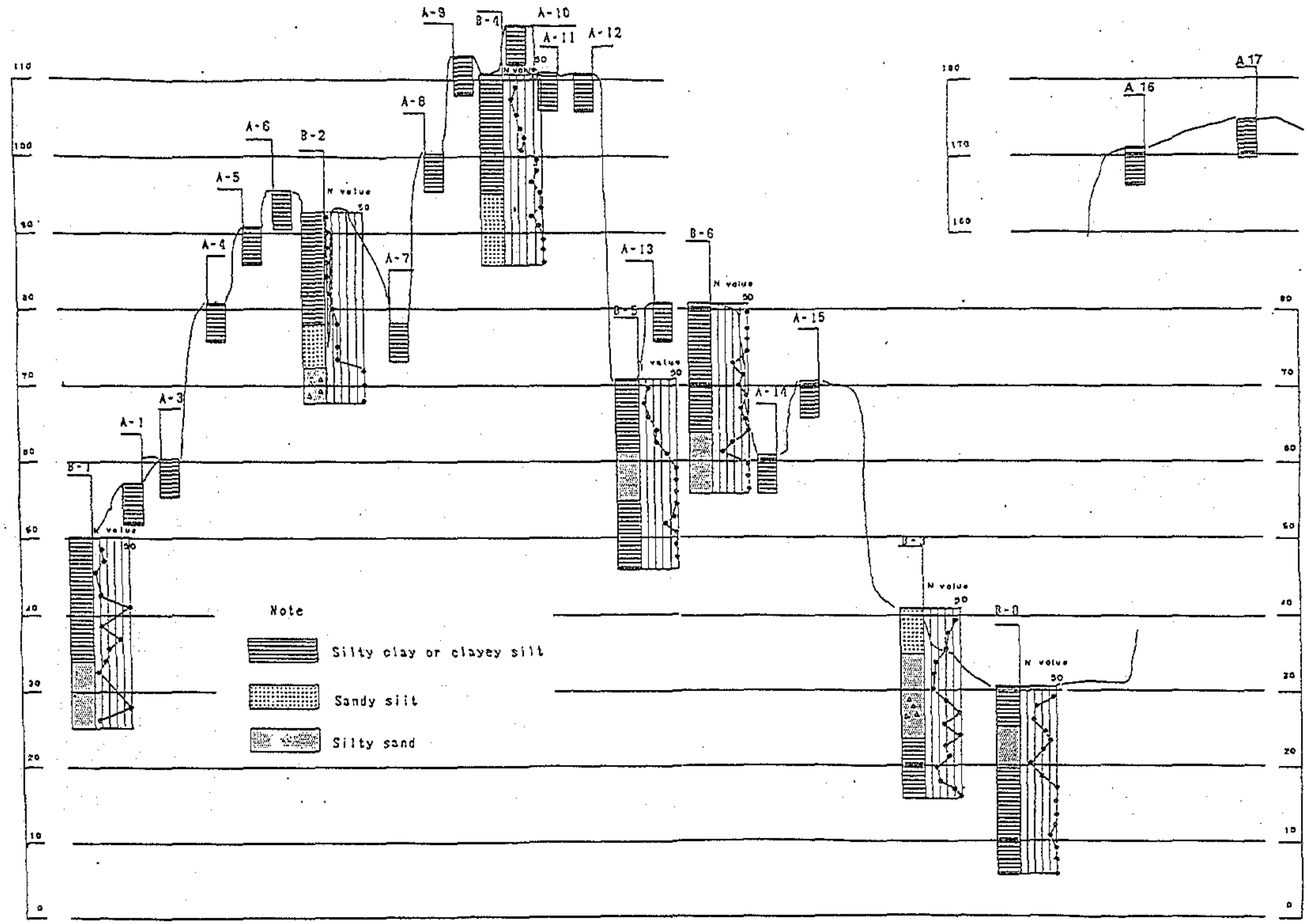

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Fig. 7.2.4 Result of Boring and Dutch Cone Sounding

Relative stiffness or density measured by the standard penetration test (N value) ranges widely from 7 to more than 50, this is because the strata are composed of weathered material and are not homogeneous. However, the bearing layer which could be utilized as pile foundation is found at the depth of between 10 to 20 m.

3) Soil Properties

To clarify the soil property of subgrade and embankment material, auger boring, test pits and laboratory soil tests including compaction and CBR tests were executed.

Most of the material for embankment and subgrade will be clayey silt of reddish lateric soil collected around route B. The characteristics of the material, in accordance with laboratory soil tests are as follows:

a) Consistency

The liquid limit ranges from 60 to 100%, the plastic limit ranges from 30 to 60%; consequently, the soil is classified as high plasticity soil, see Fig. 7.2.5 for plasticity chart. However, the soil is stable because the natural water content ranges nearly as that of the plastic limit and is relatively low. On the plasticity chart, the liquid limit and plasticity index are distributed along or below the A line and the liquid limit is greater than 50%. Accordingly, the soil is classified as CH or MH (high plasticity clay or silt) on the basis of Unified Soil Classification.

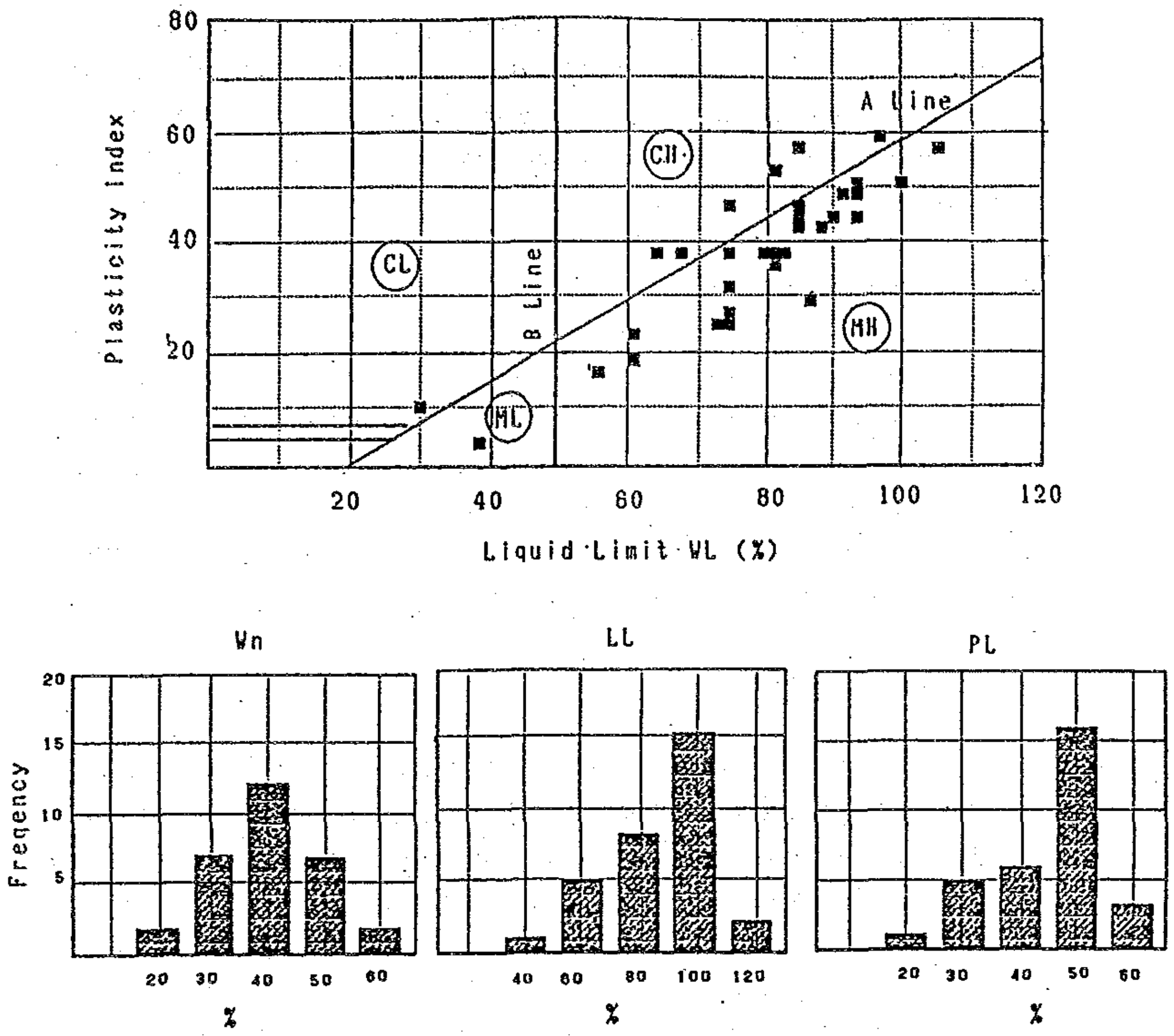

Fig. 7.2.5 Plasticity Chart

b) Particle Size Distribution

Fig. 7.2.6 shows particle size distribution curve. The material contains 5 to 20% of sand, 30 to 60% of silt and 5 to 20% of clay fraction respectively.

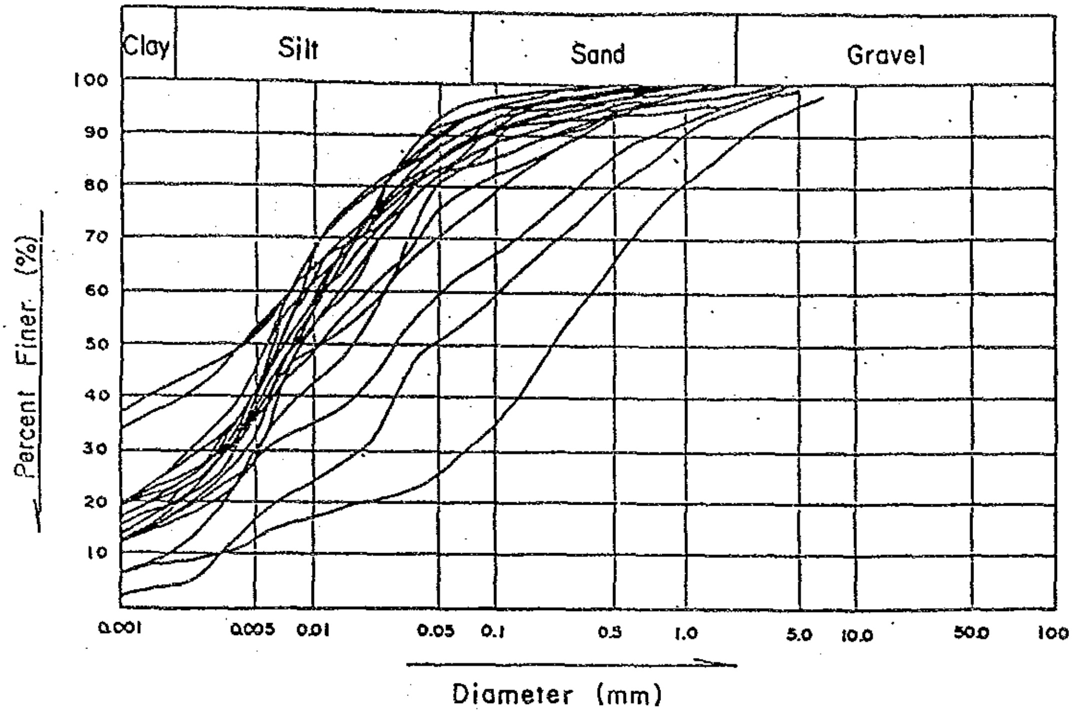

Fig. 7.2.6 Particle Size Distribution Curve

c) Moisture Content, Dry Density and CBR

Table 7.2.5 show the characteristics of the material obtained from test pits, and Fig. 7.2.7 shows the relationship between water content, dry density and CBR tested by the ASTM T-180 method.

Optimum moisture content ranges from 20 to 35% and maximum dry density ranges from 1.30 to 1.55 g/cm^3, except for sandy soil. Natural moisture content ranges from 30 to 50% and is slightly higher than the optimum moisture content. However, compaction work using the material at optimum moisture content will be possible on condition that the earth work is executed during the dry season. As the CBR value related to 95% of maximum dry density ranges from 4 to 8%, and in-situ dry densities are corresponding with 95% of maximum dry density, 5% for design CBR value could be utilized for subgrade of both the embankment and cutting area.

However, in a few sections unsuitable materials are present and not suitable for use as subgrade due to high natural moisture content. For those sections, such measures, as replacement by good quality materials or lime stabilization shall be applied.

Table 7.2.5 Characteristic of Material

Sample No	Depth m	Wn %	Field Dry Dens. g/cm3	PI	Contents 74u under %	rd max g/cm3	OMC %	Modified CBR %
TP-1 (1)	1.3	35.0	1.23	44.4	94.0	1.50	26.0	4.6
TP-1 (2)	4.0	51.0	1.26	44.7	82.1	1.43	26.0	4.7
TP-2 (1)	1.5	45.1	1.16	59.7	97.0	1.23	37.5	4.0
TP-2 (2)	2.5	43.2	1.17	36.1	87.7	1.24	37.0	4.9
TP-3 (1)	1.5	43.4	1.18	25.7	96.0	1.31	34.0	8.5
TP-3 (2)	2.5	45.8	1.2	24.8	93.0	1.31	32.3	8.6
TP-4	1.0	51.9	1.16	52.3	93.4	1.56	21.5	8.5
TP-5	0.6	51.9	1.39	38.3	86.6	1.62	17.0	5.5
TP-6	0.6	38.5	1.4	2.9	33.2	1.72	22.5	10.7

Wn Natural moisture content
PI Plasticity Index
OMC Optimum Moisture Content
CBR California Bearing Ratio

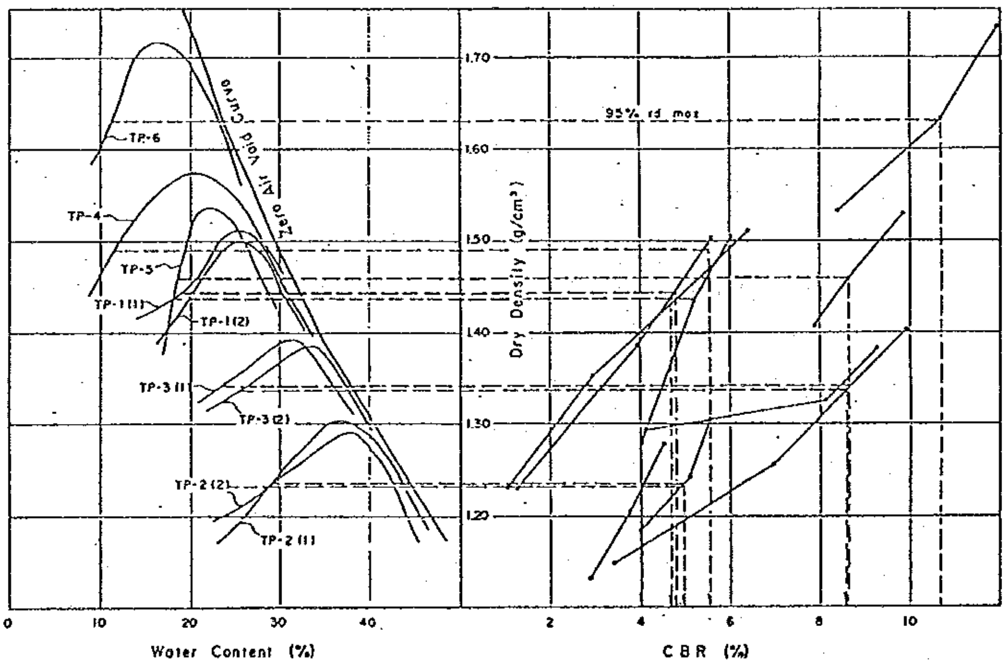

Fig. 7.2.7 Water Content, Dry Density and CBR

7.3 Hydraulic Survey

7.3.1 General

The study area is crossed by numerous rivers and channels and is located along a heavy rainfall isohyetal line with a mean annual rainfall of between 1000 mm to 2500 mm.

The provision of adequate drainage is extremely important for avoiding flood problems, maintenance of the road, and traffic safety. Therefore, attention was paid to widths of waterways which the planned tollway will cross.

7.3.2 Field Survey

1) Hearings

Hearings were carried out in the study area to collect, as far as possible, data on past flood conditions.

According to all the hearings conducted, flood levels were lower than the height of existing road surfaces and no flood damage had occurred to existing main roads within the study area.

2) Field Survey

Field surveys were carried out to investigate existing bridges which are near the site where the planned tollway will cross over major and minor rivers.

The major check points were as follows:

a) Bridge location
b) Bridge length and river or channel width
c) River bed
d) Stream flow
e) Clearance from bridge to stream surface

7.3.3 Rainfall

A number of observation stations exist in the study area and have been in operation for varying lengths of time.

Data from many observation stations were selected and analyzed; Fig. 7.3.1 shows the location of eleven (11) rainfall observation stations, falling within the study area, which were used for rainfall data analysis. The result of analysis of the maximum daily rainfall at different places in the study area is shown in Table 7.3.1. The rainfall data at station No. 14 (Cirebon) is selected for the estimation of the probable rainfall intensity for study purposes.

Table 7.3.1 Maximum Daily Rainfall

(Years of Observation 1965 - 1976)

(mm)

Station No.	Station Name	Return Period					
		5	10	20	30	50	100
J-112a	Cikampek	133	149	164	173	184	199
J-113b	Cikalong	122	142	161	173	186	205
J-138	Pasir Bungir	122	143	164	175	190	209
J-156	Subang	159	182	203	216	231	252
P-193	Udjung Jaya	149	176	203	218	236	262
P-194	Sumedang	125	145	165	176	190	209
C-9	Sumurwatu	131	154	177	190	206	228
C-14	Kertasmaya	156	186	214	230	251	278
C-21	Kadipaten	132	143	153	159	166	176
C-35	Wiahar	129	152	174	187	203	224
C-41	Majalengka	140	152	164	170	179	190

J- : Jakarta
P- : Priangan
C- : Cirebon

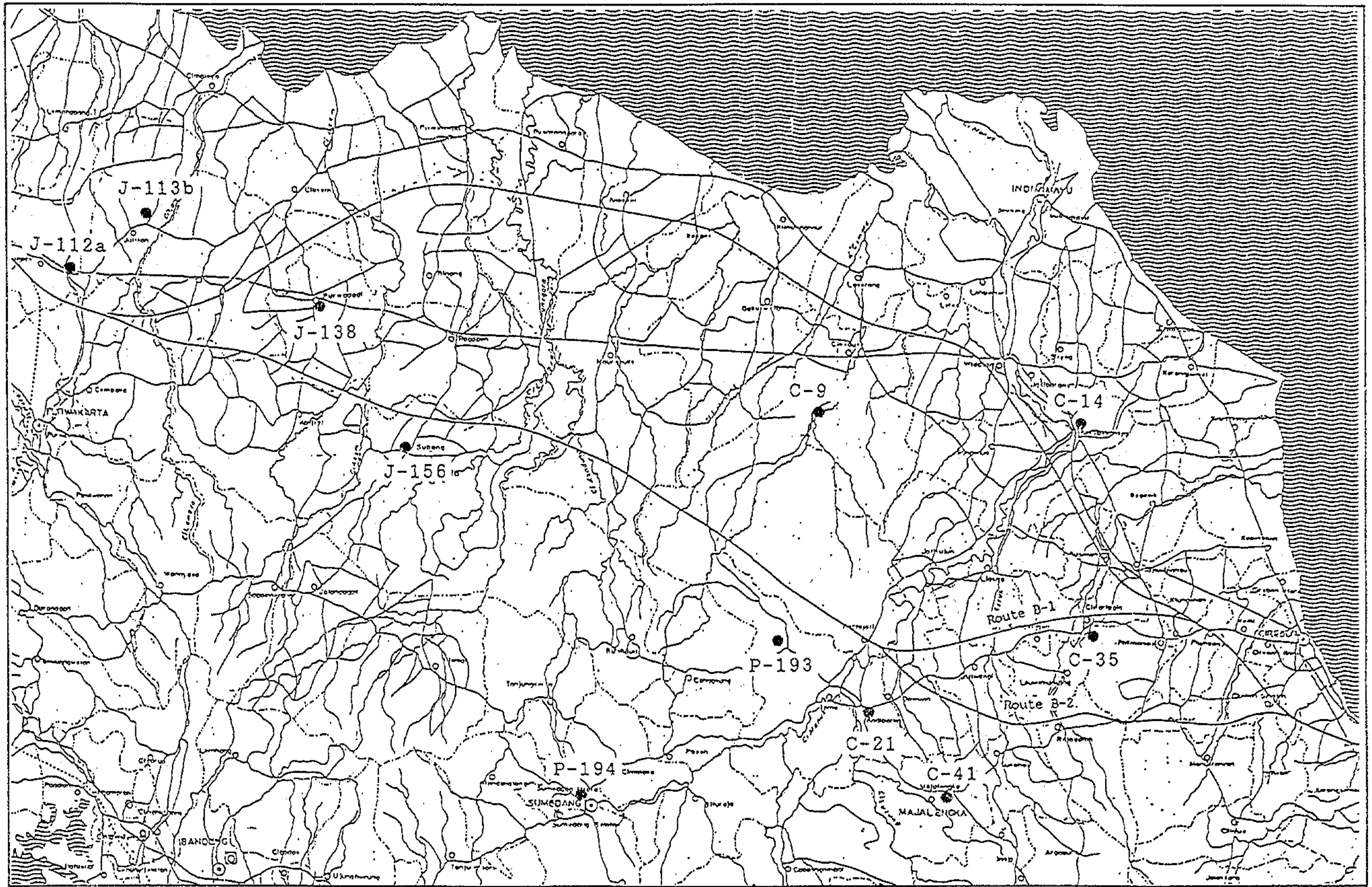

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Fig. 7.3.1 Location of Rainfall Observation Stations

7.3.4 Run-off

1) Return Period

A hydraulic study has been carried out to compute the 50 year and 100 year flood return period. The reason for selecting the above return periods is to accord to the TOLL ROAD & BRIDGE DESIGN MANUAL, MAY 1985, which states that minimum clearance distances must be established as follows:

- Structures over rivers and canals should clear a fifty-year storm flow by 180 cm or a one hundred-year storm flow by 120 cm.

- The freeboard clearance is from the calculated or recorded high water profile, whichever is higher, to the lowest point under the bridge.

2) Method of Estimating Run-off

Estimation of run-off for each river or drainage structure is based on the rational formula.

a) The Rational Formula

The rational formula is expressed as follows:

$$Q=\frac{1}{3.6}\cdot f\cdot r\cdot A$$

where: Q = Peak discharge (m^3/sec)
f = Coefficient of run-off
r = Intensity of rainfall for the estimated time of concentration (mm/hour)
A = Catchment area (km^2)

b) Coefficient of Run-off

In estimating the coefficient of run-off, a variety of geological and ground conditions are taken into consideration.

Generally the values are determined as follows:

Mountainous region	f = 0.7 - 0.85
Field or grassfield	f = 0.4 - 0.6
Paddy field	f = 0.7 - 0.8
Inhabited area	f = 0.7 - 0.9

(In this study, f = 0.8 was used.)

c) Intensity of Rainfall

Intensity of rainfall is expressed by Mononobe as follows:

$$rt = \left(\frac{R24}{24} \times \frac{24}{Tc}\right)^{2/3}$$

where: rt = Rainfall intensity (mm/hour)

R24 = Maximum daily rainfall (mm)

Tc = Concentration Time (hour)

d) Concentration Time

The concentration time was established by V. Kaven as follows:

$$T = \frac{L}{W} \quad \text{(hour)}$$

$\frac{H}{L}$	$\frac{1}{100} <$	$\frac{1}{100} - \frac{1}{200}$	$\frac{1}{200} >$
W (m/sec)	3.5	3.0	2.1

where: T = Concentration Time

L = River length

W = Maximum speed of flow

e) Catchment Area

Catchment areas of main rivers were measured on maps having a scale of 1/50,000 and referred to INVENTARISARI SUNGAI DI JAWA DAN MADURA, No. 3, No. 4.

7.3.5 Hydraulic Design Principle

1) Hydraulic Design of Culverts

The purpose of hydraulic design is to determine the type and size of culvert that will most economically accommodate the flow of the stream. Reinforced concrete box culverts and pipe culverts were planned in minor rivers and channels. The size of box culvert was determined based on run-off calculations and flow capacity calculations using Manning's formula. The minimum diameter of pipe culvert was set at 100 cm for easy maintenance. The total flow capacity for box and pipe culverts is decided by multiplying the design flow capacity area by 1.25.

2) Hydraulic Design of Bridges

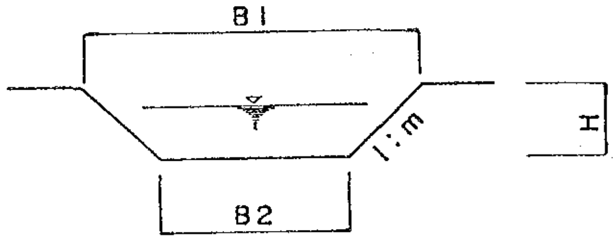
Hydraulic computations for the bridge were made to determine the bridge length and vertical clearance. (Refer to 7.3.4)

7.3.6 Results of Hydraulic Design Study

1) Minor Rivers and Channels

Standard modules were adopted to estimate flow capacity of existing minor rivers and channels. Cross sections were assumed by field survey and flow capacity was calculated using Manning's formula. The results are shown in Table 7.3.2.

Table 7.3.2 Flow Capacity of Minor Rivers and Channels



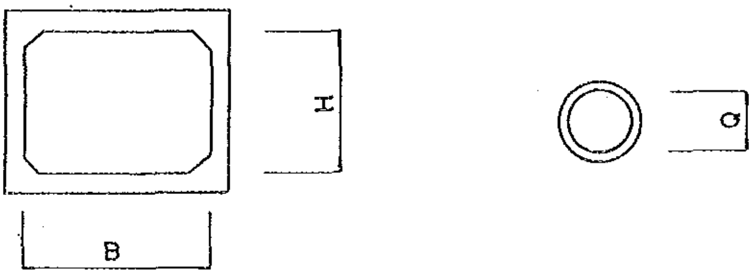
Module	B1 (m)	B2 (m)	H (m)	m	V (m/sec)	Q (m^3/sec)
1	3.0	1.0	1.0	1	1.3	1
2	4.0	2.0	1.0	1	1.5	4
3	5.0	2.0	1.5	1	1.8	9
4	10.0	4.0	1.5	2	2.0	21
5	15.0	7.0	2.0	2	2.5	55
6	20.0	8.0	3.0	2	3.2	133

Where : Q ; 100 % flow capacity

2) Culverts

The flow capacity of planned culverts was estimated to decide inlet openings that were assumed for general use. The results are shown in Table 7.3.3.

Table 7.3.3 Flow Capacity of Culverts



Module	B (m)	H or Q (m)	A (m^2)	$\bar{V}$ (m/sec)	Q (m^3/sec)
1	——	1.0	0.6	2.1	1
2	2.0	2.0	3.2	3.4	11
3	2.0	2.5	4.0	3.6	14
4	3.0	3.0	7.2	4.5	32
5	3.0	3.5	8.4	4.6	39
6	4.0	4.0	12.8	5.4	69
7	4.0	4.5	14.4	5.6	80
8	5.0	5.0	20.0	6.3	126

Where : A ; 80% area of culculated area
Q ; 80% capacity of culculated flow

3) Main Rivers

Design discharge and design flood stage of main rivers were estimated. Cross sections were determined by field surveys and the results are shown in Table 7.3.4 and Table 7.3.5.

Table 7.3.4 Design Discharge of Main Rivers (1)

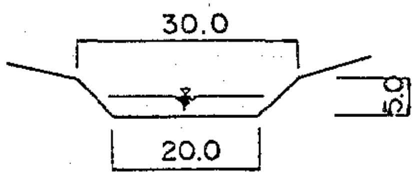
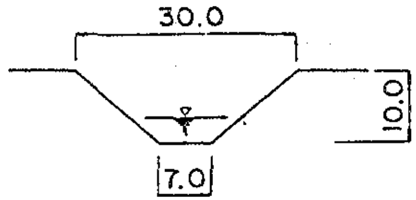
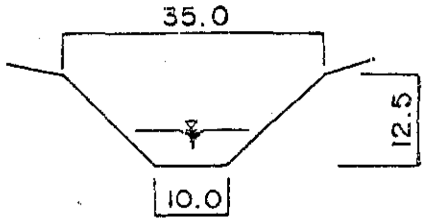
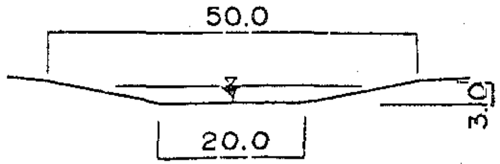
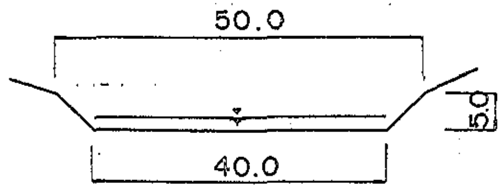
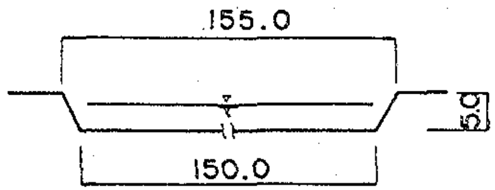
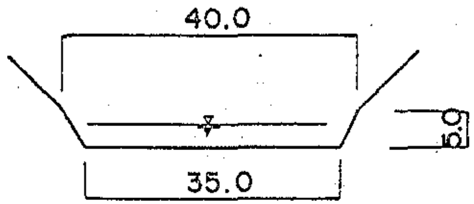
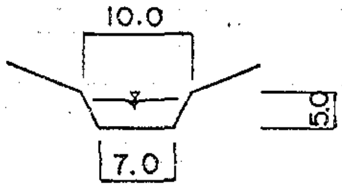
River Name	Station	Existing Section	River Length	Catchment Erea	Discharge	Floed Level
CILAMAYA	101+600		47 Km	151 Km^2	136 m^3/sec	2.5 m
CIBODAS	120+440		24 Km	73 Km^2	103 m^3/sec	3.5 m
CIASEM	123+760		37 Km	167 Km^2	176 m^3/sec	4.5 m
CILAMATAN	138+630		35 Km	164 Km^2	179 m^3/sec	2.5 m

Table 7.3.5 Design Discharge of Main Rivers (2)

River Name	Station	Existing Section	River Length	Catchment Area	Discharge	Floed Level
CIPANAS	161 + 120		29 Km	75 Km^2	93 m^3/sec	1.5 m
CIMANUKU	B - 1 180 + 940		294 Km	2436 Km^2	644 m^3/sec	3.5 m
	B - 2 180 + 160		290 Km	2337 Km^2	623 m^3/sec	3.5 m
CIKERUH	B - 1 189 - 80		27 Km	131 Km^2	170 m^3/sec	3.0 m
	B - 2 192 + 900		17 Km	76 Km^2	134 m^3/sec	2.5 m
CIWARINGIN	B - 1 198 + 950		26 Km	60 Km^2	80 m^3/sec	4.0 m
	B - 2 198 - 850		11 Km	21 Km^2	50 m^3/sec	3.0 m

7.4 Design Criteria

7.4.1 General

The applicable criteria and elements of design are in conformity with the latest requirements of the Directorate General Bina Marga.

Unless otherwise stated in the following, all design criteria are in conformity with the standard specifications for geometric design, road, bridge, pavement and drainage design of tollway and freeway as published by Bina Marga (Code No. 13 A/1976).

7.4.2 Road Design Criteria

Because flat terrain is predominant within the study area, major deviations from current Government design standards are unlikely for all alternative proposed routes. 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:

1) Design Speeds

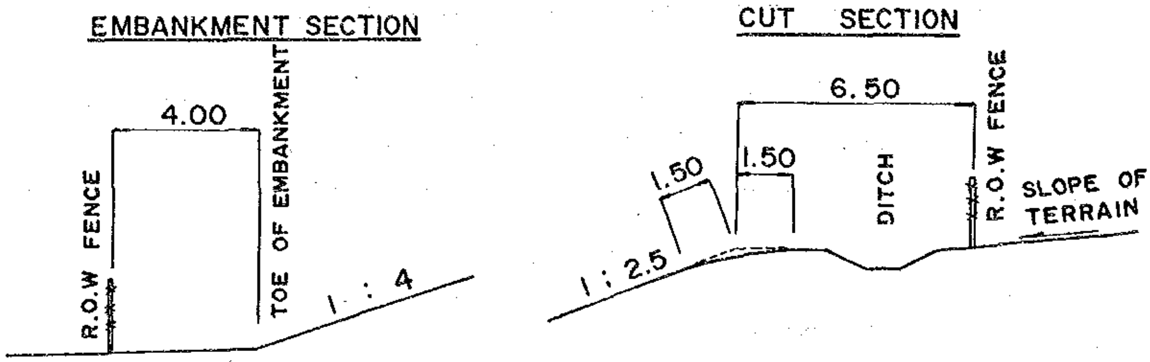
Since the terrain is favorable except for part of alternative Route B-2, a high volume, high speed highway can be constructed at reasonable cost.

The following design speeds were applied to the various types of roads in this project:

Tollway	:	120 km - 100 km/hr
Feeder roads	:	80 km/hr
Interchange loops	:	40 km/hr
Major crossing roads	:	80 km/hr
Minor crossing roads	:	60 km/hr

2) Reserve R.O.W. Width

Right-of-way width assigned to the project should anticipate all practical future expansion. For the determination of the right-of-way, the following basic marginal strip is adopted as shown in the diagrams below.



For the comparative study, it is assumed that the width is 70 m on average for the entire length for each alternative.

3) Lane Width

No modifications or changes are made to the current Government standard of 3.6 m.

4) Shoulder

The government standard of 3.00 m and 1.50 m are adopted for outer shoulder and inner shoulder respectively.

5) Median

The minimum width of 5.00 m is considered sufficient allowance for the construction of piers of flyover bridges and drainage structures.

6) Crossfall of Carriageway

For quick drainage of surface rain water, a crossfall of 2.0% for flexible pavement and 2.5% for rigid pavement is adopted for both the tollway carriageway and interchange ramps.

7) Crossfall of Shoulder

Both shoulders are generally 4% with slope towards outside.

8) Vertical Curve

Minimum length of crest vertical curves as determined by sight distance requirements generally are satisfactory from the standpoint of safety, comfort, and appearance.

For overall safety on tollway, a sag vertical curve should be long enough so that the light beam distance is nearly the same as the stopping sight distance. The resulting length of vertical curves for the upper value of the range of stopping sight distance for each design speed are shown in Fig. 7.4.1.

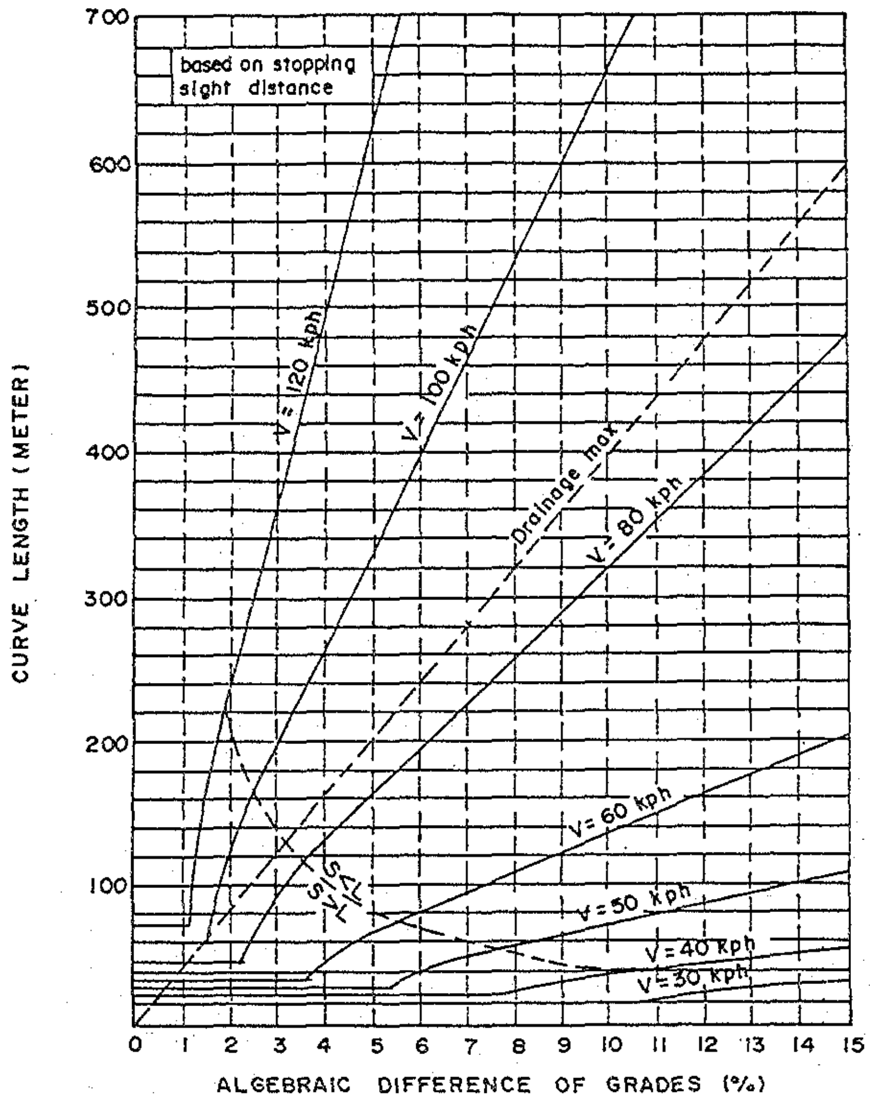
9) Minimum Horizontal Radii

The largest radius of curvature compatible with the topographic conditions should be used whenever possible. In view of gentle terrain being predominant, large minimum horizontal radii are recommended for the tollway. On the other hand, care must be taken not to use long straights as they induce sleep and distract the driver's forward attention.

The following Table 7.4.1 presents the recommended design criteria applicable for the proposed tollway.

Table 7.4.1 Highway Geometric Design Criteria

Item	Unit	Recommended Design Criteria	Government Standard
Terrain	-	flat & rolling	flat & rolling
Design speed	km/h	120	120
Reserve R.O.W. width	meter	as designed	50/60
Lane width	meter	3.60	3.60
Outer shoulder width	meter	3.00	3.00
Inner shoulder width	meter	1.50	1.50
Median width	meter	5.00	9.00
Crossfall of pavement	%	2.0 in case of Flexible pavement 2.5 in case of Rigid pavement	
Type of pavement	-	Asphalt concrete or Cement concrete	-
Maximum superelevation	%	7	7
Minimum radii	meter	760	760
Maximum gradient	%	5	5
Stopping sight distance	meter	225	225
Minimum vertical curve length	meter	see Figs.	-



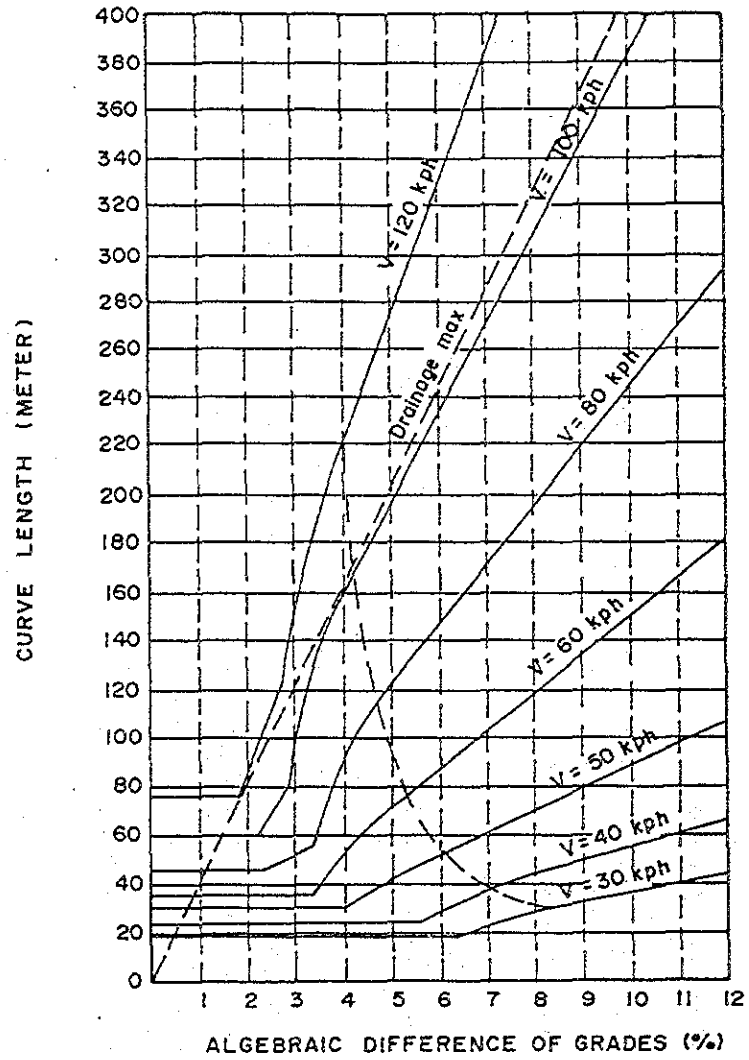


Fig. 7.4.1 Length of Crest Vertical Curve and Length of Sag Vertical Curve

7.4.3 Bridge Design Criteria

1) General

Based on the determined design standards the preliminary design will be carried out for the chosen alignment. The criteria to be used for bridge design are as below.

2) Adoption of concrete Bridges

Both the concrete bridge and steel bridge are technically possible but there are certain inherent advantages and disadvantages in each of these alternatives. It is clear that steel bridges are more costly than concrete bridges, both in initial construction and maintenance. Bridges within the study area will mostly be planned with spans of between 10 m to 40 m.

Considering the above, concrete bridges will be adopted for the preliminary design.

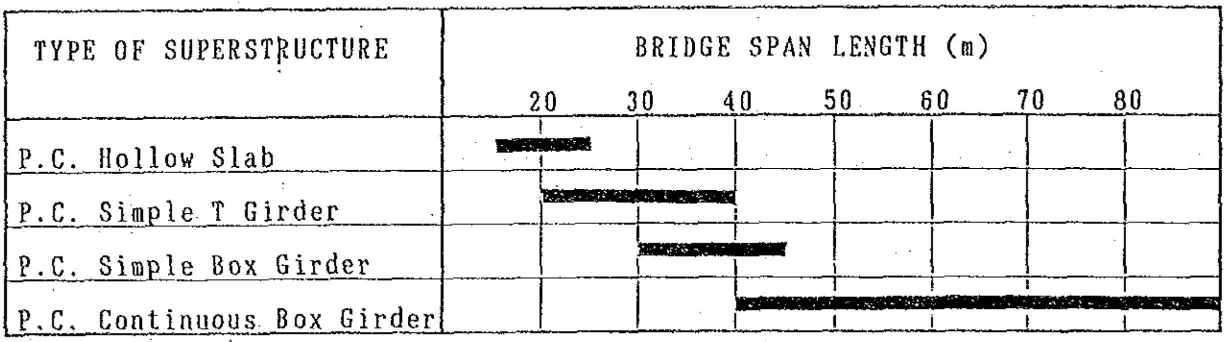
3) Functional Requirement of Superstructure

a) Span Length

Span length is one of the most important factors in determining the bridge type because once the span length is fixed then the choice of bridge type is limited.

The general relationship between span length and bridge type is shown in Table 7.4.2. The minimum span length of a bridge is generally determined by the kind of road, river, channel or railway over which the bridge is required to pass, as well as the soil conditions, and factors relating to the immediate surrounding.

Table 7.4.2 Bridge Type and Normal Span Length



b) Depth Ratios

A beam or girder has a desirable design ratio of depth to length of span which will result in minimum construction cost, and this depth ratio is generally adopted.

c) Standard Modules

Standard modules of bridges were adopted to decide span lengths, as is shown in Fig. 7.4.2 and Fig. 7.4.3.

4) Bridge Design Criteria

a) Loading Specifications

The loading specifications to be used for the design of structures are specified in Specifications for Highway Bridges, No. 12/1970, by Bina Marga.

However, for those requirements of design not covered by the above specifications, AASHTO or Japanese Specifications for Highway Bridges will be applied.

According to the above specifications by Bina Marga, the following loads and forces are to be used in computing the stresses.

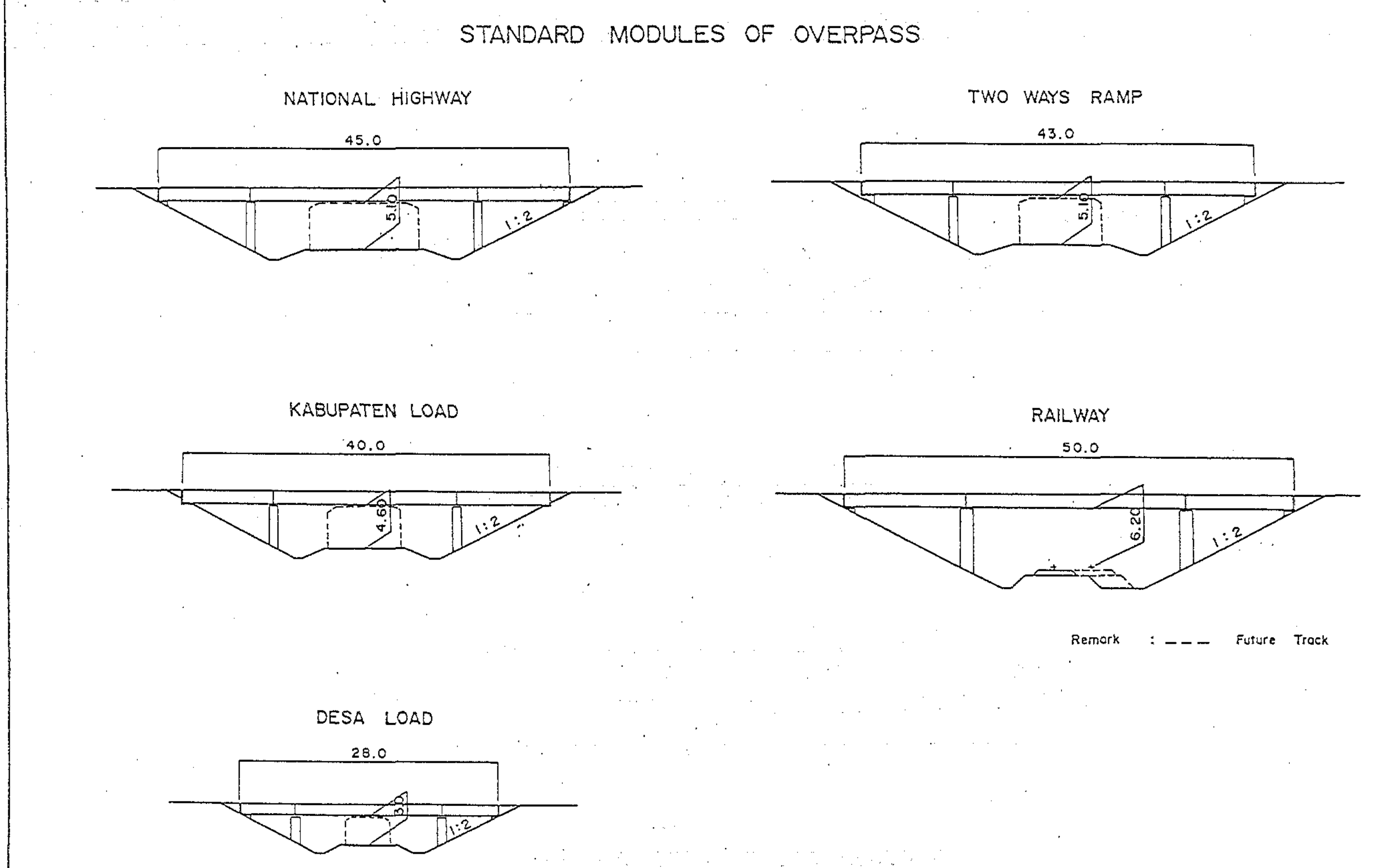


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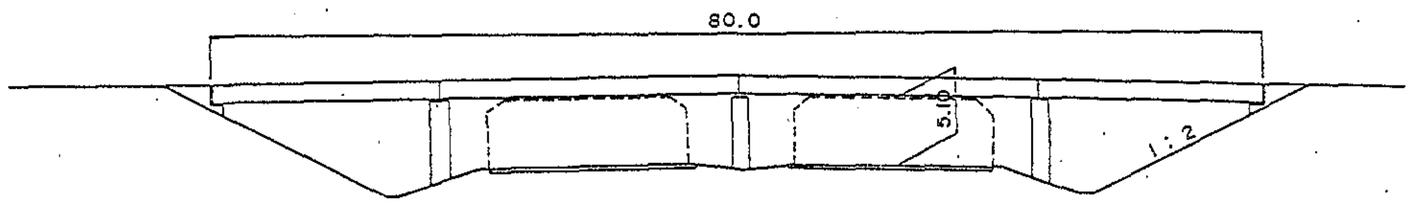
Fig. 7.4.2 Standard Module of Overpass

STANDARD MODULE OF UNDERPASS

SCALE . 1 : 400



CONTINUOUS BRIDGE (CIMANUK)

SCALE . H. 1 : 2000 , V . 1 : 400

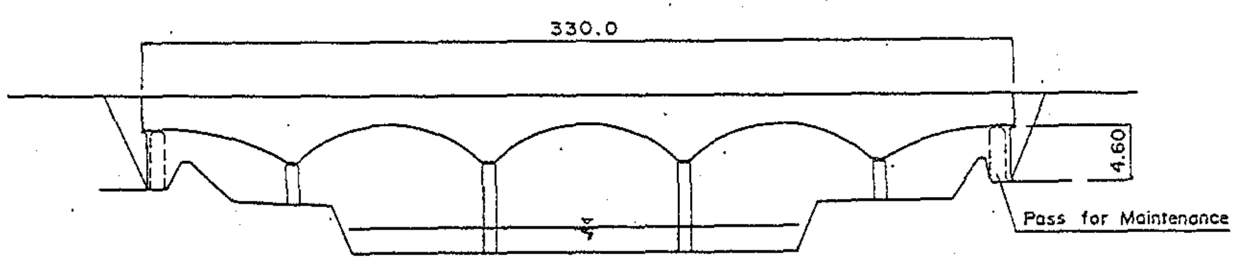


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Fig. 7.4.3 Standard Module of Underpass and Continuous Bridge

i) Primary Loads

- Deal load
- Live load
  Class I Loading, 100% "T" Load and 100% "D" Load (B.M. 100)
- Impact
  The uniform load of the "D" shall not be multiplied by an important coefficient.

ii) Secondary Loads

- Wind loads
- Thermal forces
- Shrinkage forces and creep
- Brake and friction forces

iii) Certain Circumstance Loads

- Earthquake stress
  (The study area falls in earthquake zone, Region II as per specification data supplied.)
- Earthpressure
- Earthpressure resulting from earthquake
- Centrifugal force
- Force from friction at expansion bearings
- Collision force
- Force and loads during the construction
- Force of stream current and floating materials

b) Materials and Basic Strengths

i) Concrete

The use of each class of concrete and required strengths are as shown in Tables 7.4.3 and 7.4.4 respectively.

ii) Reinforcing Steel

Type, designation and yield strength of reinforcing steel for concrete structures are specified in Table 7.4.5.

iii) Prestressing Steel

Nominal diameter and yield and breaking strengths of prestressing steel are shown in Table 7.4.6.

c) Allowable stresses

i) Concrete

The allowable stresses of each class are as shown in Table 7.4.7 and Table 7.4.8.

ii) Reinforcement

The allowable stress for each type and designation of reinforcing steel is as shown in Table 7.4.9

iii) Prestressing Steel

The allowable stresses for each type of prestressing steel are as shown in Table 7.4.10.

Table 7.4.3 Concrete Class and Use

Class of Concrete	Use of Each Class of Concrete
A-1	Prestressed concrete box girders
A-2	Prestressed concrete hollow slabs
A-3	Precast prestressed concrete I-girders
A-4	Precast prestressed concrete hollow core slab units
A-5	Precast prestressed concrete T-girders
B-1	Reinforced concrete slabs and cross beams of prestressed concrete I-girder bridge
B-2	Cast in place reinforced concrete piles
B-3	Pipe culverts
B-4	Reinforced concrete for bridge deck slab
B-5	Reinforced concrete for pier columns and cantilevered pier heads except for pedestrian bridge
C-1	Stairs of pedestrian bridge
C-2	Reinforced curbs
C-3	Piers for pedestrian bridge
C-4	Abutment, piers except for columns, approach slabs, retaining walls, foundation of street lighting poles
C-5	Box culverts including wing walls
D	Gravity type retaining walls, non-reinforced curbs
E	Levelling concrete, backfill concrete in masonry structure
AA	Prestressed concrete piles

Table 7.4.4 Concrete Class Strength

Class of Concrete	Minimum Compressive Strength at 28 days	
	By Cube Test	By Cylinder Test
A-1 to A-5	400	346
B-1 to B-5	350	290
C-1 to C-5	250	210
D	150	130
E	100	80
AA	600	500

Table 7.4.5 Type, Designation and Yield Strength of Reinforcing Steel

(kg/m2)

Type	JIS G 3112		ASTM A 615		Indonesian Standard
	Designation	Yield Strength	Designation	Yield Strength	
Round Bar	SR 24	24	Grade 40	28	As applicable
Deformed Bar	SD 30	30	Grade 60	42	As applicable

Table 7.4.6 Notation, Nominal Diameter and Strength of Prestressing Steel

Notation	Nominal Diameter	Yield Strength	Breaking Strength	Applicable Standard	
	(mm)	(kg/mm2)	(kg/mm)	JIS	ASTM
PC Wire SWPR 1	7	135	155	G3536	A 421
PC Wire SWPR 1	8	130	150	G 3536	A 421
PC 7-Wire Strand SWPR 7A	T12.4	150	175	G 3536	A 416
PC 7-Wire Strand SWPR 7B	T12.7	160	190	G 3536	A 416
PC 9-Wire Strand SWPR 19	T19.3	162	189	G 3536	A 416
PC 9-Wire Strand SWPR 19	T21.8	161	187	G 3536	A 416
PC Bar SBPR 80/95	23	80	95	G3109	A 422

Table 7.4.7 Allowable Stress of Concrete for Prestressed Concrete Structure

(kg/cm^2)

Designation	Class of Concrete					
	AA	A-1 A-2	A-3	A-4	A-5	B-1
Allowable Compressive Stress due to Bending						
- Temporary Stress before Losses due to Creep and Shrinkage	210	152	152	162	152	143
- Stress at Service Load after Losses have occurred	170	119	119	129	119	117
Allowable Axial Compressive Stress						
- Temporary Stress before Losses due to Creep and Shrinkage	160	121	121	121	121	107
- Stress at Service Load after Losses have occurred	135	93	93	93	93	83
Allowable Tensile Stress due to Bending						
- Temporary Stress before Losses due to Creep and Shrinkage	-	12.9	12.9	12.9	12.9	11.7
- Due to Deal Load and Supcrimposed Load	-	0	0	0	0	0
- Due to Dead Load, Superimposed and Live Load	-	12.9	12.9	12.9	12.9	11.7
Allowable Shearing Stress						
- Stress at Service Load	-	4.8	4.8	4.8	4.8	4.4
- Stress at Ultimate Load due to Shear Force or Torsional Moment	-	44	44	44	44	39
- Stress at Ultimate Load due to Shear Force and Torsional Moment	-	52	52	52	52	47
Allowable Diagonal Tension Stress						
- Stress at Service Load due to Shear Force or Torsional Moment	-	8.6	8.6	8.6	8.6	8.4
- Stress at Service Load due to Shear Force or Torsional Moment	-	11.6	11.6	11.6	11.6	11.0

Table 7.4.8 Allowable Stress for Reinforced and Plain Concrete Structure

(kg/cm²)

Designation	Class of Concrete			
	B-2	B-3, - 5	C-1, - 5	D
Allowable Compressive Stress due to Bending	77	97	70	31
Allowable Axial Compressive Stress	63	82	55	31
Allowable Shearing Stress	3.8	4.4	3.6	-

Table 7.4.9 Allowable Stress of Reinforcement

(kg/cm²)

Designation	SR 24	SD 30
Allowable Tensile Stress		
- General use	1400	1800
- Under water	1400	1600
Allowable Compressive Stress	1400	1800

Table 7.4.10 Allowable Stress of Prestressing Steel

(kg/mm^2)

Designation	PC Wire SWPR 1 7 mm	PC Wire SWPR 1 8 mm	PC Wire SWPR 7A T12.4 mm	PC Wire SWPR 7B T12.7 mm
Initial Prestressing Work	122	117	135	145
Immediately after Prestressing Work	108	105	123	133
Stress at Service Load after Losses have occurred	93	90	105	114

Designation	PC Wire SWPR 19 T19.3 mm	PC Wire SWPR 19 T21.8 mm	PC Bar SBPR 80/95 23 mm
Initial Prestressing Work	146	145	72
Immediately after Prestressing Work	132	131	66.5
Stress at Service Load after Losses have occurred	113	112	57

7.4.4 Pavement Design Criteria

The pavement design of the tollway, ramps and of relocated and/or improved existing roads, shown in Table 7.4.11, is based on Road Note 29 for rigid pavement and Bina Marga standard for flexible pavement.

Table 7.4.11 Pavement Design Criteria

Item	Tollway			National Road	Kabupaten Road	DESA Road
	Lane	Shoulder	Ramp-way			
Rigid Pavement						
Service Life (years)	20	-	20	-	-	-
Slab Thickness (cm)	27	-	25	-	-	-
Cement treated subbase thickness (cm)	10	-	10	-	-	-
Tie Bar: diameter	D-12	-	D-12	-	-	-
length(mm)	800	-	800	-	-	-
spacing(mm)	600	-	600	-	-	-
Dowel Bar: diameter	P-27	-	P-27	-	-	-
length	400	-	400	-	-	-
spacing	300	-	300	-	-	-
Flexible Pavement						
Service life (years)	10	-	10	10	10	-
Type of Surface	Asphalt Concrete	Double dressing	Asphalt Concrete	Asphalt Concrete	Asphalt Concrete	Double dressing
Surface, thickness(cm)	4	-	4	5	5	-
Binder, thickness (cm)	6	-	5	5	5	-
Asphalt treated base thickness (cm)	15	-	13	20	16	-
Aggregate base course thickness (cm)	-	20	-	-	-	20
Aggregate subbase thickness (cm)	27	-	13	25	15	-

Note:
1. Road Note 29 (1970) was used for designing rigid pavement, but adjustment of slab thicknesses were made on the basis of Indonesian construction practice i.e. minimum 27 cm and 25 cm in thickness of slab for Tollway.
2. The use of cement treated sub-base of 10 cm in thickness was based on Indonesian construction practice and climate condition.
3. Bina Marga Standard was adopted for tie bar and dowel bar requirements.
4. Flexible pavement design was based on Bina Marga Standard.

7.4.5 Drainage Design Criteria

1) Return Period

The hydrologic and hydraulic design procedure is based on the assumption of 100 years return period for all structures and 10 years return period for the road surface drainage respectively.

The hydrologic and hydraulic design is discussed in Chapter 10.7.

2) Surface Water Drainage

It is assumed that water ponding for a very short time over limited areas will occur once in 10 years and this is acceptable in order to achieve a less costly drainage system.

Estimation of run-off for each drainage system will be based on the rational formula. Rainwater which falls on the surface flows laterally or obliquely from it under the influence of the cross slope or superelevation on the carriageway and shoulders. If the R.O.W. situation permits, a common rule for the drainage when the roadway is on fill is to let the flow continue off the shoulder and down the side slope to the side drain or ditch.

3) Drains for Bridges

Drains for bridges will be of the free fall type and will be located suitably at points where there is no traffic under the bridges.

7.5 Highway Capacity

7.5.1 Present Traffic Characteristics

Traffic on the North Coastal Route from Cirebon to Jakarta via Pamanukan and the Central Route from Cirebon to Bandung via Palimanan will be diverted to the Cikampek - Cirebon Tollway.

The characteristics of road traffic on the Cirebon-Dawuan section of the tollway will resemble the above two routes, therefore it would be appropriate to refer to the traffic characteristics obtained at the traffic survey position No. 13 (Cirebon-Palimanan).

The Dawuan-Cikampek section should resemble the traffic characteristics on the North Coastal Route and the traffic survey position No. 12 should be referred to.

The present traffic characteristics at Pos. No. 12 and 13 are as follows:

Table 7.5.1 Traffic Characteristics

	North Route Pos. No. 12	Central Route Pos. No. 13
1) Traffic volume (vehicles/day)	10,330	15,680
Passenger cars	1,917	3,958
Bus (public)(Mini+Large)	2,683	4,596
Pick-up truck	971	2,183
Truck (Micro-Large)	4,749	4,943
2) Percentage of heavy vehicles	43% {Truck 27.5%, Bus 15%}	31% {Truck 18.3%, Bus 12.8%}
Percentage of large trucks	(60%)	(59%)
Percentage of large buses	(58%)	(40%)
3) Peak ratio	6.2%	6.2%
4) Directional distribution	53%	61%

The percentage of heavy vehicles (bus and truck) on the tollway was established by using the future distribution rates of buses and trucks which were forecast based on the present value as shown in Table 7.5.2.

Table 7.5.2 Percentage of Heavy Vehicles

		Cikampek-Dawuan	Dawuan-Cirebon
Truck	Present	60%	59%
	Future	70%	70%
Bus	Present	58%	44%
	Future	65%	55%

The peak traffic ratio and the directional distribution on the tollway were established by taking account of the future traffic volume increase and the future urbanization along the tollway that were forecast by referring to the present conditions. The results are shown in Table 7.5.3.

Table 7.5.3 Peak Traffic Ratio and Directional Distribution

	Cikampek-Dawuan	Dawuan-Cirebon
1) Percentage of heavy vehicles	38% {Truck 30%, Bus 8%}	35% {Truck 28%, Bus 7%}
2) Peak ratio	7.5%	8%
3) Directional distribution	60%	65%

7.5.2 Traffic Capacity

For the following composition of cross section, the traffic capacity for each level was calculated according to the 1985 Traffic Capacity Manual (HCM) and the result is shown in Table AP 7.5.1 through AP 7.5.10.

1) Undivided 2 lanes (4 lanes for the interchange section)

2) Divided 2 lanes (with 20% for passing lane. Concrete block separation)

3) Divided 3 lanes (second lane to be used as a passing lane for both directions alternately)

4) Inner 4 lanes (median of 5 m width and guard rail separation)

5) Outer 4 lanes (depressed type median of 12.2 m width, no guard rail)

The above composition of cross section is shown in Fig. 7.5.1.

7.5.3 Number of Lanes

According to the following reasons, 4 outer lanes at the initial stage and 6 lanes at the ultimate stage should be constructed.

1) Considering the nature of the tollway as the country's principal trunk tollway, a minimum of 4 lanes is necessary.

2) Except for section K (refer to Fig. 11.1.3), the design traffic volume on all the sections of the tollway has not fluctuated to the point where the number of lanes have to be changed.

3) The service level should be maintained above C level defined by HCM. For roads with less than 4 lanes according to the estimated design traffic volume based on the present pattern, except section K (12 km length), all the sections will be able to maintain that level within a year after the opening (1998).

4) The initial investment for the outer 4 lanes or the inner 4 lanes is almost equal (less than 0.1%), however considering the agreeability of the road, the easiness for construction work in the future stage, and low costs for the completion work, the outer 4 lanes would be better.

A comparative summary of the different composition of cross sections is shown in Table 7.5.4.

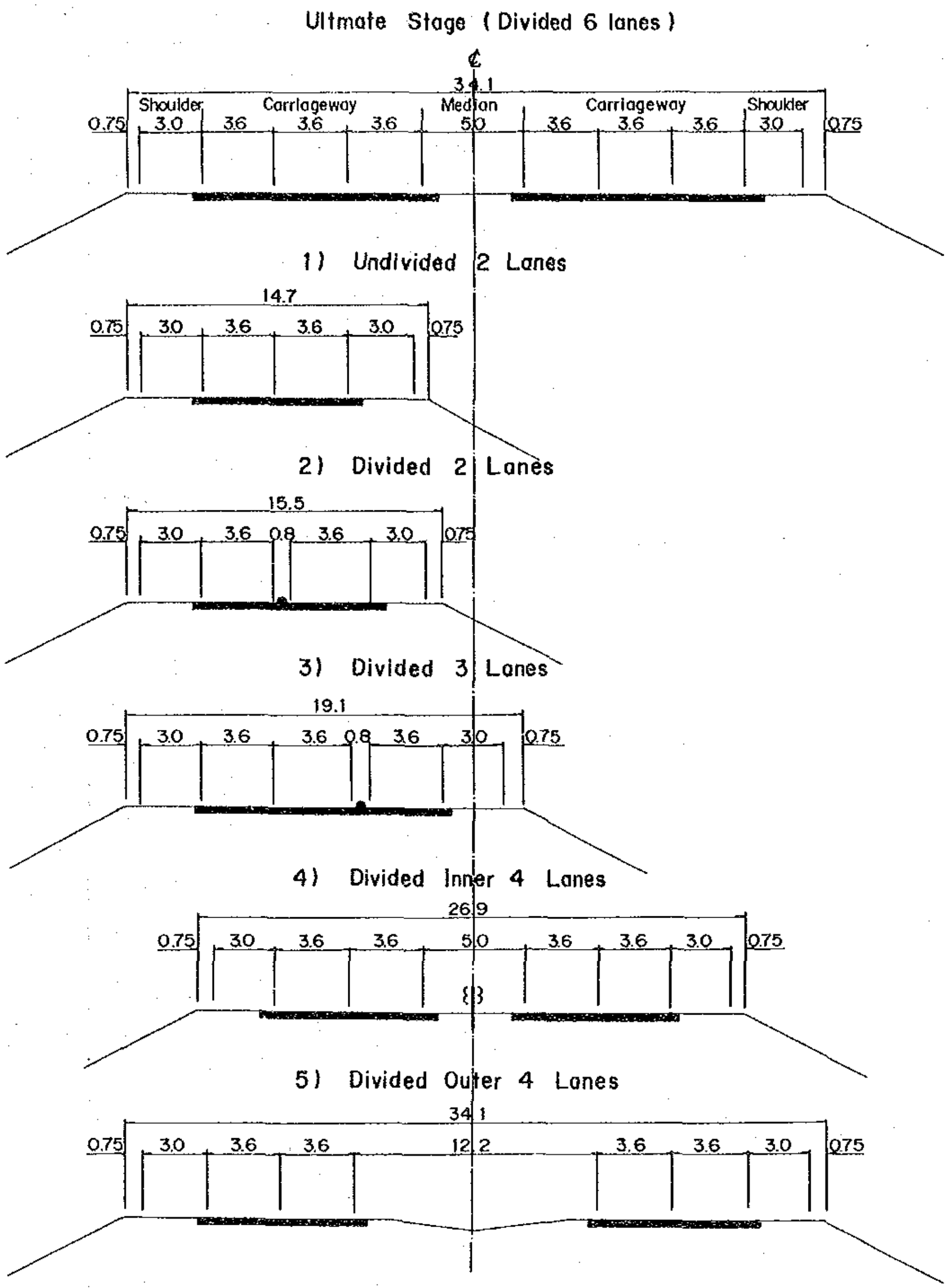


Fig. 7.5.1 Cross Section

Table 7.5.4 Comparative Summary of the Different Composition of Cross Section

	Case 1 Undivided 2 Lane	Case 2 Divided 2 Lane	Case 3 Divided 3 Lane	Case 4 Inner 4 Lane	Case 5 Outer 4 Lane
Composition of Cross Section					
Upper width of Cross Section	14.700	15.500	19.100	26.900	34.100
Width of Outer Shoulder	3.000	3.000	3.000	3.000	3.000
Width of Inner Shoulder	0.000	0.250	0.250	1.500	1.500
Width of Median	0.000	0.800	0.800	5.000	12.200
Median Barrier (Guard Rail)	nothing	nothing	nothing	establish	nothing
Passing Lane (Km)	20%	20%	50%	100%	100%
Construction Cost					
Innitial Cost (10 6Rp.)	547.400	576.600	620.900	748.000	747.539
Rate against 4-Lane	73.2%	77.1%	83.0%	100.0%	100.0%
Remainider for 4-Lane	220.900	223.100	216.700	0	0
Total Cost (10 6Rp.)	768.300	799.700	837.600	748.000	747.539
Rate against Initial 4-lane	102.7%	106.9%	112.0%	100.0%	100.0%
Traffic condition					
Max. Capacity at Rural					
LOS-B	6.050	4.830	5.960	35.330	35.330
LOS-C	9.850	9.570	10.440	47.460	47.460
Max. Capacity at Suburban					
LOS-B	5.810	4.280	5.290	27.940	27.940
LOS-C	9.460	8.490	9.260	37.530	37.530
Critical Year at B Section					
LOS-B	before 1995	before 1995	before 1995	2009	2009
LOS-C	1998	1998	1999	2011	2011
Critical Year at I Section					
LOS-B	before 1995	before 1995	before 1995	2011	2011
LOS-C	1998	1998	1998	after 2015	after 2015
Safety	serious	poor	poor	good	good
Passing Condition	poor	20%	50%	good	good
Emergency Parking Condition	good	good	good	good	good
Suitability of Classification	poor	poor	poor	good	good
Difficulty of Extending Work	good	fair	fair	fair	good
Main Extra Work	one side of slope plotection one side of sign replacement	one side of slope plotection one side of sign replacement	one side of slope plotection one side of sign replacement	both side of slope plotection both side of sign replacement	nothing
Problems against Standard	nothing	barried median	barried median	nothing	nothing

CHAPTER 8. ALTERNATIVE ROUTE STUDY

CHAPTER 8. ALTERNATIVE ROUTE STUDY

8.1 Identification of Alternative Routes

8.1.1 Preliminary Alignment Study

As a first step towards alternative route consideration for the tollway, a complete review was made of all the possible alternative routes previously discussed in the Feasibility Study Report for the Trans Java Highway. The review was carried out based on general information gathered from the analysis of collected data, examination of topographic maps and site investigations, and also took into consideration the following basic planning concepts.

a) Expressway standard with full access control as a part of the Trans-Jawa Tollway Network.

b) Viable alternative to existing national roads for through traffic from Central and East Java to Jakarta and westwards.

c) Relieve existing roads for local traffic use.

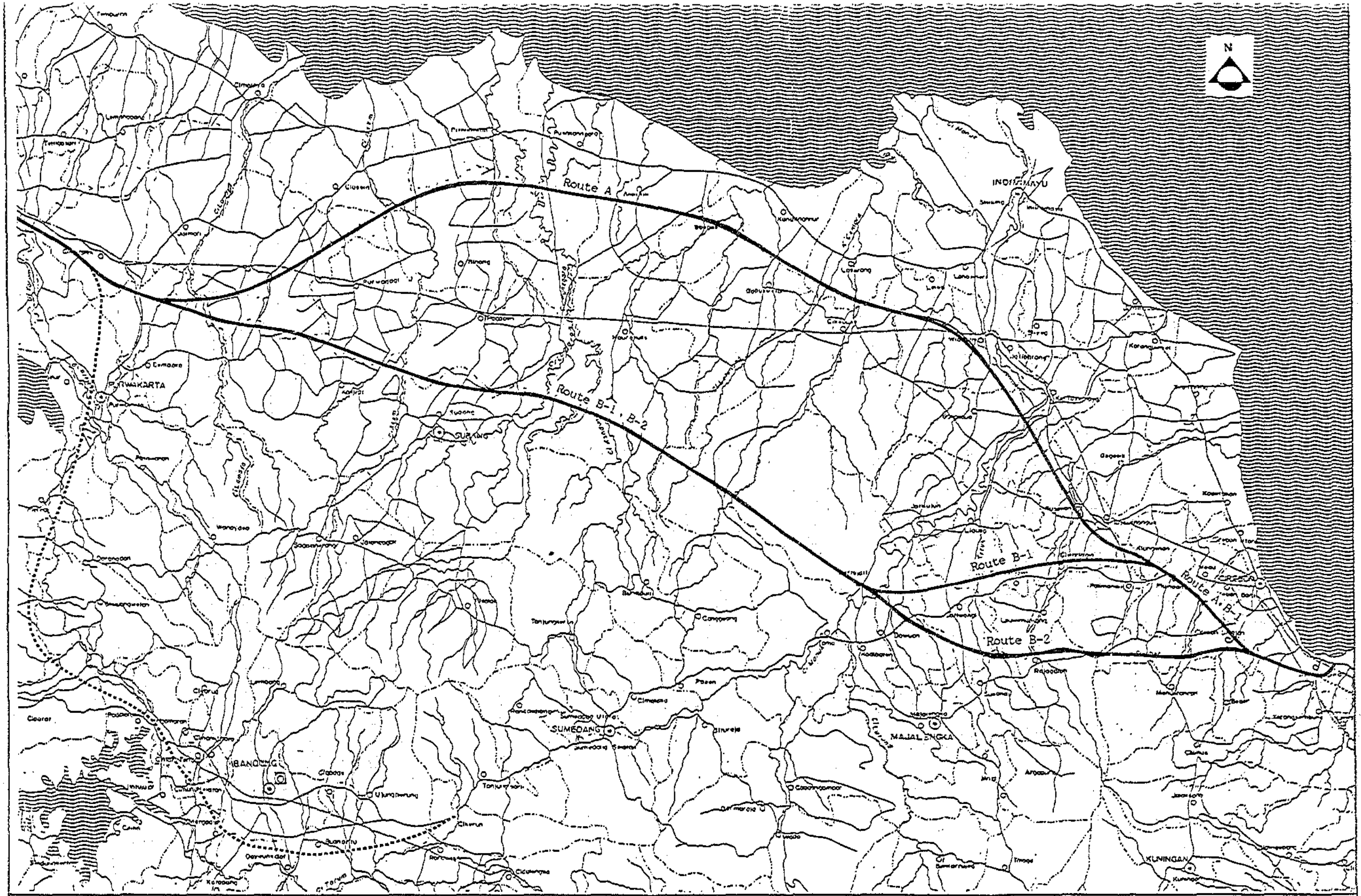
d) Bypass existing and planned high density development areas.

e) Minimum routing through irrigated paddy field and other plantation area.

f) Minimize negative impacts on environment and social aspects.

g) Provide easy accessibility to regional development centers.

At the preliminary study stage some alternative possibilities were eliminated from further study, primarily because of engineering consideration as well as conflicting with planning concepts. Three possible routes were chosen as likely suitable alternatives. The three alternative routes are shown in Fig. 8.1.1.



Feasibility Study on Cikampek - Cirebon Tollway Project

Fig. 8.1.1 Alternative Route Map

On the basis of study of the 1/25,000 topographical maps, the 1/20,000 aerial photographs and the detailed field survey, the alignments of three alternative routes were selected taking account of:

a) the topographical conditions
b) suitable interchange locations
c) minimizing housing areas and technical irrigated areas to be crossed
d) the communication network (highways and railway) in order to limit the number of bridges
e) minimizing any changes, physical and social environment
f) increasing benefits to road users
g) minimizing construction, operation and maintenance costs
h) avoiding factories, public buildings and military territories
i) minimizing green space conservation areas to be crossed
j) avoiding parks, playgrounds, golf links and cemeteries
k) avoiding clear-zone requirement of airports (Tenggung and Boentoe airport)

8.1.2 General Description of Alternative Routes

General features of the selected three alternative routes are as follows:

1) Alternative A

Alternative A generally runs along the south side of the existing national road on the alluvial coastal plain. The main objectives of this route are to provide intensive services for existing and planned development areas along the existing national road network so as to stimulate the village development in the northern part of the study area; also to strengthen the linkage between Cirebon, Palimanan industrial area, Jatibarang Development Center and the capital town of Kab. Indramayu as well as to serve as a part of the Trans-Java Tollway System.

2) Alternative B-1

Alternative B-1 passes through the diluvial foothill areas between the coastal plain and the sharply rising volcanic mountains to the south.

The route provides a shorter distance for long to medium distance traffic, not only for Cirebon - Jakarta, Cirebon - Bandung but also for Jakarta - bound traffic from the southern hinterland of the existing national road sector between Sumedang and Kadipaten.

The route has the function of supplementing the existing national roads of Cirebon - Cikampek and partly of Cirebon - Bandung and also the existing Cirebon bypass. The route will strengthen the traffic distribution of radial road traffic to and from Cirebon city, as well as constituting an integral part of the Trans Java Tollway System.

The route has sub-sections to facilitate the alternatives B-1 and B-2. Alternative B-1 separates from the left bank of Ci Manuk river of route B at approx. 80 km east from Cikampek, and runs along the national road Route 023 through built-up areas in the suburbs of Cirebon city.

The main objective of this route is to relieve heavy traffic on the existing national road sections of Cirebon - Palimanan - Kadipaten, from the viewpoint of the rapid urbanization of Cirebon city.

3) Alternative B-2

Alternative B-2 separates from alternative B at the same point as the above, and passes the rolling areas through a mountain pass to avoid built-up areas and also to provide a more rapid and shorter travel distance for the long to medium distance traffic.

This route is expected to stimulate the development of the newly established capital town of Kab. Cirebon.

8.2 Interchange Locations

8.2.1 Criteria for Location of Interchanges

The number of interchanges must be carefully limited to take account of construction and operational costs. The criteria for selecting the location of interchanges are as follows:

a) At places where the tollway crosses or is close to an existing trunk road, such as national and/or provincial roads.

b) In areas where the population is estimated to be more than 50,000 within the sphere of influence of the interchange.

c) In areas which will show reasonable economic return after studying future traffic volumes for each interchange.

d) Taking into account landuse plans and future development plans.

e) The degree of difficulty for land acquisition.

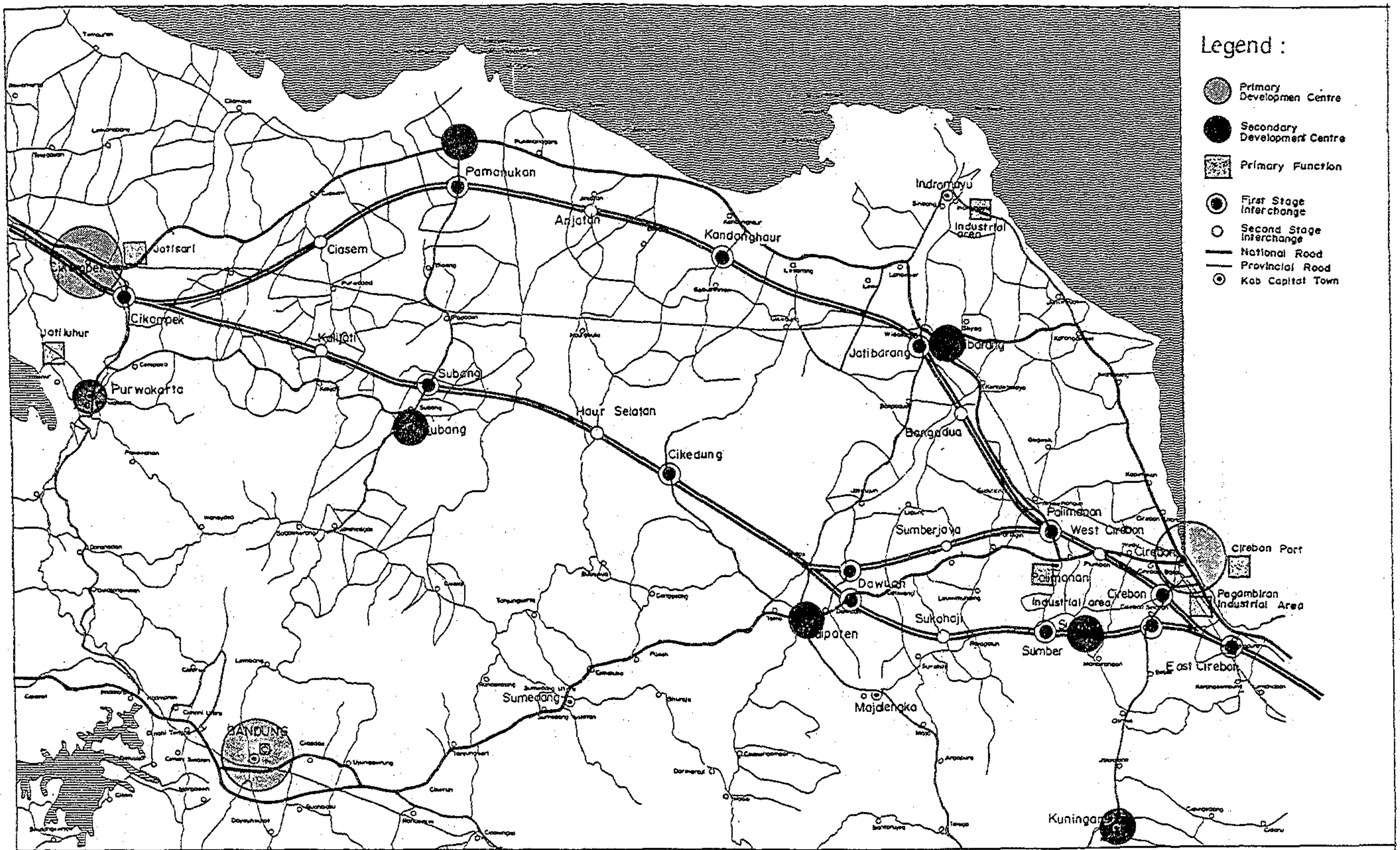
f) Having a minimum distance of about 4 km and maximum distance of about 30 km between interchanges. These criteria distances are required in order to provide for:

   i) weaving distance and good traffic application (minimum distance)
   ii) maintenance and control purposes (maximum distance)

8.2.2 Selection of Interchange Locations

Based on the above-mentioned criteria, possible interchange locations were selected as shown in Fig. 8.2.1. They are:

Route A : Cikampek, Ciasem, Pamanukan, Anjatan, Kandanghaur, Jatibarang, Bangadua, Palimanan, West Cirebon, Cirebon and East Cirebon (11 locations)



Feasibility Study on Cikampek - Cirebon Tollway Project	Fig. 8.2.1 Planned Regional Structure and Alternative Routes in Study Area

Route B1 : Cikampek, Kalijati, Subang, Haur Selatan, Cikedung, Dawuan, Sumberjaya, Palimanan, West Cirebon, Cirebon and East Cirebon (10 locations)

Route B2 : Cikampek, Kalijati, Subang, Haur Selatan, Cikedung, Dawuan, Sukahaji, Sumber, Cirebon and East Cirebon (10 locations)

In order to economize the project cost but to maximize project effects on the region and to retain a high project viability, priority should be given to the initially proposed interchange locations.

1) Estimated Interchange Traffic Volumes

Future traffic demand to the interchanges will indicate a comprehensive, but not complete, criterion for priority considerations. Assuming a minimal requirement for the interchange demand to approximate to 3,000 vehicles per day (basic standard employed in Japan), the preliminary future traffic demand to the respective interchanges were compared for the year 2005 which is about 10 years from the commencement of tollway operation.

The estimated total ramp volume in each interchange is presented in Table 8.2.1.

It should be noted that qualitative analysis results should be duly considered and supplement the traffic demand analysis results, as discussed further in the following sub-section 2.

2) General Transportation Point of View

High priority is given to an interchange which provides access to national and provincial roads, because these roads are to function as inter-regional distributors.

3) Passenger Transportation Point of View

High priority is given to an interchange which has access to a city area of high traffic generating potential.

Table 8.2.1 Preliminary Estimation of Ramp Traffic and Priority Assessment

I.C Name	Ramp Traffic in 2005 (Veh./day)	Priority[1] Assessment
Route A		
Ciasem	2,008	-
Pamanukan	3,775	*
Anjatan	1,004	-
Kandanghaur	1,992	-
Jatibarang	3,848	*
Bungadua	1,304	-
Palimanan	4,865	*
West Cirebon	1,713	-
Cirebon	8,360	*
Route B1		
Kalijati	674	-
Subang	3,373	*
Haur Selatan	1,050	-
Cikedung	1,050	-
Dawuan	6,918	*
Sumberjaya	893	-
Palimanan	4,467	*
West cirebon	1,688	-
Cirebon	8,326	*
Route B2		
Kalijati	624	-
Subang	3,134	*
Haur Selatan	938	-
Cikedung	1,137	-
Dawuan	6,049	*
Sukahaji	3,999	*
Sumber	2,837	-
Cirebon	7,192	*

Note: 1) * = Required at the initial stage
- = Required after the year 2005

The expected city area of this category will include the regional development centers enumerated in the West Java Structure Plan as shown below:

Development Region	Development Center	Sub-development Center
Purwasuka	Cikampek	Purwakarta Subang Karawang Pamanukan
Cirebon	Cirebon	Kuningan Katibarang Kadipaten Sumber

4) Goods Transportation Point of View

High priority is given to an interchange which provides access to a primary function facility, which is defined as that of producing a large demand of goods transport.

Major primary function areas other than the above development centers are designated in the West Java Structure Plan as shown below:

Development Region	Facilities with primary function
Purwasuka	Cikampek and Jatiluhur Industrial Area
Cirebon	Cirebon Port Cirebon Industrial Area (Pegambiran Industrial Estate) Palimanan Industrial Area Indramayu Industrial Area

5) Urban Transport Point of View

Cirebon City is defined not only as a regional development center in West Java but also as an emerging national development center.

The primary road structure of Cirebon City area consists of four radial roads; that is, Cirebon-Palimanan road (further extending to Jakarta or Bandung), Cirebon-Indramayu road, Cirebon-Kuningan road and Cirebon-Tegar road (further extending to Semarang, Jogyakarta and Surabaya); and the half ring Cirebon By-pass.

Ribbon type urban development has been taking place along these radial roads and the by-pass. The concentrated traffic will be distributed through radial roads to the area enclosed by the by-pass.

The urban population in Cirebon grew at about 4% per annum and it is projected that the city in year 2000 will have 1 million population which is more than double the population in 1980, as shown below:

Urban Area	1980 Census	2000 Projection by NUDS
Cirebon City	190,000	570,000
Surrounding Urban Area	240,000	380,000
Total	430,000	950,000

The urbanization in Cirebon extended originally to the northwest and southwest along the Cirebon-Indramayu and Cirebon-Kuningan roads as shown in Fig. 8.2.2.

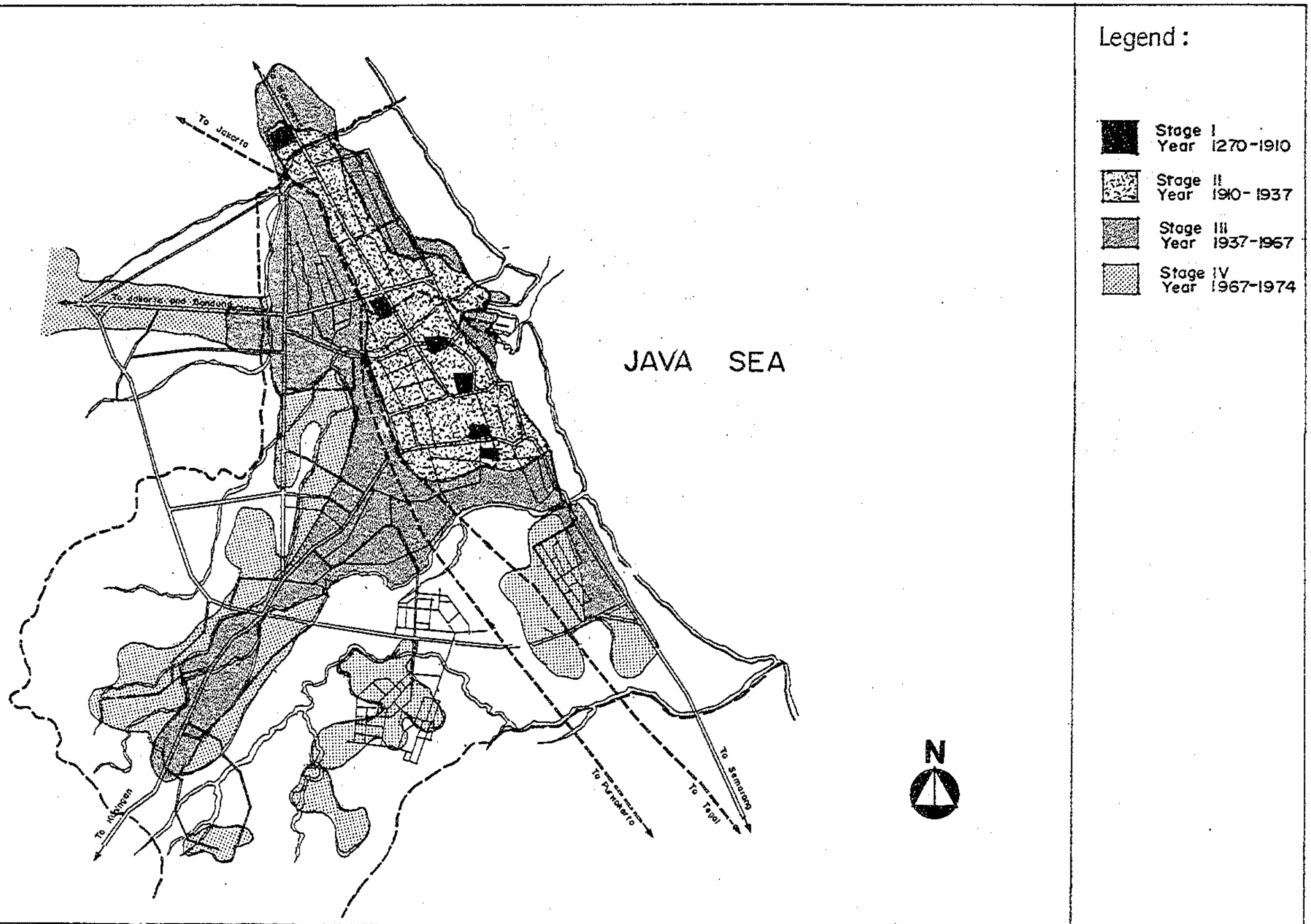
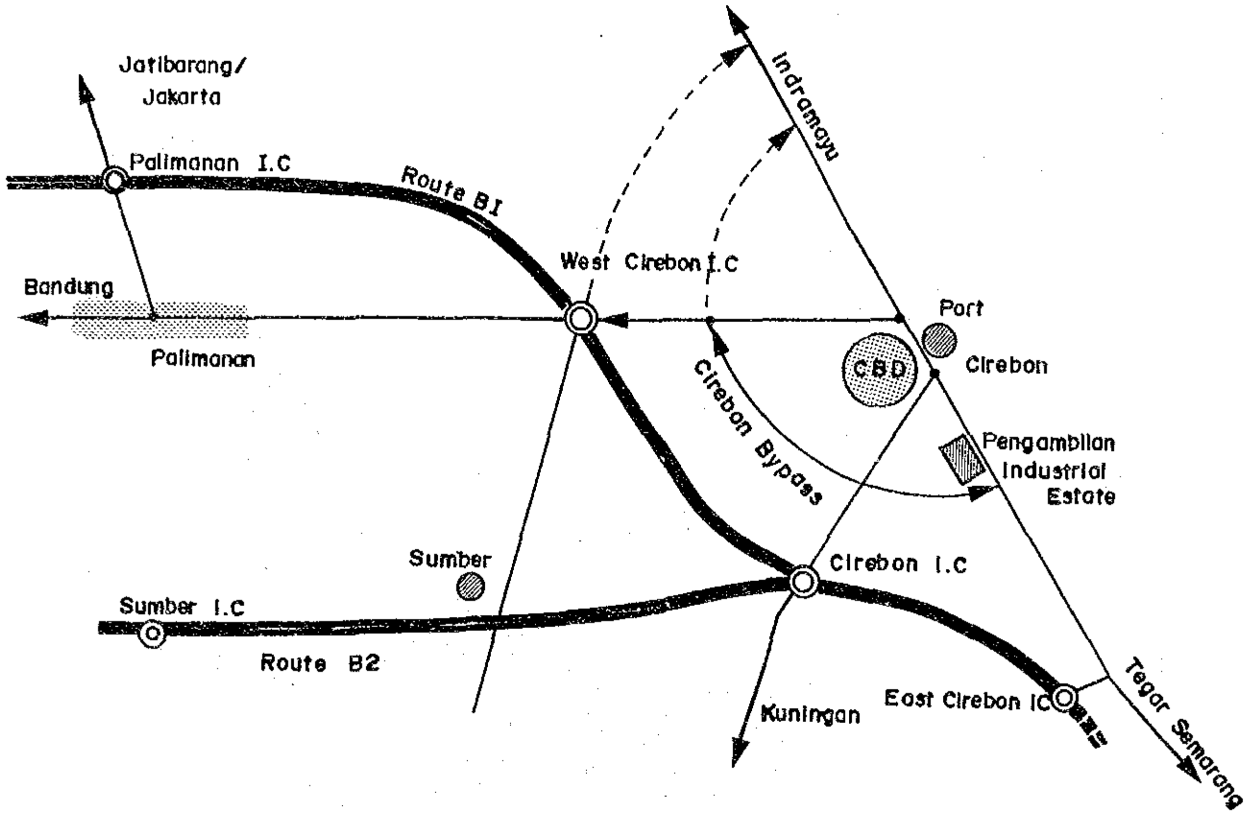


Fig. 8.2.2 Historical Urban Development

The development of Cirebon By-pass and Palimanan-Jatibarang road changed the urbanization direction to the west and to the south of the By-pass. This also influenced the traffic pattern, particularly Jakarta-bound traffic diverted from the Cirebon-Indramayu road to Cirebon-Palimanan-Jatibarang road.



The Palimanan area is heavily congested at peak-hours from the urban traffic generated along the Cirebon-Palimanan road and regional and inter-regional through-traffic bound for Jakarta and Bandung.

It is anticipated that the project tollway alternative Route B1 will relieve the traffic congestion in Palimanan area and to serve for distributing traffic to Cirebon City with three interchanges, West Cirebon, Cirebon and East Cirebon as shown above and in Fig. 8.2.3.

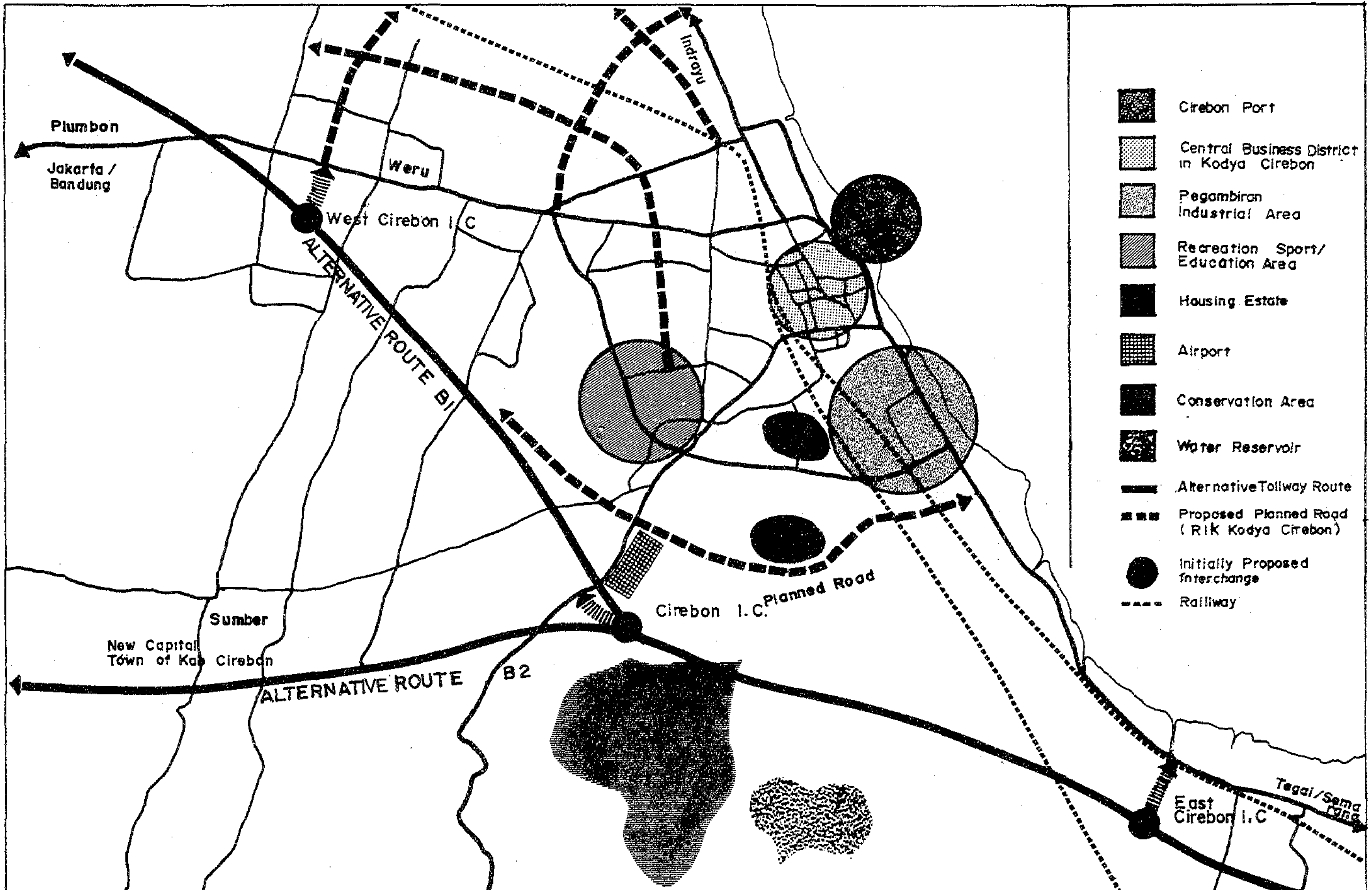


Fig. 8.2.3 Structure Plan of Cirebon City

6) Comprehensive Assessment

Several principal factors have been discussed for determining the priority schedule for the interchange construction of each route.

To summarize those factors, a priority assessment of the interchanges is set out in Table 8.2.2.

A rating system of giving one point to an interchange relevant to each assessment criterion was adopted and it was determined to select interchanges having two points or over as those to be constructed initially.

They are as follows:

Route A : Pamanukan, Jatibarang, Palimanan, West Cirebon and Cirebon (5 locations)

Route B1 : Subang, Dawuan, Palimanan, West Cirebon and Cirebon (5 locations)

Route B2 : Subang, Dawuan, Cirebon (3 locations)

In addition to the above assessment criteria the interchange interval is the critical factor for tollway maintenance, control and emergency requirements.

Therefore, Kandanghaur for Route A, Cikedung for Route B1 and B2 and Sumber for Route B2 should be included in the initial interchange construction.

Table 8.2.2 Priority Construction of Initially Proposed Interchanges

I.C Name**	(1) Traffic Demand	(2) General Transport Viewpoint	(3) Passenger Transport Viewpoint	(4) Goods Transport Viewpoint	(5) Urban Transport Viewpoint	(6) Priority Assessment
Route A						
Ciasem	-	-	-	-	-	None
Pamanukan	*	*	*	-	-	+3
Anjatan	-	-	-	-	-	None
Kadanghaur	-	-	-	-	-	None
Jatibarang	*	*	*	-	-	+3
Bungadua	-	-	-	-	-	None
Palimanan	*	*	-	*	-	+3
West Cirebon	-	*	*	*	*	+4
Cirebon [1]	*	*	*	*	*	+5
Route B1						
Kalijati	-	-	-	-	-	None
Subang	*	*	*	-	-	+3
Haur Selatan	-	-	-	-	-	None
Cikedung	-	*	-	-	-	+1
Dawuan(Kadipaten)	*	*	*	-	-	+3
Sunburjaya	-	*	-	-	-	+1
Palimanan	*	*	-	*	-	+3
West Cirebon	-	*	*	*	*	+4
Cirebon	*	*	*	*	*	+5
Route B2						
Kalijati	-	-	-	-	-	None
Subang	*	*	*	-	-	+3
Haur Selatan	-	-	-	-	-	None
Cikedung	-	*	-	-	-	+1
Dawuan(Kadipaten)	*	*	*	-	-	+3
Sukahaji	*	-	-	-	-	+1
Sumber	-	-	*	-	-	+1
Cirebon	*	*	*	*	*	+5

*Note: ** Excluding termini interchanges Cikampek and East Cirebon*

West Cirebon interchange is located close to Palimanan and Cirebon interchanges. From the urban transport point of view this interchange is obviously needed. However the estimated ramp traffic at the West Cirebon interchange is small relative to other selected interchanges.

The project study focuses mainly upon inter-city traffic rather than urban traffic, because of the nature of the project tollway. Therefore, the urban traffic demand is not reflected importantly in the traffic demand analysis. The Cirebon interchange should be considered as representative serving inter-city traffic for Cirebon City.

Therefore, the timing for construction of the West Cirebon interchange should be further studied together with an urban transport study for Cirebon.

Consequently, setting aside the necessity of the West Cirebon interchange, it can be concluded that each alternative route requires priority interchanges as follows:

Route A : Pamanukan, Kandanghaur, Jatibarang, Palimanan, and Cirebon (5 locations)

Route B1 : Subang, Cikedung, Dawuan, Palimanan, and Cirebon (5 locations)

Route B2 : Subang, Cikedung, Dawuan, Sumber and Cirebon (5 locations)

These are all marked in Fig. 8.2.1 as previously presented in this section.

8.3 Environmental and Socio-Economic Impacts

Any major project such as the Cikampek to Cirebon Tollway project has to carefully consider what effect that project might have upon the lives of people and the environment. It is the moral duty of project designers to minimize, where feasible, any negative impacts resulting from project implementation. The project study team have carried this thinking through into their project studies.

The environmental and social impacts expected to arise as a result of implementing the tollway construction are examined for the three alternative routes. Seven major perspectives are used for impact assessment, namely, traffic demand, pollution, human life impact, nature aspect, accessibility to road network (related to regional aspects), compatibility with urban development plans and driver amenity.

1) Traffic Demand

Estimated future traffic volumes on the alternative routes are not necessarily the sole parameter to represent superiority among the alternative routes.

Among others, the consideration of benefit, which is derived from the comparison between "with" and "without" project implementation, and cost, which is required to implement the project, considerations should be introduced to evaluate the effectiveness of the project investment from the comprehensive economic viewpoint. This is discussed further in Section 8.5.

However, it can be said that traffic demand on the alternative routes is an indicator showing how differently it attracts the traffic and eventually stimulates socio-economic activities in the area.

The preliminary traffic demand to the alternative routes was estimated for the target years of 1995, 2005 and 2015, and the average cross-sectional traffic volumes are compared by index factor as shown in Table 8.3.1.

Table 8.3.1 Comparison of Average Cross-Sectional Traffic

(Route A Traffic Volume = 100)

Year	Alternative Route		
	A	B1	B2
1995	100	112	108
2005	100	112	108
2015	100	110	108

Route A traffic is the smallest and Route B1 is the largest of the alternative routes.

Traffic volumes increases as the route sections come closer to Cikampek. This is because the generated traffic in the study area is highly induced towards the Jakarta direction and the volume includes much interprovincial traffic.

Routes B1 and B2 traffic indicates the inclusion of diverted traffic from the Kadipaten - Sumedang road. The Jakarta-bound traffic produced in the south of Kadipaten - Sumedang road includes those from Sumedang, Kadipaten, Majalengka, Kuningan, Tasikmalaya and Ciamis.

The number of project tollway users in the study area was estimated as a result of traffic assignment to the alternative routes. The tollway users are compared in volume index as shown in Table 8.3.2.

Table 8.3.2 Comparison of Tollway Users in Study Area

(Route A Users = 100)

Year	Alternative Route		
	A	B1	B2
1995	100	132	115
2005	100	135	112
2015	100	119	109

The highest volume of tollway users emerges in Route B1 followed by Route B2 and the lowest in Route A. From this viewpoint it can be said that the Route B1 is the most heavily utilized route in the study area, and contributes to the socio-economic activities in the study area.

2) Pollution

Air pollution and noise effects from traffic are generally caused by traffic congestion in urban areas. Traffic conversion from existing roads to the tollway would contribute towards decreasing the negative impacts of air pollution and noise effects.

Air pollution and noise by traffic on the proposed tollway would be a problem and require necessary countermeasures to minimize unfavorable impact, especially in residential districts.

Water quality is more affected by Route A unless countermeasures are taken, because it cuts through irrigation canals of paddy fields.

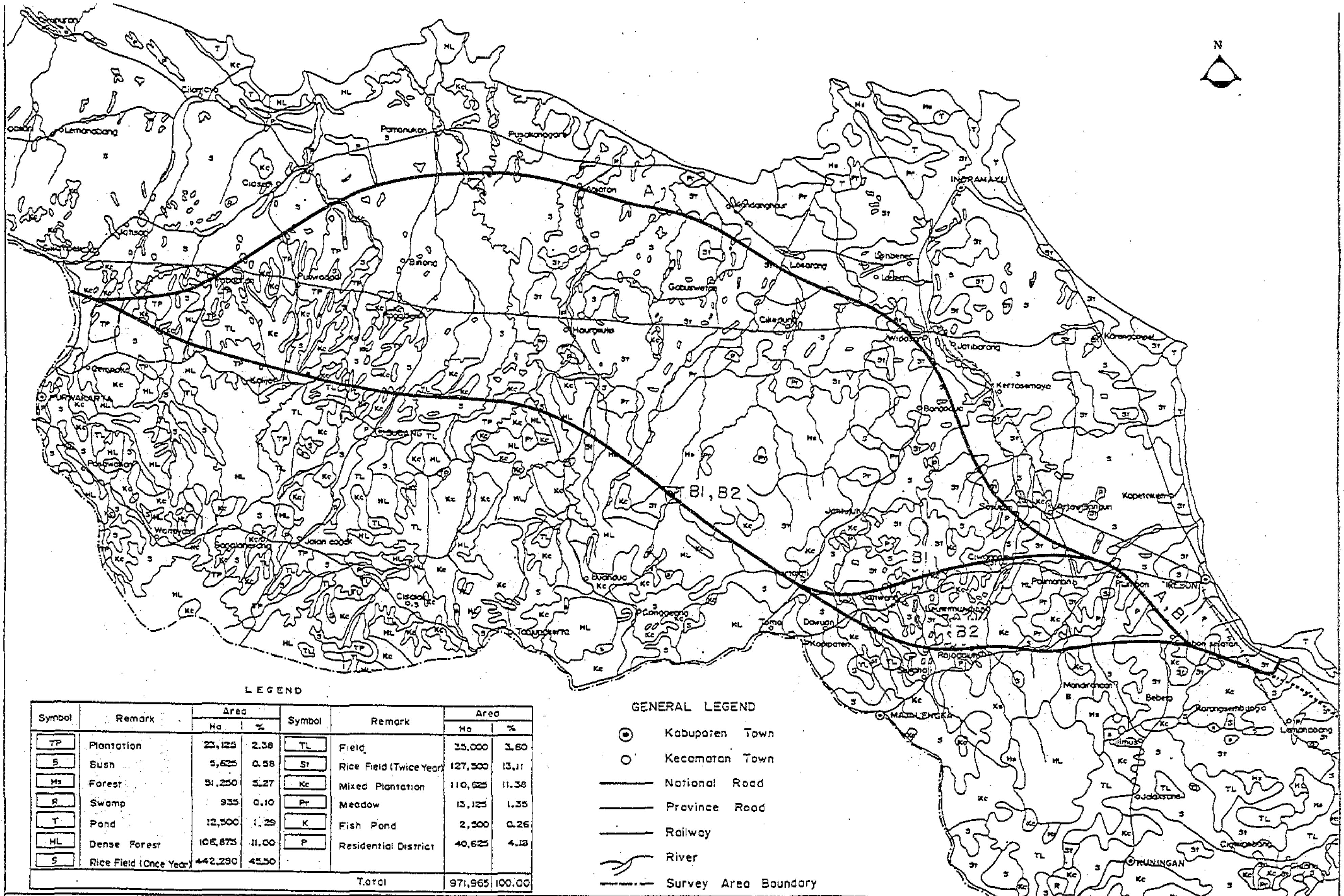
In general overall pollution impact rating Route B2 ranks better than Routes A and B1.

3) Land Use and Human Life Impact

As seen in Table 8.3.3 and Figs. 8.3.1 through 8.3.3, Route A traverses vital irrigated paddy field areas. Routes A and B1 pass through densely populated areas of Cirebon city and thus will encounter the social problems relating to right of way requirements and relocation.

Table 8.3.3 Land Use along Alternative Routes

Alternative Route / Item	A	B1	B2	Remarks
Land Use (%)				
- Town (Kampung)	6	4	3	The figure indicates percentage of the length the alternative routes pass through for each land use area.
- Paddy Field	80	50	43	
- Miscellany	2	5	8	
- Plantation	8	21	26	
- Forest	3	20	20	Source: land use map at a scale 1:25,000
- Uncultivated	1	0	0	
- Technical Irrigation area	79	31	17	Source: Kondisi dan Karakteristik Wilaya, Java Barat published BAPPEDA in 1980
- Semi-technical irrigation area	1	9	5	
- Oil and Natural Gas field	10	1	0	

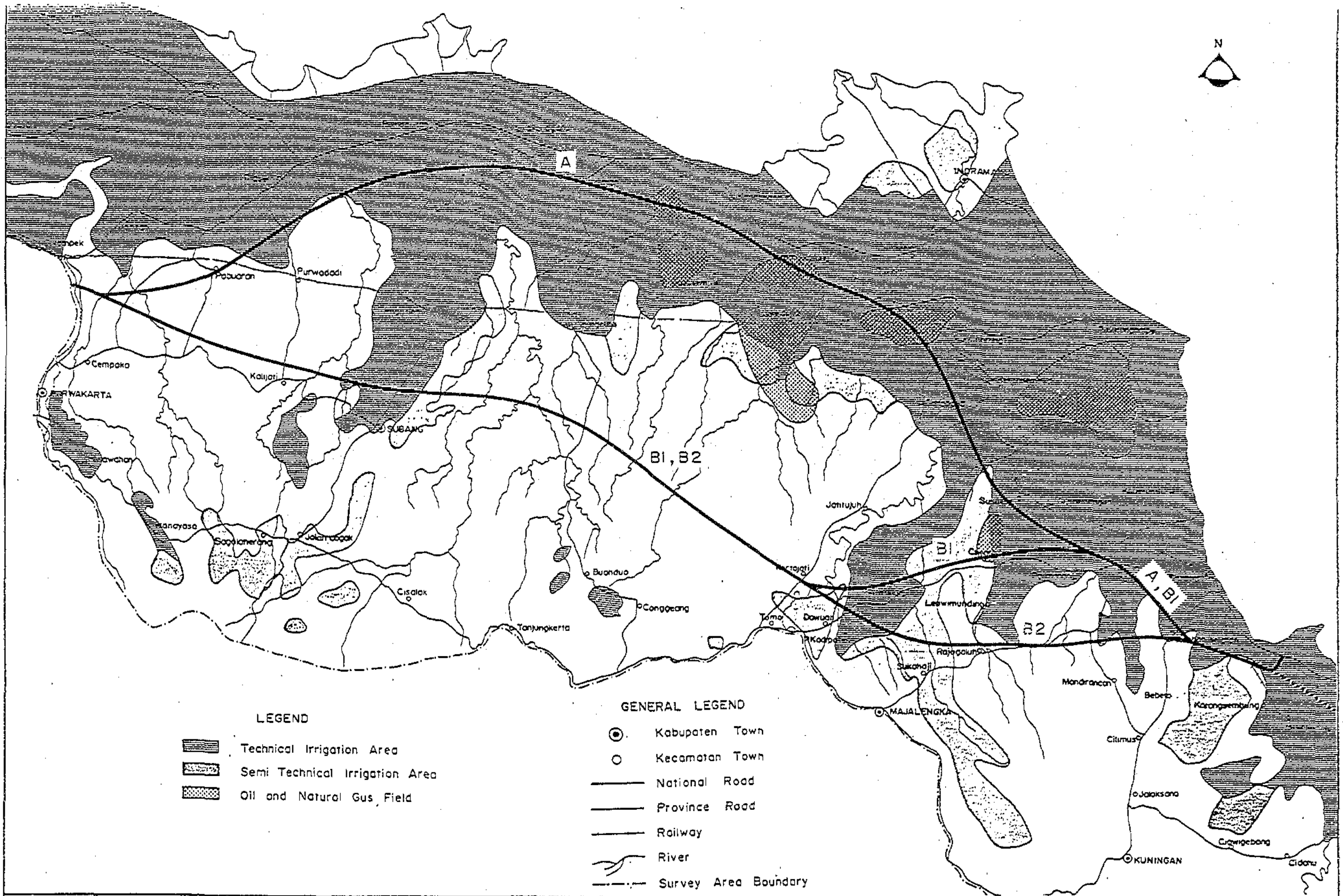


LEGEND

Symbol	Remark	Area Ha	Area %	Symbol	Remark	Area Ha	Area %
TP	Plantation	23,125	2.38	TL	Field	35,000	3.60
B	Bush	5,625	0.58	St	Rice Field (Twice Year)	127,500	13.11
Hs	Forest	51,250	5.27	Kc	Mixed Plantation	110,625	11.38
R	Swamp	935	0.10	Pr	Meadow	13,125	1.35
T	Pond	12,500	1.29	K	Fish Pond	2,500	0.26
HL	Dense Forest	105,875	11.00	P	Residential District	40,625	4.18
S	Rice Field (Once Year)	442,290	45.50				
					Total	971,965	100.00

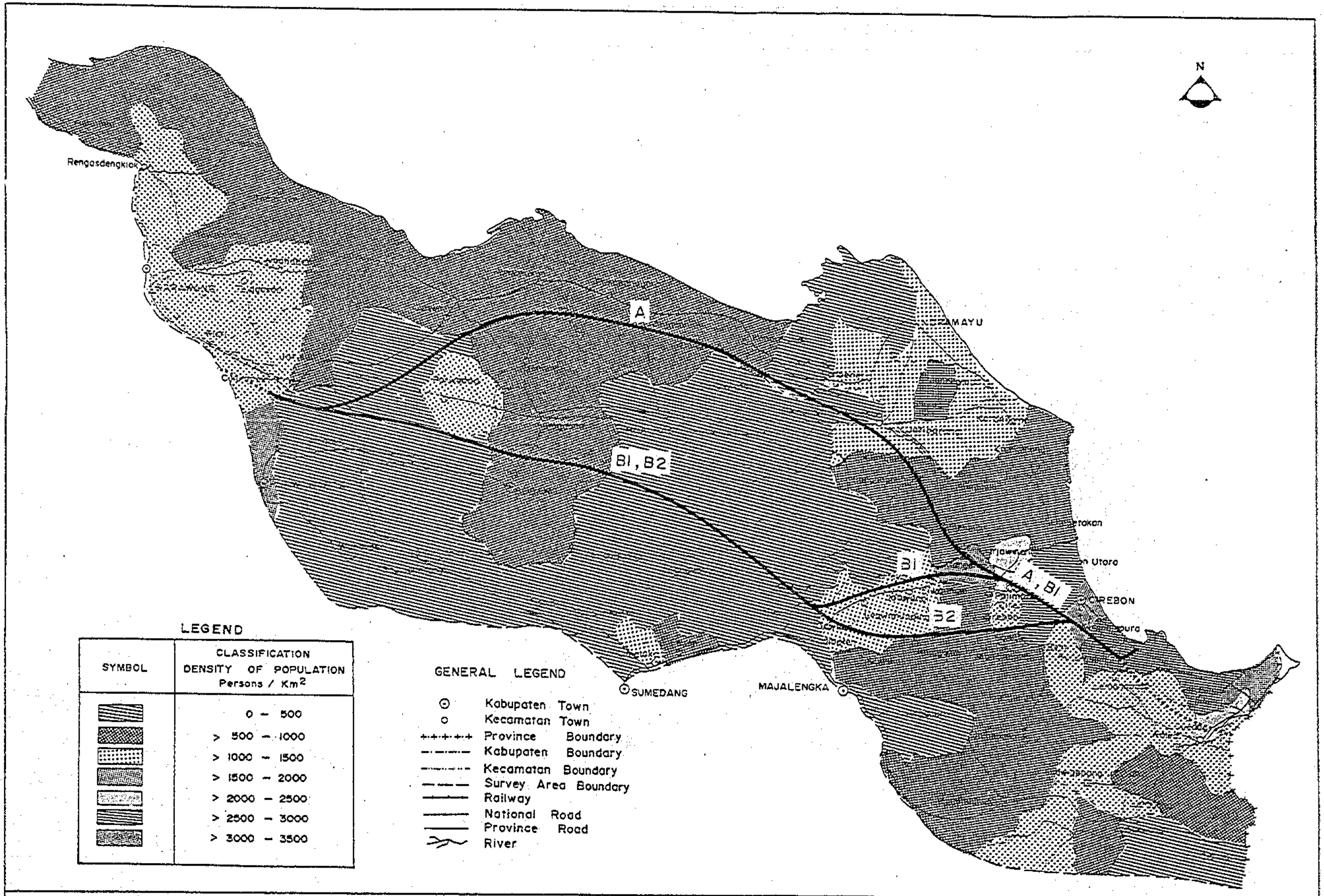
Feasibility Study on Cikampek - Cirebon Tollway Project

Fig. 8.3.1 Landuse Map



Feasibility Study on Cikampek - Cirebon Tollway Project

Fig. 8.3.2 Irrigation Area and Oil Field Map



Feasibility Study on Cikampek - Cirebon Tollway Project

Fig. 8.3.3 Population Density Map

Route B2 has a similar problem situation associated with the Rajagalum built up area.

In Cirebon city a reserved recreation/open space corridor is located along the provincial road 069. The proposed routes are planned to minimize negative impacts by avoidance of the conservation area and water reservoir.

4) Nature Aspect

The alternative routes all traverse through artificially developed areas and avoid natural areas, including the reserved forest areas located to the southwest side of Cirebon.

Route B2 would require the necessity for slope protection work in actual construction work and for later maintenance work. This is due to deep cuts and high embankment sections which are indispensable due to terrain conditions. Therefore there will be some negative impact upon the natural land condition.

5) Accessibility to Road Network

Traffic ingress and egress through an interchange system could cause traffic jams at the access road to regional centers.

By the year 2015 Cirebon city is expected to have a population of 1 million according to NUDS study (National Urban Development Strategy, 1985 by IBRD).

Routes A and B1 are planned to connect to the three radial roads of Cirebon city and will thus allow more flexibility for future traffic management in the city.

Route B2 however, has only two connections to the city radial roads.

Routes A and B1 could contribute to a decrease in traffic volume, for medium distance travel, on the national road 024 between Cirebon and Palimanan.

Route B2 would not be able to act as a bypass for the Cirebon city area.

6) Compatibility with Urban Development Plans

Route A can encourage urban development along the Cirebon-Jatibarang corridor.

Route B2 has no such existing main trunk road but has direct connection with Sumber, the administrative center of Kabupaten Cirebon.

Route B1 facilitates two corridors which are Cirebon to Kadipaten and Cirebon to Jatibarang and therefore this route has the most potential for future development.

7) Driver Amenity

Route A is not that convenient for through traffic users as it is the longest of the three routes, however it could provide relief to the existing national road thus benefitting local traffic users.

Routes B1 and B2 are viable alternatives being more convenient for long to medium distance road users and freight. However, B1 is more convenient for serving local traffic users in the vicinity of Cirebon city.

In relation to driving condition amenity, Route A is not good due to the correlation between horizontal and vertical alignment.

Route B2 passes through some rugged areas where it will be difficult to maintain a safe and comfortable alignment for users.

Route B1 provides the better alignment conditions for users safety and comfort.

Overall, route B1 is the most suitable for driver amenity aspect.

8) Evaluation

To assess the environmental preferability of the three routes each assessment category is rated as being either good, fair or poor. The overall rating is presented in Table 8.3.4, and results in the preferability of route B1.

Table 8.3.4 Environmental and Social Impacts

Environmental and Social Factors		Environmental Preferability		
		Route A	Route B1	Route B2
1)	Traffic Demand	Poor	Good	Fair
2)	Pollution	Fair	Fair	Good
3)	Land Use and Human Life Impacts:			
	- Irrigated and built-up area	Poor	Poor	Good
	- Recreation and open space	Fair	Fair	Fair
4)	Nature Aspect	Good	Good	Fair
5)	Accessibility to Road Network	Good	Good	Fair
6)	Compatibility with Urban Development Plans	Fair	Good	Fair
7)	Driver Amenity	Poor	Good	Fair
	Overall Rating	Fair	Good	Fair

8.4 Engineering and Project Cost Comparison

In order to identify an optimum route, engineering studies for the three alternative routes were undertaken and included; an aerial photographic survey, a physical condition survey, a study of design criteria and the selection of interchange locations.

8.4.1 Physical Comparison

Route A is the longest route, being 152 km from Cikampek to Cirebon. It is generally located to the south of the national roads 008, 009 and 010 and runs along the alluvial coastal plain.

Routes B1 and B2 are common from Cikampek to Dawuan and pass through the diluvial foothills which lie between the plain and volcanic mountainous topography. Between Dawuan and Cirebon Route B1 runs along the national road 023 through built-up areas, whilst Route B2 falls within rolling areas. The total lengths for Routes B1 and B2 are 140 km and 138 km respectively.

A summary of the physical descriptions for the three routes is given in Table 8.4.1 and terrain and slope conditions and geological map are shown in Figs. 8.3.4 through 8.3.6..

8.4.2 Construction Assessment

Route A has 81 major structures for river crossings and separation of grades at highways and railways; the total length of the structures is 3.0 km.

Route B2 has 62 major structures proposed, with a total length of 3.0 km.

Route B1 has 55 major structures proposed, with a total length of 2.6 km.

Accessibility for construction activities is best on Route B1; however the Cimanuk River bridge should be built at an early stage to provide a tentative track for construction purposes.

Route A has the most problems for construction access, since borrow pits for earthworks are located some 20 - 30 km away on the volcanic foothills. The suitability of Route B2 construction accessibility falls somewhere between those for Routes A and B1.

Route B2 could be constructed in the shortest time period.

Table 8.4.1 Engineering Comparison of Alternative Routes

Item			Route A	Route B1	Route B2
1)	Physical Summary Length of Alignment	(km)	152	140	138
	Topography1/				
	Flat	(%)	95	59	37
	Rolling	(%)	5	41	62
	Mountainous	(%)	0	0	1
	Geology2/				
	Alluvial	(%)	66	17	11
	Diluvial	(%)	24	72	69
	Tertiary	(%)	10	11	20
2)	Construction Assessment Number of Bridges and Structures	(Nos.)	85	59	63
	Total length of Bridges and Structures	(km)	3.0	2.6	3.0
	Time to Construct	(years)	6	5	4

Notes: 1/ Flat : Area where elevation is less than 50
Rolling : Area where elevation is more than 50 but less than 200 m
Mountainous : Area where elevation is more than 200 m

Source : Topographical Map at scale 1:250,000

2/ Alluvial : Alluvial plain deposits, composed of clay, silt and sand
Diluvial : Diluvial deposits composed of tuffaceous clay (laterite), tuffaceous sand gravel
Tertiary : Mixture of volcanic materials including debris and weathered rock from old volcanic products

Source : Hydrogeological Map at scale 1:250,000 published in 1985

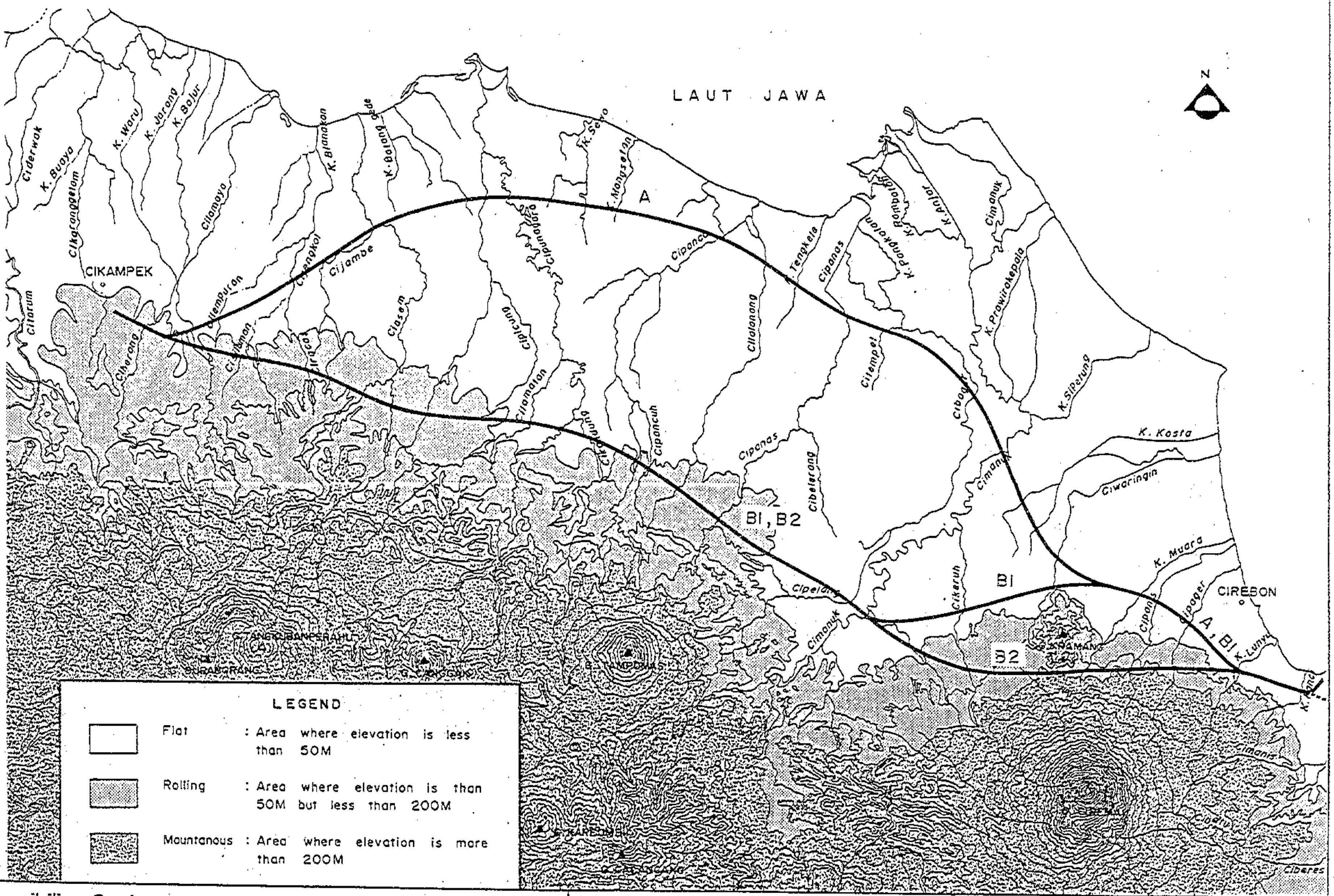


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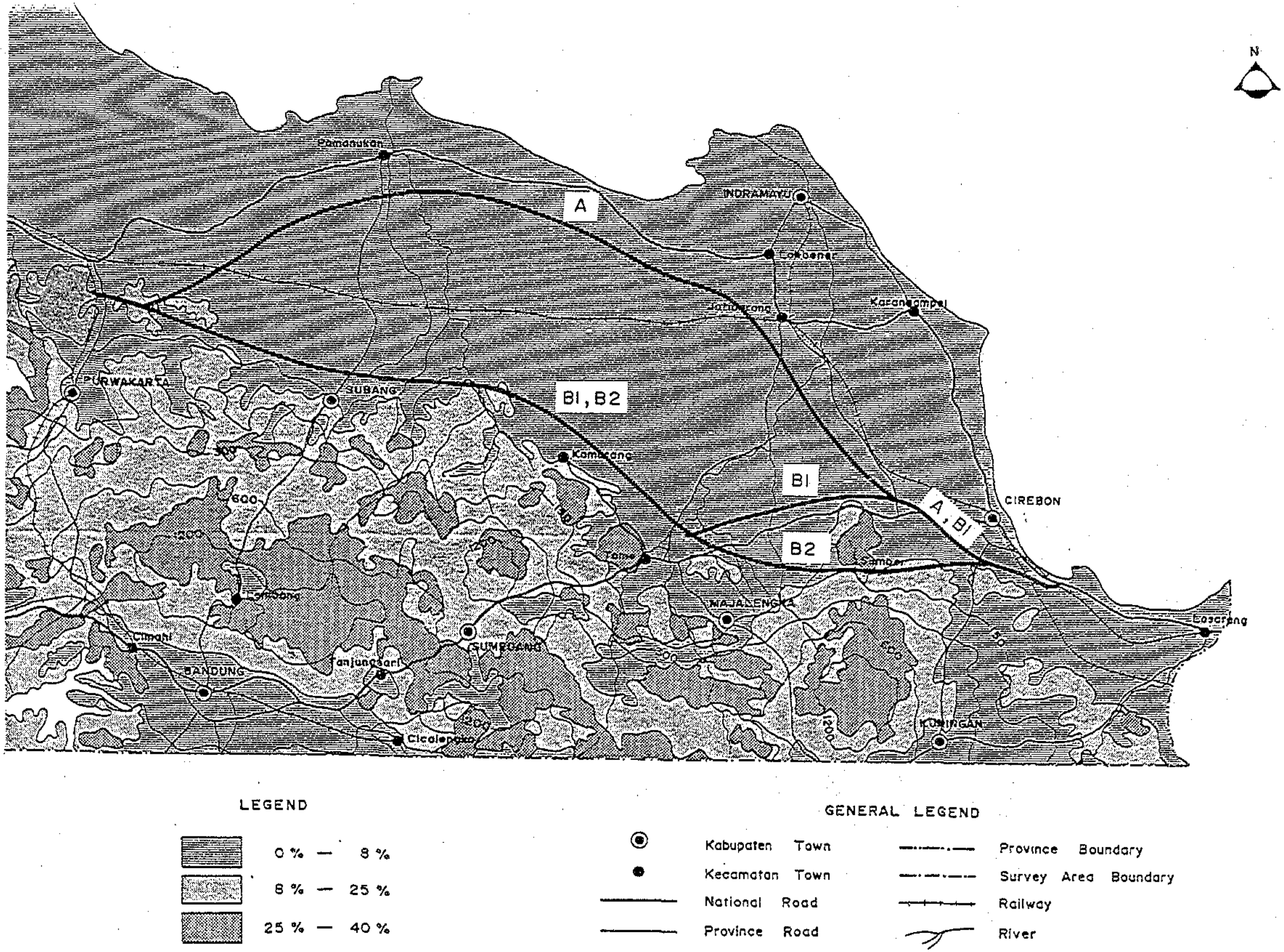
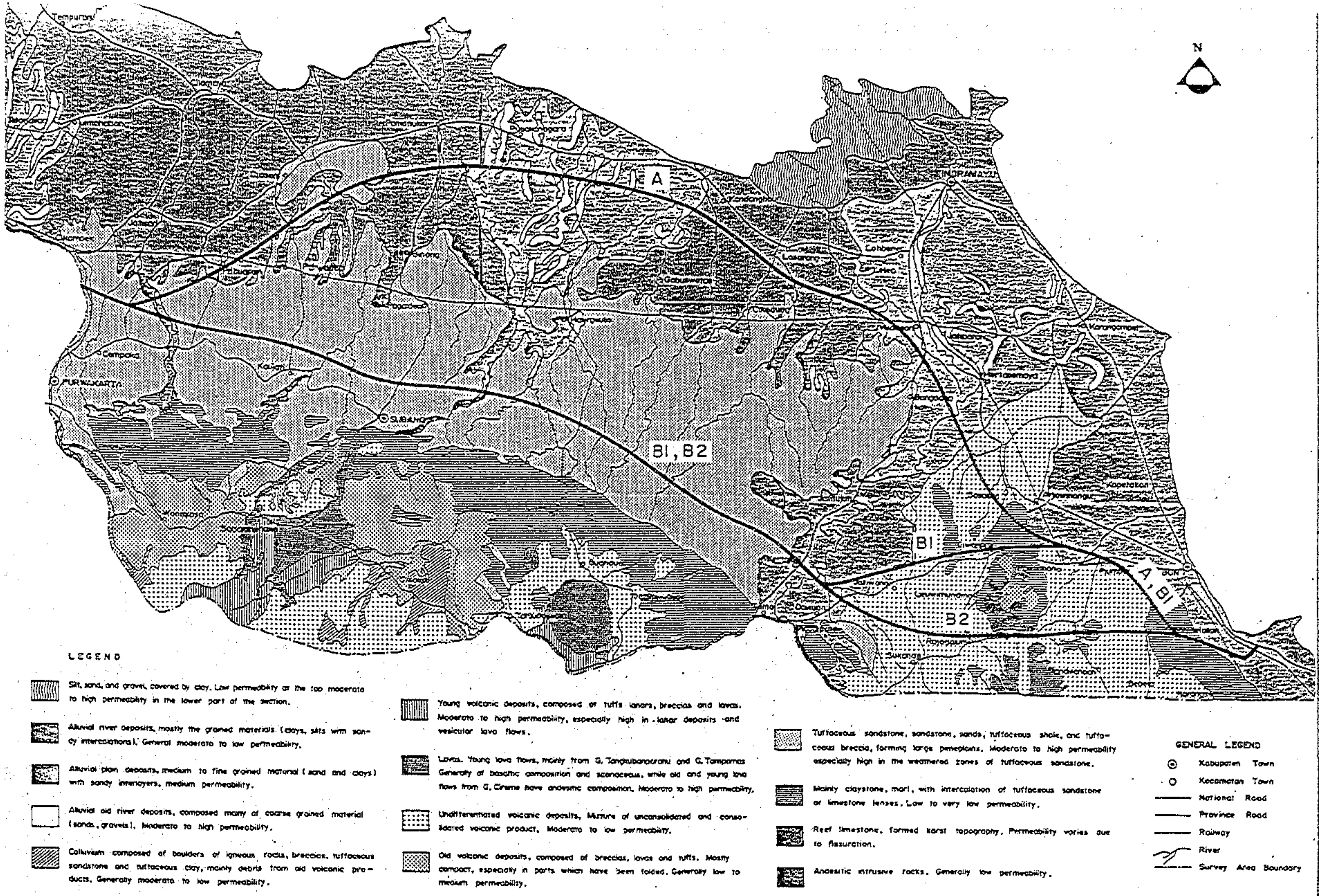
Fig. 8.3.4 Classification of Terrain



Feasibility Study on Cikampek - Cirebon Tollway Project | Fig. 8.3.5 Classification of Slope Degree



Feasibility Study on Cikampek - Cirebon Tollway Project | Fig. 8.3.6 Geological Map