Chapter 6 Examine measures to reduce the project cost and shorten the project period

6.1 Mechanized Construction of Track Works

The track works are classified mainly into following 3 methods.

- Man Power Method: In the method, man power is used as much as possible.
- Organized Mechanization Standard Method: In the method, each step of track and civil works is mechanized as much as possible, and each mechanized step is efficiently organized each other. The method is called as "Organized Mechanization Standard Method".
- Large-Scale Mechanization Method: In the method, such major track works as (1) roadbed formation, (2) ballast renewal, (3) replacing of rail and turnout, and (4) replacing of sleeper are carried out by "mechanized works trains". There are generally used two types of machine trains, which are (1) Formation of Roadbed and Ballast Renewal Machine Train and (2) Rail and Sleeper Renewal Machine Train. Other works besides above works of (1), (2), (3) and (4) are carried out by the same method of "Organized Mechanization Standard Method". The method is called as "Large-Scale Mechanization Method".

As [Man Power Method] is not proper to be considered in this project, the two methods of [Organized Mechanization Standard Method] and [Large-Scale Mechanization Method] are picked out for the discussion. Items to be discussed are as follows.

- Explanation and comparison of the two methods.
- Comparison of the working efficiency between the two methods.
- Economic comparison between the two methods.

6.1.1 Explanation and Comparison of [Organized Mechanization Standard Method] and [Large-Scale Mechanization Method]

As the theme is not easy to be understood by only language explanation even if pictures attached, a long explanation and comparison chart with pictures and explanation phrases is attached (Figure 6.1.1)

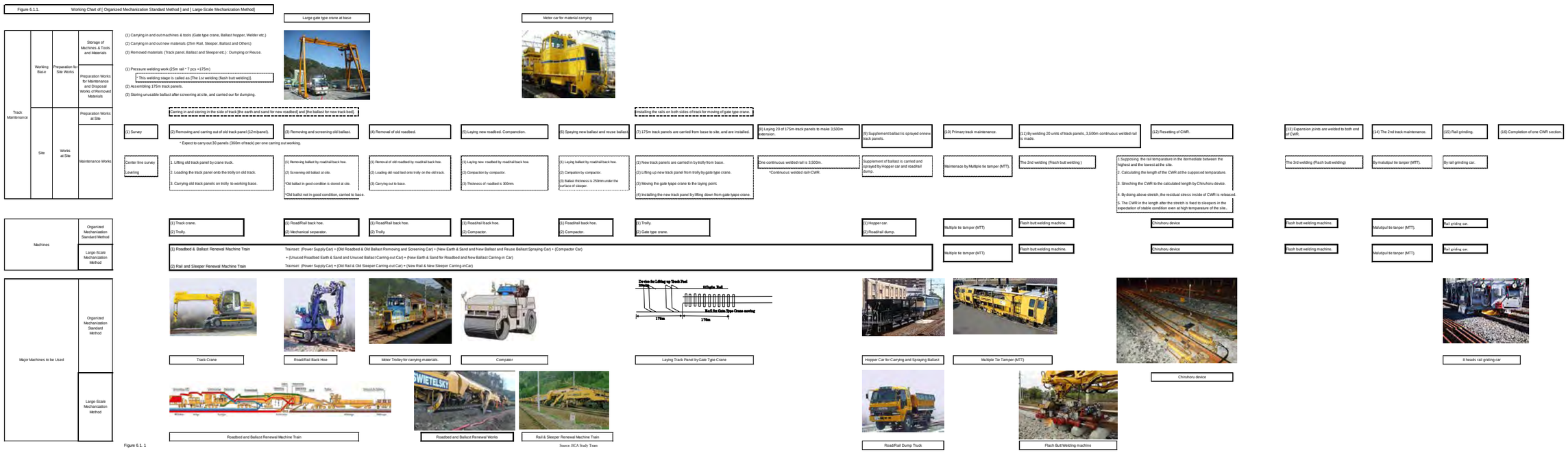


Figure 6.1. 1

Figure 6.1.1 Work Flow Chart

6.1.2 Comparison of Working Efficiency of [Organized Mechanization Standard Method] and [Large-Scale Mechanization Method]

(1) Kinds of Track Works

The works including in this project are (1) civil works and (2) track works. The civil works are the improvement mainly of (1) roadbed, (2) bridges and (3) box culverts. And the track works are (1) ballast renewal, (2) replacing of rail and turnout, and (3) replacing of sleeper. In the schedule of these works, the first step is the civil works and the track works follow, which means that the construction speed of track works is limited to the construction speed of civil works.

(2) Comparison of Construction Speed

The comparison of construction speed is shown in Table 6.1.1

Table 6.1.1 Construction Speed of Track Works by the two Methods and of Civil Works

Construction Method	Construction Speed	Comment
Organized Mechanization Standard Method	330m/day	[Reference data source] Myanmar country Yangon Mandalay Railroad Maintenance Business Phase I Detailed Design Investigation.
Large-Scale Mechanization Method	800m/day	Construction speed of each machine. ➢ Multiple Tie Tamper (MTT) 370 – 450m/h ➢ Roadbed and ballast renewal machine 30-70m/h ➢ Track renewal machine 1,000m/h The construction speed per day is calculated by using the minimum speed machine among above 3 machines.
Civil Works	250m/day	[Reference data source] Myanmar country Yangon Mandalay Railroad Maintenance Business Phase I Detailed Design Investigation.

Source: JICA Study Team

(3) Working Schedule of Civil Works and Track Works

When the construction works in double tracks are carried out, the trains operation of the construction section is enforced to use a single track for both Up Direction trains and Down Direction trains, while another track is under construction in the same section. MR requires the limitation of the distance of the single track use for both up and down trains as 30km. On the other side, the civil works such as improvement of roadbed, bridges, box culverts should be preceded such track works as ballast renewal, replacing of rail and turnout, and replacing of sleeper. In considering these conditions, the working schedule is considered as follows.

- The 350 km between Taungoo and Mandalay is divided into 4 construction sections, which means one
- construction section is about 90km.
- Each 90km construction section is divided into 3 working blocks.

- One working block is divided into up-train track working block and down-train track working block.
- Both civil works and track works are proceeded at the same time in each 4 construction sections.
- In one working block, the working period is divided into Up Line and Down Line.

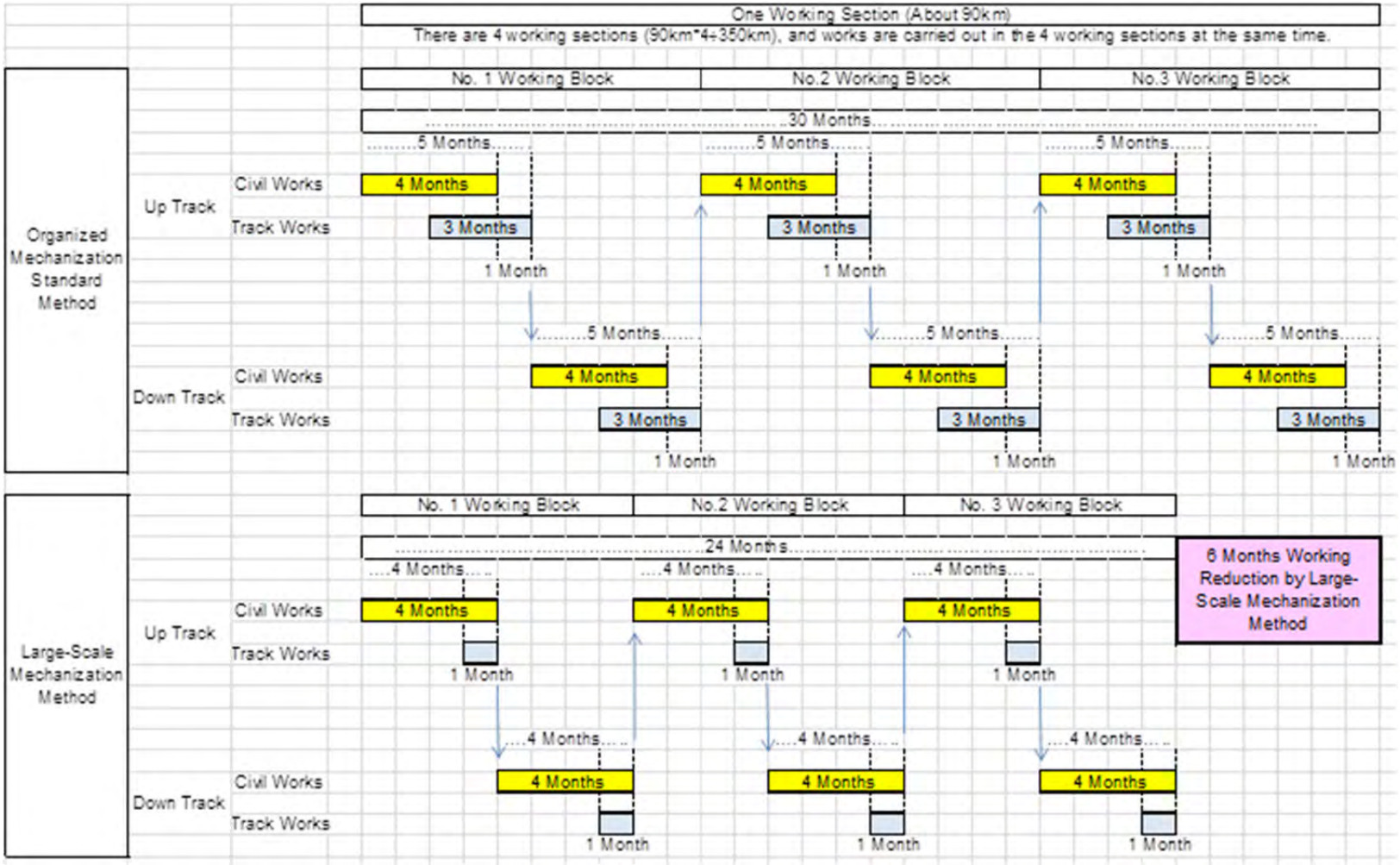
The construction working flow is shown in Figure 6.1.2, which expects the vision understanding of the relationship between civil works and track works, and also necessary working months. And Table 6.1.2 organizes the number of necessary working months of each item of Figure 6.1.2.

Table 6.1.2 Necessary Working Months of the two Methods

(Unit: Month)	Track	Work	Working Block-1		Working Block-2		Working Block-3		Sub Total & Total
Organized Mechanization Standard Method	Up	Civil	4		4		4		
		Track	(2)+1		(2)+1		(2)+1		
		Sub Total	5		5		5		15
	Down	Civil		4		4		4	
		Track		(2)+1		(2)+1		(2)+1	
		Sub Total		5		5		5	15
	Total Working Months								30
Large-Scale Mechanization Method	Up	Civil	4		4		4		
		Track	(1)		(1)		(1)		
		Sub Total	4		4		4		12
	Down	Civil		4		4		4	
		Track		(1)		(1)		(1)	
		Sub Total		4		4		4	12
	Total Working Months								24
Reduced Working Months of Large-Scale Mechanization Method in comparison with Organized Mechanization Standard Method									▲6

※Total working months are “Civil Works number” + NON parenthesis number of Track Works”

Source: JICA Study Team



Source: JICA Study Team

Figure 6.1.2 Construction Working Flow

According to Table 6.1.2 and Figure 6.1.2, the working periods of the both methods are as follows.

- In the case of Organized Mechanization Standard Method, the working period is 30 months. (2years and 6 months).
- In the case of Large-Scale Mechanization Method, the working period is 24 months (2 years).
- The efficiency of Large-Scale Mechanization Method is 6 months-shortening in comparison with Organized Mechanization Standard Method.
- As civil works is necessary to precede track works, to promote more efficiency of Large-Scale Mechanization Method, it is crucial to shorten the working period of civil works.

(4) Economic Comparison

In the comparison between Organized Mechanization Standard Method and Large-Scale Mechanization Method, economic comparison is another key factor in parallel with necessary working period of the two of the two methods. Although machine cost and personal expenses and overhead are included among the costs, the two major factors of machine cost and personal expenses are the crucial keys for the estimation.

- The costs of organized mechanization standard method.

  The costs of both machines and personal expenses are calculated using the unit costs in the final report of "Myanmar Country Yangon Mandalay Railroad Maintenance Business Phase I Detail Design Investigation".

- The costs of large-scale mechanization method.

  As the machines are not certain to be used in other future projects, the full cost of machine (machines train) is appropriated, not considering depreciation method. The necessary number of machines is estimated as 2 set (machines train), which is calculated according to the study of [3) Working Schedule of Civil Works and Track Works]. The personal expenses is estimated using the experience of both machine manufacturer and experts of working sites in similar method.

The costs comparison of the both methods is shown in Table 6.1.3.

Table 6.1.3 Cost Comparison of the Two Methods

Organized Mechanization Standard Method	Large-Scale Mechanization Method
4.62 billion yen	5.77 billion yen

Source: JICA Study Team

(5) Summary

The comprehensive summary of the comparison between Organized Mechanization Standard Method and Large-Scale Mechanization Method is shown in the following Table 6.1.4.

Table 6.1.4 Comprehensive Summary of the Comparison between Organized Mechanization Standard Method and Large-Scale Mechanization Method

Comparison Items	Organized Mechanization Standard Method	Large-Scale Mechanization Method
Possibility of Shortening Working Period ➢ Working Speed ➢ Working Period (for 350 km) (including civil works) *The working speed of track works is limited to the working speed of civil works.	330 m/day 30 months (2 years 6 months)	800 m/day 24 months (2 years)
Cost	4.62 billion Yen	5.77 billion Yen
Possibility of Participation of Japanese Companies. ➢ Professional Engineer ➢ Constructor, Firm	Acceptable Acceptable	Acceptable (Professional engineer is necessary to stay at working site.) Acceptable
Application of the Machines to Other Projects after the Works of this Project.	Possible to be used all the machines in other projects, including MTT.	➢ It is possible to use MTT and Track Laying Machine for Mandalay~Myitkyina (700km) project. ➢ It may be possible to use Ballast & Roadbed Renewal Machine Mandalay~Myitkyina (700km) project. Detail discussion with MR is necessary.
Maintenance of Machines.	MTT experience has been Accumulated in MR.	➢ MTT experience has been Accumulated in MR. ➢ For the operation of Roadbed & Ballast Renewal Machines and Track Renewal Machines, expert engineer is necessary to stay at site.
Matters to be studied	It is necessary to study how to shorten the working period of both track works and civil works. Especially civil works are the crucial key for shortening total working period, as it precedes track works.	➢ The engineering design and production period of Roadbed & Ballast Renewal Machines is said to be 2~2.5 years. The negotiation with manufacturer to shorten the period is necessary. ➢ The Roadbed & Ballast Renewal Machines have been used mainly in Europe, and the experience of the machines is limited in other areas. ➢ It is necessary to confirm at the manufacturer if it is possible to make Roadbed & Ballast Renewal Machines in MR conditions, which are axel load, gauge and construction gauge, etc. ➢ It is necessary to study the frequency of machine troubles and the cost of repair. ➢ Price negotiation.

Source: JICA Study Team

(6) Conclusion and Issues to be studied

Large- Scale Mechanization Method takes 2 to 2.5 years for designing and manufacturing. Therefore, it is so much difficult to use Large-Scale Mechanization Method with targeting in short period of 3.5 years.

So, Phase II construction work will be conducted by the standard mechanization method which introduces a part of machineries.

Issues to be studied are that careful attention should be paid especially designing and manufacturing period on the machines of Large-Scale Mechanization Method. And also, if the method is expected to be given priority, shortening of the period of the engineering design and the manufacturing the machines should be negotiated closely with the manufacturer from the beginning.

Furthermore, prior investigation should be paied whether this kind of method is a common or not in Japan, Asia or other areas.

Especially, Japanese contractor and Japanes Raiway Company have no experience on Large-Scale Mechanized Method; therefore, it was understood to introduce Large Scale Mechanized Method difficult from the beginning.

Chapter 7 Operation and Maintenance

7.1 Institutional Arrangement for Operation and Maintenance (O&M)

Passenger and freight trains will be operated at a non-conventional higher speed by the realignment of YM tracks and increase in the number of train operations. In order to secure train operation safety, Myanma Railways (MR) should change the maintenance plan from breakdown maintenance method to periodic maintenance method, and study the administration organization along with the O&M.

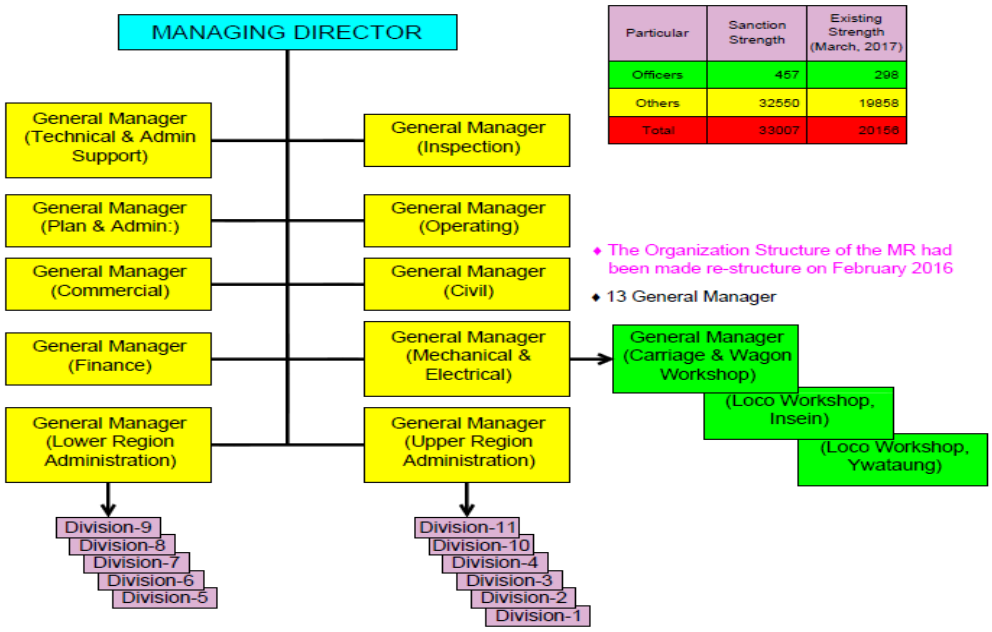
7.1.1 General

The required time of limited express trains in YM will be shortened from 15 hr to 8 hr. The scheduled speed of the train will be from 40 km/hr to 78 km/hr and the maximum speed will be 100 km/hr. Similarly, the maximum speed of the freight trains will become up to 70 km/hr. To speed up train operations, the number of passenger train operations in YM will increase from 2 round trips to 13 round trips, the local train will increase to 17 round trips while cargo train will have 11 round trips in 2023. For these reasons, the O&M plan of YM would require a corresponding plan with a maximum speed of 100 km/hr. Particularly, in order to keep a safe and comfortable train operation, the maintenance and management of tracks and rolling stocks should be an important aspect.

7.1.2 Organization

(1) Operation and Administration of Railway in Myanmar

Figure 7.1.1 shows the organization of MR. The organizational set up of MR is based on departmental system headed by the Managing Director.



Source: Ministry of Transportation Myanma Railways

Figure 7.1.1 Myanma Railways' Organizational Chart

Its system consists of six major departments, namely: Operating; Mechanical and Electrical Engineering; Civil Engineering; Commercial; Planning and Administration; and Finance. The other supporting departments are: Supply; Medical; and Inspection. The railway operation system is divided into 11 divisions which are further grouped into two local organizations (Upper Region and Lower Region). In addition, MR is the sole railway organization in Myanmar, and there is no private railway company.

Table 7.1.1 shows the six major departments and their main functions.

Table 7.1.1 Main Functions of Six Major Departments

Item	Main Function
Operating	Management of station works, operating of signalling and communication at the station
Mechanical & Electrical Engineering	Mechanical and electrical engineering works
Civil Engineering	Track and civil engineering works
Commercial	Passenger and freight tickets works
Planning & Administration	Planning and management works
Finance	Management of assets

Source: JICA Study Team

(2) Maintenance of Rolling Stock

Maintenance of the rolling stocks is conducted at the three main workshops, i.e., INSEI, YWATAUNG, and MYITNGE. A general manager is stationed at INSEI.

- INSEI is a major workshop near Yangon, equipped with large-scale inspection and repair facilities for locomotives. INSEI workshop carries out the overhaul of diesel locomotive.

- YWATAUNG workshop is a major diesel locomotive workshop near Mandalay, equipped with a railway technical training center.
- MYITNGE workshop is a major construction and repairing workshop for the carriages and wagons near Mandalay.

In addition, there are small inspection and repair workshop and stabling line for locomotives at NAYPYITAW Station.

(3) Role of Division

For the O&M of YM, there are five divisions, i.e., 11, 4, 5, 6, and 7. The sections of each division are as follows:

Table 7.1.2 Sections of Divisions of YM

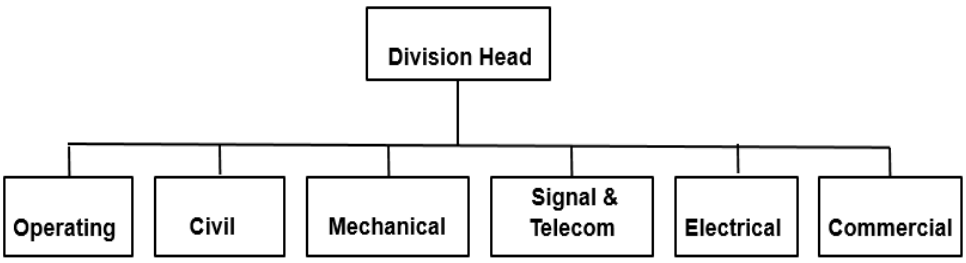
Division No.	Name of Division	Start Point	End-Point	Chainage	Distance
11	MANDALAY Station	THAZI Station	MANDALAY Station	620.5 km	128.0 km
4	KALAW Station	NYAUNGLAN Station	THAZI Station	492.5 km	11.5 km
5	TOUNGOO Station	THAUNG DAI GON Station	NYAUNGLAN Station	481.0 km	220.7 km
6	INSEIN Station	DARBAIN Station	THAUNG DAI GON Station	260.3 km	224.1 km
7	YANGON Station	YANGON Station	DARBAIN Station	36.2 km	36.2 km

Source: JICA Study Team

Same as the head office, the organization of each division constitutes the Operating, Mechanical & Electrical Engineering, Civil Engineering, Commercial, Planning & Administration, and Finance. Track and civil engineers account for the majority of staff of the divisions.

(4) O&M Organization for the Existing Civil Engineering Facilities

Existing general Organization of maintenance division is shown in Figure 7.1.2. Civil engineering facilities include tracks, bridges, and embankment structures, among others. Track works is the most important issue in terms of the maintenance of civil engineering facilities.



Source: JICA Study Team

Figure 7.1.2 Existing Organization of Maintenance Division

The outline of O&M of the existing civil engineering facilities is as follows:

- The organizational set up of the management division has a multiple structure. An assistant civil engineer is placed under the division civil engineer. Moreover, a junior engineer is placed under the assistant civil engineer.
- A track maintenance crew is placed under the junior engineer in-charge of track works. This consists of one head trackman, one patrolman, and three workers; they are stationed about 4 miles (6.4 km) apart. Commonly, two or three members of the crew are consolidated and placed at a near railway station.
- The bridge maintenance workers are assigned differently from the track maintenance workers.

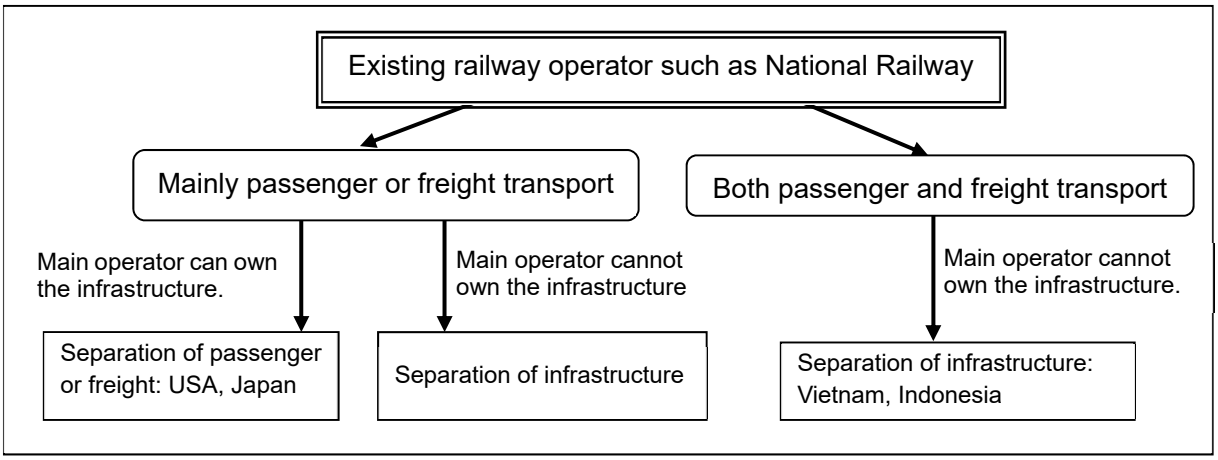
(5) O&M Organization for the Future Civil Engineering Facilities

Passenger and freight trains will be operated at a non-conventional higher speed by the realignment of YM and increase in the number of train operations. In order to secure the train operation safety, MR should completely change its maintenance plan from breakdown maintenance to periodic maintenance. For this purpose, the new O&M plan requires the introduction of the track inspection car to inspect track irregularity and extraction in advance of the section of track irregularity that requires repair. The O&M organizational set up of the future civil engineering facilities is based on the current organization of MR for the following reasons:

- Division 7 of Yangon and Division 11 of Mandalay are located at the regions of big cities, while divisions 4, 5, and 6 are established at the regional central city. O&M of MR is divided into a total of five divisions, and has been operating so far.
- The scope and responsibilities of the manager at each division are clear and it is easy to respond to the increased maintenance works of facilities after the improvement.
- Track workers understand the range of responsibility for the track maintenance and characteristics of the area prone to flooding during monsoon season.

(6) Example of Recent O&M Organization

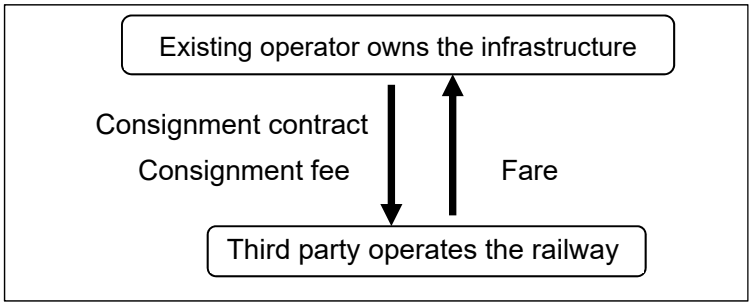
Freight transport is proceeding actively in neighboring countries. The State Railway of Thailand (SRT) is promoting inland depot, which is the infrastructure of freight transport. While Indian Railways is constructing Dedicated Freight Corridor (DFC), which is dedicated for freight transport. On the other hand, with railway business restructuring or serious financial trouble in recent years, existing railway operators follow different scheme, e.g., the national railway owns the facilities and a third party carries out the train operation. This operation system is usually called "scheme of separating infrastructure and operation" as shown in Figure 7.1.3.



Source: JICA Study Team

Figure 7.1.3 Scheme of Separating Infrastructure and Operation of Existing Railway

- Example in Japan: the private company was established and it owns the infrastructure. The freight company procured the locomotive and cargo and pays the usage fee to the owner of infrastructure.
- Example in Indonesia: the country owns the railway facilities. The private company carries out the passenger and freight transportation based on consignment contract. In this vertical separation method, the facility owner (government) pays the consignment fee as operating cost to the railway operator, and at the same time receives the fare from the railway operator.



Source: JICA Study Team

Figure 7.1.4 Example of Consignment Contract

7.1.3 Operation

The train operation needs to ensure safety, comfort, and punctuality. For this purpose, O&M of railway facilities is an important issue. The maximum speed of the express train will be 100 km/hr and the axial weight of the freight train is 20 t; this consideration is especially needed for O&M of rolling stocks and tracks. The O&M of track works shall be described in this section.

(1) Current maintenance and repair of track

The outline of O&M for YM is as follows:

- The track inspection is carried out for the alignment, cross level, twist and tamping condition of ballast of the track irregularity every once a year.
- Three track workers carry out the visual checks at the area of responsibility and repair the track irregularity during daytime.
- The track works is not outsourced at present. In the future, it is desirable to outsource the operation of multiple tie tampers (MTT), which are large-sized tamping machines.
- The inspection of bridge is carried out by a bridge specialist every once a year.

(2) Future track maintenance and repair after the improvement

There is an improvement of train speed, increase of axial load, and enhancement of tracks based on the comparison of train operation condition and track facility before and after the improvement as detailed in Table 7.1.3 below.

Table 7.1.3 Comparison Before and After the Improvement

Item		Current	After the Improvement
Maximum speed	Express train	68 km/hr	100 km/hr
	Local train	48 km/hr	70 km/hr
Entire time	Express train	15hr	8 hr
	Freight train	30hr	—
Number of train operation	Express train	2 round trip	13 round trip
	Freight train	1 round trip	11 round trip
Track	Rail	37 kg/m	50 kg/m
	Continuous welded rail	—	Execution
	Sleeper	PC and wooden sleeper	PC sleeper
	Thickness of ballast	120 - 200 mm	250 mm
Axial load		12.5 t	20 t

Source: JICA Study Team

The railway tracks are strengthened by the increase of rail weight and the continuous welded rail after the improvement of facilities. The track works is a very important issue for speeding up of train operation, increasing the number of train operation, safety, comfort, and punctual operation. For this reason, the maintenance of track works must be changed from breakdown maintenance to periodic maintenance in the maintenance plan. The following concepts are indispensable:

- The service criteria for track irregularity would be determined and reflected in the track maintenance plan.
- Track inspection car should be introduced to inspect the track irregularity for safe train operation, and should be reflected back to the safety confirmation and maintenance plan.

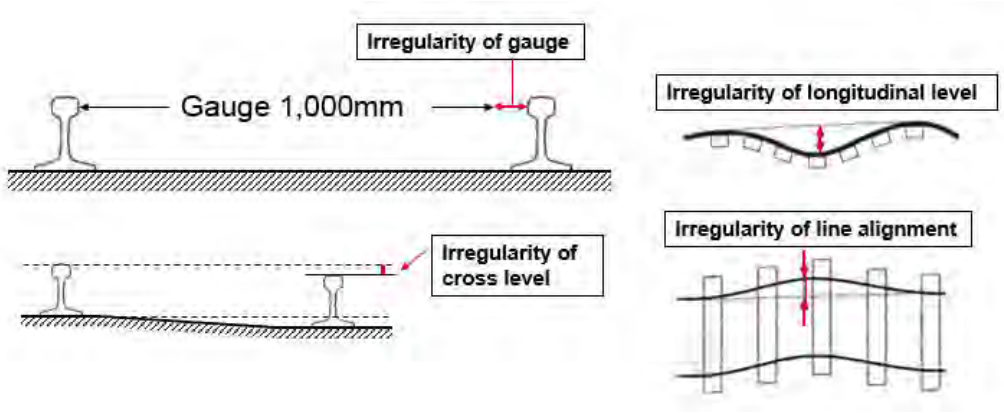
- The tamping works of the ballast tracks should be carried out periodically by MTT, and should be kept in good condition.

(3) Service criterion and safety criterion for track irregularity

Service criterion is a management standard to keep a comfortable riding condition while safety criterion is a safety control standard.

1) Service criterion of track irregularity

Service criterion is a standard to maintain the tracks in good condition, and this criterion is used as a standard value for planning to perform the realignment of track irregularity. It is desirable to keep the value of track irregularity below the value of the service criterion. The following Table 7.1.4 shows an example of service criterion where the train maximum speed is 100 km/hr.



Source: JICA Study Team

Figure 7.1.5 Track Irregularity

Table 7.1.4 Example of Service Criteria for Track Irregularity

(Unit: mm)

Type of Track Irregularity	Measurement Car	Static Measurement
Gauge	+10, -5	+6, -4
Cross level	11	7
Longitudinal level	13	7
Alignment	13	7

Source: JICA Study Team

2) Safety criterion for track irregularity

Safety criterion is a standard to ensure safety for train operation, and this criterion is used as a standard value to repair track irregularity ahead of time. Table 7.1.5 shows an example of safety criteria that should be assumed in repairing track irregularity by track works within 14 days.

Table 7.1.5 Example of Safety Criteria for Track Irregularity

(Unit* mm)

Type of Track Irregularity	Measurement Car	Static Measurement
Gauge	+20	+14
Cross level	―	―
Longitudinal level	23	15
Alignment	23	15
Twist	23	18

Source: JICA Study Team

(4) Service criteria of Train Dynamic Behavior

Service criterion of Train Dynamic Behavior is a management standard to keep a comfortable riding condition. This measurement is carried out by measurement car or passenger car, which is installed with accelerometer. The vibration acceleration of Train Dynamic Behavior is measured in the vertical and lateral direction during train-running by accelerometer.

Table 7.1.6 Example of Service Criteria of Train Dynamic Behavior

(Unit: gravity acceleration (g))

Type of Car	Vertical Acceleration	Lateral Acceleration
Measurement car or Passenger car	0.20 g	0.20 g
Other	0.25 g	0.25 g

Source: JICA Study Team

7.1.4 Maintenance

(1) Growth of the track irregularity

Many researches have been done so far on growth of track irregularity for ballast tracks caused by train operation. In the case of Railway Technical Research Institute of Japan, track irregularities are affected by many elements, e.g., type of rail, type of roadbed (section of viaduct, reinforced roadbed or soil roadbed), spacing of sleeper, ballast depth, annual passing axial of the tracks, and the calculated results are shown below. Since longitudinal level irregularity is more significant than alignment irregularity and cross level irregularity, longitudinal level irregularity should be noted.

Table 7.1.7 shows the condition of the track, and Table 7.1.8 shows the condition of the train operation in 2023.

Table 7.1.7 Calculation Condition of Growth of the Track

Item	
Rail	50N Rail
Spacing of sleepers	59 cm
Roadbed	Soil roadbed
Ballast thickness	25 cm

Source: JICA Study Team

Table 7.1.8 Calculation Condition of the train operation in 2023 (Yangon -Bago, Up)

Type of Train	Express	Local	Mail	Freight
Speed of Train (km/h)	95	65	65	65
Number of Trains per Day (a)	13	17	2	11
Train Composition (b)	6	16	18	24
Number of axle (c)=(b)×4	24	64	72	96
Passing axle per Day (d)=(a)×(c)	312	1,088	144	1,056
Passing axle per year (million ton / yr) (e)=(d)×365/1000000	0.114	0.397	0.053	0.385

Source: JICA Study Team

If the unit of growth of longitudinal level irregularity in 2023 is mm:

(Express train; growth of track irregularity / year)

= 0.75 × (Passing axle per year) = 0.75 × 0.114 = 0.09

(Local train or Mail train; growth of track irregularity / year)

= 0.48 × (Passing axle per year) = 0.48 × (0.397+0.053) = 0.22

(Freight train; growth of track irregularity / year)

= 2.16 × (Passing axle per year) = 2.16 × 0.385 = 0.83

From the above calculation, the unit of growth of irregularity in 2023 is calculated.

(Growth of longitudinal level irregularity) = 0.09 + 0.22 + 0.83 = 1.1 mm

In addition to that, the passing tonnage per year of track is calculated at 11 million tons in case of the average axial weight of freight trains is 17 tons and other trains is 10 tons by referring Table 7.1.8. The following Table 7.1.9 shows the calculation condition of the train operation in 2030.

Table 7.1.9 Calculation Condition of the train operation in 2030 (Yangon -Bago, Up)

Type of Train	Express	Local	Mail	Freight
Speed of Train (km/h)	95	65	65	65
Number of Trains per Day (a)	26	28	2	25
Train Composition (b)	12	16	18	24
Number of axle (c)=(b)×4	48	64	72	96
Passing axle per Day (d)=(a)×(c)	1,248	1,792	144	2,400
Passing axle per year (million ton / yr) (e)=(d)×365/1000000	0.456	0.654	0.053	0.876

Source: JICA Study Team

The unit of growth of longitudinal level irregularity in 2030 as in 2023 is calculated the following value.

(Growth of track irregularity / year)

= 0.75 × 0.456 + 0.48 × (0.654 + 0.053) + 2.16 × 0.876 = 2.6 mm

Additionally, the passing tonnage per year of track in 2030 is calculated to be 26 million tons by referring Table 7.1.9.

The unit of growth of track irregularity per year is estimated at 1.5 mm in 2023 and 2.6 mm in 2030 from the above calculation.

(2) Operation plan of track inspection car

The O&M of the track needs to periodically measure track irregularity by track inspection car. Track irregularity is necessary to be kept below the service criteria of track irregularity. The track inspection car can carry out measurement at approximately 50 km/hr, and the measurement results are outputs displayed in a continuous chart, which can be easily utilized as O&M data. The following Table 7.1.10 shows the examples of measurement frequencies by track inspection car.

Source: JICA Study Team

Figure 7.1.6 Track Inspection Car

Table 7.1.10 Examples of Measurement Frequencies by Track Inspection Car

Item	Measurement Frequency	Remarks
Ministerial Ordinance of MLIT	Over once a year	Standard of Japan
Indian Railways (Group D)	Once in 6 months	Maximum speed 100 km/hr
E Railways Company of Japan	Once in 4 months	Maximum speed130 km/hr
K Railways Company of Japan	Once in * months	Maximum speed 100 km/hr
T Subway of Japan	Once in 6 months	Maximum speed 80 km/hr

Source: JICA Study Team

Measurement frequency by track inspection car is twice a year which is appropriate. Considering the maximum speed of train operation and growth of track irregularity, the appropriate measurement frequency by track inspection car is once or twice a year.

(3) Realignment of track works by Multiple Tie Tamping Machine (MTT)

MTT continuously tamps the ballast tracks. It holds the rails on both side clamps and inserts the vibrated tamping tool into the ballast and tamps the ballast. MTT has the measurement function for track irregularity and can hold the ballast tracks in the correct geometrical position.

Source: JICA Study Team

Figure 7.1.7 Multiple Tie Tamping Machine (MIT)

Quantity of work per hour by MTT

The following Table 7.1.11 shows the hearing investigation from Japanese users and the operation manual of Indian Railways. The quantities of work per hour vary depending on the model used. It includes the preparation time at the work place, but does not include the deadhead time to the work place.

Table 7.1.11 Quantity of Work per Hour by MTT

Item	Model Name	Quantity of Work (m/hr)	Working Days (days/yr)	Remarks
E	Plasser 09-16	500	150-180	Constrained with the follow-up work
W	Plasser Single tool type	375	–	
W	Plasser double tool type	446	–	
I	Plasser 09-3X	400	–	Indian Railways Manual
I	CMS	300	–	Ditto
K	Plasser 08	350	120	Curve and level crossing sections are included

Source: JICA Study Team

Excluding Saturdays, Sundays, national holidays, and the maintenance of MTT, the number of working days for the annual actual performance record is 150 to 180 days/yr. In case of 120 working days/yr, the tamping works during the rainy reason cause “mud pumping of ballast tracks”. From the above table, the working days of YM will be assumed at 130 days/yr in consideration of rainy season; and the quantity of work per hour is 400 m.

(4) Frequency of tamping works by MTT and Number of required MTT

Referring to the results of the measurement data by track inspection or other results of inspections, and from the concept of preventive maintenance, the tamping works should maintain the condition of tracks below the service criteria of track irregularity. The following Table 7.1.12 shows some examples of the frequency of tamping work in Japan. There are cases in which tamping work is done once a year to keep the riding comfort condition.

Table 7.1.12 Frequency of Tamping Work by MTT

Railway Operator	Frequency of Work	Remarks
E	Once a year	Soil roadbed, Maximum speed: 120 km/hr, Annual passing tonnage: 30 million
K	Once in 2 years	Soil roadbed, Maximum speed: 100 km/hr, Annual passing tonnage: 20 million
T	Once in 5 years	Tunnel, Maximum speed: 70 km/hr, Annual passing tonnage: 2.5 million

Source: JICA Study Team

The following Table 7.1.13 shows the calculation result of number of required MTT.

Quantity of Tamping works by one MTT: 0.40(km/hour) × 3(hour) × 130(day) =156km

Table 7.1.13 Calculation result of number of required MTT

Tamping frequency	Distance of Track(km)	Number of required MTT
Once a year	620×2=1,240	1,240 / 156 = 7.9 8 Cars
Once in 2 years	ditto	1,240 / 156 / 2 =4.0 4 Cars
Once in 3 years	ditto	1,240 / 156 / 3 =2.6 3 Cars

Source: JICA Study Team

With reference to the above example, the frequency of tamping works for YM should consider the condition of track which is soil roadbed as well as the maximum speed. Growth of track irregularity per year is estimated at 1.5 mm in 2023 and 2.6 mm in 2030, and service criteria of longitudinal level is 13 mm by Table 7.1.4. For the following reasons, the frequency of tamping works by MTT should be assumed to be once every three years as a minimum value.

- Even after normal tamping work, longitudinal level of track irregularity usually remains at 2 mm to 3 mm, which is inevitable.
- To keep the riding comfort condition, before service criteria of longitudinal level grows to 13 mm, it is preferable to do tamping works within about 6 mm to avoid "rail habits of bending".

6 MTTs are scheduled to be procured at YM projects Phase I and Phase II. In future track maintenance and repair after the improvement make possible to use, one MTT in 5 Divisions, so thus the tampering frequency by MTT can be shortened to 3 years or less.

(5) Number of workers for MTT works and maintenance facility for MTT

1) Number of workers for MTT works

The following Table 7.1.14 shows the required number of workers to carry out the tamping by MTT work. The purpose of follow-up works is the arrangement of ballasts, which are scattered after tamping works by MTT and the compaction of shoulder of the tracks with a rammer.

Table 7.1.14 Number of Workers for MTT Works

Item	Role	Number of Workers
Conductor	Operations manager	1
On-board operator	Front operator, Operator	2
Grand worker	Follow-up works	8
Total		11

Source: JICA Study Team

2) Maintenance facility for MTT

MTT is a large-sized machine with a large engine, a powerful vibration tamping device, and a track measuring device; therefore, regular maintenance is required. Normally, MTT conducts an inspection once a year and general inspection is conducted once every four years. For this purpose, the maintenance facility requires a garage with pits and overhead cranes., it would use the former facility that will be constructed at YM projects Phase I and Phase II.

(6) Training for MTT's operator and Ground worker

Although MTT can perform tamping works more efficiently than manual work, operation of MTT requires someone who has experience to operate it with both hands and feet. Training to become an operator requires about three years including the periods for attending manufacturer's lecture and being an assistant of the operator. In addition, front operators require more than two years of operator’s experience.

To train MTT’s operators and Grand worker, MR should organize a large team which consists the engineers and workers of each Division during the period of YM projects, Phase I and Phase II. It is desirable to complete training by the time which operation and maintenance will begin i.e., year 2023.

(7) Maintenance of turnout and other equipment

Passenger and freight trains will be operated at a non-conventional higher speed by the realignment of YM and increase in the number of train operations. For this reason, the maintenance of the track requires higher quality than in the past. Except the measurement of track irregularity by track inspection car and tamping works by MTT, the maintenance works of the track will continue the maintenance of rails, rail joints, fastening devices, turnout and expansion joint of continuous welded rail. The adoption of continuous welded rail reduces the number of rail

joints. A different maintenance is required to prevent buckling of continuous welded rail. Also, the replacement work of continuous welded rail will accompany the welding work of rail, the removal and laying of continuous welded rails, and the setting temperature of continuous welded rail. The following Table 7.1.15 shows the outline of inspection and maintenance work.

Table 7.1.15 Maintenance of Turnout and Other Equipment

Item	Object	Maintenance Work
Inspection of material	Rail	Replacement
	Fastening device	Ditto
	Fishplate	Ditto
	Sleeper	Ditto
	Parts of turnout	Ditto
Inspection of function	Irregularity of turnout	Tamping
	Irregularity of expansion joint	Ditto
	Rail joint	Ditto
	Ballasted track	Fill the ballast

Source: JICA Study Team

7.2 O&M Costs

The following section shows the cost of required equipment for track maintenance after the improvement of YM.

7.2.1 Initial Cost for the Track Maintenance

MTT is a large-sized machine with a large engine, a powerful vibration tamping device, and a track irregular measuring device. Therefore, periodic inspection and replacement of consumables is required every year. and Normally, it is vital to be maintained every four years as heavy inspection and maintenance. For this reasons, heavy maintenance of MTT detailed inspection is required after 2023

In addition, it is generally said that the cost of heavy maintenance of MTT once every four years is about 5 to 10% of the procured price. Regarding the inspection car of track, it is assumed that the gross usage of the car is several tens of days in a year, thus regular inspections and replacement of consumable parts once every four years are assumed.

7.2.2 Price and Service Life of MTT

The price of a large-sized MMT with a tamping and measuring device is from MMK 5 billion to MMK 7 billion in Table 7.2.1 below. Service life of MTT is from 12 to 15 years.

Table 7.2.1 Price of MTT and Inspection Car (Example)

Manufacturer's Name	Specification	Price
P	MTT Series 08	MMK 4,900,000,000
P	MTT Series 09	MMK 5,600,000,000 － 6,800,000,000
M	MTT Series B50	MMK 5,000,000,000 － 5,600,000,000
M	Inspection Car M10	MMK 2,500,000,000

Note: MMK 1 = 0.0817JPY, JPY 1 = 12.2399 MMK

Source: JICA Study Team

Chapter 8 Environmental and Social Considerations

8.1 Environmental Impact Assessment

8.1.1 Introduction

(1) Environmental Approval for the Project (YGN-MDL section, phase 1 and 2 sections)

An Environmental Impact Assessment (EIA) on the Yangon-Mandalay Railway Improvement Project was carried out in 2013 and 2014 in the feasibility study (F/S) of the project as part of the 'Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar' covering the approximately 620 km section between Yangon and Mandalay. The study was implemented by the Ministry of Rail Transportation (MORT)[1] in coordination with the Department of Transport (DOT) situated under the Ministry of Transport (MOT)[2] and in collaboration with other concerned government agencies and the Japan International Cooperation Agency (JICA) F/S Team. The EIA report was produced as a result of the study and submitted to the Environmental Conservation Department (ECD) located under the Ministry of Environmental Conservation and Forestry (MOECAF)3 on September 9, 2014. The ministry reviewed the report and issued, with minor provisions, an approval letter to MORT on October 28, 2014.

Based on the F/S, a detailed design (D/D) study on the first phase of the project was carried out from 2014 to 2016 by Myanma Railways (MR) situated under the then MORT (now MOTC) with support from JICA. Focus of the first phase of the project was the approximately 270km section between Yangon and Taungoo. In the course of the study, the JICA D/D Team confirmed with ECD on March 24, 2015 that the approval of ECD/MOECAF on the EIA report was valid for the first phase of the project. The D/D study was completed successfully in June 2016.

Following the project's first phase, the preparatory survey for the second phase of the project commenced in March 2017 covering the remaining section of approximately 350km between Taungoo and Mandalay. At this time, a new legislation called the Environmental Impact Assessment (EIA) Procedure (2015), which stipulates the EIA processes to be followed in Myanmar, had been put in place. In view of this situation, the JICA Study Team confirmed with ECD in March and May,

[1] The ministry is now the Ministry of Transportation and Communication (MOTC).
[2] The ministry is now the Ministry of Transportation and Communication (MOTC).
[3] The ministry is now the Ministry of Natural Resources and Environmental Conservation (MONREC).

2017 whether the approval letter issued in October could be considered applicable to the second phase of the project. ECD told the Team that the approval letter was valid for the first phase of the project but the ongoing study for the second phase of the project, including the environmental work, needs to be carried out in accordance with the existing EIA Procedure (2015) and an EIA report should be submitted to ECD/MONREC in order to seek a separate approval. Accordingly, MR with support from the JICA Study Team has commenced with the environmental work of the project in compliance with the EIA Procedure (2015), other relevant laws and regulations in Myanmar and with the JICA Guidelines for Environmental and Social Considerations (2010).

(2) Environmental Approval Process in Myanmar and Current State

Under the EIA Procedure (2015), project proponents in Myanmar need to obtain a notification, confirmation or approval from ECD/MONREC in three or four stages of the environmental study depending on the type of economic activities the projects are classified under. Three stages are required for 'initial environment examination (IEE) Type Projects' and four stages are required for 'EIA Type Projects'. The stages at which ECD/MONREC's approval are required for IEE Type Projects and EIA Type Projects, as well as the time stipulated in the EIA Procedure (2015) for ECD/MONREC's approval of them, are shown in Figure 8.1.1.

Stages	IEE Type Project (time for approval)	EIA Type Project (time for approval)
Screening	Project proponent submits to ECD a project proposal and ECD notifies the project proponent whether the project is an IEE Type Project, an EIA Type Project or a project that requires neither of them (15 working days)	
Notification of Consultant	Project proponent notifies ECD the consultant that will undertake IEE/EIA and ECD approves/disapproves it (7 working days)	
Scoping	N/A	Project proponent submits to ECD a scoping report and ECD approves/disapproves it (15 working days)
IEE/EIA Approval	Project proponent submits to ECD an IEE report and MONREC approves/disapproves it (60 working days)	Project proponent submits to ECD an EIA report and MONREC approves/disapproves it (90 working days)

Source: JICA Study Team

Figure 8.1.1 Approval Process and Time for IEE and EIA Type Projects

As of September, 2017, ECD/MONREC's approval of the first two stages (i.e. screening and notification of consultant) has been completed (cf. a letter of notification has been issued from MONREC to MOTC dated July 17, 2017) and the scoping report has been submitted from MOTC

to MONERC by a letter dated August 17, 2017. Comments from ECD/MONREC have reached MOTC by a letter dated October 11 and the scoping report that has reflected the comments has been submitted from MOTC to MONREC by a letter dated December 4, 2017. The EIA report has already been prepared but ECD told the JICA Study Team that EIA report cannot be submitted to ECD/MONREC until ECD has completed their review on the scoping report. MR and the JICA Study Team are waiting for ECD's review so that they could be reflected into the EIA report and submitted to ECD/MONREC.

8.1.2 Results of Environmental Impact Assessment

(1) Legal Framework for Environmental and Social Considerations

1) Legal Framework concerning Environmental and Social Considerations

(a) Overview of Legislations related to Environmental and Social Considerations

Policies, legislations and guidelines in Myanmar that are of relevance to the project are summarized in Table 8.1.1. Among them, those that are more important are described in the following sections.

Table 8.1.1 Legislations related to Environmental and Social Considerations in Myanmar

No.	Name of Laws and Regulations	Year
Overarching Framework		
	Constitution of the Republic of the Union of Myanmar	2008
	National Environmental Policy	1994
	National Sustainable Development Strategy	2009
Environmental Conservation		
	Environmental Conservation Law	2012
	Environmental Conservation Rules	2014
	Environmental Impact Assessment Procedure	2015
Pollution Control and Occupational Health		
	National Environmental Quality (Emission) Guidelines	2015
	Standing Order 2_95 Occupational Health Plan	1995
	Standing Order 3_95 Water and Air Pollution Control Plan	1995
	Occupational Safety and Health Law (Draft)	2012
	The Science and Technology Development Law	1994
	Public Health Law	1972
Biodiversity and Natural Resource Conservation		
	Protection of Wildlife, Wild Plant and Conservation of Natural Area Law	2016
	Wildlife Protection Act	1936
	Fresh Water Fisheries Law	1991
	The Law Relating to Aquaculture	1989
	Animal Health and Development Law	1993
	National Biodiversity Strategy Action Plan in Myanmar	2012
	Forest Law	1992
	Myanmar Forest Policy	1995
	Conservation of Water Resources and River Law	2006

No.	Name of Laws and Regulations	Year
Land Acquisition and Resettlement		
	The Land Acquisition Act	1894
	Land Nationalization Act	1953
	Transfer of Immovable Property Restriction Act	1947
	Disposal of Land Tenancies Law	1963
	Transfer of Immovable Property Restriction Law	1987
	Farmland Law	2012
	Farmland Rules	2012
	Vacant, Fallow, Virgin Land Management Law	2012
	Vacant, Fallow, Virgin Land Management Rules	2012
Urban Development and Management		
	Development Committee Law	2013
	The Nay Pyi Taw Development Law	2009
	The City of Mandalay Development Law	2015
	The City of Bago Development Law	2016
Railway Transportation		
	Railways Transportation Business Law	2016
International Binding Commitments		
	Vienna Convention for the Protection of the Ozone Layer 1988 and Montreal Protocol on Substances that Deplete the Ozone Layer	1989
	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (CMS)	1983
	Convention on Biological Diversity	1992
	Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and Their Disposal	1992
	United Nations Framework Convention on Climate Change (UNFCCC)	1992
	Kyoto Protocol	1997
	Asia Least Cost Greenhouse Gas (GHG) Abatement Strategy	1998
	United Nations Agenda 21	1992
	Vibration Standards for Environment of International Standard Organization (ISO) criterion of international level	2015
	WHO Environmental Health and Safety guideline	2008
Other Related Regulations		
	State's Housing Rehabilitation and Town and Villages Development Board Act	1951
	Urban Rent Control Act	1960
	Protection of Ethnic Minorities Rights	2015
	Myanmar Investment Law	2016
	Myanmar Insurance Law	1993
	Labour Organization Law	2011
	The Settlement of Labor Dispute Law	2012
	The Employment and Skill Development Law	2013
	The Leave and Holiday Act	2014
	The Minimum Wage Law	2013
	Social Security Law	2012
	Public Health Law	1972
	The Prevention and Control of Communicable Diseases Law	1995

No.	Name of Laws and Regulations	Year
	The Protection and Preservation of Antique Objects Law	2015
	The Protection and Preservation of Ancient Buildings	2015
	The Protection and Preservation of Cultural Heritage Regions Law	2015
	Explosive Substance Act	1908
	Petroleum Act	1934
	Petroleum Rules	1937
	Myanmar Fire Brigade Law	2015
	The Workman's Compensation Act	1923

Source: JICA Study Team

(b) Overarching Framework

i) Constitution of the Republic of the Union of Myanmar

The Constitution of the Republic of the Union of Myanmar was ratified and promulgated by the national referendum held in May, 2011. Some provisions that relate to land management and environmental conservation are summarized as below:

a) The Union is the ultimate owner of all land and natural resources in the area (Section 37);

b) The Union shall permit citizens right of private property, right of inheritance, right of private initiative and patent in accord with the law (Section 37); and

c) 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 public property (Section 390).

ii) National Environmental Policy

The government of Myanmar established the National Commission for Environmental Affairs (NCEA) in 1990 as a policy body for environmental protection. NCEA serves as the focal point and coordinating agency in environmental affairs. NCEA developed the Myanmar National Environmental Policy which was promulgated in December 1994. The National Environmental Policy provides general guidelines for managing the environment in Myanmar.

(c) Environmental Conservation

i) Environmental Conservation Law

The Pyidaungsu Hluttaw enacted this law by Law No. 9 of 2012 on March 30, 2012. The legal mechanism for environmental conservation in Myanmar is stipulated under this law. Its objectives are as follows:

a) To enable to implement the Myanmar National Environmental Policy;

b) To enable to lay down the basic principles and give guidance for systematic integration of the matters of environmental conservation in the sustainable development process;

c) To enable to emerge a healthy and clean environment and to enable to conserve natural and cultural heritage for the benefit of present and future generations;

d) To reclaim ecosystems which are starting to degenerate and disappear;

e) To enable to manage and sustainably and beneficially use the natural resources and address their decrease and loss;

f) To promote public awareness and cooperation and dissemination of environmental perception;

g) To enable to promote international, regional and bilateral cooperation in the matters related to environmental conservation; and

h) To enable to cooperate with government departments, government organizations, international organizations, non-government organizations and individuals in matters related to environmental conservation.

The clauses most relevant to this project are as follows:

a) Monitoring is the responsibility of project proponent/business owner for reducing environmental impact (Section 13);

b) A person causing a point source of pollution shall treat, emit, discharge and deposit the substances which cause pollution in the environment in accordance with stipulated environmental quality standards (Section 14); and

c) The owner or occupier of any business, material or place which causes a point source of pollution shall install or use an on-site facility or controlling equipment in order to monitor, control, manage, reduce or eliminate environmental pollution. If it is impracticable, it shall be arranged to dispose the wastes in accordance with environmentally sound methods (Section 15).

ii) Environmental Conservation Rules

The Environmental Conservation Rules was promulgated in 2014 and provides a platform to bridge the Environmental Conservation Law with more specific and practical rules and guidelines including the EIA Procedure (2015) and National Environmental Emission Guidelines (2015). Specific provisions are stipulated in the EIA Procedure (2015) and the environmental quality standards. The principal rules for EIA review and approval are specified as follows:

a) The Ministry shall form the Environmental Impact Assessment Report Review Body with the experts from the relevant Government departments, Government organizations. (Rule 58);

b) The Ministry may assign duties to the Department to scrutinize the report of environmental impact assessment prepared and submitted by a third person or

organization relating to environment impact assessment and report through the Environmental Impact Assessment Report Review Body. (Rule 60); and

c) The Ministry may approve and reply on the environmental impact assessment report or environmental management plan with the approval of the Committee (Rule 61).

iii) Environmental Impact Assessment Procedure

The objectives of the EIA Procedure (2015) are to provide a common framework for EIA reporting and to ensure that the EIA reporting is in line with legal requirements, good practices and professional standards. Concrete steps to be followed in conducting an EIA are stipulated in the EIA Procedure (2015). Some information that is to be taken into account is presented below:

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) EIA includes an environmental and social baseline data of the study area as well as the changes that will occur during and after project implementation;

d) Public participation is essential for an Initial Environmental Examination (IEE) and an EIA;

e) Project alternatives are to be analysed and measures defined that will minimize negative environmental, social and health impacts and maximize benefits to affected communities;

f) Environmental, social, health management and monitoring plans are required to be proposed to ensure that the requests from the government and the communities of the project proponent are implemented;

g) 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;

h) Members of the EIA Review Committee will be selected by the Minister of MONREC and will include persons from the industry, academia, and civil society, as well as government officials;

i) Involuntary resettlement is carried out under the responsibility of respective regional governments and hence will not be included in the EIA Procedure (2015);

j) According to the categorization of economic activities for assessment purposes (which is described in Annex A of EIA Procedures), Railways and Tramways (including construction and maintenance of rail infrastructure and operation of rolling stock) of more than 5km in length as well as locomotives and other railway rolling material

manufacturing, repairing and assembling whose capacity is more than 100 vehicles/a is categorized as EIA projects as shown in Table 8.1.2.

Table 8.1.2 IEE and EIA Project List for Railway-related Projects

No.	Type of Economic Activity	Criteria for IEE Type Economic Activities	Criteria for EIA Type Economic Activities
Metal, Machinery and Electronics			
90	Locomotives and Other Railway Rolling Material Manufacturing, Repairing and Assembling	-	≥ 100 vehicles/a
Transportation			
123	Railways and Tramways (construction and maintenance of rail infrastructure and operation of rolling stock)	Length < 5 km	Length ≥ 5 km

Source: Environmental Impact Assessment Procedure (2015)

(d) Pollution Control and Occupational Health

i) National Environmental Quality (Emission) Guidelines

The objective of these national guidelines is to provide the basis for regulation and control of noise and vibration, air emissions, liquid discharges from various sources. According to these guidelines, all projects subject to the EIA Procedure (2015) have to comply with and refer to applicable national guidelines/standards or international standards adopted by MONERC. In addition, project proponents shall be responsible for the monitoring of their compliance with general and applicable industry specific guidelines as specified in the environmental management plan (EMP) and environmental compliance certificate (ECC).

In addition, the project proponent is responsible for monitoring the environmental quality based on the developed EMP as specified in the following sections:

a) As specified in the EIA Procedure (2015), projects shall engage in continuous, proactive and comprehensive self-monitoring of the project and comply with applicable guidelines and standards. For the purposes of these guidelines, projects shall be responsible for the monitoring of their compliance with general and applicable industry-specific guidelines as specified in the project EMP and ECC (Section 12); and

b) Air emission, noise, odour, and liquid/effluent discharges will be sampled and measured at points of compliance as specified in the project EMP and ECC (Section 13)

(e) Biodiversity and Natural Resource Conservation

i) Protection of Wildlife, Wild Plant and Conservation of Natural Area Law

This law designates national parks and other protected areas to be Scientific Reserve, National Park Marine National Park, Nature Reserve, Wildlife Sanctuary, Geo-physically Significant Reserve, or Other Nature Reserve designated by the Minister.

The objectives of this Law are as follows:

a) To implement the government policy for wildlife protection;

b) To implement the government policy for natural areas conservation;

c) To carry out in accordance with international conventions acceded by the State in respect of the protection and conservation of wildlife, ecosystems and migratory birds;

d) To protect endangered species of wildlife and their natural habitats;

e) To contribute to the development of research on natural science; and

f) To protect wildlife by the establishment of zoological gardens and botanical gardens

The law states that whoever commits any of the following acts shall, on conviction be punished with imprisonment for a term which may extend to three years or with a fine which may extend to kyats 10,000 or both:

a) Hunting without a license;

b) Violation of any condition of the hunting license;

c) Raising without permission for commercial purpose normally protected wild animals and seasonally protected wild animals;

d) Causing water and air pollution, causing damage to a water-course or putting poison in the water in a natural area;

e) Possessing or disposing pollutants or mineral pollutants in a natural area; and

f) Establishing and operating a zoological garden or a botanical garden without a license

(f) Land Acquisition and Resettlement

i) Land Acquisition Act

Under the Land Acquisition Act (1894), the government holds rights to take over the land provided that compensation is made to the original land owner. No private ownership over land is permitted and all land must be leased from the Union State.

ii) The Land Nationalization Act

The Land Nationalization Act (1953) stipulates that, with some exceptions, all types of agricultural land are owned by the President. Further, in case of a breach of regulations, even the land exempted from government confiscation will be forfeited to the country without compensation. It also states that the President reserves the right to decide the crops to be grown on agricultural lands.

iii) Farmland Law

Under the Farmland Law (2012):

a) Farmers have the rights to sell, pawn, lease, exchange, or donate, in whole or in part, for farming in accordance with prescribed disciplines;

b) In the case of repossession of farmland in the interest of the State or public, confiscated farms are to be compensated without any loss; and

c) If the farm contains a building, such buildings shall also be compensated

iv) Farmland Rules

In accordance with Farmland Rules (2012), the Township Farmland Management Committee shall calculate the amount of grievance and compensation to be given by the State or the Public and submit the statement of their amount to the Central Farmland Management Committee as follows:

a) Grievance for Crops and Buildings

   i. Three times of local current market price based on the yield per acre for paddy and other crops grown;

   ii. Three times of local current market price for perennial crop currently grown; and

   iii. Two times of local current market price for facilities and other activities aimed at improving the farm land

b) Compensation for Land

   i. Local current market price of the farm land in case it was requisitioned for non-profit construction works or other uses related to state security or the long-term interest of the State; and

   ii. In the case of land requisition for profitable business activities that are for the long-term interest of the state, in order to avoid the loss of the person who has the right to work on the farm land, the agreed amount of compensation (or) the amount of money not less than the local current market price decided by the Compensation Committee under the Central Farmland Management Committee

It also states that when farmlands are converted into different forms of land based on the interest of the State or Public, the State or Public needs to make compensation to the farmers without delay.

(g) Urban Development and Management

i) Development Committee Law

'Development Committee' means an organization formed to carry out development works within a specified bound and limit for all regions and states with the exception of Yangon City and Mandalay City where specific laws exist. That includes development committees either for a

township or for additional townships collectively for the purpose of development works. Development Committees' duties and functions include among others:

a) Carrying out works for disposal of sewage;

b) Carrying out precautionary measures against fire, flood, storm and natural disaster;

c) Administration of slow-moving vehicles;

d) Construction and maintenance of roads and bridges;

e) Demolition of squatter buildings;

f) Executing other development works in the public interest; and

g) Carrying out other duties assigned by the regional government from time to time

ii) The Nay Pyi Taw Development Law

The Nay Pyi Taw Development Law was enacted on December 30, 2009 in order to effectively carry out development activities within Nay Pyi Taw development area. Based on the law, the Chairman of the State Peace and Development Council shall: (a) form the Committee comprising a minimum of five members to a maximum of nine members; and (b) in forming the Committee, it shall do so with suitable citizens and determine the Chairman, Vice-Chairman and Secretary of the Committee simultaneously.

iii) The City of Mandalay Development Law (2015)

In section 112, whoever violates or fails to abide by any of the prohibitions, relevant provisions, rules and regulations, procedures, orders and instructions issued under this law shall, on conviction, be punished as follows:

a) Confiscation of the things related to crime by the Committee or punishment with fine kyats 10,000 which may extend to kyats 50,000; or

b) Warning, awaiting business in a limited period and cancellation of penalty to the person who obtained license, permit or registration

iv) The City of Bago Development Law

The City of Bago Development Law was enacted on December 27, 2016 so as to carry out the City of Bago Development Work effectively.

The City of Bago Development law describes the formation of this law, duties and responsibilities of Bago City Development Committee such as urban and housing development planning, construction of buildings, drainage and roads, monitoring and management of markets, environmental conservation and cleaning, public health and safety, water distribution and sewage purification, management of livestock farming, production, distribution, selling of meat and fish, killing of animals dangerous for the public, enforcement of tax collection, inspection, monitoring

and penalties, administration of public recreation centres such as parks, playgrounds and gardens, construction and maintenance of bridges, collections of parking charges, management of ferry services, supervision of private loan business, administration of offences and penalties. As per this law, Bago City Development Committee may issue Procedures, Rules and Regulations with the agreement of Bago Regional Government and Notification, Orders, Instructions and Procedures in order to implement the content of this law.

(h) Railway Transportation

i) Rail Carriers Law

Rail Transport means transport of passengers and goods as an economic activity of transportation to all regions, or part of it, or to foreign countries using the train. Rail transport is associated with transport facilities such as rail lines, underground tunnels, overpass rail lines, sections and so on.

In order to have smooth transport for the citizens and to support the State economy, MR can apply for permission to the Central Management Committee to undergo economic activity in rail transportation by investors from local companies or in association with railway companies in the form of BOT (Build, Operate, Transfer), BOOT (Build, Own, Operate, Transfer), BOO (Build, Own, Operate), BLT (Build, Lease, Transfer) DBFO (Design, Build, Finance, Operate), or DCMF (Design, Construct, Manage, Finance).

MR will review the application and with the approval of the Government can accept or refuse. The Central Management Committee can allow MR for the investment in line with the following rail transport and associated activities:

a) land lease;

b) infrastructure building and renting;

c) leasing of railway carriages, railway engines, communication facilities, factories, and workshops;

d) collection of bridges crossing fees for those constructed by MR;

e) provision of services such as banking, tourism, money exchange, research, advice, container yard and inland depots, hotel services, ferry services, production of goods and other services;

f) production and selling of railway coaches, railway engines, bridge beams and other products; and

g) business activities in line with prevailing laws

MR will undergo construction of railway tracks, construction of basic facilities in line with railway transportation and maintenance under the permission of the Central Management Committee.

If accidents happen during the operation of railway services, the responsible person from the railway coach must report to the nearest station master. When the concerned railway organizations received the news about the accident, they should report to MOTC and the Central Management Committee immediately. The Central Management Committee should conduct an investigation on the accident regarding compensation for cases concerning injury or death.

The Central Management Committee should make an investigation on the accident for providing compensation for cases concerning injury or death.

The demarcation of ROW along the railway line is:

a) ROW from each side of railway line frames is 75 feet;

b) If ditches are applied beside the railway line, ROW from each side of the ditches is 75 feet;

c) Along the separately set rail road, the minimum distance between right edge railway and left edge railway is 50 feet

(i) Other Related Regulations

Other related regulations are summarized as follows.

i) The Employment and Skill Development Law

a) The employer shall carry out a training programme in accordance with the work requirement in line with the policy of the skill development team to develop the skills relating to the employment for the workers (Section 14); and

b) The Employer:

   i. shall carry out the training for each work or compounding the work individually or group wise by providing on-the-job trainings, training systematically at the work site, sending employees to outside training and training by using information technology system, or to enhance the employment skill of the workers (Section 15); and

   ii. shall appoint the youths of 16 years as interns and shall provide training for employability skills systematically in accord with the regulations prescribed by the skill development team (Section 15).

ii) The Leave and Holiday Act

The objectives are to allow workers to take leave and holiday allowances, religious or social activities with allowances, and benefits for health allowances. Concerned workers include: daily wage workers, temporary workers, and permanent workers.

a) Causal Leave: 6 days;

b) Earned Leave: 10 days;

c) Medical Leave: 30 days;

d) Maternity Leave: 90 days;

e) Public Holidays: 21 days; and

f) Penalty for violation

iii) Public Health Law

The purpose of the law is to ensure public health including not only employees but also residents and corporation with the authorized person or organization of the health department. It is concerned with the protection of peoples' health by controlling the quality and cleanliness of food, drugs, environmental sanitation, epidemic diseases and regulation of private clinics. The project owner will cooperate with the authorized person or organization in line with Section 3 and Section 5 of the said law.

The project owner will abide by any instruction or stipulation for public health (Section 3) and accept any inspection, any time, and anywhere if needed (Section 5).

iv) The Prevention and Control of Communicable Diseases Law

The Purpose of the law is to ensure a healthy working environment and prevention the communicable diseases through cooperation with relevant health departments. The clauses most relevant to this project are as follows:

a) The project owner will cooperate with the health officer in line with Clause 9 of Subsection (a) of Section 3 of the said law;

b) The project owner will abide by any instruction or stipulation for public health (Section 4);

c) The project owner will inform promptly to the nearest health department or hospital if any of the following incidents occur (Section 9);

   i. mass death of birds or chicken

   ii. mass death of mice

   iii. suspense of occurring of communicable diseases or occurring of communicable diseases

   iv. occurring of communicable diseases which must be informed

d) The project owner will accept any inspection, any time, and anywhere if needed (Section 11)

v) The Protection and Preservation of Ancient Buildings

The village or township administration officer has to preserve the building in suitable ways and inform the township administration department within fourteen days. The township administration

officer has to take actions immediately and inform the administration department [under the Ministry of Culture] within seven days after having obtained the information.

The administration department has to assume the respective functions and carry out the respective processes for the observation, protection and preservation of the building after having obtained information (Section 13).

The project proponent shall inform promptly if any ancient monuments are found in the project area (Section 12).

vi) The Protection and Preservation of Cultural Heritage Regions Law

Any cultural heritage located nearby the project area shall be protected as specified below.

No person shall, without prior permission granted under this law, construct, extend, renovate a building or extend the boundary of its enclosure in the ancient monumental zone or ancient site zone (Section 18);

No person shall, without prior permission granted under this law, carry out construction; extension; renovation; or extension of the boundary of its enclosure with respect to a building within the protected and preserved zone (Section 19);

No person shall construct a building which is not in conformity with the conditions prescribed region wise by the Ministry of Culture in the cultural heritage region (Section 22); and

No person shall plough and cultivate or carry out any activity which may cause damage to the cultural heritage within the boundary notified by the Department in the cultural heritage region (Section 23).

vii) The Workman's Compensation Act

This law is still valid, but only for factories which have failed to register with the Social Security Office and to subscribe to the 2012 Social Security Law and Rules. Factories which fail to do so shall be required to make payments out-of-pocket to employees who become injured or who die in any accidents arising during and in consequence of their employment. Such compensation also must be made for diseases which arise as a direct consequence of employment, such as carpal tunnel syndrome.

The project proponent shall comply with the workmen compensation act for those who die or become injured during their working period if necessary.

(j) International Binding Commitments

There are a number of conventions and treaties to which Myanmar is a signatory as shown in Table 8.1.1. In addition, this project is required to conform to the JICA Guidelines for Environmental and Social Considerations (2010/JICA Environmental Guidelines) based on the agreement made between the Myanmar and Japanese government. At present, there is no law stipulating land

acquisition and resettlement comprehensively in Myanmar and by conforming to the JICA Environmental Guidelines, it is expected that the project will better meet the level of compensation and support generally required by the international community with regards to land acquisition and involuntary resettlement. Table 8.1.3 below presents a comparison between the policies of Myanmar legislations including the EIA Procedure (2015) and the principles of JICA Environmental Guidelines with relation to land acquisition and involuntary resettlement.

Since the Project does not involve large scale involuntary resettlement (i.e. involuntary resettlement at a scale of 200 persons or more), an abbreviated resettlement action plan (ARAP) will be prepared in accordance with the JICA Environmental Guidelines and the World Bank's Safeguard Policy OP 4.12. An ARAP will involve, and include the results of, census survey, demographic and socio-economic survey, lost asset inventory survey, and computation of costs and budget for compensation and other support.

Table 8.1.3 Comparison between Myanmar Legislations and JICA Environmental Guidelines (Land Acquisition and Resettlement)

No.	JICA Environmental Guidelines/WB OP 4.12	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives (JICA Environmental Guidelines).	Not specified in Myanmar legislations	There is no regulation that mentions or requires avoiding or minimizing involuntary resettlement and loss of livelihood means.	The project will avoid or minimize resettlement and loss of means of livelihood to the extent technically feasible.
2	When population displacement is unavoidable, effective measures to minimize the impact and to compensate for the losses must be agreed upon with the people who will be affected (JICA Environmental Guidelines).	Compensation or indemnity is provided in case of acquisition of farmland for the interest of the State or public. (Farmland Law (2012) Art. 26 and Farmland Rules (2012) Art. 64) In addition, Land Acquisition Act (1894) sets compensation as the precondition for the government to take over land.	In general, there is no difference.	-
3	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 so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels (JICA Environmental Guidelines).	● Land Acquisition Act (1894) stipulates that: market value of the land; damage caused by the trees and crops, and movable/immovable properties lost; inconvenience due to change in residence or business; and any diminution of profits of the land; shall be considered in determining the amount of compensation to be made. In addition, it states that 15% of the market value of such lost properties shall be paid in view of the compulsory nature of the acquisition. ● Farmland Rules (2012) Art. 67 also stipulates a rather generous level of compensation to be made for affected farmland, crops, and buildings.	While the level of compensation can be considered to be relatively generous, there is no clear requirement to improving or at least restoring the living standard, income opportunities and production levels to pre-project levels in the legislations in Myanmar.	Assistance will be provided to the project-affected persons (PAPs) to improve or restore their livelihood to at least pre-project level.

No.	JICA Environmental Guidelines/WB OP 4.12	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
4	Compensation must be provided based on the full replacement cost prior to displacement wherever possible (JICA Environmental Guidelines).	Land: Land Acquisition Act (1894) Art. 23 and Farmland Rules (2012) Art. 67 require compensation to be made based on, or in consideration of, the market value. Crops: Compensation for crops needs to be three times the value of the crops calculated based on the current market price (Farmland Rules (2012) Art. 67).	Land: Although the laws in Myanmar require considering the market value of the land, it does not assure full replacement cost. Crops: The level of compensation required under the laws in Myanmar can be considered sufficient. There is no clear indication about the timing of compensation to be made in the Myanmar legal framework.	The affected land is owned by MR, and no or very few land acquisition will be required under this project. However, any properties and crops to be affected by the project needs to be compensated at the full replacement cost which generally consists of the market value and other transaction costs. Compensation will be provided prior to displacement.
5	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public (JICA Environmental Guidelines).	Not specified under the legislations in Myanmar	There is no regulation that mentions or requires preparation and publication of a resettlement action plan.	An ARAP will be prepared reflecting the views of the PAPs.
6	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 (JICA Environmental Guidelines).	EIA Procedure (2015) stipulates the level of public consultation and information disclosure that are required under IEE and EIA level projects, respectively.	While public consultation and information disclosure is required, there is no regulation that mentions or requires holding such consultations specifically for a resettlement action plan.	Consultations have been made with the PAPs and other stakeholders at four locations at the scoping stage and four locations at the draft final report stage (i.e. eight times in total). In addition, a public consultation meeting was carried out at the planned depot site in Myohaung targeting specifically the people subject to involuntary resettlement.
7	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people (JICA Environmental Guidelines).	Not specified under the legislations in Myanmar	There is no regulation that mentions or requires holding consultations with the PAPs in a language understandable to the PAPs.	Consultations have been made with the PAPs and other stakeholders in Burmese and with visual aids.

No.	JICA Environmental Guidelines/WB OP 4.12	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
8	Appropriate participation of affected people must be promoted in the planning, implementation, and monitoring of resettlement action plans (JICA Environmental Guidelines).	Not specified under the legislations in Myanmar	There is no regulation that mentions or requires participation of the PAPs into planning, implementation and monitoring of the resettlement action plans.	Consultations have been made with the PAPs and other stakeholders at four locations at the scoping stage and four locations at the draft final report stage (i.e. eight times in total). In addition, a public consultation meeting was carried out at the planned depot site in Myohaung targeting specifically the PAPs.
9	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities (JICA Environmental Guidelines).	PAPs shall appeal to the court: i) within six weeks from the date of compensation award if the complainant was present or represented before the Collector at the time when the award was made; or ii) within six weeks of receipt of the notice of compensation from the Collector, or within six months from the date of compensation award, whichever period shall first expire (Land Acquisition Act (1894) Art. 18).	The procedure of grievance in Myanmar is direct settlement at the court, which is not necessarily easy or accessible for the PAPs.	A grievance redress mechanism will be established under this project utilizing the existing administrative mechanism so that it can be both convenient and accessible for the PAPs.
10	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 advantage of such benefits (WB OP 4.12 Para. 6).	A notification of land acquisition or public purposes shall be published in the Gazette and at a convenient place in the said locality (Land Acquisition Act (1894) Article 4).	There is no specific requirement under the laws in Myanmar to identify and record affected people as early as possible.	Affected people have been identified and recorded through a census, lost asset inventory and socioeconomic survey in the ongoing feasibility study under which, this EIA is being carried out. In addition, cut-off date was announced by MR by putting up a letter of announcement at GAD offices and railway stations.

No.	JICA Environmental Guidelines/WB OP 4.12	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
11	Eligibility for benefits includes the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who do not have formal legal rights to land at the time of the census but who have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying (WB OP 4.12 Para.15).	Occupiers/stakeholders of lands to be acquired are explained about acquisition and claims to compensations (Land Acquisition Act (1894) Article 9).	Detailed procedures as well as eligibility criteria are not defined under the laws in Myanmar. There is no specific indication of displaced persons without titles either.	The legal status of those that are expected to be affected by the project have been identified within the study and their eligibility to receiving compensation and support been established based on their legal and other status and stipulated in the ARAP.
12	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based (WB OP 4.12 Para.11).	Not specified in Myanmar legislations	There is no regulation in Myanmar that recommends land-based compensation against resettlement.	Methods of compensation have been prepared in consideration of the preference and/or situation of the PAPs and availability of land.
13	Provide support for the transition period (between displacement and livelihood restoration/WB OP 4.12 Para. 6).	Not specified in Myanmar legislations	There is no regulation that requires providing support to the PAPs for the transition period.	Support will be provided to the PAPs for the transition period.
14	Particular attention must be paid to the needs of the vulnerable groups especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP 4.12 Para. 8).	Not specified in Myanmar legislations	There is no regulation that requires providing support to vulnerable groups.	Support will be provided to vulnerable groups.
15	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, an abbreviated resettlement plan is to be prepared (WB OP 4.12 Para. 25).	Not specified in Myanmar legislations	There is no regulation that stipulates preparing a resettlement plan.	The project is expected to entail involuntary resettlement of fewer than 200 people and hence an ARAP will be prepared.

Source: JICA Study Team

2) Institutional Framework

Implementation of environmental management for the project involves a number of participants each with different positions, responsibilities, and interests. In particular, MR, supported by MOTC and line government agencies, has the primary responsibility to ensure that the people and natural environment are adequately protected from the negative impacts generated from the project and they properly benefit from the positive impact. The main players and their roles and responsibilities under the project are described in Table 8.1.4 below.

Table 8.1.4 Roles and Responsibilities of the Actors in Environmental Management

ECD	As the government body with overall responsibility for management of the environment in Myanmar, ECD and its supervising ministry (i.e. MONREC) will review the process related to environmental and social considerations of the project before (via the scoping report, EIA report and other documents), during and after (via monitoring reports) construction. It is MONREC that sets the ground for the project by issuing an ECC after approving the EIA report. ECD/MONREC will review the environmental monitoring reports during and after construction.
MR	As the project proponent and leading executing body of the project, MR carries overall responsibility for managing and protecting the social and natural environment to the extent that the project may have an effect. There are six major departments (i.e. operating, mechanical and electrical engineering, civil engineering, commercial, planning and administration and finance). There is no department that is responsible for environmental management and departments such as the planning and administration deparment and regional departments are assigned to be in charge of the environmental side on a project basis. MR may carry out necessary activities concerned with environmental management directly or through a representative (e.g. consultants and contractors).
MOTC	As the supervising body of MR. MOTC will support MR in *inter alia* implementing the Environmental Management Plan (EMP) especially in matters related to land acquisition and involuntary resettlement and other social issues that require cooperation of the regional government and other concerned bodies. MOTC serves as the formal channel between MR and ECD via MONREC as formal communications between MR and ECD need to be made via respective ministries (i.e. MOTC and MONREC).
Line Agencies	Local governments (e.g. Mandalay and Bago Region Government, GAD officers and officers from the Department of Agricultural Land Management and Statistics) will cooperate and/or supervise environmental management activities in particular those related to public consultation, provision of compensation and other support to the PAPs, land acquisition and grievance redress.

Source: JICA Study Team

(2) Environmental and Social Baseline Condition

1) Socio-economic Characteristics

The objective of the socio-economic survey is to collect baseline data on the socio-economic state of the people and the project area. The main field survey methods adopted in the social study were stakeholder meetings, in-depth interviews with individual households, focus group discussions and field observations. Survey locations were selected in consideration of the geographic location and proximity to the project area, social strata, expected project impact on the population, and in consultation with relevant local government agencies and MR. The survey consisted of: census survey; lost-asset inventory survey; and household income survey.

The survey forms were developed by the EIA consultant so that it would suit the purpose of the survey and nature of the project. The questionnaire for socio-economic survey and project-affected household survey is shown in Appendix 8.1(1)

(a) Population and Demography

The Mandalay Region is the second most populous region in Myanmar with 6,442,000 inhabitants. The average population density is 424 people per square mile. It is formed with seven districts, 30 townships and 2,320 wards and village-tracts. Mandalay with a population of over 650,000 is the capital city of Mandalay Region. The Bago Region, on the other hand, occupies an area of 15,214 square miles. The total population is 5,014,000 and the average population density is over 300 people per square mile. The Bago Region is made up of Bago, Pyay, Thayawady and Taungoo Districts which comprises of 28 townships with 1,619 wards and village-tracts.

Along the section between Taungoo and Mandalay on the Yangon - Mandaly Railway Line, local communities live in eighteen townships – Pyigyi Takon, Chan Mya Thazi, Amara Pura, Sint Gaing, Kyaukse, Myit Thar, Wundwin, Thazi, Pyaw Bwe, Yamethin, Naypyitaw-Tetkone, Naypyitaw-Pyinmana, Naypyitaw-Lewe, Pobbathiri, Yedashe, Oktwin, Taungoo and Swa. Table 8.1.5 provides a general overview of the eighteen townships.

Table 8.1.5 General and Demographic Condition in 18 Townships

No.	Region	Township	Size (sq. miles)	Highest Point ASL (feet)	Total Population			Male: Female Ratio	Population Growth Rate (2015-2016; %/year)	No of Households
					Total	Male	Female			
1	Mandalay	Pyigyi Takon	9.99	256	153,344	73,963	79,381	1:1.07	1.26	30,676
2		Chan Mya Thazi	9.97		215,094	100,373	115,021	1:1.14	1.53	38,544
3		Amara Pura	3.25	250	185,305	86,849	98,456	1:1.2	2.00	40,406
4		Sint Gaing	0.47	260	131,842	62,322	69,520	1:1.11	1.46	27,864
5		Kyaukse	1.291	271	235,086	112,747	122,339	1:1.09	1.45	7,461
6		Myit Thar	3.47	305	193,203	92,843	100,360	1:1.08	1.45	41,597
7		Wundwin	1.82	460	235,575	111,153	124,422	1;1.12	0.745	52,739
8		Thazi	0.63	700	198,449	94,107	104,342	1:1.109	0.863	41,582
9		Pyaw Bwe	0.776	683	271,321	128,621	142,700	1:1.109	0.99	57,882
10		Yamethin	1.45	654	252,524	120,067	132,457	1:1.103	0.991	54,779
11	Union Territory	Naypyitaw -Tetkone	1.83	2250	225,440	108,871	116,569	1:1.107	0.28	45,548
12		Naypyitaw -Pyinmana	2.29	320	183,604	87,375	96,229	1:1.0	2.11	36,470
13		Naypyitaw -Lewe	0.775	200	287,879	139,518	148,360	-	2.18	54,904
14		Pobbathiri	15.05	320	99,887	49,390	50,578	1:1.103	1.46	-
15	Bago	Yedashe	1.04	320	203,215	98,657	104,558	1:1.105	1.17	44,778
16		Oktwin	1.019	200	169,775	81,853	87,922	1:1.107	0.75	34,167
17		Taungoo	0.73	162	241,895	115,971	125,924	1:1.108	0.41	49,756
18		Swa	6.96	183.92	10,848	5,040	5,808	2:3	-	2,683

* ASL: Above Sea Level

Source: Township GAD (2017)

(b) Religion and Races

Mandalay and Bago are ethnically diverse cities. The primary religions practised in Mandalay and Bago are Buddhism, Islam, and Hinduism. According to township data from the GAD at the township level, the majority of the eighteen townships located along the Mandalay - Bago section of the railway line are Buddhist as shown in Table 8.1.6. Races of the people living in the townships along the section are shown in Table 8.1.7.

Table 8.1.6 Religion in 18 Townships

No.	Township	Buddhist	Islam	Hindu	Christian	Other	Total
1	Pyigyi Takon	1487,58	4,027	296	263	-	153,344
2	Chan Mya Thazi	196,805	8,284	462	822	-	215,394
3	Amara Pura	172,243	12,363	352	347	-	185,305
4	Sint Gaing	124,852	6,662	-	328	-	131,842
5	Kyaukse	218,927	16,047	10	102	-	235,086
6	Myit Thar	19,011	3,046	8	34	-	193,203
7	Wundwin	235,159	408	8	-	-	235,575
8	Thazi	190,501	7,245	463	240	-	198,449
9	Pyaw Bwe	255,611	15,161	446	103	-	271,321
10	Yamethin	243,769	8,520	177	58	-	252,524
11	Naypyitaw-Tetkone	222,710	2,474	164	92	-	225,440
12	Naypyitaw-Pyinmana	158,412	15,197	194	9801	-	183,604
13	Naypyitaw-Lewe	281,022	2,349	35	4473	-	287,879
14	Pobbathiri	99,532	364	1	89	81	99,887
15	Yedashe	199,223	1,425	615	1,809	143	203,215
16	Oktwin	161,076	1,176	1,560	4,861	1,102	169,775
17	Taungoo	230,097	6,138	2,804	679	2,177	241,895
18	Swa	10,709	84	-	55	-	10,848

Source: Township GAD (2017)

Table 8.1.7 Races in 18 Townships

No.	Township	Burma	Shan	Kayin	Chin	Rakhine	Mon	Kachin	Kayah	Other
1	Pyigyi Takon	99.29	0.49	0.065	0.055	0.035	0.012	0.03	0.005	-
2	Chan Mya Thazi	98.64	0.552	0.128	0.090	0.092	0.028	0.143	0.017	-
3	Amara Pura	99.97	0.001	0.006	0.017	0.007	-	0.006	-	-
4	Sint Gaing	94.654	0.02	0.013	0.010	0.006	0.004	0.003	-	5.286
5	Kyaukse	91.497	0.041	0.030	0.060	0.051	0.007	0.008	0.002	8.231
6	Myit Thar	99.975	0.012	-	0.005	-	-	-	-	-
7	Wundwin	99.9945	-	-	-	-	-	-	-	-
8	Thazi	95.58	0.017	0.02	-	0.003	-	0.006	-	4.37
9	Pyaw Bwe	99.986	0.005	0.006	-	0.003	-	-	-	-
10	Yamethin	99.97	0.004	0.006	0.005	0.002	0.0004	0.0008	0.0004	-
11	Naypyitaw-Tetkone	99.92	0.008	0.01	0.03	0.002	0.003	6.01	-	0.013
12	Naypyitaw-Pyinmana	83.83	0.302	5.24	0.0112	0.019	0.001	0.02	0.013	9.1
13	Naypyitaw-Lewe	97.24	0.007	0.191	0.145	0.002	-	0.001	0.002	1.41
14	Pobbathiri	99.5	0.026	0.04	0.03	0.01	0.002	0.007	-	0.37
15	Yedashe	98.3	0.35	0.91	0.005	0.01	0.002	0.008	-	-
16	Oktwin	93.89	0.003	2.89	0.28	0.005	-	-	-	-
17	Taungoo	83.1	2.25	8.96	0.15	0.07	0.01	0.02	0.73	-
18	Swa	98.72	-	0.51	-	-	-	-	-	-

Source: Township GAD (2017)

(c) Employment Status

According to information from the GAD at the township level, an average of about 85.58% of workable persons is employed and 14.42% unemployed. A breakdown of each targeted township is shown in Table 8.1.8.

Table 8.1.8 Status of Employment in 18 Townships

No.	Township	Total Population	Workable Person	Employed Person	Unemployed Person	% Employed	% Unemployed
1	Pyigyi Takon	153,344	95,575	56,993	38,582	59.63	40.37
2	Chan Mya Thazi	215,094	143,530	138,879	4,651	96.76	3.24
3	Amara Pura	185,305	181,599	177,811	3,788	97.91	2.09
4	Sint Gaing	131,842	80,715	67,989	12,726	84.23	15.77
5	Kyaukse	235,086	190,092	160,422	29,650	84.39	15.61
6	Myit Thar	193,203	136,026	122,991	13,035	90.42	9.58
7	Wundwin	235,575	199,820	198,160	1,660	99.17	0.83
8	Thazi	198,449	92,271	71,160	3,728	77.12	22.88
9	Pyaw Bwe	271,321	271,321	262,646	8,675	96.80	3.20
10	Yamethin	252,524	180,430	98,499	8,1931	54.6	45.4
11	Naypyitaw-Tetkone	225,440	150,072	130,032	10,040	86.65	13.35
12	Naypyitaw-Pyinmana	183,604	130,050	124,992	5,058	96.11	3.89
13	Naypyitaw-Lewe	287,879	176,641	169,529	7,112	95.97	4.03
14	Pobbathiri	99,887	82,359	45,096	4,263	54.76	45.24
15	Yedashe	203,215	121,069	119,797	4,850	98.95	1.05
16	Oktwin	169,775	109,069	109,000	4,386	99.94	0.06
17	Taungoo	241,895	155,516	147,940	6,587	95.13	4.87
18	Swa	10,848	7,375	5,300	2,075	71.86	28.14
Total (number/average)		3,494,286	2,503,530	2,207,236	300,566	85.58	14.42

Source: Township GAD (2017)

(d) Economic Status

Economic activities in the eighteen townships located along the Yangon-Mandalay Railway Line were examined according to the information provided by respective township GAD offices. Agriculture, livestock breeding and small-scale shop businesses take place especially in villages while small- to large-scale businesses take place in urban and sub-urban areas. The townships in the project area can be said to be generally economically better off partly because they exist along the highway that connects Yangon and Mandalay.

(e) Educational Status

The following table and figure show the educational status of the eighteen townships along the project area as per township information. It can be seen that Pyigyidagun has the largest number of illiterate (monastic) group of people with 6,474 people representing 20.22% of the population. The lowest rate of illiterate group was found in Thazi with only 0.22%. The number of university students in Amarapura township is the highest among the eighteen townships presumably because of the existence of Mandalay Yadanabon University.

Table 8.1.9 Educational Status in 18 Townships

No.	Township	Illiterate		Primary School		Middle School		High School		University		Total
		Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	
1	Pyigyidagun	6,474	20.22	1,923	6.01	13,093	40.89	10,531	32.9	-	-	32,021
2	Chanmya Thazi	5,135	12.91	2,228	5.60	4,157	10.45	25,306	63.6	2,957	7.4	39,783
3	Amarapura	757	1.54	7,124	14.49	5,706	11.61	15,699	31.9	19,878	40.4	49,164
4	Sintgaing	1,016	2.82	6,227	17.26	6,015	16.67	11,202	31.1	11,619	32.2	36,079
5	Kyaukse	2,650	2.25	86,947	73.74	4,178	3.54	19,898	16.0	4,239	3.6	117,912
6	Myittha	877	2.79	10,455	33.25	2,229	7.09	17,883	56.9	-	-	31,444
7	Wundwin	563	1.77	6,279	19.75	9,756	30.68	15,201	47.8	-	-	31,799
8	Thazi	104	0.22	21,026	43.83	6,827	14.23	20,010	41.7	-	-	47,967
9	Pyawbwe	1,820	3.90	12,602	26.99	11,788	25.25	20,484	43.9	-	-	46,694
10	Yemathin	859	1.95	21,085	47.90	3,512	7.98	17,112	38.9	1,454	3.3	44,022
11	Naypyitaw-Tatkone	1,385	3.15	13,000	29.55	10,096	22.95	19,517	44.4	-	-	43,998
12	Naypyitaw-Pyinmana	1,066	3.13	16,255	47.77	628	1.85	15,583	45.8	494	1.5	34,026
13	Naypyitaw-Lewe	1,420	2.33	31,889	52.25	9,864	16.16	17,862	29.3	-	-	61,035
14	Poppathiri	614	3.49	3,057	17.37	1,383	7.86	12,544	71.3	-	-	17,598
15	Swa	190	5.88	223	6.91	984	30.47	1,832	56.7	-	-	3,229
16	Yedashe	297	0.91	2633	8.04	17143	52.34	12678	38.7	-	-	32751
17	Oaktwin	-	-	585	3.11	8094	43.08	10110	53.8	-	-	18789
18	Taungoo	592	1.16	352	0.69	12612	24.62	21106	41.2	16572	32.4	51234

Source: Township GAD (2017)

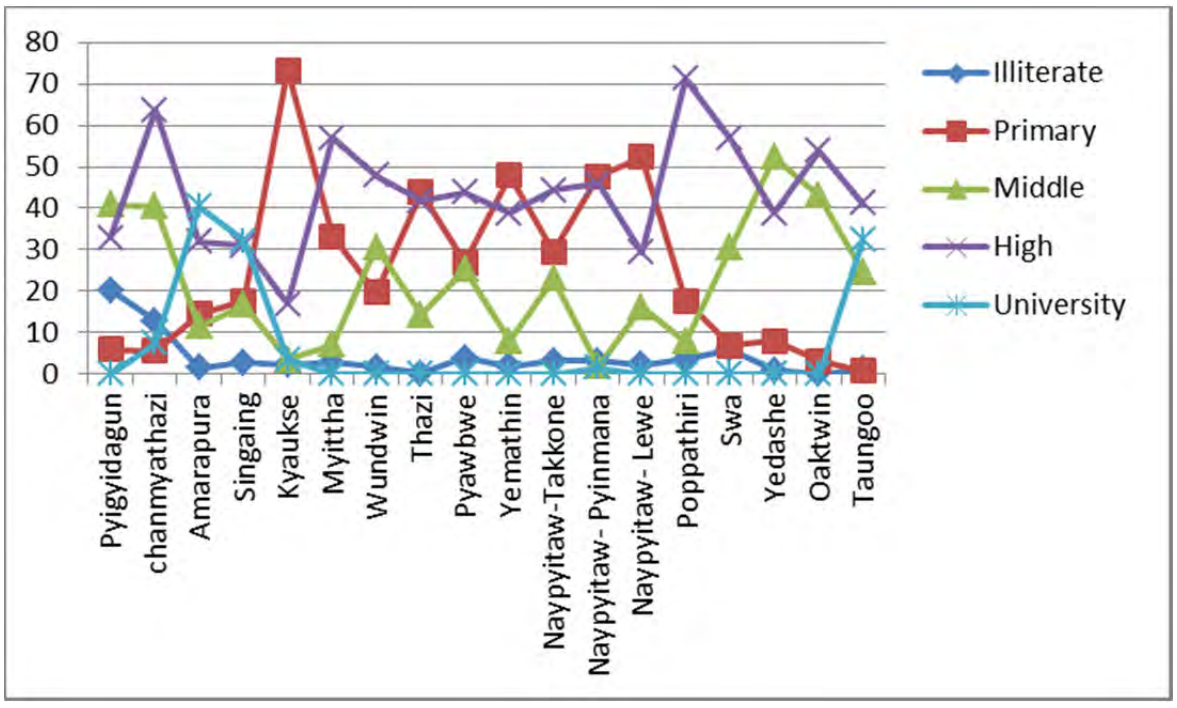


Figure 8.1.2 Educational Status in 18 Townships

According to the 'Environmental Impact Assessment for the Rehabilitation and Modernization of Yangon-Mandalay Railway Project (2014)', on the other hand, 4% of the people living along the railway line are illiterate, 28.5% have completed basic primary education (grade 1-5), 37.5% have completed middle school education (grade 6-9), 18.5% have completed high school education (grade 10-11), 1.5% are university students (undergraduates) and 10% possess a bachelor degree.

(f) Health Condition

The following table shows the statistics of the most common diseases seen in the 18 townships along the railway, namely, malaria, diarrhoea, tuberculosis, hepatitis, dysentery, acute respiratory infections (ARI), and respiratory diseases. In addition, the number of HIV/AIDS patients is also shown on the far right. According to the table, most recorded cases of malaria with a total of 205 cases are found in Naypyiatw-Tatkone. The data also shows an overwhelmingly large number of cases of diarrhoea in almost all townships with the highest being 2,561 cases in Kyaukse. The recorded cases of tuberculosis (TB) and dysentery are similarly distributed among the eighteen townships. The highest number of TB was recorded in Naypyitaw-Lewe while the highest number of dysentery cases was recorded in Taungoo. The data shows no recorded cases of hepatitis in Pyigyidagun, Chanmyathazi, Wundwin, Yamethin, Nay Pyi Taw-Pyinmana and Oktwin. According to the GAD, the only township with 555 recorded cases of respiratory diseases was Yamethin. 43 and 24 cases of ARI were documented in Sintgaing and Naypyitaw-Pyinmana, respectively. The number of HIV/AIDS cases varies among townships with the highest being Taungoo with 340 cases.

Table 8.1.10 Common Diseases and HIV Patients in 18 Townships

No	Township	Most Common Diseases							HIV/AIDS
		Malaria	Diarrhoea	TB	Hepatitis	Dysentery	Respiratory Diseases	ARI	
1	Pyigyidagun	-	338	429	-	162	-	-	56
2	Chanmyathazi	-	174	516	-	70	-	-	-
3	Amarapura	37	996	337	5	418	-	-	-
4	Sintgaing	-	131	82	19	428	-	43	4
5	Kyaukse	94	2561	280	142	949	-	-	-
6	Myittha	-	230	30	3	41	-	-	-
7	Wundwin	38	2386			983	-	-	21
8	Thazi	119	2149	88	3	945	-	-	10
9	Pyawbwe	63	1836	127	39	734	-	-	17
10	Yamethin		1859	360		685	555	-	131
11	Naypyitaw-Tatkone	205	2458	325	12	945	-		-
12	Naypyitaw-Pyinmana	80	999	154	-	157	-	24	320
13	Naypyitaw-Lewe	75	2061	607	25	551	-	-	-
14	Pobbathiri	-	484	292	22	101	-	-	20
15	Swa	6	72	5	8	2	-	-	-
16	Yedashe	5	350	14	1	64	-	-	10
17	Oktwin	10	2302	411	-	597	-	-	12
18	Taungoo	13	2137	137	34	1006	-	-	346

* - : No Data

Source: Township GAD (2017)

(g) Transportation

The following table shows the types of transportation available in the eighteen townships along the project area. Means of transportation are categorized into four different types: air, water, train and bus. In addition, the number of roads going in and out of the townships is also presented.

Almost all the townships have no air transport available with the exception of Lewe. Similarly, water transportation is also not available in the majority of the townships with the exception of Oaktwin and Taungoo each of which has small ports. According to the data, many of the townships have a small number of train stations (i.e. one to six) with the exception of Lewe and Thazi, which have ten and fourteen train stations, respectively. The number of bus terminals in Pyinmana (i.e. Nay Pyi Taw) and Pyigyidagun are documented to be 71 and 79, respectively. Pobbathiri and Singaing have no bus terminals. Most townships have a relatively small-scale of roads (one to six). The township with the most roads recorded was Kyaukse with seven roads in total.

Table 8.1.11 Number of Available Transportation Modes in 18 Townships

No.	Township	Airport	Water Port	Train Station	Bus Terminal	In/Outward Road
1	Amarapura	-	-	1	2	4
2	Chanmyatharsi	-	-	3	3	3
3	Kyaukse	-	-	2	17	7
4	Myitthar	-	-	3	6	3
5	Lewe	1	-	10	3	5
6	Pobbathiri	-	-	5	-	3
7	Pyinmana	-	-	4	70	1
8	Oaktwin	-	1	5	3	3
9	Pyawbwe	-	-	4	6	3
10	Pyikyidagun	-	-	1	78	-
11	Singaing	-	-	3	-	6
12	Swa	-	-	1	3	-
13	Tatkong	-	-	5	7	1
14	Taungoo	-	1	3	26	4
15	Thazi	-	-	14	5	4
16	Wundwin	-	-	3	3	1
17	Yemathin	-	-	5	5	6
18	Yedashe	-	-	6	6	3

Source: Township GAD (2017)

(h) Water Usage

i) Taungoo

Groundwater is the main source of water in Taungoo representing 90% of distributed water. Although Sittaung River flows through Taungoo, the local people rarely use this water. There are private tube wells in more or less every house with an average depth of 50 feet. A family uses more than 50 gallons of water a day. Groundwater overall usage remains unknown due to the multiplicity of wells in the city.

ii) Pyinmana

Not only groundwater is the main source for the city but also Nga Leik dam (surface water) has been developed as an alternative water source by the municipality. About 50% of urban areas have a city water supply system. The rest of the areas collect water from tube wells or from shallow wells. Some houses in Pyinmana have private tube wells whose depth is on average 25 feet. They use more than 40 gallons of water a day. Groundwater is unreliable in summer in which case, some people use stream or brook water.

iii) Mandalay

Groundwater

Groundwater is the main water source in Mandalay city with a capacity of nearly 100,000 m^3/day, representing 90% of water produced in the area. Most tube wells pump water from a deep aquifer located 150m underground. In fact, some of the latest tube wells have been drilled even deeper in order to reach another aquifer located approximately 300m below ground level. The Mandalay City Development Committee (MCDC) operates many publicly-owned tube wells across the city. There are 37 main boreholes with a diameter of 400 mm (16"). Among them, 25 are located along Ayeyarwaddy River. Groundwater production is weak in some areas (e.g. eastern part of the city) and, due to the slow pace of groundwater recharge, tube wells' operation hours are limited to eight hours per day in such places.

Surface Water

Due to the limited capacity of groundwater, surface water has been developed as a new source by MCDC in the last ten years. In 2006, MCDC constructed a new treatment plant (WTP4). The water comes from the Sedawgyi Dam. The treatment process consists of physical separation through sedimentation and rough filtering followed by biological and physical treatment using slow sand filters. A chlorination house was constructed but is not functioning any more. The current water production of WTP4 (i.e. 4,800 m^3/day) is much lower than its theoretical capacity (i.e. 9,000 m^3/day).

A new water treatment plant (WTP8) located on the left bank of Kyauk Thabalk Creek along Myo Patt road uses water from Ayeyarwaddy River. The current production is limited or much lower than its theoretical capacity of nearly 45,000 m^3/day. In consideration of the population in Mandalay and its needs into the future, approximately 60,000 m^3/day should be produced from Ayeyarwaddy River to supply the north of Mandalay.

Moat Water System

The moat water supply system is an old water system built by the Mandalay Kingdom. The main source of this water supply system is Sedawgyi Dam located at the north-east of Mandalay. Water is mainly treated by sedimentation and the capacity of the sedimentation tank is almost 60,000 m^3. Nowadays, the network is becoming less used since the water supply project has been implemented. There is just a little moat water which is supplied around the moat, mainly to the east of the moat. Moat water is supplied to 68 public ground tanks situated in the city.

(i) Waste Management

i) Taungoo

According to an interview survey, local people in Taungoo normally dispose of solid wastes generated from their houses in landfills (August 5, 2017). Some people incinerate wastes once or twice a week. Generally, Taungoo municipality collects waste from the households by a door to door system.

ii) Pyinmana

According to the hearing survey, local people in Pyinmana manage solid wastes disposed from their houses by land filling and incineration (August 6, 2017). The wastes are also collected by the municipality. People usually incinerate the waste twice a week. Some manage their domestic wastes by themselves in land filling. In some houses, the disposal wastes are collected by the municipality once in three days.

iii) Mandalay

According to MCDC, the government body responsible for waste management in the project site, the volume of municipal solid waste generated in the city is approximately 896 tonnes per day with a per capita waste generation of 0.64 kg/person/day.

Mandalay's existing waste management system comprises of primary collection, secondary collection and final disposal. Primary waste collection methods include door-to-door collection, container collection from the kerb site bins, and open collection points. When containers reach their maximum capacity, they will be transported to respective landfill sites. However, unauthorized, non-designated collection points continue to exist due to inadequate collection systems, poor infrastructure and limited public awareness. According to MCDC, the average waste collection ratio in the city is about 80%. Wastes are collected from industries only based upon their request/call.

MCDC currently manages four treatment facilities for waste processing including two landfill sites: one at Kyar Ni Kan (northern part of Mandalay, 450 t/day); and another at Thaung Inn Myout Inn (southern part of Mandalay, 300 t/day). The other two are an anaerobic digester (30 t/day, a pilot project targeting rural areas) and an incineration pit (Kyar Ni Kan, northern part of Mandalay for medical wastes only). In addition, there is an incinerator in Thaung Inn Myout Inn located in the southern part of Mandalay (30 t/day). However, this incinerator is now not in operation due to its low treatment capacity and high fuel consumption.

For liquid waste (i.e. industrial waste water), industries from Pyi Gyi Tagon Industrial Zone constructed their own temporary treatment system for waste water. The 10-inch main pipe line is connected to Dohte Hta Waddy River where the waste water is disposed.

Table 8.1.12 Waste Management System in Mandalay City

Type of Waste	Description
(1) Solid Waste	
Waste Disposal (final disposal)	Landfill 1 (sanitary landfill): 450 t/day at Kyar Ni Kan (northern part of Mandalay) Landfill 2 (engineering landfill): 300 t/day at Thaung Inn Myout Inn (southern part of Mandalay)
Waste Collection System	Vehicles to collect at day time: truck 211; Tricycle 179; Cart 322 Vehicles to collect at night time: 77
Industrial Waste (non-hazardous)	Collect only based on call
(2) Liquid Waste	
Industrial Waste Water from Pyi Gyi Tagon Industrial Zone	Industries from Pyi Gyi Tagon Industrial Zone constructed their own temporary treatment system to connect and dispose to Dohte Hta Waddy river through a 10- inch disposal main pipe line. The main pipe line is disposed to Dohte Hta Waddy River

Source: MCDC

2) Natural Environment

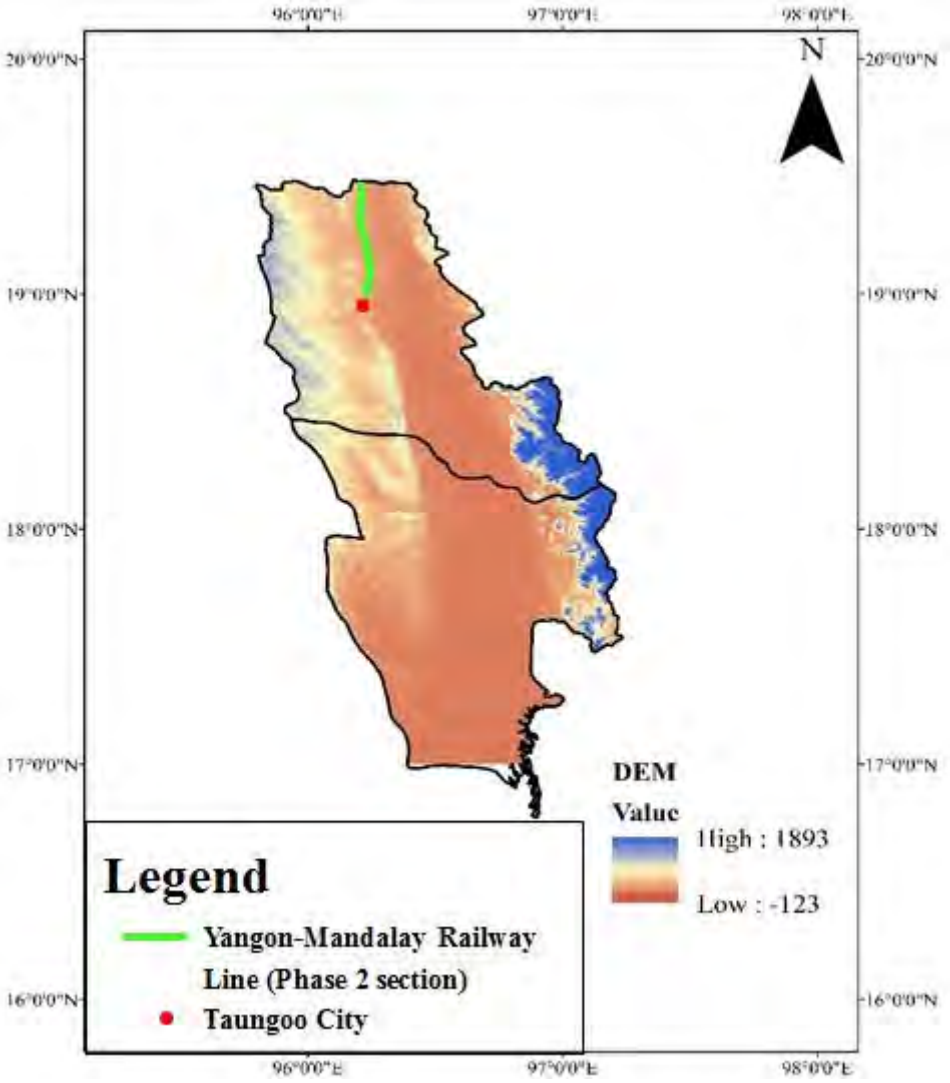
(a) Topographic and Geological Conditions

The topography in Myanmar can be divided roughly into three types: the Western Hills Region; the Central Valley Region; and the Eastern Hill Region. The project area is included in the Central Valley Region. The Central Valley Region consists of the broadest valley of Ayeyawady. There also lies the low range of Bago Yoma that slopes down from north to south.

i) Bago Region

The Bago Region is located in the southern central part of the country. It is bordered by the Magway Region and Mandalay Region to the north, Kayin State, Mon State and the Gulf of Martaban to the east, the Yangon Region to the south and Ayeyarwady Region and Rakhine State to the west. It is located between 46°45'N and 19°20'N and 94°35'E and 97°10'E. The capital is Bago.

The structural geology of Myanmar is not complex. One of the major active faults, Sagaing Fault, controls the structural geology. It passes through just east of Bago and enters into western Gulf of Martaban. This fault is right lateral strike fault. Kyauk Kyan Fault is one of the prominent seismo-tectonic features (Lat. 22˚18´N–Long. 96˚44´E). Pan Laung fault runs into the Shan Scarp accompanied by a zone of NNW–SSE sub-parallel faults towards the north. This zone has been reactivated due to Late Mesozoic and Cenozoic block movements. The different sense of lateral motion pattern long Papun Fault controls the crustal thickening, relaxation and thinning of the Shan Plateau Region.

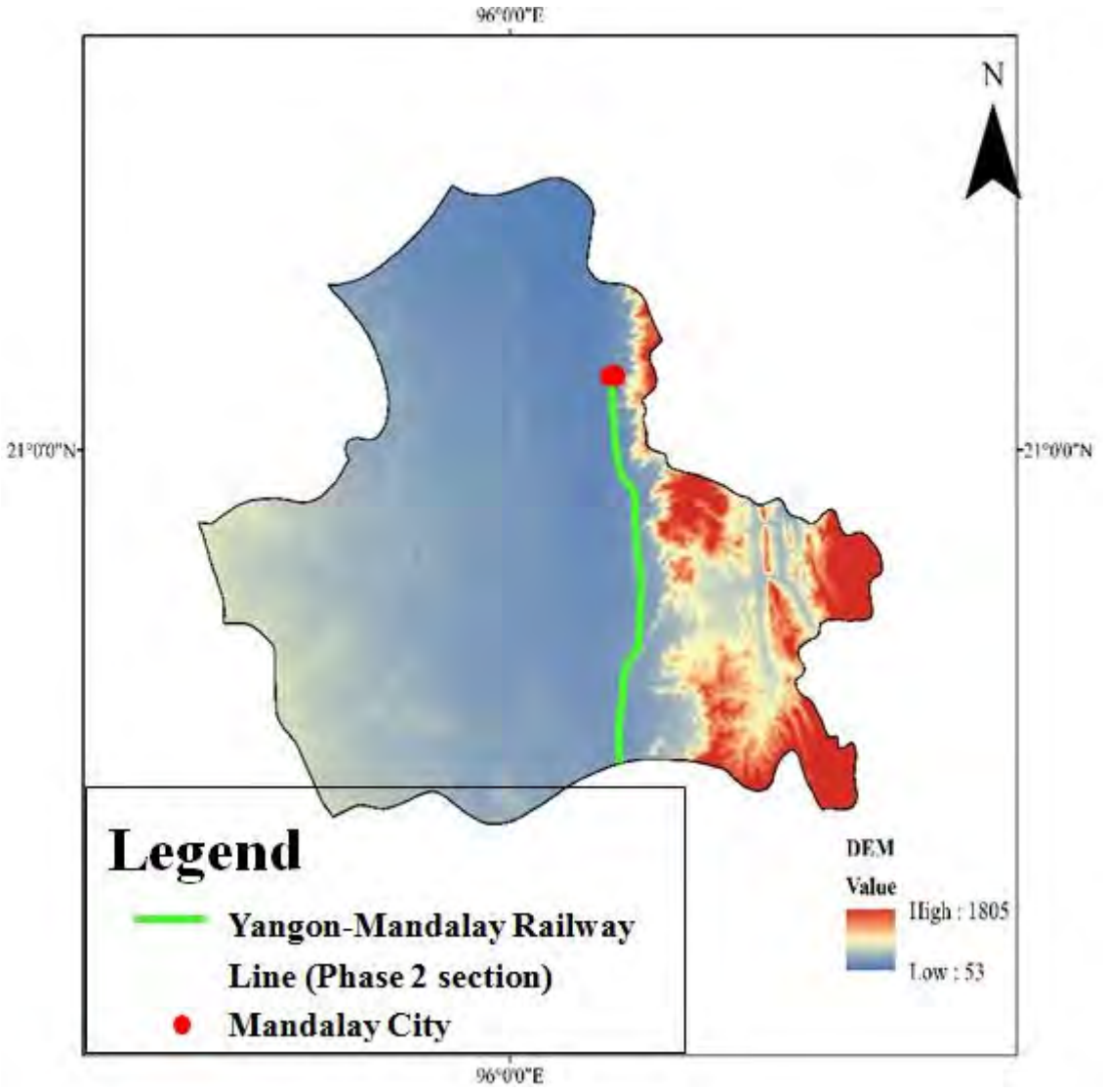


Source: JICA Study Team based on U.S. Geological Survey

Figure 8.1.3 Topography of Bago Region

ii) Mandalay Region

The Mandalay Region is bordered by the Sagaing Region and Magway Region to the west, the Shan State to the east, and the Bago Region and Kayin State to the south with geographic coordinates of between latitudes 19°20' north and 23°45' north and longitudes 94°45' east and 97°00' east in the central Myanmar. Mountains or high plateaus can be found in the eastern border of the division and Bago Yoma in the south-west. The eastern plateau is the highest area in the region elevating up from 6,000 to 7,000 feet in some places. The 4,981-foot Mount Popa, an extinct volcano, is also known to be a popular tourist destination.



Source: JICA Study Team based on U.S. Geological Survey

Figure 8.1.4 Topography of Mandalay Region

(b) Soil Type

There are several soil types in the Bago and Mandalay Regions. Along the railway line of the Bago Region, the soil types of meadow and meadow alluvial soils and alluvial soils are found. In the Mandalay Region, the soil types are mostly meadow and meadow alluvial soils, yellow brown dry forest soil, Indaing soils and compact soils. Soil maps of the Mandalay and Bago Regions are shown in Figure 8.1.5 and Figure 8.1.6.

i) Alluvial Soil (Fluvisol)

In the texture of classification, the soil is comprised of sand, silt and clay. The soil that contains large amount of silt is classified as alluvial soils. They can be found in any region of the country regardless of relief, in the river plains, deltas, former lakes and coastal areas. The soil reaction is usually neutral and being young soils, developed from recent alluvial deposits of the river. Those soil are pervious, easily tilled and so, they are very important soils for agriculture. They are suitable for rice, plantation crops, vegetables, pulses and beans, chilli, sugar cane and maize.

ii) Meadow Soil (Gleysol)

There are different subtypes of Meadow soils. The Meadow soils or paddy soils are widely observed in different parts of Myanmar in river plains, delta and low coastal plains and valleys. All types of Meadow Soils have thick solum and mostly have clayey texture. They are most suitable for paddy cultivation. The Meadow soils of the dry zone in upper Myanmar have the characteristic of being light colours. There are Meadow soils with neural reactions, whereas, some have the alkaline reaction. Although plant nutrients are not abundant, they can be used for pulses and vegetables.

The Meadow soils in the mountain region with large amounts of rainfall and Meadow soils in lower Myanmar have yellow brown colour with acid to neutral soil reaction. Meadow soil near the river plains with occasional tidal floods are non-carbonate.They usually contain large amount of salt. They contain more plant nutrients than the Meadow soils of upper Myanmar. It includes greater amount of iron but the soils can nevertheless be utilized for rice and vegetables.

iii) Meadow Alluvial Soil

Meadow Alluvial soil (Fluvic Gleyol) can be found in the flood plains. They have the texture of silty clay loam and can be utilized for groundnut, sesame, sunflower, jute, sugar cane and other vegetable cultivation in addition to rice cultivation. They have neutral soil reaction and are rich in available plant nutrients. Meadow Gley soil (Gleysol) and Meadow swampy soil (Histic Gleysol) can be found in the regions of lower depressions where the land is inundated for more than six months a year. The texture of these soils is clayey to clay. They usually have very strong acid reaction and contain large amount of iron. Moreover, soils with long periods of moisture content may contain large amount of aluminium and soluble iron, sulphur and manganese by chemical process and can be toxic to plants. The humus content is high and usually deficient in phosphorus and potassium. Rice and jute can be grown on these soils after floods recede.

iv) Yellow Brown Dry Forest and Indaing Soil (Orithic Cambisol)

These soils occur on low upland plains in the dry zone area. The land is dry and sandy so can be utilized for forests and dry cropping on uplands.

v) Dark Compact Soil (Vertisols)

Dark compact soil can be seen in the dry zone plains of the Mandalay Region often near rivers. Along with Red Brown Savanna Soil, dark compact soil is important for agriculture in the dry zone area. Located on the level plains, they are the best soil for irrigated farming. It is mostly composed of clayey materials. Due to its high content of clay, it is difficult to work when it is too dry or when it has excessive moisture. The humus content is also low. When they are dry, they contain deep cracks but after rains they turn into mud and become very sticky. The infiltration level is poor so saline and alkali problems often occur. The soil is alkaline wit pH ranging from 7 to 9 so they are strongly calcareous. With the exception of potassium, they are deficient in nitrogen and phosphorous. The soils can be used be used for Ya crops in addition to rice under irrigation.

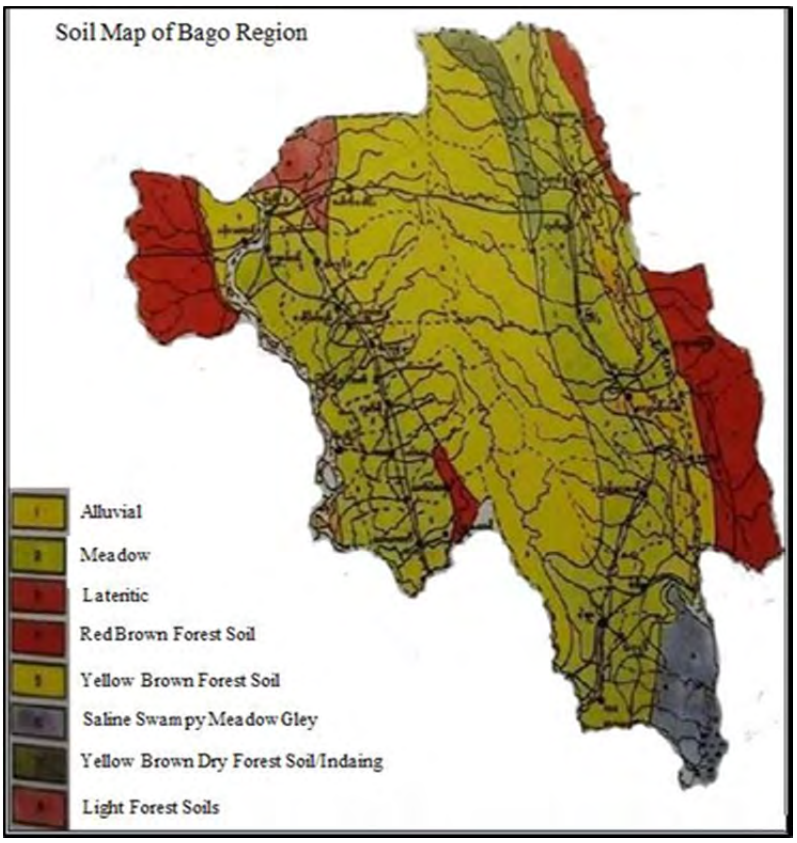
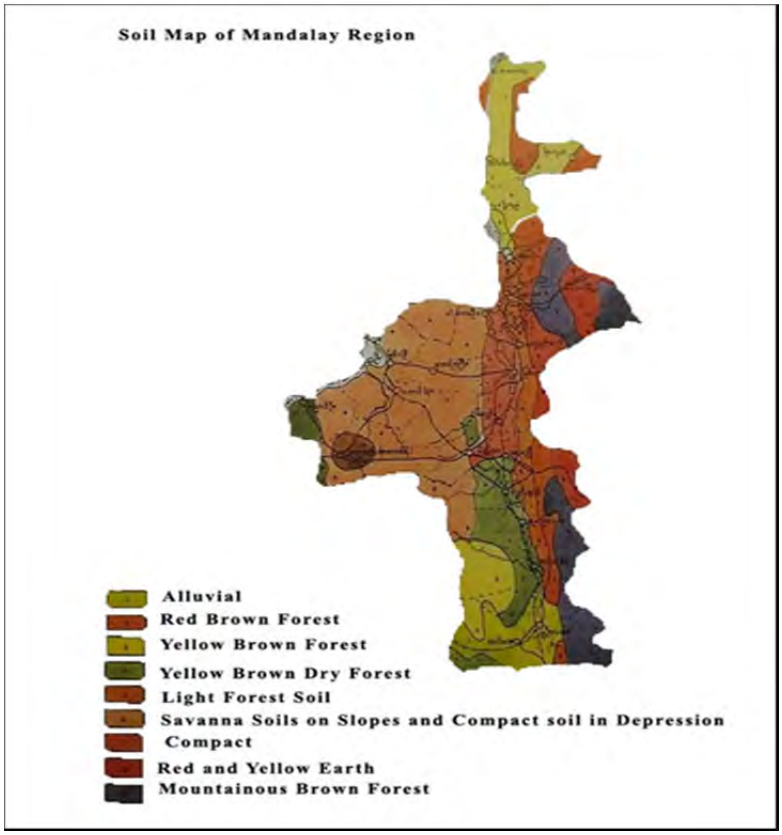


Figure 8.1.5 Soil Map of Bago Region



Source: Ministry of Agriculture, Livestock and Irrigation

Figure 8.1.6 Soil Map of Mandalay Region

(c) Climate

i) Bago Region

The southern part of the Bago Region enjoys a tropical monsoon climate and the northern part belongs to a tropical savannah climate. The average temperature in Bago, Taungoo and Pyay in April, the hottest month of the year, is around 31 to 32 °C. The average temperature in Bago in January, the coolest month, is 23.9 degrees Celsius. The average annual rainfall in the town of Myitkyo is 3,362 mm. The average rainfall in Pyay, which receives less rain than other towns, is 1,155 mm. The annual precipitation level in Taungoo in 2016 is shown below.

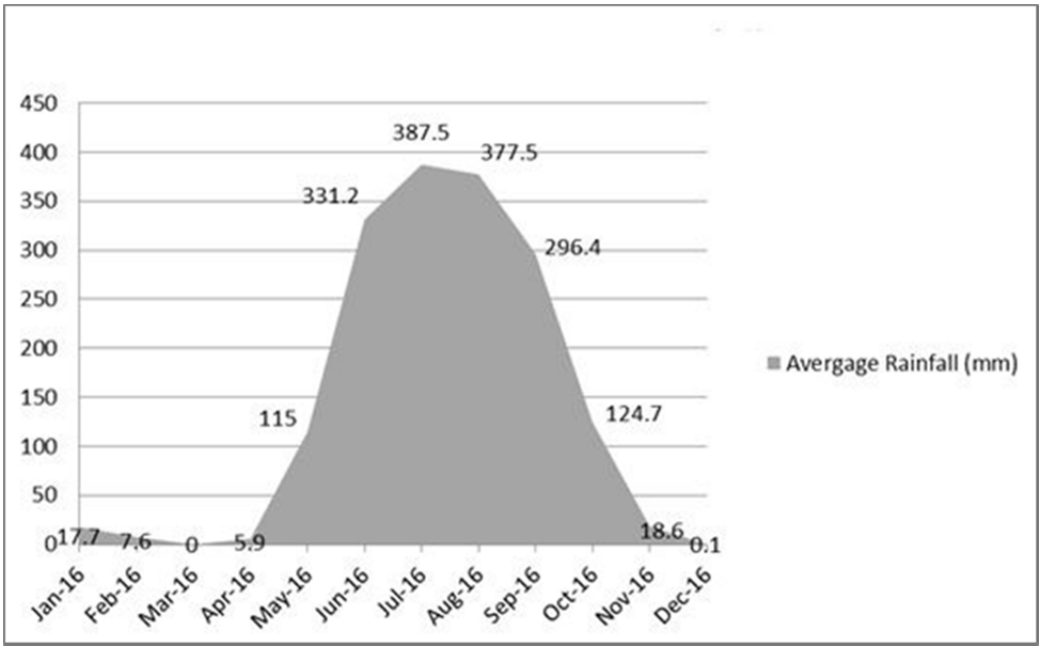


Figure 8.1.7 Precipitation Level in Taungoo

ii) Mandalay Region

There are various kinds of climate in the Mandalay Division. The climate in the eastern plateau is warm and wet. The average temperature in the region is between 21°C and 24°C in April. The average temperature in the coldest months is 15.6°C. The lowest temperature sometimes reaches the freezing point. The annual rainfall is 100 mm in Mogot and about 60 mm in Pyin Oo Lwin.

The southern part has a Savannah climate and the remaining regions are arid-like. Average temperature in the plains is 31°C and the highest day-time temperature is 43.3°C. In winter, the average temperature drops to 21°C and the lowest temperature is around 18°C. The average monthly rainfall is 131 mm in Mandalay. The annual precipitation level in 2016 in Pyinmana and Mandalay is shown in the following figures.

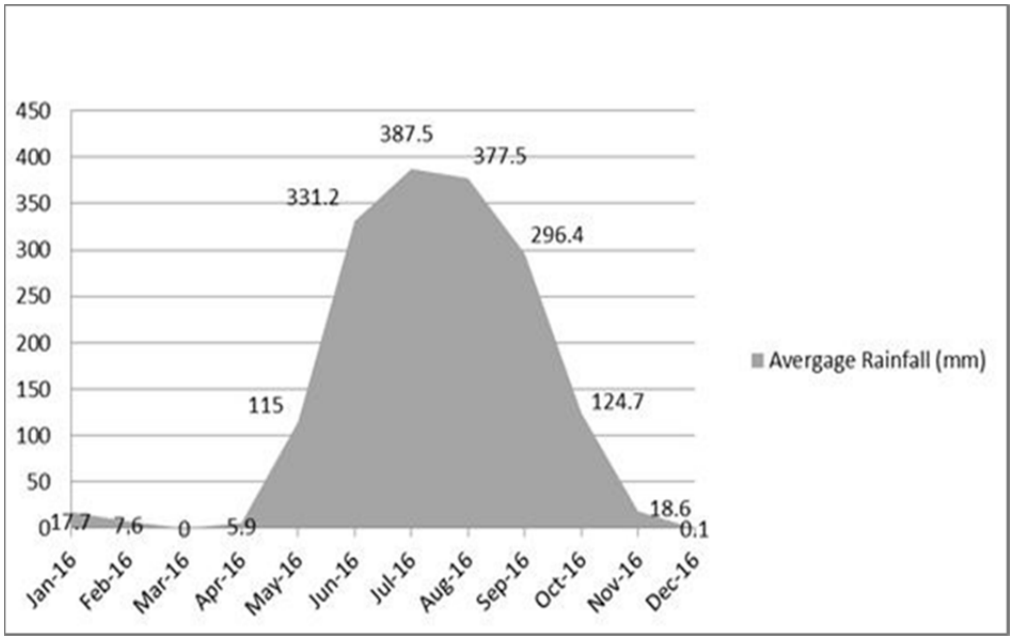


Figure 8.1.8 Precipitation Level in Pyinmana

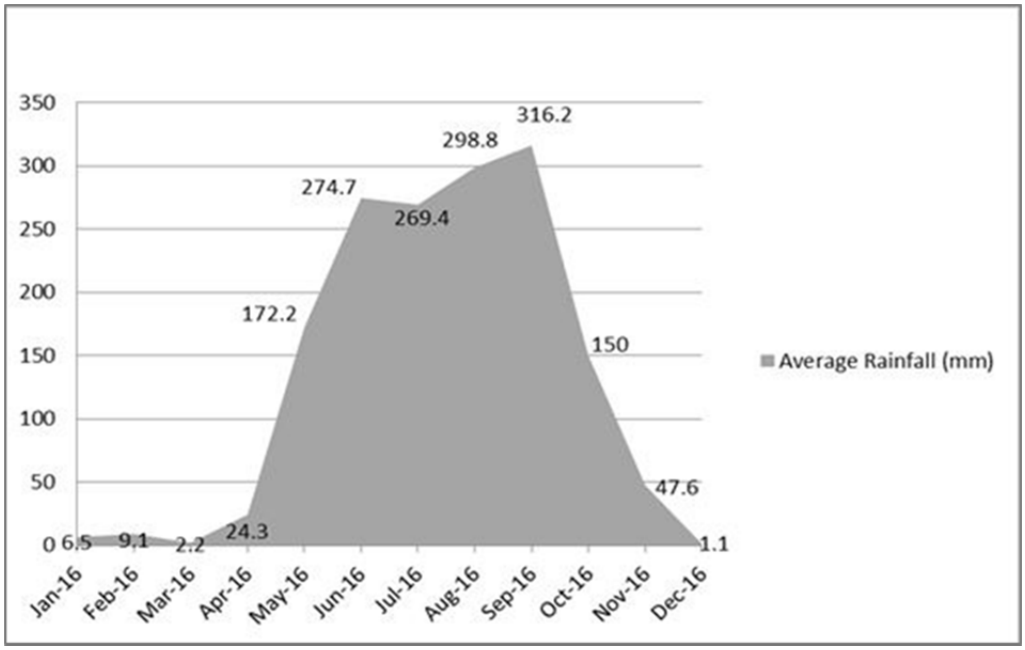


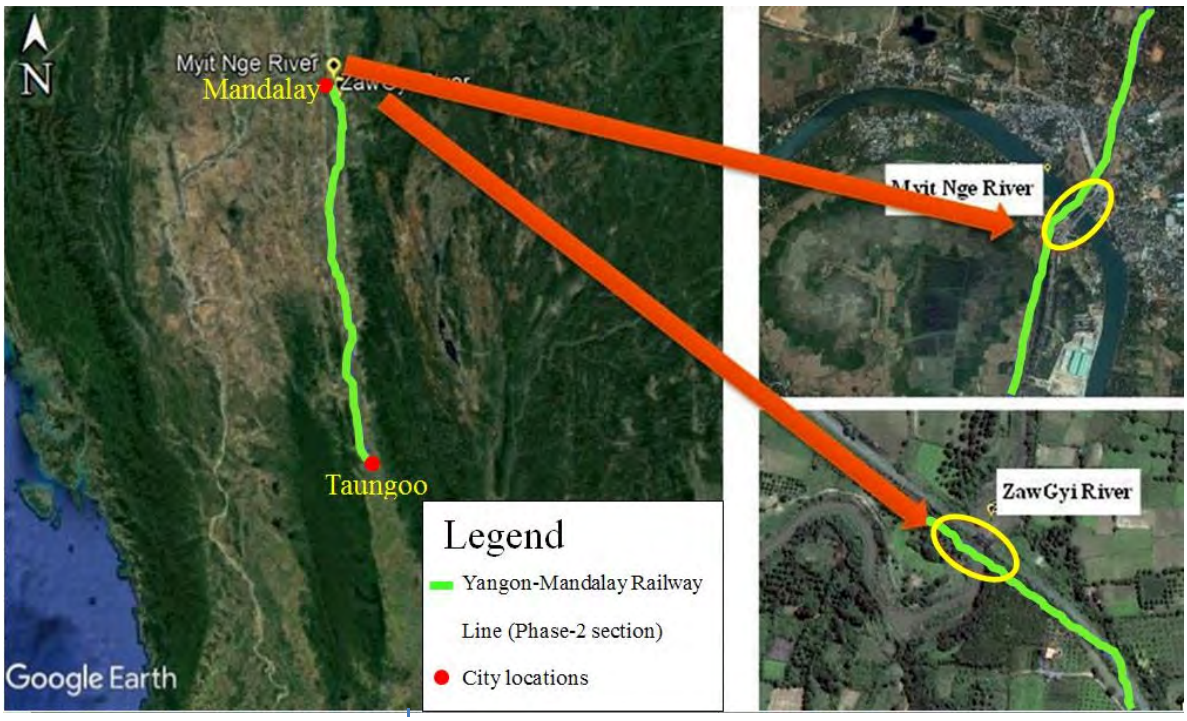
Figure 8.1.9 Precipitation Level in Mandalay

(d) Natural Disasters

Myanmar is a country exposed to a number of natural hazards such as floods, cyclones, storm surges, earthquakes, landslides, fires, and tsunamis. Over the decades, Myanmar has experienced a number of cyclones, floods, earthquakes, and landslides. Most parts of the country, especially the coastal regions, are mostly affected by the hazards. The townships located along the project area were mainly affected by flood and fire but some areas have been affected by storms as per township information of GAD.

(e) Hydrology

Zawgyi River, located 25 miles (40 km) south of Mandalay, is crossed by the Yangon-Mandalay Railway Line. Dokhtawaddy River or Myitnge River flows westwards through northern Shan Plateau of eastern Myanmar and eventually flows into Ayeyarwady at Amarapura located south of the city of Mandalay. The Yangon-Mandalay Railway Line crosses Myitnge River before it enters Ayeyarwady River. The bridge over Myitnge River is 700 feet long and 27 feet wide for motor traffic flanked on each side by a footpath 6 feet wide. Myitnge and Ayeyarwady Rivers run through and support the rice granary in Kyaukse. Panlaung River is also on the Yangon-Mandalay Railway Line and flows towards Meiktila. Figure 8.1.10 shows the location of Myitnge River and Zawgyi River that cross the railway line.



Source: JICA Study Team based on Google Earth

Figure 8.1.10 Location of Myit Nge and Zawgyi Rivers along the Railway Line

(f) Land Use

The main land use along the railway line is agriculture (i.e. farm, horticulture, etc). Some of the crops seasonally grown are rice, wheat, various kinds of beans, cotton, sesame, sugar cane, onion, maize, chilli, and so on. Reserved forests, industrial land, protected area, vacant land and others are also found but they are not part of the project area.

The following table is a collection of data concerning the land use status in the eighteen townships located along the project area. The types of land use has been classified into nine categories, namely, net area of agricultural land, vacant land, grazing land, industrial land, urban area, reserved/protected public forest, wild forest, wild land, and fallow land. It show that agricultural

land use is the most common and has a higher number in almost all townships compared to other categories.

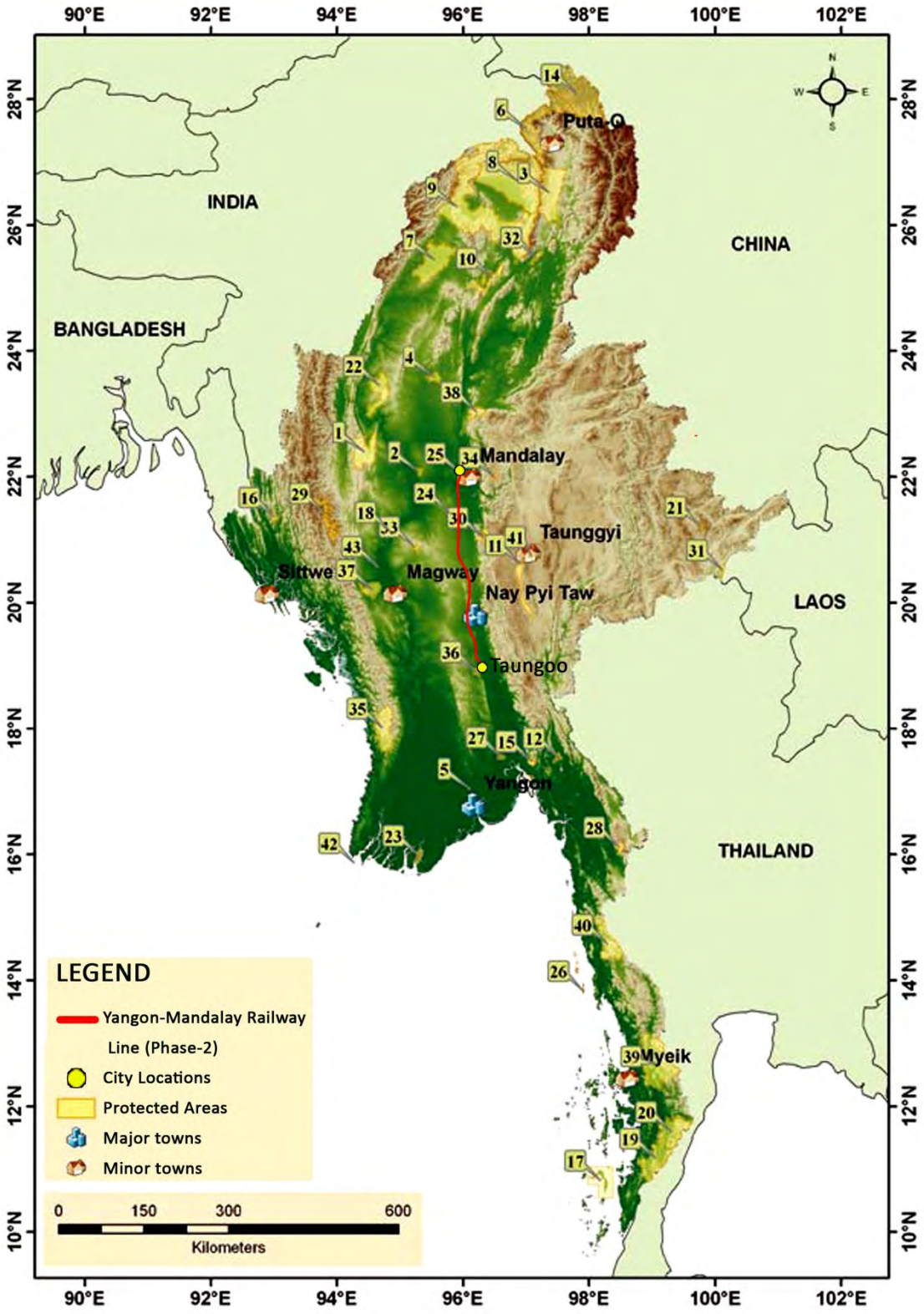
Table 8.1.13 Land Use Status in 18 Townships

No	Township	Size of Agricultural land (acre)	Vacant Land	Grazing Land	Industrial Land	Urban and Others	Reserved/ Protected Public Forest	Wild Forest	Wild Land	Fallow Land	Total
1	Pyigyidagun	201	81	-	-	-	-	-	-	6,132	6,333
2	Chanmya Thazi	-	-	-	-	6,358	-	16			6,374
3	Amarapura	31,887	837	-	-	18,544	-	-	-	-	51,268
4	Sintgaing	69,854	272	1,356	9,645	11,942	7,402	-	-	10,365	110,836
5	Kyaukse	108,969	3,126	-	3,328	99,382	248.095	2,841	-	-	353,646
6	Myittha	126,623	10,163	-	-	17,599	23,162	1,400	970	39,369	219,286
7	Wundwin	174,244	39,632	1,173	51	37,010	41,141	6,763	3,889	43,986	347,889
8	Thazi	161,073	6,857	-	26,797	90,284	192,444	320	2,568	23,959	504,068
9	Pyawbwe	220,027	7,801	-	27,497	17,103	48,645	65,590	10,440	56,102	408,605
10	Yemathin	195,617	4,769	-	73	141,515	72,206	89,409	4,032	28,005	535,626
11	Naypyitaw-Tatkone	110,704	-	-	6,325	140,720	178,125	9,494	-	147,045	445,368
12	Naypyitaw-Pyinmana	29,658	-	-	354	-	25,254	18,2893	145	34,552	272,502
13	Naypyitaw-Lewe	87,105	-	-	628	17,616	380,630	41,300	785	30,174	558,239
14	Poppathiri	25,139	-	265	54	27,900	5,987	239	24	28,219	59,608
15	Swa										
16	Yedashe	101,504	14	14,099	14,288	13,725	475,170	249	4,793	13,263	647,105
17	Oaktwin	84,178	-	7,236	191	17,584	209,136	-	5,550	43,332	342,196
18	Taungoo	68,134	-	7,541	1,802	72,829	220,103	14,234	5,338	34,436	424,417

Source: Township GAD (2017)

(g) Protected Areas

Protected areas in Myanmar are presented by location in Figure 8.1.11 and Table 8.1.14. The project area is located in Mandalay and Bago Regions. Shwe-U-Daung Wildlife Sanctuary, Pyin-O-Lwin Bird Sanctuary, Popa Mountain Park, Lawkananda Wildlife Sanctuary and Minsontaung Wildlife Sanctuary are located in Mandalay Region and Moeyongyi Wetland Bird Sanctuary belongs to Bago Region. The protected areas that are closest to the project area are: Natmataung National Park (No. 25; 15 km from project area); Panlaung-pyadalin Cave Wildlife Sanctuary (No. 34; 42 km from project area); Parsar Protected Area (No. 24; 35 km from project area); Hukaung Valley Wildlife Sanctuary (No. 30; 32 km from project area); and Lenya National Park (No. 36; 24 km from project area). No protected area is located within or near the project area.



Source: JICA Study Team based on Myanmar Protect Areas (2011)

Figure 8.1.11 Protected Areas in Myanmar

Table 8.1.14 Protected Areas in Myanmar

No.	Name	Location (distance from project area)
1	Pidaung Wildlife Sanctuary	Kachin State
2	Shwe-U-Daung Wildlife Sanctuary	Mandalay Region and 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 (approx. 35 km)**
25	**Natmataung National Park**	**Chin State (approx. 15 km)**
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 (approx. 32 km)**
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 (approx. 42 km)**
35	Maharmyaing Wildlife Sanctuary	Sagaing Region
36	**Lenya National Park**	**Taninthary Region (approx. 24 km)**
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: Myanmar Protect Areas (2011)

3) Ambient Environmental Quality

(a) Air Quality

Air quality data in the project area is available in other similar EIA level studies (i.e. Environmental Impact Assessment for the Rehabilitation and Modernization of Yangon-Mandalay Railway project). The study was conducted in October, 2014. Air quality was measured in four sites along the Yangon-Mandalay Railway in the study: Yangon; Phyu; Naypyitaw; and Mandalay out of which, two locations (i.e. Naypyitaw and Mandalay) belong to the subject project area. The level of SO_2 in Naypyitaw and Mandalay were both higher than the National Environmental Quality (NEQ) Guidelines in Myanmar.

Table 8.1.15 Ambient Air Quality in Naypyitaw and Mandalay

Parameters	Naypyitaw	Mandalay	NEQ Guideline Values	Remarks
TSP	132.1 μg/m^3	239.1 μg/m^3	N/A	24 hour average
SO_2	21 μg/m^3	79 μg/m^3	20 μg/m^3	
NO_2	27 μg/m^3	42 μg/m^3	200 μg/m^3	
CO	4.88 μg/m^3	9.46 μg/m^3	N/A	

Source: Environmental Impact Assessment for the Rehabilitation and Modernization of Yangon-Mandalay Railway Project (2014)

(b) Water Quality

In the 'Environmental Impact Assessment for the Feasibility Study for the Rehabilitation and Modernization of Yangon-Mandalay Railway Project', water quality was also measured. Among the measurement sites, the water quality of Nga Leik Stream is located within the subject project area and hence worth being referred to. The values of pH, salinity, and total dissolved solids (TDS), were within the permissible limits of NEQ and WHO guideline values. The value of dissolved oxygen (DO) was close to the minimum value for the survival of fish and aquatic organisms of between 3.0 mg/L and 4.2mh/L.

Table 8.1.16 Water Quality in Nga Leik Stream

No.	Parameter	Nga Leik Stream	
		East	West
1	DO (mg/L)	4.3	4.0
2	pH	8.9	8.5
3	Oxidation Reduction Potential (ORP/mv)	202	187
4	Conductivity (μs)	329.0	350
5	Resistivity (kΩ)	3.04	2.86
6	TDS (mg/L)	220.0	235.0
7	Salinity (ppt)	0.16	0.17
8	Turbidity	15	15
9	COD	12.1	11.4
10	TSS (g/L)	0.1401	0.1415

Source: Environmental Impact Assessment for the Rehabilitation and Modernization of Yangon-Mandalay Railway Project (2014)

(c) Noise Level

Secondary data for noise was gathered from noise level measurements carried out in the 'Environmental Impact Assessment for the Rehabilitation and Modernization of Yangon-Mandalay Railway Project'. Here, noise level was measured at two sites: Naypyitaw and Mandalay. One measurement point (i.e. Point 1) was selected to be near the railway line and another point (i.e. Point 2) was selected to be in a residential area. The following table summarizes the hourly noise level at each location.

Table 8.1.17 Noise Level in Naypyitaw and Mandalay

Location	Maximum	Minimum	Average	NEQ Guideline Values
Naypyitaw				• 55 dBA (daytime[1]; residential area) • 45 dBA (night time[2]; residential area) • 70 dBA (commercial area)
Point 1	63.3 dBA	54.8 dBA	59.7 dBA	
Point 2	72.5 dBA	48.7 dBA	55.8 dBA	
Mandalay				
Point 1	65.5 dBA	48.7 dBA	58.4 dBA	
Point 2	63.7 dBA	45.2 dBA	57 dBA	

[1] 7:00-22:00; [2] 22:00-7:00

Source: Environmental Impact Assessment for the Rehabilitation and Modernization of Yangon-Mandalay Railway Project (2014)

The NEQ Guidelines stipulates that the noise level should be kept below 45 dBA (night time) and 55 dBA (daytime) in residential areas and below 70 dBA in commercial areas (*one hour LAeq). The noise level measured in Nay Pyi Taw and Mandalay can be considered insignificant for commercial areas but relatively noisy for a residential area.

(3) Comparison of Project Alternatives

In designing a development project, it is important to aim at striking a balance among the economic, environmental and social cost and benefit such projects bring in consideration of the socio-economic context in which a country or certain geographical area resides. Under the study, the following three options were compared against each other in mind of this view. As a conclusion, the proposed rehabilitation project has been considered the best-balanced and most suitable in view of the current state in which Myanmar lies.

1. *No Project*
2. *Construction of a New Railway Line*
3. *Rehabilitation of the Current Railway Line (proposed project)*

The above three options including the proposed rehabilitation project were given a rating that ranges from 5 (i.e. most preferable) to 1 (i.e. least preferable) based on an evaluation made from an economic, ecological and social point of view. A summary of an analysis on each option will be followed by a table showing the outcome of the evaluation below.

Option 1. No Project

In the absence of a project, passengers would need to endure the existing railway system which is slow and time-consuming, unsafe, and unreliable. No additional negative impact will be generated as a result of this option. However, the current railway system is already in a critical state that requires major upgrading work. If the railway continues as the status quo, Myanmar will not only fail to accommodate the growing needs for transportation, which would be detrimental to the regional and national economy and social well being of the society but passengers' lives could also be put at serious risk.

Option 2. Construction of a New Railway Line

The option of newly constructing a railway line is considered highly costly entailing also significant adverse impact on both the natural and social environment. The project cost can be estimated to be several times greater than in the case of the proposed rehabilitation project. This is viewed as an extremely large burden on the government of Myanmar which would ultimately come down on top of its people in the form of taxes or other ways of payment. A large area of land would also need to be secured in order to pass a new railway route inevitably resulting in land acquisition, involuntary resettlement and clearance of vegetation and other assets of the people at a significantly large scale.

The current railway system has been in place for over 120 years. During this time, people have established a living near the stations or otherwise with the presence of the railway system. Constructing a new railway line in a different location would inflict a major change, most likely undesirable, to the lifestyle of such people.

Option 3. Rehabilitation of the Current Railway Line

The option of upgrading the existing railway line is considered to be well-balanced. It would generate some level of financial and environmental burden but the extent of the burden is considered to be reasonable and manageable for both the government and the people in Myanmar. The benefit accrued from this rehabilitation project, on the other hand, is considered to be profound, largely outweighing the costs mentioned above.

Table 8.1.18 Comparison of Project Alternatives

	No Project	New Construction	Rehabilitation
Economy	2 There will be no construction cost as the railway line will remain unchanged. However, the cost for maintaining the largely old railway structures and facility will continue to burden the government and people, the magnitude of which would only increase over time. Little contribution is expected from the existing railway line to the local, regional and national economy.	1 A significantly large construction cost, several times larger than the case of rehabilitation, would be necessary in order to develop a new railway line. In addition, a large amount of cost for compensation and other financial support would be necessary for the PAPs. While maintenance cost may be kept relatively low, the construction cost is likely to far outweigh the cost-saving accrued from the low maintenance cost. A significant contribution to the local, regional and national economy is expected from constructing a new railway line.	5 Relatively moderate level of cost, which is considered tolerable for the country and people of Myanmar, would be necessary for construction and maintenance of the railway line. A significant contribution to the local, regional and national economy is expected as a result of railway upgrading.
Ecology	4 In the absence of construction, no additional pollution or contamination is expected. It will not entail any clearance of natural vegetation either. Modal shift from more energy-consuming transportation modes (e.g. vehicles) is not expected to take place leading to a relatively large level of greenhouse gas emissions.	2 A significantly large number of trees and other plants would need to be cleared. This is considered a large negative impact on the flora but it can also have a large adverse effect on the wildlife and ecosystem. Large amount of waste will be generated as much of the existing structures and facilities would need to be replaced. Modal shift from more energy-consuming transportation modes (e.g. vehicles) is expected to take place contributing to a reduction in greenhouse gas emissions.	3 Limited extent of pollution and contamination as well as increase in waste will take place during construction. Some natural vegetation would also need to be cleared. Project-affected area is generally confined to the ROW of MR which has a limited number of trees. Usable railway structures and facilities will not be replaced so the amount of waste would be less than the case of new construction. Modal shift from more energy-consuming transportation modes (e.g. vehicles) is expected to take place contributing to a reduction in greenhouse gas emissions.

	No Project	New Construction	Rehabilitation
Social Welfare	1 No land acquisition or involuntary resettlement will take place as there will be no change to the land use status. Trains will not be in operation in a timely, quick, safe and comfortable manner and people's satisfaction level will remain low with high opportunity cost. The current old railway system will pose serious safety risks to railway passengers and other users as well as those people that live in or use the area nearby.	1 A significantly large number of people would need to be physically replaced and/or lose their land, structure, crops, tress or other assets as a new route will inevitably entail such impacts. This relocation and compensation process requires considerable time during which, people will not be able to benefit from the expected benefits the project is expected to bring. It will also bring a major change to the lifestyle of those that have been living in an environment with close connection to the current railway line and system. It will provide a faster, safer and more convenient and comfortable transportation option to the people in Myanmar.	4 Limited number of people, those that have been using or in occupation of the ROW, could be subject to involuntary resettlement or lose their assets. Land acquisition is expected to be kept at a minimum level, if any, as the project-affected area is generally confined to the ROW of MR. It will bring no negative change to the lifestyle of the people living in close connection with the railway line and system. It will provide a faster, safer and more convenient and comfortable transportation option to the people in Myanmar.
Total Scoring	**7**	**4**	**12**

Source: JICA Study Team

(4) Scoping and Terms of Reference of the Environmental Survey

1) Scope and Methods of Impact Evaluation

The subject project is deemed 'Category B' in accordance with JICA Environmental Guidelines. However, it is required a full EIA under the EIA Procedure (2015) in Myanmar. This chapter explains the methodology and results of environmental and social impact assessment carried out at the scoping stage and presents the terms of reference (TOR) of the environmental survey that had been formulated based on the results of this scoping. The impact assessment methodology adopted takes into account international good practices, namely, the way in which it is commonly assessed by JICA.

Impact evaluation is conducted to predict what could happen to the social and natural environment as a result of the proposed project keeping in mind any sensitive receptors. An assessment process includes a range of prediction methods. The results of the assessment have formed the basis of selecting the TOR of the survey carried out under the EIA study. It has also helped formulating environmental mitigation measures to be adopted in the project with an aim to properly contain negative impacts.

A number of possible impacts have been evaluated against the project, which was divided into five stages of the project; pre-construction; construction; operation; decommissioning; closure; and post-closure in accordance with the EIA Procedure (2015). Impacts were classified to be either positive or negative, with a degree that ranges from A+/- (significant positive/negative impact is expected), B+/- (positive/negative impact is expected to some extent), C (extent of the impact is unknown) and D (no impact is expected). The following sections explain briefly the five stages of the project and environmental impacts that commonly arise at those phases.

2) Pre-construction Stage

One of the most common and important impacts that takes place before construction is the impact associated with securing the land necessary for construction. From this perspective, it is important to consider whether the project entails any involuntary resettlement of the residents or affects any house, building, structure, crop, valuable tree, tomb or any other asset of social or economic value to the PAPs. In addition to the direct impact of resettlement of losing such assets, it is also important to take into account whether any damage would be generated more indirectly by, for example, changing the lifestyle of the people as a result of such resettlement or involuntary taking of the assets.

The proposed project aims at rehabilitating an already existing railway line and the project-affected area is generally confined to the right of way (ROW) of MR where people are technically not allowed to be in occupation or use. No additional land will be acquired for the project. For these reasons, involuntary resettlement is kept to minimum level and the impacts on crops and other assets are considered to be insignificant.

3) Construction Stage

In the construction stage, construction work will often result in the deterioration of air quality and increase in noise and vibration levels as a result of, among others, mobilization of vehicles and machinery and loading and unloading and transporting of materials. These impacts do not necessarily occur only at construction sites, but can take place also near the transport route. Water may also be contaminated as a result of civil work, and under this project, as a result of railway bridge rehabilitation work. Nevertheless, the impacts are temporary, confined to only during construction, and also site specific, namely around the bridge. For these reasons, the impact is considered to be manageable with no significant environmental impact on the surrounding water bodies.

4) Operation Stage

In the operation stage, air pollutants such as NO_2, SO_2, and CO would be generated from diesel engines as the number of trains in operation will increase. On the other hand, a shift of transportation mode from vehicles to trains is expected which would work to reduce traffic congestion, air pollution and CO_2 emissions. Solid waste is also expected to be generated from

railway and related facilities' operation and if the number of passengers grow, general waste disposal from the passengers will also likely increase.

An increase in the frequency of train operation and speed will heighten the noise and vibration level. On the other hand, improvement of railway track and roadbed will absorb the noise and vibration generated leading to contain such impacts. Rolling stocks need to be washed and human waste be removed from the trains at the depot sites. In the absence of due consideration, this could contaminate the water in the surrounding water bodies.

5) Decommissioning Stage

The decommissioning stage typically consists of activities such as small-scale earth works, use of construction machinery and vehicles, and transportation of materials. Temporary air pollutants from exhaust gas and dust pollution can be anticipated by these activities. Normally, such impacts are not so significant in magnitude and are expected to be limited in scale and period since nuisances of dust and emission gases are site-specific temporary events. In case the project is located near a water body such as a river, lake, pond and sea, water may also be contaminated by the construction works. However, the project area is not located near the sea and no major work is expected near a lake or a pond either. Hence, the water quality will potentially deteriorate only in the river, if any.

6) Closure and Post-closure Stage

No special facility or equipment, chemical product and so on is to be introduced as a result of the project and no special care is considered necessary at the end of the project lifetime or beyond. Hence, very little, if not no, impact is expected at the closure or post-closure stages.

7) Evaluation of Possible Impacts

Environmental and social impacts on the project have been assessed based on a review of the components of the project and results of the baseline survey. A summary of the expected environmental and social impact assessments on the project during pre-construction stage (P), construction stage (Co), operation stage (O), decommissioning stage (De) and closure and post-closure stage (Cl/PCl) are shown in Table 8.1.19. The impacts have been classified under pollution, natural environment and social environment from A to D in accordance with the following criteria assuming that no specific measures against the impacts have been taken:

- A+/-: Significant positive/negative impact is expected
- B+/-: Positive/Negative impact is expected to some extent
- C+/-: Extent of positive/negative impact is unknown
- D: No impact is expected

Table 8.1.19 Results of Scoping

No.	Item	Rating					Expected Impact
		P	Co	O	De	CI/ PCI	
Pollution							
1	Air Pollution	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Earthwork, loading and unloading materials as well as construction machines and vehicles will generate dust and emission gases that will deteriorate the ambient air quality. [O] Operation of more locomotives will lead to air pollution as the number of train in operation will increase. However, modal shift from vehicles to trains will help to reduce the emission of air pollutants such as PM and NOx. [De] Decommissioning work is expected to lead to temporary air pollution. [CI/PCI] No notable impact is expected.
2	Water Pollution	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Water may be temporarily polluted: (i) as a result of runoff due to construction work such as cutting, filling and excavation of earth moving work; (ii) due to waste water from worker's camps and construction office; and (iii) by spilling of materials such as oil and lubricants. [O] Water may be polluted if the waste water from the depot in terms of the water for cleaning the trains, oil and grease used in the depot and human waste are not properly treated. [De] Water may be polluted from the activities explained in [Co] above yet at a smaller scale. [CI/PCI] No notable impact is expected.
3	Soil Contamination	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Soil may be contaminated from leakage of lubricating oil from construction vehicles and machines. However, the amount of oil used is limited and the impact is considered to be insignificant. [O] Soil contamination may take place at the depot because of spilling and infiltration of oil and grease and from leakage of lubricating oil from train engines. However, introducing new rolling stock is expected to reduce such leakage and the amount of oil generated itself is limited too. Hence, the impact is considered to be insignificant. [De] Soil may be contaminated from leakage of lubricating oil from construction vehicles and machines. However, the amount of oil used is limited and the impact is considered to be insignificant. [CI/PCI] No notable impact is expected.
4	Waste Disposal	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Generation of soil, sand and construction waste is expected nevertheless at a small scale. Waste of existing devices such as sleepers, level crossings, and signal and telecommunication systems will be generated as a result of their renewal. [O] Generation of solid waste from railway line and related facilities is expected. [De] Waste will be generated from existing devices after decommissioning of railway line and related facilities. [CI/PCI] No notable impact is expected.

No.	Item	Rating					Expected Impact
		P	Co	O	De	CI/ PCI	
5	Noise and Vibration	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Noise and vibration level will increase due to construction works including operation of vehicles and diesel generators but they are site-specific, temporary events. [O] Train operation will generate noise and vibration in the vicinity along the Yangon–Mandalay Railway Line. [De] Machines and vehicles used for decommissioning works are expected to generate noise and vibration but they are site specific, temporary events. [CI/PCI] No notable impact is expected.
6	Ground Subsidence	D	D	D	D	D	Large-scale underground water use or other activities that pose a risk of ground subsidence is not expected to be carried out under this project.
7	Offensive Odours	D	B-	D	D	D	[P] No notable impact is expected. [Co] Offensive odour may be generated around the construction site due to excavation and dredging of mud in the drainage channels or due to creeking some sections or from the camp site during construction. [O] [De] [CI/PCI] No notable impact is expected.
8	Sediment Quality	D	D	D	D	D	No activity that poses a risk of degrading the sediment quality is expected under the project.
Natural Environment							
10	Protected Areas	D	D	D	D	D	No protected area is observed in the proposed project area along the Yangon-Mandalay Railway Line. Therefore, no impact is expected.
11	Ecosystem	D	B-	D	D	D	[P] No notable impact is expected. [Co] During construction, cutting, filling and removal of trees may have a negative effect on the existing ecosystem including ponds at planned depot site but at a minor scale as it is a rehabilitation project and the affected area is generally confined to the ROW of MR. [O] [De] [CI/PCI] No notable impact is expected.
12	Hydrology	D	D	D	D	D	Some bridges will be replaced but the impact is considered to be minor as it is a replacement of already existing bridges.
13	Topography and Geology	D	B-	D	D	D	[P] No notable impact is expected. [Co] No large-scale land alteration is expected due to construction work. However, cutting and filling work is expected to change the topography and possibly geology to some extent. [O] [De] [CI/PCI] No notable impact is expected.
14	Cross Boundary Impacts and Climate Change	D	B-	B+ /-	B-	D	[P] No notable impact is expected. [Co] Operation of construction-related vehicles will lead to an increase in GHG emissions. [O] While an increase in the number of rolling stocks will increase the GHG emissions, modal shift from vehicles to trains will serve to reduce GHG emissions as a whole. [De] Operation of construction-related vehicles will lead to an increase in GHG emissions. [CI/PCI] No notable impact is expected.

No.	Item	Rating					Expected Impact
		P	Co	O	De	CI/ PCI	
Social Environment							
15	Involuntary Resettlement	B-	D	D	D	D	[P] While the project is a rehabilitation of an existing railway line, a limited number of people will be subject to resettlement provided that they live in either: a section where changes in the alignment is considered necessary in order to ensure safety of high speed railway operation; or an area within the planned depot construction area where a relatively large area would need to be utilized for the project. The number of such people is expected to be insignificant (i.e. less than 200). [Co] [O] [De] [CI/PCI] No notable impact is expected.
16	Poverty	D	B+	D	B+	D	[P] No notable impact is expected. [Co] The project is expected to create job opportunities during construction. [O] No notable impact is expected. [De] The project is expected to create job opportunities during decommissioning. [CI/PCI] No notable impact is expected.
17	Local Economy such as Employment and Livelihood	D	B+	D	B+	D	[P] No notable impact is expected. [Co] The project is expected to create job opportunities during construction. [O] No notable impact is expected. [De] The project is expected to create job opportunities during decommissioning. [CI/PCI] No notable impact is expected.
18	Indigenous People and Ethnic Minority	C	C	C	C	C	No ethnic minorities have been identified to date within or near the project-affected area or nearby. However, this will be confirmed during the study.
19	Land use and Utilization of Local Resources	D	B+	B+	D	D	[P] No notable impact is expected. [Co] [O] The project is expected to contribute largely to the socio-economic development along the railway and stations. [De] [CI/PCI] No notable impact is expected.
20	Water Usage	D	C	C	C	D	[P] No notable impact is expected. [Co] Groundwater or surface water may be used for construction depending on the availability of water. This will be confirmed in the study. [O] Groundwater will likely be used for washing and other maintenance work at the depot and workshop development site. The amount of water to be used and its impact on water usage will be made apparent in the study. [De] Groundwater or surface water may be used for construction depending on the availability of water. This will be confirmed in the study. [CI/PCI] No notable impact is expected.

No.	Item	Rating					Expected Impact
		P	Co	O	De	Cl/ PCl	
21	Existing Social Infrastructure and Services	D	B-	B+	D	D	[P] No notable impact is expected. [Co] Passengers using level crossings, drainage, platforms, bridges and other railway facilities will be temporarily affected as a result of their renewal. [O] Passengers will benefit from a safer, faster and more reliable train transportation system. [De] [Cl/PCl] No notable impact is expected.
22	Social Institutions such as Local Decision Making Mechanisms	D	D	D	D	D	No notable impact is expected.
23	Misdistribution of Benefit and Damage	D	D	D	D	D	No notable impact is expected.
24	Local Conflict of Interests	D	D	D	D	D	No notable impact is expected.
25	Cultural Heritage	C	C	C	C	C	No cultural heritage has been identified to date near the railway line. However, this will be confirmed in the study.
26	Landscape	D	D	D	D	D	No major earth work is expected and its impact on the landscape is considered to be negligible.
27	Gender	C	C	C	D	D	[P] [Co] [O] No notable impact is expected. However, this will be confirmed in the study. [De] [Cl/PCl] No notable impact is expected.
28	Rights of Children	C	C	C	C	D	[P] [Co] [O] [De] No notable impact is expected. However, this will be confirmed in the study. [Cl/PCl] No notable impact is expected.
29	Infectious Diseases such as HIV/AIDS	D	B-	D	B-	D	[P] No notable impact is expected. [Co] [De] Due to inflow of construction workers, infectious diseases such as STD (Sexually Transmitted Disease) may spread. [O] No notable impact is expected. [Cl/PCl] No notable impact is expected.
30	Labour Environment	D	D	D	D	D	No notable impact is expected.
31	Accidents	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Construction is small in scale. Thus, accidents by the work are expected to be minor. However, because the work space is close to the railway track, accidents may take place with the trains. [O] Train will run at a higher speed which could hit people crossing or staying on the railway line. [De] There might be some minor accidents inevitable during decommissioning works. [Cl/PCl] No notable impact is expected.

A+/-: Significant positive/negative impact is expected; B+/-: Positive/Negative impact is expected to some extent
C: Extent of positive/negative impact is unknown; D: No impact is expected

Source: JICA Study Team

8) Terms of Reference of the Environmental Survey

Baseline air quality, water quality and noise and vibration level will all be examined through a field survey and laboratory analyses. On the other hand, the ARAP study including the census, lost-asset inventory and social-economic surveys have been carried out to provide the socio-economic baseline data of the PAPs. The terms of reference of environmental survey is shown in the table below.

Table 8.1.20 Terms of Reference of the Environmental Survey

No.	Item	Survey Item	Survey Method	Survey Point/Target Area
Pollution				
1	Air Pollution	Air quality (NO_2, SO_2, PM_{10}, $PM_{2.5}$, Ozone, and micro climate (i.e. temperature, humidity, wind speed and wind direction))	Air quality measurement using field equipment (site measurement: 24 hours per location)	Three locations along YGN-MDY Railway Line (e.g. Taungoo, Myohaung and Pyinmana)
2	Water Pollution	Water quality (BOD, COD, oil & grease, pH, total coliform, total nitrogen, total phosphorus and TSS)	Sampling and analyses using field equipment and by laboratory analyses	Four locations along YGN - MDY Railway Line (e.g. near major bridges subject to replacement and near planned depot sites)
3	Soil Contamination	Soil quality (i.e. level of pollution)	Visual observation and document analysis	Along YGN-MDY Railway Line
4	Waste Disposal	Measures to manage the solid waste	Interview and/or document analysis	Along YGN-MDY Railway Line
5	Noise and Vibration	LAeq (dBA) and LV 10	Measurement using field equipment	Three locations along YGN-MDY Railway Line (e.g. Taungoo, Myohaung and Pyinmana)
6	Offensive Odour	Possibility and source of offensive odour	Interview and/or document analysis	Along YGN-MDY Railway Line
Natural Environment				
7	Ecosystem	Fauna and Flora	Direct observation, interview, individual/target group consultation as well as secondary data collection/analyses	One location (e.g. planned depot site)
8	Topography and Geology	Project design	Document analysis	Along YGN-MDY Railway Line
9	Cross Boundary Impacts and Climate Change	Possibility and emission source	Document analysis	N/A
Social Environment				
10	Involuntary Resettlement	Scale of involuntary resettlement and socio-economic condition of the PAPs	Document analysis based on the outputs of social/ARAP study	Points of realignment, near bridges to be relocated and planned depot site
11	Water Usage	Volume of water in existence and to be used	Interview and/or document analysis	Along Yangon - Mandalay Railway Line (e.g. planned depot site)

No.	Item	Survey Item	Survey Method	Survey Point/Target Area
12	Existing Social Infrastructure and Services	Condition of existing social infrastructure and services around the project area	Document analysis	Along YGN-MDY Railway Line
13	Local Conflict of Interests	Possible source of local conflicts of interest	Document analysis and interview with relevant government bodies (e.g. GAD)	Along YGN-MDY Railway Line
14	Cultural Heritage	Cultural heritage around the project area	Document analysis	Along YGN-MDY Railway Line
15	Gender	Family structure and lifestyle of the people living around the project area	Document analysis based on the outputs of social/ARAP study	Along YGN-MDY Railway Line
16	Rights of Children	Source of labor	Document analysis	Along YGN-MDY Railway Line
17	Infectious Diseases such as HIV/AIDS	General risk of infectious diseases and community health	Document analysis	Along YGN-MDY Railway Line
18	Accidents	Analysis of accident risk and safety management	Document analysis	-

Note: Survey items for air quality water quality and noise are described in accordance with the NEQ Guidelines (2015)
Source: JICA Study Team

(5) Results of the Environmental Survey

1) Socio-economic Characteristics of the Project-affected Persons

A census survey was carried out by the JICA Study Team from May to July, 2017. As part of the survey, the team interviewed all 24 project-affected households. The socio-economic situation of the PAPs is presented in the following tables. No project-affected household was found to spend more than they earn.

Table 8.1.21 Age and Gender of the PAPs (Bridge Renovation Area)

HH Code	HH Head	Age of HH Head	Total Number	Household Members' Age				Gender	
				<=5	6-17	18-60	>60	Male	Female
379 - 01	U Kyaw Thaung	61	9	3	0	5	1	7	2
393 - 01	U Zaw Lay	55	4	0	0	4	0	2	2
393 - 02	U Mya Thein	66	8	1	1	4	2	3	5
417 - 01	U Soe Myint	58	6	0	1	5	0	2	4
683 - 01	U Kyaw Naing	35	5	0	3	2	0	3	2
683 - 02	U Than Soe	30	4	0	2	2	0	2	2
748 - 01	U Min Naing	50	5	0	1	4	-	1	4
Total			41	4	8	26	3	20	21

Source: JICA Study Team

Table 8.1.22 Age and Gender of the PAPs (Myohaung Depot Site)

HH Code	HH Head	Age of HH Head	Total Number	Household Members' Age				Gender	
				<=5	6-17	18-60	>60	Male	Female
Dep.MH 01	U Tun Win Aung	50	5	0	3	2	0	2	3
Dep.MH 02	U Myo Zaw	28	3	0	2	1	0	2	1
Dep.MH 03	U Win Hlaing	43	4	0	3	1	0	2	2
Dep.MH 04	U Zarni Win Htet Aung	26	2	0	1	1	0	1	1
Dep.MH 05	Daw Win Shwe	58	4	1	1	2	0	2	2
Dep.MH 06	U Thein Kyaw	57	5	0	4	1	0	3	2
Dep.MH 07	Daw Myo Myo	33	4	1	2	1	0	3	1
Dep.MH 08	U Zin Ko Latt	39	4	0	3	1	0	1	3
Dep.MH 09	U Soe Moe Naing	30	6	0	3	2	1	3	3
Dep.MH 10	Daw Nu	56	7	0	2	5	0	3	4
Dep.MH 11	U Kalar	29	5	1	2	2	0	4	1
Dep.MH 12	Daw Maw Lwin	30	4	0	3	1	0	1	3
Total			53	3	29	20	1	27	26

Source: JICA Study Team

Table 8.1.23 Age and Gender of the PAPs (Alignment and Track Improvement Area)

HH Code	HH Head	Age of HH Head	Total Number	Household Members' Age				Gender	
				<=5	6-17	18-60	>60	Male	Female
U-IP.182 - 01	Lila Govida Prabhu	55	1	-	-	-	-	1	0
D-IP.182 - 01	U Khin Maung Aye	55	3	1	0	2	0	2	1
D-IP.182 - 02	U Kyaw Htay	58	2	0	1	1	0	2	0
D-IP.173 - 01	U Phoe Shan	58	2	0	0	2	0	1	1
U-IP.1 - 01	U Wila Thagha	57	1	-	-	-	-	1	0
Total			9	1	1	5	0	7	2

Source: JICA Study Team

Table 8.1.24 Occupation, Income and Expenditures of the PAPs (Bridge Renovation Areas)

HH Code	Occupation	Occupation	Annual Income (MMK)	Annual Expenditures (MMK)
379 - 01	U Kyaw Thaung	Skilled Labour	2,160,000	1,800,000
393 - 01	U Zaw Lay	Shop Owner	2,400,000	1,440,000
393 - 02	U Mya Thein	Other	1,920,000	1,800,000
417 - 01	U Soe Myint	Other	1,872,000	1,800,000
683 - 01	U Kyaw Naing	Farmer	2,400,000	2,160,000
683 - 02	U Than Soe	Farmer	2,400,000	2,160,000
748 - 01	U Min Naing	Casual Labour	2,400,000	1,800,000
Average			2,221,715	1,851,429

Source: JICA Study Team

Table 8.1.25 Occupation, Income and Expenditure of the PAPs (Myohaung Depot Site)

HH Code	Name of HH	Occupation	Annual Income (MMK)	Annual Expenditures (MMK)
Dep.MH 01	U Tun Win Aung	Company Staff	3,600,000	2,880,000
Dep.MH 02	U Myo Zaw	Casual Labour	1,632,000	1,200,000
Dep.MH 03	U Win Hlaing	Stall Owner	1,560,000	1,200,000
Dep.MH 04	U Zarni Win Htet Aung	Stall Owner	1,800,000	1,080,000
Dep.MH 05	Daw Win Shwe	Vendor	2,400,000	1,800,000
Dep.MH 06	U Thein Kyaw	Skilled Labour	3,600,000	2,700,000
Dep.MH 07	Daw Myo Myo	Casual Labour	1,080,000	960,000
Dep.MH 08	U Zin Ko Latt	Livestock	2,400,000	2,160,000
Dep.MH 09	U Soe Moe Naing	Stall Owner	4,200,000	3,360,000
Dep.MH 10	Daw Nu	Other	3,600,000	2,880,000
Dep.MH 11	U Kalar	Casual Labour	2,160,000	1,800,000
Dep.MH 12	Daw Maw Lwin	Casual Labour	2,160,000	1,800,000
Average			2,516,,000	1,985,000

Source: JICA Study Team

Table 8.1.26 Occupation, Income and Expenditure of the PAPs (Track Improvement Areas)

HH Code	Name of HH	Occupation	Annual Income (MMK)	Annual Expenditure (MMK)
U-IP.182 - 01	Lila Govida Prabhu	-	-	-
D-IP.182 - 01	U Khin Maung Aye	Stall Owner	1,800,000	1,440,000
D-IP.182 - 02	U Kyaw Htay	Stall Owner	3,600,000	1,440,000
D-IP.173 - 01	U Phoe Shan	MR Staff	1,680,000	1,440,000
U-IP.1 - 01	U Wila Thagha	-	-	-
Average			2,360,000	1,440,000

Source: JICA Study Team

Ethnicity, religion and educational level of the PAPs are shown in following table. All except for one household was Myanmar following Buddhism.

Table 8.1.27 Ethnicity, Religion and Educational Level of the PAPs

Section	No	HH Code	HH Head	Ethnicity	Religion	Education Level
Bridge Renovation	1	Bdg.379 - 01	U Kyaw Thaung	Myanmar	Buddhism	Primary School
	2	Bdg.393 - 01	U Zaw Lay	Myanmar	Buddhism	High School
	3	Bdg.393 - 02	U Mya Thein	Myanmar	Buddhism	Primary School
	4	Bdg.417 - 01	U Soe Myint	Myanmar	Buddhism	Middle School
	5	Bdg.683 - 01	U Kyaw Naing	Myanmar	Buddhism	Middle School
	6	Bdg.683 - 02	U Than Soe	Myanmar	Buddhism	Middle School
	7	Bdg.748 - 01	U Min Naing	Myanmar	Buddhism	Monastery Education
Depot Improvement Area	1	Dep.MH 01	U Tun Win Aung	Myanmar	Buddhism	High School
	2	Dep.MH 02	U Myo Zaw	Myanmar	Buddhism	High School
	3	Dep.MH 03	U Win Hlaing	Myanmar	Buddhism	Middle School
	4	Dep.MH 04	U Zarni Win Htet Aung	Myanmar	Buddhism	Middle School
	5	Dep.MH 05	Daw Win Shwe	Myanmar	Buddhism	Middle School
	6	Dep.MH 06	U Thein Kyaw	Myanmar	Buddhism	Middle School
	7	Dep.MH 07	Daw Myo Myo	Myanmar	Buddhism	Primary School
	8	Dep.MH 08	U Zin Ko Latt	Myanmar	Buddhism	Middle School
	9	Dep.MH 09	U Soe Moe Naing	Myanmar	Buddhism	Middle School
	10	Dep.MH 10	Daw Nu	Myanmar	Buddhism	Primary School
	11	Dep.MH 11	U Kalar	Myanmar	Buddhism	High School
	12	Dep.MH 12	Daw Maw Lwin	Myanmar	Buddhism	Primary School
Track Improvement	1	U-IP.182 - 01	Lila Govida Prabhu	Indian	Hinduism	-
	2	D-IP.182 - 01	U Khin Maung Aye	Myanmar	Buddhism	Primary School
	3	D-IP.182 - 02	U Kyaw Htay	Myanmar	Buddhism	Primary School
	4	D-IP.173 - 01	U Phoe Shan	Myanmar	Buddhism	Middle School
	5	U-IP.1 - 01	U Wila Thaga	Myanmar	Buddhism	-

* - : No Data

Source: JICA Study Team

2) Air Quality

In order to understand the ambient air quality along Yangon-Mandalay Railway Line and to monitor the changes that may take place as a result of the project, dust (PM_{10} and $PM_{2.5}$) and gases (SO_2, NO_2) were measured using HAZSCANNER air monitoring station, and ozone (O3) was measured using Aeroqual S 500 Gas level monitor. The items to be monitored were selected with reference to the NEQ (Emission) Guidelines in Myanmar. Measured data was analysed and compared with the permissible maximum values prescribed in the NEQ Guidelines for ambient air quality. The results serve as a useful input into considering effective ways to mitigate the potential impacts on the air quality and formulating a practical and robust environmental monitoring plan.

The air quality survey and noise and vibration level measurement were conducted in three locations, namely Air Quality Point 1 (A-1), Air Quality Point 2 (A-2) and Air Quality Point 3 (A-3). All three points were chosen in residential areas near the railway line. A-1 is at kindergarten located 30 metres away from the railway line and 170 meters from the hospital in Taungoo. A-2 is at an office of the general administrative department (GAD) in Begon village near the junction of Ywa Taw and Pyinmana. This point is 55 metres away from the railway line and 10 metres from a primary school. The last point (i.e. A-3) is at a monastery near Myohaung Station and is approximately 60 metres away from the railway line and 80 metres away from Mandalay-Lasho Railway Line. Location of the air quality survey points are presented in Table 8.1.28 and Figure 8.1.12, and the equipment used is shown in Table 8.1.29, respectively.

Table 8.1.28 Location of Air Quality Survey

Point	Location (Longitude and Latitude)	Description of survey point	Duration
A-1	Taungoo Township (18° 56' 22.951" N; 96° 26' 29.667" E)	30 metres away from the railway line and 170 metres away from the hospital.	(4-5) August 2017
A-2	Pyinmana Township (19° 46' 52.871" N; 96° 11' 41.862" E)	55 meters away from the railway line and 10 metres away from a primary school.	(6-7) August 2017
A-3	Chan Mya Tha Zi Township (21° 55' 55.623" N; 96° 04' 44.958" E)	60 metres away from Yangon-Mandalay Railway Line and 80 metres away from Mandalay-Lasho Railway Line.	(8-9) August 2017

Source: JICA Study Team based on Google Earth

Figure 8.1.12 Location of Air Quality Measurement

Table 8.1.29 Instruments Used for Air Quality Measurement

No.	Name and Model of Instrument Used	Measurement Items	Image
1	EPAS HAZS-Canner	PM_{10}, $PM_{2.5}$, NO_2, SO_2, temperature, wind speed, wind direction, and relative humidity.	
2	AeroQual500 with Sensors and casing	O_3	

Air Quality Measurement at A-1

Air Quality Measurement at A-2

Air Quality Measurement at A-3

Photograph 8.1.1 Air Quality Survey

A summary of the result is shown in Table 8.1.30 below. It can be seen that the level of concentration for SO_2 was in excess of the NEQ Guideline values at A-1 (i.e. Taungoo) and that of ozone was higher at A-2 (i.e. Pyinmana) and A-3 (i.e. Chan Mya Tha Zi). A more detailed analysis will be provided in the following sections under each item measured.

Table 8.1.30 Results of Ambient Air Quality Measurement

Parameter	Location (μg/m^3)			NEQ Guildlilne Values (μg/m^3)	Averaging Period
	A-1	A-2	A-3		
PM_{10}	30.00	40.81	21.13	50.00	24hrs
$PM_{2.5}$	18.06	17.47	10.96	25.00	24hrs
NO_2	125.70	96.16	134.12	200.00	1hrs
SO_2	48.93	6.70	13.52	20.00	24hrs
Ozone	90.90	108.50	152.43	100.00	8hrs

*Measurement values that exceed the NEQ Guideline values are shown in a red square.

Source: JICA Study Team

(a) Particulate Matters (PM_{10} and $PM_{2.5}$)

PM_{10} and $PM_{2.5}$ refer to particulate matter 10 micrometers or less in diameter and particulate matter 2.5 micrometers or less in diameter, respectively. $PM_{2.5}$ is generally described as fine particles. The major components of PMs are sulfate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. It consists of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air.

The dust emission level was checked by measuring the concentration level of PM_{10} and $PM_{2.5}$ for 24 hours at three points. The first point (i.e. A-1) located in the kindergarten, showed a value of 30 μg/m^3 for PM_{10} and 18.06 μg/m^3 for $PM_{2.5}$. These values are within the NEQ (emission) guideline values of 50 μg/m^3 and 25μg/m^3. The ambient air quality of point A-2 was measured at the GAD Office in Begon village track. The level of PM_{10} and $PM_{2.5}$ here was both within the guideline values. The level of PMs at A-3 was also within the guideline values (i.e. 21.13 μg/m^3 for PM_{10} and 10.96 μg/m^3 for $PM_{2.5}$)

(b) Nitrogen Dioxide (NO_2)

Nitric oxide (NO) and nitrogen dioxide (NO_2) are the two principle nitrogen oxides. It can be generated from the operation and maintenance of vehicles and on-site power generation facilities. The quantity of nitrogen oxides depends on the available nitrogen and oxygen concentration, reaction time, and temperature. It can cause bronchitis and oedema in lungs.

Concentration of ambient NO_2 level was measured for one hour in the survey. The average concentration for 1 hour was 125.7 μg/m^3 at A-1, 96.16 μg/m^3 at A-2 and, 134.12 μg/m^3 at A-3. All were found to be lower than 200 μg/m^3, the guideline value stipulated in the NEQ (emission) Guidelines.

(c) Sulfur Dioxide (SO_2)

Sulfur dioxide is generated from combustion of fuel such as oil, and as a by-product of some chemical products. On-road and off-road vehicles can also be emission sources of SO_2. SO_2 may cause respiratory diseases and irritation of throat and eyes. Measured SO_2 level was 48.93 μg/m^3, 6.7 μg/m^3, and 13.52 μg/m^3 at A-1, A-2 and A-3, respectively.

The average concentration level of SO_2 at A-1 was measured to be more than the guideline values. The reason for the relatively high level can be considered to be the main road crossing the railway line that is located in front of the kindergarten where the measurement took place. A number of cars and motor cycles cross the road every hour.

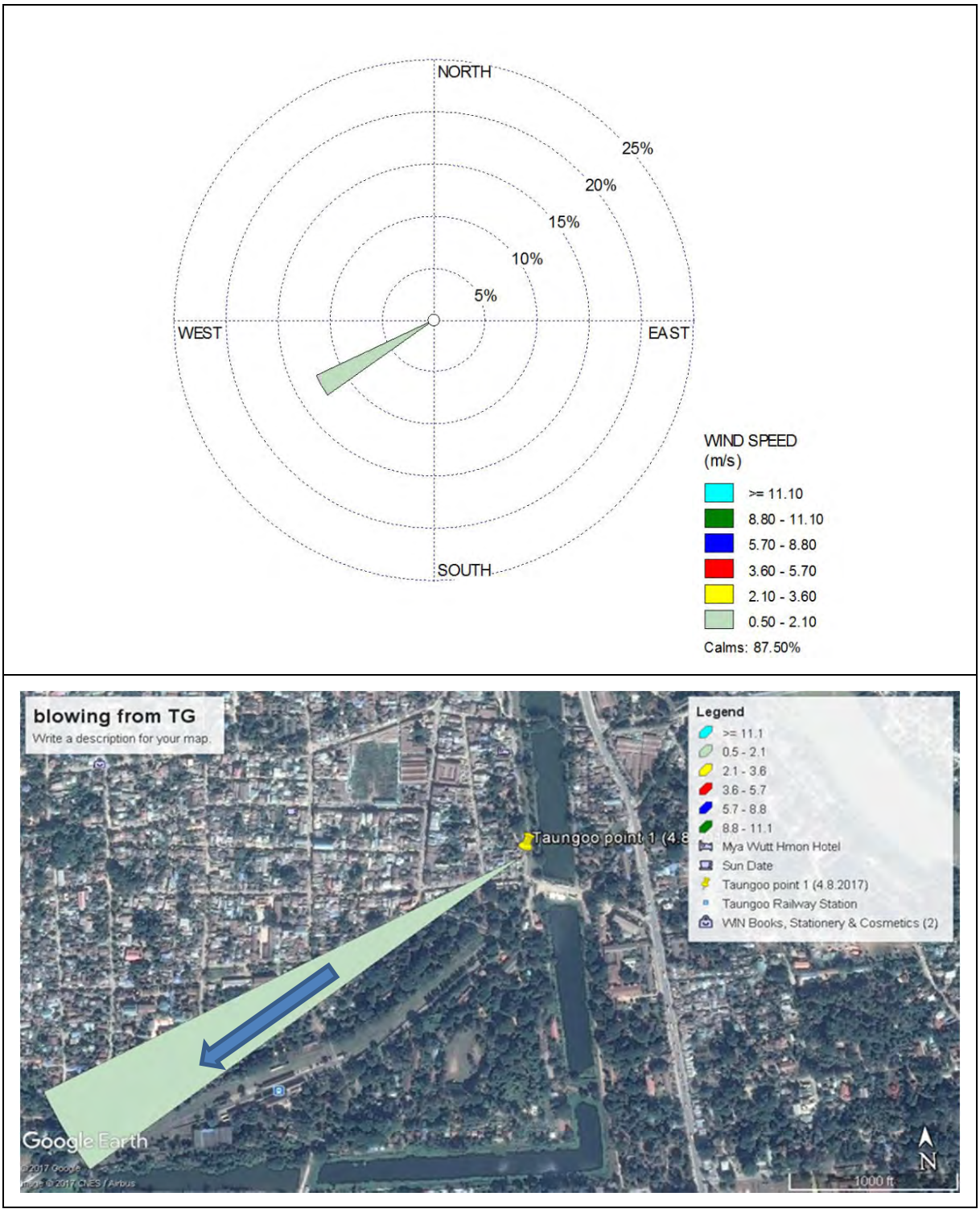
(d) Ozone (O_3)

Ozone is created by chemical reactions between oxides of nitrogen and volatile organic compounds (VOC) in the presence of sunlight. Nitrogen oxides are released into the atmosphere as a by-product of combustion. For example, nitrogen oxides are released from the burning of vegetation during a fire. However, internal combustion engines (especially automobiles) and coal-fired power plants are the two main sources of nitrogen oxides. VOCs, or hydrocarbons, on the other hand, also come from man-made sources such as cars, motor cycles and from natural sources such as trees and other vegetation. In fact, the main source of VOCs is from gases released by trees and other vegetation.

The level of concentration of ozone at three points was 90.9 μg/m^3, 108.5 μg/m^3 and 152.43 μg/m^3, respectively. These values are higher than the guideline value of the NEQ (emission) Guidelines (i.e. 100 μg/m^3) except for point A-1. The high concentration of ozone at A-2 can be attributed to the villagers' incineration of daily waste and the trees and paddy fields that are in abundance in Begon Village tract. The monastery where measurement was carried out at A-3 is located between Yangon-Mandalay Railway Line and Mandalay–Lashio Raiway Line. There are also many trees and bushes. The trains and VOCs from trees may be the factors contributing to the high ozone level at A-3.

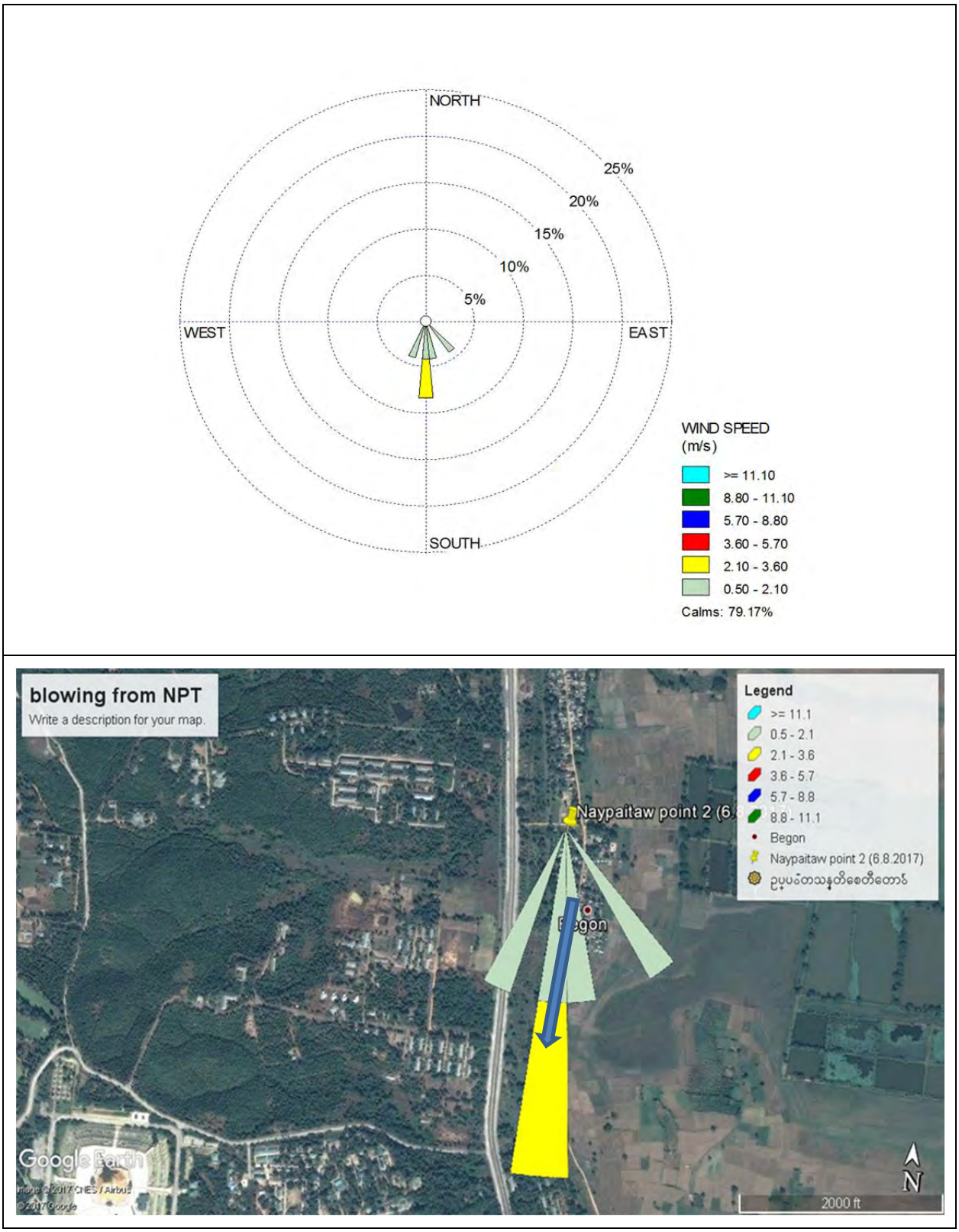
3) Wind Speed and Direction

The following figures show the wind speed and direction along the project site. It can be seen that wind was blowing from the north-west to south-east direction at A-1 (i.e. Taungoo) and A-3 (i.e. Chan Mya Tha Zi) while the wind was blowing from north to south at A-2 (i.e. Chan Mya Tha Zi).



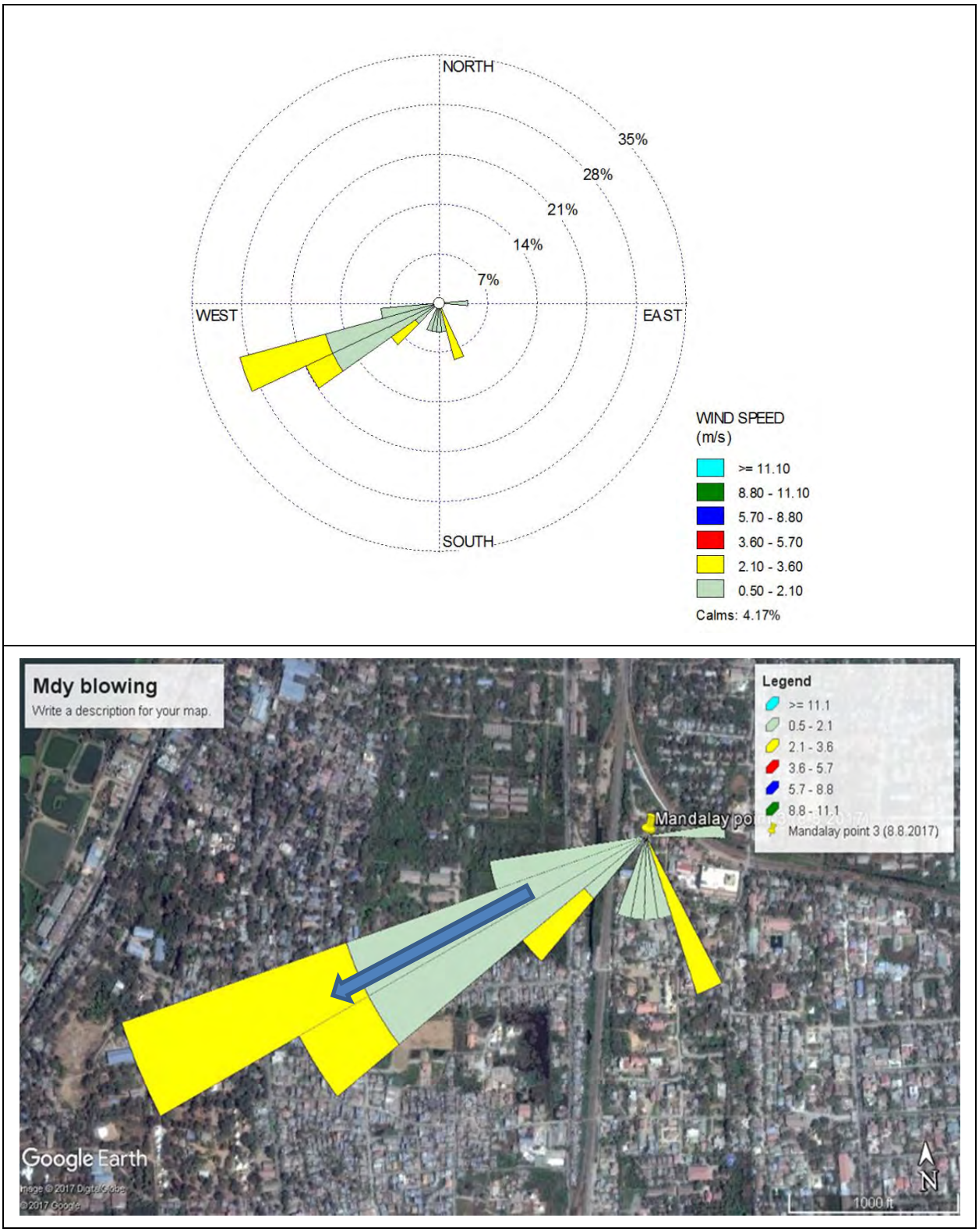
Source: JICA Study Team based on Google Earth

Figure 8.1.13 Wind Speed and Direction at A-1



Source: JICA Study Team based on Google Earth

Figure 8.1.14 Wind Speed and Direction at A-2



Source: JICA Study Team based on Google Earth

Figure 8.1.15 Wind Speed and Direction at A-3

4) Humidity and Temperature

The average humidity and temperature within the project area are shown in Table 8.1.31.

Table 8.1.31 Humidity and Temperature at A-1, A-2 and A-3

Location	Date	Item Measured	Results
A-1	August 4-5, 2017	Humidity	86.02 %
		Temperature	30.62 °C
A-2	August 6-7, 2017	Humidity	90.82 %
		Temperature	30 °C
A-3	August 8-9, 2017	Humidity	64.00 %
		Temperature	34 °C

Source: JICA Study Team

5) Water Quality

The existing water quality was measured by sampling water from four streams (i.e. W-1, W-2, W-3 and W-4) located along the project area in order to compare the difference between the quality of existing water before and after implementation of the project. Three points were downstream of the river where some of the major bridges were to be relocated (i.e. Nga Leik, Myitnge and Zawgyi rivers) and one point was at the planned depot development site in Naypyitaw. The facilities of the depot site include a fuel and water supply shop, train preparation shop and 4-6 stabling tracks where water contamination may take place as a result of waste water generated from cleaning rolling stocks and collecting night soil. Water quality was collected once during the rainy season (i.e. August 2017).

One gallon of water from each location was sampled at each point. A clean bucket of approximately 10L capacity was used to collect the water sample. The bottle was dipped into the river, firmly held and plunged downwards to a depth of approximately 0.5m. Samples were then transferred to the laboratory (i.e. SGS Limited, ISO Tech Laboratory, and Water and Sanitation Department, Suprime Group of Companies). Their physicochemical data on acidity (pH), DO, water temperature, salinity, total suspended solid, COD, BOD, oil and grease, total nitrogen, total phosphorus, and total coliform content were assessed in the laboratory by standard procedures. The location of water quality sampling as well as the equipment used is shown below.

Table 8.1.32 Location of Water Quality Sampling

Point	Location (Latitude and Longitude)	Date of Sampling
W-1	Nay Pyi Taw depot site (stream at east of depot site) (19°51'2.02"N; 96°12'11.78"E)	August 5, 2017
W-2	Bridge No (393) across Nga Lite stream, Pyinmana township (19°44'41.28"N; 96°12'13.47"E)	August 5, 2017
W-3	Bridge No (748) across Zawgyi river, Kyauk Se township (21°36'0.00"N; 96° 8'14.20"E)	August 6, 2017
W-4	Bridge No (826) across Myit Nge river, Amarapura township (21°50'33.67"N; 96° 3'59.79"E)	August 6, 2017

Source: JICA Study Team

Source: JICA Study Team based on Google Earth

Figure 8.1.16 Location of Water Quality Sampling Points

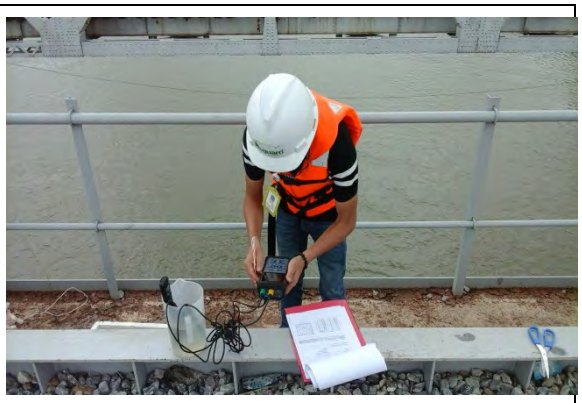
Table 8.1.33 Instruments Used for Water Quality Measurement

No.	Name and Model of Instrument Used	Measurement Items	Image
1	YSIpH100A Handheld & Probe	pH, temperature	
2	YSIDO200A Handheld& Probe	DO, temperature	
3	YSI EC300A Handheld & Probe	salinity	


Water Sampling at W-1


Water Sampling at W-2


Water Sampling at W-3



Water Samplling at W-4

Photograph 8.1.2 Water Quality Survey

Table 8.1.34 shows the results of water quality measurement carried out at W-1 (i.e. channel near the planned depot development site in Nay Pyi Taw), W-2 (i.e. downstream of Bridge No. 393 in Nga Lite stream, Pyinmana), W-3 (i.e. downstream of Bridge No. 748 in Zaw Gyi river, Kyauk Se) and W-4 (i.e. downstream of Bridge No. 826 in Myit Nge River, Amarapura) as explained in 3.2.2. The observed values were compared against the NEQ Guidelines. The results showed that all parameters were within the guideline value except for the total suspended solid that showed a value of 67 mg/l at W-2. Suspend particles in water can cause turbidity and obstruct light transmission through the water. It is an indicator for the presence of water contamination. Water quality tests and results of on-site measurement and results form laboratory are shown in Appendix 8.1(2).

Table 8.1.34 Results of Water Quality Measurement

No.	Parameter	Location				NEQ Guideline Values	Unit	Name of Laboratory
		W-1	W-2	W-3	W-4			
1	BOD	8	22	10	8	30	mg/l	ISO TECH
2	COD	32	64	32	32	125	mg/l	ISO TECH
3	Oil & Grease	<5	<5	<5	<5	10	mg/l	SGS
4	pH	7.6	7.7	7.8	7.9	6-9	Standard Unit	ISO TECH
5	Total Coliform	12	22	16	10	400	100ml	ISO TECH
6	Total Nitrogen	<1	<1	<1	<1	10	mg/l	SGS
7	Total Phosphorus	0.019	0.012	<0.01	<0.01	2	mg/l	SGS
8	Total Suspended Solids	38	67	44	27	50	mg/l	ISO TECH

*Measurement values that exceed the NEQ Guideline values are shown in a red square.

Source: JICA Study Team

6) Noise and Vibration Level

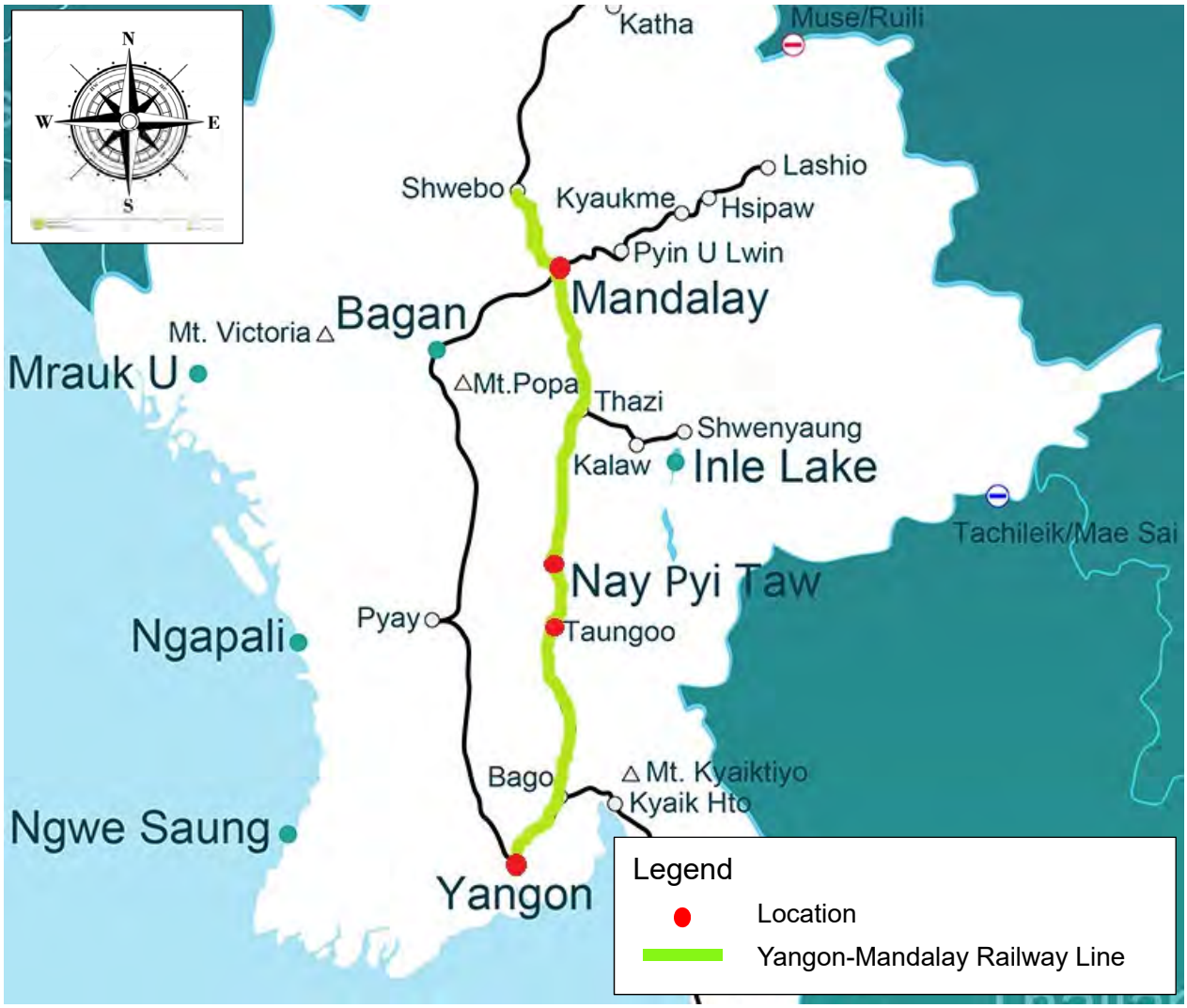
The source of noise and vibration from railway activities is the dynamic energy caused by the interaction between the rail and wheels. The magnitude is dependent on the impedance of the wheel with the bogie and the loaded carriage, the impedance of the rail with the sleepers or the complete track construction and the structural condition of the soil. The source can be differentiated in rolling noise, impulse noise and curve squeal noise. Especially for low frequency vibration (lower than approximately 8 Hz) an energy source is decisive, depending on the variation of the impedances of the track.

Aside from this, the repetitive noise and vibration caused by train operation can affect sleep, communication, and the well-being of residents in the neighbourhood. Therefore, for the impact of noise and vibration caused by the railway activities, hourly sound exposure level and vibration level were measured for noise and vibration assessment.

With regards to noise measurement, A-weighted sound pressure level was recorded for 24 hours. Movement of trains on certain locations causes a response from the surrounding environment. The magnitude of response depends on the quality of the rail track, type of foundations and type of vehicle and these factors determine the vibration level. Moreover, vibration level at the receptor also depends on the condition of the soil structure, distance from the railway and dwelling and the characteristics of the building.

Vibration measurements and assessment criteria should refer to the place at which the vibration affects people. The most basic consideration associated with vibration measurements is the direction of measurement and vibration they represent. There are three axes for measurement: horizontal (x-axis); vertical (y-axis); and axial (z-axis). In this survey, y-axis was pointed to the railway track (perpendicular direction) and x-axis was placed parallel with the railway line. Depending on whether the occupants are standing, sitting or lying down, vibration may enter the body in the x-axis, y-axis or z-axis. In general, people are more sensitive to z-axis vibration than to x-axis and y-axis vibration. Therefore, vibration in the z-axis is mostly used to analyse the impact assessment for residents.

Noise and vibration levels in and on the perimeter of the project site were measured using a digital sound level meter. Noise levels were measured for 24 hours at the same three points as the air quality measurement and were compared with the NEQ Guidelines of Myanmar. Vibration levels were measured for eight hours at the same three points as the air quality measurement. The three locations for noise and vibration measurement are shown in Figure 8.1.17 and the equipment used for noise and vibration measurements is shown in Table 8.1.35 and Table 8.1.36, respectively.



Source: JICA Study Team based on Go-Myanmar.com 2017 (www.go-myanmar.com/by-train)

Figure 8.1.17 Location of Noise and Vibration Measurement

Table 8.1.35 Instruments Used for Noise Level Measurement

No.	Name and Model of Instrument Used	Measurement Items	Image
1	Digital Sound Level Meter	noise	

Table 8.1.36 Instruments Used for Vibration Level Measurement

No.	Name and Model of Instrument Used	Measurement Items	Image
1	Vibration Level Meter	vibration	

(a) Noise Level

Noise level near railway tracks depends on the single exposure level and frequency of train passes. When a train passes by, the parameter equivalent sound level (L_{eq}), which is the receiver's cumulative noise exposure from all events over a specified period of time, is derived. It is an hourly measure that accounts for the moment-to-moment fluctuation. The level of noise measured at the three locations (i.e. A-1, A-2 and A-3) is presented in Table 8.1.37.

Table 8.1.37 Results of Noise Level Measurement

Point	Period	L_{Aeq} (dB)	NEQ Guideline Values (dB)	Number of Trains Passed
A-1	Daytime (7:00-22:00)	59.7	55	9
	Night-time (22:00-7:00)	55.5	45	5
A-2	Daytime (7:00-22:00)	46.3	55	19
	Night-time (22:00-7:00)	53.7	45	5
A-3	Daytime (7:00-22:00)	54.5	55	14
	Night-time (22:00-7:00)	60.7	45	0

*Measurement values that exceed the NEQ Guideline values are shown in a red square.

Source: JICA Study Team

In A-1, the hourly equivalent continuous sound level ranged from 49.5 dB (A) to 79.4 dB (A). As can be seen from the figure below, an hourly equivalent noise level at the daytime period was higher compared to the night-time period due to the greater number of trains passing in the daytime.

Aside from this, the hourly noise level was sometimes higher even in the absence of trains passing by. This is because a road was running parallel to the railway line near the receptor; in addition, a parking place was also there. Honking and other noise from operation of such vehicles can be considered to have increased the recorded sound level.

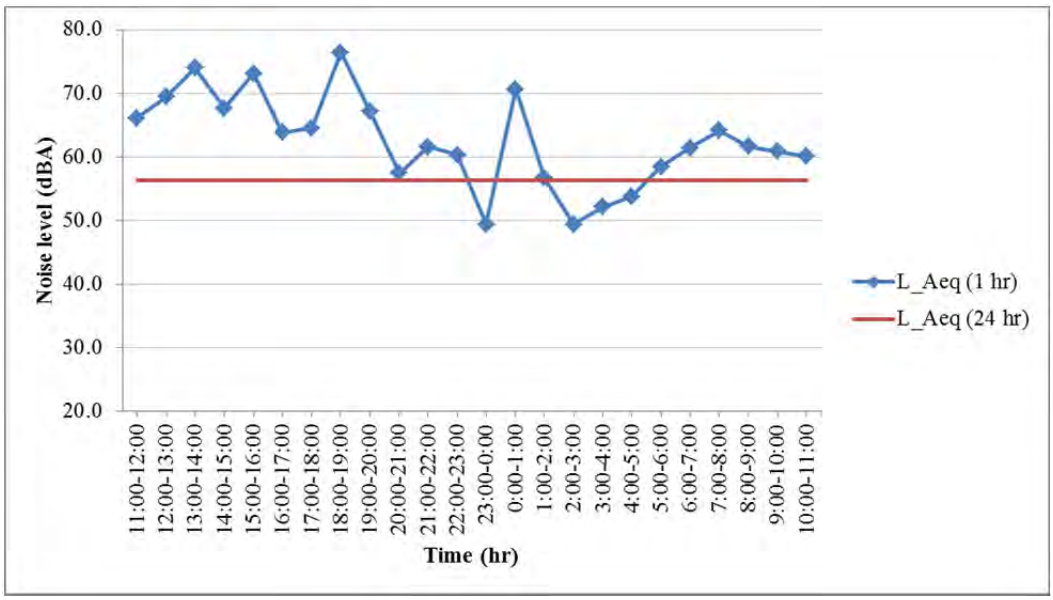


Figure 8.1.18 Noise Level at A-1

In A-2, the hourly equivalent continuous sound level ranged from 46.7 dB (A) to 65.5 dB (A). As compared with Point A-1, the recorded sound level A-2 was lower although the number of passing trains was higher than point A-1.

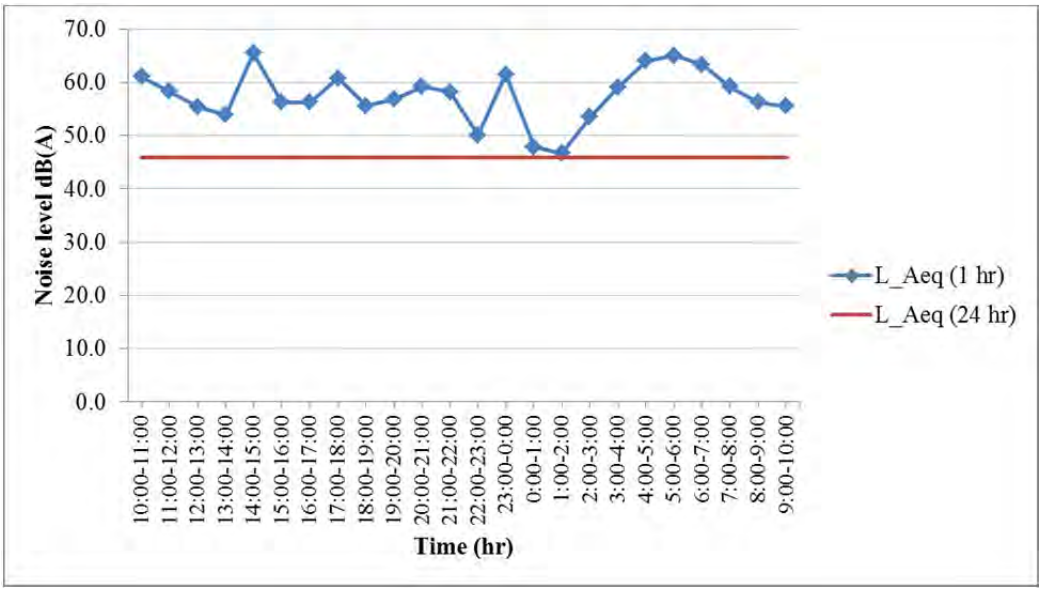


Figure 8.1.19 Noise Level at A-2

The maximum recorded hourly sound level at A-3 was 76.4 dB and the minimum 52.1 dB. The total number of trains during the 24 hour period was twelve. The frequency of the trains that passed by and the honking of them is considered to be the main source of noise.

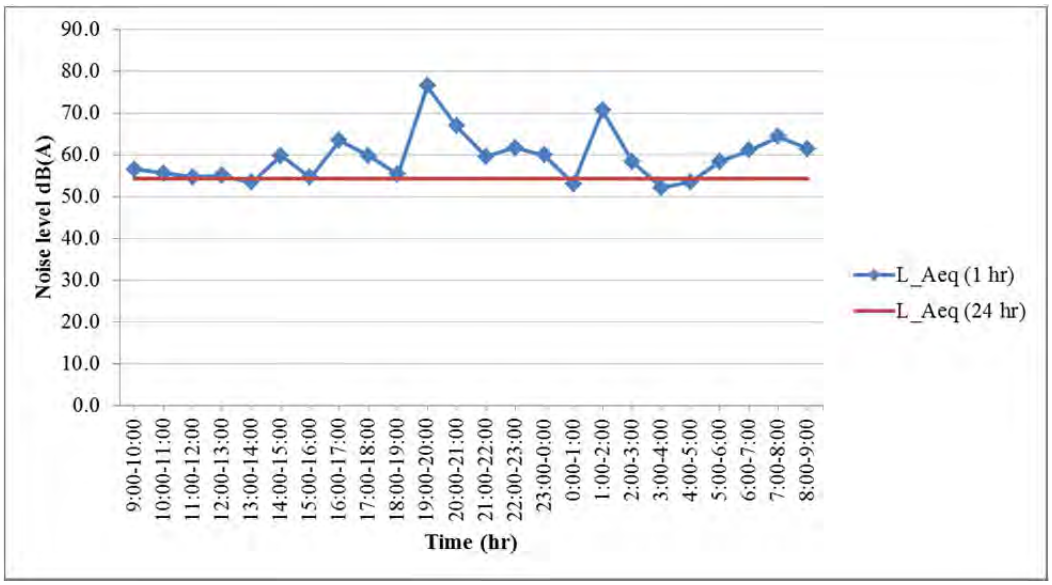


Figure 8.1.20 Noise Level at A-3

It should be noted that the noise level mentioned above includes background noise level. Therefore, they are compared with the noise levels specified in the NEQ Guidelines. The result of all points exceed the NEQ Guideline values of 55 dB (daytime) and 45 dB (night-time).

(b) Vibration Level

The resulting average value of vibration level at the three receptor locations is summarized in the following table.

Table 8.1.38 Results of Vibration Level Measurement

Point	Vibration Level (dB)			Guideline Values (Japan)*		Remarks
	X-axis	Y-axis	Z-axis	Day Time	Night Time	
A-1	30.1	32.4	34.4	65 dB	60 dB	8 hour average
A-2	30.8	31.5	33.2			
A-3	26.6	21.0	23.6			

* Guideline values that apply to areas where silence is needed to preserve a good living environment and to residential areas.

Source: JICA Study Team

Since there is no guideline value for railway-specific vibration levels in Myanmar or Japan, the standard for motor vehicle vibration in Japan was referred to and compared against the vibration level measured under this study. Vibration levels at all three receptor locations were found to be below the Japanese standard.

The vibration level at A-1 ranged from 22.1 dB to 34.2 dB. The vibration levels in all three directions were below 35 dB. Although the location of the receptor was only 12.5 m away from the vibration source, the level of vibration was low partly due to the soil type which was sandy.

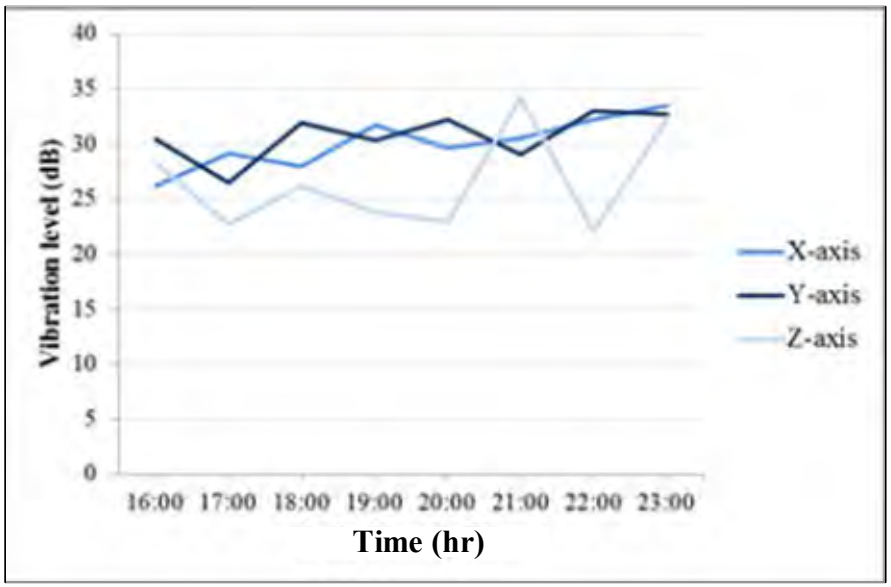


Figure 8.1.21 Vibration Level at A-1

The vibration level at A-2 was generally lower than at A-1 with a maximum vibration level of 23.6 dB and minimum vibration level of 19.5 dB in the z-direction. This is considered to be mainly due to the low speed of the train and other vehicles.

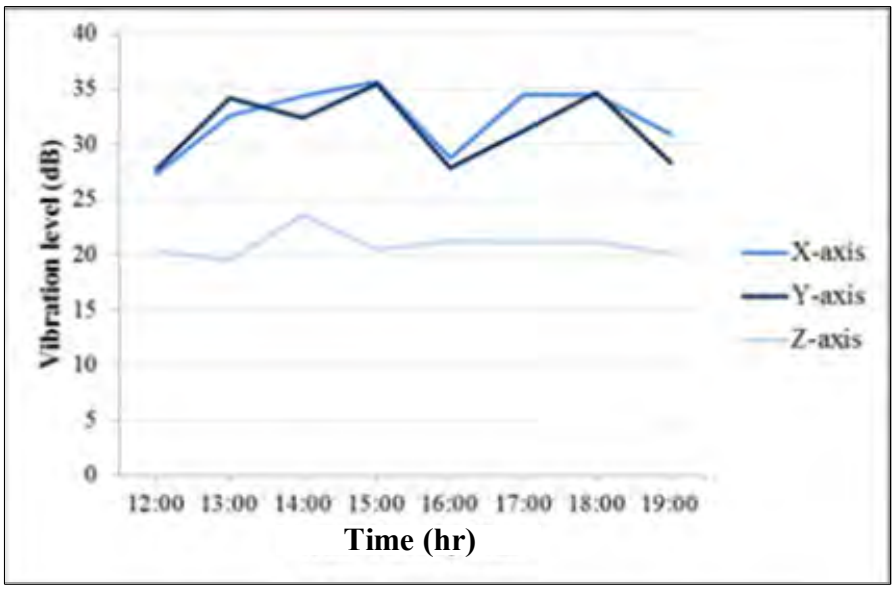


Figure 8.1.22 Vibration Level at A-2

At A-3, the vibration exposure level in z-direction ranged from 21.2 to 27.2 dB. This is also lower than A-1 and not significantly different from A-2. The soil structure at A-3 was clay type soil. According to the factors that influence the level of vibration, soil layering will have a substantial, yet unpredictable, effect on the vibration level since each stratum can have significantly different dynamic characteristics. Vibration levels are generally higher in clay type soil than loose sandy soils. Therefore, the vibration level in this location is considered to be due mainly to the train speed.

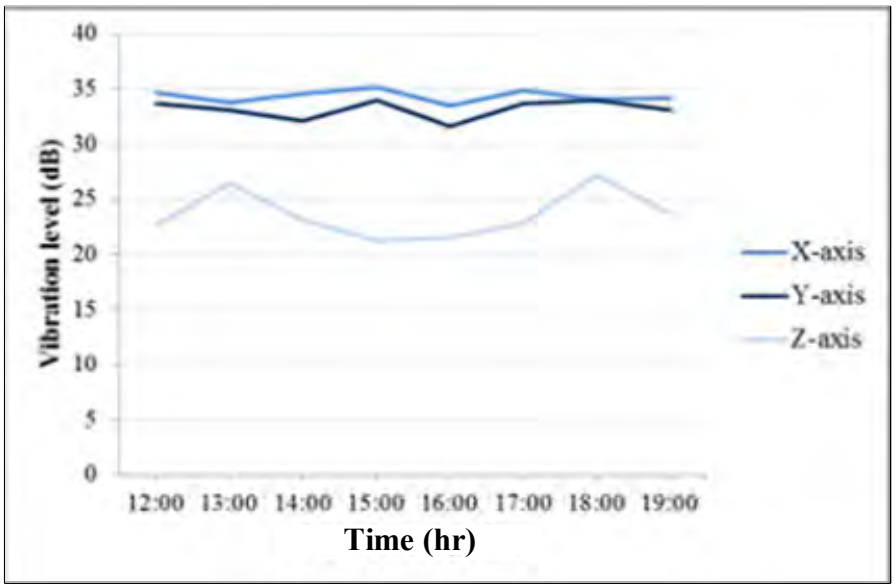
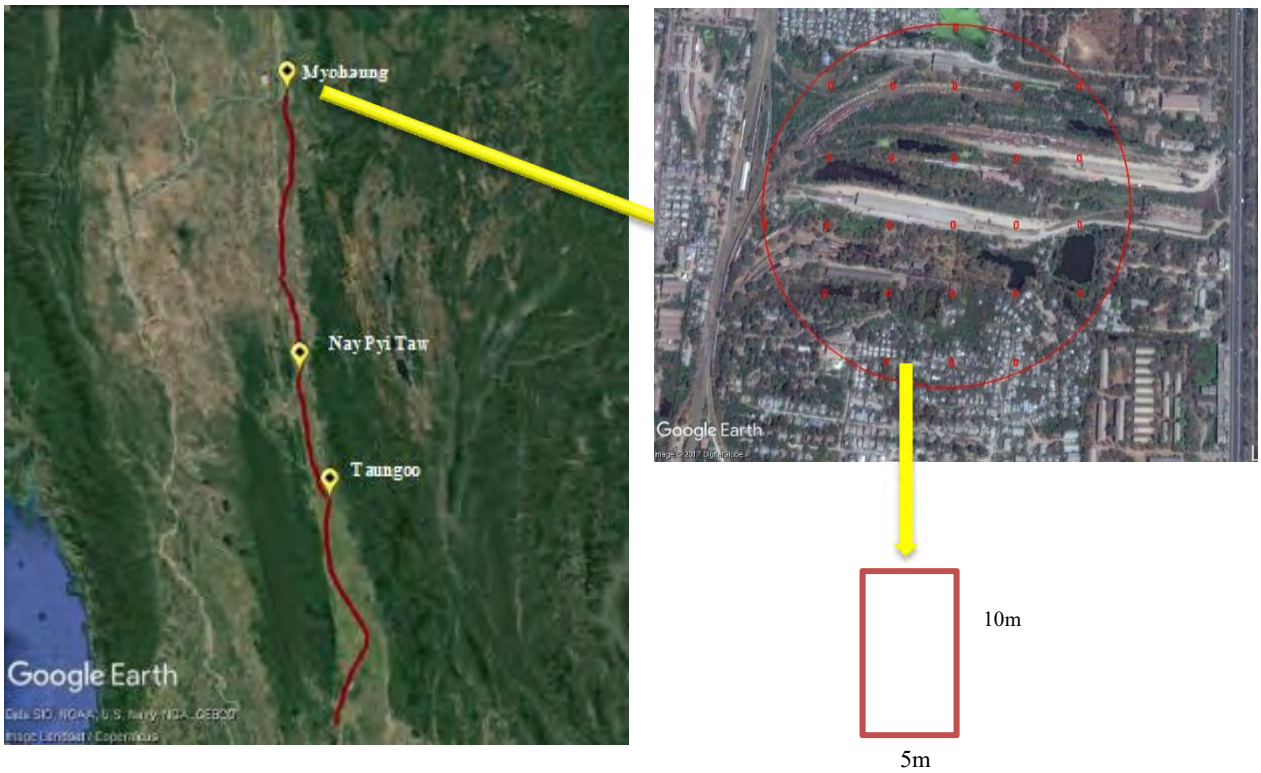


Figure 8.1.23 Vibration Level at A-3

7) Ecosystem

Primary data has been collected through direct observation supplemented by interviews and literature surveys on common resident flora (i.e. existing flora data such as trees and small trees, shrubs, herbs, climbers and bamboo) and fauna (i.e. mammals, birds, reptiles, amphibians, and various kinds of insects including butterflies, dragonflies, damselflies and so on) in the project area. The survey was conducted in Taungoo, the planned depot site in Nay Pyi Taw and the planned depot site in Myohaung in consideration of geographical distribution of the project area (i.e. Taungoo to Mandalay) and to focus on the places where relatively large areas of land are to be used by the project (i.e. depot sites). Among them, Myohaung, located approximately 5km south of Mandalay station, is the place where the largest area of land is planned to be used for the project (cf. the area is under the ownership and management of MR). The ecological data was collected during the rainy season (i.e. August 2017).

In order to obtain data for flora and fauna species composition, flora and fauna species in a circular plot of 250 metre radius were recorded by setting up 25 5 metre by 10 metre quadrants within the plot. In order to collect representative data, the quadrants were set up at a 100 metre distance between each other. The ecosystem survey in Myohaung depot site is shown in Figure 8.1.24 as an example. All collected specimens were photographed and morphometric characteristics recorded for taxonomical identification and further study.



Source: JICA Study Team based on Google Earth

Figure 8.1.24 Location and Sampling Plots/Quadrants of Ecosystem Survey (Myohaung Depot Site)

(a) Flora

A total number of 44 flora species were recorded in Taungoo, at the Nay Pyi Taw depot site and Myohaung depot site. The list of flora species is presented in Table 8.1.39. The habitat of identified species consists of seven types, including tree, small tree, shrub, herb, climber, creeper and aquatic environment. The recorded species were checked with the IUCN Red List of Threatened Species 2016 Version 3.1. All species were classified as neither threatened nor near threatened species.

Table 8.1.39 Species Inventory List

No	Genus Name	Species Name	Common Name	Family Name	IUCN status	Habit
1	Acacia	catechu	Sha	Fabaceae	Nil	T
2	Acacia	leucophloea	Tanaung	Fabaceae	Nil	T
3	Acalypha	indica	Kyaung-yo-the	Euphorbiaceae	Nil	S
4	Albizia	lebbek	Kokko	Fabaceae	Nil	T
5	Alternanthera	sessilis	Pazun-sar	Amaranthaceae	Nil	H
6	Azadirachta	indica	Tama	Meliaceae	Nil	T
7	Bauhinia	purpurea	Swedaw	Fabaceae	Nil	T
8	Boerhavia	diffusa	Pa-yan-na-war,	Nyctaginaceae	Nil	H
9	Bombax	ceiba	Letpan	Bombacaceae	Nil	T
10	Calotropis	gigantea	Mayo-gyi	Apocynaceae	Nil	ST
11	Cassia	glauca	Pyiban-nyo	Fabaceae	Nil	T
12	Cassia	tora	Dangywe	Fabaceae	Nil	S
13	Cayratia	trifolia	Taw-sabyit	Vitaceae	Nil	CL
14	Chromolaena	odorata	Bizat	Asteraceae	Nil	S
15	Chrozophora	plicata	Gyo-sagauk	Euphorbiaceae	Nil	S
16	Colocasia	affinis	Pein	Araceae	Nil	H
17	Commelina	benghalensis	Wetkyok	Commelinaceae	Nil	H
18	Croton	bonplandianum	Unknown	Euphorbiaceae	Nil	S
19	Delonix	regia	Seinban	Fabaceae	Nil	T
20	Dregea	volubilis	Gwedauk-nwe	Asclepiadaceae	Nil	CL
21	Eucalyptus	albens	Eu-ca-lit	Myrtaceae	Nil	T
22	Ficus	benghalensis	Nyaung	Moraceae	Nil	T
23	Hyptis	suaveolens	Unknown	Lamiaceae	Nil	H
24	Impatiens	balsamina	Dan-pan	Balsaminaceae	Nil	H
25	Ipomoea	obscura	Unknown	Convolvulaceae	Nil	CR
26	Lantana	indica	Se-hnit-yathi	Verbenaceae	Nil	S
27	Leptadenia	reticulata	Gon-nwe	Asclepiadaceae	Nil	CL
28	Leucas	cephalotes	Pin-gu-hteik-peik	Lamiaceae	Nil	H
29	Mangifera	indica	Thayet	Anacardiaceae	Nil	T
30	Nerium	oleander	Nwe-tha-gee	Apocynaceae	Nil	ST
31	Nymphaea	nouchali	Kya-pya	Nymphaeaceae	Nil	Aquatic
32	Pedalium	murex	Su-le-gyi	Pedaliaceae	Nil	S
33	Physalis	minima	Bauk-pin	Solanaceae	Nil	H
34	Pithecellobium	dulce	Tayok-magyi	Fabaceae	Nil	T
35	Polyalthia	longifolia	Thinbaw-te	Annonaceae	Nil	T
36	Pterocarpus	macrocarpus	Padauk	Fabaceae	Nil	T
37	Ricinus	communis	Kyetsu	Euphorbiaceae	Nil	ST
38	Ruellia	tuberosa	Byauk	Acanthaceae	Nil	H
39	Sida	acuta	Notknown	Malvaceae	Nil	S
40	Streblus	asper	Okhne	Moraceae	Nil	ST
41	Terminalia	catappa	Banda	Combretaceae	Nil	T
42	Tridax	procumbens	Hmwezok-ne-gya	Asteraceae	Nil	H
43	Typha	angustifolia	Shin-mwe-lon	Typhaceae	Nil	Aquatic
44	Ziziphus	jujuba	Zi	Rhamnaceae	Nil	ST

ST= Small Tree, T = Tree; S = Shrub; H = Herb; and CL = Climber and CR = Creeper

Source: JICA Study Team

(b) Fauna

It was found in the ecosystem survey that none of the fauna species in the study area is listed on the IUCN Red List category of endangered species for Myanmar (www.iucnredlist.org). In Taungoo, seventeen species of birds and 22 species of butterflies were recorded. In the Nay Pyi Taw depot site, nineteen species of birds, nineteen species of butterflies and ten species of dragonflies were recorded. A total number of seventeen species of birds, nineteen species of butterflies and ten species of dragonflies were recorded in the Myohaung depot development site. The list of fauna species is presented in the following tables. The photographs of the fauna species recorded are shown in Appendix 8.1(3).

i) Taungoo

The bird and butterfly species found in Taungoo are shown in Table 8.1.40 and Table 8.1.41, respectively.

Table 8.1.40 Bird Species in Taungoo

No	Common Name	Scientific Name
1	Spotted Dove	*Streptopelia chinensis*
2	Oriental Magpie Robin	Copsychus saularis
3	Grey-Breasted Prinia	Prinia hodgson
4	Vinous-Beasted Starling	Sturnus burmannicus
5	Rock Pegion	Columba livia
6	House Crow	Corvus splendens
7	Plain Martin	Riparia paludicola
8	House Sparrow	Passer domesticus
9	Eurasian Tree Sparrow	Passer montanus
10	Scaly-Breasted Munia	Lonchura punctulata
11	Pied Bushchat	Saxicola caprata
12	Coppersmith Barbet	Megalaima haemacephala
13	Barn Swallow	Hirundo rustica
14	Little Egret	Egretta garzetta
15	Great Egret	Casmerodius albus
16	Large-Billed Crow	Corvus macrohynchos
17	Common Myna	Acridotheres tristis

Table 8.1.41 Butterfly Species in Taungoo

No	Common Name	Scientific Name
1	Common Mormon	*Papilio polytes*
2	Lime butterfly	*Papilio demoleus*
3	Common Emigrant	*Catopsilia Pomona*
4	Common Rose	*Pachliopta aristolochiae*
5	Mottled Emigrant	*Catopsilia pyranthe*
6	Psyche	*Leptosia nina*
7	Striped-Albatross	*Appias libythea*
8	Blue Tiger	*Danaus limniace*
9	Plained Tiger	Danaus chrysippus
10	Great Eggfly	*Hypolimnas bolina*
11	Common Sailor	*Neptis hylas*
12	Danaid Eggfly	*Hypolimnas misippus*
13	Tawny Coster	*Acraea violae*
14	Yellow Pansy	*Junonia hierta*
15	Peacock Pansy	*Junonia almanac*
16	Gray Pansy	*Junonia atlites*
17	Common Bush Brown	*Mycalesis perseus*
18	Lemon Pansy	*Junonia lemonias*
19	Common Pierrot	*Castalius rosimon*
20	Lime Blue	*Chilades lajus*
21	Striped Pierrot	*Tarucus nara*
22	Swift	*Caltoris spp.*

ii) Nay Pyi Taw Depot Site

The bird, butterfly and dragonfly species found in the Nay Pyi Taw depot site are shown in Table 8.1.42, Table 8.1.43 and Table 8.1.44, respectively.

Table 8.1.42 Bird Species in Nay Pyi Taw Depot Site

No	Common Name	Scientific Name
1	Yellow-Eyed Babbler	*Chrysomma sinense*
2	Australasian Bushlark	*Mirafra javanica*
3	Grey-Breasted Prinia	*Prinia hodgsonii*
4	Plain Prinia	*Prinia inornata*
5	Pied Bushchat	*Saxicola caprata*
6	Scaly-Breasted Munia	*Lonchura punctulata*
7	Common Myna	*Acridotheres tristis*
8	House Sparrow	*Passer domesticus*
9	Blue-Throated Bee-Eater	*Merops viridis*
10	Eurasian Tree Sparrow	*Passer montanus*
11	Blue-Tailed Bee-Eater	*Merops philippinus*
12	Red-Vented Bulbul	*Pycnonotus cafer*
13	Streak Eared Bulbul	*Pycnonotus blanfordi*
14	Spotted Dove	*Streptopelia chinensis*
15	White-throated Babbler	*Turdoides gularis*
16	Red Collared Dove	*Streptopelia Tranquebarica*
17	Lesser Whistling Duck	*Dendrocygna javanica*
18	Black-Shouldered Kite	*Elanus caeruleus*
19	Greater Coucal	*Centropus sinensis*

Table 8.1.43 Butterfly Species in Nay Pyi Taw Depot Site

No	Common Name	Scientific Name
1	Lime butterfly	Papilio demoleus
2	Common Rose	Pachiliopta aristolochiae
3	Common grass yellow	Eurema hecabe
4	Psyche	Leptosia nina
5	Blue Tiger	Danaus limniace
6	Plained Tiger	Danaus chrysippus
7	Great Eggfly	Hypolimnas
8	Tawny Coster	Acraea violae
9	Lemon Pansy	Junonia lemonias
10	Common Bush Brown	Mycalesis perseus
11	Dark-Branded Bushbrown	Mycalesis mineus
12	Common Four-ring	*Ypthima huebneri*
13	Lime Blue	*Chilades lajus*
14	Common Five-ring	*Ypthima baldus*
15	Striped Pierrot	*Tarucus nara*
16	Common Pierrot	*Castalius rosimon*
17	Swift	Caltoris spp
18	Peablue	*Lampides boeticus*
19	Small Blue	*Cupido* spp

Table 8.1.44 Dragonfly Species in Nay Pyi Taw Depot Site

No	Common Name	Scientific Name
1	Ground Skimmer/Chalky Percher	*Diplacodes trivilis*
2	Carmine Darter	*Crocothemis erythraea*
3	Dark- winged Groundling	*Brachythemis fuscopalliata*
4	Trumpet Tail	*Acisoma panorpoides*
5	Crimson-tailed Mash Hawk (Male)	*Orthetrum pruinosum*
6	Wandering Glider	*Pantala flavescens*
7	Coromandel Marsh Dart	*Ceriagrion coromandelianum*
8	Yellow Bush Dart (Female)	*Copera marginipes*
9	Golden Dartlet	*Ischnura aurora*
10	Orange-tailed Marsh Dart	*Ceriagrion cerinorubellum*

iii) Myohaung Depot Site

The bird, butterfly and dragonfly species found in the Myohaung depot site are shown in Table 8.1.45, Table 8.1.46 and Table 8.1.47, respectively.

Table 8.1.45 Bird Species in Myohaung Depot Site

No	Common Name	Scientific Name
1	Spotted Dove	*Streptopelia chinensis*
2	Vinous-Breasted Starling	*Sturnus burmannicus*)
3	House Crow	*Corvus splendens*
4	Large-billed Crow	*Corvus macrorhynchos*
5	Eurasian Tree Sparrow	*Passer montanus*
6	House Sparrow	*Passer domesticus*
7	Blue-tailed Bee-Eater	*Merops philippinus*
8	Scaly-Breasted	*Lonchura punctulata*
9	Common Myna	*Acridotheres tristis*
10	Common Hoopoe	*Upupa epops*
11	White-throated Babbler	*Turdoides gularis*
12	Streak Eared Bulbul	*Pycnonotus blanfordi*
13	Rock Pigeon	*Columba livia*
14	Red-vented Bulbul	*Pycnonotus cafer*
15	Asian Palm Swift	*Cypsiurus balasinensis*
16	Oriental Magpie Robin	*Copsychus saularis*
17	Indian Pond Heron	*Ardeola* grayii

Table 8.1.46 Butterfly Species in Myohaung Depot Site

No	Common Name	Scientific Name
1	Lime Butterfly	*Papilio demoleus*
2	Common Rose	*Pachliopta aristolochiae*
3	Common Emigrant	*Catopsilia Pomona*
4	Mottled Emigrant	*Catopsilia crocale)*
5	Yellow Orange Tip	*Ixias pyrene*
6	Mottled Emigrant	*Catopsilia pyranthe*
7	Common Grass Yellow	*Eurema hecabe*
8	Striped-Albatross	*Appias libythea*
9	Painted Jezebal	*Delias hyparete indica*
10	Striped Tiger	*Danaus limniace*
11	Great Eggfly	*Hypolimnas bolina*
12	*Hypolimnas bolina*	*Hypolimnas misippus*
13	Peacock Pansy	*Junonia almanac*
14	Tawny Coster	*Acraea violae*
15	Blue Pansy	*Junonia orithya*
16	Angled Castor	*Ariadne Ariadne*
17	Swift	*Caltoris* spp.
18	Plains Cupid	*Chilades pandava*
19	Darts	*Potanthus spp.*

Table 8.1.47 Dragonfly Species in Myohaung Depot Site

No	Common Name	Scientific Name
1	Slender Skimmer/Green Marsh Hawk	*Orthetrum Sabina*
2	Ground Skimmer/Chalky Percher	*Diplacodes trivilis*
3	Common Picture Wing	*Rhyothemis variegate*
4	Black Pennant	*Selysiothemis nigra*
5	Blue Dasher	*Pachydiplax longipennis*
6	Ruddy Marsh Skimmer	*Crocothemis servilia*
7	Common Redbolt	*Rhodothemis rufa*
8	Antillean Saddlebags	*Tramea insularis*
9	Ditch Jewel	*Brachythemis contaminate*
10	Coromandel Marsh Dart	*Ceriagrion coromandelianum*

(6) Assessment of Environmental Impacts

This section describes the potential environmental and social impacts which are expected to take place during planning, construction, operation, decommission and closure and post-closure stages of the project. Predictions of the impacts were conducted based on the results of scoping, analysis of the project components and the baseline data including field survey results. The result of environmental and social impact assessment is shown in Table 8.1.48 along with the results of scoping. It should be noted that the evaluation has been made based on a condition that no countermeasure has been put in place.

Table 8.1.48 Environmental and Social Impact Assessment

No.	Item	Scoping					Evaluation					Impact
		P	Co	O	De	Cl/ PCl	P	Co	O	De	Cl/ PCl	
Pollution Control												
1	Air Pollution	D	B-	B-	B-	D	D	B-	B+/-	B-	D	[P] No notable impact is expected. [Co] Earthwork, loading and unloading materials as well as construction machines and vehicles will generate dust and emission gases that will deteriorate the ambient air quality. The project is located in and along Yangon-Mandalay Railway Line which passes by some cities and roads. Mobilization route may hence also run in urban or residential areas. [O] Operation of more locomotives will lead to air pollution as the number of train in operation will increase. However, a modal shift from vehicles to trains will help to reduce the emission of air pollutants. [De] Decommissioning work is expected to temporarily lead to air pollution. [Cl/PCl] No notable impact is expected.
2	Water Pollution	D	B-	B-	B-	D	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Water pollution is expected due to the following construction work, although temporarily: (i) run off of muddy water including soil from small scale cutting, filling and excavation work: (ii) waste water from construction office and other construction-related buildings; and (iii) spilling over of toxic materials such as oil and lubricants. [O] Water may be polluted if the waste water from depots such as the waste water for cleaning rolling stocks, oil and grease used in the depots and human waste are not properly treated. [De] Water may be polluted from the construction office and other facilities. However, the impact will be temporary and limited. [Cl/PCl] No notable impact is expected.

No.	Item	Scoping					Evaluation					Impact
		P	Co	O	De	Cl/ PCl	P	Co	O	De	Cl/ PCl	
3	Soil Contamination	D	B-	B-	B-	D	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Soil may be contaminated from leakage of lubricating oil from construction vehicles and machines. However, the amount of oil used is limited and the impact is considered to be insignificant. [O] Soil contamination may take place at depots by spilling and infiltration of oil and greases and from leakage of lubricating oil for train engines. However, introducing new rolling stock is expected to reduce such leakage and the amount of oil generated itself is limited too. Hence, the impact is considered to be insignificant. [De] Soil may be contaminated from leakage of lubricating oil from construction vehicles and machines. However, the amount of oil used is limited and the impact is considered to be insignificant. [Cl/PCl] No notable impact is expected.
4	Waste Disposal	D	B-	B-	B-	D	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Generation of soil, sand and construction waste is expected nevertheless at a small scale since it is a rehabilitation project. Waste of existing devices such as sleepers, level crossings, and signal and telecommunication systems will be generated as a result of their renewal. [O] Generation of solid waste from railway facilities is expected. [De] Waste of existing devices will be generated from decommissioning of railway line and related facilities. [Cl/PCl] No notable impact is expected.
5	Noise and Vibration	D	B-	B-	B-	D	D	B-	B-	B-	D	[P] No notable impact is expected. [Co] Noise and vibration will be generated due to construction works including operation of vehicles and diesel generators but they will be geographically confined and temporary events. [O] Train operation will lead to noise and vibration generation to the vicinity along the Yangon–Mandalay Railway Line. [De] Machines and vehicles used for decommissioning works are expected to generate noise and vibration but they will be site specific and temporary events. [Cl/PCl] No notable impact is expected.
6	Ground Subsidence	D	D	D	D	D	D	D	D	D	D	Large-scale underground water use or other activities that pose a risk of ground subsidence is not expected to be carried out under this project.

No.	Item	Scoping					Evaluation					Impact
		P	Co	O	De	Cl/ PCl	P	Co	O	De	Cl/ PCl	
7	Offensive Odours	D	B-	D	D	D	D	B-	D	D	D	[P] No notable impact is expected. [Co] Offensive odour may be generated around the construction site due to the excavation and dredging of mud in the drainage channels or from the camp site during construction. [O] [De] [Cl/PCl] No notable impact is expected.
8	Sediment Quality	D	D	D	D	D	D	D	D	D	D	No activity that poses a risk of degrading the sediment quality is expected under the project.
Natural Environment												
9	Protected Areas	D	D	D	D	D	D	D	D	D	D	No protected area is observed in the proposed project area along the Yangon-Mandalay Railway Line. Therefore, no impact is expected.
10	Ecosystem	D	B-	D	D	D	D	B-	D	D	D	[P] No notable impact is expected. [Co] During construction, cutting, filling and removal of trees may have a negative effect on the existing ecosystem including ponds at planned depot site although at a minor scale as it is a rehabilitation project and the affected area is generally confined to the ROW of MR. [O] [De] [Cl/PCl] No notable impact is expected.
11	Hydrology	D	D	D	D	D	D	D	D	D	D	Some bridges will be replaced but the impact is considered to be minor as it is a replacement of already existing bridges.
12	Topography and Geology	D	B-	D	D	D	D	B-	D	D	D	[P] No notable impact is expected. [Co] No large-scale land alteration is expected due to construction work. However, the cutting and filling work is expected to change the topography and possibly geology to some extent. [O] [De] [Cl/PCl] No notable impact is expected.
13	Cross Boundary Impacts and Climate Change	D	B-	B+/-	B-	D	D	B-	B+/-	B-	D	[P] No notable impact is expected. [Co] Operation of construction-related vehicles and machinery will lead to an increase in greenhouse gas (GHG) emissions although at a small scale and only during construction. [O] While an increase in the number of rolling stocks will increase the GHG emissions, modal shift from vehicles to trains will serve to reduce the GHG emissions as a whole. [De] Operation of construction-related vehicles will lead to an increase in GHG emissions but will be generated on a small scale and only during construction. [Cl/PCl] No notable impact is expected.

No.	Item	Scoping					Evaluation					Impact
		P	Co	O	De	Cl/ PCl	P	Co	O	De	Cl/ PCl	
Social Environment												
14	Involuntary Resettlement	B-	D	D	D	D	B-	D	D	D	D	[P] While the project is a rehabilitation of an existing railway line, limited number of people will be subject to resettlement provided that they live in either: a section where changes in the alignment is considered necessary in order to ensure the safety of high speed railway operation; or an area within the planned depot construction site where a relatively large space would need to be utilized. The number of such people is expected to be insignificant (i.e. fewer than 200). [Co] [O] [De] [Cl/PCl] No notable impact is expected.
15	Poverty	D	B+	D	B+	D	B-	B+	B+	B+	D	[P] Due to removal and relocation of structures, some people will lose their assets or income. [Co] The project is expected to create a significant level of employment opportunities for local people and others. [O] A faster, safer and more reliable train operation will allow people, including local people, to more easily transport goods and services leading to improve their income and livelihood. [De] The project is expected to create a employment opportunities for local people and others. [Cl/PCl] No notable impact is expected.
16	Local Economy such as Employment and Livelihood	D	B+	D	B+	D	D	B+	B+	B+	D	[P] No notable impact is expected. [Co] [O] [De] The project is expected to create a significant level of employment opportunities for local people and others. [Cl/PCl] No notable impact is expected.
17	Indigenous People and Ethnic Minority	C	C	C	C	C	D	D	D	D	D	No ethnic minorities have been identified within or around the project area. According to the data from GAD, majority of the people are Burmese and others include Kayin and Shan along the railway. None of them are considered to be minorities.
18	Land Use and Utilization of Local Resources	D	B+	B+	D	D	D	B+	B+	D	D	[P] No notable impact is expected. [Co] [O] The project is expected to bring about more productive land use change in the area along the railway and stations. It is a rehabilitation project and the project-affected area is expected to be confined only to the ROW hence no negative change in land or other local resource use is expected. [De] [Cl/PCl] No notable impact is expected.

No.	Item	Scoping					Evaluation					Impact
		P	Co	O	De	Cl/ PCl	P	Co	O	De	Cl/ PCl	
19	Water Usage	D	C	C	C	D	D	D	B-	D	D	[P] No notable impact is expected. [Co] Groundwater water may be used for construction depending on the availability of water. [O] Groundwater will likely be used for washing and other maintenance work at the depots and workshop. However, the amount of water to be used and its impact on the groundwater level is not expected to be significant enough to limit other water usage. [De] [Cl/PCl] No notable impact is expected.
20	Existing Social Infrastructure and Services	D	B-	B+	D	D	D	B-	B+	D	D	[P] No notable impact is expected. [Co] Passengers using level crossings, drainage, platforms, bridges and other railway facilities will be temporarily affected as a result of their renewal. The current railway users may need to look for a different means of transportation during construction if the railway operation stops during construction. [O] Passengers will benefit from a safer, faster and more reliable train transportation system. [De] [Cl/PCl] No notable impact is expected.
21	Social Institutions such as Local Decision Making Mechanisms	C	C	C	C	D	D	D	D	D	D	No notable impact is expected.
22	Misdistribution of Benefit and Damage	D	D	D	D	D	D	D	D	D	D	No notable impact is expected.
23	Local Conflict of Interests	D	D	D	D	D	D	D	D	D	D	No notable impact is expected.
24	Cultural Heritage	C	C	C	C	C	D	D	D	D	D	No cultural heritage has been identified near the railway line.
25	Landscape	D	D	D	D	D	D	D	D	D	D	No major earth work is expected and its impact on the landscape is considered to be negligible.

No.	Item	Scoping					Evaluation					Impact
		P	Co	O	De	Cl/ PCl	P	Co	O	De	Cl/ PCl	
26	Gender	C	C	C	D	D	D	D	B+	D	D	[P] [Co] No notable impact is expected. [O] No issue concerned with gender is expected by the project. On the other hand, the improvement including the barrier free measures and installation of rest places will benefit all passengers but pregnant and other female passengers in particular. [De] [Cl/PCl] No notable impact is expected.
27	Rights of children	C	C	C	C	D	D	D	B+	D	D	[P] [Co] No notable impact is expected. [O] The project will not cause any adverse impact on children's rights. Access to schools is expected to improve as a result of the project. [De] [Cl/PCl] No notable impact is expected.
28	Infectious Diseases such as HIV/AIDS	D	B-	D	B-	D	D	B-	D	B-	D	[P] No notable impact is expected. [Co] Due to an inflow of construction workers, infectious diseases such as STD (Sexually Transmitted Disease) may spread although at a limited scale. [O] No notable impact is expected. [De] Due to an inflow of construction workers, infectious diseases such as STD may spread although at a limited scale. [Cl/PCl] No notable impact is expected.
29	Labour Environment	D	D	D	D	D	D	D	D	D	D	No notable impact is expected.
30	Accidents	D	B-	B-	B-	D	D	B-	B-/ B+	B-	D	[P] No notable impact is expected. [Co] Construction is relatively small in scale and heavy construction machines and vehicles are limited. Thus, accidents are expected to be relatively minor. However, because the work space is close to the railway track, there is a possibility of collision with the trains. [O] Train will run at a higher speed and hence may hit people crossing or staying on the railway line. [De] There might be some minor accidents inevitable during decommissioning works. [Cl/PCl] No notable impact is expected.

A+/-: Significant positive/negative impact is expected; B+/-: Positive/Negative impact is expected to some extent;
C: Extent of positive/negative impact is unknown; D: No impact is expected

[P]: Pre-Construction Stage; [Co]: Construction Stage; [O]: Operation Stage; [De]: Decommissioning Stage; [Cl/PCL]: Closure and Post-closure Stages

Source: JICA Study Team

(7) Environmental Management Plan

1) Environmental Mitigation Measures

This section presents the proposed measures to avoid, reduce or compensate for the potential adverse impacts. A summary of the environmental mitigation measures of the project, cost and implementation structure are presented in Table 8.1.49.

Table 8.1.49 Mitigation Measures against Project Impacts

No.	Item	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
1	Air Pollution	[Co] [De] - Load of vehicle transporting fine materials such as sand, soil and waste to and from the project site shall be covered to reduce the release of dust. - Water should be frequently sprayed on the ground at construction site and, as appropriate, near residential areas. - Generators and other equipment that generate gases must be turned off when not in use. - Construction vehicles' speed should be controlled. - Air quality should be measured/monitored. [O] - Railway equipment and devices should be regularly checked and maintained well. - Air quality should be measured/monitored.	[Co] [De] Contractor [O] MR	[Co] [De] MR	Refer to EMOP for cost of air quality monitoring. Other costs should be included in the construction and O&M costs.
2	Water Pollution	[Co] [De] - Turbid waste water from construction sites shall be disposed at designated sites after treated at sedimentation ponds and waste water treatment tanks. - Waste water shall be treated properly in accordance with the city development committees' and regional governments' system. - Water quality shall be monitored to ensure that river water is not polluted by the project. [O] - Turbid waste water from depot should be treated properly using sedimentation ponds and waste water treatment tanks and in accordance with the city development committees' and regional governments' system. - Water quality shall be monitored to ensure that river water is not polluted by the project.	[Co] [De] Contractor [O] MR	MR with support from city development committees and regional governments	**USD 2,200,000** (USD 1,100,000 (MMK1,500 million) * 2 depots) *Running cost for sedimentation ponds and waste water treatment tanks should be included in the O&M cost. *Refer to EMOP for cost of water quality monitoring.
3	Soil Contamination	[Co] [De] - All waste including oil and grease shall be stored and disposed in designated sites in a way that minimizes the risk of soil contamination. [O] - Well-maintained equipment and devices shall be used to prevent leakage of toxic materials such as lubricating oil from running trains' engines and others. - Train engines and rail cars should be regularly checked.	[Co] [De] Contractor [O] MR	MR	-

No.	Item	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
4	Waste Disposal	[Co] [De] - Waste generated from construction should be disposed only after considering reducing, reusing and recycling them and in accordance with instructions from city development committees and regional governments. [O] - Night soil shall be collected and treated properly using waste water treatment tanks. - Solid waste generated from railway-related facilities should be disposed in accordance with instructions from city development committees and regional governments.	[Co] [De] Contractor [O] MR	MR with support from city development committees and regional governments	Refer to '2. Water Pollution'.
5	Noise and Vibration	[Co] [De] - Installation of a noise barrier and use of low-noise equipment shall be considered. - Construction work during night and early time should be avoided as much as possible if there are sensitive receptors nearby. - Activities and schedule of the construction shall be made public to the surrounding communities in advance so that measures can be taken as found necessary. - Noise and vibration levels should be monitored. [O] - Installation of noise barriers along the railway line shall be considered to reduce noise pollution from running trains. - Train speed shall be controlled when passing by residential areas located adjacent to the railway track. - Noise and vibration levels should be monitored.	[Co] [De] Contractor [O] MR	MR	- Refer to EMOP for cost of noise and vibration monitoring. - Other costs should be included in the construction and O&M costs.
6	Offensive Odours	[Co] - The level of offensive odours should be monitored. - Mitigation measures will be considered depending on the source of odour.	Contractor	MR	-
7	Ecosystem	[Co] - Tree cutting and natural vegetation clearance shall be minimized. - Sedimentation ponds shall be used to avoid waste water from flowing directly into the aquatic ecosystem. - Hazardous waste material shall be stored properly until final disposal.	Contractor	MR	Refer to '2. Water Pollution'.
8	Topography and Geology	[Co] - Cutting and filling shall be kept to minimum level.	Contractor	MR	-

No.	Item	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
9	Cross Boundary Impacts and Climate Change	[Co] [De] - Generators and other equipment that generate gases must be turned off when not in use. [O] - Rolling stocks should be maintained well and regularly checked in order to reduce GHG emissions.	[Co] [De] Contractor	MR	-
10	Involuntary Resettlement	[P] - Consultation meetings shall be held for those people subject to involuntary resettlement, both permanent and temporary, and to understand their status, concerns and needs and to relieve their stress. - Appropriate compensation and assistance for livelihood restoration shall be provided to both permanent and temporary PAPs in accordance with the ARAP. [Co] - Assessment shall be carried out to check whether resettlement, compensation and assistance for livelihood restoration were made in accordance with the ARAP.	MR, Department of Agricultural Land Management and Statistics and GAD	MR with support from MOTC and regional governments	**USD 25,100** (cost for compensation) *Refer to EMOP for cost of consultation meetings.
11	Poverty	[P] - Refer to '10 Involuntary Resettlement'.			
12	Water Usage	[O] - Water should be used efficiently and non-excessively to the extent possible.	MR	MR	-
13	Existing Social Infrastructure and Services	[Co] - Contents and schedule of construction work shall be made public prior to construction. - Education shall be provided to construction workers and drivers on traffic safety and manner. - Watchmen should be designated at crossings as necessary. - Staff in charge of public communication and complaints should be designated.	[Co] Contractor	MR	-
14	Infectious Diseases such as HIV/AIDS	[Co] [De] - In order to prevent spreading of infectious diseases such as HIV/AIDS, awareness training shall be provided to construction workers.	[Co] [De] Contractor	MR	Costs should be included in the construction cost.

No.	Item	Mitigation Measures	Implementing Organization	Responsible Organization	Cost
15	Accidents	[Co] [De] - Training shall be provided and adequate notice put up for constructioin workers and local residents to prevent accidents. - Cases and causes of accidents shall be recorded and analysed. - Watchmen should be designated at crossings as necessary. - Construction sites should be properly and sufficiently lightened. [O] - Education shall be provided to construction workers, passengers and residents on railway operation and safety. - Cases and causes of accidents shall be recorded and analysed. - Fences shall be installed along the railway track (e.g. in stations, near level crossings, and in urban areas and villages) to prevent encroachment such as crossing railway lines and occupation of railway yard in order to prevent accidents.	[Co] [De] Contractor [O] MR	MR	Costs should be included in the construction cost.

P: Pre-construction Stage, Co: Construction Stage, O: Operation stage, De: Decommissioning Stage

Source: JICA Study Team

2) Environmental Monitoring Plan

A summary of the environmental monitoring plan, cost and implementation structure proposed to be carried out under the project are presented in the following table.

Table 8.1.50 Environmental Monitoring Plan

No.	Category	Item	Method	Location	Frequency	Implementing Organization	Responsible Organization	Cost/Year
Planning Phase								
1	Involuntary Resettlement	- State/Progress of provision/payment of compensation and assistance for livelihood restoration - Voices and complaints from the PAPs - State of project site	- Consultation meeting and/or other means of communication with the PAPs - Confirmation of records of payment - Project site observation	Project-affected area	Quarterly and when complaints are heard in this regard	MR with support from MOTC and regional governments	MR	**USD 8,000** (USD 500 * 4 places * 4 times)
2	Poverty	Voices and complaints from the local community	Consultation meeting and/or other means of communication with the PAPs	Project-affected area and surrounding area	Quarterly and when complaints are heard in this regard	MR with support from MOTC and regional governments	MR	Included in '1. Involuntary Resettlement'.
Construction Phase								
1	Air Pollution	NO_2, SO_2, PM (PM_{10} and $PM_{2.5}$), ozone and micro climate (temperature, humidity, wind speed and direction etc. for reference)	One weekday for 24 consecutive hours per location	3 locations along YGN-MDY Railway Line (*same places as baseline survey in principle)	Biannually	Contractor under supervision of consultant	MR	**USD 6,000** (USD 1,000 * 3 points * 2 times)
2	Water Pollution	BOD, COD, oil & grease, pH, total coliform, total nitrogen, total phosphorus and TSS	Sampling and measurement using field equipment and laboratory analyses	4 locations along YGN - MDY Railway Line (*same places as baseline survey in principle)	Biannually (*once during dry season and once during rainy season)	Contractor under supervision of consultant	MR	**USD 8,000** (USD 1,000 * 4 points * 2 times)
3	Soil Contamination	- Soil condition - Voices and complaints from the local community	- Confirmation of voices and complaints - Visual observation of surface soil	Construction site and surrounding area	Quarterly and when complaints are heard in this regard	Contractor under supervision of consultant	MR	-

No.	Category	Item	Method	Location	Frequency	Implementing Organization	Responsible Organization	Cost/Year
4	Waste Disposal	- Volume of waste including soil, vegetation and garbage - Voices and complaints from the local community	- Confirmation of records of waste generated - Confirmation of voices and complaints - Visual observation	Construction site	Quarterly and when complaints are heard in this regard	Contractor under supervision of consultant	MR	-
5	Noise and Vibration	- LAeq (noise) - LV10 (vibration)	One weekday for 24 consecutive hours per location	3 locations along YGN-MDY Railway Line (*same places as baseline survey in principle)	Biannually	Contractor under supervision of consultant	MR	**USD 6,000** (USD 1,000 * 3 points * 2 times)
6	Offensive Odours	- Volume of waste including soil, vegetation and garbage - Voices and complaints from the PAPs	- Confirmation of voices and complaints - Visual observation of sources of odour such as waste	Construction site	monthly and when complaints are heard in this regard	Contractor under supervision of consultant	MR	-
7	Ecosystem	Number of trees cut and other natural vegetation cleared	Visual observation	Project-affected area	Whenever works that involve vegetation clearance take place	Contractor under supervision of consultant	MR	-
8	Topography and Geology	Extent and necessity of cutting and filling	Visual observation	Project-affected area	Whenever works that involve cutting and filling take place	Contractor under supervision of consultant	MR	-
9	Cross Boundary Impacts and Climate Change	Air quality	Refer to ‘1. Air Pollution’ above.					

No.	Category	Item	Method	Location	Frequency	Implementing Organization	Responsible Organization	Cost/Year
10	Involuntary Resettlement	- State of provision/payment of compensation and assistance for livelihood restoration - Level of income and livelihood restoration of the PAPs - Voices and complaints from the PAPs - State of project site	- Consultation meeting and/or other means of communication with the PAPs - Confirmation of records of payment - Project site observation	Project-affected area	Quarterly and when complaints are heard in this regard	MR with support from MOTC and regional governments	MR	**USD 8,000** (USD 500 * 4 places * 4 times)
11	Existing Social Infrastructure and Services	Voices and complaints from the local community	- Confirmation of voices and complaints - Visual observation	Project-affected area	When complaints are heard in this regard	Contractor under supervision of consultant	MR	-
12	Infectious Diseases such as HIV/AIDS	- Number of infected patients - Voices and complaints from the local community	- Confirmation of health check list of workers (and preferably of local community) - Confirmation of voices and complaints	Construction site and surrounding area	Monthly and when complaints are heard in this regard	Contractor with support from consultant, MR, MOTC and regional governments	MR	-
13	Accidents	Number of accidents	Confirmation of records of accidents	Construction site	Monthly	Contractor under supervision of consultant	MR	-
Operation Phase								
1	Air Pollution	NO_2, SO_2, PM (PM_{10} and $PM_{2.5}$), ozone and micro climate (temperature, humidity, wind speed and direction etc. for reference)	One weekday for 24 consecutive hours per location	3 locations along YGN-MDY Railway Line (*same places as baseline survey in principle)	Biannually for the first two years	Environmental consultant hired by MR	MR	**USD 6,000** (USD 1,000 * 3 points * 2 times)

No.	Category	Item	Method	Location	Frequency	Implementing Organization	Responsible Organization	Cost/Year
2	Water Pollution	BOD, COD, oil & grease, pH, total coliform, total nitrogen, total phosphorus and TSS	Sampling and measurement using field equipment and laboratory analyses	4 locations along YGN - MDY Railway Line (*same places as baseline survey in principle)	Biannually for the first two years (*once during dry season and once during rainy season)	Environmental consultant hired by MR	MR	**USD 8,000** (USD 1,000 * 4 points * 2 times)
3	Soil Contamination	- Soil condition - Voices and complaints from the local community	- Confirmation of voices and complaints - Visual observation of surface soil	Construction site and surrounding area	Quarterly for the first two years and when complaints are heard in this regard	MR	MR	-
4	Waste Disposal	- Volume of waste including soil, vegetation and garbage - Voices and complaints from the local community	- Confirmation of voices and complaints - Visual observation	Depot site	Quarterly for the first two years and when complaints are heard in this regard	MR	MR	-
5	Noise and Vibration	- LAeq (noise) - LV10 (vibration)	One weekday for 24 consecutive hours per location	3 locations along YGN-MDY Railway Line (*same places as baseline survey in principle)	Biannually for the first two years	Environmental consultant hired by MR	MR	**USD 6,000** (USD 1,000 * 3 points * 2 times)
6	Cross Boundary Impacts and Climate Change	Air quality	Refer to '1. Air Pollution' above.					
7	Water Usage	- Ground water level - Voices and complaints from the local community	- Confirmation of voices and complaints - Visual observation	Depot sites	Biannually and when complaints are heard in this regard for the first two years	MR	MR	Included in O&M cost
8	Accidents	Number of accidents	Confirmation of records of accidents	Project-affected area	Monthly	MR	MR	Included in O&M cost

No.	Category	Item	Method	Location	Frequency	Implementing Organization	Responsible Organization	Cost/Year
Decommissioning Phase								
1	Air Pollution	NO_2, SO_2, PM (PM_{10} and $PM_{2.5}$), ozone and micro climate (temperature, humidity, wind speed and direction etc. for reference)	One weekday for 24 consecutive hours per location	3 locations along YGN-MDY Railway Line (*same places as baseline survey in principle)	Biannually	Contractor	MR	**USD 6,000** (USD 1,000 * 3 points * 2 times)
2	Water Pollution	BOD, COD, oil & grease, pH, total coliform, total nitrogen, Total phosphorus and TSS	Sampling and measurement using field equipment and laboratory analyses	4 locations along YGN - MDY Railway Line (*same places as baseline survey in principle)	Biannually (*once during dry season and once during rainy season)	Contractor	MR	**USD 8,000** (USD 1,000 * 4 points * 2 times)
3	Soil Contamination	- Soil condition - Voices and complaints from the local community	- Confirmation of voices and complaints - Visual observation of surface soil	Construction site and surrounding area	Quarterly and when complaints are heard in this regard	Contractor under supervision of consultant	MR	-
4	Waste Disposal	- Volume of waste including soil, vegetation and garbage - Voices and complaints from the local community	- Confirmation of records of waste generated - Confirmation of voices and complaints - Visual observation	Construction site	Quarterly and when complaints are heard in this regard	Contractor	MR	-
5	Noise and Vibration	- LAeq (noise) - LV10 (vibration)	One weekday for 24 consecutive hours per location	3 locations along YGN-MDY Railway Line (*same places as baseline survey in principle)	Biannually	Contractor	MR	**USD 6,000** (USD 1,000 * 3 points *2 times)
6	Cross Boundary Impacts and Climate Change	Air quality	Refer to '1. Air Pollution' above.					

No.	Category	Item	Method	Location	Frequency	Implementing Organization	Responsible Organization	Cost/Year
7	Infectious Diseases such as HIV/AIDS	- Number of infected patients - Voices and complaints from the local community	- Confirmation of health check list of workers (and preferably of local community) - Confirmation of voices and complaints	Construction site and surrounding area	Monthly and when complaints are heard in this regard	Contractor in collaboration with MR, MCDC and regional government	MR	-
8	Accidents	Number of accidents	Confirmation of records of accidents	Construction site	Monthly	Contractor	MR	-
Closure/Post-closure Phase								
No impact is expected								

P: Pre-construction Stage, Co: Construction Stage, O: Operation stage, De: Decommissioning Stage

Source: JICA Study Team

(8) Implementation Structure

Carrying out environmental management for the project involves a number of participants each with different positions, responsibilities, and interests. In particular, MR, supported by MOTC and the line government agencies, has the primary responsibility to ensure that the people and the natural environment are adequately protected from the negative impacts generated from the project and they adequately and rightfully benefit from the positive impact. The following section presents the main players and their roles and responsibilities in and after the implementation stage of the project.

1) MR

As the project proponent and leading executing body of the project, MR carries the overall responsibility for managing and protecting the social and natural environment to the extent that the project may have an effect. In the implementation stage, MR will carry out such activities including environmental mitigation actions and monitoring through the consultant and contractor. In the operation stage, MR will directly respond to environmental issues (e.g. listen to the complaints heard by local people and take necessary measures) or take actions via a local consultant (e.g. carry out air quality measurement in three locations).

2) MOTC

As the supervising body of MR, MOTC will support MR in *inter alia* implementing the EMP especially on matters related to land acquisition and involuntary resettlement and other social issues that require cooperation with the regional government and other concerned government bodies. Formal communications between MR and ECD need to be made via respective ministries (i.e. MOTC and MONREC) and hence, while such occasions is considered to be less compared to the pre-construction stage, close coordination between MR and MOTC is important in this regard.

3) Engineer (Consultant)

The consultant will supervise the contractor in implementing environmental mitigation measures and monitoring. If an issue is identified, the consultant will suggest to MR to take appropriate countermeasures to improve any adverse impacts. The consultant will conduct environmental monitoring and inspection of the construction work and report to MR. The consultant will also support MR in preparing an environmental monitoring report to MONREC and JICA, respectively, as required by the EIA Procedure (2015) and JICA Environmental Guidelines.

4) Contractor

A contractor will be selected by MR to carry out the construction work. The contractor is the major executing body for environmental management and protection. It will carry out such works under the instruction of MR through the engineer/consultant. It is the contractor's obligation to strictly follow the EMP including environmental monitoring as stipulated in this report during

construction. It must also report promptly to MR through the engineer about the state of the environment and any other issues that may arise that relate to environmental and social considerations.

5) ECD/MONREC

As the government body with overall responsibility for management of the environment in Myanmar, ECD and its supervising ministry (i.e. MONREC) will confirm the process related to environmental and social considerations of the project and give instructions to the project proponent as found necessary during and after implementation of the project by reviewing the monitoring reports.

6) Line Agencies

The local government (e.g. Mandalay and Bago regional governments, GAD officers and officers from the Department of Agricultural Land Management and Statistics) will cooperate and/or supervise the environmental management activities and those related to public consultation, provision of compensation and other support to the PAPs, land acquisition, grievance redress in particular in the implementation stage. A close cooperation with the local authorities such as MCDC, NCDC and GAD is also crucial to dealing with and solving site-specific concerns or other complaints related to waste management and others from the local community.

7) Project-affected Persons

Project-affected persons (i.e. PAPs), the local community and other stakeholders will be affected by the project positively and/or negatively. The PAPs do not have a responsibility for environmental management in general. However, they are expected to show a willingness to understand about the project and how it may affect them and to actively participate in the public consultation process or freely express their feelings, views and opinions in other occasions found comfortable and convenient for them.

(9) Stakeholder Consultation

1) Requirements under EIA Procedure (2015)

With regards to public consultation and disclosure, Article 61 and 65 of the EIA Procedure (2015) requires project proponents to:

a) *timely disclose all relevant information about the proposed project and its likely adverse impacts to the public and civil society through local and national media, the website(s) of the project or project proponent, at public places such as libraries and community halls, and on sign boards at the project site visible to the public, and provide appropriate and timely explanations in press conferences and media interviews;*

b) arrange consultation meeting at national, regional, state, Nay Pyi Taw Union Territory and local levels, with PAPs, authorities, community based organizations and civil society;and

c) not later than fifteen (15) days after submission of the EIA Report to the Department, disclose the EIA Report to civil society, PAPs, local communities and other concerned stakeholders: (i) by means of national media (i.e. newspapers); (ii) the website(s) of the Project or Project Proponent; (iii) at public meeting places (e.g. libraries, community halls); and (iv) at the offices of the Project Proponent

Accordingly, information on the project was made public in the following three stages under this project:

1. Information disclosure on the project upon commencement of the EIA
2. Stakeholder meeting at the scoping stage
3. Stakeholder meeting upon preparation of the EIA report (draft)

In addition, MR plans to disclose the EIA report soon after submitting the report to ECD/MONREC as explained in '5) Disclosure of the EIA Report after Submission to ECD/MONREC' below.

2) Information Disclosure on the Project upon Commencement of the EIA

Information about the project was disclosed to the PAPs and other stakeholders in accordance with the EIA Procedure (2015) and JICA Environmental Guidelines at an early stage of the study. In concrete, MR put up a project notification in both English and Burmese in May, 2017 on noticeable sign boards at every station located between Taungoo and Mandalay on the Yangon-Mandalay Railway Line. The notification included: a description of the project; information on the project proponent; and information on the contact person. The notification in English is shown in Appendix 8.1(4).

3) Stakeholder Meeting at the Scoping Stage

(a) Purpose

The stakeholder meetings were carried out in the scoping stage in order to:

a) raise stakeholders' awareness and understanding towards the project including its necessity and possible positive/negative impacts;

b) ensure stakeholders understand what kind of survey is planned to be carried out under the EIA study and for what purposes; and

c) collect and adequately reflect the views and concerns of the stakeholders to the EIA study

(b) Methodology

Stakeholder meetings were held in four places at the scoping stage in June, 2017. MR, in consultation with the EIA consultant, selected the venues taking into account the following conditions:

a) geographical location and distribution in mind the distance the project covers (i.e. 350 km);

b) administrative boundaries under which the locations fall;

c) accessibility of the local people;

d) size of the cities (cf. towns and cities with more population were given priority); and

e) capacity of the venues

Notification of the stakeholder meetings, both in English and in Burmese, was put up at five major stations located between Taungoo and Mandalay on the Yangon–Mandalay Railway Line (i.e. Taungoo, Nay Pyi Taw, Pyinmana, Thazi, and Mandalay). In addition, the Burmese version of the same notification was put up at all other stations both approximately one to two weeks before the stakeholder meetings. Further, an announcement of the meeting was made in two different newspapers (i.e. The Mirror and Myanmar Alin). In addition, MR made an invitation using invitation cards to national, regional, state, Nay Pyi Taw Union Territory and to the ward level community leaders located along the project area.

(c) Outline of the Stakeholder Meetings

The stakeholder meetings attracted attendance from a wide range of stakeholders including the local people, relevant government organizations including ECD/MONREC and regional governments and the media[4]. An outline of the stakeholder meetings held at the scoping stage is presented below. A more detailed description of each meeting is shown in Appendix 8.1(5).

[4] Public consultation has been carried out separately for the 24 project-affected households.

Table 8.1.51 Summary of Stakeholder Meetings at the Scoping Stage

Date and Time	Venue	Number of Participants						
		Government Officials	Parliament Members	Local People	Media	Private Company	EIA Consultant	Total
Jun 5, 2017 (10am-12pm)	Thazi City Hall, Thazi, Mandalay Region	34	3	28	2	-	7	74
Jun 6, 2017 (10am-12pm)	Zaytawin Dhamma Hall, Myit Nge, Mandalay Region	28	-	14	8	-	7	57
Jun 15, 2017 (9am-11am)	Pyinmana Station (VIP Hall), Nay Pyi Taw Council Region	37	2	27	2	5	7	80
Jun 16, 2017 (3pm-5pm)	Taungoo Railway Station, Bago Region	41	6	13	2	6	7	75
Total		140	11	82	14	11	28	286

Source: JICA Study Team

The stakeholder meeting was held according to the following agenda:

a) Opening remarks

b) Presentation on proposed project

c) Presentation on environmental and social considerations

d) Question and answers

e) Closing remarks

According to the agenda, MR introduced the project to the floor by explaining: the purpose of the stakeholder meeting; project background including current state of the railway line; project objective and proponent; project location; project component; project schedule; and contact person using a power point presentation attached in Appendix 8.1(6).

The EIA consultant then explained: the process of EIA; environmental type of the project; project alternatives; environmental baseline condition; initial impact evaluation; and terms of reference of the EIA survey.

MR and the EIA consultant received questions and opinions from the participants and gave answers to each of them. Questions included those related to: information disclosure, resettlement, safety measures, grievance redress mechanism, and project components. The inputs received from the participants have been reflected to inter alia impact evaluation, consideration of environmental mitigation measures and preparation of environmental monitoring plans. Nobody claimed that the project should not be implemented.

4) Stakeholder Meeting upon Preparation of the EIA Report (draft)

(a) Purpose

Disclosing information of the project to the public during the preparation of the draft EIA report has the following advantages:

a) raise PAPs and other stakeholders' awareness and understanding towards the project including its necessity and possible positive/negative impacts;

b) allow PAPs and other stakeholders to be informed about the way in which the EIA was carried out as well as the result and conclusion of it; and

c) allow all stakeholders to have the opportunity to express their views and opinions so that they could be reflected to the final project design and implementation

(b) Methodology

Stakeholder meetings were held at four places in September, 2017. The venues used at the scoping stage were reviewed by MR in consultation with the EIA consultant and finally confirmed. Announcement of the meetings were made in the same way as at the scoping stage.

(c) Outline of the Stakeholder Meetings

Stakeholder meetings at the draft EIA report preparation stage were held with participation of local people, relevant government organizations including regional governments, private company and the media[5]. An outline of the meetings is presented below. Detailed records are shown in Appendix 8.1(7).

[5] Public consultation has been carried out separately for the 24 project-affected households.

Table 8.1.52 Summary of Stakeholder Meetings at the draft EIA Reporting Stage

Date and Time	Venue	Number of Participants						
		Government Officials	Parliament Members	Local People	Media	Private Company	EIA Consultant	Total
Sep 6, 2017 (9am-11am)	Thazi City Hall, Thazi, Mandalay Region	36	3	21	2	-	7	69
Sep 7, 2017 (9am-11am)	Zaytawin Dhamma Hall, Myit Nge, Mandalay Region	18	-	17	7	2	7	51
Sep 11, 2017 (9am-11am)	Mingalar Kan Taw Hall, Pyinmana, Nay Pyi Taw Council Region	16	4	15	-	-	7	42
Sep 12, 2017 (9am-11am)	Kay Tu Yadanar Hall, Taungoo, Bago Region	49	1	20	-	-	7	77
Total		119	8	73	9	2	28	239

Source: JICA Study Team

The stakeholder meeting was held according to the same agenda as the scoping stage. According to the agenda, MR introduced the project to the floor by explaining: the objective of the stakeholder meeting; project background and current state of the railway line; project objective; project location; project component; project schedule; and project proponent, contact person and EIA consultant using a power point presentation attached in Appendix 8.1(8).

Then the EIA consultant explained: the EIA process; environmental type of the project; environmental baseline condition; project alternatives; terms of reference of the EIA survey; results of the EIA survey including socio-economic characteristics of the PAPs; environmental impact assessment; mitigation measures; and monitoring plan.

In the question and answers session, MR and the EIA consultant gave an answer to each question raised from the floor which ranged from: environmental impact; compensation; safety measures; project period; and project components. No voice was heard claiming that the project should not proceed.

5) Disclosure of the EIA Report after Submission to ECD/MONREC

Once the EIA report has been submitted to ECD/MONERC, MR plans to make the report available to interested parties and the general public within fifteen days of its submission at MR's website, Taungoo Station, Pyinmana Station, Nay Pyi Taw Station, Thazi Station and Mandalay Station, as well as at district GAD offices situated along the project area.

8.2 Abbreviated Resettlement Action Plan

8.2.1 Necessity of Abbreviated Resettlement Action Plan

(1) Anticipated Resettlement and Land Acquisition

In case of Bridge Renovation activities, it was found that some 5 housings including 2 plots of farmlands are located near the bridges which are planned for renovation and these areas will be affected by the project. The locations of the expected affected areas are as follows;

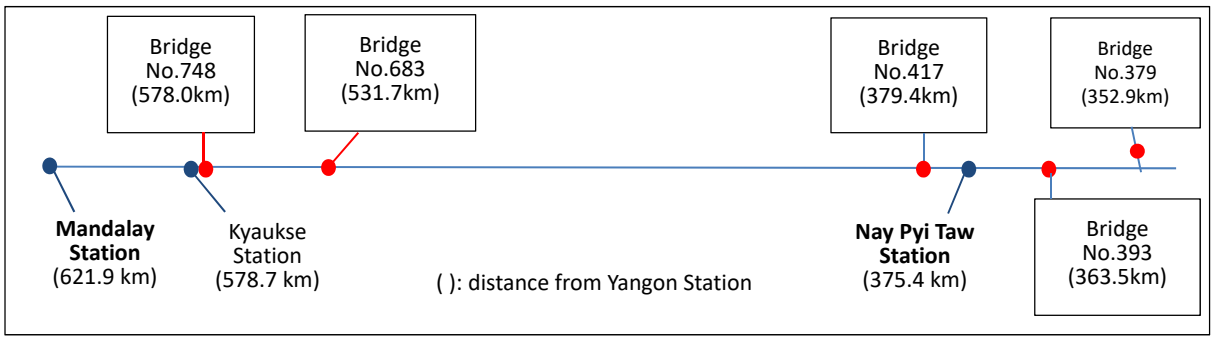


Figure 8.2.1 Locations of expected affected areas (Bridge Renovation)

Basically, all the lands inside Myohaung and Nay Pyi Taw Depot improvement plan belong to Myanma Railways and thus land acquisitions for those areas are not required for the project. However, there are some buildings such as stalls and houses inside the Myohaung Depot Improvement Area and the resettlement of **12** households is unavoidable for the project. Expected affected houses are located as shown in the following figure;

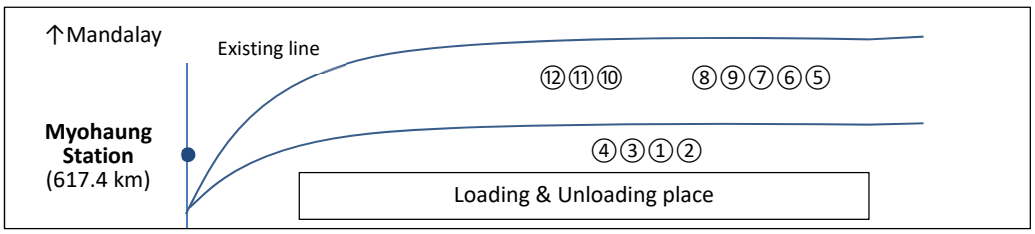


Figure 8.2.2 Locations of expected affected areas (Myohaung Depot Improvement Plan)

For Alignment and Track improvement, all the sections with radii less than 500 metres will be improved to be at least 500 metre radius. In this case, there are no affected private lands (farmlands) but **3** housings and **2** private units are expected to be affected due to improvement of the existing alignment.

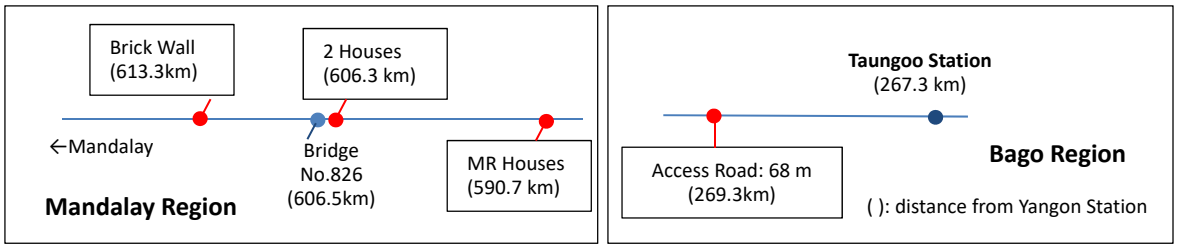


Figure 8.2.3 Locations of expected affected areas (Alignment and Track Improvement Plan)

Project Affected Units (PAUs) and Project Affected Persons (PAPs) are required to be treated with respect and to be recompensed commensurate with the extent and kind of the losses. Therefore, the occurrence of involuntary resettlement and generation of PAPs are anticipated due to the project. Accordingly, some losses of structures, assets, and/or business activities are expected and thus appropriate compensation and resettlement assistance for Project must be given.

(2) Initial effort to avoid or minimize Resettlement and Land Acquisition

To avoid and minimize involuntary resettlement and land acquisition, Myanma Railways is considering the following measures;

- In order to reduce the amount of resettlement or land acquisition, the design and facilities will be installed based on the available land.
- Most of the project activities will be implemented inside the areas (ROW) of Myanma Railways.
- MR will be responsible for providing suitable compensation related to resettlement and assistance such as conducting livelihood restoration programs for those who are affected by the project.
- All the resettlement measures will be conducted by Myanma Railways in accordance with the existing laws and regulations of Myanmar as well as JICA Guidelines related to land acquisition and resettlement.
- All necessary measures will be made by closely watching every stage of the project implementation for the purpose of reducing the significance of the resettlements.

8.2.2 Legal and Policy Framework for Resettlement and Land Acquisition in Myanmar

(1) Laws and Regulations of Myanmar related to Land Acquisition and Resettlement

There are many significant laws which govern land issues, land administration and land ownership in Myanmar such as the Land Nationalization Act (1953), Disposal of Tenancies Law (1963), Land Acquisition Act (1894), Forest Law (1992), Farm Land Law (2012), and so on. Among them, the Land Acquisition Act (1894) is the core law of land acquisition.

The Land Acquisition Act 1894 promulgated in the British Colonial Era is even now the core law for land acquisition and resettlement in Myanmar. No new effectual system has been established as of the end of 2015. The Ministry of Home Affairs, Settlement and Land Record Department and Forest Department are expected to update a better system in the near future. The flow of Land Acquisition under Myanmar Legislation is shown in Figure 8.2.4 as follows. The process is summarized as the following 5 steps;

1) Preliminary investigation,

A notification is publicized in a gazette and the substance of the public notice is announced at convenient places. Preliminary investigations are conducted, which include surveys, digging/boring, and delineation of the land boundaries.

2) Hearings about objections,

Objections to land acquisition are collected in writing within 30 days from the notification. The Collector examines the objections and attempts to reach a consensus over the issue. A report containing recommendations on the objections is submitted to the President of the Union for his decision, if the Collector finds it necessary to do so.

3) Declaration of intended acquisition,

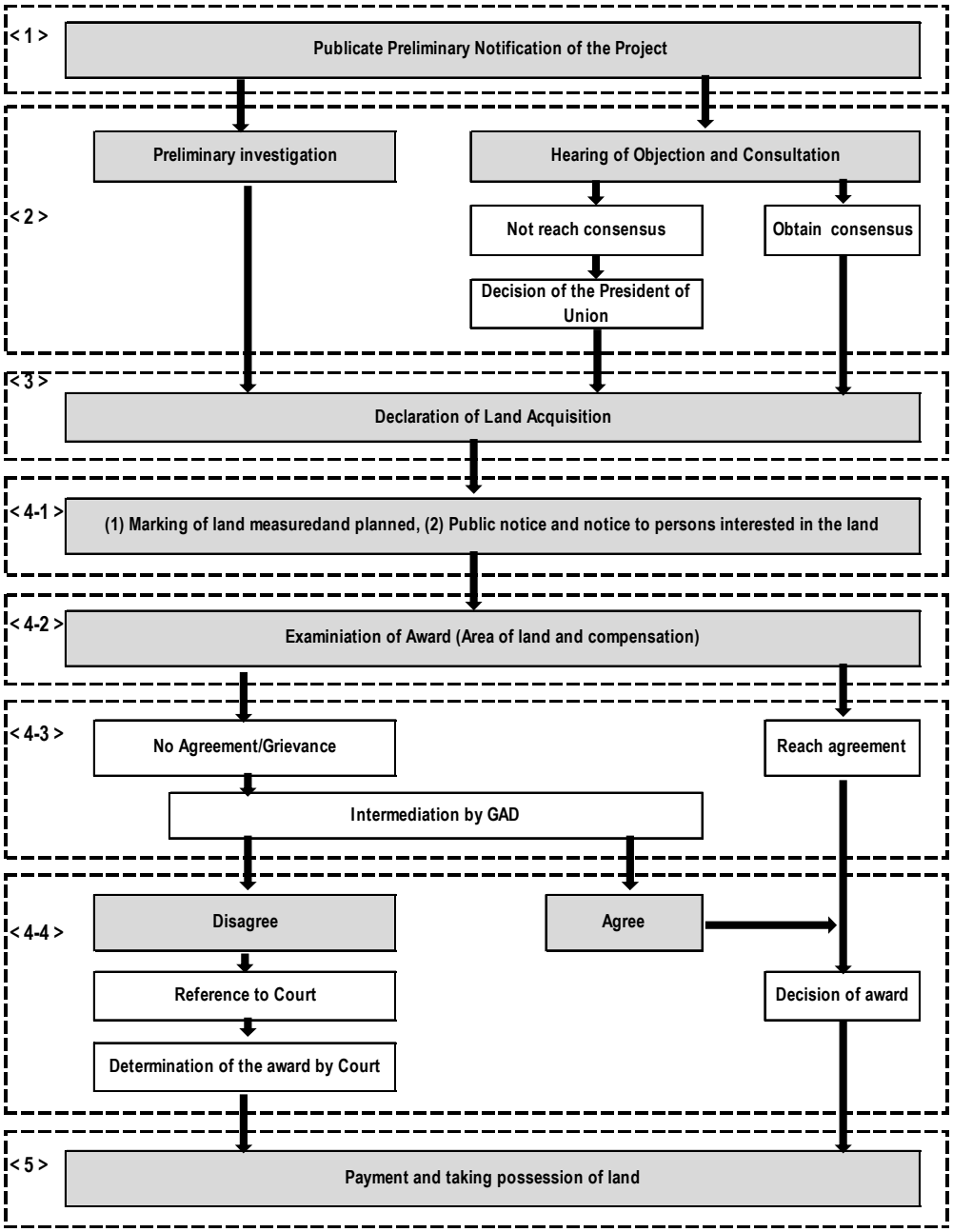
The declaration of land acquisition is publicized in the gazette, and stated in the district or other territorial division in which the land situates. The declaration includes the purposes, approximate size of the area, location and plan.

4) Enquiry into measurements, value and claims, and award by the collector,

i. The Collector marks out and measures the land, and gives the public notice at convenient places near the land. The notice is also provided to persons known or believed to be interested in the land.

ii. 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 the publication of the notification, the respective eligibilities to claim the compensation and examines an award. The award is examined based on the area of the land, compensation including opinions of PAPs and the apportionment of compensation among PAPs. The award is filed as conclusive evidence between the Collector and the persons interested in the land. The Collector immediately notices the awards to the persons who are not present or their representatives when the award is made. The Collector makes all possible efforts to modify enquiry.



Source: JICA Study team

Figure 8.2.4 Flow of Land Acquisition under Myanmar Legislation

iii. Grievances

If the deliberations reach an agreement, the Award Committee issues the decision concerning the type and amount of compensation. The deliberation is continued until agreement is reached between the affected people and the Award Committee, but the General Administration Department (GAD) can intermediate if they cannot conclude an agreement alone.

iv. Reference to Court

Any person interested in the land who does not accept the award can require that the matter be referred by the Collector for the determination of the Court with written application, this is appropriate whether the objection is to the measurement of the land, the amount of the compensation, the person to whom it is payable, or the apportionment of the compensation among the persons interested. If the persons agree to the compensation, the particulars are specified in the award for conclusive evidence. If any dispute arises, the Collector may refer the disputes to the decisions of the Court.

5) Payment and Taking possession of land

The Collector pays the compensation and takes possession of the land. The Collector gives the persons sufficient time to remove their property without inconvenience before taking possession.

(2) JICA Environmental and Social Consideration Guideline (2010)

According to JICA Guidelines, the key principles of JICA's policy on involuntary resettlement and land acquisition are as below.

a) Involuntary resettlement and loss of means of livelihood are to 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 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.

d) Compensation must be based on the full replacement cost as much as possible.

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, 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.

h) Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.

i) Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

j) 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 or others who wish to take advantage of such benefits.

k) Eligibility for Benefits include the PAPs who have formal legal rights to the land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to the 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 strategies 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, an abbreviated resettlement plan is to be prepared.

In addition to the core principles above, JICA's guideline also lays emphasis on a detailed resettlement policy inclusive of all the following points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation and detailed Financial Plan etc.

(3) Comparison of JICA Guideline and Myanmar Legislation

Table 8.2.1 shows the comparison of the JICA guidelines and Myanmar legislation and countermeasures to rectify the deficiencies.

Table 8.2.1 Comparison of the JICA guidelines and Myanmar Legislation

No	JICA Guidelines	Laws and Guidelines in Myanmar	Gap relative to JICA GL	Project Policy
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Not applicable	There is no regulation which mentions or requests to avoid or minimize involuntary resettlement or loss of livelihood means.	Follow JICA GL
2	When population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken. (JICA GL)	Compensation or indemnity is provided for farmland acquisition for the interest of the State or public (Farmland Law (2012) Art. 26, Farmland Rules (2012) Art. 64).	According to Farmland law, it refers to compensate only for crops	Follow JICA GL
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. (JICA GL)	Damage to standing crops/trees, lands, movable/immovable properties, relocation cost, and economic activities are requested to be compensated for. (Land Acquisition Act (1894) Art. 23, Farmland Rules (2012) Art. 67)	There is no stipulation of improving or at least restoring living standard, income opportunities, or production levels to pre-project levels in the Myanmar legal framework.	The project considers the assistance to improve or restore the livelihood.
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	Compensation at three times the value calculated based on the average production of crops in the current market price of that area is provided. (Farmland Rules (2012) Art. 67)	Farmland law refers to compensate only for crops	Follow JICA GL
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	When compensation is not paid on or before land acquisition, compensation amount awarded rate must be paid with interest.	There is no clear indication about timing of compensation payment in the Myanmar legal framework.	The compensation and other kinds of assistance are to be provided prior to displacement.
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	Not applicable	There is no regulation requesting to prepare a resettlement action plan.	The project prepares abbreviated resettlement action plan and makes it available to the public.

No	JICA Guidelines	Laws and Guidelines in Myanmar	Gap relative to JICA GL	Project Policy
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. (JICA GL)	Not applicable	There is no regulation requesting to organize consultations with PAPs.	The project holds the consultations with the affected people and their communities with sufficient information made available to them in advance.
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	Not applicable	Ditto	Language that is understandable to the affected people will be used.
9	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	Not applicable	There is no regulation requesting participation of PAPs into planning, implementation, and monitoring of resettlement action plans.	The project considers the appropriate participation of affected people.
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	1) Notice of compensation amount directly to PAPs: appeal to the court within 6 weeks from the date of compensation award 2) Notice of compensation amount to representatives of PAPs: i) within 6 weeks of receipt of compensation notice, or ii) within 6 months from the date of the compensation award, whichever period shall first expire (Land Acquisition Act (1894) Art. 18)	The procedure for grievance in the Myanmar context is direct settlement at the court, which is not necessarily easy or accessible to PAPs	The project considers the grievance redress mechanism by utilizing the existing administration system to be convenient for PAPs.
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 or others who wish to take advantage of such benefits. (WB OP 4.12 Para. 6)	A notification of land acquisition or public purposes is published in the Gazette, which is also published at a convenient place in the concerned municipality. (Land Acquisition Act (1894) Article 4)	There is no specific description for identifying affected people as early as possible in the national law.	The project identifies and records the affected people at the project identification stage.

No	JICA Guidelines	Laws and Guidelines in Myanmar	Gap relative to JICA GL	Project Policy
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 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 OP 4.12 Para. 15)	Occupiers/stakeholders of lands to be acquired are explained about acquisition and claims to compensations. (Land Acquisition Act (1894) Article 9)	Detail procedures as well as eligibility criteria are not clearly defined. Also there is no specific indication about displaced persons without titles.	The project considers eligibility for assistance to all households whose income sources or assets are confirmed as affected due to project implementation.
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP 4.12 Para. 11)	Not Applicable	There is no regulation stipulating to give land-based resettlement strategies.	The project considers the land-based resettlement strategies.
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP 4. 12, para.6)	Not Applicable	There is no regulation stipulating to provide support for the transition period.	The project supports the PAPs during 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, children, and ethnic minorities etc. (WB OP 4.12 Para. 8)	Not Applicable	There is no regulation stipulating to provide particular attention to the vulnerable groups.	The project pays particular attention to vulnerable groups.
16	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, an abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	Not Applicable	There is no regulation stipulating to develop an A-RAP for a project with involuntary resettlement of fewer than 200 people.	Same as JICA GL

Source: Land Acquisition Act (1894), Farmland Rules (2012), Farm Land Law (2012), JICA Guidelines (2010.4) and World Bank OP 4.12

(4) Institutional Framework for Resettlement and Land Acquisition

In general, issues of land acquisition and resettlement are complicated in Myanmar due to the issues such as entangled legislation and divided administrative structures. Roles and functions of organizations for implementing land acquisition and resettlement are shown in the following table.

Table 8.2.2 Roles of Organizations for Implementing Land Acquisition and Resettlement

Organization	Role and Function
Land Management Committee (LMC)	1) For non-agricultural land, LMC at township level investigates land use, area size, land ownership and tenant, and prepares necessary documents and maps for land acquisition. 2) The LMC routinely handles transfer of land titles or subdivisions of plots, etc. and prepares land lease certificates.
Department of Agricultural Land Management and Statistics (DALMS)	1) For agricultural lands, the SLRD under the MOALI at township level investigates area size and land ownership, prepares necessary documents and maps for land acquisition. 2) The SLRD surveys market prices of lands, buildings, crops and trees for compensation.
Award Committee	The Award Committee chaired by the respective Township Administrator is established to examine the award (entitlement, amount of compensation).
District Administrator	The District Administrator issues land lease grants for land not exceeding one (1) acre (The Lower Burma Town and Village Lands Manual, 1899).
General Administration Department (GAD), Ministry of Home Affairs (MOHA)	The GAD issues land lease grants for land exceeding five (5) acres (The Lower Burma Town and Village Lands Manual, 1899)

Source: JICA Study Team

(5) Resettlement Policy

1) General Considerations

The policy regarding the replacement of structures and resettlement caused by the project implementation needs to take both the JICA guidelines and the Myanmar Legislation into consideration. However, considering that gaps exist between the JICA guidelines and the Myanmar Legislation as shown in Table 8.2.1, and that the former is comparatively comprehensive, the policy for this particular project shall be primarily based on the JICA guidelines (2010).

2) Replacement Cost

The compensation to the PAPs who have the eligibility, namely, those who meet the cut-off date, shall be made based on the principles as stated below. A necessary compensation amount for the replacement, which is needed to replace the affected assets without depreciation or deduction for taxes and/or costs of transaction, is calculated before the displacement.

a) Productive Land (agricultural, aquaculture, garden and forest): based on the actual 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.

b) Residential Land: based on the actual 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.

c) Existing regulations of local governments regarding the calculation of compensation for buildings, crops and trees shall be used wherever available.

d) Houses and other related structures: based on the actual current market prices of affected materials.

e) Annual/Perennial crops: Compensation is provided at three times the value calculated based on the average production of crops and the current market price of that area.

f) For timber trees: The cash compensation for the replacement should be in line with local government regulations if available, or equivalent to the current market value. Value is decided 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

MOTC and the responsible agencies are requested to follow the JICA's guidelines as well as the existing laws and regulations in the country in making compensation for the losses of PAPs in this particular project. If the amount of compensation does not meet the JICA's requirement, all the relevant agencies are requested to prepare complementary compensation.

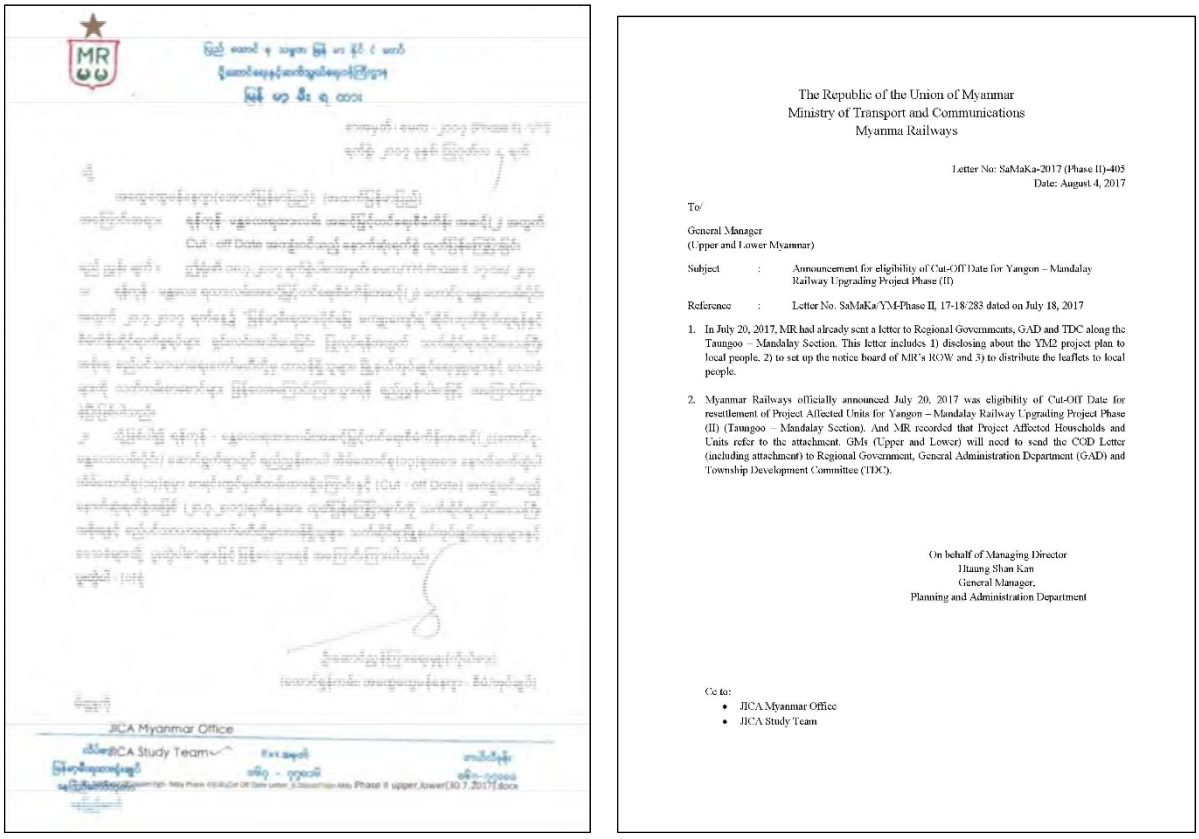
4) Eligibility Cut-Off Date

A cut-off date is set to identify and differentiate genuine eligible PAPs from non-eligible people, thereby reducing possible conflict. For this project, the cut-off date has been set at 20th July, 2017 which represents the time of completion of all socio-economic surveys for the improvement of the 3 sectors. The periods of the social surveys for the 3 sectors (Bridge renovation, Myohaung depot improvement, and alignment and track improvement) are as follow.

- Bridge Renovation Areas: from May 17-18 and July 10-12 2017(4 days)
- Myohaung Depot Improvement Area: from June 1-2, 2017. (2 days)
- Alignment and Track Improvement Areas: from June 20 – 23, 2017 (4 days)

The Process of declaration of the Cut-off date begins with the issuance of a letter containing a list of affected peoples from the MR Headquarters to the General Manager of the Upper and Lower MR. Then the Upper and Lower MR office will send copies of that letter to all GAD offices and stations that are expected to have some impacts. That letter is posted on the board at each station. After the declaration of the Cut-off date, it is effective to keep the list of PAPs to prevent some people who are not PAPs from entering the site. In addition, especially in the case of Myohaung Station, the station manager and staff will monitor or check the station area periodically in order to prevent anyone from beginning to build a house.

During the detail design stage, this result of the social survey (including census survey) will be updated. The letter for declaration of the Cut-off date is shown in the following figure. And the public announcement at each station is also shown in the following figure.



The Republic of the Union of Myanmar
Ministry of Transport and Communications
Myanma Railways

Letter No: SaMaKa-2017 (Phase II)-405
Date: August 4, 2017

To/

General Manager
(Upper and Lower Myanmar)

Subject : Announcement for eligibility of Cut-Off Date for Yangon – Mandalay Railway Upgrading Project Phase (II)

Reference : Letter No. SaMaKa/YM-Phase II, 17-18/283 dated on July 18, 2017

1. In July 20, 2017, MR had already sent a letter to Regional Governments, GAD and TDC along the Taungoo – Mandalay Section. This letter includes 1) disclosing about the YM2 project plan to local people, 2) to set up the notice board of MR's ROW and 3) to distribute the leaflets to local people.

2. Myanmar Railways officially announced July 20, 2017 was eligibility of Cut-Off Date for resettlement of Project Affected Units for Yangon – Mandalay Railway Upgrading Project Phase (II) (Taungoo – Mandalay Section). And MR recorded that Project Affected Households and Units refer to the attachment. GMs (Upper and Lower) will need to send the COD Letter (including attachment) to Regional Government, General Administration Department (GAD) and Township Development Committee (TDC).

On behalf of Managing Director
Htaung Shan Kan
General Manager,
Planning and Administration Department

Cc to:
- JICA Myanmar Office
- JICA Study Team

Figure 8.2.5 Letter for Declaration of Cut-Off Date from MR to target District Offices

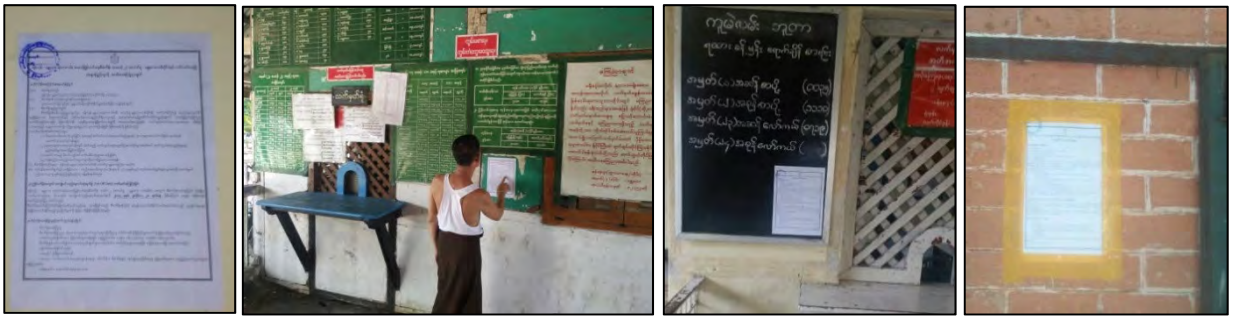


Figure 8.2.6 Cut-off Date Announcement Letters posted in MR Stations

8.2.3 Scope of Land Acquisition and Resettlement

(1) Summary of Possible Affected Persons and Units

A summary of the possible affected persons is shown in the following Table. A-RAP Study (i.e. census, asset and socio-economic study, etc.) has been conducted for the Project which is expected to involve the acquisition of private land and involuntary resettlement.

Table 8.2.3 Summary of affected households

	No	HH Code	Religion/State	District	Township	Condition
Bridge Renovation	1	Bdg.379 - 01	Nay Pyi Taw	Dekkhina	Lewe	Affected 1 house, 1 temporary shed and 1 temporary hut
	2	Bdg.393 - 01	Nay Pyi Taw	Dekkhina	Pyinmana	Affected 1 temporary shed
	3	Bdg.393 - 02	Nay Pyi Taw	Dekkhina	Pyinmana	Affected 1 house and 1 temporary shed
	4	Bdg.417 - 01	Nay Pyi Taw	Ottara	Pobbha Thiri	Affected 1 temporary shed
	5	Bdg.683 - 01	Mandalay	Meikhtila	Wundwin	Affected 1 plot of YA land
	6	Bdg.683 - 02	Mandalay	Meikhtila	Wundwin	Affected 1 plot of farmland
	7	Bdg.748 - 01	Mandalay	Kyaukse	Kyaukse	Affected 1 temporary hut
Depot Improvement	1	Dep.MH 01	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 temporary shed and 1 house
	2	Dep.MH 02	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 house
	3	Dep.MH 03	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 house and 2 temporary huts
	4	Dep.MH 04	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 house
	5	Dep.MH 05	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 house
	6	Dep.MH 06	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 house
	7	Dep.MH 07	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 house
	8	Dep.MH 08	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 house and 1 temporary shed
	9	Dep.MH 09	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 house and 1 temporary hut
	10	Dep.MH 10	Mandalay	Mandalay	Chan Mya Tharzi	Affected 2 houses
	11	Dep.MH 11	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 temporary hut
	12	Dep.MH 12	Mandalay	Mandalay	Chan Mya Tharzi	Affected 1 temporary hut
Alignment Improvement	1	U-IP.182 - 01	Mandalay	Mandalay	Pyi Gyi Tagon	Affected Brick Wall, about 60 metres in length, owned by Hindu Monastery
	2	D-IP.182 - 01	Mandalay	Kyaukse	Paleik	Affected 1 house
	3	D-IP.182 - 02	Mandalay	Kyaukse	Paleik	Affected 1 house
	4	D-IP.173 - 01	Mandalay	Kyaukse	Singaing	Affected 1 MR Staff's house
	5	U-IP.1 - 01	Bago	Taungoo	Taungoo	Affected Public access road to Monastery, about 68 metres in length, funded by Buddhist Monastery

Source: JICA Study Team

(2) Project Affected Persons and Project Affected Units

The Following Table shows the number of PAUs and PAPs. There are 24 households (103 people) for 3 sectors in total for the Phase 2 project.

Table 8.2.4 PAUs and PAPs (all)

Sectors	Affected HHs	Project Affected Persons	PAUs			Remark
			No. of Affected Units	No. of land plots	Total Land Area (m^2)	
Bridge Renovation	7	41	8	2	951.57	-
Myohaung Depot Improvement	12	53	18	-	405.58	-
Alignment and Track Improvement	5	9	5	-	875.67	Including Brick Wall and access road
TOTAL (Phase2)	**24**	**103**	**31**	**2**	**2,232.82**	
Phase 1	4	24	4			
TOTAL (Phase1+2)	28	127				

Source: JICA Study Team

Among the 24 households (103 persons) for the 3 sectors, the amount of households and affected people who need to be resettled is as shown in the following table. All lands are located within the Right of Way (ROW) and it is expected that all PAPs who need to be resettled are living illegally.

Table 8.2.5 Expected HH and PAPs who need to be resettled

Sector	No. affected HHs	No. affected Persons
Bridge Renovation	3	22
Myohaung Depot Improvement	12	53
Alignment and Track Improvement	3	7
TOTAL	**18**	**82**

Source: JICA Study Team

The corresponding number of Project Affected Persons (PAPs) is enumerated by the census survey from May - July 2017 by the JICA Study Team.

According to the evaluation criteria of the JICA's guidelines for Environmental and Social Considerations (2010), the Project can be categorized as "Category B"; meaning that the number of expected PAPs is less than 200 and adverse impacts are expected to some extent but not so significant. The following tables (Table 8.2.6, Table 8.2.7 and Table 8.2.8) show a brief account of the PAPs and PAUs for each sector. More detailed information about each PAU is shown in the Appendix to this report (Appendix8.2 (1): List of Affected Land and Units).

Table 8.2.6 PAUs and PAPs (Bridge Renovation Areas)

No.	Bridge No.	Code of Household	No. of Family Members	No. of Affected Units	Affected Unit	Affected Size (m^2)	Years Living in Affected Area	Distance from the Rail (m)
1	379	**Bdg.379 - 01**	9	3	House	27.55	26	6.7
					Temporary shed	34.44		
					Temporary hut	9.18		
2	393	**Bdg.393 - 01**	4	1	Temporary Shed	49.95	28	6.06
3	393	**Bdg.393 - 02**	8	2	House	30.30	17	19.70
					Temporary shed	20.66		
4	417	**Bdg.417 - 01**	6	1	Temporary shed	21.49	28	10.9
5	683	**Bdg.683 - 01**	5	1 plot	Farmland	627	-	7
6	683	**Bdg.683 - 02**	4	1 plot	Farmland	104	-	8
7	748	**Bdg.748 - 01**	5	1	House	27	5	8.5
		7	**41**	**10**		**951.57**		

Source: JICA Study Team

Table 8.2.7 PAUs and PAPs (Myohaung Station)

No.	Code of Household	No. of Family Members	No. of Affected Units	Affected Units	Affected Size (m^2)	Years Living in Affected Area	Distance from the Rail (m)
1	**Dep.MH 01**	5	2	Temporary shed	30.14	19	-
				House	30.14		
2	**Dep.MH 02**	3	1	House	9.30	7	-
3	**Dep.MH 03**	4	3	House	9.30	3	-
				2 Temporary huts	18.60		
4	**Dep.MH 04**	2	1	House	9.30	1	-
5	**Dep.MH 05**	4	1	House	25.09	12	-
6	**Dep.MH 06**	5	1	House	20.88	5	-
7	**Dep.MH 07**	4	1	House	13.94	8	-
8	**Dep.MH 08**	4	2	House	13.94	6	-
				Temporary Shed	51.31		
9	**Dep.MH 09**	6	2	House	34.82	9	-
				Temporary hut	9.30		
10	**Dep.MH 10**	7	2	House	81.31	10	-
				House	13.39		
11	**Dep.MH 11**	5	1	Temporary Hut	13.94	5	-
12	**Dep.MH 12**	4	1	Temporary Hut	20.88	8	-
	12	**53**	**18**		**405.58**		

Source: JICA Study Team

Table 8.2.8 PAUs and PAPs (Alignment Improvement)

No.	Code of Household	No. of Family Members	No. of Affected Units	Affected Units	Affected Size (m^2)	Years Living in Affected Area	Distance from the Rail (m)
1	**U-IP.182-01**	1	1	Brick wall 60m	13.93	-	
2	**D-IP.182-01**	3	1	House	27.87	10	
3	**D-IP.182-02**	2	1	House	27.87	2	
4	**D-IP.173-01**	2	1	MR staff house	126	-	
5	**U-IP.1-01**	1	1	Access road	680	-	
		9	**5**		**875.67**		

Source: JICA Study Team

(3) Socio-Economic Situation of Project Affected Persons

The census survey conducted by the JICA study team from May to July 2016 includes interviewing 24 respondents (households). The socio-economic situation of PAPs will be evaluated based on the information obtained from these interviews, whose results are briefly outlined in the following tables.

1) Bridge Renovation

Table 8.2.9 Age of Family Members and Gender of the PAPs

HH Code	Age of HH Head	Total Number	Household Members' Age				Gender	
			<=5	6-17	18-60	>60	Male	Female
Bdg.379 - 01	61	9	3	0	5	1	7	2
Bdg.393 - 01	55	4	0	0	4	0	2	2
Bdg.393 - 02	66	8	1	1	4	2	3	5
Bdg.417 - 01	58	6	0	1	5	0	2	4
Bdg.683 - 01	35	5	0	3	2	0	3	2
Bdg.683 - 02	30	4	0	2	2	0	2	2
Bdg.748 - 01	50	5	0	1	4	-	1	4
Total		**41**	**4**	**8**	**26**	**3**	**20**	**21**

Source: JICA Study Team

Table 8.2.10 Occupation, Income and Expenditure of the PAPs

HH Code	Occupation	Annual Income (MMK)	Annual Expenditure (MMK)
Bdg.379 - 01	Skilled Labourer	2,160,000	1,800,000
Bdg.393 - 01	Shop owner	2,400,000	1,440,000
Bdg.393 - 02	Other	1,920,000	1,800,000
Bdg.417 - 01	Other	1,872,000	1,800,000
Bdg.683 - 01	Farmer	2,400,000	2,160,000
Bdg.683 - 02	Farmer	2,400,000	2,160,000
Bdg.748 - 01	Casual Labourer	2,400,000	1,800,000
Average		2,221,715	1,851,429

Source: JICA Study Team

Table 8.2.11 Ethnicity, Religion and Education Level of the PAPs

HH Code	Ethnicity	Religion	Education Level
Bdg.379 - 01	Myanmar	Buddhism	Primary School
Bdg.393 - 01	Myanmar	Buddhism	High School
Bdg.393 - 02	Myanmar	Buddhism	Primary School
Bdg.417 - 01	Myanmar	Buddhism	Middle School
Bdg.683 - 01	Myanmar	Buddhism	Middle School
Bdg.683 - 02	Myanmar	Buddhism	Middle School
Bdg.748 - 01	Myanmar	Buddhism	Monastery Education

Source: JICA Study Team

2) Myohaung Depot Improvement

Table 8.2.12 Age of Family Members and Gender of the PAPs

HH Code	Age of HH Head	Total Number	Household Members' Age				Gender	
			<=5	6-17	18-60	>60	Male	Female
Dep.MH 01	50	5	0	3	2	0	2	3
Dep.MH 02	28	3	0	2	1	0	2	1
Dep.MH 03	43	4	0	3	1	0	2	2
Dep.MH 04	26	2	0	1	1	0	1	1
Dep.MH 05	58	4	1	1	2	0	2	2
Dep.MH 06	57	5	0	4	1	0	3	2
Dep.MH 07	33	4	1	2	1	0	3	1
Dep.MH 08	39	4	0	3	1	0	1	3
Dep.MH 09	30	6	0	3	2	1	3	3
Dep.MH 10	56	7	0	2	5	0	3	4
Dep.MH 11	29	5	1	2	2	0	4	1
Dep.MH 12	30	4	0	3	1	0	1	3
Total		**53**	**3**	**29**	**20**	**1**	**27**	**26**

Source: JICA Study Team

Table 8.2.13 Occupation, Income and Expenditure of the PAPs

HH Code	Occupation	Annual Income (MMK)	Annual Expenditure (MMK)
Dep.MH 01	Company Staff	3,600,000	2,880,000
Dep.MH 02	Casual Labourer	1,632,000	1,200,000
Dep.MH 03	Stall Owner	1,560,000	1,200,000
Dep.MH 04	Stall Owner	1,800,000	1,080,000
Dep.MH 05	Vendor	2,400,000	1,800,000
Dep.MH 06	Skilled Labourer	3,600,000	2,700,000
Dep.MH 07	Casual Labourer	1,080,000	960,000
Dep.MH 08	Livestock	2,400,000	2,160,000
Dep.MH 09	Stall Owner	4,200,000	3,360,000
Dep.MH 10	Other	3,600,000	2,880,000
Dep.MH 11	Casual Labourer	2,160,000	1,800,000
Dep.MH 12	Casual Labourer	2,160,000	1,800,000
Average		2,516,000	1,985,000

Source: JICA Study Team

Table 8.2.14 Ethnicity, Religion and Education Level of the PAPs

HH Code	Ethnicity	Religion	Education Level
Dep.MH 01	Myanmar	Buddhism	High School
Dep.MH 02	Myanmar	Buddhism	High School
Dep.MH 03	Myanmar	Buddhism	Middle School
Dep.MH 04	Myanmar	Buddhism	Middle School
Dep.MH 05	Myanmar	Buddhism	Middle School
Dep.MH 06	Myanmar	Buddhism	Middle School
Dep.MH 07	Myanmar	Buddhism	Primary School
Dep.MH 08	Myanmar	Buddhism	Middle School
Dep.MH 09	Myanmar	Buddhism	Middle School
Dep.MH 10	Myanmar	Buddhism	Primary School
Dep.MH 11	Myanmar	Buddhism	High School
Dep.MH 12	Myanmar	Buddhism	Primary School

Source: JICA Study Team

3) Alignment Improvement

Table 8.2.15 Age of Family Members and Gender of the PAPs

HH Code	Age of HH Head	Total Number	Household Members' Age				Gender	
			<=5	6-17	18-60	>60	Male	Female
U-IP.182 - 01	55	1	-	-	-	-	1	0
D-IP.182 - 01	55	3	1	0	2	0	2	1
D-IP.182 - 02	58	2	0	1	1	0	2	0
D-IP.173 - 01	58	2	0	0	2	0	1	1
U-IP.1 - 01	57	1	-	-	-	-	1	0
Total		**9**	**1**	**1**	**5**	**0**	**7**	**2**

Source: JICA Study Team

Table 8.2.16 Occupation, Income and Expenditure of the PAPs

HH Code	Occupation	Annual Income (MMK)	Annual Expenditure (MMK)
U-IP.182 - 01	-	-	-
D-IP.182 - 01	Stall Owner	1,800,000	1,440,000
D-IP.182 - 02	Stall Owner	3,600,000	1,440,000
D-IP.173 - 01	MR Staff	1,680,000	1,440,000
U-IP.1 - 01	-	-	-
Average		2,360,000	1,440,000

Source: JICA Study Team

Table 8.2.17 Ethnicity, Religion and Education Level of the PAPs

HH Code	Ethnicity	Religion	Education Level
U-IP.182 - 01	Hindu	Hindu	-
D-IP.182 - 01	Myanmar	Buddhism	Primary School
D-IP.182 - 02	Myanmar	Buddhism	Primary School
D-IP.173 - 01	Myanmar	Buddhism	Middle School
U-IP.1 - 01	Myanmar	Buddhism	-

Source: JICA Study Team

Bdg.379 - 01: House

Bdg.379 - 01: Temporary shed

Bdg.393 - 01: Temporary Shed

Bdg.393 - 02: House

Bdg.417 - 01: Temporary Shed

Bdg.683 - 01: Farmland (Chili)

Bdg.683 – 02: Paddy land

Bdg.748 – 01: House

Figure 8.2.7 Assets Affected by Bridge Renovation

Dep.MH 01: Temporary Shed

Dep.MH 01: House

Dep.MH 02: House

Dep.MH 03: 1 House and 2 temporary huts

Dep.MH 04: House

Dep.MH 05: House

Scene during Survey

Scene during Survey

Figure 8.2.8 Assets Affected by Myohaung Depot Improvement

U-IP.182 - 01: Hindu Monastery's Brick Wall

D-IP.182 - 01: House

D-IP.182 - 02: House

D-IP.173 - 01: MR Staff's House

U-IP.1 - 01: Public Access Road to Monastery

Scene during the survey

Scene during the survey

Scene during the survey

Figure 8.2.9 Assets Affected by Alignment Improvement

(4) 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 for PAPs. The following table summarizes the Entitlement Matrix designed for this Project. If gaps exist between the JICA Guideline and Myanmar Legislation about the way of setting eligibility or identifying eligible persons, this entitlement matrix should be used according to the JICA Guideline.

Table 8.2.18 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	No. of applicable households				Responsible Organization
					Bridge	Depot	Track	AR/SY*	
1. Agricultural (Farmland) land within the MR ROW									
Loss of arable and grazing agricultural land or access to it	Partial loss of Farmland used to cultivate vegetables	Farmland which is used to cultivate vegetables such as sesame, groundnut, paddy etc.)	Person cultivating vegetables.	Provide cash compensation for the crop, which is equivalent to three times the annual yield from the crop measured in market prices.	2	-	-	Number is unknown at this stage, but expected.	MR
2. Private Agricultural land and/or Private Land out of MR ROW									
Loss of arable and grazing agricultural land or access to it	Permanent (Partial or complete) loss of Farmland	Farmland which is used to cultivate vegetables such as sesame, groundnut, paddy etc.)	Individual Farmland and/or Residential Land Owner	Provide cash compensation for the land, which is equivalent to local current market price.	-	-	-	Number is unknown at this stage, but expected.	MR
3. Private Structure within the MR ROW									
Loss of private structure or access to them	Permanent loss of structure for house/ shop	Private house Private shop (not having legal ownership right to the land)	Individuals who do not have formal and legal ownership right to the land	- Provide cash compensation for replacement costs of the affected structures if they were built by the PAPs. - Provide assistance in moving and finding similar and affordable rental accommodation /structure (this may include moving allowance and rental allowance for transition period).	5	12	3	Number is unknown at this stage, but expected.	MR
4. Private Structure out of the MR ROW									
Loss of private structure or access to them	Permanent loss of structure for house/ shop	Private house Private shop (having formal legal ownership right to the land)	Individuals who have formal and legal ownership right to the structures	- Provide cash compensation for replacement costs of the affected structures. (Compensation for the land will also be provided to that PAP if he/she had formal and legal ownership right to the land.)	-	-	-	Number is unknown at this stage, but expected.	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	No. of applicable households				Responsible Organization
					Bridge	Depot	Track	AR/SY*	
5. Public Assets									
Displacement of public assets	Permanent (complete or partial) displacement of public assets	Public Assets such as religious structures	Local community organization/ individual	- Provide cash compensation for replacement costs of the public assets. - Provide cash compensation for moving costs.	-	-	2	Number is unknown at this stage, but expected.	MR TDC Local Government
6. Tree, Plants of access to them									
Loss of Trees, plants or access to them	Permanent loss of trees on the public land	Assets of Local government (There are no trees possessed by private organizations or individuals.)	Local government (TDC)	- According to the instruction from the Forestry Department under MONREC, for cutting, removing and/or replanting affected trees (regardless of whether they are private or public, including MR's trees), first submit an application letter including information about the affected tree species, locations and number of trees, to the Department for obtaining permission. - Cutting trees should be avoided as much as possible. But if unavoidable, cutting, removing and/or replanting trees should be carried out by the Civil Engineering Department, MR. - Compensation policy is ensuring a program of replanting trees in line with the layout plan of the newly-developed structures.	-	Number is unknown at this stage, but expected.	-	Number is unknown at this stage, but expected.	MR TDC FD

Type of Loss	Level of Impact	Classification of affected units	Entitled Person(s) or Organization(s) to be compensated	Policy and contents of compensation	No. of applicable households				Responsible Organization
					Bridge	Depot	Track	AR/SY*	
7. Loss of income or Access to income**									
(1) Loss of income and work days during replacement period	Temporary loss of income during replacement or resettlement of shops	- Private Shop (replacement) (resettlement) - Farmland	Shop owner Farmer Livestock Vender	- Provide cash compensation as assistance for the transition period to help PAPs to restore and/or to improve their business and livelihood.	3	5	2	Number is unknown at this stage, but expected.	MR
(2) Loss of income due to losing jobs by a reason relating to the Project	Temporary loss of Income due to losing the job	- Private Shop (replacement) (resettlement)	Employees /workers who lose their jobs	- The owner pays amount of one month wage as unemployment allowance. - Compensation amount paid to the owner by MR includes this allowance.	4	7	1	Number is unknown at this stage, but expected.	MR

Note *: AR/SY is “Approach Road and Stock Yard”

Source: JICA Study Team

(5) Estimation of Compensation

Based on interviews with local residents and market surveys in/around the affected area, the estimated compensation amount for all three sectors, the bridge renovation, Myohaung depot improvement and track improvement is set at a value of MMK 13.594 million. The initial estimate cost for the house type was classified into three types. The following tables (4.16-4.20) show the initial estimate of the cost for affected units required for compensation for all three concerned sectors.

Table 8.2.19 Estimated Value of a Typical Affected House (Type I)

No.	Particular	Quantity	Unit	Rate (MMK)		Amount
1	Column (Wood)	9	number	1 piece	600	5,400
2	Bamboo Frame (Roofing)	25	number	1 piece	300	7,500
3	Zinc Sheet (Roofing)	20	number	1 piece	5,500	110,000
4	Thin Bamboo Strips	3	viss	1 viss	500	1,500
5	Binding Wire	1	viss	1 viss	1,800	1,800
6	Iron Nails	1	viss	1 viss	2,000	2,000
Material Cost						**128,200**
(Labour Cost)						
No.	Job description	Quantity	Unit	Rate (MMK)		Amount
1	Carpenter	1	Person day		7,000	7,000
2	Worker	2	Person day		5,000	10,000
Subtotal (Labour Cost)						**17,000**
Total (Material Cost + Labour Cost)						**145,200**

Source: JICA Study Team (Phoe Wa Gyi, Bamoobo Shop, Nay Pyi Taw, Ngwe Kyel Ein Construction Material Shop, Leway Township, Nay Pyi Taw & Kaung Khant Bamboo and Timber Shop, Leway Township, Nay Pyi Taw)

The price of a structure (temporary hut and temporary shed) is therefore estimated to be MMK 145,200 per 36 m^2 = MMK 4,033 /m^2 (approximately **MMK 4,050 /m^2**).

Table 8.2.20 Estimated Value of a Typical Affected House (Type II)

No.	Particular	Quantity	Unit	Rate (MMK)		Amount
1	Column (Wood)	9	number	1 piece	5,000	45,000
2	Bamboo Frame (Roofing)	30	number	1 piece	300	9,000
3	Zinc Sheet (Roofing)	20	number	1 piece	5,500	110,000
4	Bamboo (Walling)	12	number	10' x 6'	5,000	60,000
5	Bamboo (Flooring)	40	number	1 piece	300	12,000
6	Thin Bamboo Strips	4	viss	1 viss	500	2,000
7	Binding Wire	1	viss	1 viss	1,800	1,800
8	Iron Nails	2	viss	1 viss	2,000	4,000
Material Cost						**243,800**
(Labour Cost)						
No.	Job description	Quantity	Unit	Rate (MMK)		Amount
1	Carpenter	2	Person day		7,000	14,000
2	Worker	2	Person day		5,000	10,000
Subtotal (Labour Cost)						**24,000**
Total (Material Cost + Labour Cost)						**267,800**

Source: JICA Study Team (Phoe Wa Gyi, Bamoobo Shop, Nay Pyi Taw, Ngwe Kyel Ein Construction Material Shop, Leway Township, Nay Pyi Taw & Kaung Khant Bamboo and Timber Shop, Leway Township, Nay Pyi Taw)

The price of a structure (House) is therefore estimated to be MMK 267,800 per 36 m^2 = MMK 7,440 / m^2 (approximately **MMK 7,450 /m^2**)

Table 8.2.21 Estimated Value of a Typical Affected House (Type III)

No.	Particular	Quantity	Unit	Rate (MMK)		Amount
1	Column (Wood)	9	number	1 piece	33,750	303,750
2	Wooden Frame (Roofing)	20	number	1 piece	8,000	160,000
3	Zinc Sheet (Roofing)	20	number	1 piece	5,500	110,000
4	Bamboo (Walling)	12	number	10' x 6'	5,000	60,000
5	Wood (Flooring)	36	number	6" x 0.5"	5,400	194,400
		18	number	3" x 2"	6,750	121,500
6	Doors	2	number	6' x 2.5'	6,500	13,000
7	Iron Nails	3	viss	1 viss	2,000	6,000
8	Accessories	LS	-	-	15,000	15,000
Material Cost						**983,650**
(Labour Cost)						
No.	Job description	Quantity	Unit	Rate (MMK)		Amount
1	Carpenter	5	Person day		7,000	35,000
2	Worker	10	Person day		5,000	50,000
Subtotal (Labour Cost)						**85,000**
Total (Material Cost + Labour Cost)						**1,068,650**

Source: JICA Study Team (Phoe Wa Gyi, Bamoobo Shop, Nay Pyi Taw, Ngwe Kyel Ein Construction Material Shop, Leway Township, Nay Pyi Taw & Kaung Khant Bamboo and Timber Shop, Leway Township, Nay Pyi Taw)

The price of a structure (House) is therefore estimated to be MMK 1,068,650 per 36 m^2 = MMK 29,685/ m^2 (approximately **MMK 29,685 /m^2**).

Table 8.2.22 Estimated Value for Construction of Brick Wall

No.	Particular	Quantity	Unit	Rate (MMK)		Amount
1	Brick	540	number	number	100	54,000
2	Cement	2	number	50 kg bag	5,500	11,000
3	Sand	0.5	sud	sud	10,000	5,000
4	Chipping	0.25	sud	sud	42,000	10,500
5	Accessories	-	-	-	-	0
Material Cost						**80,500**
(Labour Cost)						
No.	Job description	Quantity	Unit	Rate (MMK)		Amount
1	Manson	1	Person day		8,000	8,000
2	Worker	2	Person day		5,000	10,000
Subtotal (Labour Cost)						**18,000**
Total (Material Cost + Labour Cost)						**98,500**

Source: JICA Study Team (Than Kywel, Construction Material Shop, Mandalay). 1sud=100ft3=2.83m^3

The price of the structure (brick wall with a height of 7 feet and thickness of 9 inches) is therefore estimated to be MMK 98,500 per 3.00 m in length and so the cost for 1 meter length is MMK 32,833. **(**approximately **MMK 32,850/m).**

Table 8.2.23 Estimated Value for Construction of Bituminous Road

No.	Particular	Quantity	Unit	Rate (MMK)	Amount
Material Cost					
1	2" x 4" Crushed Rock	370	Sud	26,500	9,805,000
2	1" x 2" Crushed Rock	212	Sud	32,000	6,784,000
3	3/4" Chipping	51	Sud	35,000	1,785,000
4	3/8" Chipping	14	Sud	37,000	518,000
5	1/2" Crushed Rock	9	Sud	33,000	297,000
6	Crushed Rock	75	Sud	22,000	1,650,000
7	Crushed Rock (Granular)	57	Sud	26,000	1,482,000
8	Coarse Sand	4	Sud	12,000	48,000
9	Diesel (For Operation Machinery)	1044	Gallon	3,000	3,132,000
10	Accessories	LS	-	178,000	178,000
Subtotal (Material Cost)					**25,679,000**
Cost for Operation Machine Rent					
No.	Equipment	Quantity	Unit	Rate (MMK)	Amount
1	Compactor	75	Sud	80,000	6,000,000
2	Water Boxer	1.1	Sud	65,000	71,500
Subtotal (Cost for operation machine rent)					**6,071,500**
Labour Cost					
No.	Particular	Quantity	Unit	Rate (MMK)	Amount
1	Labourer (Senior)	93	number	7,000	651,000
2	Labourer (Junior)	1089	number	6,000	6,534,000
3	Labourer (for digging	232	number	6,000	1,392,000
Subtotal (Labour Cost)					**8,577,000**
Total (material cost + cost for operation machine rental + labour cost)					**40,327,500**

Source: Cost estimate for Villages connecting road of Zayat Phyu-Thinpoat-ThadaOolay, Kyaukse Township by Department of Rural Development. 1sud=100ft3=2.83m^3

According to above data, the cost for establishment of a 12 feet wide bituminous road having the length of 1 mile (1,609 meters) is MMK 40,327, 500. So it could be said the estimate cost for construction of 1 meter is MMK 25,064. **(**approximately **MMK 25,100/m)**

1) Estimation of compensation amount for Bridge Renovation Areas

Table 8.2.24 House Type

Code	State/Region	Township	Affected Units	House Type (m^2)	
Bdg.379 - 01	Nay Pyi Taw	Lewe	1 House 1 Temporary shed 1 Temporary hut	Type II Type I Type I	27.55 m^2 34.44 m^2 9.18 m^2
Bdg.393 - 01	Nay Pyi Taw	Pyinmana	1 Temporary shed	Type I	49.95 m^2
Bdg.393 - 02	Nay Pyi Taw	Pyinmana	1 House 1 Temporary shed	Type II Type I	30.30 m^2 20.66 m^2
Bdg.417 - 01	Nay Pyi Taw	Pobbha Thiri	1 Temporary shed	Type I	21.49 m^2
Bdg.683 - 01	Mandalay	Wundwin	1 YA land (Chili)	-	627 m^2
Bdg.683 - 02	Mandalay	Wundwin	1 Farmland (Rice)	-	104 m^2
Bdg.748 - 01	Mandalay	Kyaukse	1 Temporary hut	Type I	27 m^2

Source: JICA Study Team

Table 8.2.25 Estimation of the Budget of MR for Structures, Replacement and Resettlement

Item	Description
Type of Loss	
Land	All affected units exist within the ROW of MR and so the presences of private owned lands are not found.
Immovable Assets	Temporary sheds (Type I) MMK 4,050 × 126.54 m^2= **MMK 512,487** Temporary huts (Type I) MMK 4,050 × 36.18 m^2 = **MMK 146,529** House (Type II) MMK 7,450 × 57.85 m^2= **MMK 430,982**
Valuable Crops/ Trees	Provision of cash 3 times the value of annual yield. ✓ 0.15 acre of Chili Plantation 326 kg/1acre/1year*1841 MMK/1kg = 600,166 MMK **48.9 kg/0.15 acre/1 year*1841MMK/1kg= 90,025 MMK*3= MMK 270,075** ✓ 0.025 acre of Paddy field (Rice) 979.8 kg/1 acre/1 year* 750 MMK/1 kg= 734,850 MMK **24.5 kg/ 0.025 acre/1 year*750 MMK/1 kg= 18,375 MMK*3= MMK 55,125** *Source: Myingyan Whole Sale Centre, Myonwa Whole Sale Centre and Interview with local farmers*
Movable Assets	Provision of transportation mode to transfer the assets (if necessary)
Job Opportunity	Provision of prioritized employment opportunities in construction-related works of the Project, in compliance with gender equality. In addition, advertise a job opening first to PAPs, and introduce empty house or shop.
Loss of income	In case of resettlement, provision of compensation
Cost for finding alternate land for relocation	Project considers the cost to be based on resettlement strategies after consultation with MR
Total	**MMK 1.415 million**

Note: Based on annual yield confirmed by land owner and consultants (total annual yield =MMK 0.1 million)
Source: JICA Study Team

Estimated Value of a Typical Affected House is shown in Table 8.2.19 and 8.2.20. The condition of a typical affected house is one story, size 20 feet x 20 feet (6 m x 6 m = 36 m^2), with wood columns, GI sheet roofing, but some others are made of bamboo only.

2) Estimation of compensation amount for Myohaung Depot Improvement Area

Table 8.2.26 House Type

Code	State/Region	Township	Affected Units	House Type (m^2)	
Dep.MH 01	Mandalay	Chan Mya Tharzi	Temporary Shed	Type I	30.14
			House	Type II	30.14
Dep.MH 02	Mandalay	Chan Mya Tharzi	House	Type II	9.30
Dep.MH 03	Mandalay	Chan Mya Tharzi	House	Type II	9.30
			2 Temporary Huts	Type I	18.60
Dep.MH 04	Mandalay	Chan Mya Tharzi	House	Type II	9.30
Dep.MH 05	Mandalay	Chan Mya Tharzi	House	Type II	25.09
Dep.MH 06	Mandalay	Chan Mya Tharzi	House	Type II	20.88
Dep.MH 07	Mandalay	Chan Mya Tharzi	House	Type II	13.94
Dep.MH 08	Mandalay	Chan Mya Tharzi	House	Type II	13.94
			Temporary Shed	Type I	51.31
Dep.MH 09	Mandalay	Chan Mya Tharzi	House	Type II	34.82
			Temporary Hut	Type I	9.30
Dep.MH 10	Mandalay	Chan Mya Tharzi	House	Type III	81.31
			House	Type II	13.39
Dep.MH 11	Mandalay	Chan Mya Tharzi	Temporary Hut	Type I	13.94
Dep.MH 12	Mandalay	Chan Mya Tharzi	Temporary Hut	Type I	20.88

Source: JICA Study Team

Table 8.2.27 Estimation of the Budget of MR for Land, Structures Replacement and Resettlement

Item	Description
Type of Loss	
Land	All the affected units exist within the area of Myohaung Station which is owned by MR and so the property of private owned lands are not found.
Immovable Assets	Type I, MMK 4,050 × 144.17 m^2= **583,889 MMK** Type II, MMK 7,450 × 180.1 m^2= **1,341,745 MMK** Type III, MMK 29,685 × 81.31 m^2= **2,413,687 MMK**
Valuable Crops/Trees	Not necessary because there are no such valuable crops or trees identified in the project area.
Movable Assets	Provision of transportation mode to transfer the assets (if necessary)
Job Opportunity	Provision of prioritized employment opportunities in construction-related works of the project, in compliance with gender equality. In addition, advertise job openings first to PAPs, and introduce empty house or shop.
Loss of income	In case of resettlement, provision compensation
Cost for finding alternate land	The project considers the cost for finding alternate land based on resettlement strategies after consultation with MR
Total	**MMK 4.339million**

Source: JICA Study Team

Estimated Value of a Typical Affected House is shown in Table 8.2.19, 8.2.20 and 8.2.21. The condition of a typical affected house is one story, size 20 feet x 20 feet (6 m x 6 m = 36 m^2), with wood/bamboo columns, and GI sheet roofing, the others are made of bamboo only except type III.

3) Estimation of compensation amount for Alignment and Track Improvement Areas

Table 8.2.28 House Type

Code	State/Region	Township	Affected Units	House Type (m^2)	
D-IP.182-01	Mandalay	Paleik	House	Type II	27.87
D-IP.182-02	Mandalay	Paleik	House	Type II	27.87
D-IP 173-01	Mandalay	Kyaukse	MR Staff House	Type III	126

Source: JICA Study Team

Table 8.2.29 Estimation of the Budget of MR for Land, Structure Replacement and Resettlement

Item	Description
Type of Loss	
Land	All affected units exist within the ROW of MR and so the presences of privately owned lands are not found.
Immovable Assets	Type II, MMK 7,450 × 55.74 m^2= **415,263 MMK** Type III, MMK 29,685 × 126 m^2= **3,740,310 MMK** Hindu Monastery's Brick Wall, about 60 metres in length, and the cost for construction of 1 meter length of brick wall with a height of 7 metres and a thickness of 9 inches was 32,850 MMK. So we calculated that as follows, MMK 32,850 x 60 m = **1.971 million** Public Access Road to Buddhist Monastery, about 68 × 3 square meter, MMK 25,100 x 68 m = **1.71 million** *Ref: Cost estimate for Villages along the connecting road of Zayat Phyu-Thinpoat-ThadaOo lay, Kyauks Township, Department of Rural Development.*
Valuable Crops/Trees	Not necessary because there are no such valuable crops or trees identified in the project area.
Movable Assets	Provision of transportation mode to transfer the assets (if necessary)
Job Opportunities	Provision of prioritized employment opportunities in construction-related works of the project, in compliance with gender equality. In addition, advertise job openings first to PAPs, and introducte empty house or shop.
Loss of income	In case of resettlement, provision of compensation
Cost for finding alternate land for relocation	The project considers the cost for finding alternate land for relocation based on resettlement strategies after consultation with PAPs
Total	**MMK 7.836 million**

Note: Based on interviewed with local residents and market surveys.

Source: JICA Study Team

Estimated Value of a Typical Affected Houses is shown in Table 8.2.20 and 8.2.21. The condition of a typical affected house is one story, size 20 feet x 20 feet (6 m x 6 m = 36 m^2), with wood columns, and GI sheet roofing, others are made of bamboo only.

8.2.4 Livelihood Restoration Program (Proposed)

(1) Type of PAPs according to their losses

The affected people in this project can be generally categorized into three types of groups according to their loss of premises:

a) the people in consequence of loss of structural units such as living facilities,

b) the people in consequence of loss of agricultural lands, and

c) the people in consequence of loss of religious structures.

Only for type (a) will it be necessary to relocate the people from their existing places, because their living assets are completely located within the area of the improvement of the facilities of MR. In the case of type (b), people will not lose all of their agriculture land because land acquisition on their farmlands is just a small part (edge part of the land close to the existing rail line). So livelihood condition of type (b) people will not be changed too much. Type (c) is a different type and it is not subjected to any livelihood impact. Due to the less significant impact on livelihood, the people of type (b) and (c) will not be included in the livelihood restoration programs because they can continue to work or live in their original place.

(2) Access to resettlement assistance

(a) Providing cash,

- MR will provide cash compensation for replacement cost of the affected structures if they were built by the PAPs.
- For the displacement period, MR will also provide enough allowance (cash) for moving and finding similar and affordable rental accommodation/structure.
- If the affected unit is agricultural land within the ROW, MR will provide cash compensation which is equivalent to three times the annual crop (yield) value measured in local market prices.
- During the period of displacement, MR will provide cash in a reasonable amount as unemployment wage for one month, based on the highest monthly income reported by PAPs during the socio-economic surveys.

(b) Providing vocational training

MR shall arrange necessary capacity development training to raise the working skills of affected people through cooperation with both relevant governmental departments and non-governmental organizations to restore their income quickly. This will also consider the impact of gender to design suitable vocational training for female headed households or include family members of affected household through seeking assistance from the township social welfare department.

(c) Providing assistance in finding job opportunities in/around the project area

The project is planning to give assistance in finding job opportunities for the affected local people to avoid the shortage of workers. Moreover, the affected people will be targeted as the priority workers if they want to work as basic construction workers in/around the project site and thus could help to restore their earned income.

8.2.5 The Result of the Public Consultation

During the social survey, the consultations with PAPs have been conducted individually. And the Public Consultation has been held at Myohaung Station based on the agreement among the expected affected people and the implementation agency (Myanma Railways). The basic environmental and social conditions, including land use, socio-economic situation, and resettlement programs had been explained in the Public Consultation at Myohaung Station. In both the individual consultation and the public consultation at Myohaung Station, it was confirmed that there were no opinions opposed to this project. The Meeting Records of the individual and public consultations are shown in the Appendix to this report (Appendix 3 and 4).

8.2.6 Arrangement for Implementation of A-RAP

For A-RAP implementation, MR should build up the A-RAP task force team and assign the following personnel.

a) Supervising manager: to supervise overall implementation process of A-RAP.

b) Task management officer: to ensure the smooth and timely implementation of A-RAP and to manage and support the tasks relating to A-RAP.

c) Grievance redress officer: to ensure good relations with both the PAPs and the community-based organizations for adequate response to grievances from PAPs.

d) Accounting officer: to manage compensation payment process and the expenses in A-RAP implementation

8.2.7 Concerned Organizations

Anticipated major organizations concerned with implementation of the A-RAP are shown in the following table.

Table 8.2.30 Organizations Concerned with the Implementation of the A-RAP

Organization	Role	Responsibilities and Duties
MOTC (Ministry of Transport and Communications)	Role as the line Ministry of MR (Myanma Railways)	Approval of removing Structures and Resettlement in the project
MR (Myanma Railways)	Role as the project proponent	1) Identifying data regarding removing structures and resettlement 2) Forming and managing CFC (Compensation Fixation Committee) 3) Close communication with PAPs, GAD, State/Regional Government etc. 4) Negotiation, payment and making agreements with PAPs for process and cost of respective compensation and resettlement assistance 5) Adequate Response for grievance from PAPs with on-going interaction 6) Support of livelihood of PAPs during transition period 7) Internal monitoring of A-RAP implementation
Other organizations - Department of Agricultural Land Management and Statistics (DALMS), - Department of Human Settlement and Housing Development (DHSHD), NGOs, etc.	Support and consultation for MR	Support and consultation for MR

Note: Organizations making up the CFC will be concerned in addition to those shown above.

Source: JICA Study Team

8.2.8 Grievance Redress Mechanism

Disputes may happen during the implementation of A-RAP. 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 addressed satisfactorily. The success of a grievance mechanism is dependent on how swiftly such issues are resolved.

PAPs should be notified (e.g. handed a letter of notification that is explained to those who cannot read by a trusted intermediary) about the grievance mechanism. In addition, the grievance redress officer should be responsible for receiving and processing grievance complaints from PAPs. The name and contact information for this person should be given to all the relevant PAPs.

Under this grievance mechanism, if a PAP is dissatisfied with a resettlement or compensation measure or the delivery of entitlements, he/she must lodge a complaint in the first instance to the grievance redress officer, and the grievance redress officer must answer no later than 7 days (one week) after receiving the complaint. All complains and respective actions must be recorded.

If a dispute cannot be resolved within the stated period of fourteen (14) days, it should be referred to the A-RAP Implementation Team Manager, and he/she, in cooperation with other team members of the A-RAP Task Force, must answer within another established period of twenty-one (21) days. Compensation will be paid upon resolution of the grievance or dispute.

If the complainant is not satisfied with the decision made by A-RAP Implementation Team Manager, the PAP(s) has the right to lodge a complaint with the Court. The grievance procedure should not replace the existing legal processes, but will provide a consensus-based grievance mechanism that would seek to resolve issues rapidly in order to expedite the receipt of compensation without expensive and time consuming legal options.

A possible scheme for a Grievance Redress Mechanism is illustrated in Figure 8.2.10.

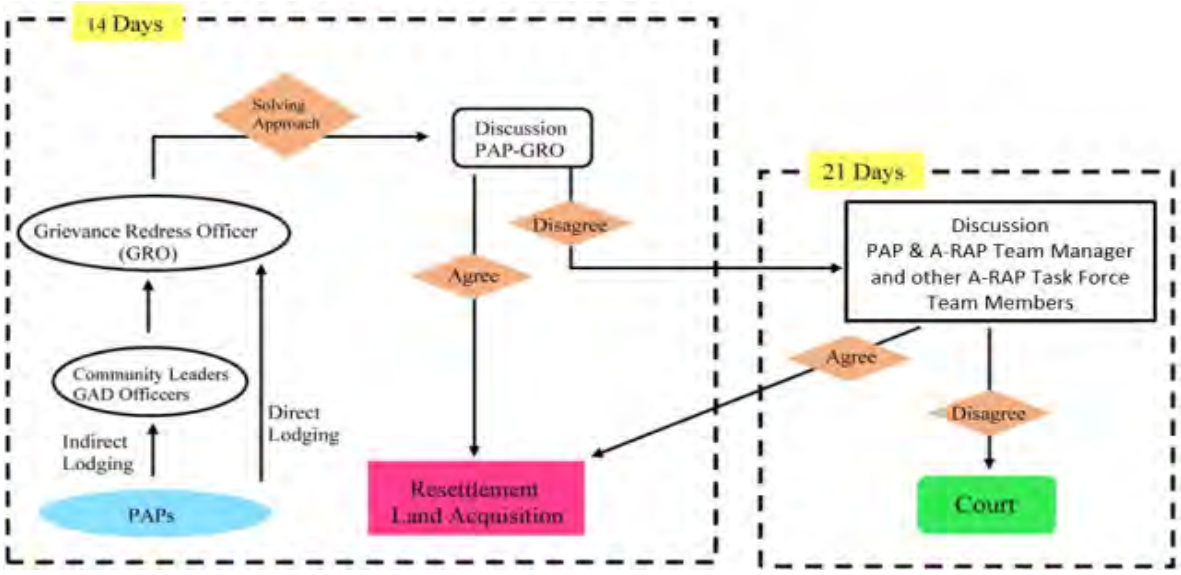


Figure 8.2.10 Scheme for Grievance Redress Mechanism (Proposed)

8.2.9 Monitoring Systems

It is required to monitor the implementation of the A-RAP from the stage of consultation and agreement with PAPs for compensation and resettlement assistance to the stage after implementation. Monitoring will 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 will be identified through the monitoring activities. Consequently, future activities shall be improved.

It is necessary that the project proponent (MR) together with State/Regional Governments, and their ministries (MOPF – PD/FERD and MOTC), establish special task force teams in order to monitor the resettlement activities. Those teams shall form a single window to respond to problems with regard to the resettlement activities of the project, and they are expected to report the progress of the resettlement activities to the project proponents and concerned authorities such as State/Regional Governments. NGOs can also be involved as a third party in the monitoring activities as becomes necessary. A flow chart for a proposed monitoring system is illustrated in Figure 8.2.11

For reference, the Resettlement Monitoring Sheet used for the preceding Phase-I Project is shown in Table 8.2.31. MR will submit a similar Monitoring Sheet at least once a quarter to JICA Myanmar Office directly.

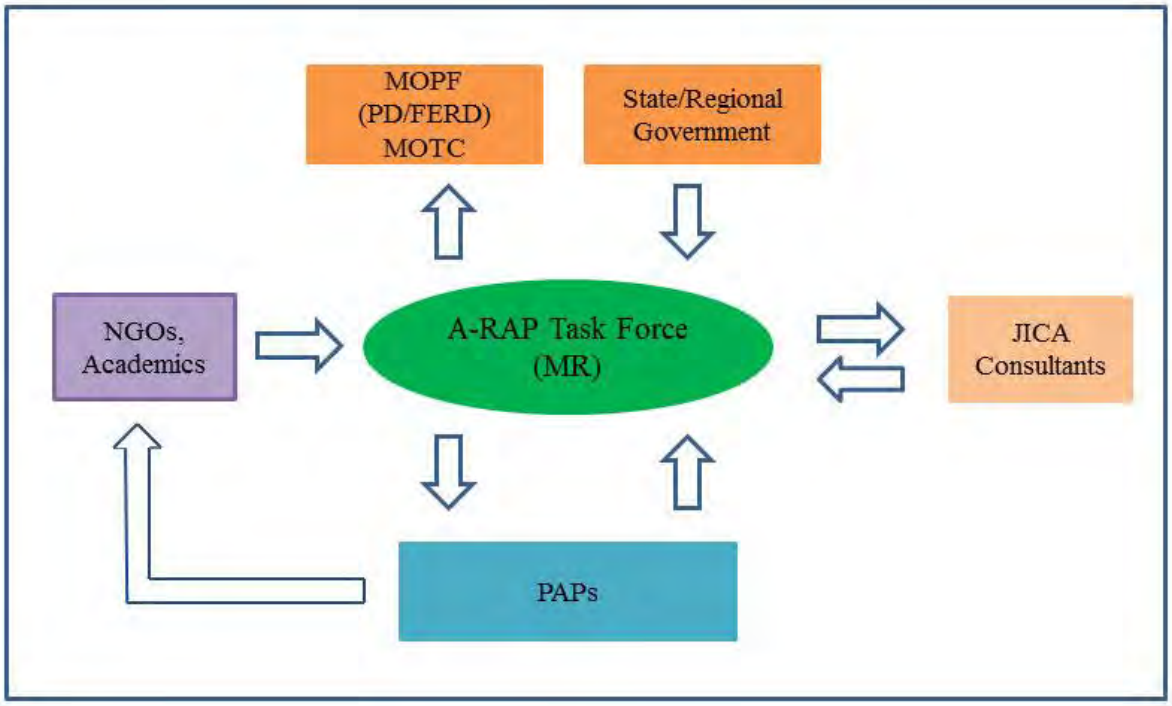


Figure 8.2.11 A-RAP Monitoring System

Table 8.2.31 Monitoring Sheet (Sample)

Resettlement Monitoring Sheet

Name of HH Head : _____

1. Progress of Resettlement

Progress	Date	Checked	Remark
Official Notice			
Confirmation on result of census survey			
Survey relocation if any			
Negotiation 1st time 2nd time 3rd time 4th time 5th time			
Agreement on compensation and relocation			
Securing of Land			

2. Post Resettlement Monitoring

Date	Location	Occupation (if changed)	Income Level	Perception	Remarks

Note: 2 times in the first year and 1 time in the second year after relocation.

3. Record of Grievance / Perception and Redress

Date	Grievance	Redress	Results	Checked by independent Org. (if any)

8.2.10 Cost and Budget

The estimated RAP implementation budget for the project is MMK 34,125,840 and this is summarized in Table 8.2.32. MR will be responsible for providing adequate funds for land acquisition and resettlement related to the project. It is important to note that these figures need to updated during the updating of the RAP in the detailed engineering stage.

Table 8.2.32 A-RAP Implementation Budget

Activities/Cost Item	Estimated Budget		Note
	MMK	USD	
Bridge Renovation			
Compensation	1,415,000	1,040	
Business loss	2,480,000	1,824	353,500* 7 HHs
Livelihood assistance	2,480,000	1,824	353,500*7 HHs
Moving assistance	350,000	257	50,000*7 HHs
Public consultation	300,000	221	100,000*3 times
Monitoring	400,000	294	100,000*4 years
Subtotal	7,425,000	5,460	
Contingency (+8%)	594,000		
Grand Total	**8,019,000**		
Activities	Estimated Budget		Note
	MMK	USD	
Myohaung Depot Improvement			
Compensation	4,339,000	3,190	
Business loss	4,242,000	3,119	353,500* 12 HHs
Livelihood assistance	4,242,000	3,119	353,500* 12 HHs
Moving assistance	600,000	441	50,000*12 HHs
Public consultation	300,000	221	100,000*3 times
Monitoring	400,000	294	100,000*4 years
Subtotal	14,123,000	10,385	
Contingency (+8%)	1,129,840		
Grand Total	**15,252,840**		
Activities	Estimated Budget		Note
	MMK	USD	
Alignment and Track Improvement			
Compensation	7,836,000	5,762	
Business loss	707,000	520	353,500* 2 HHs
Livelihood assistance	707,000	520	353,500* 2 HHs
Moving assistance	100,000	74	50,000* 2 HHs
Public consultation	300,000	221	100,000*3 times
Monitoring	400,000	294	100,000*4 years
Subtotal	10,050,000	7,390	
Contingency (+8%)	804,000		
Grand Total	**10,854,000**		
TOTAL	**34,125,840**	**25,093**	

Note1: 1USD = 1,360 MMK

Note2: Unit price of business loss and livelihood assistance (353,500 MMK) was based on the highest monthly income reported by PAPs during the interview surveys.

8.2.11 Implementation Schedule

A draft implementation schedule of A-RAP is summarized in Table 8.2.33. A series of social impact studies, including the census survey on PAPs was completed on 12th July, 2017. A stakeholders meeting (SHM), to which the PAPs, concerned local governments, parliament members and other interested persons were invited, was already held in July, 2017. The public notification of the Projects and the official cut-off date have been decided to be 20th July, 2017. Compensation committees will be established at the end of 2017. The operation of the committee will start accordingly and continue until completion of the Project in 2022/2023.

Table 8.2.33 A-RAP Implementation Schedule

No.	Implementation Schedule / years	2017								2018	2019	2020	2021	2022	2023
		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan - Dec					
1	Environmental and Social Impact Surveys (including census surveys)														
2	Stakeholder Meeting (PAPs are invited.)														
3	Establish A-RAP Implementation System in MoTC, as initiation of action														
4	Public Notification of the Sub-Projects Public Notification of Cut-Off Date														
5	Finalize A-RAP report by MoTC and Submission to JICA														
6	Establish a Compensation Committee														
7	Operation of the committee for grievance redress														
8	Establishment of Policy and procedures for compensation														
9	Estimation of compensation amount for each PAP Conduct supplementary surveys if necessary														
10	Clarify with PAPs														
11	Fix compensation (cash and assistance) and agreement with PAPs														
12	Cash Disbursement to PAPs														
13	Livelihood Restoration Program														
14	Removal of Structures														
15	Completion of A-RAP Process														
16	Monitoring of PAPs														

8.2.12 Terms of Reference (TOR) for Consulting Service

During the Detail Design stage, in parallel with the Bridge Renovation plan, the Myohaung Depot Improvement plan, Alignment Improvement plan and other additional plans (Construction Yard and Approach Road) will be finalized, so it is necessary to update this A-RAP too. The expected TOR for update of this A-RAP is as follows;

(1) Preparation for final A-RAP

1) Support the implementing institutions to implement socialization.
2) Implement the socioeconomic survey and asset survey on all PAPs who are living in the target areas.
3) In order to finalize the compensation rate and transfer cost, implement the replacement cost survey of various types of assets such as houses and lands.
4) Update an implementation schedule, grievance redressing mechanism, monitoring and evaluation of A-RAP.
5) Finalize the A-RAP. Also the summary is to be translated into Myanmar language.
6) Disclose the information of the draft and final version of A-RAP.

(2) Update Socio-Economic Survey (SES) and Inventory of Loss (IOL)

Update the socioeconomic survey. Items are as follows.

1) Information of householder: name, gender, age, livelihood means, occupation, income, educational background and ethnic group.
2) Information of family living together: number, livelihood means, occupations, number of school children, literacy rate and gender.
3) Data on affected houses: ethnic group, gender of householder, family size, main income and secondary income, elderly, disabled person and poor etc.
4) Legal position regarding affected land and building, period as owner.
5) Request for compensation, life rebuilding from PAPs.

In addition, implement the survey of the Inventory of Loss (IOL). The data obtained by this IOL is used to finalize the level of compensation and qualified eligibility. The information to be collected is as follows.

1) Area of affected buildings and their type
2) Types, areas and numbers of affected crops and trees
3) Area of affected lands and their type (for access road or if necessary)
4) Other losses (e.g. Temporary loss of income, loss of merchant income, etc.)
5) Types and areas of affected public facilities.

(3) Replacement cost survey

Update the result of the replacement cost survey at the same time as the SES and IOL. The information to be collected is as follows;

1) Replacement cost of house, shed and hut

The replacement cost of the house, shed and hut includes materials (market price) for rebuilding, transportation cost of materials, wages of the workers, required registration fee and tax, etc. Price calculation is based on the following two points.

- Unit price determined by government (GAD/DALMS)
- Unit price of recent market price

2) Price of lands

Price of lands is the sums of market price or land price of the neighbourhood and preparation costs of similar land, required registration fee and tax, etc.

(4) To refine the Livelihood Restoration Program

To refine the Livelihood Restoration Program based on the needs of affected people.

(5) Support for obtain the Environmental Compliance Certificate (ECC)

Support to MR to obtain ECC. If accompanying the incidental condition, support to MR to clear these conditions certainly.

8.2.13 The Result of Stakeholders Meeting

For the purpose of explaining and informing the local people about the project plan and implementation schedule, stakeholder meetings were held in four different townships by MR together with the local EIA Company. The date and places of the Stakeholder Meetings are the following. Detail explanation is described in the EIA report.

Table 8.2.34 List of Stakeholder Meetings for the project

No.	Date and Time	Venue	Summary
1	10:00 am to 12:00 pm, June 5th, Monday 2017	Thazi City Hall, Mandalay Region	- Participants: a total of 67 persons including the local residents, government officials, parliament members, news media, etc.
2	10:00 am to 12:00 pm, June 6th, Tuesday 2017	Zaytawin Dhamma Hall, Myit Nge, Mandalay Region	- Participants: a total of 50 persons including PAPs, news media, government officials, Parliament Representatives, etc.
3	9:00 am to 11:00 am, June 15th, Thursday 2017	Pyinmana Station (VIP Hall), Mandalay Region	- Participants: a total of 73 persons including PAPs, local interest people, government officials, members of Parliament of Pyinmana Region, etc. - The scoping of the plan was presented.
4	3:00 pm to 5:00 pm, June 16th, Friday 2017	Taungoo Railway Station, Bago Region	- Participants: a total of 68 persons including government officials, members of Parliament, News Media, etc.

Source: JICA Study Team

Chapter 9 Project Implementation Plan

This chapter is described following 4 items.

First item is described contract package and its contract category.

Second item is described about whole implementation schedule and also each implementation schedule of each package.

Third item is described about procurement experience of MOTC and MR.

Fourth item is shown in the list of local contractor.

9.1 Contract package

9.1.1 Plan of Construction Contract

Construction Projects utilize different kinds of contractual engagements. Two of the most widely used contract categories were reviewed and studied for Yangon–Mandalay Railway Line improvement Project phase II.

(1) Contract using rated items: Bill of Quantities (BOQ);

(2) Lump Sum Design and Build Contract.

The first contract category is widely used for construction projects designed by the employer and implemented by contractors in accordance with defined rates.

The second category is used in projects where the employer provides the contractors with basic requirements (or basic design), while the more comprehensive detailed design is provided by the contractors as part of a lump sum project price. Further, the Second category is widely used for electrical and mechanical ("E&M") projects, plant construction or projects utilizing special technology.

Therefore, due to risk management considerations and the careful design required for the rehabilitation and modernization of the Yangon-Mandalay railways, it was recommended to implement the category of construction contracts using BOQ for the civil and track works. Further, it was decided to use for such purpose the *Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer* issued by the International Federation of Consulting Engineers ("FIDIC"); Multilateral Development Bank Harmonized Edition; i.e. the FIDIC Pink Book (2010). The Pink Book is incorporated as part of the Standard Bidding Documents for

Procurement of Works ("SBD Works") issued by JICA.

Nevertheless, the project is also inclusive of additional components to the civil and track works: rolling stock procurement (accompanied by particular equipment) as well as Signalling & Telecommunication equipment and works (E&M Systems), including the modification of the Train Monitoring System ("TMS"). Such components are categorized as specific/technological products that usually require design, manufacture, installation and commissioning services to be performed by the Contractor as a single responsibility.

Therefore, due to the nature of the other components, their respective contractual package will require the detailed design to be completed by the contractor based on requirements determined by the employer. This work allocation is included under the second category detailed above, that of detailed design lump sum contracts.

Accordingly, it was decided to adopt the use of the new *Standard Bidding Documents for the Procurement of Electrical and Mechanical Plant and for Building and Engineering Works, Designed by the Contractor* ("SBD (Design Build")). The SBD (Design Build) are consistent with JICA guidelines and based on the *Conditions of Contract for Plant and Design Build*, published by FIDIC (i.e. the Yellow Book) which is a widely accepted contract used in Design Build projects.

Phase II Project will be adopted as same contract category as phase I.

9.1.2 Contract Package

The Contract Package is disclosed.

9.2 Implementation Schedule

Implementation Schedule is disclosed.

9.3 Examine the Procurement Plan and Method

9.3.1 How things have been procured in similar projects at the MOTC and MR

(1) General information on the way bidding is made for general civil work and facility construction work as well as on contracts, and construction methods

MR's Construction Contracts are generally divided into two categories, namely Construction under MR's Control, and Procurement with Erection Supervision under MR's Control.

The Construction Contract under MR's Control opens a local bid. The Contract is similar to a labour supply contract. MR designs and the Construction Contract carries out under MR's direct control. The material and some heavy equipment are supplied by MR. The Nay Pyi Taw station

was designed by MR and constructed by such a Contract.

Standard work unit rates and material unit prices, transportation charges, public utility charges and so on, so called as "Price Book", is formally published every year by local governments. The rates and prices, etc., vary in local governments.

MR division 7 which governs the Yangon area authorizes by an official letter, the Price Book authorized by the Chief Minister of Yangon Regional Government.

MR establishes budgetary construction cost estimates based on his design and the Price Book. However it is said that the Price Book for the year 2017 doesn't catch up with inflation and some bids are not achieved.

Procurement with Erection Supervision under MR's Control is regarding procurement contracts which require imported material and technologies. The contract assumes imported materials, special skills, etc., for instance, a long span steel box girders procurement and erection work.

(2) Track record of works directly carried out by MR

1) Track record before 2013

In the second half of 2012, a member of Study Team participated "Feasibility Study for Railway Improvement Projects in Myanmar for Enhancement of Japanese Exports for Infrastructure System, by Ministry of Economy, Trade and Industry (METI Railway FS)". In the study almost no information had found in relation with MR's bidding.

At the end of 2012, a member of Study Team participated Detailed Planning Survey on Project on Improvement of Service and Safety of Railway in Myanmar by JICA. The Study found as records of Foreign Funding Projects between the year 1988 and 2012, only information on the international development funding agencies, namely OPEC Loan and Korean Loan.

(a) OPEC Fund for International Development (OFID) Loan（1999）

Project Title: Yangon Circular Railways and Suburban Railways Rehabilitation, Rehabilitation of Yangon-Nyaunglaybin(269km) on Yangon-Mandalay Trunk Railway Line

Railway track improvement, Replacement by new track panel for 25% of the Yangon-Nyaunglaybin section(269km), including new rail and PC sleeper installation, ballast filling, drainages, etc.

Total Cost: 28.39 Million USD for the following main items.

Phase I: Yangon Circular Railways and Suburban Railways Rehabilitation

- Rehabilitation and Modernization of 6 Nos Diesel Electric Locomotives: 4.34MUSD
- Rehabilitation of (40) Nos Passenger Coaches: 1.645MUSD
- Signal and Telecom: 1.71MUSD

Phase II: Yangon Circular Railways and Suburban Railways Rehabilitation

- Rehabilitation of Seven Numbers Diesel Electric Locomotives (950)HP: 4.05MUSD
- Ordinary Class Passenger Coaches (13) Nos.; 1.97MUSD
- Resignalling of Togyaunggale Station, Provision of Automatic Signalling Equipment Inspection Fees: 1.93MUSD

Phase III: Yangon Circular Railways and Suburban Railways Rehabilitation

- Forty Nos Meter Gauge Bogie Ballast Hopper Wagons: 2.10MUSD
- PC Sleeper Plant: 2.84MUSD
- Leveling Lining & Tamping Machine with Spare Parts、1.57MUSD
- Small Track Tools & Track Machineries、0.96MUSD
- Rail Flash Butt Welding Machine and Spare Parts、0.89MUSD
- Ballast Regulator、0.59MUSD

(b) EDCF（Korea）Loan

Project Title: Coaches (60) Nos Wagons (10) Nos Procurement, 20MUSD

- Ordinary Passenger Coaches in Knock-down: 14.60MUSD
- Metre Gauge Brake Van in Knock-down condition (10) Nos: 2.28MUSD
- Maintenance Spare Parts and Equipment: 3.10MUSD

2) Track Record Since 2014

Study team, through interview with MR staff for procurements, collected documents concerning bidding and contracts, mostly since 2014. The list is shown on the table below and notes for the major projects are as the followings.

Table 9.3.1 Track Record since 2014 (1 of 2)

No.	Project Name	Classi-fication	Contets
1	Cast manganese steel crossing and headhardened switch for turnout (without sleeper bearers) and adaptor rail with fishing devices (50kg.rails Vs BS75 R rails)	Tender Doc	Bid invitation for Tender No 10_MR_INDIA(E)_2015-2016
2	Cast manganese steel crossing and headhardened switch for turnout (without sleeper bearers) and adaptor rail with fishing devices (50kg.rails Vs BS75 R rails)	Drawing	Drawing for cast manganese steel crossing and headhardened switch for turnout (without sleeper bearers) and adaptor rail with fishing devices (50kg.rails Vs BS75 R rails)
3	Cast manganese steel crossing and headhardened switch for turnout (without sleeper bearers) and adaptor rail with fishing devices (50kg.rails Vs BS75 R rails)	Question and answer	Technical compliance for caast manganese steel crossing and headhardened switch for turnout (without sleeper bearers) and adaptor rail with fishing devices (50kg.rails Vs BS75 R rails)
4	F.O.B. Near THAMINE Station	Bill of Qty	Construction BQ of F.O.B. Near THAMINE Station
5	F.O.B. Near THAMINE Station	Contract	Contract for construction of FOB near Thamine Station
6	INSEIN ROAD OVER BREDGE	Tender Doc	TheRepublic of theUnion of Myanmar Ministry of Rail transportation Myama Railways BID INVITATION for TENDER NO. / /MR€ /2014-2015 the supply of 120 FT Span Steel Box Girders for INSEIN ROAD OVER BREDGE YANGON JULY, 2014
7	INSEIN ROAD OVER BREDGE	Contract	Contract No.210/MAMA/MR€ LOCAL/2014-2015 for The Supply for Insein Road over Bridge (120 FT SPAN STEEL BOX GIRDERS) Made Between MR and J&M Steel Solutions Co., Ltd
8	INSEIN ROAD OVER BREDGE	Contract	Contract for Insein Over Bridge repair paiting
9	INSEIN ROAD OVER BREDGE	Bidding Submital	120ft span steel box girder for Insein road over bridge Yangon
10	INSEIN ROAD OVER BREDGE	Bidding Submital	Substructure of Insein Road over Bridge Yangon
11	INSEIN ROAD OVER BREDGE	Tender Doc	Tender No 335-MAMA-PaTa- substructure for Insein Road Over Bridge Yangon
12	INSEIN ROAD OVER BREDGE	Contract	Contract for substructure of Insein Road Over Bridge
13	INSEIN ROAD OVER BREDGE	DWG	INSEIN ROB (Up Date)(8-9-2014)
14	Maintenance of track by temping machine	Contract	Contract for maintenance of track (Bago-Mawlamyaing-Yae) by temping machine between MR and Myanmar Golden Crown Co, Ltd
15	Maintenance of Track by Tamping Machine	Contract	Special condition of Tender for Maintenance of Track by Tamping Machine (21.Jul.2014)
16	Myaung Chaung railway bridge	Contract	Contract for the supply of 4 x 100ft span prestressed postensioned concrete box girder for No.1117, Myaung Chaung railway bridge Gangaw - Kalay railways Line

Table 9.3.2 Track Record since 2014 (2 of 2)

No.	Project Name	Classi-fication	Contets
17	MYITNGE RAILWAY BRIDGE	Tender Doc	The Republic of theUnion of Myanmar Ministry of Rail transportation Myama Railways BID INVITATION for TENDER NO.93/MAMA/MR(E)/2014-2015 the supply of 150 FT Span Steel Box Girders and 40FT Span Steel Girders for MYITNGE RAILWAY BRIDGE YANGON-MANDALAY LINE
18	MYITNGE RAILWAY BRIDGE	Contract	Contract No.216/MAMA/MR€ LOCAL/2014-2015 for The Supply for Myitnge Railway Bridge (150 FT SPAN STEEL BOX GIRDERS AND 40 FT SPAN STEEL GIRDER BRIDGE) Made Between MR and J&M Steel Solutions Co., Ltd
19	MYITNGE RAILWAY BRIDGE	Bidding Submital	Myintnge railwa bridge (150ft span steel box girder and 40ft span steel girder bridge)
20	MYITNGE RAILWAY BRIDGE	Bidding Submital	Substructure of Myintnge Railway Bridge
21	MYITNGE RAILWAY BRIDGE	Tender Doc	Bid Invitation of Myintnge Bridge (150ft span steel box girder and 40ft span steel box girder bridge)
22	MYITNGE RAILWAY BRIDGE	Drawing	Drawng for Myintnge Railway Bridge (150ft span steel box girder nd 40ft span steel girder bridge)
23	MYITNGE RAILWAY BRIDGE	Contract & BOQ	Contract and BOQ of substructure of Myintnge railway bridge
24	MYITNGE RAILWAY BRIDGE	DWG	Myint Nge BR Drawing (Existing Level)
25	Prestressed Posttensioned concrete Box griders	Contract	Bid invitation for Tender No 58_MAMA_MR(E)_2016-17_4 x 10ft Span Prestressed Posttensioned concrete Box griders (May -2016)
26	Production of 20T AxLd PC Sleeper e-Clips, Khin Oo	Contract	Khin Oo Bid Inv. Production of 20T AxLd PC Sleeper e-Clips, Khin Oo
27	Production of 20T AxLd PC Sleeper Pandrol FD Clips	Design & Drawing	Drawing and design calculation for 20ton axle load PC sleeper (FD clip & e clip)
28	Production of 20T AxLd PC Sleeper Pandrol FD Clips, Myit Nge	Contract	Bid Inv. Production of 20T AxLd PC Sleeper Pandrol FD Clips, Myit Nge
29	Rail welding by mobile flash butt welding machine	Contract	Special conditions of Tender for Rail welding by mobile flash butt welding machine (MFBWM)
30	Rail welding by mobile flash butt welding machine	Contract	Contract for rail welding by mobile flash butt welding machine(Bago-Mawlamyaing-Yae) with MR and Rail Link Rail Device Project Co, Ltd
31	Rail welding by mobile flash butt welding machine	Contract	Contract for rail welding by mobile flash butt welding machine(Madalay-Myintgyina) with MR and Rail Link Rail Device Project Co, Ltd
32	Supply of 4x 100ft span prestressed posttensioned concrete box girder for Br No 1117, Myaung Chaung Railway Bridge Gangaw –Kalay railways Line.	Bidding Submital	The supply of 4x 100ft span prestressed posttensioned concrete box girder for Br No 1117, Myaung Chaung Railway Bridge Gangaw – Kalay railways Line.

(a) Insein Road Over Bridge (No.6 - No.13)

Invitation Document was issued in July 2014 and the Insein Road Over Bridge Project is now completed flying over Myanma Railways.

The bridge consists of concrete girders and steel box girders. The substructures and concrete girders were constructed by construction contracts under MR direct control.

The contract for steel box girders was prepared assuming imported steel superstructures supply and erection supervision. The outline performance specifications of the steel box girders in English were issued by MR. The contract includes steel box girders design, manufacture, import, erection and test supervision. MR officer directly controlled the construction. The contract includes supervision by the contractor's Experts, but other labour was provided by MR through local contracts.

(b) High Spec. Turnouts Procurement by Indian Tied Loan (No.1 - No.3)

MR issued in April 2015, a tender invitation document for CMS(Cast Manganese Steel) crossing and headhardened switch for turnout (without sleeper bearers) and adaptor rail with fishing devices (50kg rails Vs BS75R rails).

After two months biddings were closed but the contract has not yet been signed.

(c) Project for Maintenance of Track Similar Nature to MR Civil Work at YCR (No.14, No.15)

There is a particular local contract being carried out by a local contractor, namely "Contract for maintenance of track (Bago-Mawlamyaing-Yae) by tamping machine between MR and Myanmar Golden Crown Co, Ltd" (No.14, No.15).

There are two contract sections as follows.

Mandalay-Myitkyina: 547km

Bago-Mawlamyine: 353km

In the contract, commencement date sets forth 1st of May 2015 at the latest and construction period for 36 months. The contractor shall carry out track rehabilitation for 118km plus/minus 5% a year in accordance with MR's instruction.

The contract is in Burmese and is 25 pages consisting of:

- main text including cover page, 13 pages
- standard cross sections for typical works, 3 pages
- Appendix B 9 pages consisting of:
    - Bill of Quantities, 3 pages

- Technical specifications, Deep Screening of Ballast, 5 pages
- Main technical parameters, allowances, 1 page

The technical specifications apply Indian Railway Track Technical Standards. This work set a precedent for track works of YCR and Yangon – Mandalay Railway Improvement.

In addition, Price Escalation clause is written as follows:

Appendix "C"

Prices that must estimate for each year according to inflation that are regarded by Myanmar Central Bank

1. Making contract with price that succeeded tender in 1st 12months.
2. In 2nd 12 months, employer will make revised contract if inflation rate that are regarded by Myanmar Central Bank is over 5 % than 1st 12month and make contract with original unit price that are described in 1st contract if inflation rate that are regarded by Myanmar Central Bank is not over 5 %.
3. In 3rd 12 months, employer will make revised contract if inflation rate that are regarded by Myanmar Central Bank is over 5 % than 2nd 12month and make contract with original unit price that are described in 2nd contract if inflation rate that are regarded by Myanmar Central Bank is not over 5 %.

(d) Production of 20 Ton Axle Load PC Sleepers with FD Clips/ e-Clips (No.26 – No.28)

Issued in January 2017, invitation documents for procurement contract by using Khin Oo and Myit Nge existing MR PC sleeper factories. These contracts are made for Yangon-Mandalay Railway Improvement Phase I in order to suffice material supply by MR.

9.4 List of Local Contractors

JST summarizes the following list of expected local contractors for bidding, in the light of recent construction contracts and other consulting activities in Myanmar.

Table 9.4.1 List of Local Contractors

Sr No	Company Name	Service	Equipment List	Project	Contact
1	Geo Friend Engineering & Construction Co,Ltd	➢ Geotechnical Site Investigation ➢ Geological & Hydrogeological Investigation ➢ Geotechnical Engineering, Instrumentation & Monitoring ➢ Soil Laboratory Testing ➢ Surveying works ➢ Sale & Supply ➢ Field In-situ Tests ➢ Concrete Testing Laboratory	➢ Drilling Equipments & Accessories ➢ Laboratory Instruments ➢ Instrumentation Monitoring Instruments ➢ Survey Instruments ➢ Field In-situ Testing Apparatus	**2014 Project** ➢ Soil Investigation works for earthquake risk Assessment project ➢ Soil investigation works for Mingalardon Global Centre construction project ➢ Bonnamy Tower Project etc…… **2015 Project** ➢ Container cargo port terminal Myanmar ➢ Thilawa SEZ(p2) Preliminary Survey ➢ Animal Feed Mall etc….. **2016 Project** ➢ Sea view condo project ➢ Improvement of Regional general hospital in Myanmar ➢ Malikha Condo Construction etc.…	Address: 1136(A/B), Thumingalar Road, 6 block, South Okkalapa Township, Yangon, Myanmar Phone: (+95) 1577035, (+95) 12331431, (+95) 9 420107757, (+95) 9420107767, (+95) 775122122, (+95) 9776122122 E mail: service@geo-friends.com Website: www.geo-friends.com
2	Shwe Taung Development Co,Ltd	➢ Real Estate ➢ Infrastructure ➢ Construction ➢ Building Materials ➢ Distribution		➢ Junction City ➢ Union Business Centre ➢ Union Financial Centre ➢ Yeywa Hydropower Project ➢ Yangon- Mandalay Highway ➢ Hledan Flyover ➢ Junction City ➢ Crystal Residences ➢ MiCC	Address: River view Garden Housing Strand Road, Ahlone Township Yangon, Myanmar Phone: (+95) 12314567, 2316643, 2316198, 2316741 Email: info@shwetaunggroup.com

Sr No	Company Name	Service	Equipment List	Project	Contact
3.	Myanmar Golden Crown Co.Ltd			➢ Thayargone-Kyaukgyi railway construction project ➢ Katha-Bamaw new rail line project ➢ Hshipaw-Laishio new rail line project ➢ Myint nge river bridge ➢ Bago-Mawlamyaing-Yae rail line project etc…….	Address: No.(47), 165 Street, Tamwe Township, Yangon, Myanmar Phone: (+95) 1 8604683, (+95) 1 8604684, (+95) 95360644, (+95) 9401543118 Email: mgc.yangon@gmail.com Website: www.myanmargoldencrown.com
4.	Ma Ga Manufacturing Co, Ltd	➢ Concrete pipe ➢ Concrete slab ➢ Concrete wall panel ➢ Fencing system ➢ Hallow Cored Poles		➢ Myanmar Engineering Society (Hlaing) ➢ Kyite Inn Orphanage (Than Lyin) etc…..	Address: No 104, Wet Masout Wunhtouk Street, Industrial Zone (4) , Hlaing Thar Yar Township, Yangon. Phone: (+95) 1 685301, (+95) 685734, (+95) 685733 Email: Magaengineering999@gmail.com
5.	High Tech Concrete Co, Ltd	**Product** ➢ Ready Mixed Concrete **Service** ➢ Batching Plant Service ➢ Casting Service ➢ Pumping Service ➢ Quality Monitoring Service		➢ Nyaung Tone Bridge ➢ Novotal Hotel ➢ Capital Hyper Market ➢ Pin Lon Construction ➢ Mandalay University Research Centre etc……	Address: No-1(B), Yan Gyi Aung Road, Thaketa Industrial Zone, Thaketa Township, Yangon Myanmar. Phone: +95 9798893511, +95 9798893522, +95 9798893538, +95 9798893548, +95 9798893558 Email: generalinfo@hightechconcrete.com salesinfo@hightechconcrete.com

Sr No	Company Name	Service	Equipment List	Project	Contact
6.	Myanmar V pile Co, Ltd			➢ Micropiling For Pedestrian Bridge ➢ Gamone Pwint Hospital Foundation ➢ Pasodan Pedestrain Bridge ➢ Hla Thaung Pedestrain Bridge	Address: Building No 107-109, Room No. 901.902 corner of Anwyahta Road and Sint Oh Dan Street, Latha Township, Yangon Phone: +95 1 250911, +95 1 250922, +95 1 253719, +95 252493 Email: hexa@myanmar.com.mm
7.	Santac Technologies	➢ Arial Photography ➢ Digital Photogrammetry ➢ RS/GIS ➢ Surveying ➢ Geo Engineering ➢ Engineering & Construction ➢ Manufacturing automation ➢ Software Development ➢ IT & Communication ➢ Training ➢ Forestry		Only describe Arial photography project in his website.	Address: Room 7, Building 5 MICT Park, Hlaing University Compass, Hlaing Township, Yangon. Phone: +95 1652245, +951652246, +951652310, +95 1652312 Email: info@santactechnologies.com Website: www.santactechnologies.com
8.	A1 Group of company	➢ Construction ➢ Hotel & Resort ➢ Industry ➢ Mining, Oil & Gas ➢ Telecommunication ➢ Plantation			Address: 33- 49 Maha Ban Doola Garden Street, Kyauktada Township, Yangon, Myanmar. Phone: +95 1 377893 Email: info@aone-construction.com info@a1compines.biz Website: www.a1companies.biz

Sr No	Company Name	Service	Equipment List	Project	Contact
9.	Megabucks Co., Ltd	➢ Plywood/Smart Board/Gypsum Board ➢ Flatpack Container ➢ Easy Container/Knock Down Container ➢ Prefab House ➢ Raised Floor ➢ Network Installation ➢ Real Estate			Address: A1, Room-306, Aung Chan Thar Condo, Aung Chan Thar Street, Yankin Township, Yangon Myanmar. Phone: +95 9 31743835, +95 973113092, +95 95166240, +95 9799595011 Email: info@mgbg.biz Website: www.megabucksgroup.com
10.	Soil Engineer Co,Ltd	➢ Construction ➢ Earth Work ➢ Machinery ➢ Trading ➢ Eco Block ➢ Sample		➢ 33/11 KVA Electrical Power Station ➢ Internal School Myanmar ➢ Staff's Quarter (4 Units RC 2 Stories), Women and Child Centre ➢ ECO concrete Block Manufactory ➢ Bridges Construction Projects ➢ Kyant Kinn-Pakokku (Tant Kyi Taung) Railway Section ➢ Ya Zae Gyo Canal Project etc……	Address: No(8), Thistsar Street, Yankin Township, Yangon. Phone: +95 973204466, +95 9428111115, +95 9 428111116 Email: admin@soilenergy.com Website: www.soilenergy.com
11.	Myanmar Land & Development Limited	➢ Construction			Address: Yaesin Township, Zayar Thiri Township, Naypyitaw Phone: +95 9420714141

Chapter 10 Cost Estimation

The Study Team, having studied the technical matters through investigation, had produced unit quantities and unit price estimates dated July 2017.

10.1 Pre-condition of Cost Estimation

The latest version of pre-conditions, namely "General Guidelines for 2017 Appraisal for Japanese ODA Loan Projects dated September 11, 2017, is used for cost estimation. Major items are reported as follows.

10.1.1 Exchange rate

(1) Preliminary Cost Estimates Investigation Phase by Each Engineering Field

Preliminary cost estimate investigations via various measure have been conducted since July 2017 by each Engineer through many different sources and in the absence of the above mentioned latest "Genera Guidelines for 2017 Appraisal for Japanese ODA Loan Projects dated September 11, 2017", JST used the following average information in the latest three months (April, May June 2017) of the estimation month, July 2017.

① USD 1=¥ 111.06

② USD 1=Kyat 1,360

③ Kyat 1=¥ 0.0817

(2) Detailed Cost Estimates Phase for JICA Appraisal

Detailed cost estimates data from Engineers have been clarified and input the standard computerized calculation format adopting the latest "Genera Guidelines for 2017 Appraisal for Japanese ODA Loan Projects dated September 11, 2017" using the following exchange rates.

① USD 1=¥ 110

② USD 1=Kyat 1,360

③ Kyat 1=¥ 0.0809

10.1.2 Price Escalation Rate

(1) Preliminary Cost Estimates Investigation Phase by Each Engineering Field

In reference to "Detailed Design for Yangon Mandalay Railway Improvement Project Phase I, Final Report, Part II – Project Planning, Chapter 5 Cost Estimation", estimated rates and prices in March 2016 were used and the following Price Escalation Rates were adopted. Because most Engineers made their cost estimation in reference to the above-mentioned Final Report, the same Price Escalation Rates were used.

① Foreign Currency Portion 1.8 % p.a.

② Local Currency Portion 6.2% p.a.

(2) Detailed Cost Estimates Phase for JICA Appraisal

In the formatting cost estimates phase for JICA Appraisal Mission, the given rates by JICA, namely "General Guidelines for 2017 Appraisal for Japanese ODA Loan Projects dated September 11, 2017" were used.

① Foreign Cost : 1.7 % p.a.

② Local Cost : 7.0 % p.a.

10.1.3 Physical Contingency Rate, Spare Parts

Physical contingency rate shall be 5% in principal. The minimum spare parts provision as material, for the first two years after inauguration is considered.

10.1.4 Tax

The Consumption tax shall be 5% based on the Myanmar Government Rule. Import tax shall be Zero (0) because of the Yen Loan Project.

10.1.5 Others

① Rate of JICA Finance Portion: JICA 100%, Myanmar Government 0% , However Ballast, Sleepers with Clips, Tax, Administration Fees shall be borne by the Myanmar Side. FD Clip will be included in JICA Finance Portion.

② Indirect Cost: 5%

③ Interest during Construction:0.01% for construction, 0.01 % for the Consultant

④ Front end fee is not applied to this project

10.1.6 Base Year of Cost Estimation

As the base year of cost estimation, October 2017 applies in accordance with "General Guidelines for 2017 Appraisal for Japanese ODA Loan Projects dated September 11, 2017".

10.2 Cost Estimation Method

① The Yangon – Mandalay Railway Improvement Project (Phase 2) (Taungoo - Mandalay) consists of a combination of two kinds of contracts such as BOQ based contracts for civil and track works and Lump sum contracts such as Design Build for Signals, TMS, Telecom and Rolling Stock. Therefore the cost estimation of civil and track etc. is made based on the BOQ, and the Signals, TMS, Telecom and Rolling Stock are estimated by a lump sum cost or unit price from other similar projects.

② Recent wages, Materials and lease cost of the Machines in Myanmar are collected and used.

③ Unit prices of the similar projects in Myanmar and neighbouring countries are collected and used.

④ Cost estimation for Signals, TMS, Telecom and Rolling Stock are made based on similar projects of the Japanese Companies.

10.3 Cost Estimation by Package

Cost Estimation is disclosed.

10.4 Cost Estimation in Each Work Item and Package

Cost Estimation in Each Item and Packages is disclosed.

10.5 Cost Estimation in Total

Cost Estimation in Total Phase 2 is disclosed.

Chapter 11 Project Evaluation

11.1 Introduction

This project is specified as a phased implementation scheme of whole project, which has been formulated as the Rehabilitatio and Modernization of Yangon – Mandalay Railway Project in 2013 by Japan International Cooperation Agency (JICA).

Project validity as a whole was already examined and proved from both economic and financial viewpoints in previous relevant study. In this preparatoy survey, proper project viability as a phased implementation of the poject will be tested based on same methodlogy as that adopted to phase I.

In addition to project evaluation itself, this survey also conducts the review and update work for the verification of operation & effect indicators selected for this project.

11.2 Verification of Operation and Effect Indicators

According to the JICA Project Evaluation Guidelines, all ODA loan projects subject to screening after 2001 conducted their respective preliminary assessment, and the assessment prescribed the actual values of operation and effect indicators at the time of screening (baseline), the target values, and the deadline for achievement.

(1) Definition of operation and effect indicators

The operation indicators are quantitative indicators measuring the project output revealed through utilizing the operational assets brought about by project implmentation, and the effect indicators are also quantitative indicators measuring the project outcome generated as a accumulation result of project output mentiond above. In other words, as a result of infrastructure and facilities (output) implemented by a project, it is considered that (a) an operation indicator can measure how adequate its output is managed/utilized, (b)an effect indicator can measure overall effect to beneficiary and positive impact to target area.

(2) Examples of operation and effect indicators adopted in railway sector projects

Regarding the opration and effect indicators adopted for the evaluation of railway projects, typical application in past examples are summarized as shown in Table 11.2.1.

Table 11.2.1 Typical application of operation and effect indicators for railway project

	Indicators	Quantification	Features/Remarks
Opration indicators	Volume of transportation (Man*km, Ton*km)	Man*km=No. of passengers volume * travel length Ton*km=Freight volume (t) * transport distance (km)	Its high value shows high utilizing rate of target infrastructures and facillities.
	Number of running trains /day	Number of runnning trains/Annual average day/section	It shows simple form of facilities utilization.
	Operating rate (%)	Operating rate=Annual gross car operation days/Number of cars * annual operable days of car	Used for project with rolling stocks procurement.
	Running distance(km)	Running distance=sectional passing cars * station interval (km)	Used for project with rolling stocks procurement.
Effect indicators	Volume of transportation (Man*km, Ton*km)	Man*km=No. of passengers volume * travel length Ton*km=Freight volume (t) * transport distance (km)	Important indicators frequently referred to economic evaluation.
	Running hour for specific section (hr)	computed by av. Velocity and station dwelling time.	Not applicable for the project case witholding train hour reduction.
	Maximum speed (km/h)	Actual measurement.	In most cases, time reduction is more important than maximum speed.
	Congestion ratio	Peak hour congestion ratio = peak 1 hour passengers volume / peak 1 hour transport capacity	Applied for urban railway project.

Source: Operation & Effect Indicators Reference 2014 JICA

(3) Operation and effect indicators in Phase-I

As for the Project, Phase I, its operation and effect indicators are formulated based on standard values in 2013 and target values in 2026 for indicators such as passengers-cargo transport volume, number of train services-vehicle kilometres, etc., as shown in Table 11.2.2.

Table 11.2.2 Operation and effect indicators in Phase I

Indicators	Standard value	Target value
	2013 (actual)	2026
Volume of transportation (Man*km/day)*	3,317,908	27,524,873
Volume of transportation (Ton*km/day)*	2,789,477	15,815,649
Number of running trains /day	27.5	164
Running distance(km/day)	11,112	52,119
Time required between Yangon-Tanug Oo(hour)	6h21m	3h09m

Note* Yangon to Mandalay
Source: JICA Preliminary project appraisal result

(4) Operation and effect indicators in Phase-II

Subject to the scope of work of this study, target year is designated to be 2025, meaning 2 years after opening year (2023). Necessary alterlation /modification is made on afore-mentioned indicators, taking into account of the difference of project condition between Phase I and Phase II, such as their route length and transport demand, and its result is estimated as shown in Table 11.2.3

Table 11.2.3 Estimated operation and ffect indicators in Phase II

Indicators	Present value	Target value
	2017 (actual)	2026
Train Operation Ration (%)	76.6	85
Passenger Transportation (Man*km/day)*	2,089,247	10,190,618
Fright Transportation (Ton*km/day)*	922,486	2,386,800
Number of running trains /day	27.5	104
Passenger Transportation (Train*km/day)*	7,815	38,125
Passenger Transportation (train*km/day)*	13,525,493	8,824
Passenger Revenue(Kyat/day)	13,525,493	310,123,288
Freight Revenue (Kyat/day)	91,560,700	245,049,315
Time required between TaungOo and Mandalay(Passenger Express Train)(hour)	8h01m	4h49m
Time required between Tanug Oo-Mandalay(Freight Train)(hour)	11h24m	6h40m

Note* Yangon to Mandalay
Source: JICA Study Team

11.3 Basic Assumptions

11.3.1 Basic Condition

(1) Inauguration Year

In 2023, the railway transport services will be renewed from Yangon to Mandalay after completion of Phase-II project. However fiscal accounting is assumed to start from 2024.

(2) Project Life

The project life for the economic analysis is assumed 30 years same as the phase-I project

(3) With/Without Comparison

For the economic evaluation, cost-benefit analysis is apdoted. The central thesis of cost-benefit analysis is with/without comparison principle that cost and benefit is estimated by both with project case and without project case respectively. In this study, followings cases are assumed:

- Without case : without Phase-II project
- With case : with Phase-II project

(4) Prices

For conversion of economic price between foreighn currencies in project cost calculation, following currency exchange rate sets are adopted as same as the cost estimation task in this study.

US$1.0 = JPY104.68

MMK1.0 = JPY 0.083

US$1.0 = MMK 1,261

11.3.2 Demand Forecast

To estimate economic benefit and financial revenue by the project, the demand forecast result is widely used as basic input data. Outline of demand forecast is demonstrated, focusing on timelines and with/without cases, as shown in Table 11.3.1.

Table 11.3.1 Assumptions based on Demand Forecast

Type	Case	2023	2030
Passengers transport volume (1000 Pax/day)	With project	80.7	132.4
	Without project	65.4	111.0
Freight transport volume (1000tons/day)	With project	20.941	40.741
	Without project	9.674	17.187

Source: Chapter 2, JICA Study Team

Furthermore, concerning with economic evaluation folllowing data such as passengers-hours and passenegrs-kilometers indicators estimated for all transport modes are also shown in Table 11.3.2, 3 respectively.

Table 11.3.2 Estimated passengers-hours of all mode of transport

(Unit:1000pax-hours/day)

Case	Mode	2023	2030
With	Air	105	258
	Car	1,664	3,978
	IWT	0	0
	Rail	845	1,325
	Bus	1,094	2,192
Without	Air	111	272
	Car	1,692	4,263
	IWT	0	0
	Rail	790	1,327
	Bus	1,152	2,292
With-Without	Air	-6	-14
	Car	-28	-285
	IWT	0	0
	Rail	55	-2
	Bus	-57	-99

Source: JICA Study team

Table 11.3.3 Estimated passengers-kilometers of all mode of transport

(Unit:1000pax-kms/day)

Case	Mode	2023	2030
With	Air	12,232	31,665
	Car	55,384	109,532
	IWT	0	0
	Rail	30,717	53,560
	Bus	53,396	109,264
Without	Air	13,379	34,186
	Car	56,449	115,306
	IWT	0	0
	Rail	20,050	33,949
	Bus	57,171	115,249
With-Without	Air	-1,147	-2,522
	Car	-1,064	-5,774
	IWT	0	0
	Rail	10,667	19,611
	Bus	-3,775	-5,985

Source: JICA Study team

11.4 Project Costs

11.4.1 Financial Project Costs

As a result of cost estimation study, firstly the financial project costs estimation which is expressed in current market prices, is obtained. Cost estimation is disclosure.

11.4.2 Economic Project Costs

In economic analysis, all values of goods and services are stated in efficiency prices or shadow prices to reflect opportunity cost of goods and services.

Under free markets condition, such economic efficiency will be expected. However, actual economy has been often distorted due to some market failure and the government intervention etc. If the market price cannot reflect the opportunity cost, a shadow price is calculated or used instead of market price (as used in the financial analysis).

To reflect economic costs, financial prices will be adjusted by conversion technique and there are 2 approaches in converting financial prices to economic prices.

(a) Shadow Exchange Rate (SER) approach: converting traded goods to domestic market prices using SER. → Willingness to pay numeraire.

(b) Standard Conversion Factor (SCF) approach: converting non-traded goods to border prices using conversion factors to reflect opportunity cost. →Foreign Exchange Rate numeraire.

In this study, second approach is used just same as previous feasibility study.

(1) Usage of Standard conversion factor method

To adjust financial prices to economic prices, the standard conversion factor method is applied. It assumes follows:

(a) Using international prices or border prices as indicators of opportunity cost.

(b) Prices will be expressed in domestic currency using border prices.

(c) Traded goods will be converted to border prices using official exchange rate.

(d) Non-traded goods will be converted to border prices using a corrected factor called conversion factor.

In another expression, conversion factor is

$$\text{Ratio of } \frac{\text{Border Price}}{\text{Domestic Price}}$$

(2) Calculation of Standard conversion factor

Following formula is applied to get SCF (standard conversion factor) index.

$$SCF = \frac{I + E}{(I + Di) + (E - De)}$$

Where; I : Total value of import E : Total value of export
Di : Import duty De : Export incentive subsidy

In phase-I study, value of 0.88 was used as the SCF for economic cost calculation. In data collection survey for the Yangon Mass Rapid Transit (YUMRT) Line 1 project, standard conversion factor was set as 0.85. Another refference sources imply that the SCF for several neighboring countries are among same range of SCF. This study assumes value of 0.88 (same as phase-I study) as the SCF.

(3) Economic project cost estimation

In the economic cost estimation, the contingency cost is excluded from cost calculation and all financial cost items except that are converted from the finacial cost to the economic cost, applying SCF method. Economic Project Cost is disclosed.

(4) Phasing of Economic Project Cost

Whole cost is separated to phased cost stream according to the implementation program which was discussed and obtained in chapter 9.

11.4.3 Operation and Maintenance Cost

After completion of construction stage, project exploitation will start. Through the train operation services utilizing newly rehabilitated sections between Yangon and Mandalay, additional operation and maintenance cost will be required. These operation cost is estimated based on the result of Chapter 7, operation and maintenance.

11.5 Economic Analysis

11.5.1 Objective and Evaluation Policy

The objective of the economic analysis is to analyze and evaluate the viability of implementing this project from the viewpoint of the national economy.

For this project, comparison of the estimated cost and benefit is made between “with case”, in which phase II is applied to the Yangon-Mandalay railway rehabilitation and modernization project, and “without case”, in which no phase II is applied, and economic analysis will be carried out by computing several evaluation indexes, Economic Internal Rate of Return (EIRR), Cost and Benefit

Ratio (CBR) and Economic Net Present Value (ENPV) are applied as the evaluation indexes. The methodologies for these indexes are as follows.

(1) Economic Internal Rate of Return (EIRR)

The EIRR is the discount rate by which both present value of total benefits and total costs (investment cost and O&M cost) are calculated, and then its result becomes equal. The EIRR is calculated by the following formula.

$$\sum_{t=0}^{n} \frac{(B_t - C_t)}{(1 + EIRR)n}$$

Where n : The period of the analysis (first year t = 0)
Bt : The benefit in each year
Ct : The difference of investment cost and O&M cost between "With the project" and "Without the project" in each year

Generally the Social Discount Rate (SDR) is chosen as a criteria value for EIRR. Any project must have its EIIR larger than SDR in order to proclaim that it is an important project from viewpoint of national economy. In the analysis, the SDR is set 10%, same as previous feasibility study on Yangon-Mandalay railway.

(2) Cost and Benefit Ratio (CBR)

The CBR is the ratio found from the net present value of the total benefit divided by the net present value of the total cost. The advantage of the project is evaluated from the value of this ratio, and if the ratio is higher than 1.00 under the designated discount rate, this project is considered to be socially and economically viable. Same as EIRR, the SDR=10% is applied as the discount rate in the analysis.

(3) Net Present Value (NPV)

The NPV is the total net benefit found from the difference between the total benefit and the total cost in net present value. The advantage of the project is evaluated from the amount of NPV. The ENPV is discounted by the SDR=10%.

11.5.2 Economic Benefit

(1) Expected benefit

Economic effect brought about by railway project consists of

(a) User benefit

(b) Suppliers benefit (profit)

(c) Broad spillover effect resulted from linkage mechanism among social sectors.

While (a) and (b) type of benefit are considered to be direct effect by the project, however, (c)type of effect is considered to be chain-mechanism result through various social process and there is a certain risk to make double counting of benefit if it is located temporally and spatially far from the origin of effect.

To avoid double counting of benefit, following items are selected as economic benefit of project.

- User benefit
- Benefit for regional economy along the railway corridor.

User benefit is the economic benefit for transport users, ie. railway passengers and freight users, users of other transport modes and is called the consumers surplus. Items which can be measured as consumer surplus are as follows:

- Savings of travel time and cost are generated among railway passengers and freight shippers as a result of improved train speed and other relevant services.
- Operation cost savings for other transport modes including air transport, buses, private transport and inland water transport, due to the transport volume reduction as a result of traffic diversion to railway .
- Travel time and cost saving for existing traffic users not diverted by project due to easing of traffic condition resulted from traffic reduction by project.

Benefit for regional economy along the Yangon-Mandalay railway corridor is expected by gaining economic predominant position compared with other regions, as a result of railway improvement effect. These economic advantage is materialized by improvement of railway operation and services as follows:

- Increase of macro economic output by accelelating economic activity and increasing economic production through the improved railway facilities and operation.

(2) Estimation of user benefit

Estimation for each benefit is carried out by a common calculation rule, i.e. economic benefit = saving value (trip length or time) * unit cost (per length or per hour)

The quantified economic benefits of saving in vehicle operating costs and saving in vehicle time costs are defined as differences of these costs when comparing the “With Project” and “Without Project”.

(a) Data required for above calculation are provided as the result of demand forecast (described in chapter 2)

(b) Unit cost for VOC(Vehicle Operating Cost) and TTC(Travel Time Cost) is set out, refering to the previous F/S as shown in Table 11.5.

Table 11.5.1 Unit cost parameters applied to VOC, TTC

(Unit:MMK/1000km, MMK/h)

	Motorcycle	Car	Bus	Truck
VOC	24,723	222,680	270,284	345,232
TTC	1,725	5,558	2,523	2,453

Note: Original source is "Project of Comprehensive Urban Transport Plan of the Greater Yangon"

(c) By multiplying the pax/hour and pax/km index with the above unit cost respectively, both travel time cost saving and vehicle operating cost saving are estimated. It is noted that average occupncy rate by transport mode is necessay because these calculation should be done on vehicle basis instead of person basis. Adopted occupancy rate for car and bus are set 2.2 persons and 36 persons respectively same as the previous feasibility study.

(3) Estimation of economic benefit for regional economy

Based on the review for past economic analysis on the regional economic growth by transport infrastructure development, it is assumed that around +1% increase of the Gross Regional Domestic Product(GRDP) in the area of Yango-Mandalay railway corridor is generated as the economic benefit for regional economy by the project implementation.

From the administrative district along the railway corridor between Taungoo and Mandalay, following 3 states, Bago, Mandalay and Nay Pyi Taw, are slected as the target area and their GRDP is estimated based on the future economic framework described in the demand forecast section.

11.5.3 Cost Benefit Analysis

(1) Base case

Based on the initial condition assumed for cost and benefit, cost benefit analysis was carried out. Table 11.5.2 shows its briefing of eveluation. Original cash flow stream data is disclosed.

According to the result mentioned above, EIRR for the project has cleared the target interest rate, i.e. recent myanmar central bank rate, it is considered that the project proves economically feasible from viewpoints of national economy.

(2) Sensitivity Tests

In this study input data such as benefit and cost was estimated in very carefull manner, using reliable data source, however there is some possibility of poor outcome due to various unpredictable factors in future. Coping with such uncertain matters, sensitivity tests are made as follows:

- Case 1:20% increase in project cost
- Case2 :20% decrease in demand
- Case3 :both case1 and 2

Result of sensitivity tests is shown in Table 11.5.2.

Table 11.5.2 Result of Sensitivity Tests

	Case 1:20% increase in project cost	Case2 :20% decrease in demand	Case3 :Mix of case1 and Case 2
EIRR	14.55%	14.08%	12.05%

Comparing with base case result, obviously alternative test cases show worsening result. However, even for the worst scenario case (case 3) , its EIRR shows above the level of capital opportunity cost in Myanmar. It implys that the project is robust nature in terms of project feasibility.

11.6 Financial Analysis

11.6.1 Objective and Evaluation Policy

(1) Objectives

The objective of the financial analysis is to analyze and evaluate viability of implementing this project from viewpoints of project owner or operator. In other word, financial analysis focuses on more internal money flow in railway segment and examines whether their investment plan is viable or not. Several precondition should be made before the analysis, i.e. who is in charge of project implementation, how the project interface is secured between phased implementation in whole project, i.e. the Rehabilitation and Modernization of Yangon-Mandalay Railway project because this project stands for the phase 2 scheme of the total project. In this connection, following assumptions are prepared.

- This project will be executed by Myanmar railway within its authorization and obligation. It means the project is implemented under the scheme for public corporations.
- Therefore most favorable fund resources like ODA loans are to be applicable for this project.
- Myanmar Railway provides both passengers and freight railway services in whole national territory and the coverage of its accounts book is not limited to the Yangon-Mandalay railway because it is a partial segment of whole network.

Main objectives of the analysis are as follows:

(a) To examine financial viability of Phase-II project from viewpoints of financial opportunity cost of capital in Myanmar.

(b) To clarify possible fund raising plan combination applicable for this project.

(2) Evaluation indicator

- Context of the financial analysis is so simple that it only focuses on actual money flow, i.e. incoming money (revenues), outgoing money (expenditures) and its balance in project account. Specifically revenues consists of gross passengers revenues and freight revenues obtained by railway operation and expenditures include the construction cost and maintenance & operation cost.
- As a typical evaluation index in financial analysis, normally FIRR was used. The FIRR is the discount rate whereby the totals of revenue and expenditure (investment cost and O&M cost) converted into the net present value become equal. The FIRR is calculated by the following formula.

$$\sum_{t=0}^{n} \frac{(B_t - C_t)}{(1 + FIRR)n}$$

Where

n : the period of the analysis (first year t = 0)

Bt: the revenue in each year

Ct: the expenditure (investment cost and O&M cost) in each year

The FIRR is considered to be maximum interest rate applicable to loan finance scheme for the project.

The FIRR is evaluated in comparison to the Financial Opportunity Cost of Capital (FOCC). For this project, FOCC should refer to most favored lending rate applied for public work projects in Myanmar, it might be referred to the long term government bond rate etc.

(3) Fund scheme evaluation

If the project's FIRR is high enough, the project is considered to be financially viable and eligible for project execution stage. Following this, fund raising scheme will become next issue. As for the available fund, there might be considerable number of money resources in Myanmar, including foreign and private fund. In this study several fund combination cases will be made, taking into account of the possibility and finance condition of fund, among the available fund sources. Then cash flow analysis will be conducted under the specific fund combination cases to clarify financial viability of each fund cases.

11.6.2 Revenue Estimation

(1) Basic assumption on fare system

To estimate fare revenue for the Yangon-Mandalay railway, fare system is assumed as a basic condition, just same as demand forecast process.

According to demand forecast, following fare structures are taken into consideration:

- Passenger fare : average 30 MMK/km[*1]
- Freight fare : 26.3 MMK/km for general cargo[*2]
  39.4 MMK/km for petroleum cargo[*2]

Note:*1 Average fare is determined based on comparison with other transport modes and discussion with MR.

Note:*2 These figures are based on the current railway cargo tariff system.

(2) Estimated revenue

Based on the demand forecast, gross passengers fare revenue and freight revenue are estimated. Future railway revenue will increase until year 2030, however fare revenue amont is assumed to maintain same level after 2030 because of railway capacity.

Annual railway revenues for passengers and freight services are calculated as shown in Table 11.6.1. For annual revenue calculation, conversion factor of 365, i.e. 365 days/year, is used for calculation from daily traffic volumes to annual traffic volumes.

Table 11.6.1 Railway revenue estimation result

(Unit: million MMK/year)

	2023	2030
Passengers fare revenue	49,892	350,048
Freight fare revenue	35,123	319,596

Note: Ramp-up effect is assumed in the beginning three years

11.6.3 Cash Flow Analysis

(1) Base case result

Based on the cost stream data and revenue stream data, the financial cash flow analysis was conducted. Its result is shown in 11.6.3 and its summary is also shown in Table 11.6.2.

Table 11.6.2 Summary of financial cashflow analysis

Indicator	Value
FIRR	13.37%
NPV(million MMK at discounted rate of 10%	1,984,846

Source: JICA study team

For base case of financial analysis, FIRR (Financial Internal Rate of Return) is estimated at 13.4% and NPV is estimated at 1,985 billion MMK if discounted rate of 10% was adopted. Estimated FIRR is slightly over the lending interest rate for co-operatives by Central Bank of Myanmar (13% as of 2014) . Cashflow analysis data is disclosed.

(2) Sensitivity test

Past experience of various construction projects suggest that there are many project risk expected in any projects such as cost overrun and demand shrinking. As same as economic analysis, sensitivity tests are made as follows:

- Case 1:20% increase in project cost
- Case 2 :20% decrease in demand
- Case 3 :Simultaneous case for case 1 and case 2

Result of sensitivity tests is shown in Table 11.6.3.

Table 11.6.3 Result of Sensitivity Tests

	Case 1:20% increase in project cost	Case2 :20% decrease in revenue	Case3 :Mix of case1 and Case 2
FIRR	11.36%	10.91%	8.93%

Source: JICA Study team

Comparing with base case result, obviously alternative test cases show worsening result. In particular, its worst case 3 shows that project implementation is unsustainable unless adequate risk management is made.

11.6.4 Analysis on Fund Raising Plan

(1) Meaning of fund raising plan in financial analysis

As described in foregoing section, FIRR was presented as a first evaluation indicator in the financial analysis. FIRR is also called “project IRR” and it shows a financial efficiency of the project in total, and its calculation is made under am assumption that interest-free fund is available for the project without limit. Whereas, for a practical financial viability of project, its project cash flow should be calculated based on the specific fund raising plan, and then the financial viability of project under actual condition is concluded.

(2) Cases of fund raising plan

To confirm practical clarification on financial feasibility of this project, 2 alternative schenarios on fund raising plans are set as shown in Table 11.6.4 and teir financial viability are tested by cash flow analysis..

Table 11.6.4 Fund raising plan cases

Case	Case-1	Case-2	
Fund category	JICA Yen loan	Foreign loan	Local loan
% of project costs	100	70	30
Installment (grace period)	30 (10)	30 (10)	10 (-)
Interest rate (%/year)	0.01	1	15
Note	Most preferable case. applying JICA's yen loan scheme for LDC.	Foreign portion of project costs :foreign loan Local portion of project costs:local loan	

Source :JICA study team

(3) Result of analysis

Using the same cost and revenue data applied for estimating FIRR, cash flow analysis is made for each fund raising plan case. Calculation result is summarized as shown in Table 11.6.5.

As Since the result shows FIRR of the project maintains the rate higher than current market loan rate, it is considered that the project can be a bankable project if certain fund scheme is prepared for fund resource of the project.

Table 11.6.5 Result of the cash flow by fund raising plan cases

Indicator	Case-1	Case-2
FIRR	13%	10%
NPV (million MMK at discount rate of 10%)	1,967,582	1,462,723

Source: JICA study team

The cash flow calculation result for case-1 is disclosed.

11.7 Economic impact Induced by railway corridor development

11.7.1 Railway corridor area covered by Yangon-Mandalay railway

The project route runs on a railway corridor between Yangon, the south post of railway, and Mandalay, the north post of railway with its total length of arround 620km. Its railway service coverage includes not only Yangon, the largest city in Myanmar, and Mandalay, second largest city, but also Nay Pyi Taw, national capital city of Myanmar. This feature implies that the railway is most important trunk line from various aspects, i.e. simbolic image on national unity, a vital artery for economic and industry activity, com ံ n munication axis for human and material exchange, etc. Hereinafter it is expressed as "Y_M railway corridor". Following data back up the above.

(1) Current populatopn of the railway corridor is estimated around 15 million and equals to 32% of union's total population according to the census data.

(2) Total population consists of urban and rural population, depending on where they are living. The percentage of urban population in the railway corridor is 52%, relatively higher than 30% of national average.

(3) The population size and the distribution of urban population by each region is illustrated in Gigure 11.7.1. As shown by the figure, concentration of urban population is seen in major core cities such as Mandalay and Nay Pyi Taw. It is considered that these core cities are right in their urbanization process and it will be intensed further through project implementation.

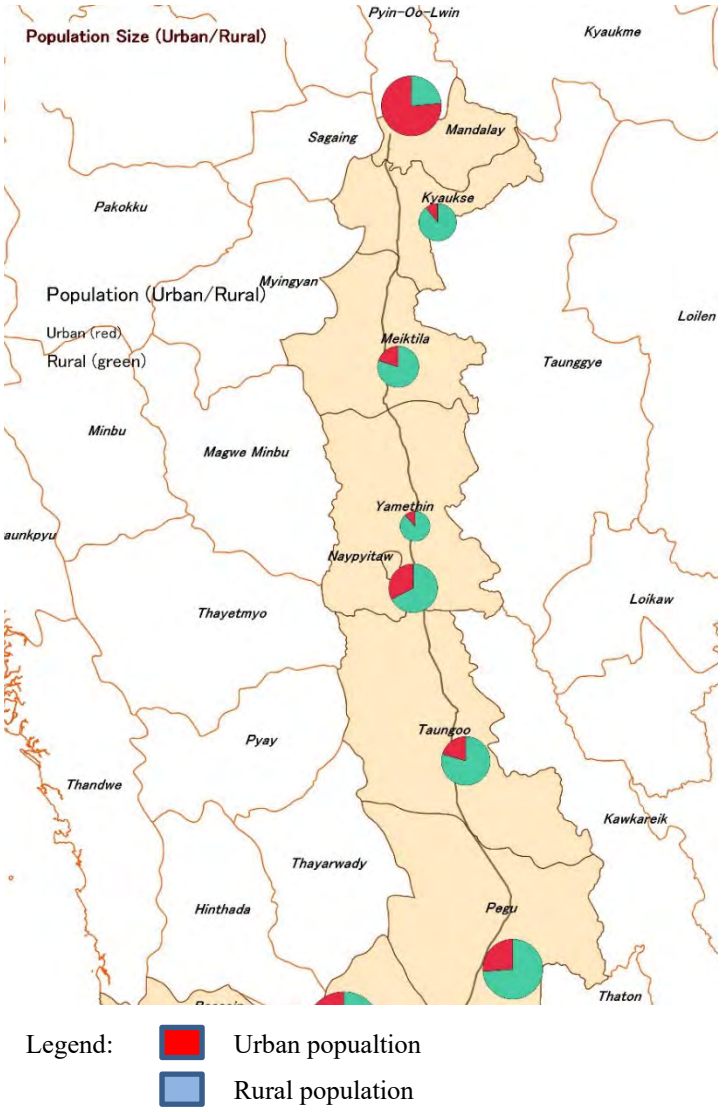
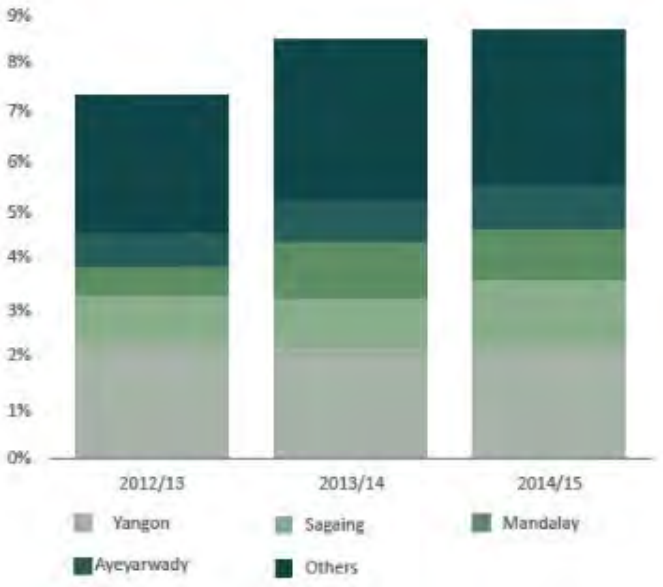


Figure 11.7.1 Distribution of urban/rural population from Taungoo to Mandalay

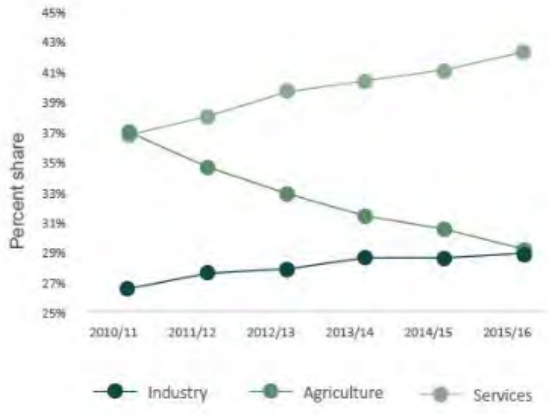
(4) Regarding the economic productivity of Y_M railway corridor, there is the statistical limitation due to the lack of precise data, i.e. GRDP, however, it is said that Yangon and Mandalay generate 25% and 15% of real GDP growth in 2014, respectively, as shown in Figure 11.7.2.



Source: Myanmar economic monitor World Bank

Figure 11.7.2 State/Region contribution to growth

(5) As shown in Figure 11.7.3, strucural change of economic sectors from agriculture dominant economy to service and industry driven economy, has taken place drastically in the macro economic trend of Myanmar. This latest change implies the importance of the Yangon and Mandalay railway corridor which provides of economic development space and opportunity for the secondary and tertially economy sector through their urban strucutre development and population increase.



Source: Myanmar economic monitor World Bank

Figure 11.7.3 Sector composition of GDP in Myanmar economy

11.7.2 Economic potential increased by Y_M railway corridor development

This project carry out the track rehabilitation and upgrading for Y_M railway corridor to improve its railway operation capacity / quality, i.e. high train speed with safety, stable train operation schedule and attractive transport services for both passengers and rail freight. As major project outcome, following advantages are pointed out:

- As its direct effect, both travel time and transport fare reduction are expected for persons and goods mobility between regions and cities connected by railway line. This effect is considered to be the user benefit.
- At the same time, these change in transport service parameter is not only change for specific trip making process, but develops area-wide impact on inter-regional transport network condition.
- The most significant parameter is the improvement of accessibility in network condition, i.e. specific change of from low to high accessibility to core city. According to some previous study, it is noted that additional transport demand will be induced or developed if there is a significant change of accessibility condition in trip making.
- Furthermore, from another viewpoint the accessibility improvement has a long term effect of providing the development opportunity to the land along the railway line.
- As a result of above process, accumulation of development demand, potential for commercial/industry development, including the area/land development, will be formulated.

(1) Estimation of development potential by applying gravity model

As an indicative example of the development potential increase by accessibility improvement, simple mathematic calculation was made as follows:

(a) The accessibility is defined as the required time between each regional center, and it is calculated based on the train schedule speed.

(b) Development potential is in proportion to magnitude of population size of regional center, and It is assumed that exchange demand potential between regions is calculated by following formular similar to the Gravity model:

$$\frac{(Pi \quad \times Pj \quad)}{(Ti,j \quad)gamma}$$

Where:

Pi, = value of urban population in zone I, Pj= value of urban population in zone J

Tij=travel time in hour between zone I and zone j, is calculated on the condition of train speed, 40km/h : Without project, 70km/h:With project,respectively.

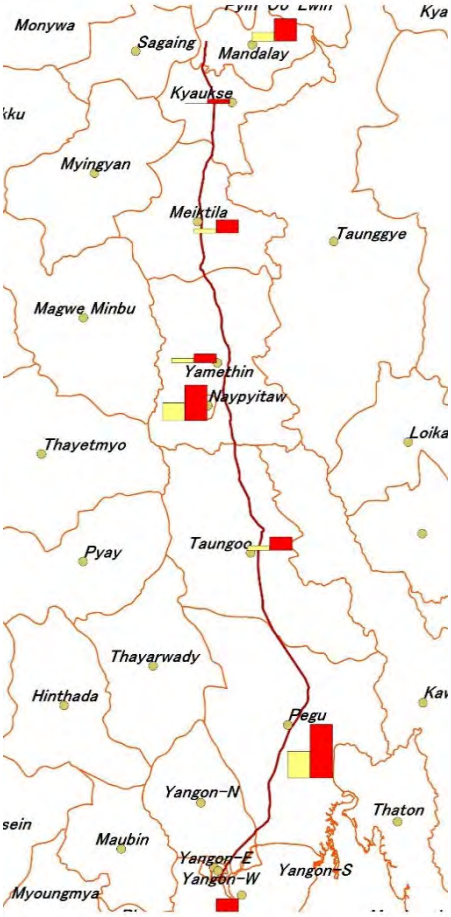
Gamma=gravity model parameter (power index), assumed as 2.0

(2) Estimation result of development potential in Y_M railway corridor

Based on the assumption above, the development potential in Y_M railway corridor was calculated by township for both of "Without case" and "With case", including the change between cases.

The result is shown in Table 11.7.1. Comparing the increase rate of each district, high increase of development potential is seen for the core cities such as Mandalay and Naypyitaw, while around 1.5 times increase rate in average is expected for whole Y_M railway corridor.

Table 11.7.1 Increase of development potential in Y_M railway corridor by the project



	Without	With	With/ Without
Pegu	9,627	18,850	1.96
Taungoo	2,826	5,460	1.93
Kyaukse	869	1,542	1.78
Mandalay	3,691	7,730	2.09
Meiktila	2,454	4,881	1.99
Yamethin	1,849	3,083	1.67
Naypyitaw	6,736	13,492	2.00
Yangon-E	107,904	155,346	1.44
Yangon-N	23,815	33,106	1.39
Yangon-S	20,265	25,940	1.28
Yangon-W	90,497	129,732	1.43
Total	270,532	399,161	1.48

Chapter 12 Conclusion and Recommendation

12.1 Conclusion

Yangon - Mandalay Railway Improvement Project was planned to be implemented by dividing into three phases in the Feasibility Study in November 2013, because the total length of the line was approximately 620km long. By the strong request of the completion of the whole project by the end of 2023 from the Myanmar Government, JICA considered to combine the remaining two phases into one project as Phase II, in which the total section is approximately 353km from Taungoo to Mandalay.

As the result of the feasibility study, it was found out that to complete the project in three years and a half is feasible. However, there is a problem in terms of the project schedule that contractors might not be able to prepare manpower necessary for the construction works, as the last one year of Phase I and the first year of the construction works of Phase II are overlapped. On the other hand, as the construction works proceed in Phase I, it is expected that construction staff will get the ability for their works. In this regard, it will be necessary to pay attention to the works by the Phase I Contractors after Year 2018 when the construction works start in Phase I, especially for civil and signalling works.

For Phase II, it is necessary to divide the whole section into four (4) contract packages to shorten the project schedule, considering the 353km length.

This project is considered an important project from the viewpoint of the economic and financial analysis. At the result of the economic analysis, this project has the EIRR of 16.7%, and from the financial analysis, it has 13.4%. Therefore, it can be said that this project has a high investment effect.

In terms of environmental category, this project is in Category B by the JICA Guideline. Most of the project implementation can be conducted in utilization of the Right of Way of MR. Therefore; people affected by resettlement could be reduced as much as possible. And also, this project is a renovation project with little environmental impact.

This project is placed a meaningful project as Japanese ODA project, which is utilized by high quality materials and technologies from Japan such as 1) Introducton of 50N rail and related materials and also technologies for high speed and safety operation, 2) Introduction of ATP (ATS-S) which is utilized high reliability and long years in Japan, and also it is compatible with the imported

Japanese used DMUs and 3) Introduction of Radio Telecommunication System using UHF radio frequency which technology is widely used in Japan.

12.2 Recommendation and Consideration for the Project

12.2.1 Consideration at the Detailed Design Stage

(1) Timing on the Bidding Documents Preparation

Contract Package is disclosed.

(2) Utilization of Phase I Bidding Document and Review of Clarification

In the discussion with MR during the Preparatory Survey in Phase II, the JICA Study Team confirmed that the design criteria of Phase II should be the same as those of Phase I. Therefore, it is necessary to utilize the bidding documents of Phase I as much as possible on the preparation of the bidding documents. This will contribute to shorten the basic design period and also the detailed design period.

It is most important to review the clarifications by the bidders in Phase I and to reflect them to the bidding documents as well as the detailed design. To review the clarifications carefully and to prepare the bidding documents should be started as early as possible.

(3) Reconfirmation of Supplying PC Sleepers and Ballast by MR

Supplying PC sleepers and ballast by MR will absolutely affect the schedule of Phase II construction works. Therefore, it is necessary to reconfirm this issue with MR in the detailed design stage.

For supplying PC sleepers, MR must produce them at their factories and transport all sleepers to the sites on appropriate time designated by the contractors. In this sense, the close communication and coordination regarding the schedules between MR and the contactors will be the most important.

Regarding the demarcation for the ballast supply, during the Phase II Preparatory Survey, it has been confirmed that MR will prepare ballast at query sites and the contractors will transport it to their sites by them. In this regard, the risks in schedule delay will be reduced for the contractors. However, MR should note that MR has to secure the supply of enough budgets for ballast.

Both two items should be reconfirmed at the detailed design stage.

(4) Establishment of PMU

PMU, Project Implementation Unit, is the most important organisation to implement the project smoothly in any of the Yen Loan projects. Establishment of PMU has been agreed between MR and JICA at the M/D of the appraisal in October 2017.

Especially, as MR has been involved in many large scale projects at the same time, such as Yangon-Mandalay Railway Improvement Project Phase I, Yangon Circular Railway Line Upgrading Project and OCC Project, etc. In order to implement each project smoothly, it is important to set up the PMU for each project and secure enough number of qualified project staff.

As Yangon-Mandalay Railway Improvement Project Phase II is scheduled to commence the tender announcement in November 2018, it is necessary to designate the Project Director (PD) and assign the person in charge of the Phase II Project by MR as soon as possible for the smooth implementation.

a) Major Role of PMU

- For the smooth implementation of the project, the PMU has important tasks which include making bidding plans and disbursement plans to get approval from JICA in advance. Also it is necessary to report the progress of the project to the Ministry of Transport and Communications (MOTC), Ministry of Planning and Finance (MOPF) and JICA.
- Proper preparation for the project must comply with the current regulations for Japanese ODA loans (resettlement of inhabitants, environmental impact assessment and social impact assessment).
- Performing bidding, contracting and monitoring for the project and disbursement in accordance with the Myanmar law and JICA's rules is required.
- The coordination of the related ministries and the social and environmental considerations as is mentioned in c) and d) will be major tasks.

b) Organization of PMU

- The organizational structure of the PMU usually consists of administrative, planning, procurement (bidding), finance and technical sections with an adequate number of staff with adequate qualifications.
- The PMU Director must be professional with leadership capability and experiences for the project management.
- The responsibility and power of the PMU should be separated from the usual MR operation.

For the smooth implementation of the project, MR should establish the PMU and report it to MOTC and JICA as soon as possible.

c) Discussions with other Authorities

In some cases, the project requires approval from other authorities for various issues including roads, rivers, electric power supply, environment, taxation and others.

MR shall take the responsibility to implement necessary coordination with the related ministries and other authorities. The details shall be discussed with the contractors after their mobilization. It is also recommended that MR explain the outline of the project to the related ministries and authorities before the tendering.

d) Fulfilment of Environmental Requirements

MR is required to fulfil the following environmental requirements as shown inTable 12.2.1.

Table 12.2.1 Environmental Requirements

Environmental Items	Requirements
Involuntary resettlement due to replacement of bridge	Completion of resettlement and compensation process based on the compensation policy, procedures and schedule set forth in the ARAP
Land clearance due to depot in Myohaung and Naypyitaw	Completion of relocation well be held in Oct. 2019 before the beginning of the tendering process and coordination with concerned authorities in order to facilitate the process
Environmental Management Plan	Preparation and finalization of the Environmental Management Plan based on the Report on Environmental and Social Considerations prepared by the JICA study team

(5) Optical Fiber Cable (OFC)

There are two types of OFC along Yangon-Mandalay Railway (YM), the buried OFC owned by MR and the overhead OFC owned by a Chinese enterprise. As the buried OFC is in a poor condition, the JICA Study Team developed the design on the assumption that the new overhead OFC is to be used for the system. In order for MR to use the overhead OFC, it is necessary to finalize the contract with the Chinese enterprise and to connect the OFC to each station along the line. It is recommended that MR conclude the contract, connect the OFC to each station and confirm that the OFC is available.

Also, as it is planned to use cranes for piling and the transport of materials in bridge construction works along the line, it is assumed that some parts of the overhead OFC have to be moved for such civil works. In order not to affect such civil works by the delay of the contract, MR is required to conclude the contract as soon as possible.

During the construction period, as such movement of the OFC at bridges will be required for the whole line, the Contractor shall be careful not to cut the OFC. In the detailed design stage, the Consultant should follow up the situation for the contact with the Chinese enterprise in the detailed design stage.

(6) Preparation of Asset Management and Implementation Plan

The number of replacement of bridges will be more than 2000 for PC Gurders and Box Culverts. Also track facilities, signal facilities, TMS and rolling stock will be newly installed in the Yangon-Mandalay Improvement Project. Those new facilities and equipment should be listed and managed by the Asset Management System, and spare parts should be also managed by MR properly.

The establishment and organizational management of the Asset Management System should be designed at the detailed design stage.

(7) Coordination with Other Projects

As there are several projects ongoing for YM, it will be important to coordinate with such projects in the detailed design. Besides the ODA projects by the Japanese Government such as OCC Project and Yangon-Mandalay Railway Improvement Project Phase I, the PPP developing dry ports in Myitnge is related with the track layout of the station and thus the consultant for the detailed design is required to obtain the information of the PPP while MR should provide enough information to the consultant accordingly.

12.2.2 Consideration items in the Implementation Stage

(1) ATP installation on Existing Locomotives

Between Yangon and Mandalay, not only the new DEMUs but also the existing locomotives and coaches will be operated by MR even after the completion of the project, nearly 30% by the new DEMUs and nearly 70% by the existing MR's rolling stock.

The conditions of the existing locomotives and coaches are poor for safe operation including brake systems, and, if the situations do not change, these cars will disturb the safe and stable train operation on YM in the future. MR is required to keep these cars in good conditions so that they can run safely.

For further improvement for safety, it is necessary to install an ATP onboard device on the existing locomotives which are expected to be operated on YM. These ATP onboard devices are supposed to be supplied by the CP105 Contractor of Phase I and be installed by MR.

The consultant for YM-CMC of Phase I is supposed to supervise the installation work of ATP to provide technical advices and instructions to MR. It is recommended that MR check that all the locomotives operated on YM be equipped with an ATP onboard device.

(2) DEMU Operation between Taungoo and Naypyitaw

Although the section between Yangon and Taungoo will be rehabilitated in Phase I, MR is planning to operate the new DEMU up to Naypyitaw. This is reasonable from the viewpoints of travel demand and demonstration to Myanmar people, compared with the operation between Yangon and Taungoo.

In this case, the new DEMU will run on the track with bad conditions between Taungoo and Naypyitaw. The Contractor of CP104, Rolling Stock Procurement, will require MR to use the new trains on the improved track. The consultant for YM-CMC is supposed to coordinate with MR and conduct the analysis of track conditions between Taungoo and Naypyitaw. If necessary, the

consultant is expected to provide advices to MR regarding the track maintenance for the section and the appropriate operation rules including train operation speed.

MR has to understand that the rolling stock supplier designs and manufactures the rolling stock assuming that it is operated on the improved track between Yangon and Taungoo and that, if MR operates the new DEMU on the track with bad conditions which has not been improved and some trouble or malfunction occurs, the Contractor will claim that the cause of such trouble or malfunction is the operation on the bad track between Taungoo and Naypyitaw. In this case, the Contractor may not remedy the defective works even during the Defect Notification Period depending on the cause of the malfunction or trouble. MR should notice that MR will not be able to get remedial works for the defect or damage by the Contractor if the cause cannot be clarified.

(3) Human Resource Development of MR, Improvement of Railway Institute in Meiktela

MR is an enormous organization with more than 20,000 staff. As MR is to be modernized through this Project in terms of facilities and equipment, it is necessary to educate and develop MR staff to meet such a modern railway system.

MOTC owns the Central Institute of Transport and Communications in Meiktela. While Yangon Mandalay Railway Improvement Project proceeds, it is important to educate MR staff so that they can operate and manage the modern railway of YM line, and the institute in Meiktela should be the basement for their education.

It is recommended that a technical cooperation project be set up in parallel with the Yangon-Mandalay Railway Improvement Project where MR can train and educate their staff of civil engineering, track, electricity, signal, train operation, and so on, so that MR can operate the railway in terms of technical skills and railway management without the subsidy from the Government.

(4) Request to MR from the Aspect of Bridge Engineering

To pave a shortcut to the modernization and rehabilitation project, MR is requested to take actions as mentioned below. The actions will provide basic existing information at the initial stage of this project and contribute significantly to the quick and appropriate implementation of the project.

i) Updating and Adding the List of Bridge Structures

There is already a bridge list but its information is defective or insufficient and does not include many newly built PC bridges. Therefore, the information should be updated and added.

ii) Arranging Past Inspection Records about Bridge Structures

Although the inspection methods and recording techniques are insufficient for the appropriate health diagnoses of bridge structures, MR conducts periodic inspection on main bridge structures.

Therefore, MR is considered to have basic reference materials. Such past records and information should be collected and arranged as useful reference materials for future.

iii) Arranging Past Inspection Records about Bridge Structures

The design documents (design drawings and calculation reports) for the PC bridges including substructures designed and constructed recently should be obtained by MR immediately, because these basic reference materials will be necessary to understand the design conditions about the axle load and design speed of train and the like, also to evaluate future health diagnoses. In addition, it was considered that the qualities of materials like concrete and construction management at the time of construction of these PC bridges were inadequate. From now on, attention should be focused on the perspective of not only ensuring of temporary bearing force but also ensuring of long-life durability.

iv) Establishing Systems for Supporting Technique Acquisition in the Field of Bridge Engineering

At the initial stage of the project, it becomes necessary to establish maintenance systems and manuals for inspecting, repairing, and reinforcing various bridge structures and also to establish information management systems and inspection standards. At the same time, organizations should be created to smoothly execute a series of operations from inspection to the planning and implementation of repairs, reinforcement, and renewal based on the inspection data. Where possible, preparations for the series of operations should be advanced (for example, conception of an educational organization for railway civil engineers and institution-building of an incentive system).

(5) Maintenance of Equipment

The maintenance of the equipment and devices installed in this project is absolutely important in order to keep their functions after the commercial operation starts. While the Contractor are supposed to provide enough and proper education and training to MR staff, MR will be required to secure the budget for the maintenance as well as enough maintenance staff and proper organization for the maintenance.

Chapter 13 Public Relations

13.1 PR materials prepared by JICA Study Team

There are several materials are considered as PR of Yangon Mandalay Railway Improvement Project.Following PR materials are made in Japanese, English, Myanmar.

- PR Video: 5minutes version.
- Book which Japanese monthly magazine will be translated into Myanmar.:5,000
- Leaflet:A4 size brochure(14,000 in Myanmar, 13,000 in English, 3,000 in Japanese)

13.2 Making Visual Presentation Material

In order to aim to increase demand of Yangon – Mandalay Railway which will be asserted against buses and cars, public relations visual presentation of improved railway transport service will be made in the Project.

In middle of May, JST was shooting a movie for comparison of before and after the improvement project at Mandalay station, Myohaung Depot, Thazi Station, Naypyitaw Station and Yangon Station. From now on, JST will make scenarios for the public relations presentation as referenced in Table 13.2.1 after the decided major improvement items.

Table 13.2.1 Public Relations items of visual presentation material

Items	Contents
Increasing train operation	Movie which is able to feel the speed felt of the train after improvement will be prepared by using CG and map. The movie is made as it can be seen how much time was shortened between Yangon Station and Naypyitaw Station by the project
Station yard and station development	The station yard will be improved in order to be more convenient for kids and pregnant women, and to be age-friendly by becoming barrier-free. Also, it will become easier to transit to buses and taxis.
Introduce of new DEMU	New DEMU has performance of comfortable riding and clear toilets and priority sheets.
Introduce of ticket vending machine and ticket reservation system	Easily buying ticket on-line system will be introduced by using PC and smartphone
Improvement safety awareness	The movie will facilitate public awareness in order to decrease railway accidents due to increased train speed

Source: JICA Study Team

13.1 Preparation and Distribution of Leaflet and Booklet

Leaflet and Boolet were prepared for the purpose of public relation for Yangon Mandalay railway Improvement Project, which included the contentsthat Train trave would be safer, faster and more comvinienet.

13.1.1 PR towards Japanese people

In consideration that many people in Japan are interested in the transportation projects, especially the railway sector in Myanmar, focus will be put on publicity activities through Japanese media, both printed magazines and websites.

(1) Running story on the International Development Journal, the monthly magazine featured on International cooperation activities in Japan

(2) Those articles towards Japanese business sector by reprinting them in JB Press, the Japanese website focused on business news will also be delivered.

13.1.2 PR towards Myanmar people

The study team is now also preparing for PR towards the people of Myanmar by editing and translating the articles above in Myanmr:

- Preparing to run maximum four of the Myanmar articles edited and translated from the International Development Journal or newly written articles for the book below on a local newspaper or magazine printed in Myanmar language.
- To appeal to more people, post four of the Myanmar articles (including newly written articles for the book below) on the Facebook page of the JICA Myanmar office.
- Issue a book with all the Burmese articles translated during not only this study but also the study for the Yangon circular line. It will be provided for free to deliver the whole story about Japanese assistance toward upgrading railway system in Myanmar. Books will be delivered not only MR, but also stations and or universities to make assure distribute as many local people as possible.