Part 2

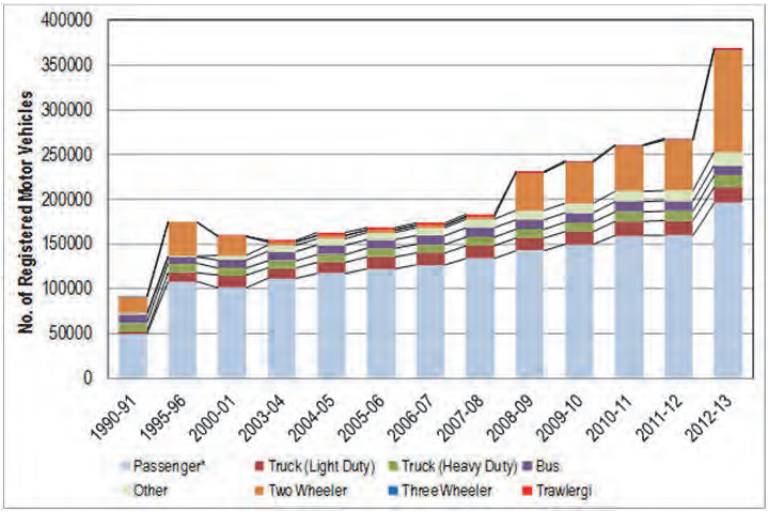
Feasibility Study on
The Yangon Circular Railway Line Upgrading Project

Chapter 1 Introduction

1.1 Background of the Project

The city of Yangon, with a population of about 5.21 million as of 2014 according to the year 2014 Census Survey, is the largest economic center of the country, and has been experiencing rapid urbanization in these days.

With the recent economic reform and corresponding deregulation, the number of imported cars has increased sharply. According to the Comprehensive Urban Transport Master Plan of the Greater Yangon (YUTRA), the number of registered vehicles in the Yangon region dramatically increased from 260,000 cars in 2011/2012 to some 370,000 cars in 2012/2013 (Figure 1.1.1). Imported used cars are used mainly for personal and business purposes such as taxi services and commodity delivery, and the Yangon residents are now suffered from serious traffic congestion. While the number of cars has increased, service level of the existing public buses has remains almost the same as before. The public buses in the city have continued to be crowded, but majority of the people have no alternative modes of public transport.



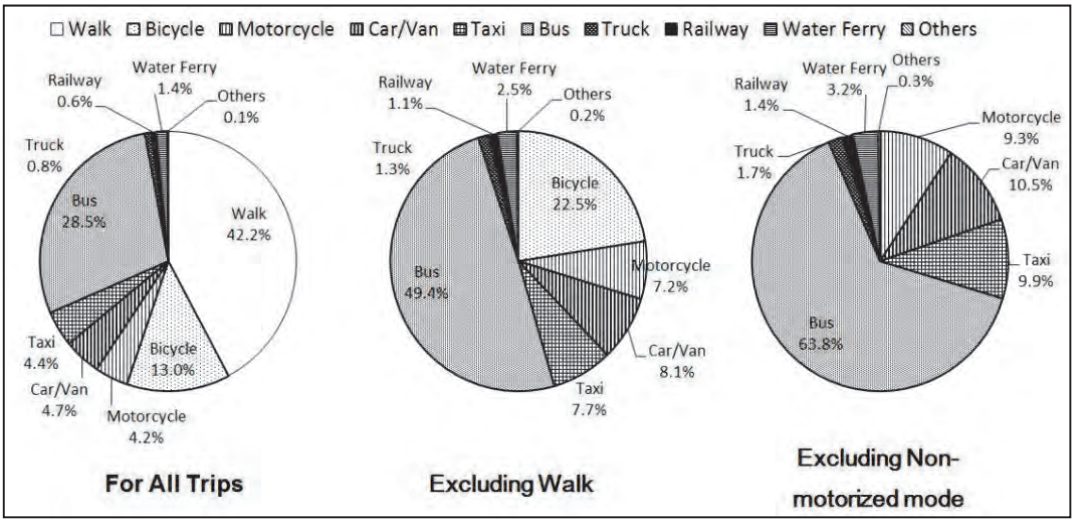
Source: YUTRA, JICA (2013)

Figure 1.1.1 The number of registered vehicles in the Yangon Region

The Yangon Circular Railway Line (herein after referred as "the YCR Line") is expected to perform as a spine urban transit system in Yangon. However, the modal share of the YCR remains low at present. Less attractive level of service of the YCR Line is resulted in a small share of rail based trips. The modal share of mechanized (representative) modes of transport in the Greater Yangon area explains the current condition as follows: 63.8% by bus, 10.5% by car/van, 9.9% by taxi, 3.2% by water transport, 1.7% by truck, and 1.4% by rail (Figure 1.1.2). Since use of motorcycles is banned in the city, bus trips are comparatively large among other modes. Actually there is almost no choice for the majority of the residents other than the crowded buses for their whole travel.

The transportation demand in Yangon city will continue to increase as the economy and the population grows (from 7.4 million in 2014 to over 10 million in the Yangon Region in 2035).

The transport model developed by YUTRA forecasts almost doubled mechanized trips, from 4.9 million trips in 2013 to 9.5 million trips by 2035. Under such circumstances, improvement of the YCR Line is considered as one of the most important transport development projects in the Yangon region, which was stated in the Myanmar Development Cooperation Forum, held in January 2013.



Source: YUTRA, JICA (2013)

Figure 1.1.2 Modal share in the Greater Yangon, 2013

Alleviation of the traffic congestion on roads paralleling the railway line is expected after completion of this Project, which generates some significant economic benefit in terms of savings in travel time, vehicle operating costs (VOC), reduction of greenhouse gases, etc. The Project is also expected to contribute to improvement of the Myanma Railways (MR) business performance through increased patronage.

1.2 Urgency of the Project

The safety level of MR has been decreasing in the last decades. On average 642 rail accidents occurred in a year during the last 10 years (including the YCR Line), which is roughly almost two accidents per day on average. Derailment consists 88.2% of the total rail accidents. Derailment within station area accounts 22.0% and derailment between stations accounts 66.2% on average of the total accidents in the last decades. With regard to the YCR Line, the particular issues are summarized as follow:

1) Decreasing level of service (speed, punctuality, riding comfort, cleanness, and safety)

   Operation of the YCR Line commenced in January 1959. After about half century since the commencement, the existing train operation speed has fallen down to almost half (15km/h) of that of the opening year, mainly because of the deteriorated tracks and limited partial rehabilitation of signalling & telecommunication system and other facilities.

2) Increasing demand

   The population in the city has been growing. The existing rail system in Yangon carries about 75,000 passengers per day in 2014, while an improved YCR Line (by the Project) is expected to carry about 700,000 passengers or more per day in 2035.

Corresponding technical problems with regard to the particular issues of the YCR Line are summarized as follow:

1) Deterioration of infrastructure, equipment, system and rolling stock

   In almost all aspects the existing rail and related facilities need improvement, including roadbed, rail track, signalling and train control system, telecommunication, level crossings and rolling stock.

2) Insufficient maintenance work of the track and other facilities

   The deformation of the track due to heavy rainfall in the rainy season is one of the main causes of such derailment. In addition, about three train collisions occur every year on average. Because of the limited technical capacity in terms of skilled workers and machine, the level of maintenance work has remained at low level. Improvement of track condition together with introduction of mechanical maintenance methods with modern machines is required to achieve a decent maintenance work level.

3) Aged rolling stock

   The existing MR's rolling stock need to be attractive to the Yangon residents by improving its low performance due to aging and unfavourable design for vulnerable people. The interior of the rolling stock are not properly designed nor furnished for commuting users, and its ride comfort is far below the desired level as a transit system in such international gateway city of Myanmar.

4) Grade crossing section

   Priority in the current train operation is given to the long distance train, namely the Yangon – Mandalay Line. The train operation of the YCR Line is sometimes disturbed by this operation because there is a cross-over rail segment between the Pa Zun Taung station and the Yangon Central station. The YCR Line has to wait until the Yangon-Mandalay Line trains pass this segment. The existing crossing operation will not be a significant issue for a while because the OCC project installs a new signalling system in the Yangon station area. However, in long-term perspective, the existing at-grade crossing operation should be improved by changing the raillines, that is, shifting the YCR to the inside.

5) Increasing road traffic volume crossing the manually operated level crossings

   All of the existing level crossings along the YCR Line (27 in total) are manually operated by MR staff. Closing time of the level crossings tends to be longer because of the manual operation and selfish behaviour of car drivers. Sometimes trains need to stop at a level crossing because of never-ending car passing. Replacement of the existing level crossing system with automated level crossings is needed to improve the level of safety.

6) Poor function as urban railway station

   Almost all of the existing stations are timeworn and heavily deteriorated; rehabilitation of station facilities essential. There are no decent facilities as an urban railway such as toilet, ceiling of platform, benches, passenger information board and etc., which resulted in low level of the passenger service.

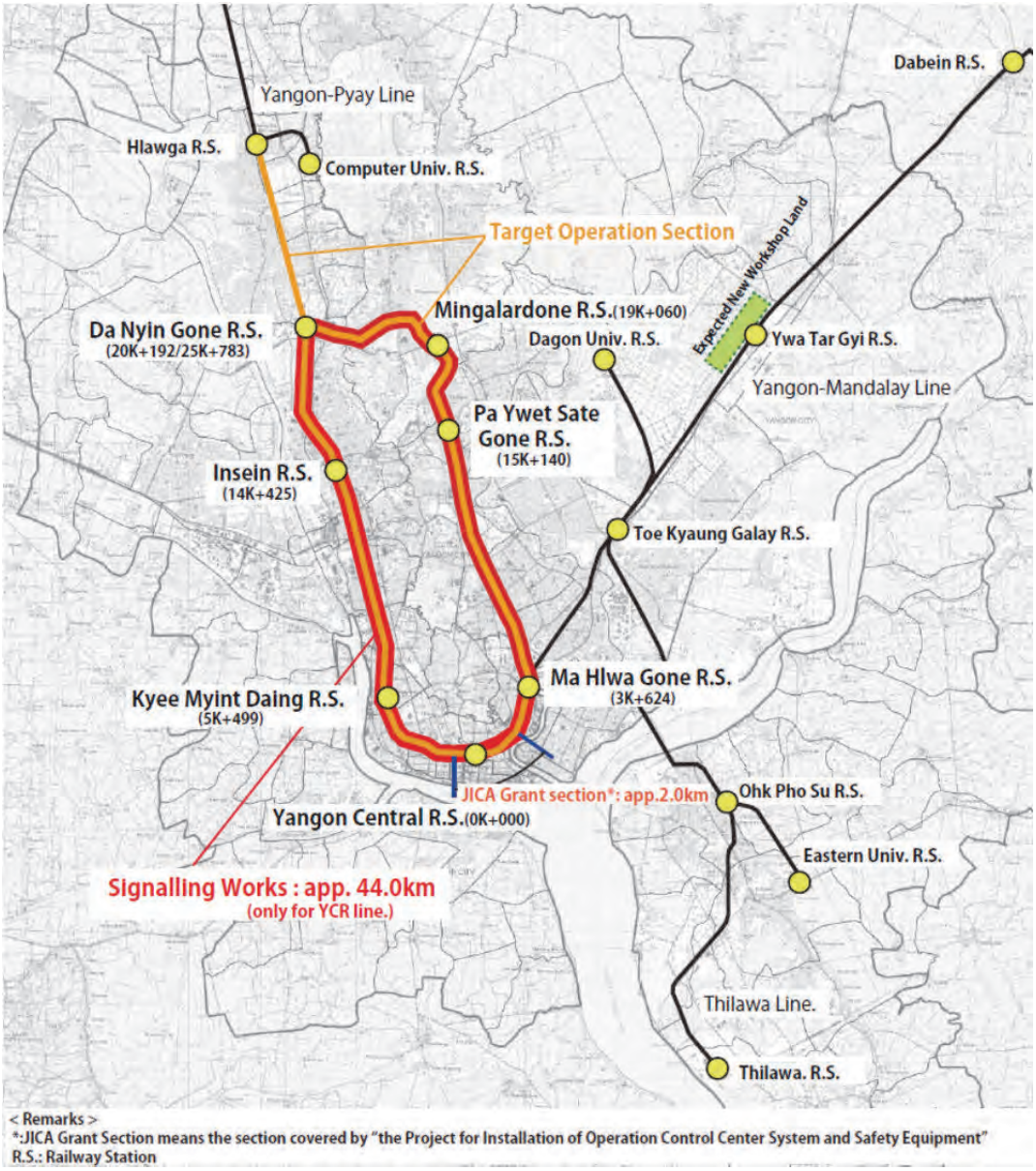
   In conclusion, the YCR Line needs major and urgent improvement and modernization of passenger services in almost every aspect in order to make it one of the safe and reliable transit systems in the Yangon metropolitan area.

1.3 Project Objective

The objective of the Project is to improve the efficiency of passenger transport capacity, and the safe and comfortable public transport services of Yangon Circular Railway Line by rehabilitating and replacing the existing railway facilities and the rolling stock, thereby contributing to the social and economic development of Greater Yangon.

1.4 Study Area

The project area is shown in the figure below. The Project section covers the whole Yangon Circular Railway Line (46.0 km in total).



Source: Study Team (2014)

Figure 1.4.1 Project Location Map

1.5 Scope of the Project

The scope of the Project Project is composed of i) improvement / rehabilitation of the railway infrastructure for the whole Project area and ii) procurement of new rolling stocks (DEMU). The detail is shown below.

1) Safety System Improvement

The existing signalling system of the YCR are seriously damaged, leading to frequent system errors. A series of significant improvement of the existing signalling and communication systems and/or installation of new system is required to achieve an

international standard level of safety. To meet this objective, the technologies used in the Project shall be as follows:

- Automatic Block System (ABS)
- Direct current track circuit system
- Automatic Train Stop System (ATS-S)
- Interlocking system in major stations other than the Yangon Central station (because OCC shall be installed in a different project)
- Automatic barrier level crossings - installation of automated level crossing barriers is required to save train running time and increase the safety for pedestrians.
- Related facilities such as power supply system, huts for level crossing watchman and signalling devices are also to be renewed or constructed as a part of the Project.

2) New DEMU Procurement

The existing diesel locomotives and passenger coaches used for the YCR Line are very aged and deteriorated. A limited number of used Diesel Multiple Units (DMUs) (Rail Bus Engines (RBEs)) imported or donated from Japan are also used at present. However, because of insufficient maintenance of the majority of the existing rolling stock, the level of service of the YCR Line is far below the expectation of the Yangon residents.

In order to attract more residents to use the railway, it is necessary to introduce modern rolling stock of higher performance in terms of safety, ride comfort, running speed, travel time, easy maintenance, etc.

Since electrification of the YCR Line is not scheduled in the near future, non-electrified system, such as DEMUs shall be introduced in the initial stage of modernization of the YCR Line.

Use of Diesel Electric Multiple Units (DEMUs), instead of using a train being composed of a locomotives and passenger coaches, makes MR easier in operating passenger trains on the YCR Line because there is no need to do shunting operation at terminal stations.

3) Drainage system improvement

The heavy rainfall in a short time period during the rainy season (from June to September) in Yangon frequently causes flooding over the rail facilities and other problems such as malfunction of signalling control system (due to shirt-circuit of track circuit).

Proper drainage facilities shall be constructed in locations and segments of frequent flooding along the Project section before installation of new signalling system.

4) Improvement of rail track irregularity

Because of serious irregularity of the existing track, the existing trains need to run at low speed. In order to achieve the target maximum running speed of this Project, the existing track should be improved (irregularity should be removed) before introduction of new rolling stock.

5) Station platform improvement

All of the existing rolling stock used for the YCR Line's services shall be replaced with new rolling stock and used DMUs in the Project. In order to realize improving user convenience and reducing boarding and alighting time, all of the station platforms need to be improved to high height platform which means the floor height of platform is same of rolling stock floor.

6) Invasion Prevention Facilities for Safety

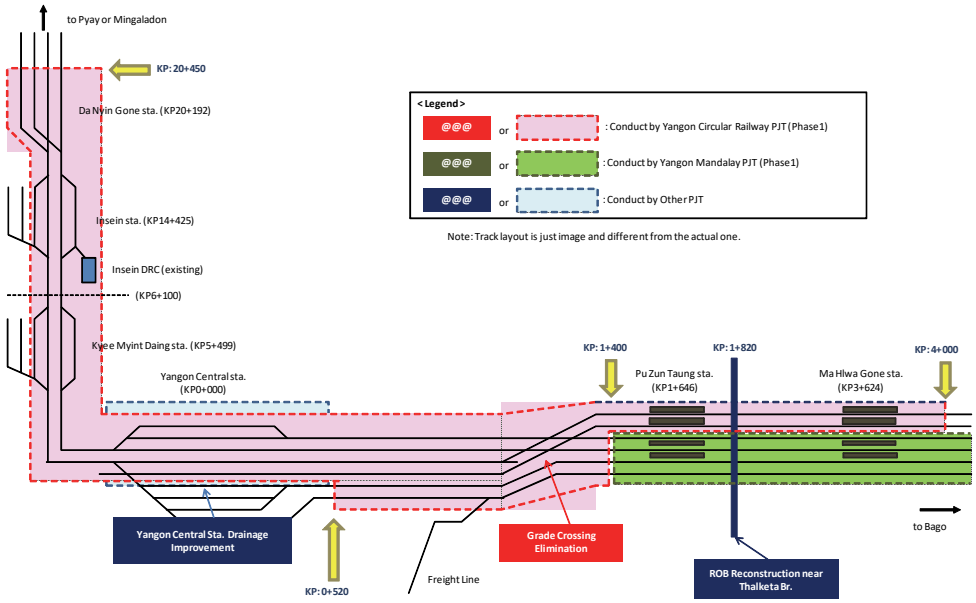
Planned frequent and fast train operation requires appropriate safety facilities such as fences along the railway line to prevent the residents from entering into the railway area.

7) Other infrastructure improvement

- Rehabilitation and/or replacement of railway bridges
- Rehabilitation and/or installation of Insein Diesel Rail Car (DRC) and Ma Hlwa Gone Depot facilities
- Improvement of power supply facilities
- Improvement / installation of FOBs

8) Demarcation

Since the section between the Yangon Central station and Ma Hlwa Gone station is used by the two rail services, namely the YCR (urban commuter service) and the Mandalay line (a long-distance service), the project section should be clearly defined. Based on the discussions with the concerned project teams and MR, the section to be improved by the YCR was determined as shown in Figure 1.5.1 (red shaded section).



Source: JICA Study Team

Figure 1.5.1 Schematic Figure for Positioning of Project

1.6 Composition of the Project

Myanmar Government requested Japanese side that signalling system and rolling stocks, which cannot be manufactured in Myanmar due to high technological facilities, are procured by using Japanese Yen loan, and the other infrastructures such as civil works, track works, etc. should be conducted by Myanmar side by using MR own budget. According to the request, the Project is divided into the following project components.

i) "Project components covered by Japanese ODA loan": Signalling system improvement and rolling stock procurement to fulfil the project objectives.

ii) "MR Works": Minimum rehabilitation of the other infrastructure to assure the proper function of the signalling system and rolling stock.

It notes that signalling system for approximately 2.0km section between the western side of Yangon Central station and the western side of Pa Zun Taung station is under improving by JICA grant aid named as "the project for Installation of Railway Operation Control Center System and Safety Equipment (OCC project)". Hence, the section for "Project components covered by Japanese ODA loan" is approximately 44km except the OCC project section.

The detailed explanation about demarcation among the related projects is showed in "4.1.2 Positioning of the Project"

Chapter 2 Passenger Demand Forecast

2.1 Travel Demand Forecast

This chapter presents the travel demand forecasts prepared for the project. It includes the broad travel demand forecast methodology employed in the Project based on the updated YUTRA travel demand model. The main items described are:

1. *Background studies, their outcome and influence on the current project;*
2. *Update of the YUTRA travel demand forecast model;*
3. *Current travel demand characteristics of travel on MR network in Myanmar area;*
4. *Travel demand forecast model input assumptions*
5. *Travel demand forecast for 2025 and 2035 for the YCR; and*
6. *Long term forecast for the full MR network in Yangon area.*

2.1.1 Background and Objectives of Travel Demand Forecast

Travel demand forecast for the Myanma Railways (MR) Yangon Circular Railway Line (YCR Line) were initially prepared by 'YUTRA' – a master plan study for the Grater Yangon area completed in late 2013. The YUTRA study in its assessment and evaluation of the integrated transport master plan for the Yangon area, showed that the upgrading of the YCR is not only essential, but it should be implemented as a top priority transport infrastructure project. A preliminary feasibility was therefore conducted immediately after the YUTRA master plan project. The travel demand forecasts for the pre-feasibility study were based on the YUTRA travel demand forecast model. The pre-feasibility study confirmed recommended that the YCR should be upgraded to a modern mass transit railway system. The key tasks are therefore prepared for the YCR upgrading project as follows:

- Prepare the travel demand forecast for the upgraded YCR line for physical design of stations, tracks, signalling, level crossings, etc.;
- Provide number of passenger access/ egress mode share at each of the existing station for the station square design to improve station accessibility;
- Daily & peak line volume in the peak direction. i.e. maximum passengers per hour per direction (pphpd) to estimate the rolling stock requirements;
- To provide model output in terms of various overall network performance to confirm the economic, financial viability and environmental impacts of the Project.

2.1.2 YUTRA Travel Demand Forecast Model Update

A number of tasks were defined at the inception stage of the this project to update the YUTRA travel demand forecast model, such that the forecasted demand is more reliable at the level of detail required by this feasibility study. These tasks were:

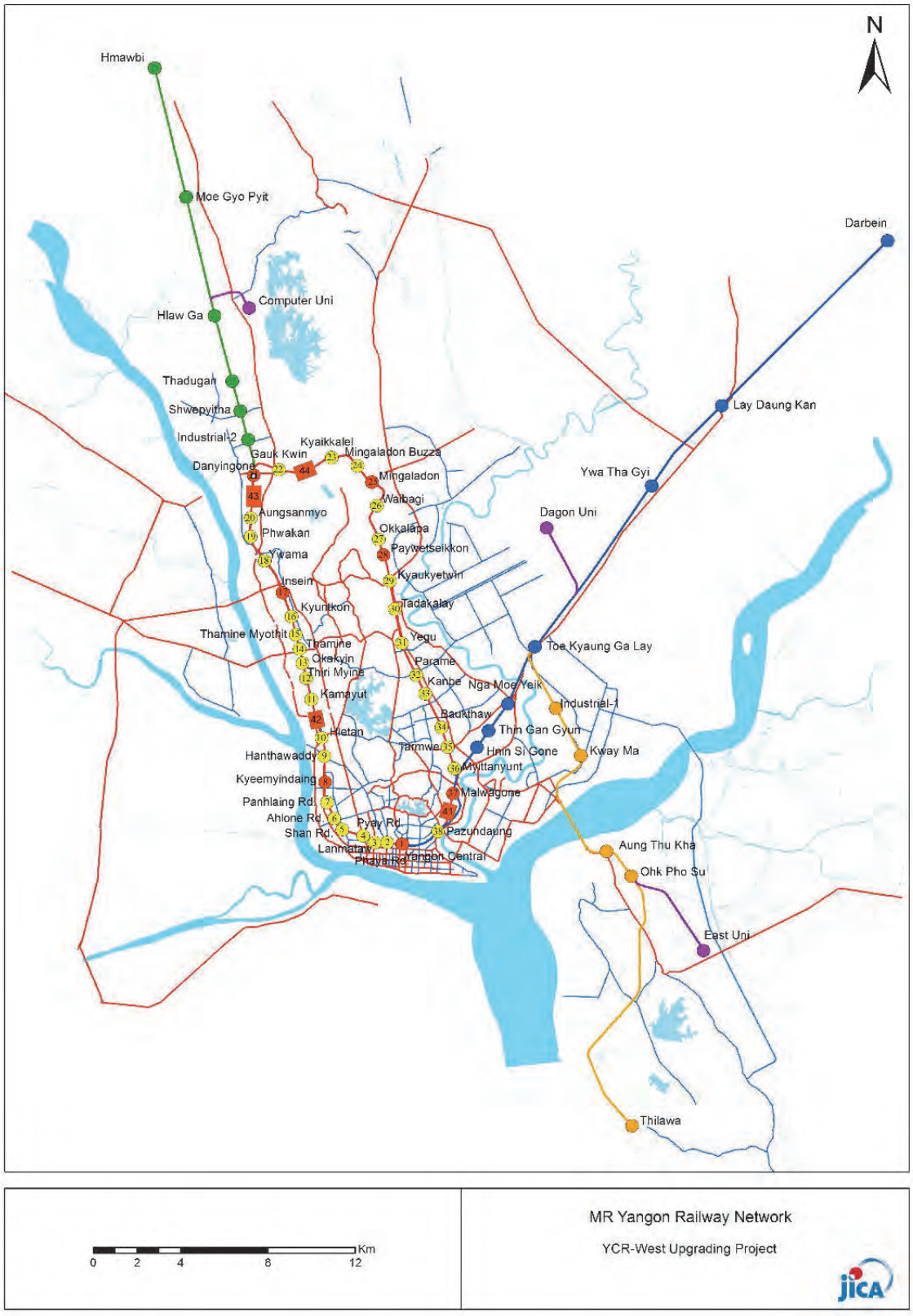
- Refine traffic analysis zone (TAZ) system – sub-division of the TAZ ststrem was made and some re-validation of the model at the finer zone system level was also carried out.

- Further analysis of the existing travel demand to better understand the current travel patterns - for this purpose both the YUTRA railway surveys and latest available MR data was further analysed and results used to enhance the YUTRA model performance. The analysis results are presented in the next section.
- Update of the 'full' Myanmar Railway (MR) existing Yangon area network characteristics: extending the rail network in the YUTRA model to the boundary of the YUTRA study area to better represent external travel demand. This extension includes the Pyay Line up to Hmawbi station in the north and Dabein in the east on Yangon Mandalay Line.
- Update the distances between stations incorporating the results of latest general surveys of the complete MR Yangon area network and the latest topographic survey data of the YCR west section.
- Update the train travel speed/ travel times based on new surveys of the YCR line.
- Use of stated preference (SP) survey results, and the micro simulation modelling for level crossing analysis.

2.1.3 Current Railway Travel Demand Characteristics on MR in Yangon Area

The characteristics of Yangon area MR network, having about 143km long with 59 stations, is summarised line-by-line below and depicted in Figure 2.1.1. The MR system runs three main lines namely:

1. Circular Line – this line is operated in two sections: West section from Yangon Central to Da Nyin Gone via Insein (20.3km & 21 Stations) and eastern section from Yangon Central to Da Nyin Gone via the western side of the Circle Line 25.8 km with 17 stations.
2. Pyay Line – It stretches north of Da Nyin Gone to Hmawbi a 26.5 km section with 6 stations and a 3.0 km spur section to serve Computer University of Yangon.
3. Yangon Mandalay Line Section in Yangon Area – This is part of the Yangon-Mandalay north-south main line section from Yangon to Mandalay, the section from Yangon Central to Dabein a 36.0 km section with 7 stations and a 6.4 km spur section which serves the Dagon University in the north-east of Yangon.
4. Thilawa Line – It is branch line of 26.7 km long to the south east industrial area of Yangon with 5 stations and a 5.0 km spur which serves the East University of Yangon.

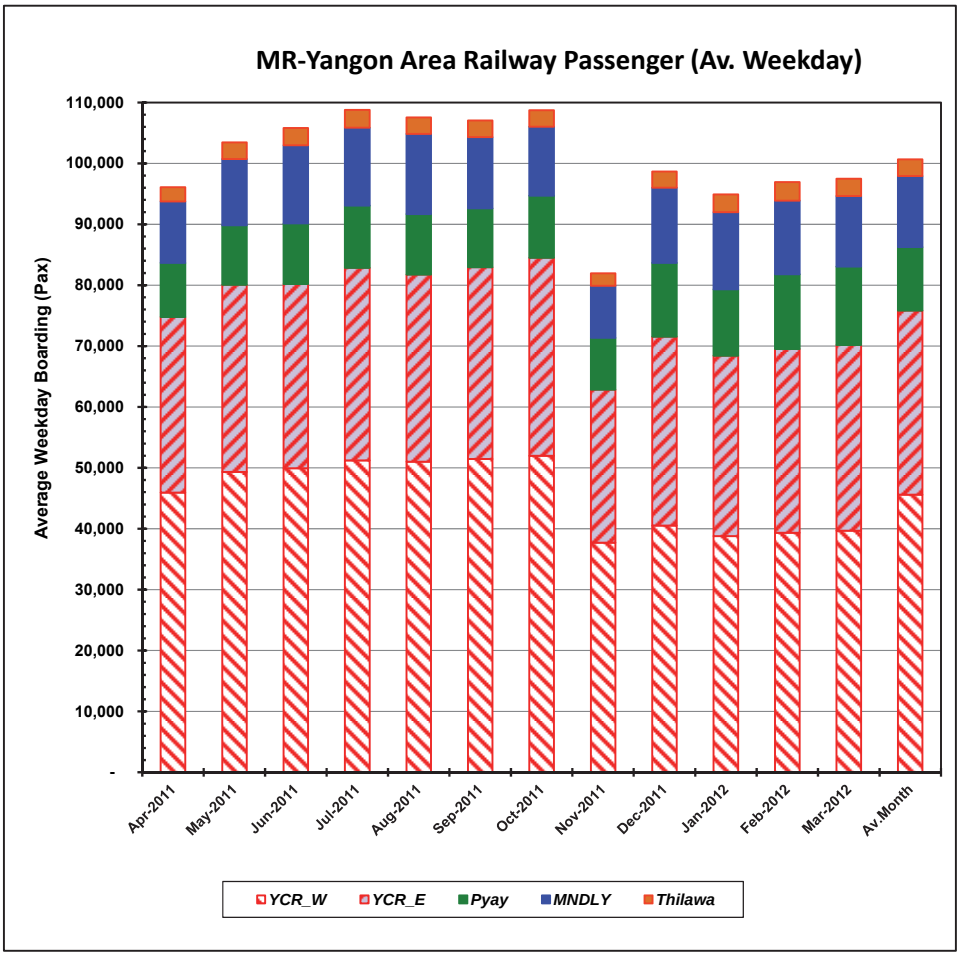


Source : JICA Study Team

Figure 2.1.1 MR Rail Lines Network in Yangon Area

The YUTRA survey data was analysed to build a station to station travel matrix. The matrix was then expanded to include all the stations in the MR network. The travel sample data collected by YUTRA surveys was expanded to cover the un-surveyed stations with the data from the MR annual demand[2] data and later updated to the 2014 demand level.

The latest data available from MR sources was for 2011-12, and average weekday demand by line is illustrated in Figure 2.1.2. The fall in demand in November 2011 is due to doubling of the fares. However, the demand picked up soon after that by mid-2012 was back at the high on early 2011.



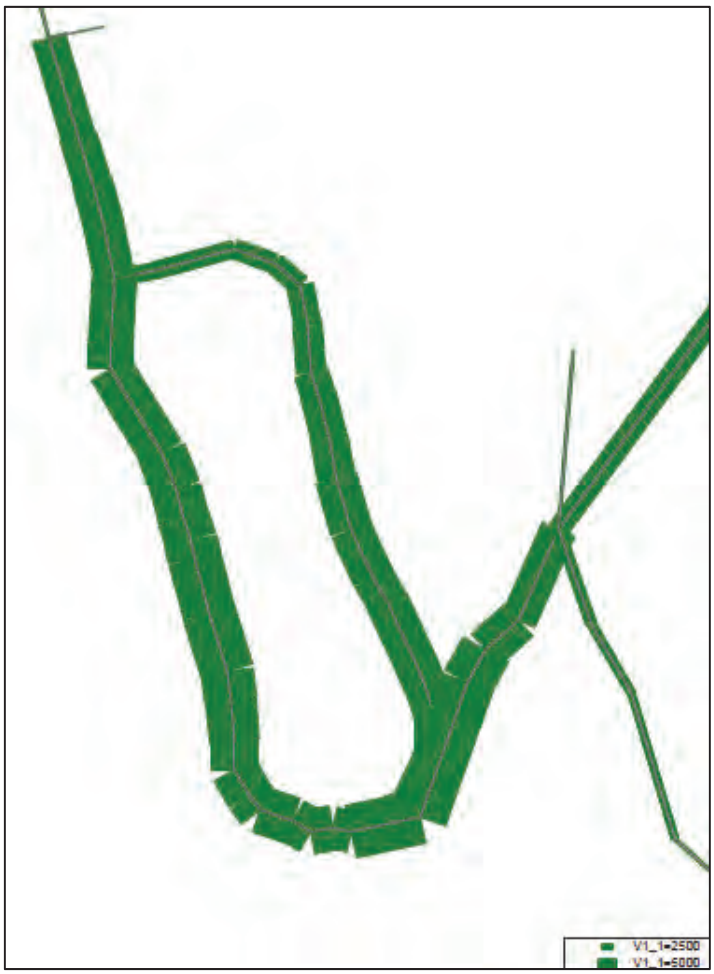
Source: YUTRA Study Team

Figure 2.1.2 Average Weekday Passenger Demand on the Four MR Lines in 2011-12

The figure illustrates that highest demand is on the circle line followed by patronage on Mandalay line. Figure 2.1.3 depicts the passenger travel pattern along the four lines. It can be seen that the demand is highest on the YCR and the Mandalay Line. The demand on both of the Pyay and the Thilawa Lines are concentrated in the YCDC area. It is our considered view that demand as illustrated is reflective of the level of service on those lines. This evident that as there are only two trains per day to Thilawa the demand is also limited.

The overall demand and MR line characteristics are summarised in Table 2.1.1 below. The table demonstrates the currently low passenger volumes on the network. The average trip length is presented in the table show that on the YCR and the two suburban lines average trip length is low (under 10 km) with the exception of Mandalay line.

[2] MR Annual passenger data for 2011-12.



Source: JICA Study Team

Figure 2.1.3 Average Weekday Passenger Demand on the Four MR Lines in 2014

Table 2.1.1 Characteristics of MR Network and Current (2014) Travel Demand

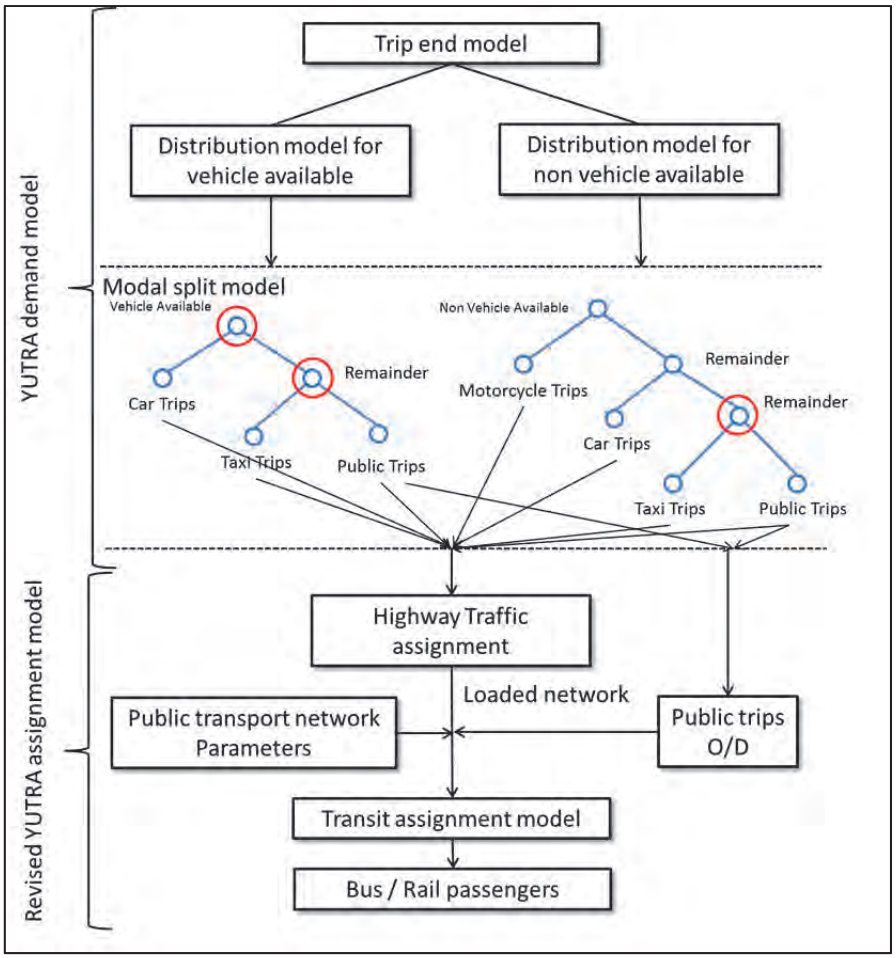
Line Description	Stations	Line Length (km)	Daily Pax Boarding		% Share	Pax*km	Pax*km /km	Av. Trip Length (km)
			Line Total	Area Total				
YCR West	21	20.1	48,400	**81,600**	**74%**	252,000	12,600	5.2
YCR East	17	26.0	33,200			222,000	8,500	6.7
Pyay Line	7	22.4	12,200	**28,300**	**26%**	83,000	3,700	6.8
Mandalay Line	8	42.4	13,100			260,000	6,100	19.8
Thilawa Line	6	31.7	3,000			30,000	900	10.0
All MR Lines	**59**	**142.6**	**109,900**	**109,900**	**100%**	**847,000**	**5,900**	**7.7**

Source: MR & YUTRA Survey Data and FS Study Team Analysis

2.1.4 Travel Demand Forecast Model Input Parameters and Assumptions

YUTRA strategic travel demand forecast model was updated as described above in Section 2.1.2 to forecast the travel demand on the YCR and other rail lines in the study area. Following figure provides an outline of the overall model structure of the YUTRA demand model, and also illustrates the sub-models for patronage forecast. The over model structure remained the same except the update and expansion of the railway network. As the changes made to the model network did not warrant model recalibration or new validation, the initial three stages of the YUTRA 4-stage model were retained.

The assignment sub-model with enhanced public and highway networks and future year public transport demand matrices was run to estimate the future year YCR patronage. The assignment process is based on the minimum generalised cost of travel between each origin and destination (OD) pair, and it includes: fare, access/ egress time, walk time, wait time (based on route headway), in vehicle time and transfer time (where applicable). The output from the assignment model is the boarding and alighting passengers at bus stop, rail station, and line volumes. The model input parameters used for the transit assignment are summarised in Table 2.1.2.



Source: JICA Study Team

Figure 2.1.4 YCR West Section Upgrade Feasibility Study Outline Demand Model

Table 2.1.2 YCR Feasibility Study Assignment Model Parameters

Description	Parameter Value
Bus & Other Para-transit Road Modes	
Bus, minibus, truck-bus and other para-transits	On all roads – no specific route
Fare (Kyat)	35.5/km (2025); 71.8/km (2035)
Ave. Operating Speed (kph)	80% of mix traffic speed (kph)
Railway Network (YCR, other MR in Yangon Area and UMRT)	
Fare Distance Based (Kyat/km) (+25% premium fare on upgraded YCR West)	Upgraded YCR West: 44.4/km (2018); 89.8/km (2035)
	Other MR Lines: 35.5/km (2018); 71.8/km (2035)
Average Daily Headway (minutes)	10 (2025 YCR West) 5 (2035YCR West) 30 (Other MR Lines) *No UMRT or BRT in 2025 or 2035*
Average Railway Operating Speed (kph)	YCR West According to Distanc between stations, Average 28kph (After Upgrade with DEMU) Other MR Lines 16kph(No upgrade) NO UMRT Line was Assumed
Ferry Services	
Fare (Kyat)	106+21.3/km (2025); 194+38.8/km (2035)
Headway (min)	15
Ave. Operating Speed (km/h)	20
Other Data Input for Transit Assignment	
Total Daily Public Transport Person Trips	4.56million (2025); 5.67million (2035)
Other Forecast Year Network	YUTRA Master Plan (Do Maximum Scenario)
Value of Time of Public Transport Users	23.4 (2025); 42.7 (2035)
• Average walk speed to access or egress the station 4kph • Average distance to walk to the station from nearest road - 100m • Average walk distance to transfer between lines - 100m • No additional frae paid to transfer between lines • Wait time is set at ½ the train headway, however for trains with longer headway a maximum value of 10 minutes is as passenger will arrive according to the timetable, and not more than 10 minute before the train arrive. • Wait time inconvenience factor, as passenger do not like to wait is set to be +50% of the wait time. • Walk and access/ egress or transfer inconvenience is set to be the same as the walk speed of 4kph. • In vehicle time factor, i.e. time spent in the train is calibrated to be 0.75 time the train travel time – as passenger would feel that they are travelling faster than the other mode, which they will be when compared to the average bus speed of under 15kph in 2035.	

Source: JICA Study Team (2015)

2.1.5 Travel Demand Forecast for Complete YCR All Section

The following tables present the daily patronage on the MR lines after the complete upgrading of YCR all section. The scenario test assumes that all other lines remain in current condition, and operate limited/ infrequent service at about the same speed as now. However, the upgraded YCR would operate full circle at 10 and 5 minutes headways in 2025 and 2035 respectively providing a frequent service. The train speed between each pair of stations was estimated according to the distance between stations, DEMU acceleration and deceleration according to

the DEMU supplier specifications. This results in an average speed of about 26 kph and the travel time of about one hour and 45 minutes to complete the full circle (including average dwell time of 30 seconds at each of the 38 stations). The upgraded YCR speed would be about double the current speed of under 15kph.

It was also assumed that the a premium fare of +25% would be charged to passenger using the upgraded YCR compared to other lines, and the distance based fare increases in line with increase in GDP per capita.

The travel demand forecast output is responsive to the line upgrade and the number of boarding passengers for the forecast years of 2025 and 2035. The total boarding passengers of YCR is expected to increase to about 359,000 passengers by 2025 and to just over 0.75 million passengers by 2035. It is assumed here that 2035 other three suburban lines are not yet upgraded and would be operating at conditions similar to today, and increased demand would result due feeding of additional demand from the upgraded YCR, which in turn will increase patronage on suburban lines. By 2035, patronage on the other three MR suburban lines would increase from just over 152,000 passenger to more than double to about 336,000 passengers per day, where details by each line are given in the following tables.

This is mainly due changes in land use and increased congestion on the road reducing bus and para-transit speeds to well below the MR lines current speed of 16 kph, making MR lines relatively attractive to public transport passengers. This goes to show that MR have a great asset in the existing railways which is in dire need of upgrade and has the potential to become the major part of city's future mass transit system, making MR to flourish as a modern day railway enterprise – away from the current dilapidated state it is in.

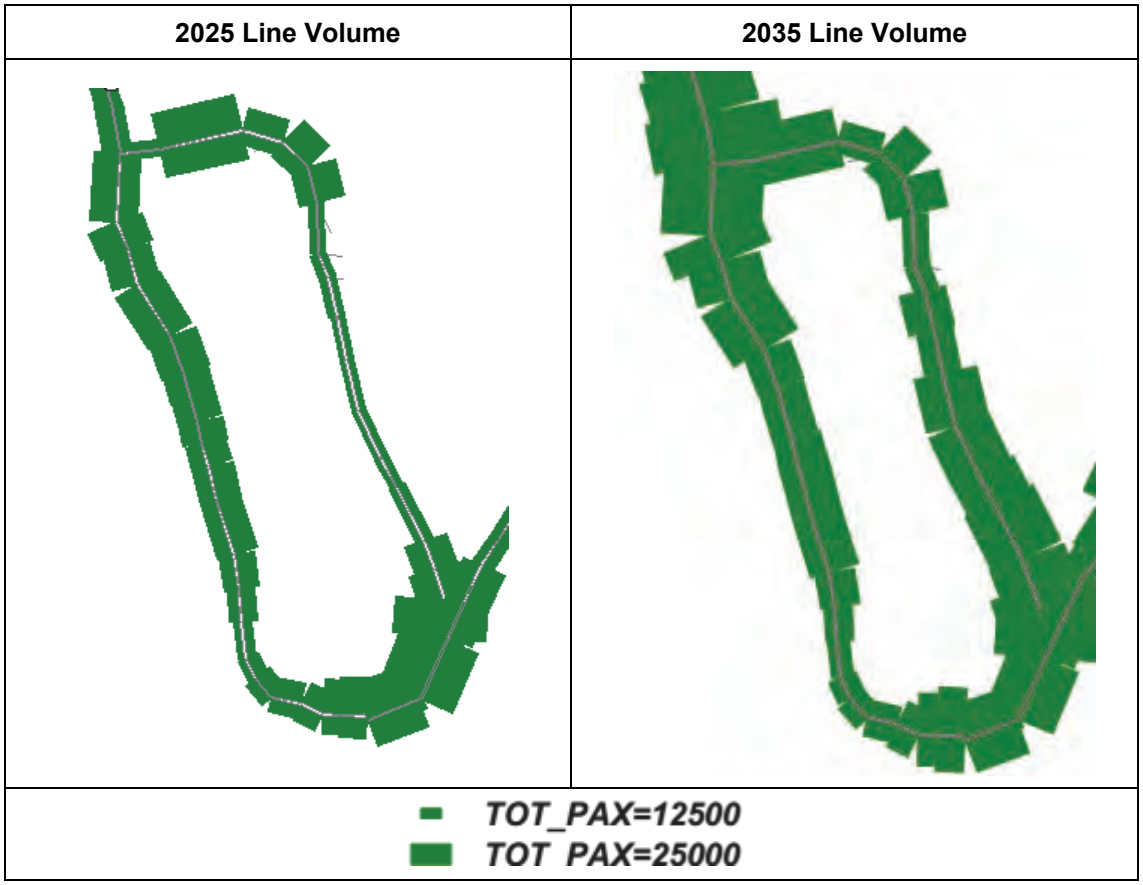
Table 2.1.3 Number of Boarding Passengers and MR Lines – 2025 & 2035

Full YCR Upgraded - Case-2				Fare=	+25%	2025
Line	**Stations**	**Line Length (km)**	**Pax Boarding**	**Pax*km**	**Pax*Hrs**	**Pax*km /km**
YCR - Full Circle	**38**	**46.1**	**359,000**	**2,471,500**	**92,600**	**53,600**
Pyay	7	22.4	28,700	290,800	13,900	13,000
Mandalay	10	42.4	75,200	583,700	19,800	13,800
Thilawa	6	31.7	48,600	317,700	11,000	10,000
Totals	**61**	**142.6**	**511,500**	**3,663,700**	**137,300**	**25,700**

Full YCR Upgraded - Case-2				Fare=	+25%	2035
Line	**Stations**	**Line Length (km)**	**Pax Boarding**	**Pax*km**	**Pax*Hrs**	**Pax*km /km**
YCR - Full Circle	**38**	**46.1**	**784,800**	**4,053,300**	**156,700**	**87,900**
Pyay	7	22.4	82,100	1,755,500	82,500	78,200
Mandalay	10	42.4	114,800	1,613,700	57,200	38,100
Thilawa	6	31.7	139,500	2,173,000	75,700	68,700
Totals	**61**	**142.6**	**1,121,200**	**9,595,500**	**372,100**	**67,300**

Source: JICA Study Team

The line volumes on the network for 2025 & 2035 are depicted in the following figure. It can be seen that the line volume on the all sections of YCR are far higher than those in the base year situation of YCR. It is also evident that the line volumes are higher around the Yangon Central station and the Da Nyin Gone station compared to the middle sections of YCR western or easter parts. The fundamental reason is that the trains speeds are much slower in the central section of YCR-West as the stations are too close to each other (many instances the distance between stations is less than 700m) train travels at its maximum speed for a short distance before it has to break to stop at the next station. Where as the demand on the central part of eastern sections is low due low density housing and private mode being more attractive. It is therefore recommended that serious consideration should be given to close some of the stations (which area less than 1,000m apart) should be closed in the future operation to improve the service on the entire YCR. Similarly where the station are more than 1,900m or so apart new station may be added to attract patronage by increasing the catchment area of the line.



Source: JICA Study Team

Figure 2.1.5 Travel Demand Volume on YCR in 2025 & 2035

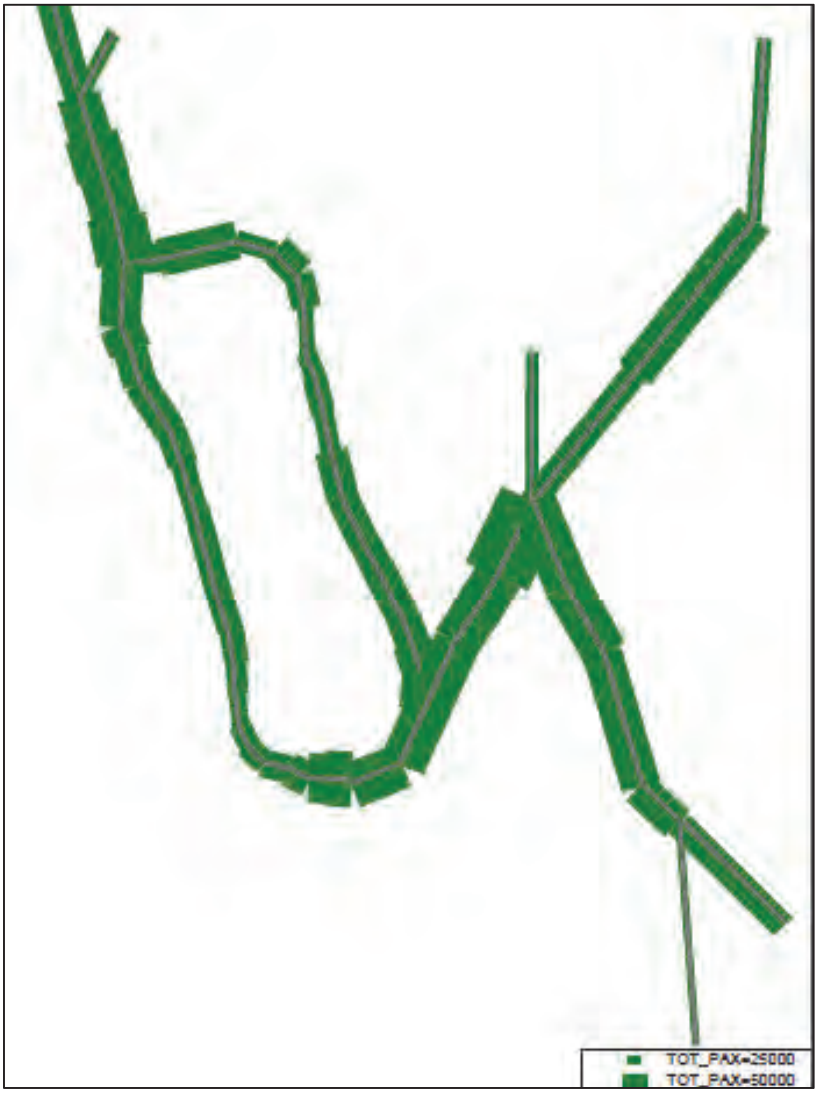
2.1.6 Travel Demand Forecast for MR Upgraded Network

Under the long term scenario, if the entire MR rail network in Yangon area is upgraded, electrified to operate modern Electric Multiple Unit (EMU) with much higher acceleration and deceleration the demand on the entire network in 2035 would exceed 1,4000,000 daily passengers. The overall patronage demand is detailed in the following table and the line volumes are depicted in Figure 2.1.6.

Table 2.1.4 Number of Boarding Passengers on Fully Upgraded MR EMU Operated Network in 2035

Scenario:	ALL Lines EMU, YCR Headway=5mins; Other Lines=10mins								2035
LNK_ TYPE	Stations	Line Description	Line Length (km)	Daily Pax Boarding		% Share	Pax*km	Pax*Hrs	Pax*km /km
				Line Total	Area Total				
101	23	YCR West	23.7	497,500	782,500	52%	2,585,000	82,700	109,000
102	15	YCR East	22.4	285,000			2,403,000	64,300	107,300
103	7	Pyay Line	22.4	179,400	713,600	48%	2,918,000	54,000	130,000
104	8	Mandalay Line	42.4	327,000			4,460,000	71,000	105,200
105	6	Thilawa Line	31.7	207,200			2,734,000	89,000	86,400
Totals	**59**	**All Rail Lines**	**142.6**	**1,496,100**	**1,496,100**	**100%**	**15,100,000**	**361,000**	**105,900**

Source: JICA Study Team



Source: JICA Study Team

Figure 2.1.6 Travel Demand Volume on Full MR Network Upgraded & Operated by EMU 2035

Chapter 3 Natural Condition of the Project Area

3.1 Geotechnical Condition

Data collection exercises on the various natural conditions along the YCR and a detailed soil condition survey along the western section of the Yangon Circular Railway line, which is from Da Nyint Gone to Ma Hlwa Gone station, were carried out in 2014, while additional relevant surveys along the eastern section of the YCR were carried out in 2015.

Section 3.1 of this report summarizes the findings from the existing secondary data and the soil condition survey carried out in 2014, which are useful to understand the geotechnical condition of the western section and to set up corresponding design parameters.

3.1.1 General Geotechnical Characteristics

(1) Topography

The western section of YCR runs parallel with the Hlaing River along the western flank of the Bago Yoma range. The Bago Yoma range is trending north to south, and ends at the south of Shwedagon Hill. Because of this topographical formation, the original topography of the project section was formed by rolling hills of gentle slope. The slope is lowering gently to the southward along the western section.

The Hlaing River is located about a half of mile outside of the existing circular railway line and it is in an old age stage. This is one of the reasons to explain that the erosion of the river bank is more severe than the erosion of the river floor. All the drains and tributaries are flowing to the Hlaing River.

The topography of the western section has been changed in accordance with the urbanization of the Yangon City. For example, the drainage pattern has been changed from the original (natural) routes to the existing urban drain system.

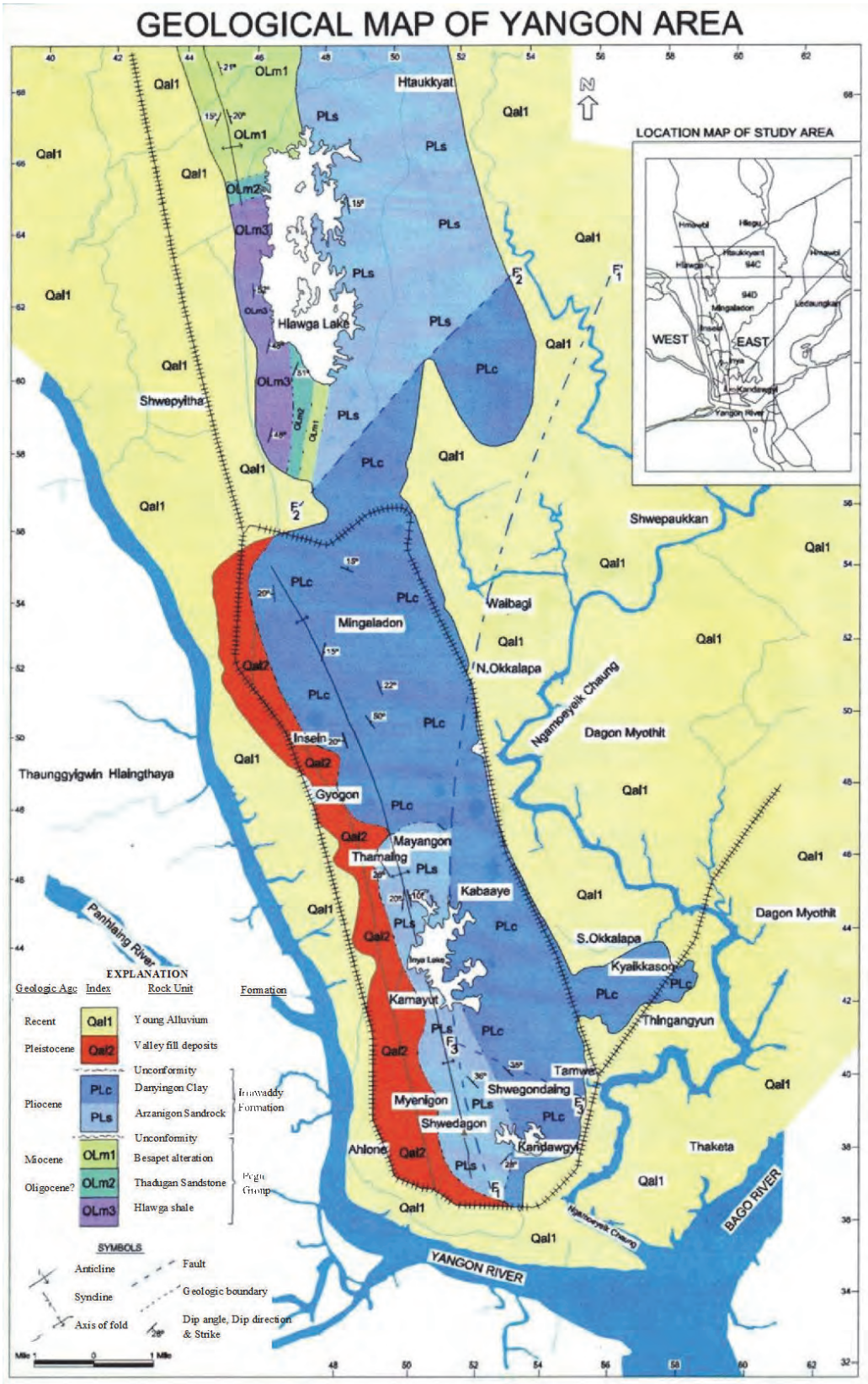
(2) Regional Geology of the western section

Most area of the Yangon city is covered by deposited soil, either transported or residual soil. Bedrock is found along the central range of Bago Yoma in the central part of Yangon.

The Arzarnigone sandstone is exposed in the north of Shwedagon Pagoda, while the Danyintgone clay is exposed in the northern part of Yangon City and Innsein Township. Both were formed from a part of Peguan Formation in the Miocene age.

The western section is situated in the Irrawaddy formation of Arzarnigon sand rocks and Danyingone clay. Transported soil is dominant rather than the residual soil along the western section because it is located at the base of the Bago Yoma Range. The transported soils are mostly valley filled deposit.

The regional geological conditions are depicted in Figure 3.1.1.



Source: U WIN NING(1972), The Hydrogeology of the Greater Rangoon, M.Sc.Thesis, Geology Department, University of Rangoon UPGRADED.W.R.U.D (1992)

Figure 3.1.1 Regional Geological Map of Yangon Area

(3) Earthquake

In the Bay of Bengal, the west of Myanmar, there is the Andaman Trench where the Indian Plate is moving northward and subducting underneath the Burma Plate from the west to the east; in the east Myanmar, there is the Sagaing fault which is the boundary between the Burma Plate and the Sunda Plate. Hence, earthquakes of magnitude 7.0 + occurred more than 16 times and six earthquakes of around magnitude 7.0 struck the main cities along the Sagaing fault such as Yangon, Bago and Mandalay from 1930 to 1956. Significantly, Yangon experienced six huge earthquakes around the 1930's as shown in Table 3.1.1.

Table 3.1.1 Major Earthquake Records around Greater Yangon

Date	Location	Magnitude	Remarks
868	Bago	-	Shwemawdaw Pagoda was destroyed
875	Bago	-	Shwemawdaw Pagoda was destroyed
13th Sep. 1564	Bago	-	Pagodas including Shwemawdaw and Mahazedi were destroyed
1567	Bago	-	Kyaikko Pagoda was destroyed
1582	Bago	-	Umbrella of Mahazedi Pagoda was destroyed
9th Feb. 1588	Bago	-	Pagodas and other buildings were destroyed
30th Mar.1591	Bago	-	The Great Incumbent Buddha destroyed
4th June 1757	Bago	-	Shwemawdaw Pagoda damaged
27th Dec. 1768	Bago	-	Ponnyayadana Pagoda was destroyed
24th Aug. 1858	Pyay	-	Collapsed houses and tops of pagodas at Pyay, Henzada and Thayetmyo Felt with some damages in Innwa, Sittwe, Kyaukpyu and Yangon
8th Oct. 1888	Bago	-	Mahazedi Pagoda collapsed
10th Sep. 1927	Yangon	-	-
17th Dec. 1927	Yangon	7.0	Impacts extended to Dedaye
5th May 1930	Near Kayan, Yangon and Bago Region	7.3	Collapsed houses and other buildings in Yangon and Bago Regions. Death counts in Bago and Yangon Regions were approximately 500 and 50, respectively.
27th Mar. 1931	Yangon	-	-
16th May 1931	Yangon	-	-
21st May 1931	Yangon	-	-

Source: SUDP, JICA (2013/2014)

Despite the fact that earthquakes have seldom strike the Greater Yangon area in the immediate past, the Greater Yangon area apparently faces a potential risk of significant earthquake disaster although it is not easy to predict the time and the magnitude of future earthquakes in the area. Myanmar Engineering Society (MES) predicts that a large scale earthquake around that Greater Yangon strikes within the next 20 years based on their analysis. MES has already prepared a seismic hazard map of the Yangon Region and they are going to prepare a more detailed hazard map considering the site conditions.

3.1.2 Objective of the Soil Condition Survey (west section)

The soil condition survey was designed to understand the subsurface condition along the western section from Da Nyint Gone (DNG) station to Ma Hlwa Gone (MHG) station. The survey result should be adequate to determine the engineering requirements in designing the rail and related structures along the western section. More concretely the objectives of the survey are:

- To study geologic stratum along the western section
- To study physical and mechanical properties of the soil based on laboratory tests

- To study appropriate soil design parameters for designing
- To identify hazardous effects of ground response during and after the construction

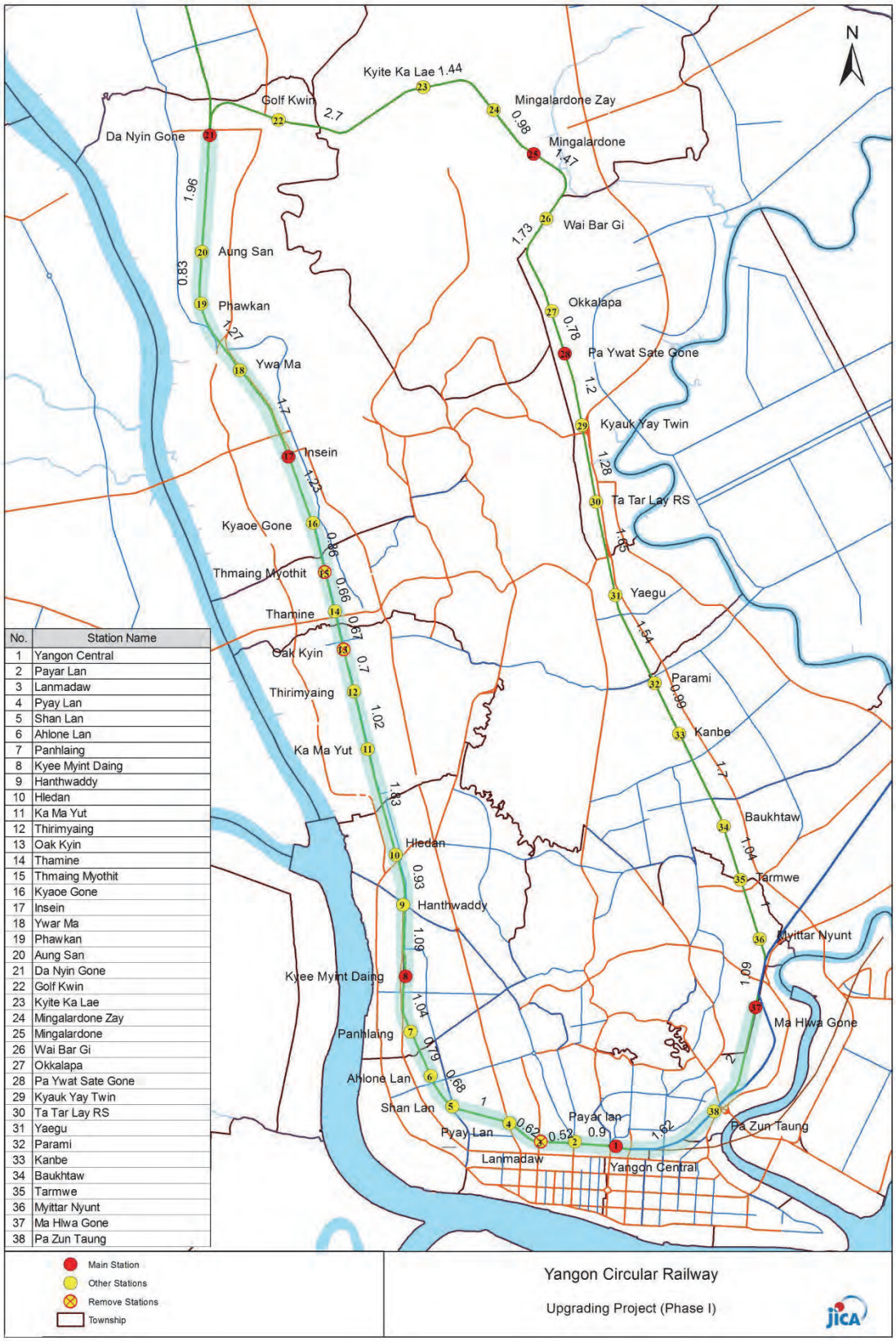
To achieve these objectives above, the survey includes two major works, namely, Soil Boring and Standard Penetration Test (SPT).

3.1.3 Survey Site

Twenty seven (27) boring points were selected along the western section, including 13 points at the rail bridges, 11 points along the railway line, and 3 points in the Insein Depot area. Exact locations of these boring points are depicted in Figure 3.1.2 and 3.1.3, and summarized in Table 3.1.2.

The total length of all of the borings was 940.5 meters. The boring depth of the points along the railway line is 15m for each, while the boring depth at the bridge sites and in the Insein Depot were determined by the JICA expert based on the actual condition of the progress of the boring survey.

For the all boring work, standard penetration tests were carried out based on the American Society for Testing and Materials (ASTM) Standard.



No.	Station Name
1	Yangon Central
2	Payar Lan
3	Lanmadaw
4	Pyay Lan
5	Shan Lan
6	Ahlone Lan
7	Panhlaing
8	Kyee Myint Daing
9	Hanthwaddy
10	Hledan
11	Ka Ma Yut
12	Thirimyaing
13	Oak Kyin
14	Thamine
15	Thmaing Myothit
16	Kyaoe Gone
17	Insein
18	Ywar Ma
19	Phawkan
20	Aung San
21	Da Nyin Gone
22	Golf Kwin
23	Kyite Ka Lae
24	Mingalardone Zay
25	Mingalardone
26	Wai Bar Gi
27	Okkalapa
28	Pa Ywat Sate Gone
29	Kyauk Yay Twin
30	Ta Tar Lay RS
31	Yaegu
32	Parami
33	Kanbe
34	Baukhtaw
35	Tarmwe
36	Myittar Nyunt
37	Ma Hlwa Gone
38	Pa Zun Taung

Source: YUTRA, JICA (2013/2014)

Figure 3.1.2 The Western Section

Table 3.1.2 Boring Location List

Boring No.	Infrastructure No	Bridge Length(m)	Location		Survey data by YUTRA (km)	Plan	Actual
			From	To		Drilling Length(m)	
			Malwagone R.S.		42.50		
BH-B- 1	B50		Malwagone	Pazundaung	43.72	50	46.50
	B51	0.60	Malwagone	Pazundaung	43.74		
			Pazundaung R.S.		44.50		
BH-R- 1					44.50	15	15.00
BH-B- 2	B52	14.00	Pazundaung	Yangon Central	45.24	50	36.00
	B53	0.60	Pazundaung	Yangon Central	45.56		
			Yangon Central R.S.		0.00		
BH-R- 2					0.50	15	15.00
			Phaya Rd. R.S.		0.90		
			Lanmataw R.S.		1.43		
BH-B- 3	B01	2.73	Lanmataw	Pyay Rd.	1.55	50	51.00
			Pyay Rd. R.S.		2.05		
BH-R- 3					2.50	15	15.00
			Shan Rd. R.S.		3.04		
BH-R- 4					3.50	15	15.00
			Ahlone Rd. R.S.		3.72		
BH-R- 5	B02	Box Culvert	Ahlone Rd.	Panhlaing Rd.	4.25	15	15.00
			Panhlaing Rd. R.S.		4.51		
BH-B- 4	B03	16.80	Panhlaing Rd.	Kyeemyindaing	5.25	50	51.00
			Kyeemyindaing R.S.		5.55		
BH-R- 6					6.50	15	15.00
			Hanthawaddy R.S.		6.64		
BH-R- 7					7.50	15	15.00
			Hletan R.S.		7.57		
	B04	2.90	Hletan	Kamayut	8.29		
BH-B- 5	B05	10.80	Hletan	Kamayut	8.42	50	60.00
BH-R- 8			Kamayut R.S.		9.40	15	15.00
	B06	Box Culvert	Kamayut	Thiri Myine	9.71		
BH-B- 6	B07	7.80	Kamayut	Thiri Myine	10.29	50	49.50
			Thiri Myine R.S.		10.42		
			Okakyin R.S.		11.12		
BH-B- 7	B08	10.80	Okakyin	Thamine	11.59	50	46.50
			Thamine R.S.		11.79		
			Thamine Myothit R.S.		12.46		
BH-B- 8	B09	7.70	Thamine Myothit	Kyuntkon	12.72	50	48.00
			Kyuntkon R.S.		13.32		
BH-R- 9					13.50	15	15.00
BH-R- 10					14.50	15	15.00
			Insein R.S.		14.54		
BH-B- 9	B10	2.85	Insein	Ywama	15.06	50	49.50
BH-B- 10	B11	5.80	Insein	Ywama	15.51	50	49.50
			Ywama R.S.		16.24		
BH-B- 11	B12	7.10	Ywama	Phwakan	16.81	50	49.50
			Phwakan R.S.		17.51		
BH-B- 12	B13	2.90	Phwakan	Aungsanmyo	17.78	50	51.00
			Aungsanmyo R.S.		18.34		
BH-R- 11	B14	Box Culvert	Aungsanmyo	Danyingone	18.65	15	15.00
	B15	0.60	Aungsanmyo	Danyingone	19.46		
BH-B- 13	B16	2.75	Aungsanmyo	Danyingone	19.79	50	46.50
			Danyingone R.S.		20.29		
BH-D- 1			Kyee Myint Daing Depot			50	49.50
BH-D- 2			Kyee Myint Daing Depot			50	39.00
BH-D- 3			Kyee Myint Daing Depot			50	52.50

Source: JICA Study Team (2014)

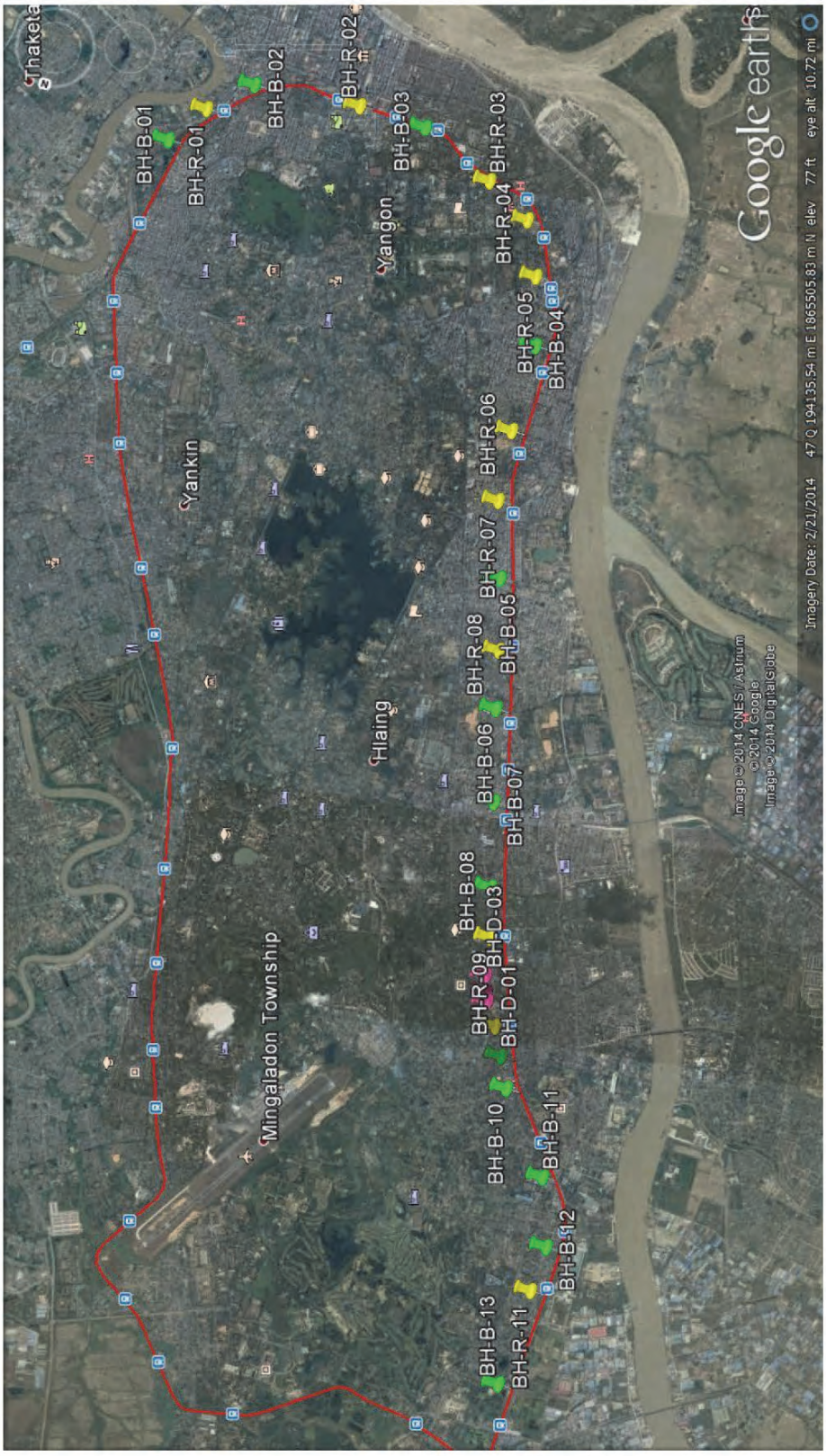


Figure 3.1.3 Boring Site Location Map

Source: JICA Study Team (2014)

3.1.4 Laboratory Tests

From the twenty seven boreholes, a total of 626 disturbed samples and 36 undisturbed samples were collected with a piston and a Denison sampler.

Some selected disturbed samples and all undisturbed samples were brought to a soil survey company's laboratory in order to test physical and mechanical properties of the soils. The tests were carried out in accordance with ASTM Standards and under the supervision of the JICA expert.

The physical properties tests include the following items:

- Natural Moisture Content Test (ASTM D 2216-05)
- Specific Gravity Test (ASTM D 854-06)
- Particle Size Analysis Test (ASTM D 422-63)

  Grain Size Distribution Test

  Hydrometer Test
- Atterberg's Limits Test (ASTM D 4318-05)

  Liquid Limit Test

  Plastic Limit Test

The mechanical properties tests include the following items:

- Unconfined Compression Test (ASTM D 2166-06)
- One Dimensional Consolidation Test (ASTM D 2435-04)

The chemical properties tests including the following items.

- Water quality test

3.1.5 Geotechnical Assessment

(1) Setting of geotechnical design parameters

The geotechnical parameters were set based on the result of the field testing and laboratory testing. Some of the design parameters referred to Japanese Railway Standard "Design Standard for Railway Structures and Commentary (hereinafter called "Japanese Railway Standard").

1) Unit weight of soil (γt)

Unit weights of soil (γt) can be obtained from the laboratory test as bulk density in the case of taking the undisturbed samples. In the case when the undisturbed samples cannot be taken, unit weights of soil (γt) of the Railway Standards are referred to as shown in Table 3.1.3.

Table 3.1.3 Unit Weight of Soil

N-Value		Unit Weight (kN/m³)		
		γt	γsat	γ'
Sandy Soil	50 or more	19	20	10
	30-50	18	19	9
	10-30	18	19	9
	less than 10	18	19	9
Cohesive Soil	10 or more	16	17	7
	less than 10	16	16	6

Source: Japanese Railway Standard

2) Effective unit weight of soil (γ′)

The effective unit weight of soil under the water table can be evaluated from the equation below:

$\gamma' = \gamma t - \gamma w$ for Clay/Silt

$\gamma' = \gamma t - 9.0$ for Sand/Gravel

where

γ' : effective unit weight of soil (kN/m^3)

γw : unit weight of water (kN/m^3)

3) Cohesion strength (Cu)

The cohesive strength, also known as undrained shear strength of cohesive soil, is normally evaluated from an unconfined compression test. The cohesive strength Cu can be derived from:

$Cu = qu / 2$ (kN/m^2)

where

Cu: cohesive strength (kN/m^2)

qu: unconfined compressive strength (kN/m^2)

However, undrained cohesive strength can also be determined from a direct shear test (for reference) and an unconsolidated undrained triaxial compression test of undisturbed soil samples.

For the sandy soil and hard clayey soil, as the undisturbed samples cannot be collected easily, the cohesive strength can be derived from the SPT N-value based on the equation below:

$Cu = 50N/8$ (kN/m^2) ……. (Terzaghi and Peck)

4) Internal friction angle (φ)

The internal friction angle of granular soil can be derived from the SPT N-value and effective overburden based on the following equation:

$$\emptyset = 1.85\left(\frac{N}{\frac{\sigma v'}{100} + 0.7}\right)^{0.6} + 26$$

where

φ : Internal friction angle (°)

N : N-value

σV' = Effective overburden (kN/m^2)

However, Minimum σV ' is 50kN/m^2

5) Deformation modulus of soil (E)

The deformation modulus of cohesive soil is usually evaluated from the unconfined compression test. As undisturbed samples of sandy soil and hard clayey soil cannot be taken easily, the deformation modulus of the soil can be evaluated based on the following equation:

$$E = (\rho gE \cdot EX)/\gamma gE \ (kN/m^2)$$

where

E : Deformation modulus of soil (kN/m^2)

ρgE : Correction factor for ground soil (refer to Table 3.1.4)

ρgE =1.0 (When deformation modulus is evaluated from N value and E50 from an unconfined compression test)

γgE :Coefficient of ground survey condition (refer to Table 3.1.5)

When deformation modulus is evaluated from N, it was set at 1.3 (Sandy Soil) or 1.7 (Cohesive Soil).

When the deformation modulus was evaluated from E50 of the unconfined compression test, it was set at 1.0.

Ex: Deformation modulus, E50 from the unconfined compression test, and EN calculated by N-value as in the following equation:

Sandy Soil: Ex=EN = 2,000N (kN/m^2)

Cohesive Soil: Ex=EN = 4,000N (kN/m^2)

Table 3.1.4 Correction Factor for Ground Soil

Method of soil survey		Symbol Ex	Correction factor of ground soil (ρ_{gE})
Material test of soil	Triaxial compression test	E_{50}	1.0
	Unconfined compression test	E_{50}	1.0
Plate loading test	Non cyclic loading	EP_{L1}	1.0
	Cyclic loading	EP_{Lr}	0.33
PS logging test		E_{PS}	0.1
Horizontal loading test of borehole		E_b	2.5
Standard penetration test	Estimate from N-Value	E_N	1.0

Source: Japanese Railway Standard

Table 3.1.5 Coefficient of Ground Survey Condition

Soil parameter	Method of soil survey		Coefficient of ground survey condition (γ_{gE})
Deformation modulus (E)	Triaxial compression test		1.2～1.4 (1.0～1.1)**
	Unconfined compression test		
	Plate loading test	Non cyclic loading	1.2～1.4
		Cyclic loading	1.0～1.1
	PS logging test		1.0～1.1
	Horizontal loading test of borehole(except gravel)		1.2～1.4
	Standard penetration test(sandy soil)		1.2～1.4
	Standard penetration test (cohesive soil)		γ_{gE} is about 1.7

** In the case of taking undistributed sample
Source: Japanese Railway Standard

6) Recommended geotechnical design parameters

The recommended geotechnical design parameters which are identified in this soil condition survey are summarized in Table 3.1.6.

It should be noted that additional soil condition surveys are needed at ROBs and the eastern section in the basic design stage because the soil condition survey was carried out at only railway bridges and between the stations in the western section.

Table 3.1.6 Recommended Geotechnical Design Parameters

No.	Soil Name	N Value	Unit weight			Internal friction angle	Unconfied compressive strength	Cohesive strength	Deformation modulus
			γ_t (kN/m^3)	γ_{sat} (kN/m^3)	γ' (kN/m^3)	φ (°)	qu (kN/m^2)	c (kN/m^2)	E_{50} (kN/m^2)
1	Filled Soil (F)	4[1]	19.0	19.0	9.0	-	50[4]	25	9,000[3]
			(Same value as AC-II)						E_N[5]=4,000N,γ_{gE}[5]=1.7
2	Alluvial CLAY-I (AC-I)	3[1]	17.0[1]	17.0	7.0	-	80[1]	40	1,500[1]
3	Alluvial CLAY-II (AC-II)	7[1]	19.0[1]	19.0	9.0	-	40[1]	20	4,500[1]
4	Alluvial CLAY-III (AC-III)	14[1]	19.0	19.0	9.0	-	175[4]	85	32,000[3]
			(Same value as AC-II)						E_N[5] 4,000N,γ_{gE}[5]=1.7
5	Alluvial SAND (AS)	14[1]	19.0[1]	20.0	10.0	30[3]	-	-	21,000[3]
									E_N[5]=2,000N,γ_{gE}[5]=1.3
6	Diluvial CLAY-I (DC-I)	20[1]	19.0[1]	19.0	9.0	-	250[4]	125	47,000[3]
									E_N[5]=4,000N,γ_{gE}[5]=1.7
7	Diluvial CLAY-II (DC-II)	50[1]	19.0	19.0	9.0	-	625[4]	310	117,000[3]
			(Same value as DC-I)						E_N[5]=4,000N,γ_{gE}[5]=1.7
8	Diluvial SAND-I (DS-I)	30[1]	19.0	20.0	10.0	31[3]	-	-	46,000[3]
			(Same value as DC-II)						E_N[5] 2,000N,γ_{gE}[5]=1.3
9	Diluvial SAND-II (DS-II)	50[1]	19.0[2]	20.0	10.0	35[3]	-	-	76,000[3]
									E_N[5]=2,000N,γ_{gE}[5]=1.3

1) These values were set up by field test or soil test result.
2) These values were set up by reference value shown in Railway Standard.
3) These values were set up by the formula of Railway Standard using N-value.
4) These value were set up by the formula of Terzaghi and Peck (100N/8 (kN/m^2)).
5) These values were set up by the formula of Railway Standard.
E_N : These values were Deformation modulus which was calculated using N-value.
γ_{gE} : Coefficient of ground survey condition.

(2) Applicable Foundation Type

Nine different types of layers are observed along the western section as below:

1. Filled Soil (F)
2. Alluvial CLAY-I (AC-I)
3. Alluvial CLAY-II (AC-II)
4. Alluvial CLAY-III (AC-III)
5. Alluvial SAND (AS)
6. Diluvia CLAY-I (DC-I)
7. Diluvia CLAY-II (DC-II)
8. Diluvia SAND-I (DS-I)
9. Diluvia SAND-II (DS-II)

The reliable bearing layer can be determined mainly based on the in-situ SPT N-value.

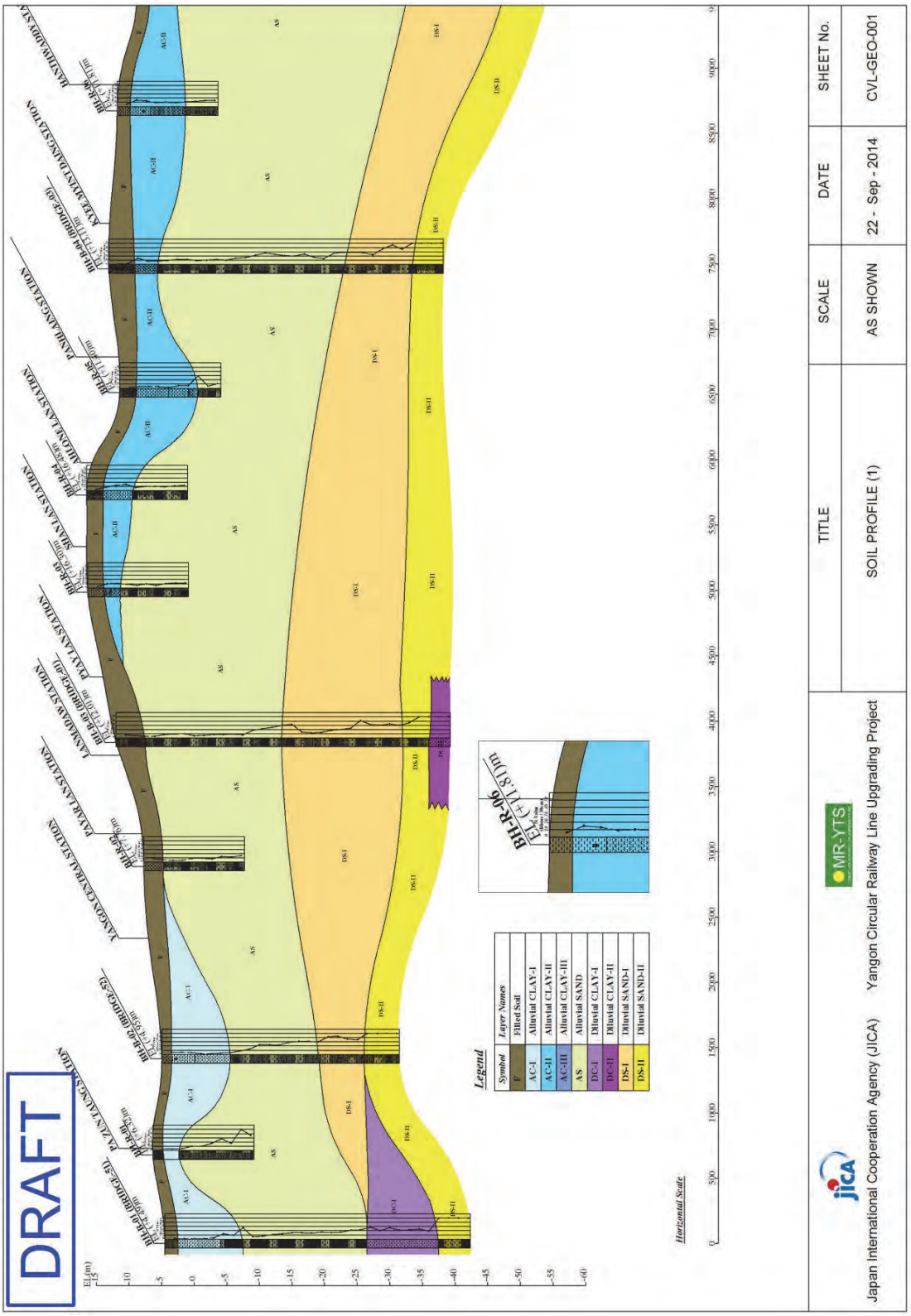
For light to medium load structures, a sand layer having SPT N-values of larger than 30 or silt/clay layer having the values of greater than 20 can be recognized as a bearing layer.

On the other hand, in case of heavy load or dynamic loaded structures, a layer having the SPT N-value of more than 50 should be considered as a reliable bearing layer.

The soil condition survey shows that the alluvial soft clay and loose sand layers are widely distributed along the western section from the surface with thickness of 30 to 40m. In addition, existence of a diluvia layer is confirmed under the alluvial layer. Therefore, an applicable foundation type for the rail and related structures except for light structures should be considered to be a pile foundation. While the bearing layer for the heavy structures shall be the Diluvia SAND-II layer of which the N-value is over 50.

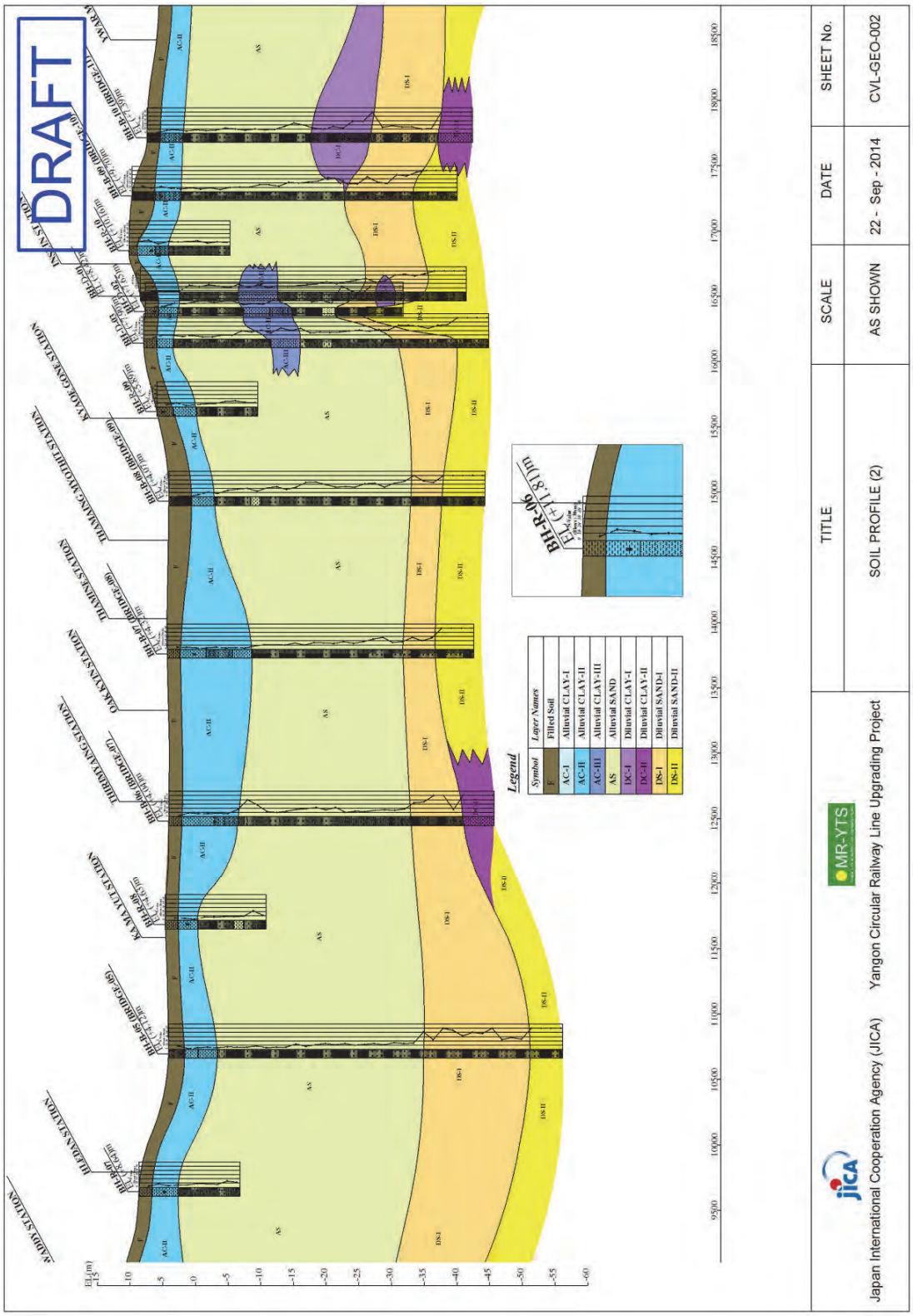
According to the liquefaction analysis, there is a possibility of liquefaction in the western section because of the loose sand layer. This indicates that very careful consideration is required in designing the pile foundation.

In summary, the soil profiles of the western section are drawn as shown in Figure 3.1.4, 3.1.5, and 3.1.6. These are based on an expert's visual check of the soil samples at the survey sites and the SPT N-values of the boreholes and a series of laboratory tests to determine the longitudinal section along the western section.



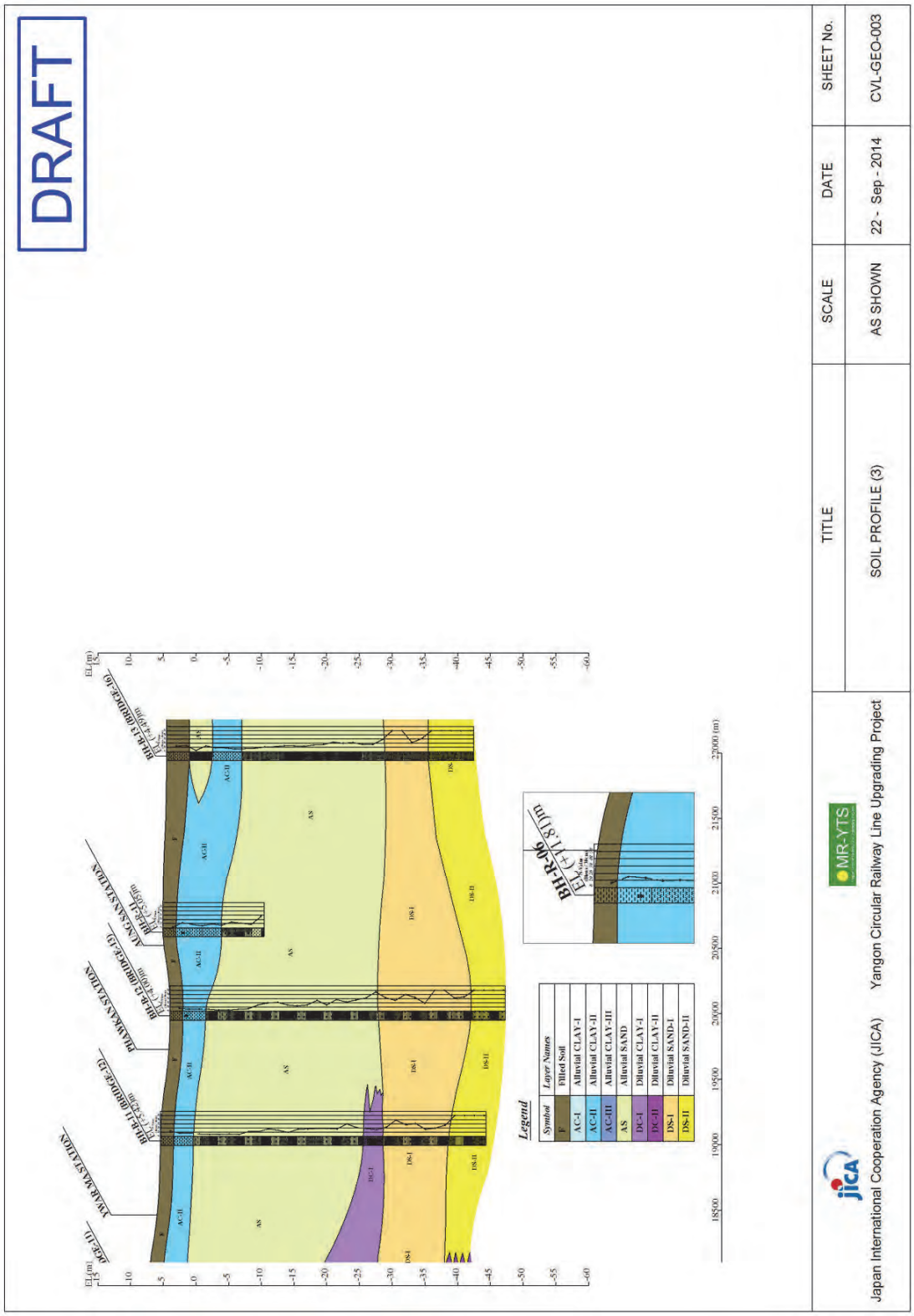
Source: JICA Study Team (2014)

Figure 3.1.4 Geological Profile (1)



Source: JICA Study Team (2014)

Figure 3.1.5 Geological Profile (2)



Source: JICA Study Team (2014)

Figure 3.1.6 Geological Profile (3)

(3) Earthquake Consideration

The Union of Myanmar lies in one of the earthquake areas called the Alpine Earthquake Belt. The central and the eastern parts of Myanmar lie on the Burma Plate which has a convergent boundary with the Indian Plate in the western part of Myanmar. The Burma Plate has been moving 2 to 3 cm per year to the north. Because of this unstable ground activity, earthquakes can be expected at any time in Myanmar. Actually many earthquakes, ranging from minor to catastrophic, have stricken in the past.

1) Earthquake Intensity of Myanmar

A Seismic Zone Map of Myanmar is shown in Figure 3.1.7. The map shows zones of five types in terms of probable range of ground acceleration. This map has been developed mainly based on empirical and historical records. The map does not report frequency (or indicative probability) of the occurrence of such earthquakes, but in designing the structures along the Yangon Circular Railway Line, an approach considering the probabilistic seismic risk should be taken into consideration.

The five seismic zones are named respectively, ***Zone I (Low Zone), Zone II (Moderate Zone), Zone III (Strong Zone), Zone IV (Severe Zone), and Zone V (Destructive Zone).*** This naming refers to the nomenclature of the European Macro seismic Scale 1992.

This zoning system is defined by probable range of ground acceleration in g values and corresponding Modified Mercalli (MM) scale classes. Zones of the highest values in Myanmar are categorized as Destructive Zones with a probable range of 0.4 - 0.5 g acceleration which is equivalent to MM class IX. There are four areas that are categorized as Destructive Zones in Myanmar, Bago-Phyu, Mandalay-Sagaing-Tagaung, Putao-Tanaing, and Kale Myo-Homalin areas.

Many of the populated cities and towns are in ***Zone IV*** (Severe Zone, with probable range of 0.3-0.4 g acceleration, namely, Taungoo, Taungdwingyi, Bagan-Nyaung-U, Kyaukse, Pyin Oo Lwin, Shwebo, Wuntho, Hkamti, Haka, Myintkyina, Taunggyi, and Kung long.

The Greater Yangon area has been expanding from ***Zone II*** into ***Zone III***, namely, the old downtown area are laid in Zone II, while new townships and satellite towns have been developed in Zone III.

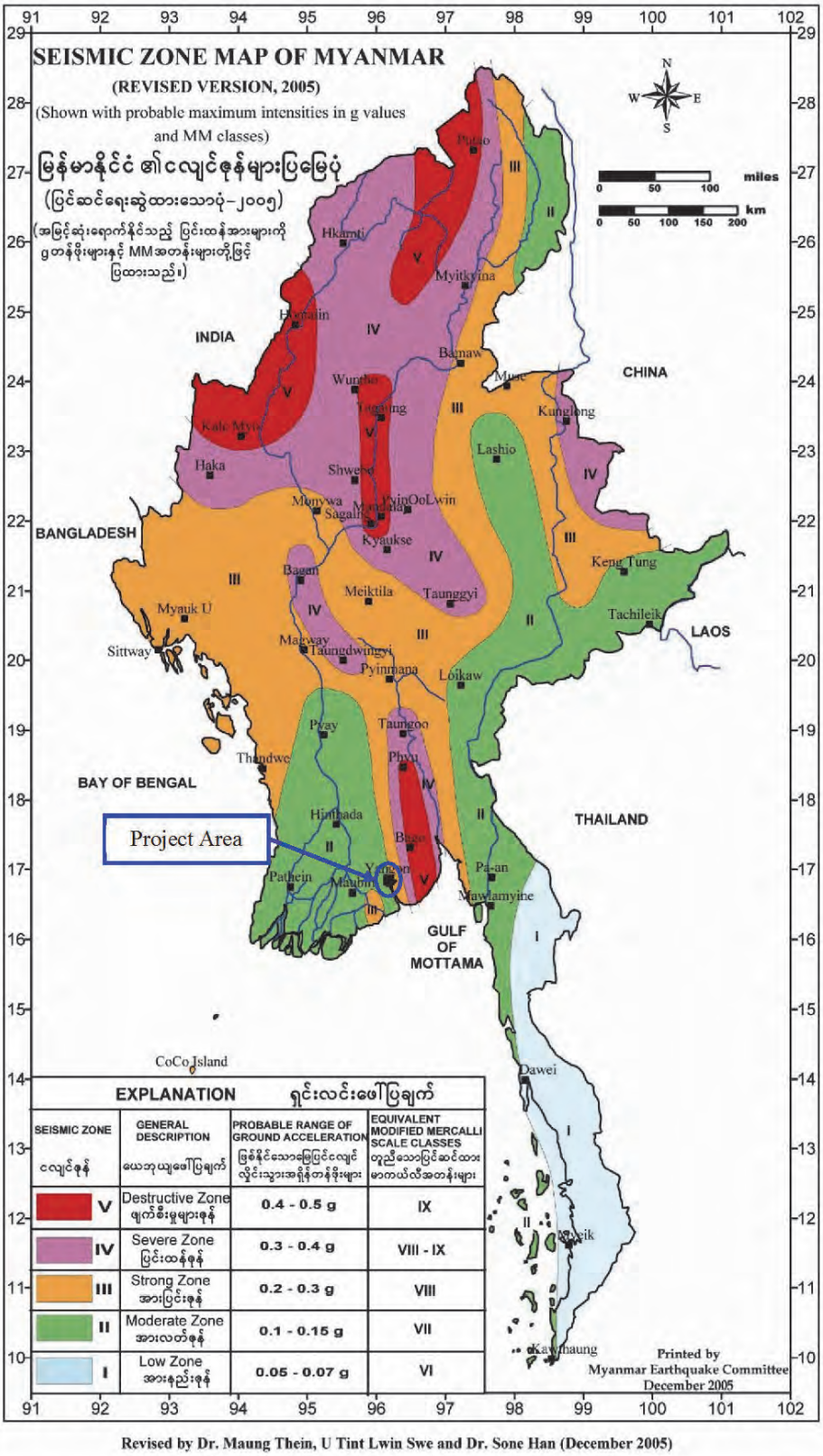
Referring to the Modified Mercalli (MM) Scale classes, the level of probable damage and destruction may be summarized as shown in Table 3.1.7.

A detailed earthquake hazard map of Yangon is shown in Figure 3.1.8.

Table 3.1.7 The Level of Probable Damage and Destruction

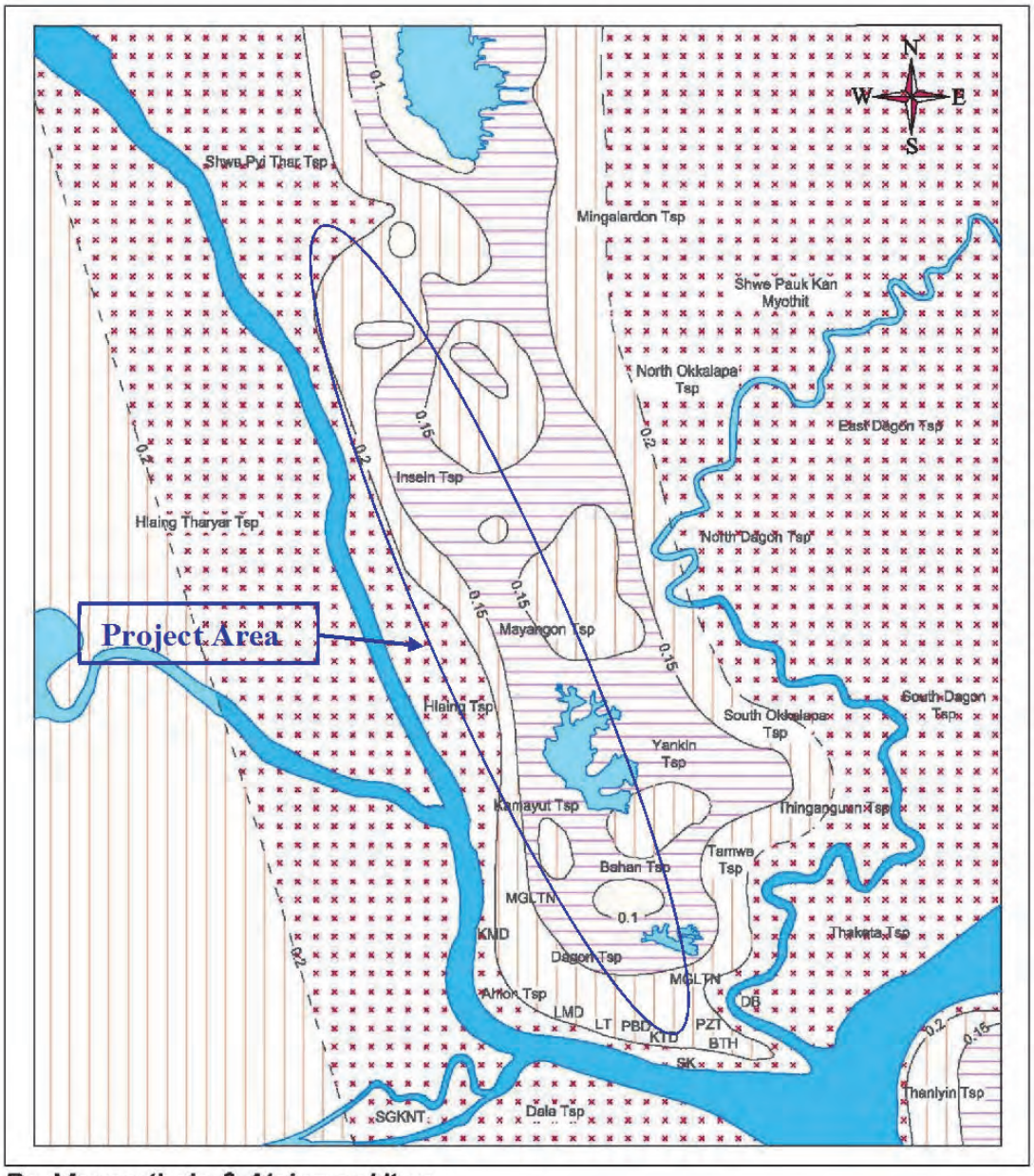
Zone	MM Class	Probable Damage	Examples of Damage
V	IX	Major damage	Considerable damage in specially designed structures Major damage in good RC buildings
IV	VIII-IX	Considerable damage	Considerable damage in good RC buildings Major damage in ordinary brick buildings
III	VIII	Moderate damage	Moderate damage in good RC buildings Considerable damage in ordinary brick buildings
II	VII	Minor damage	Minor damage in good RC buildings Moderate damage in ordinary brick buildings
I	VI	Slight damage	Minor damage in ordinary brick buildings

Source : JICA Study Team (2014)



Source : Myanmar Earthquake Committee

Figure 3.1.7 Seismic Zone Map of Myanmar (after Dr.Maung Thein et al, 2005 Dec.)



Dr. Maung thein & Aleinmar Htwe

0 5 10 (miles)

Numbers on contours refer to probable peak ground acceleration in (g) values
(Dashed where approximately located)

< 0.1 g
0.15 ~ 0.2 g
0.1 ~ 0.15 g
0.2 ~ 0.3 g

Source : Myanmar Earthquake Committee

Figure 3.1.8 Earthquake Hazard Map of Yangon Area

2) Expected Ground Acceleration in the western section

According to the seismic zone maps, the probable peak ground acceleration could be 0.2g when an earthquake occurs. The corresponding Modified Mercalli (MM) class would be 7.0.

(4) Possible liquefaction in the western section

1) General

Liquefaction is one of the most serious earthquake related hazards, which is a special case of quicksand. In this case, sudden earthquake forces immediately increases the pore pressure of shallow groundwater. The saturated liquefied soil loses strength, causing buildings or other objects on that surface to sink or fall.

The soil condition survey indicates there are soil layers that have potential quicksand along the western section. Quicksand (after Terzaghi, 1925) can happen under the following three conditions.

First, where the sand or silt concerned is saturated and loosely packed.

Second, on disturbance, the constituent grains become more closely packed, which leads to an increase in pore water pressure, reducing the forces acting between the grains. This brings about a reduction in strength.

Thirdly, where the pore water cannot escape readily, that is, if the sand or silt has a low permeability and/or the seepage path is long quicksand can form.

As explained as above, the soil condition of poorly graded sand of fine to medium grain and silty sand of saturated condition easily leads to liquefaction.

It should also be noted that liquefaction can be brought about by sudden shocks caused by action of heavy machinery and blasting.

According to the research on many earthquake experiences in the world, it is safe to say that the liquefaction can occur easily under the following conditions.

a. Lower fine content of saturated soil (fine content means the size of grain is less than 0.07 mm)
b. Lower SPT blow count (N) of saturated soil (SPT N-value < 20 blows per 30 cm)
c. Shallow groundwater table
d. Higher maximum peak acceleration

2) Liquefaction Analysis

For the analysis on potential liquefaction in the western section, the magnitude of earthquake and peak acceleration at the ground surface is assumed to be 0.2g and MM class is 7.0. With regard to the water table, the data was obtained from the field survey. Two methods were employed for the liquefaction analysis as follows:

a. “Design Standard and Explanation of Railway Structure” Railway Technical Research Institute, 2012.9
b. “Highway Bridge Design Guideline, Anti-earthquake design Chapter” Japan Road Association, 2012.3

3) Liquefaction Analysis Result

The analysis indicates that the liquefaction index of Possibility of Liquefaction (PL) could be more than 5 (refer to Table 3.1.8) at some sections along the western section. Accordingly some potential damages caused by such liquefaction should be considered in the consequent basic design of the proposed structures.

Table 3.1.8 Risk Level of Liquefaction

PL	Risk Level of Liquefaction
0	Very Low possibility of Liquefaction
less than 5	Low possibility of Liquefaction
5-15	Possibility of Liquefaction
over 15	High possibility of Liquefaction

Source: JICA Study Team (2014)

(5) Consolidation Settlement

Raising the existing track level can be considered by adding ballast and other track materials and structures to avoid floods and to achieve better vertical alignment for smooth train operation in the consequent basic design stage. Accordingly, consolidation may happen along the improved railway section, which may lead to subsidence, and accordingly may disturb smooth train operation.

In this section, consolidation settlement, which could be caused by the additional track materials, is examined.

1) Method of Calculation for the Consolidation Settlement

The following equation is employed in this examination:

e method (based on relationship between void ratio and consolidation pressure)

$S = (e_0 - e_1) / (1 + e_0) \times H$

where,

S : Total Settlement (m)

e_0 : Initial Void Ratio

e_1 : Void Ratio after Increasing Strength

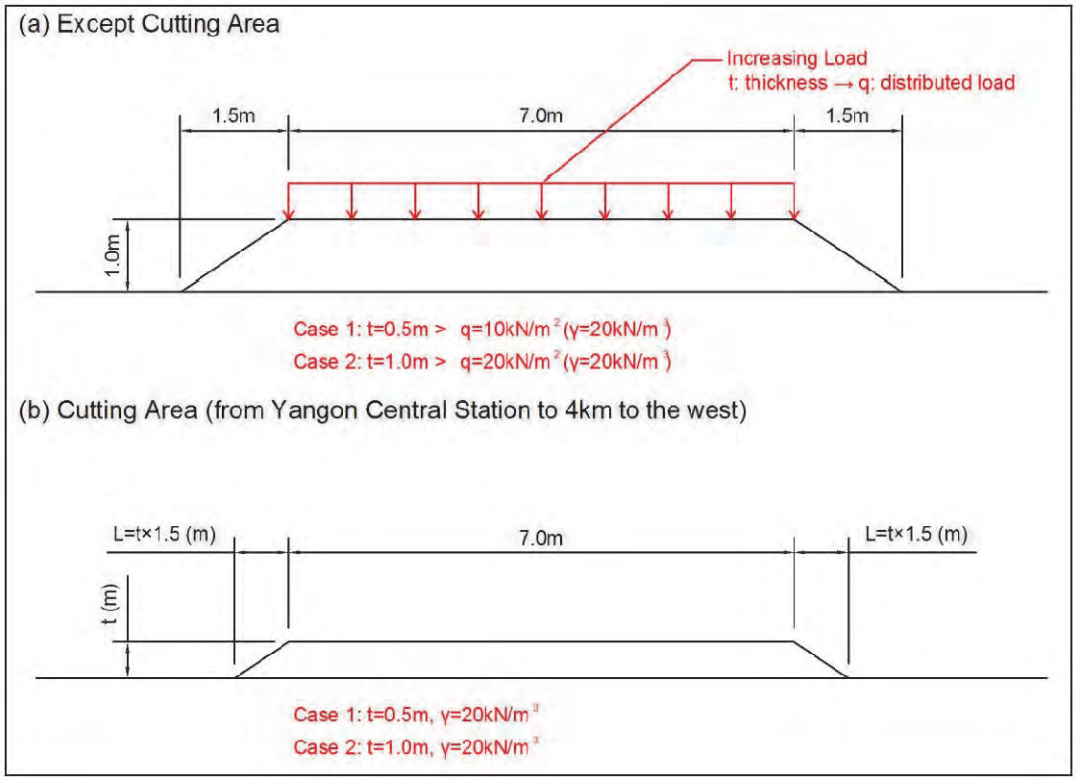
H : Thickness of Consolidation Layer (m)

2) Assumptions

The objective layer of settlement examination is set at the bottom of the “AS” layer.

There are two different assumptions in terms of typical transverse plane in this examination, namely, that of the filled area and that of the cut area. In addition to this, two different loading conditions are considered. Figure 3.1.9 shows those assumptions in terms of transverse plane that are considered in the examination.

It should be noted that the consolidation settlement due to the train loading has already been completed because the project section is on the existing railway. Moreover, stress dispersion, using the Boussinesq formula was considered in this examination because the track width is limited.



Source: JICA Study Team (2014)

Figure 3.1.9 Calculation of Consolidation Settlement

3) Results of consolidation settlement examination

Table 3.1.9 summarizes the calculation results, and Figure 3.1.10 shows distribution of consolidation settlement along the western section. Two cases for each borehole are shown in Table 3.1.9, namely the case by increasing stress Δp of 10 kN/m^2 and another case of 20 kN/m^2.

The maximum settlement of Δp=20 kN/m^2 is calculated as approximately 18 cm at BH-B-01. The settlement of BH-B-01 is the largest in the case of increasing the stress of not only Δp=20 kN/m^2, but also Δp=10 kN/m^2. The settlement of BH-B-02 is also significant in comparison with other borehole points.

Around these boreholes, AC- I layer is observed. According to the field and laboratory test, AC- I layer is softer than other layers. Therefore, although the settlement is calculated based on the corresponding layer thickness, it is considered that one becomes larger in the section where AC- I layer is distributed. The settlement in other boreholes is approximately 10 cm in the case of increasing stress of Δp=20 kN/m2 and 5cm at one of Δp=10 kN/m2. Figures 3.1.11 and 3.1.12 show the relationship between settlement and time. Figure 3.1.11 is a representative graph of the section where AC- I layer is distributed (BH-B-01). And, Figure 3.1.12 is a graph of AC- II layer (BH-B-07). The consolidation degree of BH-B-01 becomes more than 90% in about 10 years, and that of BH-B-07 is approximately 3 and a half years.

The settlement speed will be high until 200 days after completion of the work as indicated in Figures 3.1.11 and 3.11.12. After the 200 days, the settlement speed becomes constant, and it slows gradually.

As suggested, the degree of settlement becomes large where AC- I is distributed. The maximum settlement could be approximately 18cm.

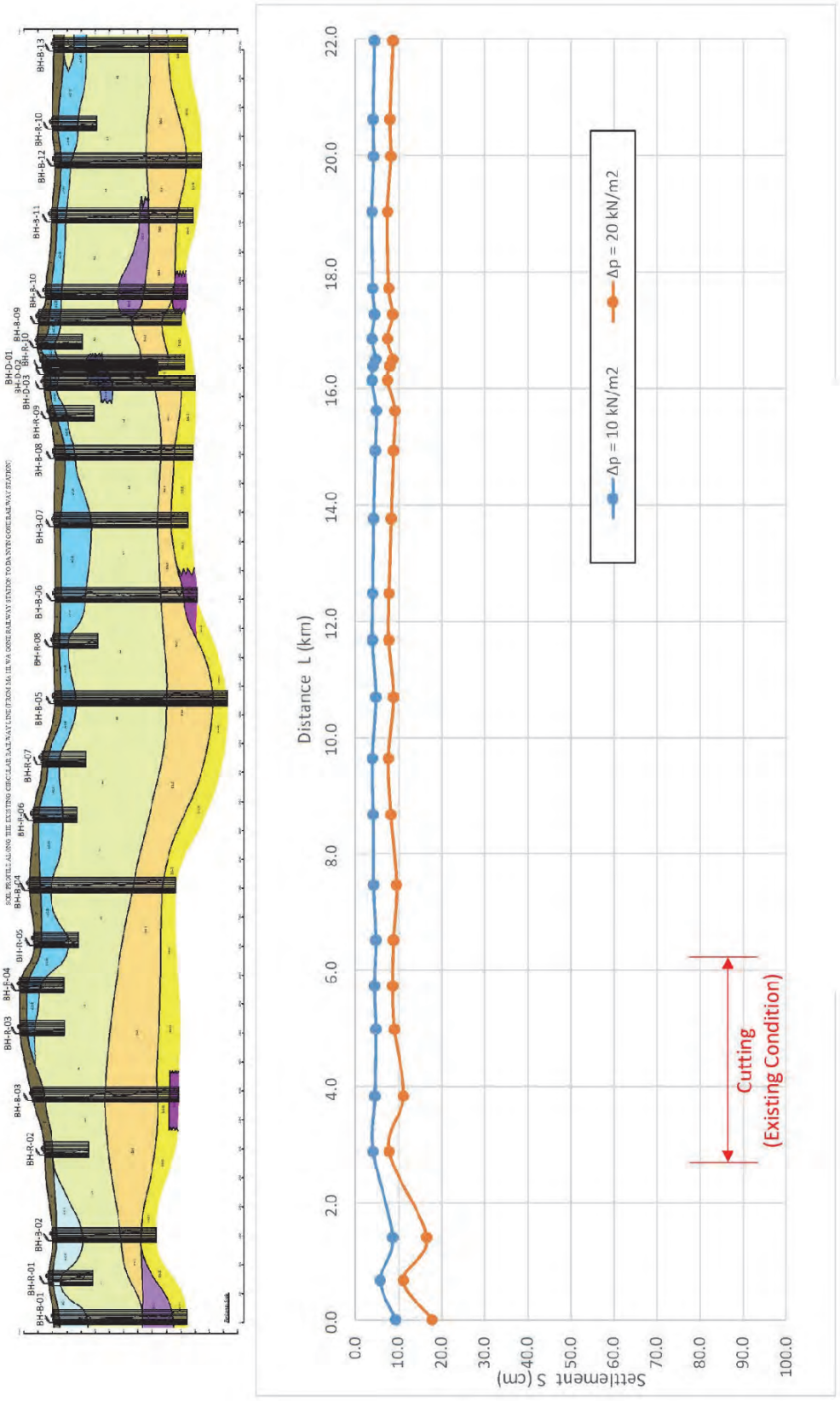
The degree of consolidation of the sections where the AC-Ⅱ layer is distributed is small. In those sections, the settlement speed slows after approximately one half of a year.

Based on these results, it is considered that adding ballast is appropriate as an economical method of maintenance work. However, it should be noted that frequency of the maintenance work increases in the beginning half year, and it is expected to be reduced gradually. It is safe to say that soil improvement work is not needed in this project.

Table 3.1.9 Calculation Results of Consolidation Settlement

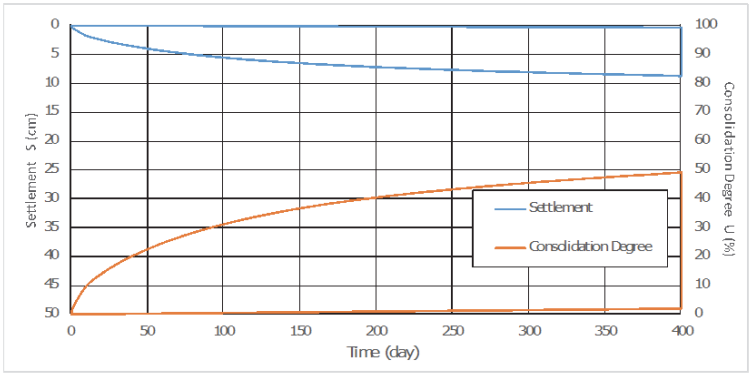
Construction Condition	Borehole No.	X Coordinate (km)	Settlement (cm)	
			$\Delta p = 10$ kN/m^2	$\Delta p = 20$ kN/m^2
Filling	BH-B-01	0.000	9.3	17.8
	BH-R-01	0.678	5.7	11.1
	BH-B-02	1.414	8.6	16.5
Cutting	BH-R-02	2.887	4.1	7.8
	BH-B-03	3.837	4.5	11.1
	BH-R-03	4.985	4.7	9.0
	BH-R-04	5.730	4.4	8.6
Filling	BH-R-05	6.513	4.7	8.8
	BH-B-04	7.461	4.2	9.5
	BH-R-06	8.671	4.1	8.2
	BH-R-07	9.642	3.9	7.6
	BH-B-05	10.696	4.7	8.8
	BH-R-08	11.683	3.9	7.7
	BH-B-06	12.481	4.0	7.8
	BH-B-07	13.763	4.2	8.3
	BH-B-08	14.930	4.6	8.8
	BH-R-09	15.616	4.8	9.1
	BH-D-03	16.139	3.8	7.4
	BH-D-02	16.381	4.1	8.0
	BH-D-01	16.499	4.7	8.6
	BH-R-10	16.850	3.8	7.4
	BH-B-09	17.267	4.4	8.6
	BH-B-10	17.714	4.0	7.7
	BH-B-11	19.028	3.8	7.4
	BH-B-12	19.985	4.2	8.2
	BH-R-11	20.623	4.1	8.0
	BH-B-13	21.976	4.4	8.7

Source: JICA Study Team (2014)

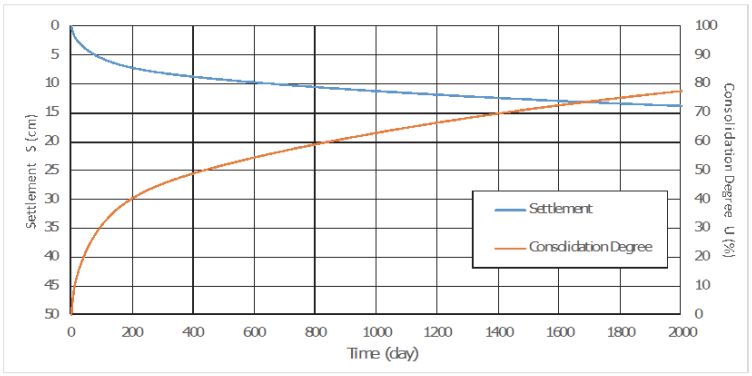


Source: JICA Study Team (2014)

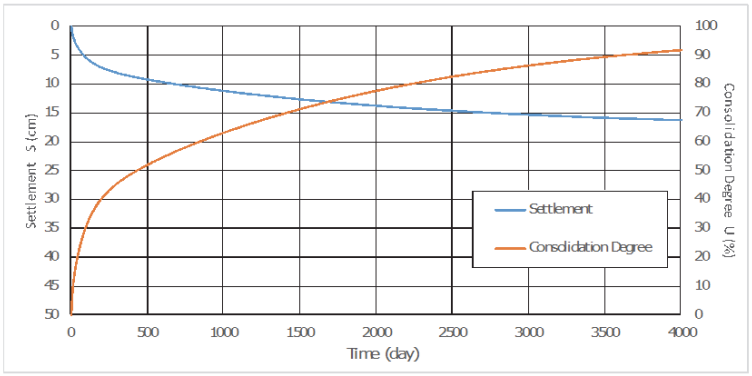
Figure 3.1.10 Distribution of Consolidation Settlement



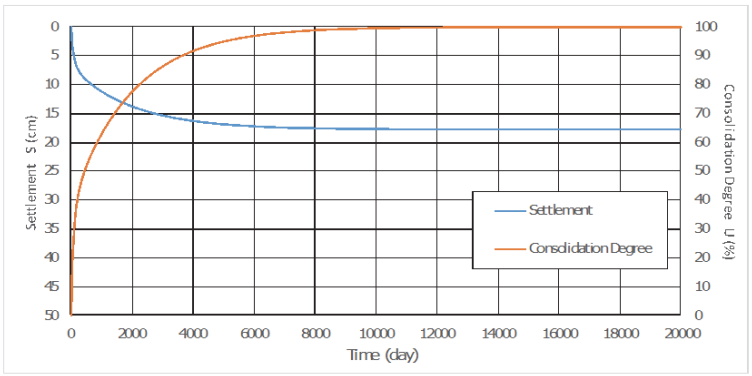
(a) 1 year later



(b) 5 year later



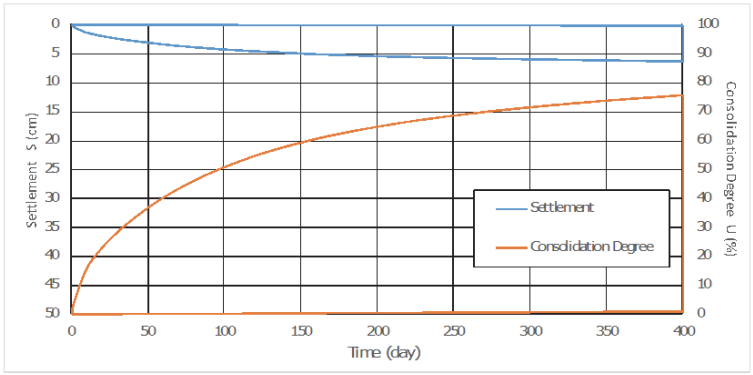
(c) 10 year later



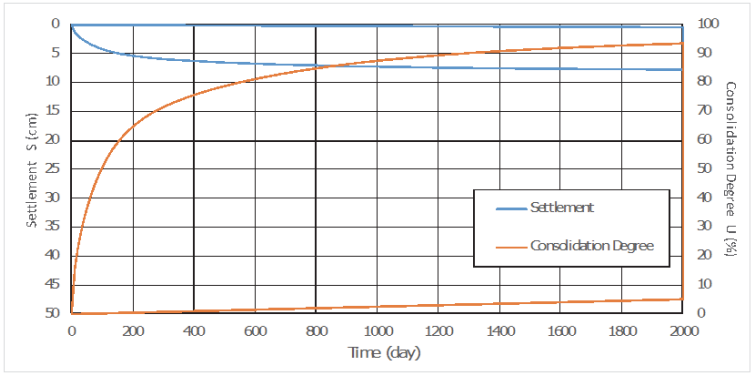
(d) 50 year later

Source: JICA Study Team (2014)

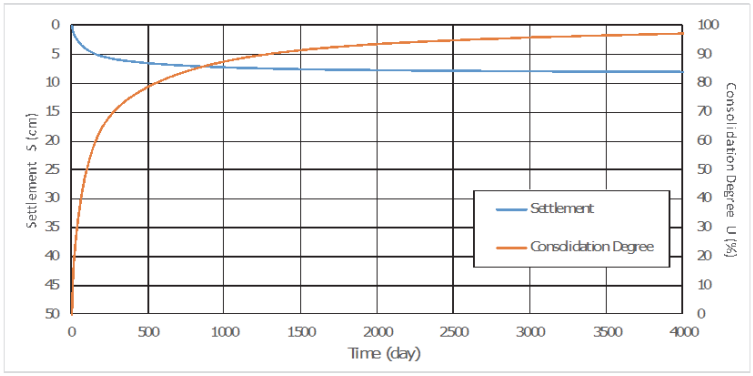
Figure 3.1.11 Relationship between Settlement and Time (BH-B-01)



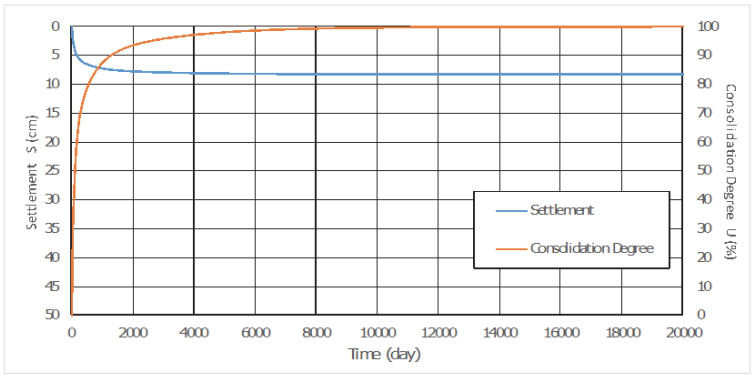
(a) 1 year later



(b) 5 year later



(c) 10 year later



(d) 50 year later

Source: JICA Study Team (2014)

Figure 3.1.12 Relationship between Settlement and Time (BH-B-07)

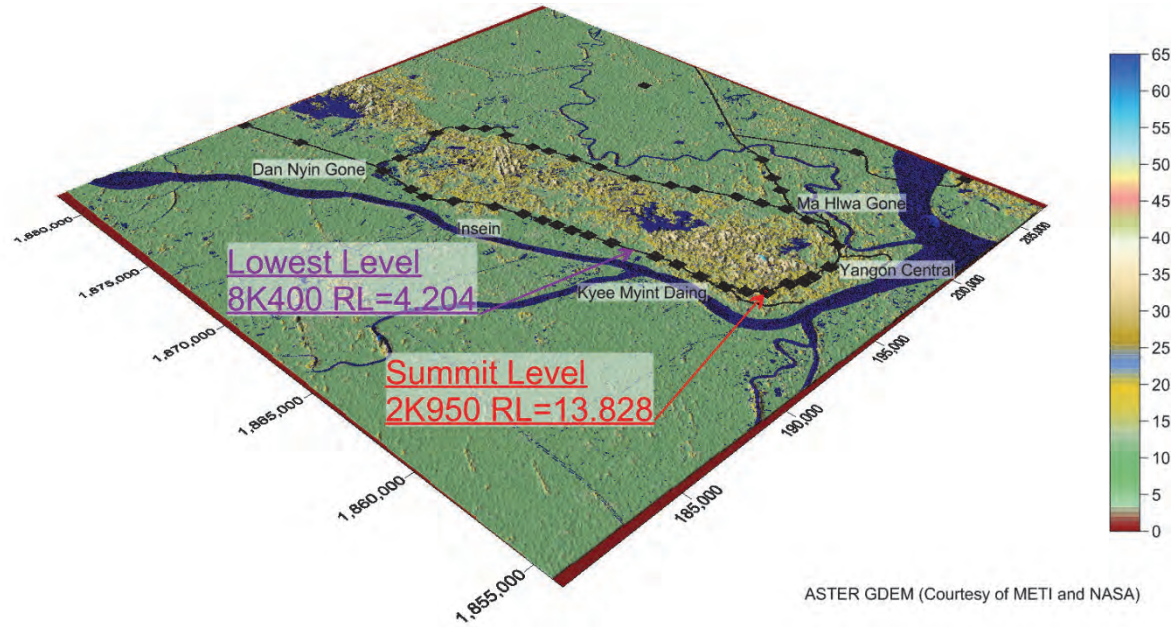
3.2 Topographic Condition

3.2.1 Overview of topography for the YCR area

The Yangon Circular Railway Line runs in an area which is surrounded by three rivers. The Yangon River runs on the southern side of the area. The Yangon River is one of the tributaries of the Ayarwaddy (Irrawaddy) River. The Hling River runs along the western side of the area and the Pazundaung Creek runs in the east.

This area consists of low flat land alleviated by the Yangon River and Bago River and a hill area formed by an anticline continues from the north. The hill area is located in the central area of Yangon and is surrounded by the lowland area.

The Yangon Circular Railway Line runs along the foot of the hill area. Yangon Central Station is located on the south end of the hill and the railway line crosses the south end of the hill running east-west. At the west side of the loop, the circular railway line runs in the north – south direction and the western section runs along some low land areas and the west foot of the hill. At the northern part of the loop, the direction of the line runs in the east-west, and crosses a part of the hill area. At the eastern side of the loop, the railway line runs in the north-south direction along the lowland area.



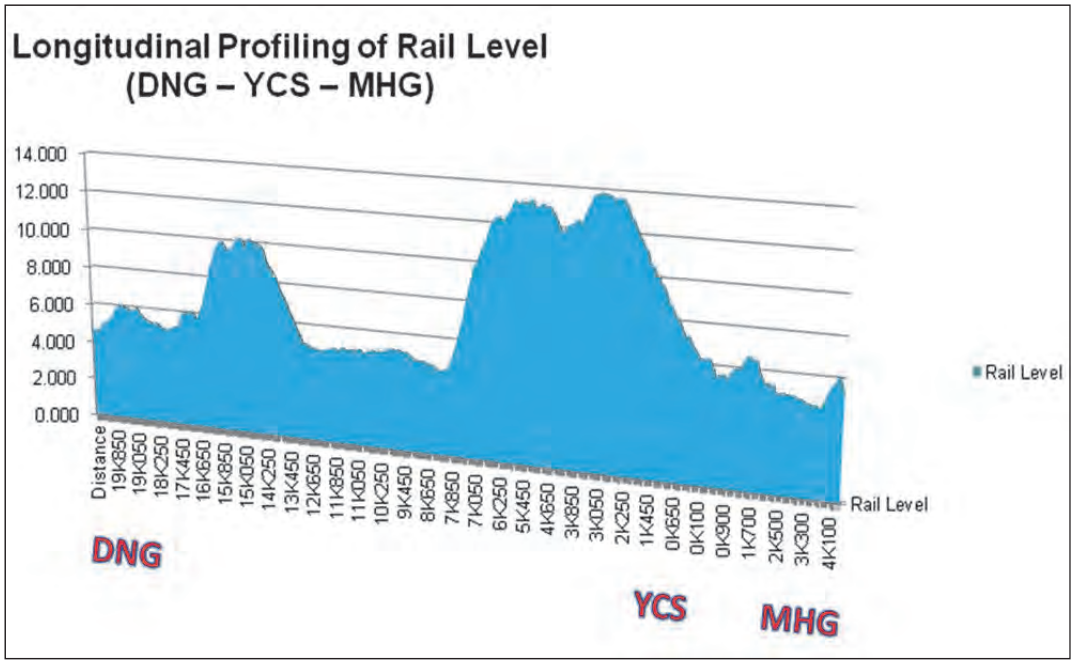
Source: JICA Study Team (2014)

Figure 3.2.1 Overview of Topography of YCR

The lowland areas located on both the east and west sides of the loop are used as rice paddy, housing land or swamp. Where the loop crosses the hilly part, the railway tracks lay in a cut in the hill. Kandawgyi Lake and Inya Lake are artificial dams which were constructed as a water reservoir in the past and located on top of the isolated hill area. There are no natural stream flows into these dams. Water resource for those dams is mainly rainfall water. For Kandawgyi Lake, there are artificial water ducts for filling water from Inya Lake. Between Mingalardone and Wai Bar Gi Station the line is close and across airplane approach course of Yangon International Airport.

3.2.2 Elevation profile along the YCR (Section for DNG – YCS – MHG)

Figure 3.2.2 shows the rail level profile for YCR: Da Nyint Gone Station (DNG) - Yangon Central Station (YCS) - Ma Hlwa Gone Station (MHG), which were derived from the result of longitudinal profile survey carried out by the JICA Study Team on 2014.

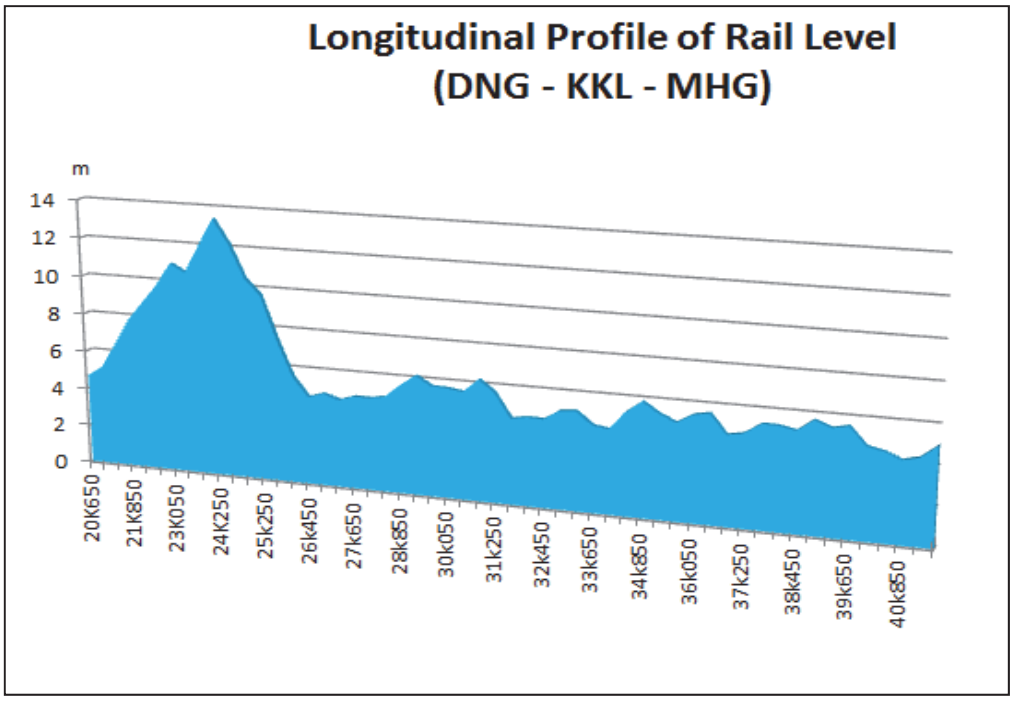


Source: JICA Study Team (2014)

Figure 3.2.2 Longitudinal Profile of Rail Level (DNG – YCS – MHG : surveyed in 2014)

3.2.3 Elevation profile along the YCR (Section for DNG – KKL – MHG)

Figure 3.2.3 shows the rail level profile for YCR: Da Nyin Gone Station (DNG) – Kyite Ka Lae Station (KKL) - Ma Hlwa Gone Station (MHG), which were derived from the result of longitudinal profile survey carried out by the JICA Study Team on 2015.



Source: JICA Study Team (2015)

Figure 3.2.3 Graph for Longitudinal Profile of Rail Level (DNG – YCS – MHG : surveyed in 2015)

3.2.4 Features of topographic along the YCR

Featured topographic conditions of the loop line are described in the following 3 tables. It should be noted that the elevations mentioned in this paragraph refer to the height based on the national bench mark system of Myanmar: above the mean sea level of Kyaikkami in Andaman Sea.

Table 3.2.1 Featured Topographic Conditions of Western half of YCR (From Yangon Central Station to DNG Station)

Section (Station or Kilo Post)	Features of topographic condition
YCS – Shan Lan (2k950m)	The line is located on the south end of a hill and crosses the hill through a cut. Elevation of track at YCS is around 6m. The summit (13.8m) in the loop is 2k950m near Shan Lan station. From YCS to Shan Lan station, the gradient continues to rise. Land utilization along the railway is mainly built-up area.
Shan Lan to Ahlone Lan (3k700m)	The line is located on a hill and crosses the hill through a cut. Elevation of railway track is around 12m.
3k700 to 6km	The line is located on the foot of the hill. Railway track runs through both cuts and fills. Elevation of railway track is around 12m.
7km to 8km	Decline, Elevation changes from 12m to 4m.
8km to 13km	Elevation of track is around 4m to 5m
13km to 14k800m	Rising gradient.
14k800 to 16km	The line is located on the west side of the hill. Elevation is from 9m to10m
16k100m to 16k800m	Decline.
16k800m to 20k	The line is located on lowland. Elevation of railway track is 4m to 5m. The line is surrounded by paddy fields and swamp.

Source: JICA Study Team (2014)

Table 3.2.2 Featured Topographic Conditions from Yangon Central Station to MHG Station

Section (Station or Kilo Post)	Features of topographic condition
Yangon Central to 0k950m	Decline to a stream crossing at 0k950m. Elevation is 6m to 5m.
1k600m	Pa Zun Taung station is located on the foot of the hill. Elevation of railway track is 6.6m.
2k550m to 4k350	The line is built on fill located in a swamp area. There are drainage ditches along the railway tracks.

Source: JICA Study Team (2014)

Table 3.2.3 Featured Topographic Conditions from DNG Station to MHG Station on the East Side of the Loop

Section (Station or Kilo Post)	Features of topographic condition
DNG to Mingalardone Zay	Elevation of railway track varies from 4m to 13m. The line crosses the ridge of the hill near Kyite Ka Lae station and elevation of railway track is 13m. The line enters lowlands near Mingalardone Zay.
Mingalardone Zay to MHG	The line is located on lowlands. There are open spaces along the railway track. The open spaces are paddy fields and swamp. Some places outside of the rice paddy and swamp areas are utilized as residential areas. Between MIngarlardone and Wai Bar Gi station, the line cross the approach course of Yangon International Airport. Clearance from end of airstrip is approximately 600 metres.

Source: JICA Study Team (2014)

3.3 Other Natural Condition

3.3.1 Climate

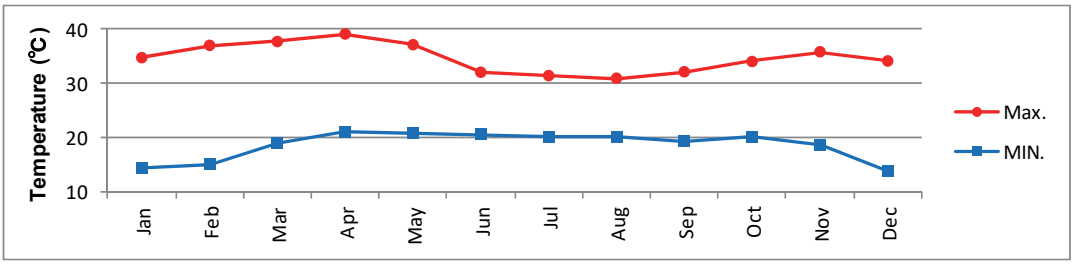
The Greater Yangon area is located in a tropical monsoon climate, characterized by three distinct seasons, namely, summer (March to middle of May), rainy (Middle of May to middle of October), and cool (Middle of October to February) seasons.

The Kaba-aye Meteorological Station, operated by the Department of Meteorology and Hydrology (DMH), and Ministry of Transport (MOT), has been recording the meteorological conditions of the Greater Yangon since 1968 at the location of 16° 54' N latitude, 96° 10' E longitude, and +20.0 m in elevation. Six parameters are observed daily, including 1) temperature, 2) humidity, 3) wind speed and its direction, 4) evaporation, 5) sunshine hours, and 6) rainfall.

The meteorological data at the Kaba-aye Station is deemed to be representative of the parameters of the Greater Yangon area.

(1) Temperature

Generally, temperature in April is high, the maximum monthly temperature recorded in April 2001 was 39.1 ^{o}C. The minimum monthly temperature recorded in December 2004 was 13.8 ^{o}C. The difference between the monthly maximum and minimum temperature is more than 20 ^{o}C from December to February and around 10 ^{o}C from June to August, which is the peak season of monsoon rainfall.

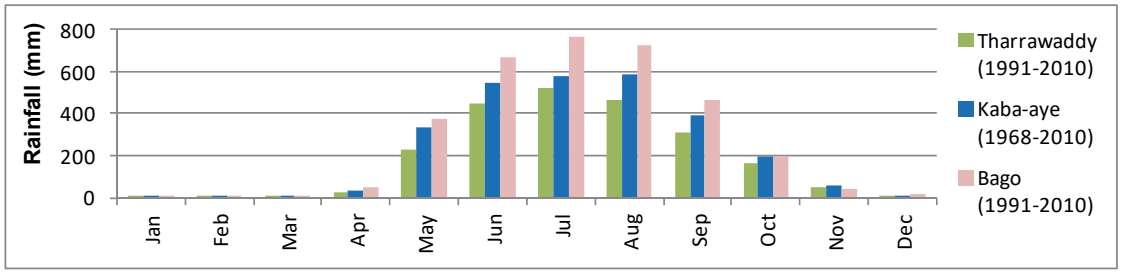


Source: SUDP

Figure 3.3.1 Mean Maximum and Minimum Temperature at Kaba-aye (1991-2008)

(2) Rainfall

At the Kaba-aye Meteorological Station, the mean annual rainfall is 2,749 mm and the maximum mean monthly rainfall is 591 mm in August and the minimum mean monthly rainfall is 3 mm in January and February. The maximum annual rainfall was recorded as 3,592 mm in 2007. The maximum monthly rainfall was 868 mm in August 1968 and the minimum monthly rainfall was zero in the past several months.



Source: SUDP

Figure 3.3.2 Mean Monthly Rainfall in and around Greater Yangon

Table 3.3.1 shows probable rainfalls at the Kaba-aye Meteorological Station which are derived from the rainfall intensity-duration-frequency relationships prepared by the Irrigation Department (ID) and Ministry of Agriculture and Irrigation (MOAI). As shown in this table, rainfall in the Greater Yangon area is short in duration and intensity. Remarkably, 50-year probable 60-minute rainfall intensity exceeds 100 mm/hour. Such a high intensity of rainfall is a major cause of inundation problems in the downtown area of Yangon City.

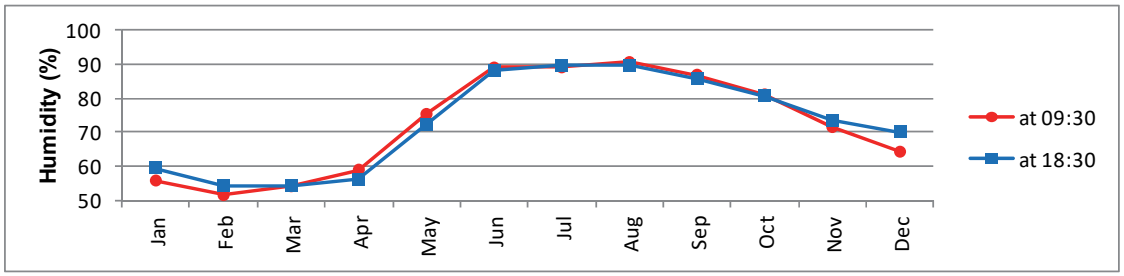
Table 3.3.1 Probable Rainfall Intensities at Kaba-aye Station

Return Period Rainfall Intensity (mm/hr)	5-yr	10-yr	20-yr	50-yr
60 minutes rainfall	63.5	71.1	78.7	104.6
75 minutes rainfall	52.1	63.9	69.9	77.5
2 hours rainfall	40.6	45.7	49.5	55.9

Source: SUDP, JICA (2012/2013)

(3) Relative Humidity

Relative humidity have been recorded twice a day; at 9:30 and at 18:30. As shown in Figure 3.3.3, humidity difference between the morning and the evening is small. The annual mean relative humidity at 9:30 and at 18:30 is 72.3% and 72.8% respectively. The maximum mean monthly relative humidity is 90.6% in August, while the minimum mean monthly relative humidity is 51.4% in February.



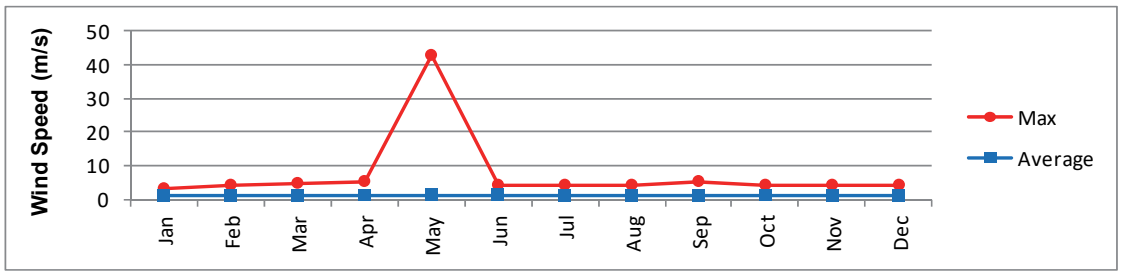
Source: SUDP

Figure 3.3.3 Mean Monthly Relative Humidity at Kaba-aye (1991-2000)

(4) Wind Speed and Direction

Annual mean wind speed at the Kaba-aye Station is 1.1 m/s. Maximum wind speed was 42.9 m/s recorded in May 2008 at the time of Cyclone Nargis. Cyclones come to the country in April, May, and October but as shown in the figure below, Greater Yangon seldom experiences such cyclonic winds.

Wind directions are generally from the SW during the summer (March to middle of May) and the rainy (Middle of May to middle of October) seasons, and NE in the cool season (Middle of October to February).



Source: SUDP, JICA (2012/2013)

Figure 3.3.4 Maximum Wind Speed and Mean Monthly Wind Speed at Kaba-aye (1991-2008)

3.3.2 Flooding

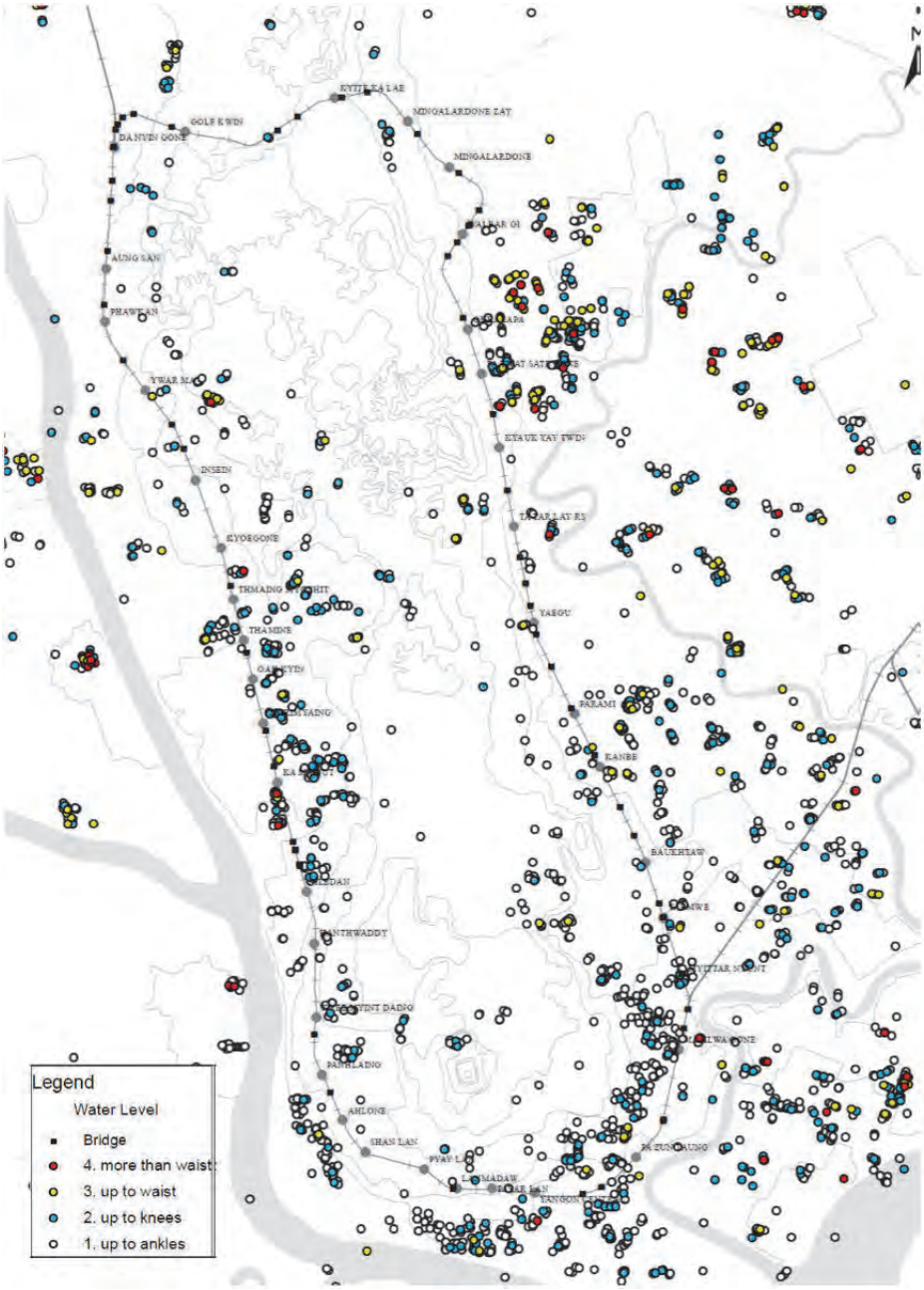
The 'Hazard Profile of Myanmar' states that flooding is one of the major hazards in Myanmar, accounting for 11% of all losses caused by disasters. It adversely affects all aspects of human activities not only from a humanitarian aspect but from the regional and national economic aspects. Floods in Myanmar usually occur during two distinct periods: from June to August and from late September to October, with the largest intensity observed in August at the peak of the monsoon season.

Floods in the Greater Yangon area can be classified into three types:

- River floods
- Localized flood inundations in urban areas are due to a combination of such factors as cloudburst, poor infiltration rate, poor drainage infrastructure, and heat island phenomenon (possibly due to climate change); and in rural areas due to decrepit dams, dykes and levees
- Floods due to cyclone and storm surge

According to the reports from MR, the main flood cause in YCR is localized flood inundations in urban areas, but not river floods or cyclones, etc.

Figure 3.3.5 is developed based on the Household Interview Survey (HIS) carried out in Strategic Urban Development Plan (SUDP). The figure shows distribution of flooding points with frequency at the locations of HIS, while flooding areas cannot be identified from the HIS. However, it is useful to understand potential flooding areas along the YCR, for example, some red points are observed in the southern area of Kamayut station, which indicates that the flood water level in that area could be more than waist high on a human being. However, it is not certain if the YCR in that area was damaged by the flooding because the flooding problem in Yangon is very site specific. Hence, careful consideration is required in the detailed design stage.



Source: HIS data conducted in SUDP, JICA (2012/2013)

Figure 3.3.5 Past Water Level in and around YCR

In order to confirm the past flooding experiences along the western section in a more quantitative manner, a series of interviews with MR staff was carried out by the JICA Study Team and its result is summarized as shown in Figure 3.3.6. The flooded rail sections are

observed in the southern part of YCR, namely between Ma Hlwa Gone station and Hledan station, of which the topographic features are flat or in cut sections. This suggests that the vertical alignment along these sections should be raised to at least higher than the past experienced water levels in order to avoid flooding the track structure.

Source: Reports from MR staff (*: Station Master, **: attended MR staff) (2014)

Figure 3.3.6 Past Flood Sections along YCR and Experienced Water Level at Stations

Chapter 4 Project Plan

4.1 Overall Improvement and Modernization Plan

The Project is planed based on the Roadmap for Yangon Circular Railway (YCR) Line Upgrading prepared as a part of this study. The Roadmap informs that the YCR is electrified or upgraded to a system having similar feature after 2030, so the improvement in the initial stage should be designed towards such further upgrading in the future.

4.1.1 Planning condition

(1) Non-electrification and At-grade Improvement

There is an idea with regard to the existing line modernization, that is, track elevation together with electrified railway from the beginning of the modernization program.

As suggested in the roadmap, the YCR line can be electrified in a long-term perspective in order to achieve higher performance as one of the spine public transport systems in Yangon. The roadmap suggests that a breakeven point in terms of life cycle costs (LCC) between the two different systems (electrified and non-electrified improvement) can be expected at 33 to 35 years after the commencement of the operation in this case.

The YCR non-electrified upgrading work will complete by 2020 and can be used for more than 25 years, that is, the said breakeven point comes after completion of the life time of the non-electrification upgrading work. This indicates that the non-electrification is preferred than the electrification.

In addition to the above discussion, it should be noted that the idea of electrification may have some negative elements as follows:

i) Own (independent) power plant for supplying the power to the electrified YCR) is required because stable power supply from the existing power grid is not expected;

ii) The necessary space for track elevation work includes the existing housing and other types of land use, accordingly the number of project affected persons (PAPs) could be very large;

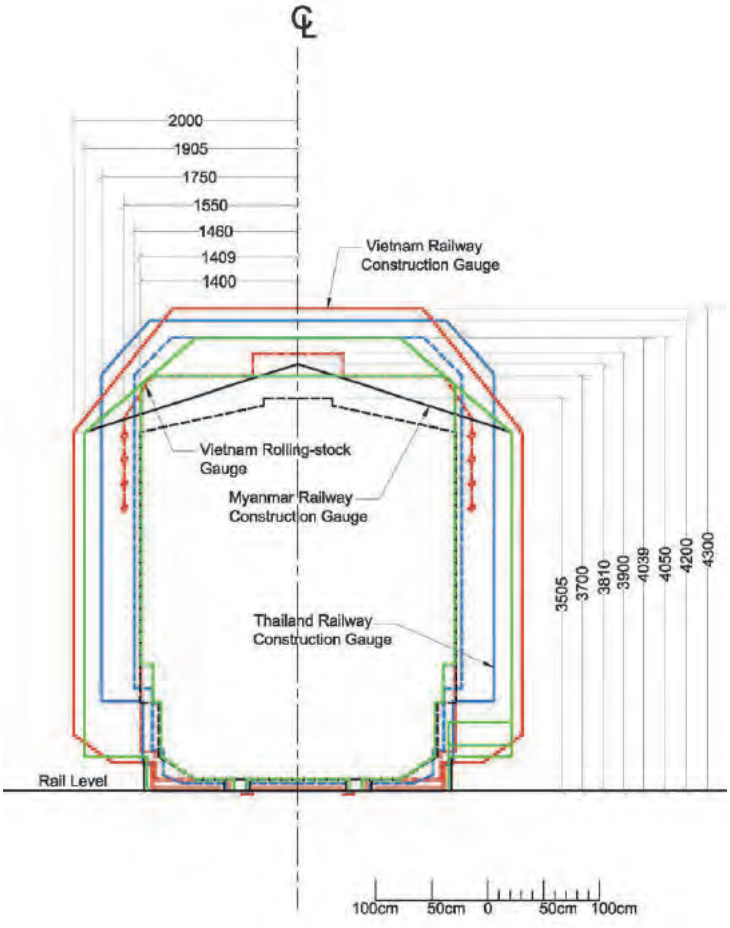
iii) Time for project implementation could be longer, including 1) finding location for MR power supply system, 2) resettlement of the project affected persons including compensation, 3) design work (more complicated in comparison with a simple non-electrified improvement method, accordingly the Yangon residents cannot enjoy the benefit of the improved system even after 2020;

iv) Initial investment costs could be much higher because of large-scale construction work, etc.

In summary, it is recommended that MR improves the YCR as at-grade and non-electrified system in its initial stage of modernization. In parallel, an option of the electrification can be studied, covering the entire transit network in the Greater Yangon area.

(2) New Construction Gauge and Rolling Stock Gauge (no ROB Reconstruction)

Figure 4.1.1 shows the construction gauges and car gauges in Association of South - East Asian Nations (ASEAN) countries including Myanmar. As shown in the figure, the current construction gauge and car gauge applied in MR (black line) is smaller than those of other railways in the ASEAN member countries. The height of the existing MR is 3,810mm and that of YCR is 3,505mm. The green line shows expanded construction gauge (the height: 4,050mm) and car gauge (the height: 3,700mm) for MR, which is proposed in the feasibility study on Yangon-Mandalay Line Improvement Project in order to carry 40ft high cube container using the existing line. However, this expanded construction gauge and car gauge cannot accommodate passenger rolling stock from other ASEAN countries, that is, inter-operability in ASEAN countries is not ensured.



Source: JICA Study Team

Figure 4.1.1 Construction Gauges and Car Gauges in ASEAN Countries

The construction cost of electrified system includes the cost of reconstruction of the existing ROB of which construction gauge is too small to run an electrified system using overhead catenary. This indicates that costs to improve the existing construction gauge are negligible in a long-term perspective. Based on this understanding it is recommended to apply construction and car gauge which is compatible with the surrounding ASEAN countries' railways, especially with that of Thailand.

(3) Track Alignment

Other conditions for the Project are summarized in Table 4.1.1.

Table 4.1.1 Other Preconditions

Item	Precondiiton	Remarks
Single Track / Double Track	Double Track	Same as the present condition
Gauge	1000mm	Same as the present condition
Axle Load	12.5ton (Reconstructed Bridge: 20ton)	At present: all 12.5ton

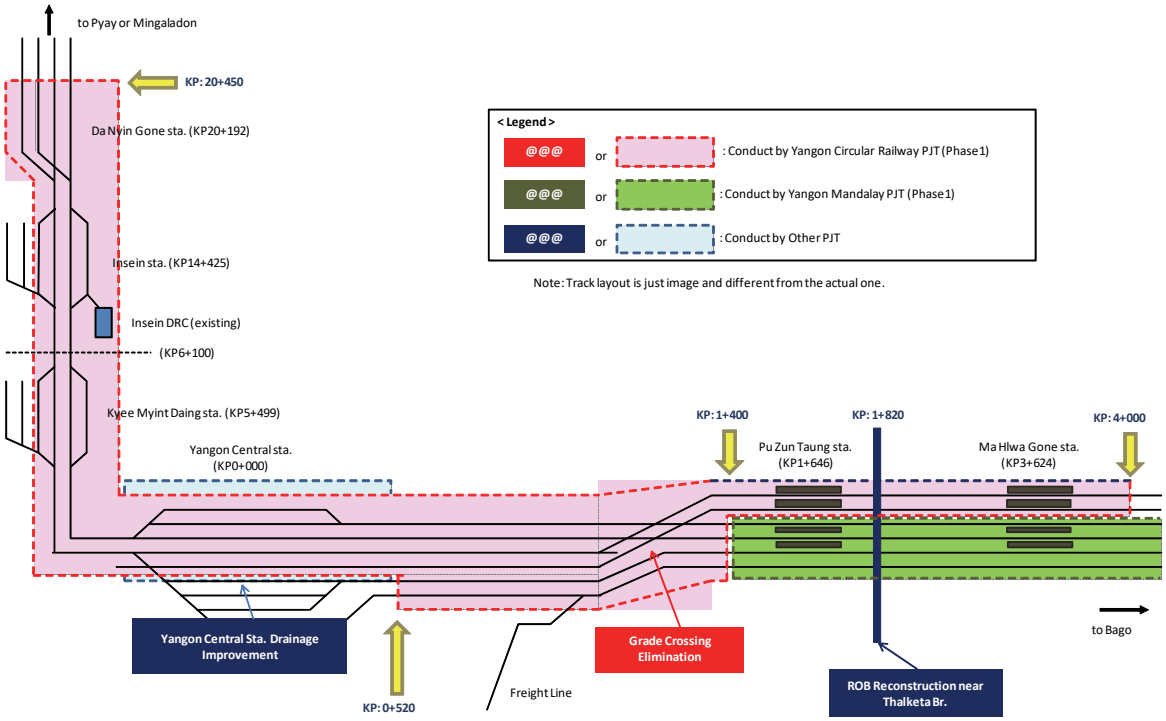
Source: JICA Study Team

4.1.2 Positioning of the Project

Several projects, which should be considered in improving the YCR, are on-going, namely, Yangon-Mandalay Line Improvement Project, and OCC Project. A special attention needs to be paid to the section between Yangon Central Station and Ma Hlwa Gone Station.

In order to avoid duplicated works in the future, the project section should be clearly defined. Based on the discussions among the concerned project teams and MR, the section improved by this Project was determined. The Project covers the section coloured red in Figure 4.1.2.

It should be noted that there are some bridges along the paralleling section of the Yangon-Mandalay line and the YCR. It is recommended to improve these bridges as part of the project, not as separated projects from the viewpoint of technical easiness and cost saving.



Source: JICA Study Team

Figure 4.1.2 Schematic Figure for Positioning of Project

4.1.3 Target Service Performance and Service Development

The upgraded YCR line should provide higher performance including punctuality, high frequency, safety, high speed, and quality ride comfort. In order to fulfil the target feature, the service performance is planned as below.

In addition, there are other non-quantitative improved items such as ride comfortability by new rolling stock and user-friendliness by same floor level between platform and rolling stock.

Table 4.1.2 Target Service Performance

Indicators	Unit	Present (Year 2014)	Target (Year 2024)	Remarks
Minimum Operation Interval during Rush Hour	min.	15-45	10-12	between Yangon Central and Insein
Train Operation Number/day	train/day	82	141	between Yangon Central and Da Nyin Gone without long and middle distance train
Passenger Train-km/day	train-km/day	2,860	4,100	
Maximum Speed	km/hr	48	60	between Ma Hlwa Gone and Da Nyin Gone. Infrastructure's design maximum speed.
Schedule Speed	km/hr	15	30	between Ma Hlwa Gone and Da Nyin Gone
Travel Time of Passenger Train	min.	75	42	between Yangon Central and Da Nyin Gone

Source: JICA Study Team

4.1.4 Planning and Design Issues

Some critical issues which must be addressed in planning and designing the Project are summarized as follows.

(1) Effective use of the existing assets

The existing YCR infrastructure has been seriously deteriorated because of continued poor maintenance in the past mainly caused by lack of budget to the YCR. The financial constraints may not be improved in a short-term, accordingly it is very necessary to develop an improvement plan using the existing asset as much as possible.

(2) Social consideration

The YCR has been used mainly by people of low-income groups including vegetable peddlers, urban commuters and students. The vegetable peddlers mainly use the YCR in the morning to carry their products. The services for such peddlers should be maintained after improvement of the YCR.

Another social issue could be separation of local communities. Many residents along the YCR often cross the YCR track freely at any places to reach the other side. This should not be allowed once the YCR is upgraded in order to maintain the safety of residents and rail passengers. Fencing along the YCR should be installed as part of the YCR upgrading project, which, however may cause separation of the local communities along the YCR. In order to maintain the existing local communities, it is necessary to include appropriate countermeasure for mitigating such impact of the YCR upgrading project such as installation of new FOB, etc.

(3) Long-distance train operation

Part of the YCR line is shared with long-distance passenger trains which start from the Yangon Central station. The improved train operation (train diagram) should be compatible with the future long-distance train operation.

(4) Electrification

The YCR line will be electrified in the future, namely after 2030. Proposed improvement plan for the initial stage of the YCR modernization should be compatible with the investment in the future. For example, new Road Over Bridges (ROBs) should be designed based on the expanded construction gauge.

(5) Careful design and construction plan

The YCR line runs in the highly urbanized areas in Yangon. There are many buildings including residential houses, schools, temples, etc. along the YCR line which may be affected by the improvement and construction work of the YCR upgrading work. In this regard, a careful design work and construction method should be considered. In general, to minimize the number of Project Affected Peoples (PAPs) and resettlement, the work needs to be made within the existing track width as much as possible.

(6) No disturbance to the existing train operation

The YCR carries about 100,000 passengers per day as a spine public transport system in Yangon. Considering this importance of the YCR, it is highly recommended not stop the existing train operation during the construction work. A careful construction plan and corresponding construction method should be employed for the upgrading work of the YCR.

(7) Compatible planning with related projects

The Yangon-Mandalay Line Improvement Project is on-going, part of which runs in parallel with the YCR line. In addition, the Project for Installation of Operation Control Centre System and Safety Equipment (OCC project) using Japan's Grant Aid is also on-going. The YCR upgrading project should be designed with careful consideration on these two projects.

(8) Simplified track layout

The existing track layout of the major stations of the YCR line is generally complicated, including many turnouts as traces during coupling/decoupling operation, which makes track maintenance work difficult. The existing track layout can be simplified with maintaining the train operation flexibility as of today.

(9) Use of appropriate design standard

MR uses the design standard which was established some time ago, however, there are some technical issues as of today, including i) some missing railway technical fields, especially on rolling stock, signalling and telecommunication system, electrical and mechanical system for urban railway, and ii) some outdated standards, etc. Therefore, it is necessary to use modern design standards in designing the Project.

(10) Increased convenience for rail users

Improvement of intermodal facilities such as station plaza including bus and taxi bay, parking lots for kiss & ride users, and other public services is the key to attract more rail passengers to the improved YCR. In this regard, MR is requested to improve surrounding area of stations as well as station building themselves.

4.2 Train Operation Plan

4.2.1 Definition of Terms

Table 4.2.1 shows definition of terms on this section.

Table 4.2.1 Definition of Terms

Term	Definition
Western side	Section of the YCR line between Ma Hlwa Gone station and Da Nyin Gone station via Yangon Central station.
Eastern side	Section of YCR line between Ma Hlwa Gone station and Da Nyin Gone station via Mingalardon station.
Dwell time	The time length from train stopping to departure.
Headway	The time interval between a preceding train and a following train.
Running time	The practical running time between each station. This time includes calculated running time and recovery margin time.

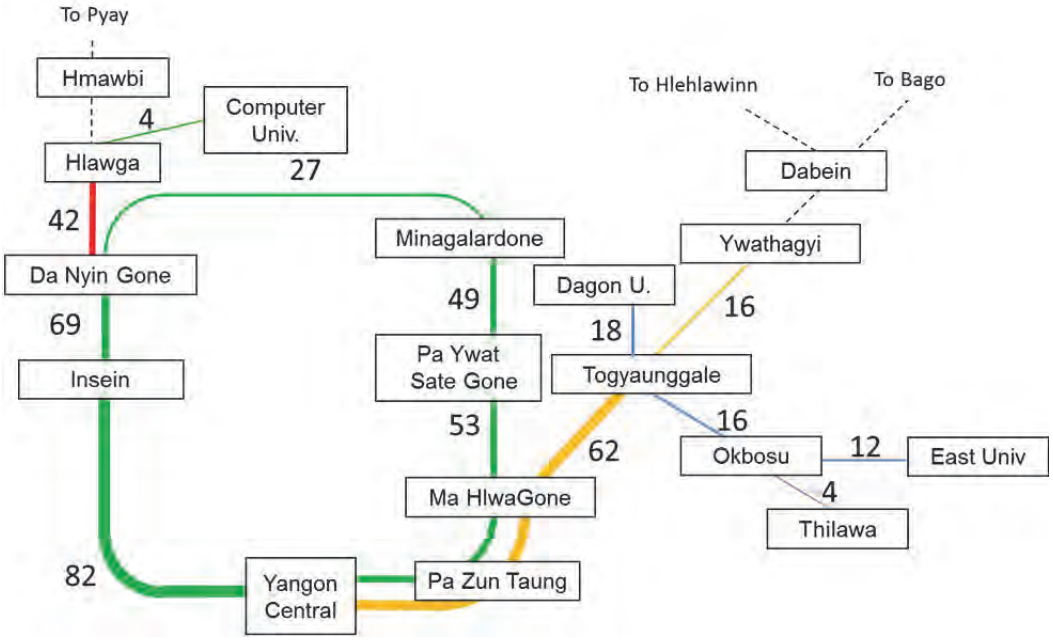
Source: JICA Study Team

4.2.2 Current train operation in the Greater Yangon area

(1) General

The existing railway network in Yangon is composed of five lines, namely the YCR line, the Pyay line, the Mandalay line, the Dagon University line and the Thilawa line. Figure 4.2.1 shows the number of trains passing at major stations a day, which is based on the existing train diagram by MR as of 2014.

Most of the trains are operated back and forth between the Yangon Central station and the Hlagwa or Togyaunggale station. Only 18 trains run in circular operation a day. The minimum headway of the existing train operation is 5 minutes.



Source: JICA Study Team

Figure 4.2.1 Daily Service number of Trains (As of 2014)

(2) Operation Situation

Table 4.2.2 shows records of "Air-2" train operation of two days in 2014, namely on May 27, 2014 and May 29, 2014. This records show departure time, dwell time and arrival time. According to these records, the dwell time is around 10 – 20 seconds at most of the stations. The existing scheduled speed is calculated at approximately 17km/h.

Table 4.2.2 Operational records of "Air-2" Train

Station ＼ Date	–	May 27, 2014 (All Circular section)			May 29, 2014 (Western half of Circular line)		
–	Planned time	Arrival time	Departure time	Dwell time	Arrival time	Departure time	Dwell time
Yangon	7:35	–	7:35	–	–	7:37	–
Phaya Rd		7:39:00	7:39:30	0:00:30	7:42:30	7:42:50	0:00:20
Lanmataw		7:41:15	7:42:00	0:00:45	7:45:20	7:45:40	0:00:20
Pray Rd.		(Missing)			7:49:05	7:49:25	0:00:20
Shan Rd.		7:47:00	7:47:10	0:00:10	7:53:20	7:55:00	0:01:40
Ahlone Rd.		7:49:00	7:49:20	0:00:20	7:57:10	7:57:55	0:00:45
Panhlaing Rd.		7:51:00	7:51:20	0:00:20	8:00:15	8:00:35	0:00:20
Kyeemyindaing	8:00	7:55:40	7:55:50	0:00:10	8:04:45	8:44:55	0:40:10
Hanthawaddy		7:58:00	7:58:20	0:00:20	8:09:20	8:09:30	0:00:10
Hletan		8:03:00	8:03:25	0:00:25	8:12:05	8:12:15	0:00:10
Kamayut		8:08:45	8:09:00	0:00:15	8:18:15	8:18:40	0:00:25
Thiri Myine		8:11:30	8:11:40	0:00:10	8:21:25	8:21:30	0:00:05
Okakyin		8:13:40	8:13:45	0:00:05	8:25:50	8:25:55	0:00:05
Thamine		8:15:45	8:16:05	0:00:20	8:27:10	8:27:45	0:00:35
Thamine Myothit		8:19:00	8:19:20	0:00:20	8:31:00	8:31:10	0:00:10
Kyuntkon		8:21:10	8:21:35	0:00:25	8:34:45	8:35:05	0:00:20
Insein	8:35	8:26:45	8:28:20	0:01:35	8:41:00	8:41:45	0:00:45
Ywama		8:33:00	8:33:10	0:00:10	8:48:40	8:48:50	0:00:10
Phwakan		8:37:50	8:38:00	0:00:10	8:51:45	8:52:10	0:00:25
Aungsanmyo		8:40:10	8:40:30	0:00:20	8:55:00	8:55:20	0:00:20
Danyingone	8:55	8:53:00	8:54:25	0:01:25	9:01:45	–	–
Gauk kwin		8:58:50	8:59:20	0:00:30			
Kyaikkalel		9:08:35	9:09:00	0:00:25			
Mingaladon Buzza		9:12:00	9:12:05	0:00:05			
Mingaladon	9:20	9:16:00	9:17:00	0:01:00			
Waibagi		9:21:15	9:22:00	0:00:45			
Okkalapa		9:25:40	9:26:00	0:00:20			
Paywetseikkon	9:35	9:28:25	9:30:30	0:02:05			
Kyaukyetwin		9:34:00	9:36:10	0:02:10			
Tadakalay		9:39:10	9:39:30	0:00:20			
Yegu		9:43:10	9:43:30	0:00:20			
Parame		9:47:00	9:47:10	0:00:10			
Kanbe		9:49:35	9:49:50	0:00:15			
Baukthaw		9:54:30	9:54:55	0:00:25			
Tarmwe		9:57:45	9:58:00	0:00:15			
Myittanyunt		10:00:30	10:01:00	0:00:30			
Maiwagone		10:03:50	10:04:15	0:00:25			
Pazundaung		10:09:10	10:10:30	0:01:20			
Yangon	10:25	10:17:40	–	–			

Source: JICA Study Team

(3) Frequency of non-blocking operation

Signal failures are observed frequently as of today, for example, some signals indicate red aspects and others indicate nothing at the same time. Accordingly, non-blocking train operation based on the driver's judgement is frequently observed, which can lead to serious accident. In this regard, it is highly recommended to install automatic train protection (ATP) system as part of the YCR upgrading project. It is very necessary because the newly introduced DEMUs run much faster than the existing DMUs, which does not allow drivers' judgement. It should be noted that the existing train operation rule or manual should be improved to correspond the new train operation by DEMUs with ATP.

4.2.3 Preconditions for train operation planning

(1) Train operation patterns of DEMU and DMU

One train set is composed of 6 rail cars. The newly introduced DEMUs are used in the YCR, but not to limited to this circular line only. That is, the new DEMUs run up to the Hlawga station from the Da Nyin Gone on the Pyay line.

The existing DMU and newly imported used DMUs from Japan can run this section from the Hlawga station to the Insein station, however, they cannot run into the section further south because of the limitation of construction gauge.

It is recommended that all DEMU trains take turn back operation at the Yangon Central station to avoid disturbance from delayed trains coming from the opposite side.

(2) Running speed

After the track improvement by MR, the maximum running speed can reach at 60km/h. However, this speed is restricted in the following sections because of curve sections and/or switches.

- Kyee Myint Daing station yard 50km/h
- Insein station yard 50km/h

The current speed restriction should be kept on the following sections.

- Ma Hlwa Gone -– Pa Zun Taung 40km/h
- Pa Zun Taung – Yangon 15km/h

Entering speed at terminal station should be restricted within 45 km/h with home signal indicating yellow.

(3) Signal system

Automatic signal system shall be adopted in this project. The signal shows three (3) aspects. The train operation speed is restricted under 45 km/h with yellow signal. The home signal at terminal station indicates yellow signal usually.

4.2.4 Train Travel Time

Table 4.2.3 shows the train running time which is calculated based on acceleration performance of DEMU. This result is also applicable for DMU.

Table 4.2.3 DEMU Travel Time Estimation on YCR

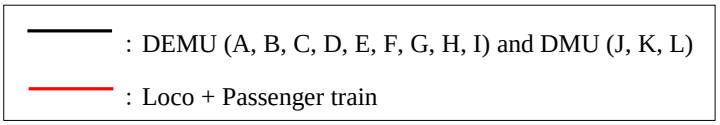
Clockwise			Station	Anti Clockwise		
Total	Running Time	Dwell Time		Dwell Time	Running Time	Total
–	0:02:00	–	Yangon	–	0:02:30	1:46:00
0:02:00	0:01:15	0:00:30	Phaya Rd	0:00:30	0:01:15	1:43:00
0:03:45	0:01:30	0:00:30	Lanmataw	0:00:30	0:01:30	1:41:15
0:05:45	0:01:45	0:00:30	Pray Rd.	0:00:30	0:01:45	1:39:15
0:08:00	0:01:30	0:00:30	Shan Rd.	0:00:30	0:01:30	1:37:00
0:10:00	0:01:30	0:00:30	Ahlone Rd.	0:00:30	0:01:30	1:35:00
0:12:00	0:03:00	0:00:30	Panhlaing Rd.	0:00:30	0:03:00	1:33:00
0:15:30	0:02:45	0:00:30	Kyeemyindaing	0:00:30	0:02:45	1:29:30
0:18:45	0:01:45	0:00:30	Hanthawaddy	0:00:30	0:01:45	1:26:15
0:21:00	0:02:45	0:00:30	Hletan	0:00:30	0:02:45	1:24:00
0:24:15	0:01:45	0:00:30	Kamayut	0:00:30	0:01:45	1:20:45
0:26:30	0:01:30	0:00:30	Thiri Myine	0:00:30	0:01:30	1:18:30
0:28:30	0:01:30	0:00:30	Okakyin	0:00:30	0:01:30	1:16:30
0:30:30	0:01:30	0:00:30	Thamine	0:00:30	0:01:30	1:14:30
0:32:30	0:01:45	0:00:30	Thamine Myothit	0:00:30	0:01:45	1:12:30
0:34:45	0:02:15	0:00:30	Kyuntkon	0:00:30	0:02:15	1:10:15
0:37:30	0:02:45	0:00:30	Insein	0:00:30	0:02:45	1:07:30
0:40:45	0:02:00	0:00:30	Ywama	0:00:30	0:02:00	1:04:15
0:43:15	0:01:30	0:00:30	Phwakan	0:00:30	0:01:30	1:01:45
0:45:15	0:02:45	0:00:30	Aungsanmyo	0:00:30	0:02:45	0:59:45
0:48:30	0:03:00	0:00:30	Danyingone	0:00:30	0:03:00	0:56:30
0:52:00	0:03:30	0:00:30	Gauk kwin	0:00:30	0:03:30	0:53:00
0:56:00	0:02:30	0:00:30	Kyaikkalel	0:00:30	0:02:30	0:49:00
0:59:00	0:02:00	0:00:30	Mingaladon Buzza	0:00:30	0:02:00	0:46:00
1:01:30	0:02:00	0:00:30	Mingaladon	0:00:30	0:02:00	0:43:30
1:04:00	0:02:45	0:00:30	Waibagi	0:00:30	0:02:45	0:41:00
1:07:15	0:01:45	0:00:30	Okkalapa	0:00:30	0:01:45	0:37:45
1:09:30	0:02:00	0:00:30	Paywetseikkon	0:00:30	0:02:00	0:35:30
1:12:00	0:02:00	0:00:30	Kyaukyetwin	0:00:30	0:02:00	0:33:00
1:14:30	0:02:30	0:00:30	Tadakalay	0:00:30	0:02:30	0:30:30
1:17:30	0:02:15	0:00:30	Yegu	0:00:30	0:02:15	0:27:30
1:20:15	0:01:45	0:00:30	Parame	0:00:30	0:01:45	0:24:45
1:22:30	0:02:30	0:00:30	Kanbe	0:00:30	0:02:30	0:22:30
1:25:30	0:01:45	0:00:30	Baukthaw	0:00:30	0:01:45	0:19:30
1:27:45	0:01:45	0:00:30	Tarmwe	0:00:30	0:01:45	0:17:15
1:30:00	0:02:00	0:00:30	Myittanyunt	0:00:30	0:02:00	0:15:00
1:32:30	0:03:45	0:00:30	Malwagone	0:00:30	0:03:45	0:12:30
1:36:45	0:08:45	0:00:30	Pazundaung	0:00:30	0:08:15	0:08:15
1:46:00		–	Yangon	–		–

Source: JICA Study Team

4.2.5 Train Operation Plan and Rolling Stock Requirement

Figure 4.2.3 through 4.2.6 show an indicative train diagram in 2022. This train diagram was developed together with MR's train operation specialists to incorporate local needs.

For example, "A-1" means " 1st operation of the pattern A train operation", then, the "A-1" train changes to the "A-2" at the terminal (Figure 4.2.2). All train departures from the Insein station where the depot for DEMUs are placed (Figure 4.2.3)



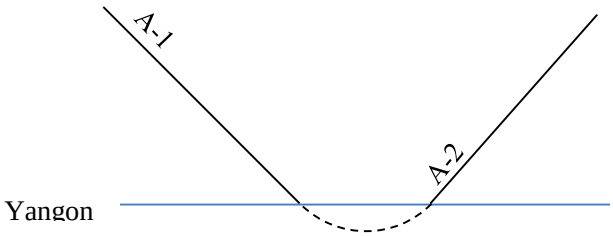
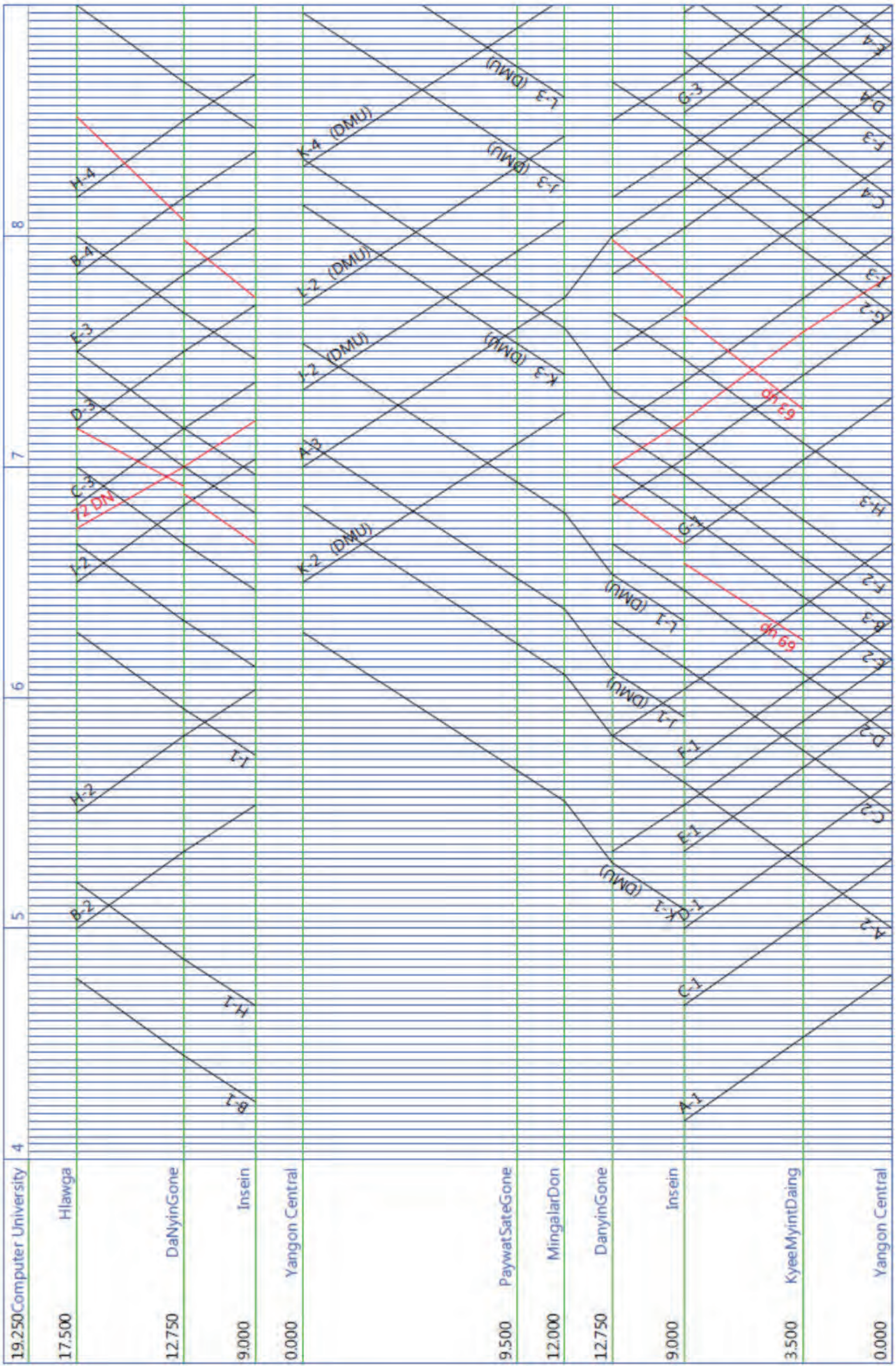
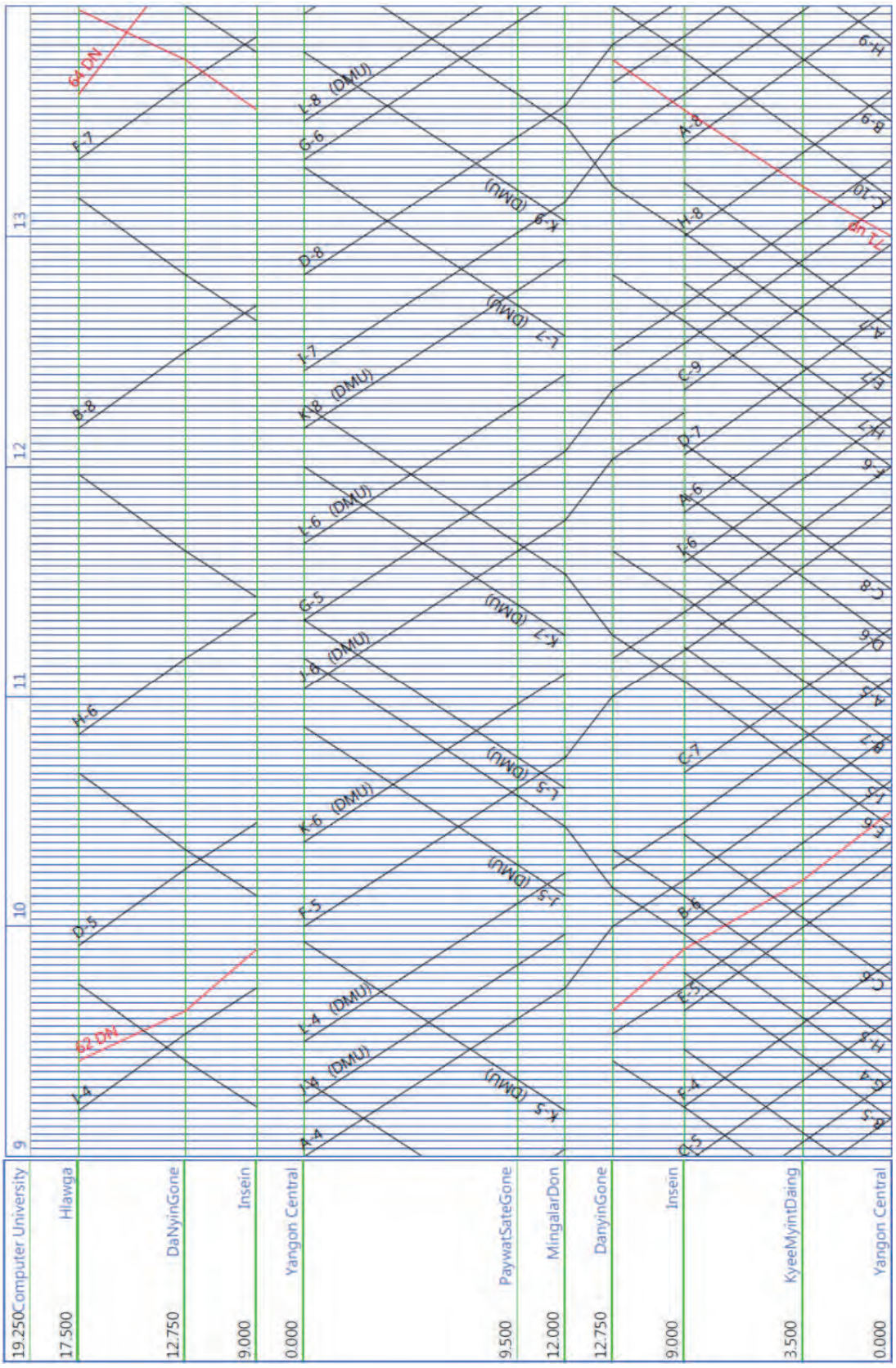


Figure 4.2.2 Example of Turn Back Operation at Yangon station



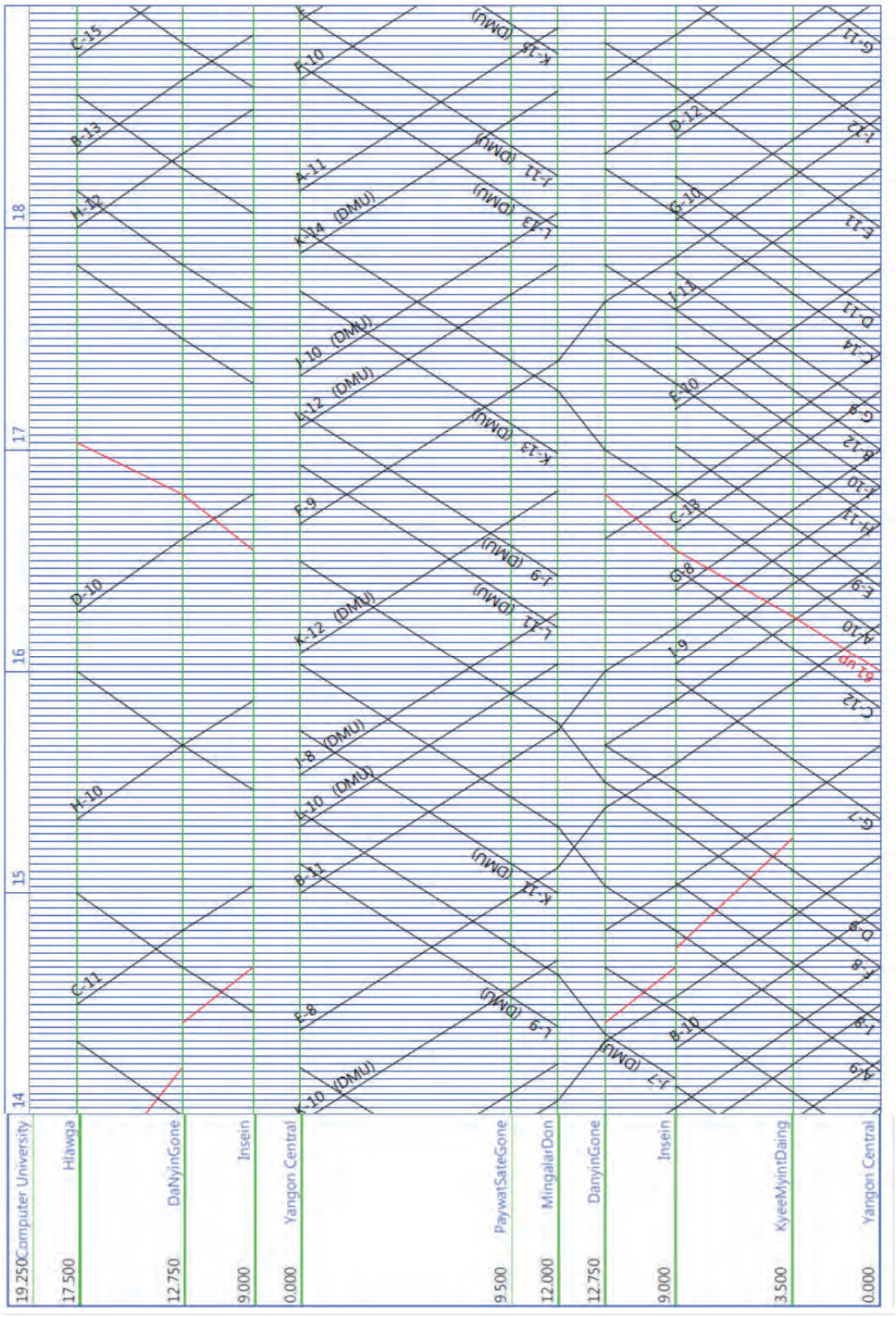
Source: JICA Study Team

Figure 4.2.3 Operation Diagram (4 a.m – 9 a.m)



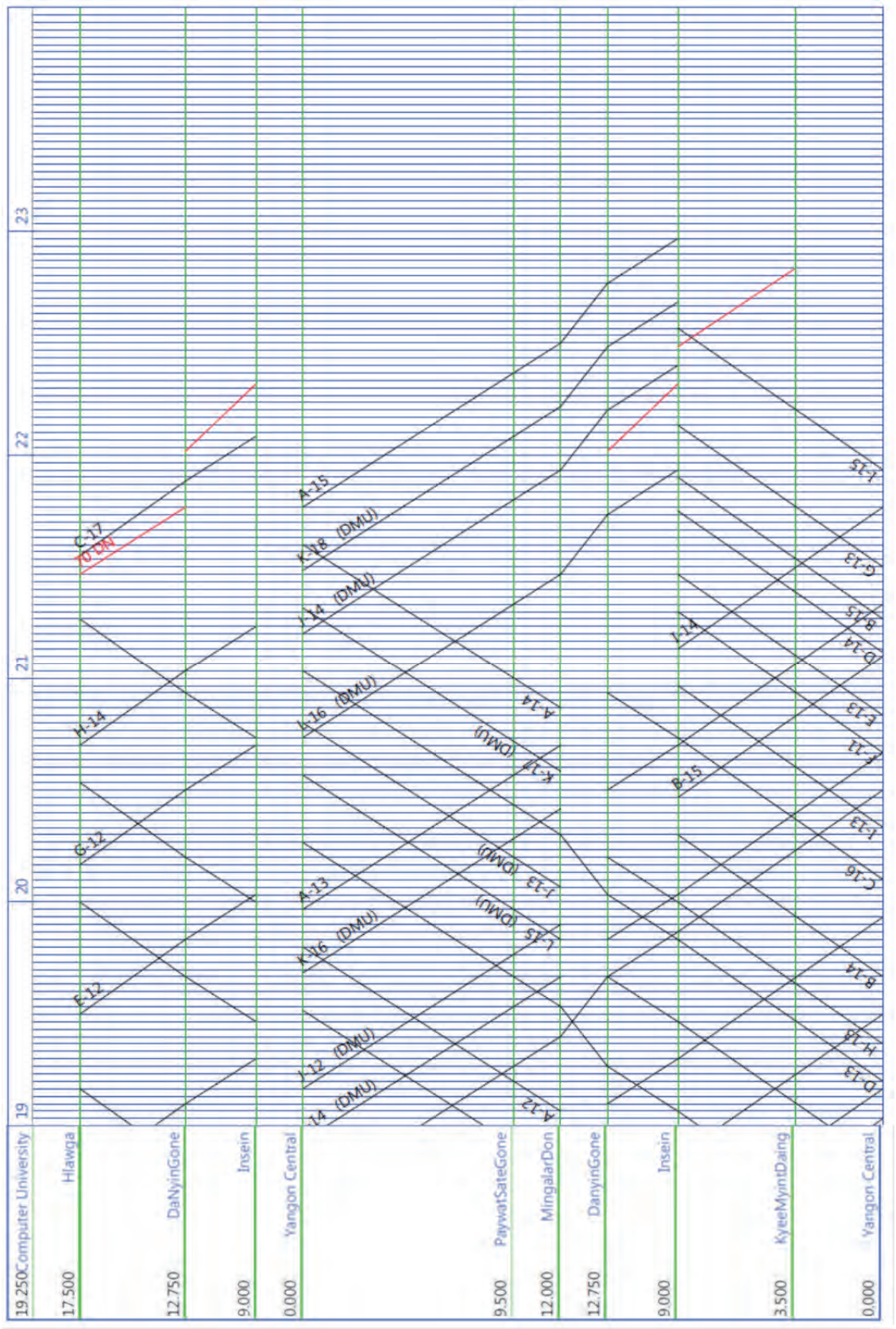
Source: JICA Study Team

Figure 4.2.4 Operation Diagram (9 a.m – 14 p.m)



Source: JICA Study Team

Figure 4.2.5 Operation Diagram (14 p.m – 19 p.m)



Source: JICA Study Team

Figure 4.2.6 Operation Diagram (19 p.m – 0 a.m)

4.2.6 Line Capacity

The headway of the future YCR line service is five (5) minutes except the section between the Yangon Central station and the Ma Hlwa Gone station.

With a train of six railcars and the five minutes headway, the carrying capacity of a train is calculated at 1,500 passengers, and the maximum sectional loading passenger is 18,000 persons / h / direction.

4.3 Rolling Stock Procurement

Procurement of the rolling stock shall be made through a design-build contract based on the basic design prepared by.

4.3.1 Existing condition

The existing rolling stock used for the Yangon Circular Railway services are composed of locomotives and passenger carriages as summarized in Table 4.3.1.

There're two kinds of locomotives, namely Diesel Electric Locomotive (DEL) and Diesel Hydraulic Locomotive (DHL). Similarly there two types of passenger carriage sets, namely five cars and six cars.

Rail Bus Engine (RBE) KIHA 181, having air-conditioning equipment, are newly imported from Japan, which are highly appreciated by Yangon residents. (It should be noted that the height of all the imported KIHA 181 was lowered in MR's workshop because the original height is higher than MR's construction gauge height.)

Table 4.3.1 Current Rolling Stock for Yangon Circular Railway

	Operation(cars)	Spare(cars)	Total(cars)
Locomotive (DEL)(*1)	7	2	9
Locomotive (DHL)(*2)	6	0	6
Subtotal for Locomotive	13	2	15
Passenger carriage (6cars)	6x4=24	0	24
Passenger carriage (5cars)	5x7=35	5x2=10	45
Subtotal for passenger carriage	59	10	69
RBE KIHA181(*3) Air conditioner	5	0	5

(*1) DEL: Diesel Electric Locomotive
(*2) DHL: Diesel Hydraulic Locomotive
(*3) RBE KIHA181: Rail Bus Engine from Japan (Type KIHA181)
Source: JICA Study Team and MR DRC (Insein DRC) as of Dec.2013

As shown in Table 4.3.2, many of the existing locomotives are over 30 years old, while age of passenger carriages is under 30 years.

Table 4.3.2 Age of Rolling Stock for Yangon Circular Railway

Age	0-10	11-20	21-30	31-40	41-50	50-
Number of locomotive (cars)	0	1	2	6	6	0
Number of passenger carriage (cars)	29	9	31	0	0	0

Source: JICA Study Team and MR DRC (Insein DRC) as of Dec.2013

Because of the lower performance of the aged locomotives, it is difficult to increase train operation density. Acceleration and deceleration performance of the existing locomotives and passenger carriages is very poor. In addition, the existing braking system depending on the braking of the locomotives is not safe. Most of the existing locomotives should be replaced with the newly introduced DEMUs.

4.3.2 Design Principle

The existing regulation for rolling stock of Myanma Railway has been adopted in a flexible manner because many and different types of new and used railcars are imported from various countries, namely from Japan, Germany, France, Korea, India, and China, etc. The used diesel-hydraulic multiple units (DMU) imported from Japan such as KIHA 181 are built based on the Japanese Regulation and Standard, which were simply adjusted to run the narrow gauge (1,000 mm) in Myanmar. According to the existing regulations and standards, the main design feature of the YCR is as follows:

- Track gauge: 1,000 (mm).
- Axle load: 12.5 (ton).
- The height of the fixed structure gauge for YCR: 3,820 (mm) and
- The height of the rolling stock gauge for YCR: 3,505 (mm).

According to the on-going project, namely the Yangon-Mandalay Line Improvement Project, the height of 3,620 (mm) is proposed as the height of the rolling stock in the future. This improvement provides more interior space and accordingly more comfort space for passengers.

In Japan, the height of fixed structure gauge and rolling stock gauge is 4,300 (mm) and 4,100 (mm) respectively. There is a space of 200 (mm) between the fixed structure and the rolling stock gauge, and under this condition, trains in Japan are operated at the speed of 130 (km/h) safely.

Based on this technical specification in Japan, the maximum height of the rolling stock for the YCR can be 3,620 (mm), which is 200 (mm) lower than the height of construction gauge of 3,820 (mm). However, it should be noted that the rolling stock gauge for the YCR upgrading project should be finally determined in the basic design stage by referring the on-going basic design for the Yangon-Mandalay Line (Y-M) Improvement Project.

4.3.3 Rolling Stock Procurement Plan

(1) Type of Rolling Stock

For the initial stage of the modernization of the YCR, Diesel-Electric Multiple Unit (DEMU) of Distributed Power System is selected by MR. Some used Diesel Multiple Unit (DMU) from Japan have been used by MR, however, MR prefers for using DEMU because the maintenance work for DEMU is easier than DMU.

It should be noted that DEMU is also selected for Yangon-Mandalay Line (Y-M) Improvement Project.

(2) Rolling Stock Performance Plan

The expected performance of DEMU used for the YCR is as follows:

- Maximum design speed: 110 (km/h)
- Maximum acceleration: 2.0 (km/h/s) and
- Maximum deceleration: 3.5 (km/h/s).

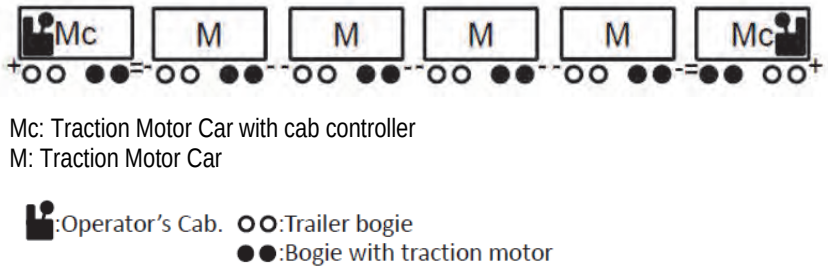
The proposed train diagram in 2030 can be achieved by this DEMU performance, accordingly the train operation density in the future will be significantly improved.

This expected performance is same as that of the Yangon-Mandalay (Y-M) DEMU so that the traction system of YCR DEMU is compatible with Y-M DEMU.

(3) Rolling Stock Configuration Plan

A train set which consists of 6 cars (Mc-M-M-M-M-Mc) including 2 cars of "Mc" (Traction motor car with cab controller) and 4 cars of "M" (Traction motor car) is proposed based on the train operation plan for the Yangon Circular Railway Line Upgrading Project, which was accepted by MR during this study.

Each car has one powered bogie with traction motor and one unpowered trailer bogie. These configurations are the same as Yangon-Mandalay (Y-M) DEMU so that the main components of YCR DEMU are compatible with Y-M DEMU. The YCR DEMU is non-articulated car with non-articulated bogies. Figure 4.3.1 shows the image of rolling stock configuration.



Source: JICA Study Team

Figure 4.3.1 Image of Rolling Stock Configuration

(4) Rolling Stock Capacity Plan

The capacity plan of the DEMU is as follows:

- Capacity of "M" (Traction motor car): approximately 128 passengers,
- Capacity of "Mc" (Traction motor car with cab controller): approximately 116 passengers, and
- Capacity of one train set: approximately 744 passengers in case of 100% (3.3 passengers /m^2).

The capacity is limited by equipment space in a cabin, so the exact figure of the capacity will be determined in the basic design.

Table 4.3.3 Rolling Stock Capacity Plan

	Mc	M	M	M	M	Mc	Total
Seating Capacity	38	44	44	44	44	38	252
Standing Capacity 100% (3.3 passengers /m^2)	78	84	84	84	84	78	492
Total	116	128	128	128	128	116	744

Source: JICA Study Team

(5) Required numbers of Rolling Stock

The required numbers of the DEMU are as follows: 11 train sets of 6 cars, total 66 cars, including 9 train sets for operation and 2 train sets for spare of maintenance and others according to the train operation plan for the YCR Upgrading Project.

(6) Basic Elements of Rolling Stock

Design-build contract method shall be employed for the procurement of YCR rolling stock. Basic design of the rolling stock should be prepared in prior to inviting bidders.

The basic design elements of DEMU are as follows:

1) Main Dimensions

The main dimensions of Yangon Circular Railway (YCR) DEMU are the same as the dimensions of Yangon-Mandalay (Y-M) DEMU. And the main dimensions of YCR DEMU are proposed as follows:

- Carbody length: 19,500 (mm),
- Carbody width: 2,770 (mm),
- Roof height of carbody: 3,620 (mm),
- Floor height: 1,130 (mm),
- Distance between coupler centre (that is the car length including coupler): 20,000 (mm),
- Train set length: 120,000 (mm), and
- Distance between bogie centre: 13,800 (mm).

It should be noted that the floor height of YCR DEMU is 1,130 (mm) to secure the underfloor space of DEMU of Distributed Power System and apply the Japanese standard size for the commuter train in urban area. Therefore, it is recommended that the height of the platform should be improved by Myanma Railways to reduce the boarding and alighting time.

2) Seat Arrangement

The seat arrangement of YCR DEMU is a long-seat type of longitudinal direction which has already been introduced to the current passenger coach for the YCR Line. The long-seat type of longitudinal direction is widely used in the major mass transit systems in the world since it secures wider space for standing passengers and reduce the boarding and alighting time.

3) Side Door Arrangement

The side door arrangement of YCR DEMU is a four-door type at each side of railcar. The four-door type of 20 (m) rolling stock for commuter is more suitable than the three-door type in order to reduce the boarding and alighting time.

The four-door type for 20 (m) car is the typical type in the urban area of Tokyo, Japan. The width of each side door will be determined at the detailed design stage. It should be noted that the typical size of side door width for commuter in Tokyo is 1,300 (mm).

4) Carbody Material

The carbody material of YCR DEMU is weather-resistant carbon steel. The carbody material of YCR DEMU should be the same as the Yangon-Mandalay (Y-M) DEMU if Myanma Railways manufactures both Y-M DEMU and YCR DEMU by themselves in local manufacturing workshops of Myanma Railways.

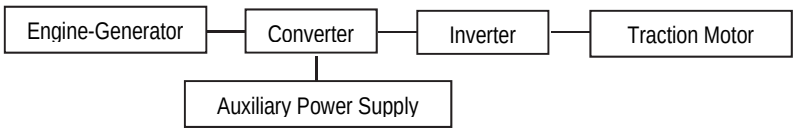
If the carbody of stainless steel or aluminium is applied, the expensive facility for stainless steel or aluminium in local manufacturing workshops of Mynama Railways has to be added and invested. Therefore, the carbody material of carbon steel is recommended from a financial aspect as well.

According to the MLIT Survey of Rolling Stock Modernization in Myanmar (2014), Myanma Railways considers that they will manufacture DEMU by themselves and the local manufacturing workshop will be Myitnge workshop using the existing facility.

5) Electrical System

The electrical system of YCR DEMU consists of diesel engine, generator, converter, inverter, and auxiliary power supply system. These should be the same as the Yangon-Mandalay (Y-M) DEMU so that the electrical components of YCR DEMU are compatible with Y-M DEMU.

The engine is the direct injection diesel engine. The generator is the three-phase Alternating Current (AC) induction generator which is easy to maintain. The traction motor is the three-phase AC induction motor which is also easy to maintain. The AC power is generated by the AC generator with the diesel engine and supplied to the AC/DC converter. The DC power is supplied to DC/AC Variable Voltage Variable Frequency (VVVF) inverter and inverted to the AC power which is supplied to the three-phase AC traction motor. The AC power from the auxiliary power supply system is used for the air conditioner, fan of radiator and lighting. The DC power from the auxiliary power supply system is used for the other equipment, the door system, the condition monitoring system, the auxiliary battery, etc. It should be noted that the auxiliary battery is mainly used for emergency in case of the DC power outage and is different from the rechargeable battery of the diesel-hybrid propulsion system which will not be introduced to YCR DEMU.



Source: JICA Study Team

Figure 4.3.2 Image of Electric System

6) Bogie

The bogie of YCR DEMU should be the same as the Yangon-Mandalay (Y-M) DEMU so that the bogie parts of YCR DEMU are compatible with Y-M DEMU. The each car equips one powered non-articulated bogie with two traction motors and one un-powered (trailer) non-articulated bogie. The type of bogie is the bolsterless and the secondary suspension is the air suspension. The detailed specification will be determined in the basic design for Y-M DEMU.

7) Brake System

The brake system of YCR DEMU should be the same as the Yangon-Mandalay (Y-M) DEMU so that the brake parts of YCR DEMU are compatible with Y-M DEMU. The mechanical brake system using the air brake is applied to YCR DEMU and the electric brake system is not applied to YCR DEMU. The pressurized air for air brake system comes from the air compressor driven by the diesel engine. The command system for the air brake system is the electrical command system. The braking devices for the mechanical brake system are considered to be the wheel-tread brakes for the powered bogie and the axle-mounted disc brakes for the trailer bogie. The detailed design will be determined at the detailed design stage in consideration of the detailed design for Y-M DEMU.

8) Safety Device

The safety device of YCR DEMU should be the same as the Yangon-Mandalay (Y-M) DEMU so that the safety device parts of YCR DEMU are compatible with Y-M DEMU. The safety device of YCR DEMU is the on-board device of the Automatic Train Stop (ATS) according to the signalling improvement plan for the YCR Line Upgrading Project. The on-board antenna is located on the underfloor and the ATS on-board devices including the alarming device and the confirmation button are located on the cab room. The detailed specification will be determined in the basic design stage in consideration of the detailed design for Y-M DEMU.

9) Side Door System

The side doors of YCR DEMU is operated by the pressurized air. The command “Open/Close” of the side doors is sent from the door command switch located on the cab room by the electrical signal.

10) Air Conditioning System

The air conditioning system of YCR DEMU should be the same as the Yangon-Mandalay (Y-M) DEMU so that the parts of YCR DEMU are compatible with Y-M DEMU. One unit with the air compressor cooling and ventilating system mounted on the roof top is under consideration for Y-M DEMU and YCR DEMU. The height of top of the air conditioner from the top of the rail shall be within the rolling stock gauge for YCR DEMU and Y-M DEMU. The detailed specification will be determined in the basic design stage in consideration of the detailed design for Y-M DEMU.

11) Condition Monitoring System and Passenger Information Device

The condition monitoring system which monitors the condition of the main components such as the propulsion system, the brake system, the side door system, the air conditioning system should be the same as the Yangon-Mandalay (Y-M) DEMU so that the parts of YCR DEMU are compatible with Y-M DEMU. Additionally, the destination indicator and the next station indicator of LED for passengers must be installed. The detailed specification will be determined in the basic design stage in consideration of the detailed design for Y-M DEMU.

12) Summary of Basic Elements of Rolling Stock

Table 4.3.4 Summary of Basic Elements of Rolling Stock

No.	Item	Description		Remark
1	Rolling Stock Type	DEMU		
		Mc	M	
2	Passenger Capacity (Seating)	38	44	
3	Passenger Capacity (Standing)	78	84	100% (3.3 passengers /m^2).
4	Passenger Capacity (Total)	116	128	100% (3.3 passengers /m^2).
5	Length of carbody	19,500 (mm)		
6	Width of carbody	2,770 (mm)		
7	Height of (carbody) roof	3,620 (mm)		
8	Height of floor	1,130 (mm)		
9	Distance between coupler face	20,000 (mm)		
10	Distance between bogie center	13,800 (mm)		
11	Maximum design speed	110 (km/h)		
12	Maximum acceleration	2.0 (km/h/s)		
13	Maximum deceleration	3.5 (km/h/s)		
14	Carbody Material	Weather-resistant carbon steel		
15	Engine	Direct injection diesel engine x 1		
16	Generator	Three-phase AC induction generator x 1		
17	Propulsion control system	Converter and VVVF inverter x 1		
18	Traction motor	Three-phase AC induction traction motor x 2		
19	Auxiliary power supply system	Static inverter x 1		
20	Bogie	Bolsterless with air suspension one un-powered (Trailer) non-articulated bogie and one powered non-articulated bogie		
21	Brake system	Electric command air brake		
22	Air compressor	Directly-coupled air compressor x 1		
23	Safety Device on board	Automatic Train Stop (ATS) Device on board		
24	Air conditioning system	Air compressor cooling and ventilating system		
25	Seat Arrangement	Long-seat type (Longitudinal direction)		
26	Side door	Side door operating equipment x4 (each side)		
27	Monitoring device	Condition Monitoring system		
28	Passenger information device	Destination indicator, next station indicator		

Source: JICA Study Team

4.4 Track Structures

4.4.1 Current Conditions of Track Structures

(1) Status of Track

Track condition of the YCR Line is inspected regularly by MR, while a comprehensive track condition survey was conducted by the JICA Study Team separately in this study.

The outline and result of survey is summarized as follows.

- On 17th and 18th of July 2014, the irregularity of horizontal alignment and vertical alignment for the section of 20.4km between Yangon central station and Da Nyin Gone station was measured with string of 10m. The result is shown as Figure 4.4.1.
- Irregularity of line alignment is observed at the joint point of rails.
- The distance of gauges is favourable with updating the wood sleeper to PC sleeper
- The static criterion value for maintenance of Myanma Railway is plus or minus 10mm for difference of height, plus or minus 10mm for horizontal difference, plus 8mm or minus 4 mm between tracks and plus or minus 10mm for cross level.
- The table below shows some measured values are over the static criterion. It means the track irregularity is in quite severe level.

Table 4.4.1 Example of Measurement Result

Unit: mm

Point	Longitudinal Level	Irregularity of Longitudinal Level	Line Alignment	Irregularity of Line Alignment
Point 1	20	0	10	0
Point 2	23	3	12	2
Point 3	28	8	17	7
Point 4	26	16	24	14
Joint 5	45	25	28	18
Joint 6	43	23	18	8
Joint 7	38	18	15	5
Joint 8	31	11	13	3
Joint 9	26	6	11	1
Joint 10	20	0	10	0

Source: JICA Study Team

Source: JICA Study Team

Figure 4.4.1 Photo of Measurement on 17 July

(2) Rail

The result of field survey on the west half section is summarised as follows.

- Rails are deteriorated because of the lack of the periodic replacement
- Joints in rail are sunk. It causes the irregularity of line alignment
- Current 12m-37kg type rail requires many seams
- Damage on rail is remarkable
- Especially, the collapses due to the rolling contact fatigue are seen on contact surface of the rail head and the wheel

Source: JICA Study Team

Figure 4.4.2 Rail Condition

(3) Sleeper

The result of field survey on the west half section is shown as follows.

- All Sleepers are made of precast concrete
- Some of sleepers are made in China and the others are made in India
- Sleepers made in China are introduced first, and damages of them are remarkable
- Almost all sleepers are made in India recently
- The interval between sleepers is irregular. The gap against the standard interval is from -30mm to +20mm; it is obvious at the seams and back side of bridges
- Lots of sleepers are not at right angle
- The erosion of wood sleepers at bridges is remarkable. Most of the sleepers are not jointed with steel beams and bracings as shown as Figure 4.4.4.

Source: JICA Study Team

Figure 4.4.3 Damage on Sleeper made in India

Source: JICA Study Team

Figure 4.4.4 Wooden Sleeper at Railway Bridge

(4) Ballast

The result of field survey on the west half section is shown as follows.

- Some ballast are too big or too small
- The amount of ballast at edge of sleeper is not enough at some locations. The thickness of 250mm is necessary, but the actual average thickness of ballast is about 150mm.
- If sleepers exposure to air, and it decrease the resistance against the load of cars; it is one reason making the irregularity of the line alignment

Source: JICA Study Team

Figure 4.4.5 Ballast Condition

(5) Turnout

The result of field survey on the west half section is shown as follows.

- Turnout parts aren't replaced regularly
- Especially, the damage on the nose rail is remarkable
- Some joint bar bolts, washer bolts, and filler blocks are missing
- Tamping is not conducted because of the luck of ballasts

Source: JICA Study Team

Figure 4.4.6 Turnout Condition

4.4.2 Improvement Plan

As stated in the previous section, the target service level of future train service is as follows.

- Passing tonnage per year : 10 million ton
- Train set DEM/DMU : 14sets*6cars/set
- Axle load : 12.5 ton
- Speed : Maximum speed 60km/h Average speed 30km/h

To meet above service level, the improvement of railway is necessary. Table 4.4.2 shows the proposal for improvement of railway.

Table 4.4.2 Contents of Track Improvement

Item	Content of Improvement
Rail	Change to the rail which is equivalent 50N rail
	Use long rail in case over radius of 600m
	Use 25m head hardened rail in case under radius of 600m, and use head hardened rail for outside rail
Sleeper	Change to the PC sleeper which can fasten 50N rail. 44 sleeper per 25m is standard span
Ballast	Change to the ballast with thickness of 250mm
rail fastening system	Change to insulation type or pandrol clip fastening

Source: JICA Study Team

And, JST compared the life cycle cost of rail, in the case of 37kg rail or 50N rail, and 12.5m rail and long rail. Features of rail, PC sleeper and ballast are described next.

(1) Rail

A comparison of specification of rail between 37kg rail and 50N are shown as follows.

Table 4.4.3 Comparison between 37kg rail and 50N

Rail Type	Height (mm)	Width (mm)	Sectional area (cm^2)	weight (kg/m)	Geometrical moment of inertia (cm^4)
50N	174	127	6.420	50.4	1,906
37kg	153	122	4.728	37.2	952

Source: [Modern Railway Track] JR West

Feature of rail;

- 50N rail decreases 35% of maintenance cost, improves riding comfortability and punctuality
- Long rail with radius of over 600m decreases 20% of maintenance cost. Possibility installing long rail section list on west half section is shown in Table 4.4.4. It will be suitable for 10 sections which correspond to 58% of all railway
- 25m head hardened rail decreases its maintenance cost by preventing the rail from end batters and joint hole splits
- Head hardened rail with radius of under 600m prevents outside rail from abrasion and damage. It decrease the cost by extending the renewal term.
- The section has 17 steel girder bridge without ballast floor. Updating it with long rail is feasible with maintaining hook bolt which fastens sleepers and steel girder with 14m span at most

Table 4.4.4 Installing long rail Section list on west half section

Section No.	Station of Start and End point		Possibility length of long rail installation
1	Ma Hlwa Gone	Pa Zun Taing	2,050m
	3km400m	1km350m	
2	Lanmadaw	Shan Lan	1,300m
	1km700m	3km000m	
3	Ahlone Lan	Kyee Myint Daing	1,450m
	3km650m	5km100m	
4	Kyee Myint Daing	Hledan	1,400m
	6km100m	7km500m	
5	Hledan	Oak Kyin	1,750m
	8km600m	10km350m	
6	Oak Kyin	Kyaoe Gone	1,200m
	11km350m	12km550m	
7	Kyaoe Gone	Insein	900m
	13km000m	13km900m	
8	Insein	Phawkan	1,300m
	14km850m	16km150m	
9	Phawkan	Aung San	1,400m
	16km650m	18km050m	
10	Aung San	Da Nyin Gone	1,000m
	18km050m	19km050m	
Total			13km750m

Source: JICA Study Team

(2) PC Sleeper

The existing PC sleeper is designed for 37kg rail. Therefore, pandrol clip fastening for 37kg rail will be impossible if we adopt 50N rail, because the width of rail is too large. New designed PC sleeper is necessary because of following reasons.

a. If 37 kg rail made from India is adapted, the track centre distance is 142mm. The base width of 37kg rail is 122mm. Therefore, the width of insulator is remaining 20 mm. Insulator plays important role as electrical insulator as well as controlling material for the gauge, irregularity of line alignment and curve. In order to fasten 37kg rail, one 5mm or 10mm insulators is set at both inside and outside of the rail. For instance, using two 10mm insulator is possible.

b. If 50N rail made from India is adapted, the track centre distance is 142mm. The base width of 50N rail is 127mm. Therefore, the width of insulator is remaining 15mm. In order to fasten 5N rail, one 8mm to 15mm insulators is set at both inside and outside of the rail; the type of insulator is 6 types in each 1 mm. However, using two 8mm is impossible.

c. If we install 5mm or 10mm insulator to 50N rail, it does not have affordance for controlling, and so it cannot respond to the irregularity of line alignment and may occur damage on electric insulator. Therefore, PC sleeper replacement is recommended.

Then JST recommends re-place all clips fastening for 50N equivalent rail for keeping train operation safety.

(3) Ballast

In order to support the load of cars, it is necessary to scatter the load equally to the roadbed and also to correct the irregularity of line alignment. The physical characteristic and particle size of ballast should be maintained. Also, the thickness of the ballast should be over 250mm so as to keep the smooth drainage and stable running. Proposed physical characteristic of the ballast is shown as follows.

Table 4.4.5 Proposed Standard of Petrous for Ballast

unit weight (tf/m^3)	absorption capacity (%)	wear rate (%)	hardness	rock specimen saturated with water (tf/cm^2)	crush ratio by press test (%)
Over 1.4	Under 3	Under 27	Over 17	Over 0.8	Under 24

Source: "Railway Engineering" Japan Railway Civil Engineering Association

Proposed standard for particle size is shown on the following table.

Table 4.4.6 Proposed Standard of Particle Size for Ballast

sieve mesh (㎜)	63.5	50.8	38.1	25.4	19.1
Penetration (%)	100	100~80	75~35	40~0	5~0

Source: "Railway Engineering" Japan Railway Civil Engineering Association

(4) Turnout

In accordance with changing to new 50N rail, the turnout will be updated. Increase of the speed, decrease of the cost, and the stable of the running will be achieved with this update.

(5) Examination of Life Cycle Cost (LCC)

1) Definition of Alternatives for Rail Tracks

Types of alternative for rail tracks are:

- Alternative A: New 50N(long rail) + New PC sleeper + New Ballast (250mm)
- Alternative B: New 37kg(24m rail) + Old PC sleeper + New Ballast (250mm)
- Alternative C: New 37kg(12m rail) +Old PC sleeper + New Ballast (250mm)

The above Alternatives do not include turnouts and yards. Classification of the alternative A, B and C is shown in Table 4.4.7.

Table 4.4.7 Classification for LCC Examination

Item \ Alternative	A	B	C
New 50N(Long rail)	✓		
New 37kg(24m rail)		✓	
New 37kg(12m rail)			✓
New PC sleeper	✓		
Old PC sleeper		✓	✓
New Ballast (250mm)	✓	✓	✓
Tamping	✓	✓	✓
Machine & Instrument	✓	✓	✓

Source: JICA Study Team

2) Initial Investment Cost for Alternatives

Initial investment cost for the alternative A,B and C (per 1track-km) is shown in Table 4.4.8.

Table 4.4.8 Initial Investment Cost

Unit: JPY Million

Item \ Alternative	A	B	C
New 50N(Long rail)	25.3		
New 37kg(24m rail)		20.2	
New 37kg(12m rail)			18.2
New PC sleeper	9.4		
Old PC sleeper		0.6	0.6
New Ballast (250mm)	6.0	6.0	6.0
Tamping	10.0	10.0	10.0
Machine & Instrument	20.0	10.0	5.0
Total	**70.7**	**46.8**	**39.8**

Source: JICA Study Team

3) O&M Cost for Alternatives

O&M cost for alternative A, B and C (per 1track-km) is shown in Table 4.4.9.

Table 4.4.9 O & M Cost

Unit: JPY Million/year

Item \ Alternative	A	B	C
Tamping	0,63	0.84	1.05
Machine & Instrument	0.35	1.05	1.05
Inspection & Management	0.60	0.75	0.75
Total	**1.58**	**2.64**	**2.85**

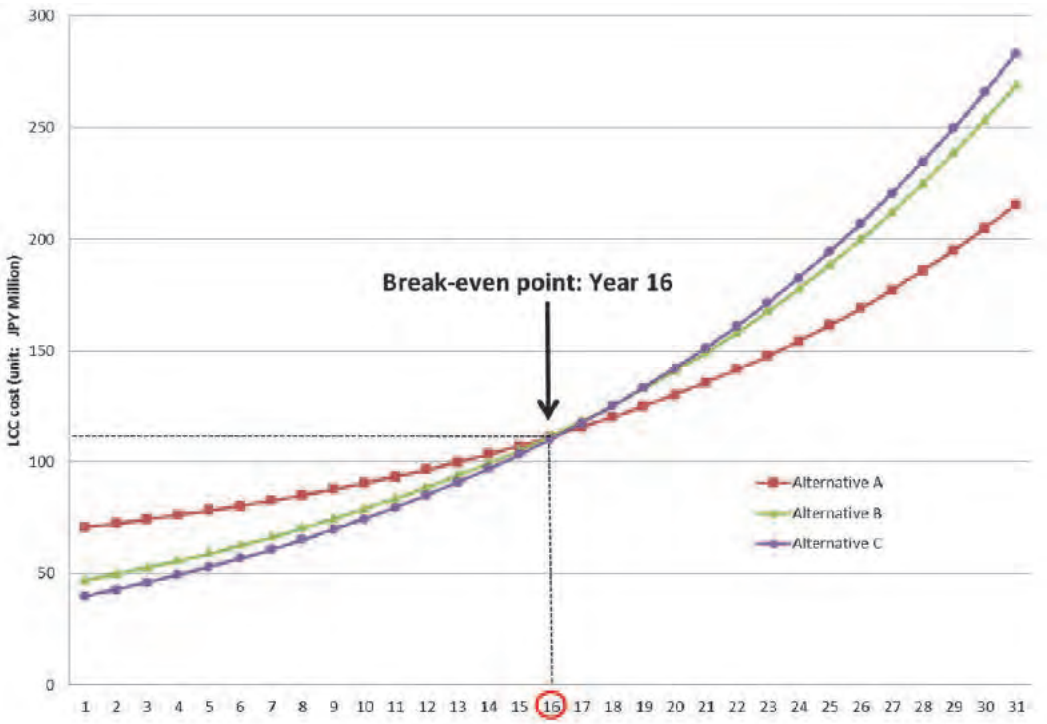
Source: JICA Study Team

The price escalation for tamping, material and inspection & management is to be adopted for the comparison of LCC among the Alternatives as follows:

a. Tamping: 7% per annum
b. Material: 4% per annum
c. Inspection & Management: 7% per annum

4) Comparison of LCC among Alternatives

LCC among the alternative A, B and C are compared and analyzed as follows.



Source: JICA Study Team

Figure 4.4.7 Comparison of LCC among Alternatives

5) LCC Analysis

The comparison figure of the previous Figure 4.4.7 shows as follows:

a. The break-even point: Year 16 (Cost of A< cost of B and C)

b. Initial investment cost, O&M cost and LCC for alternatives are summarized and compared as follows:

Table 4.4.10 O & M Cost

Item \ Alternative	Initial	O&M	LCC
Alternative A	Middle	Low	Low
Alternative B	Low	High	High
Alternative C	Low	High	High

Source: JICA Study Team

6) Recommendation

From a long term perspective, Life Cycle Costs (LCCs) of Alternative A is the lowest among the Alternatives. Therefore, JICA Study Team recommends Alternative A

4.5 Civil Structures

4.5.1 Current Condition of Civil Structures

This section describes the current condition of following minor civil strucrures along the railway;

- MR's fence and private fence,
- Concrete retaining wall,
- Brick wall drain ,
- Slope earth cutting.

Figure 4.5.1 shows the current condition of these structures on west half section.

Aother structures, the railway bridges, the road over bridegs and the foot over bridges are describes in other sections.

0km900m RC-Retaining Wall(Left)
(26/Aug/2014)

3km400m Slope and Fence
(26/Aug/2014)

Centre Drain at Earth cutting Area
(Date 27/Apr/2014)

Centre Drain at Earth cutting Area
(Date 27/Apr/2014)

Source: JICA Study Team

Figure 4.5.1 Minor Civil Structures

It is necessary to protect the private facilities adjacent to the YCR during the construction period at following locations (west half section).

2km200m(W)
Adjacency Private Fence (Right)
(26/Aug/2014)

3km550m (W)
Adjacency Private House and Slope
(26/Aug/2014)

1km600m(E)
Adjacency Private Brick Retaining Wall
(28/Aug/2014)

Adjacency Retaining Wall(Right)
(27/Apr/2014)

Note; Kilo post (W) means on Western Half of YCR/ (E) means on Eastern Half of YCR
Source: JICA Study Team

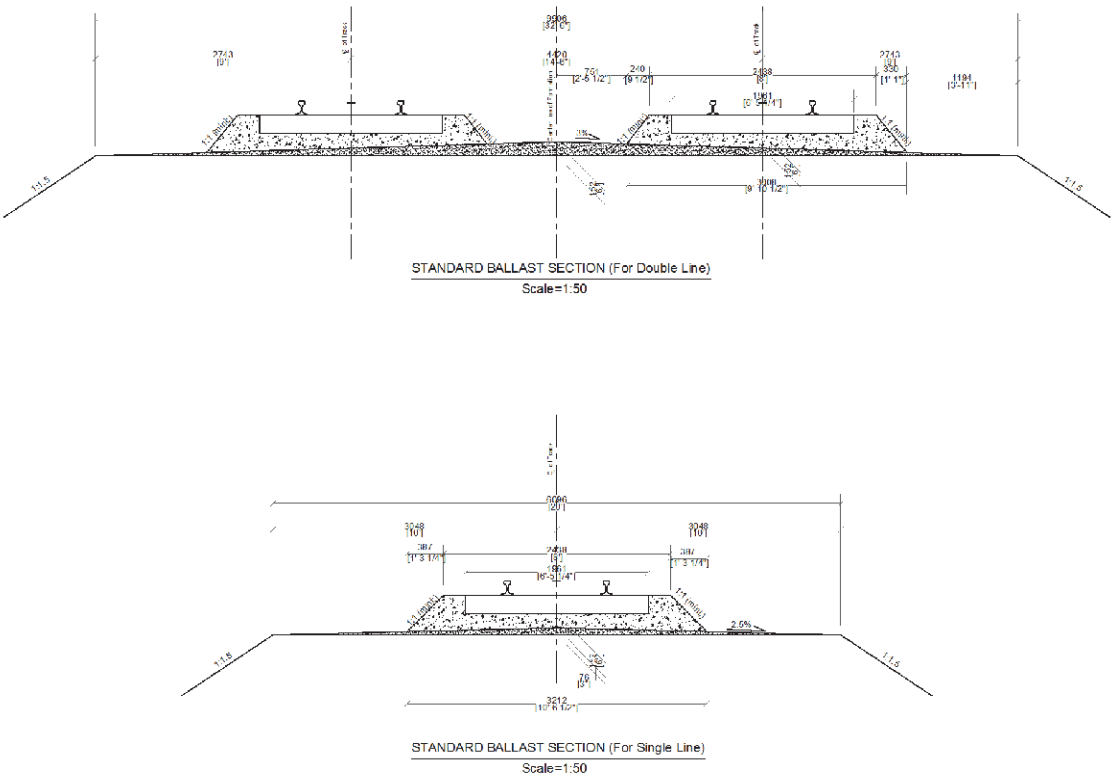
Figure 4.5.2 Adjacency Civil Structures

4.5.2 Roadbed / Earthwork

(1) Track Roadbed

1) Existing Track Structure of YCR

Figure 4.5.3 shows the standard structure section of track by MR which does not have roadbed, and ballast is installed on ground directly. After the heavy rainfall, mud pumping is occurred because of poor drainage and vibration of train operation.



Source: JICA Study Team

Figure 4.5.3 Standard Track Section by MR

2) Necessity of Roadbed

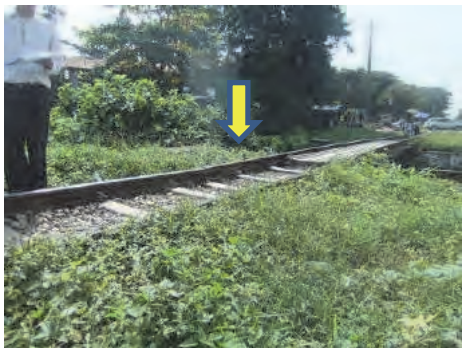
The necessity function for roadbed is to support and secure the adequate elasticity for track, preventing subgrade weakening, distributing the train load to subgrade and keeping good drainage function for rapidly discharged rainfall water.

Existing track condition on the west half section is shown in the Figures below.

Near the Insein Station
(27/Aug/2014)

16km750m (W)
Mud Pumping
(27/Aug/2014)

16km750m(W)
Non Ballast and Mud Pumping
(27/Aug/2014)



16km750m(W)
Different Rai Level at rail Joint
(27/Aug/2014)

18km000m
Nonsufficient ballast
(27/Aug/2014)

Da Nyin Gone Station
Mud Pumping
(29/Jun/2014)

Source: JICA Study Team

Figure 4.5.4 Existing Track Condition

3) Form of Roadbed

To design the width, thickness and gradient formation of road bet, it is necessary to consider the train load distribution, water interception and drainage, etc.

- Width of roadbed should be designed considering with the effective zone of train load, water interception and function of drainage on roadbed. If side track drain planning is adapted, width of roadbed should be up to these side track drain. If drainage plan at embankment isn't considered, width of roadbed should be up to edge of subgrade.
- Thickness of roadbed should be designed considering with the structure of roadbed, strength of subgrade and track structure. However, thickness of soil roadbed should be designed considering the countermeasure of mud pumping.
- Gradient of roadbed should be designed considering with the drainage function for rapidly discharge rainfall water and be set 3% gradient on transverse section of track.

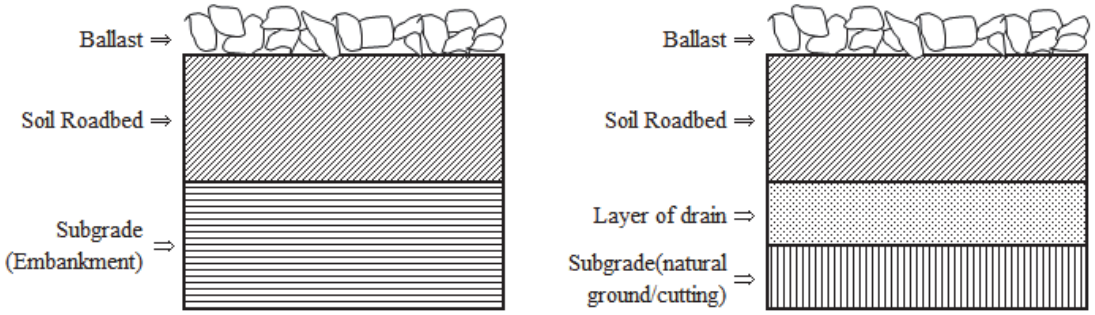
(2) Soil Roadbed

1) Structure of Soil Roadbed

Figure 4.5.5 shows the structure of soil roadbed.

Soil roadbed consists of single layer of natural soil or crushed stone.

If soil roadbed is constructed on earth cutting and natural ground, drain layer should be installed under soil roadbed.



Type1 Type2

Source: JICA Study Team

Figure 4.5.5 Structure of Soil Roadbed

Soil roadbed are required high bearing capacity, small compaction and difficulty of mud pumping. To prevent the mud pumping of subgrade, thickness of roadbed should be 300mm or over.

Natural soil such as surplus soil, pit-run gravel is used as a material of roadbed. However, roadbed material should be brought-out gravel and /or crusher-run if it is difficult to acquire the high quality natural soil because of site condition. If the roadbed is installed on the natural ground or cut earth, roadbed material should be gravel and/or sand whose fin grain factor should be less than 10%. Also, drain layer should be installed under the roadbed.

Thickness of drain layer should be 150mm. The river sand should be used as material of the drain layer to filter. If the geotextile is used for alternate drain layer, it is necessary to confirm/examine durability of the geotextile. Also, drain layer does not need to include layer of soil roadbed.

2) Property of Soil Roadbed Material

The natural soil or crusher-run for the material of soil roadbed should be high quality. The required property for the material is hard for mud pumping, stabilization of vibration and water flow, and enough strength for supporting train load.

Compatibility conditions of natural soil are below:

- Maximum grain size is under 75mm
- Include 2～20% grain which through typical 0.075mm sieve
- Not include over 40% grain which through typical 0.425mm sieve
- Uniformity coefficient is over six (6)
- Liquid limit is under thirty five (35)
- Plasticity index is under nine (9)

In addition, it is necessary to be careful that bad soil grain such as mudstone is not be included in material for roadbed.

3) Construction of Roadbed

At the time of roadbed construction, it is necessary to pay attention of material uniformed property, finished thickness and compaction for keeping stability of train load. And construction of roadbed must be carried out during no rainy season under taking into consideration of weather conditions at construction site.

(3) Subgrade at Cutting Area, Natural Ground and Low Embankment Area

1) Condition of Subgrade

Subgrade at earth cutting, natural ground and low embankment area should be satisfied below conditions.

- Subgrade should support roadbed safely and not sink itself. Also, subgrade material shouldn't include soft ground such as alluvial fine-grain soil and liquefaction sand layer under 3m from the ground level.
- Strength (K30) of subgrade on the subgrade at earth cutting, natural ground area and strength (K30) of subgrade on surface at low embankment must be over 70MN/m3.
- This strength is required to avoid settlement of subgrade due to the train load after the implementation of new train operation.

The standard described above is applied to new railway construction. The subgrade condition of Yangon circular railway seems good because of long term train operations.

2) Surface of Subgrade

The formation of subgrade at earth cutting and natural ground area should be as shown below:

- Surface of subgrade should be kept flat and smoothed with 3% gradient which towards drain.
- Subgrade formation should be decided considering the design of drain.

4.5.3 Drainage Plan

In this section, existing drainage system of YCR is described and abridgment of Design Standard for Railway Structures and Commentary (Earth Structure) in Japan is introduced.

(1) The Existing Drainage System of YCR

The topographic survey informs that the existing flow end of drainage of YCR is natural river and pond. The existing drainage systems of YCR which were made by the brick wall have been installed along the railway partially. Table 4.5.1 shows the location of the existing drain along the railway based on topographic survey result.

Table 4.5.1 The Location of the Existing Drain along Railway

No.	Location of the Existing Drain			Remarks
1	0km000m(W)	～	0km270m(W)	Yangon Central St.
2	0km480m(W)	～	0km840m(W)	Payar Lan St.
3	1km460m(W)	～	4km150m(W)	Cutting Are
4	4km900m(W)	～	5km150m(W)	South of Kyee Myint Daing St.
5	5km640m(W)	～	5km780m(W)	North of Kyee Myint Daing St.
6	6km660m(W)	～	7km440m(W)	Hanthwaddy St. ～ Hledan St.
7	11km650m(W)	～	11km830m(W)	Thamine St.
8	0km000m(E)	～	0km300m(E)	Yangon Central St.
9	0km480m(E)	～	0km660m(E)	Under Thain Phay Road
10	1km410m(E)	～	1km740m(E)	Pa Zun Taung St.
11	3km490m(E)	～	3km720m(E)	Ma Hlwa Gone St,

Source: JICA Study Team

Typical existing drainage facilities are shown in Figure 4.5.6. The centre drain system is adapted mostly.

(15/July/2014)

(15/July/2014)

(15/July/2014)

(15/July/2014)

(17/Apr/2014)

(17/Apr/2014)

(17/Apr/2014)

(17/Apr/2014)

(26/Aug/2014)

(26/Aug/2014)

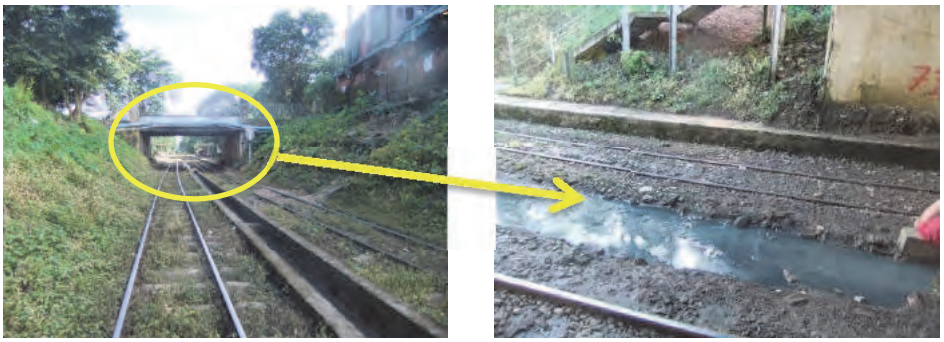
Source: JICA Study Team

Figure 4.5.6 Existing Drainage System

Poor drainage locations are shown in Figure 4.5.7. One location is at Da Nyin Gone Station, another location is at 3km550m mileage point. The reason of poor drainage at 3km550m is that the rail level under R.O.B 08 nearby Ahlone Road Station lowered due to installation of Japanese used rolling stocks. Other locations under R.O.B. are also drains badly during rainy season.

Da Nyin Gone Station
Mud Pumping
29/Jun/2014

Da Nyin Gone Station
Drain Pit Cleaning
29/Jun/2014



3km550m (W) 26/Aug/2014

Source: JICA Study Team

Figure 4.5.7 Drainage Faulty Points

Following figure shows the drainage condition at Yangon Central Station during heavy rain. The surface of track was submerged because of inadequate drainage system.

Source: JICA Study Team

Figure 4.5.8 Yangon Central Station (19/July/2014)

It is recommended that MR should develop drainage system integrated with land use planning in Yangon city, development plan of Yangon Central Station and other projects which may affect drainage systems.

(2) Basic Design Standard of Drain at Earth Cut Area and Natural Ground Area

1) General

To prevent mud pumping, drainage system at earth cut area and natural ground area is important. The purpose of drainage systems is preventing of mud pumping, securing and/or preventing deterioration of strength of subgrade and roadbed, and preventing land sliding /corrosion of slope.

The main reason of land sliding of earth cutting slope at the time of concentrated heavy rain is concentrated flow of rainfall infiltration and rising of water pressure by rainfall in ground.

2) Design Policy

- Considering with traction load, gradient of drain should be keep over 0.3%. If it is difficult to design the drain with over 0.3% gradient, design flow calculation of drain should be carried out to decide necessary area and gradient of drain.
- To keep inside of drain clean and considering with the room for soil deposition, both of minimum inner width and depth of drain should be 0.3m.
- Catch basin should be installed at hitting point of water flows and the point where water flow decreases sharply, to mitigate these effects and soil deposition.
- It is necessary to minimize deformation during drain construction.

a) Drain of Roadbed

Track side drain should be installed to discharge the surface water and ground water on roadbed and earth cutting section. Underground drain is also installed if necessary.

If it is difficult to install track side drain, track centre drain and track crossing drain should be installed.

The standard of structure and install location of drainage system is shown in Table 4.5.2.

Table 4.5.2 The standard of Structure and Install Location of Drainage System

Purpose	Type	Classification	Install Location
Surface Drain for subgrade and earth cutting slope	Open Drain	Track Side Drain	Entire Interval
		Track Centre Drain	a. Double double tracks b. Double track with bump c. Re-entrant face of roadbed for transversal direction
	Pipe Drain	Track Crossing Drain	a. Above of civil structure on gradient section b. Location of connection between track centre drain and longitudinal drain c. Boundary at downstream side of long ways earth cutting location
Drain for Underground water if necessary		Underground Drain	Lower part of track side drain and track centre drain
	Drain layer		Entire under roadbed

Note, however, that planning of underground drain must be examined to take into consideration of roadbed structure, permeability of subgrade and condition of underground water.

Source: Design Standards for Railway Structure and Commentary (Earth Structure) 2004,(in Japanese)

b) Track Side Drain

The track side drains should be installed both side of roadbed to exclude surface water on roadbed and slope of earth cutting.

In addition, the cable trough which blocks drainage should be installed with track side drain considering with the space for construction work and drain performance.

c) Track Centre Drain

Track centre drain should be installed with following conditions if it is difficult to drain adequately with track side drain.

- If track number is more than two, one track centre drain should be installed for one double-track.
- If there is a difference in construction formations, track centre drain should be installed on the lower formation.
- Track centre drain should be installed in the re-entrant face of cross gradient on roadbed face if additional track is constructed at earth cutting section. In addition, a track centre drain must be connected longitudinal drain with a track crossing drain at boundary of embankment and earth cutting.

d) Track Crossing Drain

Track crossing drain should be installed in the connection point between train centre drain and longitudinal drain in gradient section.

In the section where discharging surface water isn't required, the drain which is prevented the sediment from flowing, namely the drain with cover which doesn't have holes, should be adapted.

On the other hand, the drain with small holes should be installed to prevent the ballast from flowing in the section where surface water should be discharged.

e) Underground Water Drain

If groundwater level is increased nearby roadbed level, bearing capacity of roadbed will be decreased because of penetrating fine-grained soil into roadbed, rising of water pressure, and muddying roadbed by train load. To prevent increasing groundwater level, it is necessary to install underground drain.

Underground drain consists of pipe drain (e.g. porous concrete pipe or perforated pipe with filter such as non-woven fabric) and drain layer whose thickness is 150mm.

(3) Drainage of Embankment

1) General

Drainage planning should be considered drain form of surface, ground condition, geological condition, ground water condition and weather condition on embankment. Balanced total drainage system is required.

2) Planning Policy

- Gradient of drain should be kept over 0.3% considering traction load. However, if it is difficult to plan over 0.3% gradient of drain, design calculation of drain should be carried out to decide the section where drainage facilities should be installed and the gradient of drain.
- To keep inside of drain clean and considering with the room for soil deposition, both of minimum inner width and depth of drain should be 0.3m.
- Catch basin should be installed at hitting point of water flows and the point where water flow decreases sharply, to mitigate these effect and soil deposition.
- It is necessary to minimize deformation during drain construction.
- In addition, it is necessary to discuss/decide the method of end water treatment of drainage system with public administration.

3) Roadbed Drainage

The track side drain should be installed to discharge surface water on soil roadbed.

In addition, if it is difficult to drain adequately with track side drain, track centre drain and track crossing drain should be installed.

The standard of structure and installation location of drainage system is shown in Table 4.5.3.

Table 4.5.3 Standard of Structure and Installation Location of Drainage System

Purpose	Type	Classification	Installation Location
Surface Drain for roadbed	Open Drain	Track Side Drain	There are cables trough on top of cutting slope of soil subgrade which blocks drain.
		Track Centre Drain	a. Double-double tracks b. Double track with bump c. Re-entrant face of roadbed for transversal direction
	Pipe Drain	Track Crossing Drain	a. Above of civil structure on gradient section b. Re-entrant face location for transversal direction c. Connection between track centre drain and track side drain d. Boundary of Embankment and earth cutting at downstream location of long earth cutting section

Source: Design Standards for Railway Structure and Commentary (Earth Structure) 2004,(in Japanese)

Gradient of roadbed surface should be designed considering drainage function for rapidly discharged rainfall water and be designed over 3% in transverse section of track for preventing mud pumping.

To prevent deterioration of subgrade and roadbed strength, track side drain, track centre drain and track crossing drain should be installed. It is necessary to consider that the cover of drain and structure should be installed for smooth water flow in drain.

a) Track Side Drain

Flow water on the slope of embankment is very small. Therefore, it is not necessary to install track side drain on soil roadbed of embankment.

However, if the cable trough and the sound barrier block the drain system, surface water penetrates into roadbed. The penetrated water causes land slide of embankment and mud pumping. Therefore, the side drain on soil roadbed should be installed with cable trough adjacently.

In addition, to minimize the effect of penetrated water, following drainage measures on the side wall of should be selected.

i) Using porous concrete
ii) If ready-made U ditch drain is used, free joint should be adopted.
iii) If cast-in-place concrete drain is used, drainage holes should be made.

If structures of above ii) and iii) are adopted, pad of porous concrete and filter of non-woven fabric should be used to protect soil inflow into track side drain.

b) Track Centre Drain

It is necessary to take above drainage measures to discharge the water which penetrates into roadbed.

c) Track Crossing Drain

Installing the perforated pipe with filter such as non-woven fabric or taking the countermeasure of penetrated water which is stated in “a) Track side drain” is required at location where need discharge surface water.

4.5.4 Invasion Prevention Fence

In this chapter, purpose of invasion prevention fence is described. Topographic survey result for the existing fence on the west half section is summarized in Table 4.5.4.

Table 4.5.4 Summary of the Non-fence Location

Station		Starting KP	Station KP	Ending KP	No-Fence Location (Left Side)			No-Fence Location (Right Side)		
					Starting KP	Ending KP	Length(m)	Starting KP	Ending KP	Length(m)
St37	Ma Hlwa Gone	3+300	3+624	4+000						
					2+034	2+189	155	2+100	2+200	100
					2+337	3+300	963	2+200	2+767	567
St38	Pa Zun Taung	1+540	1+646	1+735						
							0			0
St01	Yangon Central	0+600	0+000	0+600						
					0+665	0+698	33	0+600	0+700	100
St02	Payar Lan	0+700	0+775	0+850						
					0+886	1+295	409	0+850	0+916	66
								0+953	0+970	17
								1+027	1+293	266
St03	Lanmadaw	1+295	1+367	1+440						
					1+895	1+900	5			
St04	Pyay Lan	1+900	1+986	2+055						
					2+055	2+135	80	2+055	2+103	48
					2+494	2+618	124	2+400	2+750	350
St05	Shan Lan	2+895	2+974	3+040						
					3+061	3+555	494	3+063	3+555	492
St06	Ahlone Lan	3+555	3+644	3+735						
					3+735	3+750	15	3+735	4+300	565
					4+021	4+300	279			
St07	Panhlaing	4+300	4+438	4+490						
					4+490	4+666	176	4+730	5+050	320
					4+724	4+785	61			
St08	Kyee Myint Daing	5+050	5+499	6+050						
							0			
St09	Hanthwaddy	6+505	6+587	6+645						
					6+645	7+420	775	6+650	7+420	770
St10	Hledan	7+420	7+485	7+600						
					7+600	9+200	1,600	7+600	8+550	950
St11	Ka Ma Yut	9+200	9+304	9+390						
					9+390	9+438	48			
					9+446	9+465	19			
					9+476	10+255	779			
St12	Thirimyaing	10+255	10+329	10+405						
					10+405	10+960	555			
St13	Oak Kyin	10+960	11+051	11+160						
							0			
St14	Thamine	11+620	11+722	11+825						
					12+270	12+280	10			
St15	Thmaing Myothit	12+280	12+359	12+440						
					12+440	13+100	660	13+073	13+135	62
St16	Kyaoe Gone	13+135	13+230	13+325						
					13+716	13+944	228	13+325	13+800	475
St17	Insein	13+950	14+425	14+825						
					14+825	14+847	22	15+014	15+944	930
					15+396	15+668	272	15+952	16+033	81
					15+687	15+738	51			
					15+760	15+798	38			
St18	Ywar Ma	16+045	16+124	16+205						
					16+205	17+038	833	16+208	16+956	748
								17+258	17+340	82
St19	Phawkan	17+340	17+413	17+490						
								17+490	17+737	247
							0	17+837	18+165	328
St20	Aung San	18+165	18+240	18+315						
					18+743	19+730	987	18+315	19+730	1,415
St21	Dan Nyin Gone	19+730	20+192	20+420						
					20+420	20+450	30	20+420	20+450	30
	Project END	20+450								
	TOTAL (m)						9,701			9,009

Source: JICA Study Team

The purposes of fence installation are;

- By preventing the external incursion, train accident and burglar-proof railway's electric devices is prevented
- R.O.W

The existing fences are mixed MR properties and private properties. Typical photographs of existing fence are shown in Figure 4.5.9.

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28/Aug/2014

28/Aug/2014

Source: JICA Study Team

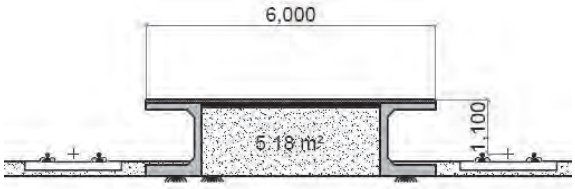
Figure 4.5.9 Existing Fence

4.5.5 Station Platform Height Improvement

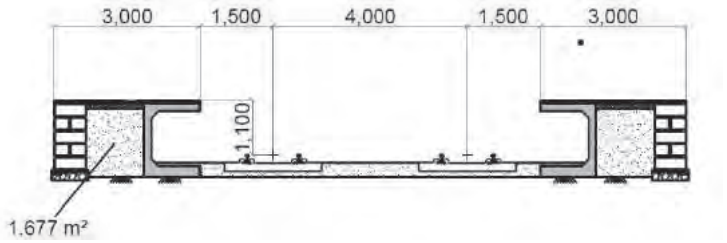
Since there is a difference in floor height between existing rolling stock currently being operated on Yangon circular railway and newly-procured DEMU, the height of platform has to be raised for passengers' smooth boarding and alighting. Although further discussions to determine the most suitable platform type is required in the next design stage, one of the options for the heightened-platform structure has been proposed .

(1) Proposed Structure of Heightened-Platform

Depending on the type of station, i.e. island platform and split platform, two type of heightened-platform are proposed. The figure below shows the typical section of each platform.



Typical section of island platform



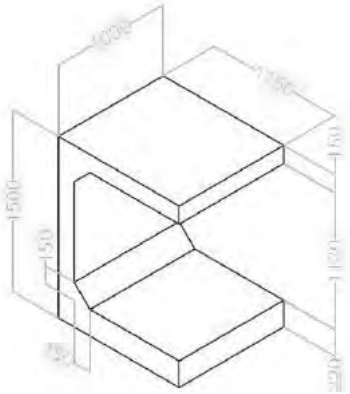
Typical section of split platform

Source: JICA Study Team

Figure 4.5.10 Typical Section of Heightened Platform Structure

The platform height should be raised about one meter from the existing platform. The precast concrete block in the shape of "C" has been proposed. This "C" shape platform will help passengers who fall onto rail track by accident to evacuate in the space of the concrete block. The detail of "C" shape concrete block is shown in Figure 4.5.11.

The surface of the platform shall be covered by asphalt concrete and the space behind the concrete block shall be back-filled by sand and well-compacted, with retaining wall built up with bricks.



Source: JICA Study Team

Figure 4.5.11 Proposed "C" figure concrete block

(2) Location and Type of Platform Improvement Work

The figure below summarizes location and type of platform improvement works for each station. It is proposed that the height of platform at Yangon central station will not be raised since it could be possible that trains from other lines may stop at platform of Yangon circular railway. In calculating the number of platform to be improved/ heightened, existing conditions of platform of each station is considered (e.g. two island platform at Kyee Mint Dying, one island and half split platform at Dan Nying Gone etc).

	Station	Station KP	Inprovement High Height Station	
			Type of Platform	
			Island	Split
St01	Yangon Central	0+000		
St02	Phayar Road	0+775		1
St03	Lanmadaw	1+367		1
St04	Pyay Lan	1+986		1
St05	Shan Lan	2+974		1
St06	Ahlone Lan	3+644		1
St07	Panhlaing	4+438	1	
St08	Kyee Myint Daing	5+499	2	
St09	Hanthwaddy	6+587		1
St10	Hledan	7+485		1
St11	Ka Ma Yut	9+304		1
St12	Thirimyaing	10+329		1
St13	Oak Kyin	11+051		1
St14	Thamine	11+722		1
St15	Thmaing Myothit	12+359		1
St16	Kyaoe Gone	13+230		1
St17	Insein	14+425	2	
St18	Ywar Ma	16+124		1
St19	Phawkan	17+413		1
St20	Aung San	18+240		1
St21	Dan Nyin Gone	20+192	1	0.5
St22	Golf Kwin	21+910		1
St23	Kyaikkale	24+610		1
St24	Mingaladon Bazzar	26+050		1
St25	Mingaladon	27+020		1
St26	Weibargi	28+500		1
St27	Okkalapa	30+230		1
St28	Pa-Ywet-Seik-Kon	31+010		1
St29	Kyauk-Ye-Dwin	32+210		1
St30	Tadagale	33+490		1
St31	Yegu	35+150		1
St32	Paryame	36+680		1
St33	Kanbe	37+670		1
St34	Bauktaw	39+370		1
St35	Tamwe	40+420		1
St36	Myttanyunt	41+420		1
St37	Ma Hlwa Gone	42+500	1	
		Subtotal	8	31.5

Source: JICA Study Team

Figure 4.5.12 Location and Type of Platform Improvement Works

4.6 Bridge and Culvert Structures

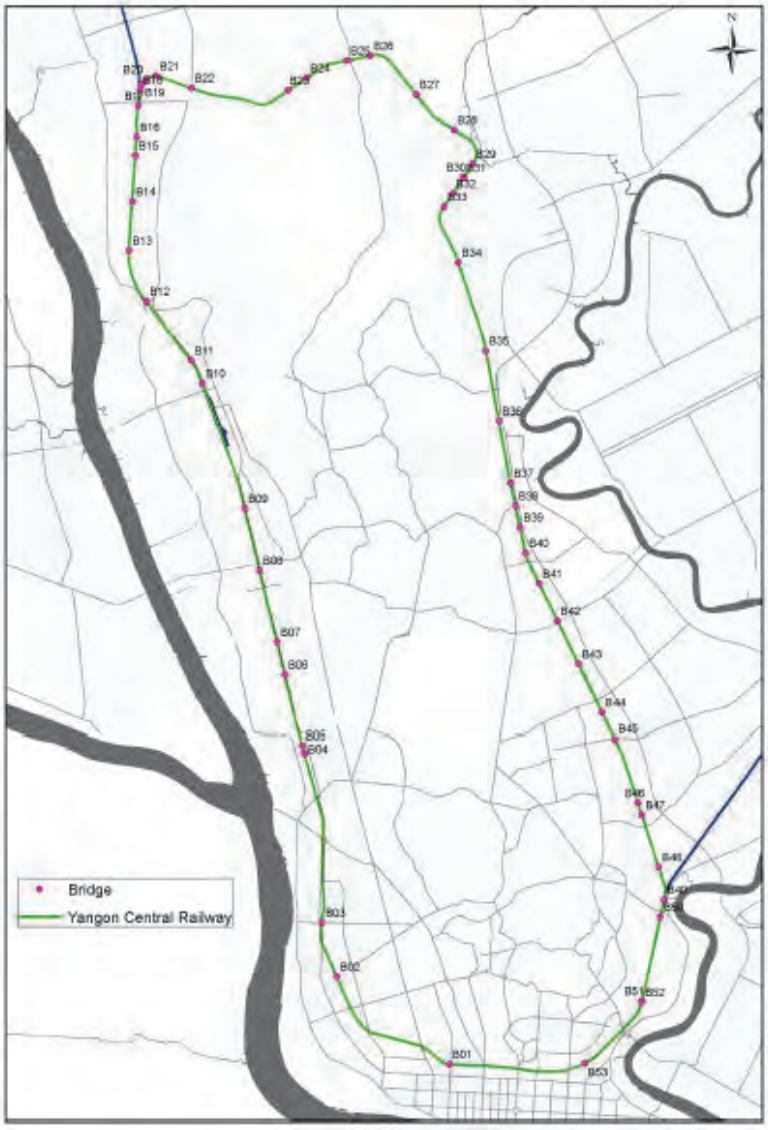
Bridge and culvert structures will be upgraded by Myanmar Railway. Although all the bridge and culvert structures are subject to be inspected and evaluated for its soundness, this section of Chapter 5 mainly describes the studies made on western half of the project.

4.6.1 Current Condition of Bridge and Culvert Structures

(1) Existing Bridge Locations

According to the results of the Pre-Feasibility Study, there are 53 bridges including culverts along Yangon Circular Railway. Among them, 15 bridges on the western half of the project have been identified to be re-constructed through the site inspections. Meanwhile, since no such inspections on bridge structure have carried out on the eastern half of the project, it is assumed that all the bridges on eastern half of the project are subject to reconstruction.

Bridge layout diagram is shown below.



Source: JICA Study Team

Figure 4.6.1 Location Map of Bridge Structures in Yangon Circular Railway

Most bridges are short span which has less than 10m made of H-steel shapes, and there are also pre-stressed concrete bridges and brick arches.

(2) Bridge List in the Priority Section

Table 4.6.1 is the list of bridges categorized as the bridges on western half of the project. Evaluation of the soundness of the bridge structure on western half bridges has been carried out through the site inspections and results of the evaluation are described in this section.

Table 4.6.1 Bridge List on the Western Half of Yangon Central Station

No	Chainage	Stations	Bridge Type	Length
B01	1k462m	Payar Lan ~ Lanmadaw	Steel Girder	2.73m
B02	4k165m	Ahlone ~ Panhlaing	Brick Arch	D2.70m x 2
B03	5k167m	Panhlaing ~ Kyee Myint Daing	PC Girder	16.80m
B04	8k113m	Hledan ~ Ka Ma Yut	Steel Girder	2.90m
B05	8k404m	Hledan ~ Ka Ma Yut	Steel Girder	2@5.40m
B06	9k573m	Ka Ma Yut ~ Thirimyaing	RC/ Brick Girder	2.30m
B07	10k185m	Ka Ma Yut ~ Thirimyaing	Steel Girder	2@3.90m
B08	11k485m	Oak Kyin ~ Thamine	Steel Girder	2@5.40m
B09	12k635m	Thmaing Myothit ~ Kyoegone	Steel Girder	2@3.85m
B10	14k958m	Insein ~ Ywar Ma	Steel Girder	2.85m
B11	15k400m	Insein ~ Ywar Ma	Steel Girder	5.80m
B12	16k715m	Ywar Ma ~ Phawkan	Steel Girder	7.10m
B13	17k685m	Phawkan ~ Aung San	Steel Girder	2.90m
B14	18k549m	Aung San ~ Da Nyin Gone	No Girde	0.60m
B15	19k360m	Aung San ~ Da Nyin Gone	No Girder	0.60m
B16	19k687m	Aung San ~ Da Nyin Gone	Steel Girder	2.75m
Bridges on this section is categorized as Eastern Half Section				
B49	3k935m	Myittar Nyunt ~ Ma Hlwa Gone	Steel Girder	13.75m
B50	2k450m	Ma Hlwa Gone ~ Pa Zun Taung	RC/ Brick Girder	0.60m
B51	2k403m	Ma Hlwa Gone ~ Pa Zun Taung	No Girder	0.60m
B52	0k955m	Pa Zun Taung ~ Yangon Central	Steel Girder	14.00m
B53	0k597m	Pa Zun Taung ~ Yangon Central	No Girder	0.60m

Source: JICA Study Team

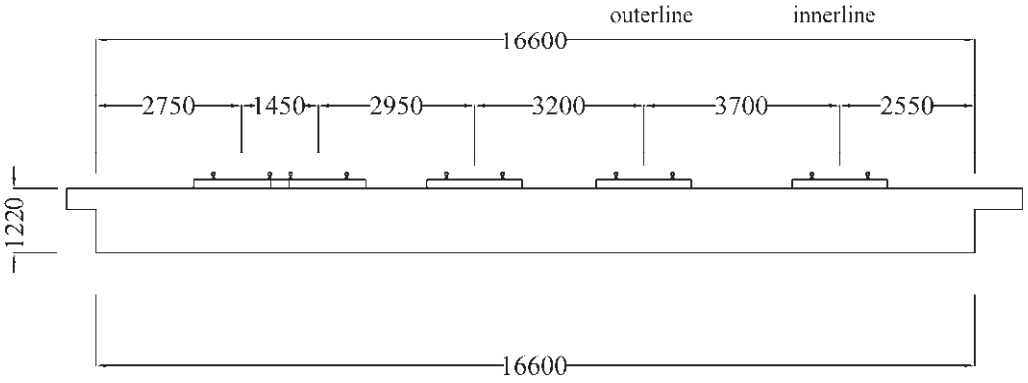
Table 4.6.2 is the list of bridges categorizes as the bridges on eastern half of the project. Site inspection and evaluation of the soundness of these bridges shall be carried out in the future studies.

Table 4.6.2 Bridge List on the Eastern Half of Yangon Central Station

No	Chainage	Stations	Bridge Type	Length
B17	20k250	Danyingone ~ Gauk Kwin	Drain Box	-
B18	-	Danyingon ~ Gauk Kwin	Pipe culvert	3.45m
B19	-	Danyingone ~ Gauk Kwin	Steel girder	4.0m
B20	-	Danyingone ~ Gauk Kwin	Pipe culvert	3.45m
B21	-	Danyingone ~ Gauk Kwin	Steel girder	3.45m
B22	-	Danyingone ~ Gauk Kwin	Steel girder	4.0m
B23	-	Gauk Kwin ~ Kyaikkalel	Brick	3.5m
B24	-	Gauk Kwin ~ Kyaikkalel	Steel girder	13.6m
B25	-	Kyaikkalel ~ Mingaladon Buzza	Box Culvert	2.9m
B26	-	Kyaikkalel ~ Mingaladon Buzza	Steel girder	11.15m
B27	-	Mingaladon Buzza ~ Mingaladon	RC	3.8m
B28	-	Mingaladon ~ Waibagi	-	0.48m
B29	-	Mingaladon ~ Waibagi	RC	7.0m
B30	-	Mingaladon ~ Waibagi	RC	3.8m
B31	-	Mingaladon ~ Waibagi	-	0.5m
B32	-	Waibagi ~ Okkalapa	RC	3.78m
B33	-	Waibagi ~ Okkalapa	RC	3.83m
B34	-	Waibagi ~ Okkalapa	Steel girder	3.9m
B35	-	Paywetseikkon ~ Kyaukyetwin	RC	7.15m
B36	-	Kyaukyetwin ~ Tadakalay	Steel girder	7.13m
B37	-	Tadakalay ~ Yegu	Steel girder	2.8m
B38	-	Tadakalay ~ Yegu	RC	3.75m
B39	-	Tadakalay ~ Yegu	Steel girder	2.85m
B40	-	Yegu ~ Parame	Steel girder	2.83m
B41	-	Yegu ~ Parame	Steel girder	2.75m
B42	-	Yegu ~ Parame	Steel girder	6.73m
B43	-	Parame ~ Kanbe	RC	7.1m
B44	-	Kanbe ~ Baukthaw	Steel girder	3.0m
B45	-	Baukthaw ~ Tarmwe	Steel, RC	3.82m
B46	-	Baukthaw ~ Tarmwe	Steel girder	8.0m
B47	-	Tarmwe ~ Myittanyunt	Steel girder	2.7m
B48	-	Myittanyunt ~ Malwagone	Steel girder	41.5m

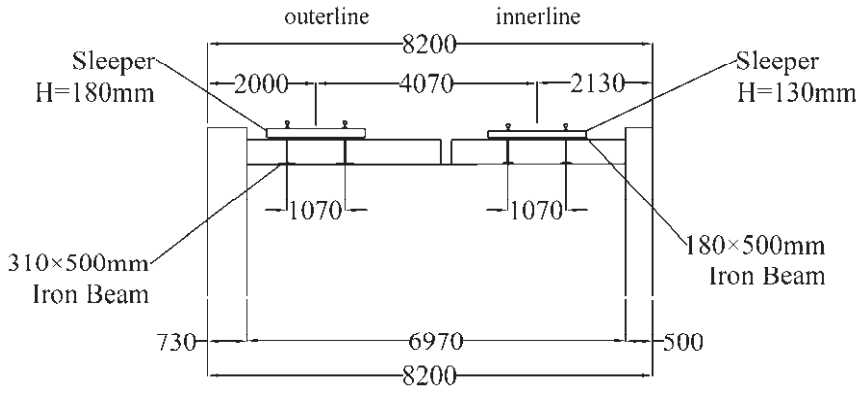
Source: JICA Study Team

(3) Cross Section of Existing Bridge on the Western Half of the Project



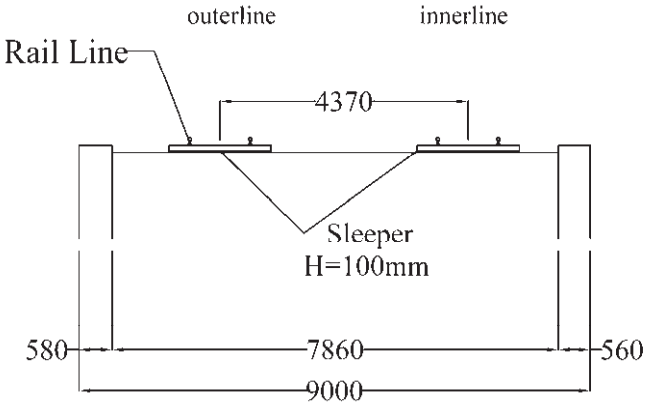
Source: JICA Study Team

Figure 4.6.2 B03 (PC Girder)



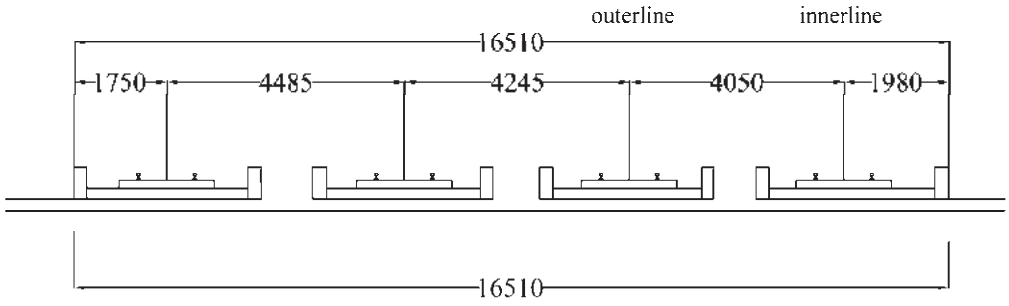
Source: JICA Study Team

Figure 4.6.3 B11 (Steel Girder)



Source: JICA Study Team

Figure 4.6.4 B15 (No Girder)



Source: JICA Study Team

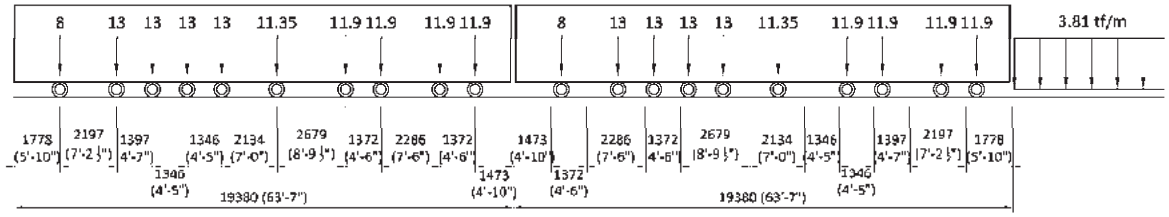
Figure 4.6.5 B50 (RC/ Brick Girder)

(4) Bridge Design Standard

Railway structures in Myanmar are designed in accordance with the railway standard in Myanmar. "Manual of the Engineering Department: Chapter VI Bridges" was issued as the standard for the design of railway bridges.

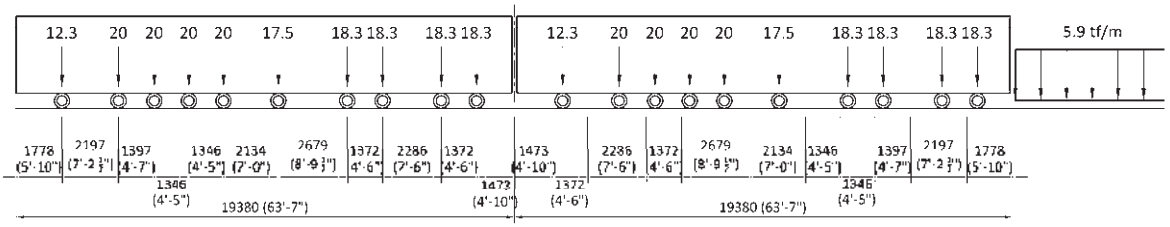
Regarding axle load, the above standard describes that axle load refers to the standards in the British Standard and Indian Standard.

Figure 4.6.6 shows the axle load diagram for the design of railway infrastructures of Myanmar Railways. The bridges and culverts, which are to be completely reconstructed, shall be designed to carry the loads shown in Figure 4.6.6. The original designed maximum axle load is 13 tons, but when bridges are completely reconstructed, maximum axle load of 12.5 tons will be applied in consideration of a future improvement plan as shown Figure 4.6.7.



Source: Myanmar Railways

Figure 4.6.6 Axle Load (Current) (Unit: ton)



Source: JICA Study Team

Figure 4.6.7 Axle Load for Structure Improvement (Proposed) (Unit: ton)

(5) Current Conditions of Bridges on the Western Half of the Project

1) Steel Girder

Most bridges on the western half are composed of steel girders in Yangon Circular Railway Line, and bridge length is less than 10m. According to documents and bridge record plates, these steel girders have been used more than 100 years. (Figure 4.6.8)

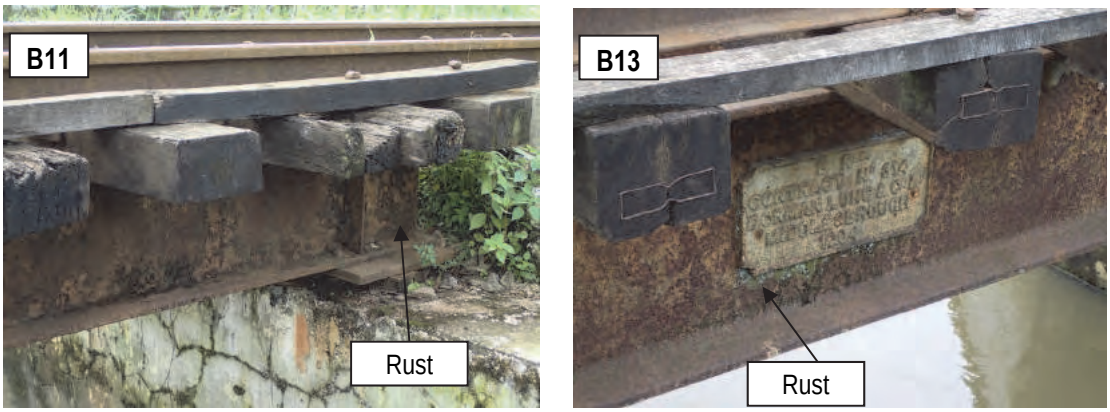
Source: JICA Study Team

Figure 4.6.8 Bridge Record Plates

Current conditions of the bridges on the western half found from the appearance survey are described below.

a) The deterioration of the Steel Girders

Since a long time has passed, the progressing corrosion in the main girder may have reduced its durability. Also, since the domestic waste water containing excreta discharged from the surrounding houses is flowing under bridges, the corrosive gas generated has furthered the corrosion. As a result, the sectional loss due to corrosion of the main girder is causing a decrease in durability.



Source: JICA Study Team

Figure 4.6.9 Appearance of Damage

b) Unstable Bearing Structure

Since the width of the pier top is insufficient, a part of the bearing is not appropriately supported. If the piers are displaced by an external force such as an earthquake, it may cause the collapse of the bridge superstructure.

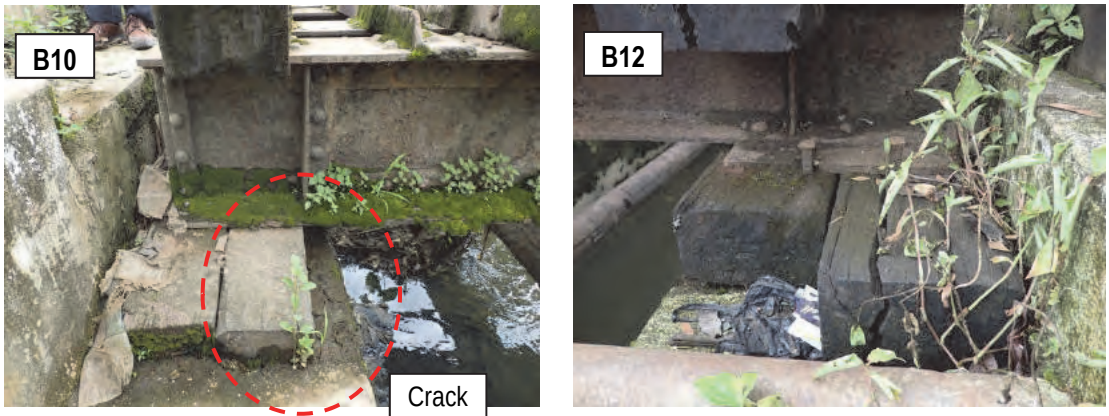
Also, there is a risk that the bearing, which is not fixed on the pier, could be displaced by the passage of a train.

Source: JICA Study Team

Figure 4.6.10 Unstable Bearing Structure

c) Height Adjustment by Wood

Wooden sleepers are used for height adjustment instead of the bearing in many piers but wood is susceptible to rot and its durability is low. Wood may be damaged by repeated passage of the train, which may lead to collapse of the bridge or the superstructure falling off of its supports in the future.



Source: JICA Study Team

Figure 4.6.11 Height Adjustment with Wood

d) Damage Caused by Sea Water

B49, which is located near the Dainingon Station, has water from Nga Moe Yeik Creek flowing under the bridge. Since sea water flows under the bridge at high tide, the bottom of the girder is soaked in the salty water. (According to information from Myanmar Railways)

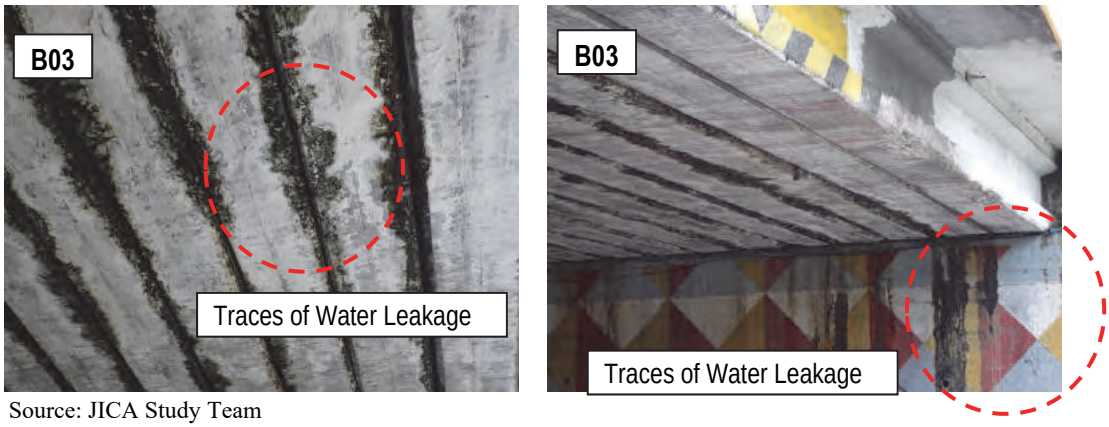
As shown in Figure 4.6.12, evidence that the girder was soaked in sea water is left in the bottom of the girder, and a part of the web is holed due to corrosion.

Source: JICA Study Team

Figure 4.6.12 Traces of Water Inundation in B49

2) Pre-stressed Concrete Girders

The pre-stressed concrete girders do not have significant damage and corrosion as compared to the steel girders, however, traces of water leakage due to rainfall are seen. This situation is expected to have been caused by not installing water proofing. Water leakage will lead to fracturing by the corrosion of the steel pre-stressing rods.

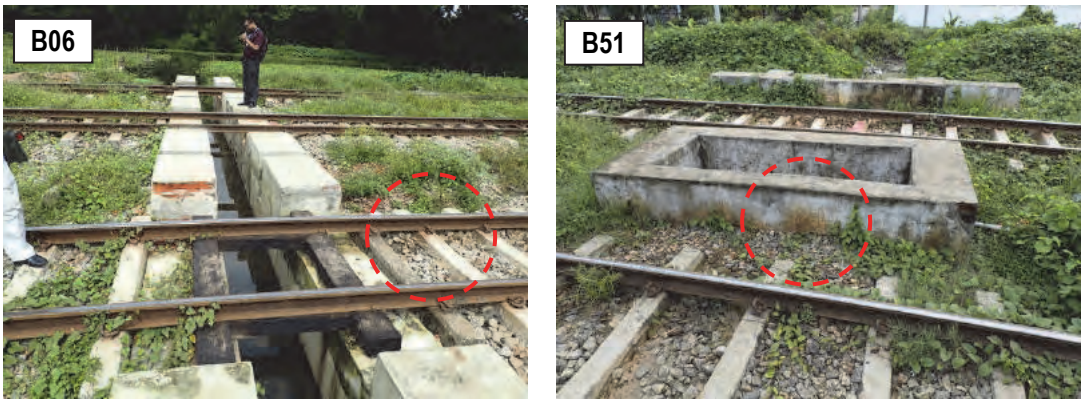


Source: JICA Study Team

Figure 4.6.13 Traces of Water Leakage at the Bottom of the Girder

3) Concrete- Brick Hybrid Structure

The structure is made of brick and concrete (or mortar), and the main structure is built of brick. Concrete (or mortar) has been used as an exterior surface, and it has been seen to spall in some places. However, it seems that there is no major structural problem regarding durability because it was built relatively recently.



Source: JICA Study Team

Figure 4.6.14 Exposed Brick

4) Brick Structure (Pier, Abutment)

Almost all substructures are built with bricks, and it is expected that 100 years or more have passed since construction as well as the steel beams. The body made of brick has suffered cracks or missing bricks because of aging, so there is risk of collapse in an earthquake.

In addition, the foundation structure is unknown because the documents and drawings for the substructure were not saved. Therefore, if the traffic volume is increased, it is not possible to verify the stability of the foundation.

Source: JICA Study Team

Figure 4.6.15 Substructure of Brick

5) Brick Structure (Arch)

A waterway composed of two circular brick arches.

There is a waterway of approximately 8m width under two brick arches. Abundant domestic water is flowing, and many houses are close to the waterway. The arches have cracked somewhat inside, but no major damage.

Source: JICA Study Team

Figure 4.6.16 Appearance of Brick Arches

4.6.2 Rehabilitation of Existing Bridges

(1) Rehabilitation Procedures

A rehabilitation plan for the railway structures must be researched and designed for the following.

1) Survey of Structure

- Confirmation of performance
- Visual inspection
- Measurement

2) Judgment of Soundness

- Judgment based on survey results
- Type, extent, and risk of progress of the deterioration
- A still more detailed survey may be required

3) Planning of Rehabilitation

- Planning based on soundness
- Shall be ensured predetermined performance
- Shall be considered the durability and economy.

Performance of the structure is verified by judging soundness which is based on the Japanese railway standards. The soundness can be judged by providing judgement categories based on the results of determined deterioration causes and prediction of future deterioration.

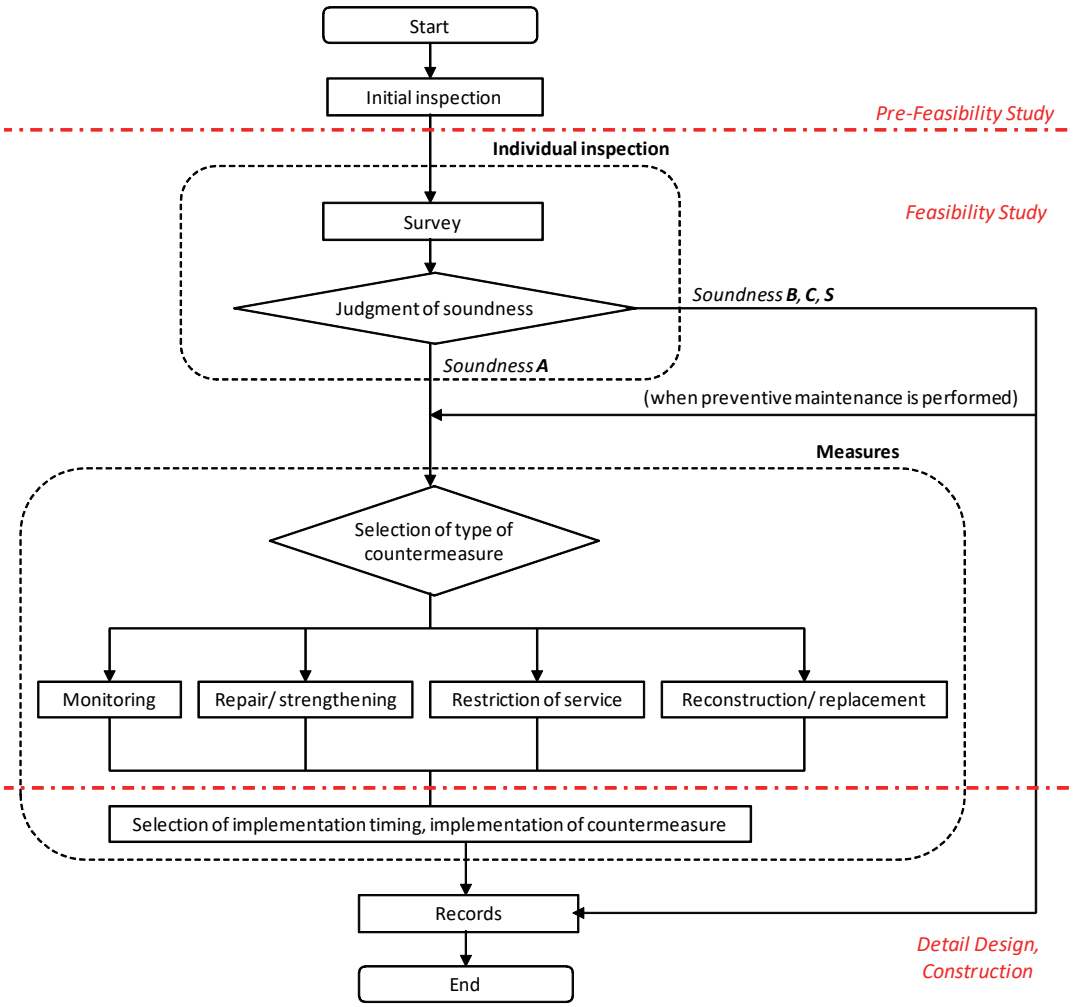
Judgement of current soundness is categorized into ranks A, B, C and S based on the survey results. Also, rank A is subdivided more finely as AA, A1 and A2.

Table 4.6.3 Judgment of Structure States and Soundness

Soundness		Structure State
A		State that threatens operational safety, safety of passengers, public safety, guarantee of regular train operational, or deterioration that might cause this state
	AA	Deterioration that threatens operational safety, safety of passengers, public safety, or the guarantee of regular train operation, and which require emergency
	A1	Progressive deterioration that causes the performance of structures to drop, or heavy rain, floods, or earthquakes that might impair the performance of structures
	A2	Deterioration that might cause a future performance drop of structures
B		Deterioration that might result in a future soundness rank of A
C		Slight deterioration
S		Sound

Source: Maintenance Standards for Railway Structures and Commentary/ Railway Technical Research Institute (Japan)

Following figure shows the procedure of rehabilitation of the structure which depends on the soundness of each structure.



Source: JICA Study Team

Figure 4.6.17 Flowchart for Rehabilitation

As shown above, the soundness of each bridge on the western half is determined based on the results of the visual inspection in the study.

(2) Results by Judgment of Soundness

Soundness of each bridge on the western half was determined to correspond with the classification of Table 4.6.4 based on the results of the visual survey, and classified superstructure, substructure and bearing.

The results of the soundness judgment are shown below.

Table 4.6.4 Bridge List on the Western Half of Yangon Central Station

No	Chainage	Bridge Type	Bridge Type		
			Superstructure	Substructure	Bearing
B01	1k462m	Steel Girder	**A1**	**A1**	**A1**
B02	4k165m	Brick Arch	---	B	---
B03	5k167m	PC Girder	C	C	Unconfirmed
B04	8k113m	Steel Girder	**A1**	**A1**	Unconfirmed
B05	8k404m	Steel Girder	**A1**	**A1**	**A2**
B06	9k573m	RC/ Brick Girder	S	S	Unconfirmed
B07	10k185m	Steel Girder	**A1**	**A1**	**A2**
B08	11k485m	Steel Girder	**A1**	**A1**	**A2**
B09	12k635m	Steel Girder	**A1**	**A1**	**A1**
B10	14k958m	Steel Girder	**A1**	**A1**	**A1**
B11	15k400m	Steel Girder	**A1**	**A1**	**A2**
B12	16k715m	Steel Girder	**A1**	**A1**	**A1**
B13	17k685m	Steel Girder	**A1**	**A1**	**A2**
B14	18k549m	RC/ Brick Girder	**A2**	**A2**	Unconfirmed
B15	19k360m	No Girder	Unconfirmed	**A1**	Unconfirmed
B16	19k687m	Steel Girder	**A1**	**A2**	**A1**
B49	3k935m	Steel Girder	**A2**	**A1**	**A2**
B50	2k450m	RC/ Brick Girder	S	S	Unconfirmed
B51	2k403m	No Girder	S	S	Unconfirmed
B52	0k955m	Steel Girder	**A2**	**A1**	**A2**
B53	0k597m	No Girder	S	S	Unconfirmed

Source: JICA Study Team

(3) Improvement Plan on the Western Half

In order to keep the bridges safe in the long term in face of the current conditions and problems, an improved scheme in accord with the bridge soundness is proposed.

The most important thing is to ensure the safety of the railway. An appropriate improvement plan is capable of realizing this. But it should also be economical, considering the improvement plan according to the status of the bridge is required.

In addition, further improvement plans should be considered during Detail Design.

Improvement plans are determined according to the judgment of soundness as shown in Figure 4.6.19.

1) Soundness Rank: S (B06, B50, B51, B53)

- There are no serious damages in appearance or function.
- It is possible to use in the current situation.
- Bridge length is short.

It is assumed that the running safety of the train has been secured in the current situation.

Therefore, the bridge is capable of being utilized in its current condition without rehabilitation.

Countermeasure: None

2) Soundness Rank: B, C

a) B02: Brick Arch

- Require further soundness survey inside the arch box.
- It is stable because of the arch structure.

Situation inside the arch cannot be confirmed by visual survey. However, there is no problem in usage because there is no major damage to the bridge.

If a problem is found in the detail soundness survey, it is necessary that the bridge is reinforced and repaired.

Countermeasure: None

b) B03: PC Girder

- There are no serious damages to the girder or substructure.
- Need to be waterproofed in order to protect the PC girder.

Although there is no need for repair and reinforcement because there is no major damage to the girder, it is necessary to carry out the water proofing works to prevent water leakage.

Also the increase in impact stress caused by increased train speed should be calculated.

Countermeasure: None

Source: JICA Study Team

Figure 4.6.18 Construction of Water Proofing Sheet

3) Soundness Rank: A

a) Steel Girder (B01, B04, B05, B07, B08, B09, B10, B11, B12, B13, B16, B49, B52)

(Superstructure)

- There is a risk of decreased strength due to rust.

Girder is H shape steel (Substructure)

- Flaking or damage to the brick.

(Bearing)

- None, Wood (Unstable), Steel (Rusty)

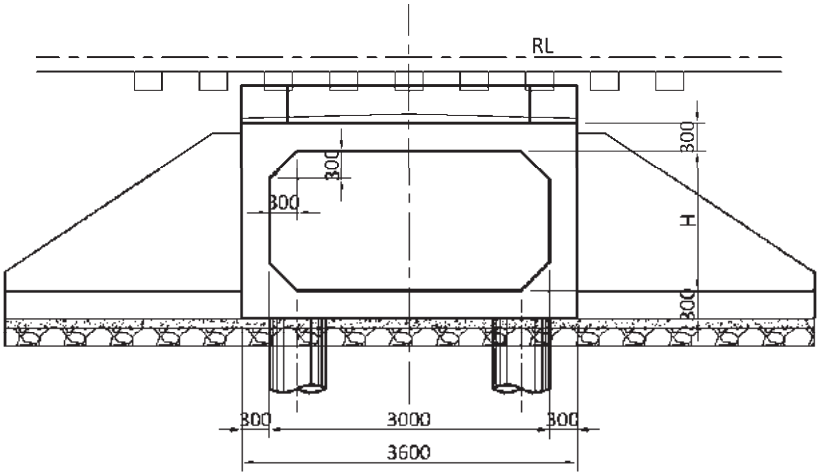
Since the superstructure has been severely degraded by aging, decreased durability of steel girders is assumed.

The brick substructure is damaged in part of the surface. If the axle load increases due to an increase in the number of passengers in the future, there is a risk of serious accident as the damage progresses.

In addition, there are no bearings in most bridges. Since it is an important structure for transmitting the load from the superstructure, bearings are required.

- The group with length less than 3m (B01, B04, B10, B13, B16)

Countermeasure: Replacement with a Box Culvert (W=3m)

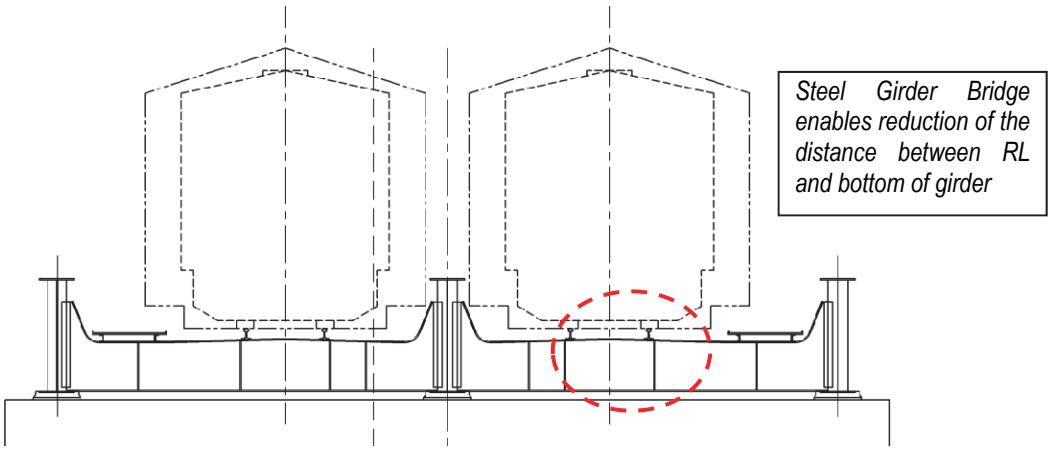


Source: JICA Study Team

Figure 4.6.19 Section of Box Culvert (W=3m)

- The group with length less than 15m (B05, B07, B08, B09, B11, B12)

Countermeasure: Replacement with Steel Girder Bridges (Through Plate Girder + RC Abutment) L=12m,15m



Source: JICA Study Team

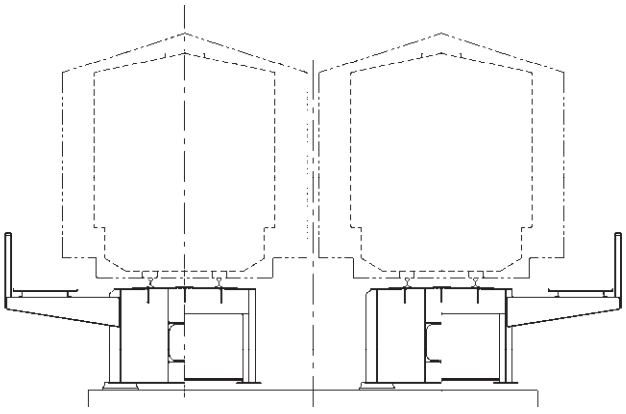
Figure 4.6.20 Section of Steel Girder Bridge (Through Plate Girder)

Source: JICA Study Team

Figure 4.6.21 Picture of Steel Girder Bridge (Through Plate Girder)

- The group with length more than 15m (B49, B52)

Countermeasure: Replacement with Steel Girder Bridges (Deck Plate Girder + RC Abutment) L=18m



Source: JICA Study Team

Figure 4.6.22 Section of Steel Girder Bridge (Deck Plate Girder)

Especially, the girder of B49 needs to be protected from salt by applying appropriate paint and use of weathering steel.

In addition, the elevation of the rails should be chosen to ensure that there is adequate clearance above higher high water level.

b) No Girder (B14, B15)

(Superstructure, Bearing)

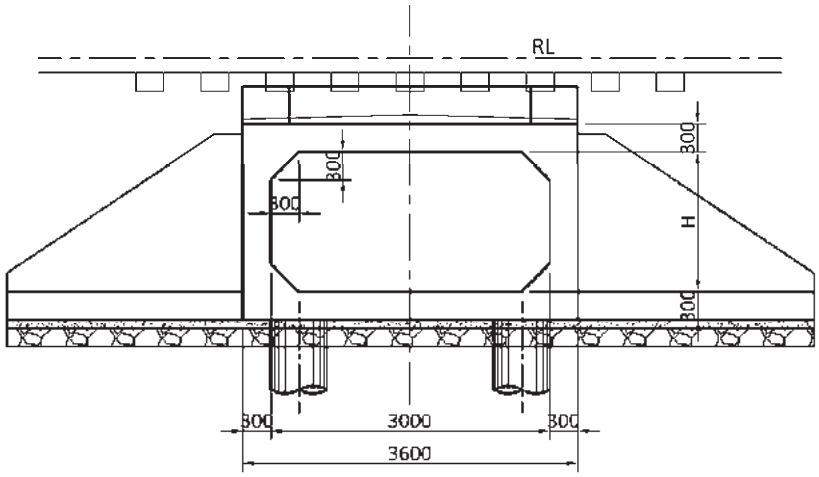
- None

(Substructure)

- Flaking or damage to the brick

The substructure is brick and has been damaged due to aging. There is a waterway around the bridge, it has been used as a domestic water. In order to cope with rising water during rainfall, a box culvert is to be installed to permit the flow of the water.

Countermeasure: Replacement with Box Culverts (W=3m)



Source: JICA Study Team

Figure 4.6.23 Section of Box Culvert (W=3m)

4) Construction Plan

Because Yangon circular railway is an important route, we recommend that construction should be carried out using a method that does not stop the train operation. Therefore, it is necessary to work on a single track at a time.

Construction plans that include detailed construction sequence shall be studied in the detailed design stage.

(4) Summary

Table 4.6.5 shows a summary of the improvement plan for each bridge on western half. In the future study, it is required that the structure inspection and evaluation of structure soudness should be carried out for the bridges on the eastern half section.

Table 4.6.5 Improvement List on the West Side of Yangon Central Station

No	Chainage	Improvement Method	Structure Type (After Improvement)
B01	1k462m	Replacement	Box Culvert
B02	4k165m	No-Measures	-------
B03	5k167m	No-Measures	-------
B04	8k113m	Replacement	Box Culvert
B05	8k404m	Replacement	Through Plate Girder Bridge
B06	9k573m	No-Measures	-------
B07	10k185m	Replacement	Through Plate Girder Bridge
B08	11k485m	Replacement	Through Plate Girder Bridge
B09	12k635m	Replacement	Through Plate Girder Bridge
B10	14k958m	Replacement	Box Culvert
B11	15k400m	Replacement	Through Plate Girder Bridge
B12	16k715m	Replacement	Through Plate Girder Bridge
B13	17k685m	Replacement	Box Culvert
B14	18k549m	Replacement	Box Culvert
B15	19k360m	Replacement	Box Culvert
B16	19k687m	Replacement	Box Culvert
B49	3k935m	Replacement	Deck Plate Girder Bridge
B50	2k450m	No-Measures	-------
B51	2k403m	No-Measures	-------
B52	0k955m	Replacement	Deck Plate Girder Bridge
B53	0k597m	No-Measures	-------

Source: JICA Study Team

4.7 Depot and Workshop

4.7.1 General

To operate railway system in safe, rolling stocks are required to maintain properly. Long term investment and regulation concerning rolling stock is planned and established at MR head-office. On the other hand, actual maintenance work is carried out at depots and workshops. The role and location of depot and workshop is as follows.

Depot and workshop for the project is considered to be utilized ones which will be constructed at IwaTha Gyi in the Yangon-Mandalay Railway project.

(1) Depot

1) Required Functions of Depot

Required functions of depot are as follows;

- Preparation of train in a yard,
- Regular light maintenance, inspection and repairing of rolling stocks,
- Refuel and water supply,
- Cleaning and washing,
- Preparation of driver and conductor.

Required facilities are as follows;

- Siding yard for arrangement of trains,
- Detective line with facilities of inspection and repairing,
- Train washing line,
- Line with devices for refuel and water supply,
- Managing office,
- Stand-by house of driver and conductor,
- Warehouse,
- Training facilities.

2) Depot Location Planning

The location of depot should be decided considering following points.

- For efficient train operation, depot should be located near the terminal. However, it should be considered the available land since the land price near the terminal is high.
- Approximately 8 – 10 ha is required for the depot if total number of rolling stocks which are maintained is 100 cars.
- The curve of tracks access to siding yard is sharp since one main line branches to some siding tracks.
- Since maintenance work is done at night, field workers live close to workspace, depot.

(2) Workshop

1) Concepts of Workshop

Regular heavy maintenance work is conducted at workshop. The heavy maintenance requires high-skilled staff and special facilities. For efficient management of human resources and facilities, all types of rolling stocks should be maintained at the same workshop even the characteristics of rolling stocks are different.

While rolling stocks are maintained, number of operating rolling stocks is decreased. Therefore, it is necessary to shorten the maintenance days. Also, it is very important how to manage adjustment of monthly maintenance schedule-program.

In workshop, rolling stock is separated to body and bogy, and resolved into parts. They are washed, detected and repaired. And then they are assembled and constructed to renewed rolling stock. At maintenance of M8, for maintenance, painting of body, exchange of passenger-sheet and diesel engine are carried out to overhaul.

Engineers are required to acquire the up-to-date knowledge and technicians are required to maintain skilled technic thought IT-engineering.

2) Location and Infrastructure of Workshop

Location and facilities for workshop should be decided considering following points.

- Workshop should be located near the main railway line to shorten “out of service running”.
- To maintain 200 rolling stocks, more than 10 ha of land are required for workshop.
- Process management is performed using computer technology.
- To wash rolling stocks, copious amount of groundwater is required. Sewage treatment plant is necessary to prevent environmental problems.

- Drainage facilities are required to drain adequately even in a heavy rain.
- Sufficient alternating current (AC) electric power should be supplied.
- Diesel fuel should be supplied constantly.

4.7.2 Current Condition

(1) Characteristics of new DEMU

Type of DEMU, Diesel Electric Multiple Unit, is under designing in this study and the detailed design for Yangon- Mandalay railway improvement project phase I.

Even DEMU consists of wear-resistant materials, it is necessary to make up practical and rational maintenance system. Table 4.7.1 shows technical specifications of proposed DEMU.

YCR's DEMU is for short distance commuter train with long benches and 6 or more doors. On the other hand, YM' DEMU is for long distance express train with reclining seat chairs, 4 doors, toilets and its water tanks.

Table 4.7.1 Technical Specifications for Proposed DEMU for YCR

No	Item	Description	
1	Type	Mc (containing driver's room)	M
2	Passenger capacity (person)	116(*1)	128(*1)
3	Length of car-body	19,500mm(*2)	
4	Width of car-body	2,770mm(*2)	
5	Height of car-body- roof	3,670mm(*2)	
6	Height of floor	1,130mm(*2)	
7	Distance of between coupler face	20,000mm(*2)	
8	Distance between bogy center	13,800m(*2)	
9	Maximum design speed	110km/h(*2)	
10	Maximum design acceleration	2.0km/h/s(*2)	
11	Maximum design deceleration	3.5km/h/s(*2)	

Note*1: They will be determined when Y-M DEMU dimensions are fixed.
Note*2: They will be as same as Y-M DEMU.
Source: JICA Study team

Development history of rolling stocks is improvement of safety, high speed running, riding quality and economic improvement of maintenance cycle. For these purposes designers and engineers progress as follows.

- By improvement of materials, rolling stock exchange to lighter weight and longer life span.
- Electronic devices bring non-connecting points and so that increase reliability.
- Using IT trouble monitor system corresponds to speedy finding of trouble.
- High lubricant brings decreasing of wear of parts.
- Analysis of maintenance data makes rational schedule.

(2) Site Selection of Depot

Considering the conditions of 4.9.1 (2), Insein Diesel Rail Car (DRC), Keemendine, Mahlwagone, Ywa Tha Gyi and HlawGa were nominated as candidate sites of depot. Table 4.7.2 shows comparison table of factors. From this table, it is assumed that Insein DRC is the suitable location for depot.

Table 4.7.2 Comparison of Nominated Site for Depot

No	Item	Insein DRC	Keemendine	Mahlwagone	Ywa Tha Gyi	HlawGa
1	Area 10hA	Satisfy	Satisfy			
2	Operation aspect	Driver & Crew depot is located at Insein.→Easy to start operation work. Stuffs can work for both existing DRC and new Depot. Evaluated as: A.	Need to prepare new Drover & Crew depot here. Evaluation as :B			
3	Necessity of land acquisition & resettlement	No land acquisition is required due to MR land. No resettlement is required because all buildings are for MR staff and these can be replaced beside of the site. Evaluated as :A	No land acquisition is required due to MR land.(to be confirmed) No resettlement is required Evaluated as :B			
4	Cost aspect	Lower (due to no new Driver & Crew depot, number of staff can be minimized.) Evaluated as :A	Higher Evaluated as :B			
5	Worker's living	Satisfy	Examine			
6	Save water	Satisfy	Examine			
7	Drainage	Satisfy	Examine			
8	Electric supply	Satisfy	Unknown			
9	Fuel supply	Satisfy	Unknown			
10	Total evaluation	Recommendable	More examination			

Source: JICA Study team

MR is planning to construct another depot infrastructure in the area of Insein DRC, therefore, it is possible that exist depot-site could transfer to DEMU depot.

Application 1 shows exit facilities of Insein DRC.

(3) Site Selection of new Workshop

The new workshop for DEMU for Yangon circular line and Yangon-Mandalay line will be selected near Ywa Tha Gyi station. Concrete feasibility study will be conducted in near future.

4.7.3 New Depot Plan

Planning diagram of YCR is shown in 4.2 'Train Operation Plan'. Based on the diagram, trains will be operated from early morning until evening. Therefore at night, there are always 12 trains of DEMU at Depot.

(1) Sewage

1) Calculation of Water Volume per day

Water volume for car washing per day W_1 :where volume from nozzle:$6\times10^{-4}m^3/s$, washing time: 30min/car, number of face of car:2, number of cars in train: 6, number of washing train: 4.

$$W_1=6\times10^{-4}\times30\times2\times60\times6\times4=54.3m^3/d$$

Drainage per day W_2: where $0.2m^3$/person, for 100 person,

$$W_2=0.2\times100=20\ m^3/d$$

Total Water volume *W* where leak percentage is 20%,

$$W=(54.3+20)\times 1.2=89.16\rightarrow 100\ m^3/d$$

2) Foundation and Roof

Size of sewage installation is: length 10m, wide 10m, height 10m.

Concrete foundation : length 10.1m, wide 10.1m, height 2m.

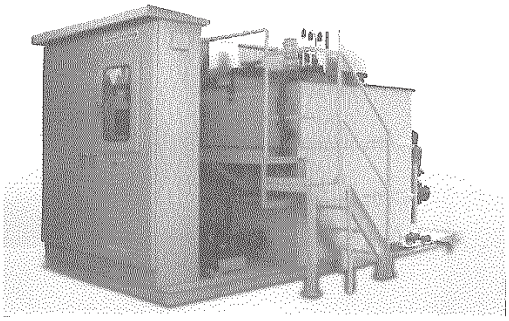
3) Reservoir for Sewage

It occurs by washing has volume is 1.5×100m3=150m3. And its measure is wide 5m×length 5m×height4m.

Duct from washing zone to reservoir has measure wide 0.3m×length 800m×height 0.34m.

4) Model of Sewage Plant for Depot (Type:J-TREAT /Figure 4.7.1)

This type is now using at depot in Japanese for 100m^3/d. This type treats multiply oil, COD/BOD, heavy metal by adding salt and electrical resolution in drainage.

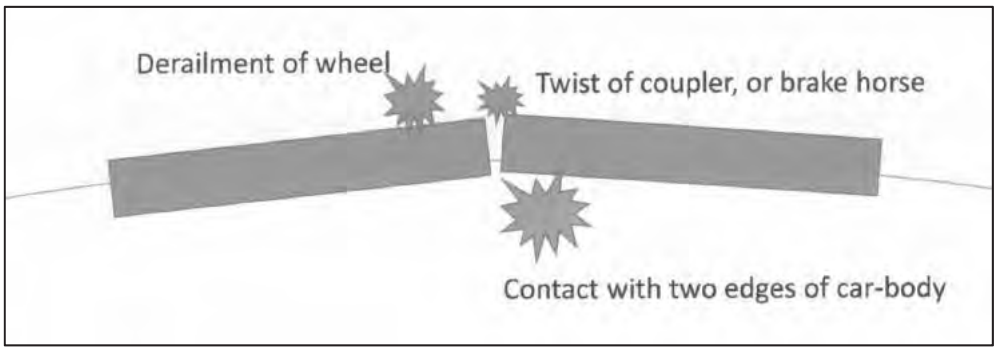


Source: Hidetoshi HUNAKI, Development of electrolysis-drain-water treatment,R&M, Feb. 2008

Figure 4.7.1 Model of Sewage Plant for 100 m^3/d

(2) Improvement of Track Radius at Tight Curve

- If radius of track is too short, it is fearful for danger phenomena such as derailment, contact edges of car-body-corner and twist of brake hose-connector as shown in Figure 4.7.2.
- Test run was conducted using 2 existing REBs on the tracks in the Insein DRC to check whether the horizontal alignment of the existing tracks of smaller radius (track No. 1~4) is suitable for the newly introduced DEMU.
- This testing plan was implemented at Insein DRC on 11. August 2014 by DRC stuffs and JICA Study Team.
- Two coupled REBs ran repeatedly from entrance gate to main building through each track. Fortunately, these above dangerous phenomena were not occurred. However, at the No. 4 line, scraped noise occurred between rail and wheel, measurement between each other's body-corner was decreased under 50% of 500 mm. So we measured the radius, it was 70m. Considering the result of test run, the radius should spread to over 100 m.



Source : JICA Study Team

Figure 4.7.2 Danger Phenomena at Tight Curve

(3) Storage Siding of Train

Trains are waiting for next day diagram-schedule with connecting 6 cars.

The capacity of storage siding at Insein DRC will be satisfied for future 14 trains, by using existing 11 lines fully.

(4) Fuel Supply Treatment

1. Number of fuel pump units (0.5kW) is 3 sets for 6 cars of DEMU.
2. 3 oil tank (10,000 gal) in outside are set, where location is the same at present.
3. Length of oil hose is 122×1.2→150m, when allowance is 20%.

(5) Mechanical Facilities

1. 1 ceiling crane (5 ton), 1 ceiling crane (10 ton) and 1 table jack are set.
2. Wiring of cranes (300m) and a power distribution panel are set。
3. 4 electric lifting-jacks (8 ton) are set.
4. 2 air compressors (air cooler screw type 0.2 kW) are set.
5. 2 electric welding machines (AC arc type) are set.
6. 2 fork-lifts (maximum load 1 ton, maximum lift scale 3 m) in Figure 4.7.3.
7. 2 pumps (0.5kW) to discharge water in pits.

Source: Takahiro, YAMAKAWA et al, Infrastructure for new quake-resistant at Nagoya Workshop of JR-central, JREA, July 2014

Figure 4.7.3 Fork Lift Truck

(6) Electrical Facilities

MR will supply electrical power 500 KVA each to new depot and existing depot.

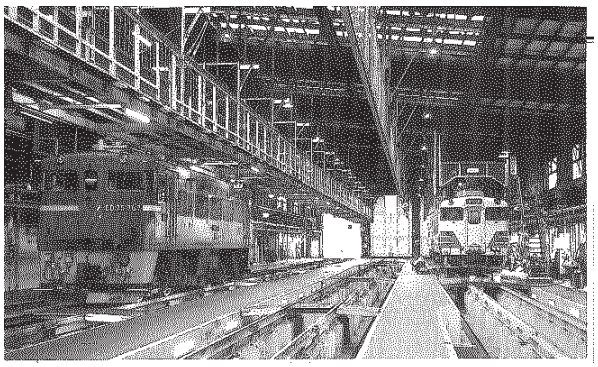
1. LED lighting in main building:

   LED lighting 20 sets for outer side pillar, 2 sets inner side pillar;(outer side 2×20)+(inner side2×2×20)=120.

2. Wiring of LED:(6×120)×1.2→870m and distributer.
3. Mercury light on ceiling: the main building is composed of 3 structures to north and south direction. When each beams of structure 10 sets are set, total number of light is 3×10=30.
4. Wiring of Mercury lighting: (3×120)×1.2→400m and distributer.
5. Number of fluorescent light in pit: (inspecting pit is 3 lines)×(2 sides of pit)×(40 for a line)=240. Figure 4.7.5 shows an example of fluorescents in pit in Japan.
6. LED lighting
7. Another LED: 10 at office, 10 at shower room, 30 at dining room, total 110.
8. 10 Air conditioner at office.
9. 40 Mercury lighting at outside.
10. 2 Iron towers of 10 m height at outside. Figure 4.7.6 shows is an example of lighting tower in Japanese Depot of DMU.
11. For diesel engine smoke ventilation which are installed at the wall of north and south side of main building, each 3 sets. Total 3×2=6 sets.
12. 2 Battery (24 V) chargers.

Source: JICA Study Team

Figure 4.7.4 Exist Lighting in Main Building of DRC



Source: Weekly JR depot No.35, Asahi Press, 14th April 2013

Figure 4.7.5 Lightning in Pit

Source: JICA Study Team

Figure 4.7.6 Lighting Tower

Trial calculation of electric power capacity is shown in Table 4.7.3.

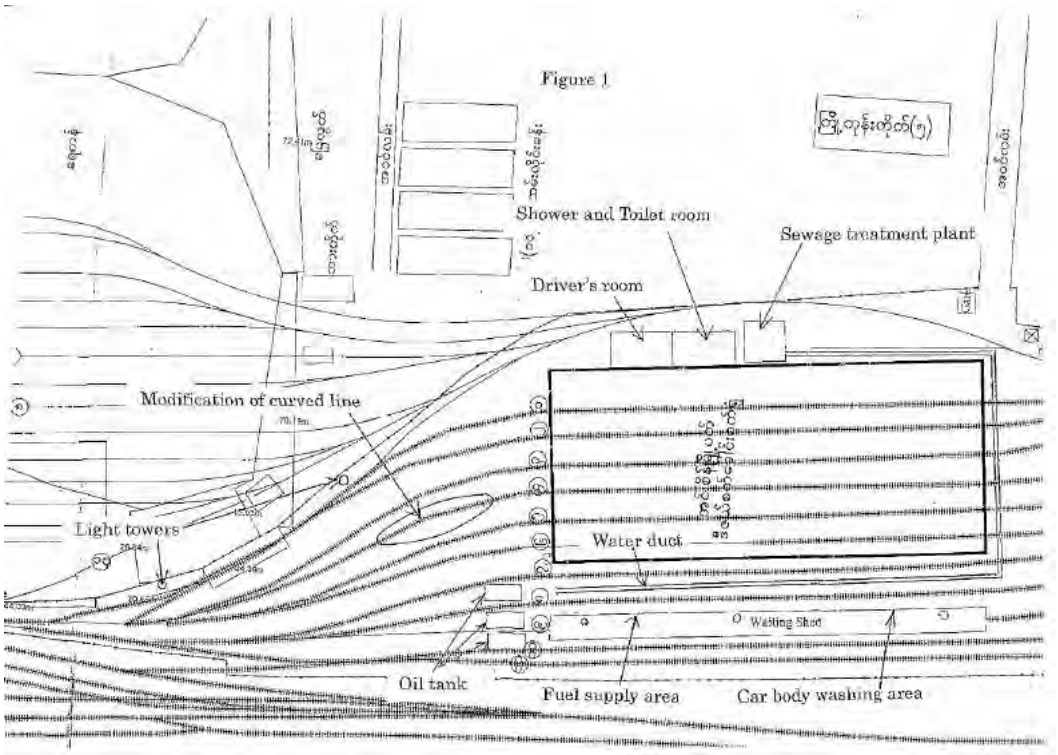
Table 4.7.3 Trial Calculation of Electric Power

No	Item	Power capacity (kW)	Operation rate(%)
1	Florescent lighting in main building	20	50
2	Mercury lighting in main building	20	50
3	Florescent lighting outside	10	50
4	Florescent lighting at pit	50	30
5	Mercury lighting at tower	100	42
6	Florescent lighting in office	20	50
7	Hot water supply in office	20	10
8	Air conditioner in office	20	60
9	Crane	10	5
10	Lifting jack	20	5
11	Compressor	10	10
12	Testing device	2	5
13	Pump for washing	5	10
14	Signal	5	60
15	Pump for well	10	50
16	Battery charger	10	30
17	Other margin	20	10
	Simple total	352	-

Source: JICA Study Team

(7) Main Building

1. Main building is already over 50 years old. Roof and wall are broken and floor is damaged. Reconstruction is necessary. Its area is 120m×60m=7,200m^2.Out-line plan is shown in Figure 4.7.7.
2. Cross section of new pit is shown in Figure 4.7.8.
3. Drivers- rest room, shower room and toilet are constructed west side of main building.



Source: JICA Study Team

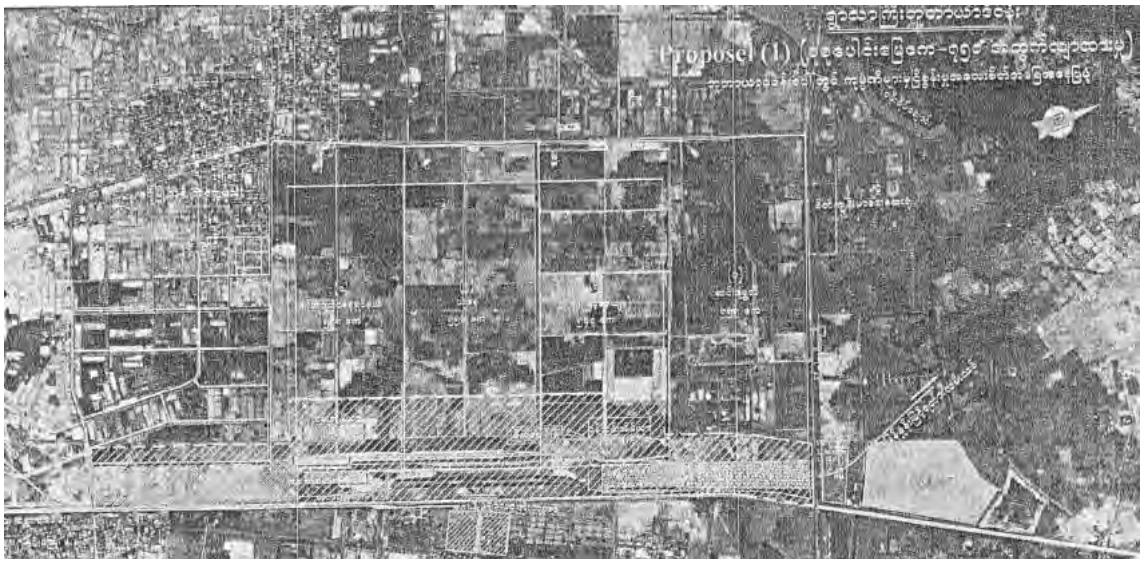
Figure 4.7.7 Outline-Plan of Insein DRC

4.7.4 Workshop Plan

(1) Site of Workshop

MR has a plan to build workshop for YCR and YML near Ywa Tha Gyi station.

The planning map of Ywa Tha Gyi station is shown in Figure 4.7.8. Detail design is not yet made a determination.



Source : Myanma Railway and Google map

Figure 4.7.8 The Planning Map of Ywa Tha Gyi

1) Facilities of Workshop

Facilities for maintenance work are followings;

- Moving of body and bogy: ceiling crane, lifting-jack.
- Inspection and tester: non-destruction inspection of axle, tester of engine power, tester of electrical parts, tester of braking performance, wheel load balance, etc..
- Processing machine: lathe of wheel, multipurpose lath, drill, welding machine, etc..
- Washing and paint: bogy washing plant, body paint, bogy paint.
- Plenty of water is draw up from well for washing body, bogy and parts.
- Sewage contained oil, rust and dust has to treat to clear before discharging.
- At the heavy rain in a short time, not submergence drainage is performed adequately.
- Adequate high pressure electric power is supplied.
- Diesel fuel is constantly supplied.
- Wide road for truck is constructed.
- Protection for vibration and noise of engine power tester.
- Managing office, ware house and stuff's room.

2) Difference Concerning Maintenance Work between YCR and YML

It is clear that frequency of driving and braking for commuting train is higher than that of express train. Therefore the wear-quality of parts for commuting train should be better than that of express train. Express train is not required high tractive effort and frequent braking.

Table 4.7.4 shows the comparison between YCR and YML. Stopping average distance per number of stations YML 1.14 km is smaller than that of YML 51.7 km. Therefore items in followed from No.3 to Mo.8 are different between YCR and YML. This is very important for the maintenance schedule in workshop. For instance, in the case of YCR, maintenance-days is longer and maintenance-quantity is higher than that of YML.

Table 4.7.4 Comparison of DEMU for YCR (West) and YML

No.	Items	DEMU for YCR (West)	DEMU for YML
1	Train style	Commuting	Express
2	Stopping average distance per number of stations	Short 24km/21=1.14km	Long 620km/12=51.7km
3	Frequency of acceleration, braking and opening/closing of door per hour	Many	Few
4	Facilities for passenger	Long sheet and lot of doors	Reclining-sheet and few doors
5	Dirtiness by using	Many	Few
6	Quantity of wear and tear of rolling parts	Many	Few
7	Processing work	Many	Few
8	Preparation of spare parts	Many	Few

Source: JICA Study Team

(2) Present indispensable equipment and future necessary equipment for Depots and a Work Shop

It is proposed for the present indispensable equipment and future necessary equipment for Depots and a Work Shop to enable the safe and stable operation of the train with DEMU and DMU as it should be performed as MR side responsibility matters.

The management of maintenance system for DEMU and DMU are as follows.

1) Plan of MR: Vehicle allocation and its inspection and repair type

Table 4.7.5 shows the vehicle allocation, its inspection and repair type. Number of allocated vehicle is unknown.

Table 4.7.5 Vehicle allocation and their inspection and repair type

Depot/ Work Shop	Location	Type of Inspection and Repair	Number of allocated vehicle	Line
Depot	Insein existing	M1 of DEMU	Unknown	YCR
	Insein new	M1 of DMU	Unknown	YCR
	Ma Hlwa Gone	M1 of DEMU and DMU	Unknown	YCR, YML,Other
	Ywa Tar Gyi	M2～M6 of DEMU and DMU	Unknown	YCR,YML,Other
Work Shop	Ywa Tar Gyi	M7～M8 DEMU and DMU	Unknown	YCR,YML,Other

Note: YCR: Yangon Circular Rail; YML: Yangon Mandalay line.

It is also possible to describe from Table1 for DEMU and DMU of YCR line that M1 is performed each in Insein Depot, Ma Hlwa Gone Depot, M2 ~ M6 are performed by aggregating in Ywa Tar Gyi Depot. M7 ~ M8 are performed by aggregating in Ywa Tar Gyi WS. This detailed plan is designed by the JICA Yangon-Mandalay team. RBE-WS where adjoins Yangon Station will move to Ywa Tar Gyi Depot and WS.

Source : JICA Study Team

Figure 4.7.9 Location of depots and a Work Shop

2) Number of cars

Number of cars in Yangon circular Railway is shown in Table 4.7.6.

Table 4.7.6 Number of DEMU and DMU

	Number of cars
DEMU	(6 cars×11 trains) 66 cars
DMU	186 cars
Total	252 cars

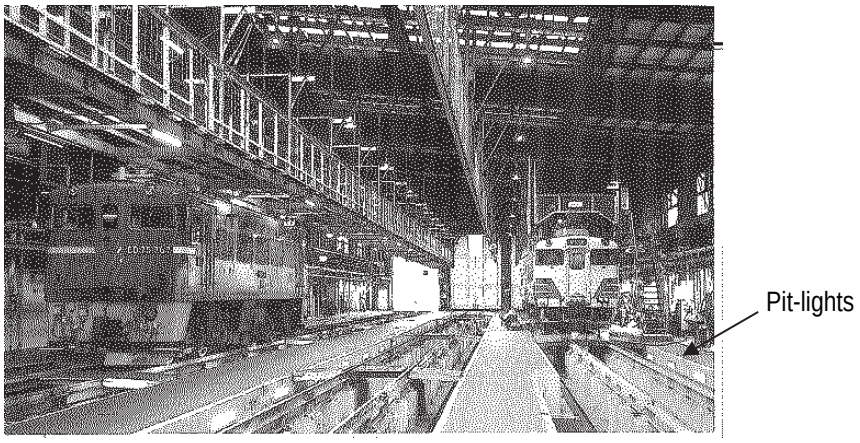
Source : JICA Study Team

3) Suggestions about equipment

a) *The present indispensable equipment* those in facility planning to add to the plan in Insein- Depot.

- It is important that MR should estimate the electric power of nighttime and supply it sufficiently, because main working of Depot is performed always at night.
- Diesel-engine, generator, motor, controller, oil tank etc. of car are installed all under car- floor. To check and repair for M1, it requires adequate lighting for underfloor.

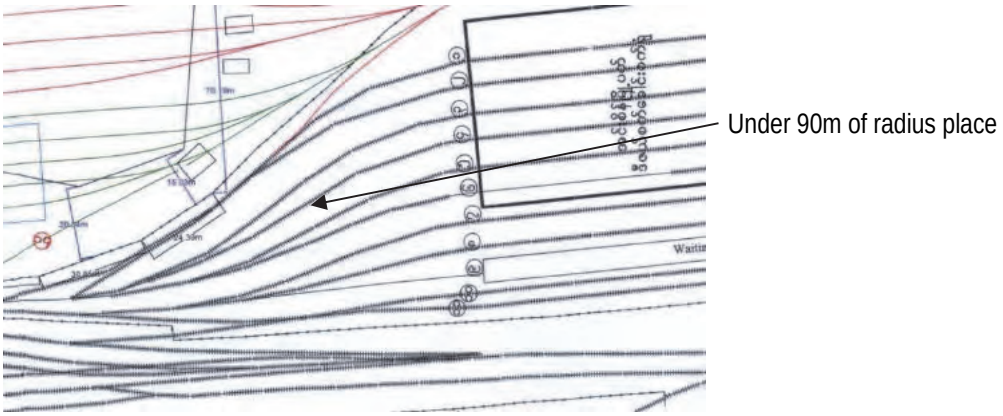
JR uses pit-lights which are showed in Figure 4.7.10.



Source : JICA Study Team

Figure 4.7.10 Pit-lights at JR-depot.

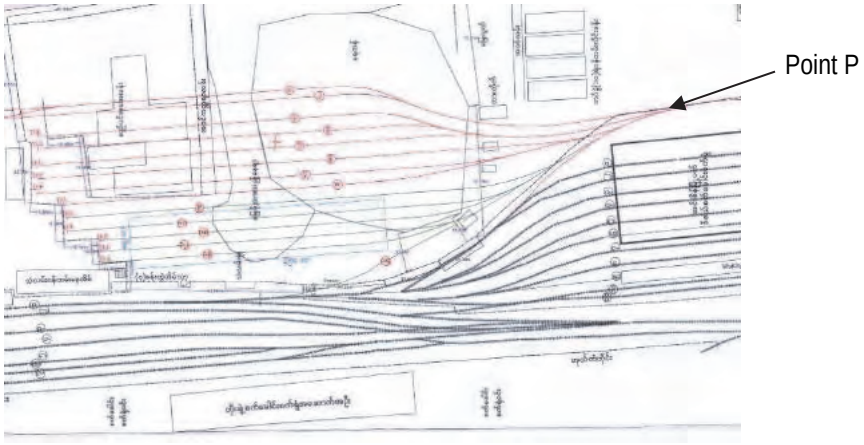
- Refueling of diesel oil and water supply are carried out under the car-floor, it is necessary to set lighting beside oil tank. An example of Japan is shown in Photo 2.
- Charging device for vehicle batteries is required.
- Powered ventilation on the roof or on the side wall of building are required, because one train is installed 6 engines, when a driver set in the engines, the building is filled with smoke.
- This time ATS is installed in train, so ATS-tester is necessary to confirm ATS-function at M1.
  Entry and exit of the traffic signals are necessary for the safety of in and out of train.
- More than 90 m of curve radius of track for the train of DEMU or DMU to safely run in the Depot yard, it is necessary to keep the curve radius more than 90 m. In 2014, JICA team checked track curve in a state of running DMU, and found less than 90 m of radius at number 4 line as showing in Figure 4.7.11. When radius of track is under 90 m, there will be danger to derailment of wheel from rail, particularly at the dry condition.



Source : JICA Study Team

Figure 4.7.11 Under 90m place near old building

- Point P
  Red lines in Figure 4.7.12 are construction lines for a new building and a new yard. As we admit, point P is a neck point. Many trains run through on this for shunting. We hope MR set here a strong switch and do always maintenance in good condition.



Source : JICA Study Team

Figure 4.7.12 New plan of Insein Depot

b) Future necessary equipment those in facility planning to add to the plan in Insein-Depot.

- Tower lighting in yard.
  It is necessary for the safety in the night.
  Figure 4.7.13. shows two examples of the tower lighting in the service area of the highway between Yangon and Naypyidaw and Japanese DMU Depot.

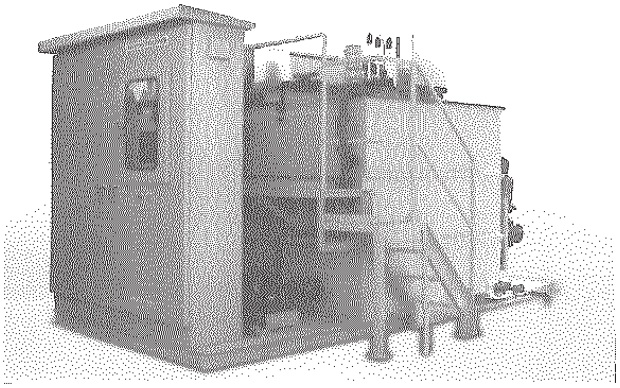
Lighting tower at the service area of route in Myanmar.

Refuelig device.↑　↑Lighting Tower.
At Japanese DMU Depot, Kanto Tetsudo

Source : JICA Study Team

Figure 4.7.13　Examples of tower lighting

- Sewage treatment equipment is required for oil, dust, cleaning water to environmental protection. A compact model is shown in Figure 4.7.14.



Source : JICA Study Team

Figure 4.7.14　A model of sewage plant for 100 m^3/d

- Shower facilities for body of worker
  It is necessary for the health condition of worker.

4)　The opinion on vehicle maintenance plan of Yangon circular railway of MR

a)　Summarizing of M2～M6

It is highly evaluated that MR arranges light maintenance M1 each at Insein Depot and Ma Hlwa Gone Depot, and that MR brings together M1～M6 at Ywa Tar Gyi Depot, because it is possible to keep technical group capacity of worker, effective application of facilities, economical preparation of spare parts. And also, it is convenient that Ywa Tar Gyi Depot is close to Ywa Tar Gyi WS.

b) Opinion about maintenance interval system

In this project uses MR time-base maintenance interval, namely M1 ～ M8. JICA Mandalay-team proposes time-base or kilo-base plan which is using in lots of country. Japanese regulation of maintenance interval is shown in Table 4.7.7.

Table 4.7.7 Japanese regulation of maintenance interval system

Level	Interval: time-base or kilo-base
Daily Inspection	Within 6 days or 2,000km
Monthly Inspection	Within 3 months or 30,000km
Semi overhaul	Within 4 years or 500,000kl
Overhaul	Within 8 years

Source : JICA Study Team

In the era of the steam locomotive, every part was easy to wear. However, as modern vehicles are improving lubricity of the wear parts, and are made by lighter and stronger material; maintenance working quantity is decreasing.

5) Maintenance difference between "commuter train" and "limited express train" at the same maintenance interval.

DEMU of Yangon Circular Railway (commuter train) has character: many frequency of starting and stopping, door-treatment repeats frequently to open and to close.

DEMU of Yangon and Mandalay Line (limited express train) has another character: constant high speed running, not so many times of starting and stopping, door-treatment is few time to open. Table 4.7.8 shows the comparision of two types of trains.

At making the maintenance schedule of DEMU at Depot and WS, it is important to consider above differences.

Table 4.7.8 Comparison of DEMU for YCR (West) and YML

No.	Items	DEMU for YCR(West)	DEMU for YML
1	Train style	Commuter	Limited Express
2	Stopping average distance per number of stations	Short 24km/21=1.14km	Long 620km/12=51.7km
3	Frequency of acceleration, braking and opening/closing of door per hour	Many	Few
4	Facilities for passenger	Long chair and many doors	Reclining chair and few doors
5	Dirtiness by using	Many	Few
6	Quantity of wear and damage of rolling parts	Many	Few
7	Processing work	Many	Few
8	Preparation of spare parts	Many	Few

Source : JICA Study Team

4.8 Safety Systems

4.8.1 Current Condition of Safety Systems

(1) Signalling system

1) Block System and Signals

An automatic block coloured light signal system is applied for the entire Yangon Circular Railway. As for the main signal, there are two kinds of signals. Two aspect main signals and three aspect main signals are intermingled. Some of the nine small stations have no Home Signal and two stations have no Starting Signal. Many main signals were broken down.

Source: JICA Study Team

Figure 4.8.1 Wayside signal

2) Interlocking Equipment

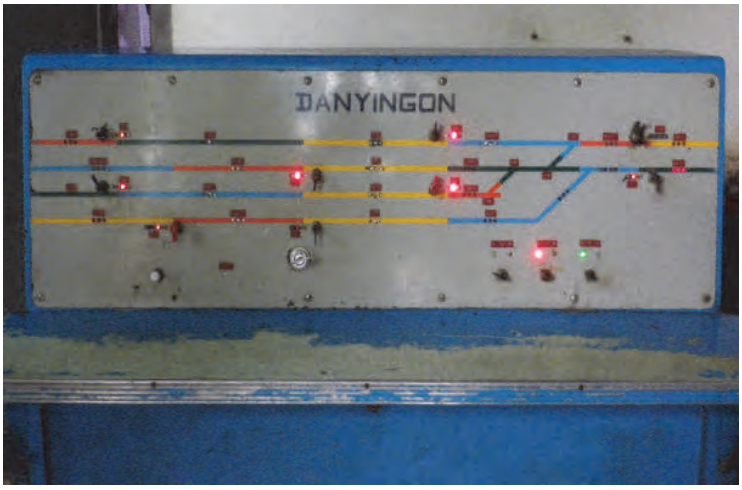
The five main large stations (Kyee Myint Daing, Insein Dan Nyin Gone, Mingaladon and Paywetseikone) have interlocking equipment. The results of an investigation of interlocking equipment are as shown in the Table 4.8.1.

Table 4.8.1 Interlocking Equipment of Five Stations

	Kyee Myint Daing	Insein	Dan Nyin Gone	Mingaladon	Paywetseikone
Method	Electro Mechanical Interlocked Color Light Signal	Relay Interlocked Color Light Signal	Relay Interlocked Color Light Signal	Relay Interlocked Color Light Signal	Relay Interlocked Color Light Signal
Manufacture Company Country	Westing House U.S.A	Goldstar Korea	Siemens Germany	Siemens German Kyousan Japan	Siemens German Kyousan Japan
Install year	1950	1994	1970	2000	2000
Main signal	13	16	9	7	7
Shunting signal	6	21	0	0	0
Point	21	35	5	4	6
Track circuit	6	27	18	13	20
Route	5	6	4	16	16

Source: JICA Study Team

All interlocking equipment in the large stations is very old and there are no spare parts. Maintenance of the interlocking equipment is not fully performed.



Source: JICA Study Team

Figure 4.8.2 Interlocking System of Dan Nyin Gone Station

3) Track Circuit

Direct current track circuit system is used for all Yangon Circular Railway. The track circuit is unstable and there are many places that experience trouble. Especially, the track circuit in flooded area does not work.

Source: JICA Study Team

Figure 4.8.3 Track Circuit

4) Level Crossing

There are eleven level crossings in the investigated section. At all level crossings, two gate watchmen are stationed and they close or open the level crossing gate. When the gate watchman finish closing the gate, the limit switch works automatically, the Gate Signal information is sent to the signal and there is a change in the aspect of the signal from ”R” to “Y”.

At interlocking station, the gate signal information turns on the indicator light on the interlocking system panel.

Source: JICA Study Team

Figure 4.8.4 Level Crossing

5) Power Supply for Signal System

It is necessary to supply the electric power to the signal system. The present power distribution line for the signal system is very old. The signal system can't get stable electric power. It is impossible to reuse this power distribution line in the future.

(2) Telecommunication System

1) Telecommunication Line

The telecommunication line is built with metallic cables and runs through a telephone exchange. Each station has an auto phone which connected with this line. The quality of line is bad, so they almost never use the auto phone.

2) Dispatcher Phone

There is a wireless network system which uses a VHF band (160MHz). The handset is a press to talk type system. It is not a bi-directional communication system. The station master reports the arrival time and departure time of trains to the OCC with this press to talk handset. The auto phone is not used for reporting.

3) Block Phone

Each interlocking station has a block phone to secure the block section between its own station and the next station.

Source: JICA Study Team

Figure 4.8.5 Auto phone, Dispatcher Phone and Block Phone

4.8.2 Signalling Improvement Plan

The scope of signalling improvement plan shall be 44.1 Km total length except the Yangon Central and Pazundung station's yards. One borderline shall be 0K600m between Ynagon Central and next Phaya Rd station. Other borderline shall be 1k400m between Pazundaung and next Malwagone station.

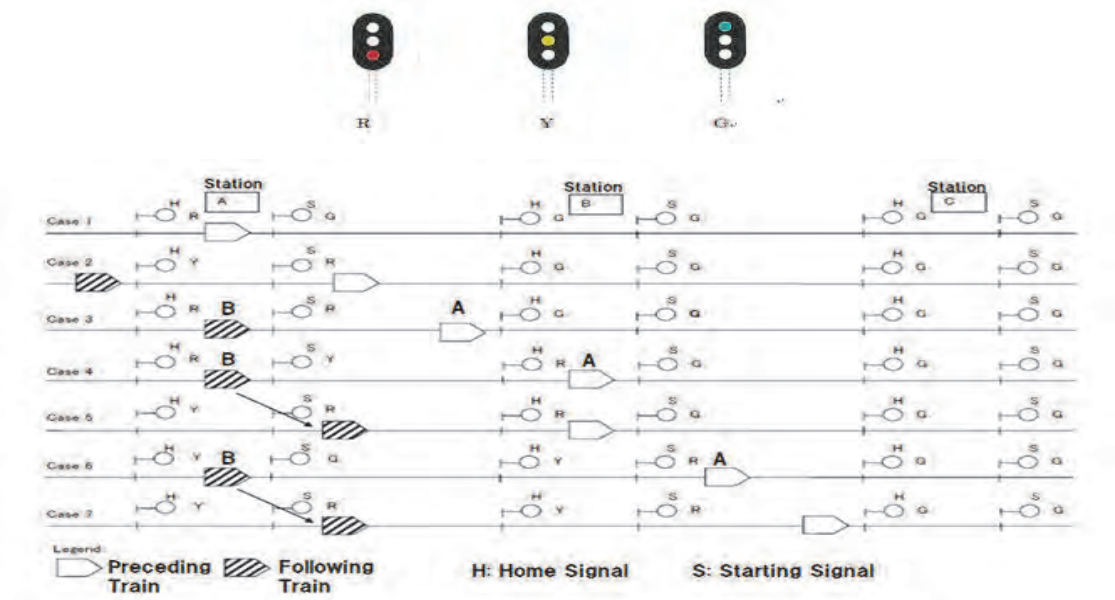
At this time, while planning the improvements, following points are considered.

- The most important thing is how to secure safe railway operation.
- Considering what kind of system fits the high-speed and high-density operation.
- Basic principles of the existing system are adapted so that maintenance can be performed easily.
- System with a track record of high reliability should be adapted.
- Newest technology that is helpful also for the future should be adapted.
- Consider what kind of system fits the Myanmar Railway and Nation.
- In repairing the Yangon Central Interlocking system, the compatibility of a Japanese Grant Aid Project should be considered.

(1) Signalling System

1) Block System and Signal

The block system shall be an automatic block system and shall be installed with coloured light signals. The signal systems have three aspects (R, Y and G).



Source: JICA Study Team

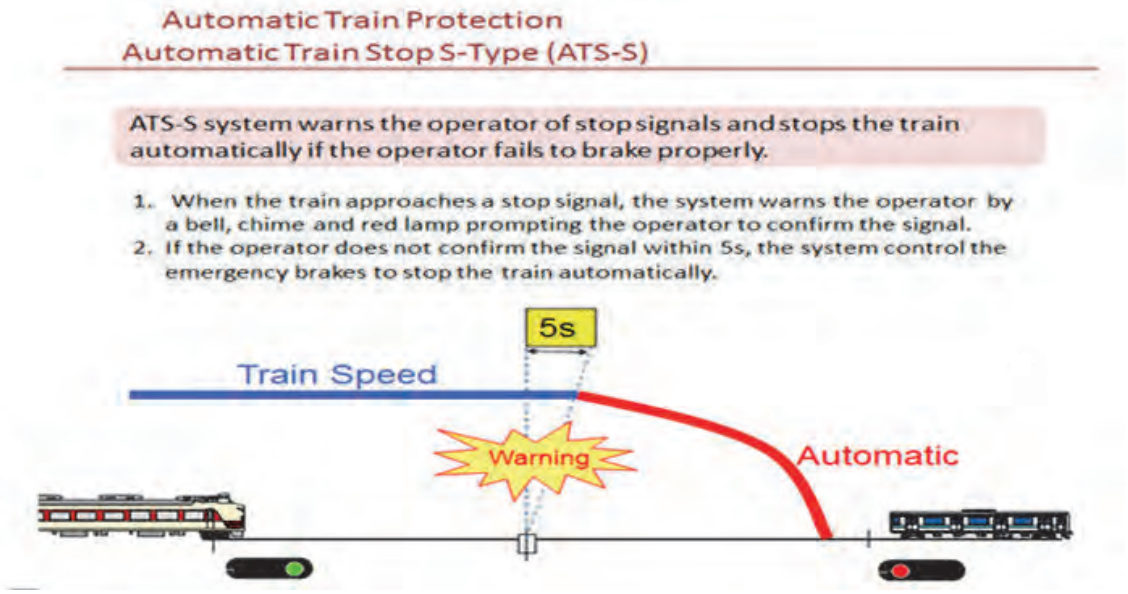
Figure 4.8.6 Automatic Block Signal system (3 aspect)

This auto block coloured light signal system can shorten the train intervals. Case 5 shows that the following train can enter the protection area of the starting signal.

2) Automatic Train Stop (ATS) System

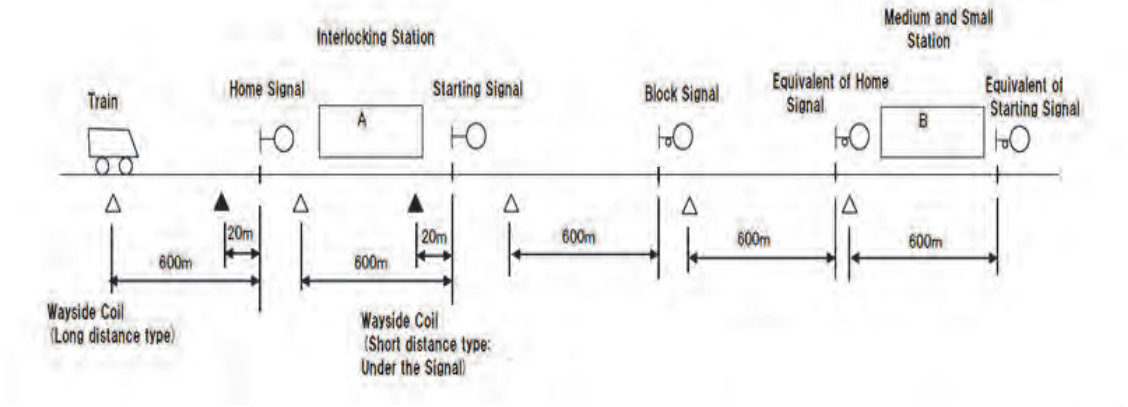
We recommend adopting an ATS system for Yangon Circular Line. An ATS system can prevent accidents which occur due to neglecting a signal.

If the train driver ignores the "R "aspect (Stop sign) of a signal, the train brakes work automatically and train stops unless the train driver pushes the confirmation button within 5 seconds.



Source: JICA Study Team

Figure 4.8.7 Function of ATS System



Source: JICA Study Team

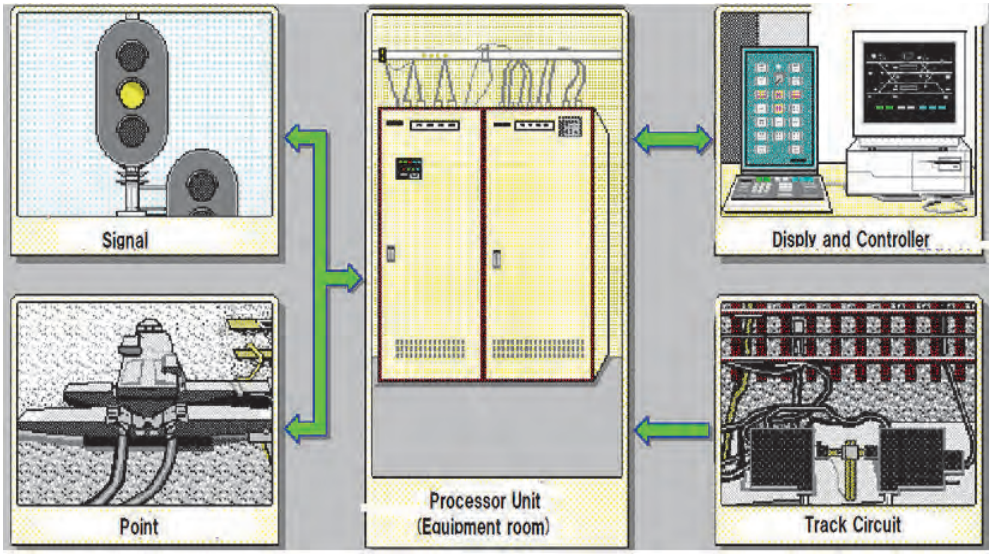
Figure 4.8.8 Configuration of ATS wayside Coil

3) Track Circuit system

The track circuit equipment is obsolete. Many of the track circuits do not work. Track circuits are very important equipment for the signal system and train operation. All present track circuits shall be replaced. Track circuits shall be Direct Current (DC) Track Circuit systems.

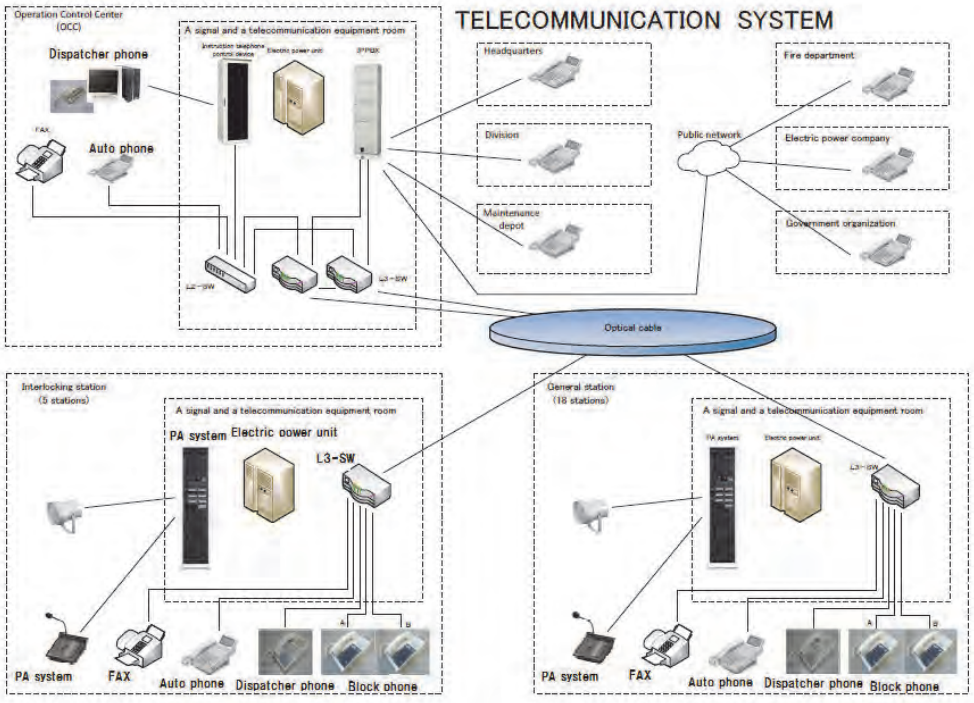
4) Interlocking system

The interlocking system shall be replaced for five interlocking stations, , Kyee Myint Daing, Insein, Dan Nyin Gone. Mingaladon and Paywetseikone. The new interlocking system shall be an electric interlocking system. The interlocking system shall be a Route selecting type.



Source: JICA Study Team

Figure 4.8.9 Configuration of Electric Interlocking System



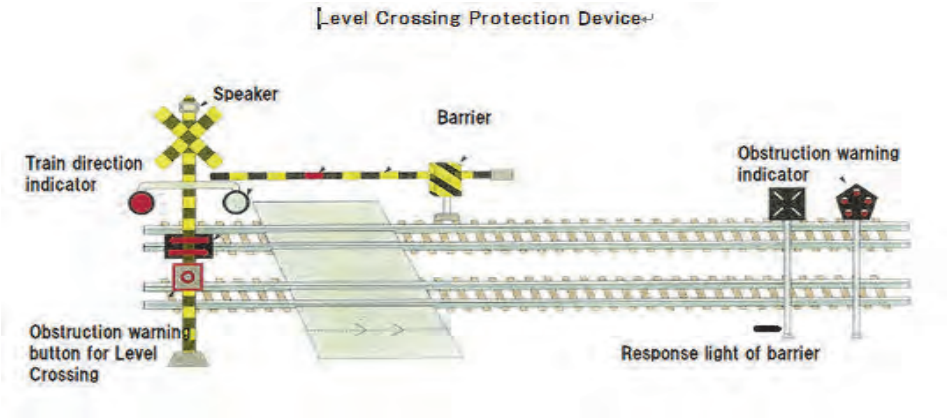
Source: JICA Study Team

Figure 4.8.10 Configuration of Telecommunication System

4.8.3 Level Crossings

Level Crossings shall be replaced with new class 1 Level Crossing systems. There are twenty seven (27) Level Crossings in Yangon Circular Line.New Level Crossings will have response light barriers instead of the existent gate signal. The train driver can confirm the complete gate closing with this response light barrier. In the case of an obstacle on the level crossing, the gate watchman pushes the obstruction warning button and the obstruction warning indicator is activated.

Standard warning time is 30 seconds, but it is adjustable by the position of the electronic train detector. The position of the electronic train detector shall be decided by train speed, traffic, and others.



Source: JICA Study Team

Figure 4.8.11 Configuration of Level Crossing

4.9 Power Supply

4.9.1 Current Condition

(1) Power Receiving Equipment

Stations of Yangon circular railway receive electric power from Yangon City Electricity Supply Board (YESB) as shown in Table 4.9.1. In the principal stations, e.g. Yangon Central and Insein, 6.6kV or 11kV transformers are installed. The transformers supply the low voltage electric power to the lightings in the stations and the signal equipment. The small stations receive the electric power from the low voltage power distribution line of YESB. Figure 4.9.1 shows the transformer of Da Nyin Gon Station and the low voltage power distribution line of Aung San Station. The electric power equipment of Yangon Circular Railway has become too old for work as shown in these figures.

Table 4.9.1 Electric Power Supply of Yangon Circular Railway

No.	Station	Electrical Supply		Power Supply for Signal	Power Supply
		Single Phase 230V	Three Phase 400V		
1	Yangon Central Station		○	○	From YESB 1000kVA Transformer
2	Payar Lan Station	○			
3	Lanmadaw Station	○			From YESB Power Line
4	Pyay Lan Station	○			From YESB Power Line
5	Shan Lan Station	○			From YESB Power Line
6	Ahlone Station	○			From MR 500kVA Transformer
7	Panhlaing Station		○		From YESB Power Line
8	Kyee Myint Daing Station		○	○	From YESB 750kVA Transformer
9	Hanth waddy Station	○			From YESB Power Line
10	Hledan Station	○			From YESB Power Line
11	Ka Ma Tut Station	○			From YESB Power Line
12	Thirimyaing Station	○			From YESB Power Line
13	Oak Kyin Station	○			From YESB Power Line
14	Thamine Station	○			From YESB Power Line
15	Thmaing Myothit Station	○			From YESB Power Line
16	Kyaoe Gone Station	○			From YESB Power Line
17	Insein Station/Depot		○	○	From MR Insein Locomotive Workshop Transformer
18	Ywar Ma Station	○			From YESB Power Line
19	Phawkan Station	○			From YESB Power Line
20	Aung San Station	○			From YESB Power Line
21	Da Nyin Gon Station		○	○	From MR 100kVA Transformer
22	Golf kwin Station	○			From YESB Power Line
23	Kyaik ka lel Station	○			From GE(Military) Power Line
24	Min galadan zay Station	○			From YESB Power Line
25	Min galardon Station	○		○	From YESB Power Line
26	Wai bar gi Station	○			From YESB Power Line
27	Oakkalapa Station	○			From YESB Power Line
28	Pa ywet sate kone Station	○		○	From YESB Power Line
29	Kyauk yae twin Station	○			From YESB Power Line
30	Ta dar ka lay Station	○			From YESB Power Line
31	Yae kuu Station		○		From YESB Power Line
32	Parami Station		○		From YESB Power Line
33	Kan bel Station		○		From MR's 300kVA Transformer
34	Bauk htaw Station		○		From YESB Power Line
35	Tar mwe Station	○			From YESB Power Line
36	Myittar nyunt Station	○			From YESB Power Line
37	Ma Hlwa Gone Station		○		From YESB 1000kVA Transformer
38	Pa Zun Taung Station		○	○	From YESB Power Line

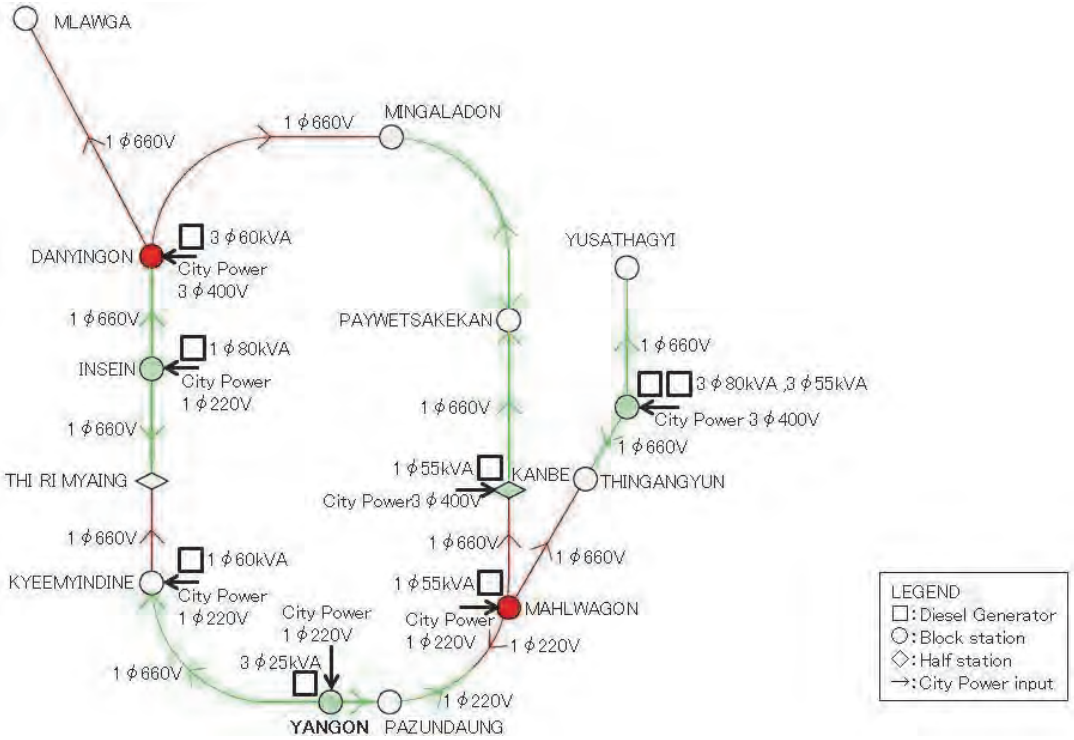
Source: JICA Study Team

Source: JICA Study Team

Figure 4.9.1 Old Transformer and Old Low Voltage Power Distribution Line

(2) Electric Power Distribution Line for Signal

AC 660V underground power distribution lines for signal equipment are installed along the railway. Figure 4.9.2 shows the system diagram of the power distribution line for the signal equipment. The bases of these power distribution lines are Yangon Central Station, Kyee Myint Daing Station, Insein Station, Da Nyin Gon Station, Kanbe Station and Mahlwagon Station. In these stations, step-up transformers, which convert AC 230V into AC 660V, and emergency generators are installed. Figure 4.9.3 shows the step-up transformer and the emergency generator. These devices also have become too old for work.



Source: JICA Study Team

Figure 4.9.2 System Diagram of Power Distribution for Signal Equipment


Source: JICA Study Team

Figure 4.9.3 Step-up Transformer and Emergency Generator

(3) Load System

The low voltage power distribution line in the station supply electric power to the lightings, the lift pumps, the railway worker houses, etc. Figure 4.9.4 shows one example of the station lighting. The lightings are too old for work. It is dark in the stations because there is little number of the lighting.

Source: JICA Study Team

Figure 4.9.4 Old lighting in Phawkan Station

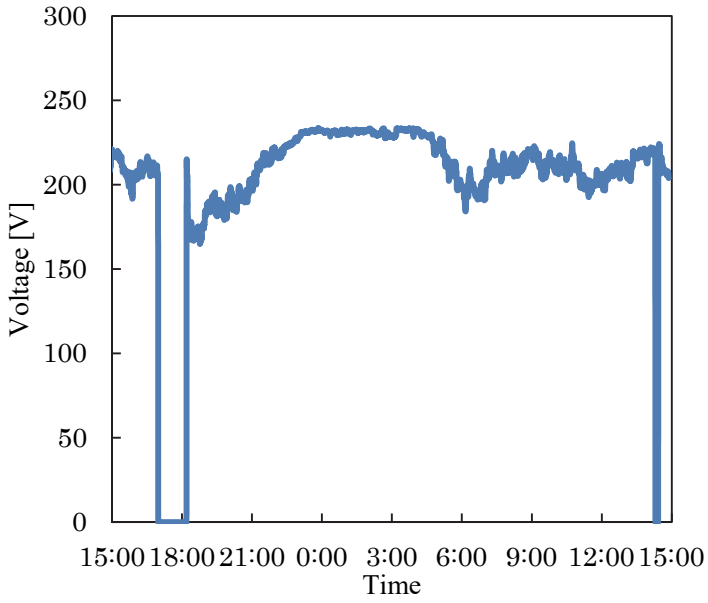
(4) Electricity Circumstance

The electricity circumstance of Myanmar is bad. A blackout occurs frequently, and the voltage is unstable. Voltage regulators are used in many stations. Table 4.9.2 shows the voltage of the low voltage power distribution line. The descent of the voltage was seen in each station in spite of the standard 230V. The voltage of Yangon Central Station seems to be relatively stable. The voltage of Insein Station descends by 17% in spite of high voltage power receiving. The voltage of Kyaeo Gon Station descends by 33%. Figure 4.9.5 shows an example of the voltage fluctuation which was measured in Mingaladon station. The voltage is extremely unstable in spite of the standard 230V.

Table 4.9.2 Voltage of low voltage power distribution line

Station	Standard	Measurement
Yangon Central	230V	213V
Insein		192V
Kyaeo Gon		155V

Source: JICA Study Team



Source: JICA Study Team

Figure 4.9.5 Voltage of Low Voltage Distribution Line of Mingaladon Station

4.9.2 Power Supply Plan

Figure 4.9.6 shows the present power diagram, and Figure 4.9.7 shows the improved power diagram. Figure 4.9.8 shows the new system diagram of the power distribution for the signal.

(1) Power Receiving Equipment

The modernization of the signal system needs large electricity. In this plan, the transformers of the bases of power distribution line for the signal are replaced to large capacity ones, and a new base is installed in Mingaladon Station to prevent from voltage descend. The transformer is also installed for an interlocking device in Paywetsakekan Station.

(2) Emergency Generator

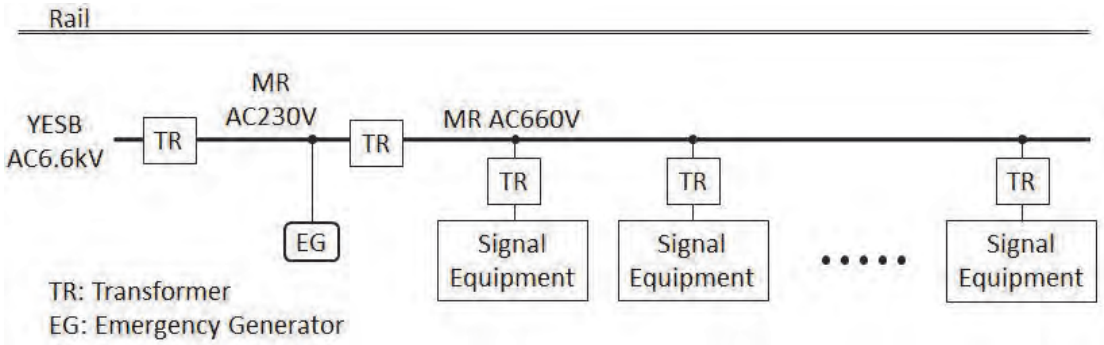
In consideration of the present electricity circumstance, the emergency generators are installed in the bases of power distribution line for the signal.

(3) Electric Power Distribution Line for Signalling

The step-up transformers are replaced with large capacity ones. And the cables are replaced with thick ones, which need 325mm^2 at least, to prevent the voltage descent.

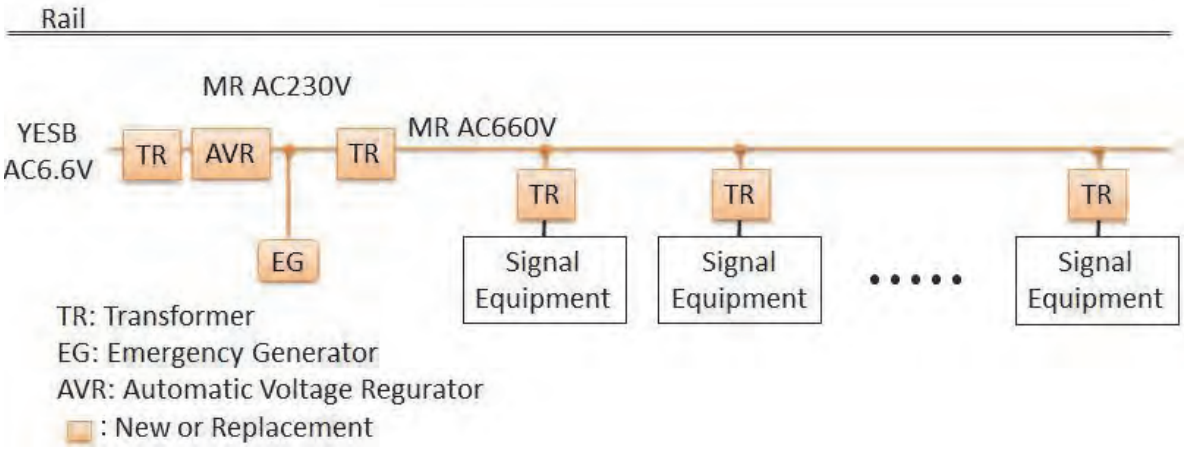
(4) Automatic Voltage Regulator

The automatic voltage regulators are installed in the base of power distribution line for the signal system to stabilize the voltage.



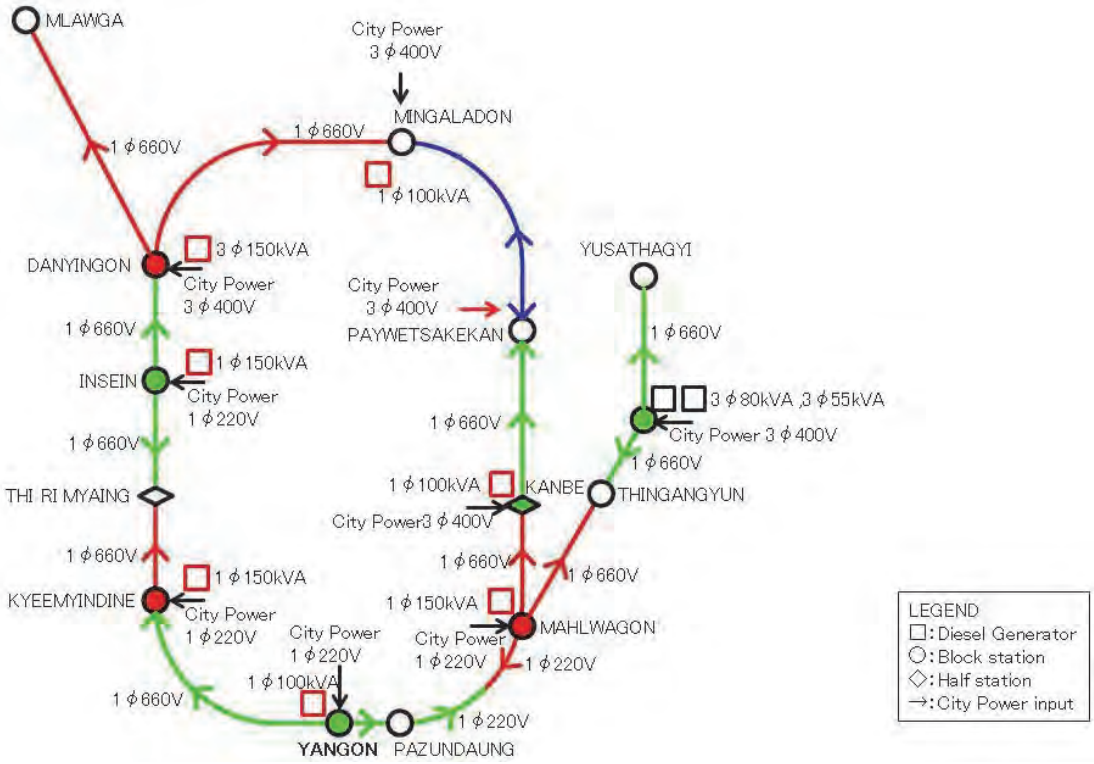
Source: JICA Study Team

Figure 4.9.6 Present Power Diagram



Source: JICA Study Team

Figure 4.9.7 Improved Power Diagram



Source: JICA Study Team

Figure 4.9.8 Improved System Diagram of Power Distribution for Signal Equipment

4.10 Building Structure

Building structures such as signalling equipment room and watchmen hut at level crossing are subject to be upgraded by Myanmar Railway.

4.10.1 Signalling Equipment Room

Specification of signalling equipment room is supposed to be equivalent to the level of the existing building structures of Myanmar Railway. Building structures to be developed in the project are Power Supply room, Relay room and Operation room.

Source: JICA Study Team

Figure 4.10.1 Existing Building Structures

4.10.2 Level Crossing Watchmen Hut

Specification of watchmen hut at level crossing is supposed to be equivalent to the level of existing watchmen hut at level crossing.

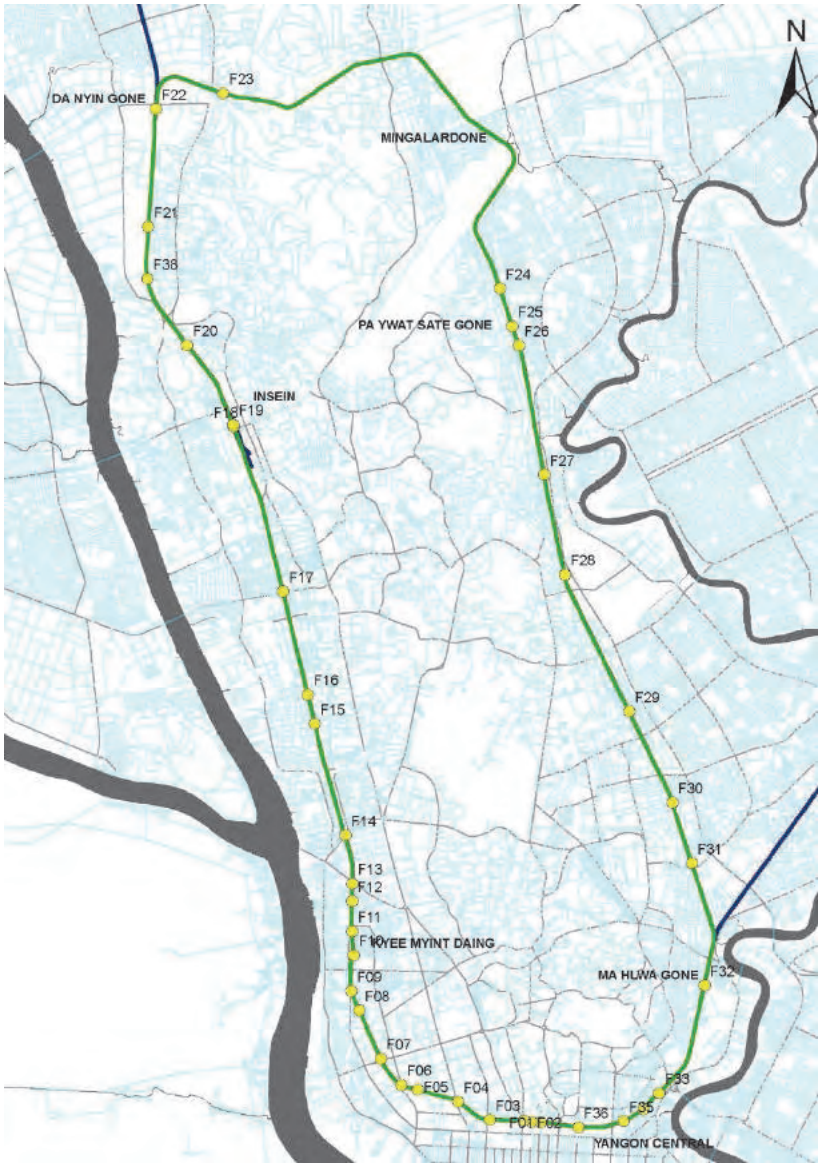
Source : JICA Study Team

Figure 4.10.2 Existing Watchmen Hut at Level Crossing

4.11 FOB

4.11.1 Current Condition

36 Foot Over Bridges, which is pedestrian overpass abbreviated to FOB, are located along Yangon Circular Railway as shown in the figure below.



Source: JICA Study Team

Figure 4.11.1 FOB location map

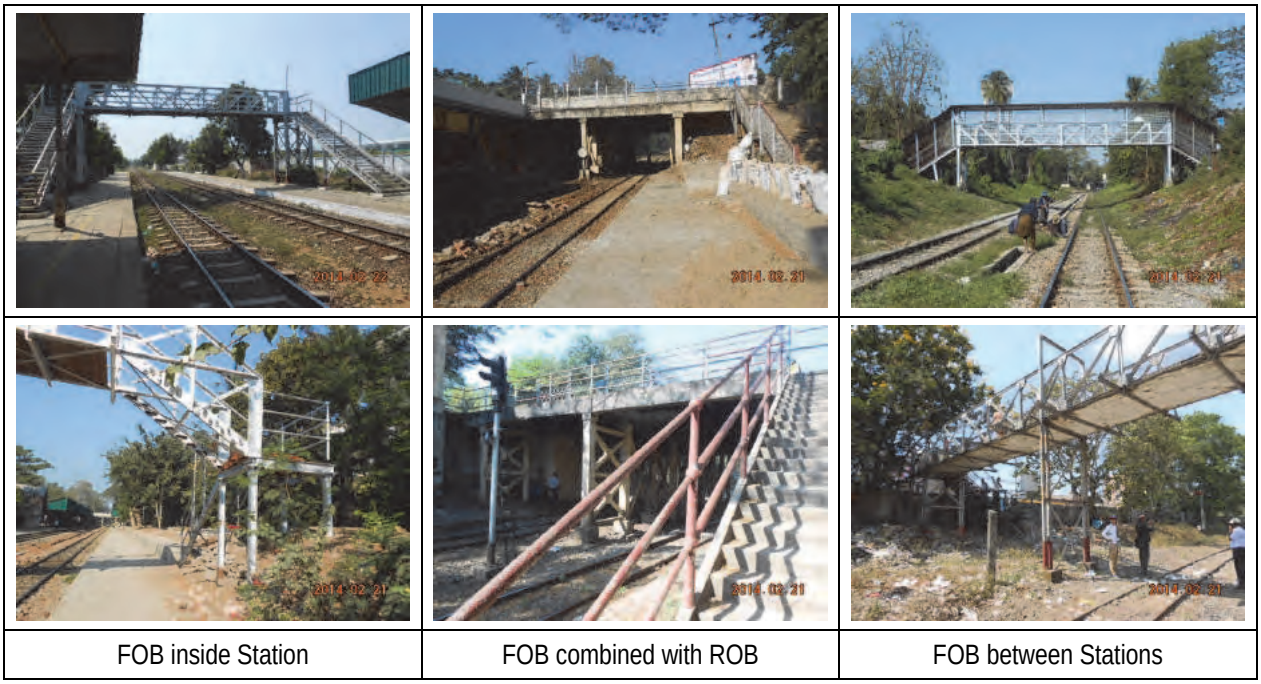
The function of FOB is dvided into two purposes, one is to connect with inside station, and the other is to connect with both side area of the railway line.

21 FOB are located inside station to connect with each platform for going across the opposite side of station. However, these are actually abandoned hence almost passengers are crossing on the track directly. It might make serious problem when train operation interval and speed become higher and faster. Some educational or physical countermeasures are required for high speed and frequency train operation after the project.

Other 15 FOBs, are located between stations in order to connect with both sides of the railway line. These are used by neighboring people with high frequency as their passage in

comparison with FOB inside station, although some of them are abandoned due to the same reason of FOB inside station. Four of them are installed as a part of ROB

The typical photos of each type of FOB are shown in the figure below.



Source: JICA Study Team

Figure 4.11.2 Typical Photos of Each Type of FOB

Steel truss type is mainly used for FOB. RC type is also found for three places. Long span FOBs are located in large station, Kyeemyindaing station and Insei station.

Table 4.11.1 Type of FOB

	Number	Type	
		Steel Truss	RC Truss
1 Span	15	15	0
2~3 Span	11	8	3
>4 Span	3	3	0
None	3	3	0
Combined with ROB	4	-	-
Total	36	29	3

Source: YUTRA Pre-FS

Detailed characteristics of each FOB investigated in YUTRA Pre-FS are shown in the table below.

As shown in the table, although the condition of the main structure (superstructure and pier) is not so serious (evaluated as OK or Repair), some walking panel is in the quite dangerous situation due to no panel, low quality panel, broken panel, etc. These should be repaired as a part of the usual maintenance by MR.

Table 4.11.2 Detailed Characteristics of Each FOB

Infrastructure No	FOB Type	Height from RL to Under Girder	No. of Span	Location (inside Station or not)	Current Condition A: OK, B: Repair C: Danger			Remarks
					Superstructure	Walking panel	Pier	
F01	Steel Truss	4.27	3 Approximately 1 span due to the less edge	Not	A	B-C rust, rot	B rust, rot	
F02	Steel Truss	4.46	1	Inside	A	A Installing	A	bottom of girder is under repairing
F03								A part of ROB
F04		4.32						A part of ROB
F05	Steel Truss	4.18	1	Not	A painted	A repaired	A painted	
F06								A part of ROB
F07								A part of ROB
F08	Steel Truss	4.99	1	Inside	A Painted	A repaired	A painted	
F09	Steel Truss	4.07	2 There is a pier at halfway position. Partially 1 span	Not	A	A	B rust	
F10	Steel Truss	3.88	7	Inside	B	A	B rust	Length of FOB is 83.5m, Rot
F11	Steel Truss	4.23	4	Not	B	B-C	B	Railway flyover span
F12	Steel Truss	4.98	2 There is a pier at halfway position. Partially 1 span	Not	A	-	A	Under construction
F13	Steel Truss	4.88	1	Not	A	-	A	Repair now
F14	Steel Truss	4.98	1	Inside	B	B-C	A	
F15	Steel Truss	4.57		Not	A	A	A	
F16	Steel Truss	4.58	2	Not	A	A	A	
F17	Steel Truss	4.18	1	Inside	B Need aint	B	B need paint	
F18	Steel Truss	4.21	2	Inside	A	A	A	For transit in platform
F19	Steel Truss	3.89	10	InsideOutside to outside	B Need paint	B	B	
F20	Steel Truss	4.93	1	Inside	B	A	A	
F21	Steel Truss	4.84	1	Inside	A	A	A	
F22	Steel Truss	4.82	1	Inside	A	A	A	
F23	Steel Truss	4.96	1	Inside	A	A	A	
F24	Steel Truss	4.94	1	Inside	B	B	B	
F25	Steel Truss	4.85	1	Inside	C	C	C	
F26	Steel Truss	4.48	1	Not	A	A	A	
F27	Steel Truss	4.96	1	Inside	B	B	B	
F28	Steel Truss	4.95	1	Inside	B	B	B	
F29	Steel Truss	4.81	1	Inside	B	A	A	
F30	Steel Truss	4.93	-	Inside	-	-	-	Underconstruction
F31	Steel Truss	4.80	-	Inside	-	-	-	Underconstruction
F32	RC Truss	4.78	2	Inside	B	B	B	
F33	RC Truss	4.62	2	Inside	B	B	B	
F34	Steel Truss	4.78	2	Not	B	B	A	
F35	Steel Truss	4.73	2	Not	A	A	A	
F36	RC Truss	4.74	3	Inside	B	B	B	

Source: JICA Study Team

4.11.2 Reconstruction Plan

After the completion of the Project, the function of FOB will be quite important because all train runs high speed with high frequency and it force passengers and neighbouring people to use FOB in order to assure their safety.

At present, 17 of total 38 stations have no FOB for connecting inside station. Four of 17 stations are not necessary to construct FOB due to nearest FOB function as access from outside to both platforms inside station. Therefore, remaining 13 station should construct FOB for connecting inside station.

On the other hand, regarding FOB between stations, the required number is assumed as 90 in order to keep 0.5km interval (44km/0.5km=approximately 90). It means 75 new FOBs should be constructed because 15 FOBs are located at present.

It notes that the design requirement for FOB should be reviewed from the viewpoint of "user friendly" hence there are some inconvenient part (too large step interval, etc.) in the existing FOB. It may be considered to install new facilities (slope for bicycle, escalator, etc.) for any sample FOB.

In addition to these new construction, FOB evaluated as B or C in the above mentioned table may be repaired or reconstructed based on the detailed survey in the next design stage.

Chapter 5 Operation and Maintenance

5.1 Institutional Arrangement for Operation and Maintenance

5.1.1 General

The existing operation and maintenance (O&M) of the YCR Line is carried out by Division 7 of MR. It is reasonable that the upgraded YCR Line is managed by Division 7 continuously, including operation and maintenance, after the commencement of the new train operation using DEMUs.

5.1.2 Operation

This project would not be successful if the operator could not use the upgraded rail infrastructures effectively. In this regard, MR is expected to make its best efforts to improve the capacity of MR staff.

1) Safety

One of the significant differences from the current operation is "train speed". Although the signalling system is updated to a more reliable system than today, a maximum of 60 kph train operation may cause fatal accidents.

In order to prevent train accidents in such operation condition of frequent and high speed, installation of a simple Automatic Train Protection (ATP) system, called ATS-S in Japan, is highly recommended as mentioned in section 4.10 of this report. This system works well with the existing train operation method, that is, a driver and an assistant driver are on board. It should be noted that education to drivers regarding how to deal with this safety device is essential.

Countermeasures are indispensable to prevent personnel injury or death by such a high speed train in stations as well as between stations. Not only physical measures such as protection barriers but also the notification to the public regarding the danger caused by the invasion into track is very necessary.

Another different aspect from the existing train operation is "side doors of rolling stock" to keep passengers safety. A door switch in a cab for closing/opening doors may be operated by a driver / assistant driver or a guard only.

Level crossing issues should also be considered seriously in terms of safety because these are the only points for trains and automobiles to meet. Education to car drivers should be provided, probably with the support from local governments, in order for car drivers to recognize possible danger in approaching to a rail level crossing.

2) Punctuality

Punctuality will be significantly improved by removing the at-grade cross operation of the YCR Line and the main line operation (Yangon – Bago / Mandalay) in the section between Pa Zun Taung Station and Yangon Central Station, which currently disturbs the operation of both lines (Upgrading work to remove the existing cross operation is not included in the existing scope of work).

Punctuality which the upgraded YCR Line should achieve is not so high in comparison with urban railways of other counties. A minimum headway achieved by the upgraded YCR during peak hours will be 10 minutes.

MR is expected to educate train drivers about the importance of punctuality. However, it should be noted that the priority is given to the "safety first".

It is also important to inform the public that the punctuality achieved by the upgraded YCR is so important to attract more railway users.

3) Efficiency

Train operation efficiency improvement is another aspect which must be addressed. A number of on-board MR staff can be reduced after upgrading the signal system and rolling stock, which will contribute to reduction of O&M cost. In total four MR staff are on board on each train, namely, a driver, an assistant driver, a mechanical engineer, and an electrical engineer. Newly introduced DEMUs do not require on-board mechanical and electrical engineers because of its reliability. Accordingly the number of train operation staff can be reduced. This could make up for the work force shortage in other sites of MR.

4) Secure Fare Revenue

Although there is no accurate statistics regarding fare evasion, it is said that nearly 20% of the YCR passengers have no tickets, that is, they do not pay for their ride.

MR may need to assign station staffs in the ticket offices and at the ticket gates of all the stations of the YCR Line. In addition to this, fences at the stations and the side doors of each train help reducing the fare evasion effectively.

This will contribute to the reduction of the deficit of MR to some degrees.

5.1.3 Maintenance

The existing various technical problems in running the YCR are mainly explained by MR's poor maintenance work and aging of the rolling stocks and the infrastructures. MR is expected to allocate necessary resources to the maintenance work of the upgraded rolling stocks and infrastructures in order to maintain the quality of newly introduced train operation in the future.

In principle, MR should change its maintenance policy from the existing breakdown maintenance method to a preventive way of maintenance. In carrying out periodic maintenance, it is highly recommended to record every maintenance work of rolling stock, facilities, structures, and others, and which should be analysed by the MR headquarter together with technical staff from work sites. This exercise will be helpful for MR to improve its technical abilities in maintaining the quality condition of the rolling stocks and the infrastructures.

1) Rolling Stock

Daily maintenance work of the rolling stock shall be carried out in the Insein depot (ex-Insein DRC) by the staff of Mechanical and Electric Department of Division 7. Periodic heavy maintenance work shall be carried out in the Ywa Thar Gyi workshop where maintenance work of all DEMUs/DMUs in Myanmar is carried out under the direct supervision of MR HQ's Mechanical and Electric Department.

A contractor (supplier) of the rolling stock is requested to prepare necessary documents to prescribe the required works of each type of maintenance work in detail and to provide a series of training with MR staff to transfer technical knowledge to them.

2) Infrastructure

Maintenance of the rail infrastructures including rail track, civil structures, signalling, and communication systems is the responsibility of corresponding departments of Division 7, namely Civil Department and Signal & Telecom Department of Division 7.

Contractors are requested to prepare necessary documents to prescribe the maintenance works of each type of infrastructure in detail, and they need to provide training with MR staff to transfer the necessary knowledge and skills to maintain the infrastructures. Minimum maintenance equipment is listed as below.

- Tie Tamper (1set=4 pieces)
- Jack (6 pieces)
- Level
- Auto-level
- Handy special measure equipment.

The new DEMU trains will be operated on the YCR Line and part of the Yangon -Pyay Line (up to Hlawga). Since the existing condition of the lines is seriously poor because of less skilled MR maintenance staff and lack of maintenance equipment, it is strongly requested that MR establishes a strong work force to maintain the improved infrastructures before starting the operation of new DEMUs. The on-going technical assistance, named "Project on Improvement of Services and Safety of Railway", must be helpful to improve the level of maintenance work by MR in this regard.

(2) Customer Satisfaction

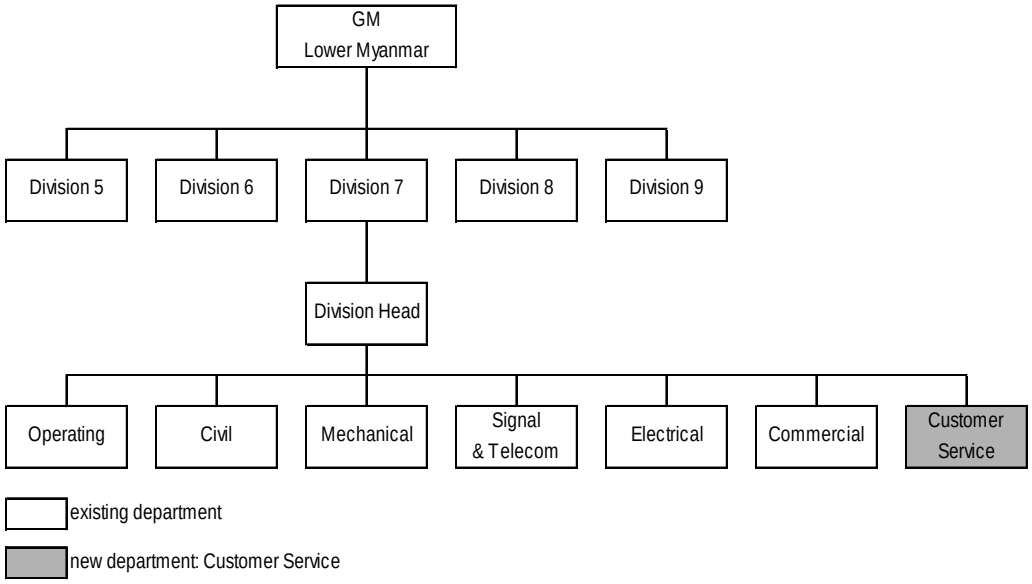
As customers (YCR users in the future) get satisfied with the new services by the new operation, they may require higher level of service (LOS) to MR. These requests might be related with train timetable, cleanliness of rolling stock and stations, toilet at stations and security. In order to meet such requests (moving target), that is to satisfy the customer in the future, it is highly recommended that Division 7 establishes a special unit, namely, "Customer Service" department, which deals with those issues swiftly and effectively. Moreover, this department will be expected to consider higher LOS not only by customers' requests but also by MR themselves.

Since the existing MR is not so accustomed to these kinds of business activities, technical support from railway companies such as Japan Railway (JR) Group and Tokyo Metro (TM) could be helpful.

5.1.4 Organization

Figure 5.1.1 shows the organizational chart of Division 7, the responsible division for the O&M of the YCR Line, based on the preconditions mentioned above.

Table 5.2.1 describes the estimated number of staffs required for YCR Line.



Source: JICA Study Team (2014)

Figure 5.1.1 Organizational Chart of Division 7

5.2 O&M Costs

The followings should be specially addressed by MR in developing an O&M plan of the upgraded YCR Line:

- Cheating by passengers should be minimized by improving the ticketing system and increasing the number of station staff;
- Regarding the maintenance of infrastructure including rolling stock, civil structures, mechanical, signal & telecom, and electrical department, adequate works should be carried out to maintain good conditions of these assets. Necessary budget and number of staff should be allotted to each responsible department of MR.

Based on the above considerations, the number of staff required for the upgraded YCR Line in 2022 is estimated as follows:

Table 5.2.1 Estimated Number of Staff for the Upgraded YCR Line

Unit: persons

	Operating	Civil	Mechanical & Electrical	Signal & Telecom	Commercial	Administration	TOTAL
Year 2014	540	190	120	80	20	-	950
Year 2022	590	190	50	150	20	20	1,020

Note 1: Mechanical & Electrical staff will be decreased as the rolling stock renewed and less necessity to ride together each train operation.

Table 5.2.2 shows the estimated annual O&M cost of the project components covered by both Japanese ODA and MR's own budget (figures are expressed in Myanmar Kyat and Japanese Yen). These figures include the whole O&M costs of the YCR Line, assuming that MR allocates sufficient O&M budget for the Project every year through its own revenue and government subsidy.

Table 5.2.2 Estimated Annual O&M Cost

Item		Estimated O&M costs at 2014 constant prices	
		(million Kyat)	(million JPY equivalent)
Fuel		CONFIDENTIAL	
Maintenance	Rolling stock		
	Signal & Telecom		
	Track		
	Civil		
	Depot		
Salary			
Total			

Note: MMK 1= 0.117 Yen

Chapter 6 Social and Environmental Consideration

6.1 Existing Social and Environmental Condition

6.1.1 Socio-economic condition

The socio-economic study conducted by the JICA Study Team in the nineteen (19) townships along the YCR Line addresses demographic condition, household attributes such as household income and education of household members, local economic activities, and some specific issues regarding local communities.

The nineteen (19) townships include Tar Mwe, Pazuntaung, Mingalar Taung Nyunt, Dagon, Botahtaung, Babe Dan, Kyauk Ta Dar, La Thar, Lanmataw, Ahlone, Myeemyin Daing, Sanchung, Kamayut, Hlaing, Mayankone, Insein, Mingalardon, North Okkalapa and Yan Kin.

(1) Characteristics of Townships

Some important characteristics of the 19 townships along the YCR Line are summerized as follows:

(a) Land area - Mingaladon township is the largest, followed by North Okkalapa township, while Lammadaw township is the smallest among the 19 townships.

(b) The highest point above the sea level – The highest point is found in Insein township, followed by Bo Ta Htaung township. The level of Mingalar Taing Ntyint and Mingaladon township is almost same as the sea level.

(c) Population – North Okkalapa township has the largest population among the 19 townships, followed by Insein township, while La Thar township has the smallest population.

(d) Population growth rate (average growth rate between 2000 and 2011) – North Okkalap township showed the highest growth rate before 2011, followed by Mingaladon township comes next, while Dagon and Hlaing township showed negative growth.

(e) Population density – Lammadaw township has the highest density, followed by Pazun Taung township. The population density of Mingaladon township is the smallest among the 19 townships.

Table 6.1.1 Land and Demographic Conditions of 19 Townships

No	Name of Township	Area*	Above Sea Level (Highest)*	Population*	Population growth rate*	Population density*	Population	
				2011	(2000-2011)	2011	2014**	2014***
		km²	m	person	%/year	person/km2	person	person
1	Tarmwae	4.79	9.1	191,114	3.1	39,899	158,877	165,348
2	Pazun Taung	1.01	4.5	52,810	3.2	52,287	45,316	48,245
3	Mingalar Taung Nyunt	5.06	0.0	155,767	2.7	30,784	131,310	132,209
4	Bo Ta Htaung	2.38	43.9	49,134	0.53	20,645	40,133	40,849
5	Dagon	11.65	17.1	24,492	-3.7	2,102	19,907	29,796
6	Babe Dan	8.84	36.6	100,695	0.4	11,391	30,421	33,264
7	Kyauk DaTar	0.71	2.3	34,794	1.8	49,006	27,971	29,796
8	La Thar	0.81	6.1	34,125	0.37	42,130	30,426	24,926
9	Lanmadaw	0.76	2.1	43,137	0.5	56,759	35,468	47,123
10	Ahlone	2.69	2.4	52,810	3.2	19,632	53,501	55,412
11	Kyeemyin Daing	10.77	15.2	115,841	2.2	10,756	95,031	111,566
12	Sanchaung	2.47	15.2	105,208	2.3	42,594	85,578	99,772
13	Kamayut	5.52	15.4	87,881	0.45	15,920	74,104	84,368
14	Hlaing	13.7	1.8	151,014	-0.81	11,023	124,344	160,018
15	Mayangone	25.33	30.5	205,403	0.89	8,109	186,897	198,038
16	Insein	35.07	45.7	311,200	2.0	8,874	254,404	305,670
17	Mingaladon	113.36	0.0	288,858	4.1	2,548	144,367	332,520
18	North Okkalapa	22.69	9.1	333,484	4.5	14,697	276,020	332,869
19	Yan Kin	5.02	24.4	125,909	1.3	25,081	65,680	70,992
Total		272.63	-	2,463,676	-	-	1,879,755	2,302,781

Note 1: * Edited from SUDP, JICA (2012/2013) "Yangon Township Data Sheet".
Note 2: ** Township Information of General Administration Department Office (March, 2014)
Note 3: *** Provisional results of the 2014 Population and Housing Census of Myanmar (www.dop.gov. mm)
Source: JICA Study Team (2014)

6.1.2 Natural Environment

(1) Biodiversity and Endangered species

The YCR Line does not pass through any environmentally protected areas nor reserved forest areas. The existing land use along the YCR Line is categorized into highly urbanized area except some limited areas in the north where some limited areas along the YCR are used for agriculture purpose.

Planting trees area observed along the YCR Line at Malaysia Padauk, Seiban, Malzali, Bandar, Kokko, Mango, Banana etc. They were planted some time ago to provide shading and as part of landscaping elements along the YCR.

There are two plant species which are categorized into “threatened plant species” in IUCN Red List, namely Sein Ban (*Delonix regia*) and Mahogany (*Swietenia macrophylia*). These species are sub-categorized as vulnerable ones, which means these are under the condition of less threatened than critically endangered or endangered species in the Red List. Actually these two species are not formally authorized as threatened species by Forest Department, MOECAF (MONREC). In fact they are planted and also found commonly in public parks, other greenery areas and along the roads in the Yangon City.

Planted Teak (Tectona grandis) trees, which are prohibited to export without permission from Forestry Department, MOECAF (MONREC), are found along the YCR. Teak trees are also found commonly in greenery areas and along the roads in the Yangon City.

No other precious and endangered fauna and flora species are found in the project area.

(2) Protected Areas and Parks

The Protection of Wildlife, Wild Plants and Conservation of Natural Area Law was enacted in 1994. There are 40 protected areas in Myanmar including wildlife and bird sanctuaries, national parks, and nature reserves as of today. Myanmar is also a Party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and Ramsar Convention.

The Hlawga Park in the Greater Yangon, being located in about 5km north from the YCR Line, having an area of 2,342 ha, is managed strictly as a watershed protection forest. Peoples are allowed to enter into the park with permission. Because of the distance from the YCR Line, almost no impact by the YCR upgrading to this park is expected.

(3) Topographic and geological condition

Refer to Chpter 3 of this report.

6.1.3 Environmental Pollution

Environmental quality standards for air, water and ambient noise have not been established yet in Myanmar. At the same time, it is not easy to find environmental quality data which can indicate level of environmental pollution.

(1) Water Quality

Service coverage of the existing sewerage system of the Yangon City is limited to a small part of the existing CBD only, while many of the Yangon residents live outside the sewerage service area. Human-based raw sewage often flows into the drainage directly without appropriate treatment.

Flooding in the residential areas by tidal backwater often occurs in the low land areas because of poor flood protection mechanism in such areas. Flooding leads to accumulation of floating debris in the drainage.

Lack of proper treatment of waste water results in poor surface and underground water quality and offensive odor. Furthermore, significant volume of waste water flows into the Yangon River directly, resulting in degradation of the river water quality as well.

The river water quality data of Pazundaung Creek and Bago River in Yangon City (See Appendix 2.2.3(1)) suggest that the existing river water quality is close to Class C or D of the Japanese Standards of Water Use.

(2) Air Quality

Stationary sources such as factories and houses and mobile sources such as road traffic and railway traffic are found as the air pollutant emission sources in Yangon City area. The vehicular emission from cars is one of the dominant factors in Yangon.

Although air quality data is hardly found in Yangon City, some observed data suggest ambient pollutant level such as SO_2, NO_2 and PM10 are within the range of Environmental Standard of Japan and Standard of WHO Guidelines (See Appendix 2.2.3 (2)).

However, it should be noted that more than 25,000 vehicles have been newly added in the first half of the year after the government approved the import permit in 2012.

(3) Ambient Noise

An ambient noise survey was carried out near the railway track and sensitive receptor sites such as monastery and school (See Appendix 2.2.3 (3)) as part of the environmental baseline data survey on the YCR Line (2014) by the JICA Study Team.

The Japanese Standards informs that a noise level of 55–60 dB averaged over the daytime along the YCR Line is considered as "moderately to seriously annoying for residential area". Because many of the survey locations were located in densely populated urban areas and close to congested roads, the baseline noise level along the YCR Line can be 55-60 dB.

(4) Solid waste

Solid wastes in Yangon City are generated from typical waste generators such as residential areas, offices, and other commercial activities. The solid waste is collected by the Pollution Control and Cleansing Department (PCCD) of YCDC. The collected solid wastes are then transported to seven final disposal sites (FDSs) including large scale FDSs such as Htantabin FDS and Htawe Chaung FDS which are open dump sites. Since there is no treatment before dumping them, there is a concern that untreated leachate may cause deterioration of the ground water.

6.1.4 Specific Conditions relevant to the YCR Line

(1) Road network and crossings (intersections)

The YCR Line runs from the Yangon Central Station northward up to the Da Nying Gone Station. Along this section the Upper Kyee Myin Daing Road and the Baha Road run in parallel with the YCR Line. Major types of land use along this section include business and commercial areas near the Yangon Central Station, densely populated housing areas along the rail line, variety of commercial activities along the roads, a relatively large market at the Da Nyin Gone Station.

From the Da Nyin Gone Station, the YCR Line runs eastward to the Mingaladon Station in the suburban area of Yangon. The lands along this section are still used as farming lands. The Yangon International Airport is located close to the YCR Line.

The YCR Line runs southward from the Mingaladon Station YCRL up to the Ma Hlwa Gone Station. Along this section, residential and commercial use are dominant along the Kabar Aye Pagoda Road and the Wai Za Yan Tar Road, while small scale farming activities are also found both sides of the YRC Line.

Major roads crossing the YCR Line in the western section are the Ahlon Road, the Bargayar Road, the Hledan Road, the Hanthawadddy Road, the Hlaing River Road, the Baint Naung Road, and the Khaye Pin Road, while those in the eastern section are the Myo pat Road, Parami Road, Yadanar Road, Thingangyun Road. Many of the crossing points are not grade separated, while there are serious traffic congestion problems, accordingly possible problems from vehicular emission at the at-grade intersections (Figure 6.1.1).

Source: JICA Study Team

Figure 6.1.1 Railway and Road Network in Yangon City

(2) Land use

1) Buildings in the MR's right of way (ROW)

A number of building structures for residential and business activities are observed within the ROW of the Yangon Central Station, the Insein Station, etc. In many cases they do not have any official documents or approval to use such lands from MR. However, they have already established their communities sometime ago. For example, some large housing and commercial buildings are found near the Okkalapa Station. Such buildings might be obstacles to modernization of the existing YCR Line, but they must be treated properly according to the newly introduced social and environmental consideration guideline in Myanmar.

2) Farming activities

Small-scale farming activities are found along the YCR Line, using shallow ponds, cultivating water vegetables. Relatively large farming activities are observed along the northern section of the YCR Line, while many of them are small-scale farming for own consumption or for a small scale side business.

3) Vendors' activities

Vendors selling vegetables and other goods are observed in some major stations such as the Da Nyin Gone Station and the Thamine Station. Many of them have a permission from MR to sell their commodities in the station area. Temporal open markets are also held at some major stations of YCR Line such as the Da Nyin Gone station. Those people will be affected by the YCR Line upgrading project positively and negatively at the same time.

4) Sensitive receptors

Sensitive receptors such as monasteries, Hindu temples are observed along the YCR Line.

Detailed information of these facilities are shown in Appendix 2.2.4.

6.2 Policies, Legislation and Institutional Framework Related to Yangon Circular Railway

6.2.1 Legislation Related to Environmental Conservation

Major legislations relevant to the environmental conservation are shown in Table 6.2.1.

Table 6.2.1 Laws and regulations relevant to Environment

Name of Laws, rules etc.	Year
1. Constitution and Environmental Policy	
Constitution of the Republic of the Union of Myanmar	2008
Myanmar National Environmental Policy	1994
National Sustainable Development Strategy 2009	2009
2. Environmental Conservation	
Myanmar Environmental Conservation Law 2012	2012
Environmental Impact Assessment Procedures (Draft) 2013	2013
3.Biodiversity and Natural Conservation	
Wildlife Protection Act 1936	1936
Myanmar Marine Fisheries Law 1990	1990
Fresh Water Fisheries Law 1991	1991
The Law Relating to Aquaculture	1989
Forest Law 1992	1992
Animal Health and Development Law 1993	1993
Protection of Wildlife and Conservation of Natural Area Law 1994	1994
Conservation of Water Resources and River Law 2006	2006
National Biodiversity Strategy Action Plan in Myanmar 2012	2012
4. Urban Development and Management	
The City of Rangoon Municipal Act 1922	1922
Law Amending the City of Yangon Development Law 1996	1963
City of Yangon Development Law 1990	1990
The City of Yangon Municipal Amendment Act 1961	1961
5. Land Acquisition and resettlement	
The Upper Burma Land and Revenue Regulation	1889
The Land Acquisition Act 1894	1894
Transfer of Immovable Property Restriction Act	1947
Land Nationalization Act	1953
Disposal of Land Tenancies Law	1963
Transfer of Immovable Property Restriction Law	1987
Farmland Law 2012	2012
Farmland Rules 2012	2012
Vacant, Fallow, Virgin Land Management Law 2012	2012
Vacant, Fallow, Virgin Land Management Rules 2012	2012
6. Pollution Control and Occupational Health	
Factory Act	1951
Standing Order 2_95 Occupational Health Plan 1995	1995
Standing Order 3_95 Water and Air Pollution Control Plan 1995	1995
Occupational Safety and Health Law (Draft)	2012
The Science and Technology Development Law 1994	1994
Myanmar Mines Law 1994	1994

Source: YUTRA, JICA (2013/2014)

6.2.2 Regulations for Environmental Impacts Assessment (EIA)

(1) Environmental Conservation Law (2012)

The principal law governing the environmental management in Myanmar is the Environmental Conservation Law, which was issued in March, 2012 (The Pyidaungsu Hluttaw Law No.9/20/2130rh). The law stipulates that government bodies are responsible for the environmental conservation as well as their relevant roles and responsibilities.

It also mentions that any new development projects must carry out Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) in order to find out whether or not a project or activity to be undertaken by any government departments, organizations or persons may cause a significant impact on the environment or not.

The law serves as the basis for establishing the Environmental Conservation Department (ECD) under the Ministry of Natural Resources and Environmental Conservation (MONREC).

Following the Environmental Conservation Law there are two legal instruments: Environmental Conservation Rules (2014); and EIA Procedures (draft, 2013).

In the context of project development, it is important to note that the Environmental Conservation Law adopts the notion of 'Polluter Pays Principle' as it implies that the project proponents are mainly responsible for covering social and environmental costs generated by the project.

(2) Environmental Conservation Rules (2014) and EIA Procedures

The Environmental Conservation Rules provide specific and practical rules and guidelines including EIA Procedures and environmental quality standards based on the Environmental Conservation Law.

These rules inform that the MONREC adopts the environmental impact assessment system including determination of categories of plans, business or activity that requires EIA. This system also stipulates the categories which require Initial Environmental Examination (IEE).

It should be noted that the Environmental Conservation Rules also provide a platform for developing Environmental Quality Standards in the future.

(3) EIA Procedures (Drafted, 2013)

The EIA Procedures show concrete steps in undertaking EIA. While it is yet to be promulgated, the draft document and the interviews with ECD staff members reveal that the EIA process in Myanmar shall consist of the following (Details of the EIA Procedures are shown in Appendix 2.3.2).

- All development projects in Myanmar are subject to an environmental screening process, through which it is decided if they require any environmental review, that is, IEE or EIA.
- EIA includes an environmental management plan and a social impact assessment report.
- Public participation is essential for IEE and EIA, with inclusion of an Environmental Management Plan (EMP).
- An EIA Review Committee is formed to give recommendations to the Minister of MONREC from an environmental point of view on whether to approve the EIA report 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.

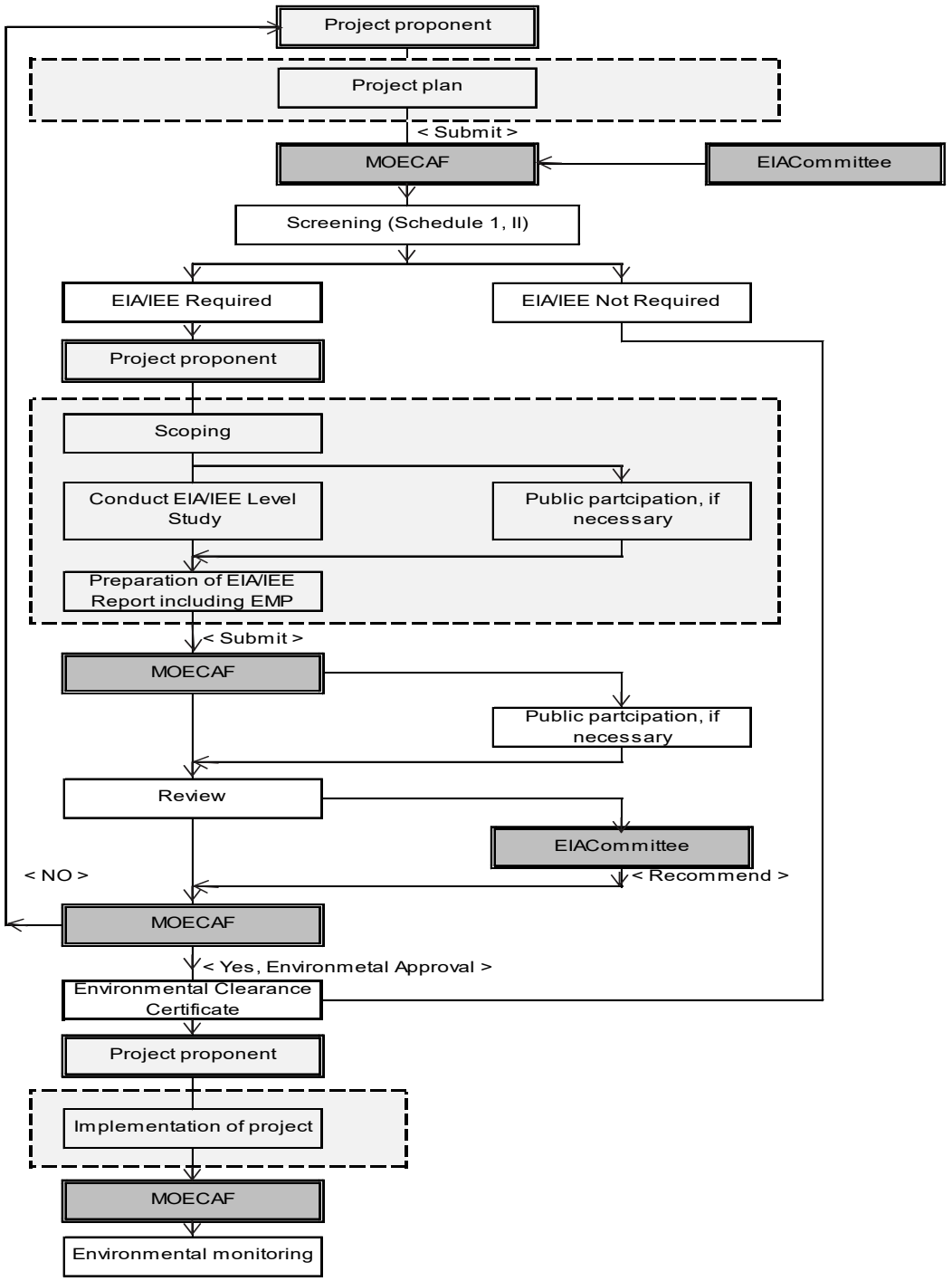
- Members of the EIA Review Committee are selected by the Minister of MOECAF and include persons from the industry, academia, and civil society, as well as government officials.
- Involuntary resettlement is carried out under the responsibility of a Respective Regional Government and hence it is not included in the EIA Procedures.
- Costs involved in conducting EIA are to be covered by the project proponent.
- EIA can be carried out by firms that are registered under ECD/MOECAF in Myanmar only.

Schematic Processes of Environmental Approval in the EIA Procedures are shown in Figure 6.2.1

6.2.3 Environmental Quality Standards

In Myanmar, environmental quality standards for specific environmental parameters had not been stipulated by MOECAF until the end of April, 2015.

However, some emission and/or discharge standards and environmental standards have been established by other ministries and practically used standards and/or guidelines as references (Details are shown in Appendix.2.3.4).



Note: MOECAF - Ministry of Environmental Conservation and Forests
Source: Enivironmental Impact Assessment Procedures (Draft, 2013)

Note: MOECAF was renamed to MONREC in 2016
Source: YUTRA, JICA (2013/2014)

Figure 6.2.1 Processes of Environmental Approval

6.3 Comparison with "Without Project" and "With Project"

Alternative plan of the Project should be prepared as a "Without Project" .

(1) Without project

The existing maintenance work in terms of budget has been limited to maintain the existing level of service (LOS) which has been at a low level in terms of travel speed, safety, punctuality, and riding comfort.

It is highly desired to improve the LOS in order to attract more YCR Line users. In this regard, several issues can be addressed as causes of the existing LOS of low level as follows:

- A shortage of maintenance budget and corresponding level of work;
- Less-skilled and almost non-mechanized maintenance work;
- Compricated train operation between the Yangon Central Station and the Ma Hlwa Gone Station;
- Lack of public enlightenment in terms of safety at level crossings;
- Poor inter-modality (no feeder services);
- Lack of rail business strategy and corresponding actions by MR;
- Non-effective use of MR assets.

If the above mentioned issues are not properly addressed and improved, no additional rail passengers are expected in the future, accordingly the YCR Line cannot be able to perform as one of the spine public transport systems in Yangon.

(2) With project

As stated in 6.1 of this report, the Project aims at:

- increasing the train operation speed (target commercial speed of 30 kph on average);
- improving the reliability and punctuality of train operation;
- increasing the passenger carrying capacity;
- improving the level of riding comfort;
- improving the level of safety both for rail passengers and residents;
- contributing to alleviation of the vehicular traffic congestion; and
- contributing contribute to MR's business performance improvement.

Eventually, the LOS will be improved, however, there are some negative impacts in carrying out the Project, namely, environmental impacts, involuntary resettlement, temporary disturbance by construction work, etc.

Table 6.3.1 summarizes those expected impacts caused by the Project.

Table 6.3.1 Comparison with "With Project" and "Wihtout Project"

Evaluation Indicator		With and Without Project	
		YCRL Upgrading Project "With Project"	Without Project
Consistency with YUTRA, SUDP and other upstream development plans		Consistent	No relation
Level of service (LOS)	Commuting and delivering time	Improvement by speed up to 30 kph and introduction of DEMU	No improvement (slow speed at around 15kph)
	Transport capacity	Increase	No increase
Engineering feasibility		Feasible with present technology	Feasible
Economic feasibility (costs)		Cost for rehabilitation work and introduction of DEMU	Increase in maintenance cost due to aging of track and rolling stock
Social Environment	Involuntary resettlement	Expected but not significant	Not expected
	Traffic congestion	1) Improvement by modal shift from road to railway transportation, 2) Improvement by renewal of level crossing and communication systems	No improvement
	Traffci accident	Avoid by installation of safety fence	No measures to prevent people entering in railway yard
Natural Environment	Inundation risk	Reduced risk by improving drain system	Inundation in lower level sections in case of heavy rain
	Global warming/ Climate change	Reduction of greenhouse gases such as CO_2 by modal shift from road to railway transportation	No improvement
Environmental pollution	Air pollution	Reduction of air pollutants such as PM and NOx by modal shift from road to railway transportation	No improvement
	Water pollution	Essentially no change	Essentially no change
	Noise	Reduction of noise generation by introducing DEMU	No improvement

Source JICA Study Team

6.4 Initial Environmental Examination (IEE)

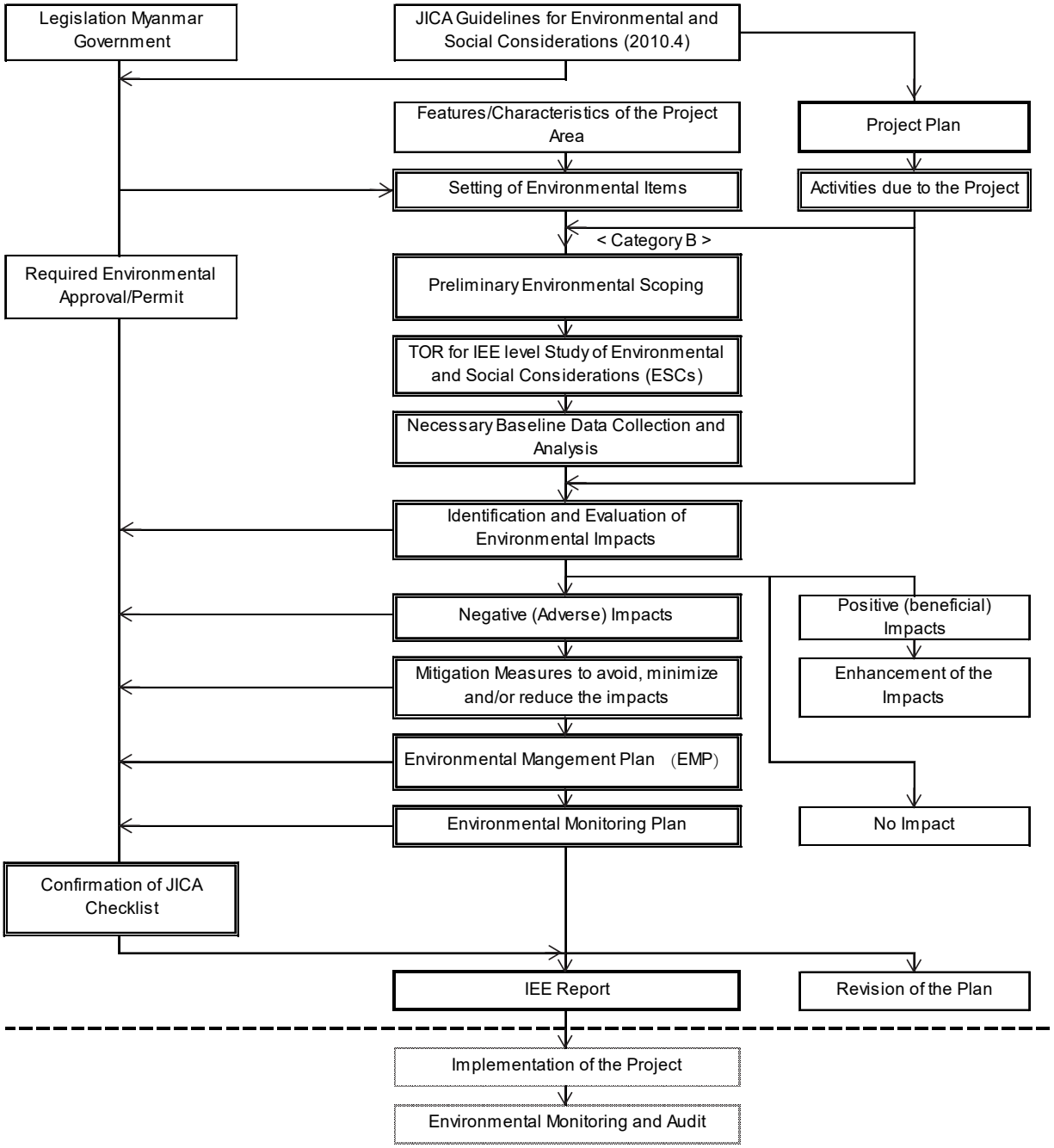
6.4.1 Requirement of IEE for the Project

Considering the proposed project components and the project area of YCR Line, the Project is categorized as "Category B" in terms of environmental and social consideration, which requires IEE according to the JICA Guidelines as following reasons:

- Potential adverse impacts on the environment and society due to the Project are site specific and not significant.
- The project does not belong to (i) sensitive sectors such as large scale development of roads and bridges, (ii) sensitive characteristics such as large-scale involuntary resettlement of more than 200 PAPs and (iii) sensitive areas such as nationally-designated protected areas, primeval forests areas or areas with unique archaeological, historical, or cultural value as listed in Appendix 3 of the JICA Guidelines.

6.4.2 Procedures of IEE

Procedures of IEE for the Project are shown in Figure 6.4.1.



Source: JICA Study Team (2015)

Figure 6.4.1 Procedures of IEE according to the JICA Guidelines

6.4.3 Activities due to the project

Activities due to the Project by stage are shown in Table 6.4.1.

Table 6.4.1 Activities due to the Project

Project Stage	Activities by the Project	Project Components						
		1. Renewal of Railway Signals and Communication System				2. Introduction of DEMU trains		
		1) Renewal of level crossing including crossing signals	2) Renewal of traffic signals and communication system along railway line	3) Rehabilitation of railway track condition for smoother and safer train running	4) Improvement of drainage condition to avoid inundation of railway track	DEMU train service	Depot for DEMU trains	Installation of fences to prevent accidents by train operation
Planning Stage (I)	Securing land/space for YCR facilities related to DEMU and, signals and telecommunication system	X	X		X		X	X
	Securing temporary land/space for construction work	X	X	X	X			X
	Change of utilization of land and local resources							X
Construction Stage (II)	Procurement of construction materials, equipment, plants, etc.	X	X	X	X			X
	Operation of construction machines and vehicles etc.	X	X	X	X			X
	Installation of construction worker's camps, storage sites, etc.	X	X	X	X			X
	Construction and rehabilitation work for railway related facilities and structures	X	X	X	X			
Operation Stage (III)	Operation of DEMU trains	X	X	X	X	X	X	X
	Operation of YCRL related facilities and structures	X	X	X	X	X	X	X
	Spatial occupancy of YCRL facilities related facilities and structures	X	X	X	X		X	X

Note: X – having some relation
Source JICA Study Team

Matrix relations of activity - component and activity - environmental item are respectively shown in Tables of Appendix 2.5.1.

6.5 Identification and Evaluation of Possible Impacts

6.5.1 Identification and Evaluation of Possible Impacts

Possible impacts are identified and their extent of the impacts is also evaluated one by one with rating of the 37 environmental items (social environment, natural environment and environmental pollution). Results are shown together with the results of scoping at Pre-Feasibility Study in Table 6.5.1.

Table 6.5.1 Identification and Evaluation of Anticipated impacts

Item	Rating				Identification and evaluation of anticipated impacts and their reasons
	Pre-FS		FS		
	I/II	III	I/II	III	
(1) Social Environment					
1) Land acquisition/resettlement	B-/D		B-		1) All the proposed project areas of Yangon Circular Railway Line as are owned by Myanma Railways (MR). Thus, all the land is public land and no land acquisition is expected. 2) However, it is expected that generation of considerable number of affected structures including houses/shops (Project Affected Units, PAUs) and Project Affected Persons (PAPs) by the project. As for PAUs totally 12 (twelve) structures including 2 (two) rented land from MR along railway line will be affected by installation of fences to ensure safety operation of train with higher speed (up to 60 km/h) train. As for PAPs totally 63 persons will be affected. Among them 48 persons are to be resettled permanently. 3) Expected number of PAPs is less than 200 in terms of persons to be subject to resettlement. Thus, MR as proponent should prepare Abbreviated Resettlement Action Plan (ARP) and provide necessary compensation and support of resettlement to these PAUs and PAPs by consultation with them through stakeholder meetings and Compensation Committee. 4) In addition, trees and electric poles along railway track should be removed, relocated or replanted by MR after necessary permit from concerned authorities, if any.
		C-		D	No negative impact is expected.
2) Local economy such as employment and livelihood etc.	B+		B+		Some temporary employment opportunity of residents for construction work by MR is expected.
		A+		A+	1) Through renewal of signals and telecommunication system as well as introduction DEMUs existing YCRL will be upgraded to faster and safer, which may give rise to more convenience and comfort to passengers as well as making easier access to working place and social services.
					2) In addition, passengers delivering and selling agricultural products to consumers by train will be also benefitted. These may result in improvement living condition and acceleration the growth of local economy.
				B-	At present many vendors are entering into railway yard of stations and sections such as Da Nyin Gone, Thamine Station and Pa Ywet Seik Gone Station to sell goods such as vegetables to train passengers in daytime. However, vendor's business activities in railway yard will be stopped due to installation of fences along railway track in order to secure smooth operation of train and to prevent railway accidents with higher train speed of 60 km/h.
3) Utilization of land and local resources	C-		D		1) Basically renewal of existing signals and telecommunication can be carried out in a small scale and mostly at the same space. Thus, it is not required any new land and local resources. 2) Water for construction work including worker's camp can be provided by MR.
		D		D	No negative impact is expected.

Item	Rating				Identification and evaluation of anticipated impacts and their reasons
	Pre-FS		FS		
	I/II	III	I/II	III	
4) Existing social infrastructures and services	B-		B-		1) According to construction work plan for renewal of level crossing, the corresponding level crossing will be closed for about 1 month. Thus, vehicles and foot passengers are requested to make a detour to other roads resulting in considerable congestion of road traffic in surrounding area. Therefore, following measures should be considered: (1) To arrange appropriate renewal schedule of the level crossing to minimize traffic congestion. (2) To inform renewal schedule to signals and telecommunications system users in advance by bulletin board of related railway stations and Township office. (3) To prepare traffic control and management plan including surrounding area.
		A+		A+	Renewal of signals and telecommunication as well as introduction of DEMUs may give rise to improve significantly public transport activity as basic social infrastructure in Yangon City.
5) Social institutions such as social infrastructure and local decision-making institutions	C-		B-		The project itself intends to improve railway transport, which is major portion of public transport in Yangon City. However, if information disclosure of the project plan, and procedure and public participation are not properly carried out, anxieties and discontents may spread over the people and communities resulting in difficulties with acceptability of the project by them.
		C-		B-	
6) Vulnerable group such as the poor, women, children, elderly, disabled etc.	C-		B+		1) In some parts along YCRL and compounds of Myanmar Railways communities and huts of the poor are distributed.
					2) The project may create employment opportunity of vulnerable group such as the poor and women for construction work.
		B+		B+	Vulnerable group such as children and women are also encouraged by the improvement of access to hospitals and schools in Yangon City due to faster and safer train operation by renovation of YCRL.
				B-	3) At present many vendors who are mostly poor, are entering into railway yard of stations and sections such as Da Nyin Gone, Thamine Station and Pa Ywet Seik Gone Station to sell goods such as vegetables to train passengers in daytime. However, vendor's business activities in railway yard will be stopped due to installation of fences along railway track in order to smooth operation of train and to prevent railway accidents with higher train speed of 60 km/h.
7) Ethnic minority	C-		D		Myanmar is an ethnically diverse nation with 135 distinct ethnic groups. However, there is found no ethnic minorities in the project site.
		C-		D	
8) Misdistribution of benefit and damage	C-		B-		1) The project itself intends to improve railway transport, which is major portion of public transport in Yangon City and may not cause any misdistribution of benefit and damage to residents and passengers.
		C-		B-	2) There is, however, some possibility of misdistribution of benefit and damage, if the project plan including procedures to the implementation including construction work and resettlement matters are not properly disseminated and consulted with concerned residents and passengers and other stakeholders.
9) Local conflict of interests	C-		B-		1) The project itself intends to improve railway transport, which is major portion of public transport in Yangon City and may not cause any local conflict of interests.
		C-		B-	2) There is, however, some possibility of the conflict, if the project plan including procedures to the implementation including construction work and resettlement matters are not properly disseminated and consulted with concerned residents and passengers and other stakeholders.

Item	Rating				Identification and evaluation of anticipated impacts and their reasons
	Pre-FS		FS		
	I/II	III	I/II	III	
10) Cultural and historical heritage site	C-		D		In Yangon City there are many cultural and historical heritage sites. However, distribution of these sites along and around YCRL is not known at present.
		D		D	No negative impact is expected.
11) Religious Facilities	C-		D		1) Along railway lines and adjacent roads religious facilities such as pagodas, monasteries, Hindu temples, mosques, churches are distributed. These facilities are required to keep clean and quiet environment. 2) However, construction work due to renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used, thus air pollutants and noise generation by construction work is expected to be negligible. In addition, due to renewal of signals and telecommunication system operation of DEMU service can be operated with less noise generation
		C-		D	No negative impact is expected.
12) Landscape	D		D		Change in existing landscape is expected to be negligible.
		C-		D	
13) Water rights, fishing rights and rights of common	C-		D		1) Water rights belong to Department of Water Resources Improvement.
					2) In Myanmar there are two types of fishing rights; one is "fishing grant", which is given with specified river area and another is "license", which is a permit of fishing.
		D		D	3) Rights of commons do not exist in the project site.
14) Public health and Sanitation	C-		D		Construction work due to renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used. Thus, an air pollutant by construction work which may cause adverse impact on respiratory organs is expected to be negligible.
		D		D	No negative impact is expected.
15) Infectious diseases such as HIV/AIDS	B-		D		It was reported infection with HIV/AIDS and venereal disease at worker's camp during road construction stage in other developing countries. However, work for renewal of signals and telecommunication system accompanied with minor rehabilitation of railway track and drainage improvement will be carried out by employees of MR and surrounding residents. Thus, it is unlikely to develop infectious diseases such as HIV/AIDS by construction work.
		D		D	No negative impact is expected.
16) Working condition (including occupational health)	B-		B-		Employees of MR and surrounding residents who will engage to the construction work will be secured for good working condition by MR. However; there is a possibility that the health and occupational safety of the workers may be jeopardized in case of severe working condition and in rainy season.
		D		D	No negative impact is expected.
17) Hazards/security risks	B-		D		The project activities may not cause any hazard and risks.
		D		D	No negative impact is expected.

Item	Rating				Identification and evaluation of anticipated impacts and their reasons
	Pre-FS		FS		
	I/II	III	I/II	III	
18) Accidents	B-		B-		Construction work for renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used. Thus, occurrence of accidents by the work is expected little, if any. However, because the work space is closed to railway track, there is a possibility that there may happen accidents by running train with even low speed.
		B+		B+	Introduction of DEMU with renewal of signals and telecommunication system may materialize train operation with higher speed (maximum 60 km/h) than existing low speed (15 -20 km/h) resulting in reduction of time spent in commuting and upgrading capacity of public transport.
				B-	At present there are found some illegal encroachment such as crossing railway lines by walk and occupation on railway yard with huts, shops and vendors along YCRL sections. Thus, there is a possibility that there may happen accidents by running train with even low speed. Thus, if it may happen accidents by running train with higher speed of 60 km/h, number of casualty and extent of damage from accidents will increase considerably. However, according to the Project plan MR will install fences along railway track for whole section in order to secure smooth operation of train and to prevent railway accidents with higher train speed of 60 km/h. Thus, increase in traffic accidents is unlikely after installation of the fences.
19) Sunlight shading	D		D		YCRL runs at grade level in urban and semi urban area. In addition, neither construction of tall building nor tall wall is planned. Thus, negative impact on sunlight shading is not expected.
		D		D	
20) Radio-frequency interference	C-		D		YCRL runs at grade level in urban and semi urban area. In addition, neither construction of tall building nor tall wall is planned in congested urban area. Thus, negative impact on radio frequency interference is expected.
		C-		D	
(2) Natural Environment					
21) Topography and Geology	C-		D		No large-scale land alteration is expected due to construction work.
		D		D	No negative impact is expected.
22) Soil erosion	C-		D		No large-scale land cutting and filling are expected. However, if improper soil embankment works are performed it is likely to cause soil erosion in rainy season.
		D		D	No negative impact is expected.
23) Groundwater	C-		D		Water can be provided by pumping up of groundwater from well owned by MR, if city water supply is not available.
		D		D	
24) Hydrological situation/drainage condition	C-		D		Generation of wastewater which may affect hydrological condition from renewal of signals and telecommunication system is hardly expected.
		C-		B-	In general railway service area of YCRL is located in flat and low land area. However, according to the hearing from station manager, rise of water level due to high tide, flooding and cyclone have never caused inundation of railway track. However, in case of strong rain in short time accumulating rain water in surrounding area may flow into some railway section, where land level is lower than surrounding area with poor drainage condition, resulting in inundation. Thus, in such sections lifting up of railway track or to establish proper drainage system is necessary to avoid inundation.
25) Coastal zone	C-		D		Topography of the railway service area of YCRL is flat and low, and located close to tidal river such as Yangon River and Pa Zund Taung Creek. However, according to the hearing from station manager rise of water level due to high tide, flooding and cyclone have never caused inundation of railway track.
		D		D	

Item	Rating				Identification and evaluation of anticipated impacts and their reasons
	Pre-FS		FS		
	I/II	III	I/II	III	
26) Protected Area and parks	C-		D		The project site does not include any protected area such as national parks, wildlife reserves or forest reserves.
		D		D	
27) Fauna, Flora, Biodiversity and Ecosystem	C-		B-		1) Precious and endangered fauna and flora species are not found in the project site.
					2) Planted trees along railway track contribute to the shading and visual amenity providing relaxation to train passengers and residents. Thus, cutting or removal of trees due to renewal of signals and communication system along railway line may spoil existing environment with greenery and amenity. Cutting trees should be avoided or relocated as much as possible. In case of tree cutting, it should be replaced by replantation of the same type of tree by MR after necessary permit from concerned authorities such as Forest Department of MOECAF and Playgrounds, Parks & Gardening Department of YCDC.
		D		D	No negative impact is expected.
28) Micro-climate	D		D		Neither construction of tall buildings nor large scale reclamation is planned. Thus, change in micro-climate is not expected.
		D		D	
29) Global warming/climate change	B-		D		Generation of greenhouse gases such as CO_2 due to construction vehicles and machines .is expected in a small scale and temporary. Thus, impact on global warming and climate change is negligible.
		B+		B+	Renovation of YCRL may give rise faster and safer operation than existing train operation. This will enhance modal shift to railway transport from road transport which generate much lower emission of CO_2 than road transport, and results in reduction of greenhouse gases generation such as CO_2.
(3) Environmental Pollution					
30) Air pollution	B-		D		1) At present ambient air quality standards are not established in Myanmar. 2) Construction work due to renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used, thus air pollutants by construction work is expected to be negligible.
		B+		B+	Renewal of railway line may give rise to modal shift to railway transport from road transport which is much lower amount of air pollutant emission than road traffic. This results in reduction of air pollutants generation such as PM and NOx.
31) Water pollution	B-		D		1) At present environmental water quality standards was not established in Myanmar. Construction work due to renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used, thus air pollutants by construction work is expected to be negligible.
		D		B-	Through daily cleaning of trains in Depot generation of wastewater containing oil and grease is expected.
32) Soil contamination	B-		D		Construction work due to renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used, thus leakage of toxic materials such as lubricating oil from construction vehicles and machines are expected to be negligible.
		D		D	No negative impact is expected.
33) Bottom sediment	D		D		No negative impact is expected.
		D		D	No negative impact is expected.

Item	Rating				Identification and evaluation of anticipated impacts and their reasons
	Pre-FS		FS		
	I/II	III	I/II	III	
34) Solid waste	B-		B-		1) Construction work due to renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used. Thus, generation of soil, sand and construction waste is expected with a small scale, if any.
					2) After renewal of level crossing, signals and telecommunication system existing devices should be subject to proper waste treatment and disposal.
		B-		D	No negative impact is expected.
35) Noise and Vibration	B-		D		1) At present ambient noise and vibration standards were not established in Myanmar.
					2) Construction work due to renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used, thus noise generation by construction work is expected to be negligible.
		B+		D	Renewal of railway track and improved condition of train operation may reduce generation of noise and vibration.
36) Ground Subsidence	C-		D		Project component is renewal of existing railway line at grade level. Thus, extraction of a large volume of groundwater such as subway construction is not expected due to the project.
		C-		D	
37) Offensive odor	C-		D		No negative impact is expected.
		D		D	No negative impact is expected.

Note 1: * Environmental items are chosen as indicators expressing environmental and social conditions. Based on JICA Guidelines for Environmental and Social Environment (2010.4) and relevant legislation of Myanmar Government as well as the project plan and environmental condition of the project area.

Note 2: ** Regarding the impacts on "Gender" and "Children's Right" might be related to all items of Social Environment.

Note 3: *** Rating -In general, both positive impact (+) and negative impact (-) are expected due to the anticipated project activities. Thus the following rating criteria are adopted with respect to the extent of impacts:

A (+/-) – Significant positive/negative impact is expected,

B (+/-) – Positive/negative impact is expected to some extent,

C (+/-) – Extent of positive/negative impact is unknown or not clear (Further examination is needed. It should be taken into consideration that impacts may become clear as study progresses.),

D – Negligible or No impact is expected.

Overall rating – Overall rating is determined by adopting the worst (negative) value of rating among three sections.

Note 4: Stage of Implementation, I - Planning stage, II - Construction stage, III - Operation stage

Source: JICA Study Team

6.6 Mitigation Measures and Environmental Management Plan

Mitigation measures, which may avoid, minimize, eliminate and/or reduce above mentioned negative impacts were examined for respective items during planning, construction and operation stage as well as whole stages in order that the project can achieve objectives with minimized accompanied environmental negative impacts.

Negative impacts identified in the above (Table 6.5.1) are written down with necessary mitigation measures are shown in Table 6.6.1.

An Environmental Management Plan (EMP) for the Project implementation was prepared by incorporating mitigation measures together with the roles of implementing, responsible and supervising organizations for each negative impact during planning, construction and operation stages and shown in Table 6.6.1.

Table 6.6.1 Mitigation Measures against Negative Impacts and Environmental Management Plan (EMP)

Affected Environment Item */**	Rating	Mitigation Measures	Implementing Organization***	Responsible and/or Supervising organization***
(I) Planning Stage				
(1) Social Environment				
1) Involuntary Resettlement	B-	1) From early stage of the plan, provide adequate information to PAPs and consult with stakeholders including PAPs to make agreement or thorough understanding of the issues as much as possible. 2) Through inventory survey on possible affected land, assets and structures to make clear feature of involuntary resettlement and to identify PAUs and PAPs. 3) Information disclosure of project often leads to influx of people into the project site for obtaining compensation/resettlement. Thus, MR as the proponent should set up "Cut-off Date" to identify/differentiate genuine PAPs from non-eligible people and identify eligibility of PAPs. Then based on eligibility data prepare Abbreviated Resettlement Plan (ARP) for compensation and resettlement assistance to PAPs complying with both Myanmar legislation and JICA Guidelines for Environmental and Social Considerations. 4) MR should make necessary institutional arrangement such as setting up staff in charge of implementation of the ARP and Compensation Committee with relating organizations. 5) Implementation of necessary compensation and resettlement assistance should be carried out before commencement of construction work.	MR	YRG, YCDC, GAD, MOECAF
(II) Construction Stage				
(1) Social Environment				
4) Existing social infrastructures and services	B-	To avoid or minimize traffic disturbance and nuisance to local people and communities, following measures will be conducted: 1) Prior to construction work, inform contents of the construction work and schedule. 2) Time shift of construction work. 3) Education of traffic safety and manner to construction workers and drivers. 4) Raise the traffic signal and arrange watchmen on approach road. 5) Equip sheet cover to prevent scattering dust from the bed of truck. 6) Setting staff in charge of complaints.	CT	MR, YCDC, YRDC
16) Working condition (including occupational health)	B-	1) In the construction work contractor should comply with requirement of Labor Law and Labor Safety Law (draft). 2) Preparation of safety management plan and enlighten occupational safety to construction workers. 3) Tangible safety considerations should be prepared for individuals involved in the project. (i) The installation of safety equipment and management of hazardous materials. (ii) Any worker and personnel who enter into construction sites have to bear safety shoes, hats and earplugs for construction works. 4) Monitoring health condition and occupational safety of workers.	CT	MR, YCDC

Affected Environment Item */**	Rating	Mitigation Measures	Implementing Organization***	Responsible and/or Supervising organization***
18) Accidents	B-	1) Suitable planning and management over construction work to prevent and minimize the number and consequences of accidents. 2) To collect and analyze cases and causes of accidents. 3) Enlighten workers and local residents to prevent accidents by training and adequate notice.	CT	MR, YCDC
(2) Natural Environment				
24) Hydrological situation/Drainage pattern	B-	In some area of railway sections, where land level is lower than surrounding area and is with poor drainage condition. In such sections lifting up of ground level of railway track should be planned to avoid inundation of railway track.	CT	MR, YCDC
27) Flora, Fauna, Biodiversity and Ecosystem	B-	1) For cutting, removal or replanting trees along railway track prior consultation with YCDC and MOECAF should be conducted. 2) After removal of trees replanting of trees for shading and visual amenity should be planned.	CT	MR, YCDC
(3) Environmental Pollution				
34) Waste	B-	1) Consider ways to minimize waste generation in the construction work plan. 2) Enlightenment and education of construction workers for waste management based on 3R principle (reduce, reuse, and recycle). 3) After renewal of level crossing, signals and telecommunication system existing devices should be subject to proper waste treatment and disposal.	CT	MR, YCDC
(III) Operation Stage				
(1) Social Environment				
2) Local economy such as employment and livelihood etc.	B-	Appropriate measures such as making space and/or facilities for vendors to sell goods near railway yard of stations and sections such as Da Nyin Gone and Thamine Station, enabling to continue their business activities should be considered by MR and relating organizations such as YCDC.	MR	MR, YRG, YCDC
6) Vulnerable group such as the poor, women, children, elderly, disabled etc.		Appropriate measures such as making space and/or facilities for vendors to sell goods near railway yard of stations and sections such as Da Nyin Gone and Thamine Station, enabling to continue their business activities should be considered by MR and relating organizations such as YCDC, because they are mostly poor farmers of surrounding area according to the results of hearing survey.	MR	MR, YRG, YCDC
18) Accidents	B-	1) Enlightenment railway operation safety to conductors and passengers as well as residents. 2) Collect cases and causes of railway accidents. 3) Install fences along railway track to stop encroachment such as crossing railway lines by walk and occupation on railway yard in order to prevent traffic accidents by train operation.	MR	YCDC, MOHA
(2) Natural Environment				
24) Hydrological situation/Drainage pattern	B-	In some area of railway sections, where land level is lower than surrounding area and is with poor drainage condition. In such sections lifting up of ground level of railway track should be planned to avoid inundation of railway track.	MR	MR, YCDC

Affected Environment Item */**	Rating	Mitigation Measures	Implementing Organization***	Responsible and/or Supervising organization***
(3) Environmental Pollution				
31) Water pollution	B-	1) Proper treatment of effluent from railway station to comply with wastewater regulation by YCDC. 2) Wastewater containing oil and grease from depot should be treated appropriately by installation of wastewater treatment facility.	MR	YCDC, MOECAF
(IV) Overall Stages				
(1) Social Environment				
5) Social institutions such as social infrastructure and local decision-making institutions	B-	1) Information disclosure and public participation should be fully considered for all the stakeholders including local residents and road users from planning stage to operation stage for obtaining thorough understanding and consensus of the people and communities. 2) MR should set up a section in charge of public communication and complaints from peoples.	MR, CT	YRG, YCDC, MOECAF
8) Misdistribution of benefit and damage	B-	1) Consultation with stakeholders including local residents, community organizations etc., should be planned from an early stage to obtain understanding and consent among the stakeholders in order to share equally benefits and damage. 2) Consider preference of employment to local residents and the poor for construction works. 3) MR should set up a section in charge of public communication and complaints from peoples.	MR, CT	YRG, YCDC, MOECAF
9) Local conflict of interests	B-	1) Consultation with stakeholders including local residents, community organizations etc., should be planned from an early stage to obtain understanding and consent among the stakeholders in order to avoid local conflict of interests. 2) Consider preference of employment to local residents and the poor for construction works. 3) MR should set up a section in charge of public communication and complaints from peoples.	MR, CT	YRG, YCDC, MOECAF

Note 1: * "x)" indicates serial number of environmental item

Note 2: ** Rating of the negative impacts are (B-) for all items.

Note 3: *** Implementing Organizations/ Responsible and supervising organizations - MR: Myanma Railways, CT: Contractor, YRG: Yangon Regional Government, YCDC: Yangon City Development Committee, MOECAF - Ministry of Environmental Conservation and Forestry, MOHA: Ministry of Home Affairs.

Source: JICA Study Team

6.7 Environmental Monitoring Plan

Considering mitigation measures against negative impacts in the EMP, environmental monitoring plan which may support the measures, was prepared as shown in Table 6.7.1.

Table 6.7.1 Environmental Monitoring Plan

Category	Item	Method of Monitoring	Monitoring Place/Point	Frequency (Period)	Referable Standards and Legislation	Implementation org.	Responsible and/or supervising org.	Cost (USD)
(I) Planning Stage								
1) Approval/ permission etc.	Permission of Project Implementation and Environmental Clearance Certificate	1) Permission procedures of projects for public purpose by foreign donors. 2) Environmental Clearance Certificate by MOECAF	FERD, PD, MOECAF	Before commencement of construction work	1) Environmental Conservation Law (2012), Environmental Conservation Rules (2014)	MR	FERD, PD, MOECAF	MR
2) Social Environment	Implementation of compensation and resettlement assistance to PAPs, and resulting existing living condition and livelihood of PAPs	Interview survey on PAPs and PAUs	PAPs and PAUs	Before commencement of construction work	1) Land related legislation of Myanmar, 2) JICA Guidelines	MR	GAD, YRG, YCDC	MR
	Securing necessary land clearance for the project site	1) Site observation 2) Documents about transfer of land using rights from YCDC, Medical University of Yangon and other concerned organizations	Area to be secured	Before commencement of construction work	Land related legislation of Myanmar	MR	GAD, YRG, YCDC	MR
(II) Construction Stage								
1) Social Environment	Increase in traffic congestion and disturbance of access to public facilities etc.	1) Collection of complaints 2) Physical observation of road traffic condition 3) hearing to Traffic Police	Construction site and surroundings	Every day of construction work	Traffic related regulations -	CT, MR	YRG, YCDC, MOHA	CT
	Working condition	Medical check and symptom of workers	Construction site and surroundings	As required	Labor Safety Law	CT, MR	YRG, YCDC, MOL	CT
	Accident	Records of accidents in the project area	Construction site and surroundings	Daily	Labor Law, Labor Safety Law	CT, MR	YRG, YCDC, MOHA	CT

Category	Item	Method of Monitoring	Monitoring Place/Point	Frequency (Period)	Referable Standards and Legislation	Implementation org.	Responsible and/or supervising org.	Cost (USD)
2) Natural Environment	Replanting trees	1) Physical observation 2) Hearing	Construction site and surroundings	One time per year		CT, MR	YRG, YCDC, MOECAF	CT
3) Environmental Pollution	Sold waste management	Record of collection, transportation and disposal	Construction site and surroundings	Daily	YCDC regulation	CT, MR	YRG, YCDC, MOH, MOECAF	CT
(III) Operation Stage								
1) Social Environment	Local economy such as employment and livelihood etc.	1) Complaints 2) Hearing	Project area	As required	Acceptance by vendors	MR	YRG, YCDC	MR
	Vulnerable group such as the poor, women, children, elderly, disabled etc.	1) Complaints 2) Hearing	Project area	As required	Acceptance by vendors	MR	YRG, YCDC	MR
	Accidents	Records of accidents	Project area	As required	Disaster Prevention Law	MR	YRG, YCDC, MOHA	MR
2) Environmental pollution	Water pollution	1) Complaints 2) Physical observation 3) Wastewater analysis (pH, BOD, COD, SS, oil and grease)	Discharged point from wastewater treatment plant of depot	3 times /year for 2 years after operation	Environmental Standards of WHO and Japan	MR	YRG, YCDC, MOECAF	1,800
(IV) Whole Stages								
1) Social Environment	Acceptability of the project	1) Arrange section and staff in charge of complaints and requests from PAPs, concerned communities, peoples and organizations. 2) Hold stakeholder meeting and consultation with residents etc.	Project area	As required	Acceptance by PAPs, concerned communities, peoples and organizations	MR	YRG, YCDC, MOECAF	MR
Monitoring Cost (USD)								1,800

Note 1 :Implementing Organizations/ Responsible and supervising organizations - MR: Myanma Railways, CT: Contractor, YRG: Yangon Regional Government, YCDC: Yangon City Development Committee, MOECAF - Ministry of Environmental Conservation and Forestry, FERD - Foreign Economic Relations Department, MNPED, PD - Planning Department, MRT, MOH-Ministry of Health, GAD- General Administration Department, Ministry of Home Affairs (MOHA), MOL-Ministry of Labour, Employment and Social Security.

Source: JICA Study Team

Above Monitoring Plan in Monitoring Form of JICA Guidelines is shown in Appnedix 6.8.

6.8 Stakeholder Meetings

For the purpose of information disclosure and public participation of the project, stakeholder meetings were held three times; the first meeting was at scoping phase, the second meeting was focused on the project plan with western section and the third meeting was based on revised scope of the project with whole section.

Outline of each meeting is shown in Table 6.8.1 to 6.8.3.

Details of the results of the meetings are shown in Appendix 2.9.1 to 2.9.3.

Table 6.8.1 The 1st Stakeholder Meeting

Project Name	Yangon Circular Railway Line Upgrading Project
Agenda	1) ***Opening Remarks*** by U Aung Khin, Minister, Ministry of Transport and communication, Yangon Region Government 2) Presentation on Project Procedures, by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railway, Ministry of Rail Transportation 3) Presentation on Environmental and Social Considerations in Yangon Circular Railway Line Upgrading Project, by U Aye Thiha, Managing Director of E Guard Environmental Services Co., Ltd. 4) Tea Break 5) Question and Answer Session 6) ***Closing Remarks*** by Mr. Tun Aung Thin, General Manager, Myanma Railway
Date	August 7, Thursday 2014
Time	13:00 pm to 16:00 pm
Venue	Ruby Hall-Asia Plaza Hotel, Yangon
Attendees	11 Local Interested Persons 66 reporters (News Media) 13 Politicians (Members of Yangon Regional Parliament and others) 29 Staffs from Government Departments and other Organization 1 Person from NGOs 5 Persons from JICA Study Team 7 Persons from E Guard Environmental Services Co., Ltd.
Materials Provided	1) Agenda 2) Power-point Presentation Document on Project Procedures 3) Power-point Presentation Document on Environmental and Social Considerations
Prepared by	U Ye Wint Aung (E Guard Environmental Services Co., Ltd)

Source JICA Study Team

Table 6.8.2 The 2nd Stakeholder Meeting

Project Name	Yangon Circular Railway Line Upgrading Project
Agenda	1) Opening Remarks by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation 2) Presentation on Project Plan, by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation 3) Presentation on Environmental and Social Considerations in Yangon Circular Railway Line Upgrading Project, by U Aye Thiha, Managing Director of E Guard Environmental Services Co., Ltd. 4) Tea Break 5) Question and Answer Session 6) Closing Remarks by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation
Date	September 23rd, Tuesday 2014
Time	13:00 pm to 16:00 pm
Venue	Yuzana Garden Hotel, Yangon
Attendees	65 Project Affected Persons (PAPs) 56 Reporters (News Media) 28 Staffs from Government Departments and other Organizations 7 Personnel from NGOs and Private Companies 7 Personnel from JICA Study Team 13 Personnel from E Guard Environmental Services Co., Ltd. Total Participants (176)
Materials Provided	1) Agenda 2) Power-point Presentation Document on Project Plan 3) Power-point Presentation Document on Environmental and Social Considerations
Prepared by	U Ye Wint Aung (E Guard Environmental Services Co., Ltd)

Source JICA Study Team

Table 6.8.3 The 3rd Stakeholder Meeting

Project Name	Yangon Circular Railway Line Upgrading Project
Agenda	1) Opening Remarks by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation 2) Presentation on Project Brief, by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation 3) Presentation on Environmental and Social Considerations in Yangon Circular Railway Line Upgrading Project, by U Tin Aung Moe, Director of E Guard Environmental Services Co., Ltd. 4) Tea Break 5) Question and Answer Session 6) Closing Remarks by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation
Date	May 12, Tuesday 2015
Time	13:00 pm to 16:00 pm
Venue	Yuzana Garden Hotel, Yangon
Attendees	19- Project Affected Persons (PAPs) and Local Interest People 62- Reporters (Media) 15- Staffs from Government Departments 7- Members of Parliament, Yangon Region 6 Personnel from JICA Study Team 10 Personnel from E Guard Environmental Services Co., Ltd. Total Participants (120)
Materials Provided	1) Agenda 2) Power-point Presentation Document on Project Brief 3) Power-point Presentation Document on Environmental and Social Considerations

Source JICA Study Team

6.9 Abbreviated Resettlement Plan (ARP)

6.9.1 Purpose and Objectives of Preparation of ARP

According to the JICA Guidelines, if the occurrence of involuntary resettlement, namely land acquisition and/or resettlement is anticipated, Resettlement Action Plan (RAP) or Abbreviated Resettlement Plan (ARP) should be prepared by the project executing agency, which depends on the number of Project Affected Persons (PAPs) to be resettled.

As described in 6.6 and later in 6.10.4, the number of anticipated PAPs to be resettled is less than 200. Therefore, preparation of an ARP is required by the proponent, namely MR.

The ARP should be prepared for guidance for MR, and a reference for concerned local governments with regard to the resettlement activities under the existing laws and regulations in Myanmar.

Objectives of the ARP are summarized as follows:

- To protect communities and peoples from possible losses and other disadvantages caused by the Project;
- To establish compensation policies for the sake of PAPs based on their existing socio-economic conditions;
- To arrange necessary budget of MR for the resettlement and other associated activities; and,
- To provide guidance with PAPs and the concerned local governments in arranging the resettlement, which helps execution of a series of necessary treatment for the PAPs in a fair and facilitated manner with transparency?

It should be noted that the ARP is prepared to support project affected persons (PAPs) in maintaining their quality of life, the existing income opportunities and livelihoods.

6.9.2 Legal and Institutional Framework for Involuntary Resettlement

(1) Relevant Myanmar Legislation

There are relevant laws that govern the land issues, the land administration, and the land ownership in Myanmar, including Land Nationalization Act (1953), Disposal of Tenancies Law (1963), Land Acquisition Act (1894), Forest Law (1992), Farm Land Law (2012), etc. The Land Acquisition Act (1894) provides the core legal framework among them in terms of land acquisition.

The existing land acquisition process is summarized as the following five steps based on the Land Acquisition Act 1894.

- Step 1: Preliminary investigation
- Step 2: Hearing of objections
- Step 3: Declaration of intended acquisition
- Step 4: Enquiry into measurements, value and claims, and award by the collector
- Step 5: Payment and Taking Possession of Land

Detailed procedures of existing land acquisition process as well as role and function of relevant organizations are shown in Appendix 2.10.

(2) Involuntary Resettlement Policy of the JICA Guidelines

It is also required that the policy applied to involuntary resettlement of the project shall comply with the JICA Guidelines in addition to the existing Myanmar Legislation.

Details of the principles suggested in the JICA Guidelines with regard to the involuntary resettlement policy (land acquisition and resettlement) are shown in Appendix 2.10.

(3) Comparison of the Policy of the JICA Guidelines with Myanmar Legislation

There are several differences; for example, neither the avoidance and minimization of involuntary resettlement and loss of livelihood nor the requirement of preparation of Resettlement Action Plan is stated in the existing Myanmar legislation. No relevant law is identified with regard to the participation of Project Affected Persons (PAPs) in public consultation for land acquisition and resettlement procedures. In general less consideration to PAPs is provided in the existing Myanmar legislation, which indicates that the JICA Guidelines should be referred in carrying out the Project.

Details of gaps in resettlement policy between Myanmar legislation and JICA Guidelines are shown in Appendix 2.10.

6.9.3 Resettlement Policy

(1) General Considerations

The Policy applied to the involuntary resettlement with regard to the project implementation shall follow both the JICA Guidelines and the Myanmar Legislation.

However, considering that the gaps exist between the JICA Guidelines and the Myanmar Legislation described above, and that the JICA Guidelines provide comprehensive guidelines comparatively, the resettlement policy for this particular project shall be based on the JICA Guidelines.

(2) Replacement Costs

The compensation to the PAPs who have the eligibility, namely, who meet the cut-off date, shall be made based on the principles stated below.

A necessary compensation amount for the replacement is calculated before the displacement, which is needed to replace the affected assets without depreciation and without deduction for taxes and/or costs of transaction:

- Productive land (agricultural, aquaculture, garden and forest): based on the current market prices that reflect recent land sales in the area, and in the absence of such recent sales, based on the recent sales in comparable locations with comparable attributes, fees and taxes or in the absence of such sales, based on the productive value.
- Residential land: based on the current market prices that reflect recent land sales, and in the absence of such recent land sales, based on the prices of recent sales in comparable locations with comparable attributes; fees and taxes.
- Existing local government regulations for calculation of compensation for building, crops and trees shall be used wherever available.
- Houses and other related structures: based on the actual current market prices of affected materials.
- Annual crops: cash compensation for the replacement should be in line with local government regulations if available or equivalent to the current market value of crops at the time of compensation.

- Perennial crops: cash compensation for the replacement should be in line with local government regulations if available, or equivalent to the current market value of crops at the time of compensation
- For timber trees: cash compensation for the replacement should be in line with local government regulations if available, equivalent to the current market value by type, age and relevant productive value at the time of compensation based on the diameter at breast height of each tree.

(3) Complementary Compensation

MR and the responsible agencies are requested to follow the JICA's Guidelines as well as the existing laws and regulation in the country in making compensation for the losses of PAPs in this particular project. In the case that an amount of compensation does not meet the JICA's requirement, MR or the responsible agencies are requested to prepare complementary compensation to meet the guideline.

(4) Cut-off-date and Eligibility

There will be no land acquisition required for the Project because all of the project works will be made within the MR's right of way (ROW), however, those who have assets (houses, shops etc.) and who do some productive activities such as growing Chinese water spinach for their living in the MR's ROW are requested to move out of their house and the places. These cases are not the cases of land acquisition, but can be treated like a case of land acquisition in terms of compensation.

Establishment of the eligibility cut-off date is important to prevent influx of ineligible non-residents who might take advantage of the project entitlements. A comprehensive census survey on the possible PAPs was completed in March 2015, and a list of PAPs was prepared accordingly. Based on this census survey, notification of the Project and the cut-off date can be informed to the public made by the end of April 2015.

6.9.4 ARP Implementation

(1) Processes for Involuntary Resettlement

MR as the project proponent has full responsibility to implement of the resettlement. Table 6.9.1 shows the responsibility and necessary actions that must be taken by MR in the process of the implementation.

Table 6.9.1 Process of the Implementation of the Resettlement and Responsibility/Necessary Action of MR

Subject	Responsibility/Actions of MR
I. In turn with process of resettlement	
Make clear project purpose and features (components, scale, location etc.)	Preparation of the Project Plan
Examine anticipated impacts	Environmental Scoping
Disclose the project information including anticipated impacts and prepare public participation in the project	Hold stakeholder meetings and individual consultations
Make clear location, features of the project area and activities during Planning, Construction and Operation Stage	Detailing and finalization of the project plan
Identify type and extent of losses, PAUs, PAPs etc.	Inventory survey on anticipated affected area
Examine the occurrence of resettlement (land acquisition/resettlement) and necessity of preparation of ARP	1) Identify generation of PAUs and/or PAPs 2) Confirm number of PAPs to be resettled (less than 200 persons)
Institutional arrangement for preparation and implementation of ARP	Establish task force/unit/staff who are in charge of preparation and implementation of ARP in MR, and build the capability.
Disclose features of expected resettlement (location, type and extent of losses, PAUs and PAPs etc.) and notification of Cut-off date	Stakeholder meeting and public notice by newspaper and/or message boards, etc.
Detailed data collection from PAUs and PAPs	Conduct census survey on PAUs and PAPs (household and socio-economic survey etc.)
Establish action plan for implementation of compensation and resettlement assistance	Prepare ARP and disclose to PAPs and concerned peoples and organizations
Identify eligibility of PAPs for compensation and/or resettlement assistance	Individual/group consultation with PAPs
Make clear method and/or cost of compensation and resettlement assistance for PAPs	Prepare entitlement matrix including types impact/loss, eligibility, compensation and resettlement assistance for PAPs etc.
Disclose ARP and inform policy and procedures of compensation and resettlement assistance	Prepare and authorize the ARP by MR itself. MR should revise/update, if necessary.
Secure fund for payment of compensation and resettlement assistance	Prepare budget for compensation and resettlement assistance
Payment of compensation fee and support of resettlement assistance	Execute payment of compensation fee and support of resettlement assistance
1) Remove affected structures and re-construct at relocation site. 2) Move PAPs from the existing residing/working site to resettle to relocation site.	Manage and control the removal of structures and transfer of PAPs
Completion of the ARP implementation	Confirm completion of the ARP implementation
II. Appropriate timing as required in the process	
Revision/Updating of ARP	Revise/update the ARP as the progress of implementation of ARP, if necessary
Grievance of redress mechanism	Establish unit/staff in charge of coping with complaints and grievances from PAPs
Steering committees to support implementation of ARP	Arrange and hold relevant committees to implement ARP as the need arises
Monitoring for ARP implementation	Internal monitoring (MR) and external monitoring by third party

Source JICA Study Team (2015)

(2) Institutional Arrangement for ARP in MR

MR should establish an ARP task force team and assign following personnel as suggested in Table 6.9.1. The key personnel of the task force team are as follows:

- ARP supervising manager - the officer who supervises all over the implementation process of ARP.
- ARP task management officer(s) - The role of this management officer is to ensure the smooth and timely implementation of ARP. The officers manage and support the tasks in MR relating to ARP
- Grievance redress officer - The key objective of this officer is to ensure good relations with both the PAPs and community based organizations for adequate response to grievance from PAPs.
- Accounting officer - The officer manages compensation payment process and the expense in ARP implementation.

(3) Concerned Organizations in implementing ARP

Major organizations concerned with implementation of the ARP for this project are shown in Table 6.9.2.

Table 6.9.2 Concerned Organizations with the Implementation of the ARP

Organization	Role	Responsibility and Duty
Ministry of Railway Transport (MRT)	Role as the line Ministry	• Supervise the activities of MR in terms of ARP implementation.
Myanma Railways (MR)	Role as the proponent	• Survey on the relevant data, statistics, etc. of the structures that are removed or relocated. • Establish Compensation Fixation Committee (CFC) as per necessity. • Establish communication mechanism (protocol) with PAPs, YCDC, GAD, YRG etc. • Consultation and making agreement with PAPs on compensation and necessary assistance for their resettlement, and corresponding payment to PAPs. • Support PAPs livelihood during transition period. • Timely, fair and reasonable response for grievance from PAPs. • Monitoring of ARP implementation
YCDC - Land Administration Department (LAD)	Role as the responsible local government relating to Structures removing and Resettlement	• Support MR and PAPs in arranging relocation and/or reconstruction place • Advice MR and PAPs to determine compensation rate
General Administration Department (GAD)	Role as the lead authority of Land Acquisition Act	• Advice MR and PAPs with regard to the procedures of Structures removing and resettlement, referring the Land Acquisition Act and case experiences in GAD. • Advice MR and PAPs in determining compensation rate.
Settlement and Land Record Department (SLRD), Department of Human Settlement and Housing Development (DHSHD), NGOs, consultants etc.	Support and consultation for MR	• Advice MR and PAPs with regard to the procedures of Structures removing and resettlement. • Advice MR and PAPs in determining compensation rate.

Source: JICA Study Team

(4) Committees for the Implementation of the ARP

Three committees should be established for the actual implementation of the ARP, namely Compensation Committee, Grievance Redress Committee, and Award Committee as shown in Table 6.9.3.

Table 6.9.3 Committees for ARP implementation

Committee	Organization	Role and Function
Compensation Committee	MR, YCDC, GAD, SRLD, DHSHD, concerned Townships etc.	To determine details of compensation and resettlement assistance including eligibility identification and valuation of compensation fee to PAPs
Grievance Redress Committee	MR, YCDC, concerned Townships etc.	To cope with grievances and complaints from PAPs
Award Committee	MR, YCDC, concerned Townships etc.	To identify eligibility and valuation of compensation to PAPs

Source JICA Study Team

6.9.5 Scope of Resettlements, and Impacts

(1) Project Affected Units and Project Affected Persons

Twelve (12) structures, Project Affected Units (PAUs) in total are affected by the Project.

The corresponding number of Project Affected Persons (PAPs) is enumerated by the census survey carried out in February 2015 by the JICA Study Team, reaching at 51 persons in total (refer to Table 6.9.4) . This figure includes MR staff and their family members living in the MR staff houses, MR shops and Non-MR shops.

There also observed some agricultural activities along the project section, namely, using liner spaces along the rail line (within MR ROW), some people are cultivating vegetables. These spaces are rented from MR to those people for their cultivation purpose. The Project may affect this kind of agricultural activities, namely, building fence along the project section will make them not to enter into those spaces. In this regard, MR might be requested to take a proper action for them. As the first step, the existing lessee on the leased land should be clearly identified. Consequently MR is requested to identify those who are using the land but without any leasing agreement with MR. These people are also deemed as PAPs. In parallel with this PAPs identification process, the existing prices of their agricultural products should also be recorded as a basis for estimating the corresponding compensation amount.

It should be noted that some trees and electric poles along the project section need to be removed and replaced by this Project. MR, the executing agency, needs to obtain approval from concerned agencies to do such work.

Table 6.9.4 Expected PAUs and PAPs by the Project

Corridor of Impact	Type of Structures/Business Assistance	PAUs*, **	PAPs*, **	Number of persons to be resettled
1. Along the Western Section	MR staff house*	0	0	0
	Non-MR staff house	2	9	9
	MR shop	0	0	0
	Non-MR shop	1	3	3
	Public facilities	0	0	0
	Community facilities	0	0	0
	Pond (Chinese water spinach cultivation)	0	0	0
Sub-total		3	12	12
2. Along Eastern Section	MR staff house*	5	25	25
	Non-MR staff house	0	0	0
	MR shop	0	0	0
	Non-MR shop	2	11	11
	Public facilities	0	0	0
	Community facilities	0	0	0
	Fence (Lettuce Plantation)	1	9	0
	Plantation for home use	1	6	0
Sub-total		**9**	**51**	**36**
3. Whole section	MR staff house*	5	25	25
	Non-MR staff house	2	9	9
	MR shop	0	0	0
	Non-MR shop	3	14	14
	Public facilities	0	0	0
	Community facilities	0	0	0
	Fence (Lettuce Plantation)**	1	9	0
	Vegetable Plantation for home use**	1	6	0
Total (1 + 2)		**12**	**63**	**48**

Note 1: * Although MR staff housed belong to MR, the project proponent, people living in the houses including MR officers are considered to be as PAPs with involuntary resettlement according to JICA Evaluation Department.

Note 2: **Agriculture activity will be able to continue with reduced area

Source: Census Survey, JICA Study Team (March 2015))

Source: JICA Study Team (2015)

(2) Entitlement Matrix

An entitlement matrix serves as a tool for evaluating the possible losses caused by the Project, namely it identifies eligibility of PAPs and provides a basis for necessary compensation and resettlement assistance with the PAPs. Table 6.9.5 summarizes the Entitlement Matrix designed for this Project.

In the case that the gaps exist between the JICA Guidelines and the Myanmar Legislation in a way of setting eligibility or identifying eligible persons, this entitlement matrix should be used according to the JICA Guidelines.

Table 6.9.5 Entitlement Matrix

Type of Loss	Level of Impact	Classification of affected units	Entitled Person(s) or Organization(s) to be compensated	Policy and contents of compensation	Remarks	Responsible Organization
1. Agricultural land within the MR ROW						
(1) Loss of arable and grazing agricultural land or access to it	Partial loss of farm land waterlogged land used to cultivate vegetables	Land which is used to cultivate lettuce and water vegetables such as Chinese water spinach	Persons cultivating lettuce and water vegetables	Provide cash compensation that is equivalent to the amount of five years net income generated from the lost land, including four years net income generated from the land as supplement to his sales loss of products and one-year net income as assistance for transition period.	Owner of the waterlogged land is MR. MR rents the land to persons who cultivate the land.	MR
2. Structures owned by private owners within MR ROW						
(1) Loss of structures and / or loss of access opportunity	Permanent (complete or partial) loss of structures of shops / workshops	MR shops	Individuals (tenants) who are doing business (shops) using the shops owned by MR.	Provide a similar and affordable rental structure (shops) and provide compensation for moving costs and assistance for the transition period.	Owner of the shop structures is MR. MR leases the structures to the shop owners.	MR
(2) Loss of private structures or access to them	Permanent (complete or partial) loss of structures for shops /workshops	1) Non-MR house 2) Non-MR shop (not having formal legal ownership right)	Individuals who do not have any recognizable legal right or claim to the land.	1) Provide cash compensation for replacement costs of the affected structures if the PAPs build them.		MR
		Non-MR shop (not having formal legal ownership right)		Provide assistance in moving and finding similar and affordable rental accommodation /structure (this may include moving allowance and rental allowance for transition period).		
3. Loss of Income or Access to Income (Commercial, Business, and Industrial Activities)						
(1) Loss of income and work days because of replacement	Temporary loss of income during replacement of shops /workshops	1) MR shop (replacement) 2) Non-MR shop (replacement)	Owner of shops /workshops with formal registered businesses and fulfilled taxation duties	Provide cash compensation as assistance for the transition period to help PAPs to restore and/or to improve their business and livelihood. (Note :*)		MR
	Temporary loss of income during resettlement	1) Non-MR house (resettlement) 2) MR shop (resettlement) 3) Non-MR shop (resettlement)	Persons who are necessary to resettle	Provide development assistance to resettlement PAPs (including job training) in order to help them to restore and/or to improve their livelihood in transition period.		MR

Type of Loss	Level of Impact	Classification of affected units	Entitled Person(s) or Organization(s) to be compensated	Policy and contents of compensation	Remarks	Responsible Organization
(2) Loss of income due to losing jobs by the reason relating to the Project	Temporary loss of income due to losing the jobs	1) Non-MR house 2) MR shop 3) Non-MR shop	Employees /workers who lose their jobs in formal registered businesses by the reason relating to the Project.	1) The owner pay amount of one-month wage as unemployment allowance. 2) Compensation amount paid to the owner by MR (Note: *) includes this allowance.		MR
4. Trees, plants or access to them						
Loss of Trees, plants or access to them	Permanent loss of trees on the public land	Assets of Local government (There is none of trees possessed by private organization or individual.)	Local government (YCDC)	1) According to the instruction from Forestry Department of MOECAF, for cutting, removing and/or replanting affected trees (regardless of the private or public, including MR's trees), at first to submit application letter including data of tree species, location and numbers of trees, to the Department for obtaining permission. 2) Cutting trees should be avoided as much as possible. If it is unavoidable, cutting, removing and/or replanting trees should be carried out by Civil Engineering Department, MR.	Ownership by MR	MR, YCDC

Source: JICA Study Team (2015)

(3) Grievance Redress Mechanism

Disputes may inevitably happen during the implementation of ARP. It is therefore important to establish a clear grievance procedure for PAPs so that concerns and disagreements regarding the resettlement process and compensation can be properly addressed. The success of a grievance mechanism is dependent on how swiftly such issues are resolved.

(4) Estimation of Compensation amount and Budget for Structures Replacement and Resettlement

1) Estimation of compensation amount

The amount of the compensation is estimated based on the "6.10.3 Resettlement Policy" in this plan. The methods of estimation are as follows:

a) Compensation for loss of farmland cultivated for vegetable

- Cash compensation for the direct loss of net income that is generated from the sale of vegetables: the amount shall be four-year net income equivalent.
- Cash compensation to assist activities in the transition period: the amount is one year net income equivalent.
- Total amount of compensation: five years net income (four plus one year).
- Productivity (vegetable-kg/ft^2) of waterlogged land, price (vegetable-MMK/kg) and sales/net income ratio are set using data obtained from the cultivator of similar waterlogged land.
- Compensation rate
  = Productivity of the land (vegetable-kg/m^2) x vegetable price (vegetable-MMK/kg)) x sales/net income ratio x affected area (m^2) x 5 (five year)
  = 150 x 50 x 0.50 x 5 x affected area (m^2) = 18,750 x affected area (MMK)

b) Compensation for replacement

- Do not take into account depreciation of the asset and value of salvage materials.
- The construction costs (using new materials) of the structures which are similar to the affected structures were surveyed by hearing from the owners of such structures.
- The unit values of construction cost by type of structures were set as shown in Table 6.9.6. For class A and B structures in Table 6.9.6, the data obtained by the survey above was used. For class C and D structures in Table 6.9.6, the data by approximation according to MR standard cost integration by the survey team.
- Replacement construction cost (MMK)
  = Unit values of construction cost (MMK/ft^2) x Structure area (ft^2)

Table 6.9.6 Unit Values

Classification			Main constructional material	Unit value of construction cost
				MMK/ft^2
A	A-1	shop	Roof: Tarpaulin	2,000
	A-2	house	Wall: bamboo	5,200
B	B-1	shop	Roof: Zinc	6,000
	B-2	house	Wall: Wood	7,500
C	C		Roof: Zinc Wall: Good wood	12,000
D	C		Roof: Zinc Wall: Concrete	25,000

Source: JICA Study Team (2015)

c) Moving support: 100,000 MMK for each structure

d) Compensation to cover loss of income source and to assist for transition period: 1.5 month sale/income of each structure.

e) Compensation to assist for resettlement: compensation amount is 200,000 MMK/person to be resettled.

Actual compensation amount will be considered and determined by Compensation Committee being composed of MR, Yangon Region, YCDC, representatives from respective township and other concerned agencies, using above mentioned method according to JICA Guidelines, and based on actual market price of construction materials, as well as actual monthly sale/income of each shop/workshop.

2) Estimation of the budget of MR for Structures Replacement and Resettlement

Table 6.9.7 summarizes the budget of MR for Structures Replacement and Resettlement.

The estimated amount of compensation for non-MR PAPs based on the JICA Guideline included in the Table 6.9.7. While Table 6.9.8 shows the indicative cost for the resettlement of MR staff housing.

Table 6.9.7 Estimation of the budget of MR for Structures Replacement and Resettlement

Items	Compensation amount (MMK)	Description
1. Compensation for loss of cultivating land and waterlogged land	CONFIDENTIAL	- Loss of net income by sale of vegetables(4 years) - Assistance of activities in transition period
2. Compensation for replacement cost of structures		Removal and construction cost of structures
3. Moving support		To move shop equipment, living ware, etc., physically
4. Assistance for transition period		To cover loss of sales / income during replacement, etc.
5. Assistance for Resettlement		Training activity cost, cost of adapting to relocation site, etc.
6. **Sub-total (1+2+3+4+5)**		This amount will be paid to the PAPs.
7. Administration cost		8% of "5 .Sub-total" , this amount shall be budgeted by MR.
8. Total (6+7)		

Source: JICA Study Team (2015)

Table 6.9.8 Cost estimation for replacement of structures owned by MR

Items	Cost (MMK)	Description
Staff house replacement cost	CONFIDENTIAL	Removal and construction cost of structures owned by MR

Source: JICA Study Team (2015)

6.9.6 Monitoring Plan for the Implementation of ARP

(1) Monitoring Plan

It is mandatory to monitor the implementation of the ARP from the stage of consultation and agreement with PAPs for compensation and resettlement assistance and afterwards. The monitoring should be implemented to investigate, analyse and evaluate the resettlement activities in a fair and facilitated manner with transparency. The aforementioned organizations shall resolve arising problems that shall be identified through the monitoring activities.

It is necessary that MR together with MRT establishes a special task force team in order to monitor the resettlement activities. The team shall be a single window to respond to problems with regard to the resettlement activities of the project, and is expected to report the progress of the resettlement activities to the MR and concerned authority such as Yangon Regional Government. Table 6.9.9 shows the Monitoring Plan

Table 6.9.9 Monitoring Plan

Monitoring Item	Monitoring Indicator	Person to be monitored	Period	Frequency	Responsible Organization
Planning /Pre-construction Stage					
Compensation	Compensation payment	PAPs to be compensated	From January 2016	Once /month	MR
End of cultivating vegetables on affected waterlogged pond	Cultivating activity	Persons who cultivate affected farm land	From January 2016	Once /month	MR
Structure Replacement Resettlement	Execution of Replacement	PAPs to be compensated	From Middle of 2016	Once /month	MR YCDC
Resettlement	Execution of Resettlement	PAPs to be compensated	From January 2016	Once /month	MR YCDC
Record/Perception of Grievance	- The presence or absence of grievance	PAPs to be compensated	from the beginning of Replacement or Resettlement	Whenever a complaint occurs	MR
Level of livelihood	- Occupation (with comment of change or not changed) - Income	PAPs to be compensated	to end of 2017 (continuing to construction stage)	4 times/year	MR
Construction /Operation Stage					
Record/Perception of Grievance	- The presence or absence of grievance - Redress - Results	PAPs to be compensated	to end of 2017 (continuing from Pre-construction Stage)	Whenever a complaint occurs (from the beginning of construction)	MR

Source: JICA Study Team (2015)

(2) Implementation Schedule of ARP

A draft implementation schedule of ARP is summarized in Table 6.9.10.

A series of environmental (IEE level) and social impact study, including the census survey on the PAPs were completed in March 2015.

A compensation committee will be established in MR for this particular project in 2015/2016. The operation of the committee will start accordingly until completion of the Project in 2021/2022.

Table 6.9.10 ARP Implementation Schedule

		2015	2016	2017	2018	2019	2020	2021	2022
	Construction of the Project								
1	Preliminary inventory survey								
2	Census survey on PAUs and PAPs								
3	Draft ARP								
4	MR ARP Team establishment and activities								
5	Cut-off Date nortification / Stakeholder meetings								
6	Identification of eligibility of PAPs								
7	Final ARP								
8	Compensation committee establiushment and activities								
9	Valuation of cost and methid of compensation resettlement assistance for PAPs								
10	Budgeting for the compensation and resettlement								
11	Grievance redress committee establishment and activities								
12	Consultation and agreement with PAPs								
13	Payment of compensation fee and provision of support to PAPs								
14	Site clearance (removal of PAPs asset, etc.)								
15	Completion of ARP implementation								
16	Monitoring and evaluation of ARP implementation								
17	Revision of ARP implemetation if necessary								

Source: JICA Study Team (2015)

6.10 Confirmation of Environmental and Social Considerations for the Proposed Project by JICA Environmental Checklist

Confirmation of environmental and social considerations were conducted by reflecting the baseline data survey and EIA level study as well as the details of the proposed project plan to items cited in JICA environmental checklist for the railway sector one by one. Results of the confirmation are shown in Table 6.10.1.

Table 6.10.1 Confirmation of Environmental and Social Considerations

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
1. Permits and Explanation	(1) EIA and Environmental permits	(a) Have EIA reports been already prepared in official process?	(a) N	(a) 1) An EIA level study was carried out by the JICA Study Team in 2014. 2) MR has not submitted the EIA report to Ministry of Environmental Conservation and Forestry (MOECAF) to obtain Environmental Clearance Certificate (ECC). 3) Environmental Conservation Law (2012) has been enacted. However, legislation regarding EIA has not been established yet to date. Environmental Impact Assessment Procedures (draft, 2013) proposed by MOECAF stipulates EIA in detail, which is still under discussion with concerned ministries and organizations as of April 2015.
		(b) Have EIA reports been approved by authorities of the host country's government?	(b) N	(b) In the case of official development scheme by the foreign public sector including foreign donors such as JICA, (i) At first, the project proponent (MR for this particular case) shall submit project proposal documents together with a feasibility study report including Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) to the Foreign Economic Relations Department (FERD), Ministry of National Planning and Economic Development (MNPED). The EIA report should be prepared by third party which can include foreign consultants. Thus, the an EIA report prepared by JICA consultants can be applicable for the submission from Myanma Railways (MR) to FERD for obtaining Environmental Clearance Certificate (ECC).
		(c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?	(c) N	(c) 1) MR has not submitted the EIA report to MOECAF to obtain Environmental Clearance Certificate (ECC). 2) FERD and/or other concerned departments may impose some conditions for the approval of EIA of this particular project.
		(d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(d) N	(d) 1) ECC issued by MOECAF does not cover matters of land acquisition and resettlement, and protection of indigenous peoples. 2) Issues relating land acquisition and resettlement are under jurisdiction of responsible local governments and agencies such as Yangon Region Government, YCDC City Planning and Land Administration Department, Award Committee, and District Administrator. 3) However, it is understood that MR is responsible for compensation to the resettlement of PAPs.
	(2) Explanation to the Local stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders?	(a) Y	(a) Stakeholder meetings were held two times: 1) 1st stakeholder meeting was held on August 7th, 2014 with participation of 132 attendants including Local stakeholders, parliament members, mass media etc. MR explained an outline of the Project plan and answered to questions and comments from the stakeholders.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
				2) 2nd stakeholders meeting was held on September 23rd, Tuesday 2014 with participation of 170 local stakeholders including 62 PAPs. In the meeting MR explained the results of EIA level study and survey on affected structures and persons along railway line of western section to get comments and opinions from participants. 3) 3rd stakeholder meeting was held on May 12th, 2015 with participation of local stakeholders including PAPs. In the meeting MR explained the results of EIA level study and survey on affected structures and persons along railway line of whole section to get comments and opinions from participants.
		(b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(b) Y	(b) The comments were reflected in designing the Project components, leading to a narrower construction space to accommodate new railcars.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Several engineering options were considered at the basic design stage to reduce the number of PAPs. Especially by reducing the width of project corridor the number of PAUs and PAPs is minimized. Furthermore, during the detailed design stage, there will be a further opportunity to reduce the number of PAPs by further incorporation g particular local conditions.
2. Pollution Control	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from the project related sources, such as vehicles traffic will affect ambient air quality? Does ambient air quality comply with the country's air quality standards?	(a) Y	(a) 1) Air quality standards have not been established yet in Myanmar. 2) Construction stage: Air pollutants emission such as PM and NOx are expected temporarily and with negligible extent. Because construction work will be carried out in a small scale and no use of heavy construction machines and tracks are expected for renewal of level crossing device and signals and minor rehabilitation of railway track as well as installation of fences. 3) Operation stage: The improved rail services will attract potential bus and car users, namely, encouraging model shift from buses and cars to the rail, which could contribute to reduction of fuel consumption, and alleviation of traffic congestion especially along the paralleling roads.
		(b) Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	(b) N	(b) There is no major industrial area along the Project corridor, while there are some commercial amalgamations. The improved rail encourage the customers who come to those commercial facilities by rail instead of private cars and other land transport (generators of emission gases), which will contribute to the betterment of air condition.
	(2) Water Quality	(a) Is there a possibility that soil run-off from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas?	(a) N	(a) 1) Ambient water quality standards have not been established yet in Myanmar. 2) Construction stage: Proper treatment of water pollutants generated from construction work to comply with wastewater regulation by YCDC.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
		(b) Is there a possibility that surface run-off from roads will contaminate water sources, such as groundwater?	(b) N	(b) Surface run-off from the construction site shall be discharged to drains after silt traps or sedimentation basin before reuse or discharge with help of channels to avoid contamination water source.
		(c) Do effluents from various facilities, such as stations and parking areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas that do not comply with the country's ambient water quality standards?	(c) N	(c) 1) Effluent and environmental quality standards have not been established yet in Myanmar. 2) Effluent containing oil and grease from the Depot will be treated properly by MR.
	(3) Waste	(a) Are wastes generated from the project facilities, such as stations and depot, properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) 1) Generated waste from railway station and other railway related facilities will be segregated, collected, stored and transported to final disposal sites Thus, impact caused by the waste can be minimized. 2) Existing level crossing devices and signals, which will be exchanged to new devices are subject to reuse in other railway lines or to iron material recycling according to plan of MR.
	(4) Noise and Vibration	(a) Do noise and vibrations from vehicle and train traffic comply with the country's standards?	(a) Y	(a) 1) Noise and vibration standards from vehicle and train traffic have not been established yet in Myanmar. 2) Construction stage: Noise generation is expected temporarily and with negligible extent. Because construction work will be carried out in a small scale and no use of heavy construction machines and tracks are expected for renewal of level crossing device and signals and minor rehabilitation of railway track. 3) Operation stage: Rehabilitation of railway track and condition of train operation may reduce generation of noise and vibration.
		b) Do low frequency sound from the vehicle and train traffic comply with the country's standards?	(b) Y	(b) There is no standard for low frequency sound in Myanmar. However, measures to reduce generation of low frequency sound will be incorporated in the Project. It is assumed that the impact of low frequency sound by vehicle traffic is small as of the noise, but the actual measurement data does not exist at all. Use of new measurement is technically difficult in Myanmar.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence (especially in case of Undergrounds/Subways)?	(a) N	(a) Project component is renewal of existing railway line at grade level. Thus, extraction of a large volume of groundwater, which is often observed in subway construction, is not expected.
3. Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(d) N	(a) The project site does not include any protected areas such as national parks nor wildlife reserves or forest reserves.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
	(2) Ecosystem and biota	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?	(a) N	(a) (b) (c) 1) The project site does not encompass areas such as primeval forests, tropical rain forests, ecologically valuable habitats. 2) Planted trees along railway track contribute to the shading and visual amenity providing relaxation to train passengers and residents. Thus, cutting or removal of trees due to renewal of signals and communication system along railway line may spoil existing environment with greenery and amenity. Cutting trees should be avoided or relocated as much as possible. In case of tree cutting, it should be replaced by replantation of the same type of tree by MR after necessary permit from concerned authorities such as Forest Department of MOECAF and Playgrounds, Parks & Gardening Department of YCDC.
		(b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?	(b) N	
		(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?	(a) N	
		(d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock?	(d) Y	(d) Project area is already urbanized and developed. Thus, impacts on disruption of migration routes, habitat fragmentation or traffic accident of wildlife are hardly expected except goats and sheep crossing railway in sub-urban area. However, railway track will be blocked to avoid the crossing accident by fence.
		(e) Is there a possibility that installation of roads will cause impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered?	(e) N	(e), (f) There are neither natural forest nor wetland. Desertification is unlikely considering located in tropical monsoon area. In addition, project area is urbanized and developed area and some exotic species have already been introduced.
		(f) In cases where the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	(f) N	
	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	(a) N	(a) Installation of structures such as tunnels is out of scope.
	(4) Topography and Geology	(a) Is there a soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed?	(a) Y	(a) Soft ground areas have been identified especially in the southern area based on the geological survey and measures such as slope reinforcement and lifting of the embankment will be implemented to prevent slope failures or landslides.
		(b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides?	(b) N	(b) The project involves very limited cutting and heightening of the foundation, which is unlikely to cause slope failures or landslides. Filling activities will be undertaken carefully with in mind the possibility of such problems.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
		(c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(c) N	(c) Since there is very limited cutting involved, soil runoff from waste soil disposal sites is not expected. At borrow sites, soil will be excavated in a way that the slope will not be excessively steep.
	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?	(a) Y	(a) 1) All the proposed project areas of Yangon Circular Railway Line improvement are owned by Myanma Railways (MR). Thus, all the land is public land and no land acquisition is expected. 2) However, some number of structures including houses/shops (Project Affected Units, PAUs) and Project Affected Persons (PAPs) will be affected by the project. As for PAUs, there are 10 structures (PAUs) in total along the rail corridor. As for PAPs totally 63 persons will be affected. Among them 48 persons need to be resettled permanently. 3) 2 (two) plots of land along some sections of the railway line are utilized for cultivation of vegetables. These pools are rent from MR. Thus, installation of fences and embankment may disturb use of some part of land. In addition, trees and electric poles along railway track should be removed, relocated or replanted by MR after necessary permit from concerned authorities, if any. 4) The project is corresponding to "category B", which means number of PAPs is less than 200 in terms of resettlement. Thus, MR as proponent should prepare Abbreviated Resettlement Action Plan (ARP) and necessary compensation and support of resettlement assistance for these PAUs and PAPs should be provided by MR after identification of eligibility of each PAU and PAP by census survey and consultation with each PAU and PAP.
4. Social Environment		(b) Is adequate explanation on relocation and compensation given to affected persons prior to resettlement?	(b) Y	(b) Explanation of the project, compensation and resettlement will be made to all PAPs prior to resettlement.
		(c) Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?	(c) Y	(c) ARP including proper compensation, restoration of livelihoods and living standards will be prepared based on the census survey complying with both Myanmar legislation and the JICA Guidelines.
		(d) Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?	(d) Y	(d) The resettlement plan will be pay particular attention to identified vulnerable groups or persons by arranging proper resettlement assistance to support their living conditions.
		(e) Are agreements with the affected persons obtained prior to resettlement?	(e) Y	(e) Agreements with the affected people are to be obtained after public consultation and prior to resettlement.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
		(f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?	(f) Y	(f) The resettlement plan will be prepared with due respect to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous people, which has been identified through the socio-economic surveys and interviews undertaken in the ARP survey.
		(g) Are agreements with the affected people obtained prior to resettlement?	(g) Y	(g) Agreements with the affected people are to be obtained after public consultation and prior to resettlement.
		(h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?	(h) Y	(h) MR is planning institutional arrangement and necessary budget.to implement resettlement, if any. The capacity and budget should be prepared after the preparation of ARP .
		(i) Are any plans developed to monitor the impacts of resettlement?	(i) Y	(i) Appropriate monitoring plan will be developed and proposed through the preparation of ARP.
		(j) Is the grievance redress mechanism established?	(j) Y	(j) Establishment of a grievance redress mechanism will be proposed through the EIA study.
	(2) Living and Livelihood	(a) Where roads or railways are newly installed, is there a possibility that the project will affect the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts?	(a) N	(a) 1) Through the project, the existing YCR transport services will be upgraded to faster and safer, which may give rise to more convenience and comfort to passengers as well as making easier access to working place and social services. 2) The railway is not newly installed and its impact on existing means of transportation and associated workers is considered not to be significant. For the same reason, other significant impacts such as extensive alteration of existing land uses, changes in sources of livelihood or unemployment are likely not to take place.
		(b) Is there a possibility that the project will adversely affect the living conditions of inhabitants other than the affected inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	(b) N	(b) Increased railway operation speed will heighten the risk and fatality of accidents. In order to reduce this adverse impact, fences will be installed along key sections of the railway route. This will, however, prevent the nearby residents' movement to the other side of the railway. In such areas, small-scale level crossings with automatic alarm system will be newly established to allow their safe movement.
		(c) Is there a possibility that diseases, including communicable diseases, such as HIV will be introduced due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary?	(c) N	(c) No significant influx of external workers is expected as most of the labours can be supplied locally and hence spread of infectious diseases is not expected.
		(d) Is there a possibility that the project will adversely affect road traffic in the surrounding areas (e.g., by causing increases in traffic congestion and traffic accidents)?	(d) Y	(d) Increased frequency of train operation may cause some level of traffic congestion at level crossings but the impact is considered not to be significant. Further, automatic alarms and automatic barrier machines will be newly installed at level crossings in order to lower the risks of traffic accidents.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
		(e) Is there a possibility that roads and railways will cause impede the movement of inhabitants?	(e) Y	(e) Fences will be installed along the railway line and this will impede the movement of inhabitants. For such areas, small-scale level crossings will be newly established to allow their safe movement.
		(f) Is there a possibility that structures associated with roads (such as bridges) will cause a sun shading and radio interference?	(c) N	(f) No high-story or large-scale structure will be constructed so will most likely not cause sun shading or radio interference.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archaeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) 1) Although in Yangon City there are many cultural and historical heritage sites, there is no major local archaeological, historical, cultural, and religious heritage site in the project site. 2) However, along railway lines and adjacent roads religious facilities such as pagodas, monasteries, Hindu temples, mosques, churches are distributed. In the project plan measures to keep clean and quiet environment for these sensitive receptors will be considered especially in the construction work.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) No. There is no landscape to need special consideration.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Where ethnic minorities and indigenous peoples are living in the rights-of-way, are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples?	(a) Y	(a) There are no ethnic minorities and indigenous peoples in the ROW.
		(b) Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples?	(b) Y	(b) There are no ethnic minorities and indigenous peoples in the ROW.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project?	(a) Y	(a) Mitigation measures to abide Law on labour and the proposed Law on Occupational Health and safety will be taken.
		(b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials?	(b) Y	(b) (i) Any worker and personnel who enter into construction sites have to bear safety shoes and hats for construction work. (ii) Site manager of the contractor must conduct morning assembly every day by collecting all the labourers and give instructions to them on safety control of construction site and thoroughly conduct safety management of the site. (iii) In the construction site where heavy machines for construction are operated, intrusiveness except concerned parties should be banned. (iv) Consider safety handling and storage in airtight containers of hazardous and dangerous materials.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
		(c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.?	(c) Y	(c) Preparation of environmental and safety management plan, and conducting education of traffic safety and public and occupational health to workers and staff. (d) Proper management and education of guards and/or relevant personnel not to infringe safety and security of residents and staff and workers.
		(d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(d) Y	In the project plan measures to control security guards not to violate safety of project site and residents, is incorporated, if any.
5. Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?	(a) Y	1) Air pollution : Construction work for renewal of signals and telecommunication as well as installation of fences are in a small scale and heavy construction machines and vehicles will be not used, thus air pollutants by construction work is expected to be negligible. 2) Water pollution: 1) Proper treatment of water pollutants generated from construction work to comply with wastewater regulation by YCDC. 2) Surface run-off from the construction site shall be directed to silt traps or sedimentation basin before reuse or discharge with help of channels. 3) Soil contamination: (i)To keep clean storage sites of construction equipment, (ii) To install storage tank for preventing spill and leakage of lubricating oil and asphalt emulsifier etc. (iii) Training of workers for proper handling of toxic materials. 4) Noise pollution: Construction work for renewal of signals and telecommunication as well as installation of fences is in a small scale and heavy construction machines and vehicles will be not used, thus noise generation by construction work is expected to be negligible. 5) Waste: (i) Consider ways to minimize waste generation in the construction work plan. (ii) Enlightenment and education of construction workers for waste management based on 3R principle (reduce, reuse, and recycle). (iii) Construction waste and waste from worker's camp will be carried out by proper segregation, collection, treatment, reuse and recycle. Then remained waste will be transferred to designated dumping site for final disposal. (iv) Existing level crossing and signal devices, which will be replaced by new devices will be properly reused for other railway lines or delivered to iron scrap factory for recycling.
		(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?	(b) Y	1) Precious and endangered fauna and flora species are not found in the project site. 2) Planted trees along railway track contribute to the shading and visual amenity providing relaxation to train passengers and residents. Thus, cutting or removal of trees along railway line may spoil environment with greenery and amenity. (1) For cutting, removal or replanting trees along railway track prior consultation with YCDC and MOECAF should be conducted. (2) After removal of trees replanting of trees for shading and visual amenity should be planned.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations
		(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) N	(c) It is unlikely that construction activities adversely affect the social environment. However, following measures are planned.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?	(a) Y	(a) In the project plan environmental monitoring program is incorporated in the project plan.
		(b) Are the items, methods and frequencies included in the monitoring program judged to be appropriate?	(b) Y	(b) In the environmental monitoring plan, items relating to expected negative impacts as well as necessary permissions are selected and indicator, methods and frequencies as well as responsible institutions are described.
		(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?	(c) Y	(c) In "EIA Procedures (draft)" MOECAF is responsible for implementing the project monitoring. However, to date institutional arrangement of the monitoring framework including budget has not been established yet in MOECAF. Thus, an in the Project plan the monitoring will be implemented under adequate monitoring framework referring to the JICA Guidelines by the proponent (MR) itself.
		(d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(d) N	(d) Any detailed regulatory requirements pertaining to the monitoring report system has not been established yet in Myanmar. In the Project details of monitoring implementation and reporting system is proposed referring to the JICA Guidelines.
6. Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation).	(d) N	(a) Not necessary.
		(b) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	(d) N	(b) Not necessary.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(d) Y	(a) Negative impact on global warming is not expected due to following reasons. 1) Construction stage: Generation of greenhouse gases such as CO_2 due to construction vehicles and machines .is expected in a small scale and temporary. Thus, impact on global warming and climate change is negligible 2) Operation stage: Renovation of YCRL may give rise faster and safer operation than existing train operation. This will enhance modal shift to railway transport from road transport which generate much lower emission of CO_2 than road transport, and results in reduction of greenhouse gases generation such as CO_2.

Source JICA Study Team (2015)

Chapter 7 Project Implementation Plan

7.1 Procurement

7.1.1 Contract Type

Considering technical characteristics of work items, work volume, construction periods, work packaging, etc., of the Project, two contract types defined by JICA are adequately applicable for the Project.

Firstly, Construction Contract with Bill of Quantities (BOQ) using JICA Standard Bidding Documents (SBD) "Works", in other word (JICA's official abbreviation) SBD (Works) is applicable for the civil works portion;.

Secondary Design and Build Contract with Lump Sum Price, in other word (JICA's official abbreviation) SBD YELLOW BOOK is applicable for the railway system works and the rolling stock portion;.

Comparison of these two types of contract, are summarized in Table 7.1.1.

Table 7.1.1 Comparison of Contract Types

Contract Type	Construction Contract with Bill of Quantities, SBD (Works) applicable for civil works portion; Contract Packages 1-A and 1-B	Design and Build Contract with Lump Sum Price, SBD YELLOW BOOK applicable for railway system works and rolling stock portion; Packages 2 and 3
Project	Widely used for typical construction projects	Widely used for E&M plants and construction projects with special technology
Contract details	Design by an employer and construction by contractors	Requirements provided by an employer; design and construction by contractors
Pros	Many issues can be clarified and resolved in the design stage. More accurate construction quantities and cost are calculated before construction. Low risk for contractors.	Less time is required for the design stage. Contractors can propose their special techniques for construction.
Cons	More time is required for the design stage.	Unforeseen problems may be encountered during construction. High risk for contractors.

Source: JICA Study Team (2015)

7.1.2 Work Category

Based on the rehabilitation and modernization plans described in Chapter 4, the works of this Project are categorized as shown in Table 7.1.2.

Table 7.1.2 Contract Category

Package	Work Item	Scope
ODA Loan Package 1	Signalling Works (44.0km)	• Signal and shunting signal • Interlocking System of major stations • Automatic Block System • Automatic Train Stop (ATS-S) • Automatic level crossing (27 crossings) • Points • Electricity works for signals • Reilway Bond • Insulator & inslation Fishplate • Wooden Sleeper, gauge tie plate and rod for turnout
ODA Loan Package 2	Rolling Stock Procurement	• Train Type: DEMUAmount: 66 cars (6 cars x 11 train sets)
Consulting Service 1	Basic Desing and Tender Document Preparation	• Review of the Existing surveys and studies, • Addistional surveys, • Basic Design (BD) and Performance Specification, • Preparation of Draft Tender Documents, • Assistance and monitoring on Environmental and Social Consideration.
Consulting Service 2	Tender assistance and construction/ procurement supervision	• Finalization of Draft Tender Documents • Tender assistance (TA), • Construction supervision (CS), • Environment Management Plan (EMP), • Environmental Monitoring Plan (EMoP), • Abbreviated Resettlement Plan (ARP), • HIV/AIDS Protection Plan (HAPP), • Securing the safety during the Project implementation, • Technology transfer by a) On-the-job training program, b) Train opration Program, c) Passenger service improvement program and d) Overseas program • Advisory services to “Project components covered by MR”, • Advisory services to “Passenger Serice and Rail Business Performance Improvement”, • Advisory services to “Telecommunication Improvement in Yangon Circular Railway”.
MR Portion (to be divided into several packages)	Civil, Rail Track, Bridge, FOB, Station, other civil structures	• Reconstruction of bridges/culverts (47) • Heightening Platform works • Power supply room, relay room and operation room • Drainage works • Fencing works • FOB • Long rail works and track irregularity improvement works • Transpormer • Removal & Demolithion of existing signals and other equipment • Procurement of used DMU

Source: JICA Study Team (2015)

7.1.3 Contract Package

The ODA Loan portion of procurement and construction works for the Project is assumed to be composed of the following two contract packages:

Package 1: Signalling Works

Package 2: Rolling Stock Procurement

The consulting services for the ODA Loan portion of procurement and construction works is supposed to be composed of the following packages,

Package 1: Basic Design and Tender Document Preparation

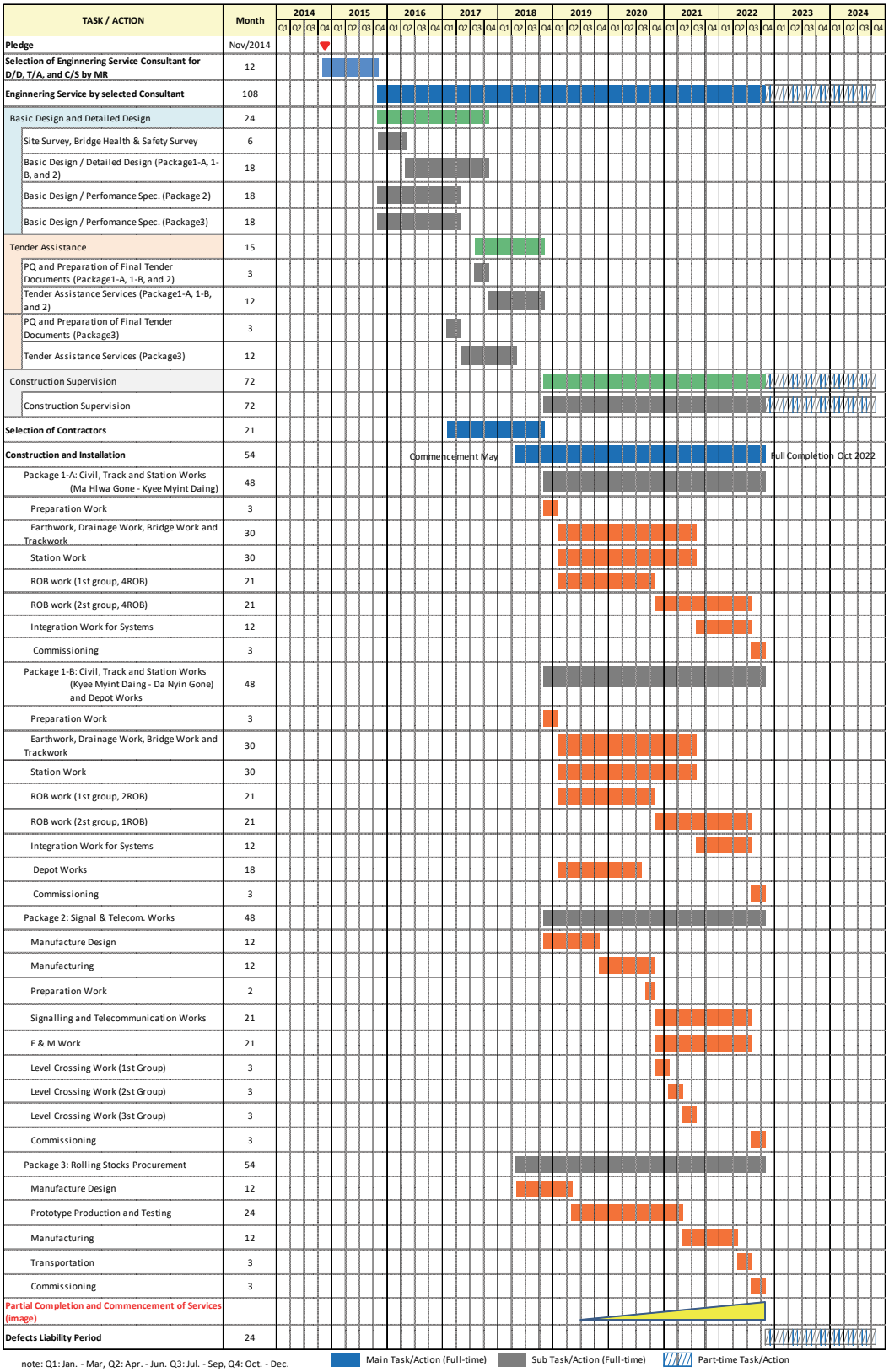
Package 2: Tender Assistance and Construction Supervision

In addition to the above contract packages to be covered by the Japanese ODA loan, works components to be covered by MR is supposed to be composed of several contract packages, details of which has yet to determined.

7.2 Project Implementation Schedule

7.2.1 Base Case Schedule for Implementation of the Project

The assumed implementation schedule based on JICA's standard procurement time for procurement under the JICA loan for the proposed project scope is prepared as shown in Figure 7.2.1.



Source: JICA Study Team (2015)

Figure 7.2.1 Base Case Schedule for Implementation

7.3 Project Cost

The cost estimate is generally carried out based on the latest plan of route alignment which mainly constitutes the double rail-track, stations, bridges, depots, stabling-lines, workshops, buildings and substations as at grade structures.

The cost is estimated based on the following major work scopes.

Table 7.3.1 Major Quantities for Cost Estimate

Description	Quantity
Length of Route	44.4 Km
Length of Boundary Fence	69.7 Km
Numbers of Rehabilitation Bridge	47 bridges
Nos. of Station	39 stations
Nos. of Train set (6 cars per set)	11 sets

Source: JICA Study Team (2015)

7.3.1 Method of Cost Estimate

(1) JICA's Cost Estimation Format

From the point of view of granting a Japanese ODA Loan, the project cost is estimated to conform to the JICA cost estimation format.

- Cost indicated with Japanese Yen for the foreign currency portion and Myanmar Kyat for the local currency portion;
- Addition of price escalation and physical contingency for non-eligible portion;
- Addition of commercial tax imposed in Myanmar; and,
- Addition of import tax imposed in Myanmar.

Table 7.3.2 Cost Estimate Format and Items

Item	FC (Foreign Currency) (Japanese Yen)	LC (Local Currency) (Myanmar Kyat)
Eligible Portion of Loan		
Construction & Procurement Costs		
Signal		
Rolling-stock		
Price escalation		
Physical contingency		
Consultancy Service Cost		
Price escalation		
Physical contingency		
Non-Eligible Portion of Loan		
Procurement/ Construction		
Civil Works		
Track Works		
Signal & Telecom		
Prcuremtn of Used DMU		
Price escalation		
Pysical contingency		
Land Acquisition		
Price escalation		
Physical contingency		
Administration cost		
Commercial tax		
Import tax		
Interest during Construction		

Source: JICA Study Team (2015)

(2) Pre-condition of Project Cost Estimate

The JICA Study Team has estimated the project cost based on the following conditions:

- Currency exchange rates: as per the following table specified by JICA for May 2014.
- Rate of price escalation: 1.8% and 5.1% per annum for the foreign and local currency portions respectively
- Rate of physical contingency: 5% of total cost of eligible portion including the price escalation
- Administration cost: 5.0% of total cost other than commercial tax and import tax
- Assumed rate of import duty & tax: 7.0% of foreign currency cost.
- Assumed rate of commercial tax: 5.0% of foreign currency cost and local currency cost incurred in Myanmar.
- Rate of interest during construction: 0.01% for construction and 0.01% for consultancy
- Rate of front end fee: 0.0%
- Base year prices for the Year 2014-2015
- Implementation schedule in Figure 7.2.1 employed for calculation of price escalation
- The origins and sources of unit rates/prices shown in Table 7.3.3 employed for computation of costs

Table 7.3.3 Currency exchange rate

Description	Exchange Rate
JPY / USD	120.4
Kyat / USD	1,030.9
Kyat / JPY	0.117

Source: JICA (2015)

(3) Component of Cost Estimate

The component of project cost is shown in Table 7.3.4.

Table 7.3.4 Component of Project Cost

A.	Project Component Covered by Japanese ODA Loan
A-1	Procurement and Construction Works
a1-01	Signalling Works
a1-02	Rolling Stock Procurement
A-2	Consulting services
A-3	Price escalation for project component covered by Japanese ODA Loan
A-4	Physical contingency for project component covered by Japanese ODA Loan
B.	Project Component Covered by MR
B-1	Procurement and Construction Works
b1-01	Civil Works
b1-02	Track Works
b1-03	Electrical Works
b1-04	Signal & Telecom
b1-05	Procurment of Used DMU
B-2	Resettlement cost
B-3	Price escalation for project component covered by MR
B-4	Physical contingency for project component covered by MR
B-5	Administration cost
B-6	VAT (Value Added Tax)
B-7	Import tax
C.	Interest during Construction

Source: JICA Study Team (2015)

(4) Definition of Cost Estimate for Each Component

The concept and general scope of individual cost components are defined below.

A-1: Construction & procurement costs

a1-1: Signalling Works

This cost package mainly includes the following items:

- Provision of signalling system for entire route including level crossing system (including concrete foundations of signalling equipments).
- Provision of power supply system for signalling equipments.
- Provision of Insulator and insulation fish plate (electrical resistance of insulated railjoig of 50kΩ is required).

- Provision of welded-type rail bond (electrical resistance of railbond of 200μΩ/ each is required).
- Provision of gauge tie plate for turnout.

a1-2: Procurement of rolling-stock

This cost package mainly includes the following items:

- Fully air-conditioned complete Diesel Electric Multiple Units (DEMUs)
- Spare parts for defect liability period

A-2: Consulting services

This package comprises the general consulting and project management services including co-ordination works between different contractors for the overall project implementation during the basic/detail design stage, pre-qualification and tender documents preparation stage, tender assistance stage and construction supervision stage including defects liability period as defined in the implementation schedule of the project. The cost has been calculated on the man-month basis.

Consulting services for the implementation of the project shall be carried out according to the project stage for the following items:

- Consultancy Services for YCR Line Upgrading Project
- Basic Design
- Preparation of Bid Documents
- Tender Assistance
- Construction Supervision
- Facilitation of Implementation of Environmental Management Plan (EMP), Environmental Monitoring Plan (EMP), Abbreviated Resettlement Plan (ARP), and HIV/AIDS Protection Plan (HAPP)
- Safety of the project
- Technology Transfer
- Business Performance Improvement

A-3: Price escalation for project components covered by Japanese ODA Loan

Price escalation for eligible portion is calculated during the implementation period of the project as per the following assumptions:

- 1.8% per annum for foreign currency portion
- 5.1% per annum for local currency portion

A-4: Physical contingency for project components covered by Japanese ODA Loan

The physical contingency allows for the possibility of additional unexpected works. The cost has been computed at a rate assumed at 5% both for direct cost and consulting service costs, including the price escalation.

B-1: Procurement and Construction Works for Non-eligble Portion

b-1: Construction of civil and station structures;

This cost package mainly includes the following items:

- Reconstruction of bridges – 47 locations
- Civil works around the level crossings
- Reconstruction of railway drainage system
- Boundary fencing for entire railway route
- Reconstruction of foot over bridge (FOB) – 89 FOBs
- Heightening platform works
- Power supply rooms, relay rooms and operation rooms

All the unit prices for the abovelisted works are provided by Myanmmar railway. Since the provided unit prices do not include indirect costs such as site operation expense, cost for common temporary works and contractors' profit etc, proper propotion of indirect cost is added to the direct cost provided by MR.

b-2: Long rail and track irregularity improvement;

This cost package mainly includes the following items:

- Rail installation
- Welding works
- Track irregularity improvement including ballast works

b-3: Electricity works

This cost package mainly includes the following items;

- Installation of 500kVA transformer at Da Nyin Gone station.
- Installation of 250kVA transformer at Mingalardone station, Pa Ywet Sake Gone station,and Ma Hlwa Gone station.

b-4: Signalling works

This cost package includes the following item;

- Removal and demolition of existing sigals and other equipments.

b-5: Procurement of Used DMU

This cost package includes the following item;

- Procurement of used DMU

B-2: Land acquisition cost

No land acquisition is required in this project, but some compensation will be required for PAPs who are doing productive activities in MRs ROW. This cost package mainly includes the following items:

- Solatium and cash assistance for the project affected persons (PAPs)
- Cost calculated based on the RAP report

B-3: Price escalation for project components covered by MR

Price escalation for land acquisition and compensation costs is calculated during the implementation period of the project on the same assumptions as the eligible portion.

B-4: Physical contingency for project components covered by MR

The physical contingency allows for the possibility of additional unexpected works. The cost has been computed same rate assumed at 5% of compensation cost including the price escalation.

B-5: Administration cost

This is the cost for the project implementation agency and is calculated at an assumed rate of 5% of total cost other than commercial tax, import tax and interest during construction.

B-6: Commercial tax

Cost is calculated at an assumed rate of 5% of total cost other than administration cost, import tax and interest during construction.

B-7: Import tax

Cost computation is based on an assumed rate 7% of total cost of foreign portion.

C: Interest during construction (JUMP loan case)

This cost is computed on the basis of the interest rates and terms and conditions applicable to Yen JUMP loans, as announced by JICA. The rates and conditions employed are set out below.

- 0.01% per annum for the main portion of project costs.
- 0.01% per annum for the consulting service cost.

D: Front End Fee

Front end fee is not considered in thr project cost estimate.

7.3.2 Estimated Project Cost

Based on the aforementioned conditions, the estimated project costs is summarized in Table 7.3.5.

Table 7.3.5 Estimate Project Cost for the Base Case

Item	Total		
	FC	LC	Total
CONFIDENTIAL			

Note: Total Amount and Eligible Amount for Japanese JUMP Loan
Source: JICA Study Team

7.4 Financial Plan

Based on the request from MR on behalf of the Government of Myanmar, it is confirmed by both Governments that the Japanese ODA loan, which is the most competitive and softest loan condition among the ODA loans provided by the other multirateral or bilateral donor agencies, is essential for financing this project.

Among the overall Project Cost, which is JPY36,276Mil., the Japanese ODA loan portion is JPY24,866Mil. and the rest amount of the Project Cost, i.e. JPY11,442Mil., shall be covered by the own finance of the Government of Myanmar. The Japanese ODA loan portion contains the direct cost of construction and procurement work and contingency, and is called as "Elgible costs". On the other hand, the own financing portion covers "Non eligible costs" such as Resettlement cost, Administration cost, Commercial Tax, Import Tax, and Interest during the construction period.

The terms and conditions of the Japanese ODA loan for the Eligible cost is as follows:

- Interest Rate: 0.01%
- Maturity Period: 40 years including 10 year grace period

Chapter 8 Project Evaluation

8.1 Economic and Financial Analysis

A series of economic analysis were carried out to evaluate the economic benefits of the Project from an aspect of national welfare, while financial analyses were made to evaluate financial viability of the Project.

8.1.1 Economic Analysis

(1) Estimate of Project Benefits

In a broad aspect, the project benefits of the rehabilitation or introduction of new urban rail system can be classified into i) consumer surplus, namely benefits for rail users and ii) producer (supplier) surplus as increased net profit.

The consumer surplus are further classified into two, namely travel time cost (TTC) saving and vehicular operating cost (VOC) saving. It is expected that the saved time is used for other purposes, which is deemed as benefit the regional (national) economy. TTC saving is again divided into two elements, namely direct and indirect benefit. The direct benefit includes the time saving of YCR users. There are two types of rail users after the improvement, namely the existing rail users and the rail users shifted from other modes of transport, manly buses.

The another consumer surplus is saving of the vehicle operating costs (VOC). The passengers shifted from buses to the YCR line will lead to mitigation of traffic congestion on road. In this way, the total VOC is expected to be decreased largely.

Supplier surplus is also the important element in estimating the economic benefits generated by the implementation of the Project. There are two major transport service providors considered for this project, namely MR (Train operator) and Bus operators. The incremental passengers' revenues by the introduction of improved urban railway operation system in economic value is considered as the supplier's benefits. On the other hand, the Project is expected to encourage bus users to use the YCR, therefore, the negative impacts (loss of profit) of the bus operators are also counted for the calculation. Thus, in terms of national (regional) economic point of views, the incremental passenger revenues are estimated by subtracting the economic loss of bus operators from the incremental revenues of new YCR Line.

Finally, although these benefits are not possible to quantify into the monetary terms, the project benefits of an urban rail transit project covers indirect economic benefits; such as environmental, social and economic benefits. These benefits are widely distributed among beneficiaries, not only passengers, but also the local citizens. These expected benefits of the project are briefly explained below (refer to Table 8.1.1).

Although the only tangible project benefits are counted as economic benefits for the Project, it is recommended for the Government of Myanmar to carefully consider these indirect economic benefits even though these affects are not shown in this EIRR calculation.

Table 8.1.1 Expected Economic Benefits of the Project

Type of Benefit	Counted	Not counted
Consumer Surplus: TTC	X	
Consumer Surplus: VOC	X	
Producer Surplus: Incremental Passenger Revenue	X	
Enhanced Traffic Safety		X
Reduced air pollution and noise		X
Increased land value		X
Job opportunities		X

Source: JICA Study Team (2015)

1) Premise

In accordance with the principle of economic and financial analysis of project, all the economic benefits are estimated by the comparison between "with and without" project case. The followings are the basic assumptions and calculation methodologies for the above mentioned economic benefits.

a) TTC

The JICA Survey Team has confirmed that the value of time (VOT) of each transportation mode passenger calculated by the previous YUTRA is convincing and eloquent based upon preliminary house hold income survey conducted in this Survey. Thereby, the same VOT projected by YUTRA was applied for the economic analysis of the Project. The applied VOT for each transportation mode is summarized in the following Table.

These figures are already converted into economic price as of FY2014, and will be increased by the growth factor mentioned in the following section.

Table 8.1.2 Summary of VOT by Travel Mode (Economic Price)

TTC	Train User	Bus User	Car User	Taxi User	Truck User	Motor Cycle User
Kyat/ hr	1,335	1,524	3,221	2,387	2,095	1,252

Source: JICA Study Team based on YUTRA

b) VOC

Vehicle operating cost (VOC) per each vehicle type was also quoted from the YUTRA. The following is summary of the average VOC by vehicle type applied to the economic analysis.

Table 8.1.3 VOC by Vehicle Type (Economic Price)

VOC	Bus	Car/ Taxi	Truck	Motor Cycle
Average Speed (km)	40	40	30	30
Kyat/ 1000km	241,521	102,952	458,489	17,492
Kyat/ km	242	103	458	17

Source: JICA Study Team based on YUTRA

c) Passenger Revenues

As discussed later, the fare setting of each YCR Line and Bus was difference each other. Considering the comprehensive study results, the passenger fare of YCR Line was set 25% higher than that of bus operation.

As the economic value of bus fare per km was Ks.15.7/km, the economic passenger fare of the improved YCR Line was Ks. 19.7/km which is 25% higher than bus fare. Each value was

increased by the same growth factor. The economic loss of the passenger revenues of bus services due to the implementation of the Project, namely "without – with" case, shall be counted as negative impact of the Project.

2) Estimated Economic Benefits

Based upon the unit economic prices mentioned in the foregoing section as well as the with – without passenger-km and passenger-hour, the economic benefits of the Project were calculated, and summarized as following Table 8.1.4.

Table 8.1.4 Summary of Economic Benefits of the Project by Factor

Unit: Million Kyat

	TTC Saved	VOC Saved	Pax- Revenues	Total Economic Benefits
Real Term	316,891	6,813,891	277,117	7,407,898
Present Value @ 10%	60,976	1,480,273	69,298	1,610,546

Source: JICA Study Team based on YUTRA

(2) Estimate of Project Costs

a) Project Costs (Investment Costs)

The nominal project costs mentioned in the previous chapter were converted into the economic project costs based on the following methodology:

- Conversion into the economic prices:

  Firstly, the local currency portion was converted by multiplying the Standard Conversion Factor (SCF) of 0.85 to rectify the distortion of price by the control or intervention of Government.

- Exclusion of the transfer cost:

  Secondly, Tax is excluded as the item is considered as the transfer cost.

- Others:

  In accordance with the principle of economic analysis, both interest and price escalation is excluded from the calculation.

Based upon the above mentioned methodology, the economic costs of the Project were summarized as follows. Costs for the civil components which are financed by the Government of Myanmar are included in this economic project costs.

The disbursement schedule was complied with the project implementation schedule proposed in the previous chapter.

Table 8.1.5 Economic Project Costs

Unit: Mil. Kyat

	2015	2016	2017	2018	2019	2020	2021	2022	**Total**
Cost	CONFIDENTIAL								
Allocation (%)									

Source: JICA Study Team

b) Annual Maintenance Costs

The annual maintenance costs are composed mainly of i) staff cost, ii) maintenance cost, and iii) fuel cost. Based upon the estimation by the JICA S/T, the total annual maintenance costs in economic value as of FY2014 are calculated at Ks. 13,440 million, i.e. Ks.872 million, Ks. 5,899 million, and Ks. 6,669 million, respectively.

However, as the value of workers is assumed to be increased annually in parallel with the growth factor. Therefore, the annual maintenance costs at the first year of the operation of improved YCR Line project is projected and summarized as following Table 8.1.6. The annual maintenance costs will be increased based upon the growth factor. Finally, the overall maintenance costs during the whole evaluation period were Ks. 951,596 million in economic price.

Table 8.1.6 Annual Maintenance Costs (Economic Price) at FY2021

Unit: Million Kyat

Staff Cost	Maintenance Cost	Fuel Cost	Total Maintenance Cost
CONFIDENTIAL			

Source: JICA Study Team based on YUTRA

(3) Economic Analysis Results

1) Assumptions

The following assumptions and standardizations were adopted for the sake of computation

a) Project Evaluation Period:

Project evaluation period was set 40 years, which is equivalent to the maturity period of Japanese ODA loan. The beginning year is FY2014, when the Loan Agreement is expected to be concluded.

b) Project Life Period:

To simplify the calculation, the project life is deemed equivalent to the project evaluation period, and therefore, no residual value was considered in this analysis.

c) Indicators for the Economic Viability

Economic viability of each project is calculated by the following three (3) Indicators from the annual cost and benefit streams:

- B/C (Cost Benefit Ratio)
- NPV (Net Present Value)
- EIRR (Economic Internal Rate of Return)

d) Social Discount Rate:

Social discount rate for the Project is set at 10 percent, same as YUTRA.

e) Annual working days:

The annual working days to be utilized for calculating from the daily economic benefits and costs into annual figures, are regarded as 324 days per year.

f) Growth Factor:

Same growth factor proposed by the YUTRA was applied to the both benefits and costs calculation. The applied growth factor was summarized as follows. After the year 2035, figures are fixed.

Table 8.1.7 Growth in YUTRA Area GRDP and GRDP per Capita

	2013-2018	2013 – 2025	2013 - 2035
Growth Factor	1.3985	2.1340	3.8809

Source: JICA Study Team based on YUTRA

2) Evaluation Results

Based upon the above mentioned benefits and costs comparison, the results of the economic analysis on the YCR Line upgrading project were conducted.

The EIRR of the Project was calculated at 20.7%, and NPV was Ks. 948,461 million, or B/C was 4.2. The threshold of the EIRR is generally 12%. Therefore, in terms of the economic indicators, the Project is assessed as economically feasible. The cash flow analysis was summarized in the final pages of this chapter.

3) Sensitivity Analysis

Finally, a sensitivity analysis was conducted for security purpose. The sensitivity of the Project was examined by the combination of each 10%, 20% increase in the cost stream, whereas each 10% and 20% decreased in the benefit stream.

Table 8.1.8 Sensitivity Analysis Results (Summary)

Cost \ Benefit	Base	-10%	-20%
Base	20.7%	19.4%	17.9%
+ 10%	19.5%	18.2%	16.8%
+ 20%	18.4%	17.2%	15.8%

Source: JICA Study Team

The sensitivity analysis results mentioned that even the harshest scenario of 20% decrease in benefit stream as well as 20% increase in cost stream, the EIRR recorded 15.8%, which is still exceeding the target ratio of 12%.

8.1.2 Financial Analysis

In order to assess the profitability of the Project, a financial analysis was also conducted. The basic conditions and assumption such as project evaluation period, project life period, working days and growth factor are same as applied for the economic analysis.

(1) Estimate of Financial Revenues

The financial revenues of the Project are revenues from railway business

As previously mentioned, the passenger fare unit of new YCR Line is expected to be 25% higher than the fare of bus. Therefore, Ks.23.1/km as base fare as of FY2013 was applied for the estimation of the financial revenues of railway business.

The annual passenger revenues, therefore, can be calculated by multiplying this unit fare per km to the annual incremental passenger-km by with-without comparison. The overall financial ridership revenues during the whole evaluation period were Ks. 2,187,683 million.

(2) Financial Costs

a) Project Costs (Investment Costs)

The financial costs of the Project were simply calculated by excluding the price escalation and interest from the original nominal project cost mentioned in the previous chapter. Such the administration cost and taxes categorized in the Non-eligible portion were also included in the project costs for the financial analysis of the Project, as these costs are necessary costs actually paid by MR to implement the Project. Thus, the financial costs of the Project were Ks. 544,681 million, and summarized as follow.

Table 8.1.9 Financial Project Costs

Unit: Mil. Kyat

	2015	2016	2017	2018	2019	2020	2021	2022	**Total**
Cost Allocation (%)	CONFIDENTIAL								

Source: JICA Study Team

b) Annual Maintenance Costs

The annual maintenance costs in financial price are estimated in exactly same manner and methodology with the economic analysis. Only the deferent point is the figure was calculated in nominal financial term. The overall maintenance costs of the Project during the whole evaluation period would be Ks. [ ] million.

(3) Evaluation Results

The financial rate of return (FIRR) is the major indicator for assessing the financial viability of the Project.

Based upon the above mentioned financial revenues and costs comparison, the FIRR was calculated at 5.2%. Although, the figure seems still low and the project seems not so profitable, the FIRR is still higher than the interest of Japanese ODA loan, which is 0.01%. The cash flow analysis also revealed that MR would be able to eliminate its accumulated deficits in FY 2044. Therefore, the Project is acceptable in terms of financial viability.

Finally the sensitivity analysis results were shown in the following Table for the estimating the impact on the financial situation by the slum rump up and cost overrun.

Table 8.1.10 Sensitivity Analysis Results (Summary)

Cost \ Benefit	Base	-10%	-20%
Base	5.2%	4.1%	2.8%
+ 10%	4.2%	3.0%	1.6%
+ 20%	3.2%	2.0%	0.3%

Source: JICA Study Team

8.1.3 Indicative Study: Suitable Fare Setting

Finally, as the indicative analysis for MR to consider the suitable passenger fare setting for the new YCR Line, JICA S/T proposed three (3) case of passenger fare and assessed the most suitable fare setting. Considering the affordability to pay of the existing railway passengers, the fare range was set from Ks. 18.5/km up to Ks. 27.8/ km. The lowest fare, Ks. 18.5/km, is equivalent to the existing bus fare, while the highest fare (Ks. 27.8/km) is 50% higher than the bus fare.

The traffic assignment model is vulnerable for the tariff affects of railway, and therefore, the larger the price difference between railway and bus, the less number of bus users would be diverted to railway. Thus, for searching the most suitable tariff practice which enables MR to maximize the financial revenue, both FIRR and EIRR were calculated per each fare case.

- Case 01: Equivalent to the Bus Fare, as Ks. 18.5/km
- Case 02: 25% higher than Bus Fare, as Ks. 23.1/km
- Case 03: 50% higher than Bus Fare, as Ks. 27.8/km

Finally, the following are the evaluation results for each EIRR and FIRR comparison based upon the different type of tariff setting.

The evaluation results indicated that Case 02, 25% higher than bus fare, shall be the most recommendable fare setting.

Table 8.1.11 Comparison of EIRR and FIRR for each Fare Setting Case

Tariff Case	EIRR	FIRR
Case 01	30.0%	2.0%
Case 02 * JICA S/T recommendation	20.7%	5.2%
Case 03	9.2%	1.8%

Source: JICA Study Team

Table 8.1.12 Economic Analysis Results

EIRR	20.68%	B/C	4.2	NPV	948,589

Unit: Mil. Kyat

CONFIDENTIAL

Source: JICA Study Team

Table 8.1.13 Financial Analysis Results

FIRR	5.24%	B/C	0.79

Unit: Mil. Kyat

CONFIDENTIAL

Source: JICA Study Team

Chapter 9 Conclusions and Recommendations

9.1 Conclusions

9.1.1 The ODA Loan Project

The Project components, which shall be financed through the Japanese ODA loan, consist of installation of new signalling system and procurement of new DEMUs, while, other works including civil work (drainage system, fence, rail bridge rehabilitation, roadbed, etc.), track work (rail welding, track irregularity improvement, etc.), power supply work, station work (high height platform), depot work, etc. shall be carried out by MR using its own budget, which should be carried out prior to execution of the components covered by the Japanese ODA loan.

The signalling work as a part of the Project starts from the west side of Yangon central station, passing though Da Nyin Gone station, to the west side of Pa Zun Taung station (44.0km in total), which covers most of the Yangon Circular Railway Line (46.0km in total). The section from Yangon Central station to Pa Zun Taung station (2.0km in total) is covered by the Project for Installation of Railway Operation Control Center System and Safety Equipment.

New DEMUs shall be procured in accordance with the Rolling Stock Procurement Works as part of the Project.

Improvement of the at-grade level crossing operation of the two lines, namely the YCR Line and the Yangon – Mandalay (Bago), which is in the rail section between the Yangon Central station and the Pa Zun Taung station, will be considered separately from this Project.

The scope of the project financed by Japanese ODA loan is summerized in Table 9.1.1

Table 9.1.1 Scope of the Project

Package	Items	Scope
Package 1	Signalling Works (44 km from the west side of Yangon Central Station to the west side of Pa Zun Taung Station	• Interlocking System of major stations • Automatic Block System (ABS) • Automatic Train Stop (ATS-S) • Automatic railway level crossings (27 crossings)
Package 2	Rolling Stock Procurement Works	• Type of Train: DEMU Units: 66 cars (6 cars x 11 train sets)
Consulting Services	Consulting Services	• Tender assistance (TA) • Construction supervision (CS) • Advisory services to MR works, including – Civil work – Hydrology / drainage – Railway bridge – Building – Depot (Insein DRC, Ma Hlwa Gone Depot) – Environmental and social consideration • Disbursement management • Facilitation of implementation of – Environment Management Plan (EMP), – Environmental Monitoring Plan(EMoP), – Abbreviated Resettlement Plan(ARP), and – HIV/AIDS Protection Plan (HAPP) • Technology transfer on: – On the Job Training – Track maintenance capacity improvement – Train operation improvement – Customer service improvement • Passenger service and rail business performance improvement

Source: JICA Study Team (2015)

9.1.2 Project Cost

The cost estimates of the project are summerized in Table 9.1.2.

Table 9.1.2 Project Costs

Unit: (JPY million)

Breakdown of Cost	Foreign Currency Portion			Local Currency Portion			Total		
	Total	Japanese ODA loan Portion	Myanmar Portion	Total	Japanese ODA loan Portion	Myanmar Portion	Total	Japanese ODA loan Portion	Myanmar Portion
CONFIDENTIAL									

Note:
1. Exchange rate: US$ 1= Kyat 1028.8 = ¥118.6（Kyat 1=¥0.115）
2. Price escalation factors: 4.7% per annum (local currency portion), 2.0% per annum (foreign currency portion)
3. Physical contingency: 5.0% (Base Cost + Price Escalation)
4. Base year for cost estimation: February 2015
5. Non eligible portion was calculated as follows:
   - Administration Cost = 5.0%
   - Commercial Tax = 5.0%
   - Import Tax = 7.0%
   - Actual Non Eligible Portion will be adjusted according to the provision by the Government of Myanmar
6. The total amount may not be the same as the sum, due to the round off

Source: JICA Study Team (2015)

9.1.3 Viability of the Project

EIRR of the Project is callculated at 20.7%, and NPV is Ks. 948,461 million (B/C raitio is 4.2). From these figures, it is safe to say that the Project is economically viable. While FIRR is calculated at 5.2%. This figure seems very low, that is, the project seems not so attractive, however, the FIRR is higher than the proposed interest of Japanese ODA loan, which is 0.01%, which means that a sort of leverage effect can be expected by using this preferred loan scheme. A cash flow analysis suggests that MR would be able to eliminate its accumulated deficits by FY 2044. In conclusion, the Project is also acceptable from the aspect of financial viability as well.

9.1.4 Environmental Category

The Project is deemed "category B" in accordance with JICA Guidelines for Environmental and Social Considerations (April 2010). There is no significant negative environmental and social impact caused by the Project during the construction and the operation phases.

9.1.5 Land Acquisition and Involuntary Resettlement

The number of PAPs who might be requested to move to other locations is confirmed as shown in the column "Number of persons to be resettled" in the same table below.

Table 9.1.3 PAUs and PAPs of the Project

Project Component	Type of buildings / business activities	PAUs	PAPs	Number of persons to be physically resettled
Along the Project section (44.0 km)	MR staff house *	5	25	25
	Non-MR staff house	2	9	9
	MR shop	0	0	0
	Non-MR shop	3	14	14
	Public facilities	0	0	0
	Community facilities	0	0	0
	Fence (lettuce plantation)**	1	9	0
	Vegetable plantation for own use (not for sale)**	1	6	0
Total		**12**	**63**	**48**

* Although MR staff houses belong to MR, the project proponent, people living in the houses including MR officers are considered as PAPs with involuntary resettlement according to JICA's Guidelines for Environmental and Social Considerations .

** Agriculture activity will be able to continue with reduced area

Source: JICA Study Team (2015)

In conclusion, the total number of PAPs is 63 persons including 48 persons of involuntary resettlement as of March 21, 2015 based on the Abbreviated Resettlement Plan (ARP) .

There observed some agricultural activities along the project section, namely, using liner spaces along the rail line (within MR Right of Way), some people are cultivating vegetables such as lettuce. These spaces are rented from MR to those people for their cultivation purpose. The Project may affect this kind of agricultural activities, namely, newly constructed fence along the project section may make them not to enter into those spaces. In this regard, MR is requested to take a proper action for them.

It should be noted that some trees and electric poles along the project section need to be removed and replaced by the Project. MR, the executing agency, needs to obtain approval from concerned agencies to do such work.

9.1.6 Technology of the Project

(1) Construction gauge and loading gauge

The maximum height of newly procured rolling stock for the YCR Line can be 3,620mm (3,820 – 200mm). The size of the newly procured rolling stock should be large as much as possible within a technically justifiable range in order to provide comfort and effective space for passengers and goods. Based on this consideration, the height of 3,620mm shall be applied as a new loading gauge regulation for the YCR Line.

(2) Safety System Improvement

Significant improvement of the existing system or installation of new system is required to achieve an international standard level of safety. To meet this objective, the technologies used in the Project shall be as follows:

Signalling System

- Automatic Block System (ABS)
- Direct current track circuit system
- Automatic Train Stop System (ATS-S)
- Interlocking system in major stations other than the Yangon Central station
- Automatic barrier level crossings (installation of automated level crossing barriers is required to save train running time and increase the safety for pedestrians.)

(3) New DEMU Procurement

In order to attract more people to the improved YCR in the future, it is recommended to introduce modern rolling stock of higher performance in terms of safety, ride comfort, running speed, travel time, easy maintenance, etc.

Since electrification of the YCR Line is not scheduled in the near future, non-electrified system, namely Diesel Electric Multiple Units (DEMUs) shall be introduced in the initial stage of modernization of the YCR Line.

Use of DEMUs, instead of using a train being composed of a locomotives and passenger coaches, makes MR easier in operating passenger trains on the YCR Line because there is no need to do shunting operation at terminal stations.

(4) Drainage system improvement

The heavy rainfall in a short time period during the rainy season (from June to September) in Yangon frequently causes flooding over the rail facilities and other problems such as malfunction of signalling control system (due to shirt-circuit of track circuit).

Locations and segments of frequent flooding along the Project section are already identified by MR. MR shall construct proper drainage facilities in these locations before installation of new signalling system.

(5) Improvement of rail track irregularity

In order to achieve the target maximum running speed of 60kph of this Project, the existing track should be improved (irregularity should be removed) before introduction of new rolling stock. MR shall employ skilled engineers and workers for this work, some of them shall be who experienced JICA's technical assistance for Railway Safety and Service Improvement (2014/2015).

(6) Station platform improvement

All of the existing rolling stock used for the YCR Line's services shall be replaced with new rolling stock and used DMUs in the Project. Floor height of these new rolling stock is higher than the existing station platform. Accordingly all of the station platforms need to be improved (elevated) in order to provide easy boarding and alighting for rail passengers. This improvement is also necessary to reduce the boarding/alighting time (time duration for stoppage).

(7) Safety Operation

Planned frequent and fast train operation requires appropriate safety facilities such as fences along the railway line to prevent the residents from entering into the railway area.

(8) Construction gauge and loading gauge

The maximum height of newly procured rolling stock for the YCR Line can be 3,620mm (3,820 – 200mm). The size of the newly procured rolling stock should be large as much as possible within a technically justifiable range in order to provide comfort and effective space for passengers and goods. Based on this consideration, the height of 3,620mm shall be applied as a new loading gauge regulation for the YCR Line.

(9) Electrification

MR has a vision of electrification of the urban rail transit system in the Yangon metropolitan area, including the YCR Line and other connecting lines in the future, which is also recommended as part of the long-term urban transit development plan in YUTRA.

MR and JICA understand that preparation of an urban transit electrification master plan, including development of exclusive power supply system for the urban transit system, is necessary, and this planning work shall be carried out after completion of the existing feasibility study on the YCR Line.

9.2 Recommendaions

9.2.1 Coordination of the Project

A steering committee shall be established to supervise the implementation of the Project.

In addition, a technical committee shall be formulated under the steering committee as a technical coordination body of projects carried out by PMUs. Those projects include, but not limited to, the Yangon Central Station Redevelopment project, Yangon-Mandalay Railway Improvement Project Phase I and the Project for Installation of Railway Operation Control Center System and Safety Equipment.

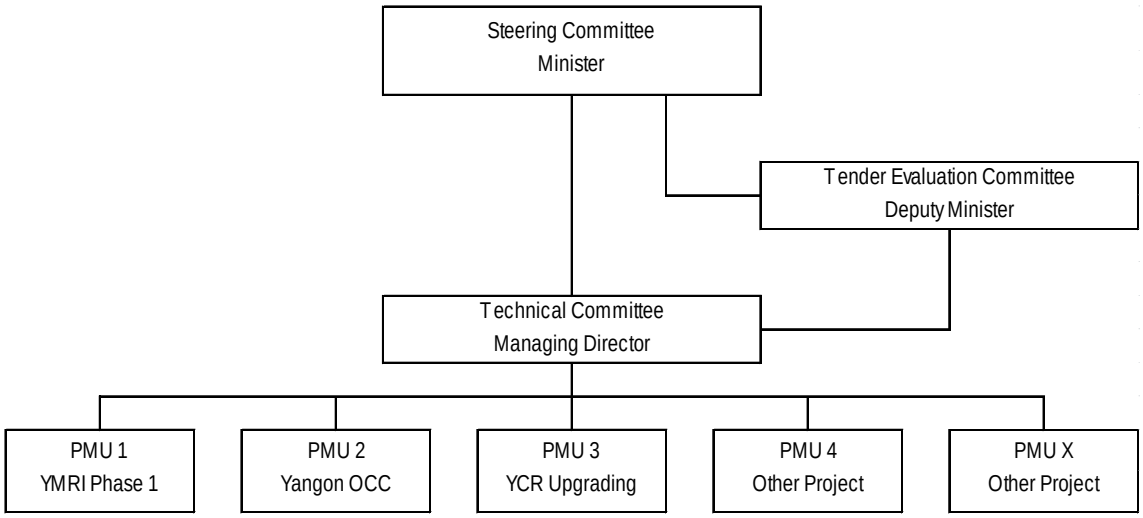
A tender evaluation committee for the Project shall be established separately from the steering committee to supervise a series of tender activities of this Project, including selection of TA and CS consultants and contractors for actual construction / installation works.

9.2.2 Project Management Unit (PMU)

It is highly recommended that MR establishes Project Management Units (PMUs) for each of the projects financed by Japanese ODA loan for their smooth and efficient implementation. An indicative organizational structure for the overall project management is depicted in Figure 9.2.1.

The Project Director shall have the authority to take necessary decisions and actions for the smooth implementation of the Project and make decision on all payment and other matters related to the Project.

The task assigned to the PMU is not limited to supporting the implementation of the Project, but also includes arrangement of training programs for train operation, signalling and telecommunication, etc. and passenger service improvement such as advanced ticketing system. Such additional feature (function) will be placed in the PMU because the Project needs careful management to assure effective operation of renewed urban mass transit services in the Greater Yangon and the surrounding area.



Source: JICA Study Team (2015)

Figure 9.2.1 Indicative organizational structure for overall project management

Members of the steering committee, the evaluation committee and the technical committee can be invited from MOTC and other concerned ministries and external organizations and individuals (third party).

Principles of organization and operation of the PMU shall be as follows, but not limited to:

- The PMU is established to assist the implementation of the Project.
- Task assignment and authorization to the PMU shall be specified in the decision on establishment of such PMU or in specific authorization documents issued by MOTC.
- The PMU shall follow the provisions of Myanmar law and the agreements signed with Japan International Cooperation Agency (herein after referred to JICA).
- The PMU and its head (the Project Director) shall take responsibility for their acts in performing their assigned tasks under the provisions of Myanmar law and agreement with JICA.
- All activities of the PMU shall be monitored and supervised by MOTC through the Steering Committee.
- The PMU is requested to manage the Project efficiently, and avoid loss and waste of resources of the Project.
- The PMU is requested to report the progress of the Project to MOTC periodically.
- Referring the anti-corruption policy instructed by the higher authorities, the PMU is requested to adopt measures to prevent any kinds of corruption.

The PMU will perform the following tasks (but not limited) to implement the Project.

General tasks

a) Planning tasks, including elaborating an overall plan and detailed annual (or monthly) plans on the Project implementation (disbursement plan, spending plan, bidding plan, etc.) which specify resources used, implementation schedules, completion deadlines, quality targets and criteria for acceptance of results of each program or the project activity, to be used as the basis for monitoring and evaluation. The overall plan on the Project implementation shall be prepared by the PMU in advance, before the Project starts and shall be approved by MOTC (the Steering Committee). Detailed annual plans shall be elaborated based on the agreement with JICA and submitted to MOTC for approval. These annual plans must conform to the annual planning schedules of MOTC and ensure timely implementation of the Project according to specific agreements with JICA.

b) Tasks of management of preparation for the Project implementation

Management of preparation for the Project implementation must comply with the current regulations while taking into consideration of the requirements particular for Japanese ODA loan (resettlement of inhabitants, ground clearance, environmental impact assessment and social impact assessment) on the basis of agreements signed with JICA.

c) Tasks of bidding and contract management:

- Performing bidding tasks assigned by MOTC(the Project owner) in accordance with the Myanmar bidding law and JICA's rules;
- Managing performance of obligations specified in contracts signed between authorized persons and contractors (in terms of work progress, volume and quality; labor safety; and environmental sanitation). Monitoring, supervising and evaluating activities and performance results of contractors. Promptly solving according to its competence problems arising in the course of contract performance;
- Organizing the take-over of works and making financial payment and settlement in accordance with the Myanmar law.

d) Tasks of financial and asset management and disbursement:

- Performing financial and asset management and carrying out procedures for disbursement in accordance with the relevant Myanmar law and JICA's rules.

e) Administrative and coordination tasks and responsibility of justification:

- Organizing an office for, and manage personnel of, the PMU;
- Establishing an internal information system, collecting, classifying and archiving all information and original documents concerning programs or projects and the PMU in accordance with the Myanmar law;
- Preparing conditions (and materials) for MOTC to publicize (inform) contents, impacts and implementation progress of the Project to direct beneficiaries of the Project and to local administrations, and non-governmental organizations in the Project area;
- Providing accurate and true information for law enforcement, oversight, inspection and auditing agencies, donors, the media and concerned individuals within the scope of its assigned tasks and responsibilities, except for information restricted by the law to the public;
- Acting as the coordinator of MOTC in working with JICA on concerned issues in the course of program or the Project implementation;
- Coordinating with MOTC in the Project activities.

f) Tasks of monitoring, evaluating and reporting program or the Project implementation:

- Organizing monitoring and assessment of the Project implementation, including reporting on the Project implementation according to regulations; supplying and sharing information through the steering committee;
- Submitting periodical and extraordinary reports on the Project implementation which will be sent to the Ministry of National Planning and Economic Development (MNPED) and the Ministry of Finance.

g) Tasks of take-over, hand-over and financial settlement of programs or the Project:

- Preparing conditions for MOTC to take over the Project and hand the completed project package over to MR for operation.
- Making reports on completion and financial settlement of the Project according to the specified in schedule stated in the agreement with JICA.

Particular tasks

h) On the basis of the content, scale and characteristics of the Project and the PMU's capability, MOTC shall authorize the PMU to decide on or sign documents under the former's competence in the course of implementation management. The authorization may be made right at the start of the Project.

i) When the agreements with JICA define the organizational structure of project management, tasks and responsibilities of the PMU, these provisions shall be concretized and fully defined as the regulation on organization and operation of the PMU.

Other tasks

- The PMU shall support MOTC to report the progress of the Project to JICA periodically.
- The PMU shall perform other tasks within the scope of the Project assigned by MOTC.

9.2.3 Institutional Strengthening for Project Implementation

The PMU requires trained personnel for the effective and smooth implementation of the Project. In this regard, it is highly recommended to increase capable human resources to assure the delivery of the Project as scheduled. Staff of the PMU can be recruited from other organizations or individuals to strengthen the capacity in advance.

9.2.4 Counterpart Fund

For smooth implementation of the Project, MR needs to take all the necessary measures to secure the fund for the MR works and non-eligible costs including (i) project components covered by MR (MR works), (ii) the administration and management costs of the PMU, (iii) taxes and duties incurred (e.g. commercial tax and custom duties) as stipulated in E/N, (iv) purchase of land and other matters related to real estate property, (v) compensation, (vi) wages for casual laborer hired on a daily basis, and (vii) other indirect items, and to secure the sufficient funds for adequate operation and maintenance.

9.2.5 Environmental Monitoring

Management and Monitoring for Environmental and Social considerations for the Project should be conducted by the Government of Myanmar in accordance with the Environmental and Social Monitoring Plan.

9.2.6 Business Improvement

Although, the adequacy ratio (equity-to-asset ratio) of MR is quite high, recording more than 90%, the source of the equity is not the cash surplus from its operating profit but the Government’s subsidy entirely. Therefore, the repayment of the loans from foreign donors and the other liabilities is principally covered by this Government’s subsidy. In this regard, it can be described that MR is not financially self-sufficient. In 2013, the deficit recorded around 43 billion Kyat, and its operation ratio (operating expenses / revenues) is higher than 150%.

To struggle with this problem, it is highly recommended that MR carries out has a series of countermeasures to increase its operating revenue to contribute reducing the government’s deficit by improving the non-passenger transport services, which are utilization of land and improvement of freight transportation.

a) Utilization of the idle (un-employed) lands:

MR is currently planning to develop the vicinal land areas of the railway stations; i.e. 16 plots in the Yangon, 2 plots in Mandalay, and 3 plots in Myitkyina, through the BOT basis. As the market value of the own land adjacent to the railway stations is hundred times higher than the

book value, the commission fees from the private developers through the BOT contract can contribute to the improvement of its financial status.

b) Modernization of cargo freight services:

To meet the growing demand of door-to-door logistics services, there is a good opportunity for MR to introduce the containerization in association with the private forwarders. In order to settle the problem of "one-way loading" due to the economic disparities between Yangon and regional cities, strengthening of connectivity with the other transportation modes through the development of logistic centres like in-land container terminal, and promotion of the industrialization in each region through the investment promotion and industrial development strategies by the strong initiatives of the Government.

Appendix

Appendix 1 Existing facilities in Insein DRC (related to Chapter 4)

A1 Basic Ground History

DRC Shed is constructed in 19**, by the engineering of Germany.

Construction cost was ** US$.

Structure of building is iron framework and concrete wall.

The floor was concrete, it contained pit-line.

The roof was triangle figure with windows.

This depot started in 1958, for circular railway.

A2 Situation and area.

Insein town, Yangon.

Area: shed area=1500 ft ×600 ft=1500×600×0.092m^2=82,800m^2=8.28ha

Main building=400ft×178ft=400×178×0.092m^2=6,764m^2

Nos of Track in shed: 11 Nos=Building inside track 6 +outside track 5

Nos of pit in building inspection=6 length 400ft =400×0.304121.6 m

A3 Machinery

- Compressor for maintenance: 1 for stationary , 2 for portable
- Welding machine 2 nos (single phase)
- Water pump 1 nos.
- Generator, Diesel engine fitted=1 Nos for fuel filling to locomotive
- Generator, Diesel Engine fitted 90 kW. 1Nos for lighting.
- Overhead crane, 5ton capacity for lifting of coach bogie.
- Lifting jack (Electric) 4nos for lifting only coaches.
- Water supply 2 tube well, water drawn by compressor
- Overhead tank 3200 gal×2×4.54 little=29,056 little→Ground 10,000gl×4.54 little=45,400 little
- Fuel fill Pump 9～90 GPm rol=Little/min, 8/min

- Fuel storage ground tank 10,000gal×4.54 little=45,000 little 1 No
  10,000gal×4.54 little=45,000 little 1 No
  Total 90,000 little.
- Water source 2 tube wells.

  No.1 tube well →air compressor 1 no, lifting pump 1 nos,

  Overhead tor locomotive for tank capacity=3200 gal×2×4.54 little=29,056 little

  Underground tank capacity= 10,000 gal×4.54=45,400 little

  No.2 tube well →air compressor 1 no, lifting pump 1 no.

  Over head tank capacity = 3200 gal×2×4.54 little=29,056 little

  →damage

  Underground tank capacity = 3200gal×4.54 little →Approxim.

  Vacuum Exhauster: 1 no for testing of vacuum coaches.

  Battery charger 2nos. for locomotive battery and coach battery.

  Injector test bench 1 no .(Pop tester) (Locomotive Diesel engine injector)

  Examination pit for locomotive=pit 7

  Locomotive DEL 900 HP=11(2 stop)
  1200HP=11
  1600HP=2
  Total 24 loco

  DHL 1100HP=6(4 stop)
  Total 30 loco

  RBE 250HP=17(11 stop)
  500HP= 9(3 stop)
  Total 26

  Coaching (Passenger)=106
  Coaching running 85
  Spare coaching 13
  Under repair 5
  To send Mitnge 3

Train-Rake Train compose

Total train Rake (Train compose)=21 day.

A4. Parking scene of rolling stocks in Insein DRC on 14th June 2014.

Table A.4.1 Insein DRC schedule on 14-15 June 2014

No	Item	Arrival	Departure	Location
1	DF1240+5 coaches	23:00	3:10	DF1240 in 6 line
				6 coaches in station
2	DF1230+5 coaches	23:05	4:04	DF1220 in 5 line
				5 coaches in station 3 line
3	DD940+6 coaches	22:20	3:30	DD940 in 3 line
				6 coaches in station 5 line
4	DF1243+5 coaches	20:50	4:00	D1243F in 6 line
				5 coaches in station 3 line
5	DF1263+5 coaches	22:30	3:45	DF1263 in 6 line
				5 coaches in 11 line in shed
6	DF1212+5 coaches	22:40	3:30	DF1212 in 3 line
				6 coaches in station 7 line
7	DD918+5 coaches		4:10	DD918 in 1 line
				5 coaches in station 5 line
8	DD938+6 coaches	21:20	5:00:00	DD938 in 1 line
				6 coaches in station 5line
9	DD936+ 5 coaches	21:40	4:55	DD936 in 3 line
				5 coaches in station in 6 line
10	DD934+6 coaches	22:10	4:40	DD924 in 1 line in shed
				6 coaches in 1 line in shed
11	DF1627+5 coaches	19:40	6:05	DF1627 in 2 line
				5 coaches in 4 station line
12	DF1248+5 coaches	20:00	3:20	Df1218 in 2 line
				5 coaches in station 4 line
13	DD931+6 coaches	21:10	6:20	DD931 in 3 line in shed
				6 coaches in 3 line in shed
14	DF1255+3 coaches	21:35	4:30	DF1255 in 5 line in shed
				3 coaches in 11 line in shed
15	RBE 2540+2576	20:30	2:50	All in shed 8 line
16	RBE2568+2519	19:00	4:00	All in shed 8 line
17	RBE 2588+2589	19:15	4:05	All in shed 8 line
18	DD1145+4 coaches		0:00	All in shed 4 line
19	DD1131+4 coaches	20:45	5:15	All in shed 7 line
20	DD2242+4 coaches	20:50	5:25	All in shed 7 line
21	RBE5033+5038+5041+5035+5032	22:15	6:00	All in shed 4 line
22	DF1257 only loco		4:20	In 5 line in shed.

This day, total locomotives which came to shed were 22 and arranged to 5 ganges.

Appendix 2 Environmental and Social Considerations (related to Chapter6)

A2.1 Outline of the proposed Project Plan and its Components

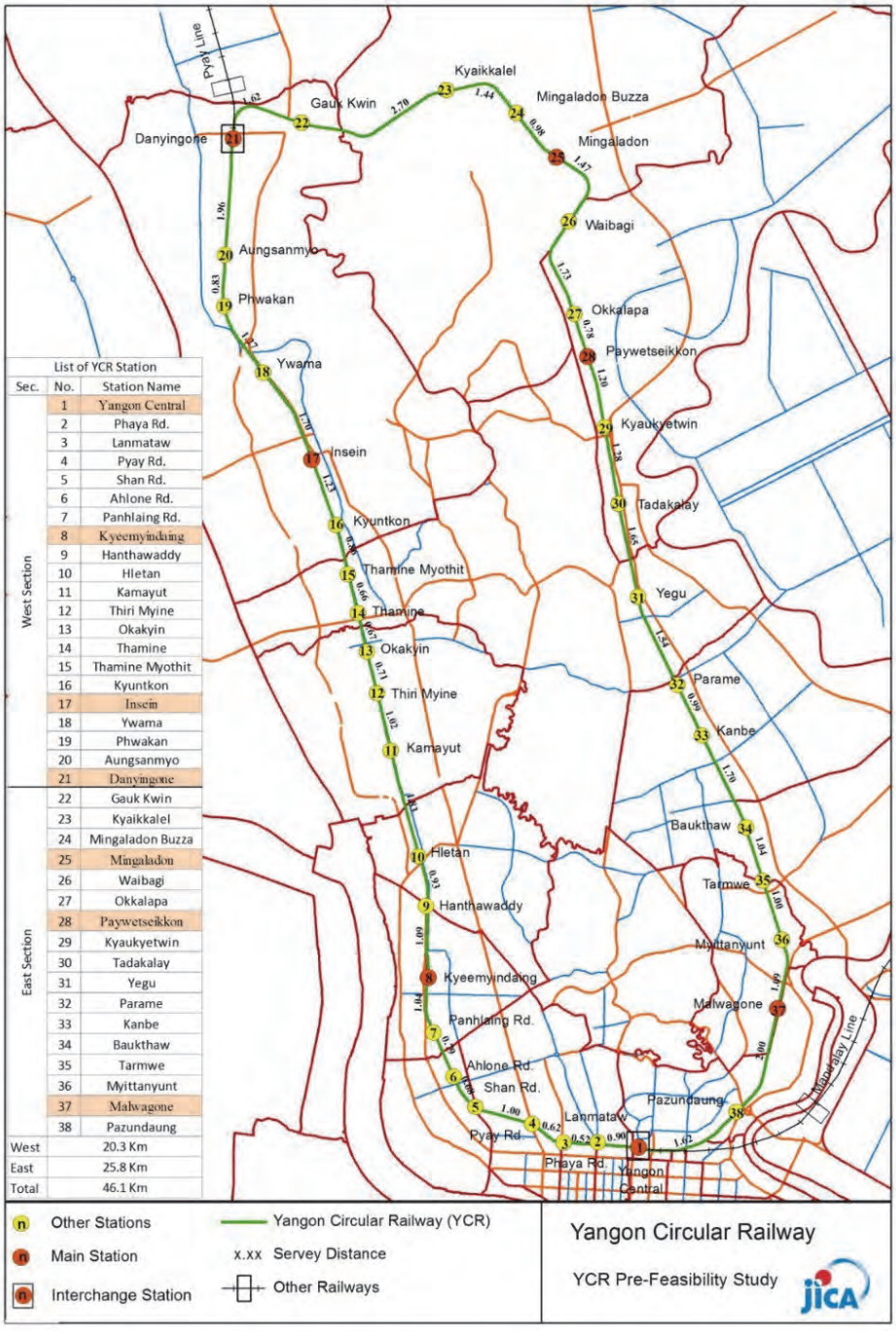


Figure A2.1.1 Map indicating Stations and Sections of YCR

A2.2 Existing Environmental and Social Conditions of the Project Area

A2.2.1 Social Environment

(1) Administration Map

Figure A2.2.1 Administration Map

(2) Economic Status and Occupational Status

1) Economic Status

The economic status of 19 townships were examined according to the aspects of industrial activities and business enterprises, and the occupational status as shown in Table A2.2.1 and A2.2.2.

Business activities in targeted sixteen townships are one aspect of the economic status. There are several factories, workshops and small-scale or domestic enterprises in these townships along the YCR Line. Moreover, Insein township had developed the industrial zones in which about 93 factories are functioning and developing the job opportunities for the city dwellers.

Table A2.2.1 Industrial Activities and Business Enterprises

No.	Name of Township	No. of Factories in Industrial Zone	No. of other Factories	No. of Workshops	No. of Small -scale/ domestic enterprises	Total
1	Tar Mwe	0	12	9	1813	1834
2	Pazuntaung	0	2	0	0	2
3	Mingalar Taung Nyunt	0	9	2	20	31
4	Botahtaung	0	2	2	0	4
5	Dagon	0	0	0	0	0
6	Pabedan	0	0	0	0	0
7	Kyauk Ta Dar	0	0	0	0	0
8	La Thar	n.a	n.a	n.a	n.a	n.a
9	Lanmadaw	0	0	0	0	0
10	Ahlone	0	3	2	0	5
11	Kyeemyin Daing	0	2	0	2	4
12	Sanchaung	0	0	0	0	0
13	Kamaryut	n.a	n.a	n.a	n.a	n.a
14	Hlaing	0	89	0	58	147
15	Mayangone	0	97	0	0	97
16	Insein	93	2	1	60	156
17	Mingaladon	61	9	0	0	70
18	North Okkalapa	243	0	0	8	251
19	Yan Kin	0	0	1	10	11
Total		397	227	17	1971	2612

Source: Township Information of General Administration Department Offices (March, 2014)

2) Occupational Status

According to the Township General Administration Department Offices, the occupational status of the targeted townships shows that an average of about 86 % of the workable persons are employed and 21% unemployed. The breakdowns for each targeted township are shown in the Table A2.2.2.

Table A2.2.2 Occupation Status

No	Name of Township	Total Population	No. of workable person	No. of Employed Person	No. of Unemployed person	% of Employed person	% of Unemployed person
1	Tar Mwe	158,877	101,146	75,488	25,658	74.6%	25.4%
2	Pazuntaung	45,316	n.a	n.a	n.a	n.a	n.a
3	Mingalar Taung Nyunt	131,310	73,728	59,026	14,702	80.1%	19.9%
4	Botahtaung	40,133	n.a	n.a	n.a	n.a	n.a
5	Dagon	19,907	12,500	14,576	881	73.2%	4.1%
6	Babae Dan	30,421	13,027	10,515	2,512	80.7%	19.3%
7	Kyauk Ta Dar	27,971	19,314	13,581	5,733	70.3%	20.5%
8	La Thar	30,426	n.a	n.a	n.a	n.a	n.a
9	Lanmataw	35,468	28,649	23,484	5,165	82.0%	18.0%
10	Ahlone	53,501	43,000	33,200	9,800	77.2%	22.8%
11	Kyeemyin Daing	95,031	43,201	38,290	6,911	88.6%	16.0%
12	Sanchaung	85,578	53,577	48,455	5,122	90.4%	9.6%
13	Kamayut	74,104	n.a	n.a	n.a	n.a	n.a
14	Hlaing	124,344	94,210	65,947	28,263	70.0%	30.0%
15	Mayangone	186,897	n.a	n.a	n.a	n.a	n.a
16	Insein	254,404	113,540	101,123	12,417	89.1%	10.0%
17	Mingaladon	828,586	135,452	34,004	101,448	79.8	20.2
18	North Okkalapa	144,401	192,928	111,419	81,509	58.0	42.0
19	Yan Kin	65,680	43,399	22,312	21,087	51.4	48.6
Total and Average (%)		**2,432,355**	**967,671**	**651,420**	**321,208**	**86.3%**	**21.9%**

Source: Township Information of General Administration Department Offices (March, 2014)

A2.2.2 Natural Environment

(1) Protected Areas

In Myanmar the Protection of Wildlife, Wild Plants and Conservation of Natural Area Law was enacted in 1994. A target has been set to increase the protected area up to 5% in the short term, and 10% in the long term. There are at present 40 protected areas in Myanmar including wildlife and bird sanctuaries, national parks, and nature reserves. Myanmar is also a Party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and Ramsar Convention.

Table A2.2.3 Protected Areas and their Locations in Myanmar

No.	Name	General Location
1	Pidaung Wildlife Sanctuary	Kachin State
2	Shwe-U-Daung Wildlife Sanctuary	Mandalay Region
2	Shwe-U-Daung Wildlife Sanctuary	Shan State
3	Pyin-O-Lwin Bird Sanctuary	Mandalay Region
4	Moscos Islands Wildlife Sanctuary	Taninthayi Region
5	Kahilu Wildlife Sanctuary	Karen State
6	Taunggyi Bird Sanctuary	Shan State
7	Mulayit Wildlife Sanctuary	Karen State
8	Wethtikan Bird Sanctuary	Magwe Region
9	Shwesettaw Wildlife Sanctuary	Magwe Region
10	Chatthin Wildlife Sanctuary	Sagaing Region
11	Kelatha Wildlife Sanctuary	Mon State
12	Thamihla Kyun Wildlife Sanctuary	Ayeyar-wady Region
13	Htamanthi Wildlife Sanctuary	Sagaing Region
14	Minwuntaung Wildlife Sanctuary	Sagaing Region
15	Hlawga Park	Yangon Region
16	Inlay Wetland Bird Sanctuary	Shan State
17	Moeyongyi Wetland Bird Sanctuary	Bago Region
18	Alaungdaw Kathapa National Park	Sagaing Region
19	Popa Mountain Park	Mandalay Region
20	Meinmahla Kyun Wildlife Sanctuary	Ayeyarwady Region
21	Lampi Island Marine N. Park	Taninthary Region
22	Hkakaborazi National Park	Kachin State
23	Loimwe Protected Area	Shan State
24	Parsar Protected Area	Shan State
25	Natmataung National Park	Chin State
26	Lawkananda Wildlife Sanctuary	Mandalay Region
27	Indawgyi Wetland Wildlife Sanctuary	Kachin State
28	Kyaikhtiyoe Wildlife Sanctuary	Mon State
29	Minsontaung Wildlife Sanctuary	Mandalay Region
30	Hukaung Valley Wildlife Sanctuary	Kachin State
31	Kyauk Pan Taung Wildlife Sanctuary	Chin State
32	Hponkanrazi Wildlife Sanctuary	Kachin State
33	Rakhine Yoma Elephant Range	Rakhine State
34	Panlaung-pyadalin Cave Wildlife Sanctuary	Shan State
35	Maharmyaing Wildlife Sanctuary	Sagaing Region
36	Lenya National Park	Taninthary Region
37	Taninthary National Park	Taninthary Region
38	Bumhpabum Wildlife Sanctuary	Kachin State
39	Hukaung Valley Wildlife Sanctuary (extension)	Kachin State
40	Taninthayi Nature Reserve	Taninthayi Region

Source: SUDP, JICA (2013)

Figure A2.2.1 Hlawga Park in Greater Yangon Area

(2) Trees along YCRL

Table A2.2.4 Major Trees along YCRL

Myanmar Name	Scientific Name
Malaysia Padauk	*Acacia auriculiformis*
Binga	*Mitragyna rotundifolia*
Malzali	*Cassia siamea*
Bandar (Indian Almond)	*Terminalia catappa*
Sein Ban (Pan)	*Delonix regia*
Mahogani	*Swietenia macrophylla*
Kokko	*Albizia lebbek*
Kyun (Teak)	*Tectona grandis*
Mango	*Mangifera indica*
Ashok	*Polyalthia loongifolia*

		
(1) Malaysia Padauk	(2) Binga	(3) Malzali
		
(4) Bandar (Indian Almond)	(5) Sein Ban	(6) Kokko
		
(7) Mahogany	(8) Kyun (Teak)	(9) Ashok

Figure A2.2.2 Major Trees distributed along YCRL track

A2.2.3 Environmental Pollution

(1) Water Quality

Table A2.2.5 Results of River Water Quality Measurements

Parameter		Observed Value	
	Unit	Pazundaung Creek	Bago River
pH	-	7.7 - 7.8	7.4- 8.0
BOD	mg/l	2 - 2.5	2 - 2.5
SS	mg/l	62 - 78	60 - 65
DO	mg/l	3.5 - 3.9	6.2– 6.7
COD	mg/l	2.2 - 7.0	1.5 – 4.4

Note: Measurement at New Thaketa Bridge Consutruction site (Mingalar Taung Nyunt Township), Novemebr 2013.

Source: JICA YUTRA (2014)

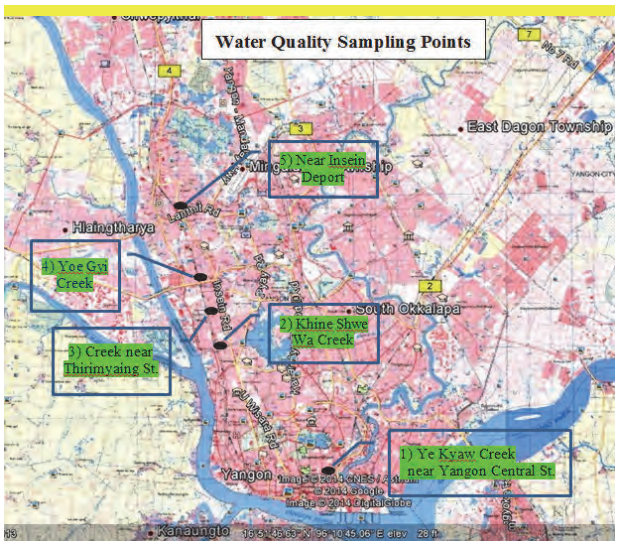
Observed values suggest that river water quality is almost to Class C or D of Japanese Standards of Water Use.

In addition, results of water quality measurements for environmental baseline data survey on YCRL are shown in Table A2.2.5 and Figure A2.2.3. As for level of BOD and COD observed values are much higher than those of Pazundaung Creek and Bago River. These water bodies are considered as drainage canals or ditches in terms of water quality.

Table A2.2.6 Results of Surface Water Quality

No.	Parameters	Unit	1	2	3	4	5
			Ye Kyaw	Khine Shwe Wa	Thiri-myaing	Yoe Gyi	Insein Depot
1	pH (On Site)	pH	7.1	7.0	7.0	7.1	7.3
2	pH (Lab Test)		7.7	7.8	7.8	7.8	7.7
3	DO (On Site)	mg/l	9.3	8.7	7.4	7.9	8.6
4	DO (Lab Test)	mg/l	6.6	6.8	6.2	6.4	6.4
5	EC (On Site)	µS/cm	347.7	485.6	620	317.6	461.5
6	EC (Labe Test)	µS/cm	327	459	590	204	437
7	Temperature	℃	26.5	26.4	26.4	26.3	26.5
8	Turbidity	NTU	52	60	70	77	79
9	SS	mg/l	90	98	128	135	138
10	COD	mg/l	64	96	64	64	96
11	BOD	mg/l	12	30	21	18	21
12	Oil and Grease	mg/l	11.7	5.2	1.2	0.4	3.8

Source: JICA Study Team (2014)



Source: JICA Study Team (2014)

Figure A2.2.3 Location of Water Sampling Points

(2) Air Quality

observed data of measurements near Thaketa Bridge site in Mingalar Taung Nyunt Township (Details are shown in Apendix A2.2.7.). Observed values of all the pollutants were within the range of Environmental Standard of Japan and Standard of WHO Guidelines.

Table A2.2.7 Results of Air Quality Measurements in Yangon City Area

Pollutant	Unit	Observed Value	Environmental Standard (24 hours average)		
			Thailand	Japan	WHO
SO_2	ppm	0.02 - 0.03	< 0.12	< 0.04	0.02
CO	ppm	0.4 - 0.7	-	< 10	-
NO_2	ppm	0.006 - 0.02	-	< 0.04~0.06	-
PM10	mg/m^3	0.04 - 0.1	< 0.12	< 0.10	0.05
PM2.5	mg/m^3	0.003 - 0.006	0.05	0.035	0.025

Note: Measurement near Thaketa Bridge site (Mingalar Taung Nyunt Township), Novemebr 2013.
Source: JICA (YUTRA)) 2014

(3) Ambient Noise

Table A2.2.8 Result of Ambient Noise Level Measurements beside the Railway Line

Station	Railway Noise Near Pyay Lan Station	Railway Noise Near Oakkyin Station
Distance from the Railway Line	3.5 m	4 m
Daytime/Nighttime	Sound level (dB)	
Daytime (6 am – 10 pm)	57.9	57.9
Nighttime (10 pm – 6 am)	51.2	50.8
Average of the Railway Noise	54.5	54.4

Source: JICA Study Team (2014)

Table A2.2.9 Result of Ambient Noise Level Measurements at Background Level and Sensitive Receptors (BLSRs)

No.	Location	Point No.	Distance from the Railway Line	Daytime (6 am – 10 pm)	Nighttime (10 pm – 6 am)
1	Islam Temple near Pa Zun Taung Station	BLSR-1	4 meter	57. 33	58.7
2	B.E.H.S School near Pyay Lan Station	BLSR-2	5 meter	67. 8	61. 3
3	B.E.H.S School near Kyee Myint Daing Station	BLSR-3	6 meter	63. 2	55. 9
4	A monastery near Thamine Myothit Station	BLSR 4	4 meter	55. 6	54.6
5	A monastery near Thirimying Station	BLSR 5	100 meter	59.6	48.5
Average on all BLSR points				59.6	51.5

Source: JICA Study Team (2014)

Source: JICA Study Team (2014)

Figure A2.2.4 Location of Ambient Noise Measurements

A2.2.4 Major Finding of Business Activities, Structures/Facilities and Land Use

(1) Major Economic and Social Infrastructures

Distribution of major facilities and bulidings located around railway stations of YCRL was investigated by field survey and map within areas of 500 m distance apart from railway station boundary.

As shown in Table A2.2.10 and A2.2.11, the results indicate that there are found 213 major facilities/buildings at present. Out of them government/public facilities such as local government offices 21, commercial/businee facilities for such as markets, banks, hotels 67, Industrial facilities such as

factories 31, religious facilities such as monasteries and churches 50, Educational facilities such as schools 29, heath related facilities such as hospitals 15.

Table2.2.10 Major Facilities/Buildings around Railway Stations of YCRL within areas of 500 m Distance apart from the Station Boundary

No.	RS	Type of Structure						
		1) Government /Public	2) Economic	3) Industrial	4) Religious	5) Educational	6) Health	Total
1	DaNyinGone RS	0	0	3	2	0	0	5
2	Aung SanMyo RS	0	0	3	2	0	0	5
3	Phawt Kan RS	0	0	2	3	1	0	6
4	Ywama RS	1	0	0	0	0	0	1
5	Insein RS	4	2	3	0	2	1	12
6	Goke Gone RS	0	1	1	1	0	0	3
7	Thamine Myothit RS	0	1	3	3	0	0	7
8	Thamine RS	0	3	0	2	1	0	6
9	Oakkyin RS	0	1	3	2	1	0	7
10	Thirimying RS	0	0	1	2	0	0	3
11	Kamayut RS	0	1	1	4	0	0	6
12	Heldan RS	1	4	1	2	2	0	10
13	Hanthwaddy RS	1	2	0	2	1	1	7
14	Kyeemyindaing RS	0	2	0	3	1	0	6
15	PannHlaing RS	1	1	0	3	3	3	11
16	Ahlone Lan RS	0	0	0	3	3	0	6
17	Shan Lan RS	1	2	0	1	0	2	6
18	Pyay Lan RS	1	2	0	0	1	1	5
19	Lanmadaw RS	3	2	0	1	3	2	11
20	Phayar Lan RS	0	10	0	3	3	0	16
21	Yangon Central RS	2	7	0	2	0	0	11
22	Pa Zun Taung RS	0	3	0	6	0	0	9
23	MaHlwaGone RS	0	4	0	1	0	0	5
24	Myittar Nyunt RS	0	3	1	1	0	0	5
25	Tarmwe RS	1	3	5	0	1	0	10
26	Bauk Htaw RS	0	1	0	0	0	1	2
27	KanBae RS	0	3	0	0	2	0	5
28	Parami RS	1	0	0	0	0	0	1
29	Yaeku RS	0	1	0	0	0	0	1
30	TantarKalay RS	0	1	0	0	1	1	3
31	KyaukYaeTwin RS	0	2	3	0	0	0	5
32	Pu Yut Sate Kone RS	1	2	0	1	0	1	5
33	Oakkalarpa RS	0	2	0	0	0	0	2
34	Waibargi RS	1	0	0	0	0	0	1
35	Mingaladon RS	0	0	0	0	0	0	0
36	Mingaladon Zay RS	0	1	1	0	1	1	4
37	Kyaik Kalae RS	0	0	0	0	2	1	3
38	Golf Kywin RS	2	0	0	0	0	0	2
	Total	21	67	31	50	29	15	213

Note: 1) Government/Public - Government offices, city hall, football stadium etc., 2) Economic - Markets, banks, hotels, cinemas etc. 3) Industrial - Factories, facilities of industrial enterprizes etc. 4) Religious - Monastreies, Mosques, Hindu Temples, Churches etc. 5) ducational - Schools etc. 6) Health - Hospitals etc.

Source: JICA Study Team

Table A2.2.11 List of Major Facilities/Buildings around Railway Station of YCRL within areas of 500 m Distance apart from the Station Boundary

1. DaNyinGone RS	
Type of Structure	Remark
- Kabarlone Garment Factory - Sweety Home Factory - CP Life Animal Factory	Industry
- Monastery - Pagoda	Religious Structure
2. AungSanMyo RS	
Type of Structure	Remark
- SUCESS Purified Drinking Water Factory - Tyre Factory - Steel Factory (MEC)	Industry
- Monastery - Pagoda (near Station)	Religious Structure
3. Phawt Kan RS	
Type of Structure	Remark
- 3 STAR Tyre Factory (MEC) - Production of Drinking Water and Pie Factory	Industry
- Aldin Disable School	Education
- WarOo Monastery - Kaemarwartha Monastery - Church	Religious Structure
4. Ywama	
Type of Structure	Remark
- Myoma Police Station (Insein)	Government Structure
5. Insein	
Type of Structure	Remark
- Insein Railway Factory - YCR Diesel Factory - Oxygen Factory	Industry
- Insein Market - LaHarPyin Market	Economic Structure
- B.E.H.S No.(1) Insein - B.E.H.S No.(2) Insein	Education
- MR Playground - MR Clinic - Central Prison (Insein) - Insein CID	Government Structure
- Insein Hospital	Health
6. GokeGone	
Type of Structure	Remark
- BPI Pharmacy and Food Products Industry	Industry
- West GokeGone Market	Economic Structure
- Sein Aung Kyi Pagoda - Monastery	Religious Structure

7. ThamineMyoThit RS	
Type of Structure	Remark
- Cake Factory - Palpyar Factory - Glass Factory	Industry
- BaYinNaung Ware House	Economic Structure
- Thirimingalar Monastery - Nyoung Thone Kwa Monastery - LwitlatYay Monastery	Religious Structure
8. Thamine RS	
Type of Structure	Remark
- ChanMyae Market - Htoo Construction Company - Housing Building	Economic Structure
- B.E.H.S No(4) Mayangone	Education
- Damma Yone Monastery - Mosque	Religious Structure
9. Oakkyin RS	
Type of Structure	Remark
- No.(1) Soap Factory - No.(1) Enamel Factory - Military Metal Factory	Industry
- YCDC Market (Hlaing Township)	Economic Structure
- B.E.M.S, Hlaing	Education
- 2 Monasteries - Pagoda	Religious Structure
10. Thirimying RS	
Type of Structure	Remark
- Noodle Factory (Private)	Industry
- ThuDammaWaDi Monastery - HlaingYadanar Monastery	Religious Structure
11. Kamayut RS	
Type of Structure	Remark
- Cigarette Factory	Industry
- ThiriMingalar Market	Economic Structure
- Phyu MaharSi Monastery - KyanKhin Monastery - Rakhine Monastery - Mosque	Religious Structure
12. Hledan RS	
Type of Structure	Remark
- Purified Drinking Water Industry(PMG)	Industry
- SeinGayhar (Heldan) - Bayinknaung Tower - KBZ Bank - Golden Royal Lotus Hotel	Economic Structure
- B.E.H.S No. (5), Kamaryut. - B.E.P.S No. (8), Kamaryut	Education
- ZayyaThukha Monastery - Palkhu Monastery (Htantabin)	Religious Structure
- YCDC Office Kamaryut Township	Government Structure

13. Hanthwaddy RS	
Type of Structure	Remark
- Sin MaLite New Market - Lippon AutoMobile Company	Economic Structure
- B.E.H.S No.(5) KyiMyinTing	Education
- WaiLiwon Monastery. - Church (1)	Religious Structure
- MPPE Gas Shop	Government Structure
- Hospital (Bone Special)	Health
14. KyiMyinTing RS	
Type of Structure	Remark
- Kyee Myint Ding Night Market - Gwa Market (Shan Lan Market)	Economic Structure
- B.E.H.S No.(4) Sanchaung	Education
- MulaOoyin Tike (36 monastery) - BarGayar Monastery - China Temple	Religious Structure
15. PanHlaing RS	
Type of Structure	Remark
- Car Showroom	Economic Structure
- B.E.H.S No.(4) Kyimyinting. - B.E.H.S No.(3) KyiMyinTing - B.E.P.S No. (15) KyiMyinTing	Education
- PonNyaYarma Monastery - AhBamaYarma Monastery - Church (3)	Religious Structure
- Unity Sailor Office	Government Structure
- West Distinct Hospital - Asia Royal Hospital (Private) - Sakura Hospital (Private)	Health
16. Ahlone Lan RS	
Type of Structure	Remark
- B.E.H.S No.(6) Ahlone. - B.E.H.S No.(2) Ahlone. - B.E.P.S No.(4) Ahlone.-	Education
- Church (3) in the Kayin Chan	Religious Structure
17. Shan Lan RS	
Type of Structure	Remark
- United Green Hotel - MaNawHary Housing	Economic Structure
- Church (1)	Religious Structure
- PyiHtungHsu Yake Thar	Government Structure
- Central Women Hospital - Children Hospital	Health
18. Pyay Lan RS	
Type of Structure	Remark
- SeinGayhar (Pyay Lan) Supermarket - TawWin Center Supermarket and Taw Win Hotel	Economic Structure
- B.E.M.S No.(1) Dagon	Education
- Russia Embassy	Government Structure
- A new hospital	Health

19. Lanmadaw RS	
Type of Structure	Remark
- MinMaNaing Market - Than Zay Market	Economic Structure
- B.E.H.S No.(2) Latha - B.E.H.S No.(2) Dagon (Myoma Kaung) - B.E.P.S No (10) Dagon	Education
- Church Housing	Religious Structure
- University Of Medicine (1) - Minor Ground (Play Ground) - National Theater	Government Structure
- Yangon Central Hospital - Hospital (Brain and Central Nerves Special)	Health
20. Phayar Lan RS	
Type of Structure	Remark
- Bogyoke Market - Olympics Hotel - Alpha Hotel - Amera Jade Hotel - FMI City - Thamata Cinema - Shwe Taung Cinema - Sule Shingrila Hotel - Central Hotel - Super One Shopping Mall	Economic Structure
- B.E.H.S No(1),Latha - B.E.H.S No(1) PaPelTan - B.E.M.S No.(2) Dagon	Education
- SeinyounChi Pagoda - 3 Church - 2 Mosque	Religious Structure
21. Yangon Central RS	
Type of Structure	Remark
- Shakura Tower - Sule Shingrila Hotel - Central Hotel - Tamata Cinema - Naypyitaw Cinema - ShaeSoung Cinema - Thwin Cinema	Economic Structure
- Church - TaChanPae Mosque	Religious Structure
- MR Building - City Hall	Government Structure
22. PuZunTaung RS	
Type of Structure	Remark
- PuZunTaung Market - Night Market - Mingalar Market	Economic Structure
- NgarMyeYa Monastery - Shwe Taung Monastery - Hinthata Monastery - Malzali Monstery - Mosque (1) - Kalar Ward	Religious Structure

23. MaHlwaGone RS	
Type of Structure	Remark
- KyokMyoung Market - Yazana Plaza - Mingalar Market - Kyet-Bell Market	Economic Structure
- 10 to 15 Monastery Compounds	Religious Structure
24. Myit Tar Nyunt RS	
Type of Structure	Remark
- Car Body Factory	Industry
- MyittarNyunt Market Platinum Hotel - YarPyae Market - Free Tax Market	Economic Structure
- B.E.M.S No (2) Myittarnyunt	Education
- LayKyunSateKyar Pagoda	Religious Structure
25. Tarmwe RS	
Type of Structure	Remark
- Plastic Industry - Tissue Industry - Pal Lake Industry - Zee Thee Industry - Jone Moker Industry	Industry
- ORANGE Supermarket - Shopping Mall - Baw Ga Zay	Economic Structure
- B.E.P.S No(1) Tarmwe	Education
- ThuWunna Football Stadium	Government Structure
26. Bauk Htaw RS	
Type of Structure	Remark
- Bouk Htaw Zay Market	Economic Structure
- Aung Yadanar Hospital	Health
27. KanBae	
Type of Structure	Remark
- KanBae Zay Market - Yankin Hotel - Shwe Thitsar Hotel	Economic Structure
- B.E.M.S No(4) South Oakkalarpa - B.E.P.S No(10) YanKin	Education
28. Parami RS	
Type of Structure	Remark
- Botanical Garden	Government Structure
29. Yaeku	
Type of Structure	Remark
- Gandamar Whole Sale Market	Economic Structure
30. TantarKalay RS	
Type of Structure	Remark
- Ward No.(2) Zay Market	Economic Structure
- B.E.P.S No.(5)	Education
- Shwe Lamin Hospital	Health

31. KyoukYaeTwin RS	
Type of Structure	Remark
- Garment Factory - Metal Industry - KyarKaung Alcohol Industry	Industry
- Pearl and Fish Export	Economic Structure
- YCDC Market	Market
32. Pu Yut SateKone RS	
Type of Structure	Remark
- MayDarWi Zay Market - Saw Pyi Hotel	Economic Structure
- Church	Religious Structure
- University of Medicine (2)	Government Structure
- North Oakkalarpa Hospital	Health
33. Oakkalarpa RS	
Type of Structure	Remark
- Kha Kwe Market - Za Myint Zwe Market	Economic Structure
34. Waibargi RS	
Type of Structure	Remark
- Yangon International Airport	Government Structure
35. Mingalardon RS	
36. Mingalardon Zay RS	
Type of Structure	Remark
- Mingalardone Industrial Zone	Industry
- Mingalardon Zaye	Economic Structure
- B.E.P.S Mingalardon - B.E.H.S Mingalardon	Education
- Mingalardon Township Hospital	Health
37. KyikeKalae RS	
Type of Structure	Remark
- Army Medicine University - Army Nursey University	Education
- Mingalardon Army Hospital	Health
38. Golf Kywin RS	
Type of Structure	Remark
- An Army - Mingalardon Golf Club	Government Structure

Source: JICA Study Team

A2.2.5 Major Findings of Structures//Facilities and Land Use along YCRL

Photos of the major finding are shown in Figure A2.2.5 to A2.2.8.

		
Residential and commercial area: (38-1) Northern area of Pazundaung St. and Yangon Central St.	Old squatter area with about 200 households: (16-17) Kyuntkon St.- Insein St.	New squatters area (16-17) Western part of Kyuntkon St.- Insein St.
		
Shops and Monastreies: (14-15) Thamine St.-Thamine Myothit St.	Huts: (28) western part of Paywetseikkon St.	Monastery and higher class residence: (27-28) Okkalapa St. – Paywetseikkon St.)
		
Weatern part of ROW (Pazundan Creek RS.)	Insein-demolished huts near railway track	Train and squatter: Thiri Myine St.-Okakyin St.

Note: Serial number in parentheses corresponds to Station and Section in Figure A5.1.1.
Source: JICA Study Team (2014, 2015)

Figure A7.2.5 Occupation on ROW of MR

		
Vendors: (21) Da Nyin Gone St..	Vendors and passengers: (21) Da Nyin Gone St.	Garbage handling workers and huts: (12-13) Thiri Myine St. –Okakyin St.
		
Garbage handling workers and huts: (1) Yangon Central St.	Temporary open market-crossing railway line: (28-29) Paywet Seikkon St. – Kyaukyetwin Kone St.	Vendors in station yard:(12) Thiri Myine St.

Source: JICA Study Team (2014, 2015)

Figure A2.2.6 Occupation on ROW (business activities)

		
Spreading water spinach in the pool: (10-11) Hletan St. -Kamayut St.	Farmland for vegetables: (21-22) Da Nyin Gone St. - Gauk Kwin St.	Farmland for vegetables: (31-32) Yegu St.-Parami St.
		
Chinese water spinach field: (27) Okkalapa St.	Chinese water spinach field: (27-28) Okkalapa-Paywet Seikkon Section	Insein RS. – Farming near railway track: (17) Insein St.

Source: JICA Study Team (2014, 2015)

Figure A2.2.7 Occupation on ROW (farmland and water-logged pond)

		
Hindu temple: (37) Ma Hlwa Gone St.	Hindu temple: (9) Hanthawaddy St.	Monastery: near (27) Okkalapa St.
		
Buddhist praying structure : (11-12) Kamayut St.– Thiri Myine St.	Pagoda: (27) Okkalapa St.	Mosque: near (11-12) Kamayut –Thiri Myine St.

Source: JICA Study Team (2014, 2015)

Figure A2.2.8 Sensitive Receptors along ROW

(1) Socio-economic Situation of the Vendors in the YCRL Stations

To know the socio-economic situation of the vendors, interview survey on about 20% for each type of vendors in each station were conducted from August 15, to August 25 of the year 2014 and results are described below

Along the priority section (Da Nyin Gone – Yangon Central – Ma Hlwa Gone), there are 18 stations in which interviews with vendors were conducted. Survey interviews with vendors were not conducted in other stations along the section, because there were very few vendors in those stations. Total respondents were 108. The socio-economic situation of the vendors can be evaluated based on the information of those 108 respondents.

(2) Profile of Vendor

Profile of the respondents is shown in Table A2.2.12.

Table A2.2.12 Profile of Vendors

Location (Name of Station)	Number of Respondents (20% for each type of vendors)	Estimated Total Numbers of Vendors in the Station	Date of the Survey
Danyingone	33	160	August 15, 2014
Ywama	1	4	August 25, 2014
Insein	6	25	August 25, 2014
Thaminemyothit	1	3	August 18, 2014
Thamine	17	100	August 18, 2014
Thirimying	3	5	August 18, 2014
Kamayut	4	8	August 18, 2014
Hledan	2	7	August 18, 2014
Hanthwaddy	1	5	August 19, 2014
Kyeemyintdaing	7	10	August 19, 2014
Panhlaing	3	10	August 19, 2014
Ahlone Lan	4	6	August 19, 2014
Shan Lan	2	5	August 19, 2014
Pyay Lan	1	4	August 19, 2014
Phayar Lan	6	15	August 19, 2014
Yangon Central	10	20	August 25, 2014
Puzuntaung	3	18	August 23, 2014
Mahlwagone	4	20	August 23, 2014
Total	108	425	-

(3) Age of Vendors

Table A2.2.13 Age of the Vendors

Age Class	No. of Respondents
Under 5yr and 5yr	0
Between 6yr and 17yr	4
Between 18yr and 60yr	100
61yr and over 61yr	4
Total	108

a) Ethnicity of Vendors

Almost all of the vendors were found to be Myanmar ethinic people. There includes a few Mon Ethnic and Muslim people.

Table A2.2.14 Ethnicity of Vendors

Ethinicity	No. of Respondents
Burma (Myanmar)	97
Kayin	1
Mon	5
Rakhine	1
Shan	1
Muslim	2
Other	1
Total	108

(4) Educational Level of Vendors

According to the survey result, almost all affected people can read and write. 5 persons of the affected household heads are graduated persons and university students. The following figures show the status of their education.

Table A2.2.15 Education Status of Vendors

Education Level	No. of Respondents
Monastery Education	18
Primary School	28
Middle School	38
High School	19
University Education	5
Total	108

(5) Type of Goods sold byVendors

There are different types of the vendors in the station. About 40% of the responds sell food and snack, 35% sell fruit and vegetables, and 14% sell betel nuts. There are some other types of vendors, namely grocery, goods, and combination of betels, goods, and snacks. Table A2.2.9 show types of vendors in the station.

Table A2.2.16 Type of Goods sold

Type of Goods	No. of Respondents
Food and snack	41
Fruit and vegetables	38
Betel	15
Good	5
Tea Shop	4
Grocery	2
Snack and Betel	2
Betel and good	1
Total	108

(6) Income Status of Vendors

Income status of Vendors were evaluated on monthly basis. The currency is Myanmar Kyat (MMK). Most of the respondents were found to get an income between 600,000 MMK and 2,400,000 MMK per year..

Tabel A2.2.17 Income Status of the Venodrs

Monthly Income (MMK)	Annual Income (MMK)	No. of Respondents
Below 50000	Below 600,000	22
Between 50000 and 100000	Between 600,000 and 1,200,000	38
Between 100000 and 150000	Between 1,200,000 and 1,800,000	32
Between 150000 and 200000	Between 1,800,000 and 2,400,000	12
200000 above	2,400,000 and Above	4
Total		108

According to the poverty line standard of JICA report (2010), more than half of the respondents were found to be under poverty line. But depending on the family size of the respondents, even some people whose annual incomes were above 1,200,000 MMK, may be unbalanced between their income and expenditure.

(7) Reason for doing business

According to the survey result, almost of the vendors are doing business as a main source of income. A few of them are working as an alternative source of income to support the family.

Table A2.2.18 Reason of Doing the Business by the Vendors

Reason of the Business	No. of Respondents	Percent of all Respondents
Alternative Sourec of Income for the family	16	15 %
Main Source of income for family	92	85 %
Total	108	100 %

A2.3 Policies, Legislation and Institutional Framework Related to Yangon Circular Railway

A2.3.1 Outline of the draft EIA Procedures (2013)

The EIA Procedures are expected to stipulate the conditions under which EIA is required and the steps to be followed in conducting and assessing the EIA. Under the Procedures, the Ministry, as the Executing Agency sets an EIA Review Committee, is to give recommendations from an environmental point of view whether to approve the EIA reports or not. Composition of the EIA Review Committee will be determined by the Minister of MOECAF but needs to include persons from the industry, academia, and civil society, as well as government officials. EIA includes an environmental management plan and a social impact assessment report. The Procedures may also include a clause for public participation in implementing the Initial Environmental Examination (IEE), EIA, and Environmental Management Plan (EMP), yet only if deemed necessary by the Ministry. It may also mention the notion of precautionary principle and touch on climate change but will not include Strategic Environmental Assessment.

Concrete steps for undertaking EIA are stipulated in the EIA Procedures. While it is yet to be promulgated, the draft document and results of the interviews with ECD staff members reveal that the EIA process in Myanmar to be in general consists of the following:

a) All development projects in Myanmar are subject to an environmental screening process through which projects will be judged to determine if they require any environmental review and, if so, at which level (i.e. IEE or EIA).

b) EIA includes an environmental management plan and a social impact assessment report.

c) Public participation is essential for the Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA), with the inclusion of an Environmental Management Plan (EMP).

d) EIA Review Committee is formed to give recommendations to the Minister of MOECAF from an environmental point of view on whether to approve the EIA report 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.

e) Members of the EIA Review Committee will be selected by the Minister of MOECAF and will include persons from the industry, academia, and civil society, as well as government officials.

f) Involuntary resettlement is carried out under the responsibility of a Respective Regional Government and hence will not be included in the EIA Procedures.

g) Costs involved in conducting EIA are to be covered by the project proponent.

h) EIA can be carried out in Myanmar only by firms that are registered under ECD/MOECAF.

(1) IEE/EIA required projects

Lists of projects, which are required of IEE/EIA are provided in Schedule I and II of the EIA Procedures.

(2) Schedule I projects

All projects that are likely to have some adverse environmental impacts, but of lesser degree and/or significance than those of Schedule II projects, an Initial Environmental Examination (IEE) is required to determine whether or not significant environmental impacts warranting an EIA (full EIA) are likely. If the EIA is not required, the report of the IEE is regarded as the final environmental assessment report.

(3) Schedule II projects

All projects that are likely to have potential for significant adverse environmental impacts, an EIA (full) is required to address such significant impacts.

Lists of IEE/EIA required projects related to transport development are shown in Table

Table A2.3.1 List of IEE/EIA required Transport Project of Infrastructure Development

Purpose and type of project	Project feature (size, etc.)
(I) IEE required project (Schedule I)	
1) River Training Works	All projects
2) Construction of Bridges	more than 50 feet and less than 200 feet
3) Port Development	All projects
(II) EIA (full EIA) required project (Schedule II)	
1) Construction of Highways and fly-over	all projects if recommended by IEE
2) Ports Development	all projects if recommended by IEE
3) Construction of Subways	all projects if recommended by IEE
4) Construction of Bridges	more than 200 feet
5) Construction of Shipyards	dead weight tonnages greater than 5,000 tons
6) Construction of Airports	airstrips of 8,200 feet (2,500 meters) or longer
7) Construction of Railways including Construction of new routes	all projects more than 1 kilometer in length

Note: Project activities other than new construction such as rehabilitation, extension and/or improvement are not clearly stipulated.

Source: Compiled from Environmental Impact Assessment Procedures (Draft, 2013)

(4) Schedule III

In addition, Schedule III identifies environmentally, ecologically and socio-culturally sensitive areas which should not be included in any development project and a reasonable distance should be ensured from such areas so as not to cause any permanent damage or result in any adverse environmental, ecological or social impacts (Table A2.3.2).

Table A2.3.2 Environmentally, Ecologically and Socio-cultural Sensitive Area (Schedule III)

No.	Sensitive Areas
1	Areas of unique historical, cultural, archaeological, scientific or geographical significance
2	Wetlands
3	Ecologically fragile area
4	National parks, wildlife sanctuaries and protected areas
5	Wilderness areas containing rare or endangered species of flora or fauna and their habitat
6	Areas susceptible to natural hazards
7	Major sources of public drinking water
8	Areas surrounding lakes and reservoirs
9	Resort areas and areas closed to oyster fishing and pearl farms areas
10	Flooded of flood plain on other or other hazardous zones

Source: Environmental Impact Assessment Procedures (draft, 2013)

A2.3.2 Gaps of Environmental and Social Considerations between Myanmar legislation and JICA Guidelines

At present roles and importance of environmental and social considerations in the planning and implementation of projects are not necessarily recognized in Myanmar. To cope with this, the Environmental Conservation Law was just enacted in 2012 and EIA Procedures were proposed as described the above.

Regarding policies for environmental and social considerations, those of JICA guidelines are basically same as those of World Bank and ADB.

Table 2.3.3 shows results of comparison between the policies of Myanmar legislations including the EIA Procedures and those of JICA Guidelines. It is found that there are still considerable gaps between Myanmar legislations and JICA Guidelines.

Table A2.3.3 Gaps between the JICA Guidelines for Environmental and Social Considerations (JICA Guidelines) and Myanmar legislations

JICA Guidelines/WB OP4.12	Legislation of Myanmar	Gaps between JICA Guidelines/WB OP4.12 and Law of Myanmar
(1) Underlying Principles		
1. Environmental impacts that may be caused by projects must be accessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.	Procedures (A 9,13)	Article 9 of the Procedures requires IEE or EIA for proposed projects based on types activities according to the defined thresholds.
		Article 13 of the Procedures stipulates to analyze feasible alternatives as well as mitigation measures. There is no description which stipulates the timing of above implementation.
2. Such examinations must be endeavored to include an analysis of environment and social costs and benefits in the most quantitative terms possible, as well as a qualitative analysis; these must be conducted in close harmony with the economic, financial, institutional, social and technical analyses of projects.	Procedures (A 13)	Article 13 of the Procedure stipulates to analyze feasible alternatives, mitigation measures as well as cost and benefit.
3. The findings of the examination of environmental and social considerations must include alternatives and mitigation measures, and must be recorded as separate documents or as a part of other documents. EIA reports must be produced for projects in which there is a reasonable expectation of particularly large adverse environmental impacts.	Procedures (A 9,13,14)	Article 9 of the Procedures requires IEE or EIA for proposed projects based on types to projects activities according to the defined thresholds. Article 13 of the Procedure stipulates to analyze feasible alternatives as well as mitigation measures.
		Article14 of the Procedures requires the preparation of EIA report for the EIA required project and preparation of EMP for IEE/EIA required project. On the other hand, there is no description so far which stipulates IEE report for IEE require project.
4. For projects that have a particularly high potential for adverse impacts or that are highly contentious, a committee of experts may be formed so that JICA may seed their opinions, in order to increase accountability.	Procedures (A 4)	Article 4 of the Procedures requires the establishment of EIA Committee composed of at least five persons with necessary expertise.
		The committee's duty is to recommend approval of the submitted IEE/EIA and EMP.
(2) Examination of Measures		
1. Multiple alternatives must be examined in order to avoid or minimize adverse impacts and to choose better project options in terms of environment and social considerations. In the examination of measures, priority is to be given to avoidance of environmental impacts; when this is not possible, minimization and reduction of impacts must be considered next. Compensation measures must be examined only when impacts cannot be avoided by any of the aforementioned measures.	Procedures (A 13)	Article 13 of the Procedures stipulates to investigate of all potential environmental impacts including an analysis of feasible alternatives and mitigation measures. Conduct of compensation measure is not stipulated in the Procedures.
2. Appropriate follow-up plan and system, such as monitoring plans and environmental management plants, must be prepared; the costs of implementing such plans and systems, and the financial methods to find such costs, must be determined. Plans for projects with particularly large potential adverse impact must be accompanied by detailed environmental management plans.	Procedures (A 13,14)	Article 13 of the Procedures stipulates to analyze feasible alternatives, mitigation measure as well as cost & benefit.
		Article 14 of the Procedures requires the preparation of EMP for IEE/EIA required project.

JICA Guidelines/WB OP4.12	Legislation of Myanmar	Gaps between JICA Guidelines/WB OP4.12 and Law of Myanmar
(3) Scope of Impacts to Be Assessed		
The impacts to be accessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accident, water usage, climate change, ecosystem, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood , utilization of land and local resources, social institution such as social capital and local decision-making institution, existing social infrastructure and services, vulnerable	Procedures (A 13)	The items of likely impacts are not clearly stated in the Procedures. Article 13 of the Procedures prescribes that a project proponent shall carry out a full analysis and investigation of all the potential impacts, both adverse and beneficial, of the proposed projects.
2. In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project.	None	No laws were identified, which mentioned assessment and examination of derivative, secondary, and cumulative impacts as well as the impacts of projects which are indivisible from the project in a reasonable extent.
(4) Compliance with Laws, Standards, and Plans		
1. Projects must comply with the laws, ordinances, and standards related to environmental and social considerations established by the governments that have jurisdiction over project sites (including both national and local governments). They must also conform to the environmental and social consideration policies and plans of the governments that have such jurisdiction.	The Environmental Conservation Law 2012 (A 28, 29)	No law directly prescribes that projects must comply with the laws, ordinances, and standards related to environmental and social considerations.
		Article 28 of The Environmental Conservation Law prescribes that "No one shall, without the prior permission, operate business, work-site or factory, workshop which is required to obtain the prior permission under this Law"
		Article 29 of the law stipulated that "No one shall violate any prohibition contained in the rules, notifications, orders, directives and procedures issued under this Law."
2. Projects must, in principle, be undertaken outside of protected areas that are specifically designated by laws or ordinances for the conservation of nature or cultural heritage (excluding projects whose primary objectives are to promote the protection or restoration of such areas). Projects are also not to impose significant adverse impacts on designated conservation areas.	Procedures (A 8)	Schedule 3 stipulated by Article 8 of the Procedures prescribes that projects must, in principle, be undertaken outside of Environmentally, Ecologically and Socio-culturally Sensitive Area.
	The Protection and Preservation of Cultural Heritage Regions Law(Article 18)	This law stipulates that no person shall construct, extend, renovate a building or extend the boundary of ancient monumental zone or ancient site zone without prior permission granted under this law.
(5) Social Acceptability		
1. Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which they are planned. For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans.	Procedures (A 6,15)	Article 6 of the Procedures stipulates that MOECAF shall arrange for public participation of civil society and relevant agencies in conduct of IEE/ EIA and EMP.
		Article 15 of the Procedures stipulates that MOECAF shall invite civil society organizations and affected persons to provide comments and suggestions on IEE/ EIA report.

JICA Guidelines/WB OP4.12	Legislation of Myanmar	Gaps between JICA Guidelines/WB OP4.12 and Law of Myanmar
2. Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, and the poor and ethnic minorities, all members of which are susceptible to environmental and social impacts and may have little access to decision-making processes within society.	Procedures (A 4)	Article 4 of the Procedures prescribes implementation of necessary actions for the project which potentially gives adverse impact on indigenous people and causes involuntary resettlement. However, the details of actions are not provided in the Procedures.
(6) Ecosystem and Biota		
1. Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests.	The Environmental Conservation Law 2012 (A 18)	The Environmental Conservation Law prescribes that relevant government departments/organizations shall carry out conservation, management, beneficial use, sustainable use and enhancement regional cooperation of environmental natural resources.
	The Forest Law 1992 (A 40)	Article 40 of the Forest Law (1992) prescribes that cause of any damage to reserved forest and its environment is prohibited and will be punished.
	The Protection of Wildlife and Conservation of Natural Areas Law 1994 (A 36)	Article 36 of The Protection of Wildlife and Conservation of Natural Areas Law prescribes that cause of any damage to protected areas is prohibited and will be punished.
2. Illegal logging of forests must be avoided. Project proponents etc. are encouraged to obtain certification by forest certification systems as a way to ensure the prevention of illegal logging	The Forest Law 1992 (A 17, 40)	The Law stipulates that forest produce may only be extracted after obtaining a permit.
(7) Involuntary Resettlement		
1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.	Procedures (A 4)	The Procedures prescribes implementation of necessary actions for the project which potentially gives impact on involuntary resettlement. However, the details of actions are not provided in the Procedures.
2. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents etc. in a timely manner. Prior compensation, at full replacement cost, must be provided as much as possible. Host countries must make efforts to enable people affected by projects and to improve their standard of living, income opportunities, and production levels, or at least to restore these to pre-project levels. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting means for an alternative sustainable livelihood, and providing the expenses necessary for the relocation and re-establishment of communities at resettlement sites.	Land Acquisition Act 1894 (A 3)	Article 3 of the Land Acquisition Act stipulates that a person who has right in land would be entitled to claim a compensation if the land were acquired under this Act.
	Farmland Rules 2012 (A 64)	Article 64 of Farmland Rules stipulates compensation in farmland acquisition for the interest of the State or public.
	Land Acquisition Act 1894 (A 23)	Article 23 of the Act stipulates that damages on standing crops and trees, on land, properties, incidental to relocate residence or business and losses of profits due to land acquisition are considered for compensation although it does not clearly state to support PAPs can improve or at least restore their standard of living. However, these laws do not clearly state any more details of compensation and supporting measures.

JICA Guidelines/WB OP4.12	Legislation of Myanmar	Gaps between JICA Guidelines/WB OP4.12 and Law of Myanmar
3. Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood. In addition, appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	Procedures (A 15)	Article 15 of the Procedures describes that relevant agencies, institutions, civil society organizations, and project-affected persons are invited as appropriate to provide comments and suggestions on the IEE/ EIA/ EMP reports. However, it does not describe resettlement action plan.
	Land Acquisition Act 1894 (A 5A, 18)	Article 5A of the Land Acquisition Act stipulates that any person whose land is affected (acquired) can claim the objection for the land acquisition within thirty
4. For projects that will result in large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP4.12, Annex A.	None	No laws were specifically mentioned about the requirement of resettlement action plans for large-scale involuntary resettlement.
		According to GAD of MOHA Land Acquisition and Resettlement Action Plan (LARAP) will be required for the large-scale developments and the GAD will approve it.
(8) Indigenous People		
1. Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous people for their losses.	Procedures (A 4)	The Procedures prescribes implementation of necessary actions for the project which potentially gives impacts on indigenous people without the details.
2. When projects may have adverse impacts on indigenous people, all of their rights in relation to land and resources must be respected in accordance with the spirit of relevant international declarations and treaties, including the United Nations Declaration on the Rights of indigenous Peoples. Efforts must be made to obtain the consent of indigenous peoples in a process of free, prior, and informed consultation.		
3. Measures for the affected indigenous peoples must be prepared as an indigenous peoples plan (which may constitute a part of other documents for environmental and social consideration) and must be made public in compliance with the relevant laws and ordinances of the host country. In preparing the indigenous peoples plan, consultations must be made with the affected indigenous peoples based on sufficient information made available to them in advance. When consultations are held, it is desirable that explanations be given in a form, manner, and language that are understandable to the people concerned. It is desirable that the indigenous peoples plan include the elements laid out in the World Bank Safeguard Policy, OP4.10, Annex B.		

JICA Guidelines/WB OP4.12	Legislation of Myanmar	Gaps between JICA Guidelines/WB OP4.12 and Law of Myanmar
(9) Monitoring		
1. After projects begin, project proponents etc. monitor whether any unforeseeable situations occur and whether the performance and effectiveness of mitigation measures are consistent with the assessment's prediction. They then take appropriate measures based on the results of such monitoring.	Procedures (A -18)	The Procedures prescribes that a project proponent shall prepare and submit an EMP with the IEE/ EIA reports.
		The MOECAF shall carry out monitoring of the implementation of the approved EMP by the project proponent although there was little information regarding the method or terms of the monitoring conduction.
2. In cases where sufficient monitoring is deemed essential for appropriate environmental and social considerations, such as projects for which mitigation measures should be implemented while monitoring their effectiveness, project proponents etc. must ensure that project plans include feasible monitoring plans.	None	
3. Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders.	None	No laws were identified, which stated that project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders.
(10) Others		
1. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	Land Acquisition Act of 1894 (A 4)	Article 4 of the Act stipulates that a notification of land requirement for public purposes is published to start surveys and land marking although it does not state the details of surveys to establish eligibility through an initial baseline survey (including population census).
2. Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	Land Acquisition Act of 1894 (A 9)	Article 9 of the Act stipulates regarding occupier (if any) of land and all persons known or believed to have rights on lands are notified or invited for explanations although the eligibility is not clearly prescribed in the Act.
3. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WBOP4.12 Para.11)	None	No law was identified on preference to land-based resettlement strategies for displaced persons.
4. Provide support for the transition period (between displacement and livelihoods are land-based. (WB OP4.12 Para 6)	None	No law was identified on the provision of support for the transition period.
5. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line , landless, elderly women and children, ethnic minorities etc. (WB OP4.12Para.8)	None	No law was identified on particular attention to vulnerable groups.
6. For projects that entail land acquisition or involuntary resettlement for fewer than 200 people, abbreviated resettlement plan is to be prepared, (WB OP4.12 Para.25)	None	No law was identified on the criteria of preparing abbreviated resettlement plan.

Note: JICA - JICA Guidelines for Environmental and Social Considerations, WB - World Bank Safeguard Policy, Procedures - Environmental Assessment Procedures (Draft, 2013,by MOECAF), A - Article.

Source: JICA Guidelines for Environmental and Social Considerations (2010.4) and World Bank OP 4.12 and relevant Myanmar legislation

A2.3.3 Existing situation of EIA regulations for Offcicial Development Scheme by Foreign Donors in Myanmar

At present, in the case of official development scheme by the foreign public sector including foreign donors, the approval for the project implementation is attained after several processes (Figure 2.1.2) as follows.

At first, the project proponent shall submit project proposal documents together with a feasibility study report including the results of Environmental Impact Assessment (EIA)/Social Impact Assessment (SIA) to the Foreign Economic Relations Department (FERD) of Ministry of National Planning and Economic Development (MNPED).

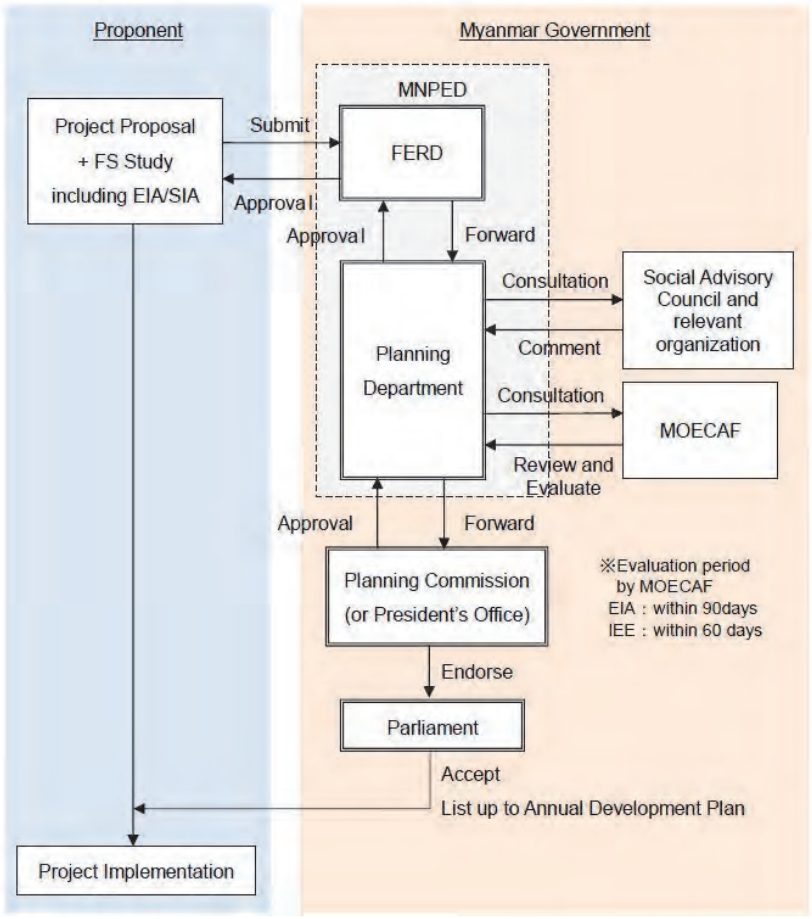
After examining all the required documents by FERD, the documents are forwarded to the Planning Department of MNPED.

The Planning Department consults with the Social Advisory Council and other relevant organizations as well as MOECAF for examination in detail the documents. In this process MOECAF reviews and evaluates the results of EIA/SIA in terms of environmental and social considerations.

After all the above organizations approved the submitted documents, the Planning Department forwards the documents together with the results of the above examination and evaluation to the Planning Commission (or the President's Office).

After the approved of the documents, the Planning Commission will endorse them together with its recommendation to the Parliament.

In the Parliament, after acceptance of the project approval, the project will be registered into the national annual project list without which no project is able to be conducted in the target year.



Source: YUTRA Project Team (2013)

Figure A2.3.1 Existing Procedures of Project and Environment Approval

A2.3.4 Environmental Quality Standards

(1) Outline of Environmental Quality Standards

In Myanmar, environmental quality standards for specific environmental parameters had not been stipulated by MOECAF until the end of August, 2014. But in the Environmental Conservation Law (2012), it is stated as follows:

- The Ministry may, with the approval of the Union Government and the Committee, insert, modify and stipulate the environmental quality standards for the interests of the public in accord with the scientific and technological advances or requirement of work according to time and area.
- If any environmental quality standard stipulated by any Government department, Government organization under any existing law is more stringent than the quality standard stipulated by the Ministry, it shall remain in force; however if it is less stringent than such standard, only the standard stipulated by the Ministry shall be in force.

Now MOECAF had already formed the 19 technical sub-committees for the development of

environmental standards, in which different government departments and organizations are working in close collaboration. But the standards have not been stipulated by MOECAF, until August 2014.

In Article 10 of the Environmental Conservation Law, 2012, MOECAF may, with the approval of the Union Government and the Committee, stipulate the environmental quality standards for items such as surface water quality, underground water quality, air quality, noise and vibration etc., although the standards have yet been established until November 2013.

However, some emission and/or discharge standards and environmental standards have been established by other ministries and practically used standards and/or guidelines as references.

(2) Pollution control standards at generation source

The Private Industrial Enterprise Law (1990) stipulates that one of the basic principles of the law is to avoid or reduce to the usage of the technology which causes environmental pollution. In addition, the law also stipulates that one of the duties of Ministry of Industry (MOI) is to secure or not allow any pollution to cause any adverse effect on environment as well as health of residents and factory workers.

Standing Order 3/95, Water and Air Pollution Control Plan (MOI) stipulates that factories shall conduct monitoring of wastewater for items defined in the Order and emission and effluent standards as shown in Table A2.3.4 and Table A2.3.5.

Table A2.3.4 Emission Standards

Gas	mg/m^3	ppm
CO_2	9000	500
CO	55	50
H_2S	14	10
Ammonia	18	25
Benzene	30	10

Source: MOI Standing Order 2/95 Occupational Health Plan 1995

Table A2.3.5 Effluent Standard

Item	Threshold	Standard Value
BOD(5days at 20°C)	max	20ppm or more but not exceeding 60ppm,depending on geography of wastewater discharging point
Suspended solids	max	30 ppm
Dissolve solids	max	2000 ppm
pH Value	Between 5 and 9	
Permanganate value	max	60 ppm
Supplied (as H2S)	max	1 ppm
Cyanide (as HCN)	max	0.2 ppm
Oil and grease	max	5 ppm
Tar	none	
Formaldehyde	max	1 ppm
Phenols and cresols	max	1 ppm
Free chlorine	max	1 ppm
Zinc	max	5 ppm
Chromium	max	0.5 ppm
Arsenic	max	0.25 ppm
Copper	max	1.0 ppm
Mercury	max	0.005 ppm
Cadmium	max	0.03 ppm
Barium	max	1.0 ppm
Selenium	max	0.02 ppm
Lead	max	0.2 ppm
Nickel	max	0.2 ppm
Insecticides	none	
Radioactive materials	none	
Temperature	max	40° C
Color and Odor	Not objectionable when mixed in receiving water	

Source: MOI Standing Order 3/95: Water and Air Pollution Control Plan

(3) Regulation of Wastewater Discharge in YCDC area

Section 7 (7) of the YCDC Order No. 10/ 99 prohibits discharging of wastewater into common properties. Nobody shall be allowed to dispose and/ or flow sewage and wastewater from any activity, such as business, factory, into drainage, creeks and rivers without necessary treatment for compliance with standards, norms and criteria designated by the agency concerned. Effluent standards from factories and facilities are shown in Table A2.3.6**.**

Table A2.3.6 Effluent Standards for Wastewater from Factory and Facilities

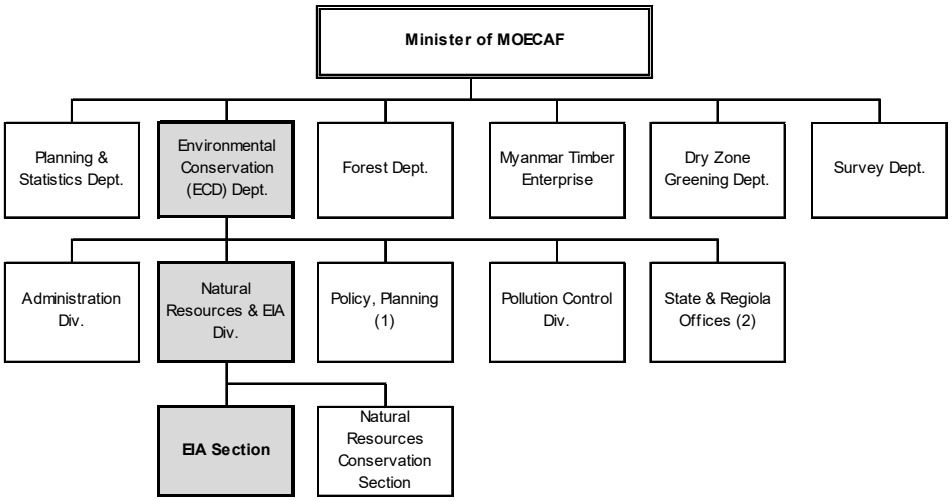
	Item	Value
1	pH	6-9.6
2	BOD	20-60 ppm
3	COD	< 200 ppm
4	TS	up to 2000 ppm
5	SS	up to 500 ppm

Source: Proposed National Standard from Occupational Health Division, Department of Health under Ministry of Health

A2.3.5 Institutional Framework for Environmental Conservation

The Ministry of Forest was re-named as the Ministry of Environmental Conservation and Forestry (MOECAF) on September 6th 2011 in order to undertake both environmental and forest conservation and management more effectively. It is after about 90 years from 1923, when the Ministry of the same name was firstly formed.

MOECAF consists of six departments as shown in Figure A2.3.2. In MOECAF Environmental Conservation Department (ECD) is responsible for environmental affairs including EIA. ECD has four divisions with state and regional offices.



Note: (1) Policy, Planning & International Relations, Research and Extension Division,
(2) State & Regional Offices (Yangon, Mandalay, Sagaing, Bago, Taninthari)

Source: Edited from documents by MOECAF

Figure A2.3.2 Organization Chart of MOECAF

A2.3.6 Legal and Regulatroy Framework related to Development, Planning and Management of Yangon City

(1) The State Level - Constitution

The State Constitution of the Republic of the Union of Myanmar was ratified and promulgated by the National Referendum held in May 2011. In the Constitution some of the provisions related to the urban planning and land management are summarized as follows:

- The Union is the ultimate owner of all lands and natural resources in the area. (Section 37)
- Citizens are given the right for private property. (Section 37);
- The Union guarantees the right to ownership and the use of property. (Section 372);
- Every citizen has the duty to assist the Union in preserving and safeguarding the cultural heritage, conserving the environment, striving for the development of human resources, and protecting and preserving the public property. (Section 390).

(2) City of Yangon Development Law

As for Yangon City area, the City of Yangon Development Law was enacted in 1990 and ordered the formation of the YCDC in order to carry out the development works of Yangon City. The Law stipulated that YCDC shall lay down the policy, give guidance, supervise or implement the following duties and responsibilities (Section 7):

- Preparation of civil projects and new towns;
- Administration of lands;
- Determining only of the population which should be allowed to settle properly;
- Construction, repair and demolition of buildings, squatter buildings, and squatter wards;
- Demolition and re-settlement of squatter huts, squatter buildings, and squatter wards;
- Construction of roads, bridges, and maintenance thereof;
- Stipulation of conditions for traffic, parking of vehicles, and slow moving vehicles;
- Construction of gardens, parks, playgrounds, and recreation centers, and maintenance thereof;
- Carrying out works for the lighting of roads;
- Carrying out works for water supply;
- Construction of reservoirs and pipelines, and maintenance thereof;
- Carrying out works for sanitation;

- Carrying out works for public health;
- Construction, maintenance, and administration of markets;
- Stipulation of conditions for road side stalls; and
- Carrying out precautionary measures against fires.

The Law also gives YCDC the following powers (Section 9):

- Demarcating and re-demarcating the territorial limit of Yangon City (the City of Yangon Municipality);
- The right to operate works independently with funds owned by YCDC;
- Prescribing, reviving, assessing, and collecting duties and taxes with their rates relating to development works, in accordance with the existing laws;
- The right to apply the foreign currency derived from the lease of building, lease of lands or by other means, for development works;
- The right to carry out works contributing to city development by making contracts with local and foreign organizations and with local and foreign individuals;
- The right to take loans and grants from the government or from foreign organizations, and being responsible for its payment;
- The right to carry out works by forming sub-committees work-wise;
- Arranging modern methods and systems in order to carry out the development works effectively;
- Exercising the powers conferred under the City of Yangon Municipal Act, rules, and bye-laws;
- Exercising the powers conferred from time to time by the chairman of the State Law and Order Restoration Council Law.

In addition, Section 10 of the Law stipulates that notwithstanding anything contained in the existing City of Yangon Municipal Act, State Housing and Town and Country Development Board Act, and other existing laws, powers relating to the formulation and implementation of civil projects, and establishment of new towns and administration of town lands within the limits of the Yangon City, shall vest in YCDC.

(3) Laws Related to Urban Planning and Land Management

Since the adoption of the new constitution in 2008, relevant laws and regulations need to be enacted or modified, but this process is far from being quick in move. Consequently, some of the old British era laws and regulations are still in use for matters of urban planning, land management, and housing.

1) Land Acquisition Act (1894)

This British era act is still effective at present due to the lack of new legislation relevant to land acquisition. The Act stipulates that a land could be acquired by the government if it was deemed to be in the interest of the public. Religious lands such as pagodas, stupas, shrines, and cemeteries were not subject for acquisition.

2) Rangoon Development Trust Act (1920)

In 1920, the Rangoon Development Trust Act was enacted under the British rule. This resulted in the establishment of Rangoon Development Trust in 1921, with powers that include the followings:

- Purchase/acquisition of immovable property;
- Project development planning and land management;
- Levy of revenue taxes and lease fees of land
- Purchase, lease, and transfer of land and management through other methods; and
- Establishment of laws, regulations, and instructions as necessary.

The Rangoon Development Trust, based on the Act, conducted long-term and short-term leases of land, and thus allowed use of land, and conducted issuance of land lease licenses, permits and abrogates for construction, industrialization, agriculture, and other special purposes.

3) State's Housing Rehabilitation and Town and Villages Development Board Act (1951)

In 1951, three years after the independence, the State's Housing Rehabilitation and Town and Villages Development Board Act was promulgated in order to solve the shelter problem occurring at the time as people were moving in to Rangoon from rural areas in large numbers.

The act stipulated that the provision of shelter would be performed through town and village development projects and public housing rehabilitation projects along with systematic management process.

- Any land (or building, if it exists on the land) could be acquired through the Land Acquisition Act (1894)
- This act enabled town and village development, supervision of public housing rehabilitation, management and improvement of land management, and others on the nationwide basis.

4) Urban Rent Control Act (1952, amended in 1960)

Shortly after the World War II, a large number of people migrated to the cities and the issue of housing became serious and acute. This Act regulated the rents in the urban areas to a low and affordable level. This Act is still in effect, keeping the housing rents in the urban areas to a

considerably low level so that proper maintenance of rented properties has become economically unbearable for most property owners.

5) Farmland Law (2012)

The Law is to be accompanied by Farmlands Bylaws and Vacant, Fallow, and Virgin Lands Management Bylaws to be approved by the Union Government. The Farmland Law enables all farmers across the country to enjoy land use rights, in which the farmer can register.

6) Other Related Laws and Regulations

The legislative system inherited from the colonial period is highly comprehensive. The following laws and rules are listed according to specific concerns to the human settlement sector.

- Towns Act, 1870;
- Lower Burma Towns and Village Act, 1894;
- Municipal Act, 1898;
- Land Revenue Manual, 1907;
- Land Rules, 1922;
- City of Rangoon Municipal Act, 1924 ;
- Underground Water Rules, 1941;
- Requisitioning (Emergency Provisions), 1947;
- Land Nationalization Act, 1953;
- Town Planning Act (Draft Proposal), 1961;
- City of Yangon Development Law (SLORC Law No. 11/90), 1990;

7) Bylaws of YCDC

As a result of SUDP, 24 bylaws, which have been enacted between 1995 and 2001, are even effective in YCDC. The contents of the bylaws cover all spheres of the city's administration front, varying from management, urban planning to infrastructure, and commercial registration.

A2.4 Comparison of Alternatives

- ◆ No item.

A2.5 Results of Initial Environmental Examinations (IEE)

A2.5.1 Matrix relations of activity - component and activity - environmental item

Impact matrix is useful to examine preliminary scoping of anticipated impacts on environment due to the project in earlier stage of planning.

1) Impact matrix of project components vs. environmental items

Impact matrix of project components vs. environmental items can identify which component may cause impacts and which environmental item will be affected by the components as shown in Table A2.5.1.

Table A2.5.1 Impact Matrix between the Project Components and Environmental items

Item *, **	Rating				Project Components						
	Pre-FS		FS		1. Renewal of Railway Signals and Communication System				2. Introduction of DEMU trains		
	I/II	III	I/II	III	1) Renewal of level crossing including crossing signals, takeoff board etc. (gatehouse)	2) Renewal of traffic signals and communication system along railway line	3) Rehablitation of railway track condition for smoother and safer train running	4) Improvement of drainage condition to avoid inundation of railway track	DEMU train service	Depot for DEMU trains	Installation of fences to secure railway safety
(1) Social Environment											
1) Land acquisition/resettlement	B-		B-/D		D	D	D	D	D	D	B-
		D		D	D	D	D	D	D	D	D
2) Local economy such as employment and livelihood etc.	B-		D/B+		B+	B+	B+	B+	D	D	B+
		B-/B+		B-/B+	B+	B+	B+	B+	B+	D	B-/B+
3) Utilization of land and local resources	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
4) Existing social infrastructures and services	B-		B-		B-	B-	B-	B-	D	D	B-
		B+		A+	A+	A+	A+	A+	A+	A+	A+
5) Social institutions such as social infrastructure and local decision-making institutions	C-		B-		B-	B-	B-	B-	B-	B-	B-
		C-		B-	B-	B-	B-	B-	B-	B-	B-
6) Vulnerable group such as the poor,women, children, elderly, disabled etc.	B-		B+		B+	B+	B+	B+	B-	D	B+
		B-		B-/B+	B+	B+	B+	B+	B+	D	B-/B+
7) Ethnic minority	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
8) Misdistribution of benefit and damage	C-		B-		B-	B-	B-	B-	B-	B-	B-
		C-		B-	B-	B-	B-	B-	B-	B-	B-
9) Local conflict of interests	C-		B-		B-	B-	B-	B-	B-	D	B-
		C-		B-	B-	B-	B-	B-	B-	D	B-

Item *, **	Rating				Project Components						
	Pre-FS		FS		1. Renewal of Railway Signals and Communication System				2. Introduction of DEMU trains		
	I/II	III	I/II	III	1) Renewal of level crossing including crossing signals, takeoff board etc. (gatehouse)	2) Renewal of traffic signals and communication system along railway line	3) Rehablitation of railway track condition for smoother and safer train running	4) Improvement of drainage condition to avoid inundation of railway track	DEMU train service	Depot for DEMU trains	Installation of fences to secure railway safety
10) Cultural and historical heritage site	D		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
11) Religious Facilities	C-		D		D	D	D	D	D	D	D
		C-		D	D	D	D	D	D	D	D
12) Landscape	D		D		D	D	D	D	D	D	D
		C-		D	D	D	D	D	D	D	D
13) Water rights, fishing rights and rights of common	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
14) Public health and Sanitation	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
15) Infectious diseases such as HIV/AIDS	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
16) Working condition (including occupational health)	C-		B-/D		B-	B-	B-	D	D	D	B-
		D		D	D	D	D	D	D	D	D
17) Hazards/security risks	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
18) Accidents	B-		B-		B-	B-	B-	B-	D	B-	B-
		B-		B-/A+	A+	A+	A+	A+	B-/A+	D	A+
19) Sunlight shading	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
20) Radio-frequency interference	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
(2) Natural Environment											
21) Topography and Geology	D		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
22) Soil erosion	D		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
23) Groundwater	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
24) Hydrological situation/Drainage pattern	C-		B-/D		D	D	D	B-	D	D	D
		D		D/A+	D	D	D	A+	D	D	D
25) Coastal zone	D		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
26) Protected Area and parks	D		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D

Item *, **	Rating				Project Components						
	Pre-FS		FS		1. Renewal of Railway Signals and Communication System				2. Introduction of DEMU trains		
	I/II	III	I/II	III	1) Renewal of level crossing including crossing signals, takeoff board etc. (gatehouse)	2) Renewal of traffic signals and communication system along railway line	3) Rehablitation of railway track condition for smoother and safer train running	4) Improvement of drainage condition to avoid inundation of railway track	DEMU train service	Depot for DEMU trains	Installation of fences to secure railway safety
27) Fauna, Flora, Biodiversity and Ecosystem	B-		B-		B-	B-	B-	B-	B-	D	D
		D		D	D	D	D	D	D	D	D
28) Micro-climate	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
29) Global warming/climate change	C-		D		D	D	D	D	D	D	D
		C-		B+	D	D	D	D	B+	D	D
(3) Environmental Pollution											
30) Air pollution	B-		D		D	D	D	D	D	D	D
		C-		D	D	D	D	D	D	D	D
31) Water pollution	B-		D		D	D	D	D	D	D	D
		D		B-	D	D	D	D	D	B-	D
32) Soil contamination	C-		B-		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
33) Bottom sediment	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
34) Solid waste	B-		B-		B-	B-	B-	B-	D	D	B-
		D		D	D	D	D	D	D	D	D
35) Noise and Vibration	B-		D		D	D	D	D	D	D	D
		B+		D	D	D	D	D	D	D	D
36) Ground Subsidence	D		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D
37) Offensive odor	C-		D		D	D	D	D	D	D	D
		D		D	D	D	D	D	D	D	D

Note 1: * Environmental items are chosen as indicators expressing environmental and social conditions. based on JICA Guidelines for Environmental and Social Environment (2010.4) and relevant legislation of Myanmar Government as well as the project plan and environmental condition of the project area.

Note 2: ** Regarding the impacts on "Gender" and "Children's Right" might be related to all items of Social Environment.

Note 3: *** Rating -In general, both positive impact (+) and negative impact (-) are expected due to the anticipated project activities. Thus the following rating criteria are adopted with respect to the extent of impacts:

A (+/-) – Significant positive/negative impact is expected,

B (+/-) – Positive/negative impact is expected to some extent,

C (+/-) – Extent of positive/negative impact is unknown or not clear (Further examination is needed. It should be taken into consideration that impacts may become clear as study progresses.),

D - Negligible or No impact is expected.

Overall rating – Overall rating is determined by adopting the worst (negative) value of rating among three sections.

Note 4: Stage of Implementation, I - Planning stage, II - Construction stage, III - Operation stage

A2.5.2 Impact matrix of project activities vs. environmental items

Impact matrix of project activities vs. environmental items can identify what kind of activities cause impacts on environmental items and which environmental item will be affected by the project activities as shown in Table 2.5.2.Preliminary scoping of environmental impacts due to each component and its anticipated activities on each environmental item

Table 2.5.2 Impact Matrix between Project Activities and Environmental Items

Item *, **	Overall		Planning Stage			Construction Stage				Operation Stage		
	Pre-FS	FS	Securing land/space for signals and telecommunication system	Securing temporary land/space for construction work	Change of utilization of land and local resources	Procurement of construction materials, equipment, plants, etc.	Operation of construction machines and vehicles etc.	Installation of construction worker's camps, storage sites, etc.	Construction and rehabilitaion work for railway related facilities and structures	Operation of DEMU trains	Operation of YCRL related facilities and structures	Spatial occupancy of YCRL facilities related facilities and structures
(1) Social Environment												
1) Land acquisition/resettlement	B-/C-	B-/D	B-	B-	B-	D	D	D	D	D	D	D
2) Local economy such as employment and livelihood etc.	B+/A+	B-/A+	D	B+	B+	B+	B+	B+	B-/B+	A+	A+	A+
3) Utilization of land and local resources	C-/D	B-/D	D	B-	B-	B-	B-	D	B-	D	D	D
4) Existing social infrastructures and services	B-/A+	B-/A+	D	D	D	B-	B-	D	B-	A+	A+	A+
5) Social institutions such as social infrastructure and local	C-	B-	D	B-	B-	B-	B-	B-	B-	B-	B-	B-
6) Vulnerable group such as the poor,women, children, elderly,	C-/B+	B-/B+	D	D	D	D	D	D	B-/B+	B+	B+	B+
7) Ethnic minority	C-	D	D	D	D	D	D	D	D	D	D	D
8) Misdistribution of benefit and damage	C-	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-
9) Local conflict of interests	C-	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-
10) Cultural and historical heritage site	C-/D	D	D	D	D	D	D	D	D	D	D	D
11) Religious Facilities	C-	B-/D	D	D	D	B-	B-	D	B-	D	D	D
12) Landscape	C-/D	D	D	D	D	D	D	D	D	D	D	D
13) Water rights, fishing rights and rights of common	C-/D	D	D	D	D	D	D	D	D	D	D	D
14) Public health and Sanitation	C-/D	B-/D	D	D	D	B-	B-	D	B-	D	D	D
15) Infectious diseases such as HIV/AIDS	B-/D	B-/D	D	D	D	B-	B-	D	B-	D	D	D
16) Working condition (including occupational health)	B-/D	B-/D	D	D	D	B-	B-	B-	B-	D	D	D
17) Hazads/security risks	B-/D	B-/D	D	D	D	B-	B-	D	B-	B-	D	D
18) Accidents	B-/A+	B/B+	D	D	D	B-	B-	B-	B-	B-/A+	D	D
19) Sunlight shading	D	D	D	D	D	D	D	D	D	D	D	D
20) Radio-frequency interference	C-	D	D	D	D	D	D	D	D	D	D	D
(2) Natural Environment												
21) Topography and Geology	C-/D	D	D	D	D	D	D	D	D	D	D	D
22) Soil erosion	C-/D	D	D	D	D	D	D	D	D	D	D	D
23) Groundwater	C-/D	D	D	D	D	D	D	D	D	D	D	D
24) Hydrological situation/Drainage pattern	C-	B-/D	D	D	D	B-	B-	D	B-	B-	D	D
25) Coastal zone	C-/D	D	D	D	D	D	D	D	D	D	D	D
26) Protected Area and parks	C-/D	D	D	D	D	D	D	D	D	D	D	D
27) Fauna, Flora, Biodiversity and Ecosystem	C-/D	B-/D	D	D	D	B-	B-	D	B-	D	D	D
28) Micro-climate	D	D	D	D	D	D	D	D	D	D	D	D
29) Global warming/climate change	B-/B+	D/B+	D	D	D	D	D	D	D	B+	D	B+
(3) Environmental Pollution												
30) Air pollution	B-/B+	D	D	D	D	D	D	D	D	D	D	D
31) Water pollution	B-/D	B-/D	D	D	D	D	D	D	D	D	B-	D
32) Soil contamination	B-/D	D	D	D	D	D	D	D	D	D	D	D
33) Bottom sediment	D	D	D	D	D	D	D	D	D	D	D	D
34) Solid waste	B-	B-/D	D	D	D	B-	B-	D	B-	D	D	D
35) Noise and Vibration	B-/B+	D	D	D	D	D	D	D	D	D	D	D
36) Ground Subsidence	C-	D	D	D	D	D	D	D	D	D	D	D
37) Offensive odor	C-/D	D	D	D	D	D	D	D	D	D	D	D

Note: Legends are same as indicated in Table 6.3.2.

A2.6 Identification and Evaluation of Possible Impacts

- No item.

A2.7 Mitigation Measures and Environmental Management Plan

A2.7.1 Mitigation Measures and Environmental Management Plan

As described below negative impacts identified in the above (See main text Table 2.6.1) are written down with necessary mitigation measures.

(1) Planning stage

1) Social Environment

(a) Land Acquisition/Involuntary Resettlement (B-)

- Expected impacts:
  - All the proposed project areas of Yangon Circular Railway Line as are owned by Myanma Railways (MR). Thus, all the land is public land and no land acquisition is expected.
  - However, it is expected that generation of considerable number of affected structures including houses/shops (Project Affected Units, PAUs) and Project Affected Persons (PAPs) by the project.As for PAUs totally 12 (twelve) structures including 2 (two) rented land from MR along railway line will be affected by installation of fences to ensure safety operation of train with higher speed (up to 60 km/h) train. As for PAPs totally 63 persons will be affected. Among them 48 persons are to be resettled permanently.
  - Expected number of PAPs is less than 200 in terms of persons to be subject to resettlement. Thus, MR as proponent should prepare Abbreviated Resettlement Action Plan (ARP) and provide necessary compensation and support of resettlement to these PAUs and PAPs by consultation with them through stakeholder meetings and Compensation Committee.
  - In addition, trees and electric poles along railway track should be removed, relocated or replanted by MR after necessary permit from concerned authorities, if any.
  - Detailed features are described in 6.4 Abbreviated Resettlement Plan (ARP).
- Mitigation measures:
  - From early stage of the plan, provide adequate information to PAPs and consult with stakeholders including PAPs to make agreement or thorough understanding of the issues as much as possible.
  - Through inventory survey on possible affected land, assets and structures to make clear features of involuntary resettlement and to identify PAUs and PAPs.
  - Information disclosure of project often leads to influx of people into the project site for obtaining compensation/resettlement. Thus, MR as the proponent should set up "Cut-off Date" to identify/differentiate genuine PAPs from non-eligible people and identify eligibility of PAPs. Then based on eligibility data prepare Abbreviated Resettlement Plan (ARP) for compensation and resettlement assistance to PAPs complying with both Myanmar legislation and JICA Guidelines for Environmental and Social Considerations.

- MR should make necessary institutional arrangement such as setting up staff in charge of implementation of the ARP and Compensation Committee with relating organizations.
- Implementation of necessary compensation and resettlement assistance should be carried out before commencement of construction work.

(2) Construction Stage

1) Social Environment

a) Existing social infrastructures and services (B-)

- Expected impacts:
  - According to construction work plan for renewal of level crossing, the corresponding level crossing will be closed for about 1 month. Thus, vehicles and foot passengers are requested to make a detour to other roads resulting in considerable congestion of road traffic in surrounding area. Therefore, following measures should be considered: (1) To arrange appropriate renewal schedule of the level crossing to minimize traffic congestion. (2) To inform renewal schedule to signals and telecommunications system users in advance by bulletin board of related railway stations and Township office. (3) To prepare traffic control and management plan including surrounding area.
- Mitigation measures:
  - To avoid or minimize traffic disturbance and nuisance to local people and communities, following measures will be conducted: 1) Prior to construction work, inform contents of the construction work and schedule, 2) Time shift of construction work. 3) Education of traffic safety and manner to construction workers and drivers, 4) Raise the traffic signal and arrange watchmen on approach road. 5) Equip sheet cover to prevent scattering dust from the bed of truck. 6) Setting staff in charge of complaints.

b) Working condition (including occupational health) (B-)

- Expected impacts:
  - Employees of MR and surrounding residents who will engage to the construction work will be secured for good working condition by MR. However, there is a possibility that the health and occupational safety of the workers may be jeopardized in case of severe working condition and in rainy season.
- Mitigation Measures:
  - In the construction work contractor should comply with requirement of Labor Law and Labor Safety Law (draft).
  - Preparation of safety management plan and enlighten occupational safety to construction workers.

- Tangible safety considerations should be prepared for individuals involved in the project. (i) The installation of safety equipment and management of hazardous materials. (ii) Any worker and personnel who enter into construction sites have to bear safety shoes, hats and earplugs for construction works.
- Monitoring health condition and occupational safety of workers.

c) Accidents (B-)

- Expected impacts:
  - Construction work for renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used. Thus, occurrence of accidents by the work is expected little, if any. However, because the work space is closed to railway track, there is a possibility that there may happen accidents by running train with even low speed.
- Mitigation Measures
  - Suitable planning and management over construction work to prevent and minimize the number and consequences of accidents.
  - Collect and analyse cases and causes of accidents.
  - Enlighten workers and local residents to prevent accidents by training and adequate notice.

2) Natural Environment

a) Hydrological situation/Drainage pattern

- Expected impacts (B-):

In general railway service area of YCRL is located in flat and low land area. However, according to the hearing from station manager, rise of water level due to high tide, flooding and cyclone have never caused inundation of railway track. However, in case of strong rain in short time accumulating rain water in surrounding area may flow into some railway section, where land level is lower than surrounding area with poor drainage condition, resulting in inundation. Thus, in such sections lifting up of railway track or to establish proper drainage system is necessary to avoid inundation.

- Mitigation Measures:
  - In some area of railway sections, where land level is lower than surrounding area and is with poor drainage condition. In such sections lifting up of ground level of railway track should be planned to avoid inundation of railway track.

b) Flora, Fauna, Biodiversity and Ecosystem

- Expected impacts (B-):
  - Precious and endangered fauna and flora species are not found in the project site.

- Planted trees along railway track contribute to the shading and visual amenity providing relaxation to train passengers and residents. Thus, cutting or removal of trees due to renewal of signals and communication system along railway line may spoil existing environment with greenery and amenity. Cutting trees should be avoided or relocated as much as possible. In case of tree cutting, it should be replaced by replantation of the same type of tree by MR after necessary permit from concerned authorities such as Forest Department of MOECAF and Playgrounds, Parks & Gardening Department of YCDC.

- Mitigation Measures:

- For cutting, removal or replanting trees along railway track prior consultation with YCDC and MOECAF should be conducted. 2) After removal of trees replanting of trees for shading and visual amenity should be planned.

3) Environmental Pollution

a) Waste

- Expected impacts (B-):

1) Construction work due to renewal of signals and telecommunication are in a small scale and heavy construction machines and vehicles will be not used. Thus, generation of soil, sand and construction waste is expected with a small scale, if any.

2) After renewal of level crossing, signals and telecommunication system existing devices should be subject to proper waste treatment and disposal.

- Mitigation Measures:

- Consider ways to minimize waste generation in the construction work plan.
- Enlightenment and education of construction workers for waste management based on 3R principle (reduce, reuse, recycle).
- After renewal of level crossing, signals and telecommunication system existing devices should be subject to proper waste treatment and disposal.

4) Operation Stage

1) Social Environment

(a) Local economy such as employment and livelihood etc.

- Expected impacts (B-):

- At present many vendors are entering into rialway yard of stations and sections such as Da Nyin Gone, Thamine Station and Pa Ywet Seik Gone Station to sell goods such as vegetables to train passengers in daytime. However, vendor's business activities in railway yard will be stopped due to installation of fences along railway track in order to secure smooth operation of train and to prevent railway accidents with higer train speed of 60 km/h.

- Mitigation Measures:
  - Appropriate measures such as making space and/or facilities for vendors to sell goods near railway yard of stations and sections such as Da Nyin Gone and Thamine Station, enabling to continue their business activities should be considered by MR and relating organizations such as YCDC.

(b) Vulnerable group such as the poor, women, children, elderly, disabled etc.

- Expected impacts (B-):

2) At present many vendors who are mostly poor, are entering into rialway yard of stations and sections such as Da Nyin Gone, Thamine Station and Pa Ywet Seik Gone Station to sell goods such as vegetables to train passengers in daytime. However, vendor's business activities in railway yard will be stopped due to installation of fences along railway track in ordr to smooth operation of train and to prevent railway accidents with higer train speed of 60 km/h.

- Mitigation Measures:
  - Appropriate measures such as making space and/or facilities for vendors to sell goods near railway yard of stations and sections such as Da Nyin Gone and Thamine Station, enabling to continue their business activities should be considered by MR and relating organizations such as YCDC, because they are mostly poor farmers of surrounding area according to the results of hearing survey.

(iii) Accidents (B-)

- Expected impacts:
  - At present there are found some illegal encroachment such as crossing railway lines by walk and occupation on railway yard with huts, shops and vendors along YCRL sections. Thus, there is a possibility that there may happen accidents by running train with even low speed. Thus, if it may happen accidents by running train with higher speed of 60 km/h, number of casualty and extent of damage from accidents will increase considerably. However, according to the Project plan MR will install fences along railway track for whole section in order to secure smooth operation of train and to prevent railway accidents with higer train speed of 60 km/h. Thus, increase in traffic accidents is unlikely after installation of the fences.

- Mitigation Measures:
  - Enlightenment railway operation safety to conductors and passengers as well as residents.
  - Collect cases and causes of railway accidents.
  - Install fences along railway track to stop encroachment such as crossing railway lines by walk and occupation on railway yard in order to prevent traffic accidents by train operation.

5) Natural Environment

(a) Hydrological situation/Drainage pattern

- Expected impacts (B-):

In general railway service area of YCRL is located in flat and low land area. However, according to the hearing from station manager, rise of water level due to high tide, flooding and cyclone have never caused inundation of railway track. However, in case of strong rain in short time accumulating rain water in surrounding area may flow into some railway section, where land level is lower than surrounding area with poor drainage condition, resulting in inundation. Thus, in such sections lifting up of railway track or to establish proper drainage system is necessary to avoid inundation.

- Mitigation Measures:

  - In some area of railway sections, where land level is lower than surrounding area and is with poor drainage condition. In such sections lifting up of ground level of railway track should be planned to avoid inundation of railway track.

6) Environmental Pollution

(a) Water pollution

- Expected impacts (B-):
  - Through daily cleaning of trains in Depot generation of wastewater containing oil and grease is expected.
- Mitigation Measures:
  - Proper treatment of effluent from railway station to comply with wastewater regulation by YCDC.
  - Wastewater containing oil and grease from depot should be treated appropriately by installation of wastewater treatment facility.

(3) Overall Stages

1) Social Environment

(a)Social institutions such as social infrastructure and local decision-making institutions

- Expected impacts (B-):
  - The project itself intends to improve railway transport, which is major portion of public transport in Yangon City. However, if information disclosure of the project plan, and procedure and public participation are not properly carried out, anxieties and discontents may spread over the people and communities resulting in difficulties with acceptability of the project by them.

- Mitigation Measures:
  - Information disclosure and public participation should be fully considered for all the stakeholders including local residents and road users from planning stage to operation stage for obtaining thorough understanding and consensus of the people and communities.
  - MR should set up a section in charge of public communication and complaints from peoples.

(b) Misdistribution of benefit and damage

- Expected impacts (B-):
  - The project itself intends to improve railway transport, which is major portion of public transport in Yangon City and may not cause any misdistribution of benefit and damage to residents and passengers.
  - There is, however, some possibility of misdistribution of benefit and damage, if the project plan including procedures to the implementation including construction work and resettlement matters are not properly disseminated and consulted with concerned residents and passengers and other stakeholders.
- Mitigation Measures:
  - Consultation with stakeholders including local residents, community organizations etc., should be planned from an early stage to obtain understanding and consent among the stakeholders in order to share equally benefits and damage.
  - Consider preference of employment to local residents and the poor for construction works.
  - MR should set up a section in charge of public communication and complaints from peoples.

(c) Local conflict of interests (B-)

- Expected impacts:
  - The project itself intends to improve railway transport, which is major portion of public transport in Yangon City and may not cause any local conflict of interests.
  - There is, however, some possibility of misdistribution of benefit and damage, if the project plan including procedures to the implementation including construction work and resettlement matters are not properly disseminated and consulted with concerned residents and passengers and other stakeholders.
- Mitigation Measures:
  - Consultation with stakeholders including local residents, community organizations etc., should be planned from an early stage to obtain understanding and consent among the stakeholders in order to avoid local conflict of interests.
  - Consider preference of employment to local residents and the poor for construction works.
  - MR should set up a section in charge of public communication and complaints from peoples.

A2.8 Environmental Monitoring Plan

Table A2.8.1 Environmental Monitoring Form

Category	Item	Measuring Point/Place	Period	Frequency	Results - Data of qualitative survey and quantitative measurement (Min., Max. and Average)	Comments and Response/Actions to comments and Guidance from Government Authorities and the Public
(I) Planning Stage						
1) Approval/permission etc.	Permission of Project Implementation and Environmental Clearance Certificate	FERD, PD, MOECAF	Before commencement of construction work	One time		
2) Social Environment	Implementation of compensation and resettlement assistance to PAPs, and resulting existing living condition and livelihood of PAPs	PAPs and PAUs	Before commencement of construction work	One time		
	Securing necessary land clearance for the project site	Area to be secured	Before commencement of construction work	One time		
(II) Construction Stage						
1) Social Environment	Increase in traffic congestion and disturbance of access to public facilities etc.	Construction site and surroundings	During Construction Stage	Every day of construction work		
	Working condition	Construction site and surroundings	During Construction Stage	As required		
	Accident	Construction site and surroundings	During Construction Stage	Daily		
2) Natural Environment	Replanting trees	Construction site and surroundings	During Construction Stage	One time per year		
3) Environmental Pollution	Sold waste management	Construction site and surroundings	During Construction Stage	Daily		
(III) Operation Stage						
1) Social Environment	Accidents	Project area	During Operation Stage	As required		
2) Environmental pollution	Water pollution (pH, SS, BOD, COD, Oil and grease)	Discharged point from wastewater treatment plant of depot	During Operation Stage	3 times /year for 2 years after operation		
(IV) Whole Stages						
1) Social Environment	Acceptability of the project	Project area	Whole Stages	As required		

A2.9 Results of Stakeholder Meetings

A2.9.1 First Stakeholder Meeting

(1) Outline of the 1st Stakeholder meeting

Outline of the meeting is shown in Table A2.9.1.

Table A2.9.1 Outline of the Meeting

Project Name	Yangon Circular Railway Line Upgrading Project
Agenda	1) ***Opening Remarks*** by U Aung Khin, Minister, Ministry of Transport and communication, Yangon Region Government 2) Presentation on Project Procedures, by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railway, Ministry of Rail Transportation 3) Presentation on Environmental and Social Considerations in Yangon Circular Railway Line Upgrading Project, by U Aye Thiha, Managing Director of E Guard Environmental Services Co., Ltd. 4) Tea Break 5) Question and Answer Session 6) ***Closing Remarks*** by Mr. Tun Aung Thin, General Manager, Myanma Railway
Date	August 7, Thursday 2014
Time	13:00 pm to 16:00 pm
Venue	Ruby Hall-Asia Plaza Hotel, Yangon
Attendees	11 Local Interested Persons 66 reporters (News Media) 13 Politicians (Members of Yangon Regional Parliament and others) 29 Staffs from Government Departments and other Organization 1 Person from NGOs 5 Persons from JICA Study Team 7 Persons from E Guard Environmental Services Co., Ltd.
Materials Provided	1) Agenda 2) Power-point Presentation Document on Project Procedures 3) Power-point Presentation Document on Environmental and Social Considerations
Prepared by	U Ye Wint Aung (E Guard Environmental Services Co., Ltd)

Figure A2.9.1 Scenes of 1st Stakeholder Meeting

(2) Results of the Meeting

1) Opening Remarks by U Aung Khin, Minister, Ministry of Transport and communication, Yangon Region Government

- U Aung Khin, the Minister, addressed the opening remark which was briefly described as follow,
  - Yangon Circular Railway Line Upgrading Project is a project jointly implemented by Myanma Railway and JICA Study Team. This project is also one of the projects that involved in Myanmar Economic Development Forum 2013. This project will be implemented with Japanese Technical Assistance.
  - Today's meeting will disclose the information about the YCR line upgrading project, focusing on project procedures and environmental and social considerations. So, all the attendees are requested to make comments, advices and questions about the project.

2) Presented by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railway, Ministry of Rail Transportation

- U Tun Aung Thin explained mainly on the following topics of the Project.
  - Objectives of YCR Upgradign Project
  - Components of the Priority Project

    Improvement of Civil and Track Structures
    - Modernization of Signaling, Telecommunication and Train Operation Systems
    - Modernization of Stations
    - Modernization of Railcars (DEMU)

  -Phased Development

  -Social and Environmental Consideration

3) Presented by U Aye Thiha, Managing Director E Guard Environmental Services Co., Ltd.

- U Aye Thiha explained mainly on the following topics about Environmental and Social Considerations for YCR Upgrading Project.
  - Objectives and Schedule of Public Hearing
  - Involved Agencies
  - Possible Impacts
  - Survey for Environmental Impact Assessment (EIA)
  - The Way Forward
  - Moreover, he explained about the Outline of EIA survey as follow.

- Environmental Policies, Legislation and Institutional Framework of Myanmar relevant to the Yangon Circular Railway Line (YCR)
- Baseline data collection (Social Environment, Natural Environment and Environmental Pollution)
- Field Survey, sampling, laboratory tests and interviews
  a) Agricultural production along the YCR
  b) Vendors' activities
  c) Vulnerable groups such as the poor, ethnic minorities etc.
  d) Flood (inundation) records in the past
  e) Noise
  f) Water quality
  g) ROB (Road Over Bridge) issues - affected houses and activities

- Census survey and socioeconomic survey for preparing the Resettlement Action Plan

4) Questions and Answers

After the presentations, many reporters and interested persons asked questions, made suggestions and comments. U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railway, Ministry of Rail Transportation, responded all the questions, comments and suggestions, as follow.

a) Questions and Answers with NGOs

- Daw Aung See Zar (Myanmar Architectures Association)
  - Question: Do you consider for the sake of Disables?
  - Answer: Yes, we do consider for them. As a culture of Myanmar People, the disables can easily get the supports from every Station Master and the Duty Officers. This is a good question and we accept the support for the Disables in the Staion and in their trip should be considered with great care. Thank you so much for your discussion.

b) Questions and Answers with Members of Parliament

- Daw Kyi Kyi Mar (Member of Parliament, Yangon Region)
  - Question: I would like to know about the multi-sectoral recruitment of this Upgrading Project.
  - Answer: There will involve most of the regional level seniors and the Members of Regional Parliament as well. I cannot say the exact number of the members at the time being.

- U Tun Lwin (Member of Parliament, Yangon Region)
  - Question: Can we do this project with our own budget and domestic construction technologies, instead of getting foreign assistance?
  - Answer: In this case, the main thing is Technology, I think. We still need modern technologies, such as surveying instruments, human resources, etc. Fro example, we have to hire the aircraft for the flight survey. Our budget is limited and foreign agencies such as JICA are very supportive in such cases.
- Dr. Saw Hla Tun (Member of Parliament, Yangon Region)
  - Question: Can this YCR Upgarding Project be sustainable and long run?
  - Answer: Yes, we had already planned for sustainability. We will explain more detailed structure designs in next stakeholders' meetings.
  - Question: Do you have plans for easy and cheap transportation to get access to Yangon Central Railway Staion?
  - Answer: Yes, we have. We are now developing a transportation network focusing the Yangon Central Railway Station as the center point.
  - Suggestion Point: One suggestion I would like to make is that we should be self-reliant in developing projects as much as we can.
- U Thaung Sein (Member of Parliament, Yangon Region, Dawbon Township)
  - Suggestion Point: I would like to suggest to implement project activities with the least social negative impacts.

c) Questions and Answers with Government Staffs/Officers

- U Myo Lwin (Director, Environmental Conservation Department, Yangon Region)
  - Discussion Point: Environmental Conservation Departments (ECDs) had been running their responsibilities in Yangon Region, Sagaing Region, Mandalay Region, Pegu Region and Taninthari Region, since 2012. In Myanmar, for all development projects, it should take environmental and social considerations in accordance with the existing environmental law, rules and regulations which had been enacted by the government of the country. For this YCR Upgrading Project, environmental impact assessment will be done, and ECD will provide advices and supports to mitigate negative impacts as much as possible, according to the environmental management and morning plans.
  - Question: Is the project of the Yangon Central Railway Station to move to YwatharGyi on-going or not? I made this question on behalf of the public, not by a Government Officer.

- Answer: Yes, it is an on-going project. Now we are in a stage of land acquisition. We made a request to the Yangon Region Government, to get some more additional area. That project will include factories, housing, primary schools, clinics, playgrounds and even the religion buildings.

d) Questions and Answers with News Media

- A Reporter
  - Question: When will you start the circular railway line upgrading project?
  - Answer: Firstly, we must do the required infrastructure for circular railway. We will do the field surveys and taking aerial photos. And then we will make considerations on budget and detailed implementation designs. So, we will start the project implementation activities in 2015.
  - Question: During the project implementation, do you see the disturbances for daily rail transportation services? Do you have preparations for that case?
  - Answer: There will be no disturbance. We will implement the project step by step.
  - Question: Do you have a compensation plan for affected structures and land in upgrading project?
  - Answer If the land is owned by Myanma Railway, we will resettle them in another place. For the other lands and structures, we will make the process for compensation step by step. That's why we are now doing the assessments such as IEE and EIA to reduce the environmental and social impacts.
  - Question: How do you think about the negative impacts of high buildings if the trains will be speeded up after the project?
  - Answer: We have a wide range of 75 feet on each side of the railway line to protect from danger. In order to avoid accidents and protect the life of people, those are very important. That will be included in our considerations.
- U Myo Min Oo (Democratic Voice of Burma)
  - Question: How about budgets used in this project?
  - Answer: We will use the budget that will be supported by JICA and the estimated amount of the Budget will depend also on the survey results.
- A Reporter (Public Journal)
  - Question: What is the other supports of JICA other than technology and budget?
  - Answer: JICA also supports mechanically as in modern machines, etc.

- U Win Oo (Ayeyarwaddy Journal)
  - Question: Some buildings are known to exist within those 75 feet and it is very dangerous. So what is your plan for those buildings?
  - Answer Normally circular railway doesn't have too much vibration because of its lower speed. We need to investigate the strength of those buildings if necessary. On the other hand, I hope that new railway technology will reduce the vibration rate. We will conduct a comprehensive survey to get the information about the religious buildings, cultural heritages, government buildings, etc. So survey results will indicate how to minimize such impacts of vibration.
  - Question: Do you have any plan to expand the rail line up to more than 75 feet, because of the high speed of the trains?
  - Answer: That depends on how fast we need to drive the trains. Next time the technicians will also explain about this question.
- U Kyaw Ohm Lwin (The Voice)
  - Question: Due to the news of compensation to project affected people, there might be an increase of people along the railway. So, how about the management for that?
  - Answer: We will take actions on those cases. That's why, we are now holding such Stakeholders' meetings to give clear messages about the project activities.
  - Question: Although Government had prohibited such encroachments in the past, it did not work properly, I think. How do you think about it?
  - Answer: We had already taken actions on those cases. They are now facing in the courts. They will have to follow the decision of the courts.
- U Wai Phyo (Eleven Media)
  - Question: Can you explain a little about upgrading the Yangon Central Railway Station?
  - Answer: We will start the project very soon. Some national companies and especially many international companies are interested in this project.
- La Pyi Wun (Mizzima News)
  - Question: How do you manage the flood and land subsidence problems before you start this YCR upgrading project? Do you know which part of the rail line is now flooded?
  - Answer: The root cause of the problems is the Climate Change. We will definitely need to strength the bed of the rail line and concrete sleepers. The whole round upgrading will cost a lot. We spent US Dollar 2.7 million for this issue ten years ago. Now we will upgrade the Rail Line again, with modern technologies. For the flood and subsidence, I heard that a case of land subsidence due to the flood happened in Hlaing Tharyar a few days ago.

- U Moe Win (Reporter)
  - Question: Will the survey include the whole round of the Yangon Circular Railway?
  - Answer: We will conduct the surveys as, sector by sector, phase by phase. We have done enough on the development plans. Now we are working on budget estimation and others together with Yangon Region Government and the YCDC.
  - Question: Which kinds of train will you select?
  - Answer: We are trying to change from Deisel Engine Trains to Electrical Prower Trains. There will include air-conditioned carriages. We are also considering on other alternative choices.
- Daw Saw Myat
  - Question: In future, will the electrical shortages have the impacts on smoothness of the Rail Transprotation? Do you also have plans to cooperate with the Ministry of Electrical Power?
  - Answer: That is a good point. It is really important to get full Electrical Power in Rail Transportation. Yes, we are cooperating with the Ministry of Electrical Power. Moreover, we hope some technological solutions such as modified electricity storage systems, etc.
- Ei Mon Zar (7 Day (Daily))
  - Question: Are there cancellations of the rail transportation services for long days, due to the Flood on the rail track?
  - Answer: The trains cannot go forward if the water level is more than six inches above the rail line. The train can be driven on if it is under six inches in flood. Normally the cancellations are not for long days, it usually takes from a few hours within the day.
- U Soe Moe Aung (Sky Space)
  - Question: Do you have the plan to relocate the staff housings of the Thein Phyu Kwin? If so, how are you planning for their convenience?
  - Answer: As a rule, the housing of MR's staff must be near to their workplace for easy accessibility. We have already selected the alternative site for them. We will also develop clinics, primary schools and other widespread considerations for them.

A2.9.2 Second Stakeholder Meeting

(1) Outline of the 2nd Stakeholder meeting

Outline of the meeting is shown in Table A2.9.2.

Table A2.9.2 Outline of the 2nd Satkeholder Meeting

Project Name	Yangon Circular Railway Line Upgrading Project
Agenda	1) Opening Remarks by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation 2) Presentation on Project Plan, by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation 3) Presentation on Environmental and Social Considerations in Yangon Circular Railway Line Upgrading Project, by U Aye Thiha, Managing Director of E Guard Environmental Services Co., Ltd. 4) Tea Break 5) Question and Answer Session 6) Closing Remarks by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation
Date	September 23rd, Tuesday 2014
Time	13:00 pm to 16:00 pm
Venue	Yuzana Garden Hotel, Yangon
Attendees	65 Project Affected Persons (PAPs) 56 Reporters (News Media) 28 Staffs from Government Departments and other Organizations 7 Personnel from NGOs and Private Companies 7 Personnel from JICA Study Team 13 Personnel from E Guard Environmental Services Co., Ltd. Total Participants (176)
Materials Provided	4) Agenda 5) Power-point Presentation Document on Project Plan 6) Power-point Presentation Document on Environmental and Social Considerations
Prepared by	U Ye Wint Aung (E Guard Environmental Services Co., Ltd)


Figure A2.9.2 Scenes of 2nd Stakeholder Meeting

(2) Results of the Meeting

1) Opening Remarks by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation

- U Tun Aung Thin, General Manager, addressed the opening remark which was briefly described as follows:
  - Yangon Circular Railway Line Upgrading Project is a project jointly implemented by Myanma Railways and JICA Study Team. We have started this project since February 21, 2014. The objectives of this project are to provide the 'Quality Urban Transport Services' for Yangon residents and visitors by improving and modernizing the existing YCR, and to make YCR as a backbone of the 'Modern Urban Transport System' in Yangon, and to improve and modernize YCR to contribute to improvement of MR business performance.
  - The objectives of this feasibility study are (1) to develop and upgrade the YCR on a long term plan up to 2045, starting in 2015, (2) to implement a comprehensive study for the main portion of the project, and (3) to prepare all the required information in submitting the Japanese ODA loan.
  - Today's meeting will disclose the information about the findings of feasibility studies for the YCR line upgrading project, focusing on project plans and environmental and social considerations. So, all the attendees are requested to make comments, advices and questions about the project.

2) Presented by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation

- U Tun Aung Thin explained mainly on the following topics of the Project:
  - Objectives of YCR Upgrading Project
  - Components of the Priority Project
    - Improvement of Civil and Track Structures
    - Modernization of Signaling, Telecommunication and Train Operation Systems
    - Modernization of Stations
    - Modernization of Railcars (DEMU)
  - Phased Development
  - Improvement of 11 Road Over Bridge (ROBs)
  - Social and Environmental Considerations
  - In his presentation, he used a lot of photographs for visualization, so that most of the attendees could get a good understanding on the project plans of the Yangon Circular Railway Line Upgrading Project.

3) Presented by U Aye Thiha, Managing Director E Guard Environmental Services Co., Ltd.

- U Aye Thiha explained mainly on the following topics about Environmental and Social Considerations for YCR Upgrading Project:
  - Objectives and Schedule of Public Hearing
  - Agencies involved
  - Environmental Impact Assessment (EIA) study and Abbreviated Resettlement Plan (ARP)
  - Major environmental impacts to be noted
  - Information of planning area and location
  - Results of the survey for Project Affected Units (PAUs) (Structures) and Project Affected Persons (PAPs)
  - Compensation for Structures Replacement and Resettlement

4) Questions and Answers

After the presentations, project affected persons, reporters and interested persons asked questions, made suggestions and comments. U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation, responded all the questions, comments and suggestions. For some questions relating the social survey, U Aye Thiha, Managing Director of E Guard Environmental Services Co. Ltd made negotiations during their discussion.

a) Questions and Answers with PAPs

- U Than Aung (PAP from Parami ROB)
  - Question: I am from a betel shop under the Parami ROB. If the project has impacts on our shops, how will you help or support us?
  - Answer: We have plans to make further identifications to get more detailed information about the shops under Parami ROB. Then we will consider how to mitigate the impacts on these shops. At least we will try to help your business to be functioning. But if the project implementation works would have been started, you might be necessary to stay away from the construction site temporarily. For such cases, we will discuss closely with you. Especially we are responsible to help you as much as possible: so meanwhile you can carry on your businesses comfortably.
- Daw Tin Oo, (PAP near Thirimyaing Station)
  - Question: I am a flower-seller from Gaw Thazin Market, Quarter (5), Hlaing Township. I was not included in the PAP list because I was absent on the survey day as I

normally went to the monastery on a Sabbath day. Not only me but other four shop keepers are also not included in the list.

- Answer: OK, don't worry about that. We will do further identifications. For those further identifications, we will get the recommendations from general administration department from your quarter. During that time, you need to be really there, so that you will not be left out from the list. Be relaxed.

- Daw , (PAP between Hledan Station and Kamayut Station)
  - Question: My fried-beans shop, named as Maw Kyun, is between Kamayut station and Hledon station. Behind my shop is a water spinach farm (Morning Glory vegetables). How and where would I have to move my shop? I already have the MIC certificate for my shop.
  - Answer: We will continue according to our plan whether you have MIC certificate or not. However, we will do the screening for each and every shop. I assume that you might need to change the type of your business. If the development activities are implemented, we need to consider how to adapt with the situation. I believe we will have many discussions on that case in future. If you have to move now, have you already looked for an alternative place? I hope you have enough time to think about it. If possible, you should try to do a better business than the present one. For the time being you can still to put your signboard of 'Maw Kyun Fried Beans'.

- U ,(PAP from Sule Road ROB)
  - Question: I am from a snack shop near Sule ROB. I would like to know about your considerations for our shops. There are about six shops in our place.
  - Answer: Yes, this is the preparatory stage. You are listed in this survey. If the construction activities are implemented, you need to move over to a safe area. As we explained in the presentation, we have two categories: permanent relocation and temporary relocation. Some PAPs will need temporary relocation and some will need permanent relocation.

- U Kyaw Myo Tun (PAP between Lanmataw Station and Pyay Lan Station)
  - Question: I am the one near Lanmataw Station. As we are counted for permanent relocation, how will you consider assisting our livelihood?
  - Answer: Our considerations on temporary and permanent will be different. We will identify all the PAPs for the next time before the commencement of the Project Implementation, and will discuss one by one. We will report the situation to the Regional Government and the Ministry of Railways Transportation. And we will follow the best option for you.

- U , (PAP from Hantharwady ROB)
  - Question: I am from the junction of Baho Road and Hantharwady Road. We are far away from the rail track, but if the ROB is reconstructed, is there any impact on us?
  - Answer: Yes, if the project implementations have been started, some areas need to be secured for construction sites. If so, the shops in this secured area need to be removed temporarily. But we will try to avoid such cases as much as possible. If engineering design has come out, we can say exactly about it.

b) Media's Perspectives

- U Myint Thein (The First Weekly Media Group)
  - Question(1): According to my understanding, there are a lot of structures in the right of way along the rail line. Some structures are granted by YCDC. I would like to know your plans to relocate those structures.
  - Question(2): Another question is what about the progress on discussion and negotiation with the affected persons.
  - Answer: Thank you for your questions. Firstly, I will explain for question 1 and 2. We have to do the feasibility study before we conduct any development project. In that case we need to check which area is legally owned by Myanma Railways because in some sections MR right of way is very narrow and small (just 25 feet from the rail line), according to the block maps and blueprints of the station yards. So we need to do screening based on that data, and we also need the budget to carry out these activities. Anyway, we must remove those structures according to the existing laws. By getting the instructions and guidelines from Yangon Region Government and Ministry of Railways Transportation and in accordance with the descriptions in the Laws, we will have to make relocation plans and give compensations, if necessary.
  - Question(3): I found some wastewater in the creek and a lot of wastes generated by nearby structures along the circular rail track. I would like to know how you, Myanma Railways and YCDC are preparing to handle this environmental pollution.
  - Answer: It mainly depends on budget. We are always trying to get enough budget to solve this problem. But we need the public participation in cleaning these solid wastes. It is very difficult to clear those wastes along the rail line, because some people generate their wastes repeatedly although MR and YCDC try to remove those wastes within the limited budget (e.g., 5,000,000 MMK per month, on contractual basis). So I hereby request not to release your solid wastes and other liquid waste to the rail track. We don't have big budget and so we need your assurance and we appreciate your participation in making clean environment along the rail track.

In some cases we need to buy some machines that must be paid in US Dollar. Some project like ODA loan and EDCF (Korea Rail cars) are the soft loans for us. Even for this Danyinkone-Yangon-Mahlwakone development project, we estimate USD 700 million. We will buy all new things for development in public transportation. This project will start in 2015. In this upgrading project it will include programs for wastewater management, canals and good drainage systems. I really thank you for your questions.

- A Reporter
  - Question: If the project is implemented, what considerations do you have for the vendors in the stations and the homeless people along the rail track?
  - Answer: Regarding the vendors, we have sympathy for them; we want to see the improvement of their livelihood. But if possible, MR does not want them selling in the stations. We want to see them selling in better places than in the stations. We will cooperate with YCDC for their resettlement. But it is not the time to say exactly about the plan.

    For the homeless, we will do the detailed surveys on that. Before we start any project, we need to find out the reason why they are in homeless situation, their background that says where they are from, etc. So let us do the detailed survey first. Then we will consider for them in cooperation with Wards and Townships GADs.

- Ei Ei Aung (Reporter, 5 Plus Channedl)
  - Question: According to my understanding, this project is a long term project and will start in 2015. If so, I would like to know what time you expect this project will finish.
  - Answer: Now, we are in a feasibility stage. If it is really feasible, we will start in 2015. That depends mainly on budget and the logistic process of the improted machines as well. And the resettlement process is also important, because the project will be delayed if the affected people do not cooperate in the resettlement works. The short term project up to 2018, the middle term up to 2025, and the long term up to 2035 or 2045.

- Daw Thet Tant (Reporter from Reporter Journal)
  - Question: As you explained earlier, if the affected persons are assisted in line with JICA standards, I would like to know what the standards will be. Can you give me some examples? Do the PAPs have the right to complain the assistance or the negotiations?
  - Answer: Regarding the standards, every country has its own standards for these case. We will conduct in line with JICA standards, but it does not mean we have to neglect our own regulations and existing laws in our country. If a person or household or

any asset is found to be really affected by the project, we (the project owner, respective GAD members, valuation committee members) will cooperate to make compensation for the PAP, based on the local current market price of the lost assets. This procedure will go to every PAP or affected household, one by one. But the core value of the process is transparency, and its ultimate goal is to make the affected persons satisfied enough, according to the existing laws, regulations and guidelines or instructions.

(Note: U Aye Thiha, MD of E Guard) added that the resettlement process is aimed to reach a win-win situation in negotiation with each individual PAP by MR and YCDC and other relating departments.)

- U Kyal Sin Lin (Reporter, Myitmakha Media)
  - Question: As you know, there are a lot of vendors around Danyinkone Station. So how do you think about them and do you have enough considerations for them? And how is your plan to resettle them in a better situation?
  - Answer: Yes, you can see many vendors on the platform of the Station. We want them to stay away from the station and sell their goods in a seperate market place. YCDC has their own plan to develop a wholesale maket for those vendors near the existing Danyinkone market. Then I hope they can sell their goods much conviently in their new maket place.
- Daw Thet Tant (Reporter from Reporter Journal)
  - Question: I have another question. Will the existing services remain during the upgrading project for the West Section (Danyinkone-Yangon-Mahlwakone)? On which track will the trains go during the project?
  - Answer: Yes, the circular rail transport services will remain on the same track. We will upgrade the rail tracks gradually (it means section by section), so our services will not change even in the construction phase.

5) Closing Remarks by by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railway, Ministry of Rail Transportation

- I would like to say thanks for your active participation in this Stakeholders' Meeting for Yangon Circular Railway Line Upgrading Project. I really appreciate all of your discussions, remarks and questions.
- In order to bring the success of this project, I would especially like to request the officials from the General Administration Department to support the public with clear messages and clarifications about the project plans more than before, as you are very close to the Public and communicating with them almost every day. So I hope your contribution to the project will be very supportive in implementing the project activities.

A2.9.3 Third Stakeholder Meeting

(1) Outline of the 3rd Stakeholder Meeting

Outline of the meeting is shown in Table A2.9.3.

Table A2.9.3 Outline of the 3rd Stakeholder Meeting

Project Name	Yangon Circular Railway Line Upgrading Project
Agenda	・ Opening Remarks by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation ・ Presentation on Project Brief, by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation ・ Presentation on Environmental and Social Considerations in Yangon Circular Railway Line Upgrading Project, by U Tin Aung Moe, Director of E Guard Environmental Services Co., Ltd. ・ Tea Break ・ Question and Answer Session ・ Closing Remarks by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation
Date	May 12, Tuesday 2015
Time	13:00 pm to 16:00 pm
Venue	Yuzana Garden Hotel, Yangon
Attendees	19- Project Affected Persons (PAPs) and Local Interest People 62- Reporters (Media) 15- Staffs from Government Departments 7- Members of Parliament, Yangon Region 6 Personnel from JICA Study Team 10 Personnel from E Guard Environmental Services Co., Ltd. Total Participants (120)
Materials Provided	・ Agenda ・ Power-point Presentation Document on Project Brief ・ Power-point Presentation Document on Environmental and Social Considerations

(2) Results of the Meeting

1) Opening Remarks by U Htun Aung Thin, General Manager (Lower Myanmar), Myanma Railways, Ministry of Railways Transportation

U Hun Aung Thin, General Manager, addressed the opening remark which was briefly described as follows:

- The Objectives of today meeting was to inform pros and cons of the YCRLUP projects , design of the project to Locals resulting knowledge development for the public and responsibility and to reduce conflicts that can be caused by this project and to implement the upgrading projects without undesired disturbances.
- The current situation of YCR line is deteriorated in some places including loss of stones, flooding in some areas, etc.

- And houses near the railway line leads to dangerous situation. We need to solve these problems in order not to occur accidents.
- Briefly, it is needed to update systems such as Signaling System, Tickets System and Telecommunication Systems.
- Finally, all the attendees are requested to make comments, advices and questions about the project.

2) Presented by U Tun Aung Thin, General Manager, (Lower Myanmar), Myanma Railway, Ministry of Rail Transportation

- U Tun Aung Thin explained mainly on the following topics of the Project.
  - Objectives of YCR Upgradign Project
  - Components of the Priority Project
    - Modernization of Signaling, Telecommunication and Train Operation Systems
    - Modernization of Stations
    - Modernization of Railcars (DEMU)
  - Public feedback
  - Presenting impacts from surveying
  - Resettlement plans
  - Phased Development (with photos)
  - Social and Environmental Consideration

3) Presented by U Tin Aung Moe, Director of E Guard Environmental Services Co. Ltd.

- U Tin Aung Moe explained mainly on the following topics about Environmental and Social Considerations for YCR Upgrading Project.
- IEE and Assessment of Resettlement action plans (A-RAP)
- JICA study Team's supplement for project
- Impacts
  - Involved Agencies
  - Household lists
  - Situation of these households with photos presenting
  - Survey for Environmental Impact Assessment (EIA)
  - The Way Forward
  - Compensation about resettlement plan
  - Moreover, he explained about the Outline of EIA survey as follow.

- Environmental Policies, Legislation and Institutional Framework of Myanmar relevant to the Yangon Circular Railway Line (YCR)
- Baseline data collection (Social Environment, Natural Environment and Environmental Pollution)

4) Questions & Answers

a) From Parliament Members

Dr.Saw Hla Htun (Member of Parliament, Yangon Region)

Discussion Point: This meeting that celebrates in third time about social and environmental impact assessment is very transparent for all of stakeholders and project affected persons. Moreover, the showing video well explained to know the expected upgrading program in coming next 40 years.

Question: Firstly, I really want to know how will be the safety plan for public when the project starts operation stage. In addition, I would like to give suggestion to provide public vehicles which is accessible to stations. By doing so, people can reach to Railway station in the short time and will choose train than other transportation services.

Answer: It is very important for public to understand about the operating system of Myanmar railway. Regarding accidents along the railway track, it is not easy to mitigate immediately. Sometimes, we, railway staffs have to always negotiate with the people around the constructed gates because they don't understand and care the operating system and risks. Railway staffs should also be active and responsible on their job. The majority is trust. While we are trying the best, public also needs to believe on Myanmar railway's system and activities and need to obey disciplines and policy as enacted law.

Question: I heard that Chinese Water Spanish (Kan-Zun) planting area along the YCRL area is one of city's food resources. Therefore, I want to know about the resettlement plan if there is any affected area in those plantations.

Answer: Thanks for your suggestion. As you know, MR did not charge money to people who are planting illegally in railway areas since years. And then, we have allowed them to carry these goods and vegetables from one station to other by train.

Dr. Saw Hla Htun (Member of Parliament, Yangon Region)

Question: I have some questions about the resettlement plans. It was explained that the compensation policy will be done according to JICA Guidelines and Myanmar law. I am not sure but I think JICA's disciplines and laws may suffer to people. It should be as Myanmar law.

Answer. We have been studied about JICA's policy in detail. JICA Guidelines are international practice and not intends for any specific country. And it will surely be advantage for Myanmar People. If any description in JICA Guidelines is not suitable to utilize in our country, we will choose the best way to continue the project as enacted Myanmar law.

b) Questions and Answers with PAPs

- U Zaw Lwin (MR Staff, North Okkalapa Township)

Question: Is there any plan to improve MR Staff Housees (Wooden House) while trying to upgrade Yangon Circular Railway Line?

Answer: Yes, MR has plan to improve MR Housing including Clinic, School and Water Supply while upgrading YCRLUP.

- U Win (Shop Keeper, Inn Sein Township)

Question: Since I was 20 years old, my livelihood has been shopkeeper in the Railway area. I want to get appropriate compensation for my shop that is affected by the project. And I want to ask for construction of FOB in order to avoid accidents while the fence is built along the railway.

Answer: The project will implement not to affect adversely socio –economic conditions of local people as much as possible. And compensation will be considered to be in line with Myanmar laws and International Guidelines.

- U Kyaw Ko Latt (PAP, Baukhtaw – Tamwe Station)

Question: There are a lot of plantation owners along the railway lines. But only my family was invited to this meeting. I want to know the reason.

Answer: We conducted socio economic survey to households whose properties are within 2.5 m from the center of the railway track. So, PAPs who attended today meeting are those that we interviewed during survey.

- Daw Moe Zar Ei (PAP, Kyauk Ye Dwin – Tadagaly station)

Question: I have understood about the project plan. What I want to know is when the project will be implemented. And I would like to request to manage for flooded area along the Yangon Circular Railway Line.

Answer: There are many stages that have to be done during project planning stage. Satellite photo of the YCR line has been recorded since last year August. It is also required to conduct feasibility before the project starts. And then further Satellite photos in the project area will be taken after declaration of PAUs via notice. If possible, it is expected to start by the end of this year. It is vital important to

cooperate by PAPs with us for smoothly implementation of the project. Regarding flooding condition during rainy season, there is upgrading works such as waste water discharge, filling stone and garbage removal along the line in this year.

c) From Media

- U Moe Min (Reporter, 7 Days Journal)

Question: I would like to know 1) duration of the project and 2) how will illegal encroachment in the project area be handled?

Answer: Duration of projects will be different according type of each project. For the next question, Government cannot monitor illegal encroachments every time. So, it is required to inform relevant administrative offices by known people in time.

- Daw Lay Lay Mon (DVB News)

Question: Regarding occurrence of accidents and mis-disciplines of people in the railway area, I want to know whether it is due to Myanmar railway or public. In addition, I heard that YCDC are doing some business activities in MR area. Is it business partnership between MR and YCDC?

Answer: Train has to be operated in the designated track as rule. If someone across the railway track or disturbs in any other way, train has to be stopped or slowed down. Consequently, trains cannot be operated to be punctual. To say in brief, both sides have responsibility to prevent accident sand mis-disciplines. For next question, rather than separating MR owned land and YCDC owned land, it is better to give understanding as Union Government property.

5) Closing Remarks by by U Tun Aung Thin, General Manager (Lower Myanmar), Myanma Railway, Ministry of Rail Transportation

- I would like to say sincere thanks for your active participation in this 3rd Stakeholders' Meeting for Yangon Circular Railway Line Upgrading Project.
- All of your discussions, opinions and comments are very informative and effective for the future development of Myanma Railways.
- Finally I would like to get active involvement of relevant government organizations, local people and PAPs for successful implementation of this project.

Figure A2.9.3 Scenes of 3rd Stakeholder Meeting

A2.10 Preparation of Abbreviated Resettlement Plan (ARP)

A2.10.1 Procedures of Land Acquisition based on the Land Acquisition Act 1894

The existing land acquisition process is summarized as the following five steps based on the Land Acquisition Act 1894.

STEP 1: Preliminary investigation

A notification is publicized in a gazette(s), and substance of such public notice is given at convenient places for the residents. Consequently a series of preliminary investigations shall be carried out, which should be sufficient enough to identify the land boundaries.

STEP 2: Hearing of objections

Objections to the land acquisition can be received in a written form within 30 days after the public notification. The collector examines the objections carefully, and makes a summary of the objections.

A report including recommendations by the collector with regard to the objections can be submitted to the President of the Republic of the Union of Myanmar for his advice if the collector needs to do so.

STEP 3: Declaration of intended acquisition

Declaration of the land acquisition is publicized in a gazette(s), and also informed at district or other territorial division in which the land situates. The declaration includes the purposes, approximate area, location and plan.

STEP 4: Enquiry into measurements, value and claims, and award by the collector

Step 4-1: Public Notification

The collector marks off and measures the target land, and give a public notice at convenient places near the land. The notice is also informed to persons who are known or believed to be interested in the land.

Step 4-2: Examination of Award (Area of Land and Compensation)

The collector proceeds to inquire into objections to the measurement, the value of the land at the date of publication of the notification, the respective eligibilities to claim the compensation and examines an award based on the area of the land, compensation including opinions of PAPs and the apportionment of compensation among PAPs.

The award is filed for conclusive evidence between the collector and the persons interested in the land. The collector immediately notices the awards to the persons who are not presented or their representatives when the award made. The collector makes his best effort to respond to the enquiry.

Step 4-3: Grievance

If deliberation reaches an agreement, Award Committee issues a decision concerning type and amount of compensation. If not reach an agreement, the deliberation is continued until reaching the agreement. If the affected people and Award Committee cannot conclude with the further deliberation meeting, the General Administration Department (GAD), Ministry of Home Affairs (MOHA) can intermediate between them.

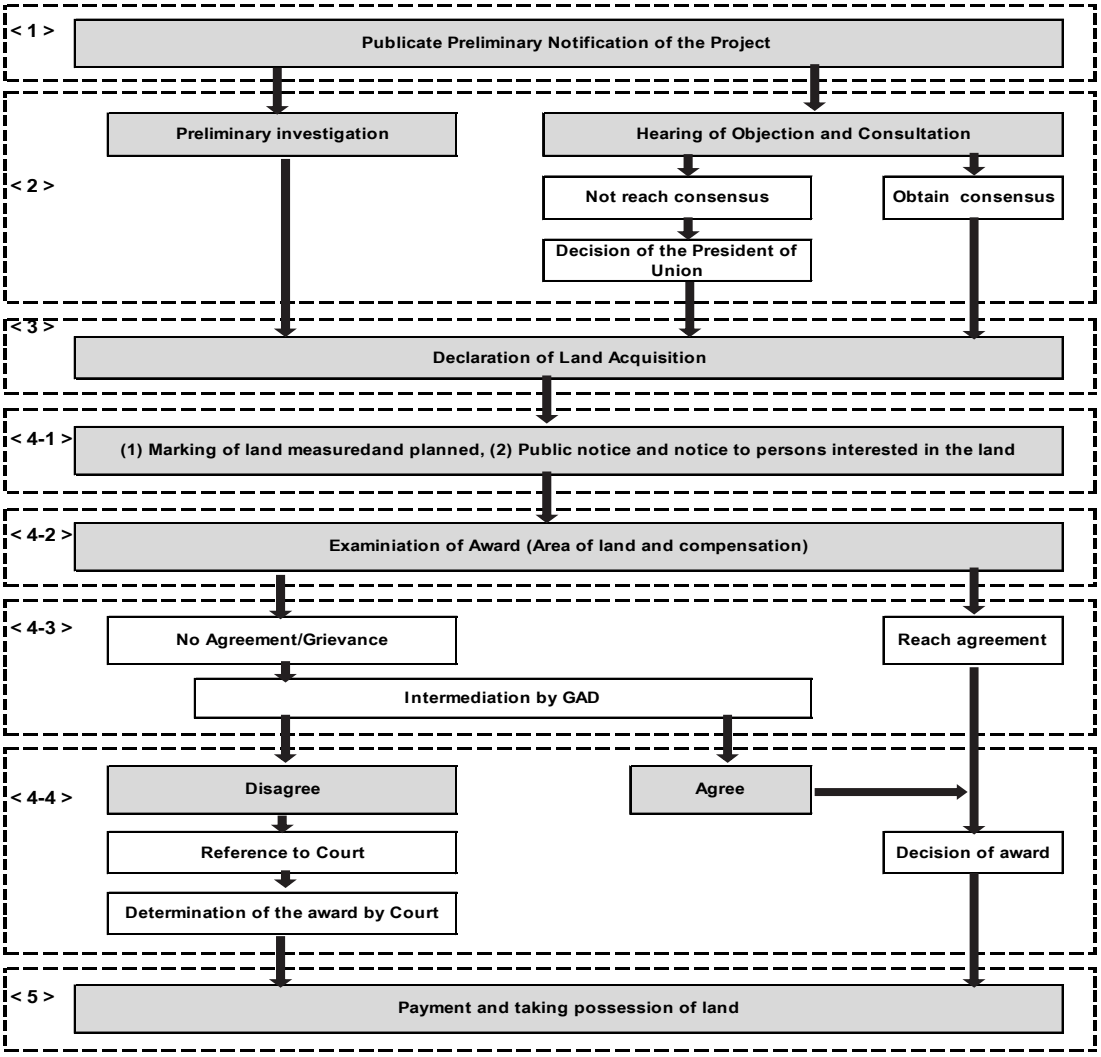
Step 4-4: Reference to the Court

Any person interested in the land who do not accept the Award can ask that the matter should be referred by the collector for the determination of the court with an application in a written form, with regard to the objection to the measurement of the land, the amount of compensation, the person(s) who can receive payment, and/or the apportionment of the compensation among the persons interested.

If the persons agree to the compensation, the particular is specified in the Award for the conclusive evidence. If any disputes arise, the collector may refer the disputes to the decisions of the Court.

STEP 5: Payment and Taking Possession of Land

The collector pays compensation and takes possession of the land. The collector gives the persons sufficient time for them to remove their property without any inconvenience before taking the possession.



Source: JICA Study Team (2014)

Figure A2.10.1 Procedures of Land Acquisition under Myanmar Legislation

A2.10.2 Principles suggested in the JICA Guidelines with regard to the involuntary resettlement policy (land acquisition and resettlement)

The principles suggested in the JICA Guidelines with regard to the involuntary resettlement policy (land acquisition and resettlement) are shown in Appendix 2.10. summarized as follows.

a) Involuntary resettlement and loss of means of livelihood shall be avoided when feasible by exploring all viable alternatives.

b) When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.

c) People who must be resettled involuntarily and people whose means of livelihood are hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.

d) Compensation must be based on the full replacement cost* as much as possible.

* Description of the "replacement cost" is as follows.

Land	Agricultural Land	The pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, and the cost of preparing the land to a level similar to those of the affected land, and the cost of any registration and transfer taxes.
	Land in Urban Areas	The pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, and the cost of any registration and transfer taxes.
Structure	Houses and Other Structures	The market value of the materials to build a replacement structure with an area and quality similar or better than those of the affected structure, or to repair a partially affected structure, and the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes.

e) Compensation and other kinds of assistance must be provided prior to displacement.

f) For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

g) In preparing a resettlement action plan, consultation meetings must be organized for the affected people and their communities based on sufficient information made available to them in advance. Explanations in the consultation meetings must be given in a form, manner, and language that are understandable to the affected people.

h) Appropriate participation of affected people must be assured in planning, implementing, and monitoring the resettlement action plans.

i) Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

j) Affected people should be identified and recorded as early as possible to establish their eligibility through an initial baseline survey (including population census that informs eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who try to take advance of such benefits.

k) Eligibility to receive benefits include the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying.

l) Preference should be given to land-based resettlement for displaced persons whose livelihoods are land-based.

m) Provide support for the transition period (between displacement and livelihood restoration).

n) Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

o) For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan (ARP) should be prepared.

A2.10.3 Gaps in Resettlement Policy between Myanmar Legislation and JICA Guidelines and the World Bank's Safeguard Policy

Table A2.10.3 Gaps in Resettlement Policy between Myanmar Legislation and JICA Guidelines

No.	JICA / WB Guidelines	Laws of Myanmar	Gaps between JICA Guidelines/World Bank and Laws of Myanmar
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICAGL)	None	No law was identified
2	When population displacement is unavoidable , effective measures to minimize impact and to compensate for losses should be taken. (JICAGL)	Land Acquisition Act of 1894 (Article 3)	Article 3 of the Land Acquisition Act stipulates that a person who has right in land would be entitled to claim compensation if the land were acquired under this Act. However, it does not state effective measures to minimize impact.
		Farm Land Law of 2012 (Article 26)	Article 26 of the Farmland Law of 2012 stipulates that suitable compensation and indemnity in farmland acquisition for the interest of the State or public would be taken. It does not state effective measures to minimize impacts. However, Farm Land Rules of 2012 (Article 66to 68) states it clearly.
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICAGL)	Land Acquisition Act of 1894 (Article 23)	Land Article 23 of the Act stipulates that damages on standing crops and trees, land, properties, incidentals to relocate residence or business and losses of profits due to land acquisition are considered for compensation although it does not clearly state to support PAPs can improve or at least restore their standards of living.
4	Compensation must be based on the full replacement cost.as much as possible. (JICAGL)	Land Acquisition Act of 1894 (Article 23)	Article 23 of the Act stipulates that "the market value of the land at the date of the publication of the notification" is considered, although it does not state "the full replacement cost."
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICAGL)	Land Acquisition Act of 1894 (Article 34)	In the Act it is not stipulated specifically that compensation and other kinds of assistance must be provided prior to displacement. However, Article 34 of the Act stipulates that when compensation is not paid before taking possession of the land, the amount awarded with interest thereon shall be paid.
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICAGL)	None	No law specifically mentions the requirement of resettlement action plans for large-scale involuntary resettlement.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICAGL)	None	No law specifically mentions that consultations must be held with the affected people and their communities in the planning and action process of resettlement.
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICAGL)	None	Almost same as the JICAGL.

No.	JICA / WB Guidelines	Laws of Myanmar	Gaps between JICA Guidelines/World Bank and Laws of Myanmar
9	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICAGL)	None	No law specifically mentions the appropriate participation of affected people in the action process of resettlement.
10	Appropriate and accessible grievance mechanism must be established for the affected people and their communities. (JICAGL)	Land Acquisition Act of 1894 (Article 5A, 18)	Article 5A of the Land Acquisition Act stipulates that any person whose land is affected (acquired) can object to the land acquisition within thirty days of the notification. Besides, Article 18 stipulates that any PAP who has not accepted the award can refer to the Court. There is no gap in necessity of grievance system itself between JICA Guidelines and Land Acquisition Act. However, in the Act, there are restrictions on the period of objection. This is a small gap.
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits (WBOP4.12 Para.6)	Land Acquisition Act of 1894 (Article 4)	Article 4 of the Act stipulates that a notification of land requirement for public purposes is published to start surveys and land marking although it does not state the details of surveys to establish eligibility through an initial baseline survey (including population census).
12	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal right to the land they occupying. (WB OP4.12 Para.11)	Land Acquisition Act of 1894 (Article 9)	Article 9 of the Act stipulates regarding occupier (if any) of land and all persons known or believed to have rights on lands are notified or invited for explanations although the eligibility is not clearly prescribed in the Act.
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihood is land-based. (WB OP 4.12 Para.11)	None	No law was identified on preference to land-based resettlement strategies for displaced person.
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP 4.12 Para.6)	None	No law was identified on the provision of support for the transition period.
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities, etc. (WB OP4.12 Para.8)	None	No law was identified on particular attention to vulnerable groups.
16	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP 4.12 Para. 25)	None	No law was identified on the criteria of abbreviated resettlement plan.

Source: JICA Study Team

A2.11 Census Survey Sheet -1 PAUs and PAPs along YC Railway Line

Table A2.10.1 Questionnaire for Environmental and Social Survey on Project Affected Units and Affected People, the Losses, Income and Livelihood of the Affected People

This questionnaire is about the **Environmental Impact Assessment (EIA)** in upgrading the **Yangon Circular Railway Line**, in which the detailed information about the project affected units, affected people, the losses, income and livelihood of those affected people, existing in the Right of Way (on both side, 20 feet from the edge of the railway line), are to be collected through field discussions, individual or group meetings.

The following two main subjects are focused in this questionnaire.

Part (A) Analysis on Project Affected Units (PAUs), Project Affected People (PAPs), and the Losses

Part (B) Survey on Income and Livelihood of the Affected People

Survey Sr. Number _____ _____

Survey Date:

Enumerator Signature _____ Name _____ Position/Org. _____

Inspector Signature _____ Name _____ Position/Org. _____

Survey No. _____ Name of PAP _____ Name of Station _____

Part (A) Analysis on Project Affected Units (PAUs), Project Affected People (PAPs), and the Losses

No.	Affected Unit	Size of the Land (Sq. Feet)	Type of Owner-ship	Age of the Unit	Housing Structure			Estimated Market Price of the Building (to get from other sources, not from PAP)	Remark
					No. Story	Roof	Post/ Beam		
1	House								
3	Shop								
3	Building for other purpose								

NOTE: In the remark column, mention the specific name and significant information; if they are different form the former descriptions.

- Type of ownership (a) legally owned (b) MR's Tenant (c) Illegal
- No. of Story (a) One Story (b) Two Story
- Roof (a) Bamboo /Leaf /Tarpaulin /Zinc Sheet (b) Tile Roofing
- Post /Beam (a) Bamboo/Wood (c) Brick/RC

Part (B) Survey on Income and Livelihood of the Affected People

1. Information of the Respondents and Household Head

Respondent	Household Head/
Asset Owner (M 1)	
Name _____	Name _____
NRC. No. _____	NRC No. _____
Age _____	Age _____
Sex _____	Sex _____
Education _____	Education _____
Relation to Household Head _____	Occupation _____
Ethnicity _____	Ethnicity _____
Religion _____	Religion _____

2. Household Structure

- To collect only the people who are actually living at the present time.

1. No. of Household Member	2. Sex	3. Age	4.Education	5. Occupation/Livelihood
M 2				
M 3				
M 4				
M 5				
M 6				
M 7				
Total HH Member =				

Sex: (a) Male (b) Female

Age: (a) 5 yr and below (b) from 6 yr to 17 yr (c) from 18 yr to 60 yr (d) 61 yr and above

Education: (a) Monastery Education (b) Primary School (c) Middle School (d) High School (e) University (f) Graduate

Occupation: (a) Total Dependent (b) Student (c) Assistant to HH Head (d) Shop (e) Vendor (f) Skilled Labour (g) Casual Labour (h) Farmer (i) Livestock/Fishery (j) Gov. Staff (k) Company or Other Staff (l) Others

3. Household Assets

3.1 Ownership of HH Assets

Kinds of HH Facilities	(1) Bicycle	(2) Motorbike	(3) Car	(4) TV Set	(5) Refrigerator	(6) Tube-well	(7) Generator
Number							

3.2 Situation in Using the Toilet ---- [(a) Not using the Toilet (b) Shared Toilet (c) HH owned Toilet]

3.3 Situation in Using the Electricity [(a) No Electricity (b) Shared Electricity (c) Own Generator (d) Gov. Electricity]

4. Tenant Information (if the tenant is doing any particular business)

4.1 Type of Business ……..

4.2 No. of Employee ……..

Annual Turnover ……..

5. Household Income

No.	Type of Occupation	Estimated Annual Income	Remark
5.1	Shop		
5.2	Vendor		
5.3	Skilled Labor		
5.4	Casual Labor		
5.5	Farmer		
5.6	Livestock /Fishery		
5.8	Government Staff		
5.9	Company or Other Staff		
5.10	Others		
	Total		

6. Estimated Annual Expenditure ---------- Kyat.

7. Remark or opinion on the impacts and benefits after this YCR Line Upgrading project has successfully implemented.

Impact Type	(1) Not so good	(2) Good a little	(3) Good enough	(4) Very Good	(5) Cannot guess
Your Household					
Regional Development					

A2.11.1 Detailed Features of PAUs

Present Usage	Location	Administrative Division	General Description of the Structure	Family size (Person)	Number of residing person (Person)	Owner ship /rent/ illegal etc.	Annual Income (MMK)	Annual Expendicture (MMK)	Total Area area (sq ft)	Estimated Affected Area (sq ft)	Construction Material		Remark
											Roof	Post/Beam	
MR Staff House	Danyingone – Golf Course	Danyingone (Insein)	Wood building	7	7	Own	1,932,000	1,800,000	200	3	Bamboo+ Tarpaulin	Bamboo/ wood	Affected portion is attached structure to Main House
MR Staff House	Danyingone- Golf Course	Danyingone (Insein)	Wood building	3	3	Own	2,100,000	900,000	250	4.5	Bamboo+Tarpaulin	Bamboo/ wood	Affected portion is attached structure to Main House
MR Staff House	Danyingone– Golf Course	Danyingone (Insein)	Wood building	7	7	Own	6,240,000	2,880,000	200	4.5	Bamboo Sheet	Bamboo/ wood	Affected portion is attached structure to Main House
MR Staff House	Kyaukyetwin- Tadagale	N-Okkalapa (Kyaukyetwin)	Wood building	2	2	Own	1,440,000	1,080,000	250	3	Bamboo+Tarpaulin	Bamboo/ wood	Affected portion is attached structure to Main House
MR Staff House	Kyaukyetwin- Tadagale	N-Okkalapa (Kyaukyetwin)	Wood building	6	6	Own	1,920,000	1,440,000	250	3	Tarpaulin	Bamboo	Affected portion is attached structure to Main House
Non-MR House	Insein-Ywama	Insein Township	Bamboo House	5	5	Municipal Tenant	2,340,000	1,200,000	200	9.8	Zinc	Bamboo/ wood	
Non-MR House	Insein-Ywama	Insein Township	Bamboo House	4	4	Municipal Tenant	2,520,000	1,800,000	200	9.8	Zinc	Bamboo/ wood	
Non-MR Shop	Tadagale - Yegu	Mayangone& N-Okkalapa	Hut	5	5	MR Tenant	2,880,000	1,080,000	200	9	Bamboo	Bamboo/ wood	
Non-MR Shop	Kanbe-Baukhtaw	Yankin Township	Wood building	6	6	MR Tenant	2,160,000	1,800,000	200	30	Zinc	wood	
Non-MR Shop	Insein-Ywama	Insein Township	Brick+ Bamboo Attached	3	3	Municipal Tenant	2,700,000	1,800,000	800	18	Zinc	Bamboo/ wood	Affected portion is attached structure to Main House
Others	Baukhtaw - Tarmwe	Tamwe Township	Farm land	9	0	Illegal	2,160,000	720,000	70	30		Bamboo Fence	
Others	Kyaukyewtin-Tadagale	N-Okkalapa (Kyaukyetwin)	Farm land	6	0	Own	2,880,000	1,800,000	60	30		Bamboo Fence	

A2.11.2 Photos of PAUs

MR staff house-1

MR staff house-2

MR staff house-3

MR staff house-4

	
MR staff house-5	Non-MR staff house -1
	
Non-MR staff house -2	Non-MR Shop-1.
	
Non-MR shop-2	Non-MR shop-3
	
Farm land rented from MR	Water-logged land rented from MR