Ministry of Transport
The Republic of the Union of Myanmar

The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar

Final Report

Executive Summary

Pre-Feasibility Study
for
East West Economic Corridor Relevant Roads Project

September 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

Oriental Consultants Co., Ltd.
International Development Center of Japan
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Currency Equivalents (average rate from April to June, 2013)
US$1.00=MMK904
US$1.00=JPY98.93
MMK1= JPY0.1094
Source: Bank of Tokyo Mitsubishi UFJ for the JPY-US$ rate
Central Bank of Myanmar for the MMK-US$ rate

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Table of Contents

List of Tables

List of Figures

Abbreviations

ADB	Asian Development Bank
ASEAN	Association of South East Asian Nations
BOT	Build, Operate and Transfer
BQ	Bill of Quantities
CBR	California Bearing Ratio
EIA	Environmental Impact Assessment
EL	Elevation
EIRR	Economic Internal Rate of Return
ESA	Equivalent Standard Axles
ESCAP	Economic and Social Commission for Asia and the Pacific
GMS	Greater Mekong Subregion
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
KNU	Karen National Union
MLIT	Ministry of Land, Infrastructure and Transport
MOECAF	Ministry of Environmental Conservation and Forestry
NGO	Non-Governmental Organization
NPV	Net Present Value
ODA	Official Development Assistance
ORN	Overseas Road Note
PC	Precast Concrete
PWD	Public Works Department
ROW	Right of Way
TA	Total Asphalt Pavement
TTC	Traveling Time Cost
VOC	Vehicle Operation Cost

Executive Summary

1. Introduction

1.1 Background of the Survey

The Republic of the Union of Myanmar (hereinafter "Myanmar") is achieving high economic growth after democratization of the politics and economy. The country will require further development for the shift of ASEAN to the ASEAN Economic Community in 2015. On the other hand, due to the economic isolation for long years, the infrastructure to revitalize the economy of Myanmar has not been well developed. It is an urgent task for the country to develop the road network. The major arterial roads to the southeast of Myanmar are as follows: (1) Myawaddy - -Eindu-Mawlamyine Road; (2) Payagyi－Mawlamyine－Dawei Road; (3) The Three Pagoda Path; and (4) the Dawei Port Access Road. These routes connecting the metropolitan Yangon and Thailand are expected to greatly contribute to the revitalization of trade with ASEAN countries and the economic growth of Myanmar, and also to repatriation of local residents who were forced to evacuate to the neighboring countries and improvement of their living standards. Based on the background described above, this study summarized the current situations of the major arterial roads in the southeastern part of Myanmar, and the status of assistances and plans promoted by donors. Based on the basic study, the projects that are necessary to be implemented were extracted, the project proposals and estimated project costs were studied, and the appropriateness of the projects in terms of design, construction, etc. was reviewed.

1.2 Objectives of the Study

This study selects project proposals that are necessary and possible to be implemented, after reviewing the current road conditions and future development plans concerning Thaton-Eindu-Myawaddy Road, Mawlamyine - Eindu Road and Payagyi-Maulamyine Road.

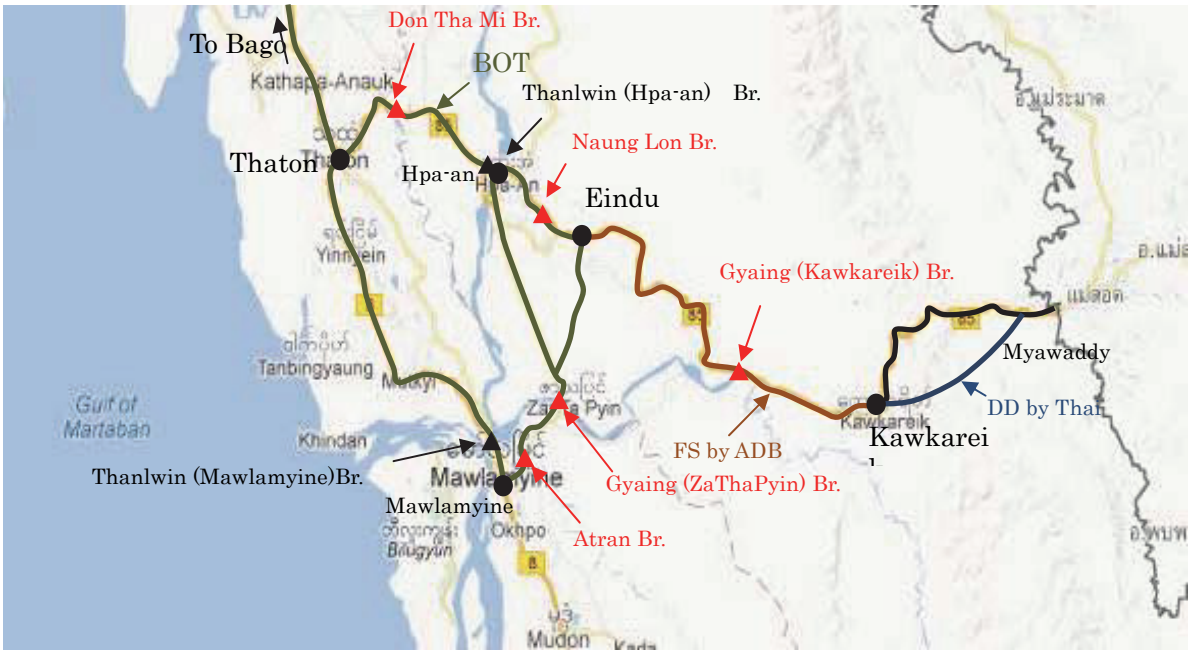


Figure 1 Location Map of Study Roads

1.3 The Sections to be studied

The study covers the roads connected to the GMS East-West Economic Corridors in the southeastern part of Myanmar (Thaton-Eindu-Myawaddy Road, Mawlamyine - Eindu Road and Payagyi-Mawlamyine Road), and the surrounding areas.

2. Current Conditions and Issues of the Study Roads and Bridges

2.1.1 The Current Conditions of Study Road Sections

The EWEC relevant road sections covered by the study, runs mostly through flatland and gentle hills. In the urban area and villages, there are houses and buildings and facilities standing along the road though basically the specified ROW(Approximately 100ft: 30m) is secured. In terms of alignment, a design speed of 50- 60km/h is secured for the most part, and there exists moderate curves and bends in the urban areas. The road width is varied from 5 to 7m including two-way, two lanes (2.5-3.5m per lane). The roadway is mostly paved by asphalt low cost pavement (macadam pavement) but the shoulders are not paved. As motorcycles and oxcarts go through the roadway, and it is difficult to overtake low-speed large vehicles, the running speed goes down on the whole. There are five (5) major existing bridges on the study road sections in which large scaled bridges such as suspension bridge and cable stayed bridges were constructed with the technical support of China. It is observed that excessive corrosion of diagonal cables and damage to steel slabs and supposed that members' yield strength not enough, with the latent possibility of bridge collapse. Therefore, the weight is regulated up to 20 - 30t, so that vehicles exceeding more than that are diverted to other routes via temporary bridge. The existing conditions of each bridge is summarized in Table 1.

Table 1 Summary of Major Existing Fives on the Study Road

Name of bridge	Length	Superstructure type	Weight limit	Completion year
Donthami Bridge	183m	PC+RC	50t	1982
Naung Lon Bridge	115m	RC（I Gurder)	30t	1970s
Gyaing（Kawkarei） Bridge	400m	Suspension	30t	1999
Name of bridge	Length	Superstructure type	Weight limit	Completion year
Gyaing (Zathapyin) Bridge	884m	Suspension Bridge	30t	1999
Atran Bridge	433m	Cable-stayed bridge	30t	1998

Source: JICA Study Team

2.1.2 Issue of Study Roads and Bridges

Issues related to the existing roads and bridges on each of the study road sections are summarized in in Table 2.

Table 2 Issues of Study Roads and Bridges

Routes concerned	Current Condtions of Study Road Sections		
	Topography and road condition	Planning, survey, management	Environmental Aspects
(1) Payagyi – Mawlamyin road (220km)	(Payagyi – Mawlamyin) The road runs basically on the flatland over the entire length, except for the rolling terrain near Kyaitoyo (80m above sea level). Satisfactory surface condition with asphalt pavement (carriageway area only).	(Payagyi – Mawlamyin) • The Payagyi – Thaton section designated as **AH1** • The route divided into three sections, in which road maintenance is done according to the private BOT system.	(Payagyi – Mawlamyin) • Many villages scattered on the wayside. Facilities found located within a part of ROW. • In case of road widening, relocation of residents may be necessary.
(2) Eindu – Myawaddy road (120km)	(Eindu - Kawkareik) • Mostly flat over the entire section • 1.5-lane low cost pavement (macadam), with damages observed in the road surface (Kawkareik – Myawaddy) • The Kawkareik – Thingannyinaung section crossing Dawna Range is the single-lane road in the poor condition. • The Thingannyinaung – Myawaddy section the asphalted 2-lane road in the satisfactory surface condition.	(Eindu - Kawkareik) • Designated as the East-West Economic Corridor/AHI • **ADB** is now implementing **FS.** • Simple repair under way under direct control of **PWD** (Kawkareik – Myawaddy) • East-West Economic Corridor /**AH1** • Bypass work being done by the Thailand Government • Simple repair of the existing road under way under direct control of PWD	(Eindu - Kawkareik) • Facilities located within a part of ROW around the village. Resettlement of residents may be necessary in case of road widening. (Kawkareik – Myawaddy) • Villages scattererd along the route • New route, if implemented, may require resettlement of residents and cause impact on the natural environment.
(3) Thaton – Eindu road (60km)	• Flat over the most part of entire route, except that the road is diverted greatly to the south near Thanlwin River. • Asphalted 2-lane pavement (carriageway only, with satisfactory surface condition)	• Designated as the East-West Economic Corridor/AHI • The route is divided into two whose maintenance is done according to the private BOT system.(Bridges are under direct control of **PWD**)	• Many urban areas and villages scattered along the route with facilities found located within a part of ROW • In case of road widening, resettlement of residents may be necessary.
(4) Mawlamyine – Eindu road (40km)	• The road runs on the flatland almost all over the route, with the horizontal alignmnet being gentle. • 1.5-lane low cost pavement (macadam) in most of sections. Road surface damage observed over the entire route	• **A part of** East-West Economic Corridor • **Road maintenance done according to the private BOT system**(Bridges are under direct control of **PWD**)	• Many urban areas and villages scattered along the route with facilities found located within a part of ROW • In case of road widening, resettlement of residents may be necessary.

Source: JICA Study Team

3. Transport Demand Forecast

3.1 Socio-economic Framework

Transport demand is determined by economic activities and demographic changes in the target area. For the purpose of this project, the demographic estimation has been developed for the regional population and GDP until the time horizon of 2030.

- ✓ The population is expected to grow at 0.9% per annum between 2012 and 2030.
- ✓ The growth in GDP is expected to average 7.1 % per annum resulting in a growth in GDP per capita of 6.1% per annum.

3.2 Demand Forecast

The base year was set as 2013 and the target years were set as 2015, 2020 and 2030. Traffic Analysis Zone (TAZ) was set to approximate the districts of the Union.

3.2.1 Passenger Demand Forecast

Passenger demand is forecasted based on the four-step estimation method. Based on the statistical information and traffic survey, existing inter-zonal traffic volume was estimated. Trip generation was estimated as a function of the future socio-economic indicator of each zone.

Furthermore, modal share of each transportation mode was estimated comparing travel time and cost of each transportation mode between each zone.

Population growth, economic development and improvement of income level will increase the trip generation volume. Considering examples of economic development and traffic growth in neighboring countries, the GDP elasticity of trip generation from each zone from 2013 to 2015 and from 2015 to 2030 were defined as 1.0 and 1.2, respectively. Total Trip generation in 2013 is approximately 300 thousand persons per day. Trip generation in 2020 and 2030 is estimated 0.55 million persons and 1.4 million persons, respectively.

Table 3 Total Trip Generation, GDP and GDP Growth Ratio

	Y2013	Y2015	Y2020	Y2030
Total Trip Generation (Persons / day)	300,448	347,118	555,311	1,397,685
GDP (Billion Kyat)	49,901	56,567	80,078	160,500
Annual Average GDP Growth Ratio (%)		6.5%	7.2%	7.2%

Source: JICA Study Team

3.2.2 Freight Demand Forecast

Domestic cargo in Myanmar is carried by a wide range of transport modes; inland water transport, coastal transport, railway and road transport. The future freight demand can be estimated, obtaining the freight and transport characteristics of these transport modes.

Following tables and figures show the results of forecasted future domestic cargo OD.

Table 4 Forecasted Future Cargo Volume in 2020

unit: 1,000 ton/day

	Truck	Inland water	Railway	Coastal	Total
1 Live Animal & Animal Products	2.3	0.0	0.0	0.0	2.4
2 Fish and Aquatic Products	5.0	0.0	0.0	0.0	5.1
3 Vegetable and Fruits	8.8	0.0	0.0	0.0	8.9
4 Grain and Grain Products	61.6	1.3	0.7	2.1	65.7
5 Other Agricultural Products (ex. Plantation Product)	32.1	1.5	0.3	0.0	33.8
6 Foodstuff, Beverage and Animal Food	28.8	2.2	4.0	5.2	40.1
7 Petroleum, Oil and Gas	9.5	8.3	0.8	24.7	43.3
8 Coal, Ore, Stone and Sand	18.5	0.3	0.8	0.0	19.6
9 Cement, Construction Material (incl. steel-frame)	46.7	3.6	5.8	2.0	58.2
10 Fertilizer (incl. Urea)	20.0	0.1	0.1	0.0	20.2
11 Garment, Textiles and fabric	5.1	0.2	0.1	0.0	5.3
12 Wood and Wood Products	5.2	0.7	2.4	0.0	8.4
13 Paper and Printed Matter	1.9	0.0	0.1	0.0	2.0
14 Metal and Metal Products (excl. construction material)	3.0	0.2	0.5	0.0	3.6
15 Industrial Material, Chemicals	9.5	0.7	0.5	0.5	11.2
16 Household articles, miscellaneous	40.0	2.7	1.1	0.4	44.2
17 Machinery and Parts, Transportation	13.4	0.3	0.2	0.1	13.9
Total	311.5	22.2	17.4	34.9	386.0
Share	81%	6%	4%	9%	100%

Source: JICA Study Team

Table 5 Forecasted Future Cargo Volume in 2030

unit: 1,000 ton/day

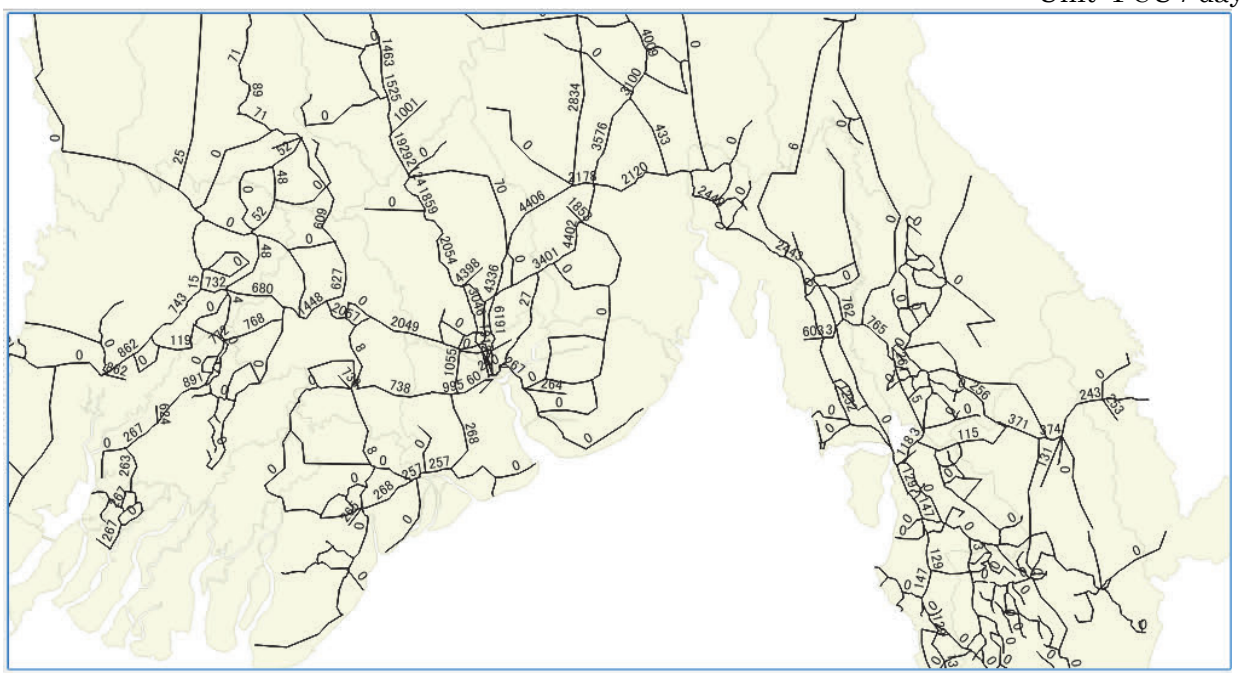
	Truck	Inland water	Railway	Coastal	Total
1 Live Animal & Animal Products	4.2	0.1	0.0	0.0	4.3
2 Fish and Aquatic Products	13.0	0.0	0.0	0.0	13.0
3 Vegetable and Fruits	15.5	0.0	0.0	0.0	15.6
4 Grain and Grain Products	157.4	3.2	1.8	4.4	166.9
5 Other Agricultural Products (ex. Plantation Product)	104.0	5.0	0.8	0.0	109.9
6 Foodstuff, Beverage and Animal Food	56.2	3.5	7.6	8.9	76.2
7 Petroleum, Oil and Gas	30.3	21.0	1.9	63.9	117.1
8 Coal, Ore, Stone and Sand	63.4	0.8	2.6	0.0	66.9
9 Cement, Construction Material (incl. steel-frame)	136.9	10.1	15.5	4.2	166.7
10 Fertilizer (incl. Urea)	33.3	0.2	0.2	0.0	33.7
11 Garment, Textiles and fabric	9.4	0.3	0.1	0.0	9.8
12 Wood and Wood Products	9.1	1.1	4.2	0.0	14.4
13 Paper and Printed Matter	3.1	0.0	0.1	0.0	3.2
14 Metal and Metal Products (excl. construction material)	5.8	0.3	0.8	0.0	6.9
15 Industrial Material, Chemicals	19.6	0.9	1.0	0.9	22.3
16 Household articles, miscellaneous	106.2	7.1	2.8	0.8	116.8
17 Machinery and Parts, Transportation	27.4	0.5	0.3	0.1	28.3
Total	794.9	54.3	39.8	83.1	972.1
Share	82%	6%	4%	9%	100%

Source: JICA Study Team

3.2.3 Traffic Assignment for Pre-Feasibility Study on Road Improvement Project

Based on the estimated passenger and freight distribution, described in the previous sections, the vehicular OD matrix is developed, applying the average number of the passengers (for passenger car and bus) and average loaded volume (for trucks). The 2013, 2020 and 2030 vehicular OD matrixes are prepared and assigned to the existing and future road networks. The following figures show the result of the traffic assignment.

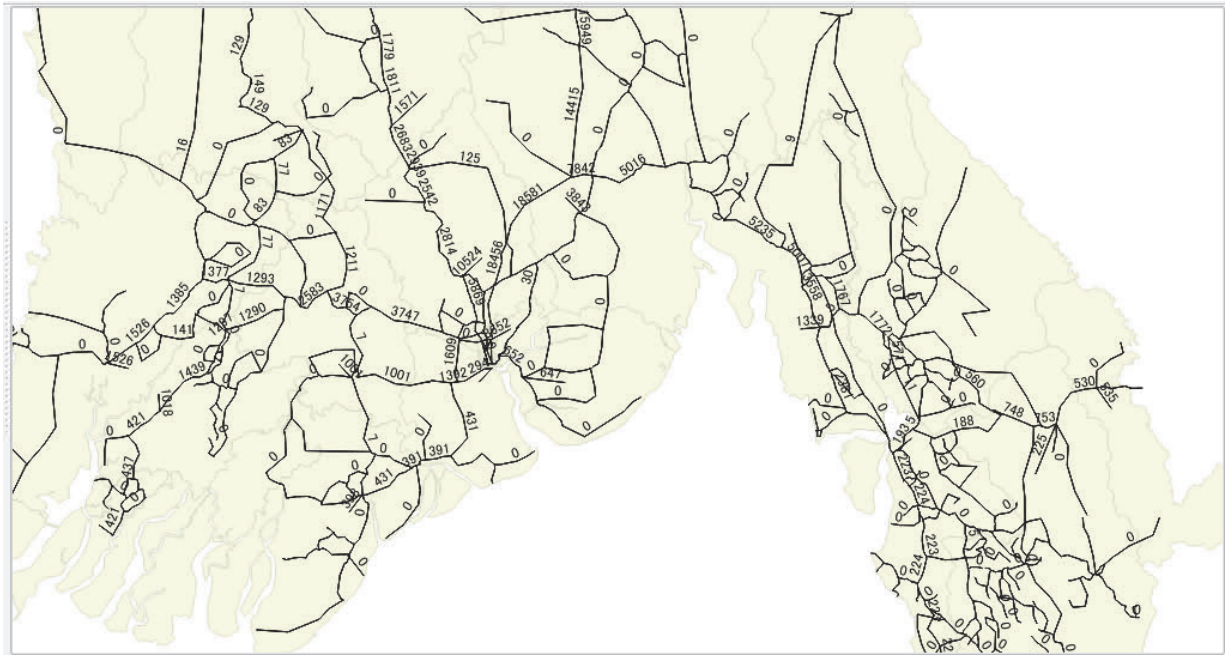
Unit: PCU / day



Source: JICA Study Team

Figure 2 2013 Traffic Assignment (Yangon and Southern Regions)

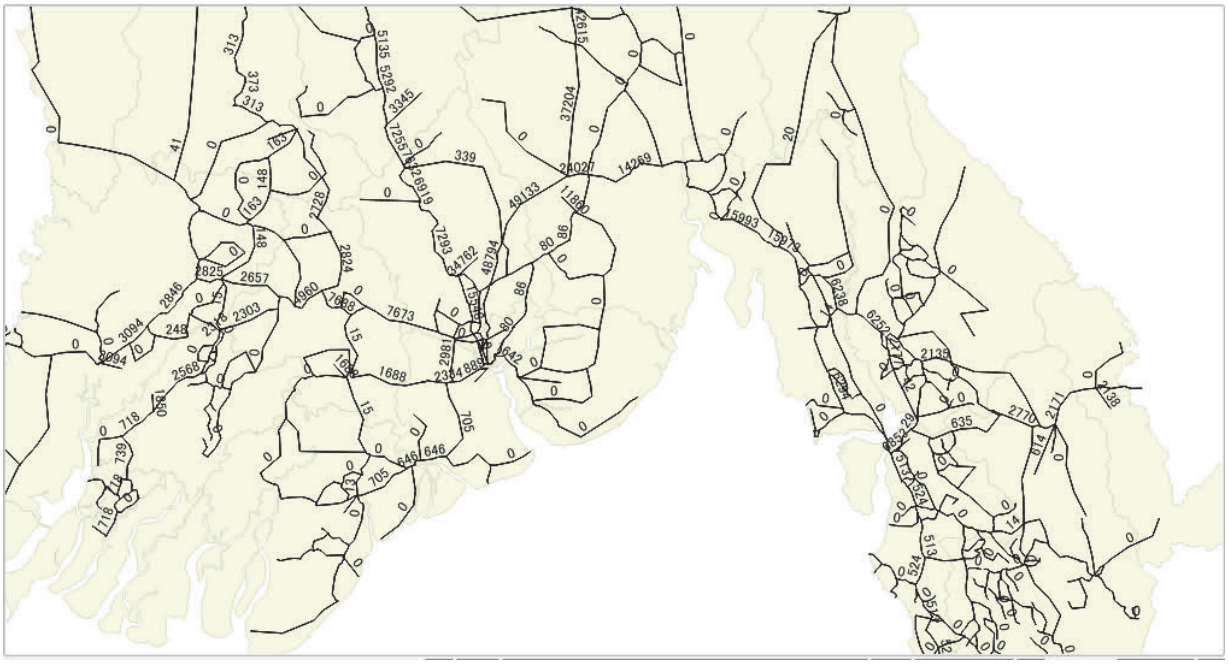
Unit: PCU / day



Source: JICA Study Team

Figure 3 2020 Traffic Assignment (Yangon and Southern Regions)

Unit: PCU / day



Source: JICA Study Team

Figure 4 2030 Traffic Assignment (Yangon and Southern Regions)

4. Selection of Priority Project

4.1 Selection of Priority Route

The priority project is selected from following viewpoints:.

- Road and bridge projects where are located on the international roads and predicted that the traffic demands rendered by increase of cross border vehicles from other countries.
- Road projects which requires for the road improvement to classify into ASEAN Class-III (standard width of road is 10m) taking into account the constraint for topographic, road alignment, surrounding conditions, maintenance, and road side environment, etc.
- Bridge project which length is more than 50 m and constrains the traffic flow due to insufficient width, unsuitable alignment, aging, and damaged should be replaced.

The projects which other donor has pledged for the financial assistance or other entities' involvement with the implementation should be excluded. In addition, the road sections which are being maintained by the private sectors under the Build & Operation contract should also be excluded to avoid the conflict of ownership for the road assets.

4.2 Listing the Candidate Projects

Upon the study of the route section mentioned above, the priority list for road and bridge will be established to select the candidate for the priority projects to be implemented by Japanese Government. The listing of the project will be conducted by two stage selection method as follows:

- First Stage: Selection of Priority Route in the target area

- Second Stage: Listing of Priority Project upon comparison study in the priority routes

Considering the assessments of road network mentioned above, the comparison study has been conducted to select the priority project taking into account the road status as national highway network, surrounding environment and the existing plan in the Public Works.

Table 6 List of Candidate Section

Candidate Section			Length	No. Lane	Paved by	Long spanned bridge
1	Payazi-Mawlamyine (200km)	Payagyi－Thaton	130km	2	AC	
		Thaton－Mawlamyine	70km	2	AC	
2	Eindu-Myawaddy (120km)	Eindu－Kawkareik	70km	2	Machadam	Gyaing Kawakareik Br
		Kawkareik－Myawaddy	32km	1	N/A	
			18km	2	AC	
3	Thaton－Eindu		60km	2	AC	DonTami Br, NaugLon Br
4	Mawlamyine- Eindu		40km	1.5	Macadam	Gyaing Zathapyin,Br Atran Br.

Source: JICA Study Team

4.2.1 Priority Projects

(1) Replacement of Five Bridges on East West Economic Corridor

1) Objective

Five candidate bridges, which are located on the East West Economic Corridor (EWEC) running through Indochina peninsula, are crucially damaged and have potentially a risk for the collapse. With replacing these bottleneck bridges will ensure a stable logistic corridor by solving the issue of insufficient capacity for supporting the current traffic loads that will be expected for positive impact on poverty reduction and economic spillover effect. On the other hand, solving the current constraint for allowable traffic load less than 30 ton will facilitate the development of regional access, Eg. a pontoon bridge located beside the existing river.

Public Works expedites the improvement of infrastructure of EWEC with financial assistances from Thailand, ADB and other donors. On the other hand, the existing infrastructure cannot meet the traffic demand by increasing the size of vehicles for cross border freight vehicles. The improvement of bridge structure has very significant aspect focused on the integration of ASEAN to take a role for strengthening a link with other partner's economic.

2) Contents of Project

ADB is scheduled to provide a financial assistance for the improvement of the section between Kawkareik and Eindu (Approximately 70km). The Gyaing Kawkareik Bridge is located in this section however the replacement or rehabilitation of the bridge is not clearly intended by the financial assistance of ADB. Public Works intends to replace the existing 17 bridges as priority in terms of urgency of requirements. The bridge is located in the area jurisdiction of Kayin State Government therefore the land acquisition will be incurred for its replacement beside the existing bridge. Public Works intends to remain the existing bridge to use it for light weight vehicles after renovating the members in the future.

Table 7 shows the summary of priority projects which are required to conduct with necessary financial assistances.

Table 7 Priority Project to be implemented by Financial Assistances (1)

	Project Name	Contents	Length
Bridge	(1) Don Tha Mi Bridge	Replace with new two lanes bridge	200m
	(2) Naung Lon Bridge	Ditto	180m
	(3) Gyaing Kawakareik Bridge	Ditto	415m
	(4) Gyaing Zathabyin Bridge	Ditto	880m
	(5) Atran Bridge	Ditto	430m

Source: JICA Study Team

3) Outstanding Issue

Public Works intends to build new bridge at the upstream side of existing bridge between the existing bridge and temporary pontoon bridge where would not be incurred for involuntary resettlement.

(2) Thaton Bypass (including partial widening for the existing rural roads)

1) Objective

The section between Thaton and Eindu, which connects directly to Yangon metropolitan region, has higher traffic volume than that of former section. Especially, the number of freight vehicles occupies more than 50% of current traffic volume. Therefore, it currently causes traffic safety issues since the large freight vehicles run through Thaton of which is 2nd highest populated town followed after Mawlamyin in South East Region of Myanmar. Under these circumstances, the construction of new bypass is recommended to detour the traffic from Thaton city not to flow the heavy freight vehicle into local communities. It would be possible to solve the problems and enhance the efficiency of the traffic flow on the East West Economic Corridor in the future. The current traffic passing through Thaton city is meandered once to the south and up north. The bypass passing through maintenance terrain will render a merit for shortening a distance of about 9km, as well as improve the travelling condition.

2) Contents of Project

Construction of new bypass on Ease West Economic Corridor (Approximately 30km)

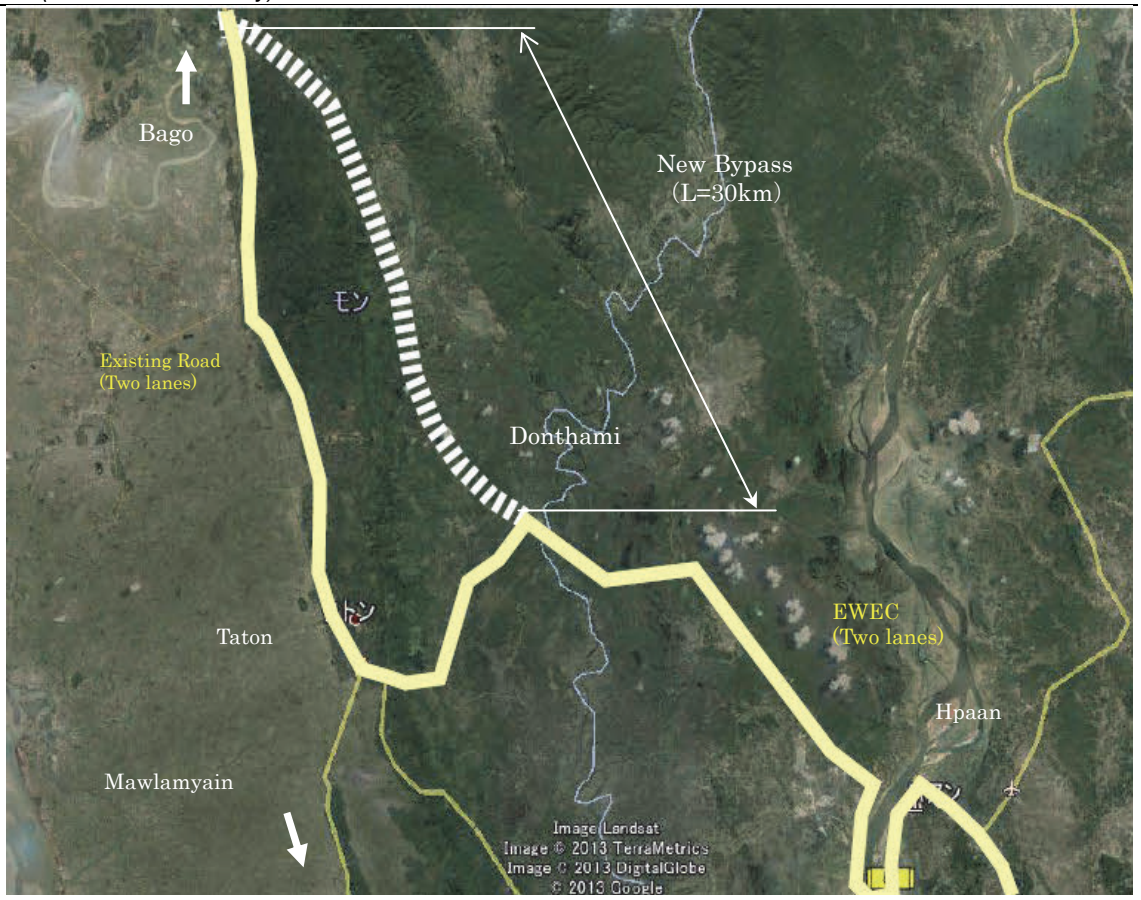
Table 8 Priority Project to be implemented by Financial Assistance (2)

	Project Name	Contents	Length
Road	(6) Thaton Bypass	Two lane with pave shoulder(Class-II)	30km

Source: JICA Study Team

3) Execution Period

Detailed Design／Procurement: App. 14 Month, Total Construction: Appx 42 months.



Source: JICA Study Team

Figure 5 Location of the Thaton Bypass Project

5. Preliminary Study

5.1 Design Standards

5.1.1 Road Geometric Standards

Myanmar standards (Union Highway Standards) which established in 2004, applies very unique value of standards so that they are unable to use similarly with international standards. It is recommended having further discussions when deciding the design standards before starting the design works.

Table 9 Comparison of Road Geometric Design Standards

Major Criteria (Two lane; Hilly)	Optional Cross Section and Criteria			
	Asian Highway Class II	ASEAN Highway (GMS Corridor) Class II	Union Highway (PW) D-III	Thai Bypass
Design Speed (km/h)	60	60-80	50	50
Traffic Lane (m)	3.50	3.50	3.66 (12ft)	3.50
Carriageway (m)	12.0	12.0	12.2 (24ft)	10.0
Paved shoulder(m)	2 x 2.50	2 x 2.50	2 x 2.44 (2x8ft)	2 x 1.50
Max. vertical grade(%)	5	7	4	9
Min. Horizontal radius of curve (m)	115	110	130	120
Cross-fall	Asphalt/ Cement Concrete Pavement			
Carriageway (%)	2-3			
Shoulder (%)	3-6			
Superelevation (%)	10	10 (6)	6	10
Design Live Load (Min.)	HS20-44			
ROW	30m (100ft)*			

* Road accessories include ROW

Source: JICA Study Team

5.2 Road Design (Bypass Construction, Bridge Approach Section)

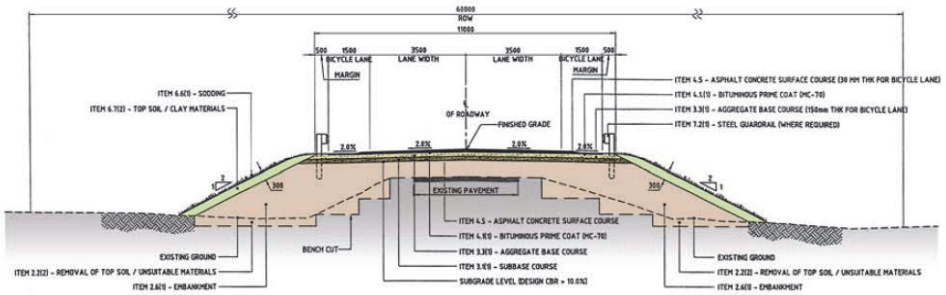
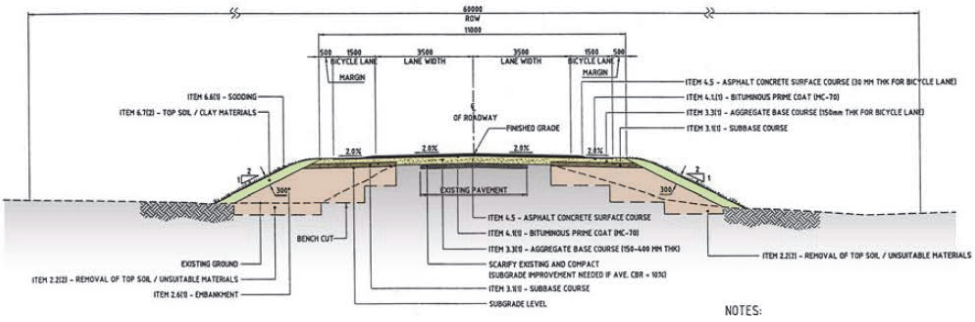
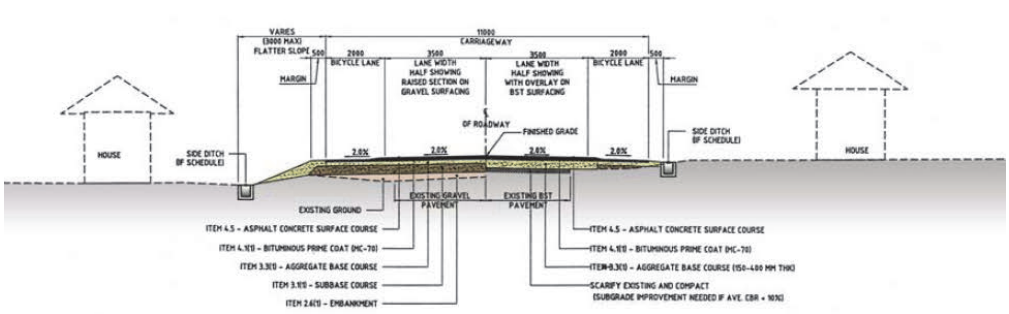
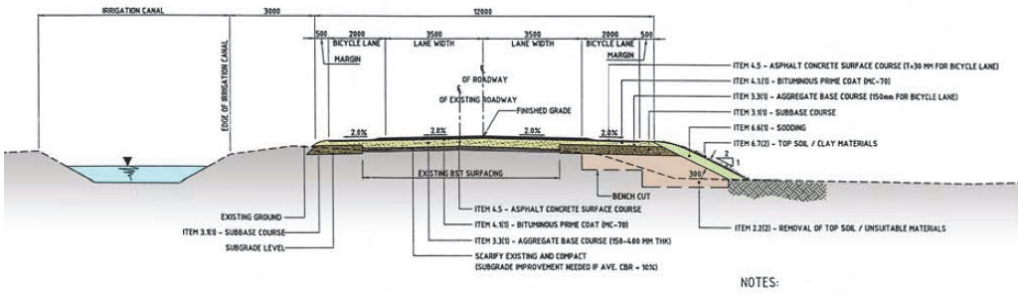
5.2.1 Road Improvement

The improvement works are summarized as below.

- Uplifting the embankment height not to submerge during the flood
- Secure adequate sight distance around the section of bridge approach road by improving alignment
- Widening to 7.0m carriageway plus 1.5m paved shoulder (Township 2.0m, 0.5m verge)
- Asphalt concrete pavement, cement concrete pavement, and DBST, etc.
- Installation of side ditch and drainage system considering erosive slope
- Installation of safety facilities, divider between carriageway and sidewalk
- Road facilities (guidance for control, foot crossing and marking)

Road Improvement plan needs to be established taking into account different terrain, land use, available width of ROW in each respective section. The standard cross section with road improvement plan applied in this pre-feasibility study is provided in Table 6.

Figure 6 Standard Cross Section with Road Improvement Plan

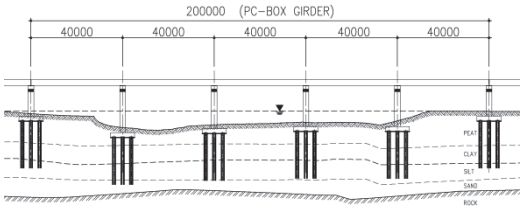
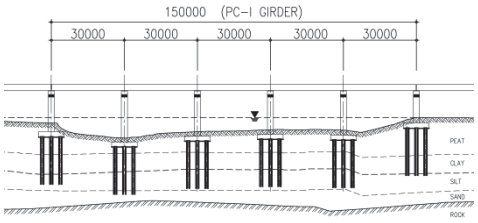
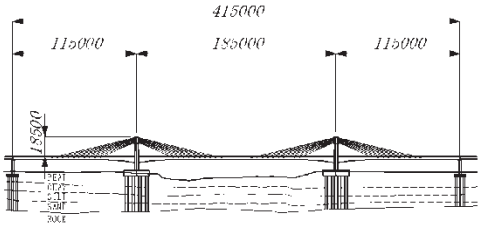
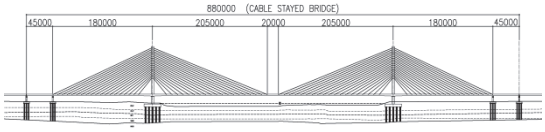
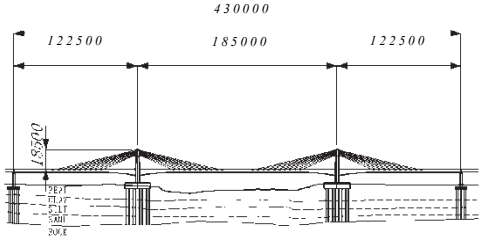
Option	Standard Cross Section with Road Improvement Plan
Type-R1	 Uplifting Embankment Section
Type-R2	 Widening Section with Overlay Section
Type-R3	 Populated Area Section
Type-R4	 Low land and swampy area Section

Source: JICA Study Team

5.2.2 Preliminary Study for Five Bridge

As the results of studies, the replacement features of each bridge are shown in Table 10.

Table 10 Main bridge type of five bridges in the East-West Economic Corridor (draft)

Main bridge type as selected by the pre-FS	Features
【Don Tha Mi Bridge】L=200 (5x40m) 	• Structural type: 5-span continuous pre-stressed concrete box-girder bridge (span length: 40m, bridge length: 200m) • Constructive property: General bridge type. The girder height of uniform section is about 2.5m, so that the girder height increases with increasing span length. • Workability: Foundation and substructure are to be constructed under water, so that due care must be taken on the timing of construction. For superstructure, all-staging construction is assumed. • Maintenance: Concrete bridge, whose maintenance is easy to perform • Economy: Inexpensive • Japanese technologies: Rotary all-casing method (pile driving method) • Construction costs: 1.2 billion yen
【Naung Lon Bridge】L=150m (5x30m) 	• Structural type: 5-span continuous pre-stressed concrete I-girder bridge (span length: 30m, bridge length: 150m) • Constructive property: General bridge type. The girder height is about 2.2m. • Workability: Workability is good in dry season because the foundation and substructure can be constructed in almost dry state. The superstructure will be constructed using the crane. • Maintenance: Concrete bridge, whose maintenance is easy to perform • Economy: Most inexpensive • Japanese technologies: Rotary all-casing method (pile driving method) • Construction costs: 1.0 billion yen
【Gyaing (Kawkareik) Bridge】L=415m (115+185+115) 	• Structural type: 3-span continuous pre-stressed concrete extradosed bridge (center span length : 185m, bridge length: 415m) • Constructive property: Extradosed Bridge with the whole of superstructure constructed as a pre-stressed concrete box girder structure. Main girder will be erected as cantilever on sides from the main tower, achieving suspension on two sides. • Workability: Foundation work will be done in the river edge, so that cofferdam is necessary. Superstructure to be erected as cantilever. • Maintenance: Concrete made, except for the cable, so that maintenance is easy to perform. • Economy: Medium • Landscape: Main tower has a symbolic value and may become a landmark. • Japanese technologies: Extradosed bridge, steel pipe sheet pile open-caisson foundation • Construction costs: 2.0 billion yen
【Gyaing (Zathapyin) Bridge】L=880m (45+180+430+180+45) 	• Structural type: 2-span continuous pre-stressed concrete cable stayed bridge (main bridge section: span length: 430 m, side span length: 225m) • Constructive property: Cable stayed bridge with the whole of superstructure constructed as a steel box girder structure. Main girder will be erected as cantilever on both sides, achieving suspension on one side. Girder height is about 3.0 m. • Workability: Foundation and substructure works, and main tower will be the large-scale underwater construction work. The superstructure to be erected as cantilever. • Maintenance: Maintenance of bracing cable necessary • Economy: Most expensive • Landscape: Main tower has a symbolic value and may become a landmark. • Japanese technologies: Steel pipe sheet pile open-caisson foundation, weather-resistant steel plate (steel girder) • Construction costs: 7.0 billion yen
【Atran Bridge】L=430m (122.5+185+122.5) 	• Structural type: 3-span continuous pre-stressed concrete extradosed bridge (center span length: 185m, bridge length: 430m) • : Extradosed bridge with the whole of superstructure constructed as the pre-stressed concrete box girder structure. Main girder will be erected as cantilever on sides from the main tower, achieving suspension on two sides. • Workability: Foundation work will be done in the river edge, so that cofferdam is necessary. Superstructure to be erected as cantilever. • Maintenance: Concrete made, except for the cable, so that maintenance is easy to perform. • Economy: Medium • Landscape : Main tower has a symbolic value and may become a landmark. • Japanese technologies: Extradosed bridge, Steel pipe sheet pile open-caisson foundation • Construction costs: 2.5 billion yen

6. Construction Plan

6.1 Formation of Construction Package (Contract Package)

The replacement of five bridges on EWEC should be divided into two contact packages taking into account the efficiency of work arrangements during the implementation. 5 bridges replacements and construction of Thaton bypass, the contract package is assumed in Table 11.

Table 11 Construction Package

Package	Length (distance of each bridge)	Candidate Bridges	No. of Bridge
Package-1	Appx. 130km	① Don Tha Mi ② Naoung Lon ③ Gyaing (Kawkareik)	3
Package-2	Appx. 15km	④ Gyaing (Zathabyin) ⑤ Atran	2
Package-3	Appx. 28km	Thaton Bypass	Small scaled bridge (6)

6.2 Construction Plan for Five Bridges Replacements

It is assumed that three bridges will be constructed in Package-1 and two brides will be constructed in Pakcage-2.

Table 12 Bridge Replacement Plan

Package / Contents	Location	Bridge type	Width	Length
Package-1 (Thaton – Eindu)				
Don Tha Mi Bridge	34km	Five span continuous PC box girder bridge	W=10.0m	L=200m
Naulong Bridge	42km	Five span continuous PC girder bridge	W=10.0m	L=150m
Gyain (Kawkareik) Bridge	79km	PC Extradosed Bridge	W=10.0m	L=415m
Package-2 (Eindu – Mawlamyin)				
Gyain (Zathabyin) Bridge	85km	PC Cable Stayed Bridge	W=10.0m	L=880m
Atran Bridge	87km	PC Extradosed Bridge	W=10.0m	L=430m

6.3 Construction Plan for Thaton Bypass

Each of plants and stockyards located in construction yard are assumed as follows:

Table 13 Plant and Stockpile in Construction Yard

Begining and end of bypass	Asphalt plant
	Crushing plant
	Stockpile (borrow)

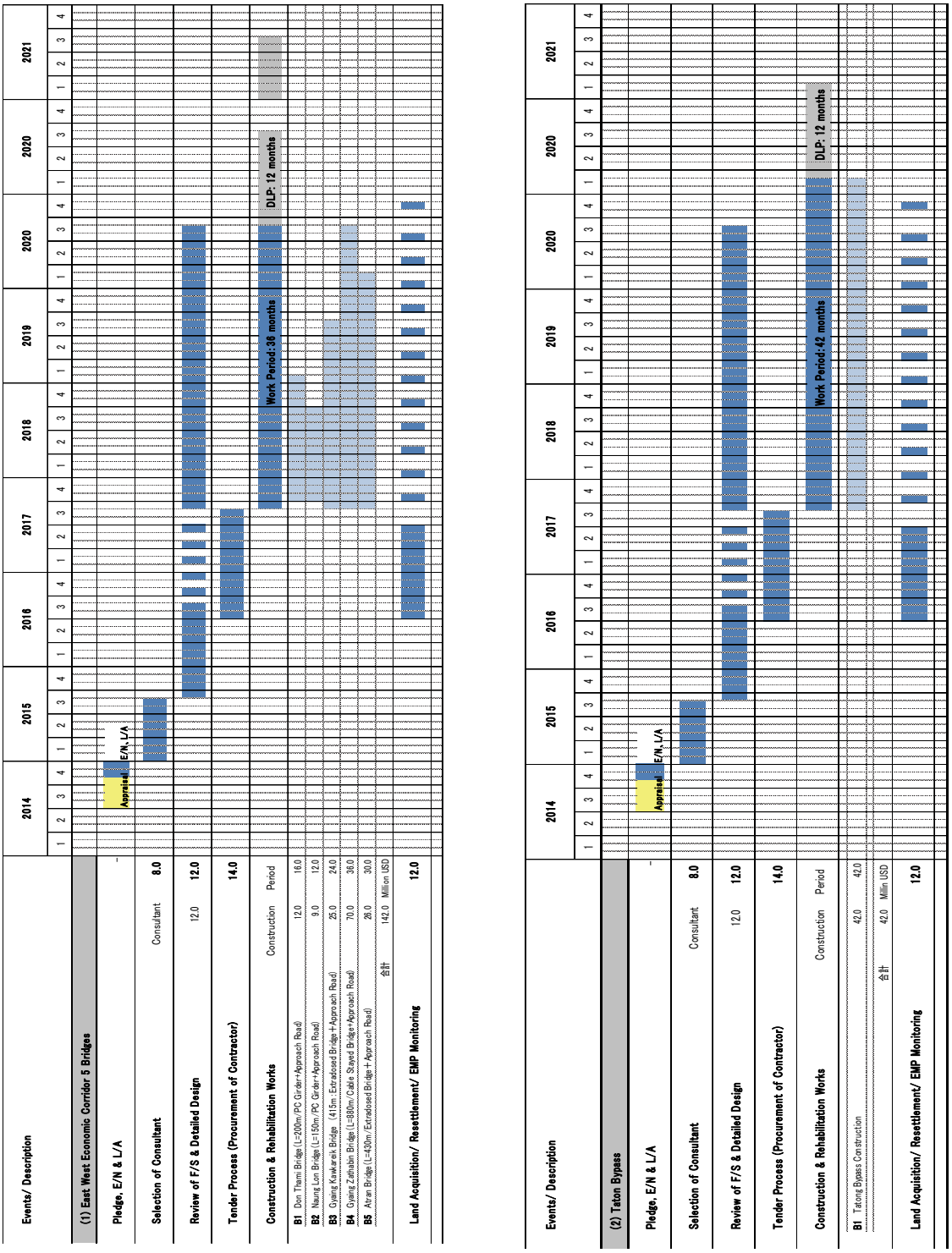
Average hauling distances for each of materials are shown in Table 14.

Table 14 Average Distances for Each of Materials

Contract Package	Materials	Borrow site, rock quarry ⇔ Plants	Average distance from plant	Remarks
Package-3	Borrow	10km	15km	
	Crusher run	20km	35km	
	Asphalt	-	0～28km	
	Concrete	10km (Crusher run)	15km	For minor 6 bridges

6.4 Implementation Schedule

The project implementation schedule is separately provided below since the construction of Thaton bypass is to be separately conducted as shown in Table 15.



Source: JICA Study Team

Table 15 Implementation Schedule (Package 1, 2 & 3)

7. Preliminary Cost Estimation

7.1 Estimation of Project Cost

(1) Compensation Cost

The following cost items are excluded from the project costs because Myanmar side should be responsible for the relevant compensations costs, price escalation and contingencies.

- Land acquisition cost
- Compensation for removal of buildings
- Price escalation and physical contingency

(2) Construction Cost

Construction cost should be estimated based on the technical specification prepared at the stage of detailed design. Some indirect costs such as contractor's administration cost, which shall be appropriately distributed and added on each "pay item", are also calculated as individual items at this pre-F/S stage.

(3) Engineering Costs (Consultant Fee)

The following costs are estimated as the engineering cost of each stage.

- Detailed design costs
- Tender assistance cost
- Construction supervision cost

(4) Operation and Maintenance Costs

The operation and maintenance costs shall include the cost of daily maintenance and periodic maintenance of bridge and roads including overlay of pavement, replacement of bridge bearing shoe and expansion joints.

7.2 Preliminary Project Cost

(1) Construction Cost

The construction cost for each respective work section is shown in Table 16.

Table 16 Breakdown of Project Cost

Unit: Million USD

Project Cost	Bridge Replacements on EWEC		Thaton Bypass Construction (Package -3)
	Section -1 (Donthami) (Naulong) (Gyaing・Kakareik) (Package – 1)	Section-2 (Gyaing・Zathapyin) (Atran) (Package – 2)	
Construction	42.78	89.28	39.06
Design & Supervision:7%	3.22	6.72	2.94
Contingency (Admin) : 2%	0.92	1.92	0.84
Total Project Cost	50.14	104.64	42.84
	154.78		

(2) Operation and Maintenance Cost

The maintenance cost to be born by Myanmar side is shown in Table 17. The costs are varied depending on the specifications of pavement structure and type of structure therefore these cost should be reviewed at the following design stage and confirm the maintenance costs concretely.

Table 17 Operation and Maintenance Cost

Items		Cost (Million USD)
Routine maintenance (Road & Bridge) costs per year	Bridges replacement on EWEC	0.04
	Thaton Bypass	0.06
Periodic maintenance (road & bridge) costs per year (Rehabilitation)	Bridges replacement on EWEC	0.71
	Thaton Bypass	6.30

* The above cost should be reviewed in accordance with the maintenance expenditures of PW

8. Environmental and Social Consideration

8.1 Scope of Preliminary Environmental Assessment

8.1.1 Survey Area

A preliminary environmental assessment was carried out for identifying environmental and social impacts likely caused by road development. The output was reflected to design the proposed project explained in this Pre-feasibility Study. The survey area covers the following three routes:

1) Payagyi – Mawlamyine Route
2) Thaton – Eindu Route and
3) Mawlamyine- -Myawaddy Route.

Main components to be assessed are summarized as below:

- Road improvement with pavement and renovation of road shoulders;
- Road widening to up to four lanes;
- Construction of by-pass roads (e.g. Kyaikhto, Theingseik, Thaton, and Yinngyein);
- Reconstruction of bridges (e.g. Don Tha Mi Br., Naung Lon Br., Gyaing (Kawkareik) Br. and Gyaing (Za Tha Pyin) Br.) and renovation.

Through a result of preliminary evaluation, construction of by-pass road in Thaton and re-construction of above five bridges are selected as a proposed project.

8.2 Environmental Impacts

Environmental impacts are assessed for the following two divided components:

- By-pass road construction in Thaton
- Replacements of five bridges

8.2.1 By-pass road construction in Thaton

Assumed environmental impacts are summarized as follows:

Table 18 Environmental Impacts by By-Pass Road Construction in Thaton

	No.	Impacts	Design	Construction	O&M
Social Environment:	1	Land Acquisition, Involuntary Resettlement	A-	D	D
	2	Local Economy Such as Employment, Livelihood, etc.	C-	B+	B+
	3	Land Use and Utilization of Local Resources	C-	C-	D
	4	Social Institutions Such as Social Infrastructure and Local Decision-Making Institutions	C-	D	D
	5	Existing Social Infrastructures and Services	D	D	D
	6	Traffic Congestion	D	C-	C+
	7	Community Division	D	B-	B-
	8	Indigenous and Ethnic People	D	D	D
	9	Misdistribution of Benefits and Damages	C-	C-	D
	10	Natural / Cultural Heritages	D	D	D
	11	Local Conflict	D	C-	C-
	12	Water Usage, Water Rights and Rights of Common	D	D	D
	13	Sanitation	D	C-	D
	14	Hazards (Risk) Infectious Diseases Such as HIV/AIDS	D	C-	D
Natural Environment	15	Topography and Geological Features	D	D	D
	16	Soil Erosion	D	C-	D
	17	Ground Water	D	C-	D
	18	Hydrological Condition	D	D	D
	19	Ecosystem, Flora, Fauna	D	D	D
	20	Meteorology	D	D	D
	21	Landscape	D	D	D
	22	Global Warming	D	D	D
Pollution	23	Air Pollution	D	C-	B-
	24	Water Pollution	D	B-	D
	25	Soil Contamination	D	B-	D
	26	Waste	D	B-	D
	27	Noise and Vibration	D	C-	B-
	28	Ground Subsidence	D	D	D
	29	Offensive Odor	D	D	D
	30	Bottom Sediment	D	D	D
	31	Accidents	D	C-	B-

Source: JICA Study Team

Rating:
A+/-: Significant positive/negative impact is expected
B+/-: Positive/negative impact is expected to some extent
C+/-: Scale of impact is unclear, need further study
D : No / less impact is expected

8.2.2 Replacements of Five Bridges

Assumed environmental impacts are summarized as follows:

Table 19 Environmental Impacts by Re-building Five Bridges

	No.	Impacts	Design	Construction	O&M
Social Environment:	1	Land Acquisition, Involuntary Resettlement	A-	D	D
	2	Local Economy Such as Employment, Livelihood, etc.	C-	B+	D
	3	Land Use and Utilization of Local Resources	C-	C-	D
	4	Social Institutions Such as Social Infrastructure and Local Decision-Making Institutions	C-	D	D
	5	Existing Social Infrastructures and Services	D	D	D
	6	Traffic Congestion	D	C-	C+
	7	Community Division	D	B-	B-
	8	Indigenous and Ethnic People	D	D	D
	9	Misdistribution of Benefits and Damages	C-	C-	D
	10	Natural / Cultural Heritages	D	D	D
	11	Local Conflict	D	C-	C-
	12	Water Usage, Water Rights and Rights of Common	D	C-	D
	13	Sanitation	D	C-	D
	14	Hazards (Risk) Infectious Diseases Such as HIV/AIDS	D	C-	D
Natural Environment	15	Topography and Geological Features	D	D	D
	16	Soil Erosion	D	B-	D
	17	Ground Water	D	C-	D
	18	Hydrological Condition	D	B-	D
	19	Ecosystem, Flora, Fauna	D	C-	D
	20	Meteorology	D	D	D
	21	Landscape	D	D	D
	22	Global Warming	D	D	D
Pollution	23	Air Pollution	D	C-	D
	24	Water Pollution	D	B-	D
	25	Soil Contamination	D	B-	D
	26	Waste	D	B-	D
	27	Noise and Vibration	D	C-	D
	28	Ground Subsidence	D	D	D
	29	Offensive Odor	D	D	D
	30	Bottom Sediment	D	D	D
	31	Accidents	D	C-	B-

Source: JICA Study Team

Rating:
A+/-: Significant positive/negative impact is expected
B+/-: Positive/negative impact is expected to some extent
C+/-: Scale of impact is unclear, need further study
D : No / less impact is expected

8.3 Environmental Management

Environmental mitigation and monitoring are proposed as below:

Table 20 Proposal for Environmental Mitigation and Monitoring

Impact	Environmental Mitigation	Environmental Monitoring
Land acquisition, resettlement	- Public consultation with resettled households - Clear compensation process based on a RAP study - For farmland, acquisition of land and property (e.g. crops) after harvesting	- Site reconnaissance - Hearing resettled persons regarding their living condition after relocation - Consultation meeting cooperated with academics, NGOs, etc.
Local Economy	- Priority to local residents/communities for employment	- Interview/hearing to residents regarding their perception and complaints - Direct observation
Community Diversion	By-pass road - Install level crossing - Public awareness for safety on crossing road, e.g.	- Interview/hearing to residents regarding their perception and complaints - Direct observation
Soil Erosion	Bridge construction - Install drainage canal to control water flow - Reinforce river bank by masonry, e.g.	- Direct observation - Interview/hearing to residents
Hydrological Condition	Bridge construction - Install drainage canal to control water flow, and to avoid turbid water directly discharging to river	- Direct observation - Survey on fishing productivity - Interview/hearing to residents
Water Pollution	- Install temporary drainage canal (culvert) for smooth water flow - Closed drainage canal development for wastewater - Prohibition of discharging domestic water from construction sites without adequate treatment	- Measurement (e.g. water quality, turbidity, pH, oil content) - Direct observation - Hearing to local residents on their perception and complaints
Soil Contamination	Bridge construction - Prohibition of discharging domestic water from construction sites without adequate treatment - Collection of residue of oils, including lubricating oil	- Direct observation - Hearing to local residents on their perception and complaints
Waste	- Preparation of a temporary waste dumping site during storage - Development of a closed drainage canal for wastewater and prohibition of discharging without adequate treatment - Installation of a signboard to prohibit waste dumping in inappropriate areas - Collection of residue of oils, including lubricating oil - Prohibition of placing materials (e.g. soil, gravel, and sand) on roadside or any other areas outside the project site - Installation of a fence to clarify the boundary between the project site and beyond - Reuse of sand materials for road improvement and others	- Site observation, - Examination of record of type and volume of waste, proportion of recycling/reuse

Source: JICA Study Team

8.4 Procedure for Environmental Impact Assessment (EIA)

Concrete steps for undertaking EIA are stipulated in the EIA Procedures. While it is yet to be finalized, a draft of the document and results of the interview to ECD (Environmental Conservation Department) in MOECAF (Ministry of Environmental Conservation and Forestry) officers reveal the EIA process in Myanmar to be generally as follows:

1) All development projects in Myanmar are subject to an environmental screening process through which, projects will be judged if they require any environmental review and if so, at which level (i.e. IEE or EIA).
2) EIA includes an environmental management plan and a social impact assessment report.
3) Public participation is required, when deemed necessary, for Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) and preparation of an Environmental Management Plan (EMP).
4) The project's executing agency forms an EIA Review Committee, which gives recommendations to the Minister of MOECAF from an environmental point of view whether to approve the EIA reports or not. The Minister makes the final decision based on this recommendation. The review period is 50 days for IEE and 90 days for EIA.
5) Members of the EIA Review Committee will be selected by the Minister of MOECAF and includes persons from the industry, academia, and civil society as well as government officials.
6) Involuntary resettlement is carried out under the responsibility of respective regional governments and hence will not be included in the EIA Procedures.
7) Costs involved in conducting EIA are to be covered by the project proponent.
8) EIA can be carried out in Myanmar only by firms that are registered under ECD/MOECAF.

8.5 Conclusion and Recommendations

Conclusion of the preliminary survey is summarized as follows:

- The ROW is basically secured along the target roads except in the towns / villages. While certain areas along the roads in the towns and villages are occupied by residential and commercial uses. Construction of by-pass road in Thaton can avoid large scale resettlement; while farmland shall be adequately compensated.
- Fishermen's villages exist beside Don Tha Mi Bridge. New bridge construction requires relocation of some houses in such villages. Similarly, reconstruction of some small bridges in the towns and villages may result in relocation of certain facilities.
- No protected area or sensitive zone is identified adjacent to the roads.

Recommendations for further assessment are described below:

– PAPs (Project Affected Persons) should be informed well in advance about the planned project. In particular, the process, schedule and others related to land acquisition, resettlement and compensation need to be explained well in accordance with the applicable

statutory and customary laws that apply to the area.

- A mechanism should be set up to properly collect PAPs opinions, complaints, etc. Those comments shall be reflected to designing the way in which compensation or other forms of relief or supporting measures are carried out.
- The level and content of compensation as well as support for resettlement should be fair; reflective to the extent possible of the needs of each PAP, and sufficient to allow the PAPs to restart their living at the same or higher level than their previous standards.
- In providing alternative sites for resettlement, sites should be selected from available lands that are close to the location of the original residence or occupation.

9. Project Evaluation and Conclusion

9.1 Economic Analysis

9.1.1 Calculation of EIRR and Sensitivity Analysis

Economic Internal Rates of Return (EIRR) of the both projects account for 30.0% (5 bridges replacement) and 13.0% (Thaton bypass), respectively. The calculated figures exceed 12%, which is commonly used for a benchmark of social discount rate in developing countries. Therefore, the project is feasible from the point of national economic development.

Table 21 Results of Sensitivity Analysis (Replacement of 5 Bridges)

Unit: Percent

Cases	EIRR
Base case	30.3
10% increase of investment cost	28.9
10% reduction of economic benefit	28.8

Source: JICA Study Team

Table 22 Results of Sensitivity Analysis (Thaton Bypass)

Unit: Percent

Cases	EIRR
Base case	13.0
10% increase of investment cost	12.2
10% reduction of economic benefit	12.0

Source: JICA Study Team

9.2 Expected Effects of the Project

9.2.1 East-West Economic Corridor (Replacement of 5 Bridges)

- Travel time between Thailand (Bangkok) and Myanmar (Yangon) would be shorter.
- Reduction of time and savings for transshipment of cargo which is caused by an issue of durability of the bridge would be expected.
- Tourism demand from Myanmar to Tak Province of Thailand would increase.
- Transport demand from the western part of Thailand to Myanmar would increase.
- Myanmar citizens who were forced to emigrate would return to their original places.
- Regional economic development along the East-West Economic Corridor, at border area and the southern part of Myanmar would be promoted.

9.2.2 East-West Economic Corridor (Thaton Bypass Construction)

- Vehicles bypassing Thaton town could save cost for fuel and travel time.
- Residents of Thaton can live safety due to the reduction of traffic at Thaton downtown.

9.3 Way Forward

9.3.1 Recommendation of Road Design in Feasibility Study

(a) Road should be satisfied with international standards as EWEC in the future development
(a) Detailed flood analysis required to set out the height of road level taking into account the remarkable heavy rain fall in 2013
(b) Coordination with private BOT project and capacity level of PWD maintenance
(c) Future development plan for infrastructure scheduled by PWD
(d) Conduct of accurate traffic demand forecast
(e) Review of pavement structure based on the accurate traffic demand forecast
(f) Collect the topographic map based on the ground survey and geotechnical information such as CBR.

9.3.2 Recommendation of Bridge Design in Feasibility Study

(a) Conduct of accurate topographic survey for preliminary design
(b) Design of bridge in satisfying international standards as EWEC in the future development of international corridor
(c) Conduct of necessary hydrological survey to decide the location of bridge
(d) Confirmation of facilities and utilities required to install on bridge prior to conduct of design