DIRECTORATE OF
WATER RESOURCES AND IMPROVEMENT OF RIVER SYSTEMS (DWIR)
INLAND WATER TRANSPORT (IWT)
MINISTRY OF TRANSPORT AND COMMUNICATIONS (MOTC)
THE REPUBLIC OF THE UNION OF MYANMAR

PREPARATORY SURVEY REPORT
ON
THE PROJECT
FOR
DEVELOPMENT OF MANDALAY PORT
IN
THE REPUBLIC OF
THE UNION OF MYANMAR

JANUARY 2018

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS GLOBAL CO., LTD.
PACIFIC CONSULTANTS CO., LTD.
FUKKEN CO., LTD.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Joint Venture of Oriental Consultants Global Co., Ltd., Pacific Consultants Co., Ltd. and Fukken Co., Ltd.

The survey Team held a series of discussions with the officials concered of the Government of the Republic of the Union of Myanmar, and conducted a field investigations. As a result of further studies in Japan, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Uniton of Myanmar for their close cooperation etended to the survey team.

January 2018

Itsu Adachi
Director General,
Infrastructure and Peacebuilding Department
Japan International Cooperation Agency

Summary

1 Background and Outline of the Project

(1) Present Conditions and Problems

Travel along inland waterways is an important transport mode for the Republic of the Union of Myanmar (hereinafter referred to as Myanmar). Myanmar has 6,650 km of navigable inland waterways, of which the longest waterway, the Ayeyarwady river, is 2,170 km long in its main streamline, and 3,938 km including branch streams. Using inland waterways it is possible to travel between the nation's biggest commercial city, Yangon, and the main national cities.

Mandalay is the second biggest commercial city in Myanmar, which is located 700 km north from Yangon and alongside the Ayeyarwady River. The city is considered as one of the transportation hubs of the nation as the major roads (National Roads No. 1 and No. 2, Expressways between Yangon and Mandalay) and the railway (Yangon-Mandalay) connect to the city. Mandalay port is one of the most important river ports of the nation, where a number of passenger ships and cargo ships come from and go to the major cities along the Ayeyarwady River waterways. Particularly, the port is a base port for the northern region of Myanmar where there is poor road development.

However, the port has no mechanical equipment or facilities, where all cargo handling depends only on manual labour. This primitive custom of cargo handling prevents national waterway transport from attaining the required development for modernization of inland water transport. This project is based on the official request for Japan's grant aid, covering installation of jetty, cargo yard, warehouse, and necessary cargo handling equipment for the purpose of modernizing the Mandalay port. By this project, Mandalay port will become the first modernized river port in Myanmar, which will be a national pilot project for extending similar development concepts to the other major river ports.

The counterpart authorities of this project are, Directorate of Water Resources and Improvement of River System (DWIR) and Inland Water Transport (IWT), both of which belong to the Ministry of Transport and Communication (MOTC). DWIR is acting as the government authority to manage river control and maintenance of river waterways. IWT is acting as a public authority which holds river vessels and barges, and operates passenger/cargo ships along the river waterway routes. After completion of this project, IWT is planned to manage the operation of the new port facilities. IWT is developing its own organization establishing a new department for river port operation. For IWT, this project is the initial experience of modernized river port management, therefore, further technical support of IWT's management will also be an important point of the project.

(2) Background of the Project

1) Goal of Inland Water Transport Development under National Development Plan

The Myanmar government formulated five-year development plan (2011~2016) based on the National Comprehensive Development Plan (NCDP), and has executed the plan for national economic development. Vision of National Industrial Development of Myanmar was formulated by the Ministry of Economy Trade and Industry (METI) of Japan for the purpose of supporting Myanmar in establishing its national development plan.

In the vision, the development of an inland waterway transport network is recommended as a transport mode to support national economic growth. In practice, development of modernized river port facilities and maintenance of existing waterways, establishment of a cold-chain

network, and development of an inland transport base such as an Inland Container Depot (ICD) are recommended.

2) National Transportation Master Plan (the 2014 NTMP JICA Study)

Receiving an official government request from Myanmar, Japan International Cooperation Agency (JICA) executed a study for creating a national transport master plan (i.e. "the Survey Program for the National Transport Development Plan", September 2014, hereinafter referred to as "the 2014 NTMP JICA Study"). The 2014 NTMP JICA Study report explains that Myanmar should develop various transportation modes considering their balance and integration, and the system shall be an effective, well-modernized and environmentally friendly transportation system for all people in Myanmar and its government.

For the field of inland water transport, it is recommended to develop waterway cargo transport services with 24-hour operation balanced with other transportation modes' development. It is also recommended to create an optimum business environment by establishing safe and well time-scheduled services, and by developing suitable transportation cost by highlighting large lot transport by waterways.

3) The Required Feasibility Study on Inland Water Transport

During the 2014 NTMP JICA Study, the Myanmar government requested a series of feasibility studies with respect to the national development of inland water transport. The request comprised two components, one was the development of six major river ports, the other was the replacement of aged river vessels owned by IWT.

The six major ports are Mandalay, Sinkan, Magway, Pakkokku, Monywa, and Kalywa, which are alongside the Ayeyarwardy river and Chindwin river. The Myanmar government has been appealing the necessity of "Development of Inland River Ports" in the international societies. The government has submitted an official request for Japan's cooperation regarding development of aged IWT vessels.

4) Feasibility Study on Mandalay Port

For the requested six river ports' development, project priority was discussed during the 2014 NTMP JICA Study, and Mandalay port was selected as it has the largest cargo volume and its feasibility study, i.e, "Feasibility Study for the Inland Water Transport Facilities Improvements and Development Project", was conducted in 2013 to 2014 as a part of the 2014 NTMP Study by JICA. The feasibility study (hereinafter referred to as "the 2014 JICA F/S") was carried out taking into consideration the possibility of either a loan project or grant aid project.

The study report recommended executing the project as a pilot project for future inland water transport system development as a Japanese grant aid project. It is also recommended that mechanized and efficient cargo handling methods should take root into the country by using this pilot project.

This preparatory survey was executed in order to study some additional subjects and to confirm the viability of the project.

2 Outline of the Study Results and Contents of the Project

(1) Survey Period

JICA dispatched the Survey Team to Myanmar from February 13 to March 14, 2017, and May 2 to May 31, 2017. The Survey Team conducted a series of site inspections including topographic surveys, soil investigations and an environmental survey, held discussions with MOTC, DWIR IWT and other related parties to confirm the requests, organizations and budget allocations. After the team returned to Japan, discussions with the Japanese side were undertaken and an outline design study was prepared and compiled with the draft outline design report. From December 3 to December 7, 2017, the draft outline design report explanation team was dispatched to Myanmar to explain the draft outline design report and the contents of the Project.

(2) Primary Goal and the Project

1) Objectives of the Project and Primary Goal of the Project

The government of Myanmar is working for revitalization of inland water transport, based on the recommendations of the 2014 NTMP JICA Study.

The objectives of this project are primarily to improve the cargo handling efficiency and to enhance the inland water transportation environment by modernizing Mandalay port, which is one of the major national river ports. Mandalay port modernization is expected to contribute that i) convenience of water transportation is improved, ii) transport of heavy cargo and container cargo is evoked, iii) regional economy of Myanmar will become active and iii) the nation economy may growth sustainably.

2) Outline of the Project (Input and Activities)

In this project, vessel berthing and mooring facilities, port terminal facilities such as warehouse and open cargo yard will be constructed and modern cargo equipment will be installed to Mandalay port, for the purpose of transforming the existing manual cargo handling operations to more efficient mechanized operations.

The followings are the concepts and considerations as inputs and activities created by this project.

- At present, annually 0.8 million tons of cargo are loaded/unloaded at the natural riverbank of Mandalay. The project is identified as a pilot project of modernization of national inland water transport. At the same time, it is carefully considered that rapid transformation of the system will cause unemployment for existing riverbank workers. Therefore, capacity of the new port facilities are not expected to cover all of the annual cargo volume (0.8 million tons).

- The port capacity is planned about 30% of total existing cargo volume in the initial development stage, and it is planned that these cargoes will be modernized by mechanized cargo handling in Mandalay port.

- The project is planned such that the port should be able to receive containerized cargo, taking into account the needs of current industries.

- The jetty is planned to accommodate the existing maximum sized cargo barges running along the Ayeyarwady river, and to be equipped with mechanical cranes for the most efficient cargo handling.

- The port will be facilitated with a paved cargo yard, warehouse and operation building, in which modern terminal operation will be achieved.

The following outputs, lead by the above inputs, are assumed.

- Machine cargo operation will be achieved by installing modernized equipment and facilities at Mandalay port.

- Highly efficient cargo operation will be achieved by installing equipment. The berthing time for cargo barges will be shortened by the mechanized operations. Such operation will make terminal functional operation possible, by which more efficient river transport, including time-fixed shuttle transportation, will be achieved.

- The project will change river transport from existing manual labour handling to mechanized cargo operation, which will also lead to new demand for heavy cargo transport by waterway, such as construction material and heavy machines.

- Because the port will be able to accept containerized cargo, the containerization of inland water transport will be expedited. Inland transport businesses will be revitalized by improving transport quality, by increasing the number of river port users and by improving the transport environment of waterways.

- The improvement of transport quality will enhance the investment of foreign private firms including Japanese companies, which will result in the activation of the regional economy and further national economic growth.

- The system modernization of Mandalay port will be applied to other national river ports, which will extend the development of the time-fixed shuttle transport system by inland waterways.

(3) Scope of the Japanese Assistance

Based on the study results, the scope of the Japanese assistance is summarized in Table 1. The facilities are planned and designed based on the following concepts.

- A new port will be constructed in Mandalay based on the request from the Myanmar Government for the modernization of the port.

- The project is the pilot project because it is the first introduction of cargo handling equipment to improve the traditional man-power loading and unloading operations on the natural river bank.

- Project location was determined by the Government of Myanmar based on the study and discussions in the preparatory survey study of the Project.

- Type of jetty shall be fixed type, which was decided by the Government of Myanmar based on discussions of the results of the comparison study conducted in the preparatory survey. Fixed type and floating type jetty, recommended in “the 2014 JICA F/S”, are compared and studied in the preparatory survey.

- For the purpose of modernization of the port, and for providing fixed-time service operations of ships, the project will introduce terminal functions with necessary facilities such as cargo yard and warehouse.

- Required land area for port development is provided by the land reclamation so that the port facilities can be operated throughout the year unaffected by the rainy or dry season's water level changes.

Table 1 Objectives of Facilities Planning

Facilities		Outline of Facilities
Civil Works	Jetty	The cargo handling capacity of the jetty was determined to allow two existing barges berthing alongside the jetty simultaneously.
	Access Bridges	Two access bridges were proposed to allow one-way traffic between yard and jetty.
	Cargo Yard	Land reclamation with revetment was planned to accommodate the cargo yard and other on-land facilities.
	Access Road	Land reclamation with revetment was planned. Refugee lanes for trucks incoming to the port were planned.
	Others	Yard lighting, storm drainage, etc., were planned if needed.
Building Works	Warehouse	Planned as general cargo and CFS area
	Port Office Building (Port Office / Workshop)	A two-story building with Workshop on ground level and Port Office on the 2nd floor
	Canteen	Planned as the rest house for port labourers
	Generator House	Planned as a house for the back-up generator for brown-outs
	Pump House	Planned as a house for water supply pump(s)
	Security Hut	Planned for security of access control at port gate
	Electric Supply / Utility Facilities	Electric power supply system, water supply/sewerage system, etc., were planned as required.

Table 2 Type and Quantity of Cargo Handling Equipment for Procurement

Type of Equipment	Usage	Quantity
1. Jib Crane	Ship-shore cargo handling on the jetty	2 units
2. Rough Terrain Crane	Cargo handling in the port yards	1 unit
3. Reach Stacker	Container and general cargo handling in the port yards	1 unit
4. Forklift	Cargo handling in warehouse and yards	5 units
5. Tractor	Towing of cargo between jetty, warehouse and cargo yards.	6 units
6. Chassis	Ditto	6 units

Image of the facilities and general layout plan is as shown in below.

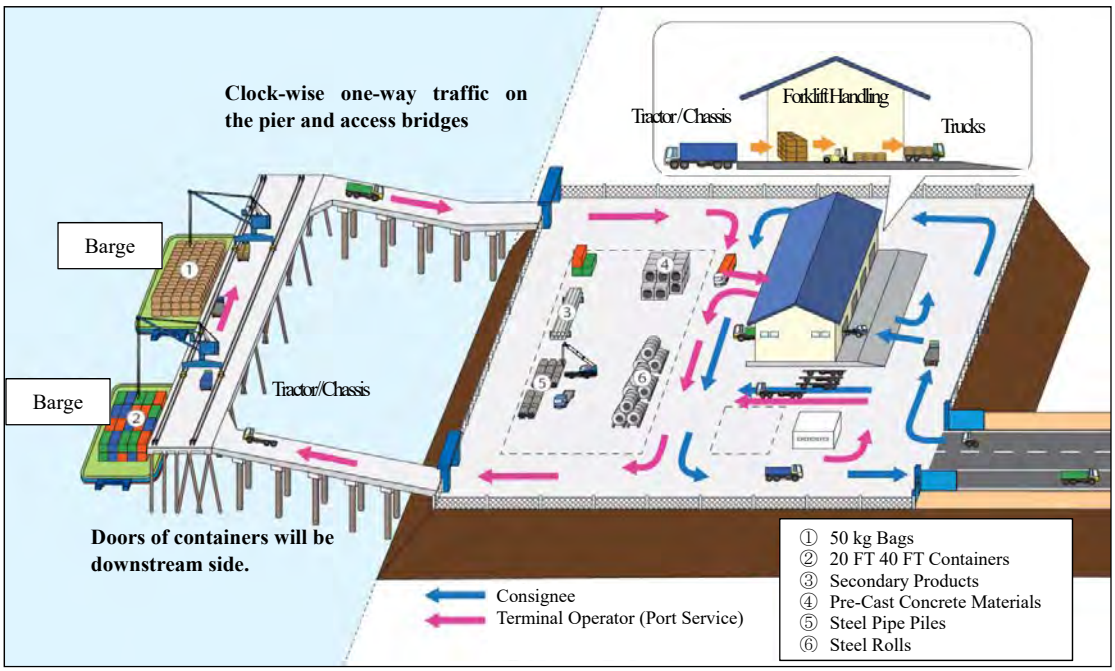

Figure 1 Image of Planned Facilities (Entire Port)

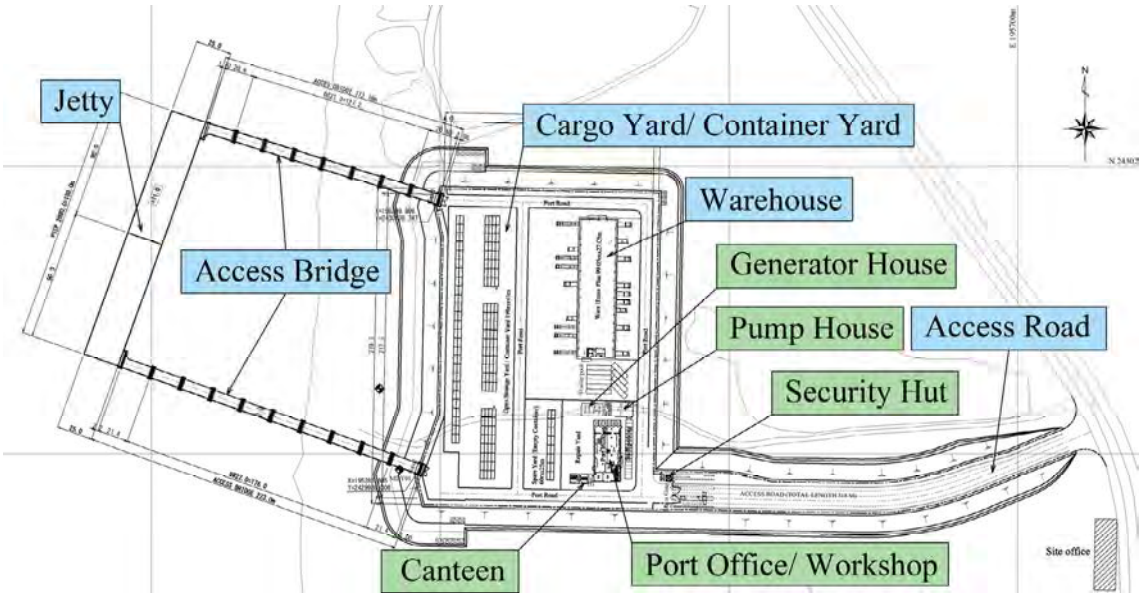

Figure 2 General Layout Plan

(4) Basic Plan (Construction Plan / Equipment Plan)

Outline of the basic plan is as follows.

Table 3 List of Objective Facilities and Equipment

(1) Civil Structures

Facilities		Outlines
1. Jetty	1) Dimensions	Length: 180 m, Width 25 m
	2) Crown height	CDL +11.0 m
	3) Planned Water Depth	CDL -2.0 m (shallowest in dry season)
	4) Lower Structures	Steel Pipe Piles D1100 mm, D800 mm
	5) Upper Structures	Reinforced Concrete
	6) Mooring Bits	Bollard 30 tons 22 units, 25 tons 66 units
	7) Fender	V Type, 92 units
2. Access Bridge	1) Dimensions	Length: 172.18 m, & 233.00 m, Width: 7.0 m
	2) Lower Structure	Steel Pipe Piles D900 mm
	3) Upper Structure	Steel Girder and Concrete Slab
3. Port Area (Cargo Yard, Port Inner Road, Building Area, etc.)	1) Reclamation	About 220 m x 150 m (along revetment shoulder)
	2) Revetment	
	a) Sand Compaction Piles	D700 mm, 2 m interval
	b) Sheet Piles	Type II, L = 8.0 m, 325 m
	c) Liquefaction Protection	High-strength geotextile mat
	d) Revetment	Riprap type with 1:2 slope Armour stone, approx. 200 kg/pc Under layer stone, approx. 10 kg/pc Core, cobble
	e) Reclamation	River sand, excavated soil materials
	f) Abutment	Reinforced concrete 2 units
	3) Pavement	
	a) ILB Pavement (Type 1)	ILB 8 cm, Thickness: 810 mm For cargo yard (container yard)
	b) ILB Pavement (Type 2)	ILB 8 cm, Thickness: 600 mm Warehouse area
	c) ILB Pavement (Type 3)	ILB 8 cm, Thickness: 450 mm Road in the terminal area
	4) Drainage	U-Shape Drainage Ditch (with grating cover at the road crossing)
4. Access Road	1) Embankment	About 320 m long, 23.5 m width* (*between embankment revetment shoulders)
	2) Revetment	
	a) Soil improvement, liquefaction protection	High-strength geotextile
	b) Revetment	Armour stone, approx. 200 kg/pc Under layer stone, approx. 10 kg/pc Embankment soil
	3) Pavement	
	a) ILB : Carriageway	ILB 8 cm
	b) ILB: Walkway	ILB 3 cm
	4) Others	Marking and Sing Board

(2) Building Facilities

Facilities	Outlines of The Facilities		
1. Warehouse	One Building	Structure	Reinforced concrete, Steel roof, Pile foundation, 96 m x 24 m,
	Floor Area	Warehouse	2,270.00 m^2
		Office	21.00 m^2
		Toilet	28.62 m^2
		Total floor area	2350.44 m^2
	Finishing	Roof	Steel Frame, Galvanized colour steel 0.5 mm
		Outer wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Concrete floor slab: t = 250 mm
		Interior wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electric Equipment	Equipment	LED light, automatic fire alarm
	Mechanical Equipment	Equipment	Air-conditioner, ventilation fan, water supply, sanitary, septic tank
2. Port Office Building (Port Office/ Workshop)	One Building	Structure	RC 2 stories, 42 m x 18 m, pile foundation
	Floor area	Ground Floor	790.00 m^2
		First floor	790.00 m^2
		Total Floor Area	1,580 m^2
	Finishing	Roof	RC, Galvanized colour steel, 0.5 mm
	Finish Material	Outer wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Mortar steel trowel with urethane coat
		Interior Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electronic Equipment	Equipment	LED light, automatic fire alarm
	Mechanical Equipment	Equipment	Air-conditioner, ventilation fan, water supply, sanitary, Septic tank
3. Canteen	One building	Structure	RC Single Story, 18 m x 12 m
	Floor Area	Ground Floor	220.00 m^2
		Total Floor Area	220.00 m^2
	Finishing	Roof	Colour galvanized steel t = 0.5 mm
	Finish	Outer Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Interlocking block
		Interior Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electric Equipment	Equipment	LED light, automatic fire alarm
	Mechanical Equipment	Equipment	Water-supply and drainage, sanitary and septic tank
4. Generator House	One Building	Structure	Reinforced concrete single story, 15 m x 10 m
	Floor Area	Ground Floor	156.00 m^2
		Total Floor Area	156.00 m^2
	Finishing	Roof	Reinforced concrete colour galvanized steel 0.5 mm
	Finish Material	Outer Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Mortar steel trowel with Urethane coat
		Interior Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electric equipment	Equipment	LED light, generator, automatic fire alarm
	Mechanical equipment	Equipment	Ventilation fan

Facilities	Outlines of The Facilities		
5. Pump House	One Building	Structure	Reinforced concrete single story, 15 m x 10 m
	Floor Area	First Floor	156.00 m^2
		Total Floor area	156.00 m^2
	Finishing	Roof	Reinforced concrete colour galvanized steel t = 0.5 mm
	Finish Material	Outer wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Mortar steel trowel with Urethane coat
		Interior Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electric Equipment	Equipment	LED light, automatic fire alarm
6. Security Hut	One Hut	Structure	Reinforced concrete single story, 2 m x 2 m
	Floor Area	Ground Floor	4.00 m^2
		Total Floor Area	4.00 m
	Finish Material	Roof	Reinforced concrete, colour galvanized steel t = 0.5 mm
	Finish Material	Outer wall	Hollow block mortar trowel steel with AEP
		Floor	Mortar trowel steel urethane coat
		Interior wall	Hollow block mortar trowel steel with AEP
		Ceiling	Wood wool cement board t = 25 mm
	Equipment	Equipment	Lighting

(3) Cargo Handling Equipment

Equipment	Specifications	Units
1. Jib Crane	Rail Mounted Type: Rail Span, 15 m Rated Load: 30.5 tons Lifting Load: 35.0 tons Slewing radius: 11.5 m to 27.0 m Power feeding system: Diesel generator mounted crane	2 units
2. Rough-Terrain Crane	Lifting Capacity: 13.0 tons (at operation radius 10 m) Lifting Capacity: 4.2 tons (at operation radius 20 m) Max. lifting height: Approx. 43 m Max. operation radius: Approx. 36 m Boom length: 11.1 m to 42 m	1 unit
3. Reach Stacker	40-ft and 20-ft containers Lifting Loads: First Row: min. 30.5 tons Second Row: min. 27.0 tons Third Row: min.14.0 tons	1 unit
4. Forklift	Rated Capacity: min. 3.5 tons Max. lifting height: min. 5.0 m	5 units
5. Tractor	Drive unit: 4 x 2 Max. output: Approx. 390 PS Exhaust Emission Level: Approx. 14,200 CC	6 units
6. Chassis	Max. loading weight: 30.5 tons Dimensions: Length: Approx. 12.6 m Height: 2.48 m Width: 1.96 m Floor Height: 1,550 mm Floor Type: Flatbed Type	6 units

3 Implementation of the Project and Project Cost

The Implementation period of the Project is estimated 32 month including tender period, 4.5 month for detailed design, 3.5 month for tender process and 24 month for constructions of the civil and building facilities including procurement and installation of the equipment.

Total cost for the scope to be borne by the Myanmar side is estimated at about 2,714.1 Million Kyat (about JPY 224 Million).

4 Project Evaluation

(1) Relevance

The Myanmar government set up a development strategy aiming to promote and revitalize inland water transport to contribute economic activities as the overall goal. Mandalay port development is regarded as a pilot project for such purpose. The aim of the project is for sustainable development of inland water transport encouraging other ports' modernization starting with this project.

The modernization of inland water transport will provide benefits to the industry of the country by enabling transport of heavy or large sized cargo which is principally not suitable for other transport modes like road or railway. Large mass transport will lower the cost of transportation, which will affect the reduction of consumer prices, and result in the provision of plentiful life to the local citizens. Lower transport cost will also affect the acceleration of development of northern regions where enough investment on infrastructure has not been provided, at present, by the government. This project implies a huge ripple development effect on the economy of local society.

(2) Effectiveness

1) Quantitative Effect

The following quantitative outcomes will be expected by executing this project.

Table 4 Project Outcome (Quantitative Effect)

Indicator	At Present Baseline in 2017	Target (2023: 3years after construction)
Cargo throughput of Mandalay port	No data (2017)	200,000 tons/year
Cargo efficiency	17 tons/hour	100 tons/hour
Berthing hours	2 weeks (approximate)	6 hours to 24 hours

2) Qualitative Effect

The following qualitative effects can be expected from this Project.

a Effectiveness of cargo handling will be gained by introducing mechanical equipment handling. It will become possible to handle heavy cargo which could not be handled with conventional manpower handling, and demand for transportation of potential cargo is evoked.

b Work environment and safety of cargo handling works will be improved.

c Quality and efficiency of transportation will be improved by introducing palletized cargo and containerized cargo.

d New transport demand will be created by improving the quality of transport. Inland transport businesses will be activated and large lot transport will be possible.

e Large lot transport will reduce transportation cost, by which local consumer prices will be lowered and people's lives will be improved as a result.

f By improving the transportation environment, it is expected that the export of local products will be activated, and the local economy will be active as a result.

g A ripple effect will be expected, by which other local river ports will be developed similarly to the Mandalay port.

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Appendices

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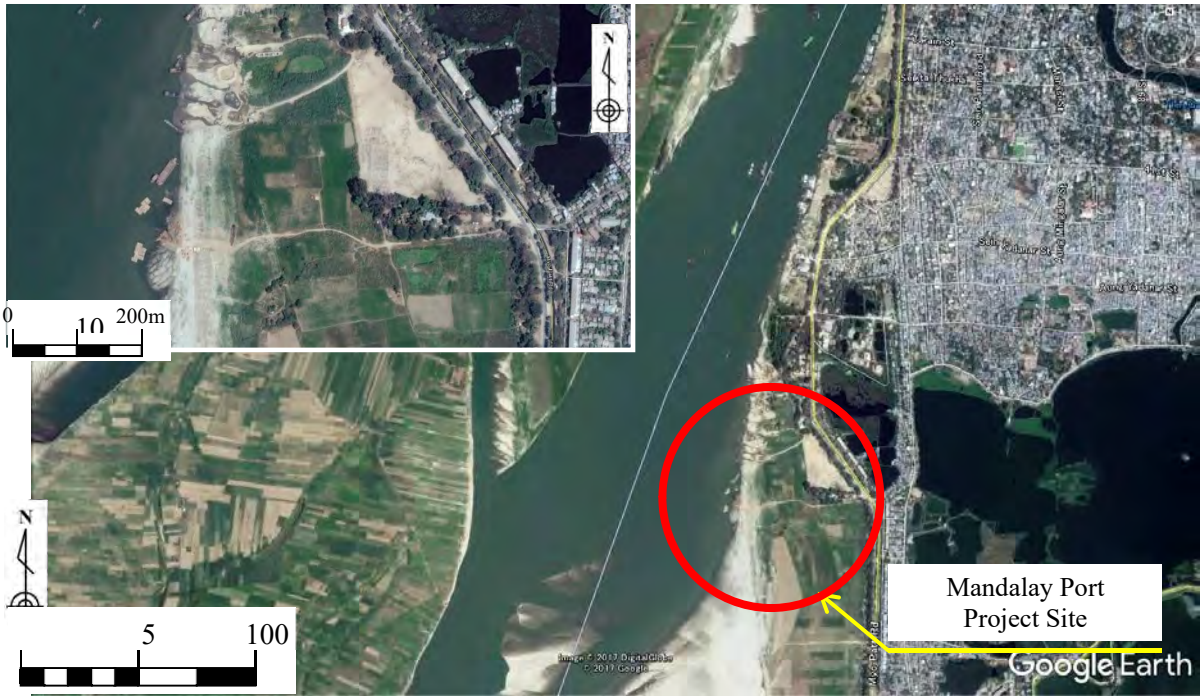
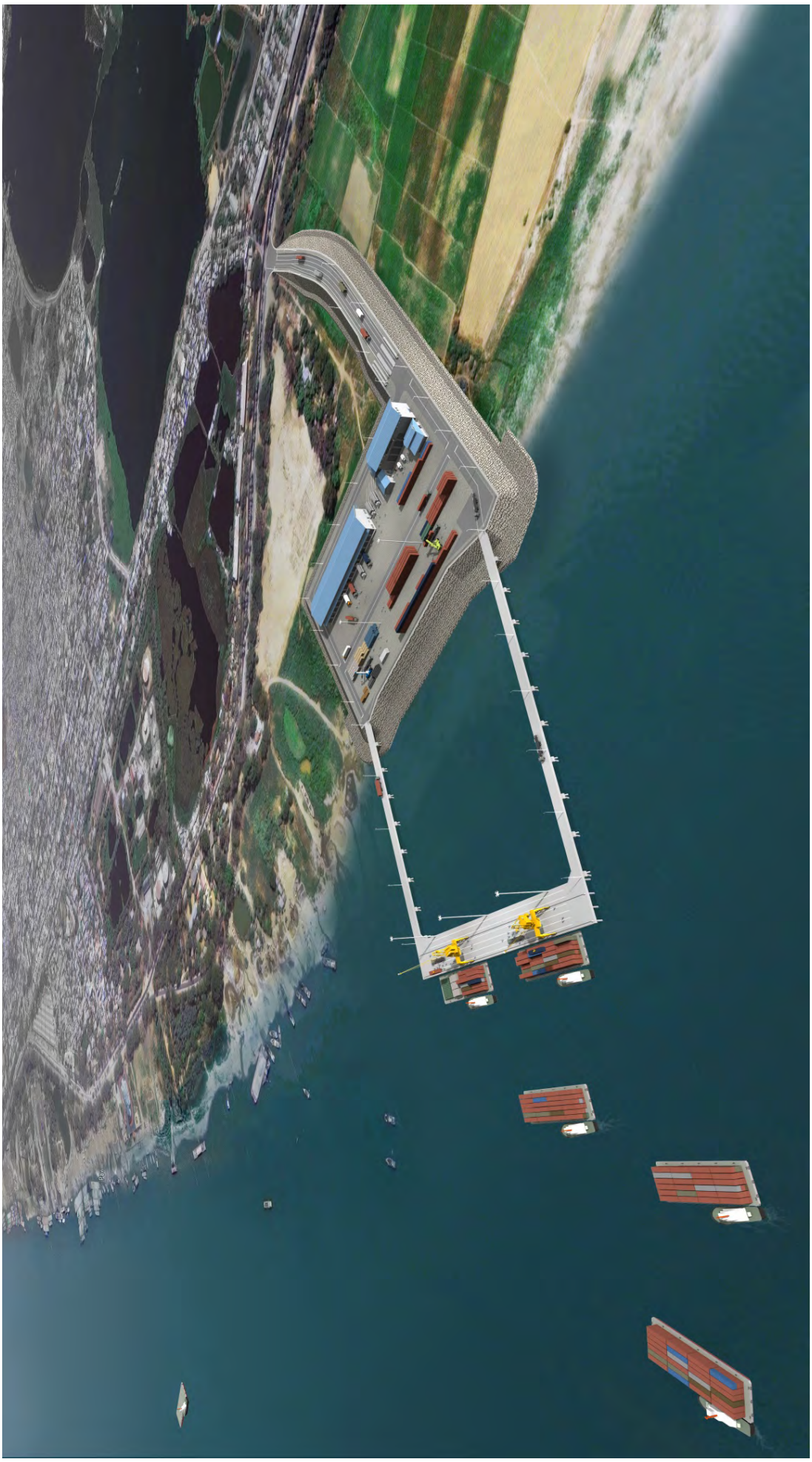


Location Map (2/2)



Perspective

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ABBREVIATIONS

A	ACGIH	American Conference of Governmental Industrial Hygienists
	AIDS	Acquired Immune Deficiency Syndrome
	AIRBM Project	Ayeyarwady Integrated River Basin Management Project
	ARAP	Abbreviated Resettlement Action Plan
B	BOD	Biochemical Oxygen Demand
C	CD	Chart Datum Level
	CO_2	Carbon Dioxide
	CO	Carbon Monoxide
	COD	Chemical Oxygen Demand
D	DALMS	Department of Agricultural Land Management and Statics
	DMA	Department of Marine Administration
	DMH	Department Meteorology and Hydrology
	DO	Dissolved Oxygen
	DWIR	Directorate of Water Resources and
	DWT	Deadweight Tonnage Improvement of River System
E	ECC	Environmental Compliance Certificate
	ECD	Environmental Conservation Department
	EIA	Environmental Impact Assessment
	EMP	Environmental Management Plan
F	FHC	Freight and Handling Committee
	FRP	Fiber-Reinforced Plastics
	F/S	Feasibility Study
G	GAD	General Administration Department
	GDP	Gross Domestic Product
	GPS	Global Positioning System
H	HIV	Human Immunodeficiency Virus
	HWL	High Water Level
I	ICD	Inland Container Depot
	IDF	Intermediate Distribution Frame
	IEE	Initial Environmental Examination
	IMF	International Money Fund
	ISO	International Organization for Standardization
	IUCN	International Union for Conservation of Nature
	IWT	Inland Water Transport
	LAN	Local Area Network
J	JICA	Japan International Cooperation Agency
L	LAN	Local Area Network
	LLC	Level luffing crane of double link type
	LOA	Length Overall
	LWL	Low Water Level
M	MALI	Ministry of Agriculture Livestock and Irrigation
	MCDC	Mandalay City Development Committee
	MDF	Main Distributing Frame
	MMID	Mandalay Myotha Industrial Development Public Co., Ltd.
	MNPED	Ministry of National Planning and Economic Development
	MOC	Ministry of Construction
	MONREC	Ministry of Natural Resources and Environmental Conservation
	MOTC	Ministry of Transport and Communication
	MPA	Myanmar Port Authority

	MRG	Mandalay Region Government
	MTS	Mandalay Township
	NAGO	National Attorney General Office
	NCDP	National Comprehensive Development Plan
	NEQ Guidelines	National Environmental Quality Guidelines
	NGO	Non-Governmental Organisation
N	NAAQS	National Ambient Air Quality Standards
	NO_2	Nitrogen Dioxide
	NLD	National League for Democracy
	NTDP	the Survey Program for the National Transport Development Plan
	NTMP	National Transport Master Plan (NTDP called as NTMP in the report)
O	O_3	Ozone
P	PAH	Project-affected Households
	PAPs	Project-affected Persons
	PDA	Pile Driving Analyzer
	$PM_{2.5}$	Particulate matters equal to or less than 2.5μm
	PM_{10}	Particulate matters equal to or less than 10μm
	PPE	Personal Protective Equipment
	ppm	Parts Per Million
R	RMG	Rail Mounted Gantry Crane
	RS	Reach Stacker
	RTG	Rubber Tired Gantry Crane
S	SCP	Sand Compaction Pile
	SLRD	Settlement and Land Records Department
	SO_2	Sulphur Dioxide
T	TSS	Total Suspended Solids
U	UNDP	United National Development Programme
	USD	United States Dollar
	USDP	Union Solidarity and Development Party
V	VOC	Volatile Organic Compounds
W	WHO	World Health Organization

Chapter 1 Background of the Project

1-1 Present Conditions and Current Problems of the Sector

1-1-1 Present Conditions and Problems

Travel along inland waterways is an important transport mode for the Republic of the Union of Myanmar (hereinafter referred to as Myanmar). Myanmar has 6,650 km of navigable inland waterways, of which the longest waterway, the Ayeyarwady river, is 2,170 km long in its main streamline, and 3,938 km including branch streams. Using inland waterways it is possible to travel between the nation's biggest commercial city, Yangon, and the main national cities.

Mandalay is the second biggest commercial city in Myanmar, which is located 700 km north from Yangon and alongside the Ayeyarwady River. The city is considered as one of the transportation hubs of the nation as the major roads (National Roads No. 1 and No. 2, Expressways between Yangon and Mandalay) and the railway (Yangon-Mandalay) connect to the city. Mandalay port is one of the most important river ports of the nation, where a number of passenger ships and cargo ships come from and go to the major cities along the Ayeyarwady River waterways. Particularly, the port is a base port for the northern region of Myanmar where there is poor road development.

However, the port has no mechanical equipment or facilities, where all cargo handling depends only on manual labour. This primitive custom of cargo handling prevents national waterway transport from attaining the required development for modernization of inland water transport. This project is based on the official request for Japan's grant aid, covering installation of jetty, cargo yard, warehouse, and necessary cargo handling equipment for the purpose of modernizing the Mandalay port. By this project, Mandalay port will become the first modernized river port in Myanmar, which will be a national pilot project for extending similar development concepts to the other major river ports.

The counterpart authorities of this project are, Directorate of Water Resources and Improvement of River System (DWIR) and Inland Water Transport (IWT), both of which belong to the Ministry of Transport and Communication (MOTC). DWIR is acting as the government authority to manage river control and maintenance of river waterways. IWT is acting as a public authority which holds river vessels and barges, and operates passenger/cargo ships along the river waterway routes. After completion of this project, IWT is planned to manage the operation of the new port facilities. IWT is developing its own organization establishing a new department for river port operation. For IWT, this project is the initial experience of modernized river port management, therefore, further technical support of IWT's management will also be an important point of the project.

1-1-2 Development Plans

(1) Primary Plans of the Port Development

1) National Development Plan

Myanmar has the National Comprehensive Development Plan (NCDP) which was formed by the Ministry of National Planning and Economic Development (MNPED). The NCDP is a governmental policy framework targeting 2030, which consists of two long term objectives and seven strategies.

(Two long term objectives)

- Establishment of sustainable development of economy holding diversity.
- To ensure national-centred comprehensive growth and development

(Seven strategies)

- Strengthening Governance and Institution
- Enabling Business Environment
- Expand domestic and global connectivity
- Fostering Competitive Sectors
- Local Economic Potentials
- Human Development
- Environmental Protection

The Myanmar government formulated a five-year development plan (2011~2016) based on the NCDP, and has executed the plan for national economic development.

2) Vision of National Industrial Development of Myanmar (METI of Japan, July 2015)

The Vision of National Industrial Development of Myanmar was formulated by the Ministry of Economy Trade and Industry (METI) of Japan for the purpose of supporting Myanmar in establishing its national development plan. The vision has the aim to contribute to the Myanmar government's formulation of a new five-year national policy. The vision points out concrete strategies and policies to realize balanced development of the country and sustainable economic growth, highlighting structural problems of the economy of Myanmar.

In the vision, the development of an inland waterway transport network is recommended as a transport mode to support national economic growth. In practice, development of modernized river port facilities and maintenance of existing waterways, establishment of a cold-chain network, and development of an inland transport base, such as an Inland Container Depot (ICD), are recommended.

3) Regional Development Plan (JICA 2016)

As of July 2017, the "Urban and Regional Development Planning Law" was formed by the Ministry of Construction (MOC) and submitted to the National Attorney General Office (NAGO). The bill will be submitted to the Diet after discussions in NAGO. The aims of the bill are that a regional development plan should be formulated considering a balance of regions, and the regional land use plan should contribute sustainable national economic development, etc.

The bill defines Mandalay as "Grade A" from the point of view of national land development (one of three important cities: Yangon, Naypyidaw and Mandalay). For regional planning of Mandalay city, Japan International Cooperation Agency (JICA) supported with its study in 2016. The JICA report, as it pertains to Mandalay city development, recommends that the city should expand toward southern areas, and transportation centres should also be developed in the same area.

4) National Transportation Master Plan (JICA September, 2014)

Receiving an official government request of Myanmar, JICA executed a study for creating a national transport master plan (the Survey Program for the National Transport Development Plan (NTDP), September 2014). The report explains that Myanmar should develop various transportation modes considering their balance and integration, and the system shall be an effective, well-modernized and environmentally friendly transportation system for all people in Myanmar and its government.

For the field of inland water transport, it is recommended to develop waterway cargo transport

services with 24-hour operation balanced with other transportation modes' development. It is also recommended to create an optimum business environment by establishing safe and well time-scheduled services, and by developing suitable transportation cost by highlighting large lot transport by waterways. The following development strategies are recommended.

- To develop all-season navigable waterways
- To establish an effective inland water transport network
- To clarify the optimum role of IWT and formulate a new business plan
- To promote replacement of aged vessels to safer and more environmentally friendly vessels

In this report, NTDP referred to as the National Transport Master Plan (hereinafter called as "the 2014 MTMP JICA Study").

1-1-3 Background of the Project

(1) Goal of Inland Water Transport Development under National Development Plan

As mentioned in the above, the Myanmar government formulated five-year development plan (2011~2016) based on the NCDP, and has executed the plan for national economic development. The development of inland waterway transport network is one of the important subjects for the growth of the national economy.

In the 2014 NTMP JICA Study which was conducted based on the official request from Myanmar Government, it is recommended that Myanmar should develop various transportation modes including inland waterway cargo transport with 24-hour operation services balanced with other transportation modes' development. In the Study, it is also pointed out that creation of the optimum business environment by establishing safe and well time-scheduled services, by developing suitable transportation cost by highlighting large lot transport by waterways is important.

(2) The Required Feasibility Study on Inland Water Transport

During the 2014 NTMP JICA Study, the Myanmar government requested a series of feasibility studies with respect to the national development of inland water transport. The request comprised two components, one was the development of six major river ports, the other was the replacement of aged river vessels owned by IWT.

The six major ports are Mandalay, Sinkan, Magway, Pakkokku, Monywa, and Kalywa, which are alongside the Ayeyarwardy river and Chindwin river. The Myanmar government has been appealing the necessity of "Development of Inland River Ports" in the international societies. The government has submitted an official request for Japan's cooperation regarding development of aged IWT vessels.

(3) Feasibility Study on Mandalay Port

For the requested six river ports' development, project priority was discussed during the 2014 NTMP JICA Study, and Mandalay port was selected as it has the largest cargo volume and its feasibility study, i.e, "Feasibility Study for the Inland Water Transport Facilities Improvements and Development Project", was conducted in 2013 to 2014 as a part of the 2014 NTMP Study by JICA. The feasibility study (hereinafter referred to as "the 2014 JICA F/S") was carried out taking into consideration the possibility of either a loan project or grant aid project.

The study report recommended executing the project as a pilot project for future inland water transport system development as a Japanese grant aid project. It is also recommended that mechanized and efficient cargo handling methods should take root into the country by using this pilot project.

This preparatory survey was executed in order to study some additional subjects and to confirm the viability of the project.

1-2 Project Site and Surrounding Conditions

1-2-1 Relevant Infrastructures

1-2-1-1 Cargo Volume of Mandalay Port

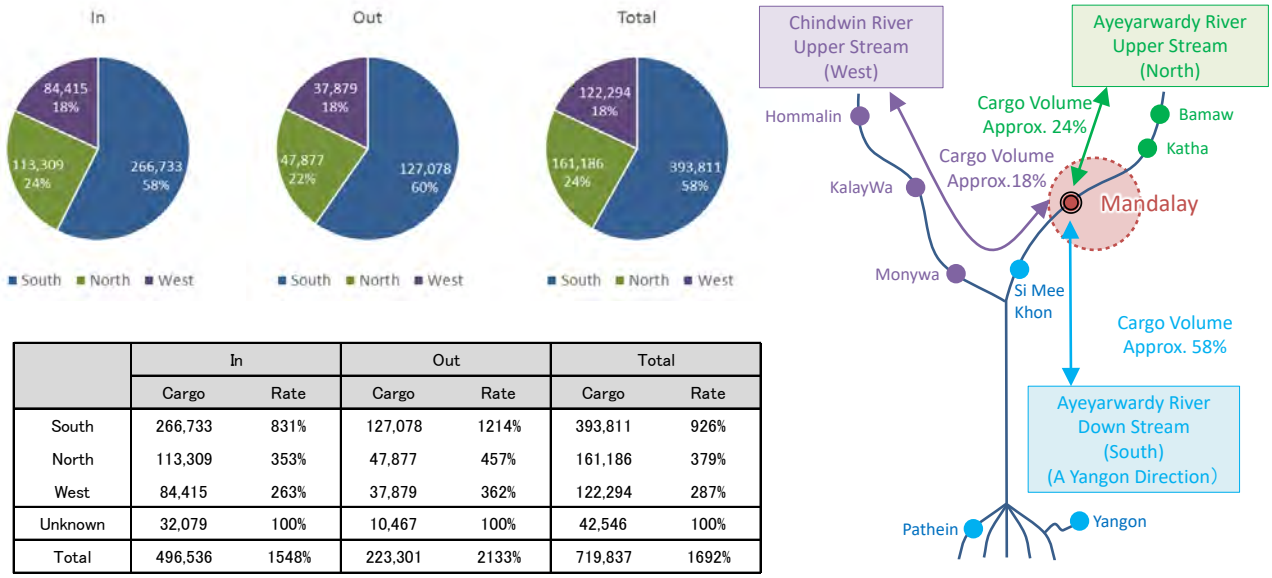
Updated cargo statistics of Mandalay port are summarized as follows.

(1) Cargo Volume of Mandalay Port

1) Cargo Volume

a. Existing cargo volume of Mandalay port is estimated at approximately 800,000 tons/year (dredged sand and liquid cargo were excluded).

b. Origin/destination share of cargo shows (from Apr. 2015 ~ Mar. 2016 data) 58% of cargo is for the southern region to Yangon, 24% is for the northern Ayeyarwady River, and 18% is for the northern Chindwin river.



	In		Out		Total	
	Cargo	Rate	Cargo	Rate	Cargo	Rate
South	266,733	831%	127,078	1214%	393,811	926%
North	113,309	353%	47,877	457%	161,186	379%
West	84,415	263%	37,879	362%	122,294	287%
Unknown	32,079	100%	10,467	100%	42,546	100%
Total	496,536	1548%	223,301	2133%	719,837	1692%

Source: JICA Study Team based on DMA's statistics data

Figure 1-2-1 Existing Cargo Volume of Mandalay Port (2015.4~2016.3)

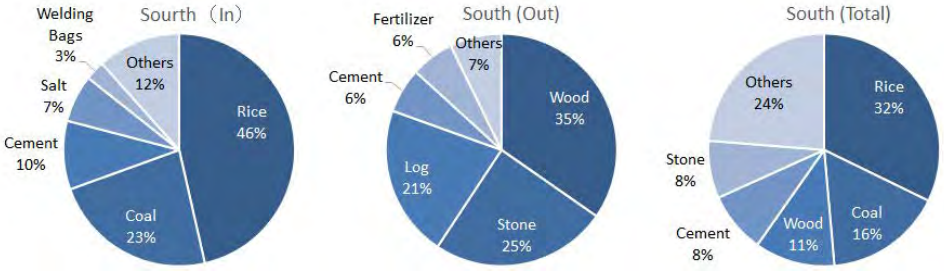
2) Major Cargo Commodities

The major cargo commodities are agricultural products. The details of the cargo commodities for the north, south and west regions are shown below.

a. Cargo for South Region

50% of incoming cargo is rice, while 90% of outgoing cargo is construction materials (wood, stone, logs and cement).

Cargo CAT.	In	Share	Cargo CAT.	Out	Share	Cargo CAT.	Total	Share
Rice	123,867	46%	Wood	44,053	35%	Rice	126,803	32%
Coal	61,517	23%	Stone	31,333	25%	Coal	64,529	16%
Cement	25,446	10%	Log	26,869	21%	Wood	44,162	11%
Salt	17,541	7%	Cement	7,952	6%	Cement	33,398	8%
Welding Bags	7,291	3%	Fertilizer	7,681	6%	Stone	31,429	8%
Others	31,071	12%	Others	9,190	7%	Others	93,490	24%
Total	266,733	100%	Total	127,078	100%	Total	393,811	100%



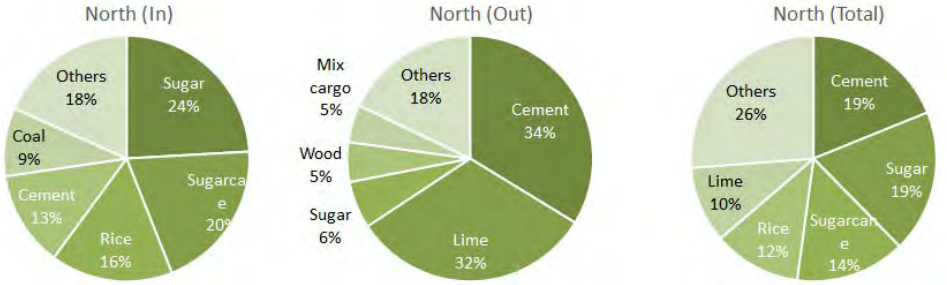
Source: JICA Study Team based on DMA's statistics data

Figure 1-2-2 Commodity-wise OD Share of Cargo Volume (For South Region 2015.4~2016.3)

b. Cargo for North Region

60% of incoming cargo is agricultural products (sugar, sugarcane and rice), while 70% of outgoing cargo is construction materials (cement, lime and wood).

Cargo CAT.	In	Share	Cargo CAT.	Out	Share	Cargo CAT.	Total	Share
Sugar	27,316	24%	Cement	16,151	34%	Cement	30,435	19%
Sugarcane	22,531	20%	Lime	15,311	32%	Sugar	30,293	19%
Rice	18,232	16%	Sugar	2,977	6%	Sugarcane	23,337	14%
Cement	14,284	13%	Wood	2,498	5%	Rice	18,633	12%
Coal	10,199	9%	Mix cargo	2,364	5%	Lime	16,255	10%
Others	20,746	18%	Others	8,576	18%	Others	42,233	26%
Total	113,309	100%	Total	47,877	100%	Total	161,186	100%



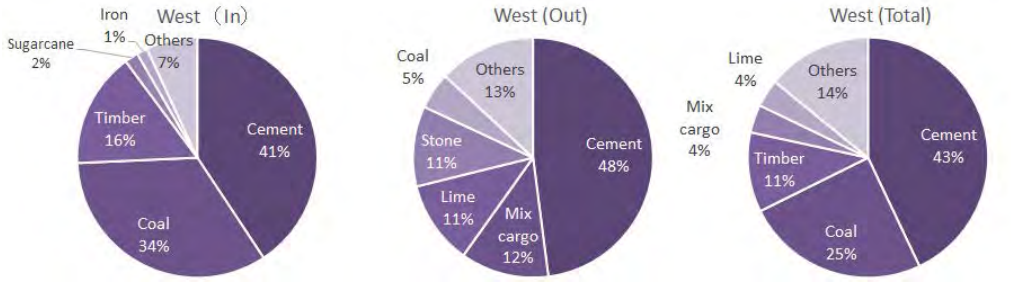
Source: JICA Study Team based on DMA's statistics data

Figure 1-2-3 Commodity-wise OD Share of Cargo Volume (For North Region 2015.4~2016.3)

c. Cargo for West Region

70% of incoming cargo and 60% of outgoing cargo are construction materials. (cement and timber for incoming, cement, lime and stone for outgoing)

Cargo CAT.	In	Share	Cargo CAT.	Out	Share	Cargo CAT.	Total	Share
Cement	34,366	41%	Cement	18,164	48%	Cement	52,530	43%
Coal	28,340	34%	Mix cargo	4,504	12%	Coal	30,219	25%
Timber	13,122	16%	Lime	4,278	11%	Timber	13,122	11%
Sugarcane	1,543	2%	Stone	4,100	11%	Mix cargo	4,618	4%
Iron	1,219	1%	Coal	1,879	5%	Lime	4,561	4%
Others	5,825	7%	Others	4,953	13%	Others	17,244	14%
Total	84,415	100%	Total	37,879	100%	Total	122,294	100%



Source: JICA Study Team based on DMA's statistics data

Figure 1-2-4 Commodity-wise OD Share of Cargo Volume (For West Region 2015.4~2016.3)

d. Features of Cargo of Mandalay Port

From the above data, the following features of cargo for Mandalay port are observed.

Feature 1: Foods such as rice, beans and sugarcane are transported from south (Yangon) and north to Mandalay.

Feature 2: Construction materials such as cement and rebar are transported from south (Yangon) to Mandalay.
These cargoes are also transported from Mandalay to the north region and to the west region.

(2) Vessels for Mandalay Port

1) Ship-calls

The ship-call of Mandalay port is approximately 5,000 vessels/year, of which 80% is passenger -cum-cargo ships and 20% is cargo barges.

Within the 80% passenger-cum-cargo ships, 20% carry passengers, but 60% carry only cargo.

2) Cargo Volumes by Ship Types

Though ship-calls of passenger-cum-cargo ships are high, 50% of 800,000 tons/year is carried by cargo barges. It is observed that the major ship-type for cargo transportation is cargo barges. Among the 50% of cargo transported by passenger-cum-cargo ships, 5% of cargo is transported with passengers but 45% of cargo is transported with cargo only.

1-2-1-2 Advantages of River Transport

(1) Transportation Cost

The cost of waterway transport is generally low compared to road transport. From the comparison of the transportation cost for the route between Yangon and Mandalay, waterway can carry cargo at 60% of the cost of road transport. On the other hand, waterway requires longer transport time compared to road transport. The advantage of waterway transport appears for cargoes which do not require quick transportation time. It is said that the existing waterway cargoes such as rice, cement and fuel take this advantage.

•	Road:	Route	Warehouse -------- (Road Transport) -------- Warehouse
		Cost	Approximately 36,000 Kyat/ton
		Time	Approximately 1.5 days
•	Waterway:	Route	Warehouse - (Road) - Port - (Waterway) – Port - (Road) - Warehouse
		Cost	Approximately 22,000 Kyat/ton
		Time	Approximately 10 days

(2) Large Cargo / Heavy Cargo

The size and weight of existing cargo for inland waterway transport are restricted by the manual labour handlings. Rice and cement are carried in 50 kg bags, and rebar is carried by manual labour, piece by piece.

However, waterway transport by barges has an essential advantage for large sized cargo and heavy cargo which are often restricted for road transport. For example, waterway transport is suitable for heavy duty equipment and its spare parts, construction materials such as steel materials and rebar. The project of Mandalay port provides heavy duty cargo equipment, therefore, cargo demand will be expanded to large/heavy cargoes when the new port is built.

(3) Environmentally Friendly Transportation Mode

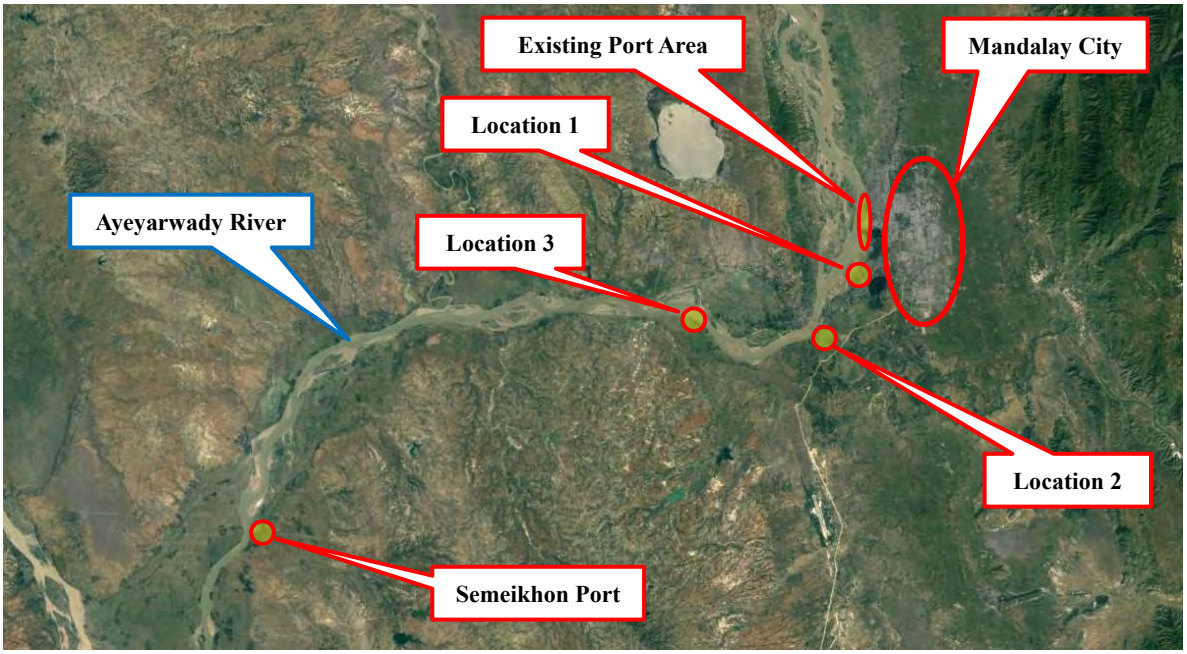
Waterway transport has the advantage that environmental burden is reduced as the large volume cargo is moved by floating barges. For example, the waterway moves 2,000 tons of cargo by one barge with one tug-boat, while road transport requires 200 trucks (10 tons each) for the same volume of cargo transport. Barge transport emits 39 g CO_2/ton-km, but truck transport discharges 158 g CO_2/ton-km, where waterway reduces CO_2 emission to 25% of road transport.

1-2-1-3 Present Conditions of Existing Mandalay Port and Candidate Project Sites

In the initial stage of the Project, the project site shall be selected from among the three candidate locations shown in Figure 1-2-5[1]. The existing port area where loading and unloading operations are conducted along the natural riverbank of the west side of Mandalay city is on the north side of Location 1 in Figure 1-2-5.

About 75 km south from Mandalay, there is Semeikhon port, which was developed by a private sector company named Mandalay Myotha Industrial Development (MMID). The location of the Semeikhon port and candidate locations are shown in Figure 1-2-5.

[1] Selection of the project site shall be refer to “2-2-1-1-2 Selection of the Project Site” in Chapter 2.



Source: JICA Study Team based on Google Earth

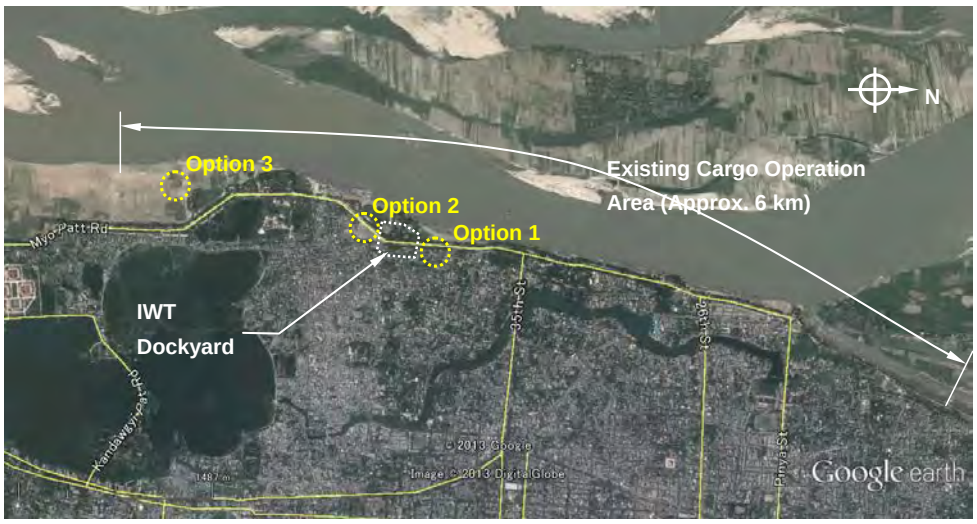
Figure 1-2-5 Three Candidate Locations and Semeikhon Port

The present conditions of the existing Mandalay port, each candidate location, and Semeikhon Port are as follows. The conditions were surveyed by site visit in this Study.

(1) Existing Mandalay Port

1) Outlines

At present, there are no port facilities at the site. Barges are anchored along the natural riverbank and loading and unloading operations are conducted by man power. The location of the existing port area is, as shown, on the natural riverbank where the cargo handling operations take place.



Source: JICA Study Team based on Google Earth

Figure 1-2-6 Location of Natural Riverbank Cargo Handling Operations

2) Present Conditions of Cargo Handling Operations

Ship berthing along the natural riverbank is as shown in Photo 1-2-1 and Photo 1-2-2. Cargo handling operations conducted by man-power to/from these ships are as shown in Photo 1-2-3 to Photo 1-2-6.

Photo 1-2-1 Ship Berthing Conditions along the Natural Riverbank

Photo 1-2-2 Ship Berthing Conditions along the Natural Riverbank

Photo 1-2-3 Cargo Handling in the Ship

Photo 1-2-4 Cargo Handling at Riverbank

Photo 1-2-5 Cargo Handling at Ship

Photo 1-2-6 Cargo Handling at Riverbank

3) Passenger Facilities

Existing facilities for passenger ships are shown in Photo 1-2-7 to Photo 1-2-9. Photo 1-2-7 shows the passenger terminal for cam-cargo ships operated by IWT. A pontoon, shown in the photograph is used by anchoring beside the riverbank. Other than IWT operated passenger ships, Ayeyarwady River cruise ships for tourism are also operated by several private firms. Each firm has its own pontoon, as shown in Photo 1-2-8. Passenger embarkations and/or disembarkations under the different water elevations in the rainy and dry seasons are conducted by using the pontoons and steps such as those shown in Photo 1-2-9.

Photo 1-2-7 Passenger Terminal for IWT Operated Ships (Pontoon)

Photo 1-2-8 Pontoon for Passenger Ships

Photo 1-2-9 Access Step to Pontoon

4) Ship Berthing and Cargo Loading/Unloading Points

At present, ship berthing and cargo loading and unloading points are allocated per company and/or person (ship owner), as shown in Figure 1-2-7.

The river is managed by DWIR and the loading points are licensed by DWIR based on the declarations by the firms.

DWIR gives the permissions/licenses to the firms for ship berthing and cargo handling along the riverbank. The berthing and loading locations with its length and cargo handling type are allocated by DWIR based on the declarations by the firms. The permissions and/or the licenses are validated for one year and the firms are required to update the permissions and/or the licenses annually.

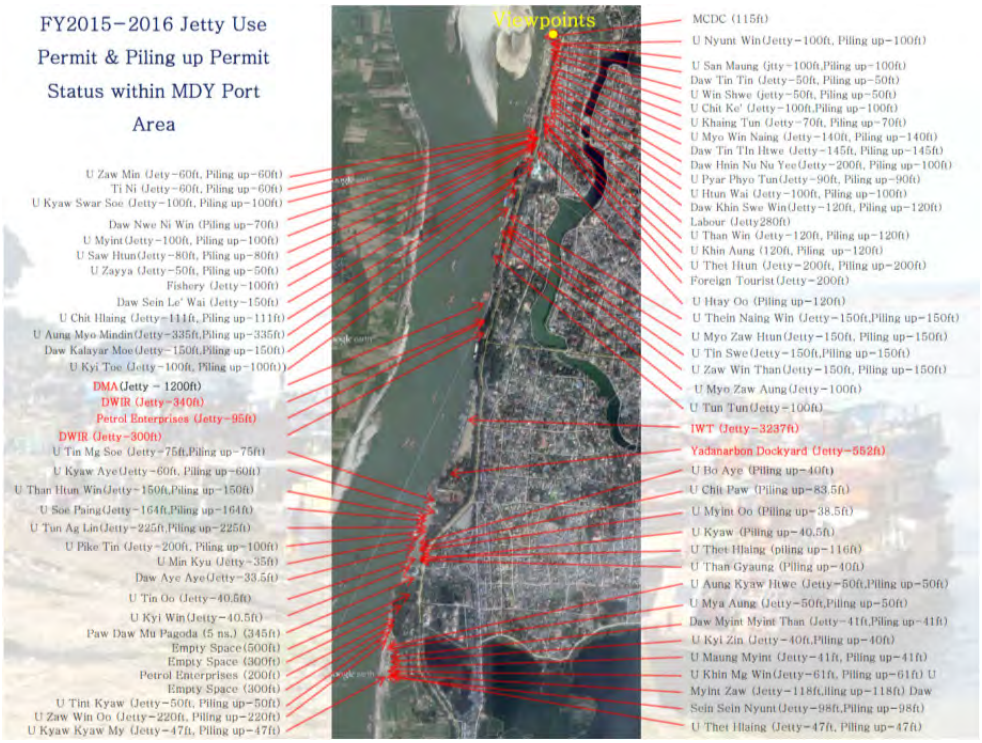


Figure 1-2-7 Licensed Allocated Ship Berthing and Cargo Loading and/or Unloading Points (Along the Natural Riverbank)

5) Loading Points and Workers

Along the natural riverbank of the Ayeyarwady River in Mandalay, there are eight locations where loading and unloading operations are conducted. Among them, two locations are allocated for and managed by DMA and IWT, respectively, and ship berthing and cargo handling operations are conducted at the remaining six locations along the riverbank in Mandalay.

Water transport and track transport cargo handling labourers are mandated to register with the Freight and Handling Committee (FHC), and about 1,000 labourers are registered to the FHC in Mandalay.

The FHC was established in 1960 under the Ministry of Labour, Employment and Social Security. The FHC is now the organization managed by the Mandalay Regional Government

(MRG) and about fifteen persons are assigned. The FHC has jurisdiction (township) and the Mandalay Township (MTS) is one of them and managed by Mandalay City.

Cargo handling labour groups are allocated and dispatched by MTS to six loading points managed by DWIR. Several labour groups are allocated at each loading point, and about 50 labourers are in one group, managed by two to three leaders. Cargo handling works are allocated and assigned to each group by MTS.

6) Cargo Handling Charges

The FHC charges 5% fees to the labour group which was paid by the consignee to the workers group. The fees are used for the retirement allowance of the labourers. The consignee shall be paid for cargo handling fees, 75 kyat per bag to the cargo handling group. The group leader receives the fees and distributes to the workers in the team (95% of the total received amount divided per number of members). The cargo handling fees are regulated per kind of commodity since 2008. Since the latest version was 2010, rather old, handling fees are negotiated per commodity. Any private companies which do not belong to the FHC are not allowed to conduct cargo handling works at the natural riverbank along the Mandalay.

(2) Candidate Location 1[2]

Conditions of the riverside at Candidate Location 1 are as shown in Photo 1-2-10 and the land side is as shown in Photo 1-2-11. Candidate Location 1 is the selected Project site for the Mandalay port construction. When the photograph was taken, cargo unloading operations were conducted along the natural riverbank as shown in the photographs.

Near the riverbank, there was a hut for a traders' office handling cargoes at the bank. On the land side, the surrounding area of the project area, there is some firm land and to the north of the firm land, there are some private firms collecting river bed sand. There is a temple between Myo Patt Road and the east side of the project area. There are no local inhabitants in the area.

Photo 1-2-10 Riverside Conditions of Candidate Location 1

Photo 1-2-11 Land Side Conditions of Candidate Site 1

[2] Conditions of the candidate sites shall also be referred to the "6-1 Urban Development Plans and Candidate Port Locations" and "6-2 Outline of Candidate Locations" in Appendix 6.

(3) Candidate Location 2

Candidate location 2 is at the river bank between the Ydanabonn Bridge and the Inwa Bridge. This location was proposed as the logistics area in "the Urban Development Plan for Mandalay 2014 (JICA 2016)".

Photo 1-2-12 shows riverside conditions. Photo 1-2-13 and Photo 1-2-14 show land side conditions of the area. There are no firm lands and residences near the site, however, there is some firm land area on the downstream side of the project area. Near the existing road behind the project area, there are many local residences. It was confirmed by interviews to the local inhabitants that the area surrounded by the fence (Photo 1-2-14 is the inside the fence) is privately owned land.

Photo 1-2-12 Riverside Conditions of Candidate Location 2

Photo 1-2-13 Land Side conditions of Candidate Location 2
(About Middle Point between the Two Bridges)

Photo 1-2-14 Land Side Conditions of Candidate Location 2 (Near Inwa Bridge)

(4) Candidate Location 3

Candidate location 3 is the riverside in the firm lands. Photo 1-2-15 and Photo 1-2-16 show site conditions. Among the three candidate sites, this site is the farthest from Mandalay city. To reach the site, one must pass through about 3 km of unpaved narrow road in the village area. There is no electrical power nor water supply. Port development requires not only port facility construction but also access road development by widening the existing road or newly constructing about 4 km from the existing road connections. Involuntary resettlement may be necessary for the former case and for the latter case; it is unavoidable to affect about 100 lots of firm lands for the road construction.

Photo 1-2-15 Riverside Conditions of Candidate Location 3

Photo 1-2-16 Land Side Conditions of Candidate Location 3

(5) Semeikhon Port

Semeikhon Port was developed by Mandalay Myotha Industrial Development Public Co., Ltd. (MMID), as the exclusive user service port of the Myotha Industrial Park, which was also developed by MMID behind the port area. Semeikhon Port is located about 80 km downstream along the river channel from Mandalay port. The road distance from Semeikhon Port to Mandalay City is a rather long distance for land transport and entails a high cost for land transport, therefore, Semeikhon Port is not convenient to use for the port of Mandalay.

One floating pontoon, 52 m long and 20 m wide, is equipped at the port copping with 10 m water level changes between the dry and rainy seasons of the Ayeyarwady River. The water depth in front of the berth is 2.3 m in the dry season. There is one 50-ton capacity[3] crane equipped on the floating pontoon for the cargo handling, however, the pontoon size is not so large, it seems inconvenient for large cargo handling.

The concept of the floating pontoon is as shown in Photo 1-2-18. The floating pontoon and the land area behind is connected by slope, and the pontoon, following the water level, changes through the year as shown in Photo 1-2-19 and Photo 1-2-20. The pontoon and slope are connected by an access bridge about 30 m long and 5 m wide. Cargoes loaded on the pontoon are transported by truck and/or trailer through the access bridge and slope to the yard area.

The slope and access bridge of Semeikhon Port are as shown in Photo 1-2-19 to Photo 1-2-21. There is a cargo handling yard area on the land area at the top of the slope as shown in Photo 1-2-22.

During the first rainy season in 2016, after starting the operation, the facility experienced about 5,800 m^3 of sand sediment on the slope. Therefore, the facility design concept was reviewed and modified by the Burmese consultant and a sand sediment protection wall was constructed as shown in Photo 1-2-23. The effectiveness of the facility is not yet proofed, since the facility has not experienced high water and a rainy season yet.

[3] According to the working range chart at site, crane capacity is 35 tons in 30m load radius.

Photo 1-2-17 General Image of the Facility

Source: MMID Brochure

Photo 1-2-18 Concept to Follow the Water Level Changes in Dry and Rainy Seasons

Photo 1-2-19 Semeikhon Port Pontoon

Photo 1-2-20 Access Slope

Photo 1-2-21 Access Bridge

Photo 1-2-22 Cargo Yard

Photo 1-2-23 Sand Protection Wall

1-2-1-4 Relevant Infrastructures

(1) Port Facilities

In terms of similar port facilities, other than Mandalay and Semeikhon Port, there is one private jetty facility (jetty length of 90 m) near Takaung town, approximately 200 km upstream from Mandalay City. This port was built by a private Chinese company, and used exclusively for a nickel mining factory.

Photo 1-2-24 Fixed Jetty Structure near Takaung Town

(2) Railway

There is railway access from Yangon to Mandalay, but the facilities are aged and deteriorated. At present, a rehabilitation project, funded by Japan's ODA loan, is ongoing. The existing railway has old bridges which cannot accommodate container cars with small vehicle space.

(3) Road

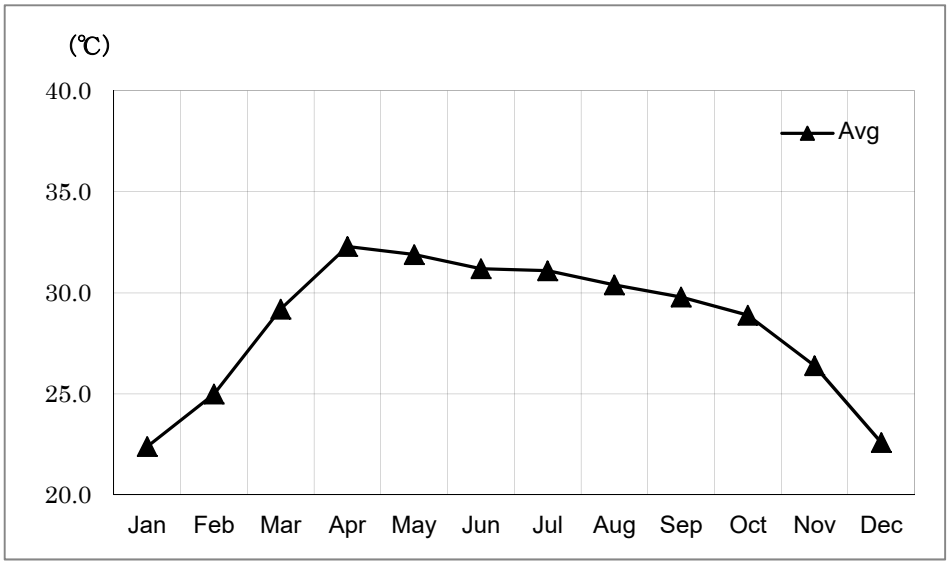
There are three access roads between Yangon and Mandalay. One is NR 1 running along the Ayeyarwady River, the second is NR 2 passing the east side of NR 1 connecting Yangon, Naypyitaw and Mandalay, and the other is the newly constructed express road passing through the middle of NR 1 and NR 2. NR 1 and NR 2 require development to become authentic cargo routes. The express way seems to be an insufficient design for heavy cargo vehicles, in which the government restricts the passage of cargo trucks at present.

1-2-2 Natural Conditions

(1) Climate

1) Temperature and Humidity

The project site belongs to a tropical climate. It has three distinct seasons: summer; rainy; and winter. Summer is normally from February to April, the rainy season is from May to October and winter is from November to January. Figure 1-2-8 shows the average monthly temperature in Mandalay in the last 10 years, from 2005 to 2014. The average temperature from April to September is higher than 30 degrees, and April has the highest temperature of the year.



Source: Department of Meteorology and Hydrology

Figure 1-2-8 Monthly Average Temperature (2005 to 2014)

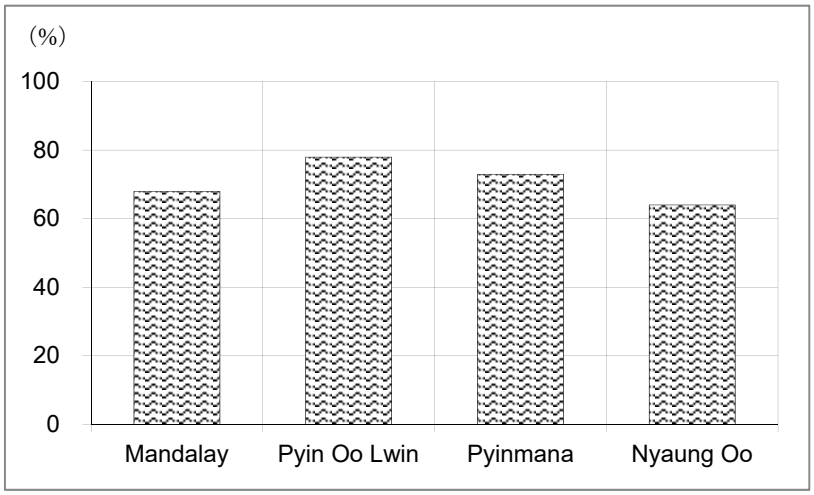
Table 1-2-1 Monthly Average Temperature (2005 – 2014) (°C)

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mandalay	Avg.	22.4	25.0	29.2	32.3	31.9	31.2	31.1	30.4	29.8	28.9	26.4	22.6

Source: Department of Meteorology and Hydrology

2) Humidity

The average annual humidity in the past 10 years in the four areas of the Mandalay Division is shown in Figure 1-2-9 from 2005 to 2014 in the Mandalay area. The average annual humidity of the Mandalay area is close to 70%.



Source: Department of Meteorology and Hydrology

Figure 1-2-9 Average Annual Humidity

Table 1-2-2 Average Annual Humidity (%)

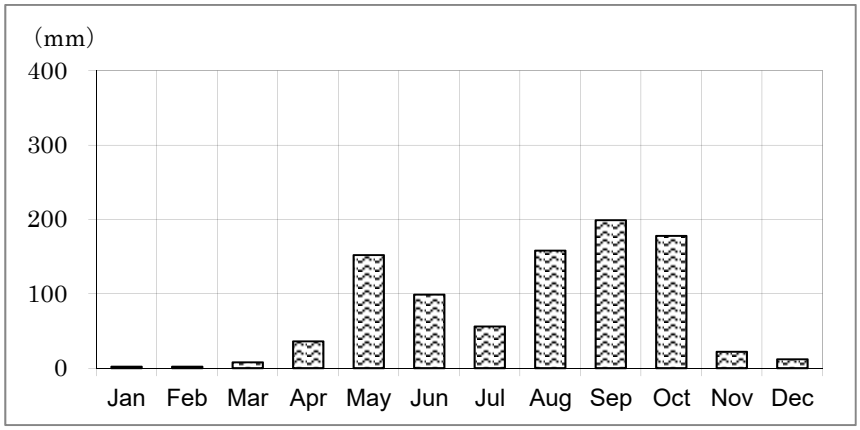
Station		Mandalay	Pyin Oo Lwin	Pyinmana	Nyaung Oo
Mandalay	Avg.	68	78	73	64

Source: Department of Meteorology and Hydrology

(2) Rainfall and Thunderstorms

1) Rainfall

Mandalay city belongs to a dry zone and the precipitation level is generally low. The distribution of monthly average rainfall in the past 10 years from 2005 to 2014 in the Mandalay area is as shown in Figure 1-2-10. Throughout the year, precipitation from May to October is relatively large, 100 mm/month or more, except in July. From November to April there is mostly no precipitation. Annual average rainfall in Mandalay is 624 mm; this is relatively small compared with Yangon, which gets 3,126 mm.



Source: Department of Meteorology and Hydrology

Figure 1-2-10 Average Monthly Rainfall

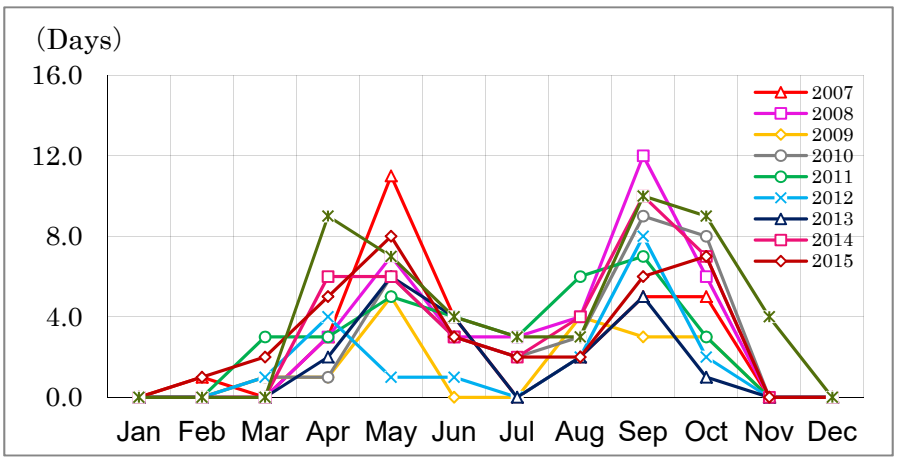
Table 1-2-3 Average Monthly Rainfall (2005-2014) (mm)

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mandalay	Avg.	2	2	8	36	152	99	56	158	199	178	22	12

Source: Department of Meteorology and Hydrology

2) Thunderstorms

Monthly storm days observed in the last 10 years, from 2007 to 2016, are as shown in Figure 1-2-11 and Table 1-2-4. Throughout the year, storms occur frequently mostly in May and September. Occurrence days are—it is different by year—approximately 20 to 40 days (except 2016). Days of occurrences are approximately the same as Japan.



Source: Department of Meteorology and Hydrology

Figure 1-2-11 Monthly Storm Rain Days

Table 1-2-4 Monthly Storm Rain Days in Last 10 Years (2007 – 2016)

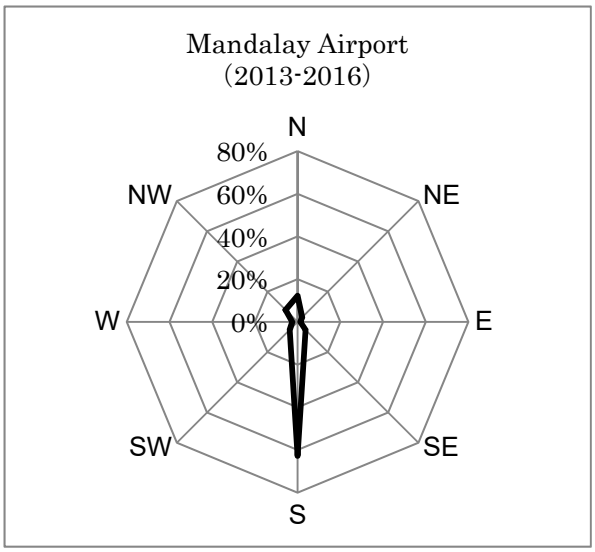
Unit: Days

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2007	0	1	0	3	11	4	0	2	5	5	0	0	31
2008	0	0	0	3	7	3	3	4	12	6	0	0	38
2009	0	0	1	1	5	0	0	4	3	3	0	0	17
2010	0	0	1	1	6	3	2	3	9	8	0	0	33
2011	0	0	3	3	5	4	3	6	7	3	0	0	34
2012	0	0	1	4	1	1	0	2	8	2	0	0	19
2013	0	0	0	2	6	4	0	2	5	1	0	0	20
2014	0	0	0	6	6	3	2	4	10	7	0	0	38
2015	0	1	2	5	8	3	2	2	6	7	0	0	36
2016	0	0	0	9	7	4	3	3	10	9	4	0	49

Source: Department of Meteorology and Hydrology

(3) Wind Direction and Wind Speed

Wind directions observed in the last 4 years, from 2013 to 2016, at Mandalay Airport are shown in Figure 1-2-12 and the average monthly wind speeds are shown in Figure 1-2-13. Based on these figures, it is obvious that the southward wind is the most dominant throughout the year, and the wind in January is generally calm since the average wind speed is 2.6 km/h (0.7 m/sec), which is the smallest of the year, and July has the highest average wind speed, 11.8 km/h (3.2 m/sec).



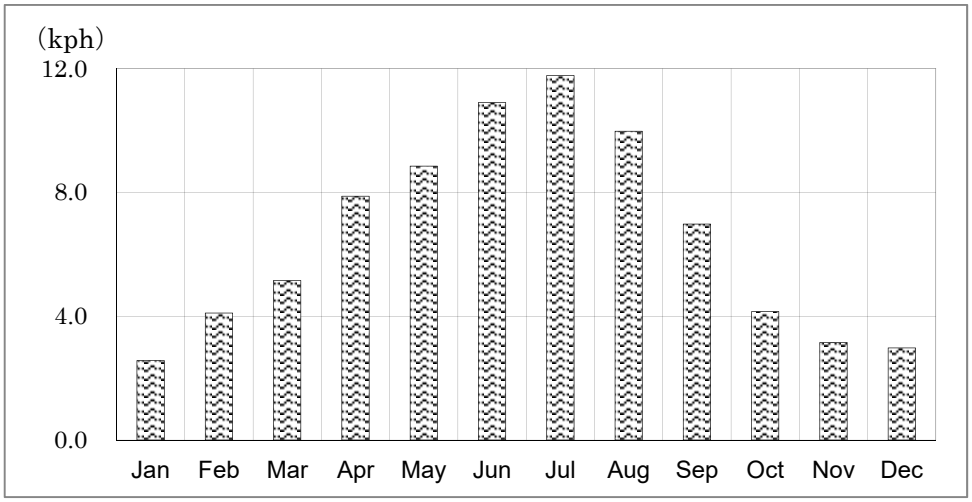
Source: www.weatheronline.co.uk

Figure 1-2-12 Annual Average Wind Direction

Table 1-2-5 Annual Average Wind Direction (2013 – 2016) (%)

2013-2016	N	NE	E	SE	S	SW	W	NW
Avg. (%)	12	3	1	5	63	5	3	8

Source: www.weatheronline.co.uk



Source: www.weatheronline.co.uk

Figure 1-2-13 Average Monthly Wind Speed

Table 1-2-6 Average Monthly Wind Speed (2013 – 2016) (km/h)

2013-2016	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. (km/h)	2.6	4.1	5.2	7.9	8.9	10.9	11.8	10.0	7.0	4.2	3.2	3.0

Source: Department of Meteorology and Hydrology

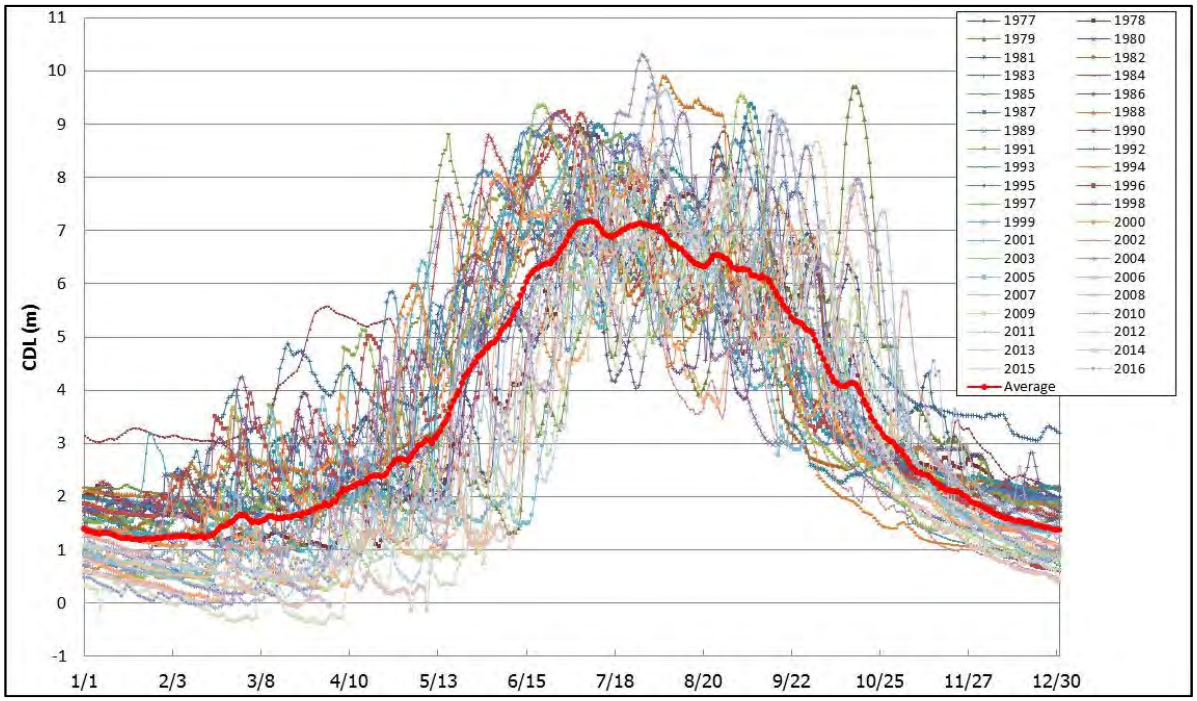
(4) River Environment

1) Base Elevation

The base elevation of Mandalay is mean sea level (MSL = 0.0 m), however, the zero level of Mandalay Port is defined as 61.3 m (MSL = 61.3) above mean sea level as Chart Datum Level (CDL = 0.0 m) by DWIR and DMH. In this study, CDL = 0.0 m is used as the base elevation of the facility design works.

2) Water Level

Water level fluctuations are observed by DWIR. Figure 1-2-14 shows the observed river water level from 1977 to 2016. Based on the figure, the highest water level occurred in August 2004, and its level was 10.3 m. This level is the highest in the observed data, and a water level higher than 10 m was only observed in this year, with infrequent occurrences of high water level of about 9 m in the other years.



Source: JICA Study Team based on the DMA Data

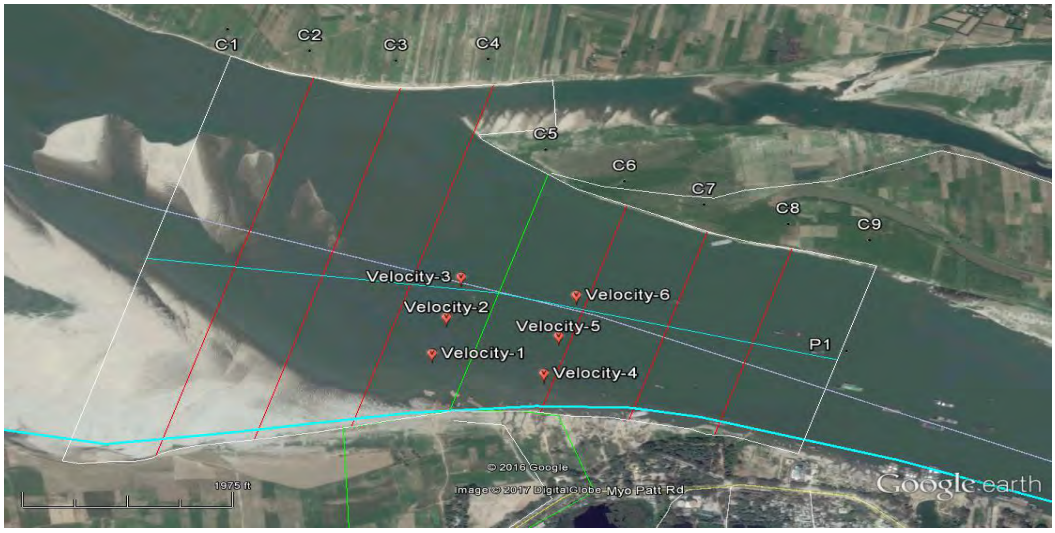
Figure 1-2-14 Fluctuation of River Water Levels

3) River flow

In this study, the water level and flow velocities are observed three times, on May 17 (dry season), June 24 (rainy season) and July 8 (rainy season) at six points, as shown in Figure 1-2-15. The observation results are shown in Table 1-2-7.

The observed water level is CDL 1.359 m to 1.389 m in May of the dry season, but the level became CDL 4.825 m to 4.905 m in June and CDL 6.658 m to 6.720 m in July when entering the rainy season. The water level was sharply increased about 5 m after entering the rainy season.

Observations twice daily, one in the morning and the other one in the afternoon, at 1 m below the water surface and at the middle depth between the riverbed and water surface were conducted at six points where the facility construction is planned, shown in Figure 1-2-15. The water flow near the river centre, near the water surface and in the rainy season, which had a higher water level than the dry seasons, is faster than it is near the riverbank, at middle water depth and in the dry season. The flow velocities are increased from 0.83 m/sec to 1.635 m/sec at 1 m below the water surface and from 0.755 m/sec to 1.502 m/sec at middle water depth.



Source: JICA Study Team based on Google Earth

Figure 1-2-15 Observation Points of River Water Levels and Flow Velocity

Table 1-2-7 Observation Results of River Water Levels and Flow Velocity

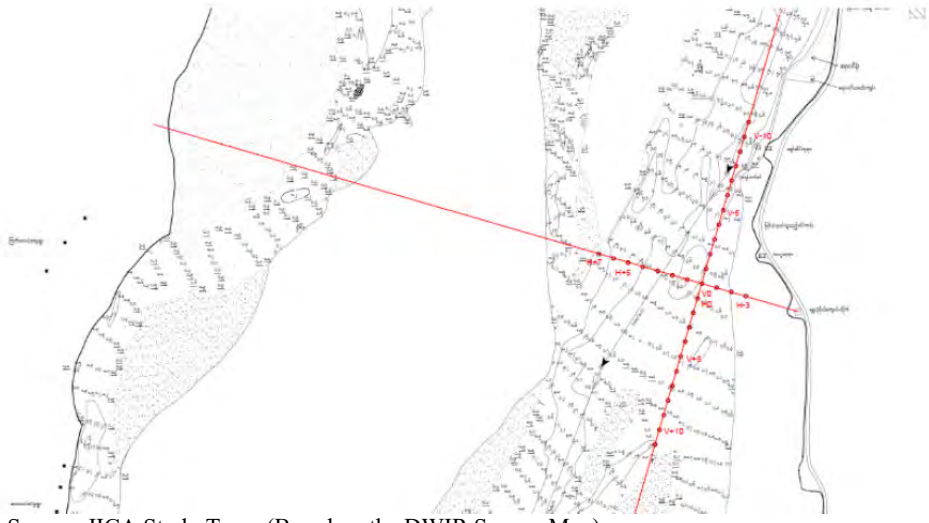
Measurement Date		2017/5/17		2017/6/24		2017/7/8	
		AM	PM	AM	PM	AM	PM
Water Level m(CDL)		1.389	1.359	4.825	4.905	6.658	6.720
Water Velocity at 1m depth (m/sec)	1	0.701	0.746	1.430	1.590	1.537	1.555
	2	0.826	0.773	1.502	1.590	1.502	1.768
	3	0.933	0.915	1.324	1.377	1.484	1.466
	4	0.808	0.879	1.875	1.910	1.786	1.733
	5	0.879	0.986	1.644	1.626	1.910	1.804
	6	0.915	0.682	1.377	1.484	1.555	1.484
Average		0.844	0.830	1.525	1.596	1.629	1.635
Water Velocity at middle depth (m/sec)	1	0.595	0.666	1.253	1.413	1.466	1.413
	2	0.648	0.666	1.448	1.448	1.448	1.537
	3	0.861	0.861	1.217	1.181	1.342	1.324
	4	0.790	0.791	1.715	1.715	1.590	1.480
	5	0.790	0.968	1.590	1.448	1.733	1.746
	6	0.897	0.577	1.306	1.253	1.430	1.377
Average		0.764	0.755	1.422	1.410	1.502	1.480

Source: JICA Study Team

(5) Riverbed variation

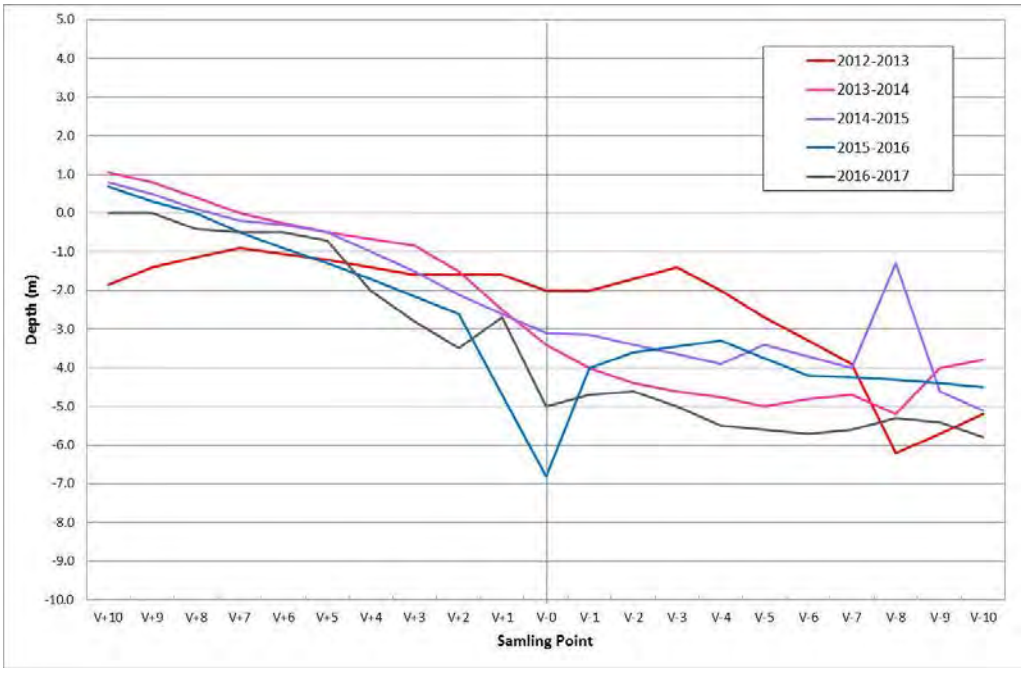
In the hydrographical survey maps from 2012 to 2017 which were surveyed by DWIR, riverbed fluctuations are studied at two sections near the facility construction site along and perpendicular to the riverbank, as shown in Figure 1-2-16. The results are shown in Figure 1-2-17 and Figure 1-2-18.

Based on the Figure 1-2-17 and Figure 1-2-18, the depth fluctuations repeatedly become deeper and shallower and it was found that the maximum 5 m water depth changes. The reasons for the riverbed fluctuations are not clear, however, the riverbed may become deep and shallow by these variation values over a long time span.



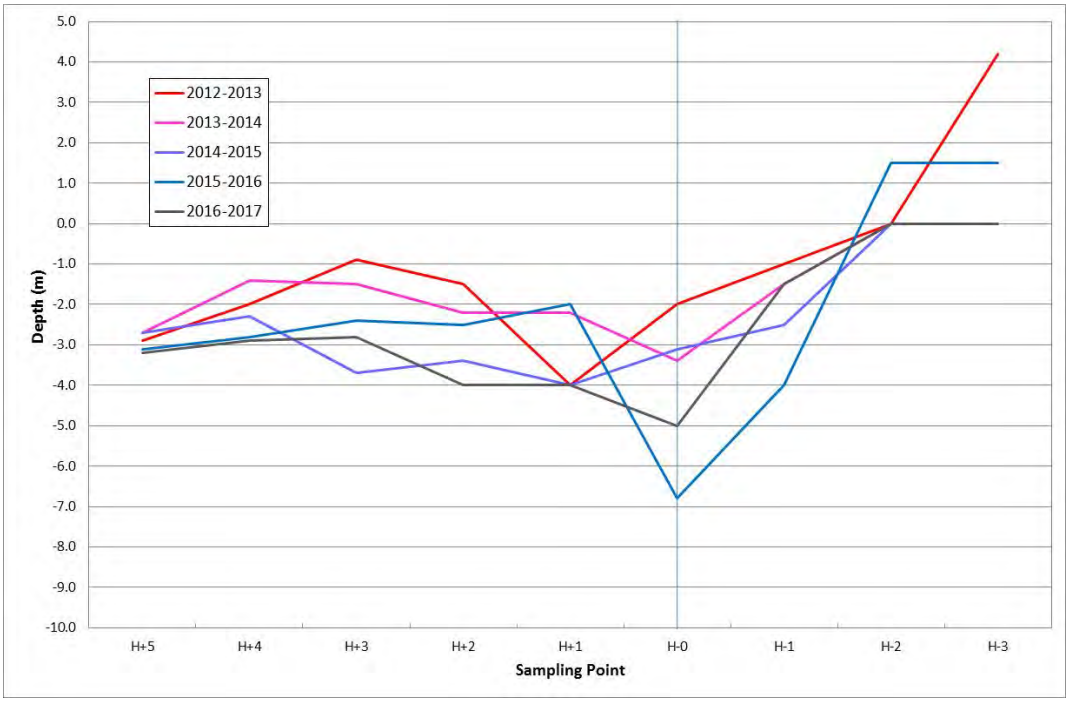
Source: JICA Study Team (Based on the DWIR Survey Map)

Figure 1-2-16 Sections to be Compared for Riverbed Variations



Source: JICA Survey Team (Based on DWIR Data)

Figure 1-2-17 Riverbed Fluctuation along the Riverbank (Longitudinal Direction)



Source: JICA Survey Team (Based on DWIR Data)

Figure 1-2-18 Riverbed Fluctuation perpendicular to the Riverbank (Transverse Direction)

(6) Soil Conditions

Boring surveys were conducted at 14 points, 6 points in the river and 8 points on land in the facility construction location. The points of the borings are shown in Figure 1-2-19. Based on these survey works, soil conditions are as described below.

Source: JICA Study Team based on Google Earth

Figure 1-2-19 Boring Survey Points

1) Stratification Conditions

Based on the boring survey, the evaluated soil profiles are as shown in Figure 1-2-20 and Figure 1-2-21. Figure 1-2-20 shows the longitudinal section of the river and Figure 1-2-21 shows the cross-section of the land side boring. As shown in the figures, the soil stratification layers are as follows, from the top downward: the sand layer continues with Silty SAND-I, Silty SAND-II, Silty SAND-III, SAND and the clay layer is confirmed CLAY-I, CLAY-II, CLAY-III between the sand layer.

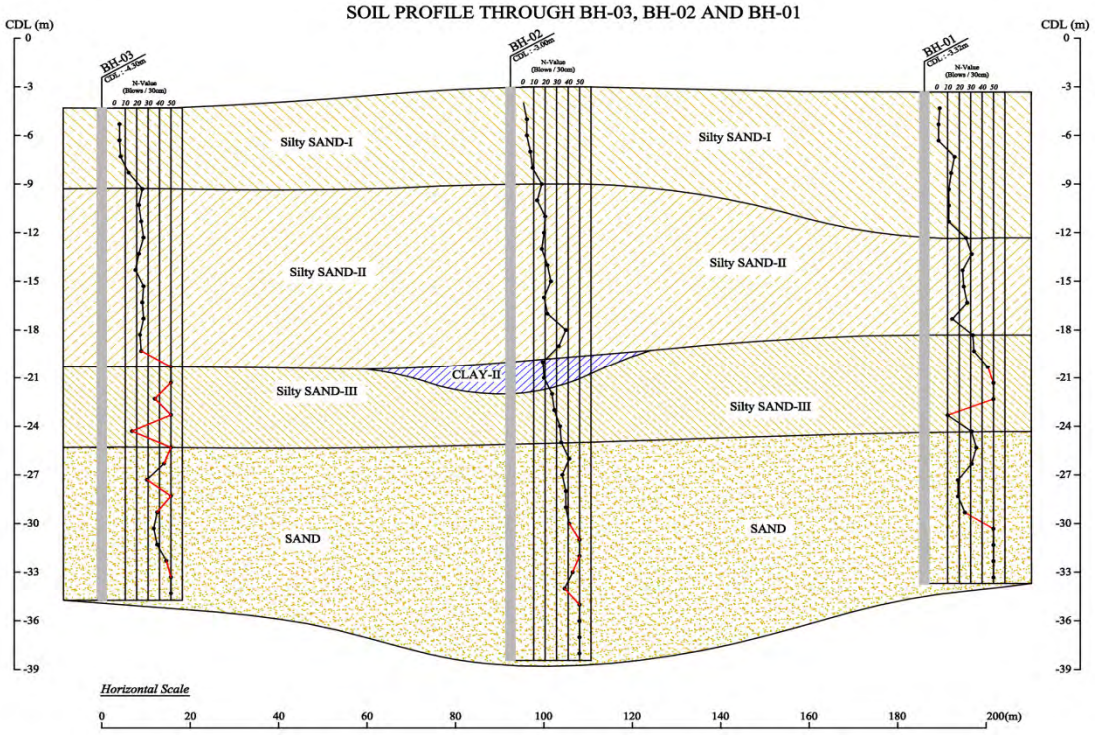


Figure 1-2-20 Soil Profile on Offshore Side (BH-3, BH-2, BH-1)

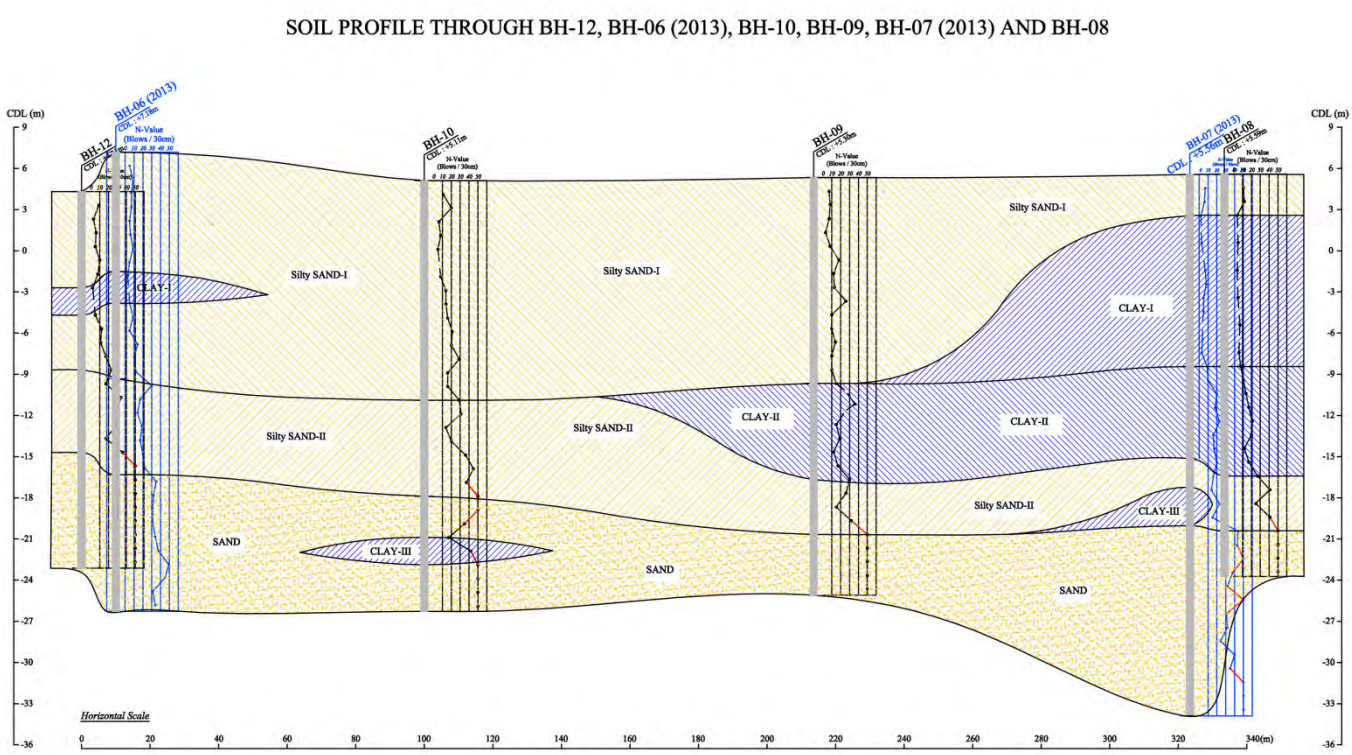


Figure 1-2-21 Soil Profile on Land Side (BH-12, BH-10, BH-9, BH-8)

2) Outline of each Stratum

a. Silty SAND-I

- This layer is confirmed from the surface at all points.
- In the part on the land side, the layer thickness is as thin as around 3 m, but in most other areas, the thickness is confirmed to be approximately 10 m to 15 m.
- The sand is classified as fine sand to medium sand, and the content of fine-grained fraction is small in the whole. The N-value is distributed from around 5 to 20, but it is loosely around 10 as a whole.

b. Silty SAND-II

- This layer is confirmed under the Silty SAND-I layer at all points.
- This layer is confirmed consecutively with a thickness of 4 m to 20 m.
- The sand is classified as fine sand to medium sand, the fine-grained fraction content is small, but a lot of silt is mixed partially. The N-value is around 20 to 30 and the relative density is Medium dense.

c. Silty SAND-III

- This layer is confirmed on the offshore side with a thickness of around 3 m to 6 m under the Silty SAND-II layer.
- The sand is mainly classified as fine sand to medium sand, and gravel is mixed partially. The N-value ranges widely from 16 to 50 and the relative density is medium dense to very dense.

d. SAND

- This layer is confirmed at the bottom of all survey points. The N-value ranges from around 20 to 50, but the N-value becomes high around 40 to 50 as it goes downward. The sand content is fine sand to medium sand.

e. ClAY-I

- This layer is confirmed with a thickness of around 11 m at the point especially near the existing road on the land side. At other points, it is thinly sandwiched in the Silty SAND-I layer with a thickness of 1 m to 2 m. The N-value ranges from 2 to 8, which is a soft to firm consistency.

f. CLAY-II

- This layer is sandwiched in the Silty SAND-II layer with a thickness of 2 m to 10 m. The N-value ranges from 8 to 23, which is a firm to very stiff consistency.

g. CLAY-III

- This layer is sandwiched in the SAND layer with a thickness of 1 m to 2 m. The N-value ranges from 14 to 23, which is a stiff to very stiff consistency.

3) Soil Properties

a. Silty SAND-I

- Moisture content varies from 12% to 40%, but overall it is mainly distributed in the range of 20% to 30%.
- Fine grain content varies from several percent to dozens of percent depending on the mixing state of the clay content. As for the tendency, the fine grain content in the riverside is distributed as low as several percent to around 10%, and it is distributed to a large extent as a whole around 10% to around 50% on the land side.
- For the soil type, it is mostly classified as Sand with Fines in the riverside and it is mostly classified as Clayey/Silty Sand on land side.

b. Silty SAND-II

- Moisture content varies from 16% to 37%, but overall it is mainly distributed in the range of 20% to 30%. Fine grain content is several percent to dozens of percent and it is mostly classified as Sand with Fines.

c. Silty SAND-III

- Moisture content varies from 15% to 41%, but overall it is mainly distributed around 20%. Fine grain content is around 10% and it is mostly classified as Sand with Fines.

d. SAND

- Moisture content varies from around 10% to 20%.
- Fine grain content, around 10% to 20%, is a little larger than that of the upper sand layer. It is classified as Clayey/Silty Sand.

e. CLAY-I

- Moisture content is partially high around 60%; it is mostly distributed from 30% to 40%.
- Bulk density is from 1.8 (g/cm^3) to 1.9 (g/cm^3) and unconfined compressive strength is 29 (kN/m^2) to 131 (kN/m^2).
- For the consolidation property, the pre-consolidation pressure (Pc) is 113 (kN/m^2) to 335 (kN/m^2), which is much higher than the current effective overburden pressure, 24 (kN/m^2) to 117 (kN/m^2). This indicates an over-consolidation state. The compression index (Cc) is also small, 0.26 to 0.35.

f. CLAY-II

- Moisture content varies from 22% to 55%, but it is mostly around 30%.
- Bulk density is from 1.9 (g/cm^3) to 2.0 (g/cm^3) and unconfined compressive strength is 92 (kN/m^2) to 283 (kN/m^2), very hard.
- For the consolidation property, pre-consolidation pressure (Pc) is 274 (kN/m^2) to 302 (kN/m^2), which is much higher than the current effective overburden pressure, 117 (kN/m^2) to 193 (kN/m^2). This indicates an over-consolidation state. The compression index (Cc) is also small, 0.15 to 0.20.

g. CLAY-III

- This layer is confirmed only thinly within the SAND layer, so the quantity of soil tests conducted is small and only the physical property test was carried out.
- Moisture content is from 25% to 31% and specific gravity is 2.68 to 2.70.

4) Ground Condition on Structure Foundation

a. Liquefaction

- Mandalay area is close to the active fault running north-south in Myanmar, the Sagaing fault. Therefore, it is necessary to consider the possibility that liquefaction might occur during an earthquake.

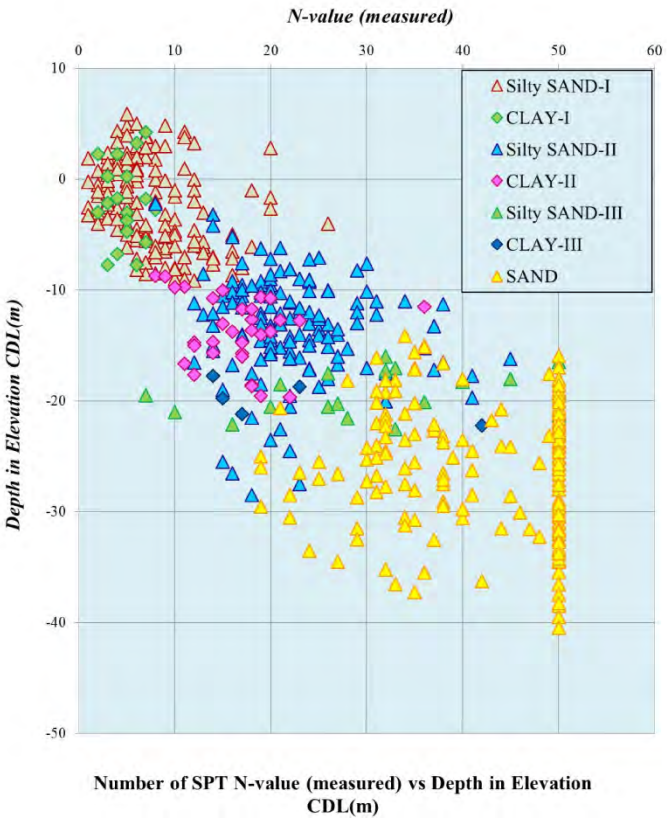
- In this survey area, the sand layer is deposited thickly from the ground surface as a whole except in one part of the land side. The layers to be liquefied are from the ground surface to a depth of 20 m, the Silty SAND-I layer and Silty SAND-II layer.

- Especially, the Silty SAND-I layer is stratified throughout the survey area from the ground surface with a thickness of around 10 m to 15 m, and the fine grain content is as low as around 10% to 20%.

- And also, as shown in Figure 2-10, the N-value is mostly around 10 or less, loose.

- The range of grain size distribution in which liquefaction is possible is indicated according to the value of the uniformity coefficient ($Uc=D_{60}/D_{10}$) as shown in Figure 2-11. D_{60} and D_{10} denote the grain sizes corresponding to 60% and 10% passing, respectively. The threshold value of Uc is 3.5.

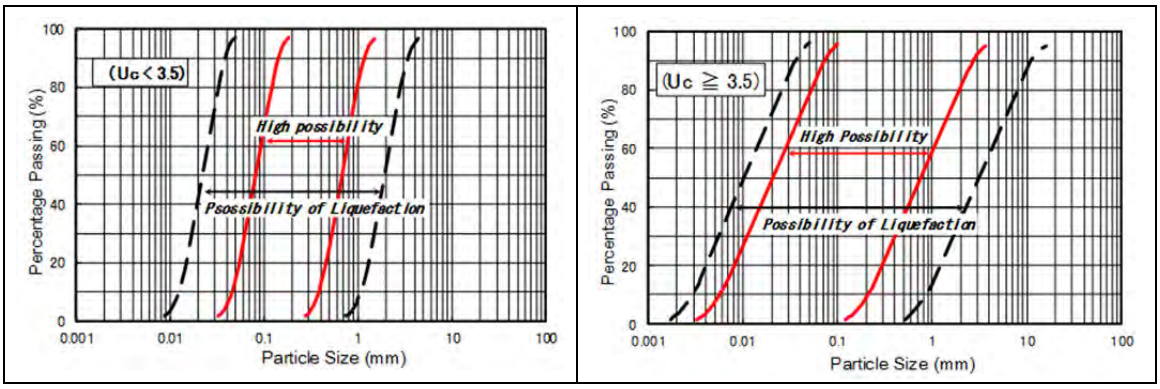
- Grain size distribution curve for the representative 4 points in the survey area is shown in Figure 2-12. According to the figure, most of the grain size distribution curve is in the range of particularly high possibility of liquefaction. Therefore, it is necessary to examine the possibility of liquefaction.



Number of SPT N-value (measured) vs Depth in Elevation CDL(m)

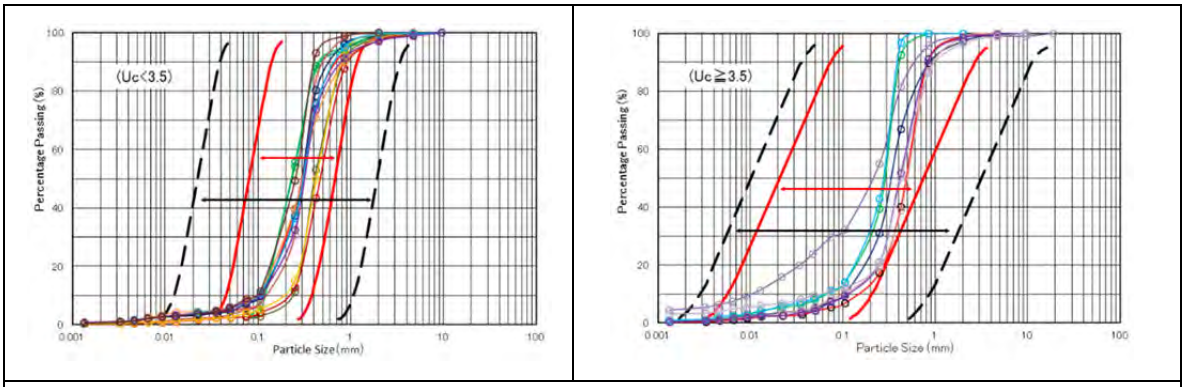
Source: JICA Study Team

Figure 1-2-22 Distribution of N-values with Depth

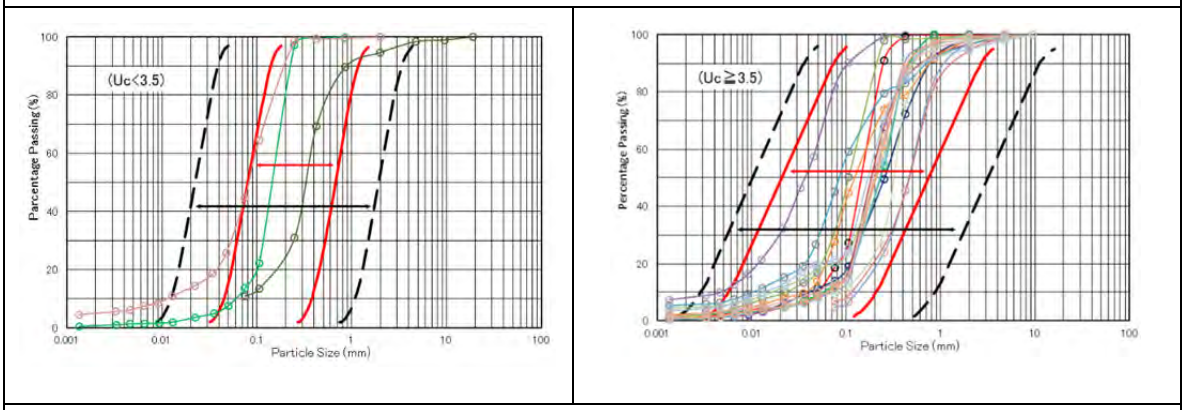


Source: Technical standards and commentaries for port and harbour facilities in Japan
(The Overseas Coastal Area Development Institute of Japan)

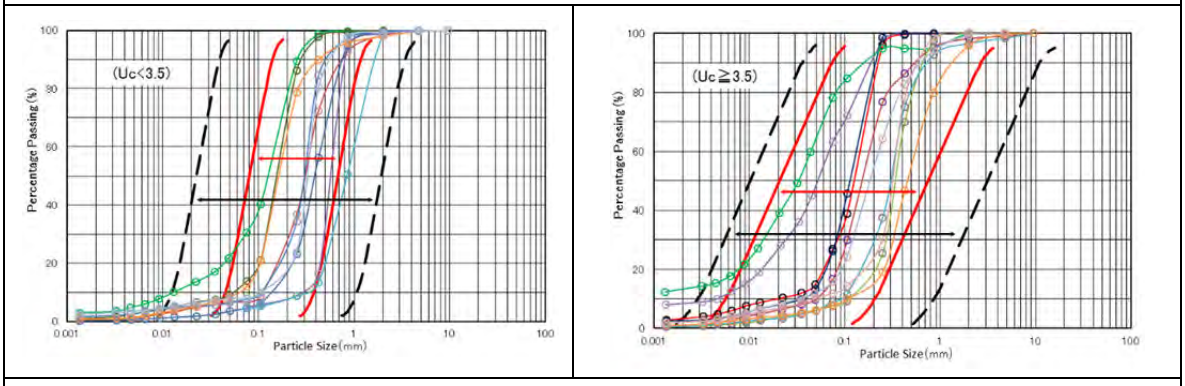
Figure 1-2-23 Grain Size Range of Possible Liquefaction



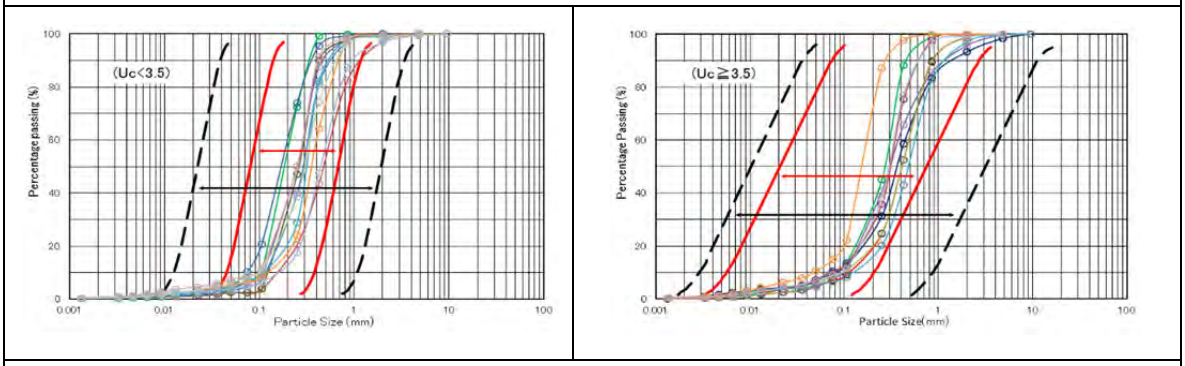
BH- 4　Grain-size distribution curve



BH- 6　Grain-size distribution curve



BH-12　Grain-size distribution curve



BH-14　Grain-size distribution curve

Figure 1-2-24　Grain-Size Distribution Properties

b. Settlement problem

- The layer to be considered for settlement is the Clay layer, but the Sand layer is thickly stratified from the ground surface throughout the area, and the Clay layer is confirmed as CLAY-I layer and CLAY-II layer, only at the existing road side on land.

- Of these, the depth of stratification of the CLAY-II layer is comparatively deep, about 15 m or more, and also as shown in Figure 2-10 (Depth distribution graph of N-value), the Clay-II layer is so hard (N-value of around 10 to 20) that it is not necessary to consider it as a layer to be settled.

- For the CLAY-I layer, as described in the above-mentioned soil property characteristics, it is over-consolidated, about 90 (kN/m^2) to 240 (kN/m^2) to current effective overburden pressure, and the amount of its over-consolidation converted into embankment height (18 kN/m^3) is about 5 m to 13 m. This means if the embankment height is within 5 m, there is almost no occurrence of settlement, and even if it is 5 m or more, there is no concern that significant settlement will occur.

c. Bearing Layer for Structure Foundation

- Depending on the scale of the structure, the layer to be expected as a bearing layer of a structure's foundation shall usually have an N-value of 30 or more for a sand layer.

- As shown in Figure 2-10 (Depth distribution graph of N-value), the N-value of the Silty SAND-I layer stratified from the ground surface in the area is mainly around 20, almost less than 20, and the N-value of the Silty SAND-II layer is around 20, and mostly less than 30.

- The layer with an expected N-value more than 30 is the SAND layer.

1-2-3 Environmental and Social Considerations

1-2-3-1 Environmental Impact Assessment

1-2-3-1-1 Environmental Approval Process in Myanmar and Current State

Under the Environmental Impact Assessment (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 1-2-25.

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 1-2-25 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 IEE consultant) has been completed (cf. a letter of notification has been issued from MONREC to MOTC dated June 2, 2017). With regards to IEE approval, DWIR has submitted to ECD/MOREC via MOTC through a letter dated September 4, 2017.

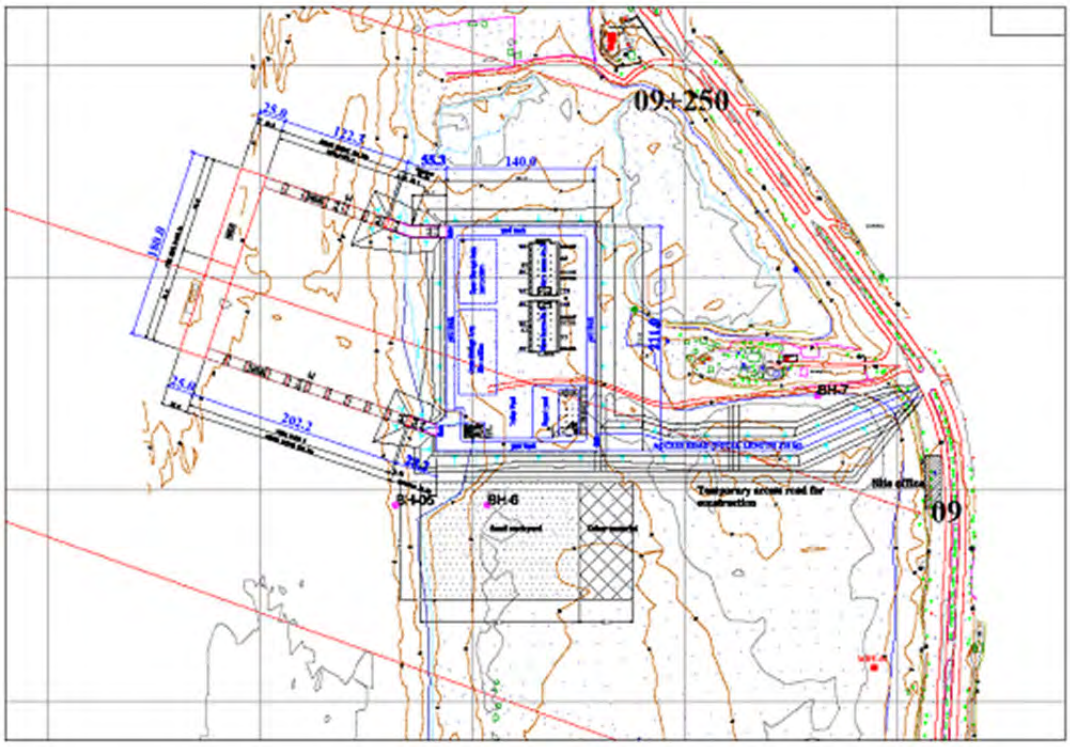
According to the law, ECD is supposed to issue a letter with their comments on the report by early December, 2017. However, this may take a longer time. This concern of the JICA study team has been shared with DWIR during the first trip to Myanmar and at the joint coordination meeting held on May 11, 2017 in the presence of DWIR and IWT, an agreement was reached that DWIR will take actions in case ECD/MONREC's review takes a longer time than stipulated under the law.

1-2-3-1-2 Major Components of the Project

The project involves construction of a new inland water port. The main components of the project are presented below and the layout plan is shown in Figure 1-2-26.

(1) Construction of New Inland Water Port in Mandalay

- Cargo handling yard (29,540 m^2) including container yards and ware houses
- Jetty (180 m)
- Two access bridges (238 m and 182 m)
- Access road (304 m)
- Procurement of Cargo Handling Machinery and Equipment



Source: JICA Study Team

Figure 1-2-26 Layout Plan of the Project

1-2-3-1-3 Baseline Condition of Natural and Social Environment

(1) Climate

The project site belongs to a tropical climate. It has three district seasons: summer; rainy; and winter. Summer is normally from February to April, rainy season from May to October and winter from November to January. Precipitation from May to October is relatively large, however, Mandalay city belongs to a dry zone , therefore, annual average rainfall in Mandalay, 624 mm is relatively small compare with Yangon, 3,126 mm.

Other details of the natural conditions are as described in “Chapter 1-2-2 Natural Conditions”.

(2) Administrative Boundary

The project site is located in Amarapura Township, Mandalay Region. Amarapura is the former capital of Myanmar and now it is a township. Amarapura is bounded by Ayeyarwady River in the west, Chanmyathazi Township in the north, and the ancient capital site of Ava (Inwa) in the south. It is also famous for its silk weaving industry. Notable places in this township include: U Bein Bridge; Kyauktawgyi Pagoda; Pahtodawgyi Pagoda; Shwe Gu Gyi Pagoda; and Mahar Wai Yan Bon Thar Bargaya Monastery.

Source: JICA Study Team based on Google Earth

Figure 1-2-27 Administrative Boundary at the Project Site

(3) Status of Land Registration and Use

Interview surveys with the PAPs and the Township Department of Agricultural Land Management and Statistics (DALMS) located under the Ministry of Agriculture, Livestock and Irrigation as well as site surveys, were carried out to confirm the land registration and land use status at the project site. The project site is a riverbank and becomes part of the river during the rainy season. Hence, the land officially is under the jurisdiction of DWIR in accordance with the Conservation of Water Resources and Rivers Rules (2013). Nonetheless, one company and two individuals have been found to have registered plots of land to DALMS.

With regards to land use status, there is a company located in the northern part of the project site that collects river sand and sells to the market in Mandalay city. Three people grow crops (i.e. beans) and seven huts are located at the project site. Other parts are left unused. There is a monastery east of the project site and a pagoda north of the site, both of which are considered not to be affected by the project. Land registration and use status are shown in Figure 1-2-28 below.

Source: JICA Study Team based on Google Earth

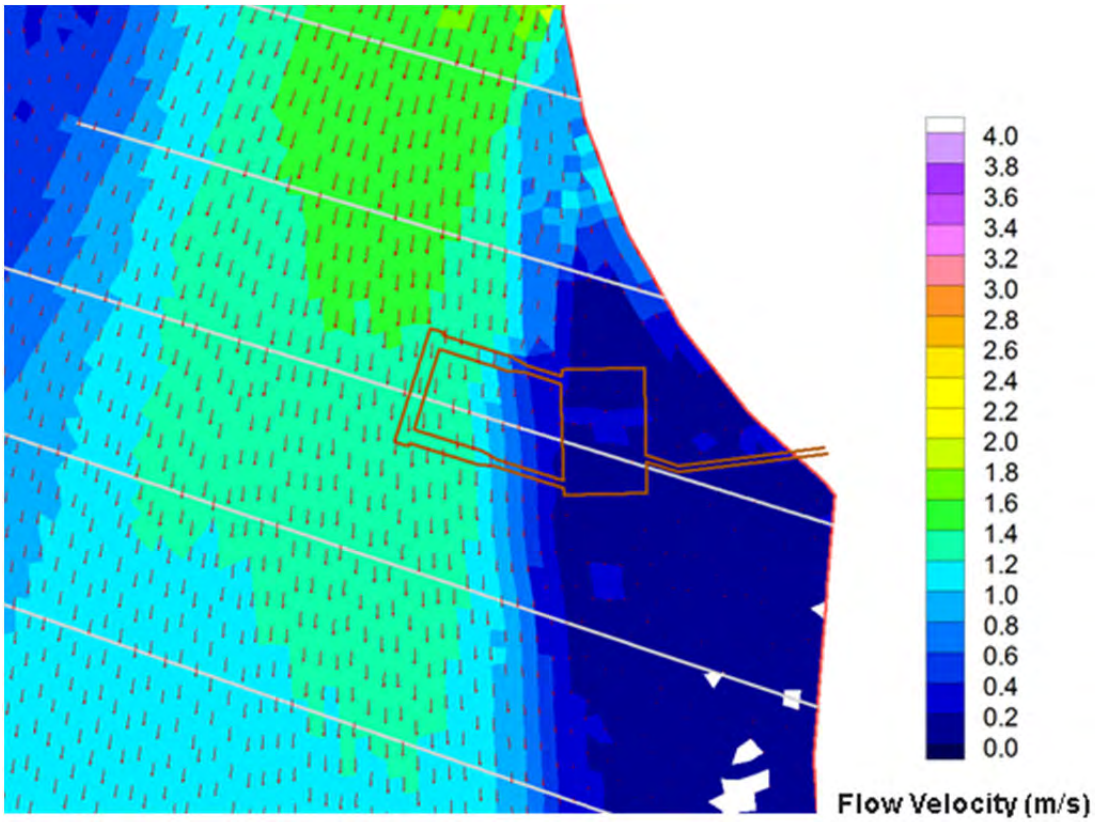
Figure 1-2-28 State of Land Registration and Use in/near the Project Site

(4) Topography and Geology

Refer to '1-2-2 Natural Conditions' of this report to find the topographic and geological conditions at the project site.

(5) Hydrology

In the 2014 JICA F/S conducted in 2013-2014, flow velocity in the project area was analysed. The results of the hydrological study are presented as follows. Figure 1-2-29 below shows a flow velocity distribution diagram of the peak flow rate obtained by the flow analysis. At the project site where the flow path width is widened, flow velocity begins to fall. Maximum flow velocity of the river near the port project site is estimated to be approximately 1.4m/s.



Source: JICA F/S Team

Figure 1-2-29 River Flow Velocity Distribution Diagram of Current River Channel

The results of the riverbed deformation analysis shows a trend that sand sediment is moved in the flow velocity vector direction. Sand sediment is accumulated approximately 1 to 2 metres near the planned jetty point. Because it is the point where the tractive force (i.e. flow velocity) is reduced, it is an area where sand sediment from upstream tends to deposit.

The tendency to accumulate sand sedimentation was observed at the port project site and conditions of sand sediment and water flow direction with and without the groyne was studied. The purpose of the groyne installation is to prevent sand accumulation from the front of the groyne to the floating dock downstream. It is necessary to have an effect of splashing water and sand sediment splashes, so a non-overflow, opaque type of groyne was applied.

The results of the analysis for flow velocity distribution and topographic change amounts were compared for the current river channel case and the 'with groyne' case.

For the accumulation conditions of sand sediment, the effect of installation of the groyne can be observed until sand passes through the head of the groyne, but after the sand sediment has passed through the head of the groyne, the sand sediment condition is almost the same as without the groyne.
For flow velocity distribution, flow is accelerated slightly because the mainstream flow moves to the centre of the river by the effect of the groyne, and the riverbed is scoured. But the flow velocity distribution trend is almost the same as the analysis of the current river channel. It should be noted that the above analysis is only for a flood of 50 days (one flood). Sand sediment is accumulated and flows downstream if water level rises again and again. However, sand sediment downstream of the groyne is expected to stay as flow velocity gets slower.

(6) Socio-economic Characteristics

Table 1-2-8 below shows the socio-economic condition in Amarapura Township.

Table 1-2-8 Socio-economic Conditions in Amarapura Township

Socio-economic Condition	
Project Location	Amarapura Township, Mandalay Region
Total Population	237,618[Male- 114,480 + Female – 123,138]
No. of Households	49,626
No. of Quarters	9
No. of Village Tracts	42
Major Economy	Services, Sales, Industries, General
Literacy Rate	95.6%
School Type	Basic Education School Middle Education School High Education School University
Public Health Facilities	5 general (public) hospitals 21 private hospitals

Source: Township General Administration Department, Myanmar

(7) Fisheries

Myanmar has impressive freshwater fisheries. For management (i.e. licensing and regulation) purposes, inland fisheries are divided into two categories in Myanmar: 'Inn' leasable fisheries; and Open fisheries. The key fishing grounds of 'Inn' leasable fisheries are almost exclusively floodplains and are primarily fished by erecting barrage fences around the lease area with fish collected using various pens or traps. Open fisheries, on the other hand, are fisheries in all other areas using all other types of fishing methods. The right to fish in these areas is licensed by the Department of Fisheries under the Ministry of Livestock, Fisheries and Rural Development. Table 1-2-9 shows the data of fishing activities along Ayeyarwady River in Amarapura Township and shows the location of the fishing grounds. It has been found through the social survey and other interviews that there is no fishery activity in the river near the project site.

Table 1-2-9 Fishing Activities in Ayeyarwady River (Amarapura Township)

No.	Fishing Area	Tax (kyat)	No. of Fishermen	No. of Boats	Type of Fish Caught	Production (viss*/allow period*)	Total (viss)
1	Near Sagging Bridge	857,700	26	13	Nga-kjin Nga-but Nga-phan-ma Tilapia Nga-zin-sat Nga-zin-yine Nga-myin Nga-phal Nga-tan	4,436 3,025 5,786 24,237 6,371 5,804 4,193 3,870 3,448	61,170
2	Near Shwe Kyat Yat	1,266,900	55	28	Nga-kjin Nga-but Nga-phan-ma Tilapia Nga-zin-yine Nga-kone-ma Nga-myin Nga-zin-sat Nga-phal Nga-tan	3,937 2,668 8,052 14,261 3,415 3,946 3,019 4,204 3,170 2,988	49,660
3	Corner of Sae Htae Chaung	920,000	22	11	Nga-kjin Nga-but Nga-phan-ma Tilapia Nga-zin-sat Nga-yant Nga-zin-yine Nga-myin Nga-phal	6,240 3,675 5,419 14,397 6,045 5,547 6,573 2,883 3,731	54,510

*1 viss = 1.63kg

*allow period = 10.7.2016 to 31.3.2017

Source: Department of Livestock, Fisheries and Rural Development, Mandalay

Source: JICA Study Team based on Google Earth

Figure 1-2-30 Location of Fishing Grounds in Ayeyarwady River (Amarapura Township)

(8) Waste Management and Disposal

According to Mandalay City Development Committee (MCDC), the government body responsible for waste management at the project site, current municipal solid waste generation in the city is approximately 896 tons per day with a per capita waste generation of 0.64 kg/person/day.
Mandalay's existing waste management system comprises primary collection, secondary collection and final disposal. Primary waste collection methods include door-to-door collection and container collection from the kerb side bins and open collection points. When containers reach their maximum capacity, they are transported to designated landfill sites. However, unauthorized, non-designated collection points continue to exist due to inefficiencies of the collection system, as well as poor infrastructure and low levels of public awareness. According to MCDC, an 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 the other 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 waste 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 their wastewater. The 10-inch main pipeline is connected to Dohte Hta Waddy River where the wastewater is disposed.

Table 1-2-10 Waste Management System in Mandalay

Waste Category	Description
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 in day time: truck 211; Tricycle 179; Cart 322 • vehicles to collect at night: 77
Industrial Waste (non-Hazardous)	Collect only based on call
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: Mandalay City Development Committee

1-2-3-1-4 Legal Framework for Environmental and Social Considerations

(1) Overview

The Ministry of Environmental Conservation and Forestry (MOECAF) was re-organized as the Ministry of Natural Resources and Environmental Conservation (MONREC) on March 30, 2016, in order to more effectively undertake both environmental and natural resources conservation and management. Under Section 3 of the Environmental Impact Assessment Procedure (2015), pursuant to section 21 of the law and Articles 52, 53 and 55 of the Environmental Conservation Rules, all projects and project expansions undertaken by any organization, which may cause an impact on environmental quality, are required to obtain prior permission from MONREC. In accordance with section 21 of the Environmental Conservation Law and Article 62 of the Environmental Conservation Rules, activities with the potential to cause adverse impacts are required to carry out an IEE or an EIA or to develop an environmental management plan (EMP), and to obtain an Environmental Compliance Certificate (ECC) in accordance with the EIA Procedure (2015).

(2) Environmental Laws and Regulations related to the Project

This section describes the national laws and regulations concerned with environmental protection in Myanmar that are applicable to the subject project. The policies, legislations and guidelines in Myanmar that are of relevance to the project are summarized inTable 1-2-11. Among them, some of the more relevant legislations are described in the following sections.

Table 1-2-11 Legislations Related to Environmental and Social Considerations in Myanmar

No.	Name of Law / Regulation	Year
Overarching Framework		
	Constitution of the Republic of the Union of Myanmar	2008
	National Environmental Policy	1994
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
	Prevention of Hazard from Chemical and Related Substances Law	2013
	Prevention and Control of Communicable Disease Law	1995
	Public Health Law	1972
Biodiversity and Natural Resource Conservation		
	Protection of Wildlife, Wild Plants and Conservation of Natural Area Law	2016
	Fresh Water Fisheries Law	1991
	Underground Water Act	1930
Land Acquisition and Resettlement		
	National Land Use Policy	2016
	Farmland Law	2012
	Farmland Rules	2012
	The Land Acquisition Act	1894
Port Development		
	Myanmar Port Authority Law	2015
	Conservation of Water Resources and River Law	2006
	Conservation of Water Resources and River Rules	2013
	The Ports Act	1908
Urban Development and Management		
	Development Committee Law	2013
	The City of Mandalay Development Law	2015
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) international level criterion	2015
	WHO Environmental Health and Safety guideline	2008
Others		
	Myanmar Fire Brigade Law	2015
	Myanmar Fire Services Law	2015
	Building Regulations	2014

Source: JICA Study Team

1) Overarching Framework

a. 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 included in the Constitution as summarized below.

i. The Union is the ultimate owner of all lands and all natural resources above and below the ground, above and beneath the water and in the atmosphere in the Union (Section 37).

ii. The Union shall enact necessary law to supervise extraction and utilization of State owned natural resources by economic forces (Section 37).

iii. Every citizen has the duty to assist the Union in carrying out the following matters (Section 390):

- preservation and safeguarding of cultural heritage;
- environmental conservation;
- striving for development of human resources; and
- protection and preservation of public property

These three provisions in the Constitution provide a basis for legalizing and institutionalizing environmental health impact assessment and social impact assessment.

b. National Environmental Policy

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

2) Environmental Conservation

a. The Environmental Conservation Law

The Pyidaungsu Hluttaw enacted this law by Law No. 9 of 2012 on 30 March 2012. The legal mechanism for ESHIA has been put in this law. This law was enacted with the following objectives:

i. To enable implementation of the Myanmar National Environmental Policy;
ii. To enable the laying down of basic principles and the giving of guidance for systematic integration of the matters of environmental conservation in the sustainable development process;
iii. To enable the emergence of a healthy and clean environment and to enable conservation of natural and cultural heritage for the benefit of present and future generations;
iv. To reclaim ecosystems as may be possible which are starting to degenerate and disappear;

v. To enable the management and prevention of a decrease and loss of natural resources and for enabling the sustainable use beneficially;
vi. To enable promotion of public awareness and cooperation in education for dissemination of environmental perception;
vii. To enable promotion of international, regional and bilateral cooperation in the matters of environmental conservation; and
viii. To enable cooperation with government departments, government organizations, international organizations, non-governmental organizations and individuals in matters of environmental conservation.

The most pertinent clauses for this project in the Environmental Conservation Law are as follows:

i. Monitoring is the responsibility of project proponents / business owners for reducing environmental impact (Section 13);
ii. A person causing a point source of pollution shall treat, emit, discharge and deposit the substances which cause pollution in the environment in accord with stipulated environmental quality standards (Section 14); and
iii. 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 of the wastes in accord with environmentally sound methods (Section 15).

b. The Environmental Conservation Rules

The Ministry of Environmental Conservation and Forestry (now MONREC), in the exercise of power conferred under sub-section (a) of section 42 of the Environmental Conservation Law, issued this rule No. 50 of 2014 on the date of June 5, 2014. The most relevant clauses for this project are as follows:

i. The Ministry shall assign duty to the Department for enabling to adopt and carry out the environmental impact assessment system (Section 51);
ii. The Ministry shall determine the categories of plan, business or activity which shall carry out environmental impact assessment (Section 52);
iii. The Ministry shall scrutinize whether or not it is necessary to conduct environmental impact assessment, determine the proposed plans, businesses or activities which are not included in stipulations under Rule 52 (Section 53);
iv. The person who carries out any project, business or activity shall arrange for and carry out the conducting of the environmental impact assessment for any project, business or activity of a qualified third person or organization accepted by the Ministry (Section 56);
v. The Ministry shall form the Environmental Impact Assessment Report Review Body with experts from relevant government departments and government organizations. (Section 58);
vi. The Ministry may approve and reply to the EIA report or IEE or EMP with the guidance of the Committee (Section 61);
vii. Any person shall not emit, cause to emit, dispose, cause to dispose, pile or cause to pile, by any means, the pollutants and the hazardous waste or hazardous material stipulated by notification under the Law and any of these rules at any place which may affect the public directly or indirectly (Section 69); and
viii. Any person shall not carry out to damage the ecosystem and the natural environment which is changing due to such system, except for carrying out with the permission of the Ministry for the interest of the people (Section 69)

c. Environmental Impact Assessment Procedure

The objectives of the EIA Procedure are to provide a common framework for EIA, IEE and EMP reporting and to ensure that the reporting is in line with legal requirements, good practices and professional standards. The most relevant clauses for the project are as follows:

i. The project proponent shall submit the Project Proposal to the Ministry for Screening (Section 23);

ii. The Ministry will send the Project Proposal to the Environmental Conservation Department to determine the need for environmental assessment (Section 23);

iii. Following the preliminary screening and verification that the Project Proposal contains all required documents and related materials, subject to Articles 8, 9, 10, 11, 26 and 27 the Department shall make a determination in accordance with Annex 1 'Categorization of Economic Activities for Assessment Purposes', taking into account Article 25 and the additional factors listed in Article 28 in order to designate the Project as one of the following, and then submit it to the Ministry (Section 23);

- An EIA Type Project, or (Section 23)
- An IEE Type Project, or (Section 23)
- A Non-IEE or -EIA Type, and therefore not required to undertake any environmental assessment (Section 23)

iv. Ministry shall also make a determination whether an EMP shall be required in respect of any Project (Section 24); and

v. Within fifteen (15) working days of receiving the complete Project Proposal, the Department shall determine the type of environmental assessment (EIA, IEE, or none) which the Project will require, and the Department shall inform the Project Proponent in writing as to such determination in accordance with the Ministry guidance (Section 29)

According to categorization of economic activities for assessment purposes (which is described in Annex 1 of EIA Procedures), ports, harbours, and terminals with an area of less than 25 ha are categorized as IEE projects as shown in Table 1-2-12.

Table 1-2-12 IEE and EIA Project List for Port Projects

No.	Type of Economic Activity	Criteria for IEE Type Economic Activities	Criteria for EIA Type Economic Activities
Infrastructure and Service Development			
117	Ports, Harbours, and Terminals (ports, harbours, and terminals for cargo and passengers transfer)	Area < 25 ha	Area ≥ 25 ha

Source: Annex 1, Environmental Impact Assessment Procedure (2015)

3) Pollution Control and Occupational Health

a. National Environmental Quality (Emission) Guidelines

The objective of the guidelines is to provide the basis for regulation and control of noise and vibration, air emissions, and liquid discharges from various sources in order to prevent pollution for purposes of protection of human and ecosystem health.

According to this guideline, air emissions, 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). Guideline values for air, water and noise are shown in (7), (8), (9) of '1-2-3-1-8 Results of the Environmental Survey'.

b. Prevention of Hazard from Chemical and Related Substances Law

The objectives of the law are: (1) to protect the natural environmental resources from being damaged and being hazardous to any living beings by chemical and related substances; (2) to supervise systematically the performance of chemical and related substances business with by issuing permission from a safety point of view; (3) to systematically obtain information and to widely educate and research the use of chemicals and related substances; and (4) to perform sustainable development for occupational safety, health and environmental conservation.

c. Prevention and Control of Communicable Disease Law

The Purpose of the law is to ensure healthy working environments and to prevent communicable diseases in cooperation with relevant health departments. The most relevant clauses for this project are as follows:

i. The project owner will cooperate with the health officer;

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

iii. The project owner will promptly inform the nearest health department or hospital if the following occurs (section 9);

- mass death of birds or chickens
- mass death of mice
- occurrence of communicable disease

iv. The project owner will accept any inspection, anytime, anywhere if it is needed (Section 11).

d. Public Health Law

The purpose of the law is to ensure public health, including not only employees but also residents, and cooperation with the authorized person or organization of the health department. It is concerned with the protection of people's 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, anytime, anywhere if it is needed (Section 5).

4) Biodiversity and Natural Resource Conservation

a. Protection of Wildlife, Wild Plants and Conservation of Natural Area Law

The objectives of this law are: (1) to implement the government policy for wildlife protection; (2) to implement the government policy for natural areas conservation; (3) to carry out in accordance with the international conventions acceded by the State in respect of the protection and conservation of wildlife, ecosystems and migratory birds; and (4) to protect endangered species of wildlife and their natural habitats.

The Director General shall, with the approval of the Minister:

i. determine and declare endangered species of wild animal which are to be protected according to the following categories:
   - completely protected species of wild animals;
   - normally protected species of wild animals; and
   - seasonally protected species of wild animals;

ii. determine and declare the endangered species of wild plants and the natural habitats thereof and lay down and carry out measures for the preservation of protected wildlife species.

b. Fresh Water Fisheries Law

The objectives of the law are: (1) to further develop the fisheries; (2) to prevent the extinction of fish: (3) to safeguard and prevent destruction of freshwater fisheries waters; (4) to obtain duties and fees payable to the State; and (5) to manage the fisheries and to take action in accordance with the Law.

c. Underground Water Act

The Underground Water Act, enacted on June 21, 1930, aims to conserve and protect underground sources of water supply. This act prohibits sinking of a tube for the purpose of obtaining underground water except under and in accordance with the terms of a license granted by the water officer. The Township Officer or sub-divisional officer has power to close a licensed tube after exercising jurisdiction over the local area concerned and the expense of such closure shall be recoverable from the owner of the tube.

5) Land Acquisition and Resettlement

a. National Land Use Policy

The objectives of the policy are: (1) to promote sustainable land use management and protection of cultural heritage areas, environment, and natural resources in the interest of all people in the country; (2) to strengthen land tenure security for the livelihood improvement and food security of all people in both urban and rural areas of the country; (3) to recognize and protect customary land tenure rights and procedures of the ethnic nationalities; (4) to develop transparent, fair, affordable and independent dispute resolution mechanisms in accordance with the rule of law; (5) to promote people-centred development in land resources and accountable land use administration in order to support the equitable economic

development of the country; and (6) to develop a National Land Law in order to implement the above objectives of the National Land Use Policy.

b. Farmland Law

The most important clauses within Farmland Law are as follows:

i. Notwithstanding any provision contained in any other existing law, the Central Farmland Management Body must be coordinated for suitable compensation and indemnity in the case of repossession of farmland either in the interest of the State or in the interest of the public. Confiscated farms are to be compensated without any loss. If farm is upgraded with building, it is required to compensate for such building (section 26);
ii. Farmers have the rights to sell, pawn, lease, exchange, or donate, in whole or in part, for farming in accordance with prescribed disciplines (Section 9a,b); and
iii. The above does not apply to alluvial land (Section 10)

c. Farmland Rules

According to Farmland Rules:

i. If the farmland is requisitioned under farmland law for the interest of the state or public grievance, compensation shall be provided without delay (Section 64); and
ii. 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 (Section 67):

<Grievance for Crops and Buildings>

- Three times the local current market price based on the yield per acre for paddy and other crops grown;
- Three times the local current market price for perennial crop currently grown; and
- Two times the local current market price for facilities and other activities aimed at improving the farmland

<Compensation for Land>

- Local current market price of the farmland 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
- In 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 farmland, 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 Stale or Public, the State or Public needs to make compensation to the farmers without delay.

d. The Land Acquisition Act

Under this law, it is stipulated that the government holds rights to take over the land, provided that compensation is made to the original land owner. No private ownership of land is permitted and all land must be leased from the Union State.

6) Port Development

a. Myanmar Port Authority Law

The objectives of the law are to enable to develop the ports and economy of the State, to enable to secure the port enterprise, to enable to transform the port enterprise to the Myanmar Port Authority which can exist independently and to enable to allow both local and foreign investors by complying with the rules and regulations according to the market economy of the State.

b. Conservation of Water Resources and River Law

The objectives of the law are to conserve and protect water resources and river systems for beneficial utilization by the public; to realize smooth and safe waterway navigation along rivers and creeks; to contribute to the development of the State economy through improving water resources and the river systems; and to reduce environmental impact.
The powers of the Directorate are as follows (Section 6):

i. granting permission after examining the application for permission to carry out the construction of switchback, dockyard, wet dockyard and water-tight dockyard, building of jetty and landing stage and vessel landing by drainage in the river-creek boundary, bank boundary and waterfront boundary (Section 6a);
ii. issuing recommendation to relevant government department and organizations in respect of application for construction of buildings and bridges in the river-creek boundary, bank boundary and waterfront boundary (Section 6c); and
iii. choosing site in the river for the inland vessels to dock, demarcating of port boundary, and opening and closing thereof (Section 6f).

c. Conservation of Water Resources and River Rules

According to the rule, 'jetty area' means jetty area boundary up to 150 feet inland from the bank, the highest river level during highest tide or highest water level at the time of river water rising if there was no specific notification from the Ministry of Transport (now MOTC) to berth vessels for passengers to embark and disembark and cargoes to be loaded and unloaded (Section 2d).
The Directorate of Water Resources and Improvement of River Systems have the authority required under the guidance of the Ministry of Transport (now MOTC) with regards to land area attained due to river extension and earth filling according to the requirement of the conservation of water resources and river creek related to river area, bank area, waterfront area and port area (Section 5f).

d. The Ports Act

In this Act, unless there is anything repugnant in the subject or context - Section (3):

i. 'Port' includes also any part of a river or channel in which this act is, for the time being, in force - Section 3 (4);
ii. The President of the Union may, in addition to any rules which may be in force at the time, make such rules, consistent with this act, as he thinks necessary for any of the following purposes, namely (Section 6):

- regulating vessels whilst taking in or discharging passengers, ballast or cargo, or any particular kind of cargo, in any port, and the stations to be occupied by

vessels whilst so engaged (Section 6e) and regulating the manner in which oil or water mixed with oil shall be discharged in any port and for the disposal of the same (Section 6e);

- prevention of danger to public health by the introduction and spread of any infectious or contagious disease from vessels arriving at, or being in, any such port, and for the prevention of the conveyance of infection or contagion by means of any vessel sailing from any such port, and in particular, and without prejudice to, the generality of this provision (Section 6p).

Section 21 also states that no ballast or rubbish, and no other thing likely to form a bank or shoal or to be detrimental to navigation, shall, without lawful excuse, be cast or thrown into any such port or into or upon any place on shore from which the same is liable to be washed into any such port, either by ordinary or high tides, or by storms or land-floods, and no oil or water mixed with oil shall be discharged in or into any such port, to which any rules made under clause (ee) of sub-section (l) of Section 6 apply, otherwise than in accordance with such rules (Section 21-1).

7) Urban Development and Management

a. Development Committee Law

'Development Committee' means an organization formed to carry out development works within the specified bounds and limits 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. Duties and functions include, among others:

i. carrying out works for disposal of sewage;
ii. carrying out precautionary measures against fire, flood, storm and natural disaster;
iii. administration of slow-moving vehicles;
iv. construction and maintenance of roads and bridges;
v. demolition of squatter buildings;
vi. executing other development works in the public interest; and
vii. carrying out other duties assigned by the regional government from time to time, etc.

b. The City of Mandalay Development Law

According to the City of Mandalay Development Law, whoever violates or fails to abide by the prohibitions, relevant provisions, rules, regulations, procedures, orders and instructions issued under this law shall, on conviction, be punished by the following actions (Section 112):

i. confiscation of the things related to the crime by the Committee or punishment with a fine of 10,000 kyats, which may extend to 50,000 kyats; and

ii. warning to awaiting business for a limited period of time and imposition of penalties on the person who obtained a license, permit or who have been registered.

8) Others

a. Myanmar Fire Services Law

The objectives of the Myanmar Fire Force Law are:

i. to take precautionary and preventive measures against loss of state-owned property, private property, cultural heritage and the lives and property of the public due to fire and other natural disasters;
ii. to organize the fire brigade systemically and to train the fire brigade;
iii. to prevent fires and to conduct release work when fire disaster, natural disaster, epidemic disease or any kind of certain danger occurs;
iv. to educate and organize extensively so as to achieve public cooperation; and
v. to participate in national security, peace for the citizens and law and order.

The relevant government department or organization shall, for the purpose of precaution and prevention, obtain the approval of the Fire Force Department before granting permission for the following cases:

i. constructing buildings, markets, and condominium buildings of three-storeys and above;
ii. operating hotel, motel or guest house enterprise;
iii. constructing factory, workshop, storage facilities or warehouse;
iv. operating business exposed to fire hazard by using flammable materials or explosive materials;
v. producing and selling fire-extinguishing apparatuses; and
vi. doing transport business, public utility vehicles train, airplane, helicopter, vessel, ship, etc.

(3) International Binding Commitments

There are a number of conventions and treaties to which Myanmar is a signatory, as shown in Table 1-2-11. 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 Myanma and Japanese governments. 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 1-2-13 below presents a comparison between the policies of Myanmar legislations including the EIA Procedure (2015) and the principles of the JICA Environmental Guidelines with relation to environmental and social considerations.

Since the project is classified as ‘Category B’ in accordance with the JICA Environmental Guidelines and the World Bank’s Safeguard Policy OP 4.12, an abbreviated resettlement action plan (ARAP) will be prepared. An ARAP will involve, and include the results of, a census survey, a demographic and socio-economic survey, a lost asset inventory survey, and computation of costs and budget for compensation and other support.

Table 1-2-13 omparison between Myanmar Legislations and JICA Environmental Guidelines (EIA)

No.	JICA Environmental Guidelines	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
1	Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan. (JICA Environmental Guidelines)	EIA Procedure (2015: Article 23) requires project proponents to carry out an IEE, EIA or neither of them at the planning stage depending on the results of screening carried out by ECD/MONREC. For EIA projects, analysis of project alternatives and formulation of mitigation measures are required. For IEE type projects, mitigation measures are required.	Comparison of project alternatives is not a requirement by law for IEE projects in Myanmar.	While it is an IEE-type project, project alternatives have been compared and analysed under this project.
2	EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them	EIA Procedure (2015) requires the IEE report, scoping report and EIA report to be prepared in either English or Burmese with an executive summary written in Burmese.	There is no difference in principle.	The IEE report has been prepared in English with an executive summary written in both English and Burmese.
3	EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted.	EIA Procedure (2015) requires project proponents to disclose to civil society, PAPs, local communities and other concerned stakeholders the IEE report and EIA report no later than fifteen days after submission of them to ECD by: (i) posting on project proponent's website(s); (ii) means of local (for IEE) or national (for EIA) media (i.e. newspapers); (iii) posting at public meeting places (e.g. libraries, community halls); and (iv) posting at the offices of the project proponent.	There is no difference in principle.	DWIR has made the IEE report available to interested parties and the general public within 15 days of its submission to ECD/MONREC at: DWIR headquarters in Yangon; its branch office in Mandalay; and Amarapura Township General Administration Department (GAD) Office in Mandalay. In addition, DWIR plans to make it available on its webpage but this has not been completed yet due to resignation of an IT person in August, 2017.

No.	JICA Environmental Guidelines	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
4	Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which they are planned. For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans.	EIA Procedure (2015) requires both IEE projects and EIA projects to: a) immediately upon commencement of the IEE (or at the scoping stage for EIA projects), disclose relevant information about the proposed project to the public and civil society through the project or project proponent's website (s) and local media, including by means of the prominent posting of legible sign boards at the project site which are visible to the public, and comply with technical guidelines issued by MONREC; and b) arrange the required complement of consultation meetings as advised by MONREC with local communities, potential PAPs, local authorities, community based organizations, and civil society, and provide appropriate and timely explanations in press conferences and media interviews. In addition, a separate information disclosure process is required for EIA projects at the EIA investigation stage.	There is no difference in principle.	A notification in both English and Burmese was put up at the township and ward GAD offices and related department offices and DWIR's webpage (http://dwir.gov.mm/index.php/news-events/advertisement) in June, 2017 upon commencement of the IEE. In addition, a stakeholder meeting was carried out and participants views' reflected to *inter alia* finalizing the impact evaluation, environmental mitigation measures including means of compensation, and environmental monitoring plans.
5	In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared		There is no difference in principle but EIA Procedure (2015) does not specifically require to keep a record of the meetings with stakeholders.	A stakeholder meeting was carried out on June 27, 2017 and a record of the meeting has been prepared and presented in this report.
6	Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared	EIA Procedure (2015) requires public consultation meetings to be held for both IEE and EIA projects. For the latter it requires this for both scoping stage and EIA investigation stage.	There is no difference in principle.	The project has been categorized to be an IEE Type Project under EIA Procedure (2015) and Category B under JICA Environmental Guidelines. Accordingly, a stakeholder meeting was held once.

No.	JICA Environmental Guidelines	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
7	The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. (JICA Environmental Guidelines)	Environmental impacts are defined under EIA Procedure (2015) to include occupational, social, cultural, socio-economic, public and community health, and safety issues. Moreover, social impacts include involuntary resettlement and those relating to indigenous people. It is also stipulated under Section 63 of EIA Procedure (2015) that management and monitoring sub-plans shall address and satisfy all relevant environmental and social management and monitoring issues such as but not limited to noise, vibrations, waste, hazardous waste, wastewater and storm water, air quality, odor, chemicals, water quality, erosion and sedimentation, biodiversity, occupational and community health and safety, cultural heritage, employment and training, and emergency response.	EIA Procedure (2015) does not cover all the items stipulated under JICA Environmental Guidelines.	Environmental impact assessment has been carried out under this project using a matrix that covers all items stipulated under JICA Environmental Guidelines.
8	In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project.	It is stipulated under EIA Procedure (2015: Section 2) that impacts can be direct or indirect, cumulative, and positive or adverse or both. Section 56 states that EIA investigation shall identify and assess all adverse impacts, risks, cumulative and residual impacts and requires an EIA investigation to cover all phases of the project, including: pre-construction, construction, operation, decommissioning, closure, and post-closure.	While it does not mention impacts that come from inseparable projects, there is no difference in principle.	Analysis of project impact covered direct, derivative, secondary, and cumulative impacts to the extent practical for pre-construction, construction and O&M phases.

No.	JICA Environmental Guidelines	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
9	Project proponents, etc., should make efforts to make the results of the monitoring process available to local project stakeholders.	EIA Procedure (2015: Section 110) states that within ten days of completing a monitoring report, the project proponent shall make such report publicly available on the project's website, at public meeting places (e.g. libraries, community halls) and at the project offices.	There is no difference in principle.	The project will follow EIA Procedure (2015).
10	When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on procedures to be adopted with a view to resolving problems.	There is no legislation in Myanmar.	There is no legislation in Myanmar except for the Land Acquisition Act (1894) which stipulates the process of appealing to the court in case the PAPs are dissatisfied with the compensation provided against their lost land.	A grievance redress mechanism will be established under this project utilizing the existing administrative mechanisms.
11	Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests.	The Forest Law (1992) defines reserved forest and protected public forest and stipulates the activities that are prohibited in these forests. The Protection of Wildlife, Wild Plants and Conservation of Natural Area Law (2016) categorizes natural areas to be either: (a) scientific reserve; (b) national park; (c) marine national park; (d) nature reserve; (e) wildlife sanctuary; (f) geo-physically significant reserve; or (g) other nature reserve and similarly stipulates the activities that are prohibited in these areas.	While the laws are not written in the framework of project development, there is no difference in principle.	The project will follow the laws and regulations in Myanmar. *There is no ecologically-important wildlife reserve or forest located at or near the project site and hence such impact is not expected.
12	Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses.	EIA Procedure (2015) covers impact on indigenous people but does not request further actions.	There is no law or regulation in Myanmar that requires avoiding, minimizing or compensating for impacts on indigenous people.	The project pays particular attention to vulnerable groups including indigenous people. But no particular vulnerable groups that require special support have been identified in this project.

Source: JICA Study Team

(4) Institutional Framework related to Environmental Conservation

Environmental management of the project requires involvement of various actors. Each of these players has different roles and responsibilities to fulfill. Among them, DWIR, the project proponent, under MOTC, has a particularly important role and responsibility. In addition, the Mandalay Region Government and associated government agencies have indispensable roles to play to ensure sound communication with the PAPs and local community, thereby ensuring smooth implementation of the project. Major actors and their roles and responsibilities for the project are explained below.

1) Directorate of Water Resources and Improvement of River Systems

DWIR is the project proponent and leading body with the responsibility to soundly execute the project. The organization carries overall responsibility for managing any adverse social and environmental impacts that are generated from the project. It will carry out such activities directly or in cooperation with other government or non-governmental bodies (e.g. MOTC, Mandalay Region Government, GAD, Department of Settlement and Land Management and Statistics, and appointed consultants and contractors).

2) Ministry of Transport and Communications

MOTC serves as the supervising organization of DWIR. It is the organization that bridges DWIR and other ministries such as MONREC. The budget for compensation of the project also needs to be requested from the union government via MOTC. It is therefore important that DWIR and MOTC work in close communication and coordination, particularly for matters related to land acquisition and compensation, which requires cooperation among various concerned bodies and people.

3) Line Agencies

The district administrator, township administrator of GAD as well as ECD will cooperate with, and/or provide advice or instructions to, DWIR so that the project is well managed and carried out in a sound and balanced manner. Other line agencies such as MCDC and DALMS will also coordinate with DWIR.

4) Contractor

The Contractor will be selected by DWIR to perform the construction works. In the implementation stage of the project, environmental protection measures will be taken by the contractor under the instruction of DWIR through the engineer/consultant (if such engineer/consultant is appointed) and based on the EMP and environmental monitoring plan, which are stipulated in '1-2-3-2-1 Environmental Mitigation Measures and Cost' and '1-2-3-2-2 Environmental Monitoring Plan' of this report.

1-2-3-1-5 Comparison of Project Alternatives

Project alternatives were compared with each other in different stages of the project. During the 2014 JICA F/S, three different locations were compared against each other, and the conclusion was reached that the current location was most suitable. In the current preparatory survey, a comparison was made in terms of the jetty structure and access road design. With regards to the structure of the jetty, a floating type jetty was compared with a fixed type jetty. With regards to road design, an option of using the existing road in addition to a new road was compared against an option of developing and using only a new road. As a conclusion, fixed type jetty with developing a new road (i.e. not using the existing road) was considered most preferable. In addition, the 'no-project' option was also analysed.

Each option included an analysis made during the 2014 JICA F/S and the results of the comparison are described below.

(1) 'No-project' Option

The 'No-project' option means that the proposed project would not be implemented. While maintaining the status quo allows avoiding some negative impacts, it does not address the core issue of meeting the growing demand for cargo, which is the reason this project is considered necessary, and hence is considered not preferable. The advantages and disadvantages of the 'No-project' option are described as below.

1) Advantages

The option does not involve any additional activity and the situation remains unchanged. Environmental and social impacts related to the project, both positive and negative, will not be present. This means that such economic activities that need to be carried out before, during and after construction of the project and the adverse impacts associated with them, can be avoided. Similarly, no financial cost would be necessary for the implementation of the project.

2) Disadvantages

The demand for cargo transportation is on the rise and Mandalay, in a strategic geographical location, is expected to play a major role in meeting this demand. In the absence of the project, Mandalay will not be able to fulfill its potential, which would have detrimental effect on the local, regional and national economy. A large part of the demand for cargo comes from the people in Myanmar and hence an insufficient supply of inland water transportation to meet this demand means that the social wellbeing of the people in Myanmar will not be met. People will not be able to benefit from the expected increase in jobs or the secondary socio-economic benefits accrued from port operation either.

(2) Comparison of Project Locations (during the 2014 JICA F/S)

The following three locations were compared and evaluated during the 2014 JICA F/S. Option 3 is the current location. Option 2 is located approximately 1,400 m north of Option 3 and Option 1 is located further north by approximately 800 m. Comparing the three alternatives, Option 3 (current project area) was selected primarily in consideration of the little impact it brings to the social environment (i.e. absence of involuntary resettlement). In addition, Option 3 was considered in best harmony with the city plan of Mandalay and more preferable as it has sufficient land for future development and expansion of the port. Each option and the results of the comparison carried out in the 2014 JICA F/S is summarized below.

Source: JICA F/S Team based on Google Earth

Figure 1-2-31 Locations of Candidate Sites Compared in the 2014 JICA F/S

Table 1-2-14 Results of Comparison based on Location (during the 2014 JICA F/S)

	Option 1	Option 2	Option 3
Pollution (e.g. water contamination, air pollution and noise)	**5** Level of pollution is expected to be small.	**5** Level of pollution is expected to be small.	**5** Level of pollution is expected to be small.
Natural Environment	**5** Reclamation will have very little influence on the river flow because the river flows close to the reclamation yard and the riverside topographical shape will not change much.	**5** Reclamation will have very little influence on the river flow because the river flows close to the reclamation yard and the riverside topographical shape will not change much.	**3** The area is flooded every year. It is foreseen that some sedimentation downstream of the reclamation site may occur because the reclamation land will block the river flow at the location.
Social Environment	**2** Number of households found: 61	**2** Number of households found: 70	**5** Number of households found: 0
Total	**12**	**12**	**13**

*1: least preferable; 5: most preferable

Source: JICA F/S Team

1) Option 1

Option 1 is located near downtown. The opposite side of the road was congested by residential and commercial areas. Also notable was the number of residents residing on the river bank. Therefore, the direct impact affecting people, such as pollution and traffic disturbance, was considered to be relatively high.

The most critical environmental concern was related to illegal occupation of the riverbank, where many residents have been illegally residing. More than 100 households were counted as of July 2013. Even though illegal, it was considered potentially problematic as it could raise social conflict unless adequate compensation and social support for improving or maintaining their life are provided.

2) Option 2

The situation in Option 2 was considered to be similar to that in Option 1 in the 2014 JICA F/S. The most critical issue was resettlement. The area was found to be similarly occupied illegally by a notable number of residents.

3) Option 3

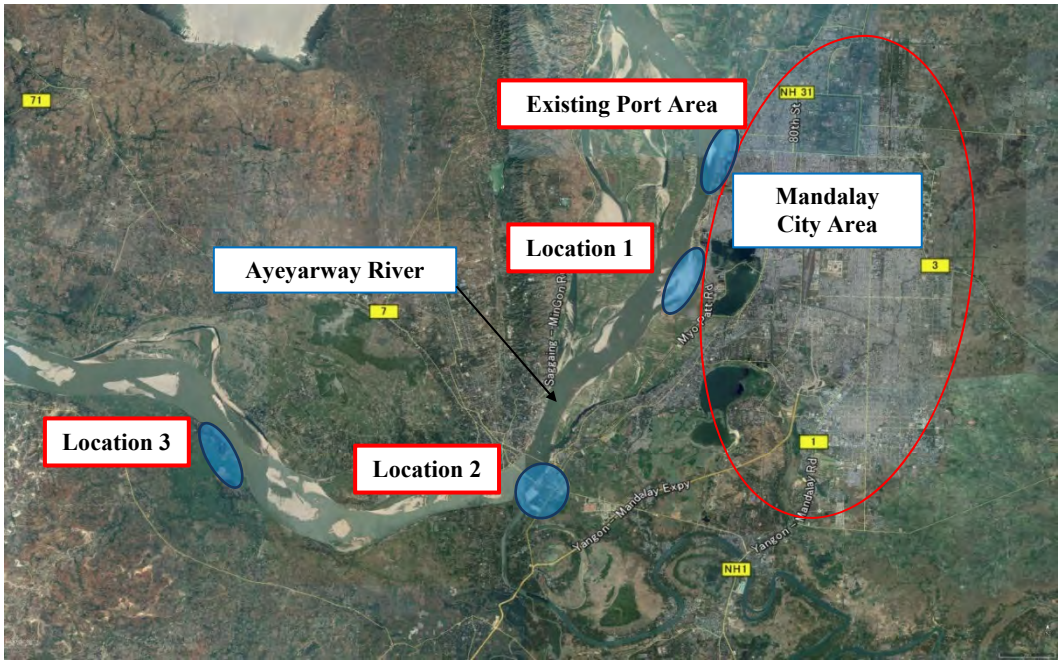
Option 3 was considered most preferable as the area was found to be mostly used only for agricultural purposes during the dry season. Since the area becomes flooded in the rainy season, no residents were to be seen. The only major impact on the people was considered to be the impact on agricultural crops. No resettlement was expected.

(3) Comparison of Project Locations (during the preparatory survey)

In this study, three candidate sites were compared. The candidate sites are as shown in Figure 1-2-32. Among them, Location 1 is Option 3, which was recommended by the 2014 JICA F/S study as mentioned above.

In this study, the sates were compared based on the results of a reconnaissance survey taking into consideration the following seven factors (i.e. natural conditions, consistency with the city development plan, natural and social environment, availability of space for future expansion, construction cost, safety for ships and barge navigation, and competitiveness against railway and road transportation).

Details of the site selections are described in 2-2-1-1-2 Selection of the Project Site.



Source: JICA Study Team based on Google Earth

Figure 1-2-32 Three Alternative Candidate Locations

(4) Comparison of Project Design

Having confirmed the location, the preparatory survey made a comparison based on more technical aspects of the project design, namely, structure of jetty and road development.

1) Comparison of Jetty Structure

With regards to jetty structure, a floating type jetty ('(A)' in Table 1-2-15 below) was compared with a fixed type jetty ('(B)' in Table 1-2-15 below). While there is little difference in terms of the social and natural environmental aspects, a fixed type jetty was considered more preferable in consideration of the following aspects.

- 40-foot containers are becoming common recently and hence the jetty should be equipped with a dock crane that can carry this type of container. By nature, a floating type jetty creates a level of movement on the quay when they carry such containers, rendering cargo handling operation more difficult, unsafe and inefficient.
- Based on an analysis of the riverbed, it has been found that the riverbed varies between -2.0 m to -6.0 m. A floating type jetty is more susceptible to damages as the floating part of the structure can hit the bottom of the river. When damaged, cargo handling must be suspended as it cannot be easily fixed.
- Maintenance of a floating type jetty is more difficult as it is composed of complex movable joints, increasing the cost for such maintenance.

2) Comparison of Road Design

Currently, a road exists south of Shwe Hlan Bo Monastery. The first option ('(a)' in Table 1-2-15 below) involves using this road as the main road during operation and also building a new road for construction. The second option ('(b)' in Table 1-2-15 below) involves not using

the existing road but building a road from the construction stage and using the same road for port operation. Developing a single road and using it during construction and operation (b) has been selected to be preferable in consideration of the following:

- The existing road, when extended under Option (a), hits part of the buildings that are planned to be developed within the project site. This disturbs the flow of traffic during construction. If a road is built further south of the existing road, on the other hand, under Option (b), the road leads into the edge of the area allowing traffic to smoothly move westward or northward.
- The existing road needs to be widened to allow construction vehicles to reach the project site under Option (a). This means additional cost for construction. This cost will not be needed in the case of developing only a new road under Option (b).
- Use of the existing road located south of Shwe Hlan Bo Monastery for transportation of construction-related vehicles, equipment, and materials under Option (a), could lead to traffic accidents with the local people and also affect the monastery by generating noise. This can be avoided under Option (b).

The layout plan for the option of using the existing road and building a new road (i.e. Option (a)) is shown in Figure 1-2-33 and that for the option of building and using only a new road (i.e. Option (b)) is shown in Figure 1-2-34.

The results of the comparison of project alternatives based on these technical aspects are shown in Table 1-2-15.

Table 1-2-15 Comparison of Project Alternatives based on Design

	Structure of Jetty		Access Road	
	(A) Floating Type	(B) Fixed Type	(a) Existing and New Road	(b) Only New Road
Technical Aspect	**2** • Less reliable for container and cargo (yet more convenient for passengers) • Difficulty in operation and maintenance (O&M)	**3** • Safe and reliable for container and cargo (yet less convenient for passenger) • Ease in O&M	**2** Inefficient traffic flow	**3** Efficient traffic flow
Cost	**2** High operation and maintenance cost	**3** Low operation and maintenance cost	**2** Higher construction cost	**3** Lower construction cost
Natural/Social Environment	**2** Little difference	**2** Little difference	**1** • Traffic accidents may occur using existing road • Existing road passes near and hence could affect Shwe Hlan Bo Monastery	**3** New road passes further south of Shwe Hlan Bo Monastery and hence will not affect the monastery
Total	6	**8**	5	**9**

*1: least preferable; 3: most preferable

Source: JICA Study Team

Source: JICA Study Team based on Google Earth

Figure 1-2-33 Layout Plan of Option (a): using existing road and new road

Source: JICA Study Team based on Google Earth

Figure 1-2-34 Layout Plan of Option (b): building and using only a new road

1-2-3-1-6 Scoping

(1) Environmental Categorization

This Project is categorized as "IEE Type Project" by MONREC through the letter dated June 2017 and in accordance with the 'Categorization of Economic Activities for Assessment Purposes' of the EIA Procedure (2015). On the other hand, the project has been categorized to be Category B by JICA according to the JICA Environmental Guidelines (2010).

(2) Scoping

Scoping has been carried out under this project in order to comprehensively evaluate a range of significant and potentially significant impacts, and to formulate the study methods to be adopted for the IEE investigation. The potential impacts have been evaluated against the following three stages: pre-construction, construction, and operation.
In fact, scoping is not required by the laws in Myanmar for IEE Type Projects. Nevertheless, it is necessary under JICA projects and hence scoping was carried out under this project. The result of scoping is presented in a scoping matrix, which is commonly used in JICA projects, in Table 1-2-16 below.

Table 1-2-16 Scoping Matrix

Category	No.	Environmental Item	Stage			Reason for Initial Evaluation
			P	C	O	
Pollution and Nuisance	1	Air Pollution	D	B-	B-	C: The operation of construction machinery and trucks can cause temporary air pollution. O: Minor level of air quality degradation is expected during port operation.
	2	Water Pollution	D	B-	B-	C: Turbid water and wastewater from offshore and civil works may flow into the river and deteriorate the river water quality. Contamination from oil, fuel and chemical leaks/spills, dust and runoff from waste can also take place. O: River water quality can deteriorate as a result of wastewater from washing cargoes, oil spill, garbage discharge and wastewater from ships and port facilities.
	3	Soil Pollution	D	C	D	C: Soil pollution may take place if a large amount of oil and other substances are used and spilled into the soil out of the construction site without proper treatment.
	4	Waste Disposal	D	B-	C	C: Waste may be generated as a result of construction activities (e.g. dredging) and operation of construction camps. However, the level of waste generation is expected to be limited in consideration of the scale of such activities. O: A level of waste may be generated from cargo handling, and ship and port facilities.
	5	Noise and Vibration	D	B-	C	C: Noise and vibration is expected to increase to some extent during construction as a result of operation of machines and equipment. O: Operation of cargo handling machinery and vehicles will generate some level of noise and vibration in the surrounding area.

Category	No.	Environmental Item	Stage			Reason for Initial Evaluation
			P	C	O	
	6	Ground Subsidence	D	D	C	O: Underground water may be used for washing containers during the operation stage potentially causing ground subsidence.
	7	Odours	D	D	D	P/C/O: There is no residential area located near the project site nor is there an activity planned to be carried out that may generate a significant level of odour. Hence the impact is considered to be negligible.
Natural Environment	8	Protected Areas	D	D	D	There is no protected area in or near the project site.
	9	Ecosystem	D	C	C	C: There is no identified ecological hotspot or other area that requires special attention in or near the project site to date. However, this will be confirmed in the IEE survey. O: Aquatic ecosystem may be affected if the water becomes largely polluted due to wastewater and other substance from ship and port facilities.
	10	Hydrology	D	D	B-	C: No significant change in the river flow is expected. O: River flow and speed may decrease to some extent under and near the jetty but no significant change is expected to the river flow.
	11	Topography and Geology	D	D	B+	O: A level of positive impact is expected due to jetty construction as it is expected to mildly reduce the river flow, which can in turn reduce river bank erosion.
	12	Bottom Sediment	D	B-	B-	C: Construction work and dredging can disturb bottom sediments and induce re-suspension, dispersal and settlement of such sediment although at a limited scale. O: Port operation can lead to accumulation of sediment in the port area in the long run, which may contain toxic substances.
Social Environment	13	Land Acquisition	B-	D	D	P: No involuntary resettlement is expected under this project. Nevertheless, land acquisition is likely to take place. Further, a limited number of crops and structures are expected to be affected.
	14	Local Economy such as Employment, Livelihood etc.	B-	B+	B+	P: As a result of land acquisition, a limited number of crops and structures are expected to be affected possibly negatively affecting the livelihood of the people that possess them. C: It is expected that port construction works will create employment opportunities. O: Creation of direct and indirect job opportunities associated with the port operation is expected.
	15	Land Use and Utilization of Natural Resources	D	C	B+	C: The project will require a limited level of land acquisition and hence bring about a level of change in the current land use status (e.g. agriculture). The extent of impact will be confirmed in the IEE survey. There will be no impact on utilization of natural resources. O: The project is expected to improve the access and land use status in the area.

Category	No.	Environmental Item	Stage			Reason for Initial Evaluation
			P	C	O	
Social Environment	16	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	D	D	P/C/O: No activity that may change social institutions and local decision-making institutions are expected.
	17	Existing Social Infrastructure and Services	D	B-	C	C/O: An increase in the number of vehicles during construction and operation may cause a level of congestion with the road nearby (e.g. Myo Patt Road).
	18	Cultural and Religious Heritages	D	D	D	P/C/O: There is only one monastery near the project site and one pagoda north of the site. No impact is expected to either of them.
	19	Landscape	D	D	D	P/C/O: The project is relatively small in scale without any structure planned to be built that may change the landscape.
	20	Ethnic Minorities and Indigenous People	D	D	D	P/C/O: No ethnic minority or indigenous people are expected in the project site or nearby.
	21	Misdistribution of Benefits and Damages	D	D	C	O: Some people and community members may benefit more than others from the project.
	22	Working Condition	D	C	C	C/O: Improper management during the construction and operation stages can lead to less than ideal working conditions.
	23	Water Use/Rights	D	D	D	Very little if not no impact is expected on water use/rights because use of a large volume of water is not expected during construction and operation.
	24	Poverty Group	D	B+	B+	C/O: Direct and indirect job opportunities are expected to benefit local people including poverty groups.
	25	Local Conflicts of Interest	D	D	D	P/C/O: No factor or situation that generates local conflict of interest is expected.
	26	Gender	D	D	D	P/C/O: No factor or situation that causes a negative impact on gender is expected.
	27	Rights of Children	D	D	D	P/C/O: No factor or situation that impacts the rights of children is expected.
	28	Transmitted Diseases such as HIV/AIDS	D	B-	C	C/O: Transmitted diseases could spread through construction workers (e.g. immigrant workers) and visitors in the absence of a health and safety program and management.
Others	29	Accidents	D	B-	B-	C: Accidents may take place in the absence of proper management. O: Accidents from operation of loading machines, moving vehicles, and water and land transportation may take place.
	30	Trans-boundary Impacts and/or Climate Change	D	D	B+	O: Modal shift of cargo transportation from truck to inland ship transportation can contribute to reduction of carbon dioxide and other greenhouse gases.

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

1-2-3-1-7 Terms of Reference of the Environmental Survey

(1) Terms of Reference of the Environmental Survey

Baseline air quality, water quality and noise level have been confirmed by field survey and laboratory analyses. On the other hand, the ARAP study, including census, lost-asset inventory and social-economic surveys, will provide useful information on socio-economic baseline data of the PAPs. The detailed terms of reference of the IEE survey in draft are in Table 1-2-17 below.

Table 1-2-17 Terms of Reference of IEE Survey

No.	Item	Survey Item	Survey Method	Survey Point/Target Area
Pollution				
1	Air Pollution	Measurement of ambient air quality (NO_2, SO_2, O_3, PM_{10}, and $PM_{2.5}$)	Air quality measurement by instrument (one weekday for 24 consecutive hours)	Two locations at/near the project site
2	Water Pollution	Water quality (water temperature, salinity, BOD, COD, oil and grease, pH, total coliform, total nitrogen, total phosphorus, and total suspended solids)	Sampling and measurement by field equipment and laboratory analysis (once during the dry season and once in the rainy season)	Two locations/season (dry and rainy season) within or near the project site.
3	Soil Pollution	Soil quality	Soil quality measurement and analysis	
4	Waste Disposal	Location and methods of treatment of waste disposal sites near the project site and in Mandalay Region	Interview and/or document analysis	
5	Noise and Vibration	Noise level	Collection of past/existing noise monitoring results such as that of the 'EIA for the 2014 JICA F/S.	-
6	Ground Subsidence	State of underground water use	Interview and/or document analysis	Around and near the project site
Natural Environment				
7	Ecosystem	Flora, fauna and biodiversity	Secondary data collection on endangered and rare species on the IUCN Red List of Threatened Species with a particular focus on the aquatic fauna and flora; and interview and/or document analysis	Around and near the project site
8	Hydrology	River flow velocity	Secondary data collection	Around and near the project site
9	Bottom Sediment	Sand sediment condition	Secondary data collection	Around and near the project site

No.	Item	Survey Item	Survey Method	Survey Point/Target Area
Social Environment				
10	Involuntary Resettlement	Analysis of socio-economic condition and livelihood status	Counting and recording the number and types of all people, assets (e.g permanent and temporary houses, public and private facilities, structures and graves), crops and valuable trees in the survey area by direct observation supplemented by interviews etc. and mapping them using GPS to indicate their location; and interview survey to identify the demographic conditions.	Project affected area
11	Land Use and Utilization of Natural Resources	Analysis of land use status	Interview and secondary data collection	Around and near the project site
12	Existing Social Infrastructures and Services	Condition of existing social infrastructures and services around the project area	ditto	ditto
13	Misdistribution of Benefits and Damages	Analysis of socio-economic conditions	ditto	ditto
14	Working Conditions	Analysis of working conditions	Secondary data collection	ditto
15	Transmitted Diseases such as HIV/AIDS	Analysis of general risk of infectious diseases and community/occupational health	Ditto	Around and near the project site
Others				
16	Accidents	Analysis of accident risk and safety management	ditto	-

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

1-2-3-1-8 Results of the Environmental Survey

(1) Socio-economic Characteristics

The objective of the socio-economic survey is to collect baseline information on the socio-economic state of the project area and to supplement development of the IEE report and ARAP. The main field survey methods adopted for 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 geographical location and proximity to the project site, social strata, expected project impact on the population, and in consultation with relevant local government and DWIR. The survey consists of: census survey, lost-asset inventory survey and household income survey.

In this survey, two wards named Than Hlet Maw (West) ward in Mahaaungmyay Township and Than

Hlet Maw (South) ward in Chanmyathazi Township were selected for interviews. Both of them are situated along Myo Patt Road and the Ayeyarwady River near the project area. Administratively, the two wards belong to Mahaaungmyay Township and Chanmyathazi Township, respectively, in Mandalay Region.

Through ward profile survey results, the survey team received data on the total number of households, the number of households by each area in the wards and selected the area along Myo Patt Road in consideration of their proximity to the project site and expected flow of movement. Before carrying out the household survey, the team developed a rough idea of the population by discussing with the General Administration Department (GAD) offices at the ward level. With help from the local informants, the team then randomly selected a calculated number of households from each ward and carried out household interviews. A total number of 137 households, or 15% of the total population of 926 households from the two wards, were selected. The total population of the two townships and selected wards are shown in Table 1-2-18 and Table 1-2-19.

Table 1-2-18 Population and Households in Mahaaungmyay Township and Chanmyathazi Township

No	Townships	Household		Population (person)		
		No. of Houses	No. of Households	Male	Female	Total
1.	Mahaaungmyay	32,691	39,160	88,781	101,281	190,062
2.	Chanmyathazi	35,923	38,520	100,128	114,689	214,817

Source: Township General Administration Department, January 2017

Table 1-2-19 Population and Households of Selected Wards

No	Townships	Ward	Households		Population (persons)		
			No. of Houses	No. of Households	Male	Female	Total
1.	Mahaaungmyay	Than Hlet Maw (West)	4,268	5,399	11,967	13,133	25,100
2.	Chanmyathazi	Than Hlet Maw (South)	2,982	3,112	7,533	8,550	16,083

Source: Township General Administration Department, January 2017

It should be noted that the Township and Ward GAD Officers did not allow surveying of the illegal occupants staying along Myo Patt Road[4]. The main reasons were that the survey: 1) might raise expectations among the people for compensation; and 2) might lead to an influx of them and other illegal occupants into the project area making it extremely difficult to manage. DWIR also had the same opinion as the GAD officers and hence the surveying of these illegal occupants staying along Myo Patt Road could not be carried out.

According to the GAD officer from Mahaaungmyay Township and wards administrative officer, there are 200-300 households of illegal occupants along Myo Patt Road within Mahaaungmyay Township and Chanmyathazi Township.

[4] These are the people who have been illegally living in the area along Myo Patt Road towards the river bed.

(2) Demographic Profile

1) Gender Distribution

A total of 137 respondents were interviewed. The size of the household population was 700, out of which 51 percent were male and 49 percent female. Gender distribution of the household population is shown in Table 1-2-20.

Table 1-2-20 Gender Distribution of Household Population

Gender	Frequency (%)
Male	354 (51%)
Female	346 (49%)
Total	700 (100%)

Source: JICA Study Team

2) Age Distribution

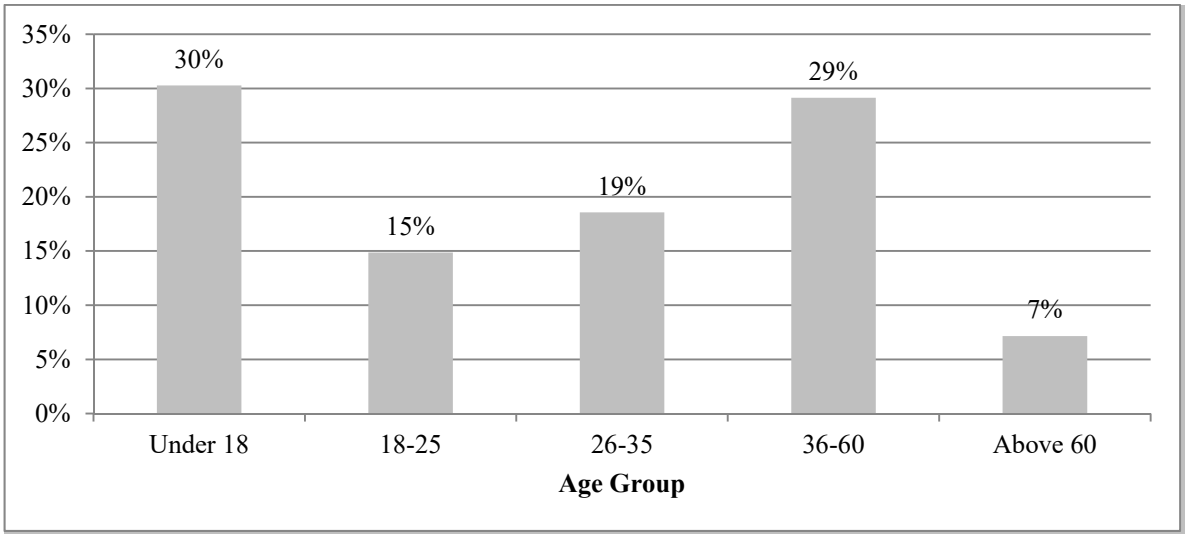
The age of respondents ranged from under 18 years old to over 60 years old. The age range was classified into the following five categories: under 18, 18-25 years old, 26-35 years old, 36-60 years old, and above 60 years old, as shown in Table 1-2-21.

The majority of the population were in the groups of 'under 18 years old' (30% of the population) and '36-60 years old' (29% of the population). 19% of the population belongs to the age group of '26-35 years old' and 15% of the population belongs to the group of '18-25 years old'. The population that fell under the age group of 'above 60 years old' was 7%. The age group distribution of each group is shown in Figure 1-2-35.

Table 1-2-21 Age Distribution of Household Population

Age	Frequency (%)
Under 18	212 (30%)
18-25	104 (15%)
26-35	130 (19%)
36-60	204 (29%)
Above 60	50 (7%)
Total	700 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-35 Age Distribution of Household Population

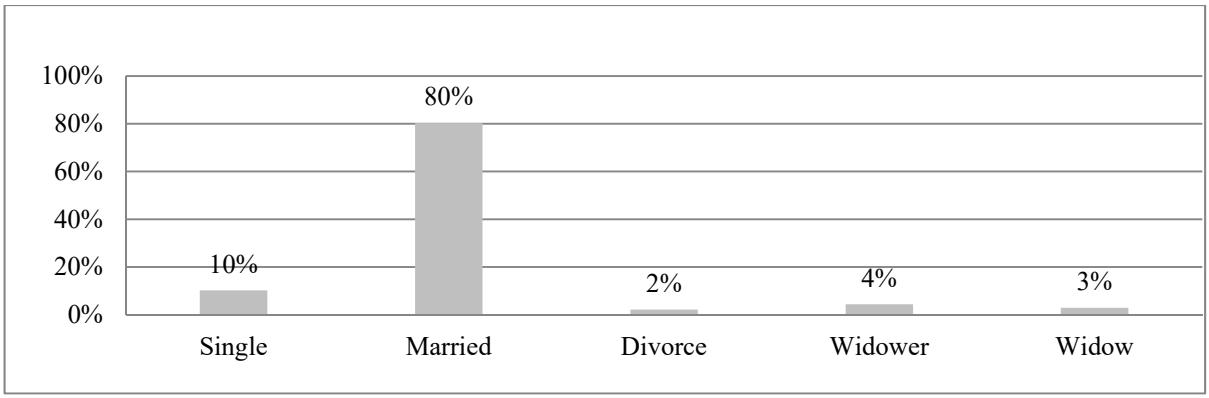
3) Marital Status

Table 1-2-22 and Figure 1-2-36 show the distribution of respondents by marital status. 80% of the respondents were married. The number of respondents that answered single was 10%. 2% of the respondents had divorced and 4% and 3% were widower and widow, respectively.

Table 1-2-22 Marital Statuses of Respondents

Marital Status	Frequency (%)
Married	110 (80%)
Single	14 (10%)
Widower	6 (4%)
Widow	4 (3%)
Divorced	3 (2%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-36 Marital Statuses of Respondents

4) Religion

Table 1-2-23 below provides information on respondents' religions. The majority (98%) of the respondents have been found to be Buddhist.

Table 1-2-23 Religions of Respondents

Religion	Frequency (%)
Buddhism	134 (98%)
Christian	1 (1%)
Hindu	1 (1%)
Muslim	1 (1%)
Total	137 (100%)

Source: JICA Study Team

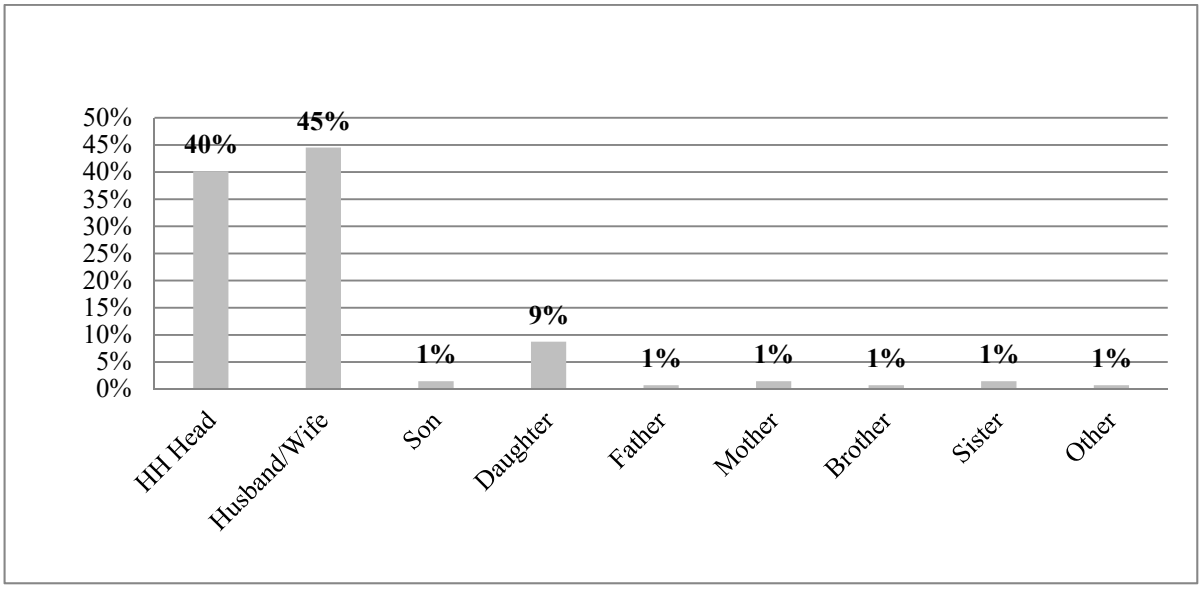
5) Relation to Household Head

45% of the respondents were either the husband or wife of household head and 40% were the household head. 9% were daughter. Respondents' relations to household head is shown in Table 1-2-24 and Figure 1-2-37.

Table 1-2-24 Respondents' Relations to Household Heads

Relation to Household head	Frequency (%)
Husband/Wife	61 (45%)
Household head	55 (40%)
Daughter	12 (9%)
Mother	2 (1%)
Sister	2 (1%)
Son	2 (1%)
Father	1 (1%)
Brother	1 (1%)
Other	1 (1%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-37 Respondents' Relations to Household Head

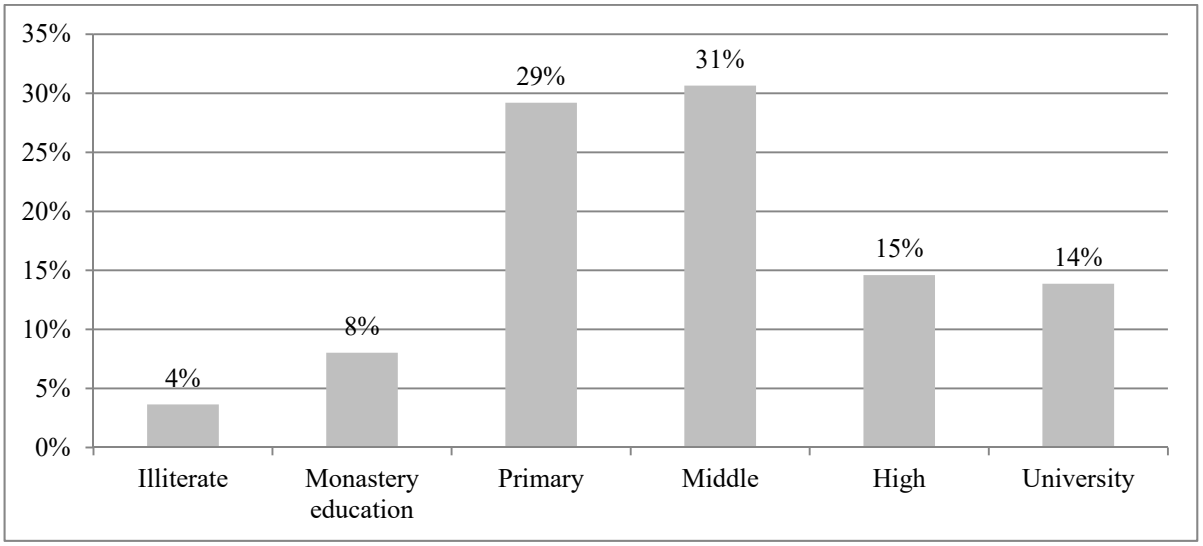
(3) Educational Statuses

According to the survey, more than 88 % of the respondents were found to have at least primary education with 14 % completing tertiary education. 4% of respondents were illiterate. Table 1-2-25 and Figure 1-2-38 show the educational statuses of the respondents.

Table 1-2-25 Educational Statuses of Respondents

Education	Frequency (%)
Illiterate	5 (4%)
Monastery Education	11 (8%)
Primary	40 (29%)
Middle	42 (31%)
High	20 (15%)
University	19 (14%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-38 Educational Statuses of Respondents

(4) Economic Statuses

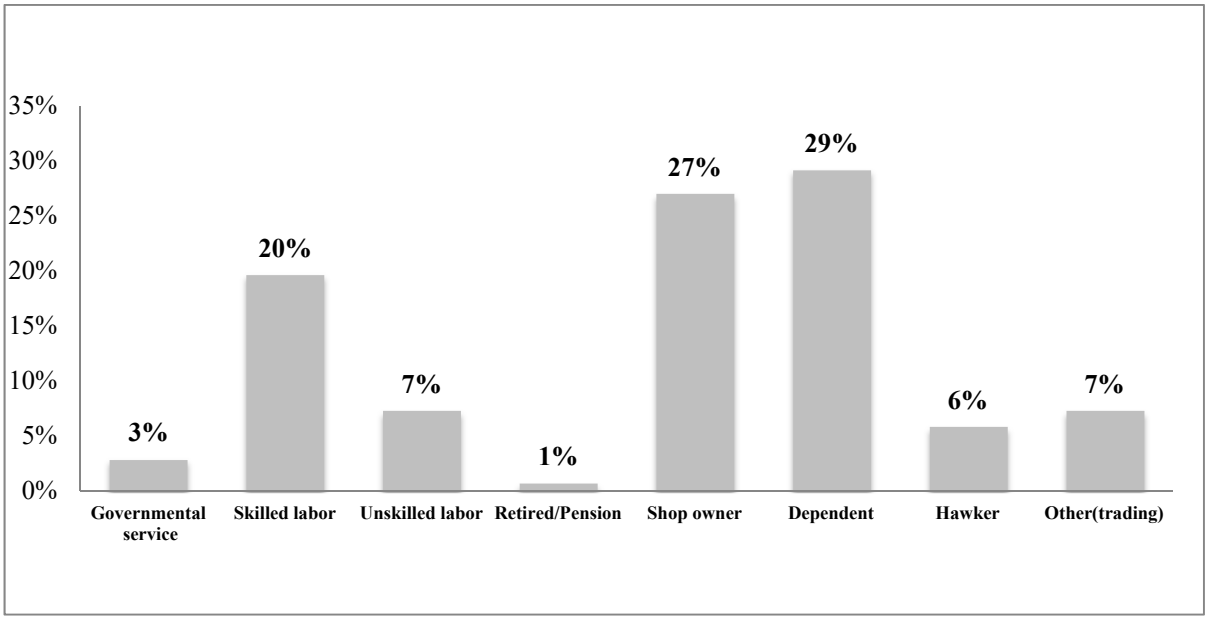
1) Occupations

Table 1-2-26 and Figure 1-2-39 show the occupations of respondents. Approximately 70% were employed and 30% unemployed. The most common occupation was shop owner (27%) and the second most common occupation was skilled labour (20%). Only 1% of the respondents were found to be retired.

Table 1-2-26 Occupations of Respondents

Type of Occupation	Frequency (%)
Shop Owner	37 (27%)
Skilled Labour	27 (20%)
Unskilled Labour	10 (7%)
Hawker	8 (6%)
Government Staff	4 (3%)
Other Job (e.g. Trading)	10 (7%)
Pension	1 (1%)
Dependent	40 (29%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-39 Occupations of Respondents

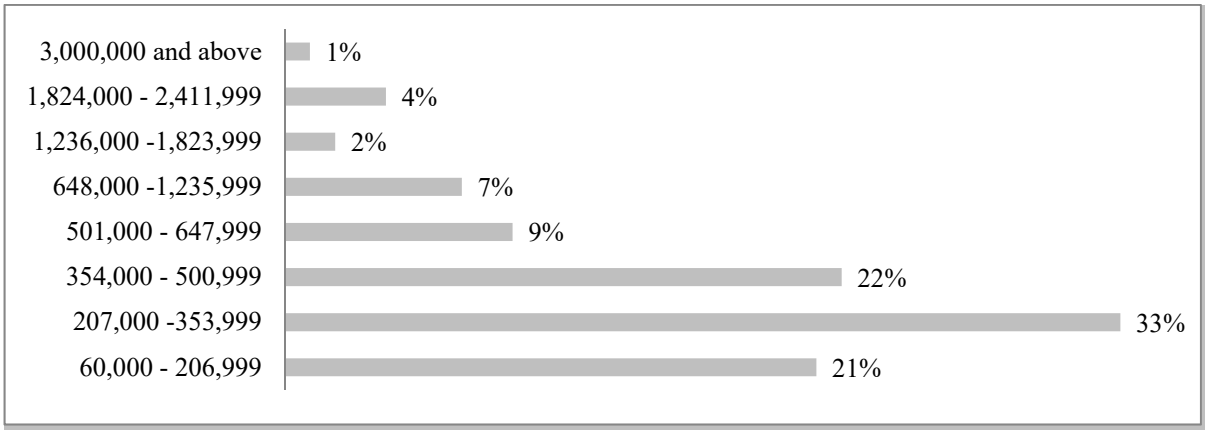
2) Household Incomes

The largest number of respondents, or 33% of the population, had an income level of 207,000–353,999 kyats. The second and third largest groups had earnings of 354,000–500,000 kyats (22%) and 60,000–206,999 kyats (21%). Respondents' monthly household incomes are shown in Table 1-2-27 and Figure 1-2-40.

Table 1-2-27 Monthly Total Household Incomes

Monthly Income Range (MMK)	Frequency (%)	
60,000 - 206,999	29	(21%)
207,000 - 353,999	45	(33%)
354,000 - 500,999	30	(22%)
501,000 - 647,999	12	(9%)
648,000 - 1,235,999	10	(7%)
1,236,000 - 1,823,999	3	(2%)
1,824,000 - 2,411,999	5	(4%)
3,000,000 and above	2	(1%)
Total	136	(100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-40 Distribution of Monthly Total Household Incomes

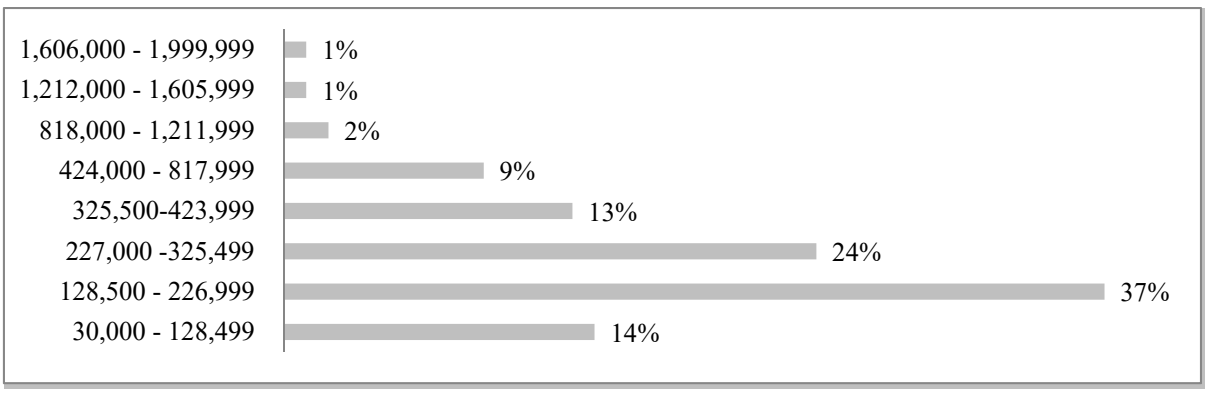
3) Household Expenditures

With regards to household expenditures, the group with the largest number of respondents was between 128,500–226,999 kyats (37%). The results of the monthly total household expenditures of respondents are classified as shown in Table 1-2-28 and Figure 1-2-41.

Table 1-2-28 Monthly Total Household Expenditures

Monthly Expenditures Range (MMK)	Frequency (%)
30,000 - 128,499	19 (14%)
128,500 - 226,999	50 (37%)
227,000 - 325,499	32 (24%)
325,500 - 423,999	17 (13%)
424,000 - 817,999	12 (9%)
818,000 - 1,211,999	3 (2%)
1,212,000 - 1,605,999	1 (1%)
1,606,000 - 1,999,999	1 (1%)
2,000,000 and Above	1 (1%)
Total	136 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-41 Distribution of Monthly Total Household Expenditures

4) Fishing Activities

Only 1% of the respondents' households were engaged in fishing activities in the last 12 months. The purpose was for domestic consumption. The majority, or 99% of the respondents, had not fished during the same period. Table 1-2-29 shows fishing activities that were or were not carried out in the last 12 months.

Table 1-2-29 Fishing Activities in the Last 12 Months

Fishing Activities	Frequency (%)
Yes	1 (1%)
No	136 (99%)
Total	137 (100%)

Source: JICA Study Team

(5) Land, House and Assets

1) Ownership of Residential Land

Most of the households (78%) own land by purchasing them while 18% of people's land was awarded with a grant. Only a few of them, or 4%, own the land by permit, which is a type of land given by the government to some civil servants. Table 1-2-30 shows the types of land ownership of the respondents.

Table 1-2-30 Types of Land Ownership of Respondents

Type of Land Ownership	Frequency (%)
Contract	107 (78%)
Grant	24 (18%)
Permit	6 (4%)
Total	137 (100%)

Source: JICA Study Team

2) Ownership of Agricultural Land

Regarding respondents' land, a majority of respondents, or 97% of the respondents, was not in ownership of any agricultural land. Table 1-2-31 shows the state of ownership of agricultural land.

Table 1-2-31 Ownership of Agricultural Land

Land in Possession	Frequency (%)
Yes	4 (3%)
No	133 (97%)
Total	137 (100%)

Source: JICA Study Team

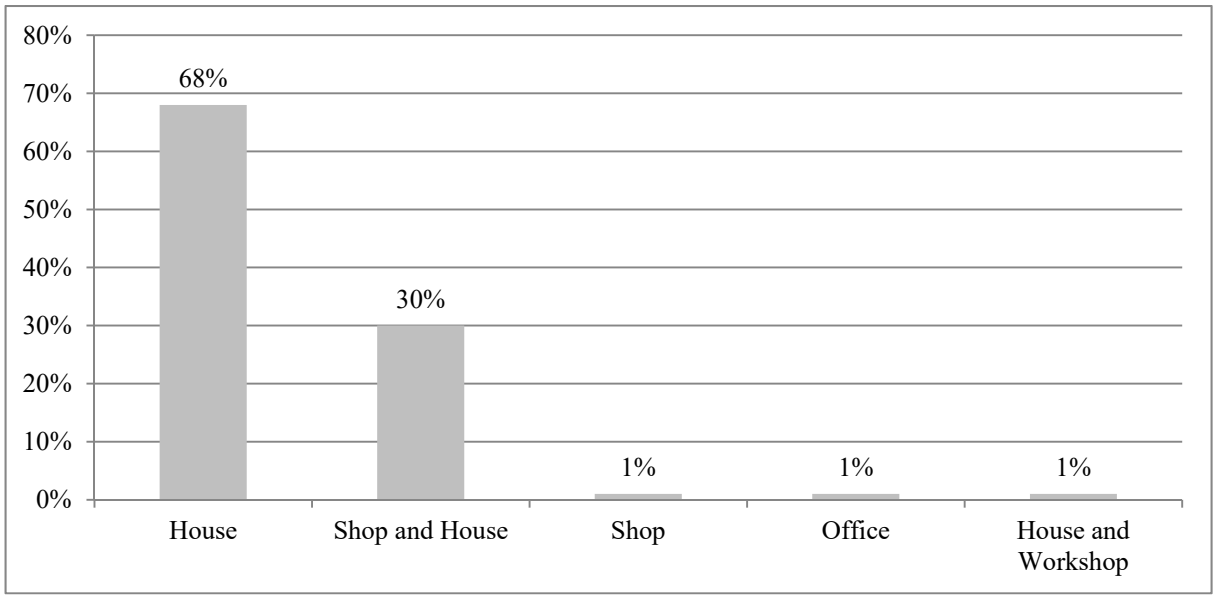
3) Houses and Buildings in Possession

Table 1-2-32 and Figure 1-2-42 show the types of houses and other buildings of the respondents. 68% of the respondents possess only a house and 30% had a shop in addition to the house.

Table 1-2-32 Types of Buildings in Possession

Type of Buildings	Frequency (%)
House Only	93 (68%)
Shop and House	41 (30%)
Shop Only	1 (1%)
Office Only	1 (1%)
House and Workshop	1 (1%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-42 Types of Buildings in Possession

4) Ownership over Residence

Table 1-2-33 shows the state of respondents' ownership over their residences. Most of the respondents, or 84% of them, own a house. 15% rent houses from others and 1% have been provided the house by their employer.

Table 1-2-33 Types of Ownership over Residences

Ownership Status of Residence	Frequency (%)
Owner	115 (84%)
Renter	21 (15%)
Provided by Employer	1 (1%)
Total	137 (100%)

Source: JICA Study Team

5) Size of House

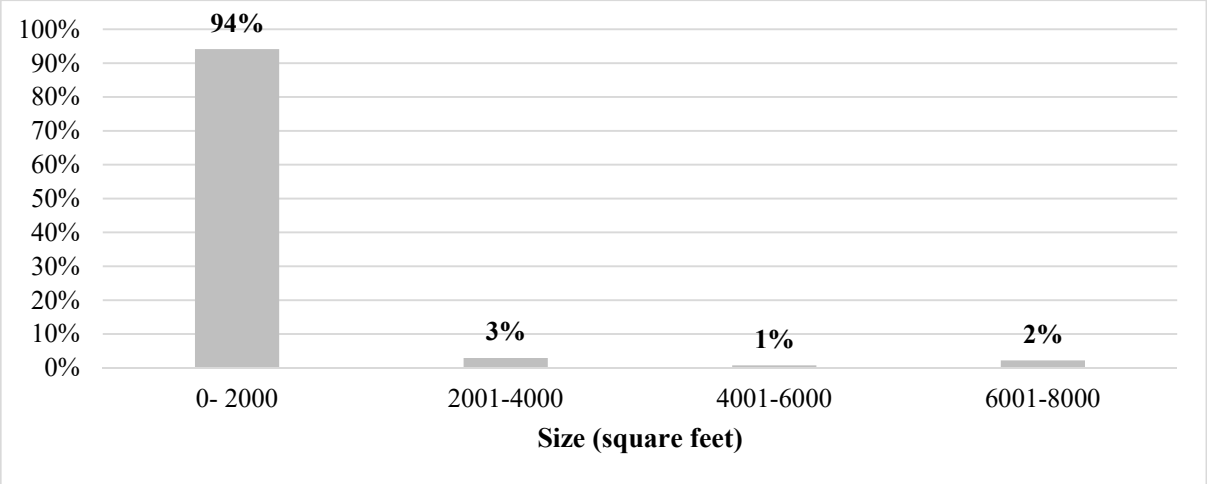
According to the survey, the smallest size of respondents' houses was 100 square feet, and the largest was 8,000 square feet. 94% of the respondents' houses are 2,000 square feet or smaller.

Table 1-2-34 and Figure 1-2-43 show the size of respondents' houses.

Table 1-2-34 Sizes of Respondents' Houses

Size of House (square feet)	Frequency (%)
0- 2,000	129 (94%)
2,001 - 4,000	4 (3%)
4,001 - 6,000	1 (1%)
6,001 - 8.000	3 (2%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-43 Sizes of Respondents' Houses

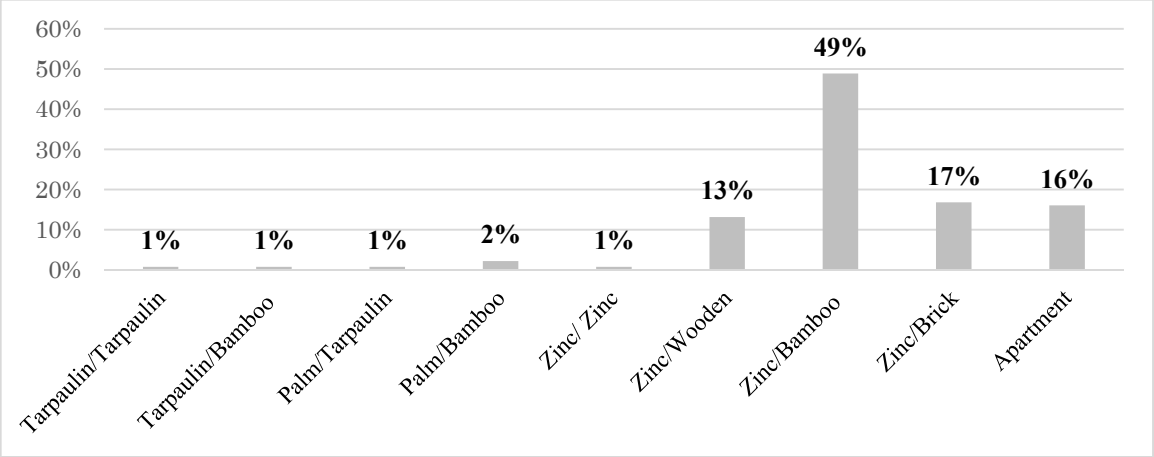
6) Types of Houses

With regards to the types of houses, the houses of close to half of the population (49%) are constructed with Zinc/Bamboo, followed by Zinc/Brick (17%), apartment (brick/16%) and Zinc/Wood (13%). The houses made from Palm/Bamboo (2%), Tarpaulin/Tarpaulin (1%), Tarpaulin/Bamboo (1%), Palm/Tarpaulin (1%) and Zinc/Zinc (1%) were limited. Table 1-2-35 and Figure 1-2-44 show the types of residences of the respondents.

Table 1-2-35 Types of Houses

Housing Type	Frequency (%)
Tarpaulin/Tarpaulin	1 (1%)
Tarpaulin/Bamboo	1 (1%)
Palm/Tarpaulin	1 (1%)
Palm/Bamboo	3 (2%)
Zinc/ Zinc	1 (1%)
Zinc/Wood	18 (13%)
Zinc/Bamboo	67 (49%)
Zinc/Brick	23 (17%)
Apartment (Brick)	22 (16%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-44 Types of Houses

7) Livestock

Most, or 95%, of the respondents did not possess livestock. The types of livestock kept by the respondents were chickens, cattle and pigs. Table 1-2-36 shows the number of respondents with livestock and Table 1-2-37 shows the types of livestock held by the respondents that owned them.

Table 1-2-36 Number of Respondents with Livestock

Livestock in Possession	Frequency (%)
Yes	7 (5%)
No	130 (95%)
Total	137 (100%)

Source: JICA Study Team

Table 1-2-37 Types and Number of Livestock in Possession

Respondent	Type of Livestock	Number
A	Chickens	14
B	Cattle	5
C	Cattle	20
D	Pigs	5
E	Chickens and Pigs	4 and 4
F	Chicken	1
G	Chickens	2

Source: JICA Study Team

(6) Utilities

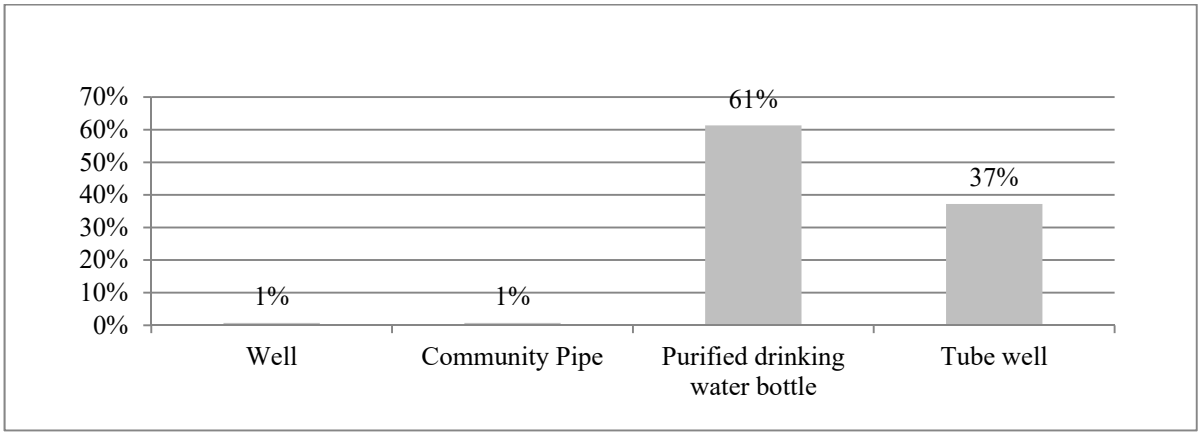
1) Access to Drinking Water

Table 1-2-38 and Figure 1-2-45 show respondents' main sources of drinking water. A majority, or 61%, of the respondents purchase purified water for the said purpose. 37% used a tube well which used a pump to extract water using electricity. Only a small number of people used water from a well or community pipe (1% each).

Table 1-2-38 Main Sources of Drinking Water

Source of Drinking Water	Frequency (%)
Purified Drinking Water Bottle	84 (61%)
Tube Well	51 (37%)
Well	1 (1%)
Community Pipe	1 (1%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-45 Main Sources of Drinking Water

2) Access to Domestic Water

Most of the respondents (96%) used tube well water for domestic purposes. Only a small number of people used domestic water from a well (1%) or community pipe (2%). Table 1-2-39 shows the main sources of domestic water used by the respondents.

Table 1-2-39 Main Sources of Domestic Water

Source of Domestic Water	Frequency (%)
Tube well	133 (97%)
Community Pipe	3 (2%)
Well	1 (1%)
Total	137 (100%)

Source: JICA Study Team

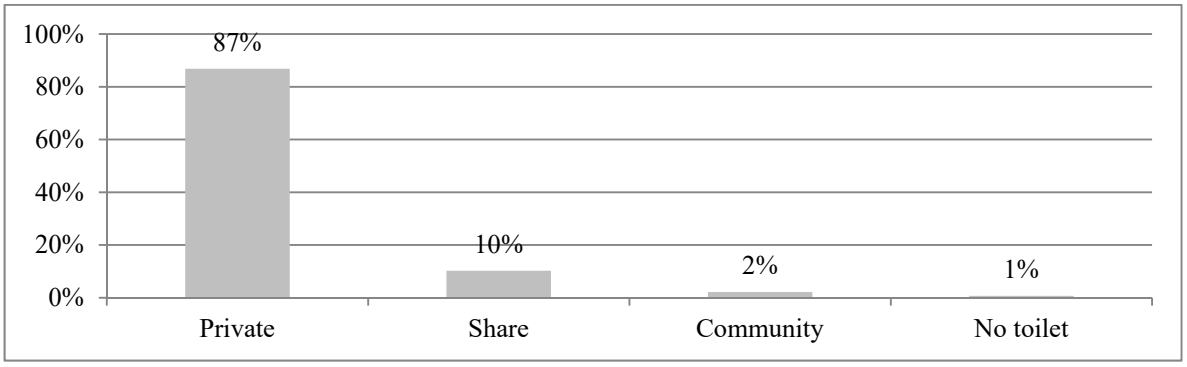
3) Access to Sanitation Facilities

87% of respondents had and used their own toilet. 10% used a shared toilet and 2% used a community toilet. 1% (i.e. one person) had no toilet. Table 1-2-40 and Figure 1-2-46 show the types of toilets used by the respondents.

Table 1-2-40 Types of Toilets Used by Respondents

Type of Toilet	Frequency (%)
Private	119 (87%)
Shared	14 (10%)
Community	3 (2%)
No Toilet	1 (1%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-46 Types of Toilets Used by Respondents

4) Drainage Systems

Approximately 60% of the respondents have a drainage system in front of their residences and the rest of them do not. Table 1-2-41 shows the result.

Table 1-2-41 Use of Drainage System

Use of Drainage System	Frequency (%)
Yes	81 (59%)
No	56 (41%)
Total	137 (100%)

Source: JICA Study Team

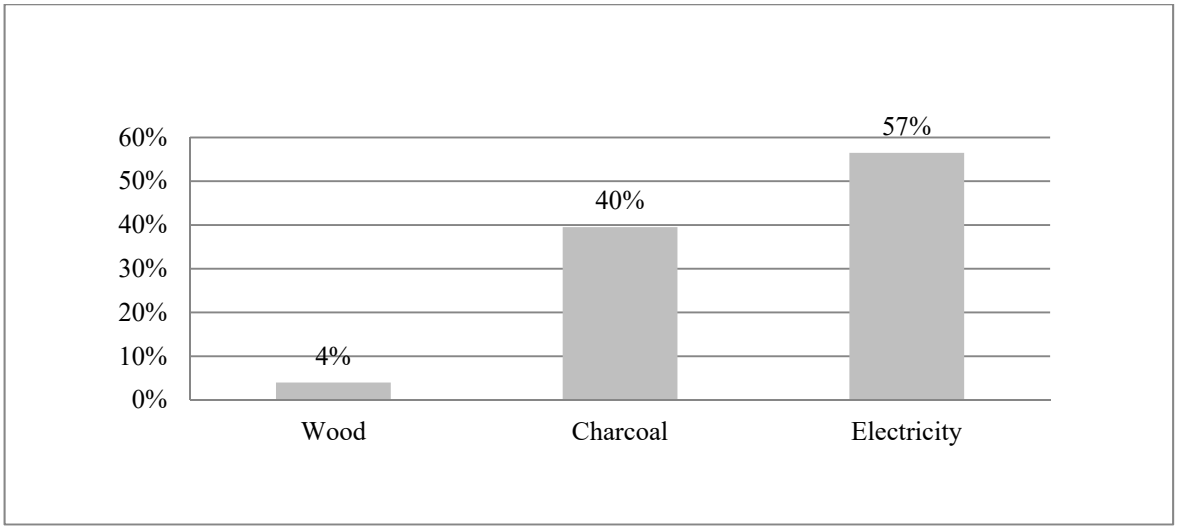
5) Energy Source

Table 1-2-42 and Figure 1-2-47 show the main sources of energy used by the respondents. It was found through the survey that a majority (57%) of the respondents used electricity as their main energy source. 40% relied on charcoal and the last 4% on wood.

Table 1-2-42 Main Sources of Energy Used

Main Source of Energy	Frequency (%)
Electricity	113 (57%)
Charcoal	79 (40%)
Wood	8 (4%)
Total	200 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-47 Main Sources of Energy Used

6) Access to Electricity

Most of the households (98%) have access to electricity. Table 1-2-43 shows the state of electricity used by the respondents.

Table 1-2-43 Access to Electricity

Access to Electricity	Frequency (%)
Yes	134 (97%)
No	3 (3%)
Total	137 (100%)

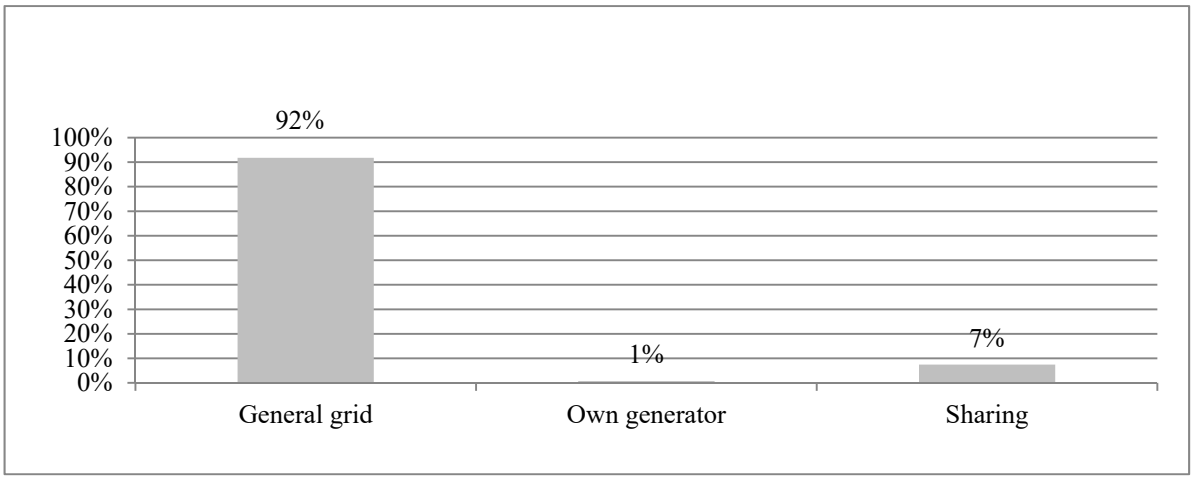
Source: JICA Study Team

The main sources of electricity have been found to be: national grid (92%); shared electricity (between two households, 7%) and own generator (1%). Table 1-2-44 and Figure 1-2-48 show the main sources of electricity among the respondents with electricity.

Table 1-2-44 Types of Electricity Used

Type of Electricity in Use	Frequency (%)
National Grid	123 (92%)
Sharing	10 (7%)
Own Generator	1 (1%)
Total	134 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-48 Types of Electricity Used

7) Access to Medical Facilities

According to the survey, 85% of respondents answered that they have health facilities in the wards in which they reside. Table 1-2-45 shows the status of health facilities in the respondents' wards.

Table 1-2-45 Access to Health Facilities

Health Facility in Ward	Frequency (%)
Yes	116 (85%)
No	21 (15%)
Total	137 (100%)

Source: JICA Study Team

98% of the respondents answered that they go to some kind of health facilities in case they become ill (91% to healthcare department and 7% to private clinic). Table 1-2-46 shows the number of respondents that went to health facilities when ill and Table 1-2-47 shows the type of health facilities used.

Table 1-2-46 Number of Respondents that Used Health Facilities

Use of Health Facilities	Frequency (%)
Yes	134 (98%)
No	3 (2%)
Total	137 (100%)

Source: JICA Study Team

Table 1-2-47 Types of Health Facilities Used

Type of Health Facilities	Frequency (%)
Private Clinic	125 (93%)
Healthcare Department	9 (7%)
Total	134 (100%)

Source: JICA Study Team

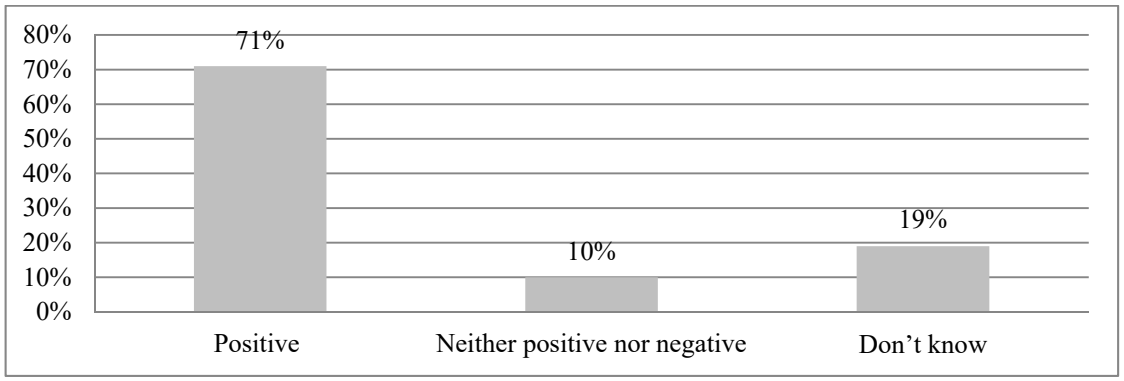
8) Impression of the Project

According to the survey, 71% of the respondents responded that they had a positive impression of the project. Their main expectations include: increase in income and employment opportunities; higher living standards; and more convenient transportation. 19% answered that they could not tell. The rest of the respondents (10%) answered that they expect neither positive nor negative impact as a result of the project. No person had a negative impression. Table 1-2-48 and Figure 1-2-49 show respondents' impressions of the project.

Table 1-2-48 Impressions of the Project

Impression on Project	Frequency (%)
Positive	97 (71%)
Don't know	26 (19%)
Neither Positive nor Negative	14 (10%)
Total	137 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-49 Impressions of the Project

(7) Air Quality

To determine the existing baseline ambient air quality within the project site and outside the project site (i.e. near the monastery), dust (PM_{10} and $PM_{2.5}$) and gases (CO, CO_2, SO_2, NO_2) were measured using a HAZSCANNER air monitoring station, and volatile organic compounds (VOCs) and ozone (O_3) were measured at the selected sites using an Aeroqual S 500 gas level monitor which provides a direct reading with data logging capabilities. The items monitored were selected with reference to the National Environmental Quality (Emission) Guidelines in Myanmar.

Results of the air quality measurements were compared against the National Environmental Quality (Emission) Guidelines and international ambient air quality standards (WHO, NAAQS, ACGIH). This data allows one to understand the current state of air quality in and near the project site and monitor any change that may take place as a result of the project. It is also a useful input into considering effective ways to mitigate the potential impact on the air quality and to formulate a practical and robust environmental monitoring plan.

The air quality survey was conducted in two locations, namely Air Quality Point 1 (P-1) located within the project site and Air Quality Point 2 (P-2) located outside the project site near the receptor (i.e. Shwe Hlan Bo Monastry). The measurement sites were selected following the steps below:

(1) Visually identify possible emission sources;
(2) Find out the highest concentration emission source and wind direction to determine the degree of dispersion; and
(3) Select suitable sampling locations considering terrain, avoiding features such as steep slopes and steep embankments close to the roadway (locations that have relatively flat terrain are considered more suitable).

The locations of the air quality survey points are presented in Table 1-2-49 and Figure 1-2-50. The equipment used for measurement is shown in Table 1-2-50.

Table 1-2-49 Locations of Air Quality Monitoring Points

Survey Point	Location (Latitude and Longitude)	Type of Survey Point	Date of Measurement
Air Quality Point 1 (P-1)	21°56'54.58"N, 96°3'4.40"E	Within the project site	May 3 and 4, 2017
Air Quality Point 2 (P-2)	21°56'53.97"N, 96°3'12.43"E	Outside the project site, near the monastery	May 4 and 5, 2017

Source: JICA Study Team

Source: JICA Study Team based on Google Earth

Figure 1-2-50 Locations of Air Quality Measurement Points

Table 1-2-50 Equipment Used for Air Quality Measurement

No.	Name and Model of Instrument Used	Measurement Items	Image
1.	EPAS HAZ SCANNER	PM $_{10}$, PM $_{2.5}$, NO_2, CO, CO_2, SO_2, temperature, wind speed, wind direction	
2.	AeroQual500 with Sensors and casing	O_3	

Source: JICA Study Team

A summary of the observed ambient air quality results with guidelines are shown in Table 1-2-51. A more detailed description of each item is presented in the following sections.

Table 1-2-51 Results of Ambient Air Quality Measurement

Parameters	Within the Project Site (P-1)	Outside the Project Site (P-2)	Guideline Value	Unit	Organization	Averaging Period
$PM_{2.5}$	82.04	65.145	25	$\mu g/m^3$	NEQa	24 hrs
PM_{10}	113.18	93.54	50	$\mu g/m^3$	NEQa	24 hrs
NO_2	177.25	93.55	200	$\mu g/m^3$	NEQa	1 hr
SO_2	49.62	46.49	20	$\mu g/m^3$	NEQa	24 hrs
Ozone	80.95	78.17	100	$\mu g/m^3$	NEQa	8 hrs
CO	0.348	0.473	35	ppm	NAAQSb	8 hrs
CO_2	289.72	279.81	5,000	ppm	ACGIHc	8 hrs
VOC	8.9	10.08	-	ppm	-	8 hrs

a National Environmental Quality (Emission) Guidelines
b National Ambient Air Quality Standards
c American Conference of Governmental Industrial Hygienists
*Measurement values that exceed the guideline values are shown in red rectangles.
Source: JICA Study Team

1) PM_{10}, $PM_{2.5}$

PM_{10} and $PM_{2.5}$ refer to particulate matter 10 micrometres or less in diameter and particulate matter 2.5 micrometres or less in diameter, respectively. $PM_{2.5}$ is generally described as fine particles. The major components of PM 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.
Dust emission, such as particulate matters PM_{10} and $PM_{2.5}$, was measured for 24 hours at two

points. The observed average values for PM_{10} and $PM_{2.5}$ were 113.18 μg/m^3 and 82.04μg/m^3, respectively. Outside the project area, at a location close to the monastery, showed a value of 93.54 μg/m^3 for PM_{10} and 65.145 μg/m^3 for $PM_{2.5}$. These values exceed the NEQ (emission) guideline values of 50 μg/m^3 for PM_{10} and 25 μg/m^3 for $PM_{2.5}$. The observed particulate matter of PM measurement for 24 hours is shown in Table 1-2-52 and Table 1-2-53.

Table 1-2-52 articulate Matter at Project Site (P-1)

No	Date	Time	Within Project Site (P-1)		NEQ Guideline Value	
			$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)
1	3/5/2017	16:44:00-17:43:00	120	150	-	-
2	3/5/2017	17:44:00-18:43:00	125.15	161.5	-	-
3	3/5/2017	18:44:00-19:43:00	93.22	120.53	-	-
4	3/5/2017	19:44:00-20:43:00	91.17	124.08	-	-
5	3/5/2017	20:44:00-21:43:00	112.75	154.33	-	-
6	3/5/2017	21:44:00-22:43:00	99.93	131.8	-	-
7	3/5/2017	22:44:00-23:43:00	79.78	113.57	-	-
8	3/5/2017	23:44:00-00:43:00	76.17	101.28	-	-
9	4/5/2017	00:44:00-01:43:00	81.37	98.03	-	-
10	4/5/2017	01:44:00-02:43:00	82.1	105.22	-	-
11	4/5/2017	02:44:00-03:43:00	110.17	150.7	-	-
12	4/5/2017	03:44:00-04:43:00	149.33	178.5	-	-
13	4/5/2017	04:44:00-05:43:00	123.73	152.92	-	-
14	4/5/2017	05:44:00-06:43:00	74.3	97.57	-	-
15	4/5/2017	06:44:00-07:43:00	23.67	61.28	-	-
16	4/5/2017	07:44:00-08:43:00	31.55	57.12	-	-
17	4/5/2017	08:44:00-09:43:00	22.73	56.58	-	-
18	4/5/2017	09:44:00-10:43:00	11.5	49.3	-	-
19	4/5/2017	10:44:00-11:43:00	21.43	53.77	-	-
20	4/5/2017	11:44:00-12:43:00	22.27	51.38	-	-
21	4/5/2017	12:44:00-13:43:00	45.07	71.08	-	-
22	4/5/2017	13:44:00-14:43:00	125.33	131.3	-	-
23	4/5/2017	14:44:00-15:43:00	125.77	185.82	-	-
24	4/5/2017	15:44:00-16:43:00	120.55	158.56	-	-
Average over 24 hours			82.043	113.18	25	50

Source: JICA Study Team

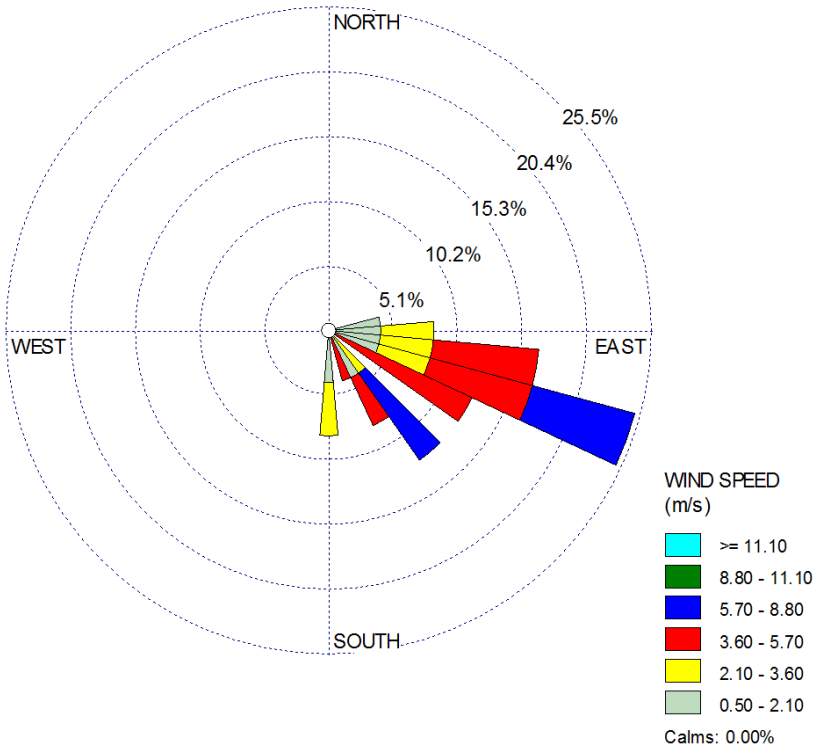
Table 1-2-53 articulate Matter Outside Project Site (P-2)

No	Date	Time	Outside Project Site (P-2)		NEQ Guideline Value	
			$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)
1	4/5/2017	20:33:00-21:32:00	81.02	109.87	-	-
2	4/5/2017	21:33:00-22:32:00	91.97	136.4	-	-
3	4/5/2017	22:33:00-23:32:00	95.23	138.45	-	-
4	4/5/2017	23:33:00-00:32:00	76.7	108.23	-	-
5	5/5/2017	00:33:00-01:32:00	74.97	111.8	-	-
6	5/5/2017	01:33:00-02:32:00	82.58	117.3	-	-
7	5/5/2017	02:33:00-03:32:00	64.93	98.68	-	-
8	5/5/2017	03:33:00-04:32:00	65.17	90.62	-	-
9	5/5/2017	04:33:00-05:32:00	48.32	67.67	-	-
10	5/5/2017	05:33:00-06:32:00	74.95	107.95	-	-
11	5/5/2017	06:33:00-07:32:00	62.48	83.55	-	-
12	5/5/2017	07:33:00-08:32:00	43.5	64.07	-	-
13	5/5/2017	08:33:00-09:32:00	32.53	50.35	-	-
14	5/5/2017	09:33:00-10:32:00	25.03	46.03	-	-
15	5/5/2017	10:33:00-11:32:00	17.05	33.27	-	-
16	5/5/2017	11:33:00-12:32:00	9.33	36.27	-	-
17	5/5/2017	12:33:00-13:32:00	16	42.47	-	-
18	5/5/2017	13:33:00-14:32:00	32.93	56.65	-	-
19	5/5/2017	14:33:00-15:32:00	57.92	70.92	-	-
20	5/5/2017	15:33:00-16:32:00	70.75	81.23	-	-
21	5/5/2017	16:33:00-17:32:00	90.87	100.73	-	-
22	5/5/2017	17:33:00-18:32:00	94.93	122.95	-	-
23	5/5/2017	18:33:00-19:32:00	140.65	211.1	-	-
24	5/5/2017	19:33:00-20:32:00	113.67	158.41	-	-
Average 24 hours			65.145	93.54	25	50

Source: JICA Study Team

The reason for the high PM_{10} values may be attributed to the sand collection work in operation at 250 m north-west of the measuring point coupled with the fact that measurements were taken in the dry season, and due to the existing soil layer (i.e. silty sand-1, which consists of mainly loose, fine-grained sand, and silty sand-2, which consists of dense, fine sand).

The following figure shows the wind speed and direction at the proposed project site on May 3, 2017. It can be seen that wind was mostly blowing from the north-west to south-east direction from the sand collection site and river towards the air quality measurement site.



Source: JICA Study Team

Figure 1-2-51 Wind Speed and Direction (Blowing Toward) at the Project Site

$PM_{2.5}$ can be carried long distances from their sources such as car, truck, bus and off-road vehicle exhaust. The air quality measuring sites were close to the roadside and the average wind speed during monitoring was 3.85 mph (min: 0.5 mph and max: 6.5 mph) with 0% calm. The main reason of the high $PM_{2.5}$ values may be due to diesel shipping boats along river and burning of fuel from hut for cooking purposes.

2) Nitrogen Dioxide (NO_2)

Nitric oxide (NO) and nitrogen dioxide (NO_2) are generated from operation and maintenance of vehicles and on-site power generation facilities, where the quantity of nitrogen oxides is a function of the available nitrogen and oxygen concentrations, reaction time, and temperature. For humans, it causes bronchitis and edema of the lungs.

The concentration level of ambient NO_2 was measured in the survey. Within the project site, the average concentration for 1 hour was 177.25 $\mu g/m^3$ and outside the project site it was 93.55 $\mu g/m^3$. These levels are lower than 200 $\mu g/m^3$, the guideline value stipulated in the National Environmental Quality (Emission) Guidelines.

3) 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. The measured SO_2 level was 49.62 $\mu g/m^3$ within the project site and 46.49 $\mu g/m^3$ outside the project site. These values exceed the guideline value of the National Environmental Quality (Emission) Guidelines (20 $\mu g/m^3$).

4) Ozone (O_3)

Ozone is created by chemical reactions between oxides of nitrogen and volatile organic compounds (VOC) in the presence of sunlight. The level of concentration of ozone at two points was 80.95 μg/m^3 within the project area and 78.17 μg/m^3 outside the project site. These values are lower than the guideline value of the National Environmental Quality (Emission) Guidelines (100 μg/m^3).

5) Carbon Monoxide (CO)

Carbon monoxide is a colourless, odourless, tasteless gas formed primarily by incomplete combustion of carbonaceous fuels. The major source of carbon monoxide is fuel combustion engines of mobile sources, operation of heavy trucks and mainly steam boilers using rice husk fuel for production purpose. Carbon monoxide has adverse effect on human and other animal health but plants are relatively insensitive. The measurement results of CO were 0.348 ppm within the project site and 0.473 ppm outside the project site (near the monastery) for an average 8-hour measurement, which are lower than the guideline value of the NAAQS Guideline (35 ppm).

6) Carbon Dioxide (CO_2)

The major source of carbon dioxide is automobile exhaust, emergency use of generators, fuel gases and so on. It can cause damage to the respiratory system. CO_2 concentration was measured for 24 hours. The average value for 8 hours was 289.72 ppm within the project site and 279.81 ppm outside the project site (near the monastery). These values are within the ACGIH international standard value of 5,000 ppm.

7) Volatile Organic Compounds (VOCs)

The emission sources of VOCs are the same as carbon monoxide (CO) and carbon dioxide (CO_2). It is generated from automobile exhaust, blast furnaces, fuel gases and so on. It causes damage to the respiratory system. The measurement results at the two points were 8.9 ppm within the project area and 10.08 ppm outside the project site (near the monastery). There is no guideline value for this.

8) Humidity and Temperature

The average humidity and temperature within and outside the project site are shown in Table 1-2-54.

Table 1-2-54 Humidity and Temperature within and outside Project Site

Location	Date and Time	Item Measured	Result
Within Project Site	4:44 pm – 4:44 pm (3/5/2017 – 4/5/2017)	Humidity	59.34%
		Temperature	30.64° C
Outside Project Site (near monastery)	8:33 pm – 8:33 pm (4/5/2017 – 5/5/2017)	Humidity	54.68%
		Temperature	30.9° C

Source: JICA Study Team

Source: JICA Study Team

Photo 1-2-25 Air Quality Measurement

(8) Water Quality

The existing water quality was measured by sampling water from upstream (W-1) and downstream (W-2) of Ayeyarwady River near the project site in order to compare the difference between the quality of existing water before and after implementation of the project. Water samples were collected once during the dry season and once in the rainy season.

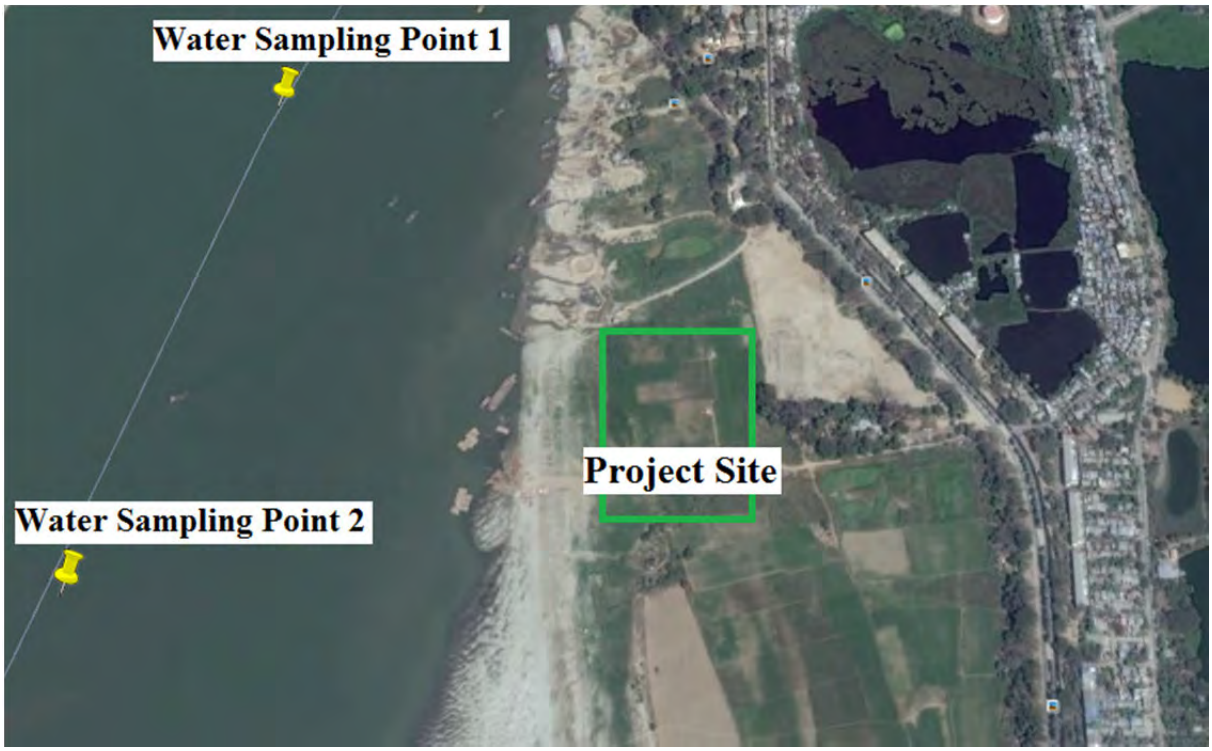
One gallon of water from each location was sampled at each point. A clean bucket of approximately 10 L capacity was used to collect the water sample. The bottle was dipped into the river, firmly held and plunged downwards to a depth of approximately 0.5 m. Samples were then transferred to the laboratory (i.e. SGS Limited, ISO Tech Laboratory, and Water and Sanitation Department, Supreme 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 analysed in the laboratory by standard procedures.

The observed values were compared with the WHO standards and the National Environmental Quality (Emission) Guidelines. The result showed that most of the parameters are within the standards except for total suspended solids both upstream and downstream. The details of the location of water sampling points are presented in Table 1-2-55 and Figure 1-2-52. The equipment used for measurement is shown in Table 1-2-56.

Table 1-2-55 Locations of Water Quality Sampling

Sampling Point	Location (Latitude and Longitude)	Type of Sampling Point	Date of sampling
Water Sampling Point 1	21°57'9.72"N 96° 02'46.17"E	Upstream	5.5.2017 and 17.5.2017 (dry season) 20.7.2017 (rainy season)
Water Sampling Point 2	21°56'50.00"N 96° 02'39.07"E	Downstream	

Source: JICA Study Team



Source: JICA Study Team based on Google Earth

Figure 1-2-52 Locations of Water Quality Sampling

Table 1-2-56 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	

Source: JICA Study Team

Table 1-2-57 and Table 1-2-58 show the results of water quality measurements carried out during the dry season (May 2017) upstream and downstream of Ayeyarwady River, respectively. Table 1-2-59 and Table 1-2-60, on the other hand, show the results of the measurements carried out during the rainy season (July 2017). Both of the measurement results were compared against the WHO drinking water quality standards and the National Environmental Quality (Emission) Guidelines. All parameters during the dry and rainy seasons were found to be within the guideline value except for total suspended solids and turbidity in the rainy season. It should be noted, however, that the WHO guideline value for turbidity is for drinking water and hence should be considered as a reference when applied to river water that is not used for drinking. Water quality tests and results of on-site measurement, and results from the laboratories are shown in "Appendix 9 Environmental and Social Considerations", "9-1 Attachments of Environmental and Social Considerations Survey Works", "(1) Results of Water Quality Analysis".

Table 1-2-57 Water Quality from Upstream of Ayeyarwady River (dry season)

No.	Parameter	Unit	Results	WHO Guidelines	NEQ (Emission) Guideline Values	Name of Laboratory
1	Water Temperature	°C	27.6	-	-	On site measurement
2	Salinity	-	0.1	-	-	MCDC Water and Sanitation Department
3	pH	Standard Unit	7.3	6.5 – 8.5	6-9	ISO TECH
4	Dissolved Oxygen(DO)	mg/l	6.86	<10	-	MCDC Water and Sanitation Department
5	Chemical Oxygen Demand (COD)	mg/l	9.75	-	125	MCDC Water and Sanitation Department
6	Biological Oxygen Demand(BOD)	mg/l	3.9	-	30	MCDC Water and Sanitation Department
7	Oil and Grease	mg/l	<5	-	10	SGS
8	Total Coliform	100ml	18	Not detected	400	ISO TECH
9	Total Nitrogen	mg/l	0.9	-	10	Supreme Group of Companies
10	Total Phosphorus	mg/l	0.4	-	2	Supreme Group of Companies
11	Total Suspended Solids	mg/l	69	-	50	MCDC Water and Sanitation Department
12	Turbidity	NTU	92	5		ISO TECH

*Measurement values that exceed the guideline values are shown in a red rectangle.

Source: JICA Study Team

Table 1-2-58 Water Quality from Downstream of Ayeyarwady River (Dry Season)

No.	Parameter	Unit	Results	WHO Guidelines	NEQ (Emission) Guideline Values	Name of Laboratory
1	Water Temperature	°C	27	-	-	On-site measurement
2	Salinity		0.1	-	-	MCDC Water and Sanitation Department
3	pH	Standard Unit	7.1	6.5 – 8.5	6-9	ISO TECH
4	Dissolved Oxygen (DO)	mg/L	6.64	<10	-	MCDC Water and Sanitation Department
5	Chemical Oxygen Demand (COD)	mg/L	9.5	-	125	MCDC Water and Sanitation Department
6	Biological Oxygen Demand (BOD)	mg/L	3.8	-	30	MCDC Water and Sanitation Department
7	Oil and Grease	mg/L	<5	-	10	SGS
8	Total Coliform	100 mL	22	Not detected	400	ISO TECH
9	Total Nitrogen	mg/L	1.4	-	10	Supreme Group of Companies
10	Total Phosphorus	mg/L	0.6	-	2	Supreme Group of Companies
11	Total Suspended Solids (TSS)	mg/L	72	-	50	MCDC Water and Sanitation Department
12	Turbidity	NTU	110	5		ISO TECH

*Measurement values that exceed the guideline values are shown in a red rectangle.

Source: JICA Study Team

Table 1-2-59 Water Quality from Upstream of Ayeyarwady River (Rainy Season)

No.	Parameter	Unit	Results	WHO Guidelines	NEQ (Emission) Guideline Values	Name of Laboratory
1	Water Temperature	°C	26	-	-	On-site measurement
2	Salinity		0.1	-	-	MCDC Water and Sanitation Department
3	pH	Standard Unit	7.1	6.5 – 8.5	6-9	ISO TECH
4	Dissolved Oxygen(DO)	mg/L	5.67	<10	-	MCDC Water and Sanitation Department
5	Chemical Oxygen Demand (C.O.D)	mg/L	9	-	125	MCDC Water and Sanitation Department
6	Biological Oxygen Demand (B.O.D)	mg/L	3.6	-	30	MCDC Water and Sanitation Department
7	Oil and Grease	mg/L	<5	-	10	SGS
8	Total Coliform	100mL	30	Not detected	400	ISO TECH
9	Total Nitrogen	mg/L	<1	-	10	Supreme Group of Company
10	Total Phosphorus	mg/L	0.02	-	2	Supreme Group of Company
11	Total Suspended Solids (T.S.S)	mg/L	49	-	50	MCDC Water and Sanitation Department
12	Turbidity	NTU	110	5		ISO TECH

*Measurement values that exceed the guideline values are shown in a red rectangle.

Source: JICA Study Team

Table 1-2-60 Water Quality from Downstream of Ayeyarwady River (Rainy Season)

No.	Parameter	Unit	Results	WHO Guidelines	NEQ (Emission) Guideline Values	Name of Laboratory
1	Water Temperature	°C	25.6	-	-	On-site measurement
2	Salinity		0.1	-	-	MCDC Water and Sanitation Department
3	pH	Standard Unit	6.9	6.5 – 8.5	6-9	ISO TECH
4	Dissolved Oxygen (DO)	mg/L	5.07	<10	-	MCDC Water and Sanitation Department
5	Chemical Oxygen Demand (COD)	mg/L	9	-	125	MCDC Water and Sanitation Department
6	Biological Oxygen Demand (BOD)	mg/L	3.5	-	30	MCDC Water and Sanitation Department
7	Oil and Grease	mg/L	<5	-	10	SGS
8	Total Coliform	100mL	42	Not detected	400	ISO TECH
9	Total Nitrogen	mg/L	<1	-	10	Supreme Group of Company
10	Total Phosphorus	mg/L	0.026	-	2	Supreme Group of Company
11	Total Suspended Solids (T.S.S)	mg/L	44	-	50	MCDC Water and Sanitation Department
12	Turbidity	NTU	158	5		ISO TECH

*Measurement values that exceed the guideline values are shown in a red rectangle.

Source: JICA Study Team

Suspended particles in water can cause turbidity and obstruct light transmission through the water. Turbidity can also give a negative impression of the river water. While it is an important indicator of possible presence of contaminants, it is not necessarily a risk to health. It can be treated by coagulation, sedimentation, and filtration, disinfection using chlorine, ozone and ultraviolet irradiation for drinking purpose.

Source: JICA Study Team

Photo 1-2-26 Water Quality on-site Measurement

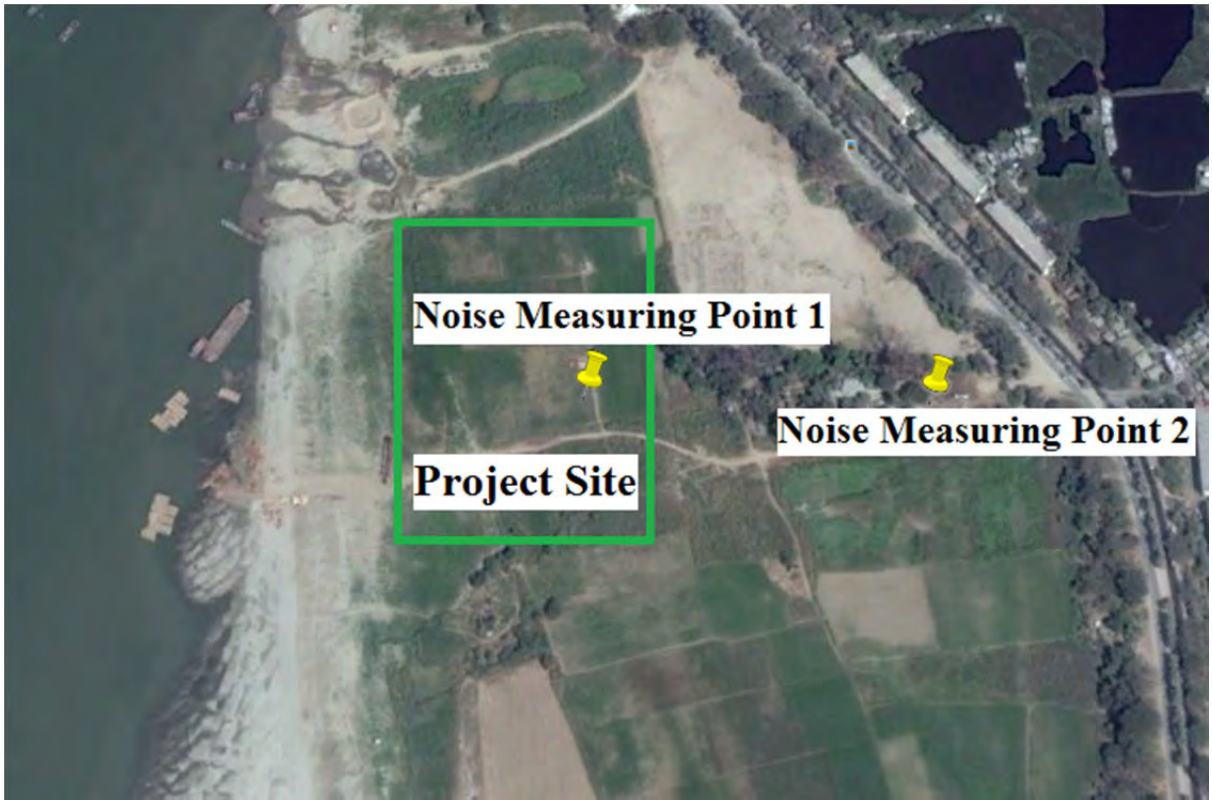
(9) Noise Levels

Noise 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 two points as the air quality measurement and were compared with the National Environmental Quality (Emission) Guidelines of Myanmar. Details of the location are presented in Table 1-2-61 and Figure 1-2-53. The equipment used for noise measurement is shown in Table 1-2-62.

Table 1-2-61 Locations of Noise Monitoring Points

Survey Point	Location (Latitude and Longitude)	Type of Survey Point	Date of Measurement
Noise Measurement Point 1 (P-1)	21°56'54.58"N, 96° 3'4.40"E	Within the project site	May 3 and 4, 2017
Noise Measurement Point 2 (P-2)	21°56'53.97"N, 96° 3'12.43"	Outside the project site, near the monastery	May 4 and 5, 2017

Source: JICA Study Team



Source: JICA Study Team based on Google Earth

Figure 1-2-53 Locations of Noise Level Measurement Points

Table 1-2-62 Equipment Used for Noise Level Measurement

No.	Name of Instrument Used	Measurement Items	Image
1.	Digital Sound Level Meter	Noise	

Source: JICA Study Team

Noise can generate frustration among people and affect human health. Human ears can be resistant to limited levels of noise, not too low and not high, especially in the range of 16-20,000 Hz. Ambient noise levels were measured within the project site from around 6 pm on 3 May 2017 to 6 pm on 4 May 2017 and outside the project site (i.e. near the monastery) from around 8 pm on May 4, 2017 to 8pm on May 5, 2017 using a digital sound level meter. The ambient noise level within and outside the project site is shown in Table 1-2-63 and Table 1-2-58, respectively. The noise level indicated in the National Environmental Quality (Emission) Guidelines is shown in Table 1-2-65. The ambient noise level of selected sites indicates that the ambient noise levels are within the acceptable levels set under the National Environmental Quality (Emission) Guidelines.

Table 1-2-63 Ambient Noise Levels within the Project Site (24 hours continuous)

No	Date	Time	Mean Value (dBA)	Day/Night
1	3/5/2017	18:06:21-19:06:21	54.347	Day
2	3/5/2017	19:06:21-20:06:21	49.583	Day
3	3/5/2017	20:06:21-21:06:21	49.342	Day
4	3/5/2017	21:06:21-22:06:21	47.337	Day
5	3/5/2017	22:06:21-23:06:21	44.428	Night
6	3/5/2017	23:06:21-00:06:21	44.087	Night
7	4/5/2017	00:06:21-01:06:21	43.27	Night
8	4/5/2017	01:06:21-02:06:21	42.948	Night
9	4/5/2017	02:06:21-03:06:21	43.95	Night
10	4/5/2017	03:06:21-04:06:21	45.04	Night
11	4/5/2017	04:06:21-05:06:21	51.237	Night
12	4/5/2017	05:06:21-06:06:21	51.447	Night
13	4/5/2017	06:06:21-07:06:21	52.002	Day
14	4/5/2017	07:06:21-08:06:21	52.165	Day
15	4/5/2017	08:06:21-09:06:21	51.788	Day
16	4/5/2017	09:06:21-10:06:21	52.9	Day
17	4/5/2017	10:06:21-11:06:21	51.462	Day
18	4/5/2017	11:06:21-12:06:21	50.72	Day
19	4/5/2017	12:06:21-13:06:21	51.428	Day
20	4/5/2017	13:06:21-14:06:21	52.275	Day
21	4/5/2017	14:06:21-15:06:21	52.697	Day
22	4/5/2017	15:06:21-16:06:21	53.852	Day
23	4/5/2017	16:06:21-17:06:21	53.116	Day
24	4/5/2017	17:06:21-18:06:21	51.1	Day
		Average day time	51.518	
		Average night time	45.8	

Source: JICA Study Team

Table 1-2-64 Ambient Noise Level outside the Project Site (24 hours continuous)

No	Date	Time	Mean Value (dBA)	Day/Night
1	4/5/2017	20:01:28-21:01:28	59.115	Day
2	4/5/2017	21:01:28-22:01:28	57.963	Day
3	4/5/2017	22:01:28-23:01:28	56.242	Night
4	4/5/2017	23:01:28-00:01:28	56.195	Night
5	5/5/2017	00:01:28-01:01:28	57.478	Night
6	5/5/2017	01:01:28-02:01:28	55.363	Night
7	5/5/2017	02:01:28-03:01:28	55.845	Night
8	5/5/2017	03:01:28-04:01:28	56.028	Night
9	5/5/2017	04:01:28-05:01:28	58.918	Night
10	5/5/2017	05:01:28-06:01:28	58.698	Night
11	5/5/2017	06:01:28-07:01:28	59.347	Day
12	5/5/2017	07:01:28-08:01:28	60.793	Day
13	5/5/2017	08:01:28-09:01:28	61.925	Day
14	5/5/2017	09:01:28-10:01:28	61.698	Day
15	5/5/2017	10:01:28-11:01:28	59.558	Day
16	5/5/2017	11:01:28-12:01:28	59.96	Day
17	5/5/2017	12:01:28-13:01:28	60.28	Day
18	5/5/2017	13:01:28-14:01:28	58.72	Day
19	5/5/2017	14:01:28-15:01:28	60.042	Day
20	5/5/2017	15:01:28-16:01:28	61.235	Day
21	5/5/2017	16:01:28-17:01:28	60.667	Day
22	5/5/2017	17:01:28-18:01:28	63.197	Day
23	5/5/2017	18:01:28-19:01:28	62.179	Day
24	5/5/2017	19:01:28-20:01:28	60.77	Day
		Average day time	60.466	
		Average night time	56.846	

Source: JICA Study Team

Table 1-2-65 Comparison of Noise Levels with National Environmental Quality (Emission) Guidelines

Location	Day Time Average Noise Level (dBA)	Night Time Average Noise Level (dBA)	NEQ Guideline
Within the project site	51.51a (47.33b - 54.34c)	45.8a (42.94b - 51.44c)	70 dBA (day time and night time)
Outside the Project site (Near the monastery)	60.46a (58.72b - 63.19c)	56.84a (55.36b - 58.91c)	70 dBA (day time and night time)

*Day Time: 7 am to 10 pm, Night Time: 10 pm to 7 am, a: Average, b: Min, c: Max

Source: JICA Study Team

(10) Terrestrial and Aquatic Ecosystems

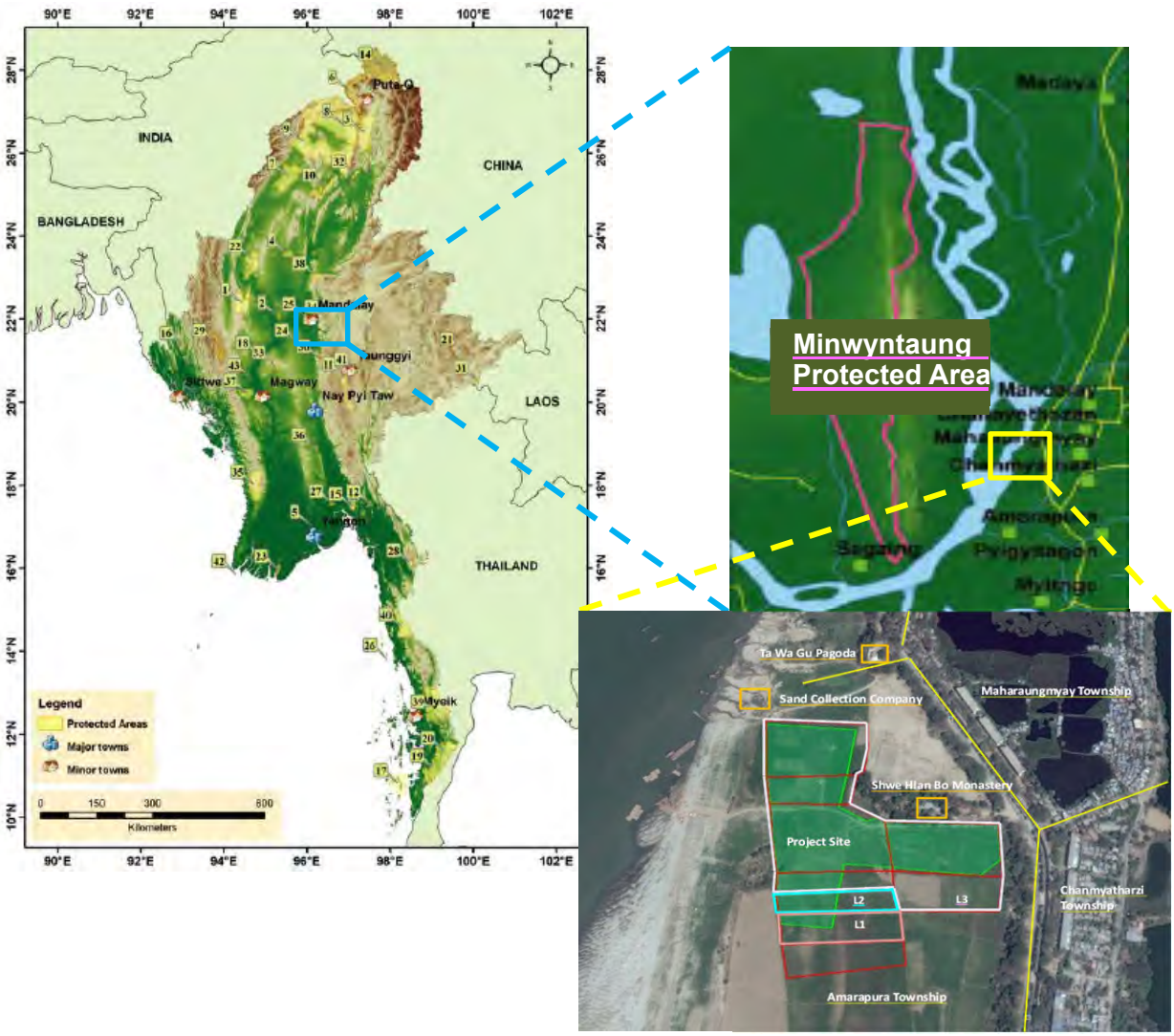
1) Protected Areas

According to 'Myanmar Protected Areas (Context, Current Status and Challenges)' published in 2011, there are no protected areas, forest reserves or biodiversity 'hotspots' located within or near the projected site.

ID	Site name	National Designation	Status	Establishment Year	Area (km2)
1	Alaungdaw Kathapa	National Park	Designated	1989	1597.62
2	Bawditataung	Nature Reserve	Proposed	2008	72.52
3	Bumhpabum	Wildlife Sanctuary	Designated	2004	1854.43
4	Chatthin	Wildlife Sanctuary	Designated	1941	269.36
5	Hlawga	Wildlife Park	Designated	1989	6.24
6	Hponkanrazi	Wildlife Sanctuary	Designated	2003	2703.95
7	Htamanthi	Wildlife Sanctuary	Designated	1974	2150.73
8	Hukaung Valley	Wildlife Sanctuary	Designated	2004	6371.37
9	Hukaung Valley (Extension)	Wildlife Sanctuary	Designated	2004	15431.16
10	Indawgyi Lake	Wildlife Sanctuary	Designated	2004	814.99
11	Inlay Lake	Wildlife Sanctuary	Designated	1985	641.90
12	Kahilu	Wildlife Sanctuary	Designated	1928	160.56
13	Kelatha	Wildlife Sanctuary	Designated	1942	23.93
14	Khakaborazi	National Park	Designated	1998	3812.46
15	Kyaikhtiyoe	Wildlife Sanctuary	Designated	2001	156.23
16	Kyauk-Pan-Taung	Wildlife Sanctuary	Proposed	2001	132.61
17	Lampi Island	Marine National Park	Designated	1996	204.84
18	Lawkananda	Wildlife Sanctuary	Designated	1995	0.47
19	Lenya	National Park	Proposed	2002	1761.19
20	Lenya (Extension)	National Park	Proposed	2004	1398.59
21	Loimwe	Protected Area	Designated	1996	42.84
22	Maharmyaing	Wildlife Sanctuary	Proposed	2002	1180.39
23	Mainmahla Kyun	Wildlife Sanctuary	Designated	1993	136.69
24	Minsontaung	Wildlife Sanctuary	Designated	2001	22.60
25	Minwuntaung	Wildlife Sanctuary	Designated	1972	205.88
26	Moscos Island	Wildlife Sanctuary	Designated	1927	49.19
27	Moyingyi Wetland	Bird Sanctuary	Designated	1988	103.60
28	Mulayit	Wildlife Sanctuary	Designated	1936	138.54
29	Natma Taung	National Park	Proposed	1997	722.61
30	Panlaung-Pyadalin Cave	Wildlife Sanctuary	Designated	2002	333.80
31	Parasar (Par Sar)	Protected Area	Designated	1996	77.02
32	Pidaung	Wildlife Sanctuary	Designated	1918	122.08
33	Popa	Mountain Park	Designated	1989	128.54
34	Pyin-O-Lwin	Bird Sanctuary	Designated	1918	127.25
35	Rakhine Yoma Elephant Range	Wildlife Reserve	Designated	2002	1755.70
36	Shinpinkyetthauk	Wildlife Sanctuary	Proposed	2006	71.90
37	Shwesettaw	Wildlife Sanctuary	Designated	1940	552.70
38	Shwe-U-Daung	Wildlife Sanctuary	Designated	1918	325.95
39	Tanintharyi	National Park	Proposed	2002	2071.81
40	Tanintharyi	Nature Reserve	Designated	2005	1699.99
41	Taunggyi	Bird Sanctuary	Designated	1930	16.06
42	Thamihla Kyun	Wildlife Sanctuary	Designated	1970	0.88
43	Wenthtikan	Bird Sanctuary	Designated	1939	4.40

Souuce: Myanmar Protected Areas (Context, Current Status and Challenges) 2011

Figure1-2-54 Protected Areas in Myanmar



Source: ICA Study Team based on Myanmar Protected Areas (Context, Current Status and Challenges (2011) and Google Earth

Figure 1-2-55 Protected Areas Located near the Project Site

2) Ecosystem and Wildlife

None of the fish species in the study area are listed on the IUCN Red List category endangered fish species for Myanmar (www.iucnredlist.org). According to the Final Report of the 2014 JICA F/S, the result is shown as below.

a. Flora

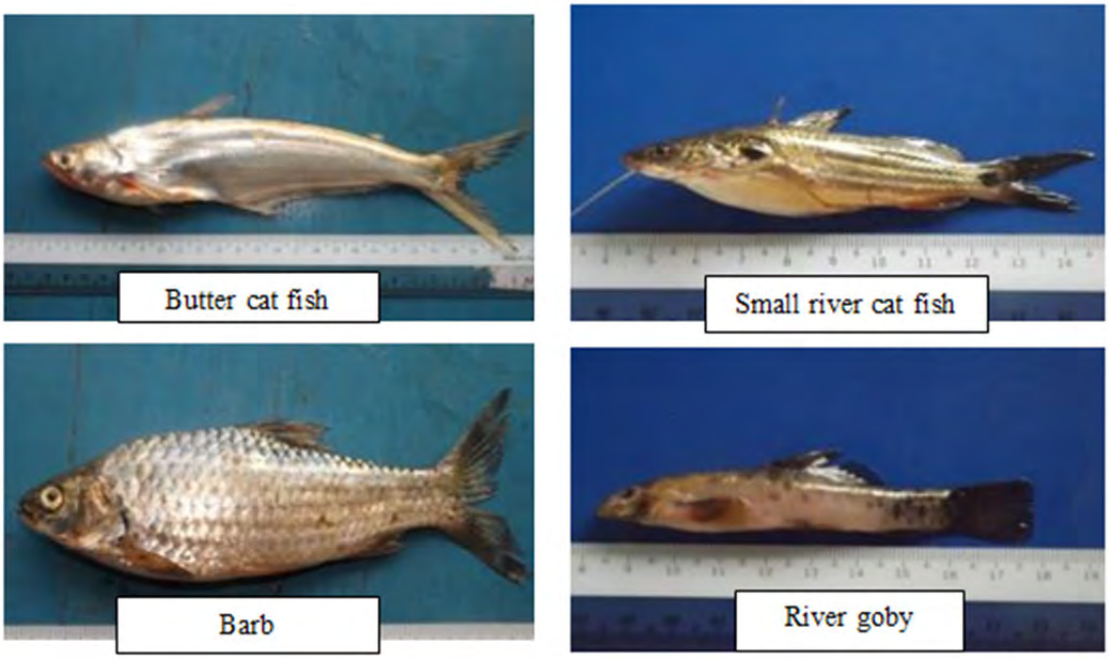
Phytoplankton such as *Spirogyra spp*. was abundant. Zooplankton, such as *Dephnia*, *Moina*, and small crustaceans, was also common. Water hyacinths were also present in the river.

b. Fauna

With the people living on either side of the river in the chosen segment, some frogs such as Sar Phar Gyi (*Rana tigrina*), Kyaw San Kay (*Rana linnocharis*), Phar Gon Hnyin (*Kaloula*

pulchra), and Pha Pyan (*Polypedades leucomystix*), and toads (*Bufo melanostitus*) have been found. The snakes found, such as water snakes, boas, green vipers, and rat snakes, were mostly non-poisonous. The presence of skinks was also reported. There are no fishing activities in the project area, but, based on an interview, tortoises were sometimes caught accidentally in fishing nets in other parts of the Ayeyarwady River.

From the Ayeyarwady River segment between Minkon and Shwe Kyet Yet, about 64 species of freshwater fish belonging to 19 families were recorded with different population abundance. Most of the recorded fish were known to be commonly consumed by the local people in their daily diet. The fishery from Ayeyarwady River provides a partial supply for the fish demand of the people living near the river. According to verbal communications with the local residents, Ayeyarwady dolphins rarely come to this area.



Source: JICA Study Team based on the 2014 JICA F/S report

Figure 1-2-56 Fish Species

Insects such as honey bee, Apis dorsata and Trigona species, butterfly of the family Papalionidae, Pieridae, Hesperidae, Nandidae, and Lycaenidae are recorded. Dragonfly, beetle, grasshopper, firefly, and cricket are also abundant. Under the leaf litter, arachnids (scorpion), centipedes (scolopandra), and millipedes (Julus spp) were observed. As for the benthos organisms, Tritellaspp, Pila globosa, and Pomacea canalacuna are there. A list of aquatic species in the Ayeyarwady River is shown in “Appendix 9 Environmental and Social Considerations”, “9-1 Attachments of Environmental and Social Considerations Survey Works”, “(2) List of Aquatic Species in Ayeyarwady River”.

1-2-3-2 Environmental Impact Assessment

This section describes the potential environmental and social impacts which are expected during the project planning, construction and operation stages. Predictions of the impacts were formulated based on the results of scoping, analysis of the project components and baseline data including field survey results. The results of the environmental and social impact assessment are shown in Table 1-2-66 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 1-2-66 Environmental and Social Impact Assessment

Category	No.	Environmental Item	Scoping			Evaluation			Reason for Evaluation
			P	C	O	P	C	O	
Pollution and Nuisance	1	Air Pollution	D	B-	B-	D	B-	B+/-	C: The project site is located along the riverbank which is far from residential areas but the mobilization route may pass adjacent to urban and residential areas, especially along Myo Patt Road. Mobilization and operation of heavy equipment, construction machinery and trucks will generate exhaust gas and dust from construction activities, possibly causing air pollution. O: Minor level of air quality degradation is expected at the time of port operation. On the other hand, the modal shift from trucks to ships in cargo transportation is expected to contribute to reduction of greenhouse gases such as carbon dioxide.
	2	Water Pollution	D	B-	B-	D	B-	B-	C: Filling may lead to some level of water contamination. However, the magnitude is limited, as sand is planned to be procured from a sand collection company and dredging will not take place in this project. Also, it is not a pollutant and hence the level of impact can be considered to be minor. O: Domestic waste and sewage from passenger and port workers as well as wastewater used after cleaning cargoes can cause water pollution. There is also a possibility of oil spill and leakage of other substances. River water may deteriorate because of maintenance dredging activity, too.
	3	Soil Pollution	D	C	D	D	D	D	C: Soil pollution is not expected because river sand will be used for reclamation work. According to the result of a laboratory test from the Final Report of the 2014 JICA F/S, the river sediment is not contaminated. Concentration of oil and grease is at a negligible level. O: No notable soil pollution is expected from port operation activities.
	4	Waste Disposal	D	B-	C	D	B-	B-	C: Waste may be generated as a result of construction activities and operation of construction camps. However, the level of waste generation is expected to be limited in consideration of the scale of such activities. O: A level of waste may be generated from cargo, ship and port facilities.
	5	Noise and Vibration	D	B-	C	D	B-	D	C: Impact of noise and vibration is expected from construction machinery and equipment but only temporarily. Excavation equipment generates noise that is estimated to be around 111 dBA. That noise level will be attenuated to below 70 dBA 100 metres away from the construction site and below 55 dBA (noise standard level for residential zone, National Emission Guideline) 350 metres away. Residential areas are mostly located out of this area while one religious facility (monastery) exists within it. In general, noise level is expected to be insignificant.

Category	No.	Environmental Item	Scoping			Evaluation			Reason for Evaluation
			P	C	O	P	C	O	
									O: Loading machines and moving vehicles during port operation are expected to generate some level of noise and vibration. However, the impact is expected to be limited given the size and scale of vehicles used and proximity to sensitive receptors.
	6	Ground Subsidence	D	D	C	D	D	D	O: While underground water is expected to be used to some extent for port operation (e.g. washing cargo), the volume of water used is not expected to be large enough to lead to ground subsidence.
	7	Odours	D	D	D	D	D	D	P/C/O: There is no residential area located near the project site nor is there an activity planned to be carried out that may generate a significant level of odour. Hence the impact is considered to be negligible.
Natural Environment	8	Protected Areas	D	D	D	D	D	D	Impact is not expected because there is no protected area in or near the project site.
	9	Ecosystem	D	C	C	D	B-	B-	C: According to the Final Report of the 2014 JICA F/S, Ayeyarwady dolphins rarely come to this area. The list above indicated that none of the fish species in the study area were listed in the IUCN Red List category of endangered fish species for Myanmar, either (www.iucnredlist.org). The species around the project site are common species. Turbid water due to construction works may affect those species; however, its intensity is expected to be limited. O: Ecosystem may be affected if the water becomes largely contaminated as a result of wastewater and other substances from ship and port facilities flowing into the river untreated.
	10	Hydrology	D	C	C	D	D	B-	C: No significant change is expected to the river flow as a result of construction activities. O: According to the Final Report of the 2014 JICA F/S, river flow and speed are expected to decrease under and near the project site, yet no significant change is expected to the river flow.
	11	Topography and Geology	D	D	B+	D	D	B+	C: No impact is expected due to construction activities. O: Jetty construction is expected to lead to a mild reduction of the river flow, which can in turn reduce river bank erosion.
	12	Bottom Sediment	D	B-	B-	D	B-	B-	C: Construction work can disturb bottom sediments but dredging is not expected to take place and hence the level of impact is considered to be limited. O: Port operation can lead to accumulation of sediment in the port area in the long run, which may contain toxic substances.

Category	No.	Environmental Item	Scoping			Evaluation			Reason for Evaluation
			P	C	O	P	C	O	
Social Environment	13	Land Acquisition	B-	D	D	B-	D	D	P: No involuntary resettlement is expected under this project. Nevertheless, land acquisition is likely to take place. Further, a limited number of crops (e.g. peanuts) and structures are expected to be affected.
	14	Local Economy such as Employment, Livelihood, etc.	B-	B+	B+	B-	B+	B+	P: As a result of land acquisition, a limited number of crops and structures are expected to be affected, possibly negatively affecting the livelihood of the people that possess them. C: People, especially local residents, can expect to be employed directly or indirectly by the project (e.g. construction activities and related businesses such as transportation services, trading, and food services), which can heighten their income level. O: Creation of direct and indirect job opportunities associated with the port operation can be expected.
	15	Land Use and Utilization of Natural Resources	D	C	B+	D	D	B+	C: The impact on land use status is limited during construction because the project involves construction of a new inland water port that occupies an area of only approximately 30 acres (12 hectares) on the land, including the area that will be used as a stock yard and for placing other materials only during construction. There will be no impact on utilization of natural resources. O: No activities of port operation are expected to affect agricultural land. The project is expected to improve the access and land use status in the area.
	16	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	D	D	D	D	D	P/C/O: No activity that may change social institutions or local decision-making institutions is expected.
	17	Existing Social Infrastructure and Services	D	C	C	D	B-	B-	C: An increase in the number of vehicles in operation during the construction phase may create traffic jams and delays on Myo Patt Road. But the impact is expected to be insignificant since the scale of construction and number of vehicles are limited. O: An increase in the vehicles may disturb the traffic on Myo Patt Road. Nevertheless, the volume of traffic and vehicles is limited and hence so is the magnitude of expected impact.
	18	Cultural and Religious Heritage	D	D	D	D	D	D	P/C/O: There is only one monastery near the project site and one pagoda north of the site. No impact is expected to either of them.
	19	Landscape	D	D	D	D	D	D	P/C/O: The project is relatively small in scale without any structure planned to be built that may change the landscape.
	20	Ethnic Minorities and Indigenous People	D	D	D	D	D	D	P/C/O: No negative impact is expected on ethnic minorities and indigenous people as they are largely absent.

Category	No.	Environmental Item	Scoping			Evaluation			Reason for Evaluation
			P	C	O	P	C	O	
Social Environment	21	Misdistribution of Benefits and Damages	D	D	C	D	D	D	C/O: Some people and community members may benefit more than others from the project. However, there is no element in the project that is expected to trigger misdistribution of benefits and damages and hence the impact is considered to be negligible.
	22	Working Conditions	D	C	C	D	B+	B+	C/O: Since the project is expected to be carried out based on the environmental management plan with assistance from JICA, working conditions can be expected to better meet national and international requirements.
	23	Water Use/Rights	D	D	D	D	D	D	C/O: The impact of water use/rights is expected to be negligible as a large volume of water is not expected to be used during construction or operation.
	24	Poverty Group	D	B+	B+	D	B+	B+	C/O: Direct and indirect job opportunities are expected to benefit local people including poverty groups (refer to '14 Local Economy such as Employment, Livelihood, etc.').
	25	Local Conflicts of Interest	D	D	D	D	D	D	P/C/O: No factor or situation that generates local conflicts of interest is expected.
	26	Gender	D	D	D	D	D	D	P/C/O: No factor or situation that causes a negative impact on gender is expected.
	27	Rights of Children	D	D	D	D	D	D	P/C/O: No factor or situation that impacts the rights of children is expected.
	28	Infectious Diseases such as HIV/AIDS	D	B-	C	D	B-	D	C: During the construction phase, an influx of construction/immigrant workers into the project area is expected, which can heighten the risk of transmission of infectious diseases. O: During operation, risks of infectious diseases are not expected because there is no influx of workers at that time. While port workers may heighten the risk, the level is expected to be limited due to the limited number of such workers.
Others	29	Accidents	D	B-	B-	D	B-	B-	C: Accidents may take place during construction as a result of various activities. O: Risks of accidents exist during port operation such as loading cargoes and machines and operating vehicles.
	30	Trans-Boundary Impacts and/or Climate Change	D	D	B+	D	D	B+	C: Greenhouse gases such as CO_2 will temporarily increase as a result of use of construction-related machinery, equipment and vehicles. But the impact is expected to be insignificant due to the limited scale of construction. O: The modal shift of cargo transportation from truck to inland ship transportation can contribute to reduction of carbon dioxide and other greenhouse gases contributing to curb the effect of global warming and climate change.

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

1-2-3-2-1 Environmental Mitigation Measures and Cost

This chapter describes the environmental management plan (EMP) with mitigation measures to avoid or minimize potential negative impacts. It focuses on the environmental impacts that had been evaluated as 'B-' (negative impact is expected to some extent) in 'Table 1-2-66 Environmental and Social Impact Assessment'. Table 1-2-67 presents the mitigation measures to be implemented in this project, the organization responsible for implementing the mitigation measure, and the cost needed to implement them.

Table 1-2-67 Mitigation Measures against Project Impacts

No.	Impacts	Mitigation Measures	Implementation Organization	Management Organization	Cost (USD)
Planning Phase					
1.	Land Acquisition	1. Compensation for all affected land, structures and crops in accordance with the ARAP 2. Information disclosure and public consultation to understand the concerns and needs of the PAPs and to relieve their stress 3. Installation of notification board concerning the project at the project site in order to prevent any occupation or use in the project site	DWIR	DWIR	1. USD 1,700,000 *refer to EMOP for cost of consultation meetings
Construction Phase					
1.	Air Pollution	1. Spraying water to suppress dust generated from construction work, site and vehicles carrying construction materials 2. Proper storage of construction materials such as covering sand and gravel that are easily diffused into the atmosphere at construction site and during their transportation 3. Limiting maximum vehicle speed to 20 km/h within the project area 4. Air quality measurement/monitoring	contractor	consultant/DWIR	refer to EMOP for cost of air quality monitoring
2.	Water Pollution	1. Proper storage and collection of used oil and lubrication using a drum 2. Development of rules for waste management and training workers to follow them 3. Development of closed drainage canal to avoid wastewater spreading to river and farmland 4. Installation of sanitary facilities such as temporary toilets or septic tanks at the construction sites 5. Selection of appropriate construction methods which generate less turbidity during pile driving 6. Good maintenance of construction equipment 7. Preparation of a contingency plan against risk of unexpected leakage 8. Water quality measurement/monitoring especially during disposal of dredging material and collection of landfill material	contractor	consultant/DWIR	to be included in construction cost *refer to EMOP for cost of water quality monitoring
3.	Waste Disposal	1. Preparation of a temporary waste dumping site during storage, and prohibition of waste dumping into the river or any other place unless approved by the consultant 2. Appropriate storage of oil residue, including used lubricant 3. Reuse of material in proper ways 4. Proper collection and final disposal of wastes with reference to, and in consultation with, MCDC and its system 5. Development of rules for waste management and training workers to follow them	contractor	consultant/DWIR	to be included in construction cost

No.	Impacts	Mitigation Measures	Implementation Organization	Management Organization	Cost (USD)
4.	Noise and Vibration	1. Development of working rules (e.g. avoid unnecessary use of air horns, keep the speed limit, turn off engines when not in operation) and training drivers and construction workers to follow the rules 2. Avoidance of construction activities that generate high level of noise and vibration during night time 3. Selection of low-noise emission machines and/or installation of silencers and temporary noise barrier (when required) 4. Appropriate maintenance of construction equipment 5. Noise level measurement/monitoring	contractor	consultant/DWIR	to be included in construction cost *refer to EMOP for cost of monitoring of noise level
5.	Ecosystem	Monitoring of turbidity and water pollution in the river during disposal of dredging material and collection of landfill material (refer to '2. Water Pollution')	contractor	consultant/DWIR	to be included in construction cost
6.	Bottom Sediment	Monitoring of sediment quality before and after filling	contractor	consultant/DWIR	refer to '2. Water Pollution'
7.	Land Acquisition	Information disclosure and public consultation to understand the socio-economic status, concerns and needs of the PAPs and to relieve their stress	DWIR/consultant/ contractor	Mandalay Region Government, MOTC and local authorities	refer to EMOP for cost of holding consultation meetings
8.	Existing Social Infrastructure and Services	1. Post traffic warning signs notifying road users that the 'construction site is ahead' and to make people aware of the movement of heavy machines 2. Notification of contents and schedule of construction work 3. Assign flagman for assisting 'entry' to the construction site and 'exit' from the construction site to reduce traffic load	contractor	consultant/DWIR	to be included in construction cost
9.	Sanitary Conditions	1. Installation of sanitary facilities such as temporary toilets or septic tanks at the construction sites and appropriate operation thereof 2. Consultation with MCDC for final disposal of sludge at their sewage disposal facilities	contractor	consultant/DWIR	to be included in construction cost
10.	Infectious Diseases such as HIV/AIDS	Education and awareness-raising of construction workers (and local people, as necessary) about prevention of infectious diseases such as HIV/AIDS	contractor	consultant/DWIR	to be included in construction cost
11.	Accidents	1. Development of, and compliance with, traffic regulations and rules 2. Prevention of outsiders entering construction sites by installing fences and sign boards and arranging guards 3. Preparation of security boats, life jackets, medical boxes, and so on 4. Preparation of proper personal protective equipment (PPE) and provision to workers 5. Proper record and analysis of the cases and causes of accidents 6. Proper lighting of construction sites	contractor	consultant/DWIR	to be included in construction cost

No.	Impacts	Mitigation Measures	Implementation Organization	Management Organization	Cost (USD)
Operation Phase					
1.	Air Pollution	1. Limiting the maximum speed of vehicles to 20 km/h within the project site 2. Air quality measurement/monitoring	port operator	consultant/DWIR	refer to EMOP for cost of air quality monitoring
2.	Water Pollution	1. Development of closed drainage canal to avoid wastewater spreading to river 2. Development of a contained storage area for oil, chemicals and others 3. Consultation with MCDC for final disposal of sludge at their sewage disposal facilities 4. Installation of adequate sanitation system with proper treatment facilities for toilet, canteen and so on 5. Training of workers so that they follow waste management rules (e.g. do not throw waste into the river) 6. Water quality measurement/monitoring	port operator	consultant/DWIR	to be included in operation cost *refer to EMOP for cost of water quality monitoring
3.	Waste Disposal	1. Periodic disposal of waste in cooperation with MCDC 2. Training of workers so that they follow waste management rules (e.g. do not throw waste into the river)	port operator	consultant/DWIR	to be included in operation cost
4.	Ecosystem	Refer to '2. Water Pollution'.	port operator	consultant/DWIR	to be included in operation cost
5.	Hydrology	Monitoring and regular dredging to prevent sedimentation and to maintain smooth river flow	port operator	consultant/DWIR	to be included in operation cost
6.	Bottom Sediment	Refer to '2. Water Pollution' and '5. Hydrology'.	port operator	consultant/DWIR	to be included in operation cost
7.	Sanitary Conditions	1. Consultation with MCDC for final disposal of sludge at their sewage disposal facilities 2. Installation of adequate sanitation system with proper treatment facilities for toilet, canteen and so on 3. Training of workers so that they follow waste management rules	port operator	consultant/DWIR	to be included in operation cost
8.	Accidents	1. Development of, and compliance with, working rules, traffic regulations and rules through education. 2. Enforcement of workers' use of PPE 3. Installation of proper signboard for safety and security 4. Preparation of security boats, life jackets, medical box and so on 5. Proper record and analysis of the cases and causes of accidents	port operator	consultant/DWIR	to be included in operation cost

Source: JICA Study Team

1-2-3-2-2 Environmental Monitoring Plan

Monitoring activities are crucial to securing a steady implementation of the mitigation measures stipulated in the EMP and to checking the actual status regarding the potential adverse impact items. Table 1-2-68 shows the proposed environmental monitoring plan for planning, construction and operation stages of the project, which was prepared for the impact items that may have negative impact. It shows the items, location, monitoring frequency and organizations that are responsible for the monitoring activity.

Table 1-2-68 Environmental Monitoring Plan

No.	Category	Monitoring Item	Location	Frequency	Implementation Organization	Management Organization	Cost (USD) per year
Planning Phase							
1.	Land Acquisition	1. progress of provision/payment of compensation and social assistance 2. level of information disclosure and public involvement 3. voices and complaints from PAPs 4. state of project site	project site and surrounding area	biweekly during ARAP implementation stage	DWIR	Mandalay Region Government, MOTC and local authorities	to be included in operation cost
Construction Phase							
1.	Air Pollution	NO_2, SO_2, PM (PM_{10} and $PM_{2.5}$) and ozone, micro-climate (temperature, humidity, wind speed and direction, etc., for reference)	2 points (same places as the baseline survey, in principle)	biannually	contractor	consultant/DWIR	USD 4,000 (USD 1,000 * 2 points * 2 times)
2.	Water Pollution	1. BOD, COD, oil & grease, pH, total coliform, total nitrogen, total phosphorus and TSS 2. turbidity during filling by visual observation	2 points (same places as the baseline survey, in principle) downstream of filling area	1. biannually 2. every day during filling	contractor	consultant/DWIR	USD 4,000 (USD 1,000 * 2 points * 2 times) to be included in construction cost
3.	Waste Disposal	1. volume, type and place of disposal of domestic and industrial waste 2. voices and complaints from local community	project site and surrounding area	monthly and whenever complaints are heard in this regard	contractor	consultant/DWIR	to be included in construction cost
4.	Noise and Vibration	1. LAeq 2. *measurement is considered necessary for noise only 3. voices and complaints from local community	2 points (same places as the baseline survey, in principle) project site and surrounding area	biannually and whenever complaints are heard in this regard	contractor	consultant/DWIR	USD 4,000 (USD 1,000 * 2 points * 2 times) to be included in construction cost
5.	Ecosystem	Refer to '2. Water Pollution' above.					
6.	Bottom Sediment	sediment quality before and after filling	downstream of filling area	every day during filling	contractor	DWIR	to be included in construction cost
7.	Land Acquisition	1. extent of livelihood and income restoration 2. level of information disclosure and public involvement 3. level of satisfaction of the PAPs	project site and surrounding area	biannually and whenever complaints are heard in this regard	DWIR/consultant/ contractor	Mandalay Region Government, MOTC and local authorities	USD 2,000 (USD 1,000 * 2 times) for public consultation

No.	Category	Monitoring Item	Location	Frequency	Implementation Organization	Management Organization	Cost (USD) per year
8.	Existing Social Infrastructure and Services	voices and complaints from local community	project site and surrounding area	biannually and whenever complaints are heard in this regard	DWIR/consultant/ contractor	Mandalay Region Government, MOTC and local authorities	
9.	Sanitary Conditions	1. state of sanitary facilities (e.g. toilets, septic tanks and rubbish bins) 2. voices and complaints from local community	project site and surrounding area	monthly and whenever complaints are heard in this regard	contractor	consultant/DWIR	to be included in construction cost
10.	Infectious Diseases such as HIV/AIDS	number of infected patients voices and complaints from local community	project site and surrounding area	biannually and whenever complaints are heard in this regard	contractor	consultant/DWIR, MOTC, MOH, Mandalay Region Government and local authorities	to be included in construction cost
11.	Accidents	1. record of number and type of accidents 2. record of safety awareness training and campaigns 3. state of use of PPE 4. state of safety equipment (e.g. fencing, sign boards, guards, security boats, life jackets, medical boxes, etc.)	project site and surrounding area	monthly	contractor	consultant/DWIR	to be included in construction cost
Operation Phase							
1.	Air Pollution	NO_2, SO_2, PM (PM_{10} and $PM_{2.5}$) and ozone, micro-climate (temperature, humidity, wind speed and direction, etc., for reference)	2 points (same places as the baseline survey, in principle)	annually for the first two years	port operator	consultant/DWIR	USD 2,000 (USD 1,000 * 2 points)
2.	Water Pollution	BOD, COD, oil & grease, pH, total coliform, total nitrogen, total phosphorus and TSS	2 points (same places as the baseline survey, in principle)	biannually for the first two years	port operator	consultant/DWIR	USD 4,000 (USD 1,000 * 2 points * 2 times)
3.	Waste Disposal	1. volume, type and place of disposal of domestic and industrial waste 2. voices and complaints from local community	project site and surrounding area	annually and whenever complaints are heard in this regard	port operator	consultant/DWIR	to be included in operation cost
4.	Ecosystem	refer to '2. Water Pollution'.					
5.	Hydrology	dredging schedule and work	project site and surrounding area	during and before dredging	port operator	consultant/DWIR	to be included in operation cost

No.	Category	Monitoring Item	Location	Frequency	Implementation Organization	Management Organization	Cost (USD) per year
6.	Bottom Sediment	refer to '2. Water Pollution' and '6. Hydrology'.					
7.	Sanitary Conditions	1. state of sanitary facilities (e.g. toilets, septic tanks and rubbish bins) 2. voices and complaints from local community	project site and surrounding area	annually and whenever complaints are heard in this regard	port operator	consultant/DWIR	to be included in operation cost
8.	Accidents	1. record of number and type of accidents 2. state of use of PPE 3. state of safety equipment (e.g. fencing, sign boards, guards, security boats, life jackets, medical boxes, etc.)	project site and surrounding area	biannually	port operator	consultant/DWIR	to be included in operation cost

Source: JICA Study Team

1-2-3-2-3 Implementation Structure

Carrying out environmental management for the project involves a number of participants, each with different responsibilities and interests. In particular, DWIR, supported by MOTC and concerned 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, followed by figures showing the implementation structure in the construction stage and operation and maintenance stages of the project.

(1) DWIR

DWIR is the project proponent and leading body with the responsibility to soundly execute the project. The organization carries overall responsibility for managing any adverse social and environmental impacts that are generated from the project. In the implementation stage, DWIR will carry out such activities directly (e.g. listen to the complaints of local people and take necessary measures) or in cooperation with other government or non-governmental bodies such as MOTC, Mandalay Region Government, GAD, Department of Settlement and Land Management and Statistics, and appointed consultants and contractors (e.g. carry out air quality measurement at three locations).

(2) Ministry of Transport and Communications

As the supervising body of DWIR, MOTC will support DWIR in, *inter alia*, implementing the EMP, especially matters related to land acquisition and other social issues that require cooperation with the regional government and other concerned government bodies. Formal communications between DWIR and ECD need to be made via the appropriate ministries (i.e. MOTC and MONREC) and hence, while such occasions are considered to be fewer compared to those at the pre-construction stage, close coordination between DWIR and MOTC is important in this regard. The budget for compensation of the project also needs to be requested to the union government via MOTC.

(3) Engineer (Consultant)

The consultant will supervise the contactor in implementing environmental mitigation measures and monitoring. When problems arise, the consultant will give instructions to the contractor in consultation with DWIR to address the issues. The consultant will carry out environmental monitoring and inspection of the construction work and report to DWIR. The consultant will also support DWIR in preparing an environmental monitoring report that is submitted to MONREC and JICA, as required by the EIA Procedure (2015) and JICA Environmental Guidelines.

(4) Contractor

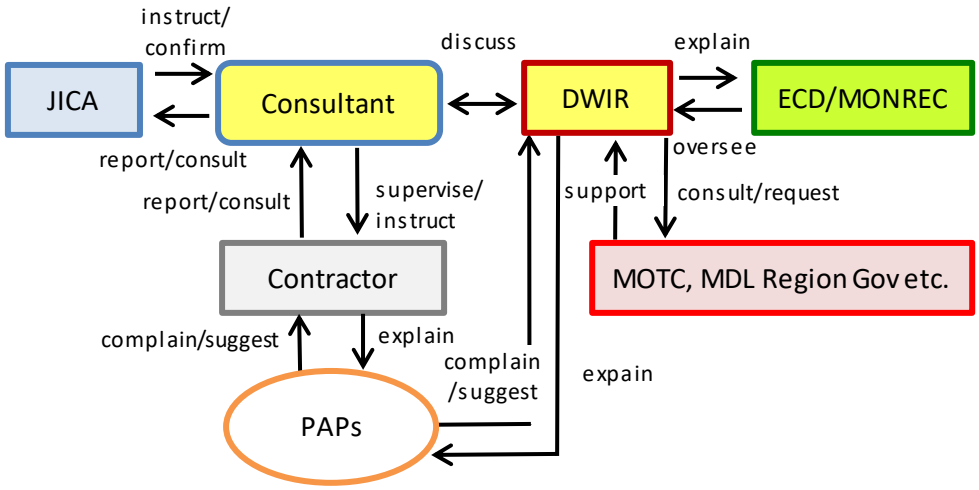
A contractor will be selected by DWIR to carry out the construction work. The contractor is the major executing body for environmental management and protection. They will carry out such works under the instruction of DWIR through the engineer/consultant. It is the contractor's obligation to strictly follow the EMP which includes environmental mitigation measures and environmental monitoring during construction. It must also report promptly to DWIR 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 DWIR as found necessary during and after implementation of the project, primarily by reviewing the monitoring reports.

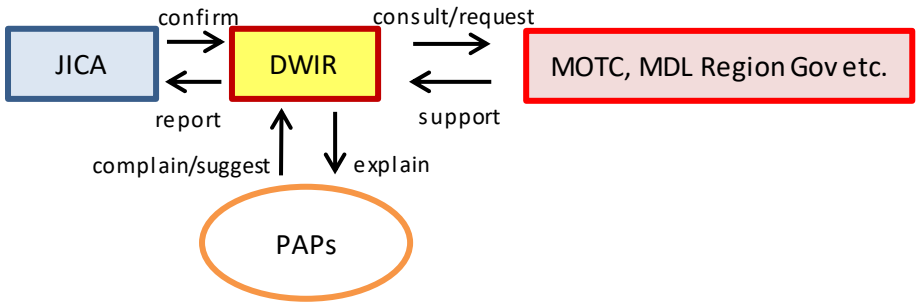
(6) Line Agencies

The local government (e.g. Mandalay Region Government, GAD and DALMS) 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 and conflict resolution in particular in the implementation stage. Close cooperation with the local authorities such as MCDC is also crucial to dealing with and solving site-specific concerns or other complaints related to waste management and others from the local community.



Source: JICA Study Team

Figure 1-2-57 mplementation Structure (construction stage)



Source: JICA Study Team

Figure 1-2-58 Implementation Structure (operation stage)

1-2-3-2-4 Stakeholder Consultation

(1) Requirements under EIA Procedure (2015)

With regards to public consultation and disclosure, Article 34 and 38 of the EIA procedure (2015) requires the project proponent to:

> *a. immediately upon commencement of the IEE, disclose relevant information about the proposed Project to the public and civil society through the Project's or Project Proponent's website(s) and local media, including by means of the prominent posting of legible sign boards at the Project site which are visible to the public, and comply with technical guidelines issued by the Ministry;*
> *b. arrange the required complement of consultation meetings as advised by the Ministry, with local communities, potential PAPs, local authorities, community based organizations, and civil society, and provide appropriate and timely explanations in press conferences and media interviews; and*
> *c. not later than fifteen (15) days after submission of the IEE Report to the Department… disclose the IEE Report to civil society, PAPs, local communities and other concerned stakeholders: (i) posting on the Project's or Project Proponent's website(s), (ii) by means of local media (i.e. newspapers); (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:

a. Information disclosure on the project upon commencement of the IEE
b. Stakeholder meeting to disclose the result of the IEE upon preparation of the IEE report (draft)
c. Disclosure of the IEE report after submission to ECD

(2) Information Disclosure on the Project upon Commencement of the IEE

Information about the project was disclosed widely in accordance with the EIA Procedure (2015) and JICA Environmental Guidelines at an early stage of the study. A notification in both English and Burmese was put up at the township and ward GAD offices and related department offices and DWIR's webpage (http://dwir.gov.mm/index.php/news-events/advertisement) in June 2017 upon commencement of the IEE. The notification included information on: description of the project, public consultation meeting, the project proponent and contact person, and cut-off date.

(3) Stakeholder Meeting upon Preparation of the IEE Report (draft)

A stakeholder meeting for the project was held by DWIR on June 27, 2017 with the following purpose, manner and information.

1) Purpose of the Stakeholder Meeting

a. to raise PAPs' and other stakeholders' awareness and understanding towards the project including its necessity and possible positive/negative impacts;
b. to allow PAPs and other stakeholders to be informed about the way in which the IEE was carried out, as well as the result and conclusion of it; and
c. to allow all stakeholders to have the opportunity to express their views and opinions so that they could be reflected to the project design and implementation.

2) Methodology of the Stakeholder Meeting

Notification of the meeting was published in two different newspapers (i.e. *The Mirror* and *Myanmar Alin*). In addition, DWIR made invitations and sent them to the local community, relevant government officials and private companies located near the project site.

3) Content of the Stakeholder Meeting

The stakeholder meeting was held from 10 am to 12 pm on June 27, 2017 with active participation of the people potentially affected by the project (i.e. PAPs) in addition to relevant government organizations including ECD/MONREC and regional governments, community-based and social organizations and the media. DWIR, in consultation with the IEE consultant, chose Damaha Hall, located near the project site, as the venue, in consideration of the proximity to the project site, accessibility for the local people and its size and capacity. The input received from the participants have informed, *inter alia*, the finalizing of the impact evaluation, environmental mitigation measures including means of compensation, and environmental monitoring plans. A record of the stakeholder meeting, including a list of participants, is shown in "Appendix 9 Environmental and Social Considerations", "9-1 Attachments of Environmental and Social Considerations Survey Works", "(3) Record of the Stakeholder Meeting". The number of attendees at the meeting is summarized in Table 1-2-69 below.

Table 1-2-69 Attendees of Stakeholder Meeting

No	Category	Number of Participants
1	Local People	17
2	NGO & INGOs	5
3	Private Company	7
4	Parliament members	4
5	Government Officials	24
6	Media	17
	Total	74

Source: JICA Study Team

The stakeholder meeting was held in accordance with the following agenda:

a. Opening Ceremony
b. Introduction to the Project by U Aung Myo Khaing (Deputy Director, Directorate of Water Resources and Improvement of River Systems)
c. Environmental and Social Issues related to the Project by U Aye Thiha (Managing Director, E Guard Environmental Services Co., Ltd.)
d. Announcement of Cut-off Date by U Aung Myo Khaing (Deputy Director, Directorate of Water Resources and Improvement of River Systems)
e. Questions and Answers
f. Closing Remarks by U Toe Aung Lin (Deputy Director, Directorate of Water Resources and Improvement of River Systems)
g. Closing Ceremony

According to the Agenda, U Aung Myo Khaing of DWIR introduced the project to the floor by explaining: the purpose of the stakeholder meeting, the project background, the project objective and proponent, the project location, project components, and the project schedule, using a PowerPoint presentation.

The IEE consultant then explained about: the environmental type of the project (i.e. IEE or EIA or others), the IEE consultant, relevant laws and regulations, the environmental baseline condition, project alternatives, terms of reference of the IEE survey, results of the IEE survey, expected environmental impact, mitigation measures, and the monitoring plan.

In the question and answer session, questions ranged from compensation, issues some of the people were having with a private company over land, and the owner of the port (i.e. private or public). DWIR and the IEE consultant gave an answer to each of them. In the end, one of the parliament members expressed his opinion saying that the project could be considered beneficial to the people and hence should be supported by the local people for implementation.

(4) Disclosure of the IEE Report after Submission to ECD

DWIR has made the IEE report available to interested parties and the general public within 15 days of its submission to ECD/MONREC at the following locations: DWIR headquarters in Yangon, its branch office in Mandalay, and Amarapura Township GAD Office in Mandalay. In addition, DWIR plans to make it available on their webpage but this has not been the case yet due to the resignation of an IT person in August 2017[5].

1-2-3-3 Land Acquisition and Involuntary Resettlement

1-2-3-3-1 Introduction

This ARAP has been prepared for the proposed project based on the following: a thorough review of the relevant laws and regulations in Myanmar, including international treaties and guidelines that are of relevance to the project; the latest project design; and a baseline survey that consists of a census survey, lost-asset inventory survey and socio-economic survey. Only those that have been recorded before the eligibility 'cut-off' date have been understood to be affected by the project and so were the plots of land that have formally been registered under DALMS (i.e. those people with 'Form 7' issued by DALMS) with regards to the land[6].

1-2-3-3-2 Necessity of Land Acquisition and Resettlement

The project involves construction of a new inland water port. Effort to avoid involuntary resettlement was made primarily during the 2014 JICA F/S by selecting a site that could minimize such impact. Consequently, no involuntary resettlement is expected to take place under this project and only huts, crops and other assets are to be affected. Refer to '1-2-3-1-2 Major Components of the Project' for the main components of the project that are expected to generate environmental impacts and '1-2-3-1-5 Comparison of Project Alternatives' for more details of how involuntary resettlement has been avoided.

[5] A new IT person is to be employed from November, 2017.

[6] According to the Farmland Law (2012), 'alluvial land' refers to land that has been flooded in the past and its land texture and location can vary in accord with the water channel (section 3c) and the rights to sell, pawn, lease, exchange, or donate, in whole or in part, the right for farming in accord with prescribed disciplines cannot be enjoyed for such alluvial land (section 10). In a strict sense, therefore, even those with Form 7 may not be considered holding legal rights over the land. However, it is considered necessary by international practice to recognize such rights of the people given that they have been, and can be expected to continue, enjoying such rights were the project not to take place. It is also considered just to respect their land title, provided that such rights have been recognized by the government (i.e. DALMS).

1-2-3-3-3 Legal Framework related to Land Acquisition and Resettlement

(1) Overview

There is no legislation, policy or guidelines in Myanmar that provide a comprehensive understanding of people's rights over different types of land. Several different legislations stipulate the requirements related to involuntary resettlement, land acquisition and compensation, separately, and they are not necessarily in accord. The Land Acquisition Act, enacted in 1894, still serves as the legal basis for land acquisition in Myanmar. It requires compensation to be provided to the land owner in case their land is taken over by the government. The Farmland Law (2012), which repealed the Land Nationalization Act (1953), on the other hand, depicts the procedures for nationalization of farmlands and conversion of farmlands to other purposes (La Na 39). The Farmland Rules (2012) clearly present how compensation and support needs to be made in the country for farmland, crops and other assets on the farmland in case they are affected by a project. While these legislations exist, there is no comprehensive legislation concerned with involuntary resettlement, land acquisition and compensation, and the procedures and conditions to be met are not depicted in sufficient detail.

(2) Laws and Regulations in Myanmar concerned with Land Acquisition and Involuntary Resettlement

The laws, regulations, policies, guidelines and others in Myanmar that are concerned with involuntary resettlement, land acquisition, and compensation and social support that the project is bound to follow, or needs to take into consideration, are described below.

1) Constitution of the Republic of the Union of Myanmar (2008)

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 included in the Constitution and are summarized below:

a. The Union is the ultimate owner of all lands and all natural resources above and below the ground, above and beneath the water and in the atmosphere in the Union (Section 37);
b. The Union shall enact necessary law to supervise extraction and utilization of State owned natural resources by economic forces (Section 37);
c. 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
d. The Union shall protect the privacy and security of home, property, correspondence and other communications of citizens under the law subject to the provisions of this Constitution (Section 357).

2) Land Acquisition Act (1894)

In accordance with this law, the government holds rights to take over the land provided that compensation is made to the original land owner. No private ownership of land is permitted and all land must be leased from the Union State. Nevertheless, Article 3 of the Act also stipulates that a person who has rights in land would be entitled to claim compensation if the land was acquired under this Act and that the following shall be considered in determining the amount of compensation to be made: the market value of the land; damage to trees and crops, and movable/immovable properties lost; inconvenience due to change in residence or business; and any diminution of profits of the land.

3) Farmland Law (2012)

The most relevant clauses for this project in the Farmland Law are described as follows.

a. The following expressions contained in this Law shall have the meaning given hereunder (section 3):
   - 'farmland' means such designated lands as paddy land, ya land, kiang land, perennial plant land, dhani land, garden land, land for growing of vegetables and flowers, and alluvial land. In this expression, it does not include land situated within any town or village boundary used for dwelling, religious building and premises, or publicly owned land which is not used for an agriculture purpose (Section 3a); and
   - 'alluvial land' means land that has flooded yearly and its land texture and location can vary in accord with water channel (Section 3c).

b. The following rights shall be enjoyed in connection with the right for farming (section 9):
   - the right to sell, pawn, lease, exchange, or donate, in whole or in part of the right for farming in accord with prescribed disciplines (section 9b).

c. The provisions under sections 4, 5, 6, 7, 8 and 9 of this law shall not apply to the allocation of alluvial land (Section 10).

d. Notwithstanding any provision contained in any other existing law, the Central Farmland Management Body must coordinate for suitable compensation and indemnity in the case of repossession of farmland either in the interest of the State or in the interest of the public. Confiscated farms are to be compensated without any loss. If a farm is upgraded with building, it is required to compensate for such building (Section 26).

e. Whosoever shall not be entitled to receiving compensation if the right for farming or farmland was revoked by the Central Farmland Management Body in accordance with subsection (d) of section 17of this Law (Section 27).

f. In the long-term national interest of the State, the respective Ministry shall utilize the farmland for the Project, based on permission of the Cabinet of the Union Government after getting the remarks of the Central Farmland Management Body (Section 29).

4) Farm Land Rules (2012)

The most relevant clauses under the Farmland Rules (2012) are as follows:

a. If the farmland is requisitioned under farmland law for the interest of the state or the public, the grievance and compensation for improving the farmland with buildings on the said farmland by the person who receives the right to work farmland in the improvement made by the original person who receives the right to work farmland, without delay from the concern, the Central Farmland Management Committee shall conduct as necessary (Section 64[7]); and

b. 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 (Section 67):

[7] The expression used in the original text of the translated legislation is used in this report to the extent possible.

Grievances for Crops and Buildings

- Three times the local current market price based on the yield per acre for paddies and other crops grown;
- Three times the local current market price for perennial crops currently grown; and
- Two times the local current market price for facilities and other activities aimed at improving the farmland

Compensation for Land

- Local current market price of the farmland 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
- In case of land requisition for profitable business activities that are for the long-term interest of the State, in order to avoid losses incurred by the person who has the right to work on the farmland, 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

c. The right to work in alluvial land is granted on a yearly basis (Section 103).

d. It shall be pre-arranged to grant the right to work alluvial land for one season of a year before the flooding covers to meet the annual summer plough work (Section 104).

e. Anyone who gets the right to work alluvial land shall pay only land tax without paying registration fees as he gets the right to work for one season within a year (Section 112a).

5) The Conservation of Water Resources and Rivers Law (2006)

According to the law:

a. Bank boundary means steep or sloped banks between the lowest water level and highest water level (Section 2 (g)) and waterfront boundary means the land area adjoining the bank boundary prescribed in accordance with the law to carry out the works of bank protection, waterway training and river-creek improvement (Section 2 (h));

b. No person shall carry out growing of a garden, digging, filling, silt trapping, closing pond, dyke building or erecting spur in the river-creek boundary, bank boundary or waterfront boundary without the permission of the relevant government department and organization (Section 12); and

c. No one shall, (b) without the permission of the Directorate, build structures in the river-creek boundary, bank boundary or waterfront boundary (Section 23).

6) Conservation of Water Resources and Rivers Rules (2013)

According to the rules:

a. 'Jetty area' means a jetty area boundary up to 150 feet inland from the bank, at the highest river level during highest tide or highest water level at the time of river water rising if there was no specific notification from the Ministry of Transport (now MOTC) to berth vessels for passengers to embark and disembark and cargoes to be loaded and unloaded (Section 2d);

b. The Directorate of Water Resources and Improvement of River Systems have the authority, under the guidance of the Ministry of Transport (now MOTC), over land area attained due to river extension and earth filling according to the requirement of the conservation of water resources and river-creek related to the river area, bank area, waterfront area and port area (Section 5f); and

c. The recommendation or giving of permission for any business, according to the laws and rules within the river-creek boundary, bank boundary and waterfront boundary, is only for the permission to use and is not concerned with land ownership (Section 92).

(3) Comparison between Myanmar Legislations and JICA Environmental Guidelines related to Land Acquisition and Resettlement

The following table presents a comparison between the existing Myanmar legislation and the JICA Environmental Guidelines / The World Bank's (WB's) safeguard policy with regards to land acquisition and involuntary resettlement.

Table 1-2-70 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 legislation in Myanmar 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. In fact, the project site has been selected for this project as a result of an effort to avoid involuntary resettlement and loss of means of livelihood.
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).	1. The Land Acquisition Act of 1894 (Article 3) stipulates that a person who has right in land would be entitled to claim compensation if the land was acquired under this Act. 2. The Farm Land Law of 2012 (Article 26) stipulates that suitable compensation and indemnity in farmland acquisition for the interest of the State or public would be taken. 3. The Farm Land Rules (Article 66) stipulate the necessity of giving indemnity and compensation by the central government in case the farmland is to be confiscated for the interests of the nation.	Article 3 of the Land Acquisition Act and Article 26 of the Farm Land Law do not mention the necessity of taking effective measures to minimize the impact.	No involuntary resettlement is expected to take place in this project. Effective measures to minimize the impact and to compensate for the losses will be taken in consideration with the socio-economic conditions and needs of the PAPs and in consultation with relevant government agencies.

No.	JICA Environmental Guidelines / WB OP 4.12	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
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).	1. The Land Acquisition Act (1894) stipulates that the following shall be considered in determining the amount of compensation to be given: 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. In addition, Article 23 (2) states that 15% of the market value of such lost properties shall be paid in view of the compulsory nature of the acquisition. 2. The Farm Land Rules (Article 67) address indemnity (crop and structure) and compensation (land) calculation form for agricultural land.	There is no stipulation of improving or at least restoring living standard, income opportunities, and production levels to pre-project levels in the legislations in Myanmar.	Assistance will be provided to the PAPs to improve or restore their livelihood to at least pre-project level.
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, market value. It also stipulates that compensation shall be calculated based on the market value of the land at the date of the publication of the notification. (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 consideration of 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 timing of compensation payment in the Myanmar legal framework.	Properties and crops to be affected by the project will be compensated at full replacement cost which generally consists of 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 in Myanmar that mentions or requires preparation and publication of a resettlement action plan.	An ARAP has been prepared reflecting the views of the PAPs. No involuntary resettlement is expected.

No.	JICA Environmental Guidelines / WB OP 4.12	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
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).	Not specified under the legislations in Myanmar	There is no regulation in Myanmar that mentions or requires holding consultations with the PAPs in advance.	A stakeholder meeting has been held with the PAPs and other stakeholders in Burmese and with visual aids.
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 in Myanmar that mentions or requires holding consultations with the PAPs in a language understandable to the PAPs.	A stakeholder meeting has been held with the PAPs and other stakeholders in Burmese and with visual aids.
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 in Myanmar that mentions or requires participation of the PAPs in the planning, implementation and monitoring of the resettlement action plans.	A stakeholder meeting has been held with the PAPs and other stakeholders in a timely manner.
9.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities (JICA Environmental Guidelines).	1. Land Acquisition Act of 1894 (Article 5A and 18) Article 5A of the Land Acquisition Act stipulates that the objection to acquisition of land is to be heard by the collector within thirty days of the notification. Article 18 of the Land Acquisition Act stipulates that objection to the amount of compensation, the persons to whom it is payable or the apportionment of the compensation among the persons interested are submitted to the Court within six weeks of the notice from the Collector or within six months from the date of the Collector's award, whichever period shall first expire. 2. Farm Land Rules (Article 68) stipulates that the concerned region/state farmland management body shall manage the complaints and the central farmland management body shall monitor and negotiate as appropriate.	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 by utilizing the existing administrative mechanism so that it can be both convenient and accessible for the PAPs.

No.	JICA Environmental Guidelines / WB OP 4.12	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
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 locality being considered. (Land Acquisition Act (1894) Article 4)	Article 4 of the Land Acquisition Act does not state the details of the surveys to establish eligibility through an initial baseline survey (including population census) nor does it mention identification and record of affected people as early as possible.	A baseline survey that consists of: a census survey, lost-asset inventory survey and socio-economic survey has been carried out and a cut-off date declared at the stakeholder meeting inviting PAPs.
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).	The Land Acquisition Act of 1894 (Article 4) stipulates regarding the occupier (if any) that land and all persons known or believed to have rights on lands are notified or invited for explanations.	Detailed procedures as well as eligibility criteria are not defined under the laws in Myanmar. There is no specific indication about displaced persons without titles either.	The legal statuses of those that are expected to be affected by the project have been identified within the study and their eligibility to receive compensation and support established based on their legal and other statuses.
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.	No involuntary resettlement is expected in this project – only land acquisition. Methods of compensation will be prepared in consideration of the preference and/or situation of the PAPs and in consultation with relevant government agencies.
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 in Myanmar that requires providing support to the PAPs for the transition period.	Support will be provided to the PAPs for the transition period.

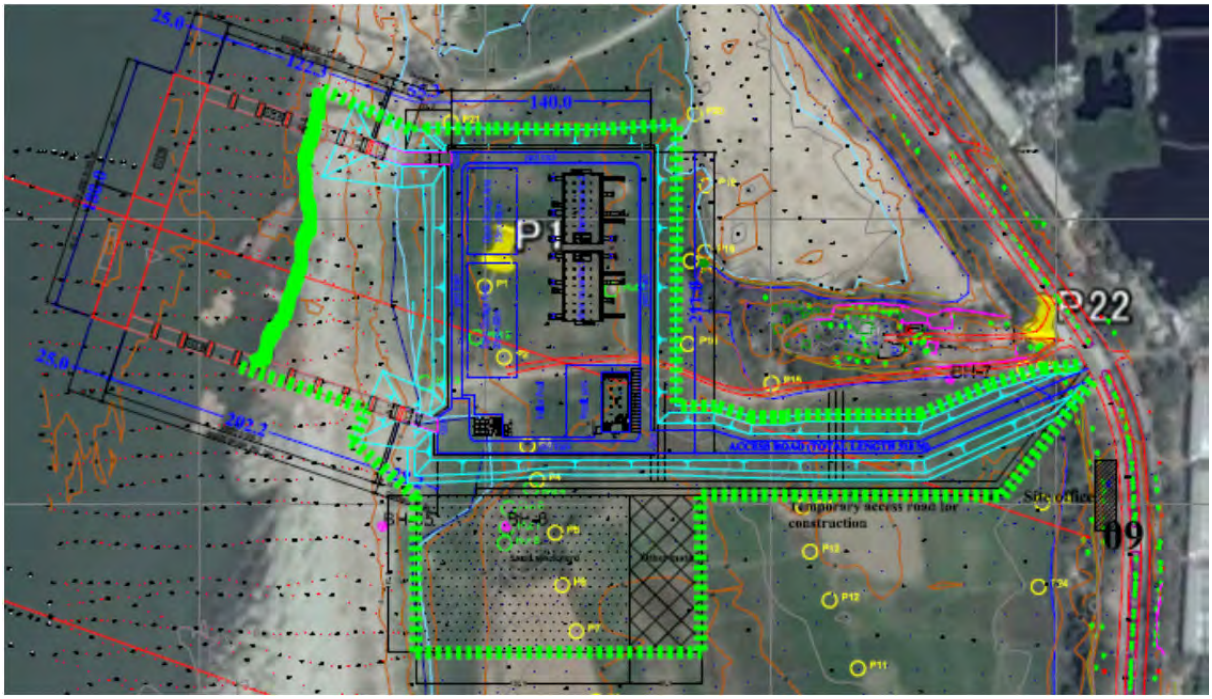
No.	JICA Environmental Guidelines / WB OP 4.12	Laws and Policies in Myanmar	Difference	Policy Applied to the Project
14.	Particular attention must be paid to the needs of the vulnerable groups especially those below the poverty line, landless, elderly, women and children, ethnic minorities, etc. (WB OP 4.12 Para.8).	Not specified in Myanmar legislations	There is no regulation in Myanmar that requires providing support to vulnerable groups.	The project pays particular attention to vulnerable groups. But no particular vulnerable groups that require special support have been identified in this project.
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 in Myanmar that stipulates preparing an abbreviated resettlement plan.	An ARAP will be prepared since the project has fewer than 200 PAPs in accordance with WB OP 4.12.

Source: JICA Study Team

1-2-3-3-4 Scale and Extent of Land Acquisition, Involuntary Resettlement, and Assets Lost

The census survey and socio-economic survey were carried out from May 2 to 5, 2017 by interviewing the PAPs using carefully designed questionnaires. The surveys were carried out in consultation with, and with substantial support from, the township and ward GAD officers and officers from DALMS at the township level. The two surveys allowed understanding the number of people directly affected by the project and their socio-economic characteristics.

The lost-asset inventory survey, on the other hand, was conducted by delineating the project-affected area as the survey area and recording by visual observation, in the presence of the owners of the crops and other assets affected, what would fall within the area. This survey was carried out from May 1 to 5, 2017. The boundary of the plots of land was confirmed based on the record of, and in the presence of officers from, DALMS. The locations of the boundaries of the land and those of other assets were recorded using a geographical positioning system (GPS). The survey area, the area expected to be affected by the project, was defined in a way that surrounds the area planned to be utilized by the project, including the area that will be used only during construction (i.e. green line in Figure 1-2-59 below). The land size is approximately 29.7 acres.



Source: JICA Study Team based on Google Earth

Figure 1-2-59 Baseline Survey Area

(1) Overview of Project-affected Persons and Assets

All properties that fall within the survey area, or project-affected area of 29.7 acres, as well as the socio-economic characteristics of the PAPs, have been identified and recorded.

As a result, the total number of project-affected households (PAHs) has been found to be three (21 PAPs in total) and one company. One PAH (i.e. PAH 1) will lose a plot of land and crops. Another PAH (i.e. PAH 2) will have her crops and two huts affected. The last PAH (i.e. PAH 3) is expected to lose her land, crops and hut due to the project. In addition, one company will have its land, registered under DALMS, affected. The owners of four huts and one ship could not be identified. In consideration of the fact that the area becomes underwater during the rainy season and the state of the ship, which does not appear to be in operation, it is possible that the owners have abandoned them.

When looking at the same picture from the point of view of assets lost, it can be said that: three plots of agricultural land, approximately 15.6 acres in total; approximately 9.2 acres of crops (i.e. butter beans and peanuts); seven huts; and one ship are expected to be affected by the project. A summary of the affected assets and households are presented in Table 1-2-71.

Table 1-2-71 Summary of Project-Affected Land and Assets

Item	Type	Owner	Size / Quantity	Location	Remarks
Land	Farmland	PAH 1	0.440 acres	L1	Plot No. 16
		PAH 3	0.734 acres	L2	Plot No. 9
		Company	14.435 acres	L3	Plot No. 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 22+24, 23+25
Crops	Peanut	PAH 1	0.440 acres	F1	
	Butter Bean	PAH 2	3.000 acres	F2	
	Butter Bean	PAH 3	0.734 acres	F3	
	Peanut / Butter Bean	PAH 3	5.032 acres	F4	Peanut (1.032 acres) and Butter Bean (4.000 acres)
Structures	Hut	PAH 3	15 ft x 25 ft (Height 7 ft)	H1	stay for up to 9 months a year
		PAH 2	7 ft x 6 ft (Height 6 ft)	H2	stay for up to 9 months a year
		PAH 2	8 ft x 7ft (Height 7 ft)	H3	stay for up to 9 months a year
		-	10 ft x 7 ft (Height 6 ft)	H4	
		-	7 ft x 7ft (Height 7 ft)	H5	
		-	7 ft x 7ft (Height 7 ft)	H6	
		-	10 ft x 12 ft (Height 7 ft)	H7	

[1] Farmers stay in the area using the huts to grow and monitor crops during the dry season. They have a residence elsewhere and hence do not stay or live there continuously during the period.

Source: JICA Study Team

(2) Project-affected Persons

1) Demographic Profile

The demographic profile of the PAPs is described below.

a. Gender Distribution

The total number of PAHs is three, composed of a population of 21. The 21 people are comprised of 12 females and nine males. Gender distributions of the PAPs are shown in Table 1-2-72.

Table 1-2-72 Gender Distribution of the PAPs

Gender	Number of People (%)
Male	9 (45%)
Female	12 (55%)
Total	21 (100%)

Source: JICA Study Team

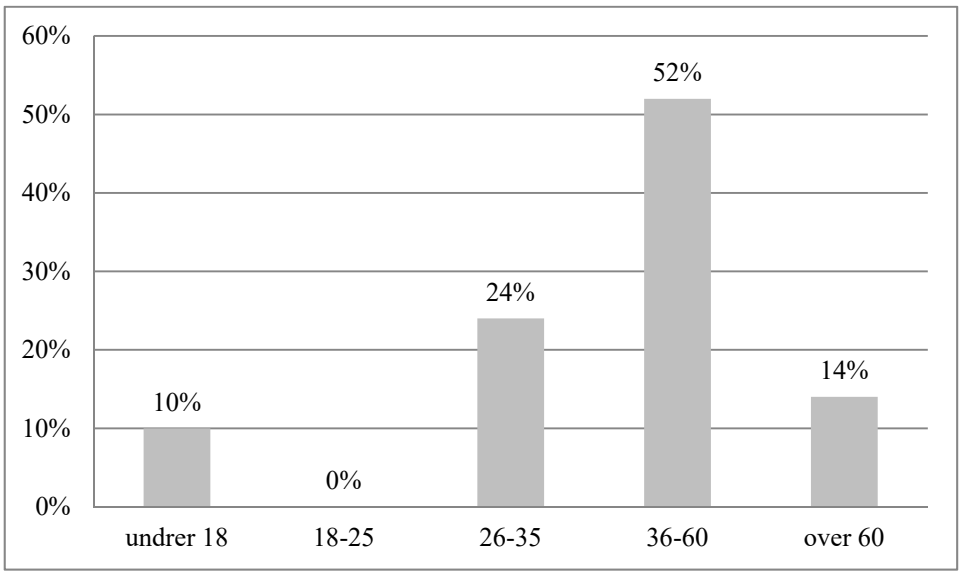
b. Age Distribution

PAPs' ages range from under 18 years old to 60 years old and above. The age ranges were classified, as shown in Table 1-2-73, into the following five categories: under 18 years old; 18 to 25 years old; 26 to 35 years old; 36 to 60 years old; and over 60 years old. A majority of the PAPs, or 52 percent of them, belonged to the age group of 36 to 60 years old. The age distribution of the PAPs is shown in Table 1-2-73 and Figure 1-2-60.

Table 1-2-73 Age Distribution of the PAPs

Age Group	Number of People (%)
Under 18	2 (10%)
18-25	0 (0%)
26-35	5 (24%)
36-60	11 (52%)
Over 60	3 (14%)
Total	21 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-60 Age Distribution of the PAPs

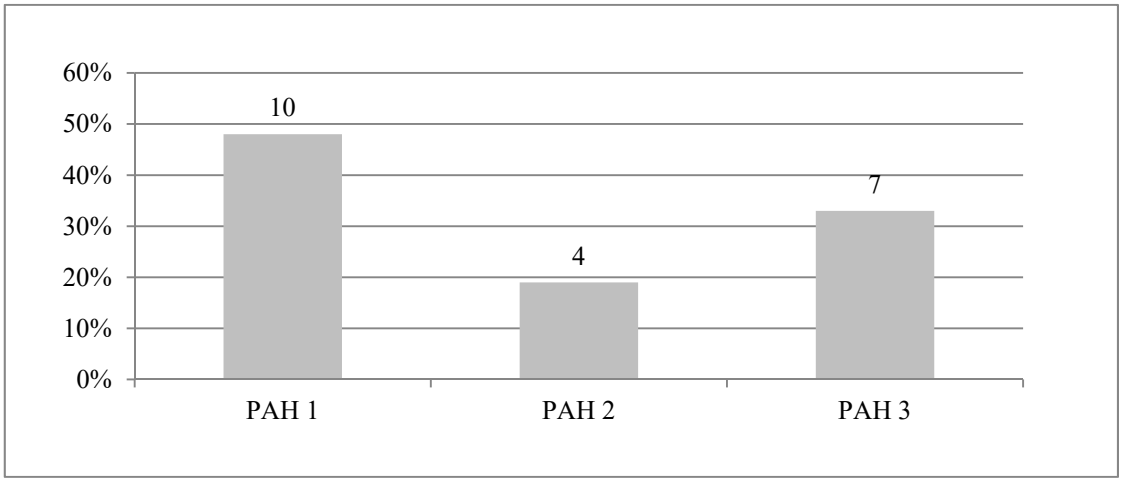
c. Household Sizes

With regards to the size of the three PAHs, one PAH (PAH 1) has 10 family members, which accounts for 48 percent of the total number of PAPs. PAH 2 has four family members (19 percent of the PAPs) and the third PAH is composed of seven family members (33 percent of the PAPs). Table 1-2-74 and Figure 1-2-61 below show the household size of the three PAHs.

Table 1-2-74 Number of Household Members in the PAHs

PAHs	Number of Household Members (%)
PAH 1	10 (48%)
PAH 2	4 (19%)
PAH 3	7 (33%)
Total	21 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-61 Number of Household Members in the PAHs

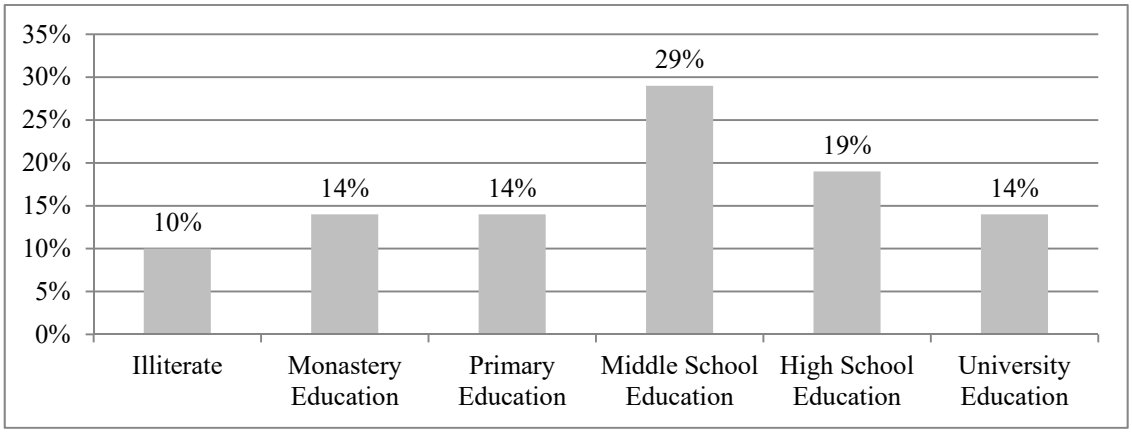
2) Educational Statuses

The level of education of the 21 PAPs was found to be fairly equally distributed. 14 percent of the PAPs have had monastery education and another 14 percent had primary education. 29 percent of the PAPs have studied up to middle school. 19 percent of the PAPs have completed high-school-level education and 14 percent of the PAPs have a university degree. Two people, or 10 percent of the PAPs, were found to be illiterate and this was the smallest group. Table 1-2-75 and Figure 1-2-62 show the levels of education completed by the PAPs.

Table 1-2-75 Educational Statuses of the PAPs

Level of Education	Number of People (%)
Illiterate	2 (10%)
Monastery Education	3 (14%)
Primary Education	3 (14%)
Middle School Education	6 (29%)
High School Education	4 (19%)
University Education	3 (14%)
Total	21 (100%)

Source: JICA Study Team



Source: JICA Study Team

Figure 1-2-62 Educational Statuses of the PAPs

3) Economic Profile

a. Occupation

Table 1-2-76 and Figure 1-2-63 show information on the PAPs' occupation. Most of the PAPs, or 52 percent of them, are farmers. The occupation with the second largest number was shop owners accounting for 19 percent of the population. 10 percent of the PAPs were engaged in trading.

Table 1-2-76 Occupations of the PAPs

Type of Occupation	Number of People (%)
Farmer	11 (52%)
Shop Owner	4 (19%)
Trader	2 (10%)
Dependent	3 (14%)
Student	1 (5%)
Total	21 (100%)

Source: JICA Study Team

Source: JICA Study Team

Figure 1-2-63 Occupations of the PAPs

b. Monthly Total Household Incomes and Expenditures

The monthly total household incomes and expenditures were made apparent by asking the head of the household their annual household income. The result showed that each PAH earned on average approximately MMK 800,000 to 1,200,000 per month. Out of which, income from agriculture was approximately MMK 100,000 to 200,000 per month and that from other sources was approximately MMK 600,000 to 900,000 per month. Agriculture did not share a major part of their income in any of the households affected by the project. Approximately, MMK 750,000 on average was spent in one month.

c. Livestock

The survey found that two out of three PAHs kept livestock. Each of them possessed two cattle.

d. Household Assets and Modes of Transportation

It was found that all PAHs owned a house in the ward they lived in (i.e. Than Hlet Maw (South) ward in Chanmyathazi Township). Table 1-2-77 shows the number of household assets each PAH possesses in their house. According to an interview, motorcycles and bicycles are the major mode of transportation for all three households.

Table 1-2-77 Types and Number of Household Assets

Assets	Number		
	PAH 1	PAH 2	PAH 3
TV	1	1	1
Refrigerator	1	1	1
Generator	-	-	-
Car	-	1	-
'Gondaung'[8]	-	-	1
Tricycle	-	-	-
Tractor	-	-	-
Bicycle	1	1	1
Motorbike	2	1	2
Phone	4	1	4
Well	1	1	1

Source: JICA Study Team

4) Utilities

a. Access to Water

PAHs answered that they used a well for general water usage and bought purified drinking water bottles for drinking even at home. They all bring water from home when they are engaged in agriculture.

b. Access to Electricity

All of the PAHs have access to the national grid system from their houses for electricity. They do not have access to electricity when they are engaged in agriculture at the project site.

c. Access to Sanitation Facilities

PAHs use private toilets at home. There is no toilet at the project site (i.e. agricultural land).

(3) Project-affected Land

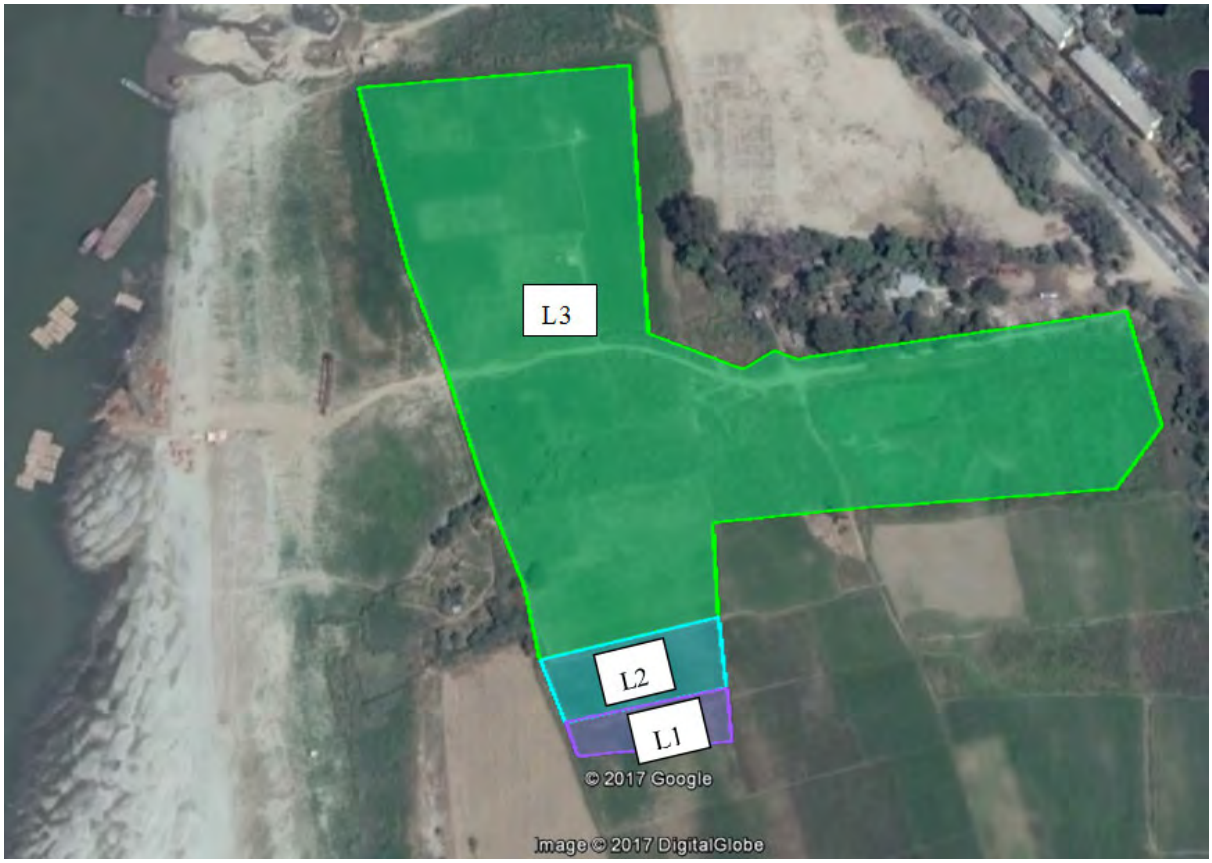
Three plots of land that have been registered as farmland are expected to be affected by the project. The owner, type of land, and size of each plot of land are shown in Table 1-2-78, and the location and boundary of each plot is shown in Figure 1-2-64. The PAHs possess the land-use certificates (i.e. 'Form 7') officially issued by DALMS.

[8] Gondaung is a type of a slow moving vehicle that can be widely seen in the country side of Myanmar. It can be used for transportation, farming and yet the engine can also be used for different purposes (e.g. to pump up water).

Table 1-2-78 Summary of Project-affected Plots of Land

No	Registered Owner of Land	Type of Land	Size of Land
L1	PAH 1	Farmland	0.440 acres
L2	PAH 3	Farmland	0.734 acres
L3	Company	Farmland	14.435 acres

Source: JICA Study Team



Source: JICA Study Team based on Google Earth

Figure 1-2-64 Locations of Project-affected Plots of Land

(4) Project-affected Crops

The major crops grown at the project site are peanut and butter bean. The owner, type of crops grown and size of the farmland is presented in Table 1-2-79. The farmland area affected by the project is shown Figure 1-2-65.

Table 1-2-79 Summary of Project-affected Crops

No	Owner of Crops	Type of Crops	Size of Farmland	Remarks
F1	PAH 1	peanut	0.440 acres	
F2	PAH 2	butter bean	3.000 acres	
F3	PAH 3	butter bean	0.734 acres	
F4	PAH 3	peanut and butter bean	5.032 acres	peanut (1.032 acres) and butter Bean (4.000 acres)

Source: JICA Study Team

Source: JICA Study Team based on Google Earth

Figure 1-2-65 Locations of Project-affected Crops

(5) Project-affected Structures

Seven structures (i.e. huts) were found to fall within the project-affected area. Six out of seven of the huts were made of the same material (i.e. roof made of palm, floor made of bamboo, and wall made of palm and bamboo) while one hut was made of zinc roof and wall. The owners of three huts could be identified but those for the remaining four could not be. Farmers use the huts to rest and avoid sunlight and heat during farming. For three huts, they also stay for up to nine months in and out a year to grow and monitor their crops. They go back to their permanent residence in their respective wards during the rainy season (i.e. June and August) when the area becomes flooded and the huts flushed away. The type, owner, size of the huts and the material used to build them are presented in Table 1-2-80 below.

Table 1-2-80 Types, Sizes, Owners and Materials of Project-affected Structures

No.	Size	Owners	Materials Used	Remarks
Hut 1	15 ft x 25 ft (Height 7 ft)	PAH 3	palm (roof), bamboo (floor), bamboo (wall)	stay for up to 9 months a year[1]
Hut 2	7 ft x 6 ft (Height 6 ft)	PAH 2	palm (roof), bamboo (floor), bamboo (wall)	stay for up to 9 months a year[1]
Hut 3	8 ft x 7ft (Height 7 ft)	PAH 2	palm (roof), bamboo (floor), bamboo (wall)	stay for up to 9 months a year[1]
Hut 4	10 ft x 7 ft (Height 6 ft)	unidentified and vacant at the time of survey	palm (roof), bamboo (floor), bamboo (wall)	
Hut 5	7 ft x 7ft (Height 7 ft)	unidentified and vacant at the time of survey	palm (roof), bamboo (floor), bamboo (wall)	
Hut 6	7 ft x 7ft (Height 7 ft)	unidentified and vacant at the time of survey	palm (roof), bamboo (floor), bamboo (wall)	
Hut 7	10 ft x 12 ft (Height 7 ft)	unidentified and vacant at the time of survey	zinc (roof), bamboo (floor), zinc (wall)	

[1] Farmers stay in the area using the huts to grow and monitor crops during the dry season. They have a residence elsewhere and hence do not stay or live there continuously during the period.

Source: JICA Study Team

(6) Others

In addition, one ship, presumably not in use and possibly abandoned, was found to be located within the survey area, which needs to be removed for the construction to commence. The owner of this ship could not be identified at the time of the survey.

(7) Vulnerable Groups

In Myanmar, there is no official definition for vulnerable groups, at present. In this project, however, due attention has been paid to such groups. The project defined a vulnerable group as any of the following: a household headed by a woman, disabled person, or elderly person (i.e. over 61 years old); a household that includes a disabled person; or a household that is below the poverty line as recognized internationally[9]. The survey found that no PAH meets any of these criteria.

1-2-3-3-5 Compensation Policy and Package

It is important that the project proponent (i.e. DWIR) provides adequate and sufficient compensation and support to the PAPs in consideration of their livings, value of the land and other assets that are to be lost by the project, and relevant laws and regulations in Myanmar in order to relieve the tension and stress of the project on the people. This will in turn better ensure sound and smooth project implementation. The level of compensation also needs to meet the standard required by JICA as the project is expected to be carried out using its grant aid scheme.

Table 1-2-81 shows the persons entitled to receiving compensation and support and the content of the support to be provided as well as the organization responsible for providing such support. This entitlement matrix has been formulated and presented with the above requirements in mind. It should be noted that only those that had been identified at the time of the eligibility cut-off date (i.e. May 3, 2017) are considered eligible. The cut-off date was announced at the stakeholder meeting held on June 27, 2017 and a notice was also put up on the notice boards of DWIR headquarters in Yangon and its branch office in Mandalay as well as the township and ward GAD offices in Mandalay from early June to the end of August 2017.
Compensation for land is to be made to only those people that have plots of land officially registered under DALMS based on their market value. No compensation or assistance will be provided to them for the transition period unless they are in productive use of the land (e.g. farming). This is because it can be considered that there exists no transition cost, or loss of income or livelihood to be restored, if they have been only registering, and not using, the land. This arrangement is considered fair in consideration of the non-legal nature of such rights over alluvial land on the riverbed that is officially under the management of DWIR. No cost is required for land registration and hence it is considered not to be subject to compensation.

Cash compensation worth four years of expected earnings accrued from farming measured in market price will be provided to the owners of the crops. This is in accordance with the Farmland Rules (2012) that require compensation worth three years of earnings and in consideration of the support needed to cover the transition period (i.e. earnings worth one year of harvesting). Immovable assets (i.e. huts) will be compensated based on the replacement cost measured in market price. Transportation cost or transportation mode will be provided by DWIR for moveable assets, if required.

Under this project, DWIR has decided to review the ARAP, including the Entitlement Matrix below in the farmland management committee that consists of relevant government agencies (e.g. GAD,

[9] In the Poverty Profile prepared by UNDP, UNICEF, SIDA and the Ministry of National Planning and Economic Development (June 2011), a total of food and, non-food expenditure of MMK 376,151 per adult equivalent per year is considered 'the poverty line'.

DALMS, Department of Agriculture, and Mandalay Region Government). The first meeting was held on September 29, 2017 and the ARAP has been accepted.

Table 1-2-81 Entitlement Matrix

Type of Loss	Eligible Entity	Compensation Policy	Responsible Organization
Land	Owner of the Land*1	cash compensation worth the value of the land lost measured in market price	DWIR in cooperation with MOTC and local and other governments concerned
Crops (i.e. peanuts and butter beans)	Owner of the Crops	cash compensation worth four years the expected earnings accrued from farming measured in market price*2	
Immovable Assets (i.e. huts)	Owner of the Assets	cash compensation based on replacement cost of the assets lost measured in market price; and assistance in finding alternative places for rebuilding huts (if necessary)	
Movable Assets	Owner of the Assets	Movable assets are not subject to compensation in principle. However, if costs for transporting the assets are required, such transportation costs or transportation mode to transfer the assets shall be provided.	

*1 Land owner has been defined to be: a person who has obtained and possesses a land use certificate; or a person that does not have the land use certificate yet is certified by DALMS to be the genuine owner of the subject plot of land.

*2 three years to cover the cost incurred by losing crops and one year to cover the transition period between displacement and livelihood restoration

Source: JICA Study Team

1-2-3-3-6 Grievance Redress Mechanism

It is important that the PAPs are provided with a mechanism through which they can lodge their complaints, if any, towards the project on matters related to land acquisition. In fact, this can be considered an instrument that helps both the PAPs and DWIR. It allows the PAPs, on the one hand, to lodge their complaints directly to the decision makers in a way that is much easier and less stressful and costly than through the judicial procedures. On the other hand, it allows DWIR to acknowledge any problem and source of frustrations of the PAPs at an early stage so that measures can be taken to relieve the tension while it is still manageable. By directing the complaints to themselves, the proponents can also have full control over the issue. A properly designed grievance redress mechanism will better ensure realization of a sound implementation of the project, which would be in the interest of both parties.

Such mechanism shall be swiftly established, practical, and easily accessible to the PAPs so that they can lodge their opinion, complaint or concern without stress and with trust. Under this project, DWIR should make sure that the PAPs know and understand the mechanism, including the members involved, the procedure, and the time and cost needed. Special attention should be paid to any people that need assistance, such as those that are illiterate, in which case, DWIR may wish to explain in a different way (e.g. verbally instead of by paper). A person responsible for receiving and processing the grievances should also be assigned within DWIR and/or GAD and the name and contact information of the person should be shared with all PAPs. It is also important that DWIR ensures that the grievances are properly treated and discussed and the conclusion delivered back to the complainants in a timely manner.

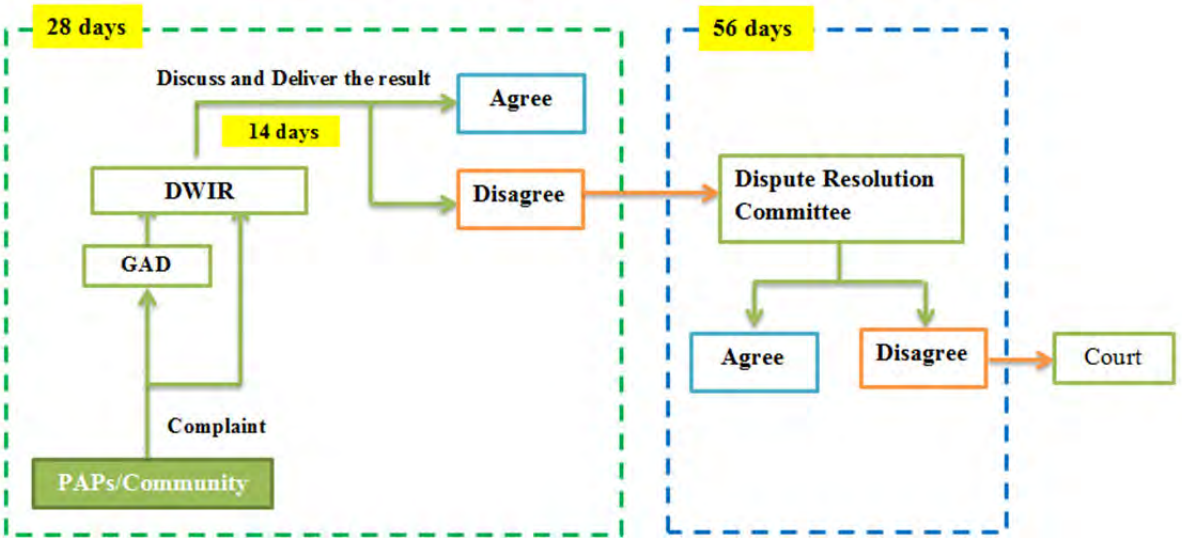
Under this grievance redress mechanism, if a PAP is dissatisfied with the compensation policy, measure or the delivery of entitlements, he or she may lodge a complaint in the first instance directly

to the designated officer of DWIR or through GAD. In doing so, the complainant should clearly state in as concrete way possible the matter he or she is complaining about, any way forward that he or she believes is necessary, and the reason why s/he thinks in that way. DWIR shall discuss the issue raised and deliver the decision made back to the complainant within 14 days.

If the dispute cannot be resolved within a period of 14 days after DWIR's delivery of their response to the complainant, the complainant can request through DWIR or GAD the matter to be referred to the dispute resolution committee. The issue must then be discussed within the committee and the conclusion be delivered to the complainant within a period of 28 days since the request. If an agreement cannot be reached within 28 days after delivery of the committee's decision to the complainant, the complainant may resort to the court to seek a legal and final decision. It is, however, recommendable that grievances be settled amicably at an earlier stage whenever possible. All complaints and respective actions must be recorded. The dispute resolution committee for this project is proposed to consist of the same members as those of the farmland management committee, as shown below:

a. Mandalay Region Government (chair);
b. DWIR (secretary);
c. GAD at the township level;
d. DALMS at the township level; and
e. Department of Agriculture at the township level

It should be noted that the above mechanism does not replace the existing legal configurations in Myanmar. It instead supplements it by providing an alternative way of addressing the complaints of the PAPs in a less formal (and often less adversarial), quicker, and less costly way based on trust and consensus-building. Figure 1-2-66 below depicts the grievance redress mechanism to be set up under this project.



Source: JICA Study Team

Figure 1-2-66 Grievance Redress Mechanism

1-2-3-3-7 Institutional Responsibility for Implementation

Implementing an ARAP requires involving various different actors. Each of these players has different roles and responsibilities to fulfil. Among them, DWIR, the project proponent, has a particularly important role and responsibility. In addition, Mandalay Region Government and associated government agencies have indispensable roles to play in maintaining effective and sound communication with the PAPs and the local community, thereby better ensuring smooth implementation of the project. The major actors and their roles and responsibilities for the project are described below. They are not so different from those for the overall environmental management of the project stipulated in '1-2-3-2-3 Implementation Structure'. However, a farmland management committee has been set up under this project in which the level and means of compensation and support to the PAPs will be confirmed and finalized and people's complaints and grievances examined based on the content of the ARAP.

(1) Farmland Management Committee

A farmland management committee has been formed under this project in order to confirm and finalize the level and content of the compensation and social support to be provided to the PAPs based on the ARAP. The committee will also manage or oversee the whole process related to land acquisition carried out by DWIR (e.g. confirmation of the affected area and assets, consensus building with the PAPs, provision of compensation and other social support and grievance redress) and make certain decisions as found needed. The committee members are: Mandalay Region Government (chair); DWIR (secretary); GAD at the township level; DALMS at the township level; and Department of Agriculture at the township level.

(2) DWIR

DWIR is the project proponent and leading body with the responsibility to soundly execute the project. The organization carries overall responsibility to formulate the compensation policy, implement the activities associated with implementing the ARAP including providing necessary compensation and other support using its own budget, managing the schedule and progress of compensation, acting as a contact point for grievance redress and managing any adverse social and environmental impacts that may generate from the project. It will carry out such activities directly or in cooperation with other government or non-governmental bodies (e.g. MOTC, Mandalay Region Government, GAD, DALMS, Department of Agriculture, and appointed consultants and contractors).

(3) MOTC

MOTC serves as the direct supervising organization of DWIR. It is also the organization that serves to bridge DWIR and other government departments such as GAD, DALMS, Department of Agriculture, and Mandalay Region Government. The budget for compensation of the project needs to be requested to the union government from DWIR via MOTC. It is important that DWIR and MOTC work in close communication and coordination, particularly with regards to matters related to land acquisition and compensation which require cooperation and coordination with a number of government and non-government actors.

(4) Local Government and Line Agencies

Local government such as district and township administrators of GAD, DALMS and Department of Agriculture are all expected to cooperate with DWIR so that the project can be managed well and carried out in a sound and balanced fashion. In concrete, DALMS and the Department of Agriculture under the Ministry of Agriculture, Livestock and Irrigation at the township level are responsible for the following: investigating the conditions of the farmland to be acquired (e.g. area, size, type of crops

grown and ownership); preparing application for land acquisition; and estimating the replacement cost of the subject farmland. Mandalay Region Government is responsible for supervising the overall process related to land acquisition and compensation. It will also review the amount of compensation. GAD is responsible for serving as a contact point in the grievance redress mechanism along with DWIR and bridging DWIR and PAPs so that agreements can be reached promptly. Support from Mandalay Region Government and GAD are needed in order to monitor and prevent encroachment of illegal settlers into the project area after the cut-off date.

1-2-3-3-8 Schedule for Implementation

Figure 1-2-67 below shows the schedule for implementing the activities stipulated in the ARAP. A baseline survey has already been carried out and the people, land, crops and other assets that are expected to be affected by the project identified as described in this report thus far. A stakeholder meeting has also been held on June 27, 2017 and the eligibility 'cut-off date' clearly announced there by DWIR as explained in more detail in '1-2-3-2-4 Stakeholder Consultation'. The farmland management committee and dispute resolution committee have been formed and the content of the ARAP has been approved.

With regards to remaining actions, concrete steps for compensation and land acquisition will be confirmed once an approval has been obtained from ECD/MONREC on the IEE report on the project. The amount of compensation and level of support will be reconfirmed within the farmland management committee, based on which DWIR will discuss and negotiate with the PAHs. Once an agreement has been reached with each PAH, compensation and other support shall be provided to the PAPs and the land secured. In accordance with JICA's rule, the land should be secured and cleared for construction before commencement of tendering of the project, which is planned for August 2018.

No.	Activities	2017								2018							
		5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
1	Baseline Survey (e.g. census, inventory, socio-economic survey)																
2	Stakeholder Meeting and Announcement of COD																
3	Preparation of ARAP																
4	Finalization of ARAP and Submission to JICA																
5	Establishment of Committees (e.g. farmland management and dispute resolution)																
6	Finalization of Compensation and Support (and necessary supplementary survey)																
7	Confirmation and Negotiation with PAPs																
8	Provision of Compensation and Support to PAPs																
9	Securement of Land (e.g. removal of structures)																
10	Monitoring of PAPs' Livelihood																

* Comments and approval of ECD/MONREC on the IEE report is to be provided by the beginning of December 2017 in accordance with EIA Procedure (2015). Here, an approval is expected to be obtained by January 2018.

Land needs to be cleared by commencement of tendering (i.e. August 2018)

Source: JICA Study Team

Figure 1-2-67 Schedule for ARAP Implementation

1-2-3-3-9 Estimated Cost for Compensation and Source of Funding

(1) Estimated Total Amount of Compensation

The budget that is considered necessary for DWIR to secure the land for the project is expected to be MMK 2,353,191,140 in total. Table 1-2-82 shows an itemized summary of the amount of money needed. The following sections provide a more detailed breakdown of the cost.

Table 1-2-82 Estimation of the Total Budget Required for Compensation

No.	Items	Compensation Amount (MMK)	Description
1	Compensation for Land	2,341,350,000	15.609 acres
2	Compensation for Crops	11,341,600	Loss of net income by sale of product (four years)
3	Compensation for Huts	299,540	Removal and construction cost of structures (seven huts)
4	Relocation of Ship	200,000	Removal of the ship
	Total Cost (MMK)	2,353,191,140	Approx. USD 1,700,000

Source: JICA Study Team

(2) Estimated Amount of Compensation for Land

The project-affected area is an alluvial land and hence not supposed to be subject to buying and selling in a formal sense. The monetary value in market price of the subject land was therefore estimated and verified using a combination of different information sources. During the field survey carried out in May 2017, information on the market price was collected by interviewing local people living in or occupying the area near the project site on the riverbed, the PAPs, and local real estate agents.

The smallest price was given by the local people living in or occupying the area near the project site on the riverbed based on the price at which they had bought their land in the past (i.e. MMK 60 million to 80 million). The highest price was provided by the PAPs who claimed that the market price in the area was MMK 200 million to 300 million. The price given by the real estate agencies was in between the two who said that the current market price of land at the project site along the Ayeyarwady River between Shan Kalay village and Tawa Gu pagoda was between MMK 100 million to MMK 200 million per acre. The price given by each group of people is summarized in Table 1-2-83 below.

Table 1-2-83 Price of Land at the Project Site Claimed by Different Groups

Group of People	Price per Acre (MMK)	Remarks
Local People	60-80 million	based on actual transactions made between 2013 and 2014
PAPs	200-300 million	estimation made by PAPs
Local Real Estate Agents	100-200 million	based on past transactions, current transactions near the project site and their expert views

Source: JICA Study Team

The price given by the local people is, while based on actual transactions, outdated and the current land price can be considered much higher now given that the area has been widely known to be used

for development in the future. The price given by the PAPs, on the other hand, was considered potentially biased as they have an incentive to state a higher price in hope of receiving a greater level of compensation. The price given by the local real estate agents, two companies in total, can be considered to be reasonably reliable given that they are engaged in, and hence aware of, the most recent transactions taking place near the area. As explained earlier, their price turned out to be in between the prices provided by the above two groups of people.

The price provided by the real estate agents (i.e. MMK 100 million to 200 million) was then cross-checked by comparing it against results of interviews and secondary data sources. The first source was the Mandalay District Farmland Management Committee, which had set the price of farmland near Myo Patt Road in Amarapura Township to be MMK 100 million per acre at a meeting held on July 17, 2014. According to the deputy staff officer from GAD of Amarapura Township[10], this amount is the latest they have on record. It is worth noting, however, that the land price can be considered higher now than three years ago when the committee was held.

The second source was from the Internal Revenue Department of Mandalay Region which had set the land price in Mahaaungmyay Township and Chanmyathazi Township, located adjacent to Amarapura Township, to be between MMK 900 million and MMK 3,600 million per acre in 2016 and 2017. Land prices for grant type of land[11] in Mahaaungmyay and Chanmyathazi Townships is shown in Table 1-2-84 below[12].

Table 1-2-84 List of Land Prices for Grant Type of Land

No.	Ward	Township	Access Road	Price per Acre (million MMK)	
				from	to
1	Than Hlet Maw (West)	Mahaaungmyay	Wide	2,700	3,600
			Narrow	1,800	2,700
			By-way (cars can enter)	1,350	1,800
			By-way (only motorbikes can enter)	900	1,350
2	Than Hlet Maw (South)	Chanmyathazi	Mandalay-Saging	2,700	3,600
			Kantawgyi Pat Road	2,700	3,600
			In front of Kantawgyi	1,800	2,700
			Kantawgyi North-east Ward	1,350	1,800
			Kantawgyi West Ward	900	1,350

Source: Internal Revenue Department of Mandalay Region (2016-2017)

In consideration of all the above information, the middle value of the price provided by the real estate agents (i.e. MMK 150 million/acre) has been considered valid and hence adopted as the unit market price of land for the project site. Applying this value, the price of compensation for land is estimated to be as follows.

[10] A meeting was held with him on August 7, 2017.
[11] Grant type of land is a form of land type with little restriction compared to other forms and hence is commonly used for residential purposes.
[12] There is no grant type of land in Amarapura Township located near the project site.

Table 1-2-85 Amount of Compensation for Project-affected Land

No	Name of PAPs	Type	Area	Amount (MMK)
L1	PAH 1	farmland	0.440 acres	66,000,000
L2	PAH 3	farmland	0.734 acres	110,100,000
L3	Company	farmland	14.435 acres	2,165,250,000
			Total	2,341,350,000

Source: JICA Study Team

(3) Estimated Amount of Compensation for Crops

The crops grown in the project site have been found to be peanuts and butter beans. The unit price of these crops was identified through interviews at the merchandise association, cross-checked by surveys at the local markets. As a result, it was found that the market price was MMK 2,000 per viss[13] for both peanuts and butter beans. On the other hand, the production rate of the land at the project site is considered to be 150-200 viss per acre for peanuts and 150 viss per acre for butter beans, according to local farmers, PAPs and the merchandise association. Therefore, the yield from peanuts and butter beans can be considered to be approximately MMK 350,000 per acre for peanuts and MMK 300,000 per acre for butter beans. The production rate and market price of them is shown in Table 1-2-86 and the amount of compensation considered necessary for project-affected crops is shown in Table 1-2-87 below.

The amount of compensation was calculated by multiplying this unit price per acre with the size of the land on which the crops were grown. The price was then multiplied by four in accordance with Farmland Rules (2012) that requires compensation for three years and in consideration of the transition period between displacement and livelihood restoration for which, an amount equivalent to an earning of one harvest year was considered appropriate.

Table 1-2-86 Production Rate and Market Price of Project-affected Crops

No.	Type of Crops	Market Price (per viss)	Production Rate (per acre)	Market Price (per acre)
1	Peanut	MMK 2,000	150-200 (175) viss	MMK 350,000
2	Butter Bean	MMK 2,000	150 viss	MMK 300,000

Source: JICA Study Team

Table 1-2-87 Amount of Compensation for Project-affected Crops

No.	Name of Owners	Crop Type	Size	Amount (MMK)	Remarks
F1	PAH 1	peanut	0.440 acres	616,000	Four years of expected earnings (i.e. three years to cover the cost incurred by losing crops and one year to cover the lost opportunity cost for the transition period between displacement and livelihood restoration)
F2	PAH 2	butter bean	3.000 acres	3,600,000	
F3	PAH 3	butter bean	0.734 acres	880,800	
F4	PAH 3	peanut (1.032 acres) and butter bean (4.000 acres)	5.032 acres	6,244,800	
			Total	11,341,600	

Source: JICA Study Team

[13] 1viss = 1.63kg

(4) Estimated Amount of Compensation for Immovable Assets/Structures

The necessary amount of compensation for immovable assets/structures was calculated based on the market price of the material used for building the structure and the required labour cost. The market price of the material cost and labour cost was collected by interviewing the building material shops located near the project site. The result is presented in Table 1-2-88. The estimated amount of compensation for each affected structure is shown in Table 1-2-89. A more detailed breakdown of the calculation is presented in "Appendix 9 Environmental and Social Considerations", "9-1 Attachments of Environmental and Social Considerations Survey Works", "(4) Detailed Calculations for Project-affected Structures".

Table 1-2-88 Material Cost and Labour Cost near the Project Site

No.	Particular	Size/Length	Rate (MMK)
Material Cost			
1	Column (wood)	10 ft	7,000
2	Bamboo for beam	12 ft	5,000
3	Bamboo for roof, wall and floor	20 ft	700
4	Palm for roof	sq-ft	80
5	Zinc roof	sheet	1,500
6	Plastic sheet	sq-ft	120
			Labour Cost
1	Worker	Day	5,000

*market price in July 2017
Source: JICA Study Team

Table 1-2-89 Amount of Compensation for Project-affected Structures

No.	Name of Owners	Type of Structure	Size	Amount (MMK)
H1	PAH 3	hut	15 ft x 25 ft (Height 7 ft)	68,900
H2	PAH 2	hut	7 ft x 6 ft (Height 6 ft)	16,860
H3	PAH 2	hut	8 ft x 7 ft (Height 7 ft)	42,400
H4	unidentified	hut	10 ft x 7 ft (Height 6 ft)	36,200
H5	unidentified	hut	7 ft x 7 ft (Height 7 ft)	23,940
H6	unidentified	hut	7 ft x 7 ft (Height 7 ft)	23,940
H7	unidentified	hut (with zinc roof and wall)	10 ft x 12 ft (Height 7 ft)	87,300
			Total	299,540

Source: JICA Study Team

(5) Estimated Amount of Compensation for Movable Assets

The cost for transporting the degraded ship has been estimated to be approximately MMK 200,000 based on the discussion with DWIR in Mandalay.

1-2-3-3-10 Monitoring System

While the grievance redress mechanism depicted in '1-2-3-3-6 Grievance Redress Mechanism' aims to address the complaints that have already been raised by the PAPs, monitoring allows project proponents to understand the current state and to detect any deviation from the state expected to be brought about before they are pointed out by the PAPs or others. There are two different stages in which monitoring is considered particularly important in land acquisition: the implementation stage of the ARAP, and the post-implementation stage of the ARAP[14]. In the implementation stage, the progress of compensation and social assistance that have reached the PAPs should be constantly checked. Once compensation and support have reached the PAPs at the post-implementation stage, then the level of the PAPs' income and livelihood restoration should be checked to see if such support has brought about the expected outcome.

At the implementation stage of the ARAP, monitoring will be carried out under the responsibility of DWIR with a great deal of support coming from relevant government agencies such as Mandalay Region Government, GAD, DALMS, Department of Agriculture, and MOTC. It is recommended that DWIR assigns personnel responsible for managing and monitoring the process and progress, which may or may not be the same person responsible for dealing with PAPs' grievances. Once compensation and support have been completed, DWIR is then expected to monitor the socio-economic condition of the PAPs by, *inter alia*, regularly holding a public consultation. At this stage, the activities may well be carried out mainly by the contractor in consultation with the consultant and DWIR. Relevant government agencies are expected to support the activities on the ground or by providing advice and supervision.

In theory, NGOs may also be involved in the monitoring progress as a third party in both of the ARAP stages mentioned above. But the scale of land acquisition is limited under the project and no involuntary resettlement will take place, either. Not many people will be affected by the project and the level of grievance is expected to be insignificant. The process of compensation and monitoring is hence likely to be rather straightforward. Therefore, it is considered not necessary to involve such independent actors in monitoring this project.

The items to be monitored with regards to land acquisition and relocation of assets in the implementation stage and post-implementation stage of ARAP as well as the methods of monitoring, responsible organizations, and expected cost of monitoring are shown in Table 1-2-90, below. A sample of the monitoring form for land acquisition is shown in "Appendix 9 Environmental and Social Considerations", "9-5 Environmental Monitoring Form (Draft)".

[14] It is worth noting that the words "implementation" and "post-implementation" referred to here indicate the stages of ARAP activities. They should not be confused with the implementation (i.e. construction) and post-implementation (i.e. operation and maintenance) stages of the project. For example, compensation will be made at the implementation stage of the ARAP, yet before the implementation (i.e. construction) stage of the project.

Table 1-2-90 Monitoring System during Implementation and Post-implementation Stages of the ARAP

Stage of ARAP	Monitoring Item	Methods	Frequency	Implementation Organization	Management Organization	Cost (USD) per Year
Implementation Stage	1. progress of provision/payment of compensation and social assistance 2. level of information disclosure and public involvement 3. voices and complaints from PAPs 4. state of project site	1. confirmation of record of payment 2. communication with the PAPs 3. site observation	weekly during ARAP implementation stage	DWIR	Mandalay Regional Government, MOTC and local authorities	to be included in the cost of day to day management
Post-implementation Stage	1. extent of livelihood and income restoration 2. level of information disclosure and public involvement 3. level of satisfaction of the PAPs	public consultation (formal and informal)	biannually and whenever complaints are heard in this regard	DWIR/consultant/contractor	Mandalay Regional Government, MOTC and local authorities	USD 2,000 (USD 1,000*2 times) for public consultation *Other costs should be included in the cost of day to day management

Source: JICA Study Team

1-2-3-3-11 Public Consultation

Explanation was given to the PAPs and their views and opinions collected by DWIR in a closed session exclusively for the PAPs after the open session broke up at the stakeholder meeting held on June 27, 2017 at Damaha Hall located near the project site (refer to '1-2-3-2-4 Stakeholder Consultation' for more details of the stakeholder meeting). The meeting between the two parties took place from 1 pm to 2:30 pm in the presence of the IEE consultant and the JICA Study Team. The purpose of the discussion was to make sure that the PAPs understood how they would be affected by the project and to understand their views, opinions and difficulties regarding the project.

DWIR briefly repeated what has been explained at the open session. The official explained about the project and the way in which the IEE and the ARAP study were carried out, and reminded them of the cut-off-date. After that, the PAPs asked questions, including how long it would take to receive the compensation and how much the compensation would be and whether they can keep growing crops in the coming crop season. One PAP also said that only the real owner of the farm and land should be compensated.

In response, DWIR explained that a farmland management committee was planned to be organized. He said that the compensation process will start after the final decision has been made within the committee as to how much compensation should be provided to each PAP and after the budget for it has been approved by the government. DWIR explained that civil work is planned to commence in November 2018 and people would be allowed to keep growing crops until close to this time. He said the above-mentioned committee will identify the real owner eligible to receive compensation. DWIR also added that it would provide an adequate level of compensation to each PAP based on relevant laws and regulations in Myanmar and in accordance with JICA Environmental Guidelines. The PAPs were also informed that a grievance redress mechanism would be set up under the project and it was explained that it is a process whereby people can lodge their complaints and give their opinions or concerns to the DWIR so that they could be addressed and the level of their stress could be eased. The PAPs expressed no objection.

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

(1) Objectives of the Project and Primary Goal of the Project

The government of Myanmar is working for revitalization of inland water transport, based on the recommendations of the 2014 NTMP JICA Study.

The objectives of this project are primarily to improve the cargo handling efficiency and to enhance the inland water transportation environment by modernizing Mandalay port, which is one of the major national river ports. Mandalay port modernization is expected to contribute that i) convenience of water transportation is improved, ii) transport of heavy cargo and container cargo is evoked, iii) regional economy of Myanmar will become active and iii) the nation economy may growth sustainably.

(2) Outline of the Project (Input and Activities)

In this project, vessel berthing and mooring facilities, port terminal facilities such as warehouse and open cargo yard will be constructed and modern cargo equipment will be installed to Mandalay port, for the purpose of transforming the existing manual cargo handling operations to more efficient mechanized operations.

The followings are the concepts and considerations as inputs and activities created by this project.

- At present, annually 0.8 million tons of cargo are loaded/unloaded at the natural riverbank of Mandalay. The project is identified as a pilot project of modernization of national inland water transport. At the same time, it is carefully considered that rapid transformation of the system will cause unemployment for existing riverbank workers. Therefore, capacity of the new port facilities are not expected to cover all of the annual cargo volume (0.8 million tons).

- The port capacity is planned about 30% of total existing cargo volume in the initial development stage, and it is planned that these cargoes will be modernized by mechanized cargo handling in Mandalay port.

- The project is planned such that the port should be able to receive containerized cargo, taking into account the needs of current industries.

- The jetty is planned to accommodate the existing maximum sized cargo barges running along the Ayeyarwady river, and to be equipped with mechanical cranes for the most efficient cargo handling.

- The port will be facilitated with a paved cargo yard, warehouse and operation building, in which modern terminal operation will be achieved.

The following outputs, lead by the above inputs, are assumed.

- Machine cargo operation will be achieved by installing modernized equipment and facilities at Mandalay port.

- Highly efficient cargo operation will be achieved by installing equipment. The berthing time for cargo barges will be shortened by the mechanized operations. Such operation will make terminal

functional operation possible, by which more efficient river transport, including time-fixed shuttle transportation, will be achieved.

- The project will change river transport from existing manual labour handling to mechanized cargo operation, which will also lead to new demand for heavy cargo transport by waterway, such as construction material and heavy machines.

- Because the port will be able to accept containerized cargo, the containerization of inland water transport will be expedited. Inland transport businesses will be revitalized by improving transport quality, by increasing the number of river port users and by improving the transport environment of waterways.

- The improvement of transport quality will enhance the investment of foreign private firms including Japanese companies, which will result in the activation of the regional economy and further national economic growth.

- The system modernization of Mandalay port will be applied to other national river ports, which will extend the development of the time-fixed shuttle transport system by inland waterways.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basis Concept

Prior to the outline design, the following two points are clarified and summarized as the basis of the Project.

- The scope of the Japanese assistance, which was discussed and decided in this study by reviewing the request by the Myanmar Government

- The process and the results of the selection of the project site, which was selected from amongst three alternative locations in this study

After the above two points are clarified, the following studies are conducted to establish the basic concept of the design, including:

- the scale of the port facilities, such as jetty length, size of warehouse and terminal areas based on the expected cargo handling volume;
- cargo handling patterns and features in the port terminal area;
- structure type of jetty, comparison and selection among the two alternative structure types, fixed type and floating type; and
- new port operations and port use concept.

Details of the above-mentioned clarifications and studies are described hereunder.

2-2-1-1-1 Scope of the Japanese Assistance

(1) Request of the Government of Myanmar

Mandalay port is one of the major river ports in Myanmar, where all cargoes are handled by manual labour along the natural river banks without jetties and machines. The government of Myanmar requested support from the government of Japan for the construction of port facilities and procurement

of cargo equipment in order to modernize its port operation. The following were requested by the government of Myanmar.

- Construction of new port facilities (jetty with length of 180 m, cargo yard with area of 29,540 m^2, access bridge with length of 238 m, access road with length of 304 m)
- Procurement of cargo handling equipment
- Construction of container yard and warehouses

(2) Scope of the Japanese Assistance

Based on the study results, the scope of the Japanese assistance is summarized in Table 2-2-1. Study details are described in 'Chapter 2-2-2 Basic Plan'. The facilities are planned and designed based on the following concepts.

- A new port will be constructed in Mandalay based on the request from the Myanmar Government for the modernization of the port.

- The project is the pilot project because it is the first introduction of cargo handling equipment to improve the traditional man-power loading and unloading operations on the natural river bank.

- Project location was determined by the Government of Myanmar based on the study and discussions in the preparatory survey study of the Project.

- Type of jetty shall be fixed type, which was decided by the Government of Myanmar based on discussions of the results of the comparison study conducted in the preparatory survey. Fixed type and floating type jetty, recommended in "the 2014 JICA F/S", are compared and studied in the preparatory survey.

- For the purpose of modernization of the port, and for providing fixed-time service operations of ships, the project will introduce terminal functions with necessary facilities such as cargo yard and warehouse.

- Required land area for port development is provided by the land reclamation so that the port facilities can be operated throughout the year unaffected by the rainy or dry season's water level changes.

Table 2-2-1 List of Facilities and Equipment Provided by Japanese Assistance

Facilities/Equipment			Contents of the Assistance
Civil Works	1-1	Jetty (Berth)	Length: 180 m, Water Depth (-2.0 m) (shallowest in dry season)
	1-2	Access Bridge	Two Bridges: 172 m and 223 m long
	1-3	Port Area	Reclamation: about 220 m x 150 m (along revetment shoulder)
	1-4	Revetment	Gentle Slope Natural Stone Type Revetment (including soil liquefaction protections)
	1-5	Cargo Yard	1.2 ha area on the reclaimed land area
	1-6	Access Road	About 320 m, including embankment and revetment
	1-7	Others	Storm water drainage, Yard lighting, etc.
Buildings	2-1	Warehouse	RC/Steel roof, 96 m x 24 m 1 unit
	2-2	Port Office Building (Port Office / Workshop)	RC 2 stories, 42 m x 18 m 1 unit 1F: Workshop, 2F: Port Office
	2-3	Canteen	RC Single Story 18 m x 12 m
	2-4	Generator House	RC Single Story 15 m x 10 m
	2-5	Pump House	RC Single Story 15 m x 10 m
	2-6	Security Hut	RC Single Story 2 m x 2 m
	2-7	Electrical and Plumbing System	Electrical power supply system, water supply and distribution system, fire hydrant, etc.
Cargo Handling Equipment	3-1	Jib Crane	Rail mount type, 35-ton capacity 2 units
	3-2	Rough-Terrain Crane	50-ton capacity, 1 unit
	3-3	Reach Stacker	For 20FT and 40FT container handling, 1 unit
	3-4	Forklift	3.5-ton lifting capacity, 5 units
	3-5	Tractor Heads	For container chassis, 6 units
	3-6	Chassis	For 20FT and 40FT container, flat floor type, 6 units

2-2-1-1-2 Selection of the Project Site

At the time this study was commenced, there were three (3) candidate locations for the project site. [1] The Study team was asked to recommend the most suitable location through the study comparing the three candidate locations considering existing land use at the project site, river sedimentation features, suitability of the operation and maintenance of the jetty, natural conditions, consistency with the future city development plan, accessibility to the existing trunk road, and environmental and social issues. The study team was also requested to lead the decision making by the government of Myanmar on the selection of the project site explaining such recommendation.

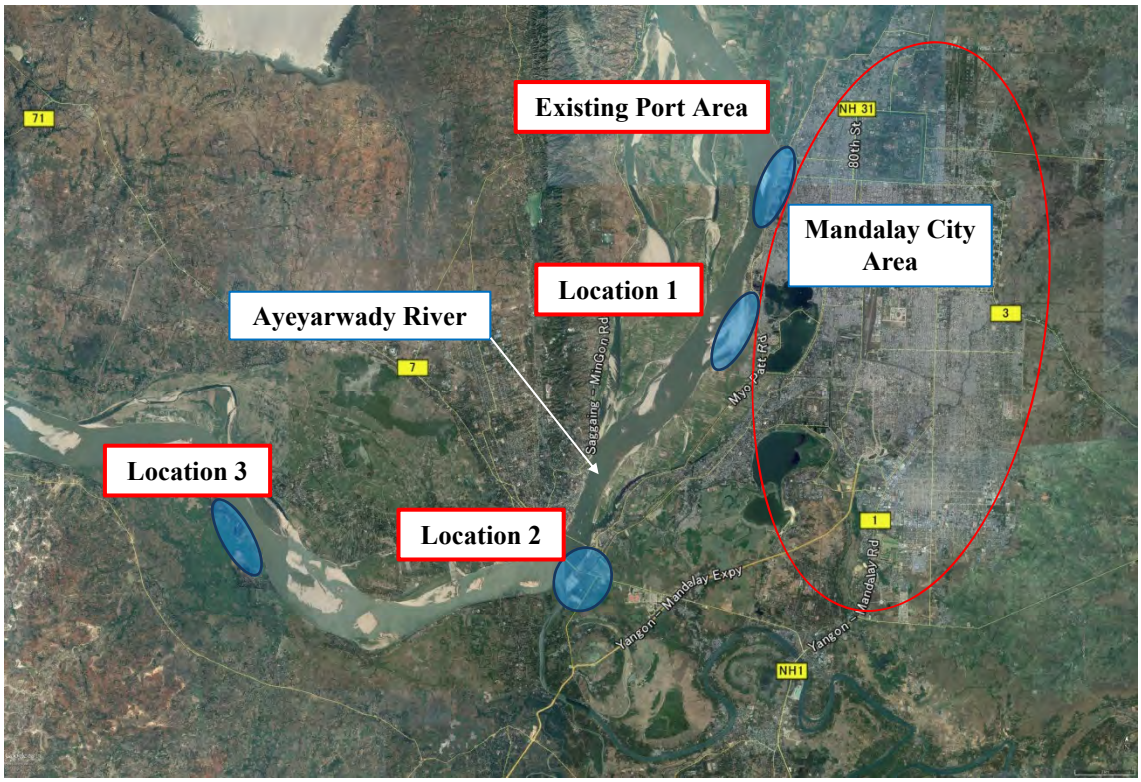
Through the discussions between the Study Team and the Myanmar side, based on the recommendation, the location was selected by the Government of Myanmar. The following are the descriptions of the process of such decision making.

(1) Candidate Sites

When the study commenced, three (3) locations, indicated in Figure 2-2-1, were under discussion. Among these candidate locations, “Location 1” is the one recommended by the 2014 JICA F/S.

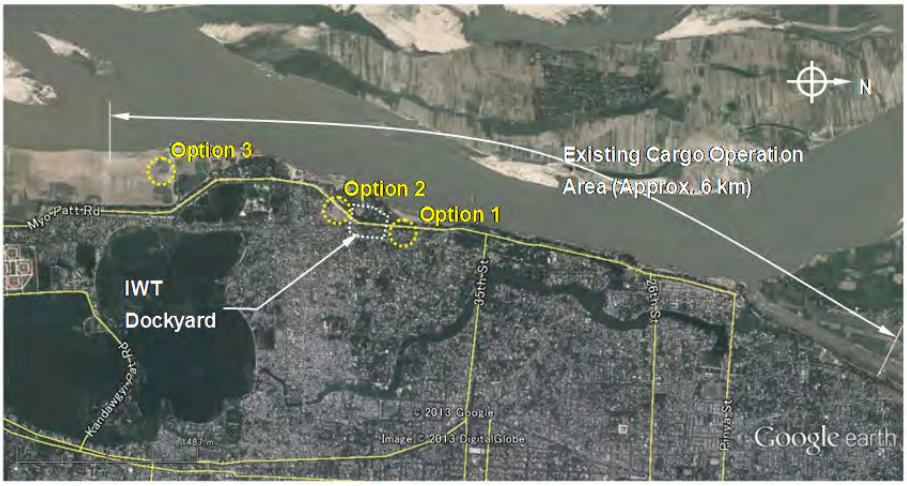
[1] About the candidate sites conditions, in addition to the main report, refer to the “6-1 Urban Development Plans and Candidate Port Locations” and “6-2 Outline of Candidate Locations” in the Appendix 6: Documents for Project Site Selection.

"Location 1" is consistent with "Option 3" as shown in Figure 2-2-2 referred to in the 2014 JICA F/S. During the 2014 JICA F/S, this "Option 3" was derived by comparing and scoring, considering fifteen aspects/conditions of the three options. The decision of MOTC was made through the discussions with the JICA Study Team of this study.



Source: JICA Study Team based on Google Earth

Figure 2-2-1 Three Candidate Locations



Source: JICA Study Team based on Google Earth

Figure 2-2-2 Three Options Compared in the 2014 JICA F/S

(2) Outline of the Candidate Sites

A careful site observation was made during this study and comparison of the three candidate locations was carried out. Table 2-2-2 shows the summary of the comparison of the three candidate locations.

Table 2-2-2 Comparison of Three Candidate Locations

Candidate Location	Features of Location
Location 1 	✓ Proposed by the 2014 JICA F/S ✓ Wide dry riverbed, behind which can be used for future expansion ✓ Land is officially owned and managed by DWIR and is flooded during rainy season ✓ There are a few farmers cultivating dry riverbed during dry season
Location 2 	✓ JICA Urban Development Planning for Regional Cities 2016 proposed this place as Industrial/Logistic Zone ✓ The place is located between two bridges linking Mandalay and Sagaing. National regulation will soon be issued by the government prohibiting installation of structures on the riverside 1,000 ft (300 m) up/downstream from bridge foundation. The area for port terminal is limited. ✓ There are two branch river streams flowing into the Ayeyarwady, one is upstream and the other is downstream. The risk of sedimentation is observed. ✓ On the land immediately downstream, Myanmar Energy Sector Development (Public Company) is constructing 32 oil tank units.
Location 3 	✓ The place is quite far from Mandalay city centre (commercial/industrial) ✓ Land is occupied by farmers permanently (all season cultivation). Condition is different from Location 1, which has only dry season cultivation. ✓ There is a need to construct a 3-km long access road to the existing trunk road, because only unpaved farm road is available for access at present.

Source: JICA Study Team

(3) Comparison Study of the Candidate Sites

For the comparison study of candidate sites, the following seven factors are considered:

1) Natural conditions: i) water depth for jetty, ii) risk of sedimentation (whether maintenance dredging will be required or not),
2) Consistency with city development plan: i) accessibility to commercial/industrial zone, ii) influence on traffic congestion of trunk roads,
3) Environmental and social issues: mainly resettlement of habitants and farmers,
4) Availability of future expansion space,
5) Construction cost,
6) Safety for ship/barge navigation, and
7) Competitiveness against railway or road transportation modes.

The Study Team made the draft comparison as shown in Table 2-2-3, which was submitted to the Myanmar side[2] and discussed. The discussion meeting was held on February 2, 2017 at Naypyidaw, with presentation by the Permanent Secretary (PS) of MOTC.

In the discussion meeting, the Myanmar side explained that the draft Bridge Law is under Diet deliberation which prohibits installation of a jetty structure and anchoring of river ships/barges along the riverbank a minimum of 3,000 ft. upstream/downstream from bridge piers of large-scale bridges. When this bill is established, port facilities installed by Location 2 will conflict with the bridge law. MOTC expressed its intention to exclude Location 2 from options to be selected. For Location 3, there was the suggestion that the superiority of river transport over other transport modes—i.e. railway and road—will not be found because the location is far from Mandalay city area. Finally, the meeting was concluded recommending Location 1 for the new port project site. Table 2-2-3 shows the concluded rating after the discussion at the meeting.

Table 2-2-3 Rating Table for Three Candidate Locations

Factors of Comparison		Location 1	Location 2	Location 3
1.	Natural Conditions			
1.1	Water depth	B	C	A
1.2	Risk of sedimentation/maintenance dredging	B	C	A
2.	Consistency with city development plan			
2.1	Accessibility to commercial/industrial zone	A	A	C
2.2	Influence on traffic congestion of trunk roads	B	A	A
3.	Environmental and social issues	B	B(-)	B(-)
4.	Availability of future expansion space	A	B	A
5.	Construction cost	B	A	C
6.	Safety for ship/barge navigation	A	B	A
7.	Competitiveness against railway or road transportation modes	A	A	C
Final Estimate		**A**	**C**	**B**

Legend: A: Suitable, B: Fair C: Not suitable

After the above discussion, MOTC communicated with DWIR and IWT as the execution agency and further conducted discussions with the Mandalay Region Government (MRG) and Mandalay City Development Committee (MCDC). The final decision was made by MOTC, receiving acceptance from all the relevant authorities. According to the Ministry, there is no need for Cabinet acceptance of the decision.

As stated above, it was officially decided that Location 1 will be the project site, and such decision was informed by a written document by MOTC to JICA on 29 March 2017.[3]

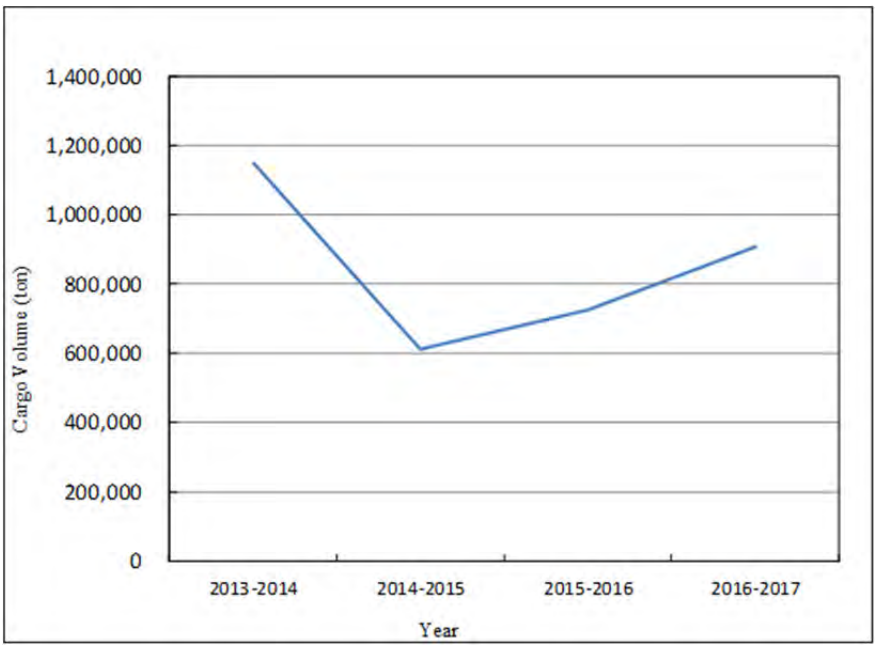
[2] Discussion paper included the draft comparison table provided by the team for the discussion is attached in the Appendix 6, "6-3 Preliminary Assessment of Port Location".

[3] The letter issued by MOTC to JICA is attached in the Appendix 5 : Letters, "5-1 MOTC Confirmation Letter for the Project Site Selection".

2-2-1-1-3 Study of the Port Scale

(1) Planned Cargo Handling Volume

Figure 2-2-3 shows the cargo volume (liquid and dredged sand are excluded) handled in Mandalay port. Since DMA started to record the statistics, the figures during the 4 years have varied in the range of 600,000 ~ 1,200,000 tons.



Source: DMA Data

Figure 2-2-3 Cargo Volume of Mandalay Port (excl. liquid cargo and dredged sand)

This project is identified as an initial pilot project aiming for modernization of river ports by changing the method of cargo handling from manual to mechanized, which will achieve higher efficiency of cargo operation. The 2014 JICA F/S recommended that such modernization should be executed in phased steps considering existing businesses and workers. In conformity with the following concept which ware stated in the 2014 JICA F/S, the capacity of the new port is set for about 30% of present total cargo volume of Mandalay port.

- It is not easy to handle all cargo with mechanization (maximum approx. 1.2 million tons per year) for Myanmar government as it will require huge budgetary support for initial investment.

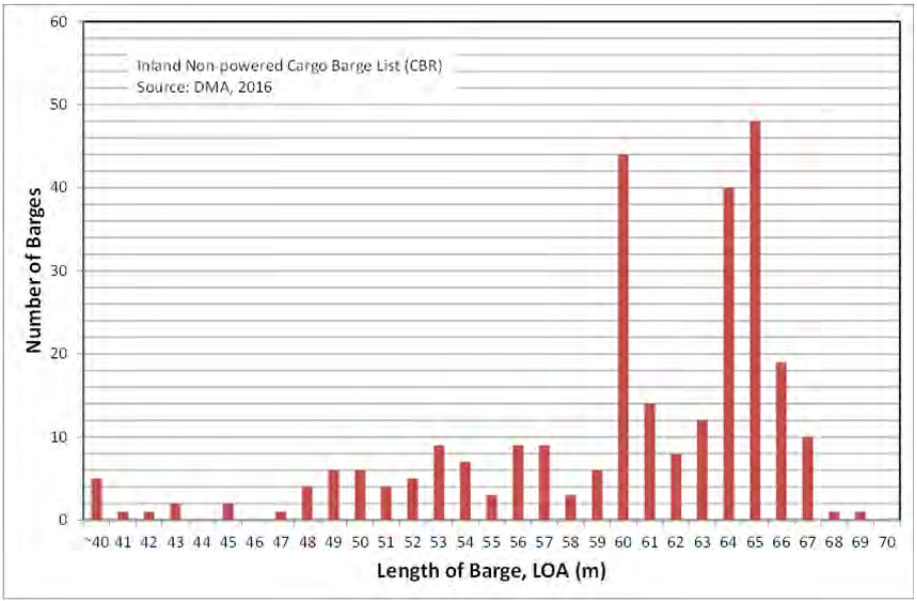
- Rapid mechanization of cargo operation shall be avoided because it might cause unemployment of existing workers.

- The majority of existing cargo ships are passenger-cum-cargo style which have roof-tops which make crane handling difficult. Loading and unloading cargo with the manpower of these ships at the natural riverbank may continue even after the new port operation has started.

Based on the study about objective vessel, jetty length, crane capacity, storage capacity of warehouse and open yard, the port facilities are planned for 200,000 tons per year (day work only) to 400,000 tons per year (day and night works). Details are described hereunder.

(2) Objective Vessels

Figure 2-2-4 shows the distribution of the number of existing barges registered to DMA for every range of length of barge (LOA).



Source: DMA Data

Figure 2-2-4 Distribution Chart of Length of Barge (Registered to DMA)

From the above distribution chart, it is found that the major range of barge length is approximately 65 m. The data show the maximum barge size is length 69.95 m, breadth 15.54 m, and depth 3.20 m.

Design barge size is estimated as follows considering the most frequent barge size should be 2,000 DWT with LOA 65 m.

- Length of Barge : 65.0 m
- Breadth : 17.5 m
- Light Draft : 0.5 m
- Fully Loaded Draft : 2.0 m

(3) Jetty

1) Jetty Length

The jetty length is designed at 180 m to accommodate two of the above design barges (LOA 65 m) at the same time. A typical mooring pattern of two 65-m barges is shown below.

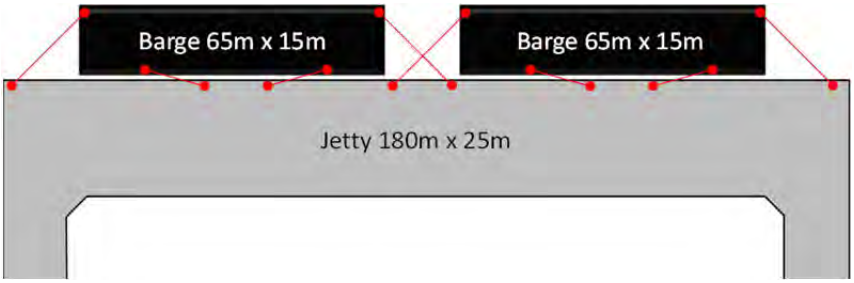


Figure 2-2-5 Typical Mooring Pattern for LOA 65 m Barges

2) Capacity of Jetty

Referred to the existing case of cargo operation (private terminal in Yangon river), 200 bags lifted (50 kg/bag, 10 tons) for one cycle is considered to be ordinary operation, as shown in Photo 2-2-1. Capacity calculation is based on the following assumptions.

Photo 2-2-1 Existing Case of Cargo Operation (Private Terminal in Yangon River)

- Cycle time of cargo lifting is assumed to be 10 times per hour
- Jetty can accommodate two barges, and cargo operation will be executed for two barges at the same time (two gangs work at the same time)
- Work hours are assumed to be 8 hours per shift. Real work hours are calculated considering break time for workers; 8 hrs x 90% = 7.2 hrs.
- Cargo handling efficiency for night work is assumed to be 75% of day work.
- Number of operation days in a year is assumed to be 341 days, eliminating from 365 days 14 national holidays and 10 new-year holidays.
- Initial berth occupancy rate is assumed to be 50%.

From above, Jetty capacity is calculated as below.

a. Case of day work only (one shift)
(Efficiency of crane) = 10 tons/cycle x 10 cycles/hr = 100 tons/hr
(Daily cargo volume) = 100 tons/hr x 7.2 hrs x 2 gangs = 1,440 ton/day
(Yearly cargo volume) = 1,440 tons/day x 50% x 341 days
= 245,520 tons/year

b. Case of day and night works (two shifts)
(Daily cargo volume for night) = 100 tons/hr x 7.2 hrs x 2 gangs x 75%
= 1,080 tons/day
(Yearly cargo volume for night) = 1,080 tons/day x 50% x 341 days
= 184,140 tons/year
(Yearly cargo volume day & night) = 245,520 + 184,140 = 429,660 tons/year

Based on the above estimation, the port facilities are planned as the capacity of 200,000 tons per year under only day work operation state at the initial stage and 400,000 tons per year capacity when introducing day and night port operations.

(4) Warehouse

For the warehouse, cargo types are assumed to be rice, sugar and cement in the form of 50 kg bags. DMA's data shows these bagged cargoes share approximately 50% of total cargo volume. Assuming the capacity of the port to be 400,000 tons per year (day and night work), 50% of which, i.e., 200,000 tons of cargo, is planned to be stored in warehouse.

Cargo volume stored = (Yearly volume) x (Average number of days for storage) / 365days x (Peak factor)
= 200,000 tons x 7 days / 365 days x 1.3
= 4,986 tons (5,000 tons)

Required storage capacity = (Cargo volume stored) x (Unit volume of cargo) (m^3/ton)
= 5,000 tons x 1.6 m^3/ton = 8,000 m^3

Required stacking space = (Required storage capacity) / (Stacking height)
= 8,000 m^3 / 5 m = 1,600 m^2

Required floor space = (Required stacking space) x (Coefficient for working space)
= 1,600 m^2 x 1.4 = 2,240 m^2

Design floor space = 2,300 m^2

In order to design the cargo floor plot and its floor loading condition, the annual cargo volume and its required floor space are calculated for each major cargo type, as shown in the Table 2-2-4. The port capacity is planned to cover 30% of the entire volume of Mandalay port, therefore all cargoes shown in the table will not be stored in the designed warehouse. However, the space of the warehouse should be enough, assuming the full cargo volume of one type goes to a new port. In addition, if average storage time for cargo could be reduced from 7 days to shorter, the storage capacity of the warehouse will be increased.

Table 2-2-4 Volume of Major Bagged Cargo and Floor Design Load

Cargo Type	Unit Weight (ton/m^3)	Floor Design Load Assuming Stacking Height 5m (ton/m^2)	Annual Cargo Volume: Entire Mandalay Port (ton)	Cargo Volume Stored Assuming Average 7 days Storage Time (ton)	Required Floor Space Assuming Stacking Height 5m (m^2)
Cement	1.50	7.50	150,000	3,740	700
Rice	0.85	4.25	140,000	3,490	1150
Sugar	0.85	4.25	200,000	4,990	1640

Conditions: Peak factor = 1.3, Coefficient of working space = 1.4

Note: In the above estimate, latest two (2) years records (2015 to 2016) were used, since these cargoes are dominantly handled in these years. Due to luck of the record of November and December in 2016, annual volume in 2016 were estimated by rate calculations (Sum of January to October divided 10 time 12).

Source: JICA Study Team based on the DMA Data

Photo 2-2-2 Existing Case of Cargo Storage Warehouse

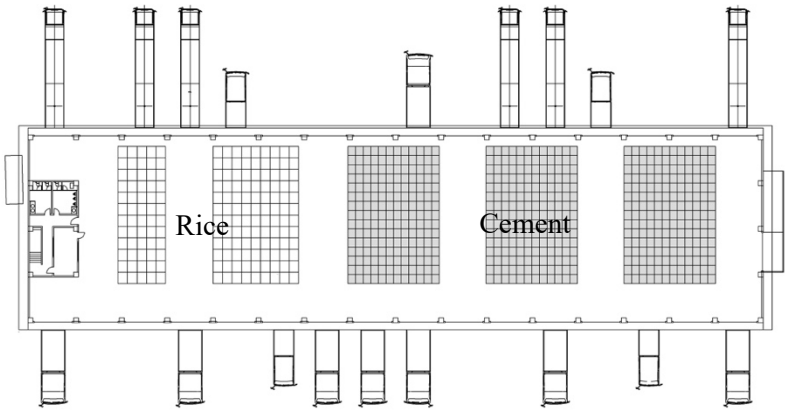


Figure 2-2-6 Typical Pattern of Floor Plot

(5) Cargo Yard

The cargo yard is planned assuming that containers and heavy cargo such as construction materials will be stored. In the design of the cargo yard, 200,000 tons of cargo (50% of the 400,000-ton port capacity) is planned to be stored. The yard is designed not for exclusive use of containers; it is capable of mixed storage of general cargo and containers.

1) General Cargo (the case for 200,000 tons of general cargo)

For planning purposes, flat storage of pallet cargo is assumed. For calculation, the unit space of a pallet is assumed to be 1.5 m^2 and the unit weight of a pallet is assumed to be 1 to 2 tons. Average storage time is assumed to be 3 days as the purpose of the yard is temporary storage for servicing handover for cargo owners.

Cargo volume stored = (Yearly volume) x (Average days for storage) x (Peak factor)
= 200,000 tons x 3 days/365 days x 1.3 = 2,137 tons

Required space = (Cargo volume stored) x (Unit area of pallet) x (Coefficient for space and work area)
= 2,137 tons x 1.5 m^2 x 1.2 = 3,847 m^2

2) Containers (the case for 200,000 tons of container cargo)

If it is assumed that the annual 200,000 tons of general cargo is fully containerized, the required yard space is calculated to be 8,600 m^2, as shown in the following table.

Table 2-2-5 Calculation of Required Yard Space for Containers

Item	Unit	Design Value			Remark
		Total	Loaded	Empty	
① Design Annual Cargo Volume	ton		200,000		50% of the port capacity
② Unit weight of container	ton/TEU		13.33		Average referred to Yangon port
③ Design annual containe volume (①/②)	TEU		15,000		
④ Share of loaded/empty container	%		70%	30%	Common figures for planning (empty container shall be
⑤ Container throughput (③x④)	TEU	21,500	15,000	6,500	handled when container transport will be started)
⑥ Average time of storage	days		7	10	Assumed free time: 7 days
⑦ Peak Factor	-		1.3	1.3	Common figures for planning
⑧ Required Container Storage Capacity (⑤/365 x ⑥x⑦)	TEU	606	374	232	
⑨ Stacking height (contrainer)	-		4	4	Common figures for planning
⑩ Average Occupancy Rate	%		70%	100%	Common figures for planning
⑪ Required Number of Slot (⑧/(⑨x⑩))	TEU	192	134	58	
⑫ Area of 1 Unit Container (Dry)	m^2/TEU		14.87	14.87	
⑬ Required Area of Slots (⑪x⑫)	m^2	2,855	1,993	862	
⑭ Coefficient for Work Space	-		3.0	3.0	The case of Reach Stacker use (refer to layout)
⑮ Required Yard Space	m^2	8,600	6,000	2,600	

From the above calculation, 190 m x 45 m of yard space is plotted as shown in Figure 2-2-7. Based on the container handling in the yard being by means of Reach Stacker, the layout arrangement of container slots is planned as shown in Figure 2-2-7. From this plot, the number of slots is 158. As additional container slot space, 16 slots are considered in the Spare Yard (60 m x 25 m). Total design number of slots is 174.

From the total of 174 slots, assuming 40 slots (16 slots of Spare Yard and 24 slots of riverside block) are allocated for empty containers, and the rest of the remaining 134 slots are to be for loaded containers, the container handling capacity of the cargo yard is estimated as below.

Annual throughput of containers (TEU) (Loaded containers):
= (Number of slots) x (Stacking height) x (Ratio of average stacking height)
x (Number of working days in a year) / (Average number of storage days)
= 134 slots x 4 stacks x 60% x 365 days/7 days = 17,000 TEU/year

Annual throughput of containers (TEU) (Empty containers):
= (Number of slots) x (Stacking height) x (Ratio of average stacking height)
x (Number of working days in a year) / (Average number of storage days)
= 40 slots x 4 stacks x 100% x 365 days/10 days = 5,800 TEU/year

The total yard capacity for container cargo estimated by the number of slots is 22,800 TEU (17,000 TEU + 5,800 TEU). This capacity is thought to be adequate compared to the available container handling volume by jib cranes on the jetty (21,500 TEU) calculated in Table 2-2-6.

3) Comparison between Jetty Capacity and Yard Capacity

Jetty container-handling capacity by means of jib crane is estimated at 18,000 TEU to 31,500 TEU per year, as shown in Table 2-2-6. Jetty capacity is well balanced with the yard capacity (22,800 TEU). The jetty and yard plan is adequate.

Table 2-2-6 Jetty Handling Capacity by Means of Jib Crane

No.	Item	Description
①	Capacity of Crane	10 Cycles/hr/crane Barge ⇔ Crane ⇔ Truck/trailer
②	Working Hours	(1) Day shift: 7 hours (excluding 1 hr break time) (2) Night shift: 7 hours (75% effectiveness and excluding 1 hr break time)
③	Number of Working Days in a Year	341 days/year Excluding 14 national holidays and 10 new-year holidays
④	Berth Occupancy Rate	50%
⑥	20 FT/40 FT Share	20FT: 40FT = 1:1 (Average 1.5 TEU/ lifting cycle)
⑥	Annual Throughput	(1) Day work only: 18,000 TEU/crane/year ① 10 × ② (7 × 100%) × ③ 341 × ④ 50% × ⑤ 1.5 (2) Night work only: 13,500 TEU/crane/year ① 10 × ② (7 × 75%) × ③ 341 × ④ 50% × ⑤ 1.5
⑦	Crane Capacity	Assuming 50 % of cargo is for the warehouse and 50% is for containers, crane capacity for containers is calculated as follows. (1) Day work only: 18,000 TEU/crane × 2 cranes × 50% = 18,000 TEU (2) Day and night work: Day work + (2) Night work: 31,500 TEU/crane × 2 cranes × 50% = 31,500 TEU

4) Layout of Cargo Yard

The following figure shows the layout plan of the cargo yard. The size of cargo yard is 10,000 m^2. The maximum number of container slots, assuming handling by reach stacker, is estimated at 174 slots. By these slots, planned maximum container cargoes (22,800 TEU, equivalent 200,000 tons cargoes) are able to handle in the cargo yard. The estimated requirement

of 3,847 m^2 for general cargo is equivalent to 40% of the total space. The initial phase of new port operation will use this yard for mixed cargo of both containers and general cargoes.

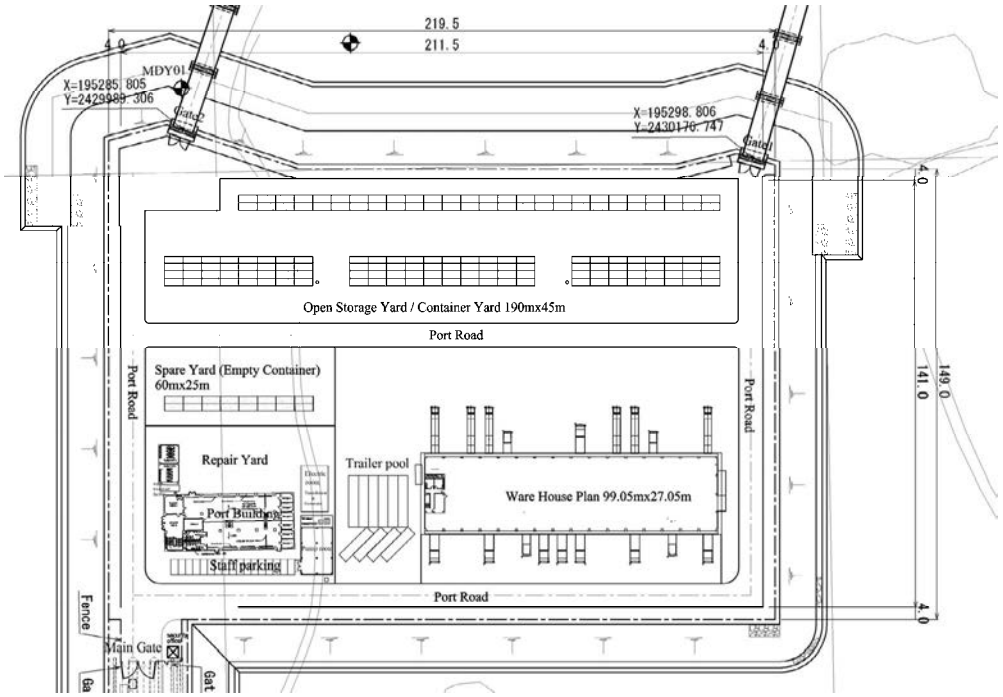


Figure 2-2-7 Yard Layout Plan

2-2-1-1-4 Study on Cargo Handling Operations in the Terminal Area

(1) Basic Concept of Handling Cargo

Based on the concept for "the Port Modernization by Introducing Cargo Handling Equipment", the following conditions are the basis of the planning.

- Bagged cargo, currently handled by man-power, will be combined and unitized and handled by equipment.
- Containerization may be moderately introduced after the project, therefore, the port shall be able to handle the container cargoes.
- Heavy cargoes such as machines, construction materials, and other heavy goods, which cannot be loaded/unloaded at the existing river bank will be able to be handled at the port by using the handling equipment.
- Bulk cargoes such as coal and ore are not considered to be handled in the new port.

(2) Packing Styles for Cargo Handling

1) Bagged cargoes

Large sized bags, which are not able to be handled at present, are also considered in addition to the bagged cargoes which are handled at the existing natural riverbank. Bagged cargo are

combined and unitized by using cargo netting and/or pallets. The following is the outline of which bagged cargoes are expected to be handled in the new port.

a. Common characteristics of bagged cargoes

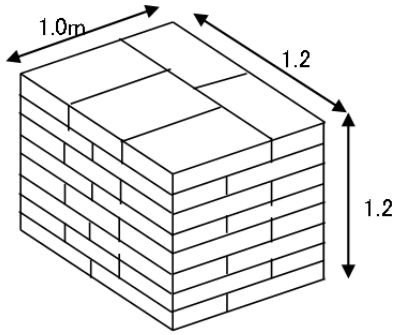
The typical size and weight of bagged cargo are as shown below. Bagged cargoes handled by man power are 50 kg per bag. For the new port planning, large sized bagged cargoes which are from 1,000 to 1,500 kg per bag are also considered.

Table 2-2-7 General Dimensions and Weight of Bagged Cargoes

Cargo	Unit Weight (t/m^3)	Shape during transportation	Approx. Size (length x width x height) (mm)	Weight (kg)
Cement	1.5	Bag	640 x 410 x 130	50
Cement	1.5	Large bag	1000 x 1000 x 1200	1,500
Rice	0.85	Bag	750 x 550 x 150	50
Rice	0.85	Large bag	1000 x 1000 x 1200	1,000

b. Handling combined bagged cargoes

The large bags are handled per bag by using the handling equipment. The small bags are unitized by binding dozens of small bags with cargo netting or pallets and handling with equipment, per each lot. General dimensions of the unit cargoes are as shown below.



Number of tiers		8 tiers	10 tiers
Length(m)		1.2	1.2
Width (m)		1.0	1.0
Height(m)		1.2	1.5
Number of bags		40	50
Weight(t)	Cement	2	2.5
	Rice	1.2	1.5

Figure 2-2-8 General Dimensions and Weight of Bagged Cargoes in Unit

c. Style of bagged cargo unit

i. Cargo netting

Cement bags are shipped from the factory after binding dozens of small bags with cargo netting to make it one lot and transported to the site by barge. 5 to 10 lots of cargo netting are unloaded by the crane and loaded onto the chassis beside the crane, and then transported to the shed. The loading/unloading work by crane shall be assumed under the following conditions.

- Handling volume at one time: 5 cargo nets per one loading/unloading operation
- Handling weight at one time: 10 tons per one loading/unloading operation
- Handling size of one operation (length x width x height): 5 m x 1.2 m x 1.5 m

The following pictures show unloading operations at a terminal near Yangon.

Photo 2-2-3 Cargo Handling Operations at a Terminal near Yangon

ii. Pallets

While the pallet size is standardized as 1,100 mm x 1,100 mm x 144 mm as flat pallets for through transit by JIS in Japan, many other pallets of different sizes are also in the market depending on the materials being handled. In this study, the following pallet size is considered to handle cement bags, which is a major handling material at present.

- Pallet size: 1200 mmx1000 mmx150 mm
- Pallet weight: 30 kg

Wooden pallet Plastic pallet

Figure 2-2-9 Example of Pallet

2) Containers

The following standard size containers are to be considered for the planning.

Table 2-2-8 Standard Dimensions of Containers

Type		Length (mm)	Width (mm)	Height (mm)	Weight (kg)
40-ft container	1AAA	12,192	2,438	2,896	30,480
	1AA			2,591	
	1A			2,438	
	1AX			< 2,438	
20-ft container	1CC	6,058	2,438	2,591	24,000
	1C			2,438	
	1cX			< 2,438	

3) Other cargoes handled

Other than the above-mentioned cargoes, the following are considered to be handled in the port.

- Lumber
- Stone materials
- Construction materials (Reinforcing bars, piles, precast/prefabricated concrete products, etc.)
- Machinery
- Others

4) Cargoes not to be considered in the plan

The port is planned under the consideration that bulk cargoes such as coal and iron ore are not to be handled.

(3) Cargo Handling Operations in the Port Area

The jetty, yard and warehouse are planned based on the following cargo handling operations to be conducted.

Table 2-2-9 Cargo Handling Patterns

Operation pattern: Inbound cargo

Pattern	Vessel Type	Cargo	Packing Style	Loading/ Unloading Method at Berth	Transportation Method	Handling Method at Yard/Shed	Delivery to Consignor
1	Barge	Rice, Beans, Cement, etc.	50 kg bag	Loaded on vehicle by crane on berth	Tractor/chassis	Stacked in shed (palletized cargo)	1) Loaded on truck by forklift (pallet) 2) Loaded on truck by manpower
2	Barge	Cement, etc.	1,500 kg bag	Loaded on vehicle by crane on berth	Tractor/chassis	Stacked in shed	Loaded on truck by forklift
3	Barge	Construction material, heavy cargo, etc.	individual piece	Loaded on vehicle by crane on berth	Tractor/chassis	Loaded/unloaded by mobile crane at open storage area	Loaded on truck by mobile crane
4	Barge	Container	20'/40' container	Loaded on vehicle by crane on berth	Tractor/chassis	Loaded/unloaded by reach stacker at container stacking area	Loaded on chassis by reach stacker

Operation pattern: Outgoing cargo

Pattern	Vessel Type	Cargo	Packing Style	Collection from Consignor	Handling Method at Yard/Shed	Transportation Method	Loading/ Unloading Method at Berth
5	Barge	Rice, Beans, Cement, etc.	50 kg bag	1) Stacked in the shed by forklift (pallet) 2) Piled up on pallet and stacked in the shed by manpower	Loaded on the tractor chassis by forklift	Tractor/chassis	Loaded on barge by crane on berth
6	Barge	Cement, etc.	1,500 kg bag	Stacked in shed by forklift	Loaded on the tractor chassis by forklift	Tractor/chassis	Loaded on barge by crane on berth
7	Barge	Construction material, heavy cargo	individual pieces	Loaded on open storage yard by mobile crane	Loaded on the truck by mobile crane	Tractor/chassis	Loaded on barge by crane on berth
8	Barge	Container	20'/40' container	Loaded on container stacking area by reach stacker	Loaded on the tractor chassis by reach stacker	Tractor/chassis	Loaded on barge by crane on berth

2-2-1-1-5 Study on Structural Type of Jetty

Based on the 2014 JICA F/S Study, the Study team is required to determine the structural type of the jetty, either floating type or fixed type, by the discussion with the Myanmar Government. Prior to the discussions, the Study Team conducted comparison study on the following five points;

1) Consistence for cargo type, i) container cargoes, ii) general cargoes and iii) passengers,
2) Suitability for sedimentation risk,
3) Ease of maintenance and repairs,
4) Application of same concept to other national river ports, and
5) Construction cost.

Each item was evaluated qualitatively and marked as [A]: Suitable, [B]: Fair and [C]: Not suitable, and summarized in the comparison table as shown Table 2-2-10.

Table 2-2-10 Comparison Table for Jetty Structural Types

Factor of Comparison		Floating Type Jetty	Fixed Type Jetty
Consistency for Cargo Type	Container cargo	B	A
	General cargo	A	A
	Passenger	A	B
Suitability for sedimentation risk		C	B
Ease of maintenance and repairs		B	A
Application of same concept to other national river ports		A	A
Construction cost		B	A
Final Estimate		B	A

Legend: A: Suitable, B: Fair C: Not suitable

The Study Team prepared the material for discussion with the Myanmar side[4], including comparison table as shown in Table 2-2-10, to lead the decision making by the government of Myanmar and mutual discussion was had during the second field survey trip.

During the discussion, the Study Team suggested the following three points for decision making.

- Considering the recent trend of transportation businesses, the port should be designed to accommodate containerized cargoes. If conventional 40 ft. container units should be lifted by crane mounted on the jetty, fixed type jetty is more suitable, avoiding the swaying of a floating jetty due to cargo operation and considering its reduction of handling efficiency.

- Looking at the yearly change in riverbed elevation at the jetty location, the water depth varies in the range of -2.0 m ~ -6.0 m, which implies that there is risk of damage for a floating jetty by touching float body to riverbed due to unexpected sedimentation. Once such damage occurs, repairing the floating body is not easy, where port operation will have to be interrupted for a long time, maybe during one cycle of rainy/dry season.

- The floating type jetty has movable joints which have particular shaped structural parts, therefore it requires more frequent maintenance and repairs. Considering this project is for a pilot project which should extend the concept to other national river ports, the fixed type structure is more suitable as it has less risk of frequent maintenance and repairs.

The Myanmar side MOTC finally agreed to determine that the structural type of the jetty should be fixed type.

2-2-1-1-6 Concept of Port Use

Prior to the port facility plan and design discussions, the concept of port use was discussed and summarized with the Myanmar Government. In conclusion, as the pilot project, the concept of port use is as summarized as follows.

(1) Break Cargo into Units/Container Cargo

Break cargo shall be combined into units and mechanical handling of unit cargo such as pallets and containers will facilitate replacing existing manual handling of bagged cargo of cement, rice and beans. Cargo containerization will be expedited for the near future.

[4] Refer to Appendix 7 “Explanatory Note for Selection of Structure Type of Jetty”.

(2) Cargo Handling by Equipment

Higher cargo handling efficiency will be achieved through installation of mechanical cargo equipment.

(3) Provision of Public Services

Existing cargo operation is dealt with by allocating riverbank space to each port user. Public services for any private port users shall be provided at the new port.

(4) Introduction of Port Terminal Functions

In the present port operation on natural riverbank, barges stay for long time after delivery of loaded cargoes, waiting for next cargo for departure.

The new port will have the function of a port terminal, where the port will stack cargo in the yard or in the warehouse until the cargo owner collects the cargo from the port terminal or until the next barge will come for loading.

The port operator will control the departure/arrival time for barges so that the jetty can accept as many barges as possible. By this function, barges will not have to wait for loading cargo or delivery to the cargo owner's trucks, therefore the jetty will handle barges and cargoes very efficiently. This terminal function will also be effective for introducing fixed-time shuttle transport between other major ports and Mandalay.

(5) Cargo Handling Port Limiting Passengers

The new port is planned that main service of the port will be cargo handling of large barges. Because, from the statistics, 50% of Mandalay cargo is transported by large barges, whilst such barges share 20% of total ship-calls.

The conventional passenger-cum-cargo ships have rooftops which are not suitable for crane lifting of cargo. During the meeting discussion, MOTC and IWT expressed their intention that the new port will receive tourism cruise ships. However, such cruise ships occupy the jetty for a long time without cargo activities, which will reduce the revenue of the port.

Main purpose of this project is port modernization introducing mechanized cargo handling operations. The new port capacity is planned about 30% of total existing cargo volume which are handling along the natural river bank in Mandalay. Considering to these two points, it is recommended that i) handling of cum-cargo ships which are not suitable for crane lifting of cargoes, and passenger (cruise) ships, which are operating by using own pontoon, shall be leave the existing riverbank operations, and ii) the new port operation shall be focused on the services of mechanical cargo handing for large barges. By this operation, along to the project concept, modernized cargo handling by using the equipment in the port will be facilitated and increment of cargo transport quality, and generation and expansion of new cargo demands, which are expected as the project effects, may be realized effectively.

2-2-1-2 Design Policy

(1) References for the Design Works

For the design of facilities, the code and standards of Myanmar will be the principal reference. International standards which are commonly applied in Myanmar will also be referred to for the design.

As there is no particular design standard for port facilities in Myanmar, the design for this study refers to "Technical Standards and Commentaries for Port and Harbour Facilities in Japan". Table 2-2-11 shows the list of codes and standards referred to for the design facilities.

Table 2-2-11 References for the Design Works

Facilities	Codes and Standards
Port Facilities	Technical Standards and Commentaries for Port and Harbour Facilities in Japan (2007), The Ports and Harbours Association of Japan, OCDI "Myanmar Building Code 3" (2012, Ministry of Construction, Myanmar Engineering Society, UN-Habitat)
Land Civil Facilities	Technical Standards and Commentaries for Port and Harbour Facilities in Japan (2007), The Ports and Harbours Association of Japan, OCDI "Myanmar Building Code 3" (2012, Ministry of Construction, Myanmar Engineering Society, UN-Habitat) Design Standards for River Structures (2016), MLIT (in Japanese) Design Standards for Seismic Design of River Structures and Commentaries II – Embankment (2016) , MLIT (in Japanese) Design Manual for Liquefaction of River Embankments (2016), PWIR (in Japanese) "THE STRUCTURAL DESIGN OF HEAVY DUTY PAVEMENTS FOR PORTS AND OTHER INDUSTRIES EDITION 4" (Inter-pave The Precast Concrete Paving and Kerb Association, 2017) "Rock Manual 2nd Edition, The use of rock in hydraulic engineering", CIRIA, 2017
Building Facilities	Ministry of Land, Infrastructure, Transport and Tourism: Standard Specifications of Construction Work for Public Building Design in 2016 Japanese Architectural Standard Specifications: Specifications on Materials Japan Industrial Standard: Material Standards

(2) Policy on Natural Conditions

The natural conditions of Myanmar are referred to for design facilities and construction planning. Particular and careful consideration are made for the season of reclamation and jetty construction as the seasonal movement of the river water level is quite high; 10 m.

Myanmar is identified as a heavy earthquake country which holds the boundary between "India and Australian Plate" which runs in the north-south direction in the middle of the country. Mandalay is located on the high intensity earthquake area. Therefore design earthquake is evaluated taking into account the seismic conditions of the area.

Risk of ground liquefaction during an earthquake was found in the design study. The facility structures are designed appropriately against such liquefaction.

(3) Policy on the Social Conditions

This project has the aim of a pilot project for changing the manner of cargo handling from the existing labour-dependent manual handling to modernized mechanical equipment handling. However, the rapid replacement of the existing labour-force handling might cause unemployment problems. The Mandalay port project plans for about 30% of total cargo to be handled in the new port to reduce such social impact.

On the other hand, the project also aims to improve the quality of river transport by providing safe and clean port facilities. Mechanical equipment will handle heavy cargoes which have not been treated in the existing port area. The efficiency of cargo handling will be improved, which will have the effect of lowering the cost of waterway transport. Like these points, Mandalay citizens will receive many social benefits in view of transport quality, new demand for heavy cargo transport, and cheaper cost of cargo transport.

(4) Policy on Construction and Procurement Conditions

According to the policy of Japan's Grant Aid Project, local construction equipment and material should principally be used for the project. However, careful attention must be paid to the quality of the local materials/equipment. If the local materials and/or equipment quality is not sufficient to satisfy the final quality of the facilities, such material and/or equipment are planned to be procured from third countries or from Japan.

From the survey of the Study Team, it is found that there is not enough heavy construction equipment, and delivery of heavy material will be difficult as the heavy lifting crane is not always available. In the planning of procurement and construction, the appropriate transport method, road or river, should be carefully considered.

(5) Policy on Environmental and Social Considerations

The process related to environmental and social considerations ought to be carried out in accordance with the JICA Guidelines for Environmental and Social Considerations (April 2014) and relevant environmental laws and regulations in force in Myanmar. The subject project is not considered large scale under the ports and harbours sector stipulated in the Guidelines and no significant adverse impact on the environment is expected to be generated. It does not carry sensitive characteristics nor is it carried out in sensitive areas as defined under the Guidelines. Hence, the project is classified to be Category B.

With regards to an environmental certificate, an IEE report on the project has been submitted by MOTC to the Ministry of Natural Resources and Environmental Conservation (MONREC) in Myanmar in September 2017. In accordance with the EIA Procedure (2015), the review process of MONREC on the report would be completed by December 2017. Once the report has been approved, the Environmental Compliance Certificate for the project will be issued by MONREC. From a natural environmental point of view, there are no protected areas nor have any precious species that require special attention been identified in or near the project site. Nevertheless, while not at any significant scale, air and water quality is expected to deteriorate and noise and vibration levels are expected to increase primarily during construction and hence require adequate attention.

With regards to the social environmental impact, no involuntary resettlement is expected as a result of the project. Nevertheless, three plots of registered land, approximately 15.6 acres in total, and crops (i.e. butter beans and peanuts), approximately 9.2 acres in total, as well as structures (i.e. seven huts) are expected to be affected by the project. A farmland management committee composed of relevant government agencies in Myanmar, including DWIR, has been formed under this project. It should be noted that coordination with this committee is considered necessary from time to time when decisions and actions related to securing the project site are to be made and taken under this project, including those related to providing compensation to the project-affected persons.

(6) Policy on Operation and Maintenance

For the operation and maintenance of the new port, IWT will establish a new department organization. In the initial phase of new port operation, government budget support is thought to be necessary. It is proposed to run the new establishment for port operation so that it will become an independently profitable organization roughly three years from the opening of the new port.

It is predicted that the cargoes for the new port in the initial phase will be the existing general cargo and unitized pallet cargo. New demand for heavy cargoes or containerized cargoes will gradually increase. The port facility is designed to accommodate both the conventional cargo and the new demand cargoes.

In order to reduce the cost burden to the new organization, facilities should be designed as low-maintenance, low runing cost structures. For instance, for a lighting device the selection of an LED light system is advantageous for life-cycle-cost, i.e., low power consumption and long life despite the initial cost being higher.

(7) Design Policy on Civil Structures and Facilities

Basic concepts of the design of the civil facilities are as follows;

1) Considering the workability of the project site

River water level at the construction site varies about 10 m in dry and rainy seasons. The structure type of the jetty was adopted pile supported fixed type. Therefore, river water level changes may affect to the pile driving works negatively. Small number of piles is advantage for the construction works, therefore, to reduce the number of piles, large-diameter piles are selected for the jetty, and a long-span pier-girder structure is selected for the access bridge.

2) Consideration of Local Conditions

The seismic zone map of Myanmar is frequently updated. Based on the latest zone map, Mandalay region is categorized as an area with high risk of earthquake. For the design of the facilities, the risk of earthquake is carefully considered, where the seismic coefficient is carefully studied and determined. Risk of liquefaction is carefully studied.

3) Consideration of operations

The facilities are designed to satisfy required port functions in conformity to the role of the port.

(8) Design Policy on Building Facilities

The site layout of the facilities is planned to reserve conditions of smooth traffic circulation in the terminal area, and to avoid the crossing of pedestrians and vehicles as much as possible. On the river side of the warehouse platform is placed a platform for the use of trailers. On the opposite side, trucks can go alongside to the warehouse for loading and unloading by forklift. For security, fences more than 2 m high are provided around the terminal area. 3 gates are provided with doors.

(9) Procurement Policy on Cargo Handling Equipment

For port modernization by introducing cargo handling equipment, the following operations in the terminal area are mechanized by equipment:

1) Cargo loading and unloading operations to /from ships at jetty,

2) Cargo handling in the cargo yard (both for general cargoes and container cargoes),

3) Cargo handling in the warehouse, and

4) Cargo transport from warehouse/cargo yard to jetty and vice versa.

Cargo handling equipment are selected based on the objective cargoes and their styles, and cargo handling operations in the terminal area.

(10) Policy of the Grade of the Facilities and Equipment

1) Jetty

Based on the comparison study, fixed type jetty was selected. The Jetty will accommodate two barges at the same time. The jetty was designed for vessel berthing at any height of water level for both rainy/dry seasons.

The structures are sufficiently safe and stable against i) river bed changes considering deepest water depth from past observation data and, ii) soil liquefaction during earthquake.

Underneath the deck slab of the jetty, a catwalk is provided for embarking and/or disembarking ship crews during low water conditions.

2) Access Bridge

To shorten the construction time and to reduce cost, a bridge structure was adopted for the access bridge by which the number of piles can be reduced. The level of structural stability for changes in water depth and for liquefaction of earthquake was adjusted to the safety level of the main jetty.

3) Reclamation and Revetment

The subsoil condition has high risk of liquefaction by earthquake. Therefore, an anti-liquefaction design was applied underneath the layer of revetment.

Access bridges connect to the reclaimed area at two points on the riverside revetment. At each connection point on the riverside revetment, abutment is constructed. To reserve the port functions, the damages of the abutment and the riverside revetment shall be avoided when earthquake. In this regard, as the measure for liquefaction, sand compaction piling method is applied to the underneath layer of revetment.

For the other revetment (south, north and landsides), some slight settlement and deformation are allowed in the design, because the risk of affecting port function is lower. Such deformation of the revetment will be repairable after the occurrence of an earthquake. Considering cost savings, a geo-textile mat placing method is applied to reduce the deformation caused by liquefaction.

The finished elevation of the reclamation area is planned as 50 cm higher than the jetty top elevation.

4) Cargo Yard

The size of the cargo yard is designed so that the capacity of jetty handling (break bulk and container) should be balanced with yard capacity. The required space is also considered for general cargo, large sized/heavy cargoes, and the space for mixed plotting of container and general cargoes during the transition period to future containerization.

Concrete block pavement is selected taking into account ease of maintenance and repairs.

5) Building Facilities

Pile foundation is designed for the office/workshop and warehouse considering the buildings are to be erected on reclaimed land with more than 5 m thickness. The risk of liquefaction caused by earthquake is also considered.

It is generally planned to use local construction materials as much as possible, but for local materials which have risks in quality, procurement from a third country consistent with the Japan Industrial Standard (JIS) is planned.

6) Cargo Handling Equipment

Cargo handling equipment is very important to achieve the project concept which changes the existing style of manual handling to the modernized mechanical cargo handling. Therefore the cargo handling process is carefully studied and the most suitable series of equipment is selected. The procurement concept pays careful attention to quality, sufficiently high performance and high quality equipment will be procured.

2-2-2 Basic Plan

2-2-2-1 Overall Plan

On the basis of the port development concept in the previous section, the following facilities were planned. The concepts of planning were as described hereunder.

(1) Facility Plan

Table 2-2-12 Objectives of Facilities Planning

Facilities		Outline of Facilities
Civil Works	Jetty	The cargo handling capacity of the jetty was determined to allow two existing barges berthing alongside the jetty simultaneously.
	Access Bridges	Two access bridges were proposed to allow one-way traffic between yard and jetty.
	Cargo Yard	Land reclamation with revetment was planned to accommodate the cargo yard and other on-land facilities.
	Access Road	Land reclamation with revetment was planned. Refugee lanes for trucks incoming to the port were planned.
	Others	Yard lighting, storm drainage, etc., were planned if needed.
Building Works	Warehouse	Planned as general cargo and CFS area
	Port Office Building (Port Office / Workshop)	A two-story building with Workshop on ground level and Port Office on the 2nd floor
	Canteen	Planned as the rest house for port labourers
	Generator House	Planned as a house for the back-up generator for brown-outs
	Pump House	Planned as a house for water supply pump(s)
	Security Hut	Planned for security of access control at port gate
	Electric Supply / Utility Facilities	Electric power supply system, water supply/sewerage system, etc., were planned as required.

An image of the above-mentioned facilities plan is shown below. The details are described in later sections.

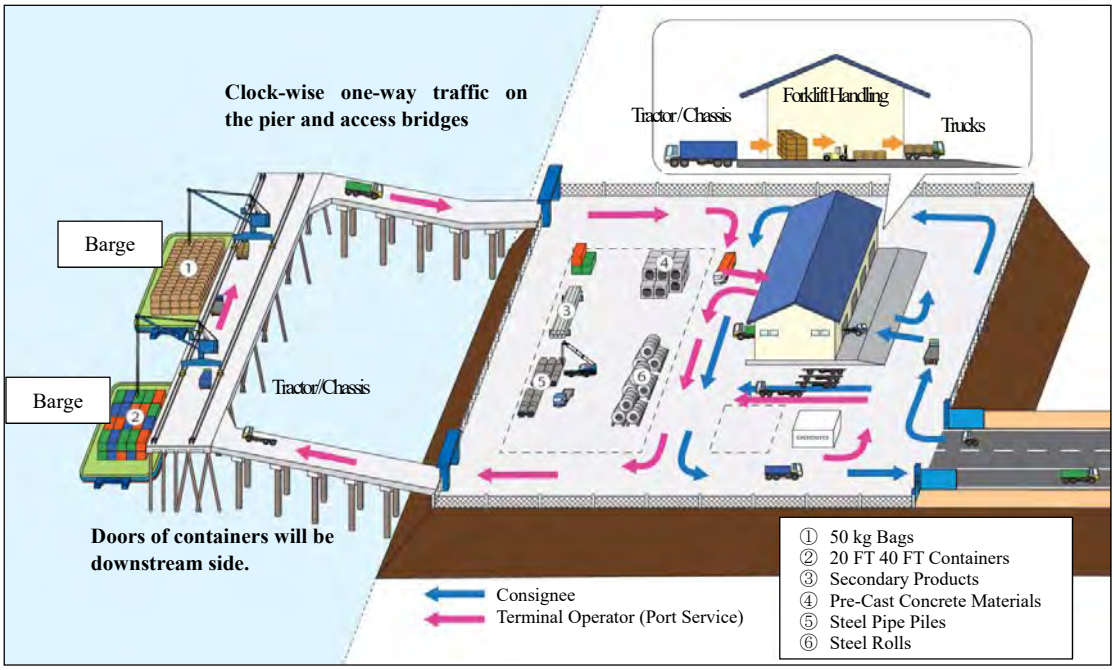


Figure 2-2-10 Image of Planned Facilities (Entire Port)

(2) General Layout Plan

The general layout plan of the above-mentioned facilities is shown in the figure below.

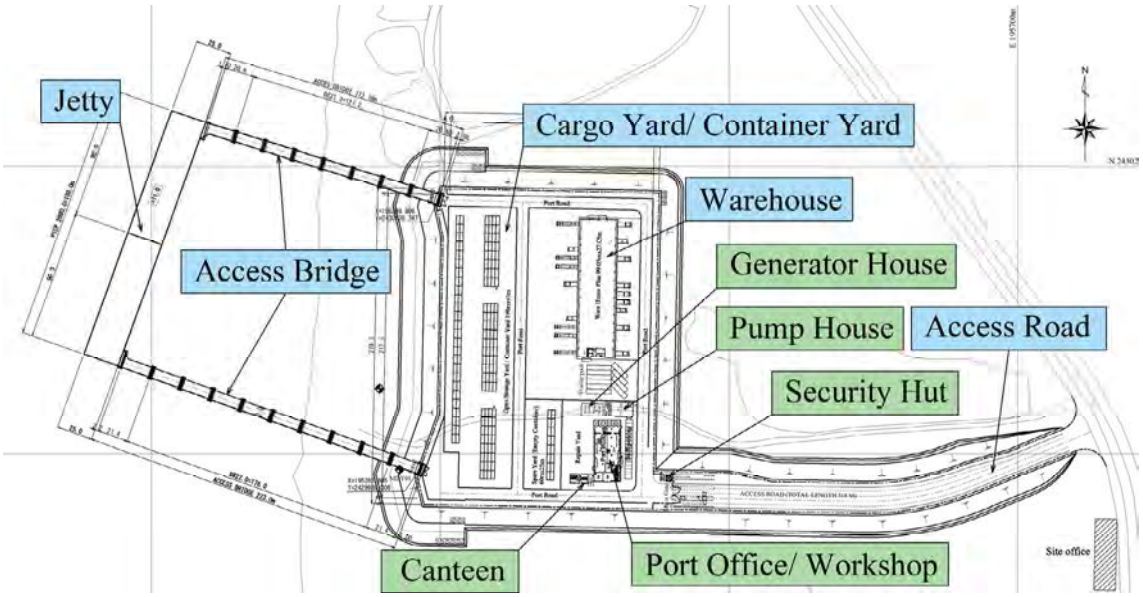


Figure 2-2-11 General Layout Plan

(3) Procurement and Operation Plan of Cargo Handling Equipment

Cargo handling equipment to be procured is as indicated in the table below.

Table 2-2-13 Type and Quantity of Cargo Handling Equipment for Procurement

Type of Equipment	Usage	Quantity
1. Jib Crane	Ship-shore cargo handling on the pier	2 units
2. Rough Terrain Crane	Cargo handling in the port yards	1 unit
3. Reach Stacker	Container and general cargo handling in the port yards	1 unit
4. Forklift	Cargo handling in warehouse and yards	5 units
5. Tractor	Towing of cargo between jetty, warehouse and cargo yards.	6 units
6. Chassis	Ditto	6 units

2-2-2-2 Basic Plan (Civil Works)

(1) Objective vessels

Objective vessel is 2,000 DWT, which is able to load 150 TEU containers.

Vessel dimensions are as follows:

Type of vessel : Cargo Vessel (Barge)
L.O.A. (Length Overall) : 60 to 65 m
Width : 17.5 m
Draft : 2.0 m
Deadweight tonnage : 2,000 DWT
Displacement tonnage : 2,348 t (DW)

(2) Jetty

1) Design Conditions

a. Planned water depth

Water depth in front of the jetty is planned necessary depth when the lowest river water level in dry season. Draft of the objective vessel is 2.0 m, however, due to water depth limitation of the river channel from Yangon to Mandalay, deeper than 1.5m draft vessel is not available to manoeuvre to Mandalay in dry season. Therefore, planned minimum water depth in dry season is set to CD -2.0 m considering some allowances against river bed fluctuations and others.

b. Design water depth

Design water depth in front of the jetty is set to CD – 7.0 m considering to the maximum depth to the river bed based on the past hydrographic survey records. For the safety reasons, existing subsoils above -7.0 m are not expected for the pile foundation design. To estimate skin frictions contribute to the bearing capacity and pulling resistances, and lateral resistance of pile foundations, subsoils above -7.0m are ignored.

c. Jetty Length

The length of berth is set to 180 m (90 m x 2 blocks) to accommodate 2 objective vessels' cargo handling at the same time.

d. Crown height of jetty

The berth crown height is set to CD +11.0 m which includes 0.7 m allowance to the highest water level record CD +10.3 m.

e. Apron width

The width of the apron of the pier is set to 25.0 m considering the width of the container crane span (rail gauge) and the other operation space on the pier.

f. Sub-soil conditions

The soil conditions, such as the depth of the hard bearing strata and ground constitution, are decided by using the results of the boring surveys from 2013 and 2017.

g. Design Seismic Coefficient

The design seismic coefficient is set to kh = 0.30 based on the one dimensional earthquake response analysis, by using the earthquake intensity database and subsoil conditions. The validity of the results of the analysis is confirmed by the latest seismic zone map 2012.

h. Load Conditions

The following load conditions are applied for the design.

i.	Dead Load		
ii.	Live Load	Ordinary condition	10 kN/m^2
		Seismic condition	5 kN/m^2
iii.	Operation Load	Wheel load of container crane, 2 cranes on 1 Pier block	
iv.	River fluid force	The river fluid force acting on the foundation piles, as ordinary load	
v.	Berthing Force	The fender reaction force due to the objective vessel berthing	
vi.	Mooring Force	Ship mooring force acting on the mooring bollard.	
vii.	Seismic Force	Seismic force for dead and live loads	

2) Calculation Results

a. Structure

Pile foundation with coupled batter piles is applied. The number of coupled piles is 16 couples both for transversal and longitudinal directions.

b. Pile dimensions

i.	Vertical piles in the front row	Dia. 1,100 mm, t = 14 mm, SKK490
ii.	Coupled batter piles	Dia. 1,100 mm, t = 14 mm, SKK400
iii.	Other vertical piles	Dia. 800 mm, t = 14 mm, SKK400

c. Maximum stress ratio

i.	Vertical piles in the front row	$0.904 \leq 1.0$
ii.	Coupled batter piles	$0.329 \leq 1.0$
iii.	Other vertical piles	$0.525 \leq 1.0$

d. Values of safety factor of bearing capacity

i.	Vertical piles at the front row	Push in	Ordinary Condition	$6.1 \geq 2.5$
			Seismic Condition	$5.2 \geq 1.5$
ii.	Coupled batter piles	Push in	Ordinary Condition	$6.2 \geq 2.5$
		Push in	Seismic Condition	$2.7 \geq 1.5$
		Pull out	Seismic Condition	$2.9 \geq 2.5$
iii.	Other vertical piles	Push in	Ordinary Condition	$5.8 \geq 2.5$
			Seismic Condition	$5.0 \geq 1.5$

(3) Access Bridge

1) Design Conditions

a. Design segment

The design of the access bridge foundation is carried out by dividing into several segments, since subsoil conditions varies and different along the access bridge. The necessary number of pile bents of the bridges is 8 (US-1 to US-8) for upstream side and 10 (DS-1 to DS-10) for downstream side bridges respectively. Based on the subsoil conditions, pile bents are categorized into the following types.

i.	TYPE-1	DS-2 to DS-6
ii.	TYPE-2	DS-7 to DS-8
iii.	TYPE-3	DS-9
iv.	TYPE-4	DS-10
v.	TYPE-5	US-2 to US-3
vi.	TYPE-6	US-4 to US-7
vii.	TYPE-7	US-8, DS-1, US-1

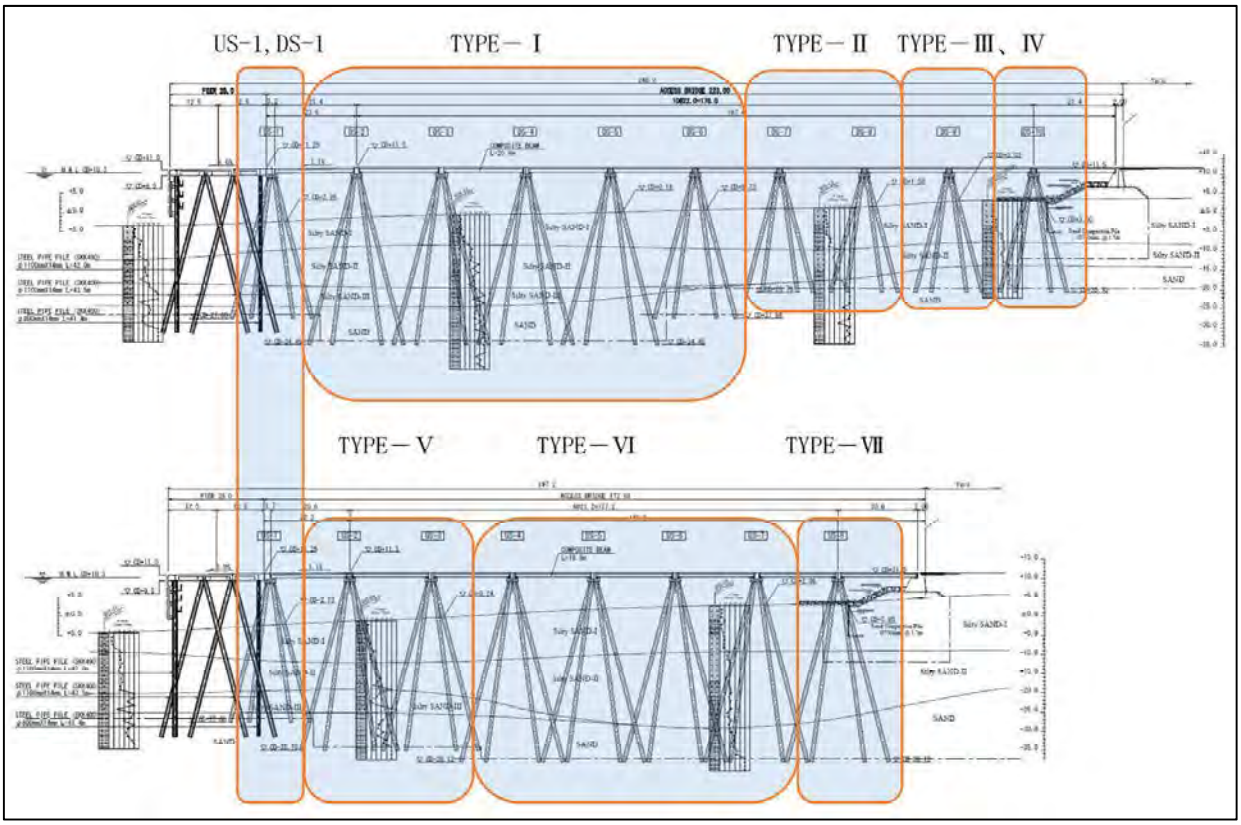


Figure 2-2-12 Section Divisions of Pile Bents of Access Bridges

b. Design water depth

The design water depth is as in the following table. Types 1 to 7 are decided based on the boring survey results. For US-1 and DS-1, since they are located adjacent to the jetty, the same design water depth as for the jetty is applied.

Table 2-2-14 Design Water Depth of Access Bridges

TYPE	1	2	3	4	5	6	7	US-1,DS-1
Existing Water depth (CD-m)	-0.55	+1.20	+3.20	+5.00	+1.20	+2.78	+5.00	(-7.00)
Design Water Depth (CD-m)	-8.55	-6.80	-1.80	-1.80	-11.20	-9.22	-9.22	(-7.00)

c. Floor level of the bridge (FH)

The floor level of the bridge is set to CD +11.5 m which is the level of the land yard area. The last bridge span adjacent to the Pier has a longitudinal gradient in order to connect to the crown height of the Berth, CD +11.0 m.

d. Type and Dimensions of Superstructure

The superstructure of the access bridge is a composite girder bridge and its dimensions are as follows:

i.	Bridge overall length	21.0 m
ii.	Span length	20.0 m
iii.	Form of bridge width	0.25 m + 6.5 m + 0.25 m = 7.0 m
iv.	Alignment	R = ∞ : Strait line
v.	Pavement	Concrete pavement with average thickness of 25 mm
vi.	Slab	Reinforced concrete slab with 60 mm thickness, 260 mm

e. Substructure of Access Bridge

The substructure of the Access Bridge is a reinforced concrete abutment with coupled piles.

f. Load Conditions

i. Composite Girder Bridge

- T-Load (Total weight of trailer with fully loaded 40 ft container)
- 2 trailers on access the bridge
- Dead weight
- Design seismic coefficient; kh = 0.30 (for transverse beam and dowel design)

ii. Substructure

- Reaction force of the superstructure = 1,247.6 KN (per 1-abutment line)
- Dead weight
- Design seismic coefficient; kh = 0.30
- River fluid force (ordinary conditions) up to the high-water level CD +10.3 m

2) Calculation Results

a. Pile Dimensions Dia. 900 mm, t = 16.0 mm, SKK400

b. Results of the stress analysis

TYPE		1	2	3	4	5	6	7	US-1,DS-1
Stress Ratio	Ordinary Condition	0.14	0.13	0.10	0.12	0.16	0.16	0.16	0.16
	Seismic Condition	0.90	0.86	0.72	0.74	0.81	0.95	0.95	0.68

c. Results of Bearing Capacity

TYPE		1	2	3	4	5	6	7	US-1,DS-1
Push in	Ordinary Condition	9.69	5.62	6.64	6.64	6.78	8.58	8.58	8.75
	Seismic Condition	3.37	1.95	2.40	2.40	2.41	2.86	2.86	3.89
Pull out	Ordinary Condition								
	Seismic Condition	7.70	2.95	4.69	4.69	4.77	5.39	5.39	6.96

(4) Ancillary Facilities

1) Fender System

The fender is selected to absorb the berthing energy of the objective vessel. The maximum berthing speed is set to 65 cm/sec. V-type 400H fender is able to accommodate to ship berthing. Required specifications of fender are as follows:

- Type and dimensions V-Type 400H 2.0 mL
- Energy absorption 117.6 kNm
  (computation result without performance clearances)
- Reaction force 940 kN (including performance clearances)

2) Mooring facility

A 250-kN-type bollard is chosen for the mooring facility to accommodate the 2,000 DWT (equivalent of 1,058 GT) vessel berthing based on Japanese technical standards. The mooring points are needed to arrange in the lower level of the berth for vessels berthing at various water levels. The 3 stages are prepared underneath the pier deck for boarding/disembarking of the ship crew and to install the mooring facility during the low water level. The 250kN cleat is used as mooring facility on the stages.

(5) Cargo Yard and Road in Terminal Area

1) Pavement Structures

Yard and road pavement are planned as the following four (4) types.

Table 2-2-15 Cargo Yard and Road Pavement

Area	Cargo Yard (Container Yard)	Around Warehouse	Circulation Road	Access Road
Maximum Load	4-high container stacking Reach stacker	50-ton crane	Trailer and chassis	Trailer and chassis
Pavement Thickness	Interlocking block 80 mm + sand 20 mm	Interlocking block 80 mm + sand 20 mm	Interlocking block 80 mm + sand 20 mm	Interlocking block 80 mm + sand 20 mm
	Concrete base coarse 560 mm	Concrete base coarse 300 mm	Concrete base coarse 200 mm	Graded base course 200 mm
	Subbase 150 mm	Subbase 150 mm	Subbase 150 mm	Subbase 250 mm

2) Storm Drainage

Storm drainage is planned to be provided with a U-ditch with grating in the yard centre, north and south direction, and U-ditches at the circumference of the yard and on the embankment slope, draining rain water to the outside of the port area (river).

3) Yard Lighting

High pole lighting for the cargo/container yard and road lighting along the roads are provided.

(6) Reclamation and Revetment

1) Revetment

Riprap type Revetment with 1:2 slope was considered. In order to prevent the slope toe facing the river stream from rupture by erosion, steel sheet pile wall and protection stone with 15 m width will be provided. The banking materials will be quarry run to avoid liquefaction.

2) Countermeasures against soil liquefaction

Based on the soil investigation results, it was found that subsoil layer shallower than 15 m to 20 m has a high risk of soil liquefaction because of its sandy layer properties with N-value of around 4 to 20.

To reduce construction cost and time, sand compaction pile (SCP), which is to prevent soil liquefactions, and high-intensity geotextile (geo-synthetics), which is to reduce the deformation of soil structures on the liquefied soil layer are selectively used as the countermeasures against the soil liquefactions.

SCP which is expensive and long execution time is required, is applied for underneath of the riverside revetment only, where deformation and damages are not allowed since there are access bridge abutments on the revetment and repair and rehabilitation works are difficult. The deformation prevention sheet, which is relatively cheap and easy to execute, is used at other area of the revetment where some deformations and slight damages are allowed. Main focus is on preventing the embankment collapse. Weak damages and deformations of the revetment can be recovered by repair and rehabilitation works.

3) Reclamation

The formation height of the port yard will be +11.5 m considering the Highest Water Level (HWL) of +10.3 m, the height of the existing river bank (approximately +11 m) and the freeboard.

(7) Access Road

A 318-m-long access road will be provided connecting the existing road and the port reclamation area. In consideration of congestion due to waiting cargo trucks around the gate and traffic other than queuing trucks, two lanes on the entrance side and one lane on the exit side are set and a parking lane with a width of 2.5 m is provided. Sidewalks will be provided on both sides of the road, but the pedestrian gate is located on the south side of the road and the width of the sidewalk also widens on the south side.

2-2-2-3 Basic Plan (Building Facilities)

(1) Building Facility Plan

1) Warehouse

A platform is provided on the river side of the warehouse, 1.1 m height, for future container vehicles. Floor inside of the warehouse is flat and land side is made same level of the ground so that cargo loading and unload by forklift between customer trucks and warehouse inside is available. Height difference between warehouse floor level and outside ground level shall make smooth by gentle slope. Some shutters of 5.5 m width and 4.8 m height are placed in between. Office, toilet and storage are provided inside the warehouse.

2) Workshop

In the workshop, some storage to stock machine parts or equipment, as well as office and toilets are provided. A maintenance pit for vehicles is planned inside the workshop. The facility is designed that overhead travelling crane is able to install inside the workshop in future.

3) Port Office

Office staff is composed of 20 persons in executive positions and 40 to 50 persons in administrative positions, so the capacity of the room is 60 staff persons, which shall also include the port director's room, secretary, toilet, locker room and staff kitchen.

4) Canteen

A canteen and toilet are provided for the port workers. Immediately, it is possible to utilize as the passenger service area.

5) Generator House

The generator room is composed of electrical room and distribution-board rooms. It works only in case of emergency use. Cables are connected under the floor pit.

6) Pump House

The water-reservoir is placed outside and the storage pump of well water and the feed water pump are located inside. The well water will be lifted to the water reservoir tank; after, the stored well water will be distributed to the buildings by pressurized pump unit.

7) Security Hut

At the main entrance, a container gate will, in the future, be placed with a new watchman office, therefore a simple hut is planned under this project.

8) Gate and Fence

To secure the port area, a fence more than 2-m height is provided surrounding the area of the terminal. One main gate at the terminal entrance and two gates at the entrance of the access bridges are provided.

(2) Structural Design Plan

1) Basic Concept

Followings are the basic concept for the structural design of the building facilities.

- Safety and practical design shall be made based on the soil conditions at site.
- Structures shall be designed without hindrance considering to the deflections and vibrations against the normal load conditions.
- Sufficiently safety structures shall be designed against the temporary loads such as strong winds and earthquake.
- Simple and durable structures shall be adopted in conformity with the easy construction works at site.

2) Materials and Structural Types

Reinforced concrete Rahmen type structure frame, which is commonly applied and economical at site with brick wall type is applied in principle. Roof structure of warehouse which has 24.0 m span is designed by H-shape steel frame, however, underneath of the roof is designed by reinforce concrete.

3) Foundations

Building facilities in this project is constructed on about 5 m thickness reclaimed ground. Live load on warehouse floor is 80 kN/m^2 . The building weight of the warehouse is more than 100 kN/m^2. Port Office Building is planned as two stories reinforced concrete structure. However, structurally, it is equivalent to three stories building comparing to the other general buildings. Building weight is more than 100 kN/m^2 as similar as the warehouse. Canteen, generator house and pump house are one story buildings and the wait of the buildings are about 30 kN/m^2.

Reclaimed soil shall be compacted per 30cm thickness in general, in such case, about 30 kN/m^2 bearing capacity of soils can be expected. Therefore, one story buildings except warehouse is planned as footing foundations with 1.0 m soil replacement to avoid unequal foundation settlement. Warehouse and port office building foundations are planned by pile foundation. Prefabricated RC concrete piles, which are obtainable at the construction site, are used. The pile length is planned to the driving depth where sufficient bearing capacity can be obtained based on the soil conditions.

4) Wind and Earthquake Resistances

Based on the "SEISMIC ZONE MAP OF MYANMAR", the project site is "ZONE4". Wind speed is 44.7 m/sec based on the "BASIC WIND SPEED 0(3-5 GUST WIND SPEED)". Building structures are designed based on the Japanese Standards and References, since there is no detailed design codes and regulations in Myanmar.

5) Grade of the design and material used

Following materials and its grades are set for the design works, considering to i) the materials are able to obtain in local market in Myanmar and ii) material property and specifications shall be satisfied the requirements of the referenced standards for the design works.

Table 2-2-16 Material Grades to be used for the Building Structures

Concrete	Foundation to First Floor Slab	24N/mm^2
	First Floor Column, Roof	24N/mm^2
Reinforcing Steel Bards	Round Bar	φ6 ~ φ9
	Deformed Bar: SD295	D10 ~ D14
	Deformed Bar; SD345	D16 ~ D25
Steels	Shaped Steel, Steel Plate	SS400
	Light Weight Shaped Steel	SSC400

(3) Utility Plan

1) Electrical System

a. Substation

Based on the site survey, it was confirmed that it is possible to lead in to the site with a 33-kV overhead power line that is currently running along the existing road on the east side of the project site. Therefore, it is planned to receive 3-Phase, 4-Wire, 33-kV, 50-Hz electric power from the above power line by installing a power entry pole on the tie-in point at the side of the existing road. Considering the safety and maintainability of the incoming power line at the site, power cabling from the lead-in point to the power-receiving panel in the Electrical Room inside the building is planned by underground placing. The incoming cables are planned to be CVMAZV Corrugate CV Cable, taking into consideration that the case may be underneath groundwater during rainy seasons. The transformer is planned to be installed in the Electrical Room to step down the power from 33 KV to 400 V/230 V. The capacity of the transformer is planned to be 300 kVA, in consideration of the building's mechanical and electrical loads and the external lighting load, etc. The type of transformer is selected to be oil-filled type, which is commonly used in Myanmar.

b. Low-Voltage Power Distribution Devices

Electrical power is stepped down from 400 V to 230 V by the transformer and distributes low voltage power from the main distribution panel to each local distribution board. The size of the low voltage main distribution cable is decided in consideration with the voltage drop. Power to the electrical motor driven for ventilation and firefighting equipment such as fans and pumps is distributed through the control panels provided by their systems.

c. Lightning Protection and Grounding System

It is planned to install lightning rods for facilities which are higher than 20 m from ground level to reduce the risk of lightning strikes. Lightning rods are provided for lighting poles in the cargo yard area, but for all of the building facilities less than 20 m high, lightning rods are not provided.

d. Lighting and Receptacles

In consideration of energy saving and maintainability, LED lamps are planned to be installed in all internal and external lighting fittings. Wall-mounted receptacles (outlets) are planned considering to the availability of wet floor cleaning. External yard lighting poles in the terminal area are planned to be equipped with manual lifting devices for maintenance of the lighting fittings.

e. Telephone

Three (3) lines (circuits) are provided to the port office/workshop building. MDF provisions and cable placing from the connection point to the MDF are within the scope of the Project. Provision of IDF and telephone outlet, including cabling and wiring to each room, is also in the scope of the Project.

Connection to the city lines and provision and connection with telephone devices and/or PABX shall be in the scope of the Myanmar side.

f. Local Area Network (LAN)

Placing the LAN cable from the connection point of the telecommunication circuit from the external network to the MDF in the port office/workshop is within the scope of the Project. CAT 6 fibre optic cable is expected to be used for the LAN connections. LAN devices such as routers, switches, patch panels, hubs, cabinets, etc., shall be provided by the Myanmar side.

g. Fire Detection and Alarm

Fire detection and alarm system are planned to be equipped in the port office, workshop, warehouse, and canteen. A fire alarm panel is provided in the office on the 2nd floor of the port office building. Detectors are to be installed in these rooms and areas.

h. Emergency Generator

A diesel-engine-driven-type emergency generator is planned to be installed in order to supply power during power failure. The capacity of the generator is estimated considering thirty-three percent operation of the total lighting loads, receptacle loads and one-hundred percent of telecommunication, information equipment and fire and security equipment loads. Available continuous operation time of the emergency generator is planned to be eight hours in consideration of the normal office hours at the port facility.

2) Plumbing

a. Domestic Water Supply

Since there are no city water supply lines near the site, a well water supply system is planned for the domestic water supply in the port facilities.

An underground water pump near the building facilities might induce settlement of the ground. Therefore, the well point is planned at a suitably remote point from the buildings.

b. Wastewater Drainage and Sewerage System

For the wastewater treatment plant, a merger-type septic tank is provided in the terminal area. Wastewater and sewage from the buildings are planned to be collected and treated by the plant. The treated water is planned to be discharged into the external rainwater drainage main.

The treated water quality by the plant is planned to be equivalent to that which is required by the Japanese standard, i.e. BOD: 20 pp, SS: 10 ppm, TN: 10 ppm. An FRP merger-type septic tank is planned considering the high durability and maintenance ability.

c. Fire-Fighting System

The following basic fire-fighting equipment are planned to be provided in consideration of the standard requirements of the relevant international regulations.

- Fire-fighting pump : 720 L/min x 0.5 MPa
- Fire-fighting pump with diesel engine : 720 L/min x 0.5 MPa
- Inside of the building : Indoor hydrant with hose reel
- Yard area : Outdoor hydrant with hose reel box
- Storage tank capacity for fire-fighting : for 30 minutes continuous operation = 21,600 L

3) Ventilation

A forced ventilation system is provided for the following places:

- Toilet and Storage
- Warehouse
- Electrical Room, Pump room

A natural ventilation system is planned for the workshop in the port office building, because indoor air is naturally replaced with the air pressure difference between air supply and exhaust.

Air exchange rates by ventilation for the above-mentioned rooms are planned as follows based on the Japanese design standard.

- Toilet : 10 times per hour
- Storage : 5 times per hour

(4) External Fire-Fighting System

Outdoor-type fire hydrants are planned at the cargo yard and roads in the terminal area. The hydrants are installed at the location to be able to cover a 100-m radius area around the facilities.

2-2-2-4 Basic Plan (Cargo Handling Equipment)

(1) Selection of Cargo Handling Equipment

Based on the expected cargo handling operations in the terminal area, it was planned that the following works shall be carried out by the equipment:

- Loading/unloading to/from ship at the jetty,
- Cargo handling in the open yard,
- Cargo handling in the warehouse, and
- Cargo transport between the jetty and the open yard/warehouse.

The following are the conditions for the cargo handling equipment planning in the terminal area.

1) Operation Conditions

a. Annual cargo handling volume : 24 thousand tons
(Total of general cargo and container cargo)

b. Operation hours

- Operation days per year : 341 days/year
- Operation hours per day : 7.2 hours/(gang-shift)

c. Berth occupation ratio: 50%

2) Object vessels and loading conditions of the vessel

Cargo handling equipment is planned based on the 2000 DWT class barges under the following conditions.

- L.O.A : 65 m
- Width : 17.5 m
- Draft (Light Load) : 0.5 m
- Draft (Full Load) : 2.0 m
- Loaded containers : 144 TEUs, (6 wide and 4 long, 3 high for 40 FT)

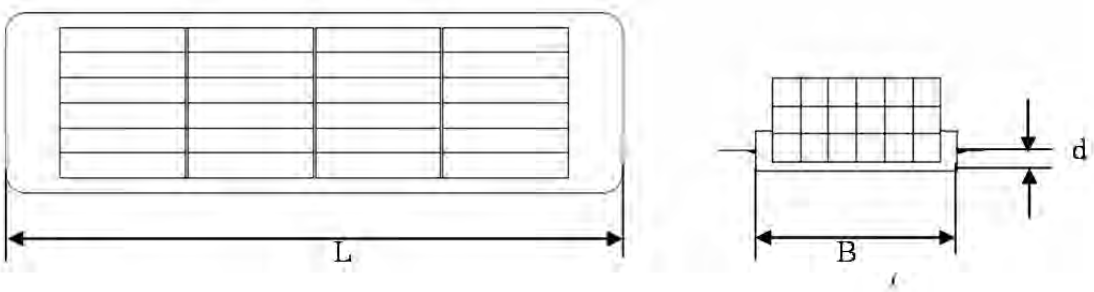


Figure 2-2-13 Expected Loaded Container on Barge

3) Conditions of Jetty

- Crown height : CD +11.0 m
- HWL : CD +10.3 m
- LWL : CD +0.0 m
- Deck width : 25 m
- Distance between river-side pier-head line and river-side rail centre : 1.75 m
- Rail span : 15 m
- Distance between land-side pier-head line and centre of land-side rail : 8.25 m
- Fender height : 0.5 m

(2) Cargo Handling Equipment on the Jetty

1) Cargo handling equipment of medium/small size ports

From the planned annual cargo handling volume and objective vessel sizes, the port of this project is categorized as a medium/small size port. The following cargo handling equipment can be listed as candidates for this scale of port.

- Bridge type crane
- Level luffing crane of double link type (LLC)
- Level luffing crane of rope balance type
- Mobile crane
- Mobile harbour crane

Cargo handling equipment can also be classified based on the travelling method.

- Tire mounted crane
- Rail mounted crane

2) Features of the equipment

The features of the above cargo handling equipment can be summarized as follows.

Table 2-2-17 Types of Crane and their Features

Cargo Handling Equipment	Features
Bridge type crane	The bridge type crane is a generally large-scale crane used in container berths, large-scale balk handling berths and product shipping berths in steel mills. Loading/unloading works can be done efficiently by the linear movement of cargo by hoisting motion and traversing motion. This type of crane is mainly used in exclusively large-scale berths, but not used in medium/small scale ports as a multipurpose crane. The machine weight is heavy and the price is high for this type of crane. Therefore, this type is excluded from the candidates in this project.
Level luffing crane of double link type (LLC)	This type of crane is widely used as a multi-purpose crane, bulk material unloader and product shipping crane, etc., in medium/small ports. Loading/unloading works are done by luffing operation by a double link mechanism, with the slewing operation of the upper part and the travelling operation of the portal frame. The dimensions of links are decided to minimize the vertical movement of cargo during luffing operation. The horizontal movement of lifting cargo can also be minimized to shorten the hoisting rope length by adopting an upper link structure. By adopting those mechanisms, the swinging movement of cargo during loading/unloading operations can be minimized and the efficiency is accordingly high. The price is relatively higher compared with a jib crane due to the complicated link mechanism. This type of crane is excluded from the candidate in this project from an economical perspective.
Level luffing crane of rope balance type	This type of crane is used as a multi-purpose crane in medium/small scale ports and as jib cranes in shipyards. The hoisting wire rope is so arranged to minimize the vertical movement during luffing operations. But the vertical movement of lifting cargo during the luffing operation is slightly larger compared with the LLC. Horizontal swinging movement during an operation is also larger than the LLC due to the longer length of wire rope from the tip of the jib to the hook. In spite of those disadvantages in operation, this type of crane is widely used as a multi-purpose crane in medium/small size ports because of its cost advantage. Judging from the planned cargo handling volume, cargo types being handled and an economical point of view, this type of crane is the most recommendable for the Mandalay port and will be constructed in this project.
Mobile crane	There are two main types of mobile crane, namely i) the tire mounted crane and ii) the crawler mounted crane. Tire mounted cranes include all-terrain cranes, rough-terrain cranes and truck cranes. The crawler mounted crane is called a crawler crane. i) Truck crane The truck crane is the crane, which is produced by a crane manufacturer and mounted on a truck produced by an automobile company. The truck crane has been decreasing in number recently because an automobile company stopped supplying the truck for the mobile crane. ii) All-terrain crane and rough-terrain crane The all-terrain crane and rough-terrain crane are being produced recently instead of the truck crane. The all-terrain crane is the mobile crane of medium to large lifting capacity, which can travel on all kinds of terrain at high speed. The rough terrain crane is the mobile crane of medium to smaller lifting capacity, which is the successor to the wheel loader and can travel in rough terrain. Both cranes have a telescopic boom which is extensible and retractable by hydraulic cylinder. The mobile crane, which can meet the requirements of this project, is the all-terrain crane having a large capacity. When the lifting radius is larger, the lifting capacity of the mobile crane must be bigger, which is the nature of mobile cranes. In case of lifting a riverside container mounted on the barge by an all-terrain crane mounted on the berth, the lifting capacity of the all-terrain crane should be around 400 tons, which corresponds to the maximum class of this type and is not considered to be the reasonable choice in terms of cost performance. Adoption of an all-terrain crane of the 200-ton class is possible. But the hook of an all-terrain crane can't reach to the lifting point of the container at the riverside end. Therefore, the barge has to be turned 180 degrees during the loading/unloading operation. Another disadvantage is the additional work to mount and dismount a counter weight by using an auxiliary crane when shifting an all-terrain crane in the direction parallel to the berth, which lowers the loading/unloading efficiency. Because of those reasons, the all-terrain crane could not be a candidate for the crane on the berth. iii) Crawler crane The block of the crawler crane is generally transported to the site by trailer and assembled on-site. Some crawler cranes have a telescopic boom with a hydraulic device, but most boom construction is of the fixed truss type and is assembled on-site to match the requirements of each site. To lift up the riverside container onto the barge, a crawler crane of large capacity with a long, fixed truss boom has to be provided. In this case, the operability is not so good due to the long swinging lifting rope caused by the long boom, and the cost is high. Therefore, the crawler crane could not be a candidate for this project.

Cargo Handling Equipment	Features
Mobile harbour crane	The mobile harbour crane is a tire mounted jib crane, which is mainly used in European countries and USA at container and bulk terminals. Mobile harbour cranes are generally standardized by each manufacturer depending on the lifting capacity. The drive unit is composed of a diesel engine and hydraulic pump. And all motion is activated by hydraulic actuator. The function and the price of mobile harbour cranes produced by European manufacturers are almost at the same level as rope balanced jib cranes produced by Japanese manufacturers. The jib cranes produced by Japanese manufacturers can be customized to meet the requirements of each project. But the customization of a standardized mobile harbour crane produced by European manufacturer may not be easy. Based on the above-mentioned features, the mobile harbour crane is not recommended for this Project.
Tire mounted crane	Most of the multipurpose cranes at medium/small sized ports in Japan are tire mounted cranes. Generally, this type of crane is transported from a stored area to the job site by driving tire, grounded at the job site with outriggers and then loading work is carried out. This type of crane is flexibly usable for various kinds of work, and construction of a rail on the berth is not needed. The disadvantage of this type of crane is lack of mobility due to the setting work of outriggers and counter weight. Another disadvantage is that the berth should be designed to have enough strength against the large acting load caused by the outrigger of the crane.
Rail mounted crane	The rail mounted crane is a crane mounted on a rail and mainly used in the berth of exclusive use. Even though the construction cost of a rail foundation is needed, this construction cost can be minimized compared with a tire mounted mobile crane, because load acting points are limited to the rail portion and the part where the reinforcement is needed can be minimized. The rail mounted crane can be moved on the rail at high speed with its travelling equipment and the position of the crane can be shifted rapidly to the lifting point of cargo on the barge. The selection of this type is most appropriate for ports of exclusive use, like this project.

3) Recommendation and Equipment Selection

Based on the above discussions, a rail mounted type jib crane is recommended for the Project.

(3) Cargo Handling Equipment in the Cargo Yard

1) General cargo handling

a. Kind of Equipment

Lumber, steel materials, piles, reinforcing bars, prefabricated concrete products and heavy cargoes, such as machinery, will be handled in the open yard. Cargo handling equipment which are good for these cargoes are listed as follows:

- Mobile crane
- Rough-terrain crane
- Crawler crane
- Forklift
- Wheel loader

b. Features

The features of the above cranes are summarized in the table below.

Table 2-2-18 Types of Crane and their Features
(Cargo Handling Cranes in the Cargo Yard)

Cargo Handling Equipment	Features
Rough terrain crane	The rough terrain crane is excellent in mobility in open storage yard and can handle everything except bulk material like coal. This crane is suitable to handle unspecified objects, like in this project. The telescopic motion and the luffing motion of the boom can be actuated with the hydraulic cylinder and efficient cargo handling work can be done.
Crawler crane	The crawler crane is suitable for work on ground of poor bearing capacity. The foundation of the open storage area shall be reinforced in this project. Therefore, there is no need to select a crawler crane. While lifting, the rope length becomes longer than necessary due to the long, fixed truss boom. Crawler crane is excluded from the candidates because of those reasons.
Forklift	The forklift is the machine to lift cargo with an L-shaped fork and transport it within a short range. Efficient handling operation can be achieved for certain cargoes. But the forklift is not suitable to handle long-shaped objects, such as lumber, pile, reinforcing bar, shaped steel, etc. In this project, several kinds of object of unspecified shape should be handled with the handling equipment. Therefore, forklift is excluded from the candidates.
Wheel loader	The wheel loader is used to handle bulk material, such as coal and gravel. The planned terminal is not expected to handle bulk materials. Therefore, wheel loader is excluded from the candidates.

c. Recommendation and Equipment Selected

Judging from the above-mentioned features, the rough-terrain crane is the most suitable and recommendable for the Project.

2) Container Cargo Handling

a. Equipment for container handling

For container handling in the yard area, in general, the following equipment can be used in the terminal area.

- Rubber tired gantry crane (RTG)
- Rail mounted gantry crane
- Reach stacker
- Top lifter
- Forklift
- Empty container handler

b. Features of the Equipment

The features of the above-mentioned equipment are as follows.

Table 2-2-19 Container Handling Equipment and their Features

Cargo Handling Equipment	Features
Rubber tired gantry crane (RTG)	The RTG is the container handling crane mounted on rubber tires and is most commonly used in the container stacking area. The positioning of the spreader, which is the handling tool to grip containers, can be done by the travelling motion by tire drive units and the traversing motion of the trolley mounted on the gantry. The hoisting and lowering of containers can be done by the hoist drive unit mounted on the trolley. The container is handled between the container stock area and the chassis beside the RTG. The RTG is efficient container handling equipment and suitable for container handling in medium/large scale container terminals, but not suitable in a small scale container terminal like this project, because of the high investment cost. Therefore, the RTG is excluded from the candidates.
Rail mounted gantry crane (RMG)	The RMG is a gantry crane which is equipped with travelling wheels and mounted on the rail. The RMG has mainly been introduced in large scale container terminals and/or an automated container terminals. The positioning of the spreader, which is the container lifting tool, can be done by the travelling motion with travelling drive units and the traversing motion of the trolley mounted on the gantry. The hoisting and lowering of containers can be done by the hoist drive unit mounted on the trolley. The container is handled between the container stocking area and the container delivery place by transporting equipment beside the RMG. The RMG is not suitable for small container terminals like this project because of the high investment cost. Therefore, RMG is excluded from the candidates.
Reach stacker	The reach stacker is composed of travelling equipment with tire, telescopic boom actuated by hydraulic equipment, spreader assembled at the tip of the boom to grip the container, luffing equipment actuated by hydraulic cylinder for luffing motion, operator's cab and main boy incorporating engine and hydraulic equipment. The positioning of the spreader and the hoisting/lowering motion are mainly achieved by the telescopic and luffing motion of the boom. The RS is simple and multifunctional equipment, and has been introduced in medium/small scale container yards. The reach stacker is the most suitable equipment for Mandalay Port, in conformity with the number of containers to be handled and the cost of the equipment.
Top lifter	The top lifter is composed of a main body and an L-shaped fork, which is similar in construction to the forklift and spreader, which is mounted on the L-shaped fork to grip the container. The container is gripped at the top, hoisted/lowered by the vertical movement of the L-shaped fork and transported with travelling equipment. Compared to the reach stacker, by which a container can be moved horizontally and vertically without using travelling equipment, the top lifter is less flexible regarding the positioning of the spreader and accordingly inferior in operability. The price range of the top lifter is equal to or higher than that of the reach stacker. Therefore, top lifter is excluded from the candidates.
Forklift	The forklift can handle containers of 20 ft or smaller by inserting the L-shaped fork into the hole at the bottom of the container. But containers of 40 ft and larger can't be handled by the forklift. Therefore, forklift is excluded from the candidates.
Empty container handler	The empty container handler is a machine to stack empty containers in the empty container stacking area within the yard. The containers are generally stacked highly to stock a large number of empty containers in the small area. It is decided not to introduce the empty container handler for this project, because the number of containers is expected to be small in the initial stage in Mandalay port and empty containers can be stacked by the reach stacker, which will be introduced in this project.

c. Recommendation and Equipment Selection

Judging from the above-mentioned features of the equipment, the reach stacker is the most suitable equipment for the Project. Therefore, the reach stacker is recommended to procure for this Project.
In general, reach stackers are only used for container handling. However, in the initial stage of port operations, the number of containers to be handled in Mandalay port is expected to be small and most of the handling of cargo might be general cargo. Under this expectation,

provision of the special attachment for the reach stacker is recommended, so that the reach stacker can be used not only for container handling but also for general cargo handling by using the special attachment. The special attachment has the same length and width as a 20 ft container, and is equipped with casting corners at four corners to fix it under the spreader with twist lock pins and a 30 t hook at the centre so as to use the reach stacker as the heavy lifting crane.

(4) Cargo Handling Equipment in the Warehouse

1) Cargo flows in the shed

Equipment for cargo handling in the shed are to be selected based on the following cargo flow in the warehouse.

a. Bagged cargos

- The cargo net of bags on the chassis is unloaded and transported to the shed. After bringing bags into the shed, those are palletized by piling up on the pallet by manpower.
- The palletized bags are piled up in the storage section.
- The palletized bags are discharged from the storage section, transported to the truck loading zone and loaded on the external truck.
- There are also opposite cargo flows from those described above.

b. Container

- The cargo in the container, which is transported to the shed by truck, are unloaded and brought to the storage section in the shed.
- The cargo stocked in the storage section are unloaded, brought to the apron and loaded on the external truck.

2) Functions required for the handling equipment in the shed

The following functions are required.

a. Cargo weight

Cargoes to be handled inside of the warehouse are mostly cargo nets and pallets. The maximum weight of these cargoes is 2.5 tons. 3.0-ton capacity of the equipment shall be considered, with some margin, since the various kinds and types of cargoes shall be handled in the warehouse.

The weight of cargo is for unitized cargo by cargo net or pallet. The maximum weight of unitized cargo is 2.5 tons as described before, but 3 tons is the selection criteria of the cargo handling equipment because various cargos have to be handled actually and some margin is necessary.

b. Lifting height

The cargo handling equipment shall have the function to stack the palletized cargo 1.35 m high.

c. Turning radius

The cargo handling equipment should have good steering ability so as to turn in a small space and pass 6 m in the width of the shed.

3) Recommendation and Equipment Selection

Forklift is the equipment to fulfil the requirements mentioned above. The forklift is commonly used for cargo handling in the shed.

(5) Transportation Equipment in the Terminal Area

1) Cargo flows between jetty and yard/warehouse

The transportation equipment shall be selected considering the following cargo flows in the terminal area.

a. Bagged cargoes

- 5 lots of cargo nets are unloaded from the barge and loaded on the chassis by jib crane on the jetty.
- Cargo nets loaded on the chassis are transported from the jetty to warehouse.
- Cargoes on the chassis are unloaded per each lot by forklift at the warehouse. The forklift operations may be on or beside of the chassis.
- Empty chassis returns to the berth for the next unloading.
- In the case of ship loading, the above operations are vice versa.

b. Containers

- Containers on the barge are unloaded by jib crane and loaded on a chassis waiting on the jetty.
- The container is transported from the jetty to the cargo yard (container stacking area) by tractor chassis.
- The container is unloaded from the chassis by reach stacker and stored in the cargo yard (container stacking area).
- Empty tractor chassis are moved to the jetty for the next container loading.
- In case the containers are loaded onto the barges, the above operations are vice versa.
- For containers loaded with cargoes from more than one consignee, such containers are transported to/from the warehouse. Cargoes inside the containers are handled in the warehouse CFS (container freight station) area and separately handled per the consignee in the CFS. These containers are transported i) between the jetty and warehouse, ii) and/or warehouse and container stacking area, accordingly.

2) Functions required for the transportation equipment

The functions required for the transportation equipment under the above-mentioned cargo handling operations are as follows.
The weight and dimensions of cargoes to be transported are as follows.

- 2 lots (1 lot/5 cargo nets)
  1 lot: 1.2 m in width x 5 m in length x 1.2 m in height x 5 nets, total 10 tons

- Container
  - One 40-ft loaded container (30.5 tons in full loaded)
  - One 20-ft loaded container (24.0 tons)
  - Two 20-ft empty containers (Approx. 2.35 tons x 2)

3) Recommendation and selection of equipment

Semi-trailers are commonly used in the container terminal. The semi-trailers are the most reasonable selection because of their good positioning functions, high movability and good usability. For bagged cargo transport, a large truck is one of the alternative selections, however, if the chassis has a flat floor, semi-trailers are able to be used both for containers and bagged cargo transport.

In conclusion, semi-trailers composed of tractor and chassis, which have flatbed for bagged cargo handling equipped with stopper for container positioning, are recommended for the transportation equipment.

(6) Operation Plan of Cargo Handling Equipment

Detailed specifications of the cargo handling equipment and design conditions of the port facilities are determined based on the cargo handling method and operation plans of the equipment as described below.

1) Loading/unloading operations on the jetty

a. Loading and unloading operations to/from the barge shall be done by rail mounted jib cranes on the jetty.

b. All cargoes, including bagged cargoes, general cargoes and containers, handled on the jetty were directly loaded on and/or unloaded from the trailer chassis by jib crane.

c. During the loading and unloading operations, temporary placing of cargoes on the jetty shall not be conducted. Cargo handling by forklift shall not be conducted on the jetty.

d. The rough-terrain crane and other large mobile crane shall not be used on the jetty. Because the lifting capacities of those mobile cranes are less than the rail mounted jib crane, and the outrigger reaction force would be larger than the allowable stress of the deck concrete of the jetty.

e. A minimum of two (2) jib crane units shall be provided so that at least one (1) crane shall be able to operate even if the other crane is out of service due to maintenance or in case of trouble.

2) Handling operation in yard area

a. Bagged cargo and palletized general cargo shall be loaded and/or unloaded by forklift.

b. Heavy cargo shall be handled by rough-terrain crane.

c. The container handling in the yard area shall be conducted by reach stacker. The reach stacker is also utilized for general cargo handling by using the special attachment under the spreader.

d. Palletized cargo in the warehouse shall be handled by forklifts.

3) Cargo transport between jetty and yard/warehouse

a. Cargo transport between jetty and yard/warehouse shall be done by tractor chassis.

b. Cargo handling other than by jib cranes shall not be conducted on the jetty. Therefore, movement of cargo handling equipment, such as reach stacker, forklift, and rough-terrain crane, on the access bridge shall not be considered.

(7) Units of Cargo Handling Equipment to be Procured in the Project

Based on the above-mentioned plan, the units of cargo handling equipment to be procured in the Project will be studied hereunder.

1) Jib crane

As mentioned above, at least one crane has to be able to operate at any time. For this reason, two (2) crane units shall be procured in the Project. To procure all-terrain cranes or other large scale mobile crane is one of the options instead of the rail mounted jib cranes. However, this option has a disadvantage in cost, since, for handling of most riverside containers (6^{th} row from the jetty side), large sized mobile cranes are required and the cost is higher than the jib crane. Additionally, jetty structures become not economical because the outrigger load of a large sized mobile crane is large, jetty structures must be designed much stronger.

In conclusion, procurement of two jib cranes is the most economical selection.

2) Rough-terrain crane

At the beginning of the port operation stated, expected cargo handling volume is not so high. Therefore one unit of rough-terrain crane is provided as the minimum requirements for the cargo handling. One unit of reach stacker will be provided in the Project for the container handling, however, as mentioned in the above, the reach stacker is also able to use for the general cargo handling together with the rough-terrain crane by utilizing special attachment.

3) Reach stacker

In the beginning of the port operation, it is expected that predominantly general cargoes will be transported through the port. However, the modernized new port equipped with cargo handling equipment may generate demand for container cargo transport, and the number of containers may increase gradually.

To reserve the availability of container cargo handling, one unit reach stacker shall be provided with special attachment which is for the general cargo handling by using the reach stacker.

If container handling volume increases in the future, one reach stacker unit is not sufficient. In such a case, purchasing of additional reach stackers will definitely be required.

4) Forklift

Forklifts are mainly used in the warehouse. Several forklift units shall be used simultaneously for the various working situations. Five (5) forklift units are provided. As a typical case, two forklift units are used for cargo transfer between chassis and warehouse, two forklift units shall

be used for cargo transfers between the other chassis or truck and the warehouse, and one forklift shall be used for handling operations in the cargo yard. But these forklifts shall be used flexibly based on operation demands.

5) Tractor-chassis

Considering simultaneous operation of the jib cranes, three tractor/chassis units shall be assigned for one jib crane for transporting cargoes between the crane and cargo yard or warehouse. Six (6) units of tractor-chasses are provided.

6) Equipment Units

Based on the above discussions, the equipment to be procured in this project are summarized in the following table.

Table 2-2-20 List of the Equipment to be Procured in the Project

Equipment	Purpose	No.
1. Jib crane	Loading/unloading operations on the jetty	2 units
2. Rough-terrain crane	General cargo handling in the open yard	1 unit
3. Reach stacker	Container/general cargo handling in the open yard	1 unit
4. Forklift	Cargo handling in warehouse/open yard	5 units
5. Tractor	Cargo transport in the terminal area	6 units
6. Chassis	Ditto	6 units

It shall be noted that the above sets of equipment are the minimum requirements in the beginning stage of the new port operations, except for jib crane.

Additional units and kinds of equipment shall be necessary depending on cargo demand, both of volume and handling in future.

If the container handling volume will increase and a wide area of open yard will be shared by container stacking, one unit of reach stacker is not sufficient for the operations. Additional procurement of reach stackers shall be necessary.

(8) Leading Particulars of Cargo Handling Equipment

The leading particulars of each cargo handling equipment are determined as follows to satisfy the required conditions and functions.

1) Jib crane

a. Leading particulars

- Number of equipment : 2 units
- Type : Rope balance type jib crane
- Rated load : 30.5 tons
- Slewing radius : approx. 25 m
- Rail span : 15 m
- Wheelbase : 15 m

- Lifting height (under hook)
  - Upper berth : 15 m
  - Below berth : 12 m
  - Total lifting height : 27 m
- Clearance under portal frame : 5 m
- Power supply : diesel generator mounted on the crane
- Travelling device : Rail mounted travelling type
  - Wheels : 4 wheels per corner, total 16 wheels
  - Drive unit : Electric motor, gear reducer, driving wheel
- Slewing device : Slewing bearing with gear on inner ring
  - Drive unit : Electric motor, planetary gear reducer, pinion
- Hoisting device : Rope winding type with drum
  - Drive unit : Electric motor, gear reducer, rope drum
- Luffing device : Rope winding type with drum
  - Drive unit : Electric motor, gear reducer, rope drum
- Operator's cab : to be mounted on the slewing frame
- Wheel load
  - At operation : 30.2 t/wheel
  - At stormy condition : 31.4 t/wheel
  - At seismic condition : 37.4 t/wheel

2) Reach stacker

- Number of Equipment : 1 set
- Lifting load:
  - First row : more than 30.5 tons
  - Second row : more than 30.5 tons
  - Third row : 20 tons
- Load centre
  - First row : approx. 2000 mm
  - Second row : approx. 3850 mm
  - Third row : approx. 6350 mm
- Lifting height
  - First row : more than 13,4000 mm
  - Second row : more than 13,400 mm
  - Third row : more than 10,500 mm
- Travelling speed
  - Forward (without load/with load) : approx. 25 km/h / 21 km/h
  - Backward (without load/with load) : approx. 25 km/h / 21 km/h
- Slope climbing ability
  - without load / with load : approx. 37% / 22%
- Machine weight
  - Machine weight : approx. 70 tons
  - Axle load : less than 85 tons per shaft
    (100 tons per shaft for lifting 45 tons load)
- Spreader
  - Extraction/contraction amount : for 20-ft and 40-ft. container
  - Slewing angle : +195°~ -105°
  - Tilting angle : 2°
  - Side shift : ±800 mm

- Special hoisting accessory
  - A hoisting accessory equipped with a 30-ton hook at the centre and corner castings at the same position as a 20-ft container shall be provided for lifting general cargo.
  - This special hoisting accessory shall be used to handle general cargo after locking this hoisting accessary under the spreader with a twist lock pin at the initial stage of Mandalay port operation when the annual handling amount is expected to be small.

3) Rough-terrain crane

a. Leading particulars

- Type : 50 t rough-terrain crane
- Maximum lifting height : approx. 38 m
- Maximum operating radius : approx. 33 m
- Boom length : approx. 9.6 m ~ 37 m
- Boom luffing angle : approx. 0 ~ 84 degrees
- Slewing angle : 360 degrees
- Machine weight : approx. 36 t
- Axle load
  - Front axle : approx. 18.5 tons
  - Rear axle : approx. 19.8 tons
- Overall length : approx. 12.6 m
- Overall width : approx. 2.8 m

4) Forklift

a. Leading particulars

- Number of Equipment : 5 units (4 regular-use units, 1 stand-by unit)
- Maximum lifting capacity : 3.5 tons
- Load centre : 600 mm
- Maximum lifting height : 5 m
- Mast inclination angle : +6 ~ -11 degrees
- Travelling speed
  - without load : approx. 27.5 km/h
  - with load : approx. 18.5 km/h
- Slope climbing ability
  - without load : approx. 23%
  - with load : approx. 26%
- Overall dimensions (L x W x H) : approx. 4 m x 2.2 m x 1.15 m
- Fork size (L x W x T) : approx. 1070 mm x 150 mm x 50 mm
- Vehicle weight : approx. 4.9 tons

5) Tractor and chassis (Semi-trailer)

a. Leading particulars

i. For tractor

- Number of equipment : 6 units
- Setup of drive line : 4 x 2
- Maximum power : approx. 390 PS
- Total displacement : approx. 14,200 cc
- Overall dimensions (L x H x W) : approx. 6 m x 2.5 m x 2.95 m
- Wheelbase : approx. 3.6 m
- Front fitting radius : approx. 2.175 m
- Rear fitting radius : approx. 1.725 m
- Loading capacity of 5th wheel : approx. 10.8 t
- Vehicle weight : approx. 7.2 t
- Gross vehicle weight : approx. 18.150 t

ii. For chassis

- Number of Equipment : 6 units
- Maximum payload : 30.5 t
- Overall dimension : approx. 12.6 m x 2.48 m x 1.96 m
- Floor height : 1550 mm
- Wheelbase : approx. 9.07 m
- Number of wheel axles : 2 axles
- Floor : Flat truck
- Tare weight : approx. 3.9 t

2-2-2-5 List of Objective Facilities and Equipment

Based on the above-mentioned plan, the following is the summary of the objective facilities and equipment in the Project.

Table 2-2-21 List of Objective Facilities and Equipment

(1) Civil Structures

Facilities		Outlines
1. Jetty	1) Dimensions	Length: 180 m, Width 25 m
	2) Crown height	CDL +11.0 m
	3) Planned Water Depth	CDL -2.0 m (shallowest in dry season)
	4) Lower Structures	Steel Pipe Piles D1100 mm, D800 mm
	5) Upper Structures	Reinforced Concrete
	6) Mooring Bits	Bollard 30 tons 22 units, 25 tons 66 units
	7) Fender	V Type, 92 units
2. Access Bridge	1) Dimensions	Length: 172.18 m, & 233.00 m, Width: 7.0 m
	2) Lower Structure	Steel Pipe Piles D900 mm
	3) Upper Structure	Steel Girder and Concrete Slab
3. Port Area (Cargo Yard, Port Inner Road, Building Area, etc.)	1) Reclamation	About 220 m x 150 m (along revetment shoulder)
	2) Revetment	
	a) Sand Compaction Piles	D700 mm, 2 m interval
	b) Sheet Piles	Type II, L = 8.0 m, 325 m
	c) Liquefaction Protection	High-strength geotextile mat
	d) Revetment	Riprap type with 1:2 slope Armour stone, approx. 200 kg/pc Under layer stone, approx. 10 kg/pc Core, cobble
	e) Reclamation	River sand, excavated soil materials
	f) Abutment	Reinforced concrete 2 units
	3) Pavement	
	a) ILB Pavement (Type 1)	ILB 8 cm, Thickness: 810 mm For cargo yard (container yard)
	b) ILB Pavement (Type 2)	ILB 8 cm, Thickness: 600 mm Warehouse area
	c) ILB Pavement (Type 3)	ILB 8 cm, Thickness: 450 mm Road in the terminal area
	4) Drainage	U-Shape Drainage Ditch (with grating cover at the road crossing)
4. Access Road	1) Embankment	About 320 m long, 23.5 m width* (*between embankment revetment shoulders)
	2) Revetment	
	a) Soil improvement, liquefaction protection	High-strength geotextile
	b) Revetment	Armour stone, approx. 200 kg/pc Under layer stone, approx. 10 kg/pc Embankment soil
	3) Pavement	
	a) ILB : Carriageway	ILB 8 cm
	b) ILB: Walkway	ILB 3 cm
	4) Others	Marking and Sing Board

(2) Building Facilities

Facilities	Outlines of The Facilities		
1. Warehouse	One Building	Structure	Reinforced concrete, Steel roof, Pile foundation, 96 m x 24 m,
	Floor Area	Warehouse	2,270.00 m^2
		Office	21.00 m^2
		Toilet	28.62 m^2
		Total floor area	2350.44 m^2
	Finishing	Roof	Steel Frame, Galvanized colour steel 0.5 mm
		Outer wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Concrete floor slab: t = 250 mm
		Interior wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electric Equipment	Equipment	LED light, automatic fire alarm
	Mechanical Equipment	Equipment	Air-conditioner, ventilation fan, water supply, sanitary, septic tank
2. Port Office Building (Port Office/ Workshop)	One Building	Structure	RC 2 stories, 42 m x 18 m, pile foundation
	Floor area	Ground Floor	790.00 m^2
		First floor	790.00 m^2
		Total Floor Area	1,580 m^2
	Finishing	Roof	RC, Galvanized colour steel, 0.5 mm
	Finish Material	Outer wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Mortar steel trowel with urethane coat
		Interior Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electronic Equipment	Equipment	LED light, automatic fire alarm
	Mechanical Equipment	Equipment	Air-conditioner, ventilation fan, water supply, sanitary, Septic tank
3. Canteen	One building	Structure	RC Single Story, 18 m x 12 m
	Floor Area	Ground Floor	220.00 m^2
		Total Floor Area	220.00 m^2
	Finishing	Roof	Colour galvanized steel t = 0.5 mm
	Finish	Outer Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Interlocking block
		Interior Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electric Equipment	Equipment	LED light, automatic fire alarm
	Mechanical Equipment	Equipment	Water-supply and drainage, sanitary and septic tank
4. Generator House	One Building	Structure	Reinforced concrete single story, 15 m x 10 m
	Floor Area	Ground Floor	156.00 m^2
		Total Floor Area	156.00 m^2
	Finishing	Roof	Reinforced concrete colour galvanized steel 0.5 mm
	Finish Material	Outer Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Mortar steel trowel with Urethane coat
		Interior Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electric equipment	Equipment	LED light, generator, automatic fire alarm
	Mechanical equipment	Equipment	Ventilation fan

Facilities	Outlines of The Facilities		
5. Pump House	One Building	Structure	Reinforced concrete single story, 15 m x 10 m
	Floor Area	First Floor	156.00 m^2
		Total Floor area	156.00 m^2
	Finishing	Roof	Reinforced concrete colour galvanized steel t = 0.5 mm
	Finish Material	Outer wall	Brick masonry work: Mortar steel trowel with AEP paint
		Floor	Mortar steel trowel with Urethane coat
		Interior Wall	Brick masonry work: Mortar steel trowel with AEP paint
		Ceiling	Ceiling finish: Patching mortar
	Electric Equipment	Equipment	LED light, automatic fire alarm
6. Security Hut	One Hut	Structure	Reinforced concrete single story, 2 m x 2 m
	Floor Area	Ground Floor	4.00 m^2
		Total Floor Area	4.00 m
	Finish Material	Roof	Reinforced concrete, colour galvanized steel t = 0.5 mm
	Finish Material	Outer wall	Hollow block mortar trowel steel with AEP
		Floor	Mortar trowel steel urethane coat
		Interior wall	Hollow block mortar trowel steel with AEP
		Ceiling	Wood wool cement board t = 25 mm
	Equipment	Equipment	Lighting

(3) Cargo Handling Equipment

Equipment	Specifications	Units
1. Jib Crane	Rail Mounted Type: Rail Span, 15 m Rated Load: 30.5 tons Lifting Load: 35.0 tons Slewing radius: 11.5 m to 27.0 m Power feeding system: Diesel generator mounted crane	2 units
2. Rough-Terrain Crane	Lifting Capacity: 13.0 tons (at operation radius 10 m) Lifting Capacity: 4.2 tons (at operation radius 20 m) Max. lifting height: Approx. 43 m Max. operation radius: Approx. 36 m Boom length: 11.1 m to 42 m	1 unit
3. Reach Stacker	40-ft and 20-ft containers Lifting Loads: First Row: min. 30.5 tons Second Row: min. 27.0 tons Third Row: min.14.0 tons	1 unit
4. Forklift	Rated Capacity: min. 3.5 tons Max. lifting height: min. 5.0 m	5 units
5. Tractor	Drive unit: 4 x 2 Max. output: Approx. 390 PS Exhaust Emission Level: Approx. 14,200 CC	6 units
6. Chassis	Max. loading weight: 30.5 tons Dimensions: Length: Approx. 12.6 m Height: 2.48 m Width: 1.96 m Floor Height: 1,550 mm Floor Type: Flatbed Type	6 units

2-2-3 Outline Design Drawings

Outline design drawings are as follows:

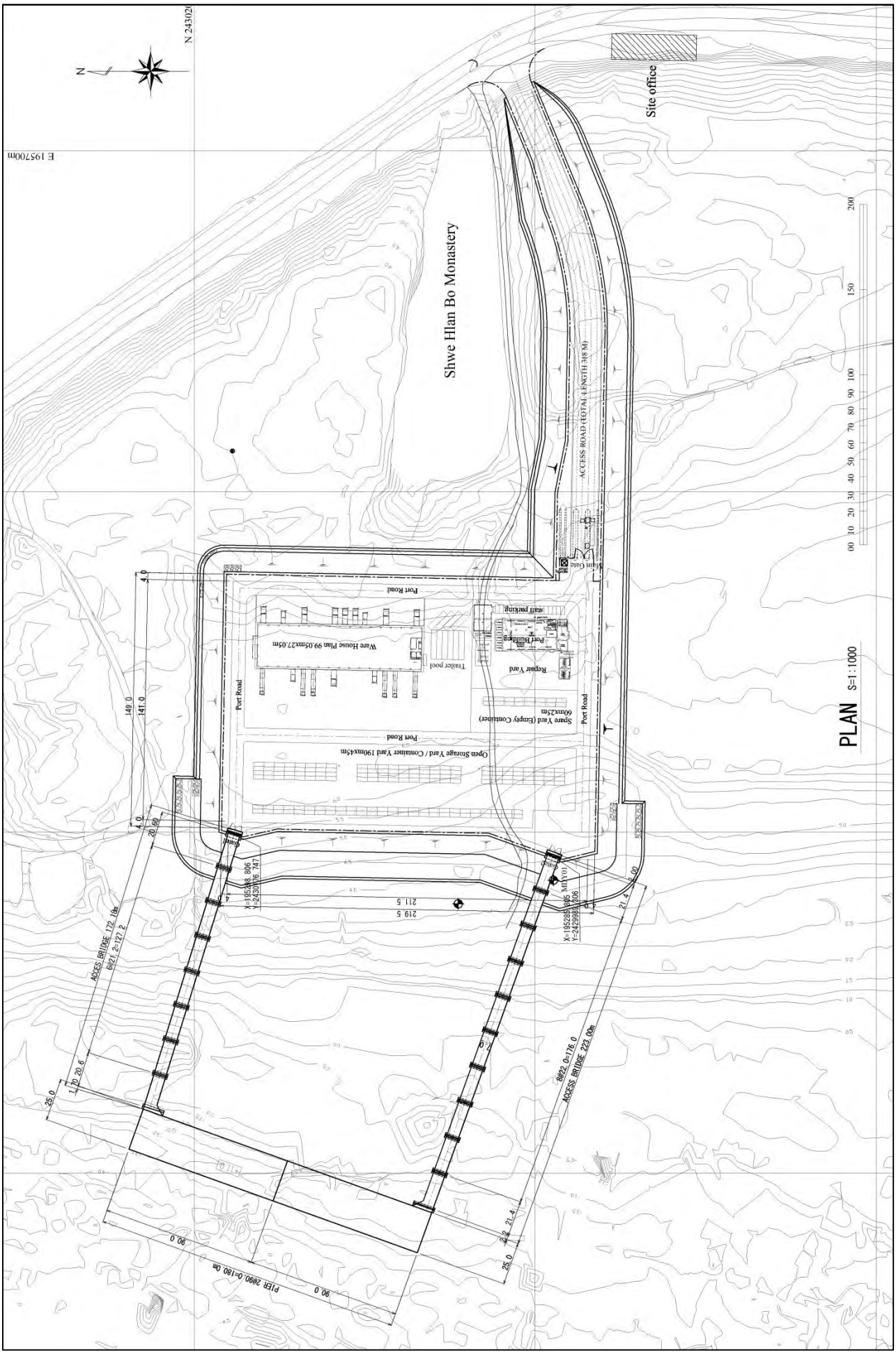


Figure 2-2-14 Plan of the Project

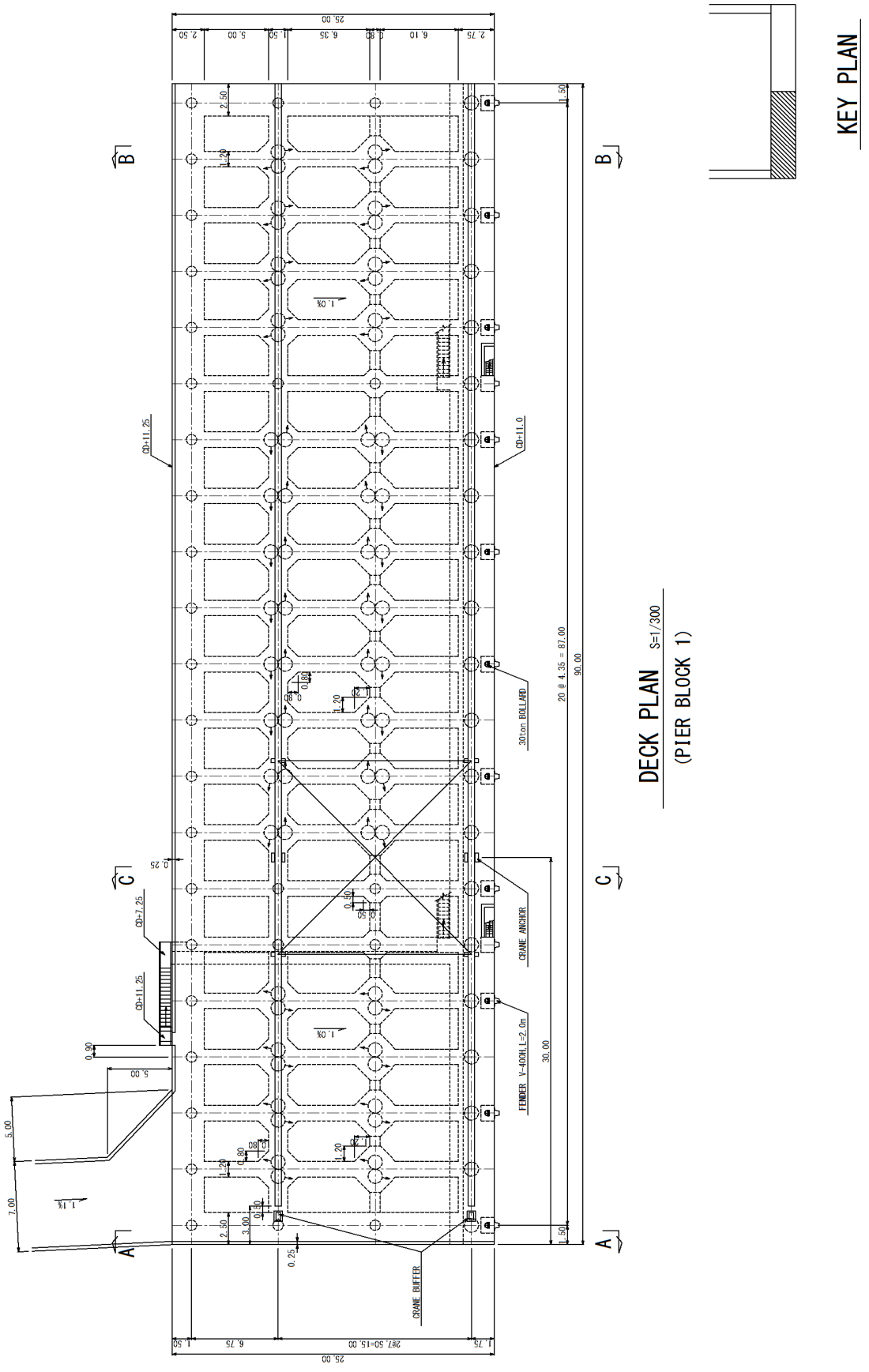


Figure 2-2-15 Plan of Jetty (1/2)

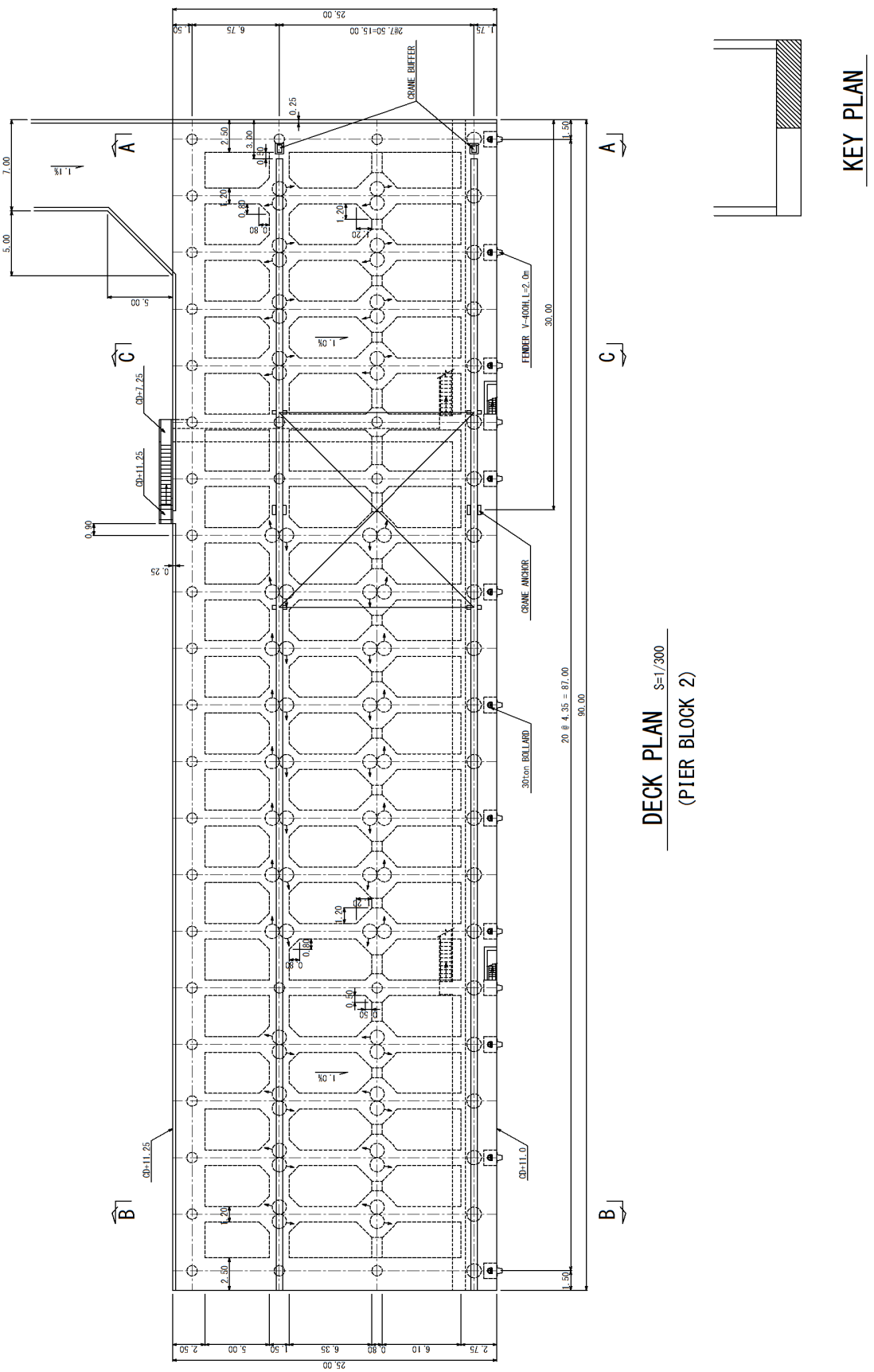


Figure 2-2-16 Plan of Jetty (2/2)

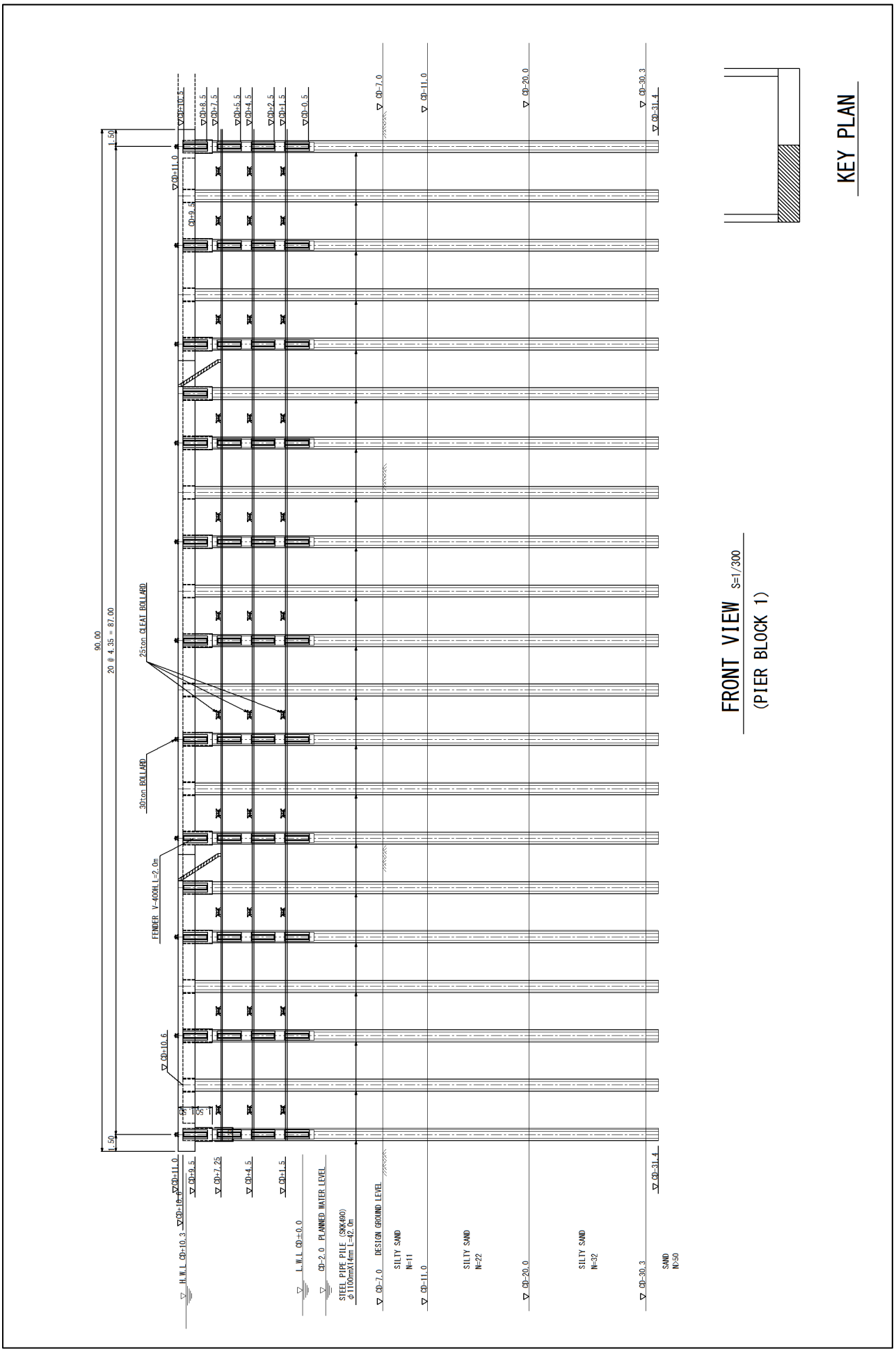


Figure 2-2-17 Front View of Jetty (1/2)

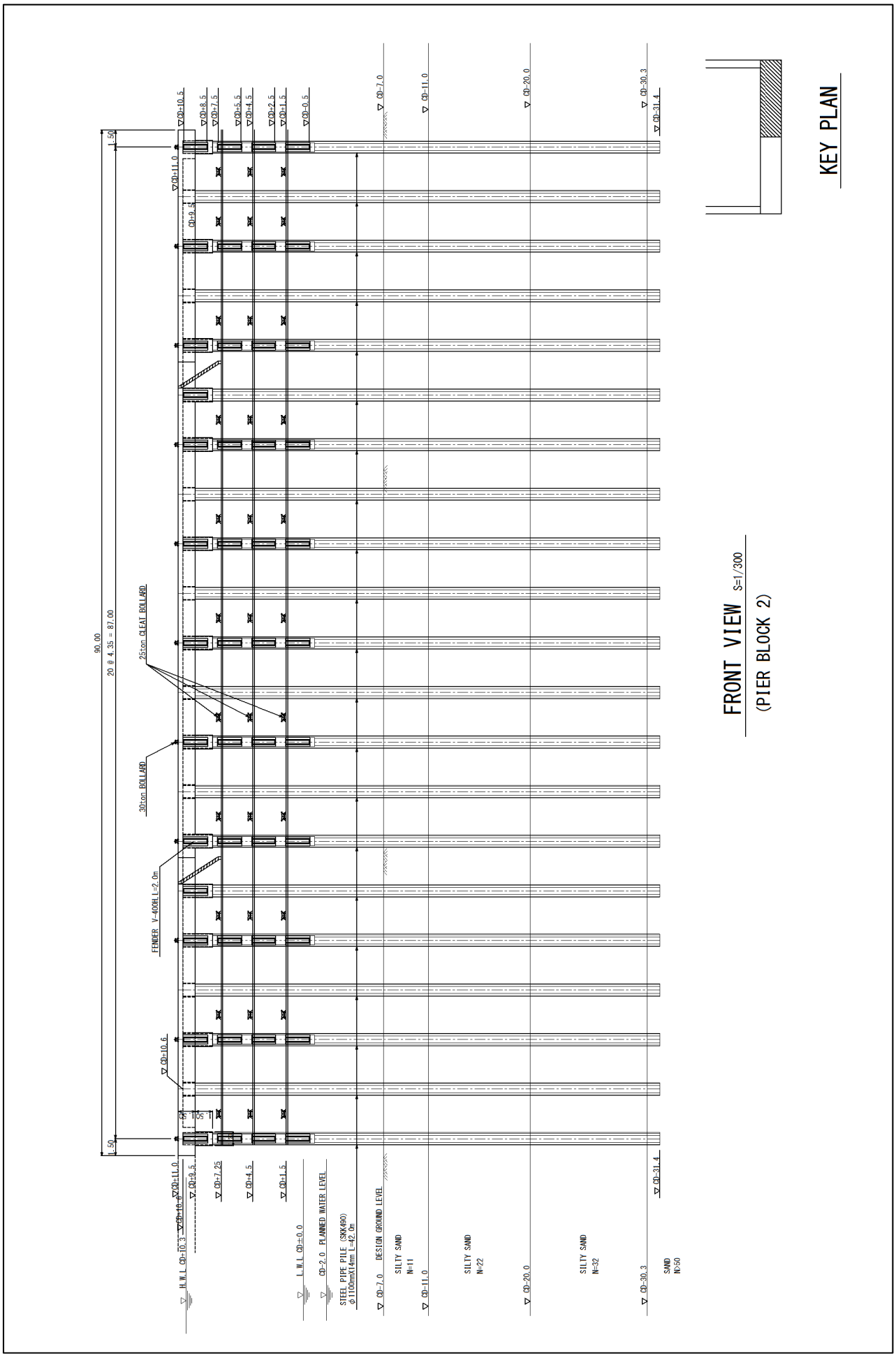


Figure 2-2-18 Front View of Jetty (2/2)

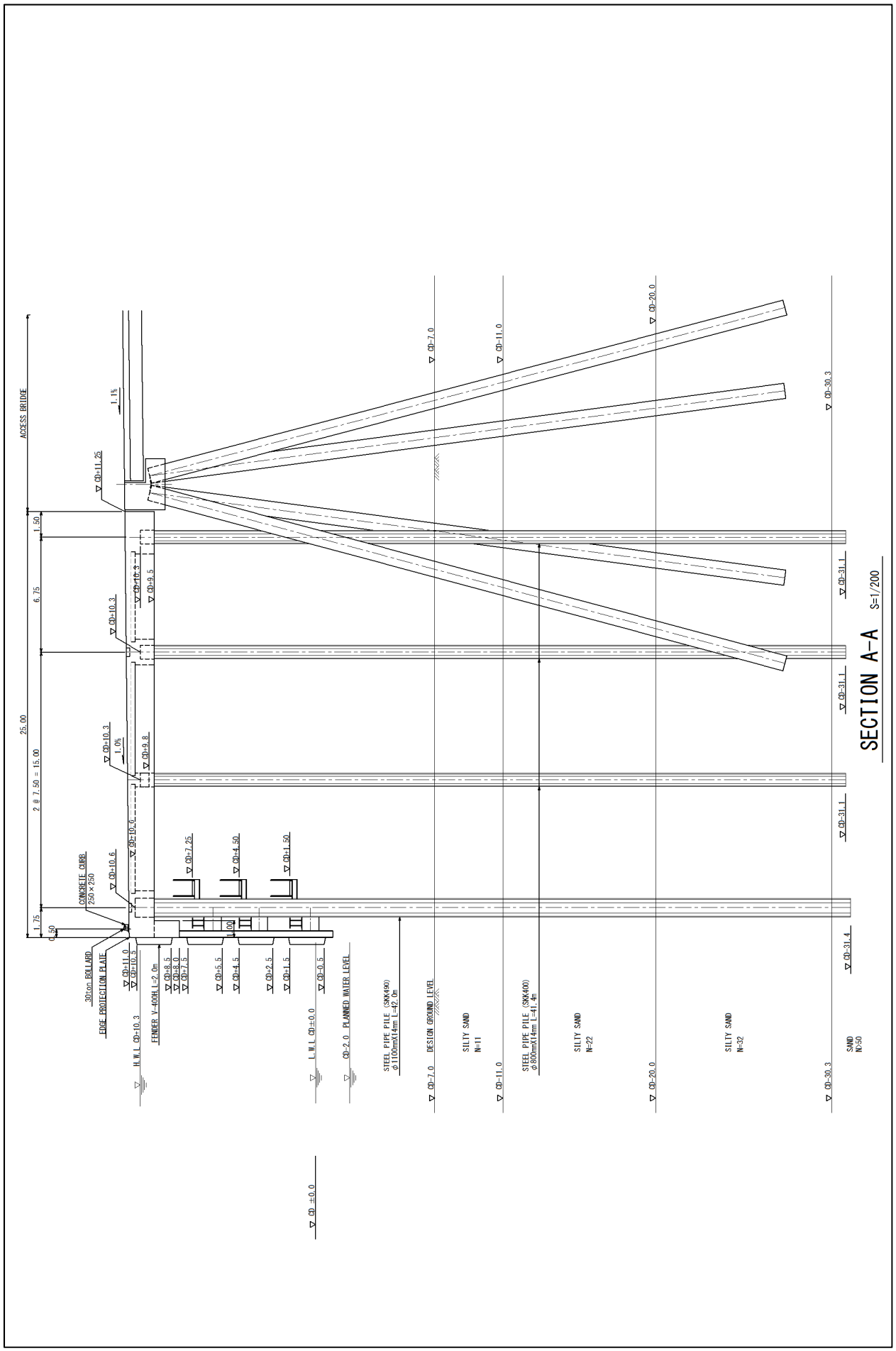


Figure 2-2-19 Section of Jetty (1/3)

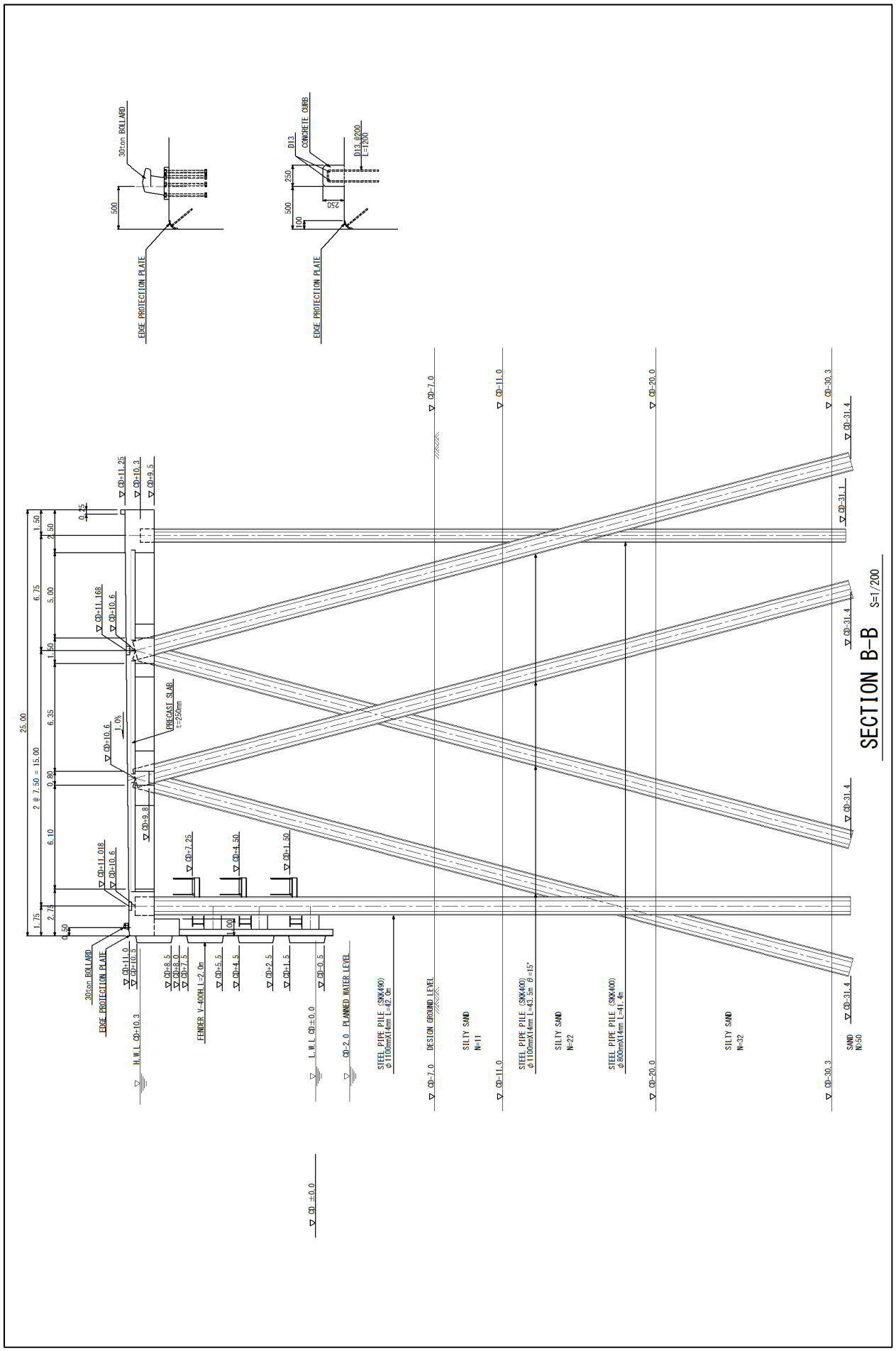


Figure 2-2-20 Section of Jetty (2/3)

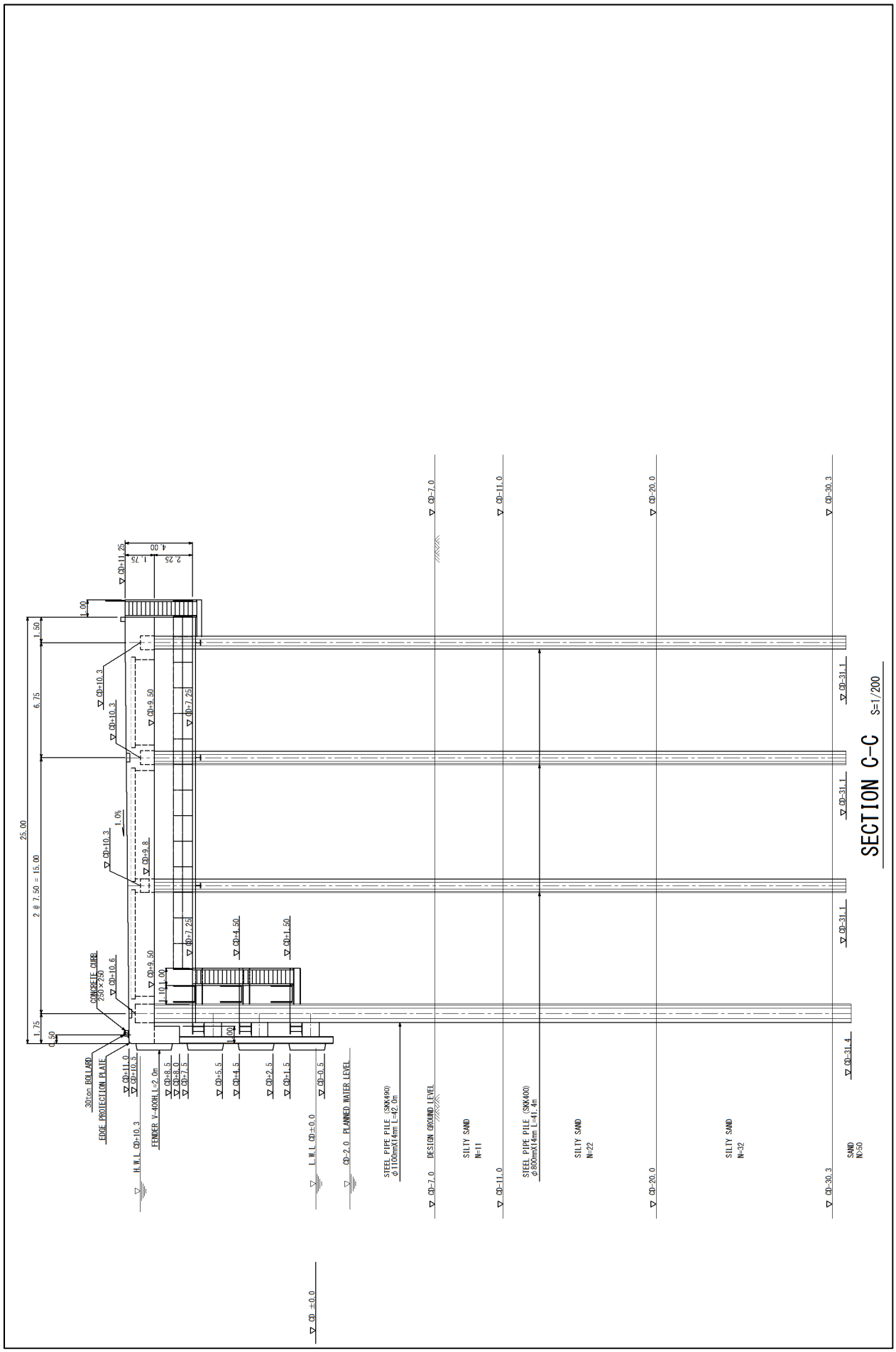


Figure 2-2-21 Section of Jetty (3/3)

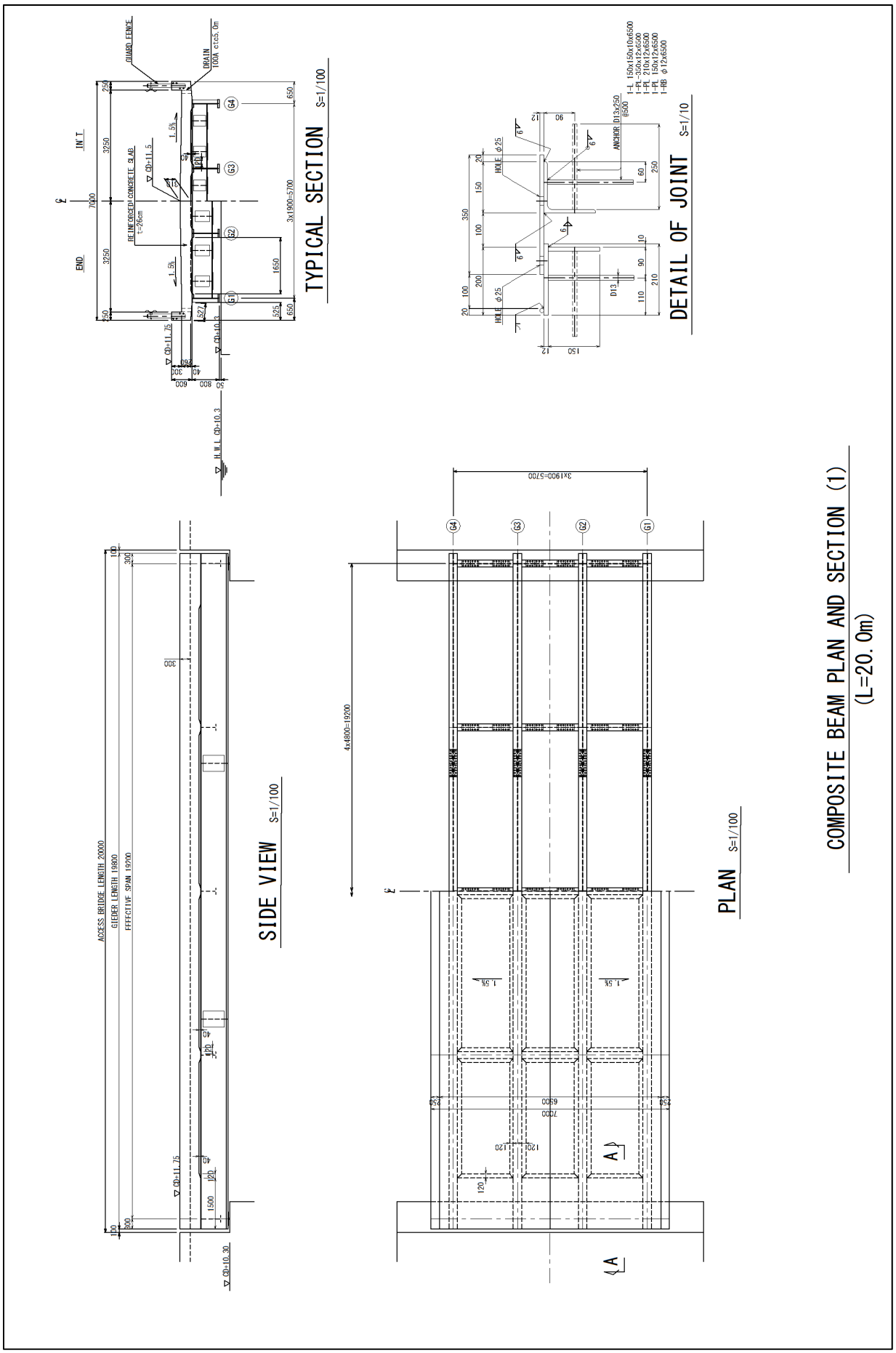
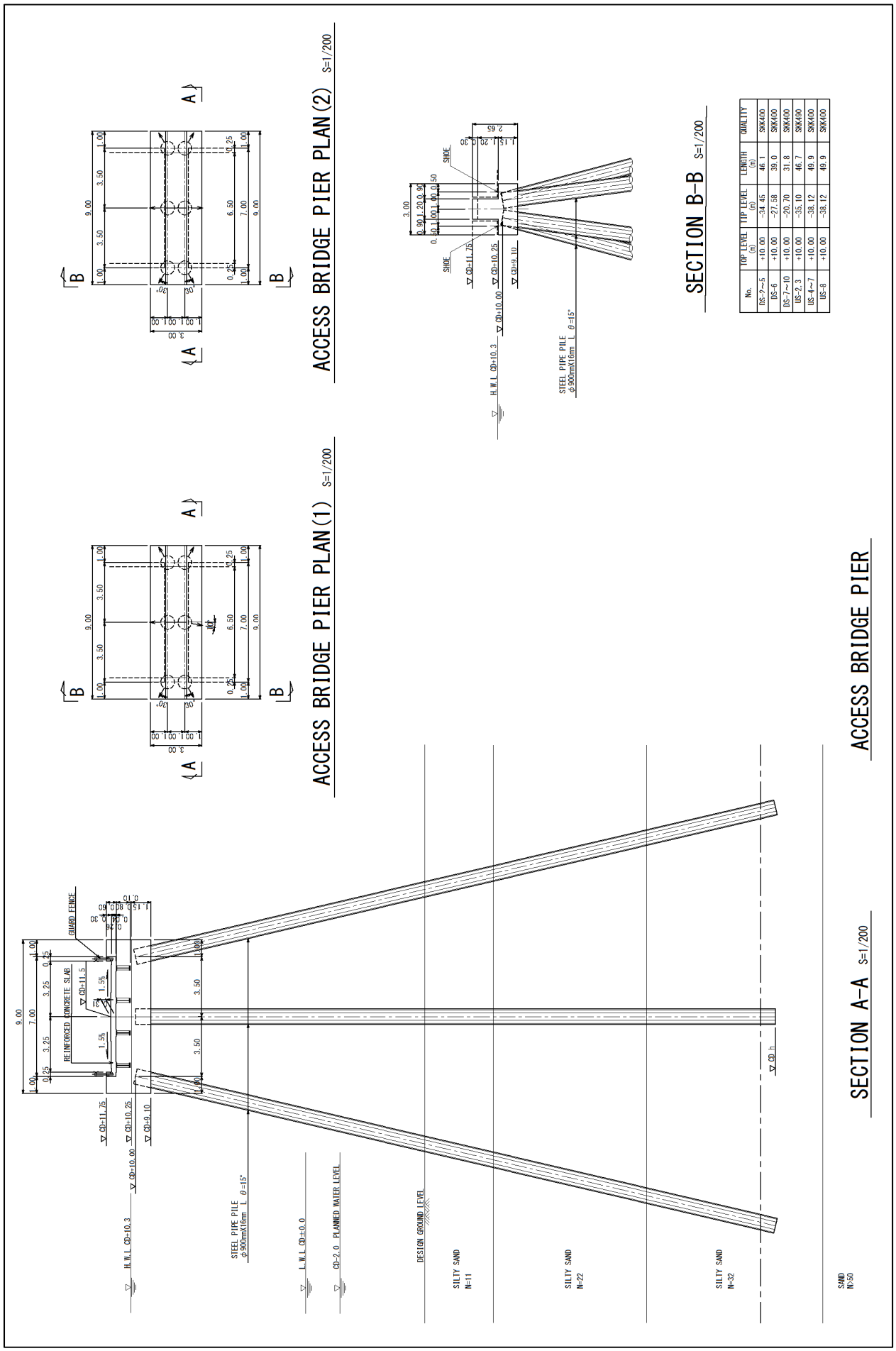


Figure 2-2-22 General Plan of Composite Beam



No.	TOP LEVEL (m)	TIP LEVEL (m)	LENGTH (m)	QUALITY
DS-7~5	+10.00	-34.45	46.1	SKK400
DS-6	+10.00	-27.58	39.0	SKK400
DS-7~10	+10.00	-20.70	31.8	SKK400
US-2,3	+10.00	-35.10	46.7	SKK490
US-4~7	+10.00	-38.12	49.9	SKK400
US-8	+10.00	-38.12	49.9	SKK400

Figure 2-2-23 General Plan of Bridge Pier

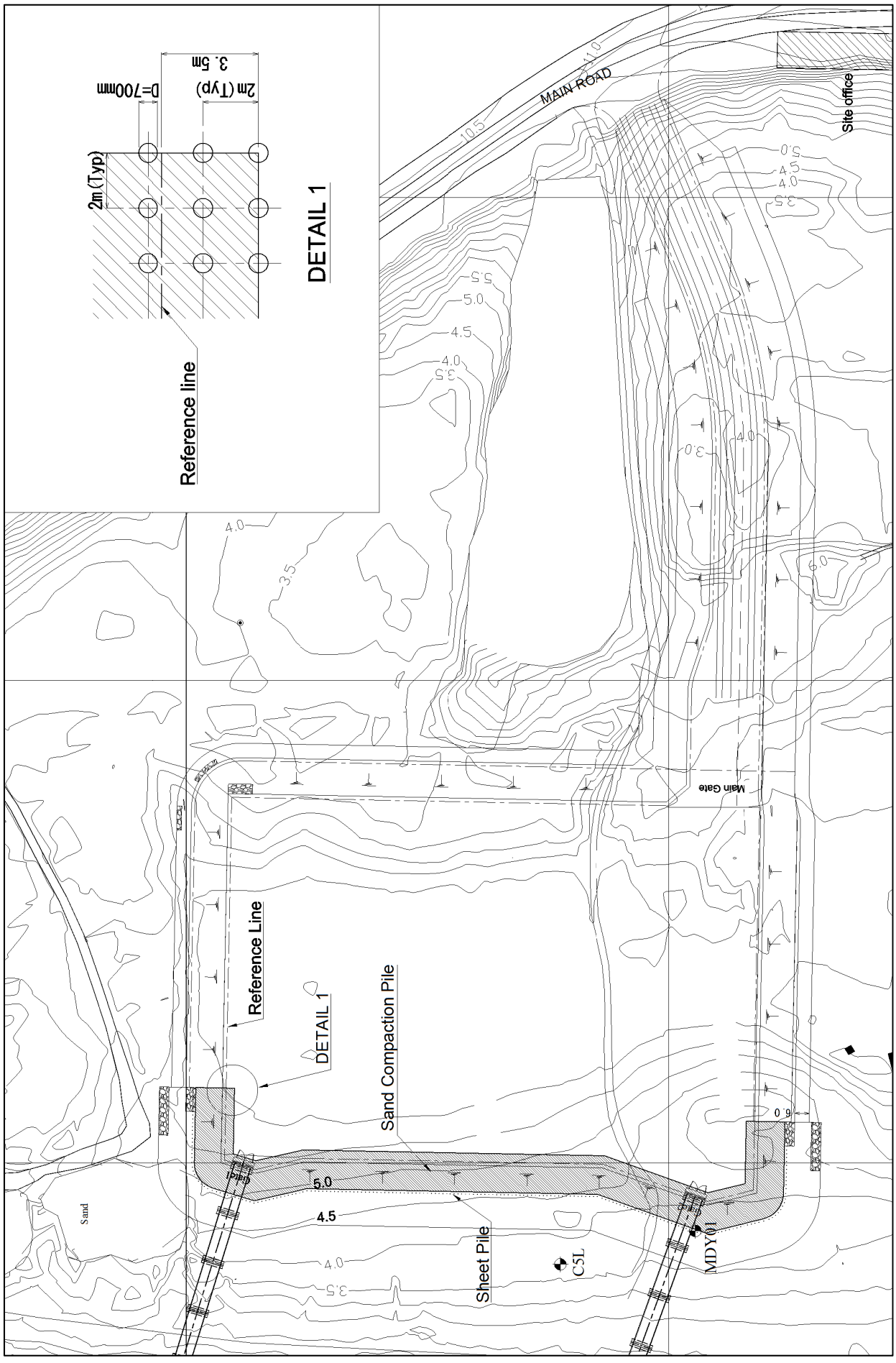


Figure 2-2-24 Reclamation and Soil Improvement Plan

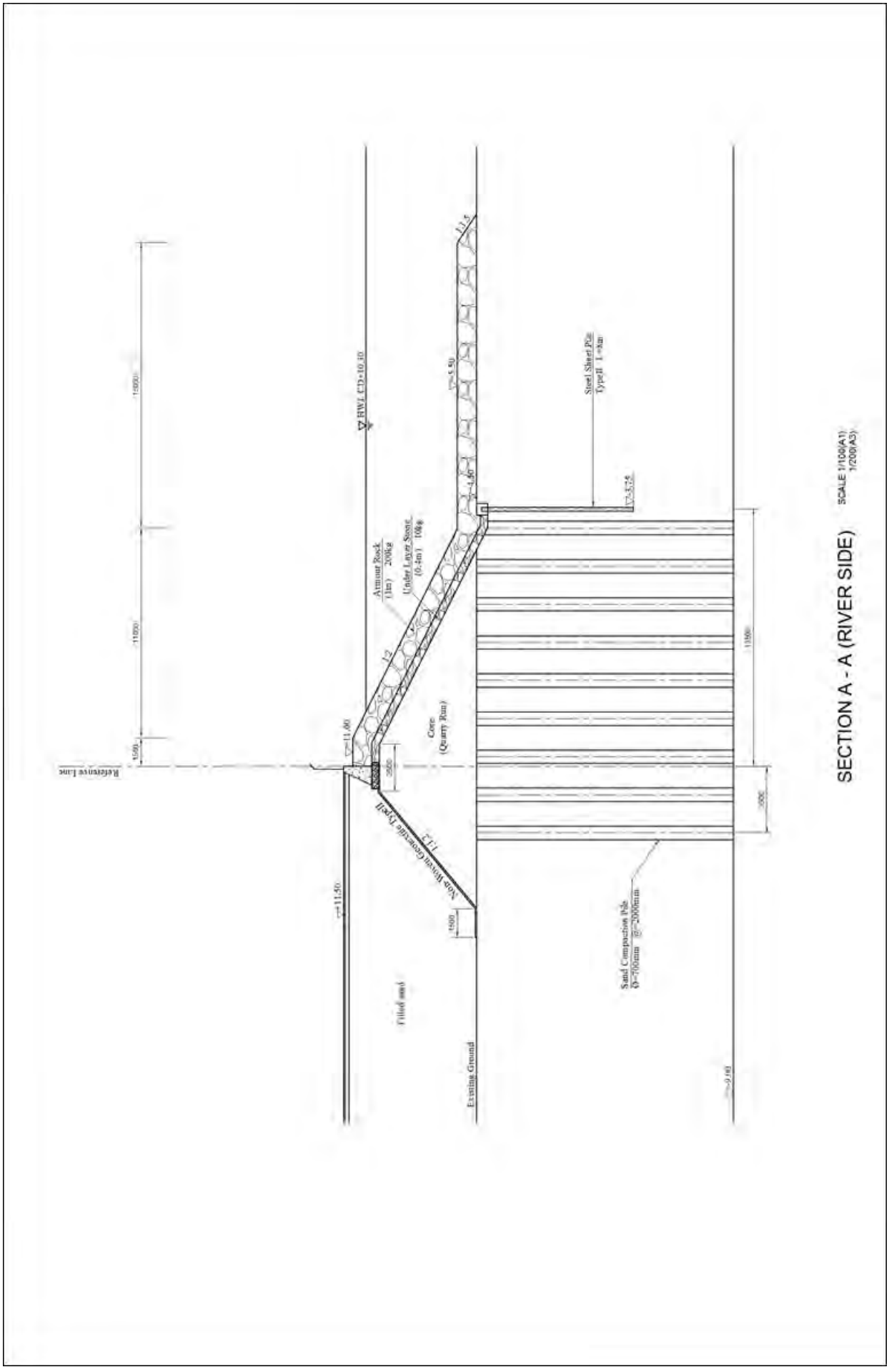
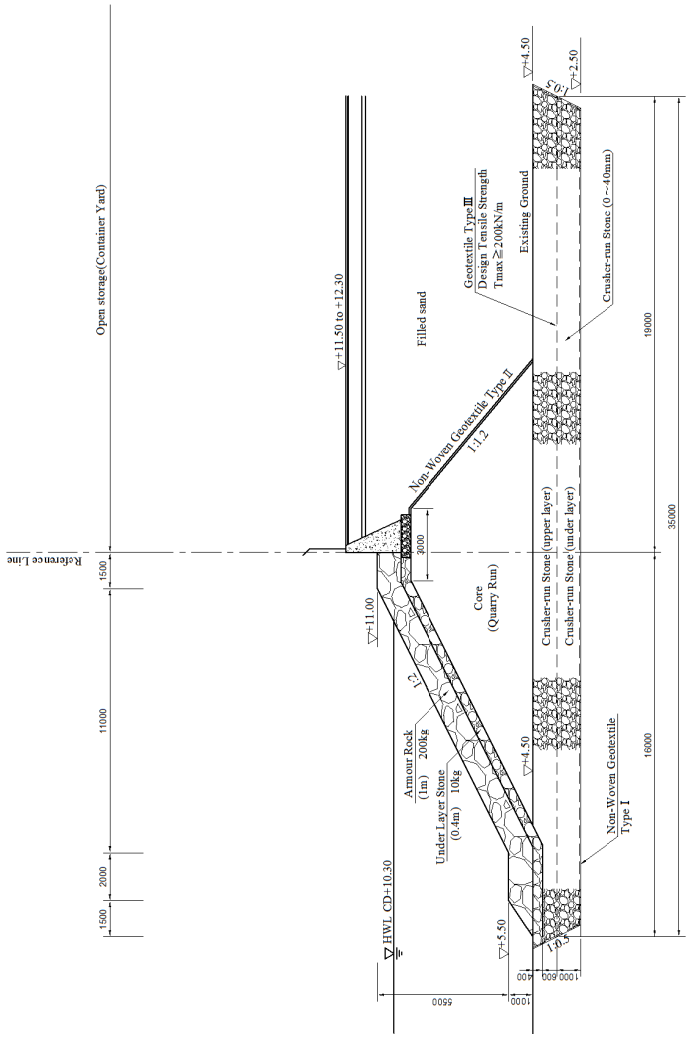


Figure 2-2-25 Typical Section of Revetment (1/2)



SECTION A - A (LAND SIDE)

SCALE 1/100(A1)
1/200(A3)

Note:
1. Specification of Crusher-run Stone
- Shear Resistance Force: φ≧35°
- Coefficient of Permeability: K≧1.0×10m^{-4}/ sec
- Rate of crused stone: Fe≦5%

2. Geotextile
- Type Ⅰ: t=1.8mm
- Type Ⅱ: t=5mm
- TypeⅢ: Design Tensile Strength Tmax≧200kN/m
- TypeⅣ: Design Tensile Strength Tmax≧600kN/m

Figure 2-2-26 Typical Section of Revetment (2/2)

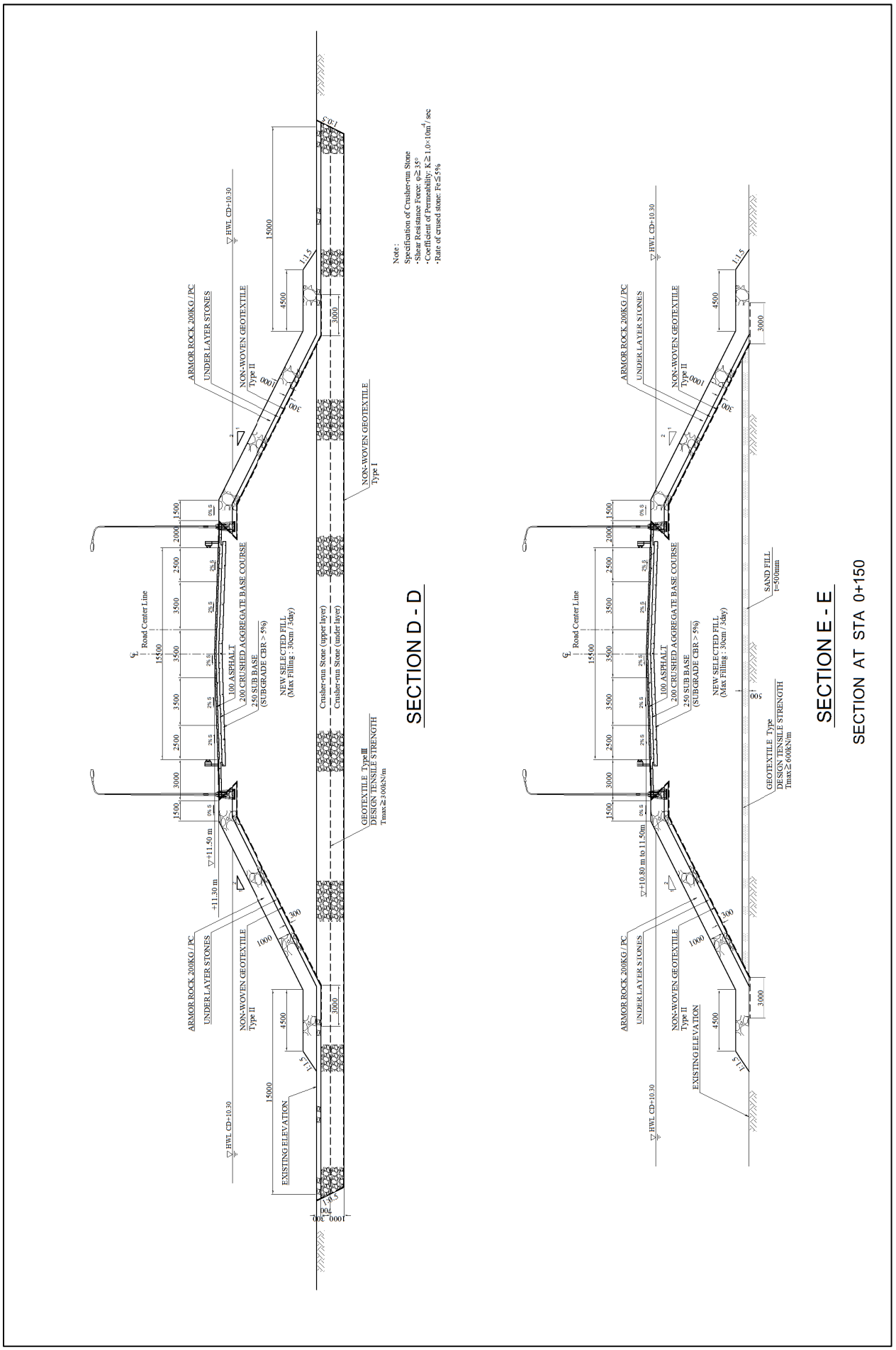


Figure 2-2-27 Typical Section of Access Road

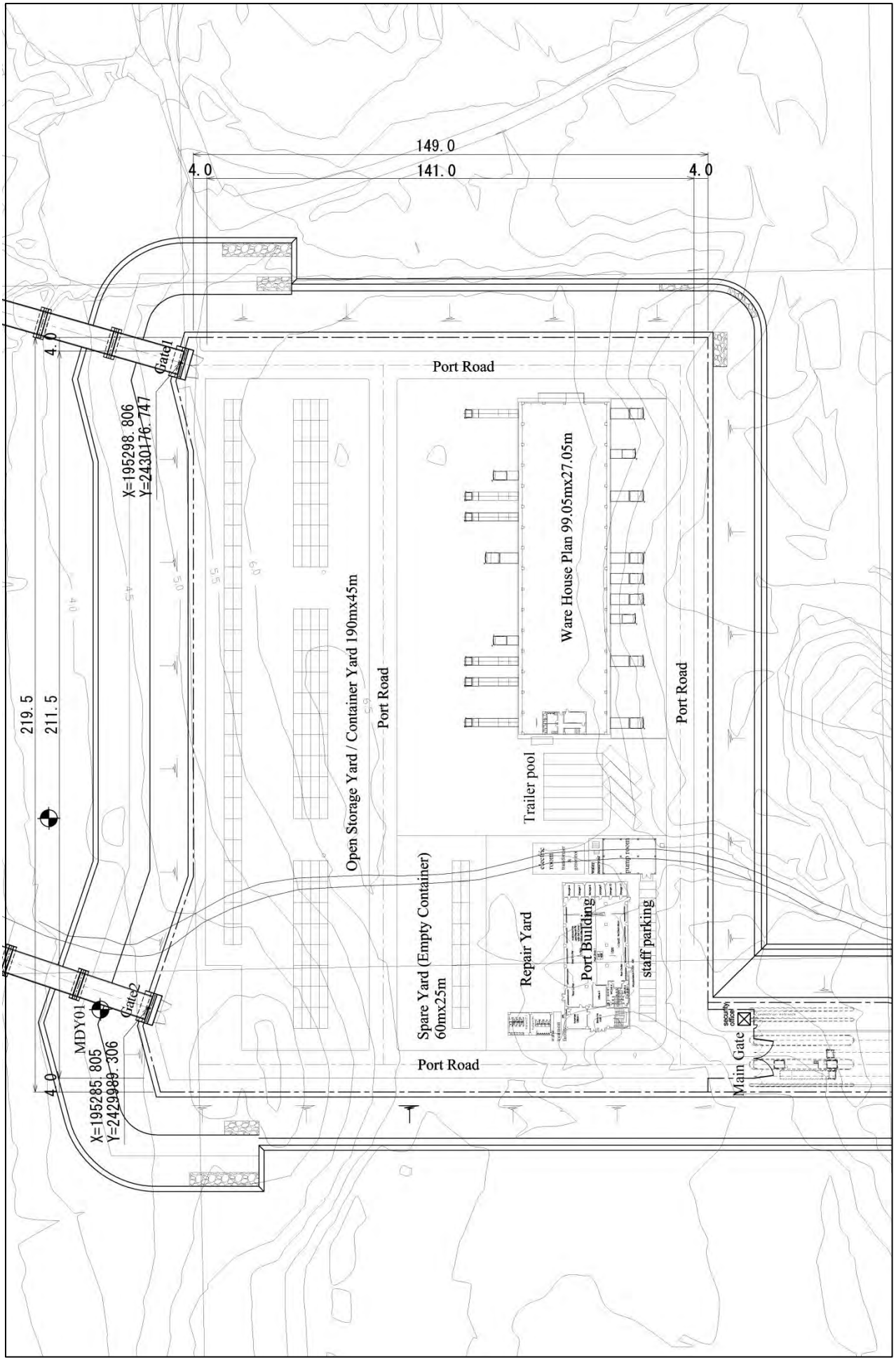


Figure 2-2-28 Plot Plan of the Building Facilities

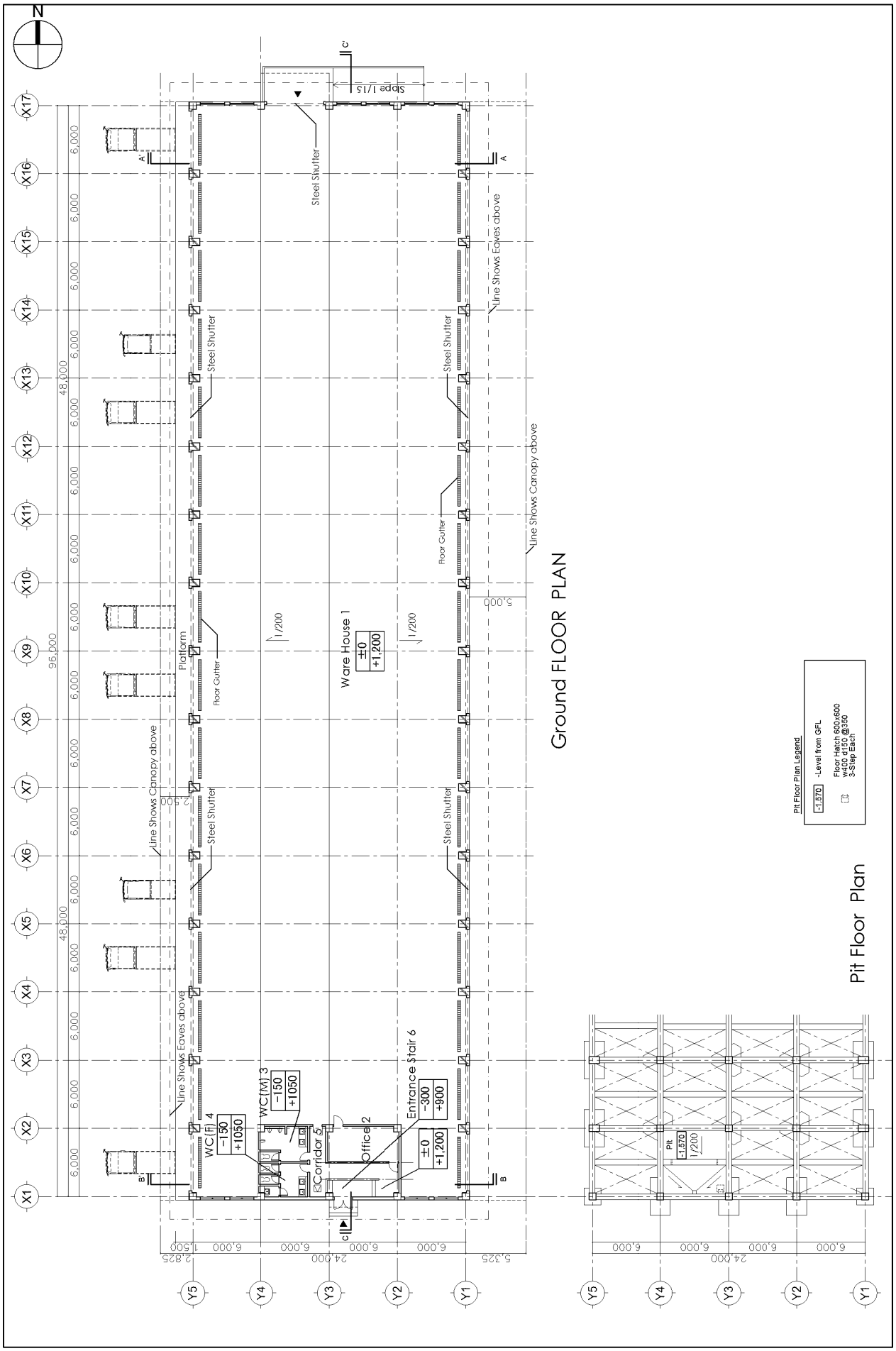


Figure 2-2-29 Warehouse Plan

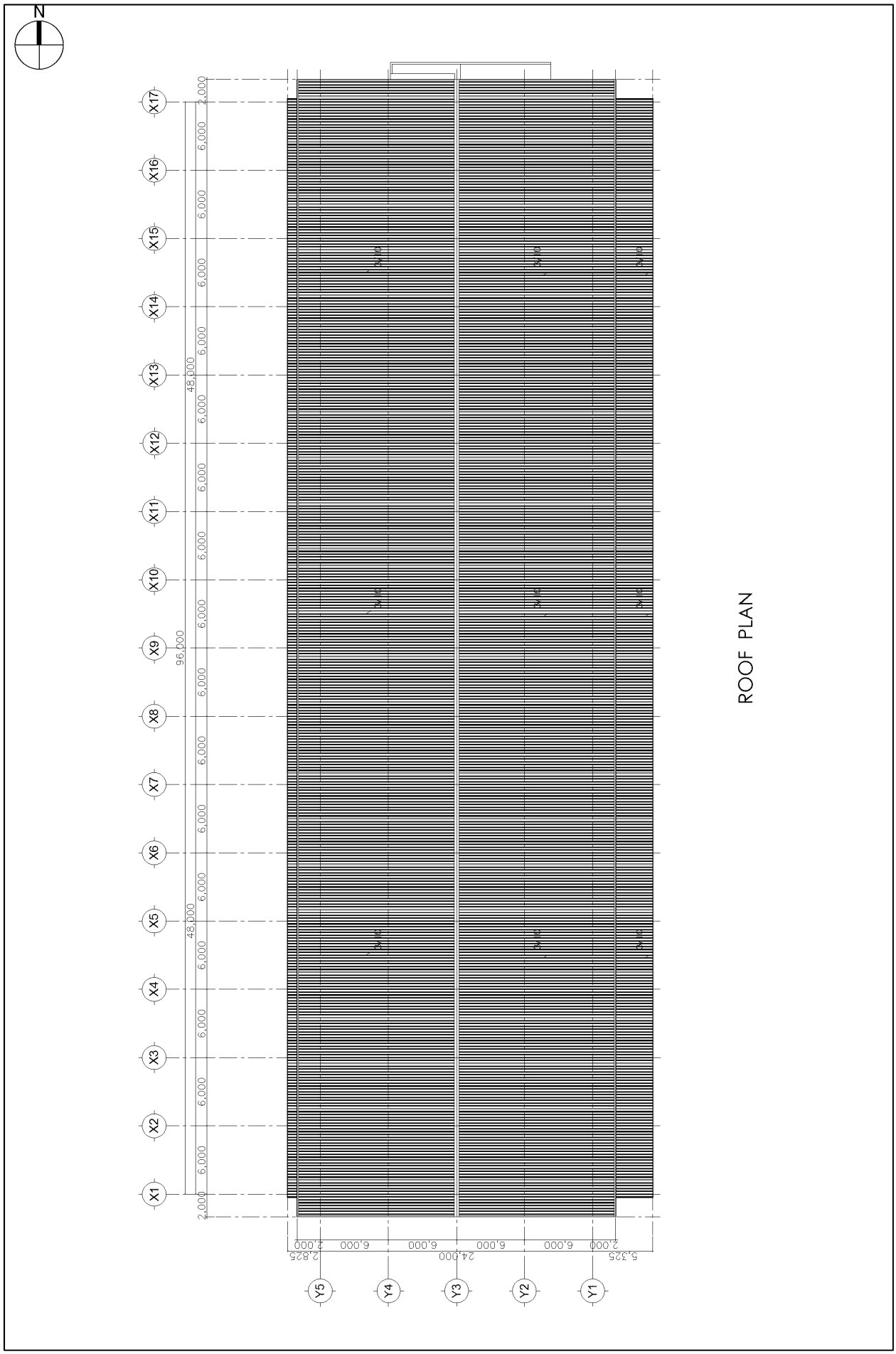


Figure 2-2-30 Warehouse Roof Plan

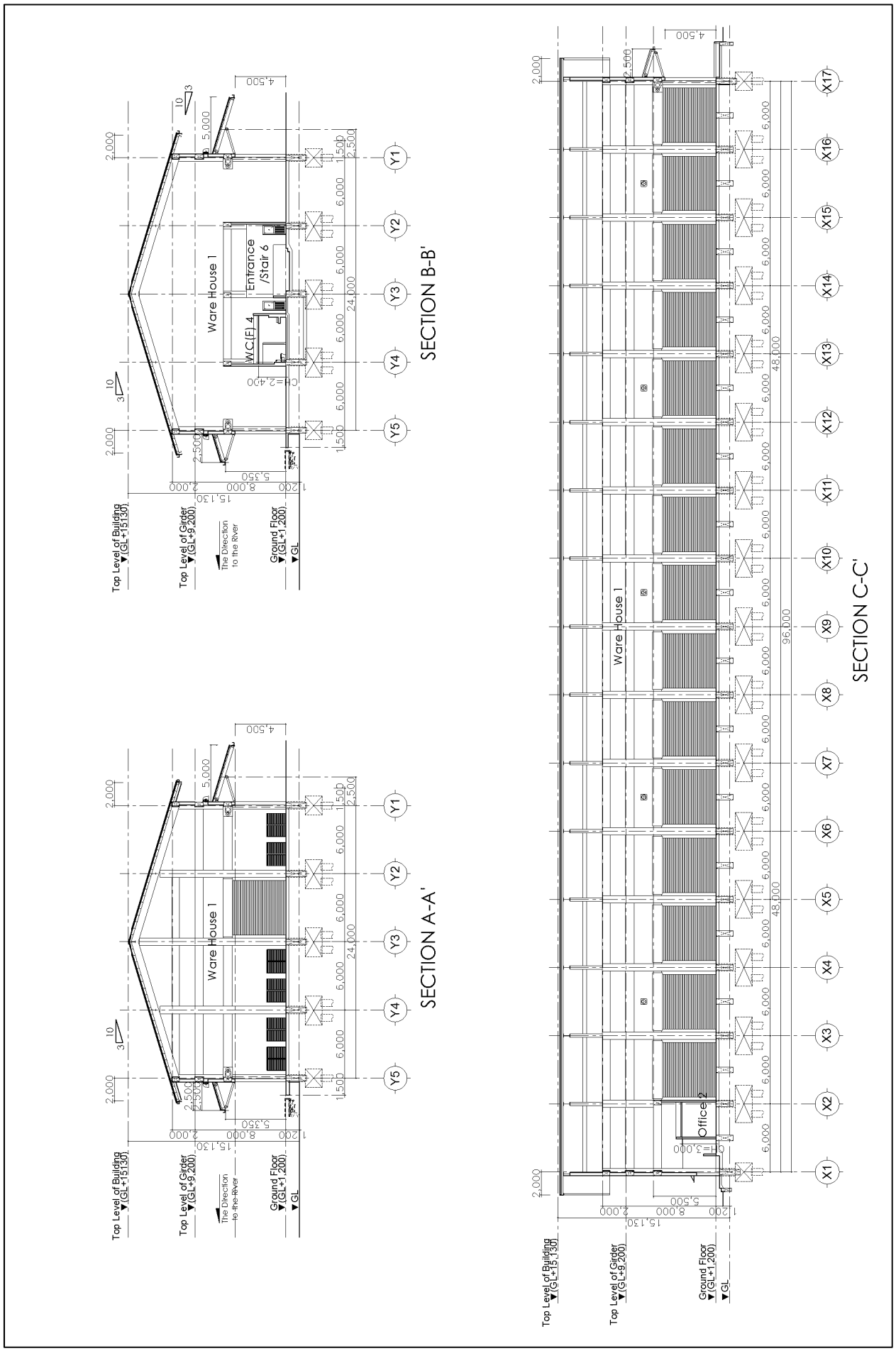


Figure 2-2-31 Warehouse Section

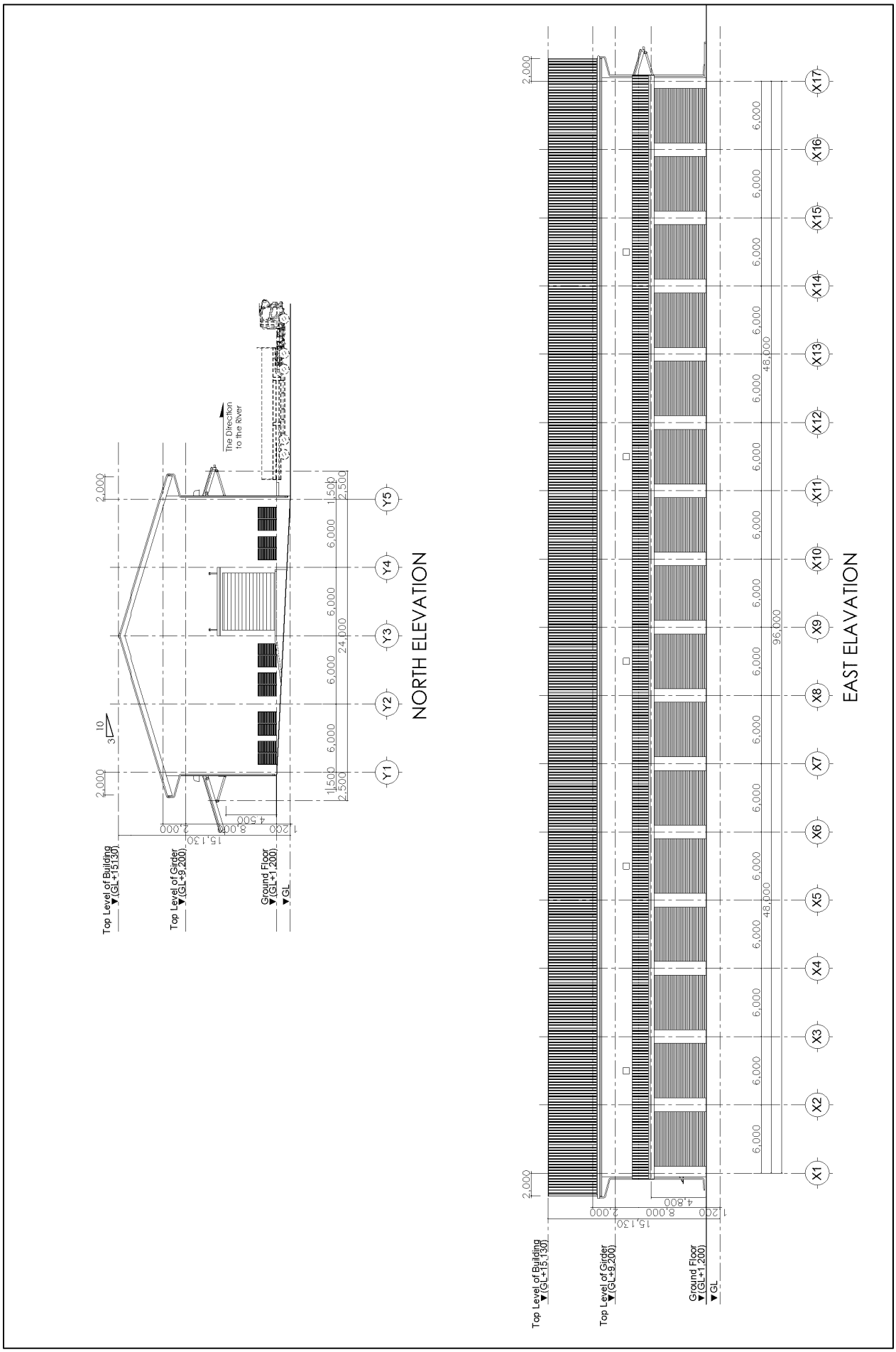


Figure 2-2-32 Warehouse Elevation (1/2)

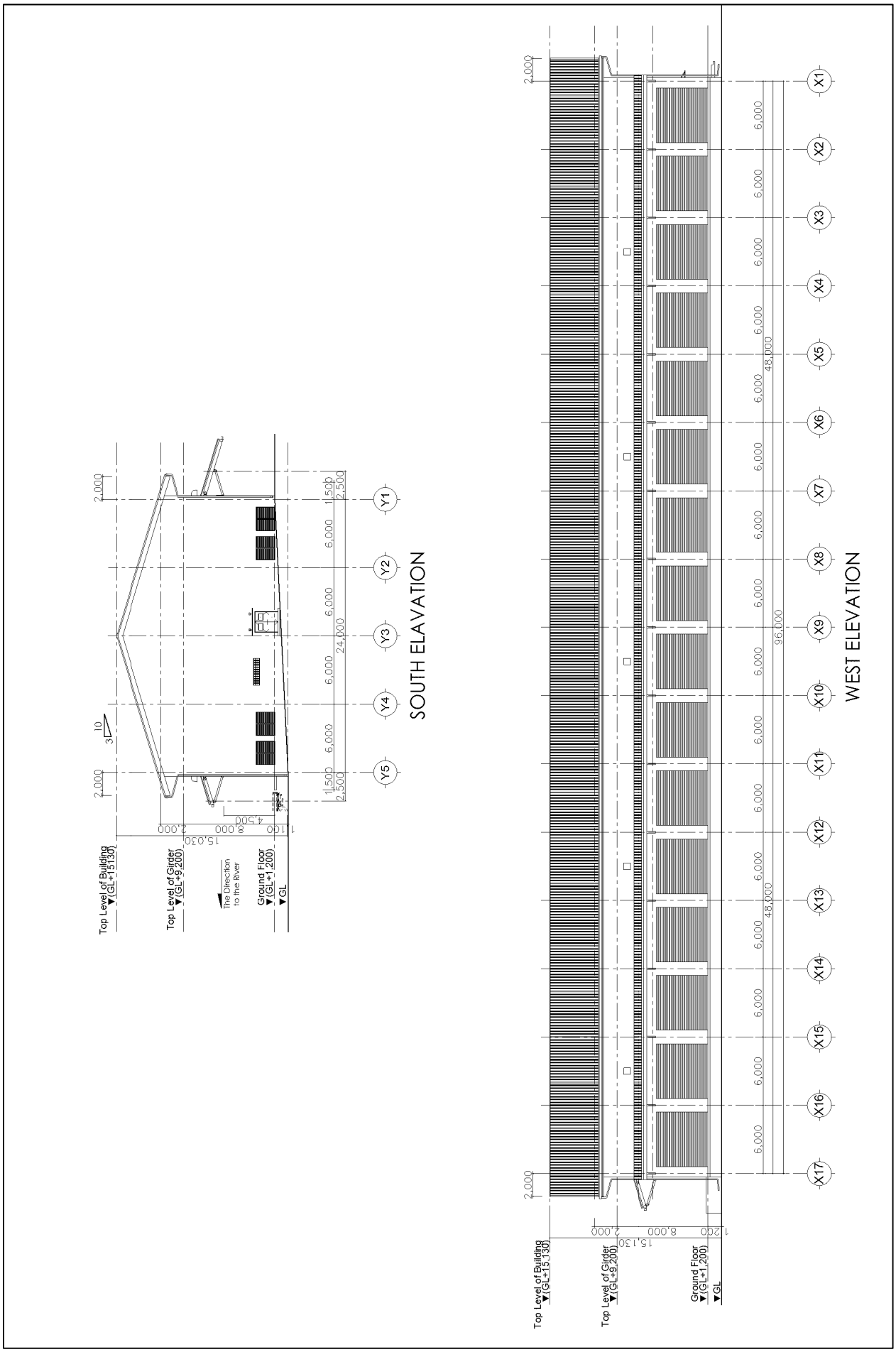


Figure 2-2-33 Warehouse Elevation (2/2)

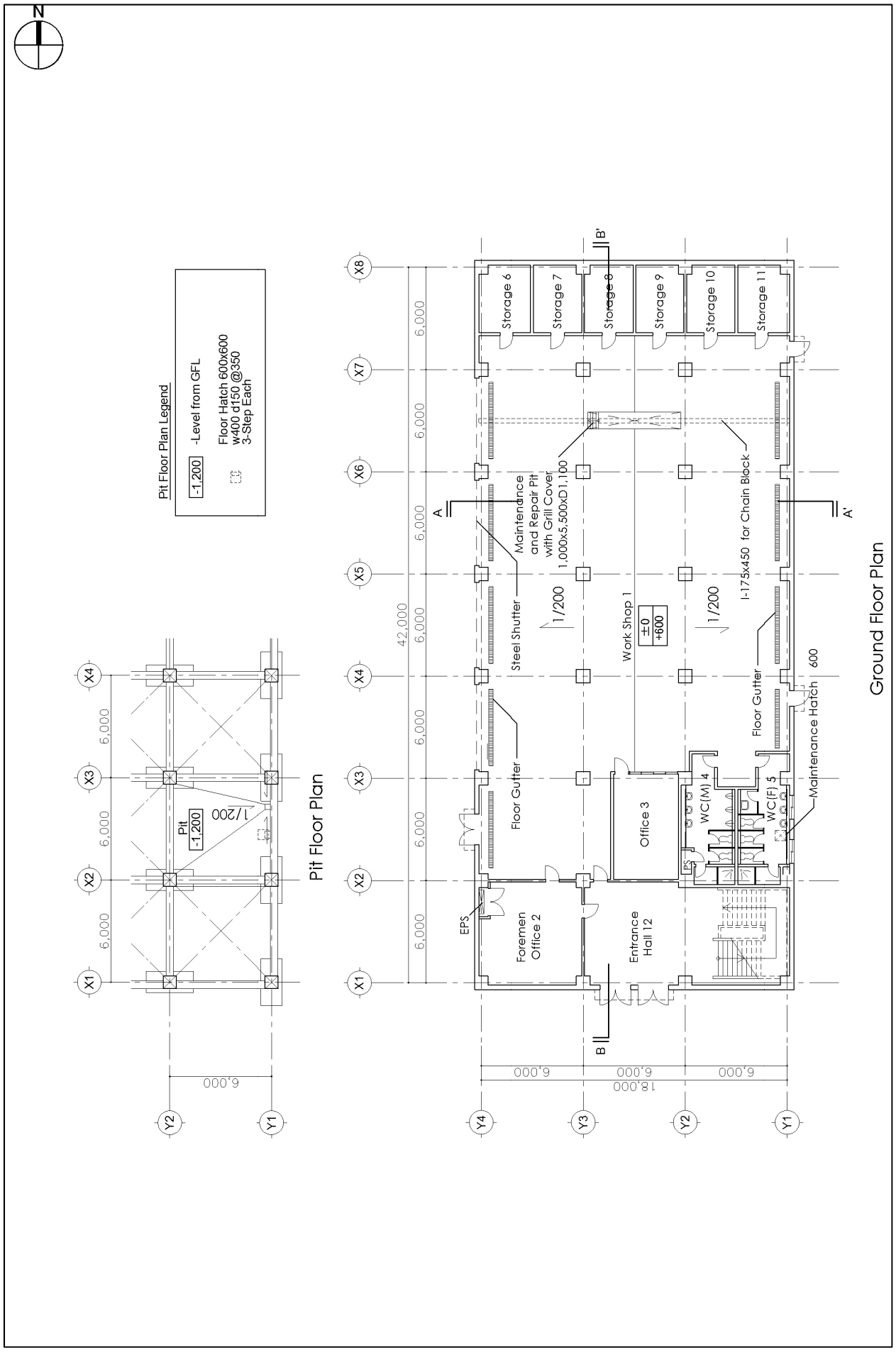


Figure 2-2-34 Port Office/Workshop Ground Floor (Workshop) Plan

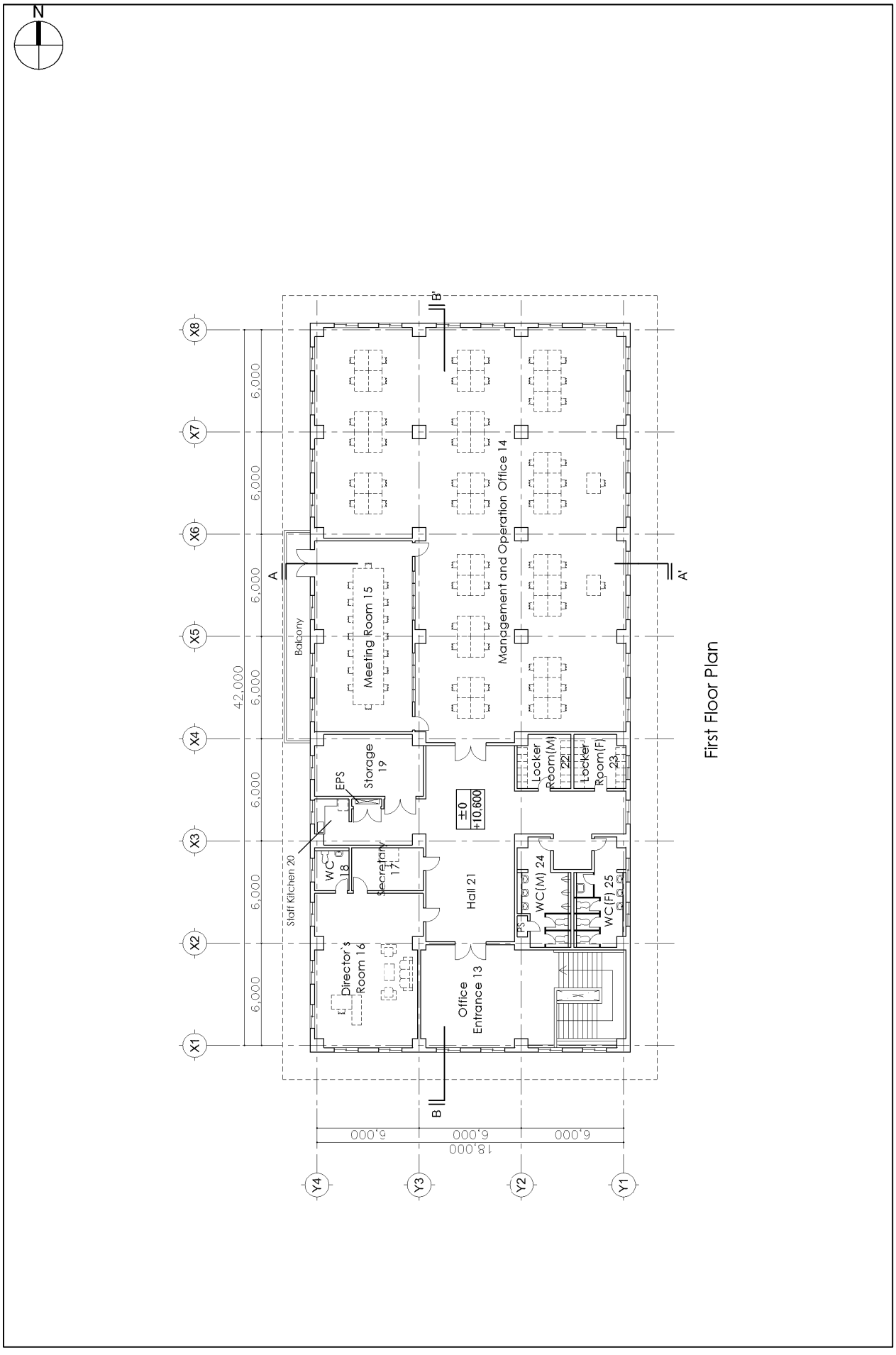


Figure 2-2-35 Port Office/Workshop First Floor (Port Office) Plan

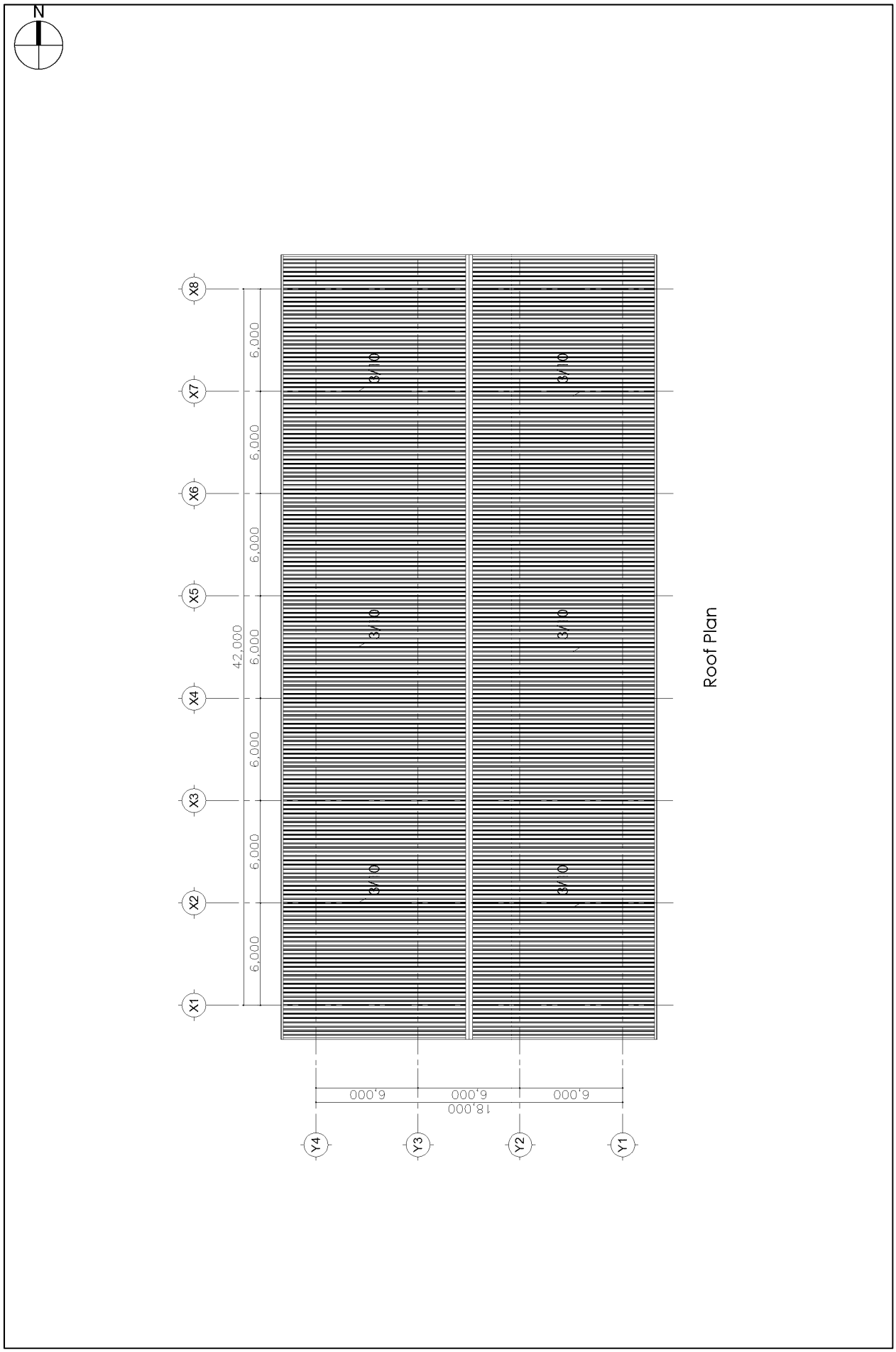


Figure 2-2-36 Port Office/Workshop Roof Plan

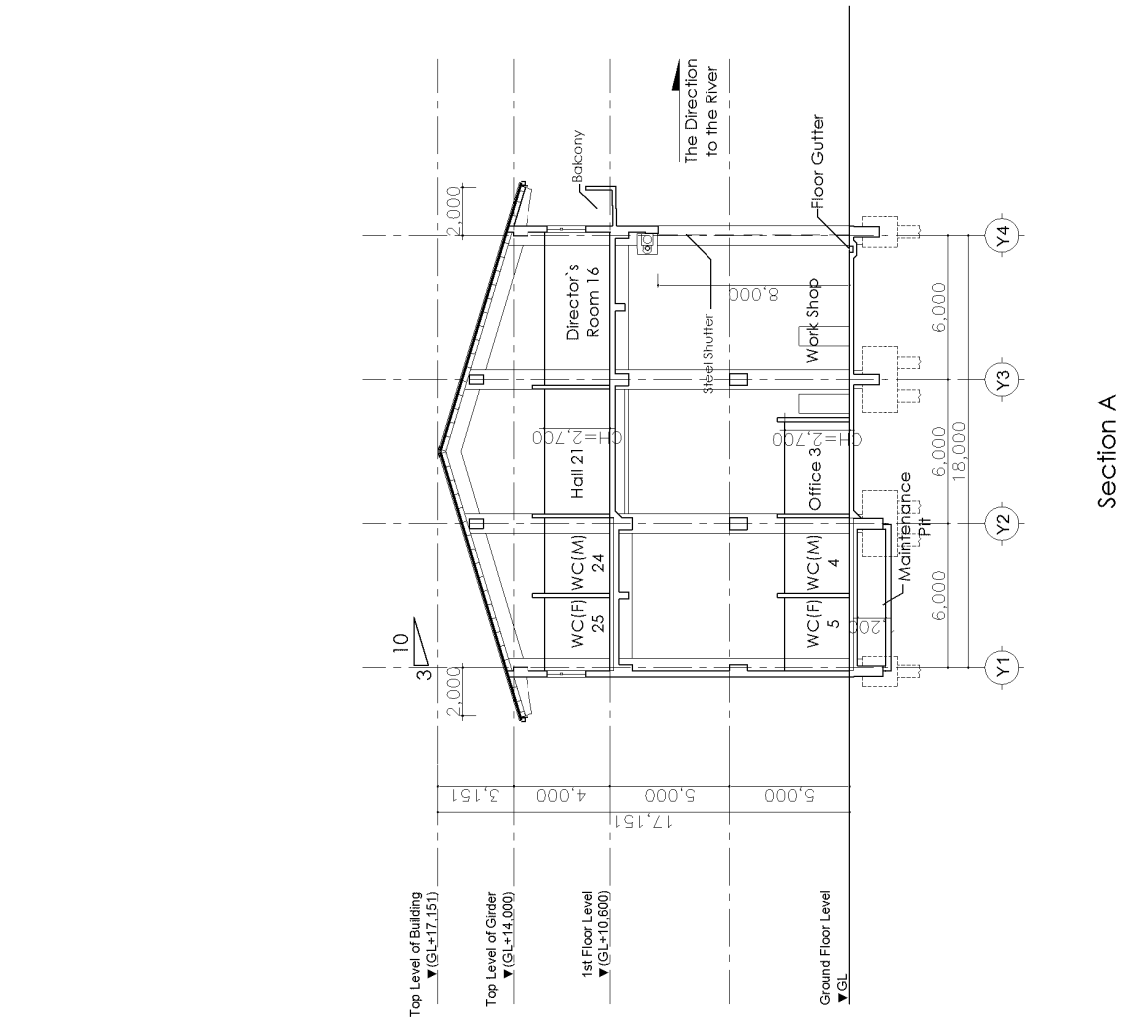


Figure 2-2-37 Port Office/Workshop Section (1/2)

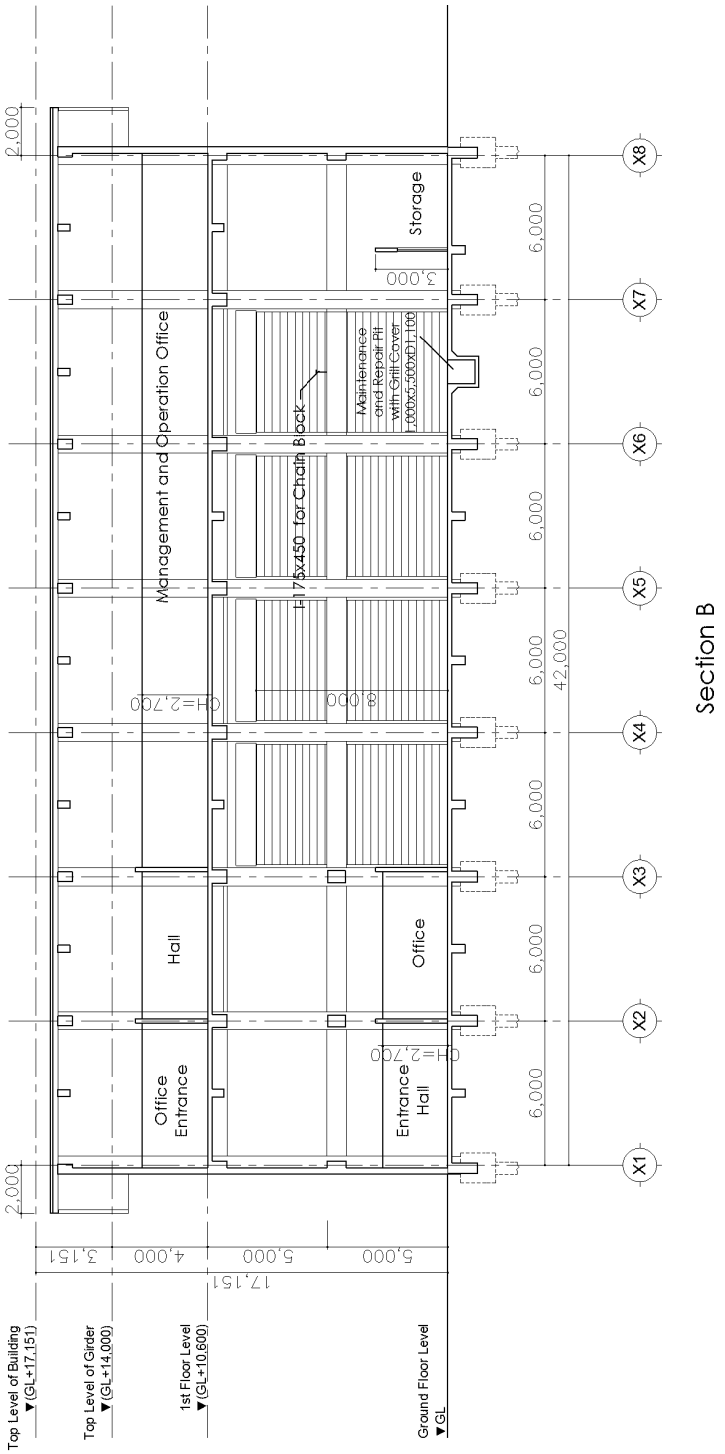


Figure 2-2-38 Port Office/Workshop Section (2/2)

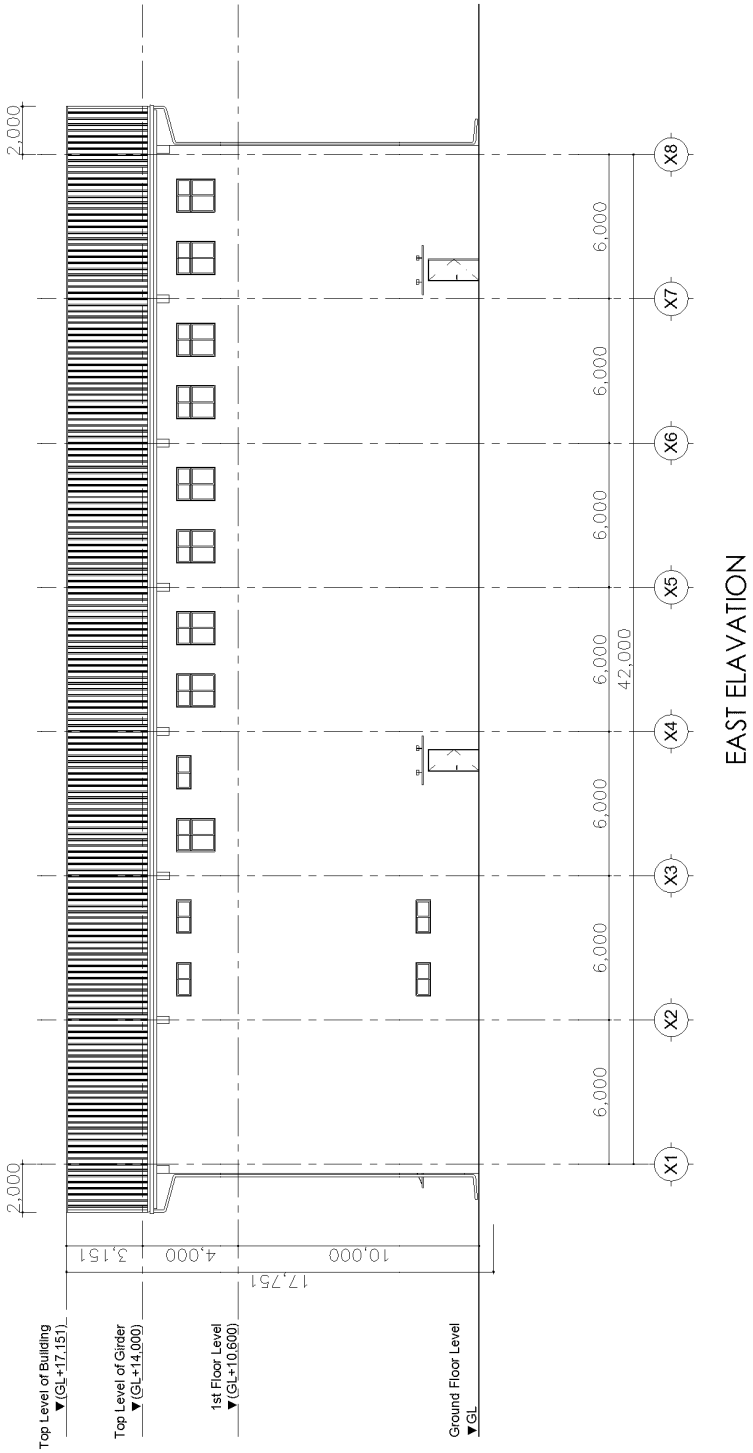


Figure 2-2-39 Port Office/Workshop Section (1/3)

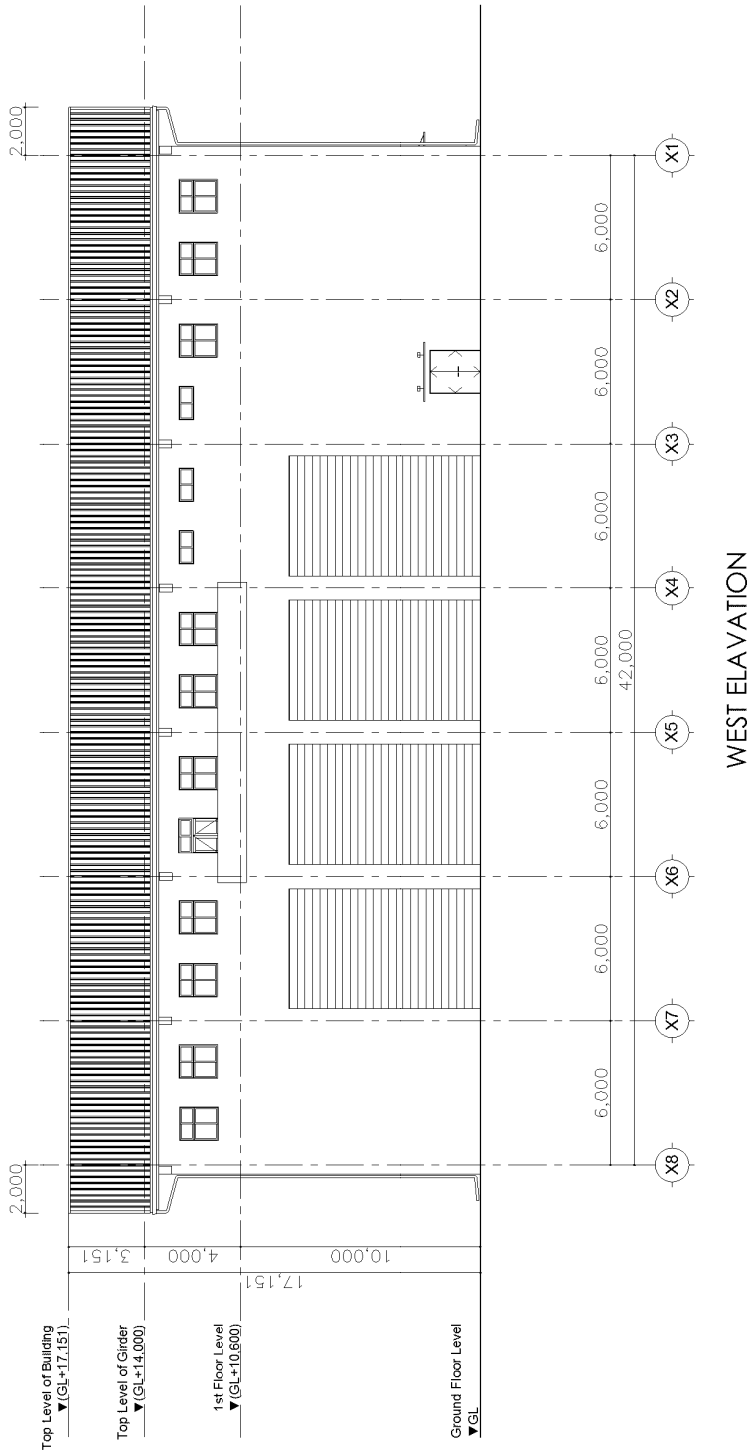


Figure 2-2-40 Port Office/Workshop Section (2/3)

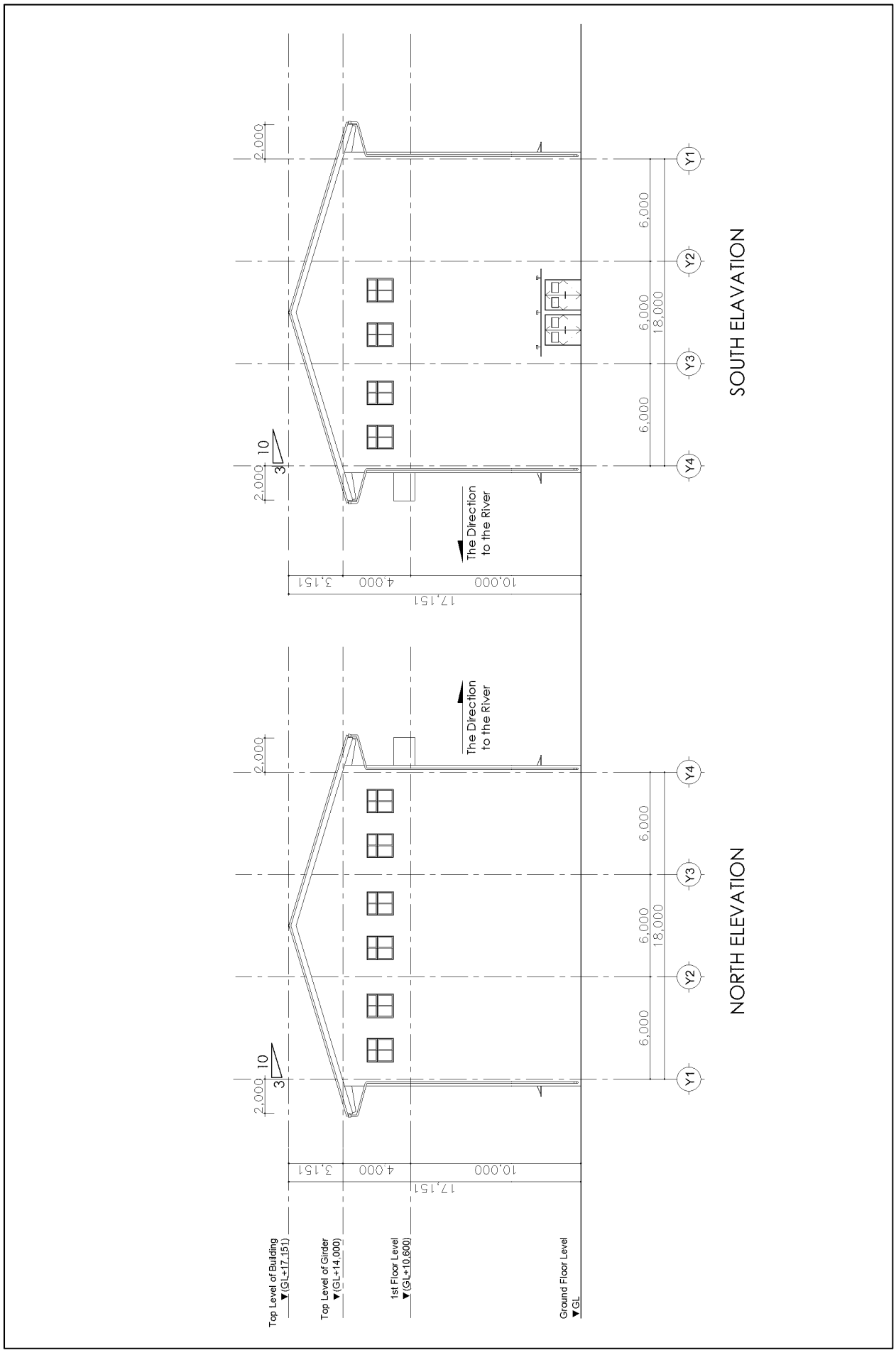


Figure 2-2-41 Port Office/Workshop Section (3/3)

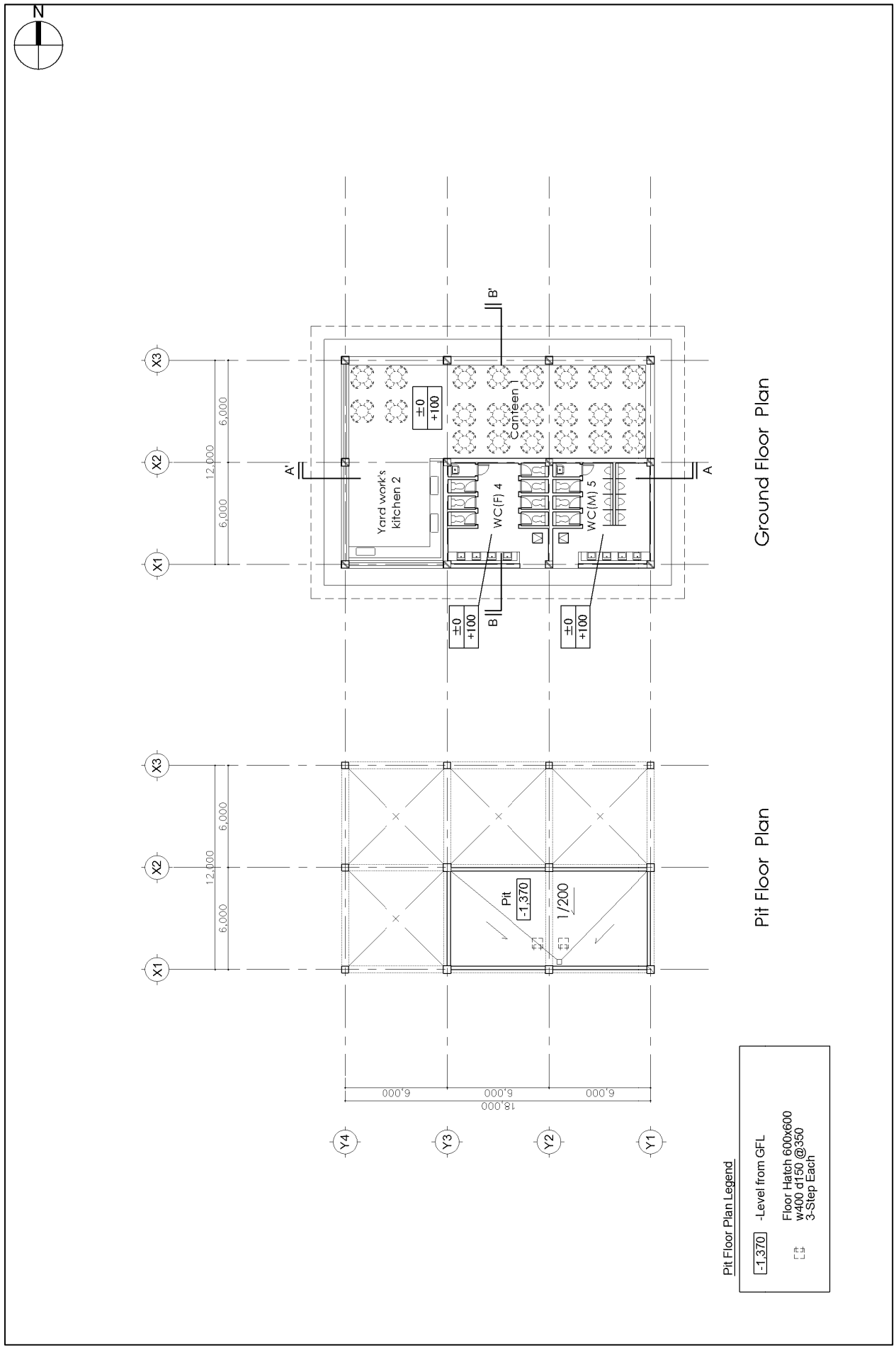


Figure 2-2-42 Canteen Plan

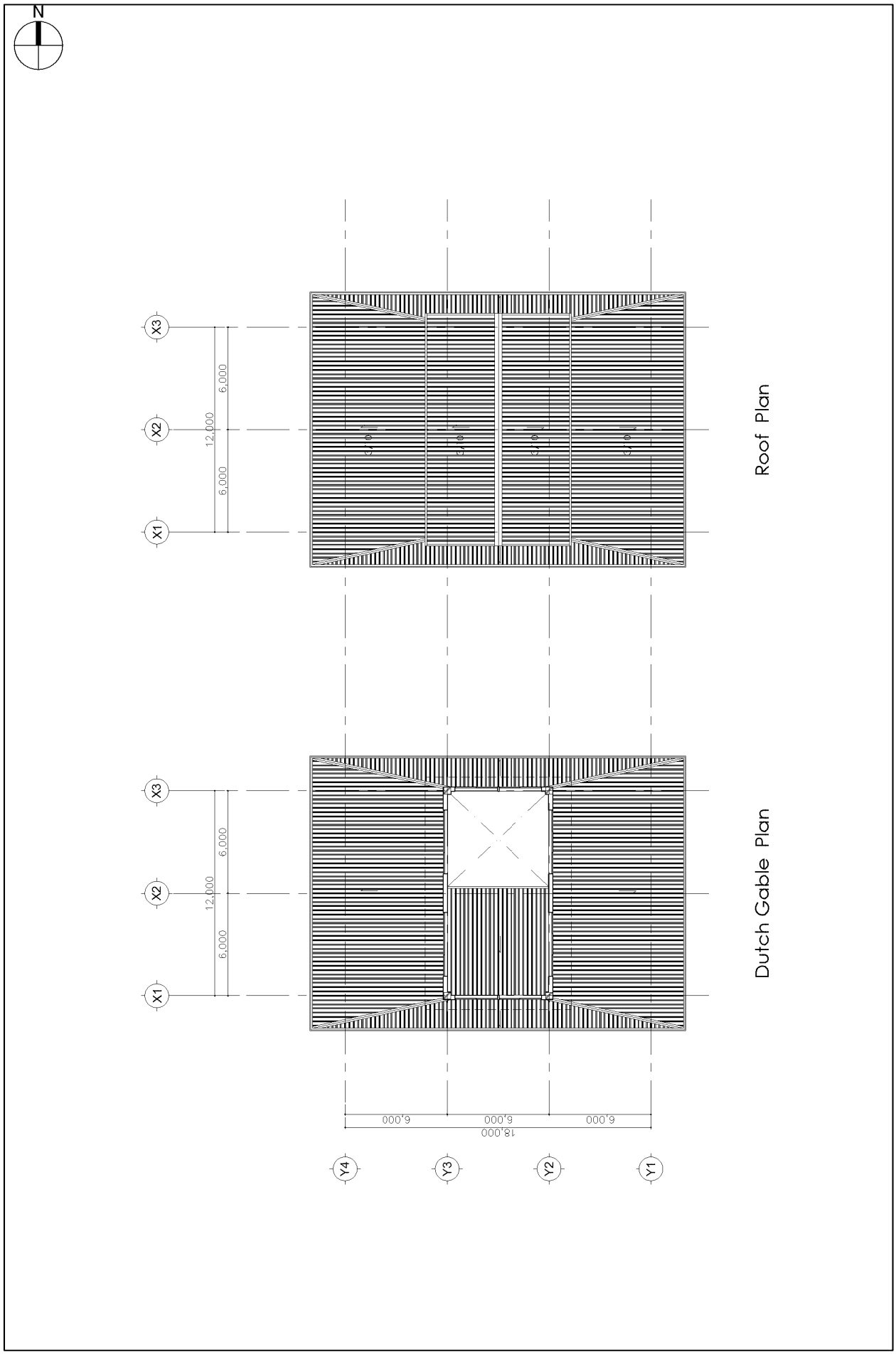


Figure 2-2-43 Canteen Roof Plan

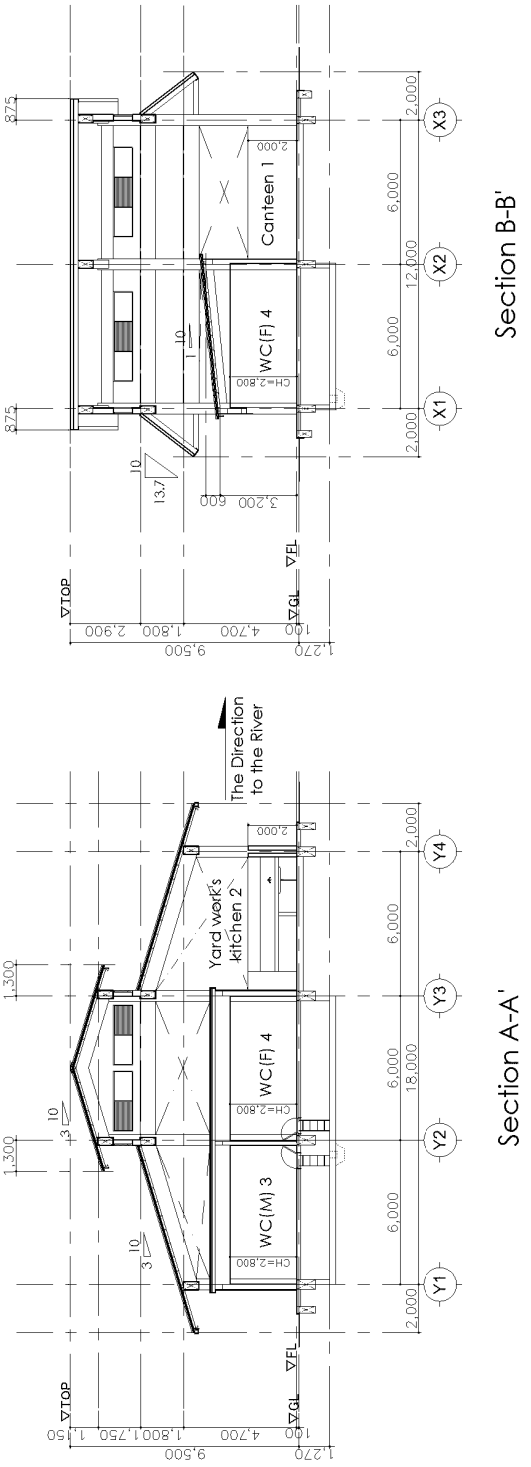


Figure 2-2-44 Canteen Section

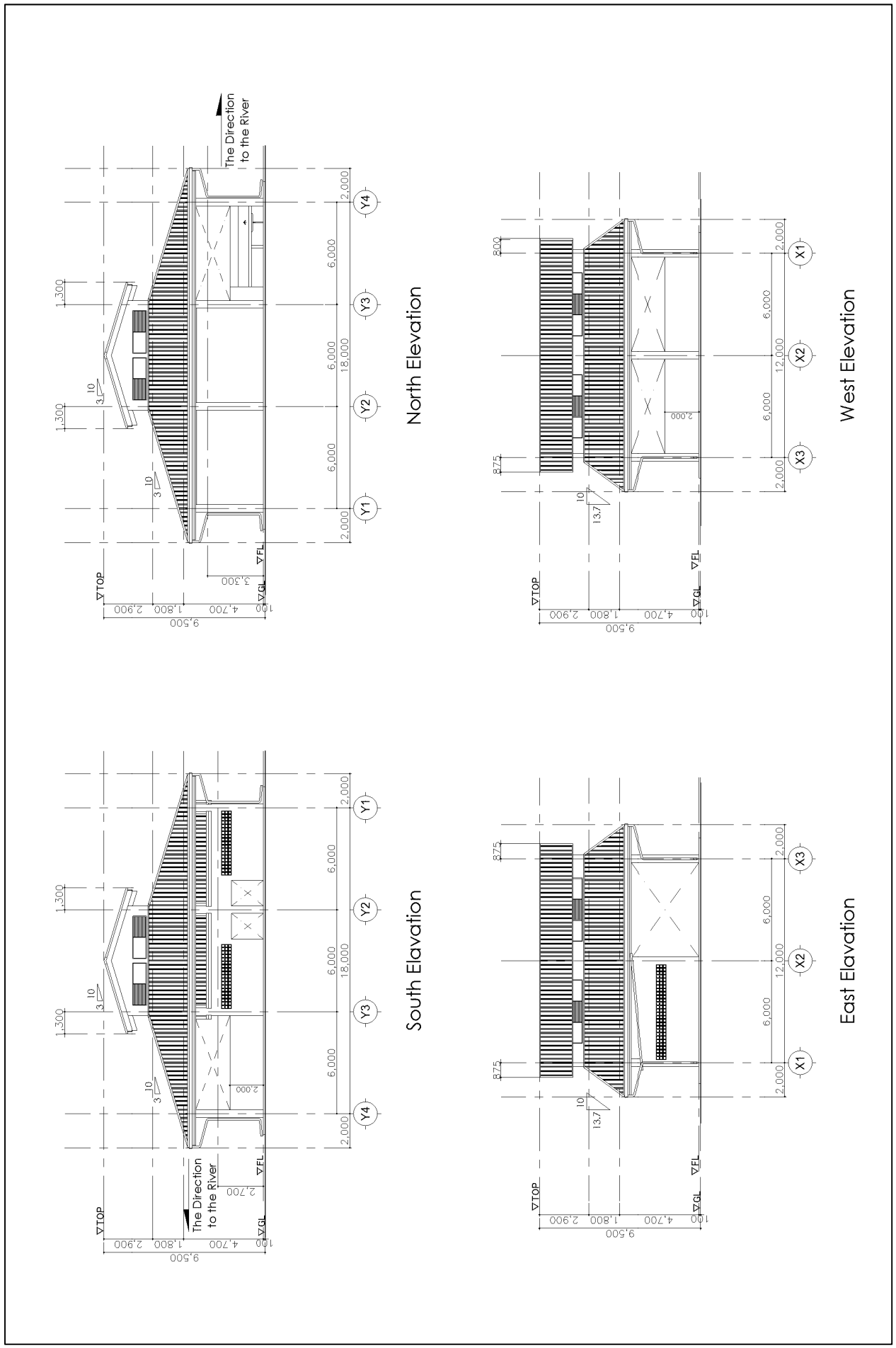


Figure 2-2-45 Canteen Section

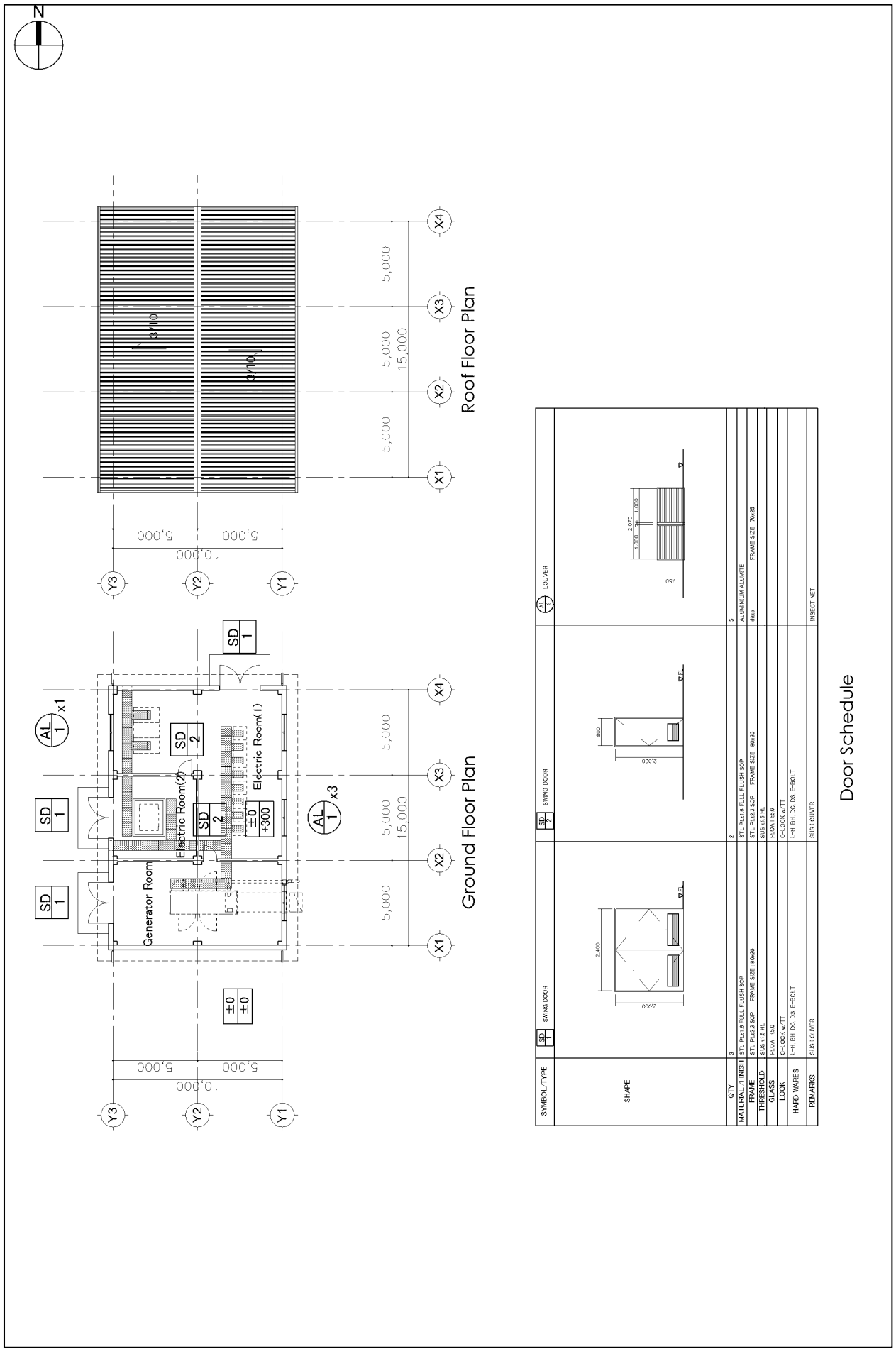


Figure 2-2-46 Generator House Plan & Roof Plan

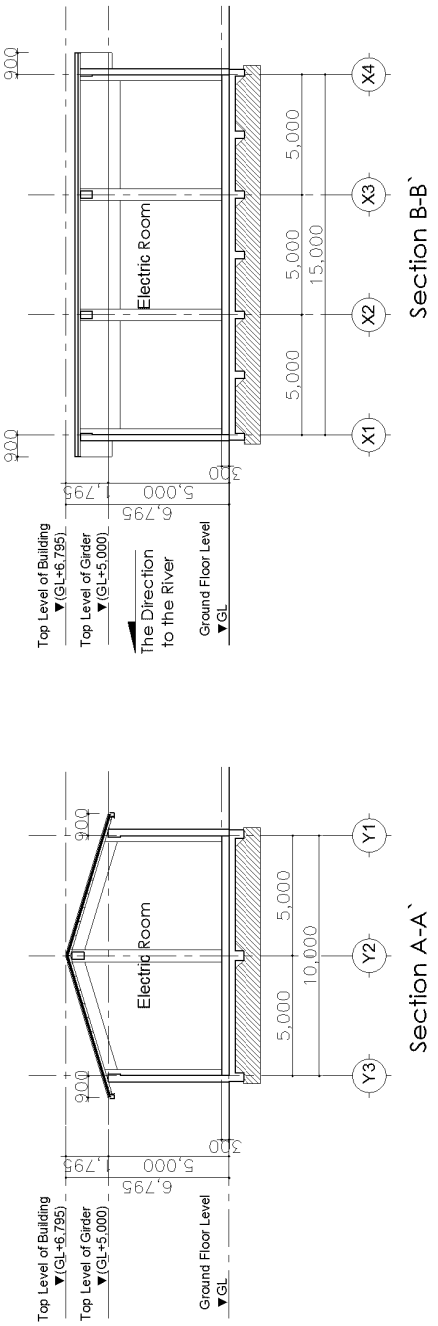


Figure 2-2-47 Generator House Section

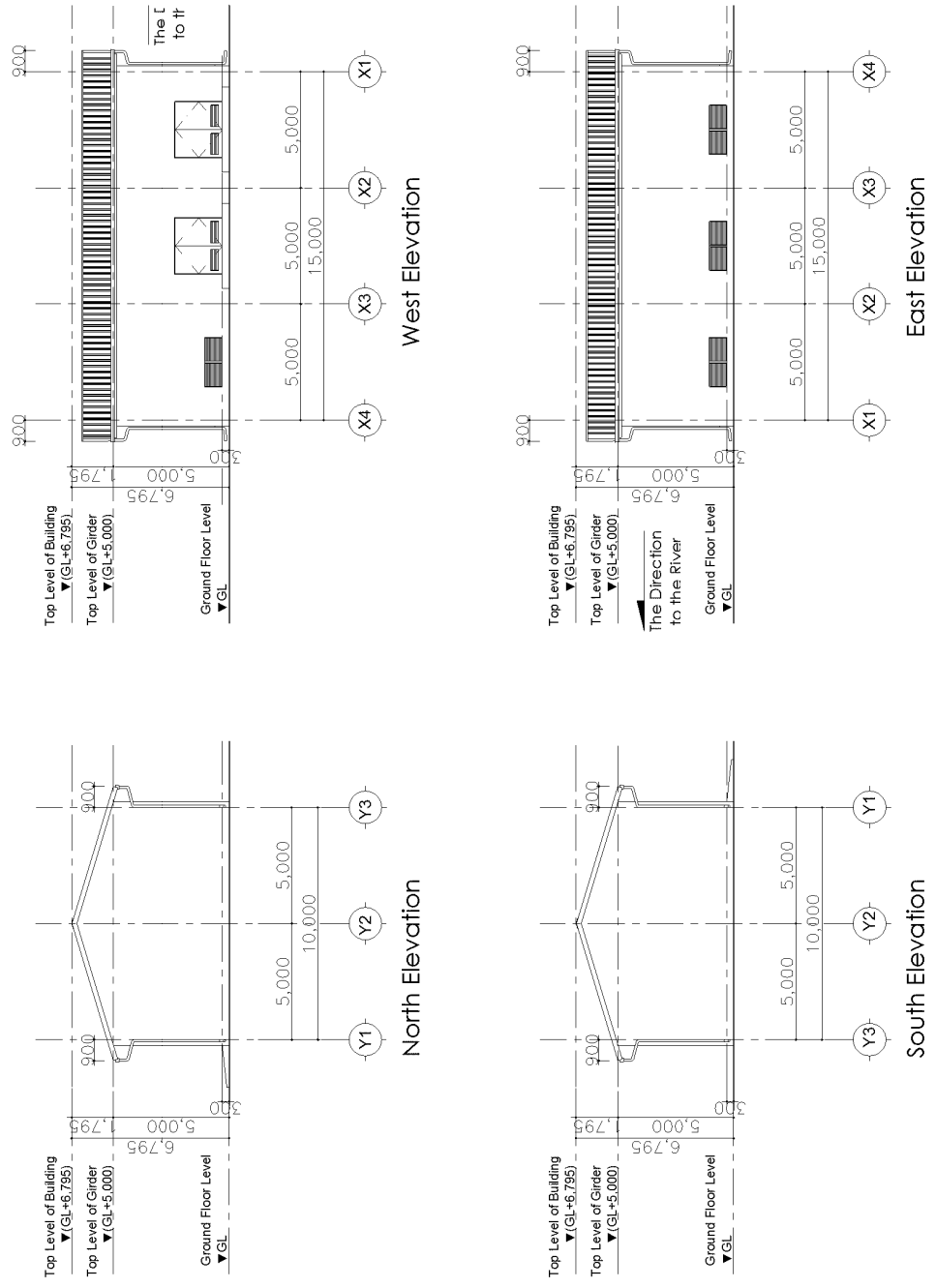


Figure 2-2-48 Generator House Elevation

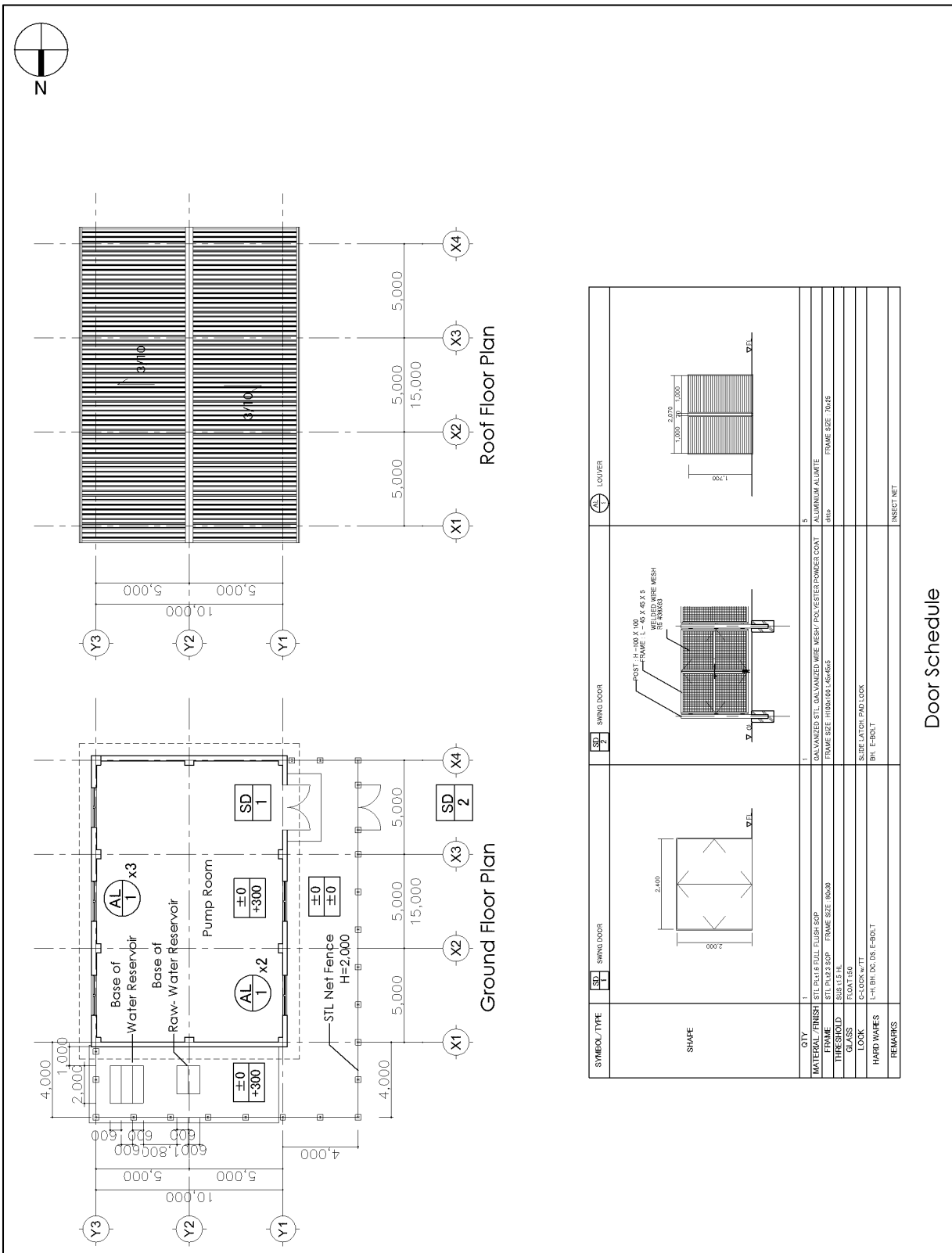


Figure 2-2-49 Pump House Plan and Roof Plan

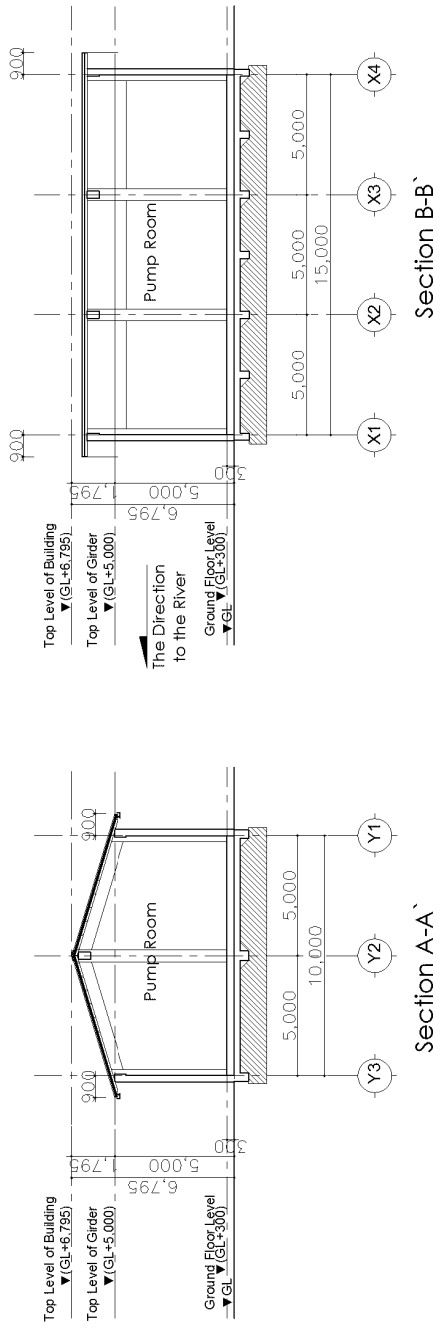


Figure 2-2-50 Pump House Section

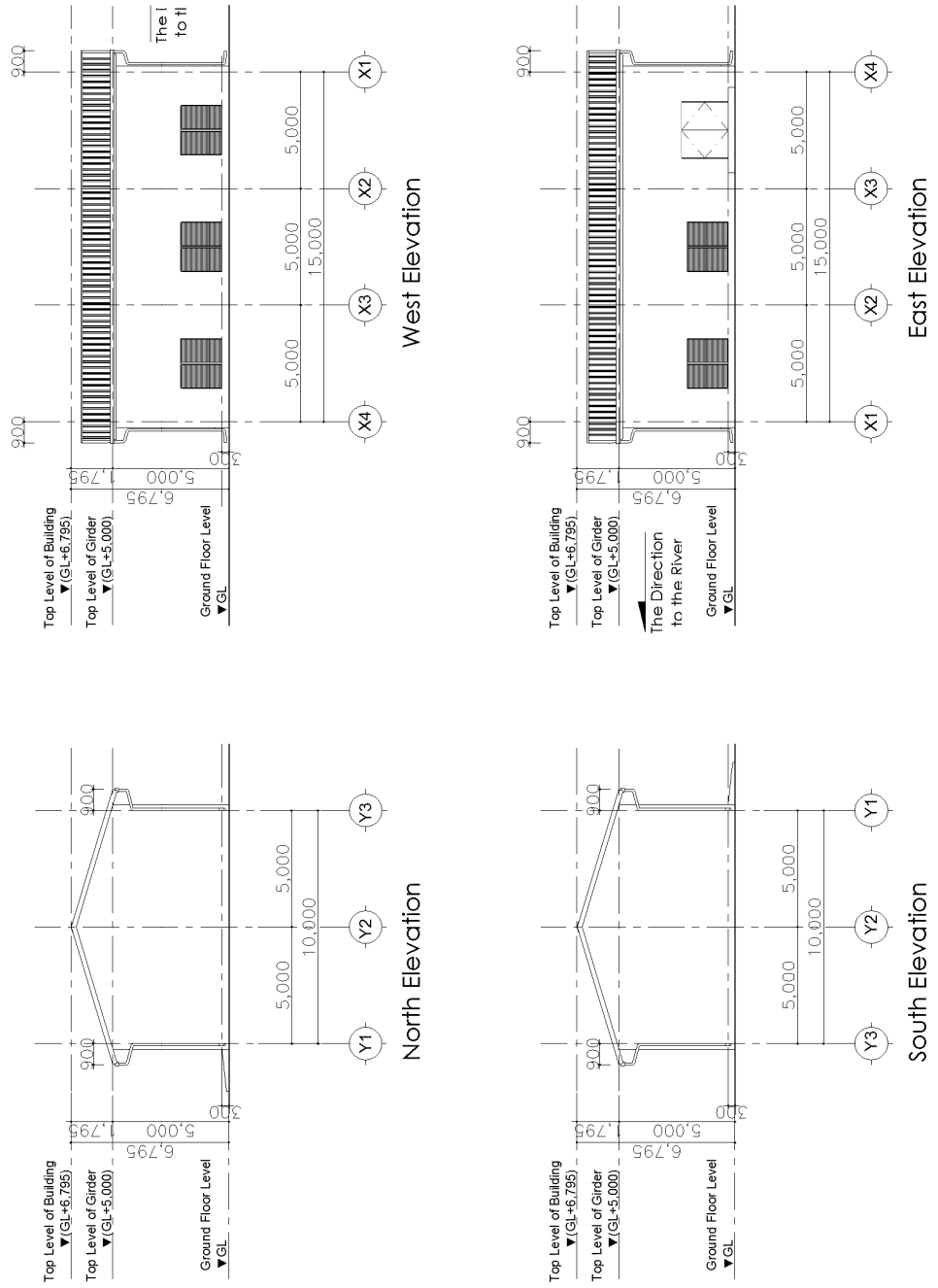


Figure 2-2-51 Pump House Elevation

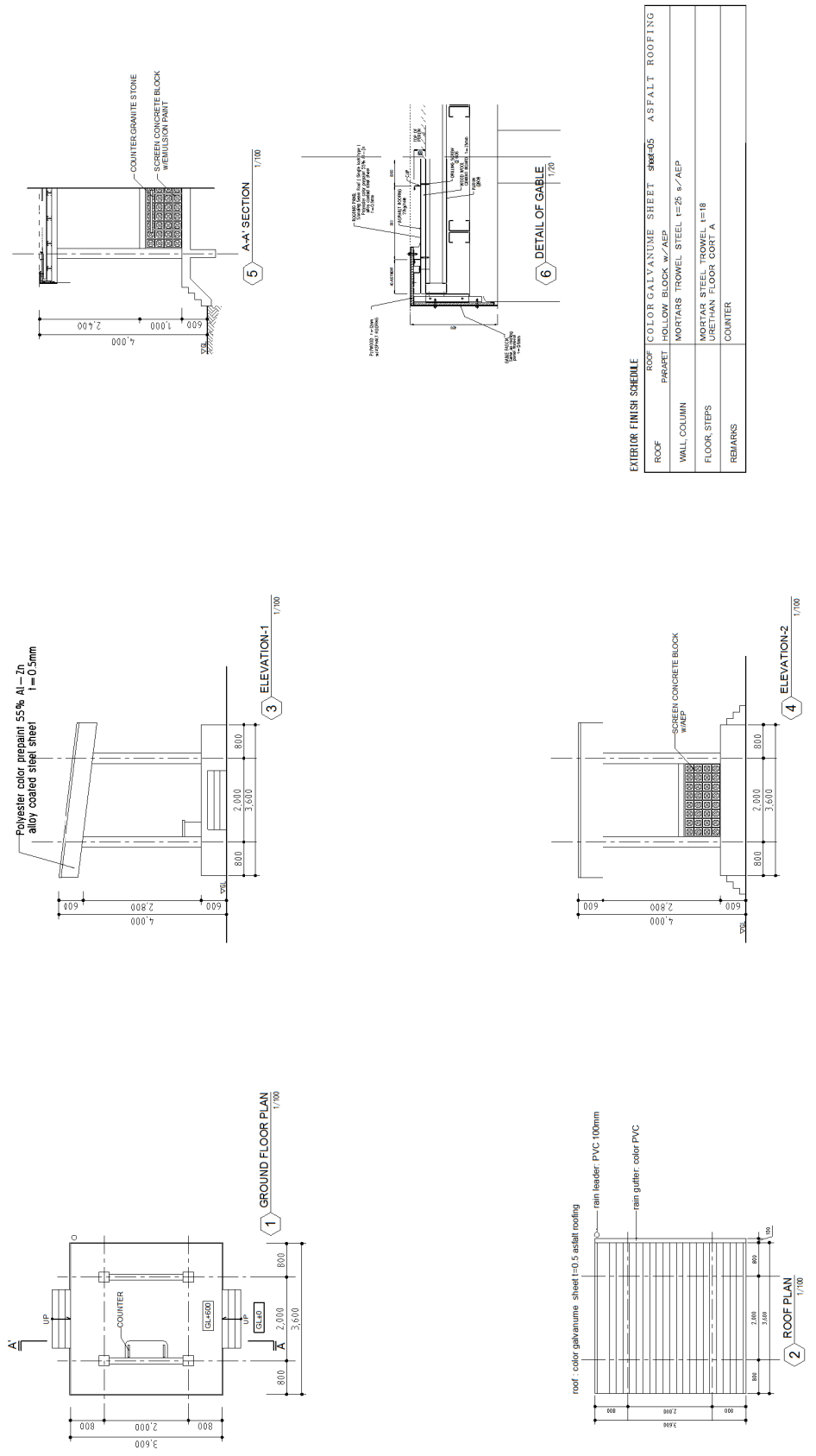


Figure 2-2-52 Security Hut

2-2-4 Implementation and Procurement Plan

2-2-4-1 Implementation and Procurement Policy

(1) Temporary Yard

The construction will be started in the dry season, which is the low water level of the river, and it is necessary to implement liquefaction countermeasure works (soil improvement works), access road works, revetment works and reclamation works during the dry season. During the above periods, a temporary road (gravel road) from the existing road and temporary yard in the southern area of the Project site will be constructed to be utilized for the assembling of construction equipment, the storage of construction materials and other works. (See map below)

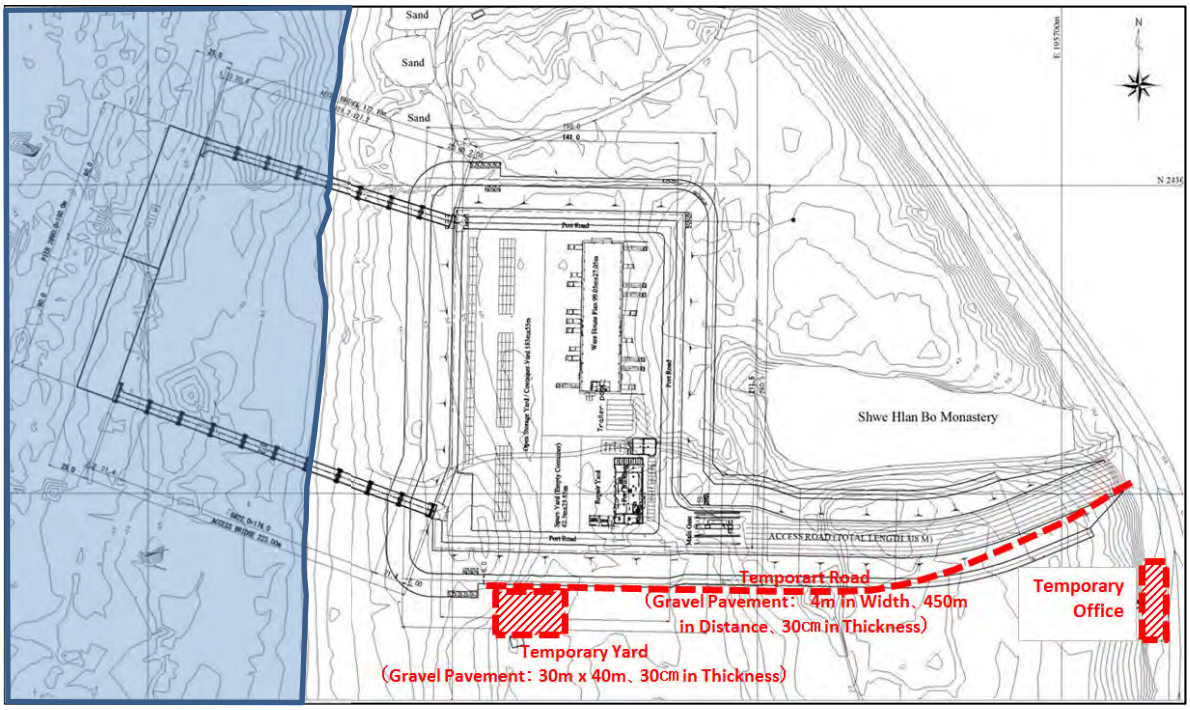


Figure 2-2-53 Temporary Office and Temporary Yard (Dry season during beginning of construction) Area

The above temporary yard will be submerged in the rainy season. Therefore, after the completion of reclamation works, the reclamation area will be used as a temporary yard for the storage of civil and architectural materials and the steel bar arrangement works.

(2) Temporary Works

A temporary jetty is planned to be constructed in the implementation state. However, since unloading of construction equipment and materials in the river side near the construction site is not easy, because there are no loading and unloading equipment. Therefore, construction materials and equipment other than barges and steel pipe pile piling work materials may be transported by land. In this regard, the temporary jetty is planned as a simple facility only for the boarding and departure of work staff during the steel pipe pile piling works. Loading and unloading of equipment and materials for construction works is not expected at the temporary jetty.

(3) Soil Improvement Works (Countermeasures against Soil Liquefaction and Soft Soil Layers)

1) Countermeasures against soil liquefaction

The two liquefaction countermeasure methods selected are the sand compaction pile (SCP) piling method and the high strength geotextile (geosynthetic) method. The SCP method is applied to the area under the revetment along the river, and the high strength geotextile method, which can keep the revetment robust by the effect of deformation control, is applied to the other areas.

The two units of piling machines for SCP are planned to use for the execution works. It is planned that the machines are transported from Japan to Yangon by sea transportation. For the transportation, the machines are dismantled. Inland transportation of the machines from Yangon to Mandalay Project site is expected by land transport. Prior to the pile driving works, the machines are assembled in the temporary yard.

SCP will be driven up to the designed depth from the existing ground surface at sufficient intervals. The high strength geotextile installation works are conducted as follows: firstly, the excavation as necessary depth after the levelling of ground; secondly, the installation of prevention sheet for soil draw-out; thirdly, the installation of the high strength geotextile after filling/levelling/compaction with gravel; and, finally, filling/levelling/compaction by gravel on the high strength geotextile. The required backhoe, truck, bulldozer, and other equipment for the works are available in/around the Mandalay area.

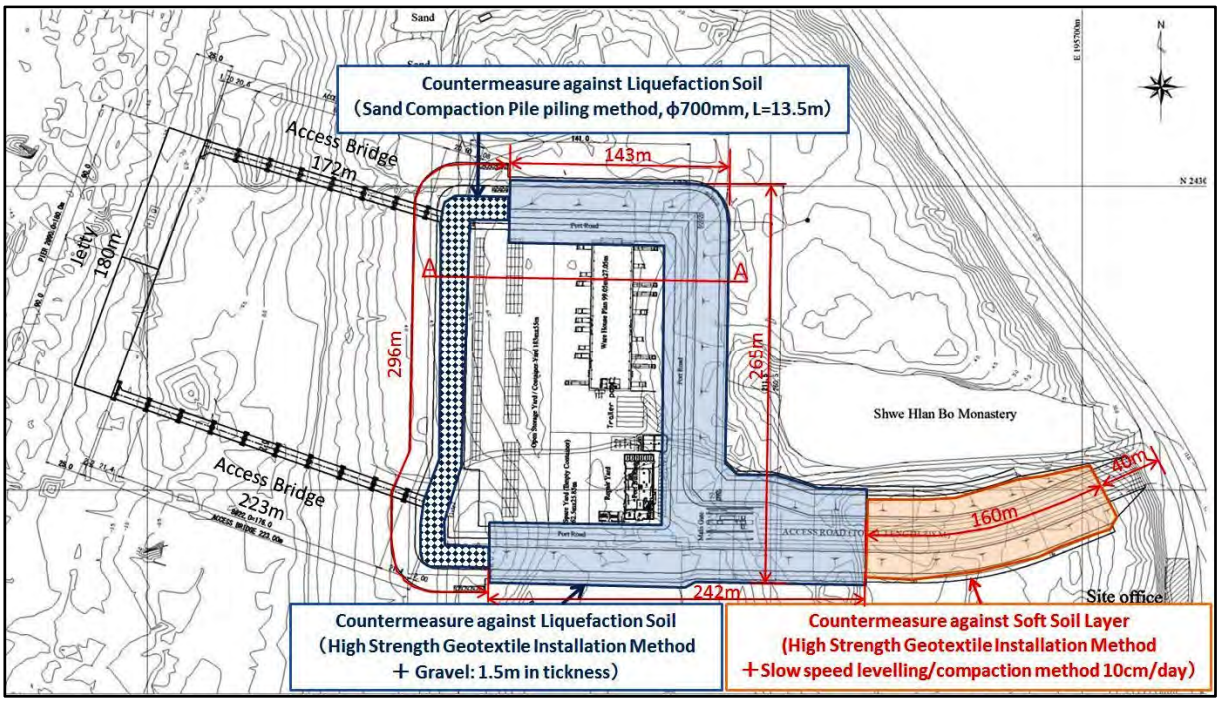


Figure 2-2-54 Countermeasures against the Liquefaction Soil and Soft Soil Layer

2) Countermeasure against soft soil layers

There are soft soil layer along the access road construction segment (from near the connection point of the existing Myo Patt road +40 to +160 m). Access road is constructed on the embankment with revetment. To prevent of slip failure of the revetment and to enhance of working traffic-ability of the embankment during the execution works, high strength geotextile with adequate tensile strength is used for the reinforcement materials for embankment. For the embankment construction, sand mat placing on the existing ground with appropriate thickness will be done by bulldozer, and on the sand mat, high strength geotextile will be placed. Because of the low safety factor (Fs ＜ 1.0) of the existing soft soil layer against the land slide, the slow speed levelling/compaction method is selected. The embankment will be constructed by the levelling/compaction of soil materials at 10 cm per day. Subsoil settlement and embankment deformation will be observed and monitored in daily basis during the embankment construction by sand filling.

(4) Revetment Works

Before revetment filling works, steel sheet piles are driven as foot protection against soil erosion by river water flows. After completion of the steel sheet pile driving works, the SCP driving works, and the high strength geotextile placing works, and the crusher-run revetment stone filling works will be conducted. After trimming of the crusher-run front slope as 1:2, soil draw-out prevention sheet (geotextile mat) will be placed, and under layer armour stones (approx. 10 kg/stone) will be placed on the mat with 40 cm thickness. Finally, 1 m thickness cover layer will be constructed by placing armour stones (approx. 200 kg/stone) on the under layer armour stones. Revetment of the reclamation side, the crusher-run slope will be trimmed as 1:1.2, and geotextile mat for prevention for soil draw-out will be placed and the reclaimed materials will be filled on the mat.

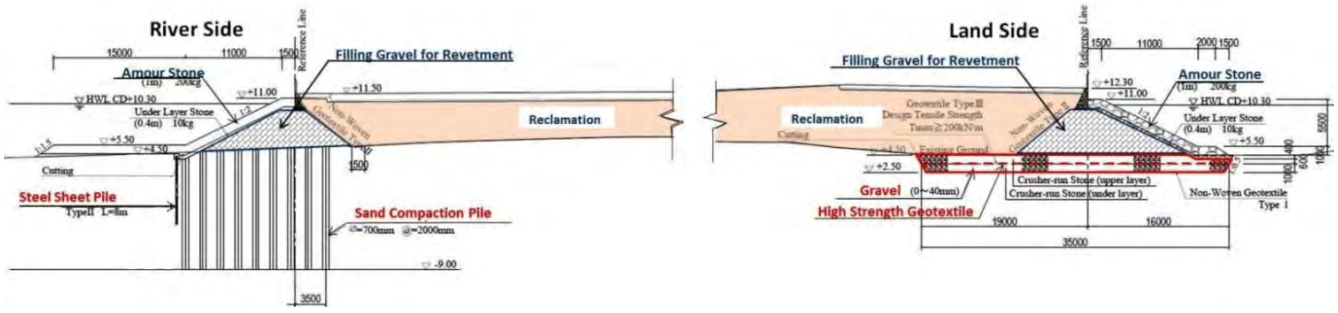


Figure 2-2-55 Revetment and Reclamation Works (Section A-A)

(5) Reclamation Works

After the revetment works, the reclamation work will be undertaken to fill the area surrounded by the revetment with river sand. The reclamation works will be conducted with discharged river sand from the discharged sand pipeline, by the three existing sand pump dredgers. The discharged sand volume is estimated at approximately 1,000 m^3 per day. During the reclamation works, levelling, compaction, and discharge pipe maintenance will be done by bulldozer.

(6) Jetty Construction Works

The steel pipe piles for the jetty foundation are planned to be transported by barge on the river from Yangon, and the barge will be moored to beside the piling barge. The driving works are planned to be conducted by barges on the river. Superstructure of the jetty is designed by the combination of the

precast concrete block segments and cast in-situ concrete to reduce the construction work periods. After the piling and precast beam concrete placing works, precast slab concrete blocks, which are lower part of the slab and constructed in the temporary yard, will be conveyed and installed on the concrete beam by using barge on the river.

Reinforcement steel bars for the upper part of the slab concrete will be transported and installed after the installation of the precast slab segment. Finally, cast-in-situ concrete will be placed for the upper part of the slab construction.

As an ancillary facilities of the jetty, 22 bollards (30 tons), 66 bollards (25 tons), 92 V-type fenders, corner plates and catwalk materials will be installed.

Under the above-mentioned expected construction plan, the main required construction equipment for the jetty construction works is shown in Table 2-2-22. Vessels to be necessary for piling works are the piling barge, barge for steel pipe piles and tug boats (including anchor boat works). The piling barges are divided into barge (2,000 tons, including winch/anchor facilities), crawler crane (300 to 400 tons) and hydraulic hammer (15 tons). Pile positioning will be made by GPS, and inclined angle of batter pikes will be set by the pile catcher.

Table 2-2-22 Main Required Construction Equipment (Jetty Construction Works)

Work	Equipment	Specification	Q'ty
Steel Pile Works	Barge	1000 t, for steel pipe piles	1
	Tugboat (including Anchor Boat)	D500PS	1
	Piling Barge	Hydraulic hammer (15 t), Barge (2000 t Winch/Anchor), Crawler Crane (300 -400 t)	1
Upper Concrete Works Upper Precast Block Works	Crane Barge	35-45 t lifting capacity	1
	Tugboat	D500PS	1
	Electric Welder	Hand powered, 300A	1
	Crawler Crane	50 t lifting capacity	1
	Generator	45 KVA	1
	Concrete Vibrator	45 mm, 2.9 kW	1
	Dump Truck	20 t	1
	Barge	500 t	2
	Crane Barge	70-100 t lifting capacity	1

(7) Access Bridge Works

An access bridge is selected from the composite girder bridge structure which is shortening the construction periods based on the decreasing number of driving piles. In consideration of the earthquake-resistance and durability of the structure, the foundation of the access bridge is selected to be a steel pipe pile structure, while the upper structure is a concrete structure. The driving pile works will be conducted on river water by piling barge, same as the jetty works.

In this implementation plan, the members of the composite girder bridge structure will be transported from Yangon by land. The beams will be assembled in the temporary yard and installed by the crane barge. The cast-in-situ concrete for the slab is placed to integrate the steel girders with many stud dowels projecting to thus achieve the composite girder structure.

Table 2-2-23 Main Required Construction Equipment (Access Bridge Works)

Work	Equipment	Specification	Q'ty
Steel Pile Works	Barge	1000 t, for steel pipe piles	1
	Tug Boat (including Anchor Boat)	D500PS	1
	Piling Barge	Hydraulic hammer (15 t), Barge (2000 t Winch/Anchor), Crawler Crane (300 -400 t)	1
Upper Concrete Works Upper Precast Block Works	Crane Barge	35-45 t lifting capacity	1
	Tugboat	D500PS	1
	Electric Welder	Hand powered, 300 A	1
	Crawler Crane	50 t lifting capacity	1
	Generator	45 KVA	1
	Concrete Vibrator	45 mm, 2.9 kW	1
	Dump Truck	20 t	1
	Barge	500 t	2
	Crane Barge	70-100 t lifting capacity	1

(8) Architecture Facilities

Architecture facilities are selected in the general structures and are not in the special structures. Therefore, local materials will be applied as much as possible. However, if some materials are not of high enough quality, JIS standard products or the equivalent will be procured from neighbouring countries for construction.

(9) Cargo Handling Equipment

Cargo handling equipment is the most important component of the project for the modernization of the port to improve the work efficiency of cargo handling by mechanization of cargo handling works. Therefore, reliable equipment with sufficiently high quality and high performances shall be procured.

2-2-4-2 Implementation and Procurement Conditions

(1) Labour and Employment Conditions in Myanmar

The Employment Act in Myanmar is regulated by the "Shops and Establishment Law" and the "Factories Act (Labour and Welfare)". In the implementation of the Project, based on the "Factories Act (Labour and Welfare)", working hours for labourers are as follows.

[Basic Restrictions] (based on Factories Act)
- Weekly Working Hours: 44 hours/week
- Daily Working Hours: 8 hours/day
- Overtime: no restriction
- Intervals for rest: Workers shall take intervals for rest (at least half an hour) before 5 working hours

[Special Restrictions]
- Weekly Working Hours: 48 hours/week (in the case of technical reasons)
- Daily Maximum Working Hours: 10 hours/day (including intervals for rest)

(2) Tax Exemption and Duties

The tax system in Myanmar is as follows.

1) Customs duties (import duty) and taxes

In case of import of the construction materials on the subject of tax exemption, customs duties (import duty) can be exempt through the tax exemption procedure in the Customs Department, Ministry of Finance.

For example, regarding steel materials (steel pipe piles, steel sheets, steel bars, etc.) for permanent works, the rate of the customs duty is 1.5% of steel material cost (CIF price and loading charge). Import goods shall collect customs duties and also commercial tax. The basic rate of commercial tax is 5%. If no tax exemption, customs duties and commercial tax have to be paid to the Customs Department, Ministry of Finance.

2) Commercial Tax

Commercial tax is similar to the VAT of other jurisdictions in general. The commercial tax rate of construction materials (concrete, precast concrete, gravel, armour stone, sand, electric cable, piping materials, electric devices, asphalt, etc.) is 5%. To refund the tax, the Contractor is requested to submit the documents specified by the Internal Revenue Department with payment certificate documents (copy of the bank order, excluding general receipt) to the Client. The Client will process to the payment on the amount of the Commercial tax to the Contractor after receiving the required documents. However, in general, payment for fuel (gasoline, diesel, etc.) is small scale individual payment, is not large payment by bank transfer, therefore, it is difficult to claim tax exemption in the case of fuel.

3) Corporate Tax

The corporate tax includes withholding the contractor's tax for Japanese grant aid/Japanese ODA loan project.

However, companies subject to taxation have to pay 25% corporate income tax and 2.0% withholding tax for goods and services in the corporate income tax.

4) Personal Income Tax

In the Japanese grant aid/Japanese ODA loan project, personal income tax can be exempt for Japanese. However, in the case of Burmese people and foreigners who are not Japanese, they are liable to deduct personal income tax from payments of salaries, wages and other remuneration. The progressive taxation rate is 0% to 25% as follows.

Table 2-2-24 Personal Income Progressive Taxation

Annual Salary Income	Progressive Taxation Rate
Less than 2 million Kyat	0%
2 million to 5 million Kyat	5%
5 million to 10 million Kyat	10%
10 million to 20 million Kyat	15%
20 million to 30 million Kyat	20%
More than 30 million Kyat	25%

2-2-4-3 Scope of Works

Major undertakings of construction, procurement and installation to be taken by Japanese and Myanmar side are based on the Japanese Grant Aid scheme as shown in the following table.

Table 2-2-25 Major Undertakings to Be Taken by Both Countries

No.	Item	Japanese Side	Myanmar Side
1	To secure the land		●
2	To clear and level the Project site (The Project site shall be cleared so that the construction work can be started)		●
3	Electric power・water supply from public facilities to the Project site		
	Temporary facilities for construction	●	
	Electric power・water supply after completion of Project		●
4	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in Myanmar and to assist internal transportation of the products.		
	1) Sea transportation of the products from Japan/third country to Myanmar	●	
	2) Tax exemption and customs clearance of the products at the port of delivery		●
	3) Inland transport from the port of delivery to the Project site	●	
5	Tax exemption for project implementation		●
6	To accord Japanese nationals whose services may be required in connection with the supply of products and services and such facilities as may be necessary for their entry into the recipient country and their stay therein for the performance of their work		●
7	To ensure that the facilities and equipment be maintained and used properly and effectively for the implementation of the Project		●
8	To give due environmental and social consideration in the implementation of the Project		●
9	To bear all expenses, other than those covered by the Grant, necessary for implementation of the Project		●
10	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A.		
	1) Advising commission of A/P		●
	2) Payment commission		●

(1) Scope of Japanese Side

The Japanese side conducts the construction and procurement of the equipment related to the jetty, access bridge, revetment, reclamation and access road, and architecture works and installation of cargo handling equipment.

(2) Scope of Myanmar Side

Among the project components, the following are within the scope of the Myanmar side:

1) Provision of Project Components

The Myanmar side is requested to conduct the necessary procedures for EIA and ARAP and provide the necessary area for the execution of the Project (including temporary yard, temporary road, temporary office, etc.)

2) Provision of Environmental Permits

The Myanmar side is requested to provide the Environmental Permits for implementation of the Project.

3) Provision of Building Permit and Construction Permits

The Myanmar side is requested to provide the Building Permit (including Construction Permits) and other permits for the execution of the Project.

4) Removal of Obstacles in the Project Site Area (Preparation for Starting the Construction Work)

On the Myanmar side, the Project site shall be cleared of obstacles so that the construction work can be started. Especially, the existing sunken dredger shall be removed.

5) Electric Power Supply

The Myanmar side is requested to supply the electric power to the tie-in point of the electrical power supply line and provide the permits for the electrical connection of the tie-in point and the electric connection works.

6) Architecture and Utility Works

In the architecture and utility works, the Myanmar side is requested to provide the following.

a. Furniture

The Myanmar side is requested to provide desks, chairs, booklets, and other furniture in the office space.

b. Telephone Facilities

The Japanese side conducts the construction of the terminal board and telephone outlet, and line utilization. 3-line utilization for telephone is considered on the Japanese side, however, telephones and the connection of telephones is provided on the Myanmar side.

c. Network (LAN) Facilities

The Japanese side conducts the supply and installation of the information outlets and installation of pipes and cables, and installation of LAN cable (CAT 6).

The Myanmar side is requested to provide the installation of the network devices, the storing racks, etc.

2-2-4-4 Consultant Supervision

(1) Civil Facilities

For the construction supervisions of the port facilities, resident engineer for the civil works will be assigned at site. Resident engineer shall be civil engineer and port and harbour specialist. A civil engineer of port and harbour, a bridge engineer, and a land civil work engineer under managing by the Project Manager will work in Japan and support to the resident engineer. These engineers will be dispatched to the site time to time accordingly based on the actual work progress and its conditions as necessary.

(2) Architecture Facilities

For the supervisions of building construction works, one resident engineer for building works will be assigned at site. Resident engineer for the building works shall be the architect or building specialist. A structural engineer, electrical and mechanical engineers will also work in Japan and support to the resident engineer. These engineers will also be dispatched the site accordingly.

(3) Cargo Handling Equipment

The procurement of cargo handling equipment is mainly composed of factory fabrication and erections and installation at site. This work is planned to be performed as follows:

1) Factory inspections

Factory inspections of the cargo handling equipment will be conducted only for the custom-made jib cranes. Since the equipment other than the jib cranes are categorized ready-made catalogue products, the quality of the products shall be guaranteed by the equipment maker, therefore the factory inspections will not be conducted.

For the jib cranes, prior to the factory fabrication and/or erection, shop drawings and technical specifications will be requested to submit by the Contractor and reviewed and checked by the Consultant engineer. Work progress of the factory fabrication and/or erection will be inspected mid-term if necessary. When completion of the fabrication and erection of the equipment, final factory inspection will be conducted, whether the equipment quality and functions are satisfied the requirements of the technical specifications or not.

2) Pre-shipment inspection

A third-party engagement is planned for the verification and quantity check of all equipment prior to shipment and also checking for the contract, equipment and material list, shipping documents, packing condition, shipping mark, ODA mark, etc.

3) Supervision of installation work

An Engineer for the supervision of the installation works for jib cranes will be dispatched at site in the beginning stage of installation work and in the arrangement and trial operation stage during installation works.

2-2-4-5 Quality Control Plan

In the Project, the following items shall be considered for quality control.

(1) Observation Management of Soil Filling Works on the Existing Soft Soil Layer

For the construction of the embankment of the access road, due to the existence of the soft soli layer, it is required that the levelling and compaction works shall be conducted less than 10 cm per day.

Therefore, during the execution works, levelling and compaction speed shall be measured and monitored carefully, and also subsoil settlement and embankment deformation will be observed by installing the settlement plates and piles for displacement observations as shown in Figure 2-2-56. The observation shall be conducted in daily basis and the observation results shall be feed back to the construction works of fill sand and stability of the embankment structures during the constructions.

Further details shall be specified and required in the Technical Specifications of the Tender and Contract Documents, and will be confirmed by the submitted documents by the Contractor in the implementation stage.

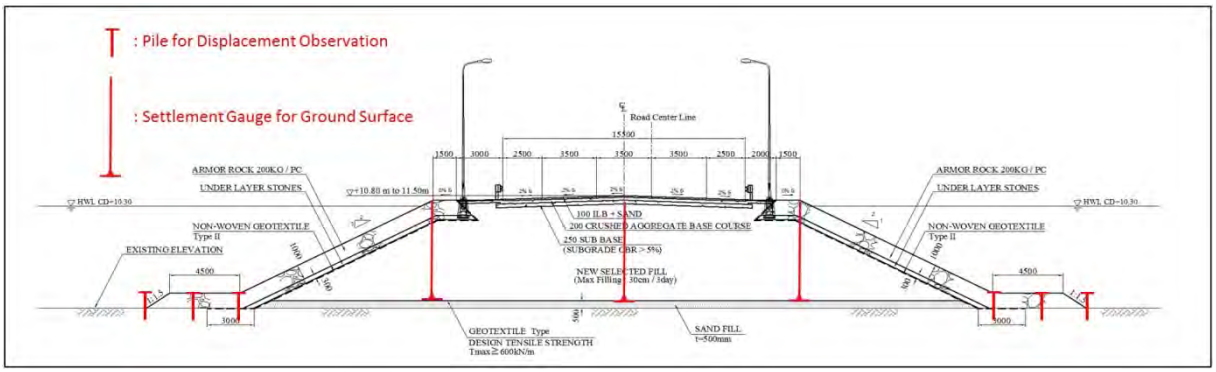


Figure 2-2-56 Stability Management on Movement Observation (Countermeasure Works against Soft Soil Layer)

(2) Management of Final Pile Driving

Piles of the jetty and access bridge foundations shall be driven up to the designed depth in principle. However, in general, actual driving depths at pile tip may not be the same as the designed depth, due to the actual subsoil conditions at each pile driving position. Prior to terminate pile driving, bearing capacity and pulling resistance of pile will be checked and confirmed whether such values are satisfied the design requirements or not. The bearing capacity will be estimated by using Hiley's equation, based on the impact energy determined by the hammer type, weight and stroke, and by measurement of penetration length and rebound of pile when driving (by rebound test).

PDA (Dynamic Loading Test) will be conducted for the three kinds of piles (φ800, φ900 and φ1100 mm) to estimate the bearing capacity.

The rebound test will be conducted in all driving piles for confirmation that they have more than the required designed bearing capacity.

(3) Management of Concrete Placing Quality

The quality of concrete is depended on the type of cement and aggregates, material mix proportions, concrete supply and placing/casting methods and other factors. Mix proportions shall be determined by trial mix test before the starting concrete works at site. The concrete quality shall be ensured by monitoring of weighing records when concrete materials mixing, time for transport (time from water addition to concrete casting at site), and others. Prior to the concrete casting at site, fresh concrete quality such as slump, temperature, salinity shall be tested and checked. Concrete strength shall be monitored by concrete compression test of test pieces which shall be made by concrete sampling in appropriate interval of concrete casting works. Further detailed method and procedures shall be specified and required in the Technical Specifications of the Tender and Contract Documents, and will be confirmed by the submitted documents by the Contractor in the implementation stage.

2-2-4-6 Safety Management Plan

For security during construction, the guard fence for construction will be installed around the planned cargo yard area in the project site and a security box will be constructed near the exit/entrance of the access road. A traffic guide staff will set and control the construction vehicles from/to the existing public road.

During construction on the river, a safety patrol boat is planned to be set for the security and prevention of collisions of construction vessels and general navigation vessels.

The night guard will be set for the piling barge and the planned cargo yard.

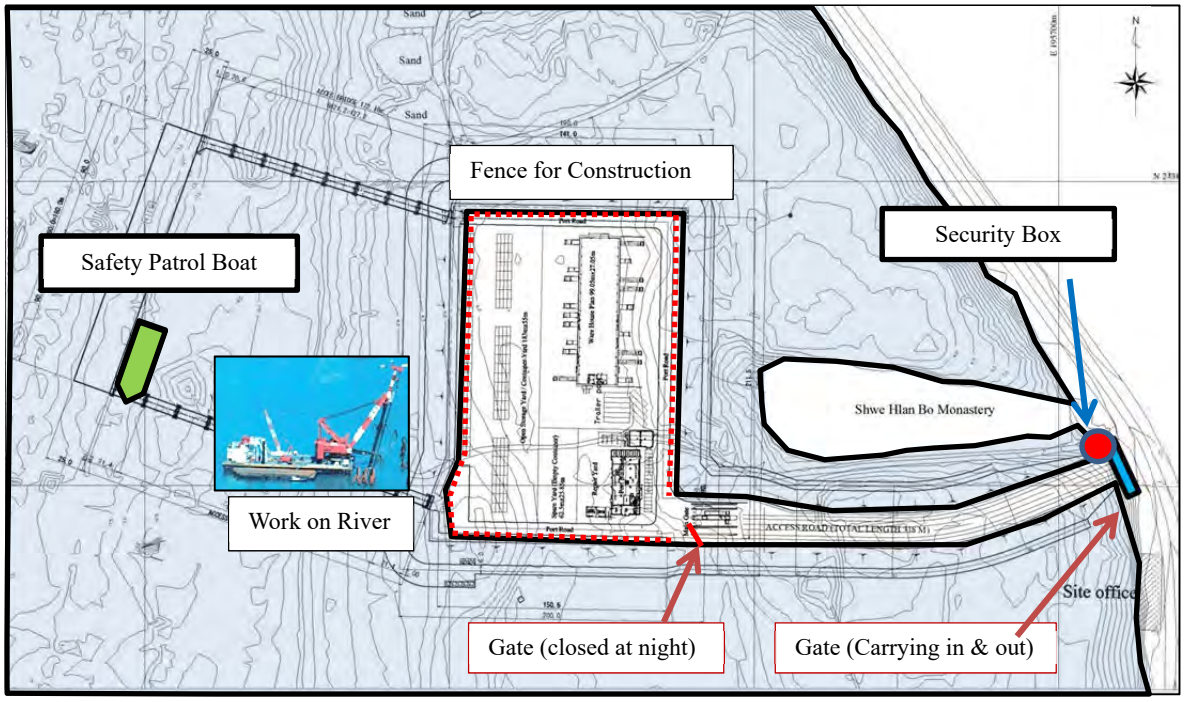


Figure 2-2-57 Facility Plan for Safety Measures (Rainy Season)

2-2-4-7 Procurement Plan

(1) Procurement Method

1) Labour

a. Procurement of Labour

In Myanmar, the engineers and skilled labourers in the construction project are mostly Burmese people. Also, there are many professional engineers and skilled workers.

b. Labour Conditions

The Employment Act in Myanmar is regulated by the "Shops and Establishment Law" and the "Factories Act (Labour and Welfare)". In the implementation of the Project, based on the "Factories Act (Labour and Welfare)", working hours for labourers are as follows.

[Basic Restrictions] (based on Factories Act)

- Weekly Working Hours: 44 hours/week
- Daily Working Hours: 8 hours/day
- Overtime: No restriction
- Intervals for rest: Workers shall take intervals for rest (at least half an hour) before 5 hours working

[Special Restrictions]

- Weekly Working Hours: 48 hours/week (in the case of technical reasons)
- Daily Maximum Working Hours: 10 hours/day (including intervals for rest)

2) Civil Construction Materials

As a basic policy of the Project, construction materials are planned to be purchased from the Myanmar market as much as possible if the quality and the quantity satisfy the requirements. The sources for the procurement of the major materials are summarized in the table below.

Table 2-2-26 Sources for the Procurement of Major Construction Materials

	Materials	Procurement Country			Remarks
		Myanmar	Japan	Third Country	
1	Cement	○	×	-	There are many poor-quality cement sources in the Myanmar market. Careful selection is necessary
2	Concrete	○	-	-	
3	Aggregates	○	-	-	
4	Steel Pipe Pile, Steel Sheet Pile, Mould Steel (H type Steel more than 400mm, L-type Steel more than 100mm, C type steel ore than 150mm)Special size etc.)	×	○	-	Local material is not available.
5	Steel bars (Deformed), Steel plate (6mm in thickness), Mould Steel (H-type Steel 300mm, L-type steel 50mm & 75mm), C type steel 125mm)	○	×	-	
6	Asphalt	○	-	-	
7	Fuel (Petrol・Diesel)	○	-	-	
8	Formwork Material	○	-	-	
9	Fender	×	○	-	Local material is not available.
10	Bollard	×	○	-	Local material is not available.
11	Scaffolding Material	○	-	-	
12	Concrete Joint Material	×	○	-	Local material is not available.
13	Geotextile	×	○	-	Local material is not available.

a. Cement

Local cement companies produce cement in Myanmar, however, the quality of the cement products is uneven. The high quality cement products imported from Thailand are available in the Myanmar market.

b. Concrete

In Mandalay city, three ready-mixed concrete supply companies have concrete batching plants. The distance between the ready-mixed concrete supply company and the Project site is about 6 km and it takes about 30 minutes for transport. The maximum supply capacity of the ready-mix concrete supply company is 60 m^3/day, which can satisfy the demand of the Project.

c. Aggregates, Crushed Stone and Sand

Aggregates, crushed stone and armour stone are available from quarries in Ohn Chaw (Htone Bo Village) and the quarry site is within 25 km and there are about 50 quarries. The reclamation sand can use Ayeyarwady River's sand near the Project site.

d. Steel Materials (Reinforcing Bars, Steel Pipe Piles, Steel Materials)

The reinforcing bars, steel pipe piles, and steel material is available in Myanmar, however, the producing country is China and other countries, and the quality is poor and unreliable. Moreover, there are no large-diameter steel pipe piles and steel sheet piles.

Considering to a large amount of steel materials cannot be procured securely in Myanmar and SS and SM grade steel beam elements are required to be high quality, therefore, the large-diameter steel pipe piles, steel sheet piles and composite beam elements (shaped steel, steel sheet and round steel) are planned to be procured from Japan.

e. Fuel and Lubricants

Fuel and lubricants are planned to be purchased in Myanmar.

f. Port Materials

Port materials, such as mooring bits, fenders, etc., are procured from Japan

g. Others

Oxygen, fence and others are purchased from Myanmar.

3) Civil Construction Equipment

The sources for the lease of the major construction equipment necessary for the execution works are summarized in the table below.

Table 2-2-27 Source of the Major Equipment Procurement

	Equipment	Source			Remarks
		Myanmar	Japan	Third Country (Singapore)	
1	Bulldozer	○	-	-	
2	Excavator	○	-	-	
3	Vibro Roller	○	-	-	
4	Tier Roller	○	-	-	
5	Truck	○	-	-	
6	Motor Grader	○	-	-	
7	Truck Crane	○	-	-	
8	Crawler Crane	○	-	-	
9	Hydraulic Pile Driver	○	-	-	
10	Electric Welder	○	-	-	
11	Generator	○	-	-	
12	Air Compressor	○	-	-	
13	Barge	○	-	-	
14	Tugboat	○	-	-	
15	Concrete Vibrator	○	-	-	
16	Vibration Hammer	○	-	-	
17	Hydraulic Hammer	-	-	○	Local equipment is not available.
18	Crane Barge (70-100 t)	-	-	○	Local equipment is not available.
19	Crane Barge (35-45 t)	○	-	-	
20	Sand Compaction Pile Driver	-	○	-	Local equipment is not available
21	Wheel Loader (Tilting Function)	-	○	-	Local equipment is not available

4) Architecture Material and Construction Material

The required main construction materials in the architecture works, Myanmar products as well as imported from neighbouring countries, are commonly available in the Myanmar market. Cement, aggregates, steel bars and formwork materials are also available in the market. Ready-mixed concrete is available in Mandalay city from the several supply companies.

Myanmar and/or other third countries products of tiles, paints, aluminium products for interior/exterior works, lighting fixtures, switches, ceiling fans, electrical line/cables, pipes, sanitary fixtures, pumps, water storage tanks, switch boards, and others for utility works, are available in the Myanmar market. The floor inspection ports, the inspection holes of the ceiling and the cast iron-made products are generally not available in the Myanmar market. If they are available in the local market, but quality and durability of these products are poor, therefore, those materials are planned to be procured from Japan.

The sources for the procurement of the major materials and equipment for the building works are summarized in the table below.

Table 2-2-28 Sources for Procurement of Major Materials and Equipment

Material/Equipment	Source			Source Country
	Myanmar	Japan	Third Country	
Material				
Portland Cement	○	-	-	Myanmar
Aggregate for Concrete	○	-	-	Myanmar
Deformed Bar	-	○	-	Myanmar
Formwork Material	○	-	-	Myanmar
Concrete Block	○	-	-	Myanmar
Wood Material	○	-	-	Myanmar, Import from Neighbouring Country
Metallic Article	○	○	-	Import from Neighbouring Country, USA, Europe Floor inspection hole, grating, cast iron product from Japan
Aluminium Sash	○	-	○	Myanmar and Neighbouring Country
Glass	○	-	○	Myanmar and Neighbouring Country
Paint	○	-	○	General paints shall be used Myanmar products
Waterproof Material	○	-	○	Myanmar and Neighbouring Country
Switch Board	○	-	○	Myanmar and Neighbouring Country
Electric Line, Cable	○	-	○	Myanmar and Neighbouring Country
Conduit Pipe	○	-	○	Myanmar and Neighbouring Country
Lighting Fixture	○	-	○	Myanmar and Neighbouring Country
Air Conditioner	○	-	○	Import from Neighbouring Country
Ventilating Fan	○	-	○	Import from Neighbouring Country
Receiving Tank	○	-	○	Import from Neighbouring Country
Sanitary Fixture	○	-	○	Import from Neighbouring Country
Waste Water Treatment Equipment	○	-	○	Myanmar and Neighbouring Country
Pipe	○	-	○	Myanmar and Neighbouring Country
Valve, Piping Appurtenance	○	-	○	Import from Neighbouring Country, USA, Europe
Electric Pole (Concrete, Wooden Pole)	○	-	-	Myanmar
Generator	○	-	○	Import from Japan, India, China

Material/Equipment	Source			Source Country
	Myanmar	Japan	Third Country	
Construction Equipment				
Shovel Bulldozer	○		○	Import from Neighbouring Country, USA, Europe
Excavator	○		○	Import from Neighbouring Country, USA, Europe
Dump Truck	○		○	Import from Neighbouring Country, USA, Europe

5) Construction Equipment for Building Works

Construction equipment is able to be leased in Myanmar without problem.

(2) Procurement of Cargo Handling Equipment

In conformity with the project concept that the port will be modernized by introducing equipment cargo handling operations, cargo handling equipment is one of the important components of the Project. Therefore, the equipment to be procured shall be reliable and have sufficiently high performance and high quality.

From the viewpoint of the competitiveness in tender and quality securing, the equipment is planned to be procured from Japan or from third countries except jib crane which is the most important equipment in the Project. In order to avoid poor quality equipment offers by the tenderers, conditions of procurement are carefully considered. Eligible source countries of the equipment are planned to be limited to Japan and DAC member countries or appropriate.

Table 2-2-29 Sources of the Major Equipment Procurement

No.	Equipment	Source		
		Myanmar	Japan	Third Country
1	Jib Crane	-	○	-
2	Rough Terrain Crane	-	○	○
3	Reach Stacker	-	○	○
4	Forklift	-	○	○
5	Tractor	-	○	○
6	Chassis	-	○	○

(3) Operational Guidance Plan

Initial guidance for operation and management (O & M) of the building facilities and equipment are planned to be provided by the Contractor and/or equipment supplier before being taken over by the Myanmar side. IWT is requested to assign their relevant staff to attend the O & M guidance.

2-2-4-8 Soft Component Plan

Soft components are not conducted in this Project. Assistance for the port operation and maintenance is planned to be fulfilled by Japan's Technical Cooperation Project which was requested by the Government of Myanmar.

2-2-4-9 Implementation Schedule

The implementation schedule is as shown below. The necessary period is estimated 32 month including tender period, 4.5 month for detailed design, 3.5 month for tender process and 24 month for constructions of the civil and building facilities including procurement and installation of the equipment.

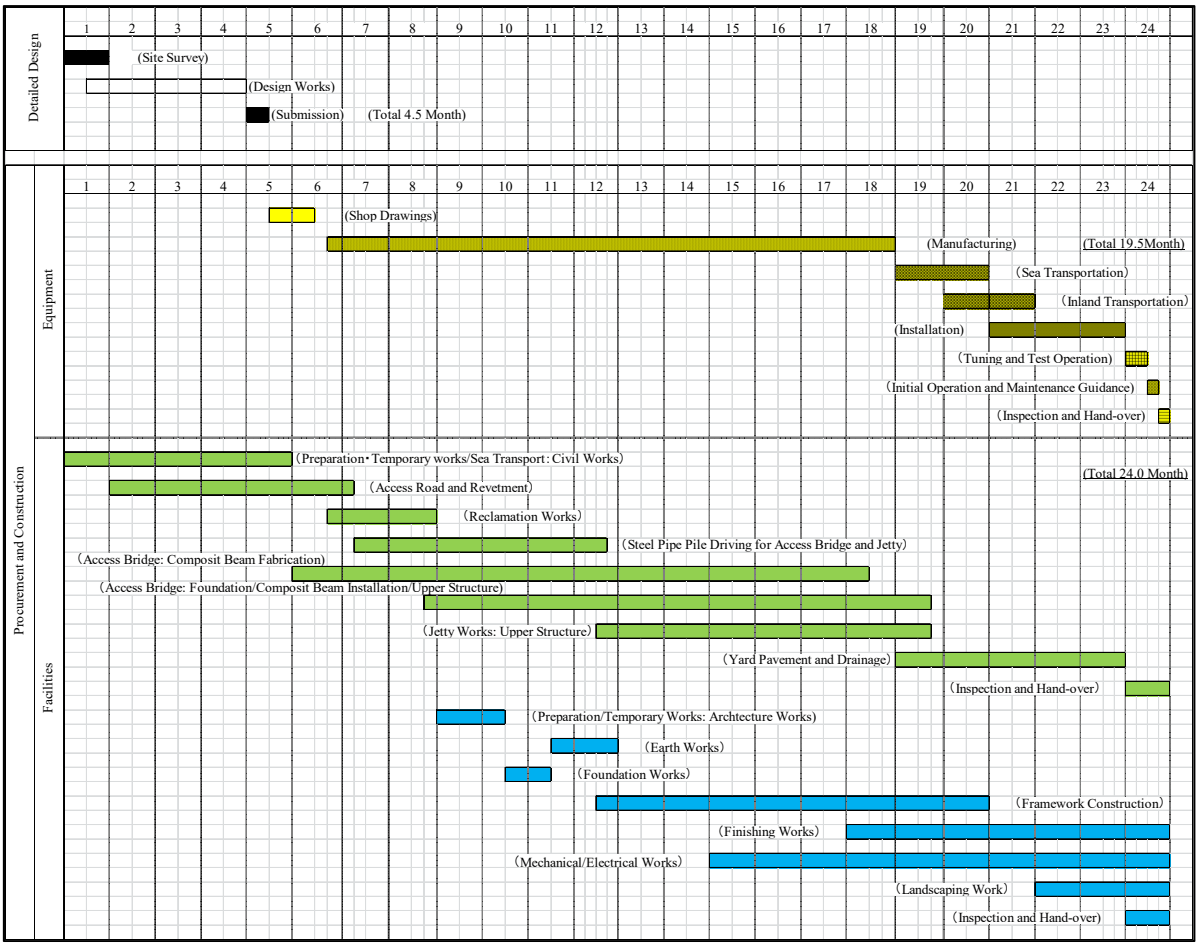


Figure 2-2-58 Implementation Schedule

2-3 Obligations of Recipient Country

In the preparatory survey for the Project, the Myanmar side and the Japanese side confirmed that the following matters are Myanmar side obligations under the Project.

2-3-1 Before Construction

(1) Land Acquisition

Land for the Project, including the area for the temporary yard, shall be obtained by the Government of Myanmar. No involuntary resettlement is expected in this project. However, three plots of agricultural land, approximately 15.6 acres in total, approximately 9.2 acres of crops (i.e. butter beans, and peanuts), seven huts, and one ship are expected to be affected by the land acquisition for the project.

It is important that the Myanmar side (project proponent, i.e. DWIR) provides adequate and sufficient compensation and support to the PAPs in consideration of their livings, the value of the land and other assets that are to be lost due to the project and relevant laws and regulations in Myanmar in order to relieve the tension and stress of the project on the people.

The level of compensation also needs to meet the standard requirement of JICA as the project is expected to be carried out using its grant aid scheme.

Land acquisition shall be completed on or before the tender announcement of the Project.

(2) Environmental Approval

IEE report for the Project was submitted to MONREC from MOTC in September 2017. DWIR, as well as MOTC, is requested to obtain the IEE approval by MONREC. The land for the Project shall be acquired prior to the tender announcement, IEE approval shall be obtained as early as possible, preferably before the E/N signing.

(3) Construction and Execution Permit

In addition to the environmental approval, the Myanmar side is requested to obtain necessary permits for the construction works.

(4) Site Clearance

The land for the project shall be ready to implement works by the Japanese Contractor. Any obstructions shall be removed and cleaned by the Myanmar side as the site clearance. In the project area, there is a sunken ship, as shown in Photo 2-3-1. This ship shall be removed by the Myanmar side prior to the construction works by the Contractor.

Photo 2-3-1 Sunken Ship in the Project Area

2-3-2 During Construction Works

(1) Power Supply

Electrical power supply and connection works, which are generally conducted by the Electrical Power Supply Company, at the tie-in point are the Myanmar side's obligation. Necessary administrative procedures and cost shall be borne by the Myanmar side.

(2) Project Components Shall Be Borne by the Myanmar Side

The following works and facilities are not included in the scope of the Grant.

1) Furniture

Desk and chair, bookshelves and other furniture and other interior belongings are requested to be provided by the Myanmar side.

2) Telephones

The Japanese side will provide MDF in the port office/warehouse, cable placed from the connection point to the MDF, IDF and telephone outlet, including cabling and wiring to each room.

Connection to the city lines and provision of and connection with the telephone devices and/or PABX shall be in the scope of the Myanmar side.

3) LAN

Similar to the telephones, MDF and wiring are provided by the Japanese side. LAN devices and installation rack and connections to the provider shall be in the scope of the Myanmar side.

(3) Tax Exemption

Customs duties and taxes shall be exempted.

(4) Bank Fees

Bank fees for banking arrangements, advising commission of A/P and payment commission for A/P shall be borne by the Myanmar side.

(5) Temporary Yard for Site Office

The temporary yard on the south side of the reclamation area is necessary for the construction works of the revetment, including soil improvement against soil liquefaction and partially identified soft subsoils. Construction of the revetment shall be completed during the dry season where the construction area is under dry conditions. The Myanmar side is requested to obtain the land for the temporary yard as well as necessary permission to use the land.

The port area will be created by land reclamation inside the constructed revetment. After completion of the land reclamation, the temporary yard will be provided in the reclaimed land area.

(6) Environmental Monitoring

During the construction works, the Myanmar side is requested to conduct environmental monitoring by using the monitoring form which was prepared during the preparatory survey period, and report to the JICA Myanmar office.

2-3-3 After Handover of the Project

(1) Operation and Maintenance

Facilities and equipment provided by the Project shall be effectively used by the recipient country. For the operation and maintenance of the new port, MOTC decided that DWIR will be the owner of the facility and IWT will be organization responsible for port operation and maintenance.

IWT expressed that they will establish an organization, the "River Port Operational Department", for the operation and management of the new port as well as the development and modernization of the inland water transportation of the country.

The Study Team recommended IWT should aim to operate the new port with independent profitability by about three years from its opening. Important tasks for IWT to achieve this target are to ensure the organization for operation, and budgetary measures to support the initial 1 to 2 years of operation. A model plan of the organization and estimated budget are recommended during the Study[5] and outlines are presented in "2-4-4 Recommendations for Operation and Maintenance by the Study Team.

In addition to the above, to provide smooth and efficient cargo handling services in the terminal area, the Myanmar side is recommended to provide pallets, welding machine, gas-cutting machine, overhead travelling crane in the workshop and chain block, and 2 ton trucks and others which are not covered by the Grant.

2-3-4 Banking Arrangement and Authorization to Pay

According to the Japanese Grant Aid scheme, the following arrangements are requested.

(1) Banking Arrangements (B/A)

The Government of Myanmar or its designated authority is requested to open an account under the name of the Government in a bank in Japan. JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of Myanmar or its designated authority under the Verified Contracts.

(2) Authorization to Pay (A/P)

The Government of Myanmar or its designated authority is requested to issue the Authorization to Pay (A/P) to the bank in Japan, in which the account under the name of the Government is opened. The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of Myanmar or its designated authority.

The Government of Myanmar is requested to bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

[5] The recommendation was made by the letter attached in "8-2 Recommendation on the Port Management and Operation" in Appendix 8.

2-4 Project Operation and Maintenance Plan

2-4-1 Important Tasks for Operation and Maintenance

The government of Myanmar shall have the responsibility of operation and maintenance for the port facilities completed by Japan's grand aid project, including establishing organization and budgetary measures. MOTC decided that DWIR will be the owner of the facility and IWT will be the organization responsible for port operation and maintenance. However, IWT is not experienced in the operation of a modernized port which handles cargoes by means of heavy equipment. Through the discussions between the Study Team and the Myanmar side, IWT expressed its plan to establish a new department (River Port Operational Management Department) in its organization.

The Study Team recommended IWT should aim to operate the new port with independent profitability by about three years from its opening. Important tasks for IWT to achieve this target are to ensure the organization for operation, budgetary measures to support the initial 1 to 2 years of operation, and a careful estimate of each rate of service charges which forms the revenue of IWT, etc.

For this initial operation of the facilities, the Myanmar side has already requested a technical assistance program from the Japanese government. The recommendations explained in this report are also based on this point.

2-4-2 Possibility of Japanese Private Sector Participation

For the management style to involve a private (possibly Japanese) firm, several options for management method might be applied: 1) public competitive bidding calling for private operator, 2) nominated competitive bid for the partner of IWT as the port operator, or 3) knowledge transfer of Japanese private operators/cargo forwarders by executing JICA's scheme of "technical assistance" in which private experts are involved.

In order to encourage participation of Japanese private firms, the above option 2) limiting nominated bidders for Japanese firms seems to be practical. However, most Japanese operators, according to the interviews carried out by the Study Team, do not intend to participate.

On the other hand, IWT as the agency of new port operation has expressed its strong intention for inviting Japanese private operators which have high-standard skills and knowledge. It is quite important to organize an appropriate Japanese technical assistance plan for Mandalay port operation, in which the appropriate management systems should be established so that a Japanese private operator will have enough profit.

2-4-3 Required Tasks for Myanmar Side on Port Operation

As a mandate condition for a Japanese grant aid project, the recipient country, Myanmar, shall take responsibilities to manage and operate the funded facilities. During the second survey trip to Myanmar, the Study Team explained the basic required tasks for IWT for port management and operation, and requested to make its own decision how such tasks can be dealt with by itself. From this viewpoint, the Study Team made the material for discussion regarding practical tasks for preparation of port management by IWT, and IWT and the Study Team exchanged opinions on it[6].

[6] Material for discussions is refer to "8-1 Discussion Paper on Management and Operation of Mandalay Port" in Appendix 8.

(1) Port Management Model

The Study Team showed and explained to IWT the following 4 management model options which referred to the "Port Reform Tool Kit, WB".

Table 2-4-1 Port Management Model

Type of Management	Infrastructure	Equipment	Port Labour	Example
Public Service Port	Public	Public	Public	Colombo, JN, Dar es Salaam
Tool Port	Public	Public	Private	Chittagong
Landlord Port	Public	Private	Private	Rotterdam, Antwerp, New York, Singapore (MITT Yangon)
Private Service Port	Private	Private	Private	Ports in UK, New Zealand (Semeikhon)

In accordance with Japan's grand aid scheme, the Myanmar government side IWT needs to undertake responsibility of management and operation of the given facilities. In addition, the provided facilities will be for the domestic port, therefore, port fees should be kept at a reasonably lower level taking into consideration the protective measure for concerned local transport businesses. From this policy, immediate application of the "Landlord Port" style is thought to be unsuitable because it would introduce a private concessionaire that requires enough profit from the port operation. During the discussion, the Study Team recommended to the Myanmar side IWT either "Public Service Port" or "Tool Port" as the preferable options.

(2) Decision of Myanmar Government

Following the discussions between the JICA Study Team and the Myanmar side, the government of Myanmar, represented by MOTC, DWIR and IWT, discussed further and the written document explaining the government decision was issued to JICA in September 2017[7]. Such decisions are as below.

1) The new port will be operated taking the style of a "Tool Port".

2) DWIR will be responsible for port construction, and IWT will be responsible for port operation and maintenance.

3) The "Port Management Committee" will be organized for port management and operation. The members of the committee are DWIR, IWT, DMA and MRG (not permanent).

4) DWIR will be the port owner.

5) IWT will undertake port operation and maintenance.

2-4-4 Recommendations for Operation and Maintenance by the Study Team

With the careful examination of the decision of the Myanmar side, the Study Team sent the following recommendations by written document to the Myanmar side[8].

[7] Refer to "5-3 DWIR Letter for Port Operation and Management Method". Two letters were received. The first one was dated June 7, 2017, however the letter was received by e-mail on September 7, 2017.

[8] Refer to "8-2 Recommendation on the Port Management and Operation" in Appendix 8.

(1) Organization

Taking into consideration the decision of the Myanmar side that IWT will undertake port operation with the style of "Tool Port", the Study Team recommended organization as shown in Figure 2-4-1. The organization recommendation was made carefully referring to the existing organization of local government port bureaus and the public company for port management in Japan, the organization of MPA, and information about further overseas port organizations found on the internet.

- The "River Port Operational Department", newly organized in IWT, is recognized as undertaking total management of all national river ports which will be developed in the future, including Mandalay port. 7 staff members are recommended at the time of establishment.

- IWT will establish the "Mandalay Port Office" at the new Mandalay port. The required number of staff at the time of port opening is estimated at 32 members.

- In order to avoid unforeseen unemployment problems caused by commencing cargo handling by means of mechanical equipment, it is proposed to employ existing port workers.

(2) Budget

The Study Team recommended that IWT should aim to operate the new port with independent profitability by about three years from its opening. In the initial period of port operation, it will need budgetary support from the government. The actual budget figures are estimated and the following recommendations were informed to the Myanmar side.

- It is recommended that the government support the expenses for 1) staff salaries during the preparation and initial period of port operation, 2) procurement of equipment/materials for opening, and 3) operational expenses. From second year after opening, the cost of operation should become gradually covered with the operational income, and the government support should be decreased.

- During FY 2018~2020, the number of staff employment will start with 7 members and it will be increased to 39 members by the middle of 2021.

- The initial cargo volume of the port is assumed to be approximately 100,000 tons, and it will be increased by 50,000 tons per year. It is planned to start day and night work when the cargo handling volume exceeds 200,000 tons per year, assuming cargo handling work only in the daytime at the beginning of port opening.

- For the initial government budget, staff salary costs, office furniture, workshop equipment, 2 ton trucks, warehouse equipment and 2,300 pallets, etc., are the main procurement items.

- As a selection option, if the government promotes the early introduction of container transportation, a method of purchasing container units for Mandalay Port and low price leasing to shippers/carriers is proposed. Government budget amount necessary for container unit purchase is as follows.

    - Quantity: 20' container, 150 units x 2 sets, assuming full loaded capacity of 2,000 ton barge. In total, 300 units of 20' container.

    - Budget: 300 x 1,500 USD = 450,000 USD (612,000,000 MMK)

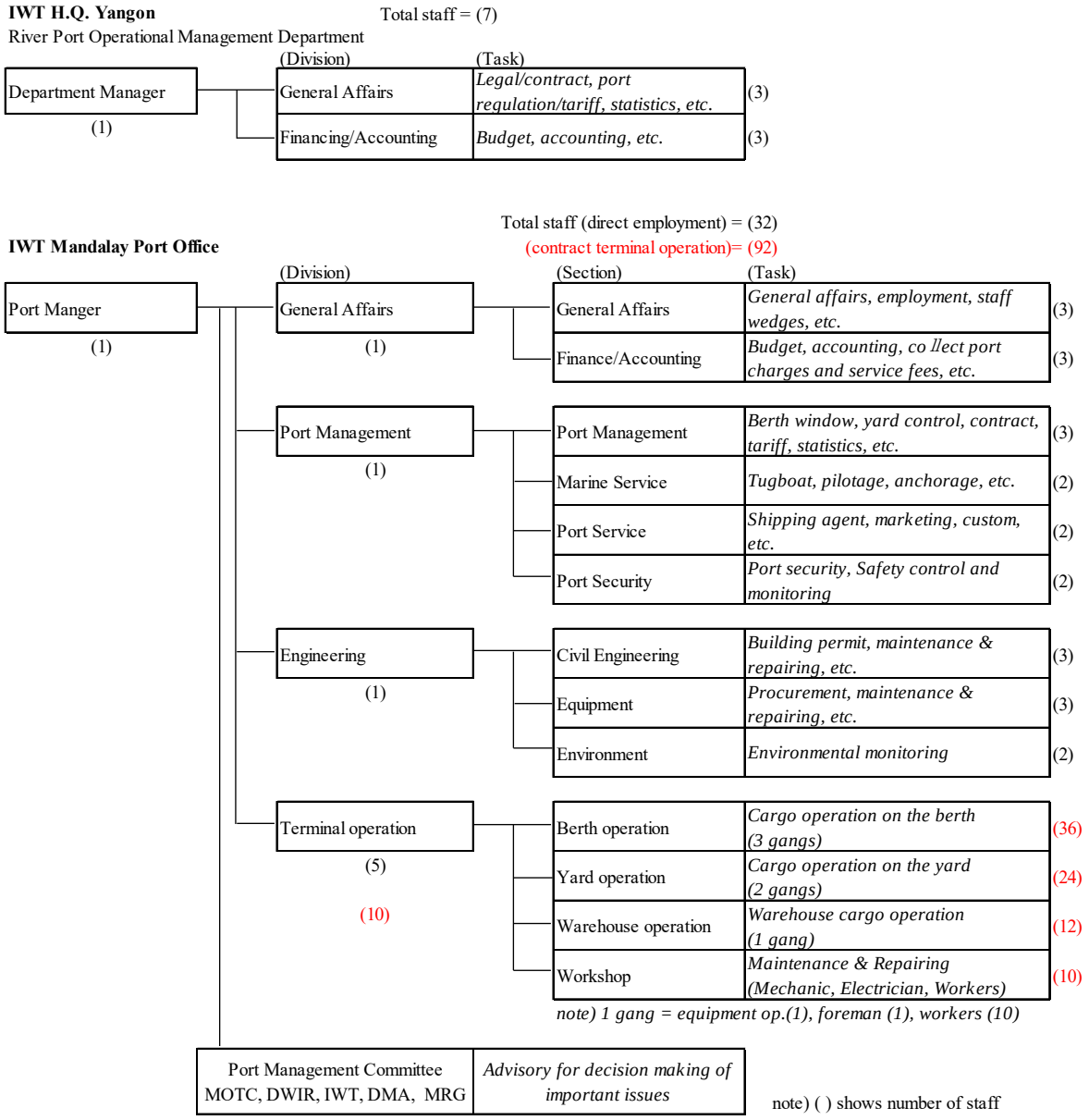


Figure 2-4-1 Organization for Mandalay Port (Proposal)

2-4-5 Operation and Maintenance of the Port Facilities and Cargo Handling Equipment

For the operation and maintenance of the port facilities and cargo handling equipment, some Japanese manual examples are presented hereunder as reference to conduct operation and maintenance after completion of the Project.

(1) Port Facilities

1) Jetty

In the Japanese manual, the key points of the operation and maintenance for the Jetty structure is organized as follows:

4.4 Process of expansion of the damage at the jetty and key points of the operation and maintenance

① Concerning to the operation and maintenance of the jetty, the inspection, diagnosis and evaluation should be conducted considering structural type, environmental factors and process of expansion of the damage. In addition, required countermeasures should be conducted appropriately based on such consideration.

② The damages causing at the structural factors of the Jetty structure have reciprocal relation to each other. Thus, the inspection diagnosis should be selected considering the process of expansion of the damage. Moreover, items and methods of the inspection diagnosis should be efficient and effective.

③ Effect to the facility performance should be evaluated appropriately based on the result of the inspection diagnosis of the jetty. Necessity of the countermeasures should be evaluated considering level of the operation and maintenance, priority, operation period, utilization status and future plans of the facilities, environmental conditions, and life-cycle-cost.

④ In case the result of the evaluation required countermeasures, the countermeasure methods and its implementation schedule should be decided based on comprehensive considerations of performance improvement of the facilities, economy, workability, environmental conditions, and impact to the loading activities.

Source: Operation and maintenance manual for the port facilities, 2007

Inspection items, methods and evaluation criteria for the jetty are as shown in Table 2-4-3. In the table, the meaning of evaluation indices a, b, c, and d are as shown in the following Table 2-4-2.

Table 2-4-2 Inspection Evaluation Indices

Level of deterioration	Conditions of Structural Members
a	Member performances are remarkably deteriorated.
b	Member performances are deteriorated.
c	Member performances are not found but deformed
d	Any deterioration and deformation are not identified.

Table 2-4-3 Inspection Items, Methods, and Evaluation Criteria for Jetty (Reference)

Facility		Inspection Item	Inspection Method	Criterion (Draft)	
Jetty	Alignment of jetty	Unevenness, Gap between neighboring upper structure	Visual Inspection ・Subsidence Volume ・Movement Volume	a	☐ There is unevenness, over 20cm, between its neighboring upper structure.
					☐ There is an ongoing deformation.
				b	☐ There is unevenness, approximately 10 ~ 20cm, between its neighboring upper structure.
				c	☐ There is unevenness, less than 10cm, between its neighboring upper structure.
				d	☐ There is no strange change.
	Apron	Gap and crack on the concrete pavement	Visual Inspection ・Gap/ Unevenness ・Large Gap ・Stain	a	☐ There is a gap, collapse, or a crack which is dangerous for drive.
					☐ There is a gap which is over 15mm.
					☐ There is an unevenness which is over 50mm.
					☐ There is a crack which width is over 3mm.
				b	☐ There is a gap which is over 10~15mm.
					☐ There is unevenness which is over 20~50mm.
					☐ There is a crack which width is less than 3mm.
				c	☐ There is a gap which is less than 10mm.
					☐ There is unevenness which is less than 20mm.
					☐ There is a slight crack.
				d	☐ There is no strange change.
	Superstructure (Lower Surface)	Deterioration/ Damage of the Concrete	Visual Inspection ・Direction of the crack ・Number of the cracks ・Length and width of the crack ・Delamination status of the covering concrete ・Status of the rust stain ・Rusting status of the steel	a	Slab
					☐ Mesh-patterned cracks cover over 50% of the surface.
					☐ There is a delamination of the covering concrete.
					☐ The rust stain caused widely.
					Beam & Haunch
					☐ There is a crack, which width is over 3mm, toward the rebar axis.
					☐ There is a delamination of the covering concrete.
					☐ The rust stain caused widely.
				b	Slab
					☐ Mesh-patterned cracks covers less than 50% of the surface.
					☐ The rust stain caused partly.
					Beam & Haunch
					☐ There is a crack, which width is less than 3 mm, toward the rebar axis.
					☐ There is dot type rust stain.
				c	Slab
					☐ There is a crack in one direction; or there are band-type or line-type of cement gel precipitates.
					☐ There is dot type rust stain.
					Beam & Haunch
					☐ There is a crack only toward vertical to the axis.
					☐ There is dot type rust stain.
				d	☐ There is no strange change.
	Superstructure (Side Surface)	Deterioration/ Damage of the Concrete	Visual Inspection ・Crack, ・Delamination/ Damage, ・Corrosion of the rebar ・Deterioration sign	a	☐ There is a damage which may affect to performance of the mooring quaywall.
				b	☐ There is a crack which width is over 3mm.
					☐ The rebar widely exposes on the surface.
				c	☐ There is a crack which width is less than 3mm.
					☐ The rebar partially exposes on the surface.
				d	☐ There is no strange change.
	Steel Pile	Corrosion, a crack, and damage of the steel	Visual Inspection ・Pitting ・Corrosion at water surface ・Status of surface damage	a	☐ There is pitting, a deformation or remarkable damage due to corrosion.
				b	☐ There is pitting near the LWL.
					☐ The rust stain caused widely.
				c	☐ The rust stain caused partially.
				d	☐ There is stain; however, there is no rust stain, pitting or damage.
	Mooring Bitt	Damage of the main body, Situation of the paint	Visual Inspection ・Damage, Deformation ・Status of paint	a	☐ The mooring bitt has difficulty in operation due to collapse or damage.
				b	
				c	☐ There is damage, a deformation, or a delamination of the paint.
				d	☐ There is no strange change.
	Fender	Damage and collapse of the main structure, Status of the joint metal parts	Visual Inspection ・Damage of the rubber part ・Rust stain and damage of the joint metal parts	a	☐ Main structure (rubber): There is chip or a permanent deformation.
					☐ Joint metal parts: There is a looseness, a lack, a deformation or a cut.
				b	
				c	☐ Main structure (rubber): There is collapse, a crack, or chip.
					☐ Joint metal parts: There is rust stain.
				d	☐ There is no strange change.
	Ladder	Damage of the main structure, Status of plating, Corrosion status	Visual Inspection ・Damage, deformation ・Paint status ・Corrosion status	a	☐ There is a lack.
					☐ The ladder has difficulty in operation due to damage or corrosion.
				b	
				c	☐ The main structure has damage or a deformation. There is a delamination or rust stain on the paint.
					☐ There is a delamination or rust stain on the paint.
				d	☐ There is no strange change.
	Vehicle Stopper/ Guard Fence	Damage of the main structure, Status of plating, Corrosion status	Visual Inspection ・Damage, deformation ・Plating status ・Corrosion status	a	☐ There is a lack.
					☐ There is damage or a deformation which may affect to the performance.
				b	
				c	☐ The main structure has damage or a deformation. There is a delamination or corrosion on the surface.
				d	☐ There is no strange change.

2) L-shape Revetment

Concerning the L-shape revetment which is used as a slope protection of the on-land yard, the key points of the operation and maintenance are as follows:

> *3.2 Process of expansion of the damage and key points of the operation and maintenance*
>
> *① Concerning the operation and maintenance of the protective facilities for harbours, the inspection, diagnosis and evaluation should be conducted considering structural type, environmental factors and process of expansion of the damage. In addition, required countermeasures should be conducted appropriately based on such considerations.*
>
> *② The damages causing the structural factors of the protective facilities for harbours have a reciprocal relation to each other. Thus, the inspection diagnosis should be selected considering the process of expansion of the damage. Moreover, items and methods of the inspection diagnosis should be efficient and effective.*
>
> *③ Effect to the facility performance should be evaluated appropriately based on the result of the inspection diagnosis of the protective facilities for harbours. Necessity of the countermeasures should be evaluated considering the level of the operation and maintenance, priority, operation period, utilization status and future plans of the facilities, environmental conditions, and life-cycle-cost.*
>
> *④ In case the result of the evaluation required countermeasures, the countermeasure methods and their implementation schedule should be decided based on comprehensive considerations of a performance improvement of the facilities, economy, workability, environmental conditions, and impact to the loading activities.*
>
> *Source: Operation and maintenance manual for the port facilities, 2007*

Inspection items, methods and evaluation criteria for the L-shape revetment are as shown in Table 2-4-4.

Table 2-4-4 Inspection Items, Methods, and Evaluation Criteria for L-shape Revetment (Reference)

Facility		Inspection Item	Inspection Method	Criterion (Draft)	
Revetment	Movement		Visual Inspection (including measuring check) ・Movement volume	a	☐ There is a deviation, which is over 20cm, between its neighboring span.
					☐ There is a deformation of the alignment which may affect to performance.
				b	☐ There is a deformation of the alignment.
					☐ There is a deviation, which is approximately 10 ~ 20cm, between its neighboring span.
				c	☐ Other than above; there is a deviation, which is less than 10cm, between its neighboring span.
				d	☐ There is no strange change.
	Subsidence		Visual Inspection ・Subsidence of the revetment	a	☐ Remarkable subsidence (approximately 1m) can be seen even though by the visual inspection.
				b	☐ There is a gap, which is several 10cm, between its neighboring span.
				c	☐ There is a gap, which is several centimeter, between its neighboring span.
				d	☐ There is no strange change.
	Main structure	Deterioration or damage of the concrete	Visual Inspection ・Crack ・Delamination, Damage, Lack ・Deterioration sign	a	☐ There is a deviation, a crack or damage which may cause suction of the backfilling material.
				b	☐ There is a crack, which width is approximately 3mm, toward multiple direction.
					☐ The rebar widely exposes on the surface.
				c	☐ There is a crack, which width is approximately 3mm, toward one direction.
					☐ The rebar partially exposes on the surface.
				d	☐ There is no strange change.
	Back of the revetment, or main structure of the revetment	Collapse, soil suction	Visual Inspection (Subsidence, Collapse, Deviation of the joint, etc.) ・Status of back of the revetment ・Gap or deviation of the joint	a	☐ There is soil suction from the back of the revetment.
					☐ There is ground collapse at back of the revetment.
				b	☐ The joint of the revetment has a remarkable gap or a deviation.
				c	☐ The joint of the revetment has a slight gap or a deviation.
				d	☐ There is no strange change.
	Drainage	Damage at the drainage facilities, Deformation or rusting of the grating	Visual Inspection (including measuring check) ・Clogging of the ditch ・Damage, Deformation ・Rusting of the grating	a	☐ There is damaged part at the ditch or the catch basin.
					☐ The ditch or the catch basin is clogged with the soil.
					☐ There is a lack of the grating.
					☐ The drainage facilities are our of order due to a remarkable deformation or rusting of the grating.
				b	
				c	☐ There is a deformation or rusting of the grating.
				d	☐ There is no strange change.

3) Access Bridge

The bridge type of the access bridge is a combination of a pier and a composite girder. The key points of the operation and maintenance of the access bridge are as follows:

> *5.2 Process of expansion of the damage and key points of the operation and maintenance*
>
> *① Concerning the operation and maintenance of the port transport facilities, the inspection, diagnosis and evaluation should be conducted considering structural type, environmental factors and process of expansion of the damage. In addition, required countermeasures should be conducted appropriately based on such considerations.*
>
> *② The port transport facilities contain roads (paved roads), bridges, and tunnels. Thus, a study on the inspection diagnosis of the port transport facilities should be selected considering items and methods which are efficient and effective.*
>
> *③ Effect to the facility performance should be evaluated appropriately based on the result of the inspection diagnosis of the port transport facilities. Necessity of the countermeasures should be evaluated considering the level of the operation and maintenance, priority, operation period, utilization status and future plans of the facilities, environmental conditions, and life-cycle-cost.*
>
> *④ In case the result of the evaluation required countermeasures, the countermeasure methods and their implementation schedule should be decided based on comprehensive considerations of performance improvement of the facilities, economy, workability, environmental conditions, and impact to the loading activities.*
>
> *Source: Operation and maintenance manual for the port facilities, 2007*

Inspection items, methods and evaluation criteria for the substructure and superstructure of the access bridge are as shown in Table 2-4-5 and Table 2-4-6, respectively.

Table 2-4-5 Inspection Items, Methods, and Evaluation Criteria for Substructure Work of the Access Bridge (Reference)

Facility		Inspection Item	Inspection Method	Criterion (Draft)		
Bridge pier	Superstructure	Deterioration/ Damage of the Concrete	Visual Inspection ・Crack, ・Delamination/ Damage, ・Corrosion of the rebar ・Deterioration sign	a	□	There is a damage which may affect to performance of the mooring quaywall.
				b	□	There is a crack which width is over 3mm.
					□	The rebar widely exposes on the surface.
				c	□	There is a crack which width is less than 3mm.
					□	The rebar partially exposes on the surface.
				d	□	There is no strange change.
	Steel pipe	Corrosion, crack, and damage of the steel	Visual Inspection ・Pitting ・Corrosion at water surface ・Status of surface damage	a	□	There is pitting, a deformation or remarkable damage due to corrosion.
				b	□	There is pitting near the LWL.
					□	The rust stain caused widely.
				c	□	The rust stain caused partially.
				d	□	There is adhesion; however, there is no rust stain, pitting or damage.

Table 2-4-6 Inspection Items, Methods, and Evaluation for Superstructure Work of the Access Bridge (Reference)

Facility		Inspection Item	Inspection Method	Criterion (Draft)	
Bridge	Steel structure	Deformation and clack of the component	Visual Inspection ・Bend of the component ・Distortion of the component ・Breakage of the component ・Clack	a	☐ There is a deformation which may cause dangereous effect to the operation.
					☐ The main structural component has cracks.
					☐ There is a large deformation which may affect to safety of the bridge.
					☐ There is problem in displacement or in stress.
					☐ There is a crack in the secondary member.
				b	☐ There is a slight deformation or scratch of the paint.
					☐ There is partial dent.
				c	
				d	☐ There is no strange change.
	Concrete slab	Deterioration and damage of the concrete	Visual Inspection Hammering Inspection ・Crack ・Delamination, Damage ・Deterioration sign	a	☐ There is a remarkable delamination or collapse of the concrete; and it is danger to operate.
					☐ There is alligator cracks; and there is collapse or a delamination at its neighboring concrete.
					☐ There is a crack which width is over 0.2mm or which span is less than 0.3m.
				b	☐ There is alligator cracks with free lime.
					☐ There is a crack which width is less than 0.2mm and which span is approximately 0.3 ~ 0.5m.
				c	☐ There is a crack toward one or two direction which width is less than 0.2mm and which span is over 0.5mm.
				d	☐ There is no strange change.
		Rusting at the steel structure	Visual Inspection ・Delamination of the covering concrete ・Crack along the steel structure ・Reddish brown by the rusting	a	☐ There is a delamination of the covering concrete due to rusting of the steel structure.
				b	☐ There is crak or flaking along the steel structure. There is concern about steel rusting.
					☐ There is rust (reddish brown) on the surface of the concrete.
				c	
				d	☐ There is no strange change.
	Shoe	Damage at the main body of the shoe, Status of installation	Visual Inspection ・Damage at the main body of the shoe ・Deterioration of the components ・Adheson status of dirt ・Anchor bolt ・Deformation and damage of the set bolt ・Loose of nuts ・Crack at the filling mortar	a	☐ It is danger for operation.
					☐ There is remarkable rusting or a looseness at joint which may affect to the safety.
				b	☐ There is change which is between item a and b.
				c	☐ There is a slight deformation or a looseness of the joint which may not affect to the safety.
					☐ There is slight rusting.
				d	☐ There is no strange change.
	Guardrail	Damage at the main body of the guardrail, Crack at the ground	Visual Inspection ・Deformation, Damage ・Crack at the ground	a	☐ There is dangerous change for driving vehicles and pedestrian.
					☐ There is a structural problem.
					☐ This status will affect to the operation.
				b	☐ There is no structural problem for operation; however, there is remarkable change or change which may cause unease.
				c	☐ There is no structural problem for operation. There is only slight change.
				d	☐ There is no strange change.
	Bridge fall prevention structure	Damage at the main body of the bridge fall prevention structure	Visual Inspection ・Deformation, Damage, Rusting of the components	a	☐ There is obstacle to the operation.
					☐ There is possibility of fall down due to a deformation, damage or rusting of the components.
				b	
				c	☐ There is no structural problem for operation. There is only slight change.
				d	☐ There is no strange change.

4) Open Yard and Road

Inspection items, methods and evaluation criteria for the cargo yard and roads are as shown in Table 2-4-7.

Table 2-4-7 Inspection Items, Methods, and Evaluation Criteria for Cargo Yard and Roads (Reference)

Facility		Inspection Item	Inspection Method	Criterion (Draft)	
Yard Road	Pavement	Gap, rutting, or crack of the pavement	Visual Inspection (including measuring check) ・Height gap, gap ・Rut ・Discrepancy	a	☐ There is a height gap, collapse, rut or crack which is dangerous for driving vehicles during the operation.
					☐ There is a height gap which is over 15mm.
					☐ There is collapse which is over 50mm.
					☐ There is a rut which is over 10mm.
					☐ There is crack which width is over 3mm.
				b	☐ There is a height gap which is approximately 10~15mm.
					☐ There is a gap which is over 20 ~ 50mm.
					☐ There is crack which width is over 3mm.
				c	☐ There is a height gap which is less than 10mm.
					☐ There is a gap which is under 20mm.
					☐ There is a rut which is less than 10mm.
					☐ There is slight crack.
				d	☐ There is no strange change.
	Drainage Facilites	Damage at the drainage facilities, Deformation or rusting of the grating	Visual Inspection (including measuring check) ・Clogging of the ditch ・Damage, Deformation ・Rusting of the grating	a	☐ There is damaged part at the ditch or the catch basin.
					☐ The ditch or the catch basin is clogged with the soil.
					☐ There is a lack of the grating.
					☐ The drainage facilities are our of order due to a remarkable deformation or rusting of the grating.
				b	
				c	☐ There is a deformation or rusting of the grating.
				d	☐ There is no strange change.
	Guardrail	Damage at the main body of the guardrail, Crack at the ground	Visual Inspection ・Deformation, Damage ・Crack on the ground	a	☐ There is dangerous change for driving vehicles and pedestrian.
					☐ There is a structural problem.
					☐ This status will affect to the operation.
				b	☐ There is no structural problem for operation; however, there is remarkable change or change which may cause unease.
				c	☐ There is no structural problem for operation. There is only slight change.
				d	☐ There is no strange change.
	Lighting Facilities	Lighting status, Damage of the lighting facilities	Visual Inspection ・Lighting status ・Deformation or Damage of the lighting facilities, Rusting of the components	a	☐ There is a problem in the lighting.
					☐ There is possibility of collapse or fall down due to a deformation, damage or rusting of the components.
				b	
				c	☐ There is no structural problem for operation. There is only slight change.
				d	☐ There is no strange change.

(2) Frequency of Inspection

The following frequency of inspection is recommended.

1) Initial inspection (Inspection prior to operation of the facilities)

It is recommended to collect initial conditions as base data of the facilities immediately after completion of the construction works, so that the quantitative evaluation will be available after starting operations.

2) Inspection under normal conditions

The following inspections are recommended:

a. Daily inspection

Regular inspections to confirm the conditions of the facility in daily routines

b. Periodic general inspection

Inspections for mainly above sea level members conditions, one or two times per year

c. Periodic detailed inspection

Detailed inspections for the members too difficult to inspect in general and/or daily routines, about a five-year interval

3) Inspection under abnormal conditions

Inspection conducted after disasters such as typhoon and earthquake. There are two categories of this type of inspection.

a. General inspection

Inspections conducted immediately after disasters such as earthquakes and stormy weather

b. Detailed inspection

Detailed inspections when damages and/or abnormal conditions have been identified by general inspections after the disasters, and/or periodic and other inspections

(3) Cargo Handling Equipment

Damages and/or trouble of the cargo handling equipment have a negative impact on port operations. Equipment shall be kept in good condition by ensuring the necessary inspections.

It is important to avoid heavy damages and/or troubles by conducting the earliest countermeasures when any weaknesses or troubles are found by daily routine and periodic inspections.

Inspection details depend on the products, therefore, they shall follow the makers' recommendations. In this report, general inspection items for jib crane are presented as a reference in the attachment. Because the jib crane is one of the most important pieces of equipment for the project, to play a main role in cargo handling operations in the new port, its trouble may induce heavy disadvantages for the port operations.

In addition to the inspection of the equipment, preparation and a spare parts area are also important. If some damaged part is identified by the inspections, it can be repaired immediately by using the spare parts stocked, and the equipment will be able to keep in good condition for operations.

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Cost to be Borne by the Recipient Country

Total cost for the scope to be borne by the Myanmar side is estimated at about 2,714.1 Million Kyat (about JPY 224 Million). Details are as follows:

Table 2-5-1 Cost to be Borne by the Recipient Country

Items	Myanmar Kyat (Million)	Japanese Yen (Million)	Remarks
Bank Fees	82.2	7	Banking Arrangement (B/A), Authorization to Pay (A/P) and Bank Commission
Land Acquisition	2,353.0	194	Land acquisition including resettlement and compensation with full replacement cost in accordance with ARAP
Site Clearance and land preparation	33.5	3	Site clearance including (i) removal of sunken ship at site and (ii) removal of huts in the project area
Environmental and Social Considerations	45.5	4	Environmental Management and Monitoring and others related to the Environmental and Social Considerations
Project Component	200.1	16	Project component which shall be borne by the Myanmar side such as electrical power supply connection, purchasing the office furniture, equipment and other necessary materials to start for the operations.

(2) Basis of the Cost Estimation

The basis of the cost estimations is listed below.

1) Base Date : June 2017

2) Exchange Rates

   a. Myanmar Kyat to Japanese Yen : 0.0823 Yen/Kyat

   b. US Dollar to Japanese Yen : 112.84 Yen/US$

   c. Euro to Japanese Yen : 122.42Yen/€

3) Procurement/Construction Period

   Detailed design, construction and equipment procurement period and schedules are as shown in the implementation schedule in Figure 2-2-58.

4) Others

   The Project will be implemented in accordance with the procedures of grant aid projects of the Japanese Government.

2-5-2 Cost for Operation and Maintenance

The approximate annual cost that may become necessary for the port operation and maintenance is estimated as shown in Table 2-5-2. The cost is estimated under the conditions that cargo handling volume is nearly equal to the planned capacity of the port, 240,000 tons/year.

Table 2-5-2 Estimated Annual Cost for Port Operation and Maintenance (Under conditions of cargo handling volume being approx. 240,000 tons/year)

Items	Contents of the Maintenance	MMK Million Kyat	JPY Million Yen
Staff Salary	For River Port Operation Department staff	290	24
Terminal Operation	Cost for employee of the terminal operation staff from the private sector	620	51
Maintenance Cost	Facility and equipment maintenance and running cost	305	25
Total		1,215	100

As stated in Chapter 2.4, it is recommended that IWT should aim to operate the new port with independent profitability by about three years from its opening.

In the initial period of port operation, budgetary support by the government will be needed[9]. The actual budget shall be estimated and prepared by the government. An example recommendation is presented in Chapter 2.4.

[9] Refer to the document attached in "8-2 Recommendation on the Port Management and Operation" in Appendix 8.

Chapter 3 Project Evaluation

3-1 Preconditions

(1) Preconditions

For the purpose of implementation of the project, the recipient country government shall execute the following tasks.

- Before commencement of construction, compensation for PAPs shall be completed following ARAP, and relevant environmental approval shall be obtained by the Government. It is recommended that the environmental approval should be obtained before February 2018, and compensation for land acquisition should be completed before July 2018.

- Required land area for construction works, including temporary yard space (12 ha), shall be obtained by the Government by July 2018.

- The sunken ship (dredger) located in the construction site area shall be removed by the Government before commencement of the construction works.

- Construction permit shall be obtained by the Government before bid announcement scheduled in August 2018.

- Environmental impact monitoring shall be executed by the Government and such records shall be reported to the JICA Myanmar office. Necessary measures shall be carried out by the Government if required.

- Environmental impact monitoring shall be executed by the Government and such records shall be reported to the JICA Myanmar office. Necessary measures shall be carried out by the Government if required.

- The Government shall establish an organization which is required for operation and maintenance of a new port, and the necessary organization staff shall be trained.

- The Construction works is scheduled to be started from the beginning of December 2018, and the time of the work start shall be ensured. The project schedule is planned such that initial construction will commence with revetment works during low water season. Consequently, if any delay occurs in the process of the land acquisition, 1 to 2 months delay will cause a one-year delay because initial construction works cannot be executed in the rainy (high-water) season

(2) Other Points to be Noted

For the project implementation, following matters shall be considered.

- The construction works shall be started from the revetment construction to be necessary for the land reclamation works. To reduce the construction cost and work period, the revetment works are planned in the initial stage of the construction works and to be completed during low water level in dry season, so that the revetment construction works are available on land executions. The revetment work in the initial stage of the construction works is the critical pass of the Project. The most important point is that required land acquisition, including compensation to PAPs, shall be completed before bid announcement which is planned in August 2018 in principle. It must be noted that there is a risk to induce one year delay of the project even if a few month delay of the

tender notice due to delay of the land acquisitions, removal of sunken ship, obtaining of the construction permit and other necessary clearance for the Project.

- The Project is planned to be implemented by the different tender packages for the civil and building construction component and cargo handling equipment procurement component. Therefore, the following points shall be noted in the implementation stage.

  1) Schedule coordination for civil works and installation of equipment

  Rail mounted jib crane on the jetty shall be installed after construction of the jetty structure. Careful schedule coordination will be necessary.

  2) Transportation and installation of equipment

  Because the existing road conditions from Yangon to Mandalay are not good enough for transportation of heavy duty cargo equipment, such equipment should be carried by waterway, but there is no suitable loading/unloading facility in Mandalay. Therefore, it is thought that the jetty of this project will be suitable for unloading the procured equipment. For use of the project jetty, particular coordination will be necessary because the jetty facility will have to be used before completion of the civil contract. The contract documents for both civil and equipment shall be prepared taking into consideration the responsibilities and risks of damage in the facility during the contract period.

- In addition to the above mentioned points, it must be noted that i) water elevations of Ayerarwady river are varies about 10m in rainy and dry seasons and, ii) there are some limitations for the execution works, for example, heavy duty cargo unloading is not available at existing Mandalay port since there is no sufficient cargo handling equipment, and iii) other particular local conditions.

- To ensure the port operation and management after completion and handed over the Project, efforts by the Myanmar Government to be established the organization and provision of the trained staff are also important.

3-2 Necessary Inputs by Recipient Country

The following inputs by the recipient country are required for the achievement of project objectives.

- Required land acquisition of port construction area, completion of compensation to stake-holding farmers, and required budget allocations for this purpose.

- Establishment of required organization and employment of staff for new port operation. The project aims for independent profit management within several years after port opening. However, staff wages required in the preparation period and initial operation need to be supported by the Government budget.

- During the preparation period and initial operation, the required staff shall be properly trained.

- For port opening, the Government budget allocation will be required for procurement of office furniture, small tools and equipment for the workshop, vehicles for maintenance works, and tools for the warehouse, such as pallets, etc.

3-3 Important Assumptions

(1) Recommendations on Promotion for Port Users

In order to achieve the project objective that the port is constructed as a pilot project for modernization of river ports, the following development concepts shall be properly understood by the relevant government officials and staff.

1) Introduction of unit cargo handling

Existing manual labour cargo handling will be changed to mechanized cargo handling. The port management shall promote the use of unit cargo such as pallets and containers.

2) Effective use of cargo equipment

Cargo handling works shall be improved in handling speed and efficiency with the continuous effort of port management and operator/workers.

3) Provision of public service to port users

The existing port takes the old system of allocating a riverside place for each private cargo operator. The new port will provide a public jetty for all port users. Such concept shall be assured by port management and the new port function shall be certainly accomplished.

4) Effective use of port terminal function

The new port will provide port users with the terminal function, in which the terminal operator will execute loading/unloading of cargoes and their temporary storage in warehouse or open yard. This function is important for effective use of the jetty and storage facilities.

The system of berth window and fixed time-schedule cargo transport should be enhanced by using the port terminal function.

5) Provision of cargo handling service targeting barge transport

The project aims for wider use of barge transport in the river waterways. More than 50% of existing cargoes are carried by river barges. Port management shall make efforts to disseminate modern mechanized cargo handling methods, to improve transport quality, and to increase new cargo demand for the waterway, in order to achieve the project objectives.

In addition, the new port is planned to have cargo capacity of approximately 30% of the entire cargo volume of Mandalay Port. It is also important to pay attention to the employment of existing workers, by making a clear division between the new and old port, because tourism boats or passenger-cum-cargo ships are principally not suitable for mechanized new port operation.

(2) Use of Unitized Cargoes and Containers

1) Use of pallets

As an initial effort for unitization of existing cargo, it is recommended to introduce pallets for existing bagged cargoes. Such units are better to be used at both the port and the cargo-owner's

warehouses. For effective promotion of widespread unitized cargo handling, IWT is recommended to procure pallets for the new port warehouse and show their convenient usage by means of mechanized handling to many private port users.

2) Use of containers

In the initial phase of development when the new port is opened, it is assumed that the place of shipping for containerized cargo will remain the same as the current custom: Yangon Port or Thilawa Port. There is a concern that containerized cargo transportation by inland waterway will not come into wide use if the place of shipment defined by the shipping company will not be changed to the inland Mandalay port from Yangon or Thilawa. This is because the conventional free time for container is about 7 days, while the time required to return the rental container to the shipping place will be over one month if we consider the barge round-trip transport between Yangon and Mandalay. As a result, the cargo owner has to pay a high detention charge for container rent. In order to overcome such an obstacle for promotion of containerization, the following measures are important.

a. Designation of bonded area and installation of customs (lead the overseas import/export containers to Mandalay)

In order to promote the containerization of inland waterway cargo, the government shall request relevant major shipping companies to designate Mandalay Port as the shipping place of containers. The minimum necessary measure by the government is to designate a bonded area and installation of customs at Mandalay port.

b. Measure for cost saving of waterway transport neglecting detention charge of container rent

As an applicable idea for promotion of container transport in the initial phase, there is a way for the government or private sector to procure container units by its own expense and provide container transport service between Yangon and Mandalay. The government or private sector will be able to induce the containerized cargo transportation by leasing containers with low price, and IWT will be able to gain some revenue from such leasing.

(3) Recommendations for arousing inland waterway transport demand

- For the government promotion of inland waterway transport, it is required for the government to lead an appropriate demarcation of cargo transportation modes, road transport, railway transport and inland waterway transport. It is recommended for the government to research what are the most suitable cargoes for each transportation mode, and set up the appropriate service fee for all transportation modes to achieve sustainable growth.

- Lead time of waterway transport is generally longer than the other transportation modes. However, if the quality of transport is high, meaning safe, damage-less, and lower cost, it is thought that latent demand will be evoked for cargo which requires quality of transport more than transport time, such as mechanical parts and precision machinery, etc. For the purpose of promoting containerized cargo transport, it is necessary to introduce larger barges and attain mass transport of containers.

- Existing tugboats owned by IWT and private companies are quite aged, and there are not enough tugboats to carry over 2,000 t barges. It is preferable if two or more units of 1,000 to 1,300 hp tug boats are available for public use.

- Procurement of tug boats is not easy, however, if the waterway transport environment will be improved, it will be a gain for the private sector to invest for the transport related service businesses, such as waterway freight businesses, barges and tug boats lease businesses, inland transport insurance businesses and so on. It is important that the inland water transportation environment shall be improved initiated by the Myanmar Government and to promote waterway transport related business market.

- For the achievement of sustainable promotion of waterway transport, it is necessary for the government to prepare regulations for the private sector to prepare cargo insurance systems.

- For total modernization of inland water transport, there is the need to develop river port facilities for not only Mandalay but also other major river ports. At present, there are no river ports which have mechanical cargo equipment except only for the Yangon area. Therefore, modernization of waterway transport should start with Mandalay and Yangon by this project as a pilot project, and it is recommended to distribute the same system to other major ports.

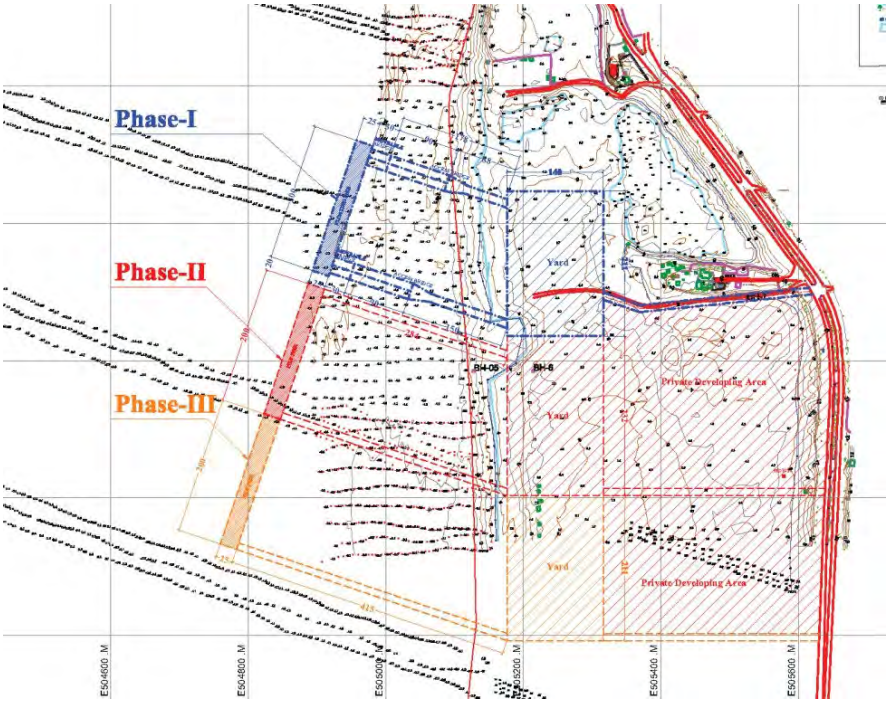
(4) Other Recommendations

- The Mandalay port management office must pay special care to the requirement of future maintenance dredging. The riverbed water depth at the jetty location of Mandalay Port is changing every year. The port management needs to execute periodic and frequent surveys, and should take suitable measures, including budget preparation if such dredging is needed for the future.

- For ensuring maintenance of the new facilities, it is recommended for Japan's government to execute technical cooperation regarding trainings of human resources for port operation and management, which has been already officially requested by Myanmar and has been under evaluation by Japan.

- This project provides one rough terrain crane and one reach stacker, as the minimum required number of equipment for the port operation in the initial stage. It is recommended for port management and the government to prepare future budget to increase the equipment suitable for the growth of demand, by considering operational revenue and profit.

- The port facility in this Project is planned for about 30% of existing cargo demand of Mandalay Port. If the port operation will be successfully started and port modernization and transportation environment will be improved successfully, the capacity of the port should be expanded according to the increase of the cargo handling volume and the expected waterway transport demand. Therefore, it is strongly recommended to reserve the area for future expansion of the port beside of the Project area. This matter was also recommended in the 2014 JICA F/S as shown in the Figure 3-3-1.



Source: JICA F/S Team

Figure 3-3-1 Future Expansion Plan Recommended by the 2014 JICA F/S

3-4 Project Evaluation

3-4-1 Relevance

The Myanmar government set up a development strategy aiming to promote and revitalize inland water transport to contribute economic activities as the overall goal. Mandalay port development is regarded as a pilot project for such purpose. The aim of the project is for sustainable development of inland water transport encouraging other ports' modernization starting with this project.

The modernization of inland water transport will provide benefits to the industry of the country by enabling transport of heavy or large sized cargo which is principally not suitable for other transport modes like road or railway. Large mass transport will lower the cost of transportation, which will affect the reduction of consumer prices, and result in the provision of plentiful life to the local citizens. Lower transport cost will also affect the acceleration of development of northern regions where enough investment on infrastructure has not been provided, at present, by the government. This project implies a huge ripple development effect on the economy of local society.

3-4-2 Effectiveness

3-4-2-1 Project Design Matrix (PDM)

The Project Design Matrix for measuring the effectiveness of the project is summarized as follows.

Table 3-4-1 Project Design Matrix

Outline of the Project	Quantitative Indicator	Possible Source of Indicator	Qualitative Effect / External Conditions
Overall Goal To activate economic activities of the country by achieving sustainable improvement of inland water transport in Myanmar	Economic Indicator ● GDP (US $) ● GDP per capita (US $)	IMF Economic Data Statistics of Myanmar	Convenience of water transportation is improved and transport of heavy cargo and container cargo is evoked. The image of water transport by shippers and local residents improves, and their usage is activated. The safety of poor harbour workers is improved. Improvement of environment in inland water transport. Promotion of investment and advancement of overseas enterprises including Japanese companies, business activities. Regional economy of Myanmar will become active.
Aim of Project Modernize river cargo handling Revitalize inland water transport	Cargo throughput of Mandalay Port. The ratio between manual labour handling and mechanized handling. Ship call of Mandalay Port.	IWT Statistics DMA Statistics	Improve cargo handling efficiency, vessel mooring safety and safety of cargo handling. Improve convenience of water transport. Improve working environment for port workers.
Expected Results Improve effectiveness of inland water transport by unitization of cargo (containers/pallets)	Berthing time of barges. Volume of cargo handling per unit time. Number of containers/pallets applied for usage.	IWT Statistics Interview with cargo owners.	Improve transport quality. Widespread use of pallets to other ports and private warehouses. Widespread use of containerized cargo to other ports.
Activities Modernized port facilities are installed at Mandalay Port. The modernized system will spread to the other river ports by taking Mandalay Port project as a pilot project.	**Input**		Education and training for operation and maintenance. Modal shifts from other modes to inland water transport.
	From Japan	**From Myanmar**	
	Jetty, cargo yard, warehouse, office building, and access road are constructed at Mandalay Port. Cargo handling equipment are procured.	Establish organization for management and operation of new port. Obtain skills for management and maintenance by education and training. Future development planning and annual budget planning.	

3-4-2-2 Baseline Survey Results

Table 3-4-2 shows the results of the baseline survey with respect to the above Project Design Matrix.

Table 3-4-2 Quantitative Indicators for PDM Baseline Survey

Indices	Present Conditions (Actual Conditions in 2017) (Baseline)	Source
GDP of Myanmar	US $67.43 Billion (2016)	World Bank
GDP per capita of Myanmar	US $1,275 (2016)	World Bank
GNI of Myanmar	US $58.80 Billion (2015)	World Bank
GNI per capita of Myanmar	MMK 1,304,000 (2015)	World Bank
Cargo throughput of Mandalay Port	907,393 tons (2016 - 2017)	JICA Study Team (DMA/IWT data)
Mandalay New Port Cargo throughput	No cargo at present (2017)	IWT
Ratio of labour handling and mechanized handing (Mechanized/Labour)	0 : 100 (2017)	JICA Study Team
Ship call	No ship calls at present (2017)	JICA Study Team
Cargo efficiency	17 tons/hour	JICA Study Team
Berthing hours	2 weeks (approximate) (Manual labour handling on natural river bank)	JICA Study Team

3-4-2-3 Project Outcome

(1) Quantitative Effect

The following quantitative outcomes will be expected by executing this project.

Table 3-4-3 Project Outcomes (Quantitative Effect)

Indicator	At Present Baseline in 2017	Target (2023: 3 years after construction)
Cargo throughput of Mandalay Port	No data (2017)	200,000 tons/year
Cargo efficiency	17 tons/hour	100 tons/hour
Berthing hours	2 weeks (approximate)	6 hours to 24 hours

(2) Qualitative Effect

The following qualitative effects can be expected from this Project.

1) Effectiveness of cargo handling will be gained by introducing mechanical equipment handling. It will become possible to handle heavy cargo which could not be handled with conventional manpower handling, and demand for transportation of potential cargo is evoked.

2) Work environment and safety of cargo handling works will be improved.

3) Quality and efficiency of transportation will be improved by introducing palletized cargo and containerized cargo.

4) New transport demand will be created by improving the quality of transport. Inland transport businesses will be activated and large lot transport will be possible.

5) Large lot transport will reduce transportation cost, by which local consumer prices will be lowered and people's lives will be improved as a result.

6) By improving the transportation environment, it is expected that the export of local products will be activated, and the local economy will be active as a result.

7) A ripple effect will be expected, by which other local river ports will be developed similarly to the Mandalay port.