8.4.3 Project Cost

1) General

The cost estimate is based on the result of the preliminary engineering study. The cost estimates of the construction works are prepared referring to the results of cost estimates (i.e. unit prices) in studies related to recent similar projects.

2) Construction Cost Estimate

Table 8.4.2 shows the summary of the preliminary construction cost estimated for each alternative route (A, B1 and B2) at the initial stage (4 lanes/2 directions) in term of financial cost at 1988 prices.

Table 8.4.2 Construction Cost Estimate

(Unit: Million Rp.)

Cost Item	Route A	Route B1	Route B2
1. Earth Work	541,584	236,789	198,681
2. Pavement	89,030	82,250	80,830
3. Bridges	53,009	50,537	73,841
4. Grade Separation	47,371	48,538	45,284
5. Drainage	6,070	8,818	8,921
6. Related Construction	4,084	4,980	4,996
7. Miscellaneous	21,647	20,849	20,102
8. Interchange & Parking Area	53,844	52,244	52,244
9. Road for Construction	33,864	4,980	4,980
Total Construction Cost:	850,503	509,976	489,879
10. Overhead	127,575	76,496	73,482
11. Tax (VAT)	97,808	58,647	56,336
12. Engineering Fee	68,465	41,053	39,435
13. Contingency	156,982	94,129	90,419
Sub-Total of 1-13:	1,301,333	780,302	749,552
14. Land Acquisition	80,000	70,000	60,000
Grand Total	1,381,333	850,302	809,552

Note: All costing at 1988 prices.

For cost estimate purposes the following assumptions are made:

a) It is assumed that major construction works will be contracted to general contractor by international open tender.

b) The unit prices of each construction item are based on the economic conditions prevailing in November 1988.

c) A price escalation factor during the construction period is not assumed.

d) The exchange rates used is:
Indonesia Rp. 1,716 = US Dollar 1.00

e) Overhead is assumed to be 15% of total construction cost.

f) Tax (the value added tax) is assumed to be 10% of total construction cost and overhead.

h) Contingency is assumed to be 15% of total construction cost, overhead and engineering fee.

i) Land acquisition cost is assumed based on the preliminary information from BINA MARGA and JASA MARGA. Furthermore, compensation costs are not yet fully studied and will be finalized after the completion of the 1/5,000 topographic map (currently at drawing stage) which is required in order to count the actual number of housing/buildings that will require compensation. The total amount of housing/buildings involved in compensation is deemed to be considerable and cannot be clearly estimated without a good larger scale map.

3) Economic Construction Costs

The economic costs for economic analysis is obtained from financial costs (shown in Table 8.4.2) by applying a conversion factor of 0.85 to the financial costs for the purpose of reducing the portion of transfer items such as taxes and duties. The conversion factor of 0.85 is based on study results related to recent similar projects.

As for the land acquisition cost, no adjustment is made. The economic costs for each alternative route are summarized in Table 8.4.3.

Table 8.4.3 Economic Construction Cost Estimate

(Unit: Million Rp.)

Particular	Route A	Route B1	Route B2
Direct Construction Cost	722,927	433,480	416,398
Overhead/Profit, Engineering Fee, Contingency, Land Acquisition, etc.	380,069	249,927	232,836
Grand Total	1,102,996	683,407	649,234

To compare the construction costs of the alternatives, Route B2 is the lowest. Route B1 costs about 5% and Route A about 70% higher than Route B2 in terms of both financial and economic costs as summarized in Table 8.4.4.

Table 8.4.4 Comparison of Construction Cost by Index Factor

(Route B2 = 100)

Construction Cost	Route A	Route B1	Route B2
Financial Cost	171	105	100
Economic Cost	170	105	100

4) Operation and Maintenance Costs

The operation and maintenance (O&M) costs for the Project are estimated based on the actual cost data of JASA MARGA.

The O&M cost data for years 1986, 1987 and 1988 (Jan. - June) of the existing tollways in service in Indonesia, related to the estimated total length of the tollways at each of the years, have been used as the basis for estimating O&M cost for the project tollway. Thus, the operation and maintenance costs per kilometer for each year of the existing tollways can be obtained. Considering the growth ratio of the consumer price index in DKI Jakarta during 1986 - 1988 (1986 = 100, 1987 = 108 and 1988 = 118), the costs are then converted to the 1988 price.

As a result, the average operating/maintenance costs of these three years was estimated to be 164.5 million Rp. per kilometer/annum. By applying this cost per kilometer to the proposed length of each alternative route, the annual operation/maintenance cost for each alternative route is obtained for a tollway with 2 lanes.

Furthermore, assuming that the variable cost portion out of total costs will be increased in proportion to the number of lanes, the cost in the case of 4 lanes and 6 lanes are assumed as follows (unit: Million Rp./year):

		2 lanes	4 lanes	6 lanes
Route A	:	24,960	29,702	38,189
Route B1	:	23,018	27,392	35,218
Route B2	:	22,689	27,000	34,714

The economic operation and maintenance costs are obtained by applying a conversion factor of 0.85 to the above financial costs.

8.5 Preliminary Economic and Financial Comparison

8.5.1 Economic Comparison of Alternative Routes

1) Economic Benefit

The economic benefits which would be realized from implementation of the project are defined as the saving in travel costs when comparing the "With" and "Without" Project conditions. Travel costs comprise vehicle operating cost and time cost.

a) Vehicle Operating Costs

For preliminary economic analysis of the Project, recent similar studies related to the tollway project are examined. Mainly for the reason of being up-to-date, the study result of "Consulting Engineering Service of Jakarta Outer Ring Road Project, Phase I Report, October 1988" was reviewed. Based on the above study result, the vehicle operating costs by type of vehicle and by travel speed is assumed.

b) Vehicle Time Cost

Based on the study result of the above report (Jakarta Outer Ring Road Project), the vehicle time costs are also presumed. On the other hand, time costs of trucks and pick-ups which convey cargo are deemed to be somewhat debatable, partially from the viewpoint that time cost of drivers and assistants of truck are included in the factor of vehicle operating cost, and the time cost of cargo is often difficult to be quantified.

Therefore, the time cost of trucks and pick-ups are not taken into consideration for the sake of conservative analysis in the preliminary study stage. The time costs are assumed to be varied for future years with conservative estimates in future real growth rates in income. From 1988 to 1995 the vehicle time costs are increased at 4% per annum. From 1995 to 2005 and from 2005 to 2015 the costs are increased at 3% and 2.5% per annum, respectively.

As a result, the time costs by vehicle type are presumed as shown in Table 8.5.1.

Table 8.5.1 Preliminary Time Cost by Vehicle Type

(unit: Rp./Vehicle/hour)

Veh. Type	1988	1995	2005	2015
Sedan	6,910	9,093	12,220	15,643
Pick-up	-	-	-	-
Truck	-	-	-	-
Bus	16,264	21,402	28,763	36,819

2) Preliminary Economic Cost Benefit Analysis

The benefit of vehicle operating costs is estimated as a difference of vehicle operating costs between "With" and "Without" Project conditions.

Table 8.5.2 shows a summary of the economic benefits in travel costs for each planning year of 1995, 2005 and 2015.

Table 8.5.2 Economic Benefit in Travel Costs for Each Alternative Route

(Unit: Million Rp./Year)

Alternative Route			1995	2005	2015
A	(1)	V.O.C.	99,866	191,791	336,330
	(2)	Time Cost	86,774	292,684	571,688
		(Total)	186,640	484,475	908,018
B1	(1)	V.O.C.	90,591	186,323	316,529
	(2)	Time Cost	76,188	276,934	528,803
		(Total)	166,779	463,257	845,332
B2	(1)	V.O.C.	83,510	168,047	284,298
	(2)	Time Cost	68,871	249,627	475,017
		(Total)	152,381	417,719	759,316

Note: V.O.C.: Vehicle Operating Cost

In case of "Without" Project, costs such as road maintenance costs on the road network would occur. When such costs are taken into consideration, the net benefit would be increased. However, such costs are excluded for cost-benefit analysis for the sake of conservative analysis.

The following assumptions for analysis are made:

Project Life	:	30 years after the completion of the construction works of the initial construction stage
Analysis Period	:	1992 to the end of the project life (1992 - 2027)
Prices	:	1988 prices
Residual Value	:	None

Following the conventional discounted cash flow method, such efficiency measures as the economic internal rate of return (EIRR), the net present value (NPV) and the benefit cost ratio (B/C) are calculated and the results are presented in Table 8.5.3.

Table 8.5.3 Economic Comparison of Alternative Routes

Efficiency Measures	Route A	Route B1	Route B2
Economic Internal Rate of Return (EIRR)	22.8%	28.6%	27.9%
Net Present Value (NPV) at Discount Rate of 15% (Million Rp.)	723,663	912,651	796,253
Benefit Cost Ratio (B/C) at Discount Rate of 15%	1.89	2.69	2.55

In terms of the above economic comparison, Route B1 showed the highest efficiency to the project investment out of the alternative Routes.

8.5.2 Financial Comparison of Alternative Routes

1) Toll Rates and Revenue

In the analysis of the traffic demand projection, the toll model was derived from the study result of existing tollway tariff which was prepared for the traffic assignment. The toll rates for the revenue estimation of financial analysis in the preliminary study stage are based on the said toll rate model.

The toll rates (at 1988 price) adopted are assumed to increase at 7 percent a year escalation rate and revised every three years. The revenue amounts estimated for each alternative route are shown in Table 8.5.4.

Table 8.5.4 Estimated Tollway Revenue for Alternative Route

(Unit: Million Rp./Year)

Alternative Route	1995	2005	2015
A	118,291	350,476	941,175
B1	115,674	339,375	912,581
B2	104,639	302,370	813,941

2) Financial Comparison of Alternative Routes

By arrangement of the revenues and costs, the financial cash flows of alternative routes of A, B1 and B2 are prepared.

The revenues in the intermediate years are interpolated and those beyond 2015 are extrapolated over the analysis period.

Following the conventional discounted cash flow method, the efficiency measures are calculated and the results are shown in Table 8.5.5.

Table 8.5.5 Financial Comparison of Alternative Routes

Efficiency Measures	Route A	Route B1	Route B2
Financial Internal Rate of Return (FIRR)	17.3%	21.6%	20.9%
Net Present Value (NPV) at Discount Rate of 15% (Million Rp.)	289,963	604,849	500,050
Benefit Cost Ratio (B/C) at Discount Rate of 15%	1.29	1.92	1.79

Route B1 again showed the highest efficiency to the project investment out of the alternative Routes.

8.6 Selection of Optimal Route

This Chapter has discussed pros and cons of the alternative routes and has compared such elements as physical, socio-economic, environmental, engineering and economic/ financial features.

A summary of the result of the above comparative analysis is given as shown in Table 8.6.1.

Table 8.6.1 Overall Comparison of Alternative Routes

Comparative Elements		Route A	Route B1	Route B2
a)	Environmental and Socio-economic Impacts	Fair	Good	Fair
b)	Economic Efficiency	Poor	Good	Fair
c)	Financial Efficiency	Poor	Good	Fair

Finally alternative Route B1 is recommended as the optimal route for Cikampek-Cirebon Tollway Project and the route to be utilized in the subsequent preliminary design work.

CHAPTER 9. TOLLWAY OPERATION AND MAINTENANCE PLANNING

CHAPTER 9. TOLLWAY OPERATION AND MAINTENANCE PLANNING

9.1 Tollway Operation

9.1.1 Tollway Operator

It is government policy at present to utilize the private sector for tollway construction and operation. A selected investor(s) is authorized to operate a tollway within a contracted concessionary period, and thereafter he has to transfer the tollway property to the government.

The government intends to apply this policy to the Cikampek-Cirebon Tollway as is the case for N-S Link and Tangerang-Merak Tollway.

The Cikampek-Cirebon Tollway is planned to connect directly with the Jakarta-Cikampek Tollway and the Cikampek-Padalarang Tollway, and these tollways will be operated by different operators.

P.T. Jasa Marga, a public tollway corporation, is to participate in all tollway investment and operation. This is an essential requirement for tollway operation as well as for design and construction to preserve the public good of the road, and to secure and maintain a standard level of traffic services and safety to the public users.

9.1.2 Toll Collection System

1) Tariff System

A distance proportional tariff is proposed for the following reasons:

- A toll per unit distance travelled is seen to be fair by users
- It is suitable for a wide fluctuation of travel distances
- Control of access into both ordinary roads and tollway can be effected, if necessary
- The directly connecting Jakarta - Cikampek Tollway is operated by distance proportional tariff.

2) Toll Collection and Management System

A magnetic card system is proposed for the project tollway. Users stop at on-ramps and off-ramps, a transit card is handed on entry and a toll is paid on exit.

In order to clearly identify the jurisdiction of toll revenue of different tollway operators, it is proposed to build throughway barrier gates at the east terminus of Jakarta - Cikampek Tollway and the west terminus of Cikampek - Cirebon Tollway.

A barrier gate will also be required at the east terminus of the project tollway when it is extended further east and operated by a different operator.

The on-line system, which connects all the toll booths with their toll offices and the respective regional operation offices and integrates all data at the head office, can be most desirable.

Since the construction of an on-line network is costly as is the maintenance of the computer system, it is proposed that the card issuing and cash transaction data be stored on floppy disks by a smaller capacity computer at the toll booths and that the data be compiled at the toll office.

The compiled data stored on floppy disk is delivered everyday from each toll office to the computer center in Head Office. The final compiled data can then be sent to the respective regional offices.

9.1.3 Operational Organization

Assuming that the project tollway is operated by a private investor separately from Jasa Marga, the operational organization must be self-sufficient.

However, since it is required that high standards of service and safety should be maintained, Jasa Marga should be authorized to dictate the technical standards and to supervise the operator to ensure that these standards are being maintained.

The organization will consist of three different levels, namely Head Office, Regional Operating Office and Toll Office as shown in Fig. 9.1.1.

The Head Office will comprise the Board of Directors and four departments with the sections shown in Fig. 9.1.2. The office is best located in Jakarta to ensure smooth and easy access to government agencies, financial institutions and business opportunities.

Organization of the regional Operation Office is proposed as shown in Fig. 9.1.3 and this should be located every 50-80 kilometers of the tollway to enable a patrol/emergency car to reach any location in not more than 30 minutes. Longitudinal staged construction is proposed for the project tollway, that is, the initial construction package between Cikampek and Dawuan and the second stage construction package between Dawuan and Cirebon. Hence Subang and Dawuan offices are proposed where good access to the administrative and development centers are assured.

A toll office is planned to be built at every interchange to administer toll ticket issuing and toll collecting activities.

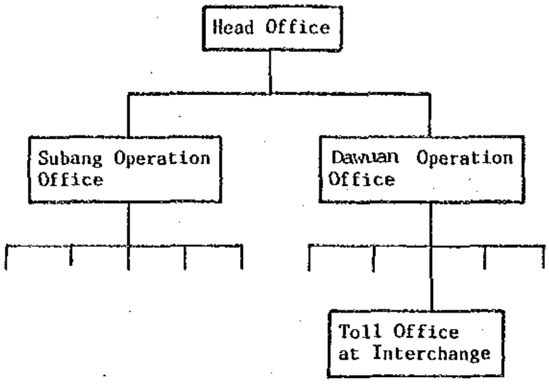


Fig. 9.1.1 Overall Organization

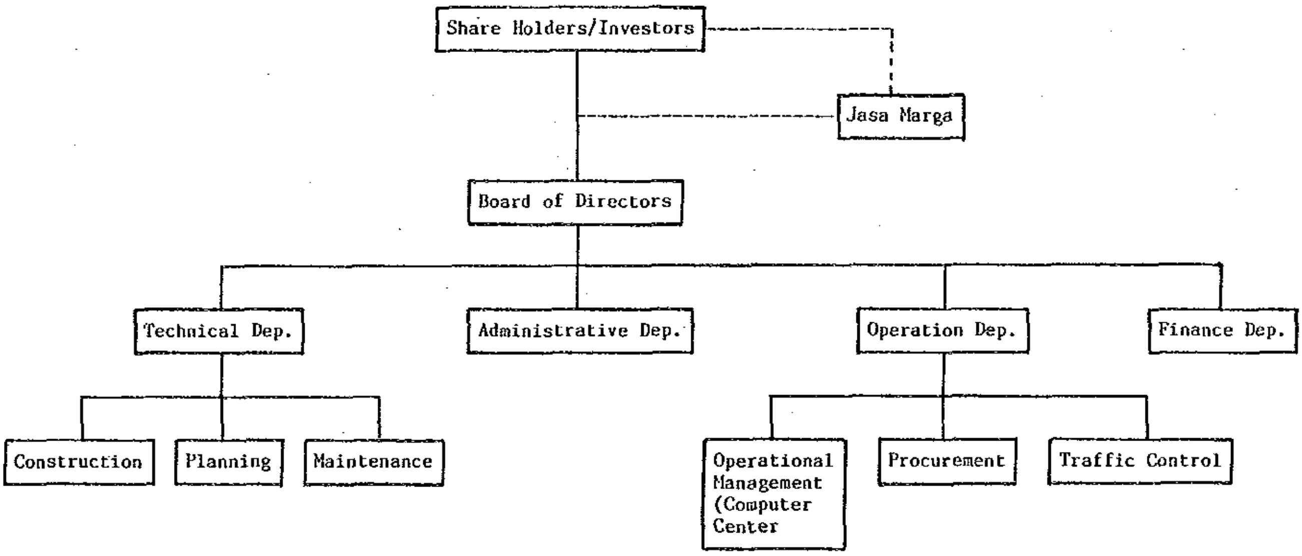


Fig. 9.1.2 Organization of Head Office

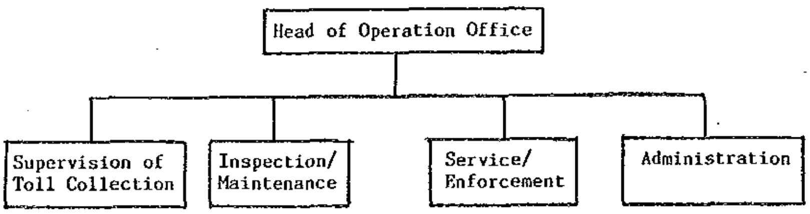


Fig. 9.1.3 Organization of Regional Operation Office

9.2 Tollway Maintenance

9.2.1 General

"Tollway Maintenance" is defined as the function of preserving, repairing, and restoring a tollway and keeping it in condition for safe, convenient, and economical use. "Maintenance" includes both physical maintenance activities, such as patching, filling joints, mowing, and so forth, and traffic service activities including remarking and removing litter. It does not include major rehabilitation or reconstruction activities, such as widening the roadbed, or extensive resurfacing projects.

Tollway maintenance programs are designed to offset the effects of weather, vandalism, organic growth, and traffic wear and damage, as well as deterioration due to the effects of ageing, material failures, and design and construction faults. ASHTO Maintenance Manual (1) includes a table that clearly distinguishes between the four general classes of roadway maintenance and construction activities:

1) Maintenance
   a. Traffic services
   b. Physical maintenance

2) Construction
   a. Betterment
   b. Construction and reconstruction

9.2.2 Maintenance Management

Routine and periodic inspections should be programmed for the maintenance activities of the regional operation office.

Since the data and information collected by the inspection should be properly assessed for maintenance works, an inspection manual is required to determine measures to be taken.

Maintenance budgets are based on the estimated costs to accomplish specific work programs to stated levels of service and performance standards. Maintenance management includes control procedures that are applied to ensure that the work accomplished by field personnel is in line with the objectives of the program and the budgeted funds available.

The basic purpose of a maintenance management system is to record information about maintenance activities performed and resources expended.

Typical features of a maintenance management system include:

1) Development of an annual work program
   a. Defining work activities
   b. Establishing work quantity planning values
   c. Establishing maintenance performance standards
   d. Conducting a road inventory and inspection
   e. Estimating the size of the work program

2) Budgeting and allocating resources
3) Work authorization and control
4) Scheduling
5) Performance evaluation
6) Fiscal control

9.2.3 Machinery and Devices

Maintenance machinery will be divided into installed devices, patrol vehicles, vehicle weight scales, axle load scales and miscellaneous devices for tollway maintenance works and traffic accidents. Table 9.2.1 shows the number of major vehicles per operation office of the Japan Highway Public Corporation in 1988. The vehicles concerned with snow, ice and tunnel are omitted.

The maintenance length for each operation office is around 50-80 km. Assuming this as the case a minimum of two operation offices are required in this project. The operation offices are recommended to be established at Subang and Dawuan Interchanges.

Table 9.2.1 Example for Stationing of Maintenance Vehicles in Japan

Bureau	Control Office	Control Length (Km)	Type of Maintenance Vehicle																	Total Number
			Patrol & Mainte				Cleaning					Special Work				Truck				
			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
TYO-I	1	57.9	4	4	3	0	1	0	1	1	0	1	0	1	1	0	0	5	11	33
	2	45.4	3	3	3	0	2	0	1	0	2	0	1	1	0	0	1	5	10	32
	3	44.5	2	4	2	0	1	0	0	1	0	1	1	1	1	0	0	1	7	22
	4	54.0	3	2	4	1	1	0	1	1	0	0	1	1	0	0	0	1	7	23
	5	49.3	3	2	4	0	2	0	1	0	0	0	0	1	0	0	0	0	5	18
	Total	251.1	15	15	16	1	7	0	4	3	2	2	3	5	2	0	1	12	40	128
TYO-II	1	58.2	2	3	3	1	2	0	1	0	0	0	0	0	1	1	0	5	4	23
	2	65.2	2	4	2	0	2	0	1	1	0	1	0	1	1	0	0	4	5	24
	3	49.5	2	1	3	1	2	1	0	0	0	0	0	1	0	0	0	5	4	20
	4	48.8	2	3	3	0	2	0	1	1	0	1	0	1	0	1	0	4	6	25
	5	29.6	2	2	2	1	2	1	0	0	0	1	0	0	0	0	0	2	4	17
	6	46.6	3	2	4	0	2	1	0	1	1	1	0	1	0	0	0	3	5	24
	7	58.7	2	2	3	0	2	0	0	0	0	0	0	0	1	0	0	2	4	16
	8	70.2	2	2	3	1	2	1	0	1	0	1	1	1	0	0	0	4	6	25
	Total	426.8	17	19	23	4	16	4	3	4	1	5	1	5	3	2	0	29	38	174
TYO-III	1	45.4	2	3	2	1	2	0	1	1	0	1	1	1	0	0	0	4	7	26
	2	67.2	2	4	2	1	3	0	0	1	1	0	1	1	0	0	1	9	6	32
	3	58.2	2	4	2	0	3	1	0	0	0	0	0	0	0	0	0	9	5	26
	4	39.4	2	2	2	0	1	0	1	1	0	0	0	1	1	0	0	4	4	19
	5	54.5	2	2	3	1	2	0	0	0	1	1	0	1	0	0	0	4	4	21
	6	48.9	2	2	4	0	3	1	0	0	0	0	1	0	0	0	0	10	4	27
	Total	313.6	12	17	15	3	14	2	2	3	2	2	3	4	1	0	1	40	30	151
NAGOYA	1	42.3	2	1	4	0	3	0	1	0	0	1	1	1	0	0	0	1	7	22
	2	60.4	2	2	3	0	4	0	1	1	0	0	0	0	0	0	0	3	9	25
	3	42.7	2	3	3	0	12	1	0	0	0	0	0	0	0	1	0	5	6	33
	4	68.2	2	4	5	0	22	1	0	0	0	1	1	1	0	1	0	2	5	45
	5	43.4	1	3	3	0	4	0	1	0	0	0	0	0	0	1	0	8	5	26
	6	48.9	1	1	4	0	2	1	0	0	0	0	0	0	0	1	0	4	4	18
	7	52.3	2	3	4	0	2	0	1	1	2	1	2	0	0	0	0	7	5	30
	8	40.0	2	2	1	1	2	0	0	0	0	0	0	0	0	0	0	4	4	16
	9	58.6	3	2	2	1	4	1	0	0	0	0	1	0	0	0	0	11	6	31
	10	22.2	2	1	2	0	1	0	0	0	0	0	0	0	0	0	0	4	3	13
	11	86.0	2	2	3	0	3	1	0	1	0	1	0	0	0	1	0	4	5	23
	12	19.1	1	1	2	0	1	0	0	0	0	1	1	0	0	0	0	2	2	11
	Total	584.1	22	25	36	2	60	5	4	3	2	5	6	2	0	5	0	55	61	293
OSAKA	1	37.0	4	1	6	0	2	1	0	0	0	1	1	2	0	0	0	4	7	29
	2	48.9	2	0	4	1	1	0	1	1	0	0	0	0	1	1	0	1	6	19
	3	66.2	2	1	4	0	2	0	0	0	0	1	1	0	0	0	0	5	5	21
	4	75.5	2	1	3	1	2	0	0	1	0	0	0	0	1	0	0	5	4	20
	5	31.3	3	3	1	1	1	0	0	1	0	1	0	0	0	0	0	1	4	16
	6	27.3	2	1	2	0	1	0	1	1	0	1	1	0	1	0	0	2	2	15
	7	25.1	1	1	2	0	1	1	0	0	0	0	1	0	0	0	0	1	2	10
	8	31.0	2	1	2	1	2	0	1	0	0	0	0	0	0	0	0	3	3	15
	Total	342.3	18	9	24	4	12	2	3	4	0	4	4	2	3	1	0	22	33	145

Note:

	Type of Vehicles	Maijor works
A	Communication car	Patrol, message relay
B	Patrol car	Patrol, inspection
C	Maintenance car (A)	Inspection and supervision of repair areas
D	Maintenance car (B)	Inspection and supervision of repair areas
E	Sprinkler	Road cleaning
F	Road sweeper (A)	Road cleaning
G	Road sweeper (B)	Road cleaning
H	Jet Cleaner	Cleaning of expansion joints and drain pipes
I	Other Cleaner	Cleaning
J	Beam lifter	Maintenance of lighting apparatus
K	Lift	Road signs and Culvert maintenance, inspection
L	Multi-purpose truck	Mowing of grass Mowing of grass and pruning
M	Miscellaneous	Special works
N	Truck (light)	Transportation
O	Truck (medium)	Transportation
P	Truck (large)	Transportation
Q	Sign plate car	Traffic regulation at work areas and accidents

As there will be a difference in conditions compared to Japan, for example, advanced information devices such as variable message signs and monitors, or a high ratio of old vehicles unfit for long distance and high speed travel, patrolling should be increased. The appropriate stationing of vehicles and personnel should be considered in order to quickly relay messages, provide effective service to drivers and quick removal of traffic obstructions.

The types and number of vehicles to be provided at each control office are recommended as shown on Table 9.2.2.

Table 9.2.2 Required Maintenance Vehicles

	Subang	Dawuan
Communication car	3	3
Patrol car	4	4
Maintenance car	4	4
Sprinkler	0	1
Road sweeper	1	1
Jet cleaner	0	1
Beam lifter	1	0
Lift	1	0
Truck (medium)	2	2
Sign plate car	5	5
Water tank truck (for plants)	1	1

9.3 Traffic Control and Information System

9.3.1 General

Traffic control and information service is vital in monitoring safe and smooth traffic flow regardless of weather or traffic conditions including the following key activities:

- Traffic regulation (volume, speed, weight);
- Information collection and dissemination;
- Accidents and congestion monitoring; and
- Facility security

Control, largely exercised by traffic police, includes monitoring of speed and driving behavior to ensure a safe operating environment.

Traffic information facilities are expected to require sophisticated treatment in future particularly as volume on key demand sectors approach saturation capacity. Closed-circuit television, radio broadcasts, variable-message boards and loop-type traffic detectors will, in all likelihood, be desirable in future.

The installation of roadside emergency telephones at approximately two kilometer intervals will serve as a valuable aid in enhancing para-medical services and removing disabled vehicles.

9.3.2 Staged Installation of Control Devices

Traffic control and information devices are generally categorized as shown in Fig. 9.3.1.

The basic traffic control devices should be provided in the initial investment stage. In order to economize the initial cost the advanced devices should be installed depending on the traffic volume and needs raised through the tollway operation.

In the initial stage, however, patrol activities should be enhanced to substitute for the advanced traffic control devices and assure the collection and dissemination of traffic information as well as other tollway environmental factors.

- Traffic Control Devices
  - Basic Traffic Control Devices
    - Traffic Signs
      - Guide Signs
      - Warning Signs
      - Regulatory Signs
    - Markings
    - Delineators
  - Advanced Traffic Control Devices
    - Information Collection Devices
      - Vehicle Detector
      - Weather Observation Equipment
      - Traffic Surveillance TV Camera
      - Emergency Telephone
    - Information Processing and Monitoring Devices (Traffic Control Center)
      - Computer
      - Monitor TV
      - Control Console
      - Graphic Display Panel
    - Information Provision Devices
      - Variable Message Signs
      - Variable Speed Limit Signs
      - Highway Advisory Information Radio

Fig. 9.3.1 Traffic Control and Information Devices

CHAPTER 10. PRELIMINARY DESIGN WORK

CHAPTER 10. PRELIMINARY DESIGN WORK

10.1 General

Based on the determined design standard as described in paragraph 7.4, the preliminary design is carried out for the selected optimal route which is described in paragraph 8.7.

10.2 Alignment Design

10.2.1 Basic Data

1) Aerial Photographic Survey and Topographic Maps

As described in the Interim Report, an aerial photographic survey including ground control survey was completed in October 1988.

Based on the aerial photography, plotting works at a scale of 1:5,000 for topographic mapping was conducted by PT. AEROKARTO INDONESIA under supervision of the survey team.

The work was completed in July 1989 and the area covers 840 km^2 with 282 models and 117 sheets.

The products of the topographical mapping are as follows:

- Aerial photograph (2,100 km^2, 1:20,000),
- Uncontrolled mosaic sheets (2,100 km^2, 1:25000),
- Topographic map (840 km^2, 1:5,000) and
- Data and survey results of aerial photography, ground survey and cartography.

2) Soils and Materials Survey

A soils and materials survey was carried out along the length of the proposed tollway in the period from October to December 1988 to provide information and data for earthwork, pavement, structural work and other items for the tollway.

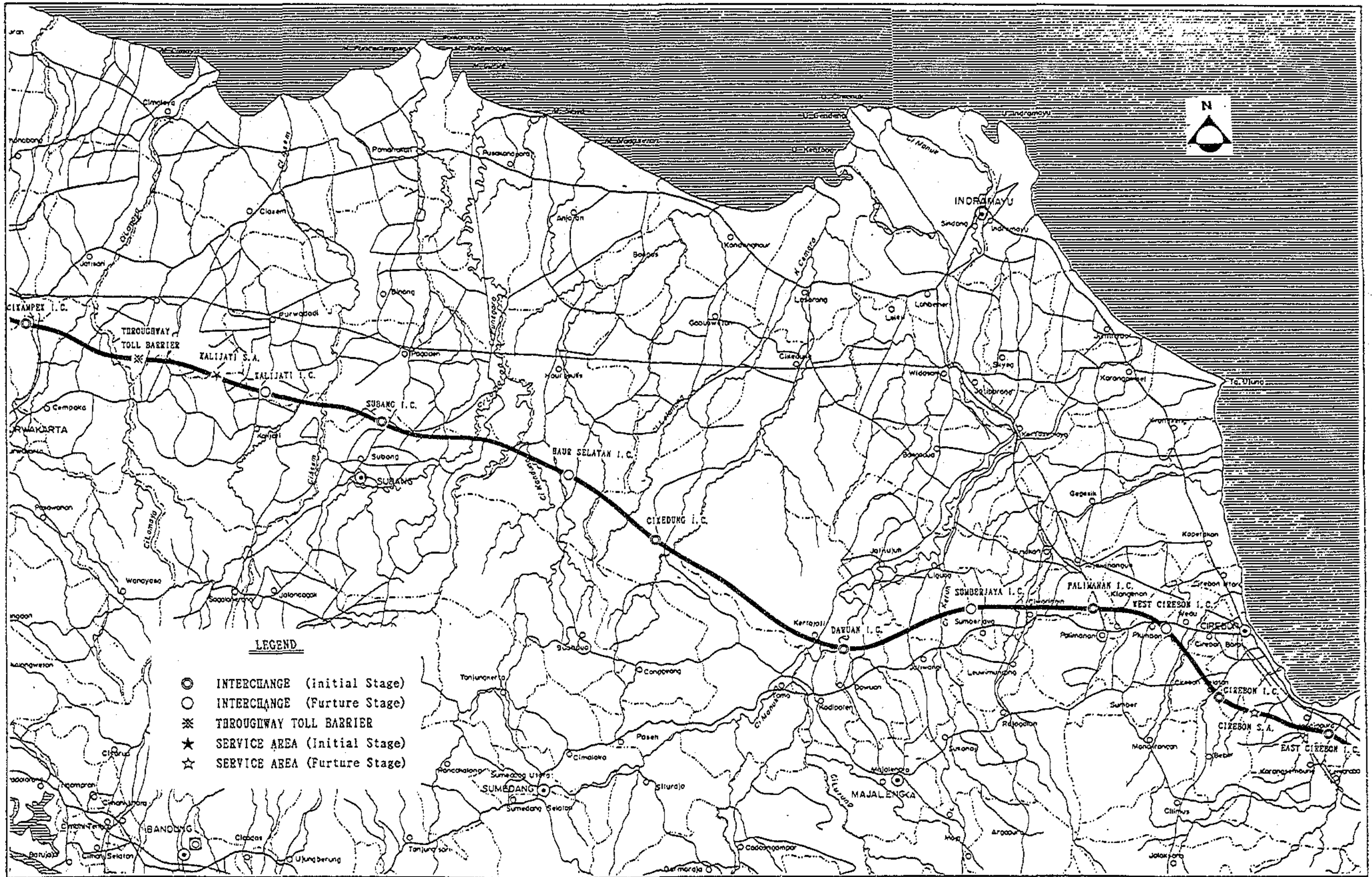
Machine boring, Dutch cone penetration tests, test pits, laboratory tests etc. were carried out by P.T. WIRA NUSANTARA and a summary of the results was included in the Interim Report.

10.2.2 Route Locations

1) General

The proposed tollway is approximately 142 km in length starting from the end point of the Jakarta-Cikampek Tollway and connecting with national road route 013 ten (10) km east of Cirebon city. A total of seven (7) interchanges is planned in the initial stage of construction and eleven (11) at the final stage. Two service areas are considered for tollway users in the Subang area and south of the Cirebon area. Taking into consideration proper amount of construction volume and economical distribution of earth works, tentative construction sections and packages are set up as follows:

Package A: Cikampek I.C. - Subang I.C.				L = 37.5 km
Section 1	STA. 92.5	-	STA. 109.5	L = 17.0 km
Section 2	STA. 109.5	-	STA. 130.0	L = 20.5 km
Package B: Subang I.C. - Dawuan I.C.				L = 52.0 km
Section 3	STA. 130.0	-	STA. 149.5	L = 19.5 km
Section 4	STA. 149.5	-	STA. 162.0	L = 12.5 km
Section 5	STA. 162.0	-	STA. 182.0	L = 20.0 km
Package C: Dawuan I.C. - East Cirebon				L = 52.8 km
Section 6	STA. 182.0	-	STA. 194.0	L = 12.0 km
Section 7	STA. 194.0	-	STA. 208.0	L = 14.0 km
Section 8	STA. 208.0	-	STA. 222.0	L = 14.0 km
Section 9	STA. 222.0	-	STA. 234.8	L = 12.8 km



Feasibility Study on Cikampek - Cirebon Tollway Project

Fig. 10.2.1 Location Map

2) Route Description

a) Package A (Cikampek I.C. - Subang I.C.)

In accordance with the regional structural plan of West Java Province, Cikampek is a development center in Purwasuka region and a connection point with the existing provincial road between Cikampek and Bandung. Large and medium industries are planned to be located along this provincial road in Cikampek and Jatiluhur areas. Jatiluhur area has high potential for tourism development.

The proposed alignment of the tollway passes through gently-sloping areas with the incline of less than 8 percent and plantation areas and paddy fields from Cikampek to the northern areas of Subang.

Subang is one of the sub-development centers of the Purwasuka region which has high potential for plantations, fishery and small home industry development. The alignment is selected to avoid physical and social constraints such as sparsely located villages, rivers, schools, mosques, etc.

Cikampek Interchange was designed according to the planning concept prepared in the Jakarta-Cikampek Project. The existing toll gate becomes unnecessary after completion of the throughway toll barrier.

A trumpet type interchange with single structure is designated for Subang and Kalijati Interchanges. The ramp terminals for both interchanges are located on the south side of the proposed tollway connecting provincial road (076) and Kabupaten road (07) respectively due to future traffic movements.

b) Package B (Subang I.C. - Dawuan I.C.)

The alignment runs through flat and partly gently-sloping areas near Sungai Cipanas when the land is used for paddy fields, forest and plantation.

Although there are no significant towns and obstructions for alignment selection, the route was plotted with such constraints as scattered villages, rivers, local roads and narrow gauge railway tracks.

Haur Selatan and deferred Cikedung interchanges are planned to be connected with the Kabupaten road (6) and the provincial road (074) respectively by trumpet pattern. Around the end of the area in this package, the route crosses Cimanuk river the largest meandering river in this project area, then connected with Dawuan city which is the most highly expected development sub center in Cirebon influenced areas and connection point with the existing national road (023) between Cirebon and Bandung.

Additionally, the tollway in this section is expected to give an impact for regional development by the reason that no existing parallel road with the tollway is found in this area.

c) Package C (Dawuan I.C. - East Cirebon I.C.)

The route in this section runs through well irrigated paddy field and is located along the north side of the national road (023) from Kadipaten to Palimanan. And the alignment passes through flat areas avoiding the built up areas developed for residential and industrial proposes. In Plumbon area, the route swings east south, crosses over the national road (024) and proceeds to the provincial road (067) providing under pass. Then the alignment swings east through the gently-sloping areas near situ Patok Lake and goes through the terminal point of the project.

This region is intended to develop in balance with the growth of Jakarta and is to function as a transport junction of Jakarta, Bandung and Central Java. In addition, the region is expected to grow up as a center of industrial, commercial and agricultural development.

10.2.3 Geometric Design Standard

1) General

The geometric design standard for the tollway was established through meetings held at the time of the Interim Report and at the commencement of Phase II Study.

2) Design Speed

Since the terrain is flat except for part of the route near Cikampek and Cirebon areas in the project corridor, a design speed of 120 km and 100 km is used for tollway carriageways in flat and rolling areas respectively.

The following design speeds are applied to the various types of roads related to this project:

- Tollway carriageway	120 - 100 km/hr
- Interchange loops	40 km/hr
- National highway	80 km/hr
- Provincial road	80 km/hr
- Kabupaten road	60 km/hr

3) Lane Width

No modification or change is made to the current government standard of 3.60 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

A 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) Others

Based on the design speed adopted, other design criteria and elements such as sight distance, horizontal curvature, vertical alignment, super elevation, etc. are determined by following government standards.

10.2.4 Alignment Design

1) General

As part of the Trans Java Tollway, the alignment design was based on the following basic planning concepts:

- to accommodate traffic safely under high speed operation,
- to prepare a comfortable driving environment for tollway users,
- to maintain a combination of horizontal and vertical alignment and
- to provide economical distribution of earth excavation and embankment works.

2) Horizontal Alignment

From a technical and socio-economic point of view as detailed in the Interim Report, the selected route was defined on the topographical maps (1:5,000 scale) developed and confirmed by supplemental field survey.

The following major factors are considered in setting up the horizontal alignment.

- to provide horizontal alignment with gentle curvature reflecting the flat terrain conditions,
- to shift the alignment to the most suitable distance to the built up areas and development centers in the proposed interchange areas,
- to arrange right angle crossings as much as possible at river sites,
- to avoid as much as possible public facilities, factories and buildings and
- to avoid parks, playgrounds, golf courses and cemeteries.

3) Vertical Alignment

The vertical alignment is attained considering the following constraints:

- to maintain local activities and communications by provision of box culverts or over passes based on comparative study of both alternatives,
- to keep a minimum embankment height of 2.0 m above existing ground in paddy fields for pipe culverts,
- to provide necessary vertical clearance for roads, rivers and narrow gauge railway tracks, and
- to provide over passes for existing roads over the tollway for grade separation, in principle, to maintain flexibility for future development at the road crossing. This is in consideration of economy and ease to adapt to any future social and regional changes in the area.

10.3 Interchange Design

10.3.1 General

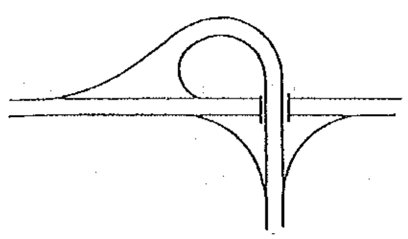
The location and type of interchanges are decided on the basis of future traffic movements and socio-economic conditions in the project area as listed in Table 10.3.1.

Table 10.3.1 Interchange List

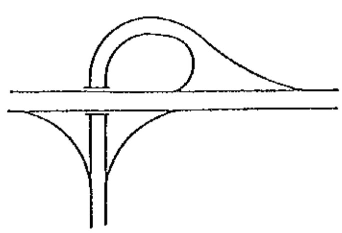
Interchange		Type	Road to be connected
Initial Stage	Future Stage		
Cikampek		Single Trumpet	Province road Route 080
	Kalijati		
Subang		Single Trumpet	Province road Route 075
	Haur Selatan		
Cikedung		Single Trumpet	Kabupaten road Route 015
Dawuan		Single Trumpet	National road Route 023
	Sumberjaya		
Palimanan		Single Trumpet	Province road Route 025
	West Cirebon		
Cirebon		Single Trumpet (+ grade separation intersection)	Province road Route 067
East Cirebon		(Single Trumpet)	National road Route 023

Note: ( ) shows future plan

In the case of the closed tollway system the trumpet type is suitable for interchanges. As shown below, trumpet type can be A type or B type depending on which direction forecast traffic volume predominates.



A Type



B Type

10.3.2 Design Criteria

The accident rate on tollways is overwhelmingly high for interchange sections, so it is not proper to apply the alignment standard of throughway to interchange sections. In addition to the geometric design criteria proposed in 10.2.3 we would propose criteria for interchange sections in accordance with the criteria of Japan Highway Public Corporation as follows:

Table 10.3.2 Geometric Design Criteria for Interchange Section

Description		Design Speed of Throughway		
		120	100	80
Horizontal-curve Radius (more than m.)	standard	2,000	1,500	1,100
	special	1,500	1,000	700
Minimum Vertical-curve Radius Convex Type (more than m.)	standard	45,000	25,000	12,000
	special	23,000	15,000	6,000
Minimum Vertical-curve Radius Dent Type (more than m.)	standard	16,000	12,000	8,000
	special	12,000	8,000	4,000
Gradient (%)	standard	2	2	3
	special	2	2	4

10.3.3 Major Points for Design of Interchanges

1) Cikampek Interchange

Cikampek interchange has been partially constructed by Jakarta-Cikampek project, which has already been opened. The partial construction includes the ramp-way 1210 and the toll plaza and office. The remaining facilities will have to be completed as the starting point for this project.

However, the longitudinal alignment for this interchange has been decided under conditions which are not applicable to the above standard. Namely it is designed such that the traffic from the Cirebon direction which will flow into provincial road Route 079 through a loop type off-ramp shall approach the ramp along a tollway section of grade 2.7% (more than the 2.0% standard).

The future Cirebon bound carriageway is at present temporarily operated as a two-lane two-way tollway, therefore, longitudinal modification will be possible at the time of the forthcoming additional construction for the Cikampek bound carriageway.

As modification of the present Cirebon bound carriageway will be difficult due to the longitudinal slope of throughway around this area, two grade separations of the adjacent railway and provincial road create vertical control points, the longitudinal grade of the Cikampek bound carriageway as it approaches the loop type off ramp should be modified so as to eliminate the dangerous situation of traffic flow exiting from carriageway via the ramp.

However, if such a longitudinal separation is adopted, a retaining wall of height 4 meters and length 200 meters must be provided within the planned narrow median.

This is beyond the scope of this project. Furthermore, the estimated traffic volume on this ramp is small, therefore the design criteria of interchanges will not be applied for the Cikampek interchange in this study. It shall be reviewed at the time of the detailed design stage.

2) Subang Interchange

Subang interchange is connected with the provincial road Route 076 about 4 Km from Subang city center. The interchange will serve the connections between the tollway and Subang-Bandung to the south and Pamanukan to the north.

In addition to the necessary facilities for the interchange, operation and maintenance offices should be built at this interchange. Two offices will be required for the operation and maintenance of the Cikampek-Cirebon tollway which has a length of approximately 142 Km.

The tollway shall be roughly divided into equal maintenance and operation sections with each office located midway on the section which it shall be responsible for. The office staff may therefore reach any location for operation or maintenance purposes in the shortest time. Thus the offices should be built at suitable sites near STA. 130 and STA. 200.

Subang city is the second largest city in the project area, and labor and material may be easily obtained there. The location of the interchange is STA. 129 + 400 and the tollway operation and maintenance range is 37 Km to the west and 30 Km to the east up to Cikedung interchange, which is well balanced.

3) Dawuan Interchange

Dawuan interchange is connected with the national road Route 023 by the right bank of Cimanuk river and will serve Kadipaten and the route towards Bandung.

Kadipaten is expected to show the greatest development of the towns within the sphere of influence of Cirebon, and will be a sub-center of Cirebon city.

The distance between this interchange and the national road Route 023 has to be as long as 4 Km because the location where this tollway crosses Cimanuk river is restricted by the meandering river and the land use conditions, and because of the balance of the alignment.

An operation and maintenance office as mentioned in paragraph 2), will be constructed at this interchange. The range allotted to this office will be up to 23 Km to the west and 53 Km to the east.

Although there is an imbalance between the east and west sections the office location is determined taking into consideration the early partial opening between Cikampek and Dawuan inerchange.

4) Cirebon Interchange

Cirebon interchange is connected with provincial road Route 067 and serves the city center of Cirebon to the north and Kuningan town to the south.

To avoid construction of a long embankment section and the problem of insufficient embankment material, the excavation type is adopted for Cirebon interchange.

In consideration of the increase of traffic volume related to the establishment of the interchange, the provincial road is recommended to be widened to 4 lanes for 3.1 Km between the interchange and Cirebon bypass.

Initially, the crossing with the provincial road should be an at-grade intersection, however, considering the fact that a grade separation will be necessary in the future, the site area should be secured in advance.

5) East Cirebon Interchange

This interchange is to be connected with the national road Route 013 at the eastern suburbs of Cirebon. This connection point is the terminus point of the project. The interchange will serve Cirebon as well as routes towards Central Java and East Java.

The ramp way of the East Cirebon interchange should not be completed until the extension of the tollway to the east is completed, thus partial construction as in the Cikampek interchange will be adequate. The off-ramp will have two lanes used for both entering and exiting traffic. The access road from the toll gate to the national road crosses the railway, however there are only 12 shuttle trains/day, therefore, for the estimated traffic, at-grade intersection will be adequate to begin with. Grade separation will be considered in the future according to the number of trains using the railway and traffic volume on the access road.

10.4 Service Area and Parking Area

10.4.1 General

In such restricted areas as the roadside of an expressway, facilities meeting the physiological needs of the drivers and facilities providing refueling, water supply and maintenance services for vehicles are required to ensure safe and comfortable journeys and for quick and economical transportation. As the lengths of the existing tollways in Indonesia are short, these facilities are not installed yet. For the future extension plans of the tollway, a standard for the installation of these facilities is being planned by Jasa Marga, however, for this preliminary design, the standards of the Japan Highway Public Corporation will be used.

10.4.2 Intervals of Service and Parking Areas

Service areas are facilities which provide sufficient services to meet the needs of drivers and vehicles. Facilities for personal use include parks, public lavatories, restaurants, stores, and mosques. Facilities for vehicles include parking lot, gas stations and service stations.

Parking areas should be installed to meet the physiological needs of the drivers as the minimum required facilities to remove fatigue and tension of the driver: parking lot, public lavatories, and stands.

The standard intervals for locating service and parking areas according to the Japan Highway Public Corporation are as follows:

Intervals for each area:	15 - 25 Km
Intervals for service areas:	50 - 100 Km

Service areas require large facilities, thus increasing the construction and maintenance costs and the demand for such facilities is greatly influenced by the amount of traffic volume, landscape, objective of traffic, habits and the country's state of affairs.

Considering these facts, the location of a service area was decided upon near STA. 111 + 500, which is a suitable site if the maximum 100 Km interval is used.

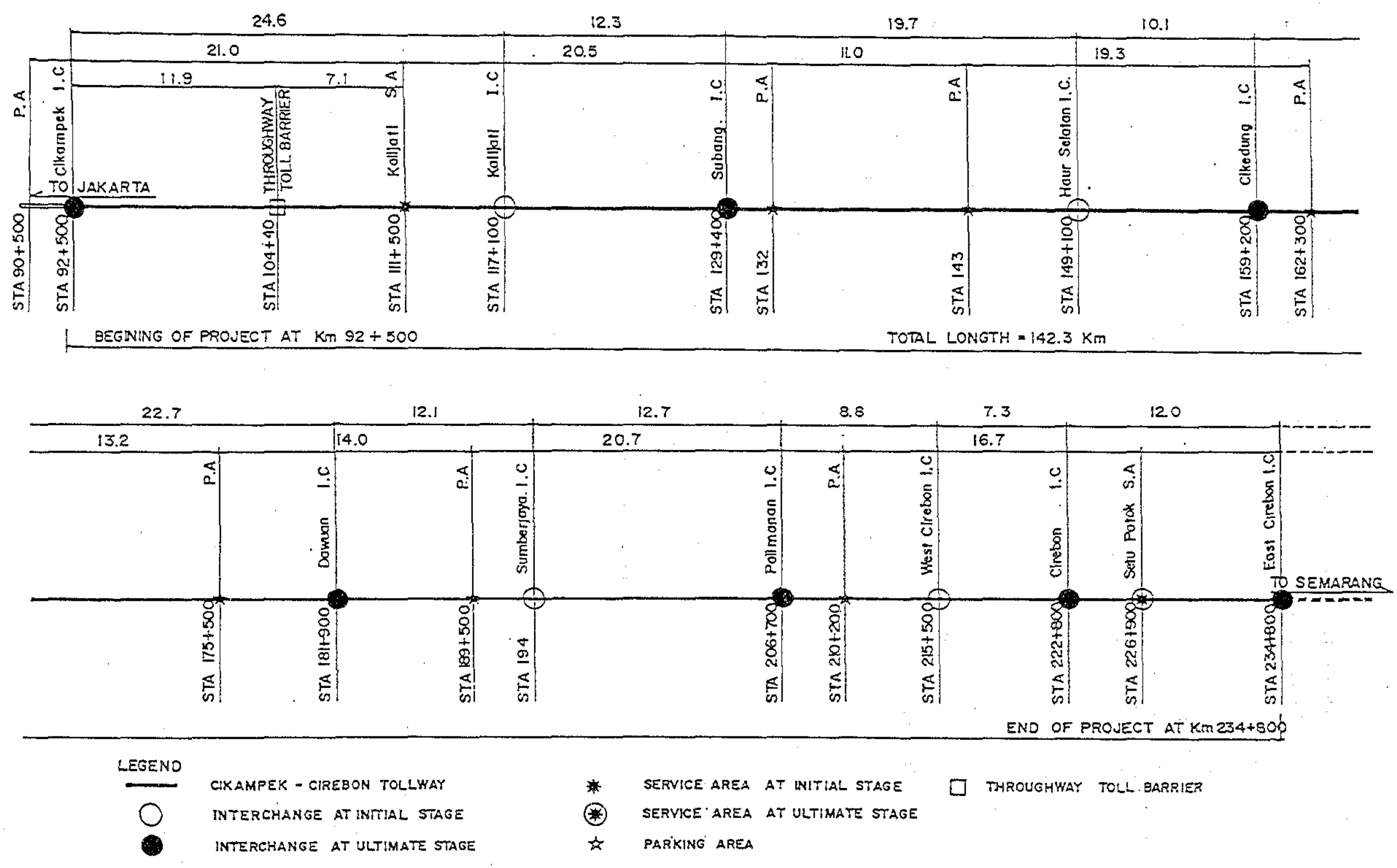
(The above interval standards may be observed even if a service area is not set up along the present Jakarta-Cikampek tollway.) (The distance from Jakarta Interchange is 92 Km.)

Another service area should be constructed near STA. 227 if the tollway is extended further east of Cirebon. Parking areas should be set up based on the above interval standards, and the locations are shown in Fig. 10.4.1.

10.4.3 Scale and Required Facilities

The scale of facilities will depend on the designed traffic volume forecast for the next 10 years after opening the tollway, and the past facilities utilization records, although it should be noted that the facilities utilization rates for new roads are difficult to estimate because they vary depending on the nature of the route, objective of traffic, habits, religion, season, and day of the week. The size of the parking lot should be decided according to the estimation of the daily traffic volume and the percentage of large vehicles.

The standard size of parking lot to meet with the traffic volume will accommodate 65 passenger cars and 35 large-sized cars. Further expansion of the parking lot and facilities will be conducted in stages according to the extent of use.



Feasibility Study on Cikampek - Cirebon Tollway Project

Fig. 10.4.1 Location of Tollway Facilities

10.5 Throughway Toll Barrier

10.5.1 General

The Indonesian authority intends to implement and operate the project tollway separately from other connecting tollways, thus, accounts should be settled separately for each different project section which will be managed by a different agency. This project concerns the tollway which makes up part of the road network system in Java Island. A throughway toll barrier should be set up at both ends of the project.

10.5.2 Location

The throughway toll barrier is a facility for stopping traffic, thus it is of a contradictory nature to roads that are meant for the smooth flow of traffic. Therefore, the following points should be considered for the installation location and design:

1) It should not endanger traffic safety.

2) It should be easily seen from a distance.

3) In order to avoid traffic congestion an adequate number of lanes should be provided for peak times.

4) The toll gate area should be in a flat and straight area.

5) Traffic control and toll service should be carried out efficiently and expediently.

6) Electricity supply should be available nearby.

The location of the throughway toll barrier was decided at STA. 104 + 500 between Cikampek and Kalijati interchange taken into account the above mentioned points.

If the tollway is extended further east of Cirebon, another barrier should be installed between the other end of Cirebon and East Cirebon interchange.

10.5.3 Scale and Required Facilities

Considering the points mentioned below, the number of lanes at the throughway toll barrier was decided upon as 11 at the initial stage, and should be increased to 16 in the future.

1) Design hour volume (DHV) of the barrier section, which is applied for the initial stage, was derived from the estimated traffic volume in 2008, that is 10 years after the opening of tollway operation.

2) As a result the design hour volume (DHV) of the barrier section resulted in 3000 vehicles/hour.

3) The average service time will be 6 seconds at the entrance and 14 seconds at the exit.

4) The service standard was measured by the average number of waiting vehicles, which was assumed to be one vehicle for this calculation.

Required facilities in the throughway toll barrier are as follows:

1) Toll Facility (Toll Plaza, Toll Gate, Equipment)
2) Offices
3) Police Box and Watch Box
4) Power Supply Facility
5) Water Supply Facility (Water Tank, Water Tower, Pump House)
6) Lighting Facility
7) Landscaping

10.6 Structural Design

10.6.1 General

Based on the design concept of economy, ease of construction, construction period and aesthetics, preliminary structural designs for bridges, culverts and retaining walls were conducted to establish standardization of structural types.

The loading specifications of Bina Marga used for the design of structures are as follows:

- Loading Specifications for Highway Bridges, No. 12/1970, by Bina Marga

- General Explanation and Interim Guide for using Loading Specifications for Highway Bridges, No. 12/1970, 1974, by Bina Marga

- Explanation and Supplementary Specifications of Loading Standards for Highway Bridges No. 12/1970, February 1977, by Bina Marga.

- Revision to the Loading Specifications 1980, Bina Marga Draft.

Other design criteria such as materials and basic strengths, and allowable stresses were discussed in the Interim Report.

10.6.2 Standardization of Bridges

A comprehensive study was made to establish standards of structure types for throughway bridges and over bridges.

The span length of bridges was determined by relating span length and bridge type construction requirements with environmental and aesthetic requirements. The substructures of throughway and over bridges are of reinforced concrete piers of aesthetic appearance.

The foundation type is determined by subsoil conditions and economic criteria.

The structures are as follows:

- Superstructure : PC hollow slab
  RC hollow slab
  PC continuous box girder

- Substructure : Column type
  Wall type

- Foundation : Precast PC Pile
  Precast RC Pile
  Steel Pipe Pile

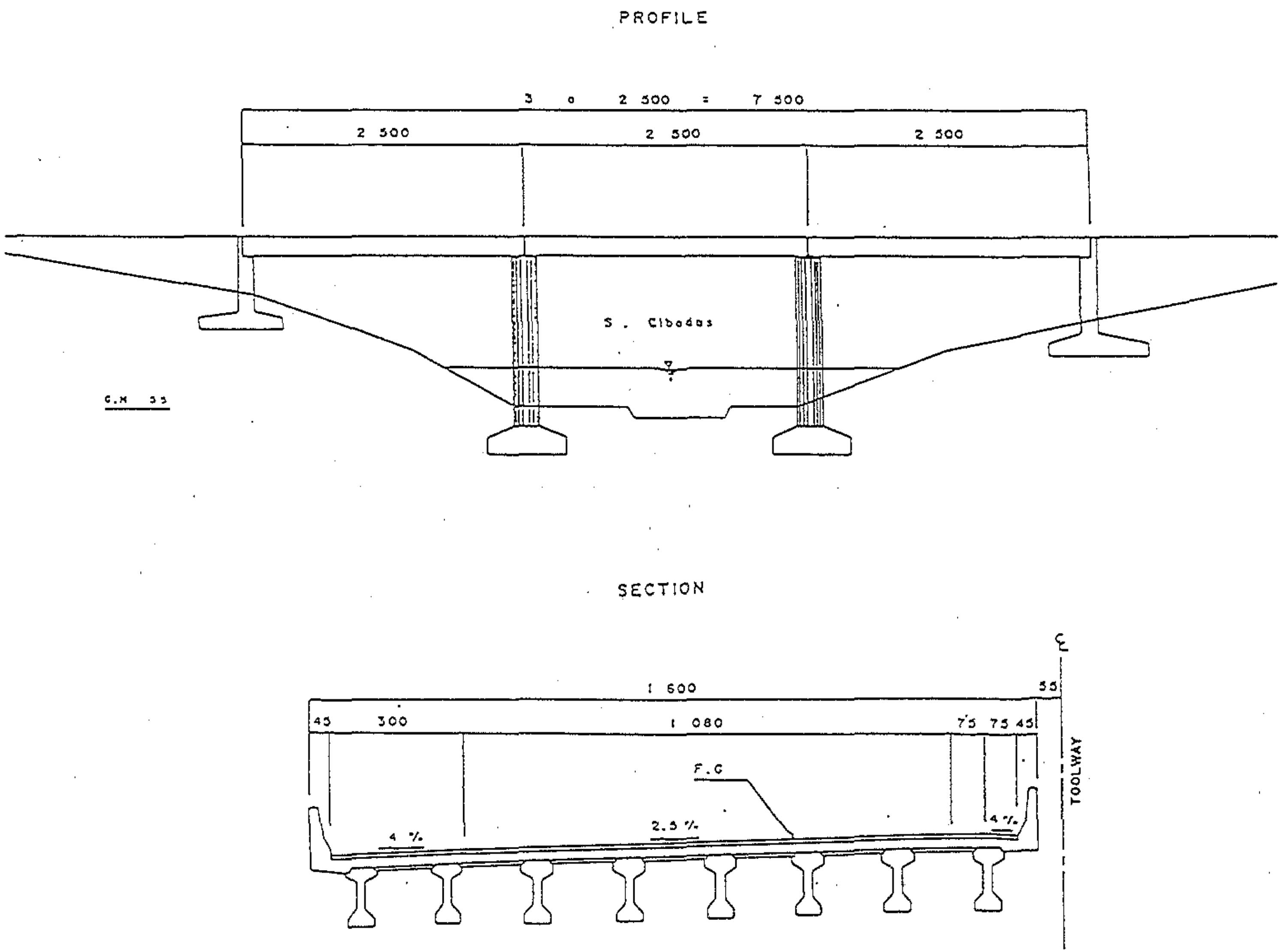


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Fig. 10.6.1 Throughway Bridge (1)

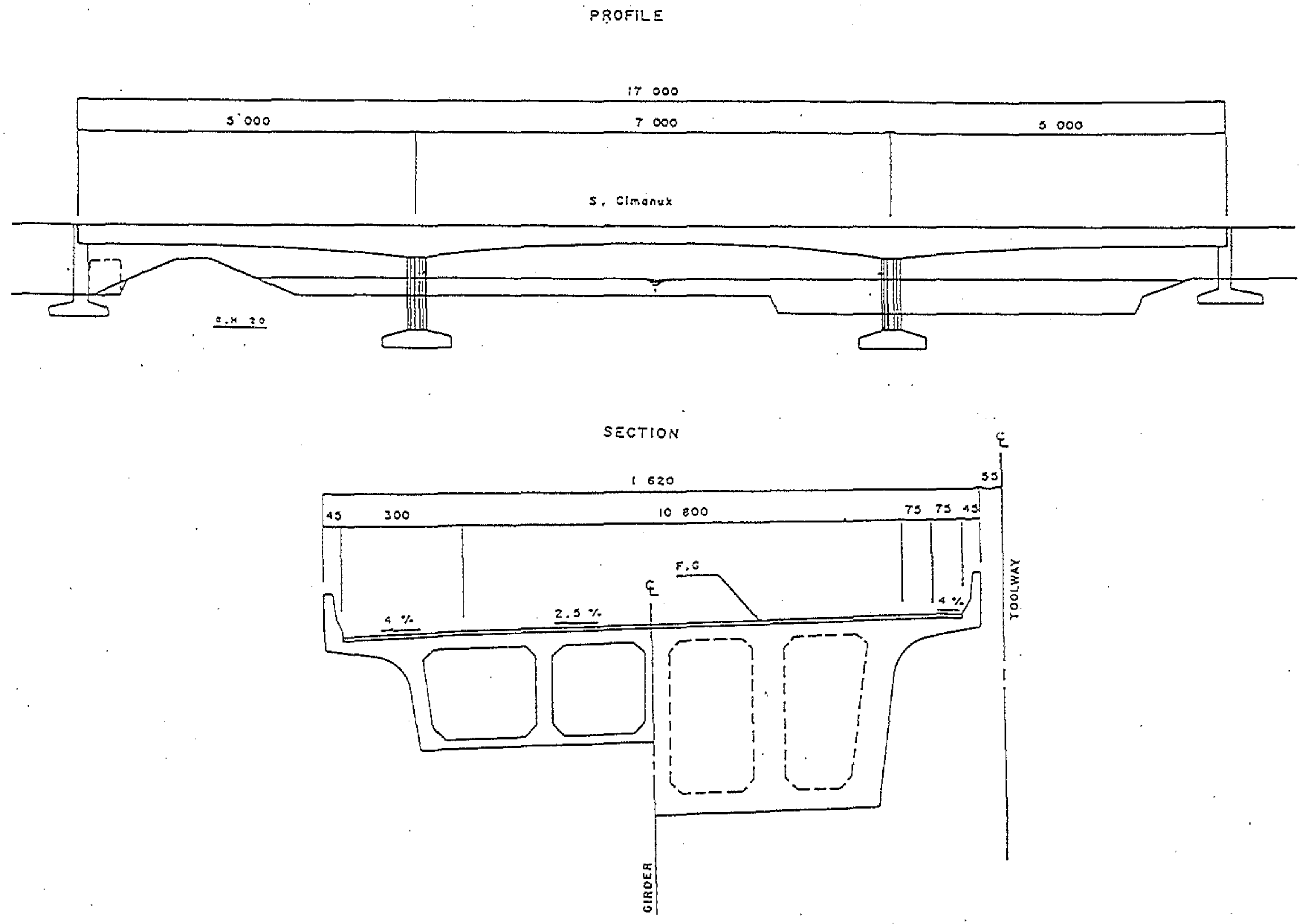

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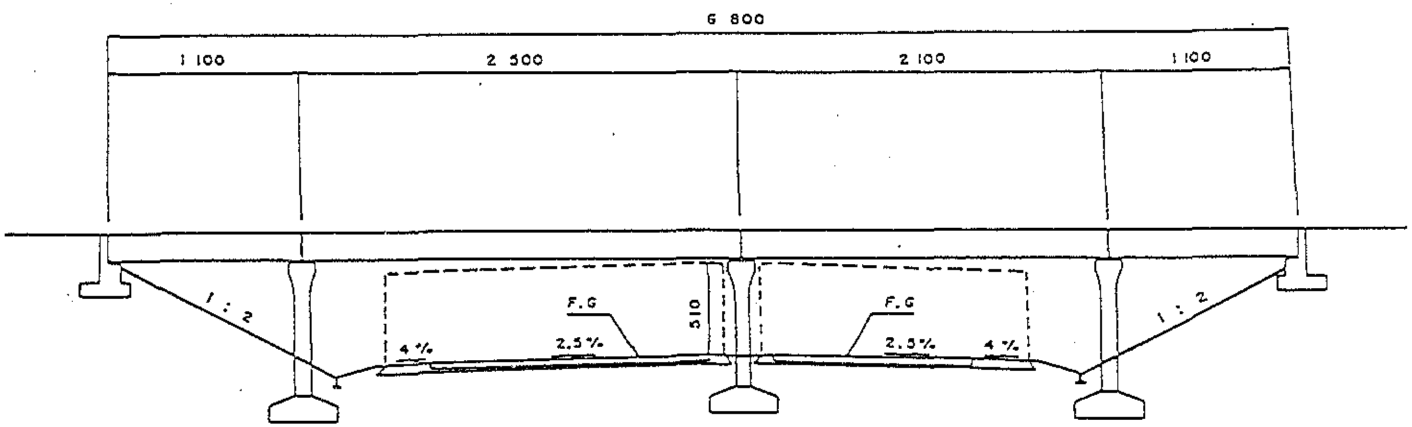
Fig. 10.6.2 Throughway Bridge (2)

PROFILE



SECTION

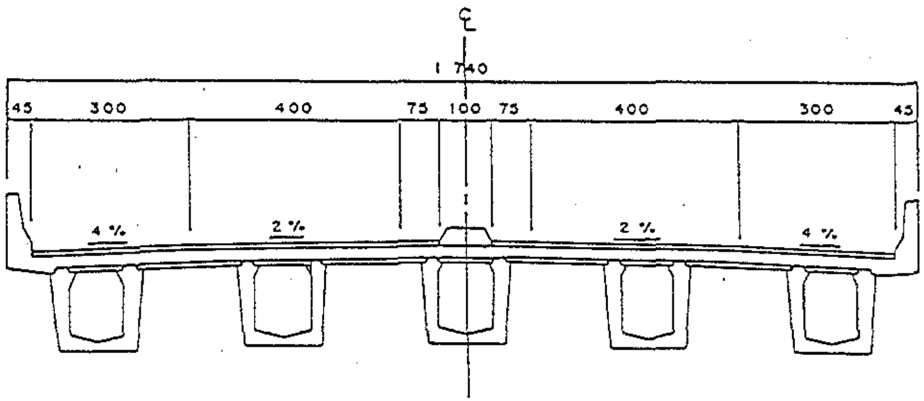


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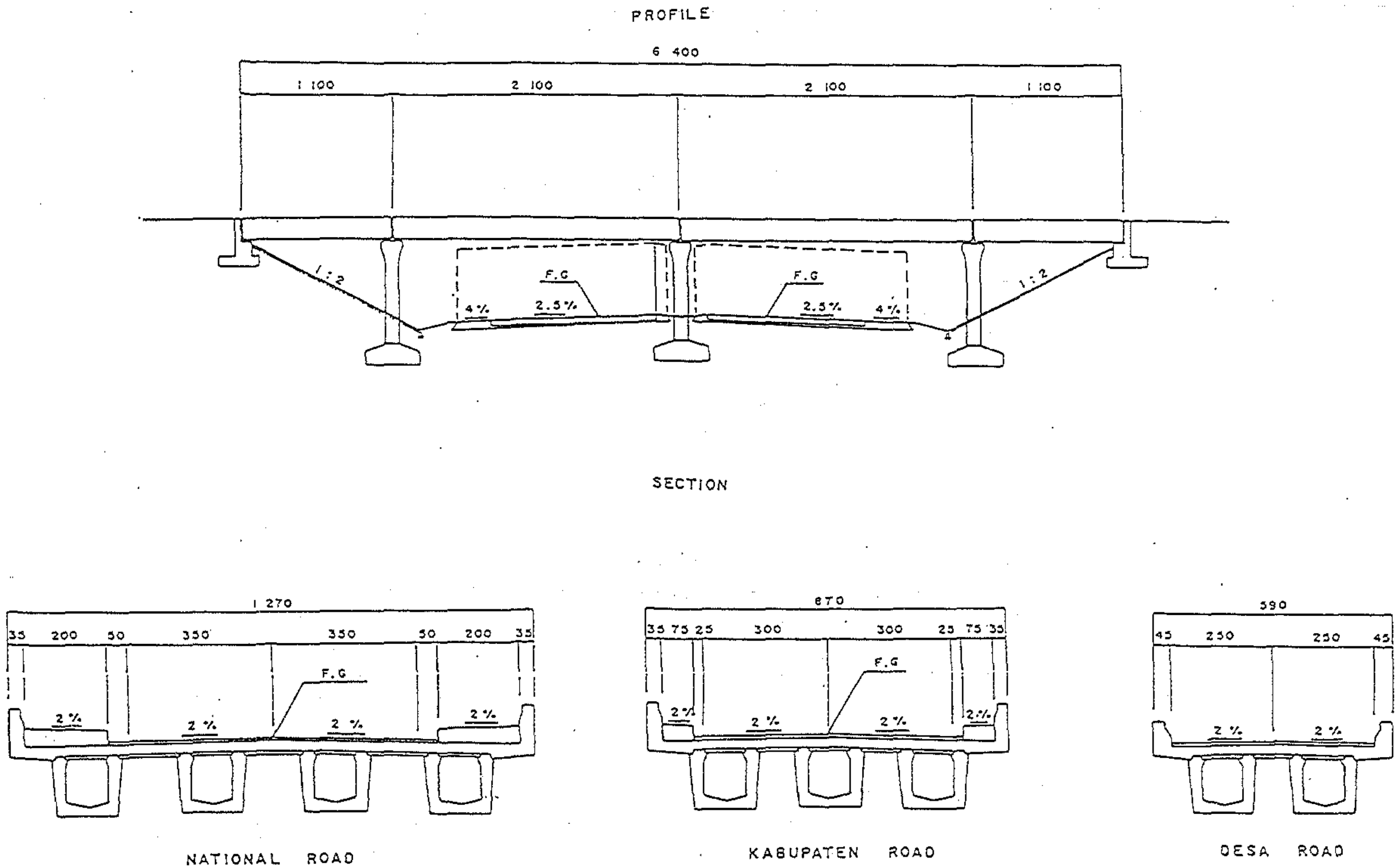
Fig. 10.6.3 Interchange Bridge



Feasibility Study on Cikampek - Cirebon Tollway Project

Fig. 10.6.4 Overpass Bridge

10.7 Hydrology and Drainage

10.7.1 General

In order to determine formation level of tollway gradients and location and size of tollway crossing structures, results of the hydraulic study as discussed in the Interim Report were used.

In this preliminary design, based on examination of the developed topographic maps (1:5,000 scale) and site investigation, the following major check points were studied:

- Bridge location
- River or channel width for bridge design
- Clearance between bridge and high water level of rivers

10.7.2 Rivers

The main rivers in the project areas listed below originate in the southern mountainous areas and flow down to the Java Sea.

Over crossing structures of rivers were designed to keep a clearance of at least 180 cm and 120 cm for 50 and 100 year storms respectively.

Table 10.7.1 River Characteristics

Name	Station	Length	Catchment Area (km^2)	Discharge (m^3/sec.)	Flood Level (m)
Cilamaya	STA. 102	47	151	136	2.5
Cibodas	STA. 120	24	73	103	3.5
Ciasem	STA. 120	37	167	176	4.5
Cilamatan	STA. 139	35	164	179	2.5
Cipanas	STA. 161	29	75	93	1.5
Cimanuku	STA. 181	294	2436	644	3.5
Cikeruh	STA. 190	27	131	170	3.0
Ciwaringin	STA. 199	26	60	80	4.0

10.7.3 Irrigation Canals

In the knowledge that the proposed alignment runs through upland areas of technical irrigation and semi technical irrigation areas with many irrigation canal crossings along the proposed tollway, careful attention was paid to maintain the existing conditions of irrigation canals.

10.7.4 Waterways

The existing waterways based on Indonesian Standards were classified on analysis of topographical data and field investigations as follows:

- Drainage: Rivers (major, minor and local)
- Irrigation: Canals

The classification identifies where bridges, box culverts or pipe-culverts are used.

10.7.5 Roadway and Roadside Drainage

In the course of the study the basic policy for roadway and roadside drainage was considered:

- To avoid discharging the road surface water into irrigation canals,
- To maintain the existing water usage in local areas and
- To design median run-off by median channels of earth, mortared rubble and U-ditches following the conditions of horizontal and vertical alignment.

10.8 Pavement Design

10.8.1 General

Based on the comments arising at the progress report meeting in August 1989, the preliminary design has been reviewed and finalized as follows:

10.8.2 Pavement Design

In the progress reporting period a comparative study was made of the following elements of rigid and flexible pavement:

	Rigid	Flexible
Service life time	Longer	Shorter
Construction works	Fair	Easier
Maintenance works	Difficult	Easier
Construction period	Longer	Shorter
Sensitivity to overloaded vehicles	Smaller	Bigger
Comfortable riding	Fair	Better
Material	Cement (National Production)	Asphalt (Imported material)

In addition to the above evaluation a cost comparative study was conducted to select the pavement type.

10.8.3 Cost Comparative Study

1) Initial Construction Cost

Cost estimates of pavement works were prepared with reference to unit prices obtained from recent similar projects.

Tables 10.8.1 and 10.8.2 detail the construction cost of rigid and flexible pavement respectively.

Table 10.8.1 Construction Cost Estimate of Rigid Pavement

Description	Unit	Quantity	Unit Price (Rp.)	Total (Rp.)
Subgrade preparation	m^2	100	150	15,000
Cement treated sub-base (t = 10 cm)	m^3	10	40,000	400,000
Portland cement concrete slab (t = 27 cm)	m^3	27	115,000	3,105,000
Total	m^2	100		3,520,000
Unit Price	Rp./m^2			35,200

Table 10.8.2 Construction Cost Estimate of Flexible Pavement - Initial Stage

Description	Unit	Quantity	Unit Price (Rp.)	Total (Rp.)
Subgrade preparation	m^2	100	150	15,000
Aggregate subbase (t = 27 cm)	m^3	27	25,000	695,000
Asphalt treated base (t = 15 cm)	ton	35.25	41,000	1,445,250
Binder course (t = 6 cm)	ton	14.10	47,000	662,900
Surface course (t = 4 cm)	ton	9.40	55,000	517,000
Prime coat	kg	175	400	70,000
Tack coat	kg	120	400	48,000
Total	m^2	100		3,432,950
Unit Price	Rp./m^2			34,330

2) Maintenance Cost

Maintenance costs were estimated based on "Evaluasi Biaya & Perwujudan Perkerasan Flexible vs Rigid pada Proyek Warung Buneit - Lingkar DKI - Juli, 1987".

Maintenance works are as follows:

for Rigid Pavement

- Patching
- Crack sealing

- Joint sealing
- Joint repair
- Retexturing

for Flexible Pavement
- Patching
- Surface dressing
- Overlay

And the above works are carried out periodically during 20 years.

The total maintenance costs are shown in Table 10.8.3.

Table 10.8.3 Total Maintenance Costs

(Rp./cm^2)

	Rigid Pavement	Flexible Pavement	
		Overlay in 5 years	Overlay in 10 years
Cost	4,390	26,520	17,840
Present Cost*	680	6,178	3,475

Note: Present value is estimated using 15% discount rate.

3) Cost Comparison

The cost comparison of flexible pavement and rigid pavement over a 20 year life span is shown in Table 10.8.4.

Table 10.8.4 Cost Comparison

	Rigid Pavement		Flexible Pavement			
			Overlay once 5 years		Overlay once 10 years	
	Cost (Rp./m^2)	PV (Rp./m^2)	Cost (Rp./m^2)	PV (Rp./m^2)	Cost (Rp./m^2)	PV (Rp./m^2)
Initial Cost	35,200	35,200	34,330	34,330	34,330	34,330
Maintenance Cost	4,390	680	26,520	6,178	17,840	3,475
Total Cost	39,590 (100%)	35,880 (100%)	60,850 (154%)	40,508 (113%)	52,170 (132%)	37,805 (105%)

Note: PV means the present value of 15% discount rate.

10.8.4 Difference in Vehicle Operating Cost

A rough surface causes relatively high vehicle running cost compared to a smooth pavement.

For the estimation of vehicle operating costs on roads in different surface conditions, the method from "An Improved Data Base for Estimating Vehicle Operating Cost in Developing Countries" - TRRL Supplementary Report 223US, by H. Hide - was adopted.

The two cost elements of vehicle maintenance and tyre consumption were considered to be affected by the roughness of road pavement.

1) Parts Consumption for Vehicle Maintenance

R = Roughness (mm/km)

PC = Parts cost per 1,000 km

VP = Cost of an equivalent new vehicle

K = Age of the vehicle in cumulative kilometers run

- Passenger Car

$$\frac{PC}{VP} = (-2.03 + 0.0018\,R) \times K \times 10^{-11}$$

- Truck

$$\frac{PC}{VP} = (0.48 + 0.00037\,R) \times K \times 10^{-11}$$

- Bus

$$\frac{PC}{VP} = (0.67 + 0.0006\,R) \times K^{1/2} \times 10^{-9}$$

2) Tyre Consumption

Tc = Number of Tyres consumed per 1,000 kilometers

L = Total weight of the vehicle (ton)

- Passenger Car

$$Tc = (-83 + 0.058\,R) \times 10^{-6}$$

- Medium and heavy vehicles

$$\frac{TC}{L} = (83 + 0.0112\,R) \times 10^{-7}$$

The roughness of flexible pavement was assumed to be 2500 mm/km and that of rigid pavement to be 10% higher, i.e. 2750 mm/km.

Accordingly, the difference between parts and tyre consumptions on flexible and rigid surface roads are calculated as follows:

- Maintenance parts consumption:

	Cost on rigid pavement/ Cost on flexible pavement
Passenger car	1.18
Pick-up	1.07
Bus	1.07
Truck	1.07

- Tyre Consumption:

Passenger car	1.23
Pick-up	1.23
Bus	1.03
Truck	1.03

Applying the above ratios to the corresponding equations of vehicle operating cost elements, an increase in cost for using the rough surface (rigid pavement) road was derived per vehicle-km.

Total vehicle-kilometers on the project tollway was estimated already in the traffic assignment phase, and on which basis a total increment of operating cost was derived for each planning year of 1995, 2005 and 2015.

Values in intermediate years were interpolated and the incremental cost stream was prepared over 20 years from 1998, when the tollway was assumed to open to traffic, to 2017.

Based on this cost stream a present value of the increased cost in vehicle operation, when using the rigid pavement road, was calculated using a discount rate of 15%. The total surface area is estimated in the engineering study to be about 2,361,000 m^2, so that the accumulated present value of vehicle operating cost increases resulted in Rp. 13,010/m^2.

10.8.5 Determination of Surface Pavement

Combining the previously estimated costs for pavement construction and maintenance, and incremental costs for vehicle operation, the difference between rigid and flexible pavement appeared as shown in Table 10.8.5.

Table 10.8.5 Comparison between Rigid and Flexible Pavement by Present Value over 20 Years Period

(Rp./m^2)

	Rigid Pavement	Flexible Pavement	
		Overlay (5 yrs)	Overlay (10 yrs)
Pavement/Maintenance	35,880	40,508	37,805
Benefit from VOC* Comparison between Rigid and Flexible Pavement	-	13,010	13,010

* VOC: Vehicle Operating Costs

As obviously shown in Table 10.8.5, the rigid pavement incurs relatively higher costs from the combined aspects of pavement cost and benefit.

Even from the tollway operator point of view the following can be said, that is:

- The difference of the totaled pavement and maintenance costs is not significant, namely, the flexible pavement is 5 ~ 13% higher than the rigid pavement in terms of present value comparison.

- In terms of construction and maintenance works, there may not be enough experience in the construction of rigid pavement to ensure the required strength and stability. Repairs and retexturing works to rigid pavement are considerable tasks where the need could arise to close one direction of the carriageway.

From a road user point of view, in addition to the above, flexible pavement is more comfortable due to smooth surface dressing and lack of construction joints.

In overall view of the above considerations it is recommended to use flexible pavement for the proposed tollway.

10.9 Tollway Facilities

10.9.1 General

The following tollway facilities are considered for the proposed tollway:

- Road lighting
- Traffic signals
- Traffic signs
- Toll gates and islands
- Other road facilities
- Traffic control facilities

10.9.2 Road Lighting

The highway lighting facilities were designed in accordance with "Toll Road & Bridge Design Manual" May 1985 Bina Marga and PT. Jasa Marga, and supplemented by CIE (Commission International De L'Eclairage), SPLN (Standard Perum Listrik Negara) and PUIL (Peraturan Umum Instalasi Listrik Indonesia).

Road lighting is designed at the interchange areas including ramps, terminals, access roads, parking and service areas.

10.9.3 Traffic Signals

Traffic signals provide for the orderly movement of traffic at grade intersections to reduce the likelihood of collisions.

10.9.4 Traffic Signs

Three kinds of signs are designed, namely, regulatory signs, warning signs and guide signs to assist traffic safety and for the convenience of users.

1) Regulatory and Warning Signs

Regulatory signs and warning signs are directly in accordance with the Government's regulations or traffic laws.

2) Guide Signs

Guide signs convey to drivers information such as destinations and distances, service facilities and route confirmation.

10.9.5 Toll Gates and Islands

The number of booths provided is for the year 2005 and additional booths may be provided later. Refuge islands of standard type provide a foundation for toll booths and protection from approaching vehicles.

10.9.6 Road Markings

Road markings provide traffic safety by lane identification, carriageway edge markings and instructions on the correct lane to use in association with traffic signs and signals.

10.9.7 Guard Rails

The major purpose of a guardrail is to protect uncontrolled vehicles from running off the highway and to protect facilities such as bridge piers from damage by such vehicles.

Guard rails are planned to be installed at the following locations:

- High embankment sections (H > 4.0 m)
- Bridge and box culvert approaches
- Box culvert wing walls and bridge piers
- Guide signs

10.9.8 Traffic Control Facilities

The design of traffic control facilities will be in accordance with the basic policy on tollway maintenance, administration and operation.

10.10 Environmental Consideration

10.10.1 General

According to the Japanese standard process of environmental study, environmental factors to be either assessed or measured are established after field work in which the following conditions are shown to be present relating to the respective environmental factors. They are:

1) Air Pollution: If housing is present along the planned road.

2) Water Pollution: If sewage from service areas and parking areas flows into public reservoirs, or if the sewage load from the construction work is great.

3) Noise: Same as for Air Pollution.

4) Vibration: If land subsidence in poor ground areas will cause a great impact on the housing around that area.

5) Land Subsidence: Same as for Vibration.

6) Topography/Geology: If the field study reveals the area to have valuable scientific objects or precious natural products.

7) Vegetation: Same as for Topography/Geology.

8) Animals: Same as for Topography/Geology.

9) Scenery: If the project area is designated as a special area by the Natural Park Laws, or if it is noted for its natural scenery, or if it is designated as a recreational area for the preservation of the natural environment.

Apart from the environmental factors mentioned above, the following factors will have to be considered: living environment of the inhabitants; separation of the community; regional sewage disposal; securing water resources for the downstream area; groundwater obstruction; dust and siltation during construction work; roads for construction use; borrow pits and spoil banks. Based on the field study results careful selection of the project route made it possible to minimize the impact on the environment.

10.10.2 Results of Field Study of the Project Area

A field study of the project area was conducted with the Indonesian counterpart, and the study revealed that the area did not fall under any of the following categories:

1) Areas containing objects of historical, archaeological, religious, artistic or scientific value or precious natural products

2) Areas containing useful or scarce animals or vegetation that need to be preserved

3) Areas with poor ground where the tollway may incur negative impacts on the existing housing area

4) Areas that may have an impact on the natural scenery

10.10.3 Study Results

In order to minimize negative impacts on the environment, criteria for the selection of the project route and mitigation measures against negative impact are established as follows:

1) Public institution areas should be avoided.

2) Cemetery areas should be avoided.

3) Irrigation channels should be crossed over at their existing location.

4) An embankment road should be applied to rice field areas to allow crossing of small irrigation channels. (minimum 2 meters high for embankment)

5) Green preservation areas should be avoided.

6) Community separation should be minimized.

7) The construction work should be carried out as far as possible away from schools, mosques and hospitals.

8) A detour distance, when unifying the existing road by a grade separation, should be made as short as possible.

Even after the above considerations are taken into the regional and route selection studies, the following four problems may still remain unsolved. A detailed field study based on Indonesian environmental standards should be conducted at the detailed design stage.

1) Water pollution due to sewage from STA. 112 Kalijati Service Area.

2) Alteration of the groundwater level caused by large scale excavation work in the rubber plantation area around STA. 162 Kerta Jati and its effects on the downstream rubber plantations.

3) Air pollution and noise in the densely built up areas around Cirebon City.

4) Effects of earth, sand and dust caused by the construction on the residential areas and cultivated land.

CHAPTER 11. FORECAST TRAFFIC VOLUME AND STAGED CONSTRUCTION

CHAPTER 11. FORECAST TRAFFIC VOLUME AND STAGED CONSTRUCTION

11.1 Traffic Volume on the Project Tollway

11.1.1 Tariff System

A toll per user kilometer which is assumed to decline as the user travels longer distances, and which is based on the present actual toll levy system was adopted as shown in Fig. 11.1.1.

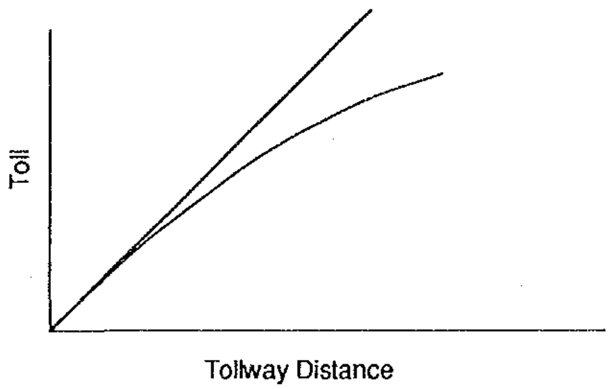


Fig. 11.1.1 Conceptual Tariff System

A regression equation was calibrated using interchange intervals (Km) and corresponding toll rates, and the results as shown below:

a) Jagorawi : $y = 142.35771 \times X^{0.831811}$

b) Jakarta-Cikampek : $y = 286.61176 \times X^{0.695307}$

c) Jakarta-Tangerang : $y = 89.728416 \times X^{0.996328}$

Equation b) was assumed to apply for Cikampek-Cirebon and also Cikampek-Padalarang Tollways; and equation c) also for the Jakarta-Merak Tollway.

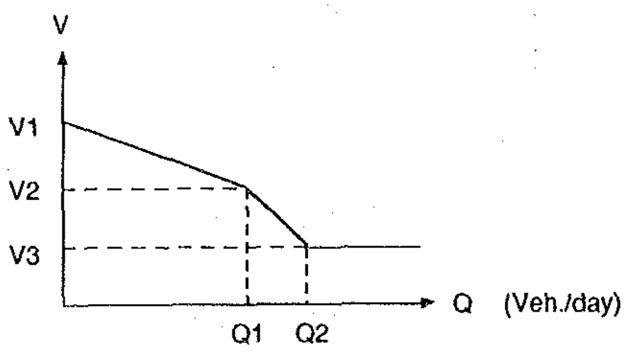
11.1.2 Link Conditions and Q-V Model

Conditions of the road links were determined by referring to the latest road inventory data and the data derived from the Study Team's travel speed survey and reconnaissance survey.

Road links incorporated into the network were classified into 7 categories and the Q-V (quantity and velocity) relationships were determined as shown in Table 11.1.1.

Table 11.1.1 Q-V Conditions of Network Links

Q-V Curve



Road Type	V1	V2	V3	Q1	Q2
1) Tollway 4-lane	100	60	30	48.000	57.600
2) Tollway 2-lane	80	40	30	14.000	16.800
3) 4-lane Arterial	70	40	15	44.000	52.800
4) 2-lane 2 way (Wider lane width)	70	40	15	11.000	13.200
5) 2-lane 2 way (About 6.5 m width)	60	30	15	9.000	10.800
6) 2-lane 2 way (5.5, 6.0 m width in flat area)	60	30	15	8.000	9.600
7) 2-lane 2 way (5.5, 6.0 m width in rolling area)	40	25	15	6.000	7.200

11.1.3 Assigned Traffic Volumes

The future road traffic volume has been estimated by assigning the future OD traffic (Matrix) to the future road network. The method used for this project traffic assignment is shown in Fig. 11.1.2.

A minimum travel time was adopted as a criterion when selecting possible alternative routes or an optimal one for a particular OD pair traffic.

The future OD matrix is divided into 5 steps of 20% OD Matrix and the assigned traffic volume was estimated separately for "via toll" and "via alternative route".

Link conditions (i.e. link speed) of the road network after the first 20% OD traffic is assigned to the network, and under the altered new conditions the second 20% of the OD traffic is assigned to the network based on minimum time travel routings under each scenario.

A travel time difference between "via tollways" and "via non-tollways" is computed for particular origin-destination traffic under the minimum route search process. Travel distance on the tollway is simultaneously calculated at the route search simulation stage. The distance is used to find the toll to be paid for respective tollways.

Derived travel time difference and the corresponding toll for using tollways are the basis used to calculate a rate of traffic diversion to the tollways. The diversion model applied to the project study has been estimated previously in Section 6.2 and the tariff system was assumed as discussed in Section 11.1.1 above.

The network scenario is composed of the network development in the planning years 1995, 2005 and 2015, which have been previously discussed in Section 5) of 6.3.2; future road network; and "with" and "without" Cikampek-Cirebon Tollway options.

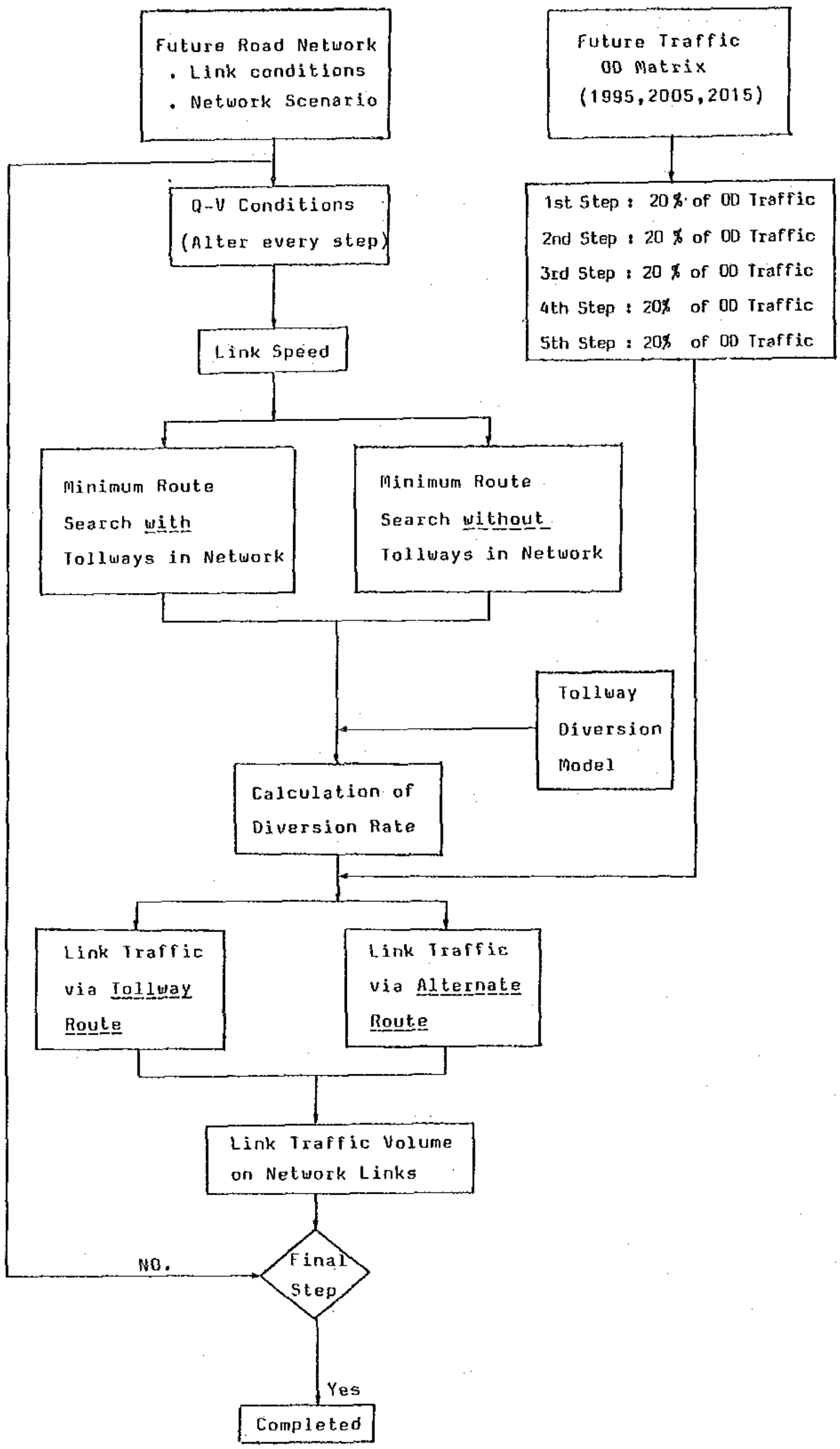


Fig. 11.1.2 Flow Chart for Estimating Future Assigned Traffic Volumes

Numeric results of the assignment scenarios present the projected future traffic volumes on the Cikampek-Cirebon Tollway and imply effects of the project tollway that are to be quantified for testing the economic feasibility of the project.

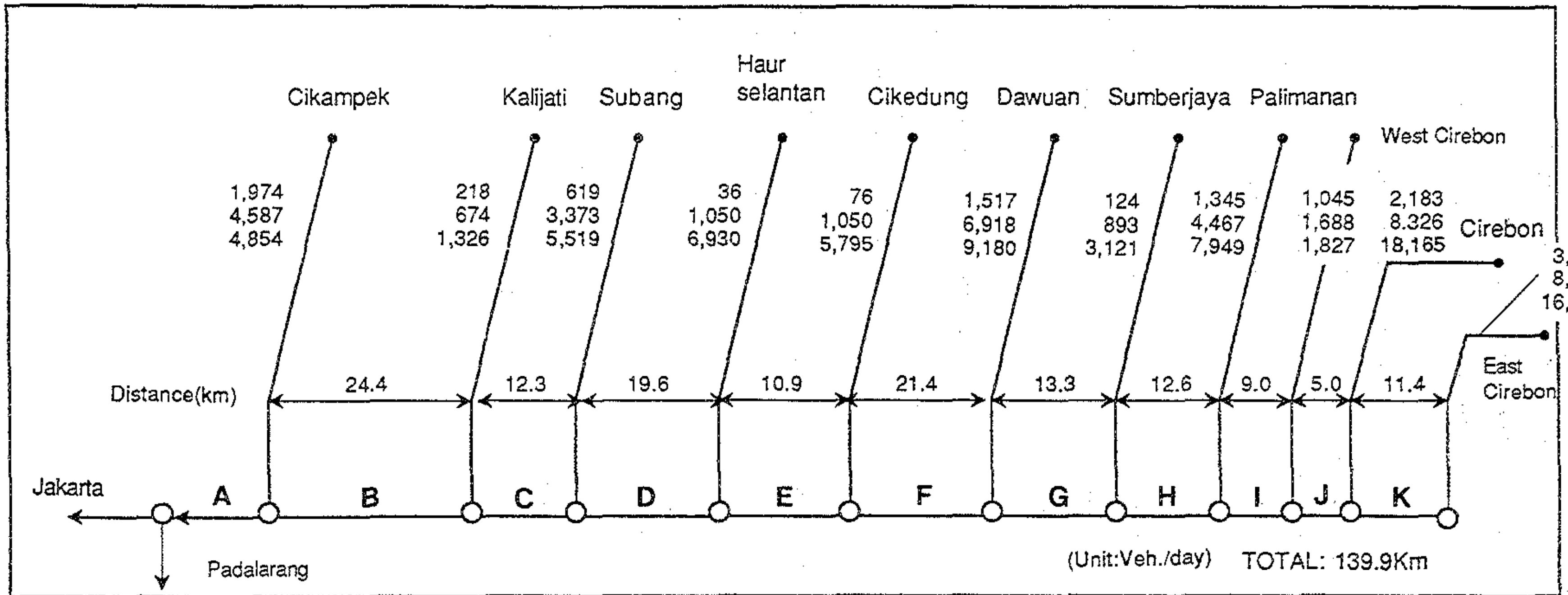
The traffic volume on the project tollway was based on the OD matrices that were estimated previously by the present pattern method and the gravity method. The OD matrices used for future tollway traffic were those made by the present pattern method for years 1995 and 2005, and those by the gravity method for years 2005 and 2015.

The commencement of the project tollway operation is assumed in 1998, so that the tollway traffic is estimated by interpolating the traffic volumes in 1995 and 2005, which result from the present pattern OD matrices.

The traffic is assumed to grow according to the present pattern projection basis until the project tollway is completed for the entire stretch between Cikampek and Cirebon, since a longitudinal staged construction is considered for the project.

The traffic volume estimated on the gravity model basis is assumed to apply for years after the Cikampek-Cirebon link is completed, because a direct tollway linkage between Jakarta-Cikampek and Cikampek-Cirebon will induce regional development and attract large numbers of traffic resulting in the alteration of the traffic distribution pattern in the influenced region.

The forecast traffic volume is presented in Fig. 11.1.3, where the 1995 volumes are based on the present pattern method and the 2005 and 2015 volumes are based on the gravity model method.



	A	B	C	D	E	F	G	H	I	J	K	Average
1995	(8,167)	6,417	6,224	6,051	6,060	5,984	5,828	5,743	6,745	5,700	3,540	5,611
2005	(35,274)	31,802	31,196	28,441	27,898	26,865	21,133	20,553	18,402	16,715	8,404	24,198
2015	(68,180)	65,379	64,162	59,580	54,469	48,894	41,155	39,362	36,507	34,680	16,610	48,160

Fig. 11.1.3 Future Traffic Demand on Cikampek-Cirebon Tollway with All Interchanges

11.2 Characteristics of Assigned Traffic in the Study Area

11.2.1 User Traffic

The number of project tollway users on average was estimated at 10,422, 38,352 and 74,728 vehicles in 1995, 2005 and 2015 respectively as shown in Table 11.2.1. The higher increase in traffic volume between 1995 and 2005 was brought about by the factor of reduced travel time through the tollway, which was incorporated into the gravity model applied to estimating 2005 and 2015 traffic demand.

The average trip length of the tollway traffic was 75.1 Km, 87.2 Km and 89.2 Km for years 1995, 2005 and 2015 respectively. As tollway traffic increases travel distance becomes longer. The average travel distance covers about 54% ~ 64% of the total length, i.e. 140 Km of Cikampek and Cirebon.

Table 11.2.1 Characteristics of Project Tollway Users

Tollway Traffic	Year		
	1995	2005	2015
(1) No. of Tollway Users (Veh./day)	10,422	38,352	74,728
(2) Total Veh.-Km on Tollway (x1000)	783	3,344	6,665
(3) Average Trip Length of Users (Km/Veh.)	75.1	87.2	89.2
(4) Average Cross Sectional Traffic (Veh./day) on Tollway with Toll Charge Condition	5,611	24,198	48,160
(5) Average Cross Sectional Traffic (Veh./day) on Tollway with Toll Free Condition	17,200	41,000	59,700
(6) Average % of Diverted Traffic (%) to Tollway	33	59	81

11.2.2 Diversion of Traffic to Tollway

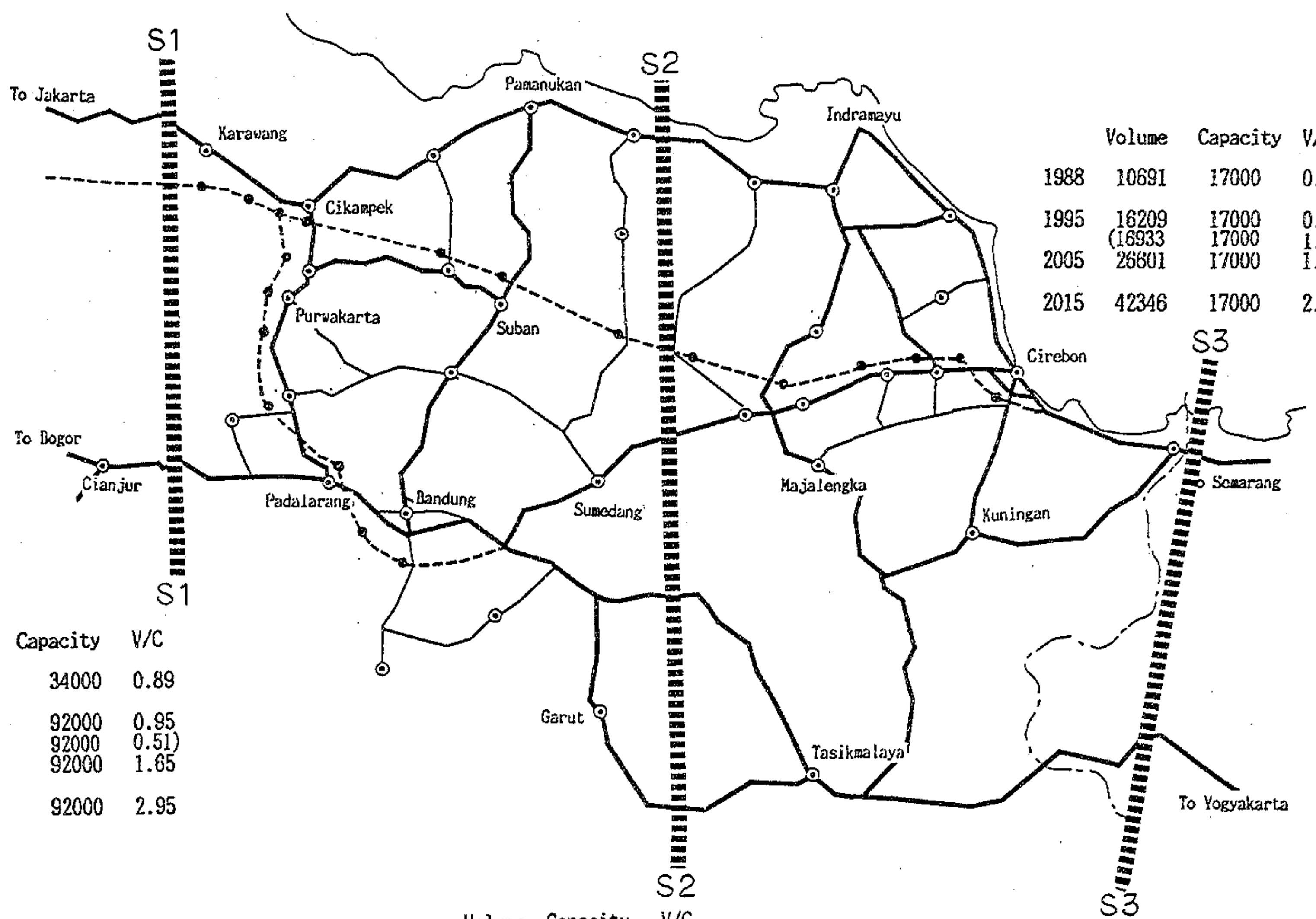
The percentage of the diverted traffic to the tollway among potential users, estimated under toll free condition, was 35%, 62% and 85% in 1995, 2005 and 2015 respectively.

The higher diversion ratio in 2015 results from a lack of road density in the study area compared to Fig. 11.2.1 the screen line traffic with road capacity. This means improvement of the network is needed to meet future traffic demand in the study area.

The situation of traffic congestion in the study area is presented in Fig. 11.2.2. According to this congestion map, the alternative routes between Cikampek and Cirebon are saturated with traffic in most cases before the year 2005.

The existing 2-lane national roads between Indramayu and Cikampek; Cikampek and Bekasi are required to be widened before 2005, even if the project tollway is to be constructed as proposed.

If the project tollway is not constructed the traffic on the above roads will exceed the road capacity in the year 1995. Therefore, not only the road widening scheme but also new road construction is urgently required to ease the anticipated traffic congestion in the study area and not to impede the development of region.



S1

	Volume	Capacity	V/C
1988	30238	34000	0.89
1995	87502	92000	0.95
	(46930	92000	0.51)
2005	152641	92000	1.65
2015	270964	92000	2.95

S2

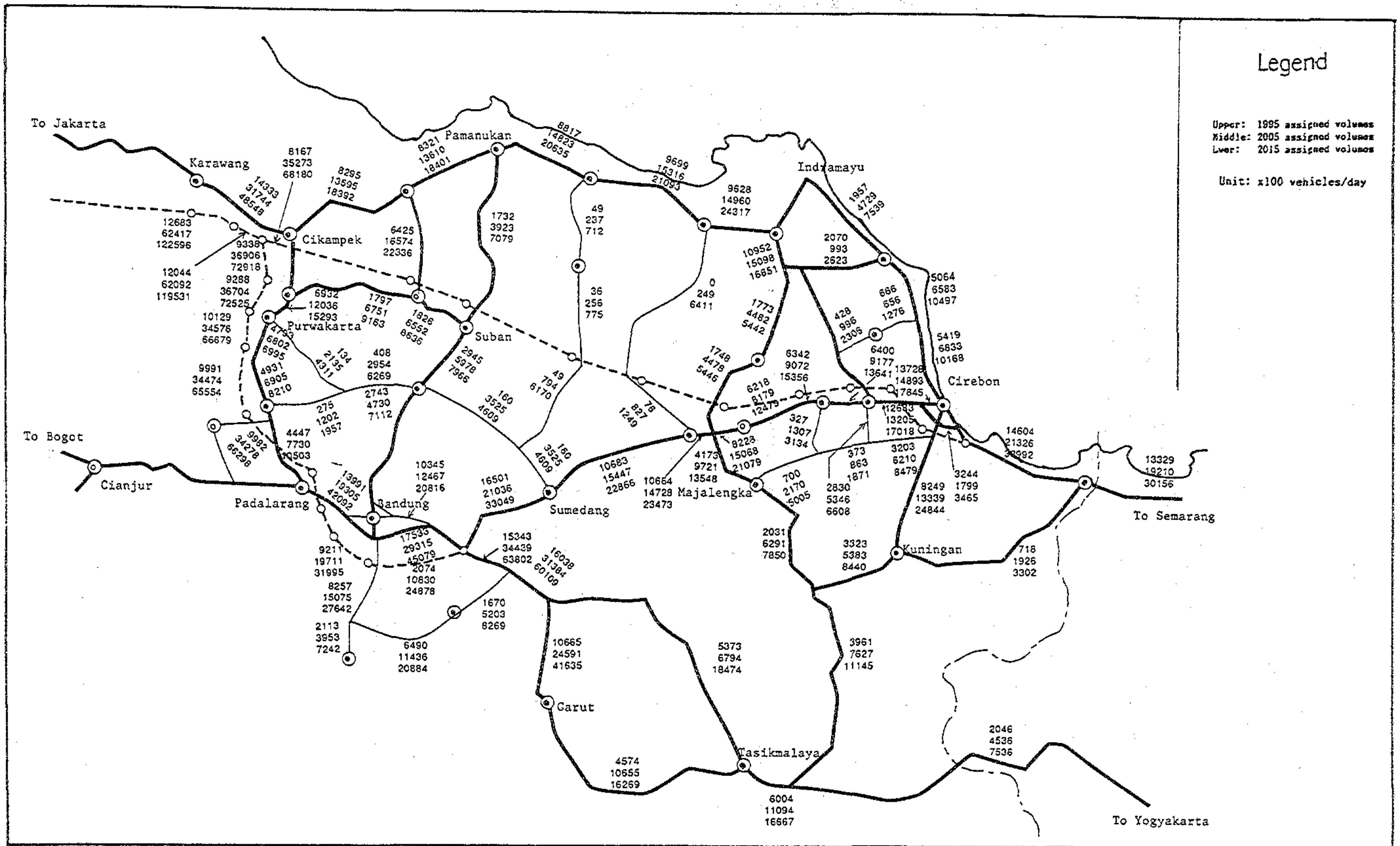
	Volume	Capacity	V/C
1988	25640	32000	0.80
1995	55494	80000	0.69
	(38740	80000	0.48)
2005	90780	80000	1.13
2015	155506	104000	1.50

S3

	Volume	Capacity	V/C
1988	10691	17000	0.62
1995	16209	17000	0.95
	(16933	17000	1.00)
2005	26601	17000	1.56
2015	42346	17000	2.49

( ) Case of O.D by Present Pattern Method

Fig. 11.2.1 Screen Line Traffic Volume and Road Capacity



Feasibility Study on Cikampek - Cirebon Tollway Project

Fig. 11.2.2 Assigned Traffic Volume and Congestion Rates with Project Tollway Network

11.2.3 Number of Traffic Lanes and Staged Construction

The relationship between the traffic demand and the tollway capacity is shown diagrammatically in Fig. 11.2.3. The tollway capacity was estimated by the Highway Capacity Manual and the resulting road capacity is presented in Section 7.5.

The traffic volume on the tollway almost reaches the capacity of a 2-lane/2-way road in the assumed opening year of 1998. Therefore, the initial stage construction of the tollway should be a 4-lane tollway.

The second stage construction to widen the tollway from 4-lane to 6-lane should be completed before the year 2010 for the Cikampek-Dawuan section and before the year 2015 for the Dawuan-Cirebon section.

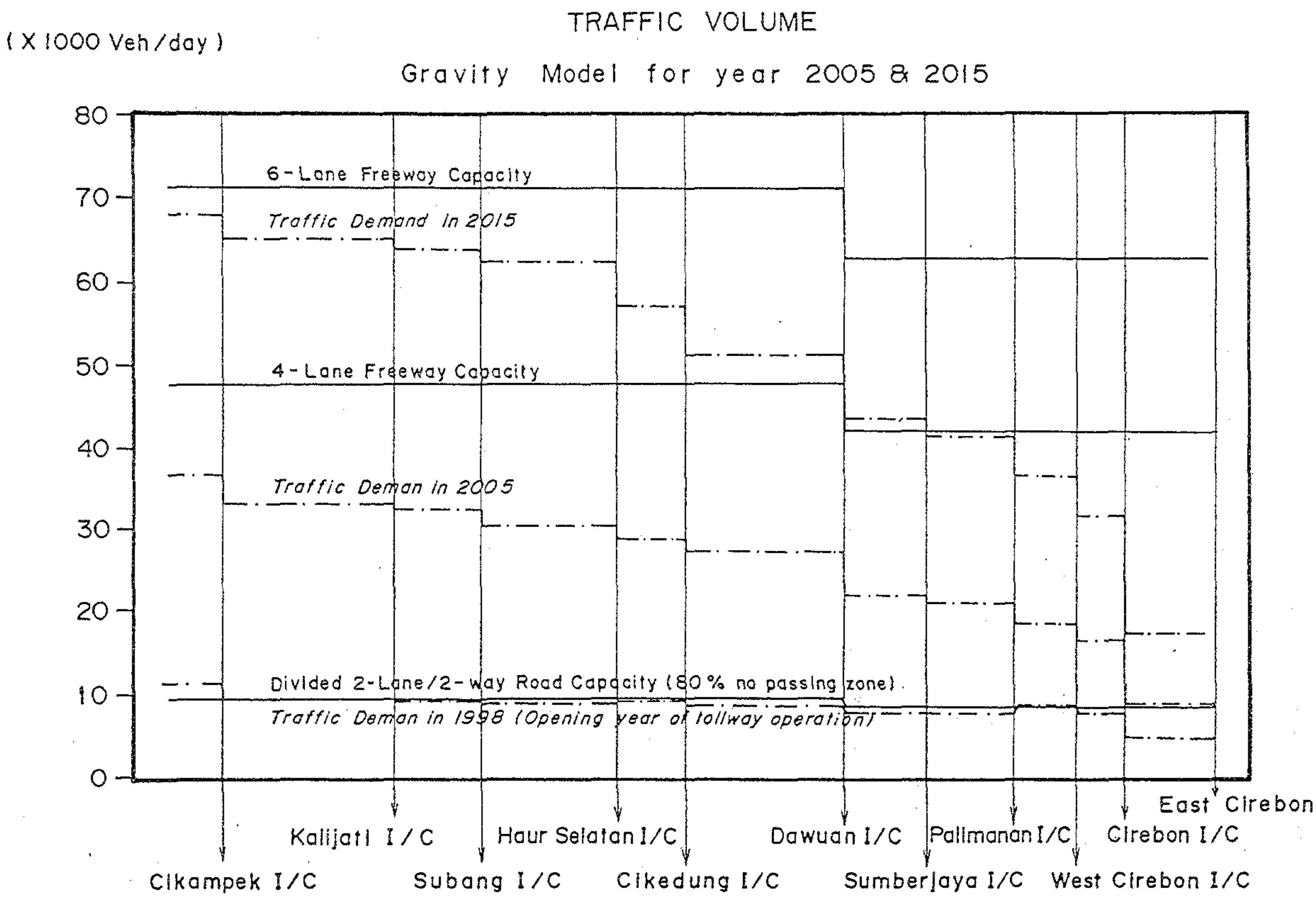


Fig 11.2.3 Relationship between Traffic Demand and Tollway Capacity

CHAPTER 12. CONSTRUCTION AND IMPLEMENTATION PLANNING

CHAPTER 12. CONSTRUCTION PLAN AND IMPLEMENTATION PLANNING

12.1 General

In order to establish a construction and implementation plan, efficient identification of construction material resources is of major importance. It is also important to determine details for funding arrangements, procurement of materials/equipment/labor, cost control, etc. The final construction plan and schedule, and breakdown into sections should take into consideration government implementation policy and schedules.

12.2 Construction Sections and Work Volume

Due to the magnitude of the project, the following construction sections are proposed:

- Section 1:
  STA. 92+500 - 109+500 L = 17.0 Km
  (Cikampek I.C. - Kalijati S.A.)

- Section 2:
  STA. 109+500 - 130+000 L = 20.5 Km
  (Kalijati S.A. - Subang I.C.)

- Section 3:
  STA. 130+000 - 149+500 L = 19.5 Km
  (Subang I.C. - Haur Selatan I.C.)

- Section 4:
  STA. 149+500 - 162+000 L = 12.5 Km
  (Haur Selatan I.C. - Cikedung I.C.)

- Section 5:
  STA. 162+000 - 182+000 L = 20.0 Km
  (Cikedung I.C. - Dawuan I.C.)

- Section 6:
  STA. 182+000 - 194+000 L = 12.0 Km
  (Dawuan I.C. - Sumbrjaya I.C.)

- Section 7:
  STA. 194+000 - 208+000 L = 14.0 Km
  (Sumbrjaya I.C. - Palimanan I.C.)

- Section 8:
  STA. 208+000 - 222+000 L = 14.0 Km
  (Palimanan I.C. - Cirebon I.C.)

- Section 9:
  STA. 222+000 - 234+800 L = 12.8 Km
  (Cirebon I.C. - East Cirebon I.C.)

Since the construction plan is divided into nine (9) sections, the method of haulage, excavation and filling has been considered using a mass curve. Accessibility to each construction area was also considered and quantities for each section were estimated as shown in Table 12.2.1.

Table 12.2.2 shows the quantities of remaining works for the ultimate stage (6-lanes).

Table 12.2.1 Quantity (Initial Outer 4-Lanes)

ITEM	UNIT	PACKAGE A from Cikampek to Subang			PACKAGE B from Subang to Dawuan				PACKAGE C from Dawuan to East Cirebon					Total
		Section 1	Section 2	Sub Total	Section 3	Section 4	Section 5	Sub Total	Section 6	Section 7	Section 8	Section 9	Sub Total	
		STA. 92.5 STA.109.5	STA.109.5 STA.130.0		STA.130.0 STA.149.5	STA.149.5 STA.162.0	STA.162.0 STA.182.0		STA.182.0 STA.194.0	STA.191.0 STA.208.0	STA.208.0 STA.222.0	STA.222.0 STA.234.8		
1 Earth works														
Clearing and grubbing	m2	1,292,000	1,640,000	2,932,000	1,287,000	800,000	1,200,000	3,287,000	720,000	840,000	910,000	870,000	3,340,000	9,559,000
Common excavation (E-L)	m3	2,191,000	3,478,000	5,669,000	1,414,000	794,000	1,253,000	3,461,000	22,000	58,000	89,000	1,291,000	1,460,000	10,590,000
Borrow excavation (E-L)	m3	0	161,000	161,000	29,000	6,000	234,000	269,000	1,289,000	1,182,000	1,061,000	4,000	3,536,000	3,969,000
Embankment (1Km T-C) soil	m3	1,800,000	3,294,000	5,094,000	1,301,000	720,000	1,362,000	3,383,000	1,309,000	1,231,000	1,141,000	1,166,000	4,850,000	13,327,000
Haulage A (7Km)	m3	270,000	675,000	945,000	68,000	203,000	1,832,000	2,103,000	0	0	0	1,080,000	1,080,000	4,128,000
Haulage B (13Km)	m3	0	1,620,000	1,620,000	0	0	0	0	1,739,000	0	1,432,000	68,000	3,239,000	4,859,000
Haulage C (20Km)	m3	0	0	0	0	0	0	0	0	1,509,000	0	0	1,509,000	1,509,000
Sodding solid	m2	166,000	198,000	364,000	191,000	123,000	196,000	510,000	118,000	137,000	137,000	124,000	516,000	1,390,000
Sodding Strip	m2	723,000	940,000	1,663,000	643,000	388,000	541,000	1,572,000	326,000	378,000	447,000	441,000	1,592,000	4,827,000
2 Flexible Pavement														
Subgrade Preparation	m2	314,000	373,000	687,000	361,000	232,000	370,000	963,000	223,000	259,000	259,000	234,000	975,000	2,625,000
Aggregate Subbase (t=27cm	m3	114,000	135,000	249,000	131,000	84,000	134,000	349,000	81,000	94,000	94,000	85,000	354,000	952,000
Asphalt treated base(15cm	ton	101,900	121,400	223,300	117,500	75,400	120,300	313,200	72,500	84,200	84,300	76,200	317,200	853,700
Binder course (t=6cm)	ton	39,900	47,500	87,400	46,000	29,500	47,100	122,600	28,400	32,900	33,000	29,800	124,100	334,100
Surface course (t=4cm)	ton	26,500	31,500	58,000	30,500	19,600	31,300	81,400	18,800	21,900	21,900	19,800	82,400	221,800
Prime coat	kg	549,500	652,750	1,202,250	631,750	406,000	647,500	1,685,250	390,250	453,250	453,250	409,500	1,706,250	4,593,750
Tack coat	kg	340,800	405,600	746,400	392,400	252,000	402,000	1,046,400	242,400	280,800	282,000	254,400	1,059,600	2,852,400
Seal coat	m2	108,000	128,000	236,000	124,000	80,000	127,000	331,000	77,000	89,000	89,000	81,000	336,000	903,000
3 Bridges														
Short span bridges	m2	1,740	1,530	3,270	0	0	2,140	2,140	2,140	3,060	5,660	5,510	16,370	21,780
Medium span bridges	m2	10,710	16,070	26,780	11,480	6,890	5,360	23,730	3,830	6,120	3,060	6,890	19,900	70,410
Long span bridges	m2	0	5,200	5,200	0	0	5,200	5,200	0	0	0	0	0	10,400
4 Grade separation structure														
Medium span bridges	m2	4,750	4,880	9,630	3,710	2,990	3,250	9,950	2,340	4,290	8,060	4,030	18,720	38,300
I/C bridges	m2	770	770	1,540	0	0	0	0	0	0	0	0	0	1,540
Over-Bridges (Pedestrian)	m2	390	590	980	390	590	780	1,760	390	590	590	390	1,960	4,700
Ramp Bridges	m2	0	0	0	0	880	0	880	880	880	0	880	2,640	3,520
5 Drainage														
U-ditch & Catchbasin	km	17.0	20.5	38	19.5	12.5	20.0	52	12.0	14.0	14.0	12.8	53	142
Concrete pipe ∅ 100	m	950	1,500	2,450	240	940	440	1,620	1,200	870	1,620	780	4,530	8,600
Culvert A (3 x 3)	m	490	1,190	1,680	890	1,020	50	1,960	470	460	270	230	1,430	5,070
Culvert B (5 x 5)	m	0	270	270	150	0	50	200	0	490	190	120	800	1,270
6 Related Construction														
Road relocation	Km	1.3	0.9	2.2	0.2	0.3	0.0	0.5	0.4	0.9	1.2	0.5	3.0	5.7
Road improvement (access)	Km	0.0	0.0	0.0	0.0	1.3	0.0	1.3	0.0	7.0	0.0	3.5	10.5	11.8
Road improvement (const.)	Km	3.5	3.0	6.5	0.0	0.0	2.0	2.0	3.0	0.0	2.0	0.0	5.0	13.5
New construction (access)	Km	0.0	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	0.0	0.5	0.5	2.5
7 Miscellaneous														
Guard Rail (single)	m	4,800	5,700	10,500	4,100	3,900	4,400	12,400	3,500	5,700	7,200	5,800	22,200	45,100
Fence, Km Post, ROW Stake	Km	17.0	20.5	38	19.5	12.5	20.0	52	12.0	14.0	14.0	12.8	53	142.3
Marking	m2	14,000	17,000	31,000	16,000	10,000	17,000	43,000	10,000	12,000	12,000	11,000	45,000	119,000
Signs and Signal	km	17.0	20.5	38	19.5	12.5	20.0	52	12.0	14.0	14.0	12.8	53	142.3
8 Interchange(exclud bridge)	each	1	1	2	0	1	1	2	0	1	0	1	2	6
9 Throughway Toll Barrier	each	1	0	1	0	0	0	0	0	0	0	0	0	1
10 Parking Area	each	0	0	0	4	0	4	8	2	0	2	0	4	12
11 Service Area	each	0	1	1	0	0	0	0	0	0	0	0	0	1

Table 12.2.2 Quantity (Remaining Works for 6-Lanes)

ITEM	UNIT	PACKAGE A from Cikampek to Subang			PACKAGE B from Subang to Dawuan				PACKAGE C from Dawuan to East Cirebon					Total
		Section 1	Section 2	Sub Total	Section 3	Section 4	Section 5	Sub Total	Section 6	Section 7	Section 8	Section 9	Sub Total	
		STA. 92.5 STA.109.5	STA.109.5 STA.130.0		STA.130.0 STA.149.5	STA.149.5 STA.162.0	STA.162.0 STA.182.0		STA.182.0 STA.194.0	STA.194.0 STA.208.0	STA.208.0 STA.222.0	STA.222.0 STA.234.8		
1 Earth works														
Clearing and grubbing	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
Common excavation (E-L)	m3	0	0	0	0	0	0	0	0	0	0	0	0	0
Borrow excavation (E-L)	m3	0	0	0	0	0	0	0	0	0	0	0	0	0
Embankment (1km T-C) soil	m3	0	0	0	0	0	0	0	0	0	0	0	0	0
Haulage A (7Km)	m3	0	0	0	0	0	0	0	0	0	0	0	0	0
Haulage B (13Km)	m3	0	0	0	0	0	0	0	0	0	0	0	0	0
Haulage C (20Km)	m3	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodding solid	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodding Strip	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Flexible Pavement														
Subgrade Preparation	m2	153,000	182,000	335,000	176,000	113,000	182,000	471,000	107,000	126,000	126,000	114,000	473,000	1,279,000
Aggregate Subbase (t=27cm	m3	48,000	57,000	105,000	55,000	35,000	57,000	147,000	33,000	40,000	40,000	36,000	149,000	401,000
Asphalt treated base (15c	ton	45,300	53,900	99,200	52,100	33,400	54,000	139,500	31,600	37,300	37,400	33,800	140,100	378,800
Binder course (t=6cm)	ton	17,200	20,500	37,700	19,800	12,700	20,500	53,000	12,000	14,200	14,200	12,800	53,200	143,900
Surface course (t=4cm)	ton	11,400	13,500	24,900	13,100	8,400	13,600	35,100	7,900	9,400	9,400	8,500	35,200	95,200
Prime coat	kg	267,750	318,500	586,250	308,000	197,750	318,500	824,250	187,250	220,500	220,500	199,500	827,750	2,238,250
Tack coat	kg	147,600	175,200	322,800	170,400	109,200	176,400	456,000	103,200	121,200	121,200	110,400	456,000	1,234,800
Seal coat	m2	25,000	30,000	55,000	29,000	18,000	30,000	77,000	17,000	21,000	21,000	19,000	78,000	210,000
3 Bridges														
Short span bridges	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium span bridges	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
Long span bridges	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Grade separation structure														
Medium span bridges	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
I/C bridges	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
Over-Bridges (Pedestrian)	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
Ramp Bridges	m2	0	0	0	0	0	0	0	0	0	0	0	0	0
5 Drainage														
U-ditch & Catchbasin	km	16.6	19.8	36.4	19.1	12.3	19.8	51.2	11.6	13.7	13.7	12.4	51.4	139.0
Concrete pipe c 100	m	0	0	0	0	0	0	0	0	0	0	0	0	0
Culvert A (3 x 3)	m	0	0	0	0	0	0	0	0	0	0	0	0	0
Culvert B (5 x 5)	m	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Related Construction														
Road relocation	Km	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Road improvement (access)	Km	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Road improvement (const.)	Km	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New construction (access)	Km	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 Miscellaneous														
Guard Rail (double)	m	17,000	20,000	37,000	19,000	12,000	20,000	51,000	12,000	14,000	14,000	12,000	52,000	140,000
Fence, Km Post, ROW Stake	Km	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0
Marking	m2	8,000	10,000	18,000	10,000	6,000	10,000	26,000	6,000	7,000	7,000	6,000	26,000	70,000
Signs and Signal	km	0.0	0.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0
8 Interchange(exclud bridge)	each	0	1	1	1	0	0	1	1	0	1	0	2	4
9 Throughway Toll Barrier	each	0	0	0	0	0	0	0	0	0	0	1	1	1
10 Parking Area	each	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Service Area	each	0	0	0	0	0	0	0	0	0	0	1	1	1

12.3 Construction Roads

Construction roads can comprise any of the following:

1) Existing Road

The locations where existing roads can be used as a construction road are shown in Fig. 12.3.2 but these may require relocation or pavement repair and improvement such as widening and/or raising.

2) New Construction Road

At several places as shown in Fig. 2.2.2,new construction roads will be required for access between arterial road and the working area.

3) Use of the Project Road

Half the project road width can be used as a construction road reversed when the first half is completed. (Refer to Fig. 12.3.1)

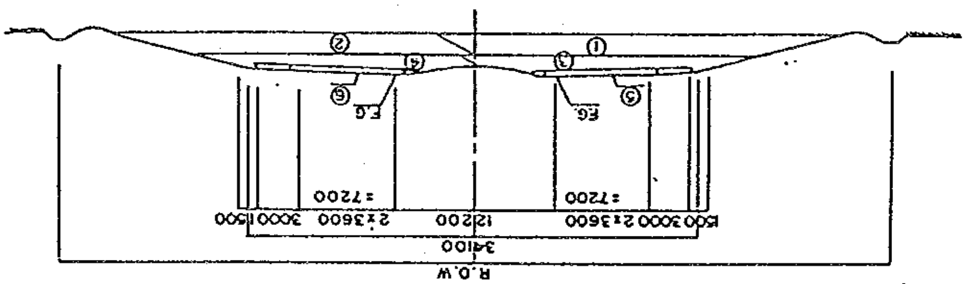
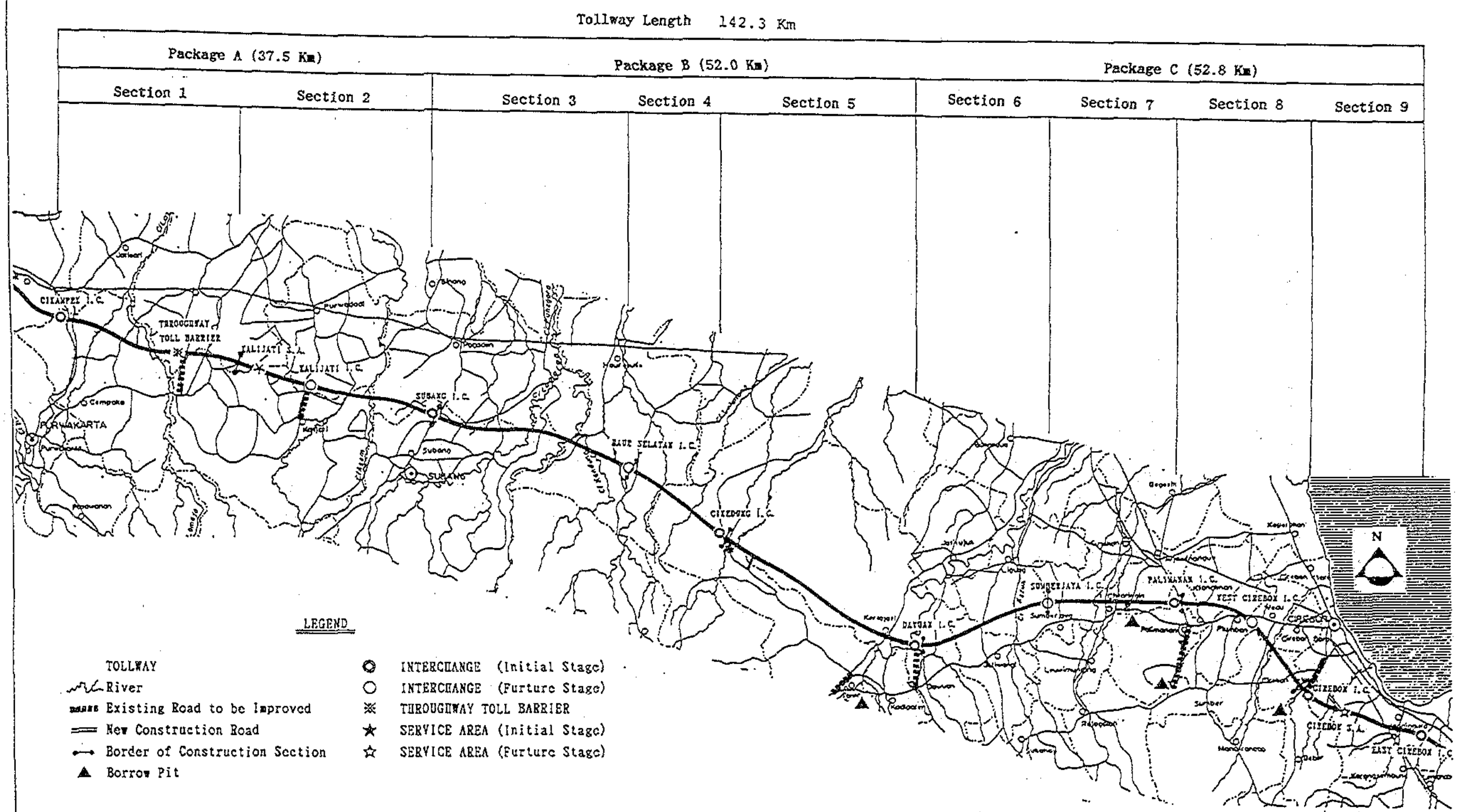


Fig. 12.3.1 Scheme of Project Road Used as Construction Road



Feasibility Study on Cikampek - Cirebon Tollway Project

Fig. 12.3.2 Construction Section and Construction Road

12.4 Construction Method

As in similar road construction projects in Indonesia in the past, mechanical plant and equipment will be utilized in this project as follows:

1) Earthworks

Table 12.4.1 Earthwork Equipment

<table>
<tr><th colspan="2" rowspan="2">Main Works</th><th colspan="3">Equipment</th></tr>
<tr><th>Max. Haul 100m</th><th>Max. Haul 500m</th><th>Max. Haul 2000m</th></tr>
<tr><td colspan="2">Clearing and grubbing</td><td colspan="3">• Bulldozer</td></tr>
<tr><td colspan="2">Excavation</td><td rowspan="2">• Bulldozer</td><td>• Bulldozer
•Tractor drawn scraper</td><td>• Motor scraper</td></tr>
<tr><td colspan="2">Loading</td><td colspan="2">• Bulldozer •Crawler type loader
• Excavator • Dump truck</td></tr>
<tr><td>Embankment</td><td>Scatter</td><td colspan="3">• Bulldozer</td></tr>
<tr><td></td><td>Levelling</td><td colspan="3">• Motor grader</td></tr>
<tr><td colspan="2">Compaction</td><td colspan="3">• Tamping roller • Vibratory roller
• Pneumatic type roller • Steel roller</td></tr>
<tr><td colspan="2">Finishing</td><td colspan="3">• Bulldozer • Motor grader</td></tr>
</table>

2) Pavement Work

Table 12.4.2 Pavement Equipment

Concrete Pavement	Asphalt Pavement
• Truck mixer • Concrete spreader • Concrete finisher • Concrete plant	• Dump truck • Asphalt finisher • Steel roller • Pneumatic tyre roller • Asphalt mixing plant

3) Bridge Work

Table 12.4.3 Bridge Construction Equipment

<table>
<tr><th colspan="2">Main Work</th><th colspan="3">Equipment</th></tr>
<tr><td rowspan="3">Sub structure</td><td>Excavation</td><td>• Bulldozer</td><td>• Excavator</td><td>• Dump truck</td></tr>
<tr><td>Foundation</td><td>• Diesel pile hammer
• Pile driver</td><td>• Truck mixer</td><td rowspan="4">• Truck crane
• Crawler crane</td></tr>
<tr><td>Structure</td><td>• Crane</td><td>• Truck mixer</td></tr>
<tr><td rowspan="2">Super structure</td><td>Making beam</td><td colspan="2">• Trailer</td></tr>
<tr><td>Erection</td><td colspan="2">• Erection girder</td></tr>
</table>

12.5 Construction Schedule

1) Construction Period

In Indonesia, although the basic working hour is generally no more than 7 hours, on construction sites the average working hour ranges from 7 to 10 hours.

Based on rainfall data obtained from stations along the project corridor, the number of suitable working days in a month was estimated for earth works and pavement works etc. as shown in Tables 12.5.1 and 12.5.2.

Table 12.5.1 Number of Rainy Days in the Project Area (1965-1976)

Place	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Cikampek	15	14	12	10	7	4	3	2	2	7	11	11
Cikalong	17	15	13	8	8	5	3	2	3	6	10	14
Pasir Bungir	19	17	16	12	10	6	5	3	4	7	12	14
Subang	19	19	20	16	13	6	5	4	4	10	16	19
Udjung Jaya	17	15	16	11	8	4	3	2	3	6	12	17
Sumedang	18	15	18	16	12	5	6	4	2	8	14	18
Sumurwatu	18	15	15	12	8	4	4	2	3	5	11	16
Kertasumaya	16	13	14	9	7	4	4	3	2	4	8	13
Kadipaten	18	17	18	14	9	5	4	2	2	6	13	18
Wiahar	18	16	17	13	8	4	4	2	2	6	12	17
Majalengka	19	17	18	12	9	4	3	2	1	5	10	16
Average	18	16	16	12	9	5	4	3	3	6	12	16

Table 12.5.2 Number of Working Days in a Month

Item	Dry Season 5-10 (6 Months)	Rainy Season 11-4 (6 Months)
Average number of rainy day in a month	5 days	15 days
Working efficiency on a rainy day	65%	35%
Number of holidays in a month	5 days	5 days
Number of actual working days in a month	23.3 days	15.3 days
Working efficiency in a month	78%	51%

2) Construction Schedule

Taking into consideration various factors, the maximum possible construction period for each section of this project is estimated to be 3 and 4 years. The scale of each work items and construction difficulties etc. were studied and schedules for individual package were prepared as shown in Figs. 12.5.1 to 12.5.2.

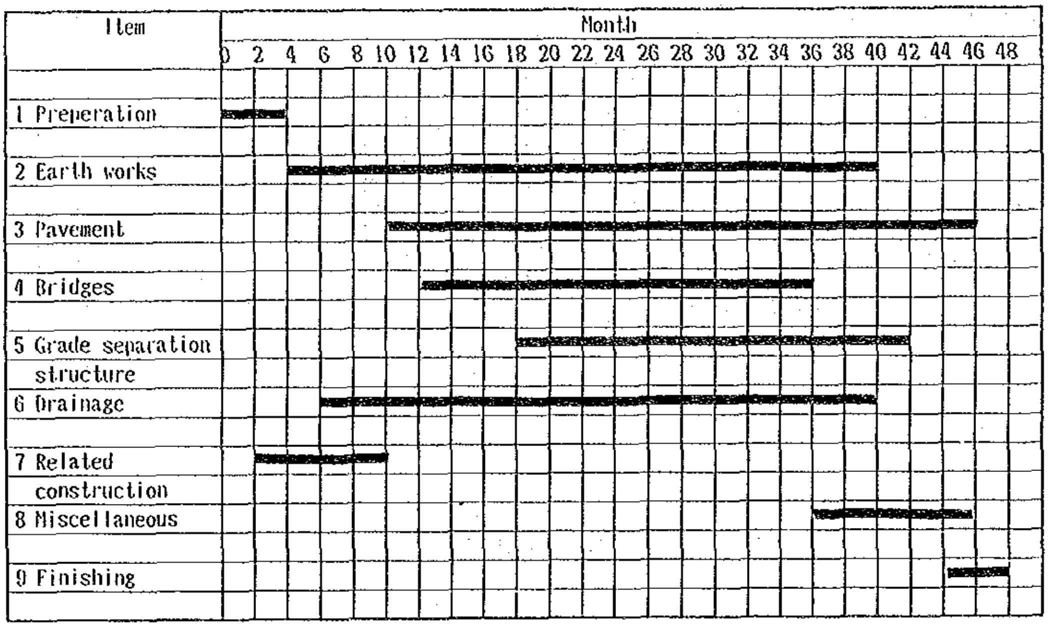


Fig. 12.5.1 Construction Schedule - Section 1 to 5 (Package A and B)

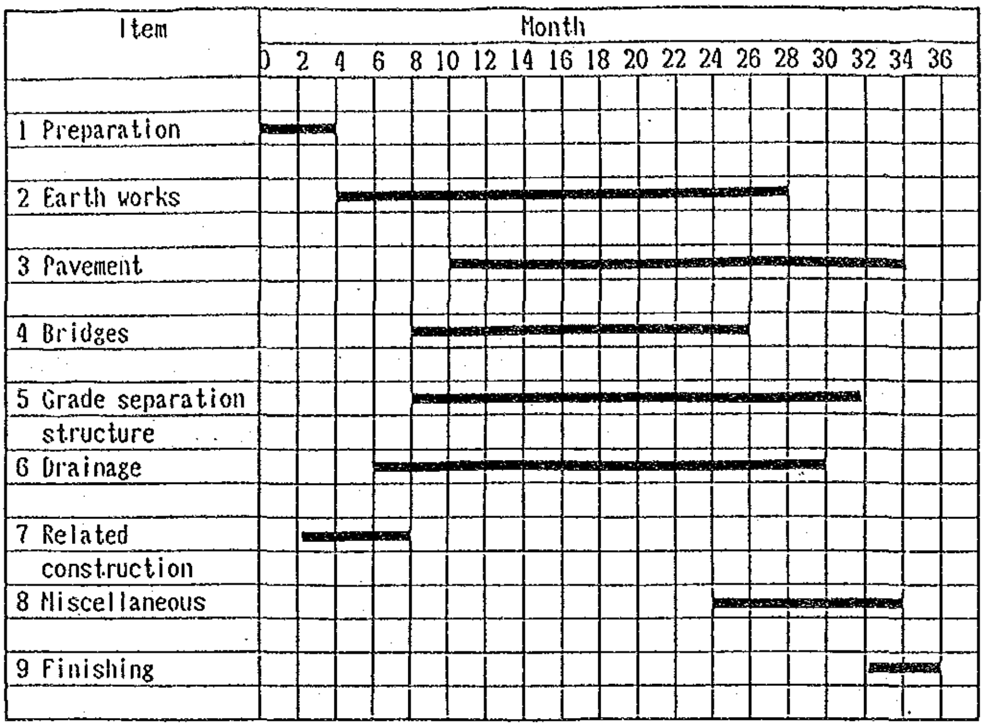


Fig. 12.5.2 Construction Schedule - Section 6 to 9 (Package C)

12.6 Implementation Plan

The schedule of project implementation is shown in Table 12.6.1 with reference to similar project in Indonesia.

Table 12.6.1 Implementation Schedule

Description \ Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Feasibility Study	━									
Loan Processing for Detailed Design		━								
Procurement for Detailed Design			━							
Detailed Design			━	━	━					
Land Acquisition and Compensation					A,B ━	C ━				
Construction Package A, B						━	━	━	━	
Package C							━	━	━	

CHAPTER 13. ESTIMATED PROJECT COST

CHAPTER 13. ESTIMATED PROJECT COST

13.1 Estimation of Construction Costs

The construction work is divided into 9 sections and 3 packages according to the construction plan and the work schedule. The quantity of each work item of construction per section is estimated and the construction cost is calculated according to the unit cost based on similar past projects.

Tables 13.1.1 to 13.1.6 show the direct construction cost for the initial stage and remaining works for the ultimate stage per package.

Table 13.1.1 Direct Construction Cost of Package-A (Outer 4-Lanes)

ITEM	UNIT	QUANTITY	UNIT COST (Rp.)	AMOUNT (1000Rp.)
1 Earth works				
Clearing and grubbing	m2	2,932,000	550	1,612,600
Common excavation (E-L)	m3	5,669,000	3,500	19,841,500
Borrow excavation (E-L)	m3	164,000	3,800	623,200
Embankment (1km T-C) soil	m3	5,094,000	2,500	12,735,000
Haulage A (7Km)	m3	945,000	3,500	3,307,500
Haulage B (13Km)	m3	1,620,000	6,500	10,530,000
Haulage C (20Km)	m3	0	10,000	0
Sodding Solid	m2	364,000	500	182,000
Sodding Strip	m2	1,663,000	350	582,050
Sub-total				49,413,850
2 Flexible Pavement				
Subgrade Preparation	m2	687,000	150	103,050
Aggregate Subbase	m3	249,000	25,000	6,225,000
Asphalt treated base	ton	223,300	41,000	9,155,300
Binder course (t=6cm)	ton	87,400	47,000	4,107,800
Surface course (t=4cm)	ton	58,000	55,000	3,190,000
Prime coat	Kg	1,202,000	400	480,800
Tackcoat	Kg	746,400	400	298,560
Seal coat	m2	236,000	1,200	283,200
Sub-total				23,843,710
3 Bridges				
Short span bridges	m2	3,270	715,000	2,338,050
Medium span bridges	m2	26,780	770,000	20,620,600
Long span bridges	m2	5,200	1,240,000	6,448,000
Sub-total				29,406,650
4 Grade separation structure				
Medium span bridges	m2	9,630	770,000	7,415,100
I/C bridges	m2	1,540	770,000	1,185,800
Over-Bridges (Pedestrian)	m2	980	957,650	938,497
Ramp Bridges	m2	0	770,000	0
Sub-total				9,539,397
5 Drainage				
U-ditch & Catchbasin	km	37.5	68,800,000	2,580,000
Concrete pipe o 100	m	2,450	227,104	556,405
Culvert A (3 x 3)	m	1,680	1,200,000	2,016,000
Culvert B (5 x 5)	m	270	2,600,000	702,000
Sub-total				5,854,405
6 Related Construction				
Road relocation	Km	2.2	498,000,000	1,095,600
Road improvement (access)	Km	0.0	415,000,000	0
Road improvement (const.)	Km	6.5	332,000,000	2,158,000
New construction (access)	Km	0.0	498,000,000	0
Sub-total				3,253,600
7 Miscellaneous				
Guard Rail (single)	m	10,500	67,415	707,858
Fence, Km Post, ROW Stake	Km	37.5	30,000,000	1,125,000
Marking	m2	31,000	2,500	77,500
Signs and Signals	km	37.5	12,800,000	480,000
Sub-total				2,390,358
8 Interchange(exclud bridge)	each	2	3,500,000,000	7,000,000
9 Throughway Toll Barrier	each	1	5,700,000,000	5,700,000
10 Parking Area	each	0	1,030,000,000	0
11 Service Area	each	1	4,200,000,000	4,200,000
Sub-total				16,900,000
Direct Construction Cost				140,602,000

Table 13.1.2 Direct Construction Cost of Package-B (Outer 4-Lanes)

ITEM	UNIT	QUANTITY	UNIT COST (Rp.)	AMOUNT (1000Rp.)
1 Earth works				
Clearing and grubbing	m2	3,287,000	550	1,807,850
Common excavation (E-L)	m3	3,461,000	3,500	12,113,500
Borrow excavation (E-L)	m3	269,000	3,800	1,022,200
Embankment (1km T-C) soil	m3	3,383,000	2,500	8,457,500
Haulage A (7Km)	m3	2,103,000	3,500	7,360,500
Haulage B (13Km)	m3	0	6,500	0
Haulage C (20Km)	m3	0	10,000	0
Sodding Solid	m2	510,000	500	255,000
Sodding Strip	m2	1,572,000	350	550,200
Sub-total				31,566,750
2 Flexible Pavement				
Subgrade Preparation	m2	963,000	150	144,450
Aggregate Subbase	m3	349,000	25,000	8,725,000
Asphalt treated base	ton	313,200	41,000	12,841,200
Binder course (t=6cm)	ton	122,600	47,000	5,762,200
Surface course (t=4cm)	ton	81,400	55,000	4,477,000
Prime coat	Kg	1,685,000	400	674,000
Tackcoat	Kg	1,046,000	400	418,400
Seal coat	m2	331,000	1,200	397,200
Sub-total				33,439,450
3 Bridges				
Short span bridges	m2	2,140	715,000	1,530,100
Medium span bridges	m2	23,730	770,000	18,272,100
Long span bridges	m2	5,200	1,240,000	6,448,000
Sub-total				26,250,200
4 Grade separation structure				
Medium span bridges	m2	9,950	770,000	7,661,500
I/C bridges	m2	0	770,000	0
Over-Bridges (Pedestrian)	m2	1,760	957,650	1,685,464
Ramp Bridges	m2	880	770,000	677,600
Sub-total				10,024,564
5 Drainage				
U-ditch & Catchbasin	km	52.0	68,800,000	3,577,600
Concrete pipe o 100	m	1,620	227,104	367,908
Culvert A (3 x 3)	m	1,960	1,200,000	2,352,000
Culvert B (5 x 5)	m	200	2,600,000	520,000
Sub-total				6,817,508
6 Related Construction				
Road relocation	Km	0.5	498,000,000	249,000
Road improvement (access)	Km	1.3	415,000,000	539,500
Road improvement (const.)	Km	2.0	332,000,000	664,000
New construction (access)	Km	2.0	498,000,000	996,000
Sub-total				2,448,500
7 Miscellaneous				
Guard Rail (single)	m	12,400	67,415	835,946
Fence, Km Post, ROW Stake	Km	52.0	30,000,000	1,560,000
Marking	m2	43,000	2,500	107,500
Signs and Signals	km	52.0	12,800,000	665,600
Sub-total				3,169,046
8 Interchange(exclud bridge)	each	2	3,500,000,000	7,000,000
9 Throughway Toll Barrier	each	0	5,700,000,000	0
10 Parking Area	each	8	1,030,000,000	8,240,000
11 Service Area	each	0	4,200,000,000	0
Sub-total				15,240,000
Direct Construction Cost				128,956,000

Table 13.1.3 Direct Construction Cost of Package-C (Outer 4-Lanes)

ITEM	UNIT	QUANTITY	UNIT COST (Rp.)	AMOUNT (1000Rp.)
1 Earth works				
Clearing and grubbing	m2	3,340,000	550	1,837,000
Common excavation (E-L)	m3	1,460,000	3,500	5,110,000
Borrow excavation (E-L)	m3	3,536,000	3,800	13,436,800
Embankment (1km T-C) soil	m3	4,850,000	2,500	12,125,000
Haulage A (7Km)	m3	1,080,000	3,500	3,780,000
Haulage B (13Km)	m3	3,239,000	6,500	21,053,500
Haulage C (20Km)	m3	1,509,000	10,000	15,090,000
Sodding Solid	m2	516,000	500	258,000
Sodding Strip	m2	1,592,000	350	557,200
Sub-total				73,247,500
2 Flexible Pavement				
Subgrade Preparation	m2	975,000	150	146,250
Aggregate Subbase	m3	354,000	25,000	8,850,000
Asphalt treated base	ton	317,200	41,000	13,005,200
Binder course (t=6cm)	ton	124,100	47,000	5,832,700
Surface course (t=4cm)	ton	82,400	55,000	4,532,000
Prime coat	Kg	1,706,000	400	682,400
Tackcoat	Kg	1,060,000	400	424,000
Seal coat	m2	336,000	1,200	403,200
Sub-total				33,875,750
3 Bridges				
Short span bridges	m2	16,370	715,000	11,704,550
Medium span bridges	m2	19,900	770,000	15,323,000
Long span bridges	m2	0	1,240,000	0
Sub-total				27,027,550
4 Grade separation structure				
Medium span bridges	m2	18,720	770,000	14,414,400
I/C bridges	m2	0	770,000	0
Over-Bridges (Pedestrian)	m2	1,960	957,650	1,876,994
Ramp Bridges	m2	2,640	770,000	2,032,800
Sub-total				18,324,194
5 Drainage				
U-ditch & Catchbasin	km	53	68,800,000	3,646,400
Concrete pipe o 100	m	4,530	227,104	1,028,781
Culvert A (3 x 3)	m	1,430	1,200,000	1,716,000
Culvert B (5 x 5)	m	800	2,600,000	2,080,000
Sub-total				8,471,181
6 Related Construction				
Road relocation	Km	3.0	498,000,000	1,494,000
Road improvement (access)	Km	10.5	415,000,000	4,357,500
Road improvement (const.)	Km	5.0	332,000,000	1,660,000
New construction (access)	Km	0.5	498,000,000	249,000
Sub-total				7,760,500
7 Miscellaneous				
Guard Rail (single)	m	22,200	67,415	1,496,613
Fence, Km Post, ROW Stake	Km	53.0	30,000,000	1,590,000
Marking	m2	45,000	2,500	112,500
Signs and Signals	km	53.0	12,800,000	678,400
Sub-total				3,877,513
8 Interchange(exclud bridge)	each	2	3,500,000,000	7,000,000
9 Throughway Toll Barrier	each	0	5,700,000,000	0
10 Parking Area	each	4	1,030,000,000	4,120,000
11 Service Area	each	0	4,200,000,000	0
Sub-total				11,120,000
Direct Construction Cost				183,704,000

Table 13.1.4 Direct Construction Cost of Package-A (Remaining Works for 6-Lanes)

ITEM	UNIT	QUANTITY	UNIT COST (Rp.)	AMOUNT (1000Rp.)
1 Earth works				
Clearing and grubbing	m2	0	550	0
Common excavation (E-L)	m3	0	3,500	0
Borrow excavation (E-L)	m3	0	3,800	0
Embankment (1km T-C) soil	m3	0	2,500	0
Haulage A (7Km)	m3	0	3,500	0
Haulage B (13Km)	m3	0	6,500	0
Haulage C (20Km)	m3	0	10,000	0
Sodding Solid	m2	0	500	0
Sodding Strip	m2	0	350	0
Sub-total				0
2 Flexible Pavement				
Subgrade Preparation	m2	335,000	150	50,250
Aggregate Subbase	m3	105,000	25,000	2,625,000
Asphalt treated base	ton	99,200	41,000	4,067,200
Binder course (t=6cm)	ton	37,700	47,000	1,771,900
Surface course (t=4cm)	ton	24,900	55,000	1,369,500
Prime coat	Kg	586,250	400	234,500
Tackcoat	Kg	322,800	400	129,120
Seal coat	m2	55,000	1,200	66,000
Sub-total				10,313,470
3 Bridges				
Short span bridges	m2	0	715,000	0
Medium span bridges	m2	0	770,000	0
Long span bridges	m2	0	1,240,000	0
Sub-total				0
4 Grade separation structure				
Medium span bridges	m2	0	770,000	0
I/C bridges	m2	0	770,000	0
Over-Bridges (Pedestrian)	m2	0	957,650	0
Ramp Bridges	m2	0	770,000	0
Sub-total				0
5 Drainage				
U-ditch & Catchbasin	km	36.4	68,800,000	2,504,320
Concrete pipe o 100	m	0	227,104	0
Culvert A (3 x 3)	m	0	1,200,000	0
Culvert B (5 x 5)	m	0	2,600,000	0
Sub-total				2,504,320
6 Related Construction				
Road relocation	Km	0.0	498,000,000	0
Road improvement (access)	Km	0.0	415,000,000	0
Road improvement (const.)	Km	0.0	332,000,000	0
New construction (access)	Km	0.0	498,000,000	0
Sub-total				0
7 Miscellaneous				
Guard Rail (double)	m	37,000	95,000	3,515,000
Fence, Km Post, ROW Stake	Km	0.0	30,000,000	0
Marking	m2	18,000	2,500	45,000
Signs and Signals	km	0.0	12,800,000	0
Sub-total				3,560,000
8 Interchange(exclud bridge)	each	1	3,500,000,000	3,500,000
9 Throughway Toll Barrier	each	0	5,700,000,000	0
10 Parking Area	each	0	1,030,000,000	0
11 Service Area	each	0	4,200,000,000	0
Sub-total				3,500,000
Direct Construction Cost				19,878,000

Table 13.1.5 Direct Construction Cost of Package-B (Remaining Works for 6-Lanes)

ITEM	UNIT	QUANTITY	UNIT COST (Rp.)	AMOUNT (1000Rp.)
1 Earth works				
Clearing and grubbing	m2	0	550	0
Common excavation (E-L)	m3	0	3,500	0
Borrow excavation (E-L)	m3	0	3,800	0
Embankment (1km T-C) soil	m3	0	2,500	0
Haulage A (7Km)	m3	0	3,500	0
Haulage B (13Km)	m3	0	6,500	0
Haulage C (20Km)	m3	0	10,000	0
Sodding Solid	m2	0	500	0
Sodding Strip	m2	0	350	0
Sub-total				0
2 Flexible Pavement				
Subgrade Preparation	m2	471,000	150	70,650
Aggregate Subbase	m3	147,000	25,000	3,675,000
Asphalt treated base	ton	139,500	41,000	5,719,500
Binder course (t=6cm)	ton	53,000	47,000	2,491,000
Surface course (t=4cm)	ton	35,100	55,000	1,930,500
Prime coat	Kg	824,250	400	329,700
Tackcoat	Kg	456,000	400	182,400
Seal coat	m2	77,000	1,200	92,400
Sub-total				14,491,150
3 Bridges				
Short span bridges	m2	0	715,000	0
Medium span bridges	m2	0	770,000	0
Long span bridges	m2	0	1,240,000	0
Sub-total				0
4 Grade separation structure				
Medium span bridges	m2	0	770,000	0
I/C bridges	m2	0	770,000	0
Over-Bridges (Pedestrian)	m2	0	957,650	0
Ramp Bridges	m2	0	770,000	0
Sub-total				0
5 Drainage				
U-ditch & Catchbasin	km	51	68,800,000	3,522,560
Concrete pipe o 100	m	0	227,104	0
Culvert A (3 x 3)	m	0	1,200,000	0
Culvert B (5 x 5)	m	0	2,600,000	0
Sub-total				3,522,560
6 Related Construction				
Road relocation	Km	0	498,000,000	0
Road improvement (access)	Km	0	415,000,000	0
Road improvement (const.)	Km	0	332,000,000	0
New construction (access)	Km	0	498,000,000	0
Sub-total				0
7 Miscellaneous				
Guard Rail (double)	m	51,000	95,000	4,845,000
Fence, Km Post, ROW Stake	Km	0.0	30,000,000	0
Marking	m2	26,000	2,500	65,000
Signs and Signals	km	0.0	12,800,000	0
Sub-total				4,910,000
8 Interchange(exclud bridge)	each	1	3,500,000,000	3,500,000
9 Throughway Toll Barrier	each	0	5,700,000,000	0
10 Parking Area	each	0	1,030,000,000	0
11 Service Area	each	0	4,200,000,000	0
Sub-total				3,500,000
Direct Construction Cost				26,424,000

Table 13.1.6 Direct Construction Cost of Package-C (Remaining Works 6-Lanes)

ITEM	UNIT	QUANTITY	UNIT COST (Rp.)	AMOUNT (1000Rp.)
1 Earth works				
Clearing and grubbing	m2	0	550	0
Common excavation (E-L)	m3	0	3,500	0
Borrow excavation (E-L)	m3	0	3,800	0
Embankment (1km T-C) soil	m3	0	2,500	0
Haulage A (7Km)	m3	0	3,500	0
Haulage B (13Km)	m3	0	6,500	0
Haulage C (20Km)	m3	0	10,000	0
Sodding Solid	m2	0	500	0
Sodding Strip	m2	0	350	0
Sub-total				0
2 Flexible Pavement				
Subgrade Preparation	m2	473,000	150	70,950
Aggregate Subbase	m3	149,000	25,000	3,725,000
Asphalt treated base	ton	140,100	41,000	5,744,100
Binder course (t=6cm)	ton	53,200	47,000	2,500,400
Surface course (t=4cm)	ton	35,200	55,000	1,936,000
Prime coat	Kg	827,750	400	331,100
Tackcoat	Kg	456,000	400	182,400
Seal coat	m2	78,000	1,200	93,600
Sub-total				14,583,550
3 Bridges				
Short span bridges	m2	0	715,000	0
Medium span bridges	m2	0	770,000	0
Long span bridges	m2	0	1,240,000	0
Sub-total				0
4 Grade separation structure				
Medium span bridges	m2	0	770,000	0
I/C bridges	m2	0	770,000	0
Over-Bridges (Pedestrian)	m2	0	957,650	0
Ramp Bridges	m2	0	770,000	0
Sub-total				0
5 Drainage				
U-ditch & Catchbasin	km	51.4	68,800,000	3,536,320
Concrete pipe o 100	m	0	227,104	0
Culvert A (3 x 3)	m	0	1,200,000	0
Culvert B (5 x 5)	m	0	2,600,000	0
Sub-total				3,536,320
6 Related Construction				
Road relocation	Km	0	498,000,000	0
Road improvement (access)	Km	0	415,000,000	0
Road improvement (const.)	Km	0	332,000,000	0
New construction (access)	Km	0	498,000,000	0
Sub-total				0
7 Miscellaneous				
Guard Rail (double)	m	52,000	95,000	4,940,000
Fence, Km Post, ROW Stake	Km	0.0	30,000,000	0
Marking	m2	26,000	2,500	65,000
Signs and Signals	km	0.0	12,800,000	0
Sub-total				5,005,000
8 Interchange(exclud bridge)	each	2	3,500,000,000	7,000,000
9 Throughway Toll Barrier	each	1	5,700,000,000	5,700,000
10 Parking Area	each	0	1,030,000,000	0
11 Service Area	each	1	4,200,000,000	4,200,000
Sub-total				16,900,000
Direct Construction Cost				40,025,000

13.2 Land Acquisition and Compensation Costs

Land acquisition and compensation costs are estimated according to the unit cost shown in Tables 13.2.1 and 13.2.2 which were investigated by Indonesian counterpart.

Table 13.2.1 Unit Costs of Land Acquisition

Category	Unit Cost (Rp./m^2)
Housing Area	4,000
Paddy Field	2,000
Vegetable Garden	1,500
Plantation	1,500
Forest	500

Table 13.2.2 Unit Costs of Compensation for Property

Category	Unit Cost (Rp./m^2)
Semi-Permanent Housing	84,500
Paddy	300
Rubber	12,000
Teak	24,000
Miscellaneous Tree	1,000
Others	200

13.3 Project Costs

Tables 13.2.3 and 13.2.4 show a summary of the project cost per package including indirect cost, maintenance vehicles and furniture purchasing cost, land acquisition cost and compensation cost.

Table 13.3.1 Project Cost (Initial 4-Lanes)

(1000 Rp.)

ITEM	Initial 4-Lanes			
	PACKAGE A	PACKAGE B	PACKAGE C	TOTAL
1 Earth works				
Clearing and grubbing	1,612,600	1,807,850	1,837,000	5,257,450
Common excavation (E-L)	19,841,500	12,113,500	5,110,000	37,065,000
Borrow excavation (E-L)	623,200	1,022,200	13,436,800	15,082,200
Embankment (1km T-C) soil	12,735,000	8,457,500	12,125,000	33,317,500
Haulage A (7Km)	3,307,500	7,360,500	3,780,000	14,448,000
Haulage B (13Km)	10,530,000	0	21,053,500	31,583,500
Haulage C (20Km)	0	0	15,090,000	15,090,000
Sodding Solid	182,000	255,000	258,000	695,000
Sodding Strip	582,050	550,200	557,200	1,689,450
Sub-total	49,413,850	31,566,750	73,247,500	154,228,100
2 Flexible Pavement				
Subgrade Preparation	103,050	144,450	146,250	393,750
Aggregate Subbase	6,225,000	8,725,000	8,850,000	23,800,000
Asphalt treated base	9,155,300	12,841,200	13,005,200	35,001,700
Binder course (t=6cm)	4,107,800	5,762,200	5,832,700	15,702,700
Surface course (t=4cm)	3,190,000	4,477,000	4,532,000	12,199,000
Prime coat	480,800	674,000	682,400	1,837,200
Tackcoat	298,560	418,400	424,000	1,140,960
Seal coat	283,200	397,200	403,200	1,083,600
Sub-total	23,843,710	33,439,450	33,875,750	91,158,910
3 Bridges				
Short span bridges	2,338,050	1,530,100	11,704,550	15,572,700
Medium span bridges	20,620,600	18,272,100	15,323,000	54,215,700
Long span bridges	6,448,000	6,448,000	0	12,896,000
Sub-total	29,406,650	26,250,200	27,027,550	82,684,400
4 Grade separation structure				
Medium span bridges	7,415,100	7,661,500	14,414,400	29,491,000
I/C bridges	1,185,800	0	0	1,185,800
Over-Bridges (Pedestrian)	938,497	1,685,464	1,876,994	4,500,955
Ramp Bridges	0	677,600	2,032,800	2,710,400
Sub-total	9,539,397	10,024,564	18,324,194	37,888,155
5 Drainage				
U-ditch & Catchbasin	2,580,000	3,577,600	3,646,400	9,804,000
Concrete pipe o 100	556,405	367,908	1,028,781	1,953,094
Culvert A (3 x 3)	2,016,000	2,352,000	1,716,000	6,084,000
Culvert B (5 x 5)	*702,000*	*520,000*	*2,080,000*	*3,302,000*
Sub-total	5,854,405	6,817,508	8,471,181	21,143,094
6 Related Construction				
Road relocation	1,095,600	249,000	1,494,000	2,838,600
Road improvement (access)	0	539,500	4,357,500	4,897,000
Road improvement (const.)	2,158,000	664,000	1,660,000	4,482,000
New construction (access)	0	996,000	249,000	1,245,000
Sub-total	3,253,600	2,448,500	7,760,500	13,462,600
7 Miscellaneous				
Guard Rail (single)	707,858	835,946	1,496,613	3,040,417
Fence, Km Post, ROW Stake	1,125,000	1,560,000	1,590,000	4,275,000
Marking	77,500	107,500	112,500	297,500
Signs and Signals	480,000	665,600	678,400	1,824,000
Sub-total	2,390,358	3,169,046	3,877,513	9,436,917
8 Interchange(exclud bridge)	7,000,000	7,000,000	7,000,000	21,000,000
9 Throughway Toll Barrier	5,700,000	0	0	5,700,000
10 Parking Area	0	8,240,000	4,120,000	12,360,000
11 Service Area	4,200,000	0	0	4,200,000
Sub-total	16,900,000	15,240,000	11,120,000	43,260,000
Direct Construction Cost	140,602,000	128,956,000	183,704,000	453,262,000
Contingency 15%	21,090,000	19,343,000	27,556,000	67,989,000
Overhead & Profit 10%	16,169,000	14,830,000	21,126,000	52,125,000
Engineering fee 7%	12,450,000	11,419,000	16,267,000	40,136,000
Vehicle & Furniture	1,042,000	1,042,000	1,042,000	3,126,000
Tax 10%	19,135,000	17,559,000	24,970,000	61,664,000
Land Acquisition & Compensat	17,364,000	35,093,000	16,780,000	69,237,000
Project Cost	*227,852,000*	*228,242,000*	*291,445,000*	*747,539,000*

Table 13.3.2 Project Cost (Remaining Works for 6-Lanes)

(1000 Rp.)

ITEM	Remaining Works for 6-Lanes			
	PACKAGE A	PACKAGE B	PACKAGE C	TOTAL
1 Earth works				
Clearing and grubbing	0	0	0	0
Common excavation (E-L)	0	0	0	0
Borrow excavation (E-L)	0	0	0	0
Embankment (1km T-C) soil	0	0	0	0
Haulage A (7Km)	0	0	0	0
Haulage B (13Km)	0	0	0	0
Haulage C (20Km)	0	0	0	0
Sodding Solid	0	0	0	0
Sodding Strip	0	0	0	0
Sub-total	0	0	0	0
2 Flexible Pavement				
Subgrade Preparation	50,250	70,650	70,950	191,850
Aggregate Subbase	2,625,000	3,675,000	3,725,000	10,025,000
Asphalt treated base	4,067,200	5,719,500	5,744,100	15,530,800
Binder course (t=6cm)	1,771,900	2,491,000	2,500,400	6,763,300
Surface course (t=4cm)	1,369,500	1,930,500	1,936,000	5,236,000
Prime coat	234,500	329,700	331,100	895,300
Tackcoat	129,120	182,400	182,400	493,920
Seal coat	66,000	92,400	93,600	252,000
Sub-total	10,313,470	14,491,150	14,583,550	39,388,170
3 Bridges				
Short span bridges	0	0	0	0
Medium span bridges	0	0	0	0
Long span bridges	0	0	0	0
Sub-total	0	0	0	0
4 Grade separation structure				
Medium span bridges	0	0	0	0
I/C bridges	0	0	0	0
Over-Bridges (Pedestrian)	0	0	0	0
Ramp Bridges	0	0	0	0
Sub-total	0	0	0	0
5 Drainage				
U-ditch & Catchbasin	2,504,320	3,522,500	3,536,320	9,563,140
Concrete pipe o 100	0	0	0	0
Culvert A (3 x 3)	0	0	0	0
Culvert B (5 x 5)	0	0	0	0
Sub-total	2,504,320	3,522,500	3,536,320	9,563,140
6 Related Construction				
Road relocation	0	0	0	0
Road improvement (access)	0	0	0	0
Road improvement (const.)	0	0	0	0
New construction (access)	0	0	0	0
Sub-total	0	0	0	0
7 Miscellaneous				
Guard Rail	3,515,000	4,845,000	4,940,000	13,300,000
Fence, Km Post, ROW Stake	0	0	0	0
Marking	45,000	65,000	65,000	175,000
Signs and Signals	0	0	0	0
Sub-total	3,560,000	4,910,000	5,005,000	13,475,000
8 Interchange(exclud bridge)	3,500,000	3,500,000	7,000,000	14,000,000
9 Throughway Toll Barrier	0	0	5,700,000	5,700,000
10 Parking Area	0	0	0	0
11 Service Area	0	0	4,200,000	4,200,000
Sub-total	3,500,000	3,500,000	16,900,000	23,900,000
Direct Construction Cost	19,878,000	26,424,000	40,025,000	86,326,000
Contingency 15%	2,982,000	3,964,000	6,004,000	12,950,000
Overhead & Profit 10%	2,286,000	3,039,000	4,603,000	9,928,000
Engineering fee 7%	1,760,000	2,340,000	3,544,000	7,644,000
Vehicle & Furniture	0	0	0	0
Tax 10%	2,691,000	3,577,000	5,418,000	11,685,000
Land Acquisition & Compensation	0	0	0	0
Project Cost	29,597,000	39,344,000	59,594,000	128,533,000

13.4 Operation and Maintenance Costs

The operation and maintenance costs for the proposed tollway are estimated based on information from Jasa Marga about the operation and maintenance costs of several existing tollways in service with 4-lanes. Based on data of the total operation and maintenance costs and the total service length of the tollways, the average operation and maintenance costs per kilometer for a tollway with 4 lanes is estimated to be about 111 Million Rp. per annum. The operation and maintenance costs of a tollway with 6 lanes is assumed to be 1.1 times those with 4 lanes (about 121 Million Rp. per annum).

Table 13.4.1 Estimation of Operation and Maintenance Costs

(1) Case of Jagorawi

	O/M Cost (Rp.Mil.)	Length (Km)	O/M Cost per Km	factor of Overhead	O/M Cost per Km (Rp.Mil.) 4 Lanes	O/M Cost per Km (Rp.Mil.) 6 Lanes
Op.	3,113.6					
Maint.	911.7					
Total	4,025.3	47.6	85.0	1.2	102.0	112.0

(2) Case of Jakarta-Merak

	O/M Cost (Rp.Mil.)	Length (Km)	O/M Cost per Km	factor of Overhead	O/M Cost per Km (Rp.Mil.) 4 Lanes	O/M Cost per Km (Rp.Mil.) 6 Lanes
Op.	2,658.6					
Maint.	808.0					
Total	3,466.6	26.8	129.0	1.2	154.8	170.0

(3) Case of Surabaya-Gempol

	O/M Cost (Rp.Mil.)	Length (Km)	O/M Cost per Km	factor of Overhead	O/M Cost per Km (Rp.Mil.) 4 Lanes	O/M Cost per Km (Rp.Mil.) 6 Lanes
Op.	2,614.4					
Maint.	748.3					
Total	3,362.7	43.6	77.0	1.2	92.4	102.0

(Average of Above Tollways)

	O/M Cost (Rp.Mil.)	Length (Km)	O/M Cost per Km	factor of Overhead	O/M Cost per Km (Rp.Mil.) 4 Lanes	O/M Cost per Km (Rp.Mil.) 6 Lanes
Op.	8,386.6					
Maint.	2,468.0					
Total	10,854.6	118.0	92.0	1.2	110.4	121.0

Note: Data source of operation and maintenance costs of above tollways is from Jasa Marga.

CHAPTER 14. ECONOMIC PROJECT ANALYSIS

CHAPTER 14. ECONOMIC PROJECT ANALYSIS

14.1 General

The main aim of the economic analysis is to show the effect of the Cikampek-Cirebon Tollway on the nation's economic well-being and to estimate the expected economic rate of return on the resources invested. The evaluation is an assessment of the economic viability of the proposed Cikampek-Cirebon Tollway.

The evaluation of quantified economic costs and benefits follows the conventional discounted cash flow methodology in determining the net present value, internal rate of return and benefit cost ratio.

Aside from these efficiency measures, positive effects of the tollway on industrial development are examined and likely development types in the proposed interchange areas are discussed in the last section of this chapter.

14.2 Project Cost

14.2.1 Construction and Land Acquisition Costs

The initial investment cost for construction and land acquisition costs of the proposed tollway were estimated at a total of 747,539.0 million rupiah in constant 1989 prices. Of this total, 658,234 million rupiah is the construction and supervision cost, 69,237.0 million rupiah is the land acquisition and compensation cost and the remaining 20,068.0 million rupiah is the final engineering costs. The implementation schedule followed in the analyses (see Table 12.6.1) indicates that final engineering activities will continue from late 1991 through 1993, with land acquisition starting in 1993. Construction is scheduled over four years from 1994 to 1997.

As with the financial costs, the economic costs are estimated in constant 1989 prices. The economic costs were estimated by adjusting and eliminating all transfer payments such as taxes and duties as summarized in Table 14.2.1. The economic costs in constant 1989 prices are properly phased according to the construction schedule as shown in Table 14.2.2.

Table 14.2.1 Economic and Financial Project Costs

(million Rp. at 1989 prices)

Package	Cost	Land Acquisition & Compensation	Engineering Services: Detailed Eng. Design	Engineering Services: Construction Supervision	Construction	Total
A:	Initial 4-lane					
	Financial	17,364.0	6,225.0	6,225.0	198,038.0	227,852.0
	Economic	17,364.0	5,185.4	5,185.4	156,772.9	184,507.7
	Remainings for 6-lane					
	Financial	0	880.0	880.0	27,837.0	29,597.0
	Economic	0	733.0	733.1	22,241.4	23,707.5
B:	Initial 4-lane					
	Financial	35,093.0	5,709.5	5,709.5	181,730.0	228,242.0
	Economic	35,093.0	4,756.0	4,756.0	144,025.2	188,630.2
	Remainings for 6-lane					
	Financial	0	1,170.0	1,170.0	37,004.0	39,344.0
	Economic	0	974.6	974.6	29,637.5	31,586.7
C:	Initial 4-lane					
	Financial	16,780.0	8,133.5	8,133.5	258,398.0	291,445.0
	Economic	16,780.0	6,775.2	6,775.2	205,008.6	235,339.0
	Remainings for 6-lane					
	Financial	0	1,772.0	1,772.0	56,050.0	59,594.0
	Economic	0	1,476.0	1,476.0	44,153.1	47,105.1
Total	Initial 4-lane					
	Financial	69,237.0	20,068.0	20,068.0	638,166.0	747,539.0
	Economic	69,237.0	16,716.6	16,716.6	505,806.7	608,476.9
	Remainings for 6-lane					
	Financial	0	3,822.0	3,822.0	120,891.0	128,535.0
	Economic	0	3,183.6	3,183.7	96,032.0	102,399.3
Grand Total	Financial	69,237.0	23,890.0	23,890.0	759,057.0	876,074.0
	Economic	69,237.0	19,900.2	19,900.3	601,838.7	710,876.2

Table 14.2.2 Economic Project Cost Flows

CONSTANT 1989 RUPIAH

YEAR		ENGINEERING SERVICES	LAND ACQ. & COMPENSATION	CONSTRUCTION COSTS	OPERATION/ MAINTENANCE	TOTAL (A+B+C)
1	1989	.0	.0	.0	.0	.0
2	1990	.0	.0	.0	.0	.0
3	1991	3,343.0	.0	.0	.0	3,343.0
4	1992	6,687.0	.0	.0	.0	6,687.0
5	1993	6,687.0	52,457.0	.0	.0	59,144.0
6	1994	3,977.0	16,780.0	60,160.0	.0	80,917.0
7	1995	4,698.0	.0	151,742.0	.0	156,440.0
8	1996	4,698.0	.0	172,242.0	.0	176,940.0
9	1997	3,343.0	.0	121,663.0	.0	125,006.0
10	1998	.0	.0	.0	14,186.0	14,186.0
11	1999	.0	.0	.0	14,186.0	14,186.0
12	2000	.0	.0	.0	14,186.0	14,186.0
13	2001	.0	.0	.0	14,186.0	14,186.0
14	2002	.0	.0	.0	14,186.0	14,186.0
15	2003	.0	.0	.0	14,186.0	14,186.0
16	2004	.0	.0	.0	14,186.0	14,186.0
17	2005	.0	.0	.0	14,186.0	14,186.0
18	2006	.0	.0	.0	14,186.0	14,186.0
19	2007	.0	.0	.0	14,186.0	14,186.0
20	2008	1,708.0	.0	25,940.0	14,186.0	41,834.0
21	2009	1,708.0	.0	25,940.0	14,186.0	41,834.0
22	2010	.0	.0	.0	15,099.0	15,099.0
23	2011	.0	.0	.0	15,099.0	15,099.0
24	2012	.0	.0	.0	15,099.0	15,099.0
25	2013	1,476.0	.0	22,076.0	15,099.0	38,651.0
26	2014	1,476.0	.0	22,076.0	15,099.0	38,651.0
27	2015	.0	.0	.0	15,464.0	15,464.0
28	2016	.0	.0	.0	15,464.0	15,464.0
29	2017	.0	.0	.0	15,464.0	15,464.0
30	2018	.0	.0	.0	15,464.0	15,464.0
31	2019	.0	.0	.0	15,464.0	15,464.0
32	2020	.0	.0	.0	15,464.0	15,464.0
33	2021	.0	.0	.0	15,464.0	15,464.0
34	2022	.0	.0	.0	15,464.0	15,464.0
TOTAL		39,801.0	69,237.0	601,839.0	369,439.0	1,080,316.0

14.2.2 Operation and Maintenance Costs

Operation and maintenance costs were estimated at 111 million rupiah per kilometer or 15,762 million rupiah per year for the initial 4-lane tollway operation between Cikampek and Cirebon. At the ultimate stage of 6-lane tollway operation these are estimated to be 121 million rupiah per kilometer or 17,182 million rupiah per year. The financial operation and maintenance costs were adjusted to economic costs by eliminating transfer payments such as taxes. The project's economic operation and maintenance costs and capital costs for each analysis year are shown in Table 14.2.1.

14.3 Vehicle Operating Costs

14.3.1 General

A major part of the estimated economic benefits which would be realized from the implementation of the project are quantified in terms of savings in the vehicle operating costs which would result from improved traffic movement on the road network in the study area. The estimation of the vehicle operating costs is based on the method accepted by Jasa Marga in previous similar studies. All cost components and variables were up-dated according to the latest information collected in this study.

14.3.2 Representative Vehicles

Since a major factor in vehicle operating costs is the cost and type of vehicles under consideration, it is necessary to establish representative vehicles for the vehicle categories of the traffic assignment. The vehicle categories of the traffic assignment are passenger car, pick-up bus and truck, which respectively consist of sedan, jeep and mini bus, pick-ups, medium and large buses, and small and large trucks. The representative vehicles for each category are discussed below and their specifications are shown in Table AP 14.3.1, Appendix to Chapter 14.

1) Passenger Car and Pick-up

The sales data of sedans in Indonesia from 1985 to 1987 were collected and reviewed in order to establish a representative sedan. Honda consistently had the largest market share in sedan cars during the above period and the Jakarta Post recently noted that again Honda had the largest market share in 1988. The top selling Honda sedan car in 1986 and 1987 was the Honda Civic. Therefore, from the above make and model, the Honda Civic Grand was selected as the representative passenger car.

In Jakarta, many minibuses, such as Mitsubishi Colt or Toyota Kijang, are commonly used as sedan substitutes. After reviewing the sales data, the Toyota Kijang Minibus was selected as the representative minibus and the Toyota Kijang Pick-up was selected as the representative pick-up.

2) Bus

The representative medium and large buses used for public transportation services were also selected according to the sales data. The Mercedes Benz 0508 I was selected for the representative medium bus and the Mercedes Benz OH 306S was selected for the large bus.

3) Truck

The Mitsubishi Colt FE 104 and Mitsubishi Fuso FM 516 H were selected for the representative small and large trucks respectively.

14.3.3 Unit Prices and Operating Cost Components

The financial and economic unit prices of the major operating cost components were up-dated with 1989 prices collected in this study. The tax structures and duties utilized in estimating the economic unit prices were also updated according to recent changes in luxury taxes. The financial and economic unit prices are discussed below and are shown in Table 14.3.1.

Table 14.3.1 Unit Prices of Vehicle Operating Cost Components

(Constant 1989 Prices)

UNIT: RP.

PRICE OF VEHICLES		FINANCIAL PRICE	ECONOMIC PRICE
Sedan	: Honda Civic Grand 1500	48,000,000	21,600,000
Minibus	: Toyota Kijang Minibus	19,000,000	14,707,000
Pick-Up	: Toyota Kijang Pick-Up	12,000,000	9,240,000
Medium Bus	: Benz 508I	73,350,000	56,480,000
Large Bus	: Benz OH 306S	128,700,000	99,099,000
Small Truck	: Mitsubishi Colt FE 104	23,518,000	18,109,000
Large Truck	: Mitsubishi Fuso Fm 516H	55,165,000	42,477,000

Depreciable value of vehicle = 90% of price

PRICE OF ONE SET OF TIRE/TUBE		FINANCIAL PRICE	ECONOMIC PRICE
Minbus/Pickup	: 550 x 13	47,500	38,285
Sedan	: 185 x 14	93,750	75,563
Medium Bus	: 750 x 16	124,750	100,549
Large Bus	: 900 x 20	254,000	204,724
Small Truck	: 750 x 15	108,750	87,653
Large Truck	: 900 x 20	254,000	204,724

FUEL AND ENGINE OIL PRICE (PER LITER)	FINANCIAL PRICE	ECONOMIC PRICE
Gasoline	385	360
Diesel oil	200	192
Engine oil for passenger car	2,075	1,886
Engine oil for van and gasoline truck	1,975	1,795
Engine oil for bus and diesel truck	2,200	2,000

WAGES (PER HOUR)	FINANCIAL PRICE	ECONOMIC PRICE
Mechanic	997	997
Bus driver	1,336	1,336
Truck driver	1,336	1,336
Bus conductor	516	516
Truck assistant	605	605

1) Vehicles

The current 1989 market prices for vehicles were obtained through interview surveys with the major dealers in Jakarta. In Indonesia, a 100% import duty on the CIF (cost, insurance and freight) value of CKD (complete knocked down) parts is imposed on sedans but does not apply, however, to commercial vehicles. After adjusting for other transfer payments such as the PPN tax and value added tax (VAT), the tax ratios on the total sales price of vehicles were estimated at 55% and 23% for sedans and commercial vehicles respectively (Appendix to Chapter 14, Table AP 14.3.2).

2) Tires

The market prices of tires for the various vehicle types were updated to 1989 prices (Table 14.3.1) and a total tax ratio was assumed at 19.4% of the actual market sales prices for determining the economic unit prices.

3) Fuels and Engine Oils

Bahan Bakar Minyak, or BBM, refers to the eight fuel products which are produced, processed and marketed in Indonesia by Pertamina. The Government of Indonesia sets the prices of these products, and if sales do not generate enough revenue to cover costs (including crude, refining, storage, transport and marketing), the Government pays Pertamina to cover the difference, thereby creating a domestic fuel subsidy.

The Petroleum Report, Indonesia, September 1988, published by the Embassy of the United States of America, Jakarta, reported that the domestic fuel subsidy was temporarily eliminated in fiscal year 1986/1987 as a result of the combined effect of lower procurement prices for crude oil and the marginally lower retail prices. For fiscal year 1987/1988, however, there was a domestic fuel subsidy totalling 401.2 billion rupiah.

For fiscal year 1988/1989, the original budget estimated a domestic fuel subsidy totalling 266.5 billion rupiah on a total domestic consumption of 26.67 billion liters of BBM. This is equivalent to a 10 rupiah per liter subsidy, assuming that the subsidy is evenly distributed among the eight fuel types of BBM. Therefore, after adjusting for a 10% value added tax, the economic price of gasoline and diesel was increased by 10 rupiah per liter to account for the subsidy.

4) Wages

The 1985 to 1987 wage rates of drivers, conductors and maintenance labor was obtained from the Central Statistics Bureau. The average growth rate of the wages in the above period was used to estimate the wages in 1989. The wage, or earned income, of taxi drivers was estimated from an interview survey with a major taxi company. The wage levels, however, are still generally low and most are not subject to any income tax, or if at all, at around one to two percent of their total income. Under these circumstances, the economic values are considered to be equal to their market wage rates.

5) Interest Costs

A discount rate of 12% per annum was used. The interest costs in relation to speed were calculated from the annual running distance.

6) Insurance Costs

The average insurance premiums from the previous study and other studies were reviewed and incorporated into this report as follows:

Passenger Car & Pick-up	:	3.5% of vehicle Price
Bus	:	4.0% of vehicle Price
Truck	:	6.0% of vehicle Price

The average insured vehicle rate was assumed at 50%, and insurance costs were equated in consideration of the annual running distance by speed.

7) Wage Costs of Crew and Overhead Costs

The average crew size by type of vehicle was obtained from field interview results, and their wage costs were derived from their traveling hours equated by average running speed. The overhead costs of commercial vehicles were assumed at 10% of the total of other cost items.

8) Cost Equations of Vehicle Operation Costs

The various operating cost elements discussed above were individually expressed in terms of a vehicle's average running speed, in order that costs at different speeds on a level tangent road could be derived. The equations with a speed variable used in this study are based on those applied in previous similar studies in Indonesia. The equations for vehicle operating costs are shown in Appendix to Chapter 14, Table AP 14.3.3.

14.3.4 Vehicle Operating Costs by Vehicle Type

Based on the cost components and the equations of vehicle operating costs described above, vehicle operating costs by speed, by vehicle type in financial and economic prices were computed. Table 14.3.2 presents the road vehicle operating costs in both financial and economic prices.

The above vehicle operating costs were calculated for the seven representative vehicle types described earlier. The costs were then combined into the four vehicle categories of the traffic assignment based upon the vehicle composition rate shown below in Table 14.3.3.

Table 14.3.2 1989 Vehicle Operating Costs

Financial Vehicle Operating Costs (Rp./Km

Speed (KPH)	CAR	MINI BUS	PICK UP	MEDIUM BUS	LARGE BUS	SMALL TRUCK	LARGE TRUCK
5	1,928	817	544	1,502	2,301	936	1,673
10	1,151	501	342	987	1,562	574	1,049
15	877	388	267	811	1,307	444	824
20	728	323	225	724	1,175	377	705
25	634	284	198	671	1,102	333	627
30	568	252	176	640	1,054	301	573
35	518	229	160	618	1,023	279	535
40	481	213	149	605	1,007	265	506
45	449	199	138	598	1,000	253	485
50	427	190	132	597	999	244	471
55	408	181	127	597	1,004	238	461
60	391	175	123	603	1,014	237	458
65	380	171	121	611	1,032	233	457
70	369	169	121	623	1,052	237	459
75	362	169	122	635	1,077	239	465
80	359	169	123	649	1,103	243	476
85	358	173	129	666	1,133	249	488
90	358	175	133	684	1,165	260	503
95	358	179	137	702	1,205	266	523
100	361	187	144	723	1,244	278	545

Economic Vehicle Operating Costs (Rp./Km.

Speed (KPH)	CAR	MINI BUS	PICK UP	MEDIUM BUS	LARGE BUS	SMALL TRUCK	LARGE TRUCK
5	906	641	431	1,288	1,925	840	1,451
10	554	396	274	833	1,291	509	902
15	426	309	217	678	1,073	391	703
20	356	259	182	600	959	329	597
25	311	226	158	552	893	289	528
30	277	202	144	521	848	262	481
35	254	184	130	503	822	240	447
40	236	171	121	492	805	228	420
45	221	159	113	482	798	215	400
50	210	151	107	480	794	208	388
55	201	144	103	481	796	202	380
60	195	141	100	483	805	199	374
65	191	137	99	488	817	199	374
70	187	135	99	498	834	199	377
75	186	137	101	508	854	201	382
80	186	137	103	518	876	206	391
85	187	139	106	532	901	212	403
90	192	146	112	549	928	219	418
95	196	150	117	563	959	230	435
100	201	154	122	581	996	239	454

Table 14.3.3 Vehicle Composition Rate

Vehicle Category	Vehicle Type	Composition Rate (%)
Passenger Car	Sedan	46
	Minibus (Private)	54
Pick-up	Pick-up	100
Bus	Medium Bus	19
	Large Bus	81
Truck	Small Truck	40
	Large Truck	60

Source: Based on Traffic Survey by Study Team in 1988 at Location No. 12

As a result, the weighted averages of the vehicle operating costs by speed, by vehicle category in financial and economic prices were obtained as shown in Table 14.3.4. The results were then applied directly to the vehicle kilometers in different speed groups of tollway users in both network cases of "with" and "without" project tollway.

Table 14.3.4 1989 Composite Vehicle Operating Costs

Financial Vehicle Operating Costs (Rp./Km.)

Speed (KPH)	Pass. Car	Bus	Pick-Up	Truck
5	1,328	2,149	544	1,378
10	800	1,453	342	859
15	613	1,213	267	672
20	509	1,089	225	574
25	445	1,020	198	509
30	397	975	176	464
35	362	946	160	433
40	336	931	149	410
45	314	924	138	392
50	299	923	132	380
55	285	927	127	372
60	274	936	123	370
65	267	952	121	367
70	261	970	121	370
75	258	993	122	375
80	256	1,017	123	383
85	258	1,044	129	392
90	259	1,074	133	406
95	261	1,109	137	420
100	267	1,145	144	438

Economic Vehicle Operating Costs (Rp./Km.)

Speed (KPH)	Pass. Car	Bus	Pick-Up	Truck
5	763	1,804	431	1,207
10	469	1,204	274	745
15	363	998	217	578
20	304	891	182	490
25	265	828	158	432
30	237	786	144	393
35	216	761	130	364
40	201	746	121	343
45	188	738	113	326
50	178	734	107	316
55	170	736	103	309
60	166	744	100	304
65	162	754	99	304
70	159	770	99	306
75	160	788	101	310
80	160	808	103	317
85	161	831	106	327
90	167	856	112	338
95	171	884	117	353
100	176	917	122	368

14.4 Vehicle Time Cost

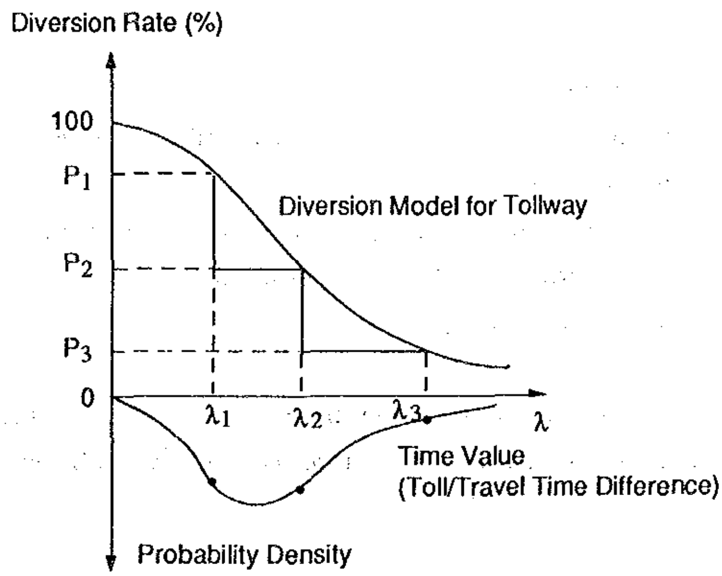
14.4.1 General

The vehicle time costs estimated here were directly applied to the vehicle hours of the potential tollway users derived from the "with" (with the project) and "without" (without the project) traffic assignment in order to estimate the vehicle time costs which would be saved with the implementation of the Tollway.

The vehicle time cost estimation involves various factors and aspects that are still controversial among specialists. Methodologies in practice have been developed for evaluating the economic viability of road projects and economical travel distances.

The method applied for this study is based on the tollway diversion equations derived from the traffic survey conducted by the Study Team in 1988.

The tollway diversion model explains the percentage tollway traffic among the potential users against the factor of the toll divided by travel time difference compared "via project tollway" with "via alternative existing road" as conceptually illustrated in the diagram below.



The diversion curve above implies that those which evaluate a saved travel time to be more than λ_1 rupiah per unit time (λ: toll/time difference) correspond to P_1%, whilst those which evaluate it to be more than λ_2 decrease to P_2%.

Therefore, the diversion curve resembles a cumulative distribution curve of time values.

14.4.2 Time Values by Vehicle Type

Tollway diversion equations were estimated in Chapter 6, section 6.2.2. The diversion equation differentiated by time value (λ) shows the probability density distribution.

Based on the obtained probability distribution function a median value of toll/time difference (λ: time value), that is a value corresponding to a diversion rate of 50%, is calculated following the equation below:

$$P = \frac{K}{1 + \alpha(T/S)^{\beta}} = 50(\%)$$

Therefore,

$$\lambda = T = S\left\{\frac{1}{\alpha}\cdot\left(\frac{k}{P} - 1\right)\right\}^{1/\beta}$$

where, P: Diversion Rate (%)

T: Toll per travel time difference (Rp./min.) between "via tollway" and "via alternative route"

S: Shift factor (for adjusting income level in different years)

α,β,K: Parameters of the diversion equation model (See Section 6.2.2)

Applying the above method to the previously estimated tollway diversion equations, time values for each vehicle time were estimated below:

Passenger car : $\lambda = S \cdot (1/\alpha)^{1/\beta} = 1.0 \times (1/2.77992 \times 10^{-5})^{1/2.080629}$
(Median Value: P = 50%) $\doteqdot$ 155 Rp./min. = 9,300 Rp./hr.

Pick-up : $\lambda = S \cdot (1.25/\alpha)^{1/\beta} = 1.0 \times (1.25/2.20822 \times 10^{-4})^{1/1.803121}$
(Median Value: P = 40%) $\doteqdot$ 121 Rp./min. = 7,260 Rp./hr.

Truck : $\lambda = S \cdot (1.67/\alpha)^{1/\beta} = 1.0 \times (1.67/2.07866 \times 10^{-5})^{1/2.276770}$
(Median Value: P = 30%) $\doteqdot$ 143 Rp./min. = 8,580 Rp./hr.

A tollway diversion model for buses was not satisfactorily estimated from the traffic data collected through the survey in 1988. Therefore, an income approach to estimate non-car owners was employed and the average occupancy per bus was used to derive the bus time cost.

Consequently, the vehicle time costs were estimated as shown in Table 14.4.1.

Table 14.4.1 Vehicle Time Cost

Vehicle Type	Time Cost (Rp./hr.)
Financial/Economic Costs:	
Passenger Car*	9,300
Pick-up	7,260
Truck	8,580
Bus	17,100

Note: * Including mini buses for private use

14.5 Economic Benefits

14.5.1 General

The quantified economic benefits which would be realized from implementation of the project are defined as the saving in travel costs when comparing the "with" and "without" project conditions. The toll revenue created by the project is regarded as a transfer payment, and is therefore excluded from the benefits, because the toll is paid by the toll road users in return for the expected savings in travel costs and/or increase in safety and comfort of travel.

Other economic benefits would also be realized from the implementation of the project which have not been quantified. The project would create additional short-term employment in the construction of the tollway and this would have a multiplier effect in the project area. Long-term jobs would also be created through the staff requirements for operation and maintenance. The tollway could also be expected to have a positive effect on industrial development. Increased efficiency in the transportation of goods should benefit both producers and consumers. In addition, the tollway would have a favorable influence on tourism development, by providing faster and more comfortable travel services. These and other benefits have not been quantified for the economic analysis; therefore, the estimated project benefits can be considered to be on the conservative side.

14.5.2 Economic Benefits in Travel Costs

As mentioned above, the quantified economic benefits in travel costs are defined as the savings in economic travel costs when comparing the "with" and "without" project situations. Travel costs are divided into vehicle operating cost and time cost.

The "with" project situation is the "with" project traffic assignment in vehicle-kilometers and vehicle-hours of tollway users on their routes between origin and destination, including the proposed Cikampek-Cirebon Tollway. The "without" project condition is the traffic assignment of the above tollway users on their routes "without" the proposed tollway.

The total daily economic vehicle operating costs, in both the "with" and "without" conditions, were calculated by taking the daily vehicle-kilometers of the traffic assignment computed under Q-V conditions of road links and multiplying them by the respective vehicle operating costs by speed. These daily costs were then converted to total annual costs by multiplying by 365. The economic benefit in operating costs was then taken as the savings in operating costs when comparing the total "with" and "without" project vehicle operating costs.

A similar method was followed in estimating the economic benefits of tollway users in time costs where the total vehicle-hours were applied directly to the time costs per hour in the "with" and "without" project conditions.

After converting from total daily time costs to yearly time costs the costs were netted out to arrive at the savings in time costs. These savings in vehicle operating costs and time costs are summarized for the planning years as described in Table 14.5.1.

Table 14.5.1 Estimated Economic User Benefits of Project Tollway

(Unit: Rp. Million/Year)

Year	Economic Benefits of Savings In:		Total Benefits	Remarks
	Vehicle Operating Costs	Time Costs		
1995	3,680	59,145	62,825	Present Pattern Model
2005	(50,227) 208,738	(176,270) 430,861	(226,497) 639,599	(Present Pattern Model) Gravity Model
2015	(250,787) 553,589	(585,367) 1,080,224	(836,154) 1,633,813	(Present Pattern Model) Gravity Model

14.6 Economic Cost-Benefit Analysis and Project Returns

14.6.1 Basic Assumptions and Methodology

The analysis follows the conventional discounted cash flow methodology in determining the net present value (NPV), the economic internal rate of return (EIRR), and the benefit cost ratio (B/C). These efficiency measures will establish the economic viability of the tollway and indicate the sensitivity of the project's economic viability to changes in project costs and benefits.

The economic costs in the "without" project condition have conservatively been defined as the travel costs that are expected in absence of the Tollway. Additional "without" project costs could be allocated as a result of higher maintenance and repair costs on the alternative routes of project tollway users, which would occur "without" the project due to higher traffic volumes. Since these additional "without" project costs would directly increase the incremental project benefit, the practical exclusion of these costs adds another conservative element into the analysis of the project's viability.

Apart from the elements previously discussed, the basic assumptions for the economic project cost-benefit analysis are described below:

Base Year	:	1989
Project Life	:	25 years after the completion of the full length between Cikampek and Cirebon
Prices	:	Constant 1989 prices
Residual Value	:	None

14.6.2 Economic Cost-Benefit Analysis

The economic project costs were previously discussed in Section 14.2. The economic benefits from savings in vehicle operating costs and time costs for the planning years were discussed previously in Section 14.5 and these were presented in Table 14.5.1. The benefits in the intermediate years were interpolated based on the projected vehicle kilometers and those beyond the year 2015 were held constant.

The total economic project cost and benefit streams are presented in Table 14.6.1. The cash flow or incremental project benefit stream is the basis for the internal rate of return calculations. The project costs and benefits streams at their net present values are the basis for the benefit-cost ratio calculations.

Following the conventional discounted cash flow methodology, the efficiency measures were calculated and the results are as follows:

Internal rate of return (EIRR)	=	32.28%
Net present value at 15% (NPV)	=	818,896 Million Rp. at 1989 constant price
Benefit Cost ratio at 15% (B/C)	=	4.29

Table 14.6.1 Economic Project Cost and Benefit Streams

CONSTANT 1989 MILLION RP

	YEAR	PROJECT COSTS			BENEFITS	INCREMENTAL PROJECT BENEFIT
		CAPITAL COSTS	O/M COSTS	TOTAL COSTS	TOTAL SAVINGS	
1	1989	0	0	0	0	0
2	1990	0	0	0	0	0
3	1991	3,343	0	3,343	0	-3,343
4	1992	6,687	0	6,687	0	-6,687
5	1993	59,144	0	59,144	0	-59,144
6	1994	80,917	0	80,917	0	-80,917
7	1995	156,440	0	156,440	0	-156,440
8	1996	176,940	0	176,940	0	-176,940
9	1997	125,006	0	125,006	0	-125,006
10	1998	0	14,186	14,186	111,927	97,741
11	1999	0	14,186	14,186	187,309	173,123
12	2000	0	14,186	14,186	262,690	248,504
13	2001	0	14,186	14,186	338,072	323,886
14	2002	0	14,186	14,186	413,454	399,268
15	2003	0	14,186	14,186	488,836	474,650
16	2004	0	14,186	14,186	564,217	550,031
17	2005	0	14,186	14,186	639,599	625,413
18	2006	0	14,186	14,186	739,020	724,834
19	2007	0	14,186	14,186	838,442	824,256
20	2008	27,648	14,186	14,186	937,863	923,677
21	2009	27,648	14,186	14,186	1,037,285	1,023,099
22	2010	0	15,099	15,099	1,136,706	1,121,607
23	2011	0	15,099	15,099	1,236,127	1,221,028
24	2012	0	15,099	15,099	1,335,549	1,320,450
25	2013	23,552	15,099	15,099	1,434,970	1,419,871
26	2014	23,552	15,099	15,099	1,534,392	1,519,293
27	2015	0	15,464	15,464	1,633,813	1,618,349
36	2016	0	15,464	15,464	1,633,813	1,618,349
29	2017	0	15,464	15,464	1,633,813	1,618,349
30	2018	0	15,464	15,464	1,633,813	1,618,349
31	2019	0	15,464	15,464	1,633,813	1,618,349
32	2020	0	15,464	15,464	1,633,813	1,618,349
33	2021	0	15,464	15,464	1,633,813	1,618,349
34	2022	0	15,464	15,464	1,633,813	1,618,349
	TOTAL	710,877	369,439	977,916	26,306,962	25,329,046

ECONOMIC IRR= 32.28%

NET PRESENT VALUE
Disc. at 15%= 818,896

B/C RATIO 4.29

14.6.3 Sensitivity Analysis

1) Sensitivity to Traffic Demand

A lower traffic demand forecast can be used to ensure the economic feasibility of the project tollway. The demand forecast derived from the OD matrix by the present pattern model shows quite slow growth of the tollway traffic, because the model does not incorporate into its formula the factor of reduced time of travel via the proposed tollway.

In order to avoid over stating the economic benefit, tollway traffic volume estimated with the present pattern method was used to examine how the IRR and other evaluation parameters would differ from those calculated previously as a base case.

The total benefit from savings in vehicle travel costs are compared in Table 14.5.1, section 14.5.2.

The analysis result is presented in Table 14.6.2 and it shows that evaluation parameters still maintain a high level of project feasibility, that is, EIRR equals 22.77%, Net Present Value is 262,026 million Rupiah at 1989 constant price and Benefit-Cost ratio is 2.05.

Table 14.6.2 Economic Project Cost and Benefit Streams by Present Pattern Model for 1995, 2005 and 2015

CONSTANT 1989 MILLION RP

YEAR	PROJECT COSTS			BENEFITS	INCREMENTAL PROJECT BENEFIT
	CAPITAL COSTS	O/M COSTS	TOTAL COSTS	TOTAL SAVINGS	
1989	0	0	0	0	0
1990	0	0	0	0	0
1991	3,343	0	3,343	0	-3,343
1992	6,687	0	6,687	0	-6,687
1993	59,144	0	59,144	0	-59,144
1994	80,917	0	80,917	0	-80,917
1995	156,440	0	156,440	0	-156,440
1996	176,940	0	176,940	0	-176,940
1997	125,006	0	125,006	0	-125,006
1998	0	14,186	14,186	111,927	97,741
1999	0	14,186	14,186	128,294	114,108
2000	0	14,186	14,186	144,661	130,475
2001	0	14,186	14,186	161,028	146,842
2002	0	14,186	14,186	177,395	163,209
2003	0	14,186	14,186	193,763	179,577
2004	0	14,186	14,186	210,130	195,944
2005	0	14,186	14,186	226,497	212,311
2006	0	14,186	14,186	287,463	273,277
2007	0	14,186	14,186	348,428	334,242
2008	27,648	14,186	14,186	409,394	395,208
2009	27,648	14,186	14,186	470,360	456,174
2010	0	15,099	15,099	531,326	516,227
2011	0	15,099	15,099	592,291	577,192
2012	0	15,099	15,099	653,257	638,158
2013	23,552	15,099	15,099	714,223	699,124
2014	23,552	15,099	15,099	775,188	760,089
2015	0	15,464	15,464	836,154	820,690
2016	0	15,464	15,464	836,154	820,690
2017	0	15,464	15,464	836,154	820,690
2018	0	15,464	15,464	836,154	820,690
2019	0	15,464	15,464	836,154	820,690
2020	0	15,464	15,464	836,154	820,690
2021	0	15,464	15,464	836,154	820,690
2022	0	15,464	15,464	836,154	820,690
TOTAL	710,877	369,439	977,916	12,824,857	11,846,941

ECONOMIC IRR 22.77%

NET PRESENT VALUE
Disc. at 15% 262,026

B/C RATIO 2.05

2) Sensitivity to Alteration of Benefit and Cost

Assuming that the benefit and cost stream might alter ±10%, ±20% and ±30%, the effect on the economic evaluation parameters was analyzed and the result is summarized in Table 14.6.3.

Table 14.6.3 EIRR by Altered Benefit and Cost

Cost\Benefit	Base	-10%	-20%	-30%
Base	32.28	30.69	29.01	27.20
+10%	30.89	29.39	27.77	26.02
+20%	29.69	28.24	26.67	24.97
+30%	28.62	27.21	25.69	24.03

Even the most severe case of -30% benefit and +30% cost still maintains a high internal rate of return of 24.03%.

According to the above analysis it appears that a percentage increase in the cost has less effect on IRR than a reduction of benefit by the same percentage of negative value.