No.

NATIONAL ROAD ADMINISTRATION
REPUBLIC OF MOZAMBIQUE

THE PREPARATORY STUDY
ON
ROAD IMPROVEMENT PLAN
IN NACALA DEVELOPMENT CORRIDOR
(N13: CUAMBA-MANDIMBA-LICHINGA)
IN
THE REPUBLIC OF MOZAMBIQUE

FINAL REPORT
1 of 3
SUMMARY

February 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

Eight - Japan Engineering Consultants Inc.

Oriental Consultants Co., Ltd.

EID
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The following foreign exchange rate is applied in the study

1 US dollar = 28.00Mtn = 91.36 JP Yen, or 1 MTn = 3.26 JP Yen (October 2009)

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PREFACE

In response to the request from the Government of the Republic of Mozambique, the Government of Japan decided to conduct the Preparatory Survey on Road Improvement Plan in Nacala Development Corridor (N13: Cuamba-Mandimba-Lichinga) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA dispatched a Study Team headed by Mr. Hisashi MUTO of Eight-Japan Engineering Consultants Inc. and consist of Eight-Japan Engineering Consultants Inc. and Oriental Consultants Co., Ltd. to Mozambique, between March 2009 and December 2009.

The Study Team held discussions with the officials concerned of the Government of Mozambique and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Mozambique for their close cooperation extended to the study.

February 2010,

Kiyofumi KONISHI
Director General
Economic Infrastructure Department
Japan International Cooperation Agency

Mr. Kiyofumi KONISHI
Director General
Economic Infrastructure Department
Japan International Cooperation Agency

February 2010

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit to you the Final Report of the Preparatory Survey on Road Improvement Plan in Nacala Development Corridor (N13: Cuamba-Mandimba-Lichinga) in the Republic of Mozambique.

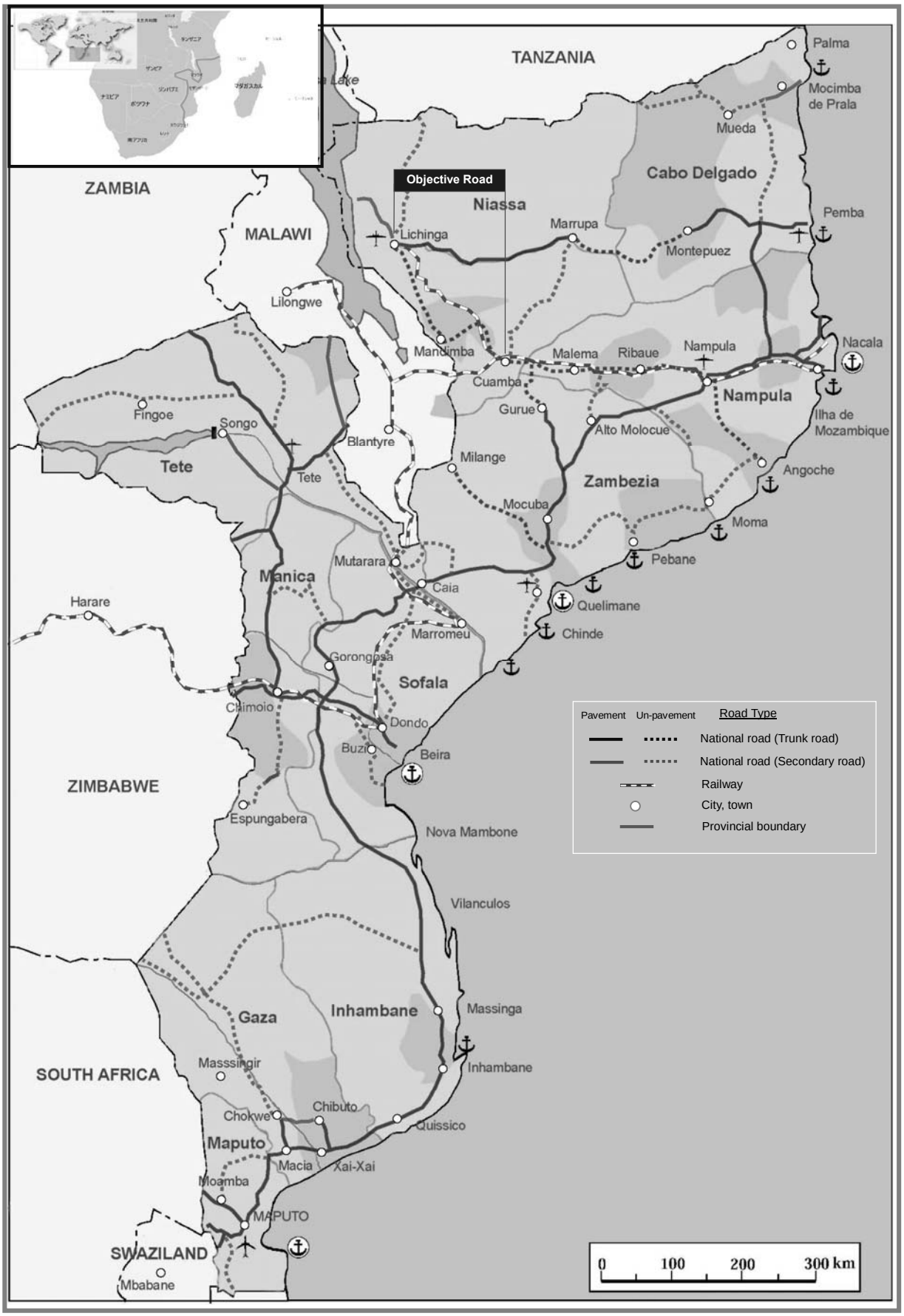
This study was conducted by Eight-Japan Engineering Consultants Inc. and Oriental Consultants Co., Ltd. under a contract to JICA, during the period from March 2009 to February 2010.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Ministry of Foreign Affairs of Japan, National Road Administration, JICA Mozambique Office and Embassy of Japan in Mozambique for their cooperation assistance throughout the Study.

Finally, we hope this report will contribute to further promotion of the project.

Very truly yours,

Hisashi MUTO
Team Leader,
The Preparatory Survey on Road Improvement Plan in Nacala Development Corridor
The Consortium of Eight-Japan Engineering Consultants Inc. and Oriental Consultants Co., Ltd.



Project Location Map

Project Outline

1. Country	Republic of Mozambique
2. Name of Study	The Preparatory Survey on Road Improvement Plan in Nacala Development Corridor (N13: Cuamba-Mandimba-Lichinga) in the Republic of Mozambique
3. Counterpart Agency	National Road Administration (ANE), Ministry of Public Works and Housing(MOPWH)
4. Objectives of the Study	(1) The objectives of the Study are to determine the most technically feasible and economically viable, environmentally acceptable and socially optimal option of upgrading the existing Cuamba – Lichinga road to an all-weather road for easier transit. (2) Formulation and recommendation of the "Regional Development Program" intended for Niassa Province is also the objective of the Study.

1. The Study Area

- The Study Road, with a total length of approximately 302km including the Mandimba-Malawi Border road, traverses four districts having high agricultural potential, namely Cuamba, Mandimba, Ngauma and Lichinga in Niassa Province.
- The Cuamba-Mandimba-Malawi Border road is an important component within the Nacala Development Corridor, since it connects Niassa and Nampula Provinces, and in addition it serves to link landlocked Zambia and Malawi to the Mozambican coast.

2. Scope of the Study

(1) Economic Feasibility Study

1) Economic Analysis, 2) Traffic Analysis, 3) Economic Evaluation, 4) Risk Analysis

(2) Preliminary Engineering Design

1) Site Measurement (Natural Condition Survey), 2) Visual Site Survey, 3) Preliminary Design, 4) Cost Estimate

(3) One Stop Border Post (OSBP)

(4) Assistance for Execution of EIA by GOM (ANE)

(5) Regional Development Program

3. Narrative Description

Feasibility Study

The Study Road passes through many small villages. The road can be broadly divided into three terrains (0 – 148km: Flat terrain, 148 – 240km: Rolling terrain, 240 – 302km: Rolling with some mountainous terrain), and it undulates from a starting altitude of 560MASL reaching up to nearly 1,400MASL at Lichinga. The existing horizontal alignment and vertical alignment generally follow the watershed crest and the natural ground, respectively. The existing road is in fair to poor condition during the dry season and becomes impassable during the rainy season due to interaction between poor drainage and erodible soils. In addition the Study Road width varies between 5m and more than 10m and is generally lower than the surrounding ground.

As a result of the traffic demand analysis, future traffic volumes for both sections (Cuamba-Mandimba and Mandimba-Lichinga) in 2023 were estimated at about 1,481AADT and 1,732AADT, respectively. From the viewpoint of terrain, traffic safety, construction cost, social impacts, traffic management and operation, a design speed of 100km/hr was recommended for the section of Cuamba - Mandimba. Similarly, a design speed of 80km/hr was recommend for the section of Mandimba - Lichinga. And furthermore, the selection of the suitable pavement composition was evaluated based on the initial cost and its financial viability using the EIRR indicator. As a result of the analysis, a DBST surface on a granular base and cemented sub-base was selected as the most economically viable pavement composition. This composition was shown to have the lowest initial cost and the highest EIRR.

Regional Development Program

Niassa Province has the potential for various kinds of development. However, bad access conditions have hindered economic development in the province. Furthermore, huge areas, scattered population and low population density have made it difficult to deliver basic social services to the people. The Study Team formulated a regional development program so that the road improvements of Cuamba-Mandimba and Mandimba-Lichinga could generate synergistic effects on regional development. For the southern part of Niassa Province, such development measures included the support to smallholding farmers' commercialization and agro-processing industries, and infrastructure development for improving logistic functions in the towns of Cuamba and Mandimba. For the middle to northern part of the province, high priority was given to the support of smallholding farmers' commercialization, wood processing industries and tourism, as well as to improvement of social infrastructure and services.

4. Conclusion and Recommendations

(1) To authorize the regional development program proposed by the Study in conjunction with the road implementation plan.
(2) To advance the bilateral discussion for OSBP and to establish a policy relevant to the following issues:
- Types of operational system for OSBP scheme
- Layout and facility size
- Implementation program such as "Two-step upgrading," proposed by the Study

(3) To adopt the COI concept for minimization of social impacts such as resettlement.
(4) To start the detailed design for Cuamba - Mandimba Road (154km) as soon as possible.
(5) To execute a severe site survey (Topographic, Geological and Soil) for Mandimba - Lichinga Road.

5. Report Structure

Name of Report	Number of Volume	Main Contents of the Report		Language		
				Eng.	Por.	Jap.
1. Summary	-	-	-	✓	✓	✓
2. Main Text	Volume-1	Part I	Overall Approach & Work Procedure	✓	✓	
		Part II	General Appreciations			
	Volume-2 **Cuamba-Mandimba Section**	Part III	Preliminary Road Engineering Design			
		Part IV	Economic Feasibility Study			
		Part V	Cross Border Facilities			
	Volume-2 **Mandimba-Lichinga Section**	Part III	Preliminary Road Engineering Design			
		Part IV	Economic Feasibility Study			
	Volume-3	Part VI	Environmental and Social Considerations			
	Volume-4	Part VII	Regional Development Program			
3. Drawings	Cuamba-Mandimba Section	-	-	✓	✓	
	Mandimba-Lichinga Section	-	-			

Executive Summary

Part I Overall Approach & Work Procedure

Mozambique is located on the south-eastern coast of Africa and covers an area of 799,380 sq. km. It is bounded on the north by Tanzania; on the west by Malawi, Zambia, Zimbabwe, Swaziland and the Republic of South Africa (RSA); and on the entire eastern boundary by the Mozambican channel of the Indian Ocean. Mozambique's 17-year civil war, which lasted until 1992, ruined much of the country and destroyed key road infrastructure.

The Government of the Republic of Mozambique (hereafter referred to as the "GOM") assumed that the limited access to roads and other socio-economic services is a cause of the country's poverty and gave priority to improving infrastructures in areas with high potential for agricultural production, etc. in the Action Plan for the Reduction of Absolute Poverty (PARPA II: 2006 – 2009).

A main goal of the Road Sector Strategy 2007-2011 (RSS) is to serve the efficient road network to the prioritized economic areas such as agricultural areas, tourist sites and areas of industrial or natural-resource development that have the greatest potential to contribute to economic growth and PARPA II.

Given the above-mentioned situation, the GOM requested the Government of Japan (hereafter referred to as the "GOJ") to conduct a feasibility study (F/S) for the Upgrading of the Nampula - Cuamba Road. In response to this request from the GOM, the GOJ conducted "The Study on Upgrading of Nampula - Cuamba Road" from 2006 to 2007. In Nampula – Cuamba section, the detail design has been put forward for construction by the counter fund of GOJ.

The Study Road (N13: Cuamba – Mandimba – Lichinga), as part of the two Mozambican corridors (Nacala N13/N1 and Lichinga-Pemba N14/N1 corridors), provides a strategic link to the Malawi Border at Mandimba with the ports of Nacala and Pemba, in Nampula and Cabo Delgado Provinces respectively. Although the Study Road has much potential for stimulating development and reducing poverty throughout the entire northern area of Mozambique by enabling efficient connection, the section concerned is the only unpaved section.

Accordingly, the Japan International Cooperation Agency (hereafter referred to as "JICA"), the official agency responsible for the technical cooperation of the GOJ, undertook the Study including regional development program of Niassa Province along the Study Road in close cooperation with the concerned authorities of Mozambique.

The objectives of the Study are to determine the most technically feasible and economically viable, environmentally acceptable and socially optimal option of upgrading the existing Cuamba – Lichinga road to an all-weather road for easier transit. The Study also determines the impact of providing an all-weather road on poverty reduction and environment.

And establishment of the "Regional Development Program" intended for Niassa Province is also the objective of the Study. This program aims to extend the improvement effect to the wide area in conjunction with the road improvement (Nacala N13/N1 and Lichinga-Pemba N14/N1 corridors).

Part II General Appreciations

1. Government/Sectoral Policy

National policy and planning in Mozambique all have poverty reduction as a key objective. The Mozambique Government has been combating absolute poverty under the Poverty Reduction Strategy Paper (PARPA: 2001-2005) and PARPA II (2006-2009). The target of PARPA II is to reduce the incidence of absolute poverty from 54% in 2003 to 45% in 2009.

And Mozambique's transport sector is governed by the following road sector policies and strategies:

- Road Sector Strategy 2007-2011 (RSS)
- Integrated Road Sector Program 2009-2011 (PRISE)
- Semi Annual Work Plan and Budget (SAWPB)

2. Responsible Institutions for the Sector

Mozambique's road network is currently managed by the National Road Administration (ANE), which reports to the Ministry of Public Works and Housing. The Road Fund is responsible for managing the funds for the sector.

3. Traffic Modal Split

In Mozambique, the roads occupy a large share of both freight (58.2%) and passenger transport (96.1%) among all modes, particularly for passenger transport which is almost totally reliant on the road network. On the other hand, at 27.9%., contribution of the railway mode is relatively high for freight transport. Marine transportation (8.3%) also contributes towards transportation of freight. The air mode only shares a low ratio for both goods and passenger transport due to lower transport capacity.

4. Road Classification System and Conditions

Mozambique has classified roads which consist of national roads (primary and secondary) and regional roads (tertiary and vicinal roads). These roads are administrated by ANE. Urban roads and unclassified roads fall under the jurisdiction of the municipal councils and the district administrations respectively.

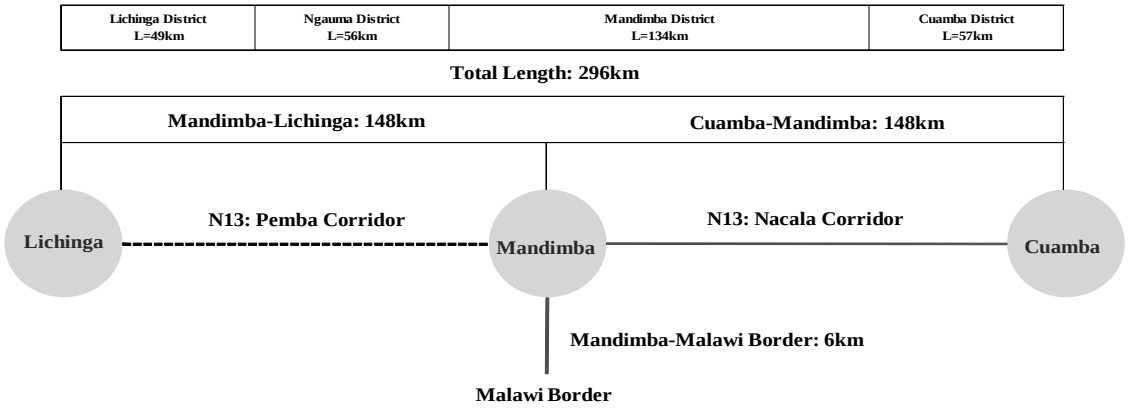
The current Mozambique classified road network is estimated at around 30,000km of which less than 20% is paved. Of the paved roads, the majority are estimated to be in good to fair condition (88%), however only 57% of the unpaved roads are estimated to be fully travelable. A key element of the RSS and of the Strategic Maintenance Plan (SMP) is the introduction of a Paved Road Management Programme (PRMP), which will be managed separately from the rest of the road network. SMP takes care of the 30,000km of classified roads and an additional 3,000km of urban roads.

[Cuamba-Mandimba Section]

Part III Preliminary Engineering Design

1. General Observations

The Study Road can be broadly divided into two sections (Cuamba-Mandimba Section and Mandimba-Malawi Border Section) and the road length of each section is indicated in the following figure.



Outline of the Study Road

2. Natural Condition Survey for the Study Road

The aim of the natural condition survey is to confirm the existing natural conditions for the Study Road with a view to making a road design. Natural condition survey is composed of the following three works.

1) Topographic Survey (Road alignment survey, Aerial survey, Bridge survey, Benchmark setting), 2) Geological Survey, 3) Soil & Material Survey

3. Hydrology and Hydrological Analysis

Following table shows the results of the flood level calculation by the HEC-Ras, which is based on the calculation for non-uniform flow.

Bridge	Return Period	Discharge (m3/s)	Calculated Flood Level (m)	Results of Field Survey (m)
Muambessi	50-Year	312.0	618.50	616.9
	100-Year	390.9	619.28	
Lussangassi	50 Year	589.9	639.42	637.5
	100 Year	731.4	639.92	
Ngolua	50-Year	246.4	704.16	706.2
	100-Year	307.9	704.85	
Ngame II	50 Year	243.7	708.61	709.2
	100 Year	301.7	709.15	

4. Applicable Design Standards

The application of a proper design standard will ensure that the following objectives are achieved:

- Ensure safety, a high standard service level and comfort for road users by the provision of adequate sight distance and roadway space,
- Ensure that the roadway is designed economically
- Ensure uniformity in the design
- Ensure safety of the structures (bridges and culverts).

For the design studies of the Nampula-Nacala Road and Nampla-Cuamba Road which are a part of Nacala Corridor, the Study Team proposed to use the Southern Africa Transport and Communications Commission (SATCC) design standards, as these were commonly used for other projects in the region.

5. Preliminary Engineering Design

Through discussions with ANE and the results of field surveys by the Study Team, the concept of the Project was confirmed as follows:

- To create an efficient primary road connection securing smooth traffic flow throughout the year corresponding to the future traffic demand
- To create a safe primary road connection by reducing the risk of accidents and the rate of injuries to pedestrians by motorized vehicles

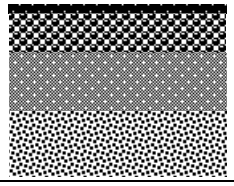
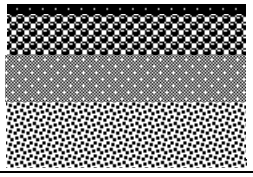
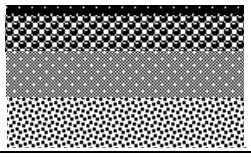
(1) Recommendable Alignment

The following table shows the improvement magnitude and effect of the recommended alignment. In regard to the section between Cuamba and Malawi Border, it was clarified by two indices (horizontal curvature and rise plus fall) that the existing alignments both horizontal and vertical almost meet criteria for a design speed of 100km/h. This means that improvement to the recommended alignment will basically be carried out on the existing road.

			Existing	Plan
Length (km)			153.8km	152.9km
Terrain			Flat	Flat
Design Speed			-	100km/h
Geometry	Horizontal Curvature	deg/km	22.4 (1.00)	21.2 (0.95)
	Rise + Fall	m/km	9.8 (1.00)	9.8 (1.00)
	No. of Rises + Falls	no./km	4.5	3.3
No. of Level Crossings			8	2

(2) Suitable Pavement Compositions

A mechanistic analysis using ELSYM5 was conducted according to the design CBR. The results of the analysis are as shown in following table.

S2 (3-4)	***S3 (5-7)***	***S4 (8-14)***
 200 250 250	 200 200 250	 150 200 200

: G4 Crushed or Natural Gravel Base Soaked CBR>80%@98% mod. AASHTO density

: C4 Cemented stabilized Sub-base 0.75-1.5Mpa@100% mod. AASHTO density

: G7 Selected Layer Soaked CBR>15%@93% mod. AASHTO density

Poisson's ratio & Elastic coefficient (Elastic coefficient = (10 x CBR)Mpa)

G4: 0.35, Phase-I: 400Mpa, Phase-II: 400Mpa, Phase-III: 300Mpa

C4: 0.25, Phase-I: 1500Mpa, Phase-II: 600Mpa, Phase-III: 300Mpa

G7: 0.35, Phase-I: 150Mpa, Phase-II: 150Mpa, Phase-III: 150Mpa

(3) Bridge Design

By the discussion with ANE, bridge inner width has been set as 9.2m for two-lane bridges. Those are summarized in following table.

General		Existing bridge			New bridge			
No.	name	width	length	existing	lane	width	length	from existing Br.
(Cuamba)								
1	Muambessi	4.8	14.3	demolish	2-lane	9.2	17	same position
2	Lussangassi	3.2	28.0	demolish	2-lane	9.2	34	down stream 8m
3	Ngolua	4.7	14.0	demolish	2-lane	9.2	17	same position
4	Ngame-II	4.9	28.0	demolish	2-lane	9.2	34	same position
(Mandimba)								

6. Construction Planning

The construction plan was proposed for improvement of Cuamba – Mandimba road on N13 including construction method, procurement of material and equipment, and construction schedule according to site condition, structural scale and work quantities.

7. Project Implementation Plan

Project implementation plan was proposed based on some constraints affecting the schedule as below:

- Selection of consultant for D/D will require four to five months procedure and preparation of D/D with tender documents will require minimum five months.
- Preparation of environmental impact assessment and RAP will require about eight to nine months and will be submitted to AfDB and JICA 120 days prior to the submission of the appraisal report and loan agreement of the Project, respectively.

- Tendering for construction contractor will require minimum nine to ten months procedure including pre-qualification, tender announcement, tender preparation limited to 90 days and tender evaluation and approval by ANE and lending agencies
- Construction work and supervision service will require about three years (33 months)

8. Project Cost Estimate

Basically unit construction cost of "Upgrading of Nampula – Cuamba Road" (hereinafter referred as "NCR") is utilized for the Estimate due to high similarities between the two projects as follows.

- Site location: The Project road is the extension of NCR beyond Cuamba in northern region.
- Time of estimate: Engineering estimate of NCR was finalized at its detailed design stage in April 2009.

The results of the Estimate are summarized in the following table.

Description		Final (USD)
		DBST
1000	General	21,773,229
2000	Drainage	6,205,937
3000	EW & granular layers	47,887,098
4000	AC & seals	13,525,335
5000	Ancillary	2,501,784
6000	Structures	6,051,036
7000	Test & QC	17,250
8000	Others	1,573,090
	Total (Bill A: Road)	**99,534,760**
	Bill B: Day works	855,999
	Bill C: Social issues	935,627
	Bill D: Environmental	248,837
	Total (Bill A to D)	**101,575,223**
	Contingencies (10%)	10,157,522
	IVA (6.8%)	7,597,827
	Total construction cost	**119,330,572**
	Engineering cost (5%)	5,586,637
	IVA (6.8%)	379,891
	Total project cost	**125,297,100**
	Compensation cost	156,103

Project cost per km	**820,492**

9. Road Maintenance Systems

ANE's ten provincial delegations are responsible for the implementation of all maintenance works on classified roads. The Directorate of Maintenance has a crucial role in ensuring that the delegations in provinces are fully aware of and complying with the technical and operational guidelines for implementation of the annual maintenance plan; and that roads of all types (primary, secondary, tertiary, vicinal, paved, unpaved) are being maintained and provided .

Part IV Economic Feasibility Study

1. Existing Traffic Flow Patterns

The Study Team conducted the following surveys and research to recognize the characteristics of traffic flow patterns for each section.

- Previous traffic volume data in ANE
- Traffic volume and roadside OD survey in May and August, 2009 at three locations in Cuamba, Mandimba and Lichinga on the Study Road
- OD survey at four borders between Mozambique, Malawi and Zambia
- Interview survey of stakeholders both in Mozambique and Malawi

This section is used for passenger movement from Lichinga and other districts in Niassa to connect railway or Nampula province. Regarding goods transportation, some consumer goods are dispatched from Cuamba to Lichinga. On the other hand, most consumer goods for Cuamba city come from the Nampula side mainly by railway.

2. Methodology of Traffic Demand Forecast

The Study Team applied the socio-economic framework based on the development strategy in Niassa (PEP), and the concepts of forecast methodology as three different types of traffic;

Passenger traffic volume is estimated by "Gravity Model" with the variable index of potential population and road section impedance, developed by the actual number of passengers for each O-D trip.

Regional traffic volume is considered by dividing traffic as attraction and generation for each zone. Trip attraction is estimated by the consumption of daily goods, and trip generation is based on the agro-products from Niassa Province.

International traffic volume is thought to be generated after the road network is improved. It is estimated by the Malawi trade and railway capacity, and applies the corridor choice model, named lodgit model.

3. Results of Traffic Demand Forecast

Accumulating the results of each component, future traffic volume for both sections will be summarized. For the section of Cuamba – Mandimba, future traffic volume in AADT is estimated at about 457AADT in 2014, 1,481AADT in 2023 and 5,027AADT in 2033 in the "with" case.

The section of Cuamba - Mandimba is characterized by the numbers of trailers that will be diverted from Beira corridor and railway. It is evidenced that this section will be composed of a part of international corridor.

Compared with the previous feasibility study between Nampula and Cuamba, this estimated traffic volume is almost the same level of volume as for the previous section.

4. Economic Analysis

Economic analysis is conducted on the following assumptions:

Analysis Tool : HDM-4 (RED, Comprehensive for reference)
Project life : 20 years after the opening of the project road (2014)
Pricing date : as of October 2009
Social discount rate : 12%
Conversion Factor : Construction work (0.84), Maintenance work (0.75)
Exchange rate : US$1.00 = 28.00 Meticais (MT)

Results of analysis are tabulated as follows:

Sensitivity Analysis

Case	Assumptions	EIRR
Base	Upgrade to paved road with DBST with Lichinga-Mandinba intervention	19.5%
1	Decrease in traffic volume of -20%	16.6%
2	Increase in investment costs of +20%	16.9%
3	Combination of above as the worst case	14.3%

The Project scores an average level as an upgrade-to-paved intervention and its economic viability is acceptable, with an EIRR of over 12% of the opportunity cost among alternatives. Based on this result, the Project is evaluated as one of the prioritized projects to be implemented in the nation. The particular importance of this primary road and of bringing it to all-weather travelable condition is well established. The Study Team concludes that the road upgrading project is economically feasible in terms of the national economy of Mozambique.

Part V Cross Border Facilities

1. Baseline Study and Fact Findings for Upgrading Border Facilities:

Upgrading of facilities at Mandimba-Chiponde border post was assessed in terms of its needs and requirements in conformity with baseline study and facts found upon the following issues.

- Current Conditions of Borders at Mozambique-Malawi
  - Cross Border Traffic
  - Control System and Facility
- Characteristics of Mandimba-Chiponde Border
  - Geographical and Commercial Features
  - Interactions and Border Communities
  - Strategic Importance on Regional Corridor Development
  - Site Conditions and Facilities
- Strategy for Upgrading Border Control and Facility
  - SADC Regional Strategy
  - Mozambique-Malawi Bilateral Strategy

2. Implementation Approach for Upgrading Border Facilities:

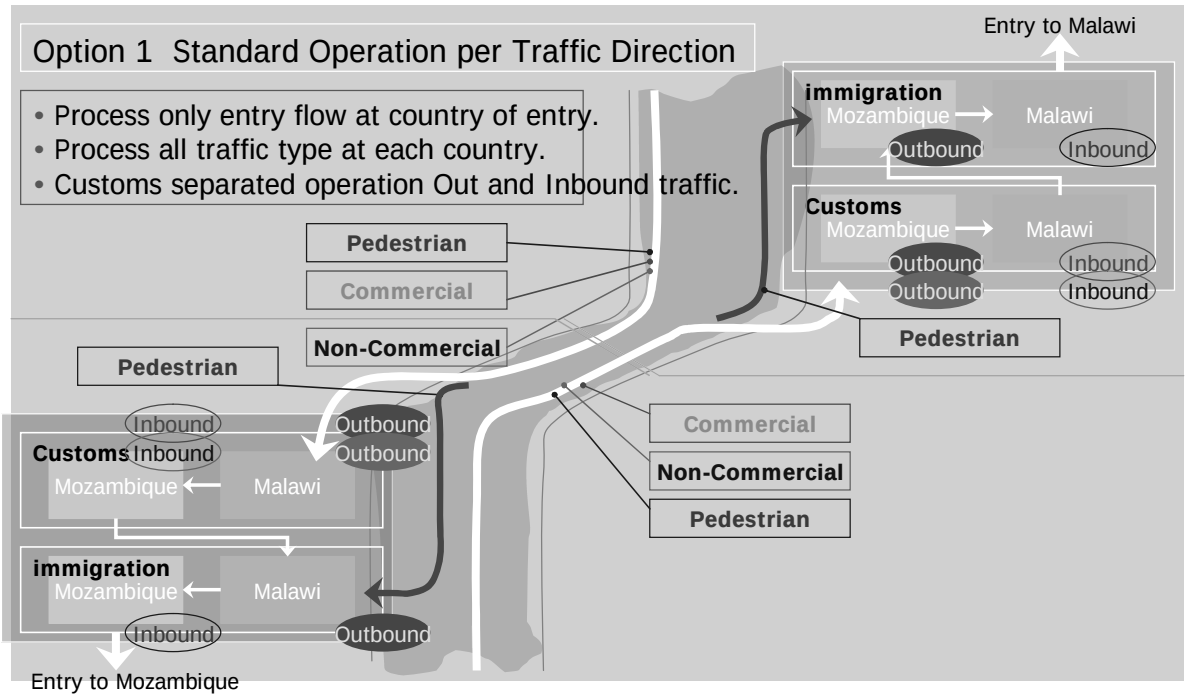
Implementation approach was formulated with the following proposals:

- Phased introduction for OSBP shall be employed,
- Existing facility shall be practically adapted and utilized under the environment of OSBP operation,
- Phased introduction shall be examined in line with: i) magnitude of future demands of cross border traffic and year forecasted, ii) time schedule of the bilateral discussion and the agreement, and iii) time schedule to introduce OSBP environment to other borders.

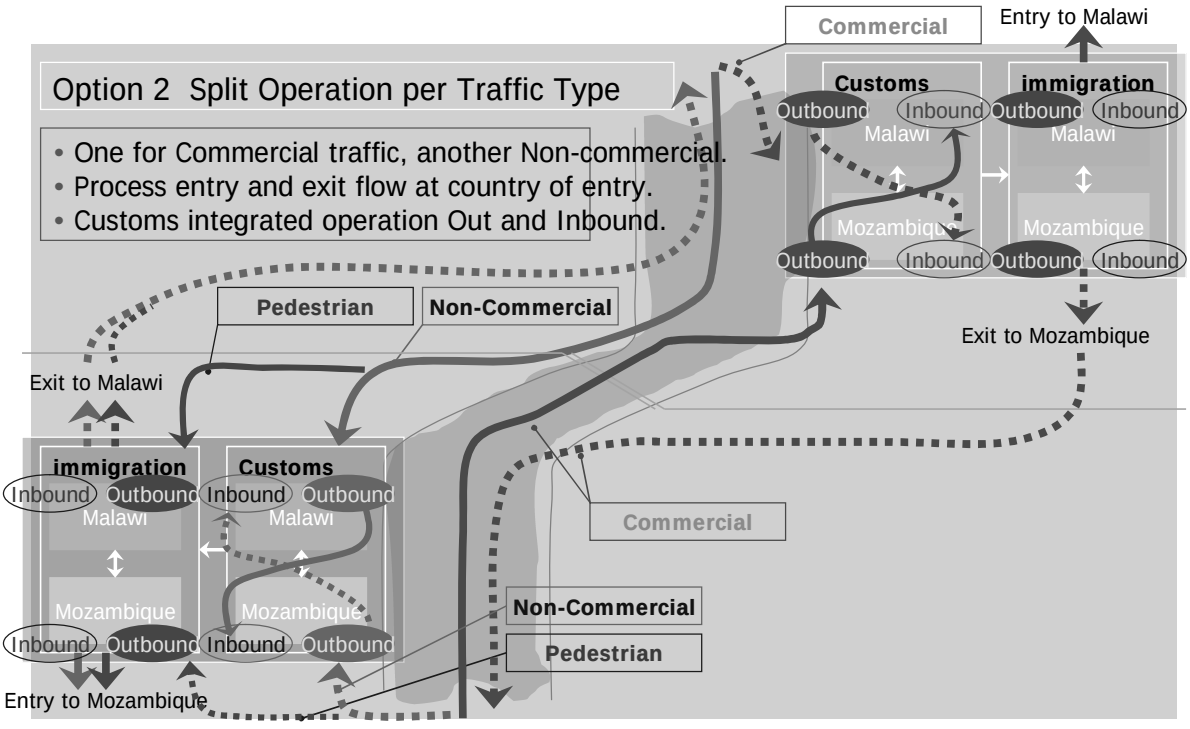
3. Implementation Policy for Upgrading Border Facilities:

"**Two-step upgrading**" as competitive scenario and "**Juxtaposed facility model**" were technically selected for the phased introduction of OSBP. And facility planning was preliminarily formulated estimating provisional conditions such as border control procedures and performance benchmarks (target time release, total processing time, unit workforce etc.) to be applied for OSBP operation.

Two types of operational options for OSBP scheme were proposed and preliminary layout and facility size were proposed for two target years according to "Two-step upgrading," that is, 2014 as the first step and 2024 as the second step introduction:



Option 1: Split Operation per Traffic Direction



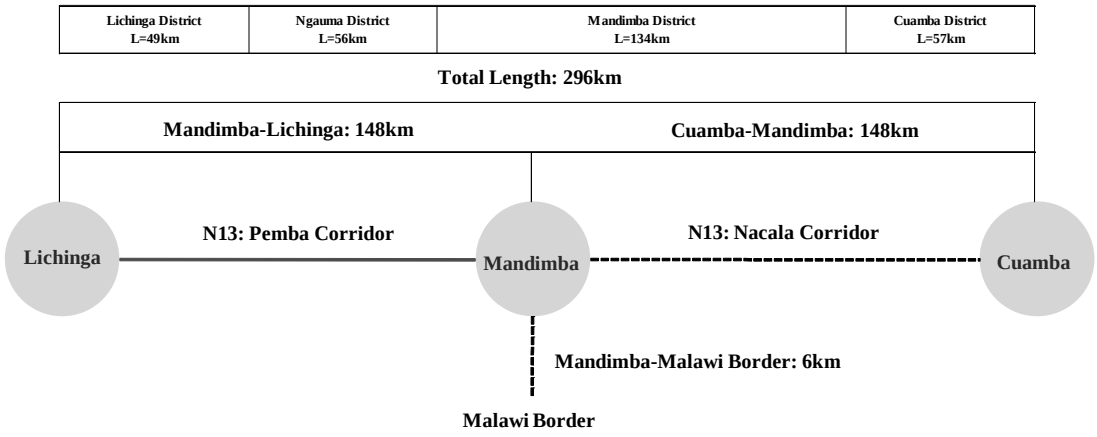
Option2: Split Operation per Traffic Type

[Mandimba-Lichinga Section]

Part III Preliminary Engineering Design

1. General Observations

As shown in Figure 1.1.1, the Study Road, with a total length of approximately 148km, traverses three districts having high agricultural potential, namely Mandimba, Ngauma and Lichinga in Niassa Province. The Mandimba-Lichinga road is part of the Pemba Corridor.



Outline of the Study Road

2. Natural Condition Survey for the Study Road

The aim of the natural condition survey is to confirm the existing natural conditions for the Study Road with a view to making a road design. Natural condition survey is composed of the following three components:

1) Topographic survey (Aerial survey, Bridge survey, Benchmark setting), 2) Geological survey, and 3) Soil & material survey.

3. Hydrology and Hydrological Analysis

Following table shows the results of the flood level calculation by the HEC-Ras, which is based on the calculation for non-uniform flow.

Bridge	Return Period	Discharge (m3/s)	Calculated Flood Level (m)	Results of Field Survey (m)
Ngame I	50-Year	225.6	731.10	732.9
	100-Year	278.9	731.68	
Lilasse	50 Year	277.3	892.76	893.2
	100 Year	342.7	893.01	
Ninde	50-Year	256.6	902.47	902.9
	100-Year	316.9	902.75	
Luculumesi	50 Year	716.2	992.98	990.0
	100 Year	885.0	993.63	
Lutembue	50-Year	310.9	1045.64	1043.9
	100-Year	384.7	1046.01	
Luambala	50 Year	463.2	1107.61	1105.5
	100 Year	576.5	1108.09	

4. Applicable Design Standards

The application of a proper design standard will ensure that the following objectives are achieved:

- Ensure safety, a high standard service level and comfort for road users by the provision of adequate sight distance and roadway space,
- Ensure that the roadway is designed economically
- Ensure uniformity in the design
- Ensure safety of the structures (bridges and culverts).

The Study Team proposed to use the Southern Africa Transport and Communications Commission (SATCC) design standards, as these were commonly used for other projects in the region. The Lichinga- Montepuez Road is also subject to the SATCC design standards.

5. Preliminary Engineering Design

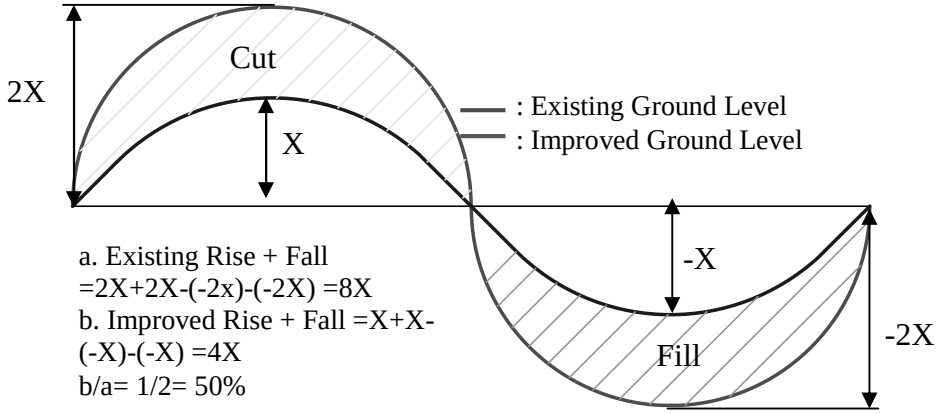
Through discussions with ANE and the results of field surveys by the Study Team, the concept of the Project was confirmed as follows:

- To create an efficient primary road connection securing smooth traffic flow throughout the year corresponding to the future traffic demand
- To create a safe primary road connection by reducing the risk of accidents and the rate of injuries to pedestrians by motorized vehicles

(1) Recommendable Alignment

The following table shows the improvement magnitude and effect of the recommended alignment. In regard to the section between Mandimba and Lichinga, although the horizontal alignment almost meets criteria for a design speed of 80km/h, the vertical alignment should be improved more than 50% for meeting a design speed of 80km/h as shown in following figure. This means that this section should be improved on large scale.

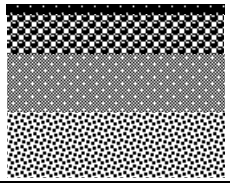
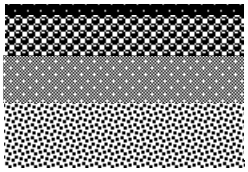
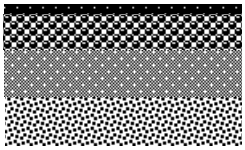
			Existing	Plan
Length (km)			148.1km	148.6km
Terrain			Rolling and mountainous	Rolling and mountainous
Design Speed			-	80km/h
Geometry	Horizontal Curvature	deg/km	164.1 (1.00)	174.8 (1.07)
	Rise + Fall	m/km	55.8 (1.00)	24.2 (***0.43***)
	No. of Rises + Falls	no./km	3.1	2.8



Improvement Image of the Vertical Alignment

(2) Suitable Pavement Compositions

A mechanistic analysis using ELSYM5 was conducted according to the design CBR. The results of the analysis are as shown in following table.

S2 (3-4)	***S3 (5-7)***	***S4 (8-14)***
 200 250 250	 200 200 250	 150 200 200

: G4 Crushed or Natural Gravel Base Soaked CBR>80%@98% mod. AASHTO density

: C4 Cemented stabilized Sub-base 0.75-1.5Mpa@100% mod. AASHTO density

: G7 Selected Layer Soaked CBR>15%@93% mod. AASHTO density

Poisson's ratio & Elastic coefficient (Elastic coefficient = (10 x CBR)Mpa)

G4: 0.35, Phase-I: 400Mpa, Phase-II: 400Mpa, Phase-III: 300Mpa

C4: 0.25, Phase-I: 1500Mpa, Phase-II: 600Mpa, Phase-III: 300Mpa

G7: 0.35, Phase-I: 150Mpa, Phase-II: 150Mpa, Phase-III: 150Mpa

(3) Bridge Design

By the discussion with ANE, bridge inner width has been set as 9.2m for two-lane bridges. Those are summarized in following table.

General		Existing bridge			New bridge			
No.	name	width	length	existing	lane	width	length	from existing Br.
(Mandimba)								
5	Ngame-I	4.2	28.0	demolish	2-lane	9.2	30	same position
6	Lilasse	4.0	10.0	demolish	2-lane	9.2	17	same position
7	Ninde	4.1	31.0	demolish	2-lane	9.2	34	down stream 8m
8	Luculumesi	4.4	22.0	demolish	2-lane	9.2	34	down stream 8m
9	Lutembue	4.1	34.0	demolish	2-lane	9.2	34	down stream 8m
10	Luambala	4.2	22.0	demolish	2-lane	9.2	30	up stream 8m
(Lichinga)								

6. Construction Planning

The construction plan was proposed for improvement of Mandimba - Lichinga road on N13 including construction method, procurement of material and equipment, and construction schedule according to site condition, structural scale and work quantities.

7. Project Implementation Plan

Project implementation plan was proposed based on some constraints affecting the schedule as shown below:

- Selection of consultant for D/D will require four months procedure and preparation of D/D and tender documents will require minimum six months.
- Preparation of environmental impact assessment and RAP will require about eight to nine months and will be submitted to a donor 120 days prior to the submission of the appraisal report and loan agreement of the Project.
- Tendering for construction contractor will require minimum nine to ten months procedure including pre-qualification, tender announcement, tender preparation of 90 days limitation and tender evaluation and approval by ANE and lending agencies
- Construction work and supervision service will require about three years (33 months)

The GOM/ANE is willing to make a request to apply for this Project as NEPAD project or component of the Cuanma-Mandimba Road Project. NEPAD project has to contribute to enhancing regional economic integration as a multinational project. However, the function of the Lichinga-Mandimba Road is not international trunk road linking other countries but rather essential road for regional development of Niassa Province.

For the reasons mentioned above, the possibility of applying this Project as NEPAD project will not be high. In that case, the GOM/ANE should consider a phased improvement in line with the existing road conditions and regional development program.

8. Project Cost Estimate

Basically unit construction cost of “Upgrading of Nampula – Cuamba Road” (hereinafter referred as “NCR”) is utilized for the Estimate due to high similarities between the two projects as follows.

- Site location: The Project Road is the extension of NCR beyond Cuamba in northern region.
- Time of estimate: Engineering estimate of NCR was finalized at its detailed design stage in April 2009.

The results of the Estimate are summarized in following tables.

Description		Final (USD)
		DBST
1000	General	28,083,346
2000	Drainage	11,519,383
3000	EW & granular layers	66,843,578
4000	AC & seals	14,259,205
5000	Ancillary	3,578,272
6000	Structures	5,797,170
7000	Test & QC	17,250
8000	Others	1,997,534
	Total (Bill A: Road)	**132,095,738**
	Bill B: Day works	1,136,023
	Bill C: Social issues	1,241,700
	Bill D: Environmental	330,239
	Total (Bill A to D)	**134,803,700**
	Contingencies (10%)	13,480,370
	IVA (6.8%)	10,083,317
	Total construction cost	**158,367,387**
	Engineering cost (5%)	7,414,204
	IVA (6.8%)	504,166
	Total project cost	**166,285,757**
	Compensation cost	199,391

Project cost per km	**1,121,868**

9. Road Maintenance Systems

ANE's ten provincial delegations are responsible for the implementation of all maintenance works on classified roads. The Directorate of Maintenance has a crucial role in ensuring that the delegations in provinces are fully aware of and complying with the technical and operational guidelines for implementation of the annual maintenance plan; and that roads of all types (primary, secondary, tertiary, vicinal, paved, unpaved) are being maintained and provided .

Part IV Traffic Demand Forecast and Economic Analysis

1. Existing Traffic Flow Patterns

The Study Team conducted the following surveys and research to recognize the characteristics of traffic flow patterns for each section:

- Previous traffic volume data in ANE
- Traffic volume and roadside OD survey in May and August, 2009 at three locations in Cuamba, Mandimba and Lichinga on the Study Road
- OD survey at four borders between Mozambique, Malawi and Zambia
- Interview survey with stakeholders in both Mozambique and Malawi

This section is the only route for delivering consumer goods to Lichinga, which is the provincial capital of Niassa, which is the base for distributing to the northern part. This section can be said to be the lifeline for the northern area. The majority of social and official movement is along the OD-pair between Lichinga and Cuamba.

2. Methodology of Traffic Demand Forecast

The Study Team applied the socio-economic framework based on the development strategy in Niassa (PEP), and the concepts of forecast methodology as three different types of traffic:

Passenger traffic volume is estimated by "Gravity Model" with the variable index of potential population and road section impedance, developed by the actual number of passengers for each O-D trip.

Regional traffic volume is considered by dividing traffic as attraction and generation for each zone. Trip attraction is estimated by the consumption of daily goods, and trip generation is based on the agro-products from Niassa province.

International traffic volume is thought to be generated after the road network is improved. It is estimated by the Malawi trade and railway capacity, and applies the corridor choice model, named lodgit model.

3. Results of Traffic Demand Forecast

Accumulating the results of each component, future traffic volume for both sections will be summarized. For the section of Mandimba – Lichinga, future traffic volume in AADT is estimated at about 467AADT in 2014, 1,732AADT in 2023 and 6,417AADT in 2033 in the "with" case.

The future AADT of section between Lichinga – Mandimba is more than Mandimba – Cuamba. It is because social communication will be more active by minibus and passenger car to the connection of provincial capital in Lichinga.

Compared with the previous feasibility study between Nampula and Cuamba, this estimated traffic volume is almost the same level of volume as for the previous section.

4. Economic Analysis

Economic analysis was conducted on the following assumptions:

Analysis Tool : HDM-4 (RED, Comprehensive for reference)
Project life : 20 years after the opening of the project road (2016)
Pricing date : As of October 2009
Social discount rate : 12%
Conversion Factor : Construction work (0.84), Maintenance work (0.75)
Exchange rate : US$1.00 = 28.00 Meticais (MT)

Results of analysis are tabulated as follows:

Sensitivity Analysis

Case	Assumptions	EIRR
Base	Upgrade to paved road with DBST (revised cost)	18.1%
1	Decrease in traffic volume of -20%	15.4%
2	Increase in investment costs of +20%	15.6%
3	Combination of above as the worst case	13.6%

The Project scores an average level as an upgrade-to-paved intervention and its economic viability is acceptable, with an EIRR of over 12% of the opportunity cost among alternatives. Based on this result, the Project is evaluated as one of the prioritized projects to be implemented in the nation. The particular importance of this primary road and of bringing it to all-weather travelable condition is well established. The Study Team concludes that the road upgrading project is economically feasible in terms of the national economy of Mozambique.

Part VI Environmental and Social Considerations

1. Environmental Law and Relevant Guidelines

The Government of Mozambique has issued laws relevant to the environment. According to the EIA Law, all project proponents must obtain environmental certification from the approval organization which is the Ministry of Environmental Coordination (hereinafter referred to as "MICOA"). This environmental law prescribes that rural road rehabilitation projects are classified as "category A" projects, which require an EIA basically. With regard to Malawi side, the Part V in Environmental Management Act 1996 says, "A4.5 construction new road / widening of existing road of highway / rural road" requires EIA process. On the other hand, construction of immigration facilities is not prescribed in the mandatory list for EIA.

The environmental and social consideration survey based on the JBIC and JICA guidelines indicated that it seems serious environmental impacts are not expected, so far, however some key issues such as resettlement, elephant migration corridor and infectious disease items were picked up, and some mitigation measures were recommended from the Study Team.

2. Environmental Recommendations

The Study Team recommends the following:

[Implementation of Mitigation Measure against Key Issues]

- With regard to African elephant migration routes in the Study Area, signboards should be set up to warn drivers and inhabitants and environmental education should be conducted for construction workers and inhabitants by the proponent.
- In terms of resettlement, adequate law-based process under land law, RPF and other relevant guidelines shall be conducted. Especially, sufficient discussion for negotiation of price determination shall be carried out with stakeholders because the GOM does not have a prescribed compensation price list for structures and assets at the moment.

[Implementation of Adequate EIA]

- ToR for EIA which will be prepared by ANE should consider relevant guidelines such as GOM, JBIC, JICA and AfDB.
- The Study Report shall be referred and incorporated into the EIA report which will be prepared by ANE, especially analysis of elephants and quantitative pollution forecast in air quality and noise pollution

[Implementation of Required Environmental Process during Construction]

- Appropriate law-based processes shall be adopted for development of quarries and borrow pits during construction. Generally, development of new quarry site shall take environmental certificate from Provincial MICOA.

Part VII Regional Development Program

1. Present Situation and Development Potential of Niassa Province

Niassa Province has inherent development potential in agriculture, forestry, mining and tourism. However, poor access conditions have hindered economic development in the province. Furthermore, its territorial size, scattered population and low population density have made it difficult to deliver basic social services to the people.

The majority of provincial population is rural and the majority of rural population is smallholding farmers (smallholders). They grow a variety of food crops including maize, cassava and beans. Poor access conditions increase transport costs. It is difficult for smallholders to transport their agricultural produce by car and sell them at market places. As a result, smallholders have to wait for middlemen to come to their villages or they need to bring produce to nearby buying places by bicycle or on foot. Moreover, in order to satisfy cash needs, they have to sell part of food crops for their own family consumption.

Some smallholders grow cash crops, such as tobacco and cotton. On the other hand, in recent years, in the southern part of Niassa Province, where access conditions are relatively good because of its railway linkage, some smallholders grow sesame for export in the activities of agricultural associations. However, these kinds of cash cropping are still limited in number and to certain areas.

Agriculture is a major and important economic sector, which provides food and cash for the majority of people in the province. In Niassa Province, there is much room for improvement of agriculture in technical production and commercialization. Furthermore, agro-processing industries are expected highly not only to increase the demand for local agricultural produce, but also to increase non-agricultural employment.

In the northern part of Niassa Province, since 2005, industrial tree plantations have been increasingly developed by foreign investments. Harvesting of trees will start at those plantations around 2013. Those harvested wood and/or locally processed wood products would be exported to other regions. In the short term, they rely on road transport from Lichinga to Cuamba to get railway at Cuamba. In the mid and long terms, it is expected that the railway line between Cuamba and Lichinga could be rehabilitated so as to transport unprocessed wood or processed wood products to Cuamba and further to Nampula or to Nacala, sometime to Malawi.

In Niassa Province, Niassa Lake in the north-western area and Niassa Reserve in the north-eastern area have tourism potential. Lichinga, provincial town of Niassa, has beautiful streetscape due to Portuguese colonial legacy. Lichinga has development potential to be a base for tourist accommodation. Such tourism potential including tourist resorts, water sports, ecotourism and game hunting has been hardly exploited yet.

It has been known that the north-western area of the province has mineral resources including coal. However, high transport costs have hindered exploration and development of mineral resources.

2. Regional Development Measures for Promoting Synergy Effect of Trunk Road Improvement and Regional Development

(1) Corridor along Cuamba-Mandimba Trunk Road: Southern Part of Niassa Province

Smallholder Agriculture and Agro-Processing Industries

The upgrading and pavement project of Cuamba-Mandimba Road could reduce transport costs, as well as improve road access along the corridor. As a result, regional potential to commercialize smallholder agriculture and to expand their production would be enhanced. However, such road upgrading alone cannot realize the enhanced regional potential and achieve smallholder commercialization and production expansion. Therefore, it is necessary to assist in strengthening their agriculture associations and securing market channels for their produce.

The upgrading and integration of Cuamba-Mandimba Road with already upgraded Nampula-Cuamba Road would substantially reduce long-distance transport costs by truck so as to reduce goods prices imported from other regions.

It is considered that such smallholder commercialization and agricultural production expansion would increase business potential of agro-processing industries along the corridor. However, such road upgrading alone is not enough to exploit improved opportunities in agro-processing industries. It is essential to assist in not only feasibility studies but also business development services, for providing information and support to private sectors. Such measures would help private sectors to actually invest in the field of agro-processing.

Urban Economy and Logistics Function

The integrated upgrading of trunk roads of Nacala Development Corridor would vitalize regional economy along the corridor. This could promote geographical expansion of commercial catchments Nampula Town and Nacala Town, resulting in upgraded commercial agglomeration.

Similarly the inland towns, such as Cuamba Town and Mandimba Town, would expand their commercial catchments and increase demands for transport and logistics sectors.

In addition to the upgrading of Nampula-Cuamba-Mandimba Road, development of bypass roads, logistics centers and loading-unloading facilities between roads and railways would be necessary for making regional transport more effective and efficient by taking advantage of upgraded trunk roads and rehabilitated railway of Nacala Development Corridor.

(2) Periphery of Nacala Development Corridor: Central and Northern Parts of Niassa Province

Smallholder Commercialization and Production Improvement

Commercialization of smallholders in the periphery of Nacala Development Corridor would be encouraged by the road improvement between Nampula, Cuamba and Mandimba. Due to the reduced long-distance transport costs, the farmers would be able to sell their agricultural products at higher prices. As the economic activities in Nacala Development Corridor are vitalized with the trunk road improvement, populations of Cuamba Town and Mandimba Town would

increase. As a result, the amount of agricultural products to be dealt with by the middlemen would increase. Currently the support to the smallholder commercialization by organizing agricultural associations and by making linkage with marketing companies is provided in a limited number of villages in the southern part of the province. In order to make full use of the enhanced opportunities for smallholder commercialization, such support should be expanded to the central and northern parts. In addition, agricultural technical support should be introduced to improve their production.

Tourism Development

If the road between Nampula, Cuamba and Mandimba is improved, tourists visiting southern part of the Province from Malawi or Nampula by bus or car would increase. It is expected that Lichinga would be developed as a comfortable tourist base to provide accommodation to tourists, traveling along the route via Cuamba and Mandimba. Measures should be taken to improve the quality of tourism services in hotels, restaurants and car rentals, as well as to provide tourist information in Lichinga Town. Furthermore, efforts should be made to attract tourists to make trips from Lichinga to nearby tourist spots such as Niassa Lake and nature conservation areas.

In order to fully develop tourism in Niassa Province to such an extent that more international and domestic tourists would visit Niassa Lake and/or Niassa Reserve as popular tourist destinations, good access conditions should be ensured with improved Mandimba-Lichinga Road. In combination with the road improvement, it is necessary to make Lichinga Town an attractive tourist center, by providing small tourist-oriented facilities, such as tourist information centers, museums and sign boards. It is also necessary to start developing the capacity of local tourist industries by providing training programs. More tourist accommodations and attractions should be developed at Niassa Lake and Niassa Reserve. For facilitating tourism development at the provincial level and for promoting tourism in Niassa Province, it is also recommended to establish a local tourism board involving government and private sectors.

Development of Wood Processing Industry

Improvement of Mandimba-Lichinga Road is essential for promoting industrial development, such as wood-processing industries, in the central and northern part of Niassa Province. The road improvement would largely contribute to cost reduction of long-distance truck transport and furthermore to price reduction of imported goods, such as spare parts and fuels. This could lead to enhancement of basic conditions for attracting industries.

For actual promotion of wood-processing industries, business development services should be provided for foreign investors and companies. Furthermore, it is also necessary to develop small and medium scale enterprises (SMEs) of wood-processing for local employment generation.

Mineral Resources Development

The improvement of Lichinga-Mandimba Road is essential to realize mineral resources development in the north-western area of the province. Together with the road improvement, geological surveys and research is important to provide information on mineral resources availability to promote private investment in mineral exploration and furthermore in mineral exploitation. In the long term, rehabilitation of Lichinga-Cuamba Railway Line is highly expected for

transporting exploited mineral resources through Cuamba, Nampula and Nacala.

Improvement of Social Services

In addition to the above-mentioned economic development measures, the improvement of social services, such as water, education and health, as well as the improvement of local roads are very important for the regional development in the central and northern parts of Niassa Province. In the decentralization policy of Mozambique, budgets for the development are allocated to district governments, and they are supposed to play central roles in planning and implementation for local development. However, their capacity is limited. In order to improve social infrastructure and services, assistance programs for capacity development of district governments are necessary.

The Preparatory Survey on Road Improvement Plan in Nacala Development Corridor (N13: Cuamba-Mandimba-Lichinga) in the Republic of Mozambique

Final Report

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Abbreviation

AADT	Annual Average Daily Traffic
ACE	Competent Authority of Road Sector
ACV	Aggregate Crushed Value
ADT	Average Daily Traffic
AfDB	African Development Bank
ANE	National Road Administration
AU	Africa Union
BOO	Build Own Operate
BOT	Build Operate Transfer
BOOT	Build Own Operate and Transfer
CBR	California Bearing Ration
CDN	Northern Development Corridor
CFM	Mozambique Railway Authority
CLUSA	Cooperative League of the U.S.A.
COI	Corridor of Impact
COMESA	Common Market for Eastern and Southern Africa
DA	Directorate of Administration
DCP	Dynamic Cone Penetration
DIMAN	Directorate of Maintenance of ANE
DIPRO	Directorate of Project of ANE
DNEP	National Directorate of Roads and Bridges
DPANE	Provincial Delegation of ANE
DPOPH	Provincial Directorate of Public Works and Housing
DTI	Department of Trade and Industry
EAC	East African Community
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ESCS	Environmental and Social Consideration Survey
EU	European Union
FDD	Full Due Diligence
FIP	Preliminary Information File
GAT	Cross Cutting Issues Unit (Environmental Unit in ANE)
GAS	Director of Assessor and Supervision Cabinet
GDP	Gross Domestic Product
GED	Cabinet for Development and Strategic Study
GOJ	Government of Japan
GOM	Government of the Republic of Mozambique
GPS	Global Positioning System
H.W.L	High Water Level
HDM-4	Highway Design and Maintenance Standards Model
HIV/AIDS	Human Immunodeficiency Virus /Acquires Immune Deficiency Syndrome
ICB	International Competitive Bidding
IDA	International Development Association
IND	National De-mining Institute
INE	National Statistics Institute
IRI	International Roughness Index
IRR	Internal Rate of Return
IUCN	International Union for the Conservation of Nature and Natural Resources
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency

MASL	Meter Above Sea Level
MCA	Multi Criteria Analysis
MCC	Millennium Challenge Corporation
MICOA	Ministry for Coordination of Environmental Affairs
MOAF	Ministry of Agriculture & Fisheries
MODP	Ministry of Development & Planning
MOIC	Ministry of Industry & Commerce
MOPWH	Ministry of Public Works and Housing
MOTC	Ministry of Transport & Communication
MTEF	Medium Term Expenditure Framework
NCB	National Competitive Bidding
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
NPV	Net Present Value
OSBP	One Stop Border Post
OD	Origin and Destination
PAC	Environmental Accompanying Plans
PAP	Project Affected Person(s)
PARPA	The Action Plan for the Reduction of Absolute Poverty
PEP	Provincial Strategic Plan
PES	Economic and Social Plan
PGA	Environmental Administration Plan
PPP	Public-Private Partnership
PRISE	Road Sector Integrate Program
RAP	Resettlement Action Plan
RECs	Regional Economic Communities
RED	Roads Economic Decision Model
RF	Road Fund
RMF	Regional Maximum Flood
ROW	Right of Way
RPF	Resettlement Policy Framework
RSS	Roads Sector Strategy 2007-2011
SADC	Southern African Development Community
SATCC	the Southern Africa Transport and Communications Commission
SAWPB	Semi Annual Workplan and Budget
SEA	Strategic Environmental Assessment
SDI	Spatial Development Initiatives
SISTAF	Ministries of Finance and Planning and Development in the Government's financial management system
SIDA	Swedish International Development Cooperation Agency
SMEs	Medium-scale National Entrepreneurs
SMP	Strategic Maintenance Plan
SPT	Standard Penetration Test
STD	Sexually Transmitted Disease
SWOT	Strength, Opportunity, Weakness and Threat
TMH	Technical Measures for Highways
TRH	Technical Recommendations for Highways
TOR	Terms of Reference
VEF	Vehicle Equivalent Factor
VOC	Vehicle Operation Cost
WB	The World Bank

Part I Overall Approach & Work Procedure

1. Background and Study Objectives

Mozambique is located on the south-eastern coast of Africa and covers an area of 799,380 sq. km. It is bounded on the north by Tanzania; on the west by Malawi, Zambia, Zimbabwe, Swaziland and the Republic of South Africa (RSA); and the entire eastern boundary by the Mozambican channel of the Indian Ocean.

Mozambique's 17-year civil war, which lasted until 1992, ruined much of the country and destroyed key road infrastructure.

The Government of the Republic of Mozambique (hereafter referred to as the "GOM") assumed that the limited access to roads and other socio-economic services is a cause of the country's poverty and gave priority to improve infrastructures in areas with high potential for agricultural production, etc in the Action Plan for the Reduction of Absolute Poverty (PARPA II: 2006 – 2009).

A main goal of the Road Sector Strategy 2007-2011 (RSS) is to serve the efficient road network to the prioritized economic areas that have the greatest potential to contribute to economic growth and PARPA II such as agricultural areas, tourist sites and areas of industrial or natural-resource development.

Given the above-mentioned situation, the GOM requested the Government of Japan (hereafter referred to as the "GOJ") to conduct a feasibility study (F/S) for the Upgrading of the Nampula - Cuamba Road. In response to this request from the GOM, the GOJ conducted "The Study on Upgrading of Nampula - Cuamba Road" from 2006 to 2007. In Nampula – Cuamba section, the detail design has been put forward for construction by the counter fund of GOM.

The Study Road (N13: Cuamba – Mandimba – Lichinga), as part of the two Mozambican corridors (Nacala N13/N1 and Lichinga-Pemba N14/N1 corridors), provides a strategic link to the Malawi Border at Mandimba with the ports of Nacala and Pemba, in Nampula and Cabo Delgado Provinces respectively. Although the Study Road has much potential for stimulating development and reducing poverty throughout the entire northern area of Mozambique by enabling efficient connection, the section concerned is the only unpaved section.

The study objectives are as below:

(1) The objectives of the study are to determine the most technically feasible and economically viable, environmentally acceptable and socially optimal option of upgrading the existing Cuamba – Lichinga road to an all-weather road for easier transit. The study also determines the impact of providing an all-weather road on poverty reduction and environment.

(2) Establishment of the "Regional Development Program" intended for Niassa Province is also the objective of the study. This program aims to extend the improvement effect to the wide area in conjunction with the road improvement (Nacala N13/N1 and Lichinga-Pemba N14/N1 corridors).

2. Scope of the Study

The Consultant shall perform all necessary planning, engineering, economic, financial, social and environmental analysis, field investigations, and related works to attain the objectives of the Study under cooperation of ANE.

The Study includes conducting the economic feasibility study, preliminary engineering design, assistance for environmental impact assessment and establishment of regional development program for Cuamba - Lichinga road over 302km.

(1) Economic Feasibility Study

The consultant shall carry out Economic Feasibility Study consist the following items.
1) Economic Analysis, 2) Traffic Analysis, 3) Economic Evaluation, 4) Risk Analysis

(2) Preliminary Engineering Design

The consultant shall carry out Economic Feasibility Study consist the following items.
1) Site Measurement (Natural Condition Survey), 2) Visual Site Survey, 3) Preliminary Design, 4) Cost Estimate, 5) One Stop Border Post (OSBP)

(3) Assistance for Execution of EIA by GOM (ANE)

The Consultant shall assist ANE for execution of the EIA for the Study Road, because procedure and contents of the EIA shall comply with the EIA guidelines of both AfDB and JICA.

(4) Regional Development Program

The Consultant shall establish the “Regional Development Program” intended for Niassa Province based on the “PEP Niassa 2017”. This program shall propose to Niassa Province.

Part II General Appreciations

1. Features of the Sector

(1) Government/Sectoral Policy

National policy and planning in Mozambique all have poverty reduction as a key objective. The Mozambique Government has been combating absolute poverty under the Poverty Reduction Strategy Paper (PARPA: 2001-2005) and PARPA II (2006-2009). The target of PARPA II is to reduce the incidence of absolute poverty from 54 percent in 2003 to 45 percent in 2009.

In addition, PARPA II has leaned to greater integration of the national economy and an increase in productivity. In particular, PARPA II pays more attention to district-based development, creation of an enabling environment for the productive sector, improvement of the financial system, measures to help small and medium-size companies and the development of both the internal revenue collection system and the methods of allocating budgeted funds. Although PARPA II calls for an increase in internal revenues in real terms, it still expects to continue to rely on the contribution of foreign donors to finance about 49 percent of the state budget every year during the period.

For these purposes, PARPA II formulated three pillars, comprising good governance, investment in human capital and economic development.

(2) Features of the Sector

The Road Sector Strategy 2007-2011 (RSS) presents the main elements of the Government of Mozambique's (GOM's) strategy for developing and managing the classified road network. The RSS adds a level of detail to the GOM's Road Sector Policy to establish the main principles, approaches, and activities.

The RSS takes into account a medium to long term perspective, however it includes 5-year horizon investment plan, reviewed and revised for implementation on a 3-year basis which in turn is adjusted annually, considering needs and budget constraints.

The road sector national objectives, as stated in the RSS, aim at achieving the following objectives through the improvement of the road network:

- Ensuring the social and economic mobility necessary for promoting growth, and
- Fostering regional development by providing secure road links to all areas of the country.

Mozambique's road network is currently managed by the National Road Administration (ANE), which reports to the Ministry of Public Works and Housing. The Road Fund is responsible for managing the funds for the sector.

2. Transport Sector and Related Parameters

(1) Traffic Modal Split

Table 2.2.1 shows the traffic modal split for both goods and passenger transportation in Mozambique. In general, the road mode occupies a large share of both freight (58.2%) and passenger transport (96.1%) among all modes, particularly for passenger transport which is almost totally reliant on the road network. On the other hand, at 27.9%., contribution of the railway mode is relatively high for the freight transport. Marine transportation (8.3%) also contributes towards transportation of freight. The air mode only shares a low ratio for both goods and passenger transport due to lower transport capacity.

Table2.2.1 Traffic Modal Split in Mozambique

Transportation		Road	Railway	Sea	Air	Pipeline
Goods (million TKM)	2004	950.7 (42.3%)	760.6 (33.8%)	279.1 (12.4%)	9.3 (0.4%)	248.3 (11.0%)
	2005	1,048.8 (46.8%)	762.8 (34.1%)	295.6 (13.2%)	7.4 (0.3%)	125.4 (5.6%)
	2006	1238.3 (53.8%)	775.1 (33.7%)	178.8 (7.8%)	6.0 (0.3%)	102.1 (4.4%)
	2007	1534.5 (58.2%)	736.3 (27.9%)	217.8 (8.3%)	8.1 (0.3%)	137.9 (5.2%)
Passengers (million PKM)	2004	20,906.2 (97.2%)	106.0 (0.5%)	29.8 (0.1%)	467.5 (2.2%)	-
	2005	23,909.7 (97.2%)	172.2 (0.7%)	18.5 (0.1%)	504.5 (2.1%)	-
	2006	26486.8 (96.3%)	342.3 (1.2%)	9.0 (0.0%)	662.3 (2.4%)	-
	2007	28769.6 (96.1%)	319.6 (1.1%)	9.4 (0.0%)	845.8 (2.8%)	-

Source: Statistical Yearbook

(2) Road Classification System and Conditions

The classification system of roads, which account for high ratios of both goods and passenger transport, is summarized in Table 2.2. The classified roads consist of national roads (primary and secondary) and regional roads (tertiary and vicinal roads). These roads are administrated by ANE. Urban roads and unclassified roads fall under the jurisdiction of the municipal councils and the district administrations respectively.

Table 2.2.2 New Road Classification System

Categorization	Designation	Functional Definition	Numbering
National Roads	Primary Roads	Form the national trunk road network and link: • Provincial capitals • Provincial capitals and other cities • Provincial capitals and main ports • Provincial capitals and important border posts	(a): N1 to N100 (b): N101 to N199
	Secondary Roads	Form the secondary network complementing the trunk road network and link: • Primary roads • Provincial capitals and sea or river ports • Primary roads and economic poles of high importance • Primary roads and (other) border posts	N200 to N399
Regional Roads	Tertiary Roads	Tertiary roads link: • Secondary roads with primary roads or with other secondary roads • District centres • District centres and administrative posts • District centres and economic poles of high importance	R400 to R799
	Vicinal Roads	Vicinal roads link: • Tertiary roads • Administrative posts • Administrative posts and other population centres	R800 onwards

(a): Roads that constitute major routes
(b): Other primary roads
Source: Final Report on the Reclassification of the Mozambique Road Network, 2003

The current Mozambique classified road network is estimated at around 30,000 km of which less than 20% are paved. Of the paved roads, the majority were estimated to be in good to fair condition (88%), however only 57% of the unpaved roads were estimated to be fully travelable. A key element of the RSS and of the Strategic Maintenance Plan (SMP) is the introduction of a Paved Road Management Programme (PRMP), which will be managed separately from the rest of the road network. SMP takes care of the 30,000 km of the classified roads and an additional 3,000 km of urban road.

[Cuamba- Mandimba Section]

Part III Preliminary Engineering Design

1. Inventory Survey for the Study Road

(1) General Observations

The Study Road can be broadly divided into two sections (Cuamba-Mandimba Section and Mandimba-Malawi Border Section) and the road length of each section is indicated in Figure 3.1.1.

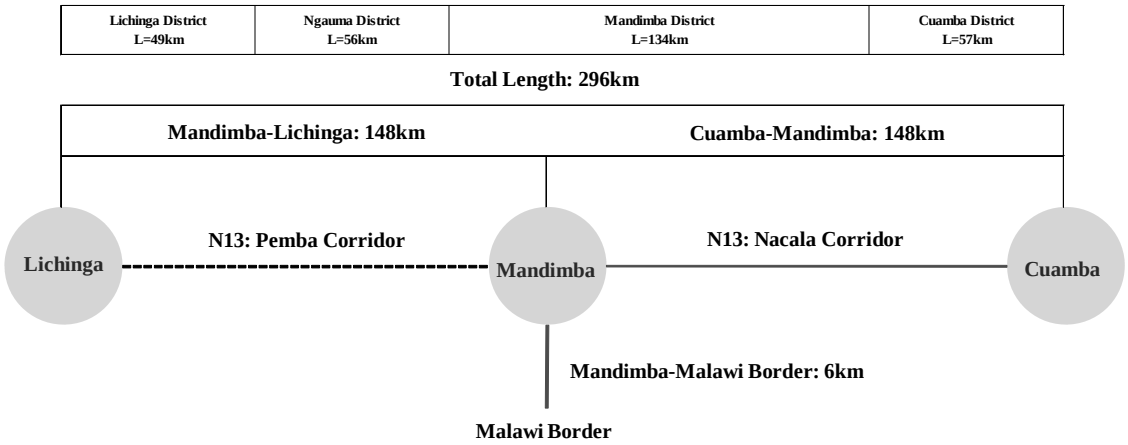


Figure 3.1.1 Outline of the Study Road

(2) Existing Road and Bridge Conditions

1) Cuamba-Mandimba Section

The Study Road passes through many small villages. The terrain is mostly flat, starting at an altitude of about 560 MASL climbing towards Mandimba, located at an altitude of approximately 760 MASL. The Study Road steadily climbs at a gradient of 0.13% on average.

The existing road alignment generally follows the watershed crest, and its horizontal alignment is characterized by straight line, large and/or medium size curves apart from a few sections such as the level crossing. The Study Road runs parallel with the railway line and crosses the railway line on eight occasions within a short length.

2) Mandimba-Malawi Border Section

Mandimba-Malawi Border road which has a length of 6km leads up to Malawi after bisecting from N13 in Mandimba. This road undulates at nearly 760 – 800 MASL while passing three minor rivers and rolling terrain. The road has an earth surface and is significantly deteriorated by lack of maintenance activities and heavy rains. Typically, the road width varies between 6m and 7m (between the edge of road), and is not generally adequate for two-lanes of heavy trucks.

3) Existing Bridge Condition

The bridge conditions are relatively fair even after being constructed 40-60 years ago. The main reason is that earthquakes and river flooding seldom occur, and the hilly atmosphere is good for steel bridges.

The investigated 14 bridges are grouped in three (3) categories as follows.

Category Good [3]: Strong or new bridge that will remain in use

These are structurally strong continuous RC-T bridge [1], road-railway bridge [1], and a newly completed bridge granted by GOJ [1].

Category Fair [5]: Bridges that will remain in use for the next 20 years approximately

These are simple RC-T bridges [5].

Category Poor [6]: Bridges that will be replaced by new structures

These are non-girder bridges such as RC-slab bridges [4] and H-beams [2], in which slab and gird post are damaged.

2. Natural Condition Survey for the Study Road

(1) Topographic Survey

The aim of the topographic survey is to confirm the existing topographic condition for the Study Road with a view to making a road design. Topographic survey is composed of the following four works.

1) Road alignment survey, 2) Aerial survey, 3) Bridge survey, 4) Benchmark setting

(2) Geological Survey

The aim of the boring survey and SPT is to confirm the boundary between weathered layer and hard basement rock layer and the depth of foundation for the four bridges in the Study area. Two boreholes are performed for each bridge site. The Location of target bridges is as follows;

Muambessi bridge, Lussangassi bridge, Ngolua bridge, Ngame II bridge

(3) Soil & Material Survey

1) CBR and DCP Test

The aim of the California Bearing Ration (CBR) and Dynamic Cone Penetration (DCP) test is to confirm the bearing capacity of the in-situ sub-grade material so that the pavement will be able to fulfill the service objective over the design period.

2) Borrow-Pit's Material Survey for Pavement Layer and Fill

Some borrow-pit's material from appropriate spots along the Study Road were sampled by the Study Team for testing of fill and pavement layer materials.

3) Quarry's Material Survey for Pavement Layer and Concrete Work

Some quarry materials were sampled to confirm the possible positions of materials to be used in both pavement and concrete work. And each estimated available volume of the quarry site was also surveyed.

3. Hydrology and Hydrological Analysis

(1) Hydrological Analysis

A statistical analysis was done on the rainfall data at stations Cuamba and, Mandimba. Two statistical distribution methods (Iwai Method and Log Pearson III) were applied to the observed rainfall records. The most conservative design rainfall was selected from the two distributions and is shown in Table 3.3.1 below.

Table 3.3.1 Day Design Rainfall at each of the Rainfall Stations

Duration	1 Day Return Period Rainfall (mm)					
	2	5	10	20	50	100
Cuamba	75.7	97.9	111.4	123.5	138.2	148.7
Mandimba	82.2	101.9	113.1	122.9	134.3	142.2

The statistical rainfall at Mandimba is not supplied with a high confidence due to the short records. The calculated design rainfall may prove to be more conservative than necessary. Hence an average of the design rainfall experienced at Cuamba may prove sufficient for the purposes of the Study.

(2) Flood Hydrology

Flood hydrological methods used in this Study include the Rational method and Regional Maximum flood. Not all methods could be applied to calculating the flood peaks at each catchment. The Rational method can be applied to catchments up to 500km^2.

The Regional Maximum Flood (RMF) can only be applied to large catchments and is based on a regional K factor. There has been work done in southern Mozambique where the K factor varies from 5 - 5.6. A sensitivity analysis will be performed to compare the flood peaks.

Table 3.3.2 Limitation of Flood Calculation Method

Method	Maximum Area (km2)
Alternative Rational Method	No limitation (0 to 500: Study Team Recommendation)
Empirical Method (RMF)	No limitation

Source: Drainage Manual 5th Edition (SA National Road Agency)

(3) Flood Level Estimation for Bridges

The software used to model for the flood level calculation is HEC-Ras in which primary input is cross-sectional data, Manning's roughness and the flood peaks. Cross sections were extracted from the topographic survey. A Manning's roughness of 0.035 was assumed.

Table 3.3.3 shows the results of the flood level calculation by the HEC-Ras, which is based on the calculation for non-uniform flow.

Table 3.3.3 Suggested Flood Level for Return Period of 50-years and 100-years

Bridge	Return Period	Discharge (m3/s)	Calculated Flood Level (m)	Results of Field Survey (m)
Muambessi	50-Year	312.0	618.50	616.9
	100-Year	390.9	619.28	
Lussangassi	50 Year	589.9	639.42	637.5
	100 Year	731.4	639.92	
Ngolua	50-Year	246.4	704.16	706.2
	100-Year	307.9	704.85	
Ngame II	50 Year	243.7	708.61	709.2
	100 Year	301.7	709.15	

4. Applicable Design Standards

(1) General

The application of a proper design standard will ensure that the following objectives are achieved:

- Ensure safety, a high standard service level and comfort for road users by the provision of adequate sight distance and roadway space,
- Ensure that the roadway is designed economically
- Ensure uniformity in the design
- Ensure safety of the structures (bridges and culverts).

For the design studies of the Nampula-Nacala Road and Nampla-Cuamba Road which are a part of Nacala Corridor, the Study Team proposed to use the Southern Africa Transport and Communications Commission (SATCC) design standards, as these were commonly used for other projects in the region.

(2) Applicable Design Standards for Road Design

1) Geometric Design Parameter

The road geometric design is based on the “SATCC Code of Practice for the Geometric Design of Trunk Roads”, September 1998.

2) Typical Cross Sections

The Study Team recommends that the same typical cross section as the Nampula-Nacala road and Nampula-Cuamba road is adopted to ensure consistency in the design standard. In addition, the risk of traffic accidents is likely to increase with increased volume of traffic and higher driving speeds. Therefore, a 2.5m shoulder width (2.0m paved shoulder and 0.5m soft shoulder) is proposed in populated areas, as a large number of pedestrians use the road.

3) Pavement Design

The design of pavement structures is based on the methods given by the

"SATCC Practice for the Design of Road Pavements". In addition to the SATCC standard, other design methods such as "Road Notes 31" and "TRH4 of South Africa" are also considered as reference.

4) Level Crossing Design

The section between Cuamba and Mandimba crosses the railway on a skew at 8 points, and these crossing angles reduce the safety such as visibility. In this Study, these level crossings should be improved from the aspect of safety in accordance with the standard applied in Nampla-Cuamba road project.

5) Road Safety Facilities

The Study Team follows the SATCC manuals of November 1997 for specifying the road signs and road markings. As a general rule, road traffic signs give warning to the drivers, and increase the safety of all road users including pedestrians.

6) Bridges and Culverts

For a long time in Mozambique, Portuguese standards and specifications were widely used for the design of highway bridges and culverts. After SATCC "Code of Practice for the Design of Highway Bridges and Culverts in South Africa" were introduced in 1981, this became the principal design standard and specification although it still remains a provisional status.

Since the SATCC codes are formulated on the basis of British Design Codes, ANE staff still uses the Portuguese codes for checking the design done by SATCC codes. The latest SATCC code (September 1998, reprinted July 2001) should be adopted as the standards and specifications for bridge and culvert design for this Study road. The relevant specifications published by AASHTO, British Standard (BS) and the Portuguese Bridge Code are also used.

5. Preliminary Engineering Design

(1) Introduction

Through discussions with ANE and the results of field surveys by the Study Team, the concept of the Project was confirmed as follows:

- To create an efficient primary road connection securing smooth traffic flow throughout the year corresponding to the future traffic demand
- To create a safe primary road connection by reducing the risk of accidents and the rate of injuries to pedestrians by motorized vehicles

(2) Screening of Conceivable Alternative Routes and Pavement Design

1) Procedure of the Preferable Route and Design

Alternatives for the road alignment and design should be determined and compared in accordance with the concept. The "Do nothing" option is not appropriate to the stated upgrading concept described above. In this Study, the preferable route and design should be selected in accordance with the following procedure.

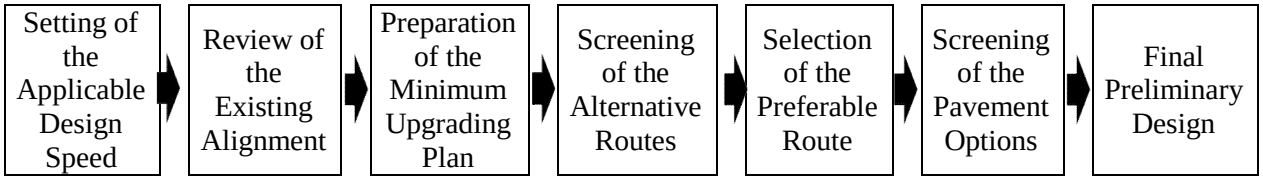


Figure 3.5.1 Procedure of the Preferable Route and Design

2) Recommendable Alignment

The following table shows the improvement magnitude and effect of the recommended alignment. In regard to the section between Cuamba and Malawi Border, it was clarified by two indices (horizontal curvature and rise plus fall) that the existing alignments both horizontal and vertical almost meet criteria for a design speed of 100km/h. This means that improvement to the recommended alignment will basically be carried out on the existing road excluding the bypass sections discussed above.

Table 3.5.1 Improvement Magnitude and Effects

			Existing	Plan
Length (km)			153.8km	152.9km
Terrain			Flat	Flat
Design Speed			-	100km/h
Geometry	Horizontal Curvature	deg/km	22.4 (1.00)	21.2 (0.95)
	Rise + Fall	m/km	9.8 (1.00)	9.8 (1.00)
	No. of Rises + Falls	no./km	4.5	3.3
No. of Level Crossings			8	2

(3) Preliminary Design for the Pavement Options

1) Screening of the Pavement Options

From the experience of past and ongoing projects, it was decided that there are three possible scenarios regarding the upgrading of the Study Road:

Alternative-A: Asphalt Concrete based on the SATCC Standard

Alternative-B: Double Surface Treatment based on the Road Note 31

Alternative-C: Gravel Surfacing requested by the AfDB as reference

Table 3.5.2 Economic Analysis for Selection of the Pavement Type

Pavement Type	Construction Cost		NPV (USD Mil.)	B/C	EIRR
	US$ Mil.	US$/km			
Alt.-1 Asphalt Concrete	197.4	1,281,659	-1.2	1.0	11.9%
Alt.-2 Double Surface Treatment	120.6	783,391	62.9	1.7	19.0%
Alt.-3 Gravel Wearing	54.2	351,863	-44.8	-0.2	-30.0%

The selection of the suitable pavement type is evaluated based on the initial cost

and its financial viability using the EIRR indicator. The result of the cost estimates and the economic analysis, the Alt-2 which constitutes a double surface treatment, is selected as the most economically viable pavement composition.

2) Suitable Pavement Compositions

The proposed pavement type (double surface treatment) was defined to be the most effective and economical. However its pavement composition can be expensive in construction because the necessary care, construction method and also curing of the two cemented layers with thin thickness (125mm) can contribute to a longer construction period and consequently increase in costs.

Thus the pavement composition discussed above should be modified into more economical and effective composition based on the cemented sub-base in granular base. For this purpose, a mechanistic analysis using ELSYM5 was conducted according to the design CBR. The results of the analysis are as shown in Table 3.5.3. At the moment, there are some ideas and opinions relevant to determine pavement capacity. In this Study, the structural life of pavement was evaluated in two common ways. These approach methods are derived from the RR91/242 and the report written by Mr. H L Theyse, respectively.

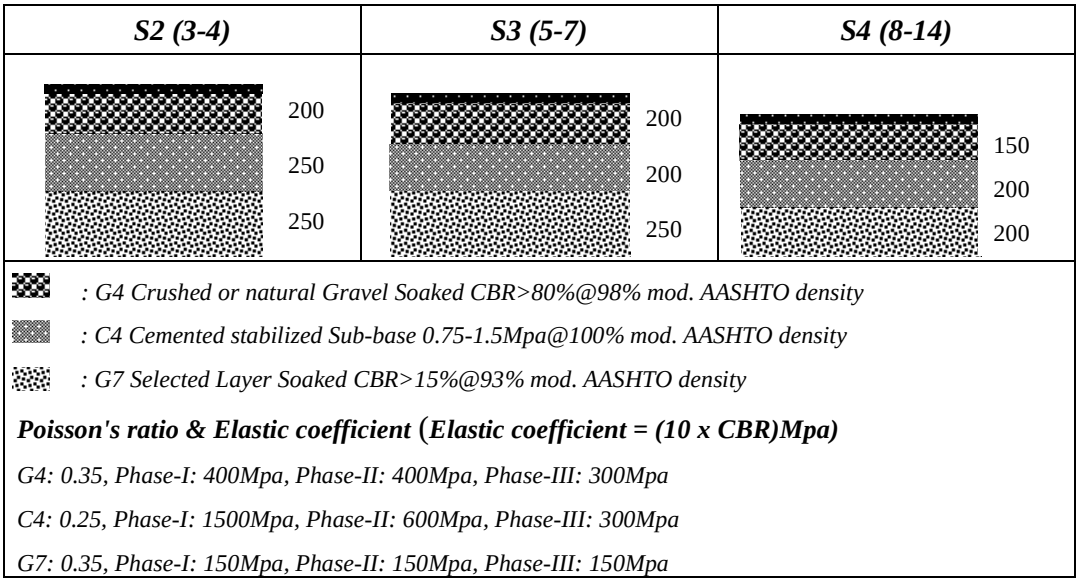


Figure 3.5.2 Recommendable Pavement Compositions based on the Mechanistic Analysis

Table 3.5.3 Summary of the Pavement Capacity

Sub-grade Class	Method	Structural Life	Calculated Design ESA for 15 years
S2 (3-4)	RR91/242	2.22E+07 (wet)	9.5E+06 (Cuamba-Mandimba)
	H L Theyse	1.01E+07 (wet)	
S3 (5-7)	RR91/242	4.12E+07 (wet)	9.5E+06 (Cuamba-Mandimba)
	H L Theyse	1.78E+07 (wet)	
S4 (8-14)	RR91/242	2.64E+07 (wet)	9.5E+06 (Cuamba-Mandimba)
	H L Theyse	1.13E+07 (wet)	

(4) Bridge Design

1) Concept of Improvement Plan

The 4 concepts of improvement plan have been set up for Cuamba-Mandimba section.

- ✓ If the bridge width is for 2-lanes (assume minimum 6.0 m width) and the bridge condition is good or fair, the existing bridge remains to be used.
- ✓ If the bridge condition is poor, the existing bridge is replaced by new 2-lane bridge (or 2-lane culvert when the existing bridge length<12m).
- ✓ If the river flooding over road surface is reported at the bridge or culvert, the structure is replaced by 2-lane bridge to clear enough HWL and discharge.
- ✓ If the bridge width is for 1-lane and the bridge condition is good or fair, the existing bridge is replaced by new 2-lane bridge.

2) Preliminary Bridge Design

For the preliminary design of 4 bridges in Cuamba-Mandimba section, some design conditions such as bridge length and bridge position shall be decided by sight investigation of existing bridge and river. By the discussion with ANE, bridge inner width has been set as 9.2m for 2-lane bridge. Those are summarized in Table 3.5.4.

Table 3.5.4 New Bridges to be Designed

General		Existing bridge			New bridge			
No.	name	width	length	existing	lane	width	length	from existing Br.
(Cuamba)								
1	Muambessi	4.8	14.3	demolish	2-lane	9.2	17	same position
2	Lussangassi	3.2	28.0	demolish	2-lane	9.2	34	down stream 8m
3	Ngolua	4.7	14.0	demolish	2-lane	9.2	17	same position
4	Ngame-II	4.9	28.0	demolish	2-lane	9.2	34	same position
(Mandimba)								

6. Construction Planning

(1) Construction Material

1) Material from Natural Source

Generally construction materials such as soil, aggregate and sand are available along and/or suburbs of the Project Road. The Team conducted material survey and laboratory test to confirm qualities and potential quantities of the materials. Detailed analysis of the survey is discussed to meet demand of the design result of the Project in Chapter 2 “Natural Condition Survey”.

2) Material from Industrial Source

Local suppliers around the Project are not able to supply large amounts of construction materials (e.g. cement, re-bar, bitumen) due to their limited business scale. The contractor has to secure reliable and sustainable sources such as Maputo, Beira, Nampula, Nacala and/or overseas at the construction stage. Potential sources of major materials are as follows:

- Cement : Nacala
- Re-bar : Beira, Maputo and/or overseas
- Bitumen : Beira, Maputo and/or overseas

(2) Construction Equipment

The local market of the leasing business is still too immature to provide construction equipments with sufficient types, numbers and performance to meet demands of the contractor. Therefore, the contractor has to outsource the equipments from Maputo, Beira, Nampula, Nacala and/or overseas unless bringing in his own equipments.

(3) Transportation Method of Material and Equipment

Currently railway service is operational from Nacala to Lichinga by Corredor de Desenvolvimento do Norte (CDN). However, only the line between Nacala and Entre-Lagos (aka border with Malawi) has a regular service (six round trips per week). Moreover cargo service of this line is unable to fully meet requirements of the users due to shortages of locomotives and wagons according to interview and study with relevant persons/organizations. Therefore, the contractor shall use the railway service between Nacala and Cuamba for transportation of material and equipment while adjusting with other users.

Currently the line between Cuamba and Lichinga has no regular service because of frequent damage of structures (e.g. track, sleeper and roadbed) due to shortage of finance for repair and maintenance. Therefore, the contractor shall use vehicle transport instead of uncertain railway service.

7. Project Implementation Plan

(1) Executing Agency

The ANE has been delegated by the Ministry of Public Works and Housing to manage the national road network. The project implementation responsibility will be located under the DEPRO of ANE. There is also GAJUTORA dealing with environmental and social issues that also serves this directorate though reporting directly to the Director General of ANE.

(2) Typical Implementation Conditions

Project implementation plan was proposed based on some constraints affecting the schedule as below:

- ✓ The Feasibility Study Report on this Project shall be submitted by February 2010.

- ✓ GOM/ANE will try to find an expected source of funding for the detailed design (D/D) of this Project as early as possible.

- ✓ After finding of the fund, selection of consultant for D/D will require four to five months procedure and preparation of D/D with tender documents will require minimum five months.

- ✓ Preparation of environmental impact assessment and RAP will require about eight to nine months and will be submitted to AfDB and JICA 120 days prior to the submission of the appraisal report and loan agreement of the Project, respectively.

- ✓ Negotiation with the lending agencies (AfDB and/or other donors) for approval and finalization of loan agreement will require minimum four months

- ✓ Tendering for construction contractor will require minimum nine to ten months procedure including pre-qualification, tender announcement, tender preparation of 90 days limitation and tender evaluation and approval by ANE and lending agencies

- ✓ Selection of supervision consultant and tender assistance will require about five to six months.

- ✓ Physical commencement of contractors' work (usually 30 days from notice to proceed)

- ✓ Construction work and supervision service will require about three years (33 months)

(3) Project Implementation Plan

Based on the abovementioned conditions, proposed implementation plan for this Project can be summarized as shown below and in Fig. 3.7.1.

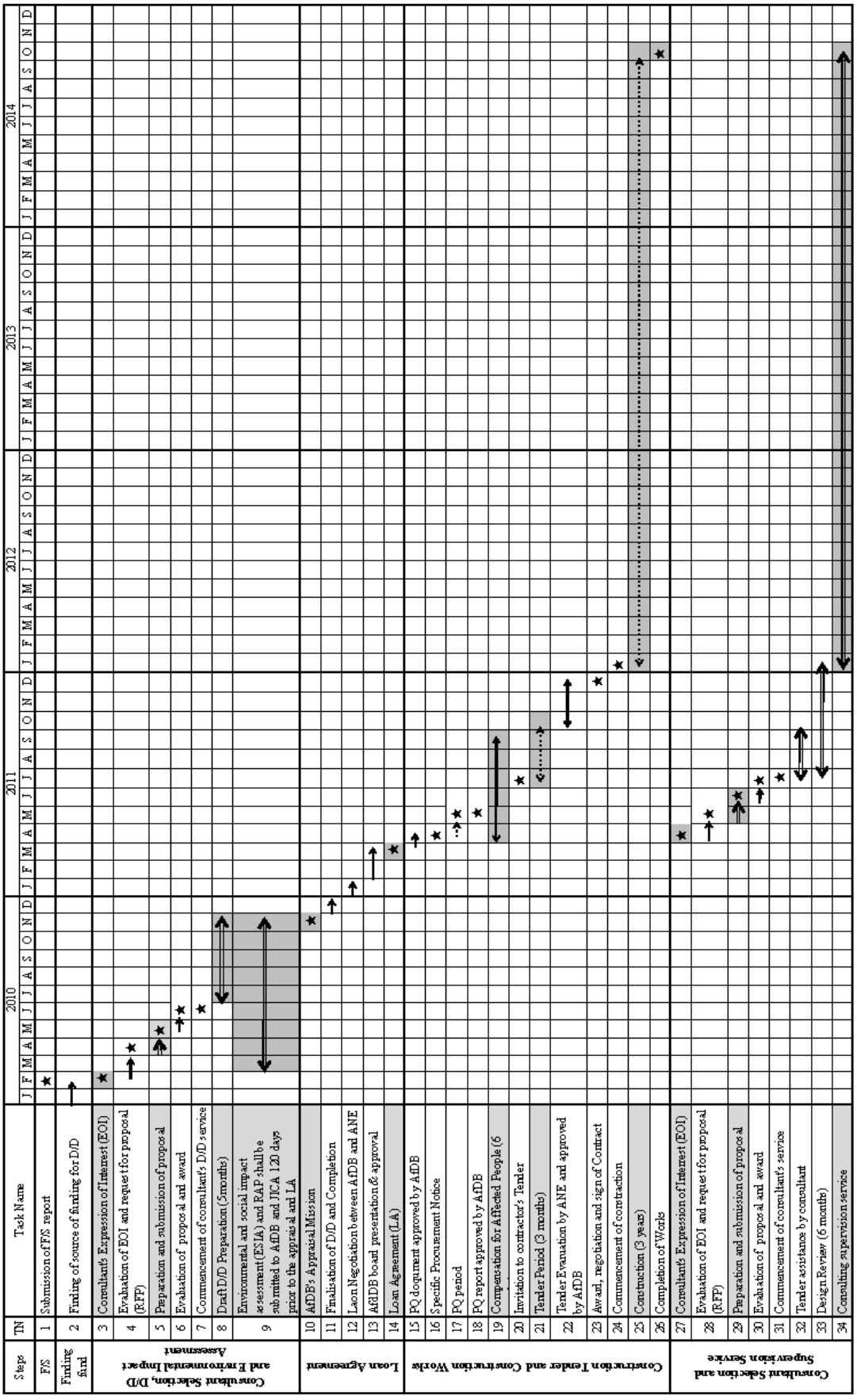


Figure 3.7.1 Proposed Implementation Program for Cuamba-Mandimba Road

8. Project Cost Estimate

(1) Methodology of the Estimate

Basically unit construction cost of "Upgrading of Nampula – Cuamba Road" (hereinafter referred as "NCR") is utilized for the Estimate due to high similarities between the two projects as follows.

- Site location: The Project road is the extension of NCR beyond Cuamba in northern region.
- Time of estimate: Engineering estimate of NCR was finalized at its detailed design stage in April 2009.

(2) Cost of Non-Construction Works

Costs of non-construction works are determined as follows.

1) General Works (Bill-A: No. 1000)

Cost of this item is estimated as percentage of total amount of bill No. 2000 – 8000 on the basis of comparative analysis among similar type of road projects previously implemented in Mozambique.

2) Day Works, Social Issues and Environmental Mitigation

Costs of captioned items are estimated as percentage of total amount of Bill-A (Road works) based on the engineering estimate of NCR.

3) Contingency and Engineering Cost

Contingency and engineering costs are estimated according to engineering estimate of NCR as follows.

- Contingency cost: 10% of total construction & non-construction costs (Bill A – D)
- Engineering cost: 5% of Bill A – D + contingency cost

4) Value Added Tax (VAT)

17% of VAT is regulated in Mozambique. However, the rate will be eased to 6.8% in case of road project according to recent regulation. Therefore, the Estimate applies the eased rate.

(3) Result of the Estimate

The results of the Estimate are summarized in Table 3.8.1 and 3.8.2.

Table 3.8.1 Total Project Cost

Currency: US $

Item	Description			Unit	Rate	Quantity	Amount	Remarks
Bill A: Road works								
1000	General			Ls.	21,773,228.78	1.00	21,773,228.78	28.00% of 2000 to 8000
2000	Drainage	(1)	Prefabricated pipe culvert (RC)	m	1,236.63	2,906.00	3,593,645.33	
		(2)	Concrete lined ditch	m	158.62	12,920.00	2,049,363.94	
		(3)	Concrete kerb	m	33.35		0.00	
		(4)	Stone pitching	sq.m	65.55	5,100.00	334,305.00	
		(5)	Gabion	cu.m	142.00	1,610.00	228,623.22	
			Total (2000)				**6,205,937.49**	
3000	Earthworks & pavement layers of gravel or crushed stone	(1)	Cut & fill	cu.m	6.11	170,436.00	1,040,767.43	
		(2)	Haulage of embankment material from borrow pit (1.0km)	cu.m	0.92	5,895,030.00	5,423,427.60	Distance btw. site & pit = 10km
		(3)	Disposal of surplus material (1.0km)	cu.m	5.75	42,609.00	245,001.75	
		(4.1)	Upper subgrade	cu.m	5.92	350,157.00	2,073,804.83	
		(4.2)	Lower subgrade	cu.m	4.74			
		(5.1)	Cement stabilized gravel sub base course (C2)	cu.m	67.78			
		(5.2)	Cement stabilized gravel sub base course (C3)	cu.m	58.10			
		(5.3)	Cement stabilized gravel sub base course (C4)	cu.m	48.42	313,512.00	15,178,683.48	
		(5.4)	Gravel wearing course	cu.m	36.80			Equivalent with gravel sub base course (CBR>30%)
		(6)	Crushed stone base course	cu.m	88.55	270,191.00	23,925,413.05	Transport distance of aggregate = 40km
			Total (3000)				**47,887,098.15**	
4000	Asphalt pavements & seals	(1)	Prime coat	sq.m	1.53	1,376,110.00	2,104,760.25	
		(2)	Single seal	sq.m	5.52	229,349.00	1,266,006.48	
		(3)	Double seal	sq.m	8.86	1,146,761.00	10,154,568.66	
		(4)	Asphalt concrete (t=10cm)	sq.m	51.75		0.00	
		(5)	Interlocking block pavement	sq.m	25.30		0.00	
			Total (4000)				**13,525,335.38**	
5000	Ancillary roadworks	(1)	Km post	No.	110.76	306.00	33,891.49	
		(2)	Guardrail	m	64.62	905.00	58,479.74	
		(3)	Road sign	sq.m	473.01	171.90	81,309.82	
		(4)	Road marking (W=10cm)	km	1,523.88	458.70	699,002.15	
		(5)	Grassing (embankment slope)	sq.m	2.94	553,363.00	1,629,100.67	
			Total (5000)				**2,501,783.87**	
6000	Structures	(1)	Box culvert	cu.m	646.29	3,349.00	2,164,420.19	
		(2)	Bridge	Ls.	3,886,616.26	1.00	3,886,616.26	
			Total (6000)				**6,051,036.44**	
7000	Testing & quality control			Ls.	17,250.00	1.00	**17,250.00**	
8000	Other works	(1)	Railway level crossing	No.	115,000.00	2.00	230,000.00	
		(2)	One stop border post	Ls.	0.00	1.00	0.00	
		(3)	Demolishing existing concrete	cu.m	42.99	3,836.00	164,898.13	
		(4)	Removal of corrugated pipe	m	6.79	1,243.00	8,433.76	
		(5)	Finishing of road & road reserve (single carriageway)	km	1,725.00	152.90	263,752.50	
		(6)	Treatment of old road & temp. diversion	km	1,380.00	153.80	212,244.00	
		(7)	Transportation of construction material	Ls.	693,761.65	1.00	693,761.65	75km from Cuamba by trailer truck (50t)
			Total (8000)				**1,573,090.04**	
Total (Bill A: Road works)							**99,534,760.15**	
Bill B: Day works				Ls.	855,998.94	1.00	855,998.94	0.86% of Bill A
Bill C: Social issues				Ls.	935,626.75	1.00	935,626.75	0.94% of Bill A
Bill D: Environmental mitigation				Ls.	248,836.90	1.00	248,836.90	0.25% of Bill A
Total (Bill A+B+C+D)							**101,575,222.73**	
Contingencies				Ls.	10,157,522.27	1.00	10,157,522.27	10% of A to D
IVA				Ls.	7,597,826.66	1.00	7,597,826.66	6.8% of (A to D) & Contingencies
Total construction cost							**119,330,571.66**	
Engineering cost				Ls.	5,586,637.25	1.00	5,586,637.25	5% of (A to D) & Contingencies
IVA				Ls.	379,891.33	1.00	379,891.33	6.8% of Engineering cost
Total project cost							**125,297,100.25**	
Compensation for land acquisition & resettlement							156,103.00	

(USD 820,492 per km)

Table 3.8.2 Bridge Construction Cost

Currency: US $

No.	River name	Description	Area (sq.m)	Amount	Cost per sq.m	Remarks
1	Muambessi	L=17.00m, W=10.15m, Pile foundation	172.55	868,972.00	5,036.06	
2	Lussangassi	L=2@17.00m=34.00m, W=10.15m, Pile foundation	345.10	945,484.89	2,739.74	
3	Ngolua	L=17.00m, W=10.15m, Pile foundation	172.55	680,084.17	3,941.37	
4	Ngame II	L=2@17.00m=34.00m, W=10.15m, Pile foundation	345.10	1,392,075.20	4,033.83	
		Total	**1,035.30**	**3,886,616.26**	**3,754.10**	

9. Road Maintenance Systems

(1) Existing Road Maintenance System

1) Road Maintenance

ANE's ten provincial delegations are responsible for the implementation of all maintenance works on classified roads. The Directorate of Maintenance has a crucial role in ensuring that the delegations in provinces are fully aware of and complying with the technical and operational guidelines for implementation of the annual maintenance plan; and that roads of all types (Primary, Secondary, Tertiary, vicinal, paved, unpaved) are being maintained and provided . DIMAN also supports the provinces in the execution of the improvement, rehabilitation and construction of tertiary and vicinal roads. The directorate's role includes providing technical advice to municipal councils and districts on their road programs through the provincial delegations.

2) Road Safety

ANE's responsibilities for road safety (thorough road design standards, physical measures to enhance safety and the placement of signs and road markings) have been entrusted to DIMAN given the important role of the provinces in the process. Activities will be coordinated with the National Road Traffic Institute, INAV. DIMAN is also responsible for overseeing vehicle overloading control measures, the use of the road reserve and the management of road concessions.

(2) Realizing an Effective Road Maintenance System

The detailed information required as 'input data' for the new Integrated Road Management System (IRMS) is being launched and the surveys will be implemented beginning at the end of 2009. This project is being funded by SIDA under the Support for the Decentralized Management of Regional Roads. Road condition surveys and traffic counts also includes in this project.

By appropriate operation of this system, following issues will be solved.

- Development of core road network for prioritizing maintenance
- Development of operability and systematic maintenance
- Selection of cost-effective maintenance solution
- Preparation of appropriate routine and periodic maintenance program
- Technical design of maintenance works

Part IV Economic Feasibility Study

1. Existing Traffic Flow Patterns

Through the information researched by previous traffic volume data in ANE, interview to stakeholders and traffic volume and origin-destination (OD) survey, study team recognized the characteristics of traffic flow patterns for each section of Cuamba – Mandimba and Mandimba - Lichinga, which tend to be different types. Traffic volume and roadside OD survey were conducted for 1st period in May and 2nd period in August, 2009 at 3 locations in Cuamba, Mandimba and Lichinga on the study road. The characteristics are summarized in table below.

Table 4.1.1 Characteristics of Trip Pattern for Each Section

Category	Lichinga - Mandimba	Mandimba - Cuamba
Characteristics in General	・ This section is the only route for delivering consumer goods to Lichinga which is the provincial capital of Niassa, where is the base for distributing to northern part. This section can be said the lifeline for northern area. ・ Majority of social and official movement is the OD-pair between Lichinga and Cuamba. ・ Some agro-products are generated from northern side to southern side of Mozambique and Malawi through Mandimba.	・ This section is used for passenger movement from Lichinga and other district in Niassa to connect railway or Nampula province. ・ Some consumer goods are dispatched from Cuamba to Lichinga. On the other hand, most consumer goods for Cuamba city are come from Nampula side mainly by railway. ・ Some trailers with empty container are found which delivers to Nacala port from Malawi. ・ Some agro-products generated around Cuamba to transport to Malawi or Tete province.
Vehicle Type	・ More than half of vehicles are trucks including medium and trailer. ・ Minibus is major for passenger movement.	・ More than half of vehicles are trucks with mainly trailer and large truck. ・ Minibus is major for passenger movement.
Average Trip Length (time) without internal zone trip	・ **16.8** hours (All Vehicles) ・ 11.5 hours (Passenger Car + Bus) ・ 25.2 hours (Trucks) ・ 2.86 days (Trailer)	・ **19.3** hours (All Vehicles) ・ 11.4 hours (Passenger Car + Bus) ・ 28.5 hours (Trucks) ・ 1.99 days (Trailer)

In order to grasp the trend of international transport movement on Nacala development corridor, traffic volume count and OD survey were conducted at 3 border posts between Mozambique and Malawi which are named Zobue/Mwanza, Milange/Muloza and Mandimba/Chiponde, and at one border between Malawi and Zambia named Mchinji. In addition, the study team conducted interview survey for governmental organizations/ private companies both in Mozambique and Malawi.

2. Concepts for Traffic Demand Forecasting Method

(1) Socio-Economic Framework

The socio-economic framework for traffic demand forecast was applied based on the development strategy in Niassa (PEP) described in table below.

Table 4.2.1 Summary for Macro-Economics Assumption

Item	Assumptions	Annual increase rate (2050/2007)
Population	Future population up to 2050 has been estimated in each district based on PEP's estimation, and applied logistic curve by study team	About 2.5 – 2.8% (2.2times)
GDP	Future provincial GDP up to 2050 has been estimated based on PEP's estimation, applied logistic curve	Conservative: 8% (3.0times) Moderate: 10% (4.3times) Optimistic: 12% (7.0times)
Agro-products	Future agro-products up to 2050 has been estimated based on PEP's estimation, applied logistic curve and some conditions/ assumptions	About 4.5% (2.6times)
Forest	Future forest products up to 2050 has been estimated based on PEP's estimation, applied logistic curve and some conditions/ assumptions	Annual production after 2035 Pulp: 1.7 mil. m^3 Log: 0.6 mil. m^3 Chacol: 0.4 mil. m^3
Tourism	Future tourists up to 2050 has been estimated based on PEP's estimation, applied logistic curve and some conditions/ assumptions	Annual visitor after 2030, One-day: 40,000 visitors Stay: 60,000 visitors

(2) General Concepts for Development of Traffic Demand Forecast

In order to apply suitable forecasting method, the study team examines previous studies which are a) Lichinga – Montepuez (2001), b) Milange – Mucuba (2008) and c) Nampula – Cuamba (2007). Also, study team took into consideration of the issues which AfDB pointed for the preliminary appraisal mission of Nampula – Cumaba road improvement project. Based on the characteristics of traffic flow pattern, study team has set the general concepts for traffic demand forecasting method described below.

- Forecasting model shall be able to explain the potential/ hidden demands caused by rainy season and bad surface conditions.
  - Passenger traffic: model includes difficulties of moving in rainy and dry seasons.
  - Freight transport: model includes the demands of consumption and supplement in market by each item.
- Route choice shall be considered by each item's origin/ destination
- International freight transport from Malawi shall be considered as diverted traffic.
- Railway transportation shall be treated as below;
  - Nacala - Nampula – Entre Lagos – Malawi Line: Capacity of railway transpiration has been already matured because of poor rail condition and limited number of locomotive as described in 1.6. In this estimation, railway improvement will not be considered, and capacity of traffic will be stable as it is.
  - Cuamba – Lichinga line: As described in 1.6, Northern line is not operated properly, in only once per month for wagons. And CDN which is operation firm under concession has difficulties of rehabilitation of railway condition under their concession agreement. Therefore, this line will be the same status of current condition.
- Port facility shall be considered as same condition and capacity as it is.
- Border facility at Mandimba will be thought both current status and improved status such as one-stop-border post.

Note that in the middle of October 2009, there was an announcement for new railway construction plan between Motatize to Blantyre for coal transporting to Nacala port. It was said that feasibility study would be started soon. At this moment, there is nothing concreted information for this project. However, there must be much rehabilitation thorough the SEAR and CDN for allying coal transportation. Therefore, in this study, it is not considered to be applied to this estimation.

(3) Estimation Periods and Scenarios

The following years are defined as the analysis periods, and forecasting scenarios are formulated as below.

- Horizon year: 2009
- Construction periods: 2011-2013
- Base year: 2014
- Analysis periods: 2014 – 2034 (20 years)

Table 4.2.2 Scenarios for Traffic Demand Forecasting

Scenario Case	Road Network			Border	Railway Network			Port
	Lichinga ~ Mandimba	Mandimba ~ Cuamba	Nampula ~ Cuamba	OSBP	Nacala~ Entre Lagos	Cuamba ~ Lichinga	Malawi Domest.	Nacala
Without Case	As it is	As it is	As it is	As it is	As it is	As it is	As it is	As it is
With Case (Scenario -1)	As it is	Improved	Improved	As it is	As it is	As it is	As it is	As it is
With Case (Scenario -2A)	Improved	Improved	Improved	As it is	As it is	As it is	As it is	As it is
With Case (Scenario –2B)	Improved	Improved	Improved	Improved	As it is	As it is	As it is	As it is

Note that all of “with case” take this section to be improved because Nampula – Cuamba (N13) section has already been started implementation of construction.

3. Methodology of Traffic Demand Forecast

According to the concepts described above, future traffic volume had been estimated by three different type of traffic, such as i) passenger, ii) regional goods and iii) international goods. The each component of traffic estimation is described below;

Passenger traffic volume is estimated by “Gravity Model” with the variable index of potential population and road section impedance, developed by the actual number of passenger for each O-D trips.

Regional traffic volume is considered by divided traffic as attraction and generation for each zone. Trip attraction is estimated by the consumption of daily goods, and trip generation is based on the agro-products from the Niassa province.

International traffic volume is thought to be generated after the road network is improved. It is estimated by the Malawi trade and railway capacity, and applied the corridor choice model, named lodgit model.

The diagram below shows the process for traffic demand forecast. Details for each process and results are described in the main report.

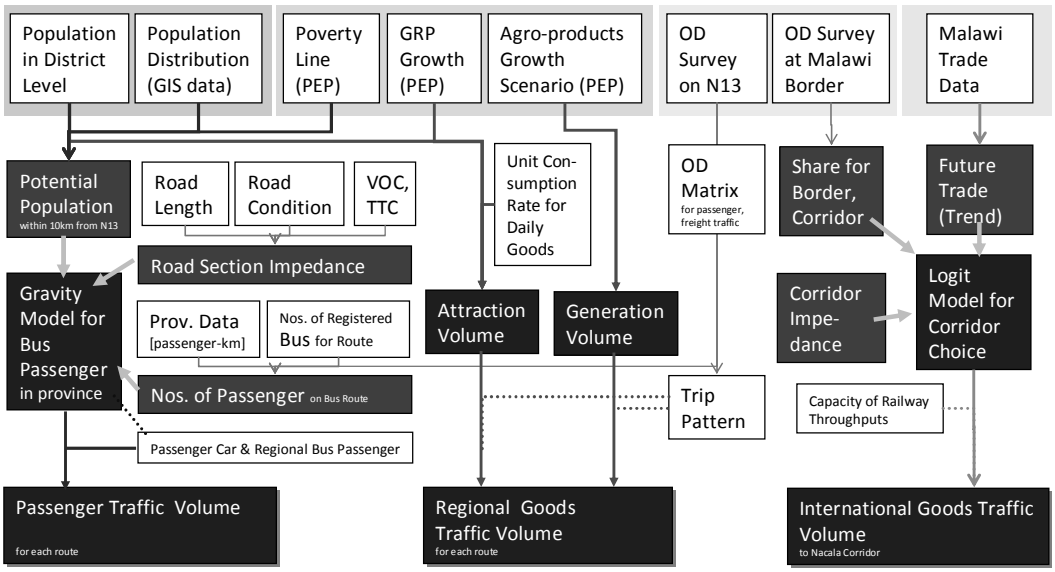


Figure 4.3.1 Process of Traffic Demand Forecast

4. Results of Traffic Demand Forecast

Accumulating with the results of each component, future traffic volume for both sections will be summarized. For the section of Cuamba – Mandimba, future traffic volume in AADT is estimated about 457AADT in 2014, 1,481AADT in 2023 and 5,027AADT in 2033 in with case.

Table 4.4.1 Future Traffic Volume in Cuamba - Mandimba

year	2009	2014	*With case*	2023	*With case*	2033	*With case*
Passenger Car	35	77	*96*	193	*239*	519	*643*
Minibus	26	117	*145*	641	*795*	2,587	*3,207*
Trailer	23	118	*164*	213	*272*	343	*425*
Others	17	42	*52*	143	*176*	612	*753*
Total	101	355	*457*	1,190	*1,481*	4,061	*5,027*

The comparison of sections is indicated in figure below. The section of Cuamba - Mandimba is characterized by numbers of trailers will be diverted from Beira corridor and railway. It is evidenced that this section will be composed of a part of international corridor.

Compared with the previous feasibility study between Nampula and Cuamba, this estimated traffic volume is almost same level of volume for previous section. The table below shows the both results on same time series.

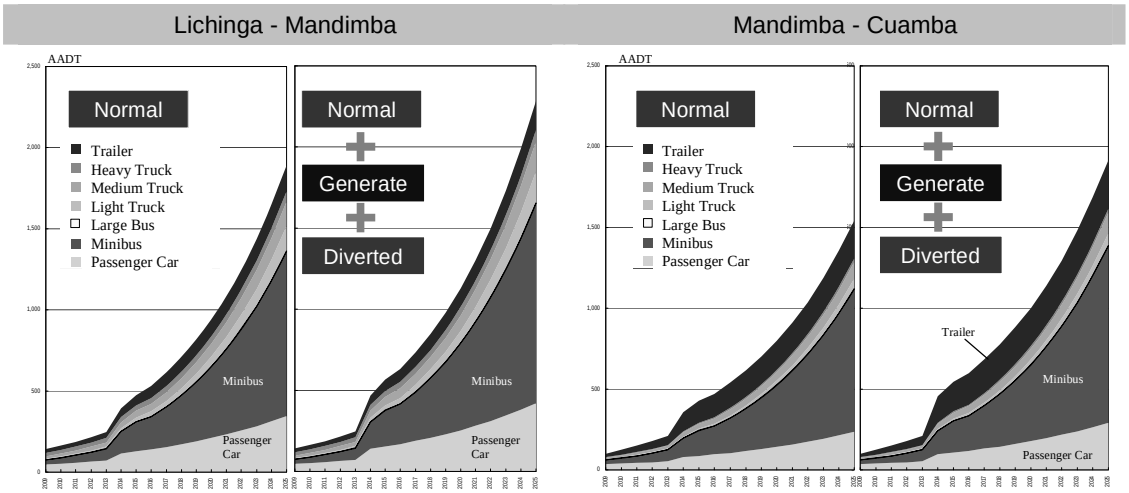


Figure 4.4.1 Estimated Traffic Volume for Each Section

5. Economic Analysis

Economic analysis is conducted for the alternative cases and scenarios proposed in Table 4.2.2.

Assumptions for analysis are as follows:

Analysis Tool : HDM-4 (RED, Comprehensive for reference)

Project life : 20 years after the opening of the project road (2014)

Pricing date : as of October 2009

Social discount rate: 12%

Conversion Factor : Construction work (0.84), Maintenance work (0.75)

Exchange rate : US$1.00 = 28.00 Meticais (MT)

Major HDM-4 input includes natural condition in the project area, existing road condition, improvement plan of the project road, vehicle characteristics, traffic demand forecast and project cost, etc.

Results of Analysis are tabulated as follows:

Table 4.5.1 Sensitivity Analysis

Case	Assumptions	EIRR
Base	Upgrade to paved road with DBST with Lichinga-Mandinba intervention	19.5%
1	Decrease in traffic volume of -20%	16.6%
2	Increase in investment costs of +20%	16.9%
3	Both combined of above as the worst case	14.3%

Table 4.5.2 Elasticity of Oil Price change to Construction Cost

Price	Increase	Decrease
Oil Price	50%	50%
Construction Cost	105%	95%

Table 4.5.3 Switching Value

	Base Case	Case that yields NPV=0		
NPV @12% (Mil. US$)	Value	Value	Factor	Change
Cost	80.4	146.0	1.80	81.6%
Benefit	146.0	80.4	0.45	-44.9%

The project scores an average level as an upgrade-to-paved intervention and its economic viability is acceptable, with an EIRR of over 12% of the opportunity cost among alternatives. Based on this result, the project is evaluated as one of the prioritized projects to be implemented in the nation. The particular importance of this primary road and of bringing it to all-weather transit-able condition is well established. The Study Team concludes that the road upgrading project is economically feasible in terms of national economy of Mozambique.

Part V Cross Border Facilities

1. Baseline Study and Fact Findings for Upgrading Border Facilities

(1) Mozambique-Malawi Borders and Facilities

There are main 6 borders between Malawi and Mozambique. The study team visited 5 borders including 4 borders with Mozambique (Chiponde, Mwanza, Muloza, Dedza) and 1 border with Zambia (Mchinji) where is the part of Nacala Development Corridor. Current conditions of each border are summarized as follows:

Name in Malawi		Chiponde	Mwanza	Mchinji	Muloza	Dedza
Name in Mozambique		Mandimba	Zobue	(Zambia)	Mulange	Calomue
Location		60km from Mangochi	70km form Blantyre	90km from Lilongwe	80km form Blantyre	85km from Lilongwe
Facility scale		Small	Large	Small	Small	Small
Distance between borders		1km	3km	200m	300m	150m
Opening hour		6-18	6-21	24hours (6-18 Truck)	6-18	6-18
Toll Fee Collected by		Custom	RFA	RFA	Custom	RFA
Weighbridge		No	Yes	Yes	Yes	No
Inspection equipment		No	No	No	No	No
Parking		No	Yes (150)	No	No	No
Monthly traffic volume		1000	9000	3000	2000	3000
Nos. of Agent		6	Over 20	8	4	-
Nos. of Insurance		-	3	2	1	-
Nos. of staff	Custom	-	49	11	9	13
	Immigration	6	18	14	6	-
Accommodation	Custom	Yes	Yes	Yes	Yes	Yes
	Immigration	Yes	Yes	Yes	Yes	Yes
Average border pass time		30min	2 hours	1.0 hours	30min	1.5 hours
Main traffic type		Small cargo	Large cargo Passengers	Passengers	Medium cargo	Large cargo

(2) Mandimba Border Control and Facility

Mandimba border facilities comprise one office building, which is designated for customs services and immigration services, two lodges for customs officers, vacant natural terrain utilized as temporal parking space and border security's watch house. Findings from baseline study on land covers and existing border facilities summarizes as follows:

- Relatively sound building structure both the office and the lodges
- No surplus working space, unaffordable for increase of staff in the office
- Undeveloped and no designated parking space for commercial and/or passenger vehicles
- Sufficient land area for renovation of the facilities

Chiponde border facilities comprise one office building, which is designated for customs services and immigration services and built by EU assistance in 2005, seven lodges for customs and immigration officers, customs agency office, vacant natural terrain former school ground utilized as temporal parking space and small retail shops.

- Very sound building structure both the office and the lodges
- Surplus working space, affordable for increase of staff in the office
- Undeveloped and no designated parking space for commercial and/or passenger vehicles

- Inadequate approach and inconvenient flow for commercial vehicles
- Sufficient land area for renovation of the facilities

Cross border traffic is summarized as follows based on facts found from the baseline study:

- Currently small volume observed of Cargo, Vehicles and People crossing the border which is within the limits of the current border capacity.
- Release time of customs clearance and passport control are tolerable against current traffic volume.
- Formal trading and petit informal trading are observed and informal trading is predominant.
- Exportation (Mozambique to Malawi) is predominant and increasing.
- Import of goods with the value less than 500 US is predominant to goods over 500US, which are subjects to be transferred to the inland truck terminal an the provincial customs office for levy.
- Domestic transit of cargo is remarkable movement amongst the cross border formal trading and predominant to international transit.
- No critical congestions are observed for current cross border traffic.
- Customs procedures are to be upgraded with the ICT system of customs clearance which is under processing for governmental approval to introduce.

(3) Strategy for Upgrading Border Control and Facility

Facts found from the baseline study regarding the background of OSBP introduction are to be summarized as follows:

- Region's strategic framework for upgrading the border posts has been established.
- Mandimba- Chiponde border is a point of the strategic importance for the corridor development.
- Under the SADC regional strategy, trade facilitation programs and infrastructure projects which represent RISDP, RTFP and RTRN, have been widely prompted and OSBP introduction ranks one of the effective measures for trade facilitation as well as streamlined customs procedures and systems.
- Both Mozambique and Malawi have a common intention that Mandimba-Chiponde OSBP ranks a pilot project to disseminate to Zobue, Chipata and other borders.
- In accordance with above regional strategy and bilateral intention, bilateral discussion has been held for introduction of OSBP since late 2008 and the bilateral agreement is about to be signed.
- Experiences and lessons learnt from the OSBP projects underway in Mozambique are to be fully taken advantage and fed back to the operation of the technical committee as well as working groups which must be organized for further examination and discussion of OSBP introduction.

2. Needs Assessment and Approach for Up-grading Border Facilities

Based on facts above mentioned, despite no urgency confirmed by the current traffic volume and pattern, OSBP introduction will be justifiable and viable for upgrading Mandimba-Chiponde border post in terms of attaining and

maintaining competitiveness of the Nacala Road Corridor as well as moving the trade facilitation ahead, which is a multinational commitment for economic development and regional integration in Southern Africa.

Cross border security, safety and hygiene will be subsequently expected to be enhanced as well through upgrading of the customs procedures which shall be incorporated into OSBP environment. Furthermore, it will be another significant benefit that dissemination of OSBP environment to other critical borders of higher traffic demands will gain momentum and provide a stimulus to the elimination of Non-Tariff Barriers between two countries when Mandimba-Chiponde OSBP is expected to become an ideal pilot.

Based on the fact findings and needs assessment, it is a proposed approach for an ideal OSBP at Mandimba-Chiponde that;

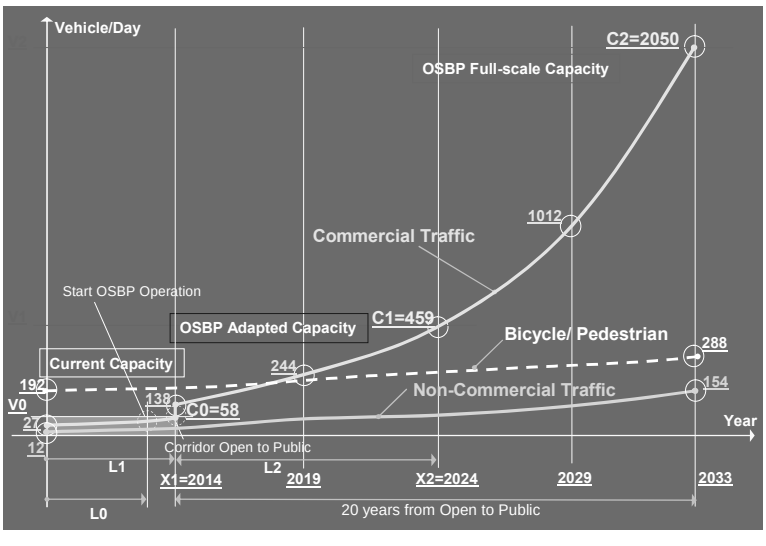
- Phased introduction for OSBP shall be employed,
- Existing facility shall be practically adapted and utilized under the environment of OSBP operation,
- Phased introduction shall be examined in line with i) Magnitude of future demands of cross border traffic and Year forecasted, ii) time schedule of the bilateral discussion and the agreement, iii) time schedule to introduce OSBP environment to other borders.

3. Implementation Policy for Up-grading Mandimba Border Facilities

(1) Scenario and Model Selection for Phased Introduction of OSBP

"2 steps up-grade concept" is selected based on traffic demand forecast estimated by the Study team and scenarios are summarized as follows:

1st Step of Facility Up-grading



Targeting Year 2014, OSBP environment will be phasedly or partially introduced with giving the current facility a capacity of "C1" 459 [vehicle/day] of commercial traffic processing. On this stage, certain renovation or remodeling of the existing facility shall be required in order for adaption and utilization under the environment of OSBP operation. This OSBP adapted facility will operate during next 10 years until Year 2024.

2nd Step Facility Up-grading

Targeting Year 2024, above OSBP adapted facility will be expanded to its full-scale capacity which shall satisfy "C1" 2,050 [vehicle/day] of commercial traffic processing. This OSBP full scale facility will operate during next 10 years or

more until Year 2033.

"Juxtaposed facility" model will be technically more explicable and justifiable than the other. Remarkable advantages are that existing utility and facility will be fully utilized in terms of infrastructure, and that fitness and flexibility against traffic patter and demand growth is quite superior. Project period and costs might also be shorter and smaller.

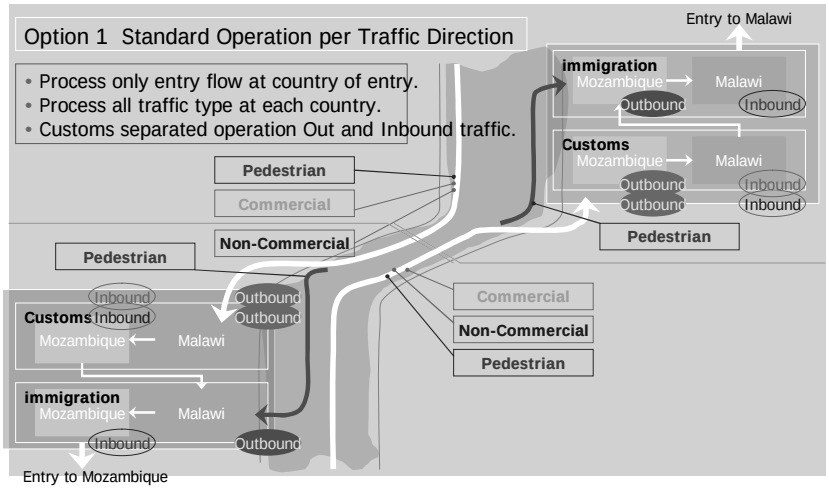
(2) Facility Planning for Phased Introduction of OSBP

Facility planning is detailed in conformity with resource deployment and space allocation which are tentatively proposed by the study team based on provisional border control procedures and performance benchmarks such as Target Time Release, Total Processing Time, Unit Workforce.

Following 2 type of operational options for OSBP scheme are proposed and preliminary layout and facility size are proposed for 2 target year according to "2 steps up-grade concept" such as Year 2014 as the 1st step Year 2024 as the 2nd step introduction

Option 1: Split Operation per Traffic Direction

This operational scheme is an option which shall comply with traffic direction, and very standard for OSBP operation. Characteristics of the scheme are summarized as follows:



- Only entry flow at the country of entry to be processed for border crossing procedures.
- All traffic type shall be subject to process at two different buildings at each country, such as commercial traffic and non-commercial traffic.
- Customs and immigration shall be in separate operation for Out-bound (exit) traffic and In-bound (entry) traffic.
- Customs and immigration of two countries shall jointly reside at two different facilities and shall process only one flow.

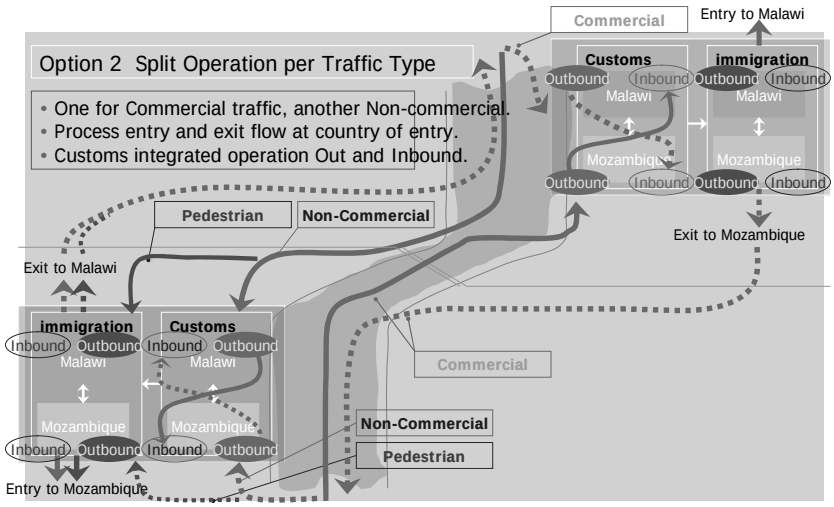
Year 2024 (2nd step introduction) necessary effective space of facility

Facility	Mandimba Border [m2]		Chiponde Border [m2]	
	Mozambique	Malawi	Mozambique	Malawi
Customs Office	1,360	1,400	65	75
Immigration Office	460	550	60	75
Sub-total -building		3,770		275
Total building				4,045
Parking area		5,650		600
Total parking				6,250

Option2: Sprit Operation per Traffic Type

This operational scheme is another option which shall comply with traffic type.

Characteristics of the scheme are summarized as follows:



- Entry and exit flow at the country of entry to be processed for border crossing procedures.
- Two building to be separated one for processing commercial traffic and another for non-commercial traffic.
- Customs office and immigration of two countries shall reside jointly at each facility and shall process two flow of each type of traffic.
- Customs and Immigration shall be in dual operation for Out-bound (exit) traffic and In-bound (entry) traffic at country of entry.

Year 2024 (2nd step introduction) necessary effective space of facility

Facility	Mandimba Border [m2]				Chiponde Border [m2]			
	Out-bound		In-bound		Out-bound		In-bound	
	Moz	Malw	Moz	Malw	Moz	Malw	Moz	Malw
Customs Office	35	45	1,325	1,365	40	45	40	45
Immigration Office	15	20	415	495	45	55	45	55
Sub-total building		115		3,600		185		185
Total building								4,085
Parking area		600		5,205		360		360
Total parking								6,525

[Mandimba – Lichinga Section]

Part III Preliminary Engineering Design

1. Inventory Survey for the Study Road

(1) General Observations

As shown in Figure 3.1.1, the Study Road, with a total length of approximately 148km, traverses three districts having high agricultural potential, namely Mandimba, Ngauma and Lichinga in Niassa Province.

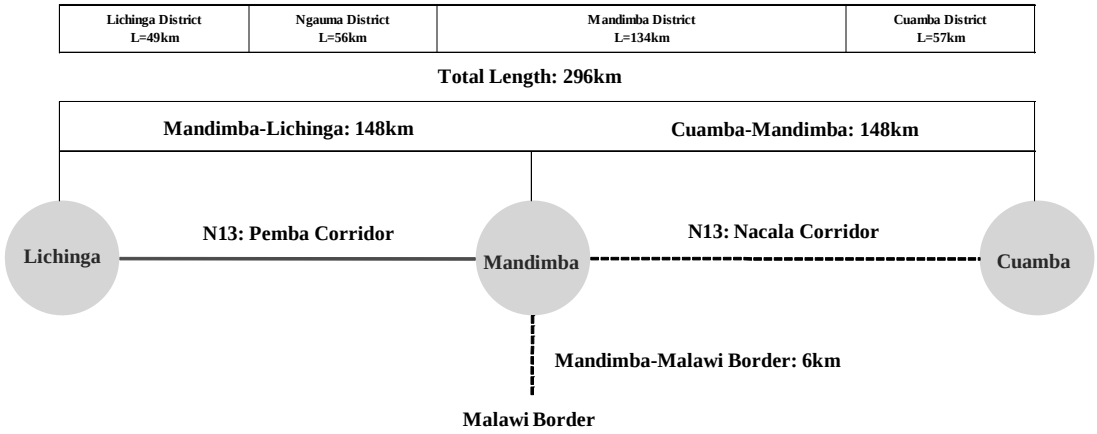


Figure 3.1.1 Outline of the Study Road

(2) Existing Road and Bridge Conditions

1) Existing Road Condition

The Study Road passes through many small villages. The road can be broadly divided into two terrains (0 – 90km: Rolling terrain, 90 – 148km: Rolling with some mountainous terrain), and it undulates from a starting altitude of 760MASL reaching up to nearly 1,400MASL at Lichinga. The existing horizontal alignment and vertical alignment generally follow the watershed crest and the natural ground, respectively. Hence, both horizontal alignment and vertical alignment are sub-standard in some sections. They do not allow adequate visibility. This is because there are no large cuts and fills, and the existing alignment follows the slope of the natural terrain.

The existing road is in fair to poor condition during the dry season and becomes impassable during the rainy season due to interaction between poor drainage and erodible soils.

2) Existing Bridge Condition

The bridge conditions are relatively fair even after being constructed 40-60 years ago. The main reason is that earthquakes and river flooding seldom occur, and the hilly atmosphere is good for steel bridges.

The investigated 10 bridges and one (1) culvert are grouped in three (3) categories as follows.

Category Good [1]: Strong or new bridge that will remain in use

This is structurally strong continuous RC-T bridges [1].

Category Fair [8]: Bridges that will remain in use for the next 20 years approximately

These are simple RC-T bridges [2], Bailey steel bridges [5] and the culvert [1].

Category Poor [2]: Bridges that will be replaced by new structures

These are non-girder bridges such as RC-slab bridges [1] and H-beams [1], in which slab and gird post are damaged.

2. Natural Condition Survey for the Study Road

(1) Topographic Survey

The aim of the topographic survey is to confirm the existing topographic condition for the Study Road with a view to making a road design. Topographic survey is composed of the following three works.

1) Aerial survey, 2) Bridge survey, 3) Benchmark setting

(2) Geological Survey

The aim of the boring survey and SPT is to confirm the boundary between weathered layer and hard basement rock layer and the depth of foundation for the six bridges in the Study area. Two boreholes are performed for each bridge site. The Location of target bridges is as follows;

Ngame I bridge, Lilasse (culvert), Ninde bridge, Luculumesi bridge, Lutembue bridge, Luambala bridge

(3) Soil & Material Survey

1) CBR and DCP Test

The aim of the California Bearing Ration (CBR) and Dynamic Cone Penetration (DCP) test is to confirm the bearing capacity of the in-situ sub-grade material so that the pavement will be able to fulfill the service objective over the design period.

2) Borrow-Pit's Material Survey for Pavement Layer and Fill

Some borrow-pit's material from appropriate spots along the Study Road were sampled by the Study Team for testing of fill and pavement layer materials.

3) Quarry's Material Survey for Pavement Layer and Concrete Work

Some quarry materials were sampled to confirm the possible positions of materials to be used in both pavement and concrete work. And each estimated available volume of the quarry site was also surveyed.

3. Hydrology and Hydrological Analysis

(1) Hydrological Analysis

A statistical analysis was done on the rainfall data at stations Mandimba and Lichinga. Two statistical distribution methods (Iwai Method and Log Pearson III) were applied to the observed rainfall records. The most conservative design rainfall was selected from the two distributions and is shown in Table 3.3.1 below.

Table 3.3.1 Day Design Rainfall at each of the Rainfall Stations

Duration	1 Day Return Period Rainfall (mm)					
	2	5	10	20	50	100
Mandimba	82.2	101.9	113.1	122.9	134.3	142.2
Lichinga	66.8	83.2	93.9	104.1	117.4	127.6

The statistical rainfall at Mandimba is not supplied with a high confidence due to the short records. The calculated design rainfall may prove to be more conservative than necessary. Hence an average of the design rainfall experienced at Lichinga may prove sufficient for the purposes of the Study.

(2) Flood Hydrology

Flood hydrological methods used in this Study include the Rational method and Regional Maximum flood. Not all methods could be applied to calculating the flood peaks at each catchment. The Rational method can be applied to catchments up to 500km^2.

The Regional Maximum Flood (RMF) can only be applied to large catchments and is based on a regional K factor. There has been work done in southern Mozambique where the K factor varies from 5 - 5.6. A sensitivity analysis will be performed to compare the flood peaks.

Table 3.3.2 Limitation of Flood Calculation Method

Method	Maximum Area (km2)
Alternative Rational Method	No limitation (0 to 500: Study Team Recommendation)
Empirical Method (RMF)	No limitation

Source: Drainage Manual 5th Edition (SA National Road Agency)

(3) Flood Level Estimation for Bridges

The software used to model for the flood level calculation is HEC-Ras in which primary input is cross-sectional data, Manning's roughness and the flood peaks. Cross sections were extracted from the topographic survey. A Manning's roughness of 0.035 was assumed.

Table 3.3 shows the results of the flood level calculation by the HEC-Ras, which is based on the calculation for non-uniform flow.

Table 3.3.3 Suggested Flood Level for Return Period of 50-years and 100-years

Bridge	Return Period	Discharge (m3/s)	Calculated Flood Level (m)	Results of Field Survey (m)
Ngame I	50-Year	225.6	731.10	732.9
	100-Year	278.9	731.68	
Lilasse	50 Year	277.3	892.76	893.2
	100 Year	342.7	893.01	
Ninde	50-Year	256.6	902.47	902.9
	100-Year	316.9	902.75	
Luculumesi	50 Year	716.2	992.98	990.0
	100 Year	885.0	993.63	
Lutembue	50-Year	310.9	1045.64	1043.9
	100-Year	384.7	1046.01	
Luambala	50 Year	463.2	1107.61	1105.5
	100 Year	576.5	1108.09	

4. Applicable Design Standards

(1) General

The application of a proper design standard will ensure that the following objectives are achieved:

- Ensure safety, a high standard service level and comfort for road users by the provision of adequate sight distance and roadway space,
- Ensure that the roadway is designed economically
- Ensure uniformity in the design
- Ensure safety of the structures (bridges and culverts).

The Study Team proposed to use the Southern Africa Transport and Communications Commission (SATCC) design standards, as these were commonly used for other projects in the region. The Lichinga- Montepuez Road is also subject to the SATCC design standards.

(2) Applicable Design Standards for Road Design

1) Geometric Design Parameter

The road geometric design is based on the “SATCC Code of Practice for the Geometric Design of Trunk Roads”, September 1998.

2) Typical Cross Sections

The Study Team recommends that the same typical cross section as the Nampula-Nacala road and Nampula-Cuamba road is adopted to ensure consistency in the design standard. In addition, the risk of traffic accidents is likely to increase with increased volume of traffic and higher driving speeds. Therefore, a 2.5m shoulder width (2.0m paved shoulder and 0.5m soft shoulder) is proposed in populated areas, as a large number of pedestrians use the road.

3) Pavement Design

The design of pavement structures is based on the methods given by the "SATCC Practice for the Design of Road Pavements". In addition to the SATCC standard, other design methods such as "Road Notes 31" and "TRH4 of South Africa" are also considered as reference.

4) Road Safety Facilities

The Study Team follows the SATCC manuals of November 1997 for specifying the road signs and road markings. As a general rule, road traffic signs give warning to the drivers, and increase the safety of all road users including pedestrians.

5) Bridges and Culverts

For a long time in Mozambique, Portuguese standards and specifications were widely used for the design of highway bridges and culverts. After SATCC "Code of Practice for the Design of Highway Bridges and Culverts in South Africa" were introduced in 1981, this became the principal design standard and specification although it still remains a provisional status.

Since the SATCC codes are formulated on the basis of British Design Codes, ANE staff still uses the Portuguese codes for checking the design done by SATCC codes. The latest SATCC code (September 1998, reprinted July 2001) should be adopted as the standards and specifications for bridge and culvert design for this Study road. The relevant specifications published by AASHTO, British Standard (BS) and the Portuguese Bridge Code are also used.

5. Preliminary Engineering Design

(1) Introduction

Through discussions with ANE and the results of field surveys by the Study Team, the concept of the Project was confirmed as follows:

- To create an efficient primary road connection securing smooth traffic flow throughout the year corresponding to the future traffic demand
- To create a safe primary road connection by reducing the risk of accidents and the rate of injuries to pedestrians by motorized vehicles

(2) Screening of Conceivable Alternative Routes and Pavement Design

1) Procedure of the Preferable Route and Design

Alternatives for the road alignment and design should be determined and compared in accordance with the concept. The "Do nothing" option is not appropriate to the stated upgrading concept described above. In this Study, the preferable route and design should be selected in accordance with the following procedure.

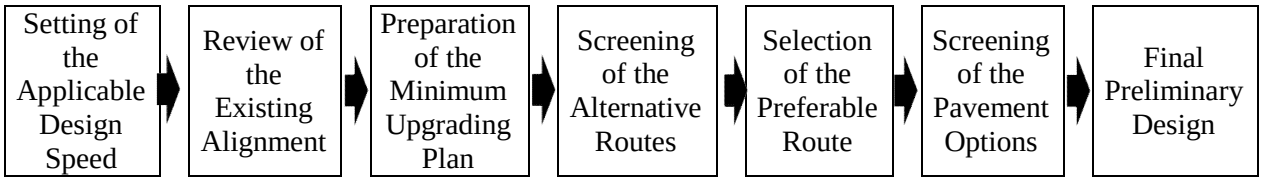


Figure 3.5.1 Procedure of the Preferable Route and Design

2) Recommendable Alignment

The following table shows the improvement magnitude and effect of the recommended alignment. In regard to the section between Mandimba and Lichinga, although the horizontal alignment almost meets criteria for a design speed of 80km/h, the vertical alignment should be improved more than 50% for meeting a design speed of 80km/h as shown in Figure 3.5.2. This means that this section should be improved on large scale.

Table 3.5.1 Improvement Magnitude and Effects (Mandimba-Lichinga)

			Existing	Plan
Length (km)			148.1km	148.6km
Terrain			Rolling and mountainous	Rolling and mountainous
Design Speed			-	80km/h
Geometry	Horizontal Curvature	deg/km	164.1 (1.00)	174.8 (1.07)
	Rise + Fall	m/km	55.8 (1.00)	24.2 (***0.43***)
	No. of Rises + Falls	no./km	3.1	2.8

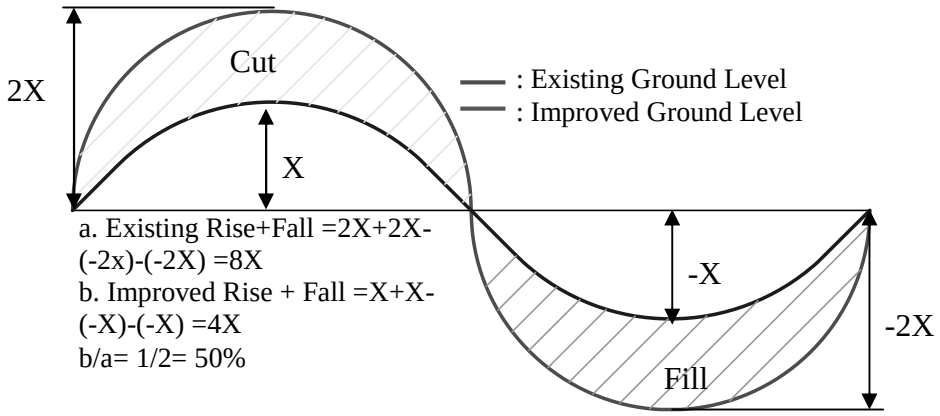


Figure 3.5.2 Improvement Image of the Vertical Alignment

(3) Preliminary Design for the Pavement Options

1) Screening of the Pavement Options

From the experience of past and ongoing projects, it was decided that there are three possible scenarios regarding the upgrading of the Study Road:

Alternative-A: Asphalt Concrete based on the SATCC Standard

Alternative-B: Double Surface Treatment based on the Road Note 31

Alternative-C: Gravel Surfacing requested by the AfDB as reference

Table 3.5.2 Economic Analysis for Selection of the Pavement Type

Pavement Type	Construction Cost		NPV (USD Mil.)	B/C	EIRR
	US$ Mil.	US$/km			
Alt.-1 Asphalt Concrete	224.4	1,516,223	-7.2	0.9	11.6%
Alt.-2 Double Surface Treatment	160.5	1,084,319	69.7	1.6	17.7%
Alt.-3 Gravel Wearing	81.2	552,538	-104.1	-0.8	-

The selection of the suitable pavement type is evaluated based on the initial cost and its financial viability using the EIRR indicator. The result of the cost estimates and the economic analysis, the Alt-2 which constitutes a double surface treatment, is selected as the most economically viable pavement composition.

2) Suitable Pavement Compositions

The proposed pavement type (double surface treatment) was defined to be the most effective and economical. However its pavement composition can be expensive in construction because the necessary care, construction method and also curing of the two cemented layers with thin thickness (125mm) can contribute to a longer construction period and consequently increase in costs.

Thus the pavement composition discussed above should be modified into more economical and effective composition based on the cemented sub-base in granular base. For this purpose, a mechanistic analysis using ELSYM5 was conducted according to the design CBR. The results of the analysis are as shown in Table 5.3. At the moment, there are some ideas and opinions relevant to determine pavement capacity. In this Study, the structural life of pavement was evaluated in two common ways. These approach methods are derived from the RR91/242 and the report written by Mr. H L Theyse, respectively.

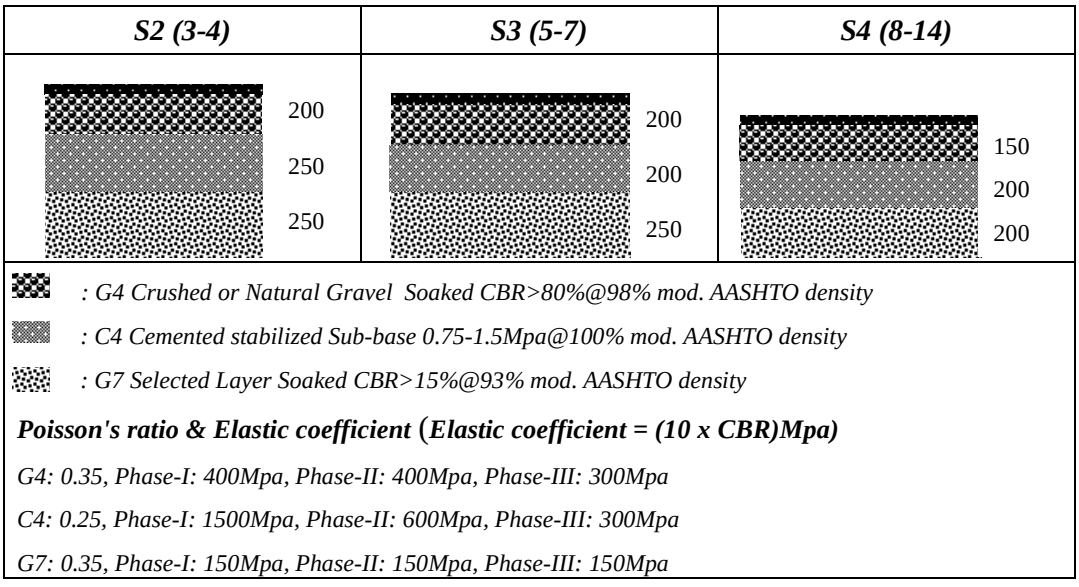


Figure 3.5.3 Recommendable Pavement Compositions based on the Mechanistic Analysis

Table 3.5.3 Summary of the Pavement Capacity

Sub-grade Class	Method	Structural Life	Calculated Design ESA for 15 years
S2 (3-4)	RR91/242	2.22E+07 (wet)	6.8E+06 (Mandimba-Lichinga)
	H L Theyse	1.01E+07 (wet)	
S3 (5-7)	RR91/242	4.12E+07 (wet)	6.8E+06 (Mandimba-Lichinga)
	H L Theyse	1.78E+07 (wet)	
S4 (8-14)	RR91/242	2.64E+07 (wet)	6.8E+06 (Mandimba-Lichinga)
	H L Theyse	1.13E+07 (wet)	

(3) Bridge Design

1) Concept of Improvement Plan

The 4 concepts of improvement plan have been set up for Mandimaba-Lichinga section.

- ✓ If the bridge width is for 2-lanes (assume minimum 6.0 m width) and the bridge condition is good or fair, the existing bridge remains to be used.
- ✓ If the bridge condition is poor, the existing bridge is replaced by new 2-lane bridge (or 2-lane culvert when the existing bridge length<12m).
- ✓ If the river flooding over road surface is reported at the bridge or culvert, the structure is replaced by 2-lane bridge to clear enough HWL and discharge.
- ✓ If the bridge width is for 1-lane and the bridge condition is good or fair, the existing Bailey bridge (1-lane) is replaced by new 2-lane bridge.

2) Preliminary Bridge Design

For the preliminary design of 6 bridges in Mandimba-Lichinga section, some design conditions such as bridge length and bridge position shall be decided by sight investigation of existing bridge and river. By the discussion with ANE, bridge inner width has been set as 9.2m for 2-lane bridge. Those are summarized in Table 3.5.4.

Table 3.5.4 New Bridges to be Designed

General		Existing bridge			New bridge			
No.	name	width	length	existing	lane	width	length	from existing Br.
(Mandimba)								
5	Ngame-I	4.2	28.0	demolish	2-lane	9.2	30	same position
6	Lilasse	4.0	10.0	demolish	2-lane	9.2	17	same position
7	Ninde	4.1	31.0	demolish	2-lane	9.2	34	down stream 8m
8	Luculumesi	4.4	22.0	demolish	2-lane	9.2	34	down stream 8m
9	Lutembue	4.1	34.0	demolish	2-lane	9.2	34	down stream 8m
10	Luambala	4.2	22.0	demolish	2-lane	9.2	30	up stream 8m
(Lichinga)								

6. Construction Planning

(1) Construction Material

1) Material from Natural Source

Generally construction materials such as soil, aggregate and sand are available along and/or suburbs of the Project Road. The Team conducted material survey and laboratory test to confirm qualities and potential quantities of the materials. Detailed analysis of the survey is discussed to meet demand of the design result of the Project in Chapter 2 “Natural Condition Survey”.

2) Material from Industrial Source

Local suppliers around the Project are not able to supply large amounts of construction materials (e.g. cement, re-bar, bitumen) due to their limited business scale. The contractor has to secure reliable and sustainable source such as Maputo, Beira, Nampula, Nacala and/or overseas at the construction stage. Potential sources of major materials are as follows.

- Cement : Nacala
- Re-bar : Beira, Maputo and/or overseas
- Bitumen : Beira, Maputo and/or overseas

(2) Construction Equipment

The local market of the leasing business is still too immature to provide construction equipments with sufficient types, numbers and performance to meet demands of the contractor. Therefore, the contractor has to outsource the equipments from Maputo, Beira, Nampula, Nacala and/or overseas unless bringing his own equipments.

(3) Transportation Method of Material and Equipment

Currently railway service is operational from Nacala to Lichinga by Corredor de Desenvolvimento do Norte (CDN). However, only the line between Nacala and Entre-Lagos (aka border with Malawi) has a regular service (six round trips per week). Moreover cargo service of this line is unable to fully meet requirements of the users due to shortages of locomotives and wagons according to interview and study with relevant persons/organizations. Therefore, the contractor shall use the railway service between Nacala and Cuamba for transportation of material and equipment while adjusting with other users.

Currently the line between Cuamba and Lichinga has no regular service because of frequent damage of structures (e.g. track, sleeper and roadbed) due to shortage of finance for repair and maintenance. Therefore, the contractor shall use vehicle transport instead of uncertain railway service.

7. Project Implementation Plan

(1) Executing Agency

The ANE has been delegated by the Ministry of Public Works and Housing to manage the national road network. The Project implementation responsibility will be located under the DEPRO of ANE. There is also GAJUTORA dealing

with Environmental and Social Issues that also serves this directorate though reporting directly to the Director General of ANE.

(2) Typical Implementation Conditions

Project implementation plan was proposed based on some constraints affecting the schedule as below:

- The Feasibility Study Report on this Project shall be submitted by February 2010.
- GOM/ANE will try to find an expected source of funding both for the civil work and the detailed design (D/D) of this Project.
- After finding of the fund, selection of consultant for D/D will require four months procedure and preparation of D/D and tender documents will require minimum six months.
- Preparation of Environmental Impact Assessment and RAP will require about eight to nine months and will be submitted to a donor 120 days prior to the submission of the appraisal report and loan agreement of the Project.
- Negotiation with the donor agencies' approval and finalization of Loan Agreement will require a minimum three to four months
- Tendering for construction contractor will require total ten to eleven months procedure including pre-qualification, tender announcement, tender preparation of 90 days limitation and tender evaluation and approval by ANE and donor agencies
- Selection of supervision consultant and tender assistance will require about five to seven months.
- Physical commencement of contractors' work (usually 30 days from notice to proceed)
- Construction work and supervision service will require about three years (33 months)

(3) Project Implementation Plan

Based on the above-mentioned conditions, proposed implementation plan for this Project could be summarized as shown below and in Fig. 3.7.1.

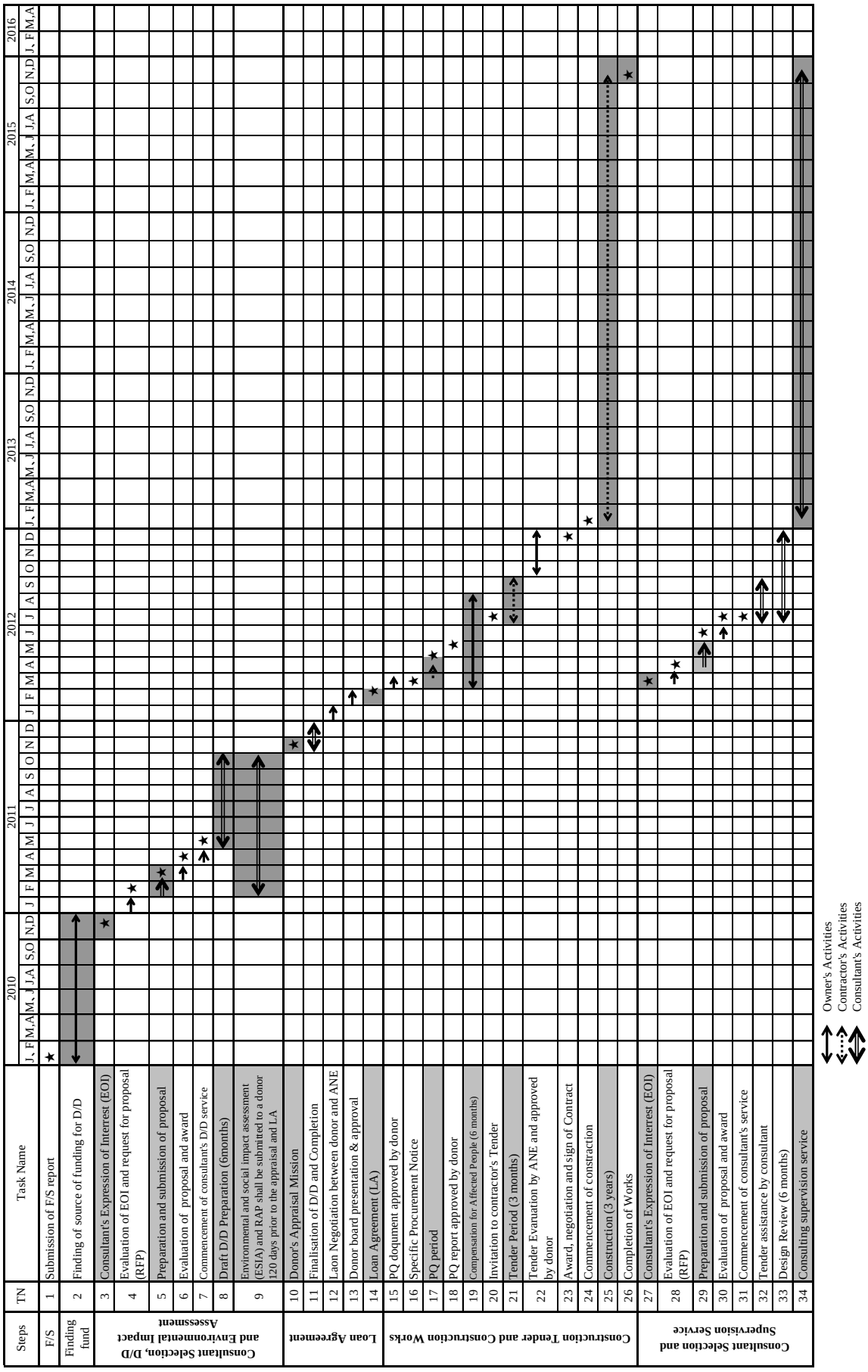


Figure 3.7.1 Proposed Implementation Program for Mandimba-Lichinga Road

(4) Another Possibility for the Project Implementation Plan

The ultimate objective of the NEPAD Project is to support economic growth in the Southern Africa Development Community (SADC) region and foster regional integration through reliable, efficient and seamless transport infrastructure to improve the competitiveness of the region. That means NEPAD Project has to contribute to enhancing regional economic integration as a multinational project.

However, the function of the Lichinga-Mandimba Road is not international trunk road which links other countries but rather essential road for regional development of Niassa Province. Without a doubt transport linkage by paved road between Mandimba and Lichinga will contribute to poverty reduction through upgrading of accessibility to market and improvement of transport services.

For the reasons mentioned above, the possibility to apply this Project as NEPAD Project will not be high. In that case, the GOM/ANE should consider a phased improvement in line with the existing road conditions and regional development program. The Study Team recommends following priorities from the aspect of both road conditions and regional development.

Table 3.7.1 Priority for the Phased Improvement

The ultimate objective: **Provision of reliable road transport**	
From Ex. Road Conditions	From Regional Development Program
1. Upgrading of impassable sections during the rainy season ✓ Improvement of the inundation sections	**1. Basic Human Needs** ✓ Upgrading of accessibility to appropriate social services such as major hospitals
2. Improvement of the dangerous paths ✓ Improvement of the bypass and climbing lane	**2. Agriculture Promotion** ✓ Upgrading of accessibility to the markets
3. Improvement of the black spots ✓ Road improvement in populated area	**3. Industrial Development** ✓ Provision of a reliable road freight service for the forestry investment ✓ Provision of a reliable road to tourists
4. Linkage by paved road ✓ Construction of an all weather road	

8. Project Cost Estimate

(1) Methodology of the Estimate

Basically unit construction cost of "Upgrading of Nampula – Cuamba Road" (hereinafter referred as "NCR") is utilized for the Estimate due to high similarities between the two projects as follows.

- Site location: The Project road is the extension of NCR beyond

Cuamba in northern region.

- Time of estimate: Engineering estimate of NCR was finalized at its detailed design stage in April 2009.

However, the following matters are considered and modified to customize for the Estimate.

(2) Cost of Non-Construction Works

Costs of non-construction works are determined as follows.

1) General Works (Bill-A: No. 1000)

Cost of this item is estimated as percentage of total amount of bill No. 2000 – 8000 on the basis of comparative analysis among similar type of road projects previously implemented in Mozambique.

2) Day Works, Social Issues and Environmental Mitigation

Costs of captioned items are estimated as percentage of total amount of Bill-A (Road works) based on the engineering estimate of NCR.

3) Contingency and Engineering Cost

Contingency and engineering costs are estimated according to engineering estimate of NCR as follows.

- Contingency cost: 10% of total construction & non-construction costs (Bill A – D)
- Engineering cost: 5% of Bill A – D + contingency cost

4) Value Added Tax (VAT)

17% of VAT is regulated in Mozambique. However, the rate will be eased to 6.8% in case of road project according to recent regulation. Therefore, the Estimate applies the eased rate.

(3) Result of the Estimate

The results of the Estimate are summarized in Table 8.1 and 8.2.

Table 3.8.1 Total Project Cost

Currency: US $

Item	Description			Unit	Rate	Quantity	Amount	Remarks
Bill A: Road works								
1000	General			Ls.	28,083,345.82	1.00	28,083,345.82	27.00% of 2000 to 8000
2000	Drainage	(1)	Prefabricated pipe culvert (RC)	m	1,236.63	2,276.00	2,814,568.74	
		(2.1)	Concrete lined ditch (type 1)	m	158.62	32,812.00	5,204,623.03	
		(2.2)	Concrete lined ditch (type 2)	m	78.04	1,370.00	106,915.89	
		(2.3)	Concrete lined ditch (type 3)	m	396.55	3,465.00	1,374,041.42	
		(3)	Concrete kerb	m	33.35	2,740.00	91,379.00	
		(4)	Stone pitching	sq.m	65.55	2,325.00	152,403.75	
		(5)	Gabion	cu.m	142.00	12,503.00	1,775,451.01	
			Total (2000)				**11,519,382.84**	
3000	Earthworks & pavement layers of gravel or crushed stone	(1)	Cut & fill	cu.m	6.11	744,280.00	4,544,945.82	
		(2)	Haulage of embankment material from borrow pit (1.0km)	cu.m	0.92	14,916,670.00	13,723,336.40	Distance btw. site & pit = 10km
		(3)	Disposal of surplus material (1.0km)	cu.m	5.75	186,070.00	1,069,902.50	
		(4.1)	Upper subgrade	cu.m	5.92	321,710.00	1,905,327.48	
		(4.2)	Lower subgrade	cu.m	4.74			
		(5.1)	Cement stabilized gravel sub base course (C2)	cu.m	72.62			
		(5.2)	Cement stabilized gravel sub base course (C3)	cu.m	60.52			
		(5.3)	Cement stabilized gravel sub base course (C4)	cu.m	48.42	293,333.00	14,201,717.20	
		(5.4)	Gravel wearing course	cu.m	36.80			Equivalent with gravel sub base course (CBR>30%)
		(6)	Crushed stone base course	cu.m	128.80	243,776.00	31,398,348.80	Transport distance of aggregate = 110km
			Total (3000)				**66,843,578.19**	
4000	Asphalt pavements & seals	(1)	Prime coat	sq.m	1.53	1,348,550.00	2,062,607.23	
		(2)	Single seal	sq.m	5.98	225,651.00	1,349,392.98	
		(3)	Double seal	sq.m	9.66	1,122,899.00	10,847,204.34	
		(4)	Asphalt concrete (t=10cm)	sq.m	51.75		0.00	
		(5)	Interlocking block pavement	sq.m	25.30	2,740.00	69,322.00	
			Total (4000)				**14,259,204.55**	
5000	Ancillary roadworks	(1)	Km post	No.	110.76	300.00	33,226.95	
		(2)	Guardrail	m	64.62	1,235.00	79,803.85	
		(3)	Road sign	sq.m	473.01	166.78	78,888.02	
		(4)	Road marking (W=10cm)	km	1,523.88	447.36	681,721.39	
		(5)	Grassing (embankment slope)	sq.m	2.94	918,693.00	2,704,632.19	
			Total (5000)				**3,578,272.40**	
6000	Structures	(1)	Box culvert	cu.m	646.29	2,378.00	1,536,874.05	
		(2)	Bridge	Ls.	4,260,296.01	1.00	4,260,296.01	
			Total (6000)				**5,797,170.06**	
7000	Testing & quality control			Ls.	17,250.00	1.00	**17,250.00**	
8000	Other works	(1)	Railway level crossing	No.	115,000.00		0.00	
		(2)	Demolishing existing concrete	cu.m	42.99	2,421.60	104,097.32	
		(3)	Removal of corrugated pipe	m	6.79	880.10	5,971.48	
		(4)	Finishing of road & road reserve (single carriageway)	km	1,725.00	148.40	255,990.00	
		(5)	Treatment of old road & temp. diversion	km	1,380.00	148.10	204,378.00	
		(6)	Transportation of construction material	Ls.	1,427,097.10	1.00	1,427,097.10	225km from Cuamba by trailer truck (50t)
			Total (8000)				**1,997,533.90**	
			Total (Bill A: Road works)				**132,095,737.76**	
Bill B: Day works				Ls.	1,136,023.34	1.00	1,136,023.34	0.86% of Bill A
Bill C: Social issues				Ls.	1,241,699.93	1.00	1,241,699.93	0.94% of Bill A
Bill D: Environmental mitigation				Ls.	330,239.34	1.00	330,239.34	0.25% of Bill A
			Total (Bill A+B+C+D)				**134,803,700.39**	
Contingencies				Ls.	13,480,370.04	1.00	13,480,370.04	10% of A to D
IVA				Ls.	10,083,316.79	1.00	10,083,316.79	6.8% of (A to D) & Contingencies
			Total construction cost				**158,367,387.21**	
Engineering cost				Ls.	7,414,203.52	1.00	7,414,203.52	5% of (A to D) & Contingencies
IVA				Ls.	504,165.84	1.00	504,165.84	6.8% of Engineering cost
			Total project cost				**166,285,756.57**	
			Compensation for land acquisition & resettlement				199,391.00	

(USD 1,121,868 per km)

Table 3.8.2 Bridge Construction Cost

Currency: US $

No.	River name	Description	Area (sq.m)	Amount	Cost per sq.m	Remarks
5	Ngame I	L=2@15.00m=30.00m, W=10.15m, Spread foundation	304.50	667,843.14	2,193.25	
6	Lilasse	L=17.00m, W=10.15m, Pile foundation	172.55	640,318.15	3,710.91	
7	Ninde	L=2@17.00m=34.00m, W=10.15m, Spread foundation	345.10	598,282.08	1,733.65	
8	Luculumesi	L=2@17.00m=34.00m, W=10.15m, Spread foundation	345.10	777,762.15	2,253.73	
9	Lutembue	L=2@17.00m=34.00m, W=10.15m, Pile foundation	345.10	875,533.48	2,537.04	
10	Luambala	L=2@15.00m=30.00m, W=10.15m, Spread foundation	304.50	700,557.02	2,300.68	
		Total	**1,816.85**	**4,260,296.01**	**2,344.88**	

9. Road Maintenance Systems

(1) Existing Road Maintenance System

1) Road Maintenance

ANE's ten provincial delegations are responsible for the implementation of all maintenance works on classified roads. The Directorate of Maintenance has a crucial role in ensuring that the delegations in provinces are fully aware of and complying with the technical and operational guidelines for implementation of the annual maintenance plan; and that roads of all types (Primary, Secondary, Tertiary, vicinal, paved, unpaved) are being maintained and provided . DIMAN also supports the provinces in the execution of the improvement, rehabilitation and construction of tertiary and vicinal roads. The directorate's role includes providing technical advice to municipal councils and districts on their road programs through the provincial delegations.

2) Road Safety

ANE's responsibilities for road safety (thorough road design standards, physical measures to enhance safety and the placement of signs and road markings) have been entrusted to DIMAN given the important role of the provinces in the process. Activities will be coordinated with the National Road Traffic Institute, INAV. DIMAN is also responsible for overseeing vehicle overloading control measures, the use of the road reserve and the management of road concessions.

(2) Realizing an Effective Road Maintenance System

The detailed information required as 'input data' for the new Integrated Road Management System (IRMS) is being launched and the surveys will be implemented beginning at the end of 2009. This project is being funded by SIDA under the Support for the Decentralized Management of Regional Roads. Road condition surveys and traffic counts also includes in this project.

By appropriate operation of this system, following issues will be solved.

- Development of core road network for prioritizing maintenance
- Development of operability and systematic maintenance
- Selection of cost-effective maintenance solution
- Preparation of appropriate routine and periodic maintenance program
- Technical design of maintenance works

Part IV Economic Feasibility Study

1. Existing Traffic Flow Patterns

Through the information researched by previous traffic volume data in ANE, interview to stakeholders and traffic volume and origin-destination (OD) survey, study team recognized the characteristics of traffic flow patterns for each section of Cuamba – Mandimba and Mandimba - Lichinga, which tend to be different types. Traffic volume and roadside OD survey were conducted for 1st period in May and 2nd period in August, 2009 at 3 locations in Cuamba, Mandimba and Lichinga on the study road. The characteristics are summarized in table below.

Table 4.1.1 Characteristics of Trip Pattern for Each Section

Category	Lichinga - Mandimba	Mandimba - Cuamba
Characteristics in General	・ This section is the only route for delivering consumer goods to Lichinga which is the provincial capital of Niassa, where is the base for distributing to northern part. This section can be said the lifeline for northern area. ・ Majority of social and official movement is the OD-pair between Lichinga and Cuamba. ・ Some agro-products are generated from northern side to southern side of Mozambique and Malawi through Mandimba.	・ This section is used for passenger movement from Lichinga and other district in Niassa to connect railway or Nampula province. ・ Some consumer goods are dispatched from Cuamba to Lichinga. On the other hand, most consumer goods for Cuamba city are come from Nampula side mainly by railway. ・ Some trailers with empty container are found which delivers to Nacala port from Malawi. ・ Some agro-products generated around Cuamba to transport to Malawi or Tete province.
Vehicle Type	・ More than half of vehicles are trucks including medium and trailer. ・ Minibus is major for passenger movement.	・ More than half of vehicles are trucks with mainly trailer and large truck. ・ Minibus is major for passenger movement.
Average Trip Length (time) without internal zone trip	・ **16.8** hours (All Vehicles) ・ 11.5 hours (Passenger Car + Bus) ・ 25.2 hours (Trucks) ・ 2.86 days (Trailer)	・ **19.3** hours (All Vehicles) ・ 11.4 hours (Passenger Car + Bus) ・ 28.5 hours (Trucks) ・ 1.99 days (Trailer)

In order to grasp the trend of international transport movement on Nacala development corridor, traffic volume count and OD survey were conducted at 3 border posts between Mozambique and Malawi which are named Zobue/Mwanza, Milange/Muloza and Mandimba/Chiponde, and at one border between Malawi and Zambia named Mchinji. In addition, the study team conducted interview survey for governmental organizations/ private companies both in Mozambique and Malawi.

2. Concepts for Traffic Demand Forecasting Method

(1) Socio-Economic Framework

The socio-economic framework for traffic demand forecast was applied based on the development strategy in Niassa (PEP) described in table below.

Table 4.2.1 Summary for Macro-Economics Assumption

Item	Assumptions	Annual increase rate (2050/2007)
Population	Future population up to 2050 has been estimated in each district based on PEP's estimation, and applied logistic curve by study team	About 2.5 – 2.8% (2.2times)
GDP	Future provincial GDP up to 2050 has been estimated based on PEP's estimation, applied logistic curve	Conservative: 8% (3.0times) Moderate: 10% (4.3times) Optimistic: 12% (7.0times)
Agro-products	Future agro-products up to 2050 has been estimated based on PEP's estimation, applied logistic curve and some conditions/ assumptions	About 4.5% (2.6times)
Forest	Future forest products up to 2050 has been estimated based on PEP's estimation, applied logistic curve and some conditions/ assumptions	Annual production after 2035 Pulp: 1.7 mil. m^3 Log: 0.6 mil. m^3 Chacol: 0.4 mil. m^3
Tourism	Future tourists up to 2050 has been estimated based on PEP's estimation, applied logistic curve and some conditions/ assumptions	Annual visitor after 2030, One-day: 40,000 visitors Stay: 60,000 visitors

(2) General Concepts for Development of Traffic Demand Forecast

In order to apply suitable forecasting method, the study team examines previous studies which are a) Lichinga – Montepuez (2001), b) Milange – Mucuba (2008) and c) Nampula – Cuamba (2007). Also, study team took into consideration of the issues which AfDB pointed for the preliminary appraisal mission of Nampula – Cumaba road improvement project. Based on the characteristics of traffic flow pattern, study team has set the general concepts for traffic demand forecasting method described below.

- Forecasting model shall be able to explain the potential/ hidden demands caused by rainy season and bad surface conditions.
  - Passenger traffic: model includes difficulties of moving in rainy and dry seasons.
  - Freight transport: model includes the demands of consumption and supplement in market by each item.
- Route choice shall be considered by each item's origin/ destination
- International freight transport from Malawi shall be considered as diverted traffic.
- Railway transportation shall be treated as below;
  - Nacala - Nampula – Entre Lagos – Malawi Line: Capacity of railway transpiration has been already matured because of poor rail condition and limited number of locomotive as described in 1.6. In this estimation, railway improvement will not be considered, and capacity of traffic will be stable as it is.
  - Cuamba – Lichinga line: As described in 1.6, Northern line is not operated properly, in only once per month for wagons. And CDN which is operation firm under concession has difficulties of rehabilitation of railway condition under their concession agreement. Therefore, this line will be the same status of current condition.
- Port facility shall be considered as same condition and capacity as it is.
- Border facility at Mandimba will be thought both current status and improved status such as one-stop-border post.

Note that in the middle of October 2009, there was an announcement for new railway construction plan between Moatize to Blantyre for coal transporting to Nacala port. It was said that feasibility study would be started soon. At this moment, there is nothing concreted information for this project. However, there must be much rehabilitation thorough the SEAR and CDN for allying coal transportation. Therefore, in this study, it is not considered to be applied to this estimation.

(3) Estimation Periods and Scenarios

The following years are defined as the analysis periods, and forecasting scenarios are formulated as below.

- Horizon year: 2009
- Construction periods: 2011-2013
- Base year: 2014
- Analysis periods: 2014 – 2034 (20 years)

Table 4.2.2 Scenarios for Traffic Demand Forecasting

Scenario Case	Road Network			Border	Railway Network			Port
	Lichinga ~ Mandimba	Mandimba ~ Cuamba	Nampula ~ Cuamba	OSBP	Nacala~ Entre Lagos	Cuamba ~ Lichinga	Malawi Doest.	Nacala
Without Case	As it is	As it is	As it is	As it is	As it is	As it is	As it is	As it is
With Case (Scenario -1)	As it is	Improved	Improved	As it is	As it is	As it is	As it is	As it is
With Case (Scenario -2A)	Improved	Improved	Improved	As it is	As it is	As it is	As it is	As it is
With Case (Scenario –2B)	Improved	Improved	Improved	Improved	As it is	As it is	As it is	As it is

Note that all of “with case” take this section to be improved because Nampula – Cuamba (N13) section has already been started implementation of construction.

3. Methodology of Traffic Demand Forecast

According to the concepts described above, future traffic volume had been estimated by three different type of traffic, such as i) passenger, ii) regional goods and iii) international goods. The each component of traffic estimation is described below;

Passenger traffic volume is estimated by “Gravity Model” with the variable index of potential population and road section impedance, developed by the actual number of passenger for each O-D trips.

Regional traffic volume is considered by divided traffic as attraction and generation for each zone. Trip attraction is estimated by the consumption of daily goods, and trip generation is based on the agro-products from the Niassa province.

International traffic volume is thought to be generated after the road network is improved. It is estimated by the Malawi trade and railway capacity, and applied the corridor choice model, named lodgit model.

The diagram below shows the process for traffic demand forecast. Details for each process and results are described in the main report.

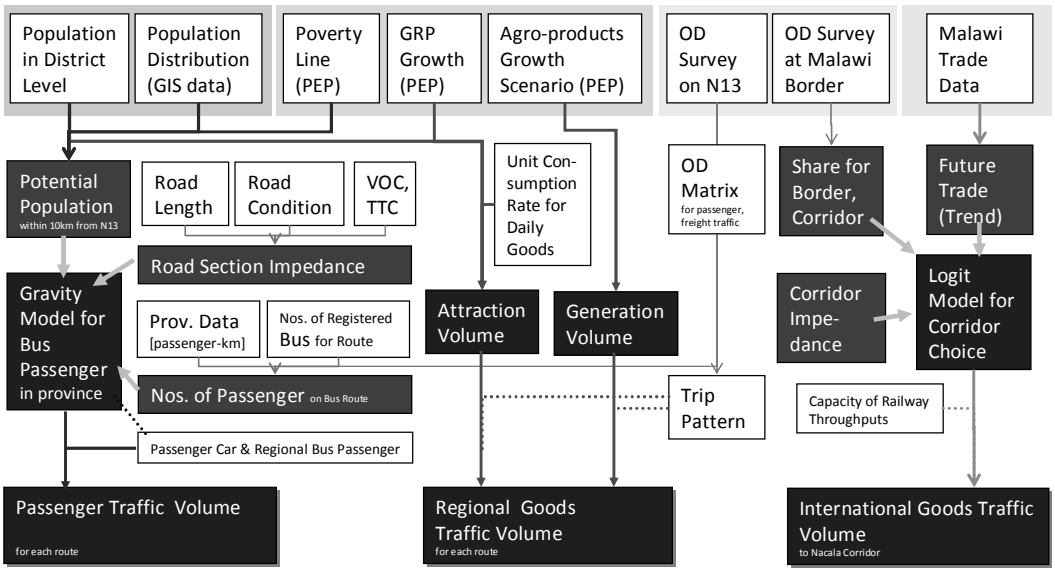


Figure 4.3.1 Process of Traffic Demand Forecast

4. Results of Traffic Demand Forecast

Accumulating with the results of each component, future traffic volume for both sections will be summarized. For the section of Mandimba – Lichinga, future traffic volume in AADT is estimated about 467AADT in 2014, 1,732AADT in 2023 and 6,417AADT in 2033 in with case.

Table 4.4.1 Future Traffic Volume in Mandimba - Lichinga

year	2009	2014	*With case*	2023	*With case*	2033	*With case*
Passenger Car	46	113	*138*	283	*344*	760	*925*
Minibus	28	136	*165*	738	*897*	2,958	*3,598*
Trailer	26	53	*58*	138	*152*	288	*328*
Others	42	91	*106*	280	*339*	1,278	*1,566*
Total	142	393	*467*	1,439	1,732	5,284	*6,417*

The comparison of sections is indicated in figure below. The future AADT of section between Lichinga – Mandimba is more than Mandimba – Cuamba. It is because that social communication will be more active by minibus and passenger car to the connection of provincial capital in Lichinga.

Compared with the previous feasibility study between Nampula and Cuamba, this estimated traffic volume is almost same level of volume for previous section. The table below shows the both results on same time series.

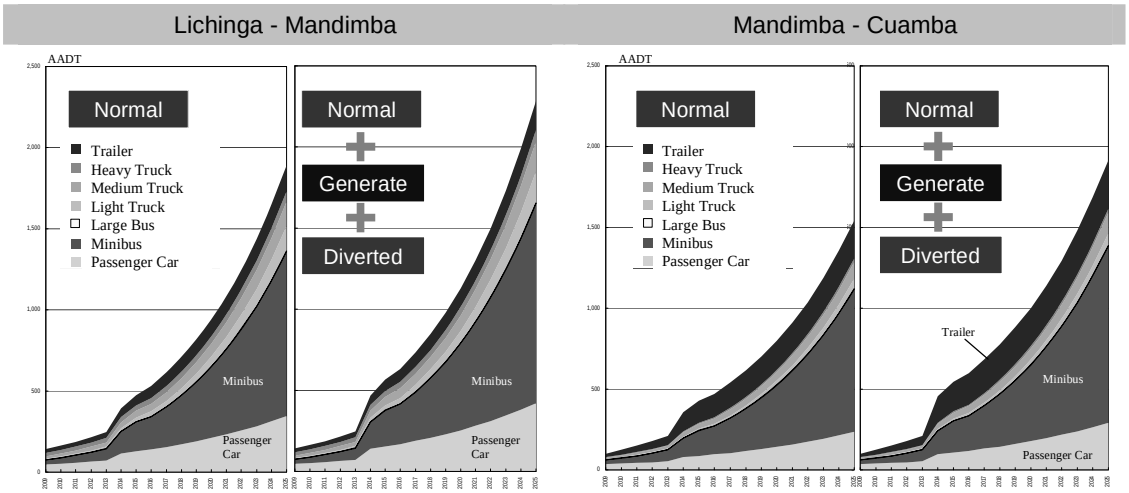


Figure 4.4.1 Estimated Traffic Volume for Each Section

5. Economic Analysis

Economic analysis is conducted for the alternative cases and scenarios proposed in Table 4.2.2.

Assumptions for analysis are as follows:

Analysis Tool : HDM-4 (RED, Comprehensive for reference)

Project life : 20 years after the opening of the project road (2016)

Pricing date : as of October 2009

Social discount rate: 12%

Conversion Factor : Construction work (0.84), Maintenance work (0.75)

Exchange rate : US$1.00 = 28.00 Meticais (MT)

Results of Analysis are tabulated as follows:

Table 4.5.1 Sensitivity Analysis

Case	Assumptions	EIRR
Base	Upgrade to paved road with DBST (revised cost)	18.1%
1	Decrease in traffic volume of -20%	15.4%
2	Increase in investment costs of +20%	15.6%
3	Both combined of above as the worst case	13.6%

Table 4.5.2 Switching Value

	Base Case	Case that yields NPV=0		
NPV @12% (Mil. US$)	Value	Value	Factor	Change
Cost	106.0	179.2	1.69	69.1%
Benefit	179.2	106.0	0.41	-40.8%

The project scores an average level as an upgrade-to-paved intervention and its economic viability is acceptable, with an EIRR of over 12% of the opportunity cost among alternatives. Based on this result, the project is evaluated as one of the prioritized projects to be implemented in the nation. The particular importance of this primary road and of bringing it to all-weather transit-able condition is well established. The Study Team concludes that the road upgrading project is economically feasible in terms of national economy of Mozambique.

Part VI Environmental and Social Considerations

1. Environmental Legislation

The GOM has issued laws relevant to the environment. According to the EIA Law, project proponents must obtain environmental certification from the Ministry of Environmental Coordination (hereinafter referred to as "MICOA"). This environmental law prescribes that rural road rehabilitation projects are classified as "category A" projects, which requires an EIA. Furthermore the land law prescribes compensation for resettlement, and ANE will prepare a resettlement action plan (hereinafter referred to as "RAP") for appropriate compensation based on the land law and the resettlement policy framework (hereinafter refereed to as "RPF") which was established by ANE in September 2006 in cooperation with the World Bank.

With regard to Malawi side, Part V in the Environmental Management Act 1996 says, " A4.5 construction new road / widening of existing road of highway / rural road " requires EIA process. On the other hand, construction of immigration and custom facilities are not included in this mandatory list.

Generally the series of processes for an EIA approval takes 1-2 year(s) at least from the experience of Nampual-Cuamba road. This expected duration includes the procurement of environmental consultants and revision of documents in relevant organizations.

2. Screening and Scoping for Environmental and Social Considerations

All relevant EIA guidelines such as GOM, JBIC, JICA and Malawi prescribe that a project of widening and construction of new road is required EIA. With regard to building of immigration facilities are not required EIA due to small scale development and few impacts. According to scoping result, resettlement in social area and elephant migration corridor in natural area are picked up as key issues.

Table 6.2.1 Requirements for Full-Scale EIA

Title of Laws or Guidelines	Requirement of full scale EIA
Mozambique EIA Guidelines	Construction of new section road except in urban area, and upgrading
JBIC EIA Guidelines	Upgrading more than 5km road and 50 households resettlement
JICA EIA Guidelines	The project gives serious impact to social and natural environment
AfDB EIA Guidelines	Large-scale roads and railways construction, upgrading and major rehabilitation
Malawi EIA Guidelines	Construction new road / widening of existing road of highway / rural road

3. Environmental and Social Consideration Survey

The Environmental and social consideration survey which was conducted by JICA Study Team in cooperation with ANE identified that serious environmental impacts are not expected, however some key issues were picked up. The most important being the "Resettlement" and the "Elephant migration corridor". With regard to resettlement, approximately 6,000 structures are located in the right of way (30ms on each side from the existing road shoulder). According to a rough

estimation, approximately 400 structures are affected by the new road alignment.

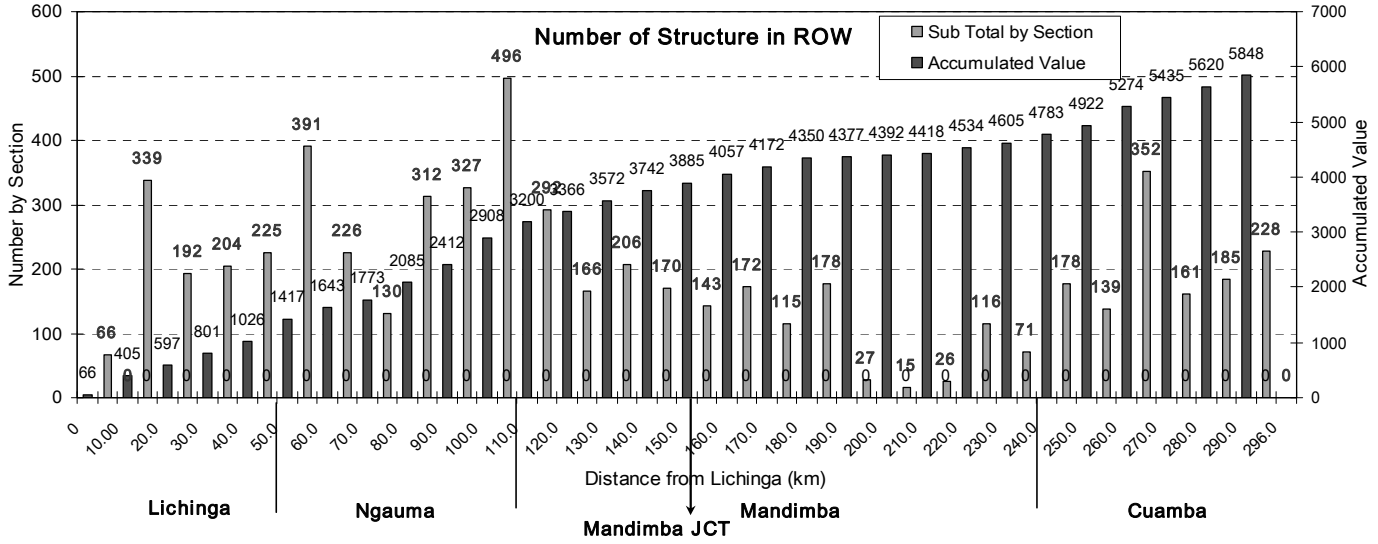


Figure 6.3.1 Number of Structures in Right of Way

Source: JICA Study Team

Table 6.3.1 Estimated Affected Numbers of Structures in ROW

Number of Alternative	Clearance Width of ROW (each side from road shoulder	Other Conditions	Affected Number of All Structures	Affected Number of Structures per 1km	Remarks
Alernative-1	Approximately 30m (total 60m width 30 + 30 + road width without shoulder)	Including all towns and villages	**5,848**	**19.8**	Concept: Full-ROW 30m of ROW is established by the Land Law
Alernative-2	Approximately 7m from designed shoulders (total 14m width)	Excluding major villages and towns	**390 (970)**	**1.3 (3.3)**	( ):calculated number out of consideration of actual location of residential area

Note) Approximately 30 structures are affected by new bypass alignment

The exact magnitude of the impact will be defined in a detailed EIA and RAP which will be conducted by GOM in 2009 and 2010.

With respect to the elephant corridor, according to specialists from government organization and international institutions, although this project will give a degree of impacts, it is not likely to give direct serious impacts. However indirect impacts such as expansion of human activities, deforestation and poaching will increase and affect the elephant corridor in the future. Therefore appropriate mitigations such as setting up sign boards and worker's education will be required. Major solution against indirect impacts is land control, thus ANE should suggest appropriate mitigation measures to relevant government organization and local authorities.

(see recommended range for setting up sign boards)

Furthermore the spread of the sexual transmitted diseases such as HIV/AIDS is a serious social issue with development projects in African countries. ANE in cooperation with relevant organizations should conduct appropriate education campaigns and other mitigation measures for the project affected persons and road construction workers.

Additionally some quantitative pollution survey and impact forecast such as air quality and noise level was carried out, air pollution is not serious, forecasted value of noise level indicates that noise level will exceed Japan's environmental standard for sensitive area such as schools and health center. Thus mitigation measure such as setting up sound proof wall on the school boundary is recommended.

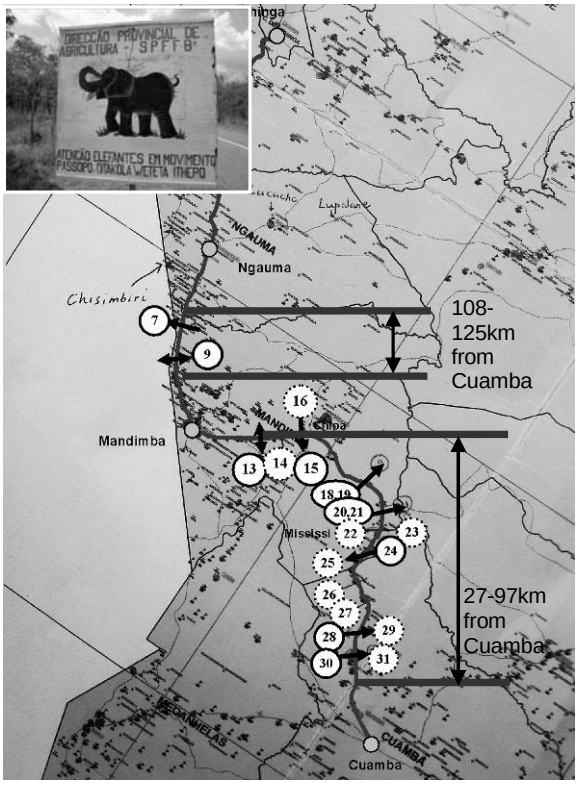


Figure 6.3.2 Range for Setting up Sign Boards
Source: prepared by the Study Team

Table 6.3.2 Predicted Noise Level (2035) [Along the EN13]

Target Year \ Item		Predicted Noise Level			Criteria (Japanese Standard Value)
		In Town 60km/h	Out of Town		
			80km/h	100km/h	
Present Surveyed Noise level (2009) roadside	Daytime 10min	57-63dB(A)			70 dB(A)
Forecasted noise level on boundary (2035)	0600-2100	66 dB(A)	68 dB(A)	70 dB(A)	70 dB(A)
	2100-0600	62 dB(A)	64 dB(A)	65 dB(A)	65 dB(A)

Table 6.3.3 Predicted Noise Level (2035) [Along the EN13 Sensitive Area]

Case \ Noise Level		Predicted Noise Level Laeq, dB(A)							Criteria: Japanese standard value along trunk road * (sensitive area)
		0m	5m	10m	15m	20m	25m	**30m**	
Without countermeasures	0600-2100	70	68	67	66	65	65	**64**	70 dB(A)
	2100-0600	65	64	63	62	61	60	**60**	65 dB(A)
With countermeasures (Soundproof wall of 1.8m on boundary)	0600-2100	-	58	57	57	56	55	**55**	55dB(A)
	2100-0600	-	54	53	52	51	51	**50**	-

Note) Although forecasted point is in Cuamba – Mandimba section, 100km/hr is adopted as design speed due to sample analysis

4. Recommendations for the EIA and Design

An EIA will be carried out based on the procedures outlined by the GOM's environmental law. However other relevant environmental guidelines should be considered as well from the view point of social considerations. Therefore JICA's has proposed a comprehensive ToR for the EIA based on the guidelines from GOM, AfDB, JBIC and JICA. This recommended ToR has been submitted to ANE in June 2009 and the environmental section in ANE, GAT, has adopted this proposed ToR for the EIA.

According to the timetable, the EIA inclusive the RAP will be processing in 2009 and ANE will receive environmental permission by the end of 2010.

Table 6.4.1 Proposed EIA Timetable and Current Progress (2009-2010)

Year/Month / ITEMS	2009				2010											
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec-March
Prequalification for environmental consultant	■ ■ ■ ■															
Preparation of proposal report, evaluation		■	■	■												
Negotiation and contract with local consultant					■	■										
Baseline survey based on the FS (including review screening and scoping by MICOA)						■	■	■	■	■	■	■	■			
Preparation of EIA and RAP											■	■	■	■	■	
Review, Revised and Approval draft EIA report (by MICOA)																■
SHM (public consultation for EIA)							1st ▲			2nd ▲						

Table 6.4.2 Long Term EIA Process Schedule (Tentative)

Month / Item	2009				2010				2011			
	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12
Feasibility Study	■	■	■	■								
Detailed Design						■	■	■				
EIA Preparation by ANE				■	■	■	■	■	■	■		
Pre-RAP						■	■	■				
Detailed RAP								■	■	■		
Compensation (after L/A)											■	■
SHMs by JBIC/JICA Guidelines		■										
SHMs by Mozambique Guidelines					■			■				

Preliminary Alignment (2009)
Contract with local consultant by ANE (June-)
Announcement of EIA after approval (120days rule)
Scoping
Draft EIA

Part VII Regional Development Program

1. Present Situation and Development Potential of Niassa Province

Niassa Province has inherent development potential in agriculture, forestry, mining and tourism. However, poor access conditions have hindered economic development in the province. Furthermore, its territorial size, scattered population and low population density have made it difficult to deliver basic social services to the people.

The majority of provincial population is rural and the majority of rural population is smallholding farmers (smallholders). They grow a variety of food crops including maize, cassava and beans. Poor access conditions increase transport costs. It is difficult for smallholders to transport their agricultural produce by car and sell them at market places. As a result, smallholders have to wait for middlemen to come to their villages or they need to bring produce to nearby buying places by bicycle or on foot. Moreover, in order to satisfy cash needs, they have to sell part of food crops for their own family consumption.

Some smallholders grow cash crops, such as tobacco and cotton. On the other hand, in recent years, in the southern part of Niassa Province, where access conditions are relatively good because of its railway linkage, some smallholders grow sesame for export in the activities of agricultural associations. However, these kinds of cash cropping are still limited in number and to certain areas.

Agriculture is a major and important economic sector, which provides food and cash for the majority of people in the province. In Niassa Province, there is much room for improvement of agriculture in technical production and commercialization. Furthermore, agro-processing industries are expected highly not only to increase the demand for local agricultural produce, but also to increase non-agricultural employment.

In the northern part of Niassa Province, since 2005, industrial tree plantations have been increasingly developed by foreign investments. Harvesting of trees will start at those plantations around 2013. Those harvested wood and/or locally processed wood products would be exported to other regions. In the short term, they rely on road transport from Lichinga to Cuamba to get railway at Cuamba. In the mid and long terms, it is expected that the railway line between Cuamba and Lichinga could be rehabilitated so as to transport unprocessed wood or processed wood products to Cuamba and further to Nampula or to Nacala, sometime to Malawi.

In Niassa Province, Niassa Lake in the north-western area and Niassa Reserve in the north-eastern area have tourism potential. Lichinga, provincial town of Niassa, has beautiful streetscape due to Portuguese colonial legacy. Lichinga has development potential to be a base for tourist accommodation. Such tourism potential including tourist resorts, water sports, ecotourism and game hunting has been hardly exploited yet.

2. Future Improvement Scenario of Transport Network in Northern Mozambique and Malawi

Nampula-Cuamba Road, a trunk road of Nacala Development Corridor, is expected to be upgraded by 2014. When Cuamba-Mandimba Road is completed,

the trunk road would connect Nacala Port to Mandimba, border with Malawi, through Nampula and Cuamba by 2016. This road upgrading and connection would largely improve traffic conditions and potential for regional development. As a result, Niassa Province, which is an inland province, would be strongly integrated with Nacala Development Corridor, as well as with Nampula Area and Nacala Port, which could create the important foundation for developing various economic sectors.

Moreover, a grand idea for coal export from Tete through Nacala Corridor and Nacala Port has emerged. Tete has a huge reserve of good quality coal, whose exploitation will be started in 2011 or so. This plan needs a new railway line connecting Tete to Malawi, as well as the rehabilitation of Malawi Railway and CFM-North in the Nacala Corridor. If this grand plan is realized, the integrated corridor of railway and trunk roads from Tete, Malawi, Cuamba and Nampula and Nacala could form a very solid basis for economic and social development.

Furthermore, Mandimba-Lichinga Road is an important key to diffuse the development impact of Nacala Development Corridor to the central and northern part of Niassa Province. In the long term, the major rehabilitation of Cuamba-Lichinga Railway Line is essential for securing sustainability of industrial tree plantations and attracting medium or large economic sector development, such as wood-processing industries and mineral resources development. See Figure 7.3.1.

3. Basic Strategies for Regional Development

Basic strategies are set for making maximum use of development potential of Niassa Province and Nacala Development Corridor to guide the formulation of sectoral strategies, as follows:

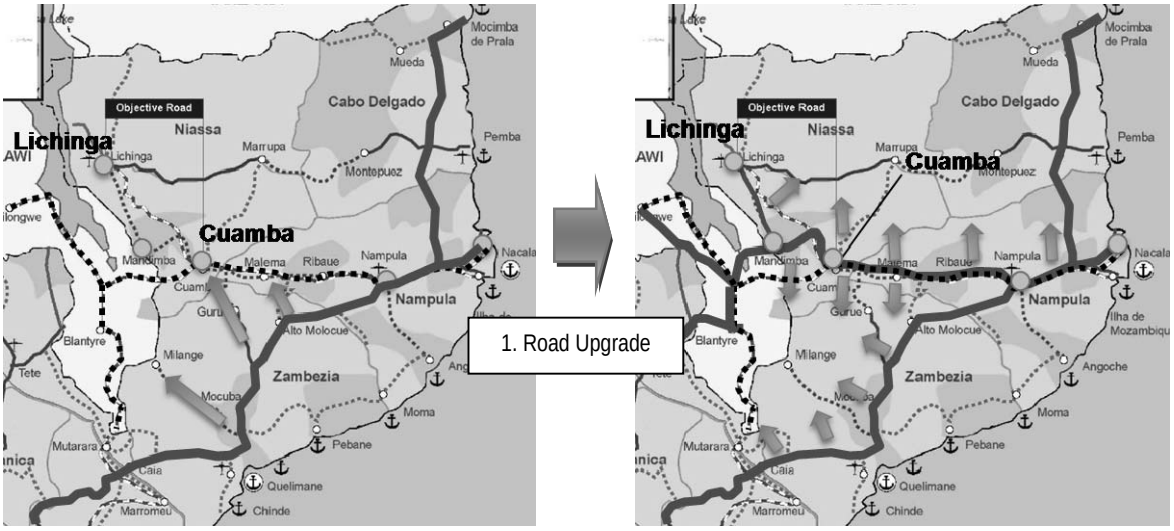
Basic Strategy 1: Upgrading of the trunk road of Nacala Development Corridor in order to promote regional development not only within Nacala Development Corridor but also in its periphery by making use of their development potential

Basic Strategy 2: Make the most of development opportunities to be created due to the prospective development of a new rail link between Tete and Malawi and rehabilitation of CFM-North of Nacala Development Corridor for exporting Tete's high-quality coal, as well as due to the upgrading of the trunk road of Nacala Development Corridor

Basic Strategy 3: Promote the development of smallholder agriculture and agro-processing industries by making the most of agricultural potential of the region

Basic Strategy 4: Promote the sustainability of industrial tree plantations and the development of wood-processing industries so that they could be new mainstays of the future economy of the central and northern part of Niassa Province

Basic Strategy 5: Reduce economic and social disparity between the inside of the Nacala Corridor and the periphery of the Nacala Corridor by taking necessary measures

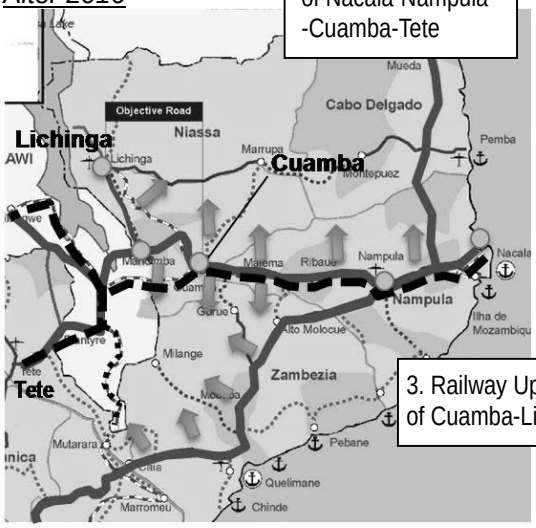


- Not Upgraded Railway
- Highway No.1

- Not Upgraded Railway
- Upgraded Road of Nacala-Nampula-Cuamba-Mandimba
- Highway No.1

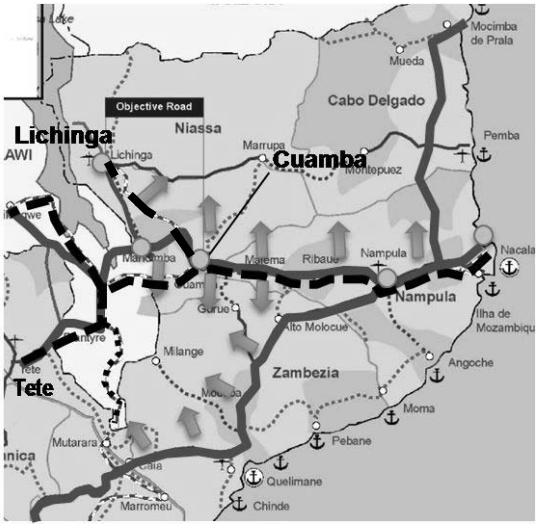
After 2016

2. Railway Upgrade of Nacala-Nampula -Cuamba-Tete



- Upgraded Road of Nacala-Nampula-Cuamba-Mandimba
- Upgraded Railway of Nacala-Nampula-Cuamba-Tete
- Upgraded Road of Mandimba-Lichinga
- Highway No.1

Long Term Future



- Upgraded Road of Nacala-Nampula-Cuamba-Mandimba
- Upgraded Railway of Nacala-Nampula-Cuamba-Tete
- Upgraded Road of Mandimba-Lichinga
- Upgraded Railway of Cuamba-Lichinga
- Highway No.1

Figure 7.3.1 Future Improvement Scenario of Transport Network in Northern Mozambique and Malawi

4. Regional Development Measures for Promoting Synergy Effect of Trunk Road Improvement and Regional Development

(1) Corridor along Cuamba-Mandimba Trunk Road: Southern Part of Niassa Province

Smallholder Agriculture and Agro-Processing Industries

The upgrading and pavement project of Cuamba-Mandimba Road could reduce transport costs, as well as improve road access along the corridor. As a result, regional potential to commercialize smallholder agriculture and to expand their production would be enhanced. However, such road upgrading alone cannot realize the enhanced regional potential and achieve smallholder commercialization and production expansion. Therefore, it is necessary to assist in strengthening their agriculture associations and securing market channels for their produce.

The upgrading and integration of Cuamba-Mandimba Road with already upgraded Nampula-Cuamba Road would substantially reduce long-distance transport costs by truck so as to reduce goods prices to be imported from other regions.

It is considered that such smallholder commercialization and agricultural production expansion would increase business potential of agro-processing industries along the corridor. However, such road upgrading alone is not enough to exploit improved opportunities in agro-processing industries. It is essential to assist in not only feasibility studies but also business development services, for providing information and support to private sectors. Such measures would help private sectors to actually invest in the field of agro-processing.

Urban Economy and Logistics Function

The integrated upgrading of trunk roads of Nacala Development Corridor would vitalize regional economy along the corridor. This could promote geographical expansion of commercial catchments Nampula Town and Nacala Town, resulting in upgraded commercial agglomeration.

Similarly the inland towns, such as Cuamba Town and Mandimba Town, would expand their commercial catchments and increase demands for transport and logistics sectors.

In addition to the upgrading of Nampula-Cuamba-Mandimba Road, development of bypass roads, logistics centers and loading-unloading facilities between roads and railways would be necessary for making regional transport more effective and efficient by taking advantage of upgraded trunk roads and rehabilitated railway of Nacala Development Corridor.

(2) Periphery of Nacala Development Corridor: Central and Northern Parts of Niassa Province

Smallholder Commercialization and Production Improvement

Commercialization of smallholders in the periphery of Nacala development Corridor would be encouraged by the road improvement between Nampula, Cuamba and Mandimba. Due to the reduced long-distance transport costs, the farmers would be able to sell their agricultural products at higher prices. As the economic activities in Nacala Development Corridor are vitalized with the trunk road improvement, populations of Cuamba Town and Mandimba Town would increase. As a result, the amount of agricultural products to be dealt with by the middlemen would increase. Currently the support to the smallholder commercialization by organizing agricultural associations and by making linkage with marketing companies is provided in a limited number of villages in the southern part of the province. In order to make full use of the enhanced opportunities for smallholder commercialization, such support should be expanded to the central and northern parts. In addition, agricultural technical support should be introduced to improve their production.

Tourism Development

If the road between Nampula, Cuamba and Mandimba is improved, tourists visiting southern part of the Province from Malawi or Nampula by bus or car would increase. It is expected that Lichinga would be developed as a comfortable tourist base to provide accommodation to tourists, traveling along the route via Cuamba and Mandimba. Measures should be taken to improve the quality of tourism services in hotels, restaurants and car rentals, as well as to provide tourist information in Lichinga Town. Furthermore, efforts should be made to attract tourists to make trips from Lichinga to nearby tourist spots such as Niassa Lake and nature conservation areas.

In order to fully develop tourism in Niassa Province to such an extent that more international and domestic tourists would visit Niassa Lake and/or Niassa Reserve as popular tourist destinations, good access condition should be ensured with improved Mandimba-Lichinga Road. In combination with the road improvement, it is necessary to make Lichinga Town an attractive tourist center, by providing small tourist-oriented facilities, such as tourist information centers, museums and sign boards. It is also necessary to start developing the capacity of local tourist industries by providing training programs. More tourist accommodations and attractions should be developed at Niassa Lake and Niassa Reserve. For facilitating tourism development at the provincial level and for promoting tourism in Niassa Province, it is also recommended to establish a local tourism board involving government and private sectors.

Development of Wood Processing Industry

Improvement of Mandimba-Lichinga Road is essential for promoting industrial development, such as wood-processing industries, in the central and northern par of Niassa Province. The road improvement would largely contribute to cost reduction of long-distance truck transport and furthermore to price reduction of imported goods, such as spare parts and fuels. This could lead to enhancement of basic conditions for attracting industries.

For actual promotion of wood-processing industries, business development services should be provided for foreign investors and companies. Furthermore, it is also necessary to develop small and medium scale enterprises (SMEs) of

wood-processing for local employment generation.

Mineral Resources Development

The improvement of Lichinga-Mandimba Road is essential to realize mineral resources development in the north-western area of the province. Together with the road improvement, geological surveys and research is important to provide information on mineral resources availability to promote private investment in mineral exploration and furthermore in mineral exploitation. In the long term, rehabilitation of Lichinga-Cuamba Railway Line is highly expected for transporting exploited mineral resources through Cuamba, Nampula and Nacala.

Improvement of Social Services

In addition to the above-mentioned economic development measures, the improvement of social services, such as water, education and health, as well as the improvement of local roads are very important for the regional development in the central and northern parts of Niassa Province. In the decentralization policy of Mozambique, budgets for the development are allocated to district governments, and they are supposed to play central roles in planning and implementation for local development. However, their capacity is limited. In order to improve social infrastructure and services, assistance programs for capacity development of district governments are necessary.

Table 7.4.1 Sector Strategies and High-Priority Measures

Sector Strategy 1: Transport Infrastructure Development	Measure 1-1: Upgrade Cuamba-Mandimba Road to ensure high mobility on the trunk road from Nacala Port to the border with Malawi, through Nampula and Cuamba Measure 1-2: (a) Develop a bypass road for Cuamba Town and other facilities including truck parking areas/truck terminals along the bypass road, industrial estates along the bypass road, access road to Cuamba train station and loading-unloading facilities of Cuamba train station for integrating road and railway transport. (b) Establish a town plan of Cuamba Town for accommodating these facilities and for securing lands for these facilities. Measure 1-3: (a) Develop a bypass road for Mandimba Town and truck parking areas along the bypass road. (b) Establish a town plan of Mandimba Town for accommodating these facilities and for securing lands for these facilities. Measure 1-4: Upgrade Lichinga-Mandimba Road for connecting to Nampula-Cuamba-Mandimba Road and for ensuring safe and smooth transport of vehicles all the year around.
Sector Strategy 2: Smallholder Agriculture commercialization	Measure 2-1: Assist small farmers in organizing their agricultural associations and in making their agriculture produce so as to increase their agricultural production Measure 2-2: Assist small farmers in agricultural technical improvement
Sector Strategy 3: Development of Agro-Processing Industry	Measure 3-1: Conduct a feasibility study of agro-processing industrial development in Niassa Province, in order to clarify potential products and markets, as well as to establish a development strategy for agro-processing industry. Measure 3-2: Provide business development services on agro-processing industry for private investors, in accordance with the established development strategy for agro-processing industry.
Sector Strategy 4: Tourism	Possible Measure 4-1: Establish a tourism development strategy at the provincial level of Niassa.

Development	Possible Measure 4-2: Conduct activities for local-level capacity development for tourism, including organizing seminars and workshops on what are better services for tourists, by involving tourist operators, such as hotels, rental cars and restaurants. Possible Measure 4-3: Start up a tourism board involving government and private sectors at the provincial level, and start activities for local capacity development, tourism promotion, small facilities development, such as tourist information centers, museums and sign boards.
Sector Strategy 5: Development of Wood Processing Industry	Measure 5-1: Provide and expand business development services for foreign companies and investors who are interested in the wood processing industry for attracting middle and large-scale operations of wood processing. Measure 5-2: Promote local development of small and medium enterprises (SME) of wood processing industry.
Sector Strategy 6: Improvement of Social Services	Measure 6-1: Improve district-level capacity of development planning and project implementation for improvement of social services and minor roads at the village level by adopting an integrated approach paying attention to actual situations of districts and villages, especially village settlement patterns.
Sector Strategy 7: Mineral Resources Development	Measure 7-1: Promote private investment to exploration of mineral resources and further to mining development, by conducting studies on geological models in relation to mineral resources in the northern part of Niassa Province and by providing information of geological models to the public.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