Chapter 7

Planning of Road Maintenance, Improvement and Development for Master Plan

Chapter 7 PLANNING OF ROAD MAINTENANCE, IMPROVEMENT AND DEVELOPMENT FOR MASTER PLAN

7.1 Road

7.1.1 Policy for Implementation of the Master Plan

Pavement width is 4.5 ~ 5.5 m for 60% of the paved roads in the study area, and 34% are 3.5 m. Pavement width of 5.5 m or more accounts for only 6%. Accordingly, most of the existing road network covered by the master plan is finished with simple pavement of 4.5 m or less. These have a narrow pavement width while suffering problems related to maintenance, and are thus not compatible with disaster prevention.
Activity and continuous use of the existing road are the most important factors to secure a minimum standard of living for local residents and to ensure continuation of industrial activities. As a consequence, road development and betterment of the master plan described in 6.3.2 must be implemented along with minimum required maintenance to assure existing road functions.
Road development and the betterment proposed in the master plan involve new road development and road betterment work among five categories of road work listed below. Others are maintenance of the existing roads.

Road development work can be classified into following five categories:

- New road development
  Planning and construction of new roads.
- Road betterment
  Upgrade work of existing roads, including widening and improvement of roads and improvement of horizontal or vertical alignment.
- Support work
  Work to restore roads damaged by disasters or roads not serviceable due to collapse of the slope.
- Road rehabilitation
  Special maintenance work or so-called periodic maintenance implemented to cope with deterioration of the pavement and drainage facility in the course of use.
- Road maintenance
  Daily and small road work such as patching of road surface, clearing of gutters, and general maintenance.

7.1.2 Standards for Road Development and Betterment Plans

(1) Typical Cross Section

According to standards set by the Directorate General of Highways (Bina Marga), pavement width is specified at 4.5 m, min. shoulder widths at 1.0 m, and total width at more than 6.5 m for routes with a future daily traffic volume of 3000 PCU or less (Type1). In case of a future daily traffic volume of 3000 ~ 20,000 PCU, total width of 10.0 m (Type 2) with a carriageway of 3.0 m x 2 and shoulders of 2.00 m x 2 is needed. Considering improvements of the traffic functions of the road studied, and in principle wide enough for two-way traffic. For the pavement width, two types shown below are planned on the basis of the above standards to cope with a future daily traffic volume of 3000 PCU. The shoulder width is reduced by 1 m for a total width of 8 m as a minimum width in mountainous areas with a precipitous land form. Typical cross sections for standard type shown Figure 7-1-1 and 7-1-2.

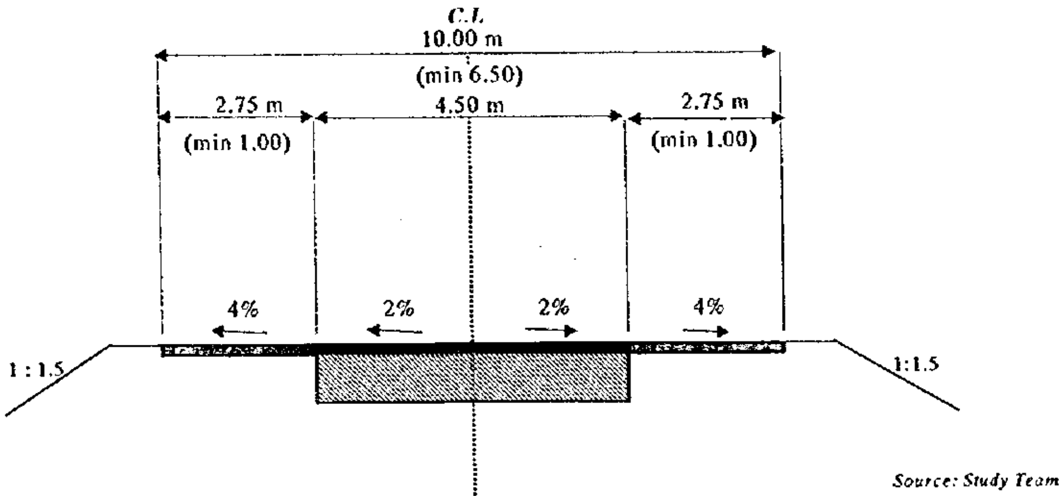


Figure 7-1-1 Typical Cross Section of Type 1
(Future daily traffic volume of 3000 PCU or less)

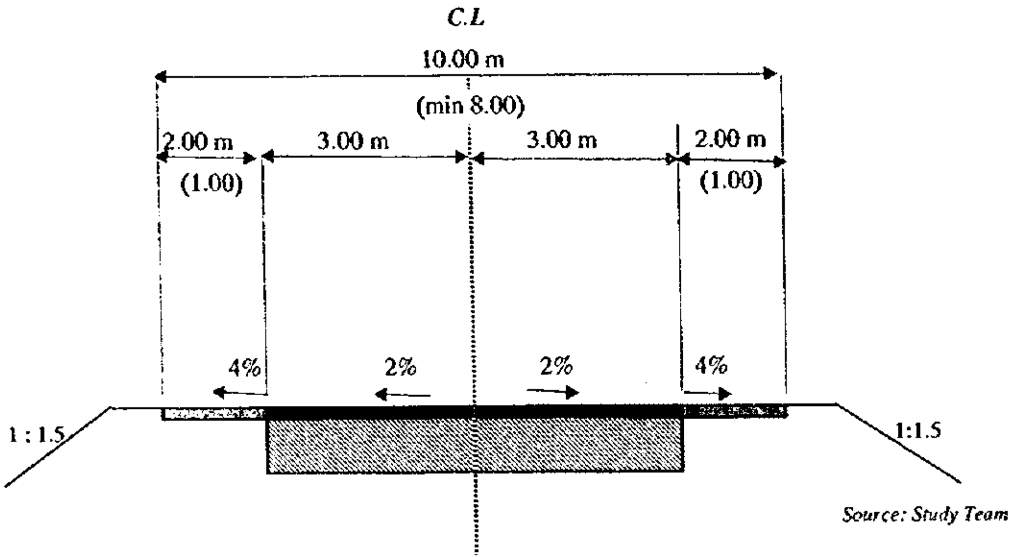


Figure 7-1-2 Typical Cross Section of Type 2
(Future daily traffic volume of 3000 PCU or over)

(2) Pavement structure

1) Pavement of carriage way

Of the 6,462 km inter-regional road network of the area studied, 77% or 4677 km is paved while the remaining 1785 km is not paved. Asphalt concrete paving is used for 33% or 1,544 km of the paved roads, and macadam paving with bitumen is used for the remaining 67% or 3,133 km. Macadam pavement is susceptible to rapid deterioration due to rainfall and traffic by heavy trucks. All sections recently constructed for the routes designated to be arterial were finished with multi-asphalt concrete pavement based on crusher run stone, which has been used for the study road to be newly paved. An overlay will be provided in seven years in consideration of deterioration, etc. of the asphalt pavement.

The pavement structure is determined from CBR of subbase soil and the accumulated wheel load based on the traffic demand. In this study, the structure is planned to have a 30 cm embankment on the basis of the assumption of the field CBR value of 5 ~ 10 for the road bed. The pavement design is established by assuming the design CBR value of the subbase of 6 %. The wheel load was calculated from the projected traffic volume per day per direction for the year 2018.

For the pavement structure, four types shown in the Table 7-1-1 are proposed on the basis of the traffic volumes of large sized vehicles (buses and trucks) in the year 2018. The pavement surface is planned to be in two layers by considering the overlay to be provided in the future while using an asphalt surface course for the surface. Namely, the base course is treated with asphalt while the subbase is made from mechanical stabilized crushed stone.

Table 7-1-1 Pavement Types for Traffic Volumes of Large Sized Vehicle

Pavement Type	Traffic Volumes (Vehicles/Day)
AA	More than 3000
A	1000 – 3000
B	250 – 1000
C	Less than 250

Source: Study Team

Table 7-1-2 Pavement Structure by Type

Unit : cm

Item	AA	A	B	C
Over-lay 1*	5	5	5	5
Surface 2	5	5	5	5
Base Course**	20	15	10	0
Subbase Course	25	25	20	20
Total	55	50	40	30

*After 10 years from operation

**Bituminous Treatment

Source: Study Team

2) Shoulder pavement

The unpaved shoulder of 1.0 m or more, which is made from the same material as the subbase, is constructed for the stopping line for a vehicles in trouble and pedestrians as well as for the waiting bay.

3) Drainage facility

Seepage of water into the road surface is one of factors causing deterioration of the pavement. To prevent seepage into the pavement subbase, an appropriate drainage facility as a rule is constructed as there will be a problem of spring water from the mountain side (that is cut section) of the road. The channel constructed to cross the road has a minimum diameter of 60 cm not only to prevent flooding of the road, but also to facilitate maintenance.

4) Safety devices

A guardrail to prevent vehicles from falling is installed on the shoulder for the 50 m section of the approach to the bridge. A guardrail is also installed in places where vehicle falling must be prevented for sections with an embankment of 3 m or more and at inlet/outlets of culverts.

7.1.3 Management and Maintenance Plan

(1) Overall system of road

In order to attain proper highway management and maintenance, all systems of road maintenance must be conducted orderly and in a proper manner, and established organization must be consistent with the requirement of work components and needed capacities.

(2) Road maintenance works

There are three types of tasks in maintenance work. One is routine maintenance in which task volumes are not affected by road standards and traffic volume. Another is periodic maintenance which inherently varies depending on traffic volume and lane width, and is proportional to number of lanes. The third is incidental maintenance which is basically work to be conducted being to restore the road and related facilities to their normal operating condition after they are damaged by road accidents 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, care of roadside trees
d. Repair and repainting of traffic safety and management facilities
e. Repair of lighting facilities

Periodic maintenance:

f. Renewal of traffic markings

g. Pavement maintenance and repair
h. Overlay
i. Maintenance and repair of bridges and culverts

Incidental maintenance
j. Disaster prevention and restoration

(3) Maintenance operation system

Of the above maintenance and operations "a" through "c" can be implemented over about 250 km a year by one site office. However, maintenance operations "d" through "j" are expected to be difficult in practical implementation due to their scale and need for additional workers and skills. 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 management and the contracting of works other than those under force account.

(4) Equipment and workshops

The number and type of maintenance equipment required on every maintenance operation differs. It is also necessary to consider whether the work will be done by force account or on a contract basis to determine the numbers and types of these facilities.

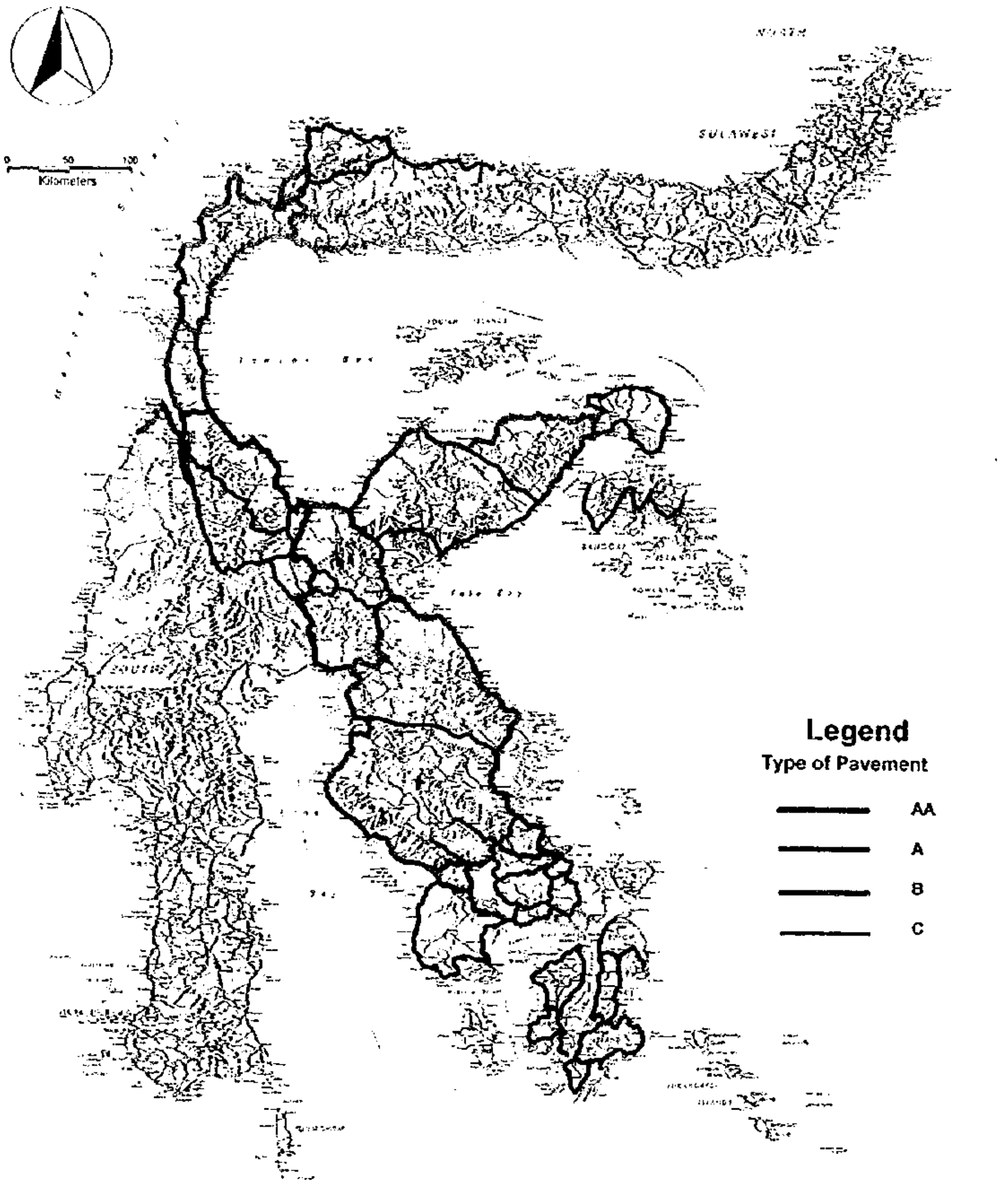
7.1.4 Arterial Road Development Project

Figure 7-1-3 shows pavement type and road link length of the inter-regional road network.

Table 7-1-3 Length of Pavement Type

Type of Pavement	Central	Southeast	Total Length
New Road Development	357	279	636
Pavement Widening Type AA	1662	1509	3171
Pavement Widening Type A	2049	807	2856
Pavement Widening Type B	235	0	235
Pavement Widening Type C	1341	668	2009

Source: Study Team



Source: Study Team

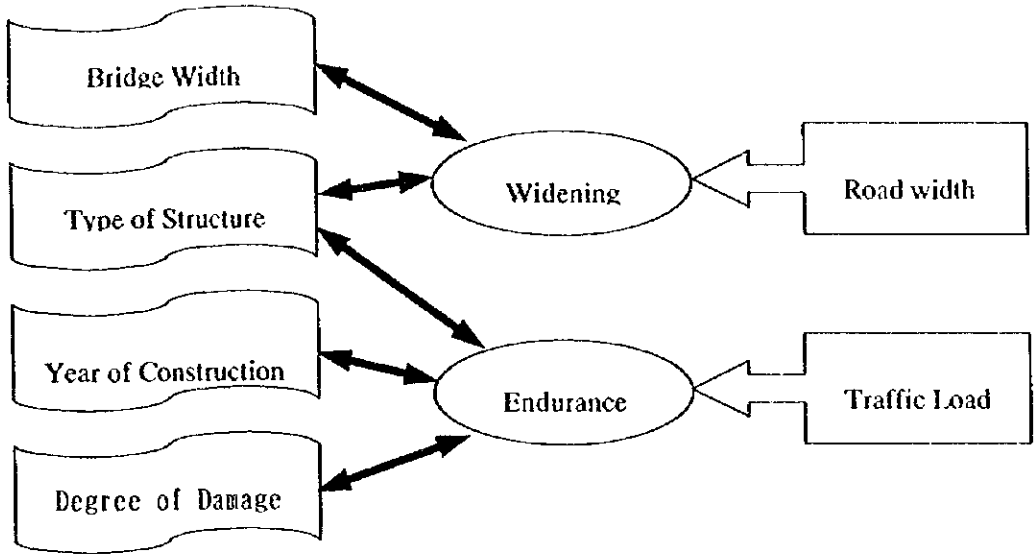
Figure 7-1-3 Type of Pavement for Inter-Regional Road Network

7.2 Bridges

7.2.1 Bridge Improvement Policies

There are about 2,500 existing bridges in the study area of Central and Southeast Sulawesi as mentioned in section 2.3.5. These bridges should be improved in accordance with the road development plan in order to ensure the safety traffic flow as most of these bridges are aged, narrow or lacking in strength.

For the improvement plan of bridge, existing bridges should first be investigated in accordance with the items of road improvement plan. These items are shown in Figure 7-2-1.



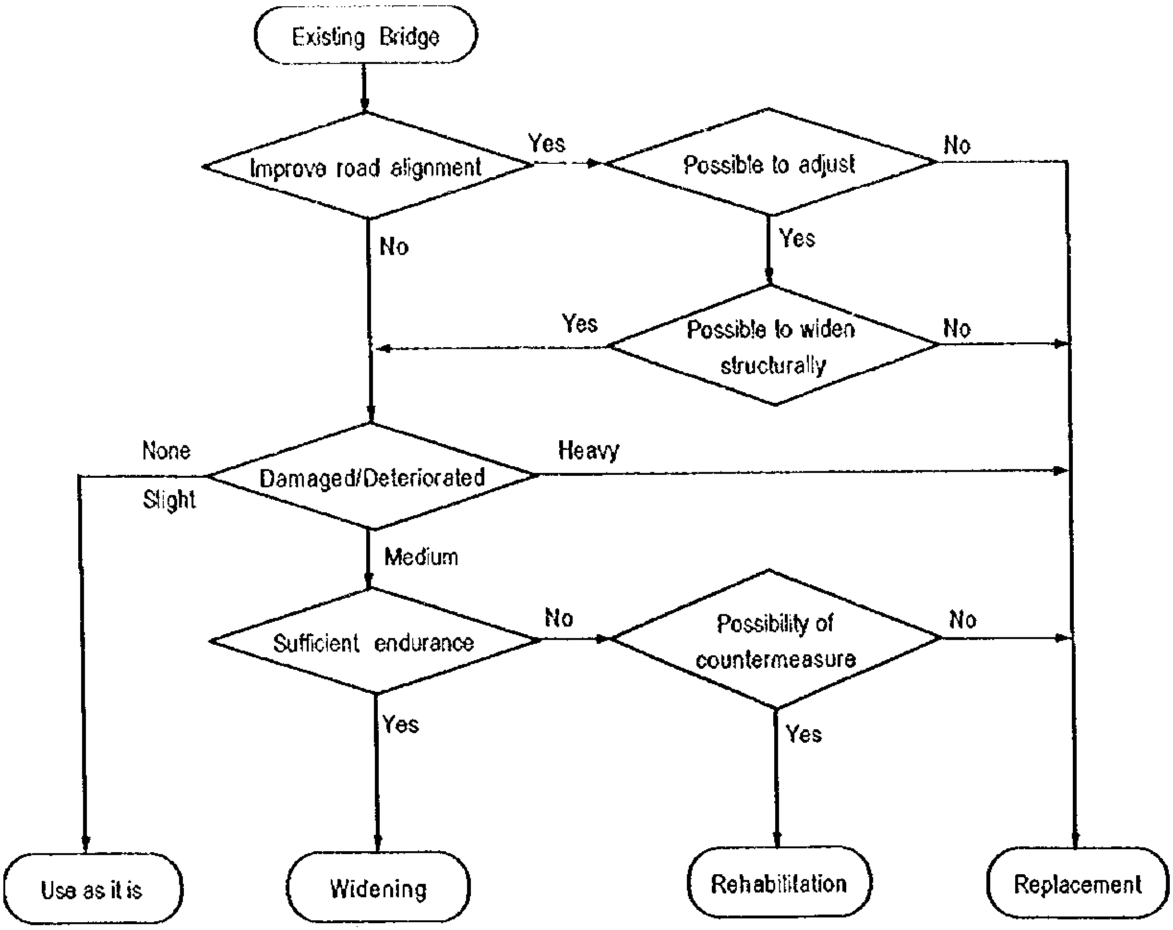
Source: Study Team

Figure 7-2-1 Relation Between Bridge Improvement and Road Improvement

Bridge improvement plan was classified into the following four categories.

- Replacement (bridges affected by the improvement of road alignment, seriously damaged or deteriorated bridges, and bridges with narrow width);
- Rehabilitation (replacement of deck slab, repair and reinforcing of structure, protection of substructure);
- Widening; and
- No improvements necessary (use as is).

General procedure for the determination of bridge improvement plan is shown in Figure 7-2-2.



Source: Study Team

Figure 7-2-2 General Procedure for the Determination of Bridge Improvement Plan

7.2.2 Bridge Improvement Plan

(1) Data of Existing Bridge Condition

The data of existing bridge condition were obtained from the bridge inventory of Bina Marga. The data were examined and the bridge improvement plan was established.

(2) Bridge Improvement Plan

In this Study, bridge improvement is planned as follows;

- Existence of Bridge

  When no bridge exists on the road which is to be improved, new bridges should be constructed by the targeted year.

- Main Material of Structure

All timber/stone bridges are to be replaced, as they are not likely to suffice in future traffic conditions. Therefore these bridges were planned to be replaced.

- Effective Width

The concerned roads are improved in accordance with two kinds of width, which are 6.0m wide and 4.5m wide. Basically, bridges on the concerned roads should be replaced as they lack sufficient width. However, even if the bridge lacks sufficient width, the influence on the ordinal traffic flow is not so serious. Therefore in this Study bridges should not be replaced if they are sufficiently durable despite narrow width.

- Endurance

Endurance was estimated based on the bridge inventory, which is mentioned in Section 2.5.1. In that inventory, the degree of damage of bridges is recorded by use of numerals, 0 to 5 according to amount of damage. The numerals to describe damage are shown in Table 7-2-1.

Table 7-2-1 Description of Bridge Condition in the Bridge Inventory

Score	Condition of Bridge
0	The bridge is in new condition, no damage. The bridge element is in good condition.
1	Damage is very small. (The damage can be repaired through the maintenance and does not affect safety or function of the bridge.) E.g., Little scouring, corrosion on the surface, loose wood board
2	Damage which needs inspection or maintenance in the future. E.g., A little putrefaction in the wooden structure, loosing of wood coupling, garbage and/or dirt piled on or at base of bridge needing removal.
3	Damage which needs attention. (The damage may become serious within 12 months.) E.g., Concrete structure with small cracks, decayed wooden framework, hole at slab surface, heap of asphalt at slab surface and bridge head, scouring in medium quantity at bridge head, rusty steel frameworks.
4	Critical conditions. (Serious damage, which needs attention immediately.) E.g., Framework failure, concrete floor slab or creaking floor, erosion of foundation, concrete framework not visible, and no guardrail.
5	Collapsing or malfunction element

Source: Study Team

In this Study bridges ranked from 3 to 5 should be replaced based on the judgement that they lack endurance for the road and bridge improvement plan.

- Year of Construction

  This item also concerns the bridge endurance and structural material.
  Bridges which were constructed before 1970 should be replaced in consideration of the fact that most of them are the wooden or stone bridges, or lack endurance du to aging.

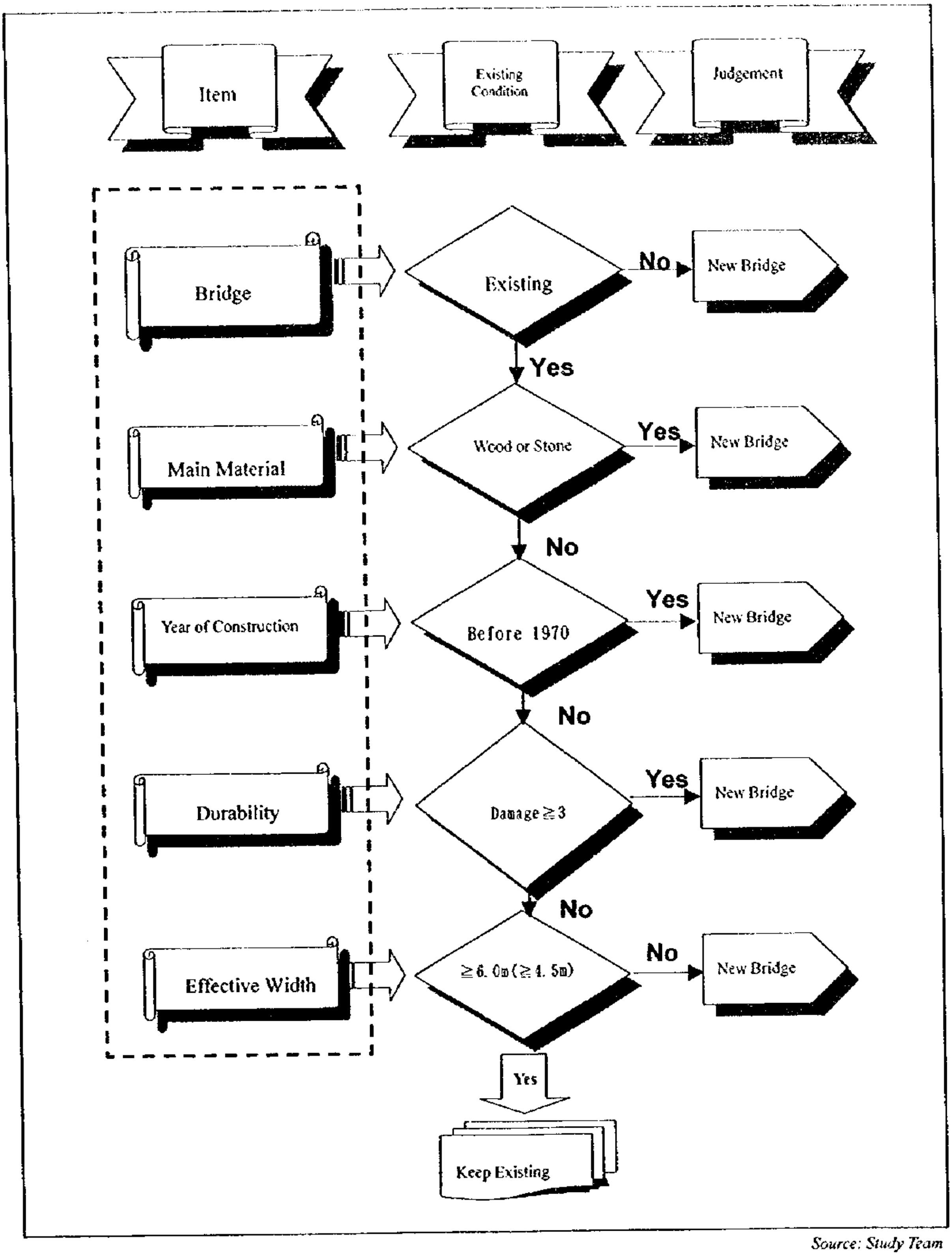
The concepts of bridge improvement for the Study are summarized in Figure 7-2-3.

(3) Specifications of New Bridges

Replacement (new construction) is not necessary for bridges with sufficient endurance even though they may not have sufficient width. On the other hand, the width of newly constructed bridges should be 6.0 m in effective width even if the road width is only required to be 4.5m.

Assumed specifications of bridge in this improvement plan are as follows;

- Superstructure : Prestressed concrete I-Girder
- Substructure : Reinforced concrete
  - Abutment : Inverted T type
  - Pier : Hammer head type



Source: Study Team

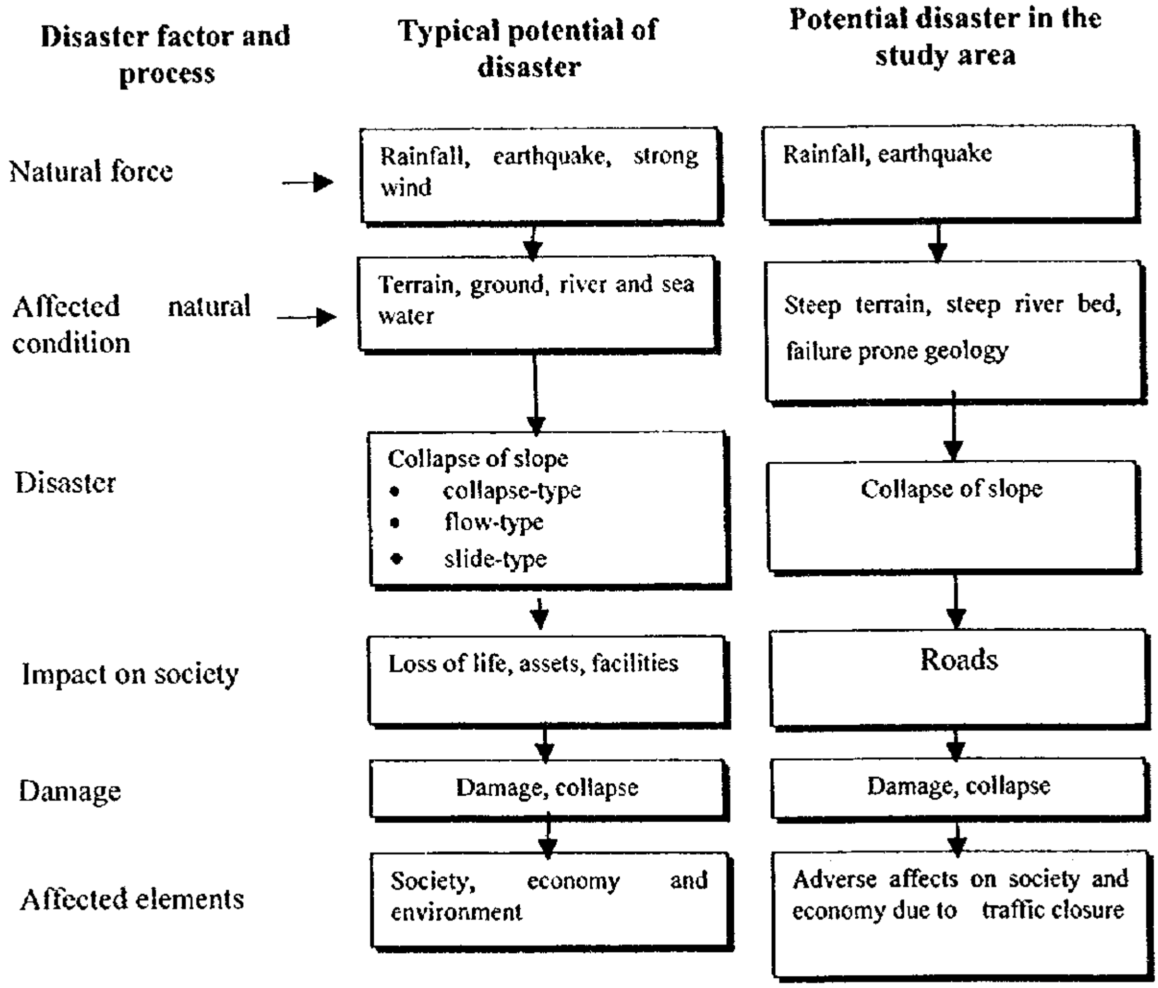
Figure 7-2-3 Procedure for the Design of Bridge Improvement Plan

7.3 Slope Protection Works

7.3.1 General

Due to high percentage of steep terrain in the study area where road slope failures are prone to occur, the road master plan should incorporate slope protection works which are applied roads that are resistant to potentially hazardous natural forces.

In conducting road disaster prevention works, potential disasters are foreseen and necessary basic information was obtained. Typical forseeable disasters in the study area are shown in Figure 7-3-1. As illustrated in Figure 7-3-1, damage due to the natural disaster will seriously affect society, economy and environment.



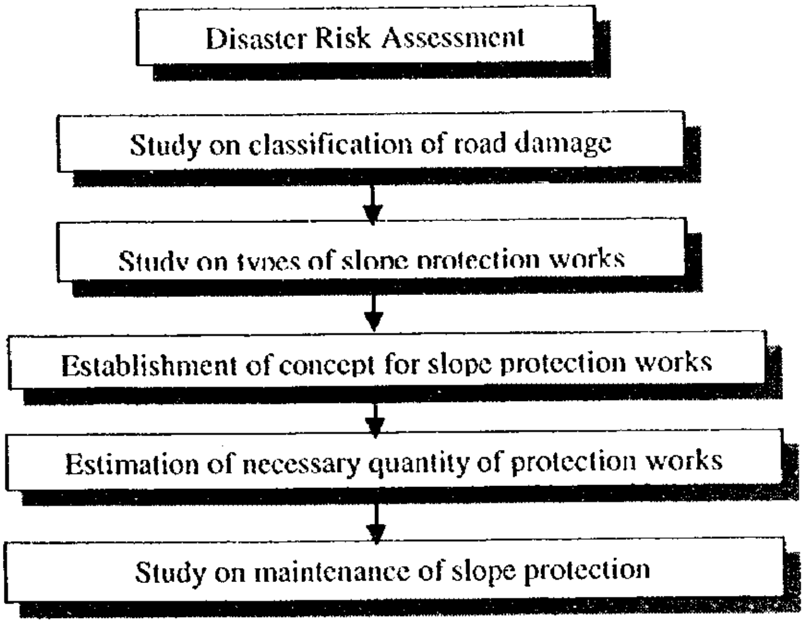
Source: Study Team

Figure 7-3-1 Typical Disaster and Potential for Disaster in the Study Area

By understanding the relation of slope protection and disaster prevention, one can ascertain the need of such protection.

- Classification of road damage
  Type and characteristics of road damage were clarified.
- Types of slope protection's purpose and characteristics.
  Slope protection's purpose and characteristics were clarified.

The concept of slope protection works has been established as to how to select and apply a type, after which quantity estimate of the works will be prepared. The study flow chart is as shown in Figure 7-3-2.



Source Study Team

Figure 7-3-2 Flow Chart of Study on Slope Protection Works

7.3.2 Classification of Road Damage

The initial classification of disaster-induced traffic interruptions, as used in this study, is based on the four basic types below:

- Bridge Collapsing
- Road Collapsing
- Road Flooding
- Slope Damage

The next level of classification involves subdividing bridge, road, and slope structures into more specific structural types.
The final component of the road damage classification is to identify damage in more detail. The full classification is summarized below in Table 7-3-1.

Table 7-3-1 Classification of Damage

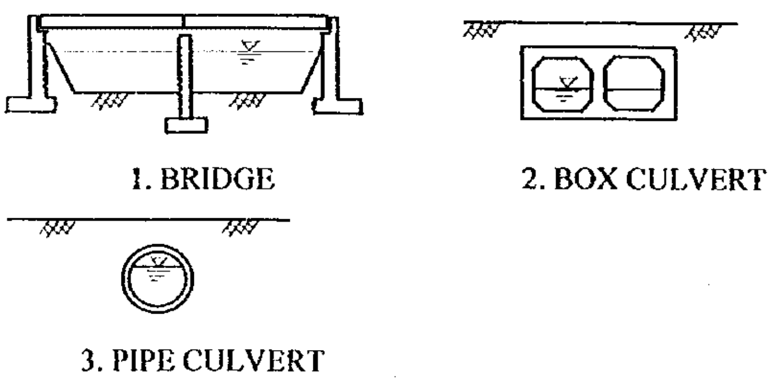
Cause of Traffic Interruption	Features	Damage
Bridge Collapsing	1.Bridge 2.Box Culvert 3.Pipe Culvert	1.Girder collapsing 2.Pier collapsing 3.Abutment collapsing 4.Pier scouring 5.Abutment scouring 6.Abutment protection collapsing 7.Erosion of approach road 8.Overflow 9.Scouring of river bank 10.River choking with sediment
Road collapsing	1. At grade 2.Embankment on flat ground 3.Embankment on sloping ground	1.Scouring of embankment slope 2.Washing out of shoulder
Road Flooding	1.At grade 2.Embankment on flat ground 3.Embankment on sloping ground	1.Inundation 2.Overflow 3.Road burial by debris flow
Slope Damage	1.Natural slope 2.Cut slope 3.Fill slope 4.High embankment	1.Sheet erosion 2.Rill erosion 3.Gully erosion 4.Tunnel erosion 5.Scouring by incident stream 6.Rotational landslide 7.Two-dimensional landslide 8.Three-dimensional landslide 9.Rockfalls by toppling 10.Rockfalls by undercutting

Source: Study Team

(1) Bridge Collapsing

1) Classification of Features

In this category, all hydraulic road structures were considered. These are bridges, box culverts and pipe culverts as shown in Figure 7-3-3.



Source: Study Team

Figure 7-3-3 Classification of Structures

2) Damage Classification

Classification of bridge collapse was divided into ten major categories depending on the bridge part affected and the type of damage incurred. These collapses are associated with the substructure, superstructure and associated structure as illustrated in Figure. 7-3-4.

a) Girder Collapsing

A girder can be displaced by the lateral water pressure, or floating debris. This results in the horizontal displacement on the top of the substructure or the main deck elements downstream by the flow.

b) Pier Collapsing

There are two major causes for a pier collapsing: the lateral pressure of water, floating debris or debris flow and scouring. If scouring around a pier is deep, its lateral resistance would be reduced and result in the complete collapse of the pier and the supported superstructure. The scouring of a foundation may also result in the vertical settlement of a pier due to the loss of side friction at piles.

c) Abutment Scouring

The collapse of an abutment occurs usually in the same manner as that of a pier, i.e., by lateral pressure and scouring. In addition, the erosion of abutment back-fill can result in an abutment collapsing.

d) Pier Scouring

Pier scouring that affects a substructure occurs when the supporting system, such as piles and pile caps, is undercut by scouring that produces a reduction in the resistance to horizontal and vertical forces.

e) Abutment Scouring

Abutment scouring can take place if water velocity is fast relative to the soil characteristics. The abutments of bridges are vulnerable, as they form the boundaries of a constriction in flow during periods of flooding with high water velocities.

f) Collapsing of Abutment Protection

The loss of toe support for an abutment protection by scouring and the impact of debris can result in the breakup of protection.

g) Erosion of Approach Road

If a river meanders close to a bridge, the approach road can be scoured by the river flow. The sides of the abutment approaches may be scoured prior to the bridge being submerged if they are at a level lower than the deck.

h) Overflow

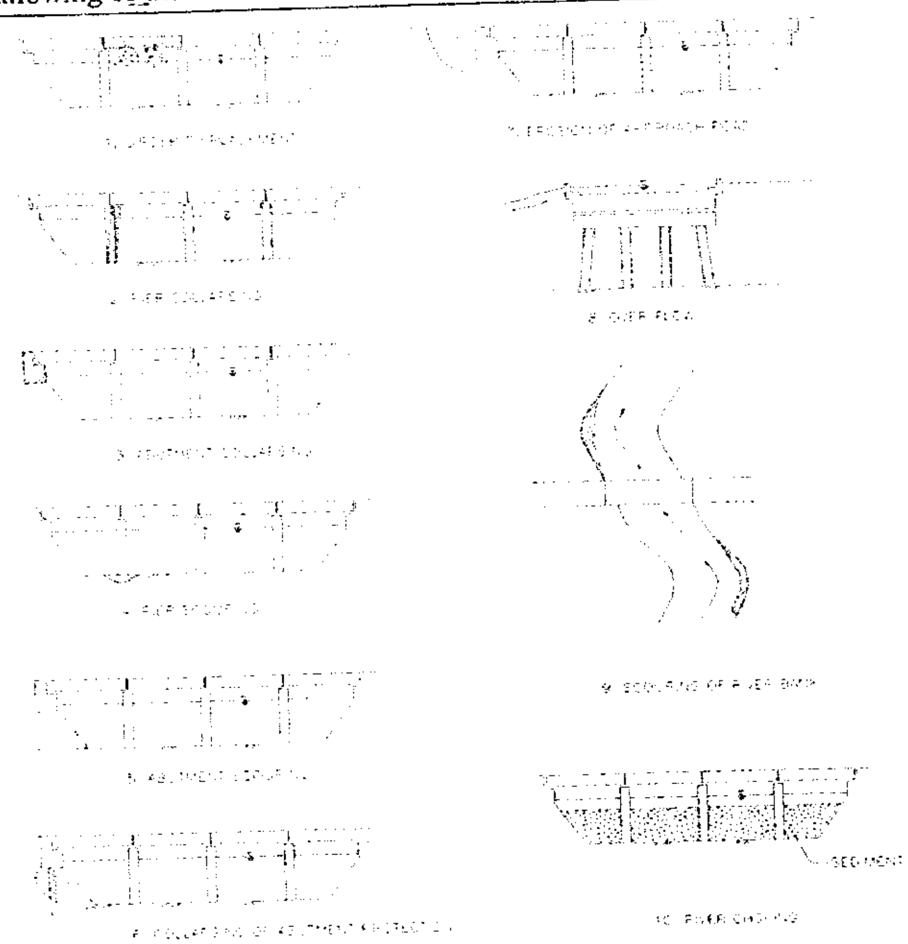
Overflow occurs if the water level rises above the deck level and traffic can not pass. This classification is used when there is no damage to the bridge and the interruption to traffic is entirely due to the submergence of the bridge.

i) Scouring of River Bank

Scouring may be confined to the banks of a river upstream or downstream from a bridge. A change in the river's path may be a precursor for other damage, such as the scouring of abutments and the erosion of approach roads.

j) River Choking with Sediment

River choking is caused by the over supply of river sediment such as sand, boulders and other debris. It results in the reduction of the clearance from water level to the bottom of girder and shallowing of the water channel section which can induce flooding.



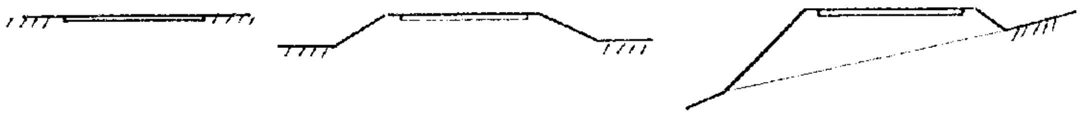
Source: Study Team

Figure 7-3-4 Classification of Bridge Damage

(2) Road Collapse

1) Classification

Road features were classified into three categories as shown in Figure 7-3-5. Cut slopes were excluded and described in the slope damage section of this report.



a.. AT GRADE b. EMBANKMENT ON FLAT GROUND c. EMBANKMENT ON SLOPE

Source: Study Team

Figure 7-3-5 Classification of Road Structures

2) Classification of Damage

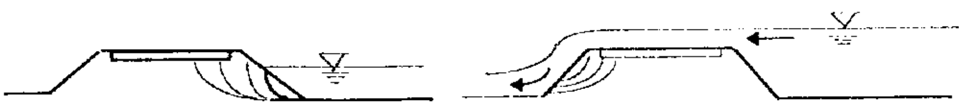
a) Scouring of Embankment

Scouring can affect a road embankment when rapidly moving flood waters flow parallel with the side slopes. If such a flow continues for a sustained period, the resultant scouring would produce major damage and eventually the whole embankment would collapse.

b) Washing Out of Embankment Shoulder

When flood waters overflow an embankment, the high velocity of the flow on the downstream side can wash out the road shoulder. The downstream side of a road embankment edge experience maximum water velocity and is the most vulnerable.

The damage classification system is illustrated in Figure 7-3-6.



a. SCOURING OF EMBANKMENT SLOPE b. WASHING OUT OF EMBANKMENT SHOULDER

Source: Study Team

Figure 7-3-6 Classification of Road Collapsing

(3) Flood on Road

1) Classification

The classification of features for road flooding is the same as that used in the Road Collapsing section above.

a) Inundation(sheet flood)

This classification is used when there is no damage to a road embankment and the interruption to traffic is entirely due to the submergence of the road's surface. Here, water velocities are generally low but may be of significant duration.

b) Overflows (channel flooding)

An overflow is potentially more destructive to an embankment than inundation, but this classification is used when there is no damage to a road embankment by an overflow.

c) Road Burial by Debris Flows

This classification is used when a road's surface is buried by the mass of material transported by debris flows. The damage classification is illustrated in Figure 7-3-7.

a. INUNDATION b. OVERFLOW c. ROAD BURIAL BY DEBRIS FLOW

Figure 7-3-7 Classification of Flood on Road

(4) Slope Damage

1) Classification of Features

Slope damage can be subdivided based in the mechanism of failure and the nature of the features affected. The failure mechanism are erosion, landslides and rockfalls. The features that are affected are natural slopes, cut slopes, fill slopes and embankments. The different types of features are illustrated in Figure 7-3-8.

a. NATURAL SLOPE b. CUT SLOPE c. FILL SLOPE d. HIGH EMBANKMENT SLOPE

Source: Study Team

Figure 7-3-8 Classification of Slope

a) Natural Slope

This classification is used if a failure has occurred on natural ground that has neither been cut nor filled.

b) Cut Slope

This classification is used only when a failure occurs in area that have been excavated and material removed.

c) Fill Slope

This classification applied to failures that occur primarily at fills on sloping ground. There should be only one primary sloping fill face at the cross section.

d) High Embankments

This classification is used for high mounds or embankments placed on gently sloping or flat ground that have two sloping fill faces.

2) Classification of Slope Damage

The principal causes for slope failure are divided into erosion, landslides, and rockfalls. They can further be subdivided into ten damage types as below.

a) Sheet Erosion

Sheet erosion is the sheet-like wearing away of surface material that leaves no individual channels. It is relatively uncommon as most natural materials have minor variations that result in local concentrations of erosion.

b) Rill Erosion

This form of erosion is characterized by numerous small parallel shallow channelways across a surface. This is common in a newly exposed surface.

c) Gully Erosion

This form of erosion is most common and typically consists of deeply incised channels. These may merge and result in a large cavity in the ground's surface.

d) Tunnel Erosion

This form of erosion occurs in ground with a large volume of groundwater flow. Frequently, this type of erosion is initiated by the roots of dead trees or piping of embankments that are ponding water upstream due to inadequate or blocked drainage facilities. It can also occur naturally in permeable friable material that has high groundwater pressure gradients. Tunnel erosion progresses from the surface back into a slope.

e) Scouring by an Incident Stream

This type of erosion is induced by water flows from external sources. High velocity flows from streams and rivers incident to engineering features such as the toes of fills or natural slopes or the sides of embankments are examples. Wave action is also included in this class.

f) Rotational Landslide

This classification is used when the movement of a mass is about a center of rotation resulting in an accurate sliding surface. This occurs most frequently in relatively homogeneous materials, such as alluvial and marine soils and fill slope.

g) Two-Dimensional (2D) Landslide

When a sliding surface is essentially planar, the movement is considered to be a two-dimensional translation. The crest and toe sections may be curved, but should not constitute more than 10% of the slip length. Rock slopes sliding on a single plane of weakness are examples. In fill slopes, the original ground surface may act as a 2D sliding surface if the top soil and vegetation were not first removed.

h) Three-Dimensional (3D) Landslide

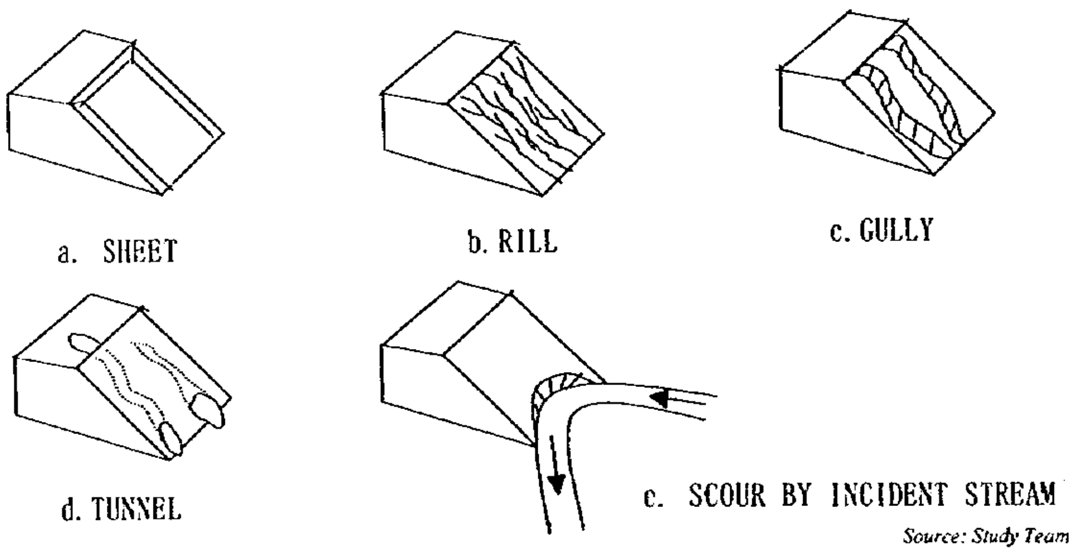
When two planes of weakness intersect, they form a wedge, sliding can occur down the direction of the intersection to form a three-dimensional translational mass. This type of failure is usually restricted to cut and natural rock slopes with inclined intersecting joint sets.

i) Rockfalls by Toppling

This classification is used when individual rock blocks are dispatched by rotation about a plane inclined towards a roadway. The dispatching force can occur from a build up of water pressure in the back-face joint boundary. Steeply cut rock slopes with near vertical and horizontal orthogonal joint sets have the highest potential for this type of failure.

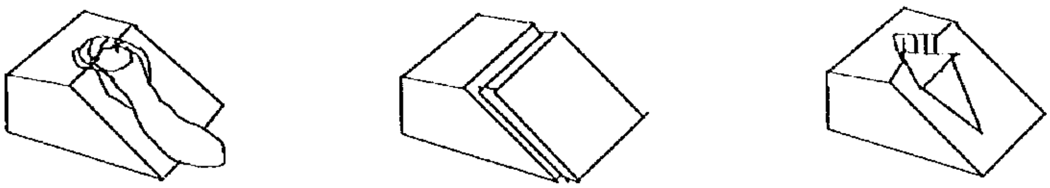
j) Rockfalls by Undercutting

Localized erosion can remove the matrix of soil that is supporting a block of rock. This is the most common form of rockfall as many natural slopes have quasi-stable blocks of rocks supported by loose soil and vegetation.



Source: Study Team

Figure 7-3-9 Classification of Erosion



f. ROTATIONAL LANDSLIDE g. DIMENSIONAL LANDSLIDE h. DIMENSIONAL LANDSLIDE

Source: Study Team

Figure 7-3-10 Classification of Landslides

i. ROCKFALLS BY TOPPLING j. ROCKFALLS BY UNDERCUTTING

Figure 7-3-11 Classification of Rockfalls

(5) Findings of Road Damage

Investigation by the study team revealed a large amount of slope damage, caused by the following factors:

- Steeply topography
- Easily eroded soil
- Weathered natural slopes and cut slopes
- Lack of protection for cut slope
- Lack of drainage facilities for cut slope

Therefore, slope protection works are required to prevent slope failure as a part of this project.

7.3.3 Type of Slope Protection Works

The main purpose of the slope protection works is to prevent weathering and erosion, therefore the type of prevention should be selected based on geological and topographical conditions. The study team recommends the types found in following Table 7-3-2 as follows, for selection of type of slope protection works.

Table 7-3-2 Types of Slope Protection Works and their Purposes

Type of Work	Purposes and Features
Shotcrete Stone pitching Block pitching	For preventing weathering and erosion
Concrete block cribworks	For preventing erosion when filled up with sediment or gravel
Concrete pitching Sprayed concrete cribworks Slope anchor works	For preventing collapse of surface layer of slope, preventing separation of bedrock, and retaining earth where there is earth pressure.
Wicker works Slope gabion works	For controlling erosion of surface layer of slope and outflow of surface layer due to spring water
Rockfall prevention nets Rockfall prevention fences Rockfall shed	For prevention of rockfall

Source: Study Team

7.3.4 Concept of Application for Slope Protection Works

Countermeasures by preventive work is required for the steep terrain where slope failure is prone to occur for the following reasons;.

- Increment quantity of cut volume is required when cut is conducted according to safe gradients for cut slope.
- In case of insufficient drainage facilities , slope failure can easily occur even if required cut is conducted according to safe gradients.
- Due to geological conditions, quick erosion is to be expected.
- Slope failure has serious effects on society , the economy and the environment.

Countermeasure works are applied based on the following concepts;

- Countermeasure works should adopt semi-permanent facilities for durability for all road classes of the roads concerned,
- When combining the prevention countermeasures for works and surface drainage, run-off rain will not penetrate structures, therefore, durability of slope protection works will be long-lasting.
- Countermeasure works should use semi-permanent structures of the most economic type.

7.3.5 Selection and Quantity Estimates of Slope Protection Works

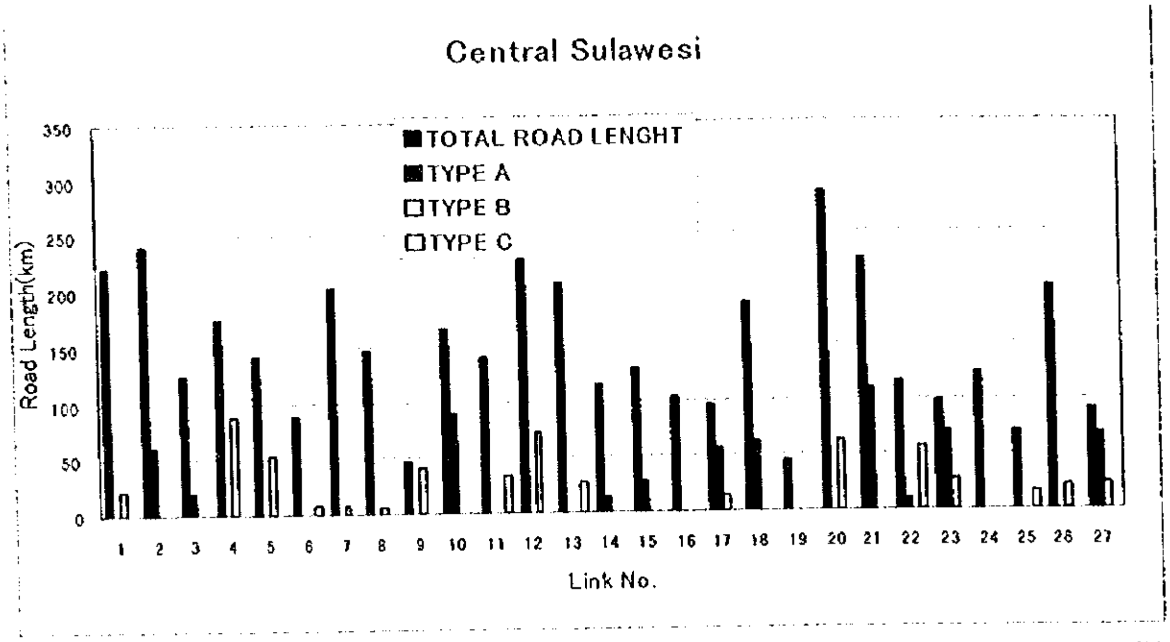
Slope protection works are constructed to protect the slopes from erosion or weathering by covering them with vegetation or structures and also to stabilize the slopes by means of drainage works or retaining structures. The following types of slope protection works are adopted for the master plan considering the terrain and geology, as shown in Table 7-3-3. Necessary length of slope protection works for each link is shown in Figure 7-3-12.

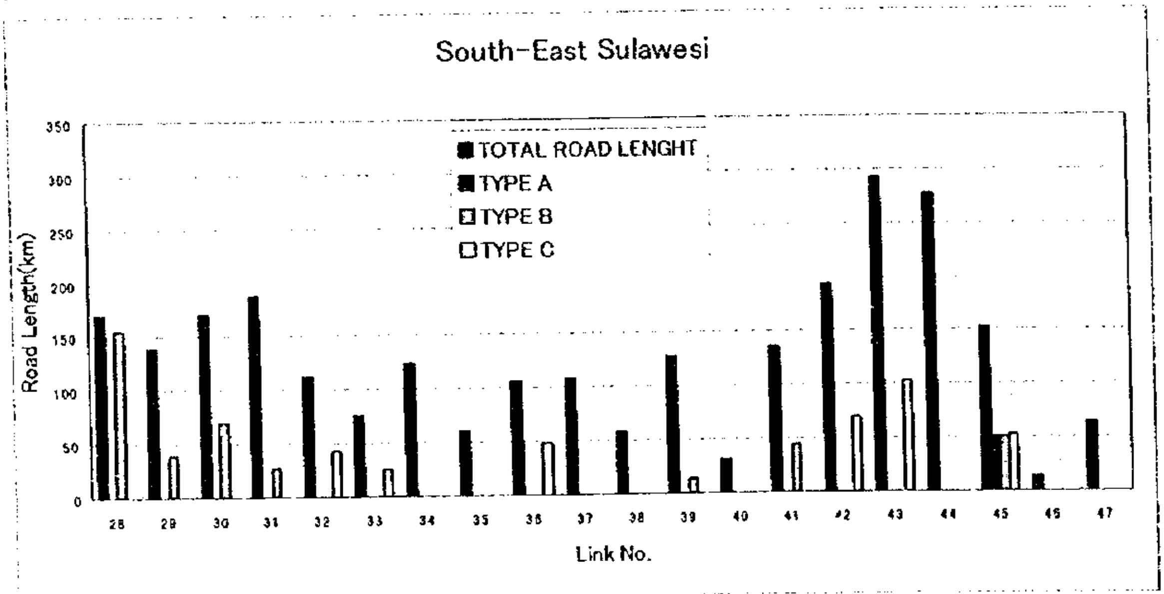
Table 7-3-3 Selection of Slope Protection Works

Type	TYPE A H=10m	TYPE B H=8m	TYPE C H=6m	Application
Sprayed Concrete Cribwork	80%	80%	80%	Soil & Soft Rock
Shotcrete	20%	20%	20%	Hard Rock (Weathered)

Note: H= Average slope height(m)
%= Each type length/necessary prevention road length

Source: Study Team





Note: Type of slope protection is classified by height (m).
TYPE A: More than 10m
TYPE B: From 6m up to 10m
TYPE C: Less than 6m

Source: Study Team

Figure 7-3-12 Proposed Slope Protection Type

7.3.6 Maintenance of Slope Protections

Slope protection works will gradually deteriorate and weaken with age. They will be gradually deformed by external forces predicted at the project out set, and in the worst case, may end in slope failure. Therefore, maintenance and inspection are required to keep the slopes in good condition. When unexpected external forces arise, then new countermeasures must be taken.

The maintenance of slopes can be classified into three types of work, i.e., for maintaining the present situation by repairing the aged and deteriorated structures and removing old or overgrown, work for monitoring irregular situations and failures, and prevention work.

The first type of repair work is needed to fully insure the functions of protection works and includes the application of additional fertilizer to vegetation, the periodic removal of sediment deposited in ditches and at the rear of rockfall prevention nets, etc.

Monitoring work is needed to fully insure the functions of protections of slopes and other protection works. When there is any sign of deformation, measurements should be taken be to determine the degree of danger from future changes.

The third type of work for countermeasures includes the construction of structures for preventing potential slope failures. Slope cutting and earth removal after failures, and emergency countermeasures will prevent subsequent failures.

7.4 Tunnels

7.4.1 Tunnel Design Standard

(1) General

Use of tunnels is one of the most effective means of the preventing slope failure and land slides, protecting existing environmental conditions, and securing an efficient road alignment within the mountain range. However, there are some disadvantages such as those indicated below which should be considered:

- Construction cost is higher than that of roads and bridges
- Maintenance cost for ventilation system is needed
- Psychological problem due to closed space
- Potential of subsequent disaster following traffic accidents

At present, there is no design standard for road tunnels in Indonesia. For this study, there is a need to establish tunnel design standards for a dual-lane traffic tunnel. "SPECIFIKASI STANDAR UNTUK PERENCAN GEOMETRIC JALAN LUAR KOTA" and "BRIDGE DESIGN CODE" published by Bina Marga, and "Design Standard for Road Tunnel" and "Standard Specification for Tunnel" published by the Japan Road Association have been employed for the establishment of tunnel standard for the Study.

(2) Interior Section and Construction Limit of Tunnel

The shape and dimensions of a tunnel should be determined based on the facilities required for the tunnel interior and its stability.
The tunnel interior cross section must include consideration of the following conditions:

- Width and construction limit in accordance with standards indicated in road structure statutes
- Construction limit in case of existence of inspection way and/or pedestrian way
- Variation of crossfall
- Dimensions of pavement and drainage
- Margin for ventilation facilities
- Implementation error

Furthermore, design and structure must be pragmatic in terms of implementation and economics, and carried out in full consideration of topographical and geological conditions.

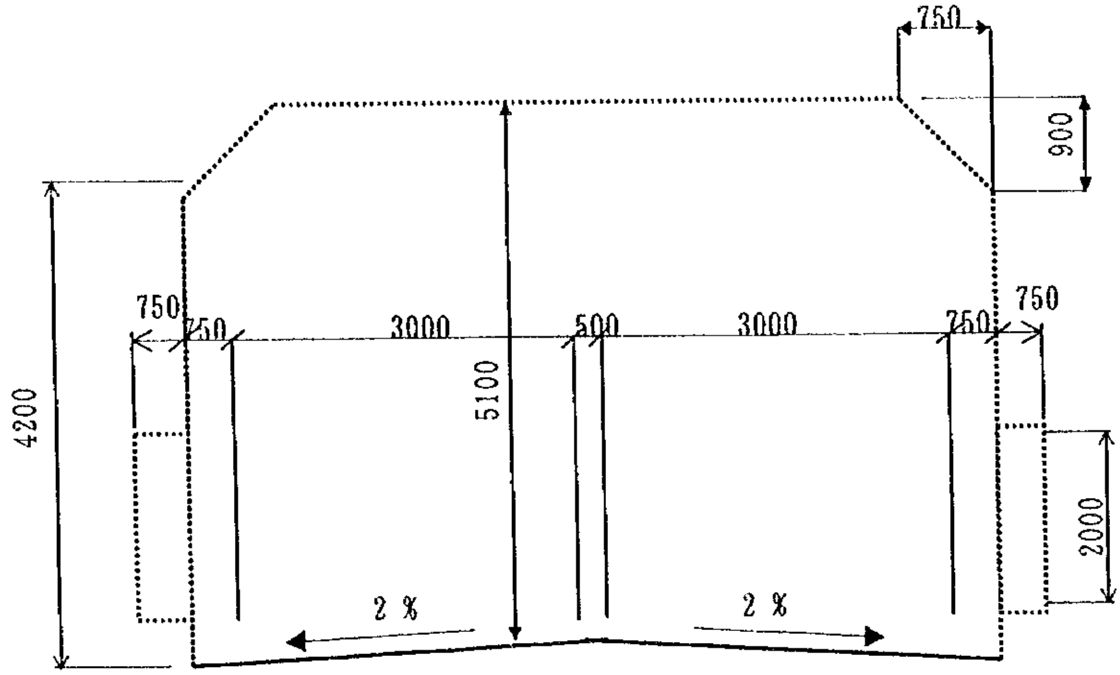
Construction limit for tunnel is not mentioned in the "Specifikasi Standar Untuk Perencan Geometric Jalan Luar Kota", but, concerning roads, it is mentioned that the roadway should be at least 5.0 m in width. Also, concerning vertical clearance, the Bridge Design Code mentions that parts of the superstructure or substructure of bridge crossing over a road or a railway should be at least 100 mm greater than the operation vertical clearance to allow for settlement and road resurfacing. Considering the above two items, a construction limit of 5.0 m for tunnels is applicable.
Shoulder height of tunnel is decided based on "A POLICY OF GEOMETRIC DESIGN OF HIGHWAY AND STREETS 1994". In this material, a trailer height of 4.1 m plus 0.1 m freeway is the minimum construction limit for shoulder space. Therefore 4.2 m is applicable for shoulder height.

Also, a maintenance gallery with a width of 0.75 m should be provided on both sides of the traffic lanes.

Lighting and ventilation facility can be provided between construction limit and interior area of tunnel.

The width and construction limit of the tunnel is as shown in Figure 7-4-1.

- Full width : W=0.75+(0.75+3.00)x2;0.50+0.75=9.50 m
- Crossfall : i= 2.00% (upward grade from both portals)
- Inspection way : Installed on both sides (w=0.75 m, h=2.00 m)



Source: Study Team

Figure7-4-1 Construction Clearance of Tunnel

(3) Horizontal Alignment

Alignment standards should follow road alignment standards as the tunnel is a part of the road.

Since traffic accidents are prone to occur at the entrance of the tunnel, an application of higher standards for the tunnel entrances is desirable.

Curves with small radii are not applicable for this tunnel, as wider section needs to be designed in order to accommodate minimum sight distance, thereby increasing construction cost. Necessary considerations for design of tunnel are as mentioned below:

- Tunnel should be planned to be straight since drivers in Indonesia are unaccustomed to tunnels.
- Relation between design speed and minimum radius are shown below:

Design Speed	40 km/h	r=800 m
Design Speed	30 km/h	r=500 m
Design Speed	20 km/h	r=300 m

(4) Vertical Alignment

Tunnel gradient should be minimized for the following reasons:

- In consideration of the use of rail hauling in excavation, a tunnel gradient of less than 2 % is preferable.
- As a exhaust density will rise in proportion to tunnel gradient, it should be less than 3 %.
- A steep grade will cause excess driving speed as well as dangerous passing maneuvers.

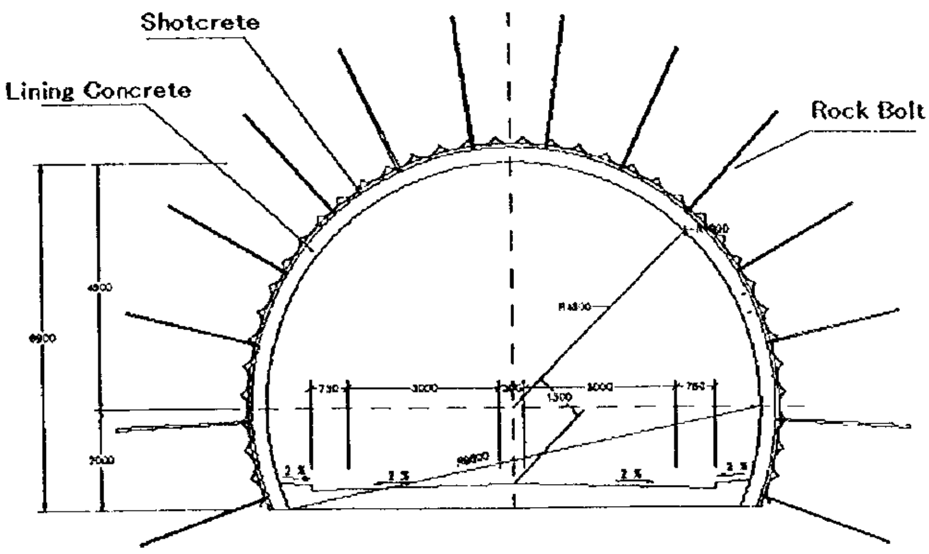
In consideration of the above, the following standards are established;

- 4 % gradient is applicable (the maximum grade that a truck can drive at half of design speed)
- Minimum gradient of tunnel is 0.3 % for drainage purpose.
- For the bypass route, maximum tunnel length of 3000 m and maximum gradient 3.5 % are applicable for upgrading of service level.

(5) Tunnel Cross Section

Tunnel cross-section should be decided based on soil conditions, excavation method, width of traffic lane and type of tunnel support. Tunnel support is a vital component of tunnel structure, protecting the overall tunnel structure from failure of rock mass and earth pressure which constantly bears dawn upon it. These tunnel support functions to stabilize the excavated section.

A tunnel cross section for less than 1000 m in length is recommended as shown in Figure 7-4-2.



Source: Study Team

Figure 7-4-2 Tunnel Cross Section

7.4.2 Rock Mass Classification of Tunnel

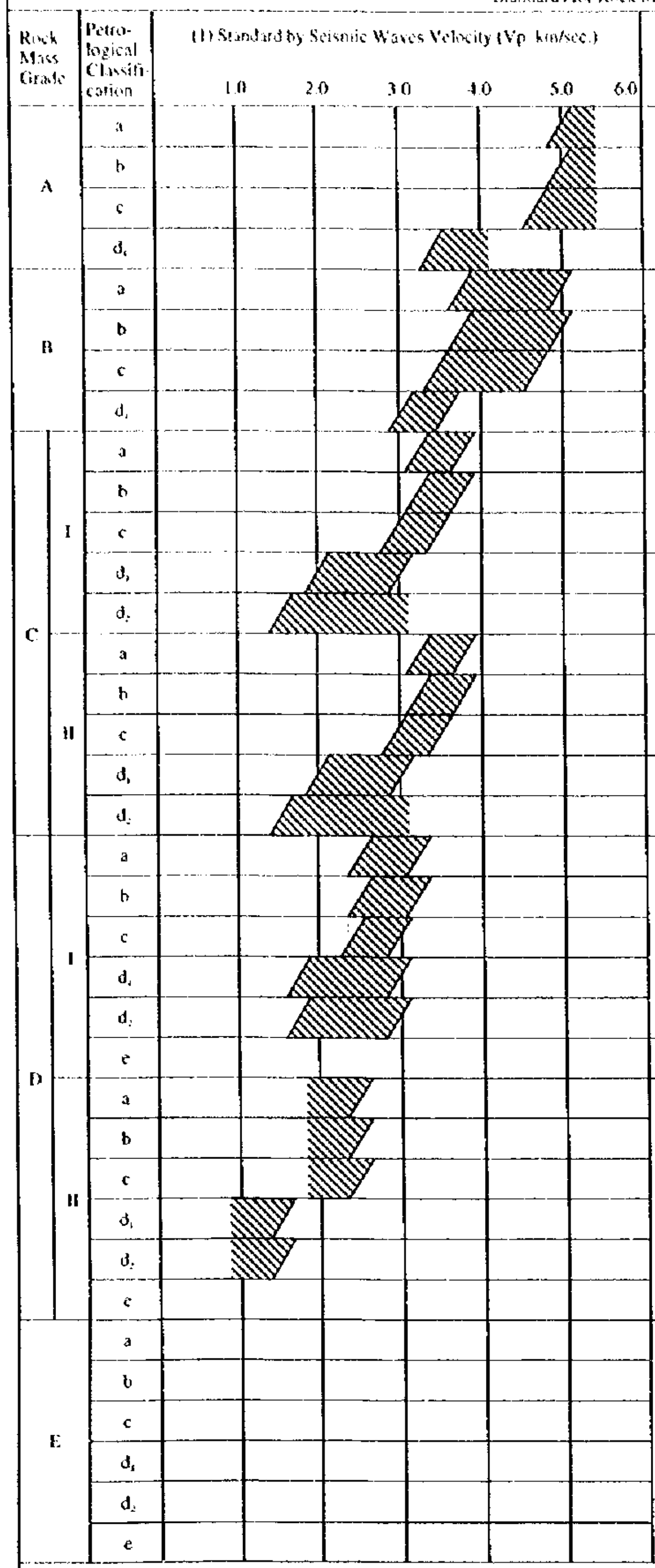
Whereas the behavior of the interior of the tunnel is dominated by intraterrane conditions of rock quality and geological structure, the behavior of the tunnel entrance area is dominated by these conditions as well as by external conditions of topography, meteorology, etc.
Therefore, in determining rock mass classification, tunnel entrance and tunnel interior are designed separately.
As for what the tunnel entrance area entails, it is often considered as the area from the point of the tunnel portal to the point inside the entrance where the formation of a grand arch 1 to 2 x D is possible.
The categories classify rock with favorable conditions in class "A" (extremely hard rock with few cracks) and categorized downward to "D II" in order of degradation of rock condition.
Seismic speeds of the tunnel in question are shown in the right-hand column. Based on these results, the rock category is postulated as shown.
The lower speed belt is classified under "D II". Furthermore, although the seismic speed at the center of the tunnel is analyzed at 2.5~3.3 km / sec, the area of the planned tunnel is assumed to be of better bedrock, so is categorized at "C II". And also a common rock mass classification is shown Table 7-4-2.

Table 7-4-1 Rock Categories at Tunnel Interior

Standard Japanese Classification	
Category	**Seismic speed (km/sec)**
A	More than 5.0
B	3.80～4.9
CI, CII	3.2～3.7
DI	2.5～3.1
DII	Less than 2.4

Source : Road & Tunnel Engineering Standards (structure edition), Japan

Standards for Rock Mass Classification



Rock Mass Grade		Petro-logical Classifi-cation	(2) Gx	(3) Standard by Boring Core Sample: Condition of core sample	(3) Standard by Boring Core Sample: RQD (%)	(4) Standard by geological condition (the result of ground investigation or the condition of excavated rock mass)	(5) Standard by Observation: Hitting with Hammer	(5) Standard by Observation: Spacing of Cracks	(6) After excavated condition: Standard by stability of face	(6) After excavated condition: Convergence
A		a, b, c, d_1	....	Core recovery rate is more than about 90 % with complete column shape, having length of more than about 20 cm, without containing small pieces.	more than 90	• The condition of rock is very hard and fresh, and consists of massive blocks without cracks, which continuous and stable over the large area. • Rock mass is not inferior by water.	Hammer is bounded. The rock is cracked with fresh surface only when hitted strongly.	50 ~ more than 100 cm	• The condition of face stability is very good and not loose for a long time. • Height of looseness, less than 1.6 m	very small
B		a, b, c, d_1	....	Core recovery rate is more than about 70 % and the core shows large block or short column or bar shape. Core having length may be about 10 to 20 cm, but in rare case, 5 cm or so.	70 ~ 90	• The condition of rock is hard and fresh, and contains relatively less cracks. • The condition of rock is relatively hard but shows somewhat altered property due to weathering. • The condition of rock is hard but assumes a layer from having bedding or schistosity and tends to be cracked along the surface. • Rock mass is not inferior by water.	The rock develops cracking or cut relatively largely along the joint or crack when hit strongly.	30 ~ 70 cm	• Cutting face keeps stability and excavation without support has sectionally fall of rocks but generally stable. • The sectionally loose zone must support. • Height of looseness, 1.5 to 3.0 m	very small
C	I	a, b, c	....	Core recovery rate is roughly 40 to 70 % containing many cracks, and the core also cracks easily to a mass less than 5 cm. Restore of original shape is difficult or impossible.	10 ~ 70	• Altered property due to weathering, and the condition of rock is somewhat soft. • The condition of rock is relatively hard but contains many small cracks thereby showing the appearance of small masses. Joint may contain clay despot. • Bedding and schistosity are remarkable. Easy cleavage with thin layer. • Narrow, small fault is contained. • Rock mass is not inferior by water.	Crushed easily with hammer. Crushed into small pieces along the cracked face. Faces without containing cracks are hardly crushed.	about less than 50 cm	• Cutting face keeps stability. • Excavation without support needs concrete shotcrete for crown area at once after blasting. • Height of looseness, 2.0 to 4.0 m	less than 50 mm
		d_1, d_2	more than 4							
	II	a, b, c	....						• Cutting face keeps stability. • Excavation without support has fall of rock near crown area and which needs presupport. • Height of looseness, 2.0 to 4.0 m	
		d_1, d_2	more than 4							
D	I	a, b, c, d_1, d_2	2 ~ 4	Core recovery rate reduces down to less than 40 %, the core may be composed of small pieces or may be a rubble sand state or clay state.	about less than 10	• Considerably weathered rock mass, partly showing soiled part containing some hard parts, is soft and fragile. • Rock mass has many cracks and rock can be crushed easily from any part other than crack. • Rock mass has crushed rock zonein which tendency toward clay, not much progressing, and contained some hard components in which clayer soil and fine pieces are being mixed. • Soils, taluses, etc. • The case which the cutting face having fragile by water is D II grade.	Crushed easily if hitted by hammer. Crashed easily by fingers.	-----	• Cutting face and excavation without support have substantially fall of rocks, and the side wall has some squeezing. The ground needs presupport and landside protection at a early stage. • Plastic zone or height of looseness, 3.0 to 6.0 m	less than 60 mm
		e	more than 2							
	II	a, b, c, d_1, d_2, e	1 ~ 2				Crushed easily by a small hammer damage. The point of hammer sticks into rocks.	-----	• Cutting face has substantially fall of rocks. At excavation without support, the side wall has squeezing. • Plastic zone or height of looseness, 3.0 to 6.0 m	less than 200 mm
E		a, b, c, d_1, d_2, e	less than 1	-----	-----	• Fault and crushed rock zone or taluses with a considerable width, on which considerable eccentric earth pressure is acting. • Inferior by ground water is relatively, and to be weakness.	-----	-----	• Cutting face has squeezing and in a striking case, cutting face collapse. • Excavation without support has squeezing with circumference pressure. • Plastic zone, more than 7.0 m	less than 400 mm

1. Petrological classification
   a: Metamorphite: (phyllite, graphite, schist, silicic graphite, schist, quartzschist, greenschist, gneiss, serpentine, hornfels, etc.) Plutonite: (grabboro, peridotite, etc.)
   b: Paleozoic strata and Mesozoic formation: (Slate, sandstone and conglomerate, graywacke, limestone, quartzite, schalstein, etc.)
   c: Vocanic rock : (liparite, andesite, basalt, etc.)
   Dike rock : (quartz porphyry, granite, diabase, etc.)
   Plutonite : (granite, diorite, etc.)
   d: Tertiary formation and lower diluvium: (mudstone, shale, siliceous shale, sandstone and psephite, limestone, tuff, breccia, agglomerate, etc.)
   But, the classfication d_1, and d_2 is due to the compressive strength of fresh rock mass which point of out 200 kgf/cm².
   d_1: qu ≥ 200 kgf/cm²
   d_2: qu < 200 kgf/cm²
   e: Upper diluium (loam and cray, volcanic crushed foremation, etc.)
   Alluvium (talus, surface soil, etc.)
2. The condition of boring core sample, RQD, and spacing of cracks applies petrological classification for a, b, c, d_1.
3. $Gx = qu / \gamma h$ qu: uniaxial compressive strength of ground, γ: unit weignt of ground, h: depth of overburden

Table 7-4-2 Common Rock Mass Classification

7.4.3 Examination of Support Structure

The purpose of support structure is to preserve stability and provide safer conditions in the basically unstable status which prevails in the rock mass throughout excavation, construction, as well as following completion.
The stability of the surrounding rock during tunnel excavation depends on the rock mass conditions. Therefore, it is necessary to select a construction method and support structure which meets the conditions presented locally.
The support structure of the project tunnel is considered according to the differing construction methods of the tunnel interior and tunnel entrance.

(1) Consideration of support structure for tunnel interior

As the scale of the project tunnel is two-lane with an excavation width of 10m, planning of tunnel support structure is prepared according to the " Road & Tunnel Engineering Standards (structure edition)".
Standard support structure combinations taken from " Road & Tunnel Engineering Standards (structure edition)" are shown below.

Table 7-4-3 Standard Support Structure Combinations

Rock category	Rock bolt			Steel arch support			Spray thickness (cm)	Cover thickness (cm)	Invert thickness (cm)
	Length (m)	Interval		Upper half	Lower half	Interval (m)			
		Circuit direction (m)	Length direction (m)						
A	Differs greatly according to rock condition. Considered separately.								
B	3.0	over 1.5	2.0	None	None		5	30	
CI	3.0	1.5	1.5	None	None		10	30	(40)
CII	3.0	1.5	1.2	H-125 U-21	None	1.2	10	30	(40)
DI	4.0	1.2	1.0	H-125 U-21	H-125 U-21	1.0	15	30	45
DII	4.0	1.2	Under 1.0	H-125 U-21	H-125 U-21	Under 1.0	20	30	50
E	Differs greatly according to rock condition. Considered separately.								

(For interior width of 10 m, upper half cross-section construction technique)

Source : Road & Tunnel Engineering Standards (structure edition), Japan

(3) Consideration of support structure of tunnel entrance

In regards to the support structure of the tunnel entrance, it is a general rule that it is constructed with more durable strength than the interior. The table below indicates the criteria for the standard combinations of support structures of an interior width of about 10 m. In general, upper half cross-section construction techniques are used, but in cases where the bearing capacity of the supporting strata is small, a side-drift progression construction technique may also be used.

Table 7-4-3 Standard Combinations for Tunnel Entrance Support Structures

Excavation method	Steel arch support			Spray thickness (cm)	Cover thickness (cm)		
	Upper half	Lower half	Interval		Arch	Side-wall	Invert
Upper half cross-section technique (leaving core)	H-200	H-200	1.0	25	35	35	50
Side-drift progression technique (leaving core)	H-200	-	Over 1.0	25	25	*	under 50

Source : Road & Tunnel Engineering Standards (structure edition), Japan

7.4.4 Examination of Construction Methods

(1) Excavation methods

Regarding excavation methods for the project tunnel, the concrete spraying and rock bolt method (NATM) is adopted in this case, as it is a basic construction method in Japan, and has been utilized in underground electrical generation plants and water tunnels in Indonesia.
Generally, the concrete spraying and rock bolt method combines the functions of spraying concrete, rock bolts, and steel arch support, and is commonly used in situations for retaining rock mass. Specifically, it entails the provision of immediate support (by spraying concrete) following excavation which helps prevent the loosening of surrounding rock during construction, followed by the implementation of rock bolts which retain the rock-supporting capacity. At present, this is one of the most representative methods of tunnel excavation.

(2) Types of excavation

Among methods of excavation for tunnels there are use of explosives, use of excavating machinery and use of manpower. In terms of labor efficiency and constructability, the former two have become the most prevailing methods. In choosing the most suitable type of excavation, sufficient consideration must be made for ease in construction, economics, safety, etc., as well as for rock conditions, scale of tunnel, and environmental circumstances to prevent loosening of ground rock.
In selecting the type of excavation for the project tunnel, it should be remembered that metamorphic gneiss is widely distributed throughout the area and it its predicted that there should be relatively favorable rock conditions in the area of depth of the tunnel.
Therefore, judging from the points mentioned above, excavation will be carried out by blasting methods.

- Excavation construction method : Concrete spraying and rock bolt method
- Type of excavating : Excavation by blasting

Reference is made to the sequence of construction in Figure 7-4-3.

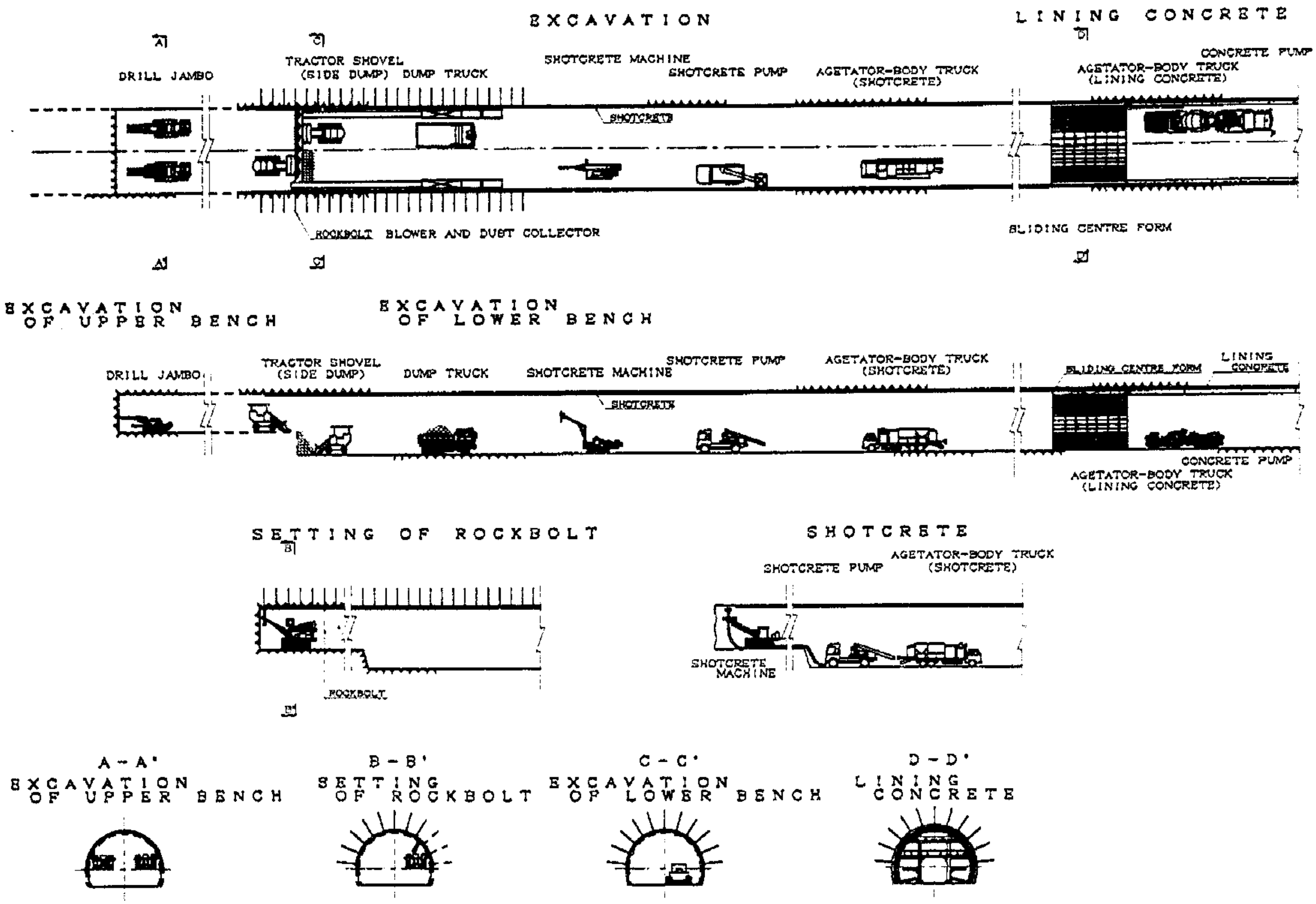


Figure 7-4-3 Tunnel Construction Sequence

Chapter 8

Cost Estimation for Master Plan

Chapter 8 COST ESTIMATES FOR MASTER PLAN

8.1 Precondition of Cost Estimates

8.1.1 Entity of Implementation

The works of road development mainly consist of widening of the existing roads and linking of missing parts by constructing new roads in the inter-regional road network. The works serve to increase public interests in developing industries and higher standards of living in the region. Considering these, Bina Marga will undertake the road development and improvement works on contract basis.

8.1.2 Execution of Works

Considering the difference of work load by area and the fluctuation of work time, the construction will be subcontracted through competitive bidding.

8.1.3 Calculation Basis

The proportion of the total cost which is in foreign currency and local currency has also been estimated. The foreign component has been expressed in rupiah at the governing exchange rate in July 1998, i.e. 1US$ = 10,600 Rp. Cost calculations are based on the material cost, labor cost and equipment cost. Imported materials costs used include all import taxes and rates listed (issued by Directorate General of Customs and Excise in Department of Finance) at October 1996.

8.2. Construction Work Plans

8.2.1 Existing Pavement

Costs of widening the existing Trans-Sulawesi road and Poso-Luwku road which are asphalt concrete paved are referred to.
Macadam paving of existing roads begin with surface restoration, and then are undergone hot mix-asphalt concrete paving with crusher rum stone.
On the shoulder of the road, the same material as subbase course is laid and compacted.
The average transportation distance of paving materials were considered 5 km for Subbase and 30 km for asphalt.

8.2.2 Maintenance of Existing Roads (Overlay)

When the existing road is macadam paving, it will first undergo surface restoration, followed by the laying of macadam paving material.
When the existing road is of asphalt concrete, the surface will be first cleaned, then tack coat will be sprinkled on it, and finally asphalt is laid and compacted.

8.2.3 Bridge

Bridge construction works basically are defined as new construction to replace bridges. However, the bridge construction cost depends on the bridge scale. Bridge construction works, therefore, are classified into following four (4) categories by span length;

Type A : Span length is less than 10m
Type B : Span length is10m - 20m
Type C : Span length is 20m- 30m
Type D : Span length is more than 30m

8.2.4 Hazard Prevention Works

The roads to be constructed are divided into four categories using a geological map and a topographical map of 1/50000; (1) flat, (2) rolling, (3) mountainous, and (4) steep mountain. As for (1) and (2), no special works are planed. Slope protection is applied to 40% of the category (3) with average height set at 8 meters. Slope protection is applied to 60% of the category (4) with average height set at 10 meters. Slope protection work includes concrete spray work and the concrete crib work with the ratio of 1 to 4.

8.2.5 Earth Works

Construction cost of earth works is summed up by using premium rates of 1.0 for flat areas, 1.05 for rolling areas, 1.1 for mountainous areas, and 1.2 for steep mountains utilizing the categories for the estimates of slope protection works cost.

8.2.6 Drainage Works

Drainage is constructed all along the cut parts on the mountain sides for the protection of pavement. The minimum diameter of drainage pipe on 60 cm crossing the road is installed. The concrete pipes are to be set every 300 meters in the road length. The width of the existing roads is estimated as 6 meters.

8.2.7 Safety device

As for lane marking, a center line is to be laid on all the roads.
Along the roads, two stones of a height of 0.5 m are to be one meter apart all along the length of the roads for embankment protection. Guardrails of 100 meters for the prevention of road accidents are constructed at every 2 kilometers of the road length. A road sign, traffic sign, kilometer post is to be set up at every kilometer of road length.

8.2.8 Indirect cost

Costs of common building, overhead, common machinery transportation, and accommodation for construction workers, contingency and engineering service constitute 40% of direct cost of road construction.

8.3 Unit Cost

The construction unit costs are shown in Table 8-3-1.

Table 8-3-1 Unit Cost for Improvement and New Construction

Type of Road Development	Unit	Foreign (US$)	Financial Local (1000Rp)	Financial Total (1000.Rp)
1) New road development				
Pavement width 6.0m				
Pavement type A	1km	85,119	918,855	1,821,116
Pavement type B	1km	71,790	778,931	1,539,905
Pavement width 4.5m				
Pavement type C	1km	45,458	515,162	997,017
2) Widening				
Pavement width 6.0m				
Pavement type AA	1km	84,800	925,624	1,824,504
Pavement type A	1km	74,171	820,801	1,607,014
Pavement type B	1km	60,842	680,878	1,325,803
Pavement width 4.5m				
Pavement type C	1km	34,510	417,109	782,915
Hazard Prevention				
Sprayed Concrete Cribwork	100m2	2,055	17,808	39,591
Shotcrete Work	100m2	1,655	14,195	31,738
Bridge				
Type A (L<10m)	100m2	28,868	312,700	618,701
Type B (10m<L<20m)	100m2	40,257	350,874	777,598
Type C (20m<L<30m)	100m2	43,911	370,128	835,585
Type D (L>30m)	100m2	48,303	407,141	919,153

Source : Study Team

Note :1. The pavement is included asphalt, earth, drainage and safety device works.
2. Each unit costs are included 40% of indirect cost.

8.4 Bill of Quantities for Master Plan

The salient features of inter-region road development master plan are shown in Table 8-4-1(1), (2) by road link.

Table 8-4-1(1) Quantities of Work for Masterplan

No.	LINK NAME			Link Length (km)	Construction of Road Development: Pavement Width (km): New Road (km) (4.5M)	(6.0M)	Widening (km) (4.5M)	(6.0M)	Existing Road Development: Pavement Work: Type of Pavement Structure (km): AA	A	B	C	Hazard Prevention Work: Classification of Area (m²): Steep Mountain	Mountain	Rolling	Bridge Work: Area of Bridge (m2): L<=10m	10m<L<=20m	20m<L<=30m	L>30m
	CENTRAL SULAWESI PROVINCE																		
1	SURUNAMA DONGARA PALU KASINBAR																		
	SURUNAMA	DONGARA		40.9				40.9		40.9					30,187	453	495	0	0
	DONGARA	PALU		33.5				33.5	33.5						46,957	611	910	143	1404
	PALU	TAWAELI		24.8				9.0	9.0							196	178	0	304
	TAWAELI	PANTALOAN		3.7												30	21	0	46
	PANTALOAN	TOMPE		62.4				62.8		62.8						1,054	0	0	0
	TOMPE	TAMBU		27.8				27.6		27.6						27	0	0	0
	TAMBU	KASINBAR		29.5				29.5		29.5			170,623			296	296	0	0
2	TAMBU MALALA																		
	TAMBU	SABANG		26.7				26.7			26.7			167,941		226	0	0	0
	SABANG	SIBONG		53.2				53.2			53.2					350	422	0	0
	SIBONG	OGAMAS		64.4				64.4			64.4		301,869			443	133	0	0
	OGAMAS	OGOTUA		35.9				35.9			35.9					160	0	141	6
	OGOTUA	MALALA		59.6				59.6			59.6		456,525			578	0	0	6
3	MALALA TOLITOLI,BASI MEPANGA																		
	MALALA	SILONDOU		38.4				38.4			38.4					159	0	0	374
	SILONDOU	TOLITOLI		38.0				38.5			38.0		76,262			34	0	281	0
	BASI	MEPANGA		47.7				47.7			47.7		134,154			198	0	349	62
4	TOLITOLI BUOL																		
	TOLITOLI	LINGADAN		36.7			36.6					36.6			127,456	321	0	0	6
	LINGADAN	LAULALANG		19.8			19.8					19.8				87	0	0	0
	LAULALANG	LEOK		48.7			48.7					48.7				214	0	0	0
	LEOK	BUOL		55.1			55.1					55.1		612,663		613	0	0	0
5	BUOL UMU																		
	BUOL	BOOI		48.0			48.0					48.0				1,193	126	0	0
	BOOI	PALELEH		46.0			46.0					46.0				1,794	120	0	540
	PALELEH	UMU		47.0			47.0					47.0		474,391		240	0	190	240
6	MEPANGA MOLOSIPAT																		
	MEPANGA	LAMBUNU		45.9				45.9		45.9						0	0	0	0
	LAMBUNU	MOLOSIPAT		42.0				42.0		42.0					57,020	0	0	0	480
7	TOBOLI MEPANGA																		
	TOBOLI	ANGKABO		29.7				29.7		29.7				8,944		126	30	0	0
	ANGKABO	KASINBAR		56.7				56.7		56.7						22	126	0	0
	KASINBAR	TINAMBA		58.5				58.5		58.5						17	0	0	0
	TINAMBA	MEPANGA		56.5				56.5		56.5					43,803	24	0	249	198
8	TAWAELI POSO																		
	TOBOLI	PARIGI		15.5				15.5	15.5							215	257	0	361
	PARIGI	TOLAI		29.8				29.8	29.8							0	0	0	0
	TOLAI	SAUSU		28.4				28.4	28.4							30	0	0	0
	SAUSU	TAMBARANA		21.5				21.5	21.5					44,321		50	63	0	575
	TAMBARANA	POSO		51.6				51.6	51.6						6,720	71	63	0	150
9	TAWAELI	TOBOLI		46.6				45.5	46.6				438,394			690	5,360	330	0
10	POSO TINDATANA																		
	POSO	TENTENA		53.9				53.9		53.9						412	0	0	0
	TENTENA	TARIPA		31.2				31.2		31.2			637,279			0	0	0	0
	TARIPA	PAPE		26.2				26.2		26.2						30	0	0	0
	PAPE	TINDATANA		40.1				53.1		53.1			368,951			30	0	0	0
11	TAGOLU AMPANA																		
	TAGOLU	UEKULI		43.0				43.0		43.0						52	238	0	0
	UEKULI	MAROWO		71.1				71.1		71.1						321	0	0	0
	MAROWO	AMPANA		26.1				26.1		26.1					271,371	36	98	0	0
12	AMPANA LUWUK																		
	AMPANA	BALINGGARA		41.4				41.4		41.4						60	0	0	30
	BALINGGARA	BUNTA		52.4				52.4		52.4						401	0	132	0
	BUNTA	PAGIMANA		69.0				69.0		69.0						72	900	0	0
	PAGIMANA	BIAK		53.9				53.9		53.9				848,460		307	0	132	212
	BIAK	LUWUK		10.3				10.3		10.3						42	0	0	0
13	LUWUK BATURUBE																		
	LUWUK	BATUI		54.0				54.0				54.0				178	0	0	98
	BATUI	TOILI		42.0			42.0					42.0				164	0	0	1,021
	TOILI	RATA		62.7			62.7					62.7				1,152	473	306	3,314
	RATA	BATURUBE		47.8			47.8					47.8			181,122	1,476	192	596	1,387
14	TARIPA BETELEME, PAPE TOMATA																		
	TARIPA	TOMATA		32.1			32.1					32.1				174	0	325	132
	TOMATA	BETELEME		51.5			51.5					51.5				439	0	176	0
	PAPE	TOMATA		31.4			31.4					31.4	156,525			51	118	0	0
15	UEKULI NUHA																		
	UEKULI	MALINA		26.4				26.4		26.4						375	75	320	6
	MALINA	TANDOYONDO		29.0		20.0		9		29.0						412	30	372	0
	TANDOYONDO	KOLONODALE		22.3				22.3		22.3						317	62	440	6
	KOLONODALE	BETELEME		34.7				34.7		34.7			301,369			493	96	654	0
	BETELEME	NUHA		16.4				16.4			16.4					231	45	325	0
16	TOMPIRA BUNGKU																		
	TOMPIRA	WOSU		55.4				55.4		55.4						1,447	728	0	360
	WOSU	BUNGKU		48.5				48.5		48.5						3,010	0	672	0
17	PALU GINPU																		
	PALU	KALAWARA		27.9				27.9		27.9						417	0	0	0
	KALAWARA	KULAWI		40.1				40.1			40.4					919	698	0	266
	KULAWI	GINPU		27.9			27.9					27.9	178,585			147	0	0	0
18	TENTENA GINTU																		
	TENTENA	TENTENA 340		36.0			36.0					36.0				1,350	0	0	0
	TENTENA 340	GINTU		58.4			58.4					58.4	459,574			1,368	240	0	0
	GINPU	GINTU		54.0	54.0							54.0				4,248	940	0	397
	TONUSU	PENDOLO		58.2			58.2					58.2	225,007			1,264	207	0	0
19	PALU SINGGORA																		
	PALU	BANGGA		7.0				7.0			7.0					0	0	0	0
	BANGGA	SINGGORA		38.5				38.5			38.5					234	662	350	360
20	BIAK SALODIK																		
	BIAK	BONEBOBAKAL		63.7			63.7					63.7				3,505	162	0	0
	BONEBOBAKAL	BALANTAK		59.1			59.1					59.1		265,726		263	0	0	332
	BALANTAK	BUALEMO		69.9			69.9					69.9		422,053		535	912	176	626
	BUALEMO	TIKUPON		45.1			45.1					45.1		26,833		345	598	114	456
	TIKUPON	SALODIK		45.8			45.8					43.8		178,985		401	637	123	460
21	PALU KASIGUNCU, SANGGINORA BATUNONCU																		
	PALU	PALOLO		50.5			50.5					50.5	29,262	10		0	130	294	0
	PALOLO	NAPU		56.9			56.9					56.9	178,565	10		0	0	0	0
	NAPU	SANGGINORA		76.9			76.9					76.9	637,279	10		3,308	287	136	0
	SANGGINORA	KASIGUNCU		24.0			24.0					24.0	156,525	10		1,126	0	0	0
	SANGGINORA	BATUNONCU	18.2	19.2	18.2							19.2	156,525	10		854	0	0	0
22	BUNGKU S E																		
	BUNGKU	LABOTA		43.9				43.9		43.9					47,262	4,184	0	0	227
	LABOTA	LAITU		51.1				51.1		51.1					315,256	5,336	0	0	282
	LAITU	S E		20.0		20.0				20.0						2,568	0	0	104
23	BATURUBE TONDOYANDA																		
	BATURUBE	TONDOYANDA		97.4	97.4							97.4				3,810	364	175	0
24	BUOL BASI																		
				25.0			25.0					25.0				978	93	45	0
				96.7	45.5		51.2					96.7				3,762	362	176	0
25	TOLITOLI BASI			70.5			70.5					70.5			100,623	2,758	263	127	0
26	BANGAI ISLAND		25.4	199.9	25.4		174.5					199.9		196,774		1,530	2,607	504	1,182
27	BALINGARA TOILI		90	90.0	67.5		22.5					67.5				3,279	249	3,774	0
	SUB TOTAL (CENTRAL SULAWESI PROVINCE)			3,905.3	3,9.0	40.0	1569.8	2056.9	235.9	1341.1	467.9	19,95.3	4,774,265	2,719,109	1,197,414	61,937	29,130	10,193	16,470

Source : Study Team

Table 8-4-1(2) Quantities of Work for Masterplan

No.	LINK NAME		Link Length (km)	Contents of Road Development: Pavement Width (km), New Road (km) (4.5M)	(6.0M)	Widening (km) (4.5M)	(6.0M)	Contents of Road Work plan: Pavement Work, Type of Pavement Structure (Km) AA	A	B	C	Hazard Prevention Work, Classification of Area (m3) Steep Mountain	Mountain	Rolling	Bridge Work, Area of Bridge (m2) L<10m	10m<L<20m	20m<L<50m	L>50m
	SOUTH EAST PROVINCE																	
28	LASUSUA BTS PROP SUL																	
	LASUSUA	LAPAI	41.0				41.0		41.0						234	562	300	1,590
	LAPAI	POREKU	59.0				59.0		59.0						342	966	600	2,400
	POREKU	BTS PROP	71.0				71.0		71.0				1,381,330		156	720	264	360
29	KOLAKA LASUSUA																	
	KOLAKA	WOLO	61.0				61.0		61.0				345,927		139	0	300	540
	WOLO	LASUSUA	78.0				78.0		78.0						136	349	1,200	660
30	KENDARI KOLAKA																	
	KENDARI	UNAAHA	35.3				35.3		35.3						546	0	0	0
	UNAAHA	RATE RATE	30.1				30.1		30.1						0	78	0	530
	RATA RATA	KOLAKA	65.0				65.0		65.0				617,151		0	457	391	0
31	BARRU KASIPUTE																	
	BARRU	POMALA	20.2			20.2					20.2				85	290	351	0
	POMALA	22KM	41.5			41.5					41.5				262	0	325	0
	22KM	BTS CADIN	17.1			17.1					17.1				95	249	0	270
	BTS CADIN	BUASIN	33.3			33.3					33.3				217	545	152	180
	BUASIN	32KM	40.8			40.8					40.8				305	250	275	0
	32KM	KASIPUTE	35.0			35.0					35.0		250,440		318	714	155	0
32	POHARA ASERA																	
	POHARA	BELALO	40.4				40.4		40.4						130	90	263	1,670
	BELALO	TINOBU	4.4				4.4		4.4						54	342	606	2,150
	TINOBU	ANDOWIA	24.5				24.5		24.5						73	241	428	1,561
	ANDOWIA	ASERA	12.2				12.2		12.2						36	120	213	600
33	ASERA BTS PRO																	
	ASERA	LANDAWE	40.5				40.5		40.5						120	90	263	1,470
	LANDAWE	BTS PRO	35.5		35.5				35.5					429,325	105	70	231	2,390
34	BELALO TINANGGEA																	
	BELALO	UNAAHA	40.6			40.6					40.6				774	612	0	0
	LAMBUYA	MOTAHA	37.6			37.6					37.6				156	0	0	0
	MOTAHA	ALANGGA	29.7			29.7					29.7				279	120	0	0
	ALANGGA	TINANGGEA	16.1			16.1					16.1				0	120	0	0
35	MOTAHA TOBIMATE																	
	MOTAHA	KENDARI B	43.0			43.0					43.0				138	226	0	0
	KENDARI B	LEPOLEPO	14.7			14.7					14.7				0	240	0	0
	WUA WUA	TOBIMATA	4.0			4.0					4.0				0	240	0	0
36	NANGA NANGA AMBESIA																	
	NANGA NANGA	LAPUKO	46.2			46.2					46.2				430	942	265	0
	LAPUKO	AMUNIO	21.1			21.1					21.1				192	430	93	0
	AMUNIO	LAINEA	25.0			25.0					25.0		160,992		227	510	313	0
	LAINEA	AMBESA	13.5			13.5					13.5			210,216	0	0	112	240
37	MANDONGA TINANGGEA																	
	MANDONGA	LEPOLEPO	10.0			10.0					10.0				84	0	0	0
	LEPOLEPO	AMBESIA	52.5			52.5					52.5				904	145	648	0
	AMBESIA	TINANGGEA	45.2			45.2					45.2				216	0	0	530
38	LATE LATE BAULA																	
	LATE LATE	POLIPOLIA	21.9				21.9			21.9					91	240	0	0
	POLIPOLIA	BAULA	35.6				35.6			35.6					0	120	0	0
39	POLIPOLIA KASIPUTE																	
	POLIPOLIA	LAPOA	63.2	10			53.2			63.2					279	351	0	0
	TINANGGEA	KASIPUTE	64.5				64.5			64.5			116,276		0	80	457	0
40	ALANGGA PUNGGALUKU																	
	ALANGGA	PUNGGALUKU	31.2			31.2					31.2				55	542	172	0
41	TAMPE WARA		136.2			136.2					136.2		393,548		426	330	419	0
42	MUNA ISLAND K		193.7	36		157.2					193.7			461,526	592	469	596	0
43	BUTON ISLAND		292.0			292.0					292.0			684,237	2,527	1,273	948	3,540
44	BUTON ISLAND K		242.9	35		207.9					242.9				2,358	1,203	896	3,440
45	TRANCE PENL		153.0	153.0							153.0				1,047	1,152	567	1,700
46	UNAAHA ABUKI		13.3			13.3					13.3				254	210	85	250
47	BTS PROP SUL		37.3		10	27.3					67.2				433	641	235	700
	SUB TOTAL of SOUTH EAST PROVINCE		2507.5	234.9	45.5	1450.7	777.6	0.0	637.9	385.2	1210.6	0	3,269,631	1,276,142	15,374	16,756	11,714	27,180
	GRAND TOTAL		6523.1	542.0	85.5	3020.5	2636.5	215.9	1979.0	657.1	3629.9	4,774,201	3,369,240	2,973,747	29,112	35,855	21,947	45,657

Source : JICA Study Team

8.5 Maintenance Cost

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 work as overlay, patching, sealing, and other road surface repair, as well as the repair of bridge slabs. The existing roads employ macadam pavement, therefore they requires overlay in every 3-5 year until the completion of road improvement, and in case of after improvement, periodic maintenance will be required for every 7 years for overlay works. For unit cost of maintenance works are shown in the Table 8-5-1.

Table 8-5-1 Unit Cost of Maintenance works

Type of Maintenance	Unit	Foreign (US$)	Financial Local (1000Rp)	Financial Total (1000.Rp)
Routine Maintenance Work	1 km/year	93	718	1,700
Periodic Maintenance Work before Improvement Construction	1 km/year	6,097	65,646	130,274
Periodic Maintenance Work after Improvement and New Construction	1 km/year	9,594	99,537	201,233

Source : Study Team

8.6 Results of Cost Estimates

To estimate the total road improvement construction cost, it is necessary to calculate firstly the unit cost such pavement and earth work cost per km, bridge per m_2, slope protection per m_2 and tunnel per km into the construction cost and maintenance cost by each link road shown in Table 8-6-1.

Table 8-6-1 Total Construction Cost And Maintenance Cost for Each Road Link of Road Network

No	Link Name	Road Length (Km)	Construction Cost Foreign (US$)	Construction Cost Local (Mill. Rp)	Construction Cost Total (Mill.Rp)	Maintenance Cost (Financial) Foreign (US$)	Maintenance Cost (Financial) Local (Mill. Rp)	Maintenance Cost (Financial) Total (Mill.Rp)	Total Cost (Financial) Total (Mill Rp)	Total Appraisal Score
	CENTRAL PROVINCE									
1	SURUNAMA-DONGARA-PALU-KASINBAR	223.0	16,996,599	177,957	358,121	4,678,765	47,650	97,245	455,366	9
2	TAMBU-MALALA	241.8	24,974,248	252,269	516,996	5,767,821	58,741	119,880	636,876	6
3	MALALA-TORITORI,BASI-MEPANGA	124.1	11,908,251	121,342	247,569	2,180,635	22,208	45,323	292,892	8
4	TOLITORI-BUOL	174.2	12,595,094	127,299	260,807	3,063,441	31,199	63,672	324,479	8
5	BUOL-UMU	141.0	11,395,620	116,145	236,939	2,479,594	25,253	51,537	288,475	8
6	MEPANGA-MOLOSIPAT	87.9	4,208,006	45,738	90,343	1,545,789	15,743	32,128	122,471	8
7	TOBOLI-MEPANGA	201.4	9,203,058	101,273	198,825	3,540,015	36,053	73,577	272,402	8
8	TAWALI-POSO	146.8	8,347,087	87,812	176,291	2,581,591	26,292	53,657	229,948	9
9	TAWAELI - TOBOLI	40.1	15,369,493	133,199	296,116	974,781	9,927	20,260	316,376	10
10	POSO-TINDATANA	151.4	23,382,185	214,322	462,173	2,662,485	27,116	55,338	517,511	9
11	TAGOLU-AMPANA	140.2	10,988,608	120,377	236,856	3,344,287	34,059	69,509	306,365	8
12	AMPANA-LUWUX	227.0	22,777,203	236,916	478,354	5,414,786	55,146	112,543	590,896	8
13	LUWUX-BATURUBE	206.5	12,011,915	129,546	256,872	4,220,779	42,986	87,726	344,598	5
14	TARIPA-BETEREME, PAPE-TOMATA	115.0	7,026,157	74,117	148,594	1,629,745	16,598	33,873	182,467	6
15	UEKUULI-NUHA	174.0	16,549,349	165,557	340,980	2,704,780	27,546	56,217	397,197	9
16	TOMPIRA-BUNGKU	103.9	9,907,627	107,253	212,274	2,833,120	28,853	58,884	271,158	9
17	PALU-GINPU	95.9	9,337,297	95,462	194,437	2,561,252	26,085	53,234	247,671	4
18	TENTENA-GINTU	186.6	29,002,048	271,114	578,536	4,983,624	50,755	103,581	682,118	2
19	PALU-SIMORA	45.5	3,481,900	37,251	74,159	930,002	9,471	19,329	93,488	5
20	BIAK-SALODIK	286.6	18,786,502	196,785	395,922	5,857,992	59,660	121,754	517,676	5
21	PALU-KASIGUNCU, SANGGINORA-BATUNONCU	226.5	29,855,265	283,097	599,563	4,627,528	47,128	96,180	695,743	6
22	BUNGKU-BORDR OF PROVINCE	115.0	17,252,048	176,727	359,599	2,414,982	24,595	50,194	409,793	11
23	BATURUBE -TONDOYANDA	97.4	23,981,321	225,424	479,626	2,601,313	26,493	54,067	533,693	2
24	BUOL-BASI	121.7	8,367,072	92,344	181,035	2,902,993	29,565	60,337	241,371	7
25	TOLITORI-BASI	70.5	3,666,542	41,876	80,741	1,681,685	17,127	34,953	115,694	7
26	BANGAI ISLAND	199.9	13,926,375	145,129	292,749	4,085,878	41,612	84,922	377,671	5
27	BALINGARA-TOILI	90.0	24,130,381	212,291	468,073	2,146,832	21,864	44,620	512,694	7
	Total in Central Province	4,033.9	399,427,251	3,988,622	8,222,551	84,416,496	859,724	1,754,539	9,977,090	
	SOUTHEAST PROVINCE									
28	LASUSUA-BORDR OF PROVINCE	171.0	31,203,069	296,811	627,564	3,007,167	30,626	62,502	690,065	9
29	KOLAKA-LASUSUA	139.0	15,500,140	157,944	322,245	2,444,422	24,895	50,806	373,051	9
30	KUNDARI-KOLAKA	170.4	19,993,147	202,005	413,932	2,998,374	30,536	62,319	476,252	9
31	BARRU-KASIPUTE	188.0	10,985,233	117,388	233,831	3,306,125	33,671	68,716	302,547	9
32	POHARA-ASERA	91.7	11,207,129	112,711	231,507	1,709,387	17,409	35,528	267,035	9
33	ASERA-BORDER OF PROVINCE	76.0	12,407,725	116,633	248,155	1,595,988	16,254	33,172	281,326	11
34	BELALO-TINANGGEA	124.0	5,004,892	58,804	111,856	1,768,858	18,015	36,764	148,621	6
35	MOTAHA-TOBIMATE	59.7	2,417,581	28,126	53,752	850,933	8,666	17,686	71,438	6
36	NANGA NANGA-AMBESIA	105.8	5,913,717	63,097	125,782	2,834,310	28,865	58,909	184,691	5
37	MANDONGA-TINANGGEA	107.7	4,731,833	54,407	104,564	2,577,851	26,254	53,579	158,143	7
38	LATE LATE-BAULA	57.5	3,681,835	40,809	79,836	1,376,290	14,017	28,605	108,441	7
39	POLIPOLIA-KASIPUTE	127.7	10,142,667	107,502	215,014	2,610,138	26,582	54,250	269,264	4
40	ALANGGA-PUNGGALUKU	31.2	1,387,052	15,738	30,441	442,157	4,503	9,190	39,631	5
41	TAMPE-WARA	136.2	9,228,625	95,125	192,948	3,226,591	32,861	67,062	260,011	8
42	NUNA ISLAND K	193.7	8,302,656	94,883	182,891	5,173,247	52,686	107,522	290,413	5
43	BUTON ISLAND	292.0	15,152,346	166,541	327,156	6,965,276	70,937	144,768	471,925	7
44	BUTON ISLAND K	242.9	26,419,373	254,537	534,582	4,964,781	50,563	103,190	637,772	5
45	TRANCE PENI	153.0	12,690,651	119,292	253,813	4,086,231	41,616	84,930	338,743	5
46	UNAAHA-ABUKI	13.3	798,838	8,625	17,093	271,847	2,769	5,650	22,743	6
47	TOLUBU-MOWEWE	37.5	3,408,704	36,138	72,270	787,494	8,020	16,368	88,638	9
	Total in Southeast Province	2,518.3	4,379,234	2,147,116	4,379,234	1,101,516	539,743	1,101,516	5,480,750	
	Ground Total (Mill Rp)	6,552.2	12,601,785	6,135,738	12,601,785	85,518,012	1,399,467	2,856,055	15,457,840	

Source: Study Team

Chapter 9

Master Plan of Future Road Network System

Chapter 9 MASTER PLAN OF FUTURE ROAD NETWORK SYSTEM

9.1 Road Links and Development Characteristics

Most road links of Master Plan Network are existing ones. Road link Nos. 23, 27 and 45 are newly constructed. Major purposes of improving the existing road alignments, pavement, drainage and slope protection works and of widening the road width are to attain higher traveling speed, greater traffic volume, safe travel and smooth traffic flow. Therefore, industrial and agricultural products and services along the relevant roads to markets will be facilitated and accelerated. It is clarified herewith that the Master Plan Network is effective and useful in developing potential industry, agriculture and services based on the socio-economic data in Chapter 3 of this report. Those socio-economic data are indicated in Table 9-1-1 by matrix form for the relationship between each road links and development characteristics. In this table, one asterisk shows the possibility of development due to road development (for agriculture, development potential exists for sections equivalent to 10 - 30 % along the road). Two asterisk shows high possibility of development (for agriculture, development potential exists for sections equivalent to 30 - 70 % along the road). Three asterisk shows extremely high possibility of development (for agriculture, development potential exists for sections equivalent to 70 % or more along the road).

Figure 9-1-1 summarizes the following for quick reference together with potential industrial and agricultural area based on Table 9-1-1 along road links in Central and Southeast Sulawesi;

- Population by Kecamatan in 2018;
- Environmental conservation areas;
- Road betterment and upgrading projects in progress; and
- Traffic volume.

There are major industy development plans for 11 locations in Central Sulawesi and 9 locations in Southeast Sulawesi. In particular, agriculture sector is the dominant sector of Central and Southeast Sulawesi Provinces. The potential areas for rice, cotton, soy beans, copra, palm oil, mango, banana, cacao and cashew nut cultivation are indicated in Table 9-1-1.

The populations of Central Sulawesi (1.89 million in 1995) and Southeast Sulawesi (1.46 million in 1995) will increase up to 2.63 million and 2.21 million, respectively, by the year 2018.

There are 9 existing conservation areas and 10 proposed conservation areas in Central Sulawesi, and also 9 existing and 9 proposed conservation areas in South-east Sulawesi.

The above land use information is basic factor for deciding implementation schedule.

Table 9-1-1 (1) Possibilities of Development by Road Improvement (Central Sulawesi)

Link No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Tourism										**					*		*	*			**						
Mining						*										*						*					
Industry	***	**	**	**	**	**		***	***		*	*				**									**		
Transmigration		**		**	***	**						**			**	*				***		*		**			*
Fishery	*	*			*	*		*				*	*			*						*					
Agro Forestry						*	*														*						*
Agriculture																											
1 Rice	**	**	*	**	*	**	**	***	*	***	*	**	**	***	*	***	*		***	**	*	*	*	*	*	*	
2 Soybean																											
3 Mango	**	**	**	**	**	**	**	**	*	*	*	*	*	**		*	*		***	*			*	**			*
4 Banana																											
5 Palm oil	**	***	**	**	**	***	***	***	*		**	**	**	**	*	***				***		**	**	*	***	**	
6 Copra	***	***	*	***	*	***	***	***	*		**	**	*	***	*	***	*		***	**		**	*	**		*	
7 Gum	*	***	*	**	*	**	*	***	*	*	*	**	*	**	*	***				**		*	*	*			*
8 Cacao	**	***	**	**	*	**	***	***	*	*	**	*	*	***	*	**	**		***	**		*	**	**	*	*	
9 Raw cotton	**	**	*	**	*	***	**	***		*	*	*		*		**	*		***	**		**		**		*	
10 Cashewnut																											

Source: Ministry of Public Works

Table 9-1-1 (2) Possibilities of Development by Road Improvement (Southeast Sulawesi)

Link No.	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Tourism					**			*	*			**			*	*	*			
Mining														*	*					
Industry	*	*	**	**	**					*		*		*		*	*			
Transmigration		**	*	***	**	***		**	*	***	**	**						**	*	
Fishery	*				*															*
Agro Forestry	*																			
Agriculture						*														
1 Rice	**	**	**	***	*	***	*	**		**	*	*	***	*	***	*		*	***	***
2 Soybean	**	*	**	***	***	***	*	**	*	***	*	**	***		***	**	**	*	***	**
3 Mango	**	*	**	***	**	**	**	***	**	**		**	***		***	**	**	*	***	***
4 Banana	***	***	**	**	***	***		***		**	*	**	*	**	***	***	***	***	***	***
5 Palm oil						**														
6 Copra	**	**	***	**	**	**	*	***	*	***	*	*	***	*	***	**	**	*	**	***
7 Gum																				
8 Cacao	**	*	**	**	***	***	*	***	*	**	*	*	**		***	**	**		***	
9 Raw cotton		**	**	**	*		*	**		**	*	**	*	*	***	**	**		**	
10 Cashewnut			*	**	*	**		**	*	**	*	*	*	*	***	**	*	*	*	

Source: Ministry of Public Works

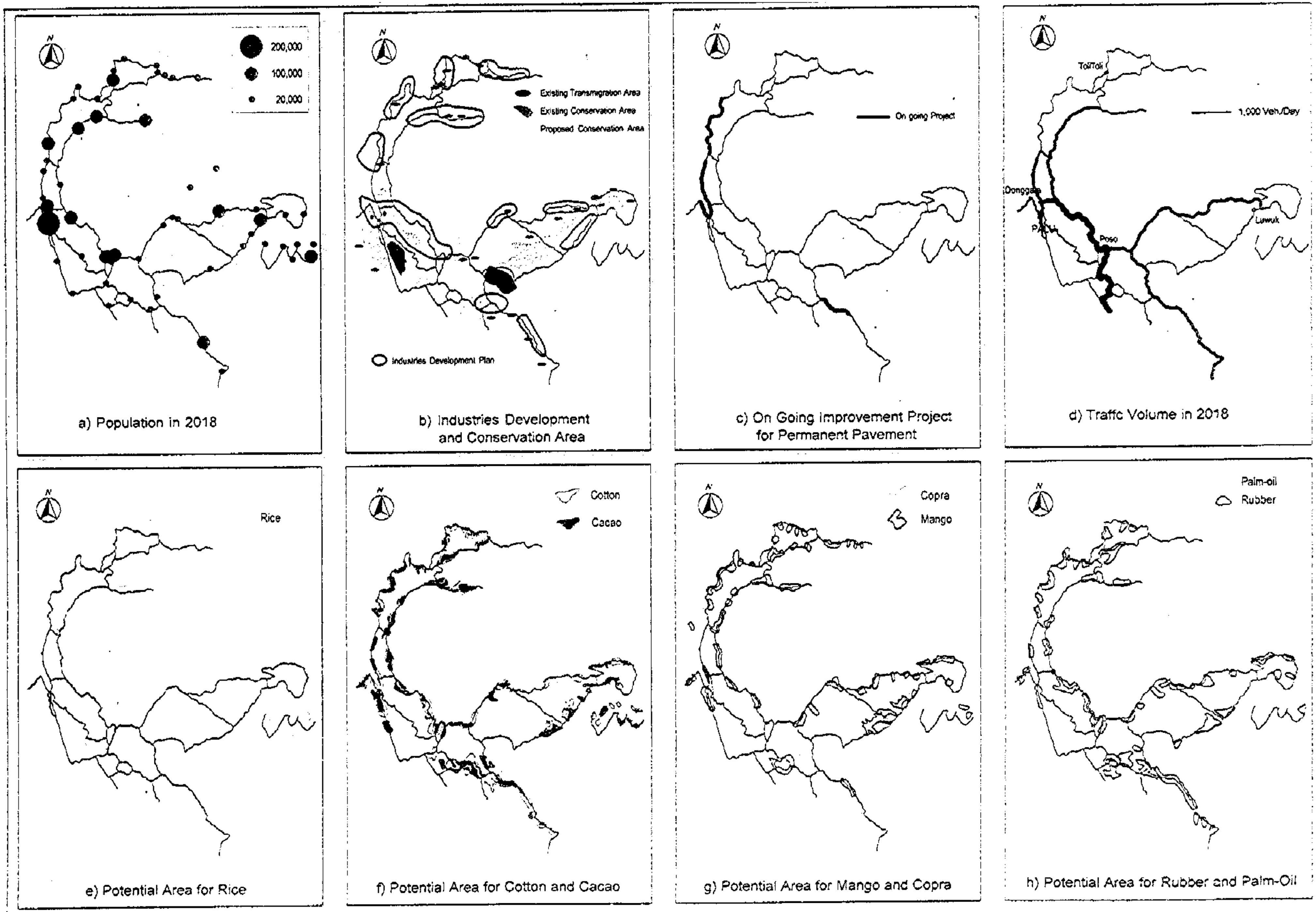


Figure 9-1-1 (1) Landuse and Road Link Characteristics in Central Sulawesi

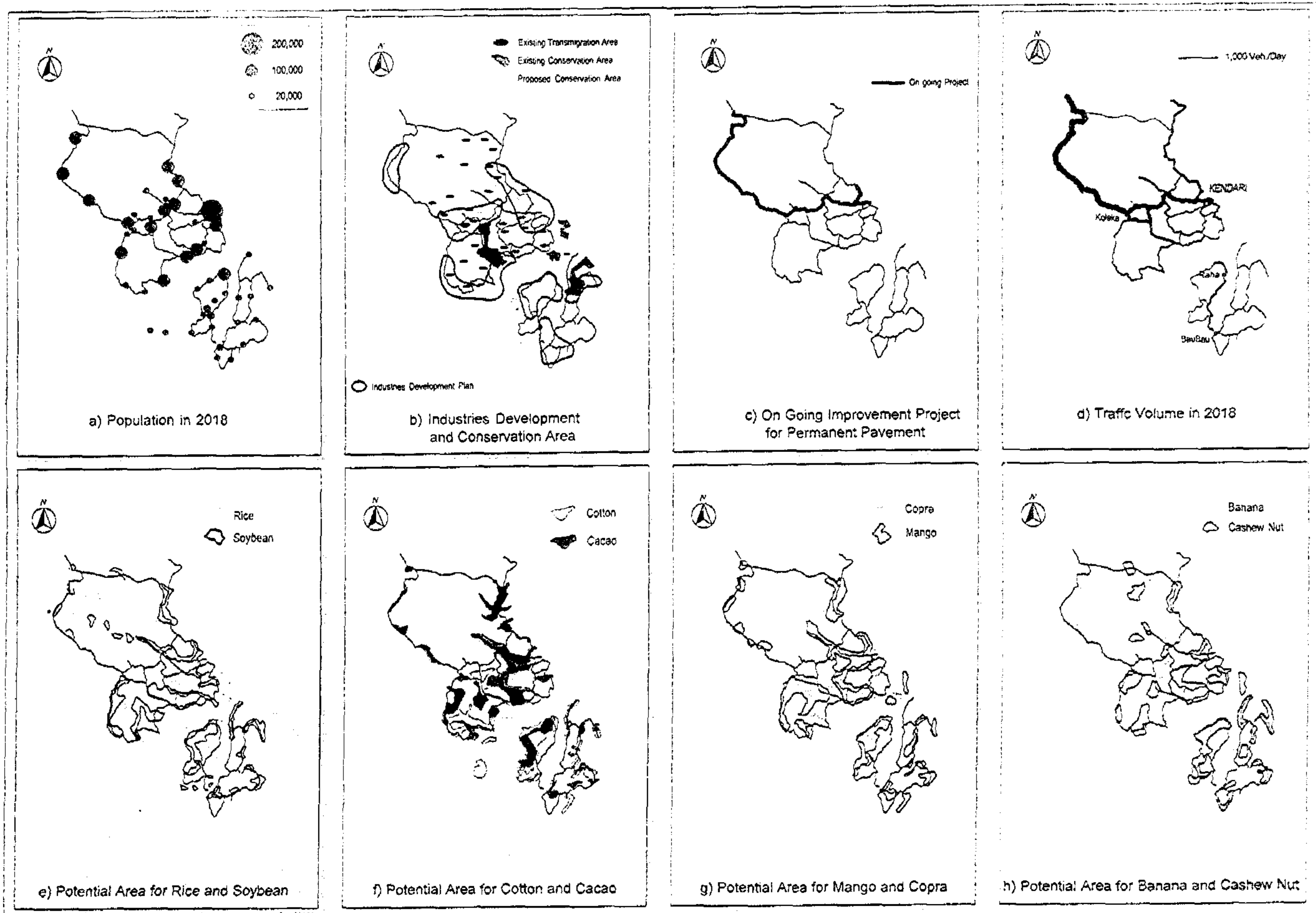


Figure 9-1-1 (2) Landuse and Road Link Characteristics in South-East Sulawesi

9.2 Implementation Plan

The total road length of the master plan is about 6,500 km. The master plan will be carried out over 20 years. Implementation schedule is to be determined according to limited regional budget and priority of the packaged project. Project costs are limited by the available budget but priority of the projects is determined in consideration of total score obtained according to appraisal items such as the road hierarchy, future traffic volumes, existing road condition, progress of present road development plan and environmental aspects of each project package. The implementation sequence for each package will be divided into four terms by five (5) year plans. Table 9-2-1 shows the score of each appraisal items to establish the implementation schedule.

Table 9-2-1 Score of Appraisal Items

1 Road Classification	Points
a Gross Corridor	4
b Sub-Gross Corridor	3
c Corridor to Ports	2
d Corridor for hazard prevention	1
and permanent settlement	
2 Traffic Volumes (Vehicles /Day)	
a More than 3000	4
b 3000>V>1000	3
c 1000>V>250	2
d Less than 250	1
3 Condition of Existing Road	
a Missing Link	5
b Pavement width < 3.0m	3
c 3.0m<Pavement width< 5.0m	2
d 5.0m<Pavement width	1
4 Road investment	
a Progress of implementation	5
b Invested past in 5 years	-1
5 Environmental aspect	
a Affect the National Park	-5
b Affect	-1

Source: JICA Study Team

- Roads which will become arterial roads in Sulawesi and the road network connecting provincial cities where traffic demand will increase are to be preferred. (Package Nos. 9,28,29, 30 and 47)
- Roads, whose accessibility is to be improved for growing traffic demand on the traffic node, are to be provided with higher priority. (Nos. 1 and 15)
- Routes which are arterial roads with high traffic demand are provided with high priority. (Nos. 6,7,8,10,28,29,30 and 47)

- In recently-invested areas, roads will be maintained in the present condition and remain in service for 10 years after investment despite arterial road status. (Nos. 6,7,8,10,11 and 12)
- Improvement of roads with low traffic demand is deferred. However, note that improvement plan will be accelerated for routes for which the road development plan has made substantial progress or the route in which two access points to major cities must be established. (Nos. 3,4,5, and 25)
- In areas where road development will exert critical effects on the environment, basic agreement on the environment will have to be reached with authorities concerned and further technical research must be conducted before start of construction. (Nos. 17,18, 23, 34 and 39)

The current ongoing projects are handled as follows in this master plan study:

- Projects concerned are to be implemented as scheduled.
- Projects concerned are shown Table 9-2-2.
- Ongoing road improvement projects include roads which are lower in design standard than those proposed in the master plan. Though the roads have to be improved to a higher standard level in the future, the currently applied standard of construction will be used. The period for traffic use after the completion of improvement roads will be at least five years. Therefore, no new improvement will be made for five years after completion of ongoing projects.
- For the construction cost according to this master plan, the investment cost of ongoing projects will be taken into account. Namely, ongoing projects are considered to be a step to achieve the proposed road standard level, and the ongoing project, investment cost is to be deducted from the overall investment amount in the future.

Table 9-2-2 Ongoing Project List

Project Package Section Link No.	Investment	Investment (Billion Rp.)	Province
1	Surunama-Palu-Kasinbar	5.484	Central S.
2	Tambu-Malala	11.567	Central S.
9	Tawaeli-Toboli	5.220	Central S.
16	Tompira-Umpanga	-	Central S.
17	Palu- Ginpu	3.206	Central S.
28	Lasusua-Bts.Propi.SUL.	38.628	Southeast S.
29	Kolaka-Lasusua	18.565	Southeast S.
30	Kundari-Kolaka	5.418	Southeast S.

Source: Bina Marga

Table 9-2-3 shows the results of total scores of appraisal items by each packaged project link. Figure 9-2-1 shows the implementation schedule based on result of appraisal by each packaged project link. Map indicating implementation plan schedule over four five-year spans from 1999 to 2018 is shown in Figure 9-2-2.

Table 9-2-3 Total Appraisal Score of Each Road Link

No.	Name of Project Segment	Length (km)	Road Hierarchy	Traffic Volumes	Road Condition	Road Invest.	Env. Aspect	Total Scores
	CENTRAL SULAWESI							
1	Surunama-Gongara-Paul-Kasinbar	222.8	4	3	3	-1		9
2	Tambu-Malala	241.8	3	2	2	-1		6
3	Malala-Tori Tori, Basi-Mepanga	124.0	3	2	3			8
4	Toli Tori-Buol	174.2	3	1	4			8
5	Buol-Umu	141.0	3	1	4			8
6	Mepanga-Molosipat	87.9	4	3	2	-1		8
7	Toboli-Mepanga	201.3	4	3	2	-1		8
8	Tawali-Poso	146.8	4	4	2	-1		9
9	Tawaeli-Toboli	46.6	4	4	3	-1		10
10	Poso-Tindatana	151.4	4	4	2	-1		9
11	Tagolu-Ampana	140.2	3	4	2	-1		8
12	Ampana-Luwux	227.0	3	4	2	-1		8
13	Luwux-Baturube	206.5	1	2	2			5
14	Taripa-Betereme, Pape-Tomata	115.0	3	1	2			6
15	Uekuuli-Nuha	174.0	3	3	5		-2	9
16	Tompira-Bungku	103.9	3	3	3			9
17	Paul-Ginpu	95.9	1	2	3		-2	4
18	Tentena-Gintu	186.6	1	1	5		-5	2
19	Poalu-Simora	45.5	1	2	2			5
20	Biak-Salodik	286.6	1	1	3			5
21	Paul-Kasiguncu, Sangginora-Batunoncu	226.4	1	2	3			6
22	Bungku-S.E.	115.0	3	3	5			11
23	Baturube-Tondoyanda	97.4	1	1	5		-5	2
24	Buol-Basi	121.7	1	1	5			7
25	Toli Toli-Basi	70.5	3	1	3			7
26	Bangai Island	199.9	1	1	3			5
27	Balingara-Toili	90.0	1	1	5			7
	Sub-Total	3,994.7						
	SOUTHEAST-SULAWESI							
28	Lasusua-Bts.Prop.Sul.	171.0	4	4	2	-1		9
29	Kolaka-Lasusua	139.0	4	4	2	-1		9
30	Kundari-Kolaka	170.5	4	4	2	-1		9
31	Barru-Kasipute	188.0	3	3	3			9
32	Pohara-Asera	81.4	3	3	3			9
33	Asera-Bts.Pro.	76.0	3	3	5			11
34	Belalo-Tinanggea	124.1	2	2	2			6
35	Motaha-Tobimate	59.6	2	2	2			6
36	Nanga Nanga-Ambesia	105.8	1	1	3			5
37	Mandonga-Tinanggea	107.7	3	2	2			7
38	Late Late-Baula	57.5	1	4	2			7
39	Polipolia-Kasipute	127.7	1	3	5		-5	4
40	Alangga-Punggaluku	31.2	1	2	2			5
41	Tampe-Wara	36.2	3	3	2			8
42	Nuna Island K	193.7	1	1	3			5
43	Buton Island	292.0	3	1	3			7
44	Buton Island K	242.9	1	1	3			5
45	Trance Peni.	153.0	1	1	5		-2	5
46	Unaaha-Abuki	13.3	1	3	2			6
47	Malili-Totola	37.5	4	4	2	-1		9
	Sub-Total	2,508.1						
	Total	6,502.8						

Source: Study Team

No.	NAME OF SEGUMENT	LENGTH (Km)	CONSTRUCTION YEAR 1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	CENTRAL SULAWESI																					
1	SURUNAMA-DONGARA-PALU-KASINBAR	223.0			*	*	*															
2	TAMBU-MALALA	241.8											*	*	*							
3	MALALA-TORITORI,BASI-MEPANGA	124.1							*	*	*											
4	TOLITORI-BUOL	174.2						*	*	*												
5	BUOL-UMU	141.0							*	*	*											
6	MEPANGA-MOLOSIPAT	87.9								*	*	*										
7	TOBOLI-MEPANGA	201.4							*	*	*											
8	TAWALI-POSO	146.8								*	*	*										
9	TAWAELI-TOBOLI	40.1		*	*	*	*															
10	POSO-TINDATANA	151.4								*	*	*										
11	TAGOLU-AMPANA	140.2											*	*	*							
12	AMPANA-LUWUX	227.0											*	*	*							
13	LUWUX-BATURUBE	206.5																*	*	*		
14	TARIPA-BETEREME, PAPE-TOMATA	115.0													*	*	*					
15	UEKUULI-NUHA	174.0			*	*	*															
16	TOMPIRA-BUNGKU	103.9			*	*	*															
17	PALU-GINPU	95.9																		*	*	*
18	TENTENA-GINTU	186.6																		*	*	*
19	PALU-SIMORA	45.5																*	*	*		
20	BIAK-SALODIK	286.6																*	*	*		
21	PALU-KASIGUNCU, SANGGINORA-BATUNONCU	226.5													*	*	*					
22	BUNGKU-S.E	115.0			*	*	*															
23	BATURUBE-TONDOYANDA	97.4																		*	*	*
24	BUOL-BASI	121.7											*	*	*							
25	TOLITORI-BASI	70.5								*	*	*										
26	BANGAI ISLAND	199.9																*	*	*		
27	BALINGARA-TOILI	90.0											*	*	*							
	SUB-TOTAL OF CENTRAL PROVINCE	4033.9																				
	SOUTH-EAST PROVINCE																					
28	LASUSUA-BTS.PROP.SUL	171.0								*	*	*										
29	KOLAKA-LASUSUA	139.0								*	*	*										
30	KUNDARI-KOLAKA	170.4							*	*	*											
31	BARRU-KASIPUTE	188.0						*	*	*												
32	POHARA-ASERA	91.7			*	*	*															
33	ASERA-BTS.PRO.	76.0			*	*	*															
34	BELALO-TINANGGEA	124.0													*	*	*					
35	MOTAHA-TOBIMETA	59.7													*	*	*					
36	NANGA NANGA-AMBESIA	105.8																*	*	*		
37	MANDONGA-TINANGGEA	107.7											*	*	*							
38	LATE LATE-BAULA	57.5											*	*	*							
39	POLIPOLIA-KASIPUTE	127.7																*	*	*		
40	ALANGGA-PUNGGALUKU	31.2													*	*	*					
41	TAMPE-WARA	136.2											*	*	*							
42	MUNA ISLAND K	193.7																*	*	*		
43	BUTON ISLAND	292.0											*	*	*							
44	BUTON ISLAND K	242.9																*	*	*		
45	TRANCE PENI.	153.0																		*	*	*
46	UNAAHA-ABUKI	13.3													*	*	*					
47	MALILI-TOTOLA	37.5			*	*	*															
	SUB-TOTAL of SOUTH-EAST PROVINCE	2518.3																				
	GROUND TOTAL	6552.2																				

Figure 9-2-1 Implementation Schedule for Each Road Link

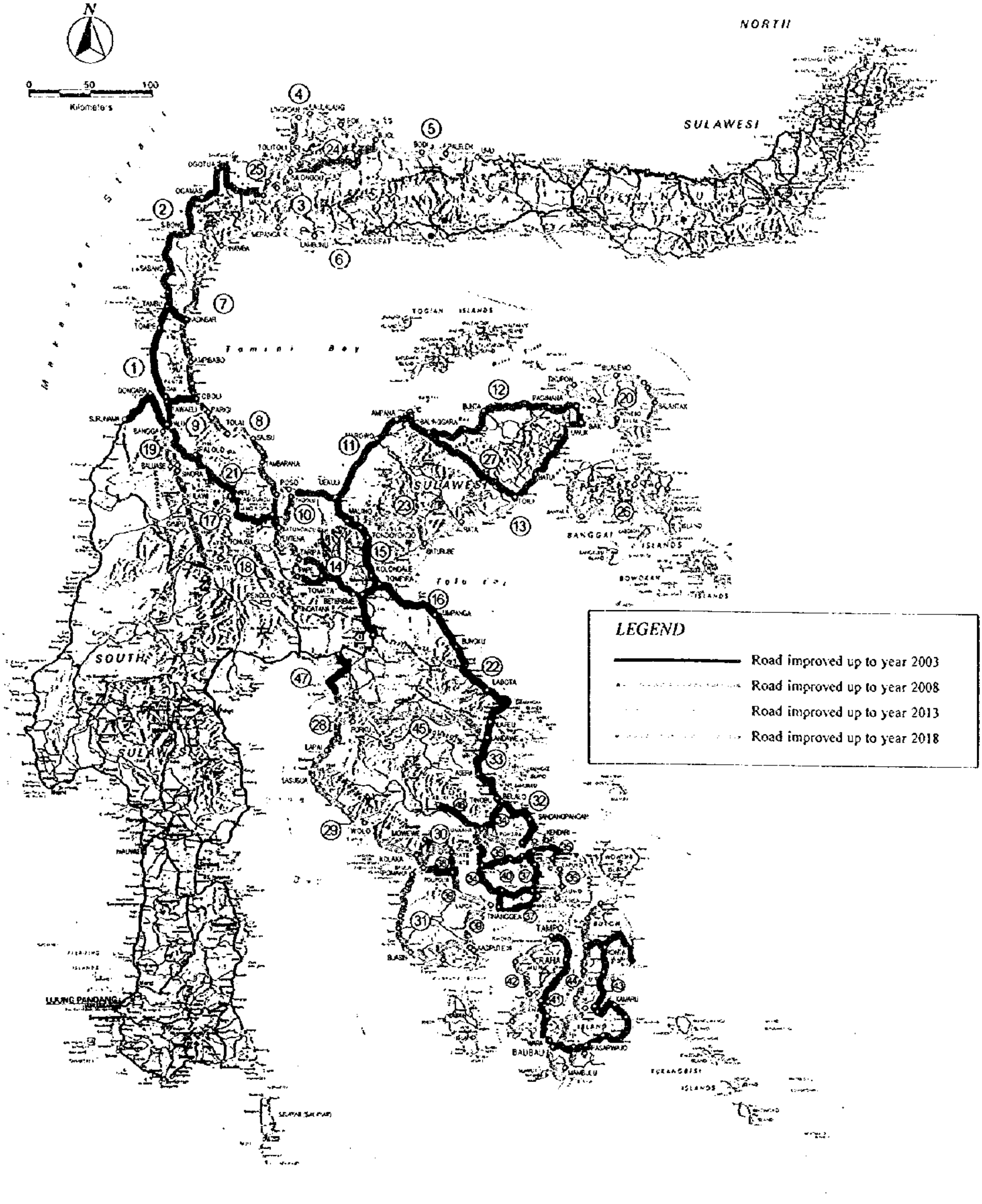


Figure 9-2-2 Map of Implementation Schedule for Each Road Link

9.3 Budgetary Plan

This section discusses fund available for the investment to the Master Plan of the proposed road network system, considering the past road budget administrated by Bina Marga and future growth rate of GRDP in Sulawesi.

The last 8-year annual budget of Bina Marga road projects is shown in Table 2-4-1 of Chapter 2 of this report and indicates the following;

- Annual budgetary increase on average varies from 5.3 % to -7.8 % for the whole of Indonesia, and varies from 9.6 % to 1.8 % for Central and Southeast Sulawesi excluding annual price escalation (see Table 9-3-1);

Table 9-3-1 Annual Budgetary Increase of Bina Marga Road Projects

Average Budgetary Increase Per Year	Last 8 Years 89/90 - 96/97		Last 5 Years 92/93 - 96/97		Last 3 Years 94/96 - 96/97	
	Indonesia	Central & Southeast	Indonesia	Central & Southeast	Indonesia	Central & Southeast
Including Price Escalation (%)	13.2	17.5	4.6	9.7	-1.5	15.2
Price Escalation (%)	7.9	7.9	7.9	7.9	6.3	6.3
Net Increase (%)	5.3	9.6	-3.3	1.8	-7.8	8.9

Source: JICA Study Team

- Annual budget of the Bina Marga road projects in the whole of Indonesia, has been decreased for the last 3 years due to reasons such as BOT projects in Jakarta, Java and others, but in Central and Southeast Sulawesi have increased steadily due to the rectification of regional economic imbalance. In particular, the 1998/1999 budget for Central and Southeast Sulawesi has increased by 54 % compared with the 1996/1997 budget(see Table 2-4-1).

The annual budget for Central and Southeast Sulawesi will be increased by 9 % to 10 % per year based on the above findings and planned growth rate (7.7 % to 9.5 %) of GRDP in the area.

To attain budgetary guideline for the investment of the road network master plan, high annual increase of budget is required for each Five-Year Plan from year 1999 to 2018

In case of an annual increase of 10%, about 2,900 billion Rp. in the first 5-year plan (1999-2003) will be available to invest in road maintenance, rehabilitation, improvements, and new construction.

The following are the available budget covering the period of 20 years from year 1999 to 2018.

Table 9-3-2 Budgetary Guideline for Central and Southeast Sulawesi

Covering Period	1999 - 2003	2004 - 2008	2009 - 2013	2014 - 2018
Annual increase of budget for investment	10 %	6 %	4 %	0 %
Available budget for investment for each period (Billion Rp.)	2,900	4,100	5,200	5,600
Accumulative (Billion Rp.)	2,900	7,000	12,200	17,800

Source: JICA Study Team

In case budgetary shortage takes place, the road link No. 1 and 15 will be deferred for the implementation by five (5) years. The budget 88.6 of billion Rp. for the road link No. 47 should be excluded from the budget of Central and Southeast Sulawesi as it located in South Sulawesi.

9.4 Economic Study

In this section, economic viability for the implementation of a master plan for the road network system in the provinces of Central and Southeast Sulawesi (the Project) is examined.

9.4.1 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.

The five-years basis phased financial and economic costs are summarized in Table 9-4-1.

Table 9-4-1 Five-years Basis Phased Costs of Master Plan in 1998 Prices

(Million Rp.)

Year	Financial Prices		Economic Prices	
	Investment	Total Cost including Maintenance	Investment	Total Cost including Maintenance
1999 – 2003	2,119,022	2,929,211	1,997,037	2,761,439
2004 – 2008	3,412,727	3,988,834	3,204,281	3,758,889
2009 – 2013	3,527,579	4,187,457	3,307,856	3,953,620
2014 – 2018	3,542,456	4,352,417	3,314,904	4,127,469
Total	12,601,784	15,457,919	11,824,078	14,601,417

Source: JICA Study Team

The maintenance cost of the proposed roads follows the engineering study results of the cost estimates Besides, the maintenance cost of the proposed roads in the case of "without the improvement of the proposed roads" is treated as a negative cost.

9.4.2 Economic Benefits

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

(1) Direct Benefits

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 a direct benefit.). Besides, a promotion of traffic safety and a saving in accident costs are anticipated.

(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 road improvement will lead not only to better and easier access among the related areas (both a resolution of limited traffic condition and an assurance of twenty-four hour traffic), but it will also induce the so-called development effect such as the inducement of new and/or incremental industrial development along the related corridor through an improvement of distribution of commodities especially for agricultural and/or agro-industry sectors.

It is particularly expected that new-realized development/improvement of roads will have a great impact on regional economic development. In particular, some new links will have a function to connect the provinces of Central and Southeast Sulawesi, leading to the a promotion of economic and cultural exchanges between two provinces.

(3) Benefits to be Treated

In this economic analysis, the above-mentioned direct benefit, e.g. the saving of vehicle operating cost is computed as a quantified benefit. The calculation of direct benefits are made for the planning years of 2003 and 2018.

9.4.3 Computation of Benefit of Saving in Vehicle Operating Cost

The unit vehicle operating costs are determined by both speed and IRI (international roughness index) conditions in each road link. The data of speed and IRI for each road link in the case of "without" were based on the inventory data compiled by Bina Marga and reviewed by the Study Team. And those in the case of "with" were assumed from the viewpoint of the engineering study by the Study Team.

The details of the assumption of unit vehicle operating cost and the estimation of vehicle operating costs refer to the description in the chapter of "Economic Project Analysis" (Chapter 11) in the report of "Feasibility Study for Tawaeli - Toboli Road".

As a result, the saving in vehicle operating cost is summarized as shown in Table 9-4-2.

Table 9-4-2 Estimated Economic Benefits

(Million Rp. at 1998 prices)

Year	Benefit of Saving in VOC
2003	481,444
2018	2,749,309

Source: Study Team

9.4.4 Economic Cost-Benefit Analysis

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) (NPV and B/C are calculated at a discount rate of 15 percent.). The project life is assumed to be 25 years after year 2004.

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 9-4-3. The efficiency measures were calculated and the results are as follows:

(1998 prices)

Efficiency Measures	
EIRR	24.3 %
NPV (Million Rp.)	1,607,981
B/C	1.61

Source: JICA Study Team

These results indicate that implementation of the Project (road development master plan of two provinces of Central and Southeast Sulawesi) is economically feasible.

Table 9-4-3 Economic Cash Flow (For Master Plan Stage)

EIRR = 24.3%
NPV = 1,670,981 (Million Rp.)
B/C = 1.61
(Discount Rate = 15.0%)

(Million Rp.)

	Year	Benefits VOC Saving	Total	Costs Invest. Costs	Maint. Cost (With)	Total	Maint. Cost (Without)	Net Cash Flow
1	1999			0	0	0	0	0
2	2000			69,580	90,739	160,319	115,415	-44,904
3	2001			642,486	214,073	856,559	262,881	-593,678
4	2002			642,486	149,995	792,481	137,403	-655,078
5	2003	0	0	642,486	172,404	814,890	247,389	-567,501
6	2004	431,444	431,444	154,728	92,300	247,028	101,955	336,371
7	2005	643,434	643,434	500,381	11,813	512,194	115,415	246,655
8	2006	805,424	805,424	1,048,401	115,911	1,164,312	250,995	-107,893
9	2007	967,415	967,415	893,673	161,881	1,055,554	149,289	61,150
10	2008	1,129,405	1,129,405	607,098	172,704	779,802	247,389	596,992
11	2009	1,291,396	1,291,396	750,351	50,651	801,002	117,857	608,251
12	2010	1,453,386	1,453,386	803,638	245,964	1,049,602	228,884	632,668
13	2011	1,615,376	1,615,376	1,050,016	172,403	1,222,419	470,670	863,627
14	2012	1,777,367	1,777,367	358,743	11,812	370,555	141,864	1,548,676
15	2013	1,939,357	1,939,357	345,109	164,932	510,041	228,884	1,658,200
16	2014	2,101,348	2,101,348	653,792	122,577	776,369	155,059	1,480,038
17	2015	2,263,338	2,263,338	653,792	159,357	813,149	83,371	1,533,560
18	2016	2,425,329	2,425,329	1,078,533	68,419	1,146,952	86,110	1,364,487
19	2017	2,587,319	2,587,319	464,393	142,694	607,087	470,670	2,450,902
20	2018	2,749,309	2,749,309	464,393	319,518	783,911	141,864	2,107,262
21	2019	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
22	2020	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
23	2021	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
24	2022	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
25	2023	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
26	2024	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
27	2025	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
28	2026	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
29	2027	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
30	2028	2,749,309	2,749,309	0	176,877	176,877	232,881	2,805,314
				11,824,079	4,408,917	16,232,996	6,082,177	

Source: JICA Study Team

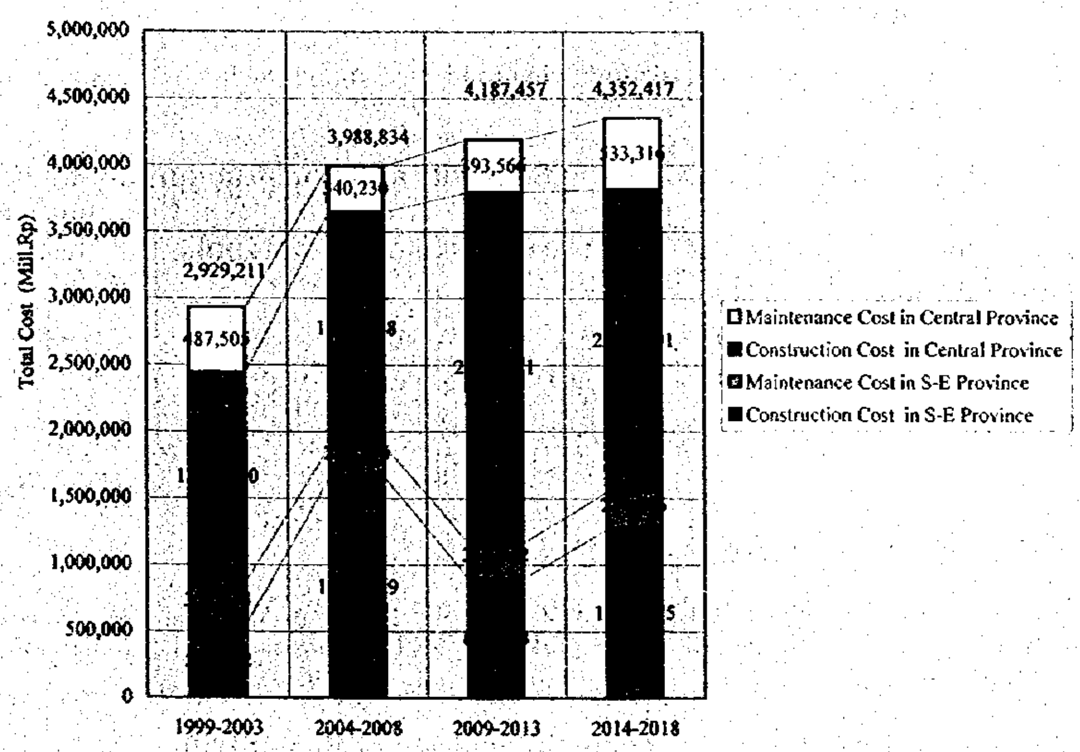
9.5 Investment Plan

Construction cost was allotted in the order of implementation of each work item. The total amount of investment for five years calculated by adding the maintenance cost before and after improvement to the construction cost is shown in Table 9-5-1, and quick reference as shows Figure 9-5-1.

Table 9-5-1 Disburcement for Inter-Region Road Net Work for Every Five Years

Unit : Mill Rp

Years	1999-2003	2004-2008	2009-2013	2014-2018	Total
Construction Cost in S-E Province	551,932	1,659,039	898,108	1,270,155	4,379,234
Maintenance Cost in S-E Province	322,683	235,876	266,312	276,645	1,101,516
Construction Cost in Central Province	1,567,090	1,753,688	2,629,471	2,272,301	8,222,551
Maintenance Cost in Central Province	487,505	340,230	393,566	533,316	1,754,618
Total	2,929,211	3,988,834	4,187,457	4,352,417	15,457,919



Source: Study Team

Figure 9-5-1 Disbursement Cost of Inter Regional Road for Every Five Year

Table 9-5-1 Disburcement for Inter-Region Road Net Work for Every Five Years

Unit : Mill Rp

Years	1999-2003	2004-2008	2009-2013	2014-2018	Total
Construction Cost in S-E Province	551,932	1,659,039	898,108	1,270,155	4,379,234
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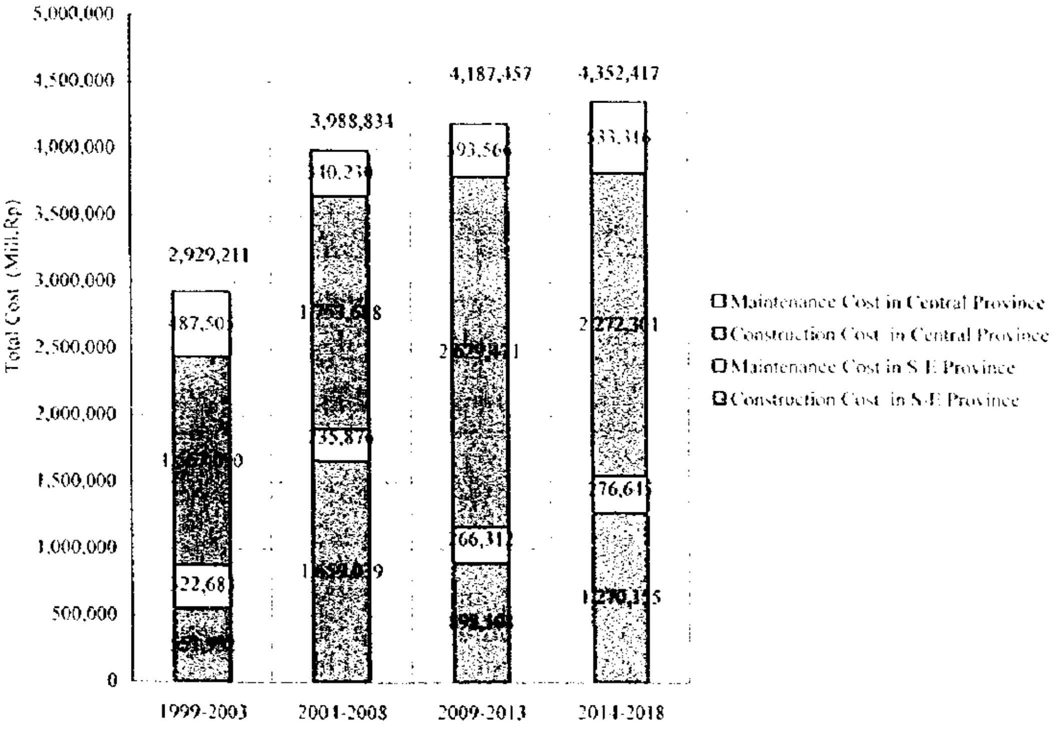

Source: Study Team

Figure 9-5-1 Disbursement Cost of Inter Regional Road for Every Five Year

Table 9-5-1 Disburcement for Inter Region Road Net Wo[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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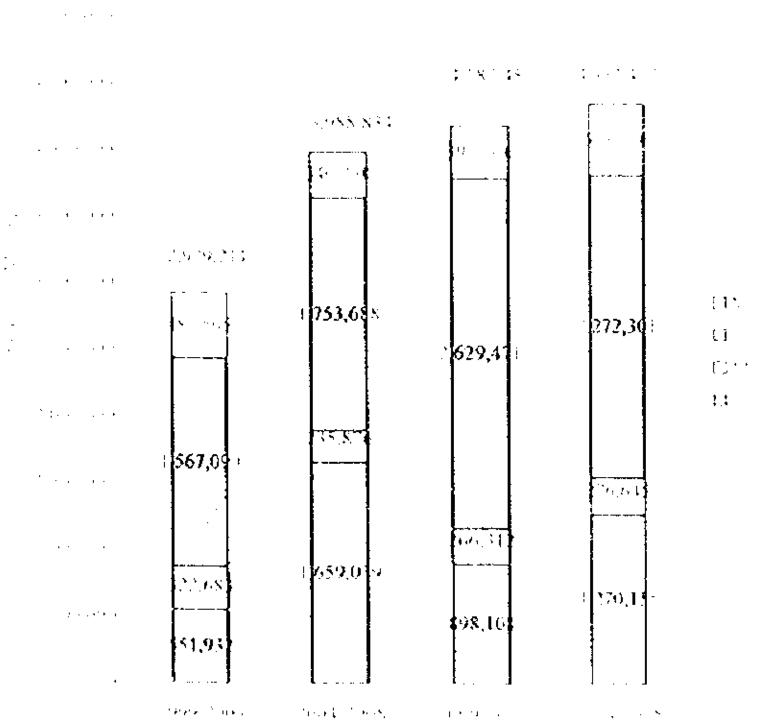


Figure 9-5-1 Disbursement Cost of Inter Regional Road for Every Five Yea[illegible]

9.6 Recommendation

9.6.1 Construction Cost

A construction cost of 15,459 billion Rp is required for the master plan for road network of 6,514 km in length, including maintenance cost for 20-years period from 1999 to 2018 as shown in Table 9-6-1.

Table 9-6-1 Construction Cost of Master Plan

Unit: Billion Rp

Cost	Central Sulawesi	South-east Sulawesi	Total
Construction	8,223	4,379	12,602
Maintenance	1,755	1,102	2,857
Total	9,978	5,481	15,459

Source: JICA Study Team

9.6.2 Implementing Schedule

Based on the above discussion, the following implementation schedule is recommended as shown in Table 9-6-2.

Table 9-6-2 Implementing Schedule and Construction Cost

Unit: Billion Rp

Year	1999-2003	2004-2008	2009-2013	2014-2018	Total
Construction Cost	2,119	3,413	3,528	3,542	12,602
Maintenance Cost	810	576	661	810	2,857
Total Cost	2,929	3,989	4,189	4,352	15,459
Cumulative Cost	2,929	6,918	11,107	15,459	15,459

Source: JICA Study Team

9.6.3 Economic Analysis

The investment of 15,459 billion Rp (1998 prices) to the master plan for the road network of 6,514 km in length is economically feasible, considering the construction cost, implementation schedule and benefit as shown in Table 9-6-3.

Table 9-6-3 Economic Analysis of Master Plan

EIRR	NPV	B/C
24.3	1,671 Billion Rp	1.6

Discount Rate : 15 %

Source: JICA Study Team

9.6.4 Selection of Road Links for Pre-Feasibility Study

Road link Nos.1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 16, 22, 28, 29, 30, 31, 32, 33, 41 and 47 are accorded high priority based on the appraisal score shown in Table 6.8.

However, road link Nos. 1, 6, 7, 10, 11, 12, 28, 29, 30 and 47 were not studied under the pre-feasibility study as they have already been the object of investment at some point within the past 5 years. In addition, road link No. 9 was omitted from the pre-feasibility study as this road link had been selected for the feasibility study due to its high priority and urgent need of improvement.

Because of the above reasons, road link Nos. 4, 5, 8, 15, 16, 22, 28, 31, 32 and 33 were selected for the pre-feasibility study for roads totalling of 1,200.2 km in length which are to serve as road links by the year 2008.

Road links for pre-feasibility study are shown in Table 9-6-4.

Table 9-6-4 Road Links for Pre-Feasibility Study

Link No.	Road Length (km)	Location	Province
4	174.2	Toli Toli – Buol	Central Sulawesi
5	141.0	Buol – Umu	Central Sulawesi
8	146.8	Toboli -- Poso	Central Sulawesi
15	174.0	Uekuli – Nuha	Central Sulawesi
16	103.9	Tompira – Bungku	Central Sulawesi
22	115.0	Bungku – Provincial Border	Central Sulawesi
31	188.0	Barru – Kasipute	Southeast Sulawesi
32	91.7	Pohara – Asera	Southeast Sulawesi
33	76.0	Asera – Provincial Border	Southeast Sulawesi
Total	1210.6		

Source: JICA Study Team

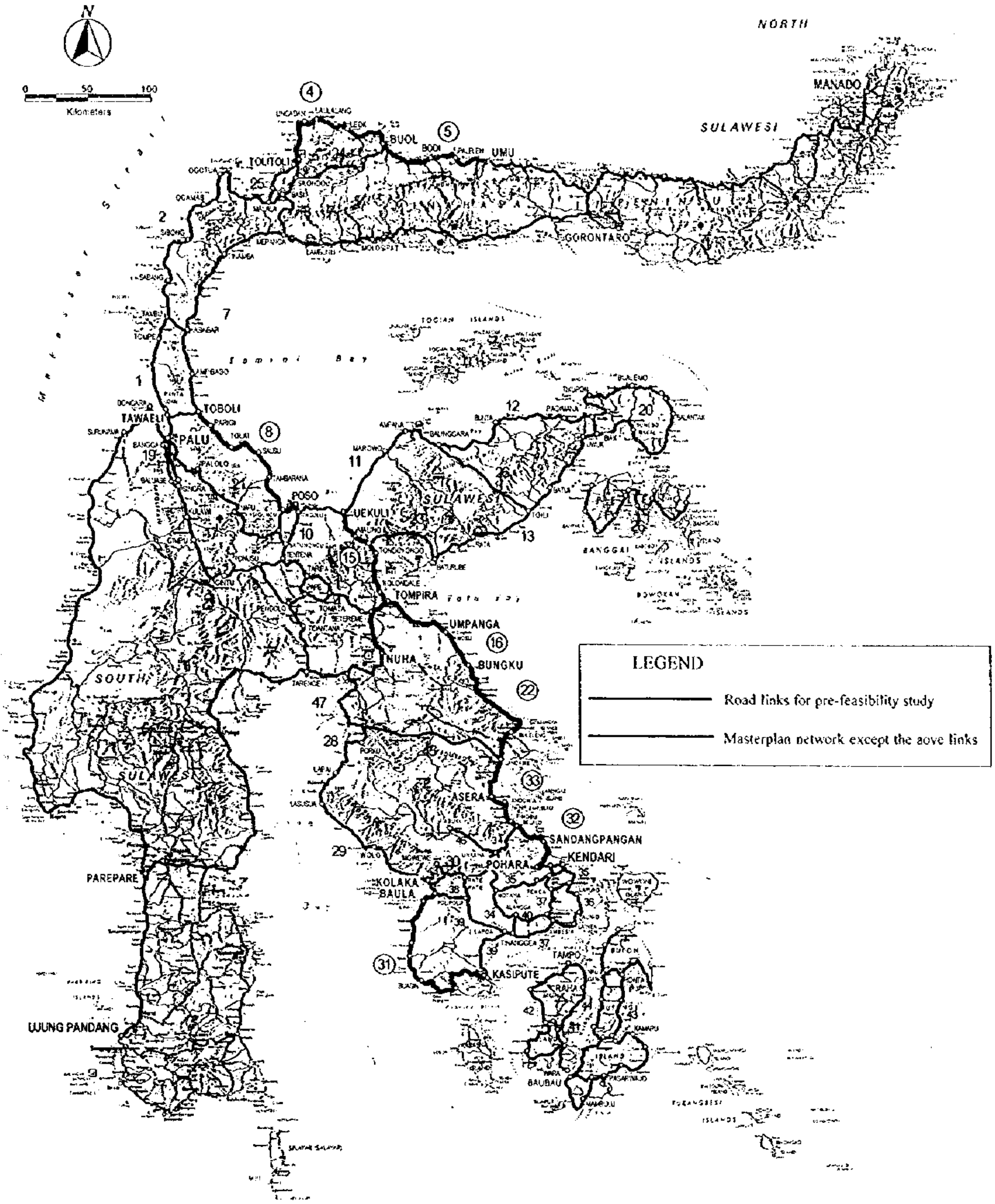
9.6.5 Recommendations

(1) The master plan of road network is to be employed together with the implementation schedule to promote the construction of the priority road links in Central and Southeast Sulawesi.

(2) 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.

(3) 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.



Source: Study Team

Figure 9-6-1 Road Link Map of Pre-feasibility Study