7.7 Preliminary Pavement Design

7.7.1 General

There are two kind of pavement type, i.e., rigid and flexible pavement. Each type has an own characteristics as shown in Table 7-7-1.

Table 7-7-1 Characteristic of Flexible and Rigid Pavement

	Flexible Pavement	Rigid Pavement
Target design performance period	15 years extendable by stage overlay or project rehabilitation works	20 years
Aspects of deformation and wear	Compared with rigid pavement, there is potential of deformation and rut wear.	Seldom rutted and more wear-proof.
Noise and vibration	Little noise and small vibration	Joints and grooves cause vibration and noise
Brightness of road surface	Weak reflection from road surface	Brighter than flexible pavement in the dark.
Construction aspects	Short construction period enabling early opening to traffic.	1. Generally, the composition of construction machinery is a longer line than that of flexible pavement and causes a longer construction period than that of flexible pavement. 2. It is not customary to pave bridges and viaducts with rigid pavement. 3. The curing period and/or construction of joints may cause delays on opening to traffic.
Maintenance works	Easy maintenance work by simple maintenance methods.	Maintenance is seldom necessary expect when placed on soft ground areas where sub-grade or sub-base are damaged by consolidation or sliding and large scale maintenance becomes necessary.
Construction cost and maintenance cost	Initially cheaper construction cost plus frequent maintenance costs over 20 years period may result in the same level as normal rigid pavement.	Initially higher construction cost plus usually cheaper maintenance cost. It may be liable to huge re-construction cost as described above.

For Tawaeli-Toboli road, flexible pavement (asphalt concrete surface) is proposed as bitumen is widely available in Sulawesi.

The pavement layers and thickness should be determined based on the following factors governing the design (flexible pavement design):

- Traffic
- Strength of sub-grade and
- Construction materials adopted to the pavement layers.

In most of the prevailing pavement design guides, traffic is expressed in terms of the cumulative single axle load of 8200 kg (18-kip), over the design life of the road. The number of equivalent axles is computed mainly based on the number of commercial vehicles, in particular, heavy vehicles such as buses and trucks.

A value of 2.5 for truck factor has been applied for the computation of comulative 18-kip equivalent single axle loads (ESAL). In case of bus factor, 0.6 has been used for the computation.

The strength of sub-grade will govern the thickness design of pavement. Commonly the strength is expressed by California Bearing Ratio (CBR) value determined by the laboratory testing. A CBR value of 5.0 to 6.0% is adopted in the computation of pavement thickness.

There are three types of materials suitable for the base course, i.e., asphalt treated, cement treated and graded crushed-stone base course. Asphalt treated base course is applied in this study. River gravel is usually used for the sub-base course.

For the pavement surface, asphalt pavement is employed for the pavement design.

7.7.2 Pavement Design

Based on the above discussion, ASSHTO (1986) and Japan Road Association standards have been used for design of the thickness of the pavement layers. The design condition is indicated as follows:

AASHTO standards

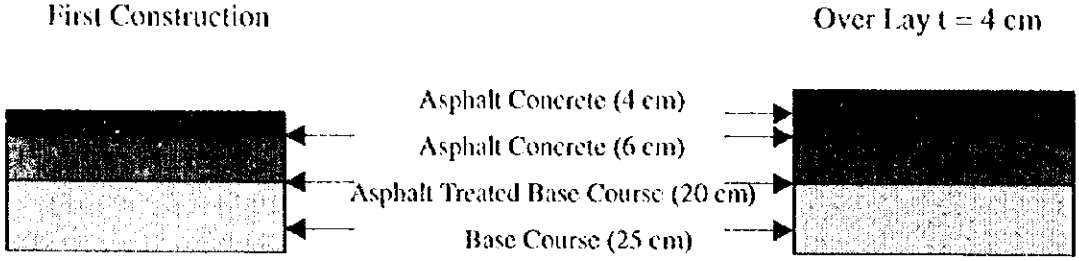
- Design life : 20 years
- Regional factor : 2.0
- Terminal serviceability index : 2.5
- Truck factor : 2.5

- Bus factor : 0.6
- CBR of sub-grade : 5.0 to 6.0 %
- Cumulative 18-kip equivalent Single axle loads : 13.9 x 10^6

Calculation of SN

SN = 10 cm/2.54 x 0.44 + 20 cm/2.54 x 0.31 + 25/2.54 x 0.11
= 5.26 > 5.2 OK

Stage construction will be required as shown below :



Japan Road Association standards

Condition : CBR 6%
: C traffic
: TA = 28

TA = 1 x 10 cm + 0.8 x 20 + 0.25 x 25 = 32.25 > 28 OK

Chapter 8
Environmental Study

Chapter 8 ENVIRONMENTAL STUDY

8.1 Initial Environmental Examination

8.1.1 Environmental Examination Matrix

The objectives of the initial environmental examination (IEE) are to examine any possible impacts on the environment when the project proposed in Tawaeli-Toboli road is implemented, and to identify the environmental elements on which significant impacts are anticipated. The IEE of Tawaeli-Toboli road was conducted, based on IEE result carried out in the master plan of this study which deals with Central and Southeast Sulawesi, by using an environmental examination matrix (Table 8-1-1) with its vertical axis consisting of rows for environmental elements grouped in three categories: i.e. social environment, natural environment and environmental pollution, and horizontal axis consisting of columns of project activities; i.e. pre-construction stage, construction stage and post-construction stage.

The environmental elements are those specified in JICA Environmental Guidelines for Road Engineering, as shown in Table 8-1-1. Three kinds of marks are used to identify the extent of impact of each project activity on each environmental item according to an analysis of environmental conditions at the project site. As a result, significant negative impact was identified on two environmental elements, and possible negative impact was envisaged on ten environmental elements from some project activities. The following paragraphs give the rationale.

8.1.2 Environmental Consideration for EIA Study

(1) Social Environment

1) Resettlement, Economic Activity and Traffic & Public Facilities

It is predicted that the project implementation may require a temporary and/or permanent resettlement program for a number of residences and some small-scale public facilities. However, scale of resettlement program will be small, as houses are located mainly at the valley side of Tawaeli-Toboli road.

Along the new road construction area of the Project, economic activities of regional peoples, such as vegetable farming, coffee plantation, etc. will be affected by the project activity.

During the construction stage, a large number of vehicles will be deployed. This may more or less influence the traffic condition of Tawaeli-Toboli road and the roads leading to the project site.

2) Nature Reserves

Tawaeli-Toboli road passes through the Pangi Binanga Nature Reserve. Some necessary measures will be taken into consideration for the project implementation.

3) Solid Waste

The construction work for road improvement, especially cut slopes and tunnel construction, will result in generating large quantities of solid waste (surplus soil). Its transportation and final disposal must be carafully planned.

4) Hazards (Risk)

Potentially hazardous area in the project site, especially concerning landslides, are to be carefully investigated and necessary measures taken in construction and pre-construction stages of the project.

(2) Natural Environment

1) Topography/Geography and Soil Erosion

Project site is located in a mountainous area. Implementation of Tawaeli-Toboli road may involve large scale excavation and banking of earth. Its impact on topography, geography and soil erosion should be further investigated.

2) Groundwater and Hydrological Situation

During the construction and post-construction stages of the tunnel works, groundwater is the environmental element on which impact is anticipated. Hydro-geological consideration will be necessary for an assessment of this impact.

Impacts on hydrological situation of the project area by the bridge construction will be taken into consideration.

3) Flora and Fauna

Some endemic flora and fauna may be observed in the project area. Depending on the scale of impact from the project implementation, proper countermeasures will be taken into consideration for their protection.

(3) Environmental Pollution

1) Noise and Vibration

Noise and vibration from construction machinery and vehicles may more or less affect the life of residents near the construction site and/or transportation road.

2) Other Environmental Pollution Elements

Regarding other environmental pollution elements; i.e., air and water pollution, soil contamination, land subsidence and offensive odor, no significant negative impacts are anticipated from any of the project activities, taking into consideration of contents of the project and its scale; i.e. lower traffic volume in the study area, no toxic substances produced, no groundwater pumping, etc. Therefore, these elements will not be considered in the environmental impact assessment to be conducted for the project.

Table 8-1-1 Environmental Examination Matrix

Major Facilities/Activities			Road / Roadside Facilities / Road Construction			
Environmental Items			Overall Evaluation	Pre-construction stage	Construction stage	Post-Construction stage
Social Environment	1	Resettlement	X	X		X
	2	Economic Activity	X	X		X
	3	Traffic and Public Facility	X		X	X
	4	Split of Communities				
	5	Cultural Property				
	6	Nature Reserves	X	X	X	X
	7	Public Health Condition				
	8	Waste	X		X	
	9	Hazards (Risk)	XX	XX	XX	
Natural Environment	10	Topography and Geology	X		X	
	11	Soil Erosion	XX		XX	XX
	12	Groundwater	X		X	X
	13	Hydrological Situation	X		X	
	14	Coastal Zone				
	15	Fauna and Flora	X	X	X	X
	16	Meteorology				
	17	Landscape				
Pollution	18	Air Pollution				
	19	Water Pollution				
	20	Soil Contamination				
	21	Noise and Vibration	X		X	
	22	Land Subsidence				
	23	Offensive Odor				

Source: Study Team

Note XX: The environmental items to which special attention has to be paid. Such may cause serious impact that may affect the project formulation depending on the magnitude of the impact and the possibility of the measures.

X: The environmental items which may have a significant impact depending on the scale of the project and site conditions.

No mark: The environmental items requiring to impact assessment since the anticipated impacts are, in general, not significant.

8.2 Environmental Impact Assessment

8.2.1 Objectives and Guidelines

(1) Objectives

The objectives of the environmental impact assessment (EIA) for Tawaeli-Toboli road are as follows:

- To understand the present condition of the environment in the project area
- To identify the particular activities of the project which may induce significant impact on the environment
- To predict the environmental impacts and evaluate their magnitudes
- To propose countermeasures for a mitigation of the envisaged negative impacts
- To formulate plans for environmental management and monitoring

(2) Guidelines

The EIA basically follows the Indonesian environmental regulations with reference to JICA and OECF environmental guidelines. The main regulations/guidelines applied include the follows:

- Regulation of the Ministry of Public Works, No. 69/PRT/1995 Concerning the Technical Guidelines of Environmental Impact Analysis (AMDAL) for the Public Works Projects

- Decree of the Ministry of Public Works, No. 40/KPTS/1997 Concerning the Technical Guidance of Environmental Impact Assessment (EIA) for Road Projects

- Decree of the Ministry of Public Works, No. 148/KPTS/1995 Concerning the Guidance of Environmental Management Plan (RKL) and Environmental Monitoring Plan (RPL)

- Japan International Cooperation Agency (JICA), Environmental Guidelines for Infrastructure Projects, III. Roads (1992)

- The Overseas Economic Cooperation Fund (OECF), Environmental Consideration Guidelines (1996)

8.2.2 Scope of Works

(1) Project Activities

The EIA study covers all the project activities to be involved in the implementation of

Tawaeli-Toboli road in Central Sulawesi. In general, the project will consist of three stages, namely pre-construction, construction and post-construction. The project activities of each stage can be summarized as follow:

1) Pre-construction stage

- Sectional and longitudinal survey, terrestrial mapping
- Inventory of land, houses and other properties, traffic and public facilities in the project area
- Land acquisition and compensation
- Resettlement of inhabitants

2) Construction stage

a) Preparation

- Mobilization of labor
- Introduction of construction machinery and equipment
- Preparation of access road
- Construction of site office/base camp

b) Construction

- Land clearing and stripping
- Transport of machinery and construction materials
- Earth works (excavation and filling)
- Road, bridge and tunnel construction
- Surplus soil disposal

3) Post-construction stage

a) Road operation
b) Road maintenance

(2) Environmental Elements

The environmental elements for the Environmental Impact Assessment (EIA) study are shown in Table 8-2-1. These elements were identified by the initial environmental examination (IEE) conducted in the Master Plan Study as items on which significant or possible negative impacts are envisaged from the above-mentioned project activities.

With regards to environmental pollution elements, taking into consideration of the contents of the project and its scale; i.e., lower traffic volume in the study area, no toxic substances produced, no groundwater pumping, etc.; no significant negative impacts are anticipated from any of the project activities, except noise and vibration. Noise and

vibration will occur, especially during construction stages, by the use of construction devices and vehicles. Therefore, noise and vibration as environmental pollution will be considered as the environmental element for EIA to be conducted for the project.

Table 8-2-1 Environment Elements for EIA

Social Environment	Natural Environment	Environmental Pollution
- Resettlement - Economic Activity - Traffic & Public Facilities - Nature Reserves - Solid Waste (Surplus Soil) - Hazards (Risk)	-Topography & Geography - Soil Erosion - Groundwater - Hydrological Situation - Flora & Fauna - Landscape	- Noise & vibration

Source: Study Team

(3) The Relation to Other Activities

The implementation of the Tawaeli - Toboli Road development has a relation to other regional development, including :

- Transmigration Activities (Department of Transmigration / PPH)

  Residents around the Tawaeli-Toboli road section, particularly in the coffee plantation area, will be effected by the resettlement of certain people to the transmigration locations of UPT Baliyara, Sangira and Malino.

- Forest Conservation Activities / Ministry of Forestry

  Along the Tawaeli-Toboli road section there is limited forestry, a protected forest and the Pangi-Binangga Nature Sanctuary.

8.2.3 Summary of Project Description

(1) Objective and Benefit of the Project

1) Objective

The objective of improvement and development of Tawaeli - Toboli Road is to provide road infrastructure to support acceleration of transportation of goods and services in Satuan Wilayah Pengembangan Sulawesi, covering mainly Central Sulawesi, Southeast Sulawesi, and some regions in South Sulawesi. The Tawaeli - Toboli Road development and improvement will increase the economic and social activities of the people of Sulawesi.

2) Project benefit

The benefit of the improvement and development of the Tawaeli - Toboli Road, concurrently with Trans Sulawesi road which connects the road systems in North, Central and South Sulawesi, is the improvement of the development growth in Central Sulawesi and the enhancement of economic growth in that region.

(2) Component and Dimension of the Project

1) Location

The Tawaeli-Toboli Road is located in north of Palu, the capital of Central Sulawesi Province, at 0.4° - 0.5° south latitude. The location of the activities of the Tawaeli - Toboli Road development project is at Kotamadya Daerah Tk.II Palu and Kabupaten Daerah Tk.II Donggala in Daerah Tk.I Central Sulawesi Province.

2) Project Plan

The Tawaeli-Toboli Road Development Project is one component of the Road Network System Project in Daerah Tk.I Central Sulawesi Province and Daerah Tk.I Southeast Sulawesi Province, the study of which is now in progress.

The study of the road system in Central Sulawesi and Southeast Sulawesi, which has been conducted by Ditjen Bina Marga, the Ministry of Public Works is planned to be completed by the end of September 1998. Objectives of the Study are as follows;

- To prepare the Master Plan (target year :2018) of the road network system about primary arterial and collector roads including the potential candidate of those road s in Central Sulawesi Province, Southeast Sulawesi Province, and in someparts of South Sulawesi Province adjacent to the two provinces.

- To select priority road links to carry out feasibility study on the selected road links.

3) Description

The determination of route options for Tawaeli-Toboli road was completed by June 1997, with one preferred option among the alternative options. A brief description of the Project of Tawaeli - Toboli Road is shown as follows and in Fig.8-2-1. Tawaeli - Toboli Road is planned to be in operation by the year 2002 and to have a life span of 20 years.

- This alternative covers a new alignment 12.5 km long in the south and makes use of the existing alignment from 8.5 km to 22 km of Tawaeli. After 22 km, the alignment is the same as Alternative B, including development of a tunnel 650 m in length.
- The route length is 41.35 km section requiring new road construction section is

about 12.72 km in length.
- Tunnel (650 m), Bridge (840 m) and Slope protection(247,470 m^2)
- The area that is most susceptible to natural hazards on the Tawaeli side is avoided by a bypass route.
- Cost estimation is Rp.122,133 million as of June 1997.

8.2.4 Existing Environmental Conditions

(1) Natural Environment

1) Meteorology

Central Sulawesi is located in the tropics, therefore, in general, rainfall intensity of this region is rather high. However, mountains oriented in a north-south direction create a rain shadow for virtually the whole year. Because of the sheltered nature of the central part of the west coast, Palu valley is one of the driest areas in Indonesia. As shown in Table 8-2-2, rainfall in Tawaeli (located in west coast of the peninsula) is rather small compare with that of in Parigi (located in east coast of the peninsula). Here, the west part of Tawaeli-Toboli road is located in Kec. Palu Utara & Kec. Tawaeli and east part of in Kec. Parigi.

Table 8-2-2 Rainfall in Tawaeli and Parigi in 1995 and 1996

Month	Tawaeli				Parigi			
	1995		1996		1995		1996	
	Rainy days	Rainfall (mm)	Rainy Days	Rainfall (mm)	Rainy Days	Rainfall (mm)	Rainy days	Rainfall (mm)
January	11	60	12	227	6	31	13	10
February	10	53	9	270	13	85	13	193
March	14	76	14	212	23	149	17	614
April	12	59	4	129	11	131	14	185
May	16	118	11	134	15	8	17	150
June	11	92	2	76	19	386	22	204
July	11	121	5	105	17	175	18	263
August	8	33	3	57	25	340	25	405
September	1	1	4	96	20	163	14	152
October	3	21	12	288	11	140	20	250
November	6	25	8	213	16	97	14	82
December	8	56	9	144	8	88	15	215
Total	111	715	193	1,951	184	1,793	202	2,723

Source : Tawaeli : BPP Lubuan 1995, Parigi : Dinas Pertanian Kecamatan Parigi 1995

As is general in the tropics, fluctuation of temperature throughout the year is small. Table 8-2-3 shows average temperature by months in the study area.

Table 8-2-3 Average Temperature in the study area of 1993 - 1995

Month	1993			1994			1995		
	Min	Max	Average	Min	Max	Averag e	Min	Max	Averag e
January	23.0	32.8	26.7	22.0	34.6	27.1	22.2	35.5	26.7
February	23.0	31.3	26.2	21.6	35.0	26.9	22.0	35.4	25.5
March	23.3	33.1	27.0	21.4	34.4	26.1	21.0	35.2	26.6
April	23.3	32.9	27.1	22.0	35.2	26.8	22.0	35.8	27.4
May	23.5	33.2	27.5	21.8	34.2	26.5	22.3	34.7	27.1
June	23.7	33.4	27.2	22.0	33.7	26.3	22.5	35.2	26.7
July	23.4	33.3	27.0	21.0	33.7	26.3	21.0	34.2	26.0
August	22.7	34.1	27.3	21.2	35.0	26.9	22.2	32.4	25.9
September	23.5	33.7	27.8	21.7	36.0	27.3	22.2	33.9	26.6
October	23.7	34.5	27.1	22.0	36.4	28.1	22.4	35.4	26.9
November	24.3	35.0	26.7	22.0	36.0	28.0	21.4	34.8	26.6
December	23.4	33.6	28.0	22.1	33.8	26.4	21.2	34.2	25.9
Average	23.4	33.4	27.1	21.7	34.8	26.8	21.8	34.7	26.4

Source : Mutiara Meteorological Station, Palu

2) Topography

Tawaeli-Toboli road crosses the peninsula over high mountains, the highest point being approximately. 1,000m. Most part of the road is situated along steep slopes. Tawaeli, on the west side of the road, faces the Makassar Sea and Toboli, on the east end of the road, faces Tomini Bay.

The details of topographic features of the study area have already been described in Chapter 2, Section 2.1 of this report and will not be reported in this section.

3) Geology

The study area, Tawaeli-Toboli region, consists of three geological formations; namely, Alluvium, Celebes and Metamorphic Rock formations. Surmised characteristics concerning these three formations are shown in Table 8-2-4.

Table 8-2-4 Characteristics of Geological Formations in Tawaeli-Toboli Region

Age	Formation	Geology	Note
Holocene	Alluvium	Unconsolidated sand Clay, gravel.	Alluvium is distributed in the low plane near Tawaeli and Toboli.
Miocene	Celebes	Sandstone, Conglomerate, Mud-stone	This formation is loosely consolidated and classified as material between soil and soft rock in properties.
Palaeogene Period	Metamorphic Rock	Schist Gneiss	Schist is distributed in Tawaeli side, gneiss is distributed in Toboli side.

Source : Tawaeli - Toboli road feasibility study, 1997.

The details of geological features of Alluvium, Celebes and Metamorphic Rocks formations have already been described in Chapter 2, Section 2.4 of this report,

therefore they will not be included in this section.

4) Soil Erosion

As most of the Tawaeli-Toboli road passes through high mountains with steep slopes, many cases of soil erosion/landslide have occurred here.

Recently, landslide heve been experoenced at three places along Tawaeli-Toboli road; at points of 37 km, 40 km and 46 km east from Tawaeli. As a result heavy rain, schist rock of the slopes collapsed, and cut off road traffic, according to government officials in Palu. Meanwhile, a large scale of fracture zone can be observed at a point of 35 km east of Tawaeli. This area mainly consists of schist rock.

In general, landslides take place more frequently in places/slopes consisting of schist rock. On the schist rock slopes, rock cracks tend to be created and develop with relative ease and following heavy rain the slopes may start to collapse and slide.

Table 8-2-5 shows potential area for soil erosion in Kabupaten DT. II Donggala, Central Sulawesi.

Table 8-2-5 Potential Area for Soil Erosion in Kabupaten DT II Donggala

No.	Villages	Area (ha)	Percentage (%)
1	Kec. Kulalwi	23,184	6.69
2	Kec. Dolo	31,680	9.14
3	Kec. Sigi Biromaru	52,560	15.17
4	Kec. Parigi	4,032	1.16
5	Kec. Marawola	59,184	17.08
6	Kec. Banawa	35,424	10.22
7	Kec. Tawaeli	10,224	2.95
8	Kec. Ampibabo	34,272	9.89
9	Kec. Sindue	8,208	2.37
10	Kec. Sirenja	288	0.08
11	Kec. Balaesang	16,488	4.76
12	Kec. Dampelas Sojol	30,960	8.93
13	Kec. Tinombo	8,208	2.37
14	Kec. Tomini	11,088	3.20
15	Kec. Moutong	12,096	3.49
16	Kec. Palu Timur	5,328	1.54
17	Kec. Palu Barat	3,312	0.96
	Total	346,536	100.00

Source : Data Pokok Untuk Pembangunan Daerah Kabupaten DT II Donggala, tahun 1990

5) Hydrological Situations

There are three rivers flowing through the study area, including Nopabomba river in Kecamatan Tawaeli, Kuala Satubai river and Kuala Toboli river in Kecamatan Parigi. The length of Nopabomba river is about 85 km and its flow rate is between 1.5 m^3/sec and 10 m^3/sec. Nopabomba river plays the role of domestic water source mainly for the

people of Kecamatan Tawaeli. More details of hydrological situations/river systems of the study area are described in Chapter 2, Section 2.1 of this report.

There is almost no data available regarding groundwater which relates to the construction of tunnel.

6) Natural Hazard (Earthquake)

Earthquakes are observed frequently in Sulawesi. Table 8-2-6 shows the number of earthquakes occurring in Central Sulawesi between the years 1993 and 1995. Earthquakes with the magnitude of greater than 4 are less than 20% of the total, and more than 80% are small ones of which are indetectable to humans. More details of seismology in the study area are described in Chapter 2, Section 2.3 of this report.

Table 8-2-6 Earthquake Data in Central Sulawesi

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	322	574	403	633	1184	788	365	505	340	358	442	353
1994	370	218	283	254	297	314	359	320	344	539	348	470
1993	359	158	170	150	180	204	147	116	155	80	610	397
Average	350	317	285	346	554	435	290	314	280	326	467	407

Source: Mining Office in Palu

7) Fauna and Flora

Sulawesi comprises an area of 159,000 km^2 and has a coastline of approx. 6,000 km. The indonesian archipelag is inhabited by two distinct sets of wildlife. Contrary to Sumatra, Java and Borneo which were connected to the South Asian mainland during the last ice-age, some 10,000 years ago, Sulawesi has never been connected to any great land area. "Wallace's Line" is drawn between Bali and Lombok and between Borneo and Sulawesi. Sulawesi's isolated position lead to the development of an unique fauna. 98% of the Sulawesian mammals are endemic, while 89 of 247 known birds species on Sulawesi are not found anywhere else.

Topographically, Sulawesi is very mountainous. Most of the island lies above 500 meters, and one-fifth lies above the 1,000 meter from mean sea-level. Forest types on the island reflect the geological diversity. Tropical rain-forest is fund on volcanic soil. The limestone and basic grounds are poor, therefore, its trees won't become as tall as in the rain-forest. Both, limestone and basic mountain areas have their own characteristics flora.

A regulating use and trade of wildlife has attempted by signing CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) in 1979. The two main executing body of CITES in Indonesia are Directorate General of Forest Protection and Nature Conservation (PHPA) in the Ministry of Forestry and National Institute of Sciences (LIPI).

Existing Tawaeli - Toboli road cross a nature reserve area named "Pangi - Binangga Nature Reserve", a protected forest area, and HPH (concession) area. However, the study area is composed of secondary forest, and it can be said that the quality of its ecosystem and diversity of the fauna and flora are relatively low.

a) Fauna

Many of the mammals in Sulawesi, including tarsiers, monkeys, deer, civets and pigs are of Asian origin. The two species of *cuscus*, one endemic are marsupial phalangers with close cousins in Australia. The island, because of its long isolation, has other curious animals uniquely its own - *babirusa*, an aberrant pig; *anoa*, smallest of all known buffalo; and *heavy-set black apes* which are not apes at all but monkeys closely related to the pig-tailed macaques of South-East Asia. Although Sulawesi has a somewhat impoverished mammal fauna, it has a rich avifauna made up of both Oriental and Australian families - *hornbills, drongos, babblers, sunbirds* and *maleo* bird. (Source: Indonesian publish).

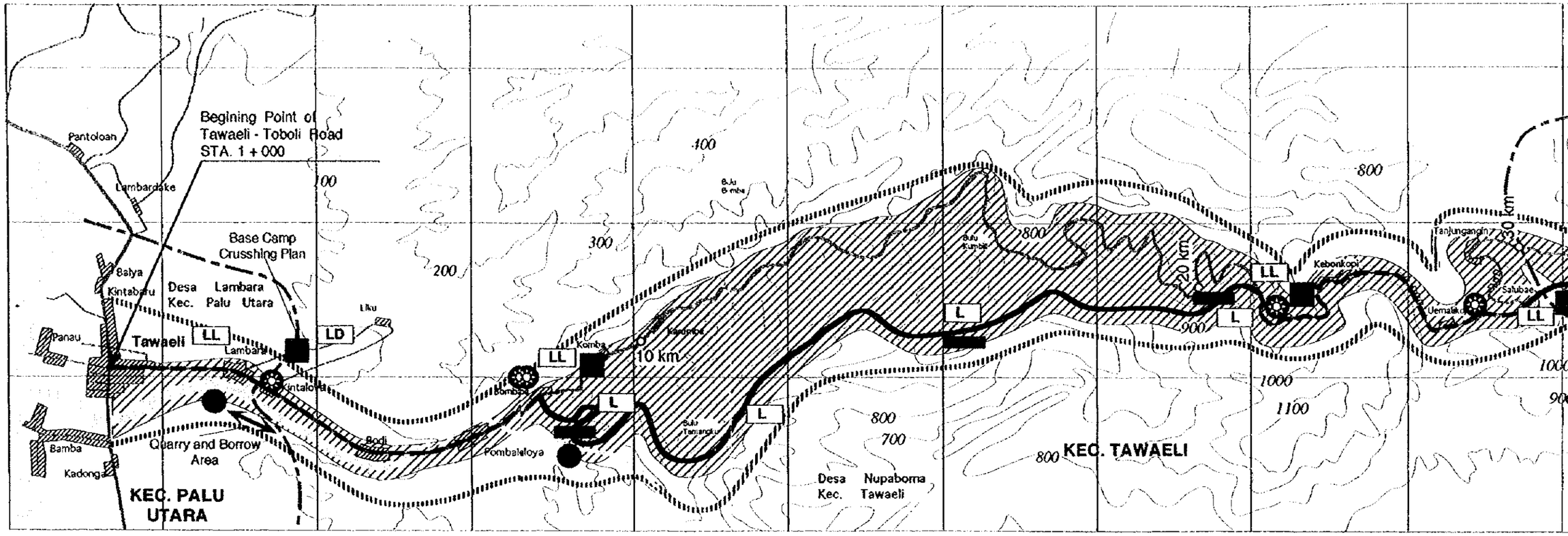
An observation survey on fauna was carried out at five locations along the Tawaeli - Toboli road plan; i.e. Tawaeli settlement area, limited forestry area, protected forest area, Pangi-Binangga Nature Reserve area and Toboli settlement area. Siting in each area are shown in Fig. 8-2-1.

Characteristics of fauna in each area of Tawaeli-Toboli Road are described in the followings:

- Tawaeli Settlement Area
  The altitude of Tawaeli settled area is between 5m and 200m above sea level. The fauna existing in this area consists of domestic animals such as cattle, cows (*Bos sp.*), goats (*Capricorhlis*), dogs (*Canis sp.*), poultry etc. Endemic wild fauna is not found in this area.

- Limited Forestry Area (HPT: Hutan Produksi Terbatas)
  Some groups of black apes (cynopithecus niger) have been observed on the road side between 16km to 21km east from Tawaeli. Besides the black ape, rangkong/lupi (*Renticeros cassidix*), raja udang biru bakako (*Halcyon chloris*), elang hitam/lope (*Iintinaetus melayensis*) (*Falco Molucensis*), puyuh/rombo (*Turnix sp.*), ayam hutan/lingga kayu (*Gallus gallus*), togou (*Ducula aenea*) and (*Ducula forsteni*) have also been observed.

  As a result of the interview survey, it is found that endemic fauna; i.e. anoa (*Bubalus depresicornis*), babi rusa (*Babyrousa babirussa*), tersier (*Tarsius spectrum*) and kuskus (*Phalanger ursinus*), are still existing in this area and also in protected forest area.



LEGEND :

a. Land Use

b. Air Quality and Noise Level

c. Water Quality

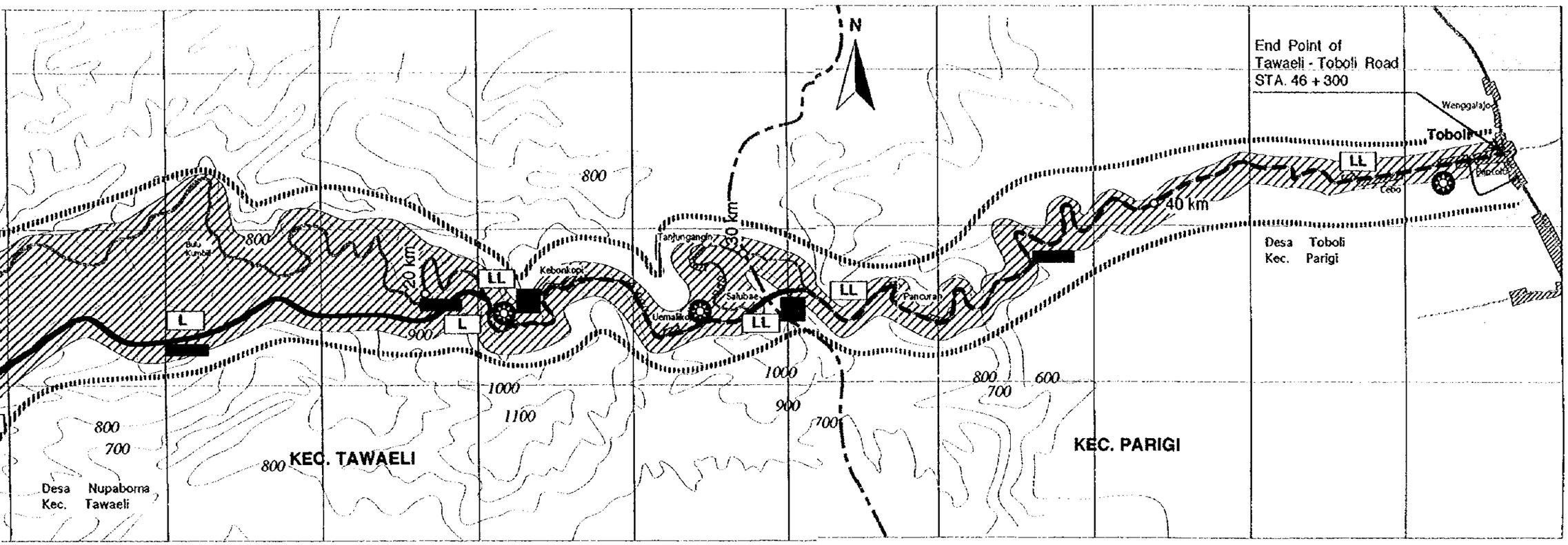
d. Landslide — L

e. Flora & Fauna

f. Traffic — LL

g. Domestic Waste — LD

h. Public Perception



LEGEND :

a. Land Use
b. Air Quality and Noise Level
c. Water Quality
d. Landslide
e. Flora & Fauna
f. Traffic
g. Domestic Waste
h. Public Perception

Existing Road
Road Development Plan
Road Improvment Plan
Tunnel
Kecamatan Boundary

Ecologi Boundary
Project Boundary
Study Area Boundary

0 1 2 4 km

Figure 8-2-1 SAMPLING LOCATION

Recently, numbers of the above-noted species of endemic fauna have declined, due to disruption of habitat by the residents' activities, such as dry land cultivation, illegal plantation and traditional activities of Hak Pengusahaan Hutan (HPH : concession). In order to prevent these activities, especially in coffee plantation area, the Governor of Central Sulawesi has issued a Decree Number: 522/403/1995 concerning the formation of an integrated team to manage the coffee plantation area and its surroundings.

- Protected Forest Area

  Protected forest area consists of old secondary forest and primary forest, with an altitude between 500m and 1,100m above mean sea level. Species of wild fauna found in this area are not so different from the species at the limited production forest area. Species which have been observed on the road sides in this area are monyet jambul (*Macaca tonkeana*) as one of the endemic fauna in Sulawesi, enggang (Remificeros cassidix), elang kecil (*Falleo molucensis*), ayam hutan (Gallus gallus), molo/bubut (*Centropus bengalensis*), batutu (*Mulleripicus fulvus*), rectar cater (*Meropogon forsteni*), insectivore (*Fiadula rufigola*) and burung golkar (*Oriolus chinensis*).

  Besides the above noted species, as a result of the interview survey, it can be said that there exist babi rusa (Babyrousa babirussa), anoa (*Bobalus depresicornis*), Musang coklat (*Macrogalidia muschenbroekii*), kus kus (Phalanger ursinus), biawak/giba (*Varanus salvator*), kura-kura / bantiluhu, tupai / kaisisi, maleo (Macrocephalon maleo), kakatua putih (*Cacatua sulphurea*), babi hutan (*Sus vitatus*) and rusa (*cervas timoreusis*). According to the residents, these species are hardly seen as numbers have declined dramatically in recent years. The exploitation of the forest, dry land cultivation, etc., may be causing the decline, according to the residents.

- Pangi-Binangga Nature Reserve Area
  Pangi-Binangga Nature Reserve is crossed by the Tawaeli-Toboli road for about 3 km in length, specifically from 38 km to 41 km from Tawaeli.

  The total area of the Pangi-Binangga Nature Reserve is 6,000 hectare and settled for the purpose of ebony (*Diospyros celebica*) protection.

  At the road sides around the nature reserve, monyet jambul (*Macaca tonkeana*), rangkong (*Penelopides exaratus*), burung gagap (*Corvus euca*), elang (*Pernis celebensis*) and kum-kum (*Ducula bicolor*) have been observed. Based on interviews with the local people, it is found that a lot of babirusa (Babyrousa babirussa), babi (*Sus vitarus*), musang coklat (*Marcrogalidia musschenbroekii*), kus-kus (*Phalanger ursinus*), Anoa (*Bubalus depresicornis*) and rusa (*Cervus timorensis*) can be found in this area.

- Toboli Settlement Area
  Endemic wild fauna is not found in this area.

Table 8-2-7 shows the results of fauna inventory survey along Tawaeli-Toboli road.

Table 8-2-7 Fauna in Taweali-Toboli Road Area (1/2)

No.	Indonesian/Local Names	Common Names	Scientific Names	Status	Location				
					PT	HPT	HL	CA	PTB
A.	Mamalia								
1	Anoa	Anoa	*Bubalus depresicornis*	Endemic	-	X	X	X	-
2	Babi Hutan/Fafu	Pig	*Sus vitatus*		-	X	X	X	-
3	Babi Rusa	Baby russa/pig deer	*Babyroussa babirusa*	Endemic	-	X	X	X	-
4	Kus-Kus	-	*Phalanger ursinur*	Protected	-	X	X	X	-
5	Musang Sulawesi	Celebes Palm Civet	*Macrogalidia musschenbroeki*	Endemic	-	X	X	X	-
6	Monyet Hitam Sulawesi	Crested Celebes Macaque	*Cynopinhecus niger*	Protected	-	X	X	X	-
7	Monyet Hitam Sulawesi	Celebes Macaque	*Macaca hecki*		-	X	X	X	-
8	Monyet Jambul/Digo	Tonkean Macaque	*Macaca tonkeana*	Endemic	-	X	X	X	-
9	Rusa	Deer	*Cervus timorensis*		-	X	X	X	-
10	Loris	-	*Loriscus insignis*	Protected	-	X	X	X	-
11	Binatang Hantu	Western Tarsier	*Tarsies spectrum*	Endemic	-	X	X	X	-
B.	Aves								
1	Ayam hutan		*Galus galus*		-	X	X	X	-
2	Bayan	Ornate Lorikeet	*Trichoglossus ornatus*	Endemic	-	X	X	X	-
3	Burung Gagap	Crow	*Cervus enca*		-	X	X	X	-
4	Elang	Barret Honey-Buzzard	*Permis celebensis*	Endemic	-	X	X	X	X
5	Elang	Spotted Kerstrel	*Falco molucensis*		X	X	X	X	X
6	Kakatua Putih	Yellow-Crested Cockatoo	*Cacatua sulphurea*	Endemic	-	X	X	X	-
7	Kum Kum	Pied Imperial Pigeon	*Ducula bicolor*		-	X	X	X	-
8	Maleo	Maleo	*Macrocephalon maleo*	Endemic	-	X	X	X	-
9	Nuri Kecil	Tiny Hanging-Parrot	*Loriculus exilis*		-	X	X	X	-
10	Burung Madu	Olive-Backed Sunbird	*Nectarinia jugularis*	Protected	-	X	X	X	-
11	Rangkong	Knobbed Hornbill	*Rhitioros cassidix*	Protected	-	X	X	X	-
12	Rangkong	Sulawesi Hornbill	*Penelopides exarhatus*	Protected	-	X	X	X	-
13	Pelatuk/Batutu	Sulawesi Woodpecker	*Rentrocopos temminkii*		-	X	X	X	-
14	Raja Udang Biru/Bakaka	Collared King Fisher	*Halcyon chloris*	Protected	X	X	X	X	-

Table 8-2-7 Fauna in Taweali-Toboli Road Area (2/2)

No.	Indonesian/Local Names	Common Name	Scientific Names	Status	Location				
					PT	HPT	HL	CA	PTB
15	Puyuh/Rombo	Buff-Banded Rail	*Gallirallus philippinensis*		-	X	X	X	-
16	Togon	Red Collared Dove	*Streptopelia tranquebarica*		-	X	X	X	-
17	Bubut Imolo	Lesser Coucal	*Centropus bengalensis*		-	X	X	X	-
18	Batutu	Asny Wood pecker	*Mulleripicus folvus*		X	X	X	X	-
19	Kepodang/Burung Golkar	Black-raped oriole	*Oriolus chinensis*		-	X	X	X	-
20	Pipit Ironeh	Scaly-Brested Monia	*Lonchura punctulata*		X	X	X	X	X
21	Burung Hantu (poah)	Sulawesi Owl	*Tito alba*		-	X	X	X	-
C.	**Reptilia**								
1	Kadal	-	*Mabvia multifasciata*		X	X	X	X	X
2	Biawak/Giba	- Lizard	*Varanus Salvator*		X	X	X	X	-
3	Kura-Kura/Bantiluhu	- Turtle	-		-	X	X	X	-
4	Ular/Uleh Sawa	- Snake	*Phyton molorus*	Protected	-	X	X	X	-
5	Ular Sendok	- Snake	*Naja Sp*		X	X	X	X	-

Source : Inventory on July 1997

Notice :

PT	Tawaeli settlement
HPT	Limited production forest
HL	Protected forest
CA	Nature sanctuaries
PTB	Toboli settlement

b) Flora

In flora composition, the forests of Sulawesi are similar to Maluku and the Lesser Sundas, with many species in common. Sulawesi has few endemic plant species of its own, and is greatly impoverished in flora richness when compared with neighboring Borneo. The flora is clearly Malaysian, however, with few Australian forms except in the pockets of high mountain flora. Many of the forests in Sulawesi are characterized by an abundance of palm, and this family can be used as a good indicator of flora type.

In dry coastal areas, *Corypha* palms predominate, on lowland sandy soils the beautiful fan-palm *Livistona rotundifolia* is common colonizer of wetter upland forests. *Delicate Pinanga* and *Areca* palms occur throughout the mountain forest, and everywhere rattans, *Calamus*, and *Caryota* palms are abundant. Meanwhile, some excellent timber trees are found in Sulawesi, including riverine stands of beautiful *Eucalyptus deglupta*.

Sulawesi is famed for its many fine orchids such as *Grammatophyllum sp., Phallanopsis amabilis* and *Vanda celebica*. (Source: National Conservation Plan for Indonesia, 1995).

Characteristics of flora in each area of Tawaeli-Toboli Road are described in the followings.

- Tawaeli Settlement Area
  Coconut plantation (*Cocos mucifera*) is dominant in this area to product a raw material for the coconut-oil industry. Meanwhile, in the dry land, food crops and vegetables; namely corn (*Zea mays*), cassava (*Manihot utilisima*), peanut (*Arackys hypogea*) etc. are planted. No protected flora is found in this area.

- Limited Production Forest Area
  - Composition of Species: Flora species in this area consist of seedling, stake, pole and trees dominated by non-commercial species. The dominant species based on IVI in this area is Kayu Oley (*Alstonia macrophylla wall ex G. Don*) with Ivi : 86.37, at the tree level, Pangi (*Pangium edule reinw*) with IVI: 122.65 at the pole level, mako putih (*Syzygium sp.*) with IVI : 56.756 at the stake level and Mako (*Syzygium sp.*) with IVI : 65.45 at seedling level.
  - Dominance of Species: At seedling level, the dominant species are Mako (20.00%), Tali duri (20.00%) and Pala hutan (13.33%). At stake level, the dominant species are Mako putih (30.56%), Buluh suling (22.22%) and Rotan (16.67%). At pole level, the dominant species are Pangi (45.38%), Andolia (30.25%) and Ganemon (10.08%). While at the trees level, the dominant species are Kayu Oley (32.36%), Poli kuning (26.21%) and Kume (12.94%).
  - Stability of Vegetation Community (Diversity of Species): The stability of the vegetation community, regarding to the value of diversity of species, from the seedling level up to trees level, is not so good with the value of below 3. This condition shows that the community at the seedling level up to the tree level is less stable.

- Protected Species: Based on the Decree of the Minister of Agriculture Number 54/Kpts/Um/2/1992 concerning trees in a protected forest, this area has been set aside as a Limited Production Forestry. No protected flora found by sampling survey of this area.

- Protected Forest Area
  - Composition of Species: Flora species of seedling level and stake level of this area are dominated by non commercial species, while at the pole level and trees level, the commercial species is more dominant. The dominant species based on IVI in this area is Mako merah (*Syzygium sp.*) with IVI: 39.22 at the trees level, Rattan with IVI : 75.73 at the pole level and Maraula (*Diospyros macrophylla*) with IVI : 38.02 at seedling level.
  - Dominance of Species: At the seedling level, the dominant species are Maraula (13.89%), Wolo (13.89%), and Lera, Poli putih, Bamba (11.11%). At the pole level, the dominant species are Buluh Suling (22.28%), Birongge (21.09%) and Rattan (16.93%). While at the tree level, the dominant species are Poli kuning (26.82%), Mako merah (11.61%) and Cempaga, Kalaka (10.32%).
  - Stability of vegetation community (Diversity of Species): The stability of the vegetation community, regarding to the value of diversity of species, at seedling level up to the tree level is not so good with the value of below score 3. This condition shows the community of seedling level up to the tree level is less stable.
  - Protected Species: Species of protected flora were not found by sampling survey in this area.

- Natural Forest Preserve Area
  - Composition of Species: Flora species at the seedling and stake levels in this area is dominated by non-commercial species, while at the pole and trees levels are more dominant of commercial species. The dominant species based on IVI is Sagner (*Arenga pinnata*) with IVI: 20.41 at the tree level, Phaleria capitata with IVI: 25.63 at the pole level and Rattan (*Calamus sp.*) with IVI: 14.07 at seedling level.
  - Dominance of Space: At the seedling level, the dominant species are Rattan (7.06%), Sasaro ayam (6.65%) and Bomba (4.11%). At the pole level, the dominant species are Phaleria capitata (12.84%), Rattan (3.68%) and Pondang/pandan (3.61%). While at the tree level, the dominant species are Ficus sp. (10.98%) Gondong/ayu (9.11%) and Uru (7.20%).
  - Stability of Vegetation Community (Diversity of Species): The stability of the vegetation community, regarding to the value of diversity of species, at seedling level up to the tree level, is not so good with the value under the score 3. This condition shows the community of the seedling level up to the tree level is stable.

- Toboli Settlement Area
  Species of protected flora were not found by sampling survey in this area.

8) Conservation Area

The conservation area system is legally based on the provisions of Act No.5 of 1990, "Concerning Conservation of Living Resources and Their Ecosystems". This allows for a number of types of conservation areas with different objectives and characteristics. The areas concerned include Sanctuary Reserves (Article 14, comprising Strict Nature Reserves and Wildlife Sanctuaries) and Nature Conservation Areas (Article 29, comprising National Parks, Grand Forest Parks and Natural Recreation Parks). The law also allows the constitution of biosphere reserves, protection of endangered and rare species, etc.

The conservation area system is managed by PHPA. Two Directorates of PHPA are concerned specifically with conservation areas: (i) the Directorate of Nature Conservation is responsible for overall planning of the protected area system, drafting conservation legislation, and proposing, establishing and managing individual protected areas; while (ii) the Directorate of National Parks and Recreation Forests is responsible specifically for the national parks program.

The existing Tawaeli - Toboli road crosses a nature reserve area named "Pangi-Binangga Nature Reserve" which has been stipulated since August 30, 1989 under the Decree of the Governor of Central Sulawesi Number 188.44/3932/DinHut/89. Fig. 8-2-3 shows its location.

(2) Social Environment

1) Demography

Tawaeli-Toboli road crosses three Kecamatans; i.e., Kecamatan Palu Utara, Kecamatan Tawaeli and Kecamatan Parigi. Meanwhile, three villages will be affected by the project activities; i.e. Lambara village (in Kecamatan Palu Utara) which is along the west part of Tawaeli-Toboli road, Nupabomba village (in Kecamatan Tawaeli) which is along the central part of the road, and Toboli village (in Kecamatan Parigi) which is along the east part of the road. Location of these villages are shown in Fig. 8-2-3.

The population density of each village in 1996 is 155 person/km^2 (Lambara village), 19 person/km^2 (Nupabomba village) and 20 person/km^2 (Toboli village), respectively. Table 8-2-8 shows population of each Kecamatan and village, and its population density.

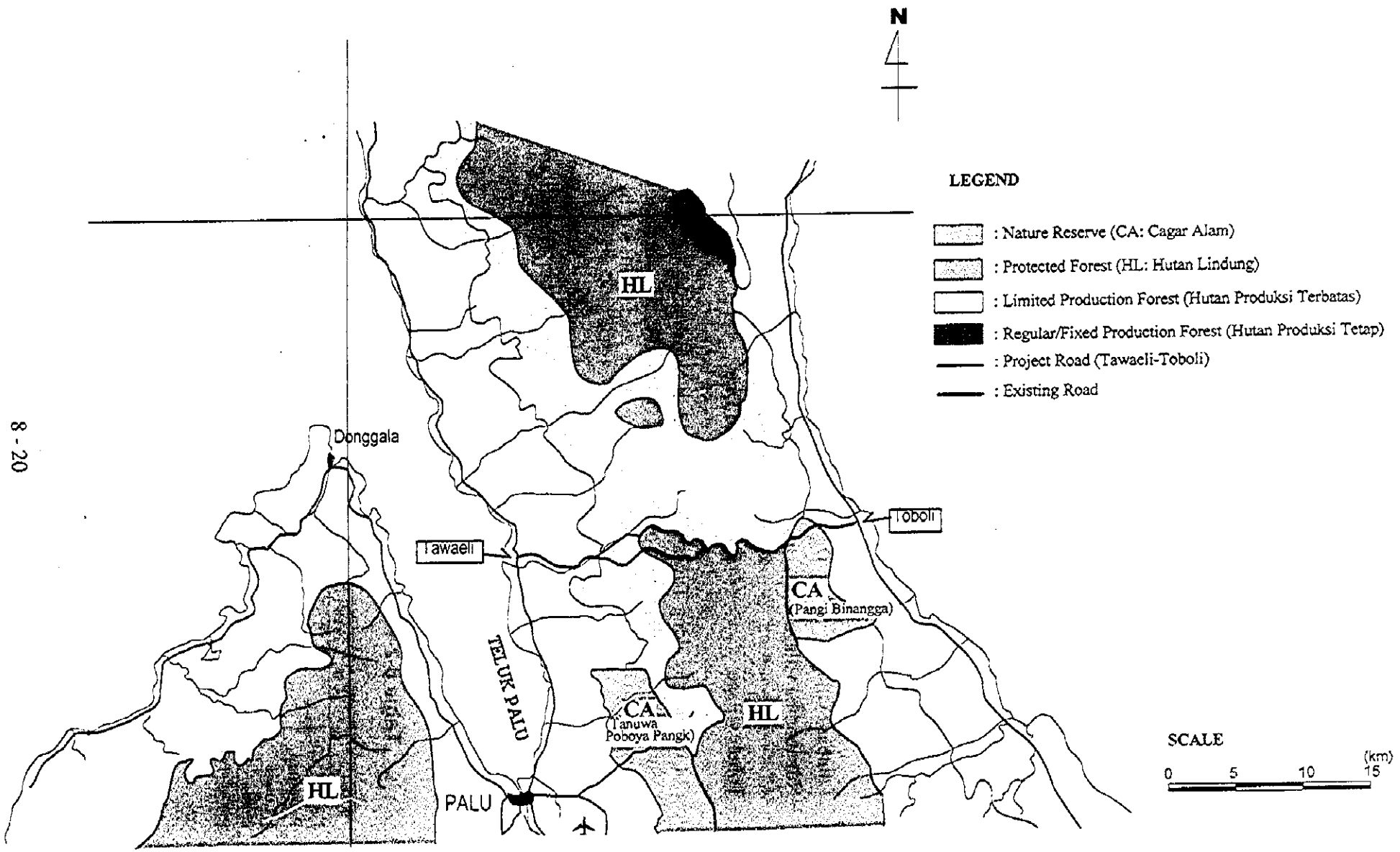


Figure 8-2-2 Tawaeli-Toboli Road and Pangi-Binangga Nature Reserve

Table 8-2-8 Population in the Study Area

No	Sub District	Area	Total Population			Total Household	Household Size(Ave.)	Population Density
		(km^2)	Male	Female	Total	Family	Person	(Pop/km^2)
1	Kec. Palu Utara	107.72	13,185	13,055	26,220	5,244	5	243
	Lambara village	13.86	1,059	1,088	2,147	429	5	155
2	Keg. Tawaeli	450.32	11,735	11,420	23,155	4,238	5	51
	Nupabomba vill.	135.28	1,389	1,236	2,625	550	5	19
3	Kec. Parigi	565.06	23,085	22,256	45,341	9,593	5	80
	Toboli village	120.64	1,281	1,241	2,522	452	5	21

Source : Kecamatan Palu Utara in Figure, 1996
Kecamatan Tawaeli in Figure, 1996
Kecamatan Parigi in Figure, 1996

Three villages mentioned above can be divided into some Dusuns (sub-villages) which are directly affected by the project, as follows.

- Lambara village : Dusun Lambara
- Nupabomba village : Dusuns Kintalova Bodi, Pombalaya, Karumba, Kebon kopi, and Tanjung
- Toboli village : Dusuns Satu and Dua

Most of the houses along Tawaeli-Toboli road in Nupabomba village (in mountainous area) are located valley side of the road. Therefore, the impact by the project construction activity which is, mainly, widening of the road width will be small.

Meanwhile, the average population growth rate per year of each Kecamatan in the study area is 1.25% of Kecamatan Palu Utara, 3.23% of Kecamatan Tawaeli and 0.37% of Kecamatan Parigi, respectively.

The leading religion of the people in this study area is Islam, followed by Protestant, Catholic and Hindu, as shown in Table 8-2-9.

Table 8-2-9 Population in the Study Area by Religion

Religion	Kec. Tawaeli (person)	Kec. Parigi (person)	Total (person)
Islam	23,074	46,090	69,164
Protestant	73	13,645	13,718
Catholic	175	2,221	2,396
Hindu	-	23,210	23,210

Source : Kabupaten Donggala in figure, 1995

2) Spatial Structure

As a spatial structure plan in the future, Kabupaten Donggala has own plan named "Rencana Tata Ruang Wilayah Kabupaten Donggala". Kabupaten Donggala consists of six administrative boundaries; i.e. Wilayah Penbangunan I, II, III, IV, V and VI. Fig. 8-2-4 shows the spatial structure of them. Each Wilayah Penbangunan has their own spatial plans which has settled based on Rencana Tata Ruang Wilayah Kabupaten Donggala. Details are described as follows;

- Wilayah Pembangunan I, has its center in Palu, covers Kecamatan Palu Barat, Palu Timur, Sigi Biromaru, Dolo, Marawala and Tawaeli. The sectors planned to be developed in this area are trade and service, industrial, sub sector of food crops agriculture, irrigation, cattle breeding, rural development, urban development and forestry sectors.

- Wilayah Pembangunan II, has its center in Parigi, covers Kecamatan Parigi and Ampibabo. The sectors planned to be developed in this area are agricultural, forestry, road infrastructure, water resources and irrigation, regional development and transmigration and sea transportation sectors.

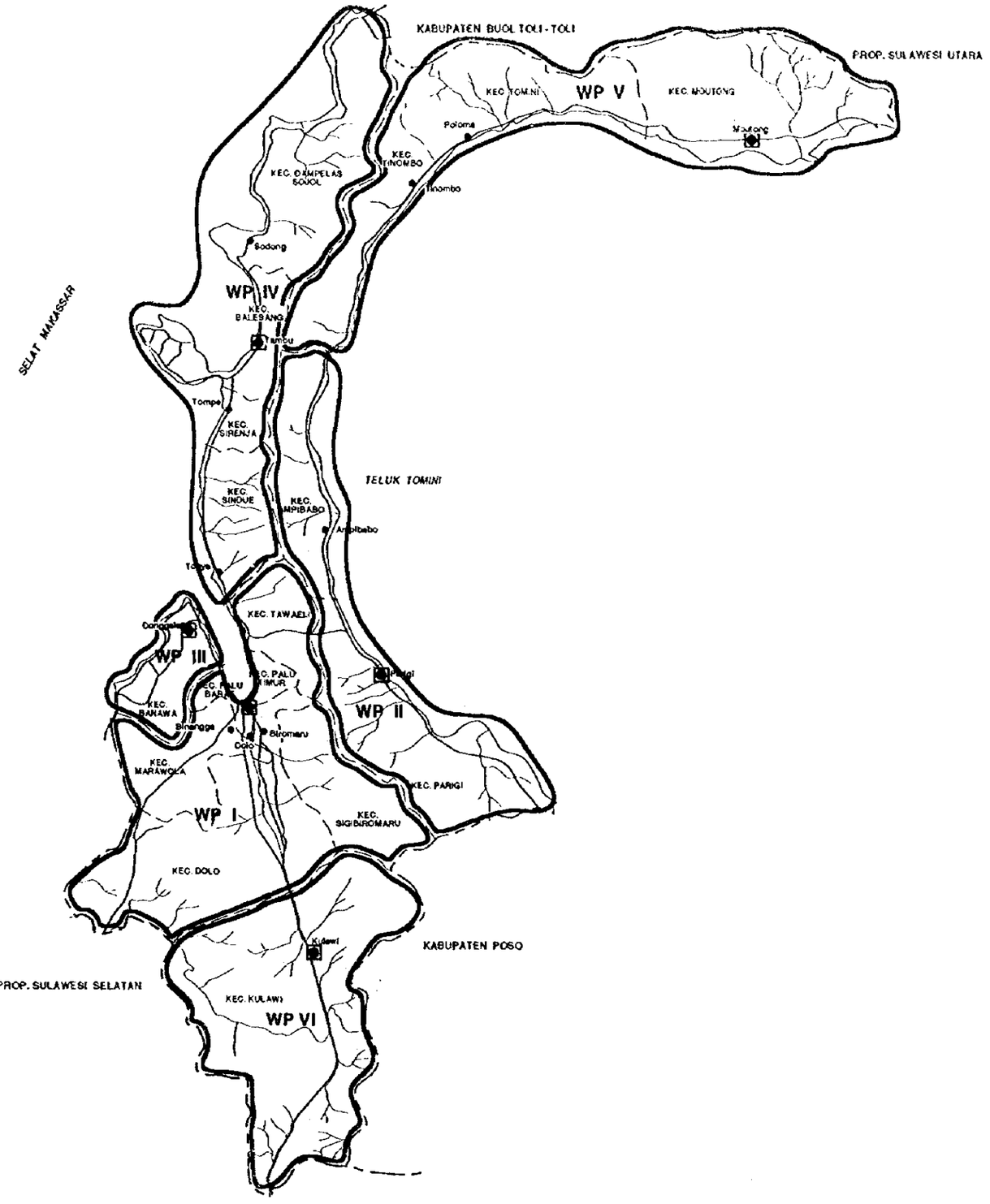
- Wilayah Pembangunan III, has its center in Donggala, covers Kecamatan Banawa. The sectors planned to be developed in this area are tourism, agriculture, water resources, mining and road infrastructure sectors.

- Wilayah Pembangunan IV, has its center in Tambu, covers Kecamatan Sindue, Sirenja, Balesang and Dampelas Sojol. The sectors planned to be developed in this area are agriculture, forestry, road infrastructure, sea transportation, tourism and regional development sectors.

- Wilayah Pembangunan V, has its center in Moutong, covers Kecamatan Tinombo, Tomini and Mautong. The sectors planned to be developed in this area are agriculture and forestry, water resources and irrigation, regional development and transmigration, marine and environment and industry sectors.

- Wilayah Pembangunan VI, has center in Kulawi, covers Kecamatan Kulawi. The sectors planned to be developed in this area are agriculture and forestry, regional development, health, social welfare, environment, transportation and mining and energy sectors.

Tawaeli - Toboli road is contained in Wilayah Pembangunan I, along the west part of the road, and II, along the east part of the road.



STUDY ON ENVIRONMENTAL IMPACT ASSESSMENT OF TAWAELI - TOBOLI ROAD DEVELOPMENT

LOCATION : Kab. DATI II DONGGALA
PROVINCE : CENTRAL SULAWESI

LEGEND :

- River
- Road
- Province Boundary
- Kabupaten Boundary
- Kecamatan Boundary
- City of Kecamatan
- Center of WP
- WP Boundary

0 23 46 92 Km

Source: Peta Rupa Bumi 1982

Figure 8-2-3
SPATIAL STRUCTURE MAP

DEPARTMENT OF PUBLIC WORKS
DIRECTORATE GENERAL OF HIGHWAYS
DIRECTORATE OF BINA PROGRAMME

3) Economic Activities

a) Ownership of Lands and Houses/Buildings

In principle, lands of the Tawaeli-Toboli area are owned by the government. However, there is a significant number of housing lots in this area through land ownership is unclear as most residents do not posses land regisration certificates. Among 266 households living in this area, only two of them have the certificate. The area of housing lot in this area ranges between approximately approx. $42m^2$ - $72m^2$, the average being 48 m^2.

The land price in the study area ranges between Rp. 7,500 - Rp. 15,000 per square meter for housing lots, and Rp. 400,000- Rp.800,000 per hectare for plantation yards.

In the past, coffee plantations were widespread , mainly in Nupabomba village, in the forest protection area. However, because of the deforestation of this area by the coffee plantation activity, the government applied the transmigration plan to the people of this area to move them to outside of this region. From 1991 to 1995, 172 households (860 persons) had transmigrated, as follows;

- 1991/1992 : 54 households moved to Balingara, Central Sulawesi
- 1992/1993 : 30 households moved to Balingara, Central Sulawesi
- 1993/1994 : 50 households moved to Sangira, Central Sulawesi
- 1994/1995 : 38 households moved to Malino, Central Sulawesi

However, based on the hearing survey from the residential people of this area, Kantor Wilayah Departemen Transmigrasi dan Pemukiman Perambah Hutan Propinsi Sulawesi Tengah and the local government officers, most of the people who already had transmigrated from this area had returned back to the original place (location of coffee plantation in Nupabomba village). Therefore, total number of the settlers residing in the coffee plantation area is estimated to be increased.

Taking into consideration these conditions, currently Pemerintah Daerah Tingkat I Sulawesi Tengah organized integrated team to manage the proper spatial and activity plan in the coffee plantation area and surroundings under the Decree of the Governor Kepala Daerah Tingkat I Sulawesi Tengah Number 522/403/1995.

Existing land-use and road conditions along Tawaeli - Toboli road in according to section are surmised as follows (following "km" indicates distance from Tawaeli):

- 0 km - 8.5 km : state owned land, road width 9.5m- 12m.
- 8.5 km - 22 km : state owned land, most area is forest while others are dry land or garden.
- 22 km - 28 km : state owned land, road width 7m - 9.5m. On the valley side of road for houses; both sides for trade activities, clove cultivation and vegetable plantation.

- 28 km - 32 km : state owned land, used as dry land and clove cultivation.
- 32 km - 33 km : state owned land, road width ranges 7m - 9.5m. Both sides of road utilized for clove cultivation.
- 33 km - 40 km : state owned land, road width 6m - 8m; in protected forest.
- 40 km - 44 km : state owned land, road width 6m - 8m; in wildlife preserve.
- 44 km - 46.3 km : state-owned land, and road width 9.5m - 12m; land utilized for residences and for trade and agriculture.

4) Employment Opportunity

People in study area chiefly subsist through the agricultural sector.

People in the coastal areas, at th west and east ends of Tawaeli-Toboli road, subsist in the make a living by the plantation sub-sector, namely coconut, especially in Desa Lambara, Desa Toboli and some parts of Desa Nupabomba, others by civil servant/private enterprise, trade and service. People in mountainous areas, mostly in Desa Nupabomba, subsist in the food crops agricultural sub-sector and on plantations.

The source of income of most people is derived from agricultural practices in coconut (copra), corn, vegetables and the yield from the cultivation of coffee and clove. The native people in this area, called Kaili, living by the migratory farming, namely coconut plants, corns, vegetables and coffee. Newer settlers in this area make a living by the growing vagetables such as cabbage, leeks, carrots, etc. and working on clove, coffee and cacao plantations. Some are involved in vegetable and fruit trade, other in small restaurant operation.

Based on the result of the interview survey, it was found that 80% of the people is a farmer, 10% civil servants and the remaining 10% in service sectors such as trade, carpentry, workshops, etc.

The people's average monthly income of residents of the three villages in the study area is approx. Rp.100,000 - Rp.300,000 per month. However, 62% of the people has the average monthly income of less than Rp.100,000.

5) Economic facilities

The number of economic facilities such as markets, stores, shops and stalls in Kecamatan and/or in the villages of the study area is mentioned in Table 8-2-10.

Regarding the transportation infrastructure, Tawaeli-Toboli road has the status of artery route mainly for the people in Kotamadya Palu and Kabupaten Donggala. This road connects Kota Madya Palu with other urban areas in Central Sulawesi, South-east Sulawesi, South Sulawesi and North Sulawesi as the part of Trans-Sulawesi road network.

The existing Tawaeli-Toboli road has been rehabilitated, since some part of the road frequently is broken off by landslide caused by heavy rain. On such occasions, to prevent traffic accidents and congestion, the traffic flow of Tawaeli-Toboli road is regulated under the Decree of the Governor of Sulawesi Tengah Number 18, 1997.

Table 8-2-10 Economic Facilities in the Study Area

No.	Study Area	Market	Store	Shop	Stall
1	Kecamatan Palu Utara	4	10	112	36
	Desa Iambara	0	3	18	3
2	Kecamatan Tawaeli	2	14	231	44
	Desa Nupabomba	0	0	25	6
3	Kecamatan Parigi	5	56	198	53
	Desa Toboli	1	5	8	6

Sourse : BPS, Kecamatan Palu Utara in Figure,1996
Kecamatan Tawaeli in Figure, 1996
Kecamatan Parigi in Figure,1996.

6) Community's Life Pattern

a) Education

Data from Kabupaten Donggala Dalam Angka 1995 shows that the most of the people in the study area have relatively low education standards, described as follows.

- graduates from Senior High School : 17.39%
- graduates from Junior High School : 26.09%
- graduated from Preliminary School : 47.83%
- ungraduated from Preliminary School : 4.35%
- others : 4.34%

b) The Community's life pattern and custom

The life pattern and custom of the community in the study area is mainly influenced by ethnic group and religion. The native ethnic group in the study area is Suku Kuali. Newcomers are categorized as Suku Bugis, Suku Makassar, Suku Jawa, Suku Sunda, Suku Toraja and Suku Bali. The religions in the study area are Islam, Protestant, Catholic and Hindu.

The life pattern of the people in the study area is heterogeneous, so that the existing customs and/or norms in the communities are not binding to each other.

c) Housing conditions

Based on the results of the site observation and interview survey, housing condition/structure of the residents owned are 61.90% permanent, 9.52% semi-

permanent and 28.58% temporary. Permanent houses are made of concrete/brick and/or stiff wood, while temporary houses are made of thin wood and/or pleated bamboo with simple roof, etc.

d) Community's acceptance

Based on the results of the interview survey, people in the study area, 25 respondents, totally agreed with the implementation of Tawaeli-Toboli improvement project, as the road improvement will facilitate smooth traffic conditions and support their economic activities. Meanwhile, during construction stage, all respondents declared that they would not be disturbed by the project activities as its disturbance is just temporary.

The respondents replied that in case the project involved the people's lands, such as houses, farms and/or plants, and made it necessary to move, they would be willing to move to a new place if not so far. According to thair response, in case to be resettlement, they would be willing to receive compensation as money in order to obtain their new livelihood by their own response.

On the other hand, 60% of the respondents of interview survey are willing to participate in the project as an employee and/or laborer during construction stage of the project, while others do not want to be involved in the project as they have a fixed livelihood.

7) Existing Road Conditions and Traffic

a) Condition of existing Tawaeli-Toboli Road

Field reconnaissance survey of existing Tawaeli-Toboli road, including bridges and landslide area, has been carried out and, from the environmental viewpoint, findings are surmised as follows.

- Surplus soil mainly produced by the slope excavation work of this betterment project are directly disposed into the valley side of the road with no environmental consideration. Also, cutting surface of the steep slope is in critical condition due to soil characteristics. Most of the cut slopes need permanent slope protection facilities as disaster prevention measures.
- The existing condition of the road pavement is unsatisfactory, and be the cause of traffic accidentss.
- There are limited safety facilities such as guard rails, etc., but there are no curve mirrors, safety poss, etc., but road alignment is particularly critical.
- Existing road width of some sections are too narrow for bus and truck traffic. It can be the cause of traffic accident.

b) Traffic conditions of existing Tawaeli - Toboli Road

According to traffic inventory survey carried out by the study team, traffic volume

(ADT) of Tawaeli - Toboli road was 886 vehicle/day. The study team also predicted the future traffic demand of the road. Table 8-2-11 summarizes the existing and future traffic volume of Tawaeli - Toboli road.

Table 8-2-11 Existing and Future Traffic Volume of Tawaeli-Toboli Road

Vehicle Type	Year 1997 (vehicle/day)	Year 2018 (vehicle/day)
Motor Cycle	716	2,324
Passenger Car	177	1,185
Bus	319	1,441
Truck	390	2,406
Total	886	5,032

Source: Study Team
Note: The total does not include the number of motorcycles.

For the traffic accident prevention measures, Governor of Central Sulawesi sets the road control regulation (Regulation Number 18 in 1997) for Tawaeli-Toboli road. Its content is summarized as follows.

i. All of the vehicles from Palu and/or from Pantoloan are to enter the Tawaeli-Toboli Road during the following period.

- 06:00 a.m. to 08:00 a.m.
- 02:00 p.m. to 04:00 p.m.

ii. All of the vehicles from Parigi and/or from Ampibabo are to enter the Tawaeli-Toboli
Road during the following period.

- 10:00 a.m. to 12:00 a.m.
- 06:00 p.m. to 08:00 p.m.

iii. Type of vehicles forbidden to enter Tawaeli-Toboli Road :

- Bus, width 2,250 mm - length 9,000 mm or more
- Truck, 7 tons or more.

8) Infrastructure

a) Public Facilities

Small scale hospital existing in the study area will not be directly affected by the project activities, while the religious service facilities, such as mosque and church, will be affected.
Education facilities existing in the study area, including preliminary school, junior high

School and senior high school, will not be directly affected by the project activities.

b) Infrastructure Network

The network system of urban infrastructures existing in the study area are electricity, telecommunication lines and road system. These infrastructure network systems, especially electricity and telecommunications, are not located close to the existing road edge; therefore, will not be affected by the project activities. However, in the construction stage, their condition and location are to be clearly identified in order not to disturb their functions.

(3) Environmental Pollution

1) Noise and Vibration

In order to assess the environmental impact by noise along the Tawaeli-Toboli road development project area, intensity of noise level existing in that environmenta was measured by the use of a sound level meter in the scale of 40 - 100dB(A). The results of the measurement of the noise level is seen in Table 8-2-12.

Table 8-2-12 The Result of Measurement of the Noise Level

Location	Noise Level (dB(A))		standard (dB(A))
	10:00 - 11:00 am	2:00 - 3:00 pm	
Pombaloya settlement	40 - 50	60 - 65	60
19 km	80 - 85	60 - 65	
24 km	60 - 65	50 - 55	
Kebon Kopi Settlement	60 - 65	55 - 60	

Source: Field measurement, July 1997 by study team

The result of measurement on the noise level shows that at the location of 19 km, the noise level of 80 - 85 dB(A), derived from the sound of an excavator in the distance of three meters from measurement point. This excavator was conducting the flattening of the slope and the road. The noise level of 60 - 65dB(A) at the 19 km point was derived from vehicles which passed the area (four-wheel and two-wheel vehicle). The distance of measurement from the source of the sound was two meters.

8.2.5 Impact Analysis

(1) Prediction and Evaluation of Major Impacts

1) Pre-Construction Stage

a) Social Environment

- Social unrest:
  The determination of the road location and its trace will have potential impact on the social environment as unrest, especially by people who may be affected by this road project. Generally, social unrest may occur due to the anxiety of the people from not receiving compensation for the land, building, and plants growing on their land.

  Based on the interview, it was clear that the respondents who have land or some facility which might be affected by the project would demand some compensation for it. Similarly, those who have dry land that might be influenced by the project would also demand compensation for the plants growing it. These outcomes show that the people strongly expect some kind of compensation for the impact on the social environment from this project. It can also be evaluated that social unrest as the result of the process of determination of the road location and its trace is categorized as a potential impact.

- Land acquisition:
  Based on the results of the interview, it was recognized that the land which may be influenced by the road project is not private land, but the state land. The land to be used for the road improvement section is on both sides of the existing road, and the land used for new road development is the state land of around 25 ha in area located in the protected forest area which, however, has partially been utilized illegally by the people for crop cultivation.

  It is not necessary, therefore, to carry out land acquisition for the activities of the road project, as the land will be used for the improvement and new development of the road is belonging to the Government as state land. As for the protected forest area in where new road will be constructed by this road development project scheme, the status of protected forest which has been managed by the Ministry of Forestry, must be changed to Damija status under supervision of the Ministry of Public Works. However, this is another issue regarding governmental administrative procedure.

  In addition to the above, there is a program regarding management of the coffee plantation area and its surroundings which includes the protected forest area, by PEMDA Tk.I Central Sulawesi, which clearly indicates also that the land which would be influenced by the road development project is state land.

On the other hand, however, considering that the land has actually been planted by the local people, it is predicted that social unrest would occur, in case that the implementation of the road project is conducted without any consideration for the plants made based on the above noted the PEMDA program and others. (See: Decree of the Governor of Central Sulawesi Number 522/403/1995).

Based on the results of interview, it is recognized that the people generally agree with the road development activities, however, it can be predicted that the people would demand some compensation for the plants on their dry land, as these plants are owned by them.

At the same time, specific consideration for the negative impacts due to the road project implementation on economic activities such as coffee plantation and vegetable cultivation have been carried out by the people should be made.

- Resettlement:
  As noted above, in the Tawaeli-Toboli road project, land for improvement and new development will be implemented on state land. It can be considered, therefore, that it is not necessary in principle to resettle and relocate people for the project. In other words, it can be concluded that the Tawaeli-Toboli road project will not have specific impact on the social environment with regards to relocation. Special consideration for resettlement and relocation may be deemed the case of necessary in following example.

  For example, there are about 100 structures (including houses, shops, mosque and elementary school) located in Kebun Kopi within 8 km of the existing road. In this area, the existing road will be widening and the side of a hill cut as part of road improvement. As almost all residences, etc., are located downhill from the site, it is believed that few structures would require relocation. However, as some dwellings are built directly on the roadside, these will need to be temporarily relocated during the construction phase in consideration of personal safety and smooth progress of the project.

b) Natural Environment

No significant impact on natural environment is predicted in the pre-construction stage.

2) Construction Stage

a) Social Environment

- Labor mobilization:
  Mobilization of labor will have a positive impact on the society, namely by providing working opportunity for people entailing about 13.18% of the total labor force in three kecamatans (sub-district) in the study area.

On the other hand, the mobilization can also raise a negative impact, such as social jealousy and related unrest in case local people living in the project area are not included as construction laborers during the construction stage of the project. Based on the results of the interview, it was found that 60% of respondents want to work for the project. This shows that how great the people's expectation is to be able to work for this project. If the implementation of the project construction is done by the more people from out of the project area, social jealousy and unrest, such as social conflict leading to disturbance to implementation of the project, would be aroused.

Such social unrest may be temporary, mainly during construction phase. However, this unrest would influence the cost and social economic benefit to the communities.

- Traffic disturbance:
  The transportation of the construction materials will have a significant impact on the traffic on the Tawaeli-Toboli road. The economic activities of the people will be disturbed during the construction phase, about one year. Therefore, the Governor of the Central Sulawesi issued a Decree in 1996 to regulate the time for vehicles passing the Tawaeli-Toboli road section.

- Public facilities:
  It is considered that the activities of cut and fill for basic land preparation would affect some public facilities, mainly at the existing alignment of Tawaeli - Toboli road section.

  Transportation of soil and construction material with heavy vehicles that would lead to road damage, especially if truck loads exceed the allowed limit.

- Surplus soil:
  The surplus soil as solid waste generated during construction of a certain project in progress, being thrown into the valley along the road as it is. This causes detrimental impact on the flora and landscape. Therefore, this project is required to make the appropriate treatment measure for the surplus soil which would be generated.

b) Natural Environment

- Landslide:
  Excavation activities cause disturbance to slope stability. The land condition along the planned route is mountainous. With frequent sliding caused by heavy rain and earthquakes, the slopes should be given protection. The impact by excavation on the slope stability leads to land sliding.

- Soil erosion
  Excavation activities cause land erosion, especially on hills and steep slopes, and where soil texture and structure is relatively sensitive to erosion.
  Impact from material mining in the Nopabomba River will be a disturbance of the morphology of the river basin and river erosion, especially when it rains. This impact will happen during the construction phase, until balance is achieved in the river after mining of the rocks and sand.

- Groundwater:
  As a result of the geological boring survey with 21 test holes at the tunnel development location, no groundwater flow was encountered in any of the test holes. The site is located in the mountains about 1,000 m above sea level. It can be predicted that, therefore, there is no specific groundwater flow in the tunnel development site or impact thereof.

  On the other hand, however, the geological survey indicates that some fault and geological strata exist in the tunnel development site. Accordingly, in general, it may be thought that there is possibility of some ground water existence in the fault and along the strata. Therefore, more or less water leakage may be predicted during the tunnel construction.

- Natural reserves:
  A road section of approximately 4 km in length of the existing road on the Toboli side, passes through the territory of Pangi Binanga Natural Reserves. Therefore, some impact on the ecosystem of the fauna and flora around the both sides along between the road and the reserves may be concern, as some endangered species of fauna have been observed and reported which may be affected by the road improvement project.

  However, this road section of the 4 km in the reserves will not be newly constructed, but only be improved and widened without great physical damage to the territory during construction stage. With this project description and with a view of risk - benefit idea in the development scheme, special and actual consideration, evaluation and assessment should be made on these impacts.

- Flora :
  As mentioned already, the land for new development road is in the limited production forest area and the protected forest area. Most existing vegetation are of non-commercial types, and the diversity of the type existing at the limited production forest and protected forest is poor.

  Some parts of the land for the improvement of existing road section is in the natural reserves. Stands of trees grow on the right side of the existing road around Pangi Binangga Nature Reserve.

Activities during the construction stage, such as land clearing and development of access road, would have impact on the flora along the road. Especially, the activities of the new road development in the protected forest area will undoubtedly have impact on the Flora.

- Fauna
  The presence of activities of land clearing and cut, especially in the Nature Sanctuary, is believed to have an impact on the fauna. The impact is in the form of disturbance of fauna habitat by the noise and vibration from construction equipment and vehicles, destruction of part of the vegetation as feed for the fauna, specifically at both sides of the road in the territory of the Pangi-Binangga Nature Reserves.

  Although impact will continue over the construction period of about two years, the situation will likely return to normal after completion and the intensity of the impact can be consider as relatively small for the project scale. The component that will be affected by the impact, among others, is fauna that is categorized as rare, endemic and protected.

c) Pollution

- Noise and vibration
  Taking into consideration the contents of the project and its scale; i.e., lower traffic volume in the study area, as the environmental pollution, noise and vibration will be aroused during construction stage by the use of construction devices and vehicles. Therefore, noise and vibration will be considered in the environmental element for environmental impact assessment (EIA) to be conducted for the project.

3) Post-Construction Stage

a) Social Environment

- Traffic accident
  After the opening Tawaeli-Toboli road section, the number of vehicles passing the road section will increase. Even though it has been planned conforming to existing standards of road planning, it will rise the potential of traffic accidents.

- Economic activity
  The completion of the Tawaeli - Toboli road project will make the distance shorter, from around 48 km to be around 41.35 km, and will accelerate the traffic flow to and from Palu and its surroundings. This will support the development in Palu and its surroundings. Therefore, operation activities of the Tawaeli - Toboli road project will provide a positive impact in supporting regional development and enhancement of regional economic activities.

However, activities in the road operation, especially on the newly developed new road, will raise a negative impact such as increase of squatters in the protected forest. Thus, the impact by the road maintenance may have a positive impact in supplying working opportunity, and have also a negative one of social unrest as the result of traffic congestion.

- Natural reserves
  As mentioned above already, the road section of approximate 4 km that would be improved and widened by this project in the territory of Pangi Binanga Natural Reserves will have some impacts on the ecosystem of the fauna and flora. In this reserves, some endangered species of fauna have been observed and reported, but they are live in the deeper parts of the reserves. With this project description, with this situation and with a standpoint of "risk -benefit" idea in the development scheme, special and actual consideration, evaluation and assessment should be made on these impacts.

b) Natural Environment

- Slope collapse:
  The road between Tawaeli and Toboli runs mostly through a mountainous region with steep terrain and soil property where slope collapse may be caused by rain water after deforestation, etc. Appropriate protection measures for slope collapse are required.

- Groundwater:
  The changing of the groundwater flow made by the completion the new developed tunnel would be predicted. Some consideration such as monitoring should be made on the groundwater flow.

- Flora:
  The road operation after the construction will have an impact on flora such as a possibility to open new dry land by the people around the new road developed. In other words, the road development will be increasing the forest squatters and illegal cultivation with fire and cutting. They will reduce natural vegetation which is the feed for the fauna in the protected forest and the nature sanctuary.

- Fauna
  The impact that will be brought about during post-construction phase on fauna may be raised by the presence of road traffic that will increase all types of activities of the people in that region, such as house building and farming activities.

  The presence of the new road about 12 km length in the protected forest area forms new access for the people. Settlement, dry land farming and exploitation of the forest wood, forest yield and fauna hunting occurred. The impact by these activities will disturb the forest's ecosystem. The disturbance of the function of the forest as

the habitat of fauna will lead to an impact on the habitat of fauna, especially rare, endemic and protected species. Some endangered species of fauna have been observed and reported, however, they live in the deeper parts of the natural reserves.

(2) Environmental Mitigation Measures

1) Pre-Construction Stage

a) Determination of the Road Location and Trace

- Social unrest
  Due to possible appearance of speculation, disturbances could occur which would impede or even foil survey activities. Potential social unrest may be dealt with by giving explanation to local residents concerning planned project activities.

- Compensation
  Compensation for plants and vegetation, etc., managed and/or owned by the people is carried out by:

  - Explanation regarding project purpose and its impact on residents who possess land effected by the project
  - Explanation to citizens regarding the benefits of the project such as increased flow of goods and services, income, working opportunity and regional development.
  - Offering adequate compensation
  - To deal with local residents' loss of means of making a living as a result of land appropriation, these people involved will be given priority in job opportunities connected to the road development project.

- Relocation
  In the case that certain residents need to be relocated whether temporarily or permanently due to road construction, a full explanation should be given regarding the necessity of relocation the project and compensation program, including consideration of the following:

  - Selection of location for people to be relocated.
  - Proper living facilities at the new location.

2) Construction Stage

a) Social Environment

- Labor mobilization

  Potential unfavorable impacts are as follows:

- People's dissatisfaction towards project activities.
- Disturbance that can impede and/or obstruct construction activities.

The above can be dealt with by giving working opportunity with the project for the people around it conforming with required qualifications and social interaction between the incoming labor and the local communities. Operation of construction base camp should be managed as follows:

- Selection of location that is rather far from the settlement
- Explanations to the incoming workers

- Traffic disturbance
  Such impact is dealt with by issuing some program for regulating traffic flow depending on time, weather and so on. Traffic congestion is expected due to increase of construction vehicles and equipment

  - Traffic regulations to be enforced and traffic signs installed.
  - Application of the traffic schedule in line with the Decree of the Governor of Central Sulawesi Number 8, 1997.

- Destruction to public utilities
  Management to the impact is done by removal of public utilities (water supply system, electric circuitry, telephone line, etc.) and rehabilitation of they damaged. Monitoring of the impact is done accelerate the function of public utilities.

- Damage of public road:
  Management to the impact is conducted by rehabilitation of the damaged road infrastructure. Monitoring of the impact is done on the condition of public road infrastructure passed by Tawaeli - Toboli road.

b) Natural Environment

- Land sliding

i. Slope protection:
Slope protection works such as sprayed concrete cribwork, shotcrete work, stone masonry and mat gabions for fill and cut slopes should be constructed to prevent soil erosion and landslides. The following measures should also be taken:

- To cut the steep riverbank in line with the planned sloping
- To strengthen the excavated slope by herbage packing, retaining wall, gabion and concrete at the protected location.
- To monitor impact of slides

ii. Surface soil run-off
Run-off of surface soil is to be dealt with by adequate arrangement of

implementation and development of drainage/culvert systems. Impact is monitored to avoid water inundation.

- Surplus soil
  Surplus soil, of which more than 560,000 m3 is estimated as disposal waste during construction stage, must be managed as follows:

  - Excavated soil should not be dumped or left as is in excessively rainy or dry seasons.
  - Dump sites in which exposed or graded surfaces of excavated soil can be minimized should be selected.
  - Planting or seeding of dumped soil should be undertaken immediately.
  - Proper drainage facilities should be supplied to prevent negative environmental affects such as a water contamination, filling, muddiness, etc., downstream from the site.

- Groundwater flow
  No ground water flow was found around the tunnel development site based on the geological and other surveys. However, more and less water leakage can be considered during completion of the tunnel construction due to the existence of some faults and geological strata. Therefore, some monitoring should be conducted on groundwater flow and leakage.

- Fauna and flora
  Impact on fauna and flora is to be mitigated by restricting the speed of vehicles, reducing the noise and vibration, and regulating solid waste, especially surplus soil dumping in that area. Impact on fauna and flora can be slightly alleviated by the following measures:

  - Educating the people and laborers regarding the environment.
  - Construction of warning boards about protection of fauna and flora.

3) Post-Construction Stage

a) Social Environment

- Traffic accidents
  - Installation of the traffic signs and road marking.
  - Construction of the guard rail.

- Road operation and maintenance:
  - Traffic regulation.
  - Regulation on the implementation of jobs

b) Natural Environment

- Groundwater flow:
  No ground water flow was found around the tunnel development site based on the geological and other surveys. However, more and less water leakage can be considered during completion of the tunnel construction due to the existence of some faults and geological strata. Therefore, some monitoring should be conducted on groundwater flow and leakage.

- Fauna and flora
  Impact on fauna and flora is to be mitigated by restricting the speed of vehicles, reducing the noise and vibration, prohibiting illegal cultivation and settlements in that area.
  Impact on fauna and flora can be slightly alleviated by the following measures:

  - Educating the people and labores regarding the environment.
  - Construction of warning boards about protection of fauna and flora.

8.2.6 Considerations on Environmental Management and Monitoring

(1) Environmental Management Plan

Environmental management is important in each stage of the Project, i.e., pre-construction stage, construction stage and post-construction stage. This includes not only the management of environmental issues related to the Project, but also those related to environmental improvement of the environment throughout Central Sulawesi. Recommendations can be given as follows:

1) Organization for Environmental Management
   Under the project office which is to be organized by Bina Marga, Ministry of Public Works, there should be a branch with at least one acting officer in charge of environmental management. This environment branch will make plans for environmental protection and improvement of the environment, and manage all related activities. Effective coordination among the project office, local government and environmental agencies are also very important.

2) Management of Resettlement and Land Acquisition
   Resettlement and land acquisition are very sensitive issues and must be effectively managed. Some households may be involved in the resettlement program. Careful inventory of these houses, lands and properties, economic activities, hearings on their opinions and desires are indispensable. Besides compensation, provision of locations for new residences is also very important.

3) Environmental Surveillance of Construction Work
   Construction work should follow environmental regulations. This requires effective organization of work and also surveillance during the construction work. Disputes

may occur with local residents on environment-related issues, or complaints may come to the project office or local government. These issues need to be resolved on the basis of environmental laws and regulations.

4) Forest Environment Management

It is recommended that forest environment management and improvement will be considered during and after the project, especially in Pangi Binanga Nature Reserve and its surroundings. This includes reforestation, protection of endemic fauna, garbage collection and regulating market and other tourism/business activities, etc.

5) Environmental Education

For effective environmental management, education on the environmental and sanitation is indispensable for raising public awareness of the importance of environmental protection. The habit of using forest area as receivers for all kinds of wastes should be completely abandoned, and creation of a comfortable and beautiful environment should become the target of all the residents in Central Sulawesi. This needs a long term education program for people of all ages and strong administrative measures such as proposing new regulations including strict penalties for environmental contamination.

(2) Environmental Monitoring Plan

Environmental monitoring is important for understanding the environmental conditions before, during and after the project. In the pre-construction stage, environmental monitoring aims for an understanding of the environmental settings of the project through IEE and EIA in the construction stage, monitoring is for controlling the impact on the environment; and in the post-construction stage, monitoring is for good operation and maintenance of facilities and expanding the effect of the project. The followings are the main monitoring items.

1) Traffic Volume Monitoring

At the pre-construction stage, the traffic volume of Tawaeli-Toboli road should be monitored to make a reasonable transportation plan for the Project, and during the construction, monitoring is still necessary to check the project impact.

2) Noise and Vibration

Noise and vibration levels should be monitored during the project construction especially at locations where people complain about the impact. By following monitoring results, work plan should be modified and countermeasures will be taken.

3) Groundwater Level:

No ground water flow was found around the tunnel development site based on the geological and other surveys. However, more and less water leakage can be considered during completion and/or after completion of the tunnel construction due to the existence of some faults and geological strata. Therefore, some monitoring should be conducted on groundwater flow and leakage.

4) Soil Erosion Surveillance

Soil erosion surveillance should be conducted during and after project construction at the site. Necessary measures should be considered for all the locations where soil erosion may occur.

5) Post-Resettlement Survey

As has been mentioned above, resettlement is a socially sensitive issue. The impacts will not only be significant until people relocate to a new place but also continue over a long period of time. Whether or not people are satisfied with their new living conditions, what kind of problems they are facing, and what do they want the government to do for them should be understood. It is recommendable that post-resettlement survey will be conducted to investigate these people's conditions after the resettlement and hearing be conducted regarding their opinion and requests. The information should be reported to the related governmental organization.

Chapter 9

Road Management and Maintenance Plan

Chapter 9 ROAD MANAGEMENT AND MAINTENANCE PLAN

9.1 Basic Concept

The purpose of road maintenance and operation is:

- To attain traffic safety, smooth traffic flows and ride comfort on highway,
- To maintain the road structure and facilities as originally constructed or improved,
- To restore ordinary road conditions after the damaging effect of weather, vegetation growth, deterioration, traffic wear and tear, traffic accidents and disasters.

The organization of road maintenance uses the existing system. But basically all tasks of maintenance are on a contract basis. Components of road maintenance are inspection, maintenance and repairs.

9.2 Definition of the Maintenance System of the Road

The organization of road maintenance consists of the maintenance center (Provincial Office), maintenance offices (Regency office and site office) under the Dinas PU.
At present, the provincial offices control the road maintenance of the national roads, provincial roads and prefectural roads. It is recommended in this study that the road maintenance works shall be divided into 3 levels, namely provincial level, prefectural level and site level, and that level of each work shall be controlled by the corresponding level of organization using the present maintenance system.

Table 9-1-1 shows the main work items of each level of provincial, regency and site offices. Provincial office (Dinas PU) shall co-ordinate with national government, establishing maintenance grade of the roads within their jurisdiction, and overall management of the implementation program of the maintenance works. The main works for the regency office shall be coordinated with provincial government and implementation planning for all the roads in the regency. Each site office in each sub-area shall conduct the implementation of the road maintenance and operations. The maintenance work, basically, shall be conducted by contract with a private company, except for routine maintenance and urgent countermeasures for damages caused by disaster.

Table 9-1-1 Main Tasks of Road Maintenance System and Responsible Office

Main Tasks	Activities	Responsible Office		
		Provincial office	Maintenance Office	
		(Dinas PU)	Regency office	Site office
1. Planning and Programming	a) Planning	O	O	
	b) Implementation programming	O	O	
2. Traffic Engineering and Safety	a) Road and Traffic engineering development and research	O		
	b) Traffic forecasts	O	O	
	c) Implementation of traffic survey		O	
	d) Statistical data processing		O	O
3. Maintenance and Operations	a) Setting of standards	O	O	
	b) Supervision and consultation works		O	
	c) Maintenance and operations			O
4. Coordination and Public Relation	a) Coordination with relevant agencies	O	O	
	b) Response activity	O	O	
5. Administration	a) Personnel management, salary, welfare, etc	O		

Source: JICA Study Team

9.3 Road Maintenance and Operations

There are three types of task in maintenance. One is routine maintenance where task volumes are not affected by road standards or traffic volumes. Another is periodic maintenance which is related to traffic volumes and lane width and is proportional to the number of lanes. The third is incidental maintenance which is basically the works to be conducted to prevent and to restore the road and related facilities to normal operating conditions after damage by road accident or natural causes.

- Routine maintenance

  a. Patrol, inspection, removal of obstacles on road
  b. Cleaning of surface, side ditch, canal, culvert
  c. Vegetation control; grass cutting of slope and shoulder, take care of roadside trees
  d. Repairing and repainting of traffic safety and management facilities
  e. Repairing lighting facilities

- Periodic maintenance

  f. Renewal of traffic marking
  g. Pavement maintenance and repair
  h. Overlay
  i. Maintenance and repair of bridges and culverts

- Incidental maintenance

  j. Disaster restoration

"a" through "e" of the above maintenance and operations can be implemented by force account. However, the works of "d" through "j" are implemented by contract basis except emergent countermeasure such as suffer from collapse of slope due to heavy rainfall, cave-in in the road due to erosion and road damage from traffic accident.

In line with improved pavements in the future, operations under direct road management control, such as monitoring of the road surface, etc., may increase. It is therefore desirable to establish a maintenance system based primarily on force account and the contracting of works other than those under force account.

9.4 Location of Offices

The present Dinas PU and its regency offices shall control the maintenance work for the national and provincial roads in Central Sulawesi Province.
Existing each maintenance office (regency and site offices) shall conduct the direct implementation of the maintenance and operations for the national and provincial roads in regency, and the offices will be located as follows:

- The present regency office at Paul city shall control about 1,000 km road length of national and provincial road with the existing office facility.
- Each site office shall maintain about 250 km of national and provincial road under control of regency office.
- Tawaeli-Toboli road is maintained by one of the site offices which use the existing Tawaeli-Toboli improvement office.

9.5 Equipment and Workshop

The maintenance equipment are located in each site office which charges the maintenance and operation for about 250 km of national and provincial road. Required vehicles and equipment per one site office are as follows:

1. Vehicles for patrol and inspection	Pick up	20 units
2. Vehicles for road cleaning and vegetation control and equipment of emergency works	Dump Truck	1 unit
	Loader	1 unit
	Bulldozer	1 unit

9.6 Maintenance and Operation Cost

The annual operation and maintenance cost of Tawaeli-Toboli road is estimated to be Rp. 509 million with over lay (every 7 years) cost of Rp. 5,200 million at July 1998 prices.

Table 9-6-1 Maintenance Cost of Tawaeli-Toboli Road (40.05 km)

Unit: Million Rp.

Maintenance Cost Item		Maintenance Cost		Remarks
		(per seven year)	(per year)	
1)	Personal cost		54	40 km
2)	Vehicle, oil, lubricants cost		108	
3)	Inspection			
	One year check		8	Work by force account
	Monthly check		10	Work by force account
4)	Cleaning of road and facilities		41	Work by force account
5)	Vegetation control		40	Work by force account
6)	Safety device and management facilities		30	Work by contract basis
7)	Renewal of traffic marking		83	Work by contract basis
8)	Repair of lighting facilities		12	Work by contract basis
9)	Minor repairs of pavement		53	Work by contract basis
10)	Overlay (interval 7 years)	5,200		Work by contract basis
11)	Maintenance and repair of bridges		20	Work by contract basis
12)	Disaster restoration		50	Work by contract basis
	Total	5,200	509	

Chapter 10

Construction Planning and Cost Estimates

Chapter 10 CONSTRUCTION PLANNING AND COST ESTIMATES

10.1 Precondition of Cost Estimates

10.1.1 Contract Method

The construction consists of improvement and new construction of earthworks, pavements, bridges, slope protection works, tunnels and others.
Bina Marga has implemented construction projects by either force account or contract basis. Usually the contract method for large-scale construction projects such as long road pavement, long bridges and tunnel works is by general competition bid by international open tender.

10.1.2 Construction Method

Large scaled construction project including earth works of big amount excavation, tunnel works, etc. requires special techniques and various works of road construction with heavy construction equipment. Cost estimates were made, considering an efficient construction method and applying to use heavy construction equipment.

10.1.3 Work Methods

(1) Earth work

The construction site includes steep mountainous areas and needs cutting and embankment of a large amount of earthworks. For the preservation of environment and prevention of disasters, excavated surplus materials should be controlled and treated so as to preserve environment. As the newly constructed road locates in a steep hill, the works is assumed to be started from the both ends using a pilot road taking account of preservation of environment. The excavated soils are disposed of in the site with a hauling distance of about 5 km on average.

(2) Slope protection work

Slope protection must be done by stabilizing cut and embanked areas taking account of prevention of road disasters and preservation of environment.

(3) Drainage work

Drainage facilities are constructed on the hill side of cut section areas in order to prevent flooding of the roadbed and the damage of pavement. Concrete pipes of more than 60 cm in diameter are applied for the road crossing waterway to facilitate its maintenance.

(4) Tunnel work

The scale of tunnel construction is 620 m long with a cross sectional area of 65 - 70 m^2. Regarding excavation method for tunnels, the concrete spraying and rock bolt method (NATM) is adopted. The excavation equipment are drill -jumbo, splayed machines etc. which are to be imported from overseas.

(5) Bridge

Prestressed concrete I-girders of the standard span length of 10, 20 and 30 meters were planned to be produced at a factory near the construction site. PC-I girders will be launched by crane, which simplifies the work procedure. Cast-in-place concrete for slabs and substructure was planned to be carried into the site from the concrete plant.

(6) Pavement work

Bituminous asphalt was applied for surface course. Natural (Buton) asphalt was adopted for the asphalt treated base course. Mechanical stabilized crushed stone was planned for subbase course.

(7) Plants

An asphalt pavement plant and a concrete plant were assumed to be set up at the Tawaeli side.

10.1.4 Base Year for Cost Estimation

The construction cost was estimated based on foreign currency and local currency. The foreign component has been expressed in rupiah at July 1998 prices with an exchange rate of one (1) US dollar to 10,600 Rp. Cost calculations were based on the material cost, labor cost and equipment cost. Imported materials costs included all import taxes and rates (issued in October 1996 by directorate general of customs and excise in the Department of Finance).

10.1.5 Foreign and Local Currency Portions

Classification into foreign and local currency component was based on the following principles.

(1) Foreign currency

- Wage of foreign personnel;
- Overheads and profit of foreign firms;
- Imported equipment, material and supplies; and
- Foreign component cost of material purchased in domestic market.

(2) Local currency

- Domestic equipment, materials and supplies
- Wages of local personnel;
- Overhead and profit of local firms; and
- Taxes.

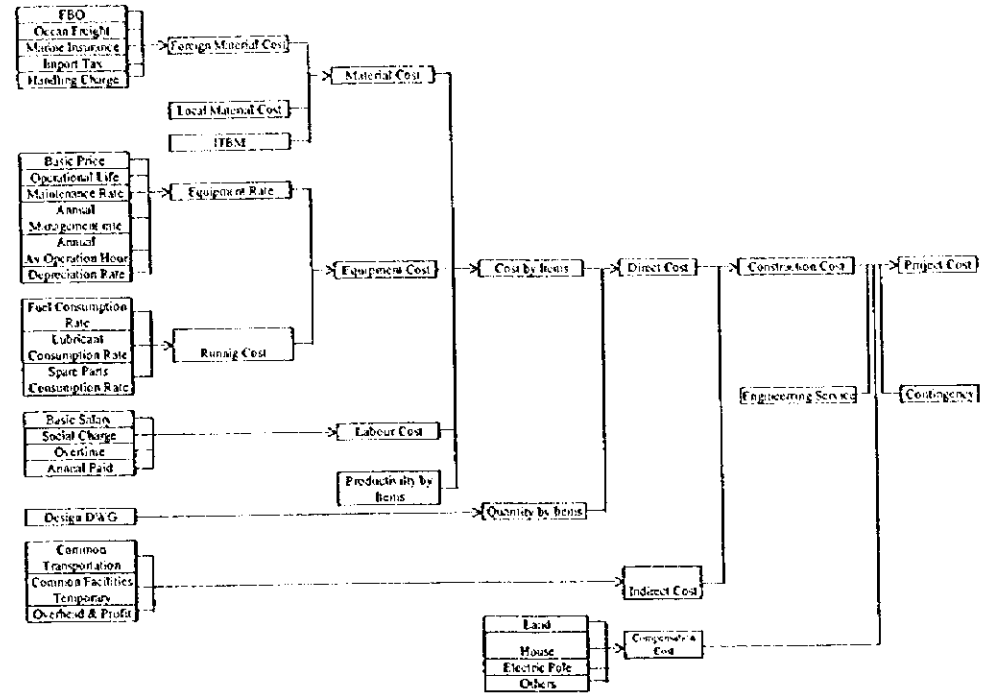
10.1.6 Economic Costs

To assist in the economic evaluation of the projects, economic costs have also been estimated by subtraction of transfer cost, taxes, etc. from the local component.

10.2 Cost Estimates Procedure

10.2.1 Method

The cost estimates process are shown in Figure 10-2-1. The direct construction costs of each work item were estimated by a method which combines the cost of labor, equipment and material. The indirect construction cost were calculated based on common expenses such as temporary works, over heads and profits. The project costs also included contingencies, land acquisition and compensation cost which were calculated and added separately.



Source : JICA Study Team

Figure 10-2-1 Cost Estimates Process

10.2.2 Labor Cost

Basic salaries were calculated including social charges which account for 26% of the average unit wage. Labour cost is classified into 5 categories df driver, forman, operator, skilled labor and unskilled labor as shown in the following Table 10-2-1.

Table 10-2-1 Labour Cost

Categories	Unit	Foreign(US$)	Local(Rp)
Driver	Hr	0	3865
Forman	Hr	0	4637
Operator	Hr	0	5670
Skilled Labour	Hr	0	4126
Unskilled Labour	Hr	0	2962

Source : JICA Study Team

10.2.3 Material Cost

Material costs are divided into local and imported materials. The CIF (cost, insurance and freight) prices of imported materials which are not available in Sulawesi, are estimated from foreign prices. Material costs are estimated including import tax, handling charge, consumption tax in the country.
Where the selling price of imported materials are known, 25% of the selling prices is regarded as handling charge, of which 7.5% of the selling prices are transportation expenses. 50% of the transportation expenses are estimated as the foreign portion. Consumption tax of 10% is added to the material costs.
In case of the domestic product the majority of the cost component of raw materials are regarded to expenses of the production plants, equipment, transportation and fuel which would have been imported. The unit costs and assumed foreign and local currency portions for the major materials are shown in Table 10-2-2.

Table 10-2-2 Foreign Currency Portion in Raw Material

Description	Unit Cost (Rp)	Unit	Foreign currency portion (%)	Local currency portion(%)
Cement	380,000	ton	60.0	40.0
Sand	30,000	m3	40.0	60.0
Crusher stone	37,000	m3	40.0	60.0
Steel	4,600,000	ton	80.0	20.0
Reinforcement	4,300,000	ton	80.0	20.0
Wood	350,000	m3	40.0	60.0
Concrete product	397,000	m3	60.0	40.0
Asphalt	1,700,000	ton	80.0	20.0
Gasoline	1,000	l	40.0	60.0
Diesel oil	600	l	50.0	50.0
Heavy oil	400	l	40.0	60.0
Electricity	105	kwh	0.0	100.0

Source : Bina Marga in Sulawesi

10.2.4 Equipment Cost

The construction equipment costs are estimated assuming that the equipment are assigned to other projects when not being used. All construction equipment could be supplied in Republic of Indonesia. Equipment costs include import tax, consumption tax and all other expenses except operator and driver costs, which are calculated in labor costs.
Equipment cost could be divided into rental cost and operation cost.

Rental cost per hour = ((basic price (1.0 - residual value ratio)) * depreciation rate + annual maintenance rate per hour + management rate per hour.

Depreciation rate = 1/(annual operation hour * operation life)
Operation cost are included for fuel, lubricant, spare part, wage of management and maintenance costs per hour.
Table 10-2-3 shows result of calculation for equipment cost per hour.

Table 10-2-3 Equipment Cost

Equipment Name	Unit Cost (Hr./Rp)	Equipment Name	Unit Cost (Hr./Rp)
Agg. Spreader 2.3m	28,566	Vib-Roller 3.5t	171,831
Apron Feeder 30t	55,006	Watering Cart 5.5kl	94,096
Asphalt Plant 60t	665,242	Wheel Loader 1.4m3	127,704
Asp. Finisher 3m	383,909	Dump Truck 2t	30,293
Batching Plant	885,713	Dump Truck 6t	89,262
Belt Con. 0.35*10m	12,514	Dump Truck 11t	135,068
Belt Con. 0.6*15m	99,297	Earth Oager 0.45	149,076
Boring Machine 19kw	304,321	Engine Pump 4in	1,973
Breaker 1200kg	57,803	Grout Mixer	40,212
Bulldozer 11t	123,646	Grout Pump	27,501
Bulldozer 21t	264,819	Hand Hammer 1.1m3	4,873
Compressor 4.6m3	64,244	Hydro-Shovel 0.6m3	131,656
Compressor 9.6m3	133,871	Line Marker 90kg	20,297
Compressor 20m3	186,829	Mac. Roller 12t	154,100
Tandem Roller 10t	75,125	Motor Grader 3.7m	107,976
Tire Roller 15t	98,835	PC Jack	5,839
Conc. Bucket	17,969	Road Sweeper 1.8m	214,837
Truck 5t	56,634	Soil Compactor 0.05t	9,095
Truck 8t	74,513	Soil Compactor 0.2t	19,430
Crawler Crane 35t	497,468	Soil Mixing Plant 15	235,263
Truck Crane 40t	464,911	Spray Gun	134,577
Truck Crane 70t	1,187,467	Spray Gun for tunnel	282,298
Distributor 4kl	126,986	Sprayer 0.3kl	4,122
Drill Jumbo 49ps	1,594,176	Surf. Vibrator 1.5*0	9,482

Source : JICA Study Team

10.2.5 Indirect Costs

Temporary work costs which include transportation of equipment and plant, mobilization and demobilization, installation and removal of such temporary facilities as power supply, environmental protection, safety facilities, quality and progress control, utilities and field office maintenance. Field management cost includes wages, office supplies, and other expenses included at field offices, while general administration includes the overhead of the contractor's head office.

These indirect costs can vary substantially from one contractor to another and are also dependent on the scale of project, and a number of assumptions must be made for their estimates. Therefore, for simplicity of the estimates, indirect costs have been estimated to be 20% of direct cost from previously implemented projects. The foreign currency portion and the local currency portion of indirect costs are shown in Table 10-2-4.

Table 10-2-4 Indirect Cost Component

Unit : Percent

Description	Foreign Portion	Local Portion	Total
1.Common Temporary Facilities			
1-1 Transportation	1.0 %	0.5 %	1.5 %
1-2 Mobilization	0.5	1.0	1.5
1-3 Temporary Facilities	0.5	1.0	1.5
1-4 Environment Control	0.5	0.5	1.0
1-5 Safety Facilities	0.5	0.5	210
1-6 Public Services Charge	0.0	0.5	0.5
1-7 Quality Control	1.0	0.5	1.5
1-8 Field Office Maintenance	0.5	1.5	2.0
Sub-total	5.0	5.0	10.0
2.Field Management	0.0	5.0	5.0
3.General Management	5.0	0.0	5.0
Total	10.0 %	10.0 %	20.0 %

Source : JICA Study Team

10.2.6 Engineering Services Cost

Engineering service costs vary and depend on the scales of the project, tender processing and contract method. Based on previous experiences the engineering service costs are estimated at 20% of the total of direct and indirect costs. The currency portion of foreign and local allocated to same ratio of the total cost.

10.2.7 Contingency

A contingency allowance has been included in the total cost to allow for unexpected cost identified through the detail design and construction stage. 10% of total construction and engineering service cost is assumed as physical contingency.

10.3 Result of Cost Estimates

10.3.1 Cost Items

Cost items are grouped into those each of which can be expressed by finished work quantity such as unit price per square meter of pavement areas. For actual cost estimation, each cost item is conceived of three stages: plant products, site products and work items. The work items conform with cost items for unit price. Plant product and site product are the items of the breakdown of each work items. Plant products are materials produced and delivered by a field plant, such as batching plant and asphalt mixture. The concrete pavement is placed, compacted, finished and cured, which is a site product. Work item is for example a pavement consisting of site product such as an aggregate sub base course, and expansion joint. The unit price of each work item, such as per square meter in the case of pavement, is multiplied by the quantity calculated through designing.

10.3.2 Estimated Project Cost

The Ratio of each item of construction is shown in Figure 10-3-1, and Table 10-3-1 shows the result of estimated cost for Tawaeli - Toboli road.

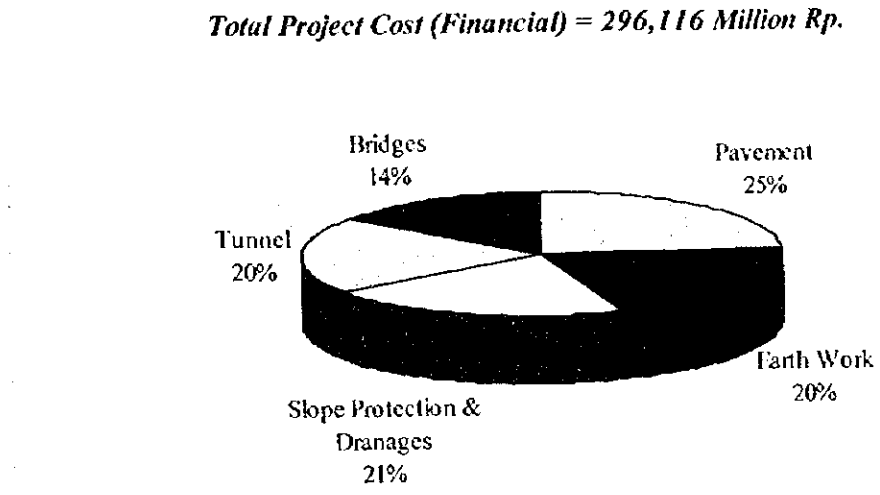


Figure 10-3-1 Construction Cost Ratio for Tawaeli-Toboli Road

Table 10-3-1 Total Construction Cost For Tawaeli - Toboli Road

Rate : 1US$ = 10600Rp = 140Yen

Item	Unit	Quantity	Unit Price			Total Price (Mill.Rp)			
			Foreign (US$)	Financial (Rp)	Economic (Rp)	Foreign (US$)	Financial (Rp)	Economic (Rp)	otal Financial (Mill.R
1.Preparation Works									
Clearing and Grubbing	m2	408,273	0.23	1,867	2,099	93,903	762,245,691	856,965,027	1,758
2.Pavement									
Road Asphalt Concrete + Sub base	m	40,050	44.02	463,998	426,836	1,763,001	18,583,119,900	17,094,781,800	37,271
3.Earth Work									
Excavation (Common)	m3	681,982	0.92	7,407	8,213	627,423	5,051,437,711	5,601,114,881	11,702
Excavation (Soft Rock)	m3	170,495	4.12	33,605	36,492	702,441	5,729,497,917	6,221,718,137	13,175
Disposal soil (L=5km)	m3	564,842	1.20	8,610	10,050	677,810	4,863,289,620	5,676,662,100	12,048
Sub-3						2,007,675	15,644,225,248	17,499,495,118	36,926
4.Drninage									
Pipe Culvert (D=100cm)	m	2,630	44.35	634,758	554,426	116,662	1,669,726,687	1,458,413,897	2,906
Box Culvert (B=2.0m, H=2.0m)	m	500	325.89	3,064,762	2,510,606	162,945	1,532,381,000	1,255,303,000	3,260
U-ditch (U=30cm)	m	19,729	1.71	41,910	36,720	33,736	826,829,817	724,437,864	1,184
Sub-4						313,343	4,028,937,504	3,438,154,761	7,350
5.Slope Protection									
Sprayed Concrete Cribwork	m2	83,921	14.68	127,197	88,984	1,231,957	10,674,473,998	7,467,608,467	23,733
Shotcrete Work	m2	22,654	11.82	101,390	67,157	267,770	2,296,889,060	1,521,374,678	5,135
Stone Masonry	m2	6,530	6.91	116,286	109,711	45,121	759,324,323	716,390,888	1,238
Mat Gabion	m2	10,518	9.20	72,584	61,374	96,766	763,438,512	645,531,732	1,789
Sodding	m2	42,072	0.08	3,238	2,851	3,366	136,229,136	119,947,272	172
Sub-5						1,644,980	14,630,355,028	10,470,853,037	32,067
6.Tunnel	m	650	3,500.00	22,400,000	17,920,000	2,275,000	14,560,000,000	11,648,000,000	38,675
7.Bridges									
10m	No	9	12,372.18	134,014,085	110,585,665	111,350	1,206,126,765	995,270,985	2,386
20m	No	16	34,505.53	300,749,082	241,058,427	552,088	4,811,985,313	3,856,934,829	10,664
30m	No	7	56,457.22	475,879,223	378,527,486	395,201	3,331,154,559	2,649,692,405	7,520
40m (20+20)	No	4	67,604.07	588,044,892	468,562,717	270,416	2,352,179,568	1,874,250,868	5,219
50m (25+25)	No	1	86,933.54	743,917,706	590,880,074	86,934	743,917,706	590,880,074	1,665
60m (30+30)	No		111,194.78	935,315,558	740,488,806	0	0	0	0
Sub-7						1,415,988	12,445,363,911	9,967,029,161	27,455
8.Sefty Facilities Works									
Guard Railing	m	28,500	11.30	168,012	143,025	322,050	4,788,342,000	4,076,212,500	8,202
Traffic Sign	each	132	27.98	426,548	373,259	3,680	56,101,584	49,092,766	95
Line Marking	m	39,457	0.42	4,231	3,518	16,572	166,944,259	138,811,133	343
Sub-8						342,302	5,011,387,843	4,264,116,399	8,640
9.Mobilization & Temporally Works (20% of Total Cost)						1,793,786	19,014,127,266	16,542,290,722	38,028
10.Sub -Total						11,649,978	104,679,762,392	91,781,686,024	228,170
11.Reduction of Bina Marga Project *						-217,302	-1,535,600,000	-1,228,480,000	-3,839
12.Engineering Cost (20% of 10-11)						2,539,591	17,946,442,176	14,357,153,740	44,866
13.Contingency (10% of 10-11+12)						1,397,227	12,109,060,457	10,491,035,976	26,920
Ground Total Cost (10-11+12+13)						15,369,493	133,199,665,025	115,401,395,740	296,116
NOTES			Total Cost Yen (Mill.)			2,152	1,759	1,524	3,911

*1. * : Bina Marga's design section in 1995 .*

10.4 Implementation Plan

As shown in Figure 10-4-2, the construction period will be in total 5 years consisting of one year for preparation of project fund raising plan, 1.5 years for detail design of the roads and 2.5 years for construction. Also, the investment plan was proposed to be set in accordance with the construction plan.

10.5 Maintenance Cost

Maintenance costs are necessary for the financial and economic analysis of the project. Maintenance work is classified into routine maintenance work and periodic maintenance work. Routine maintenance work is required irrespective of traffic volume and includes such as works as grass cutting and the cleaning of road side ditch or culverts. Periodic maintenance work is required depending on traffic volume and road surface condition and includes such works as overlay, patching, sealing, and other road surface repair, as well as the repair of bridge structures.

Item	Unit	Quantity	1999	2000	2001	2002	2003	Total
1. Preparation of Project								
2. Survey and Design								
3. Construction								
Earth Work								
Slope Protection								
Tunnel								
Bridges								
Pavement								
Foreign (US$)				698,387	3,281,909	6,048,951	5,340,245	15,369,493
Financial (Rp)				4,935,271,598	27,006,774,703	50,027,831,666	51,229,787,058	133,199,665,025
Economic (Rp)				3,948,217,279	25,224,850,173	42,473,168,921	43,755,159,368	115,401,395,740
Total Financial (Mill. Rp)				12,338	61,795	114,147	107,836	296,116

Figure10-4-1 Implementation Schedule For Tawaeli - Toboli Road

Chapter 11

Economic Project Analysis

Chapter 11 ECONOMIC PROJECT ANALYSIS

11.1 General

The main purpose of the economic project analysis is to show the effect of the improvement of the Tawaeli - Toboli road (the Project) from the nation's economic well-being viewpoint and to assess the economic viability of the Project.

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

11.2 Economic Project Costs

The economic investment costs are estimated in constant 1998 prices. The financial investment costs in terms of market price include the component of taxes. The economic costs for economic analysis are obtained by subtracting the portion of transfer payment such as taxes from financial costs. Implementation is scheduled over four years from 2000 to 2003. The phased financial and economic investment costs (initial investment) summarized in Table 11-2-1.

Table 11-2-1 Phased Initial Project Costs in 1998 Prices

(Million Rp.)

Year	Financial Prices	Economic Prices
2000	12,338	11,351
2001	61,795	60,013
2002	114,147	106,592
2003	107,836	100,362
Total	296,116	278,318

Source : JICA Study Team

The maintenance cost of the proposed road follows the engineering study results of the cost estimates (refer to Chapter 10). Besides, the maintenance cost of the proposed road in the case of "without the improvement of the proposed road" is treated as a negative cost. Moreover, the counter-disaster cost for the land slide of Million Rp. 152 per annum is assumed additionally as a maintenance cost of "without the improvement of the proposed road".

No conversion factors are assumed, considering the estimation results of values of some factors. The standard conversion factor and the consumption conversion factor were estimated as 0.98 and 0.99. As these values are judged to be negligible, no adjustment by conversion factors is assumed as a result.

11.3 Economic Benefits

11.3.1 General

Benefits are classified into two types, one is the direct benefit and the other is the indirect benefit or intangible benefit.

(1) Direct Benefits

1) Benefit of Saving in Vehicle Operating Cost

The direct benefits which would be realized from the implementation of the Project are defined as the savings in travel costs, composed of the vehicle operating cost and vehicle time cost when comparing the "with" and "without" project conditions.

The benefit of vehicle operating costs is estimated as a difference of vehicle operating costs between "with" Project" case and "without" Project" case. The vehicle operating cost is derived from the obtained daily vehicle-kilometers and the unit vehicle operating cost by vehicle type.

In this economic analysis, no benefit of savings in vehicle time cost is assumed as direct benefit.

2) Benefit of Disaster Prevention

Currently, Tawaeli - Toboli road suffers from a traffic blockade due to frequent disasters especially during a wet season. According to the information obtained from Bina Marga, the period of traffic blockade is estimated approximately two weeks per annum.

When the road improvement is implemented, such a traffic blockade condition will be expected to be prevented. In this economic analysis, such a prevention of traffic blockade is treated as a benefit of disaster prevention.

(2) Indirect Benefits

Indirect benefits would be many possible intangible benefits of the Project, e.g. additional employment, multiple effects, etc.

Additional employment (job creation) can be expected during the period of the construction stage. The realization of the road improvement will lead not only better and easier access between the related area (both a resolution of limited traffic condition and an assurance of twenty-four hour sound traffic), but it will also induce so-called development effects such as the inducement of new and/or incremental industrial development along the corridor through an improvement of distribution of commodities.

(3) Benefits to be Treated

In this economic analysis, the above-mentioned direct benefits, e.g. the saving in vehicle

operating cost and the effect of disaster prevention are computed as quantified benefits.

The calculation of direct benefits are made for the planning year of 2003 and 2018.

11.3.2 Computation of Economic Benefit

(1) Saving in Vehicle Operating Cost

1) General

The quantified economic benefit is defined as the saving in vehicle operating cost when comparing the "with" and "without" project situations.

The "with" project situation means the "with" project traffic assignment in vehicle-kilometers on vehicles' route between origin and destination, including an improvement of the proposed Tawaeli - Toboli road. The "without" project situation is the traffic assignment on vehicles' route without an improvement of the proposed road.

The total daily economic vehicle operating costs, in both the "with" and "without" conditions, are calculated by taking the daily vehicle-kilometers of the traffic assignment of road links and multiplying them by the respective unit vehicle operating costs determined by both speed and IRI (international roughness index). These daily costs are then converted to total annual costs by multiplying by 365 days.

The economic benefit in operating costs is then taken as the saving in operating costs when comparing the total "with" and "without" project vehicle operating costs.

2) Unit Vehicle Operating Cost

a) General

The estimation of unit vehicle operating cost was based on the method in the study results of "Revised Road User Cost Model Manual - Working Paper, Integrated Road Management Systems (IRMSs), September 1997, Bina Marga," compiled by N.D. Lea International Ltd., (hereinafter referred to as "Revised Model".) Then, such major cost components comprising unit vehicle operating costs as vehicle price, tyre price, fuel price, lubrication price, etc. were reviewed through the latest site survey (interview survey) at Jakarta by the Study Team, and the reviewed values of "Base Cost" in the cost equations were assumed.

According to the above "Revised Model", the unit vehicle operating costs (VOC) are expressed by the following equations:

Unit VOC	=	VOC Index x Base Cost
VOC Index	=	K1 + K2/V + K3 x V^2 + K4 x V x IRI + K5 x IRI^2
where,		
K1, K2, K3, K4, K5	:	Parameters
V	:	Velocity
IRI	:	International Roughness Index

The values of Parameters and Base Cost are different by vehicle type.

The vehicle categories in the study of "Revised Model" are as follows:

- Passenger car
- Utility
- Light truck
- Medium truck
- Heavy truck
- Small bus
- Large bus

b) Review of Vehicle Type

For application of the above equations of unit vehicle operation cost, the vehicle categories were reviewed.

The vehicle categories used in the transportation analysis in this Study are as follows:

- Passenger car
- Bus
- Truck
- Motorcycle

According to the results of traffic survey conducted by the Study Term, the vehicle category of "bus" in the Study represents a so-called microlet type bus out of microlet type bus, mini-bus and large-bus. This vehicle type is equivalent to that of "utility" in the study of "Revised Model". Accordingly, the unit vehicle operating cost equation for "utility" in the "Revised Model" was applied to the "bus" in the economic analysis.

Also according to the traffic survey results, the vehicle category of "truck" in the Study represents the pick-up type or two-axles truck out of pick-up, two-axles truck, three-axles truck, heavy truck and trailer. This vehicle type is judged to be equivalent to that of "light truck" in the study of "Revised Model". Accordingly, the unit vehicle operating cost equation for "light truck" in the "Revised Model" was applied to the "truck" in the economic analysis.

For "passenger car", the equations for the vehicle types of "passenger car" was directly applied.

Regarding "motorcycle", not cost equation is available in the report of "Revised Model". Consequently, due to the data limitation, the estimation of the cost equation of "motorcycle" was similarly assumed based on that of "passenger car". That is, "parameters" in the equation of "motorcycle" was assumed to be the same at those of "passenger car", and "Base Cost" was estimated based on the manner mentioned below:

- The report of "Revised Model" has shown the calculation results of unit vehicle operation costs of "motorcycle" in monetary basis for several combinations of

velocity and IRI, instead of cost equation for "motorcycle".

- The unit vehicle operating costs in monetary basis of "passenger car" was calculated based on the given equation for "passenger car" in "Revised Model" for the same combination of velocity and IRI as in the above case of "motorcycle".
- Through comparison of calculated results of unit vehicle operating costs between "passenger car" and "motorcycle", the average ratio between "passenger car" and "motorcycle" was obtained. So, using this average ratio, "Base Cost" for "motorcycle" was assumed to be 0.16 of that for "passenger car".

c) Assumption of Cost Equations

Based on the obtained price information about such major cost components comprising unit vehicle operating costs as vehicle price, tyre price, fuel price, lubrication price, etc. through the latest interview survey to car dealers, type shops, gasoline station at Jakarta by the Study Team, the values of "Base Cost" in the equations were reviewed.
As a result, the reviewed values of parameters and base cost in the unit vehicle operating cost equations (with passenger time) assumed for this economic analysis are expressed as follows:

Vehicle Type	Parameters					Base Cost
	K1	K2	K3	K4	K5	
Psg. Car	0.841862	14.061501	0.000003	0.000009	0.000804	770.90
Bus	0.690233	25.978714	0.000007	0.000011	0.001708	881.30
Truck	0.614855	27.584956	0.000013	0.000044	0.001153	968.80
Motorcycle	0.841862	14.061501	0.000003	0.000008	0.000804	123.40

Note: Parameters for Passenger Car, Bus and Truck were based on "Revised Road" User Cost Model Manual, September 1997.
Base Costs for Passenger Car, Bus and Truck were assumed by the Study Team.
Parameters and Base Cost for Motorcycle were assumed by the Study Team.

The details of review of unit vehicle operating cost are shown in APPENDIX .
The data of speed and IRI (International Roughness Index) for each road link in the case of "without Project" were based on the inventory data complied by Bina Marga and reviewed by the Study Team. And those in the case of "with Project" were assumed from the viewpoint of the engineering study by the Study Team.

3) Estimation of Benefits

The benefits of saving in vehicle operating cost are estimated as below:

Benefit = (Total vehicle operating costs in Without case) - (Total vehicle operating costs in With case)

Total vehicle operating costs in Without case = (Vehicle-kilometer in Without case) x (Unit VOC in Without case)

Total vehicle operating costs in With case = (Vehicle-kilometer in With case) x (Unit

VOC in With case)

The calculations of vehicle operating cost are made for each vehicle type and each road link in the whole network, and the above costs are summed up.

(2) Disaster Prevention

The benefit of disaster prevention is estimated as below:

Benefit = (Vehicle-kilometer in without case) x (Unit vehicle operating cost in without case) x 0.5 x (Blockade days (assumed to be 14 days))

The above calculation is made for the link of Tawaeli - Toboli road.

(3) Estimation of Economic Benefit

As a result, the saving in vehicle operating cost and the disaster prevention are summarized as shown in Table 11-3-1.

Table 11-3-1 Estimated Economic Benefits

(Million Rp. at 1998 price)

Year	Saving in VOC	Disaster Prevention	Total
2004	19,359	912	22,275
2018	159,918	4,453	166,389

Source : JICA Study Team

11.4 Economic Cost-Benefit Analysis

(1) Basic Assumptions

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

Apart from the elements previously discussed, the following basic assumptions were made for the economic project analysis:

Project life : 20 years after completion of the proposed road
Price : 1998 prices
Residual value : None

The NPV and B/C were calculated based on a discount rate of 15 percent.

(2) Economic Cost-benefit Analysis

The economic project costs were previously discussed in Section 11.2. The economic benefit of the savings in vehicle operating costs and disaster prevention for the planning years were discussed previously in Section 11.3. The benefits in the intermediate years were interpolated and those beyond 2018 were assumed to be fixed.

The total economic project costs and benefits streams are presented in Table 11-4-1.

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

Efficiency Measures	
EIRR	19.8 %
NPV (Million Rp.)	76,555
B/C	1.5

Source : *JICA Study Team*

Notes EIRR: Economic Internal Rate of Return
NPV: Net Present Value at discount rate of 15 %
B/C: Benefit Cost Ratio at discount rate of 15 %

These results indicate that implementation of the Project (road improvement of Tawaeli - Toboli) is economically feasible.

Table 11-4-1 Economic Analysis Cash Flow (For F/S of Tawaeli - Toboli Road

EIRR = 19.8%
NPV = 76,555 (Million Rp.)
B/C = 1.50
(Discount Rate = 15.0 %)

(Million Rp.)

	Year	Benefits		Total	Costs		Total	Maint. Cost (Without)	Net Cash Flow
		VOC Saving	Disaster prevention		Invest. Costs	Maint. Cost (With)			
1	1999				0	0	0	0	0
2	2000				11,351	85	11,436	5,860	-5,576
3	2001				60,013	85	60,098	85	-60,013
4	2002				106,592	85	106,677	85	-106,592
5	2003	0	0		100,362	85	100,447	85	-100,362
6	2004	19,359	912	20,271		85	85	85	20,271
7	2005	29,399	1,165	30,564		85	85	5,860	36,339
8	2006	39,438	1,418	40,857		85	85	85	40,857
9	2007	49,478	1,671	51,150		85	85	85	51,150
10	2008	59,518	1,924	61,442		85	85	85	61,442
11	2009	69,558	2,177	71,735		9,462	9,462	85	62,358
12	2010	79,598	2,430	82,028		85	85	5,860	87,803
13	2011	89,638	2,683	92,321		85	85	85	92,321
14	2012	99,678	2,936	102,614		85	85	85	102,614
15	2013	109,718	3,188	112,907		85	85	5,860	118,682
16	2014	119,758	3,441	123,200		85	85	85	123,200
17	2015	129,798	3,694	133,493		85	85	85	133,493
18	2016	139,838	3,947	143,786		9,462	9,462	5,860	140,184
19	2017	149,878	4,200	154,078		85	85	85	154,078
20	2018	159,918	4,453	164,371		85	85	85	164,371
21	2019	159,918	4,453	164,371		85	85	5,860	170,146
22	2020	159,918	4,453	164,371		85	85	85	164,371
23	2021	159,918	4,453	164,371		85	85	85	164,371
24	2022	159,918	4,453	164,371		85	85	5,860	170,146
25	2023	159,918	4,453	164,371		9,462	9,462	85	154,994
					278,318				

(3) Sensitivity Analysis

Assuming that the benefits and cost stream might alter ±10 %、±20 %, the effect on the EIRR was tested and the results are summarized in Table 11-4-2. In the most severe case of - 20 % benefit and + 20 % cost, the value of EIRR is 15.0 %.

Table 11-4-2 EIRR by Altered Benefit and Cost

Cost	Benefit		
	Base	- 10 %	- 20 %
Base	19.8 %	18.5 %	17.1 %
+ 10 %	18.6 %	17.4 %	16.0 %
+ 20 %	17.6 %	16.3 %	15.0 %

Source : JICA Study Team

Chapter 12

Conclusions and Recommendations

Chapter 12 CONCLUSIONS AND RECOMMENDATIONS

12.1 Design Standard

The following design standards are recommended as shown in Table 12-1-1.

Table 12-1-1 Design Standards

Items	Design Standards
1. Road Classification	Arterial Road
2. Design Speed	60 km/h (Flat & Rolling Terrain) 30 km/h (Mountainous Terrain)
3. Number of Lanes	Two lane
4. Road Width	3.0 m x 2 (lane width) 1.0 m x 2 (shoulder width)
5. Pavement Thickness	Asphalt (10 cm), Asphalt Treated Base (20 cm), Sub-Base Course (25 cm)
6. Traffic Volume	886 veh/d (1997) 3,850 veh/d (2018)

Source: JICA Study Team

12.2 Selection of Route and Salient Features

Alternative C Route is recommended and its salient features are as follows:

Table 12-2-1 Salient Features of Tawaeli-Toboli Road

Items	Major Salient Features
1. Existing Road Length	45.8 km
2. Planned Road Length	40.1 km
3. Bridge Length	830 m (cumulative)
4. Tunnel Length	620 m
5. Slope Protection Works	165,700 m^2

Source: JICA Study Team

Tunnel construction was recommended for the following reasons:

- Disaster prevention on the road where slope protection structure is not practical.
- Ensuring of adequate road alignment by reducing of sharp turns.

12.3 Environment

(1) Slope protection works such as sprayed concrete cribwork, shotcrete work, stone masonry and mat gabion for fill and cut slopes should be constructed for prevention from soil erosion and land sliding.

(2) More than 560,000 m^3 of disposal soil was estimated to be produced by construction of the road due to the imbalance of cut and fill volume. The following points need to be heeded in regards to selection of dumping sites:

- Excavated soil should not be dumped or left as is in excessively rainy or dry seasons.
- Dump sites in which exposed or graded surfaces of excavated soil can be minimized should be selected.
- Planting or seeding of dumped soil should be undertaken immediately.
- Proper drainage facilities should be supplied to prevent adverse environmental affects (e.g., water contamination, filling, maddiness, etc.) down stream from the locations.
- Access roads to dump sites should be supplied.

(3) The changing of the groundwater flow made by the construction stage of the tunnel would be predicted. Some consideration such as monitoring should be made on the groundwater flow.

(4) The alignment change and widening of the existing road should be minimized to reduce impact on the Parigi-Binangga Nature Reserve.

12.4 Project Cost and Implementation Schedule

The estimated project cost (in July 1998 prices) and implementation schedule are shown in Figure 12-3-1.

Item	Unit	Quantity	1999	2000	2001	2002	2003	Total
1. Preparation of Project								
2. Survey and Design	km	40.05						
3. Construction								
Earth work	m^3	852,447.00						
Slope Protection	m^2	165,695.00						
Tunnel	m	650.00						
Bridges	m	830.00						
Pavement	km	40.05						
Foreign Currency (Thousand US$)			-	698	3,282	6,049	5,340	15,369
Local Currency (Billion Rp)			-	4.94	27.01	50.03	51.23	133.20
Total Cost (Billion Rp)			-	12.34	61.80	114.15	107.84	296.12

Source: JICA Study Team

Figure 12-3-1 Project Cost and Implementation Schedule for Tawaeli-Toboli Road

12.5 Economic Analysis

The economic cost and benefit calculation is as shown in Table 12-5-1.

Table 12-5-1 Benefit and Cost Analysis

EIRR	NPV (Million Rp)	B/C
19.8 %	76,555	1.50

Source: Discount Rate 15 % p.a.

Tawaeli-Toboli road is a feasible project and should be completed by the end of year 2003.

APPENDICES

APPENDICES

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APPENDIX A-11-1 Details of Review of Unit Vehicle Operating Cost

(1) General

The estimation of unit vehicle operating cost was based on the method in the study results of "Revised Road User Cost Model Manual -- Working Paper, Integrated Road Management Systems (IRMSs), September 1997, Bina Marga," compiled by N.D. Lea International Ltd., (hereinafter referred to as "Revised Model".)

Then, such major cost components comprising unit vehicle operating costs as vehicle price, tyre price, fuel price, lubrication price, etc. were reviewed through the latest site survey (interview survey) at Jakarta by the Study Team, and the reviewed values of "Base Cost" in the cost equations were assumed for this economic analysis.

According to the above "Revised Model", the unit vehicle operating costs (VOC) are expressed by the following equations:

Unit VOC = VOC Index x Base Cost

VOC Index = $K1 + K2/V + K3 \times V^{2} + K4 \times V \times IRI + K5 \times IRI^{2}$

where,

K1, K2, K3, K4, K5	:	Parameters
V	:	Velocity
IRI	:	International Roughness Index

The values of Parameters and Base Cost are different by vehicle type.

The vehicle categories in the study of "Revised Model" are as follows:

- Passenger car
- Utility
- Light truck
- Medium truck
- Heavy truck
- Small bus
- Large bus

(2) Review of Vehicle Type

For application of the above equations of unit vehicle operating cost, the vehicle categories were reviewed.

The vehicle categories used in the transportation analysis in this Study are as follows:

- Passenger car
- Bus
- Truck
- Motorcycle

According to the results of traffic survey conducted by the Study Team, the vehicle

category of "bus" in the Study represents a so-called microlet type bus out of microlet type bus, mini-bus and large-bus. This vehicle type is equivalent to that of "utility" in the study of "Revised Model." Accordingly, the unit vehicle operating cost equation for "utility" in the "Revised Model" was applied to the "bus" in the economic analysis.

Also according to the traffic survey results, the vehicle category of "truck" in the Study represents the pick-up type or two-axles truck out of pick-up, two-axles truck, three-axles truck, heavy truck and trailer. This vehicle type is judged to be equivalent to that of "light truck" in the study of "Revised Model". Accordingly, the unit vehicle operating cost equation for "light truck" in the "Revised Model" was applied to the "truck" in the economic analysis.

For "passenger car," the equations for the vehicle types of "passenger car" was directly applied.

Regarding "motorcycle", no cost equation is available in the report of "Revised Model". Consequently, due to the data limitation, the estimation of the cost equation of "motorcycle" was similarly assumed based on that of "passenger car". That is, "Parameters" in the equation of "motorcycle" were assumed to be the same as those of "passenger car", and "Base Cost" was estimated based on the manner mentioned below:

- The report of "Revised Model" has shown the calculation results of unit vehicle operating costs of "motorcycle" in monetary basis for several combinations of velocity and IRI, instead of cost equation itself for "motorcycle".
- The unit vehicle operating costs in monetary basis of "passenger car" were calculated based on the given equation for "passenger car" in "Revised Model" for the same combination of velocity and IRI as in the above case of "motorcycle".
- Through comparison of calculated results of monetary basis unit vehicle operating costs between "passenger car" and "motorcycle", the average ratio between "passenger car" and "motorcycle" was obtained. So, using this average ratio, "Base Cost" for "motorcycle" was assumed to be 0.16 of that for "passenger car" (See Table A 11-17).

After reviewing about vehicle category, the cost equations of unit vehicle operating cost is reviewed. The Parameters and Base Costs for Passenger Car, Bus and Truck were based on "Revised Model", and the Parameter and Base Cost for Motorcycle was assumed by the Study Team.

As a result, the tabulation of the cost equations of unit vehicle operating cost (with passenger time) is shown as follows:

Table A 11-1 Unit Vehicle Operating Cost

Vehicle Type	Parameters					Base Cost
	K1	K2	K3	K4	K5	
Psg. Car	0.841862	14.061501	0.000003	0.000008	0.000804	428.30
Bus	0.690233	25.978714	0.000007	0.000011	0.001708	417.70
Truck	0.614855	27.584956	0.000013	0.000044	0.001153	419.40
Motorcycle	0.841862	14.061501	0.000003	0.000008	0.000804	68.50

Note : Parameters and Base Costs for Passenger Car, Bus and Truck were based on "Revised Road User Cost Model Manual, September 1997. Parameters and Base Cost for Motorcycle were assumed by the Study Team.

(3) Review of "Base Cost" Values

Through reviewing about cost components comprising unit vehicle operating cost, the values of "Base Cost" in the cost equation are reviewed.

1) Cost Component in "Revised Model"

According to "Revised Model", the percentage breakdown of cost components about unit vehicle operating cost are shown as follows:

Table A 11-2 Breakdown of Cost Components

		Psg. Car (Psg Car)	Utility (Bus)	Light Truck (Truck)
Total	%	100.0	100.0	100.0
Fuel	%	10.0	19.7	21.9
Lubricants	%	2.3	2.3	3.4
Tyres	%	1.2	1.5	10.5
Crew Time	%	0.0	9.3	11.9
Passenger Time	%	10.0	9.7	9.7
Cargo Holding	%	0.0	0.0	0.0
Maintenance Labour	%	0.9	2.3	4.8
Maintenance Parts	%	8.8	19.6	10.7
Depreciation	%	38.1	25.1	18.1
Interest	%	28.6	10.4	8.9
Overhead	%	0.0	0.0	0.0

Source: Revised Road User Cost Model Manual, Sep. 1997.

Considering the characteristics of above each cost component, the above percentages were aggregated by major cost component items, for the sake of convenience of estimation, as follows:

Table A 11-3 Major Cost Component Items

		Psg. Car (Psg Car)	Utility (Bus)	Light Truck (Truck)
Total	%	100.0	100.0	100.0
Related to Fuel	%	10.0	19.7	21.9
Related to Lubricants	%	2.3	2.3	3.4
Related to Tyres	%	1.2	1.5	10.5
Related to Vehicle Price	%	75.5	55.1	37.7
Related to Personnel Cost	%	0.9	11.6	16.7
Related to Passenger Time Value	%	10.0	9.7	9.7

Note: Aggregated by the Study Team based on "Revised Model".

2) Review of Prices for Cost Component Items

For reviewing above cost component items, the survey to obtain information about vehicle price, tyre price, fuel price, lubrication price, etc., was made by interview to car dealer, tyre shop, gasoline station, etc. at Jakarta on July 1998 by the Study Team.

The prices shown in "Revised Model" and those obtained by "interview survey" for each major cost component were compared, and the changing ratios were obtained.

a. Vehicle Prices

i) According to "Revised Model", the vehicle prices are shown below:

Table A 11-4 Vehicle Prices

Revised Model				
Vehicle Category	Representative Vehicle	Financial Price (Rp. 1,000)	Economic Price (Rp. 1,000)	
Psg. Car	Toyota Corolla 1600	75,702	41,418 (a)	
Utility	Mitsubishi Colt L300 Mini Bus	48,026	41,558 (b)	
Light Truck	Mitsubishi Colt FE119	47,050	39,859 (c)	

Source: Revised Road User Cost Model Manual, Sep. 1997

ii) According to the interview survey results, the revised vehicle prices and the estimated changing ratios are shown as follows:

Table A 11-5 Revised Vehicle Prices

Interview Survey				
Vehicle Category	Representative Vehicle	Financial Price (Rp. 1,000) (Interviewed)	Economic Price (Rp. 1,000) (Estimated)	Estimated Changing Ratio
Psg. Car	Toyota Corolla 1600	128,591	70,355 (d)	1.70 (d) / (a)
Utility	Mitsubishi Colt L300 Mini Bus	99,400	86,013 (e)	2.07 (e) / (b)
Light Truck	Mitsubishi Colt FE119	103,600	87,766 (f)	2.20 (f) / (c)

Source: Interview survey from car dealers at Jakarta, July 1998.
Note: Economic prices were estimated based on the same ratios between financial price and economic price shown in "Revised Model".

b. Tyre Price

i) According to "Revised Model", the tyre prices are shown as below:

Table A 11-6 Tyre Prices

Revised Model				
Vehicle Category	Tyre Type	Financial Price (Rp. 1,000 / Set)	Economic Price (Rp. 1,000 / Set)	
Psg. Car	155/80 R-13	Tyre 56.0 Tube 13.0 Total 69.0	Total 62.7 (a)	
Utility	600 - 13	Tyre 70.0 Tube 13.0 Total 83.0	Total 75.5 (b)	
Light Truck	750 - 16	Tyre 175.0 Tube 25.0 Total 200.0	Total 181.8 (c)	

Source: Revised Road User Cost Model Manual, Sep. 1997

ii) According to the interview survey results, the revised tyre prices and the estimated changing ratios are shown as follows:

Table A 11-7 Revised Tyre Prices

Interview Survey				
Vehicle Category	Tyre Type	Financial Price (Rp. 1,000 / Set) (Interviewed)	Economic Price (Rp. 1,000 / Set) (Estimated)	Estimated Changing Ratio
Psg. Car	155/80 R-13	Tyre 251.0 Tube 27.5 Total 278.5	Total 253.2 (d)	4.04 (d) / (a)
Utility	600 – 13	Tyre 330.4 Tube 27.5 Total 357.9	Total 325.4 (e)	4.31 (e) / (b)
Light Truck	750 – 16	Tyre 735.5 Tube 75.0 Total 810.5	Total 736.8 (f)	4.05 (f) / (c)

Source: Interview survey from tyre shop at Jakarta, July 1998.
Note: Economic prices were estimated based on the same ratios between financial price and economic price shown in "Revised Model".

c. Lubricant Price

i) According to "Revised Model", the lubricants prices are shown as below:

Table A 11-8 Lubricants Prices

Revised Model				
Engine Type	(Vehicle Type)	Financial Price (Rp. / liter)	Economic Price (Rp. / liter)	
Gasoline	For : Psg. Car Utility	5,500	5,000 (a)	
Diesel	For : Light Truck	6,000	5,455 (b)	

Source: Revised Road User Cost Model Manual, Sep. 1997

ii) According to the interview survey results, the reviewed lubricants prices and the estimated changing ratios are shown as follows:

Table A 11-9 Revised Lubricants Prices

Interview Survey				
Engine Type	(Vehicle Type)	Financial Price (Rp. / liter)	Economic Price (Rp. / liter)	Estimated Changing Ratio
Gasoline	For : Psg. Car Utility	7,000	6,360 (c)	(d) 27 (c) / (a)
Diesel	For : Light Truck	7,500	6,810 (d)	(d) 25 (d) / (b)

Source: Interview survey from gasoline at Jakarta, July 1998.
Note: Economic prices were estimated based on the same ratios between financial price and economic price shown in "Revised Model".

d. Fuel Price

i) Economic Fuel Price in "Revised Model"

In "Revised Model", the economic fuel prices have been estimated on the basis of "petroleum product price".

"Revised Model" has assumed the economic fuel prices as follows:

- Gasoline Rp. 460/liter (equivalent to US$ 0.1812/liter)
- Diesel Rp. 450/liter (equivalent to US$ 0.1773/liter)

(Assumed exchange rate in "Revised Model" is estimated to be Rp. 2,538 per US$)

(According to "Revised Model", these economic fuel prices were assumed based on the two alternative calculations of "Indonesian Resource Cost Basis" and "World/Border Price Basis.)

According to "Indonesian Resource Cost Basis" calculation, the fuel cost component in "Revised Model" is shown as follows:

Table A 11-10 Fuel Cost

(US$ / liter)

	Gasoline	Diesel
Crude oil price	0.1132	0.1132
Other costs	0.0625	0.0593
Total	0.1757 (a)	0.1725 (b)

In the above cost component, the price of crude oil is assumed to be US$ 18 per barrel.

ii) Review of Economic Fuel Price

The review of economic fuel price is assumed to be based on the above cost component tabulation.

According to the obtained information, the recent price level of crude oil is reported to be approximately US$ 11 - 13 per barrel.

So that, applying this price level of US$ 12 per barrel., the above cost component tabulation is reviewed as follows:

Table A 11-11 Revised Fuel Cost

(US$ / liter)

	Gasoline	Diesel
Crude oil price (Estimated)	- 0755 (0.1132 x 12/18)	- 0755 (0.1132 x 12/18)
Other costs (the same as above)	0.0625	0.0593
Total	0.1380 (c)	0.1348 (d)

Then the factor was estimated below:

- Gasoline (c) / (a) = 0.1380 / 0.1757 = 0.785
- Diesel (d) / (b) = 0.1380 / 0.1725 = 0.782

As a result, the factor was assumed to be 0.78.

The reviewed economic fuel prices in US$ basis were assumed below:

- Gasoline 0.1812 x 0.78 = 0.1413 (US$ per liter)
- Diesel 0.1773 x 0.78 = 0.1383 (US$ per liter)

Assuming the exchange rate of Rupiah 10,600 per US$, the economic fuel prices in Rupiah basis were estimated below:

- Gasoline US$ 0.1413 x Rp. 10,600 = Rp. 1,498
- Diesel US$ 0.1383 x Rp. 10,600 = Rp. 1,466

Finally, the changing ratios of economic fuel prices were assumed below:

- Gasoline Rp. 1,498 / Rp. 460 = 3.26
- Diesel Rp. 1,466 / Rp. 450 = 3.26

e. Personnel Cost

Regarding "Personnel Cost", the changing ratios are assumed to be 1.2, in consideration with the personnel cost in the cost estimates about the proposed road construction in this Study.

f. Passenger Time Value

Regarding "Passenger Time Value", the changing ratios are assumed to be 1.0.

3) Assumed Weighted Average Changing Ratio

Based on the above results of estimated changing ratio about cost components, the

weighted average changing ratios for each vehicle type were assumed as follows:

Table A 11-12 Weighted Average Changing Ratio (Car)

(a) Psg. Car				
Cost Component	Cost Composition	Assumed Changing Ratio	Assumed Cost Composition	Weighted Average Cost Composition
Fuel Price	10.0	3.26	32.6	
Lubricants Price	2.3	1.27	2.9	
Tyre Price	1.2	4.04	4.8	
Vehicle Price	75.5	1.70	128.4	
Personnel Cost	0.9	1.20	1.1	
Passenger Time Cost	10.0	1.00	10.0	
Total	100.0		179.8	1.80

Source: Estimated by the Study Team.

Table A 11-13 Weighted Average Changing Ratio (Utility)

(b) Utility				
Cost Component	Cost Composition	Assumed Changing Ratio	Assumed Cost Composition	Weighted Average Cost Composition
Fuel Price	19.7	3.26	64.2	
Lubricants Price	2.3	1.27	2.9	
Tyre Price	1.5	4.31	6.5	
Vehicle Price	55.1	2.07	114.1	
Personnel Cost	11.6	1.20	13.9	
Passenger Time Cost	9.7	1.00	9.7	
Total	100.0		211.3	2.11

Source: Estimated by the Study Team.

Table A 11-14 Weighted Average Changing Ratio (Light Truck)

(c) Light Truck				
Cost Component	Cost Composition	Assumed Changing Ratio	Assumed Cost Composition	Weighted Average Cost Composition
Fuel Price	21.9	3.26	71.4	
Lubricants Price	3.4	1.25	4.3	
Tyre Price	10.5	4.05	42.5	
Vehicle Price	37.7	2.20	82.9	
Personnel Cost	16.7	1.20	20.0	
Passenger Time Cost	9.7	1.00	9.7	
Total	100.0		230.8	2.31

Source: Estimated by the Study Team.

4) Assumption of Reviewed "Base Cost" as of July 1998

Based on the assumed changing ratios by vehicle type, the "Base Costs" in "Revised

Model" were reviewed as follows:

Table A 11-15 Revised Weighted Average Changing Ratio

	Base Cost in "Revised Model"	Assumed Changing Ratio	Assumed Reviewed Base Cost
Psg. Car	428.3	1.80	770.9
Utility	417.7	2.11	881.3
Light Truck	419.4	2.31	968.8
Motorcycle	(68.5) (428.3 x 0.16)		(123.4) (770.9 x 0.16)

Source: Estimated by the Study Team.

(4) Reviewed Cost Equations

As a result, the revised values of parameters and base cost in the unit vehicle operating cost equations (with passenger time) assumed for this economic analysis are expressed as follows:

Table A 11-16 Revised Values of Base Cost

	Parameters					
Vehicle Type	K1	K2	K3	K4	K5	Base Cost
Psg. Car	0.841862	14.061501	0.000003	0.000008	0.000804	770.90
Bus	0.690233	25.978714	0.000007	0.000011	0.001708	881.30
Truck	0.614855	27.584956	0.000013	0.000044	0.001153	968.80
Motorcycle	0.841862	14.061501	0.000003	0.000008	0.000804	123.40

Note : Parameters for Passenger Car, Bus and Truck were based on "Revised Road User Cost Model Manual, September 1997.
Base Costs for Passenger Car, Bus and Truck were assumed by the Study Team.
Parameters and Base Cost for Motorcycle were assumed by the Study Team.

Table A 11-17 Estimation of Average Ratio of Unit VOC between "Passenger Car" and "Motorcycle"

Speed	IRI	Motorcycle VOC
10	3	232.9
	5	235.7
	7	234.9
	9	239.0
	11	242.7
	13	243.5
	15	246.0
	17	246.1
21.4	3	133.0
	5	135.9
	7	135.1
	9	139.3
	11	143.0
	13	143.9
	15	147.4
	17	146.6
32.9	3	96.1
	5	99.1
	7	98.4
	9	102.2
	11	105.8
	13	106.7
	15	109.2
	17	109.4
44.3	3	78.5
	5	81.7
	7	80.9
	9	84.6
	11	88.1
	13	89.0
	15	91.6
	17	91.7
55.7	3	68.3
	5	71.6
	7	70.8
	9	74.4
	11	77.9
	13	78.7
	15	81.3
	17	81.5
67.1	3	61.8
	5	65.1
	7	64.3
	9	67.9
	11	71.3
	13	72.2
	15	74.7
	17	74.9
78.6	3	57.3
	5	60.6
	7	59.8
	9	63.4
	11	66.8
	13	67.7
	15	70.3
	17	70.5
90	3	54.2
	5	57.5
	7	56.7
	9	60.3
	11	63.7
	13	64.6
	15	67.2
	17	67.4

Speed	IRI	Psg. Car Index	Psg. Car VOC
10	3	2.25579	966.15
10	5	2.26881	971.73
10	7	2.28827	980.07
10	9	2.31416	991.15
10	11	2.34648	1005.00
10	13	2.38523	1021.59
10	15	2.43041	1040.95
10	17	2.48203	1063.05
21.4	3	1.50806	645.90
21.4	5	1.52127	651.56
21.4	7	1.54091	659.97
21.4	9	1.56698	671.14
21.4	11	1.59948	685.06
21.4	13	1.63842	701.73
21.4	15	1.68378	721.16
21.4	17	1.73558	743.35
32.9	3	1.28054	548.45
32.9	5	1.29393	554.19
32.9	7	1.31375	562.68
32.9	9	1.34000	573.92
32.9	11	1.37269	587.92
32.9	13	1.41181	604.68
32.9	15	1.45736	624.19
32.9	17	1.50934	646.45
44.3	3	1.17346	502.59
44.3	5	1.18704	508.41
44.3	7	1.20704	516.98
44.3	9	1.23348	528.30
44.3	11	1.26635	542.38
44.3	13	1.30565	559.21
44.3	15	1.35138	578.80
44.3	17	1.40355	601.14
55.7	3	1.11219	476.35
55.7	5	1.12595	482.24
55.7	7	1.14614	490.89
55.7	9	1.17275	502.29
55.7	11	1.20581	516.45
55.7	13	1.24529	533.36
55.7	15	1.29120	553.02
55.7	17	1.34355	575.44
67.1	3	1.07378	459.90
67.1	5	1.08771	465.87
67.1	7	1.10808	474.59
67.1	9	1.13488	486.07
67.1	11	1.16812	500.31
67.1	13	1.20778	517.29
67.1	15	1.25388	537.01
67.1	17	1.30641	559.54
78.6	3	1.04842	449.04
78.6	5	1.06254	455.09
78.6	7	1.08309	463.89
78.6	9	1.11008	475.45
78.6	11	1.14350	489.76
78.6	13	1.18335	506.83
78.6	15	1.22963	526.65
78.6	17	1.28234	549.23
90	3	1.03180	441.92
90	5	1.04610	448.05
90	7	1.06684	456.93
90	9	1.09400	468.56
90	11	1.12760	482.95
90	13	1.16764	500.10
90	15	1.21410	520.00
90	17	1.26700	542.65

Ratio
0.2411
0.2426
0.2397
0.2411
0.2415
0.2384
0.2363
0.2385
0.2059
0.2086
0.2047
0.2076
0.2087
0.2051
0.2041
0.1972
0.1752
0.1788
0.1749
0.1781
0.1800
0.1765
0.1749
0.1692
0.1562
0.1607
0.1565
0.1601
0.1624
0.1592
0.1583
0.1525
0.1434
0.1485
0.1442
0.1481
0.1508
0.1476
0.1470
0.1416
0.1344
0.1397
0.1355
0.1397
0.1425
0.1396
0.1391
0.1339
0.1276
0.1332
0.1289
0.1333
0.1364
0.1336
0.1335
0.1284
0.1226
0.1283
0.1241
0.1287
0.1319
0.1292
0.1292
0.1242
0.1653