MANDALAY BUSINESS CAPITAL CITY DEVELOPMENT

AMARAPURA URBAN DEVELOPMENT PROJECT

Environmental Impact Assessment (EIA) Report

Revised Report

July,2024

Prepared by:

Hexagonal Angle

International Consultants Co., Ltd.

ကတိကဝတ်များ

(က) ဤပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း(EIA)အစီရင်ခံစာတွင် ပါဝင်သော ကတိကဝတ်များနှင့် သက်ဆိုင်ရာဥပဒေများကို တိကျစွာ လိုက်နာဆောင်ရွက်ပါမည်။

(ခ) အစီရင်ခံစာပါ ပတ်ဝန်းကျင်အရည်အသွေး တန်ဖိုးများကိုလည်း လုပ်ငန်း ဖော်ဆောင်မှုကြောင့် သက်ရောက်မှု မရှိအောင် ထိန်းသိမ်းကာကွယ်သွားပါမည်။

(ဂ) Mandalay Business Capital City Development Ltd. ၏ အမရပူရမြို့ပြဖွံ့ဖြိုးရေးစီမံကိန်း လုပ်ငန်း ဆောင်ရွက်ခြင်းကြောင့် ပတ်ဝန်းကျင်နှင့် လူမှုဝန်းကျင်အပေါ် ဖြစ်ပေါ်နိုင်သော ဆိုးကျိုး သက်ရောက်မှုများအတွက် လျော့ချရေး လုပ်ငန်းစဉ်များနှင့် အစီအစဉ်များကိုလည်း အပြည့်အဝ အစဉ်အမြဲ လိုက်နာဆောင်ရွက်သွားပါမည်။

(ဃ) ကောင်းကျိုးသက်ရောက်မှုများကိုလည်း ပိုမိုကောင်းမွန်အောင် လုပ်ဆောင်သွားပါမည်။

(င) ပတ်ဝန်းကျင်စောင့်ကြပ်ကြည့်ရှုရမည့် အစီအစဉ်တွင် ပါဝင်သော စောင့်ကြည့်ရမည့် ကဏ္ဍများကိုလည်း သေချာစွာ လိုက်နာဆောင်ရွက်ပါမည်။

(စ) စောင့်ကြပ်ကြည့်ရှုရမည့် အစီအစဉ်အတွက် အသုံးပြုမည့် လျာထားရန်ပုံငွေ၊ ထိခိုက်မှု လျော့ပါးစေရေးအတွက် ရန်ပုံငွေ၊ ဘေးအန္တရာယ် ကာကွယ်ရေး အစီအစဉ်၊ အများပြည်သူနှင့် တိုင်ပင်ဆွေးနွေးခြင်းနှင့် ဒေသဖွံ့ဖြိုးရေး လုပ်ငန်းများအတွက် ရန်ပုံငွေ စသည့် လျာထားရန်ပုံငွေများအတိုင်း လိုက်နာဆောင်ရွက်မည်ဖြစ်ကြောင်းနှင့် အဆိုပါ လျာထားရန်ပုံငွေသည် လုံလောက်မှုမရှိပါက ကုမ္ပဏီမှ ထပ်မံထည့်သွင်း ဆောင်ရွက် သွားပါမည်။

(ဆ) စီမံကိန်းလုပ်ငန်းများ တည်ဆောက်ခြင်း၊ လုပ်ငန်းလည်ပတ်ခြင်း/ ထိန်းသိမ်းခြင်း ကာလများတွင်လည်း ပတ်ဝန်းကျင်နှင့်လူမှုဝန်းကျင် အပေါ်သက်ရောက်မှု အနည်းဆုံး ဖြစ်အောင် ဆောင်ရွက်မည်ဖြစ်ပြီး၊ အကယ်၍ သက်ရောက်မှုများ ဖြစ်ပေါ်နိုင်ခြေရှိလျှင် ကြိုတင်အစီအစဉ်များ ရေးဆွဲ၍ ဆောင်ရွက် သွားမည်ဖြစ်ကြောင်း ကတိကဝတ် ပြုပါသည်။

U Than Htike San
Managing Director
Mandalay Business Capital City Development Ltd.

အကြံပေးအဖွဲ့အစည်း၏ဝန်ခံချက်

ဤပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း အစီရင်ခံစာအား ကျွန်ုပ်တို့၏ ဟက်ဇာဂွန်နယ် အန်ဂယ် နိုင်ငံတကာ အကြံပေးများ ကုမ္ပဏီလီမိတက်မှ တာဝန်ယူရေးဆွဲ ဆောင်ရွက်ထားကြောင်း ဝန်ခံ ကတိပြုပါသည်။ ဤအစီရင်ခံစာအား လက်မှတ်ရေးထိုးခြင်းအားဖြင့် ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဦးစီးဌာန၏ လိုအပ်ချက်များအား ကိုက်ညီမှုရှိစေရန် အကြံပေးအဖွဲ့၏ ကျွမ်းကျင်မှုဖြင့် မှန်ကန်စွာဆောင်ရွက်ထားကြောင်း ဝန်ခံကတိပြု ပါသည်။

(က) ဤပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း အစီရင်ခံစာ ရေးဆွဲရန် အကြံပေးအဖွဲ့အစည်း ရွေးချယ်ခြင်း အတည်ပြုချက်အား သယံဇာတနှင့် သဘာဝပတ်ဝန်းကျင်ထိန်းသိမ်းရေး ဝန်ကြီးဌာန၊ ပတ်ဝန်းကျင်ထိန်းသိမ်းရေး ဦးစီးဌာန၊ နေပြည်တော်မှ ၂၀၂၂ ခုနှစ်၊ အောက်တိုဘာလ၊ (၂၈) ရက်စွဲပါ စာအမှတ် EIA-၁/၃/အတည်ပြု (TP) (၂၉၂၈ / ၂၀၂၂) ဖြင့် ရရှိ ပြီးဖြစ်ကြောင်း ဝန်ခံပါသည်။

(ခ) ဤပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း အစီရင်ခံစာအား တိကျခိုင်မာမှုများနှင့် ပြည့်စုံစွာ ဆောင်ရွက် ထားပါသည်။

(ဂ) အစီရင်ခံစာကို ပတ်ဝန်းကျင်ထိခိုက်မှု ဆန်းစစ်ခြင်းဆိုင်ရာ လုပ်ထုံးလုပ်နည်း (၂၀၁၅)၊ သက်ဆိုင်ရာ ဥပဒေများ၊ မူဘောင်များနှင့်အညီ ရေးဆွဲထားပါသည်။

(ဃ) အမရပူရမြို့ပြဖွံ့ဖြိုးရေးစီမံကိန်း လုပ်ငန်းကြောင့် ဖြစ်ပေါ်နိုင်သော သက်ရောက်မှုများကို လုပ်ငန်းဆိုင်ရာ နားလည်တတ်ကျွမ်းမှုနှင့် စုံစမ်းရရှိသော အချက်အလက်များကို အခြေခံ၍ လေ့လာ ဆန်းစစ် ဖော်ထုတ်ထားပါသည်။

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(စ) ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း လေ့လာမှုနှင့် စုံစမ်းစစ်ဆေးမှုများအား ဖော်ပြရာတွင် စီမံကိန်းကြောင့် သက်ရောက်နိုင်မည့် အနီးပတ်ဝန်းကျင် အခြေအနေများ၊ ဇီဝမျိုးစုံမျိုးကွဲများနှင့် ဒေသခံပြည်သူများ စသည့် အချက်အလက်များအပေါ် အခြေခံ၍ ထည့်သွင်းစဉ်းစားပြီး ရေးဆွဲထားပါသည်။

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Hexagonal Angle International Consultants Co., Ltd.
No. HAU-2210/2443
Date. 15.5.2022

THU THU AUNG
Managing Director
Hexagonal Angle International Consultants Co.,Ltd.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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LIST OF ABBREVIATION

%	- Percentage
BOD	- Biological Oxygen Demand
COD	- Chemical Oxygen Demand
TSS	- Total Suspended Solids
EC	- Electricity Conductivity
TDS	- Total Dissolved Solid
CEC	- Cation exchange capacity
VOC	- Volatile Organic Compound
CSR	- Corporate Social Responsibility
ECC	- Environmental Compliance Certificate
ECD	- Environmental Conservation Department
ECR	- Environmental Conservation Rules
EHS	- Environmental Health and Safety
EIA	- Environmental Impact Assessment
ESIA	- Environmental and Social Impact Assessment
EMP	- Environmental Management Plan
EMR	- Environmental Monitoring Report
EPA	- Environmental Protection Agency
MBCCD	- Mandalay Business Capital City Development Ltd
HA	- Hexagonal Angle International Consultants Co., Ltd.
IEE	-Initial Environmental Examination
IFC	- International Finance Corporation
ILO	- International Labor Organization
kVA	- Kilovolt-ampere
MONREC	- Ministry of Natural Resources and Environmental Conservation
NEQEG	- National Environmental Quality (Emission) Guideline
FAO	- Food and Agriculture Organization of the United States
NO_2	- Nitrogen Dioxide
O_3	-Ozone
OHS	- Occupational Health and Safety
PCM	- Public Consultation Meeting

PD	- Public Disclosure
PM_{10}	- Particulate Matter 10 micrometers or less in diameter
$PM_{2.5}$	- Particulate Matter 2.5 micrometers or less in diameter
WS	- Windspeed
WD	- Wind direction
PPE	- Personal Protective Equipment
QGIS	- Quantum Geographic Information System
TSP	-Total Suspended Solid
U.S EPA	- United States Environmental Protection Agency
UNESCO	- United Nations Educational, Scientific and Cultural Organization
WHO	- World Health Organization
OBOR	- One Belt One Road
IUCN	- International Union for Conservation of Nature
MIC	- Myanmar Investment Commission
PPAH	- Pollution Prevention and Abatement Handbook
UNFCCC	- United Nations Framework Convention on Climate Change
CITES	- Convention on International Trade in Endangered Species of Wild Fauna and Flora
NBSAP	- National Biodiversity Strategies and Action Plans
CBD	- Convention on Biodiversity
UNCCD	- United Nations Convention to Combat Desertification
ITTA	- International Tropical Timber Agreement
POPS	- Persistent Organic Pollutants
MARPOL	- International Convention for the Prevention of Pollution from Ships
WHC	- World Heritage Convention
MAB	- Man and the Biosphere
ASEAN-WEN	- Association of Southeast Asian Nations' Wildlife Enforcement Network
UNDHR	- Universal Declaration of Human Rights
MoU	- Memorandum of Understanding
ELV	- Extra Low Voltage
BOD	- Board of Directors
MOLES	- Ministry of Labour, Immigration & Population
MOALI	- Ministry of Agriculture, Livestock and Irrigation

NECCCCC - National Environmental Conservation and Climate Change Central Committee

FESR - Framework for Economic and Social Reform

NCDP - National Comprehensive Development Plan

ECL - Environmental Conservation Law

ETC - Environmental Technology Centre

UNEP - United Nations Environment Programme

IGES - Institute for Global Environmental Strategies

CCET - Center for Communication and Educational Technology

MCCP - Myanmar Climate Change Policy' (MCCP) principles

NAPA - National Adaptation Programme of Action

NDC - Nationally Determined Contribution

MCCS - Myanmar Climate Change Strategy

ECRs -Environmental Conservation Rules

MNBC - Myanmar National Building Code

MES - Myanmar Engineering Society

POPs - Stockholm Convention on Persistent Organic Pollutants

FCCC - Framework Convention on Climate Change

UNDHR - Universal Declaration of Human Rights

CEDAW - Convention on Elimination of All Forms of Discrimination against women

MLC - Maritime Labour Convention

CPTu - Piezocone Test

SPT - Standard Penetration Test

DWIR - Directorate of Water Resources and Improvement of River Systems

FS - Factor Safety

USACE - United States Army Corps of Engineers

USBR - United States Bureau of Reclamation

PGA - Peak Ground Acceleration

RA - Roundabout

ANSI - American National Standards Institute

NEC - National Electrical Code

IEFT - Internet Engineering Task Force

IEEE - Institute of Electrical and Electronics Engineered

EIA - Electronics Industries Association

MOEP	- Ministry of Electricity and Energy
LED	- Light-Emitting Diode
kV	- Kilovolt
kVA	- Kilo-Volt-Amperes
MVA	- Mega Volt-Amperes
XLPE	- Thermoset Insulation Material
PVC	- Polyvinyl Chloride
HDPE	- High Density Polyethylene
PACI	- Poly Aluminum Chloride
JICA	- Japan International Cooperation Agency
DMA	- Designated Market Area
OSWT	- Onsite wastewater treatment system
ANSI	- American National Standard Institute
ASTM	- American Society for Testing and Materials Standard
BS	- British Standard
DIN	- Deutsch Industrial Norm, German
IS	- Indian Standard
ISO	- International Organization for Standardization
JIS	- Japanese Industrial Standards
MNBC	- Myanmar National Building Code (2016)
MCDC	- Mandalay City Development Committee Regulations
TIS	- Thai Industrial Standard
YCDC	- Yangon City Development Committee Regulations
STP	- Sewage Treatment Plant
UV	- Ultraviolent
DMH	- Department of Meteorology and Hydrology
N	- North
E	- East
NE	- Northeast
S	- South
W	- West
SW	- Southwest
SE	- Southeast

NW	- Northwest
RC	- Reinforced concrete
USGS	- United States Geological Survey
IRIS	- Incorporated Research Institutions for Seismology
GMPEs	- Ground Motion Prediction Equations
PSHA	- Probabilistic Seismic Hazard Assessment
FSliq	- Factor of Safety Against Liquefaction
MNBC	- Myanmar National Building Code
ADT	- Average Daily Traffic
LOS	- Level of Service
V/C	- A Volume to Capacity
LRP	- Livelihood Restoration Plan
AOI	- Area of Influence
PAPs	- Project Affected Person
LPI	- Liquefaction Potential Index

CHAPTER 1
CONTEXT OF THE PROJECT

1.1. BACKGROUND OF THE PROJECT

The Amarapura Urban Development project is situated in the Amarapura Township, Mandalay Region, Myanmar. The project proponent is Mandalay Business Capital City Development Ltd (MBCCD) which type is a wholly Myanmar investment with an authorized capital investment of 1,305,285.44 million Myanmar Kyat. It was established in 28th January, 2016 as a private company with company registration number 112465421 under the Myanmar Companies Act (1914) as shown in Appendix A. The project is planning to implement the urban development with an area of approximately 2,500 acres (1000 hectares) with different development sectors.

Mandalay Business Capital City Development Ltd., (MBCCD) has signed the Memorandum of Understanding (MoU) with Mandalay Regional Government in Mach 2016 for the Amarapura Urban Development Project at Amarapura Township, Mandalay Region. According to the agreement, Mandalay Business Capital City Development Ltd., has to develop an urban development at an area of around 2500 acres in Amarapura Township. The Amarapura Urban Development will be constructed following the laws of Myanmar including environmental law and regulations.

1.1.1. The Project Type and Location

The type of project is an urban development at an area of around 2500 acres in Amarapura Township. Currently, the condition of the project is construction phase and soil improvement, dyke wall construction and other construction activities are still construted in the project area. The project area is located beside the Ayeyarwaddy river. Therefore, most part of the project area is cropland which covered with shrub-land and seasonal crops such as ground nut, water melon, vegetables and seasonally flooded by the Ayeyarwady River water. The location map of the project site is presented in Figure 1-1.

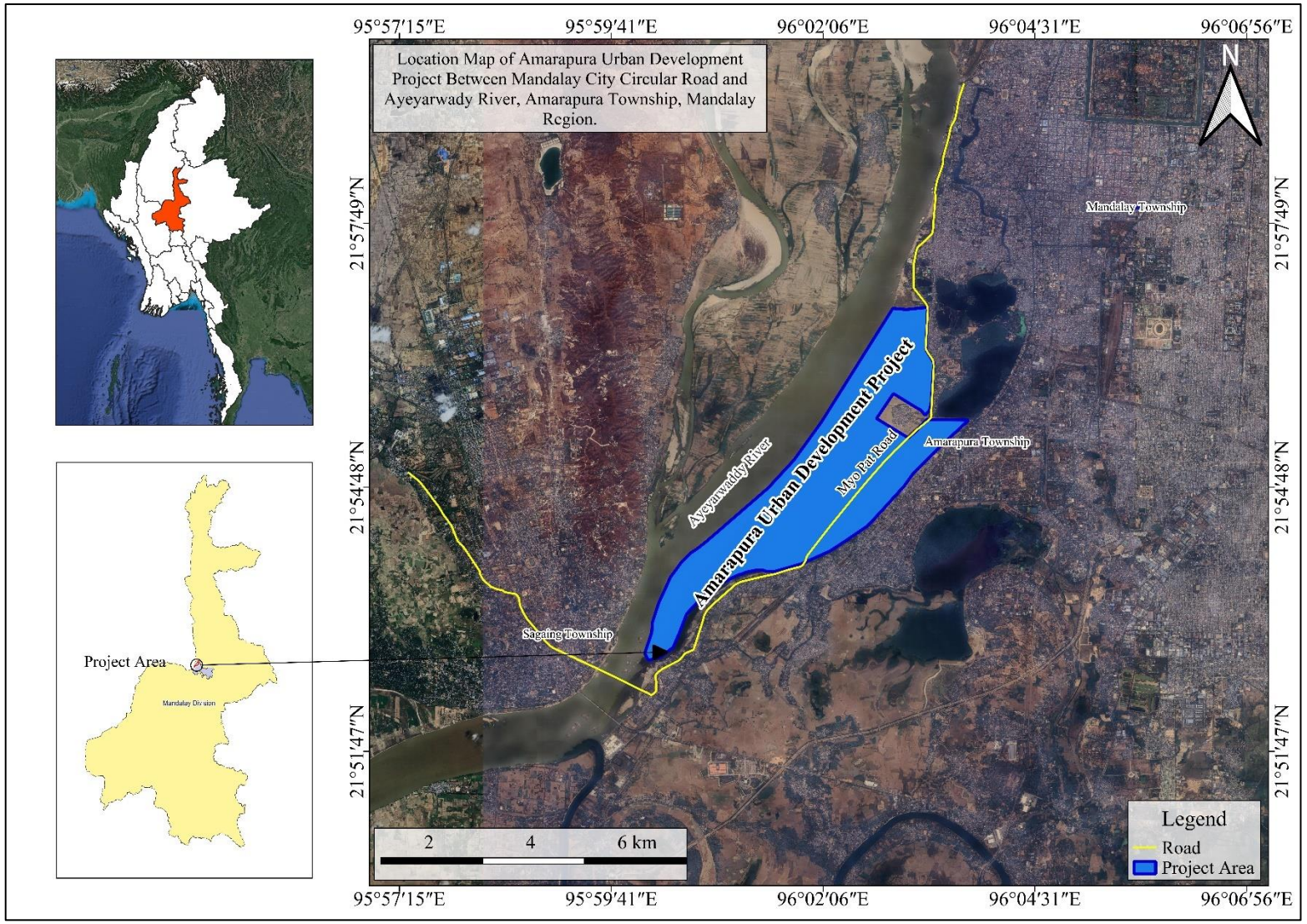

Location Map of Amarapura Urban Development Project Between Mandalay City Circular Road and Ayeyarwady River, Amarapura Township, Mandalay Region.
95°57′15″E
95°59′41″E
96°02′06″E
96°04′31″E
96°06′56″E
21°57′49″N
21°54′48″N
21°51′47″N
N
Mandalay Township
Amarapura Township
Amarapura Urban Development Project
Ayeyarwaddy River
Myo Pat Road
Sagaing Township
Project Area
Mandalay Division
2
4
6 km
Legend
Road
Project Area

Figure 1-1 Location Map of the Project Site

1.1.2. Purpose of the Project Implementation

The purpose of the project is to develop an environmentally sustainable a modern urban center, which will play an important role in the social economic growth of Mandalay City. In accordance with green growth and the green economy, the proposed project intends to develop a new urban area with a complete infrastructure. The project is intended to be built with the purpose of fostering sustainable urban development and offering the populace high-quality urban infrastructure. In Amarapura Township's Shan Kalay Kyun alluvial plain, MBCCD plans to develop a substantial new urban area with natural scenic views of the Ayeyarwady River and Sagaing highlands.

1.2. PURPOSE OF THE EIA STUDY

Environmental Impact Assessment (EIA) is mandated by the Environmental Conservation Law (No. 9/2012). Section 42 (b) of this law allows the Environmental Conservation Committee to establish and implement a system of environmental and social impact assessment. The EIA procedure (2015) provides detailed legal guidance on how the EIA process should work and outlines the responsibilities of government institutions and project proponents as well as the decision-making process surrounding initial environmental examination (IEE) and EIA report and/or environmental management plan (EMP) approval. The Ministry of Natural Resources and Environmental Conservation issues a certificate in accordance with Notice No. 616/2015. According to that announcement, the project proponent requested Hexagonal Angle International Consultants Co., Ltd (HA). to implement the Environmental Impact Assessment (EIA) for Amarapura Urban Development project in strict compliance with applicable national laws, rules, and regulations issued especially by the Environmental Conservation Department (ECD) under the Ministry of Natural Resources and Environmental Conservation (MONREC). The third-party confirmation approval letter is presented in **Appendix B**.

The EIA for the project identifies the principal approaches, procedures, and methods to control and minimize the environmental and social impacts of the project's operation. The main objectives of the EIA are (a) to identify, evaluate, and report the environmental and socio-economic impacts; (b) to define details of who, what, where, and when environmental management and mitigation measures are to be implemented; and (c) to ensure that the environmental quality of the area does not deteriorate due to the project.

The scoping report of the project was submitted to ECD on 10th November, 2021 and this report is approved from MONREC on 26th August, 2022. According to the approval letter, the final EIA report must be continuously submitted to MONREC after assessed the environmental impact during implementation of a project. In addition, the project proponent must follow up the article 55 of the EIA Procedure (2015),

1.3. EIA STUDY SCHEDULE

The HA Company starts the EIA research in October 2022, and it is completed in August 2023. According to Table 1-1, the estimated time frame for studying is six months. The HA company will proceed through each stage as planned.

Table 1-1 EIA Study Schedule

No.	Stages	2022-2023										
		October	November	December	January	February	March	April	May	June	July	August
1.	First Time Field Survey (Environmental and Biodiversity Survey)											
2.	Third Party Confirmation											
3.	Data Processing and Analysis											
4.	Impact assessment and analysis											
5.	Second Time Field Survey (Biodiversity Survey and Social Survey and Public Disclosure)											
6.	Data Processing and Analysis											
7.	Third Time Field Survey											
8.	Prepare Impact Assessment and Mitigation Measure of the Project											
9.	Prepare Environmental Management Plan											
10.	Conduct Public Consultation Meeting (Government and Local People)											
11.	EIA Report Preparation											
12.	EIA Report Submission to Client											

1.4. ECONOMIC STRATEGY

The project will be carried out in two stages, from 2017 to 2021 for the phase (1) and from 2022 to 2026 for the phase (2).

The project phase (1) includes design work, land purchasing, land reclamation, dyke wall construction, ground improvement work, and infra-structure work. In design work, it includes feasibility study, master plan, infrastructure design, dyke wall design, and ground improvement design. In infrastructure work, it includes road construction, storm drainage system, water supply system, wastewater system, solid waste system, power supply system, and communication and ELV system.

In the project phase (2), it intends to conduct continuing land purchasing, land reclamation, ground improvement work, and infrastructure work. In the infrastructure work, it also includes road construction, storm drainage system, water supply system, wastewater system, solid waste system, power supply system, and communication and ELV system.

The project proponent will employ the most of local people as worker for each phase. They purchase the necessary sand from a local provider for the land reclamation stage in order to compact the project site's land. For all construction projects, buy rock and other construction materials as a raw material from a nearby provider and it will build the infrastructure with both local and foreign contractors for each sector.

The project area is situated in the Amarapura Township and close to the Chan Mya Tha Zi and Maha Aung Myay Townships, the Ayeyarwaddy River bank and Sagaing Hill which have beautiful natural scenery. The project's goal is to create a modern, environmentally sustainable urban core that will be crucial to Mandalay City's social and economic development. As a result, it will be developed to increase the city's infrastructure and high level of living. In the future, the project proponent will sell or lent the land plot of residential and commercial area as well as relax and greening area to buyer. From a business standpoint, the location will develop into a key location for the economy.

1.5. RELATED PROJECTS AND DEVELOPMENT ACTION

There are three related projects near the study area. These are Shwege Stormwater pumping station, Shwe Kyet Yat port projects and Sagaing Bridge. Shwege stormwater pumping station is situated near the project area in west. Shwe Kyet Yat port projects and Sagaing Bridge is situated in the east west. Shwege Stormwater pumping station is the wastewater generation station of Mandalay city and the wastewater will be generated to the Ayeyarwaddy River. Shwe Kyet Yat port is the general cargo and fuel port of the Mandalay. Moreover, there is a famous bridge connecting Sagaing and Mandalay and it has been built to enhance trade and connectivity in the region. The bridge plays a crucial role in facilitating trade and transportation by providing easier access and connectivity between different regions.

1.6. THE INFORMATION ABOUT PROJECT PROPONENT

The organization chart of Mandalay Business Capital City Development Ltd. is shown in Figure 1-2 and List of Project Managers is shown in Table 1-3. A brief description of the project is given below Table 1-2.

Table 1-2 List of Information about Project Proponent

Company Name	Mandalay Business Capital City Development Ltd.	
Types of Business	Amarapura Urban Development Project	
Amount of Investment	500 billion Kyat	
Land use Area	2500 Acres	
Project Location	21° 55’ 7.02’’ N, 96° 2’ 19.51’’E.	
Office Location	No. (17/10), Corner of Myasandarst and 27th St, Pyigyimyetmhan Quarter, Chanayetharsan Township, Mandalay Region, Myanmar	
Project Proponent	Name	U Than Htike San
	Position	Managing Director
	Address	No. (17/10), Corner of Myasandarst and 27th St, Pyigyimyetmhan Quarter, Chanayetharsan Township, Mandalay Region, Myanmar
	Phone Number	09-969988890, 09-969988897
Contact Person	Name	U San Nyunt Zaw
	Position	Deputy Managing Director
	Address	No. (17/10), Corner of Myasandarst and 27th St, Pyigyimyetmhan Quarter, Chanayetharsan Township, Mandalay Region, Myanmar
	Phone Number	09-969988011

The responsible persons of project for construction and operation phase and their responsibility and contact information are presented in Table 1-3.

Table 1-3 **List of Project Manager (Construction and Decomission Phases)**

No	Name	Position	Email	Website	Address
1	U Than Htike San	Managing Director	thanhtikesan@saepaing.com	https://mbccd.com/	Mandalay Business Capital City Development Ltd
2	U San Nyunt Zaw	Deputy Managing Director	Sannyuntzaw262@gmail.com		
3	U Zaw Ye Win	Director	zawyewin@saepaing.com		

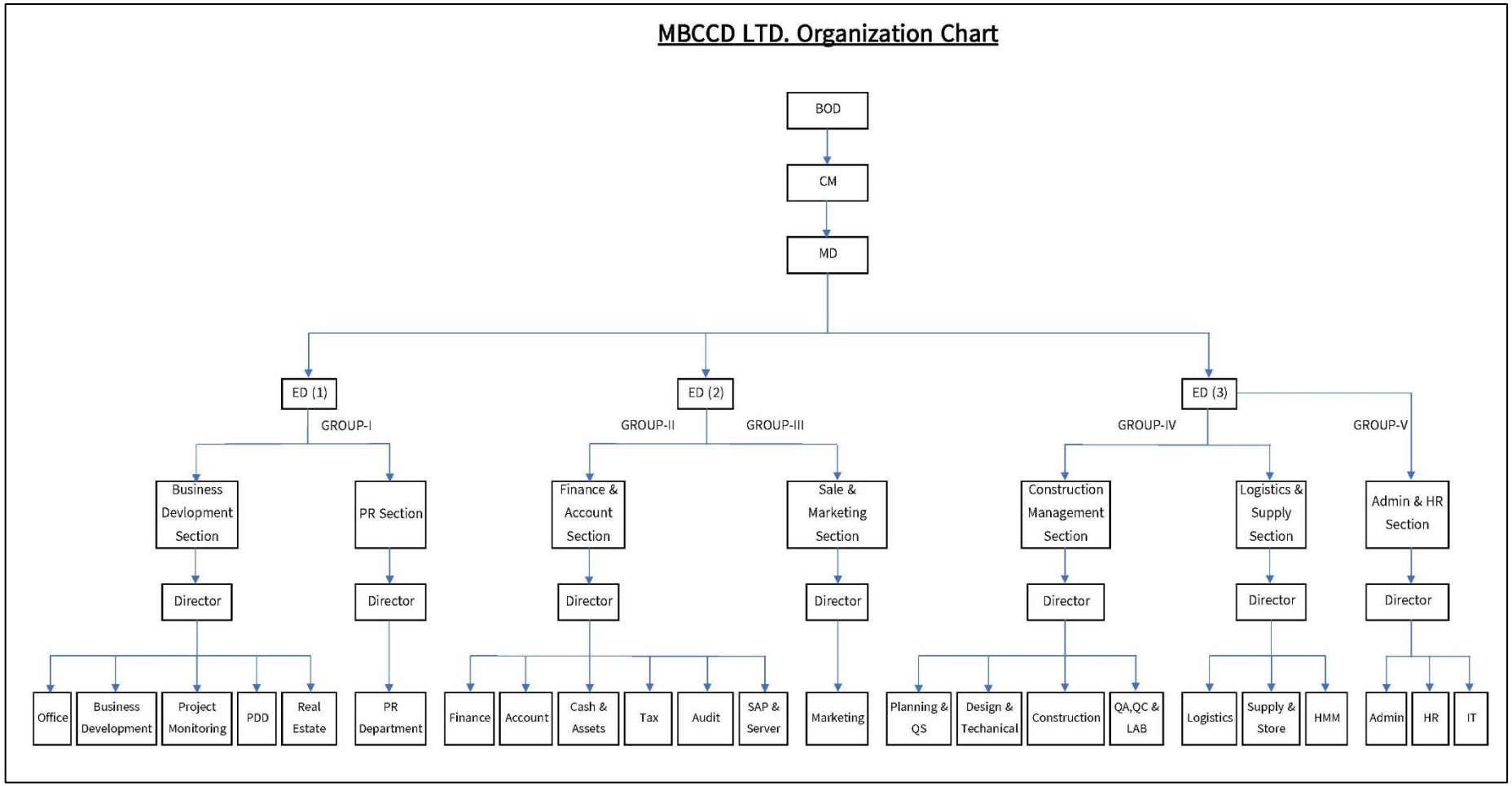


Figure 1-2 Organization Chart of Mandalay Business Capital City Development Ltd.

1.6.1. List of Directors

There are eleven members of directors in the company and lists of them are described in Table 1-4.

Table 1-4 List of Directors

No.	Name	NRC Number	Position
1.	Hsu Paik Yadanar	12/PABATA(N)033523	Director
2.	Khin San Dar	12/TAMANA(N)096351	Director
3.	Lan Chan	9/MAMANA(N)000447	Director
4.	Lwin Hnin Hnin	12/PABATA(N)005637	Director
5.	Phyu Thwe Hnin	8/THAYANA(N)078213	Director
6.	Su Su Myat Aye	8/KHAMANA(N)068017	Director
7.	Than Htike San	12/KHAYANA(N)001938	Director
8.	Than Lwin	9/YAMATHA(N)027059	Director
9.	Weik	12/PABATA(N)000908	Director
10.	Zaw Htay	12/KAMAYA(N)027634	Director
11.	Zaw Ye Win	12/MAGATA(N)011708	Director

1.7. THE DESCRIPTION OF ENVIRONMENTAL, HEALTH AND SOCIAL EXPERTS TEAM

1.7.1. EIA Consultant

Hexagonal Angle International Consultants Co., Ltd. (HA) is the third-party organization, which conducted the EIA of this project. The contact's name and address of the Environmental Consulting Organization described below:

Representative : Ms. Thu Thu Aung

Position : Managing Director

Mobil Phone : +95 9898333733

Office Phone : +95 13551620

Email : thuthuaung@hexagonalangle.com

Address : No. 99/1, Nan Thar Phyu Street, 14/3 Quarter, South Okkalapa Township, Yangon, Myanmar.

1.7.2. Background Information of HA Company

Hexagonal Angle International Consultants is a local company, leading the transport sector projects, environmental consulting, research & survey, business consultancy, coaching and trainings in Myanmar. The company is motivated by its intention to provide high quality services. We carefully select our consultants in order to offer our customers foremost quality of expertise together with extensive experience of industry practices. We have successfully teamed with Transport Specialist, GIS Specialist, Business Advisor, Environmental Specialist, Geologist, Engineer, Research and Survey Specialist, Project Management Specialist and Project Coordinator.

Its office is located at No. 99/1, Nan Thar Phyu Street, 14/3 Quarter, South Okkalapa Township, Yangon, Myanmar. The company was founded in September 2017 by Ms. Thu Thu Aung and the main idea is to collaborate with local experts and foreign consultants for government and development partners' transport sector projects. Since that time, our company participated in activities which are ADB's Myanma Railway Modernization project, ADB's Yangon-Pyay Railway On-board Passenger Survey and ADB & CDIA's Yangon Urban Transport Development project, Yangon Smart Car Parking System for YCDC, Traffic Survey Project for Shwe Taung Company, Level Crossing Survey Project for Yangon Circular Railway Upgrading Project and Mandalay-Lashio-Muse Railway Traffic Study and Freight Forwarding Survey Project. In addition, we will start the World Bank's Road Safety Project in Yangon & Mandalay Region.

Hexagonal Angle (HA) is supporting the services for environmental and social sector. The company have experts and team for environmental and social services which are Environmental and Social Impact Assessment (ESIA), Environmental Impact Assessment (EIA), Initial Environmental Examination (IEE), Environmental Management Plan (EMP), Social Survey and Monitoring Projects in Myanmar. There are over 20 projects which are Garment, Foundry, Pulp & Paper, Cement, Construction, Hotel, Mining, and Food & Beverages Industries in Myanmar Table 1-5 presents the key team members for the preparation of this IEE report who completed the report.

Hexagonal Angle (HA) has another business which is called "HA INSTITUTE" that was established on August 2019. HA Institute is now running the training programs for GIS, Data Visualization and Analysis, Environmental Studies, Social Studies and other online trainings. Furthermore, QGIS, social impact assessment and pollution control online training program are starting in mid-2020. The consultant registeration are described in **Appendix B**.

Table 1-5 Environmental Consultants Profile

Name	Role	Responsibility
Daw Thu Thu Aung	Team Leader	▪ Write physical environment of soil and analysis of soil characteristics and topography ▪ Soil conservation and erosion study, soil contamination studies and impact on soils ▪ Write potential impact on soil and landscape and soil contamination and landscaping management plan ▪ Produce soil map, seismic map and other maps ▪ Study and write waste generation, identification of hazard and hazardous substances. ▪ Analysis the risk and hazard and write mitigation measures of risk and hazardous ▪ Write mitigation measure and management plan of waste pollution ▪ Prepare the scope of environmental management and write environmental management plan ▪ Lead public consultation & disclosure and stakeholder engagement ▪ Lead project management
Daw Ei Ei Zaw	Member	▪ Study the baseline air quality measurement and write potential impact on ambient air quality for construction and operation/maintenance phases ▪ Write air quality management plan ▪ Study and analysis of alternative for water supply, flood protection alternative, alternative of revetment waterfront and typical storm drainage system ▪ Analysis on river level statistics, establishing of the project elevation level, ground water level, differences of elevation between water level and land level ▪ Study the river morphology of the project area ▪ Study and write hydrology, water level impact, flow velocity, morphological impacts, sediment extraction from nearby river bed and erosion of river bank ▪ Assessing and mitigating natural disaster risk of earthquake, floods and ground subsidence ▪ Identifying the environmental impact assessment methodology, potential environmental impacts of the projects and potential impacts and sources for each project phases ▪ Study and write potential environmental impacts and mitigation measures of ambient air

Name	Role	Responsibility
		quality
Daw Thandar Kyaw	Member	▪ Study and write the baseline environmental air quality of wet and dry seasons for different locations ▪ Designing and development of questionnaire formats for baseline surveys ▪ Compiling, tabulating and analyzing the collected data including demographic and socio-economic ▪ Study and write socio economic component for demography, minority and religious, education level, economic condition ▪ Analyze and write social impacts and mitigation measures of livelihood, local population during construction and operation/maintenance phases ▪ Prepare and write the public consultation and disclosure for scoping and EIA stages ▪ Study physical environment of climate and metrology and geology ▪ Write cumulative impact assessment of the affected projects
U Win Thein	Member	▪ Conduct baseline environmental quality for noise and vibration monitoring in wet and dry seasons ▪ Analysis the potential environmental impact on noise and vibration ▪ Write impact assessment and management plan of noise and vibration ▪ Write risk assessment methodology for hazard identification and risk evaluation and control ▪ Assessing and mitigating the risks for occupational safety risk, community risk, health impact assessment Risk Assessment and Hazard Management ▪ Write risk management plan and emergency response plan for occupational health and safety and natural disasters ▪ Study current transportation system and traffic data ▪ Support traffic management plan

Name	Role	Responsibility
U Kyaw Thet	Member	▪ Collect baseline data of birds and biodiversity ▪ Make taxonomy for resource inventory of fauna ▪ Prepare the status of endangered animal species ▪ Analysis of collected data ▪ Study of habitat and rehabilitation system of project area ▪ Report writing of mitigation measure and management plan for fauna
Daw Su Myat Noe	Member	▪ Studies the international, regional and domestic rules and regulation ▪ Conduct and analyze the legal related documents of project ▪ Conduct assessment of legal requirements for project ▪ Prepare Myanmar Government Institutional Framework ▪ Prepare commitments table ▪ Report writing of standard guideline, rules, laws, standards
Daw Chue Shwe Sin Kyi	Member	▪ Prepare water supply for project utilities ▪ Study the analysis of water supply alternative ▪ Write water quality monitoring in wet and dry seasons ▪ Analysis the potential environmental impacts and mitigation measures of water pollution ▪ Write water pollution management plan
Dr. Khin Khin Wai	Member	▪ Study the context of the project and background, purpose and study team ▪ Write project description of the project and overview of the project ▪ Study the component of the project for technology, infrastructure and land use ▪ Analysis of the project development alternative, location, technology and power supply alternative ▪ Write the characteristics of residential area, infrastructure and landuse

Name	Role	Responsibility
Daw Khant Zin Thant	Member	▪ Identification and analysis of hazard and hazardous substances ▪ Write mitigation measures of risk and hazardous ▪ Planning of risk management and hazard management ▪ Prepare waste and sewage management ▪ Report writing of mitigation measure and management plan of solid waste and hazardous waste
U Win Naing Oo	Member	▪ Manage and collect the baseline environmental quality of air, water and soil quality for dry and wet seasons ▪ Collect socio economic component, demography, religious, education and health data of project surrounding area ▪ Facilitating and coordinating for social and cultural activities of local communities ▪ Designing and development of questionnaire formats for baseline surveys ▪ Compiling, tabulating and analyzing the collected data including demographic and socio-economic data ▪ Collect health questions to community of surrounding project area. ▪ Conduct questions to key stakeholders and the relevant host community health authorities ▪ Report writing of health management plan and analysis report ▪ Lead traffic data collection for traffic survey
Daw Su Myat Mon	Member	▪ Collect insect and flora for the study area for three seasons ▪ Make taxonomy for resource inventory of fauna ▪ Prepare the status of endangered plant and animal species ▪ Analysis of collected data ▪ Study of habitat and rehabilitation system of project area ▪ Report writing of mitigation measure and management plan for fauna

Name	Role	Responsibility
Daw Myat Noe Pwint	Member	▪ Write project utilities for raw material, machineries and equipment, employment, water and power supply ▪ Collect social and traffic data for study ▪ Study landuse type and coverage of project area ▪ Analysis on soil type and conservation due to project ▪ Township and project area landuse type study and analysis and report writing ▪ Produce GIS maps for study
U Aung Kyaw Phyo	Member	▪ Check & analyze the ambient air quality for project & study scope ▪ Write the wind speed, wind direction, meteorology and hydrology data ▪ Write the assessment of climate change and air quality analysis ▪ Conduct noise & vibration data of project area ▪ Analysis of data collection and report writing of noise & vibration ▪ Define sensitive area of noise & vibration impact ▪ Analyze and write control measures for vehicular noise, noise from project area, noise from community activities & indoor noise
Daw Khin Htet Tay Zar Maung	Member	▪ Participate the study team for project implementation. ▪ Support public consultation meeting ▪ Attend the concept plan and implementation plan meeting with study team ▪ Report reviewing the report contents, concept and report
Dr. Aung Swe	Member	▪ River channel assessment and river sediment analysis, ▪ Remote sensing and GIS, ▪ Alluvial channel morphology ▪ River bank drainage network study
Dr. Pyi Soe Thein	Member	▪ Seismic data analysis and processing

Name	Role	Responsibility
		▪ Geotechnical analysis and engineering ▪ Geotechnical data research ▪ Ground motion research
Dr. Aung Kyaw Myat	Member	▪ Landslide prediction and management ▪ Geotechnical engineering ▪ Hydrology, ground water and modeling, ▪ Geology and soil, ▪ Earthquake and seismic assessment and management, ▪ Flood analysis and management, ▪ Seismic analysis, landslide analysis, geophysics
Daw Hnin Aye Aye Naing	Member	▪ Signaling design and traffic forecast ▪ Traffic impact assessment ▪ Geometric design and cost estimation ▪ Prepare technical report and site supervision

CHAPTER 2

POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

2.1. THE INTRODUCTION

The Hexagonal Angle Company Limited has been appointed by the Mandalay Business Capital City Development Ltd (MBCCD) to prepare the EIA report for the Amarapura Urban Development Project. This chapter of the report mainly entailed stating and recommending a legal and regulatory framework for existing legal rights of national laws and regulations relating to natural resource conservation, labour rights, land use rights, and laws relating to employees within Myanmar, whilst sub-chapters include the international laws, international treaties, and conventions. It is essential for MBCCD to identify and implement appropriate legal arrangements which were required for performing the urban development project. This chapter will be the summary of the regulations and legal framework for the proposed project and recommendations to regulatory frameworks that fit with the Myanmar context and requirements will be covered. The project proponent is committed to the existing relevant Myanmar Laws, rules, and regulations. The Project Proponent will be followed and committed to National laws and regulations for environmental protection of Myanmar which are as the following Table 2-1.

Table 2-1 Commitment of the National Laws and Regulations in Myanmar

Sr	Laws and regulations	Enacted Year	Committed Section
Environmental Conservation			
1	The Constitution of the Republic of the Union of Myanmar	2008	37, 45, 390
2	The Environmental Conservation Law	2012	7 (o), 14, 15, 24, 29
3	The Environmental Conservation Rules	2014	
4	Environmental Impact Assessment Procedure	2015	102, 103, 104, 105, 106, 107, 108, 109, 110, 113, 115, 117
5	National Environmental Quality (Emission) Guidelines	2015	-
Forest, Biodiversity and Natural Resources			
6	Underground Water Act	1930	3, 5
7	Forest Law	2018	12 (a)
8	Forest Rules	1995	20, 22, 36, 60
9	The Conservation of Biodiversity and Protected Area Law	2018	35 (a), (c), (d), 29 (e), 39 (d)

Sr	Laws and regulations	Enacted Year	Committed Section
10	The Conservation of Water Resources and Rivers Law	2006 (Amended 2017)	6, 8 (a), 11, 19, 21 (b), 22, 24 (b), 30
11	The Conservation of Water Resources and Rivers Rules	2013	8
Human Rights and Cultural Heritage			
12	The Ethnic Rights Protection Law	2015	5
13	The Ethnic Rights Protection Rules	2019	20, 21
14	The Protection and Preservation of Cultural Heritage Regions Law	2019	2, 18, 19, 21 (b)
15	The Protection and Preservation of Antique Objects Law	2015	2, 12, 13
16	The Protection and Preservation of Ancient Monuments Law	2015	2, 12, 15, 20
Land use			
17	National Land Use Policy	2016	-
18	Land Law	2012	30
19	The Vacant, Fallow and Virgin Lands Management Law	2012 (Amended 2018)	10 (a), 19 (a), (d)
Urban Development and Industrial			
20	The City of Mandalay Development Law	2002 (Amended 2016)	8
21	Myanmar National Building Code	2016 (Amended 2020)	-
22	The Electricity Law	2014	20, 21 (a), 24, 27, 29, 33, 40, 68
23	Private Industrial Enterprise Law	1990	27
24	The Industrial Zone Law	2020	3, 28, 29
25	Prevention of Hazard from Chemical and Related Substances Law	2013	15 (a), (b), 16 (b) to (j), 17, 22, 27 (a) to (d)
26	Prevention of Hazard from Chemical and Related Substances Rules	2016	-
27	The Factories Act	1951 (Amended 2016)	7, 47, 48, 49, 62
28	Myanmar Engineering Council Law	2013	34

Sr	Laws and regulations	Enacted Year	Committed Section
Economic and Investment			
29	Myanmar Investment Law	2016 (Amended 2019)	50, 51, 65, 73
30	Myanmar Investment Rules	2017	202, 203, 206, 212
31	The Myanmar Companies Law	2017	2 to 10
32	Myanmar Insurance Law	1993	15, 16
33	Income Tax Law	1974 (Amended 2016)	26
34	The Export and Import Law	2012	7
35	The Shop and Establishment Act	1951	3, 20, 24
Workers and Workplace			
36	The Social Security Law	2012 (Amended 2014)	11 (a), 15 (a), (b), 18 (b), 48 (b), 75
37	The Minimum Wage Law	2013 (Amended 2023)	12, 13
38	The Minimum Wages Rules	2013 (Amended 2015)	43, 44
39	The Payment of Wages Law	2016	3, 4, 5, 14, Chapter 3
40	The Leave and Holidays Act	1951	5
41	The Labour Organization Law	2011 (Amended 2012)	18, 19, 20, 21, 22
42	The Labour Organization Rules	2012	29, 30
43	The Settlement of Labour Dispute Law	2012 (Amended 2019)	38 (a), 39, 40, 51
44	The Employment and Skill Development Law	2013	5, 14, 30
45	The Workmen's Compensation Act	1923	12, 13
46	Occupational Safety and Health Law	2019	12, 14, 16, 17, 18, 26, 27, 34, 36
47	The Petroleum and Petroleum Product Law	2017	8 (a), (c), 9 (a), (e), 10 (a), (b), (d),(e), 11
48	The Petroleum Rules	1937	Chapter 3 and 5
49	The Standardization Law	2014	16, 17, 19
Health			
50	Public Health Law	1972	3, 5

Sr	Laws and regulations	Enacted Year	Committed Section
51	Prevention and Control of Communicable Diseases Law	1995	3 (a) (9), 4, 11
52	The Control of Smoking and Consumption of Tobacco Product Law	2006	9
Transportation			
53	Vehicle Safety and Vehicle Management Law	2020	9 (a), 12 (c), 14 (r), 18 (a), 81 (g)
54	Vehicle Safety and Vehicle Management Rules	2022	252, 253, 254, 256, 261, 262, 263, 269, 271
55	Multimodal Transport Law	2015	3
Emergency			
56	Natural Disaster Management Law	2013	14 to 18
57	The Myanmar Fire Force Law	2015	25

2.2. MYANMAR GOVERNMENT INSTITUTIONAL FRAMEWORK

Myanmar has 23 ministries under the Office of the President as of 2021. The leading ministries in charge of environmental and social considerations are the Environmental Conservation Department of the Ministry of Environmental Conservation and Forestry (MOECAF), now transformed into the Ministry of Natural Resources and Environmental Conservation (MONREC), the Ministry of Agriculture, Livestock and Irrigation (MOALI), the Ministry of Labour, Immigration & Population (MOLES) and the Ministry of Social Welfare, Relief & Resettlement. Institutional structure of MONREC is shown in Figure 2-1.

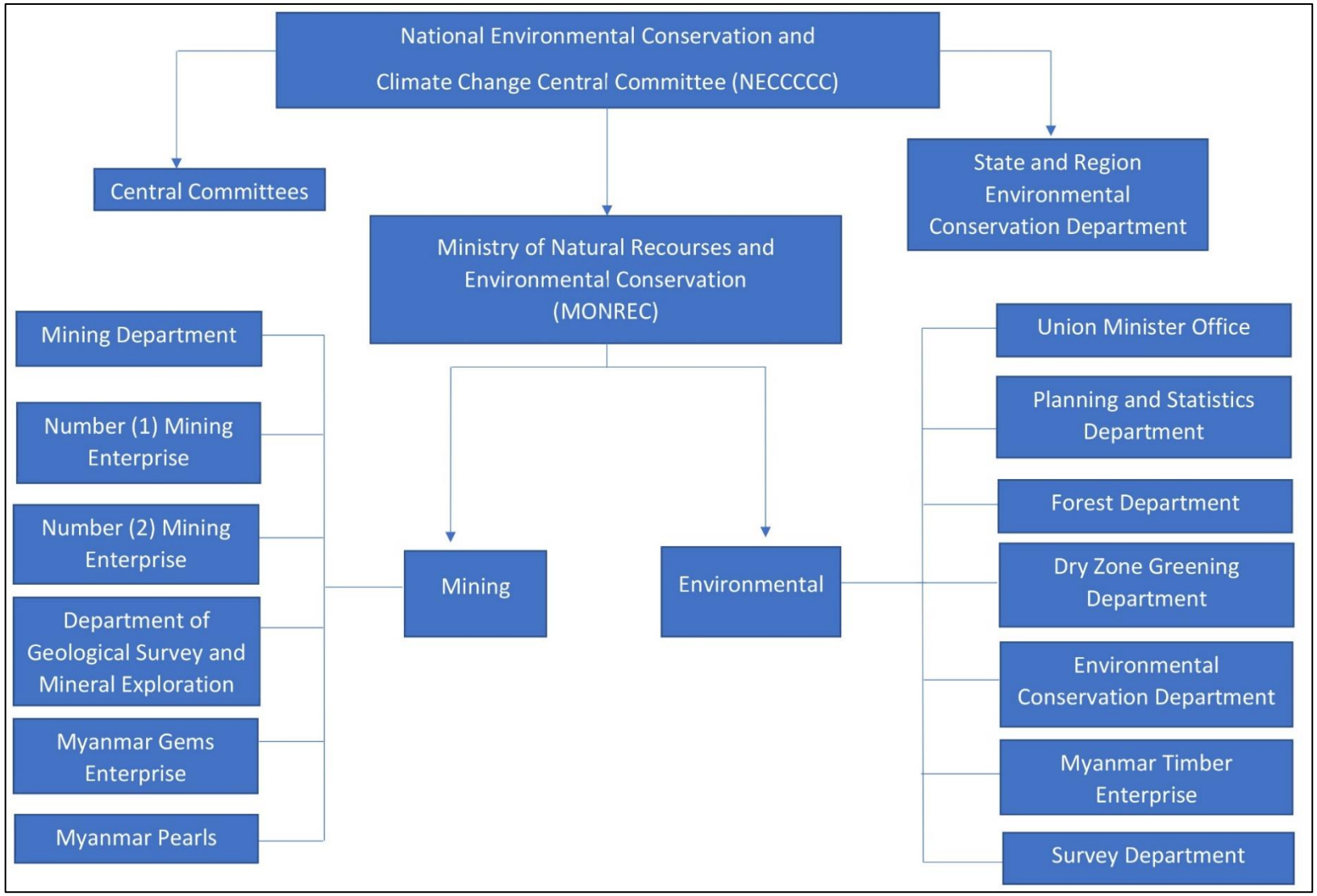


Figure 2-1 Institutional Structure of the Ministry of Natural Resources and Environmental Conservation

2.2.1. National Policy and Legal Framework

According to the Myanmar Constitution (2008) - Section 45: 'the Union shall protect and conserve natural environment'. Additionally, Section 390 (b) states that 'every citizen has the duty to assist the Union in carrying out the following matters:

- Preservation and safeguarding of cultural heritage
- Environmental conservation
- Striving for development of human resources
- Protection and preservation of public property

This represents the highest commitment of the Republic of the Union of Myanmar to responsible environmental management.

Part of Myanmar's reform process involves updating and enforcing environmental policy and legislation. The Government of Myanmar has publicly stated its commitment to a development path that is economically strong, but also socially and environmentally sustainable for its citizens. The Framework for Economic and Social Reform (FESR 2013) and the National Comprehensive Development Plan (NCDP 2011-2030) express this vision.

The Environmental Conservation Law (ECL 2012) and Rules (ECL Rules 2014) both have implications for domestic and foreign investors in Myanmar. Section 7 of the ECL states the duties and powers of the Ministry of Environmental Conservation and Forestry (MOECAF), which includes prescribing environmental quality standards on emissions, effluents, solid waste, production procedures, processes and products, facilitating the settlement of environmental disputes, specifying categories and classes of hazardous wastes generated from the production and use of chemicals or other hazardous substances used in industry, agriculture, mineral production, sanitation and other activities, prescribing categories of hazardous substances that may significantly affect the environment, prescribing the terms and conditions for effluent treatment in industrial estates, buildings, and other sites and emissions of machines, vehicles and mechanisms, developing and implementing a system of environmental impact assessment (EIA) and social impact assessment (SIA), enforcing compensation by polluters for environmental impacts; collecting funds from organizations which benefit from natural ecosystems and revenues from businesses which explore, trade and use natural resources, in order to support environmental conservation works.

The National Environmental Conservation and Climate Change Central Committee (NECCCCC) was formed in 2011 with the aim to achieve sound environmental management in the country. With a view to effectively implementing the protection and conservation of the environment the new government in 2016 has created the new ministry, Ministry of Natural Resources and Environmental Conservation (MONREC). It is believed that effective and meaningful management of the environmental affair will be achieved. The Environmental Conservation Department (ECD) is the focal and coordinating agency for the overall and detail environmental management throughout the country.

As this project is carrying out in Myanmar, the project proponent will follow and commit to the laws and regulations enacted by the Ministry of Environmental Conservation and Forestry, Ministry of Natural Resources & Environmental Conservation and the laws enacted by the Pyidaungsu Hluttaw that are relating to the environmental conservation, workplace and environment safety and health. The project proponent to follow laws, rules and regulations, procedures and guidelines are included in this chapter.

2.2.1.1. National Environmental Policy (2019)

The National Environmental Policy provides long-term, strategic guidance for achieving a sustainable future for Myanmar. It requires the mainstreaming of environmental protection into planning and decision-making at all levels of government and in all sectors. Its detailed principles respect livelihood needs and development objectives while at the same time recognizing the full value of Myanmar's ecosystems and the implications of climate change. This Policy ensures that environmental protection continues to be a central objective in Myanmar's sustainable development pathway. This Policy builds on Myanmar's 1994 National Environment Policy and reaffirms its core values:

(a) The wealth of the nation is its people, its cultural heritage, its environment and its natural resources.

(b) It is the responsibility of the State and every citizen to preserve our natural resources in the interests of present and future generations.

(c) Environmental protection should always be the primary objective in seeking development.

(d) Section 3, This Policy builds on Myanmar's 1994 National Environment Policy and reaffirms its core values:

(e) The wealth of the nation is its people, its cultural heritage, its environment and its natural resources.

(f) It is the responsibility of the State and every citizen to preserve our natural resources in the interests of present and future generations.

(g) Environmental protection should always be the primary objective in seeking development.

Section 4, It also builds on the 1997 Myanmar Agenda 21, the 2009 National Sustainable Development Strategy. It is grounded in the environmental responsibilities in the 2008 Constitution of the Republic of the Union of Myanmar, and the obligations contained in the 2012 Environmental Conservation Law. It also aligns with, and expands upon, the environmental considerations in the 2015 National Comprehensive Development Plan and the 2018 Myanmar Sustainable Development Plan. The Policy recognizes and integrates Myanmar's commitments to Multilateral Environmental Agreements, including the 2015 Paris Agreement.

As this project is carrying out in Myanmar, the project proponent will follow and commit to the laws and regulations enacted by the Ministry of Environmental Conservation and Forestry, Ministry of Natural Resources & Environmental Conservation and the laws enacted by the Pyidaungsu Hluttaw that are relating to the environmental conservation, workplace and environment safety and health.

Figure 2-2 Linkages between the National Environmental Policy, Strategic Framework and Master Plans

2.2.1.2. National Waste Management Strategy and Master Plan (2018-2030)

Myanmar has had to face tremendous challenges in waste management in the recent past, due to many factors including the growing population, economy, increasing complexity of waste streams and lack of effective waste management systems, proper infrastructure, capital investment, financial and human resources, as well as effective policy and regulatory environment. To solve these issues, the National Waste Management Strategy and Master Plan (2018-2030) was developed by the MONREC with the assistance of the International Environmental Technology Centre (ETC) of the United Nations Environment Programme (UN Environment) and the IGES Centre Collaborating with UNEP on Environmental Technologies (CCET).

The aim of the National Waste Management Strategy and the Master Plan is to develop and implement the holistic and integrated waste management strategy based on the principles of inclusiveness, zero waste, zero emissions, and circular economy to achieve a greener, cleaner and healthier environment in Myanmar.

2.2.1.3. Myanmar Climate Change Strategy (2018-2030)

The Myanmar Climate Change Strategy (MCCS) 2018-2030 has been formulated and adopted to provide a roadmap for Myanmar to strategically address climate-related risks, and also seize opportunities, over the next 13 years and beyond. The MCCS fully builds on the Myanmar Climate Change Policy' (MCCP) principles and also upholds principles of inclusive development, resource-efficient development, integrated development, results-oriented development.

The MCCS is aligned with Myanmar's development policies and supports the National Comprehensive Development Plan (NCDP), Myanmar Sustainable Development Plan (MSDP) and National Sustainable Development Strategy and is mandated by the MCCP as well as the National Adaptation Programme of Action (NAPA) and the Nationally Determined Contribution (NDC). The MCCS also complements the country's Green Growth Strategy which is currently under preparation.

2.2.1.4. National Land Use Policy (2016)

Myanmar is a country that has rich natural resources and environment, the land resources shall be managed, administered and used, with special attention, by adopting long-term objectives for the livelihood improvement of the citizens and sustainable development of the country, When the land resources are systematically used and well managed, the more it will be possible to fulfill the basic needs of the citizens, develop the social and economic life of the people, and develop the country harmoniously.

Under section 37 of the Constitution of the Republic of the Union of Myanmar, it is provided that the Union is the ultimate owner of all lands in the Union, shall enact necessary law to supervise extraction and utilization of State-owned natural resources by economic forces; shall permit citizens right of private property, right of inheritance, right of private

initiative and patent in accord with the law. According to such provision, the President of the Union also guided on 19th June, 2012 to adopt a necessary, strong and precise policy for the sustainable management, administration and use of the land resources of the country, as such, " the National Land Use Policy " has been developed.

This National Land Use Policy aims to implement, manage and carry out land use and tenure rights in the country systematically and successfully, including both urban and rural areas, in accordance with the objectives of the Policy and shall be the guide for the development and enactment of a National Land Law, including harmonization and implementation of the existing laws related to land, and issues to be decided by all relevant departments and organizations relating to land use and tenure rights.

The objectives of the National Land Use Policy are as follows:

a. To promote sustainable land use management and protection of cultural areas, environment, and natural resources for the interest of all people in the country;
b. To strengthen land tenure security for the livelihood's improvement and food security of all people in both urban and rural areas of the country;
c. To recognize and protect customary land tenure rights and procedures of the ethnic nationalities;
d. To develop transparent, fair and independent dispute resolution mechanisms in accordance with rule of law;
e. To promote responsible investment in land resources in order to support the equitable economic development of the country
f. To develop a National Land Law in order to implement the above objectives of National Land Use Policy.

2.3. PROJECT PROPONENT INSTITUTIONAL FRAMEWORK

The institutional framework of project proponent consists of seven sections and the organizational structure of the institutional arrangement of the project proponent is shown in Figure 2-3.

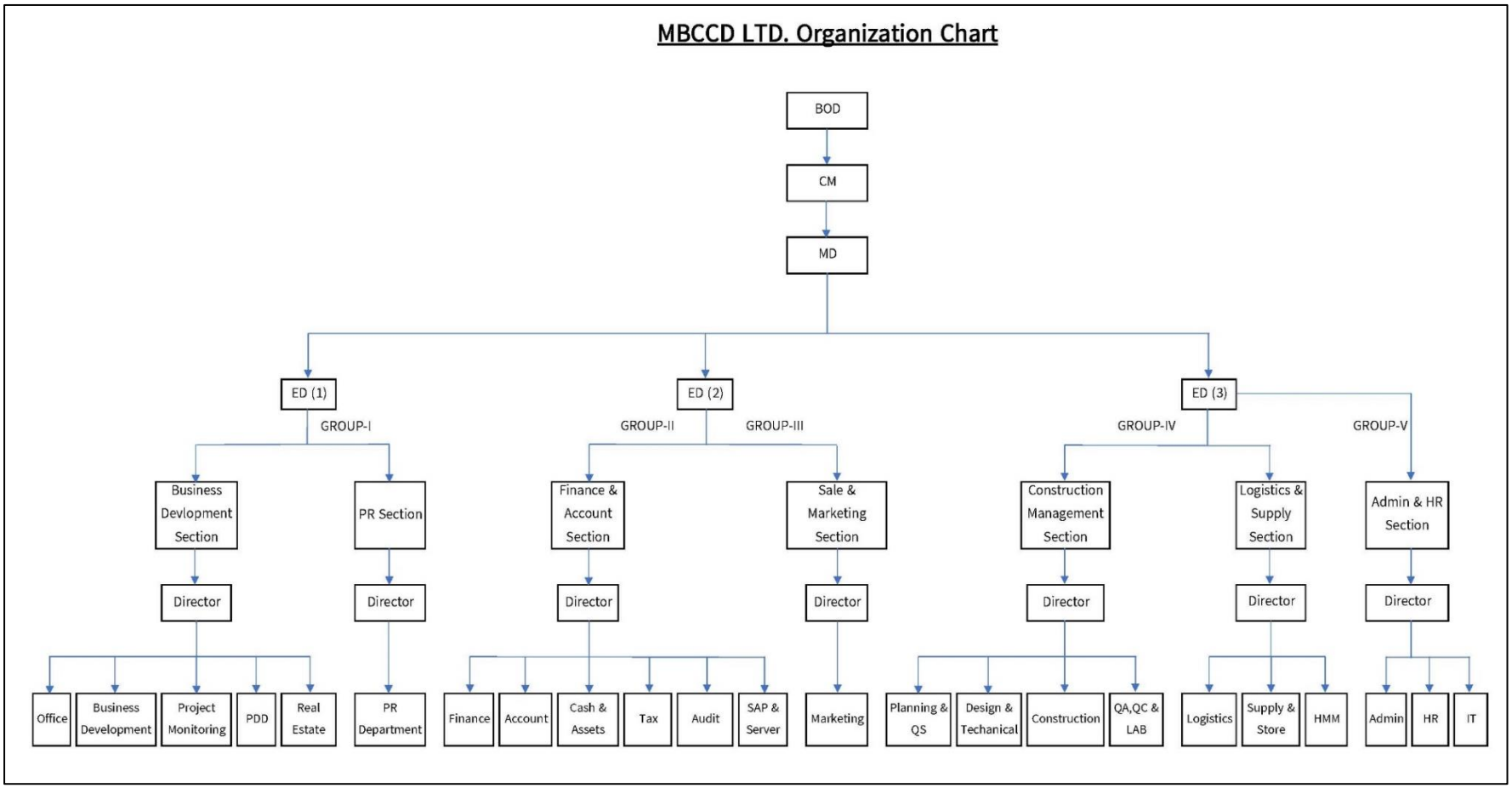


Figure 2-3 Institutional Arrangement of the Project Proponent

The EMP cell is a small core organization consisting of ten staff members that manages environmental management plan, monitoring plan and mitigation measure implementation. The EMP member list will be updated as needed with more employees. The organization structure of environmental management and monitoring team is shown in Figure 2-4 and their responsibilities is described in Table 7-1 and Table 7-21.

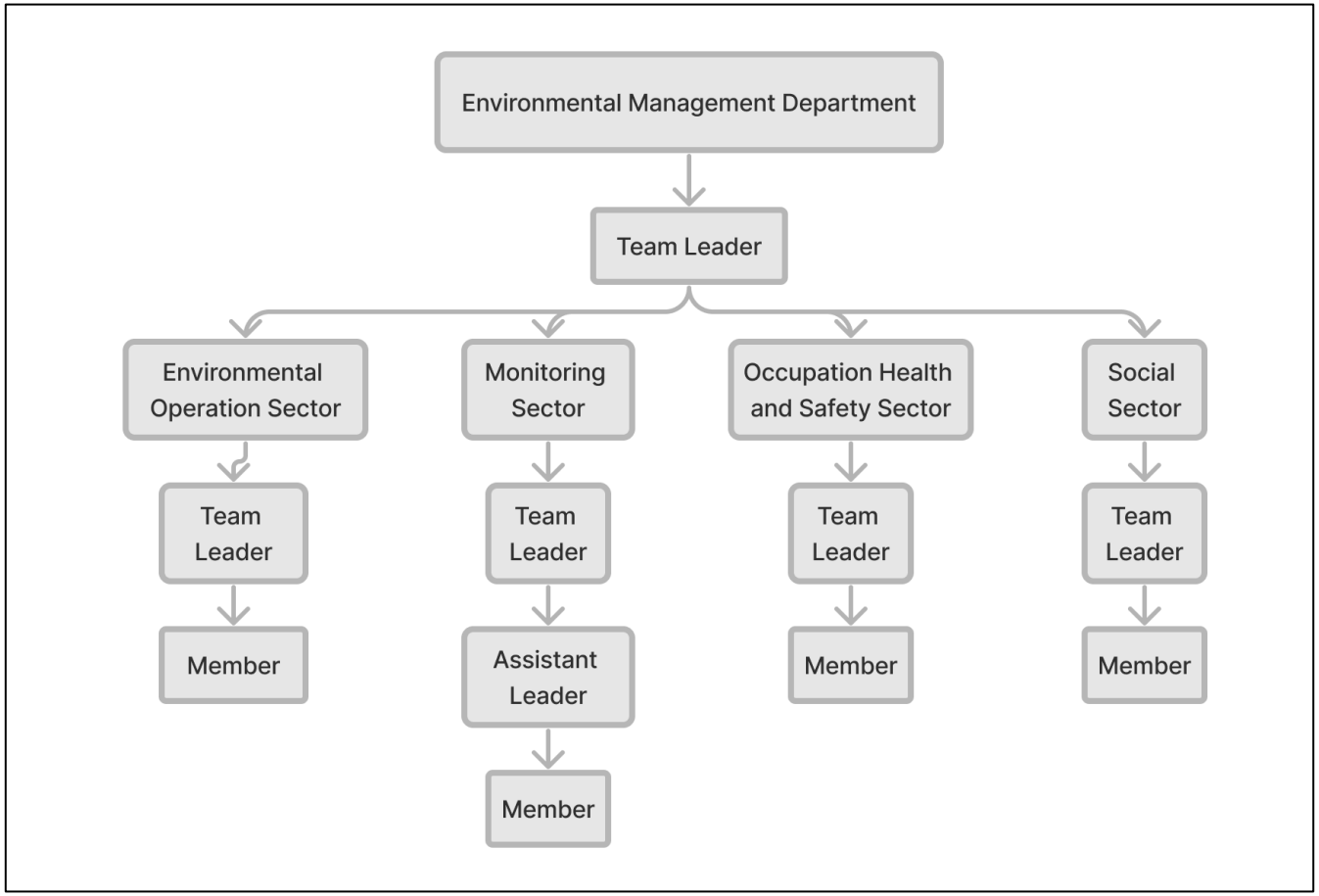


Figure 2-4 Organization Structure of Environmental Management and Monitoring Team

The list of responsible government departments involved in the stages of project operations and the activities of government departments and organizations related to the project.

Table 2-2 Related department to the Project

Sr.	Related Departments	Related Context	Location
1	Mandalay City Development Committee (MCDC)	Project Permission	Manadalay Region
2	Ministry of Religious Affairs and Culture (MORAC)	Pagoda repairing and renovations	Manadalay Region
3	Myanmar Investment Comission (MIC)	Submission of project completion report once every 3 months	Manadalay Region
4	Directorate of Water Resources and Improvement of River Systems (DWIR)	Permits to build dyke walls, licensing for sand mining production location	Manadalay Region
5	Inland Water Transport (IWT)	Sand Pumping Permit and Licensing	Manadalay Region
6	Environmental Conservation Department (ECD)	EIA Matters	Amarapura Township, Amarapura District, Nay Pyi Taw
7	General Administration Department (GAD)	Land issues, sand mining license and general	Amarapura Township, Amarapura District, Manadalay Region
8	Department of Agricultural Land Management and Statistics (DALMS)	Land issues	Amarapura Township, Amarapura District, Manadalay Region
9	Mandalay Electricity Supply Corporation (MESC)	Electrical energy issues	Amarapura Township, Amarapura District, Manadalay Region
10	Department of Fisheries (DOF)	Inland fisheries in the project area	Amarapura Township, Amarapura District, Manadalay Region
11	Internal Revenue Department	Taxation	Amarapura Township, Amarapura District, Manadalay Region
12	Planning Department	-	Amarapura Township
13	Municipal Administration Office	Licesening	Amarapura Township
14	Fire Department	Fire safety	Amarapura Township, Amarapura District, Manadalay Region
15	Ministry of Energy	Fuel matters	Manadalay Region
16	Ministry of Mines	Fuel matters	Manadalay Region
17	Petroleum Products Supervision and	Fuel matters	Manadalay Region

Sr.	Related Departments	Related Context	Location
	Inspection Department		
18	Directorate of Industrial Supervision and Inspection	License applying for Transformers	Manadalay Region
19	Factories and General Labour Laws Inspection Department	Labour matters	Amarapura Township

2.4. LAWS AND REGULATIONS RELATED TO THE PROJECT

The Project Proponent is committed to follow these laws relating to environmental and social issues and their relevance to the EIA study for the proposed project:

2.4.1. Laws Relating to Environmental Conservation

2.4.1.1. The Constitution of the Republic of the Union of Myanmar, 2008

The Constitution of the Republic of the Union of Myanmar (2008) states in the Section 37 that the Union (a) 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, (b) the Union shall enact necessary law to supervise extraction and utilization of State-owned natural resources by economic forces, (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 45, the Union shall protect and conserve natural environment.

Section 390, Every citizen has the duty to assist the Union in carrying out the following matters (a) preservation and safeguarding of cultural heritage, (b) environmental conservation, (c) striving for development of human resources, and (d) protection and preservation of public property. As the Sections said, the following and implementation of the conservation of the environment is one of the most important priorities of the government.

2.4.1.2. The Environmental Conservation Law (2012)

The Environmental Conservation Law was enacted in March 2021 by MOECAF, and this law the fundamental law of environmental management and environmental conservation in Myanmar. The laws related to the proposed project are as these following Sections:

Section 4 mentioned that the duties and powers relating to the environmental conservation of the Ministry are as follows:

(a) implementing the environmental conservation policies;

(b) planning and laying down national or regional work plans relating to environmental management;

(c) laying down, carrying out and monitoring programs for conservation and enhancement of the environment, and for conservation, control and abatement not to cause environmental pollution;

(d) prescribing environmental quality standards including standards on emissions, effluents, solid wastes, production procedures, processes and products for conservation and enhancement of environmental quality;

(e) submitting proposals to the Committee for economic incentive mechanisms and terms and conditions which may not affect the environment or cause least environmental affect for sustainable development in addition to legal affairs and guidelines relating to environment;

(f) facilitating for the settlement of environmental disputes and, if necessary, forming bodies to negotiate such disputes;

(g) specifying categories and classes of hazardous wastes generated from the production and use of chemicals or other hazardous substances in carrying out industry, agriculture, mineral production, sanitation and other activities;

(h) prescribing categories of hazardous substances that may affect significantly at present or in the long run on the environment;

(i) promoting and carrying out the establishment of necessary factories and stations for the treatment of solid wastes, effluents and emissions which contain toxic and hazardous substances;

(j) prescribing the terms and conditions relating to effluent treatment in industrial estates and other necessary places and buildings and emissions of machines, vehicles and mechanisms;

(k) negotiating, cooperating and implementing in respect of international, regional and bilateral agreements, instruments and programs relating to matters of environment;

(l) implementing the international, regional and bilateral agreements accepted by Myanmar for environmental conservation and enhancement of environmental quality in accord with the guidance adopted by the Union Government or the Committee;

(m) causing to lay down and carry out a system of environmental impact assessment and social impact assessment as to whether or not a project or activity to be undertaken by any Government department, organization or person may cause a significant impact on the environment;

(n) laying down guidance relating to the management, conservation and enhancement of environment for the matters of protection of ozone layer, conservation of biological diversity, conservation of coastal environment, mitigation and adaptation of global warming and climate change, combating desertification and management of non-depleting substances and management of other environmental matters;

(o) managing to cause the polluter to compensate for environmental impact, cause to contribute fund by the organizations which obtain benefit from the natural environmental service system, cause to contribute a part of the benefit from the businesses which explore, trade and use the natural resources in environmental conservation works;

(p) carrying out other functions and duties assigned by the Union Government relating to environmental conservation.

Section 7, The duties and powers relating to the environmental conservation of the Ministry are as follows:

(o) managing to cause the polluter to compensate for environmental impact, cause to contribute fund by the organizations which obtain benefit from the natural environmental service system, cause to contribute a part of the benefit from the businesses which explore, trade and use the natural resources in environmental conservation works;

Section 14, 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 15, The owner or occupier of any business, material or place which causes a point source of pollution shall install or use an on-site facility or controlling equipment in order to monitor, control, manage, reduce or eliminate environmental pollution. If it is impracticable, it shall be arranged to dispose the wastes in accord with environmentally sound methods.

Section 24, The Ministry may, in issuing the prior permission, stipulate terms and conditions relating to environmental conservation. It may conduct inspection whether or not it is performed in conformity with such terms and conditions or inform the relevant Government departments, Government organizations to carry out inspections.

Section 25, The Ministry may, if it is found that a holder of the prior permission fails to comply with any of the terms and conditions relating to environmental conservation contained in the prior permission, pass any of the following administrative penalties:

(a) causing to comply with in accord with the terms and conditions after warning, causing to sign the bond;

(b) causing to comply with in accord with the terms and conditions after paying a fine.

Section 29, No one shall violate any prohibition contained in the rules, notifications, orders, directives and procedures issued under this Law.

Section 30, No one shall, without permission of the Ministry, import, export, produce, store, carry or trade any material which causes impact on the environment prohibited by the Ministry.

Section 31, Whoever, without the prior permission, operates business, work-site or factory, workshop which is required to obtain the prior permission under this Law shall, on conviction, be punished with imprisonment for a term not exceeding three years, or with fine from a minimum of one hundred thousand kyats to a maximum of one million kyats, or with both.

Section 32, Whoever violates any prohibition contained in the rules, notifications, orders, directives and procedures issued under this Law shall, on conviction, be punished with imprisonment for a term not exceeding one year, or with fine, or with both.

Section 34, Whoever imports, exports, produces, stores, carries or trades any material prohibited by the Ministry due to its impact on environment shall on conviction, be punished with imprisonment for a term from a minimum of three years to a maximum of five years, or with fine from a minimum of one hundred thousand kyats to a maximum of two million kyats, or with both. Moreover, he shall incur the expenditure for the treatment and disposal of such material until the process that has no impact on the environment.

2.4.1.3. Environmental Conservation Rules (2014)

Environmental Conservation Rules (ECRs) as detailed enforcement regulations for ECL was gotten through parliament in July 2013 and going to be issued. ECRs stipulates basic policy and concept on EIA application of the development of Projects. The project proponent is comply with Section 69, (a) Any person shall not emit, cause to emit, dispose, cause to dispose, pile and cause to pile, by any means, the pollutants to environment 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, (b) Any person shall not carry out the actions which can be damaged to natural environment which is changing due to ecosystem and such system, except permission of the relevant Ministry in order to the interest of the public.

2.4.1.4. Environmental Impact Assessment Procedure (2015)

The Ministry of Environmental Conservation and Forestry, in exercise of the power conferred by sub-section (b) of Section 42 of the Environmental Conservation Law, issued the Environmental Impact Assessment Procedure in 2015. This procedure mentioned the legal responsibilities for the project proponent and the project proponent is commit to follow the procedures in performing the proposed project.

In Article 102 of EIA Procedure, the Project Proponent shall bear full legal and financial responsibility for:

(a) all of the Project Proponent's actions and omissions and those of its contractors, subcontractors, officers, employees, agents, representatives, and consultants employed, hired, or authorized by the Project acting for or on behalf of the Project, in carrying out work on the Project; and

(b) PAPs until they have achieved socio-economic stability at a level not lower than that in effect prior to the commencement of the Project, and shall support programs for livelihood restoration and resettlement in consultation with the PAPs, related government agencies, and organizations and other concerned persons for all Adverse Impacts.

Article 103, The Project Proponent shall fully implement the EMP, all Project commitments, and conditions, and is liable to ensure that all contractors and subcontractors of the Project comply fully with all applicable Laws, the Rules, this Procedure, the EMP, Project commitments and conditions when providing services to the Project.

Section 104, The Project Proponent shall be responsible for, and shall fully and effectively implement, all requirements set forth in the ECC, applicable Laws, the Rules, this Procedure and standards.

Section 105, The Project Proponent shall timely notify and identify in writing to the Ministry, providing detailed information as to the proposed Project's potential Adverse Impacts.

Section 106, The Project Proponent shall, during all phases of the Project (pre-construction, construction, operation, decommissioning, closure and post-closure), engage in continuous, proactive and comprehensive self-monitoring of the Project and activities related thereto, all Adverse Impacts, and compliance with applicable laws, the Rules, this Procedure, standards, the ECC, and the EMP.

2.4.2. Laws Relating to Forest, Biodiversity and Natural Resources

2.4.2.1. Underground Water Act (1930)

Section 3, No person shall sink 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. Every person owning a tube which was in existence before the extension of this Act to the local area concerned shall apply to the water officer for a license for the said tube, and such license shall be granted free of charge.

Section 4, (1) Any magistrate taking cognizance of an offence under section 3 may at any time order the tube inspect of which the offence has been or is alleged to have been committed to be forthwith closed until such time as a license for the same has been taken out in accordance with the provisions of the said section.

(2) If the order for the closure of a tube under sub-section (1) is not complied with, the Deputy Commissioner, Subdivisional Officer or township Officer exercising jurisdiction over the local area concerned may cause the said tube to be closed, and the expense of such closure shall be recoverable from the owner of the tube as if it were an arrear of land-revenue.

Section 5, Every person obtaining or attempting to obtain underground water shall supply the water officer with such information as the Governor may by rule prescribe.

2.4.2.2. Forest Law (2018)

The Forest Law was enacted in September 2018 by the Forest Department and this law mentioned the objectives and duties of the government. The project proponent hereby commits that they're aware of this law. In Section 3, The objectives of this Law are:

(a) to implement the forest policy of the Government;

(b) to implement the policy of the Government related to natural resources and environmental conservation;

(c) to promote public cooperation in implementing the forest policy and the natural resources and environmental conservation policy of the Government;

(d) to support economic development of the State, to contribute towards food, clothing and shelter needs of the public and to enjoy benefits perpetually through conservation and protection of forests;

(e) to comply with the international agreements relating to conservation of forests, conservation of natural resources and environment, climate change and natural disaster risk reduction;

(f) to prevent deforestation, biodiversity decline, outbreak of fires, insect infestation and plant disease incidence;

(g) to conserve natural forests and establish forest plantations simultaneously;

(h) to contribute towards fuel requirement of the State;

(i) to implement sustainable forest management in order to support sustainable development.

Section 9, The functions of the Forest Department are:

(a) implementation of the Myanmar forest policy of the Government;

(b) implementation of the plans relating to conservation of water, soil, biodiversity and environment, sustained yield of forest products and protection of forest covered land;

(c) management of forest land in accordance with the provisions of this Law;

(d) submission of proposals to the Ministry for constitution or declaration, alteration or cancellation of reserved forests, protected public forests and species of reserved trees;

(e) upgrading forestry practices, forestry extension and human resource development in natural environment and forest sector;

(f) upgrading forest management database system, inventorying forest resources and disseminating information to the public;

(g) conducting forestry research;

(h) supporting and supervising implementation of community forestry;

(i) determining the payment for environmental services for doing business in forest land;

(j) carrying out other forestry related tasks assigned by the Ministry.

2.4.2.3. Forest Rules (1995)

As the Forest Law was first enacted in 1992, the Forest Rules were essential in sustaining the long-lasting forest. This forest rules mention in Section 20, In the forest area and forest-covered land at the disposal of the government:

(a) the Ministry of Forestry may allow for carrying out any development work or any economic scheme if it does not affect or damage the natural environment;

(b) the Director General or a forest officer delegated by him may allow carrying out education or research work, conducting a training course or establishing study camp if it does not affect or damage the natural environment.

Rule 22, According to sub-rules (a) or (b) of rule 20, the permission holder:

(a) is entitled to carry out only the matters determined and allowed in the relevant

(b) permission. In doing so, it shall take care not to damage or destroy the natural environment;

(c) shall not transfer the relevant permission without the agreement of the person who issued permission;

Rule 36, In establishing the forest plantations according to sub-section (a) of section 13 of the Forest Law, the following principles shall be based:

(a) planting at the depleted or degraded forests;

(b) planting at the forest where commercially fewer valuable trees are grown;

(c) planting tree species which are compatible with water, soil and climate;

(d) planting tree species which have good yield and valuable in extraction and use;

(e) planting by the methods which do not affect the water, soil environment;

(f) contributing to improvement of living standard of local people and development of local area.

Rule 60, Any person, if he does not obtain the special permit issued by the Director General or a person who is delegated by him, in moving the forest produces;

(a) shall not cause reducing water flow, change or blockage of watercourse in the rivers;

(b) shall not cause any traffic jam along the motor road or rail road.

2.4.2.4. The Conservation of Biodiversity and Protected Area Law (2018)

This law hereby indicates the duties of the government as in Section 19, With the approval of the Ministry, the Forest Department:

(a) shall declare the following categories of endangered wild fauna that need to be protected from extinction, in accordance with the necessity of the State:

(b) completely protected wild fauna;

(c) normally protected wild fauna;

(d) seasonally protected wild fauna.

(e) may revise categories of endangered wild fauna declared under sub-section (a);

(f) shall declare species and associated site to conserve wild flora that need to be protected from extinction, in accordance with the necessity of the State;

(g) shall declare conservation status of wild fauna and wild flora from time to time to conserve for sustainability and to prevent their extinction in accordance with the necessity of the State;

(h) shall declare the appendices designated by the Convention for the public

(i) shall take measures to protect endangered wild fauna and wild flora species;

(j) shall coordinate with the relevant department and organization if protected endangered wild fauna and wild flora are under the administration of other Ministries.

2.4.2.5. The Conservation of Water Resources and Rivers Law 2006 (Amended 2017)

Section 8, No person shall;

(a) carry out any act or channel shifting with the aim to ruin the water resources and rivers and creeks.

(b) cause the wastage of water resources willfully.

Section 11, No person shall;

(a) dispose of engine oil, chemical, poisonous material and other materials which may cause environmental damage, or dispose of explosives from the bank or from a vessel which is plying, vessel which has berthed, anchored, stranded or sunk.

(b) catch aquatic creatures within river-creek boundary, bank boundary or waterfront boundary with poisonous materials or explosives.

(c) dispose of disposal soil and other materials from panning for gold, gold mineral dredging or resource production in the river and creek, into the river and creek or into the water outlet gully which can flow into the river and creek.

Section 13, No person shall carry out sand suction, sand dredging, sand excavating, river shingle suction, panning for gold, gold mineral dredging or resource production for commercial purpose in the river-creek boundary, bank boundary and waterfront boundary without the recommendation of the Directorate.

Section 19, No one shall dispose of any substance into the river-creek that may cause damage to waterway or change of watercourse from the bank or vessel which is plying, vessel which has berthed, anchored, stranded or sunk.

Section 21, No one shall (a) build lavatories unsuitable to the urban and rural community lifestyle in the bank area and waterfront area, (b) drill well or pond or dig earth without the permission of the Directorate.

Section 22, No one shall, without the permission of the directorate, pile sand, shingle and other heavy materials for business purposes in the bank area and waterfront area.

Section 24, No one shall;

(a) violate the conditions relating to navigation of vessel in rivers and creek prescribed by the Directorate for conservation of water resources, rivers and creeks.

(b) violate the conditions prescribed by the Directorate so as not to cause water pollution and change of watercourse in rivers and creeks.

Section 30, Any government department and organization or any person desirous of constructing drainage, utilizing river water intake, constructing bridges spanning rivers, connecting underground pipe, connecting underground electric power cable, connecting underground telecom cable or digging in rivers and creeks, bank boundary and waterfront boundary, under the requirement of work, shall in order not to adversely affect the water resources and rivers and creeks, carry out only after obtaining the approval of the Ministry of Transport. As the proposed project is located nearly a mile from the river, the project proponent must comply with the laws of not disposing wastes and not harming the natural resources by dumping or releasing the harmful substances into the natural rivers.

2.4.2.6. The Conservation of Water Resources and Rivers Rules (2013)

Section 8, No person shall;

(a) carry out any act or channel shifting with the aim to ruin the water resources and rivers and creeks.

(b) cause the wastage of water resources willfully.

2.4.3. Laws Relating to Human Rights and Cultural Heritage

2.4.3.1. The Ethnic Rights Protection Law (2015)

Section 5, The matters of projects shall completely be informed, coordinated and performed with the relevant local ethnic groups in the case of development works, major projects, businesses and extraction of natural resources will be implemented within the area of ethnic groups.

2.4.3.2. The Ethnic Rights Protection Rules (2019)

Rules 20, In relation to the project to be developed in the area inhabited by ethnic peoples, the project proponent:

(a) The benefits and contents of the project must be fully and accurately explained in advance, using languages and methods that they can understand so that the local ethnic groups who are settled in the area where the project is planned to be implemented are aware of it.
(b) The policy directions of the Myanmar Sustainable Development Plan (MSDP); strategies; It must be carried out in accordance with the procedures.
(c) In order to find out whether it can cause changes to the environment and socio-economic life in the area, environmental impact assessment and socio-economic development impact assessment shall be carried out in accordance with the relevant department's guidelines.
(d) In all stages of the environmental impact assessment and socio-economic development impact assessment process, discussions and consultations with ethnic peoples shall be carried out in an open manner.

Rules 21, The project proponent:

(a) Before starting the project, the implementation according to Rule 20 must be reported to the Ministry and get comments.
(b) Upon completion of project implementation, pre-planned activities and completion conditions shall be submitted to the Ministry.

2.4.3.3. The Protection and Preservation of Cultural Heritage Regions Law 2019

Section 2, The following expressions contained in this Law shall have the meaning given hereunder:

(a) Cultural Heritage means ancient monument or ancient site which is required to be protected and preserved by reason of its historical, cultural artistic or anthropological value

Section 18, No person can construct a building in the zone where the ancient monument or ancient site is located or shall amend or extend the boundaries of its courtyard within the zone without obtaining prior permission issued by this law.

Section 19, No person shall do any of the following to any building within the protected zone without obtaining prior permission issued under this Act -

(a) construction or extension of construction;

(b) amending or extending the boundary of its premises.

Section 21, No person shall, without prior permission granted under this Law, carry out any of the following in the cultural heritage region: -

carrying out archaeological excavation;

2.4.3.4. The Protection and Preservation of Antique Objects Law (2015)

Section 2, The following expressions contained in this Law shall have the meanings given hereunder:

(a) Antique Object means objects which are used by human beings including fossils over one hundred years old in above or under the ground or in above or under the water;

Section 3, The objectives of this law are as follows:

(a) to implement the policy of protection and preservation for the perpetuation of antique objects;

(b) to protect and preserve antique objects so as not to deteriorate due to natural disaster or man-made destruction;

(c) to uplift hereditary pride and to cause dynamism of patriotic spirit by protection and preservation of antique objects;

(d) to have public awareness of the high value of antique objects;

(e) to carry out in respect of protection and preservation of antique objects in conformity with the International Convention and Regional Agreement ratified by the State.

Section 12, The person who finds any object which has no owner or custodian, he shall promptly inform the relevant Ward or Village-Tract Administrator if he knows or it seems reasonable to assume that the said object is an antique object.

Section 13, (a) If the information is received under section 12, the Ward or Village-Tract Administrator shall keep the said object as may be necessary and shall forward the information to the relevant Township Administrative Office within 14 days. The Township Administrator shall promptly carry out the necessities and inform the Department within 7 days from the date on which the information is received;

(b) The Department shall inspect whether it is a real antique object or not and keep or cause to keep as may be necessary in accord with the stipulations when the information is received under sub-section (a).

2.4.3.5. The Protection and Preservation of Ancient Monuments Law (2015)

Section 2, The following expressions in this Law shall have the meanings given hereunder:

(a) Ancient Monument means building sites lived, made, used and built by human beings including geological environments where fossils of over one hundred years old are found above or under the ground or above or under the water;

(b) Listed Ancient Monument means a building included in the listed ancient monuments prescribed by the Ministry by notification;

(c) Protection and preservation include protecting and preserving an ancient monument and its environment, fencing that monument and carrying out to access easily there in accord with the requirement, repairing without altering the original form, renovating, cleaning, and modifying by scientific method including archaeological engineering, chemical and other methods for the purpose of perpetuation of them;

Section 3, The objectives of this Law are as follows:

(a) to implement the policy of protection and preservation for the perpetuation of ancient monuments;

(b) to protect and preserve ancient monuments so as not to deteriorate due to natural disaster or man-made destruction;

(c) to uplift hereditary pride and to cause dynamism of patriotic spirit by protecting and preserving ancient monuments;

(d) to have public awareness of the high value of ancient monuments;

(e) to protect and preserve ancient monuments from destruction;

(f) to search and maintain ancient monuments;

(g) to carry out in respect of protection and preservation of ancient monuments in conformity with the International Convention and Regional Agreement ratified by the State.

Section 4, The following buildings which are consistent with the definitions in sub-section (a) of Section 2 are specified as ancient monuments:

(a) religious buildings including zedi, stupa, temple, monastery, brick monastery, rest house, buddhist ordination hall, worship monument, brick mounds and collapsed damages;

(b) ancient city, palace, city wall, moat, earth bunker, gate, archway, gateway, forts, residential buildings, residential site, garden, working site, and ancient mounds dwelt by ancient people and their remains;

(c) natural or man-made cave where human beings had dwelt, natural cave, ancient rock cave, other residential place and geological environments including mound, brook, depression, hole, ravine, and river terrace where ancient people had dwelt and the places where primates and other fossils are found;

(d) place where objects of ancient people were made, pottery kiln, glazed kiln, iron furnace, glass furnace and other metal furnace and places related to them;

(e) ancient monument, road, bridge, excavations, well, lake, pond and, gravel stone made as monumental structure, stone pillar, heaped stone, cemetery, burial site, burial building, cave and pavilion;

(f) epigraphy, archive and the building where they are placed or epigraph cave, monumental structure, pillars and stone slabs;

(g) the buildings that should be protected and preserved by the State because of their high cultural, historical, architectural and artistic value;

(h) Other buildings stipulated as listed ancient monuments by the Ministry by notification.

Section 12, If a person who finds an ancient monument of over one hundred years old and above or under the ground or above or under the water which has no owner or custodian knows or it seems reasonable to assume that the said monument is an ancient monument, he shall promptly inform the relevant Ward or Village-Tract Administrative Office.

Section 15, A person desirous of any of the followings within the specified area of an ancient monument shall apply to get prior permission to the Department:

(a) extending towns, wards and villages;

(b) constructing or extending or repairing new buildings including hotels, factories and residential buildings or fencing or extending a fence;

(c) digging to search petroleum, natural gas, gem or mineral, piping petroleum and natural gas, constructing factories, connecting national grid, constructing communication tower, constructing or extending infrastructures such as road, bridge, airfield, irrigation and embankment;

(d) connecting underground electric cable, communication cable and other underground works;

(e) digging or extending wells, lakes, cannels and ponds;

(f) gold sieving, digging, burning bricks, digging well, lake, creek, ditch, gully, pit digging, refilling, levelling, mining, quarry, gravel digging and unearth sand, removing the mounds and hills which can damage the physical feature of the land;

(g) placing and fencing ancient monuments in a private compound and area;

(h) constructing a building which is not consistent with the terms and conditions stipulated according to the region by the Ministry near and at the surrounding of an ancient monument.

Section 17, No one shall fail to inform in accord with the provision in Section 12 of this Law if he finds an ancient monument which has no owner or custodian.

Section 20, No one shall carry out any of the following acts which is assumed to cause damage to an ancient monument within the specified area of an ancient monument or of a listed ancient monument without a written prior permission:

(a) taking photo, video, film or copying and modeling an ancient monument stipulated as a listed ancient monument for commercial purposes;

(b) using machines which causes vibration within the specified place of an ancient monument and running various types of vehicles;

(c) cultivating, gardening, breeding, fencing by blocking nearby an ancient monument or doing any other act which can affect an ancient monument;

(d) emission of gas such as hot-air balloon which can affect an ancient monument;

(e) landing and taking off and, flying aeroplane and helicopter which can directly or indirectly affect an ancient monument;

(f) discarding chemical substance and rubbish which can affect an ancient monument and the environment.

2.4.4. Laws Relating to Land use

2.4.4.1. Land Law (2012)

Section 12, The person who gets the right to farm land:

(a) Farm land shall be operated as provided in this law.

(b) Land tax and other taxes levied by the Ministry shall be paid in relation to agricultural land.

(c) Sale of land rights; mortgage rental When exchanging and giving, the stamp duty and contract registration fee set by the Department must be paid and registered at the relevant Township Department office.

(d) In accordance with existing law, when the right to farm land is obtained through inheritance, it must be registered at the relevant township department office in accordance with the requirements.

(e) The right to mortgage agricultural land is allowed only for agricultural production capital and must be mortgaged only in a government bank or a bank recognized by the government.

(f) No trespassing without permission from the relevant farmland management group.

(g) The agricultural land shall not be used in any other way without obtaining a permit.

(h) The agricultural land must not be changed from the type of crop that is originally cultivated to another type of crop without permission.

(i) The land shall not be occupied without a valid reason.

(j) Selling the agricultural land during the period before obtaining the right to the agricultural land or during the period when there is a dispute regarding the right to the agricultural land; mortgage rental Not to be exchanged or given away.

Section 13, After this law comes into force, if there is a dispute over the right to farm land, it can only be legally resolved after it has been registered with the Department.

Section 14, The person who gets the right to farm land has all the right to farm land or sell any part of it to any foreigner or foreigner-owned organization without the permission of the national government; mortgage rental Not to be exchanged or given away.

2.4.4.2. The Land Acquisition Act (1894 (Amended up to 1954)

Publication of preliminary notification and powers of officers thereupon. In Act (4),

(1) Whenever it appears to the President of the Union that land in any locality is needed or is likely to be needed for any public purpose, a notification to that effect shall be published in the Gazette, and the Collector shall cause public notice of the substance of such notification to be given at convenient places in the said locality.

(2) Thereupon it shall be lawful for any officer, either generally or specially authorized by the President of the Union in this behalf, and for his servants and workmen, -

(a) to enter upon and survey and take levels of any land in such locality;

(b) to dig or bore into the subsoil;

(c) to do all other acts necessary to ascertain whether the land is adapted for such purpose;

(d) to set out the boundaries of the land proposed to be taken and the intended line of the work (if any) proposed to be made thereon;

(e) to mark such levels, boundaries and line by placing marks and cutting trenches; and,

Where otherwise the survey cannot be completed and the levels taken and the boundaries and line marked, to cut down and clear away any part of any standing crop, fence or jungle:

Provided that no person shall enter into any building or upon any enclosed court or garden attached to a dwelling-house (unless with the consent of the occupier thereof) without previously giving such occupier at least seven days' notice in writing of his intention to do so.

Payment for damage. Act (5) The officer so authorized shall at the time of such entry pay or tender payment for all necessary damage to be done as aforesaid, and, in case of dispute as to the sufficiency of the amount so paid or tendered, he shall at once refer the dispute to the decision of the Collector or other chief revenue-officer of the district, and such decision shall be final.

Act 38 (a), An industrial concern, ordinarily employing not less than one hundred workmen owned by an individual or by an association of individuals and not being a company, desiring to acquire land for the erection of dwelling houses for workmen employed

by the concern or for the provision of amenities directly connected therewith shall, so far as concerns the acquisition of such land, be deemed to be a company for the purposes of this Part, and the references to company in sections 5A,6,7,17 and 50 shall be interpreted as references also to such concern.

Acquisition of land at cost of a local authority or company. In Act 50.

(1) Where the provisions of this Act are put in force for the purpose of acquiring land at the cost of any fund controlled or managed by a local authority or of any company, the charges of and incidental to such acquisition shall be defrayed from or by such fund or company.

(2) In any proceeding held before a Collector or Court in such cases the local authority or company concerned may appear and adduce evidence for the purpose of determining the amount of compensation:

Provided that no such local authority or company shall be entitled to demand a reference under section 18.

2.4.4.3. The Land Acquisition, Resettlement and Rehabilitation Law (2019)

Section (2) of this law mentions that the provisions of this Law shall apply to land acquisition, payment of compensation and damages, resettlement and, social and economic rehabilitation when the land is acquired by the Union Government or with the approval of the Union Government for public purpose, including permanent or temporary use of, holding of and supervision on land, as may be necessary, and shall also apply to:

(a) land requirements for national defence and security;

(b) projects to be carried out for the development of the State in accordance with the national economic policy;

(c) socioeconomic development projects as set out in the National Planning Law;

(d) projects for urban and rural extension, and infrastructure development projects;

(e) rehabilitation and resettlement matters; and

(f) acquisition of land under any other existing law other than payment of compensation and damages for acquisition of farmland in accordance with the Farmland Law and for reclamation of vacant, fallow and virgin land in accordance with the Vacant, Fallow and Virgin Land Law.

Section (4), the objectives of this Law are as follows:

(a) to implement land acquisition process in accordance with this Law based on the National Land Use Policy approved by the Union Government for public purpose;

(b) to protect the interest of the persons whose land is legally acquired for public purpose;

(c) to acquire land through a process involving affected persons and local people to be transparent in the issuance of prior notice, negotiation and decision-making;
(d) to ensure fair compensation and damages for affected persons;
(e) to resettle or rehabilitate landowners in accordance with any rights negotiated and agreed with the department or organization proposing land acquisition, for being affected by land acquisition; and
(f) to reduce adverse environmental and socioeconomic impacts resulting from the use of the acquired land.

2.4.4.4. The Vacant, Fallow and Virgin Lands Management Law (2012)

In this law, the right to carry out or use vacant, fallow and virgin lands described as in Section (4) the Central Committee may permit the right to carry out or use vacant, fallow and virgin lands in the State for the following businesses:

(a) agricultural business;
(b) livestock breeding business;
(c) mineral production business;
(d) other businesses permitted by the Government which are in accord with law.

Section (5) The following persons and organizations may, if it is desirous to obtain the right to carry out or use vacant, fallow and virgin lands in the State for the businesses contained in section 4, apply to the Central Committee in accord with the stipulations:

(a) Myanmar citizen investors;
(b) Government departments, Government organizations and non- Government organizations;
(c) persons who are exempted in accord with section 14 of the Transfer of Immoveable Property Restriction Law, 1987;
(d) investors permitted under the Foreign Investment Law who shall carry out matters for the common interest with any Government department and Government organization;
(e) investors permitted under the Foreign Investment Law who shall carry out matters for the common interest with Myanmar citizen investors.

2.4.5. Laws Relating to Urban Development and Industrial

2.4.5.1. The City of Mandalay Development Law (2002)

Section 8, The Committee shall, in respect of the following functions and duties lay down policy, give guidance, supervise and implement within the City territory:

(a) drawing up civil project and establishing new towns;

(b) administering the lands in accordance with the existing laws;

(c) constructing, maintaining and demolishing buildings;

(d) demolishing and resettlement of squatter houses, squatter buildings and squatter wards;

(e) constructing roads and bridges and maintaining thereof;

(f) stipulating conditions and in respect of traffic and parking of vehicles and Slow-moving Vehicles;

(g) determining road regulations and road use and naming of the road and determining the number of the building;

(h) carrying out environmental conservation works;

(i) building gardens, parks, playgrounds and recreation centres and maintaining thereof;

(j) carrying out works for lighting of roads;

(k) carrying out works for water supply;

(l) carrying out works for sanitation;

(m) carrying out works for public health;

(n) constructing, maintaining and administering of markets;

(o) prescribing conditions in respect of food businesses, restaurants and roadside stalls;

(p) granting permission to open guest houses to accommodate local travellers only and inspecting hotels, motels, inns and guest houses in respect of development matters;

(q) granting permission and administering ferry services, braking businesses and private pawn shops businesses;

(r) building slaughter houses and granting permission to slaughter cattle for consumptions;

(s) holding and managing cattle fair;

(t) granting permission for keeping and breeding animals and catching and impounding the stray animals;

(u) carrying out tasks to look after the stray insane persons, lepers and beggars;

(v) carrying out precautionary measures against fire, flood, storm and natural disaster;

(w) determining and demolishing graveyards, cremating building and administering crematories;

(x) carrying out other development works beneficial to the general public;

(y) carrying out other functions and duties assigned from time to time by the Prime Minister.

2.4.5.2. Myanmar National Building Code (2016 (Amended up to 2020))

The Myanmar National Building Code (MNBC) was created as a crucial instrument for the planning, design, construction, and upkeep of buildings and the built environment, as well as for raising living standards, enhancing quality of life, and ensuring public safety. The Ministry of Construction, UN-Habitat, and the Myanmar Engineering Society (MES) collaborated to create the Myanmar National Building Code with funding assistance from the Norwegian Ministry of Foreign Affairs. MNBC consist of 7 parts as follows:

(1) Administration of Planning, Building and Built Environment

(2) Architecture and Urban Design

(3) Structural Design

(4) Soil and Foundation

(5) Building Services

(6) Building Materials

(7) Constructional Practices, Safety and Building Maintenance

MNBC shall apply to the construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal and demolition of every urban development plan, building or structure or any appurtenances connected or attached to such buildings or structures.

2.4.5.3. The Electricity Law (2014)

The objectives of this laws are as follows:

(g) to have the right to use the electric power which has the standardized voltage, current, and frequency by the users of electric power and to protect from causing damages to the electrical equipment of users due to the electric power which is not consistent with standardization

(h) to adhere in accord with the international environmental protection treaties which Myanmar has ratified.

Section 20, The permit holder shall abide by the rules, regulations, bye-laws, notifications, orders, directives and procedures issued by the Ministry in carrying out the electrical business contained in the permit.

Section 21, (a) The permit holder shall, if causes damages and losses to any person and entity for failing to abide by this laws, rules, procedures, regulations, bye-laws, order and directives and failing to abide by the prescribed qualities and standardization, be liable according to law.

Section 24, If damages or losses arise to any other electric power user or any electrical business due to negligence of any electric power user, the calculated compensation in accord with the method prescribed by the Ministry for the value of damage or loss shall be paid.

Section 27, In the event of electricity hazard occurs in respect of generation, transmission, distribution and utilization of electric power, the permit holder and the

electrical authorized person shall report to the Chief Inspector and in-charge of the relevant department as soon as possible.

Section 29, The Ministry shall inspect the specification of quality and standardizations in respect of the factories, equipments installed to them, business buildings, and electrical equipment which are manufactured, imported and sold from the local and foreign country.

Section 33, The Chief Inspector, Inspectors and persons conferred duty by them have the right to enter and inspect any place or building to perform their duties in accord with stipulations.

Section 40, The permit holders shall carry out in accord with the rules, standardizations and procedures issued by the Ministry and shall be subjected to necessary inspection of relevant Government department and organizations.

Section 68, If a person is injured, or disabled or killed by the electric shock or outbreak of fire due to negligence or default of the permit holder or the person designated by him, the aggrieved person shall have the right to claim for compensation from the permit holder as follows:

(a) if the aggrieved person is applied to the existing Workmen's Compensation Act, the compensation prescribed under such law;

(b) if the aggrieved person is not applied to the existing Workmen's Compensation Act, the compensation prescribed by the rules issued under this Law.

2.4.5.4. Private Industrial Enterprise Law (1990)

Section 27, An entrepreneur:

(a) in distributing and selling the goods he has produced shall not sell without a trade mark;

(h) shall not violate any provision of section 13;

(c) shall not fail to comply with any order or decision passed by the Minister and the Director Genera

2.4.5.5. The Industrial Zone Law (2020)

The objectives of this law are as follows:

(a) Sustainable development of industrial businesses and successful establishment and implementation of industrial zones

(b) Systematic establishment of industrial zones under the economic development policies of the Union and enablement of investments in these zones by domestic and foreign investors

(c) Creation of competitive industrial businesses by catering to the needs of manufacturing and services businesses and creation of business networks within industrial zones

(d) Promotion of the operation of industrial businesses within industrial zones, systematic management reducing environmental and social impacts, implementation of the

relevant rules, procedures, and standards for the reduction of these impacts caused by industrial businesses

(e) Promotion of living standards of citizens and narrowing the development gaps among the regions through employment opportunities created by the development of industrial zones

(f) Development networks among industrial zones, catering to the needs of industrial zones, promotion of responsibility and accountability among industrial zones

(g) Promotion of economic growth of the Union and employment opportunities through the actual use of land for which permission was granted.

As the duties of the investor, Section 27 mentioned that the investor

(a) Shall register with the relevant departments according to the laws in force

(b) Shall implement the business as specified by the relevant departments and organizations

(c) Shall report the implementation status to the Management Committee as prescribed

(d) Shall comply with the laws, rules, orders, and directives regarding hazardous raw materials and inferior goods.

Section 28 mentioned that the investor shall comply with the provisions of the Environmental Conservation Law, and with the laws in force concerning occupational safety and healthcare matters.

Section 29 mentioned that the investor shall notify the relevant departments and the Management Committee in advance about business commencement, closure, or liquidation and proceed as prescribed.

2.4.5.6. Prevention of Hazard from Chemical and Related Substances Law (2013)

The nature of the proposed project fits with the Section 2 (c) which describes as Chemical and Related Substances Business means the business that are storing, treating by technique, for the commercial purpose of producing, using, import, export, transporting, possessing, distributing, purchasing, selling or discharging of the chemical or the related substances. Section (3) of the aims of this law set out as follows:

(a) to protect from being damaged the natural environment resources and being hazardous any living beings by chemical and related substances

(b) to supervise systematically in performing the chemical and related substances business with permission for being safety

(c) to perform the system of obtaining information and to perform widely educative and research for using the chemical and related substance systematically

(d) to perform the sustainable development for the occupational safety, health and environmental conservation.

Section 15, A person who has obtained a licence, before starting the respective chemical and related substances business:-

(a) shall be inspected for the safety and the power of resistance of the machinery and equipments by the respective Supervisory Board and Board of Inspection;

(b) shall be attended the person who serve in the work to the respective foreign trainings or the trainings and the expert trainings on prevention of hazard from the chemical and related substances opened by the government department and the government organizations.

Section 16 of this law described a person who has obtained a licence permitted for the chemical and related substances business:

(a) shall abide the licence regulations,

(b) shall perform to abide strictly the instructions for being safety in using the chemical and related substances by himself and also the persons who serve the work,

(c) shall keep the required safety equipments enough in the chemical and related substances businesses, furthermore shall grant the personal protection equipments and dresses free of charge to the working persons;

(d) shall make the course of training and study and instruction if necessary to the working persons for using the occupational safety equipment, the personal protection equipment and the dresses systematically in the chemical and related substances business,

(e) shall be inspected by the respective Supervisory Board and Boards of Inspection in respect of whether or not the hazard may impact on the Human Being and Animals' health and the environment,

(f) shall make medical checkup the working persons who will work in the chemical and related substances business and shall permit to serve in that work after obtaining the recommendation that his health is suitable for that work. This medical checkup records shall be kept systematically,

(g) shall send the copy of informative letter of the permission to the respective Department of Township Administration, if the hazardous chemical or related substances are permitted to store,

(h) shall acquire in advance the guidance and agreement of the respective Department of Fire Brigade, if the business that is worried to fire hazard is operated by using the fire hazard substances or the explosive substances,

(i) shall transport only the permitted amount of the chemical and related substances in accordance with the prescriptive stipulations, if they are transported in local,

(j) shall take the permission from the Central Supervisory Board if the chemical and related substance is altered and transferred from one place to any other place which contained in the licence,

(k) shall abide and perform in accordance with the related environmental laws not to impact and damage to the environment in operating the chemical and related substances business.

Section 17, A person who has obtained a licence, shall put the insurance in accordance with the prescriptive stipulations to be able to pay the compensation, if the impact and damage is occurred on the Human Being and Animals or the environment in respect of the chemical and related substances businesses.

Section 22, A person who has obtained the registration certificate shall abide the regulations consisted in the registration certificate furthermore shall also abide the order and instructions issued occasionally by the Central Supervisory Board.

Section 27, the prevention of the hazard control and decrease mentioned, a person who has obtained the licence to be complied the following matters to control and decrease the hazard of the chemical and related substances,

(a) classifying the hazard level to protect in advance the hazard according to the properties of the chemical and related substances,

(b) expressing the Material Safety Data Sheet and Pictogram,

(c) providing the safety equipments, the personal protection equipments to protect and decrease the accident and attending to the training to be used systematically,

(d) performing in accordance with the stipulations in respect of transporting, possessing, storing, using, discharging the chemical and related substances

(e) not being imported or exported the chemical and related substances banned by the Central Supervisory Board and the machinery and equipments which are used them.

2.4.5.7. **Prevention of Hazard from Chemical and Related Substance Rules (2016)**

The Ministry of Industry issued the Prevention of Hazard from Chemical and related Substances Rules on 12th January, 2016. The rules mentioned the aspects of the prevention of hazard from chemical and related substances.

2.4.5.8. The Factories Act (1951) (Amended 2016)

The Factory Act stipulates the work condition of the workers in the factory such as working hours, worksite safety and health measures. According to the act, worker at age 18 or over shall not work exceed 8 working hours per day or 44 hours per week, and the working days shall not exceed 6 days per week. As for worksite safety, the factory shall be kept clean with proper ventilation, light and heat and the workspace shall be situated away from drains, latrines, or other things which create a bad or unhealthy smell. Some of the important sections of the Act are as follows.

Section 7 of working hours of adults mentions in Section 59 that no adult worker shall be required or allowed to work in a factory for more than forty-fours hours in a week; Provided that an adult male worker in a factory engaged in work which for technical reasons must be continuous throughout the day may work forty-eight hours in a week.

In the section of the Power to require specifications of defective parts or tests of stability of Section 47 mentions that if it appears to the Inspector that any building or part of a building, or any part of the passage ways, machinery or plant in a factory is in such a

condition that it will be dangerous to human life or safety, he may serve on the manager of the factory an order in writing requiring him before a specified date-

(a) To furnish such plans, specifications and other particulars as may be necessary to determine whether such building, passage ways, machinery or plant can be used with safety, or

(b) To carry out such tests in such manner as may be specified in the order and to inform the Inspector of the results thereof.

Section 48,

(1) The President may make rules requiring that in any specified factory or class of factories where in more than two hundred and fifty workers are ordinarily employed, a canteen adequate for the use of workers shall be provided and maintained by the occupier.

(2) Without prejudice to the generality of the foregoing power, such rules may provide for

(a) the date by which such canteen shall be opened;

(b) the plans of the canteen to be constructed, and the method of accommodation, furniture and other equipment to be provide therein;

(c) the foodstuffs to be served therein and the charges to be made there for; and

(d) the constitution of a committee for the management of the canteen and the inclusion of workers' representative there on.

Section 49,

(1) In every factory wherein more than one hundred workers are ordinarily employed adequate and suitable rest-sheds or rest rooms and an adequate and suitable lunch room, with drinking water facilities, where workers can take meals brought by them, shall be provided and maintained for the use of the workers:

Provided that any canteen maintained in accordance with the provide

Section 62, subject to the provision of section 59 no adult worker shall be required or allowed to work in a factory for more than eight hours in any day.

2.4.5.9. Myanmar Engineering Council Law (2013)

Section 34, If, whoever has received a registration certificate, is found to have breached any rules contained in the registration certificate or violated any prohibition contained in a rule, order or directive enacted under this law or in any stipulation of this law, the executive committee may take the following administrative actions-

(a) giving a warning;

(b) assessing a suitable fine;

(c) suspending the registration certificate;

(d) cancelling the registration certificate.

Section 37, No one shall perform any engineering work and technological work which are specified as being dangerous to the public by a rule enacted under this law without having received a registration certificate issued by the council, except for engineers appointed in a government department or an organization in the performance of their duties.

2.4.6. Laws Relating to Economic and Investment

2.4.6.1. The Myanmar Investment Law (2016) (Amended 2019)

Section 51, The investor:

(a) may appoint any citizen who is a qualified person as senior manager, technical and operational experts, and advisor in his investment within the Union in accordance with the Laws;

(b) shall appoint them to replace, after providing for capacity building programs in order to be able to appoint citizens to different level positions of manager, technical and operational experts, and advisors;

(c) shall appoint only citizens for works which do not require skill;

(d) shall appoint skilled citizen and foreign workers, technicians, and staffs by signing an employment contract between employer and employee in accordance with the labour laws and rules;

(e) shall ensure to obtain the entitlements and rights in the labour law and rules, including minimum wages and salary, leave, holiday, overtime fee, damages, compensation of the workman, social welfare, and other insurance relating to workers in stipulating the rights and duties of employers and employees and the occupational terms and conditions in the employment contract.

(f) shall settle disputes arisen among employers, among workers, between employers and workers and technicians or staff in the investment in accordance with the existing law.

Section 65, The investor:

(a) shall respect and comply with the customs, traditions, and traditional culture of the ethnic groups in the Union;

(b) shall establish and register a company or sole proprietorship or legal entities or branches of such entities under the Laws in order to invest;

(c) shall abide by the terms and conditions, stipulations of a special license, permit, and business operation certificates issued to them, including the rules, notifications, orders and directives and procedures issued by this Law and the existing laws, terms and conditions of contract and tax obligations;

(d) shall carry out in accordance with the stipulations of the relevant department if it is, by the nature of the business or by other need, required to obtain any license or permit from the relevant Union Ministries, government departments and government organizations, or to carry out registration;

(e) shall immediately inform the Commission if it is found that natural mineral resources or antique objects and treasure troves are not related to the investment permitted above and under the land on which the investor is entitled to lease or use and not included in the original contracts. If the Commission allows, the investor shall continue to carry out the investment in such land, and if not allowed, the investor shall transfer and carry out, by obtaining the permission, at the substituted place which is selected and submitted by him;

(f) shall not make any significant alteration of topography or elevation of the land on which he is entitled to lease or to use, without the approval of the Commission;

(g) shall abide by the existing laws, rules, procedures and best standards practiced internationally for his investment so as not to cause damage, pollution, and loss to the natural and social environment and not to cause damage to cultural heritage;

(h) shall list and keep proper records of books of account and annual financial statements, and necessary financial matters relating to the investments performed by permit or endorsement in accordance with internationally and locally recognized accounting standards;

(i) shall close and discontinue the investment only after payment of compensation to employees in accordance with the existing laws for any breach of employment contracts, closure of investment, sale and transfer of investment, discontinuation of investment, or reduction of the workforce;

(j) shall pay wages and salaries to employees in accordance with the existing laws, rules, procedures, directives and so forth during the period of suspension of investment for a credible reason;

(k) shall pay compensation and indemnification in accordance with the existing laws to the relevant employee or his successor for injury, disability, disease and death due to the work;

(l) shall supervise foreign experts, supervisors and their families, who employ in his investment, to abide by the existing laws, rules, orders and directives, and the culture and traditions of Myanmar;

(m) shall respect and comply with the labour laws;

(n) shall have the right to sue and to be sued in accordance with the laws;

(o) shall pay effective compensation for loss incurred to the victim, if there are damage to the natural environment and socio-economic losses caused by logging or extraction of natural resources which are not related to the scope of permissible investment, except

carrying out the measures required to conduct investment in a permit or an endorsement;

(p) shall allow the Commission to inspect in any places when the Commission informs the prior notice to inspect the investment;

(q) shall take in advance permit or endorsement of the Commission for the investments which need to obtain prior approval under the Environmental Conservation Law and the procedures of environmental impact assessment, before undertaking the assessment, and shall submit the situation of environmental and social impact assessment to the Commission along the period of the activities of the investments which obtained permit or endorsement of the commission.

Section 73, The investor shall insure the types of insurance stipulated in the provision of the rules at any insurance enterprise which is entitled to carry out insurance businesses within the Union.

2.4.6.2. Myanmar Investment Rules (2017)

Rules 202 states the Investor must comply with the conditions of the Permit and other applicable laws when making an investment.

Rules 203 states the Investor shall fully assist while negotiating with the Authority for settling the grievances of the local community that have been affected due to Investments.

Rules 206 states if the Investor is desirous to appoint a foreigner as senior management, technician expert or consultant according to section 51 (a) of the Law, it shall submit such foreigner's passport, expertise evidence or degree and profile to the Commission Office for approval.

Rules 212 states every Investor that holds the Permit or Tax Incentives must have taken out the relevant insurance out of the following types of insurance at any insurance business that holds the license in the Union based on the nature of the business:

(a) Property and Business Interruption Insurance;

(b) Engineering Insurance;

(c) Professional Liability Insurance;

(d) Professional Accident Insurance;

(e) Marine Insurance; and

(f) Workmen Compensation Insurance.

2.4.6.3. The Myanmar Companies Law (2017)

Companies in Myanmar shall be incorporate and registered as the following:

Section 2, The following types of company may be incorporated and registered under this law:

(a) a company limited by shares, which may be either:

(i) a private company which may have no more than 50 members not including persons who are in the employment of the company; or

(ii) a public company which may have any number of members;

(b) a company limited by guarantee which may have any unlimited number of members; and

(c) an unlimited company which may have any number of members.

Other corporations that may be registered under this law, Section (3), As further provided by and subject to Chapter IX, the following bodies corporate formed under this law or other laws may be registered under this law:

(a) a business association;

(b) an overseas corporation;

(c) any other corporation which is entitled to register as a company by this law or any other applicable law; and

(d) such other entities as may be prescribed by the Union Minister from time to time.

As an essential Requirements of Companies, Section 4,

(a) A company registered under this law shall have the following facts:

(i) a name;

(ii) a constitution;

(iii) at least one share in issue (provided that a company limited by guarantee need not have a share capital);

(iv) at least one member;

(v) subject to sub-section (vi), at least one director who shall be ordinarily resident in the Union;

(vi) if the company is a public company, at least three directors, one of whom shall be a Myanmar citizen who is ordinarily resident in the Union; and

(vii) a registered office address in the Union.

(b) A company may appoint a company secretary and have a common seal.

Section 5, Capacity and powers of companies

(a) A company:

(i) will be a legal entity in its own right separate from its members having full rights, powers, and privileges and continuing in existence until it is removed from the register; and

(ii) subject to this law and any other law, has both within and outside the Union full legal capacity to carry on any business or activity, do any act, or enter into any transaction, including the power to:

(aa) issue shares, debentures or securities which convert into shares in the company;

(bb) grant options to subscribe for shares or debentures in the company;

(cc) grant a security interest over any of its property; and

(dd) distribute any of the company's property among the members, in kind or otherwise.

(b) The constitution of a company may contain a provision relating to the capacity, rights, powers, or privileges of the company only if the capacity of the company or those rights, powers, and privileges are restricted.

(c) A company may act as a holding company of another company and incorporate and hold shares in any number of subsidiaries.

Mode of incorporating a company, Section 6,

(a) Any person or persons in association may apply to the registrar to incorporate and register a company under this law:

(i) a company having the liability of its members limited by the constitution to the amount, if any, unpaid on the shares respectively held by them in a company limited by shares; or

(ii) a company having the liability of its members limited by the constitution to such amount as the members may respectively thereby undertake to contribute to the assets of the company in the event of its being wound up in a company limited by guarantee; or

(iii) a company not having any limit on the liability of its members in an unlimited company.

(b) The application to the registrar for the registration of any company under this law shall be made in the prescribed form and shall state the following facts:

(i) the proposed name of the company;

(ii) the proposed type of the company;

(iii) the full name and address of each applicant;

(iv) the full name, date of birth, gender, nationality and address of every director and any secretary of the proposed company;

(v) that each individual named as a director or secretary of the proposed company has given their written consent to act as a director or secretary of the proposed company;

(vi) the address of the registered office of the proposed company, which in the absence of any other notice will be taken to be the address for service of documents to the proposed company;

(vii) the address of the company's principal place of business if different to the registered office; and

(viii) in the case of a private, public or unlimited company:

(aa) the full name and address of every member of the proposed company;

(bb) that each member of the proposed company has given their written consent to be a member and subscribe for the shares to be allotted to them;

(cc) the number and class of shares to be issued to each member;

(dd) the currency in which the company's share capital is to be denominated;

(ee) the amount that each member agrees to pay for each share;

(ff) whether these shares will be fully paid on registration;

(gg) whether the proposed company has an ultimate holding company;

(hh) whether the proposed company will, on incorporation, be a foreign company;

(ix) in the case of a company limited by guarantee:

(aa) the full name and address of every member of the proposed company;

(bb) that each member of the proposed company has given their written consent to be a member;

(cc) the proposed amount of the guarantee that each member agrees to provide;

(dd) if the company have a share capital:

(i) the number and class of shares to be issued;

(ii) the currency in which the company's share capital is to be denominated;

(iii) the amount (if any) each member agrees to pay for each share; and

(iv) whether these shares will be fully paid on registration.

(c) An application for registration shall:

(i) be signed by each applicant;

(ii) include a declaration by each applicant that all matters stated in the application are correct; and

(iii) where the company proposes to use a constitution, which differs in any substantive way from the model constitution, be accompanied by a copy of the proposed company's constitution certified by at least one applicant, otherwise a statement that the company proposes to use the model constitution.

(d) The prescribed fee shall be paid to the registrar when filing the application.

(e) Duplicate originals of the application and all documents accompanying it shall be kept by the applicants together with the originals of the consents referred to in sub-sections (b)(v), (viii) and (ix). On incorporation, these should be passed to the company and then maintained with the company's records.

Section 7, The penalty for an applicant making a false declaration in an application under section 6 shall be a fine of 2,500,000 kyats.

Registration, Section 8

(a) When the registrar receives a completed application which upon any necessary examination meets the requirements of this law, the registrar shall:

(i) register the application; and

(ii) issue a certificate of incorporation which states:

(aa) the company's name;

(bb) the company's type;

(cc) that the company is incorporated and registered as a company under this law;

(dd) the date of registration; and

(ee) any other matters that may be prescribed.

(b) The registrar shall keep a record of the registration.

(c) The registrar may not require the submission of any other documents in connection with the registration other than those referred to in sub-sections 6(b) and (c) or save as may be prescribed by the Union Minister.

Effect of registration, Section 9, From the date of registration mentioned in the certificate of incorporation, the members named in the application shall become members of the company having a separate legal personality and the name contained in the certificate of incorporation. Without limiting section 5 or any other provision of this law, the company will be capable forthwith of exercising all the functions of an incorporated company, and have perpetual succession.

Conclusiveness of certificate of incorporation, Section 10. A certificate of incorporation given by the registrar under section 8 shall be conclusive evidence that all the requirements of this law in respect of registration have been complied with, and that from the

date of incorporation stated in the certificate the company is incorporated and duly registered under this law.

2.4.6.4. Myanmar Insurance Law (1993)

Section 15 states owners of motor vehicles shall affect compulsory Third Party Liability Insurance with the Myanmar Insurance.

Section 16 states an entrepreneur or an organization operating an enterprise which may cause loss to State-owned property or which may cause damage to the life and property of the public or which may cause pollution to the environment shall affect compulsory General Liability Insurance with the Myanmar Insurance.

2.4.6.5. Income Tax Law (1974) (Amended 2016)

Section 26 (a) If a non-resident foreigner has received Income by any of the following means, that income received shall be deemed to be income received within Myanmar and income-tax shall be assessed accordingly;

(i) Income received from any capital asset within Myanmar;

(ii) Income received from any source of income within Myanmar;

(b) In lieu of the non-resident foreigner, income-tax may be assed and collected from his agent in respect of the said incomes. Any arrear of income-tax may be recovered from any assets of the non-resident foreigner which are or may at any time come, within Myanmar.

2.4.6.6. Export Import Law (2012)

Section 5, No person shall export or import restricted, prohibited and banned goods.

Section 6, Without obtaining license, no person shall export or import the specified goods which is to obtain permission.

Section 7, A person who obtained any license shall not violate the conditions contained in the license.

2.4.6.7. The Shop and Establishment Act (1951)

Section 3, The objectives of this Law are as follows:

(a) to fix working hour of workers in shops and establishments;

(b) to enjoy wages accurately;

(c) to be safe at the workplace;

(d) to safeguard the rights to health.

Section 20, An employer shall send the inspector a notice with the copy of license issued by the respective department and committee in the prescribed form within 10 days

from the date of opening, transferring of place any shop or establishment or changing of business, extension of business, changing of employer, closing of business or appointing and changing of employee.

Section 24, An employer shall, in every shop or establishment, comply with the followings:

(a) manage to be sanitation, free from bad smell, and hygiene;

(b) manage well ventilation and good lighting;

(c) manage not to exceed the prescribed noise;

(d) manage not to overheat and to take the fire safety precaution;

(e) manage sufficiently first aid box and medicines for employees in accordance with the stipulations.

2.4.7. Laws Relating to Workers and Workplace

2.4.7.1. The Social Security Law (2012) (Amended 2014)

Section 3, The objectives of this Law are as follows:

(a) Causing to support the development of the State's economy through the increase of production to enjoy more security in social life and health care of workers who are major productive force of the Union by the collective guaranty of the employer, worker and the Union for enabling to fulfill health and social needs of the workers;

(b) Causing to enjoy more security in social life and health care by the public by their voluntary insurance;

(c) Causing to raise public reliance upon the social security system by providing benefits which are commensurate with the realities;

(d) Causing to have the right to draw back some of the contributions paid by the employers and the workers as savings, in accord with the stipulations;

(e) Causing to obtain the right to continued medical treatment, family assistance benefit, invalidity benefit, superannuation benefit, survivors' benefit, unemployment benefit, the right to residency and ownership of housing after retirement in addition to health care and pecuniary benefit for sickness, maternity, decease and employment injury of the workers.

2.4.7.2. The Minimum Wage Law (2013) (Amended up to 2018)

Section 12, The employer:

(a) shall not pay wage to the worker less than the minimum wage stipulated under this Law;

(b) may pay more than the minimum wage stipulated under this Law;

(c) shall not have the right to deduct any other wage except the wage for which it has the right to deduct as stipulated in the notification issued under this Law;

(d) shall pay the minimum wage to the workers working in the commerce, production business and service in cash. Moreover, if the specific benefits, interests or opportunities are to be paid, it may be paid in cash in accord with the stipulations or jointly in some cash and in some produce prescribed in local price according to the desire of the worker;

(e) may pay jointly in some cash and some produce prescribed in local price according to the local custom or desire of the majority of workers or collective agreement in paying the minimum wage to the workers and working in the agriculture and livestock breeding business. Such payment shall be for any personal use and benefit of the worker and his family and the value shall also be considerable and fair.

Section 13, The employer:

(a) shall inform the workers the rates of minimum wage relating to the business among the rates of minimum wage stipulated under this Law and advertise it at the workplace to enable to be seen by the relevant workers;

(b) shall record the lists, schedules, documents and wages of the workers correctly in accord with the stipulation;

(c) shall report the lists, schedules and documents recorded under sub-section (b) to the relevant department in accord with the stipulations;

(d) shall accept the inspection when summoned by the inspection. Moreover, he shall produce the said lists and documents when so required;

(e) shall allow the entry and inspection of the inspector workplaces of commerce, production and service, agriculture and livestock breeding and give necessary assistances;

(f) shall give them holiday for medical treatment in accord with the stipulations if the workers cannot work due to sickness;

(g) shall give holiday without deducting from the minimum wage, in accord with the stipulations if the funeral matter of the family of worker or his parent occurs.

Section 15, The worker who is entitled to obtain the wage and other benefits under section 14:

(a) if he does not obtain all wages or other benefits entitled to be obtained, or obtains less than the stipulated minimum wage, may submit to the relevant Union Territory Committee, Region committee or State committee and Department within one year from the day he is entitled to obtain such injured wages and other benefits;

(b) may sue under civil proceeding for all wages that is entitled to obtain.

Section 16, If an employer is convicted by a court for his failure to pay the minimum wages and other benefits stipulated under this Law or for the payment to worker less than such minimum wage and ordered to pay defaulted wages and other benefits to the relevant worker as fine, and if such worker does not obtain fully the wages and other benefits which is entitled under section 14, it shall not affect the right to institute civil proceeding for such wages and benefits.

The National Committee for Minimum Wage finally issued the Notification 2/2018 on 14th May 2018, repealing and replacing Notification 2/2015. With immediate effect, this notification set that employee in the entire Republic of the Union of Myanmar – regardless of the location or the type of business shall enjoy an increased minimum wage at 600 kyats per hour for each standard 8 hour working day (total of 4,800 Kyats per day). This stipulated the rate of minimum wage applies uniformly to all workers nationwide and across all industries except those in small, family-run businesses with a workforce of fewer than 15 workers.

2.4.7.3. The Minimum Wages Rules (2013) (Amended 2015)

Rule 43, The employer:

(a) shall increase the remuneration depending on the skill, to promote the productivity and the employment skill of the employees;

(b) shall perform in accord with the factory act 1951, leave and holiday act 1951 under section 13 (b) at the law for the list, schedule and document, remunerations;

(c) when the employees are not able to work due to ill health, injury at work site:

  i. if they are under premium paid insurance to the health and social care fund, the insurance Under health and social security care 2012, or

  ii. if they are not entitled to enjoy social security law 2012, they must be arranged to enjoy the leave and holiday act 1951.

(d) in the event of family or parents' funeral affairs, his entitled remuneration should not be deducted and shall be arranged to enjoy according to leave and holiday act 1951;

(e) before fixing of the minimum wage by the National Committee under this rule, if his remuneration is less than the prescribed amount, he should be paid up to the full amount;

(f) part time, hourly job employees shall be paid the prescribed minimum wage for the working hours;

(g) for the salary employees one day day-off shall be allowed in a week. If he has to work on the off day, overtime wage shall be paid in accord with the existing law;

(h) if the employee has to work less than the prescribed working hour and if it is not due to his will or he has to stop the work due to the shortage of work from the employer, he shall be entitled to enjoy the remuneration as if he has to work full time;

(i) the prescribed minimum wage shall be paid without discrimination of the male or female;

(j) although he has the obligation to pay the minimum wage in cash, separate entitlement, benefit in accord with the stipulation shall be given due to the employee's will, majority of the employees' will, collective consent, in cash or partial in cash or prevailing regional rate or regional tradition;

(k) overtime work shall be allowed according to the law after negotiation with the employees;

(l) the employee who is not capable to fulfill the standard norm or production norm prescribed in accord with the factory, workshop, department, shall be trained to be skillful in the probation period. If necessary, the relevant factory, workshop, departments under this law shall be paid for not less than 50% of the remuneration within three months. In the probation period 75% of the remuneration shall be paid.

Rule 44, The employees:

(a) shall perform to fulfill the productivity in accord with the employment grade of skill;

(b) shall be responsible to continue to serve the duty in accord with the employment grade of skill, if sent by the employer to attend the skill training;

(c) unable to work due to ill health, injury at work site:

i. if they are under premium paid insurance to the health and social care fund, the insurance under health and social security care 2012, or

ii. if they are not entitled to enjoy social security law 2012, he is entitled to enjoy the leave and holiday act 1951.

(d) in the event of family or parents' funeral affairs, his entitled remuneration should not be deducted and shall be entitled to enjoy according to leave and holiday act 1951;

(e) salary earner, wages earner, piece rate employees are entitled to enjoy allowed leave and public holidays;

(f) if the remuneration given to the skillful and competent employee is more than the minimum wage, the said remuneration shall be continued to be confirmed;

(g) if employment agreement, any other contract, the accepted remuneration is less than the minimum wage the said employment agreement or the prescribed remuneration contained in the agreement shall be repealed.

2.4.7.4. The Payment of Wages Law (2016)

The Payment of Wages Act was firstly enacted in 1936, the act was repealed on 25th January 2016 as the Payment of Wages Law, 2016. The purpose of this law is the employer must pay wage or salary to the employee (working part-time, weekly or monthly) within a designated time frame. This Act contains 9 main Chapters.

In Chapter 2 (Method of Payment and period) of the law, Section 3 and 4 describe the following:

Section 3, The employer must;

(a) Pay in local currency or foreign currency recognized by the central bank of Myanmar. This may be in cash, check or deposit into the bank account of the Employee.

(b) Moreover, pay can be in the mean of;

i. Totally in cash or half the cash and half in things set as local price according to the local price to those employees working in trade, manufacturing and service sector.

ii. Totally in cash or half the cash and half in things set as local price according to local traditions or common agreement to those working in agriculture and livestock sectors. However, this must be for the sake of the employees and their families. Moreover, it must be reasonable and fair.

iii. An employee shall receive the payment for 60 days when he/she is in Alternative Civil Service.

Section 4. An employer must pay for;

(a) Part-time, daily, weekly or other part-time job, temporary or piecework when the work is done or at the agreed time.

(b) According to the Section (a), the period shall not exceed one month.

(c) Wages for the permanent work must pay per monthly basic as below.

i. Must pay at the end of the payment period when there are not more than 100 workers.

ii. If there are 100 workers and above, pay must not be administered later than 5 days after the end of the payment period.

(d) Upon termination, wages must pay within 2 days from the date of termination.

(e) If a resignation letter submitted, wages must pay at the ending day of the payment period.

(f) If an employee dies, wages must pay to legally recognized person within 2 working days after the day he/she died.

(g) All wages must pay during the working day.

2.4.7.5. The Leave and Holiday Act (1951)

Section 5,

(1) An employee shall be admissible to casual leave with wages or pay (as the case may be) aggregating six days in a year: Provided that he shall only be admissible to a maximum casual leave of three days at any one time.

(2) Casual leave shall not be combined with any other kind of leave.

(3) If the employee does not take the casual leave which he is entitled to within the year, it shall lapse.

2.4.7.6. The Labour Organization Law (2011) (Amended 2012)

Section 18, The labour organization has the right to demand the relevant employer to re-appoint a worker if such worker is dismissed by the employer and if there is cause to believe that the reasons of such dismissal were based on labour organization membership or activities, or were not in conformity with the labour laws.

Section 19, The labour organizations have the right to send representatives to the Conciliation Body in settling a dispute between the employer and the worker. Similarly, they have the right to send representatives to the Conciliation Tribunals formed with the representatives from the various levels of labour organizations.

Section 20, In discussing with the Government, the employer and the complaining workers in respect of worker's rights or interests contained in the labour laws, the representatives of the labour organization also have the right to participate and discuss.

Section 21, The labour organizations have the right to participate in solving the collective bargains of the workers in accord with the labour laws.

Section 22, The labour organizations shall carry out peacefully in carrying out holding of meetings, going on strike and carrying out other collective activities in accord with their procedures, regulations, by-laws and any directives prescribed by the relevant Labour Federation.

Section 43, No employer shall, without permission of the relevant conciliation body, lock-out a public utility service or service which is not included in public utility service.

Section 44, No employer shall:

(a) lock-out a work due to such dispute during the pendency of a trade dispute settlement;

(b) carry out an illegal lock-out which is involved with any provision contained in sub-sections (a) and (c) of section 41;

(c) dismiss a worker who opposes an illegal lock-out which is involved with any provision contained in sub-sections (a) and (c) of section 41;

(d) dismiss a worker for his membership in a labour organization for the exercise of organizational activities or participating in a strike in accord with this Law.

2.4.7.7. The Labour Organization Rules (2012)

Rule 29, The employer shall recognize the labour organizations of his trade as the organizations representing the workers.

Rule 30, The employer shall allow the worker who is assigned any duty on the recommendation of the relevant executive committee to perform such duty not exceeding two days per month unless they have agreed otherwise. Such period shall be deemed as if he is performing the original duty of his work.

2.4.7.8. The Settlement of Labour Dispute Law (2012) (Amended 2019)

Section 3, In any trade in which more than 30 workers are employed to obtain the collective agreement by negotiating, the employer shall:

(a) if there is any labour organization, shall form the Workplace Coordinating Committee with the view to make a collective bargaining as follows:
    i. two representatives of workers nominated by each of the labour organizations;
    ii. representatives of worker and an equivalent number of representatives of employer;
(b) if there is no labour organization, shall form the Workplace Coordinating Committee as follows:
    i. two representatives of workers elected by them;
    ii. two representatives of employer.

Section 15, The dispute relevant to interest that cannot be settled by negotiating and coordination between employer and the labour organizations, the employer may appoint the representatives of the employer or the labour organizations may appoint the representative of the workers before the period of conciliation. Where no labour organization exists, the workers shall elect their representatives.

Section 23, An employer or worker, may complain individual dispute relating to his grievance to the Conciliation Body and if he is not satisfied with the conciliation made by in accord with stipulated manners, such party may apply to the competent court in person or by the legal representative.

Section 24, The relevant Conciliation Body shall, in respect of the collective dispute known or received by the complaint of employer or worker, in respect of the dispute; information sent by the Minister or the Region or State Government or any other means, carry out as follows:

(a) conciliating so as to be settled within three days, not including the official holidays, from the day of knowing or receipt of such dispute;

(b) concluding mutual agreement if the settlement is reached in conciliating under sub-section (a), before the Conciliation Body.

Section 34, No one shall do the following in the any freshwater fisheries waters:

(a) catching fish or causing mischief with explosive substance, poison, chemicals and dangerous material of a like nature;
(b) catching fish by a prohibited method and fishing implement;
(c) catching fish of a prohibited species and size;
(d) catching fish during a prohibited period and at a prohibited place.

Section 38, No employer shall fail to negotiate and coordinate in respect of the complaint within the prescribed period without sufficient cause.

Section 39, No one shall cultivate agricultural crops within the boundary of a fishery creek.

Section 40, No one shall cause harassment of fish and other aquatic organisms or pollution of the water in a freshwater fisheries water.

Section 51, If any employer, in the course of settlement of dispute, commits any act or omission, without sufficient cause, which by causing a reduction in production resulting so as to reduce the workers' benefits shall be liable to pay full compensation in the amount determined by the Arbitration Body or Tribunal. Such money shall be recovered as the arrear of land revenue.

2.4.7.9. The Workmen's Compensation Act (1923)

Section 13, Where a workman has recovered compensation in respect of any injury caused under circumstances creating a legal liability of some person other than the person by whom the compensation was paid to pay damages in respect thereof, the person by whom the compensation was paid and any person who has been called on to pay an indemnity under section 12 shall be entitled to be indemnified by the person so liable to pay damages as aforesaid.

2.4.7.10. Occupational Safety and Health Law (2019)

This law was enacted on 15th March 2019 with the objectives of

(a) To implement Occupational Safety and Health matters effectively in the respective industries or businesses
(b) To determine the duties of relevant persons applicable under this law including employers and workers to lessen and mitigate occurrence of occupational disease and occupational accidents

(c) To cause relevant persons applicable under this law, employers and workers to take precaution and prevention against occupational hazards and occupational diseases

(d) To improve the productivity and health of workers by preventing the occurrence of occupational accidents and occupational disease for their safety

(e) To create workplaces that are safe and good for health by prescribing the occupational safety and health standards relevant to the Union's status after considering international and regional standards and

(f) To support and help research activities carried out for the development of occupational safety and health matters.

2.4.7.11. The Petroleum and Petroleum Product Law (2017)

The objectives of this Law are as follows:

(a) to carry out the petroleum and petroleum product business activities systematically in accordance with the provisions of the law, stipulated standards, procedures and conditions;

(b) to enable the petroleum and petroleum product business activities to carry out safely without environmental impact;

(c) to establish free and fair competition in carrying out petroleum and petroleum product business activities;

(d) to secure energy requirement and energy security of the Union;

(e) to obtain tax revenue of the Union.

When applying for the License, Issue of Permit, Determining Conditions to be abided by, and Supervision, the project proponent is committed to comply with the laws as followings:

Section 9, The Ministry of Transport and Communications shall carry out the following functions relating to any petroleum and petroleum product:

(a) issuing license to vehicles, vessels and barges that carry any petroleum and petroleum product;

(b) determining period, form, conditions, means of applying for license, permitting authority and fees to be assessed for licenses under subsection (a);

(c) determining and supervision on ports for vessels and barges that carry out import, export, and transport by water in accord with procedures;

(d) taking action, as necessary, in accordance with the existing laws if it occurs spill or accident in carrying out import, export, transport, and sale and distribution of petroleum and petroleum product by water;

(e) determining procedures and conditions to be abided by in carrying out transport business except transport by pipeline.

Section 10, The Ministry of Natural Resources and Environmental Conservation shall carry out the following functions relating to any petroleum and petroleum product:

(a) issuing license for the right to store for the storage tanks and warehouses;

(b) issuing transport permit for the vehicles, vessels and barges that shall carry any petroleum and petroleum product;

(c) determining the period, form and terms and conditions, manners of applying license, permitting authority and fees to be assessed for license under subsection (a) and permit under subsection (b);

(d) if it occurs environmental impacts in carrying out petroleum and petroleum product business activities, taking action, as necessary, in accordance with the existing laws of on-site inspection;

(e) determining, in coordination with ministries concerned, procedures and conditions relating to standard and quality of storage tanks and warehouse, and tanks of vehicles, vessels and barges that carry any petroleum and petroleum product.

Section 11, On all receptacles containing any dangerous petroleum and petroleum product, the warning sign of danger by stamping, embossing, painting, printing or any other means shall be expressed. If it is impossible to express as such, similar warning signs of the nature of danger of gasoline, spirit or petroleum shall be expressed in writing at the ostensible place in salient words or signs near to the receptacle.

Section 12, The provisions contained in section 11 shall not apply to any following receptacles:

(a) any glass, stone or metal receptacle in which the dangerous petroleum lesser than two gallons is put with secure cap;

(b) a tank attached to machine-powered vehicle or machinery that uses any petroleum and petroleum product;

(c) a storage tank absolutely buried underground;

(d) any class of receptacles, by notification, exempted from the application of this section by the Ministry.

Section 30, Any person shall, without the relevant license, not carry out any business activities or measures required to obtain license under this law.

Section 37, Any person who violates the prohibition contained in section 30 shall, on conviction, be punished with imprisonment for a term not exceeding one year, or with fine from a minimum of three hundred thousand Kyats to a maximum of five million Kyats, or with both, and the property concerned with the commission of offence shall be confiscated.

2.4.8. Laws Relating to the Public Health

2.4.8.1. Public Health Law (1972)

The law deals with the provisions to promote and safeguard public health including preventive measures to promote environmental health. The laws related to public health are provided in Sections 2 to 5. 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.

Section 3, Notwithstanding any other existing laws, the government shall further improve the health of the working people. To prevent the health of workers from being affected, and advising on the health issues described below; checking supervision; and repair Works such as prohibition shall be carried out.

(1) Environmental health activities:

(a) Garbage in the residential environment; Storage and disposal of waste.
(b) Establishing and protecting public drinking water to international standards.
(c) Smoke that will cause danger to people in the surrounding atmosphere where people live; width age powder, Protection from contamination by noise and radiation.
(d) City and village municipalities; Buildings used by housing construction and workers to travel and live. Or for the health and hygiene of places.

(2) Matters related to food produced and sold by workers:

(a) food manufacturing and selling workshop; factory Registration of business units; Cancellation and re-registration of registration.
(b) Making the food sold to the workers healthy and clean.
(c) adulteration of food sold to the working public; mixed with other inferior materials; Protection from the extraction of addictive substances in food.
(d) Workshops that produce and sell food; factory Keeping business departments healthy and clean.
(e) Keeping premises where food is sold healthy and clean.
(f) Preventing people with infectious diseases from entering and serving in places where food is produced and sold to the working public.
(g) Storage and destruction of hazardous food.
(h) Sending food-related matters to government laboratories for inspection if necessary.
(i) Ensuring that food meets the standards set by the government from time to time.

(3) Matters related to home appliances and beauty products to be used by working people:

(a) A workshop that manufactures home appliances and beauty products; Registration of factories; Cancellation and re-registration.
(b) If the manufactured home appliances and beauty products may cause danger to workers, or if it can be poisonous, Prohibition of manufacturing even if it contains harmful radiation.

(c) Destruction of dangerous manufactured home appliances and beauty products in a way that does not pose any danger to workers.
(d) Seizing and destroying dangerous household items and cosmetics from shops.
(e) Making home appliances and beauty products conform to the standards set by the government from time to time.

(4) Matters related to infectious diseases:

(a) To suppress and prevent the spread of infectious diseases; Promulgation of diagnoses to be reported by region from time to time.
(b) for the prevention of infectious diseases; investigation Establishing a vaccination program for the entire workforce; vaccination; Extermination of pest animals and other necessary activities.
(c) If there is a situation where the health of the workers may be affected by an infectious disease. or if an infectious disease occurs; The government is the state, every district Township neighborhood village Or declaring a certain area as an emergency area of concern for health and carrying out the necessary disease prevention activities.

(5) Matters related to private medical centers:

(a) Prescribing requirements regarding private medical facilities.
(b) registration of all private medical facilities; Deregistration and re-registration.

(6) Matters related to medicine required for use by workers:

(a) Manufacture of medicines for distribution and sale; Registration of businesses such as retail and wholesale sales; Cancellation and re-registration.
(b) To ensure that the medicines are safe and effective for the workers, and to send samples of the medicines to the organizations that the government will set up for this purpose.
(c) more or more than the medicinal power. or lying Prohibition of advertising.
(d) Distribution of medicines imported from abroad only after verification of potency.
(e) To test the potency of medicine. Assignment to a laboratory designated by the government.

Section 5, Organizations established by this law, or Those who have been assigned by these groups, or Government departments and organizations subordinate to the government assigned under this law; matters related to environmental health activities; issues related to food; Issues related to home appliances and beauty products for the working people. Issues related to infectious diseases; Matters related to private medical centers; Workshop for matters related to medicines used by workers, etc. factories, business departments, shops, metaphors Places He has the right to enter and inspect the buildings at any time.

2.4.8.2. Prevention and Control of communicable Diseases Law (1995)

This law was enacted in March, 1995 by the Ministry of Health & Sports. This law describes functions and responsibilities of health personnel and citizens in relation to

prevention and control of communicable diseases. It also describes measures to be taken in relation to environmental sanitation, reporting and control of outbreaks of epidemics and penalties for those failing to comply. The law also authorizes the Ministry of Health to issue rules and procedures, when necessary, with approval of the government.

Section 3, (a) In order to prevent the outbreak of communicable diseases, the Department of Health shall implement the following activities systematically under the guidance of the Ministry of Health:

(ix) giving advice to and coordinating with relevant Government departments, organizations and non-governmental organizations for construction of healthy housing, obtaining safe drinking water and fresh water for use, proper waste disposal in order to prevent occurrence of communicable disease for workers who are carrying out activities of social and economic development;

Section 9, When the head of the household, any member of the household or any entrepreneur knows the occurrence of any of the following matters, he shall report immediately to the nearest health department or hospital:

(a) enmasse death of animals including chicken and birds;

(b) rat fall;

(c) suspicion or occurrence of epidemic disease;

(d) occurrence of notifiable disease.

Section 11, In order to prevent and control the spread of a Epidemic Disease, the Health Officer may undertake the following measures: -

(a) investigation of a patient or any other person required;

(b) medical examination;

(c) causing laboratory investigation of stool, urine, sputum and blood samples to be carried out;

(d) other necessary investigation;

(e) prohibition of the right of movement of the vehicle carrying animal or animal product suspected of having epidemic disease.

2.4.8.3. The Control of Smoking and Consumption of Tobacco Product Law (2006)

Section 9, The person in charge shall:

(a) keep the caption and mark referring that it is a non-smoking area at the place mentioned in section 6 following the stipulations;

(b) arrange the specific place where smoking is allowed as mentioned in section 7 and keep the caption and mark also referring that it is a specific place where smoking is allowed, following the stipulations;

(c) supervise and carry out measures so that no one shall smoke in the non-smoking area;

(d) accept the inspection when the supervisory body comes to the place for which he is responsible.

2.4.9. Laws Relating to the Transportation

2.4.9.1. Vehicle Safety and Vehicle Management Law (2020)

Section 9, The Ministry shall undertake the following matters with the approval of the Union Government -

(a) Determining and restricting the areas where domestic vehicles are allowed to travel.

Section 12 (c), The Ministry shall approve and publish the standards and criteria relating to the safety and environmental protection regulations about the initial registration of motor vehicles.

Section 14 (r), The powers and responsibilities of the Department are as follows - Speed setting for the safe movement of vehicles traveling on public roads.

Section 18, The owner of the vehicle -

(a) The vehicle must be maintained and repaired following the standards set by the Department to drive it safely.

Section 81 (g), No one in a public place

(g) Dangerous Goods shall not be loaded or transported in a vehicle without complying with the requirements;

2.4.9.2. Vehicle Safety and Vehicle Management Rules (2022)

Rule 5, The motor vehicle owner must register the motor vehicle with the relevant registration and submitted to the officer in the form prescribed by the Department.

Rule 7, The concerned registration officer shall receive the reservation under rule 5. Whether or not the specified documents are fully attached or comply with the standards for safe driving, regardless of whether or not the motor vehicle is equipped, Export document, verify whether or not the motor vehicle does not meet the requirements. The registration of the motor vehicle must be completed.

2.4.9.3. Multimodal Transport Law (2014)

Section 3, The objectives of this Law are as follows:

(a) to implement the provisions contained in international convention and promises contained in regional agreement related to the multimodal transport;

(b) to support the development of commercial business systematically through the cooperation and coordination of multimodal transport operators in land and at abroad;

(c) to cause more development of, effective and fast multimodal transport services to fulfill the requirements of international trade;

(d) to perform operation by the multimodal transport operators in accord with the terms and conditions by registering under this Law;

(e) to enable to enjoy fair interests between users and operators in multimodal transport services and to settle the problems peacefully arising thereof;

(f) to reduce and free from difficulties and problems in every step-in transporting good through intermediary countries by formal method and to facilitate the transport of goods more quickly.

2.4.10. Laws Relating to the Emergency

2.4.10.1. Natural Disaster Management Law (2013)

Section 3, the objectives of this Law are as follows:

(a) to implement natural disaster management programs systematically and expeditiously to reduce disaster risks;

(b) to form the National Committee and Local Bodies to implement natural disaster management programs systematically and expeditiously;

(c) to coordinate with domestic and foreign government departments and organizations, social organizations, other non-government organizations or international organizations and foreign regional organizations in carrying out natural disaster management activities;

(d) to conserve and restore the environment affected by natural disasters;

(e) to provide health, education, social and livelihood programs to bring about better living conditions for victims.

Section 14, Preparatory measures for natural disaster risk reduction before the natural disaster strikes include the followings:

(a) prioritization of the natural disaster risk reduction by the National Committee and each Local Body;
(b) carrying out improvement on early warning system of natural disaster;
(c) applying education, knowledge and innovation to be a habit of safety and resilience at every level from the national level to the ward or village tract level;
(d) incorporating measures of natural disaster risk reduction in development plans of the State;
(e) establishing sound preparations to confront the natural disaster at every level from the national level to the ward or village tract level.

Section 15, Preparatory measures to be organized before the natural disaster in the area where it is likely to strike include the followings:

(a) indentifying the area where the natural disaster is likely to strike and preparing the natural disaster risk assessment and drawing emergency plans;
(b) assuring public awareness of knowledge of the natural disaster, keeping the early warning systems, training for search and rescue and holding rehearsal;
(c) enhancing the capacity of the public for emergence of a disaster resilient community in compatible with climate change for reduction of damage and losses due to unforeseen disaster risk caused by climate change;

(d) guiding, motivating and implementing active participation of the community including youth volunteers in the community-based natural disaster management activities and disaster reduction activities by the National Committee and Local Body;
(e) issuing information and early warning to the public to enable timely evacuation of their properties and cattle to a safety area;
(f) stockpiling to provide readily the minimum requirement of food and relief items and rehabilitation materials according to the type of natural disaster;
(g) taking measures to enable to get assistance of the Defence Services, the Myanmar Police Force, the Fire Brigade, the Red Cross, volunteer organizations, civil societies and other non-government organizations for search, rescue and assistance expeditiously;
(h) communications network for providing necessary assistance by foreign countries, international organizations and foreign regional organizations in case of serious damage and heavy losses caused by the natural disaster;
(i) taking preparatory measures for rehabilitation and reconstruction of health, education, social and other sectors for improving better living standard after the natural disaster strikes;
(j) performing other duties assigned by this Law in respect of the preparatory measures.

Section 16, Preventive measures to be carried out in the area where the natural disaster is likely to strike before the natural disaster include the followings:

(a) building cyclone shelters and life-saving hillock-sanctuaries in the area where easy evacuation is impossible;
(b) constructing embankments along the coast and in the possible flooded areas;
(c) preservation of mangroves along the coast and planting fast-growing trees;
(d) taking preventive measures according to the type of natural disaster;
(e) performing other duties assigned by this Law in respect of the preventive measures.

Section 17, When the natural disaster strikes, emergency responses including search and rescue include the following:

(a) emergency search and rescue of missing persons due to the natural disaster;
(b) evacuation of the victims to a safety area and providing accommodation in temporary shelters;
(c) emergency providing of food and relief items;
(d) clearance of damage and collecting preliminary data on losses and making examinations for necessaries to provide;
(e) opening an emergency natural disaster management centre and supervising closely;
(f) providing emergency health care to the local people and prevention of the outbreak of contagious diseases by forming mobile healthcare teams;
(g) providing medical treatment to the injured and the sick by opening temporary clinics and hospitals;
(h) conducting emergency responses including search and rescue according to the type of natural disaster;

(i) performing other duties assigned by this Law in respect of emergency responses including search and rescue.

Section 18, Rehabilitation and reconstruction activities to be carried out after the disaster include the following:

(a) collecting data and confirming damage and losses due to natural disaster;
(b) providing the continuation of sufficient food, relief items and rehabilitation items and appropriate financial assistance from the allotted funds to the victims;
(c) laying down the plan for rehabilitation and reconstruction on the situation of damage and losses;
(d) reconstructing buildings and houses damaged by the natural disaster in an appropriate place as disaster-resilient buildings;
(e) rehabilitating to restore agriculture, livestock breedings and other vocations required for victims;
(f) establishing reintegration into society by uplifting the mental affected person due to the natural disaster;
(g) providing medical treatment to the victims and taking preventive measures against contagious diseases that is likely to cause as consequences;
(h) taking measures for the continuation of students' studies out of the victims and reconstruction of schools;
(i) taking measures for the safety of the victims and the rule of law in the disaster affected area;
(j) coordination with the relevant body of prevention against human trafficking to the victims;
(k) performing other duties assigned by this Law in respect of rehabilitation and reconstruction.

2.4.10.2. The Myanmar Fire Force Law (2015)

The main objectives of this Law are as follows:

(a) to prevent destruction of State-owned property, private property, cultural heritage and the lives and property of the public by fire and other natural disaster;

(b) to organize the Fire brigade systematically and to train members of the fire brigade;

(c) to carry out extinguishing fire, prevention and search and rescue when fire, other natural disaster, epidemic disease or any kind of sudden disaster occurs;

(d) to educate, organize and incite extensively so as to achieve public cooperation when any disaster occurs;

(e) to participate and help, if necessary, for the State safety, peace of the public and the rule of law.

The project proponent must comply with Section 14, The Reserve Fire Brigade shall:

(a) accept supervision and inspection of the head of the relevant Department of Fire Services

(b) coordinate with the relevant fire service personnel and members of the Auxiliary Fire Brigade in performing the activities of fire safety and in the occurrence of fire hazard, other disaster, epidemic disease or sudden disasters

(c) accept the direction of the Department of Fire Services for training and acquiring skills and technology of fire safety.

Section 16, The person-in-charge of the Township Fire Services Department shall:

(b) issue, from time to time, the directives on fire safety to be abided by the residents in the city, ward or village - tract;

(c) inspect or cause to inspect in accord with the stipulations whether the residents in the city, ward or village - tract abide by the directives issued under sub-section (a) and arrange to enable warning or taking action, as may be necessary, against those who do not abide by.

2.4.11. International Environmental and Social Conventions, Protocols and Agrements

Myanmar participated in ratifications of the international environmental conventions in which directly or indirectly related to biological diversity, chemical and waste, climate and atmosphere, environmental governance, land and agriculture, marine and freshwater. The Project Proponent have proposed to follow and commit to the following environmental conventions, protocols, and agreements related to the project:

Table 2-3 Conventions and Agreements

No.	Conventions/Agreements
1	United Nations Framework Convention on Climate Change (UNFCCC), 1992,
2	International Tropical Timber Agreement (ITTA), 1994,
3	UN Convention on Biological Diversity, 1995
4	United Nations Convention to Combat Desertification (UNCCD) 1997
5	Botanic Gardens Conservation International, 1998
6	The Cartagena Biosafety Protocol, a subsidiary agreement to the UN Convention on Biological Diversity, 2000
7	Convention on Biological Diversity (CBD), Rio de Janeiro, 1992 (1994)
9	International Labour Organization Conventions, 2012
10	National Biodiversity Strategy Action Plans (NBSAP) 2011)
11	Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), 2005
12	Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985
13	Montreal Protocol on Substances that Deplete Ozone Layer, Vienna, 1985 (1993)

No.	Conventions/Agreements
15	Montreal Amendment, 1997 and Beijing Amendment, 199 to the Montreal Protocol on Substances that Deplete Ozone Layer, 1997 (2012)
16	Plant Protection agreement for the South-East Asia and the Pacific Region, 1956 (1959)
17	Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973, and this Convention as amended in 1979 (CITIES) (1997)
18	ASEAN Agreement on the Conservation of Nature and Natural Resources, Kuala Lumpur, 1985 (1997)
19	ASEAN Agreement on Transboundary Haze Pollution, 1997
20	International Convention for the Prevention of Pollution from Ships (MARPOL)
21	Agreement on the Networks of Aquaculture Centers in Asia and the Pacific Region
22	International Treaty on Plant Genetic Resources for Food and Agriculture, 2001 (2004)
23	Stockholm Convention on Persistent Organic Pollutants (POPs), 2001 (2004)
24	The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971 as amended in 1982 and 1987 (2004)
25	Establishment of ASEAN Regional Centre for Biodiversity (2005)
26	Framework Convention on Climate Change (FCCC) 1995
27	Universal Declaration of Human Rights (UNDHR)
28	Convention on Elimination of All Forms of Discrimination against women (CEDAW)
29	ILO Conventions ratified for Myanmar that still in force C029 – Forced Labour Convention, 1930 (No.29) C087 - Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87) C138 - Minimum Age Convention, 1973 (No. 138) C182 - Worst Forms of Child Labour Convention, 1999 (No. 182) C001 - Hours of Work (Industry) Convention, 1919 (No. 1) C002 - Unemployment Convention, 1919 (No. 2) C006 - Night Work of Young Persons (Industry) Convention, 1919 (No. 6) C011 - Right of Association (Agriculture) Convention, 1921 (No. 11) C014 - Weekly Rest (Industry) Convention, 1921 (No. 14) C017 - Workmen's Compensation (Accidents) Convention, 1925 (No. 17) C018 - Workmen's Compensation (Occupational Diseases) Convention, 1925 (No. 18) C019 - Equality of Treatment (Accident Compensation) Convention, 1925 (No. 19) C026 - Minimum Wage-Fixing Machinery Convention, 1928 (No. 26) C027 - Marking of Weight (Packages Transported by Vessels) Convention, 1929 (No. 27) C042 - Workmen's Compensation (Occupational Diseases) Convention (Revised), 1934 (No. 42) C052 - Holidays with Pay Convention, 1936 (No. 52) C063 - Convention concerning Statistics of Wages and Hours of Work, 1938 (No. 63) C185 - Seafarers' Identity Documents Convention (Revised), 2003, as amended (No. 185) MLC, 2006 - Maritime Labour Convention, 2006 (MLC, 2006)

2.5. NATIONAL ENVIRONMENAL QUALITY (EMISSION) GUIDELINES (2015)

Objectives of the National Environmental Quality (Emission) Guidelines (NEQG) are to provide the regulation and control of noise and vibration, air emissions, solid wastes, and effluent discharges from various sources to prevent pollution and protection of human health and the ecosystem.

NEQG guidelines are set out as a basic principle to control the emission levels of noise, vibration, air emission, and water quality. Emission guidelines and standards should consider in the impact assessment and the Environmental Management Plans of the proposed project.

The type of the proposed project must follow with the guidelines applied to Section 1.1 (Air emission), Section (1.2) Wastewater, Section 1.3 (Noise) and 1.4 (Odor) of National Environmental Quality (Emission) Guidelines (2015). Guidelines for parameters relevant to the Proposed Project are shown in Table 2-4 to Table 2-9.

Table 2-4 National Guidelines of Air Quality

Parameter	Averaging Period	Guideline Value µg/ m^3
Nitrogen dioxide	1-year 1-hour	40 200
Ozone	8-hour daily maximum	100
Particulate matter PM_{10}[a]	1-year 24-hour	20 50
Particulate matter $PM_{2.5}$[b]	1-year 24-hour	10 25
Sulphur dioxide	24-hour 10 -minute	20 500

[a] Particulate matter 10 micrometers or less in diameter

[b] Particulate matter 2.5 micrometers or less in diameter

Table 2-5 Wastewater, storm water runoff, effluent and sanitary discharges (general application)

Parameter	Unit	Guideline Value
5-day Biochemical oxygen demand	mg/l	50
Ammonia	mg/l	10
Arsenic	mg/l	0.1
Cadmium	mg/l	0.01
Chemical oxygen demand	mg/l	250
Chlorine (total residual)	mg/l	0.2
Chromium (hexavalent)	mg/l	0.1
Chromium (total)	mg/l	0.5
Copper	mg/l	0.5
Cyanide (free)	mg/l	0.1
Cyanide (total)	mg/l	1

Parameter	Unit	Guideline Value
Fluoride	mg/l	20
Heavy metals (total)	mg/l	10
Iron	mg/l	3.5
Lead	mg/l	0.1
Mercury	mg/l	0.01
Nickel	mg/l	0.5
Oil and grease	mg/l	10
pH	S.U.[C]	6-9
Phenol	mg/l	0.5
Selenium	mg/l	0.1
Silver	mg/l	0.5
Sulphide	mg/l	1
Temperature increase	℃	<3[b]
Total coliform bacteria	100ml	400
Total phosphorus	mg/l	2
Total suspended solids	mg/l	50
Zinc	mg/l	2

a Standard unit

b At the edge of a scientifically established mixing zone which takes into account ambient water quality receiving water use, potential receptors and assimilative capacity; when the zone is not defined, use 100 meters form the point of discharge

Table 2-6 Site Runoff and Wastewater Discharges (Construction Phase

Parameter	Unit	Maximum Concentration
Biological oxygen demand	mg/l	30
Chemical oxygen demand	mg/l	125
Oil and grease	mg/l	10
pH	S.U.	6-9
Total coliform bacteria	100ml	400
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Total suspended solids	mg/l	50

The surface water quality is compared with TCVN 5942-1995: Water Quality-Surface Quality Standard of the people's Socialist Republic of Vietnam. In the standards, Barium, DDT, Cadmium, Detergent, Gross Alpha Activity, Gross Beta Activity, Tin and Total Pesticide (except DDT) parameters cannot tested in laboratories in Myanmar.

Table 2-7 TCVN 5942-1995: Water Quality-Surface Quality Standard

Surface water	Unit	Standard
Arsenic	mg/l	0.1
BOD	mg/l	<25
COD	mg/l	<35
Dissolved Oxygen	mg/l	≥2
Iron	mg/l	2
pH	mg/l	5.5 - 9
Lead	mg/l	0.1
Oil and Grease	mg/l	0.3
Ammonia (as N)	mg/l	1
Barium	mg/l	4
Chromium (Hexa)	mg/l	0.05
Coliform	MPN/100 ml	10000
DDT	mg/l	0.01
Cadimium	mg/l	0.02
Chromium (Tri)	mg/l	1
Copper	mg/l	1
Cyanide	mg/l	0.05
Detergent	mg/l	0.5
Flouride	mg/l	1.5
Gross Alpha Activity	Bq/l	0.1
Gross Beta Activity	Bq/l	1.0
Manganese	mg/l	0.8
Mercury	mg/l	0.002
Nickel	mg/l	1
Nitrate (as N)	mg/l	15
Nitrites (as N)	mg/l	0.05
Phenol compounds	mg/l	0.02
Suspended Solids	mg/l	80
Tin	mg/l	2
Total Pesticide (except DDT)	mg/l	0.15
Zinc	mg/l	2

The ground water quality is compared with Myanmar National Drinking water standard (2019). In the standards, the parameters of Tast and odor cannot test in laboratories at Myanmar.

Table 2-8 Myanmar National Drinking water standard (2019)

No.	Parameters	Unit	Limitation
1	pH	mg/L	6.5 - 8.5
2	Total Dissolved Solid	mg/L	1000
3	Hardness	mg/L (as CaCO3)	500
4	Arsenic	mg/L	0.05
5	Total Coliform	MPN/100ml	3
6	Iron	mg/L	1
7	Turbidity	NTU (Nephelometric Turbidity Units)	5
8	Color	TCU (True Color Unit)	15
9	Lead	mg/L	0.01
10	Fecal coliform	MPN/100ml	0
11	Manganese	mg/L	0.4
12	Chloride	mg/L	250
13	Sulphate	mg/L	250
14	Taste	Acceptable/ No objectionable taste	
15	Odor	Acceptable/ No objectionable taste	
16	Nitrate	mg/L	50

Table 2-9 National Guidelines on Noise Level

Receptor	**One Hour LAeq (dBA)a**	
	Daytime 07:00-22:00 (10:00-22:00 for public holidays)	**Night time 22:00-07:00 (22:00-10:00 for public holidays)**
Residential, institutional, educational	55	45
Industrial, commercial	70	70

National Guidelines on Odor

Point and diffuse source odors from industries should be minimized using available prevention and control techniques as described in the IFC EHS industry-specific guidelines. Point source activities are those that involve stack emissions of odor and which generally can be controlled using waste reduction, waste minimization and cleaner production principles or conventional emission control equipment. Diffuse source activities are generally dominated by area or volume source emissions of odor (e.g. intensive agricultural activities) and which can be more difficult to control. Projects should control odors to ensure that odors that are offensive or unacceptable to neighbors do not occur. Generally, odor levels should not exceed five to ten odorant units6 at the edge of populated areas in the vicinity of a project. Projects with multiple odorous point or diffuse

releases, or emitting complex odors should conduct an odor impact assessment to determine ground-level maximum concentrations considering site-specific factors including proximity to populated areas.

2.6. INTERNATIONAL POLICIES, STANDARDS AND GUIDELINES FOR ENVIRONMENTAL AND SOCIAL

International policies, guidelines and standards relevant to environmental and social impacts of projects that referred to by most countries are those issued by the NEQG, World Health Organization (WHO), the U.S Environmental Protection Agency (EPA), the World Bank, and the International Finance Corporation (IFC). The policies, guidelines and standards of the World Bank and IFC are cross-referenced and complementary as the IFC is an organization of the World Bank Group. They are also adopted by most development organizations such as the Asian Development Bank, and Japan Bank for International Cooperation. It should be noted that the guidelines and standards recommended by the World Bank and IFC, especially those related to environmental pollution, also provide due consideration to the guidelines and standards of U.S. EPA and WHO.

Only those international policies, guidelines and standards relevant to this Project discussed herein.

2.6.1. International Finance Corporation (IFC)'S Environmental, Health, And Safety (EHS) Standards and Guidelines

IFC's standards and guidelines relevant to this project described in two documents:

(1) Performance Standards on Environmental and Social Sustainability, January 1, 2012 and

(2) Environmental, Health and Safety-General Guidelines, April 30, 2007.

The first document describes eight performance standards on environmental and social sustainability, which IFC requires its clients to apply throughout the project life cycle.

The second document provides general guidelines for environmental, health and safety (EHS) for development projects.

Illumination standards

Work area light intensity should be adequate for the general purpose of the location and type of activity, and should be supplemented with dedicated work station illumination, as needed. The minimum limits for illumination intensity for a range of locations/activities of IFC are described in Table 2-10.

Table 2-10 Minimum Limits for workplace illumination intensity

Location / Activity	Light Intensity (Lux)

Emergency light	10
Outdoor Non-working Area	20
Simple orientation and temporary visits (machine storage, garage, warehouse)	50
Workspace with occasional visual tasks only (Corridors, stairways, lobby, etc.)	100
Medium precision work (simple assembly, rough machine works, welding, packing, etc.)	200
Precision work (reading, moderately difficult assembly, sorting, checking, medium bench and machine works, etc.)	500
High precision work (difficult assembly, color inspection, fine sorting, etc.)	1000-3000

2.6.1.1. IFC Performance Standards

IFC strives for positive development outcomes in the activities it supports in developing countries. IFC pursues and expects to achieve through the application of this Policy on Environmental and Social Sustainability (the Sustainability Policy or the Policy), and a comprehensive set of environmental and social Performance Standards. The Performance Standards that the project proponent must comply are as the followings:

Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts

Performance Standard 2: Labour and Working Conditions

Performance Standard 3: Resource Efficiency and Pollution Prevention

Performance Standard 4: Community Health, Safety, and Security

Performance Standard 5: Land Acquisition and Involuntary Resettlement

Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

Performance Standard 7: Indigenous Peoples

Performance Standard 8: Cultural Heritage

2.6.2. Regulation of Occupational Safety, Health and Environment in Relation to Heat, Light and Noise (2006)

The regulation of occupational safety, health and environment in relation to heat, light and noise (2006) was issued by the Kingdom of Thailand, the Minister of Labour and Social Welfare. This regulation was acknowledged by the International Labour Organization (ILO) and was places as a standard for the heat, light and noise pollution within the workplace of industrial sectors. Clause 3 of this regulation states that the workers shall control and maintain the heat level within the workplace in which employees are working not to exceed the standard of 30 - 34 degrees Celsius of the wet bulb globe temperature.

2.6.3. World Bank's Pollution Prevention and Abatement Handbook (1988) "Towards Clear Production"

The World Bank's Pollution Prevention and Abatement Handbook (PPAH) is a comprehensive document providing guidelines for industrial pollution control, and it recommends emission and ambient quality standards to apply in environmental management. These recommends standards have considered the standards enforced by U.S.EPA and those recommended by WHO. They are referred to in the IFC's EHS Guidelines.

2.7. CORPORATE ENVIRONMENTAL AND SOCIAL POLICIES

Mandalay Business Capital City Development Ltd., acknowledges that the company and its activities have special design reducing the negative impact on the environment. The company has identified the key areas as energy, water, waste, transport, hazardous materials, business operations, biodiversity and health. The company aims to protect and improve the environment by an in-depth analysis, identification and measurement of these environmental aspects and impacts and to set targets to reduce them.

The company's Commitment is to:

- Continuously improve the environmental performance and integrate environmental best practice into the business operations
- Reduce our consumption of resources and improve the efficient use of those resources
- Assess, measure, record and take action to reduce the carbon footprint of the business activities
- Manage waste generated from our business operations according to the principles of reduction, re-use and recycling
- Continue to improve our environmental performance through effective communication, provision of staff training and adoption of best techniques available
- Manage our business operations to prevent pollution Ensure environmental, including climate change, criteria are taken into account in the procurement of goods and services
- Be a respectful neighbor by minimizing the impact that our activities, sites and premises have on local communities
- Protect and, where feasible, enhance biodiversity on sites and premises where we hold responsibility or can influence those who do
- Seek to Influence our clients to adopt, and our designers to provide, solutions that benefit the environment

To meet commitments the company will:

- Reduce and replace the use of toxic chemicals 'with _green' replacements where possible

- Regular maintain and service our vehicles to ensure emissions are kept as low as possible
- Maximize delivery of materials and reduce return trips made by unladen vehicles.
- Identify our waste streams and reduce material wastage by carefully planning recycling, reusing and selective ordering
- Make lighting and power energy savings both at work and on site,
- Use peat alternatives in landscaping and ensure that mature trees are retained, wherever possible, on site
- Minimize the need to travel but, where travel is unavoidable, use modern and efficient modes of transport
- Establish, measure and monitor key objectives and targets annually
- Apply the following standards

2.8. GUIDELNES AND STANDARDS FOR PROJECT DESIGN

The project proponent will comply with to the standards and requirements listed in the table for project design.

Table 2-11Guidelines and Standards for Project Design

No	Items	Referred Design code & Standard
1	Traffic and transportation	➢ MNBC 2020: Urban Road Hierarchies/Design speed/Lane width/ Internal Turning Radius. ➢ AASHTO 2018: Horizontal and Vertical geometric design/ Design vehicle/ Intersection and Roundabout Design.
2	Electrical and communication system	➢ MNBC 2016,2020 ➢ Ministry of Electricity and Energy standard (MOEP) ➢ International Electro-technical Commission (IEC) ➢ American National Standards Institute (ANSI) ➢ National Electrical Code (NEC) ➢ Institute of Electrical and Electronics Engineered (IEEE) ➢ Internet Engineering Task Force (IETF) ➢ Electronics Industry Association (EIA)
3	Water supply	➢ MNBC 2020 ➢ World Health Organization (WHO) ➢ World Bank ➢ Asian Development Bank (ADB)

No	Items	Referred Design code & Standard
4	Fire Protection	➢ Myanmar Fire Safety Code 2020 ➢ NFPA ➢ US Fire Administration
5	Wastewat	➢ MNBC 2020 ➢ World Health Organization (WHO) ➢ World Bank ➢ Asian Development Bank (ADB)
6	Solid waste (Waste transfer station)	➢ NEQG ➢ United States Environmental Protection Agency (USEPA)
7	Population estimation	Regard to FAR, BCR and occupant loads ➢ MNBC 2020 ➢ International Code Council (ICC)
8	Storm Drainage System	➢ ANSI ➢ American Concrete Institute (ACI) ➢ American Society for Testing and Materials Standard (ASTM) ➢ British Standard (BS) ➢ Engineering Institute of Thailand Standard (EIT)
9	MNBC 2020	➢ Administration of Planning, Building and Built Environment ➢ Architectural and Urban Design ➢ Structural Design ➢ Soil and Foundation ➢ Building Services ➢ Building Materials ➢ Constructional Practices, Safety and Building Maintenance
10	Seismic Design Criteria and Performance level of ground Improvement	➢ Geotechnical Engineering Circular No. 3, Design Guidance: geotechnical Earthquake Engineering for Highways, Volume 1 – Design Principles (1997) ➢ Indian Institute of Technology Kanpur – Gujarat State Disaster Management Authority Guidelines for Seismic Design of Earth Dams and Embankments (2007) ➢ Myanmar National Building Code (2016) ➢ Myanmar National Building Code (2020) ➢ Seismic Coefficients for Pseudo-static Slope Analysis by Cristino MELD and Sunil SHARM (2004) ➢ Seismic Design Guidelines for Dikes, 2nd Edition, British Columbia (2014).

No	Items	Referred Design code & Standard
		➢ Project-Specific Probabilistic Seismic Hazard Analysis (Dr Myo Thant)

2.9. COMMITMENTS OF THE EIA

Commitment List	No	Explanation of Commitment	Chapter
Legal requirement	1	Environmental policy and legal framework The project proponent will follow all the legal requirements mentioned in Chapter 2.	Chapter 2
Environmental quality monitoring	2	Measured based on National Environmental Quality (Emission) Guidelines (2015) and international environmental guidelines and Environmental management guidelines	Chapter 4
Outdoor Air quality	2.1	The results of outdoor air quality measurements are presented by comparing with NEQEG (2015).	Paragraph Section 4.7.1, 4.7.2, 4.7.3, 4.7.4, 4.7.5, 4.7.6, 4.7.7, 4.7.8, 4.7.9, 4.7.10, 4.7.11, 4.7.12
Water quality	2.2	Surface water and ground water quality were collected and the results are indicated by comparing NEQEG (2015), National Drinking Water Quality Standard of Myanmar and WHO Guidelines.	Paragraph Section 4.7.13, 4.7.14
Noise and Vibration	2.3	Noise Quality Results are described by comparing NEQEG (2015). Vibration results are described by comparing Assessing Vibration: a technical guideline, 2006, Department of Environment and Conservation, NSW (New South Wales), Australia.	Paragraph Section 4.7.15
Soil	2.4	Soil results are presented by comparing with FAO Guidelines.	Paragraph Section 4.7.16
Environmental management plan	3	Responsible organization, responsibilities, estimated budget and emergency response plan for implementing mitigation measures and monitoring to mitigate environmental impacts are completely described.	Chapter 7

Commitment List	No	Explanation of Commitment	Chapter
Air pollution	3.1	**Construction Phase**	Paragraph Section 7.4.1 and Table 7.6
		• Air Quality Management Plan mentioned in section 7.4.1.1 and Table 7.6 will be followed and implemented by the project proponent and contractor.	
		Operation/ Maintenance Phase	
		• Air Quality Management Plan mentioned in section 7.4.1.2 and Table 7.6 will be followed and implemented by the project proponent.	
Water pollution	3.2	**Construction Phase**	Paragraph Section 7.4.2 and Table 7.7
		• Water Quality Management Plan mentioned in section 7.4.2.1 and Table 7.7 will be followed and implemented by the project proponent and contractor.	
		Operation/ Maintenance Phase	
		• Water Quality Management Plan mentioned in section 7.4.2.2 and Table 7.7 will be followed and implemented by the project proponent.	
Solid Wastes	3.3	**Construction Phase**	Paragraph Section 7.4.3 and Table 7.8
		• Water Quality Management Plan mentioned in section 7.4.3.1 and Table 7.8 will be followed and implemented by the project proponent and contractor.	
		Operation/ Maintenance Phase	
		• Water Quality Management Plan mentioned in section 7.4.3.2 and Table 7.8 will be followed and implemented by the project proponent.	
Noise and Vibration	3.4	**Construction Phae**	Paragraph Section 7.4.4 and Table 7.9
		• Noise and Vibration Quality Management Plan mentioned in section 7.4.4.1 and Table 7.9 will be followed and implemented by the project proponent and contractor.	
		Operation/ Maintenance Phase	

Commitment List	No	Explanation of Commitment	Chapter
		• Noise and Vibration Quality Management Plan mentioned in section 7.4.4.2 and Table 7.9 will be followed and implemented by the project proponent.	
Soil Contamination	3.5	**Construction Phase**	Paragraph Section 7.4.5 and Table 7.10
		• Soil contamination and landscaping Management Plan mentioned in section 7.4.5.1 and Table 7.10 will be followed and implemented by the project proponent and contractor.	
		Operation/ Maintenance Phase	
		• Soil contamination and landscaping Management Plan mentioned in section 7.4.5.2 and Table 7.10 will be followed and implemented by the project proponent.	
Biodiversity	3.6	**Construction Phase**	Paragraph Section 7.4.6 and Table 7.11
		• Biodiversity Management Plan mentioned in section 7.4.6.1 and Table 7.11 will be followed and implemented by the project proponent and contractor.	
		Operation/ Maintenance Phase	
		• Biodiversity Management Plan mentioned in section 7.4.6.2 and Table 7.11 will be followed and implemented by the project proponent.	
Traffic Congestion	3.7	**Construction Phase**	Paragraph Section 7.4.7 and Table 7.12
		• Traffic Congestion Management Plan mentioned in section 7.4.7.1 and Table 7.12 will be followed and implemented by the project proponent and contractor.	
		Operation/ Maintenance Phase	
		• Biodiversity Management Plan mentioned in section 7.4.7.2 and Table 7.12 will be followed and implemented by the project proponent.	
Environmental Monitoring	4	The objectives of environmental monitoring program are outlined in five points.	Paragraph Section 7.3.

Commitment List	No	Explanation of Commitment	Chapter
Program			
Outdoor Air Quality	4.1	• **Parameter** - PM2.5 and PM10, TSP, NO2, SO2, CO2, CO, VOC, O3, Humidity • **Guidelines** - NEQEG (2015) • **For construction, operation/ maintenance phase** • **Area to be Monitored** - Lat:21°56'12.27"N Long: 96°2'59.27"E, Lat:21°54'57.92"N Long: 96°2'7.89"E, Lat:21°53'55.89"N, long: 96°0'54.32"E	Table 7.4, Table 7.5,
Water Quality	4.2	**Parameter** - **Surface Water Quality (**BOD, COD, Iron, Oil & Grease, pH, chlorine(free), Total Suspended Solid, Hardness, Total Dissolved Solid, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Phosphorus, Total Coliform Bacteria, Ammonia (as N), Chromium (Hexa), Chromium (Tri), Copper, Cyanide, Manganese, Flouride, Mercury, Nikkel, Nitrate (as N), Nitrite (as N), Phenol compounds and Zinc Guidelines - NEQEG (2015) and National Drinking Water Quality Standards of Myanmar, TCVN 5942 : 1995 Water Quality Standards (Vietnam) • **For construction and Operation/ maintenance phase** • Frequency - Twice a year • Area to be Monitored • **Ayeyarwady River, downstream,** Lat:21°53'39.49"N, Long: 96°0'13.72"E • **Ayeyarwady River, upstream,** Lat:21°57'47.38"N, Long: 96°2'9.03"E • **Ayeyarwady River, middle stream,** Lat:21°55'18.37"N, Long: 96°1'33.96"E **Wastewater outlet point, beside the project boundary** Lat:21°54'32.69"N, Long:96° 1'17.29"E	Table 7.4, Table 7.5
Wastewater	4.3	• Parameter - BOD, COD, Iron, Oil & Grease, pH, chlorine(free), Total Suspended Solid, Hardness, Total Dissolved Solid, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead,	Table 7.4, Table 7.5

Commitment List	No	Explanation of Commitment	Chapter
		Total Phosphorus, Total Coliform Bacteria) • Guidelines - NEQEG (2015) • **For construction phase** Area to be Monitored - Final water discharge point from construction site • Frequency - Twice a year • **For operation/ maintenance phase** • Area to be Monitored - wastewater discharge points (11 points) from the project site • Frequency - Twice a year	
Ground Water	4.4	• Parameter - pH, Iron, Oil and Grease, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform, Fecal Coliform, Manganese, Chloride, Sulphate, Nitrate • Guidelines - NEQEG (2015), National Drinking Water Quality Standards of Myanmar (2019) • **For construction phase/ operation/ maintenance phase** Area to be Monitored - Lat: 21°56'20.22"N ,Long: 96°03'15.66"E Lat: 21°54'45.49"N , Long: 96°02'32.26"E • Frequency - Twice a year	Table 7.4, Table 7.5
Noise and Vibration	4.5	• Parameter - For 24 hours Noise level (dB(A) Pascale), For Vibration level, Acceleration (m/s2), Velocity (mm/s) • Guidelines - NEQEG (2015), a technical guideline, 2006,	Table 7.4, Table 7.5

Commitment List	No	Explanation of Commitment	Chapter
		Department of Environment and Conservation, NSW (New South Wales), Australia. **For construction, operation/ maintenance phase** • Frequency - Twice a year • Area to be Monitored Lat:21°56'12.27"N, Long: 96°2'59.27"E Lat:21°54'57.92"N, Long: 96°2'7.89"E Lat:21°53'55.89"N,Long: 96°0'54.32"E	
Solid waste and Hazardous waste	4.6	• Parameter - The amount of waste generation and classification, Daily weighing and recording of segregated waste, Recording the quantity and method of waste disposal, checking whether or not there is a systematic disposal of waste, Checking the waste burning or not • Guidelines - Standards of Myanmar National Master Plan **For construction phase** • Area to be Monitored - Waste generation source of each operation process at project area • Frequency - Daily • **For operation/ maintenance phase** • Area to be Monitored - Waster Transfer Station within the project site • Frequency - Daily	Table 7.4, Table 7.5
Biodiversity	4.7	• **Parameter** - Plantation, growing and conservation within the project area, Conservation and checking the species of bird, insect and fish. **Law** • The Conservation of Biodiversity and Protected Area Law (2018) **For construction, operation/ maintenance phase** • **Frequency** - 3 seasons	Table 7.4, Table 7.5

Commitment List	No	Explanation of Commitment	Chapter
		• **Area to be Monitored** - For fish survey, Within the project site 21°53'46.99"N &96° 1'11.37"E and surrounding environment 21°56'12.42"N & 96° 2'30.57"E For Flora & Fauna Urban Area (1); 21°55'39.24"N & 96° 3'12.65"E Urban Area (2); 21°54'27.74"N & 96° 3'7.13"E Cultivated Area (1); 21°55'38.90"N & 96° 2'14.17"E Cultivated Area (2); 21°54'57.61"N & 96° 2'36.18"E	
Occupational Health and Safety	4.8	• **Parameter** - Record of incident/accident report, first aid training report, health checkup and seasonal diseases • **Guideline** • EHS Guideline for Occupational Health & Safety (2007) **For construction, operation/ maintenance phase** • **Area to be Monitored** - The whole project area, supply of PPE, Providing warning signs, First Aid Kid, Emergency Contact Number • **Frequency** - Monthly	Table 7.4, Table 7.5
Community Health and Safety	4.9	• **Parameter** - Social impact situation, Health Issue to the surrounding environment due to the project implementation **For construction, operation/ maintenance phase** • **Area to be Monitored** - Project Surrounding Area • **Frequency** - Twice a year	Table 7.4, Table 7.5
Fire Hazard	4.10	• **Parameter** - monthly inspection of pressure gauge and seal on fire extinguisher, monthly inspection on smoke detector, water sprinklers **Law** • .The Myanmar Fire Brigade Law (2015) **For construction, operation/ maintenance phase**	Table 7.4, Table 7.5

Commitment List	No	Explanation of Commitment	Chapter
		• **Area to be Monitored** - The whole project area • **Frequency** - Quarterly	
Emergency Risk	4.11	Parameter - Practicing emergency drill, records of emergency plan, education and training, Emergency Response Plan **Law** • Natural Disaster Management Law (2013) **For construction, operation/ maintenance phase** • Area to be Monitored - The whole project area • Frequency - Twice a year	Table 7.4, Table 7.5
Environmental monitoring team	4.12	The names and positions of people who are responsible for environmental monitoring program are described in table 7.1.	Table 7.1
Estimated budget for environmental monitoring	4.13	The estimated budget for environmental monitoring program is described in table 7.2.	Table 7.2
Corporate Social Responsibilities	4.14	CSR program of project proponent is mentioned in paragraph section 7.7.	Paragraph Section 7.8

If the standards to be followed due to the nature of the project have not yet been set in Myanmar, international standards and best available practices will be followed. Regarding the socio-economy, the project proponent will comply with the commitments to be followed by the project (e.g. land compensation issue, crop compensation issue, employment opportunity issue). In addition, the project proponent will implement the above commitment during project implementation.

U Than Htike San

Managing Director

Mandalay Business Capital City Development Ltd.

CHAPTER 3

PROJECT DESCRIPTION AND ALTERNATIVE SELECTION

3.1. DESCRIPTION OF THE PROJECT

Amarapura Urban Development Project is located between Mandalay city circular road and Ayeyarwady River, Amarapura Township, Mandalay Region. The exact GPS location of the project area is 21° 55' 7.02'' N, 96° 2' 19.51''E. The average elevation of the project location is around 239 ft above the sea level. The project area is about 15 miles from Mandalay International Airport and about 4 miles from Mandalay Railway Station. The location of the project is free from national/regional/protected areas, historical/cultural heritage zones, and other project areas. The project area photo and location map of the project is as shown in Figure 3-1 and Figure 3-2.

Figure 3-1 Project Area Photos

Figure 3-2 Overview Map of the Project Area

3.2. OVERVIEW OF THE PROJECT

In the project area boundary, Shan Kalay Kyun Village is located. Shan Kalay Kyun Village has total population of over (3,590) in 2016 and its gender ratio of male to female is about (1:1.09). There are more than (588) households in the village. In addition, Ka Di Par village, War Kote village, Kyan Tan village, Yin Taw village, Koe Taung village, Moe Kaung village, Let Ywey village, etc are also located near the project area.

Mandalay Kandawgyi Lake is situated in north-east of project area. It covers 322.43 hectares. It is 3657.6 m long from north to south and 975.36 m from east to west. Other famous places near the project area such as Kandawgyi lake are the Taungthaman lake and Sagaing Hill. Taungthaman lake is an idyllic body of water in Amarapura and located south-east part of the project area. Sagaing Hill is one of the main places for meditation in the country and home to numerous Buddhist monasteries and pagoda. Sagaing Hill is located west part of the project area. Shwege stormwater pumping station is situated near the project area in east.

In conclusion, the project area is surrounded by the Ayeyarwaddy River in the west, Chanmyathazan Township in the north, Pyigyitagon township and Chanmyathazi township in east, and Tada-U township in the south. Famous places near the project area is shown in Figure 3-3.

	
Sagaing Hill	Mandalay Kandawgyi Lake

Figure 3-3 Famous places near the project area

3.3. COMPONENT OF THE PROJECT

The Amarapura Urban Development Project is an urban development project that focuses in particular on promoting social sustainability and community growth. Pagoda and religious buildings, residential buildings, commercial buildings, markets, office buildings, workshops, recreation areas, centers, hotels, a mix of commercial space and residential units, clinics and hospitals, police station and administrative offices, fire fighting stations, nursing homes and orphanages, libries, football field and stadium, silk weaving factory and showrooms, primary schools, high schools, vocational school, staff housing and rental housing which contain 1,200 rooms with 600 square feet per room are

all part of the proposed project. Additionally, other infrastructures such as dyke walls, roads, drianges and sewage disposal system, water supply and fire system, communication and electricity supply system, and waste disposal systems are also included in the proposed project.

In Amarapura Urban Development Project, drainage system, wastewater treatment system and water supply are systematically arranged. Sport ground, gymnasium and public spaces are designed in the Amarapura Urban Development Project. Mixed residential buildings, fire station, recreation area and shopping mall are included. Among them, amenities building manages the spaces systematically. Moreover, the waste storage area and wastewater treatment system are arranged with safety first designs.

Figure 3-4 Project Concept Master Plan

3.3.1. Technology

The Amarapura Urban Development involves the number of operations such as land ownership and land purchasing, land reclaiming and leveling, dyke wall construction, soil improving, road construction, drainage and sewage disposal system construction, communication and electricity supply system construction, etc.

Land leveling is the important step of the project. Since the project area is planned to develop the floodplain area of the Ayeyarwady River, a low project elevation will lead to frequent flooding of the project area. Therefore, dyke wall construction and land level process are using to prevent from flooding in the project area currently. The Revetment Riprap Structure method is used to construct the dyke wall. Land leveling process is continued after dyke wall construction. After the land leveling, the soil improvement is required to prevent the site liquefaction and to increase the bearing capacity of ground.

The standard elevation of th project level is +73.00 MSL so the land leveling will advance to 5 to 6 m above the ground. This will be carried out until the northern part of the project have the same elevation and the city road circuit is higher 0.5 to 1.0 m compared to previous condition. When the project is complete, Shankalay village which borders with project will have ground difference by 5 ~ 6 m. According to normal condition of Shankalay village, the low flood plain area is already situated 5~6 m difference from the Proposed project. Depending on the current statuts of the project, the land leveling of Shankalay Village will not be proceeded, instead the construction of water collection area and Main U Ditch will facilitate the systematic disposal of wastewater and rain water which flow through the village will release into the Main Channel of the Amarapura Urban Development.

Vibroflotation compaction method or double axis vibroflotation compaction method will be used to soil improving. Since the project is related to the Sagaing Fault line, soil strengthening activities are required to achieve the Relative Density of the soil adjacent to the retaining wall along the project. In order to prevent movement caused by earthquake and to avoid liquefaction, the project proponents are working to strengthen the sandy soil by Vibro-flotation Method. In the process of strengthening the sandy soils, PGA 0.3g-Magnitude 6~6.5 will be able to withstand, and the buildings of urban housing included in the project will be able to withstand Magnitude 7~7.5.

3.3.2. Infrastructure

The project aims to be an important modern urban project in the socio-economic development sector of Mandalay City, to emerge a River City Business Zone that contribute to the development of Mandalay Region and environmental beauty, and to remain a good example in the urban construction sector by implementing Green growth and Green economy system.

In the project area, the basic infrastructures such as retaining wall, drainage channel, roads, water treatement plant, wastewater treatement plant, power supply system, communication system and other structures like public places, hospital, schools will be implemented.

The project construction plan is divided into 7 sectors and sector 1 is divided into 2 parts, which is section 1 A and section 1B. In each section, landed housing, shop houses, supermarket and public buildings, etc. are planned to construct. The specific tentative plan of the project site is shown in Table 3-1 and Figure 3-5.

Table 3-1 Details Estimate Arrangement of Building Construction in Each Sector

No	Sector (1)	Sector (2)	Sector (3)	Sector (4)	Sector (5)	Sector (6)	Sector (7)
1.	Resort	Riverside shopping & leisure complex	Cruise centre	Large-scale retail	Riverside park	High school & vocational school	Public housing
2.	Exhibition centre	Restaurant	Promenade	Resort	Executive housing	Football field & Stadium	
3.	Executive housing	Private hospital	Commercial centre	Single family housing	Supermarket	Public hospital	
4.	Single family housing	Public buildings	Pagoda	Terraced houses	Cargo Jetty		
5.	Business park	Area for utilities	Riverfront shopping	Agri commodities trade market & heavy truck terminal	Area for utilities		
6.	Jade market		Mid-rise apartment	Auto parts & accessories market & construction materials market			
7.	Textile, flower and fruits market		Public car parking	Mid-rise apartment			
8.			Showrooms				
9.			Hi-rise apartment				

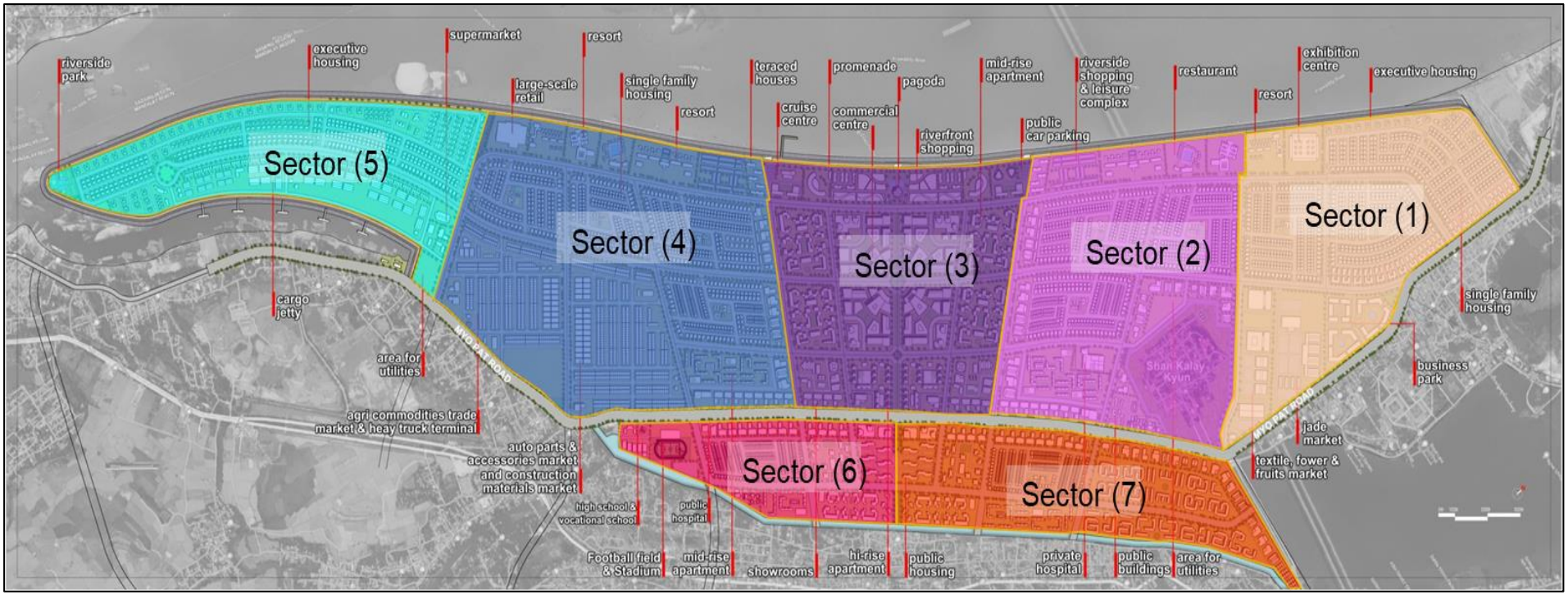


Figure 3-5 Tentative Plan of the Project Site

3.3.3. Land Use in the Project Area

Land use in the project area is divided by two land which is the developable land and supportive land. In the developable land, low rise apartment, high rise apartment, hotel/ condominium/ resort, business places, mixed use building, educational building, etc. are divided and the land use percentage is 59 percent. The remaining percent includes public buildings, government offices, open space (park, plaza, green area) and infrastructures. The specific land use area and percentages are shown in Table 3-2 and Figure 3-6.

Table 3-2 Land use are and percentage in project area

No.	Type	Land	Percentage
1	Low rise apartment	Developable Land	59 %
2	High rise apartment		
3	High end apartment		
4	Hotel/ Condominium/ Resort		
5	Business places		
6	Mixed Use Building		
7	Educational Building		
8	Health Care Building		
9	Trade and Transportation Works		
10	Public Buildings/ Government Offices	Supportive Land	2 %
11	Open Space (Park/ Plaza/ Green Area)		6 %
12	Roads (Infrastructure)		12 %
13	Connecting Roads (Infrastructure)		7 %
14	Dyke Walls (Infrastructure)		14 %

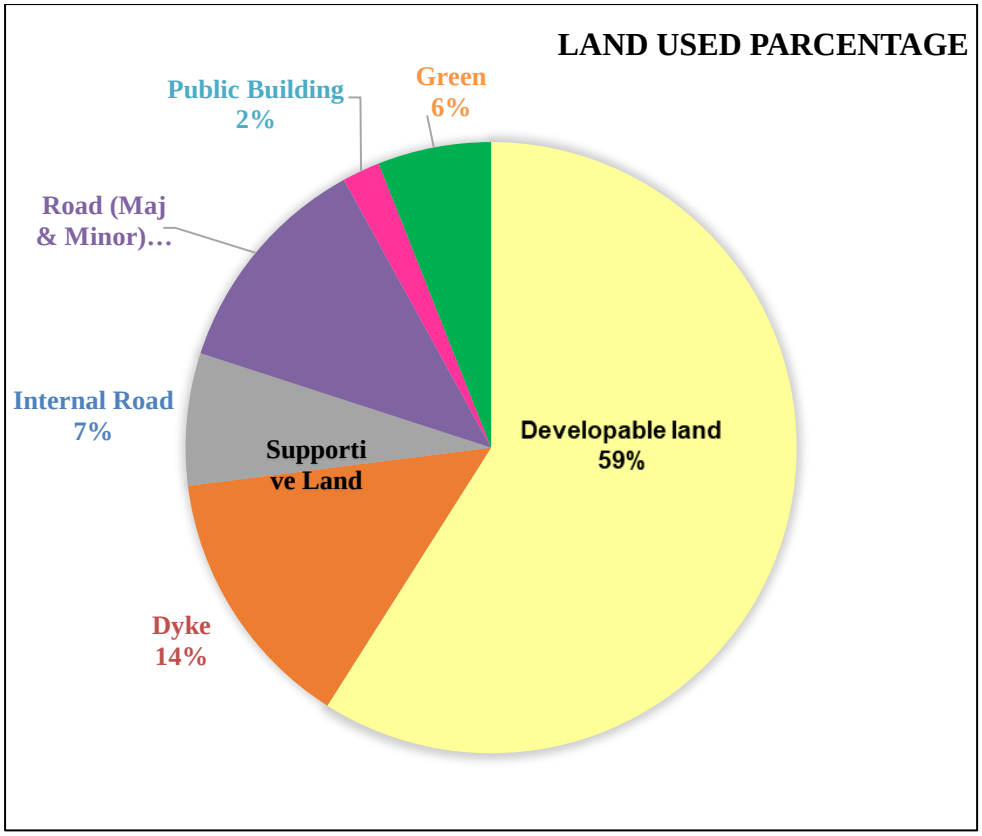


Figure 3-6 Land Used Percentage in the project area

3.4. PROJECT DEVELOPMENT AND IMPLEMENTATION TIME SCHEDULES

The project will be implemented within two phases, 1st phase is from 2017 to 2021 and 2nd phase is from 2022 to 2026. The project phase (1) includes design work, land purchasing, land reclamation, dyke wall construction, ground improvement work, and infrastructure work. In design work, it includes designing urban building designs, infrastructure designs, geotechnical design and dyke wall structure design. In infrastructure work, it includes road construction, drainage and sewage disposal system construction, water supply system construction, wastewater system implementation, solid waste system implementation, communication and electricity supply system construction, etc.

In the project phase (2), it intends to conduct continuing land purchasing, continuing land reclamation, ground improvement work and continuing infrastructure work. If the construction of this phase exceeds the proposed timeline, this construction phase can be prolonged to five years with the permission of Myanmar City Development Committee (MCDC). There are two possible Five-year extension to this construction phase. Once the project advances to the stage of constructing infrastructure, the project approver will grant a 60-year lease agreement for the land. Currently, the main activities are land purchasing and initiation of construction in B2 Black areas of the project. Time schedule of the project is shown in Table 3-3.

Table 3-3 Time Schedule of the project

No.	Project	Sector	Period Year									
			1st Period 2017 – 2021 (5 Years)					2nd Period 2022 – 2026 (5 Years)				
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
1	B-1 (426 Acre)	Sector-1	10%	10%	10%	15%	15%	20%	10%	10%		
2	B-2 (454 Acre)	Sector-2			10%	10%	10%	10%	20%	20%	20%	
3	B-3 (493 Acre)	Sector-3				5%	5%	10%	20%	20%	20%	20%
4	B-4 (426 Acre)	Sector-4				5%	5%	10%	20%	20%	20%	20%
5	B-5 (337 Acre)	Sector-5					5%	5%	10%	20%	30%	30%
6	A-2 (185 Acre)	Sector-6					5%	5%	10%	20%	30%	30%
7	A-1 (178 Acre)	Sector-7					5%	5%	10%	20%	30%	30%

3.4.1. Main Category of the project

The implementation of Amarapura Urban Development project includes 3 stages, which is pre-construction stage, construction stage and operation stage/ maintenance stage. In Pre-construction stage, land ownership & land purchasing, designing for project (water supply, flood prevention, waste management, waste water treatment, transportation, etc.), river level analyzing and project elevation analysis are conducted.

The second stage is the construction stage which is the current condition of the project area. Land reclaiming & levelling, soil improvement and dike wall construction are all carried out during the construction stage. In addition, constructing the infrastructures like storm drainage, roads, water treatment plant, communication system, etc. will also conduct in the construction stage. In the operation stage/ maintenance stage of the project, the maintenance process will be conducted such as maintaining the basic infrastructures such as roads, drainage channels, dyke wall, electrical system, communication system, etc.

3.4.2. Pre-construction Stage

The following process activities are conducted in the pre-construction stage.

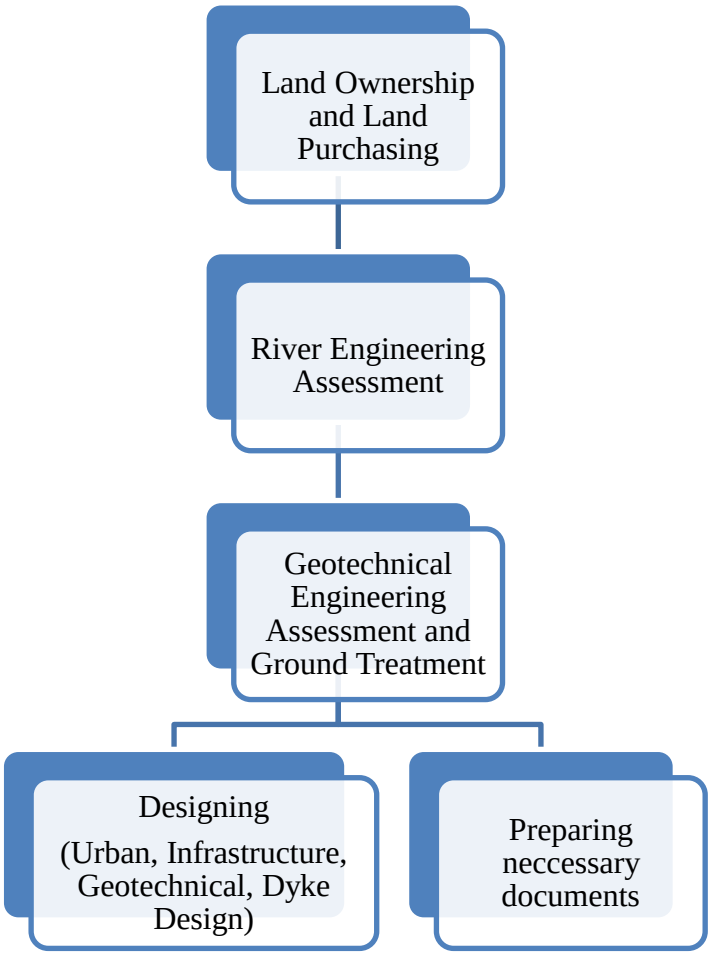


Figure 3-7 Pre-construction Process Activities

3.4.2.1. Land Ownership and Land Purchasing

The first step of pre-construction stage is land ownership & purchasing for the project area. The designed acre of project area is 2,500 acres and the most part of the project area is located at an open land where seasonal cultivation is undertaken. The land which will be used for the proposed Amarapura Urban Development Project was permitted by the Mandalay Regional Government. An agreement contract was signed by MBCCD and MCDC in March 2016. Land-ownership status of all the land areas was previously managed by the Mandalay Regional Government. Most of the land areas were purchased and owned by MBCCD for the Amarapura Urban Development project. The purchased remaining lands were all privately owned and came from other villages, including Shangalay Kyun village. The lands are purchased under the guidelines of MCDC and according to the Land Acquisition Law (2015). Land ownership and land purchasing activities are shown in Figure 3-8 and example document are shown in Appendix C.

In the project area, most of the land are alluvial soil cultivation land, Form 7 land and the village land. The project lands will be acquired by two main methods for implementation of the over project.

(1) According to the relevant land type, buying a land with negotiating a fair market price from each land owner. In the current stage, the company have been purchased approximately 2,000 acres of the land and 500 acres remains.

(2) For the land owners who do not want to sell with negotiating price, the land will be exchanged with developed city land with the accordance of the terms of the project contract. For the example, the land owner which has **Form 7 land 1 acre**, he or she can exchange (80'x 80') town plot which mean that 15% of the property area. The plot was ready to build a house with complete infrastructure and the value of exchanged land will be higher than the current Form 7 land value.

For alluvial land 1 acre, he or she can exchange (30'x80') town plot which mean that 5% of the property area.

For village land owner, he or she can directly exchange 100% to developed land. If there has some building on the village land, it will be compensated with reasonable price. If the Shankalay Kyun Village does not wish to participate with the project, it will be left. Currently, the village area was excluded and the surrounding environment will be upgrade with green area, landscaping and also drainage system. (note: The exchanged plan with developed town will start later 2024)

Figure 3-8 Land Ownership and Purchasing Activities

3.4.2.2. River Engineering Assessment

River engineering assessment is the important statistical analysis because the project area is located beside the Ayeyarwaddy river. The establishment of the project elevation strongly depends on expected river levels statistics. For Mandalay station, annual maxima of water levels of the Ayeyarwaddy river are available from 1968 to 1986, while daily data are available from 1994 to 2013 (Ministry of Hydrology DMH). For Sagaing station, daily data on water levels and discharges are available from 1980 to 2014. Due to the Mandalay station's proximity and the slightly higher water levels observed at that station, the water levels measured at Mandalay station are considered to be normative. The mean value of the water level is shown for various probabilities of occurrence in the third column of Table 3-4. The confidence levels of 5% and 95% for the mean are provided in columns two and four as a measure of the statistical uncertainty.

Table 3-4 River Level Statistics Ayeyarwaddy River at Mandalay

Probability (1/year)	5% Confidence Water Level (MSL + m)	Water Level (MSL + m)	95% Confidence Water Level (MSL + m)
1	69.64	69.77	69.91
0.5	69.93	70.07	70.25
0.2	70.21	70.52	70.90
0.1	70.41	70.84	71.36
0.04	70.66	71.25	71.95
0.02	70.84	71.55	72.37
0.01	71.02	71.83	72.76
0.001	71.58	72.71	74.01

3.4.2.3. Geotechnical Engineering Assessment and Ground Treatment

Since the project area is located near the Ayeyarwady river, geotechnical engineering assessment and ground treatment is need. Field survey is conducted containing

CPTu measurements and boreholes with SPT measurements. According to the results, the top soil layers at the project site is packed sands and silts. At larger depths, around 30 m below ground level, densely packed sands are found. The field survey is stopped at a depth of 35 m below ground level. At two locations borings are made attempting to establish the bed rock depth. Each of the borings is stopped at a depth of 100 m, while not reaching bed rock. Therefore, the bedrock depth at the project area is unknown, but at least at these two locations, larger than 100 m below ground level. The large bed rock depth is remarkable since at the other side of the river the bed rock extents to more than MSL + 200 m.

As the ground water levels, CPTu measurements show a hydrostatic pore pressure development in the sand layers. No differences in hydraulic head for the different sand layers are found. The pore pressures, as measured by CPTu, indicate that the hydraulic head follows the river level.

One of the key geotechnical design parameters is the future ground level of the project area. The low elevation ground level of project area can lead to frequent flooding if the river water level increases. Therefore, the designed ground elevation level needs to calculate. The establishment of the project elevation strongly depends on expected river levels. The designated project elevation is set to +73.00 MSL.

3.4.2.1. Designing for the Project

During the pre-construction stage, tentative plan, the master plan of the project and layout plan of infrastructures are designed. In tentative plan, the project area is divided into 7 sections among them Sector 1 is divided into Sector 1A and Sector 1B. Various type of buildings are mix in each sector and Shan Kalay Kyun village is located at the boundary of the project area. The tentative plan and master plan of the project is shown in section 3.3.2.

3.4.2.2. Preparing Necessary Documents

River Engineering Assessments, Geotechnical Engineering Assessments and Waterfront Revetment Structurer Design reports for the project area are conducted by Deltares (Netherlands). Seismic Hazard Analysis is conducted by Dr. Myo Thant (Local Sepcialist) at 2017. Urban Planning by Morrow Architects & Planners Pte. Ltd. (Singapore) at 2018, Infrastructure Design by TEAM Consulting Engineering and Management Co., Ltd. (Thailand) at 2018, Ground Improvement Design by Tokin & Taylor (New Zealand) and CTI International Co., Ltd. (Japan) (2018-2021) and EIA Scoping report by Environment Myanmar Cooperative – EMC Ltd. at 2022 are conducted. Building Designs are still prepared by Mr Joel (Philippines), D&B Design & Construction Team and Inhouse Design Team. The deatails records of the design and report prepared for the implementation of the project are shown in Table 3-5.

Table 3-5 Details records of the design and report prepared for the implementation of the project

No.	Report Name	Period	Responsible Organization
1	River Engineering Assessments	2017	Deltares (Netherlands)
2	Geotechnical Engineering Assessments	2017	Deltares (Netherlands)
3	Seismic Hazard Analysis	2017	Dr. Myo Thant (Local Specialist)
4	Urban Planning	2018	Morrow Architects & Planners Pte.Ltd (Singapore)
5	Waterfront Revetment Structurer Design	2018	Deltares (Netherlands)
6	Ground Improvement Design	2018-2021	Tokin & Taylor (New Zealand) CTI International Co., Ltd. (Japan)
7	Infrastructure Design	2018	TEAM Consulting Engineering and Management Co., Ltd. (Thailand)
8	EIA Scoping Report	2022	Environment Myanmar Cooperative-EMC Ltd. (Local Specialist)
9	Building Designs	Still Prepare	MR. JOEL A. PARCON (Filipinos Architect) D&B Design & Construction Team (Local) MBCCD Design Team

3.4.3. Construction Stage

Construction stage is a main stage of the project since the project is an urban development project. The current situation of the project is construction stage and it is still implemented the dike wall and soil improving process. The following steps will be implemented in the construction as shown in Figure 3-9.

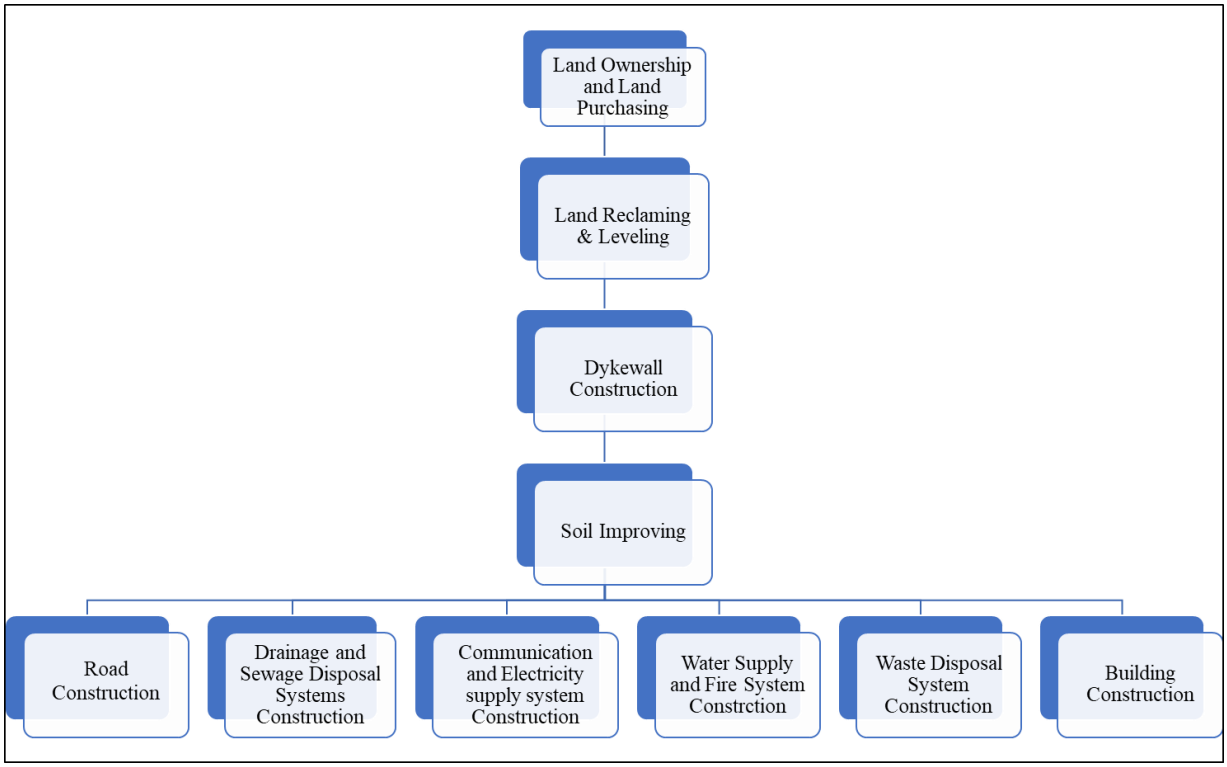


Figure 3-9 Construction Process activities

3.4.3.1. Land Ownership and Land Purchasing

Some of the land in the project area remained for purchase during the pre-construction period. As a result, during the construction phase, these lands are purchased from locals.

3.4.3.2. Land Reclaiming and Levelling

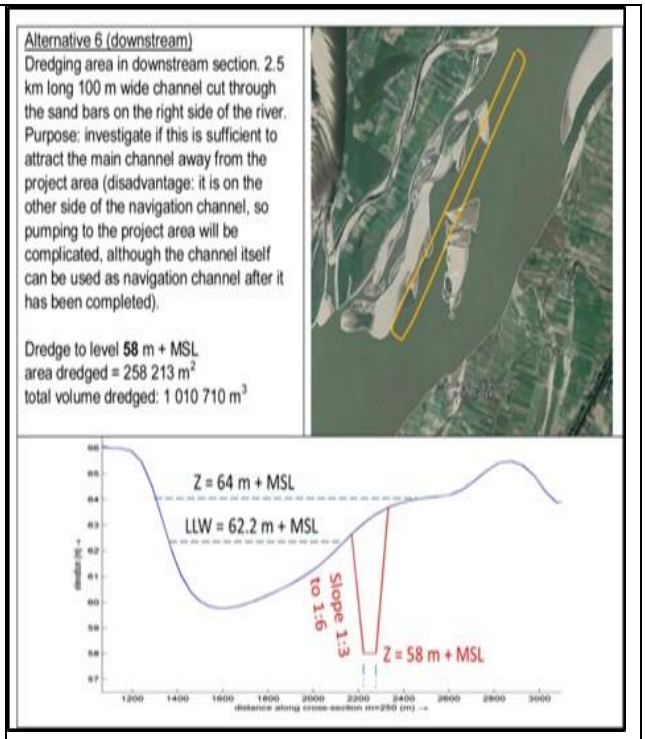
In reclaiming, the bush and small tree are clear in the project area to avoid the risk from the dangerous insects like snake. Sands are extracted by water pumps on sand barge vessels from the river and transported to the project area via pipes in the land filling process.

A large quantity of sand needs to be dredged and pumped out to the project site for the land fill of the project. The estimated demand of the sand is approximately 30 million suds for the whole project. Dredging was carried out in accordance with the instructions, technical recommendations, simulation research, local consultants, and dredging places designated by the Directorate of Water Resources and Improvement of River Systems (DWIR). Dredging activity will be conducted in coordination with Directorate of Water Resources and Improvement of River Systems (DWIR). The Dredging procedure will be conducted through the Simulation Study with the consultation of River Morphology Experts from Local and Deltares Institute, also with the supervision of Directorate of Water Resources and Improvement of River Systems-DWIR), it will be conducted at designated place. The permission of sand transportation by departmental authorities is described in Appendix (L).

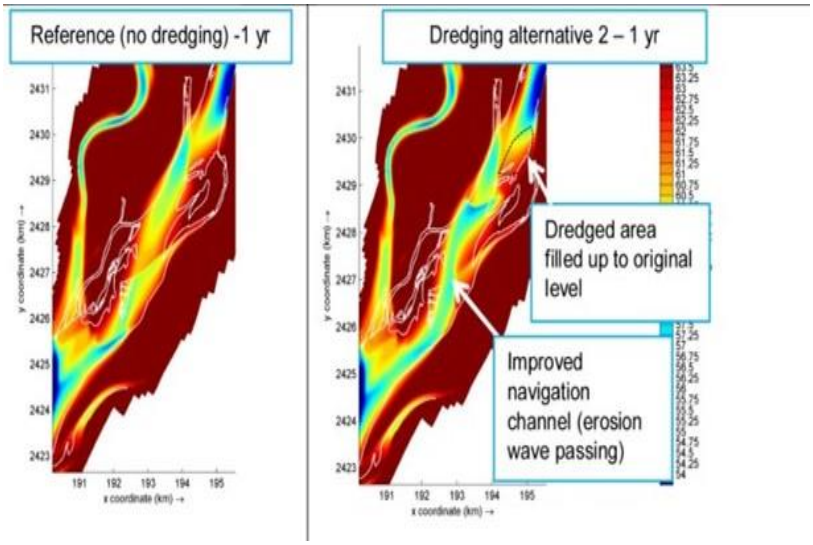
The navigation of the river adjacent to the project side can be improved by dredging from the Ayeyarwaddy and construction a dyke wall. Hence, it can save the National Budget as well as the World Bank loan that the Directorate of Water Resources and Improvement of River Systems (DWIR) received for the Ayeyarwaddy River's improvement and training programs.

Since the calculated project elevation level is +73.00 MSL, land filling and leveling process will be conducted to reach the specific ground level. Photo of the land filling process and dredging process are shown in Figure 3-10 and Figure 3-11.

Figure 3-10 Land filling activities

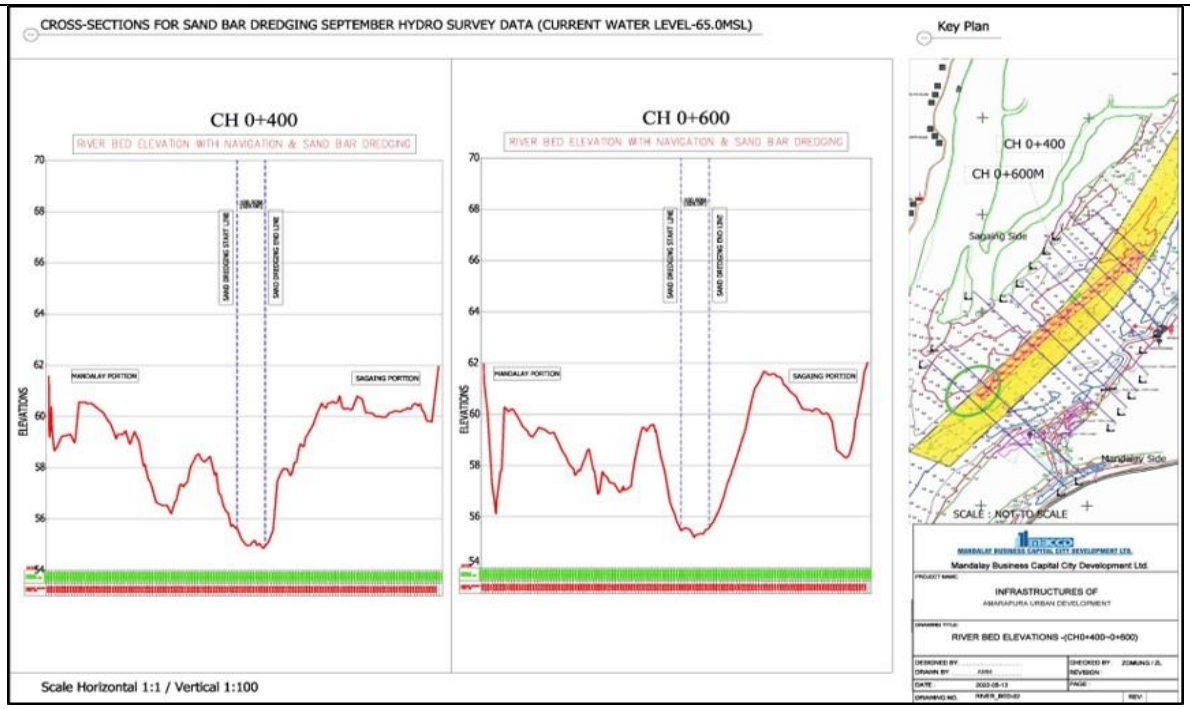


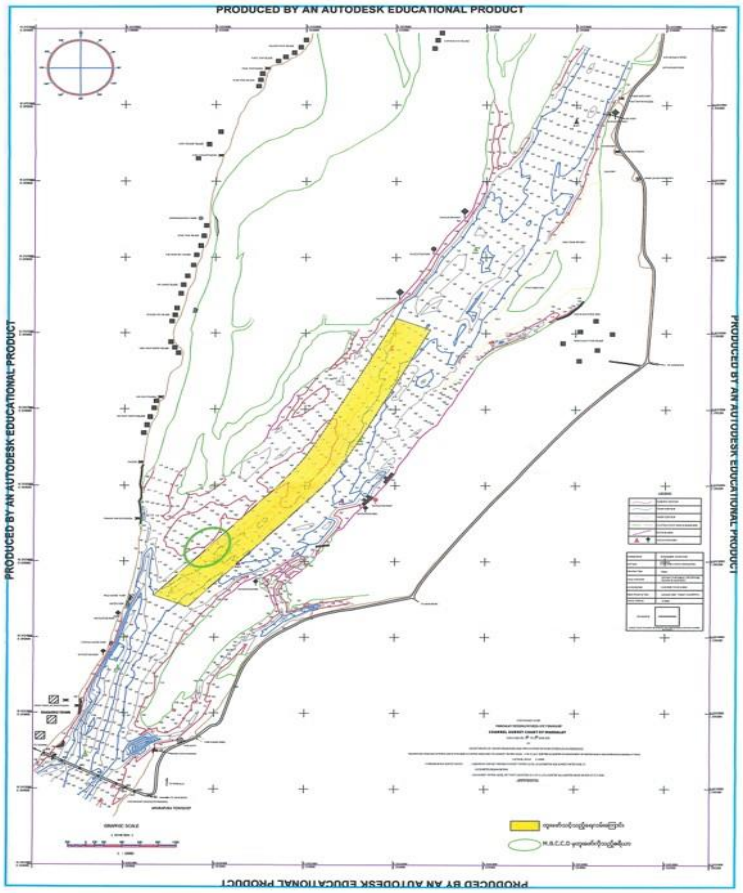
Google Earth Image with Projections of Deep Channels and possible dredging Work



Example of Simulated bed topography after 1 years for dredging alternavtive 2 (right panel) and reference simulation without dredging (left panel)

Some Reference Figures for Sand Dredging area (Sources DWIR)





Dredging Location Plan

Some Reference Figures for Sand Dredging area (Sources DWIR)

Figure 3-11 Dredging Process

3.4.3.3. Retaining Structure Construction (Dyke Wall Structure)

3.4.3.3.1 General

There are several types of retaining structure including gravity, sheet pile, cantilever, and anchored earth/mechanically stabilized earth (reinforced earth) walls and slopes. The mixed type of retaining structures should be employed in the design and construction of steps, steep slopes, or walls in infrastructure projects when space must be conserved or land acquisition must be limited. Retaining structures are used to retain the compacted sand backfill for the Amarapura urban development project.

3.4.3.3.2 Review and Evaluation of Available Data

The project area is located in the low level of the river bank and needs to be filled up to the high flood level. In addition, part of the project area contains loose sand in the subsurface layer and is prone to the effect of liquefaction during and after major earthquakes. The following criteria will be used to develop retaining structures:

(1) Earthquake Loading

(2) Stability of Retaining Structures and

(3) Erosion, Scour and Toe Protection of River Bank

3.4.3.3.3 Design Criteria

The waterfront comprises of retaining structures and revetment. The function of retaining structures is to retain the compacted sand backfill that filled up to the high flood level.

Table 3-6 Design Criteria

Waterfront	Slope Stability	Hydraulic
The standard of design codes that follow are as below • Myanmar National Building Code 2016, Part1 to Part7 • USACE - Shore Protection Manual 1984 volume1 & 2 • USBR - Bank Stabilization Design	• Factor safety (FS) of slope stability waterfront i. Normal conditions (FS. allowble 1.5) ii. ii. Earthquake conditions case 0.1g -0.4g (FS. allowable 1.0) iii. iii. Post-earthquake conditions case 0.1g -0.4g (FS. allowable 1.0) • The design of retaining structures will base on the subsoil improved conditions.	• Design revetment for return periods are smaller flood 10 years (32,168 m3 s) • Flow velocity condition • Height wave condition

3.4.3.3.4 Conceptual design of the Waterfront

According to the conceptual design report, earthquake loading, the stability of permanent waterfront, erosion, scour and toe protection of river bank, the basic geotechnical design for a landfill special attention is given to the river bank for which a natural slope 1:4 to 1:7 and summary optimize F.S. slope 1:7-1:5-1:4-1:3.5-1:3-1:2.5 with PGA.(0.1g - 0.4g) in basic design report and previewed in the preliminary drawings. The related analysis and design comparison for each slope of waterfront will be performed on the accepted preliminary drawings as shown in Figure 3-12.

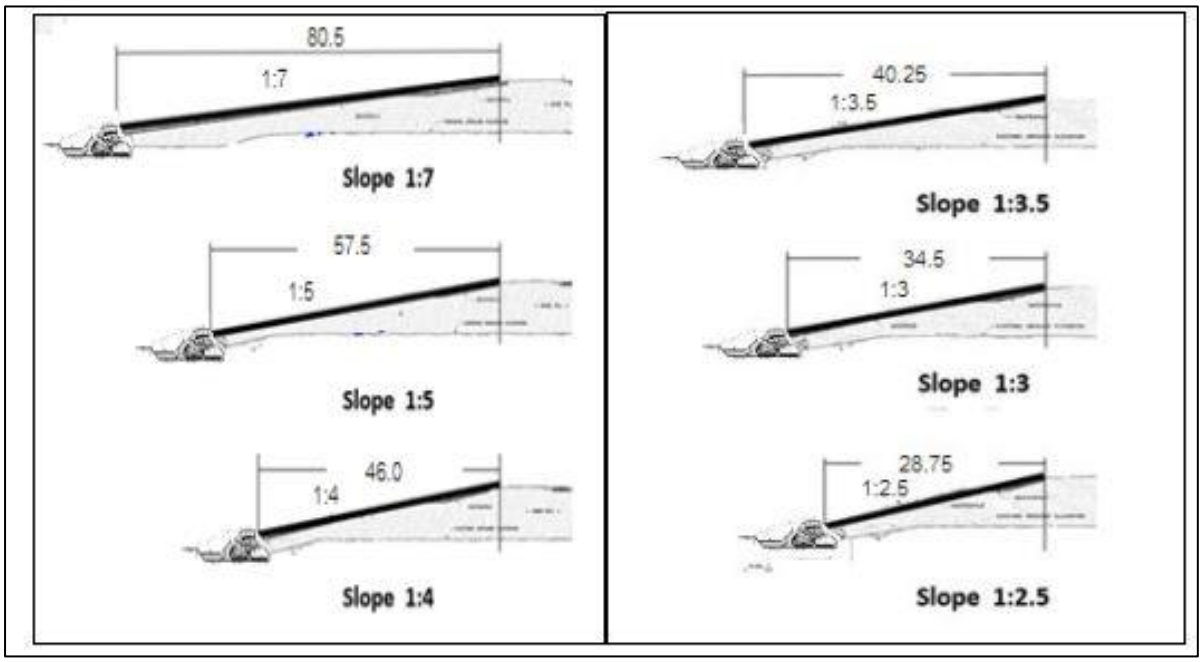


Figure 3-12 Comparison for each Slope of Waterfront

3.4.3.3.5 Factor of Revetment Design

There are two types of design for revetment which are structure design and slope design. The detail description of each design is following table.

Table 3-7 Description of Revetment Design

No.	Type of Design	Hydraulic and Hydrology Analysis	Geotechnical Analysis	Design structure of erosion protection
1	Structure Design	1. Water Level (max/min) 2. Water velocity 3. Appropriate erosion protection distance	-	1. Type of erosion protection 2. Size, thickness and length of material
2	Slope Design	-	1. Soil properties 2. Slope stability 3. Soil movement	1. Excavation level 2. Height and slope ratio 3. Type, size, spacing of reinforced

According to the conceptual design report, from consider the basic geotechnical design a natural slope 1(V):4(H) to 1(V):7(H). TEAM proposed conceptual global slope 1(V):4(H) against erosion due to wave and water erosion as shown in Figure 3-13. In general, the step slope consists of maintenance parts global slope 1(V):4(H) with berm, first the slope protection layer. Second the walk way maintenance, as shown in Figure 3-14.

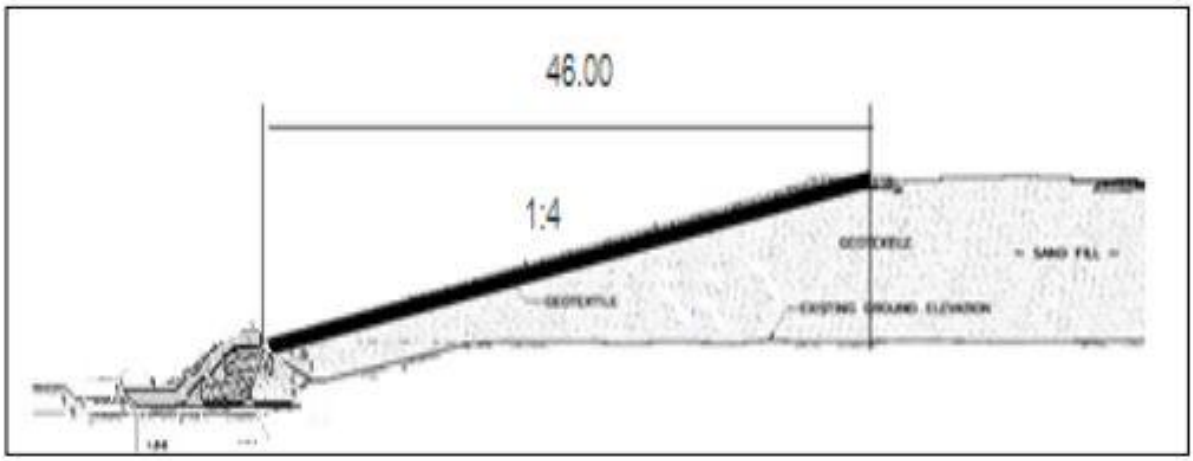


Figure 3-13 Global Slope 1(V):4(H)

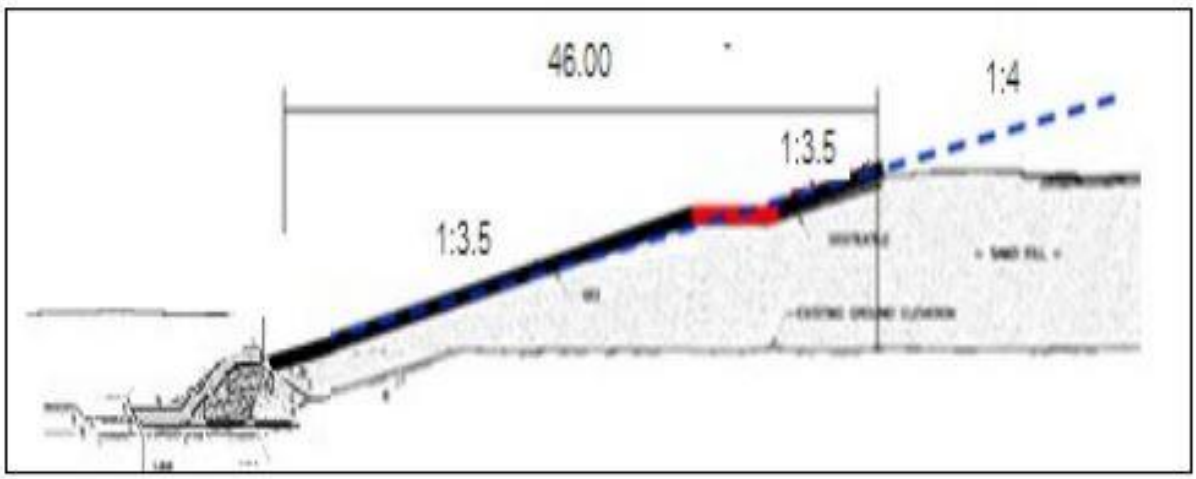


Figure 3-14 Global Slope 1(V):4(H) with Berm

3.4.3.3.6 Component of the waterfront

1. Upper Part or Crest (Top) consists of a usable area behind the waterfront and other utilities such as sidewalks, drainage systems and roads. Typically, the waterfront is above the maximum water level and it should be considered as part of the design due to erosion surface of water flow. Such erosion protection can be achieved by plant with deep root which can resist erosion well.
2. Protection Part (Slope) is to protect the bank from erosion due to tides and waves. Designers may choose to use structural for surface protection or permanent structures, such as a retaining wall to protect surface erosion.

3. Lower or toe is the bottom of the waterfront. It is the base of the waterfront and prevents erosion of the water surface at the foot of the waterfront. The problem of erosion is a major problem it can be damage to the waterfront.

Component of waterfront is described in Figure 3-15.

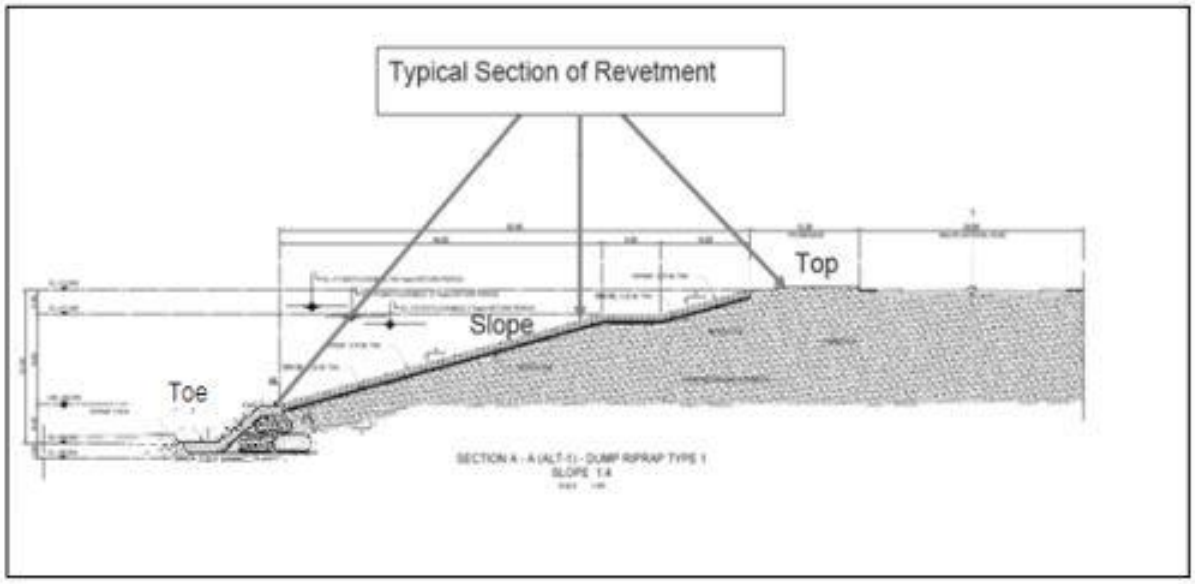


Figure 3-15 Components of the Waterfront

Followings are the factors to consider type of revetment slope –

1. Strength and durability
2. Availability of construction material
3. Construction methodology
4. Time or Rapidity of construction
5. Construction cost for revetment slope,

TEAM proposed conceptual revetment overhead protection against erosion due to wave and water erosion. In general, the surface slope structure consists of two parts, first The Armor layer and second, the Filter layer, as shown in Figure 3-16.

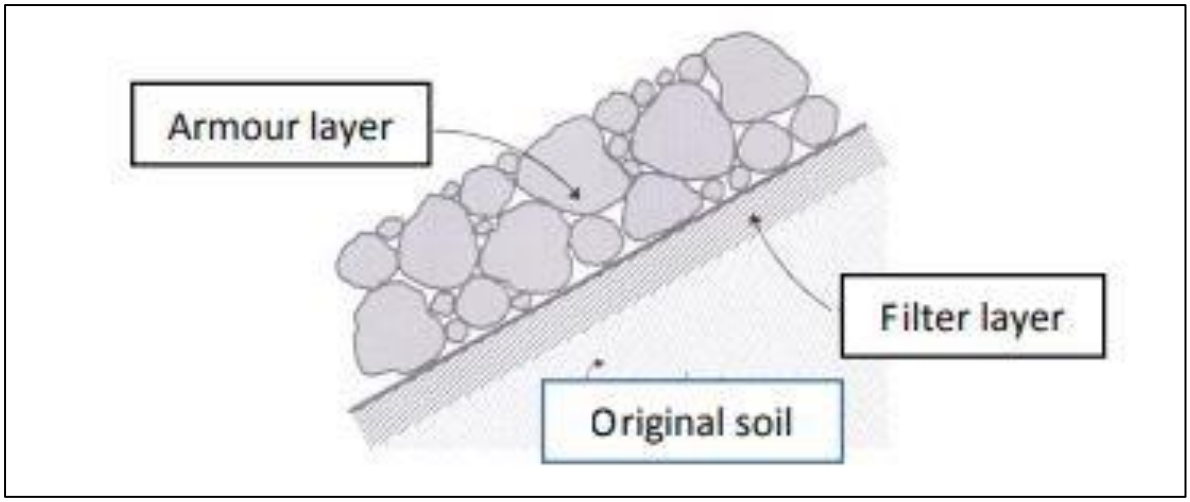


Figure 3-16 Structure of Slope Surface

3.4.3.3.7 The Waterfront Revetment Structure (Dyke Wall Design)

According to the scoping report, the soil type of the project area was investigated by MBCCD before urban structures, a riverfront, and a dike wall were built to prevent river flooding. The soil tests are measuring for the strength of the project area. Soil tests include local professionals of geology and professionals from Deltares Team in Netherlands. The soil was confirmed to be strong enough for the project's implementation based on the results of the soil test.

The Ayeyarwady River's upstream and downstream (20 km) sections, which are connected to the project region, were surveyed for sedimentation, river flow conditions, river flow, and other factors. The Deltares Team from Netherland obtained the yearly river level of Ayeyarwady and Dr. Kees Sloft is building the Technical River Model. This model can explain the comparison of River Flow Condition of Ayeyarwady River with project and without project within the project related 40 km.

Dike walls along the river of project related 40 km will be calculated by Dr. Cornells Zwanenburg from Deltares Team. The strength of the Dike Walls and the River Flow conditions relating with them will be analyzed in the River Model. In constructing the dyke wall, the 1st layer will be constructed by compacting the sand and for the 2nd layer, geotextile (MR 501) will be laid and armour rocks (0.7m ~ 1.0 m thick) will be laid on the geotextile layer. Currently, the construction work is completed approximately 9.55 km within the project site.

The Amarapura Urban Development project intends to build a 11.8-kilometer-long waterfront revetment structure that will follow the Ayeyarwaddy river. Currently in construction stage and completed up to about 6.1km. The main source of the 400,000 tons of rock needed for the revetment construction is from Ohn Chaw Quarry, which is 30 km away from the Amarapura Urban Development project.

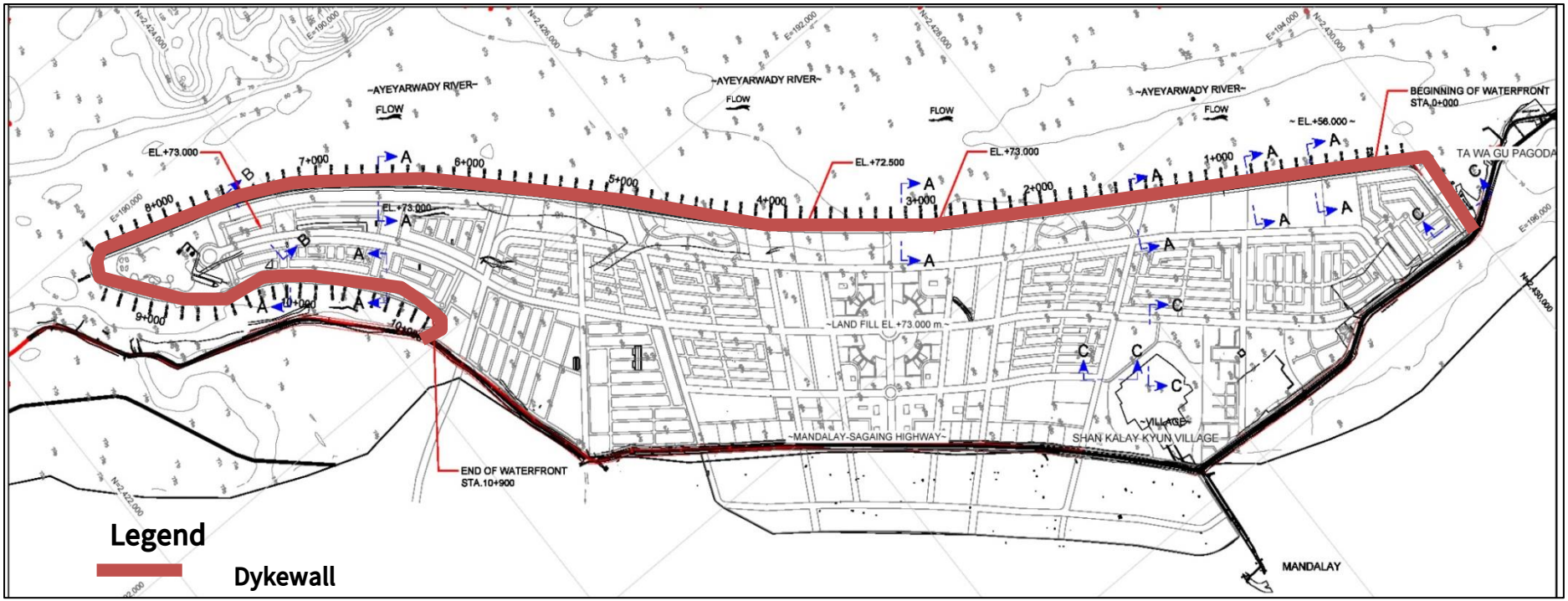


Figure 3-17 Dike Plan of Project Area

3.4.3.4. Soil Improvement

The project area is located in seismic zone and potential to be earthquake. The project is also beside the Ayeyarwaddy river and thus, the sand layer needs to be improved to reduce potential liquefaction which could damage to the buildings and utilities. In soil improvement process, two process are need to conduct which is elimination of site liquefaction and increase bearing capacity of ground.

The criteria of soil improvement are as follows:

- Ground bearing capacity ≥ 100 kpa
- Solve the site liquefaction problem, based on the classification of building

  For Classification B – Eliminate liquefaction completely

  For Classification C – Eliminate liquefaction partially, accordingly the foundation and upper structure design shall be improved.

3.4.3.4.1 Conceptual Soil Improvement

The conceptual soil improvement for this project is governed by two factors: (1) underground water level (3 m and 6 m) and (2) classification of building (B and C). Based on the two factors, four scenarios are developed, as shown in Table 3-8 and the calculation results (treatment depth and SPT values) is shown in Table 3-9. Based on soil improvement requirement and site condition, the treatment depth will mainly be between 10 to 20 m. Clay content of sand is assumed to be 10%. Vibrofloation Compaction method is preferred as soil improvement solution proposal and Double Axis Vibrofloation Compaction method is recommended method.

Table 3-8 Scenarios for Liquefaction Analysis

Option/ Scenario	Underground water level from surface ground (m)	(Importance) Classification of buildings	Description	Remark
1	3	B	Important buildings Functions of buildings cannot be interrupted or need To be restored as soon as possible Serious consequences by seismic	Or prioritized follow local
2	3	C	Exclude A, B and D	Or prioritized follow local
3	6	B	Important buildings Functions of buildings cannot be interrupted or need To be restored as soon as possible Serious consequences by seismic	Or prioritized follow local

Option/ Scenario	Underground water level from surface ground (m)	(Importance) Classification of buildings	Description	Remark
4	6	C	Exclude A, B and D	Or prioritized follow local

Table 3-9 Summary of Calculation Results of Different Options

Option/ Scenario	Treatment depth (m)	Required SPT N value
1	15.6-20	13-25
2	10.5-16.4	13-23
3	14.4-20	11-22
4	8.5-16.4	11-20

3.4.3.5. Road Construction

The project area's road network that will be constructed is divided into four groups based on the functions and capacities: Central Road, Major Arterials Road, Collector Road, and Local Road. Moreover, there is Myo Pat highway connecting to the road network within the project area. The criteria using to the geometric road design in the project is based on Myanmar National Building Code 2016 in conjunction with international criteria and design guideline such as AASHTO 2011 and Ausroads Guide to Road Design 2015. The geometrical requirements for road design, typical section figurations, and design speeds for each category of the project road, including the Myo Pat highway are displayed in Table 3-10. The main road to be built in the project area are shown in Figure 3-18.

Table 3-10 Road Design Standards of the project

Highway Classification		MYO PAT Highway	Central Road	Major Arterials Road	Minor Road	Local Road
Max. Design speed (km/h)		(130) ((70))	70	50	50	30
Total No. of Lane (Main Road)		6	6	4	2	2
Bus/Truck Lane		2 (1 Lane for each side)	2 (1 Lane for each side)	-	-	-
Parking Lane		1 (beside the Project area)	-	2 (1 Lane for each side)	2 (1 Lane for each side)	-
Frontage Road		1 for side beside the Project area	-	-	-	-
Width (m)	Right of way	40.00-60.00	36.58	25.00	18.30	12.20
	Lane	-3.50 for Normal Lane -3.97 for Bus/Truck Lane	- 3.50 for Normal Lane - 3.97 for Bus/Truck Lane	3.50	3.50	3.50
	Median	4.27	4.27	1.22	-	-

Highway Classification		MYO PAT Highway	Central Road	Major Arterials Road	Minor Road	Local Road
	Shoulder	-	-	-	2.44	-
	Separator	4.57	-	-	-	-
	Sidewalk	1.83	5.19	2.44	3.21	2.60
Min. Hor. curve radius (m)		(830) ((190))	190	80	80	20
Type of pavement		Bituminous	Concrete	Bituminous		
Max. superelevation (%)		(8) ((6))	6	6	6	6
Max. vertical grade (%)		5.0				
Min. vertical clearance (m)		5.0				
Design Vehicle		SU 12	SU 9			
Min. Turning Radius (m)		15.00	11.00			
Total Distance (m)		9,323	6,585	35,672	30,015	65,110

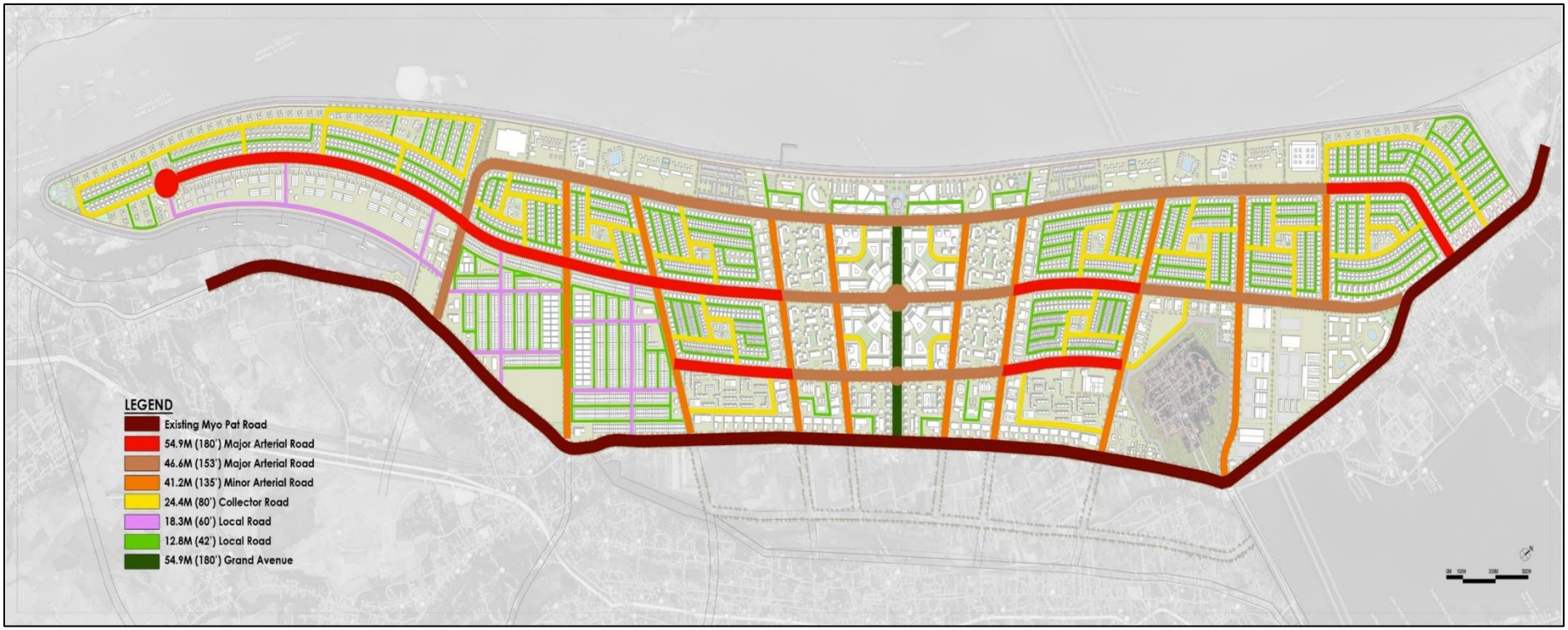
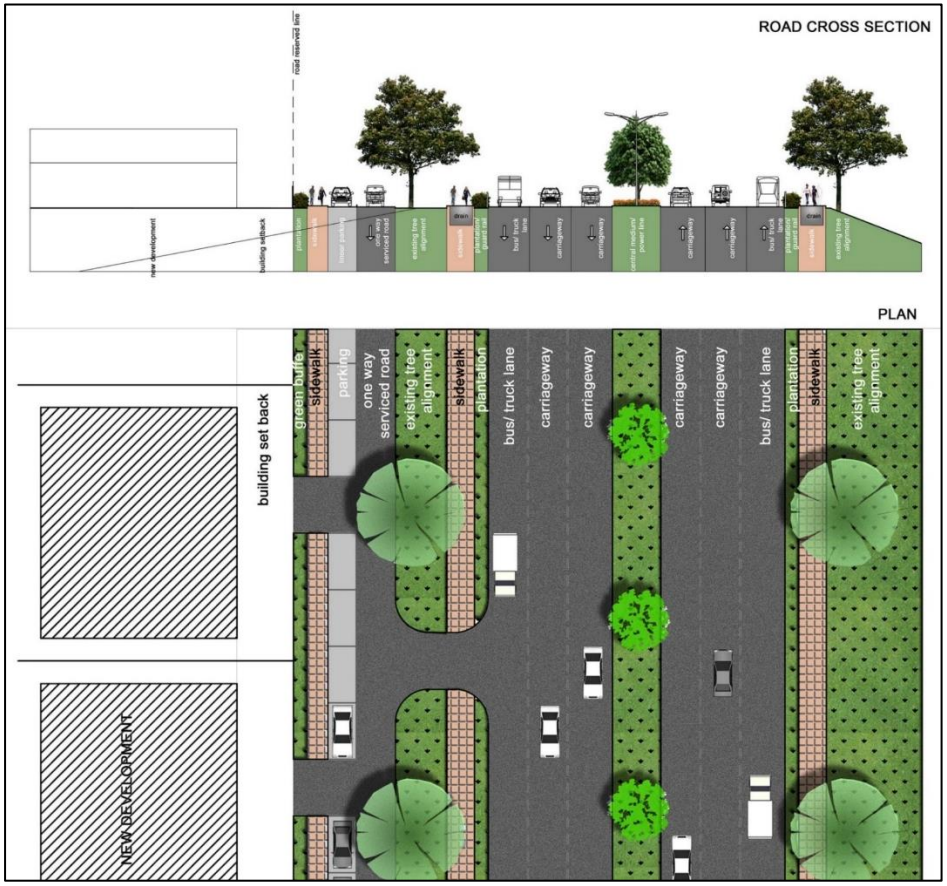


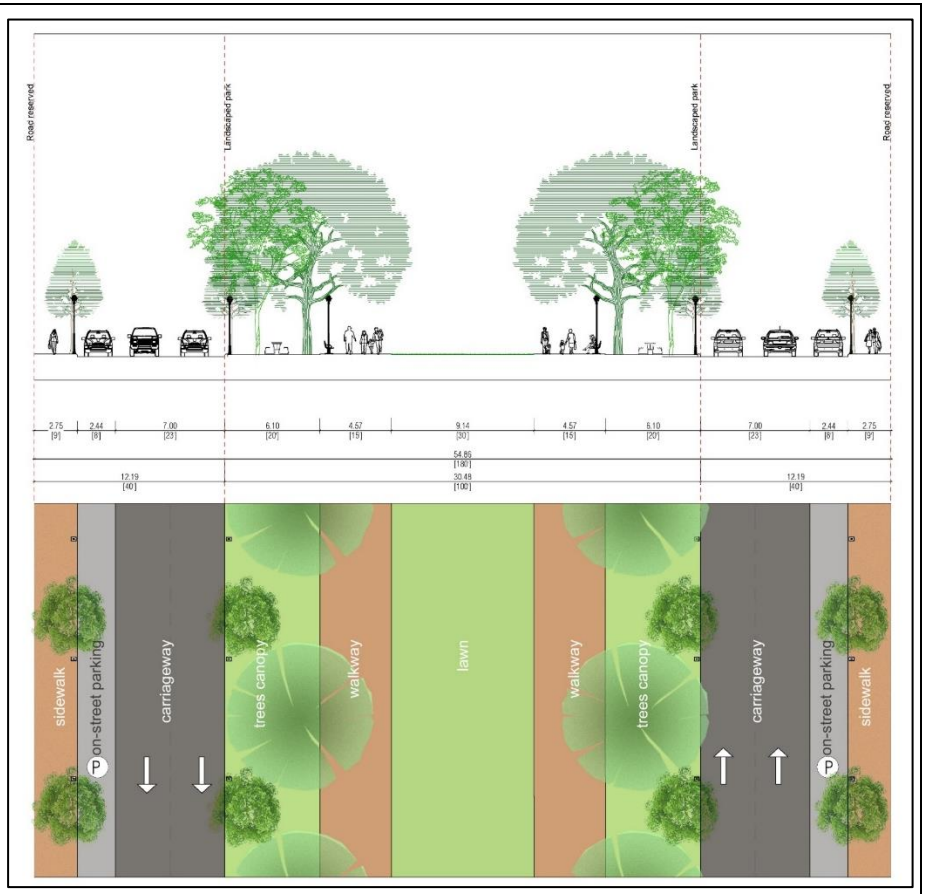
Figure 3-18 Main Road to be Built in the Project Area

3.4.3.5.1 Typical Section

The sufficient number and size of lanes in the roads, facilities for motorists and pedestrians such as parking pocket, shoulder, sidewalk and street lighting etc. will also construct for each road type according to the following Figure 3-19 to Figure 3-24.



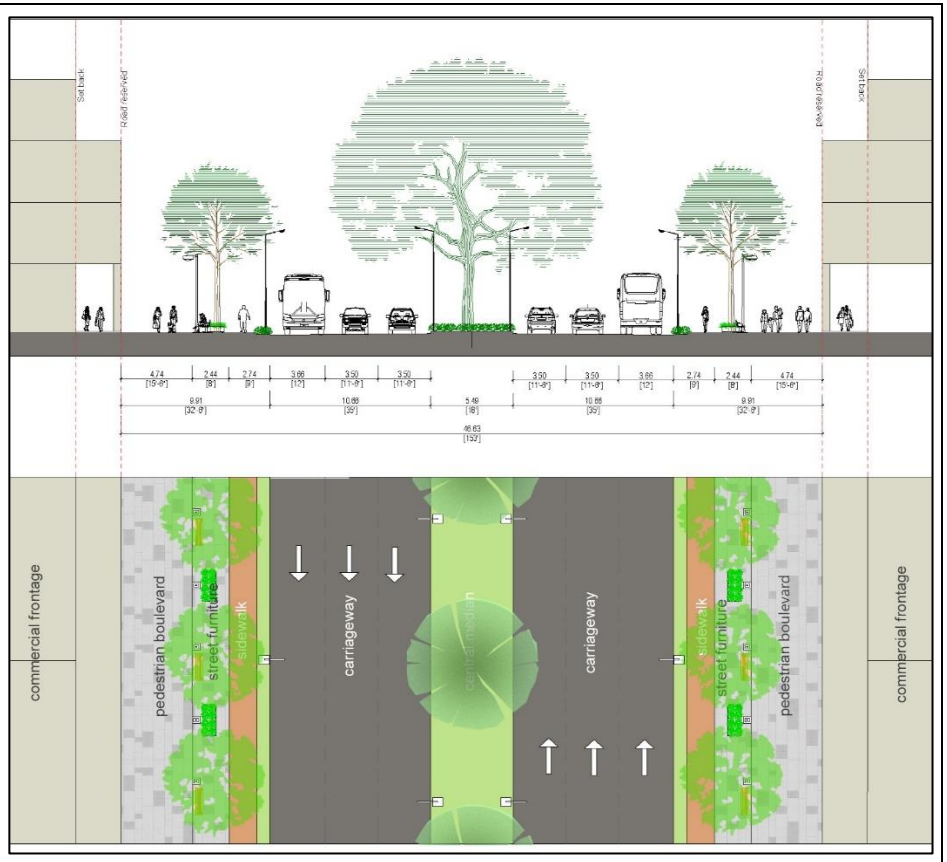
Myo Pat Road Enlargement



54.9M (180') Grand Avenue

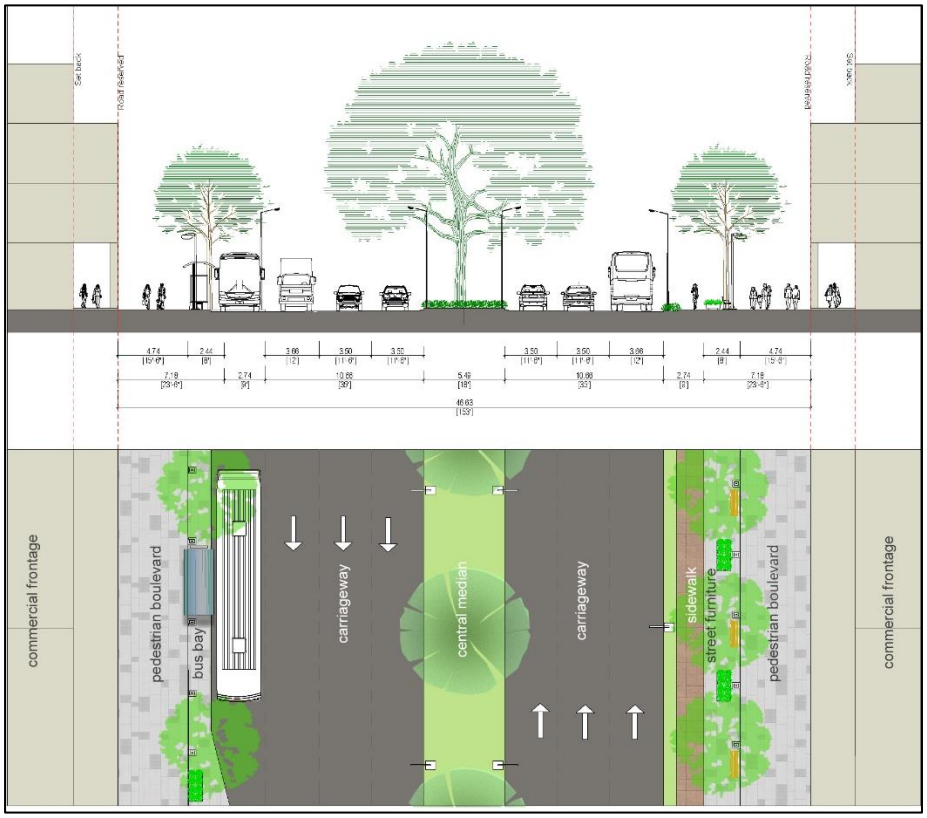
Figure 3-19 Typical Section of Myo Pat Road

54.9M (180') Major Arterial Road



46.6M (153') Major Arterial Road (CBD area)

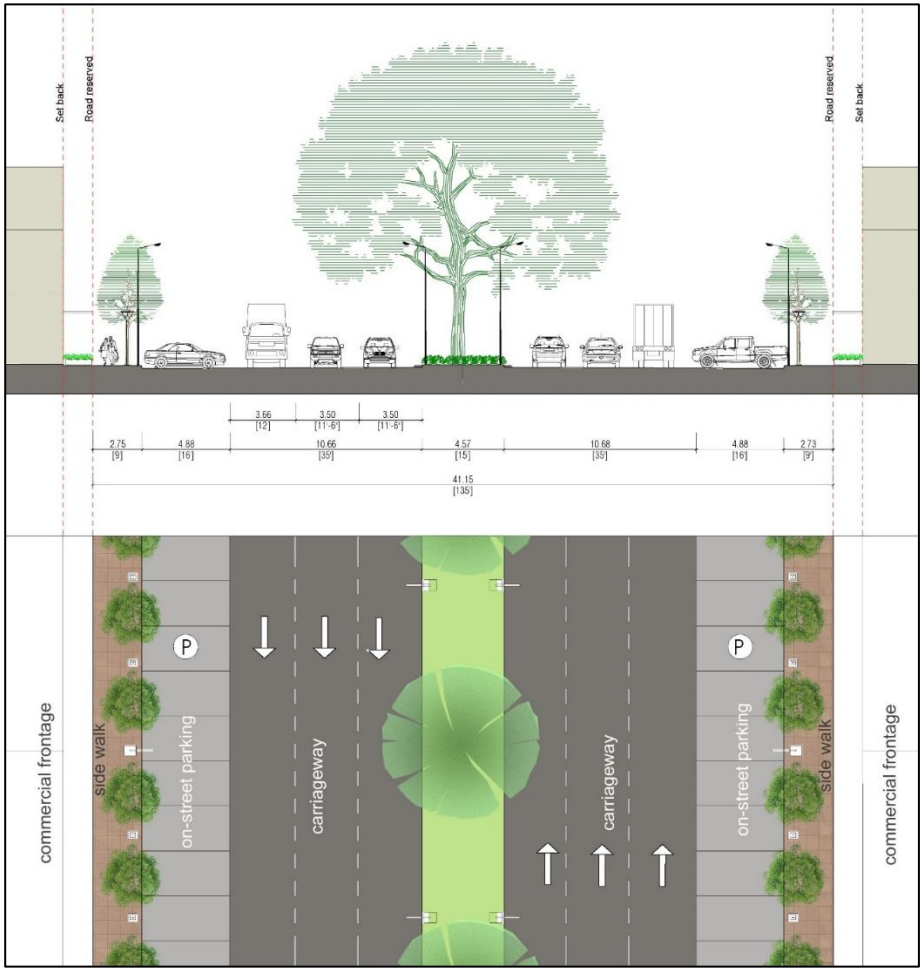
Figure 3-20 Typical Section of Major Arterial Road



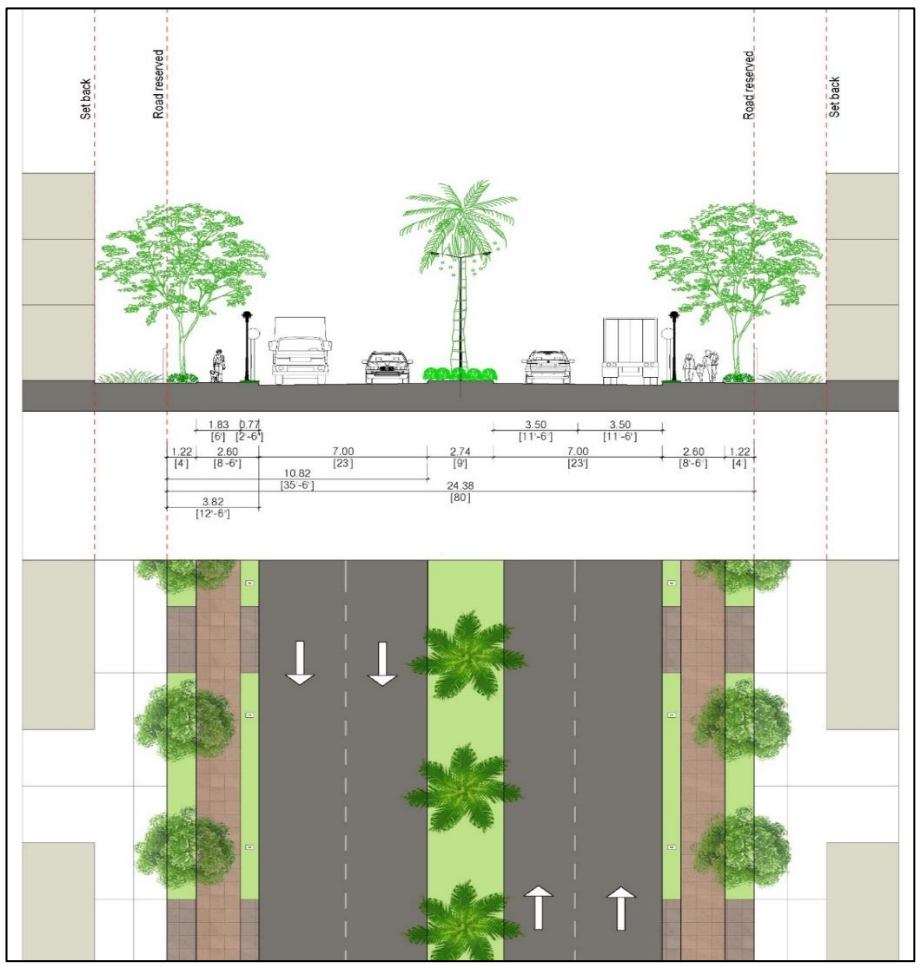
46.6M (153') Major Arterial Road (Bus stop area at CBD)

46.6M (153') Major Arterial Road (Outside of CBD area)

Figure 3-21 Typical Section of Major Arterial Road (Bus Stop Area at CBD and Outside)

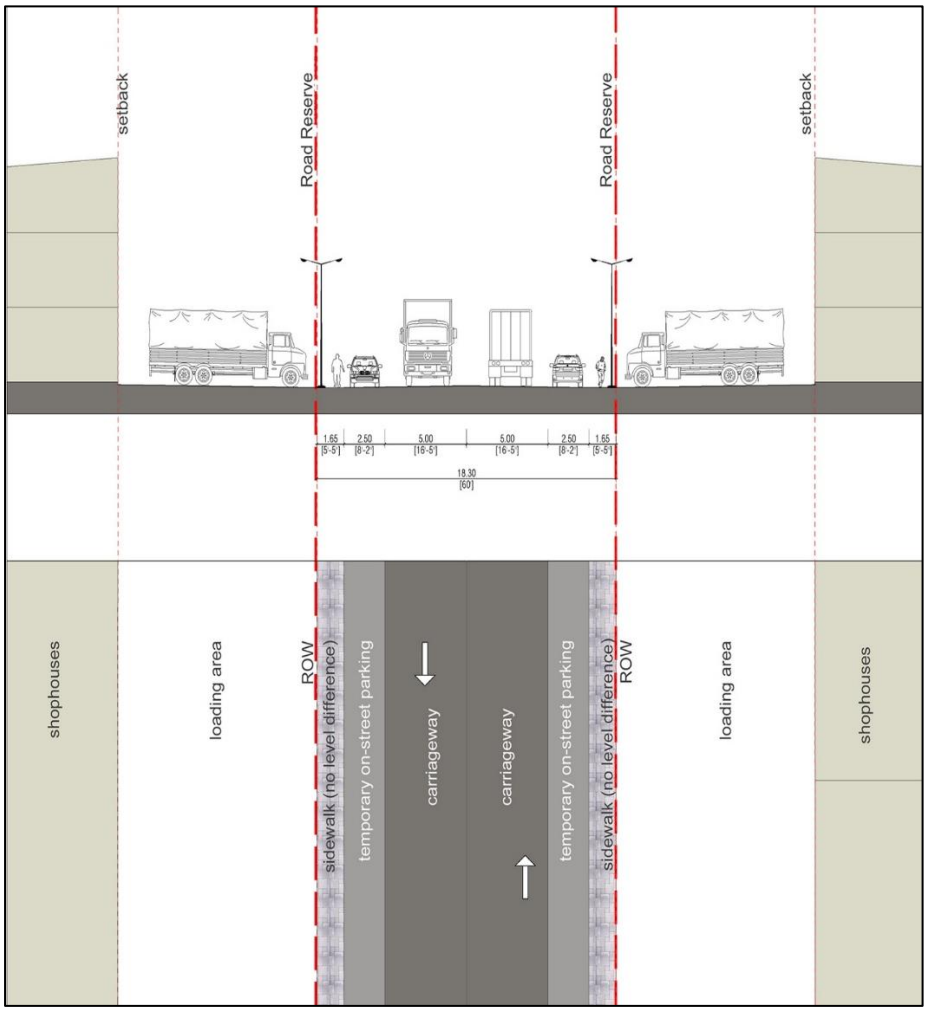


41.2M (135') Minor Arterial Road

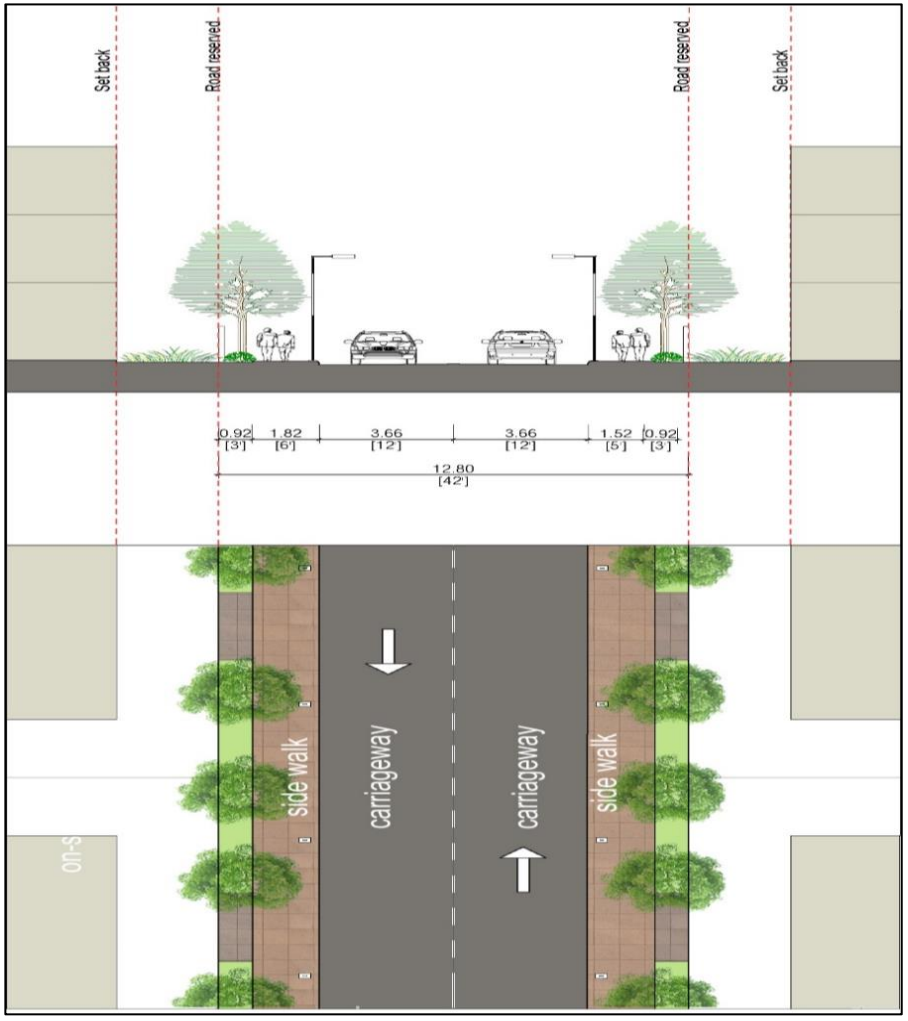


24.4M (80') Collector Road

Figure 3-22 Typical Section of Minor Arterial Road or Collector Road



18.3M (60') Local Road



12.8M (42') Residential area

Figure 3-23 Typical Section of Local Road

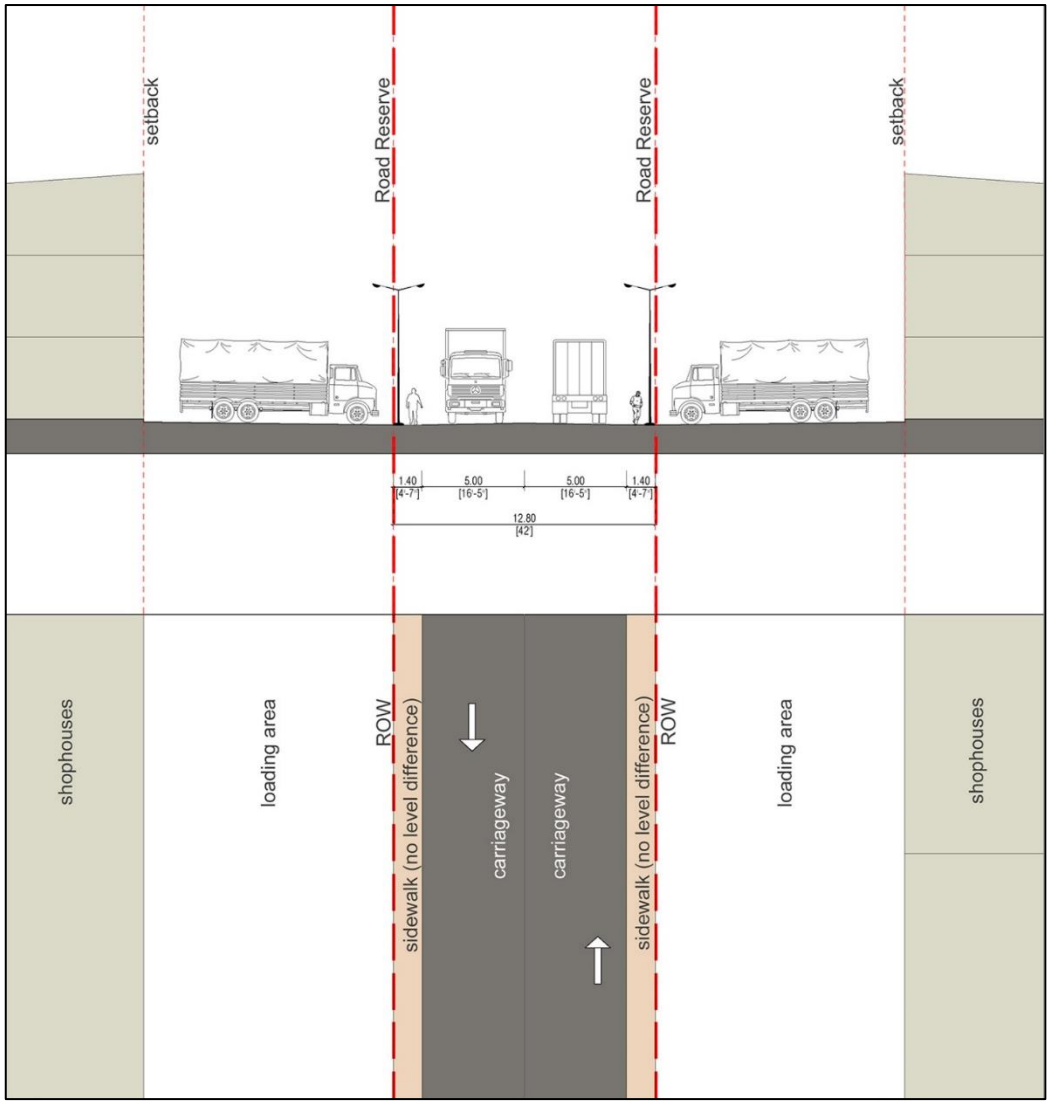


Figure 3-24 Typical Section of Logistics Area

3.4.3.5.2 Design Vehicle

Vehicle types are also considered in road design for construction. The two types of typical design vehicles are taken into consideration for usage in the project road design, according AASHTO 2011. Firstly, the SU 9 with minimum turning radius 11.0 meters is use for only for Local Road. Then, SU 12 with wider minimum turning radius 15.0 meters for MYO PAT highway, Central Road, Major Road and Minor Road are designed to accommodate large trucks for logistic connected to the road network of the project. Dimension and figurations of turning paths of both Design Vehicles are shown in Figure 3-25 and Figure 3-26.

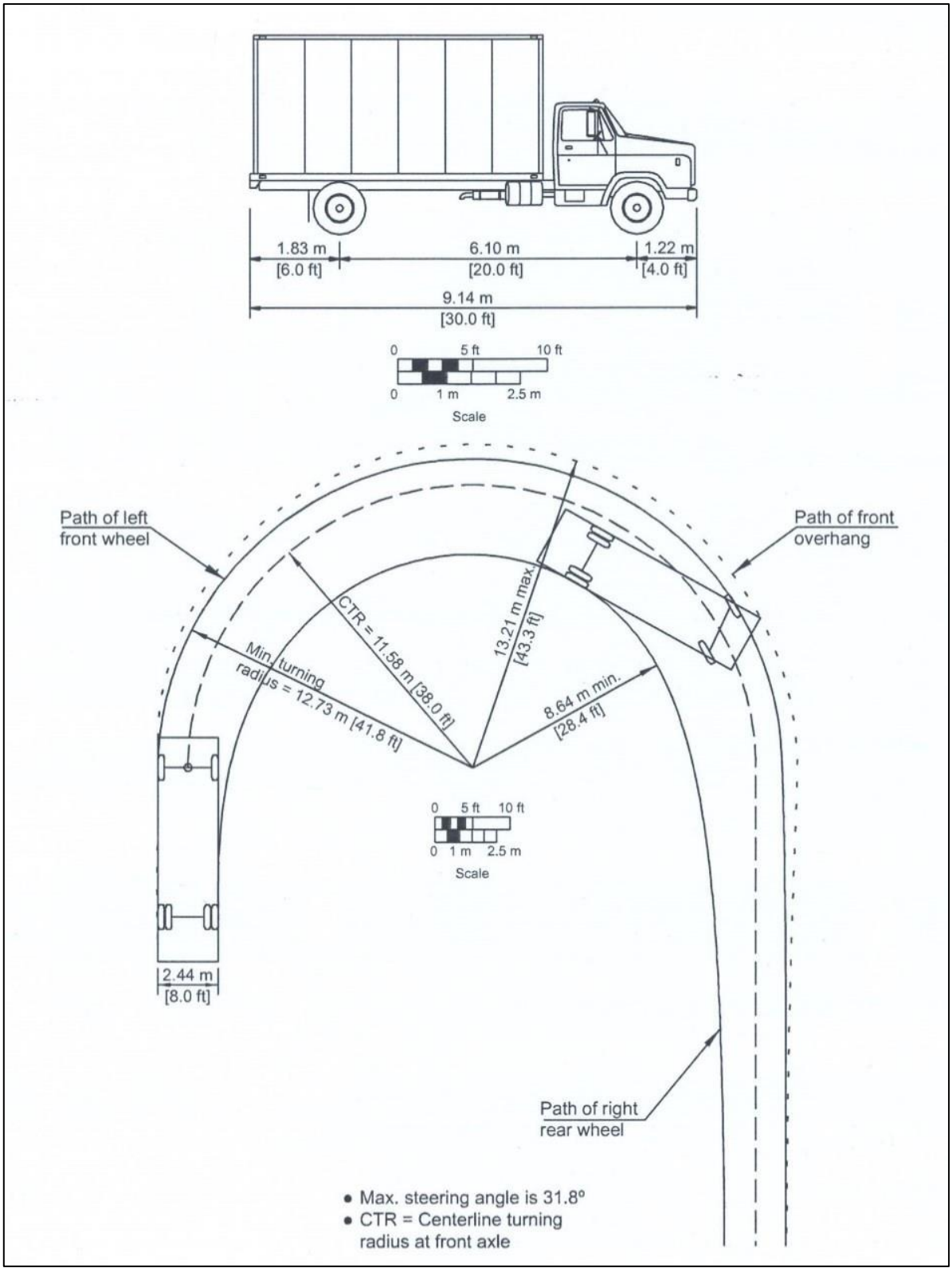


Figure 3-25 Dimension and figurations of turning paths of SU9 (AASHTO 2011)

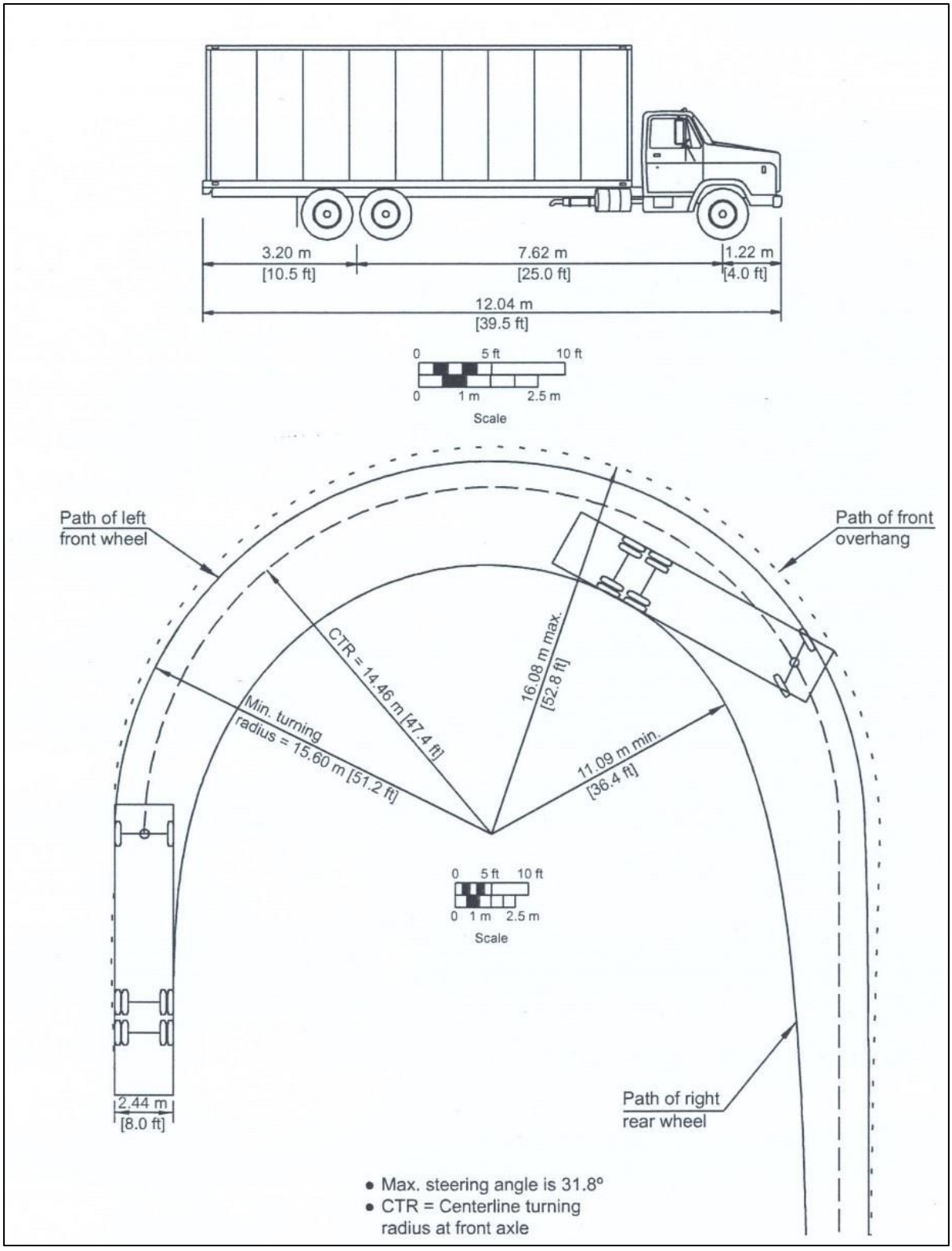


Figure 3-26 Dimension and figurations of turning paths of SU12 (AASHTO 2011)

3.4.3.5.3 Intersection and Roundabout

In the project area, there are two high volume traffic roads, MYO PAT highway and Central Road, crossing together into 6 locations. Two types of at-grade intersection will be used

in the project area, which is signalized intersection and roundabout. The intersection points that will be constructed are shown in Table 3-11 and Figure 3-27.

According to the conceptual design report of the project, the physical conjunction with sharp angle of road connections at the starting point (RA1) and the end of the central road (RA4) will be constructed signalized intersection. The at-grade intersection at (RA5) shall be designed as signalized intersection because of the low traffic volume on the connection local road. The at-grade intersection (RA4) will also be constructed signalized intersection while the other at-grade intersections shall be constructed as roundabouts. The specific intersection points are shown in Figure 3-28 to Figure 3-33.

Table 3-11 Intersection points in project area

At-grade Intersection No.	Recommendation	Remark
RA1	Signalized Intersection	Beginning of the Central Road
RA2	Roundabout	MYO PAT connectd with Major Arterail road and Local Road
RA3	Signalized Intersection	MYO PAT connected with Local Road
RA4	Signalized Intersection	End of the Central Road
RA5	Signalized Intersection	MYO PAT connected with Local Road
RA6	Roundabout	Internal Intersection in Project Area

Figure 3-27 Locations of At-Grade Intersection

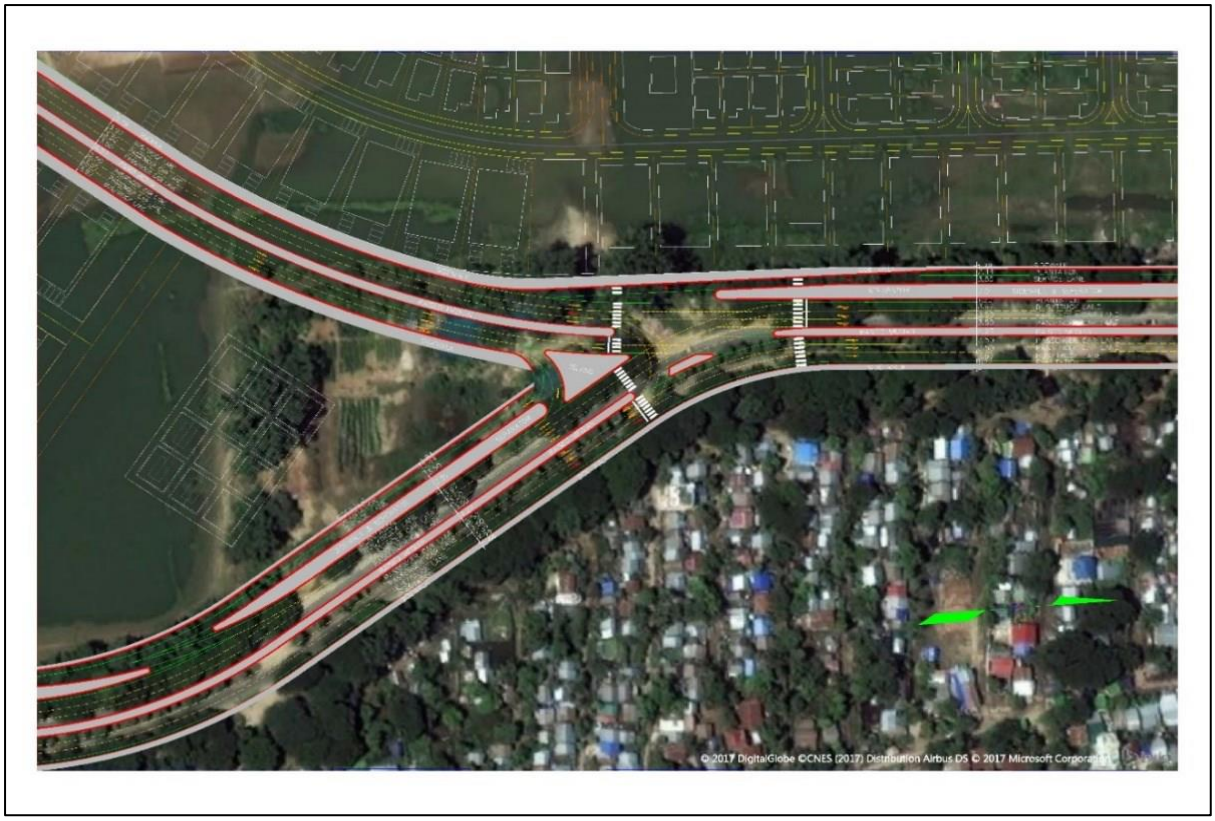


Figure 3-28 At-Grade Intersection of RA1

Figure 3-29 At-Grade Intersection of RA2

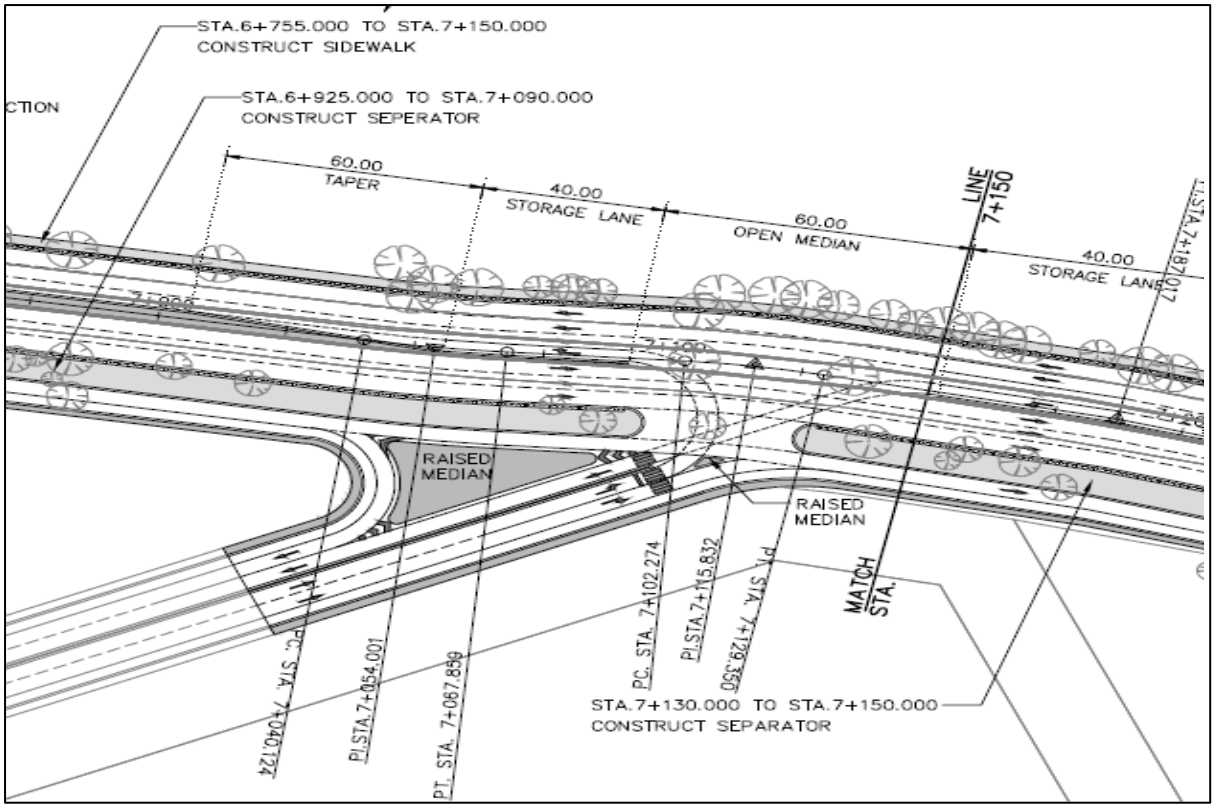


Figure 3-30 At-Grade Intersection of RA3

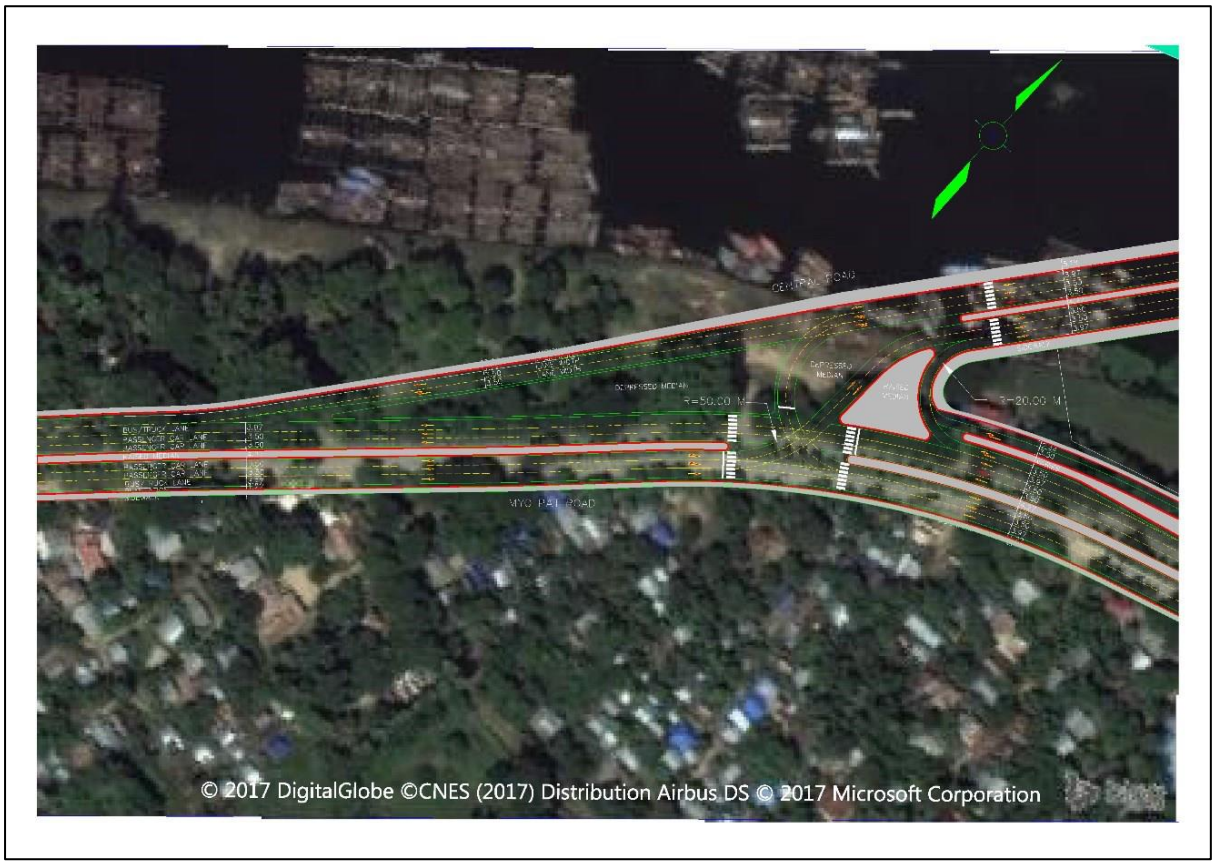


Figure 3-31 At-Grade Intersection of RA4

Figure 3-32 At-Grade Intersection of RA5

Figure 3-33 At-Grade Intersection of RA6

3.4.3.5.4 Pavement Design Consideration

The road pavement design is necessary for considering the benefit of the project. In considering for construction of pavement, traffic volume, durability, skid resistance/vehicle traction, construction cost, maintenance cost, maintenance frequency and traffic impact during the maintenance are also considered. Two types of pavements will be constructed which are rigit pavement and flexible pavement. Flexible pavement will be constructed along most of the roads in project area. The rigid pavement will be constructed along the Central Road which has high traffic volumes and many important utilities because the rigid pavement structure is more resist seismic force from the earthquake vibration. The preliminary design of rigid and flexible pavement is shown in Figure 3-34 and Figure 3-35.

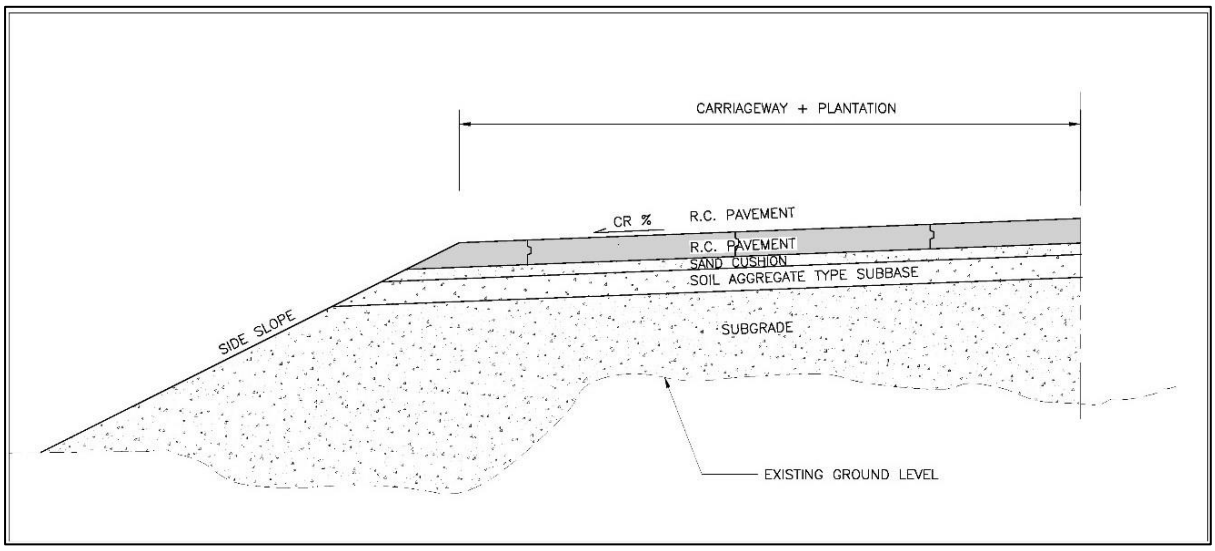


Figure 3-34 Preliminary Design of Rigid pavement

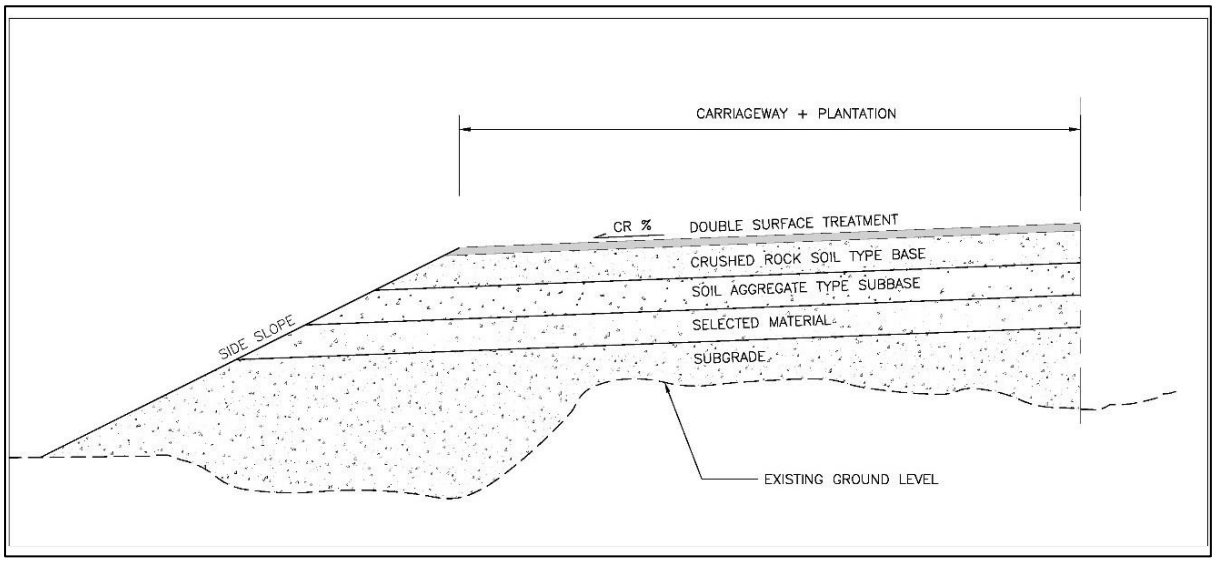


Figure 3-35 Preliminary Design of Flexible pavement

3.4.3.5.5 Batching Plant

The project's internal roads will use the rigid pavement. Only about thirty percent of the concrete needed for the project will be used by the batching plant; the remaining part will be purchased from suppliers. The location of the batching plant is Plot 606, Yin Taw ward, Amarapura Township. 21° 54.744'N and 96° 2.421'E are the coordinates of the location. The plant has a 3600 square foot space. For the purpose of implementing batching plants, the license certificate has been completed and is detailed in Appendix (M). The location map of batching plant is shown in Figure 3-36 and Figure 3-37.

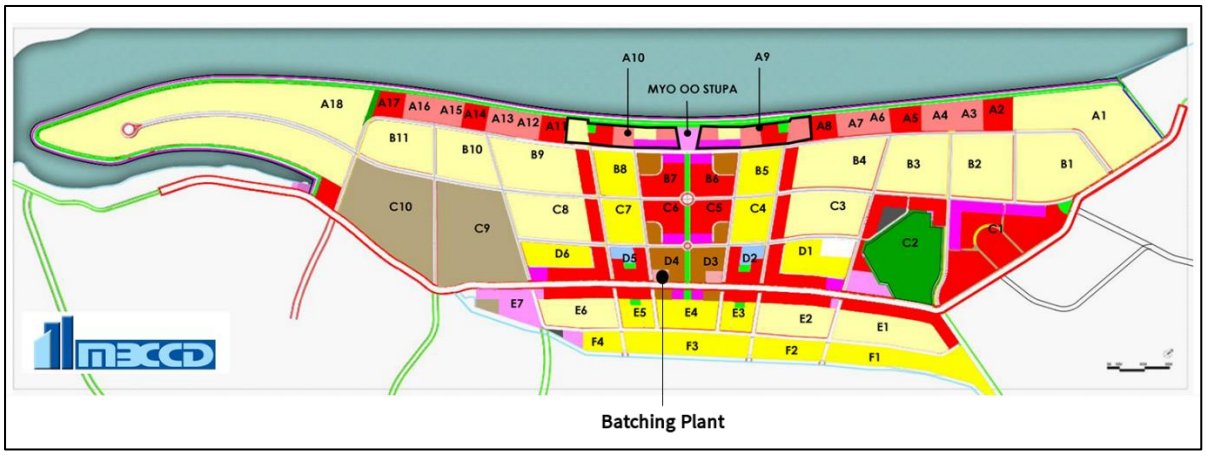


Figure 3-36 Location Map of Batching Plant

Figure 3-37 Batching Plant

3.4.3.6. Drainage and Sewage Disposal System Construction

Drainage system need to design and construct based on the rainfall data of project area for safe discharge into the receiving watercourse or the river. In addition, the magnitude of peak flows that have to be accommodated will depend primarily on the intensity of rainfall and features of the catchment, such as size, topography, soil type, configuration and land use.

In drainage system construction, U-shape drainage channel, storm drainage pipe, manhole, outfall, main drainage along village and main drainage connection are included. Some examples of components in typical systems are shown in Figure 3-38 to Figure 3-42. The drainage system zones and an example of planned drainage system for sector 1A that will be constructed are shown in Figure 3-43 and Figure 3-44.

Sewage from the project area will be treated by Onsite Waste Water Treatment – OSWT in each area and disposed according to the NEQEG after treatment. This treated sewage water will be disposed of through (11) final outlets in operation area. The specific water treatment system is shown in Section 3.5.6.2.

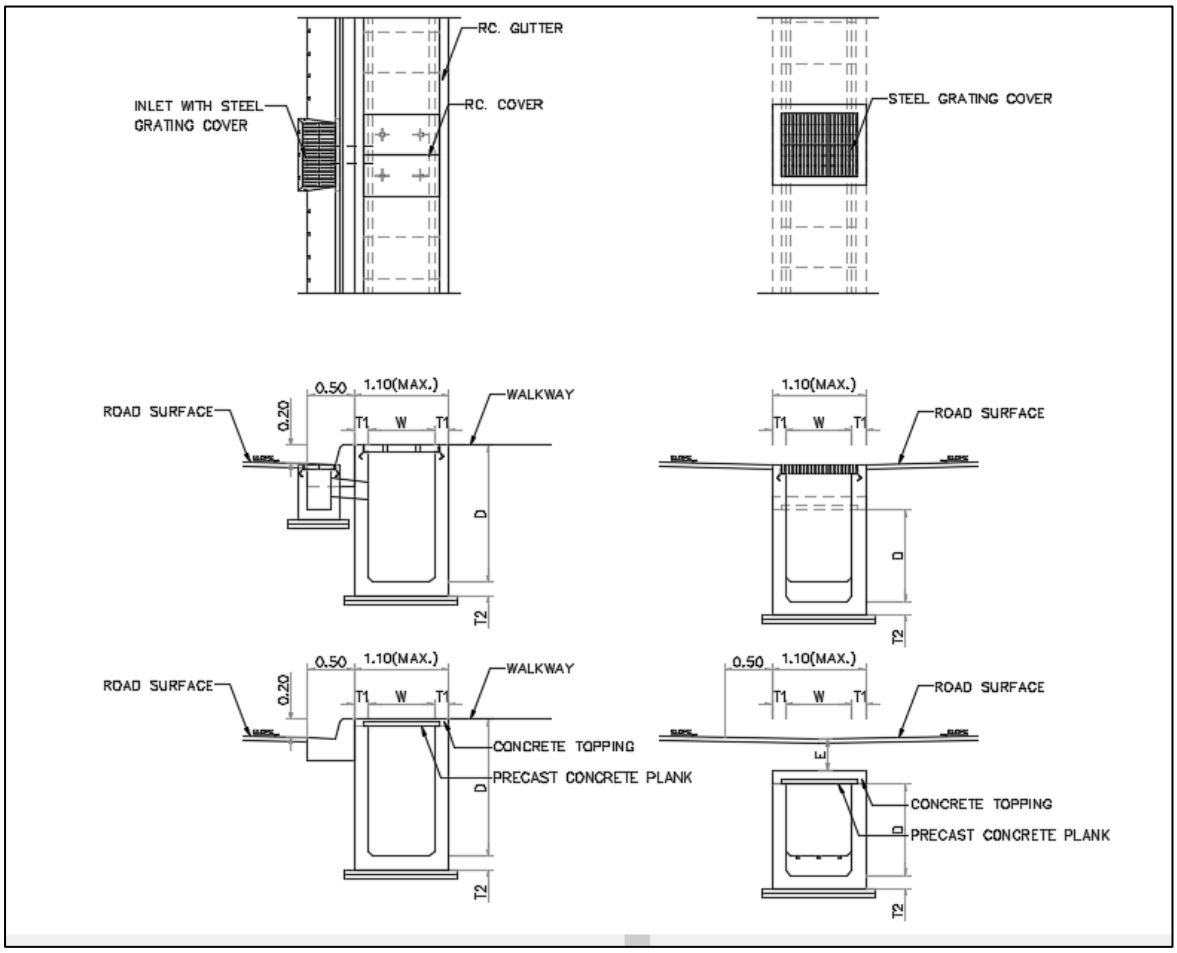


Figure 3-38 Typical Section of U-Shape Drainage channel

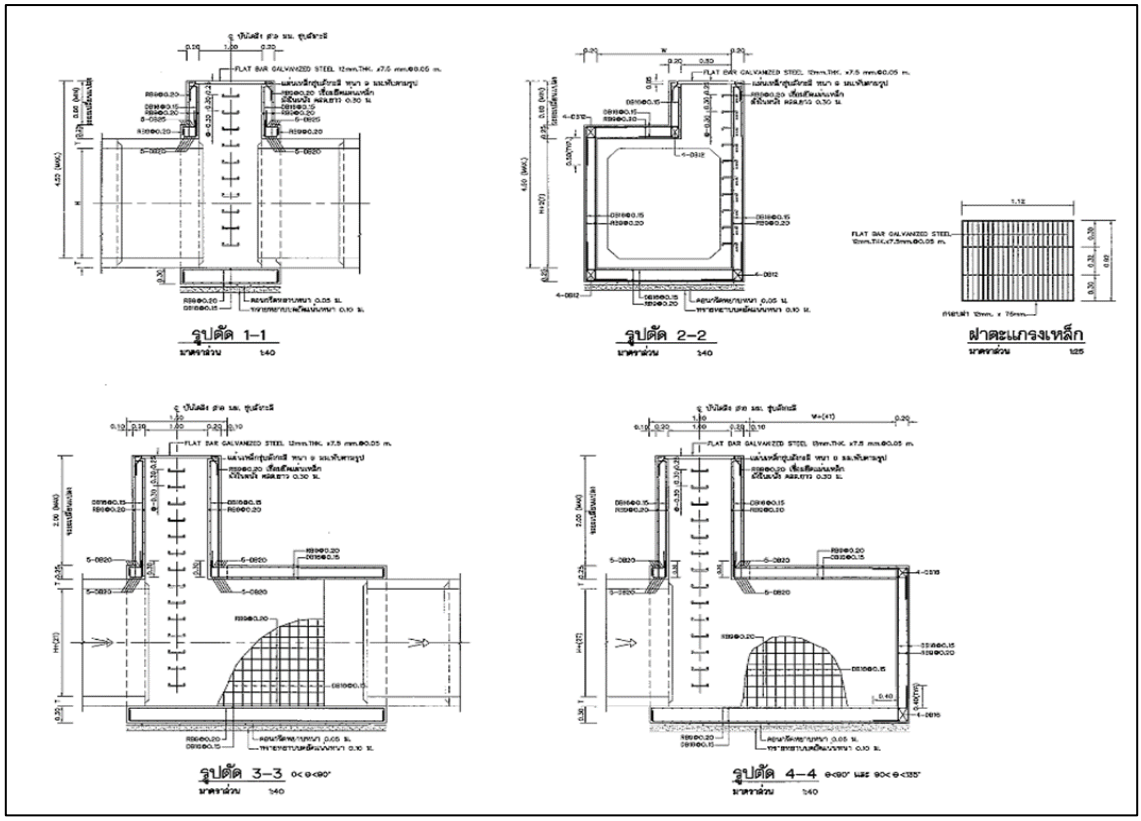


Figure 3-39 Typical Section of Rectangular Pipe

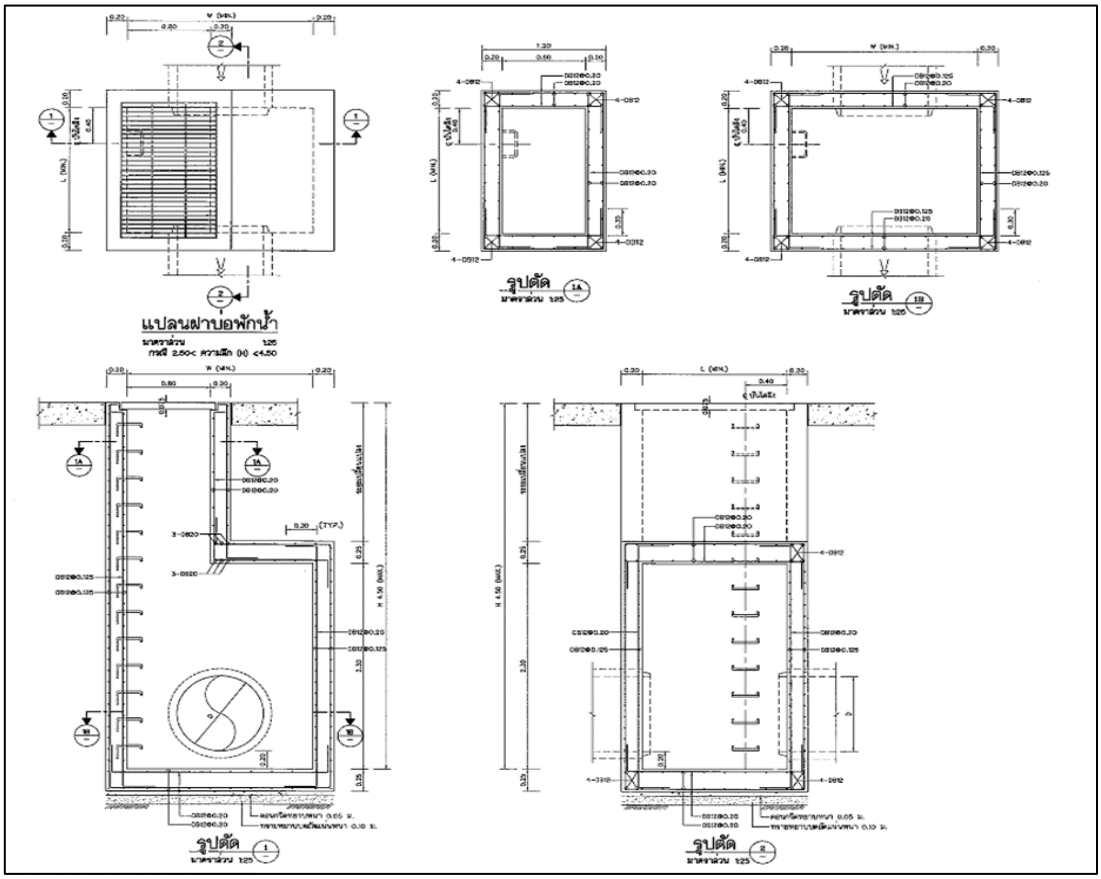


Figure 3-40 Typical Section of Circular Pipe

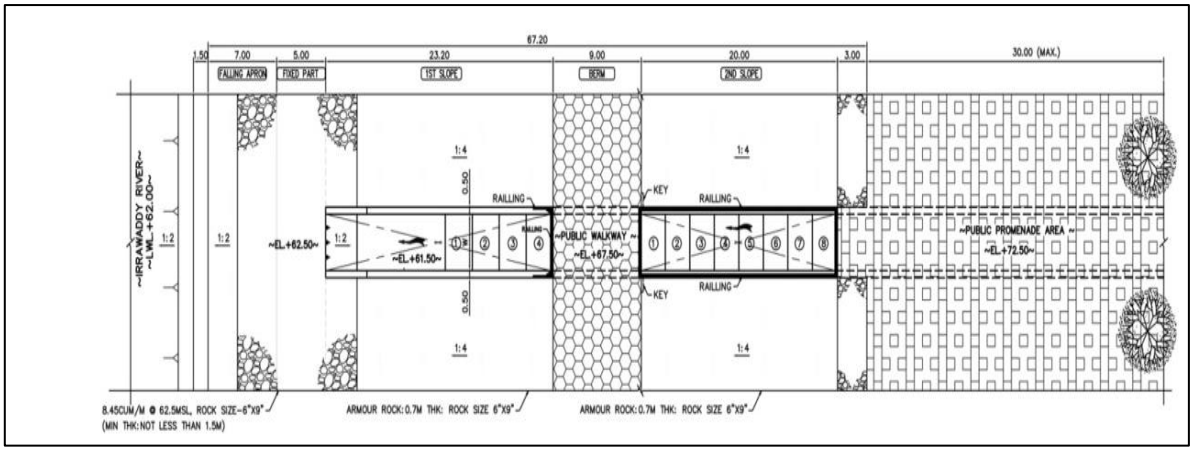


Figure 3-41 Typical Plan and Section of Outfall

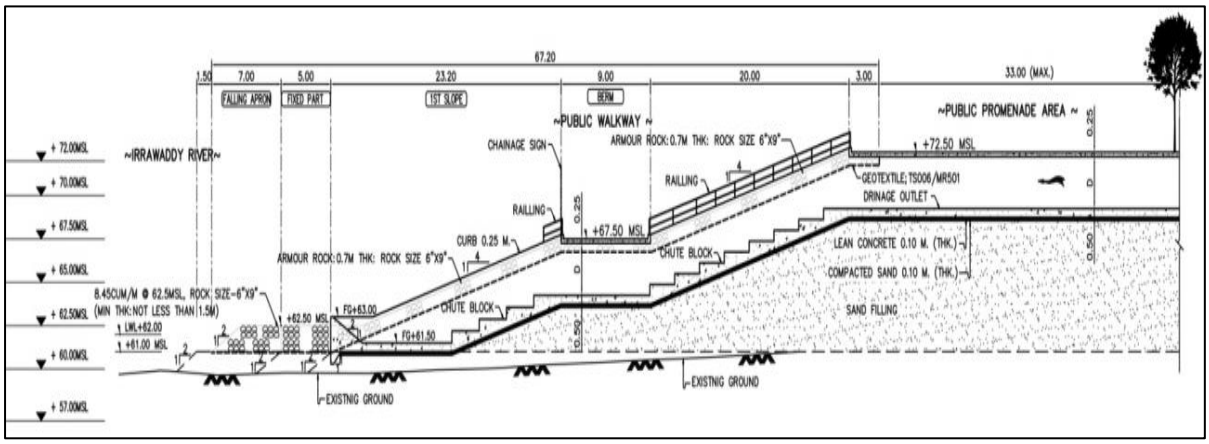


Figure 3-42 Typical Plan and Section of Outfall

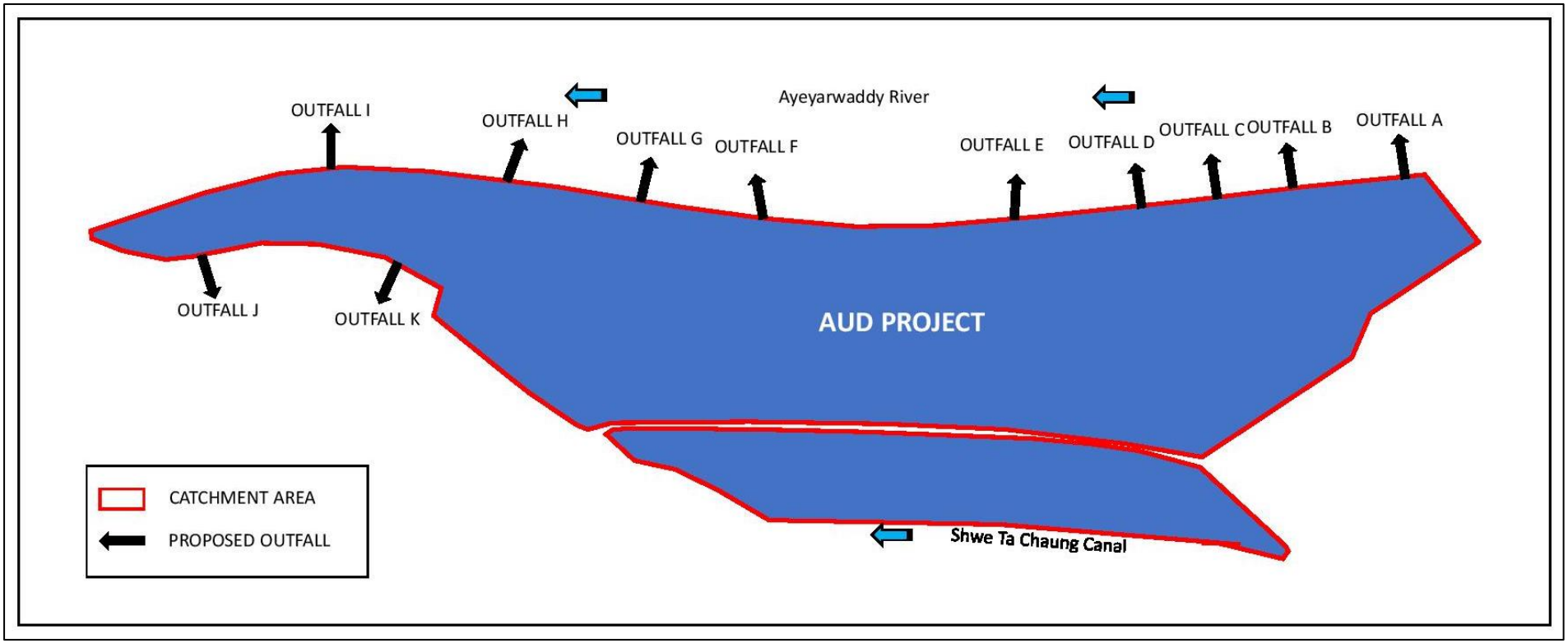


Figure 3-43 Overall Drainage System with Outfalls

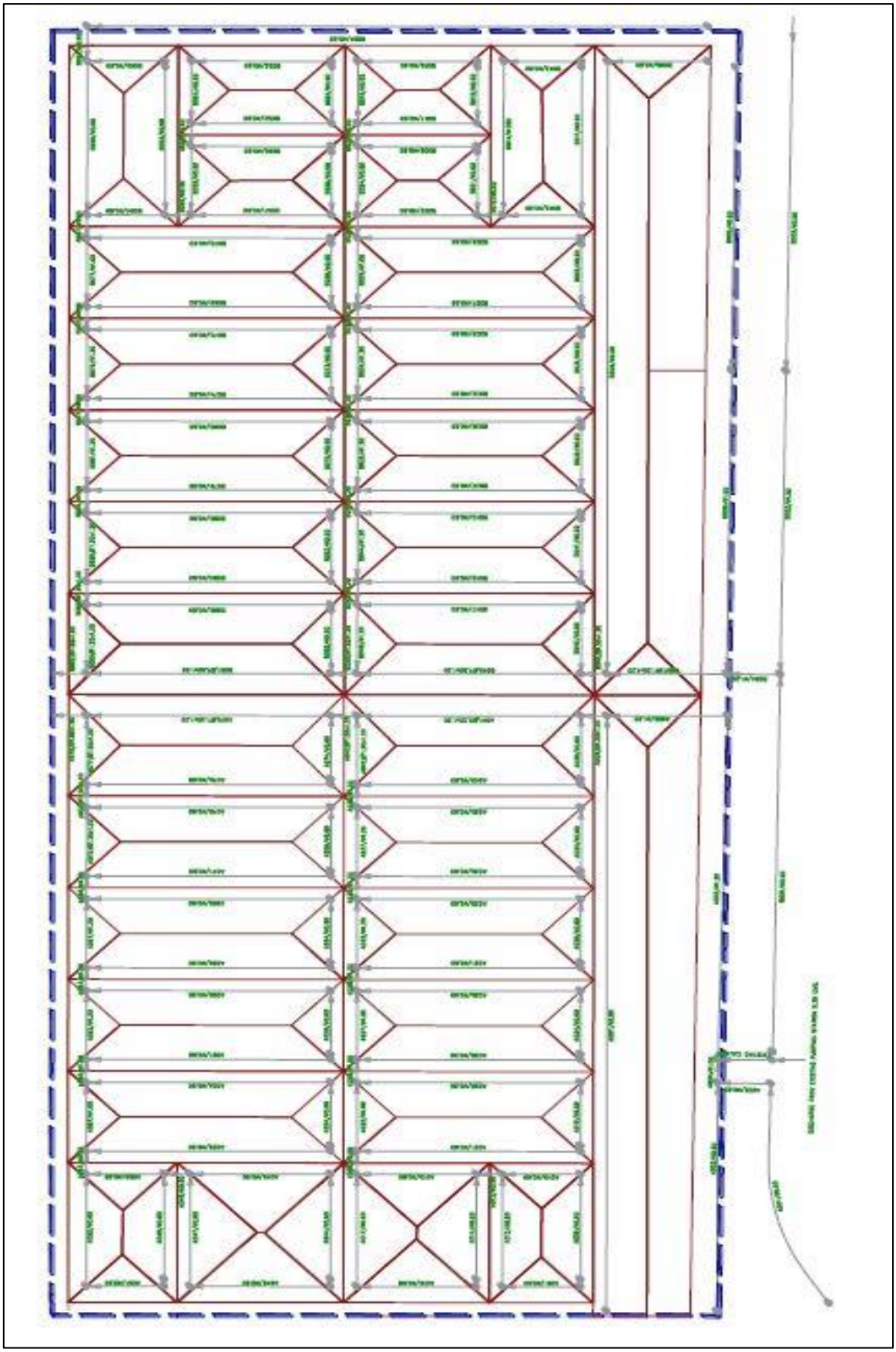


Figure 3-44 Drainage System, Zone A

3.4.3.7. Communication and Electricity Supply System Construction

3.4.3.7.1 Communication System

Source of communication network in the planning area is from existing communication network service provider. Optic cable will be installed from the telecommunication supplier's exchange point to the end-user's network access point to meet the demand of large bandwidth including internet, cable television, telephone and ensuring expansion of bandwidth capacity in future as per the requirement of national development orientation of telecommunication infrastructure. In addition, international technical standards such as American National Standards Institute (ANSI), National Electrical Code (NEC), Institute of Electrical and Electronics Engineered (IEEE), Internet Engineering Task Force (IEFT), Electronics Industries Association (EIA) will be followed in implementation of communication system.

The major components of the communication system are as follows.

Main cable: Single mode 96 core optic cable using optic cable will be installed in underground HDPE pipe. Cable pull box will be used on the main cable network for the purpose of connecting and installing cables and branch cables. Using concrete pull box adds to advantages of strong bearing capacity, minimizing distortion of chamber walls while being buried and also keeping cable duct, chamber, jointing chamber stable under the ground with a durability of over 20 years. Additional holes for future expansion will be provided for cable. Interval of cable chambers will be not more than 500m.

Optical distribution cabinets on the main fiber optic cable lines will be used to ensure service radius of not more than 50m for each cabinet. Fiber optic converter or fiber optic switching module will be installed in the cabinet.

Distribution cable line: Distribution cable line will use single mode optic cable and will be buried with optical distribution frame location in main road.

Customer cable line: Will use a single mode optical cable connected to over head network access point.

The estimated bandwidth demand and cost estimate for telecommunication system is shown in Table 3-12 and Table 3-13.

Table 3-12 Estimated Bandwidth Demand

Item	Area	Estimated Bandwidth Sector 1 Mbps	Estimated Bandwidth Sector 2 Mbps	Estimated Bandwidth Sector 3 Mbps	Estimated Bandwidth Sector 4 Mbps	Estimated Bandwidth Sector 5 Mbps	Estimated Bandwidth Sector 6 Mbps	Estimated Bandwidth Sector 7 Mbps	Estimated Bandwidth Sector 1-7 Mbps
1	Warehouse	-	-	-	120	-	60	-	180
2	Transportation	-	-	-	10	10	-	-	20
3	School	10	280	-	-	-	-	-	290
4	Tennis Court	-	10	-	-	-	10	-	20
5	Utilities	70	10	-	30	-	10	10	130
6	Public Building	30	10	50	40	-	-	-	130
7	Business	-	-	8730	3600	5400	-	5100	22,830
8	Shophouse	630	480	650	570	50	150	150	2,680
9	Commercial	3,720	1,680	1,680	1,080	840	300	480	9,780
10	Residential	18,060	4,140	130	180	40	8,070	11,190	41,810
Total Estimated Bandwidth (Gbps)		**22.52**	**6.61**	**11.24**	**5.63**	**6.34**	**8.60**	**16.93**	**77.87**

Table 3-13 Summary of Quantity and Preliminary Cost Estimate for Telecommunication Investment

PART	TITLE	TOTAL AMOUNT (U.S. DOLLAR)
6.2	Communication	
6.2.1	Sector 1A/ Sector 1B	90,780.00
6.2.2	Sector 2	67,880.00
6.2.3	Sector 3	81,230.00
6.2.4	Sector 4	106,990.00
6.2.5	Sector 5	59,970.00
6.2.6	Sector 6	50,420.00
6.2.7	Sector 7	51,120.00
6.2.8	Service	14,672.00
	GRAND TOTAL	**523,062.00**

3.4.3.7.2 Electricity Supply System

Electricity supply is designed and planned on the land use plan map of Mandalay Business Capital City Development Ltd (MBCCD) and Ministry of Electricity and Energy Standard (MOEP).

For the Amarapura Urban Development Project, 4 sub stations (66/11kV or 33/11 KV substations) are considered. In the first phase, a substation of 20 MVA will be installed in Sector (1) which will fulfill the expected demand for the phase 1, utilities for the whole project construction process. Installation of the subsequent substations will be subjected to each development phase as per requirement.

3.4.3.7.2.1 Medium Voltage 11 kV Network

The power distribution voltage will be of 11kV. The plants, administrative facilities and residential facilities will be supplied at this voltage from the overhead/underground distribution lines as per requirement. The transmission lines parallel to the Myo-Pat Road, Central Road and Major Arterial Road will be underground as per requirement and for the other locations overhead transmission system is considered.

For 11kV lines, spaced aerial cable type will be installed on centrifugal concrete pole at 14-16m height, the average interval of pole will be 30 m. Total length of 11kV line in the entire area is 51km. Low-voltage stations supply power for plants, public service works, and technical infrastructure will be identified in the subsequent future development.

3.4.3.7.2.2 Lighting Network 0.4 kV

Low-voltage transformers of 11/0.4kV are proposed to supply low-voltage power for street lights. 3-phased pole type transformers with a total expected capacity of 100kVA for 11 sets will be used for this purpose.

Low-voltage lines supplying for street lights will use bronze cable (Cu/XLPE/PVC, 0.6/1kV) installed in buried HDPE conduit. For lighting lines on twin roads, double lighting poles to be installed on separated strips. LED 220V Street lights with capacity ranging from 110W to 200W, to be installed on steel tube at 9m height in an average interval of 25m-40m along the roads.

3.4.3.8. Water Supply and Fire System Construction

Water supply system will be established up for the entire Amarapura Urban Development project by pumping water from the Ayeyarwady River and ground water. The river water will be used directly for firefighting system and irrigation system (spraying trees) by distribution system in each sector. In construction phase, the required amount of water consumption rate is 1300 m3/day for the whole project by pumping water from the river.

Pumping test & Draw-down tests are conducted in order not to affect the recharge and discharge of the underground aquifers and Geophysical survey are conducted to know the ground water condition, hydrogeology condition before using the ground water. Pumping test & Draw-down test and Geophysical survey photo are shown in Figure 3-45. Ground water

will be treated with treatment system and used for household and other buildings in the project area.

Figure 3-45 Pumping test & Draw-down test and Geophysical survey activities

3.4.3.8.1 Water Treatment Process

Water may be treated differently in different communities depending on the quality of the water source that enters the treatment plant. The water that enters the treatment plant is generally from either surface water or groundwater. Surface water, lakes, rivers and streams, typically require more treatment and filtration than groundwater because of high contaminants of sediment (sand, clay, silt and other soil particles), germs, chemicals, and toxins than groundwater.

3.4.3.8.1.1 Surface Water

Major method for surface water treatment process is turbidity demolition. The conventional treatment process is usually used for treating surface water because the process is practically non-complexity and require simple operation as Figure 3-46.

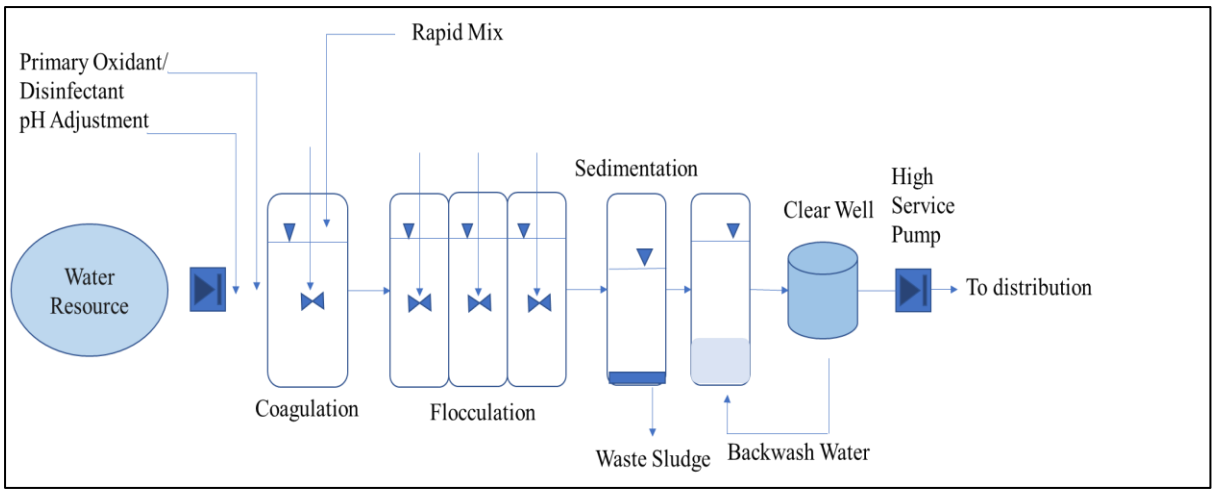


Figure 3-46 Conventional Treatment, Surface Water

As described in above figure, conventional water treatment process includes the following treatment process;

- ✓ Coagulation and Flocculation Process (Rapid Mixing System and Slow Mixing System)
- ✓ Sedimentation Process
- ✓ Filtration Process
- ✓ Chemical Storage and Feeding System

(a) Coagulation and Flocculation Process

To demolish turbidity or colloid particle from surface raw water to gain clearer water, filling of some chemical is needed such as Alum to accelerate self-sedimentation capability. Process that colloid particle gathering and bonded together to form bigger sizing particle called Coagulation.

All waters, especially surface waters, contain both dissolved and suspended particles. Coagulation and flocculation processes are used to separate the suspended solids portion (turbidity) from water. Coagulation and flocculation occur in successive steps intended to overcome the forces stabilizing the suspended particles, allowing particle collision and growth of floc.

Coagulation, rapid mixing, is the first step to destabilize the particle ‘s charge. Coagulants with charges opposite those of the suspended solids are add to the water to neutralize the negative charges on dispersed non-settable solids such as clay and color-producing organic substances.

Rapid mixing (Coagulation process) is the first step that supports major role to accelerate chemical reaction of alum in raw water for affecting colloid particle to be unstable and formulate floc particle in slow mixing tank.

Important parameter for equipment mixing design of rapid mixing tank is Velocity Gradient which is defined as symbol ―G‖. In Velocity Gradient water is turbulent, turbulent water in rapid mixing tank is needed to be high to stimulate mixing between water and chemical in every spot. Another important parameter is mixing time as defined by symbol "T" which means contact time in between chemical and turbidity. Time in rapid mixing tank is consumed only 1 minute or less.

For this project the consultant selected to use Static Mixer in rapid mixing system because of its easy to be controlled, cheaper cost and not required electrical supply. Design of Static Mixer is as follow:

i. Installing on ground for convenient maintenance.

ii. By-pass is available in case of taken off raw water pipeline for washing or maintenance.

iii. Chemical Filler at water inlet point is existed.

iv. Water Baffle Plate in raw water mixing pipeline is made of stainless.

v. Criteria for Raw water mixing design is as follow:

G = 500-1,000 second-1

GT = not more than 1,500

T = 1-3 second

After the first step of coagulation is finished, the second process called flocculation will be occurred. Flocculation, slow mixing (Flocculation process) parameters are majorly nearly the same as those used in Rapid Mixing. The differences are in slow mixing G is required to be low but T to be long. Water Baffle Plate to be used in slow mixing system is Baffle Type with horizontal flow.

(b) Sedimentation Process

Sedimentation Process is to subtract colloid particles (turbidity) that formulated as floc out of mixing water then water will become clearer. Good sedimentation tank performed demolition of almost all floc particles without burden need of filtration tank.

To design sedimentation tank, Surface Overflow Rate and Water Detention Time are needed to be considered. Moreover, Ratio of Tank Width per Tank Length, Tank Bedding slope, Details of water inlet and water outlet for uniform water distribution inside the tank without any shortcuts and turbulence occurred are also considered.

(c) Filtration Process

Filtration tank performed separation of suspended particle out of water spilling over sedimentation tank. Water passing through filtration tank will be very clear without any suspended solids and with less turbidity. In general sand is major material to be applied in filtration tank to catch suspended load.

Filtration process in water treatment system is majorly composed of Rapid Sand Filter. As time goes by, to keep filtration performance effective backwashing of sand filter is needed. As long as operation period goes, suspended particles will be accumulated in between filter void until clogging can be occurred. Washing of filter material will be needed and can be done by letting clear water flow backward to filter direction. Turbidity and other clogging particles shall be wiped away by inputting additional clear water. In this project backwash water operating to wash the filter material while washing the surface of the filter layer.

Factors to be considered for designing filtration system are Filtration Rate, Type and Size of Filter Material, Thickness of Filter Layer, Filtration Control System, Subsurface Drainage of Filter Layer, Spilling Drainage System, Backwashing System, and Piping system in filtration system.

(d) Chemical Storage and feeding system

Design concepts are as follows:

1) Space of Chemical Storage must be sufficient for keeping chemical for 1-month use including with installation of feeder system equipment.

2) Chemical Feeder Capacity must be sufficient to supply for feeding 0.5-1 of daily usage.

3) Location of entrance/exit and chemical storage layout must be convenient for operating such as relocating, mixing and feeding.

Chemical Use in Water Treatment System can be categorized in 3 types as follows:

1) Coagulation Chemical (coagulant) to be used can be alum, ferric salts,

poly Aluminium Chloride (PACI) and various types of polymers.

2) Chemical for pH adjustment such as Sodium Hydroxide, Sodium Carbonate and Lime.

3) Disinfection Chemical properly uses Chlorine

In chemical feeding process, normally the chemicals are prepared in the form of solution before passing through the feeder typed Diaphragm Metering Pump.

Chemical Dosing in Water Treatment System should be applied as follows:

- ✓ Alum should be ranging in between 20 - 100 mg./l.
- ✓ Lime should be ranging in between 10 - 50 mg./l.
- ✓ Chlorine should be ranging in between 0.5 - 10 mg./l. (in the form of Cl2)

(e) Clear water tank

Design Criteria for clear water tank are as follows:

- ✓ Storage Capacity of the clear water tank is not less than 6 hours of Maximum Daily Demand.
- ✓ Connection to existing clear water tank must be installed at the bottom elevation of the clear water tank.
- ✓ Pipe Connectors for future extension of clear water tank must be provided and installed.

3.4.3.8.1.2 Groundwater

Groundwater treatment process is designed to remove natural and anthropogenic contaminants. Efficacy, capital, and operation and maintenance (O & M) costs, and owner's preference are considered to select proper treatment. A flow schematic for a typical conventional groundwater treatment including some form of oxidation, coagulation/ clarification process, filtration, and disinfection is presented in Figure 3-47.

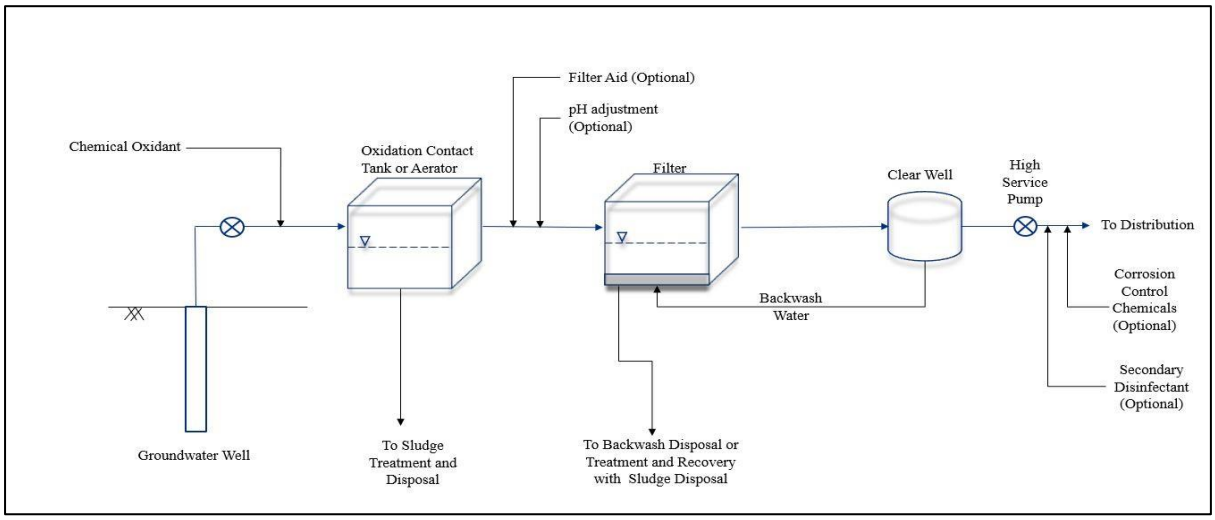


Figure 3-47 Basic Groundwater Treatment Plant with Iron and Manganese Oxidation and Removal

(a) Oxidation Contact Tank or Aerator

The groundwater is aerated (supplied with air) by passing it over a series of steps to take in oxygen from the air. This process helps in expelling soluble gases such as carbon dioxide and hydrogen sulphide (both of which are acidic, soo this process makes the water less corrosive) and expels any gaseous organic compounds an undesirable taste to the water. Aeration also removes iron or manganese by oxidation of these substances to their insoluble form. Iron and manganese can cause peculiar tastes and can stain clothes. Those substances can be removed by filtration when they are in insoluble forms.

Iron and manganese removal is one of the most common objectives of groundwater treatment. Many systems remove iron and manganese with a combination of oxidation, coagulation/ precipitation, and filtration. Oxidation is normally placed at the plant headwork to change the form of iron and manganese from the bivalent form (Fe^{2+} or Mn^{2+}), which is soluble to the trivalent form (Fe^{3+} or Mn^{3+}), which is both insoluble and colored

(Mongtomery, 1985). Oxidation methods used in drinking water treatment are aeration, chlorine, permanganate, ozone, and chlorine dioxide (Kawamura, 2000).

(b) Filter

The process is same as described in Filtration process of Section 3.4.3.4.1.1 (c): Surface water.

(c) Disinfection

Typically, some form of disinfection is the last step in the treatment process to ensure that the water is microbiologically safe (free from bacteria, viruses, and protozoan parasites) before the water is consumed.

Because water quality is deteriorated as soon as it enters the distribution system and water in the distribution system can be contaminated by a variety of pollution sources, such as backflow, pipe leaks and intrusion, and bacterial regrowth in the distribution pipe, therefore many utilities apply a secondary disinfectant to maintain the microbiological quality of water.

(d) Clear Well

The clear well collects filtered water once the pH and chlorine levels are adjusted to assure optimum levels when the water leaves the plant.

3.4.3.9. Waste Disposal System Establishing

Waste from residential (domestic waste) and commercial (non-hazardous waste) will be collected door-to-door system with compactor trucks. Waste will be collected from each household/building 3 days per week. Waste truck will collect waste along the routing which design for each zoning area. Each zoning area will be collected 3 days per week. Waste truck will collect waste to the transfer station 2-3 trips per day. Hazardous waste and hospital waste will be collected by the specific truck and transfer to specific waste disposal site of Mandalay.

Waste transfer station will be constructed in (4) parts. Waste transfer station for sector 1 has an area of 0.33 ha and a design capacity of 15 tons per day. Waste transfer station for the rest sectors area is 0.88 ha for design capacity of 96 tons per day. The specific details plan is shown in 3.5.6.1.

3.4.3.10. Building Construction

The first step of infrastructure construction is to build the ground foundation. Since the project area is exist beside the Ayeyarwaddy River, to avoid long term settlement of those clay layer, the consolidation acceleration is needed which can do by put few meters thick of extra surcharge (act as preload) onto the backfilled area and let the layer squeeze out of any pore water in clay as shown in Figure 3-48. Compaction method of Vibrofloting is presented and accepted by MBCCD. Moreover, a piling technique will be used to reinforce the

infrastructures' foundation on the area affected by clay pocket underneath as shown in Figure 3-49.

In the project area, some buildings such as hospital, technical school and high school will be constructed by project proponent and transfer to the Mandalay City Development Committee (MCDC) after the constructed. The construction designs and layout plan of these buildings are shown in Figure 3-50 to Figure 3-57.

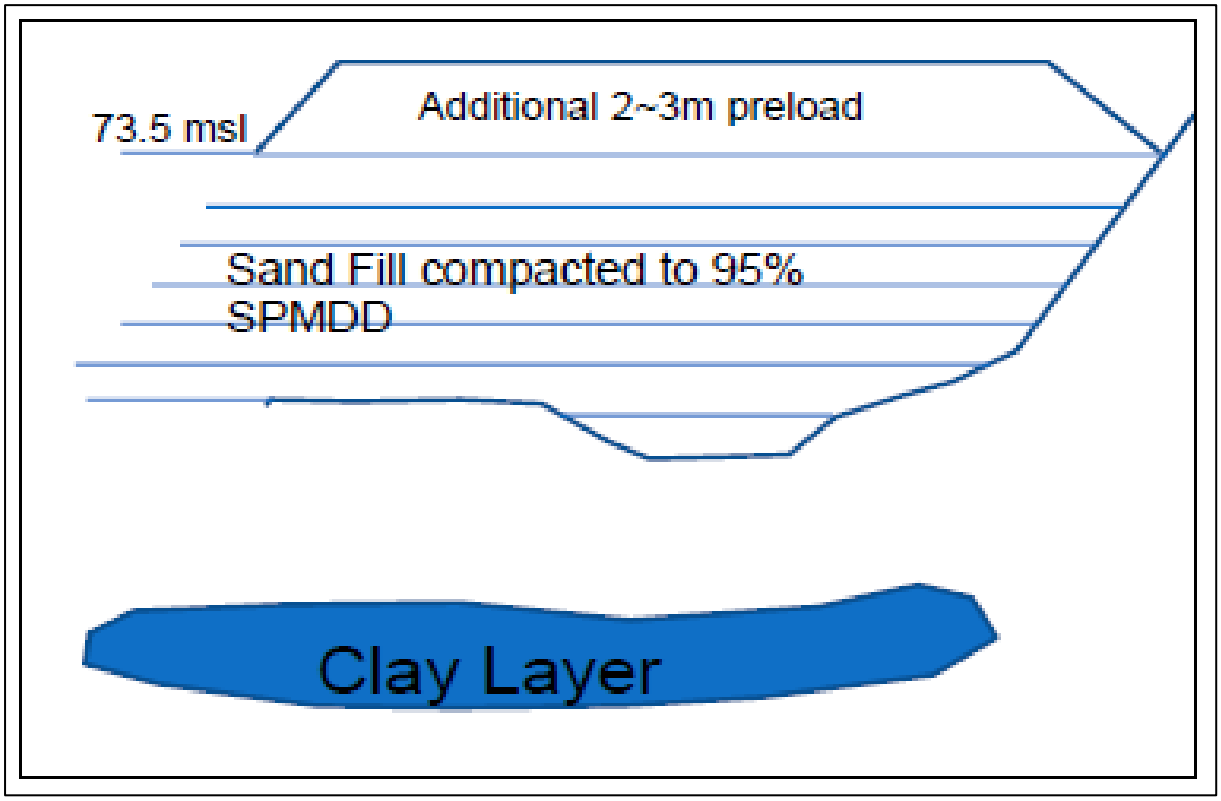


Figure 3-48 Additional Surcharge of 2-3m to Preload Clay Pocket (For Consolidation Acceleration)

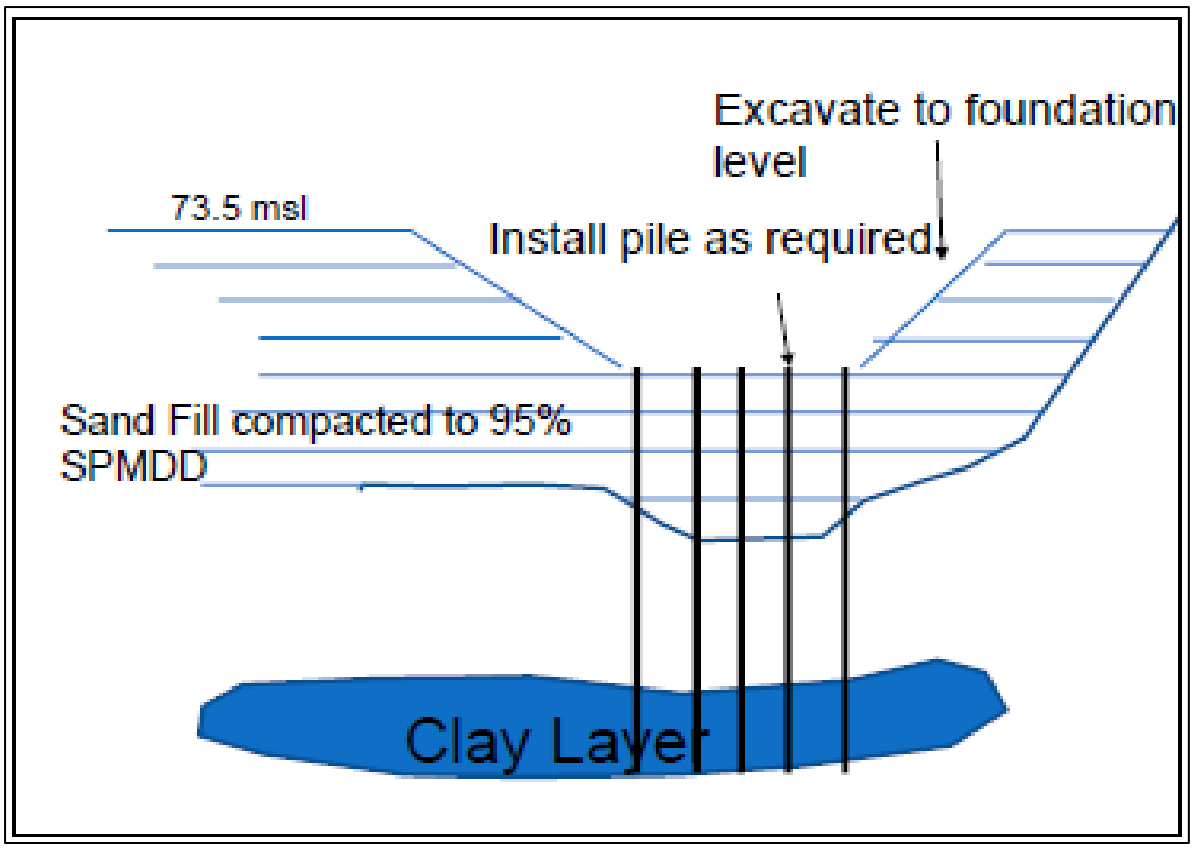


Figure 3-49 Proposed Pilling Scheme on the Area Affected by Clay Pocket Underneath

Figure 3-50 Front and side view of the hospital

Figure 3-51 Site ground floor plan of the hospital

Figure 3-52 First floor plan of the hospital

Figure 3-53 Front and side views of the technical school

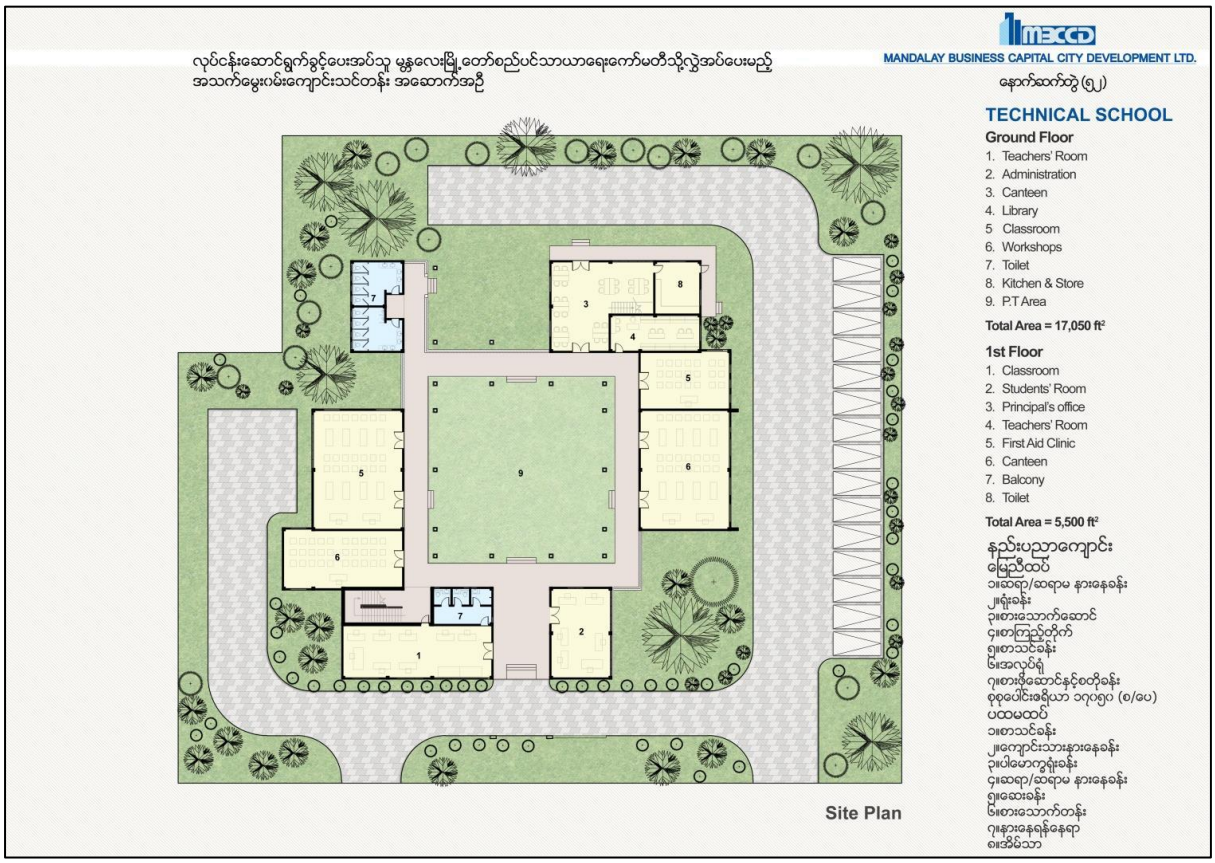


Figure 3-54 Site floor plan of the technical school

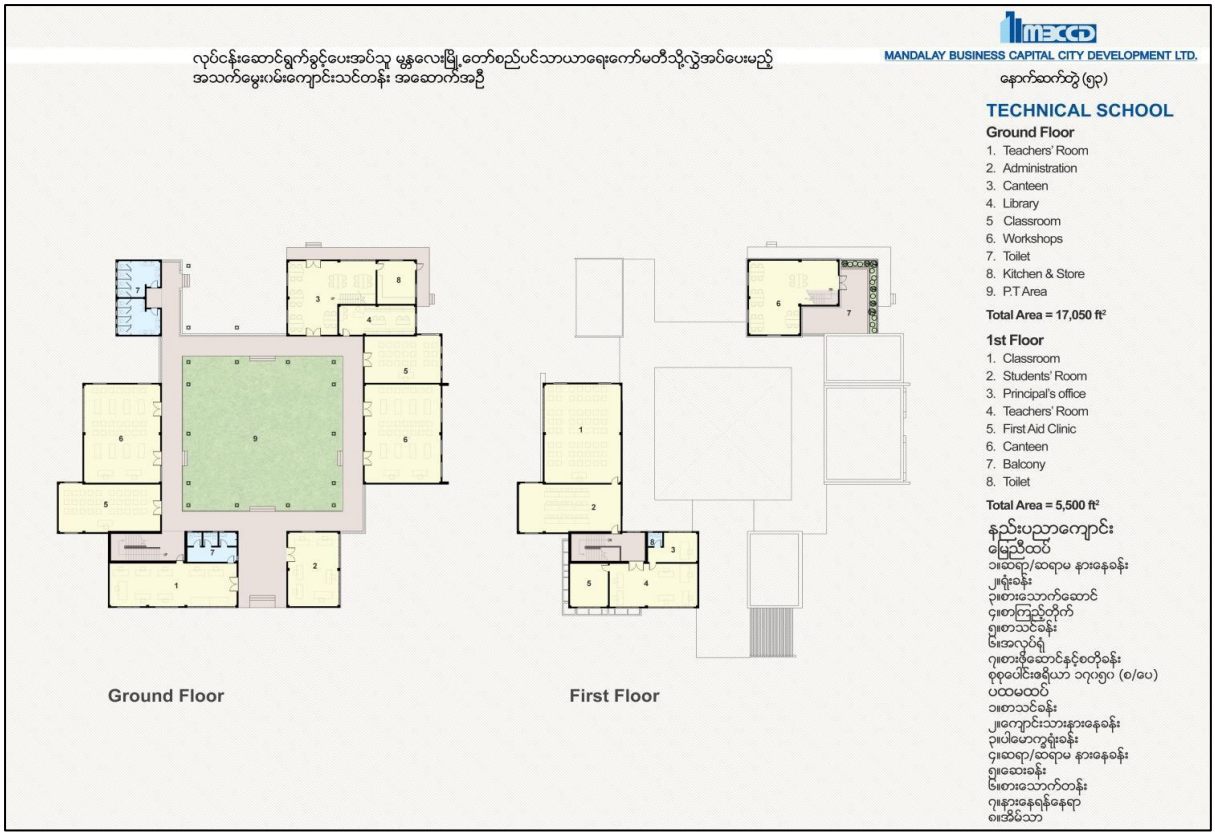


Figure 3-55 Ground floor and 1st floor plans of the technical school

Figure 3-56 Front and side elecation views of the high school

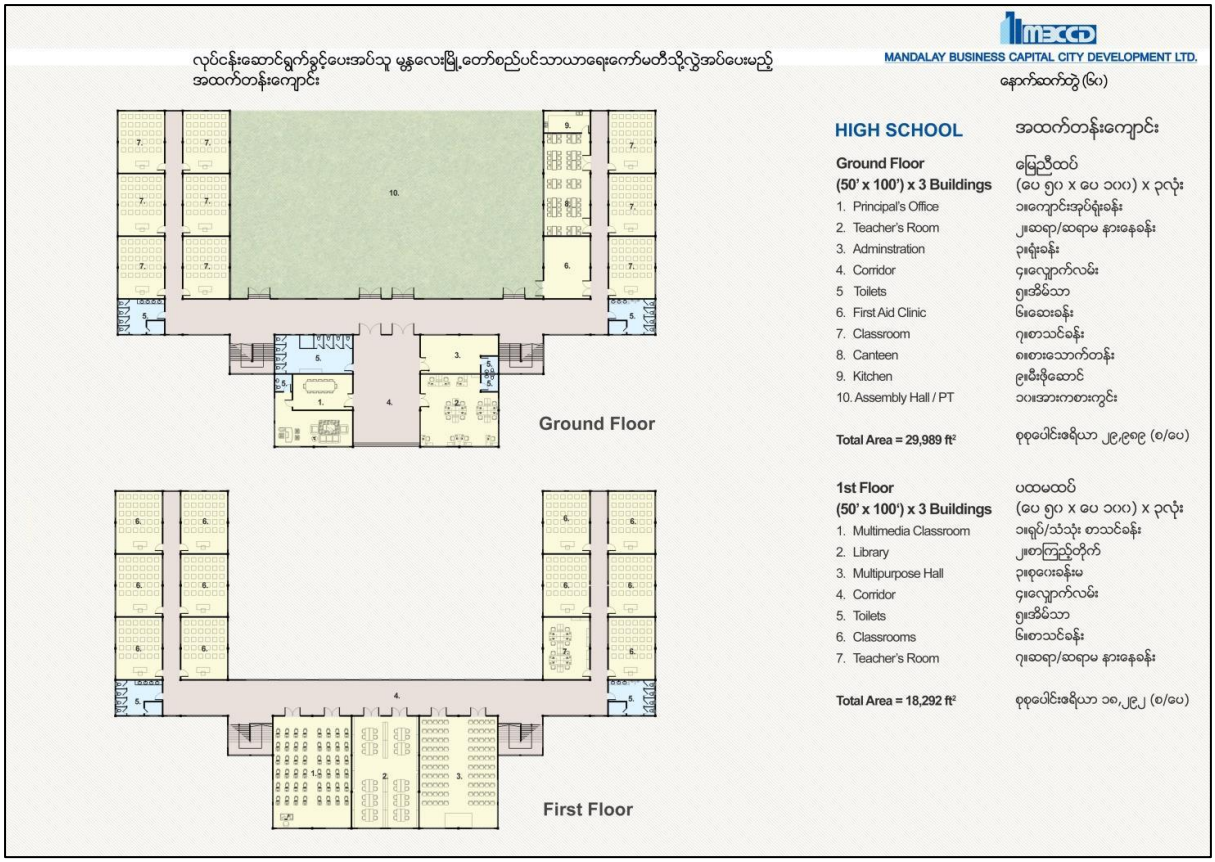


Figure 3-57 Ground floor and 1st floor plans of the high school

3.4.4. Operation/ Maintenance Stage

Since the proposed project is an urban development project, there is no specific maintenance phase. Thus, it is assumed that the operating and maintaining phases are identical. In the operation stage, the basic infrastructures in the project area such as dike wall, drainage channels, roads, power supply facilities, water supply facilities and communication facilities will be maintained. In addition, the project committee will be in charge of managing the project area's waste generation, including solid waste and wastewater. The operation/ decommission stage activities are shown in Figure 3-58.

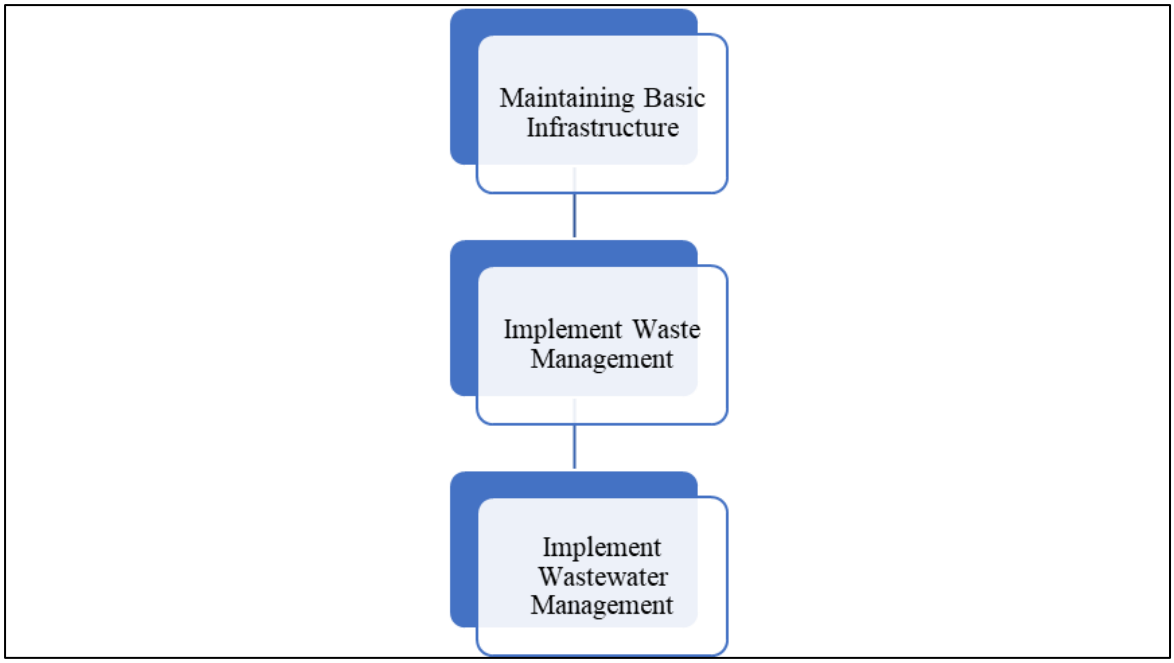


Figure 3-58 Operation/ Maintenance stage activities

3.5. PROJECT UTILITIES

3.5.1. Raw Material Requirement

The current condition of the project is in the construction stage and retaining structure construction, land reclaiming and levelling processes are underway. The raw materials used in retaining structures such as stones were brought from Hton Bo township. To build the essential basic infrastructure like Main Roads and Channels, 30% of the required 350,000 m^3 concrete will be supplied from our internal batching plant and the remaining will be obtained from outer source. The estimated demand of the sand is approximately 30 million suds for the whole project. For the revetment structure, the rock demand is approximately 400,000 suds and the main source is from Ohn Chaw Quarry, 30 km far from the project site.

3.5.2. Machineries and Equipment

Various types of vehicles and equipment are needed to use in implementation of Amarapura Urban Development project. The current project phase is the construction phase and thus, many sand barge vessel and ships are used in the sand extraction process. The current usage of sand barge vessel and ships are 58 Nos and will be increased to 119 Nos. Other machineries such as excavator, dozer, roller compactor, grader, wheel loader, etc. are also used for project implementation in the current construction phase of the project. For transportation purpose, various types of vehicles such as motor cars and motorcycles are used and the exact number is shown from Table 3-14 to Table 3-19.

Table 3-14 Summary of Machineries and Equipment list used in process

No.	Type	Current List	Fuel Consumption Rate (Lit/day)	Future Increase List
1	Sand Ship + Ship	58 Nos	3840	119
2	Vehicle/ Machinery	48 Nos	1449	65
3	Vessel	21 Nos	2439	42
Total		**127 Nos**	7728	7728

Table 3-15 Specific list of Sand Ship and Ship Used in the Process

No	Ship Name	Suds	No:	Fuel Consumption Rate (Lit/day)
1	Amarapura -1	39.00	1 No	56.00
2	Amarapura -2	40.75	1 No	63.00
3	Amarapura -3	39.25	1 No	45.00
4	Amarapura -4	41.75	1 No	70.00
5	Amarapura -5	41.25	1 No	55.00
6	Amarapura -6	41.75	1 No	80.00
7	Amarapura -7	41.75	1 No	60.00
8	Amarapura -8	41.25	1 No	62.50
9	Amarapura -9	45.00	1 No	40.00
10	Amarapura -10	26.00	1 No	45.00
11	Amarapura -1	41.75	1 No	58.00
12	Amarapura -12	41.75	1 No	55.00
13	Amarapura -13	41.75	1 No	40.00
14	Amarapura -14	41.75	1 No	68.00
15	Amarapura -15	47.00	1 No	98.00
16	Amarapura -16	47.00	1 No	80.00
17	Amarapura -17	46.75	1 No	75.00

No	Ship Name	Suds	No:	Fuel Consumption Rate (Lit/day)
18	Amarapura -18	46.00	1 No	75.00
19	Amarapura -19	50.25	1 No	55.00
20	Amarapura -20	40.75	1 No	90.00
21	Amarapura -21	56.00	1 No	65.00
22	Amarapura -22	64.50	1 No	125.00
23	Amarapura -23	36.25	1 No	70.00
24	Amarapura -24	43.50	1 No	110.00
25	Amarapura -25	31.00	1 No	50.00
26	Amarapura -26	49.50	1 No	55.00
27	Amarapura -27	68.75	1 No	110.00
28	Amarapura -28	36.75	1 No	55.00
29	Amarapura -29	35.50	1 No	60.00
30	Amarapura -30	54.25	1 No	50.00
31	Amarapura -31	125.75	1 No	250.00
32	Bagan Min Thar	187.50	1 No	73.00
33	Bagan Thar	273.25	1 No	94.00
34	Bagan Thar(CB)+(water test ship)	273.25	1 No	94.00
35	Bagan Min Thar(CB)+(water test ship)	273.25	1 No	60.00
36	Dredger-01		1 No	100.00
37	Dredger-02		1 No	125.00
38	Service Boat-02		1 No	5.00
39	Speed Boat		1 No	30.00

No	Ship Name	Suds	No:	Fuel Consumption Rate (Lit/day)
Total sand ship and boat			**39 Nos**	2851.50

Table 3-16 Specific list of Other Supplier for Sand Ship and ship used in the process

No	Ship Name	Suds	No:	Fuel Consumption Rate (Lit/day)
1	Aung Takhon	43.25	1 No	63.00
2	Aung Takhon -1	32.00	1 No	50.00
3	Than Gabar	54.00	1 No	50.00
4	Aung Myin Tun	41.00	1 No	55.00
5	Yan Myo Ag Ag	20.50	1 No	45.00
6	Yan Myo Ag Ag -1	27.50	1 No	45.00
7	Yan Myo Ag Ag -2	28.50	1 No	45.00
8	Paing -3	25.00	1 No	45.00
9	Nyne Hylan	30.50	1 No	50.00
10	Phyone Mg Mg	68.50	1 No	110.00
11	Phyone Mg Mg -3	38.75	1 No	50.00
12	Phyone Mg Mg -6	39.00	1 No	50.00
13	Phyone Mg Mg -9	49.25	1 No	55.00
14	Phyone Mg Mg -10	53.25	1 No	50.00
15	Thidar Mya Aye	42.75	1 No	50.00
16	Myanmar Nyunt	24.25	1 No	45.00
17	Tun Kyaw	42.50	1 No	50.00
18	5 Star	25.50	1 No	40.00
19	5 Star -1	21.25	1 No	40.00
Total sand ship			**19 Nos**	988.00

Table 3-17 Specific list of Vehicle/ Machinery and Vessel

Sr.	Vehicle/ Machinery	No	Fuel Consumption Rate (Lit/day)
1	Excavator-01 (30 TON) (Liugong)	1 No	95.00
2	Excavator-02 (30 TON) (Liugong)	1 No	95.00
3	Excavator-03 (25 TON) (Liugong)	1 No	70.00
4	Excavator-04 (25 TON) (Liugong)	1 No	70.00
5	Excavator-05 (21 TON) (Volvo)	1 No	70.00
6	Excavator-06 (21 TON) (Volvo)	1 No	70.00
7	Dozer-01 (16 Ton)	1 No	65.00
8	Dozer-02 (16 Ton)	1 No	65.00
9	Roller Compactor-01 (14 Ton)	1 No	30.00
10	Roller Compactor-02 (14 Ton)	1 No	30.00
11	Grader-01 (14 Ton)	1 No	30.00
12	Wheel Loader-01 (11 Ton)	1 No	30.00
13	Trailer Jeep (G-01)	1 No	3.00
14	Trailer Jeep (G-02)	1 No	3.00
15	Boxer-01-1B-9087 (Water)	1 No	27.00
16	Boxer-02-5Q-8440 (Oil)	1 No	13.00
17	Dump Truck -01 (3M-9617)	1 No	15.00
18	Dump Truck-02 (3M-9760)	1 No	15.00
19	Dump Truck-03 (1M-8688)	1 No	15.00
20	Dump Truck-04 (3M-9762)	1 No	15.00
21	Dump Truck-05 (7M-1366)	1 No	15.00
22	Dump Truck -06 (7M-1369)	1 No	15.00

23	Dump Truck-07 (2C-6799)	1 No	25.00
24	Dump Truck-08 (48-7496	1 No	25.00
25	Dump Truck-09 (7M-1368)	1 No	15.00
26	Dump Truck -10 (7M-1357)	1 No	15.00
27	Trailer (91-9588)	1 No	65.00
28	Trailer (3J-6072)	1 No	65.00
29	နောက်တွဲ (TRL-8137)	1 No	65.00
30	နောက်တွဲ (TRL-4281)	1 No	65.00
31	နောက်တွဲ (TRL-8836)	1 No	65.00
32	14'(5L-1364)	1 No	10.00
33	10' (3J-6903)	1 No	10.00
34	Lighting Tower-01	1 No	10.00
35	Lighting Tower-02	1 No	10.00
36	Lighting Tower-03	1 No	10.00
37	Lighting Tower-04	1 No	10.00
38	200KVA Generator	1 No	72.00
39	150KVA Generator	1 No	36.00
40	Weigh Bridge	2 No	
41	Cone Penetration Test Machine	1 No	20.00
42	Breaker	2 No	
43	Vibro Hammer	1 No	
44	Compaction Probe	3 No	
	Total	48 Nos	1,449.00
No.	Vessel	No:	Fuel Consumption rate

			(Lit/Day)
1	MBCCD-01(8DC-10)(430950)	1No	145
2	MBCCD-02(8DC-10)(417704)	1No	115
3	MBCCD-03(6D-22 Engine)	1No	117
4	MBCCD-04(6D-22 Engine)	1No	105
5	MBCCD-05(6D-22 Engine)	1No	125
6	MBCCD-06(6D-22 Engine)	1No	124
7	MBCCD-07(6D-22 Engine)	1No	118
8	MBCCD-08(6D-24 Engine)	1No	115
9	MBCCD-09(6D-24 Engine)	1No	80
10	MBCCD-10(6D-24 Engine)	1No	80
11	MBCCD-11(6D-24 Engine)	1No	80
12	MBCCD-12(6D-24 Engine)	1No	80
13	MBCCD-13(Hino) (EF-750,8 လုံးထိုး)	1No	125
14	MBCCD-14(FE6-206 Engine)	1No	100
15	MBCCD-15(FE6-170 Engine)	1No	130
16	MBCCD-16(6D-24 Engine)	1No	125
17	MBCCD-17(6D-24 Engine)	1No	115
18	MBCCD-18(Hino 7 C, machine-02)	1No	130
19	MBCCD-19(6D -24 Engine)	1No	155
20	MBCCD-20(Machine -03,04) (FE6-170 Engine)	1No	130
21	MBCCD-21(Nissan, MD92 Engine	1No	145
	Total Vessel	21Nos	2439

Table 3-18 Specific list of Vehicle List (Car) Used for Transportation

Sr.	Vehicle Type (Car)	Current Usage List	Future Usage List
1	Hilux surf	2	
2	Alphard	1	
3	Prado	2	
4	Ford	1	
5	Pajero	2	
6	Isuzu	3	
7	Succeed	4	
8	Belta	1	
9	Hilux	1	
10	Avanza	1	
11	Caldina	1	
12	Toyota Vigo	1	
13	Toyota Hiace	1	
14	Fielder	2	
15	Hijet	5	
Total		**28**	**53**

Table 3-19 Specific list of Motorcycle List used for Transportation

Sr.	Motorcycle Type	Current Usage List	Future Usage List
1	Suzuki	2	
2	Canda Czi (125)	14	
3	Kamax Czi (125)	5	
4	Lonxuan	3	
5	Super cub	2	
6	Kenbo	1	
7	FZ	1	
8	YES SUMBO (125)	1	
9	Yin Xing	1	
Total		**30**	**60**

3.5.3. Employment

The project needs a lot of staff and labours. The total estimated number of labours that will be employed is 3,598 labors which include consultants, permeant staffs, supplier staffs, contractor staffs, daily labours, etc. The working time is from 8:30 AM to 5:30 PM and lunch time is 12:00 PM to 1:00 PM. The office staff is in the office Monday through Saturday, with Sundays off. The holiday of the site labour is one day off per week. The specific number of project staff and labour is shown in Table 3-20.

Table 3-20 Number of Project Staff and Labour

No	Employment Type	Number
1	Consultant	20
2	Adviser	40
3	Permanent Staff	442
4	Monthly/ Daily Staff	1,266
5	Piecework Staff	320
6	Supplier Staff	450
7	Contractor Staff	1,060
Total		3,598

Working Hour: 8:30 AM to 5:30 PM

Lunch Time: 12:00 PM to 1:00 PM

Working Day Monday to Saturday (Office Staff)

Holiday Sunday (Office Staff)

One day off per week (Site Labour)

3.5.4. Water Supply

Water supply system will be established up for the entire Amarapura Urban Development project by pumping water from the Ayeyarwady River and underground water. The river water will be pumped and stored in a reservoir. The river water will be used directly for firefighting system and irrigation system (spraying trees) by distribution system in each sector. Ground water will be treated with treatment system and used for household and other buildings in the project area.

3.5.4.1. Water Demand

Water demand in terms of quantity and distribution depends on the projected population, land use and behaviors of water users. Techniques and approached for projecting future water demands are based on the premise that an analysis of historic trends can serve as the basis for predicting future trends.

To estimate water demand, these water demand rates are proposed as shown in Table 3-21. There are temporary and permanent population in project area and the total average water demand is approximately 2,910,000 gallon/day for 7 sectors. The estimated water demands are shown in Table 3-22 and Table 3-23.

Table 3-21 Rate of Water Demand

Item	Land use categories	Water Consumption Rate	
		(liter/person/day)	(gallon/person/day)
1	Residential	200	44
2	Commercial	100	22
3	Shophouse	100	22
4	Business	75	16
5	Public	75	16
6	Utility	75	16
7	Sport	40	9
8	Education	75	16
9	Transport	10	2
10	Warehouse	60	13
11	Hospital	1,000	220

Source: Conceptual Design Report of Amarapura Urban Development Project

Table 3-22 Water Demand Rate

Item	Land use categories	Water Demand (gallon/day)							
		Phase 1		Phase 2		Phase 3		Phase 4	
		Sector 1A	Sector 1B	Sector 3	Sector 5	Sector 4	Sector 6	Sector 2	Sector 7
1	Residential	71,710	239,327	91,727	22,437	137,701	56,312	209,191	197,093
2	Commercial	27,496	107,345	182,135	462,157	93,707	27,056	89,528	44,654
3	Shophouse	3,300	31,676	67,311	-	42,234	15,398	47,953	35,415
4	Business	-	-	100,966	-	42,454	31,456	-	-
5	Public	440	660	166,957	11,878	440	5,279	6,819	220
6	Utility	-	660	-	-	440	220	-	220
7	Sport	-	-	-	-	220	-	-	220
8	Education	-	5,059	-	-	106,905	-	113,724	-
9	Transport	-	2,420	-	2,420	3,520	-	-	-
10	Warehouse	-	-	-	-	2,200	1,320	-	-
11	Hospital	-	-	-	-	-	-	-	-
Sub-Total (in Sectors)		**102,946**	**387,147**	**609,097**	**498,892**	**429,821**	**137,041**	**467,216**	**277,822**
Total (in Phases)		**490,093**		**1,107,989**		**566,863**		**745,038**	
Total		**2,910,000 (APPROXIMATE)**							

Table 3-23 Summary of Average water demand, ADD, MDD and MHD

Phase	Sector	Average Useful Water Demand (Water Scale)	Average Daily Demand (ADD)	Average Unaccounted Water Demand (NRW)	Average Daily Demand (ADD)	Maximum Daily Demand (MDD)	Maximum Hourly Demand (MHD)	Maximum Hourly Demand (MHD)
		(Water Demand)	(Water Scale) ÷ (1-%NRW)	(10% of ADD)	(Water Scale ÷ NRW)	(1.3 x ADD)	(1.5 x MDD)	(1.5 x MDD)
		(gallon/day)	(gallon/day)	(gallon/day)	(gallon/day)	(gallon/day)	(gallon/day)	(gallon/hour)
1	1A	102,946	114,384	11,438	114,384	148,700	223,050	9,293.73
	1B	387,367	430,481	43,048	430,415	559,540	839,310	34,971
2	3	680,367	756,037	75,604	755,971	982,762	1,474,143	61,423
	5	499,112	554,544	55,454	554,566	720,936	1,081,404	45,059
3	4	429,821	477,555	47,755	477,577	620,850	931,275	38,803
	6	136,821	151,999	15,200	152,021	197,628	296,441	12,352
4	2	467,436	519,349	51,935	519,371	675,183	1,012,774	42,199
	7	277,822	318,618	30,862	308,684	401,289	601,934	25,081
Total		**2,981,693**	**3,312,968**	**331,297**	**3,312,990**	**4,306,887**	**6,460,331**	**269,180**

3.5.4.2. Water Source

Amarapura Township is the place that the Mandalay water supply system is not available including the project site area. Therefore, the water supply system will be provided by MBCCD.

3.5.4.2.1 Ayeyarwaddy River

Since the project area is located at Ayeyarwaddy river bank, Ayeyarwaddy River serves as the major river transportation route connecting north to south. The river provides water supply for both the majority of the population in the country, and being the major contributor for most of the country ‘s irrigation water need. The river flow varies from 2,300 m 3 /s in the summer to 32,600 m 3 /s flow in the monsoon season (EB, 2000).

As total water demand is approximately 15,000 m3/day or 0.2 m3/s which is small amount when compare with the river flow of Ayeyarwaddy. Therefore, the river is sufficient in term of quantity.

The water quality of Ayeyarwaddy River has been in decline for many years and the failure to deal urgently with various critical issues can lead the river to a point of no return. Siltation from mining operations, the result of deforestation, and lack of soil protection or over exploitation of land poses as a major threat the river has been facing. Serious levels of arsenic and cyanide can be traced seasonally in the river. During site survey in September 2017, the water sampling was collected nearby the project area at the north, where is Yan Myo Lone Pawdawmu Pagoda location. According to the currently water quality, arsenic and cyanide are lower amount when compare with the results of year 2013 and less than the limited level of WHO standard. However, to use water from the river shall need water quality monitoring every month from now until construction state and operation state.

3.5.4.2.2 Ground Water

Groundwater is another source to be considered for alternative when the water quality of Ayeyarwaddy river is lower the water resource standards. The Study on Water Supply Systems in Mandalay City and in the Central Dry Zone (July 2003) by JICA reported that the collected hydrogeological data and the results of the electrical resistivity prospecting for 110 m to 120 m deep ground conducted by the JIC team, it was confirmed there were a high resistivity zone along the left bank of the Ayeyarwaddy River.

Permeability coefficients gained through the hydrogeological survey were 220 m/day in the northwest area including the present well field and 1.3 m/day in the southern area. This difference suggested that the northwest area has 6 to 8 times bigger potential of groundwater than the south area. The water yield in the northwest area was estimated at about 5,000 m 3 /day per one well, on the other hand, 800 m3/day from a well in the southern area. The JICA study on water supply systems in Mandalay City concluded that most of the groundwater belongs to non-carbonate hardness type or mixture type, except that some of shallow confined groundwater contains slightly higher magnesium and/or lower calcium. It was found that the wells from downtown have low ion concentration in deep confined

groundwater. On the other hand, in the southern and eastern side of the city, deep confined groundwater is relatively high in sodium, chloride and calcium. If most of the wells are chemically potable, their contamination by coliforms, from septic tanks and surface wastewater drains represent a major public health issue for the population of Mandalay.

3.5.4.3. Water Distribution System

A looped distribution system helps reduce stagnant water, chlorine residual loss problems, and taste and odor complaints. Water distribution system of tap water and water for firefighting is via a combined pipeline system. There are 7 storages for firefighting systems besides main water treatment plant. Water Pipe from water treatment plant is transmitted by pipeline network to service each land plots and water using area. High Density Polyethylene (HDPE) and Steel pipe sleeves are used for water distribution system along the road. The velocity of water in the pipe is not to exceed 1.5 m/s and the pressure at the end of the pipe is not to be less than 1.5 bar. Using EPANET Program to model of water distribution piping system.

There are 7 DMAs that related to phasing development are proposed for this project. To summary of length of water distribution pipe of each 7 sectors as described in the following table. The main pipe of 630 mm. was counted to each sector. The total length of water distribution pipe is approximately 260,000 meters. Length of water distribution pipe in each sector is shown in Table 3-24.

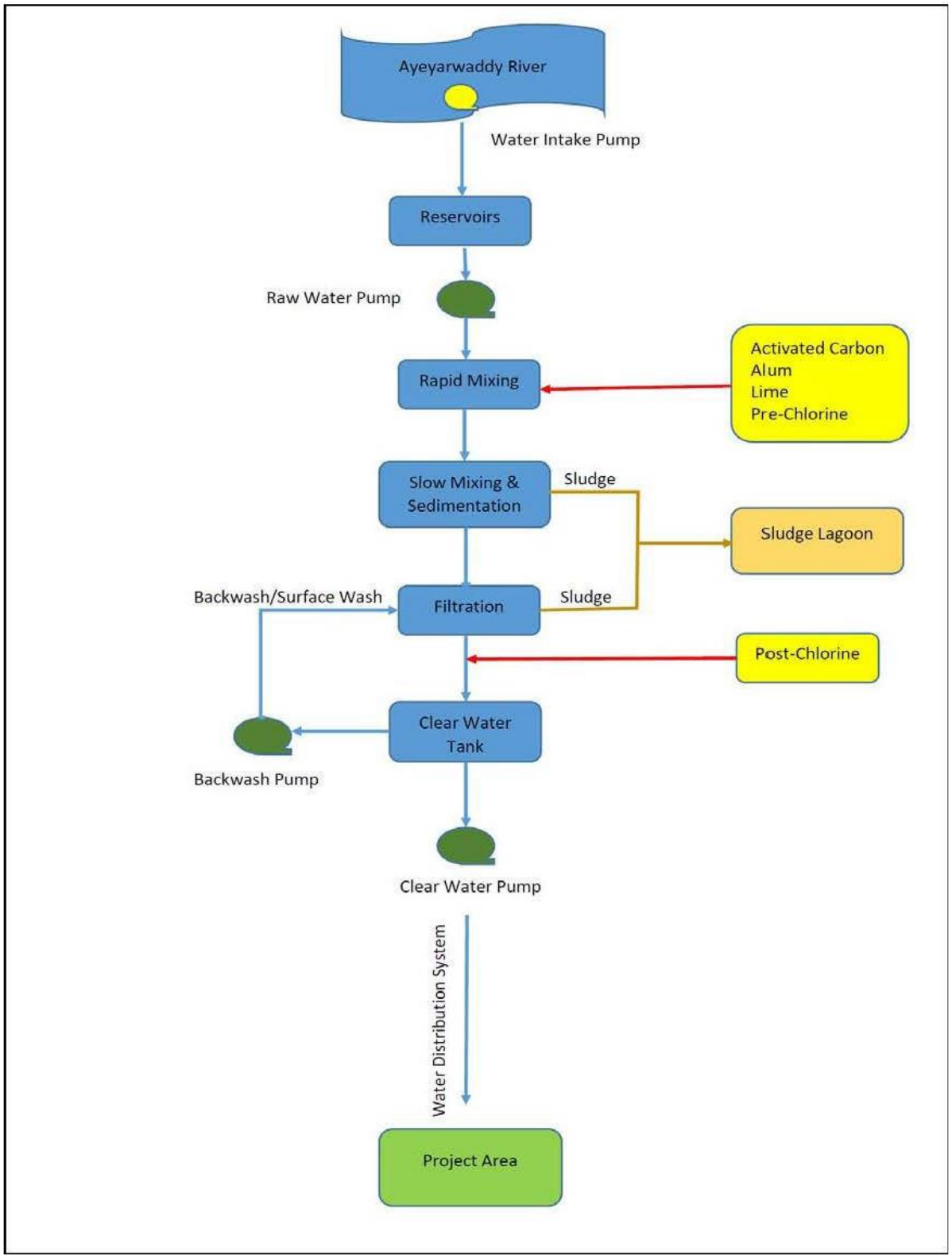
The main HDPE water distribution pipe diameter of 630 mm that be laid along to main road with the length of pipe is 16,200 meters and location of DMA metering chambers. As a priority, most of water pipelines are located on sidewalk and along roads. Water supply pipe network is installed to ensure minimum length of pipeline and flow as well as pressure for all water consuming points in the project, at the same time ensure the intersection with other utility pipes. For each DMA areas, 160 - 315 mm HDPE water pipe diameter will be laid under sidewalk. HDPE water pipes will be proposed are similar to other area for other sectors. The flow diagram of water supply system is shown in Figure 3-59.

Table 3-24 Length of Water Distribution Pipe in Each Sector

Sector	DMA	Length (Meter)
1A	1	11,910
1B	1	46,188
2	2	41,649
3	3	52,816
4	4	45,069
5	5	19,660
6	6	21,528
7	7	21,056

Sector	DMA	Length (Meter)
TOTAL		**259,877**

Source: Conceptual Design Report of Amarapura Urban Development Project



Source: Conceptual Design Report of Amarapura Urban Development Project

Figure 3-59 Flow diagram of water supply system Power Supply

3.5.5. Power Supply

Power supply is designed and planned on the land use plan map of MBCCD and Ministry of Electricity and Energy Standard (MOEP). For the Amarapura Urban Development Project, 4 sub stations (66/11kV or 33/11 KV substations) are considered. The estimated demand for each sector is as shown in Table 3-25.

Table 3-25 Estimated Power Load

Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7
7.01MVA	11.37MVA	16.84MVA	9.04 MVA	16.67 MVA	5.24 MVA	13.23 MVA

3.6. STAFF FACILITIES

The project provides accommodations that include inside the project area and outside of the project area for the staff and staff's families. In addition, food, medicines, employee loan, vehicles are support for the staff and staff's families including welding gift, funeral supporting, celebrate birthday party, excursion. An advance salary payment program is also included for the staff.

As the transportation, shuttle bus services are provided for the staff who far from the project site and motorcycles are provided to the staff who can't reach shuttle bus services including fuel charges. In the working places, meal allowance (3 meals a day), uniforms and necessary PPE are provided to staff and employees. If the incident is occurred and employees get injured, the project provides the necessary medical expenses including salary.

For the Covid-19 protection and treatment, the project provides food delivery, oxygen concentrator and cylinders, surgical mask, hand sanitizers, Vitamin-C, supplements, Covid-19 vaccinate (3) times to the staff and employees. The project proponent takes thorough precautions to maintain a safe environment by regularly sanitizing both its outdoor and indoor areas using disinfectant spray. Furthermore, the office ensures the well-being of individuals by offering dedicated infirmary and isolation wards. These facilities are particularly designed for patients diagnosed with contagious (Covid-19) or infectious diseases and are placed under the careful supervision of medical professionals.

3.7. TRANSPORTATION SYSTEM

In the Amarapura Urban Development Project, the project area is consisting of 7 sectors and divided to 4 phases to develop. Phase development will be divided in 2 stages. According to the plan, the first stage will construct the Central Road and Myo Patt Road, which will only encompass Sector 1 as shown in Figure 3-60. When Phase 2 is complete, Central Road will be built along the project corridor that connects Sectors 1 and 5 to begin

the second stage as shown in Figure 3-61. Phases 3 and 4 of the development processes can then be carried out along Central Road, respectively.

The traffic flow of the project area is also pre-arranged according to the development of the transportation system as shown in Figure 3-62 to Figure 3-65. Traffic flow at sector 1A and 1B has the same layout. An example of traffic flow at sector 1A is shown in Figure 3-66. According to the traffic flow figure in sector 1A, local roads are connected to collector roads and some major arterial roads, preventing direct traffic interference on the Myo Patt Road.

The traffic flow at sector 2 to 7 has the same layout. An example of traffic flow at sector 1A is shown in Figure 3-67. Local roads are connected with collector road and some major arterial road where the traffic will not directly interfere on the Central Road and Myo Patt Road. Then, collector road and major arterial road are connected to Central Road and Myo Patt Road respectively.

Collecting traffic & transportation data in the design of the roads to be used in the Amarapura urban development project; Road widths and Design speed has been set by collecting traffic surveys and considering future traffic volumes and growth rates. Signalized analysis roundabouts will be installed depending on the traffic growth rate in order to avoid traffic congestion in connection with the city ring road. The infrastructure designers were planned motorcycle lane in the main road of within the project to use motorcycle as described in Figure 3-68.

Figure 3-60 Development of Transportation System in Stage 1

Figure 3-61 Development of Transportation System in Stage 2

Figure 3-62 Traffic Flow Phase 1

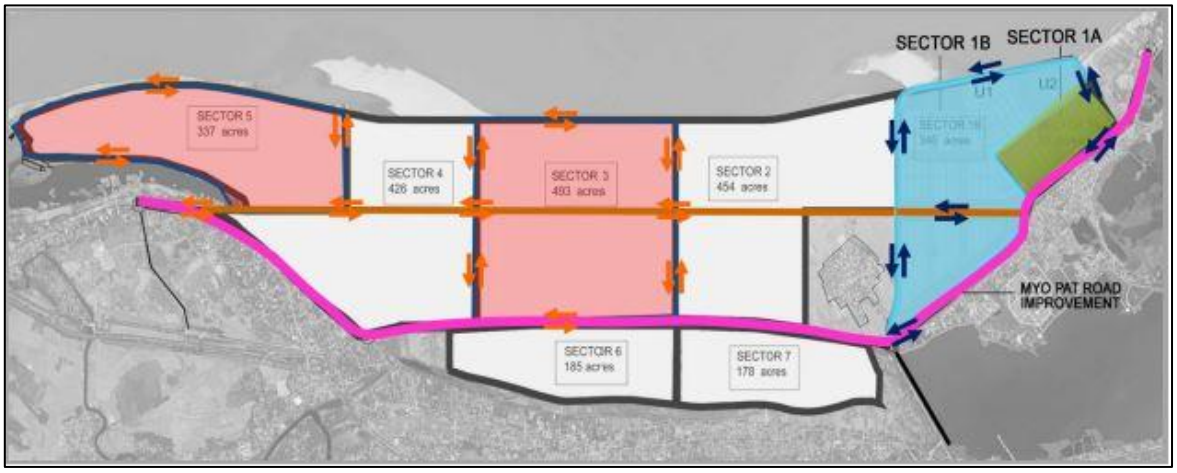


Figure 3-63 Traffic Flow Phase 1 & 2

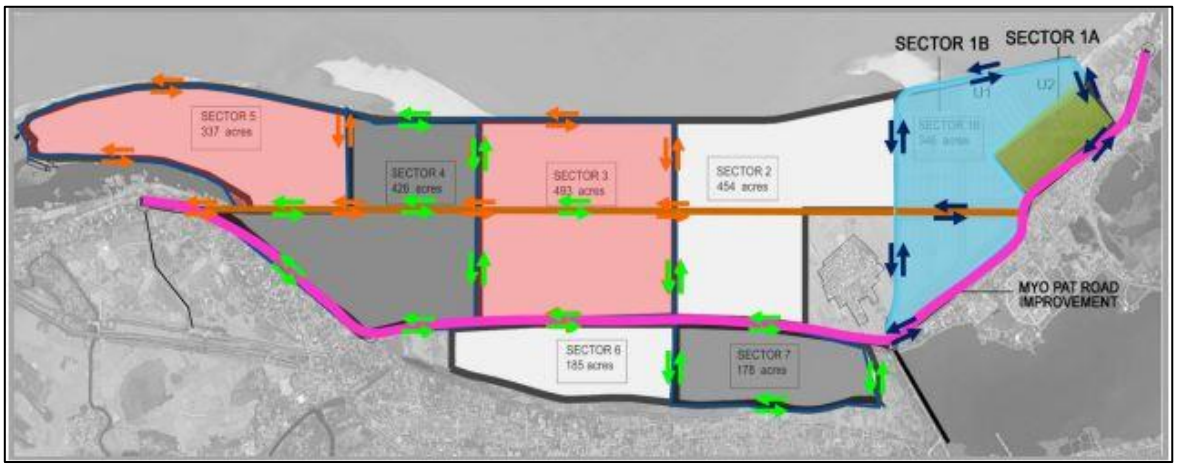


Figure 3-64 Traffic Flow Phase 1,2 & 3

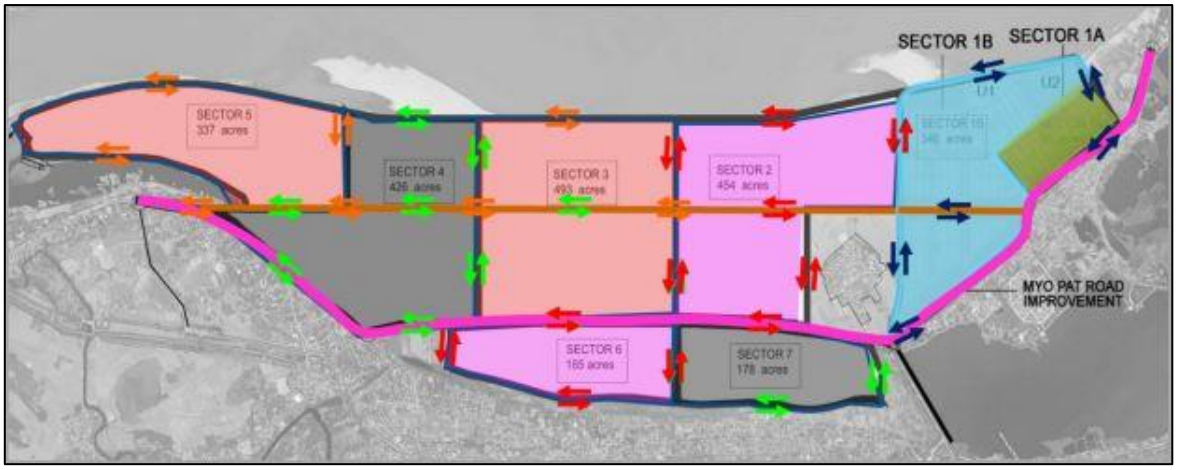


Figure 3-65 Traffic Flow All Phase

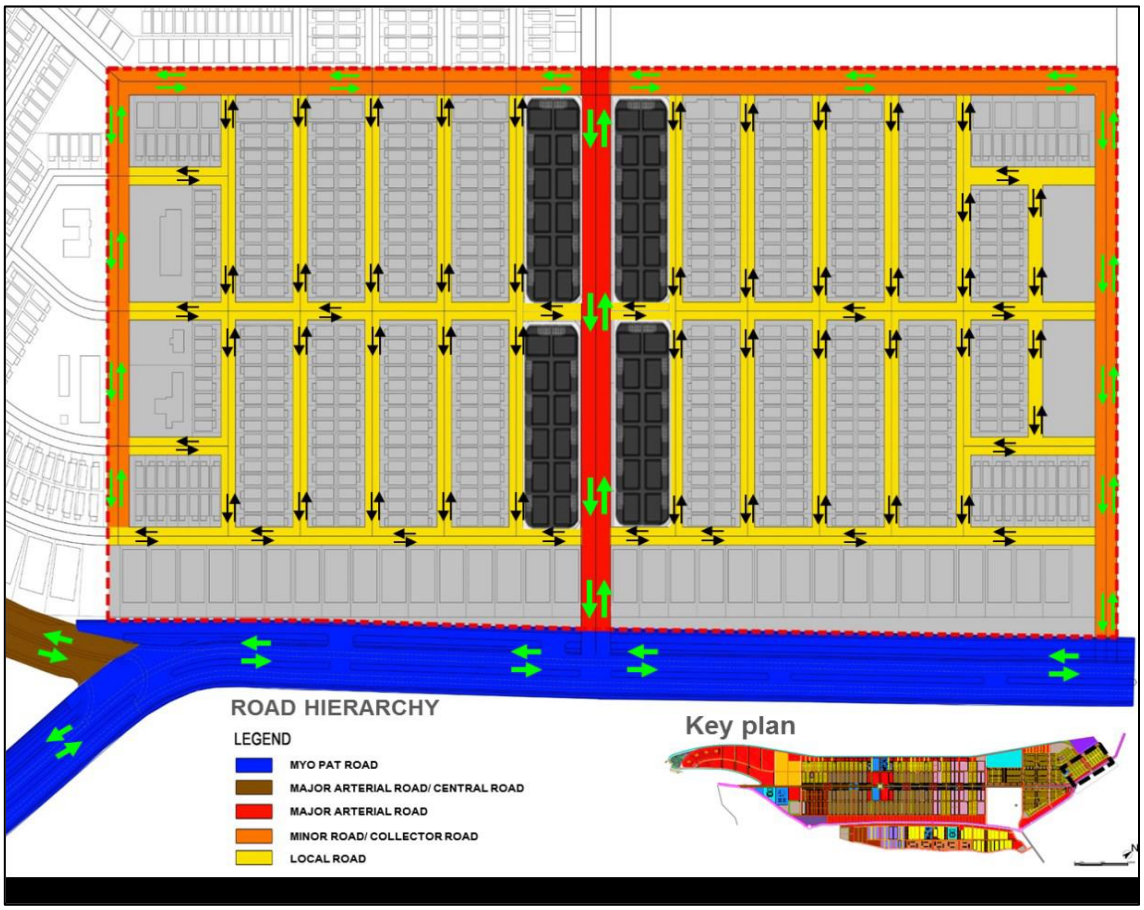


Figure 3-66 Example of Traffic Flow at Sector 1A

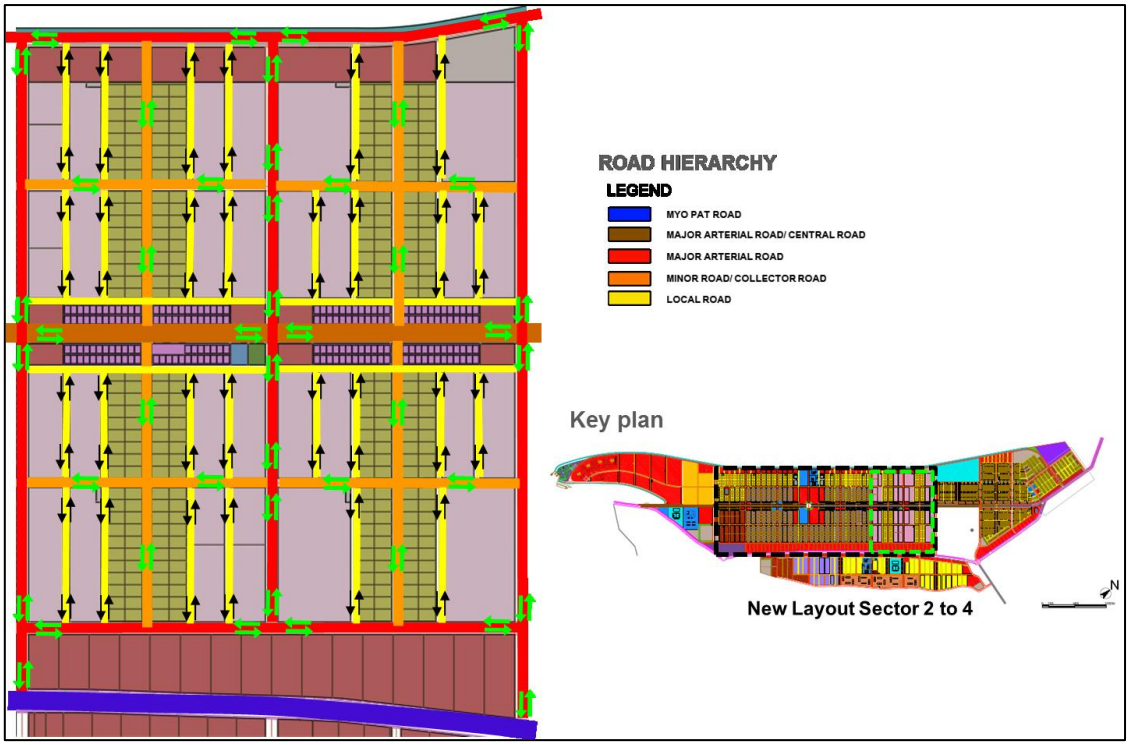


Figure 3-67 Example of Traffic Flow at Sector 2

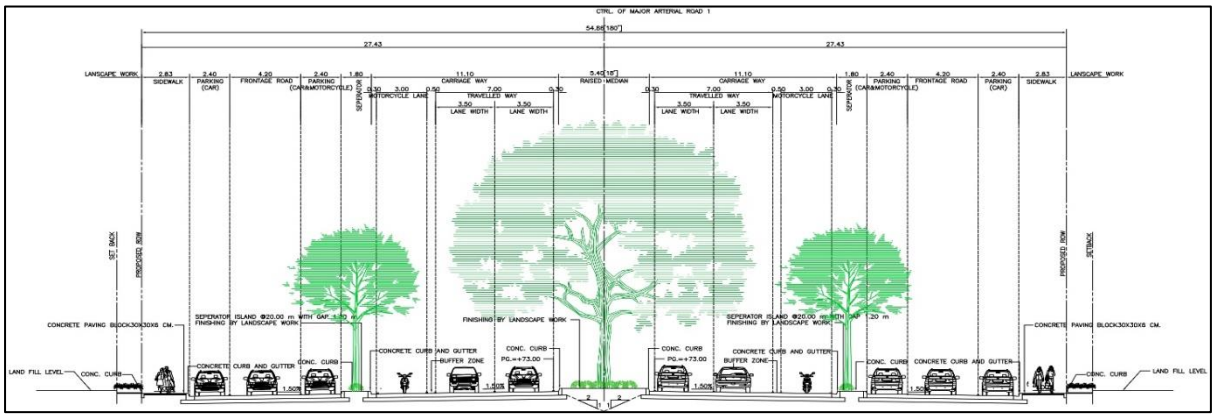


Figure 3-68 Motorcycle Lane

3.8. WASTE GENERATION

3.8.1. Solid Waste

In the construction phase, the solid waste generation was increased depend on the construction sector and it can be generated about 79,000 kg/day for the whole project. Currently, the solid waste is generating about 2,000 kg/day and it disposes to the regarded area of the project site. The solid waste generation system during project period will be implemented as per below section

3.8.1.1. Solid Waste Generation

According to World Bank (2012), it was estimated that the solid waste generation in Myanmar was 5,616 tonnes/ day with the per capita waste generation of 0.44 kg/capita/day. This figure was expected to reach about 21,012 tonnes/day with 0.85 kg/capita/day by 2025. As that figure was for the whole country, the generation rate was cross-checked with city income generation rate. As Mandalay is at lower middle-income level, solid waste generation rate for such level as per World Bank was 1.2 kg/ capita/ day in 2025. Thus, in this report, waste generation rate was taken the average of these two figures which was 1 kg/ capita/ day and generation volume for each sector as shown in Table 3-26.

Table 3-26 Waste Generation Rate per Sector

Phase	Population	Solid Waste (T/d)	Solid Waste Volume (m^3/d)
P1A	2,784	3	13
P1B	10,911	11	50
P1	13,694	14	63
P2 (Sec 3)	18,225	18	83
P2 (Sec 5)	23,273	23	106
P2	41,498	41	189
P3(Sec 4)	13,582	14	62
P3(Sec 7)	17,495	17	80
P3	31,077	31	142
P4(Sec 2)	17,261	17	79
P4(Sec 6)	6,727	7	31
P4	23,988	24	110
Full Phases	110,258	110	503

3.8.1.2. Solid Waste Collection

Domestic and non-hazardous waste will be collected by the internal sanitation team to the waste transfer station in site where such waste will be transported to land fill area. Collection trucks by internal sanitation team are classified into the following types:

- ✓ Compaction truck, capacity: 10-15 m^3
- ✓ Waste collection vehicles will be selected by taking into consideration the following factors:
- ✓ Waste amount and characteristics
- ✓ Collection method
- ✓ Solid waste collection cost

- ✓ Distance between service area and disposal site
- ✓ With those factors, it is estimated that at least 2 vehicles are required for sector 1 and 13 vehicles for overall project area, with 2-3 trips per day.

3.8.1.3. Waste Transfer Station

The collected waste from the sectors will be transferred to the waste transfer station. It is proposed that waste will be transferred to disposal site by the transfer truck capacity 30 ton. The frequency of transfer will be depending on the amount of waste generated. Number of trip and working day of transfer truck will be 1-2 trips per day and working day might be every day or every twice day.

Each site contains transfer station, administration office and parking lots. Site for sector 1 has an area of 0.33 ha and a design capacity of 15 tons per day. Site for the rest sectors area is 0.88 ha for design capacity of 96 tons per day. It serves both the general public and waste collection vehicles, but does not allow the resident drop-off for safety and security. Site plan for sector 1 and site plan of waste transfer station for the rest of the sectors are shown in Figure 3-69 and Figure 3-70.

Site design plan typically show the following features:

- ✓ Road entrance and exit: Since the transfer station for sector 1 is at small scale, the opening for entrance and exit is given the same to have better control. However, the station for the rest of the sectors has a separate access for entrance and exit for better traffic flow.
- ✓ Traffic flow routes on site: Sharp turns, intersection and steep ramps are eliminated as much as possible and turning radius is kept at 12 m radius for truck turning.
- ✓ Buildings: Include entrances and exits for vehicles and people
- ✓ Parking areas: for employees, visitors and transfer vehicles
- ✓ Buffer areas: Open space, landscaping, trees, and walls that reduce impacts on the community

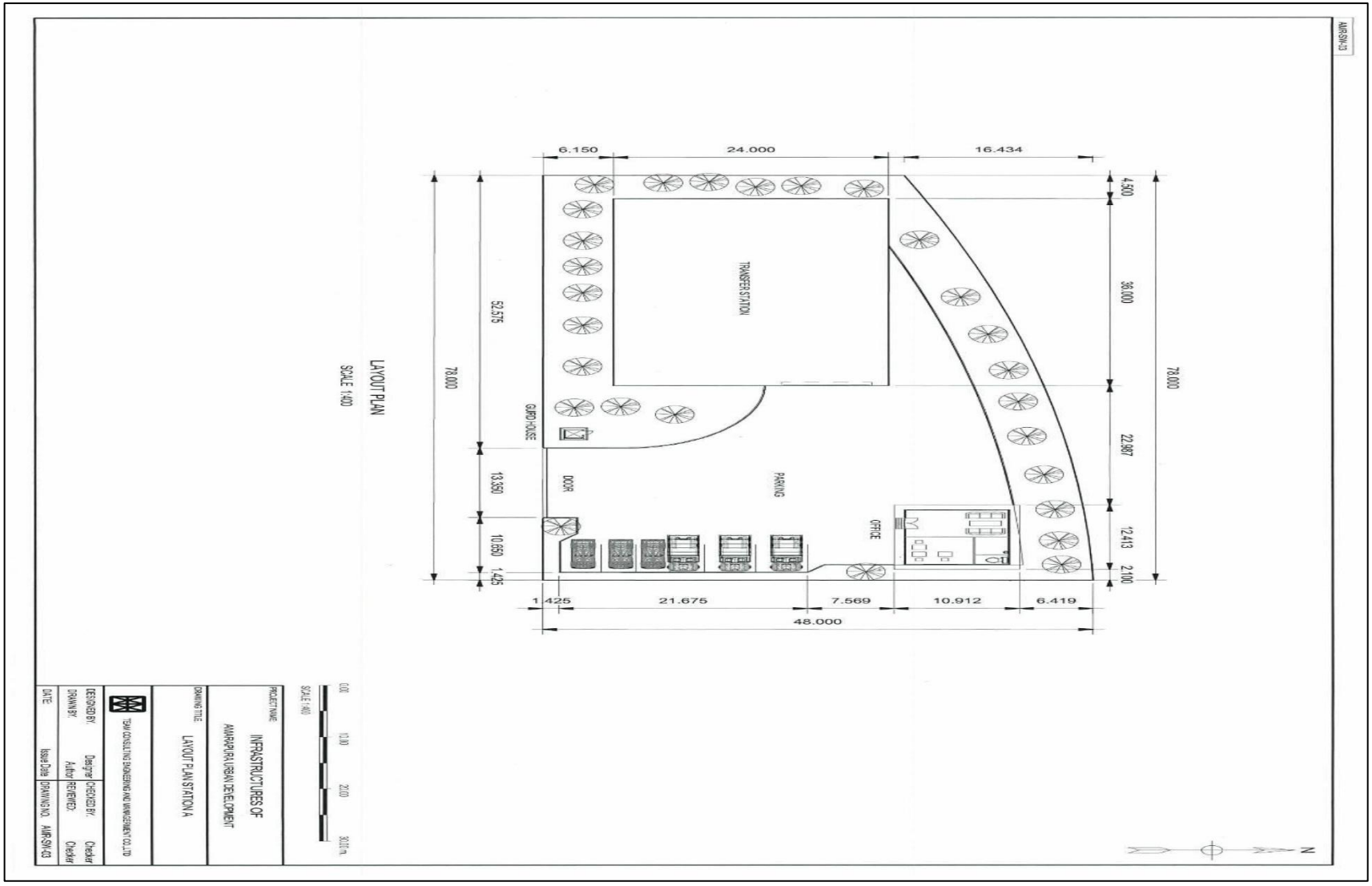


Figure 3-69 Site design plan for sector 1 (Station A)

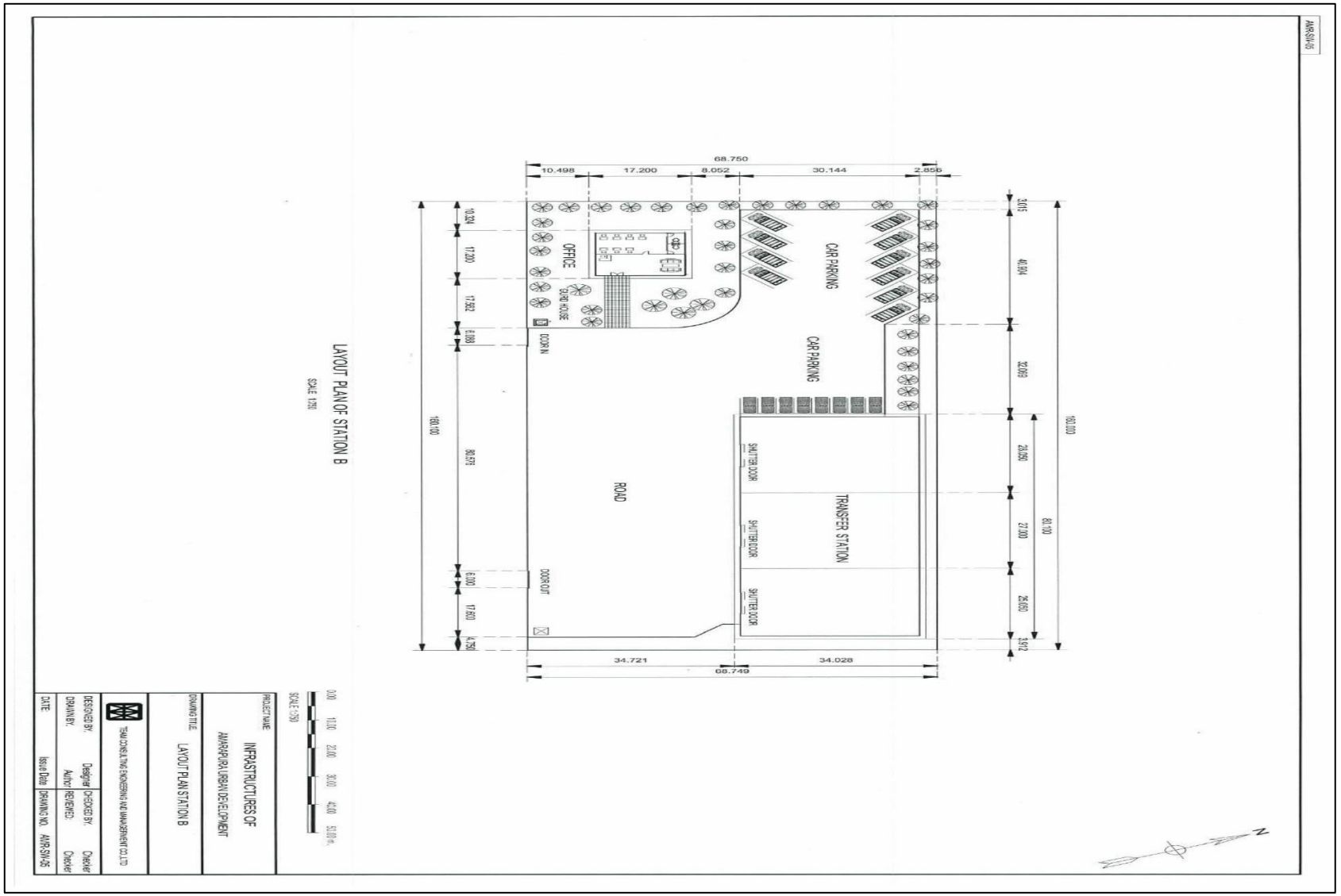


Figure 3-70 Site design plan for sector 2 (Section B)

3.8.1.4. Transfer Area Design

The operation system of both transfer station is direct dumping system where trucks unload their waste onto the floor directly as the stations aim only for temporary storage and this operation system can simplify operations. For reloading, the waste will directly reload from floor to transfer truck and loader truck will be used for compacting and picking up the waste from floor to truck. Both the stations will be enclosed building where walling will be built with pre-cast concrete panels and deep rib metal panels. Glass panels are installed at the top of walling for lightning and whirl louvers are used for better air flow inside the station. Whirlybirds louvers (14 in diameter) are used and the numbers of ventilation louvers are determined based on standards.

The estimated area for transfer station storage area for each sector based on generated waste per population as shown in Table 3-27. Station for sector 1 has a total area, including both storage and circulation areas, of 864 m2 and has only one entrance for vehicle and one for people (Figure 3-69). It can accommodate one loader truck and one compaction truck or waste loading truck at maximum. Another station, as shown in Figure 3-70, has a total area of 2,340 m2 and has only three entrances for vehicle and one for people. For that station, at least 2 loader trucks and 3 waste trucks can be operated at the same time.

Table 3-27 Estimated Transfer Station Design Area

P1A	2,784	3	13	1	1	38	51	
P1B	10,911	11	50	2	1	149	199	
P1	13,694	14	63	3	2	188	250	300
P2 (Sec 3)	18,225	18	83	3	2	250	333	
P2 (Sec 5)	23,273	23	106	4	2	319	425	
P2	41,498	41	189	8	4	568	758	800
P3 (Sec 4)	13,582	14	62	3	2	186	248	
P3 (Sec 7)	17,495	17	80	3	2	240	320	
P3	31,077	31	142	6	4	426	568	600
P4 (Sec 2)	17,261	17	79	3	2	236	315	
P4 (Sec 6)	6,727	7	31	1	1	92	123	
P4	23,988	24	110	5	3	329	438	600
Full Phases	**110,258**	**110**	**503**	**21**	**13**	**1,510**	**2,014**	**2,300**

3.8.1.5. Waste Separation

Separating the different elements found in waste streams is essential for enabling the recovery of useful materials, minimizing the amount of material sent to landfill and allowing recyclable materials to find a new incarnation. Waste sorting can occur manually at the household and collected through curbside collection schemes, or automatically separated in materials recovery facilities.

3.8.1.6. Recycling

Waste for recycling will be separated before waste disposition. Recyclable materials include plastic, PVC plastic pipe, cardboard, paper, iron, steel, tins, aluminum sheet, bottle glass, copper, lead, rubber, etc.

Refer to ADB report, Integrated Solid Waste Management Plan in Mandalay in 2016, the waste samples were collected and classify the components shown in Table 3-28.

Table 3-28 Waste Components of Mandalay

Waste Type	% by Weight
Organic Waste	55
Paper and Cardboard	5
Plastic	14
Textiles	3.6
Glass	5.7
Metal	5
Wood	3
Soil & Dirt	8.3
Miscellaneous	0.4
Total	**100**

According to waste generation which presented in the above section, the estimated of recycling waste is shown in Table 3-29. The total recycling waste is 30% of total waste which is 32.75 ton/day. This amount includes paper 5.51 ton/day, plastic 15.44 ton/day, glass 6.28 ton/day and metal 5.51 ton/day.

Table 3-29 Estimated Recyclable Waste

Phase	Population	Solid Waste (T/d)	Paper (T/d)	Plastic (T/d)	Glass (T/d)	Metal (T/d)	Total Recycling Waste (T/d)
P1A	2,784	3	0.14	0.39	0.16	0.14	0.83
P1B	10,911	11	0.55	1.53	0.62	0.55	3.24

Phase	Population	Solid Waste (T/d)	Paper (T/d)	Plastic (T/d)	Glass (T/d)	Metal (T/d)	Total Recycling Waste (T/d)
P1	13,694	14	0.68	1.92	0.78	0.68	4.07
P2 (Sec 3)	18,225	18	0.91	2.55	1.04	0.91	5.41
P2 (Sec 5)	23,273	23	1.16	3.26	1.33	1.16	6.91
P2	41,498	41	2.07	5.81	2.37	2.07	12.33
P3(Sec 4)	13,582	14	0.68	1.90	0.77	0.68	4.03
P3(Sec 7)	17,495	17	0.87	2.45	1.00	0.87	5.20
P3	31,077	31	1.55	4.35	1.77	1.55	9.23
P4(Sec 2)	17,261	17	0.86	2.42	0.98	0.86	5.13
P4(Sec 6)	6,727	7	0.34	0.94	0.38	0.34	2.00
P4	23,988	24	1.20	3.36	1.37	1.20	7.12
Full Phases	110,258	110	5.51	15.44	6.28	5.51	32.75

3.8.1.7. Waste Disposal

The waste generated from the site will be transferred and disposed at sanitary landfill sites designated by Mandalay City Development Committee. Waste is also taken to one of two dumping sites located to the north and the south of the city respectively. Both dump sites are operated essentially as uncontrolled open dumps but with some attempts to provide limited compaction and cover. The dumping site at the south is nearest which far from the project site around 15 kilometers as shown in Figure 3-71.

Source: Conceptual Design Report of Amarapura Urban Development Project

Figure 3-71 Existing Solid Waste Disposal Site

3.8.2. Waste Water System

Wastewater treatment system is the process of removing contaminants from wastewater, primarily from household sewage. It includes physical, chemical, and biological processes to remove these contaminants and produce environmentally safer treated wastewater. A by-product of sewage treatment is usually a semi-solid waste or slurry, called sewage sludge that has to undergo further treatment before being suitable for disposal or land application.

3.8.2.1. Design Concept

The project area is located in the earth quake sensitive zone, the civil/structure design of wastewater systems will be taken into account the Myanmar earth quake code. In addition, part of project area contains loose sand in the subsoil layer and subject to quicksand conditions with earth quake thus civil/structure design of wastewater systems will be considered of this condition.

Onsite wastewater treatment system (OSWT) is recommended for this project, as the OSWT is one of the most technical, economic and environmental feasible treatment systems.

Packaged wastewater treatment plants are suitable for onsite applications, especially for wastewater disposal at outlying areas and places where no central municipal sewer or sewage collection and treatment system is available. The advantages include: easy installation, less mechanical and moving parts. This OSWT will consist of septic, anaerobic, aerobic and sediment chamber. The small individual package OSWT for household and some small shop house shall be consist of septic and anaerobic chamber while the medium and big package OSWT for commercial and public buildings shall consist of septic, aerobic and sediment chamber.

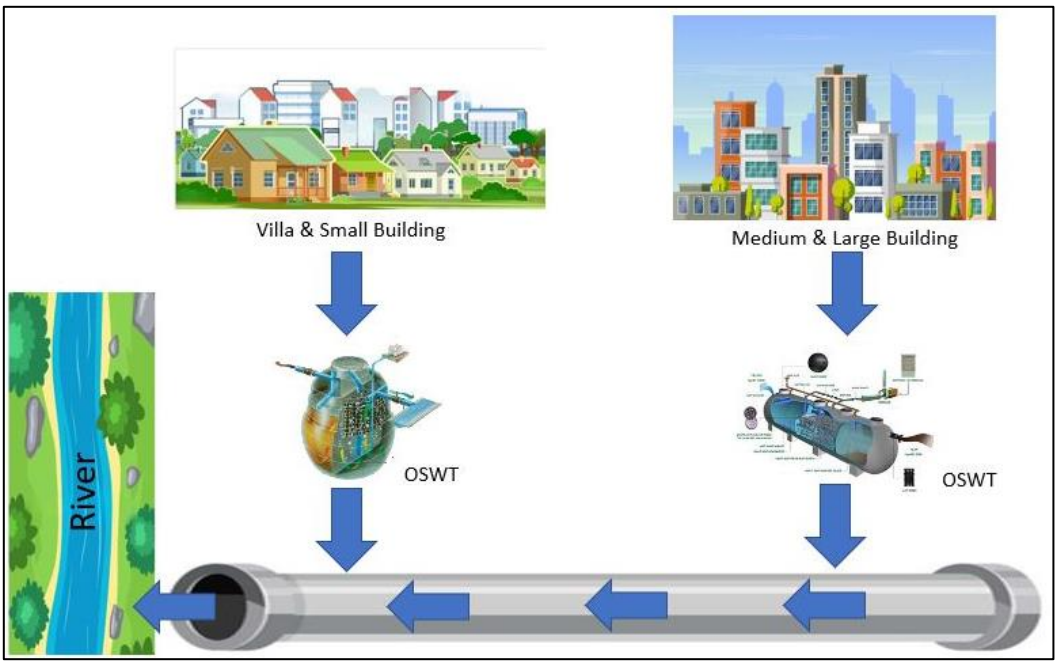


Figure 3-72 Wastewater treatment system and flow diagram

3.8.2.2. Technical Standards Applied

For conceptual design of wastewater collection systems will be referred in accordance with these following technical regulations and standards. The following is a list of acceptable Myanmar and International standards and abbreviations are given for each of the standards used to achieve the following standard:

ANSI	American National Standard Institute
ASTM	American Society for Testing and Materials Standard
BS	British Standard
DIN	Deutsch Industrial Norm, German
IS	Indian Standard
ISO	International Organization for Standardization
JIS	Japanese Industrial Standards
MNBC	Myanmar National Building Code (2016)
MCDC	Mandalay City Development Committee Regulations
TIS	Thai Industrial Standard
YCDC	Yangon City Development Committee Regulations
NEQG	National Environmental Quality (Emission) Guidelines

3.8.2.3. Wastewater Flow Rate

Wastewater generation will be estimated to be 80% of the water requirement, which will vary depending on the various land use categories, since the project development area is separated into seven (7) sectors. Total wastewater generation for sector 1 to sector 7 is 222,228 gallon/day. Wastewater generation of each sector is presented in Table 3-30.

Table 3-30 Wastewater Generation

Item	Land use categories	Wastewater Generated (gal/day)							
		Phase 1		Phase 2		Phase 3		Phase 4	
		Sector 1A	Sector 1B	Sector 3	Sector 5	Sector 4	Sector 6	Sector 2	Sector 7
1	Residence	57,356	191,416	73,411	17,963	110,230	45,026	167,403	157,676
2	Commercial	21,942	85,958	145,741	369,761	74,993	21,707	71,691	35,796
3	Shophouse	2,598	25,424	53,864	-	33,749	12,293	38,443	28,329
4	Business	-	-	80,819	-	33,968	25,079	-	-
5	Public	324	590	133,641	9,548	286	4,190	5,383	134
6	Utility	70	598	70	70	282	141	70	141
7	Sport	-	-	-	-	181	-	-	152
8	Education	-	4,035	-	-	85,565	-	90,934	-
9	Transport	-	1,906	-	1,916	2,852	-	-	-
10	Warehouse	-	-	-	-	1,723	1,040	-	-
11	Hospital	-	-	56,763	-	-	-	-	-
Total		**82,291**	**309,927**	**544,310**	**399,258**	**343,828**	**109,475**	**373,925**	**222,228**

Source: Conceptual Design Report of Amarapura Urban Development Project

3.8.2.4. Wastewater Characteristic

As almost of project areas are residential and commercial which is domestic wastewater, therefore the inlet wastewater characteristics will be assumed as shown in the following Table 3-31. However, the wastewater characteristic of some land use category shall be verified during land use development state such as hotel, hospital, market, restaurant and department store.

Table 3-31 General Inlet Wastewater Characteristics

Design Parameters	Unit	Volume
1. pH		6 -8
2. TSS	mg/l	300
3. BOD_5	mg/l	250
4. Total N	mg/l	35
5. Total P	mg/l	4
6. Max Temperature	C^o	30

Effluent must be released to the storm drainage system after treatment. The quality of the treated effluent must meet with the Effluent Standard as allowable limits for pollutant substance discharging to prevent negative environmental effects. The Effluent Standard is indicated in Myanmar Environmental Quality (Emission) Guidelines which presented in the following Table 3-32.

Table 3-32 Discharge Standard of Wastewater, Stormwater Runoff, Effluent and Sanitary Discharges

Parameter	Limit rate	Unit
BOD_5	50	mg/l
COD	250	mg/l
Oil & grease	10	mg/l
TSS	50	mg/l
pH	5.5–9.0	
Metals		
Heavy Metals, Total	10	mg/l
Iron(Fe)	3.5	mg/l
Cadmium (Cd)	0.1	mg/l
Arsenic (As)	0.1	mg/l
Chromium		
Hexavalent	0.1	mg/l
Total	0.5	mg/l
Copper (Cu)	0.5	mg/l
Mercury	0.01	mg/l
Lead (Pb)	0.1	mg/l
Zinc (Zn)	2	mg/l
Selenium	0.1	mg/l
Nickel	0.5	mg/l
Selenium	0.1	mg/l
Silver	0.5	mg/l
Cyanide		
Free	0.1	mg/l
Total	1	mg/l
Ammonia	10	mg/l

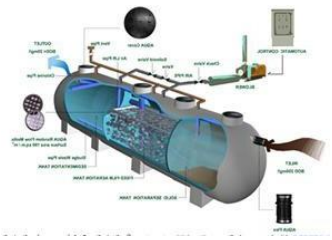
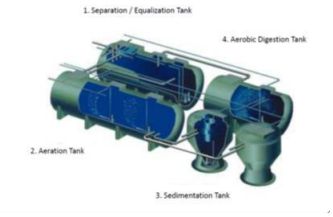
Parameter	Limit rate	Unit
Fluoride	20	mg/l
Chloride, Total residual	0.2	mg/l
Phenols Compound	0.5	mg/l
Phosphous	2	mg/l
Sulfide	1	mg/l
Coliform Bacteria	<400	MPN/ 100 ml
Temperature increase	<3	C

3.8.2.5. Onsite Wastewater Treatment System (OSWT)

OSWT is available in different sizes (for treating different volume of wastewater) and treatment processes. Examples of OSWT models are shown in the following Table 3-33. Treated wastewater from onsite wastewater treatment system is drained into storm drainage system before it is discharged to the river.

Table 3-33 Examples of OSWT Models

Type of Building	Model	Effluent (mg/l)	
		BOD*	ss**
Residential Villa/Household Some small shop house	Anaerobic treatment process 	50	30
Small sized building Office Shop house	Aerobic treatment process 	20	30

Type of Building	Model	Effluent (mg/l)	
		BOD*	ss**
Medium sized building -Condominium -School -Market	Aerobic treatment process 	20	30
Large sized building -Hotel -Department Store -Hospital	Aerobic treatment process 	20	30

3.8.2.6. Sludge Disposal

All onsite wastewater treatment tanks require to collect the sludge every 6-12 months. The vacuum truck is required to collect these sludges to the disposal site. The amount of sludge for overall project area is around 30 m3/d. The vacuum truck capacity generally is 5 to 15 m3. The vacuum truck capacity 15 m3 is required for 2 trucks. The trucks will collect sludge from each household and building to disposal site outside the project by the Authority (MCDC).

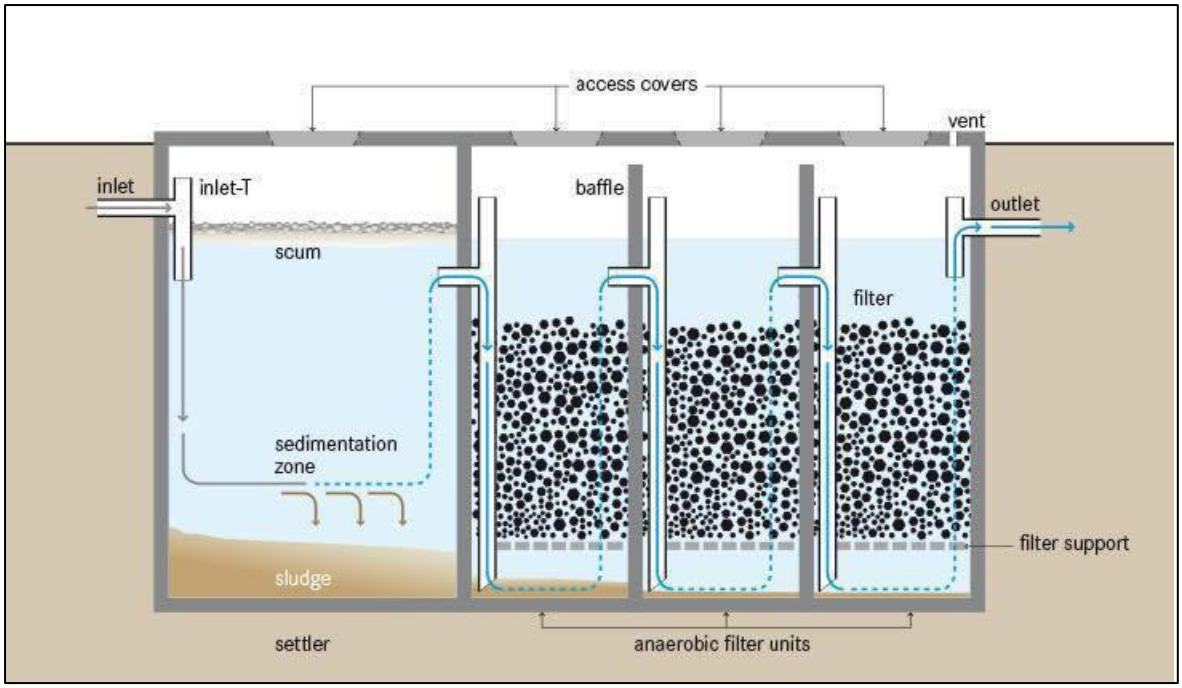


Figure 3-73 Wastewater Treatment System

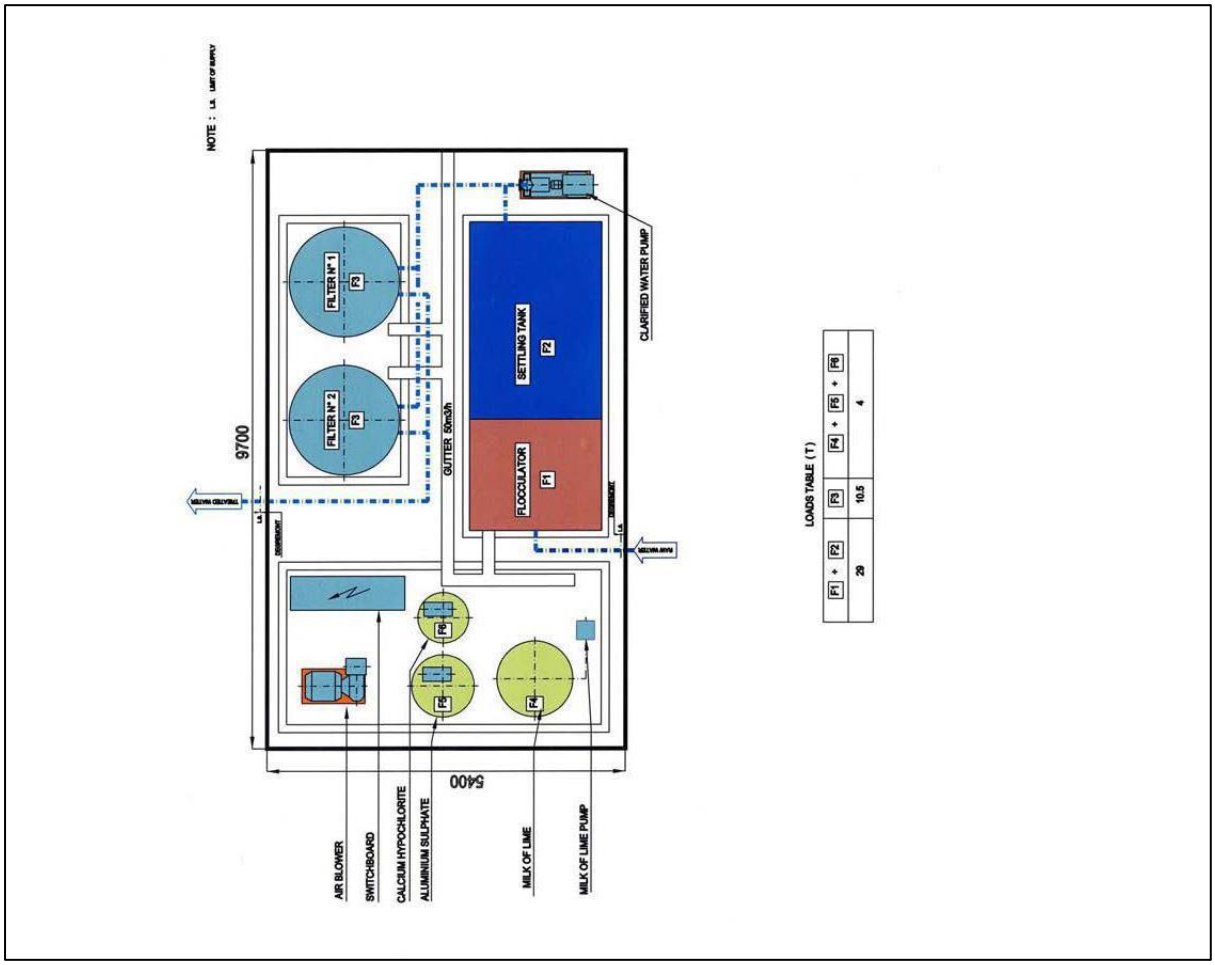


Figure 3-74 Layout plan of bio-filter septic tank

3.9. ANALYSIS OF ALTERNATIVE

3.9.1. General

During the preparation of the strategic development plan for the Amarapura Urban Development Project, various possibilities were specifically investigated, and this chapter provides an analytical summary of these alternatives.

3.9.2. Project Development

This option would result in the construction of the development project recommended by the developers. Employment opportunities throughout construction and operation would be positive consequences. According to its multiplier effect, this form of development would also have a positive significant economic impact on the area. By preserving the environment in the greatest number of areas, the proposed project would also improve social infrastructure, general residential development, maintenance, and renovation of the residential area.

3.9.3. Location Alternatives

Since the current property has many benefits over any other potential locations to be considered, including land size, view, geographic position, infrastructure, and permits, no other locations could be considered in conjunction with the proposed location for the implementation of this project.

3.9.4. Technology

The Sewage Treatment Plant (STP) feasibility study was conducted by Mandalay Business Capital City Development Ltd. (MBCCD), which also studied at alternative locations for the STP site and different technologies.

3.9.5. Power Supply

The power supply will get from the Ministry of Electricity and Energy Standard (MOEP) to the project area. There is no other method to use energy, and it is sufficient.

3.9.6. Water Supply

Pumping water from the Ayeyarwady River will be used to set up a water supply infrastructure for the entire Amarapura Urban Development project. When the Ayeyarwaddy river's water quality drops below of acceptable levels, groundwater should be considered as an alternative source of water.

3.9.7. Project Design Plan

The project proponent has two alternative plans for project design to implement the urban project in proposed area. There are design A and B which will be more benefit to the community. The main difference between alternative design A and alternative design B is that a small land area will be created at the sand bar that is located at the river's edge in the

eastern part of the planned project area. The river will be able to run more freely as a result, making it more navigable and protecting the village of Shan-Ga-Lay Kyun from seasonal erosion and flood hazards. In order to increase the project's positive effect on the community, it was finally decided to choose design A.

Figure 3-75 Design A

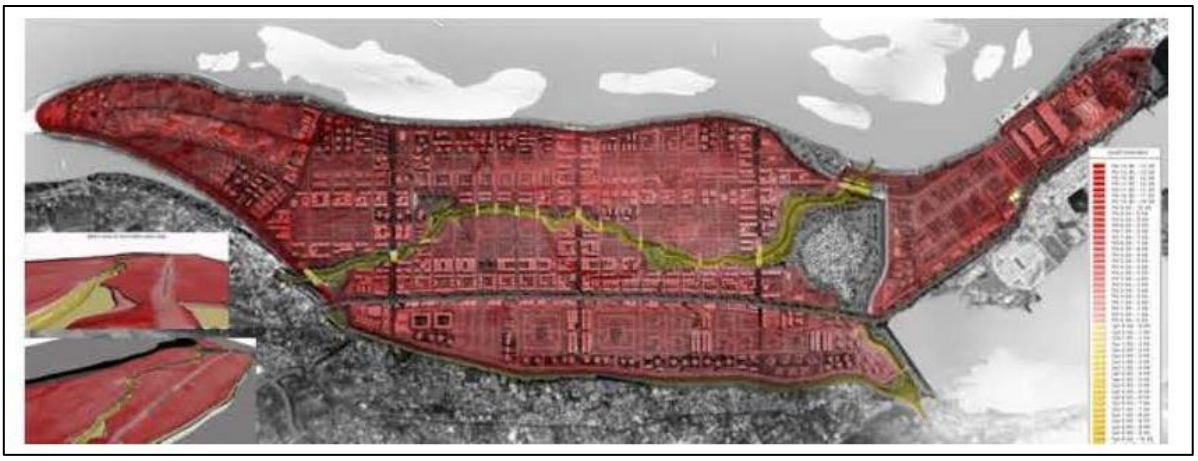


Figure 3-76 Design B

3.9.8. Flood Protection Alternative

Flooding in Ayeyarwady River is caused by intense rainfall during the period of monsoon season, some of the water is retained in ponds or soil, others are absorbed by grass and vegetation, some evaporate and the rest travels over the land as surface runoff. There are three alternative option to prevent flooding in the project area. These are polder construction, landfill and partly filled polder.

Dikes must be built at the waterfront in accordance with the polder idea. The project area is connected to portions of Mandalay city that are already protected by dikes. Regarding the polder construction, it should be mentioned that at the Mandalay site of the project area, breaching of the dikes next to the project area could lead in flooding of the project area. For

polder construction and partly filled polder, design conditions should be related to the possibility of a dike breach with rapid inundation of the polder as a consequence. The ground level of the complete project is raised to the design level by a landfill. In the event of river water levels exceeding the future project ground level, the project area will be flooded gradually. The landfill is chosen as the project's flood protection alternative for the reasons stated above.

In this urban development project, flood prevention dyke will be built along river banks so that if the river floods, the water will not be able to cause damage. The dyke will be built without disturbing the river beauty and scenic view. The dyke construction is most proper flood prevention technique in the project area. It is cheaper than flood walls, dam and reservoir construction. A river water flow model will be made with the support of TUDelft from Netherlands, and based on this model the dyke construction will be conducted so that the speed of the water in the river will not cause any potential erosion and flooding further downstream.

As alternatives, some methods of flood control other than dyke construction include planting vegetation to retain excess water, terrace slopes to reduce slope flow, and building *alluviums* (man-made channels to divert water from flooding), construction of dams, reservoirs or holding tanks to store extra water during flood periods and straightening and deepening the river channel. The planting vegetation, terrace slope construction and building alluviums will not be effective in preventing the Ayeyarwady River flood. In the straightening and deepening the river channel, the altering the river channel may lead to a greater risk of flooding downstream, as the water is carried there faster.

3.9.9. Alternative of Revetment Waterfront

Compared to other forms of flood walls, the waterfront riverbank with an appropriate side slope is typically the least expensive. While pumping river sand for land filling is inexpensive for this project, Type Alt.1 - Alt.8 are acceptable options. It's also a simple procedure to construct. There is no special equipment or construction technique needed. However, the backfilling of the side slope will need to go into the river in order to maintain the land boundary. It is crucial to verify with the relevant government departments whether an activity is legal.

Preliminary slope stability analyses were conducted to establish the most appropriate side slope based on the typical riverbank cross section and soil conditions at the project site. The analyses' findings indicate that the riverbank's side slope shouldn't be greater than 1(V):4 (H).

As was previously mentioned, in order to maintain the stability of the riverbank over the long term, erosion protection along the side slope is essential. For slope protection, it is advised to use either Rock Riprap with a Thickness of 0.50-1.20 m (Type Alt.1,3,5), 30 cm Thick Concrete Block Mattress (Type Alt.2,4,7), or 30 cm Thick Rock Mattress (Type Alt.8). This is because water velocity is estimated to be less than 2.5-3.5 m/s. Use size for the

Geotube Slope System is 50.50 x 4.50 x 1.80 meters (Type Alt.6). The alternative for waterfront of river type is described in Figure 3-77 and Figure 3-84.

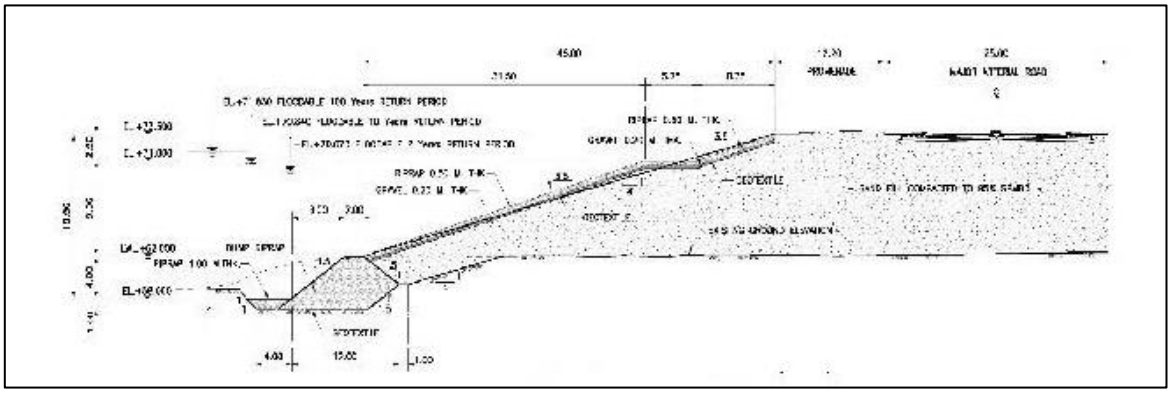


Figure 3-77 Section of Waterfront (dump rip ap + rip ap) Alternative 1

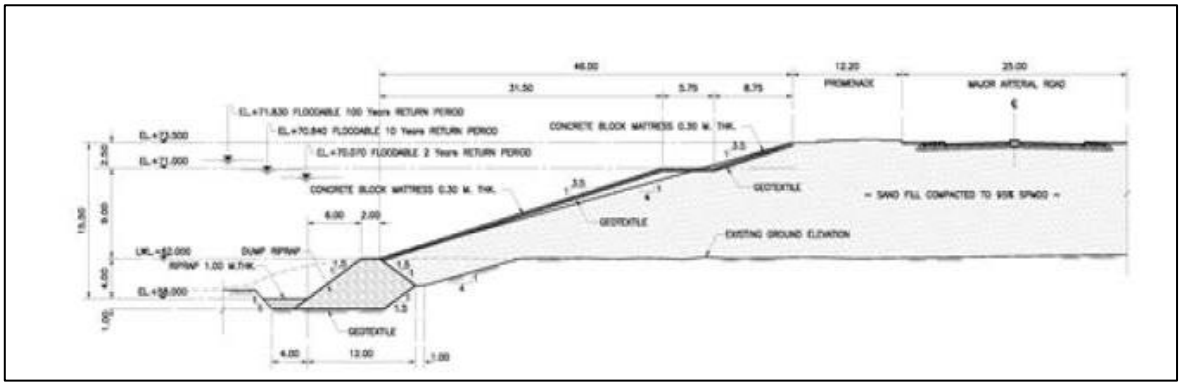


Figure 3-78 section of Waterfront (dump rip ap + concrete block matterss) Alternative 2

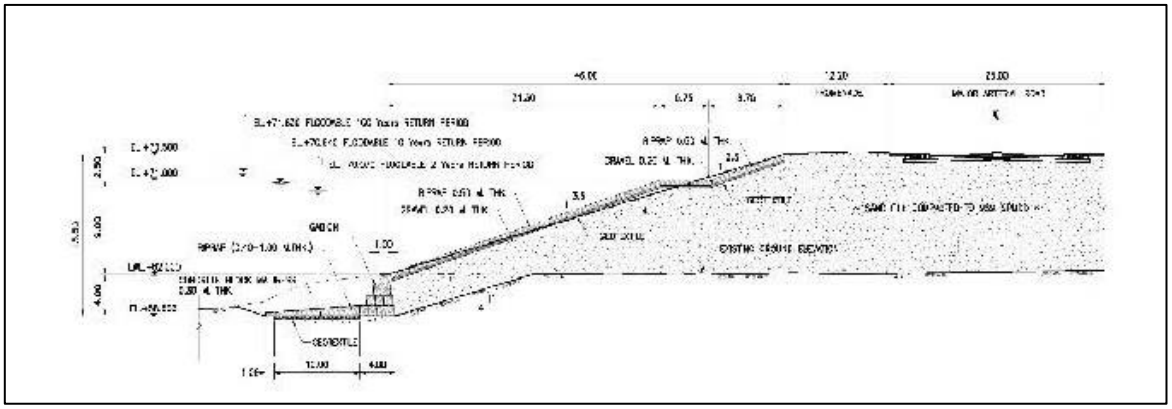


Figure 3-79 Section of Waterfront (gabion + rip ap) Alternative 3

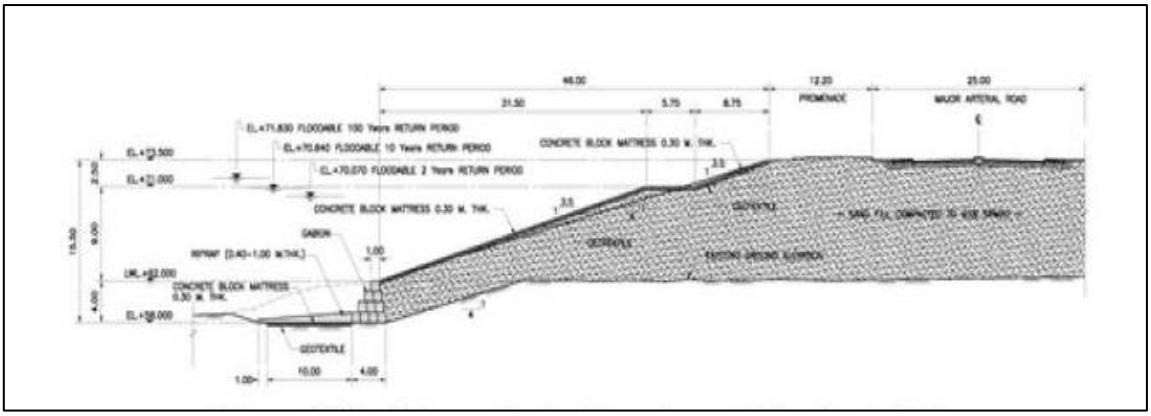


Figure 3-80 Section of Waterfront (gabion + concrete block matterss) Alternative 4

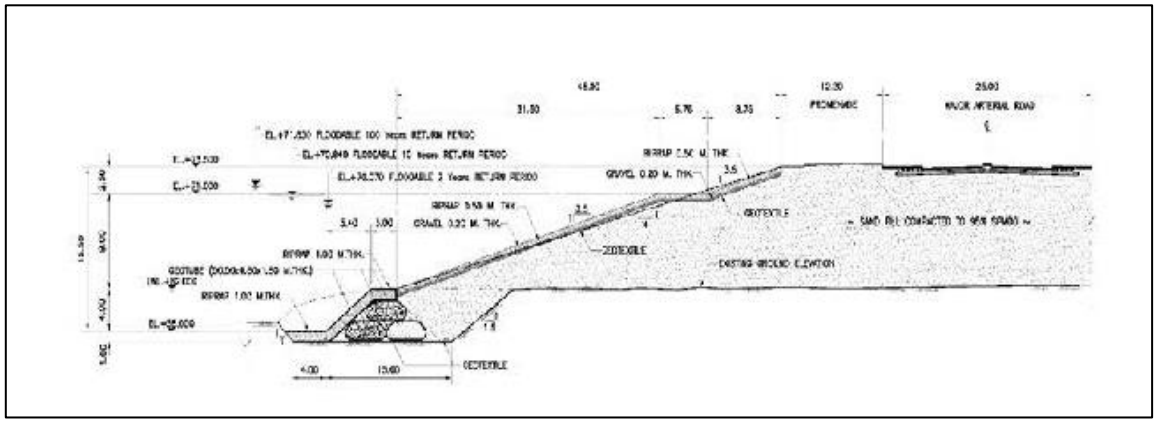


Figure 3-81 Section of Waterfront (riprap geotube + riprap) Alternative 5

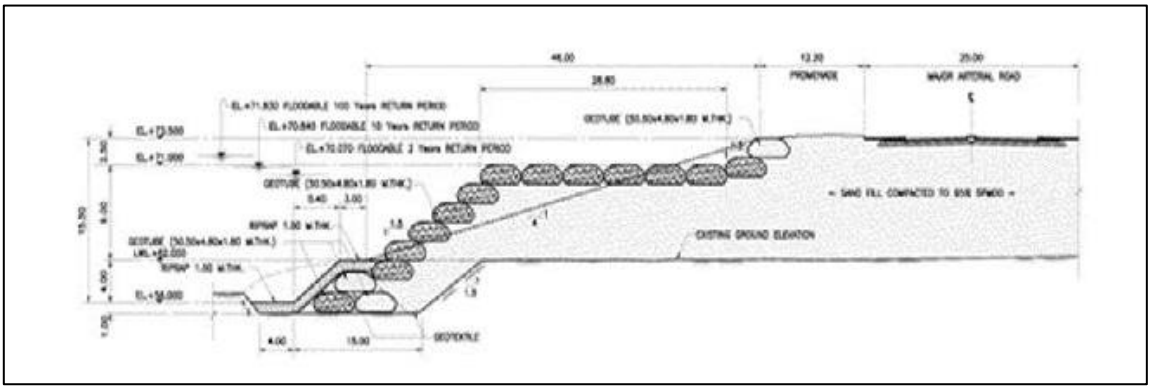


Figure 3-82 Section of Waterfront (riprap geotube + geotube) Alternative 6

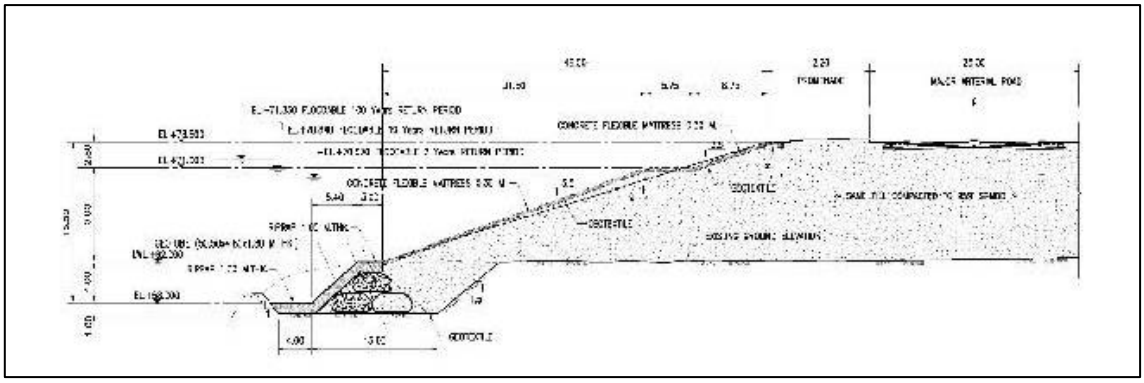


Figure 3-83 Section of Waterfront (riprap geotube + concrete flexible mattress) Alternative 7

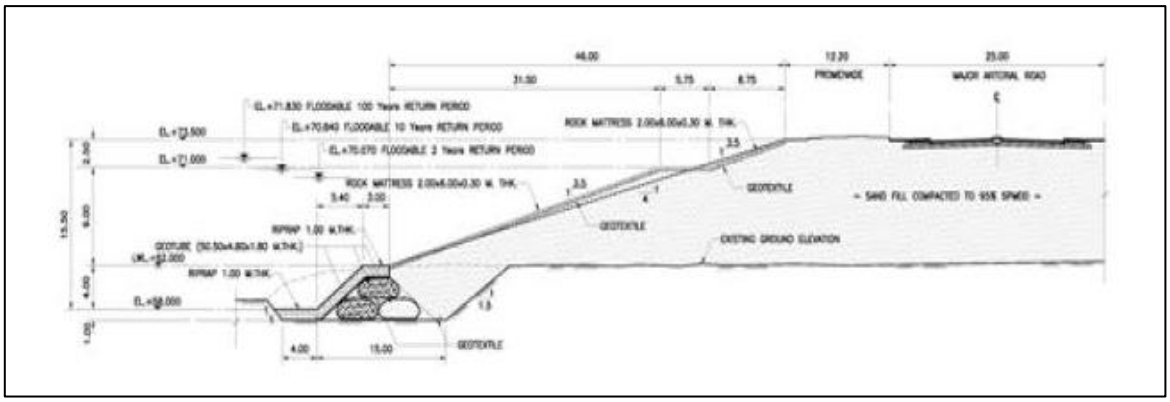


Figure 3-84 Section of Waterfront (rip rap geotube + rock mattress) Alternative 8

3.9.9.1. Comparison Revetment of Waterfront

Based on the comparison, it is advised that flood wall Type Alt.5 (Geotube with riprap slope protection) is clearly more suitable for the project due to easy construction and fast construction, easy material source, and easy quality control. If backfilling of the side slope of the river bank can be extended into the river. The comparison of revetment of waterfront system in terms of constructability is shown in Table 3-34.

Table 3-34 Comparison of Slope Protection System

Name	Type Alt.1	Type Alt.2	Type Alt.3	Type Alt.4	Type Alt.5	Type Alt.6	Type Alt.7	Type Alt.8
Example Toe + Slope	Dumpriprap + Riprap	Dumpriprap + Concrete block Mattress	Gabion + Riprap	Gabion + Concrete block Mattress	Geotube + Riprap	Geotube+Geotube	Geotube+Concrete Flexible Mattress	Geotube+Rock Mattress
Rapidity of construction	Moderate	Moderate	Slow	Fast	Fast	Fast	Fast	Slow
Material source	Easy	Difficult	Difficult	Difficult	Moderate	Moderate	Difficult	Difficult
Water velocity	Resist Moderate	Resist High	Resist Moderate	Resist High	Resist Moderate	Resist Low	Resist High	Resist Moderate
Construction Method	Moderate	Easy	Moderate	Moderate	Easy	Easy	Difficult	Moderate
Maintenance	Easy	Easy	Difficult	Difficult	Easy	Easy	Difficult	Moderate
Construction Period	Only in dry season	All season	Only in dry season	All season	All season	All season	All season	All season
Quality control	Easy	Difficult	Moderate	Difficult	Easy	Easy	Difficult	Moderate
Cost waterfront	**3,550 USD/m**	**6,250 USD/m**	**4,050 USD/m**	**6,750 USD/m**	**3,750 USD/m**	**5,350 USD/m**	**4,400 USD/m**	**3,750 USD/m**

3.9.9.2. Alternative Structural Revetment of waterfront

There are five types of alternative structural revetment for waterfront which are Armour layer, Pre-cast Concrete Block Revetments, Concrete Flexible Mattress Systems, Gabion rock mattress and Geotube Systems as accordingly conceptual design report.

3.9.9.2.1 Armour layer

Overhead protection against erosion due to wave and water erosion. In general, the surface structure consists of two parts, first The Armor layer. Second, the Filter layer, as shown in Figure 3-85.

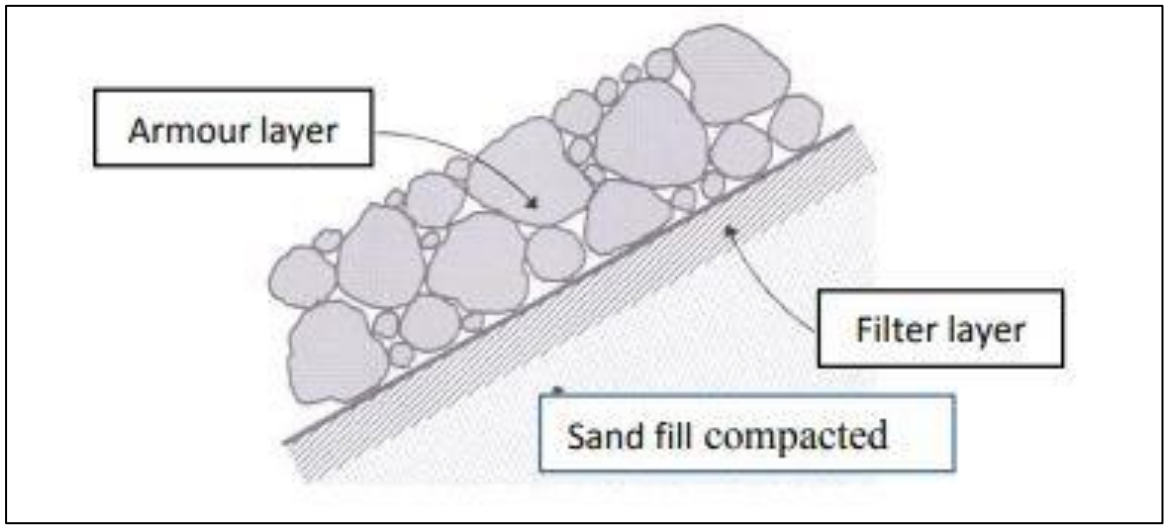


Figure 3-85 Surface Structure of Revetment

1. Armor layer is a structure that protects the bank from erosion by waves and direct tides. The designer must be designing a protective layer against erosion, absorb the waves and tides from the waves, and be strong enough to withstand erosion. They must have enough weight to not be torn down. The main material made from rock that it out to be cheap and convenient to build. Riprap is widely graded rock, (D85/D15~ 2 –2.5) which is placed in bulk to give an armor layer about 2 to 3 layers thick.

1. Construction is simple and uses standard plant and a small work force
2. Can be costly when haulage distance is large
3. Rock may not be available in some locations

2. Filter layer the material in Armor layer is much larger than filled soil. Therefore, the filled soil can be removed by the gap of the Armor layer. It is necessary to have a layer of filter material, which is between the Armor layer and the sand fill compacted. In part design of the filter material layer consideration the size of the original soil and the size of Armor layer. Consider the ability to provide water through to reduce the pressure of water. Materials used for filtering materials include Stone or gravel, and synthetic fiber (Geotextile).

3.9.9.2.2 Pre-cast Concrete Block Revetments

Components of a pre-cast concrete block revetment design include layout of a general scheme or concept, bank preparation, mattress and block size, slope, edge treatment, filter design, and surface treatment. Design information is provided below in each of these areas. As illustrated as shown in Figure 3-86 and example Pre-cast Concrete Block Mattress with Geotextile as shown in Figure 3-87.

1. The pre-cast block revetments are placed on the channel bank as continuous mattresses. The vertical and longitudinal extent of the mattress should be set based on information provided. Emphasis in design should be placed on toe design, edge treatment, and filter design.
2. Channel banks should be graded to a uniform slope. Any large boulders, roots, and debris should be removed from the bank prior to final grading. Also, holes, soft areas, and large cavities should be filled.
3. The graded surface, either on the slope or on the stream bed at the toe of the slope on which the revetment is to be constructed, should be true to line and grade.
4. Light compaction of the bank surface is recommended to provide a solid foundation for the mattress.
5. The overall mattress size is dictated by the longitudinal and vertical extent required of the revetment system. Articulated block mattresses are assembled in sections prior to placement on the bank; individual mattress sections should be constructed to a size that is easily handled on site by available construction equipment.
6. The size of individual blocks is quite variable from manufacturer to manufacturer. In addition, individual manufacturers usually have several standard sizes of a particular block available. Manufacturer's literature should be consulted when selecting an appropriate block size for a given hydraulic condition.

This work consists of furnishing materials and performing all work necessary to place pre-cast concrete block revetment on bottoms and side slopes of channels or as directed by the engineer. The types of pre-cast concrete blocks included in this specification are:

1. Cellular pre-cast concrete blocks: Cellular blocks which interlock with each other in some manner when placed on the embankment slope, and allow vegetation to grow through the blocks.
2. Articulated concrete blocks: Concrete blocks held together by steel rods or cables and placed on the embankment slope.

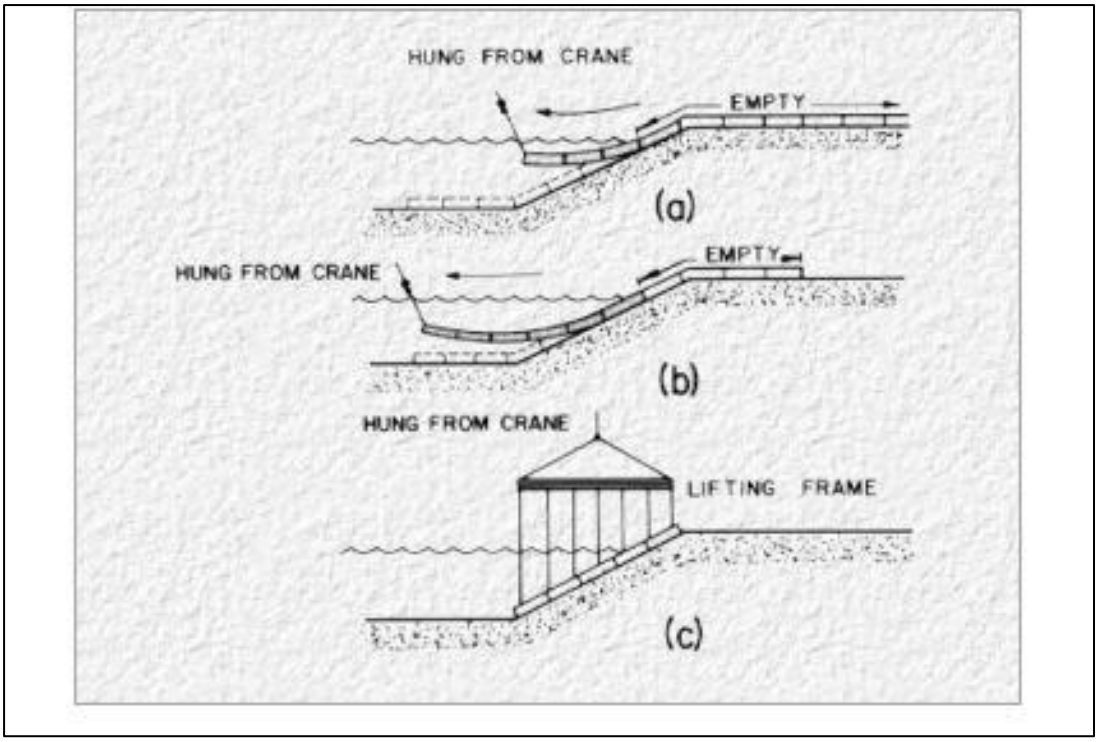


Figure 3-86 Mattress Placement Underwater by Crane

Figure 3-87 Example Pre-Cast Concrete Block Mattress with Geotextile

3.9.9.2.3 Concrete Flexible Mattress Systems

Concrete mattress can be used:

1. Erosion control/stabilization of embankments and steep slopes

2. Erosion protection in tidal zone area

3. Protection of slopes and beds of canals, rivers and other flowing bodies of water, jetties, inshore and offshore structures.

Concrete mattress can be installed onto the existing soil profile and thereby provides specific erosion protection for the unprofiled natural beds and slopes, even in

areas below water where access is difficult. A highly fluid sand/cement mortar is pumped into this fabric envelope after it has been placed on the areas to be protected.

Range of concrete mattress is a geotextile concrete shuttering forming a cellular mattress suitable for soil erosion protection of slopes, canals, riverbanks and coastal shorelines. The versatile mattress offers cost advantage and ease of installation.

1. Flexi Type: This flexible block mattress is designed to accommodate movement in the underlying ground and is recommended for high hydraulic loads. The two-layered geo-fabric is weaved together with a special designed hydrostatic filter which allows water behind the installed structure to pass through thus eliminating the build-up of hydrostatic pressure behind the structure. The mattress is available in thicknesses of 120mm and 180mm.
2. Rigid Type: This is a rigid monolithic mattress recommended for medium hydraulic loads. The two-layered geo-fabric is weaved together with a special designed hydrostatic filter which allows the mattress to be permeable. The rigid mattress is available in thicknesses of 120mm and 180mm.
3. Standard Type: This mattress is impermeable and suitable for erosion protection of rigid-based subgrade. Made from a double-weave fabric with internal distance threads to stabilize the upper- and lower-layer fabrics, this ensures the concrete-filled mattress achieves a uniform thickness. This concrete mattress is available in thicknesses of 100mm, 200mm and 300mm.
4. Green Type: This mattress allows concrete injection into the specially designed two-layer weaved geo-fabric to form a rectangular tubular perimeter. Inside the tubular perimeter, openings can be made to allow filling of topsoil for vegetation growth for better integration to the environment. This mattress is suitable for low hydraulic loads. View of slope Concrete Flexible Mattress and Example Concrete Flexible Mattress Systems as shown in Figure 3-88 and Figure 3-89.

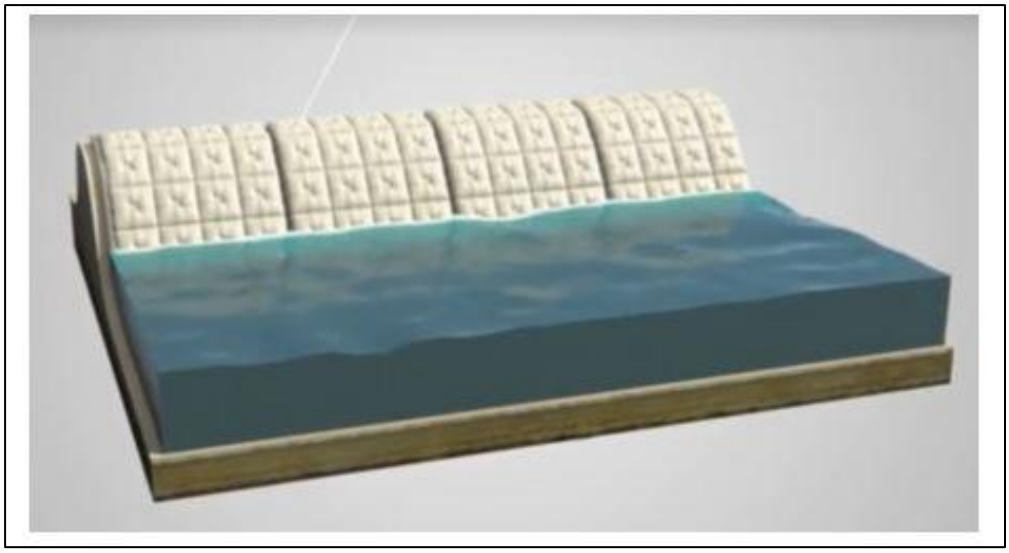


Figure 3-88 View of slope Concrete Flexible Mattress

Figure 3-89 Example Concrete Flexible Mattress System

3.9.9.2.4 Gabion rock mattress

Gabion rock mattress features: 1. Improve the stability of river bed slope 2. Protect the river from being prevented erosion. 3. Increase the roughness coefficient of river bank Structure of Gabion Rock Mattress and Example of Gabion Rock Mattress Figure as shown in Figure 3-90 and Figure 3-91.

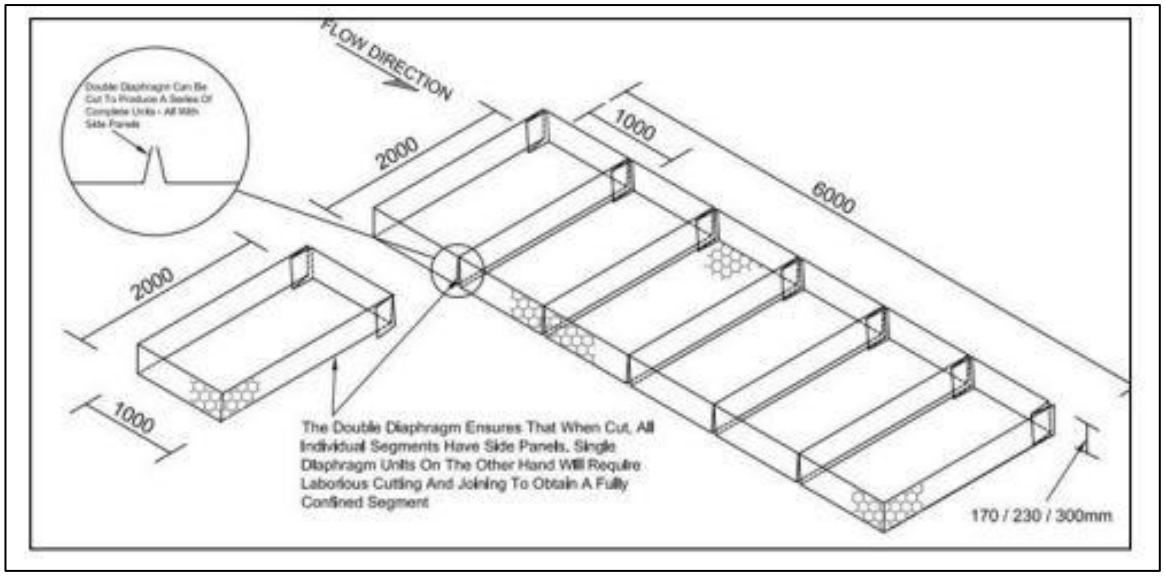


Figure 3-90 Structure of Gabion Rock Mattress

Figure 3-91 Example of Gabion Rock Mattress

Step of Installation Gabion Rock Mattress

For easy handling and shipping, Mattresses are supplied folded flat in bundles of 25. Lids are packaged in separate bundles or in rolls for larger units of Mattresses.

1. Individual Mattress is first unfolded on flat, hard ground and stamped to remove all kinks. The two long sides and both end panels are then lifted upright and secured in position by tying the selvedge wires together.
2. The vertical edges of all internal diaphragms are attached to the sides and laced with typing wire or approved interlocking wire fastener.
3. The assembled Mattress is then aligned in the required position and tied or fastened to adjacent mattress along the whole length of selvedge wire. Mattress units should be placed in proper position so that movement of rock fill inside the cage -- due to gravity or flowing current -- is minimal. Thus, on slopes, Mattresses should be placed with its internal diaphragms at right angles to the

direction of the slope. On river beds, position Mattress with the internal diaphragms at right angles to the direction flow.

4. The stone is placed into the compartments (cells). If it's a slope, start from the bottom. One or more Mattresses can be filled at the same time. 5. Sequence the installation by keeping the stone filling crew well ahead of the lid placement crew. Lids or top panels must be securely tied or fastened to side-tops and end panels and also to the top of the inner partitions. 6. The Mattresses may be either telescoped or cut to form and tied at required shape, when necessary, e.g. when Mattresses are laid on a radius. For a sharp curve, it may be necessary to cut the Mattress diagonally into triangular sections and tie the open side securely to an intact side panel.

3.9.9.2.5 Geotube Systems

Geotube systems are Geo-containment systems replace rock in erosion protection works for waterways and impoundments. It has the widest range of engineered fabrics and composites for the fabrication of Geotube Geo-containment systems. These engineered fabrics are designed for strength, robustness, abrasion resistance, UV resistance, etc. for the most demanding of site conditions.

For Geotube, high tenacity woven polypropylene is used. Special fibers and yarns may be incorporated to form engineered composites for additional engineering functions. Geotube Dyke Systems can also be manufactured with a coarse grain fiber substrate that enhances resistance to sand abrasion, debris impact resistance. Geotube dewatering technology has become the dewatering method of choice for organizations around the world and used for both large and small projects. They are simple and low cost. There is in no need of belts, gears, or complicated mechanics.

Geotube containers are constructed of high-strength, permeable, specially engineered textiles designed for containment and dewatering of high moisture content sludge and sediment. They are available in a variety of sizes, depending on volume and space requirements. Geotube Dewatering containers are effective drain technology fabricated from an engineered textile that provides confidence of fine solids inside the container, while allowing water to permeate through the engineered textile. As water drains, continue to densify and consolidate over time.

Once the solids are fully consolidated or have met minimum requirements for transport, several options are available for disposal of the drain material. In the construction process Geotube is used to block the water from the construction site and to use as a barrier to prevent soil damage. The examples of Geotube are as shown in Figure 3-92 and Figure 3-93.

Benefits of Geotube Structures

1. Costs.

Costs can be saved from the availability of local sand. This reduces the cost for filling materials and logistics from quarrying and transporting rocks to the site.

2. Environmentally friendly.

It has a smaller footprint than other traditional structures, resulting more environmentally friendly and reduces impacts on environment. Geotextiles have been proven to encourage greater marine growth and diversity than rock or concrete, creating a natural marine habitat. A smaller footprint has lesser impact on the sensitive coastal habitats.

3. Visual aesthetic.

Geo-containers allow for a more precise design than rock. The lower crest and reduced footprint is ideally suited to beach where an unrestricted view is required. A combination of sand-coloured geotextile and enhanced marine growth help the containers blend in with the environment.

4. Sand-filled geo-containers are proven to have the duration of over 30 years in all conditions.

5. Safety.

The use of sand-filled geo-containers' provide a sac structure that is safe.

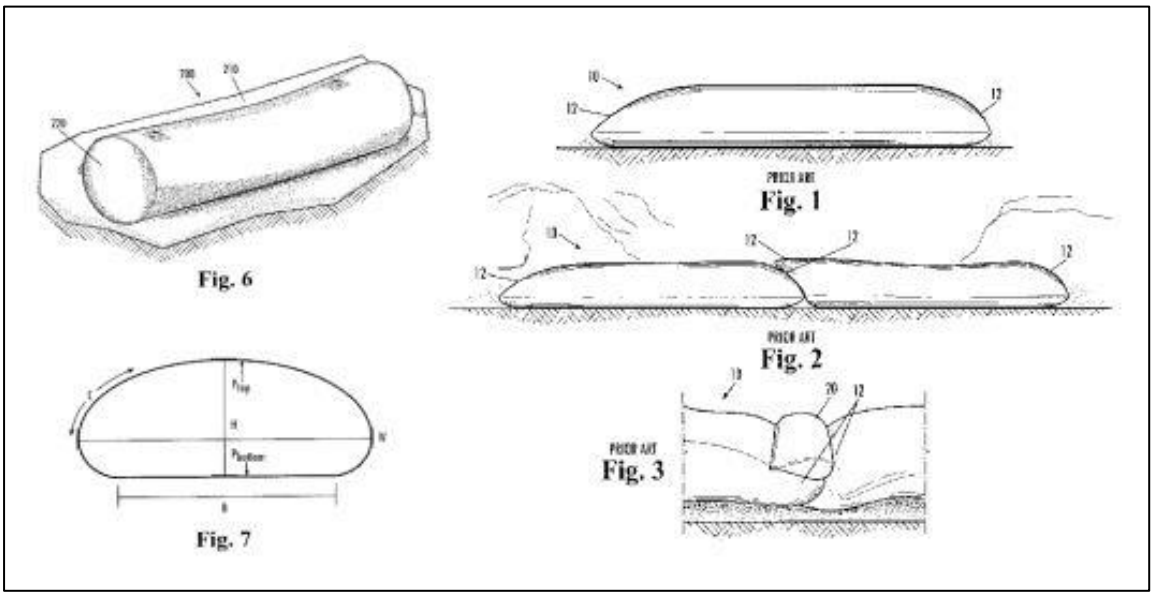


Figure 3-92 Continuous Lapping of Geotube

Figure 3-93 Examples of Geotube Systems

3.9.10. Typical Storm Drainage System

Circular, rectangular, and U-shaped pipes and U-ditsches were used in the drainage system's design to collect rainwater from smaller catchments on the project site before discharging flows into the Ayeyarwaddy River. There are two conceptual design alternatives for the proposed drainage system outside the project area.

Alternative 1: The drainage system similar to current conditions consist of the new improvements canal connected with the box culvert size 4-3.00x3.00-meter drain water through sector 4 and install the floodgate and 4 sets of pumping size 3.0 m3/s (12.0 m3/s) at the end of culvert to drain out water from the urban and nearby.

Alternative 2: To allow drainage water from the cities can flow by gravity, so there is new concept to design drainage canal elevation can flow when the water level in the Ayeyarwaddy River is lower than the highest average water level and the side drainage system can use the existing pumping stations.

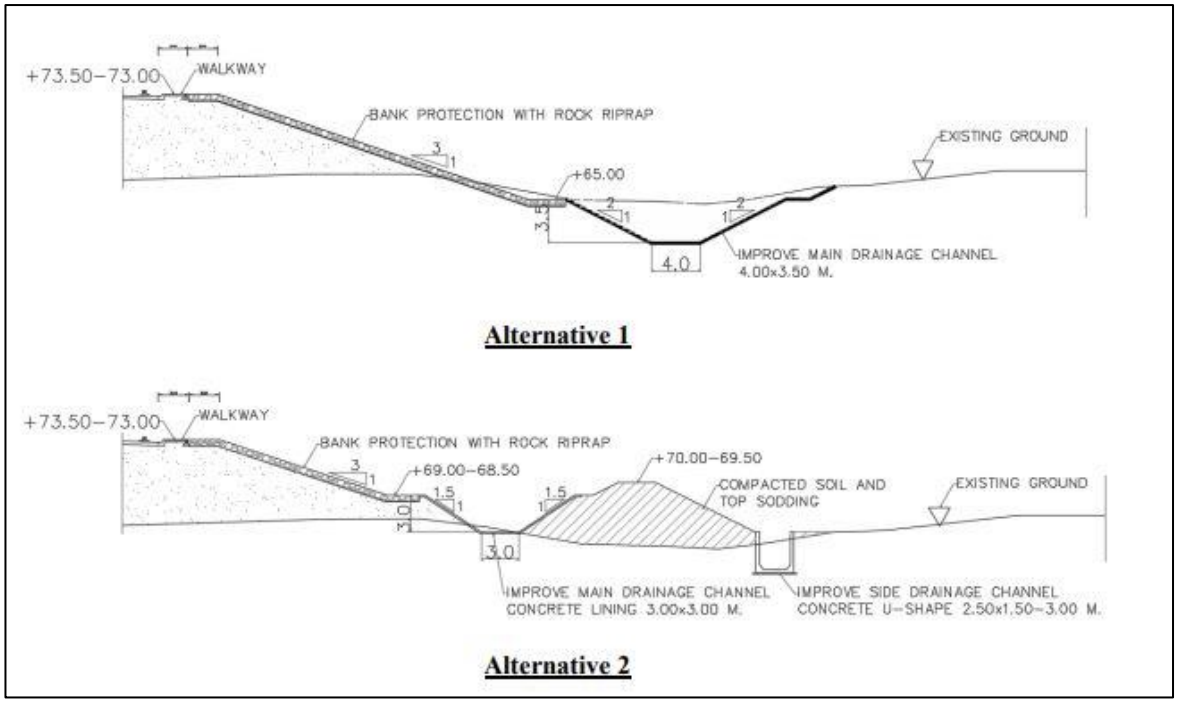


Figure 3-94 Typical Plan and Section of Main Drainage along Village

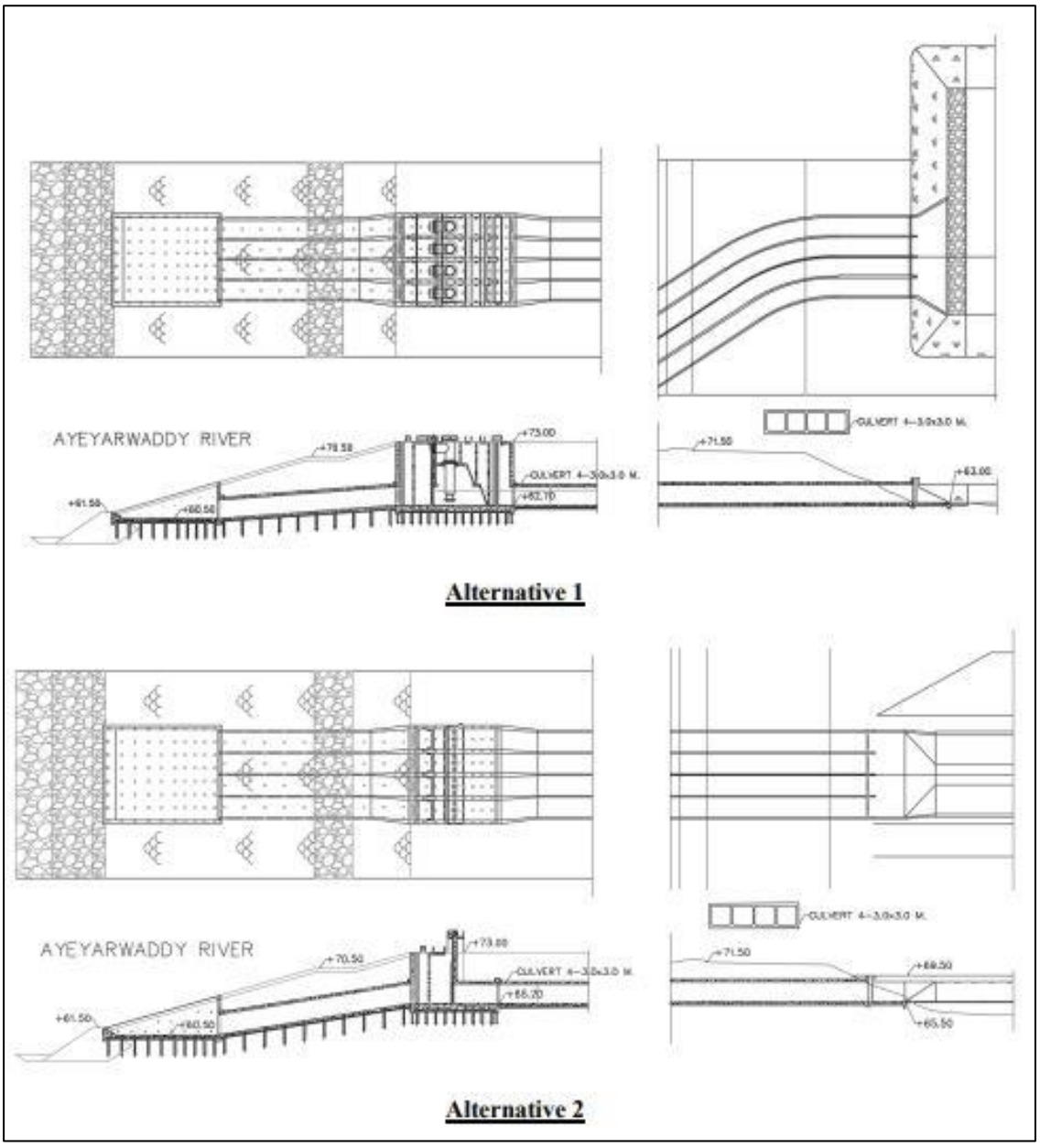


Figure 3-95 Typical Plan and Section of Main Drainage Connection

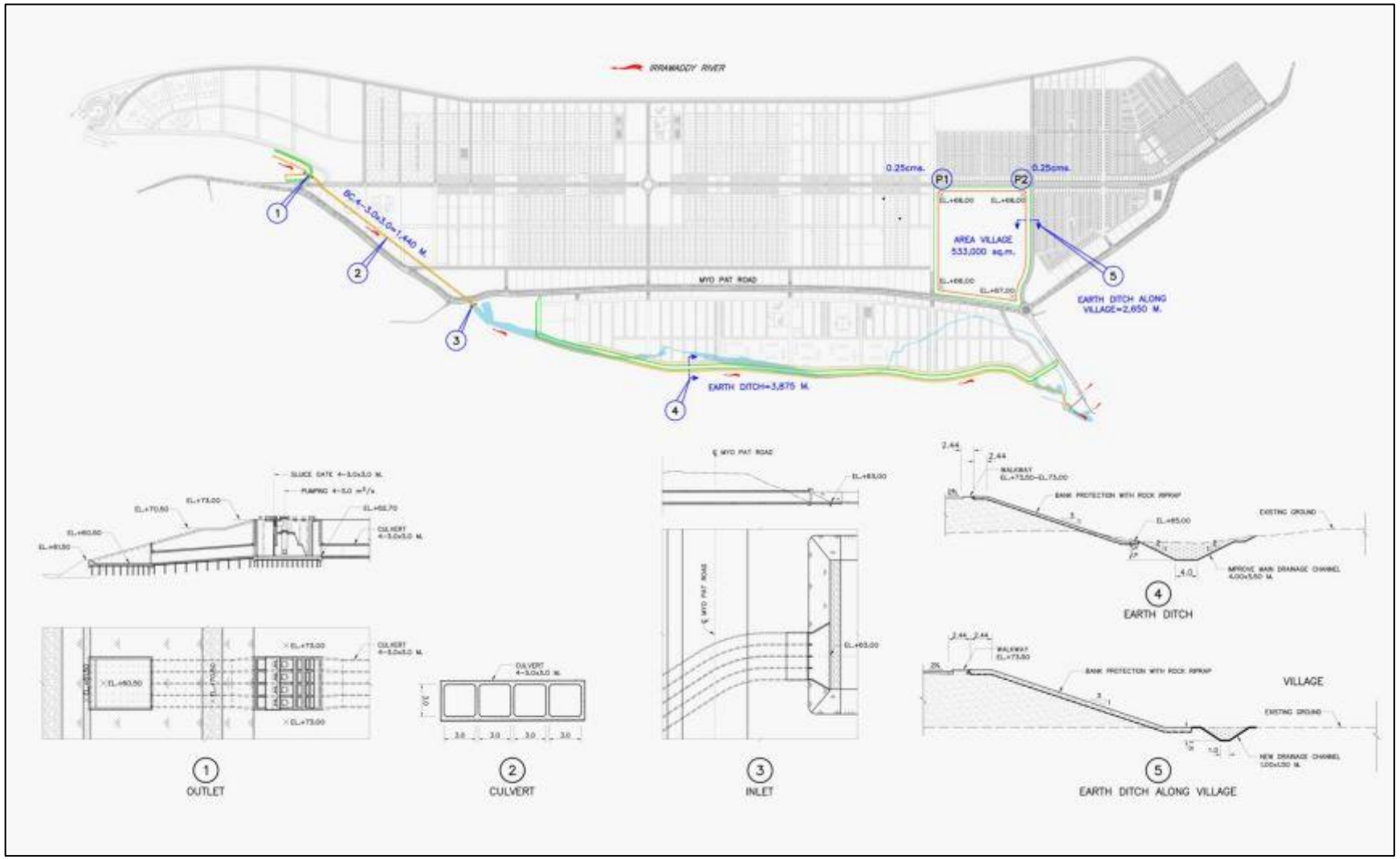


Figure 3-96 Design Drainage Systems for Outside after Project Development Alternative 1

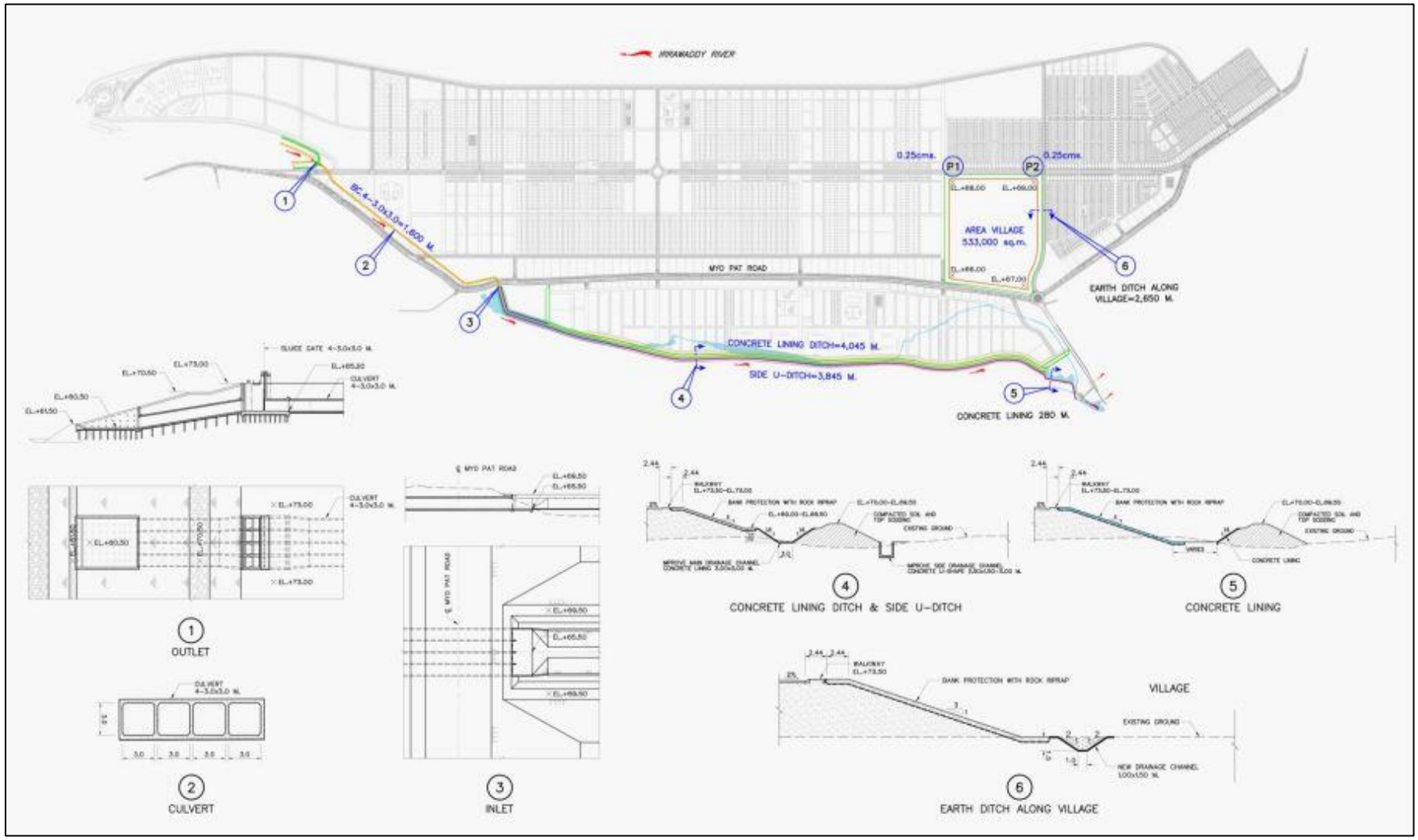


Figure 3-97 Design Drainage Systems for Outside after Project Development Alternative 2

3.10. ALTERNATIVE OF PROJECT

3.10.1. Description

The project is the urban development project which is located in Mandalay. Other places are considered before choosing the current project site but they are not chosen due to the difficulties in water requirement, land requirement and to reduce environmental impact from the project. The current site is chosen because it has more positive facts over other places.

3.10.2. Comparison

The comparison of the project is described about project location and other places as following table.

Table 3-35 Method of Comparison

Alternative	The current project area	Other places	Possible environmental and social impacts of other sites
Location	-Since it is an urban development project, location selection is very important. -The project site is located next to the river and have wide land area, good view and geography; has easy transportation.	-Not getting enough land in other places; The view is not beautiful. Unable to implement urban development project due to factors such as bad geographical location.	-Water demand may be a problem for project operation -Potential impact on surrounding residential areas due to waste water and garbage produced from the project's properties.
Water source	-The project area is located on the banks of the Ayeyarwaddy River, so it has sufficient water resources. -Sufficient supply of drinking water and water for the whole zone from river water and underground water to carry out the work. -Treatment process is used for used underground water and use of distribution system.	-Not having enough water resources; -Low groundwater recharging rate in other places; -water demand may happen in the region.	-The possibility of water demand in the region; -In dry seasons, fresh water may be scarce; - Groundwater drying up, -If there is no proper disposal system of waste water from the project zone, it may cause water pollution in the surrounding area
Energy	-Because the current project location is an urban area, it is easy to get electricity.	-It takes longer to get electricity in other places.	-There may be a case of insufficient electrical power due to the need for electricity to run the business.

Alternative	The current project area	Other places	Possible environmental and social impacts of other sites
Retaining wall design and technology	-Since the project implementation site is located on the banks of the Ayeyarwaddy River, the Dyke wall was designed by experts from Deltares in the Netherlands and local experts to protect the river from flooding. -Building with Revetment Riprap structure method.	-Because it will be built on the banks of the Ayeyarwaddy River, a dyke wall is needed, and other areas do not need such design and techniques	-Modern technologies can be a source of negative impact on the environment and society -Can cause internal technical conflicts.
Soil strength, seismic design and technology	-For soil strengthening and seismic works. local experts Coordinate with experts from Japan and New Zeland and drawing up designs -In order to obtain the specified relative density of soil, stiffening of sandy soils by Vibro-floatation Method (Vibro-compaction) in order to prevent the movements that may occur due to water and to avoid liquefaction.	- Since the project is located on the banks of the Ayeyarwaddy River, it is necessary to carry out soil strengthening works and because it is located on the Sagaing fault, it is necessary to carry out seismic works, and other areas do not need such design and techniques.	-Due to soil strengthening activities, negative impact of vibration can cause for environment and society.
Socioeconomic status	-Being a type of urban development project leads to the development of socioeconomic conditions.	-In other places, if the population is dense, there may be social problems with the locals. Possible problems with workers.	-Due to the presence of commercial areas and residential area can cause possible social problems.
Culture	-The project location is located on the banks of the Ayeyarwaddy River in Amarapura Township, so there is no cultural impact due to the construction of the project.	-Other areas may not be suitable for implementing urban development projects.	- Cultural buildings in the vicinity of the project area; religious buildings; Pagodas may be affected by the construction of the project.

3.10.3. No Project Option

The No Action Alternative would result in no additional environmental impacts compared to the proposed project. This alternative would not increase potential impacts associated with soil, water quality, biodiversity, traffic and circulation, air quality, noise, aesthetics and other utilities.

However, if this alternative would be adopted, it will likely have the greatest implications on the socioeconomic environment. This action would result in the loss of a major direct and indirect employment generating activity and foreign exchange revenue; benefits associated with the construction tourism industry and potentially significant business opportunities for existing and new tourism support businesses. In addition, the site is likely to undergo erosion, which may be a possibility due to natural effects that are already taking place at the site.

If the proposed project is not implemented, economic benefits generated by the project would not be gained. Benefits loss would include:

• Employment generation and project expenditures during the development and operation of the project;

• Loss of revenue for the Union and region governments;

• Potential loss of infrastructure upgrading in Mandalay region;

• Potential slowdown in the economic development of Mandalay region;

Table 3-36 Zero Option of Proposed Project

Aspect	Conditions without the project	Conditions with the project
Design and technology	✓ Lack of high-tech design and implementation of urban development projects in the country along the banks of the river.	✓ It is an urban development project that will be implemented with modern design and technology coordinated by international experts and local experts, so it can be a pioneer in the country.
environmental and social conditions	✓ No impact on the environment and social situation due to the project.	✓ Potential impacts on environmental quality due to project construction and operation.
Economic Aspect	✓ Loss of revenue to the state. ✓ Mandalay Region's economic development potential may be slow down. ✓ Scarcity of employment opportunities for local residents. ✓ Unable to develop the socio-economic status of the locals.	✓ Increasing of revenue to the state. ✓ Development of Mandalay Region's economic situation. ✓ Getting employment opportunities for locals. ✓ Development of the socio-economic status of local residents near the project.

Aspect	Conditions without the project	Conditions with the project
	✓ Recession of urban development in Mandalay Region. ✓ Risk of loss of upgrading infrastructure in Mandalay Region.	✓ Amarapura Township, where the project is located, can be developed and infrastructure can be upgraded.

CHAPTER 4

DESCRIPTION OF THE SURROUNDING ENVIRONMENT

4.1. INTRODUCTION

The purpose of this section is to predict how environmental and socio-economic conditions will be impacted because of the operation of the proposed project. This requires a sound understanding of the baseline conditions at the project site, which established through desktop study research, site surveys, primary data collection and projections for future developments. Findings provide the current and future characteristics of the project site and the value and vulnerability of the key environmental and socio-economic resources and receptors. The following sections provide a description of the environmental and socio-economic aspects of the project.

In this chapter, the area of about 5 km radius around the project site has been studied to check the impacts for the surrounding environment. Three groups of components are consisted in studying surrounding environment. They are (i) Physical Components including description with data and maps of topography; water resources; geology and soils, hydrology/hydrogeology; environmental quality; climate; vegetation cover; and natural hazards (ii) Biological Components: descriptions on fauna and flora (iii) Socio-economic Components: descriptions of income and livelihoods, living conditions and access to public services and natural resources, land use maps, population distribution maps, maps and charts of other socio-economic indicators such as poverty, employment and education.

4.2. AREA OF THE INFLUENCE OF THE STUDY AREA

- In the project area, soil improvement activities, dyke wall construction, road construction, communication system implementation, water supply system, drainage and wastewater generation system will be constructed.
- The area of influence (AOI) of the study area is regarded as 1 km in the scoping stage. In addition, in the EIA stage, AOI is recognized as 5 km to consider the overall impact of the study area.
- However, there has little direct impact on the surrounding environment from the project site.

Area of the influence map of the project area as shown in Figure 4-1.

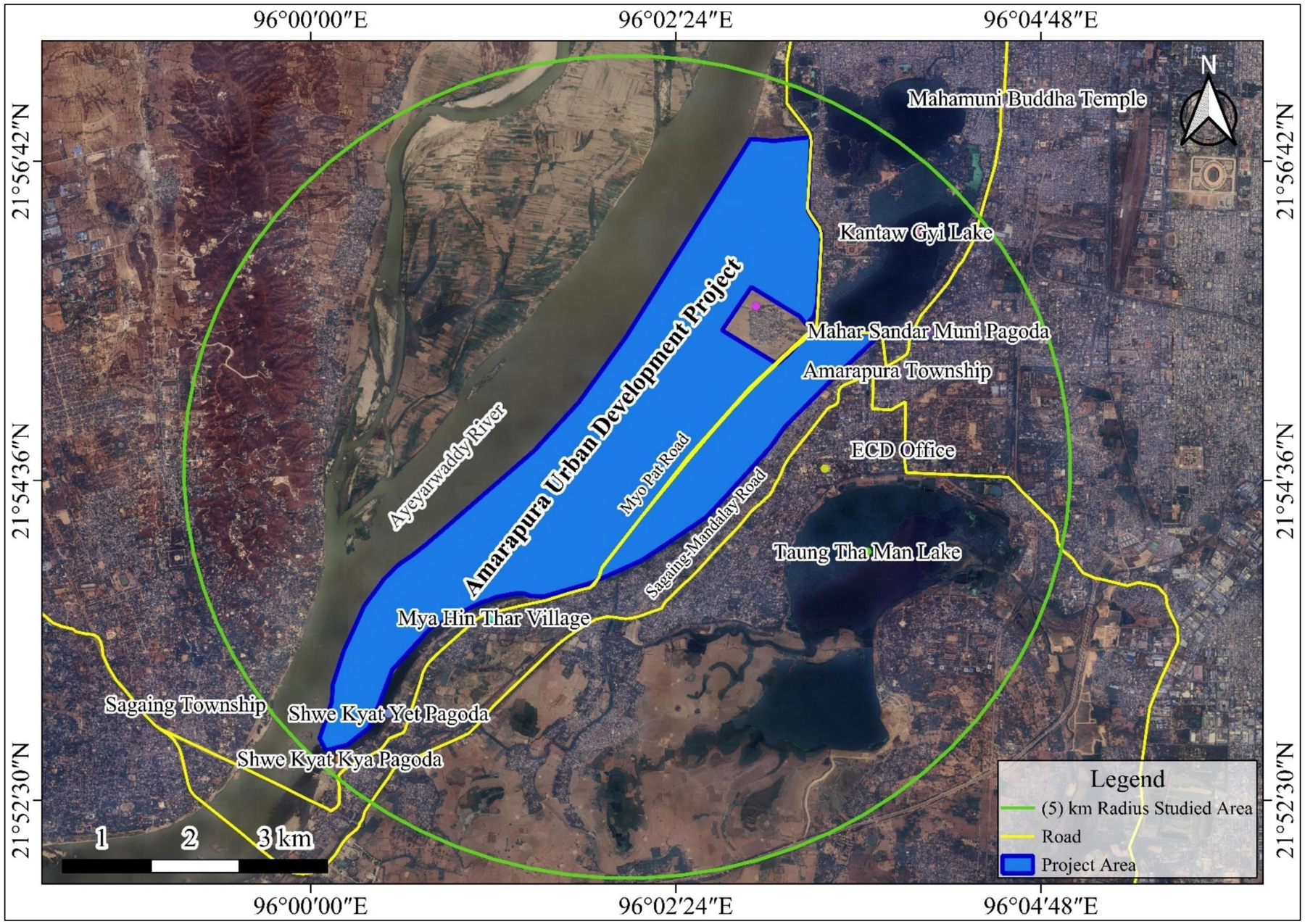


Figure 4-1 Area of Influence Map of the Study Area

4.3. PHYSICAL ENVIRONMENT

Air quality, water quality, noise, vibration, soil, climate and meteorology, hydrology, and geology had been studied to know the physical environmental condition.

4.3.1. Climate and Meteorology

The proposed project location is situated in Mandalay's Amarapura Township, which experiences tropical monsoon weather. Mandalay has a tropical monsoon climate under the climate classification system. The difference in temperature between the coolest and hottest months is less noticeable. Summer, rainy season, and cool season roughly correspond to the three main seasons of the atmosphere. The summer season lasts from mid-March to mid-May. The southeast monsoon wind is the main source of rain and the study area receives rain during the period from mid-May to end of September. The cool season lasts from November through February. The weather is good for cultivation and different crops are cultivated in the area. The months like November, December and January have low temperature and defined as cold months.

According to the Department of Meteorology and Hydrology (DMH), Yangon Division, Myanmar (2022), the mean monthly temperature is highest in May at 42.3 °C and lowest in January at 13.5°C. Except in December and January, the monthly temperatures are above 27.0 °C. The southwest monsoon wind is the main source of rain, and receives rain during the period from May to November. Rainfall sharply decreases from November and continues to be less than 0 mm from January to February.

Table 4-1 2017-2022 Rainfall Data in Mandalay (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	Trace	0	14	63	194	28	153	122	233	313	34	5
2018	51	Trace	Trace	74	150	95	25	195	170	179	1	11
2019	46	Trace	1	9	94	40	24	226	29	54	100	Trace
2020	24	0	0	12	174	44	69	81	82	118	102	0
2021	0	Trace	0	83	124	22	95	197	154	255	15	Trace
2022	2	Trace	27	109	249	60	31	94				

(Source: Regional Data, Department of Meteorology and Hydrology (DMH), Yangon Division, Myanmar, 2022)

Table 4-2 2017-2022 Temperature Data in Mandalay (°C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	22.1	25.0	26.9	29.6	30.5	31.1	30.4	30.3	29.9	28.7	26.9	22.9
2018	21.7	25.2	29.1	31.3	31.2	29.8	31.2	30.0	30.5	27.6	25.8	23.7
2019	22.0	25.3	28.3	32.9	34.2	32.2	31.3	30.5	30.3	29.7	27.7	22.9
2020	22.1	24.6	29.8	32.2	33.2	32.3	31.2	30.8	31.8	30.7	26.2	23.7
2021	23.9	25.7	30.1	32.4	32.9	32.3	31.2	30.4	29.7	30.0	27.1	23.9
2022	22.7	23.0	30.6	32.0	30.2	31.4	31.9	30.7				

(Source: Regional Data, Department of Meteorology and Hydrology (DMH), Yangon Division, Myanmar, 2022)

4.3.2. Topography

Topographically, Amarapura Township is located on the Mandalay-Kyaukse plain and it is mostly flat plains. The topographic feature of the Amarapura Township is a level plain which is situated at the junction of the Ayeyarwady River and the Myitnge River. It is a flat plain with a height that about 192 feet above sea level in the west and 250 feet above sea level in the east. The topographic surface is slightly higher in the eastern part and the land gradually slopes towards the Ayeyarwady River in the west.

The proposed project site is located in Amarapura Township surrounded by the Ayeyarwady River and other private lands and villages. The area is flat and no protected area is found around the area. The landscape can therefore be classified as flat area covered with wasteland and scattered vegetation.

The landscape of the proposed project area is an alluvial plain which is flooded in monsoon season. In dry season when the land is exposed, various kinds of crops including pulses, beans, water melon and cucumber are cultivated by the local farmers. Small-scale fishing activities are practiced in the small wetlands which emerge when the monsoon water flow back to the river. The topography map of the study area is shown in Figure 4-2.

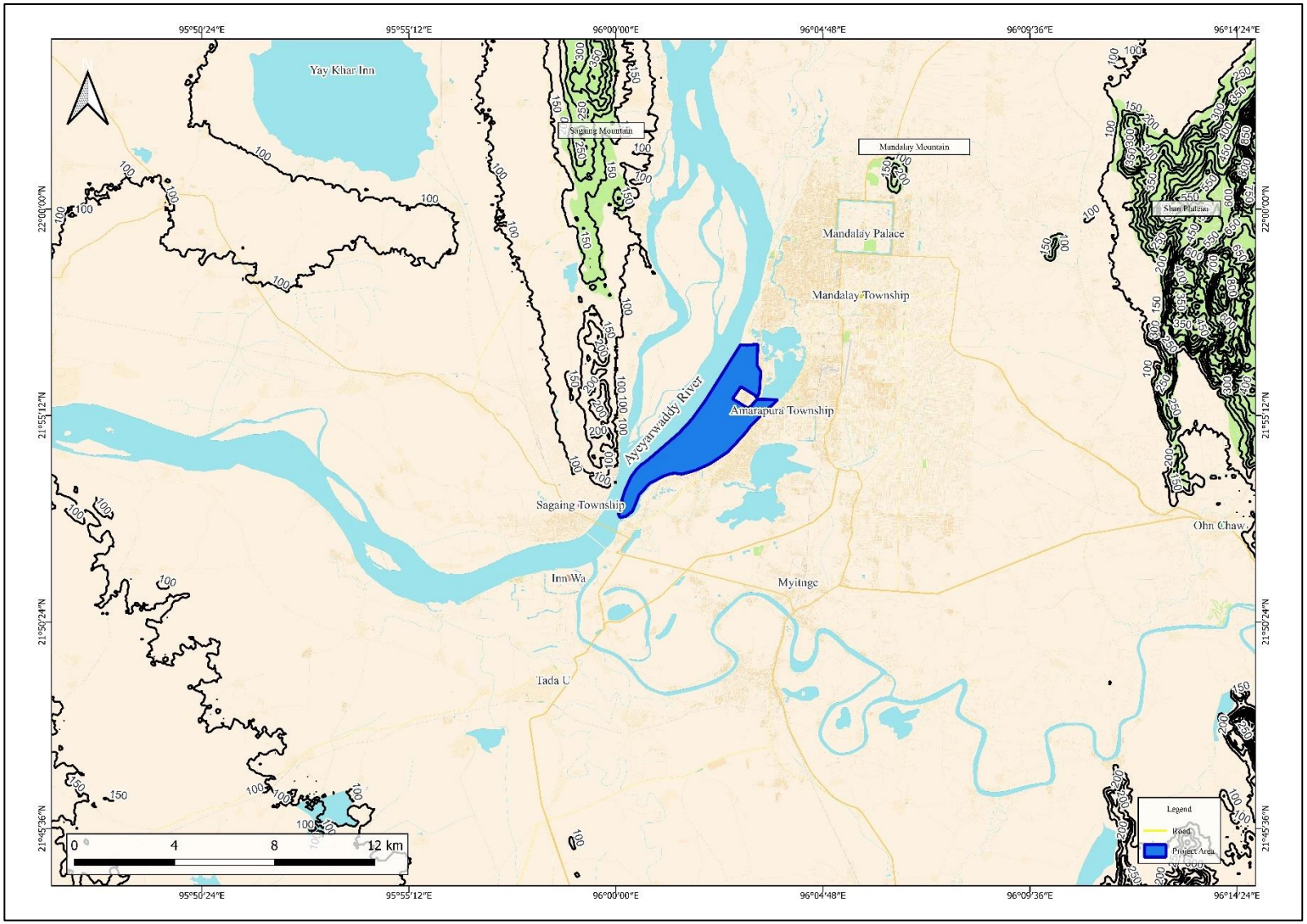


Figure 4-2 Topography Map of the Project Area

4.3.3. Geology

On the geological map, the Amarapura Urban Development Project region is located at the centre. This area is mainly underlain by younger alluvial deposits (Holocene). The E and NE of the project area are formed by the Carboniferous-aged portions and Paleozoic, partially Jurassic-aged Metamorphosed unit. In metamorphosed unit mainly consists of lower Paleozoic rocks. This unit can also occur in the W and NW of the project area. Moreover, there is an active strike-slip fault in this unit along the NS trending. Jurassic age of the Loi-An Group, Namyau Group, Upper Miocene, and Pliocene of the Irrawaddy Formation can also be found in NW of the project area. Then Miocene age of Upper Pegu Group of Minbu Basin is situated in both NW and SW of the project area. And in the E and SE of the project area, can be occurred Silurian and Middle Permian, Middle Triassic age of the Plateau Limestone Group known as Moulmein Limestone Group respectively. Additionally, this project area is also formed along the river- bank of Irrawaddy River. The geology map of the study area is shown in Figure 4-3.

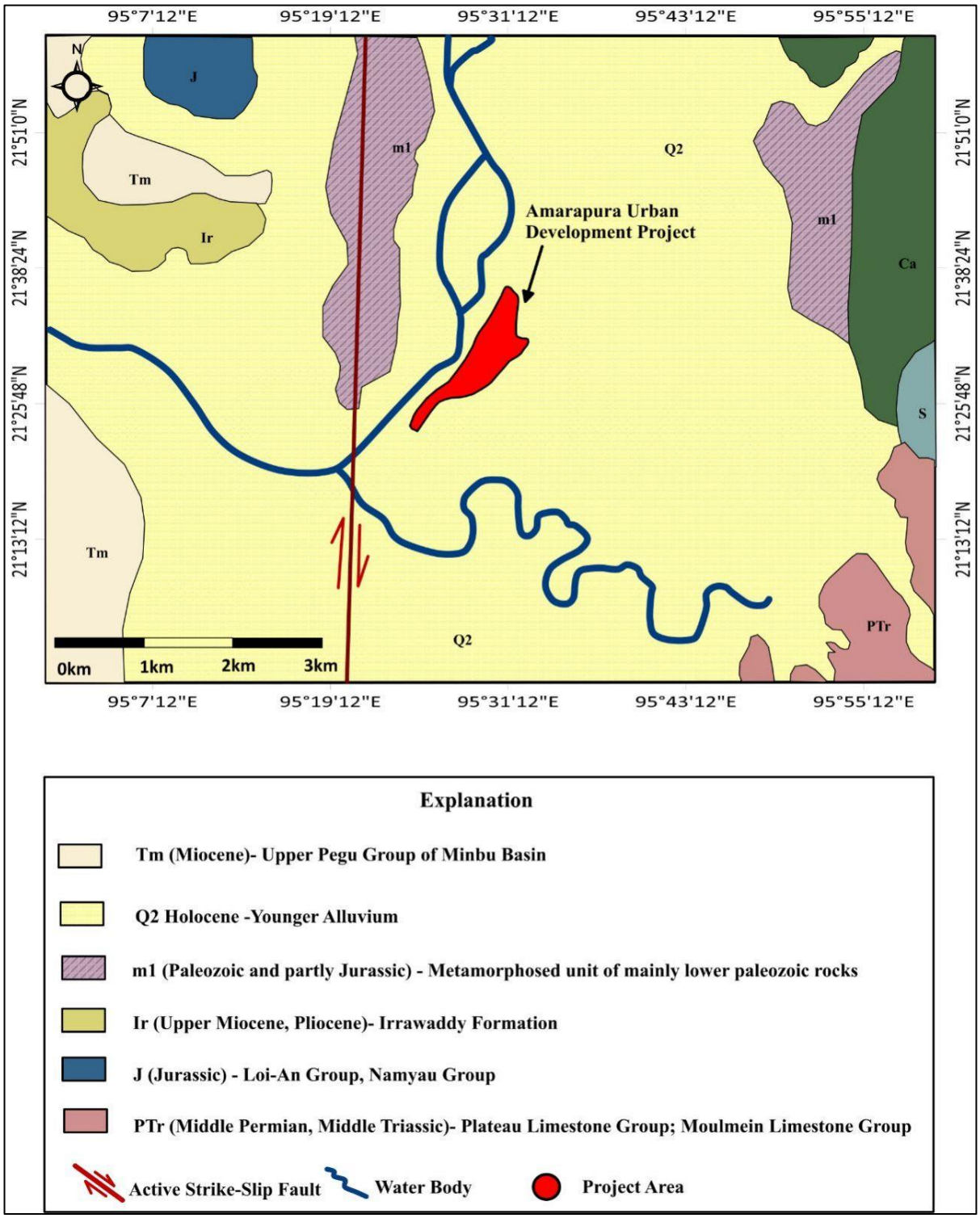


Figure 4-3 Geology Map of the Project Area

4.3.4. Soil

According to the modern classification, there are 24 main soil types being recognized in the Union of Myanmar. The characteristics of these soils are determined upon (1) the physical and mineral composition of the parent material, (2) the relief (physical features), (3) the climate under the which the soil material has been developed and, (4) the vegetation. The soil types of the project located division Mandalay are meadow & meadow alluvial soils, red brown forest soils, yellow brown forest soils, yellow brown dry forest and indaing soils, light forest soils, cantena of savana soils on depressions, compact soils, red earth and yellow earth, mountainousred forest soils, popa complex soils and primitive crushed stonesoils. The soil type of the project area is located in the compact soil. The dark compact soils occur in the dry zone in the level plains of Sagaing, Mandalay and Magway Regions. The soils are deep and mostly composed of clayey materials. The soil map of the study area is shown in Figure 4-4.

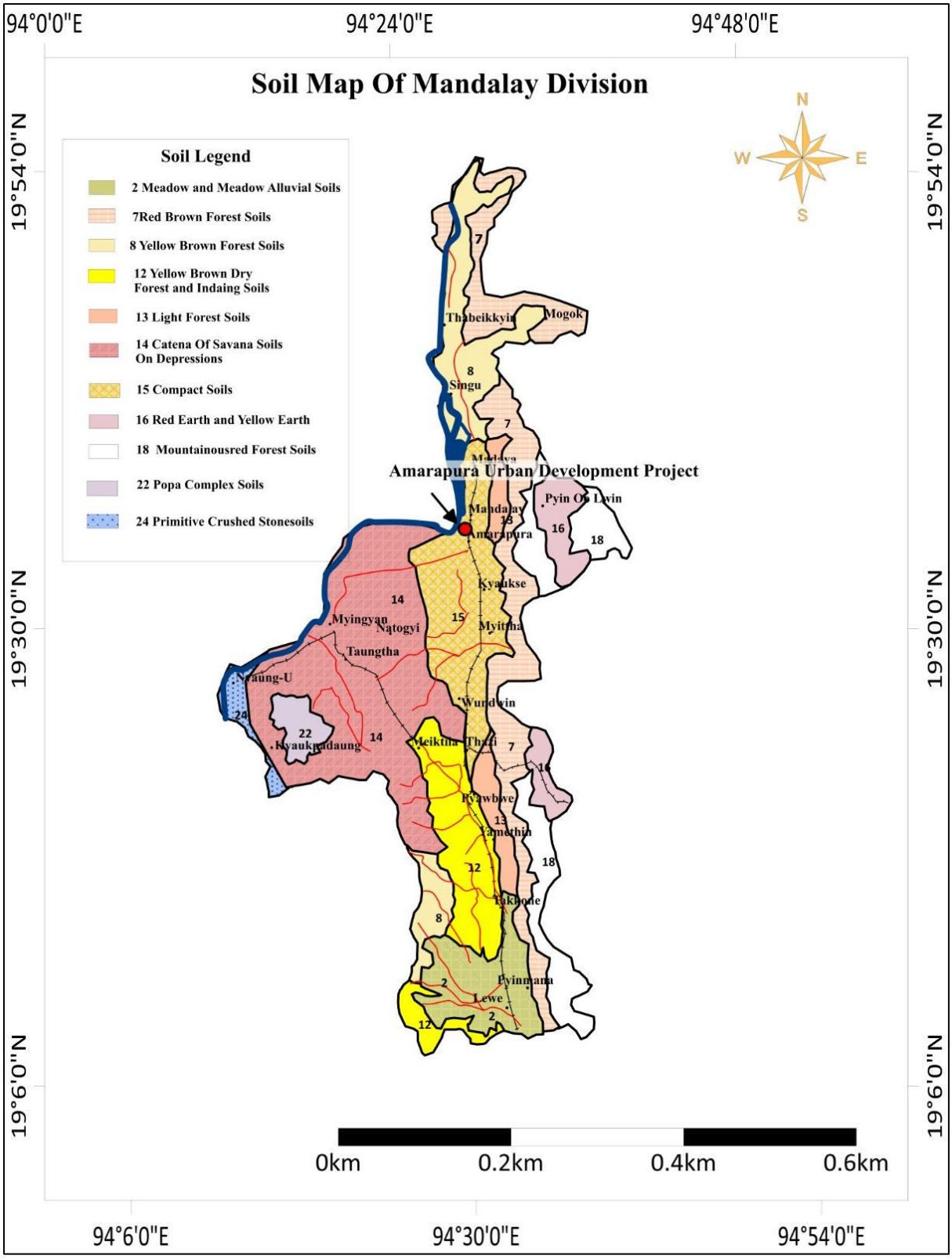
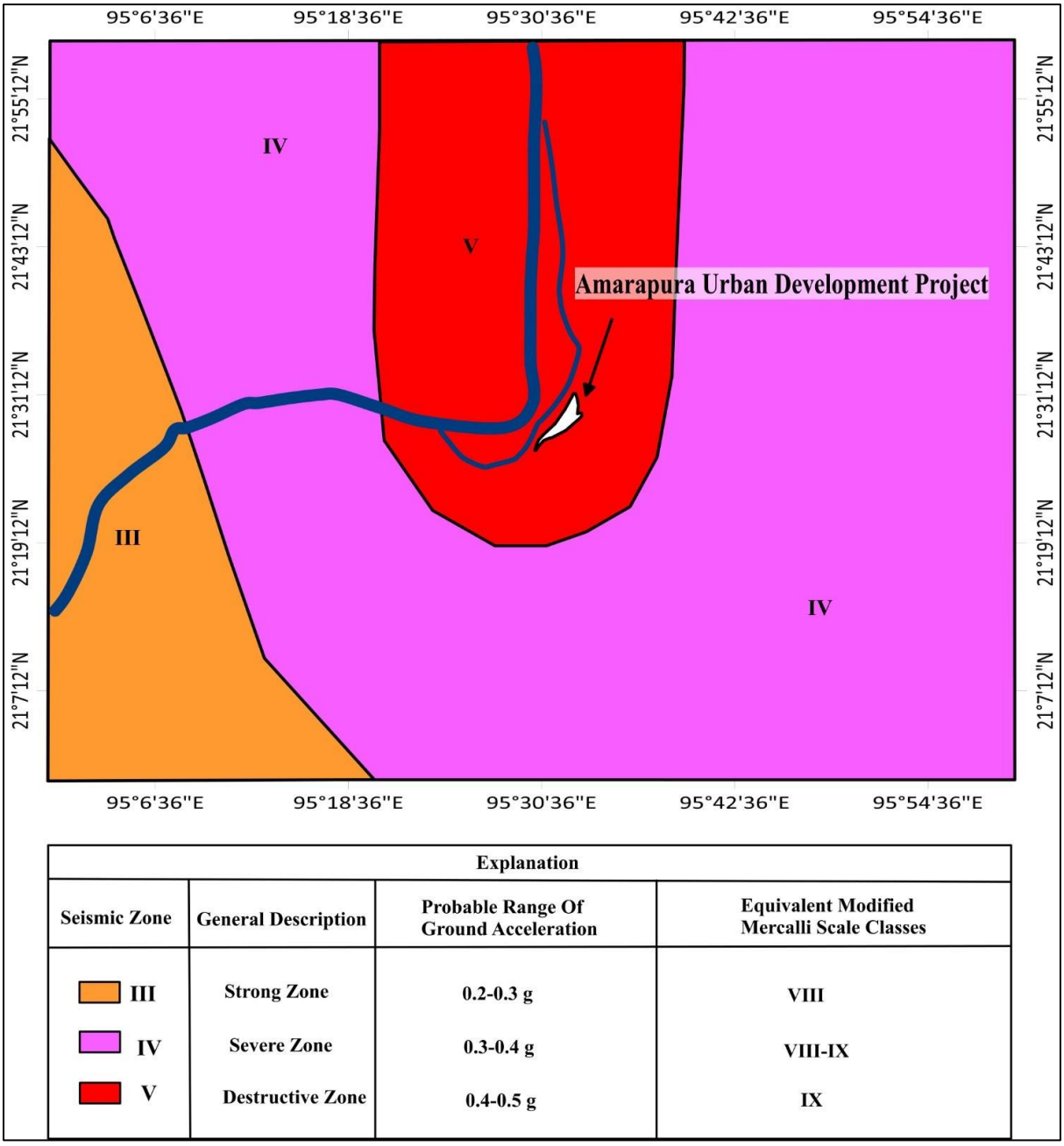


Figure 4-4 Soil Map of the Project Area

4.3.5. Seismic Background

Myanmar is located in a seismic zone with a moderate to strong earthquakes. According to earthquake observatory, most earthquakes that occur in Myanmar are in the

western part of Myanmar, it is caused by the Active Subduction Zone in the Andaman Megathrust zone and the Sagaing fault zone in central Myanmar. The project site is located in seismic zone V by earthquake zone. This zone is a destructive zone of (0.4g - 0.5g) according to the Probable Range of Ground Acceleration. The seismic zone map of the project area is as shown in Figure 4-5. Therefore, even if there is an earthquake because of the project areas is a destructive zone, major damage in good RC buildings and damage in specially designed structures.



Explanation			
Seismic Zone	General Description	Probable Range Of Ground Acceleration	Equivalent Modified Mercalli Scale Classes
III	Strong Zone	0.2-0.3 g	VIII
IV	Severe Zone	0.3-0.4 g	VIII-IX
V	Destructive Zone	0.4-0.5 g	IX

Figure 4-5 Seismic Map of the Project Area

4.3.6. Seismic Hazard Analysis

From the seismicity point of view, it is situated closed to the most active fault of Myanmar, right-lateral strike-slip Sagaing Fault. The Project area is about 4 to 8 km far from the Sagaing Fault. In the historical records, about ten major earthquakes struck in and around this area in 1429, 1467, 1501, 1602, 1696, 1762, 1771, 1776, 1830 and 1839. Among them, the most destructive and deadliest one is 1839 Innwa (Ava) earthquake and that caused several pagodas destroyed and 300 – 400 deaths. Based on the current research works, the magnitude of this event is ~ 8 (Wang Yu et al., 2015). In the instrumental record, the most recent event around this area is 1956 Sagaing earthquake that struck on July 16 and the magnitude is Mw 7.0. Due to this earthquake 50 people's dead in Sagaing and several

pagodas were severely damaged. All of these events are generated by Sagaing Fault, 1839 event from Innwa (Ava) Segment and 1956 event from Sagaing Segment. Therefore, it is very clear, this area lies in high seismic hazard area. When the project is implemented and to design various sorts of buildings and infrastructures as seismic resistant ones, the seismic hazard parameters are very important to take account.

The seismic hazard assessment is carried out by using the classical probabilistic way which consists of 4 steps. For different building performance levels, the seismic hazards are calculated for 4 different recurrence intervals: 50% probability of exceedance in 50 years (75 years recurrence interval); 20% probability of exceedance in 50 years (225 years recurrence interval); 10% probability of exceedance in 50 years (475 years recurrence interval); and 2% probability of exceedance in 50 years (2475 years recurrence interval).

The seismic hazards are presented in terms of peak ground acceleration (pga) in g; spectral acceleration at the periods of 0.2 s and 1.0 s in g; peak ground velocity (pgv) in cm/s. Therefore, 16 seismic hazard maps are developed for the project area.

4.3.6.1. Methodology

The four steps procedure of Probabilistic Seismic Hazard Assessment (PSHA) (Cornell, 1968, McGuire, 1976, Reiter, 1990 and Kramer, 1996) is applied for the seismic hazard analysis for the Project area.

Moreover, the Guttenberg and Richter's classical earthquake recurrent law is also based for earthquake recurrence modeling. The standard PSHA integrates the mean annual rate of occurrence of earthquakes over all possible earthquake sources, which means all possible locations and earthquake magnitudes are considered for all potential seismic sources; faults and areal zones (Marin et al., 2004).

The procedure of PSHA is as follows:

1) Identification of earthquake sources: Source areas or zones that are capable to produce the significant ground motion at the site must be defined.

2) Characterization of earthquake sources: A recurrence relationship which specifies the average rate at which an earthquake of certain size will be exceeded is used to characterize the seismicity of each source zone and then the maximum magnitude of the earthquake is determined for each seismic source.

3) Choosing the ground motion prediction equations: the ground motion at the site, resulted by earthquakes of any possible size at a point in each seismic source zone can be determined by using the most suitable ground motion prediction equations.

4) Estimation of the seismic hazard: By considering the uncertainties of the seismic sources' geometrical information, earthquake size, and ground motion prediction and by combining the effects of all the earthquakes with the different magnitude, different distance and diverse occurrence probability on a specific site are integrated and the probability of exceedance of different levels of accelerations are estimated for specific periods of time.

The mathematical expression of the probability of the ground motion parameter Z will exceed a specified value z, during a specified time period T at a given site is as follow:

$$P\ (Z>z) = 1\text{-}e^{\ -v(z).t}$$

where v(z) is the mean annual rate of events from which the ground motion parameter Z will exceed z at a certain site resulting from the earthquakes from all seismic sources in a region. It can be calculated by applying the following equation:

$$V(Z) = \sum_{n=1}^{N} \lambda(m_i) \iint f_M\ (m)\ f_R(r).\ P\left(Z > \frac{z}{m}, r\right) drdm$$

where λ (m) i = the frequency of earthquakes on seismic source n above a minimum magnitude of engineering significance, mi;

f (m) M = the probability density function of event size on source n between m 0 and maximum earthquake size for the source, m u;

f (r) R = the probability density function for distance to earthquake rupture on source n, which may be conditional on the earthquake size; and

P(Z>z|m, r) = the probability that, at a given a magnitude m earthquake and at a distance r from the site, the ground motion exceeds value z.

On the other hand, the seismic hazards calculation includes the following steps;

1) Calculating the frequency of the occurrence of the event of magnitude m on source n,

2) Computing the probability density function of event size on source n between m 0 and m u,

3) Computing the probability distribution for the distance from the site to source n where the event with the magnitude m will occur, and

4) Calculating, at each distance, the probability that an event with magnitude m will exceed the specified ground motion level z, i.e. calculating the ground motion amplitude parameters for a certain recurrence interval.

4.3.6.2. Seismicity of the Project Area

According to the seismicity of the project area, almost all of the events are shallow focus earthquakes (< 40 km in focal depth) as shown in Figure 1-2. However, there are some deep focus earthquakes (> 80 km in focal depth), while some medium deep earthquakes (40 – 80 km in hypocentral depth) also happened in the west of the project area. This is based on the earthquake catalog of ISC (1900 – 2012), with complement of USGS and IRIS catalog.

This area has experienced about ten major earthquakes in the historical record and with regards to the instrumental record, 1956 Sagaing earthquake and very recent one is 2012 Thabeikkyin earthquake. The events are listed in Table 4-3and Table 4-4 and shown Figure 4-6, Figure 4-7 and Figure 4-8. It can be noticed that the events happened in the west of the project site were originated by Subduction zone of Indo-Austrilia Plate beneath Myanmar (Myanmar (Burma)) Platelet and its related faults.

Table 4-3 List of the past earthquakes happened in the west of the project area, within 250 km radius of the project area

Date	Latitude	Longitude	Magnitude	Depth
24.8.1858	19.3	94.8	-	-
16.8.1938	23.5	94.25	7.2	60
21.3.1954	24.6	95.2	7	150
8.7.1975	21.5	94.7	6.8	84
16.3.1927	24.5	95	6.5	
22.9.1930	25	94	6.25	
2.6.1934	24.5	95	6.5	
23.4.1935	24	94.75	6.25	
14.4.1938	23.5	95	6.75	
27.5.1939	24.5	94	6.75	
11.5.1940	23.75	94.25	6.5	
12.3.1952	24.6	95.2	7.7	
29.2.1956	23.5	94.5	6.5	
19.9.1956	23.5	94.5	6.3	
6.8.2023	25.12	95.17	7.5	

Table 4-4 List of the past earthquakes happened in and around the project area, from the active fault

Date	Location	Magnitude or brief description
1429	Innwa	Fire-stoping enclosure walls fell
1467	Innwa	Pagodas, solid and hollow, and brick monasteries destroyed

Date	Location	Magnitude or brief description
24.7.1485	Mandalay	3 well-known pagodas fell
1501	Innwa	Pagodas, etc. fell
6.6.1620	Innwa	Ground surface broken. River fishes were killed after quake
10.9.1646	Innwa	
11.6.1648	Innwa	
1.9.1660	Innwa	
3.4.1690	Innwa	
15.9.1690	Innwa	
15.9.1696	Innwa	
8.8.1714	Innwa	4 well-known pagodas destroyed
15.7.1771	Innwa	
9.6.1776	Innwa	A well-known pagoda fell
2.4.1830	Innwa	
21.3.1839	Innwa	Old palace and many buildings demolished; pagodas and city walls fell; ground surface broken; the river's flow was reversed for sometime; Mingun pagoda shattered, death tolls-300 to 400
23.5.1912	Taunggyi	M=8.0, almost all of cities in Myanar were shocked, 30 to 40 peoples dead
16.7.1956	Mandalay	Several pagodas severely dead
11.11.2012	Thabeikkyin	M= 6.8, Landslide and liquefaction occurred, above 500 buildings such as pagodas, houses, schools damaged; 26 deaths and231 injures.

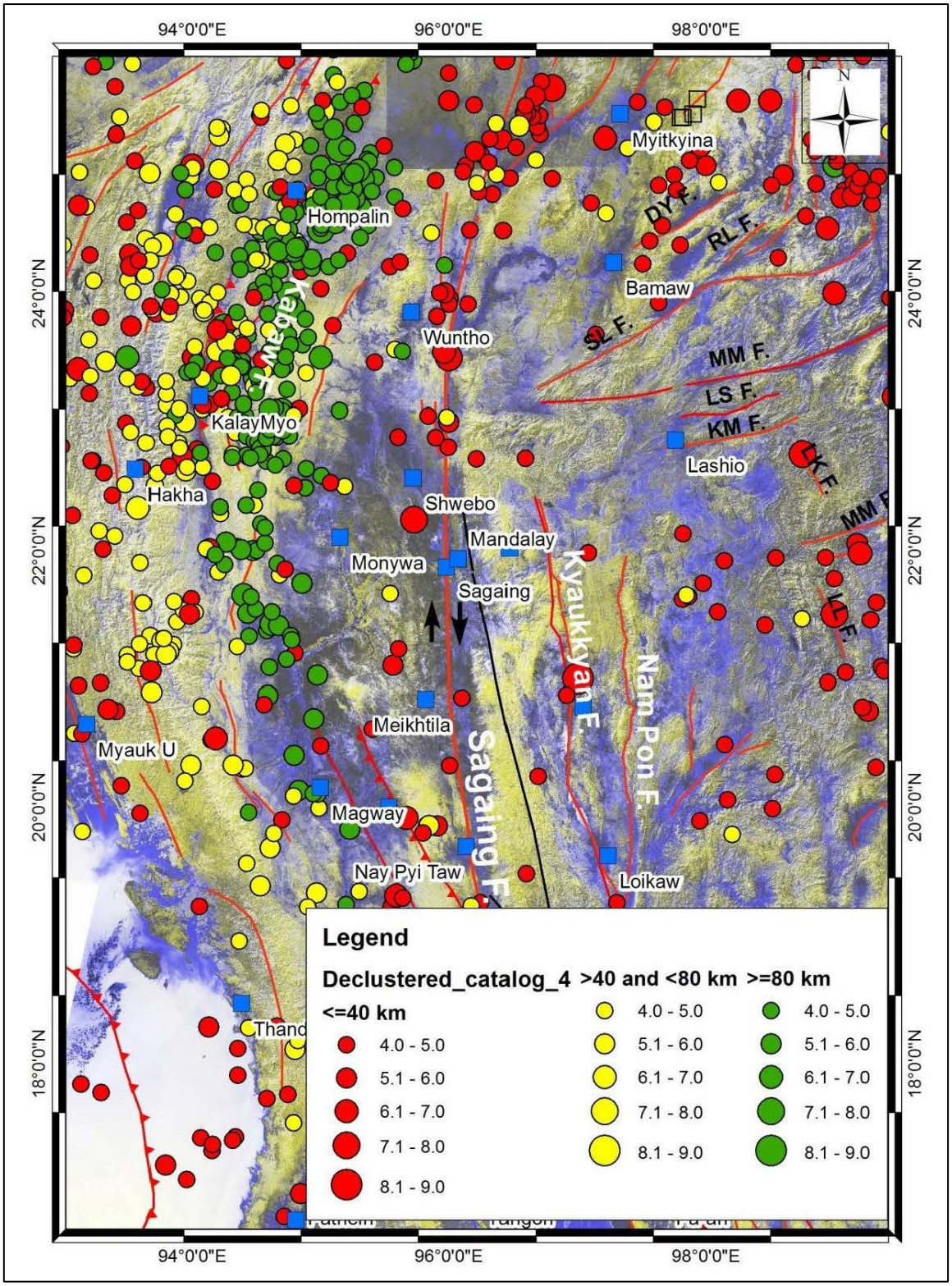


Figure 4-6 Seismicity map of the Amarapura New Capital project area

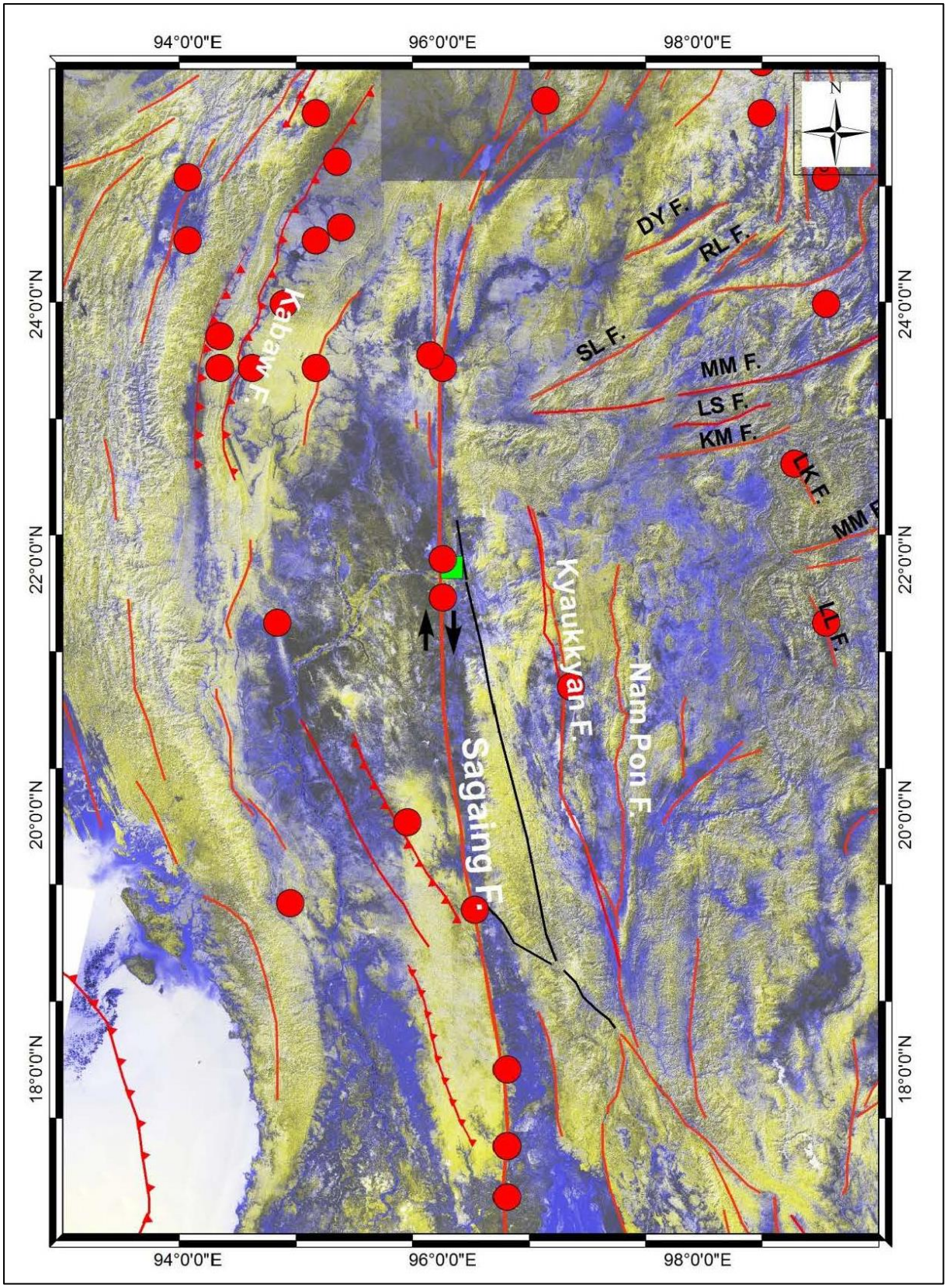


Figure 4-7 Map of the large earthquakes around the project area

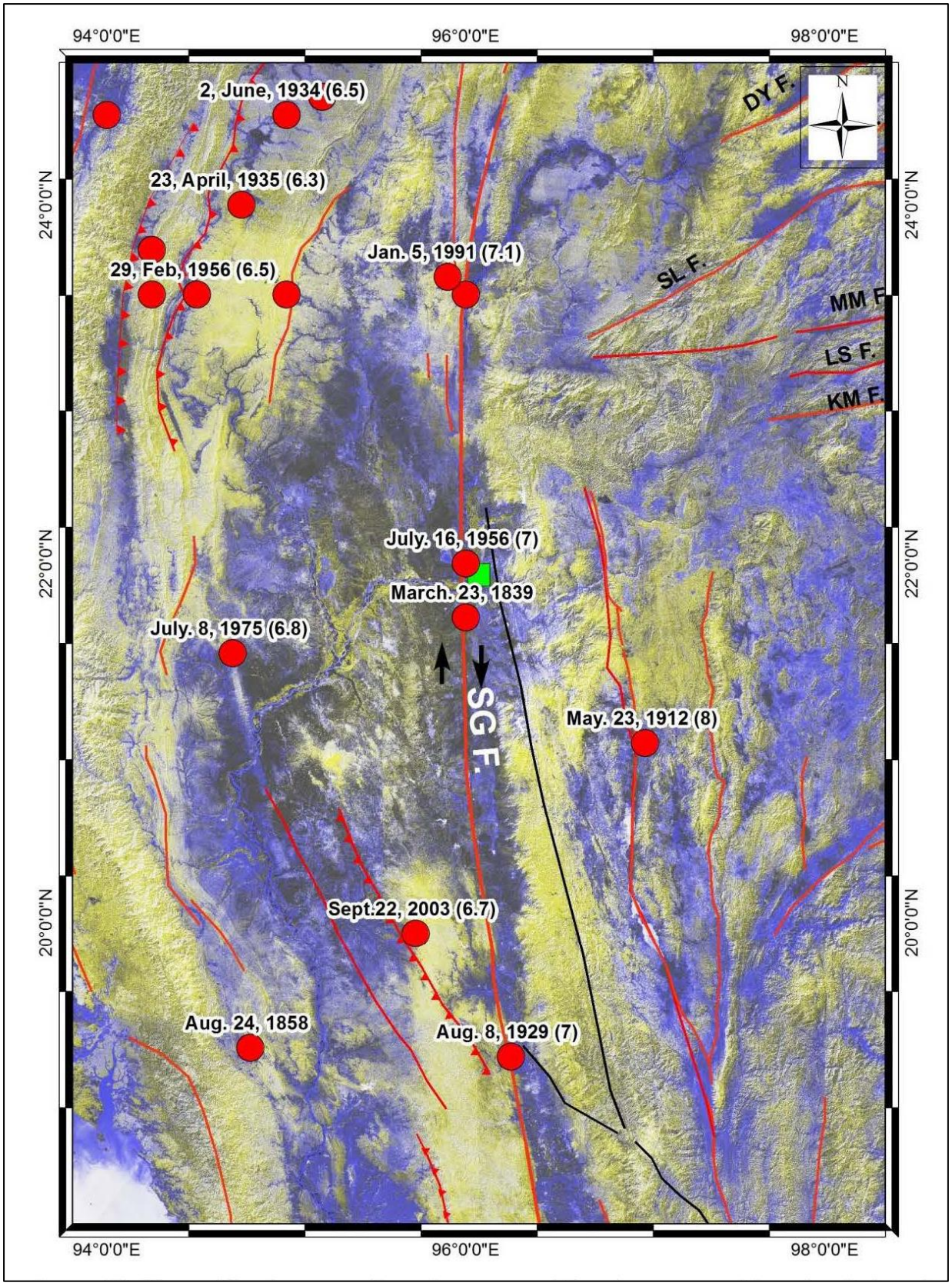


Figure 4-8 Map of the large earthquakes around the project area

4.3.6.3. Seismic Hazard of the Project Area

Based on the probabilistic seismic hazard maps of Myanmar (Figure 7 and 8) as the nation level; of Mandalay Region (Figure 9 and 10), the maximum peak ground acceleration (PGA) for the project area is 0.4 to 0.5 g for 10% probability of exceedance in 50 years (475 years recurrence interval) and 0.7 to 0.8 g for 2% probability of exceedance in 50 years (2475 years recurrence interval). All of these PGA values are calculated by assuming the site condition as rock. To understand the PGA level of the project area, the seismic hazard maps of Mandalay City is also presented in Figure 4-9 to Figure 4-14.

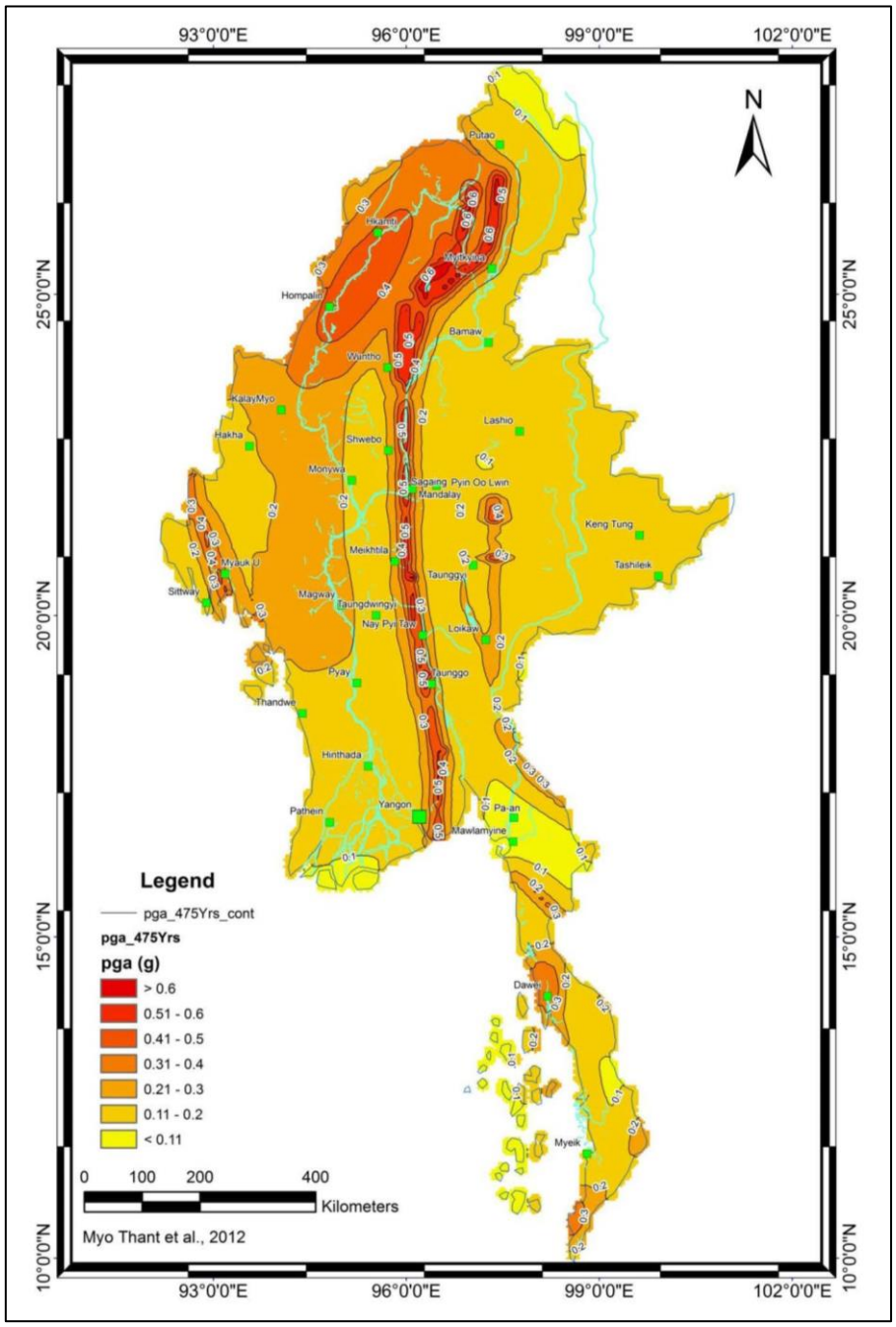


Figure 4-9 Probabilistic seismic hazard map of Myanmar for 10% probability of exceedance in 50 years (475 years recurrence interval)

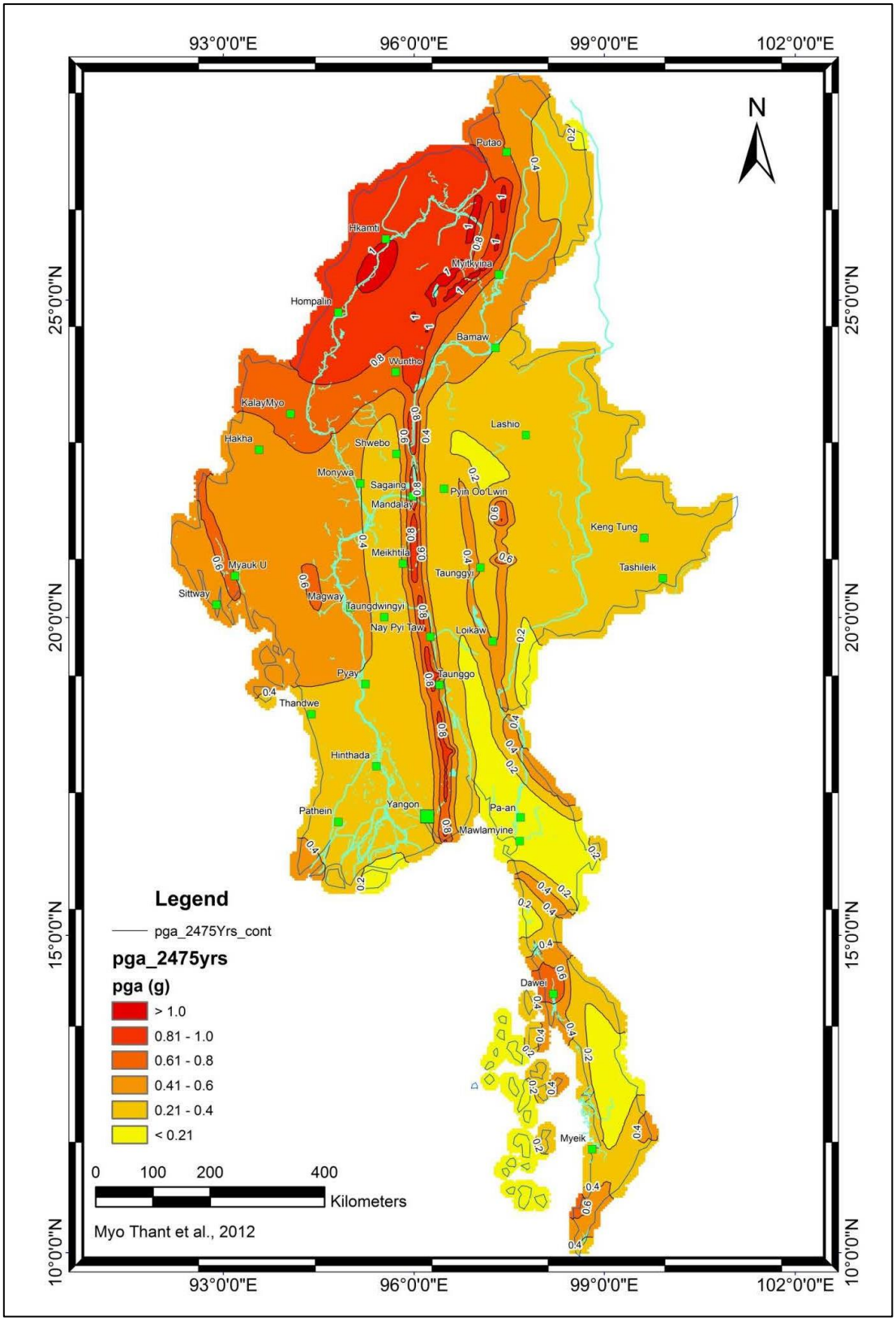


Figure 4-10 Probabilistic seismic hazard map of Myanmar for 2% probability of exceedance in 50 years (2475 years recurrence interval)

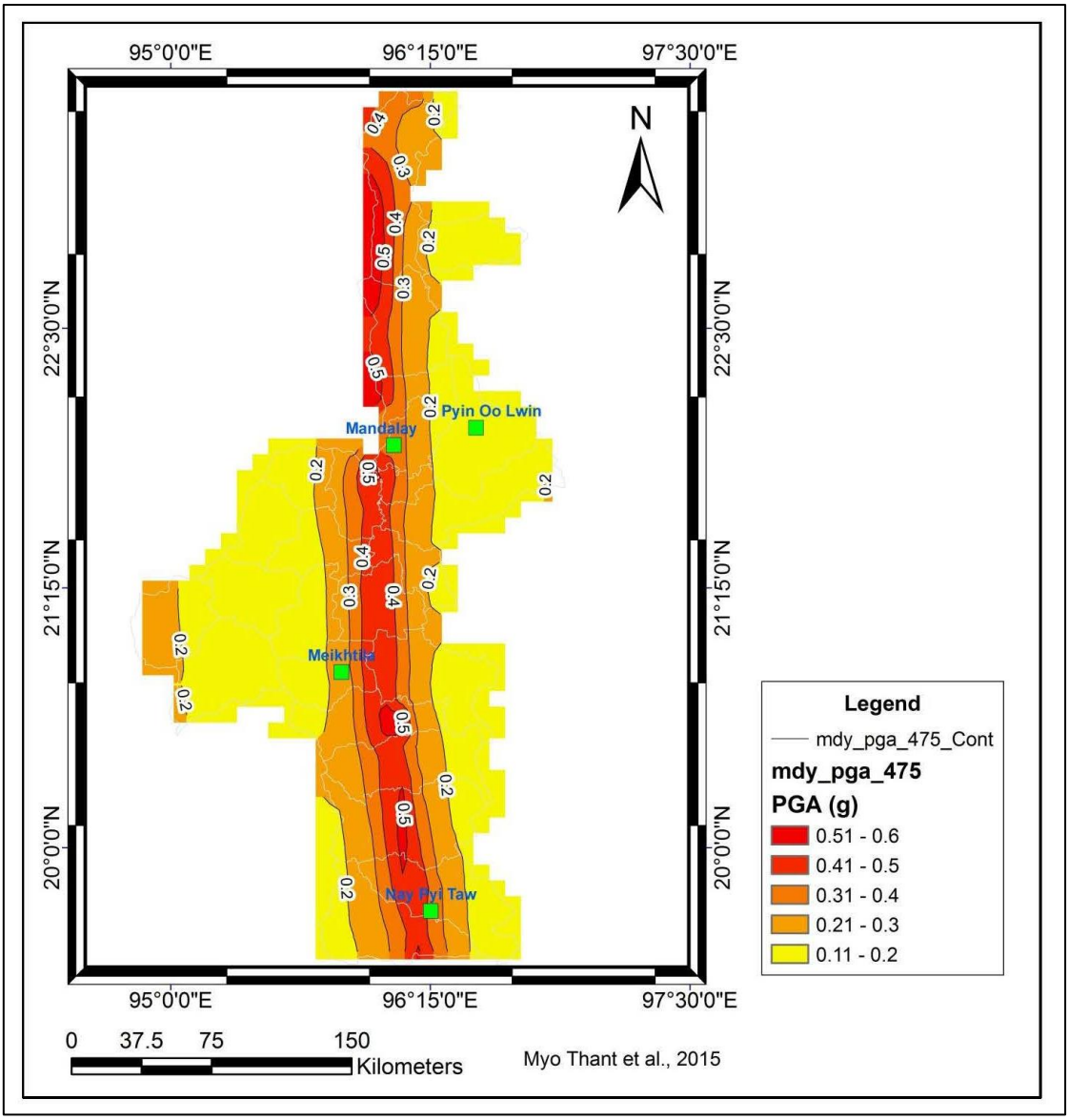


Figure 4-11 Probabilistic seismic hazard map of Mandalay Region for 10% probability of exceedance in 50 years (475 years recurrence interval).

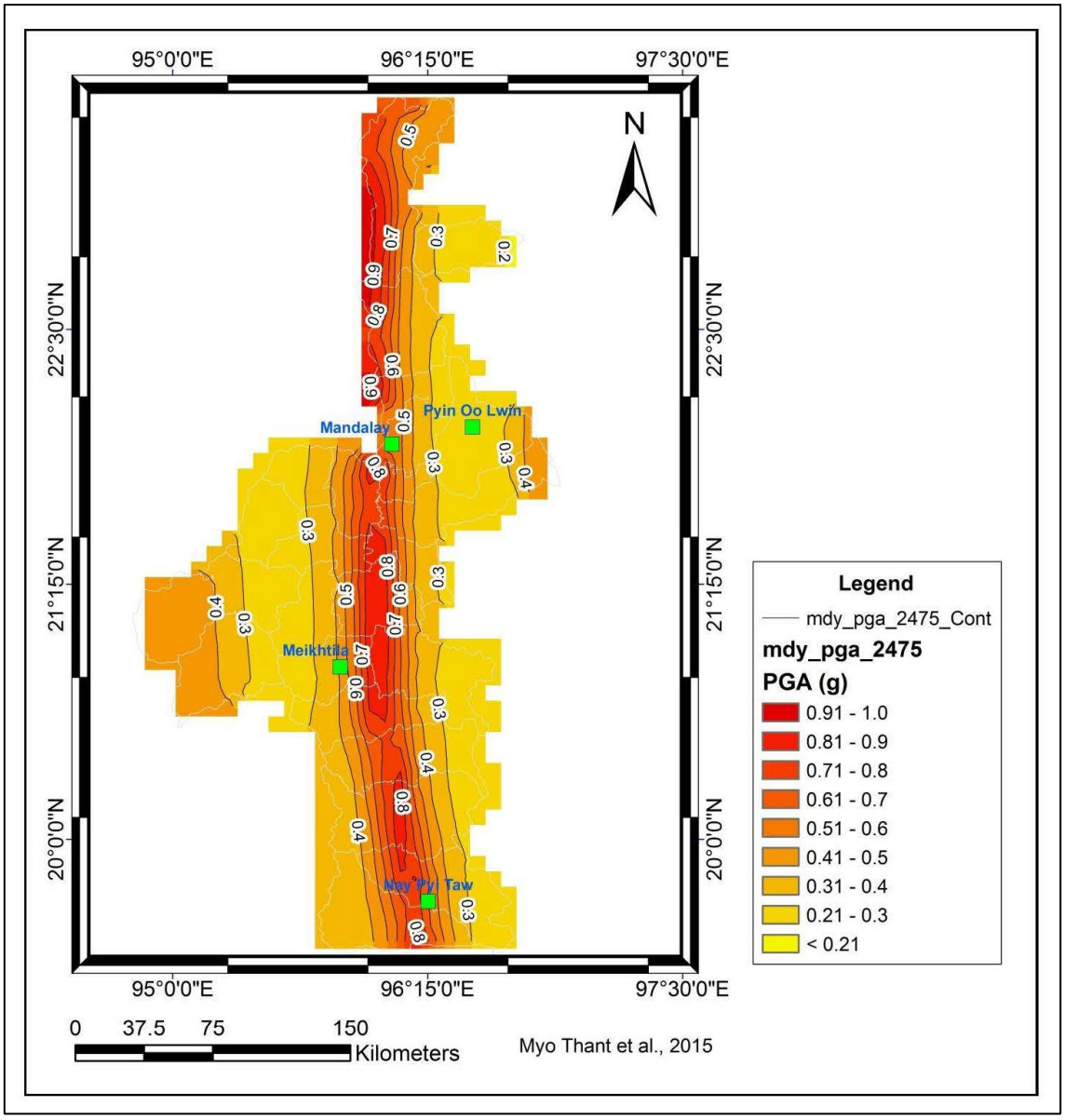


Figure 4-12 Probabilistic seismic hazard map of Myanmar for 2% probability of exceedance in 50 years (2475 years recurrence interval).

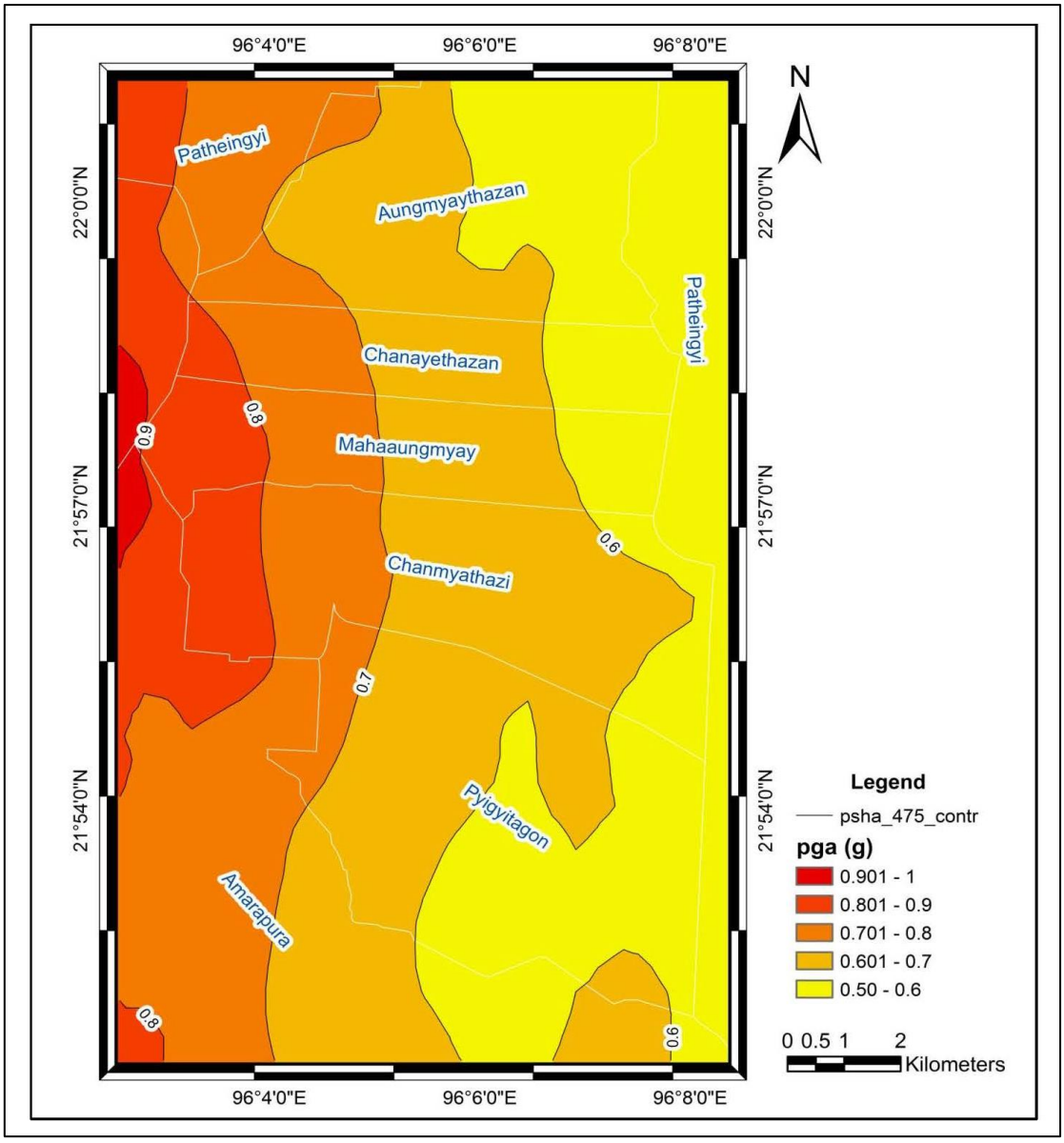


Figure 4-13 Probabilistic Seismic Hazard Map of Mandalay for 10% of Probability of exceedance in 50 years by means of peak ground acceleration, PGA (g), considering site condition, Vs30.

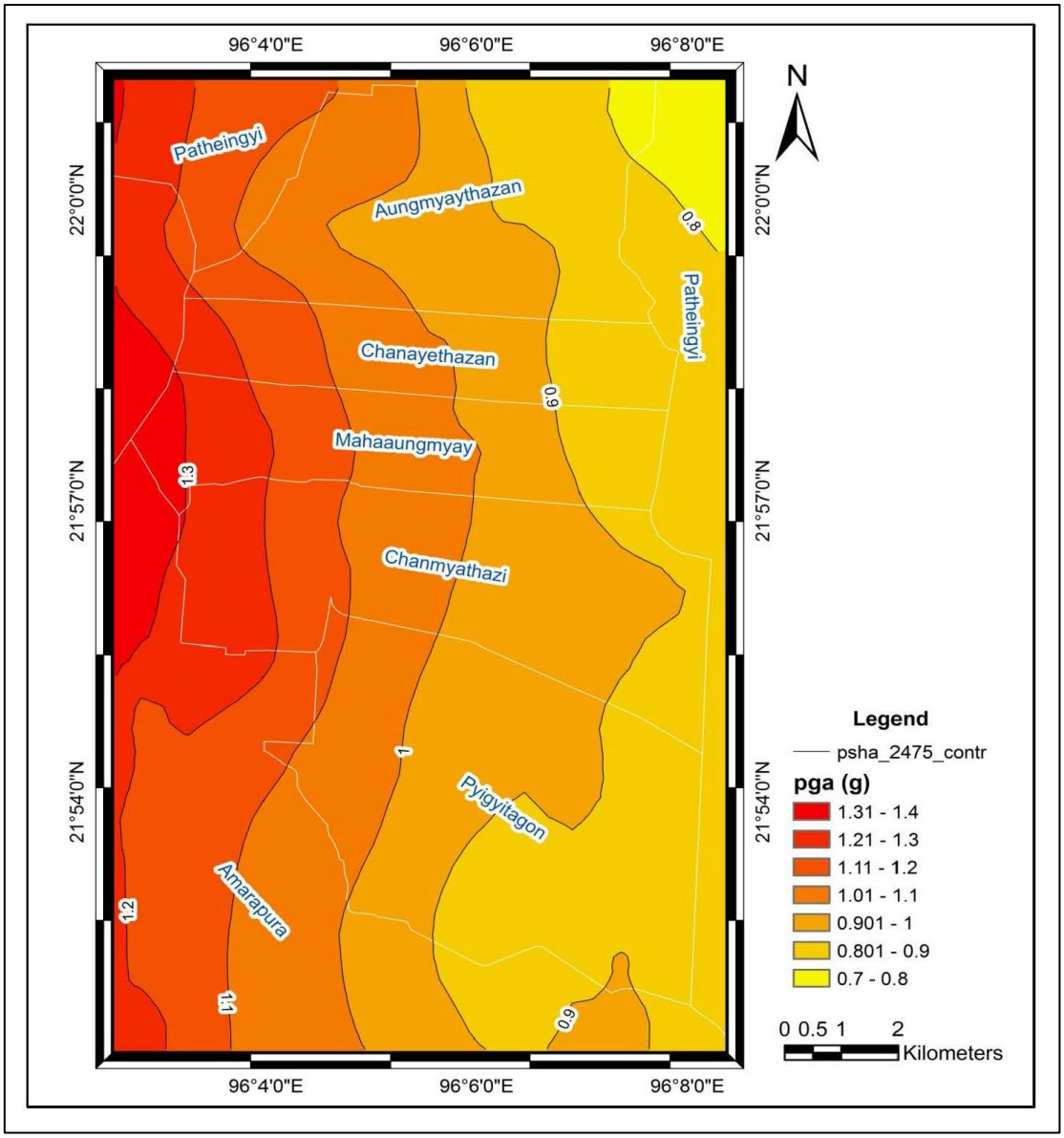


Figure 4-14 Probabilistic Seismic Hazard Map of Mandalay for 2% of Probability of exceedance in 50 years by means of peak ground acceleration, PGA (g), considering site condition, Vs30.

4.3.6.4. Seismic Hazard Assessment

As the first step, the seismic sources that can contribute seismic hazard on the Amarapura New Capital Project area are identified. The seismic sources can be identified as fault specific seismic sources and areal seismic sources based on the available information such as geology and seismicity. Myo Thant et al. (2012) proposed seismic sources model when they developed probabilistic seismic hazard models for Myanmar, based on the active fault information of Soe Thura Tun et al. (2011) and seismicity of the country. In their 2012 seismic sources model, the active faults in the Eastern Highlan (Shan Plateau) are identified as areal seismic sources, because the information available the active faults in Eastern Highland is not enough to model as fault specific sources. During a couple of years, the available information of the active faults in Eastern Highland is more sufficient. Therefore,

the new seismic sources model was proposed by Myo Thant et al., (2016) for new hazard model of Myanmar, by modifying areal seismic sources in the west of Myanmar.

For the Project area, the seismic sources from new seismic sources model as shown in Figure 4-15, that lies within 250 km radius of the project area are taken into an account for seismic hazard assessment. the fault specific seismic sources are therefore identified for the project site. Within 250 km radius of Project area, the active faults that can cause the considerable seismic hazard, i.e. large ground motion, for the project are are Sagaing Fault (Middle and Northern segments), Kabaw Fault, and Gwegyo Fault in the west; Kyaukkyan Fault, Nampon Fault, Moemeik Fault, Kyaukkme Fault, and Shweli Fault in the east; as the fault specific seismic sources and MAS_8, MAS_10, MAS_11, MAS-14 and MAS_15 as the areal seismic sources, are identified as the seismic sources for seismic hazard analysis for Amarapura New Capital Project area.

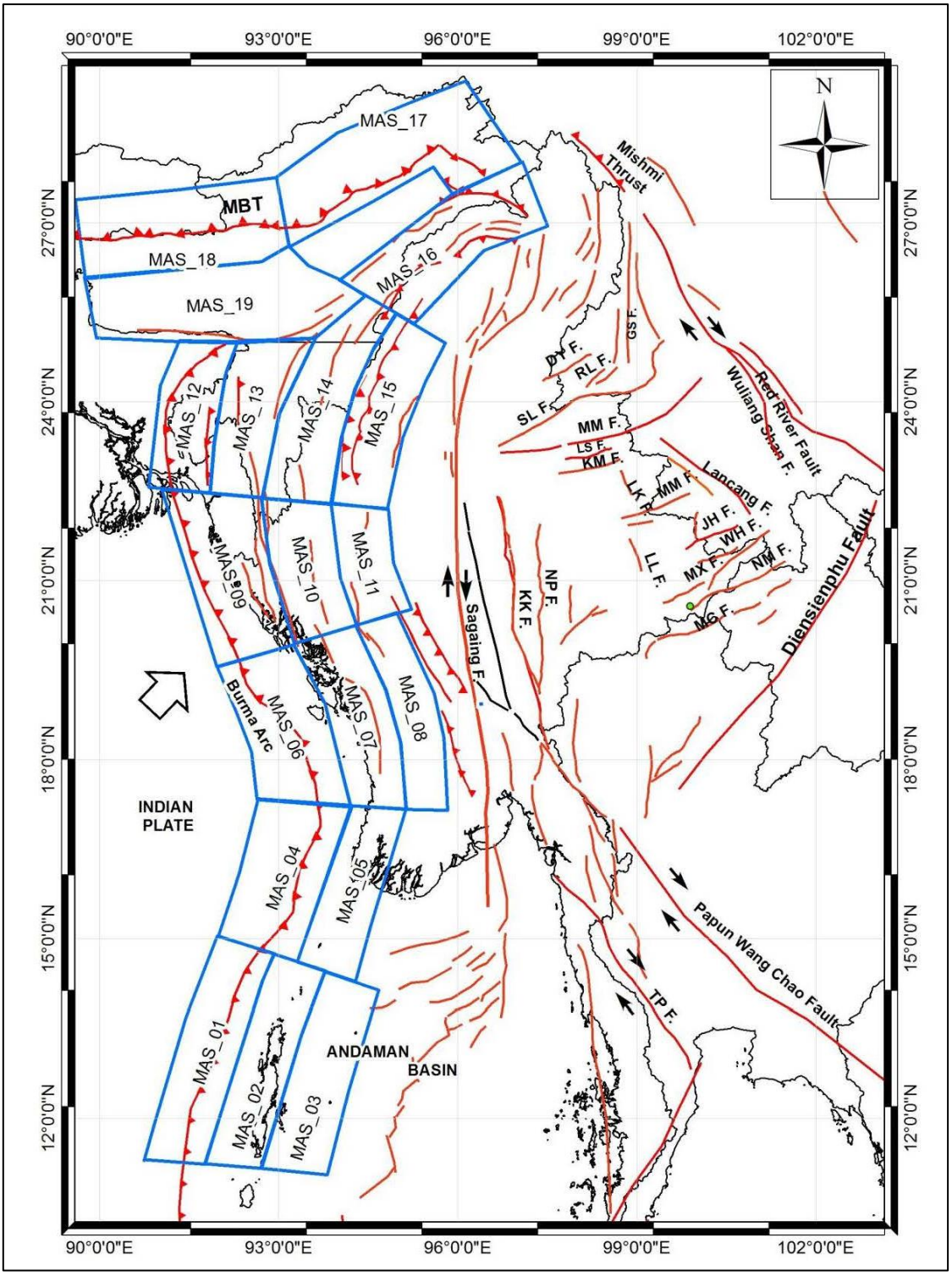


Figure 4-15 Map of seismic sources of Myanmar (Myo Thant et al., 2016), in which the blue-colored rectangles are the areal seismic sources corresponding to the subduction zone and collision zone.

4.3.6.5. Site Characterization

The intensity of seismic hazard, i.e. the ground motion level depends on the site condition. Most of ground motion prediction equations (GMPEs) as mentioned in the above use the site parameters in terms of average shear wave velocity to the upper 30 m (Vs30). In

2012, Faculty of Engineering, Chulalongkorn University developed the map of average shear wave velocity to the upper 30 m (Vs30) by using Multichannel Analysis of Shear Wave velocity method. Myo Thant et al., 2014 conducted mircrotremor survey and H/V spectral ratio analysis for 43 sites in Mandalay, and developed the map of average shear wave velocity to the upper 30 m (Vs30) by using Multichannel Analysis of Shear Wave velocity method. However, the project area is not included in those analysis. Therefore, geophysical survey (microtremor survey in here) is carried out at some sites of Amarapura New Capital Project area. Then H/V spectral ratio analysis is carried out by using the computer code of Prof. Shinichi Matsushima (Disaster Prevention Research Institute, Kyoto University), with the consideration of 39 Borehole Logs (SPT, N values). Then, the Vs30 Map of the project area is developed for site specific seismic hazard estimation.

4.3.6.6. Seismic Hazard Calculation and Results

As mentioned in the methodology session, identification of seismic sources (seismogenic fault sources and areal seismic sources in this seismic hazard analysis for Amarapura New Capital Project); study on previous seismicity (together with developing the seismotectonic map of the area) as the first step; estimation of seismic source parameters such as temporal earthquake occurrences: a- and (β) bvalues, maximum earthquake potentials (Mmax), the return period (annual of occurrence) of earthquake magnitude are carried out as the seismic sources characterization as the second step.

By assumption of different seismic source models (exponential and characteristic models), applying the different ground motion prediction models (GMPEs), the seismic hazard assessment is conducted by probabilistic seismic hazard assessment (PSHA) by considering the site condition. It means that site specific 43 peak ground acceleration are calculated for 50%, 20%, 10% and 2% probability of exceedance in 50 years (75, 225, 475- and 2475-years recurrent intervals).

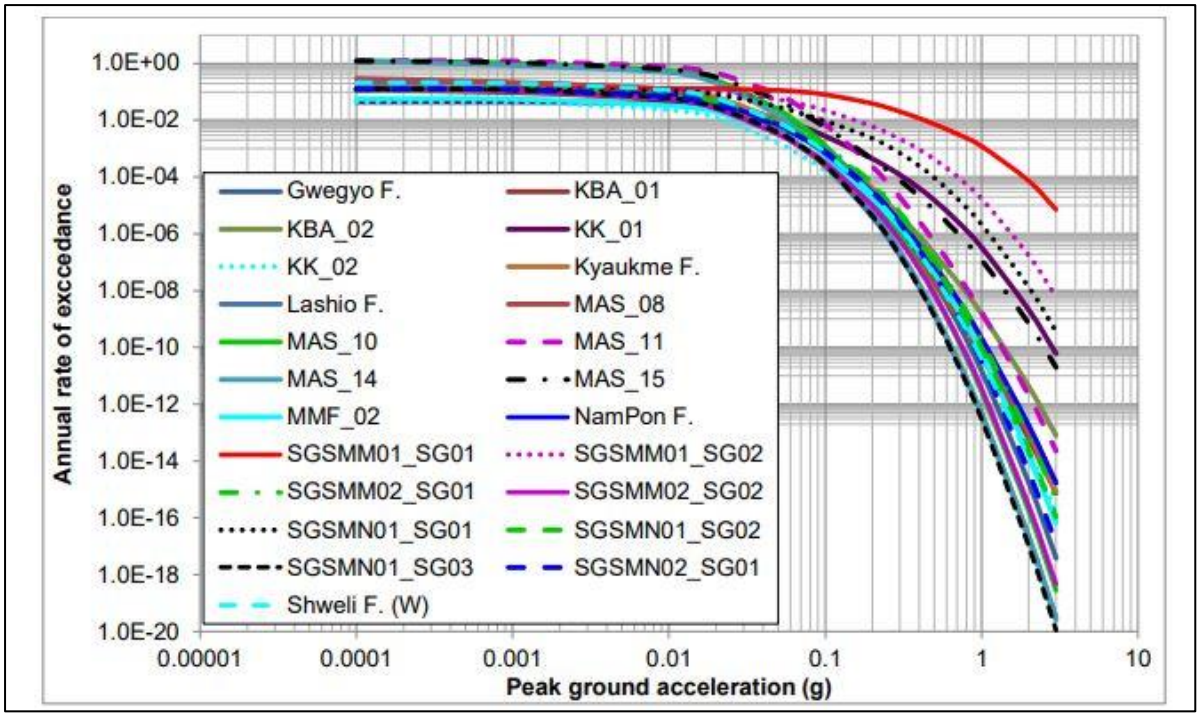


Figure 4-16 The Possibility of Seismic Hazard (PGA) on the Project Site by the Fault Specific Seismic Sources

The annual rate of exceedance of seismic hazard, peak ground acceleration (PGA) that can be distributed by all seismic sources: fault seismic sources and areal seismic sources on the project area is illustrated in Figure 4-16.

4.3.6.7. Conclusion for Seismicity

The project area is located very closed to the seismically active Sagaing Fault that is right-lateral strike-slip fault with average slip rate of 18 – 20 mm/yr. With regards to the previous seismicity, several strong earthquakes struck in this area, the largest events are probably 1839 Innwa (Ava) originated by Sagaing Fault and 1912 Burma (Maymyo) Earthquake by Kyaukkyan Fault. Recently 2012 Thabeikkyin Earthquake (Mw6.8) is the last one to this area, rather than 1856 Sagaing Earthquake. Among them, 1839 is the most severe earthquake and caused 300 – 400 deaths, and several buildings, most are pagodas, damaged and the second one 1956 Sagaing Earthquake that caused 50 deaths in Sagaing and several buildings damaged. In the previous time, most assumed 1839 event and 1956 event are shocked by the same segment of Sagaing Fault, however, current research works suggest that these two events are from different segments; 1856 event by Sagaing Segment which run from Sagaing to Singu; and Wundwin Segment that run from Innwa till north of Nay Pyi Taw. All of these segments belong to the middle segment of Sagaing Fault, the maximum possible magnitude of the earthquake potentials is estimated as from 7.6 to 7.9 Mw. By Gutenberg-Richter law, the recurrence interval for the earthquake ≥ 7.5 Mw is around 130 years and for the event with the magnitude ≥ 8.0 is 290 years recurrence interval. Based on those estimation, the occurrence of large event by Wundwin Segment of Sagaing Fault from

where 1839 event happened is high in possibility. This is the important issue taken into an account for seismic resistant design in this the Project area.

On the other hand, the area is closed to the Sagaing Fault, it is a little bit difficult to correlate the intensity of earthquake ground motion and frequency contents with site condition, because the main controlling factors on the ground motion are probably the source-to-site distance and the magnitude of the earthquake. Moreover, the frequency contents of the ground motion are probably from low to high frequency. This is another important fact to consider in developing the seismic resistant designs for various buildings.

In this seismic hazard analysis, since the fundamental frequency map is also prepared and the PSHA maps of four different recurrence intervals are developed, the information to be considered are fulfill with the needs. The summarized ground motion intensity in terms of peak ground acceleration (PGA) and (PGV) are listed in Table 4-5.

Table 4-5 Summarize ground motion intensity level for the project area

Type	**Peak ground acceleration intensity**			
	50% probability in 50 years (75 years recurrence interval)	**20% probability in 50 years (225 years recurrence interval)**	**10% probability in 50 years (475 years recurrence interval)**	**2% probability in 50 years (2475 years recurrence interval)**
PGA (in g)	0.31 – 0.38	0.48 – 0.7	0.59 -0.93	0.65 – 1.47
PGV (in cm/s)	30 - 42	60 - 88	81 - 121	78 - 209

4.3.6.8. Recommendation

1. The Project area is located very closed to the seismically active Sagaing Fault that is right-lateral strike-slip fault with average slip rate of 18 – 20 mm/yr. All of these segments belong to the middle segment of Sagaing Fault, the maximum possible magnitude of the earthquake potentials is estimated as from 7.6 to 7.9 Mw.
2. The area is closed to the Sagaing Fault, it is a little bit difficult to correlate the intensity of earthquake ground motion and frequency contents with site condition, because the main controlling factors on the ground motion are probably the source-to-site distance and the magnitude of the earthquake. Moreover, the frequency contents of the ground motion are probably from low to high frequency.
3. This is another important fact to consider in developing the seismic resistant designs for various buildings**.**

4. For geotechnical consideration. a thorough and detailed geotechnical investigation of each building site, leading to development of a full site model, should be recognized as a key requirement for achieving good foundation performance.
5. There should be greater focus on geotechnical investigations to reduce the risk of unsatisfactory foundation performance.
6. For seismic design consideration, the response spectral shape factor, for deep alluvial soils under Amarapura Urban Area, should be considered.
7. The likely change in spectral shape with earthquakes on more distant faults also needs to be considered. The shape of response spectra for vertical ground motion should be considered.
8. The implications of vertical ground motion for seismic design actions should be considered and locations identified where high vertical accelerations may be expected in earthquakes.
9. Design actions for floors acting as diaphragms need to be more clearly identified in the Standard as:
    1. the weight of the floor and its associated gravity loading and the acceleration of the floor;
    2. shear transfer between the lateral-force-resisting elements;
    3. self-strain forces induced by elongation and bending of beams; and
    4. local forces induced by structural elements such as T-shaped walls that have differing strengths for displacement in the forward and backward directions.

While the initial lateral strength of a building may be acceptable, critical non-ductile weak links in load paths may result in rapid degradation in strength during an earthquake. It is essential to identify these characteristics and allow for this degradation in assessing potential seismic performance. The ability of a building to deform in a ductile mode and sustain its lateral strength is more important than its initial lateral strength.

4.4. GEOTECHNICAL CONCEPTUAL DESIGN

Since the project area is flooded yearly, measures, like a landfill, are needed to project the urban development. The project area is also subjected to occurrence of severe earthquakes. To withstand these two natural hazards and to create a sufficiently safe environment for the urban development, a geotechnical design is needed.

4.4.1. Introduction

The following data are described base on the geotechnical conceptual design of the Amarapura urban development project. The report focusses on Phase 1, the northern part of the project. Based on an extended field survey, the subsoil stratification is determined and relevant geotechnical parameters have been assessed. The geotechnical conceptual design consists of determination of the project elevation level, the stability of the water front including a sheet pile design, erosion protection, stability of the south boundary of Phase 1 and the expected surface settlements due to sub soil compaction.

The geotechnical analysis shows that the design earthquake causes the normative loading conditions in geotechnical design. Without further measures large parts of the subsoil will liquefy during design earthquake loading, with a nearly complete loss of strength as consequence. To prevent subsoil liquefaction, the landfill and the top 20 m of the subsoil should be mechanically densified. It is strongly recommended to densify the entire project area to form a good foundation for future construction. However, densification should at least be done near the river bank. In the geotechnical conceptual design, it is assumed that the subsoil is densified and calculations are based on the improved subsoil characteristics.

There are two options for the waterfront position, Figure 4-17. The first position follows the present-day river bank. The second position smoothens the river bank and is located further into the flood plain. The field survey shows no significant differences in subsoil characteristics for the two options. The stability analyses are conducted for the subsoil characteristics found at the present-day river bank, option 1. However, the conclusions resulting from the geotechnical conceptual design also holds for option 2.

Figure 4-17 Project area phase 1, left option 1 right option 2

4.4.2. Objectives

This report describes the relevant geotechnical design principles for the geotechnical design of the Amarapura urban development project and provides for Phase 1 of the project a conceptual geotechnical design for a landfill. Special attention is given to the river bank for which a natural slope and a stepped slope using sheet pile wall are elaborated.

4.4.3. Subsoil

According to the geotechnical conceptual design report, the subsoil is the project area consist of alluvial deposits, mainly containing sands, silts and silty sands. An extended field survey is conducted containing CPTu measurements and boreholes with SPT measurements. Based on the field survey data geotechnical profiles are created. At the project site, the top layers consist of loosely packed sands and silts. At larger depths, around 30 m below ground level, densely packed sands are found. The field survey is stopped at a depth of 35 m below ground level. At two locations borings are made attempting to establish the bed rock depth. The location of these two borings is given in Figure 4-18 . Each of the borings is stopped at a depth of 100 m, while not reaching bed rock. Therefore, the bedrock depth at the project area is unknown, but at least at these two locations, larger than 100 m below ground level. The large bed rock depth is remarkable since at the other side of the river the bed rock extents to more than MSL + 200 m. In the Phase 1 area some clay layers are found near Myo Patt Road, at the east side of the project area. Along the river bank no clay layers are detected within the surveyed depth.

Figure 4-18 Location of deep holes meant to establish bed rock depth

4.4.4. Project Elevation

To prevent flooding of the project area, an elevated landfill will be constructed as foundation for the urban expansion. The level of top of the landfill, the project elevation level, is carefully selected based on river statistics measured at the Sagaing and Mandalay River station. The proposed project elevation is MSL + 74 m and corresponds to a river level with a probability of occurrence of 0.001 1/year.

4.4.5. River Level Statistics

For Mandalay station, annual maxima of water levels of the Ayeyarwaddy river are available from 1968 to 1986, while daily data are available from 1994 to 2013 (Ministry of Hydrology DMH). For Sagaing station, daily data on water levels and discharges are available from 1980 to 2014. Table 4-6 shows the results of the river levels statistics for the Mandalay station. Due to the Mandalay station's proximity and the slightly higher water levels observed at that station, the water levels measured at Mandalay station are considered to be normative. Table 4-6 gives for different probabilities of occurrence, the mean value of

the water level in the third column of the table. Columns two and four provide a measure for the statistical uncertainty by providing the 5% and 95% confidence levels for the mean.

Table 4-6 River level statistics Ayeyarwaddy river at Mandalay (1997-2014)

Probability [1/year]	5% Confidence Water level [MSL+m]	Water level [MSL+m]	95% Confidence Water Level [MSL+m]
1	69.64	69.77	69.91
0.5	69.93	70.07	70.25
0.2	70.21	70.52	70.90
0.1	70.41	70.84	71.36
0.04	70.66	71.25	71.95
0.02	70.84	71.55	72.37
0.01	71.02	71.83	72.76
0.001	71.58	72.71	74.01

Source: Mandalay Station, Ministry of Hydrology DMH (1997-2014)

4.4.6. Establishing of the Project Elevation Level

Discussions in the project team about obtaining the project elevation level showed two approaches. The first approach starts with the water level corresponding to a probability of Amarapura Urban Development Project 1231018-002-ZWS-0001, Version 1, 17 July 2017, final 6 of 78 occurrence of 0.01 1/year and adds extra margins for wave run-up and uncertainty in river level statistics e.g. due to climate change. The second approach uses a lower probability of occurrence, 0.001 1/year and does not add extra safety margins.

Elaborating the two approaches leads to the following elevation levels:

Approach 1:

In approach 1 the derivation of the project elevation consists of three components:

- Design river water level, with a probability of occurrence of 0.01 1/year. According to Table 4-6, the 95% confidence level is MSL + 72.76 m.
- A safety margin to account for wave run up. In daily engineering the safety margin is taken as 0.5 m.
- A safety margin for uncertainty in river statistics, e.g., due to climate change, this safety margin is taken as 0.5 m. The project elevation following this approach becomes MSL + 72.67 m+ 0.5 m + 0.5 m = MSL + 73.67 m.

Approach 2:

Approach 2 consists of only 1 component, the river level with a probability of occurrence of 0.001 1/year. According to Table 4-6 the 95 % confidence level is MSL + 74.01 m. Since the difference between the two approaches is small, it is decided to establish the project elevation at MSL + 74.00 m.

Regarding the project elevation it should be noted that:

- The proposed project elevation does not include compaction of the subsoil due to the weight of the landfill. The subsoil compaction is further elaborated in section 5.6.
- Due to the sandy subsoil the settlement will be relatively small, will also occur relatively rapidly.
- The river level statistics are based on a 20-year record. This means that extrapolation is needed to get the water levels belonging to the probability of occurrence of 0.02 1/year and smaller. The uncertainty of in the river statistics is reflected by the 5% and 95 % confidence level in Table 4-6.

4.4.7. Ground Water Level

The CPTu measurements show a hydrostatic pore pressure development in the sand layers. No differences in hydraulic head for the different sand layers are found. The pore pressures, as measured by CPTu, indicate that the hydraulic head follows the river level.

4.4.8. The Differences of Elevation Between Water Level and Land Level

By embankment of the project area, effectively the cross-sectional profile (or conveyance) during flood will be reduced. This will initially cause flood-level to rise upstream in a way as shown in Figure 4-19. The situation with project, i.e. with narrowed section, will create a backwater effect relative to the undisturbed situation (without the project). This river reach is presently already subject to back water from the narrow section at Sagaing, and the Amarapura Urban Development Project is located such that it has only limited through flow. Furthermore, the maximum effect is located in the widest part of the flooded river. As such, the effect of the planned project is expected to be somewhat less than in a free-flowing river with high discharges through the flood plain. In Figure 4-20 is shown how after some time (one or two decades) the bed level reaches a new equilibrium with a lower river bed, and lower flood levels. In the final situation the flood levels can be even somewhat lower than the present flood levels.

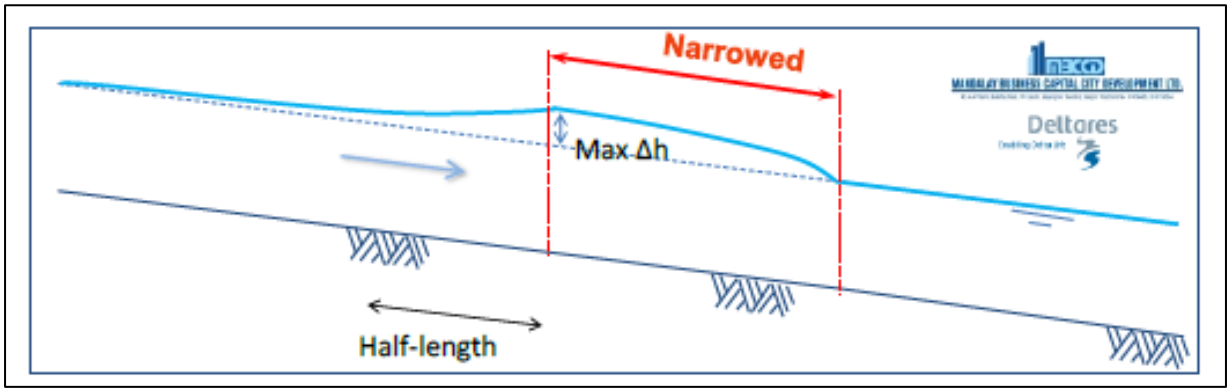


Figure 4-19 Schematic representation of INITIAL water-level change during flood with the project (after narrowing the flood plain). The dotted line represents the water-level for the present situation (without project)

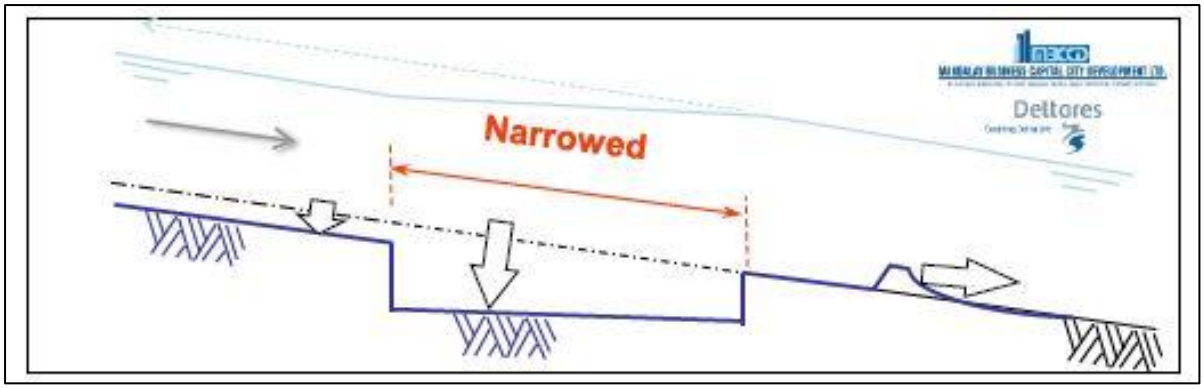


Figure 4-20 Schematic representation of LONG-TERM water-level change during flood with the project (narrowing the flood plain), due to morphological adjustment (bed-level lowering). The dotted line represents the water-level for the present situation (without project)

The following table shows the water-level difference with and without Amarapura project for the design conditions. High flow requires a roughness value of Chezy = 65 m1/2/s.

Table 4-7 The water level difference with and without Amarapura project for design conditions

Probability of occurrence (1/year)	Discharges (m3/s)	95% Confidence Discharges (m3/s)	95% Confidence Water Level (m+MSL)	Water-level difference calculated for 95 % discharge (m)
1	23129	23861	69.91	+0.11
0.5	24725	25650	70.25	+0.12
0.2	27170	29318	70.90	+0.13
0.1	29020	32168	71.36	+0.14
0.04	31466	35937	71.95	+0.15
0.02	33316	38806	72.37	+0.17
0.01	35166	41673	72.76	+0.18
0.001	41311	51458	74.01	+0.21

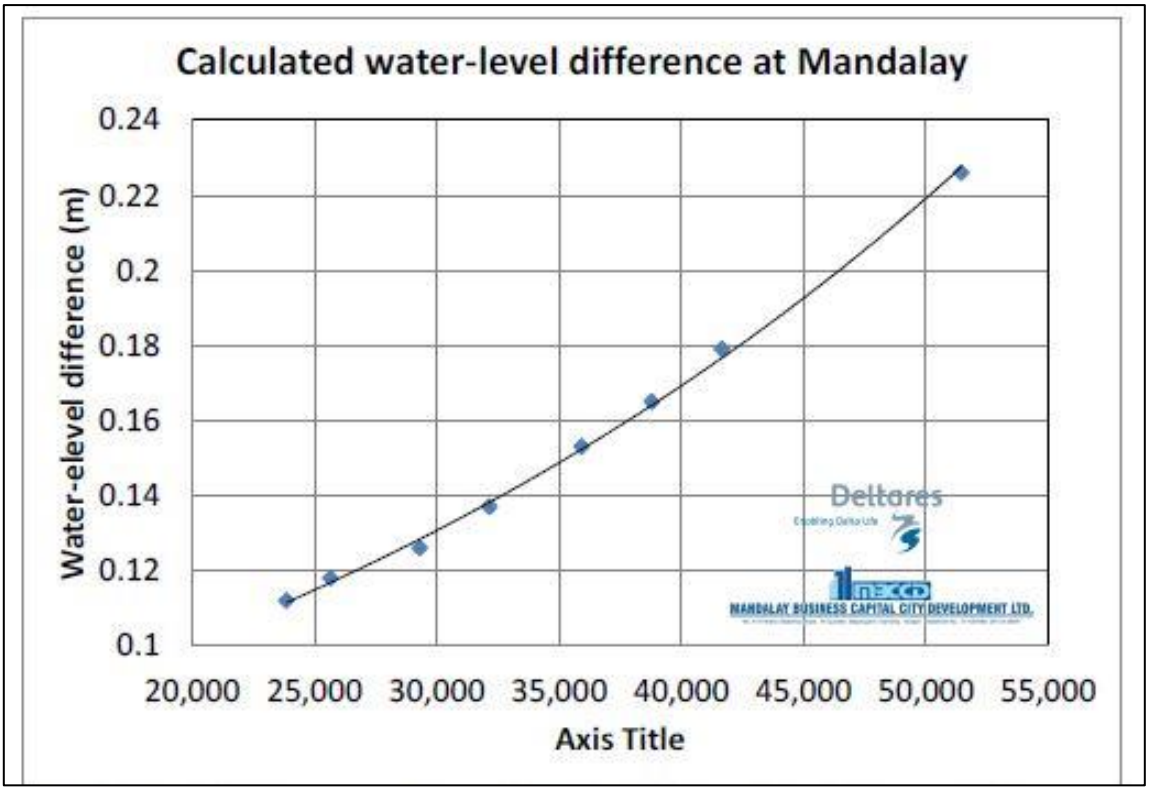


Figure 4-21 Calculated difference in water level at Mandalay due to the project: positive values mean that water levels are higher with the project, relative to the present situation.

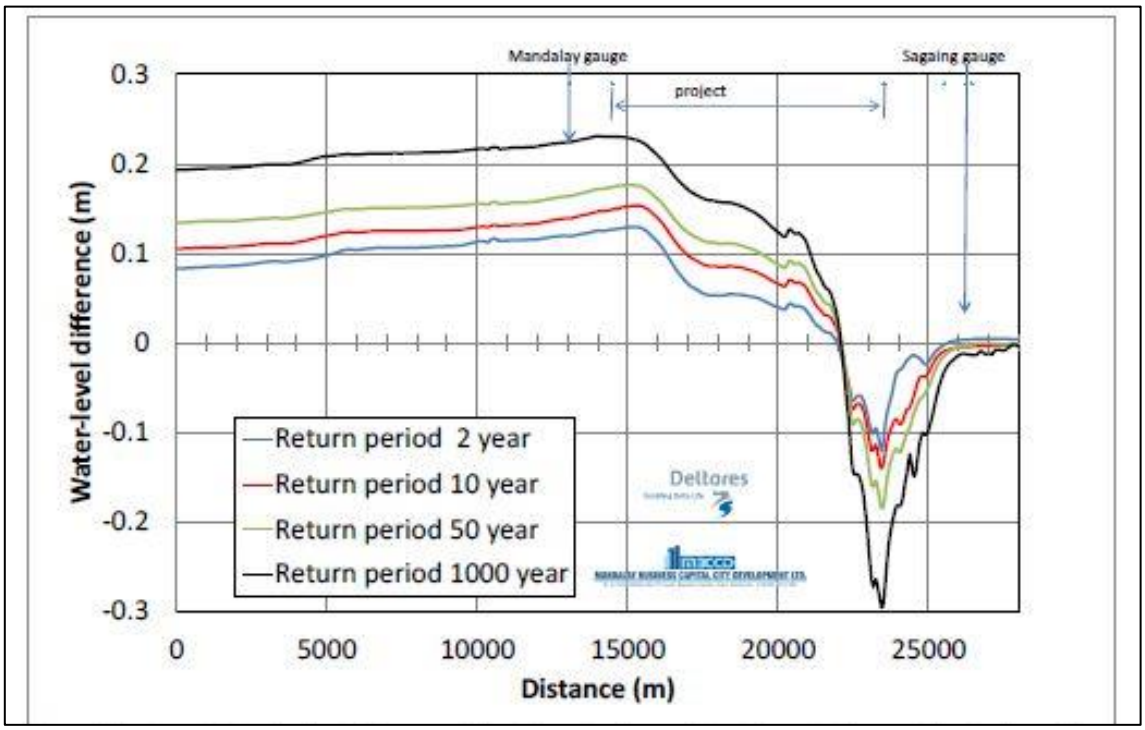


Figure 4-22 Computed water-level difference plotted along the river axis for different return periods. Positive values mean that water levels are higher with the project, relative to the present situation.

4.4.9. Design Principles

The project proponent will follow the Myanmar National Building Codes (MNBC) (2016) and MES (2016) for the design of the landfill. For some aspects regarding earthquake loading, information from the Unified Building Codes1997, ICBO (1997), hereafter referred to as UB97 and Idriss & Boulanger (2008) are used. Handbook (CIRIA, 2013), hereafter referred to as ILH. The regarding the in-situ measurements primary guidance is based on the American Standards for Testing Materials (ASTM).

The following sectors will include the geotechnical design for Phase 1 of the project implementation;

1) Liquefaction of subsoil or landfill due to earthquake loading;
2) Instability of water front due to either earthquake loading or hydraulic conditions;
3) Instability of the canal bank, south side of Phase 1, due to earthquake loading or hydraulic conditions;
4) Subsoil compaction due to landfill weight.

4.4.10. Liquefaction

The first step in design is checking the liquefaction potential for subsoil and proposed landfill. Liquefaction represents the condition of complete loss of strength. So, in the first design step sufficient reduction in liquefaction potential during design earthquake loading should be guaranteed. The relevance of liquefaction can be subdivided into liquefaction potential at the waterfront, which endangers the stability of the river bank and the liquefaction potential underneath the landfill. It should be noted that if the subsoil, at some distance from the river bank, liquefies, the landfill itself is not endangered. However, the structures built upon it will be and the measures taken to reduce the liquefaction potential should be considered for the entire project area. This point forms the interaction between the geotechnical design and the structural design.

4.4.10.1. Methodology

The subsoil liquefaction risk will be determined from the CPTu measurements at the site. For the landfill, the liquefaction risk might lead to design considerations regarding the required characteristics for sand to be used for building the landfill and density of the landfill including the need for mechanical densification.

The susceptibility of the subsoil for liquefaction will be determined from the CPTu's in accordance to MNBC2016 section 4.5.1.4 and Idriss & Boulanger (2008). The summary of working procedure and relevant formulae are bellowed.

4.4.10.2. Design Calculation for Liquefaction

The safety against liquefaction for design earthquake situation is checked as the first stage in determining the foreshore stability. For Phase 1, a total of 37 CPTu measurements have been analyzed. The factor of safety against liquefaction (FSliq) is calculated for two conditions for each CPTu measurement:

1. Present day conditions, based on the CPTu measurements according to equation (4).
2. After construction, including the weight of the landfill and mechanical densification of the subsoil.

4.4.10.3. Formula Approach

The analysis of a CPTu in terms of FSliq provides an in-depth profile of FSliq. In these, in depth profiles, layers with a low FSliq and high FSliq values might be present. This might result in a difficulty in evaluating the susceptibility for liquefaction at a specific location. A further analysis of the data can be made by calculating the Liquefaction Potential Index, LPI, Iwasaki et al (1978):

$$LPI=\int_{z=0}^{z=20} [\![F \times w(z) dz]\!]$$

$$F=1-FS_{liq}, F=O \text{ for } FS_{(liq)} \geq 1$$

$$w=10-0.5\times z \qquad \text{(Eq 1)}$$

As shown by the equations above, the LPI provides a scaled average liquefaction potential of the top 20 m of the subsoil. The data is scaled such that the FSliq at the top attributes more to the LPI than the bottom. It should be noted that liquefaction at a depth larger than 20 m is not considered relevant for constructions at ground level. It should be noted that in equation (1) z starts at ground level. The ground water level is situated at a lower level, leading to a dry landfill and top of the original subsoil. Since dry soil will not liquefy, raising the ground level will reduce the susceptibility for liquefaction.

In evaluating the LPI data the following criteria are applied.

LPI < 5 = no susceptibility for liquefaction during design earthquake conditions.

5 < LPI < 15 = some liquefaction might occur.

LPI > 15 = the subsoil will liquefy during design earthquake conditions

4.4.10.4. Description of Result

For phase 1 of the project, the CPTu analysis is conducted within the project area. Figure 4-23 shows the result of the analysis of CPTu-029, which is considered typical for the CPTu measurements along the river bank. Figure 5.1 shows the measured cone resistance, qc in the first graph. The second graph shows the normalized cone resistance, qc1NCS, as defined by equation (6). The third graph shows the soil behavior type index, Ic, which is used

for soil type identification, see Table 4-8. The fourth graph shows the relative density, Dr using the Villet & Mitchell (1981) correlation. The fifth graph shows the calculated FSliq, as defined by equation (4) and further. Finally, the sixth graph shows the relative excess pore pressure during design earthquake, ru.

The Figure 4-24 shows an overview of the calculated LPI values for Phase 1. The LPI values are well beyond 15, indicating the strong susceptibility for liquefaction.

Table 4-8 Relation Between the Soil Type Behaviour Index, Ic and Soil Type according to Robertson & Cabal, 2015

No.	Soil Type	Ic [-]
1	Organic soil/clay	>3.6
2	Clays – silty clay to clay	2.95-3.6
3	Silt mixtures – clayey silt to silty clay	2.60-2.95
4	Sand mixtures – silty sand to sandy silt	2.05-2.60
5	Sands – clean sands to silty sand	1.31-2.05
6	Gravelly sand to dense sand	<1.31

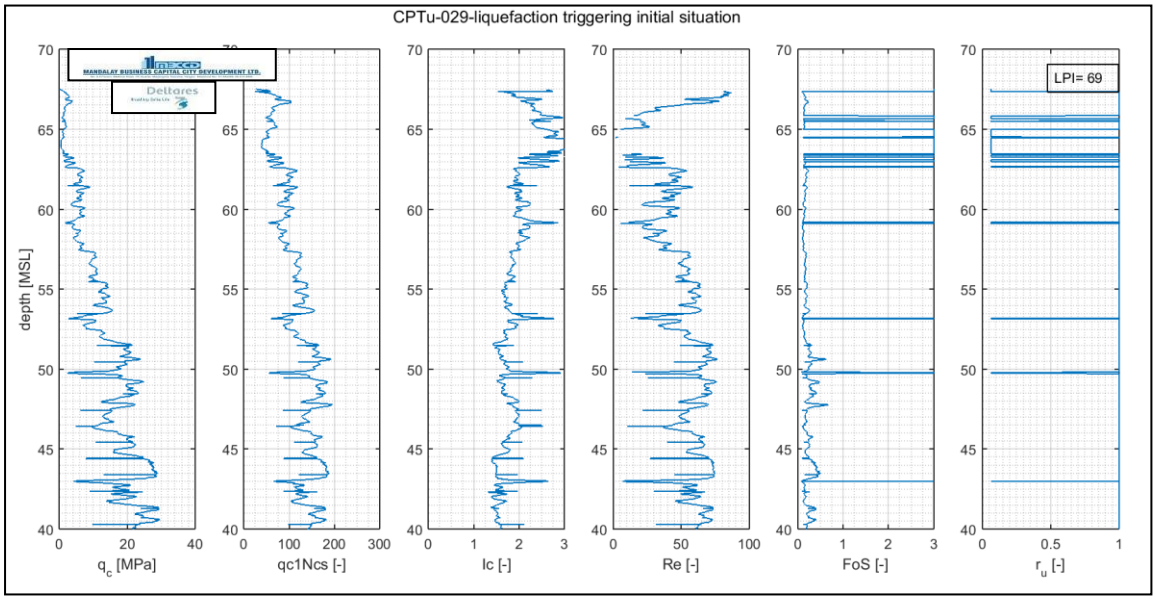


Figure 4-23 Analysis of CPTu-029, results of other CPTu data

Figure 4-24 Overview of calculated LPI for initial conditions

The CPTu analysis shows low values for FSliq and consequently high values for LPI. This means that liquefaction and accompanied loss of subsoil strength during design earthquake conditions is relevant. To reduce the susceptibility for liquefaction the subsoil can be densified. Mechanical densification leads to a strength increase of the subsoil. The residual strength during liquefaction is given by ru. For ru =1 the excess pore pressure Du equals the

initial effective stress level s'v representing a nearly complete loss of strength. As an example, Figure 4-25 shows for CPTu 012 how ru changes for changing relative density Dr. The left graph shows that without densification, i.e. for original soil conditions, ru = 1 during design earthquake conditions. The following graphs in Figure 4-25 show how ru changes when Dr is increased in steps from 60% to 85%. For Dr = 85% a ru equal to 0.1 is found, resulting in a limited increase in excess pore pressure.

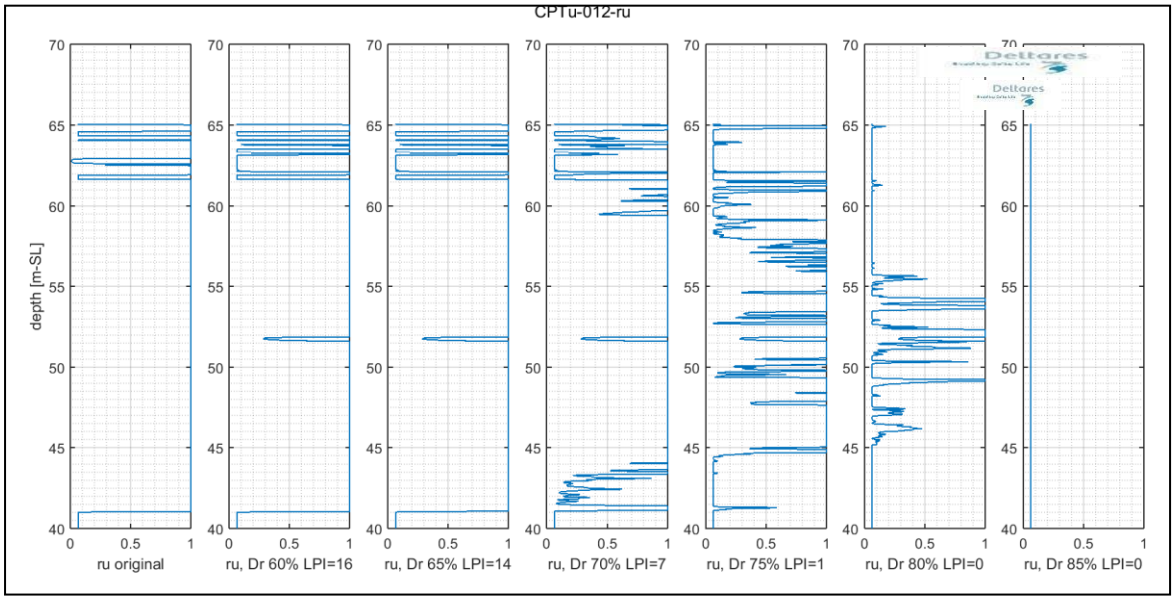


Figure 4-25 Analysis of CPTu 012; r_u as function of relative density, initial *LPI* = 78

To provide enough safety against liquefaction it is strongly recommended to densify the subsoil and landfill. Complete densification, Dr = 100%, will not be achieved in the field.

Instead, based on engineering judgement, it is assumed that after mechanical densification Dr= 75% for sands and Dr = 65% for silts are reasonable values. Field tests at the site are required to verify the achieved densities after densification.

Since subsoil densification is part of the proposed design, the future conditions include both the weight of the landfill and densification of the subsoil. Several relations are available to estimate the relative density from CPTu data. The general shape of these relations is given by equation (2). The parameters A, B and C for the different relations are given by Table 2 4.

D_r=A ln⁡(q_c/(Bσ^(C))) (Eq 2)

Table 2 4 Parameters for different correlatins between relative density Dr and cone resistance qc

No.	Description	A	B	C
1	Schmertmann	34.36	0.047	0.71
2	Lunne & Christofferson	34.36	0.061	0.71
3	Baldi	40	0.14	0.6

4 Villet & Mitchell 41.67 0.08 0.78

In further analysis the relation according to Villet & Mitchell (1981) is used. The LPI after construction is calculated by including the positive effect of densification and the effective stress increase due to the weight of the landfill. The change in effective stress not only influences the analysis through Cn in equation (6) and CSR in equation (8) but also themeasured cone resistance, qc, according to equation (7).

In adjusting qc to the new stress condition, the ratio, (σ (v, new)^')/(σ_(v,old)^') is cut off at a value of 5. This is done to avoid extreme values due to the low effective stress level at the top of the CPTu.

4.4.10.5. Liquefaction Potential Index (LPI) Calculation

The LPI for future conditions is then found by the following steps:

Calculate the relative density Dr according to equation (2) using the Villet & Mitchell (1981) constants and present-day stress condition

If Dr < 65% for silt layers and < 75% for sand layers densification is simulated by

calculating qc from rewriting equation (2) to:

$$q_{(c, dens)}=B\sigma^{(,C)} \exp (D_r/A) \quad \text{(Eq 3)}$$

In which Dr = 65% for silts and Dr = 75% for sands and qc, dens is the cone resistance after densification.

Increase qc, dens for the stress conditions after the landfill has been constructed according to equation (7).

Evaluate the FSliq and LPI for the increased qc, dens.

An overview of the calculated LPI is shown by Figure 2 10. The calculated LPI values shows that after densification and landfill construction full liquefaction during design earthquake conditions is not to be expected. It should be noted that ru values show that still some strength reduction will occur. This strength reduction is accounted for in the stability analyses that are discussed in the following sections as the post-earthquake conditions.

The LPI after constructing the landfill represents the relevant conditions for the project. However, these values are calculated based on estimations of the influence of densification and landfill weight on the cone resistance. It is mandatory to check and verify these assumptions by conducting new CPTu measurements after densification and construction of the landfill.

Figure 2 10 Overview of LPI after landfill construction

The factor of safety against liquefaction, FS_liq is given by:

$$FS_{liq} = CRR/CSR \quad \text{(Eq 4)}$$

In which:

CRR = Cyclic Residence Ratio of the situ subsoil

CSR = Cyclic Shear stress Ratio of the in situ subsoil

The subsoil strength, CRR, is derived from the CPTu measurements. For a reference Earthquake, M = 7.5 and reference stress level, σ_v^,= 100 kPa (=1 atm), follows:

〖CRR〗(M=7.5, σ_v^,=1)= exp(q_c1Ncs/540 +(q_c1Ncs/67)^2-(q_c1Ncs/80)^3+ (q_c1Ncs/114)^4 - 3) (Eq 5)

In which q_c1Ns is the normalized corrected cone resistance. The correction accounts for the fine content, FC; q_c1Ns is given by:

$$q_{c1Ns} = q_{c1N} + \Delta q_{c1N}$$

$$q_{c1N} = q_{c1}/P_a$$

$$q_{c1} = C_N q_c \; ; \quad C_N = (P_a/〖\sigma'〗_v)^{0.5} \leq 1.7$$

$$\Delta q_{c1N} = (5.4 + q_{c1N}/16) \exp(1.63+9.7/(FC+0.01)-(15.7/(FC+0.01))^2) \quad \text{(Eq 6)}$$

$$Fc = 2.8 \times Ic^{2.6}$$

In which:

q_c= cone resistance, [kN/m2]

q_c1= cone resistance corrected for stress level, [kN/m2]

q_c1N= normalised corrected cone resistance, [-]

q_c1Ncs= normalized cone resistance corrected for stress level and fine content, [-]

C_N = correction factor, [-]

P_a = atmospheric pressure, 100 kN/m2

σ_v^, = vertical effective stress in the field, [kN/m2]

FC = fine content, [%]

Ic = soil classification index, according to Robertson & Wride, 1998, [-]

It should be noted that safety against liquefaction, 〖FS〗_liq is relevant for future conditions, after construction of the landfill. The weight of the landfill will have an impact on subsoil stresses and therefore on the q_c value. The expected cone resistance after

construction of the landfill can be estimated from the expected increase in stress level and present q_c value, by:

$$q_{(c,new)}=q_{(c,old)}\ (\sigma_{(v,new)}{}')/(\sigma_{(v,old)}{}') \qquad \text{(Eq 7)}$$

In which:

$q_{(c,new)}$ = the cone resistance after construction of the landfill

$q_{(c,old)}$ = the cone resistance before construction of the landfill

$〖\sigma'〗_{(v,new)}$ = the vertical effective stress after construction of the landfill

$〖\sigma'〗_{(v,old)}$ = the vertical effective stress before construction of the landfill

By using $q_{(c,a)}$ instead of q_c in equation (6) the positive influence of future stress increase is taken into account. It should be noted that landfill weight will not only affect the q_c but also the measured friction f_s. Changes in f_s might have some effects on the final determination of $〖FS〗_{liq}$. However, these changes are negligible and are not further considered in the analysis.

Since the CRR is given for a reference earthquake and reference stress level, the CSR should be determined for the same reference levels:

$$〖CSR〗_{(M=7.5,\ 〖\sigma'〗_{v-1})}=0.65\ \alpha_{max}/g\ \ \sigma_v/(\sigma_c{}')\ r_d\ \ 1/MSF\ \ 1/K_\sigma\ 1/K_\alpha$$

$$r_d=\exp〖(\alpha+\beta\times M)〗$$

$$\alpha= -1.012-1.126\times\sin(z/11.73+5.133)$$

$$\beta=0.106+0.118\times\sin(z/11.28+5.143) \qquad \text{(Eq 8)}$$

$$K_\sigma=1-C_\sigma \ln((\sigma_v{}')/P_a)\leq 1.1$$

$$C_\sigma= 1/(37.3-8.27〖(q_{c1N})〗^{0.264})\leq 0.3$$

$$MSF=6.9\times\exp((-M)/4)-0.058$$

In which:

α_{max} = maximum acceleration during earthquake, α_{max}=PGA x g, [m/s2]

g =9.8 [m/s2]

σ_v =overburden pressure, [kN/m2]

$\sigma_v{}'$ =vertical effective stress in the field, [kN/m2]

r_d =depth reduction factor, [m]

z =depth [m]

M =earthquake magnitude, [-]

MSF =Magnitude Scaling Factor, correction for earthquake magnitude different form M=7.5, [-]

K_σ =correction for reference stress level, [-]

K_α =correction for static shear stress, see below, [-]

P_a =atmospheric pressure, 100 kN/m2.

A static pre-shearing influences the susceptibility for liquefaction. The influence can be positive or negative. The correction for static shear stress is given by:

$$K_\alpha = a + b \exp((-\xi_r)/C)$$

$$a = 1267 + 636a^2 - 634 \exp(\exp(a) - 632 \exp(\exp(a)))$$

$$b = \exp(\exp(-1.11 + 12.3a^2 + 1.31 \ln(\ln(a + 0.0001))))$$

$$c = 0.138 + 0.126a + 2.52a^3 \qquad \text{(Eq 9)}$$

$$\alpha = \tau_s / (\sigma_v')$$

$$\xi_r = 1/(Q - \ln((100(1+2K_0)\sigma_v')/(3P_a))) - (0.478(q_{c1N})^{0.264} - 1.063)$$

In which

K_α = correction factor for static shear stress, [-]

τ_s = static shear stress, [kN/m2]

Q = parameter in I_RD-ξ_r relationship, here Q=10, [-]

K_0 = ratio of horizontal to vertical stress, K_0=1-sin(Ø^'), [-]

Ø' = angle of internal friction, [°]

Application of the above given equations (4) to (9) requires, besides the CPTu data, information on the fine content, FC, the overburden pressure and the vertical effective stress. Information on these parameters is mainly based on the CPTu results and when possible, validated against laboratory measurements or in situ tests.

4.4.10.6. Stability Waterfront

The geotechnical conceptual design considers two options for constructing the waterfront. The first is a natural slope. The second is a stepped slope in which sheet piles are used to construct the steps. The stability of the slopes is evaluated for normative hydraulic conditions, earthquake loading and post-earthquake conditions.

The calculated factor of safety for the natural slope under normative hydraulic conditions is evaluated by slip circle analysis. The results show a sufficiently high factor of safety for slopes up to 1(V):2(H). As is to be expected, for more gentle slopes higher safety factors are found. For earthquake loading the safety factor is not relevant due to the very

short duration of the loading conditions. Instead, the resulting residual displacements have been assessed. The assessment is based on a comparison between calculation results and data base information of displacements observed during earthquakes around the world. Two approaches have been followed resulting in different results. The differences in results illustrate the range of expected displacements. After testing several slopes, the calculations are focused on a 1(V):4(H) and 1(V):7(H) slope.

Besides maximum displacements along the slope, also the displacements at near the road, situated at 5 m from the top of the slope are evaluated. It should be noted that maximum displacement along the slope causes only damage, while displacements at 5 m from the crest of the slope might result in blocking the road reducing the accessibility of the area after a design earthquake event.

The expected displacements are in the order of 0.5 – 1.8 m along the slope and 0.3 – 1.1 m at 5 m distance from the crest for a 1(V):4(H) slope. A reduction of the slope to 1(V):7(H) slightly reduces the expected displacements; 0.5 – 1.4 along the slope and 0.2 – 0.7 m at 5 distance from the crest. At this moment no maximum tolerated displacements have been established. Expected residual displacements > 1 m near the road will hamper its use. Based on these results it is suggested not to construct the 1(V):7(H) slope, or gentler, unless more information on the earthquake loading is available allowing more accurate displacement calculations.

For post-earthquake conditions superficial sliding is to be expected for a 1(V):4(H) slope. It should be noted that for these calculations the positive effect of the erosion protection on superficial sliding is not considered. For the 1(V):7(H) slopes no superficial stability problems are expected for post-earthquake conditions.

The option of a stepped slope is elaborated for a four-stepped slope with an overall slope of 1(V):7.5(H) and 1(V):4(H). The stability of the stepped slope is checked for the same loading conditions as applied for the natural slope. It should be noted that for the stepped slope design the earthquake is simulated by a time series of horizontal acceleration. A representative time series is selected for this project based on engineering judgement in combination to a data base of worldwide earthquake measurements. The modelling of the earthquake for the stepped slope is therefore different than for the natural slope. Calculations show the feasibility of a stepped slope with an overall slope of 1(V):7.5(H) for sheet piles applied to a depth of MSL + 51 m, using a general sheet pile type, AZ36-700N-240. Optimisations have been tested for reduction of sheet pile length to a depth of MSL + 59.5 m, the mutual distance of the sheet piles, to an overall slope of 1(V):4(H) and a combination sheet pile reduction and mutual distance. The calculations show that a reduction in sheet pile length can be obtained.

To provide sufficient stability during earthquake conditions for both tested slope angles the subsoil should be densified at the waterfront up to the top of the layer which is identified as very dense sand in the geotechnical profiles. If the sand layer between the end of the sheet piles and the top of the very dense sand layer is not densified, the post - earthquake

reduced strength of this layer will lead to large displacements and / or failure of the construction independent of the applied slope. The residual strength strongly depends on the earthquake characteristics and the ability for densifying the subsoil, which in its turn depends on subsoil conditions and available methods and techniques. With more information on both topics a better estimate of post-earthquake stability can be given.

Further optimisations in design of the stepped slope are only relevant when more information is available for the design earthquake and available construction materials and techniques.

4.4.10.7. Slope South Side Phase (1)

A natural slope forms the southern side for Phase 1 landfill. A canal is planned along the south boundary of Phase 1 and therefore it is optional that the south boundary of Phase 1 is incorporated in the canal slope. The canal depth is not established yet. Instead, a series of calculations for different slope angles in combination to different canal depths is conducted. If no excavation is applied, the canal bottom equals present day ground level than a slope as steep as 1(V):1.5(H) is sufficiently stable for normative hydraulic loading and for postearthquake conditions. However, large displacements are to be expected during earthquake loading. For 2 m or 4 m excavation a 1(V):3(H) or gentler is needed to provide sufficient stability.

4.4.10.8. Settlement

The settlement and pore pressure development are calculated by Finite Element Analysis, FEM, using PLAXIS 2Dv2015.02, using the Hardening Soil small strain model with the Parameters. The bedrock level is not established for the project area and lies beyond MSL - 30 m. For thicker compressible layers more settlement and longer settlement duration will be found. Therefore, two schematisations have been applied. In the first schematisation, the bedrock is assumed at MSL – 30 m. This represents a total layer thickness of approximately 100 m. In the second schematisation, the bedrock is assumed at MSL – 80 m. This represents a total layer thickness of 150 m.

Schematisation 2 includes a clay layer. The Soft Soil Creep model, as implemented in PLAXIS, is used to model the clay behaviour. The Soft Soil Creep model is a material model based on the isotache concept. For this type of model, the initial creep rate, the creep rate before loading, is an important parameter in settlement prediction. The initial creep rate is given by:

d_ε/dt=μ^*/τ, τ=t_0 OCR^((λ^*-κ^*)/μ^*), OCR= (σ_vy^')/(σ_vi^') (Eq 10)

In which:

dε/dt =strain rate

λ^*,κ^*,μ^* =stiffness parameter,

OCR	= Over Consolidation Ratio
σ_vy^'	=pre-consolidation stress
σ_vi^'	=initial vertical effective stress

Due to the weight of the landfill the subsoil will compact. This compaction will result in settlement of the ground level. The amount of compaction depends on the stiffness of the different soil types and the thickness of the compressible layers. Densification of the landfill and subsoil will have a reducing effect on the settlement. Since the bed rock depth is not established at the project site, it is unavoidable to assume on the total thickness of the compressible layer. Fortunately, the compressibility of the soil is highest near the surface and smaller deeper at depth, hence this assumption is not too critical for the design. Apart from the magnitude of the settlement also settlement rate is important.

The settlement rate is determined by the subsoil permeability and creep. In contrast to sands and silts, clay is more susceptible for creep. As a consequence, settlement and settlement development is calculated for two subsoil schematisations; a schematisation without clay and a schematisation with the largest clay layer thickness found in the field survey. The schematisation without clay results in a small settlement in the order of 0.1 to 0.15 m that will already develop during the construction of the landfill.

The schematisation that includes a clay layer results in settlement in the order of 0.3 m that will develop over a period of 27 years. For the schematisation containing a clay layer, the majority of the settlement will occur during the construction of the landfill. The amount of remaining settlement after construction of the landfill, the residual settlement, depends on the construction time which is not established yet. When it is assumed that the construction period of the landfill is approximately 1 year, the residual settlement will be in the order of 0.1 m. This is an acceptable value for general urban areas. For sensitive structures, e.g. like chemical plants or some types of high tech industry, more strict requirements on the residual settlement might be needed.

To reduce the residual settlement, it is recommended to start constructing the landfill at the location where clay layers are present in the subsoil. The settlement calculations are based on only a few laboratory tests. More information will improve the accuracy of the settlement prediction. Besides extra oedometer tests, it is recommended to measure the settlement during construction and use these measurements for updating the settlement prediction.

4.4.10.9. Revetment and Scour Hole

Relevant parameters for designing a stone revetment have been established and a stone revetment for a 1(V):4(H) slope has been designed. The design shows the feasibility of a stone revetment for project conditions and gives guidance for further detailed design. For a detailed revetment design more information on available materials are needed and preferably

a choice in final slope is needed. The boundary conditions can be optimized if more information on normative wind fields is established.

The analysis of relevant parameters for designing the stone revetment reveals the possibility for the development of scour hole near the waterfront of the project area. Such a scour hole can reach a depth of 22 m below present river bed and will endanger the stability of the waterfront.

In the analysis it is assumed that the development of a scour hole is not related to earthquake loading. To prevent a scour hole causing damage to the waterfront a falling apron can be constructed. When activated, the falling apron will result in a 1(V):2(H) under water slope of the scour hole. Such a slope is stable under normal conditions, but will result in large deformations during earthquake loading. This means that if a scour hole develops and the falling apron is activated, some maintenance measures are required to prevent slope failure during earthquake loading. This forms a topic to be elaborated in the detailed design. Although the dimensions of the scour hole parallel to the waterfront might be limited, a falling apron is needed along the entire length of the waterfront.

4.4.10.10. Earthquake

According to article 3.4.1.8.3 from MNBC (2016), peak ground acceleration of our project is 0.4 and seismic coefficient is 0.16. therefore, selection of seismic coefficient, kh=0.3 is reasonable. According to MNBC (2020), Ss (MCE spectral response at short periods) and S1 (MCE spectral response acceleration at a period of 1 sec) values of Mandalay region are 1.2 and 0.7 respectively.

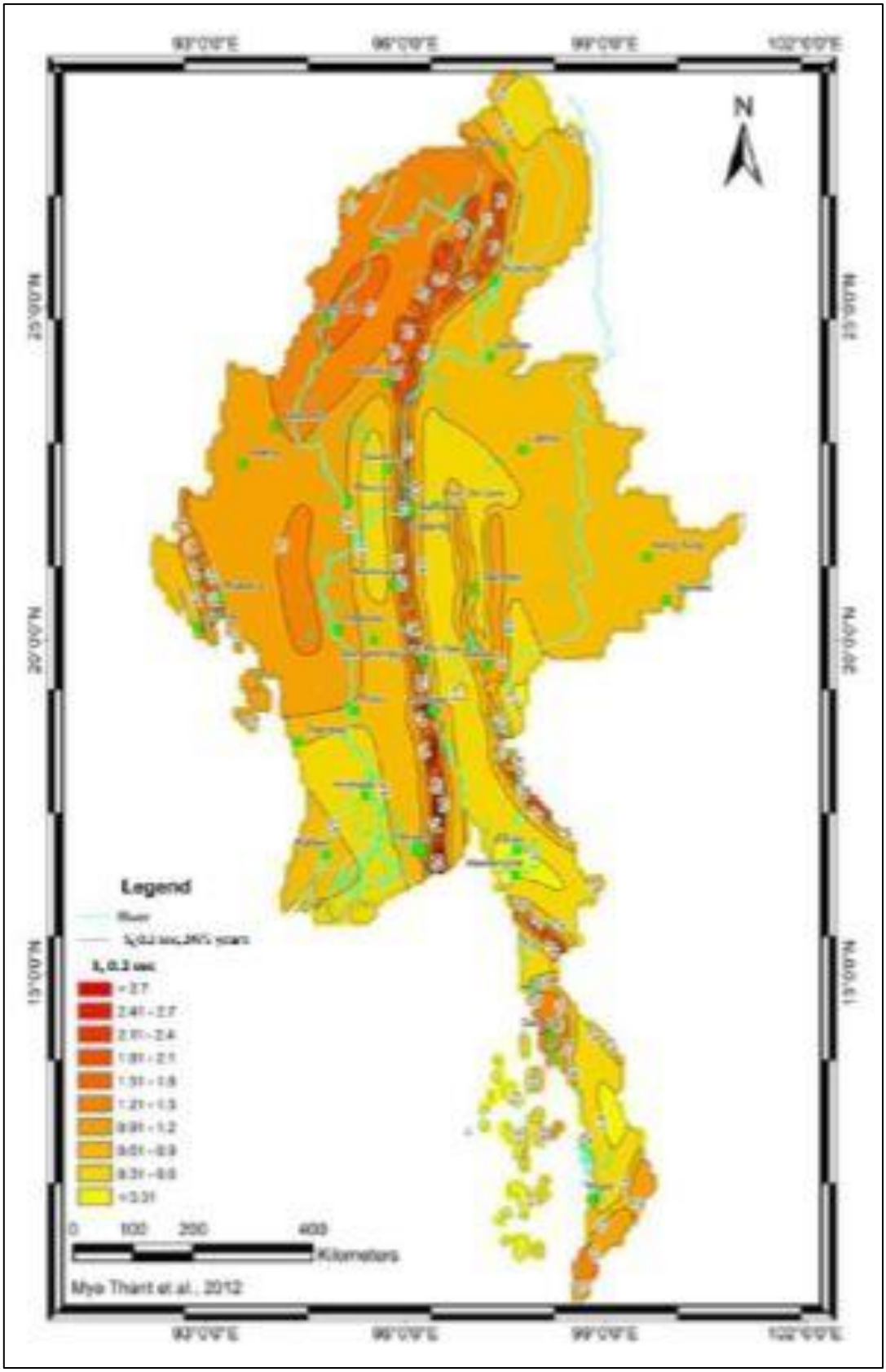


Figure 4-26 Maximum Considered Earthquake Ground Motion for 0.2 Sec Spectral Response Acceleration at 2% Probability in 50 Years with 5% Critical Damping, Site Class B.

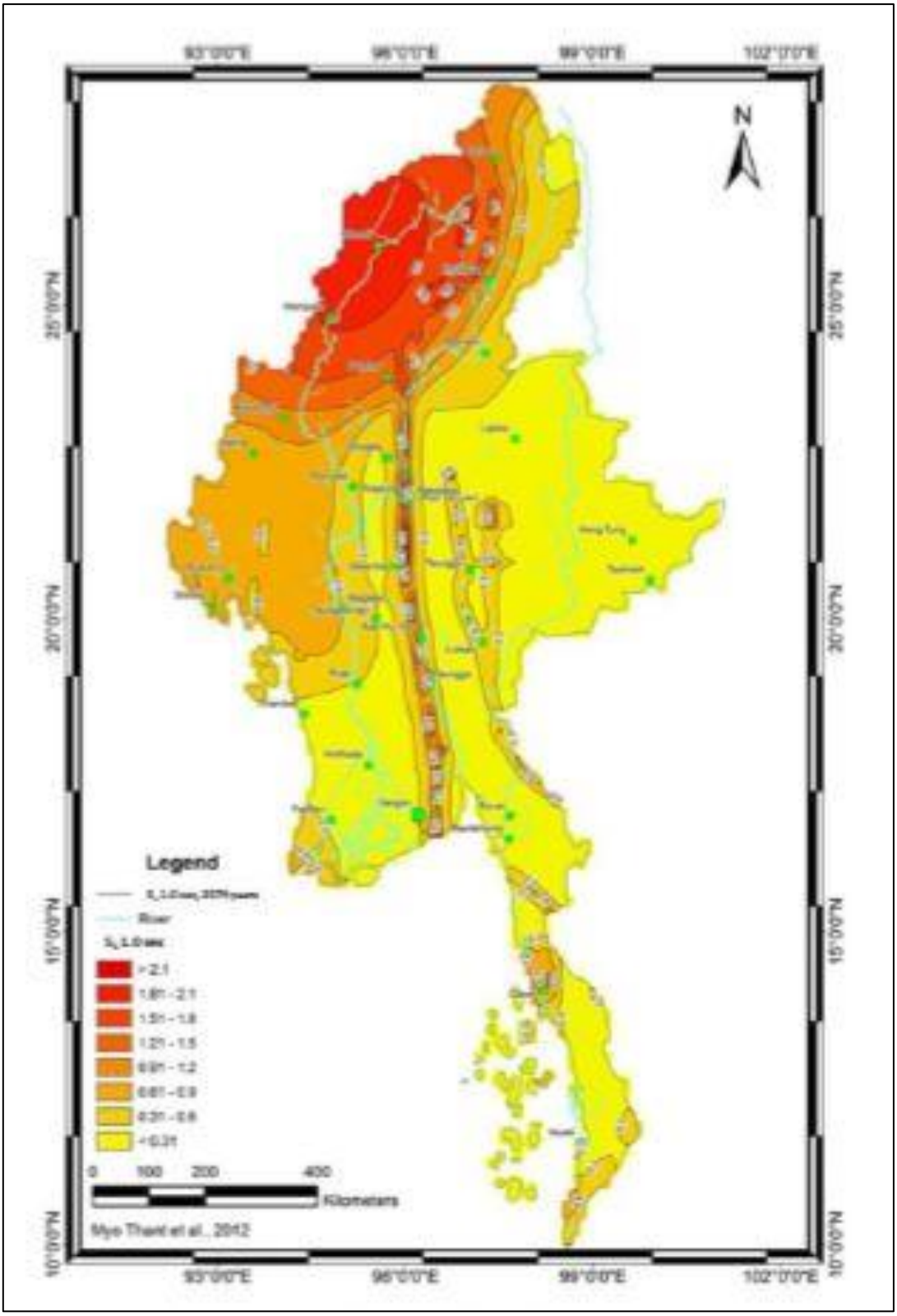


Figure 4-27 Maximum Considered Earthquake Ground Motion for 1 Sec Spectral Response Acceleration at 2% Probability in 50 Years with 5% Critical Damping, Site Calss B

4.4.10.11. Seismic Design Guidelines for Dikes, 2nd Edition (2014), British Columbia

Design Objectives

The design objective for dikes are established as follows,

- Dikes subjected to seismic ground motions with a short return period or a high annual exceedance probability event during the desing life should perform with insignificant damage to the dike body, withour compromising the post-earthquake flood protection ability.
- Dikes subjected to seismic ground motions with an intermediate return period or an intermediate annual exceedance probability event during the design life may experience some repairable damage to the the dike body, without compromising the post-earthquake flood protection ability and
- Dikes subjected to seismic ground motions with a long return period or a rare or a low annual exceedance probability event during the design life may undergo significant damage to the dike body potentially requiring more complex subsurface repairs, with the shot-term post-earthquake flood protection ability possibly compromised.

Typical return periods or annual exceedance probabilities considered are summarized in Table 4-9.

Table 4-9 Return Periods and Annual Exceedance Probabilities

Return Period Classification	Event Classification	Return Period (Years)	Annual Exceedance Probability	Percent Change of Being Excedded in 100 Years
Short	Frequent	100 to 200	0.01 to 0.005	65% to 40%
Intermediate	Intermediate	475 to 975	0.0021 to 0.001	20% to 10%
Long	Rare	2475 to 10000	0.0004 to 0.0001	4% to 1%

4.4.10.12. Performance Based Seismic Design Criteria

A performance – based seismic design is accomplished by defining appropriate levels of desing earthquake ground motions and corresponding acceptable levels of demage.

1. Design Earthquade Ground Motions

Ground motions that correspond to three different return periods described below shall be considered in seismic design.

- Earthquake Shaking Level 1 (EQL-1)

  1:100-yr return period ground motions that are equivalent to having a 40% chance of exceedance in 50 years or 63% chance of exceedance in 100 years.

For dikes located in the lower mainland, this level of shaking is associated with an M_w6 earthquake.

- Earthquake Shaking Level 2 (EQL-2)

  1:475-yr return period ground motions that are equivalent to hacing a 10% chance of exceedance in 50 years or 19% chance of exceedance in 100years.

  For dikes located in the lower mainland, this level of shaking is associated with an M_w7 earthquake.

- Earthquake Shaking Level 3 (EQL-3)

  1:2475-yr return period ground motions that are equivalent to having a 2% chance of exceedance in 50 years or 4% chance of exceedance in 100 years.

  For dikes located in the lower mainland, this level of shaking is associated with an M_w7 earthquake.

2. Performance Categories and Permissible Displacements

Performance Category A: No significant damage to the dike body, post seismic flood protection ability is not compromised.

Performance Category B: Some repairable damage to the dike body, post-seismic flood protection ability is not compromised.

Performance Category C: Significant damage to the dike body, post-seismic flood protection ability is possibly compromised.

Table 4-10 Summary of Maximum Allowable Crest Displacement Corresponding to Performance Categories

Performance Category	Earthquake Shaking Level	Maximum Allowable Vertical Displacement	Maximum Allowable Horizontal Displacement
A	EQL-1	Small (<0.03 m)	Small (<0.03 m)
B	EQL-2	0.15m	0.3m
C	EQL-3	0.5m	0.9m

The maximum allowable displacements given in Table have been established with the intent of preserving the structural integrity of the dike body. They represented total displacements. It is implied that for earthen dikes, satisfying the maximum horizontal distance of 300m along the dike would reduce the hazards associated with a dike breach as a result of differential or relative displacements.

According to MNBC (2020) as explained before, peak ground acceleration of the project for 2475 years return period that is equivalent to 2% probability of exceedance in 50 years design period (EQL-3) is 0.48.

4.4.10.13. Recommendation

1. The Amarapura Urban Development Project is located in the Sagaing Region of Central Myanmar that is a suitable site for the establishment of the urban area according to not only good transportation but also topography**.** Being located on the bank of the Ayeyarwaddy River, it is also a good location for water resource utilization.
2. There is not too much variation in elevation between the level of the river and the level of the land where it is necessary to make the landfill with a suitable height and a type of soil having good engineering properties.
3. According to the field survey of CPTu measurements and boreholes with SPT measurements, the top layers consist of loosely packed sands and silts at the project site and these types of soil are prone to liquefaction if affected by an earthquake. Moreover, this area has the liquefaction potential in case of an earthquake according to the liquefaction potential analysis in the report. Liquefaction generated by the earthquake's surface wave can only affects about 20 meters of ground depth.
4. Therefore, the commonly used techniques such as dynamic compaction, vibro-compaction and grouting will have to be conducted to reduce the risk of liquefaction. .
5. The new CPTu measurements should be done to explore engineering properties of subsoils and the situation of liquefaction potential after densification and construction of the landfill. Moreover, in case of an earthquake, liquefaction potential analysis and settlement probability based on new CPTu measurements after landfilling should be provided with detailed layer by layer calculations.
6. Besides, clay layers are found near Myo Patt Road, at the east side of the project area where settlement potential can be happened according to the laboratory measurement. In this area, after landfilling, the settlement problem should be rechecked and foundation design for buildings should be selected with the suitable settlement resistance design like mat foundation.
7. According to the waterfront stability analysis, stone revetment and scour hole protection by sheet piles are mentioned to reduce the risk of river bank erosion.
8. Since this area is close to the Sagaing Fault, when constructing the buildings, it should be made in an accordance with detailed earthquake micro-zonation maps and chosen the type of foundation that can withstand earthquake.
9. This project area may be a high-risk area in case of an earthquake, hence a long term and short term earthquake monitoring system or earthquake warning system should be installed in place based on the precursors of an earthquake such as the sudden rise of groundwater, the changes of elasticity in rocks and soils, etc.
10. Monitoring systems for river bank erosion and the stability of retaining walls should be implemented with a long-term plan.

11. Groundwater use should not exceed the amount of water that can be extracted based on the results of the pumping test. It is suggested that surface water should be primarily concerned to water utilization in this project area.

4.5. RIVER MORPHOLOGY

4.5.1. Hydrology of Ayeyarwady river in the project area

The Amarapura Urban Development project (AUDP) is aiming at considerable improvement of the relation between the inhabitants of the city of Mandalay and the river and its surrounding. As its location is in the area that is presently still inundated during floods and therefore part of the river bed (flood plain), it is important to study the effects of these works on the water levels, the river bed, and the river banks.

The project is located in the wide section of the Ayeyarwady River at Mandalay, where the flow is contracted towards the narrow control section at Sagaing. Due to its position between 'hard points' at Mandalay and the downstream Shwekyet Kya Pagoda, the main flow is mostly directed away from the project. Therefore, the project area has shown to be quite stable historically. Only its lower end is located in a more dynamic section, affected by migrating channels. The overall behavior of the river is controlled by the channel trifurcation upstream of Mandalay, near Mingun, which has shown periodic shifts in importance of the left (Mandalay) and right (Sagaing channel). A stable Mandalay channel is controlling the stability of the project area. The understanding of the large-scale channel and bar behavior from historic imagery and model simulations in this study has provided crucial knowledge on the influence of the project on the river, and the forces that have to be resisted by the protection works. The land-reclamation of this project, is found not 'acting against' the natural migration of the main channels.

River dynamic and hydrology including flood and impact on the water level by the proposed project is studied by the hydrologist group of Deltares from Netherland. A modeling software, Delft3D, is used to assess the possible effects from the proposed project on flood level and river water discharge. River-bed topography (Bathymetry) study is undertaken and the information and data collected from the study are used in modeling for the change of river dynamic and hydrology by the proposed project. To determine the relevant flood conditions for risk-assessment of Mandalay and the project area, some hydrological analyses are carried out using the historical data of Mandalay water-level gauge. The statistical properties of observed hydrological data series are used to establish the safety levels, characteristic conditions, and potential risks for the project site.

4.5.2. Methodology

Two methodologies are intended to investigate the river morphological behavior in the Ayeyarwady River. The first one refers to the analyses of satellite and aerial images which determine the historic changes in plan form by comparing the satellite and aerial images of the river for several years/decades. The second approach uses the Delft3D

modelling system of Deltares which simulates the hydraulic and morphodynamic behavior of river in the future developments after implementation of the project. Delft3D simulates the time-dependent development of the river bed at the project area and the river sections upstream (near Mandalay Port) and downstream (up till Innwa), flow velocities and water-level variations along the river banks of the project, and the flow conditions during design conditions (extreme events).

An advanced hydrodynamic and morphodynamic model, using the Delft3D software, has been developed based on recent survey data and with a dense computational grid to allow a high-resolution output of the future hydraulics, sediment loads, and morphological developments with and without the project. The comparison of conditions with and without project is relevant input for impact assessment and mitigation. The model reproduces the development and propagation of sand bars and migration of channels for several tenths of years, as well as the flood levels for extreme conditions.

4.5.3. Water Level Impact of the Project

To determine the relevant flood conditions for risk-assessment of Mandalay and the project area, some hydrological analyses were carried out using the historical data of Mandalay water-level gauge. The statistical properties of observed hydrological data series are used to establish the safety levels, characteristic conditions, and potential risks for the project site.

In the first years high flood levels will rise roughly 0.1 m to 0.2 m directly upstream of the project area. This effect extends upstream over a distance of several tenths of kilometers, gradually decaying in upstream direction (backwater). There are no impacts on flood levels downstream. The effect is limited because the largest effects occur in the wide part of the river (islands and channels opposite of Mandalay water front). Also, its (backwater) extension in upstream direction is located on the very wide flood plain section that extends upstream of Mandalay. In time, the water level rise at floods will reduce and disappear due to the deepening of the river bed by erosion (as an effect of the project). When the river bed has eroded to its final level (dynamic equilibrium) after some decades, the flood levels will be equal or lower than the situation without project. The (initial) flood-level rise can be reduced by dredging of the river channel next to the plan to set-it more quickly to its final equilibrium level.

In time by erosion of the river bed, as well as by dredging operations, the flood levels become slightly lower again. The highest flow velocities during extreme floods can be found along the bank line in the lower section of the project bund. At this point velocities between 2.5 and 3.5 m/s can be expected in extreme conditions. Bank protection can be designed to withstand these velocities.

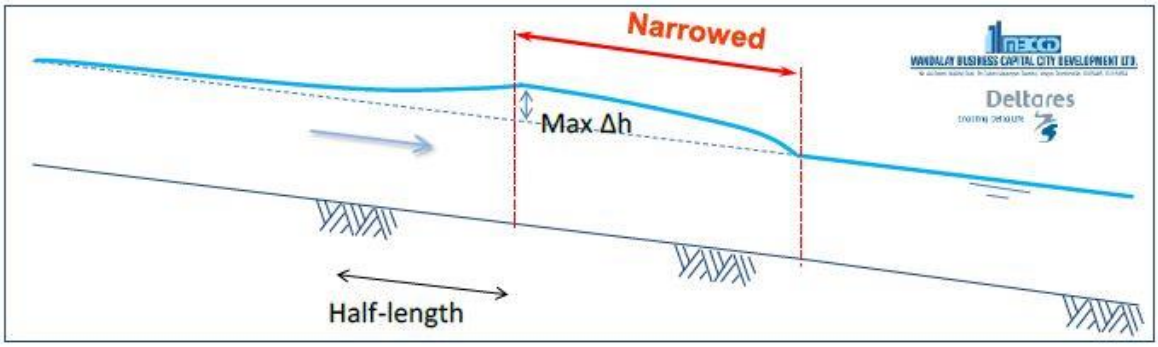


Figure 4-28 Schematic representation of INITIAL water-level change during flood with the project (after narrowing the flood plain). The dotted line represents the water-level for the present situation (without project)

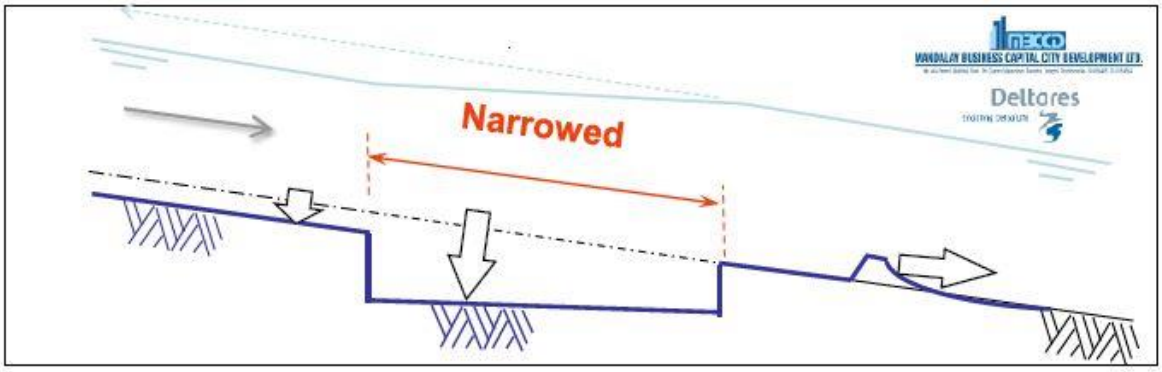
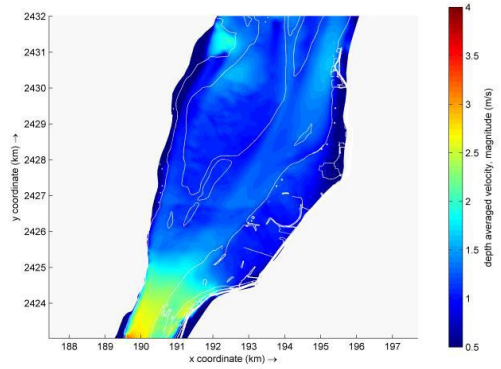


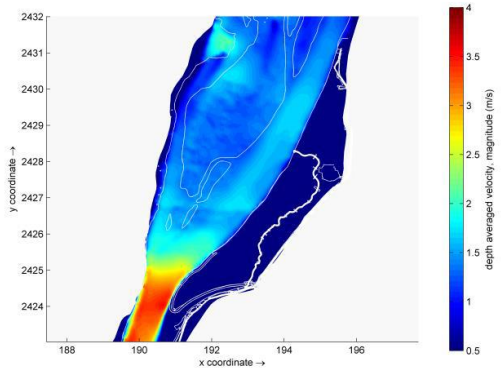
Figure 4-29 Schematic representation of LONG-TERM water-level change during flood with the project (narrowing the flood plain). The dotted line represents the water-level for the present situation (without project)

4.5.4. Impacts on flow velocity

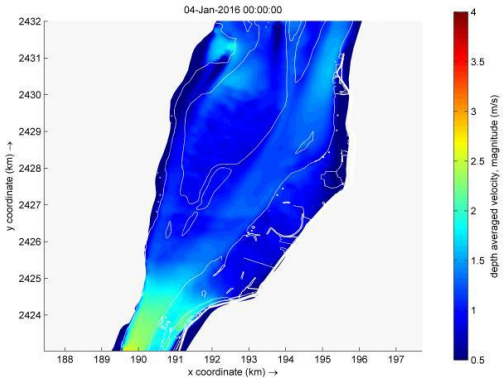
The flow velocity in the river during design conditions (extreme floods) is relevant for design of the bank protection works. To prevent bank erosion and failure of the bund, it is relevant that the protection works can withstand the high flow velocities during these conditions.

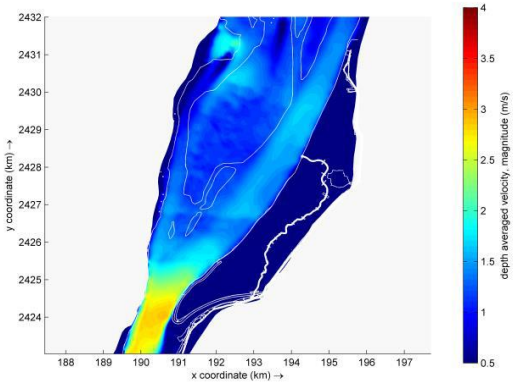
The highest flow velocities during design floods are found at the lower most downstream part of the project. This is true for both the situation with and without the project, because flow velocities are increased by the narrowing towards Sagaing bridges anyway. In the present situation, simulated flow velocities vary between 1 and 2.5 m/s during the extreme floods (1/50-year and 1/1000 year). Due to the project the velocities show some increase in the main channel, from 1 - 1.5 m/s to 1.5 - 2 m/s next to the project area. The velocities in the narrow section near Sagaing increase from 2.5 to 3.5 m/s for the 1/1000 flood.



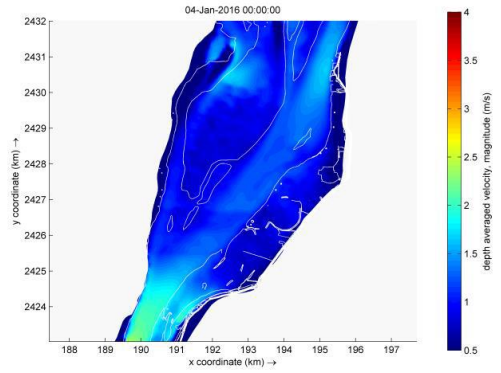


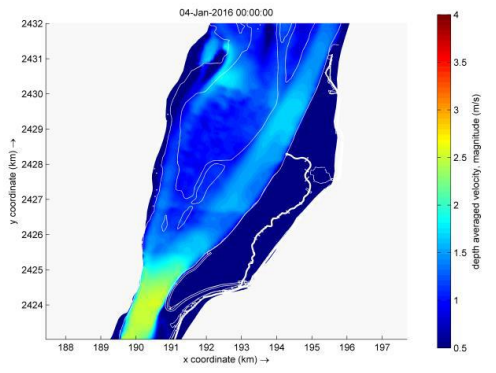
Magnitude of flow velocity calculated for a 1/1000-year discharge (51,458 m3/s) for velocities between 0.5 and 4 m/s: left figure shows present situation, right figure shows situation with project.





Magnitude of flow velocity calculated for a 1/50-year discharge (38,806 m3/s), for velocities between 0.5 and 4 m/s: left figure shows present situation, right figure shows situation with project.





Magnitude of flow velocity calculated for a 1/10-year discharge (32,168 m3/s), for velocities between 0.5 and 4 m/s: left figure shows present situation, right figure shows situation with project.

Figure 4-30 Calculated Flow Velocity

The flow velocities are also plotted near the two bridges at Sagaing for a 1/1000-year extreme flood. The results show an increase upstream of the bridges (just below the lower tip of the project), but do not show a noticeable increase at the bridge site itself. This is relevant for scour processes at the bridge piers during such extreme events. For lower floods the differences are even less pronounced.

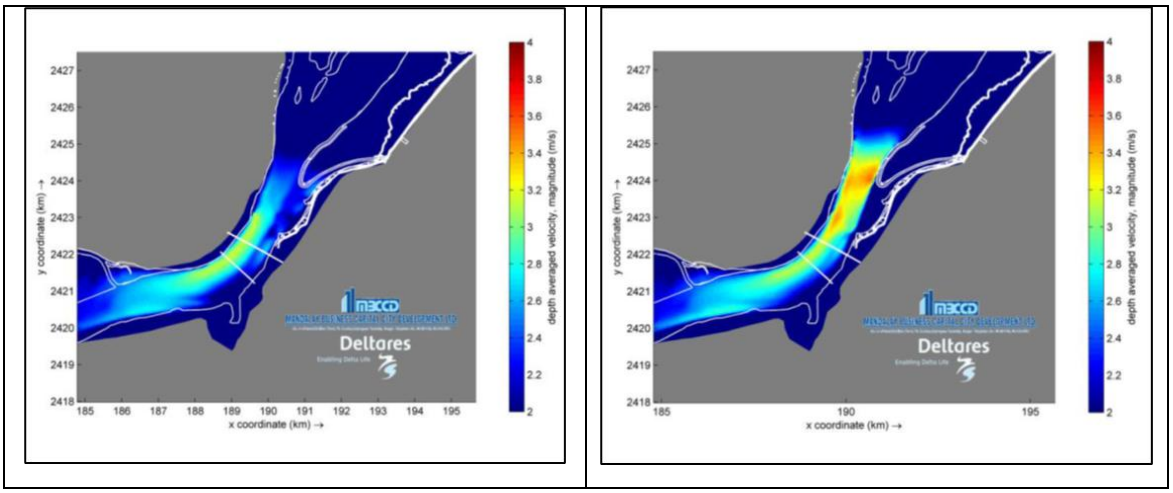


Figure 4-31 Calculated magnitude of flow velocity for a 1/1000-year flood peak (51458 m3/s) for velocities higher than 2 m/s: left figure shows present situation, right figure shows situation with project.

4.5.5. Stability of the Project Area

The major part of the Amarapura Project Area has been a stable area for many decades. Only the most downstream part can be considered more dynamic, and has been affected by migrating channels and bars in the past. Most of the morphological changes to the area occur during floods, when the project area and the islands opposite this area are inundated. The channel shift upstream of Mandalay, where the river splits into the Sagaing channel and Mandalay channel may pose a relevant risk to the lower part of the project area. If Sagaing channel becomes the dominant channel, a risk occurs that the end of this channel turns towards the project. This will cause the outflow from this channel to hit the bank protection works almost perpendicular. Other potential shifts in upstream inflow are also a potential risk, as the consequences from these large-scale changes for Mandalay City and the AUDP cannot be predicted with the models. As these will occur very gradually, it is expected that impacts of such developments can be mitigated with proper river-management approaches.

The presence of a stable main channel in front of Mandalay is an important control for the stable presence of Amarapura Project area. As indicated in Figure 4-32 the main channel entering from the North-West hits the water front of Mandalay, by which it is deflected and continues In South-West direction. Due to this enforced curvature, its natural (meandering) path causes the main channel to move away from the Amarapura Project area. The secondary channels on the right (Sagaing channel) show more braids and more dynamic evolution

during the past decades. According to simulations with the model, that the lower parts of the project area are more dynamic than the upstream part as shown in Figure 4-33.

Towards the lower end of the Amarapura Urban Development Project area (before the bridges), the flow converges gradually to the geological constraint with much higher flow velocity as shown in Figure 4-35. This constraint acts as a bottleneck during flood, causing backwater to inundate the project area and islands. It also forces the main channel to its present position. Presently, the red zone indicated (lower end of the project area), is a downstream developing sand bar which can be considered as part of the active river bed. This sand bar is considered to negatively affect the location of the navigation channel downstream of Sagaing. It pushes the channel towards the right bank at Sagaing, which in turn causes the channel to turn to the left bank further downstream. This is adding up to the increase of bank erosion at Inwa, and positions the channel over the rock outcrop at Inwa. This has become a navigation bottleneck. Figure 4-34 shows with colours the zones that have been more dynamic in the past due to presence of channels and due to higher velocities during flood conditions.

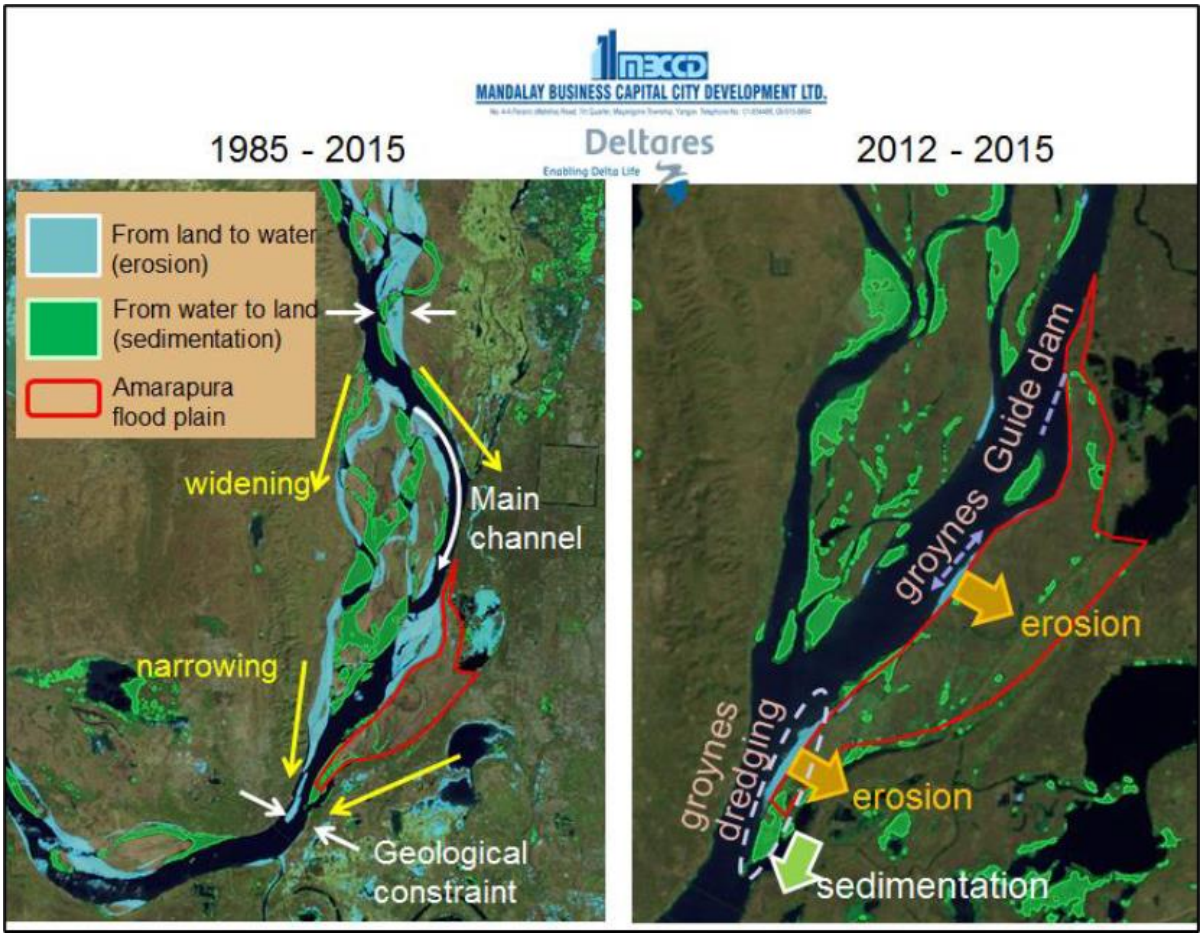


Figure 4-32 Left panel: change from land to water and from water to land between 1985 and 2015 (left) with major controls; and right panel: zoomed picture of recent geomorphic changes (right) with trends at Amarapura Project location. Also indicated are proposed river training works for navigability study.

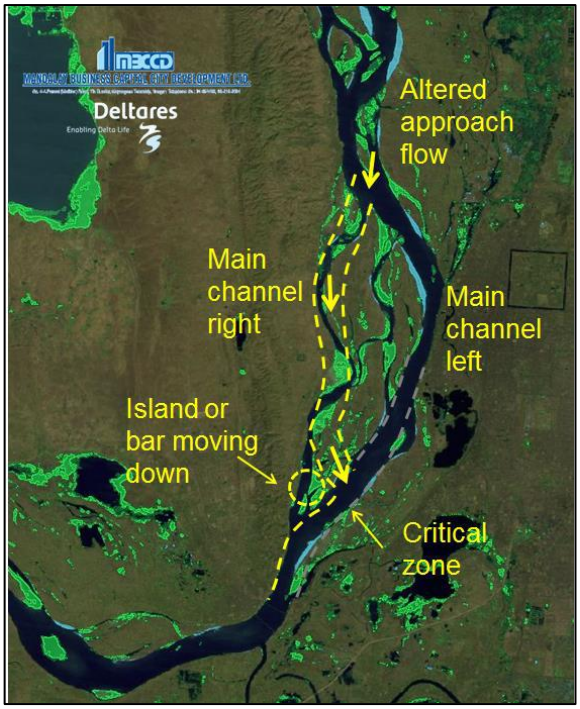


Figure 4-33 Evaluation of plan form risks (long term): avulsion of main channel by altered approach flow at Mingun, and sand bars/island forcing the channel towards Amarapura Project area.

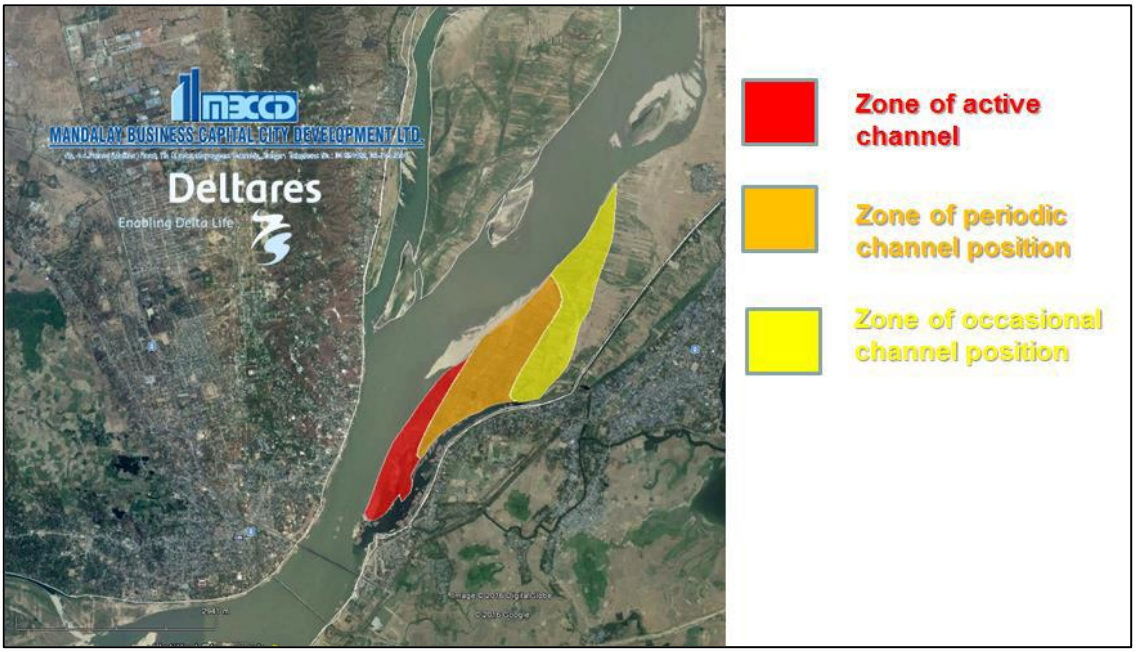


Figure 4-34 Zone of active river bed (red), high dynamics (orange), median dynamics (yellow) and low dynamics (remaining part)

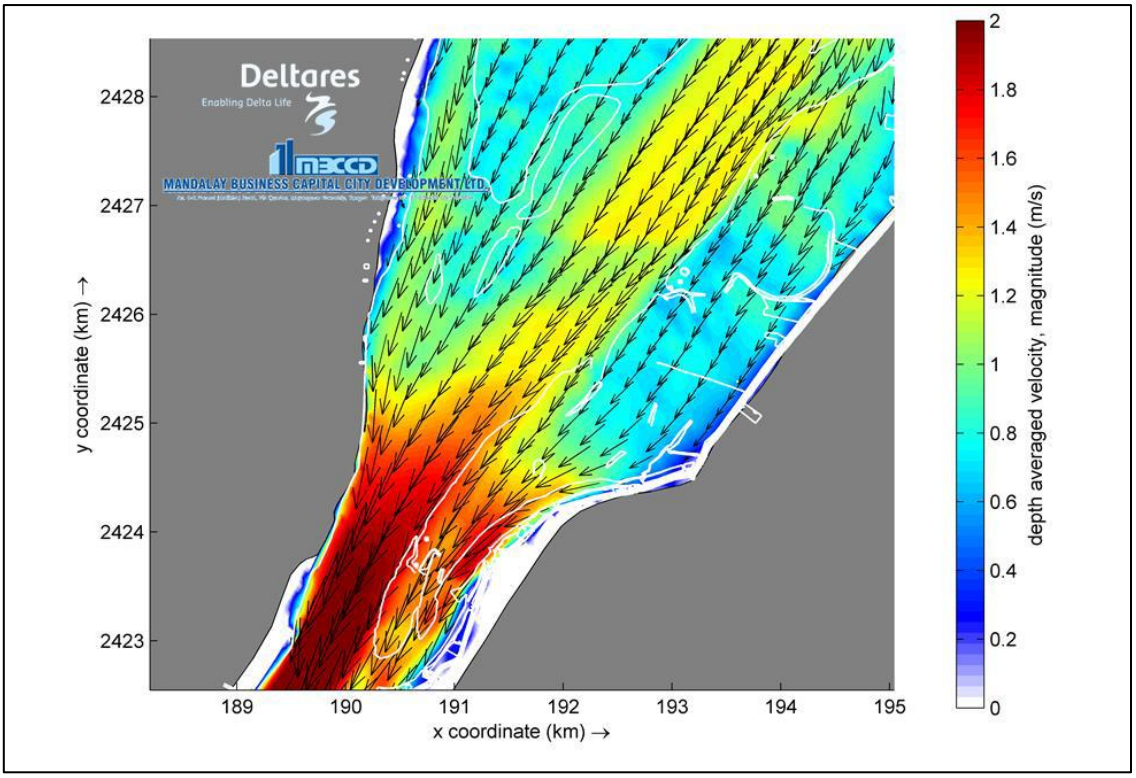


Figure 4-35 Calculated Flow Velocity during Flood Conditions (10 years Return Period)

4.5.6. Morphological Impacts of the Project

Building the project will reduce the available flow cross-sectional area of the river during floods. Although presently the flow velocities and discharges over the considered project area are small, the closure of the project area will lead to a small increase of flow velocity in the main channel. The morphological impacts (bed-level change) of this increased velocity can be separated for the short term and the long term. Figure 4-36 schematically presents the general impact on bed levels after narrowing the river.

The short-term geomorphological response of the river bed to AUDP is a downstream propagating erosion wave starting from the upstream of the project location, and downstream propagating sedimentation wave starting from the lower end of the project area. On the long term, the section next to the project area will have a lower bed level (relative to the situation without project). The simulated bed-level impacts over a period of 10 years are relatively small compared to the variations in bed level that occur naturally over a period of 10 year. AUDP is causing the cross-sections to become slightly more stable. The formation of stable channel along the left bank (along the project bund) is positive for navigability. Figure 4-37 shows the model simulation of bed level after 0,5,10 and 20 years without (left) and with the project.

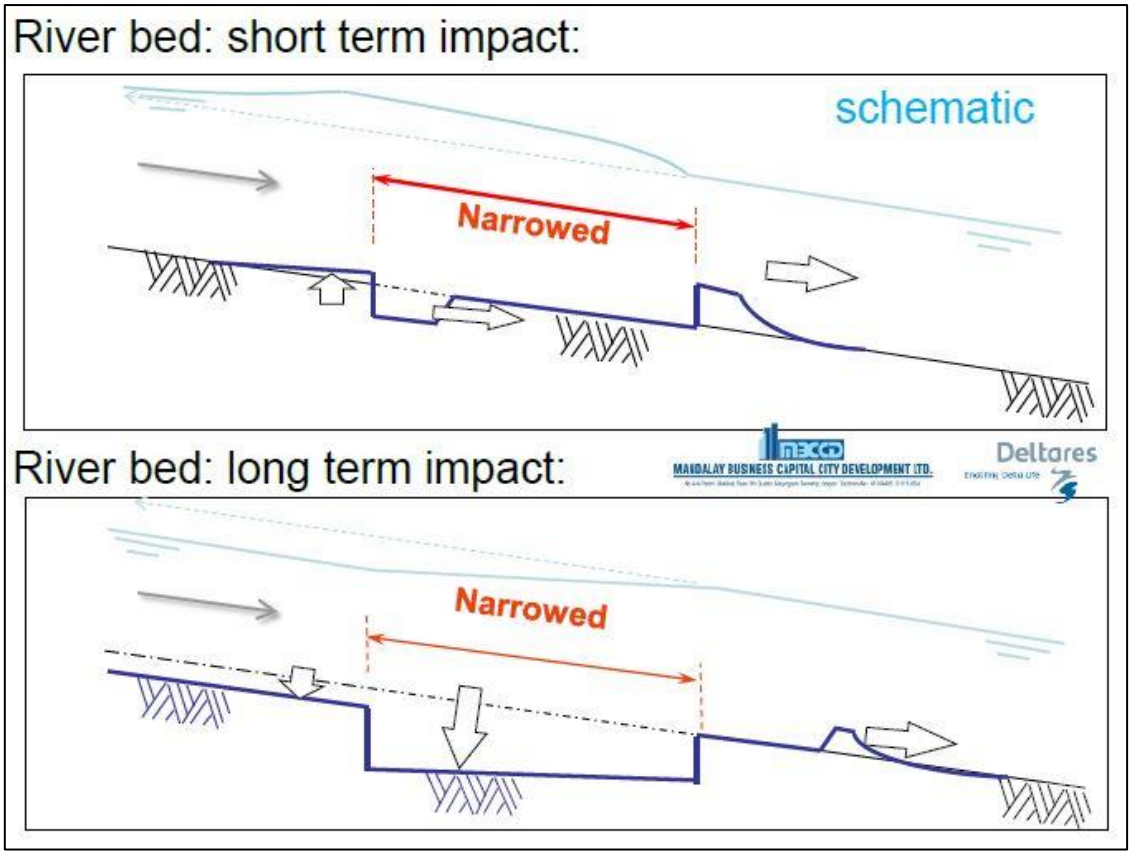


Figure 4-36 Schematic representation of bed-level change with the project

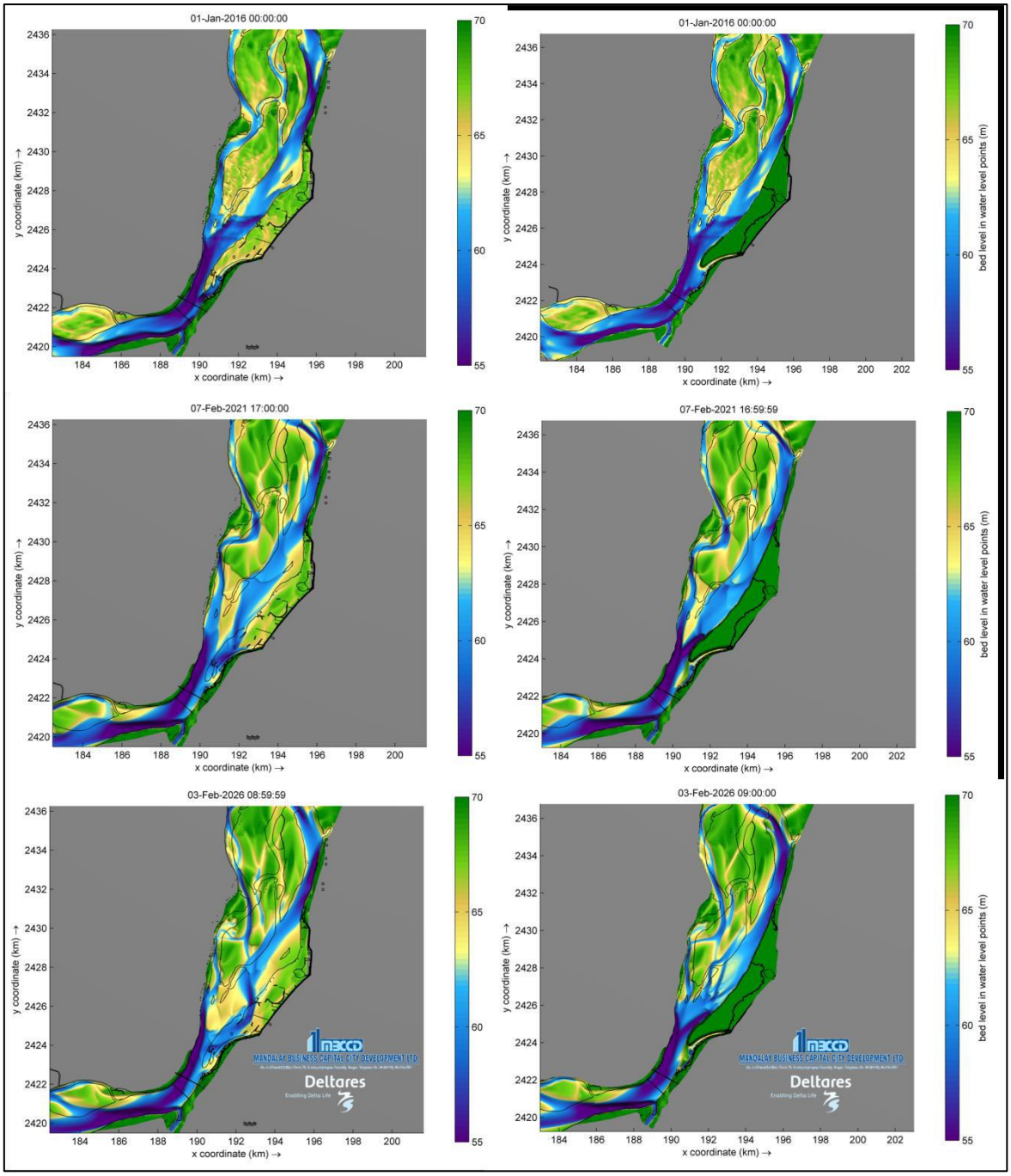


Figure 4-37 Computed bed-level (Delft3D) after 0, 5, 10 and 20 years without (left) and with the Amarapura Urban Development Project

4.5.7. Sediment Extraction from nearby River Bed

Sediment dredged from the river bed can be used for land fill. Required quantities for Phase 1 are approximately 20 million m^3 which is in the same order of magnitude as the calculated annual sediment load. Dredging will help to lower the flood levels (compensate for the increased levels after completion of the project phases), at least temporarily. The simulations of dredging scenarios show that the best dredging locations for land fill for Phase 1 are in the main channel directly next to the project site. Second option is to dredge from

several locations in the main channel upstream of Mandalay Port, and third is the wide section downstream of the Sagaing bridges. Locations along the Sagaing Channel (right side) are not recommended as these will lead to diversion of flow from the main channel, eventually leading to sedimentation and less navigable depth in the main channel. Dredging operations proposed in the section do not have noticeable impact on the foundation of the two bridges or the bank erosion at Innwa.

To find appropriate locations for dredging or sediment extraction from the river bed, several locations have been tested. The aim of these calculations is to assess the impacts of the dredging operation on the surrounding river bed as function of time. The investigated locations for sediment-extraction scenarios were particularly selected because of the presence of large sediment bars and shallow parts. In the Delft3D simulations the initial bed topography was lowered ('instantaneously') at the respective areas to represent the effect of dredging. Figure 4-38 presents the areas that were lowered for the Delft3D simulations.

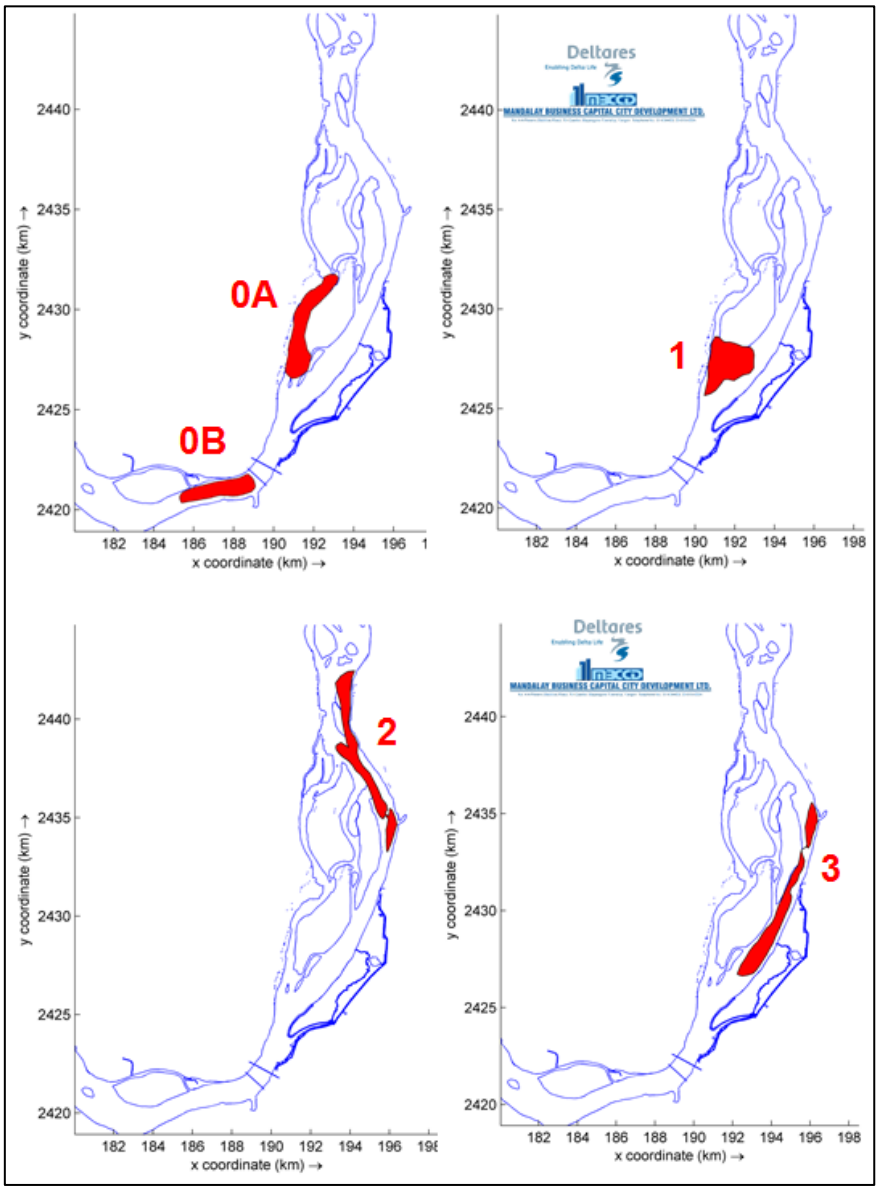


Figure 4-38 Investigated dredging locations for sediment-extraction scenarios

Based on these results it is recommended to first find the dredging locations in the main channel according to dredging scenario 3, and secondly find additional dredging locations in the reach upstream of Mandalay port according to scenario 2. The use of sediment from the island and sand bars opposite of the project area (Scenario 1) and from the Sagaing Channel (scenario 0A) is not recommended, because it will negatively affect the navigability of the main channel. Although a little away from the project area, it is also very well possible to excavate and use the sediment downstream of Sagaing. It might be beneficial to dredge a 'channel' in the river axis which will attract the flow away from the eroding Innwa river bank.

4.5.8. Practical Considerations

For design of the dredging operations, it is relevant to consider local impacts on the bank line as well as the large-scale geomorphological responses. To look for the appropriate dredging locations it is necessary to look at both the local impacts on the river banks, and at the larger picture. The amount of sediment needed is enormous, and requires careful spreading of the dredging locations. Therefore, it is recommended to consider three dredging zones: the zone directly next to the project area, in the main channel, the zone upstream of Mandalay and in front of Mandalay Port, in the main channel and the zone downstream of the bridges to Sagaing.

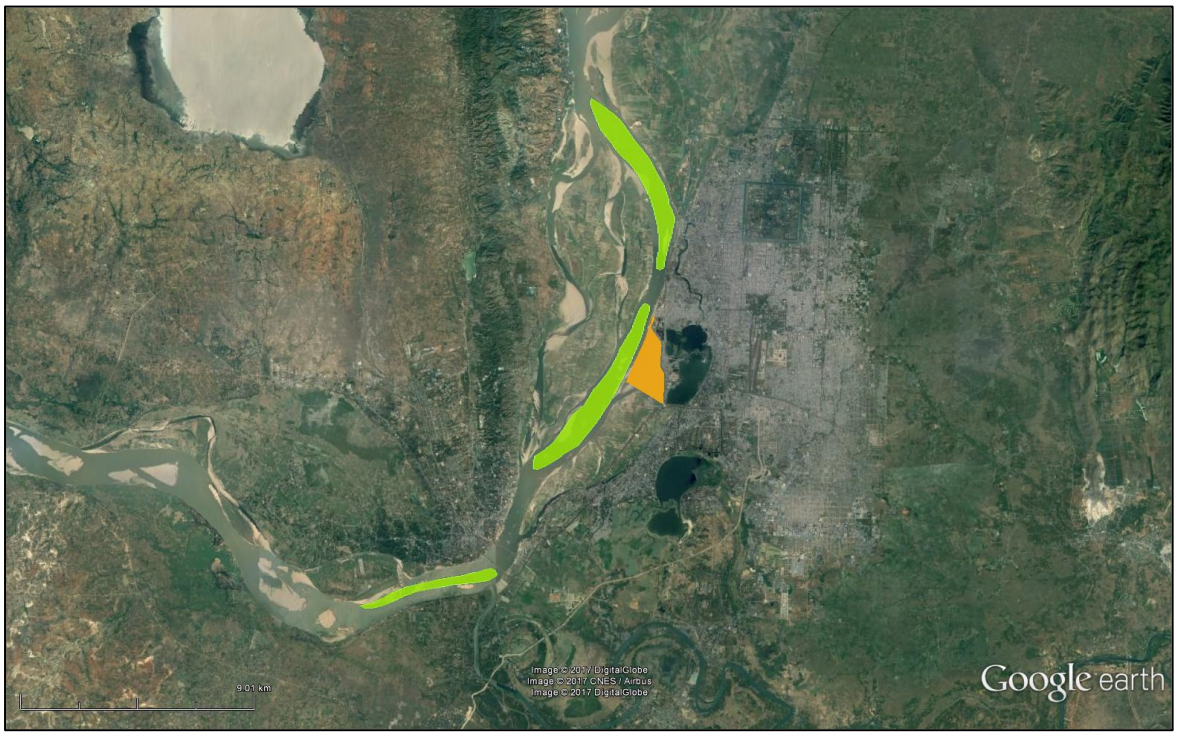


Figure 4-39 Location of three zones for searching dredging locations for Phase 1 reclamation works. These polygons do not show an exact contour of the dredging works, as that should follow from a more detailed survey and advice from the contractor as well as DWIR.

The reason to select the zones 1 and 2, is that with dredging in these sections the large-scale response will be a deepening of the Mandalay channel, which will be beneficial for navigation. The dredging zone downstream of Sagaing bridges is a relatively shallow sand bar that covers most of the cross-section. The preferred dredging operation would be to dredge a relatively deep channel (3 to 4 m) through this sediment bar in the middle of the river. This will draw water to the middle, and reduces the pressure of flow on the eroding river bank of Innwa. The zones are added as figures and kml. The kml-files give polygons that may be used for searching the right sediment and do excavations. They do not show an exact contour of the dredging work, as this should follow from a more detailed survey and advise from the contractor as well as DWIR consider these as optional zones.

4.5.9. Erosion of River Bank at Innwa and Sagaing, and bridge scour at Sagaing Bridge

The erosion processes at the Innwa river bank started more or less directly after the start of operations of Yeywa dam in the Myitnge River around 2010. The observed impact of Yeywa dam on the mouth of the Myitnge River can be explained from hydrological impacts on the Myitnge River due to the start of operation of the dam, and the effects on sediment loads into the Ayeyarwady River as observed from some of the Delft3D simulations. Although the explanations, cannot be verified with observed data so far, the observations and model results show that bank erosion processes can be coupled directly to the impacted outflow of sediment.

To illustrate the impact of reduced sediment load from Myitgne river, Figure 4-40 shows the results for two Delf3D simulations with a low sediment outflow from Myitgne River (left) and with a very high outflow of sediment (right). It shows how high sediment load causes sand to be deposited in front of the river bank of Inwa, while with a low sediment outflow the river bed along the Inwa bank shows a very deep channel. It also shows that even the larger pattern is affected by this input of sediment. Obviously, the reduction of sediment outflow from Myitgne River causes the Ayeyarwady channel in front of the Inwa river bank to become deeper, and allowing the bank to collapse. Figure 4-41 and Figure 4-42 shows that the bed level in the main channel.

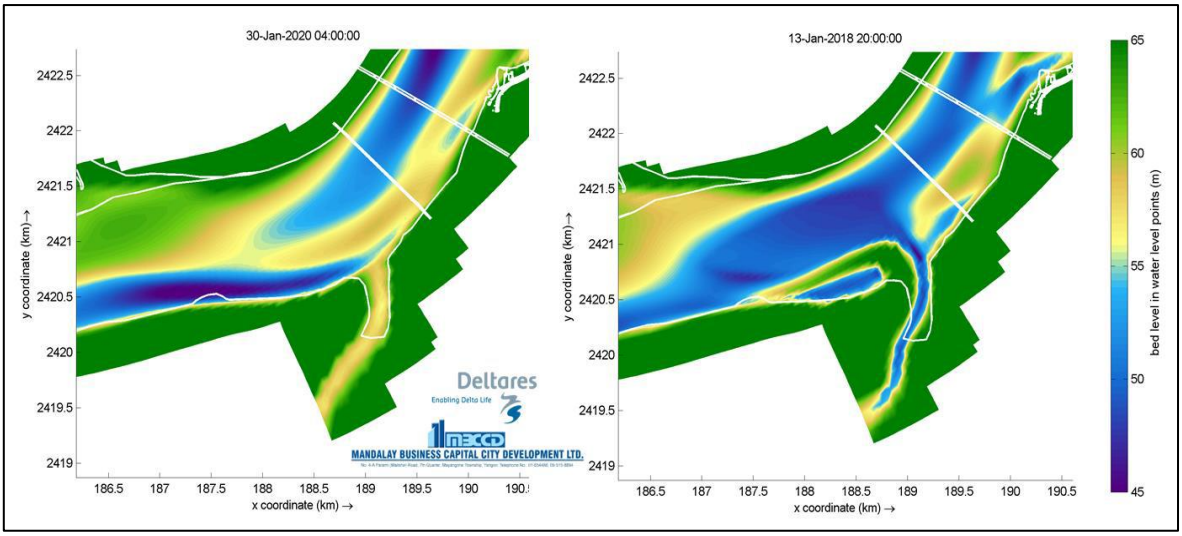


Figure 4-40 Computed bed elevation for a simulation with low sediment outflow from Myitnge River (left) and with a high sediment outflow from Myitnge River (right), illustrating the impact of sediment outflow on erosion of the river bed in front of the river bank at Innwa

The Delft3D model runs have been used to evaluate the impacts of the project to the bed levels and flow velocities at both the bridges and at Innwa and Sagaing. Simulations show that, with partial removal of the lower part of the Amarapura Project-area edge, only small changes in flow velocities and bed-levels occur compared to the simulation without the project. These velocity changes are of the order of 0.1 m/s for extreme floods near Sagaing bank and bridge piers, which are too small to enhance local scour near the banks and piers. Additionally, it was found that along Sagaing bank and the right half of the river bed under the bridges shows higher bed levels, which will contribute to the stability of the bank and piers. Only in the left half of the river the bridge piers may experience a roughly 1 m lower bed compared to the situation without the project, but this is well within the natural variations in this part of the river, and does not cause any risks. It is caused by repositioning of the main channel towards the South (left bank).

In front of the river bank at Innwa some sedimentation is expected, which reduces the on-going erosion of the left bank. There are signs that the bank erosion problem is closely connected to the operation of Yeywa dam. No further measures are required to mitigate these effects, as they are not increasing erosion risk. However, sand mining in the area next to the project may eliminate the reduced impact of bank erosion at Innwa. Based on the findings it has been concluded by that this project is feasible and well aligned with the natural geomorphology of the Ayeyarwady River.

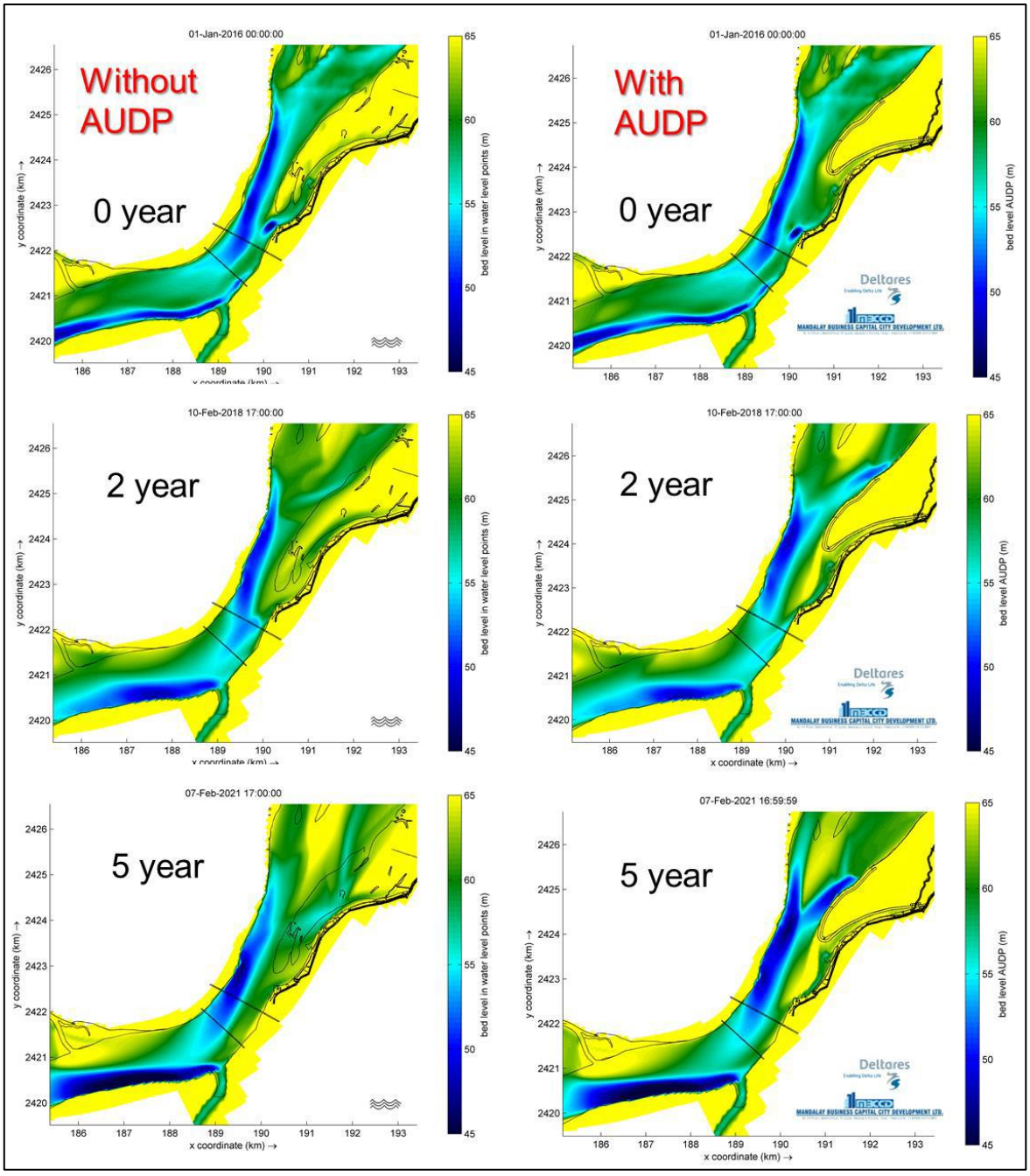


Figure 4-41 Bed-level computed without the project (left) and with the project (right) near Sagaing bridges and Innwa river bank (short term)

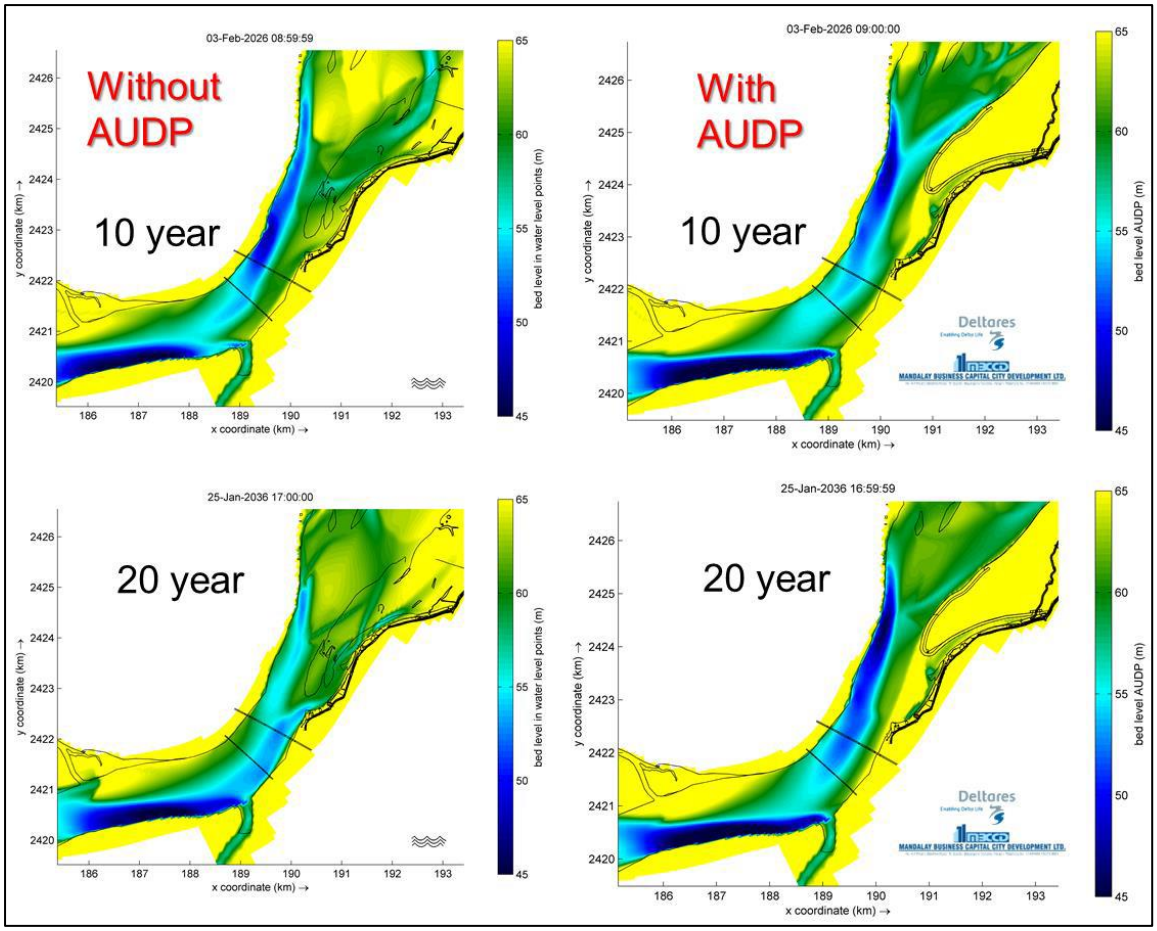


Figure 4-42 Bed-level computed without the project (left) and with the project (right) near Sagaing bridges and Inwa river bank (long term)

4.6. RECOMMENDATIONS

The project is located in the wide section of the Ayeyarwady River at Mandalay, where the flow is contracted towards the narrow control section at Sagaing. Due to its position between 'hard points' at Mandalay and the downstream Shwekyet Kya Pagoda, the main flow is mostly directed away from the project. Therefore, the project area has shown to be quite stable historically. Only its lower end is located in a more dynamic section, affected by migrating channels. The overall behavior of the river is controlled by the channel trifurcation upstream of Mandalay, near Mingun, which has shown periodic shifts in importance of the left (Mandalay) and right (Sagaing channel). A stable Mandalay channel is controlling the stability of the project area. The understanding of the large-scale channel and bar behavior from historic imagery and model simulations in this study has provided crucial knowledge on the influence of the project on the river, and the forces that have to be resisted by the protection works. The land-reclamation of this project, is found not 'acting against' the natural migration of the main channels.

The recommendations for river morphology are as follows;

1. Amarapura Urban Development Project area lies within the production zone and deposition zone of the Ayeyarwady River.

2. At the upper most northern point of the project area is 72.76 (95% confidence water level (m+MSL)) and the elevation of bank line is 73.76 m+MSL. So, bank line rises 1 meter above 95% confidence water level (m+MSL). If there is a flash flood, one meter difference is not a reliable situation. It needs to calculate using the highest water level data to get more accurate conclusion.
3. Even when external conditions are constant, the braided pattern is continually changing, yet statistically consistent: a true dynamic equilibrium.
4. It is considered necessary to fully understand the nature of braided channel morphology.
5. The project area falls on the meandering channel headwaters. Therefore, you should systematic study the path of headwaters. It is necessary to know the flow path of the active channel where the highest velocity is along the channel cross section.
6. the current situation of the project site area related to inundation or flood should be clearly described with photographs and ground evidence.
7. The cross-section at Mandalay Port shows that the bed level in this section is slightly more stable than the Phase 1 bed level without dredging. There are no noticeable impacts on the bed level near the bridges. In this project, river training is considered to be a very important aspect. The way to solve it must be considered sediment problem from the up-stream area.
8. During rainy season, Ayeyarwady river velocity must conduct regular monitoring one time per year.
9. Regular monitor and make record the measurement of riverbed level during Dry and Rainy seasons.

4.7. BASELINE ENVIRONMENTAL QUALITY

The purpose of the baseline quality measurement is to assess the existing environmental conditions in the project area. This section will be provided to proponent and employees to assist them in carrying out the project to avoid or mitigate the impacts on the environment. Environmental baseline quality (air quality, noise quality, water quality and soil quality) is used to assess the environmental impact of the operation phase and monitored. The baseline quality measurement was carried out three time, once in October during the wet season, once in March and once in February during the dry season. The baseline measurement is conducted to cover the project area and 5 km area of influence (AOI). In addition, the measurement location is generally located at east, west, south, north, middle points and measured 2 seasons to cover the impact influence of the project. Therefore, the measurements are sufficient for the construction and operation phase. Outlines of the monitoring process are shown in Table 4-11 and Table 4-12.

Table 4-11 Outlines of Monitoring Item in the Monitoring Report for Wet Season

Monitoring Date	Monitoring Item	Parameters	Number of Point	Location	Monitoring Methodology
20th October – 25th October, 2022	Air Quality	Gas Emission: O_3, SO_2, NO_2, CO, CO_2, TVOC Dust Emission: PM_{10}, $PM_{2.5}$, TSP, Meteorology: RH%, Temperature, Wind Speed, Wind Direction	5	Amarapura Urban Development Project Area, and the study villages	On site measurement by Air Quality Monitoring Station (AQM-09)
20th October – 25th October, 2022	Noise Quality	dB (A)	5	Amarapura Urban Development Project Area and the study villages	On site measurement by GM-1356 Digital Sound Level Meter
24th October and 25th October, 2022	Surface Water Quality from River	BOD, COD, Iron, Oil and Grease, pH, Free Chlorine, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform	5	Ayeyarwaddy river and the study villages	On site measurement by Hanna Instrument and collect sample water to send the laboratory
	Ground Water Quality	pH, Iron, Oil and Grease, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform	2	Ground water in the project area	On site measurement by Hanna Instrument and collect sample water to send the laboratory

Table 4-12 Outlines of Monitoring Item in the Monitoring Report for Dry Season

Monitoring Date	Monitoring Item	Parameters	Number of Point	Location	Monitoring Methodology
1st March – 6th March, 2023	Air Quality	Gas Emission: O3, SO2, NO2, CO, CO2, TVOC Dust Emission: PM10, PM2.5, TSP, Meteorology: RH%, Temperature, Wind Speed, Wind Direction	5	Amarapura Urban Development Project Area and the study villages	On site measurement by Air Quality Monitoring Station (AQM-09)
1st March – 6th March, 2023	Noise Quality	dB (A)	5	Amarapura Urban Development Project Area and the study villages	On site measurement by GM-1356 Digital Sound Level Meter
2nd March- 3rd March, 2023	Surface Water Quality from River	BOD, COD, Iron, Oil and Grease, pH, Free Chlorine, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform	5	Ayeyarwaddy river and the study villages	On site measurement by Hanna Instrument and collect sample water to send the laboratory
	Ground Water Quality	pH, Iron, Oil and Grease, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead,	2	Goundwater in the project area	On site measurement by Hanna Instrument and collect sample water to send the laboratory

Monitoring Date	Monitoring Item	Parameters	Number of Point	Location	Monitoring Methodology
		Total Coliform			
1st February 2024	Surface Water Quality from River	Ammonia (as N), Chromium (Hexa), Chromium (Tri), Copper, Cyanide, Flouride, Manganese, Mercury, Nickel< Nitrate (as N), Nitrite (as N)	5	Ayeyarwaddy river and the study villages	On site measurement by Hanna Instrument and collect sample water to send the laboratory
	Ground Water Quality	Fecal Coliform, Manganese, Chloride, Sulphate, Nitrate	2	Goundwater in the project area	On site measurement by Hanna Instrument and collect sample water to send the laboratory

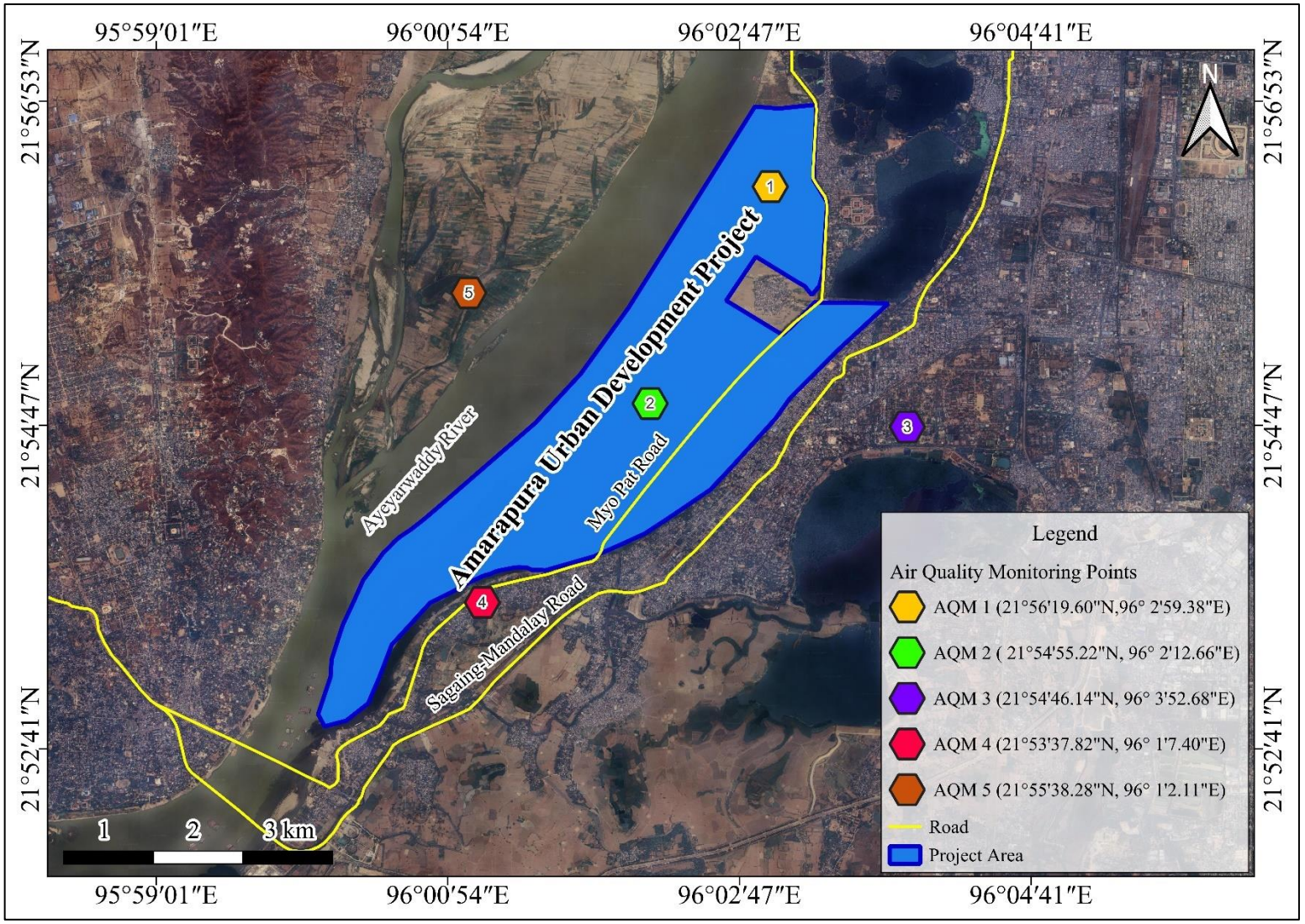


Figure 4-43 Air Quality Measurement Location Map

4.7.1. Ambient Air Quality Monitoring for Wet Season

Outdoor air quality assessment was conducted 24 hours measuring from 20th to 25th October 2022, which could identify sources of air emissions and assess the potential effects on sensitive receptors due to proposed project. The air quality measurement was conducted at five locations as Project area site (1), Project area site (2), ECD office at Amarapura township, Myahinthar village, and Warchat village which are the nearest villages to the project site.

4.7.1.1. Method and Methodology

Air quality measurement was conducted at the project area during the wet season of 20th to 25th October, 2022. During this survey, Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (Rh), Air pressure and Temperature have been measured using the OCEANUS-AQM09. The results were compared with National Environmental Quality (Emission) Guidelines (NEQEG). The measurement station for air quality is displayed in Table 4-13. Outdoor air quality monitoring location map is as shown in Figure 4-43.

Table 4-13 Air quality Location Point for Wet Season

Item	GPS Coordinates	Locations	Parameters
Air Quality Monitoring Point on 20th – 21st October, 2022	21°56'19.6"N 96°02'59.38"E	Amarapura Project Site-1	Gas Emission: O_3, SO_2, NO_2, CO, CO_2, TVOC Dust Emission: PM_{10}, $PM_{2.5}$, TSP, Meteorology: RH%, Temperature, Wind Speed, Wind Direction
Air Quality Monitoring Point on 21st – 22nd October, 2022	21°54'55.22"N 96°02'12.66"E	Amarapura Project Site-2	
Air Quality Monitoring Point on 22nd – 23rd October, 2022	21°54'46.14"N 96°03'52.68"E	ECD Office at Amarapura Township	
Air Quality Monitoring Point on 23rd– 24th October, 2022	21°53'37.82"N 96°01'07.40"E	Myahinthar Village	
Air Quality Monitoring Point on 24th – 25th October, 2022	21°55'38.28"N 96°01'2.11"E	Warchat Village	

4.7.2. Ambient Air Quality Monitoring for Dry Season

Outdoor air quality assessment was conducted 24 hours measuring from 1st to 2nd March 2023, which could identify sources of air emissions and assess the potential effects on sensitive receptors due to proposed project. The air quality measurement was conducted at five locations as Project area site (1), Project area site (2), ECD office at Amarapura township, Myahinthar village, and Warchat village which are the nearest villages to the project site.

4.7.2.1. Method and Methodology

Air quality measurement was conducted at the project area during the dry season of 1st to 2nd March 2023. During this survey, Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (Rh), Air pressure and Temperature have been measured using the OCEANUS-AQM09. The results were compared with National Environmental Quality (Emission) Guidelines (NEQEG). The measurement station for air quality is displayed in Table 4-14. Outdoor air quality monitoring location map is as shown in Figure 4-43.

Table 4-14 Air quality Location Point for Dry Season

Item	GPS Coordinates	Locations	Parameters
Air Quality Monitoring Point on 1st – 2nd March, 2023	21°56'19.6"N 96°02'59.38"E	Amarapura Project Site-1	Gas Emission: O_3, SO_2, NO_2, CO, CO_2, TVOC Dust Emission: PM_{10}, $PM_{2.5}$, TSP, Meteorology: RH%, Temperature, Wind Speed, Wind Direction
Air Quality Monitoring Point on 2nd – 3rd March, 2023	21°54'55.22"N 96°02'12.66"E	Amarapura Project Site-2	
Air Quality Monitoring Point on 3rd - 4th March, 2023	21°54'46.14"N 96°03'52.68"E	ECD Office at Amarapura Township	
Air Quality Monitoring Point on 4th – 5th March, 2023	21°53'37.82"N 96°01'07.40"E	Myahinthar Village	
Air Quality Monitoring Point on 5th – 6th March, 2023	21°55'38.28"N 96°01'2.11"E	Warchat Village	

4.7.3. Air Quality Measurements of Amarapura Project Site (1) in Wet Season

The air quality measurement for project site (1) is located inside Amarapura Urban Development Project Site and the exact location is at North Latitude 21°56'19.6"N and East Longitude 96°02'59.38" on 20th to 21st October, 2022. The outdoor air quality monitoring photos of the project site is shown in Figure 4-44.

	
The OCEANUS-AQM09	Air Quality Monitoring

Figure 4-44 Air Quality Monitoring Photos at Project Site (1)

4.7.3.1. Result of the Study

The measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines and conducted 24-hour measurement in the project site area. The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-15.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-45 and Figure 4-46 respectively.

Table 4-15 Air Quality Monitoring Results at Amarapura Project Site (1) (20th to 21st October, 2022)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQ(E)G* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	47.82	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Within the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	20.19	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Within the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	88.87	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	19.36	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	25	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	23	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.19	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	330.08	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.22	ppm	-		NG	-
10	Relative humidity	24-Hour	59	RH%	-		NG	-
11	Temperature	24-Hour	31.05	°C	-		NG	-
12	Wind Speed	24-Hour	1.7	m/s	-		NG	-
13	Wind Direction	24-Hour	284.02	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

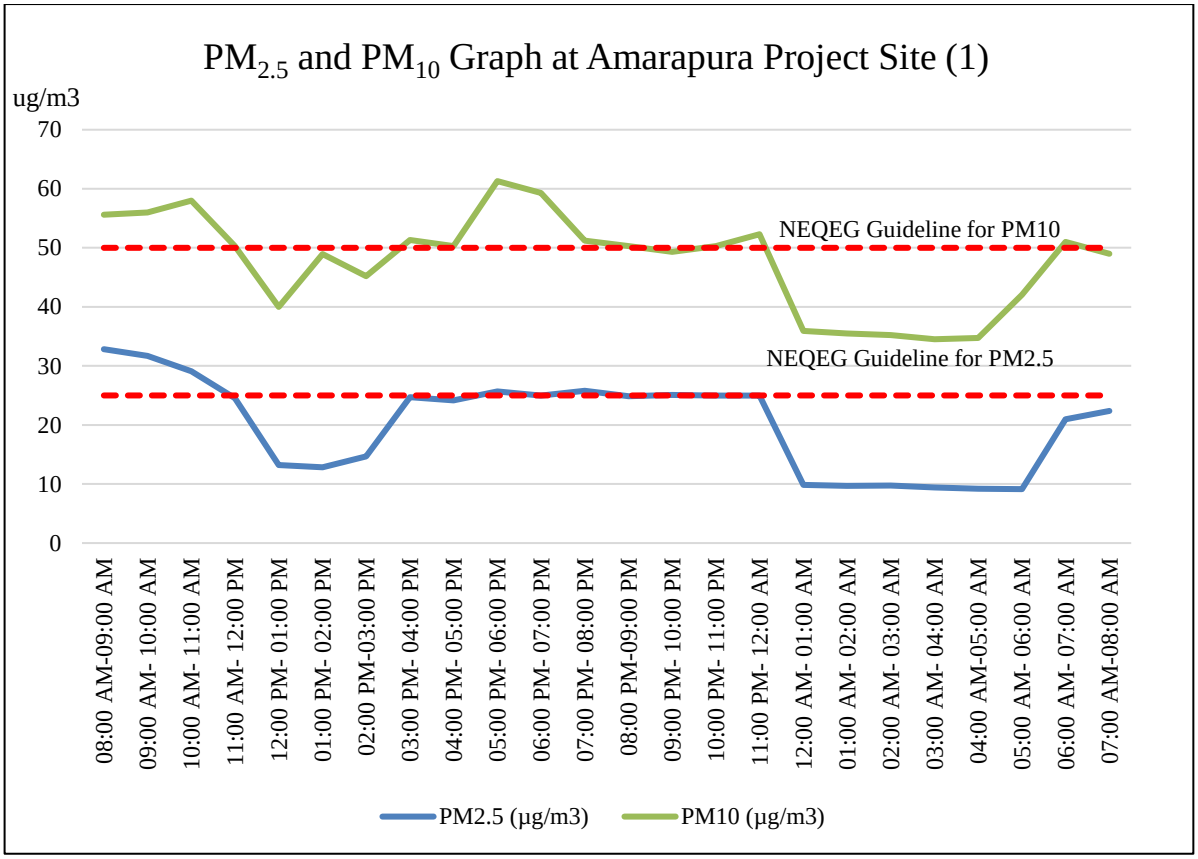


Figure 4-45 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at Amarapura Project Site (1)

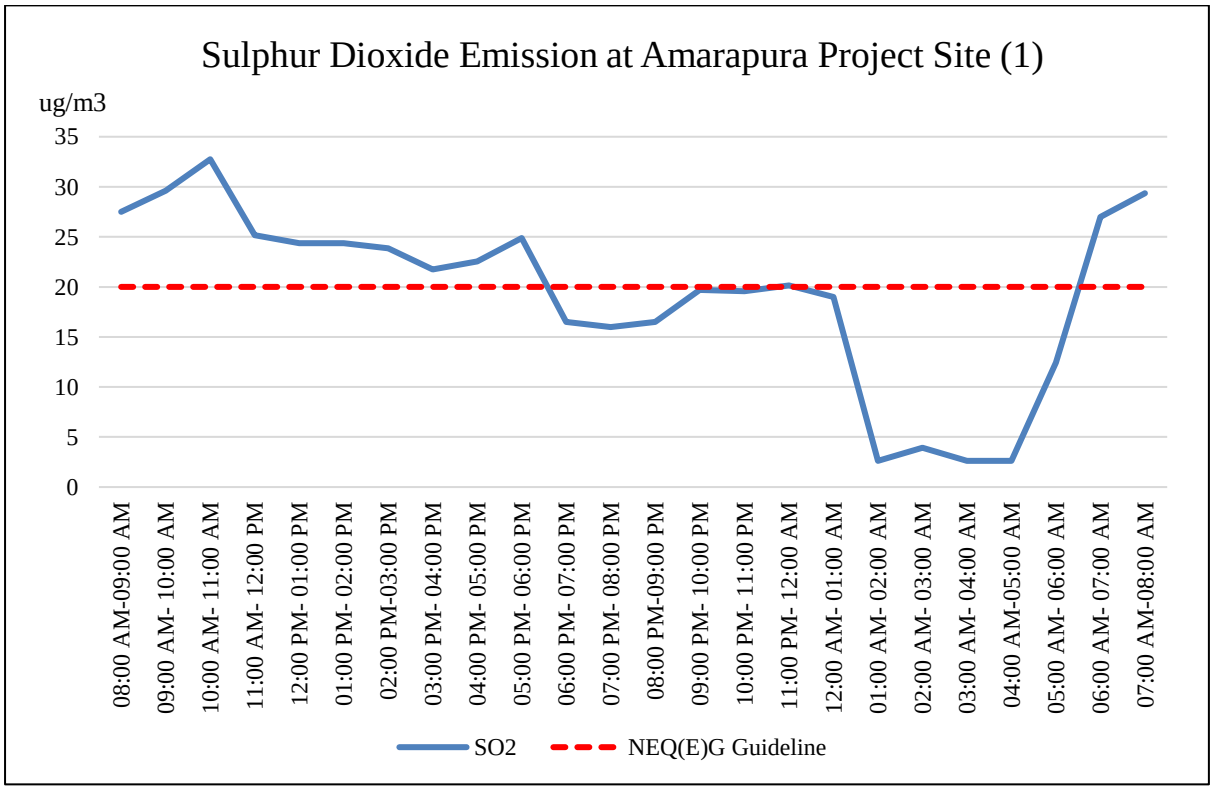


Figure 4-46 Demonstration Graphs of SO_2 Emission at Amarapura Project Site (1)

According to the air quality analysis, the ambient air parameters are within the guidelines of National Environmental Quality (Emission) Guidelines in the project site area (1). The 24-hour average result of particulate matter (PM_{10} and $PM_{2.5}$) are 47.82 µg/m^3 and 20.19 µg/m3 respectively and Sulphur Dioxide (SO_2) is 19.36 µg/m^3 under the NEQ(E)G standard guidelines. The highest results of PM_{10} and $PM_{2.5}$ and SO_2 are 29.08 µg/m3, 58.83 µg/m3, and 30.5 µg/m3 respectively at around 10:00 AM and 05:00 PM, but they are still relevant to the guidelines. The point source of emission and SO_2 is that vehicular passing through on the roads of the project area occasionally in day time.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E)G Guidelines as shown in Table 4-15.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.3.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area (1). The observation period is from 20th to 21st October, 2022.

Wind speed and wind direction's average values of project area are 1.71 m/s and 284.02° (SW/NW) respectively. The wind is generally blowing from the South West to North West direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-47.

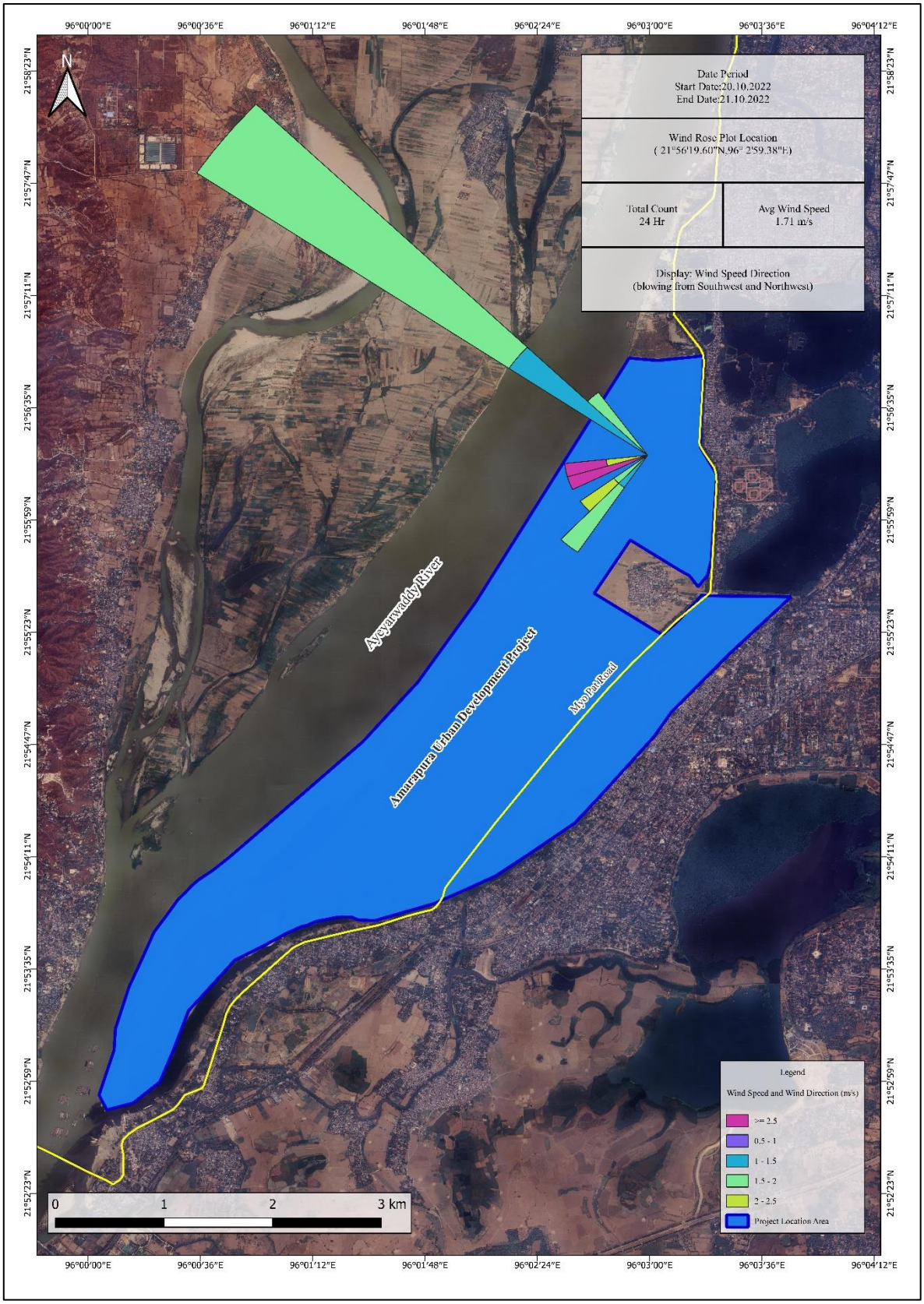


Figure 4-47 Wind Speed and Wind Direction of Amarapura Project Site (1)

4.7.4. Air Quality Measurements of Amarapura Project Site (1) in Dry Season

The air quality measurement for project site (1) is located inside Amarapura Urban Development Project Site and the exact location is at North Latitude 21°56'19.6"N and East Longitude 96°02'59.38" on 1st to 2nd March, 2023. The outdoor air quality monitoring points map and field photos of the project site as shown in Figure 4-43 and Figure 4-48.

Air Quality Monitoring

Figure 4-48 Air Quality Monitoring Photos at Project Site (1)

4.7.4.1. Result of the Study

The measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines and conducted 24-hour measurement in the project site area. The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-16.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-49 and Figure 4-50 respectively.

Table 4-16 Air Quality Monitoring Results at Amarapura Project Site (1) on (1st to 2nd March, 2023)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQ(E)G* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	48.67	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Within the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	23.33	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Within the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	85.84	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	15.54	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	27.66	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	57.95	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.26	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	258.96	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.24	ppm	-		NG	-
10	Relative humidity	24-Hour	43.95	RH%	-		NG	-
11	Temperature	24-Hour	29.17	℃	-		NG	-
12	Wind Speed	24-Hour	1.51	m/s	-		NG	-
13	Wind Direction	24-Hour	238.30	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

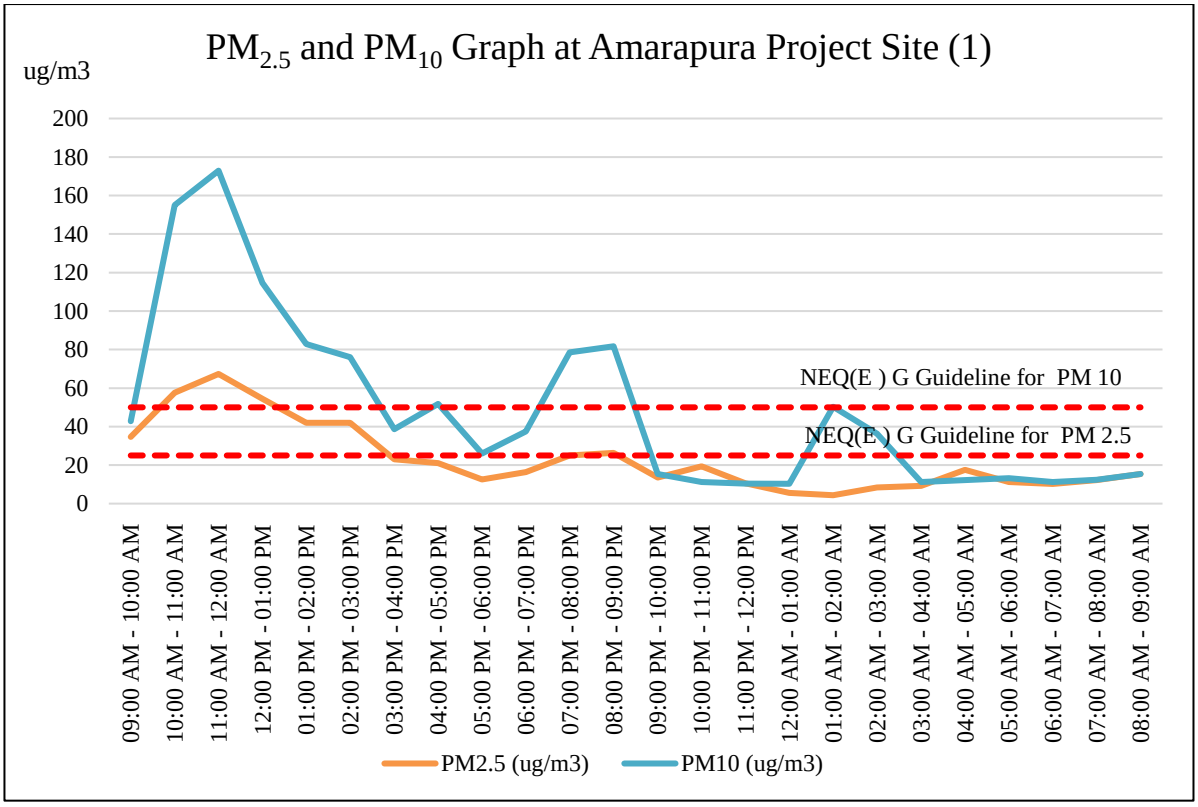


Figure 4-49 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at Amarapura Project Site (1)

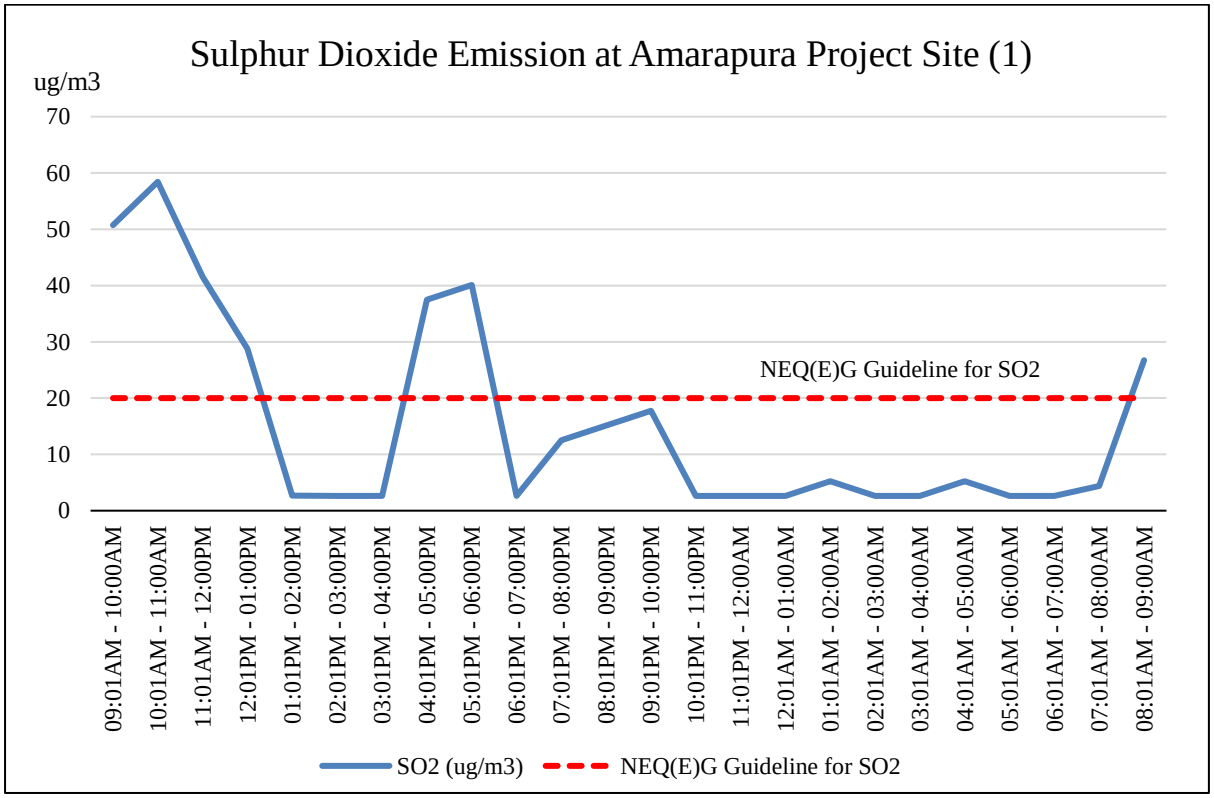


Figure 4-50 Demonstration Graphs of SO_2 Emission at Amarapura Project Site (1)

According to the air quality analysis, the ambient air parameters are within the guidelines of National Environmental Quality (Emission) Guidelines in the project site area (1). The 24-hour average result of particulate matter (PM_{10} and $PM_{2.5}$) are 48.67 µg/m^3 and 23.33 µg/m^3 respectively, and Sulphur Dioxide (SO_2) is 15.54 µg/m^3 under the NEQ(E)G standard guidelines. The highest results of PM_{10} and $PM_{2.5}$ and SO_2 are 172.92 µg/m3, 67.35 µg/m3, and 58.43 µg/m3 at around 9:00 AM and 10:00 AM, but they are still relevant to the guidelines. Land filling process and dump trucks that occasionally go through the project area during the day time on its roadways are the main source of SO_2 and particulate matter emissions.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E)G Guidelines as shown in Table 4-16.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.4.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area (1). The observation period is from 1st to 2nd March, 2023.

Wind speed and wind direction's average values of project area is 1.51 m/s and 238.30° (SE/NW) respectively. The wind is generally blowing from the South East to North West direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-51.

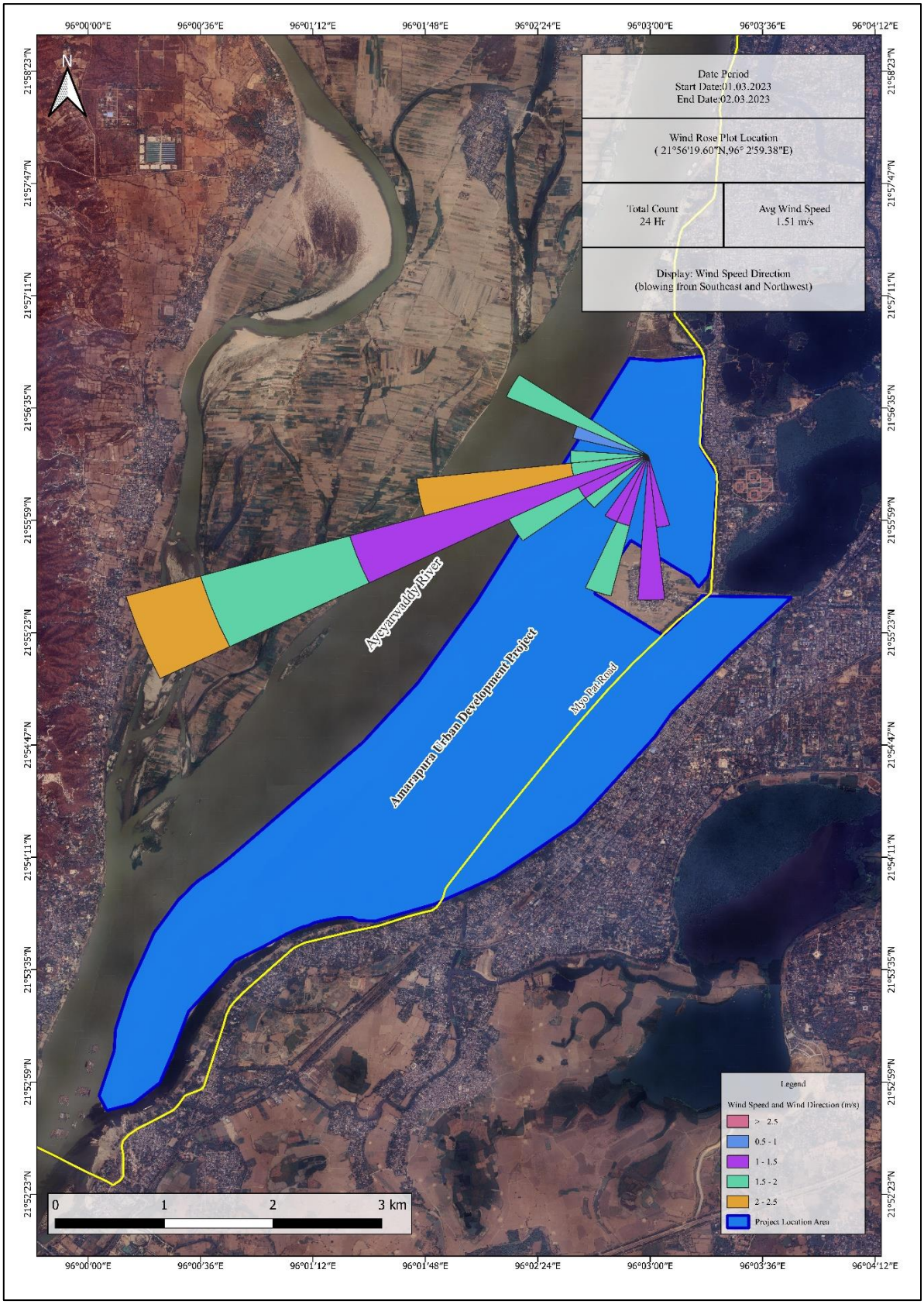


Figure 4-51 Wind Speed and Wind Direction of Amarapura Project Site (1)

4.7.5. Air Quality Measurements of Amarapura Project Site (2) in Wet Season

The air quality measurement for project site (2) is located inside Amarapura Urban Development Project Site and the exact location is at North Latitude 21°54'55.22" and East Longitude 96°02'12.66" on 21st to 22nd October, 2022. The outdoor air quality monitoring points field photos of the project site (2) is as shown in Figure 4-52.

	
The OCEANUS-AQM09	Air Quality Measurement

Figure 4-52 Air Quality Monitoring Photos at Project Site (2)

4.7.5.1. Result of the Study

These measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines in the project site area (2). The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-17.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-53 and Figure 4-54 respectively.

Table 4-17 Air Quality Monitoring Results at Amarapura Project Site (2) (21st to 22nd October, 2022)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQE* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	36.13	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Within the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	11.57	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Within the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	50.54	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	13.69	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	6.62	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	8.19	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.01	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	346.54	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.23	ppm	-		NG	-
10	Relative humidity	24-Hour	50.29	RH%	-		NG	-
11	Temperature	24-Hour	34.63	℃	-		NG	-
12	Wind Speed	24-Hour	1.65	m/s	-		NG	-
13	Wind Direction	24-Hour	225.73	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

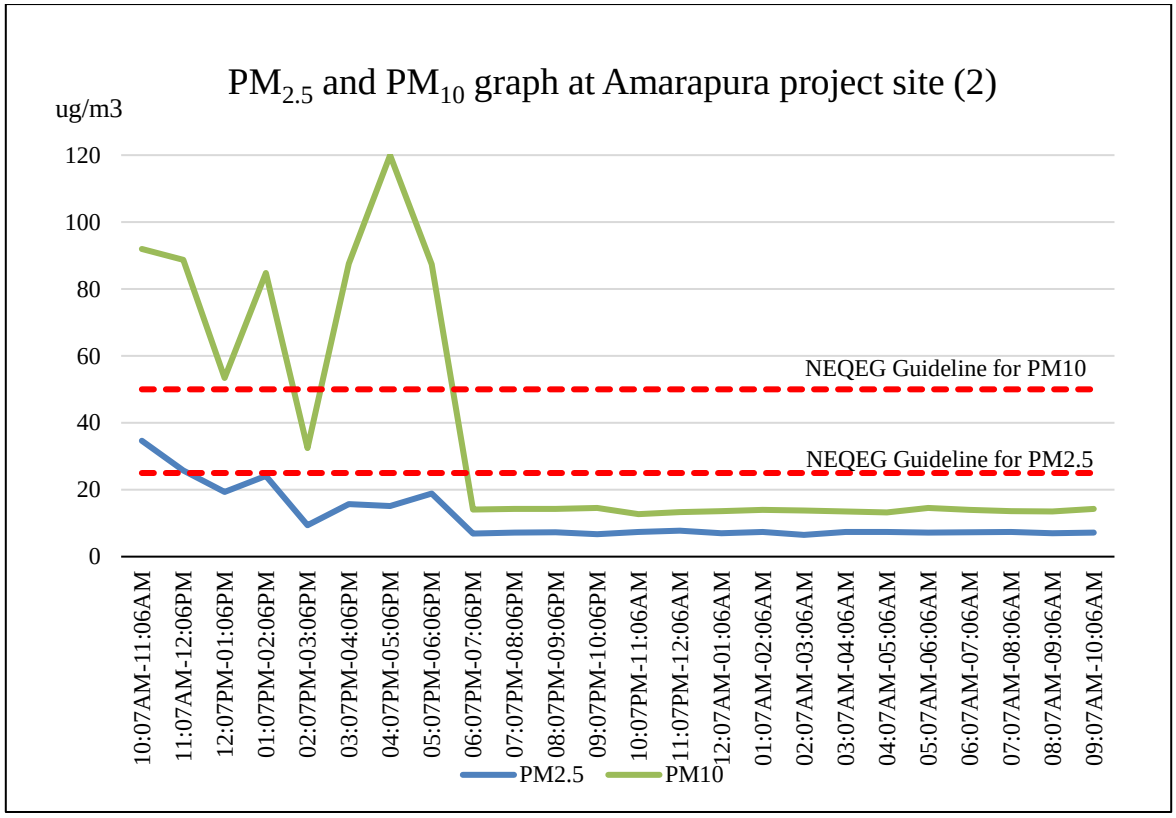


Figure 4-53 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at Amarapura Project Site (2)

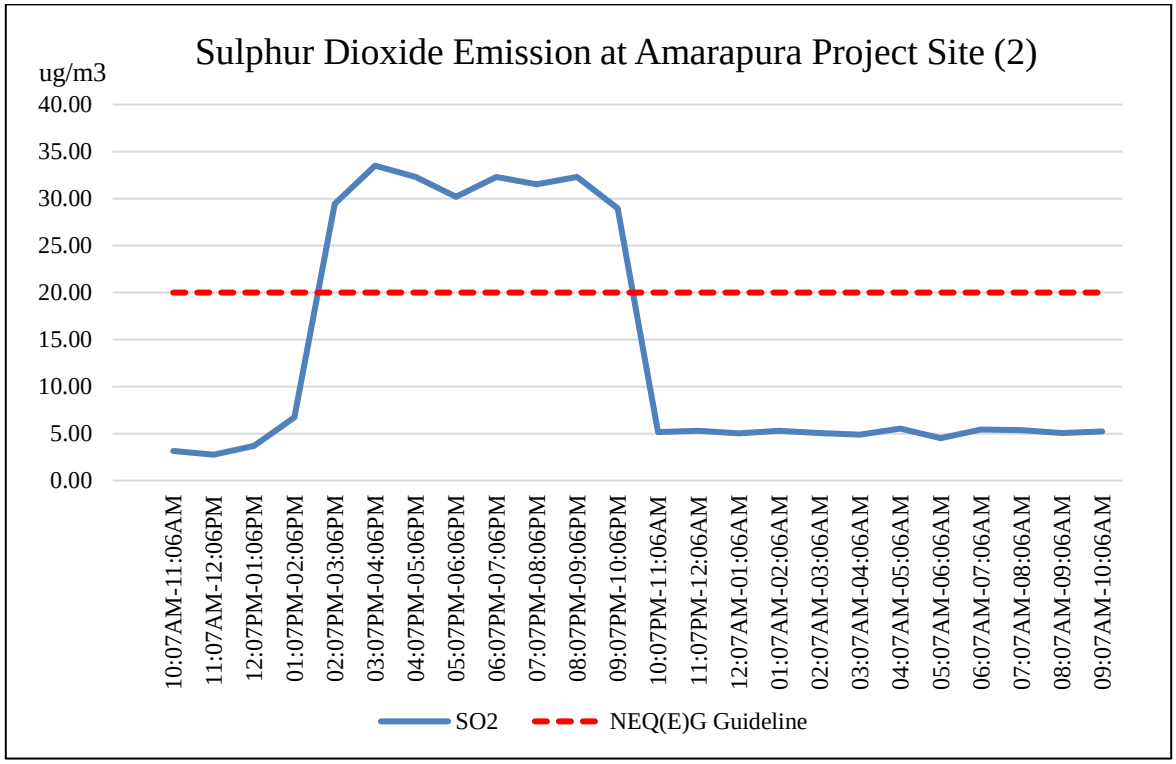


Figure 4-54 Demonstration Graphs of SO_2 Emission at Amarapura Project Site (2)

According to the air quality analysis, the ambient air parameters are within the National Environmental Quality (Emission) Guidelines (NEQEG) (2015). The average result of Particulate matters as $PM_{2.5}$ and PM_{10} are 36.13 µg/m^3 and 11.57 µg/m^3 within the NEQ(E)G Guideline. The 24-hour average result of Sulphur Dioxide (SO_2) is 13.69 µg/m^3 and is under the NEQ(E)G guidelines of 20 µg/m^3. According to the data analysis graph shown in Figure 4-54 peak of 02:00 PM to 08:00 PM are exceeded above the NEQ(E)G Guideline. During the peak hour, there are vehicles passing nearby in day time.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E)G Guidelines as shown in Table 4-17.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.5.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area. The observation period is from 21st to 22nd October.

Wind speed and wind direction's average values of project area are 1.65 m/s and 225.73° (NE/SW) respectively. The wind is generally blowing from the North East to South West direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-55.

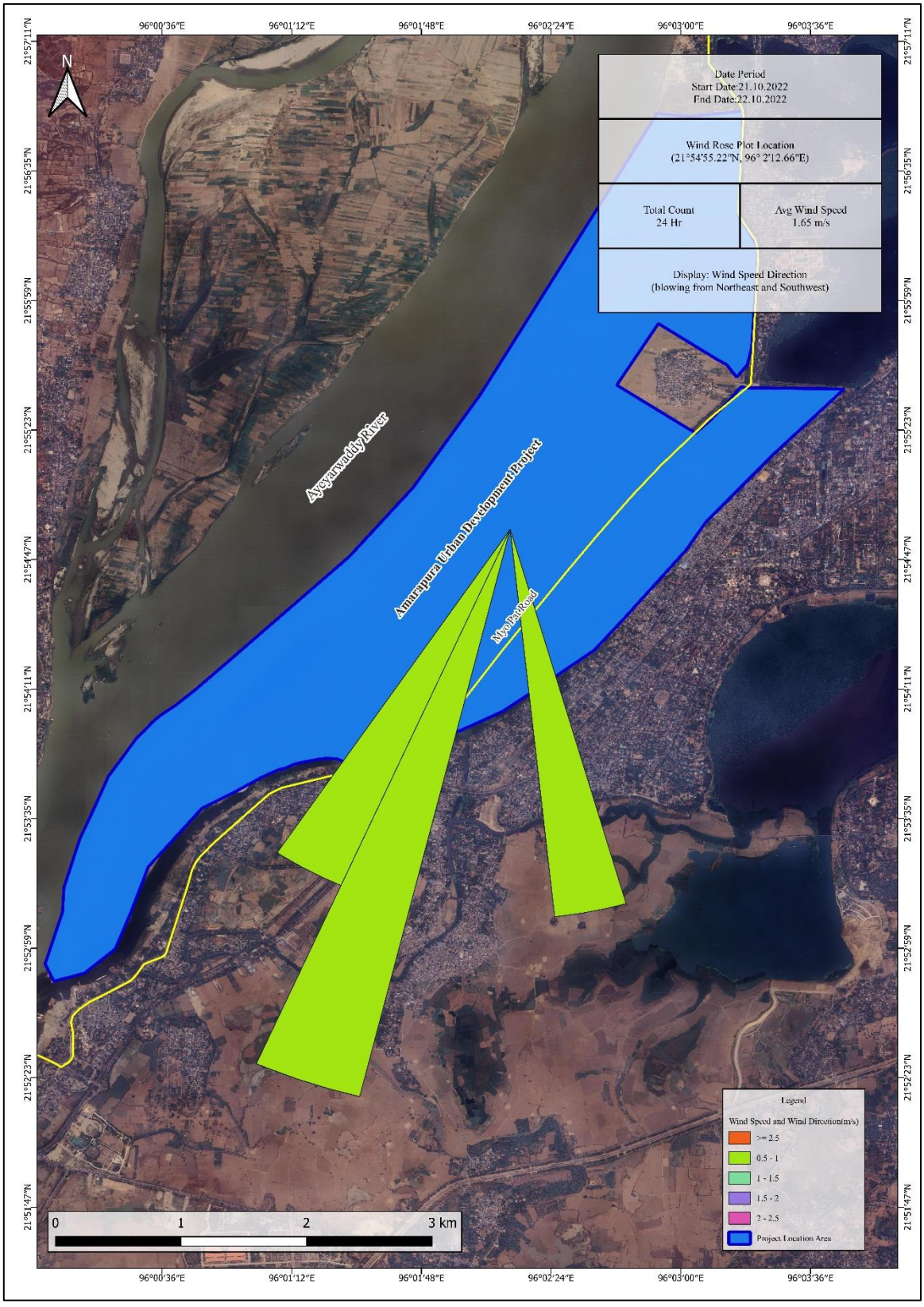


Figure 4-55 Wind Speed and Wind Direction of Amarapura Project Site (2)

4.7.6. Air Quality Measurements of Amarapura Project Site (2) in Dry Season

The air quality measurement for project site (2) is located inside Amarapura Urban Development Project site and the exact location is at North Latitude 21°54'55.22" and East Longitude 96°02'12.66" on 2nd to 3rd March, 2023. The outdoor air quality monitoring points field photos of the project site (2) is as shown in Figure 4-56.

	
The OCEANUS-AQM09	**Air Quality Measurement**

Figure 4-56 Air Quality Monitoring Photos at Project Site (2)

4.7.6.1. Result of the Study

These measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines in the project site area (2). The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-18.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-57 and Figure 4-58 respectively.

Table 4-18 Air Quality Monitoring Results at Amarapura Project Site (2) (2nd to 3rd March, 2023)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQE* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	34.83	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Within the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	17.33	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Within the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	49.21	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	16.37	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	4.25	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	60.86	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.49	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	303.93	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.38	ppm	-		NG	-
10	Relative humidity	24-Hour	41.70	RH%	-		NG	-
11	Temperature	24-Hour	28.6	℃	-		NG	-
12	Wind Speed	24-Hour	0.83	m/s	-		NG	-
13	Wind Direction	24-Hour	196.98	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

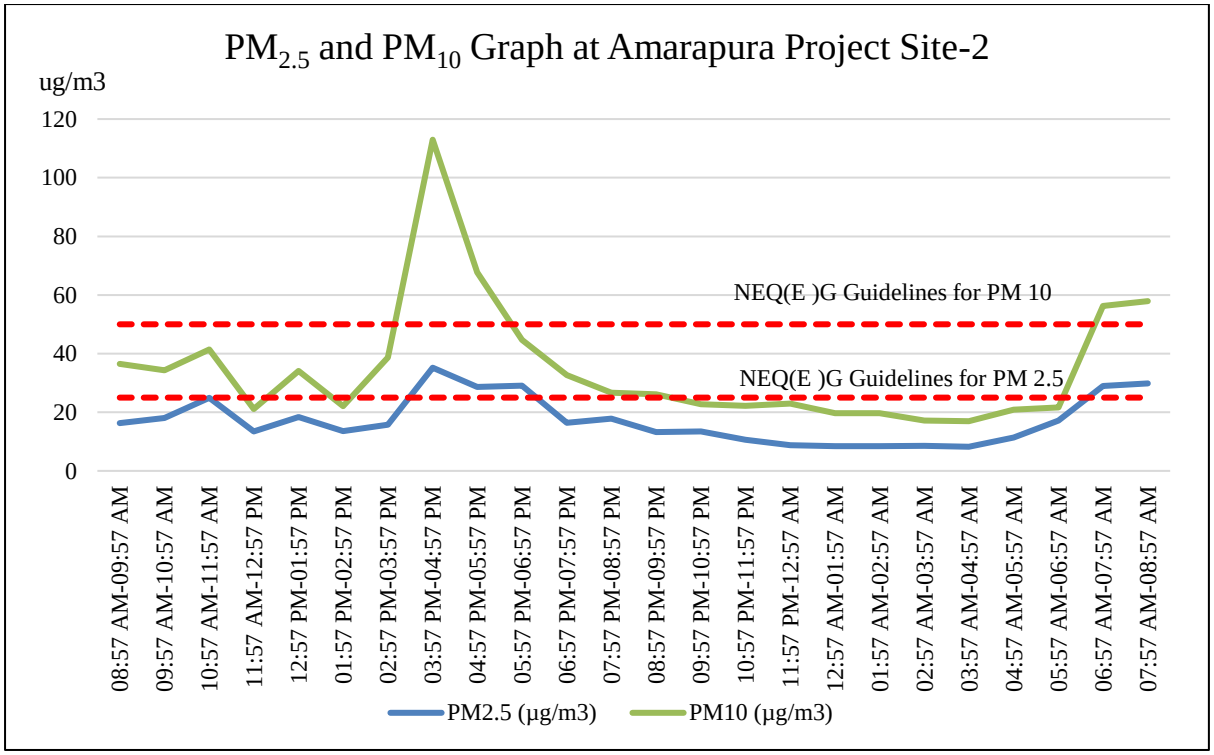


Figure 4-57 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at Amarapura Project Site (2)

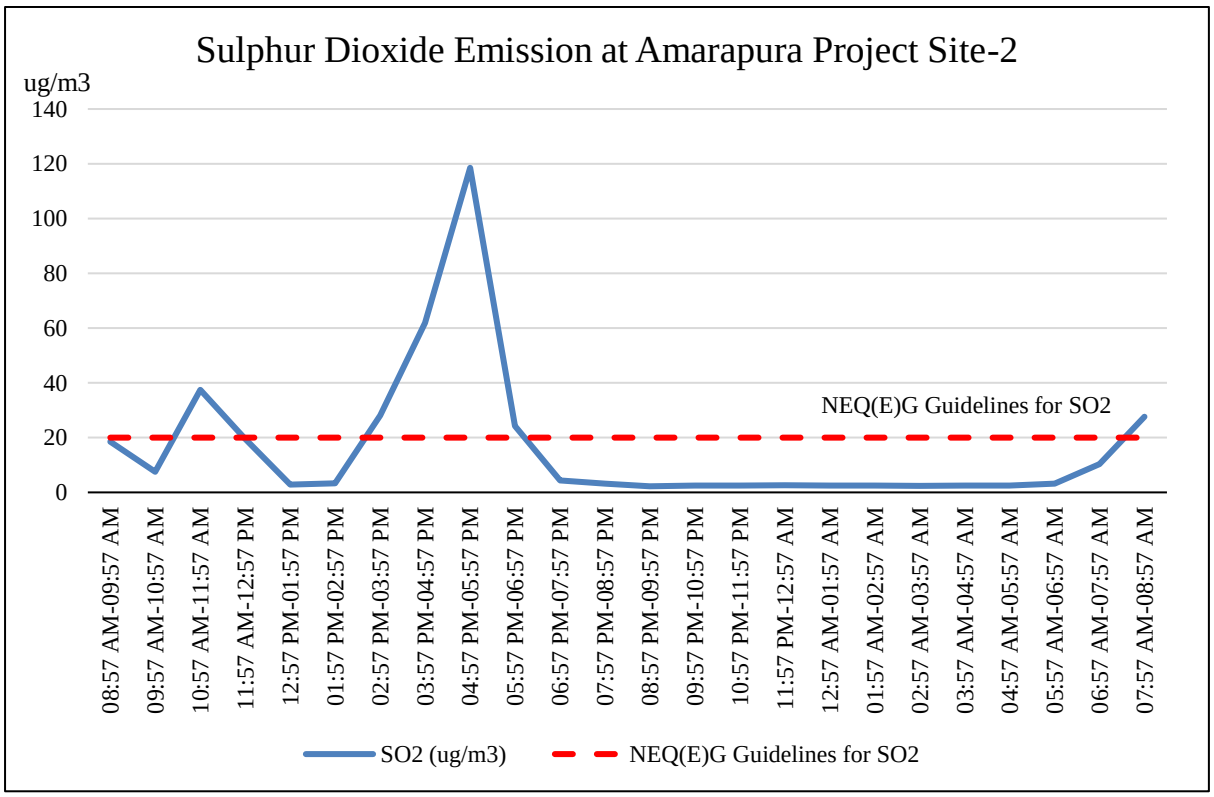


Figure 4-58 Demonstration Graphs of SO_2 Emission at Amarapura Project Site (2)

According to the air quality analysis, the ambient air parameters are within the National Environmental Quality (Emission) Guidelines (NEQEG) (2015). The average result of Particulate matters as PM_{10} and $PM_{2.5}$ are 34.83 µg/m^3 and 17.33 µg/m^3 within the NEQ(E)G Guideline. The 24-hour average result of Sulphur Dioxide (SO_2) is 16.37 µg/m^3 and is under the NEQ(E)G guidelines of 20 µg/m^3. According to the data analysis graph shown in Figure 4-58 peak of 03:00 PM to 05:00 PM are higher than the NEQ(E)G Guideline. During the peak hour, there are transport vehicles and truck passing nearby in day time. The particles can also include wind-blown dust from uncovered soil and fields in the project area.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E)G Guidelines as shown in Table 4-18.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.6.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area. The observation period is from 2nd to 3rd March, 2023.

Wind speed and wind direction's average values of project area are 0.83 m/s and 196.98° (SE/NW) respectively. The wind is generally blowing from the South East to North West direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-59.

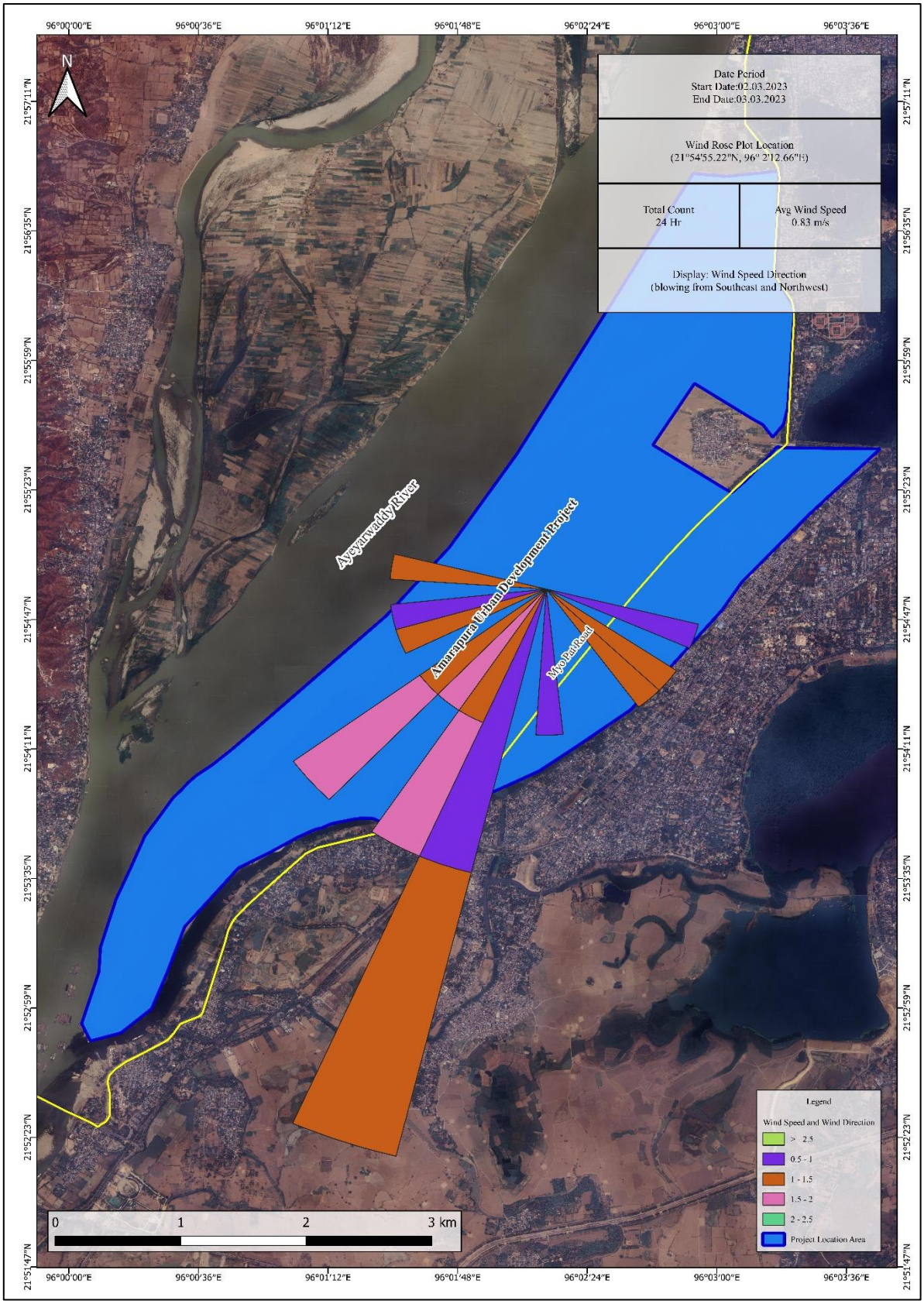


Figure 4-59 Wind Speed and Wind Direction of Amarapura Project Site (2)

4.7.7. Air Quality Measurements of ECD Office in Wet Season

The air quality measurement for ECD office at Amarapura township is located near Amarapura Urban Development Project and the exact location is at Latitude 21°54'46.14" and East Longitude 96°03'52.68" on 22nd to 23rd October, 2022. The outdoor air quality monitoring field photos of ECD office is as shown in Figure 4-60.

	
The OCEANUS-AQM09	**Air Quality Monitoring**

Figure 4-60 Air Quality Monitoring Photos at ECD Office

4.7.7.1. Result of the Study

The measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines and conducted 24-hour measurement at ECD office near the project site area. The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-19.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-61 and Figure 4-62 respectively.

Table 4-19 Air Quality Monitoring Results at ECD Office (22nd to 23rd October, 2022)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQE* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	28.12	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Within the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	19.16	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Within the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	37.55	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	19.73	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	55.95	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	38.18	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.2	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	362.65	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.16	ppm	-		NG	-
10	Relative humidity	24-Hour	67.54	RH%	-		NG	-
11	Temperature	24-Hour	31.05	℃	-		NG	-
12	Wind Speed	24-Hour	0.32	m/s	-		NG	-
13	Wind Direction	24-Hour	197.25	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

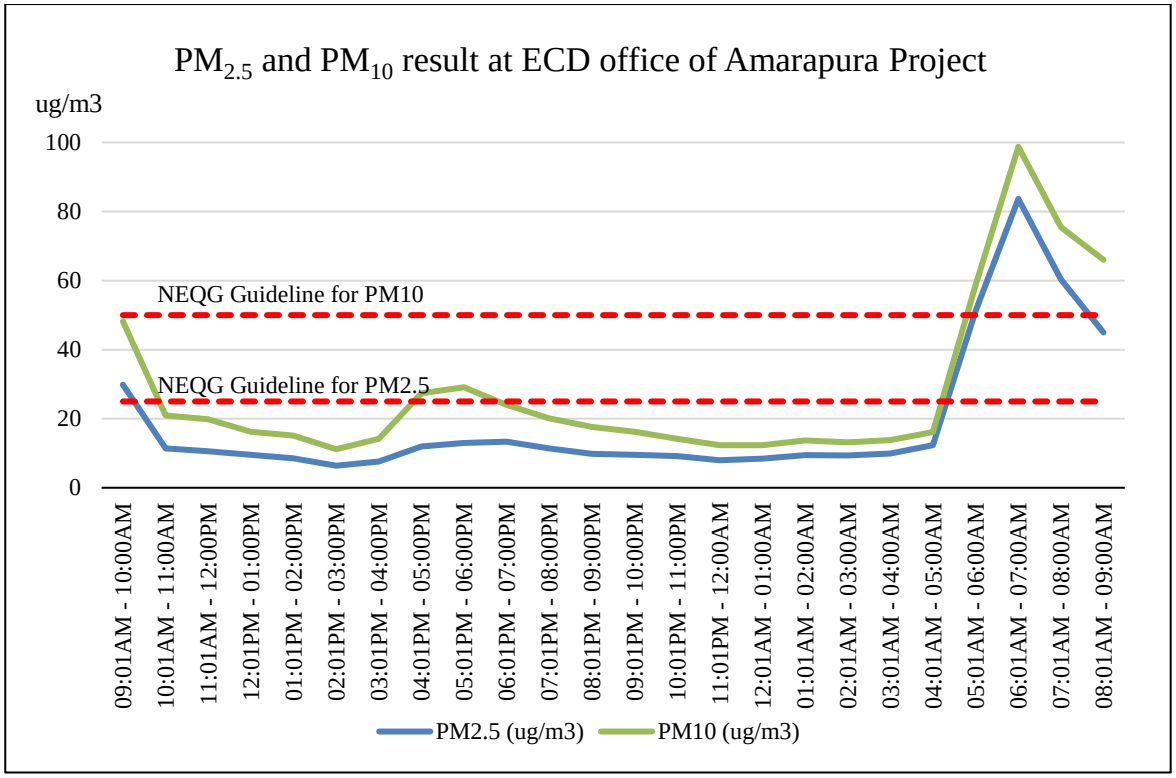


Figure 4-61 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at ECD Office

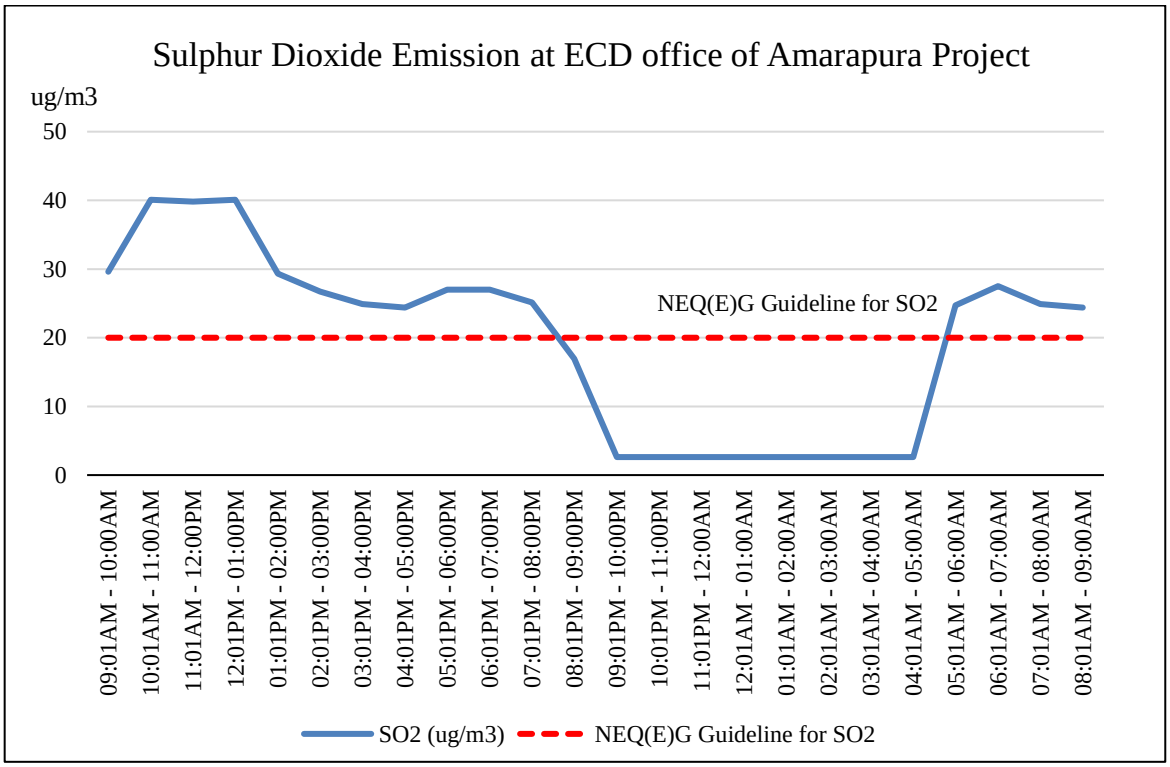


Figure 4-62 Demonstration Graphs of SO_2 Emission at ECD Office

According to the air quality analysis, the ambient air parameters are within the National Environmental Quality (Emission) Guidelines (NEQEG) (2015). The average result

of Particulate matters as $PM_{2.5}$ and PM_{10} are 28.12 µg/m^3 and 19.16 µg/m^3 within the NEQE Guideline. The 24-hour average result of Sulphur Dioxide (SO_2) is 19.73 µg/m^3 and is under the NEQ(E)G guidelines of 20 µg/m^3. According to the data analysis graph shown in Figure 4-62 peak of 10:00 AM on 22nd October, 2022 are exceeded above the NEQ(E)G Guideline. During the peak hour, vehicular traffic passes through the roads near the monitoring station occasionally during the day time and office hour, and it is also located in the corner of the Sagaing Mandalay Road.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E)G Guidelines as shown in Table 4-19.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.7.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area. The observation period is from 22nd to 23rd October, 2022.

Wind speed and wind direction's average values of project area is 0.32 m/s and 197.25° (SE/NW) respectively. The wind is generally blowing from the South East to North West direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-63.

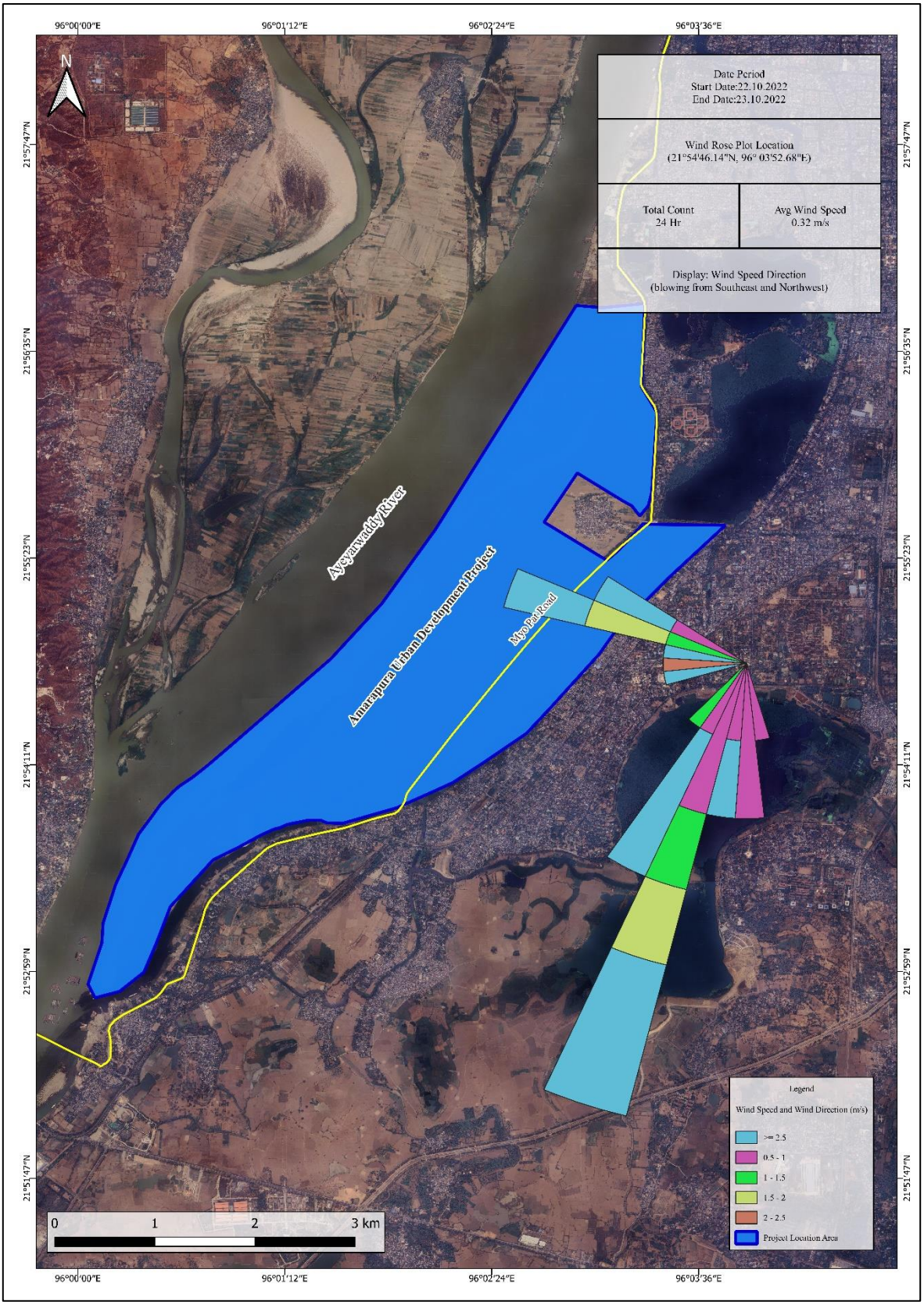


Figure 4-63 Wind Speed and Wind Direction of ECD Office

4.7.8. Air Quality Measurements of ECD Office in Dry Season

The air quality measurement for ECD office at Amarapura township is located near Amarapura Urban Development Project and the exact location is at Latitude 21°54'46.14" and East Longitude 96°03'52.68" on 3rd to 4th March, 2023. The outdoor air quality monitoring field photos of ECD office is as shown in Figure 4-64.

	
The OCEANUS-AQM09	Air Quality Monitoring

Figure 4-64 Air Quality Monitoring Photos at ECD Office

4.7.8.1. Result of the Study

The measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines and conducted 24-hour measurement at ECD office near the project site area. The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-20.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-65 and Figure 4-66 respectively.

Table 4-20 Air Quality Monitoring Results at ECD Office (3rd to 4th March, 2023)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQE* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	33.73	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Within the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	25.39	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Within the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	39.73	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	19.85	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	1.89	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	59.12	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.48	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	336.17	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.32	ppm	-		NG	-
10	Relative humidity	24-Hour	30.7	RH%	-		NG	-
11	Temperature	24-Hour	30.54	°C	-		NG	-
12	Wind Speed	24-Hour	0.26	m/s	-		NG	-
13	Wind Direction	24-Hour	172.55	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

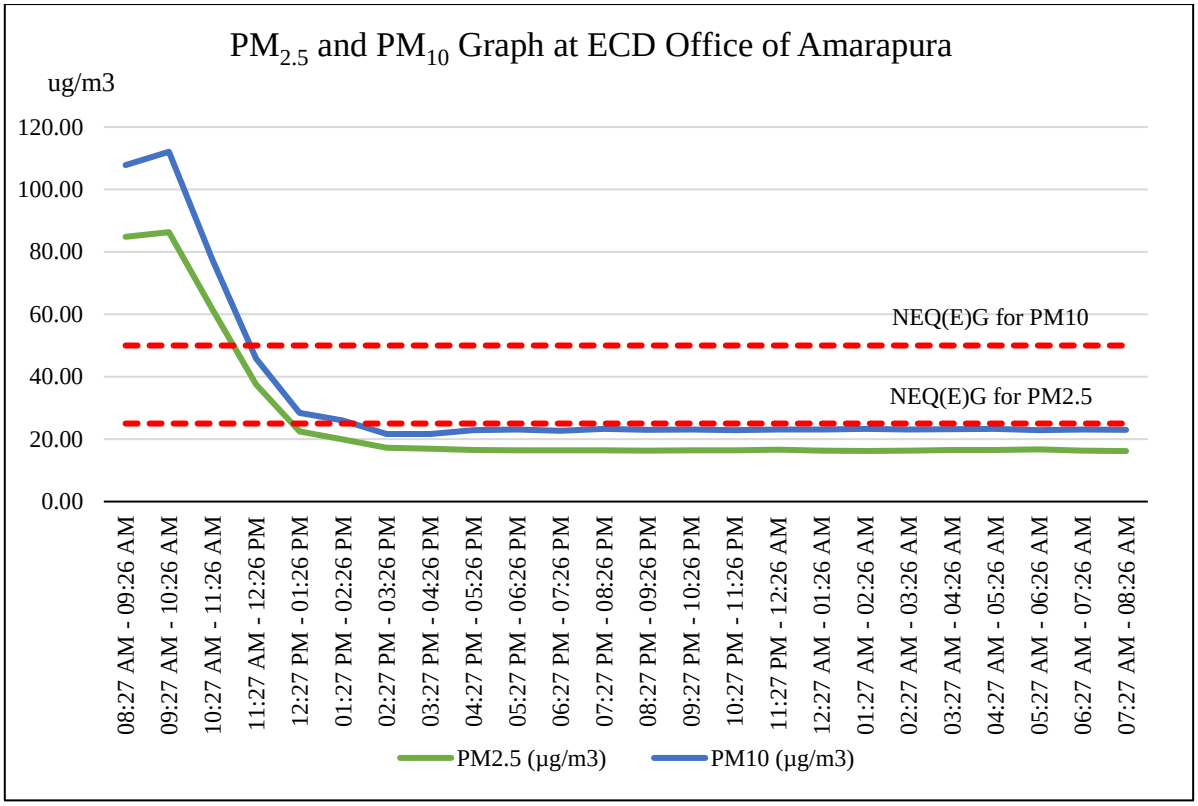


Figure 4-65 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at ECD Office

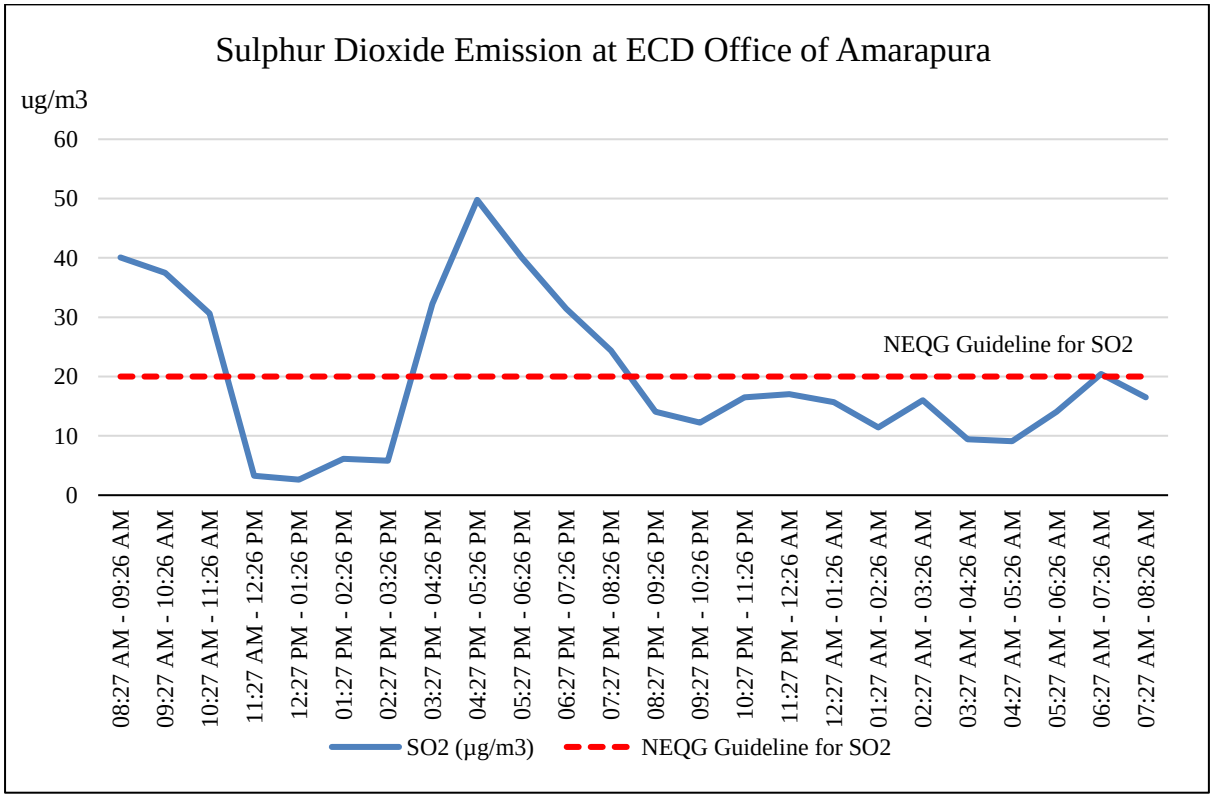


Figure 4-66 Demonstration Graphs of SO_2 Emission at ECD Office

According to the air quality analysis, the ambient air parameters are within the National Environmental Quality (Emission) Guidelines (NEQEG) (2015). The average result of Particulate matters as PM_{10} and $PM_{2.5}$ are 33.73 µg/m^3 and 25.39 µg/m^3 within the NEQ(E)G Guideline. The 24-hour average result of Sulphur Dioxide (SO_2) is 19.85 µg/m^3 and is under the NEQ(E)G guidelines of 20 µg/m^3. According to the data analysis graph shown in Figure 4-66 peak of 9:00 AM to 10:00 AM on 3rd March, 2023 are higher than the Guideline. During the peak hour, vehicular traffic passes through the roads near the monitoring station occasionally during the day time and office hour, and it is also located in the corner of the Sagaing-Mandalay Road.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E)G Guidelines as shown in Figure 4-66.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.8.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area. The observation period is from 3rd to 4th March, 2023.

Wind speed and wind direction's average values of the study area is 0.26 m/s and 172.55° (SW/NW) respectively. The wind is generally blowing from the South West to North West direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-67.

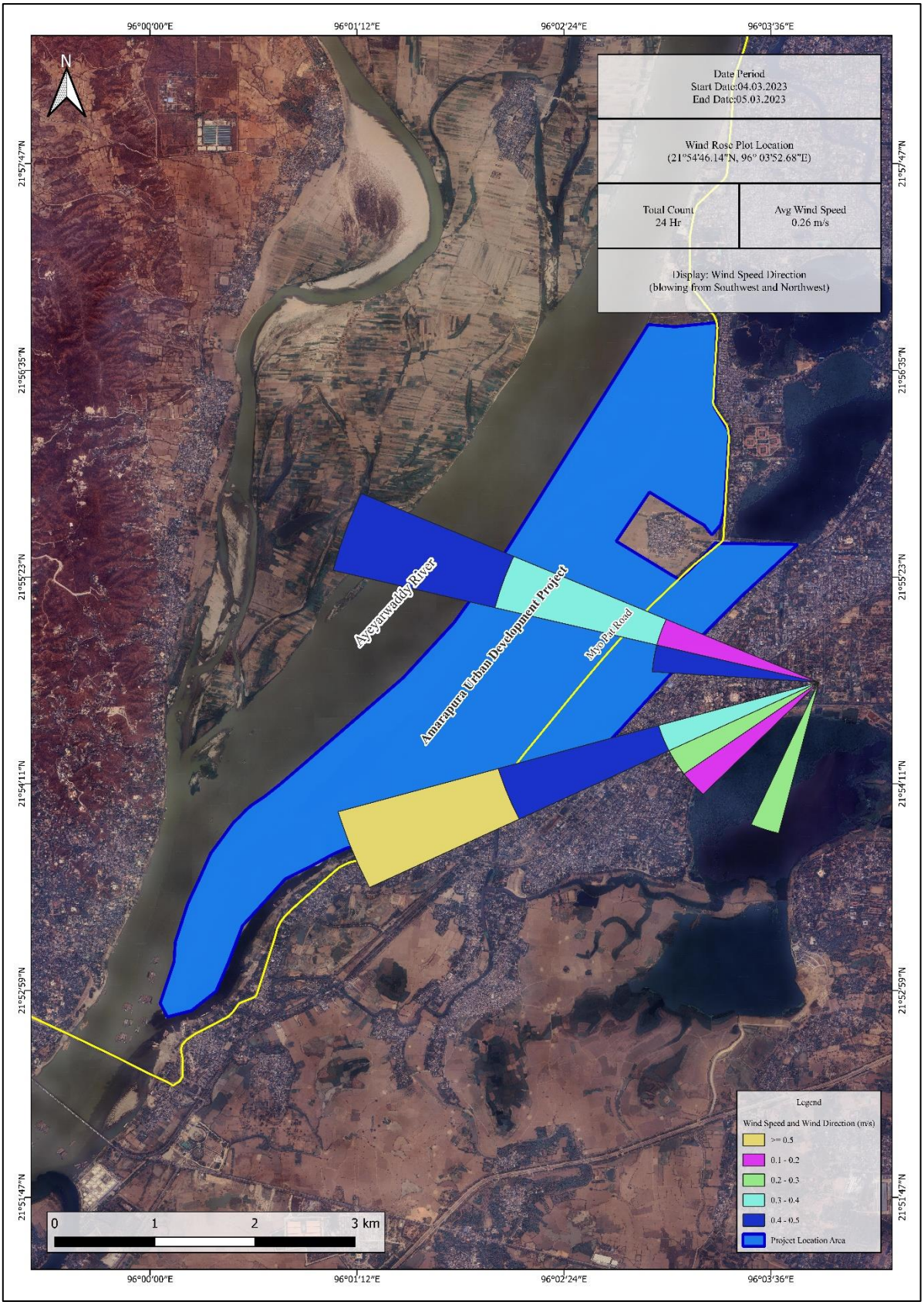


Figure 4-67 Wind Speed and Wind Direction of ECD Office

4.7.9. Air Quality Measurements of Myahinthar Village in Wet Season

The air quality measurement at Myahinthar Village is located near the Amarapura Urban Development Project Site and the exact location is at North Latitude 21°53'37.82" and East Longitude 96°01'7.40" on 23rd to 24th October, 2022. The outdoor air quality monitoring points map and field photos of Myahinthar Village is as shown in Figure 4-68.

	
The OCEANUS-AQM09	Air Quality Measurement

Figure 4-68 Air Quality Monitoring Photos at Myahinthar Village

4.7.9.1. Result of the Study

These measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines at Myahinthar Village which is around 5 kilometers from the project site. The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-21.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-69 and Figure 4-70 respectively.

Table 4-21 Air Quality Monitoring Results at Myahinthar Village (23th to 24th October, 2022)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQE* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	42.78	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Within the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	21.14	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Within the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	69.18	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	18.99	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	15	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	20	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.22	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	281.30	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.15	ppm	-		NG	-
10	Relative humidity	24-Hour	60.88	RH%	-		NG	-
11	Temperature	24-Hour	32.18	°C	-		NG	-
12	Wind Speed	24-Hour	0.26	m/s	-		NG	-
13	Wind Direction	24-Hour	203.96	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

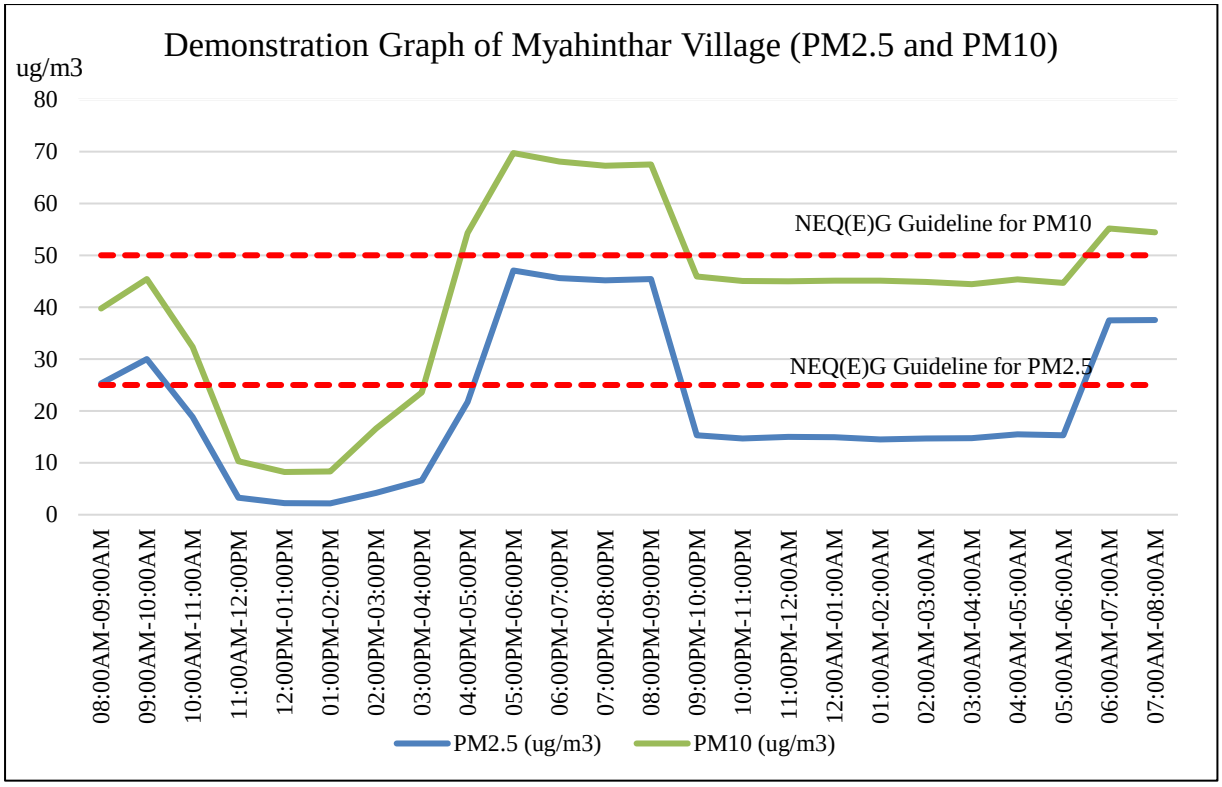


Figure 4-69 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at Myahinthar Village

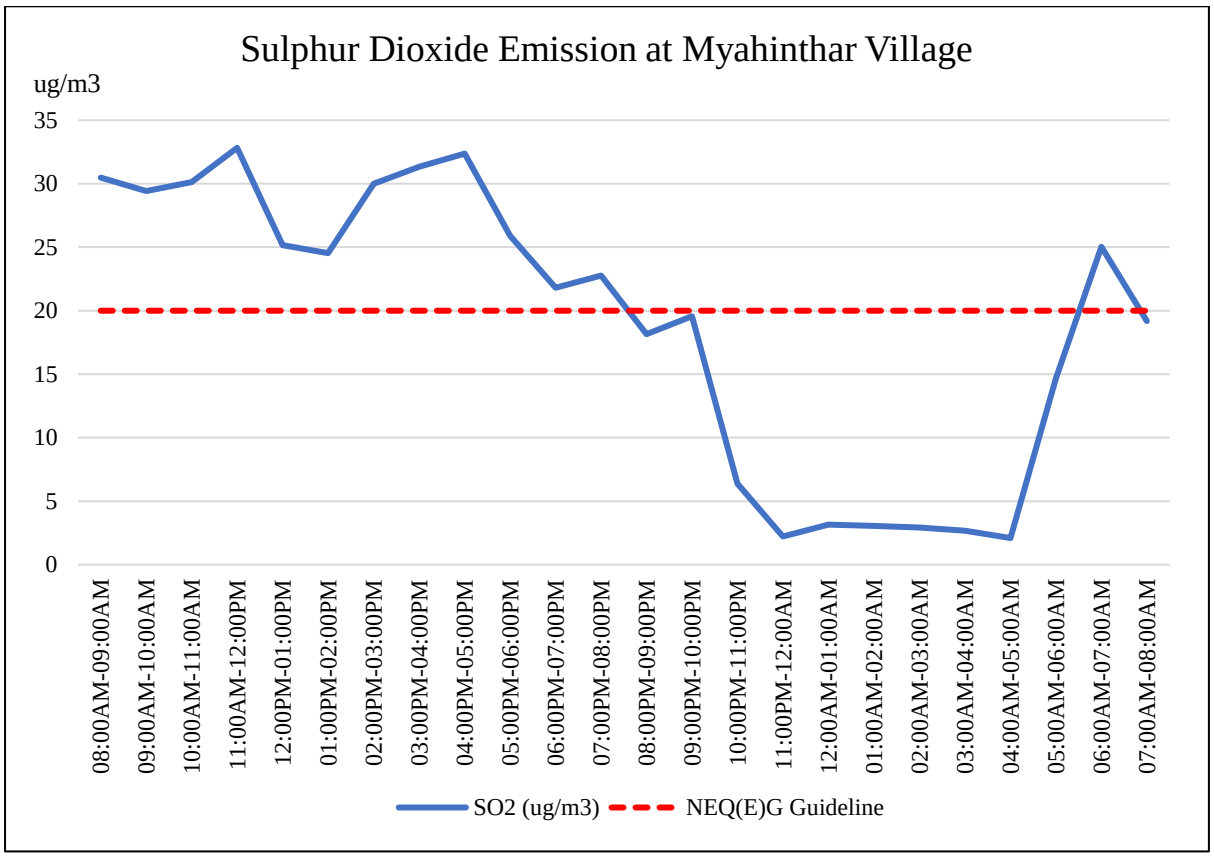


Figure 4-70 Demonstration Graphs of SO_2 Emission at Myahinthar Village

According to the air quality analysis, the ambient air parameters are within the guidelines of National Environmental Quality (Emission) Guidelines in the study area. The 24-hour average result of particulate matter (PM_{10} and $PM_{2.5}$) are 42.78 µg/m^3 and 21.14 µg/m^3 respectively and Sulphur Dioxide (SO_2) is 18.99 µg/m^3 under the NEQ(E)G standard guidelines. The highest result of SO_2 is 32.5 g/m3 at around 11:00 AM and 12:00 PM, but they are still relevant to the guidelines. During peak hours, there were vehicular passing through on the roads near the monitoring station occasionally in day time.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E) Guidelines as shown in Table 4-21.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.9.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area. The observation period is from 23rd to 24th October, 2022.

Wind speed and wind direction's average values of project area is 0.26 m/s and 203.96° (SE/SW) respectively. The wind is generally blowing from the South East to South West direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-71.

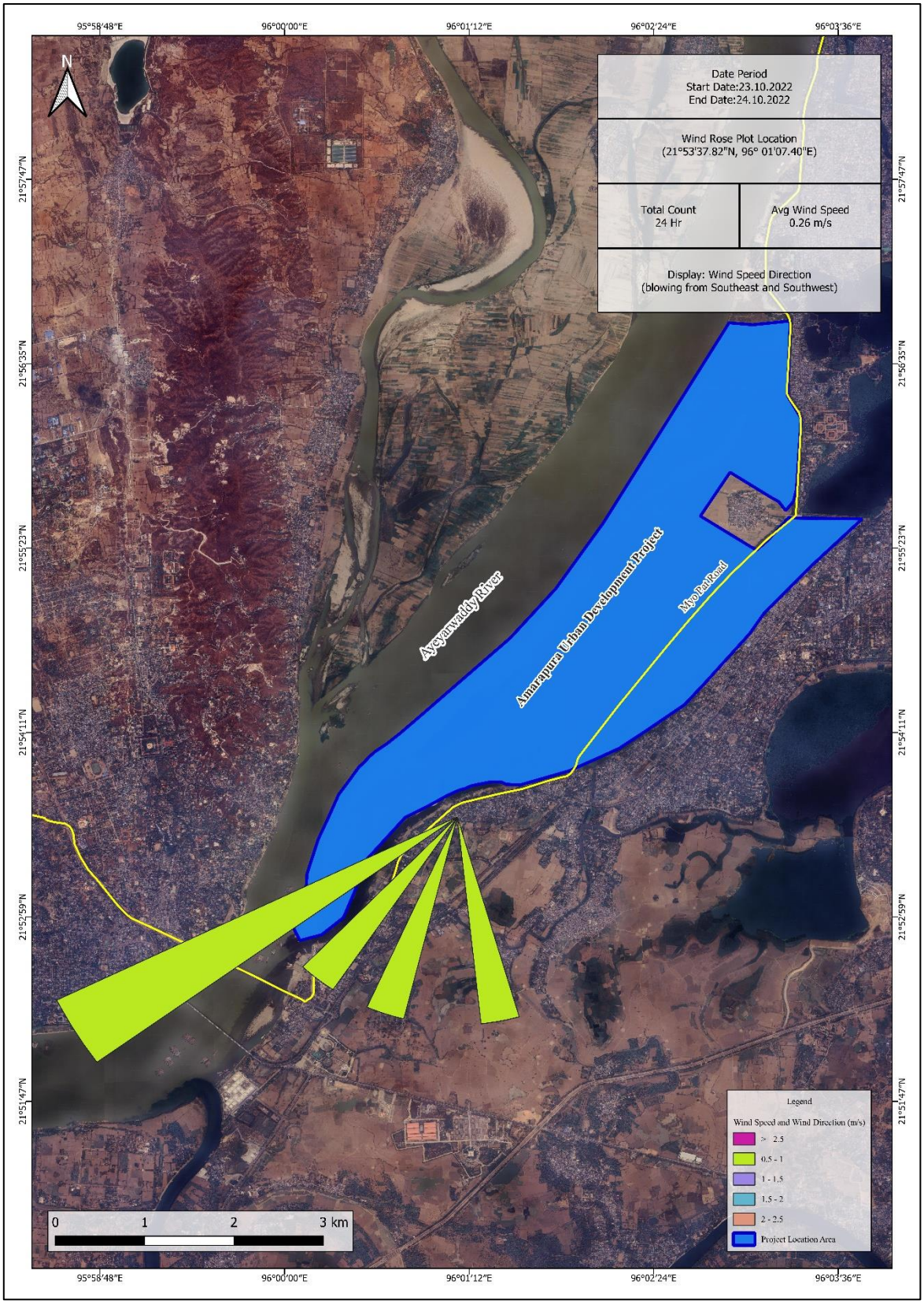


Figure 4-71 Wind Speed and Wind Direction of Myahinthar Village

4.7.10. Air Quality Measurements of Myahinthar Village in Dry Season

The air quality measurement for Myahinthar Village is located near Amarapura Urban Development Project Site and the exact location is at North Latitude 21°53'37.82" and East Longitude 96°01'7.40" on 4th to 5th March, 2023. The outdoor air quality monitoring points map and field photos of Myahinthar Village is as shown in Figure 4-72.

	
The OCEANUS-AQM09	Air Quality Measurement

Figure 4-72 Air Quality Monitoring Photos at Myahinthar Village

4.7.10.1. Result of the Study

These measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines at Myahinthar Village which is around 5 kilometers from the project site. The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-22.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-73 and Figure 4-74 respectively.

Table 4-22 Air Quality Monitoring Results at Myahinthar Village (3rd to 4th March, 2023)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQE* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	56.17	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Above the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	38.08	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Above the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	85.43	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	18.65	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	45.30	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	82.38	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.61	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	331.71	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.26	ppm	-		NG	-
10	Relative humidity	24-Hour	40.78	RH%	-		NG	-
11	Temperature	24-Hour	31.37	°C	-		NG	-
12	Wind Speed	24-Hour	0.11	m/s	-		NG	-
13	Wind Direction	24-Hour	186.10	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

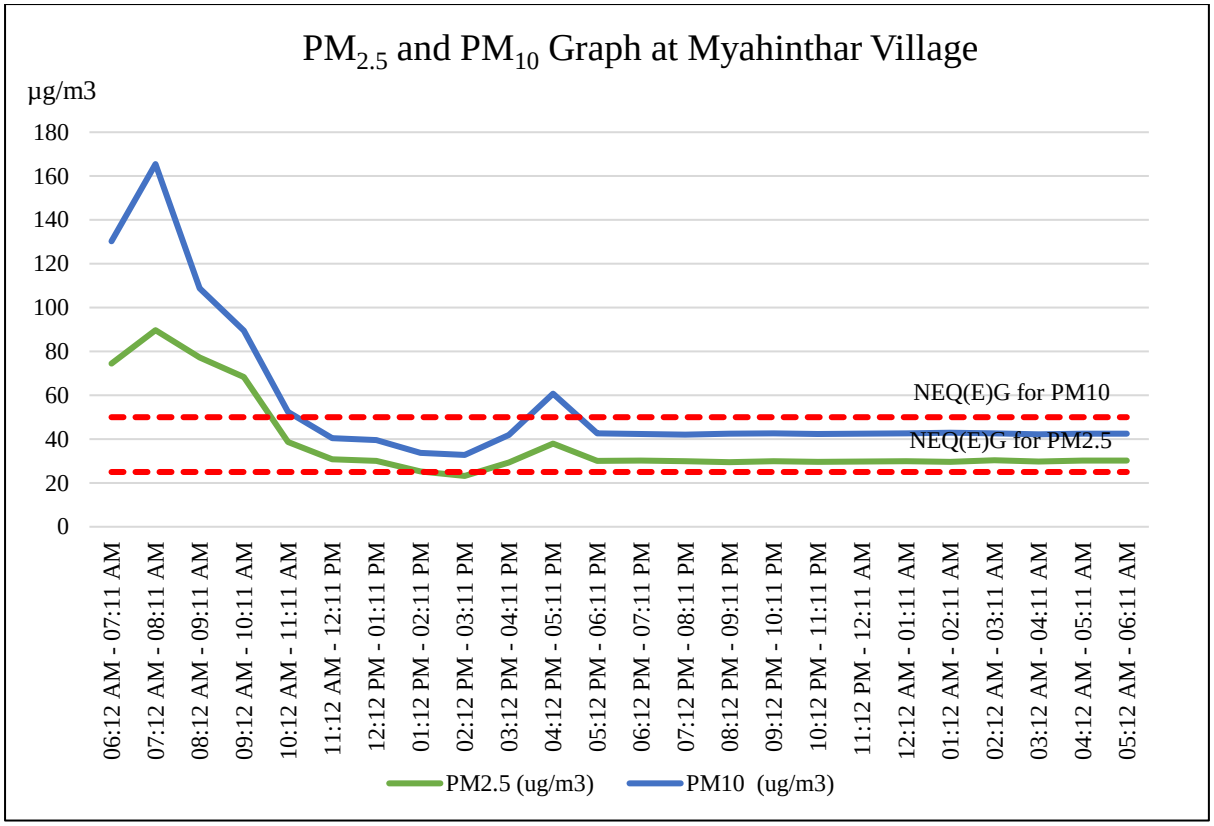


Figure 4-73 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at Myahinthar Village

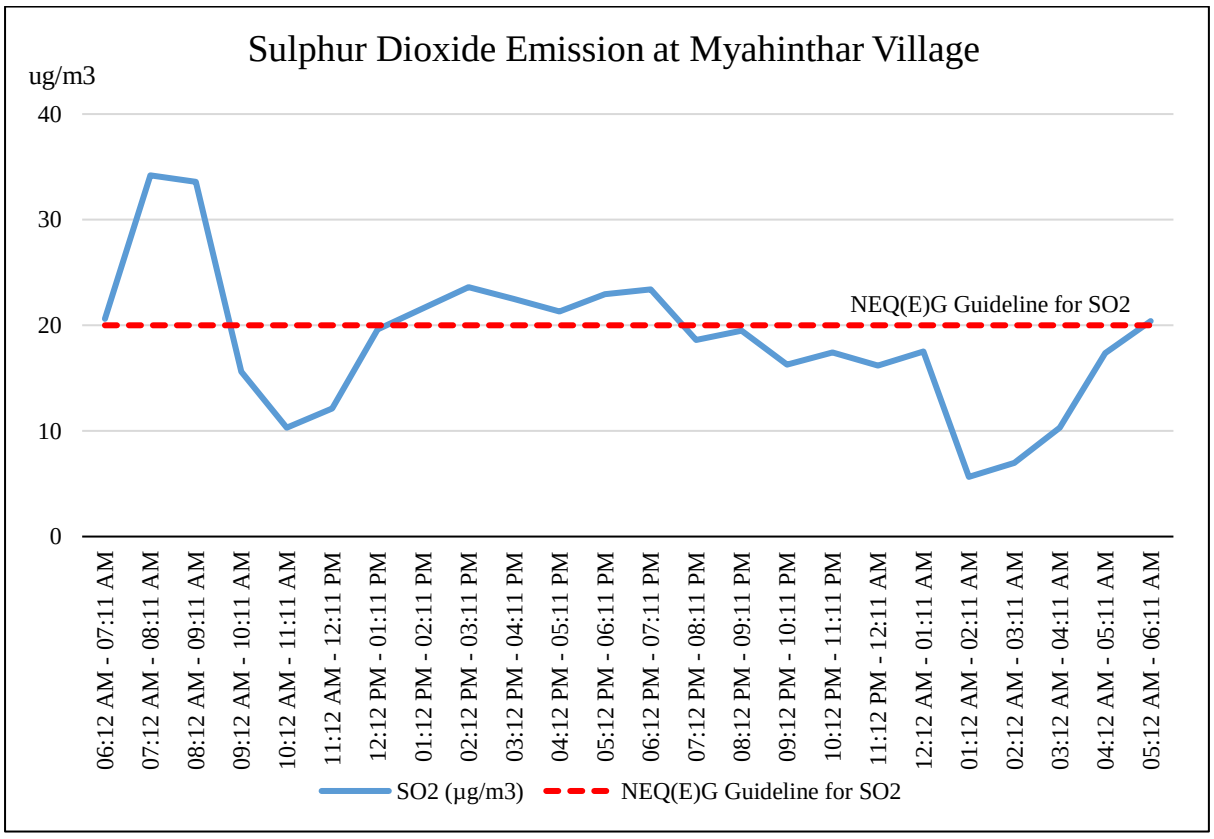


Figure 4-74 Demonstration Graphs of SO_2 Emission at Myahinthar Village

According to the air quality analysis, the ambient air parameters are within the guidelines of National Environmental Quality (Emission) Guidelines in the study area expect PM parameters. The 24-hour average result of particulate matter (PM_{10} and $PM_{2.5}$) are 56.17 $\mu g/m^3$ and 38.08 $\mu g/m^3$ respectively that exceeded the guidelines. Sulphur Dioxide (SO_2) is 18.99 $\mu g/m^3$ under the NEQ(E)G standard guidelines. The highest result of SO_2 is 34.20 $\mu g/m^3$ at around 07:00 AM and 09:00 AM as shown in demonstration graph, but they are still relevant to the guidelines. During peak hours, there were vehicular passing through on the roads near the monitoring station occasionally in day time.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E) Guidelines as shown in Table 4-22.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.10.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area. The observation period is from 4th to 5th March, 2023.

Wind speed and wind direction's average values of project area is 0.11 m/s and 186.10° (SE/SW) respectively. The wind is generally blowing from the South East to South West direction. direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-75.

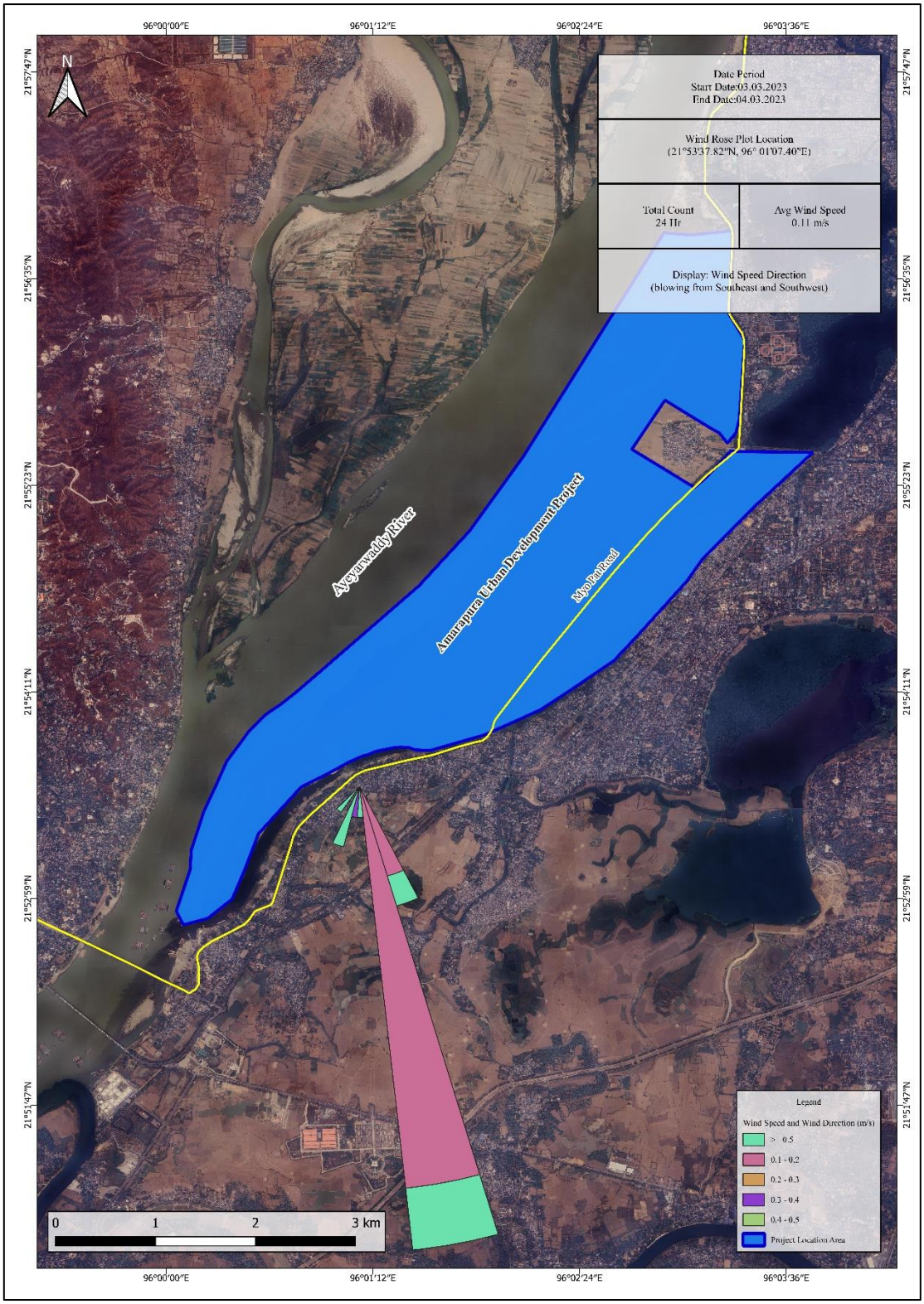


Figure 4-75 Wind Speed and Wind Direction of Myahinthar Village

4.7.11. Air Quality Measurements of Warchat Village in Wet Season

The air quality measurement for Warchat village is located near their project site and the exact location is at North Latitude 21°55'38.28" and East Longitude 96°01'2.11" on 24th to 25th October, 2022. The outdoor air quality monitoring points map and field photos of Warchat Village is as shown in Figure 4-76.

	
The OCEANUS-AQM09	Air Quality Measurement

Figure 4-76 Air Quality Monitoring Photos at Warchat Village

4.7.11.1. Result of the Study

The measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines and conducted 24-hour measurement at Warchat Village which is around 5 kilometers from the project site. The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-23.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-77 and Figure 4-78 respectively.

Table 4-23 Air Quality Monitoring Results at Warchat Village (24th to 25th October, 2022)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQE* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	9.23	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Within the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	4.49	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Within the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	19.07	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	17.94	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	16.6	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	18.93	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.08	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	320.96	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.13	ppm	-		NG	-
10	Relative humidity	24-Hour	64.91	RH%	-		NG	-
11	Temperature	24-Hour	30.11	℃	-		NG	-
12	Wind Speed	24-Hour	0.25	m/s	-		NG	-
13	Wind Direction	24-Hour	195	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

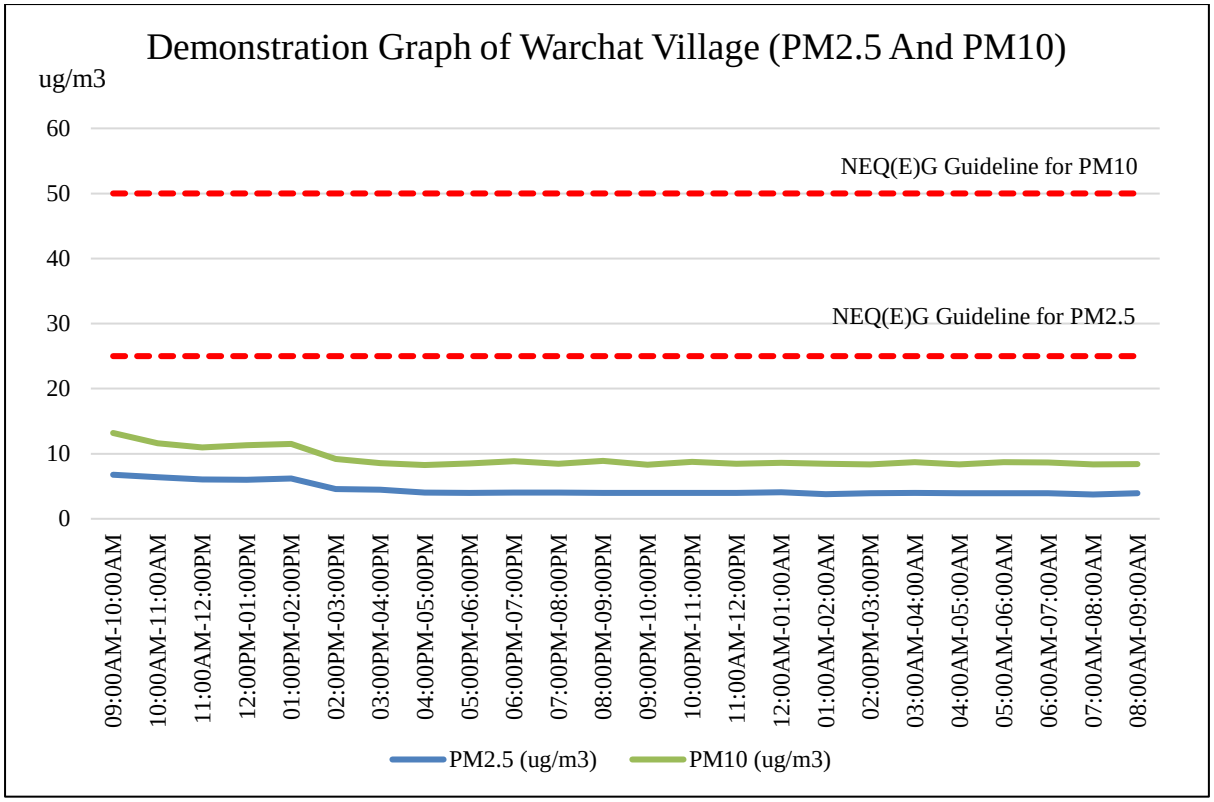


Figure 4-77 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at Warchat Village

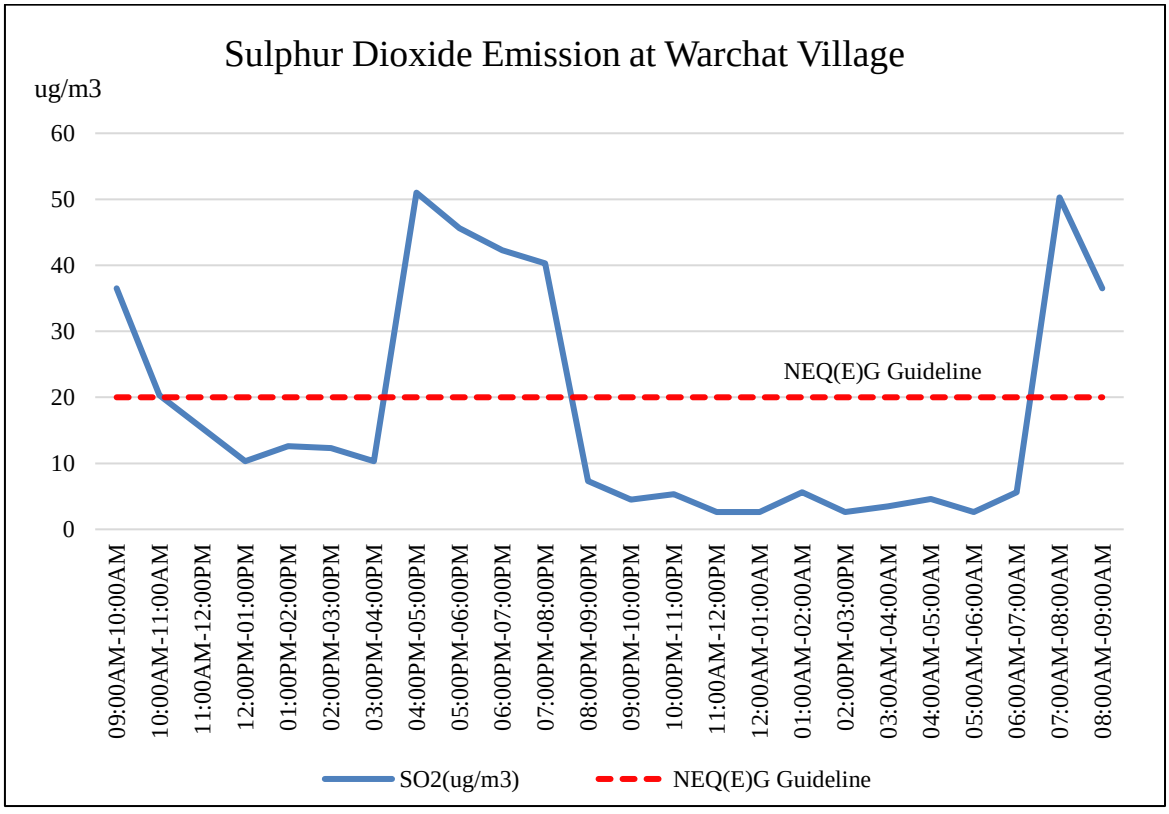


Figure 4-78 Demonstration Graphs of SO_2 Emission at Warchat Village

According to the air quality analysis, the ambient air parameters are within the guidelines of the National Environmental Quality (Emission) Guidelines at Warchat Village. The 24-hour average result of particulate matter (PM_{10} and $PM_{2.5}$) are 9.23 µg/m^3 and 4.49 µg/m^3 respectively and Sulphur Dioxide (SO_2) is 17.94 µg/m^3 under the NEQ(E)G standard guidelines. The highest result of SO_2 is 51.00 µg/m^3 at around 04:00 PM and 07:00 PM as shown in demonstration graph, but they are still relevant to the guidelines.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E) Guidelines as shown in Table 4-23.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.11.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area. The observation period is from 24th to 25th October, 2022.

Wind speed and wind direction's average values of project area is 0.25 m/s and 195° (SE/SW) respectively. The wind is generally blowing from the South East to South West direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-79.

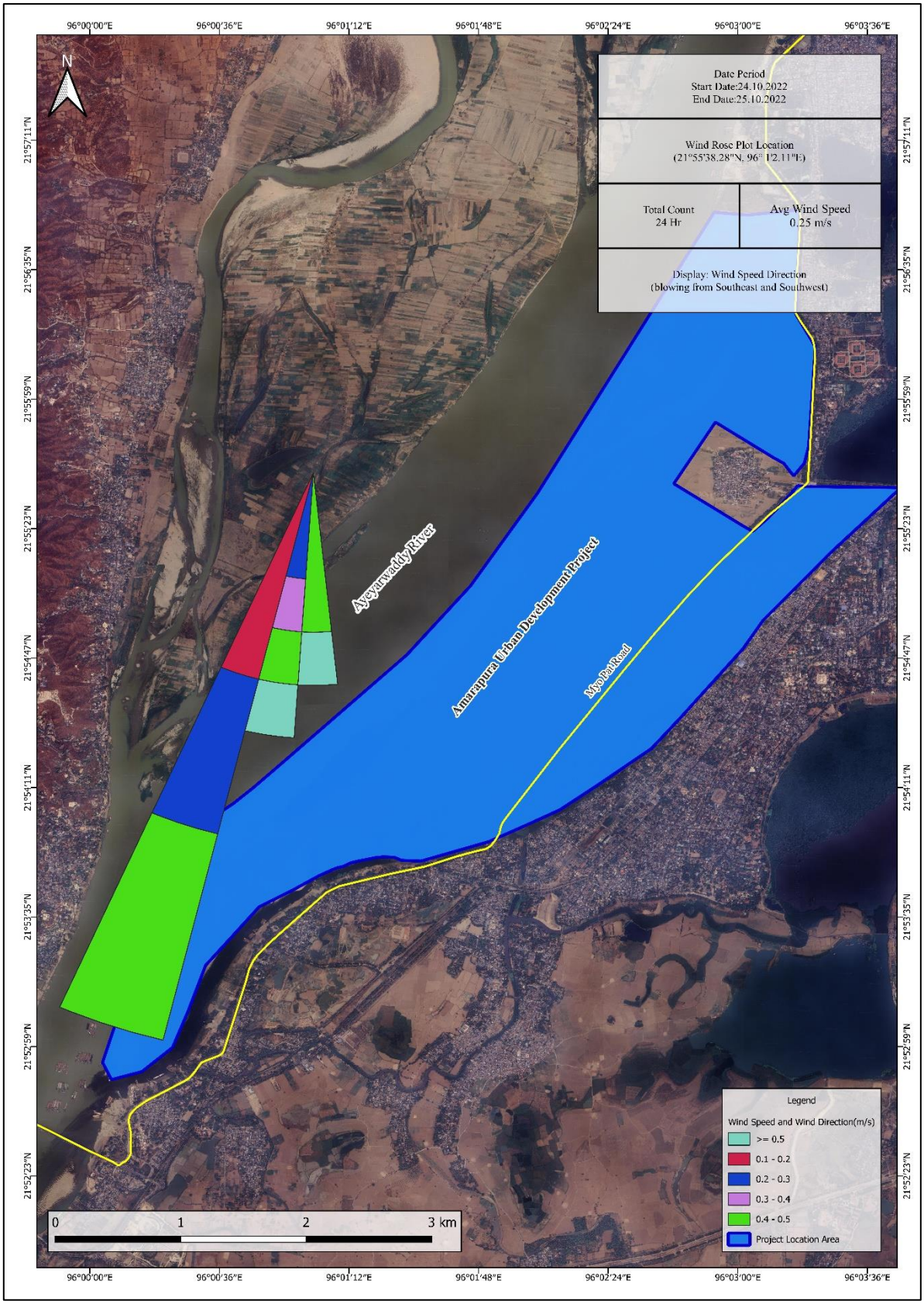


Figure 4-79 Wind Speed and Wind Direction of Warchat Village

4.7.12. Air Quality Measurements of Warchat Village in Dry Season

The air quality measurement for Warchat village is located near their project site and the exact location is at North Latitude 21°55'38.28" and East Longitude 96°01'2.11" on 5th to 6th March, 2023. The outdoor air quality monitoring points map and field photos of Warchat Village is as shown in Figure 4-80.

Figure 4-80 Air Quality Monitoring Photos at Warchat Village

4.7.12.1. Result of the Study

The measurements were made in accordance with the guidelines of National Environmental Quality (Emission) Guidelines and conducted 24-hour measurement at Warchat Village which is around 5 kilometers from the project site. The measured parameters are Particulate Matters (PM_{10} and $PM_{2.5}$) and gases Carbon monoxide (CO), Carbon dioxide (CO_2), Ozone (O_3), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), VOC, Total suspended particulate (TSP), Wind speed (WS), Wind direction (WD), Relative humidity (RH) and Temperature for outdoor air quality. Both results of the study and guidelines are as shown in Table 4-24.

Result of the demonstration graph of particulate matters (PM_{10} and $PM_{2.5}$) and Sulphur dioxide (SO_2) are shown in Figure 4-81 and Figure 4-82 respectively.

Table 4-24 Air Quality Monitoring Results at Warchat Village (5th to 6th March, 2023)

No.	Parameter	Measurement Period	Result	Unit	Average Period		NEQE* Guideline Value	Remark
1	Particulate Matter (PM_{10})	24-Hour	10.16	µg/m^3	1 24	Year Hour	*20 µg/m^3 *50 µg/m^3	Within the Guideline
2	Particulate Matter ($PM_{2.5}$)	24-Hour	5.82	µg/m^3	1 24	Year Hour	*10 µg/m^3 *25 µg/m^3	Within the Guideline
3	Total Suspended Particulate (TSP)	24-Hour	15.86	µg/m^3	24 Hours		NG	-
4	Sulphur Dioxide (SO_2)	24-Hour	11.05	µg/m^3	10 24	Mins Hour	*500 µg/m^3 *20 µg/m^3	Within the Guideline
5	Nitrogen Dioxide (NO_2)	1-Hour	13.59	µg/m^3	1 1	Year Hour	*40 µg/m^3 *200 µg/m^3	Within the Guideline
6	Ozone (O_3)	8-Hour	15.55	µg/m^3	8 Hour daily maximum		*100 µg/m^3	-
7	Carbon Monoxide (CO)	24-Hour	0.11	ppm	-		NG	-
8	Carbon Dioxide (CO_2)	24-Hour	337.89	ppm	-		NG	-
9	Volatile Organic Compound (VOC)	24-Hour	0.24	ppm	-		NG	-
10	Relative humidity	24-Hour	63.40	RH%	-		NG	-
11	Temperature	24-Hour	29.07	°C	-		NG	-
12	Wind Speed	24-Hour	0.18	m/s	-		NG	-
13	Wind Direction	24-Hour	194.47	Degree	-		NG	-

*National Environmental Quality (Emission) Guidelines (2015)

NG=No Guideline

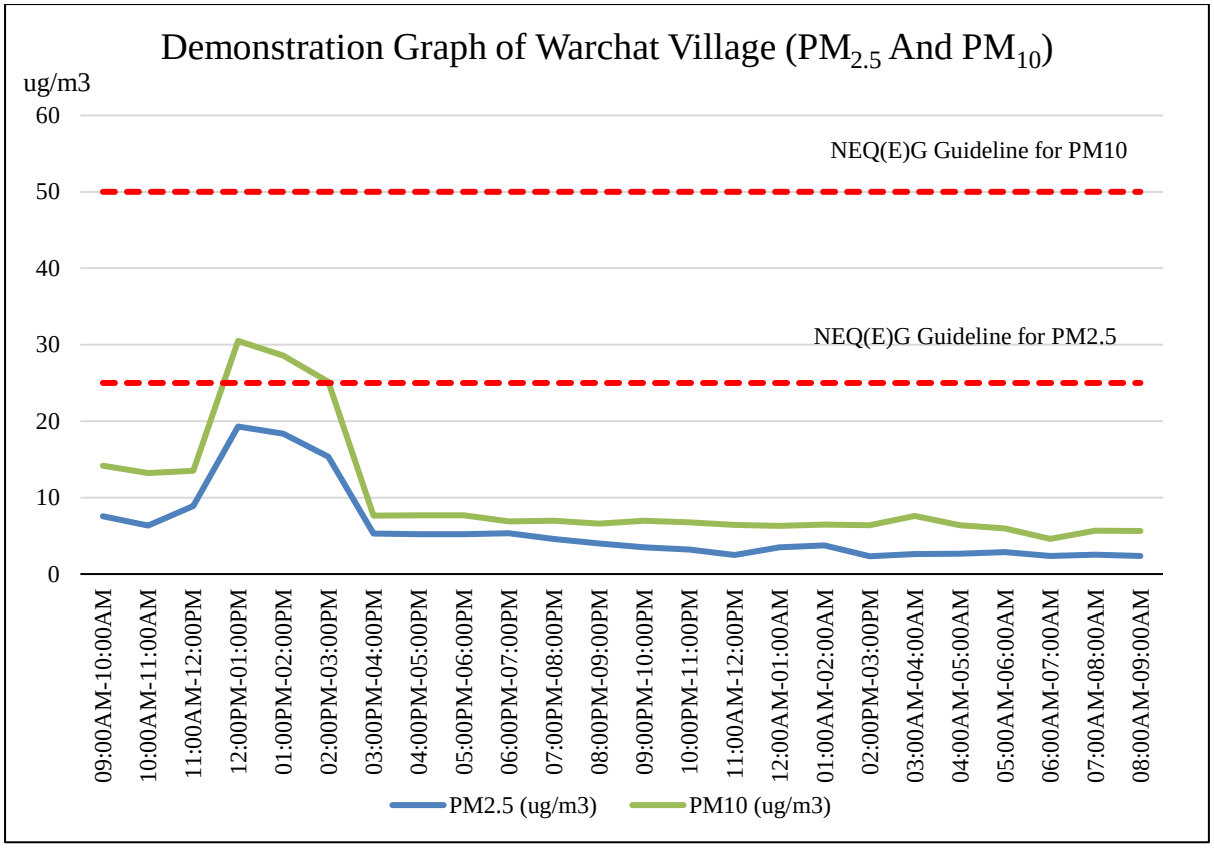


Figure 4-81 Demonstration Graphs of Particulate Matter as $PM_{2.5}$ and PM_{10} at Warchat Village

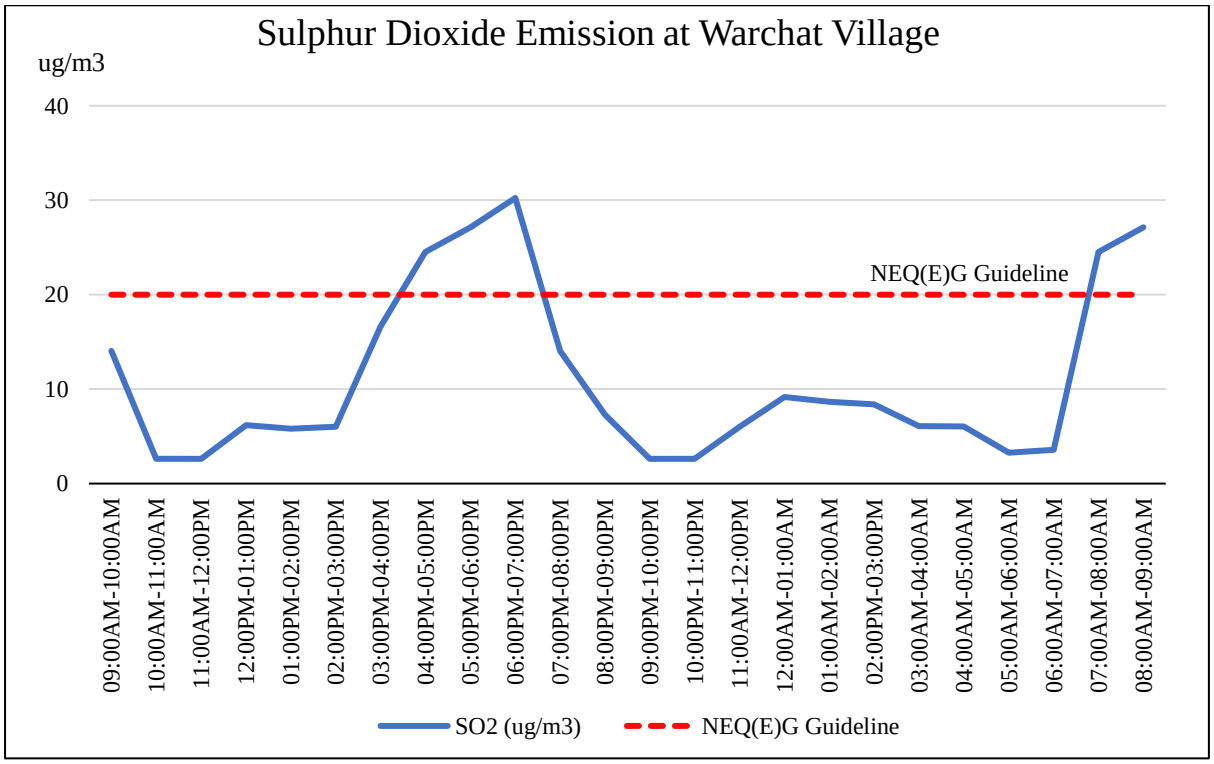


Figure 4-82 Demonstration Graphs of SO_2 Emission at Warchat Village

According to the air quality analysis, the ambient air parameters are within the guidelines of the National Environmental Quality (Emission) Guidelines at Warchat Village. The 24-hour average result of particulate matter (PM_{10} and $PM_{2.5}$) are 10.16 µg/m^3 and 5.82 µg/m^3 respectively and Sulphur Dioxide (SO_2) is 11.05 µg/m^3 under the NEQ(E)G standard guidelines. The highest result of SO_2 is 30.23 µg/m^3 at around 05:00 PM and 06:00 PM as described in demonstration graph, but the average results are still relevant to the guidelines.

Based on the findings, both 8-hour daily maximum result of Ozone (O_3) and 1-hour average result of Nitrogen dioxide (NO_2) are not exceeding the guideline values of NEQ(E) Guidelines as shown in Table 4-24.

The potential impacts of air quality are assessed in the CHAPTER (5) and its related mitigation measures are also described.

4.7.12.2. Wind Speed and Wind Direction

Wind is an integral part of the thermodynamic mechanism of the atmosphere by which cloud, heat, moisture, and particles are carried from one place to another. The exchange of pollutants and other environmentally important trace gases are also affected by wind speed and wind direction. The data are collected by using OCEANUS-AQM09 inside the project area. The observation period is from 5th to 6th March, 2023.

Wind speed and wind direction's average values of the study area is 0.18 m/s and 195° (S/SW) respectively. The wind is generally blowing from the South East-to-South West direction. The result of the analyzed wind speed and wind speed is shown in Figure 4-83.

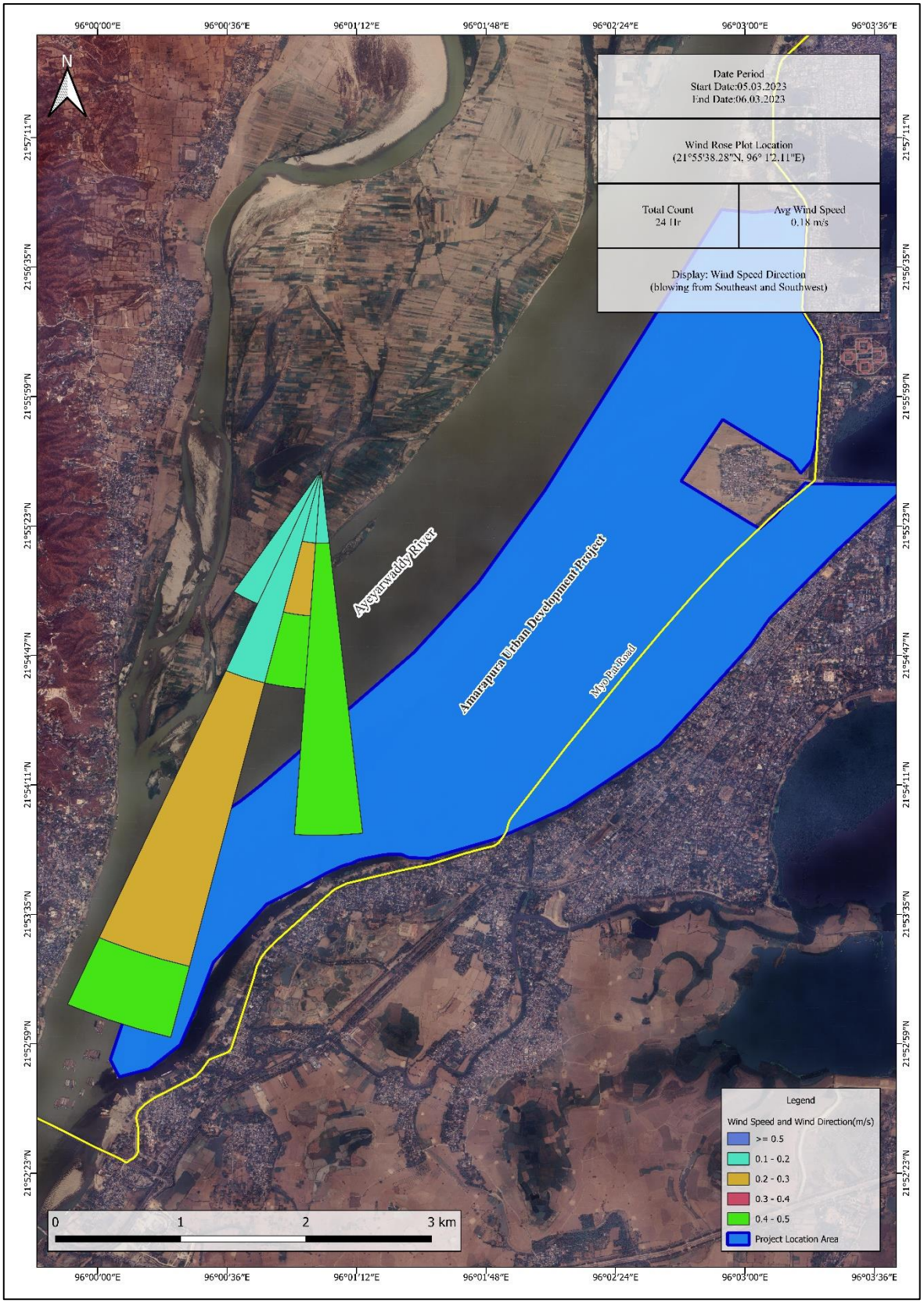


Figure 4-83 Wind Speed and Wind Direction of Warchat Village

4.7.13. Water Quality Monitoring in Wet Season

The water quality data in the project area is collected and analyzed, focusing on physical, biological and chemical contamination. The objectives of water quality for water quality survey for project area is to investigate the seasonal change of water quality and to confirm water quality whether it is suitable for domestic water supply. Surface water and groundwater may be impacted by the project due to solid waste and liquid waste released from the project. Water samplings are made at Ayeyarwady Rivers and existing tube wells. The water samples are sent to the laboratory for measuring the water quality parameters.

4.7.13.1. Method and Methodology for Collection of Surface Water and Groundwater

The process of collecting sample water in the project area was carried out from five locations for surface water and two locations for groundwater on 25th October, 2022 and sent to the laboratory. When collecting samples, the operator wears gloves and rinse the bottle and cap for three times with sample water. And collected (2) Liter of sample water as its will be tested for BOD, COD, Iron, Oil and Grease, pH, Free Chlorine, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead and Total Coliform. After collection, place the samples into cooler box with ice and immediately deliver to the laboratory within (24) hour. The results are compared with National Drinking Water Quality Standards of Myanmar (2019), NEQ(E)G Guideline Value and TCVN 5942: 1995 Surface Water Quality Standards (Vietnam).

In addition, on-site water quality measurement of the tube well water and surface water on river bank was measured with the Hanna instrument (HI98129) within the project area and measuring temperature, pH, EC (Electric Conductivity) and TDS (Total Dissolved Solids).

Water quality sample collected locations are shown in Table 4-25, Table 4-26, Figure 4-85 and water collection photos are shown in Figure 4-84. The laboratory test result is attached in **Appendix D**.

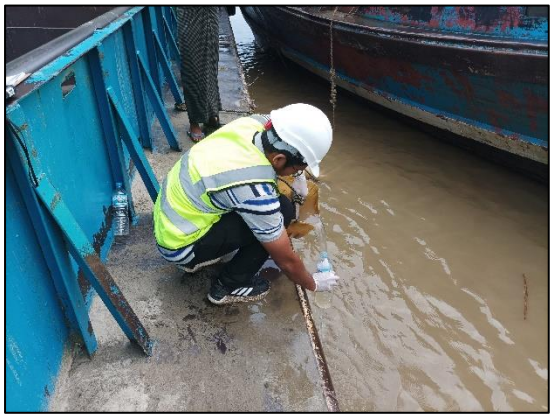
Table 4-25 Water Sample Collection Points

Type	GPS Location	Location	Method	Parameters	Date
Surface Water-1	21°53'39.49"N 96°00'13.72"E	Downstream of Ayeyarwaddy River	Collect Samples and Send to Lab	BOD, COD, Iron, Oil and Grease, pH, Free Chlorine, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity,	25th October, 2022
Surface Water-2	21°55'18.37"N 96°01'33.96"E	Ayeyarwaddy River beside Project Area			
Surface Water-3	21°57'47.38"N 96°2'59.03"E	Upstream of Ayeyarwaddy River			

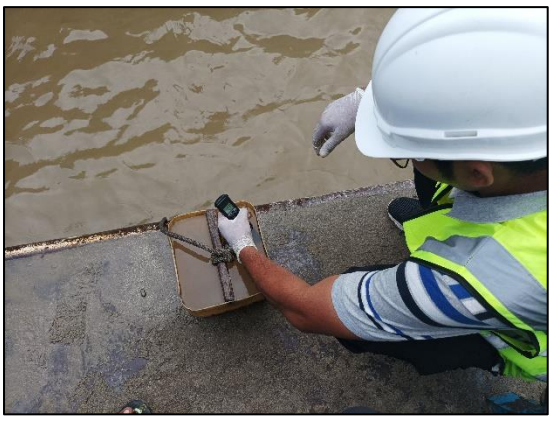
Type	GPS Location	Location	Method	Parameters	Date
Surface Water-4	21°55'44.98"N 96°03'36.04"E	Kandaw Gyi Lake, Chan Mya Thar Si Township		Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform	
Surface Water-5	21°54'21.93"N 96°03'31.66"E	Taung Thaman Inn, Amarapura Township			
Groundwater (1)	21°54'45.49"N 96°02'32.26"E	Yangon-Mandalay Circular Road, Shan Kalay Village, Amarapura Township		pH, Iron, Oil and Grease, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform	
Groundwater (2)	21°56'20.22"N 96°03'15.66"E	Staff Accommodation in the Project Area			

Table 4-26 On-site Water Quality Measurement Points

Type	GPS Location	Location	Method	Parameters	Date
Groundwater-1 (400 ft)	21°54'46.78"N 96°02'32.31"E	Aung Thar Fuel Station near Project Area	On-site Water Quality Measurement	Temperature, pH, EC and TDS	25th October, 2022
Groundwater-2 (375 ft)	21°56'20.221"N 96°03'15.602"E	Mandalay Business Capital City Project Area			
Surface Water	21°54'48.8"N 96°01'29.3"E	River Bank of Mandalay Business Capital City Project Area			



Collection of Surface Water



Hanna instrument (HI98129)

On-site Water Quality Measurement

On-site Water Quality Measurement

Figure 4-84 Water Sample Collection Photos

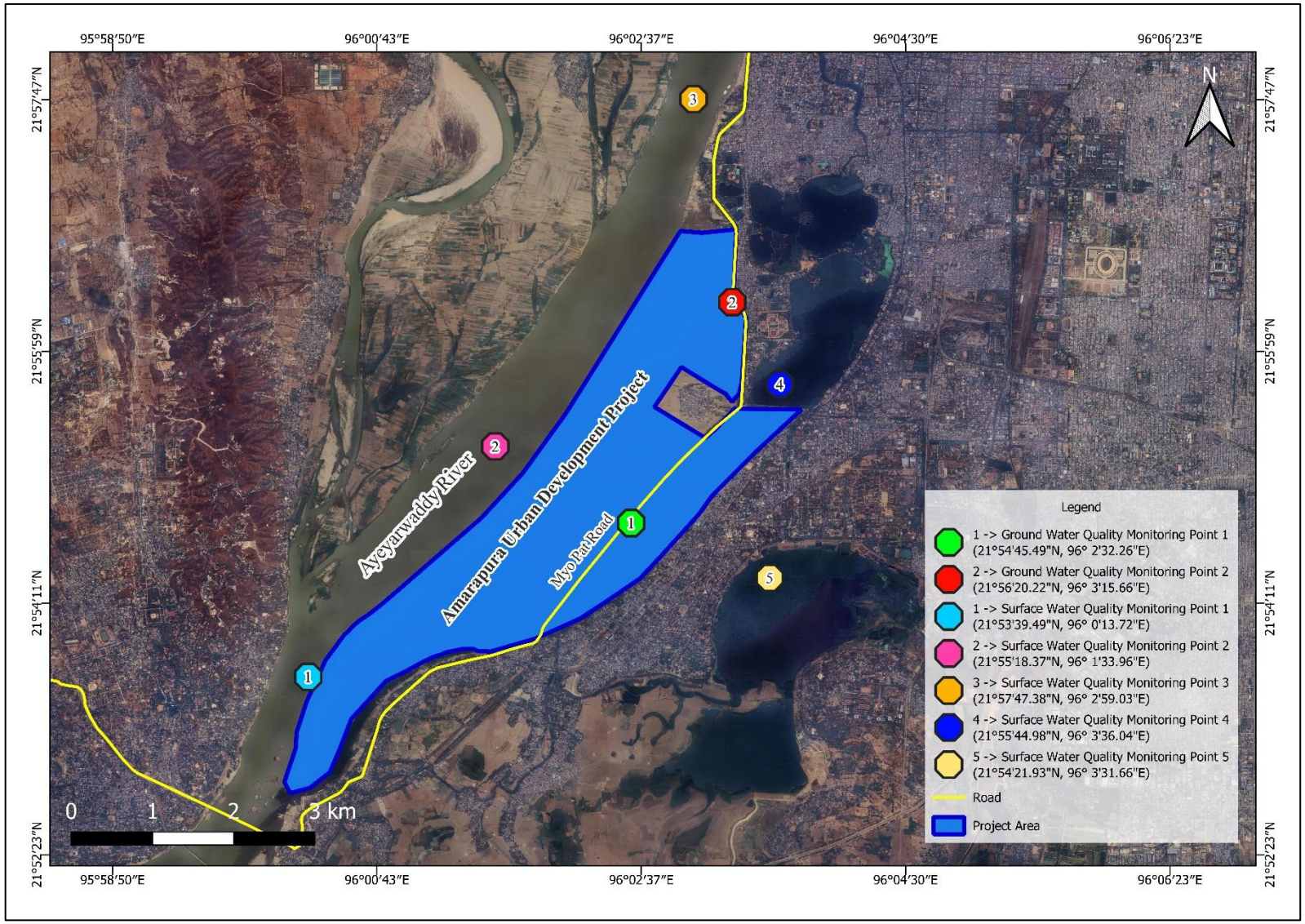


Figure 4-85 Map of Surface Water and Groundwater Quality Testing Point

4.7.13.2. Result of Surface Water Quality

Surface water quality result and groundwater quality result are as shown Table 4-27to **Table 4-33**.

Table 4-27 Result of Surface Water Quality (1)

No.	Parameter	Result of Surface Water-1	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	7.8	S. U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	27	°C	-	< 3	-
3	Color	367	HU	≤ 15	NG	-
4	Turbidity	46	FAU	≤ 5	-	-
5	Total Dissolved Solid	52	mg/L	≤ 1000	-	≥2
6	Total Suspended Solid	43	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.1	mS/cm	≤ 2.5	NG	-
8	Hardness	27	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	5.9	mg/L	-	NG	-
10	Biochemical Oxygen Demand	12	mg/L	-	50 mg/L	<25

No.	Parameter	Result of Surface Water-1	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
11	Chemical Oxygen Demand	32	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.5	mg/L	≤ 0.2	0.2 mg/L	-
13	Total Phosphorus	0.29	mg/L	-	2 mg/L	-
14	Arsenic	0.01	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	1	mg/L	≤ 1	3.5 mg/L	2
16	Lead	ND	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	6	mg/L	-	10 mg/L	0.3
18	Total Nitrogen	< 0.5	mg/L	-	10 mg/L	-
19	Total Coliform	>1100	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-28 Result of Surface Water Quality (2)

No.	Parameter	Result of Surface Water-2	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	7.6	S. U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	27	°C	-	< 3	-
3	Color	1105	HU	≤ 15	NG	-
4	Turbidity	201	FAU	≤ 5	-	-
5	Total Dissolved Solid	50	mg/L	≤ 1000	-	≥2
6	Total Suspended Solid	160	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.09	mS/cm	≤ 2.5	NG	-
8	Hardness	26	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	7.7	mg/L	-	NG	-
10	Biochemical Oxygen Demand	8	mg/L	-	50 mg/L	<25

No.	Parameter	Result of Surface Water-2	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
11	Chemical Oxygen Demand	< 30	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.33	mg/L	≤ 0.2	0.2 mg/L	-
13	Total Phosphorus	< 0.02	mg/L	-	2 mg/L	-
14	Arsenic	0.02	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	1.6	mg/L	≤ 1	3.5 mg/L	2
16	Lead	0.2	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	5	mg/L	-	10 mg/L	0.3

No.	Parameter	Result of Surface Water-2	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
18	Total Nitrogen	< 0.5	mg/L	-	10 mg/L	-
19	Total Coliform	>1100	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-29 Result of Surface Water Quality (3)

No.	Parameter	Result of Surface Water-3	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	7.5	S.U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	28	°C	-	< 3	-
3	Color	426	HU	≤ 15	NG	-
4	Turbidity	80	FAU	≤ 5	-	-
5	Total Dissolved Solid	50	mg/L	≤ 1000	-	≥2

No.	Parameter	Result of Surface Water-3	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
6	Total Suspended Solid	79	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.09	mS/cm	≤ 2.5	NG	-
8	Hardness	27	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	7.1	mg/L	-	NG	-
10	Biochemical Oxygen Demand	14	mg/L	-	50 mg/L	<25
11	Chemical Oxygen Demand	36	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.19	mg/L	≤ 0.2	0.2 mg/L	-
13	Total Phosphorus	0.21	mg/L	-	2 mg/L	-

No.	Parameter	Result of Surface Water-3	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
14	Arsenic	0.01	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	1.2	mg/L	≤ 1	3.5 mg/L	2
16	Lead	0.1	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	7	mg/L	-	10 mg/L	0.3
18	Total Nitrogen	< 0.5	mg/L	-	10 mg/L	-
19	Total Coliform	>1100	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-30 Result of Surface Water Quality (4)

No.	Parameter	Result of Surface Water-4	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	8.3	S.U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	28	°C	-	< 3	-
3	Color	112	HU	≤ 15	NG	-
4	Turbidity	16	FAU	≤ 5	-	-
5	Total Dissolved Solid	358	mg/L	≤ 1000	-	≥2
6	Total Suspended Solid	14	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.6	mS/cm	≤ 2.5	NG	-
8	Hardness	137	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	4	mg/L	-	NG	-
10	Biochemical	12	mg/L	-	50 mg/L	<25

No.	Parameter	Result of Surface Water-4	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
	Oxygen Demand					
11	Chemical Oxygen Demand	< 30	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.26	mg/L	≤ 0.2	0.2 mg/L	-
13	Total Phosphorus	0.43	mg/L	-	2 mg/L	-
14	Arsenic	0.01	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	0.8	mg/L	≤ 1	3.5 mg/L	2
16	Lead	ND	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	4	mg/L	-	10 mg/L	0.3

No.	Parameter	Result of Surface Water-4	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
18	Total Nitrogen	< 0.5	mg/L	-	10 mg/L	-
19	Total Coliform	>1100	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-31 Result of Surface Water Quality (5)

No.	Parameter	Result of Surface Water-5	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	7.3	S.U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	28	°C	-	< 3	-
3	Color	174	HU	≤ 15	NG	-
4	Turbidity	17	FAU	≤ 5	-	-
5	Total Dissolved Solid	276	mg/L	≤ 1000	-	≥2

No.	Parameter	Result of Surface Water-5	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
6	Total Suspended Solid	16	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.5	mS/cm	≤ 2.5	NG	-
8	Hardness	141	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	0.5	mg/L	-	NG	-
10	Biochemical Oxygen Demand	12	mg/L	-	50 mg/L	<25
11	Chemical Oxygen Demand	32	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.03	mg/L	≤ 0.2	0.2 mg/L	-
13	Total Phosphorus	0.6	mg/L	-	2 mg/L	-

No.	Parameter	Result of Surface Water-5	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
14	Arsenic	0.01	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	0.9	mg/L	≤ 1	3.5 mg/L	2
16	Lead	0.1	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	6	mg/L	-	10 mg/L	0.3
18	Total Nitrogen	15	mg/L	-	10 mg/L	-
19	Total Coliform	>1100	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-32 Groundwater Quality Monitoring Results (Groundwater Point-1)

No.	Parameter	Groundwater Result (1)	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	Remark
1	pH	8.1	S.U	6.5-8.5	6 - 9	Normal
2	Temperature	26	°C	-	< 3	Normal
3	Color	19	HU	≤ 15	NG	Above the limit
4	Turbidity	< 5	FAU	≤ 5	-	Clear
5	Total Dissolved Solid	455	mg/L	≤ 1000	-	Normal
6	Total Suspended Solid	1	mg/L	-	0.2 mg/L	Above the limit
7	Conductivity	0.9	mS/cm	≤ 2.5	2 mg/L	Normal
8	Hardness	212	mg/L	≤ 500	50 mg/L	Normal
9	Dissolved Oxygen	6.4	mg/L	-	NG	-
10	Total Phosphorus	0.13	mg/L	-	2 mg/L	Normal
11	Arsenic	0.005	mg/L	≤ 0.05	0.1 mg/L	Normal
12	Iron	0.6	mg/L	≤ 1	3.5 mg/L	Normal
13	Lead	ND	mg/L	≤ 0.01	0.1 mg/L	LOD=0.1 mg/L
14	Oil & Grease	3	mg/L	-	10 mg/L	Normal

No.	Parameter	Groundwater Result (1)	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	Remark
15	Total Nitrogen	1.2	mg/L	-	10 mg/L	Normal
16	Total Coliform	210	MPN/100ml		400	Within the guideline

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-33 Groundwater Quality Monitoring Results (Groundwater Point-2)

No.	Parameter	Groundwater Result (2)	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	Remark
1	pH	8.5	S.U	6.5-8.5	6 - 9	Normal
2	Temperature	26	°C	-	< 3	Normal
3	Color	5	HU	≤ 15	NG	Normal
4	Turbidity	< 5	FAU	≤ 5	-	Clear
5	Total Dissolved Solid	128	mg/L	≤ 1000	-	Normal
6	Total Suspended Solid	0	mg/L	-	0.2 mg/L	-
7	Conductivity	0.2	mS/cm	≤ 2.5	2 mg/L	Normal
8	Hardness	23	mg/L	≤ 500	50 mg/L	Normal

No.	Parameter	Groundwater Result (2)	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	Remark
9	Dissolved Oxygen	6.7	mg/L	-	NG	-
10	Total Phosphorus	0.22	mg/L	-	2 mg/L	Normal
11	Arsenic	0.005	mg/L	≤ 0.05	0.1 mg/L	Normal
12	Iron	0.5	mg/L	≤ 1	3.5 mg/L	Normal
13	Lead	ND	mg/L	≤ 0.01	0.1 mg/L	LOD=0.1 mg/L
14	Oil & Grease	3	mg/L	-	10 mg/L	Normal
15	Total Nitrogen	0.8	mg/L	-	10 mg/L	Normal
16	Total Coliform	1100	MPN/100ml		400	Above the limit

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

For on-site measurement, Hanna instrument water quality meter was used for the measurement of the parameters as mentioned in the table below.

Table 4-34 Water Quality Result of On-site Measurement with Hanna instrument (HI98129)

No	Parameter	Onsite Groundwater Quality Result on Project Area (1)	Onsite Groundwater Quality Result on Project Area (2)	Onsite Surface Water Quality Result (3)	Unit	WHO Guideline (2018)[1]	Remark
1.	pH	7.7	8.185	7.76	-	6.5-8.5	Within the guideline
2.	TDS	482	123	48	ppm	1000 mg/l	Within the guideline
3.	Electric conductivity	966	247	97	µS/cm	2500 µS/cm	Within the guideline
4.	Temperature	31.1	29.35	28	˚C	25˚C	Above the guideline

[1]World Health Organiation (2018)

4.7.14. Water Quality Monitoring in Dry Season

The 1st time water quality results are used as background data comparing with the second time results to access the water quality changes of the project area. The 1st time result was conducted in October 2022 and the results represent for the rainy season. The 2nd time result represents the dry season data. The 3rd time water monitoring was conducted in 1st February, 2024.

4.7.14.1. Method and Methodology for Collection of Surface Water and Groundwater

The process of collecting sample water in the project area was carried out from five locations for surface water and two locations for groundwater on 2nd March, 2023 and sent to the laboratory. When collecting samples, the operator wears gloves and rinse the bottle and cap for three times with sample water. And collected (2) Liter of sample water as its will be tested for BOD, COD, Iron, Oil and Grease, pH, Free Chlorine, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead and Total Coliform. After collection, place the samples into cooler box with ice and immediately deliver to the laboratory within

(24) hour. The results are compared with National Drinking Water Quality Standards of Myanmar (2019) and NEQ(E)G Guideline Value. Water samples were collected at five places in the project area. the water samples are sent to the lab.

In 3rd time water monitoring, the surface water samples are tested for Ammonia (as N), Chromium (Hexa), Chromium (Tri), Copper, Cyanide, Manganese, Flouride, Mercury, Nikkel, Nitrate (as N), Nitrite (as N), Phenol compounds and Zinc to compare with **TCVN 5942: 1995 Surface Water Quality Standards (Vietnam)**. The ground water was also tested for Fecal Coliform, Manganese, Chloride, Sulphate and Nitrate. And ground water is also tested for Fecal Coliform, Manganese, Chloride, Sulphate, Nitrate to compare with **National Drinking Water Quality Standards of Myanmar (2019)**.

In addition, on-site water quality measurement of the tube well water and surface water on river bank was measured with the Hanna instrument (HI98129) within the project area and measuring temperature, pH, EC (Electric Conductivity) and TDS (Total Dissolved Solids).

Water quality sample collected location are shown in Table 4-35, Table 4-36 and water collection photos are shown in Figure 4-86. The laboratory test result is attached in Appendix D.

Table 4-35 Water Sample Collection Points

Type	GPS Location	Location	Method	Parameters	Date
Surface Water-1	21°53'39.49"N 96°00'13.72"E	Downstream of Ayeyarwaddy River	Collect Samples and Send to Lab	BOD, COD, Iron, Oil and Grease, pH, Free Chlorine, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform	2nd March, 2023
Surface Water-2	21°55'18.37"N 96°01'33.96"E	Ayeyarwaddy River beside Project Area			
Surface Water-3	21°57'47.38"N 96°2'59.03"E	Upstream of Ayeyarwaddy River			
Surface Water-4	21°55'44.98"N 96°03'36.04"E	Kandaw Gyi Lake, Chan Mya Thar Si Township			
Surface Water-5	21°54'21.93"N 96°03'31.66"E	Taung Thaman Inn, Amarapura Township			
Groundwater (1)	21°56'20.22"N 96°03'15.66"E	Yangon-Mandalay Circular Road, Shan Kalay Village, Amarapura Township		pH, Iron, Oil and Grease, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform	
Groundwater (2)	21°54'45.49"N 96°02'32.26"E	Staff Accommodation in the Project Area			

Table 4-36 Water Sample Collecting Points (3rd Time)

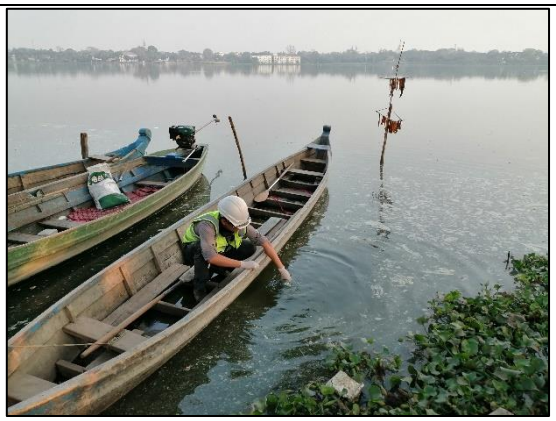
Type	GPS Location	Location	Method	Parameters	Date
Surface Water-1	21°53'39.49"N 96°00'13.72"E	Downstream of Ayeyarwaddy River	Collect Samples and Send to Lab	Ammonia (as N), Chromium (Hexa), Chromium (Tri), Copper, Cyanide, Flouride, Manganese, Mercury, Nickel< Nitrate (as N), Nitrite (as N)	1st February 2024
Surface Water-2	21°55'18.37"N 96°01'33.96"E	Ayeyarwaddy River beside Project Area			
Surface Water-3	21°57'47.38"N 96°2'59.03"E	Upstream of Ayeyarwaddy River			
Surface Water-4	21°55'44.98"N 96°03'36.04"E	Kandaw Gyi Lake, Chan Mya Thar Si Township			
Surface Water-5	21°54'21.93"N 96°03'31.66"E	Taung Thaman Inn, Amarapura Township			
Groundwater (1)	21°56'20.22"N 96°03'15.66"E	Yangon-Mandalay Circular Road, Shan Kalay Village, Amarapura Township		Fecal Coliform, Manganese, Chloride, Sulphate, Nitrate	
Groundwater (2)	21°54'45.49"N 96°02'32.26"E	Staff Accommodation in the Project Area			

Table 4-37 On-site Water Quality Measurement Points

Type	GPS Location	Location	Method	Parameters	Date
Surface Water-1	21°54'11.79"N 96° 0'33.42"E	Downstream of Ayeyarwady River	On-site Water Quality Measurement	Temperature, pH, EC and TDS	2nd March, 2023
Surface Water-2	21°55'11.95"N 96° 1'30.90"E	Riverbank of Project Area			
Surface Water-3	21°56'21.68"N 96° 2'21.87"E	Upstream of Ayeyarwady River			
Groundwater-1	21°54'46.78"N 96° 2'32.31"E	Aung Thar Fuel Station near Project Area			
Groundwater-2	21°56'20.22"N 96° 3'15.60"E	Mandalay Business Capital City Project Area			


Collection of Surface Water Ayeyarwady Downstream


Collection of Surface Water Ayeyarwady

<table>
<tr><td colspan="2">   </td></tr>
<tr><td colspan="2">Collection of Surface Water Ayeyarwady Upstream</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Collection of Surface Water from Kandaw Gyi Lake</td><td>Collection of Surface Water from Taung Thaman Inn</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">Collection of Groundwater Sample</td></tr>
</table>

Collection of Groundwater Sample

Figure 4-86 Water Sample Collection Photos

4.7.14.2. Result of Surface Water Quality

Surface water quality result and groundwater quality result are as shown in Table 4-38 to Table 4-47.

Table 4-38 Result of Surface Water Quality (1)

No.	Parameter	Result of Surface Water-1	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	7	S.U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	27	℃	-	< 3	-
3	Color	119	HU	≤ 15	NG	-
4	Turbidity	39	FAU	≤ 5	-	-
5	Total Dissolved Solid	66	mg/L	≤ 1000	-	≥2
6	Total Suspended Solid	26	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.1	mS/cm	≤ 2.5	NG	-

No.	Parameter	Result of Surface Water-1	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
8	Hardness	39	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	5.82	mg/L	-	NG	-
10	Biochemical Oxygen Demand	3.3	mg/L	-	50 mg/L	<25
11	Chemical Oxygen Demand	< 15	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.08	mg/L	≤ 0.2	0.2 mg/L	-
13	Total Phosphorus	0.07	mg/L	-	2 mg/L	-
14	Arsenic	0.005	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	0.6	mg/L	≤ 1	3.5 mg/L	2

No.	Parameter	Result of Surface Water-1	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
16	Lead	ND	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	3	mg/L	-	10 mg/L	0.3
18	Total Nitrogen	2.7	mg/L	-	10 mg/L	-
19	Total Coliform	1100	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-39 Result of Surface Water Quality (2)

No.	Parameter	Result of Surface Water-2	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	6.6	S.U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	27	℃	-	< 3	-
3	Color	155	HU	≤ 15	NG	-

No.	Parameter	Result of Surface Water-2	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
4	Turbidity	30	FAU	≤ 5	-	-
5	Total Dissolved Solid	67	mg/L	≤ 1000	-	≥2
6	Total Suspended Solid	0	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.1	mS/cm	≤ 2.5	NG	-
8	Hardness	< 2	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	5.99	mg/L	-	NG	-
10	Biochemical Oxygen Demand	3.5	mg/L	-	50 mg/L	<25
11	Chemical Oxygen Demand	< 15	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.1	mg/L	≤ 0.2	0.2 mg/L	-

No.	Parameter	Result of Surface Water-2	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
13	Total Phosphorus	0.15	mg/L	-	2 mg/L	-
14	Arsenic	0.005	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	0.8	mg/L	≤ 1	3.5 mg/L	2
16	Lead	ND	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	3	mg/L	-	10 mg/L	0.3
18	Total Nitrogen	1.8	mg/L	-	10 mg/L	-
19	Total Coliform	1100	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-40 Result of Surface Water Quality (3)

No.	Parameter	Result of Surface Water-3	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	7.2	S.U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	27	℃	-	< 3	-
3	Color	122	HU	≤ 15	NG	-
4	Turbidity	20	FAU	≤ 5	-	-
5	Total Dissolved Solid	67	mg/L	≤ 1000	-	≥2
6	Total Suspended Solid	21	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.1	mS/cm	≤ 2.5	NG	-
8	Hardness	35	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	6.56	mg/L	-	NG	-
10	Biochemical	3.2	mg/L	-	50 mg/L	<25

No.	Parameter	Result of Surface Water-3	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
	Oxygen Demand					
11	Chemical Oxygen Demand	< 15	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.08	mg/L	≤ 0.2	0.2 mg/L	-
13	Total Phosphorus	0.12	mg/L	-	2 mg/L	-
14	Arsenic	0.005	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	0.5	mg/L	≤ 1	3.5 mg/L	2
16	Lead	ND	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	3	mg/L	-	10 mg/L	0.3

No.	Parameter	Result of Surface Water-3	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
18	Total Nitrogen	2.1	mg/L	-	10 mg/L	-
19	Total Coliform	93	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-41 Result of Surface Water Quality (4)

No.	Parameter	Result of Surface Water-4	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	8.6	S.U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	27	℃	-	< 3	-
3	Color	120	HU	≤ 15	NG	-
4	Turbidity	22	FAU	≤ 5	-	-
5	Total Dissolved Solid	407	mg/L	≤ 1000	-	≥2

No.	Parameter	Result of Surface Water-4	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
6	Total Suspended Solid	18	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.7	mS/cm	≤ 2.5	NG	-
8	Hardness	300	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	0	mg/L	-	NG	-
10	Biochemical Oxygen Demand	8.5	mg/L	-	50 mg/L	<25
11	Chemical Oxygen Demand	38	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.13	mg/L	≤ 0.2	0.2 mg/L	-
13	Total Phosphorus	0.86	mg/L	-	2 mg/L	-

No.	Parameter	Result of Surface Water-4	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
14	Arsenic	0.005	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	0.4	mg/L	≤ 1	3.5 mg/L	2
16	Lead	ND	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	4	mg/L	-	10 mg/L	0.3
18	Total Nitrogen	4.2	mg/L	-	10 mg/L	-
19	Total Coliform	120	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-42 Result of Surface Water Quality (5)

No.	Parameter	Result of Surface Water-5	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
1	pH	8.7	S.U	6.5-8.5	6 - 9	5.5 - 9
2	Temperature	27	℃	-	< 3	-
3	Color	190	HU	≤ 15	NG	-
4	Turbidity	75	FAU	≤ 5	-	-
5	Total Dissolved Solid	437	mg/L	≤ 1000	-	≥2
6	Total Suspended Solid	78	mg/L	-	≤ 50 mg/L	80
7	Conductivity	0.7	mS/cm	≤ 2.5	NG	-
8	Hardness	250	mg/L	≤ 500	NG	-
9	Dissolved Oxygen	0	mg/L	-	NG	-
10	Biochemical	210	mg/L	-	50 mg/L	<25

No.	Parameter	Result of Surface Water-5	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
	Oxygen Demand					
11	Chemical Oxygen Demand	327	mg/L	-	250 mg/L	<35
12	Free Chlorine	0.03	mg/L	≤ 0.2	0.2 mg/L	-
13	Total Phosphorus	0.78	mg/L	-	2 mg/L	-
14	Arsenic	0.005	mg/L	≤ 0.05	0.1 mg/L	0.1
15	Iron	0.6	mg/L	≤ 1	3.5 mg/L	2
16	Lead	0.1	mg/L	≤ 0.01	0.1 mg/L	0.1
17	Oil & Grease	6	mg/L	-	10 mg/L	0.3

No.	Parameter	Result of Surface Water-5	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	TCVN 5942 : 1995 Surface Water Quality Standards (Vietnam)
18	Total Nitrogen	5.1	mg/L	-	10 mg/L	-
19	Total Coliform	>1100	MPN/100ml	-	400	10000

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

E[1] National Drinking Water Quality Standard of Myanmar, 201

Table 4-43 Results of Surface water Quality (3rd Time)

No	Parameter	Unit	TCVN 5942 : 1995 Water Quality Standards (Vietnam)	Surface Water (1)	Surface Water (2)	Surface Water (3)	Surface Water (4)	Surface Water (5)
1	Ammonia (as N)	mg/L	1	0.5	0.6	0.3	0.236	0.12
2	Chromium (Hexa)	mg/L	0.05	0	0	0.01	0	0
3	Chromium (Tri)	mg/L	1	0.2	0.1	0.2	0.5	0.32

No	Parameter	Unit	TCVN 5942 : 1995 Water Quality Standards (Vietnam)	Surface Water (1)	Surface Water (2)	Surface Water (3)	Surface Water (4)	Surface Water (5)
4	Copper	mg/L	1	0.1	0.3	0.5	0.1	0.25
5	Cyanide	mg/L	0.05	0	0	0	0	0
6	Fluoride	mg/L	1.5	0.5	0.3	0.6	0.5	0.65
7	Manganese	mg/L	0.8	0	0	0	0	0
8	Mercury	mg/L	0.002	0	0	0	0	0
9	Nickel	mg/L	1	0.2	0.1	0.14	0.45	0.2
10	Nitrate (as N)	mg/L	15	2	3	2.36	4	5.32
11	Nitrites (as N)	mg/L	0.05	0	0	0	0	0
12	Phenol compounds	mg/L	0.02	0	0	0	0	0
13	Zinc	mg/L	2	0.1	0.1	0.112	0.154	0.54

Text in Red indicates the parameter is the guideline.

TCVN 5942: 1995 Water Quality Standards – Surface water (Vietnam)

Table 4-44 Groundwater Quality Monitoring Results (Groundwater Point-1)

No.	Parameter	Groundwater Result (1)	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	Remark
1	pH	7.6	S.U	6.5-8.5	6 - 9	Normal
2	Temperature	27	℃	-	< 3	Normal
3	Color	8	HU	≤ 15	NG	Normal
4	Turbidity	< 5	FAU	≤ 5	-	Clear
5	Total Dissolved Solid	448	mg/L	≤ 1000	-	Normal
6	Total Suspended Solid	1	mg/L	-	0.2 mg/L	Above the limit
7	Conductivity	0.8	mS/cm	≤ 2.5	2 mg/L	Normal
8	Hardness	390	mg/L	≤ 500	50 mg/L	Normal
9	Dissolved Oxygen	0	mg/L	-	NG	-
10	Total Phosphorus	2.4	mg/L	-	2 mg/L	Normal
11	Arsenic	0.005	mg/L	≤ 0.05	0.1 mg/L	Normal
12	Iron	0.3	mg/L	≤ 1	3.5 mg/L	Normal
13	Lead	0.1	mg/L	≤ 0.01	0.1 mg/L	LOD=0.1 mg/L
14	Oil & Grease	2	mg/L	-	10 mg/L	Normal

No.	Parameter	Groundwater Result (1)	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	Remark
15	Total Nitrogen	0.31	mg/L	-	10 mg/L	Normal
16	Total Coliform	>1100	MPN/100ml		400	Above the limit

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-45 Groundwater Quality Monitoring Results (Groundwater Point-2)

No.	Parameter	Groundwater Result (2)	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	Remark
1	pH	7.8	S.U	6.5-8.5	6 - 9	Normal
2	Temperature	27	℃	-	< 3	-
3	Color	0	HU	≤ 15	NG	Normal
4	Turbidity	< 5	FAU	≤ 5	-	Clear
5	Total Dissolved Solid	154	mg/L	≤ 1000	-	Normal
6	Total Suspended Solid	1	mg/L	-	0.2 mg/L	-
7	Conductivity	0.27	mS/cm	≤ 2.5	2 mg/L	Normal
8	Hardness	28	mg/L	≤ 500	50 mg/L	Normal

No.	Parameter	Groundwater Result (2)	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	NEQ(E)G Guideline Value[2]	Remark
9	Dissolved Oxygen	0	mg/L	-	NG	-
10	Total Phosphorus	2.8	mg/L	-	2 mg/L	Normal
11	Arsenic	0.005	mg/L	≤ 0.05	0.1 mg/L	Normal
12	Iron	0.4	mg/L	≤ 1	3.5 mg/L	Normal
13	Lead	ND	mg/L	≤ 0.01	0.1 mg/L	LOD=0.1 mg/L
14	Oil & Grease	3	mg/L	-	10 mg/L	Normal
15	Total Nitrogen	0.38	mg/L	-	10 mg/L	Normal
16	Total Coliform	43	MPN/100ml		400	Within the limit

[1] National Drinking Water Quality Standard of Myanmar, 2019

[2] National Environmental Quality (Emission) Guideline-Wastewater, Storm Water Runoff, Effluent and Sanitary Discharges (General Application)

Table 4-46 Groundwater Monitoring Results (3rd Time)

No.	Parameter	Unit	National Drinking Water Quality Standards of Myanmar (2019) [1]	Ground Water (1)	Ground Water (2)	Remark
1	Fecal coliform	MPN/100ml	0	0	0	Within the Guideline
2	Manganese	mg/L	0.4	0	0	Within the Guideline
3	Chloride	mg/L	250	112	112	Within the Guideline
4	Sulphate	mg/L	250	56	56	Within the Guideline
5	Nitrate	mg/L	50	12	12	Within the Guideline

National Drinking Water Quality Standard of Myanmar, 2019

For on-site measurement, Hanna instrument water quality meter for dry season was used for the measurement of the parameters as mentioned in the table below.

Table 4-47 Water Quality Result of On-site Measurement with Hanna instrument (HI98129)

No	Parameter	Onsite Groundwater Quality Result on Project Area (1)	Onsite Groundwater Quality Result on Project Area (2)	Onsite Surface water Quality Result on Project Area (1)	Onsite Surface water Quality Result on Project Area (2)	Onsite Surface water Quality Result on Project Area (3)	Unit	WHO Guideline (2018)[1]	Remark
1.	pH	7.73	7.87	7.63	7.27	7.39	S.U.	6.5-8.5	Within the guideline
2.	TDS	475	121	62	62	62	ppm	1000 mg/l	Within the guideline
3.	Electric conductivity	949	243	122.33	125	124	µS/cm	2500 µS/cm	Within the guideline
4.	Temperature	33.3	29	25.2	25.7	25.6	˚C	25˚C	Above the guideline

[1]World Health Organization (2018)

4.7.14.3. Results and Discussion for Collection of Surface Water and Groundwater Quality

A water quality survey team conducted on-site measurement and sampling collection in tube wells in the project area, surface water (1), (2), (3), in the project area, surface water (4) (conducted in Kandawgyi Lake) and surface water (5) (conducted in Taungthaman Lake) during the survey times. During the 1st time water quality survey in wet season, eighteen parameters for laboratory analysis were collected and send to the Alarm Ecological laboratory. The sampling activities were conducted in accordance with the standards operation procedure for water sampling of the project.

The on-site measurement on surface water and groundwater quality results are within the guideline of the NEQ(E)G Guideline. As the laboratory result, most of the parameters are within TCVN 5942 : 1995 Water Quality Standards (Vietnam) but the result of Total Dissolved Solid and Oil & Grease are slightly exceeded above the guideline in surface water quality whereas the results of groundwater quality are within the guidelines. Gaw Wein jetty and other port operation activities are reasons of over the guideline.

The pH values in wet season and dry season survey for surface water and groundwater quality fall within the guidelines. Due to the season dissimilarity in the survey period, color and turbidity in the surface water quality for the first time (conducted in wet season) survey was greater than the second time water quality survey (conducted in dry season) whereas in groundwater is within the guidelines. Total Dissolved Solid (TDS) and suspended solids (TSS) values in Ayeyarwaddy River quality (conducted in surface water (2) and (3)) in wet season are exceed the guidelines because of the direct discharging of the industrial wastewater was flowing to the water body of the Ayeyarwady River. The BOD and COD values in surface water quality were within the acceptable range of the guidelines for both seasons.

Total coliform is investigated to estimate the possible conditions of the water quality in terms of bacteria. Total coliform indicates the degree of pollution and sanitary of water. According to the result, total coliform in surface water and groundwater result for wet season is higher than the dry season at most points. The impurities of settle down area are washed out into the water bodies, and it is likely that the concentration of total coliform is higher than that in the 2nd time survey.

Based on the surveys, no heavy metal was detected above the standard guidelines. However, to use water from the river shall need water quality monitoring seasonally until construction state and operation state.

Most of the parameters The summary of above the guideline of parameters are below;

Wet Season	Parameters above the guideline TCVN 5942: 1995 Surface Water Quality Standards	Dry Season	Parameters above the guideline TCVN 5942: 1995 Surface Water Quality Standards
Surface Water (1)	TDS, Oil & Grease	Surface Water (1)	TDS, Oil & Grease
Surface Water (2)	TDS, TSS, Lead, Oil & Grease	Surface Water (2)	-
Surface Water (3)	TDS, COD, Oil & Grease	Surface Water (3)	-
Surface Water (4)	TDS, Free Chlorine, Oil & Grease	Surface Water (4)	-
Surface Water (5)	TDS, Oil & Grease	Surface Water (5)	-
Wet Season	**Parameters above the guideline National Drinking Water Quality Standards of Myanmar (2019)**	**Dry Season**	**Parameters above the guideline National Drinking Water Quality Standards of Myanmar (2019)**
Ground Water (1)	Color	Ground Water (1)	-
Ground Water (2)	Total Coliform	Ground Water (2)	-

4.7.15. Noise and Vibration Monitoring in Wet Season and Dry Season

4.7.15.1. Noise

World Health Organization (WHO) has described noise pollution as an underestimated threat that can cause hearing loss, cardiovascular problems, cognitive impairment, stress and suffering from depression. Noise pollution can affect people in several ways, some of which are hearing loss, cardiovascular diseases, and sleep disturbances.

MONREC (Ministry of Natural Resources and Environmental Conservation) has issued National Environmental Quality (Emission) Guidelines to provide the basis for regulations and control of noise level. Noise impacts should not exceed the levels presented in Table 4-48.

4.7.15.2. Method and Methodology for Noise Monitoring

In order to find out whether the noise from the project area reaches the outside and to know whether the noise level in the project area affects the workers, noise levels are monitored as 24-hr outdoor noise monitoring by using GM-1356 Digital Sound Level Meter shown in Figure 4-87.

Noise monitoring points and photos are shown in Table 4-49, Table 4-50 and Figure 4-89, Figure 4-90 respectively. Map of noise quality monitoring is described in Figure 4-88.

Table 4-48 Noise Level Standard of NEQ(E)G

Receptor	One Hour LAeq (dBA)[a]	
	Daytime 07:00-22:00 (10:00-22:00 for Public Holidays)	**Nighttime 22:00 – 07:00 (22:00 – 10:00 for Public Holidays)**
Residential, Institutional, Educational	55	45
Industrial, commercial	70	70

[a] Equivalent continuous sound level in decibels

Figure 4-87 Noise Measuring Equipment (GM-1356 Digital Sound Level Meter)

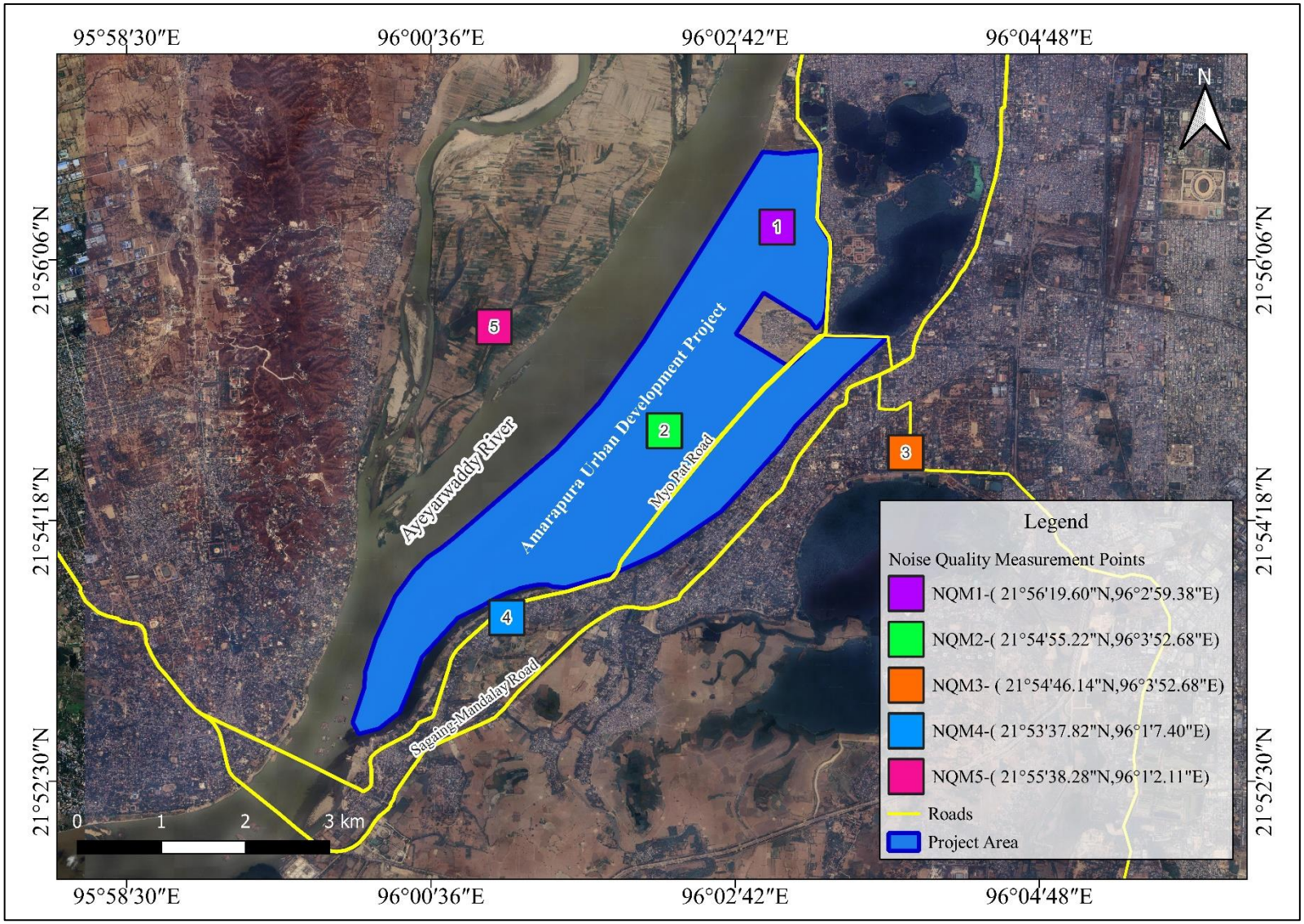


Figure 4-88 Noise Quality Monitoring Points

Table 4-49 Noise Monitoring Points in Wet Season

No	GPS Coordinates	Noise Quality Measurement Location	Duration
24-hr Outdoor Noise Monitoring			
1	21°56'19.6"N 96°02'59.38"E	Amarapura Project Area-1 (Ambient Air Monitoring Point)	24-hour Monitoring (20^{th} – 21^{st} October, 2022)
2	21°54'55.22"N 96°02'12.66"E	Amarapura Project Area-2 (Ambient Air Monitoring Point)	24-hour Monitoring (21^{st} – 22^{nd} October, 2022)
3	21°54'46.14"N 96°03'52.68"E	ECD Office of Amarapura Township (Ambient Air Monitoring Point)	24-hour Monitoring (22^{nd} – 23^{rd} October, 2022)
4	21°53'37.82"N 96°01'07.40"E	Myahinthar Village (Ambient Air Monitoring Point)	24-hour Monitoring (23^{rd} – 24^{th} October, 2022)
5	21°55'38.28"N 96°01'2.11"E	Warchat Village (Sagaing) (Ambient Air Monitoring Point)	24-hour Monitoring (24^{th} – 25^{th} October, 2022)

GM-1356 Digital Sound Level Meter

Amarapura Project Site-1	Amarapura Project Site-2
	
Myahinthar Village	Warchat Village

Figure 4-89 24 Hour Outdoor Noise Measurement Activities

Table 4-50 Noise Monitoring Points in Dry Season

No	GPS Coordinates	Noise Quality Measurement Location	Duration
24-hr Outdoor Noise Monitoring			
1	21°56'19.6"N 96°02'59.38"E	Amarapura Project Area-1 (Ambient Air Monitoring Point)	24-hour Monitoring (1^{st} – 2^{nd} March, 2023)
2	21°54'55.22"N 96°02'12.66"E	Amarapura Project Area-2 (Ambient Air Monitoring Point)	24-hour Monitoring (2^{nd} – 3^{rd} March, 2023)
3	21°54'46.14"N 96°03'52.68"E	ECD Office of Amarapura Township (Ambient Air Monitoring Point)	24-hour Monitoring (3^{rd} – 4^{th} March, 2023)
4	21°53'37.82"N 96°01'07.40"E	Myahinthar Village (Ambient Air Monitoring Point)	24-hour Monitoring (4^{th} – 5^{th} March, 2023)
5	21°55'38.28"N 96°01'2.11"E	Warchat Village (Sagaing) (Ambient Air Monitoring Point)	24-hour Monitoring (5^{th} – 6^{th} March, 2023)

Amarapura Project Area-1

Amarapura Project Area-2

ECD Office at Amarapura Township

Myahinthar Village

Figure 4-90 24 Hour Outdoor Noise Measurement Activities

4.7.15.3. Result of Noise Monitoring at Amarapura Project Site (1) in Wet Season

The outdoor noise measurements were conducted in 20th to 21st October, 2022 in the proposed Amarapura project site (1) and are scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor air noise is shown in Table 4-51 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-91 and Figure 4-92.

Table 4-51 Outdoor Noise Measurement Results

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	Amarapura Project Area-1	49.14	47.46	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-52 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
07:20 AM-08:20 AM	48.93	70
08:20 AM-09:20 AM	54.22	
09:20 AM-10:20 AM	55.42	
10:20 AM-11:20 AM	49.27	
11:20 AM-12:20 AM	49.68	
12:20 PM-01:20 PM	47.63	
01:20 PM-02:20 PM	46.09	
02:20 PM-03:20 PM	45.89	
03:20 PM-04:20 PM	51.52	
04:20 PM-05:20 PM	47.68	
05:20 PM-06:20 PM	49.09	
06:20 PM-07:20 PM	48.75	
07:20 PM-08:20 PM	50.57	
08:20 PM-09:20 PM	47.65	
09:20 PM-10:20 PM	44.76	

Table 4-53 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:20 PM-11:20 PM	44.89	70
11:20 PM-12:20 PM	44.76	
12:20 AM-01:20 AM	44.97	
01:20 AM-02:20 AM	49.22	
02:20 AM-03:20 AM	49.37	
03:20 AM-04:20 AM	50.19	
04:20 AM-05:20 AM	47.33	
05:20 AM-06:20 AM	47.28	
06:20 AM-07:20 AM	49.17	

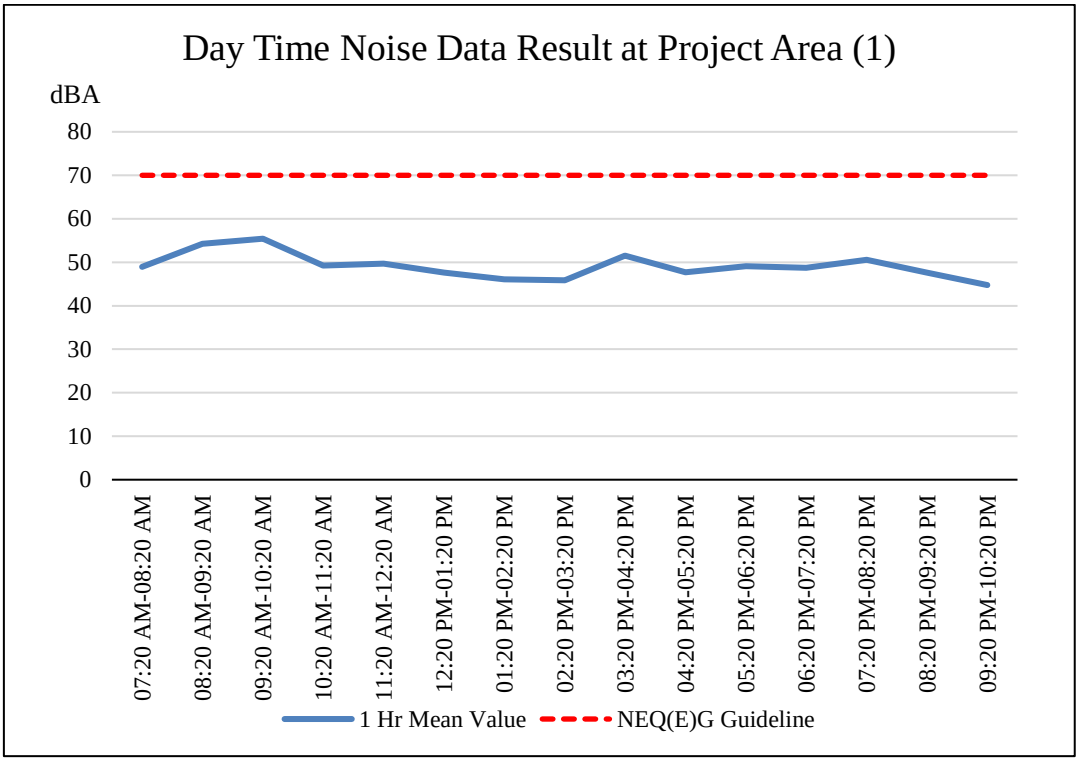


Figure 4-91 Daytime Noise Level Demonstration Graph

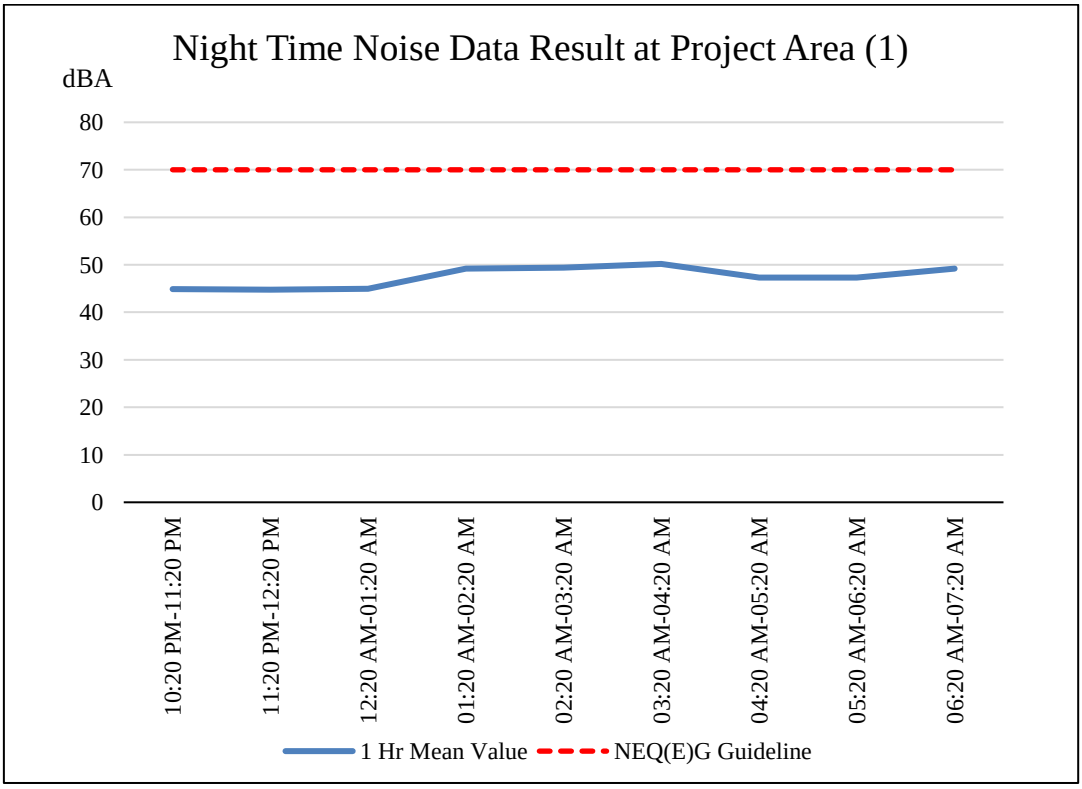


Figure 4-92 Nighttime Noise Level Demonstration Graph

4.7.15.4. Result of Noise Monitoring at Amarapura Project Site (1) in Dry Season

The outdoor noise measurement was conducted in 1st to 2nd March, 2023 in the proposed Amarapura project site (1) and is scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor air noise is

shown in Table 4-54 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-93 and Figure 4-94.

Table 4-54 Outdoor Noise Measurement Results

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	Amarapura Project Area-1	45.07	38.92	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-55 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission)Guidelines, Industrial, commercial
07:12 AM-08:12 AM	53.36	70
08:12 AM-09:12 AM	51.81	
09:12 AM-10:12 AM	53.36	
10:12 AM-11:12 AM	50.15	
11:12 AM-12:12 AM	49.29	
12:12 PM-01:12 PM	43.69	
01:12 PM-02:12 PM	42.71	
02:12 PM-03:12 PM	41.47	
03:12 PM-04:12 PM	40.99	
04:12 PM-05:12 PM	41.73	
05:12 PM-06:12 PM	41.77	
06:12 PM-07:12 PM	42.39	
07:12 PM-08:12 PM	41.30	
08:12 PM-09:12 PM	40.48	
09:12 PM-10:12 PM	41.58	

Table 4-56 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:12 PM-11:12 PM	40.99	70
11:12 PM-12:12 PM	37.45	
12:12 AM-01:12 AM	38.64	
01:12 AM-02:12 AM	38.23	
02:12 AM-03:12 AM	35.43	
03:12 AM-04:12 AM	36.55	
04:12 AM-05:12 AM	37.29	
05:12 AM-06:12 AM	40.99	
06:12 AM-07:12 AM	44.73	

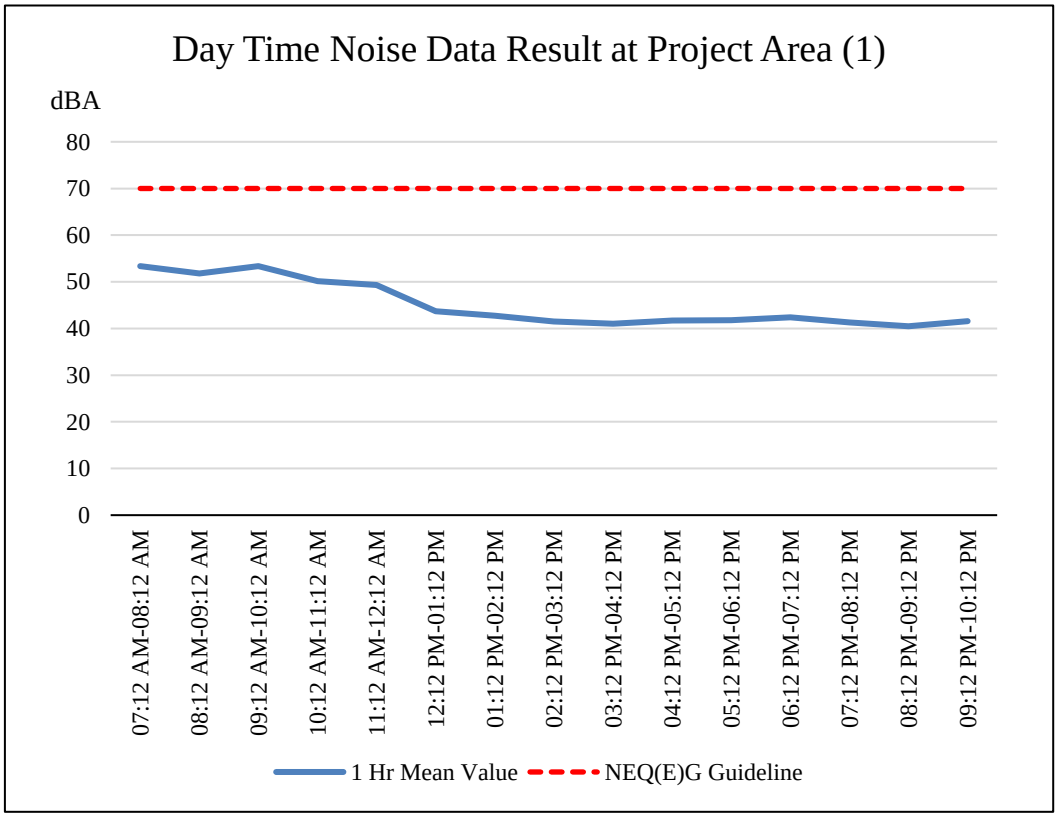


Figure 4-93 Daytime Noise Level Demonstration Graph

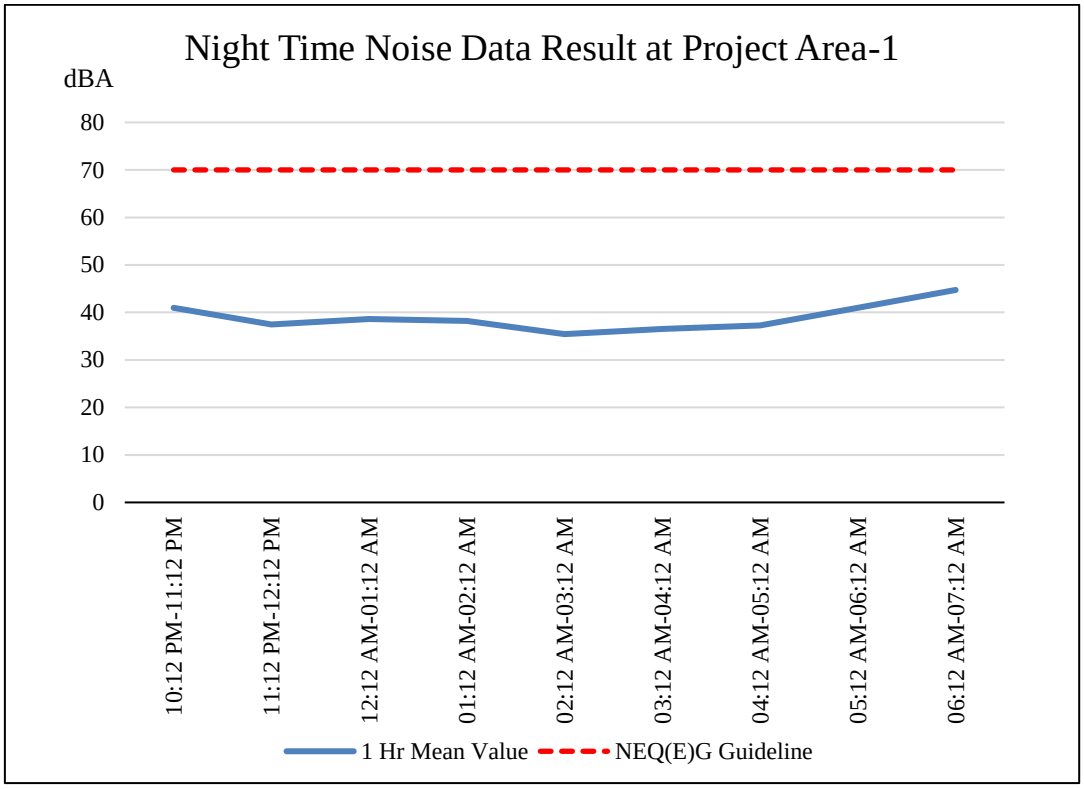


Figure 4-94 Nighttime Noise Level Demonstration Graph

4.7.15.5. Result of Noise Monitoring at Amarapura Project Site (2) in Wet Season

The outdoor noise measurement was conducted in 21st to 22nd October, 2022 in the proposed Amarapura project site (2) and is scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor air noise is shown in Table 4-57 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-95 and Figure 4-96.

Table 4-57 Outdoor Noise Measurement Results at Project Site (2)

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	Amarapura Project Area-2	46.79	45.88	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-58 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
07:00 AM-08:00 AM	45.41	70
08:00 AM-09:00 AM	45.81	
09:00 AM-10:00 AM	48.46	
10:00 AM-11:00 AM	52.42	
11:00 AM-12:00 AM	48.24	
12:00 PM-01:00 PM	49.88	
01:00 PM-02:00 PM	45.81	
02:00 PM-03:00 PM	44.15	
03:00 PM-04:00 PM	42.49	
04:00 PM-05:00 PM	50.63	
05:00 PM-06:00 PM	45.01	
06:00 PM-07:00 PM	44.30	
07:00 PM-08:00 PM	44.32	
08:00 PM-09:00 PM	45.01	
09:00 PM-10:00 PM	49.88	

Table 4-59 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:00 PM-11:00 PM	44.32	70
11:00 PM-12:00 AM	45.81	
12:00 AM-01:00 AM	45.01	
01:00 AM-02:00 AM	47.87	
02:00 AM-03:00 AM	48.24	
03:00 AM-04:00 AM	45.10	
04:00 AM-05:00 AM	48.24	
05:00 AM-06:00 AM	42.91	
06:00 AM-07:00 AM	45.41	

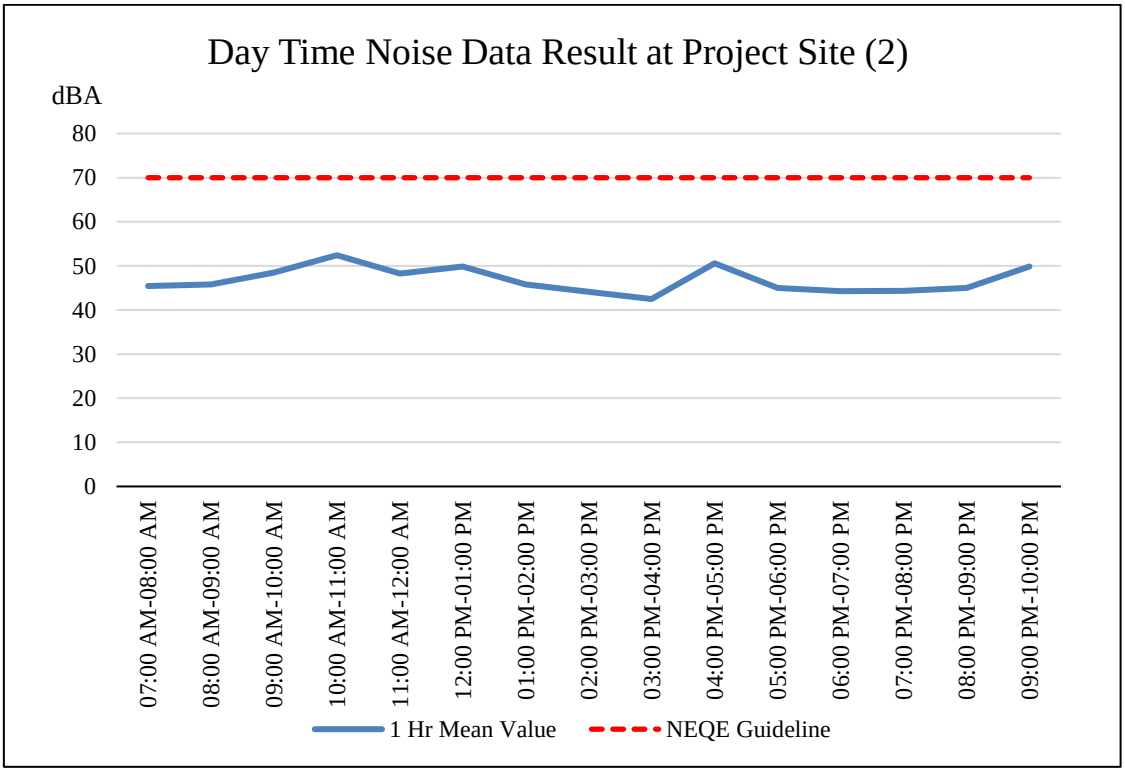


Figure 4-95 Daytime Noise Level Demonstration Graph

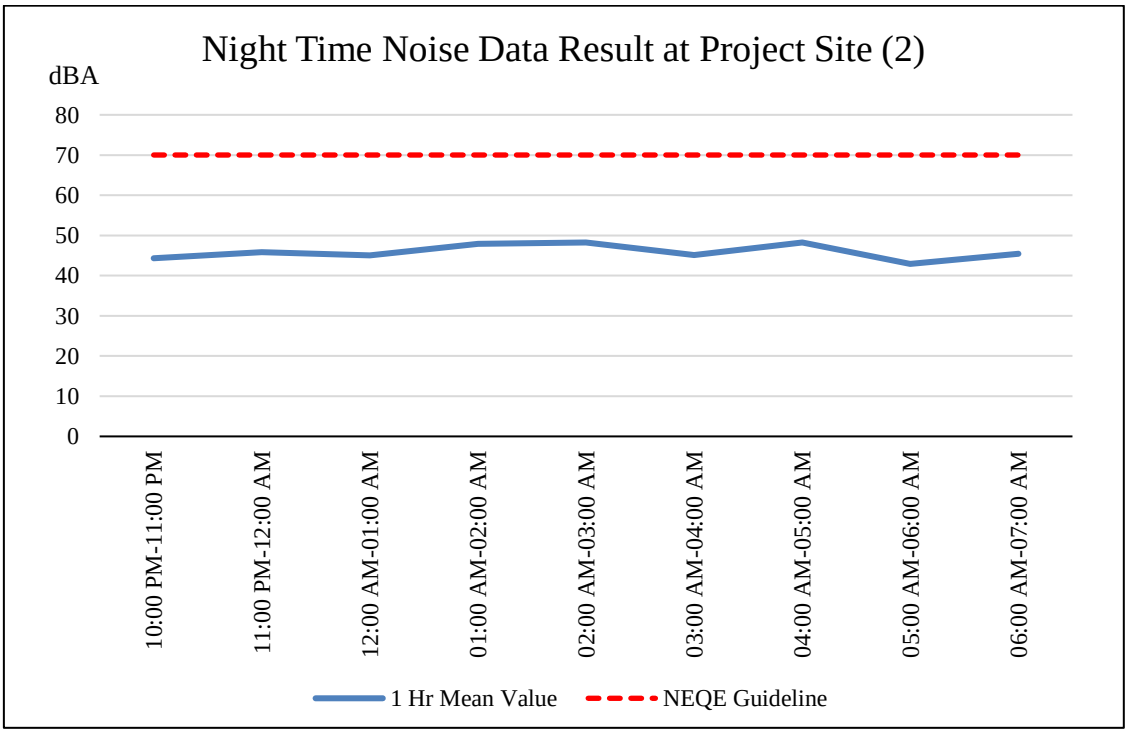


Figure 4-96 Nighttime Noise Level Demonstration Graph

4.7.15.6. Result of Noise Monitoring at Amarapura Project Site (2) in Dry Season

The outdoor noise measurement was conducted in 2nd to 3rd March, 2023 in the proposed Amarapura project site (2) and is scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor air noise is

shown in Table 4-60 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-97 and Figure 4-98.

Table 4-60 Outdoor Noise Measurement Results at Project Site (2)

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	Amarapura Project Area-2	45.41	42.79	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-61 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
07:16 AM-08:16 AM	41.83	70
08:16 AM-09:16 AM	45.41	
09:16 AM-10:16 AM	44.59	
10:16 AM-11:16 AM	45.41	
11:16 AM-12:16 AM	51.21	
12:16 PM-01:16 AM	47.44	
01:16 PM-02:16 PM	45.79	
02:16 PM-03:16 PM	44.67	
03:16 PM-04:16 PM	41.47	
04:16 PM-05:16 PM	44.17	
05:16 PM-06:16 PM	45.41	
06:16 PM-07:16 PM	49.38	
07:16 PM-08:16 PM	47.44	
08:16 PM-09:16 PM	41.47	
09:16 PM-10:16 PM	45.41	

Table 4-62 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:16 PM-11:16 PM	41.47	70
11:16 PM-12:16 PM	45.41	
12:16 AM-01:16 AM	41.47	
01:16 AM-02:16 AM	41.47	
02:16 AM-03:16 AM	45.41	
03:16 AM-04:16 AM	41.47	
04:16 AM-05:16 AM	45.41	
05:16 AM-06:16 AM	41.47	
06:16 AM-07:16 AM	41.47	

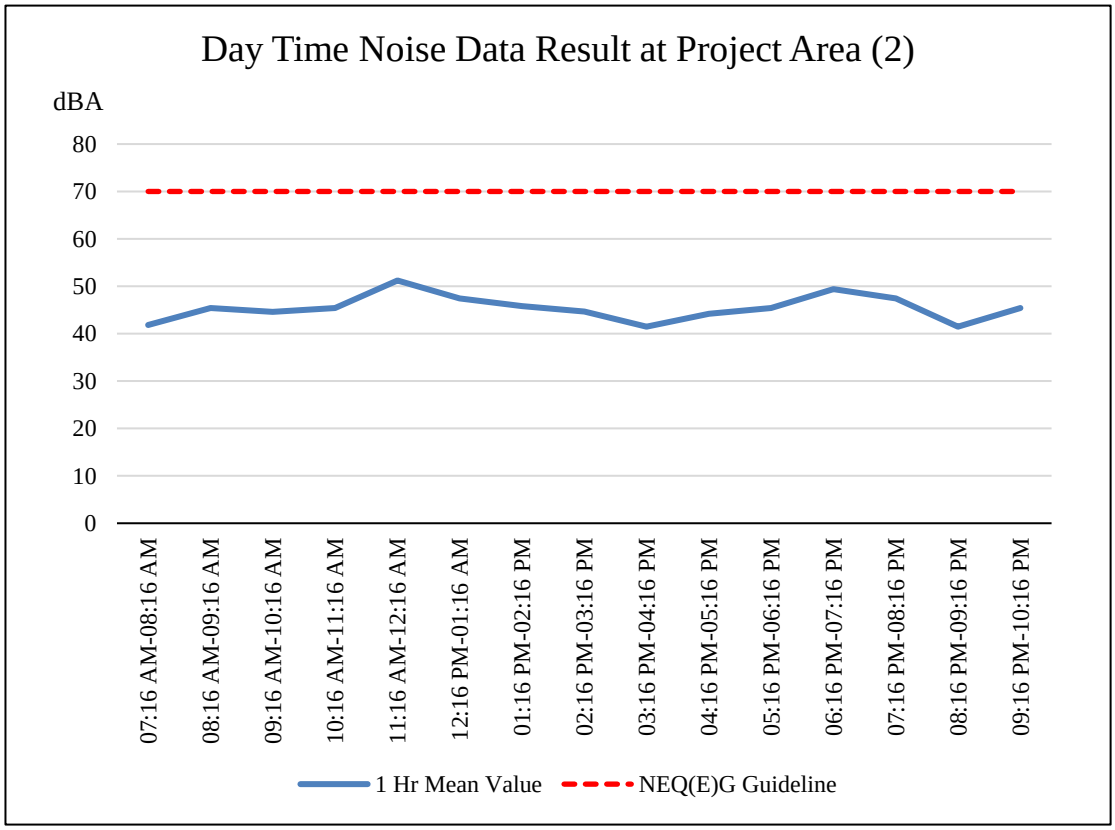


Figure 4-97 Daytime Noise Level Demonstration Graph

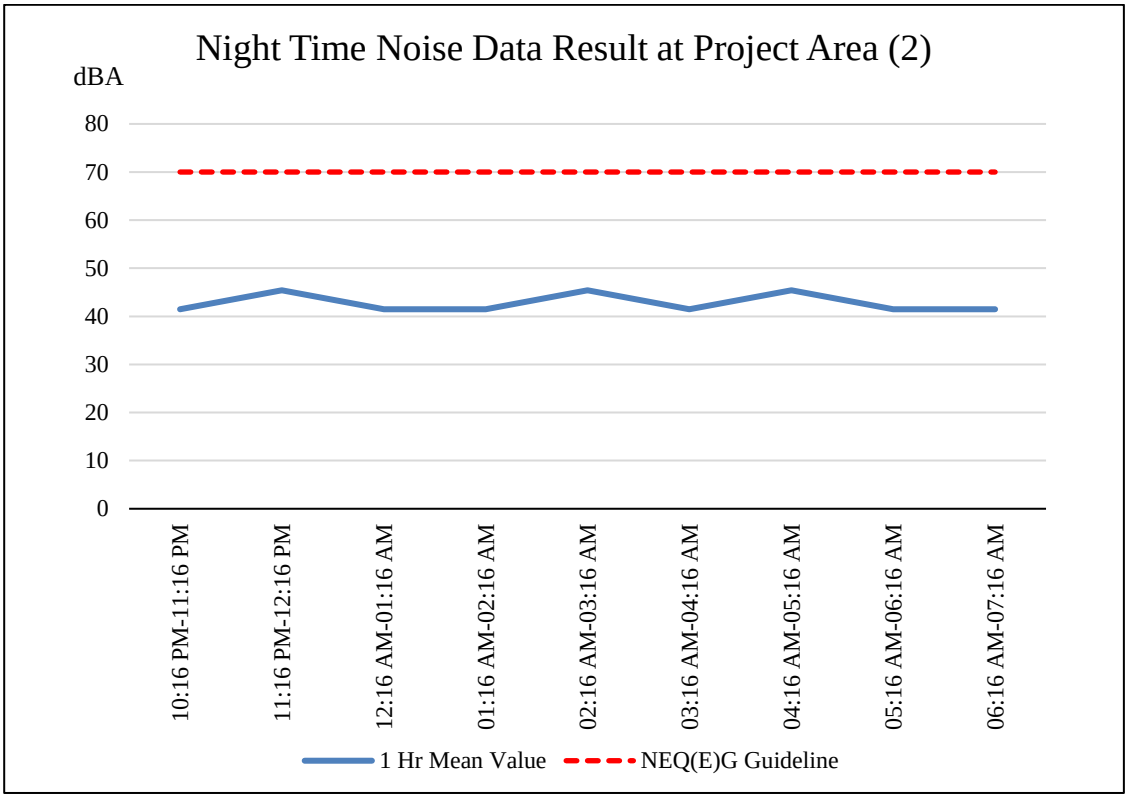


Figure 4-98 Nighttime Noise Level Demonstration Graph

4.7.15.7. Result of Noise Monitoring at ECD Office in Wet Season

The outdoor noise measurements were conducted in 22nd to 23rd October, 2022 in the proposed ECD office Amarapura township and is scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor air noise is shown in Table 4-63 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-99 and Figure 4-100.

Table 4-63 Outdoor Noise Measurement Results at ECD Office

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	ECD Office	47.30	52.88	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-64 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
07:20 AM-08:20 AM	49.78	70
08:20 AM-09:20 AM	50.15	
09:20 AM-10:20 AM	51.06	
10:20 AM-11:20 AM	49.27	
11:20 AM-12:20 AM	51.32	
12:20 PM-01:20 PM	49.09	
01:20 PM-02:20 PM	46.70	
02:20 PM-03:20 PM	43.69	
03:20 PM-04:20 PM	42.54	
04:20 PM-05:20 PM	40.69	
05:20 PM-06:20 PM	42.85	
06:20 PM-07:20 PM	46.33	
07:20 PM-08:20 PM	48.39	
08:20 PM-09:20 PM	49.09	
09:20 PM-10:20 PM	48.61	

Table 4-65 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:20 PM-11:20 PM	49.12	70
11:20 PM-12:20 PM	54.53	
12:20 AM-01:20 AM	55.36	
01:20 AM-02:20 AM	53.13	
02:20 AM-03:20 AM	52.94	
03:20 AM-04:20 AM	53.19	
04:20 AM-05:20 AM	52.85	
05:20 AM-06:20 AM	53.15	
06:20 AM-07:20 AM	51.71	

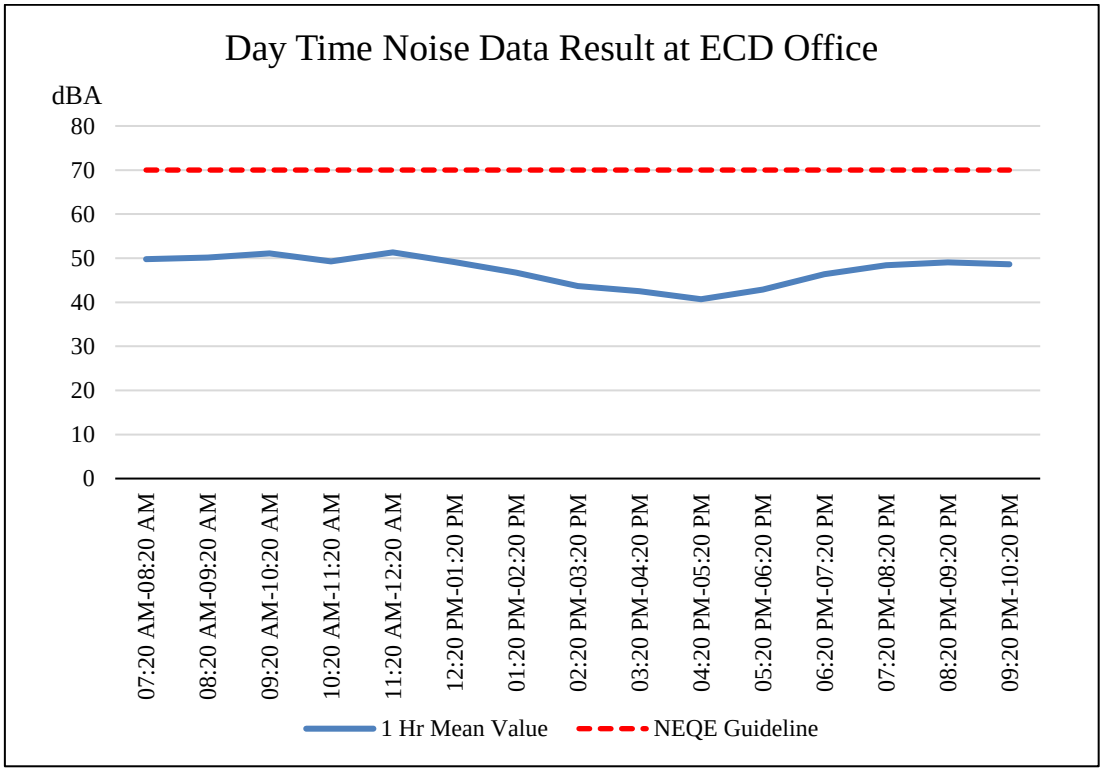


Figure 4-99 Daytime Noise Level Demonstration Graph

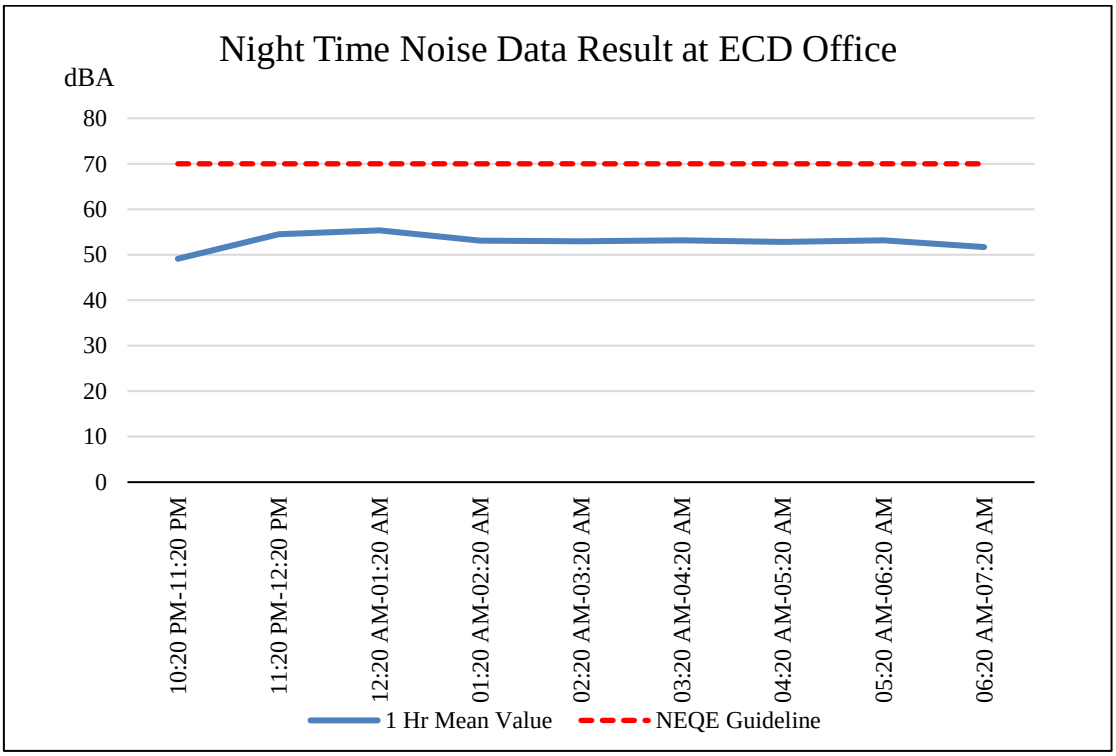


Figure 4-100 Nighttime Noise Level Demonstration Graph

4.7.15.8. Result of Noise Monitoring at ECD Office in Dry Season

The outdoor noise measurements were conducted in 3rd to 4th March, 2023 in the proposed ECD office, Amarapura township and is scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor

air noise is shown in Table 4-66 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-101 and Figure 4-102.

Table 4-66 Outdoor Noise Measurement Results at ECD Office

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	ECD Office	46.04	42.22	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-67 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
07:47 AM-08:47 AM	45.16	70
08:47 AM-09:47 AM	44.22	
09:47 AM-10:47 AM	45.16	
10:47 AM-11:47 AM	54.02	
11:47 AM-12:47 AM	49.57	
12:47 PM-01:47 AM	49.02	
01:47 PM-02:47 PM	44.23	
02:47 PM-03:47 PM	42.99	
03:47 PM-04:47 PM	43.82	
04:47 PM-05:47 PM	43.61	
05:47 PM-06:47 PM	43.87	
06:47 PM-07:47 PM	49.02	
07:47 PM-08:47 PM	46.21	
08:47 PM-09:47 PM	42.83	
09:47 PM-10:47 PM	46.83	

Table 4-68 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:47 PM-11:47 PM	44.54	70
11:47 PM-12:47 PM	45.16	
12:47 AM-01:47 AM	43.40	
01:47 AM-02:47 AM	38.49	
02:47 AM-03:47 AM	38.53	
03:47 AM-04:47 AM	38.79	
04:47 AM-05:47 AM	41.81	
05:47 AM-06:47 AM	44.57	
06:47 AM-07:47 AM	44.67	

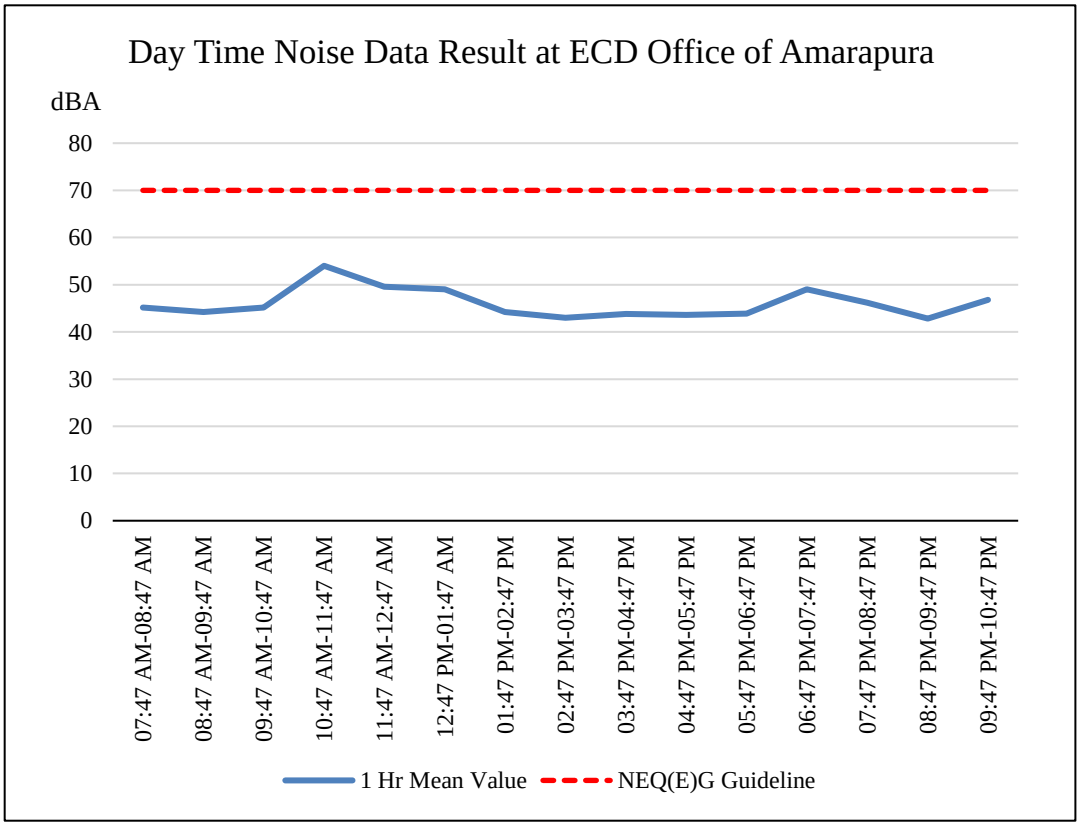


Figure 4-101 Daytime Noise Level Demonstration Graph

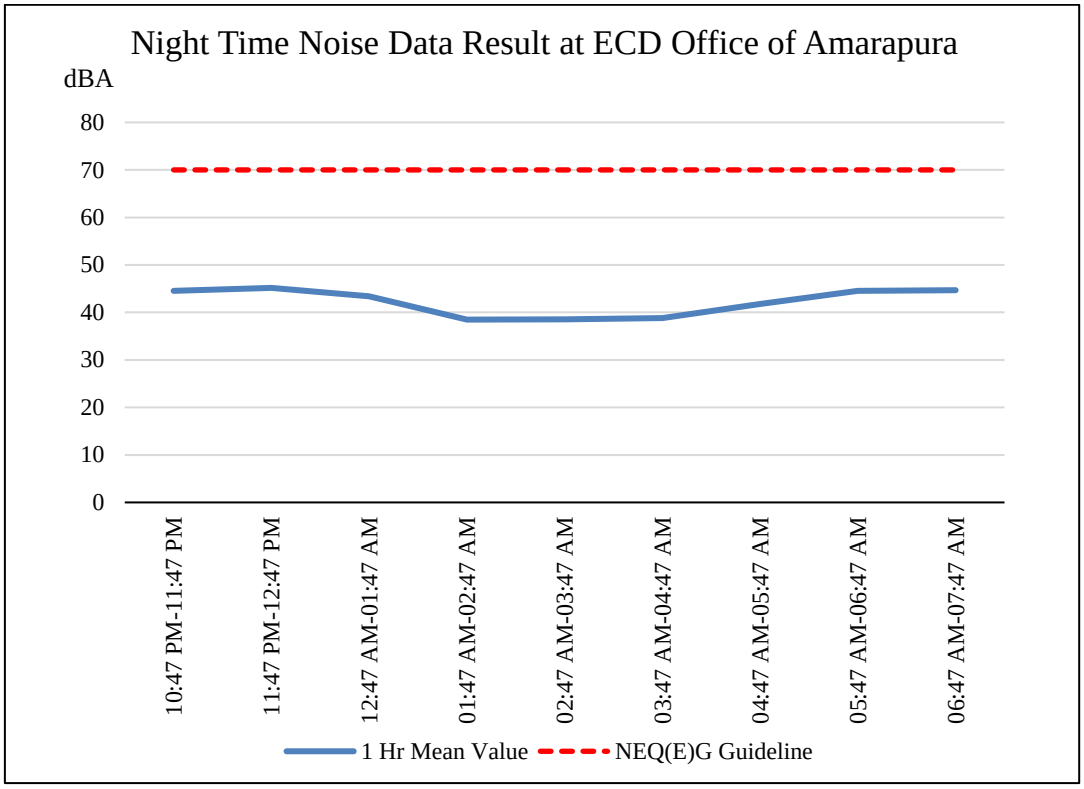


Figure 4-102 Nighttime Noise Level Demonstration Graph

4.7.15.9. Result of Noise Monitoring at Myahinthar Village in Wet Season

The outdoor noise measurement was conducted in 23rd to 24th October, 2022 in the proposed Myahinthar Village and is scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor air noise is shown in Table 4-69 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-103 and Figure 4-104.

Table 4-69 Outdoor Noise Measurement Results at Myahinthar Village

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	Myahinthar Village	49.66	48.97	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-70 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
07:52 AM-08:52 AM	47.52	70
08:52 AM-09:52 AM	49.21	
09:52 AM-10:52 AM	53.96	
10:52 AM-11:52 AM	54.44	
11:52 AM-12:52 AM	47.91	
12:52 PM-01:52 PM	46.51	
01:52 PM-02:52 PM	46.25	
02:52 PM-03:52 PM	49.30	
03:52 PM-04:52 PM	51.85	
04:52 PM-05:52 PM	49.24	
05:52 PM-06:52 PM	53.96	
06:52 PM-07:52 PM	49.39	
07:52 PM-08:52 PM	49.55	
08:52 PM-09:52 PM	46.51	
09:52 PM-10:52 PM	49.24	

Table 4-71 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:52 PM-11:52 PM	49.24	70
11:52 PM-12:52 AM	46.51	
12:52 AM-01:52 AM	49.24	
01:52 AM-02:52 AM	48.11	
02:52 AM-03:52 AM	49.24	
03:52 AM-04:52 AM	48.27	
04:52 AM-05:52 AM	51.82	
05:52 AM-06:52 AM	49.36	
06:52 AM-07:52 AM	50.65	

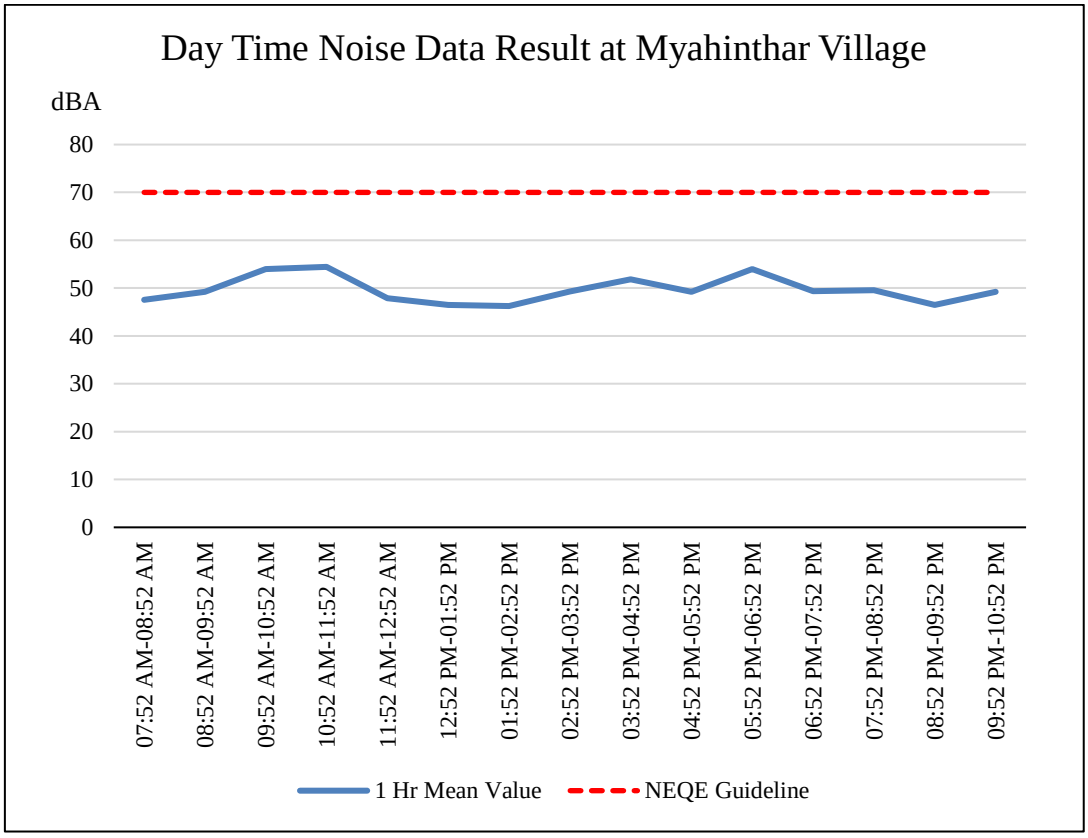


Figure 4-103 Daytime Noise Level Demonstration Graph

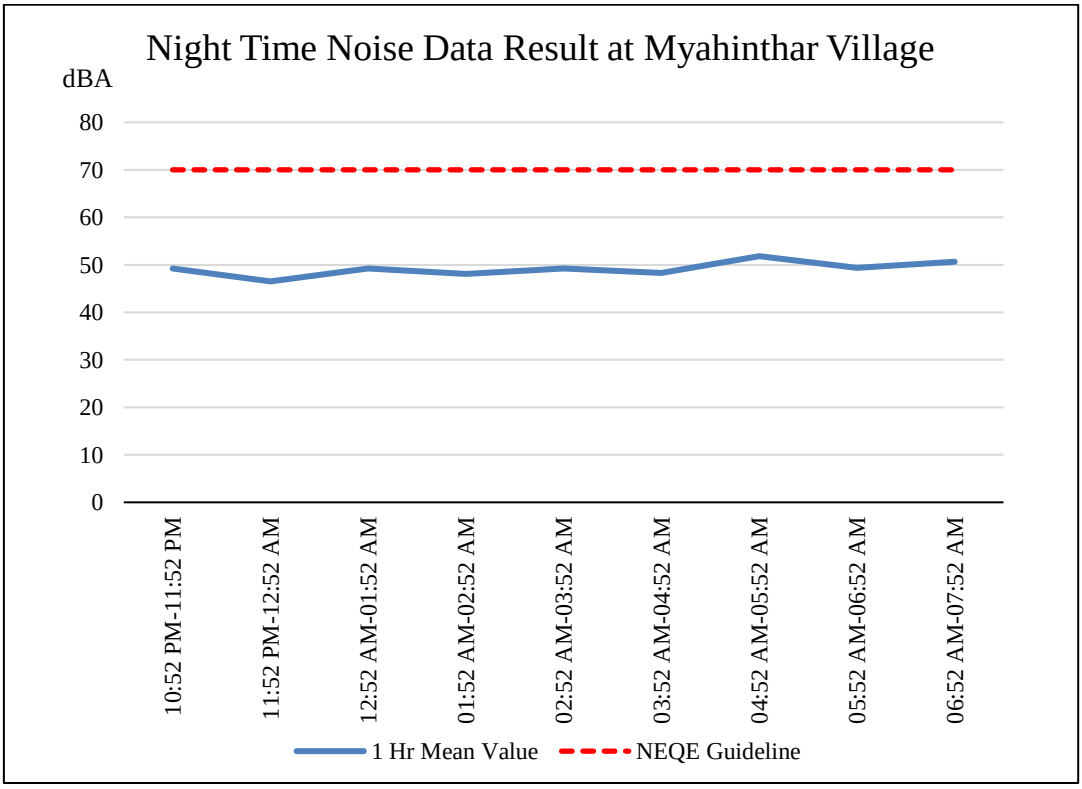


Figure 4-104 Nighttime Noise Level Demonstration Graph

4.7.15.10. Result of Noise Monitoring at Myahinthar Village in Dry Season

The outdoor noise measurements were conducted in 4th to 5th March, 2023 in the proposed Myahinthar Village and is scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor air noise is shown in Table 4-72 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-105 and Figure 4-106.

Table 4-72 Outdoor Noise Measurement Results at Myahinthar Village

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	Myahinthar Village	46.57	40.76	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-73 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
07:33 AM-08:33 AM	41.18	70
08:33 AM-09:33 AM	47.22	
09:33 AM-10:33 AM	45.43	
10:33 AM-11:33 AM	50.44	
11:33 AM-12:33 AM	48.10	
12:33 PM-01:33 AM	48.53	
01:33 PM-02:33 PM	45.17	
02:33 PM-03:33 PM	45.13	
03:33 PM-04:33 PM	49.96	
04:33 PM-05:33 PM	50.99	
05:33 PM-06:33 PM	47.51	
06:33 PM-07:33 PM	46.60	
07:33 PM-08:33 PM	43.70	
08:33 PM-09:33 PM	44.25	
09:33 PM-10:33 PM	44.40	

Table 4-74 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:33 PM-11:33 PM	41.18	70
11:33 PM-12:33 PM	41.40	
12:33 AM-01:33 AM	39.55	
01:33 AM-02:33 AM	40.02	
02:33 AM-03:33 AM	39.09	
03:33 AM-04:33 AM	40.86	
04:33 AM-05:33 AM	41.18	
05:33 AM-06:33 AM	41.08	
06:33 AM-07:33 AM	42.52	

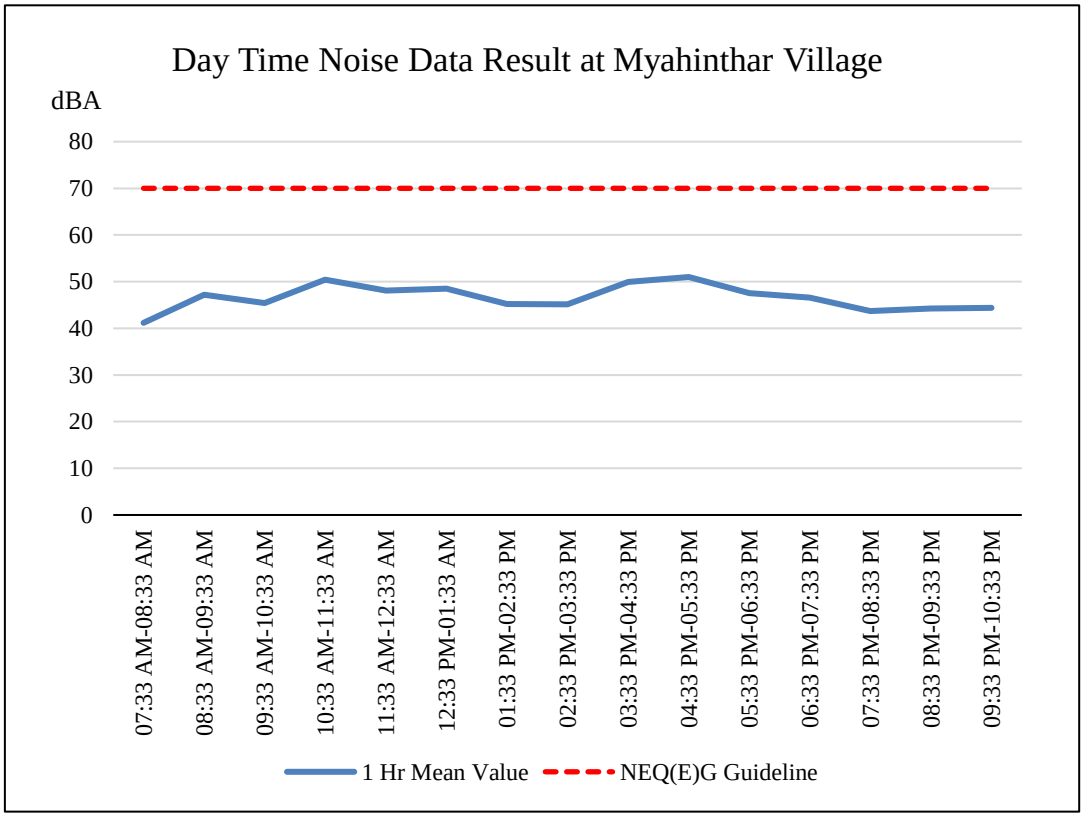


Figure 4-105 Daytime Noise Level Demonstration Graph

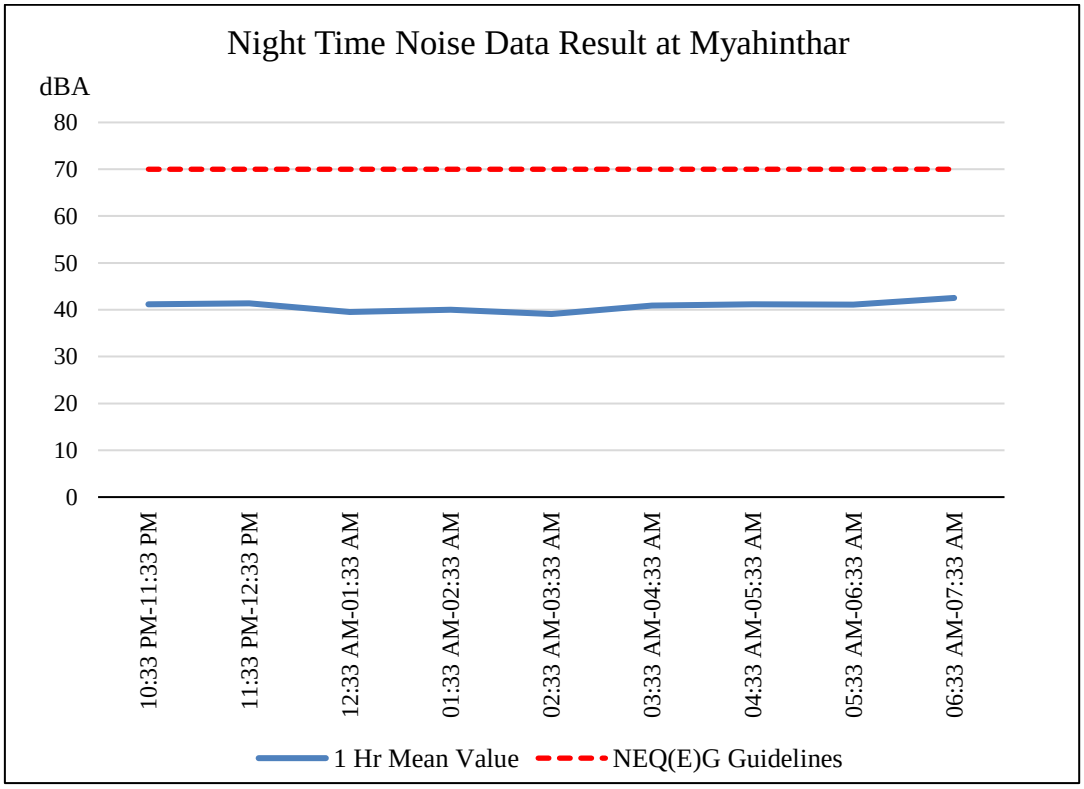


Figure 4-106 Nighttime Noise Level Demonstration Graph

4.7.15.11. Result of Noise Monitoring at Warchat Village in Wet Season

The outdoor noise measurements were conducted in 24th to 25th October, 2022 in the proposed Warchat Village and is scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor air noise is shown in Table 4-75 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-107 and Figure 4-108.

Table 4-75 Outdoor Noise Measurement Results at Warchat Village

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	Warchat Village	45.40	45.39	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-76 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
07:17 AM-08:17 AM	45.89	70
08:17 AM-09:17 AM	46.38	
09:17 AM-10:17 AM	45.89	
10:17 AM-11:17 AM	44.43	
11:17 AM-12:17 AM	45.86	
12:17 PM-01:17 PM	39.27	
01:17 PM-02:17 PM	41.91	
02:17 PM-03:17 PM	44.96	
03:17 PM-04:17 PM	44.05	
04:17 PM-05:17 PM	47.91	
05:17 PM-06:17 PM	46.25	
06:17 PM-07:17 PM	49.30	
07:17 PM-08:17 PM	47.75	
08:17 PM-09:17 PM	45.61	
09:17 PM-10:17 PM	45.58	

Table 4-77 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:17 PM-11:17 PM	43.90	70
11:17 PM-12:17 PM	42.31	
12:17 AM-01:17 AM	49.32	
01:17 AM-02:17 AM	43.64	
02:17 AM-03:17 AM	43.54	
03:17 AM-04:17 AM	45.99	
04:17 AM-05:17 AM	46.38	
05:17 AM-06:17 AM	47.07	
06:17 AM-07:17 AM	46.38	

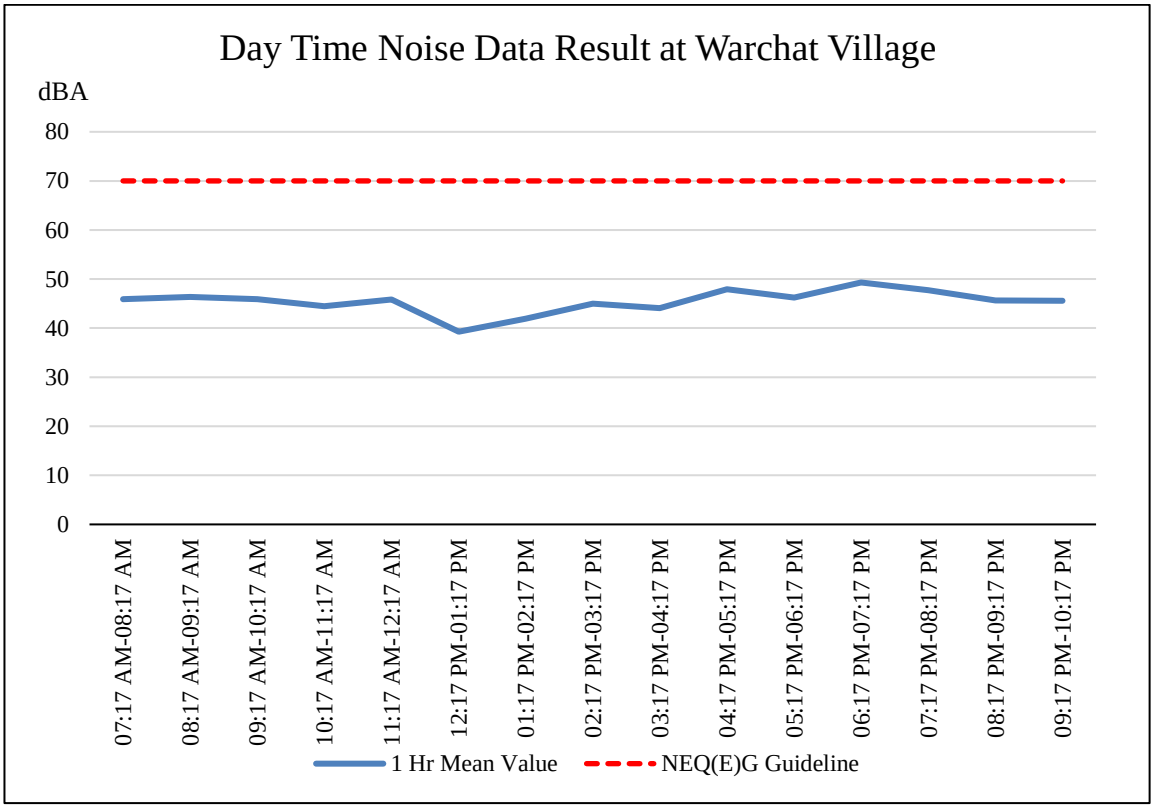


Figure 4-107 Daytime Noise Level Demonstration Graph

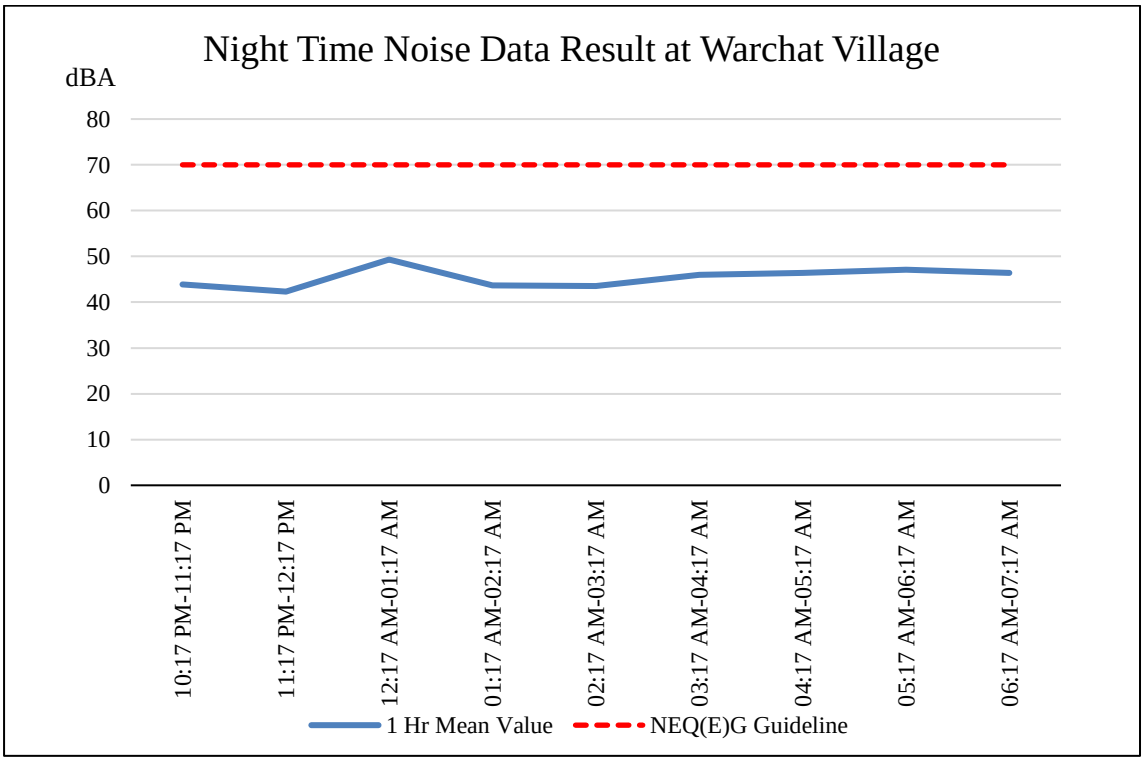


Figure 4-108 Nighttime Noise Level Demonstration Graph

As the result, the daytime and nighttime outdoor noise levels of the project area and the nearby villages are within the guidelines and safe for workers and the environment around the project area.

4.7.15.12. Result of Noise Monitoring at Warchat Village in Dry Season

The outdoor noise measurements were conducted in 5th to 6th March, 2023 in the proposed Warchat Village and is scrutinized with the National Environmental Quality (Emission) Guideline. The result of daytime and nighttime in outdoor air noise is shown in Table 4-78 and the demonstration graph of daytime and nighttime noise data results are as shown in Figure 4-109 and Figure 4-110.

Table 4-78 Outdoor Noise Measurement Results at Warchat Village

No.	Measurement Place	Noise Level (dBA)		NEQ(E)G[1] standard	
		Day Time (07:00-22:00 Average (dBA)	Night Time (22:00-07:00) Average (dBA)	Industrial, commercial	
				Day Time (07:00-22:00	Nighttime (22:00-07:00)
1	Warchat Village	45.43	41.03	70	70

[1]National Environmental Quality (Emission) Guidelines; 2015

Table 4-79 Daytime Noise Measurement Results

Day Time (07:00-22:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
07:17 AM-08:17 AM	45.20	70
08:17 AM-09:17 AM	44.30	
09:17 AM-10:17 AM	43.60	
10:17 AM-11:17 AM	45.30	
11:17 AM-12:17 AM	44.30	
12:17 PM-01:17 PM	41.30	
01:17 PM-02:17 PM	45.60	
02:17 PM-03:17 PM	47.30	
03:17 PM-04:17 PM	45.30	
04:17 PM-05:17 PM	48.30	
05:17 PM-06:17 PM	46.30	
06:17 PM-07:17 PM	49.30	
07:17 PM-08:17 PM	47.75	
08:17 PM-09:17 PM	42.30	
09:17 PM-10:17 PM	45.30	

Table 4-80 Night Time Noise Measurement Results

Night Time (22:00-07:00)	Noise Level (dBA)	National Environmental Quality (Emission) Guidelines, Industrial, commercial
10:17 PM-11:17 PM	42.30	70
11:17 PM-12:17 PM	41.30	
12:17 AM-01:17 AM	40.60	
01:17 AM-02:17 AM	39.50	
02:17 AM-03:17 AM	39.80	
03:17 AM-04:17 AM	38.60	
04:17 AM-05:17 AM	40.30	
05:17 AM-06:17 AM	41.30	
06:17 AM-07:17 AM	45.60	

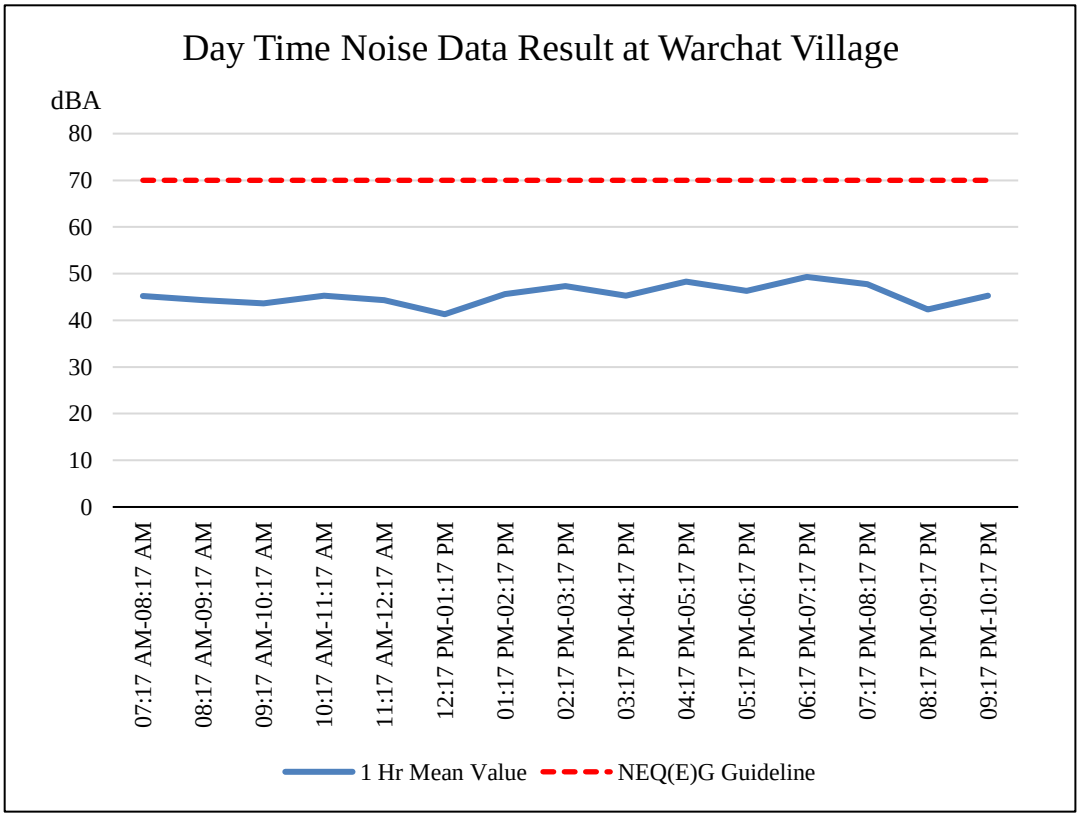


Figure 4-109 Daytime Noise Level Demonstration Graph

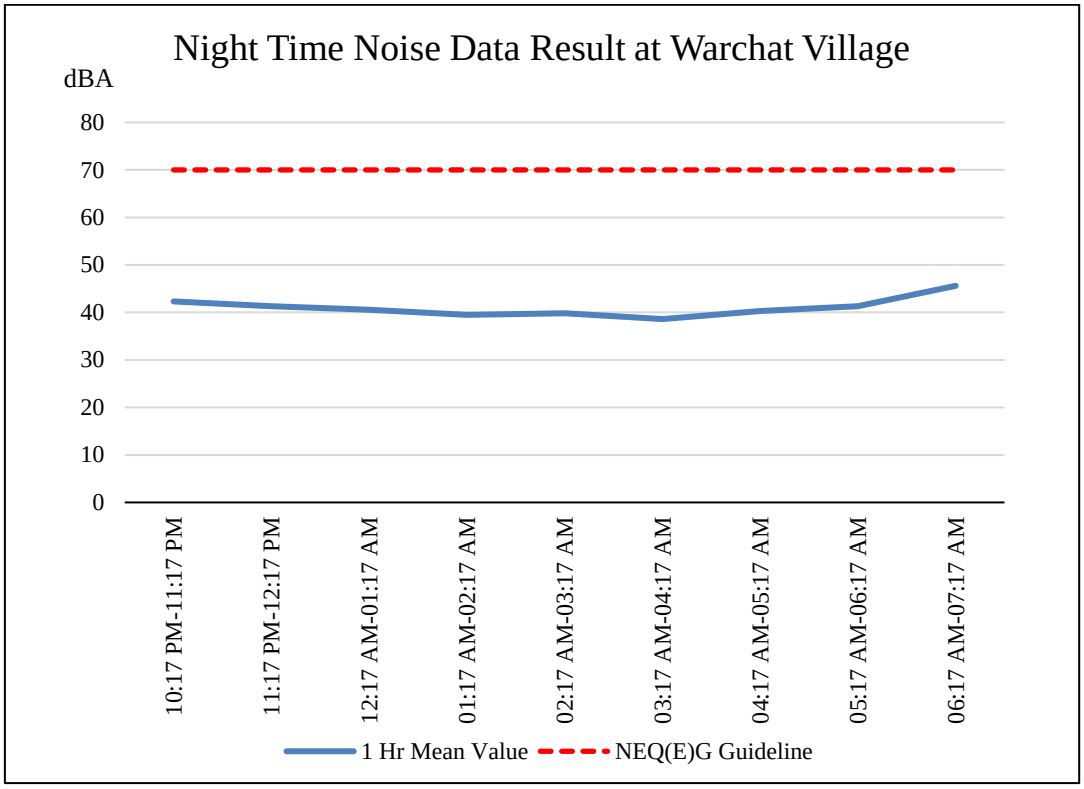


Figure 4-110 Nighttime Noise Level Demonstration Graph

As the results show, the daytime and nighttime outdoor noise levels of the project area and the nearby villages for both seasons are within the guidelines, and it is safe for workers and the environment around the project area.

4.7.15.13. Vibration Measurement in Wet Season and Dry Season

Vibration in building can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes, varying or remaining contact with time), impulsive (such as in shocks), or intermittent (with the magnitude of each event being either constant or varying with time).

4.7.15.14. Method and Methodology for Vibration Measurement in Dry Season and Wet Season

In order to assess the potential impact generated from vibration, vibration of the Amarapura project site (1), Amarapura project site (2), ECD office, Myahinthar Village and Warchat Village are measured by using vibration monitoring device as shown in Figure 4-112. The location and measurement station for vibration monitoring is displayed in Table 4-81 and Figure 4-111.

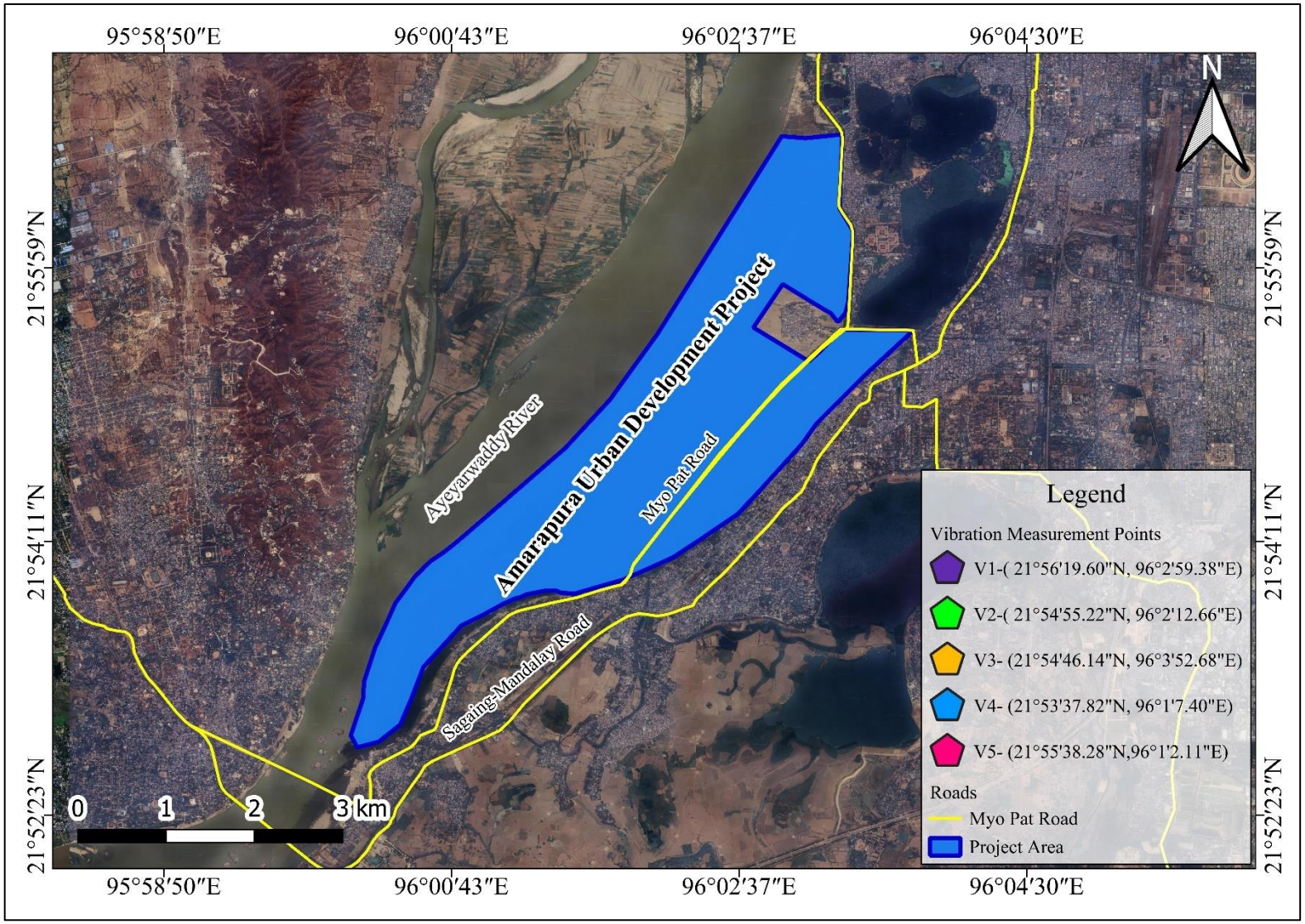


Figure 4-111 Location of Vibration Monitoring

Table 4-81 Vibration Monitoring Points

No.	Location	Coordinate Points	Parameter	Wet Season	Dry Season
1	Amarapura Project Site-1	21°56'19.6"N 96°02'59.38"E	Velocity and Acceleration	24 Hour Monitoring, 20th – 21st October, 2022	24 Hour Monitoring, 2nd – 3rd March, 2023
2	Amarapura Project Site-2	21°54'55.22"N 96°02'12.66"E	Velocity and Acceleration	24 Hour Monitoring, 21st – 22nd October, 2022	24 Hour Monitoring, 1st - 2nd March, 2023
3	ECD Office at Amarapura Township	21°54'46.14"N 96°03'52.68"E	Velocity and Acceleration	24 Hour Monitoring, 22nd – 23rd October, 2022	24 Hour Monitoring, 3rd – 4th March, 2023
4	Myahinthar Village	21°53'37.82"N 96°01'07.40"E	Velocity and Acceleration	24 Hour Monitoring, 23rd– 24th October, 2022	24 Hour Monitoring, 4th – 5th March, 2023
5	Warchat Village	21°55'38.28"N 96°01'2.11"E	Velocity and Acceleration	24 Hour Monitoring, 24th – 25th October, 2022	24 Hour Monitoring, 5th – 6th March, 2023

Figure 4-112 BENETECH Vibration Monitoring Equipment

4.7.15.15. Result of Vibration Measurement in Wet Season

The vibration measurements were conducted on 20th to 25th October, 2022 at five measuring points. The vibration meter BENETECH Vibration Monitoring Equipment was used for ground vibration measurements. The vibration measurement result at the project site in wet season is shown in Table 4-82.

Table 4-82 Result of Vibration with Criteria (20th to 25th October, 2022)

No.	Location	Result		*Criteria for Workshop				Source
		Acceleration (m/s^2)	Velocity (mm/s)	Acceleration (m/s^2) (dB re 10^{-6} m/s^2)		Velocity (mm/s) (dB re 10^{-6} m/s^2)		
				Preferred	Max	Preferred	Max	
1.	Amarapura Project Site-1	0.03	0.6	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles
2.	Amarapura Project Site-2	0.025	0.5	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles
3.	ECD Office	0.01	0.1	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles
4.	Myahinthar	0.006	0.01	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles
5.	Warchat	0.005	0.002	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles

* Assessing Vibration: a technical guideline, 2006, Department of Environment and Conservation, NSW (New South Wales), Australia

According to the field survey results, evaluation results of vibration level for all stations are within the guidelines and it is observed that the results are significantly lower than the standard.

4.7.15.16. Result of Vibration Measurement in Dry Season

The vibration measurements were conducted on 1st to 6th March, 2023 at five measuring points. The vibration meter was used for ground vibration measurements. The vibration measurement result at the project site in dry season is shown in Table 4-83.

Table 4-83 Result of Vibration with Criteria (1st to 6th March, 2023)

No.	Location	Result		*Criteria for Workshop				Source
		Acceleration (m/s^2)	Velocity (mm/s)	Acceleration (m/s^2) (dB re 10^{-6} m/s^2)		Velocity (mm/s) (dB re 10^{-6} m/s^2)		
				Preferred	Max	Preferred	Max	
1.	Amarapura Project Site-1	0.02	0.5	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles
2.	Amarapura Project Site-2	0.035	0.5	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles
3.	ECD Office	0.001	0.01	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles
4.	Myahinthar	0.005	0.05	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles
5.	Warchat	0.01	0.04	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)	Vehicles

* Assessing Vibration: a technical guideline, 2006, Department of Environment and Conservation, NSW (New South Wales), Australia

The result of vibration measurement over a 24-hr period in wet season and dry season is shown in the following table, and the results are compared with the International Standard guidelines. According to the field survey results, evaluation results of vibration level for all stations are within the guidelines and it is observed that the results are significantly lower than the standard.

4.7.16. Soil Quality Monitoring

Soil pH is a measure of the amount of acidity or alkalinity (basicity) that is presented in the soil. Soil pH measure on a scale of 0 to 14 with pH level below 7 being acid while pH level above 7 being alkaline (or Basic). pH of 7 is considered neutral (neither acidic nor alkaline). Soil pH is a very important soil property due to its ability to determine the availability of nutrients for plant uptake. Different soil nutrients are available at acidic pH while others are available at alkaline pH levels. The Soil pH level that allows for a wider nutrient availability to crops is in the 5.5 to 7.5 range.

4.7.16.1. Method and Methodology for Collection of Soil Quality Monitoring

The process of collecting sample soil in the project area was carried out from four locations on 1st March, 2023 and sent to the laboratory. The soil measurement location points and location map are as shown in Table 4-84 and Figure 4-113 respectively. In order to investigate the quality of the soil in the project area, soil samples were dug to a depth of about 2 feet and collected soil samples. The sample were sent in a sealed and labelled plastic bag to the central land use laboratory, Department of Agriculture and tested for pH, moisture, texture, total nitrogen (N) and Cation exchange capacity (CEC). The lab results are as shown in Table 4-87.

In addition, on-site soil quality measurement was conducted in the study area by using on site soil survey instrument as shown in Figure 4-114 and measured temperature, pH and moisture are scrutinized with a guideline to soil pH by Food and Agriculture Organization of the United States (FAO) (2006) as mentioned in Table 4-85. The analyzed of soil quality results are shown in Table 4-86.

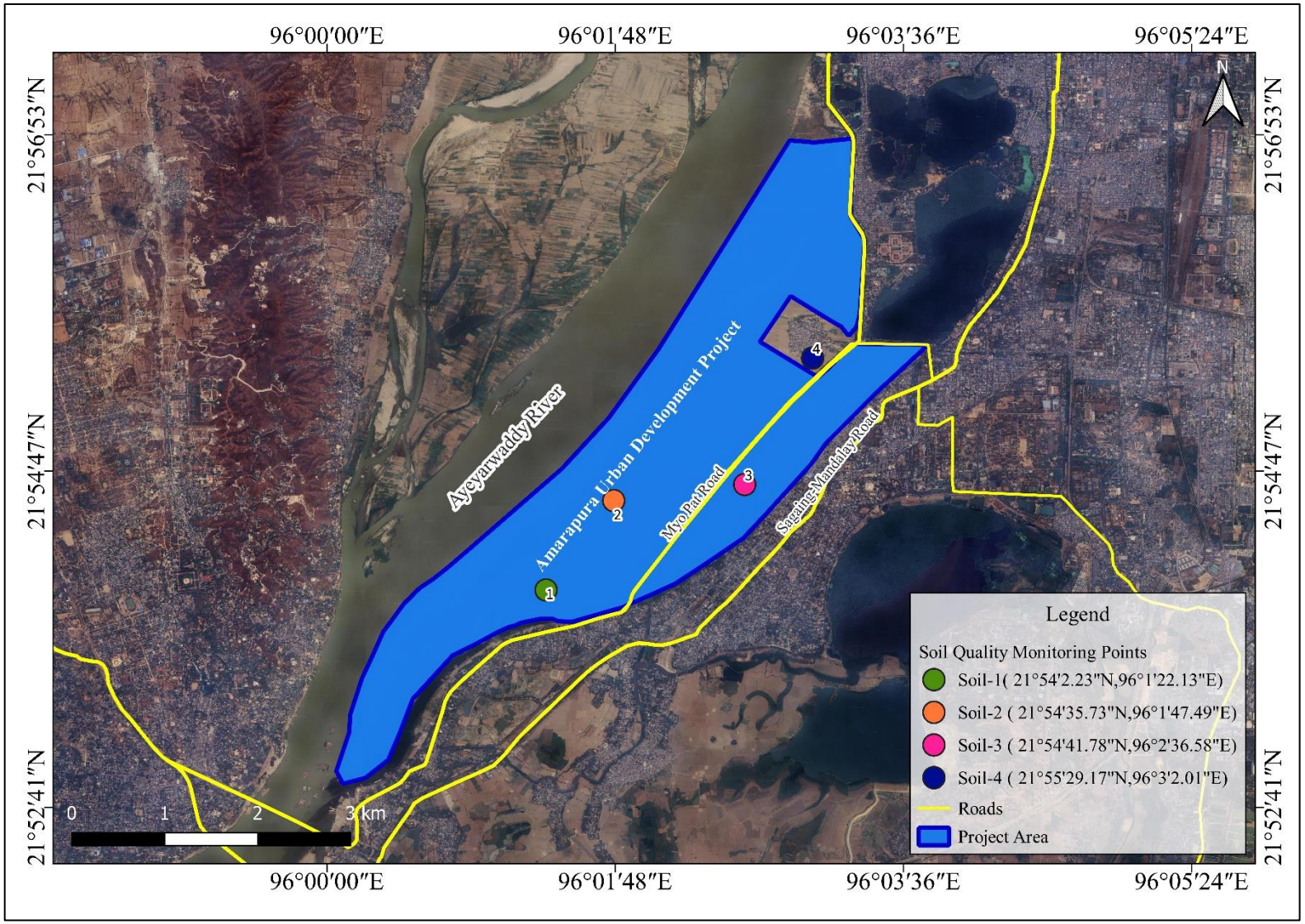


Figure 4-113 Location Map of Soil Quality Measurement

Table 4-84 Soil Measurement Points

No	GPS Coordinates	Measurement Location
1	21°54.032’N 96°01.377'E	Maize, Beans and Pulses Plantation at Project Area
2	21°54.595'N 96°01.792'E	Bottle Gourd Plantation at Project Area
3	21°54.696'"N 96°02.610'E	Radish and Parsley Plantation at Yin Taw Village
4	21°55.486'N 96°03.034'E	Peanuts Plantation at Shan Kalay Kyun

Table 4-85 Standard Guideline for Soil Quality Measurement

No	Standard Range	Guideline Description (FAO 2006*)
1	7.5	Alkaline
2	7.0	Neutral
3	6.5	Slightly Acid
4	6.0-5.5	Acidity
5	5.0-4.5	Strongly Acidic

*FAO= Food and Agriculture Organization of the United States (2006)

Figure 4-114 4 in 1 Soil Survey Instrument


Soil Sampling in Plantation of Project Area


Soil Sampling in Plantation of Project Area


Soil Sampling at Yintaw Village


Soil Sampling at Shan Kalay Village

Figure 4-115 Soil Quality Measurement

Table 4-86 On-Site Soil Quality Measurement Results

No	Sample	GPS Coordinates	Measurement Location	Result			Standard Guidelines (FAO 2006) *
				pH	Temperature	Moisture	
1	Sample-1	21°54.032'N 96°01.377'E	Corn and Peas Plantation at Project Area	6.05	29	Dry (+)	Slightly Acidic
2	Sample-2	21°54.595'N 96°01.792'E	Bottle Gourd Plantation at Project Area	5.93	32	Dry (+)	Slightly Acidic
3	Sample-3	21°54.696'"N 96°02.610'E	Radish and Parsley Plantation at Yin Taw Village	5.53	27	Dry (+)	Slightly Acidic
4	Sample-4	21°55.486'N 96°03.034'E	Peanuts Plantation at Shan Kalay Kyun	6	36	Dry (+)	Slightly Acidic

*FAO= Food and Agriculture Organization of the United States (2006)

Table 4-87 Soil Quality Measurement Results

No	Sample	Soil Parameter		Result	Standard Guidelines for Soil pH (FAO) 2006*	Remark Texture	Remark Total N	Remark CEC
1	Sample-1	Moisture (%)		2.14	-	-	-	-
		pH (Soil: Water - 1:2.5)		6.37	Slightly Acidic	-	-	-
		Texture	Sand (%)	57.98	-	Sandy Loam	-	-
			Silt (%)	28.74	-		-	-
			Clay (%)	13.28	-		-	-
		Total N (%)		0.09	-	-	Very Low	-
		CEC (meq/100 gm)	Ca^{++}	12.93	-	-	-	Medium
			Mg^{++}	10.21	-	-	-	
			K^{+}	0.16	-	-	-	

No	Sample	Soil Parameter		Result	Standard Guidelines for Soil pH (FAO) 2006*	Remark Texture	Remark Total N	Remark CEC
			Na^{+}	0.36	-	-	-	
			H^{+}	-	-	-	-	
			Al^{3+}	-	-	-	-	
2	Sample-2	Moisture (%)		1.42	-	-	-	-
		pH (Soil: Water - 1:2.5)		6.16	Slightly Acidic	-	-	-
		Texture	Sand (%)	64.98	-	Sandy Loam	-	-
			Silt (%)	23.74	-		-	-
			Clay (%)	11.28	-		-	-
		Total N (%)		0.09	-	-	Very Low	-
		CEC (meq/100 gm)	Ca^{++}	11.49	-	-	-	Low
			Mg^{++}	0.68	-	-	-	
			K^{+}	0.14	-	-	-	
			Na^{+}	0.24	-	-	-	
			H^{+}	-	-	-	-	
			Al^{3+}	-	-	-	-	
3	Sample-3	Moisture (%)		1.75	-	-	-	-
		pH (Soil: Water - 1:2.5)		6.44	Slightly Acidic	-	-	-
		Texture	Sand (%)	36.98	-	Loam	-	-
			Silt (%)	36.74	-		-	-
			Clay (%)	26.28	-		-	-
		Total N (%)		0.11	-	-	Low	-
		CEC	Ca^{++}	17.63	-	-	-	High

No	Sample	Soil Parameter		Result	Standard Guidelines for Soil pH (FAO) 2006*	Remark Texture	Remark Total N	Remark CEC
		(meq/100 gm)	Mg^{++}	8.14	-	-	-	
			K^{+}	0.16	-	-	-	
			Na^{+}	1.22	-	-	-	
			H^{+}	-	-	-	-	
			Al^{3+}	-	-	-	-	
4	Sample-4	Moisture (%)		2.87	-	-	-	-
		pH (Soil: Water - 1:2.5)		6.73	Nearly Neutral	-	-	-
		Texture	Sand (%)	50.98	-	Loam	-	-
			Silt (%)	35.30	-		-	-
			Clay (%)	13.72	-		-	-
		Total N (%)		0.11	-	-	Low	-
		CEC (meq/100 gm)	Ca^{++}	16.46	-	-	-	Medium
			Mg^{++}	4.11	-	-	-	
			K^{+}	0.14	-	-	-	
			Na^{+}	0.36	-	-	-	
			H^{+}	-	-	-	-	
			Al^{3+}	-	-	-	-	

Soil pH is important because the acidity or alkalinity of the soil determines the availability of the nutrients to plant roots. When the soil is too acidic or too alkaline, plant nutrients cannot be dissolved in the soil. The Soil pH level that allows for a wider nutrient availability to crops is in the 5.5 to 7.5 range. The soil reaction is usually acid to neutral soil reaction which occur near the river plains with occasional tidal floods are non-carbonate. They are suitable for plantation crops.

Cation exchange capacity (CEC) refers to the total capacity of soil to hold, absorb and exchange cations. The CEC of soils varies according the type of clay, soil pH and amount of organic matter. In this study, CEC varies from 12.55 meq/100g to 27.13 meq/100g. According to the result of the soil quality measurement, the pH is slightly acidic and near neutral.

4.8. BIOLOGICAL COMPONENT

4.8.1. Introduction

This sector is the study of biodiversity of the proposed project area within 5 km with the sector of identifying the flora and fauna spices, identification of IUCN Red List status, species diversity of avifauna, and seasonal occurrence of fauna species in the proposed project area, Amarapura. When studying the flora species, desktop survey, remote sensing data, and ground census data were collected and analyze to identify the vegetation cover, vegetation type and flora species of the proposed project area. Fauna species are studied on ground for three seasons, and classification, identification of the collected fauna species and diversity of the bioindicator, avifauna are analyzed and depicted. The developing urban project like the Amarapura Urban Development Project, which include implementation of the land clearance, leveling, and construction of building which could cause the impact on the exiting fauna and flora. In order to assess the significant impact, or conserve the exiting biodiversity status, biodiversity survey, analysis and assessment are conducted for the three seasons and results data are described in the following sector.

The Ayeyarwady river runs through Mandalay, which has a tropical monsoon climate and a mixed kind of dry forest and scrub forest due to its location in the center of Myanmar. Large native trees such as Tamar, Tamarind, Kokko, Tanaung, Mango and Plum are sparsely spread throughout the area. In the more isolated, elevated, higher rainfall areas, the natural vegetation become denser and tropical monsoon forests are present. In these areas, valuable timbers such as Tamar, Pyingado, In, Ingyin, Padauk, Ngu and Panga may occur (Drury, 2017). In Amarapura, Mandalay, aquatic species including fish, snails, mollusks, and planktons, as well as mammal species like squirrels, rats, and civets, are thriving. Thaungthaman Lake, the surrounding terrain, and the Ayeyarwady flood plains are also home to a plethora of avifauna in Amarapura Township. There is also herpetofauna, including amphibians and reptiles. The residential parts of Amarapura and its sandbanks along the Ayeyarwady River harbor a variety of grasses, herbs, shrubs, thorny small trees, and tree species that thrive in the area's climate. Within the Amarapura Township, diverse types of

grassland, scrub woodland, urban forest, and farming areas converge. There has been extensive soil erosion across a considerable area. Erosion is particularly common in areas with a thin, sand-covered soil layer. Plants that can withstand dryness and have good adaptability, such *Prosopis* sp., *Acacia* spp., *Leucaena leucocephala*, and *Eucalyptus* spp., are introduced in these types of environments.

4.8.2. Limitations

Flora species and mammals from the scope of work outlined in the Terms of Reference (TOR) raises important considerations and limitations for the study. As a result, alternative approaches have been implemented to capture relevant data and address the objectives within the study. These following modifications were applied to gain the valuable observations despite the restrictions.

No.	TOR (Scope of Work)	Current EIA (Scope of Work)
1	Flora	
	Samples will be taken for almost all individuals >10cm diameter at breast height (DBH). A number of quadrats/plots (15x15m) will be studied for the quantitative data. Quantitative analysis of dominance and their relative values of frequency and density will be calculated and summed to get Importance Value Index.	The study area primarily consists of herbs, grasses, and developed farmland, with few trees that have a diameter at breast height (DBH) larger than 10cm. Additionally, the tree species present are mostly small trees with DBH ranging from 3-6cm, and they are sparsely grown. Due to these factors, it may not be feasible or necessary to take samples for all individuals larger than 10cm DBH, as there may be limited representation of such individuals in the study area. So, the transects method was used for collecting data on various vegetation types, including trees, small trees, herbs, shrubs, and grass species. Transects involve establishing a straight line or path across the study area and systematically recording observations at predetermined intervals along that line.
2	Fauna	
	Large Mammals Distribution and presence of large mammals will be examined by conducting track and sign surveys. Sighting of prey species, tracks, scats, droppings will be undertaken as data gathering in the field. Direct observation will be made to record the mammal species.	In urban areas with no forest like vegetation area or protected areas, it's common for larger mammal populations to be sparse or absent. Instead, smaller mammals, such as rodent species, are often more prevalent and adaptable to live in urban environments. So, to study and document small mammal species in the study area, live trapping techniques was used to capture and observe small mammals in the study area, agricultural field.

4.8.3. Objective

The following relevant ecological and biodiversity concerns were investigated using an on-site field survey, data analysis, and desktop evaluation to provide trustworthy information and proof for the field survey findings:

- To describe the biological components according to the EIA procedure paragraph 63, Section 5.6, descriptions and maps on fauna and flora, including abundance, spatial distribution of rare, endangered, and vulnerable species, species of economic and health/nutritional value, and maps and descriptions of valued or sensitive environmental areas and habitats.
- To identify and characterize the biodiversity and ecological aspects of proposed project area.
- To identify about the flora and fauna of the proposed project and its surrounding area, Amarapura.
- To identify of all fauna and flora species with IUCN red list that could exist present on the study area.
- To identify of places with protected biodiversity within a 5-kilometer range of the proposed project (to indicate the status of the protected biodiversity sites (i.e., whether they are protected globally, nationally, or regionally)
- To identify of unprotected areas around the site that will be vulnerable/sensitive to the proposed project (for example, watercourses and wetland habitats)
- To study the vegetation types and habitats of the study area.
- To assess the biodiversity impact evaluation on the study area's flora and fauna.
- To investigate the variety, richness, occurrence, habitat types, and species composition of the study's flora and fauna.

4.8.4. Flora

4.8.4.1. Introduction

The Mandalay Region, located in central Myanmar, has a diversified ecology that includes terrain, river basins, and dry plains. This geographic variety, paired with good climatic circumstances, creates an ideal environment for a diverse range of plant species.

The Mandalay Region has a very diversified plant community, with many different plant families, genera, and species being found. The area is home to unique and indigenous species as well as species that have been introduced from neighboring countries. Mandalay region is characterized by various forest types, such as tropical evergreen forest, mixed deciduous forests, dry dipterocarp forest, and savannah woodlands. Tropical evergreen forests, also known as rainforests, are characterized by high rainfall and a dense canopy cover throughout the year. These forests are home to a diverse array of plant species, including tall

trees, epiphytes, and lianas (Tint Lwin, 2017). Mixed deciduous forests are characterized by a combination of deciduous and evergreen tree species. These forests experience seasonal changes, with leaf shedding during the dry season and leaf growth during the wet season. They are found in the lowland areas of the Mandalay Region, such as the Irrawaddy River basin (Mon, 2019). Dry dipterocarp forests are prevalent in areas with a distinct dry season. These forests are dominated by dipterocarp tree species, known for their valuable timber. They are adapted to prolonged periods of drought and have a lower tree density compared to evergreen forests. Dry dipterocarp forests are found in the central part of the Mandalay Region, including the Dry Zone(Aung, 2014). Savannah woodlands are open, grassy ecosystems with scattered trees. They are characterized by a distinct dry season and are often associated with fire regimes. Savannah woodlands occur in the drier areas of the Mandalay Region, particularly in the southern part of the Dry Zone(Htun, 2017).

For the ecological aspect, the flora species in the Mandalay Region play a vital role in maintaining ecological balance and supporting the region's biodiversity. They contribute to soil stabilization, nutrient cycling, and water regulation and provide habitats for diverse animal species. Additionally, many plant species have medicinal properties and are used in traditional healthcare systems. Despite its ecological importance, the flora in the Mandalay Region is facing several threats. Habitat destruction due to agriculture, logging, urbanization, and infrastructure development poses a significant risk. Additionally, climate change, invasive species, weak awareness of the biodiversity of the region by locals, and uncontrollable hunting practices further exacerbate the conditions of the region's biodiversity richness. The following section describes the studying method, the recorded species, and the IUCN status in order to learn more about the flora and vegetation of the intended study area.

4.8.4.2. Method and Methodology

The HA Environmental Team has conducted a comprehensive study on desktop survey and remote sensing techniques to analyze vegetation types and map land cover for the proposed study area. Through desktop surveys, the team gathered relevant data such as satellite or aerial imagery, existing maps, and reports pertaining to the study area. This data serves as the foundation for subsequent analysis and provides a basis for understanding the current state of vegetation and land cover within the forest.

To know the types of plants in the area of the proposed project and the types of plants in Amarapu city, the project area to be developed and the area in Amarapura city (Maha Gandharam Road, Sinsweput Ward and Near Kun Thee Tan Street) were selected as sample areas, and Transect Line Method was conducted. The description of the study area is shown in Table 4-88 and Figure 4-117. There is a total of four transect line study and while performing the field study, all plants seen, including trees, fruit trees, shrubs, grasses, herbs, ornamental plants, and all types of plants, were documented, recorded, and photographed. Since the transect lines are allocated in the proposed project area and nearby Amarapura Township, two types of habitats are studied differently, and the results are compared to each other.

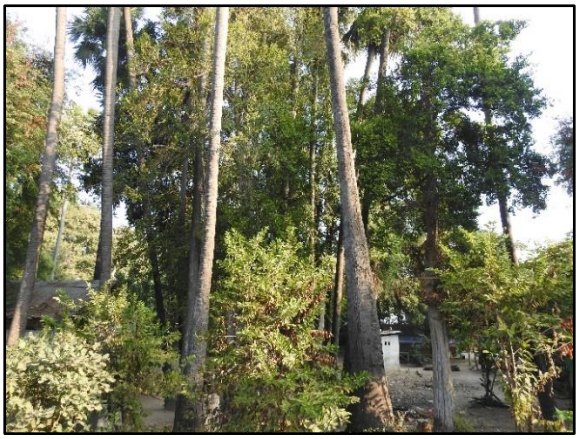
In this study, the identification of recorded plant species was conducted using three primary references: Kress et al. (2003), Gardner et al. (2000), and Lin et al. (2013). These references have been widely recognized and utilized in the field of plant taxonomy and identification, providing reliable and comprehensive information on various plant species.

Table 4-88 Study Area for Flora Species

No.	Transect Line	Description
1	Transect Line-1	Within the Proposed Project Area
2	Transect Line-2	Within the Proposed Project Area
3	Transect Line-3	Near Kun Thee Tan Street, Amarapura Tsp, Mandalay Region
4	Transect Line-4	MaharGandarYone Street, Amarapura Tsp, Mandalay Region


Study Area in Proposed Project Area


Field Study in Proposed Project Area



Study Area in Amarapura Township Area

Field Study in Amarapura Township Area

Figure 4-116 Photos of Field Activities and Study Area

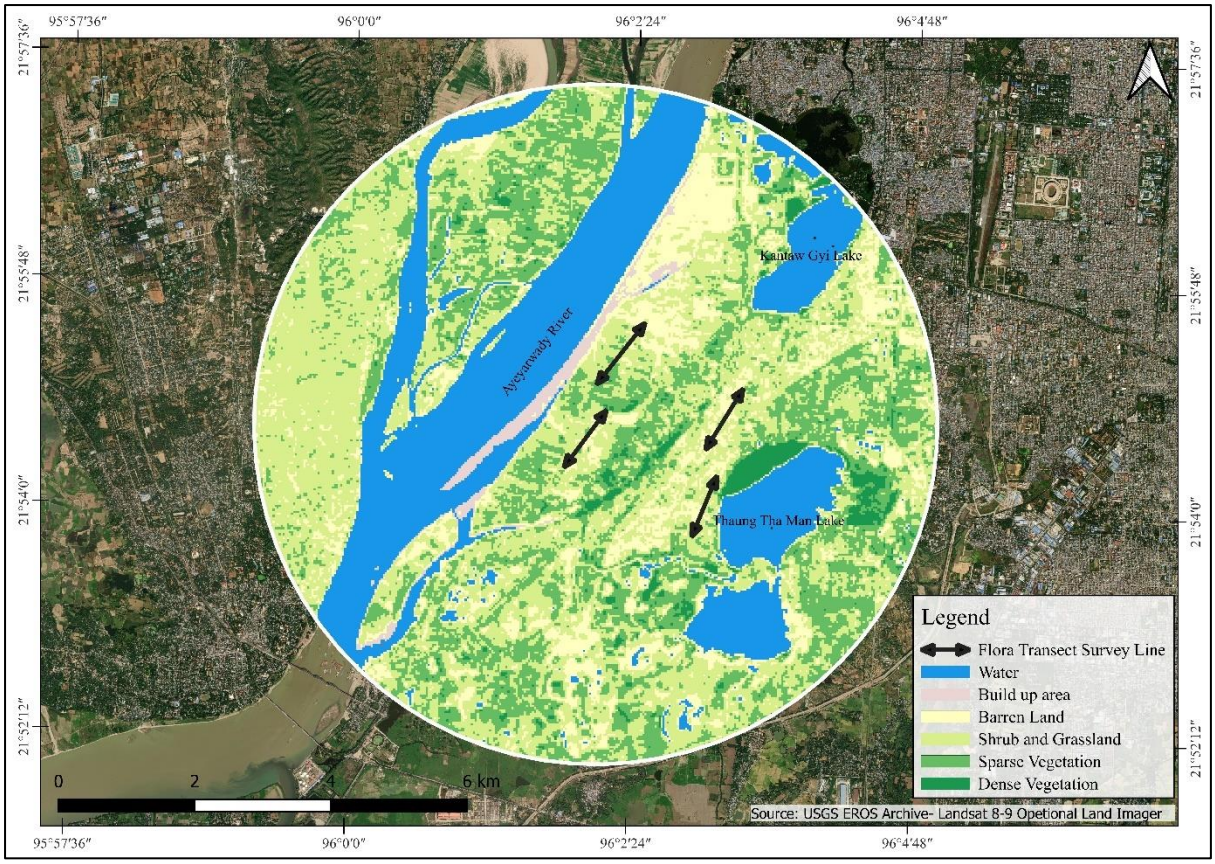


Figure 4-117 Maps of Flora Survey Lines

4.8.4.3. Results

4.8.4.3.1 Species composition

According to the results of the field study, 67 species, 61 genus, 29 genera and 19 orders of plants were observed in the project area, and 38 species, 37 genera, 21 family and 14 orders of plants were observed in Amarapura city, where the sample was determined. The findings in the field study area are described as following paragraphs. Species composition found in the proposed project area and Amarapura township area are shown in Figure 4-118 and Figure 4-119.

In the flora species composition of the present study, a range of plants are observed in the proposed project area, herb as *Grangea maderaspatana* (L.) Poir, *Hypochaeris radicata* L., *Synedrella nodiflora* (L.) Gaertn., *Tridax procumbens* L., *Xanthium strumarium* L., *Heliotropium indicum* L., *Brassica* sp., *Rorippa palustris* Besser., *Alternanthera sessilis* L., *Amaranthus spinosus* L., *Celosia argentea* L., *Chenopodium album* L., *Persicaria hydropiper* (L.) Delarbre., *Portulaca oleracea* L., *Leucas lavandulifolia* Sm., *Lindernia rotundifolia* (L.) Alston, *Abutilon indicum* (Linn.) Sweet, *Sida acuta* Burm.f., *Urena lobata* L., *Rotala rotundifolia* (Buch. -Ham. ex Roxb.) Koehne., *Cyperus* sp., *Sorghum bicolor* Kuntze, *Zea mays* L., *Ranunculus sceleratus* L., *Ipomoea triloba* L., *Cuscuta reflexa* Roxb., *Solanum melongena* L., and *Solanum nigrum* L. are recorded. Tree species as *Borassus flabellifer* L., *Crateva magna* (Lour.) DC., *Barringtonia acutangula* (L.) Gaertn,

Madhuca longifolia (L.) J.F.Macbr., *Albizia lebbekoides* (DC.) Benth., *Delonix regia* (Bojer ex Hook.) Raf., *Pithecellobium dulce* (Roxb.) Benth., *Samanea saman* (Jacq.) Merr., *Plumeria obtusa* L., *Tabebuia aurea* (Silva Manso), *Monoon longifolium* (Sonn.) B.Xue & R.M.K.Saunders Thomson, *Bombax ceiba* L., *Artocarpus heterophyllus* Lam., and *Azadirachta indica* A.Juss. are found. Shrubs as *Ageratum conyzoides* L., *Cassia occidentalis* L., *Crotalaria striata* DC., *Tephrosia purpurea* Pers., *Calotropis gigantea* (L.) W.T.Aiton., *Lantana indica* Roxb., *Acalypha indica* L., *Abelmoschus esculentus* (L.) Moench., *Hibiscus sabdariffa* L., *Melhania hamiltoniana* Wall., *Caspicum annuum* L. are listed. Climber and creeper species as *Benincasa hispida* (Thunb.) Cogn., *Cardiospermum halicacabum* L., *Ipomoea aquatica* Forssk., *Ipomoea batatas* (L.) Lam., *Ipomoea obscura* (L.) Ker Gawl., *Lagenaria siceraria* (Molina) Standl are recorded and grass species as *Chloris barbata* Sw., *Chloris* sp., *Cyperus* sp., *Neyraudia reynaudiana* (Kunth) Keng ex Hitchc., and *Saccharum spontaneum* L.

In the urban area, Amarapura Township, tree species as *Aegle marmelos* (L.) Correa., *Azadirachta indica* A.Juss., *Bauhinia purpurea* L., *Bombax ceiba* L., *Borassus flabellifer* L., *Cassia fistula* L., *Cocos nucifera*., *Delonix regia* (Bojer ex Hook.) Raf., *Ficus religiosa* L., *Gliricidia sepium* (Jacp.) Steud., *Holoptelea integrifolia* Planch., *Madhuca longifolia* (L.) J.F.Macbr., *Mangifera indica*, *Millingtonia hortensis* L.f., Mimusops elengi Roxb., *Monoon longifolium* (Sonn.) B.Xue & R.M.K.Saunders Thomson., *Pithecellobium dulce* (Roxb.) Benth., *Psidium acidum* Mart. ex O.Berg., *Pterocarpus indicus Willd.*, *Samanea saman* (Jacq.) Merr., *Senna siamea* (Lam.) Irwin & Barneby., *Sizygium* sp., *Streblus asper* Lour., *Tamarindus indica* L., *Tectona grandis* L.f., *Terminalia catappa* L., *Terminalia mantaly* H.Perrier., and *Vachellia leucophloea* (Roxb.) Maslin Seigler & Ebinger are recorded. Small trees as *Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult., *Gardenia jasminoides* J. Ellis., *Plumeria rubra* L., *Muntingia calabura* L., *Clausena excavata* Burm.f., and *Citrus* sp. are found. Climber as *Bougainvillea glabra* Choisy., shrub as *Codiaeum variegatum* (L.) A.Juss., bamboo as *Bambusa bambos* (L.) Voss., and herb as *Musa* sp. are found in the present study.

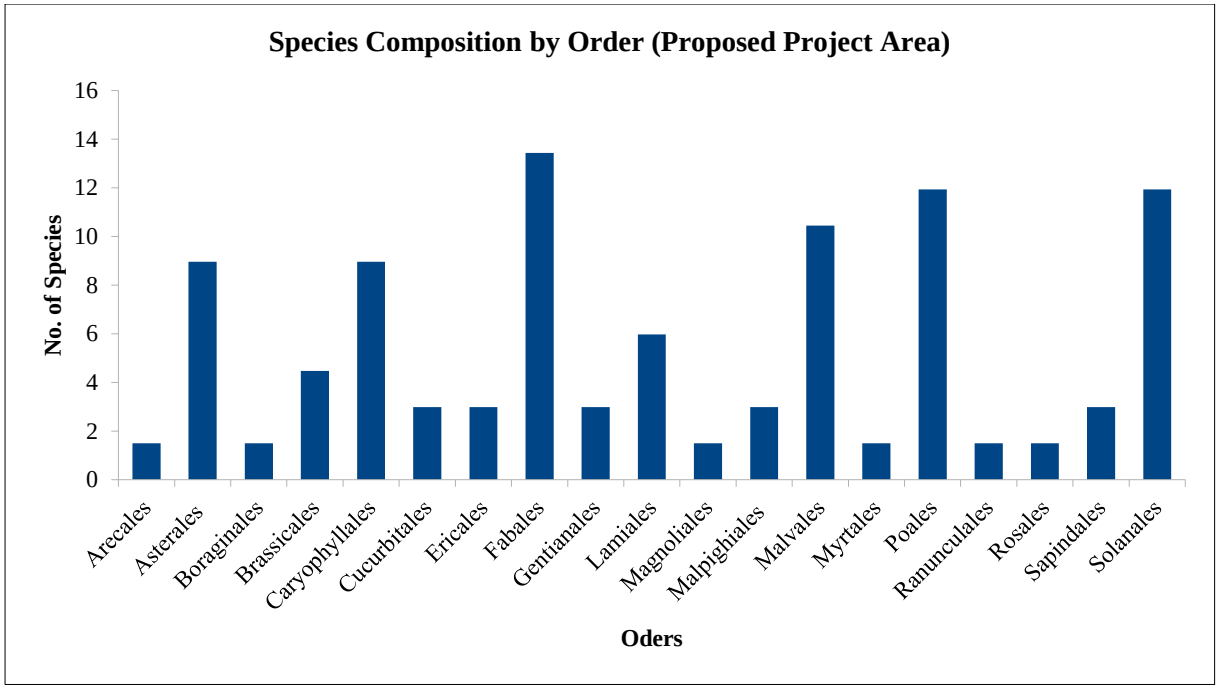


Figure 4-118 Species composition found in the proposed project

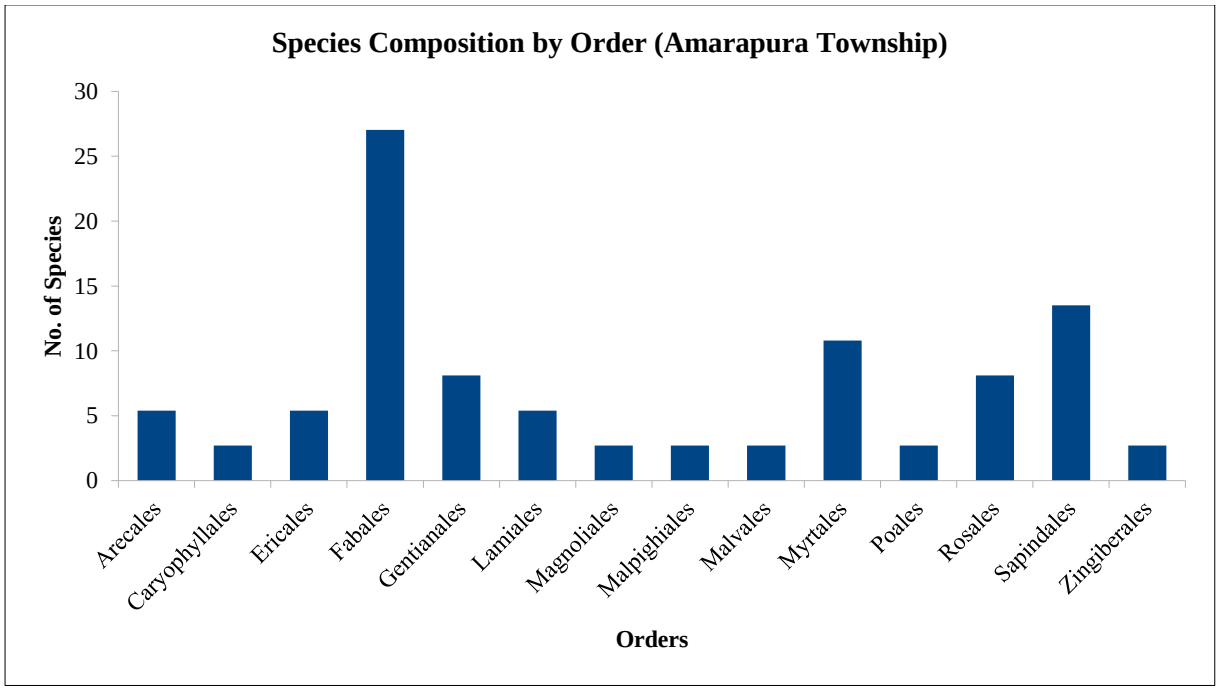


Figure 4-119 Species composition found in the Amarapura Township Area

Among the listed flora species of the proposed project area, Fabales holds the highest representation with 13.4%. This order includes important plants such as legumes (beans, peas, and lentils) and trees like acacias. Following closely are Poales and Solanales, both accounting for 11.9% of the flora species. Poales includes grasses, and sedges, forming dominant vegetation in many habitats and serving as crucial food sources. Solanales encompasses plants like peppers, and tomatoes, which are economically significant crops. Malvales represents 10.4% of the flora species. This order includes plants such as rosella, and

okra. Asterales and Caryophyllales share the same percentage of 9.0% representation. Lamiales follows with 6.0% representation. Brassicales represents 4.5% of the flora species. Cucurbitales, Ericales, Gentianales, Malpighiales, and Sapindales all have a representation of 3.0% among the flora species. Lastly, Arecales, Boraginales, Magnoliales, Myrtales, Ranunculales, and Rosales all have a representation of 1.5% among the flora species.

In the Amarapura Urban Area, the following flora order are found. The flora species found in the Amarapura Urban Area, Fabales takes the lead with a diversification value of 27%, showcasing its significance and abundance in the area. Sapindales and Myrtales follow closely behind with percent values of 13.5% and 10.8% respectively, indicating their substantial presence. Gentianales and Rosales, both with values of 8.1%, contribute to the floral diversity of the region. Additionally, Arecales, Ericales, Lamiales, and Malvales, each with values of 5.4 %, while Caryophyllales, Magnoliales, Malpighiales, Poales, and Zingiberales.

4.8.4.3.2 Vegetation Type and Vegetation Cover of the Proposed Project Area

The proposed project area is situated on the eastern bank of the Ayeyarwady River. Fine silt soil and sand are regularly replaced on the river bank and its riparian zones by rich alluvium transported downstream by the Ayeyarwady river. The sandbanks of the Ayeyarwady river are covered in Kaing, also known as Kans grass. Numerous herbaceous plants and other grass species start to emerge as soon as these grasses have more or less stabilized the sand. According to Stamp (1924), the project area's vegetation type was Kaing grassland on sandbanks. However, the majority of the land of the proposed area are developed as vegetable farming areas (crops), which is around 52.1% due to the fertile alluvium, which makes the soil rich in sand and silt.

In the Kaing Grassland, grass species such as *Saccharum spontaneum* (Kaing) and *Neyraudia reynaudiana* (Kyu) are dominant, with a mix of small clusters of plants such as *Tephrosia purpurea* (Me-yaing), *Cassia occidentalis* (kazaw-bok/dangwe), *Ricinus communis* (Kyetsu), and *Calotropis gigantea* (Mayo) dispersed on a landscape that shows there are few small tree species, such as *Mimosa pigra*, filled in clearings within the grassland.

In the agricultural area, vegetables such as *Zea mays* (Pyaung-bu), *Abelmoschus esculentus* (Yonebade), *Lagenaria seceraria* (Bu), *Hibiscus sabdariffa* (Chinbaung-ni), *Ipomoea aquatica* (Kazun-ywet), *Benincasa hispida* (Kyauk Phawone), *Solanum* spp., and *Sorghum* spp. are found. However, depending on the town's market need and the weather, several vegetable varieties may be cultivated. On the sides of the Mandalay Circular Road and in the vicinity of the project area, shade-giving trees such as *Bombax ceiba* L. (Letpan), *Samanea saman* (Thinbaw-kokko), *Monoon longifolium* (Thinbaw-te), and *Albizia lebbekoides* (Anya-koko) have been planted.

In the proposed project area, the dominant plant vegetation is herbs, constituting a substantial portion of the flora with 27 species, representing 40.3% of the total. Herbs are non-woody plants that generally have a short lifespan and are characterized by their soft,

flexible stems. Their abundance and diversity contribute significantly to the overall floral composition. Among these, climbers and creepers collectively represent a small but significant portion, accounting for 4.5% each. The region is also home to various grass species, comprising 9.0% of the total flora. Shrubs, comprising 16.4% of the total flora with 11 species, which are characterized by multiple stems and are generally shorter in height compared to trees. Shrubs provide important habitats and food sources for various animal species, and their presence contributes to the overall biodiversity of the region. Lastly, trees represent a substantial portion of the flora in the study area, with 14 species accounting for 20.9% of the total. Small trees, with 3 species accounting for 4.5% of the total flora, are an integral part of the study area's plant diversity. These trees, though smaller in size, play significant ecological roles, providing shade, shelter, and food resources for small animals such as birds. They also contribute to the overall aesthetic value of the region's landscapes. Graph demonstration of the vegetation types found in the proposed project area is shown in the Figure 4-120. For the land cover in the proposed project area, about 52.9% of the project area is normally covered with crops, which implies that crops and vegetables have been planted. Rangeland (14.2%), bare ground (12.3%), construction areas (10.2%), water areas (9.6%), and tree areas (0.8%) are the next largest land uses. Scrub and grass species are present in the rangeland region. In the bare ground area, the project proponent has been working on construction activities. The built-up area includes the road as well as residential areas such as houses, stores, and buildings. The Ayeyarwady River and the water on the inundated plains are included in the water area. Only ornamental and shady trees have been planted in the tree area. The land cover area of the proposed project area is shown in Figure 4-122.

In the Amarapura urban area, bamboo, climber, herb, and shrub are all represented with one individual each, making up 2.63% of the plant population each. Small trees, which make up a significant portion of the plant population with six individuals, accounting for 15.79% of the total. These small trees bring a sense of charm and elegance to their surroundings, contributing to the overall aesthetics of landscapes. However, it is the grand presence of trees that truly dominates the plant population, comprising an impressive 73.68% with a total of 28 representatives. Graph demonstration of the vegetation types found in the Amarapura urban area is shown in the Figure 4-121.

In conclusion, the present study reveals a significant finding regarding the distribution of the order Fabales, as it is **commonly observed** in two distinct habitats: the Amarapura Township Urban Area and the proposed project area. The occurrence of Fabales in both these environments is because of its adaptability and ability to thrive in diverse ecological settings. The presence of Fabales in the Amarapura Township Urban Area highlights its ability to thrive amidst the urban environment. Despite the concrete infrastructure and human activities dominating the area, Fabales species can manage to adapt and grow themselves, adding to landscape to the urban setting. Their presence contributed by the human activities to the aesthetic appeal of the residential area that can also bring ecological benefits by providing green spaces and supporting urban landscape.

Similarly, the occurrence of Fabales in the proposed project area indicates its adaptability to potentially modified habitats. The present study shown that the occurrence of the order Fabales in two distinct habitats: the Amarapura Township Urban Area and the proposed project area. This finding underscores the adaptability and resilience of Fabales species, as they thrive in both urban and potentially modified environments.

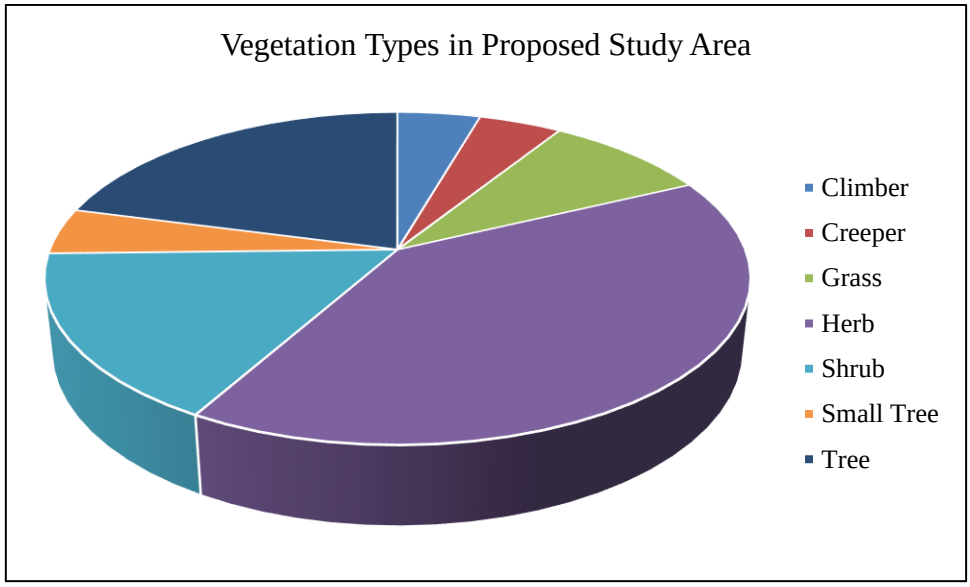


Figure 4-120 Recorded Vegetation Types found in Proposed Study Area

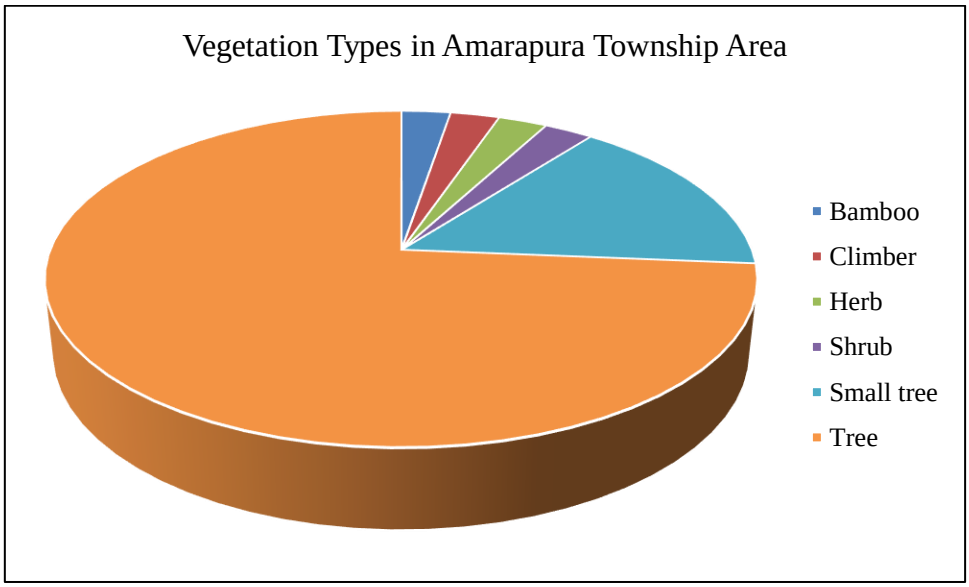


Figure 4-121 Recorded Vegetation Types found in Amarapura Township Area

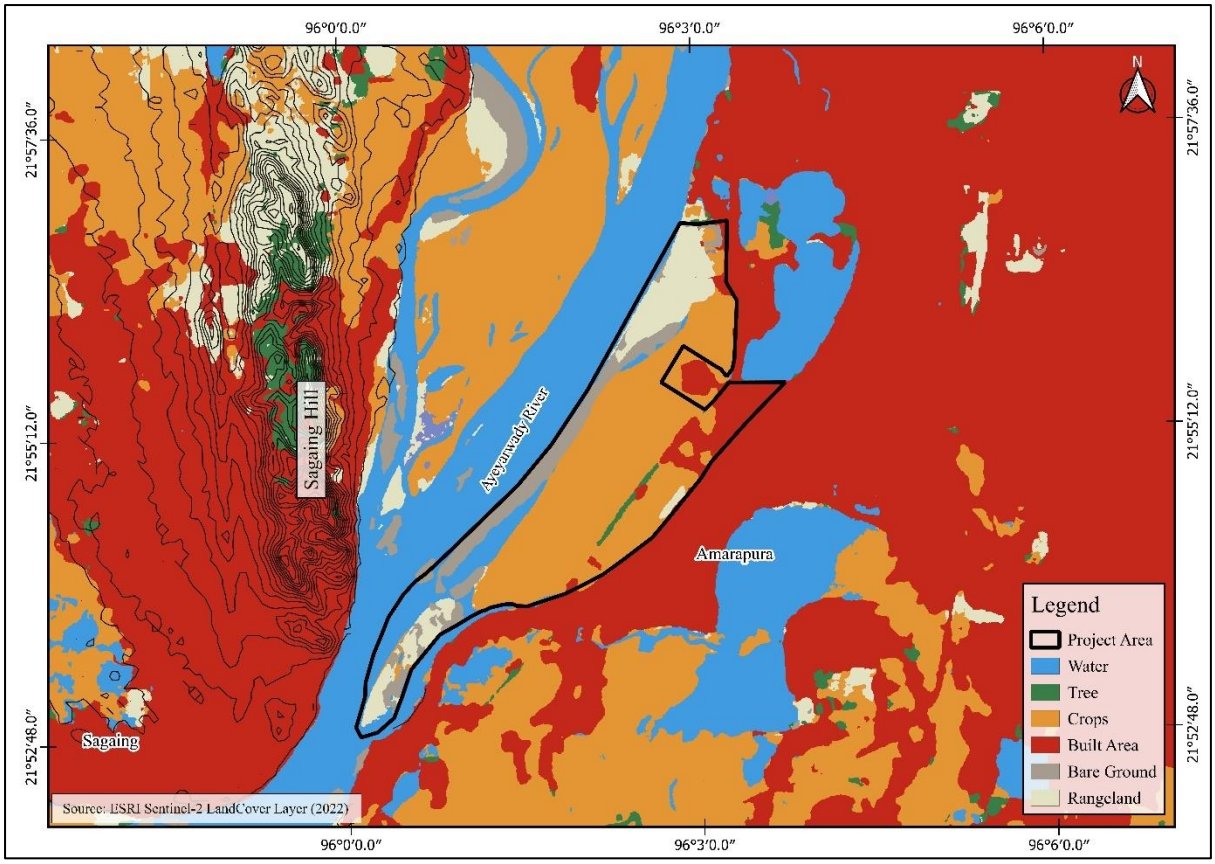


Figure 4-122 Land cover class of the study area

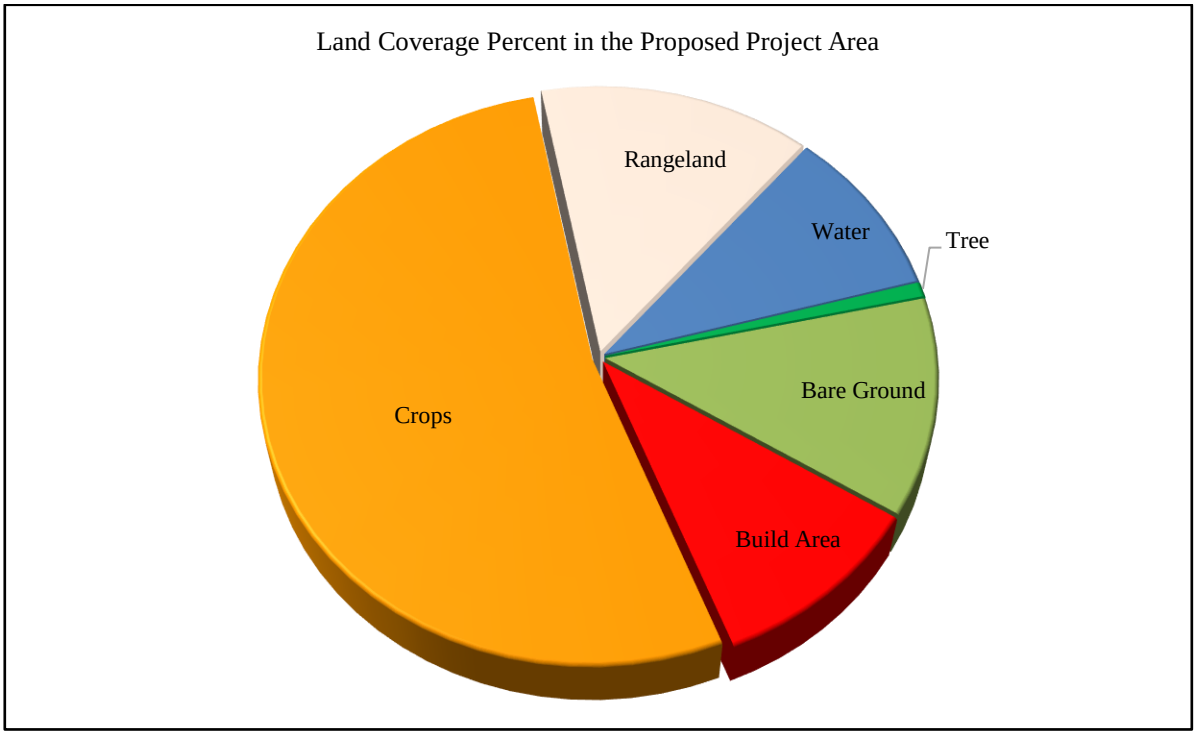
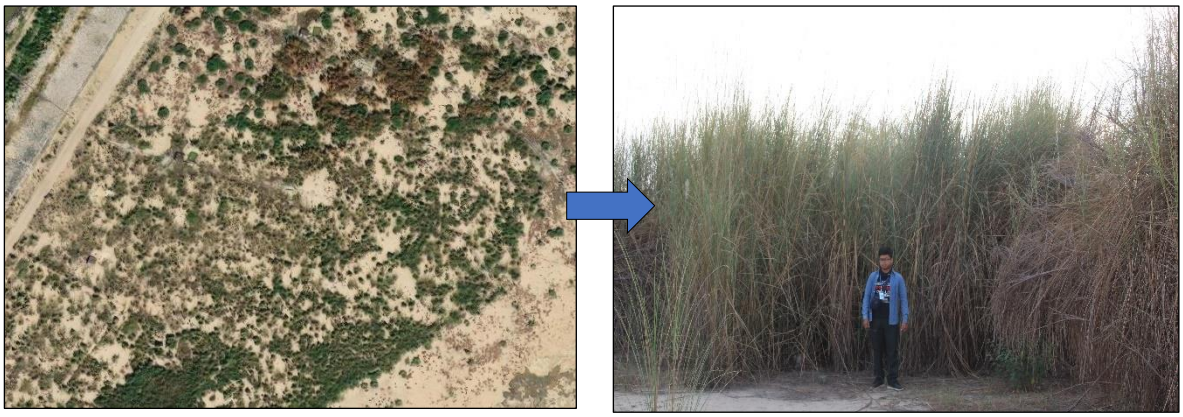


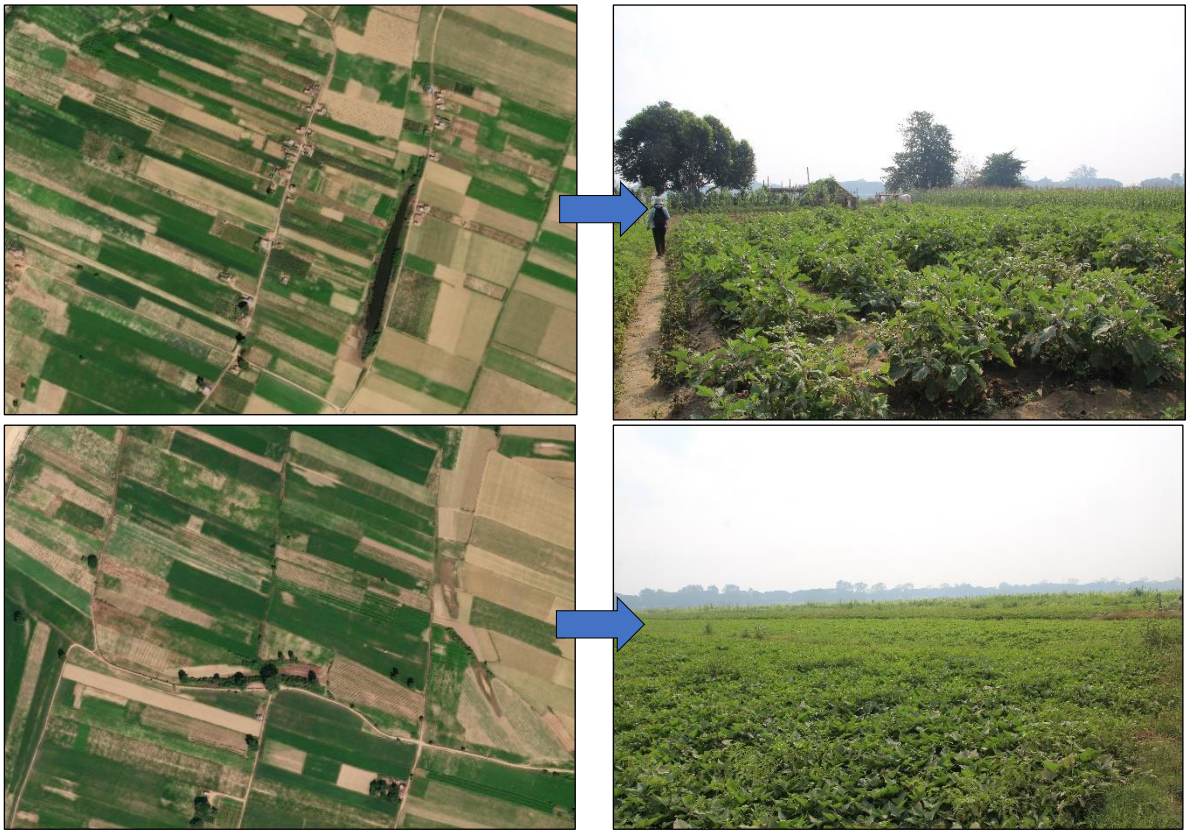
Figure 4-123 Land Coverage Percent of the Proposed Project Area (Source: Land Cover Class, ESRI, Landuse Data)

Clusters of Sparse Vegetation, *Mimosa pigra*



Mix of *Neyraudia reynaudiana* with *Mimosa pigra*

Vegetation of the Proposed Project Area



Vegetation of Agricultural Land within Proposed Project Area

Groundnut and Eggplant Field

Roselle Field

Pea and Wax Gourd Field

Sweet Potato Field

Groundnut and Corn Field

Wax Gourd Field

Vegatable Farming Areas (Crops)

Figure 4-124 Vegetation and Landuse found in the Proposed Project Area

4.8.4.3.3 Variation in Vegetation

Variation in environmental conditions like precipitation, temperature, and seasonal changes would lead to changes in vegetation. Topography also contributes to vegetation variation. Factors such as altitude, slope, and aspect influence the availability of sunlight, water drainage, and soil characteristics. These factors create distinct microhabitats within a larger landscape, fostering the growth of different plant communities. Alpine regions, for example, exhibit a unique assemblage of plants adapted to harsh conditions, including low temperatures, strong winds, and rocky terrain(Korner, 2003).

Variation in vegetation is also significantly influenced by human activities including deforestation, urbanization, and agriculture. When forests and other natural vegetation are removed to make enough space for agricultural land or urban development, various plant communities are lost, and ecological processes are thrown off. Land-use changes frequently result in the domination of a small number of species, such as exotic and invasive species, which reduces the variety of the ecosystem. and modifies its dynamics. Moreover, the varieties of plants that can flourish in a particular region are also significantly influenced by the soil conditions. Vegetation patterns are influenced by soil fertility, pH values, and nutrient availability. While certain plants are suited to nutrient-poor soils, such as those found in shrubland, others need particular soil types and do best in wet or acidic conditions.

To discuss about the vegetation of the proposed project area, the study results show that the proposed project area does not existing forests or forest like vegetations, but rather consists of cultivated lands, sand banks, grasses, herbs, and shrublands. Therefore, any vegetation changes in the area would primarily be influenced by variations in herbs and grasses in the crop field and riversides. The vegetation dynamics in the study area will likely be driven by factors such as climate (wet and dry seasons), soil conditions, human activities (such as cultivation practices), and natural processes like succession. The seasonal vegetation changes of the proposed area are shown in Figure 4-125. The specific species composition and distribution of herbs, grasses and other species will depend on these factors, as well as the specific region or activities in which the project area is located.

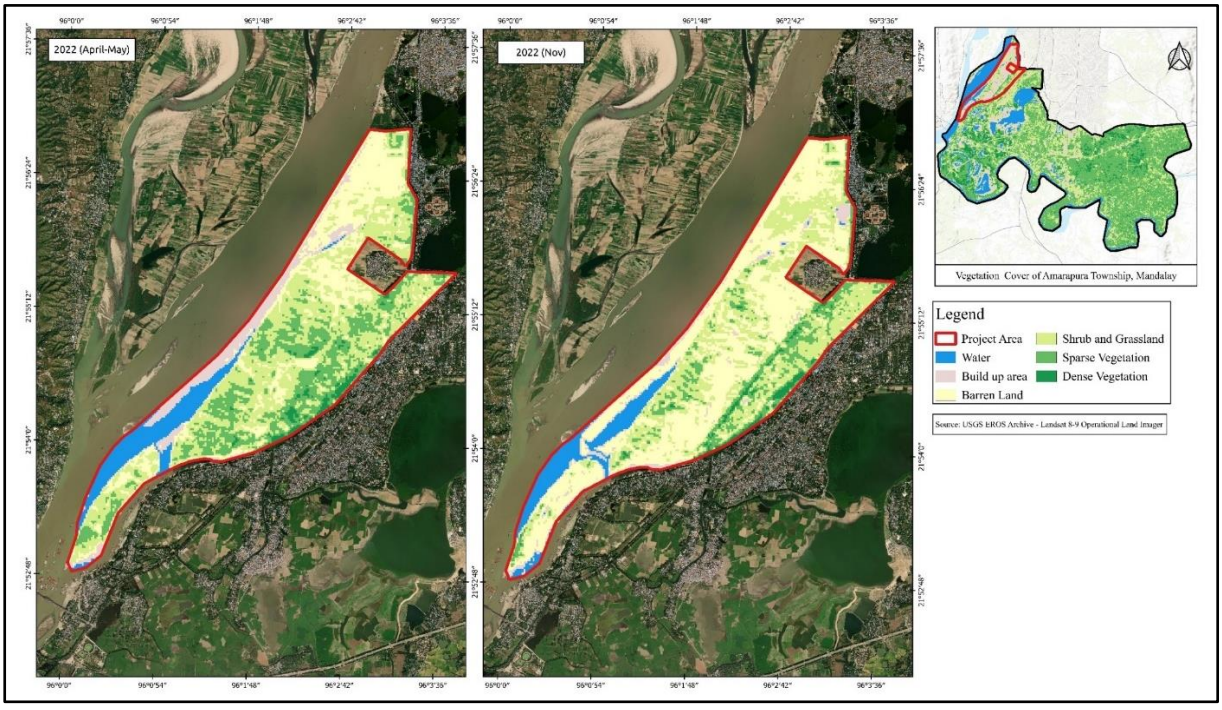


Figure 4-125 Variation in Vegetation due to Temperature and Precipitation

4.8.4.3.4 Recorded Species

The observed species are described in Table 4-89 and shown in the Figure 4-126.

Abutilon indicum Flower

Abutilon indicum Fruit

Acalypha indica

Ageratum conyzoides L.

Calotropis gigantea (L.) W.T.Aiton

Azadirachta indica A.Juss.

Tridax procumbens L.

Barringtonia acutangula (L.) Gaertn

Tabebuia aurea Silva Manso

Cuscuta reflexa Roxb.

Pithecellobium dulce (Roxb.) Benth.,

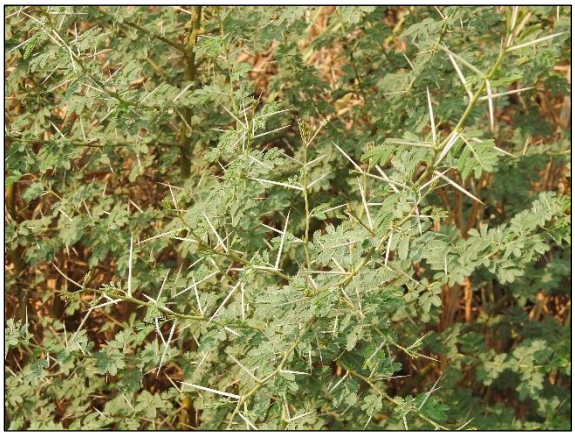
Ipomoea obscura (L.) Ker Gawl.

Lindernia rotundifolia (L.) Alston

Ipomoea aquatica Forssk.

Urena lobata L.

Vachellia nilotica (L.)



Vachellia nilotica (L.)

Sesbania sesban Britton Merr.

Mimosa pigra L. (Tree)

Mimosa pigra L. (Flower and Fruit)

Cardiospermum halicacabum L.

Saccharum spontaneum L.

Xanthium strumarium L.

Tephrosia purpurea Pers

Muntingia calabura L.

Melhania hamiltoniana Wall.

Grangea maderaspatana (L.) Poir.

Ricinus communis L.

Chenopodium album L.

Heliotropium indicum L..

Ranunculus sceleratus L. (Fruit)

Ranunculus sceleratus L. (Flower)

Cassia occidentalis L.

Amaranthus spinosus L.

Lantana indica Roxb.

Rorippa palustris Besser.

Ageratum conyzoides L.

Crotalaria striata DC.

Lagenaria siceraria (Molina) Standl.

Persicaria hydropiper (L.) Delarbre

Alternanthera sessilis L.

Leucas lavandulifolia Sm.

Portulaca oleracea L.

Crepis subscaposa Collett & Hemsley

Crateva magna (Lour.) DC. (Flowers)

Crateva magna (Lour.) DC. (Tree)

Celosia argentea L.

Vachellia leucophloea (Roxb.) Maslin Seigler & Ebinger

Tamarindus indica L.

Tabernaemontana divaricata (L.) R.Br. ex Roem. & Schult.

Borassus flabellifer L.

Muntingia calabura L.

Figure 4-126 Photos of recorded plant species

Table 4-89 List of recorded Species

No.	Vernacular Name	Order	Family	Genus	Species	Habit	IUCN Red List Status
1.	Yonebade	Malvales	Malvaceae	Abelmoschus	Abelmoschus esculentus (L.) Moench	Shrub	NA
2.	Bauk-gale/Bauk-khway/Bauk-khway-gale	Malvales	Malvaceae	Abutilon	Abutilon indicum (Linn.) Sweet	Herb	NA
3.	Kyaung-se-pin/kyaung-yo-the	Malpighiales	Euphorbiaceae	Acalypha	Acalypha indica L.	Shrub	NA
4.	Okshit	Sapindales	Rutaceae	Aegle	Aegle marmelos (L.) Correa	Tree	NT
5.	Kadu-hpo	Asterales	Asteraceae	Agratum	Ageratum conyzoides L.	Shrub	LC
6.	Anya-koko	Fabales	Fabaceae	Albizia	Albizia lebbekoides (DC.) Benth.	Tree	LC
7.	Pazun-sar	Caryophyllales	Amaranthaceae	Alternanthera	Alternanthera sessilis (Linnaeus)	Herb	NA
8.	Hin-nu-new-subauk	Caryophyllales	Amaranthaceae	Amaranthus	Amaranthus spinosus L.	Herb	NA
9.	Myay-Pe	Fabales	Fabaceae	Arachis	Arachis hypogaea L.	Herb	NA
10	Peinne	Rosales	Moraceae	Artocarpus	Artocarpus heterophyllus Lam.	Tree	NA
11	Tama	Sapindales	Meliaceae	Azardirachta	Azadirachta indica A.Juss.	Tree	LC
12	Kyakat-wa	Poales	Poaceae	Bambusa	Bambusa bambos (L.) Voss	Bamboo	NA
13	Kyi/Kyi-ni/Ye-kyi	Ericales	Lechthidaceae	Barringtonia	Barringtonia acutangula (L.) Gaertn	Tree	LC
14	Swedaw-ni	Fabales	Fabaceae	Bauhinia	Bauhinia purpurea L.	Tree	LC
15	Kyauk phawone	Cucurbitales	Cucurbitaceae	Benincasa	Benincasa hispida (Thunb.) Cogn.	Climber	NA
16	Letpan	Malvales	Malvaceae	Bombax	Bombax ceiba L.	Tree	LC
17	Htan	Arecales	Arecaceae	Borassus	Borassus flabellifer L.	Tree	NA
18	Sekku-pan	Caryophyllales	Nyctaginaceae	Bougainvillea	Bougainvillea glabra Choisy	Climber	LC
19	Wild Mustard	Brassicales	Brassicaceae	Brassica	Brassica spp.	Herb	NA

20	Mayo	Gentianales	Apocynaceae	Calotropis	Calotropis gigantea (L.) W.T.Aiton	Shrub	NA
21	ngayoke	Solanales	Solanaceae	Capsicum	Caspicum annuum L.	Shrub	LC
22	Kala-myetsi-galay	Sapindales	Sapindaceae	Cardiospermum	Cardiospermum halicacabum L.	Climber	LC
23	Kazaw-bok/dangwe	Fabales	Fabaceae	Cassia	Cassia occidentalis L.	Shrub	LC
24	Ngu	Fabales	Fabaceae	Cassia	Cassia fistula L.	Tree	LC
25	Kyet-mauk (8916)	Caryophyllales	Amaranthaceae	Celosia	Celosia argentea L.	Herb	LC
26	My	Caryophyllales	Amaranthaceae	Chenopodium	Chenopodium album L.	Herb	LC
27	Lay-gwa-myet/Sin-ngo-myet	Poales	Poaceae	Chloris	Chloris barbata Sw.	Grass	NA
28	-	Poales	Poaceae	Chloris	Chloris spp.	Grass	NA
29	Thanbaya	Sapindales	Rutaceae	Citrus	Citrus sp.	Small Tree	NA
30	Pyin-daw-thein	Sapindales	Rutaceae	Clausena	Clausena excavata Burm.f	Small Tree	NA
31	Ohn	Arecales	Arecaceae	Cocos	Cocos nucifera	Tree	NA
32	Ywethla	Malpighiales	Euphorbiaceae	Codiaeum	Codiaeum variegatum (L.) A.Juss.	Shrub	LC
33	Kadet/Kadet-kha/Kon-Kadet	Brassicales	Capparaceae	Crateva	Crateva magna (Lour.) DC.	Tree	NA
34	Taw-pike-san	Fabales	Fabaceae	Crotalaria	Crotalaria striata DC. Syn. Crotalaria pallida	Shrub	NA
35	Shwe-new	Solanales	Convolvulaceae	Cuscuta	Cuscuta reflexa Roxb.	Herb	NA
36	Myet	Poales	Cyperaceae	Cyperus	Cyperus sp.	Grass	NA
37	Myet-mon-nyin	Poales	Cyperaceae	Cyperus	Cyperus sp.	Grass	NA
38	Seinban	Fabales	Fabaceae	Delonix	Delonix regia (Bojer ex Hook.) Raf.	Tree	LC
39	Bawdi-nyaung	Rosales	Moraceae	Ficus	Ficus religiosa L.	Tree	LC
40	Zizawa	Gentianales	Rubiaceae	Gardenia	Gardenia jasminoides J. Ellis	Small	NA

						Tree	
41	Thinbaw-ngusat	Fabales	Fabaceae	Gliricidia	Gliricidia sepium (Jacp.) Steud.	Tree	LC
42	Taw-ma-hnyo-lon, Ye-tazwet -	Asterales	Asteraceae	Grangea	Grangea maderaspatana (L.) Poir.	Herb	LC
43	Sin-hna-maung/Sin-let-maung	Boraginales	Boraginaceae	Heliotropium	Heliotropium indicum L.	Herb	NA
44	Chinbaung-ni	Malvales	Malvaceae	Hibiscus	Hibiscus sabdariffa L.	Shrub	NA
45	Pyauk-seik	Rosales	Ulmaceae	Holoptelea	Holoptelea integrifolia Planch.	Tree	NA
46	-	Asterales	Asteraceae	Hopochaeris	Crepis subscaposa Collett & Hemsley	Herb	NA
47	Me-	Fabales	Fabaceae	Indigofera	Tephrosia purpurea Pers	Shrub	NA
48	-	Solanales	Convolvulaceae	Ipomoea	Ipomoea triloba L.	Herb	LC
49	Kazun-ywet	Solanales	Convolvulaceae	Ipomoea	Ipomoea aquatica Forssk.	Creeper	LC
50	Kazun	Solanales	Convolvulaceae	Ipomoea	Ipomoea batatas (L.) Lam.	Creeper	DD
51	-	Solanales	Convolvulaceae	Ipomoea	Ipomoea obscura (L.) Ker Gawl.	Creeper	NA
52	Bu	Cucurbitales	Cucurbitaceae	Lagenaria	Lagenaria siceraria (Molina) Standl.	Climber	NA
53	Se-hnit-yathi Nadaung-pan	Lamiales	Verbenaceae	Lantana	Lantana indica Roxb.	Shrub	NA
54	Taw-Hnan	Lamiales	Lamiaceae	Leucas	Leucas lavandulifolia Sm.	Herb	NA
55	-	Lamiales	Linderniaceae	Lindernia	Lindernia rotundifolia (L.) Alston	Herb	LC
56	Myitzu-thaka-natpan/Meze	Ericales	Sapotaceae	Madhuca	Madhuca longifolia (L.) J.F.Macbr.	Tree	NA
57	Thayet	Sapindales	Anacardiaceae	Mangifera	Mangifera indica	Tree	DD
58	-	Malvales	Malvaceae	Melhania	Melhania hamiltoniana Wall.	Shrub	NA
59	Egayit	Lamiales	Bignoniaceae	Millingtonia	Millingtonia hortensis L.f.	Tree	NA
60	-	Fabales	Fabaceae	Mimosa	Mimosa pigra L.	Small Tree	LC
61	Khayay	Ericales	Sapotaceae	Mimusops	Mimusops elengi Roxb. L.	Tree	LC

62	Thinbaw-te	Magnoliales	Annonaceae	Monoon	Monoon longifolium (Sonn.) B.Xue & R.M.K.Saunders Thomson	Tree	NA
63	Hnget-thagya	Malvales	Muntingiaceae	Muntingia	Muntingia calabura L.	Small Tree	NA
64	Nga-pyaw	Zingiberales	Musaceae	Musa	Musa sp.	Herb	NA
65	Kyu	Poales	Poaceae	Neyraudia	Neyraudia reynaudiana (Kunth) Keng ex Hitchc.	Grass	NA
66	-	Caryophyllales	Polygonaceae	Persicaria	Persicaria hydropiper (L.) Delarbre	Herb	LC
67	Tayok-magyi	Fabales	Fabaceae	Pithecellobium	Pithecellobium dulce (Roxb.) Benth.,	Tree	LC
68	Akyaw/Tayok-saga-aphyu	Gentianales	Apocynaceae	Plumeria	Plumeria obtusa Linnaeus	Tree	LC
69	Tayok-saga	Gentianales	Apocynaceae	Plumeria	Plumeria rubra L.	Small Tree	LC
70	Mya-byit/Myet-htauk	Caryophyllales	Portulacaceae	Portulaca	Portulaca oleracea L.	Herb	LC
71	Malaka	Myrtales	Myrtaceae	Psidium	Psidium acidum Mart. ex O.Berg	Tree	-
72	Padauk	Fabales	Fabaceae	Pterocarpus	Pterocarpus indicus Willd.	Tree	EN
73	Tanga-ngayoke	Ranunculales	Ranunculaceae	Ranunculus	Ranunculus sceleratus L.	Herb	LC
74	Kyetsu	Malpighiales	Euphorbiaceae	Ricinus	Ricinus communis L.	Small Tree	NA
75	Pauk-thin-bin/Taw-mon-hnyin	Brassicales	Brassicaceae	Rorippa	Rorippa palustris(L.) Besser	Herb	LC
76	-	Myrtales	Lythraceae	Rotala	Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne	Herb	-
77	Kaing	Poales	Poaceae	Saccharum	Saccharum spontaneum L.	Grass	LC
78	Thinbaw-kokko	Fabales	Fabaceae	Samanea	Samanea saman (Jacq.) Merr.	Tree	LC
79	Mezali	Fabales	Fabaceae	Senna	Senna siamea (Lam.) Irwin & Barneby	Tree	LC

80	Ye-thagyi	Fabales	Fabaceae	Sesbania	Sesbania sesban Britton (L.) Merr.	Small Tree	LC
81	-	Malvales	Malvaceae	Sida	Sida acuta Burm.f.	Herb	-
82	Thabye	Myrtales	Myrtaceae	Sizygium	Sizygium sp.	Tree	-
83	Khayan	Solanales	Solanaceae	Solanum	Solanum melongena L.	Herb	-
84	Baung-laung-nyo	Solanales	Solanaceae	Solanum	Solanum nigrum L.	Herb	-
85	Pyaung	Poales	Poaceae	Sorghum	Sorghum bicolor Kuntze	Herb	LC
86	Okhne	Rosales	Moraceae	Streblus	Streblus asper Lour.	Tree	LC
87	Bizat-pho	Asterales	Asteraceae	Synedrella	Synedrella nodiflora (L.) Gaertn.	Herb	LC
88	Ta-bay-bu-ah	Lamiales	Bignoniaceae	Tabebuia	Tabebuia aurea (Silva Manso)	Tree	-
89	Zalat-setkya	Gentianales	Apocynaceae	Tabernaemontana	Tabernaemontana divaricata (L.) R.Br. ex Roem. & Schult.	Small Tree	LC
90	Magyi	Fabales	Fabaceae	Tamarindus	Tamarindus indica L.	Tree	LC
91	Kyun	Lamiales	Laminaceae	Tectona	Tectona grandis L.f.	Tree	EN
92	Banda	Myrtales	Combretaceae	Terminalia	Terminalia catappa L.	Tree	LC
93	Taiwan-Banda	Myrtales	Combretaceae	Terminalia	Terminalia mantaly H.Perrier	Tree	LC
94	Hmwezok-ne-gya	Asterales	Asteraceae	Tridax	Tridax procumbens L.	Herb	-
95	Kat-sine/Popee/Wetchi-pane	Malvales	Malvaceae	Urena	Urena lobata L.	Herb	LC
96	Tanaung	Fabales	Fabaceae	Vachellia	Vachellia leucophloea (Roxb.) Maslin Seigler & Ebinger	Tree	LC
97	Su-byu	Fabales	Fabaceae	Vachellia	Vachellia nilotica (L.)	Small Tree	LC
98	Gyosa-gauk-pin/Katsine/ kyat/Pinle-ze	Asterales	Asteraceae	Xanthium	Xanthium strumarium L.	Herb	-
99	Pyaung-bu	Poales	Poaceae	Zea	Zea mays L.	Herb	LC

4.8.4.3.5 IUCN Red List Status

The assessment of flora species found in the present study area indicates varying conservation statuses as per the International Union for Conservation of Nature (IUCN) categorization. The flora species are scrutinized with the Scope of Assessment: Global in IUCN 2023: The IUCN Red List of Threatened Species: Version 2022-2.

Among the recorded species, two species fall under the category of Data Deficient, signifying insufficient information to evaluate their conservation status accurately. Furthermore, two species as *Tectona grandis* and *Pterocarpus macrocarpus* are classified as Endangered, indicating a high risk of extinction. But these plants are recorded in the Amarapura township area and are grown artificially for timber and aesthetics. The majority of the recorded species, comprising 45 of them, are categorized as Least Concern, which means they have stable populations and a lower risk of extinction. Additionally, 49 species are classified as Not Applicable, indicating that their conservation status is not applicable or evaluated according to the IUCN criteria. Lastly, one species falls under the category of Nearly Threatened.

Within the proposed project area, no endangered or nearly threatened species have been documented. The absence of such species is a significant finding, indicating that the ecosystem within the project's boundaries is not currently under immediate threat. This information holds vital implications for the project's environmental impact assessment, as it suggests that the implementation of the project is less likely to pose a direct risk to vulnerable plant species. However, it is essential to remain vigilant and continue monitoring the area to ensure that any potential changes in the ecological landscape are addressed.

4.8.4.3.6 Conservation Area or Wildlife Sanctuaries

This proposed Project is located in Amarapura Township, Mandalay Division, and along the Ayeyarwady Basin. There is a natural reserve forest that is located about 3 kilometers Northwest of the proposed project area. The name of this area is Minwuntaung Wildlife Sanctuary, located in Sagaing Township, Sagaing Division. The protected area near project area is shown in Figure 4-127.

Minwuntaung Wildlife Sanctuary, established in 1971, covers an area of 206 square kilometers and falls under the category of a Wildlife Sanctuary. It is primarily characterized by dry forest habitat and is classified as a Fully Protection Type area. The sanctuary encompasses a range of elevations, from 75 to 305 meters, within Sagaing Township. Within the Minwuntaung Wildlife Sanctuary, notable species include Barking Deer, Hot Deer, and various bird species.

Although the proposed project area is in close proximity to the sanctuary, it's important to note that the project itself does not encompass any part of the wildlife sanctuary. The Ayeyarwady River acts as a physical barrier between the project and the sanctuary, ensuring that they are separate entities.

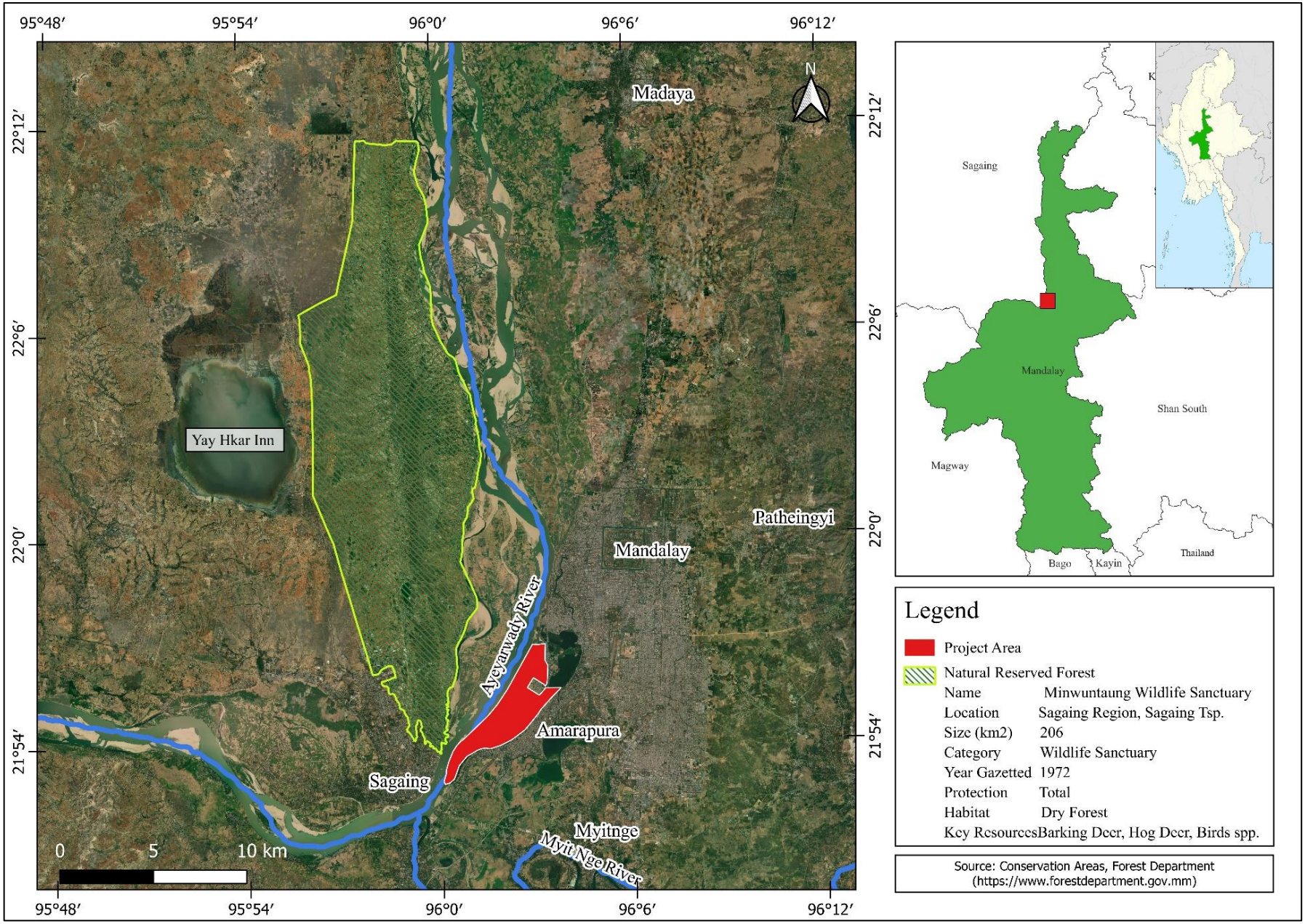


Figure 4-127 Minwuntaung Wildlife Sanctury

4.8.4.3.7 Medicinal and Economic Value

The objective of studying the economic and health/nutritional value of species recorded in the proposed study area is to gain a comprehensive description of the vegetations and plants species and to comply with the description of the biodiversity according to the EIA procedure (2019). Species that have significant economic and health benefits are shown in the following Table 4-90. This present study focuses on examining the medicinal values of ninety-nine plants that have been recorded. Through comprehensive ground surveys, it has been discovered that the local community does not utilize these plants for medicinal purposes. Instead, the majority of the plants are cultivated for ornamental, shade, or economic values. In order to gather information for the medicinal use, the study refers to the medicinal plants of Myanmar, as documented by DeFilipps et al. in 2018, along with other research papers accessible through online platforms or in libraries. This approach allows for a broader understanding of the potential medicinal properties of these plants. This study aims to provide therapeutic potentials of these plants and encourage further exploration in the field of herbal medicine. The accessibility of modern medicine and drugs has significantly impacted the utilization of local plant species for their medical value. While the area may be diverse in plant species, it is observed that the majority of these species are not employed by the local community for medicinal purposes. These changes in traditional practices can be attributed to the ease with which modern medicine and pharmaceuticals are now accessible. The convenience, reliability, and quick results offered by modern healthcare alternatives have rendered the use of local plants less prevalent among the locals.

Table 4-90 List of Species with Medicinal and Economic Values

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Abelmoschus esculentus (L.) Moench	Fruit: Used as stomachic and emollient. Helps to stabilize blood sugar by regulating the rate at which sugar is absorbed from the intestinal tract. Used to treat digestive issues. Used to promote healthy skin and blood. Used to promote a healthy of the pregnancy. Used to improves heart health. Used to controls the body's cholesterol level. Root: Used in a decoction for impotency.	Okra (Abelmoschus esculentus L. Moench), is an economically important vegetable crop with a potential to increase farm incomes of small producers.
	Abutilon indicum (Linn.) Sweet	Leaves: A. indicum is used as an aphrodisiac, demulcent, diuretic, laxative, pulmonary and sedative Seeds: The bark is astringent and diuretic; Plant: laxative, expectorant and demulcent laxative and tonic, anti-inflammatory and anthelmintic Fixed oil: analgesic Roots: diuretic and for leprosy.	-
	Acalypha indica L.	Leaf: A mixture of the juice and that of the leaves from the neem tree (Azadirachta indica) acts as an expectorant and is given for bronchitis, diarrhea, and vomiting. Cooked leaves are eaten to alleviate asthma, hypertension, impurities in the blood, and to treat various illnesses in infants.	-

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Aegle marmelos (L.) Correa	Fruit: Ripe fruit diminishes phlegm and is used to treat indigestion. Also, used to regulate bowels and cure fevers. Inner pulp eaten with sugar to treat severe diarrhea. Leaves: Children may be treated with one tablespoon of the distillate of leaves for diarrhea, bronchitis, and mucus in the breathing passages and treated with juice from crushed leaves for intestinal worms.	The Unripe fruits are astringent, digestive and are useful in providing relief in diarrhoea and dysentery. The pulp is aromatic and cooling and is frequently used for making a cooling drink- sherbet. The gum like substance around seeds serves as an adhesive. It is also used as a varnish for pictures and adds brilliancy to water- colour paints. Pill boxes are made after emptying the fruits. Gum is obtained from the stem. Essential oil is obtained from leaves
	Ageratum conyzoides L.	Leaf: Serves as an antiseptic for skin diseases and leprosy.	Have only economic impacts
	Albizia lebbekoides (DC.) Benth.	The flowers and stem bark are used to make medicine. Albizia is taken by mouth for anxiety, cancer, depression, sleep problems (insomnia), and sore throat; to improve mood; and to reduce swelling associated with trauma. Albizia is applied to the skin to treat insect bites, skin infections (boils and abscesses), ulcers, fractures, and sprains.	A. lebbeck is an attractive tree and is widely planted for shade in gardens, and as a roadside tree in India and Pakistan. Due to its extensive, shallow root system, A. lebbeck is a good soil binder and is recommended for soil conservation and erosion control. An extensive literature on the trialling of A. lebbeck for land reclamation after mining and revegetation of fly-ash dumps indicates that there are alternative, better adapted species available for this purpose
	Alternanthera sessilis (Linnaeus)	Leaf, Juice: Used as a galactagogue. The root is used for hazy vision and night blindness.	-

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Amaranthus spinosus L.	Whole plant: Leaves, roots, and whole plant used as a laxative, blood purifier, diuretic, and soporific. Taking the crushed and squeezed juice from the plant will neutralize the venom in snake bites. Boiling the plant and taking it will keep help prevent miscarriages. Leaf: Cure nose bleeds. Eating the leaves cooked in a curry will cure pain in urination and kidney stones. Juice squeezed from leaves can be licked with honey to cure vomiting and passing of blood, excessive menstruation, white vaginal discharge, gonorrhea, and sores and bumps. Root: The paste of the root made with water will neutralize the poison if applied to the site of a scorpion sting. It can also be applied onto boils to cure them. Applying either the paste of the root or using the crushed root as a poultice will cure stiffness of the muscles. The paste made with water can be strained and taken once in the morning and once at night to cure excessive menstruation.	A. spinosus leaves and young plants are collected for home consumption as a cooked, steamed or fried vegetable, especially during periods of drought. Leaves are occasionally found for sale on markets. However, its use is declining, and it is acquiring the status of a famine food. It has a bitter taste and is usually eaten in small quantities as a substitute when no other vegetables are available.
	Arachis hypogaea L.	Seed: Used for production of peanut oil. Oil aperient, emollient.	Peanut (Arachis hypogaea L.) is an important grain legume crop of tropics and subtropics. It is increasingly being accepted as a functional food and protein extender in developing countries. peanuts are a rich source of medicinally important phytochemicals of diverse nature. Due to this reason peanut cultivation in developing countries can benefit local communities. Various studies have also increasingly linked peanut consumption with improved human health and with

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
			decreased risks of life-threatening diseases.
	Artocarpus heterophyllus Lam.	Bark: Employed as poultice to treat ulcers and abscesses. Sap: Utilized for same purposes as the bark. Seed: Used to treat indigestion. Root: Used to treat diarrhea, and in a compound extract for fever.	Fruits can be harvested and consumed before they ripen; at this stage, they are often consumed in savoury dishes and must be cooked before being eaten. Once matured, fruits may be consumed raw or processed to make juice, chutney, jam, jelly and pickles. Its seeds can be ground into flour and turned into biscuits. Roasted seeds are said to taste like chestnuts. Young leaf shoots and male flowers from the jack tree are also edible. The leaf shoots can be cooked in soups and stews while the flowers are added to chilli-based condiments.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Azadirachta indica A.Juss.	Whole plant: Bitter in taste, hot and sharp when digested, and with cooling properties. Sap: Used in making tonics and digestives. Gum: Used as a demulcent and tonic. Bark: Used as a tonic. Also, made into a paste and taken with salt to reduce fever. Leaf, Bark, and Oil: Used in treatment of skin diseases; also, as a tonic, anthelmintic, and insecticide. Leaf: Crushed leaves are made into a poultice applied as a remedy for scabies and boils. A decoction of the leaves is used as a wash to alleviate rashes, itching, and bumps on the skin. Oil, Leaf and Fruit: Utilized as a local stimulant and as an insecticide. Flower: Used as a stomachic; also, inhaled to alleviate dizziness. Fruit: Eaten daily as a remedy for urinary infections.	The wood peels well and is found useful for making shuttering grade plywood. Tree is grown for fuel wood purposes in India and Africa. Seeds yield a oil having strong disagreeable garlic like odour and known as “margosa “oil, heals bleeding gums and cures pyorrhoea when it is used in mouth was and toothpaste. The same compound is also found effective in various skin diseases, burns and scabies. Neem seed cake, a residue after extraction of the oil is valued as a fertilizer and repellent for insects. It contains more sulphur than any other cake.
	Bambusa bambos (L.) Voss	Shoot: Applied as poultice; also, edible.	B. bambos is a multipurpose bamboo. Its edible shoots are consumed by humans as a vegetable and its leaves are used for animal forage. It is often planted for erosion control and as a wind-break plant around farms and along rivers to check water floods. The culms are used as a construction material and they are also important raw material for paper, pulp and plywood industries.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Barringtonia acutangula (L.) Gaertn	Leaf: Used to treat dysentery and diarrhea. Fruit: Used for blood diseases. Seed: Used to treat ophthalmia. Root: An aperient.	B. acutangula has been used in a variety of ways by local peoples. The tree has long been used for medicine and timber
	Bauhinia purpurea L.	Leaf: The juice is used as a treatment for ulcers. Root: Used as a stomachic. Bark is used for cholera, swelling and choking in the throat	Used mainly for heavy packing cases, agricultural implements, posts, scantlings, rafters and inferior construction, besides it is used for fuel. The leaves give a fodder of medium quality. Flowers are cooked as vegetable and pickles. The bark is used as a cheap tan, dye and in indigenous medicine.
	Benincasa hispida (Thunb.) Cogn.	Flower: Crushed and ingested as a cure for cholera. Fruit: Has restorative properties important in the treatment of weaknesses from lung disease. The ripe fruit promotes bowel movements, cleanses the bladder, and alleviates diseases of the blood. Seed: Used for deworming. Root: A mixture of root powder and hot water is taken for coughing, bronchitis, and asthma	The heartwood is dark-brown, strong, hard easy to polish and work. But it is not a durable timber and is readily attacked by wood borers, white ants and decay. Used mainly for heavy packing cases, agricultural implements, posts, scantlings, rafters and inferior construction, besides it is used for fuel. The leaves give a fodder of medium quality. Flowers are cooked as vegetable and pickles. The bark is used as a cheap tan, dye and in indigenous medicine. The tree has ornamental value because of its gorgeous flowers.
	Bombax ceiba L.	Fruit: Used as a digestive. Seed: Spicy hot, the seeds (peppercorns) are used to stimulate taste buds, whet the appetite, support liver function and circulation, and to reduce phlegm and gas.	The timber is also used for making cheap furniture. The tree produces floss suitable for mattresses, cushions, pillows and quilts. The young leaves, petioles and seed cake (with very little or no gossypol) are used as excellent cattle feed. The tap roots of young plants of this tree species are used as food in Australia.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Borassus flabellifer L.	Sap: Aids in regulating bowels and healing sores. Rhizome: Employed as a diaphoretic, demulcent, and to treat fever and dropsy. Thinly sliced, dried, made into a preserve with jaggery and stored in a glass jar after adding the powder of five kinds of spices Flower and Fruit: Young flowers and fruits, lightly boiled in water and eaten with a dip or in a salad, used to treat too little urine and difficulty in passing urine; also, to treat a fever. Root: Taking about a quarter cup of the liquid in which the roots have been boiled after adding some roasted salt, used to treat fever, sore throat, and mucus in the respiratory system; about a half cup of liquid in which the roots have been boiled together with jaggery, used to treat edema, body aches, and sharp spasmodic pain in the bowels.	Fiber which is obtained by scraping young leaves of Borassus flabellifer, are used in textiles industries, construction field, and production of ropes, shoes and mats, also used for making sticks, supporting beams, roof covering, construction of thatched houses, making furniture's, carpets, baskets, bags and so on. The leaf stalks and trunks are used as supporting for kutcha houses, pillars, pipes to supply water, window grills and in boats in coastal regions
	Bougainvillea glabra Choisy	B. glabra is used as a traditional medicine for different therapeutic conditions like insecticidal, anti-inflammatory, anti-diarrhoeal, anti-ulcer, anti-microbial, and anti-diabetic activities. The flowers of B. glabra are utilized for the management of hypotension. Different parts of B. glabra are being used to treat many disorders including diarrhoea, stomach acidity, cough, sour throat, blood vessels problems, leucorrhoea and hepatitis. The flowers of B. glabra are utilized to treat stomach ache, nausea and diarrhoea.	-
	Brassica sp.	Common usage includes its juncea relations in mustard plasters and other remedies. Mustard plasters were once purchasable at stores, but they are tricky to work with because they will burn	Most of the vegetable Brassica crops and they display many choices of edible forms within each species. Brassica crops together with cereals represent the basis of world supplies.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
		skin quickly, even causing blisters if misused.	Vegetable Brassica crops have the nutritional characteristics of other vegetable crops Vegetable Brassicas are of great economic importance throughout the world. Currently, Brassica crops together with cereals represent the basis of world supplies.
	Calotropis gigantea (L.) W.T.Aiton	Sap: Used in treating leprosy and as a purgative. Bark: Used as an anthelmintic. Bark and Latex: Used to treat skin diseases and as a vermifuge. Flower: Used as an antiasthmatic. Root: Root bark has been substituted for ipecac, especially to treat dysentery; also used in treating skin disease.	Calotropis gigantea plant is suitable to produce activated carbon with high yield. The surface of the activated carbon was found highly porous from FESEM analysis. Not only pores, different functional groups present in produced activated carbon found
	Caspicum annuum L.	The plant is also grown as an ornamental or as a source of medicine. When dried pods of this plant are potentized according to homeopathic formula which is a process of arousing medicinal powers of crude substance, it is converted into a very beneficial homeopathic medicine. The main keynote for its use is burning type of pain in any body part. The way it helps to reduce burning pain is highly commendable.	Capsicum annuum is the most economically important of the species in the Capsicum genus. Its common forms including bell, poblano, cayenne, pimiento. The fruits of this species are integral ingredients in the cuisines of many countries worldwide.
	Cardiospermum halicacabum L.	The root is the most important plant part used for medicinal purposes. Whole plant: Used to treat rheumatism and fever, as well as tumors. Shoot and Leaf: Boiled and eaten as a diuretic. Leaf: Decoction ingested as a remedy for rheumatism or applied in an oil as an embrocation. Most uses of the leaves are external. Root: Employed as a laxative, diuretic, emetic, purgative, and diaphoretic; also administered to treat catarrh of	C. halicacabum is cultivated as an ornamental and medicinal plant. The stems serve to make baskets and the seeds are used as beads. An edible oil can be obtained from the seed

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
		the bladder and urinary tract.	
	Cassia occidentalis L.	All parts of the plant have almost similar properties. They possess purgative, tonic, febrifugal, expectorant and diuretic properties. The plant is used to cure sore eyes, haematuria, rheumatism, typhoid, asthma and disorders of haemoglobin, is also reported to cure leprosy. The leaves have purgative, febrifugal, tonic, sudorific, diuretic and stomachic properties. They are given in cough and hysteria.	S. occidentalis is used as a coffee substitute in Egypt and elsewhere despite reports that the seeds are toxic to cattle. The leaves, fruits and flowers are consumed as a vegetable, to accompany rice or added to soups It is used as an ornamental and for green manure.
	Cassia fistula L.	Whole plant: The five parts – roots, bark, fruit, flower, and leaf are mixed with water to form a paste and applied to ringworm, scabies, and skin disorders stemming from impurities in the blood. Leaf: Sweet yet bitter with a strong taste, act as a laxative. Fruit: Used as a laxative. Stimulates the tastebuds, alleviates leprosy, and controls phlegm. Root: Used as a purgative. Milk in which roots have been boiled is taken as a remedy for flatulence.	The species provides a useful timber which is widely used on a local scale within its natural distribution as well as in tropical America. The wood is heavy to very heavy, hard and strong. The wood is used for many products and tools including wheels and shafts of carts, turnery, tool handles, ploughs, harrows and rollers, house building posts, rice pounders, bows, for boat spars, and bed plates for machinery; also, for tent poles and tent pegs, toys and carvings, for making high-grade charcoal and for boat building, furniture, pick-axe and axe handles, mallet heads, railway keys and similar articles where strength and toughness are primary considerations.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Celosia argentea L.	Leaf, Flower, and Seed: Used as antipyretic, aphrodisiac, and vulnerary.	-
	Chenopodium album L.	Root: Paste used to treat diarrhea in children.	-
	Chloris barbata Sw.	Anti-diabetic, analgesic, antibacterial, anti-hyperlipidemic, Used to treat rheumatism in traditional medicine in India. The leaf paste is used externally for skin disorders. Leaves juice used in fever, diarrhea and diabetes.	-
	Chloris sp.	-	-
	Citrus sp.	The fruit has numerous nutraceutical benefits, proven by pharmacological studies; for example, anti-catarrhal, capillary protector, anti-hypertensive, diuretic, antibacterial, antifungal, anthelmintic, antimicrobial, analgesic, strong antioxidant, anti-cancerous, antidiabetic, estrogenic, antiulcer, cardioprotective, and antihyperglycemic	Citrus is one of the most popular and widely grown fruit crops in the world. Citrus and its products are a rich source of vitamins, minerals and dietary fibre that are essential for the overall nutritional well-being.
	Clausena excavata Burm.f	Leaf: bitter and astringent, promotes good digestion. Used to treat diseases caused by “abnormal blood”. A drink of milk in which the leaves were stewed used to neutralize poisons. Leaves also used in making up carminatives and to control leprosy. Root: Used as an anti-spasmodic.	-

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Cocos nucifera L.	It is the unique source of various natural products for the development of medicines against various diseases and also for the development of industrial products. The parts of its fruit like coconut kernel and tender coconut water have numerous medicinal properties such as antibacterial, antifungal, antiviral, antiparasitic, anti-dermatophytic, antioxidant, hypoglycemic, hepatoprotective, immunostimulant. Coconut water and coconut kernel contain microminerals and nutrients, which are essential to human health, and hence coconut is used as food by the peoples in the globe, mainly in the tropical countries.	It provides food, fuel, cosmetics, and folk medicine and building materials, among many other uses. Dried coconut flesh is called copra, and the oil and milk derived from it are commonly used in cooking – frying in particular – as well as in soaps and cosmetics. The hard shells, fibrous husks and long pinnate leaves can be used as material to make a variety of products for furnishing and decoration.
	Codiaeum variegatum (L.) A.Juss.	Leaf decoction is mostly used in the treatment of diarrhoea, stomach-ache, intestinal worms, and bacterial infections. Root decoction is drunk against gastric ulcers while the bark decoction and sap are applied on external ulcers or skin infections	Codiaeum variegatum also called miracle shrub, is a plant species constituted of more than 300 cultivars which are mostly used as indoor plants for decoration. However, some of these varieties are used by indigenous populations for the treatment of diarrhoea, stomach ache, external wounds, intestinal worms and ulcers.
	Crateva magna (Lour.) DC.	The juice from the bitter stem or root bark is used in decoction for stimulating the appetite or as a digestive, as a laxative against colic and as a febrifuge.The root bark is used to treat urolithiasis. The bark and roots are generally used against various female disorders or as a tonic. The fresh leaves are rubefacient and tonic. They are applied as a tonic and skin irritant against high fever	The bark is used to wash clothes. The wood is moderately hard. It is used locally for carving and to make household utensils, drums and match sticks. The wood-chips are made into a moderately strong and poorly water resistant hardboard.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Crotalaria striata DC.	The leaves, branches and roots can be used as a cooling medicine. Plant juice is useful for treatments of gout, eczema, hydrophobia, pain and swellings, wounds and cuts, infection, kidney pain, abdominal problems, rheumatism and joint pain in traditional medicine system.	The seed oils containing unusual fatty acids are industrially important as they are used in the protective coatings, plastics, urethane derivatives, surfactants, dispersants, cosmetics, lubricants, varieties of synthetic intermediates, stabilizers in plastic formulations and in the preparations of other long-chain compounds.
	Cuscuta reflexa Roxb.	Sweet-tasting; used to treat diseases of the bile as well as to increases strength and the sperm count; also considered to promote longevity. Whole plant: The liquid from boiling it is either drunk or rubbed onto the abdomen to treat inflammation and hardening of the liver. Equal parts of the powdered plant mixed with dried ginger powder are mixed with butter and applied to longstanding sores to heal them. After crushing the plant and making a paste with water, it is applied to cure itches and rashes. The plant is also used to treat irregularities of the blood.	-
	Cyperus sp.	-	-
	Cyperus sp.	-	-
	Delonix regia (Bojer ex Hook.) Raf.	This species as having medicinal properties, but the plant parts and uses are unspecified. The bark of this species is employed as a febrifuge in Indo-China. The gum which oozes from it “is similar to gum Arabic”. The leaves contain saponin and alkaloid	They are often seen planted along roadsides as living fence posts or as shade trees on both sides of the road that arch over the entire road. The wood is yellow brown, weak, brittle, and soft, with a specific gravity of about 0.3. Although the species is not a good timber source, the wood is widely used as

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
			firewood.
	Ficus religiosa L.	Whole plant: Bitter and astringent in taste with cooling properties, drying, and difficult to digest. Sap: Used to treat female-related disorders. Bark: Considered binding, promotes weight gain and used to alleviate toothaches and gum pain. Sap and Leaf: An anti-emetic. Used to cleanse the blood; also used in preparations to treat boils in the groin, hemorrhaging, and cracked tongues and lips. Fruit: The ripe fruit, which has cooling properties, is considered beneficial for the heart. It is used to treat blood diseases, “heat” or bile conditions, nausea, lung infections, and loss of appetite. Root: The root bark is stewed in water, reduced to one-half the starting volume, and given for herpes infections. The roots are ground to form a paste applied topically as a remedy for leprosy and other sores.	F. religiosa has been used as an ornamental, as invertebrate food for lac insects and silkworms, in folkloric medicine, and for materials and religious uses The fruits are commonly eaten by birds as food, while the leaves and twigs are lopped for cattle and goats. The species is a rare ornamental and shade tree. The bark fibre was also formerly used in the manufacture of paper. The wood is used to make packing cases as it is durable under water, and has also been reportedly used to make cheap boarding, yokes, and bowls
	Gardenia jasminoides J. Ellis	frequently used not only as an excellent natural colourant, but also as an important traditional The desiccative ripe fruits of this plant (called Zhizi in China) are well known and medicine for the treatment of different diseases, such as reducing fire except vexed, clearing away heat evil, and cooling blood and eliminating stasis to activate blood circulation.	The desiccative ripe fruits of this plant (called Zhizi in China) are well known and frequently used not only as an excellent natural colourant, but also as an important traditional medicine for the treatment of different diseases.t has also been declared as the first batch of dual-purpose plants used for food and medical functions in China. Gardenia yellow pigment has been the most important source of a natural colourant for food, cloth and paint for thousands of years. This herb has made great contributions to human survival and development. Moreover, it

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
			has also achieved outstanding progress in human life and even in art.
	Gliricidia sepium (Jacp.) Steud.	Gliricidia sepium is the topic of much research due to its numerous traditional applications, which include treating coughs, asthma, curing urticaria, rash, burns, scabies, dermatitis, acting as an antipruritic on the skin, and treating bacterial and protozoal infections. Many medicinal uses for Gliricidia sepium have been discovered over time, including cytotoxic activity, anti-microbial activity, anti-bacterial activity, anti-inflammatory activity, antioxidant activity, thrombolytic anti-sickling activity, wound healing, mosquitocidal activity, and anthelmintic activity.	Gliricidia is considered to be the most widely cultivated multipurpose tree it was mainly used as a shade tree in plantation crops, but more recently it has become a widely cultivated multipurpose tree integrated into several cropping systems, It has also been planted to stabilize soil, to prevent erosion and to reclaim denuded land or land infested with Imperata cylindrica (L.) Raeuschel. The wood is often utilized as firewood, for charcoal production or as posts and farm implements, and locally for furniture, construction and railway sleepers.
	Grangea maderaspatana (L.) Poir.	Leaf: Used as anthelmintic, antipyretic, and antispasmodic.	-
	Heliotropium indicum L.	Whole plant: Used as diuretic. A decoction used in treating gonorrhea; one is also used for the treatment of diabetes by Kawkareik inhabitants. Leaf: Applied to boils, ulcers, and	-

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
		wounds.	
	Hibiscus sabdariffa L.	Leaf: Used as an emollient. Seed: Used to treat debility. the leaf, calyx and seed are used as an antiscorbutic and diuretic; and the fruit is used as an antiscorbutic.	-
	Holoptelea integrifolia Planch.	Bark: Used to treat rheumatism. The bark and leaves are bitter, astringent, acrid, thermogenic, anti-inflammatory, digestive, carminative, laxative, anthelmintic, depurative, and revulsive; considered useful in vitiated conditions of kapha and pitta, inflammations, dyspepsia, flatulence, colic, helminthiasis, vomiting, skin diseases, leprosy, diabetes, hemorrhoids, and rheumatism	Holoptelea integrifolia is used for timber which makes cheap furniture and also used as firewood in rural parts. It is also used in ecological forestry for its heat and drought tolerance and regenerative abilities. Its flowers, leaves and bark have medicinal uses against several diseases.
	Crepis subscaposa Collett & Hemsley	-	-
	Tephrosia purpurea Pers	Whole plant: Used as an anthelmintic and antipyretic. The root is used for dyspepsia, diarrhea, rheumatism, fever, snakebite, asthma, urinary disorders, colic; also as a liniment on elephantiasis. The aerial parts used as a remedy for cough, tightness in the chest, bilious febrile attacks, and obstruction of the liver, spleen and kidneys, as blood purifier for boils, pimples and other skin disorders; the root is bitter and used for dyspepsia and diarrhea.	-
	Ipomoea triloba L.	The plant is used as a poultice in the treatment against	-

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
		headaches. A decoction of the leaves is used as a treatment against stomach ache.	
	Ipomoea aquatica Forssk.	Leaf: Sweet with cooling properties, stimulates lactation, protects against germs found in water, works as an expectorant, and neutralizes poisons. Leaves are used to treat burning, thirst, and fevers associated with urinary diseases, as well as to treat wounds caused by burns. The leaves are considered a good source of minerals and vitamins, especially carotene. Hentriacontane, sitosterol, and sitosterol glycoside have been separated from the lipoids	The young tops or plants (stem and leaves) are cooked like spinach or lightly fried in oil and eaten as a vegetable in various dishes. A small portion of the production is canned. The vines are used as fodder for cattle and pigs. In Malaysia it is widely grown in fish ponds and used to feed pigs
	Ipomoea batatas (L.) Lam.	Being a good source of energy and nutrients, sweet potato is a staple food in many Asian, sub-Saharan Africa and South Pacific countries. It is also a valuable medicinal plant having anti-cancer, antidiabetic, and anti-inflammatory activities. Sweet potato is now considered a valuable source of unique natural products, including some that can be used in the development of medicines against various diseases and in making industrial products. The overall objective of this review is to give a bird's-eye view of the nutritional value, health benefits, phytochemical composition, and medicinal properties of sweet potato.	Sweet potato [Ipomoea batatas (L.) Lam] is cultivated worldwide, and it is a staple food in many developing countries. In some regions (e.g., Africa) drought is a major production constraint that results in significant yield loss. We speculate that the storage roots of sweet potato may play an important role into the response of cultivated sweet potatoes to environmental stresses.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Ipomoea obscura (L.) Ker Gawl.	Leaves of the plant find valuable application in aphthous affection paste of the leaves is applied on sores, ulcers, hemorrhoids and swellings.	Ipomoea obscura is cultivated worldwide as an ornamental crop for its attractive flowers. Its leaves are used as a vegetable or added to soups. The following medicinal uses have been reported: treatment of insanity, open sores, fevers, pustules, aphthae, dysentery, tuberculosis, impotence, sedative, antioxidant, and anti-diarrhoeal. Used in Ayurveda and Siddha medicine in India, I. obscura has hallucinogenic properties and is used in magical-religious rituals. The species is recommended as an alternative treatment for suppressing tumour progression by improving the immune response and inhibiting cell proliferation
	Lagenaria siceraria (Molina) Standl.	Gastrointestinal crypt stem cells and enteric microflora are believed to be affected by diet, which can result in improved health. Lagenaria siceraria (Molina) Standl. is a vegetable food also used as a traditional medicine. It is reported to have immunomodulatory, hepatoprotective, cardioprotective, antioxidant, anti-stress and adaptogenic, antihyperlipidemic, analgesic, and anti-inflammatory properties. A novel protein, Lagenin (20 kDa), isolated from seeds is reported to have antitumor, antiviral, antiproliferative, and anti-HIV activities. The consumption of bottle gourd can be considered to improve human health, but additional research is required.	Lagenaria Siceraria (Molina) Standl can be harvested when it is not ripe and eaten as a vegetable. The shell of Lagenaria Siceraria (Molina) Standl is lignified and hollow after maturity. It can be used as various containers, gourds or children's toys, as the bailer; singing bug toys, such as grasshopper gourd.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Lantana indica Roxb.	The plant is used in folklore and traditional systems of medicine as a sudorific, intestinal antiseptic, diaphoretic and to treat asthma, abdominal disorders, bilious fever, cancer, catarrhal infections, chicken pox, eczema, hypertension, malaria, measles, swelling, rheumatism, tetanus and ulcers	-
	Leucas lavandulifolia Sm.	As a treatment for bronchial asthma, emphysema, chronic cough, and whooping cough. For persistent itching and redness of the skin. To Treat Sprains Sicknesses such the common cold, the flu, fever, jaundice, chest infections, and rheumatism. Protection against respiratory tract infections, mumps, and mouth sores.	-
	Lindernia rotundifolia (L.) Alston	Used for treating chalosma and boils.	-
	Madhuca longifolia (L.) J.F.Macbr.	Madhuca longifolia is also considered as medicinal herbs and is useful for external application in treating skin diseases, rheumatism, headache, chronic constipation, piles, haemorrhoids and sometimes used as an emetic and galactagogue. The leaves of Mahua tree contain saponin, an alkaloid glucoside. Sapogenin and other basic acid have been found in the seeds. Mahua flowers are well known for their high reducing sugar and nutrient content	Mahua seeds are rich in edible fats so they have economic importance. Mahua fruits are used as vegetable and widely consumed by the tribes of western Odisha. Madhuca longifolia is also considered as medicinal herbs. Mahua oil is used for manufacturer of laundry soaps and detergent, and also used as cooking oil in various tribal region of India.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Mangifera indica L.	Bark: Used as an astringent. Fruit: Ripe fruit used as laxative and rind used as tonic. Seed: Employed as an antiasthmatic.	Wood is extensively used for low-cost furniture, floor, ceiling boards, window frames, heavy packing cases, match splints, brush backs, oar blades, agricultural implements etc. Also suitable for tea chest plywood. A hard charcoal of high calorific value is obtained from mango wood. After preservative treatment, it can be used as a substitute for teak as beams, rafters, trusses, and door and window frames. Suitable for slate frames, ammunition boxes, bobbins, carving and turnery work.The bark possesses 16% to 20% tannin and has been employed for tanning hides. It yields a yellow dye, or, with turmeric and lime, a bright rose-pink. The bark contains mangiferine and is astringent and employed against rheumatism and diphtheria in India.
	Melhania hamiltoniana Wall.	-	-
	Millingtonia hortensis L.f.	Leaf: Boiled in water and eaten, or made into a stir-fry, for menstruation and hypertension. Flower and Shoot: Drinking a soup made with the flowers or eating the shoots will cure hypertension and heart palpitations. Root: Taking the paste of the root after adding salt or sugar will cure heart palpitations and dizziness; drawing circles around the eyes with a paste made from the root and bark will cure sore eyes; applying a paste made from the root will cure gas disorders; drinking the liquid in which the fresh root has been boiled with jaggery will cure vitiligo; rubbing a paste of the root or bark onto the	Millingtonia hortensis (Family Bignoniaceae) is a native deciduous tree that ranges through India, Myanmar, Thailand and south China and is often cultivated as an ornamental tree in yards, gardens and avenues. This plant is colloquially known as “cork tree” or “peep” or “Gaa Sa Long” (Thai). The flowers of M. hortensis have a very rich and pleasant scent.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
		tongue will cure alcoholic intoxication.	
	Mimosa pigra L.	The species is used in a various herbal remedies and magic rites in Africa (Burkill, 1995). In Malaysia it is reported to be used to cure snake bites in traditional medicine. Methane production from rumen incubation is lower from M. pigra leaves than from Gliricidia sepium.	It has also been used as a green manure, a cover crop, beanpoles, and for hedges and fuel wood.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Mimusops elengi Roxb. L.	Bark: Liquid from boiling the bark together with the bark of zee-hpyu (Phyllanthus emblica) and shah (or A. chundra) is held in the mouth to treat thrush, inflamed gums, burns within the mouth, gingivitis, and other gum disorders. Liquid from boiling the bark is also used to clean cuts and wounds. Bark, Flower and Fruit: Used for heart problems, a decoction of the bark is taken, the flowers are inhaled, and the fruit is eaten. Flower: Fresh flowers are used for treating white vaginal discharge and dental diseases. Water from soaking them overnight is given to children for coughs. Dried flowers, ground together with thanakha (paste of bark of Chloranthus erectus, especially useful for its astringent properties), are applied to cure heat rashes and prickly heat. Fruit and Seed: Paste of seeds is made with cold water or the ripe fruits are ingested for persistent diarrhea.	-
	Monoon longifolium (Sonn.) B.Xue & R.M.K.Saunders Thomson	The oil of the seed has been confirmed to possess anti-oxidant, anti-lipooxygenase and antimicrobial (against various microbe strains) activities, among others. Methanolic extracts of Monoon longifolium have yielded 20 known and two new organic compounds, some of which show cytotoxic properties. The fatty acid composition of the seed has also been reported	This evergreen tree is known to grow over 20 m. in height and is commonly planted due to its effectiveness in alleviating noise pollution. It exhibits symmetrical pyramidal growth with willowy weeping pendulous branches and long narrow lanceolate leaves with undulate margins. Monoon longifolium is sometimes incorrectly identified as the ashoka tree (Saraca indica) because of the close resemblance of both trees. The cultivated, column-like pendula form can appear to have no branches, but in fact a non-hybrid M. longifolium allowed to grow naturally (without trimming the branches out for decorative reasons) grows into a normal large tree giving plenty

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
			of shade. Today, its wood is mostly used for manufacturing small articles such as pencils, boxes, matchsticks, etc.
	Muntingia calabura L.	Muntingia calabura is of great medicinal value because of the variety of health benefits it offers. The well-studied pharmacological activities it possesses include antitumor, antinociceptive, anti-inflammatory, antipyretic, antibacterial, antiproliferative and antioxidant properties. However, studies on its effects on female reproductive health are lacking. Hence, this study aimed to evaluate the potential benefits of M. calabura on maternal and neonatal health and its potential estrogenic property.	A number of bioactive compounds, mostly flavonoids (flavones, flavanones and flavans), have been isolated from the roots, bark, wood, leaves and flowers of M. calabura. A formulation developed from the roots showed inhibitory activity against the fungal pathogen Alternaria solani, which produces the early blight disease in tomato and potato. The wood pulp has potential for the production of cellulose. A granular biomaterial prepared from a mixture of leaves, fruits and twigs was effective in the removal of cationic dyes from dye-contaminated waters
	Musa sp.	The fruit has mild laxative property, helps to maintain cardiovascular health, protection against strokes, protection from ulcers; it also helps to reduce water retention, also preferred for anemic patients as it is highly rich in iron. Banana possesses antioxidant, antimicrobial, anticancer, antidiabetic, and antiulcerogenic properties. It is also rich in vitamins, as	- Among the tropical regions' most significant commercial fruits.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
		well as minerals and it also well-known edible fruit and foodstuff. The flower of this plant is used to treat ulcers, dysentery, and bronchitis and cooked flowers are good food for diabetics. The astringent ashes of the unripe banana peel and leaves are used in the treatment of dysentery and diarrhea and also for the treatment of malignant ulcers.	
	Neyraudia reynaudiana (Kunth) Keng ex Hitchc.	-	There are a number of reported uses for N. reynaudiana, but overall usage of the species seems to be minimal. It has been grown as an ornamental in Florida. N. reynaudiana has been used as a substrate for mushroom cultivation in China
	Persicaria hydropiper (L.) Delarbre	Persicaria hydropiper (L.) Delarbre (Syn.: Polygonum hydropiper L., Family: Polygonaceae) are used in traditional medicine systems as astringent, sedative, antiseptic and also for the treatment of respiratory disorders, edema and snake bites. It is also used as a spice in many Asian countries.	-
	Pithecellobium dulce (Roxb.) Benth.,	Leaf: Used as an abortive and as a digestive.The bark is used in a decoction as an enema	Pithecellobium dulce is most often cultivated as an ornamental, shade or street tree planted along roadsides and in backyards and hedges. As a hardy, drought- and heat-tolerant, nitrogen-fixing tree, it is often planted because it tolerates harsh sites and heavy cutting rather than because of the products it produces, none of which are of particularly high quality or of significant commercial value. The wood is used locally for construction, panelling, boxes, crates, agricultural implements and cart wheels. Its irregular growth habit and branchiness prevent it from being used as sawn timber and the wood has never been

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
			used commercially, except in some areas for fuel.
	Plumeria obtusa L.	The different parts of the plant are used traditionally to treat various diseases like diabetes mellitus, wounds and skin disease, diuretic, purgative, abortion and also used in cosmetics, aromatherapy, necklaces and as offerings.	Plumeria obtusa L. (Apocynaceae) is a deciduous, ornamental, tropical plant grown in premises, parks, gardens, graveyards, because of its attractive and fragrant flowers.
	Plumeria rubra L.	Known to promote digestive, excretory, respiratory, and immune functioning, with activity against leprosy, infections, and stomach ailments. Sap: The milky sap from the branches and bark is used as a laxative; also, in remedies for stomach-ache and bloating. Bark and Leaf: Used as laxative and for gonorrhea and venereal sores. Leaf and Flower: The leaves can be eaten, the flowers can either be boiled in water. Flower: Used for treatment of asthma.	Plumeria rubra is cultivated as an ornamental tree and has widespread use in tropical landscapes and it is often associated with temples and graveyards. The flowers are commonly used in garlands (e.g., Hawaiian lei) and wreaths and in religious offerings.
	Portulaca oleracea L.	Leaf: Used in kidney disease treatment; also, as a laxative and digestive.	It is eaten extensively as a potherb and added in soups and salads around the Mediterranean and tropical Asian countries and has been used as a folk medicine in many countries.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Psidium acidum Mart. ex O.Berg	Used for the treatment of malaria, and administered either orally in the form of a decoction or applied externally over the whole body.	-
	Pterocarpus indicus Willd.	Tree sap is applied externally to heal diseases of the mouth. The roots are used in traditional medicine.	P. macrocarpus is an important timber species of South East Asia used for furniture, construction timber, cartwheels, tool handles, decorative flooring, cabinetwork, billiard tables and posts. The wood is hard, dense, relatively heavy, very durable and also resistant to termite attack. The resin can be used as a red dye; the bark and roots are used in indigenous medicine as a remedy for bladder ailments and diarrhoea. The valuable heartwood is considered a luxury timber. It varies in colour from orange-yellow to reddish-brown and has beautiful markings. It is used to make fine furniture, musical instruments, and decorative objects.
	Ranunculus sceleratus L.	The celery-leafed buttercup is one of the most virulent of our native plants. The whole plant is acrid, anodyne, antispasmodic, diaphoretic and emmenagogue and rubefacient. When bruised and applied to the skin it raises a blister and creates a sore that is by no means easy to heal. If chewed it inflames the tongue and produces violent effects. The herb should be used fresh since it loses its effects when dried. The leaves and the root are used externally as an antirheumatic. The seed is tonic and is used in the treatment of colds, general debility, rheumatism and spermatorrhoea.	An extract of the leaves can be used as a fungicide

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Ricinus communis L.	Leaf: Used in remedies for headaches and in poultices for sores and wounds. A decoction of leaves reduced to one-third the starting volume is ingested to alleviate strong gas and phlegm; also used for testes enlargement, bladder aches and pains, sore throat, and bile problems. Seed: They and their oil (lethal in their natural form) are used in oral medications after detoxifying.	At present, the oil is produced mainly as basic material for industry, particularly as a lubricant. The presscake is poisonous and cannot be fed to animals. It is used as fertilizer or as fuel. The castor oil also has commercial value for making soap, margarine, lubricants, paints, inks, plastics, and linoleum. The crop is also regarded as a useful feedstock for biodiesel production
	Rorippa palustris(L.) Besser	Leaves are used for antiscorbutic.	The young leaves, stems and young seedlings can be eaten raw in salads or cooked
	Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne	Rotala rotundifolia is used in its native range as a medicinal plant. The species is known for its anti-pyretic, detoxication, anti-swelling, and diuresis properties. Also used in treatment of cirrhosis, gonorrhea, menstrual cramps and piles in China	It is sold in the aquarium trade, but is of uncertain status. It is a common weed in rice paddies and wet places in India, China, Taiwan, Thailand, Laos, and Vietnam, and has been introduced to the United States.
	Saccharum spontaneum L.	Numerous medicinal uses have been described in the Philippines, and young shoots are boiled and eaten with rice in Indonesia	S. spontaneum is a coarse grass, is not favoured by cattle and is generally only grazed in times of scarcity. It has, however, been reported as good fodder for goats and camels It provides good thatching material and is also used in the production of ropes, mats and brooms. Pulp of S. spontaneum is suitable for wrapping, writing, printing and for the production of grease-proof paper. Its slow rate of decomposition makes it an excellent mulching material
	Samanea saman (Jacq.) Merr.	the plant has been used as a folk medicine for the remedy of headache, cold, diarrhea, stomach-ache intestinal ailments, sore throat, and stomach cancer. The boiled bark is used as a	It is a tree and grows primarily in the seasonally dry tropical biome. It is used as animal food, a poison and a medicine, has

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
		bandage to cure constipation	environmental uses and social uses and for fuel and food.
	Senna siamea (Lam.) Irwin & Barneby	Leaf, Flower, Fruit: Made into a soup which is drunk as a tonic and to relieve stomach pains.	S. siamea is widely grown for fodder. The dense, dark-coloured wood of S. siamea makes good fuel, although it produces some smoke when burning. All parts of the plant can be used for tanning. The concentrations of tannin vary slightly from 17% in the leaves to 9% in the bark and 7% in the fruits.
	Sesbania sesban Britton (L.) Merr.	Bark: Used for skin conditions, liquid from the crushed bark is given orally, and the seed paste is applied topically. It is also used to clear infections, promote new tissue formation, and heal chronic sores. Leaf: Used in maturative poultices. Seed: Component of remedies for irregular menstrual periods, liver inflammation, and lung infections. Root: Used in medicines to treat stomach bloating, tumors, fevers, sores, diabetes, skin irregularities caused by blood problems, and throat ailments, as well as to protect against colds, leprosy, spleen inflammation, and germs. They are also used in remedies to neutralize venom from scorpion stings.	The aerial parts, especially the soft, young parts were consumed by both humans and animals. Sesbania species also have other economic importance as weeds, pest host, and host for an economic plant. Sesbania seeds in too large doses are lethal to some animals. According to the vast advantages, the knowledge of Sesbania uses, including the safe dosages, should be passed on for the welfare of humans.
	Sida acuta Burm.f.	indigenous people used this plant to treat common illnesses which include fever, headache, and various infections. Scientifically, Sida acuta has already been studied for several potential benefits. Studies reveal that roots of Sida acuta can be chewed to relieve toothache and leaves are soaked in water to make hair conditioner or shampoo to treat scaly skin.	-

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Sizygium sp.	Traditional plant based medicines are generally used as crude formulations (e.g., infusions, tinctures and extracts, essential oils, powders, poultices, and other herbal preparations).Modern natural product drug discovery generally focuses on isolating and characterizing the individual phytochemical components with the aim of producing an analogue with increased bioactivity/bioavailability.	The reviewed investigation revealed many different pharmacological activities obtained from several organic extracts, essential oils, and compounds isolated from Syzygium species. Some of the activities such as antioxidant, anti-inflammatory, antibacterial, anticancer,hepatoprotective, antidiarrheal activities, etc. were exhibited as pharmacological activities. Many of them also applied on the animal model for better result along with in vitro screening.
	Solanum melongena L.	Leaf: Employed as a narcotic and as a stimulant.	Small portions of eggplant can be used as ingredients in the mixture for fruit and vegetable smoothies.The color of the fruit, the proportion of seeds to pulp, short cooking time, and lower olanine levels are important attributes in assessing quality.
	Solanum nigrum L.	people boil the leaves and have it to cure liver complaints. It helps flush the toxins out of the body. People with jaundice can be cured by eating the cooked leaves of the plant. During the times when women have menstrual pain, they must drink the juice of the plant three times a day. Once must continue to do this for one or two months at least.Burns: Make a paste of the plant and apply on the burns to get relief. Have Nightshade regularly and see the enhancement in the quality of the blood.	Genotypes of the S. nigrum complex with large fruits are sometimes cultivated, the fruit being used in pies, and young shoots are also sometimes eaten as pot herbs. The taxon is very variable, and edible cultivars could undoubtedly be selected and improved by standard plant breeding methods. in many developing countries they constitute a minor food crop, with the shoots and berries not only being used as vegetables and fruits, but also for various medicinal and local uses.
	Sorghum bicolor Kuntze	Anaemia is caused by either a decrease in production of red blood cells or hemoglobin, or an increase in loss or destruction of red blood cells. Hypothyroidism is when the thyroid gland does not produce enough thyroid hormones to meet the needs	It is ranked as the fifth key cereal crop globally and acts as a source of grain, animal feed, pasturage, fodder, fiber, fuel, bioethanol, alcoholic beverages as well as building materials.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
		of the body. The thyroid is underactive.	
	Streblus asper Lour.	Bark: Used as a remedy to treat diarrhea. Leaf: Decoction of the dried leaves administered for dysentery. Root: Used to treat ulcers	the plant can be used as animal feed and bio-insecticide. It also helps in the coagulation of skimmed milk and cheese production. Further, it has some economic uses, including vermicompost production and papermaking and its use as a fuel.
	Synedrella nodiflora (L.) Gaertn.	Crushed leaves have been used as a treatment for rheumatism, and when mixed with those of other plants to relieve stomach pains (Soerjani et al. 1987).	Young shoots can be eaten as a cooked vegetable, and the shoots are fed to pigs in Papua New Guinea.
	Tabebuia aurea (Silva Manso)	The bioactivity-guided fractionation of the total ethanolic extract of the leaves of Tabebuia aurea revealed the cytotoxic and antileishmanial potency of the ethyl acetate fraction, in which its phytochemical investigation resulted in the isolation of five triterpenes; identified as oleanolic acid, ursolic acid, pomolic acid, tormentic acid, in addition to one triterpenoid glucoside, spathodic acid glucopyranoside.	Tabebuia aurea is found in areas of Cerrado, Caatinga, Amazon Forest and Pantanal., It is used medicinally, for landscaping, and as timber for construction
	Tabernaemontana divaricata (L.) R.Br. ex Roem. & Schult.	The root paste used for scorpion sting. The root is prescribed for biliousness, epilepsy and paralysis. The root is chewed to relieve toothache. The flower is kept in water for 12hours and then flower juice is applied on the eye for eye injury	Cultivated as an ornamental plant. The red pulp around the seed is used as a dye.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Tamarindus indica L.	Root: Used in treating gonorrhea, urinary diseases, hemorrhoids, jaundice, and shooting or dull pains in the stomach. Bark: The entire bark can be made into an ash and taken with water after meals to cure vomiting and gastic problems. The bark ash can be mixed with honey to cure shooting or dull stomach pains. Leaf: The juice from the leaves can be cooked with sesame oil and a small amount applied into the ear to cure earaches. Fruit: The pulp of the fruit is used in making up laxatives and tonics.	Its fruit is marketed worldwide in sauces, syrups and processed foods, and the juice is an ingredient in Worcestershire Sauce. These economic benefits could have an indirect positive effect on food security and nutrition for producers who can use the income to diversify their diets.
	Tectona grandis L.f.	Bark, Wood, Fruit: Components of medicines used to reduce phlegm, cure gonorrhea, treat leprosy, alleviate bloating, and stop hemorrhaging. Wood: Pul-verized and used on swellings. Fruit: A paste, made by grinding the fruit with cooking oil, is used to alleviate itching and rashes. A second paste, made by grinding the fruit with rice washing water, is applied topically to clear clogged milk glands. Finely crushed fruit is cooked, applied as a poultice over the navel, and bound there with a cloth to treat urinary problems. Oil of fruit is used as a remedy for skin diseases. Root: Used to treat urinary discharges. Bark: Used as an astringent. Water from soaking the bark overnight is given for white vaginal discharge.	Teak is employed for sound – boards of musical instruments, keys etc. and for different grades of plywood. Wood waste in the form of wood- shavings and sawdust is used for chip-boards, fibreboards, and plastic boards. Leaves contain about 6% tannin and a dye; also used for thatching.
	Terminalia catappa L.	Whole plant: Astringent, also used in treating dysentery. Nordal lists this plant as having medicinal value, but does not give use(s)	The tree is little used economically, but it is suggested that is might have value not only for shade and ornament but also as a food source and for fuelwood, building timber, mulch and fertilizer, cooking oil, gum and tannin.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Terminalia mantaly H.Perrier	The treatment of uncomplicated and severe malaria relies heavily on a single class of compounds, viz. artemisinin derivatives. Although artemisinin-based combination therapies (ACTs) have proven to be effective in controlling the disease in many malaria-endemic areas	This is particularly problematic, as the use of T. mantaly raises many concerns attributed to the mechanical defect (proneness of its branches to breaking/fallings), and entomological problems with its potential risks to human, wood-based industries, cash, and food insecurities. Data from literature review and observational-based findings revealed these risks associated with the use of T. mantaly as extensive yet the species is highly sought-after by commercial nursery operators and urban dwellers.
	Tridax procumbens L.	Tridax procumbens is a very promising species that produces secondary metabolites reported to have a variety of medicinal uses including among others, anti-anemic, anti-inflammatory, anti-diabetic and anesthetic properties. This species has a long history of traditional use by different communities.	Aqueous extracts inhibit aflatoxin production by Aspergillus flavus and a petroleum ether extract from flowers protects cowpea seeds from damage by the bruchid Callosobruchus maculatus
	Urena lobata L.	Bark: Dried and powdered, combined in equal amounts with sugar, and taken with milk twice daily to increase virility and sperm production. Twig: Chewed for toothaches. Leaf: A mixture of the crushed leaves and black pepper is taken once each morning and each night to remedy weight loss and low energy or with equal amounts of black sesame seeds and cooked over a slow fire to make an ointment applied to reduce edema.Leaf, Root: Used as a diuretic and expectorant.	Although a weed in crops, U. lobata is cultivated in some regions of South America, South East Asia, and tropical Africa as a fibre crop. The fibres are used for making carpets and ropes. Seeds are used to produce soap, while the charcoal of the whole plant is used for blackening teeth.

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
	Vachellia leucophloea (Roxb.) Maslin Seigler & Ebinger	The bark extracts of Vachellia leucophloea are used in Pakistani traditional medicine as an astringent, a bitter, a thermogenic, a styptic, a preventive of infections, an anthelmintic, a vulnerary, a demulcent, an expectorant, an antipyretic, an antidote for snake bites and in the treatment of bronchitis, cough, vomiting, wounds, ulcers, diarrhea, dysentery, internal and external hemorrhages, dental caries, stomatitis, and intermittent fevers and skin diseases. An ethanolic extract ointment has shown marked wound healing activity in trials.	The wood is sometimes used to make attractive furniture and other implements, though it can be difficult to work with and is not durable.
	Vachellia nilotica (L.)	Vachellia nilotica (V. nilotica) is a widely used plant specie in folk medicine for viral diseases and in some communities for HCV infection. However, little is known regarding its role and possible mechanisms in the prevention and treatment of this viral infection.	It is used as animal food, a medicine and invertebrate food, has environmental uses and social uses and for fuel and food.
	Xanthium strumarium L.	The entire plant is utilised as medicine, particularly the root and fruit. Ayurvedic medicine claims that Xanthium strumarium has cooling, laxative, fattening, anthelmintic, alexiteric, tonic, digestive, and antipyretic properties in addition to improving memory, appetite, voice, and skin. Leucoderma, biliousness, insect bite poisoning, epilepsy, salivation, and fever are all treated by it.	Xanthium strumarium can be used as a medicinal plant. A yellow dye can be made from its leaves. However, these uses cannot compensate for its overall negative impacts.
	Zea mays L.	Flower: A fermented preparation from the style of the plant is said to have a strong hypoglycemic effect.	Maize has been revealed to have the potential to sustained human health-related cases, raise standard of living of farmers,

No.	Species	Medicinal/Health/Nutritional Values	Economic Values
			served as a soil fertility indicator crop, generate income and increase food-crop production for the increasing human population. Industrial utilization of maize has been shown to include: wet milling, production of bio-fuel, ethanol and other sub-byproducts

4.8.4.3.8 Discussion and Conclusion

In conclusion, the field study conducted in the project area and Amarapura city yielded valuable observations regarding the flora composition and vegetation types of the study area. The project area exhibited a diverse range of plant species, with Fabales, Poales, and Solanales being the most represented orders. In the project area, a total of 67 species, 61 genera, 29 families, and 19 orders of plants were observed. Fabales stood out as the most common order, accounting for 13.4% of the recorded species. Poales and Solanales closely followed, each representing 11.9% of the flora species and including grasses, sedges, peppers, and tomatoes. Other notable orders, such as Malvales, Asterales, and Caryophyllales, were also recorded. The vegetation type in the project area was identified as Kaing grassland on sandbanks, although the majority of the land is utilized for vegetable farming due to its fertile alluvium. The grassland predominantly featured grass species like Saccharum spontaneum and Neyraudia reynaudiana, alongside other plants such as *Tephrosia purpurea*, *Cassia occidentalis*, *Ricinus communis*, and *Calotropis gigantea*. Herbs constituted a significant portion of the flora in the project area, followed by shrubs, trees, and grasses. The study highlighted the absence of existing forests or forest-like vegetation in the proposed project area, emphasizing the influence of human activities and natural processes on vegetation dynamics.

On the other hand, Amarapura city exhibited a slightly different flora composition, with Fabales dominating at 27%. Sapindales and Myrtales were also prominent in the area. The data collected indicates that the majority of plants documented in the area are classified as shade trees, fruit trees, and ornamental plants. As a residential area, the availability of shade trees is essential to creating comfortable and cooler environments, especially during hot and sunny periods. Additionally, the prevalence of ornamental plants suggests the local community's appreciation for beautifying their surroundings. Ornamental plants serve both aesthetic and cultural purposes, enhancing the visual appeal of the area and reflecting the community's values and traditions.

The investigation conducted in this study aimed to explore the medicinal, nutritional, and economic value of the recorded plant species in the study area. However, the findings reveal a notable decline in the reliance of the local community on traditional practices related to the utilization of plant species for their medicinal value. This decrease in traditional medicine usage can be attributed to the increased accessibility and effectiveness of modern healthcare alternatives. The availability of modern medicine has brought significant changes to healthcare practices globally, and the study area, the Amarapura Township is no exception.

Regarding conservation status, no endangered or nearly threatened species were documented within the proposed project area. This finding suggests that the ecosystem within the project boundaries is not currently under immediate threat. However, continued monitoring is necessary to address potential changes and ensure the preservation of plant species.

In conclusion, this research contributes to the flora composition, vegetation cover, and status of the recorded plant species on the IUCN Red List. The findings underscore the considerable facts for conducting an environmental impact assessment process, monitoring, and conservation efforts to protect the ecological integrity of the region and preserve valuable plant species.

4.8.5. Fauna

4.8.5.1. Mammals

4.8.5.1.1 Introduction

Mammals are familiar to everybody, as they include domestic animals such as dogs, cats, horses, and cattle as well as, of course, ourselves – humans. The greatest single threat to most Asian mammals is loss of habitat. However, many smaller mammals with more specialized habitat requirements may be unable to adapt. Another threat to many mammals is hunting. Although some mammals have been traditionally hunted for centuries, growing human populations and the widespread availability of guns have greatly increased hunting pressure. At the same time, with loss of habitat, many mammal populations have become smaller and more vulnerable to hunting. World-wide, rodents are the most diverse group of mammals with over 1800 species. In southeast Asia, more than 170 species are known, with new forms being discovered regularly. They are group into Sciuridae with both the tree squirrels and flying squirrels, the Muroidae (mice and rat) and Hystricidae and the newly discovered Diatomyidae with the single species *Laonastes aenigmamus*. The tree squirrels are diurnal, while others are mainly nocturnal (Francis, 2019).

With 2,277 species, the order Rodentia represents approximately 42 % of all mammal diversity (Musser and Carleton, 2005). Geographically widespread and highly adaptable, rodents occupy a vast array of diverse ecological niches. They impact on the composition, structure, and succession of vegetation and fulfil many important ecosystem services, including assisting with nutrient cycling and the dispersal of seed and spores. Through their burrowing activities, they mix and aerate soils and with their high biomass, they provide an essential prey base for many predator species (Witmer, 2004). A minority of species causes significant problems to man. For example, in Asia, it is considered that in any one particular area between 5 and 10 % of rodent taxa are major agricultural pests (Aplin, Brown, Jacobs, Krebs and Singleton (2003)). As such, they eat crops in the field, typically reducing yields of rice by 5 to 10 % (Aplin et al. 2003), 6 % in pineapples (Joomwong 2007) and 5 % in oil palms. They eat, spoil and contaminate stored food and post-harvest losses of 20 % are not unusual. (Aplin et al. 2003)

From all, squirrels are members of the family Sciuridae, consisting of small or medium-size rodents. The family includes tree squirrels, ground squirrels, chipmunks, marmots (including woodchucks), flying squirrels, and prairie dogs. Squirrels have short forelimbs and their toes bear sharp claws, which assist climbing in arboreal species. Their long hind limbs provide the propulsion necessary for leaping. (Antara et al. 2015).

4.8.5.1.2 Method and Methodology

In the proposed project area, characterized by urbanization and the absence of forest-like vegetation or protected areas, large mammal populations are non-existent. To study the small mammal species in this study, a live trapping method was employed. This method involved setting traps to capture small mammals, allowing for their subsequent identification, measurement, and documentation. Weight data were recorded, photographs were taken, and relevant information about the captured species was documented. However, in residential areas, exhibited an abundance of squirrels, live trapping methods were not suitable for capturing them. Nevertheless, the live trapping approach remains valuable for gaining observations into the small mammal species within the proposed project area. Field activities for studying mammal species are shown in Figure 4-128.

4.8.5.1.3 Results

Small animals including tree squirrel species like the Irrawaddy squirrel and rat species like the black rat are observed.

Table 4-91 List of recorded small mammal species

Class	Order	Family	Genus	Species	Common Name	IUCN Status
Mammalia	Rodentia	Muridae	*Rattus*	*Rattus rattus*	Black Rat	LC
Mammalia	Rodentia	Sciuridae	*Callosciurus*	*Callosciurus pygerythrus*	Irrawaddy squirrel	LC

Figure 4-128 Field Activity for Small Mammals Species

Callosciurus pygerythrus

Irrawaddy squirrel

Rattus rattus

Black Rat

Figure 4-129 Photos of Recorded Small Mammal Species

4.8.5.1.4 Discussion and Conclusion

There is only one species, namely *Callosciurus pygerythrus*, under the family Sciuridae, belonging to order Rodentia, and one species of rat, namely *Rattus rattus*, under the family Muridae, also belonging to order Rodentia, that are observed. During the survey, Irrawaddy squirrels were seen in residential areas, villages, and trees, but not in cultivated areas or along rivers. Irrawaddy squirrels are mostly observed in M*ad*huca *longifolia*, *Mangifera indica*, and *Carica papaya*. Irrawaddy squirrels vary in fur color, some squirrels being greyish-brown and reddish-brown, with some squirrels being grizzled. Some squirrels have dark tips of their tails, and pale hip patches. Its head to body length is about 20 centimeters, and its tail length is about 20 centimeters as well. Irrawaddy squirrels weigh approximately 45 grams. It is native to Bangladesh, China, India, Myanmar, and Nepal. Most squirrels that live in Myanmar live west of the Irrawaddy River (Duckworth, 2016).

In the present study, Black rats, *Rattus rattus* was recorded. *Rattus rattus* was only found in cultivated fields, bushes, under tall grasses, and piles of dry leaves. The black rat is black to light brown in color with a lighter underside. It is a generalist omnivore and a serious pest to farmers because it feeds on a wide range of agricultural crops. The species found are in the category of Least Concern. The black rat originated in India and Southeast Asia.

One of the most common causes of habitat destruction and overall environmental change is growing urbanization. The development of roads and agricultural areas and the expansion of residential areas in the Amarapura Township reduce the number of mammals to be observed. Urbanization is one of the most pervasive causes of habitat fragmentation and general landscape change.

4.8.5.2. Birds

4.8.5.2.1 Introduction

“Birds occur on land, sea and freshwater, and in virtually every habitat, from the lowest deserts to the highest mountains (Rahbek and Graves, 2001). Birds constitute one of

the common faunas of all habitat types, and because they are responsive to change, their diversity and abundance can reflect ecological trends in other biodiversity (Furness and Greenwood, 1993)."

"In order to understand the health of the environment it is necessary to use indicators because ecological systems are too complex to measure fully (KBO, 2013). Birds are excellent barometer for the health of the environment (Carignan and Villard, 2002). Birds are also more sensitive to environmental contaminants than other vertebrates, therefore can act as bioindicators (Vashishat and Kler, 2014). Birds are bellwethers of our natural and cultural health as a nation—they are indicators of the integrity of the environments that provide us with clean air and water, fertile soils, abundant wildlife, and the natural resources on which our economic development depends (The State of the Birds, 2009)".

Birds are good indicators and can be used to identify the most biologically rich areas as well as environmental changes and problem. In general, places that are rich in bird species are also rich for other form of biodiversity. Thus, birds can be used as indicators to locate the important areas. Studying birds can talk about the habitats on which people all depend and loss of Asia's threatened birds from many parts of the region is a measure of a more general deterioration in other biodiversity and natural environment (Gill, 1990).

In Southeast Asia, including Myanmar, Thailand, Peninsular, Malaysia, Singapore, Cambodia, Laos and Vietnam, a total of 1327 species are known to occur (Robson, 2015). Myanmar revealed a rich and diverse avifauna, amounting to more than 1027 species (Smythies, 2001). Myanmar has 1086 recorded bird species, five of which are endemic bird to Myanmar, 57 bird species are globally threatened and two have been introduced by humans (Avebase, Birdlife International, 2017).

Simpson's diversity index (also known as species diversity index) is one of a number of diversity indices, used to measure diversity. In ecology, it is often used to quantity the biodiversity of a habitat. It takes into an account the number of species present, as well as the relative abundance of each species. The Simpson index represents the probability that two randomly selected individuals in the habitat will not belong to the same species (Simpson's Diversity Index, 2000)

Since the birds are indicators of the biodiversity, the avian species of the proposed project area, river area, and residential area for the three seasons (wet season, cool season, and hot season) are studied to indicate species composition, relative abundance, species richness, diversity, and IUCN Red List status.

4.8.5.2.2 Method and Methodology

The area of proposed project is 2500 acre (10.11714 km2) and is located between the Ayeyarwady River and Amarapura Township.

In order to find out the bird species, relative abundance, species richness, and diversity located in the large project area, the study method that will match the study area has

been adapted based on the current situations. The study area, study method and data analysis method are described as below.

4.8.5.2.2.1 Study Area

The proposed project area is situated is located between Mandalay City circular road and Ayeyarwady River, Amarapura Township, Mandalay Region. Most parts of the project are covered with seasonal crop field. It lies between 21°52'50"N to 21°56'50"N and 96° 0'7.56"E to 96° 3'17.67"E with area of 2500 acre. Sampling site were stratified based on the habitat type. Three study sites were allocated to observe bird species in proposed project and its environs shown in Figure 4-130 as Site I (Cultivated Area), Site II (River Area) and Site III (Residential Area).

Site I

Site I represented the seasonal crop field and located between the Ayeyarwady River and Mandalay City circular road. This site includes mainly crop field (cucurbit, bitter guard, beans, eggplant, brassica, corn, water melon), bushy area, tall grass, some bare land and occasionally flooded plain. As the crop fields are mainly in Site I, it is allocated as cultivated area.

Site II

Site II represented the Ayeyarwady River and located between the proposed project area and Sagaing Hills. As the site is river, shore, sandy plains, wetlands adjacent to rivers, tall grasses near riparian are found.

Site III

Site III situated to the east of the proposed project area and located between Taungthaman Lake and Mandalay City circular road. The site is inhabited with roads, housing, commercial areas, grass, trees, bushes, various plantation. Since the housing area, commercial areas are mainly in Site III, it is allocated as residential area.

Site I (Cultivated Area)

Bird Watching in Site I

Site II (River Area)

Bird Watching in Site II

Site III (Residential Area)

Bird Watching in Site III

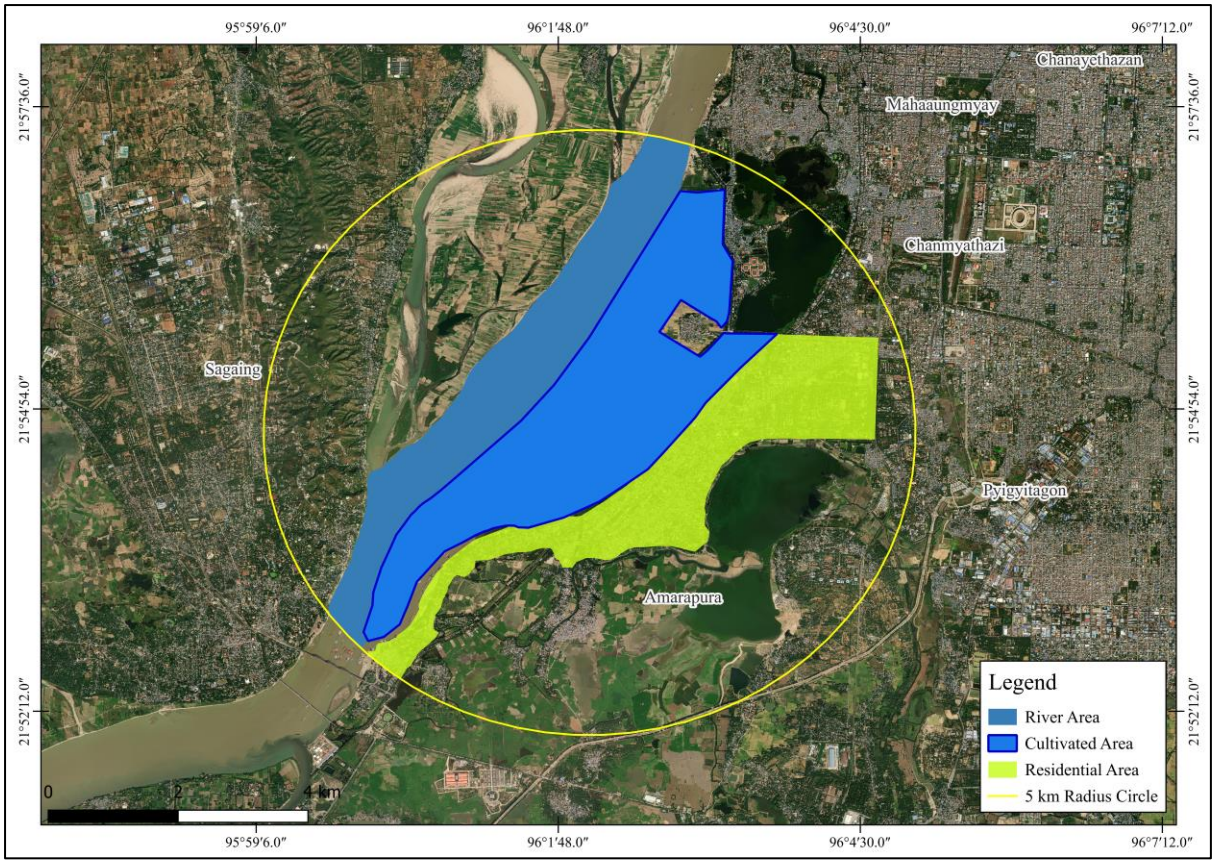


Figure 4-130 Study Area of Bird Species

4.8.5.2.2.2 Study Period

Currently, Myanmar experiences a tropical-monsoon climate with three dominant seasons: the March-to-May hot season, the June-to-October wet season and the November-to-February cool season (Horton, e.t., al, 2017). The field survey was conducted for three seasons as October (Wet Season), December (Cool Season) and March (Hot Season).

4.8.5.2.2.3 Study Design and Data Collection

The collection of data was made using the line transect method. Birds are counted while walking the transect. The transects are 250 m long, with a fixed transect width of 50 m on both sides. The birds are recorded along six transect lines at each site for three seasons. In each transect, 150 m apart were allocated to avoid counting the same bird again.

Binoculars (60 x 90) were used to view the birds, and a Nikon P-900 digital camera was used to capture pictures of them. A bird census was done between the hours of 3 p.m. and 6 p.m. in the afternoon and 6 a.m. to 10 a.m. in the morning, when avian activity is most noticeable. The characteristics of the plumage, size, shape, and color were also recorded. Counting was done by estimating blocks and then verifying with photos for big flocks in flight or at a roost.

Identification of specimens

Identification was done based on the bird's body color, morphological features, call, and flight pattern. Identification and classification of the bird species followed that of Smythies, (2001), Robson, (2007) and (2015), Avebase (2022).

Data analysis

Data entry was done using Microsoft excel and analysis was calculated using species composition formula, relative abundance formula, population density formula, evenness, and diversity formula.

Species Composition

$$Species\ Composition = \frac{Total\ number\ of\ species\ in\ particular\ family\ or\ order}{Total\ number\ of\ all\ species\ recorded} \times 100$$

Relative Abundance

$$Relative\ Abundance = \frac{Number\ of\ individuals\ of\ a\ species}{Total\ number\ of\ individuals\ of\ all\ the\ species} \times 100$$

4.8.5.2.2.4 Criteria for Relative Abundance

Classification of relative abundance index values using criteria as presented in Table 4-92.

Table 4-92 Criteria for Relative Abundance Index Values

Index	Explanation
uC	Uncommon, having relative abundance less than 0.01
C	Common, having relative abundance of 0.01 and above less than 0.05
vC	Very Common, having relative abundance of 0.05 and above

4.8.5.2.2.5 Species Evenness and Richness

Species diversity increases with the complexity of habitat. This diversity considers both the richness and evenness of species. Evenness is a measure of the relative abundance of different species making up the richness of an area. This evenness is an important component of diversity indices (Hill, 1973; Turchi et al., 1995; Leinster and Cobbold, 2012) and expresses evenly distribution of the individuals among different species.

Species Richness (Margalef's (1958) method

Species richness index (R) = $\frac{S-1}{In\ N}$

Where, R is index of species richness (Margalef),

S is total number of species observed,

In is natural logarithm value

N is total number of individuals (all types observed),

Criteria for Richness Index Values

Classification of Margalef richness index values using criteria as presented in Table 4-93.

Table 4-93 Criteria for Margalef Richness Index Values

Index Value	Category
R < 2.5	Low species richness
2.5 > R < 4	Medium species richness
R > 4	High species richness

Evenness (J')

"Evenness Index intended to find out how the data on the number of individuals of one type (abundance of species) is spread out among the many species found (abundance of all types). This is to find out how the number of individuals of one type is scattered in a data sample (community). If all types in a data sample have an individual number that goes to the same number or has the same number of numbers; it shows that the evenness index is equal or not difference. If all types really reach the same number (one number); means that evenness is perfect, and will go to zero (0) as an abundance of uneven or unequal species'' (Latumahina, Mardiatmoko and Sahusilawane, 2020). Pielou's Evenness uses the following formula

$$J' = \frac{H'}{LnS}$$

Where,

J is Pielou's evenness index,

H' is value of Shannon-Wiener's index,

S is total number of species.

Criteria for Evenness Index Value

The evenness index value classification uses the criteria shown in Table 4-94.

Table 4-94 Criteria for Evenness Index Value

Index Value	Category
J' approaches 0	The distribution of individuals between species is uneven / unequal. Unstable species abundance distribution conditions.
J' approaches 1	Distribution of individuals between types is evenly distributed. Stable species abundance distribution conditions.

4.8.5.2.2.6 Diversity

Species evenness, richness, and diversity indices as Shannon-Weiner (Shannon and "Weaver, 1949) and Simpson Index (Simpson, 1949) were used to evaluate the bird species diversity. Shannon-Weiner Index assumes that individuals are randomly sampled from an independent large population and all the species are represented in the sample. Shannon diversity is very widely used index for comparing diversity between various habitats (Clarke and Warwick, 2001). It was calculated in order to know the species diversity in different habitat (Hutchison, 1970) based on the abundance of the species by the following formula":

Shannon-Weiner Index (1949)

$$H' = \sum_{i=1}^{s} \left(\frac{n1}{n}\right) Ln \left(\frac{n1}{n}\right)$$

Where,

H′is Shannon-Wiener Index of Diversity,

S is number of species, n1 is number of individuals in the ith species in the sample

n is total number of individuals in the sample

The presence of one individual of a species is not necessarily indicative of the species being present in a large number. The value of Shannon Weiner Diversity Index usually falls between 1.5 and 3.5, only rarely it surpasses 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species.

Table 4-95 Criteria for Diversity Index Values

Index Value	Category
H'<1	Low diversity
1 > H'< 3	Medium diversity
H'> 3	High diversity

Simpson's Index of Diversity (1949)

The value of this index also ranges between 0 and 1, the greater the value, the greater the sample diversity. It has been measured by the given formula:

$$D = 1 - \sum_{i=1}^{x} \left(\frac{n1(n1-1)}{n(n-1)}\right)$$

Where,

D is Simpson's Index of Diversity

n1 is the number of individuals in the ith species

n is the total number of individuals of all species

Population Density

$$Density = \frac{Number\ of\ Birds}{2 \times L \times W}$$

Where,

D is Density,

L is Total length of transect,

W is1/2 Width of Transect

4.8.5.2.3 Field Survey Results

4.8.5.2.3.1 Seasonal Occurrence and Species Composition

A total of 73 bird species distributed under 57 genera, 42 families and 20 orders were identified and recorded during this study.

The highest composition of species was recorded in order Passeriformes (45.20%), followed by Pelecaniformers (13.70%), Coraciiformes (5.47 %), Columbiformes, Cuculiformes, Charadriiformes (each with 4.11%), Anseriformes, Gruiformes, Charadriiformes (each with 2.74 %), and the remaining eleven orders Ciconiiformes, Anseriformes, Suliformes, Falconiformes, Accipitriformes, Psittaciformes, Strigiformes, Bucerotiformes, Piciformes, Caprimulgiformes, Galliformes (each with 1.34 %). Demonstration graph for the species composition by the order is shown in Figure 4-131. In the present study, the order Passeriformes constitute the highest number of species (33), followed by Pelecaniformes with (10) species while the remaining (18) orders were represented by (1) to (4) species only.

Species occurrence by the habitat type and seasons is shown in Table 4-97. There are 73 kinds of birds in total, 15 of which are migrant species, and 58 of which are resident species. There are also 20 waterbirds to be spotted and listed as shown in Table 4-98. Seasonal per composition of bird species recorded at the study area (cultivated, river and residential area) is shown in Figure 4-133.

With respect to the number of species encountered at each study site, the largest number of species (64) was encountered in Site (I), followed by those of Site (II) with (51) species, and Site (II) with (42) species. However, (28) species as Barn Swallow, Black Drongo, Black Kite, Cinnamon Bittern, Common Iora, Common Myna, Common Tailorbird, Eastern Cattle Egret, Eurasian Tree-Sparrow, Glossy Ibis, House Crow, House Sparrow, House Swift, Indian Roller, Intermediate Egret, Irrawaddy Bulbul, Little Cormorant, Little Egret, Little Green Bee-eater, Plain Prinia, Red-vented Bulbul, Rock Pigeon, Spotted Dove, Vinous-breasted Myna, White Wagtail, White-throated Kingfisher, White-vented Myna, and Yellow Bittern were recorded common to all the study site.

On the other hand, (10) species namely Asian Golden Weaver, Black-winged Stilt, Common Kestrel, Common Moorhen, Dusky Warbler, Great Egret, Green Sandpiper, Purple

Heron, Rain Quail, Wood Sandpiper were encountered only in Site (I). Finally, the three species namely Black-naped Oriole, Plaintive Cuckoo, Ruddy Shelduck were recorded only in Site (II). The four species namely Asian Koel, Graylag Goose, Scarlet-backed Flowerpecker, White-throated Babbler were observed only in Site (III).

Table 4-96 Total number species in family, genus, species and composition of the recorded bird species

Order	Total Number			Species Composition
	Family	Genus	Species	
Passeriformes	19	25	33	45.21
Pelecaniformes	2	6	10	13.70
Coraciiformes	3	3	4	5.48
Columbiformes	1	2	3	4.11
Cuculiformes	1	3	3	4.11
Charadriiformes	1	2	3	4.11
Anseriformes	1	2	2	2.74
Gruiformes	1	1	2	2.74
Charadriiformes	2	2	2	2.74
Ciconiiformes	1	1	1	1.37
Anseriformes	1	1	1	1.37
Suliformes	1	1	1	1.37
Falconiformes	1	1	1	1.37
Accipitriformes	1	1	1	1.37
Psittaciformes	1	1	1	1.37
Strigiformes	1	1	1	1.37
Bucerotiformes	1	1	1	1.37
Piciformes	1	1	1	1.37
Caprimulgiformes	1	1	1	1.37
Galliformes	1	1	1	1.37
Total	42	57	73	

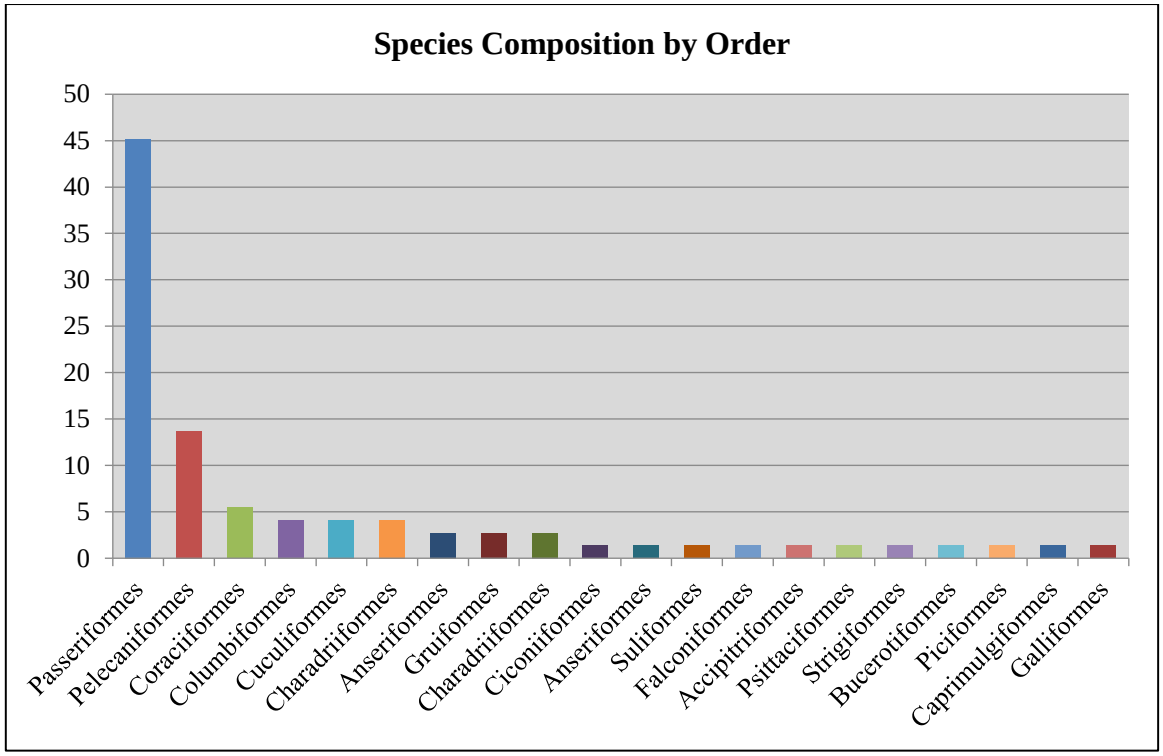


Figure 4-131 Species Composition by Order of the Recorded Bird Species

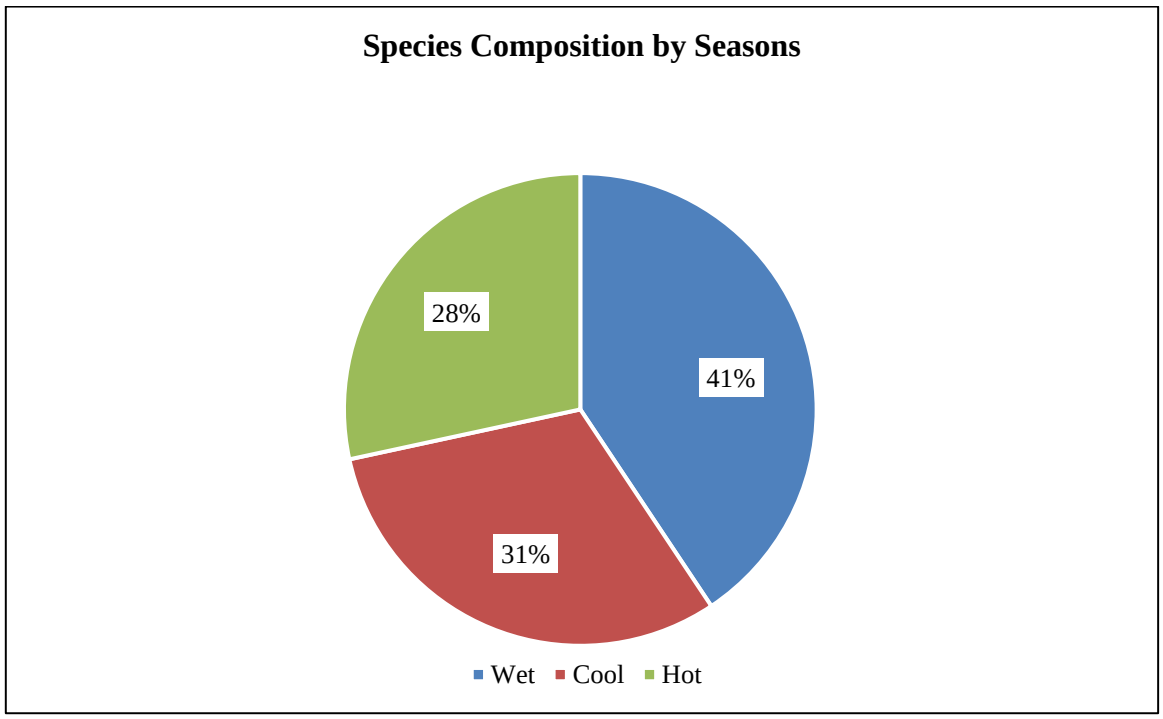


Figure 4-132 Species Composition by Seasons

Table 4-97 List of Birds Observed in Cultivated, River and Residential Area by Seasonally

No.	Common Name	Scientific Name	Study Site			Season			Status	IUCN Status
			Site I	Site II	Site III	Wet	Cool	Hot		
1	Asian Golden Weaver	Ploceus hypoxanthus	✓	-	-	✓	-	✓	R	NT
2	Asian Koel	Eudynamys scolopaceus	-	-	✓	-	-	✓	R	LC
3	Asian Openbill	Anastomus oscitans*	✓	✓	-	-	✓	✓	M	LC
4	Barn Swallow	Hirundo rustica	✓	✓	✓	✓	✓	✓	M	LC
5	Black Drongo	Dicrurus macrocercus	✓	✓	✓	✓	✓	✓	R	LC
6	Black Kite	Milvus migrans	✓	✓	✓	✓	✓	-	R	LC
7	Black-naped Oriole	Oriolus chinensis	-	✓	-	-	✓	-	R	LC
8	Black-winged Stilt	Himantopus himantopus	✓	-	-	-	-	✓	R	LC
9	Blue-tailed Bee-eater	Merops philippinus	✓	-	✓	-	✓	-	R	LC
10	Bluethroat	Luscinia svecica	✓	✓	-	✓	-	✓	M	LC
11	Brown Shrike	Lanius cristatus	✓	✓	-	✓	✓	-	M	LC
12	Chestnut Munia	Lonchura atricapilla	✓	✓	-	✓	✓	✓	R	LC
13	Chinese Pond-heron	Ardeola bacchus*	✓	-	✓	✓	-	-	M	LC
14	Cinnamon Bittern	Ixobrychus cinnamomeus*	✓	✓	✓	✓	✓	✓	R	LC
15	Citrine Wagtail	Motachilla citreola	✓	✓	-	✓	✓	-	M	LC
16	Common Hoopoe	Upupa epops	✓	✓	-	✓	✓	✓	R	LC
17	Common Iora	Aegithina tiphia	✓	✓	✓	✓	✓	-	R	LC
18	Common Kestrel	Falco tinnunculus	✓	-	-	✓	-	-	M	LC
19	Common Moorhen	Gallinula chloropus	✓	-	-	-	✓	✓	M	LC
20	Common Myna	Acridotheres tristis	✓	✓	✓	✓	✓	✓	R	LC

No.	Common Name	Scientific Name	Study Site			Season			Status	IUCN Status
			Site I	Site II	Site III	Wet	Cool	Hot		
21	Common Sandpiper	Actitis hypoleucos*	✓	✓	-	✓	-	✓	M	LC
22	Common Tailorbird	Orthotomus sutorius	✓	✓	✓	✓	✓	-	R	LC
23	Coppersmith Barbet	Psilopogon haemacephala	✓	-	✓	✓	-	-	R	LC
24	Dusky Warbler	Phylloscopus fuscatus	✓	-	-	✓	✓	✓	M	LC
25	Eastern Cattle Egret	Bubulcus coromandus*	✓	✓	✓	✓	-	✓	R	LC
26	Eastern Stonechat	Saxicola maurus	✓	✓	-	✓	✓	✓	R	LC
27	Eurasian collared Dove	Streptopelia decaocto	✓	✓	-	✓	✓	-	R	LC
28	Eurasian Tree-Sparrow	Passer montanus	✓	✓	✓	✓	✓	-	R	LC
29	Glossy Ibis	Plegadis falcinellus*	✓	✓	✓	✓	✓	-	R	LC
30	Graylag Goose	Anser anser*	-	-	✓	-	✓	-	M	LC
31	Great Egret	Ardea alba*	✓	-	-	✓	-	-	R	LC
32	Greater Coucal	Centropus sinensis	✓	-	✓	✓	-	-	R	LC
33	Green Iora	Aegithina viridissima	-	✓	✓	✓	-	✓	R	NT
34	Green Sandpiper	Tringa ochropus*	✓	-	-	✓	-	-	M	LC
35	Grey Heron	Ardea cinerea*	✓	✓	-	✓	✓	-	R	LC
36	House Crow	Corvus splendens	✓	✓	✓	✓	✓	✓	R	LC
37	House Sparrow	Passer domesticus	✓	✓	✓	✓	✓	✓	R	LC
38	House Swift	Apus nipalensis	✓	✓	✓	✓	✓	✓	R	LC
39	Indian Roller	Coracias benghalensis	✓	✓	✓	✓	-	✓	R	LC
40	Indian Spot-billed Duck	Anas poecilorhyncha*	✓	✓	-	✓	✓	✓	R	LC
41	Intermediate Egret	Ardea intermedia*	✓	✓	✓	✓	✓	-	R	LC

No.	Common Name	Scientific Name	Study Site			Season			Status	IUCN Status
			Site I	Site II	Site III	Wet	Cool	Hot		
42	Irrawaddy Bulbul	Pycnonotus blanfordi	✓	✓	✓	✓	✓	✓	R	LC
43	Little Cormorant	Microcarbo niger*	✓	✓	✓	✓	✓	✓	R	LC
44	Little Egret	Egretta garzetta*	✓	✓	✓	✓	✓	✓	R	LC
45	Little Green Bee-eater	Merops orientalis	✓	✓	✓	✓	✓	✓	R	LC
46	Little Ringed Plover	Charadrius dubius*	✓	✓	-	✓	✓	✓	M	LC
47	Oriental Magpie-Robin	Copsychus saularis	-	✓	✓	✓	✓	✓	R	LC
48	Oriental Skylark	Alauda gulgula	✓	✓	-	✓	✓	✓	R	LC
49	Paddy Field Pipit	Anthus rufulus	✓	✓	-	✓	✓	✓	R	LC
50	Pied Bushchat	Saxicola caprata	✓	✓	-	✓	✓	✓	R	LC
51	Plain Prinia	Prinia inornate	✓	✓	✓	✓	✓	✓	R	LC
52	Plaintive Cuckoo	Cacomantis merulinus	-	✓	-	-	-	✓	R	LC
53	Purple Heron	Ardea purpurea*	✓	-	-	✓	-	-	R	LC
54	Purple Sunbird	Cinnyris asiaticus	✓	-	✓	✓	-	-	R	LC
55	Rain Quail	Coturnix coromandelica	✓	-	-	✓	-	-	R	LC
56	Red Avadavat	Amandava amandava	✓	✓	-	✓	✓	✓	R	LC
57	Red-vented Bulbul	Pycnonotus cafer	✓	✓	✓	✓	✓	✓	R	LC
58	Rock Pigeon	Columba livia	✓	✓	✓	✓	✓	✓	R	LC
59	Rose-ringed Parakeet	Psittacula krameria	✓	-	✓	✓	-	-	R	LC
60	Ruddy Shelduck	Tadorna ferruginea*	-	✓	-	-	✓	✓	M	LC
61	Scaly-breasted Munia	Lonchura punctulate	✓	✓	-	✓	✓	✓	R	LC
62	Scarlet-backed	Dicaeum cruentatum	-	-	✓	✓	-	-	R	LC

No.	Common Name	Scientific Name	Study Site			Season			Status	IUCN Status
			Site I	Site II	Site III	Wet	Cool	Hot		
	Flowerpecker									
63	Spotted Dove	Streptopelia chinensis	✓	✓	✓	✓	✓	✓	R	LC
64	Spotted Owlet	Athene brama	✓	-	✓	✓	-	-	R	LC
65	Vinous-breasted Myna	Acridotheres burmannicus	✓	✓	✓	✓	✓	✓	R	LC
66	White Wagtail	Motacilla alba	✓	✓	✓	✓	✓	✓	M	LC
67	White-breasted Waterhen	Amaurornis phoenicurus*	✓	-	✓	✓	-	-	R	LC
68	White-throated Babbler	Argya gularis	-	-	✓	✓	✓	✓	R	LC
69	White-throated Kingfisher	Halcyon smyrnensis	✓	✓	✓	✓	✓	-	R	LC
70	White-vented Myna	Acridotheres grandis	✓	✓	✓	✓	✓	✓	R	LC
71	Wood Sandpiper	Tringa glareola*	✓	-	-	✓	-	-	M	LC
72	Yellow Bittern	Ixobrychus sinensis*	✓	✓	✓	✓	-	-	R	LC
73	Zitting Cisticola	Cisticola juncidis	✓	✓	-	-	-	✓	R	LC

M-Migratory R-Resident LC- Least Concern NT- Near Threatened *- Water Bir

M-Migratory R-Resident LC- Least Concern NT- Near Threatened *- Water Bir

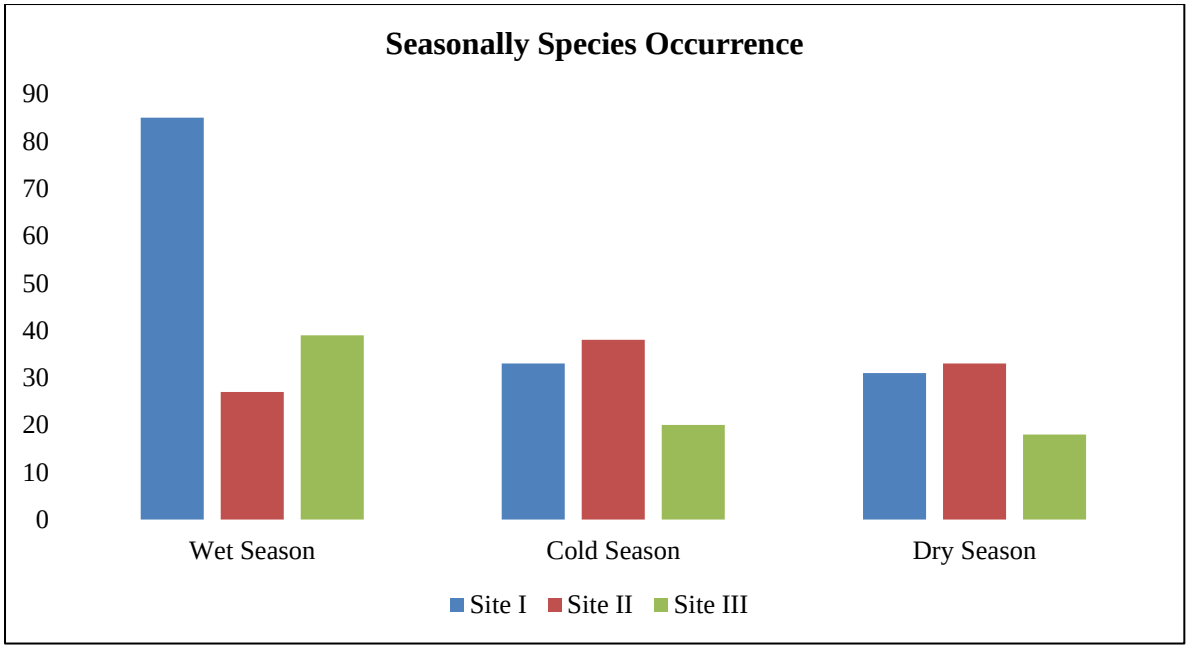


Figure 4-133 Demonstration Graph of Birds Observed in Cultivated, River and Residential Area by Seasonally

4.8.5.2.3.2 Relative Abundance

The result of relative abundance of bird species by seasonally is shown in Table 4-98 and Figure 4-134. The result show that hot season has bird species which are "very common", followed by wet season and cool season. Moreover, the cool season has bird species that are "uncommon", followed by hot season and wet season.

Table 4-98 Seasonally abundance and status of birds in the studied areas.

No.	Species Common Name	Number of Species by Seasons					
		WET		COOL		HOT	
		R.A	I.A	R.A	I.A	R.A	I.A
1	Asian Gloden Weaver	0.00	uC	0.00	uC	0.00	uC
2	Asian Koel	0.00	uC	0.00	uC	0.00	uC
3	Asian Openbill	0.00	uC	0.01	C	0.00	uC
4	Barn Swallow	0.07	vC	0.10	vC	0.11	vC
5	Black Drongo	0.02	C	0.01	C	0.01	C
6	Black Kite	0.05	vC	0.01	C	0.00	uC
7	Black-naped Oriole	0.00	uC	0.00	uC	0.00	uC
8	Black-winged Stilt	0.00	uC	0.00	uC	0.00	uC
9	Blue-tailed Bee-eater	0.00	uC	0.01	C	0.00	uC
10	Bluethroat	0.01	C	0.00	uC	0.00	uC
11	Brown Shrike	0.00	uC	0.00	uC	0.00	uC
12	Chestnut Munia	0.09	vC	0.03	C	0.03	C

No.	Species Common Name	Number of Species by Seasons					
		WET		COOL		HOT	
		R.A	I.A	R.A	I.A	R.A	I.A
13	Chinese Pond-heron	0.01	C	0.00	uC	0.00	uC
14	Cinnamon Bittern	0.00	uC	0.01	C	0.02	C
15	Citrine Wagtail	0.01	C	0.00	uC	0.00	uC
16	Common Hoopoe	0.01	C	0.00	uC	0.00	uC
17	Common Iora	0.00	uC	0.00	uC	0.00	uC
18	Common Kestrel	0.00	uC	0.00	uC	0.00	uC
19	Common Moorhen	0.00	uC	0.00	uC	0.00	uC
20	Common Myna	0.06	vC	0.07	vC	0.08	vC
21	Common Sandpiper	0.00	uC	0.00	uC	0.01	C
22	Common Tailorbird	0.00	uC	0.01	C	0.00	uC
23	Coppersmith Barbet	0.00	uC	0.00	uC	0.00	uC
24	Dusky Warbler	0.01	C	0.00	uC	0.00	uC
25	Eastern Cattle Egret	0.03	C	0.00	uC	0.01	C
26	Eastern Stonechat	0.03	C	0.05	vC	0.02	C
27	Eurasian collared Dove	0.00	uC	0.00	uC	0.00	uC
28	Eurasian Tree-Sparrow	0.06	vC	0.00	uC	0.00	uC
29	Glossy Ibis	0.01	C	0.00	uC	0.00	uC
30	Graylag Goose	0.00	uC	0.00	uC	0.00	uC
31	Great Egret	0.00	uC	0.00	uC	0.00	uC
32	Greater Cocal	0.00	uC	0.00	uC	0.00	uC
33	Green Iora	0.00	uC	0.00	uC	0.00	uC
34	Green Sandpiper	0.00	uC	0.00	uC	0.00	uC
35	Grey Heron	0.00	uC	0.00	uC	0.00	uC
36	House Crow	0.07	vC	0.15	vC	0.08	vC
37	House Sparrow	0.05	vC	0.13	vC	0.18	vC
38	House Swift	0.01	C	0.09	vC	0.05	vC
39	Indian Roller	0.00	uC	0.00	uC	0.00	uC
40	Indian Spot-billed Duck	0.00	uC	0.02	C	0.02	C
41	Intermediate Egret	0.03	C	0.00	uC	0.00	uC
42	Irrawaddy Bulbul	0.02	C	0.01	C	0.04	C
43	Little Cormorant	0.01	C	0.02	C	0.01	C
44	Little Egret	0.02	C	0.04	C	0.01	C
45	Little Green Bee-eater	0.04	C	0.03	C	0.02	C

No.	Species Common Name	Number of Species by Seasons					
		WET		COOL		HOT	
		R.A	I.A	R.A	I.A	R.A	I.A
46	Little Ringed Plover	0.01	C	0.00	uC	0.00	uC
47	Oriental Magpie-Robin	0.00	uC	0.00	uC	0.00	uC
48	Oriental Skylark	0.00	uC	0.00	uC	0.00	uC
49	Paddyfield Pipit	0.01	C	0.01	C	0.01	C
50	Pied Bushchat	0.00	uC	0.00	uC	0.01	C
51	Plain Prinia	0.01	C	0.01	C	0.01	C
52	Plaintive Cuckoo	0.00	uC	0.00	uC	0.00	uC
53	Purple Heron	0.00	uC	0.00	uC	0.00	uC
54	Purple Sunbird	0.00	uC	0.00	uC	0.00	uC
55	Rain Quail	0.00	uC	0.00	uC	0.00	uC
56	Red Avadavat	0.02	C	0.01	C	0.02	C
57	Red-vented Bulbul	0.01	C	0.01	C	0.03	C
58	Rock Pigeon	0.02	C	0.00	uC	0.06	vC
59	Rose-ringed Parakeet	0.00	uC	0.00	uC	0.00	uC
60	Ruddy Shelduck	0.00	uC	0.02	C	0.01	C
61	Scaly-breasted Munia	0.02	C	0.04	C	0.06	vC
62	Scarlet-backed Flowerpecker	0.00	uC	0.00	uC	0.00	uC
63	Spotted Dove	0.03	C	0.01	C	0.02	C
64	Spotted owlet	0.00	uC	0.00	uC	0.00	uC
65	Vinous-breasted Myna	0.04	C	0.00	uC	0.04	C
66	White Wagtail	0.03	C	0.04	C	0.01	C
67	White-breasted Waterhen	0.00	uC	0.00	uC	0.00	uC
68	White-throated Babbler	0.00	uC	0.01	C	0.01	C
69	White-throated Kingfisher	0.00	uC	0.00	uC	0.00	uC
70	White-vented Myna	0.04	C	0.01	C	0.01	C
71	Wood Sandpiper	0.00	uC	0.00	uC	0.00	uC
72	Yellow Bittern	0.00	uC	0.00	uC	0.00	uC
73	Zitting Cisticola	0.00	uC	0.00	uC	0.00	uC

I.A – Index of Abundance R.A – Relative Abundance

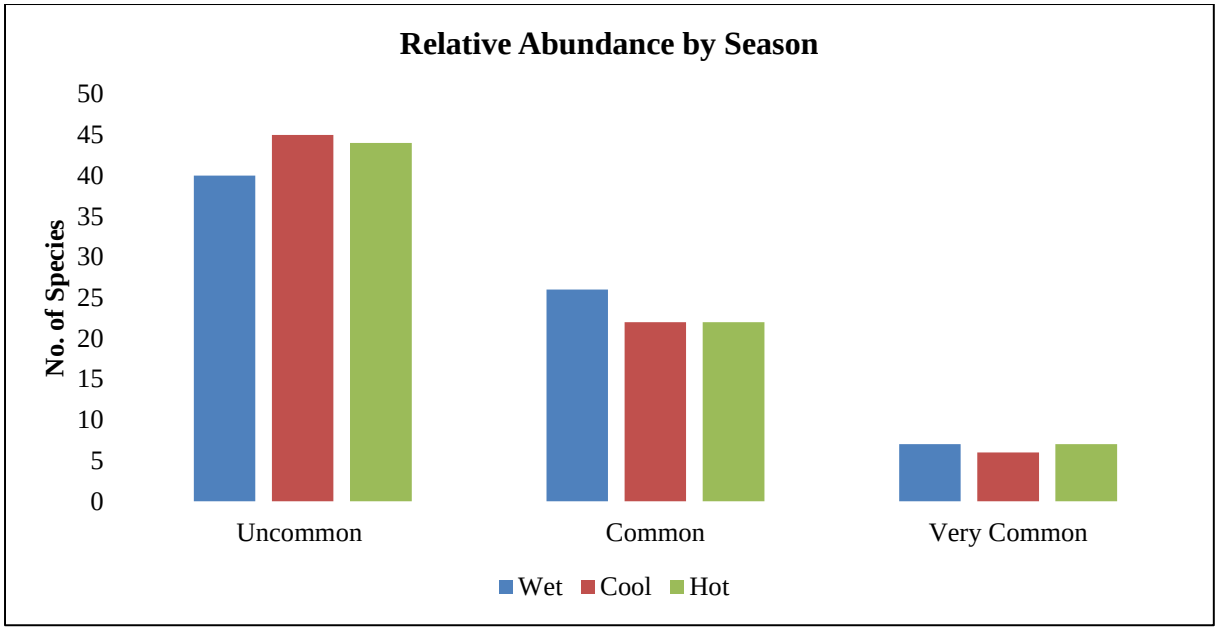


Figure 4-134 Relative Abundance by Season

4.8.5.2.3.3 Population Density

The results, as indicated in Table 4-99 showed that the hot season had the highest bird species (5402/km2) followed by cool season (5244/km2) and wet season (3376/km2).

House Sparrow, House Crow, Barn Swallow, Common Myna, House Swift, Scaly-breasted Munia, Chestnut Munia, Eastern Stonechat, Little Green Bee-eater, White Wagtail, Vinous-breasted Myna, Rock Pigeon, Little Egret, Irrawaddy Bulbul, Spotted Dove, Red Avadavat, White-vented Myna, Black Kite, Red-vented Bulbul, Indian Spot-billed Duck, Eurasian Tree-Sparrow, Little Cormorant, Black Drongo, Eastern Cattle Egret, Cinnamon Bittern, Ruddy Shelduck, Plain Prinia, Paddyfield Pipit, were the most abundant species while Common Iora, Coppersmith Barbet, Rose-ringed Parakeet, Zitting Cisticola, Asian Koel, Grey Heron, Plaintive Cuckoo, Yellow Bittern, Common Moorhen, Green Sandpiper, Purple Sunbird, Scarlet-backed Flowerpecker, Asian Golden Weaver, Spotted owlet, White-breasted Waterhen, Wood Sandpiper, Greater Cocal, Purple Heron, Black-naped Oriole, Black-winged Stilt, Common Kestrel, Rain Quail seemed to be the rare species.

Table 4-99 Population Density of Bird Species by Seasonally (Birds/km2)

No.	Species Common Name	Number of Species by Season			Total	Mean
		Wet	Cool	Hot		
1	Asian Golden Weaver	2	0	4	7	2
2	Asian Koel	0	0	11	11	4
3	Asian Openbill	0	58	18	76	25
4	Barn Swallow	222	522	602	1347	449
5	Black Drongo	58	73	29	160	53
6	Black Kite	178	51	0	229	76

No.	Species Common Name	Number of Species by Season			Total	Mean
		Wet	Cool	Hot		
7	Black-naped Oriole	0	2	0	2	1
8	Black-winged Stilt	0	0	2	2	1
9	Blue-tailed Bee-eater	0	49	0	49	16
10	Bluethroat	20	0	9	29	10
11	Brown Shrike	4	20	0	24	8
12	Chestnut Munia	289	151	144	584	195
13	Chinese Pond-heron	31	0	0	31	10
14	Cinnamon Bittern	9	56	93	158	53
15	Citrine Wagtail	44	4	0	49	16
16	Common Hoopoe	18	2	9	29	10
17	Common Iora	11	2	0	13	4
18	Common Kestrel	2	0	0	2	1
19	Common Moorhen	0	4	4	9	3
20	Common Myna	200	358	422	980	327
21	Common Sandpiper	9	0	33	42	14
22	Common Tailorbird	4	29	0	33	11
23	Coppersmith Barbet	13	0	0	13	4
24	Dusky Warbler	33	20	9	62	21
25	Eastern Cattle Egret	89	0	71	160	53
26	Eastern Stonechat	89	244	122	456	152
27	Eurasian collared Dove	4	11	0	16	5
28	Eurasian Tree-Sparrow	187	4	0	191	64
29	Glossy Ibis	38	9	0	47	16
30	Graylag Goose	0	18	0	18	6
31	Great Egret	16	0	0	16	5
32	Greater Cocal	4	0	0	4	1
33	Green Iora	2	0	16	18	6
34	Green Sandpiper	9	0	0	9	3
35	Grey Heron	7	4	0	11	4
36	House Crow	249	767	456	1471	490
37	House Sparrow	184	664	962	1811	604
38	House Swift	27	498	276	800	267
39	Indian Roller	9	0	13	22	7
40	Indian Spot-billed Duck	2	120	91	213	71
41	Intermediate Egret	91	4	0	96	32

No.	Species Common Name	Number of Species by Season			Total	Mean
		Wet	Cool	Hot		
42	Irrawaddy Bulbul	56	47	193	296	99
43	Little Cormorant	44	111	31	187	62
44	Little Egret	71	227	64	362	121
45	Little Green Bee-eater	142	162	129	433	144
46	Little Ringed Plover	36	20	9	64	21
47	Oriental Magpie-Robin	7	13	11	31	10
48	Oriental Skylark	13	11	4	29	10
49	Paddyfield Pipit	22	40	38	100	33
50	Pied Bushchat	13	9	40	62	21
51	Plain Prinia	44	42	44	131	44
52	Plaintive Cuckoo	0	0	11	11	4
53	Purple Heron	4	0	0	4	1
54	Purple Sunbird	9	0	0	9	3
55	Rain Quail	2	0	0	2	1
56	Red Avadavat	67	78	102	247	82
57	Red-vented Bulbul	18	64	138	220	73
58	Rock Pigeon	60	4	304	369	123
59	Rose-ringed Parakeet	13	0	0	13	4
60	Ruddy Shelduck	0	89	53	142	47
61	Scaly-breasted Munia	64	233	313	611	204
62	Scarlet-backed Flowerpecker	9	0	0	9	3
63	Spotted Dove	118	40	102	260	87
64	Spotted owlet	7	0	0	7	2
65	Vinous-breasted Myna	127	20	224	371	124
66	White Wagtail	104	200	67	371	124
67	White-breasted Waterhen	7	0	0	7	2
68	White-throated Babbler	16	33	44	93	31
69	White-throated Kingfisher	4	13	0	18	6
70	White-vented Myna	124	40	67	231	77
71	Wood Sandpiper	7	0	0	7	2
72	Yellow Bittern	11	0	0	11	4
73	Zitting Cisticola	0	0	13	13	4
	Total	3376	5244	5402		
	Average	46	72	74		

4.8.5.2.3.4 Diversity

Seasonally species richness, diversity, evenness of bird species in the three-study area. Diversity indices of recorded bird species by seasons is shown in Table 4-100.

Table 4-100 Diversity indices of bird species

Season	No. of Species	Total Individual	Population Density (Bird/km2)	Species Richness (R)	Evenness (J')	Shannon-Wiener (H')	Simpson Diversity (D)
Wet	63	1519	3376	8.46	0.84	3.48	0.95
Cool	48	2360	5244	6.05	0.78	3.01	0.93
Hot	44	2431	5402	5.52	0.80	3.01	0.93

Margalef Richness Index (R)

The Margalef Richness Index Value (R), shows that the data in the study periods have a high bird species richness index, since there are the values greater than the richness index (R>4) in all seasons.

Shanon-Winer Diversity Index (H')

The Shanon-Winer Diversity Index Value (H') shows that all three seasons have a high species diversity index value, with the diversity index value ranging from 3.01 to 3.48 (H'> 3). This condition means the number of species are rich in all three seasons while the total number of individuals recorded in all seasons is 6310.

Simpson's Index of Diversity (D)

The value of *D* will always fall between 0 and 1, where 1 denotes complete diversity and 0 represents complete uniformity. In the above table, the higher value in the Wet Season shows which is appears to be more diverse in species than in Cool and Hot Season. But all three seasons have a diversity index value ranging from 0.93 to 0.95.

Evenness Index (J')

Evenness Index Value (E) shows that all three seasons had an Evenness Index, with an evenness index value of 0.78 to 0.84 (evenness conditions that are between the numbers 0 and 1). Wet Season has the value of evenness that all species are more equally abundant to compare with the cool and hot season.

4.8.5.2.3.5 Recorded Bird Species

Asian Openbill
Anastomus oscitans

Barn Swallow
Hirundo rustica

Black Drongo
Dicrurus macrocercus

Black Kite
Milvus migrans

Black-naped Oriole
Oriolus chinensis

Black-winged Stilt
Himantopus himantopus

Blue-tailed Bee-eater
Merops philippinus

Bluethroat
Luscinia svecica

Brown Shrike
Lanius cristatus

Chestnut Munia
Lonchura atricapilla

Cinnamon Bittern
Ixobrychus cinnamomeus

Citrine Wagtail
Motacilla citreola

Common Hoopoe
Upupa epops

Common Moorhen
Gallinula chloropus

Common Myna
Acridotheres tristis

Common Sandpiper
Actitis hypoleucos

Dusky Warbler
Phylloscopus fuscatus

Eastern Cattle Egret
Bubulcus coromandus

Eastern Stonechat
Saxicola maurus

Eurasian collared Dove
Streptopelia decaocto

Eurasian Tree-Sparrow
Passer montanus

Glossy Ibis
Plegadis falcinellus

Great Egret
Ardea alba

Grey Heron
Ardea cinerea

House Crow
Corvus splendens

House Sparrow
Passer domesticus

Indian Spot-billed Duck
Anas poecilorhyncha

Indian Spot-billed Duck
Anas poecilorhyncha

Intermediate Egret
Mesophoyx intermedia

Irrawaddy Bulbul
Pycnonotus blanfordi

Indian Roller
Coracias benghalensis

Little Cormorant
Phalacrocorax niger

Little Egret
Egretta garzetta

Little Green Bee-eater
Merops orientalis

Little Ringed Plover
Charadrius dubius

Oriental Magpie-Robin
Copsychus saularis

Oriental Skylark
Alauda gulgula

Paddyfield Pipit
Anthus rufulus

Plain Prinia
Prinia inornata

Plainive Cuckoo
Cacomantis merulinus

Red Avadavat
Amandava amandava

Red-vented Bulbul
Pycnonotus cafer

Rock Pigeon
Columba livia

Ruddy Shelduck
Tadorna ferruginea

Scaly-breasted Munia
Lonchura punctulata

Spotted Dove
Streptopelia decaocto

Spotted Owlet
Athene brama

Vinous-breasted Myna
Acridotheres burmannicus

White Wagtail
Motacilla alba

White-throated Babbler
Turdoides gularis

White-throated Kingfisher
Halcyon smyrnensis

White-vented Myna
Acridotheres grandis

Pied Bushchat
Saxicola caprata

Zitting Cisticola
Cisticola juncidis

Figure 4-135 Photos of Recorded Birds Species

4.8.5.2.4 Discussion and Conclusion

During the period of this study, a total of 73 bird species belonging to 57 genera, 42 families, and 20 orders have been identified and documented. 20 species of water birds, representing 16 genera, 10 families, and 8 orders, were identified among the recored species.

The highest composition of species was recorded in the order Passeriformes (45.20%), followed by Pelecaniformers (13.70%), Coraciiformes (5.47%), Columbiformes, Cuculiformes, Charadriiformes (each with 4.11%), Anseriformes, Gruiformes, Charadriiformes (each with 2.74%), and the remaining eleven orders Ciconiiformes, Anseriformes, Suliformes, Falconiformes, Accipitriformes, Psittaciformes, Strigiformes, Bucerotiformes, Piciformes, Caprimulgiformes, and Galliformes. The order Passeriformes has the most species (33), followed by Pelecaniformes with (10) species, while the rest (18) orders are represented only by (1) to (4) species in the current study. Passerines are globally distributed and are among the most abundant birds at nearly every terrestrial location on Earth (Schmitt and Edwards, 2022). According to the number of species found at each research location, Site (I) had the most species (64), followed by Site (II), which had (51) and Site (II), which had (42) respectively.

In the present study, order Passeriformes was recorded the highest number of families than the other order. Roboson (2015) reported the order Passeriformes represent as largest order among all recorded bird in South East Asia. So, it agreed with the result of present study.

Among the seasonal records, the diversity of Shannon-Wiener's Index value (H') was 3.48 in the wet season and 3.01 in the cool season, and hot season, respectively. It is because of the both the migration birds and terrestrial birds were recorded in the wet season and were less common in the hot and cool seasons. Although the largest number of species (63) is recorded in the wet season, the number of individuals is low compared with the cool and hot seasons. Only in the wet season, Chinese Pond-Heron, Common Kestrel, Coppersmith Barbet, Purple Heron, Purple Sunbird, Rain Quail, Rose-ringed Parakeet, Scarlet-backed Flowerpecker, White-breasted Waterhen, Wood Sandpiper, and Yellow Bittern recorded. In terms of bird's species diversity in wet season, Shannon Weiner and Simpson indices a value of 3.48 and 0.95 respectively, while, the value of the evenness of bird species gave a value of 0.84.

It was concluded that the high population distribution of bird species recorded in the wet season indicated that the wet season was very rich in plant species and a favorable climatic condition, attracting a diverse number of bird species. The relative abundance of bird species during seasons might be related to the availability of food, habitat condition and breeding season of the species (Gaston, Blackburn, Greenwood, Gregory, Quinn and Lawton, 2000). The distribution of abundance of many bird species are determined by the composition of the vegetation that forms a major element of their habitats. As vegetation changes along the environmental gradients, a particular bird species may appear, increase or decrease in number, and disappear as the habit changes (Roboson, 2015). Hence, the wet season has the high diversity and abundance of bird species types as a result of prosperous food, good vegetations, and field activities (ploughing, sowing) can cause insects and larva which can be easily be eaten by bird. The cultivated area having a mixture of green patches, tall grasses, bushes, shrub, and thorny scrub could promote the high diversity includes a wide variety of resources, high reproduction rate in the wet season. Although human settlement and

interference have occurred in all study areas, it has been documented that bird species have managed to exit and thrive in these habitats.

While we were conducting the surveys, the foliage on the trees was minimal and there are plenty of grass, shrub and bushes. In wet season, the weather had warmed and caused the vegetation to blossom, creating new layers of foliage. Plant species can directly or indirectly affect type of resources, food the abundance and available to birds. As the foliage, and vegetation layers are increased, the level of insects, a food resource for many birds, would increase as well. Most of the bird species found in wet seasons are found in bushes, tall grasses, and cultivated areas because insects are in high abundance in wet seasons. Most birds are likely to position themselves to hide in the bushes, and tall grass causes birds to have to protect themselves from predators. It can be concluded that resources are abundant in the wet season in the study area, which is why birds, including winter visitors, can migrate, breed, and utilize the plenty of resources.

4.8.5.3. Insect

4.8.5.3.1 Butterfly

4.8.5.3.1.1 Introduction

Butterflies are suitable for biodiversity studies, as the taxonomy, geographic distribution and status of many species are relatively well known. Further, butterflies are good biological indicator of habitat quality as well as general environmental health (Larsen, 1988), as many species are strictly seasonal and prefer only particular set of habitats. (Kunte, 1997).

A butterfly is a winged insect with scales on its wings. Butterflies come in a variety of colors, sizes, and patterns. It is estimated that there are around 20,000 different butterfly species. These different types of butterflies live all around the world. In all ecosystems, butterflies are essential to plants that depend on cross-pollination. They visit flowering plants, feeding on the nectar found in the flowers and assisting in the pollination process.

Some butterflies also migrate. The monarch butterfly is best known for its migration, traveling many miles across North America to California and Mexico for the winter months. Several other species also migrate, but to a lesser degree, traveling shorter distances to their winter habitats.

Butterflies live in many different types of habitats as they can be found on every continent, except Antarctica. You can find some butterflies in deserts while others live in rainforests. Some live where it is very hot while others live in more moderate climates (Seamons, 2003).

The use of butterflies as indicator species as biological measure of ecosystem health motivates the quest to determine the best data collection in methods and model of population dynamics to aid in conservation and management of butterflies

(Thomas, 2005) Life of butterflies mainly depend upon the all plants and water. They distribute geographically and seasonally (Scudder et al., 2007).

Butterflies are found throughout the world and in all types of environments hot and cold, dry and moist at sea level and mountains. Abundance of butterfly species in a place indicates healthy environment. Butterflies, like plants and other animals need sun to keep their bodies warm in order to fly and visit one flowering plant after another to gather their food source. Climatic conditions that affect the activities of the butterfly species. Butterflies are associated with warm, sunny days when they fly purposefully, visiting flowers pursuing mates and sparing with in trader (Willians, 2009).

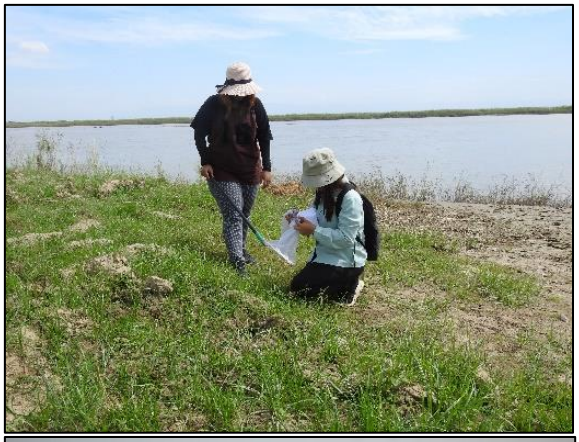
Benefiting plants in the process of pollination and on the other hand, the plant serves as food or host plant for the larva to undergo the life cycle for butterfly. The abundance of butterfly species in an environment indicates the rich flora in this area (Gooden, 1975).

Many butterfly species are strictly seasonal indicators in terms of anthropogenic disturbance and habitat quality (Kocher and Williams, 2000). Butterflies enable sustenance of ecosystem service through their role in pollination and serving as important food chain component. They also serve as indicator of health and quality of their host plant and the ecosystem as a whole. Lepidoptera community assembly and the factors which influence it have long been a topic of interest to ecologists and conservationists. Human dominated landscape forms a substantial and ever-increasing amount of the earth's surface. These modified habitats often influence butterfly species and their dynamics (Gascon et al., 1999 and Rickets et al., 200l). (Yager et al., 2018)

4.8.5.3.1.2 Materials and Methods

4.8.5.3.1.2.1 Study Area


Cultivated Area

River Area


Residential Area

Figure 4-136 Photos of Three Different Study Area

4.8.5.3.1.2.2 Study Design and Data Collection

Butterfly censuses were made in three study areas. The survey was made by using transect method and each line was drawn in 250 meters in length with 5 meters on either side. All butterflies within 5 m of observer were recorded and identified and Nikon P-900 digital camera was used to capture pictures of them during field study. If it is not easy to identify, a net was utilized to capture butterflies for identification and put in the envelope. After that, the collected specimens were pinned through the middle of mesothorax and wings were spread out with the aid of setting needles and forceps and secured with paper strips on foam sheets.

Catching insects by nets

Collecting specimens by putting them into envelope

Attaching collected specimens by pins

Figure 4-137 Photos of Three Steps of Identification of Data Collection

4.8.5.3.1.2.3 Identification of specimens

Identification of the recorded species, based on the natural color and markings of the specimens were followed after Abrera (1998), Morgan (2013) and Khoon (2015).

4.8.5.3.1.2.4 Data Analysis

The data were calculated using the following formula., The recorded data were analyzed by using the following formula.

- Species Composition
- Relative Abundance

The data analysis method and criteria for index values are mentioned in paragraph 4.8.5.2.2.

4.8.5.3.1.3 Butterfly Survey Results

4.8.5.3.1.3.1 Seasonal Occurrence and Species Composition

According to field survey results, a total of 22 butterfly species into 17 genera and 3 families were recorded and identified.

Table 4-101 Relative Abundance of Butterfly Species in Three Seasons in Study Area

Scientific Name	Total Number of Individuals												Species Total	Relative Abundance	Average Relative Abundance
	Wet Season				Cool Season				Hot Season						
	C.A	Rd.A	R.A	T	C.A	Rd.A	R.A	T	C.A	Rd.A	R.A	T			
Danaus chrysippus	17	27	22	**66**	2	16	21	**39**	3	5	0	**8**	113	0.27	vC
Danaus genutia	0	3	2	**5**	0	1	0	**1**	0	0	0	**0**	6	0.01	C
Tirumala limniace	0	4	0	**4**	0	6	0	**6**	0	1	0	**1**	11	0.03	C
Leptotes plinius	20	14	19	**53**	7	5	37	**49**	0	0	0	**0**	102	0.24	vC
Eurema blanda	14	11	27	**52**	4	21	23	**48**	0	3	0	**3**	103	0.24	vC
Ariadne ariadne	0	0	0	**0**	0	5	3	**8**	0	0	0	**0**	8	0.02	C
Junonia almana	0	0	0	**0**	0	1	1	**2**	0	0	0	**0**	2	0.00	uC
Junonia orithya	1	0	0	**1**	0	0	0	**0**	0	0	0	**0**	1	0.00	uC
Junonia lemonias	2	0	0	**2**	0	2	0	**2**	0	2	0	**2**	6	0.01	C
Acraea terpsicore	0	0	0	**0**	0	1	0	**1**	0	0	0	**0**	1	0.00	uC
Freyeria putli	6	0	0	**6**	0	0	0	**0**	11	0	5	**16**	22	0.05	vC
Zizula hylax	12	0	14	**26**	0	0	0	**0**	0	0	0	**0**	26	0.06	vC
Catopsilia pyranthe pyranthe	0	3	0	**3**	2	2	0	**4**	1	0	3	**4**	11	0.03	C
Appias libythea alferna	3	0	0	**3**	0	0	0	**0**	0	0	0	**0**	3	0.01	C
Catopsilia pomona pomona	2	0	0	**2**	0	0	0	**0**	0	0	0	**0**	2	0.00	uC
Mycalesis mineus	1	0	0	**1**	0	0	0	**0**	0	0	0	**0**	1	0.00	uC
Ypthima baldus	0	1	0	**1**	0	0	0	**0**	0	2	0	**2**	3	0.01	C
Lampides boeticus	1	0	0	**1**	0	0	0	**0**	0	0	0	**0**	1	0.00	uC
Cepora pactolicus	0	1	0	**1**	0	0	0	**0**	0	0	0	**0**	1	0.00	uC

Ixias undatus	1	0	0	**1**	0	0	0	**0**	0	0	0	**0**	1	0.00	uC
Appias epaphia	0	0	0	**0**	0	0	0	**0**	0	1	0	**1**	1	0.00	uC
Appias olferna	0	1	0	**1**	0	0	0	**0**	0	0	0	**0**	1	0.00	uC
Total Number of Species	80	65	84	**229**	15	60	85	**160**	15	14	8	**37**	**426**		

uC – Uncommon C- Common vC – Very common

C.A – Cultivated Area Rd.A – Residential Area R.A – River Area

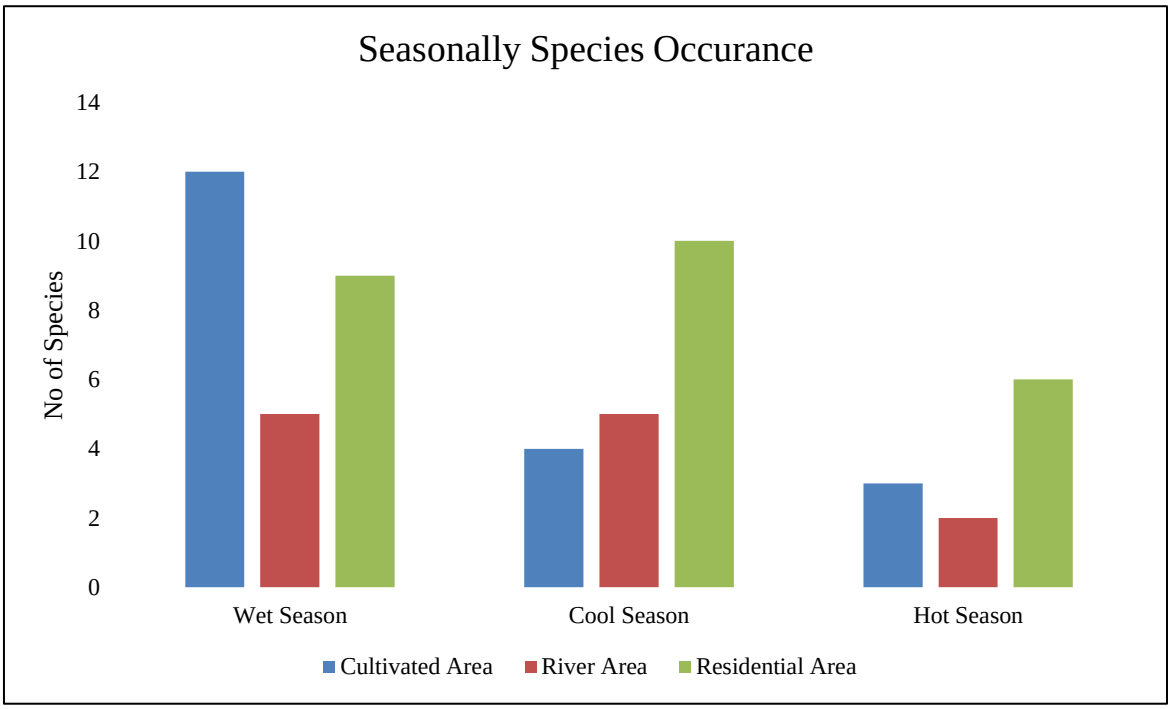


Figure 4-138 Seasonally Species Occurrence

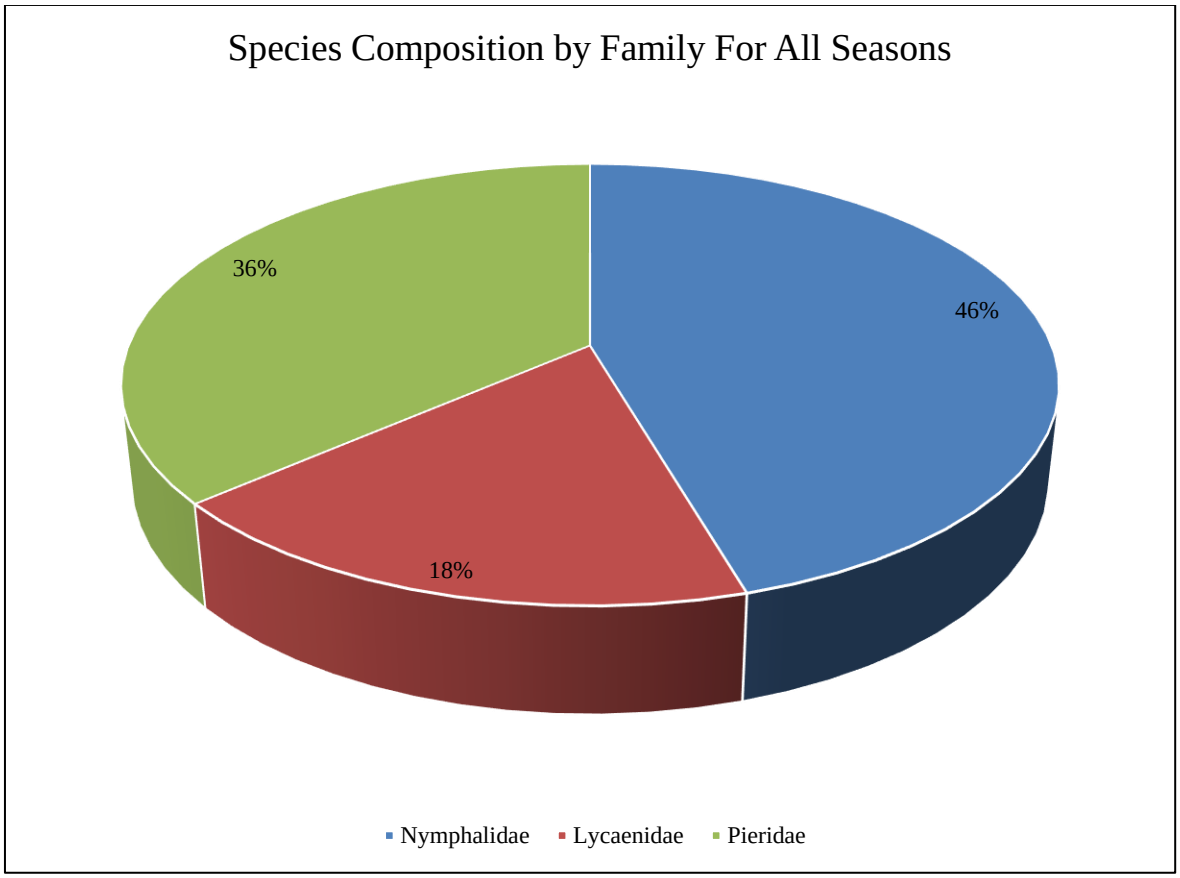


Figure 4-139 Species Composition by Family for All Season in Study Area

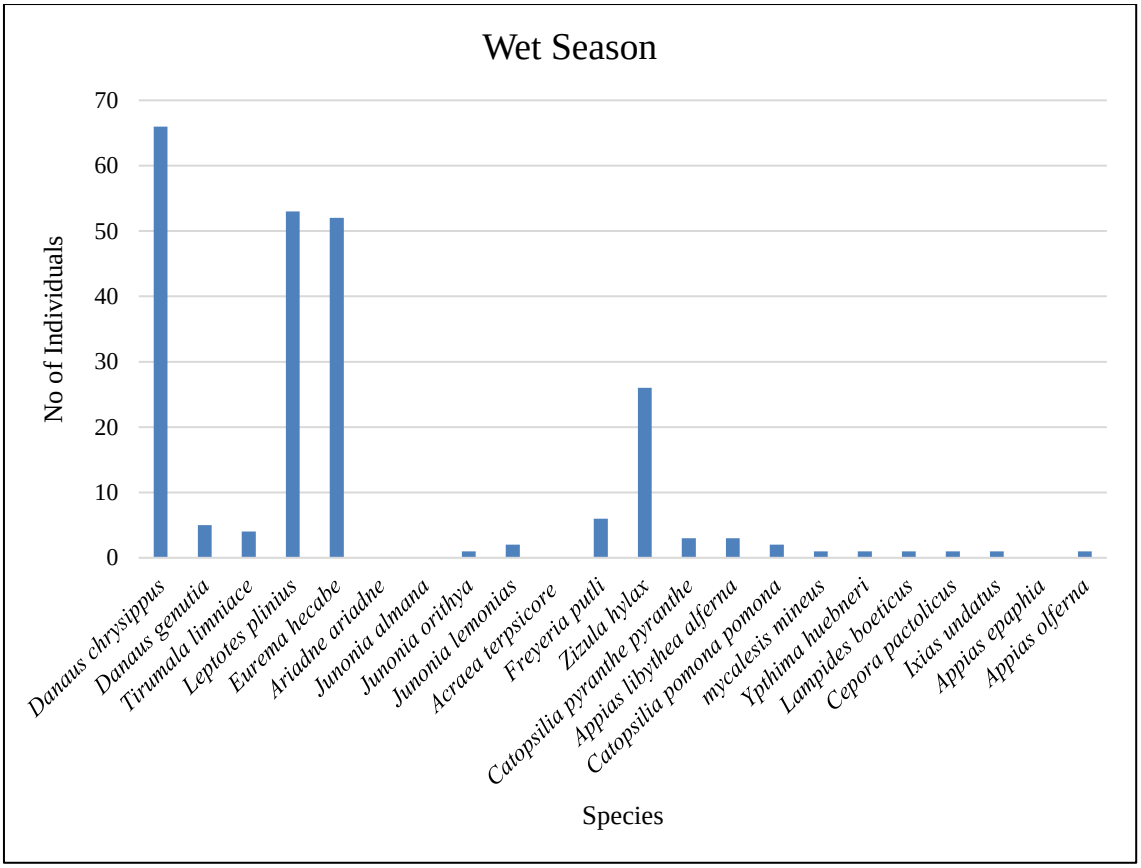


Figure 4-140 Total Number of Butterfly Species in Wet Season in Study Area

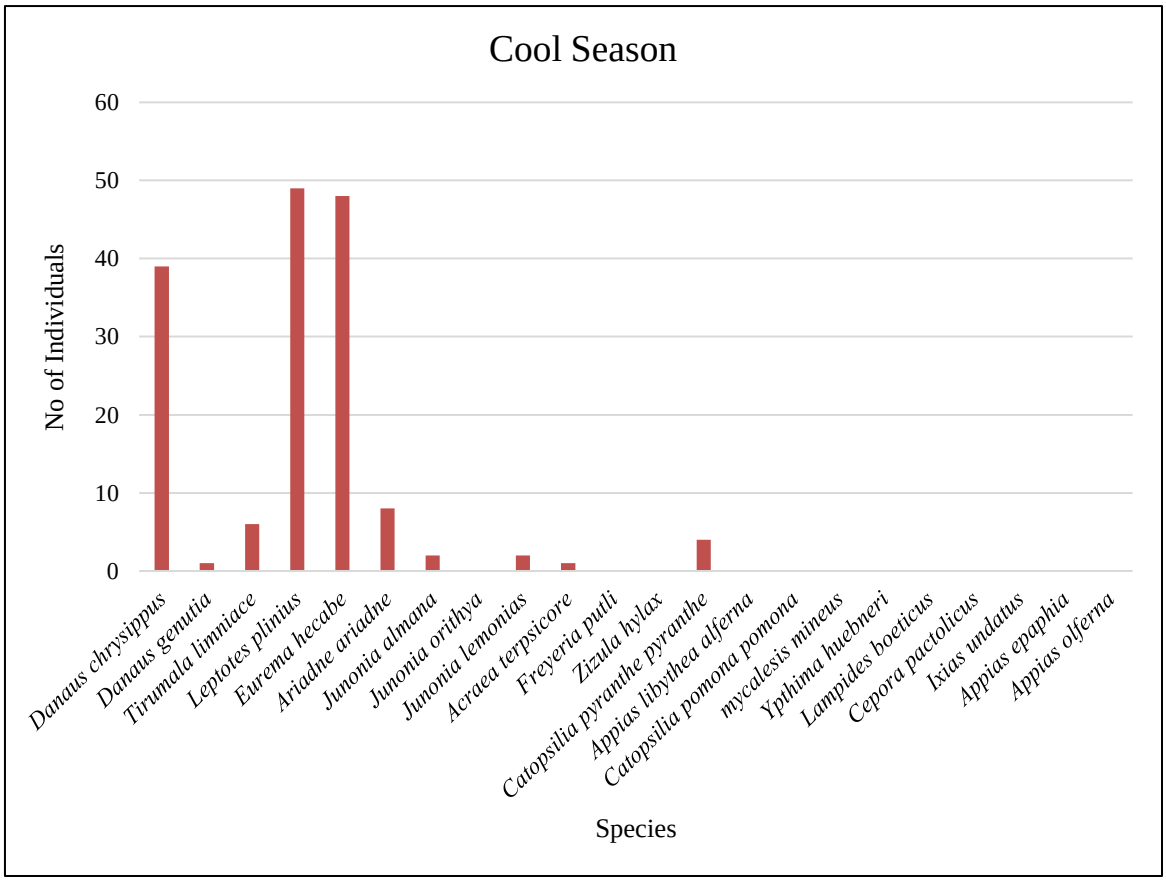


Figure 4-141 Total Number of Butterfly Species in Cool Season in Study Area

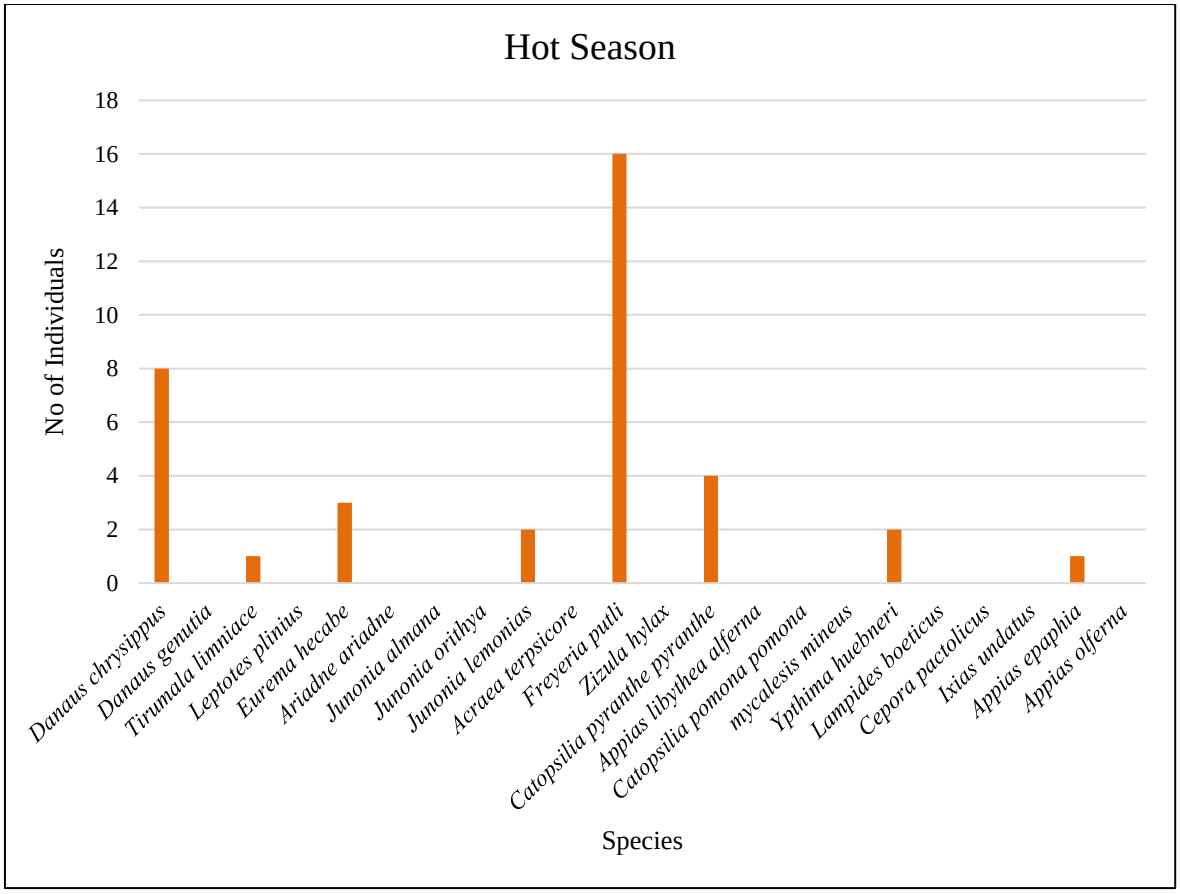


Figure 4-142 Total Number of Butterfly Species in Hot Season in Study Area

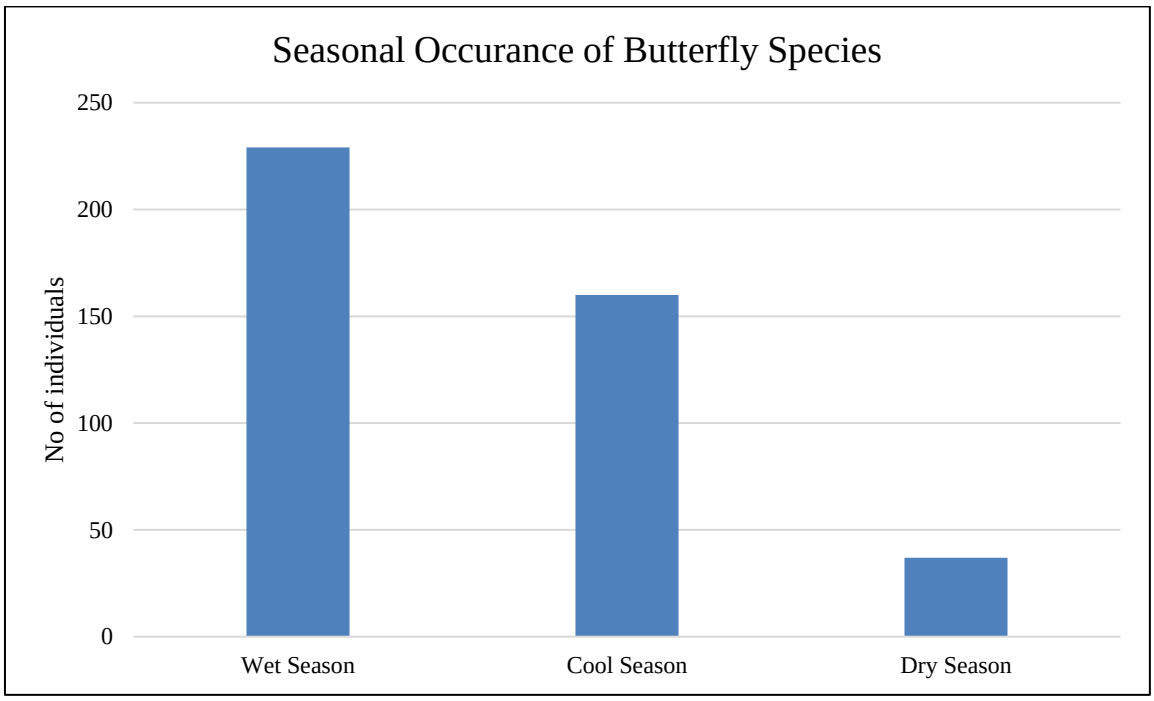


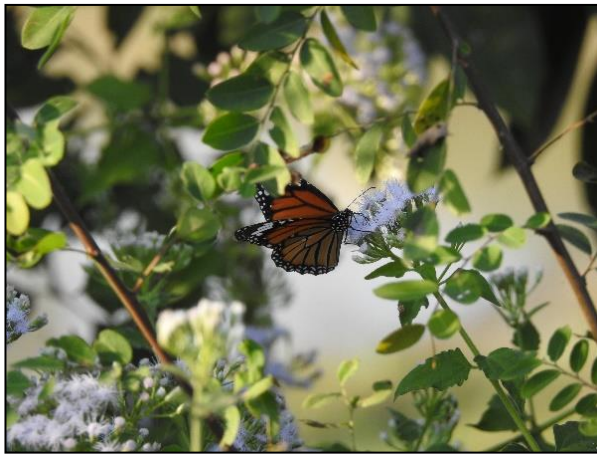
Figure 4-143 Seasonal Occurrence of Butterfly Species in Study Area

4.8.5.3.1.3.2 Recorded Butterfly Species

Danaus chrysippus

Tirumala limniace

Ariadne ariadne



Danaus genutia

Junonia lemonias

Leptotes plinius

Junonia almana

Acraea terpsicore (or) Acraea violae

Zizula hylax

Mycalesis mineus

Junonia orithya

Freyeria putli

Lampides boeticus

Appias libythea

Eurema blanda

Appias olferna

Cepora pactolicus

Catopsilia pyranthe

Catopsilia pomona pomona

Appias epaphia

Ypthima baldus

Figure 4-144 Recorded Butterfly Species

4.8.5.3.1.4 Discussion and Conclusion

It can be seen that numbers of Butterfly species and numbers of individuals change with the season. From all three seasons, 22 butterfly species in total, under 17 genera and 3 families, were recorded and identified based on the findings of a field survey.

Based on Figure 4-139, among three families recorded, Nymphalidae family was found the most at 46 % and it is the most dominant species in the study area. Pieridae family is the second most finding species with 36 % and lycaenidae is the least common species found in all three seasons with 18 %.

During the study period, family Nymphalidae appeared the highest in species composition among all butterfly families. Members of the Nymphalidae were always dominant in the tropical region because most of the species are polyphagous in nature, making them to become efficient fliers and able them to live in all habitats. Many species of this family: Nymphalidae are strong, active fliers that might help them in searching for resources in large areas (Eswaran and Pramod 2005).

During the study period, the total number of 426 individuals were observed and recorded. Among them, the most common species was *Danaus chrysippus* with the highest number of 113, followed by with 103 individuals, whereas the least common species were *Junonia orithya, Acraea terpsicore, mycalesis mineus, Lampides boeticus, Cepora pactolicus, Ixias undatus, Appias epaphia, Appias olferna* with only one individual.

Under the family Nymphalidae of *Danaus chrysippus* was most abundance followed by Family Peridae, *Eurema blanda* and Family Lycaenidae, *Leptates plinius* during the study period. Family Lycaenidae is the second-largest family of butterflies (behind Nymphalidae, brush-footed butterflies), with over 6,000 species worldwide. Butterfly species are directly dependent on plant species composition for larval and adult food resources in an area (Kunte, 1997).

According to Figure 4-143, the species were found the most with 229 individuals in wet season, followed by cool season with 160 individuals while the least number of species were found in hot season with 37 individuals.

Ariadne Ariadne, Junonia almanac, Acraea terpsicore were found only in cool season. Likewise, *Zizula hylax, Appias libythea alferna, Catopsilia pomona Pomona, mycalesis mineus, Ypthima baldus, Lampides boeticus, Cepora pactolicus, Ixias undatus, Appias olferna* were found only in wet season and *Appias epaphia* was observed only in hot season.

There are more butterfly species in wet season and cool season than hot season during study period. Life of butterflies mainly depends upon the all plants and water. They distribute geographically and seasonally (Scudder et al., 2007). Wet season butterflies were more active in general than in the hot season. The adult butterflies spent long period during the hot season (Brakefield and Larsen, 1984).

Butterflies belong to one of the most important taxa of insects. Understanding their significance in an ecosystem as an environmental health indicator and pollination of flowering plants is crucial to achieving sustainability and conservation of floral diversity. Owing to habitat destruction due to some anthropogenic activities, butterflies are fast disappearing and at present, their survival is under threat. (Yager et al., 2018)

Disappearance of insects could lead to extinction of earth's animals because of the disappearance of so much plant life. Today they are by far the planet's most diverse, abundant and successful insects. The roles that insects play in nature require us to understand how insects and other organisms living in a biological community interact with living and non-living environment (Miller, 2006).

During the wet season, cultivated areas were being plowed and there were no agricultural plants yet. In cool and hot season, the fields were full of crops. Nevertheless, the insects are less likely to be observed because of the insecticides used in the field and their distribution and abundance are affected by changes in habitat and climate because they are sensitive to these changes.

4.8.5.3.2 Dragonfly and Damselfly

4.8.5.3.2.1 Introduction

The order Odonata is one of the most popular insect groups. They are primarily aquatic insects and their life history is closely linked to specific aquatic habitats. Their habitat specificity makes them a good indicator of wetland health. Dragonflies are amongst the most attractive creatures on earth. Dragonflies have been used as indicator species for assessing habitat and water quality in a variety of wetlands, riparian forests and lakeshore habitat around the world (Subramanian, 2005). Based on morphology, the ordernata is divided into three suborders, namely Anisoptera (dragonfly), Zygoptera (damselfly) and Anisozygoptera (Vick, 2002).

They are widely distributed in variable habitats such as ponds, lakes, streams, rivers and canals of all sites. Many species have small distributional ranges and are specific of certain habitats. Kalkman (2008) documented that dragonflies are a relatively small order of insects and most of these species are found in the tropics. The dragonflies to be prominent feature in nature and they are used as indicators of environmental health and conservation management (cited in IUCN, 2018).

Dragonflies and damselflies are large, conspicuous insects generally found near freshwater habitats. They are an ancient and successful group that was around long before the dinosaurs evolved.

Dragonflies begin their lives in the water. Around midsummer, females hover over bodies of fresh water and dip in their abdomens, laying eggs that hatch in about seven to eight days. Called naiads or nymphs, these larvae stay in the water for up to three years, hunting aquatic insects, mosquito larvae, or small fish with a lower jaw that reaches out and opens up sideways, snatching prey into their mouths. They may even cannibalize other dragonfly nymphs.

Dragonflies and damselflies are one species that lived around 250 million years ago was the largest insect known to exist and had a wingspan of over 70 cm. Their success as a group is largely because of their fantastic flying abilities and their well-developed eyes. They are excellent hunters of other flying insects and can hover, move in zigzags, and even fly backwards. And they are fast - some of the larger dragonflies can reach flying speeds of 70 km per hour - possibly the fastest flying insects on Earth. Many people find their size and speed intimidating but, despite their powerful jaws, they are harmless. In fact, they do us a favor by eating many insects that bite us.

A dragonfly's life cycle is an example of incomplete metamorphosis. Eggs are laid in or near water. Nymphs hatch from the eggs. Dragonflies spend most of their life as a nymph where they molt anywhere from six to fifteen times. Eventually, the nymph will shed its final exoskeleton and an adult will emerge, leave the water, and fly away. Water pollution has negative impacts on dragonflies due to their reliance on aquatic ecosystems throughout their life, making dragonflies important environmental indicators of water quality. (Pupke, 2018).

Damselflies are flying insects of the suborder Zygoptera in the order Odonata. They are similar to dragonflies, which constitute the other odonatan suborder, Anisoptera, but are smaller and have slimmer bodies. Most species fold the wings along the body when at rest, unlike dragonflies which hold the wings flat and away from the body. All damselflies are predatory insects; both nymphs and adults actively hunt and eat other insects. The nymphs are aquatic, with different species living in a variety of freshwater habitats including acidic bogs, ponds, lakes and rivers. The nymphs moult repeatedly, at the last moult climbing out of the water to undergo metamorphosis. The skin splits down the back; they emerge and inflate their wings and abdomen to gain their adult form. Their

presence on a body of water indicates that it is relatively unpolluted, but their dependence on freshwater makes them vulnerable to damage to their wetland habitats (Naeole, 2012). Damselflies exist in a range of habitats in and around the wetlands needed for their larval development; these include open spaces for finding mates, suitable perches, open aspect, roosting sites, and suitable plant species for ovipositing and suitable water quality. Odonates have been used for bio-indication purposes regarding the quality of the ecosystem (Kleinzahlerm, 2015).

4.8.5.3.2.2 Dragonfly and Damselfly Survey Results

According to field survey results, a total of 5 dragonfly species into 5 genera and 1 family were recorded and identified and a total of 2 damselfly species into 2 genera and 1 family were recorded and identified.

Table 4-102 Relative Abundance of Dragonfly and Damselfly Species in Three Seasons during the Study Period

Scientific Name	Total Number of Individuals												Species Total	Relative Abundance	Average Relative Abundance
	Wet Season				Cool Season				Hot Season						
	C.A	Rd.A	R.A	T	C.A	Rd.A	R.A	T	C.A	Rd.A	R.A	T			
Pantala Flavescens	25	21	36	**82**	2	21	6	**29**	2	9	5	**16**	127	0.31	vC
Brachythemis contaminata	7	24	17	**48**	0	8	0	**8**	0	2	12	**14**	70	0.17	vC
Diplacodes travialis	27	12	26	**65**	0	0	0	**0**	7	1	8	**16**	81	0.20	vC
Crocothemis servilia	0	7	14	**21**	0	15	0	**15**	0	0	2	**2**	38	0.09	vC
Orthetrum Sabina	23	11	31	**65**	2	0	12	**14**	3	0	0	**3**	82	0.20	vC
Ischnura rubilio	3	0	5	**8**	1	0	6	**7**	0	0	0	**0**	15	0.04	C
Agriocnemis femina	1	0	0	**1**	0	0	0	**0**	0	0	0	**0**	1	0.00	uC
Total Number of Species	85	75	129	**290**	5	44	24	**73**	12	12	27	**51**	**414**		

uC – Uncommon C- Common vC – Very common

C.A – Cultivated Area Rd.A – Residential Area R.A – River Area

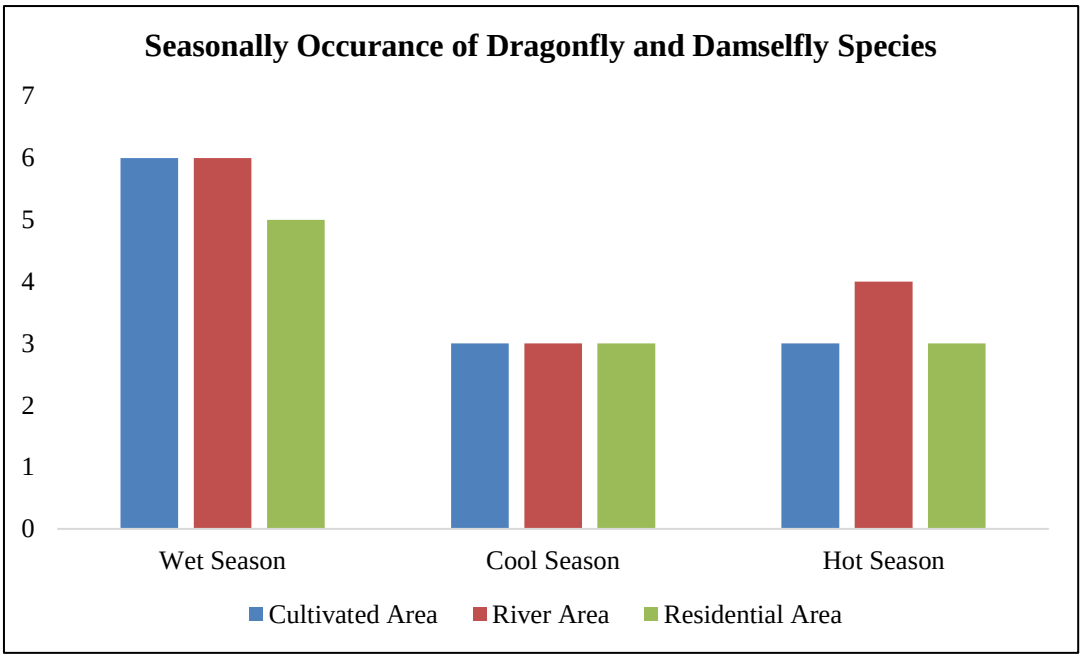


Figure 4-145 Seasonal Occurrence of Dragonfly and Damselfly Species

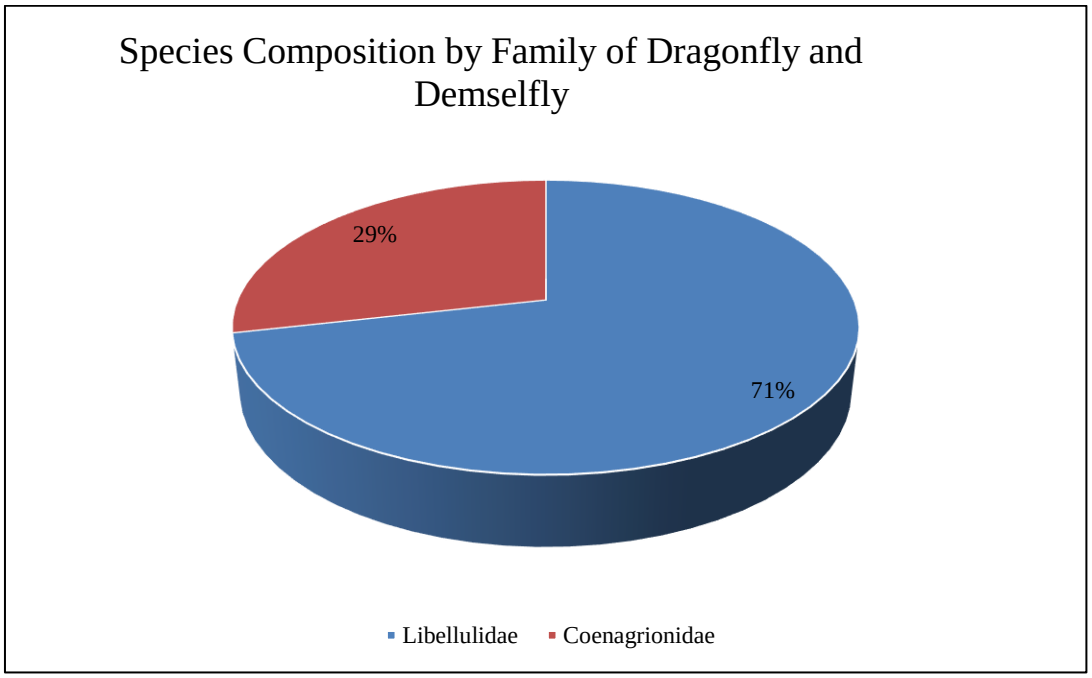


Figure 4-146 Species Composition by Family for All Season

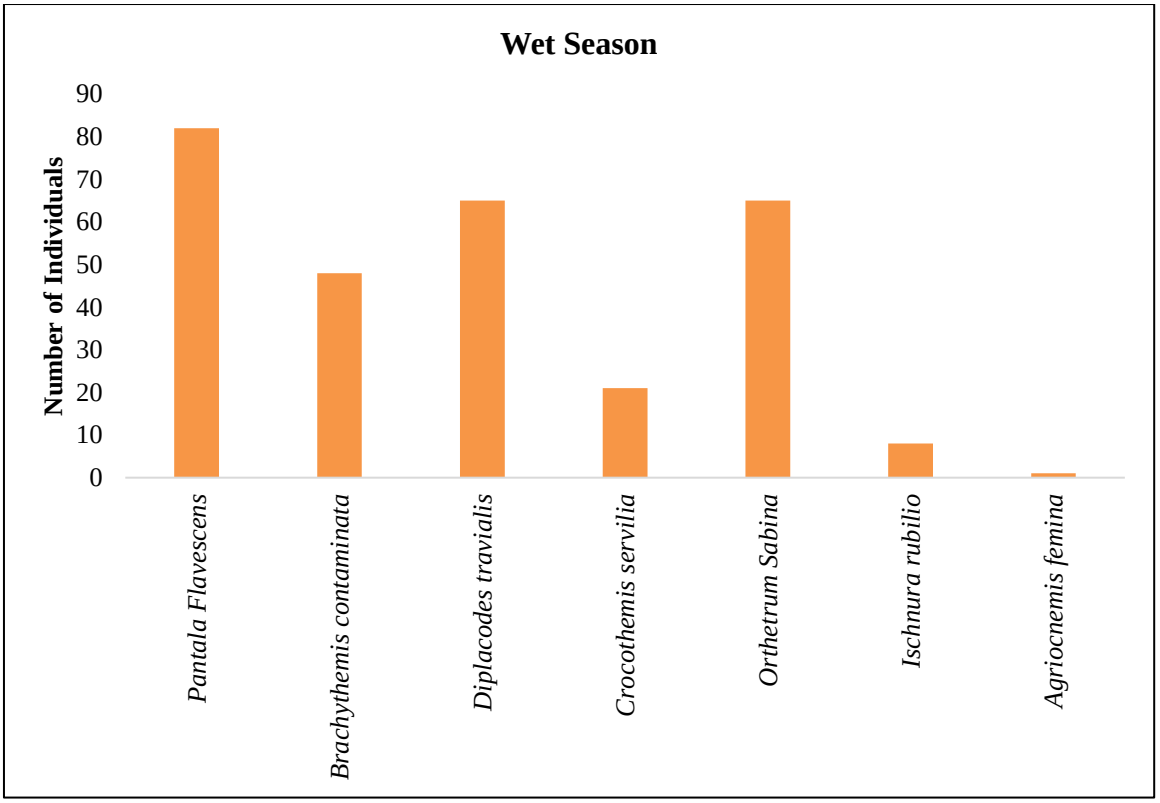


Figure 4-147 Total Number of Dragonfly and Damselfly Species in Wet Season

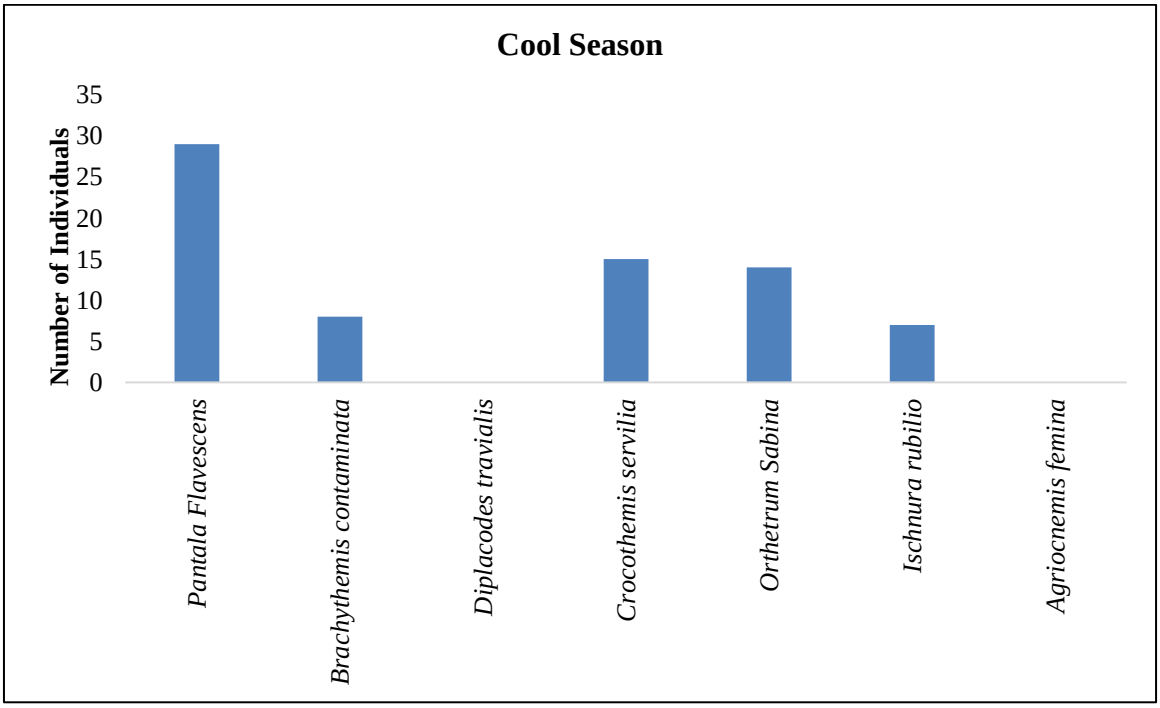


Figure 4-148 Total Number of Dragonfly and Damselfly Species in Cool Season

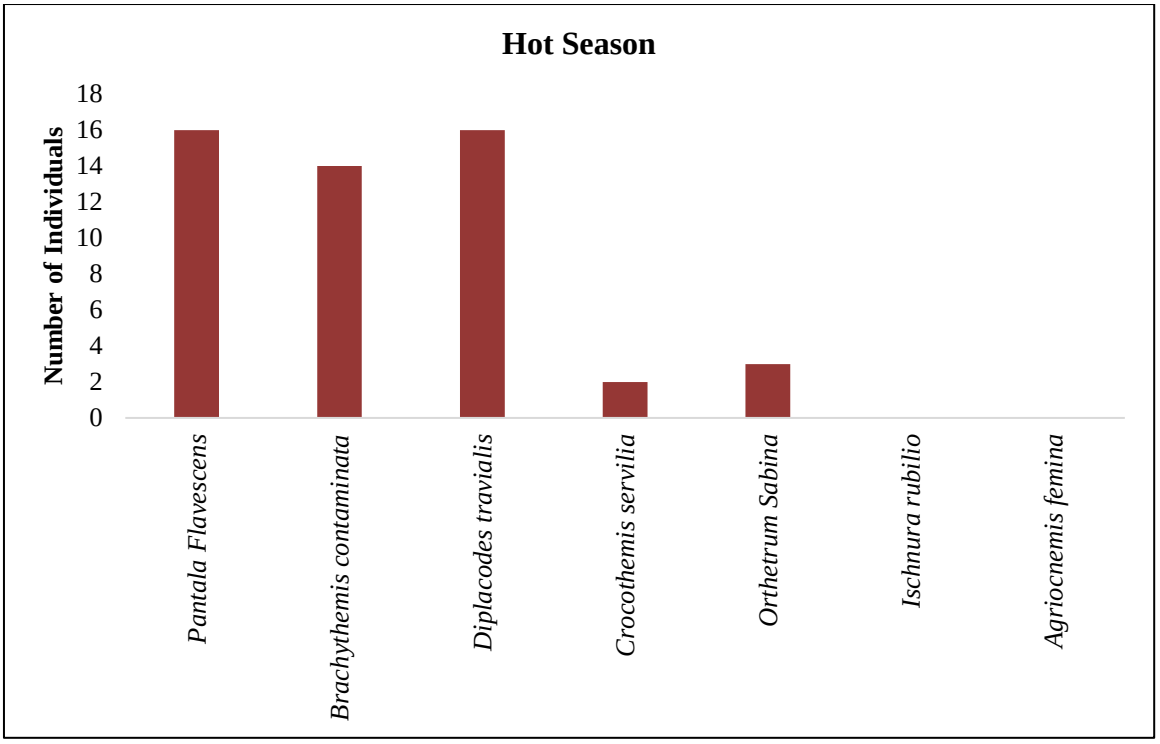


Figure 4-149 Total Number of Dragonfly and Damselfly Species in Hot Season

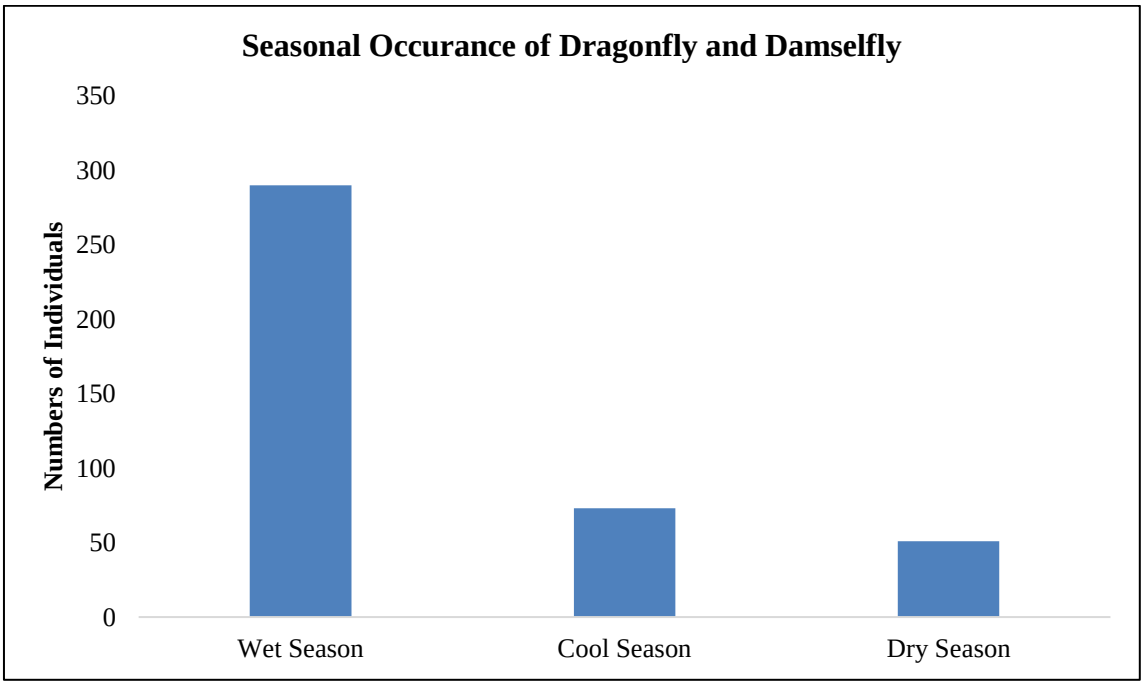


Figure 4-150 Seasonal Occurrence of Dragonfly and Damselfly Species

4.8.5.3.2.2.1 Recorded Dragonfly and Damselfly Species

Diplacodes Travialis (Female)

Diplacodes Travialis (Male)

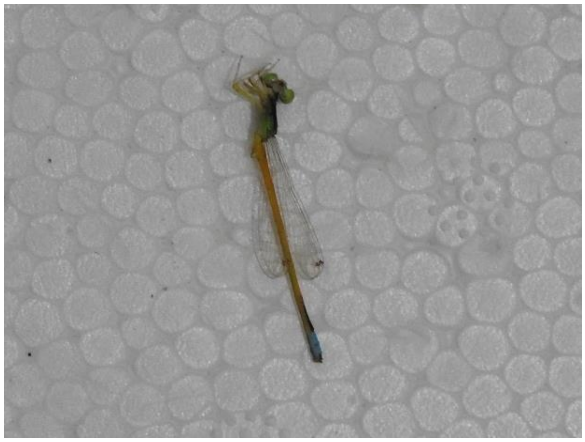
Pantala flavescens

Crocothemis servilia

Brachythemis contaminata

Agriocnemis femina

Orthetrum sabina



Ischnura rubilio

Figure 4-151 Recorded Dragonfly and Damselfly Species

4.8.5.3.2.3 Discussion and Conclusion

It can be seen that numbers of dragonfly and damselfly species and numbers of individuals change with the season. From all three seasons, 7 dragonfly and damselfly species in total, under 7 genera and 2 families, were recorded and identified based on the findings of a field survey.

During the study period, the total number of 414 individuals were observed and recorded. Among them, the most common species was Pantala Flavescens with the highest number of 127, followed by Orthetrum Sabina with 82 individuals, whereas the least common species was Agriocnemis femina with only one individual and it was found only in cool season.

Based on Figure 4-146, among two families recorded, Libellulidae family was found the most at 71 % and it is the most dominant species in the study area. Coenagrionidae family is the least observed species with 29 %. Family Libellulidae was found to be the most dominant family. As in many other studies, this family is also widely represented in survey elsewhere locally and globally. Many species have patterned wings and distinctive colors on the thorax and abdomen. They generally prefer still water, like ponds or lakes, although some live near streams or rivers. (Norma et al., 2001).

According to Figure 4-143, the species were found the most with 289 individuals in wet season, followed by cool season with 73 individuals while the least number of species were found in hot season with 51 individuals.

According to Figure 4-145, number of species is the highest among three seasons. during the wet season, cultivated areas were being plowed and there were no agricultural plants yet. In cool and hot season, the fields were full of crops. Nevertheless, the insects are less likely to be observed because of the insecticides used in the field and their distribution and abundance are affected by changes in habitat and climate because they are sensitive to these changes.

4.8.5.4. Aquatic Life

4.8.5.4.1.1 Phytoplankton, Zooplankton and Benthic Macroinvertebrates

4.8.5.4.1.2 Introduction

A microscopic community of plants (phytoplankton) and animals (zooplankton), found usually free floating, swimming with or no resistance to water currents, suspended in water, non-motile or sufficiently motile to overcome transport by water current are called as "Plankton". The qualitative and quantitative studies of plankton are an important factor to access the water quality (Shekhar et al, 2008).

Hans (1998) reported phytoplankton and zooplankton are two of the common biological parameters collected because they form the base of the aquatic food web and influence other aspects of the lake including color and clarity of the water. Phytoplankton species are used as an indicator for determining the nutrient level which is the basis for preparing and monitoring the strategies of the management in the lakes.

Phytoplankton are widely present in freshwater environments, such as lakes and rivers, where they are typically present as microorganisms-visible only with the aid of a light microscope. They have a major importance in the freshwater environment, both in terms of

fundamental ecology and in relation to human use of natural resources (Bellinger and Sigee, 2010).

Both phytoplankton and zooplankton are used in various ways as indicators of water quality. Phytoplankton communities are sensitive to changes in their environment and therefore phytoplankton total biomass and many phytoplankton species are used as indicators of water quality (Reynolds 1997; Reynolds et al., 2002; Brettum and Andersen, 2005), cited by Medupin, 2011).

"Benthic macro invertebrates are common inhabitants of lakes and streams where they are important in moving energy through food webs. The term "benthic" means "bottom-living"and indicated that these organisms usually inhabit bottom substrates for at least part of their life cycle; the prefix "macro" indicates that these organisms are retained by mesh size of approx. 200-500 µm (micro-meter) Different groups of macro invertebrates have different tolerances to pollution, which means they can serve as useful indicators of water quality" (Peckarsky et al, 1990; Williams & Feltmate, 1992; Rosenberg et al, 1997; Mackie, 1998)

Benthic macroinvertebrates are commonly used as indicators of the biological condition of water bodies. They are reliable indicators because they spend all or most of their lives in water, are easy to collect and differ in their tolerance to pollution. Macro invertebrates respond to human disturbance in fairly predictable ways, are relatively easy to identify in the laboratory, often live for more than a year and, unlike fish, have limited mobility. (Indicators-benthic-microinvertebrates,US EPA)

Among the communities that are considered bioindicators of water quality, the most commonly used are the benthic macroinvertebrates because they have several characteristics that make them easy to study, and show clear responses when faced with adverse environmental conditions (Moreno et al., 2009). The structure of the benthic communities in an aquatic ecosystem reflects its ecological conditions, including habitat heterogeneity and water quality (Soldner et al., 2004).

The roles of benthic macro invertebrates in cycling nutrients and controlling nutrient outflows from ecosystems. The benthos transforms organic detritus from sedimentary storage into dissolved nutrients that can be mixed into overlying waters and used by rooted plants (macrophages) and algae (phytoplankton)to enhance primary productivity. Some benthic species are omnivores and feed on macrophages, algae, and zooplankton. Many benthic species are consumed by fishes. Through their mixing of sediments and consumption of diverse resources, benthic invertebrates can, directly and indirectly, influence microbial production and release of greenhouse gases (CO2 and CH4), toxic gases (H2S and NH4), and nitrogen (N2).(Covich, et. al., 1999).

About two-third of the earth's surface is covered by oceans and seas. In them live the photosynthetic plants we call algae. Algae are two – third of the Earth's biomass. (Vashishata, 1983). Many researchers worked on the algae flora in many places. Skuja (1949) treated on the algal flora of Burma with about 600 species. In the present study, morphology,

classification and identification of freshwater algae, plankton, and benthos have been investigated from the Ayeyarwady river, Amarapura Township.

4.8.5.4.1.3 Material and Method

4.8.5.4.1.3.1 Study Area

Ayeyarwady river, Amarapura Township is an ecological habitat for freshwater species, fishes, algae, benthos, and birds which is about 3 kilo-meters from Amarapura Township. The area has humid climate, characterized by three dominant seasons: the March-to-May hot season, the June-to-October wet season and the November-to-February cool season. The annual rainfall varies between 706 mm – 945 mm in 2020-2021. During the study, human disturbance, jetty, transportation, fishing, and discharging wastewater from the Amarapura Township to the Ayeyarwady River are the current situations engaged by the human are observed. Four study area are designated along the bank of the Ayeyarwady River.

The coordinate points of the study area are shown in Table 4-103 and Figure 4-152.

Table 4-103 Location points of the study area for Planktons, Snails and Mollusks.

Study Site	Coordinates	Description
Site I	21°56'8.92"N 96° 0'29.50"E	River bank, Ahrlaung Village, Sagaing Tsp.
Site II	21°54'41.01"N 96° 0'8.85"E	River bank,Near Mingon Road, Sagaing Tsp.
Site III	21°52'27.73"N 95°59'51.11"E	River bank, near Yadanabon Bridge, Shwe
Site IV	21°57'28.75"N 96° 3'4.34"E	River bank, Near Pawtaw Yan Myo Lone Pawdawmu Pagoda, Circular Road, Amarapura.

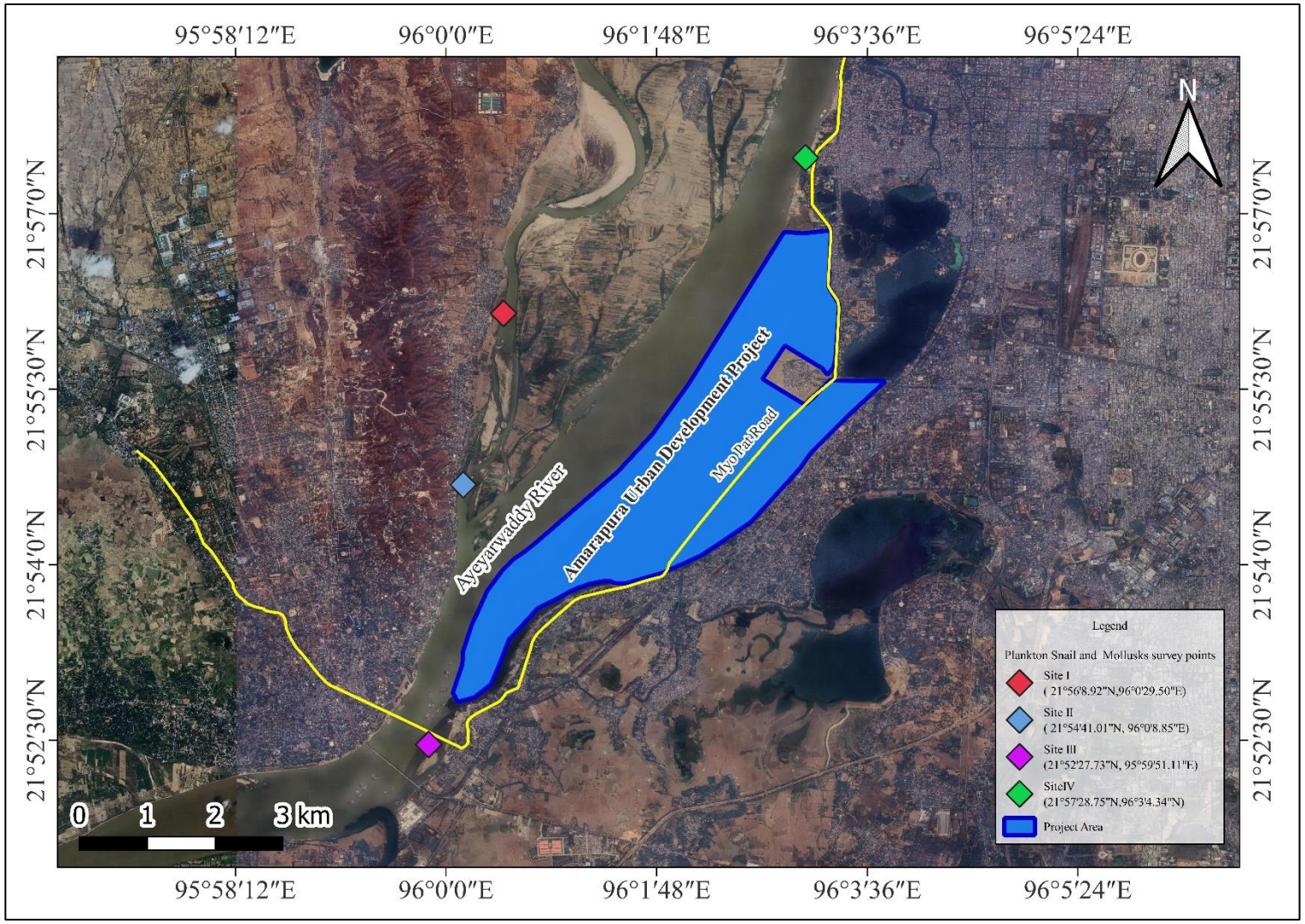


Figure 4-152 Map of study area for planktons, snail and mollusk

4.8.5.4.1.3.2 Study period

This study was carried out in 1st April, 2023 during the dry season.

4.8.5.4.1.3.3 Method of Sample Collection and Identification

Four study sites are designated to collected the specimens in the Ayeyarwady river. When collection the sample, the plankton net has to pull horizontally along with the water surface by using plankton with (75) cm length and (30) cm width, the mesh size of (30) micro-meter. To study the plankton, a capacity of 1000 milliliters is collected. After collection the sample, the specimens are transferred to a plastic container, and label with collected date and time. Moreover, ambient temperature of water and surrounding environment is noted.

1 ml of specimens is transferred to concave slide by using pipette, and examined by the microscope using the preferable magnification. When examining the specimen under microscope, characters of the specimens and length are documented using ocular micrometer, the microphotographs are taken with the camera for documentation.

Identification of specimens

Identification was done based on the specimen size, color, and microscopical features. Identification and classification of the collected species followed that of Bellinger and Sigee (2010), Desikachary (1959), Otsuka *et al.* (2000) and classification of zooplankton was followed by Singh *et al* (2014).

Specimen collection in Site I

Specimen collection in Site II

Specimen collection in Site III

Specimen collection in Site IV

Figure 4-153 Photos of collection specimens of plankton

Site I

Site II

Site III

Site IV

Figure 4-154 Photos of Study Area

Data Analysis

Data entry was done using Microsoft excel and analysis was done using species composition, and occurrence.

Species Composition

$$SpeciesComposition = \frac{Total\ number\ of specie\ particular\ family/order}{Total\ number\ of\ all\ species\ recorded} \times 100$$

4.8.5.4.1.4 Field Survey Results of Phytoplankton and Zooplankton

During the study, (4) species of phytoplanktons belonging to (4) genera, (4) families, (4) orders and (2) classes under (2) phyla, namely Chlorophyta and Cyanophyta. For zooplankton, (7) species of zooplanktons belonging to (6) genera, (4) families, (5) orders, and (6) classes under (3) phyla, namely Arthropoda, Rotifera, Perifera were observed. List of recorded species are shown in. Table 4-104.

The highest composition of species was recorded in class Cyanophyceae (33.33%), followed by Chlorophyceae, Branchiopoda, Copepoda, Insecta, Eurotatoria, Eurotatoria, and Demosponglae (each with 11.11%).

With respect to the number of species encountered at each study site, the largest number of species (5) was encountered in Site (I), (II) and (IV). Only (3) species are observed in site III. Species occurrence of the study area are shown in Table 4-105 and Figure 4-155.

Table 4-104 List of recorded microorganisms

No.	Phylum	Class	Order	Family	Genus / Species
1	Chlorophyta	Chlorophyceae	Zygnematales	Zygnemataceae	*Spirogyra sp.*
2	Cyanophyta	Cyanophyceae	Oscillatoriales	Oscillatoria	*Oscillatoria sp.*
3			Chroococcales	Chroococcaceae	*Microcystis sp.*
4			Spirulinales	Spirulinaceae	*Spirulina sp.*
5	Arthropoda	Branchiopoda	Cladocera	Chydoridae	*Chydorus ovalis*
6		Copepoda	Cyclopoida	Cyclopidae	*Mesocyclops sp.*
7		Insecta	Odonata	Libellulidae	*Pantala sp.*
8	Rotifera	Eurotatoria	Ploima	Brachionidae	*Keratella valga*
9		Eurotatoria	Ploima	Brachionidae	*Keratella cochlearis*
10					*Notholca sp.*
11	Perifera	Demosponglae	Poecilosclerida	Esperiopsidae	*Amphilectus sp.*

Table 4-105 Occurrence of recorded microorganisms

Genus/ Species	Site I	Site II	Site III	Site IV
Spirogyra sp.	✓	✓	✓	✓
Oscillatoria sp.	✓	✓	-	✓
Spirulina sp.	-	-	✓	-
Microcystis sp.	-	-	-	✓
Chydorus ovalis	✓	-	-	-
Mesocyclops sp.	✓	✓	-	-
Pantala sp.	-	✓	-	-
Keratella vulga	✓	-	-	-
Keratella cochlearis	-	✓	-	✓
Notholca sp.	-	-	✓	-
Amphilectus sp.	-	-	-	✓

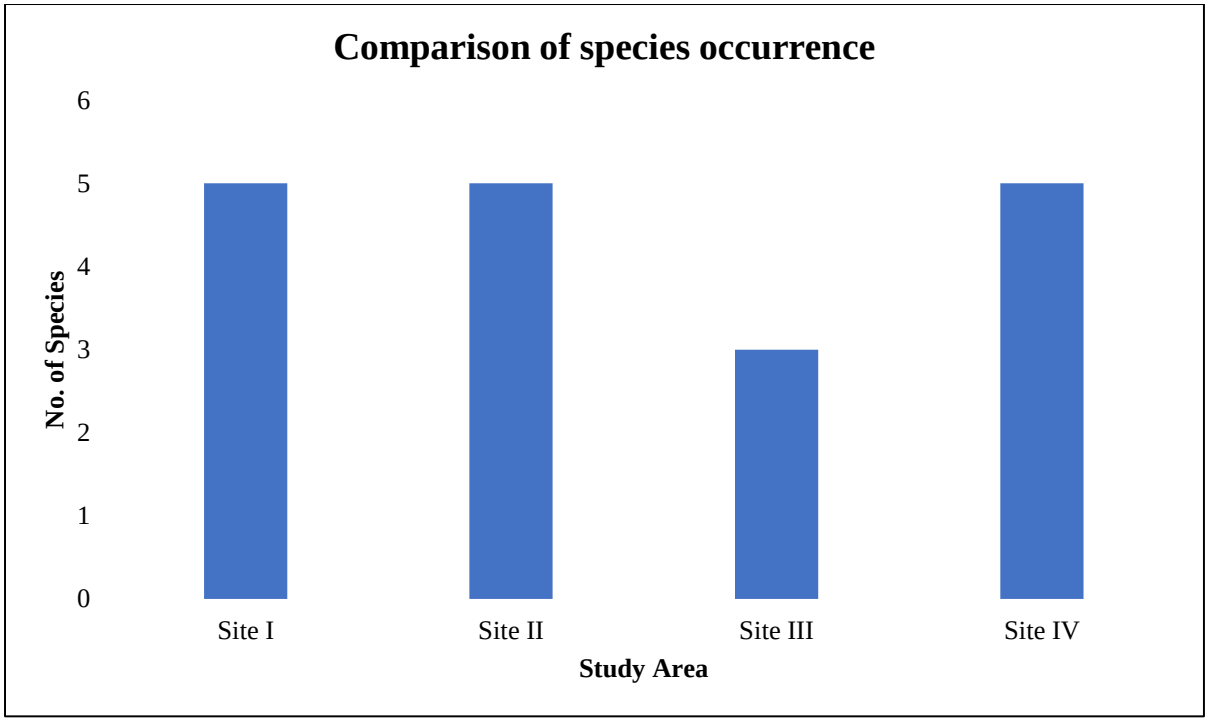
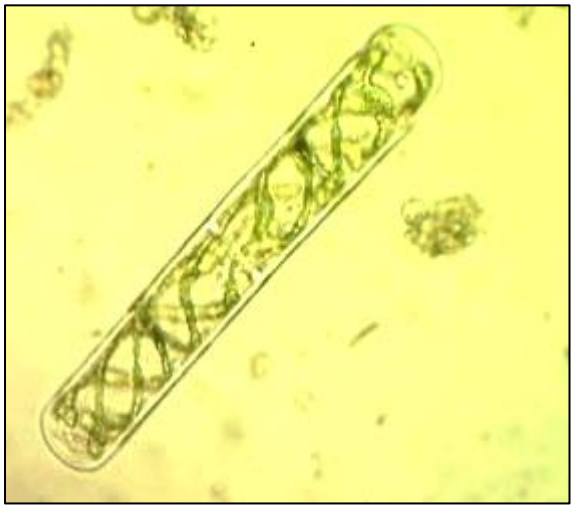
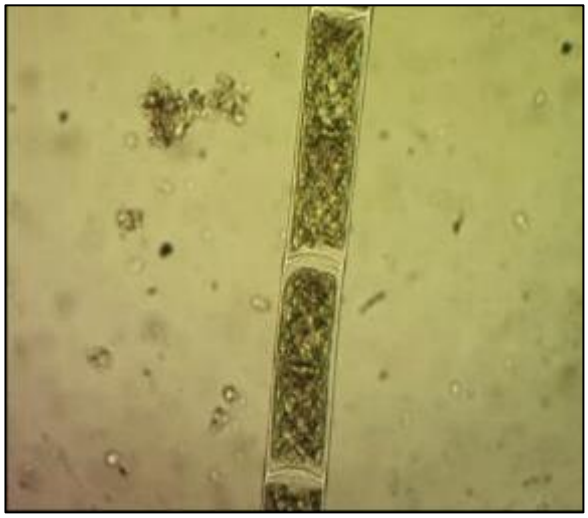


Figure 4-155 Comparison of Species Occurrence of Plankton

4.8.5.4.1.4.1 Recorded Plankton Photos



Spirogyra sp. (x 400)

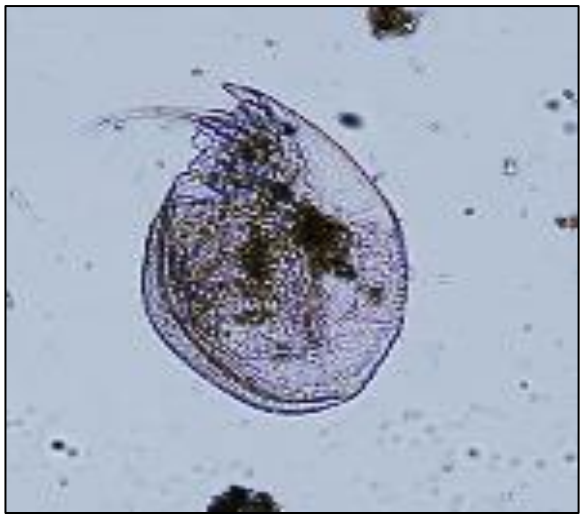


Spirogyra sp. (x 400)

Mesocyclops sp. (x 400)

Oscillatoria sp. (x 400)

Keratella valga (x 400)



Chydorus ovalis (x 400)

Figure 4-156 Recorded Species in Site I

Spirogyra sp. (x400)

Ocillatoria sp. (x400)

Keratella cochlearis (x400)

*Mesocyclop*s sp. (x400)

Pantala sp. (Dragon Fly Larva) (x400)

Figure 4-157 Recorded species in site II

Spirogyra sp. (x400)

Spirogyra sp. (x400)

Spirogyra sp. (x400)

Spirulina sp. (x400)

Notholca sp. (x400)

Figure 4-158 Recorded species in site III

*Spirogyr*a sp. (x400)

Microcystis sp. (x400)

Oscillatoria sp. (x400)

Keratella cochlearis (x400)

Amphileptus sp. (x400)

Figure 4-159 Recorded species in site IV

4.8.5.4.1.5 Discussion and Conclusion

From this present study, the total of (4) algal species, (3) species of Cyanphyta, (1) species of Chlorophyta are overserved. Moreover, the total of (7) species, (3) species of Arthropoda, (3) species of Rotifera and (1) species of Perifera are recorded in the study area.

Phytoplankton species are used as an indicator for determining the nutrient level which is the basis for preparing and monitoring the strategies of the management in the lakes and river. Phytoplankton are widely present in freshwater environments, such as lakes and rivers, where they are typically present as microorganisms-visible only with the aid of a light microscope. They have a major importance in the freshwater environment, both in terms of fundamental ecology and in relation to human use of natural resources (Bellinger and Sigee, 2010). The phytoplankton preferred to pH 7.4 to 7.6 and zooplankton to pH 8 to 9. More DO (dissolved oxygen) level the more zooplankton observed and the less DO level the less zooplankton were observed.(Yin, 2019) The BOD (biological oxygen demand) depends on temperature of the environment and on the particular kinds of microorganisms and nutrient present. BOD directly affects the amount of DO in water bodies. The consequence of high BOD is the same as those for low DO; aquatic organisms become stressed, suffocate and die. (Spellman, 2008)

In the present study, filamented algae, *Spirogyra* spp. were found on the surface of Ayeyarwady River as dominant phytoplankton. *Spirogyra* (common names include water silk, mermaid's tresses, and blanket weed) is a genus of filamentous charophyte green algae, named for the helical or spiral arrangement of the chloroplasts that is characteristic of the genus. *Spirogyra* species, of which there are more than 400, are commonly found in freshwater habitats. When there is enough sunlight and warmth they produce large amounts of oxygen, adhering as bubbles between the tangled filaments. The filamentous masses come to the surface and become visible as slimy green mats (Algaebase,2022).

In phylum Rotifera, three species Rotifers, *Keratella valga*, *Keratella cochlearis* and *Notholca caudata* were recorded in this work. Herzig (1987) reported rotifers are group of primary freshwater invertebrates. Rotifers play a vital role in many freshwater ecosystems. Singh (2014) also reported rotifers are important part of the freshwater zooplankton being a major food source for aquatic organisms such as fish and prawn.

Marten and Reid (2007) stated that *Mesocyclops* is a genus of copepod crustaceans in the family Cyclopidae. Because the various species of *Mesocyclops* are known to prey on mosquito larvae, it is used as a nontoxic and inexpensive form of biological mosquito control. In this study, *Mesocyclops* sp. was recorded in Ayeyarwady River.

According to the recorded species of plankton, which indicate the water quality of the Ayeyarwady River is within the preferable pH range (6.5–8.5) for aquatic organisms. The phytoplankton photosynthesizes and produce oxygen as a byproduct. Moreover, zooplankton can provide a food chain for larger aquatic organisms. The abundant numbers of fish species are observed in Thayetkoepin Village, and Shankalaykun Village (habitats, less likely affected by humans) in comparison with manmade fishery ponds (Thadarphy,

Oakphulankwel, Thaungthama and Lantawkyi). It can be concluded that by observing this kind of phytoplankton and zooplankton, the water bodies that they inhibit have decent quality and provide food for aquatic life. Even though the water quality is good, human interference, jetty, fishing, and wastewater discharge can all cause the water's quality to decline and the primary producers like plankton and benthos to decrease, which can subsequently cause the aquatic life to decline.

4.8.5.4.2 Benthic Macro invertebrates (Snail and Mussel)

4.8.5.4.2.1 Introduction

One way to assess water quality is to study biodiversity especially benthic macro invertebrates. The use of biodiversity indicators in habitat quality assessments has gained increasing importance in the recent years. Benthic macro invertebrates or benthos are animals that live on rivers and lake bottoms or simply called bottom-dwelling organisms (Rai, 2000).

Freshwater mollusks are those members of the Phylum Mollusca which live in freshwater habitats, both lotic (flowing water) such as rivers, streams, canals, springs, and cave streams and lentic (still water) such as lakes, ponds (including temporary or vernal ponds), and ditches. The two major classes of mollusks have representatives in freshwater: the gastropods (snails) and the bivalves (freshwater mussels and clams.) It appears that the other classes within the Phylum Mollusca -the cephalopods, scaphopods, polyplacophorans, etc. never made the transition from a fully marine environment to a freshwater environment.

Freshwater snails are **gastropod mollusks that live in fresh water.** There are many different families. They are found throughout the world in various habitats, ranging from ephemeral pools to the largest lakes, and from small seeps and springs to major rivers. “Freshwater snail, any of the approximately 5,000 snail species that live in lakes, ponds, rivers, and streams. Most are members of the subclass Pulmonata, which also includes the terrestrial snails and slugs, but some are members of the subclass Prosobranchia; both subclasses belong to the class Gastropod. Freshwater snails are dispersed between isolated bodies of water via birds’ feet, wind-blown leaves, and floods.

Freshwater mussels live burrowed into sediment, where they anchor themselves with their muscular foot. The opposite end of the bivalve, containing body-parts called siphons, protrudes out of the sediment. Bivalves use the siphons to create a current of water through their bodies. This current carries in algae and detritus that the bivalve filters from the water and consumes. Dissolved oxygen is also carried in on this water current and absorbed through the bivalve's gills and mantle. Freshwater bivalves can be found in all sizes of lakes and rivers. Mussels are the most diverse and abundant in the littoral (near-shore) zones of large natural lakes and in shallow areas of medium to large rivers with a moderate current. Mussels generally are not found in springs, small streams, or ponds. They prefer courser sediments, such as sand and gravel, as it is difficult for them to stay at the surface of loose, fine sediment. (Rai, 2000).

Mussel, any of numerous bivalve mollusks belonging to the marine family Mytilidae and to the freshwater family Unionidae. The Unionidae are a family of freshwater mussels, the largest in the order Unionida, the bivalve molluscs sometimes known as river mussels, or simply as unionids. The range of distribution for this family is world-wide. It is at its most diverse in North America, with about 297 recognized taxa, but China and Southeast Asia also support very diverse faunas. Freshwater mussels occupy a wide range of habitats, but most often occupy lotic waters, i.e. flowing water such as rivers, streams and creeks. (Huber, Markus, 2010).

Freshwater mussels, also known as naiads, include about 1,000 known species inhabiting streams, lakes, and ponds over most of the world. The largest family of freshwater mussels is the Unionidae, with about 750 species, the greatest number of which occur in the United States. Many unionid species also live in Southeast Asian waters." (Britannica,2000)

Snail and mussels are studied to identify the freshwater snail and mollusk species found in the Ayeyarwady River, near project area, to give basic information of existing species for the further ecological assessment.

4.8.5.4.2.2 Material and Method

4.8.5.4.2.2.1 Study area and Study period

Study area and study period for snail and mollusks are shown in materials and method of phytoplankton and zooplankton.

4.8.5.4.2.2.2 Method of Sample Collection and Identification

The snails were collected using two methods: hand picking and scooping. While conducting the sample collection, the surveyor wore rubber gloves to reduce the chances of coming into contact with the snails or any of their excretions, which could cause a parasitic or bacterial infection. The method of snail collection is shown in Figure 4-160 . The collected snails and mussels are put into plastic containers for macroscopic identification.

Identification was done based on the specimen size, color, and morphological features. Identification and classification of the collected species followed that of Burnhill (2006).

Specimen collection in Site I

Specimen collection in Site II

Specimen collection in Site III

Specimen collection in Site IV

Figure 4-160 Photos of collection specimens of snail and mollusk

Figure 4-161 Human Disturbance Activities, Jetty, Using Pesticides, and Discharging Wastewater

4.8.5.4.2.3 Results Field Survey Results of Snail and Mollusk

4.8.5.4.2.3.1 Species Composition

A total of 8 species distributed under (5) genera, (5) families and (4) orders were identified and recorded during this study. List of recorded species are shown in Table 4-106.

The highest composition of species was recorded in order Neotaenioglossa (37.5%), followed by Venerida, Architaenioglossa (each with 25%), and Unionida (12.5%). With respect to the number of species encountered at each study site, the largest number of species (7) was encountered in Site (I), followed by those of Site (II) with (5) species, and Site (IV) with (4) species. Only 2 species are overserved in site III. Species occurrence of the study area are shown in Table 4-107 and Figure 4-162.

Table 4-106 List of recorded species found in four sample collection sites

No.	Phylum	Class	Order	Family	Genus/Species
1	Mollusca	Bivalvia	Venerida	Cyrenidae	*Corbicula* sp. 1
2					*Corbicula* sp. 2
3			Unionida	Unionoidae	*Lamellidens* sp.
4		Gastropoda	Architaenioglossa	Viviparidae	*Viviparus* sp.
5				Ampullariidae	*Pila* sp.
6			Neotaenioglossa	Thiaridae	*Melanoides* sp. 1
7					*Melanoides* sp. 2
8					*Melanoides* sp. 3

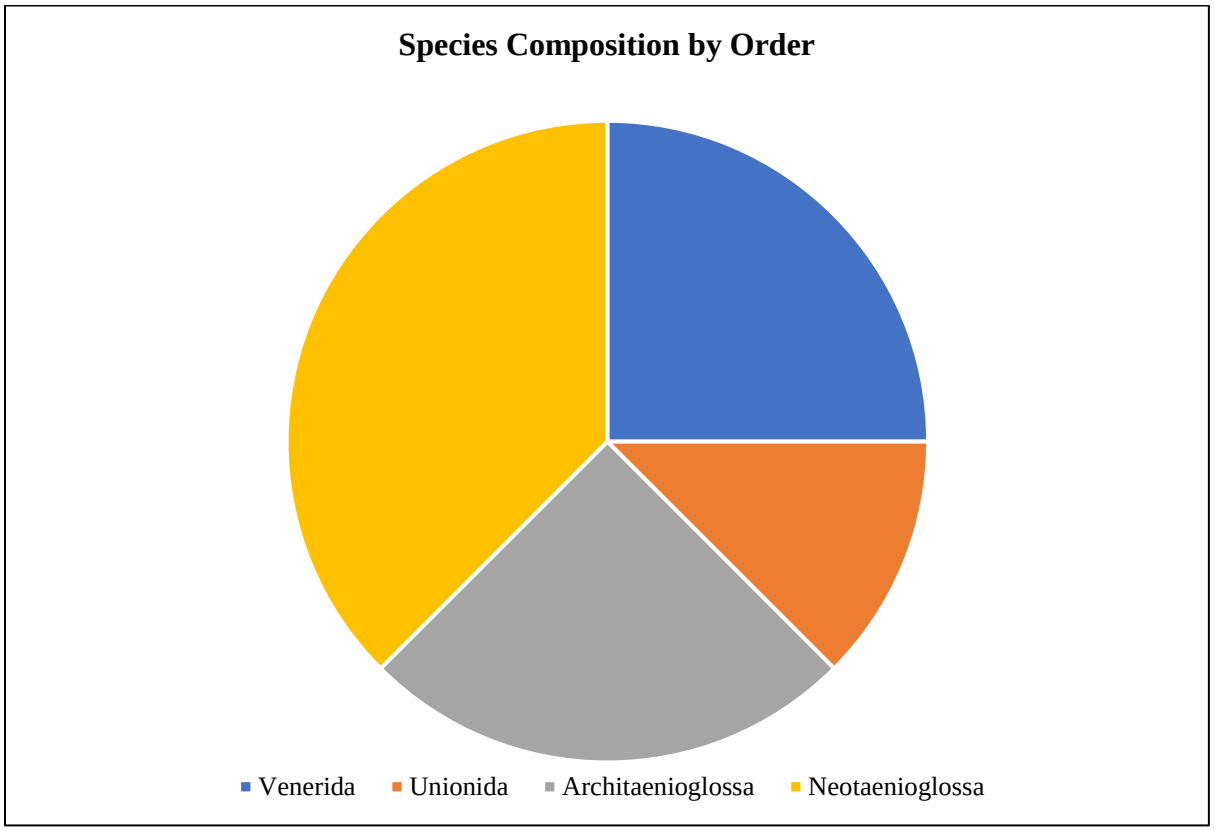


Figure 4-162 Species composition by order of snails and mollusks

4.8.5.4.2.3.2 Species occurrence

Table 4-107 Occurrence of recorded species found in four sample collection sites

Species	Site I	Site II	Site III	Site IV
Corbicula sp. 1	✓	✓	✓	✓
Corbicula sp. 2	✓	✓	-	✓
Viviparus sp.	✓	-	-	✓
Melanoides sp. 1	✓	✓	-	-
Melanoides sp. 2	✓	✓	-	-
Melanoides sp. 3	✓	-	-	-
Lamellidens sp.	✓	✓	✓	-
Pila sp.	-	-	-	✓

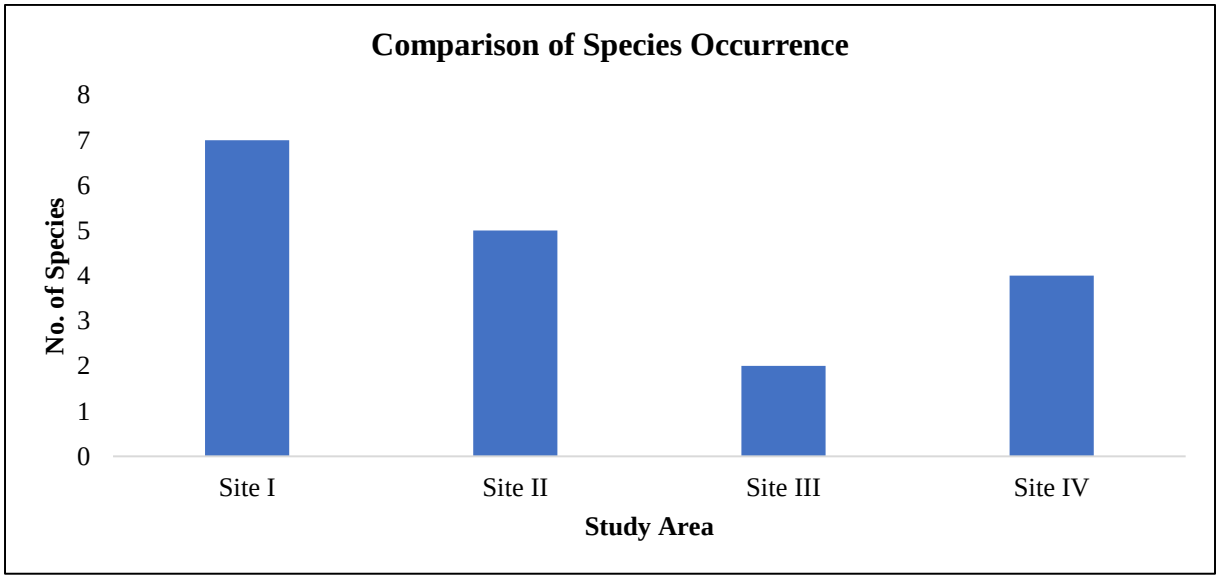


Figure 4-163 Comparison of species occurrence of snail and mollusks

4.8.5.4.2.3.3 Recorded Snail and Mollusks

Corbicula sp. 1 (Dorsal View)

Corbicula sp. 1 (Ventral View)

Corbicula sp. 2 (Dorsal View)

Corbicula sp. 2 (Ventral View)

Viviparus sp.

Melanoides sp. 1


Melanoides sp. 2


Melanoides sp. 3

Lamellidens sp.(Dorsal View)

Lamellidens sp.(Ventral View)

Pila sp.

Figure 4-164 Recorded species photos

4.8.5.4.2.4 Discussion and Conclusion

Taking this into consideration, the study site area is an environment, that is characterized by jetties, human disturbance, fishing, using pesticides, and discharging wastewater. In the present study, Corbicula sp. 1, Corbicula sp. 2, Viviparus sp., Melanoides sp. 1, Melanoides sp. 2, Melanoides sp. 3, and Lamellidens sp. are recorded in Site I except Pila sp. Corbicula sp. has been found in substrates of muddy to sandy-gravelly texture. Corbicula sp. is found in the sandy bank area of the river. Site I is a river bank that is near Ahrlaung village, where fewer human activities (fishing, jetties, solid wastes, wastewater, and environmental disturbance activities) are found.

Freshwater mussels (Mollusca: Bivalvia: Unionida) are important members of the benthic community in aquatic ecosystems and play key ecological roles in primary and secondary production, biogeochemical cycles, sedimentation rates and water clarity. Furthermore, because of their high sensitivity to habitat disturbances, these animals can be used as ecological indicators to assess environmental disturbance in freshwater habitats (Lopes-Lima et al., 2020).

Gastropods occupy an important position in the food web and are ubiquitous and abundant in aquatic ecosystems. In freshwater ecosystems, they constitute an important link in circulation of organic matter and nutrients. Freshwater gastropods, which are hololimnic organisms, have limited mobility and therefore could be used as bioindicators of changes in their habitats. They reflect the abiotic or biotic state of water habitats, which represents the impact of environmental changes on the habitat, the community and the ecosystem (Lewin 2014).

Three mollusk species (*Corbicula* sp. 1, *Corbicula* sp. 2, and *Lamellidens* sp.) and two snail species (*Melanoides* sp. 1 and *Melanoides* sp. 2) are found in Site II.

Two mollusk species (*Corbicula* sp. and *Corbicula* sp. 2) and one snail species (Viviparus sp.) are recorded in Site III. But only mollusks, namely *Pila* sp., are encountered in Site IV, river bank near Yan Myo Lone Pawdawmu Pagoda, Amarapura.

In site III, only *Corbicula* sp. 1 (mollusk) and *Lamellidens* sp. (snail) are overserved. Site III is located about 0.5 km southeast of the jetty area. And Yadanarbon Bridge, jetty, and Shwe Kyet Yet Pagoda is located within 1km of Site III.

In comparison, area as Site I (near Ahrlaung Village) and Site II (river bank near Sagaing Hills), which have fewer disturbance activities have more species than Site III (Jetty) which has regular activities like navigation, jetty loading/unloading, and waste discharge to the water body. It can be concluded that the habitats, feeding grounds, nesting sites of aquatic organisms like snails and mollusks are affected by human activities.

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Lewin I. 2014. Mollusc communities of lowland rivers and oxbow lakes in agricultural areas with anthropogenically elevated nutrient concentration. – Folia Malacologica, 22 (2): 87-15

4.8.5.4.3 Fish

4.8.5.4.3.1 Introduction

First of all, fish are aquatic vertebrates, which means they have an internal backbone and live underwater. Most fish are cold-blooded and long in the body. They also have gills for respiration, fins for movement, and swim bladders to keep them afloat. Aside from this, fish vary greatly in size, shape, habitat, and diet.

Over 33,000 fish species exist in the world. And more are being discovered all the time, which means that in the future, that number could skyrocket. After all, humans have only explored about 20% of the ocean; who knows what resides in the remaining 80%. Scientists estimate that 3.5 trillion fish live in all the oceans combined. About half of all fish species make their homes in freshwater. (Dueck, 2022)

Unlike mammals, fish are cold-blooded (ectothermic). This means that they do not maintain a constant internal body temperature; instead, their temperature is greatly influenced by their environment. True fish have a backbone and fins. Most also breathe with gills and have scales that cover their bodies. It is currently believed that fish began to evolve about 480 million years ago. There are about 22,000 known species of fish. (Francis-Floyd & Petty, 2023)

Fish constitute one of the major protein sources for humans around the world. There are to date some 25,000 different known fish species of which 15,000 are marine and nearly 10,000 are freshwater (Nelson, 1994)

The fisheries sector is a very important component of Myanmar's economy, as fish constitute a major source of animal protein in the diet of the Myanmar people, who are largely consumers of rice and fish in their daily life. According to the Myanmar Country Environmental Analysis Report (World Bank, 2019), the fisheries sector contributes roughly 2% of Myanmar's gross domestic product (GDP), 50% of animal protein consumption, 6% of employment, rising to as high as 34% in some coastal areas, and up to 56% of state/regional government revenue. Over 3.2 million people are employed in the fisheries sector, 800 000 full-time and 2.4 million parttime, amounting to 6% of Myanmar's population (World Fish, 2017). (Psomadakis, et al, 2019)

Myanmar fish production is composed of about 863,000 metric tons or 30% of inland capture fish, 1,062,000 metric tons or 37% of marine capture fish, and 942,000 metric tons or 33% of aquaculture fish. The Ayeyarwady Basin is the most important source of inland fisheries for the country. The overall number of fish species recorded in the Ayeyarwady Basin is 388, of which 311 are present in the Myanmar part. The others are being found in India and China. Among the 388 fish species, 193 (50 %) are endemic to the basin, and 100 (26 %) of the endemics are presently known only from Myanmar (WWF, 2018).

Inland capture fisheries provide a valuable contribution to food security in many parts of the developing countries including Myanmar. Union of Myanmar is littoral and largest country in main land in Southeast Asia, comprising a land area of 676,577 sq km, a coastline of nearly 2,832 km, a continental shelf of 228,781 sq km and Exclusive Economic Zone of 486,000 sq km. Inland freshwater bodies cover 8.1 million ha of which 1.3 million ha are permanent; the remainder are seasonally inundated floodplains, with a population of 54 million in 2005. Fish is one of the most main animal protein resources in Myanmar and fish is a rich source of lysine as well as all other essential amino acids, vitamin A, essential fatty acids and calcium which are difficult to secure in non-fish products including many meats. (Southeast Asian Fisheries Development Center, Inland Fishery in Myanmar)

Fish are keystone species, which determine the distribution and abundance of other organisms in the ecosystem. They are good indicators of the water quality and the health of the ecosystem. (Nelson, 1984).

4.8.5.4.3.2 Materials and Methods

4.8.5.4.3.2.1 Study Area

There were six study sites in total. These sites were selected on the basis of physical condition, water quality type, availability of fish. These are described as Site I (Thayetkoepin), II (Shankalaykyun Village), III (Okpho Junction), IV (Tadarhpyu) , V (Kan Taw Gyi Lake), VI (Taung Tha Man Lake).

Table 4-108 Study Sites

No	Study Site	Lat Long	Description
1	Site I	Latitude 21° 53' 46.99″ Longitude 96° 1' 11.37″	(Thayetkoepin) Jetty where fish from Ayeyarwady River are collected initially before selling the market.
2	Site II	Latitude 21° 55' 58.73″ Longitude 96° 2' 51.93″	(Shankalaykyun Village) A village near Ayeyarwady River bank
3	Site III	Latitude 21° 53' 21.81″ Longitude 96° 1' 13.51″	Okpho Junction
4	Site IV	Latitude 21° 53' 3.20″ Longitude 96° 1' 1.74″	Tadarhpyu
5	Site V	Latitude 21° 55' 59.20″ Longitude 96° 4' 6.64″	Kan Taw Gyi Lake
6	Site VI	Latitude 21° 53' 45.47″ Longitude 96° 3' 8.99″	Taung Tha Man Lake

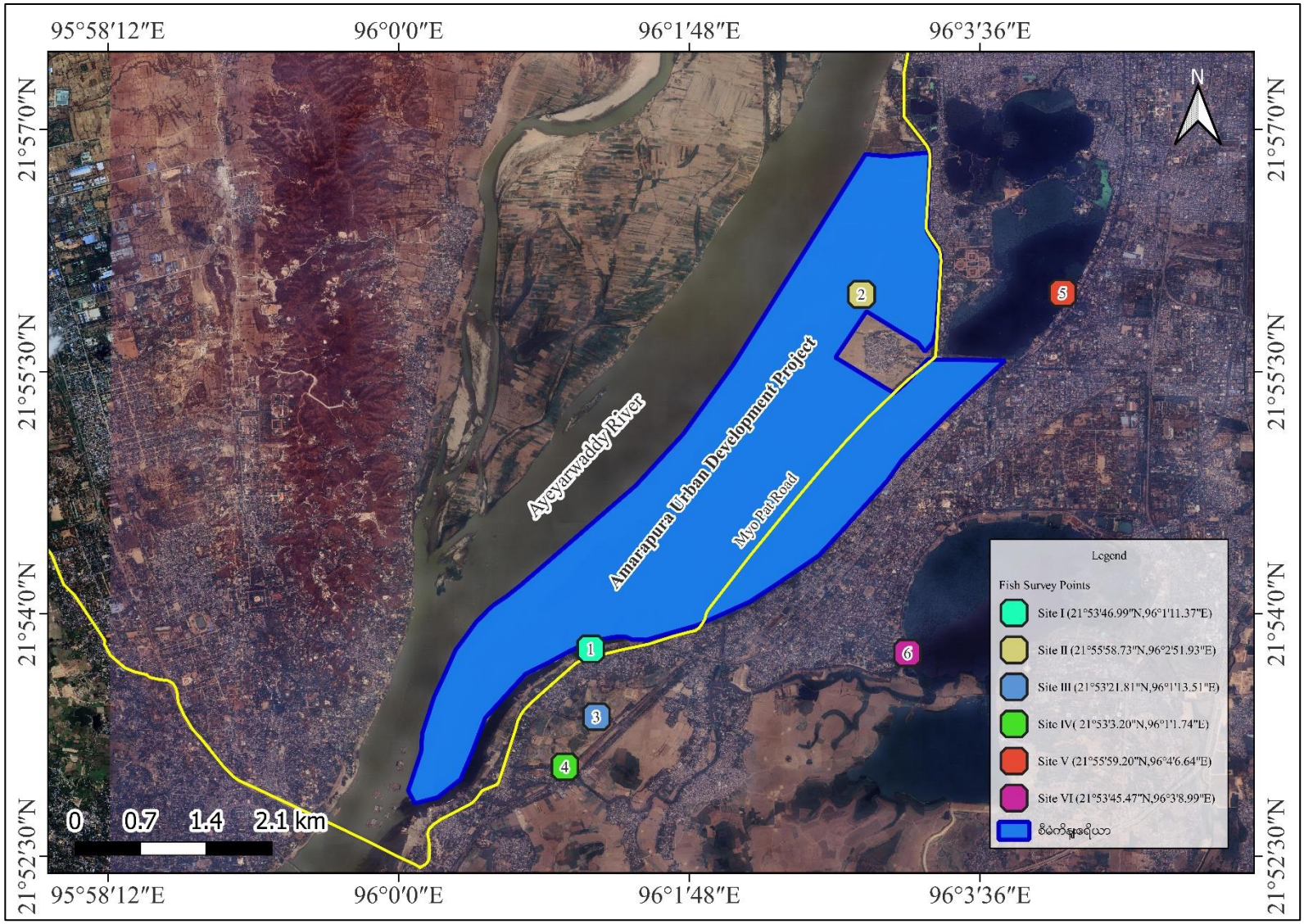


Figure 4-165 Map of study area for fish species


Thayetkoepin


Kan Taw Gyi Lake


Tadarphyu


Taung Tha Man Lake

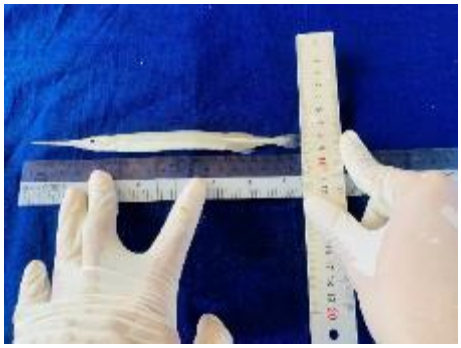
Figure 4-166 Photos of Habitats of Fish Species

4.8.5.4.3.2.2 Study Period

Currently, Myanmar experiences a tropical-monsoon climate with three dominant seasons: the March-to-May hot season, the June-to-October wet season and the November-to-February cool season (Horton, e.t., al, 2017). The field survey was conducted for three seasons as October (Wet Season), December (Cool Season) and March (Hot Season).

4.8.5.4.3.2.3 Study Design and Data Collection

The specimens were collected from the stations caught by fisherman. The fish were caught by various type of fishing gears and fish nets. The physical appearance of fish was noted down and the photos were also taken immediately. The length, body weight and morphometric characteristics were collected for at least two individual specimens from each species. The number of individuals in each species were recorded in each species. If the specimens were difficult to identify, those were preserved with formalin for further process.



Measuring Body length of Fish Species

Measuring Body weight of Fish Species

Figure 4-167 Photos of Measuring Fish Species

Fishing net (Mesh size of the drift-gill net)

Fishing hook

Fishing net (Gill net)

Fishing Net (Drift net)

Fishing net (Cast net – Let Pyit Con)

Fishing Net (Drift net)

Fishing net (Push net)

Fishing Net (Bamboo Trap)

Figure 4-168 Photos of Fishing Gear

4.8.5.4.3.2.4 Identification of specimens

Identification and classification of the collected fish species were made according to Jayaram (2013), Talwar and Jhingran (1991) and Fishbase (2022).

4.8.5.4.3.2.5 Data Analysis

The data were calculated using the following formula. The recorded data were analyzed by using the following formula.

- Species Composition
- Relative Abundance

Data analysis method and formula are fully described in paragraph 4.8.5.2.2.4

Field Survey Results of Fish Species

Among six habitats, numbers of fish species were observed the most at site I with the total of 28 species, followed by site II with 21 species. Specimens collected from site I and site II were from Ayeyarwady River, whereas other sites are manmade area for aquaculture. Site I is thayetkoepin and the fish from this area is caught by local fishermen from Ayeyarwady river.

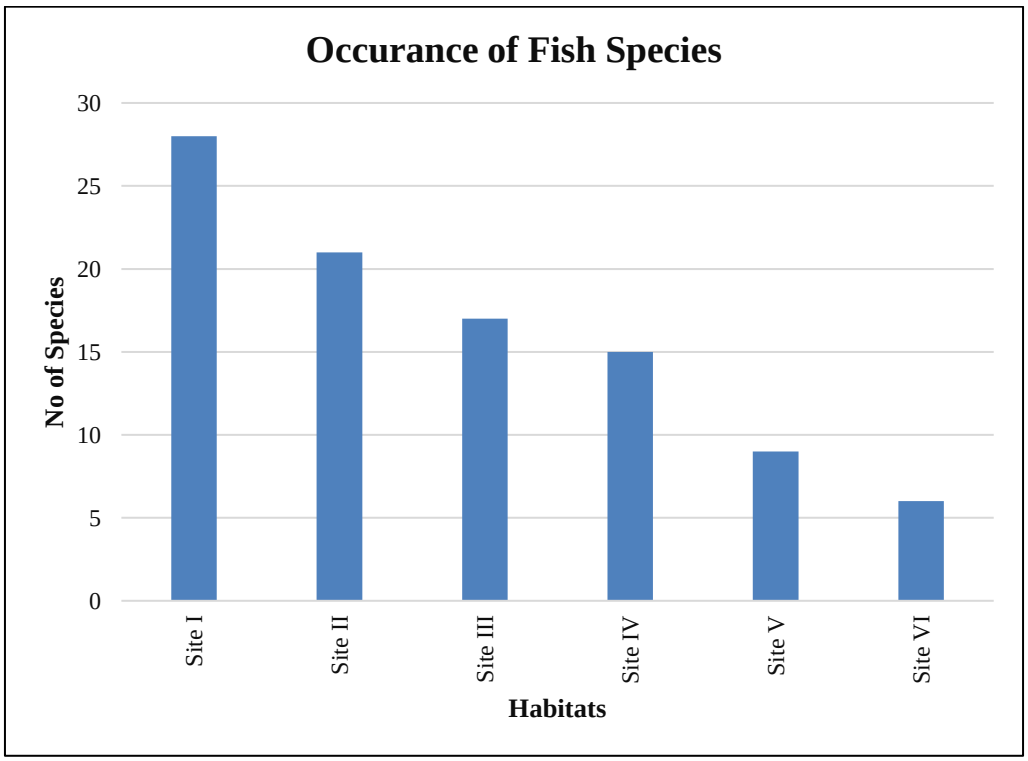


Figure 4-169 Occurrence of Fish Species at Different Sites

Table 4-109 List of Fish Observed in Study Areas

No.	Common Name	Scientific Name	Study Site						IUCN Status
			Site I	Site II	Site III	Site IV	Site V	Site VI	
1	Boal	Wallago attu	✓	✓	✓	-	-	-	VU
2	Talapia	Oreochromis sp.	✓	✓	✓	-	✓	✓	-
3	Silver carp	Hypophthalmichthys	✓	-	-	-	✓	-	NT

No.	Common Name	Scientific Name	Study Site						IUCN Status
			Site I	Site II	Site III	Site IV	Site V	Site VI	
		molitrix							
4	Boga Labeo	Labeo boga	✓	✓	-	✓	-	-	LC
5	Java barb	Barbonymus gonionotus	✓	✓	-	-	✓	-	LC
6	Burmese river shad	Gudusia variegata	✓	✓	✓	✓	-	-	LC
7	Genetic mystus pulcher	Mystus pulcher	✓	-	✓	-	-	-	LC
8	Catla	Gibelion catla	✓	-	✓	-	-	✓	LC
9	Bronce Feather back	Notopterus notopterus	✓	-	✓	-	-	-	LC
10	Indian Butter Catfish	Ompok pabo	✓	-	-	-	-	-	NT
11	Freshwater garfish	Xenentodon cancila	✓	✓	-	-	-	-	LC
12	Long whiskered catfish	Sperata aor	✓	-	-	-	-	-	LC
13	Ocellated pufferfish	Leiodon cutcutia	✓	-	-	-	-	-	LC
14	Sittaung mystus	Mystus leucophasis	✓	✓	-	-	-	-	LC
15	Moulmeinlabeo	Labeo stoliczkae	✓	-	-	-	-	-	DD
16	India Gagata	Gagata cenia	✓	-	-	-	-	-	LC
17	Cunma osteobrama	Osteobrama cunma	✓	✓	-	-	-	-	LC
18	Black rohus	Labeo calbasu	✓	-	-	✓	-	-	LC
19	Mulabar-loach	Lepidocephalichthys thermalis	✓	✓	-	-	-	-	LC
20	Mrigal	Cirrhinus mrigala	✓	✓	-	✓	✓	-	LC
21	Burmese carplet	Amblypharyngodon atkinsonii	✓	✓	✓	-	-	-	LC
22	Olive-barb	Salmophasia sardinella	-	-	✓	✓	-	-	LC
23	Striped snakehead	Channa striata	-	✓	✓	-	-	✓	LC
24	Indian glassy fish	Parambassis ranga	✓	✓	✓	✓	-	-	LC
25	Zebra-spinyeel	Macrognathus zebrinus	-	-	✓	-	-	-	LC

No.	Common Name	Scientific Name	Study Site						IUCN Status
			Site I	Site II	Site III	Site IV	Site V	Site VI	
26	Burmese Trout	Raiamas guttatus	-	-	✓	✓	-	-	LC
27	Schilbid catfish	Eutropiichthys vacha	-	✓	-	-	-	-	LC
28	Manipur osterobrama	Osteobrama belangeri	✓	✓	✓	✓	-	-	NT
29	One-stripe spiny eel	Macrogathus aral	-	✓	-	-	-	-	LC
30	Burmese osteobrama	Osteobrama feae	✓	✓	-	✓	-	-	LC
31	Genetic mystus	Mystus cavasius	✓	✓	✓	✓	-	-	LC
32	Spotfin Swamp barb	Puntius sophore	✓	✓	-	✓	-	-	LC
33	Olive-barb	Systomus sarana	-	✓	✓	✓	✓	✓	LC
34	Angra labeo	Labeo angra	-	-	-	✓	-	-	LC
35	Tank goby	Glossogobius giuris	✓	-	✓	✓	-	✓	LC
36	Philippine catfish	Clarias batrachus	-	-	-	-	✓	✓	LC
37	Rohu Labeo	Labeo rohita	✓	✓	✓	✓	✓	-	LC
38	Common carp	Cyprinus carpio	-	-	-	-	✓	-	VU
39	Pangas catfish	Pangasius pangasius	-	-	-	-	✓	-	LC

LC- Least Concern VU- Vulnerable NT- Near Threatened DD- Data Deficient

4.8.5.4.3.2.6 Species Composition and Relative Abundance at Site I (Thayetkoepin)

The sample fish community was composed of 28 species belonging to 21 genera from 12 families under 7 orders. Among them, Cyprinifomes is the most abundance order at Site I (Thayetkoepin).

Table 4-110 Species Composition at Site I

No	Order	Number of Family	Number of Genus	Number of Species	Species Composition
1	Osteoglossiformes	1	1	1	3.571
2	Clupeiformes	1	1	1	3.571
3	Cyprinifomes	2	9	14	50.000
4	Siluriformes	3	5	7	25.000
5	Biloniformes	1	1	1	3.571
6	Perciformes	3	3	3	10.714
7	Tetraodontiformes	1	1	1	3.571
	Total	**12**	**21**	**28**	**100**

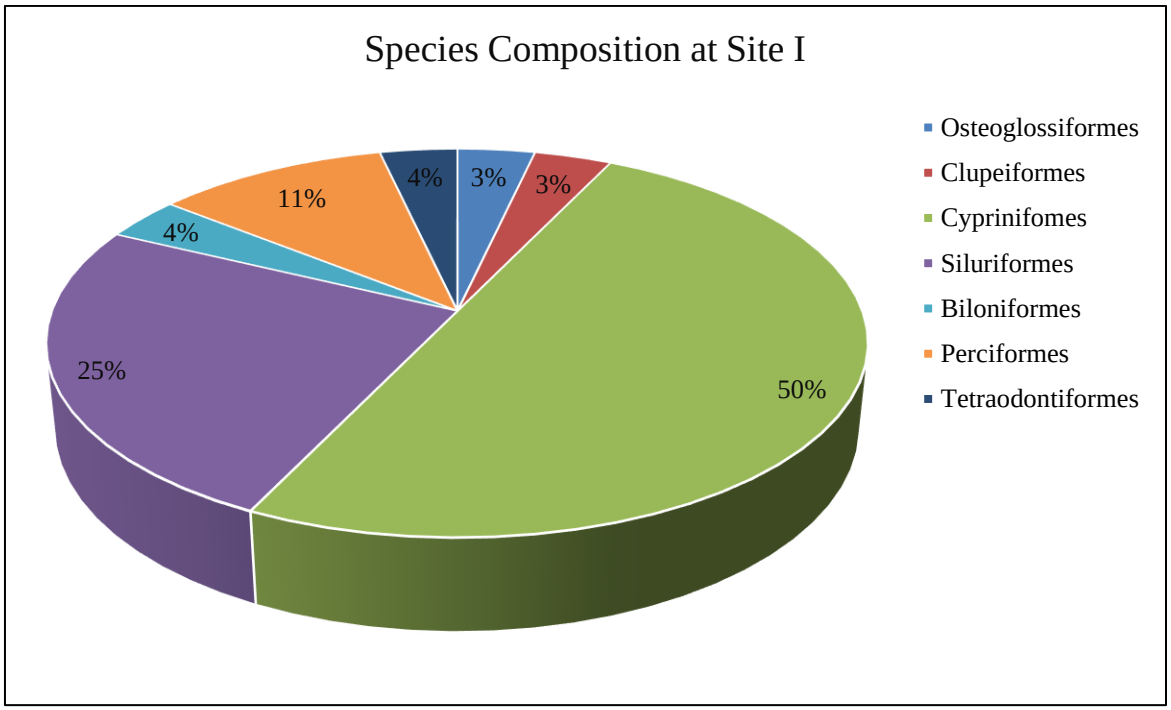


Figure 4-170 Species Composition at Site I

Table 4-111 Relative Abundance and Status of Fish in Site I

No.	Common Name	Scientific Name	R.A	I.A
1	Boal	*Wallago attu*	0.005	uC
2	Talapia	*Oreochromis sp.*	0.005	uC
3	Silver carp	*Hypophthalmichthys molitrix*	0.005	uC
4	Boga Labeo	*Labeo boga*	0.031	C
5	Manipur osterobrama	*Osteobrama belangeri*	0.005	uC
6	Burmese osteobrama	*Osteobrama feae*	0.008	uC
7	Java barb	*Barbonymus gonionotus*	0.078	vC
8	Spotfin Swamp barb	*Puntius sophore*	0.078	vC
9	Rohu Labeo	*Labeo rohita*	0.024	C
10	Burmese river shad	*Gudusia variegata*	0.110	vC
11	Indian glassy fish	*Parambassis ranga*	0.118	vC
12	Genetic mystus	*Mystus cavasius*	0.039	C
13	Genetic mystus pulcher	*Mystus pulcher*	0.039	C
14	Catla	*Gibelion catla*	0.007	uC
15	Bronce Feather back	*Notopterus notopterus*	0.002	uC
16	Indian Butter Catfish	*Ompok pabo*	0.008	uC
17	Freshwater garfish	*Xenentodon cancila*	0.020	C
18	Long whiskered catfish	*Sperata aor*	0.009	uC
19	Ocellated pufferfish	*Leiodon cutcutia*	0.002	uC
20	Sittaung mystus	*Mystus leucophasis*	0.001	uC
21	Moulmeinlabeo	*Labeo stoliczkae*	0.007	uC
22	India Gagata	*Gagata cenia*	0.011	C
23	Tank goby	*Glossogobius giuris*	0.064	vC
24	Cunma osteobrama	*Osteobrama cunma*	0.058	vC
25	Black rohus	*Labeo calbasu*	0.071	vC
26	Mulabar-loach	*Lepidocephalichthys thermalis*	0.088	vC
27	Mrigal	*Cirrhinus mrigala*	0.005	uC
28	Burmese carplet	*Amblypharyngodon atkinsonii*	0.100	vC

4.8.5.4.3.2.7 Species Composition and Relative Abundance at Site II (Shankalaykyun)

The sample fish community was composed of 21 species belonging to 17 genera from 10 families under 6 orders. Among them, Cypriniformes is the most abundance order at Site II (Shankalaykyun).

Table 4-112 Species Composition at Site II

No	Order	Number of Family	Number of Genus	Number of Species	Species Composition
1	Clupeiformes	1	1	1	4.762
2	Cyprinifomes	2	8	11	52.381
3	Siluriformes	2	3	4	19.048
4	Biloniformes	1	1	1	4.762
5	Perciformes	3	3	3	14.286
6	Synbranchiformes	1	1	1	4.762
	Total	**10**	**17**	**21**	**100.000**

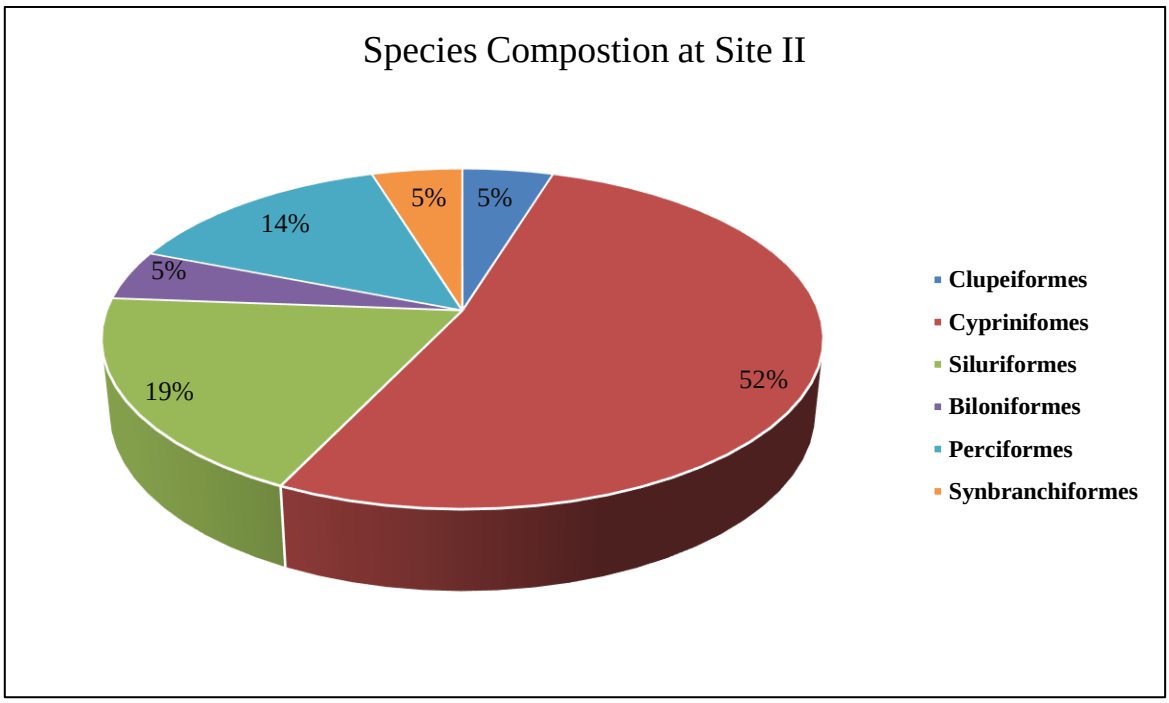


Figure 4-171 Species Composition at Site II

Table 4-113 Relative Abundance and status of Fish in Site II

No.	Common Name	Scientific Name	R.A	I.A
1	Talapia	*Oreochromis sp.*	0.001	uC
2	Java barb	*Barbonymus gonionotus*	0.079	vC
3	Rohu Labeo	*Labeo rohita*	0.000	uC
4	Schilbid catfish	*Eutropiichthys vacha*	0.001	uC
5	Freshwater garfish	*Xenentodon cancila*	0.000	uC
6	Manipur osterobrama	*Osteobrama belangeri*	0.135	vC
7	One-stripe spinyeel	*Macrogathus aral*	0.003	uC
8	Mulabar-loach	*Lepidocephalichthys thermalis*	0.000	uC
9	Indian glassy fish	*Parambassis ranga*	0.000	uC
10	Olive-barb	*Systomus sarana*	0.293	vC
11	Spotfin Swamp barb	*Puntius sophore*	0.003	uC
12	Sittaung mystus	*Mystus leucophasis*	0.006	uC
13	Boga Labeo	*Labeo boga*	0.079	vC
14	Burmese carplet	*Amblypharyngodon atkinsonii*	0.002	uC
15	Cunma osteobrama	*Osteobrama cunma*	0.011	C
16	Striped snakehead	*Channa striata*	0.011	C
17	Mrigal	*Cirrhinus mrigala*	0.338	vC
18	Boal	*Wallago attu*	0.034	C
19	Burmese osteobrama	*Osteobrama feae*	0.000	uC
20	Genetic mystus	*Mystus cavasius*	0.002	uC
21	Burmese river shad	*Gudusia variegata*	0.001	uC

4.8.5.4.3.2.8 Species Composition and Relative Abundance at Site III (Okpho Junction)

The sample fish community was composed of 17 species belonging to 16 genera from 10 families under 6 orders. Among them, Cypriniformes is the most abundance order at Site III (Okpho Junction).

Table 4-114 Species Composition at Site III

No	Order	Number of Family	Number of Genus	Number of Species	Species Composition
1	Clupeiformes	1	1	1	4.762
2	Cyprinifomes	2	8	11	52.381
3	Siluriformes	2	3	4	19.048
4	Biloniformes	1	1	1	4.762
5	Perciformes	3	3	3	14.286
6	Synbranchiformes	1	1	1	4.762
	Total	**10**	**17**	**21**	**100.000**

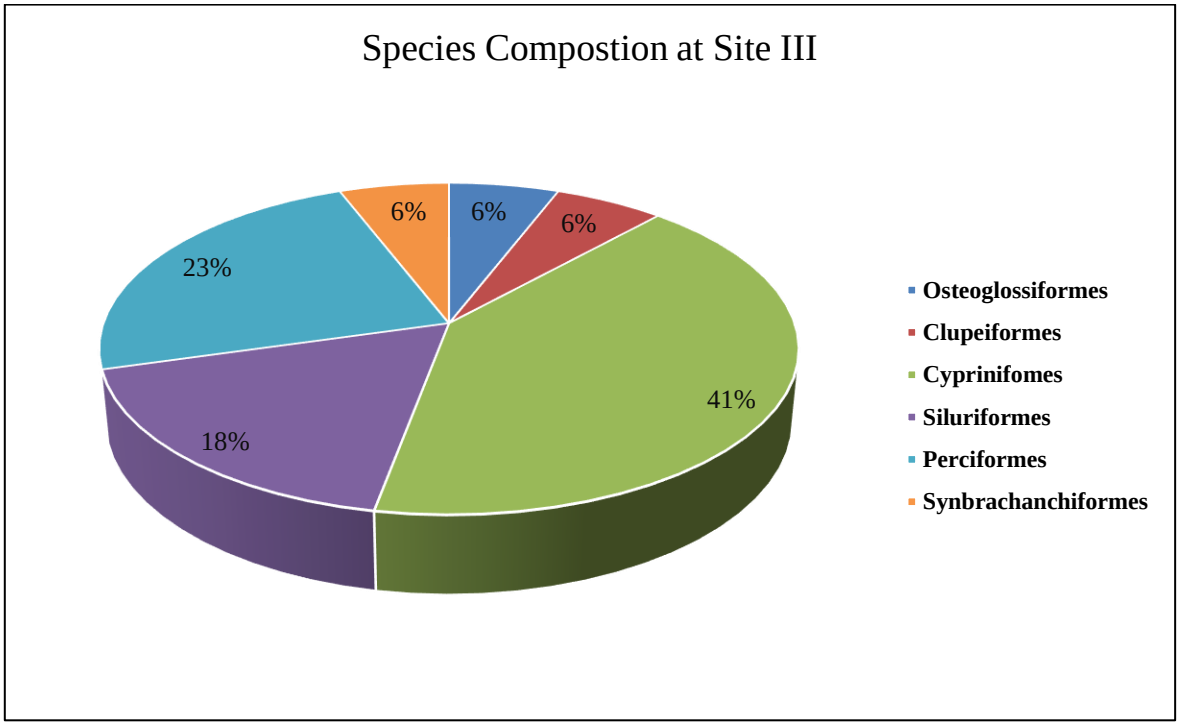


Figure 4-172 Species Composition at Site III

Table 4-115 Relative Abundance and status of Fish in Site III

No.	Common Name	Scientific Name	R. A	I.A
1	Tank goby	*Glossogobius giuris*	0.230	vC
2	Genetic mystus pulcher	*Mystus pulcher*	0.102	vC
3	Manipur osterobrama	*Osteobrama belangeri*	0.077	vC
4	Burmese river shad	*Gudusia variegata*	0.281	vC
5	Sardinella razobelly	*Salmophasia sardinella*	0.077	vC
6	Catla	*Gibelion catla*	0.013	C
7	Rohu Labeo	*Labeo rohita*	0.003	u
8	Boal	*Wallago attu*	0.005	u
9	Talapia	*Oreochromis sp.*	0.065	vC
10	Striped snakehead	*Channa striata*	0.003	u
11	Bronce Feather back	*Notopterus notopterus*	0.001	u
12	Sardinella razobelly	*Systomus sarana*	0.001	u
13	Indian glassy fish	*Parambassis ranga*	0.001	u
14	Zebra-spinyeel	*Macrognathus zebrinus*	0.000	u
15	Burmese Trout	*Raiamas guttatus*	0.000	u
16	Genetic mystus	*Mystus cavasius*	0.022	C
17	Burmese carplet	*Amblypharyngodon atkinsonii*	0.120	vC

4.8.5.4.3.2.9 Species Composition and Relative Abundance at Site IV (Tadarhpyu)

The sample fish community was composed of 15 species belonging to 11 genera from 5 families under 3 orders. Among them, Cypriniformes is the most abundance order at Site IV (Tadarhpyu).

Table 4-116 Species Composition at Site IV

No	Order	Number of Family	Number of Genus	Number of Species	Species Composition
1	Clupeiformes	1	1	1	6.667
2	Cyprinifomes	1	7	11	73.333
3	Siluriformes	3	3	3	20.000
	Total	5	11	15	100.000

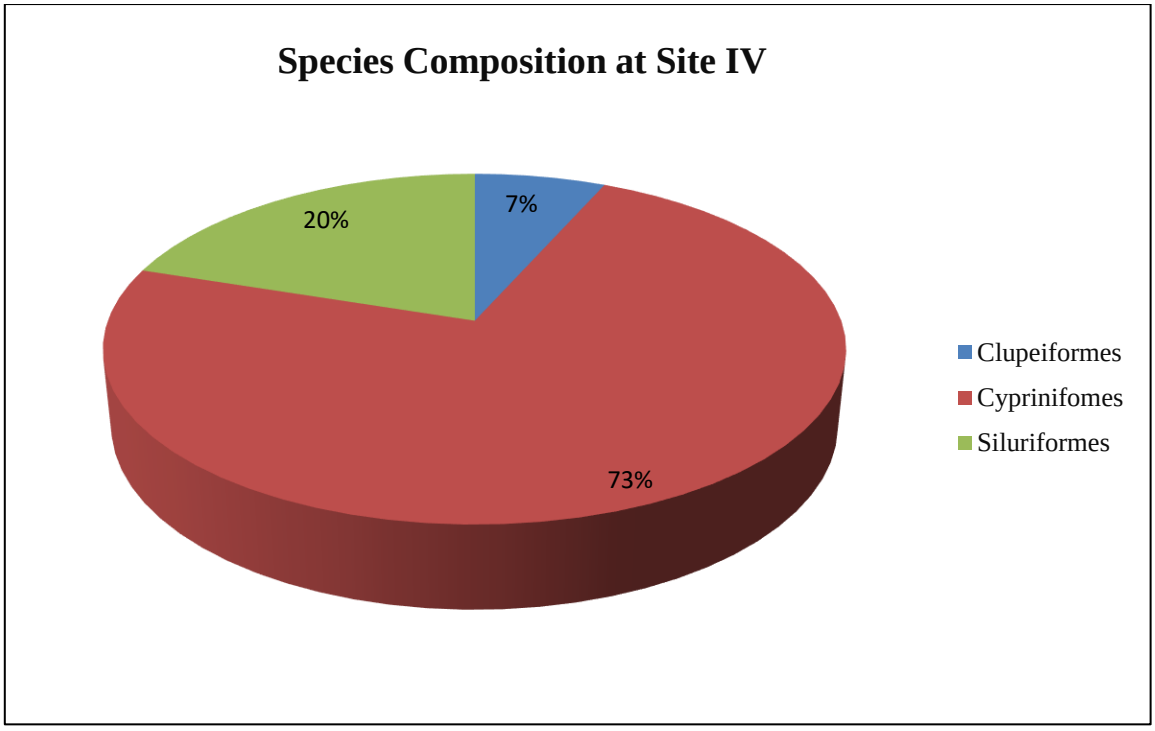


Figure 4-173 Species Composition at Site IV (Tadarhpyu)

Table 4-117 Relative Abundance and status of Fish in Site IV (Tadarhpyu)

No.	Common Name	Scientific Name	R.A	I.A
1	Black rohus	*Labeo calbasu*	0.001	uC
2	Burmese osteobrama	*Osteobrama feae*	0.002	uC
3	Rohu Labeo	*Labeo rohita*	0.000	uC
4	Mrigal	*Cirrhinus mrigala*	0.000	uC
5	Spotfin Swamp barb	*Puntius sophore*	0.265	vC
6	Sardinella razobelly	*Salmophasia sardinella*	0.003	uC
7	Genetic mystus	*Mystus cavasius*	0.001	uC
8	Indian glassy fish	*Parambassis ranga*	0.707	vC
9	Manipur osterobrama	*Osteobrama belangeri*	0.001	uC
10	Boga Labeo	*Labeo boga*	0.001	uC
11	Burmese river shad	*Gudusia variegata*	0.018	C
12	Olive-barb	*Systomus sarana*	0.000	uC
13	Angra labeo	*Labeo angra*	0.000	uC
14	Tank goby	*Glossogobius giuris*	0.000	uC
15	Burmese Trout	*Raiamas guttatus*	0.000	uC

4.8.5.4.3.2.10 Species Composition and Relative Abundance at Site V (Kan Taw Gyi Lake)

The sample fish community was composed of 9 species belonging to 9 genera from 4 families under 3 orders. Among them, Cypriniformes is the most abundance order at Site V (Kan Taw Gyi Lake).

Table 4-118 Species Composition at Site V

No	Order	Number of Family	Number of Genus	Number of Species	Species Composition
1	Cyprinifomes	1	6	6	66.667
2	Siluriformes	2	2	2	22.222
3	Perciformes	1	1	1	11.111
	Total	**4**	**9**	**9**	100.000

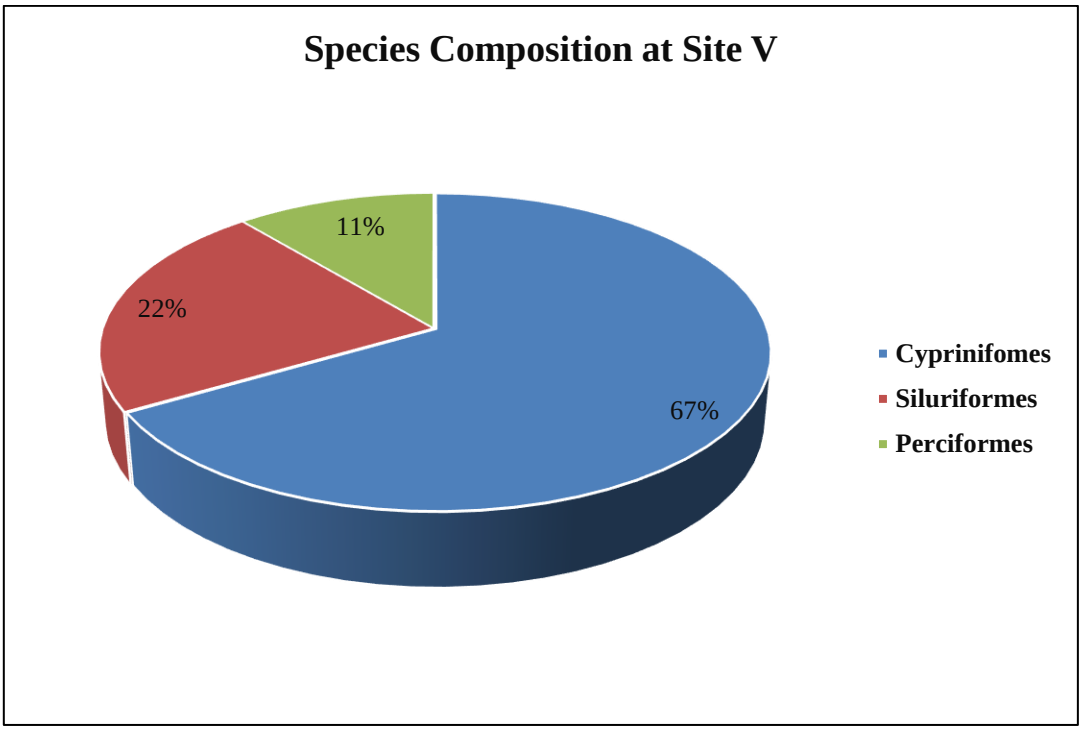


Figure 4-174 Species Composition at Site V

Table 4-119 Relative Abundance and status of Fish in Site V

No.	Common Name	Scientific Name	R.A	I.A
1	Rohu Labeo	*Labeo rohita*	0.287	vC
2	Common carp	*Cyprinus carpio*	0.027	C
3	Mrigal	*Cirrhinus mrigala*	0.089	vC

No.	Common Name	Scientific Name	R.A	I.A
4	Talapia	*Oreochromis sp.*	0.039	C
5	Silver carp	*Hypophthalmichthys molitrix*	0.349	vC
6	Pangas catfish	*Pangasius pangasius*	0.077	vC
7	Java barb	*Barbonymus gonionotus*	0.116	vC
8	Philippine catfish	*Clarias batrachus*	0.001	uC
9	Olive-barb	*Systomus sarana*	0.015	C

4.8.5.4.3.2.11 Species Composition and Relative Abundance at Site VI (Taung Tha Man Lake)

The sample fish community was composed of 17 species belonging to 16 genera from 10 families under 6 orders. Among them, Cypriniformes is the most abundance order at VI (Taung Tha Man Lake).

Table 4-120 Species Composition at Site VI

No	Order	Number of Family	Number of Genus	Number of Species	Species Composition
1	Cyprinifomes	1	2	2	33.333
2	Siluriformes	2	2	2	33.333
3	Perciformes	2	2	2	33.333
	Total	5	6	6	100.000

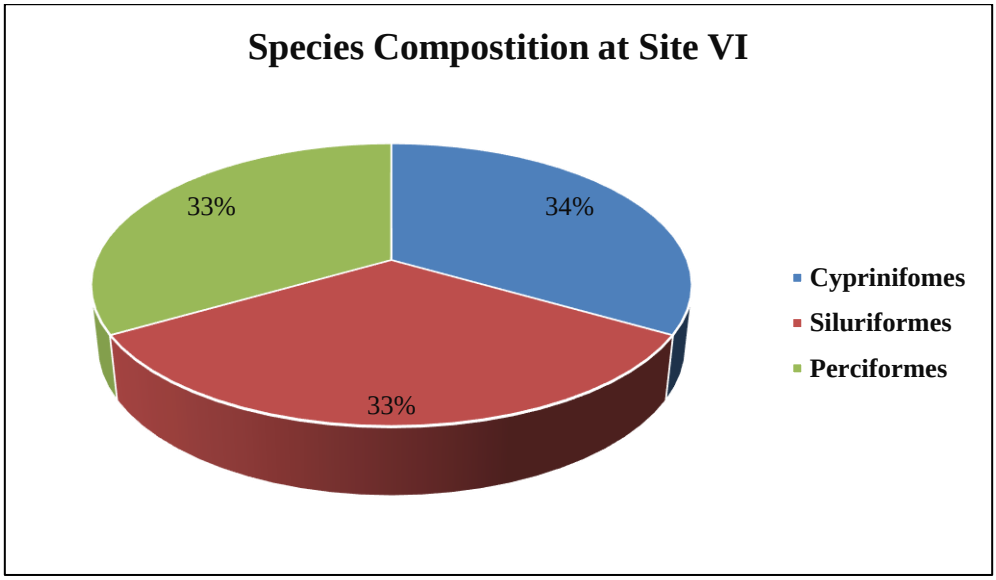


Figure 4-175 Species Composition at Site VI

Table 4-121 Relative Abundance and status of Fish in Site VI

No.	Common Name	Scientific Name	R.A	I.A
1	Talapia	*Oreochromis sp.*	0.802	vC
2	Striped snakehead	*Channa striaia*	0.040	C
3	Tank goby	*Glossogobius giuris*	0.030	C
4	Olive-barb	*Systomus sarana*	0.100	vC
5	Catla	*Gibelion catla*	0.016	C
6	Philippine catfish	*Clarias batrachus*	0.012	C

4.8.5.4.3.2.12 Recorded Fish Species

Oreochromis sp
(Talapia)

Hypophthalmichthys molitrix
(Silver Carp)

Cyprinus carpio
(Common carp)

Eutropiichthys vacha
(Schilbid catfish)

Pangasius pangasius

(Pangas catfish)

Cirrhinus mrigala

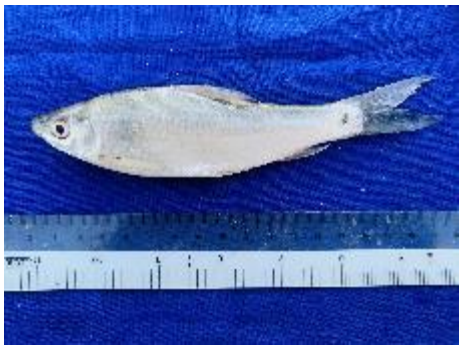
(Mrigal)

Labeo rohita

(Rohu labeo)

Barbonymus gonionotus

(Java barb)



Labeo angra

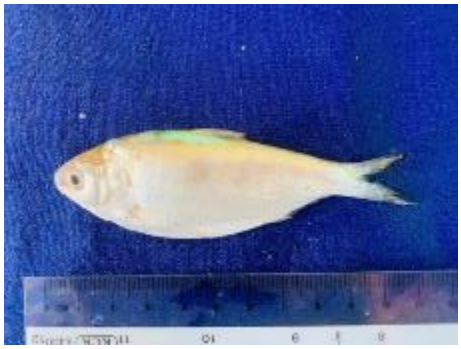
(Angra labeo)

Labeo calbasu

(Black rohus)

Osteobrama feae

(Burmese osteobrama)



gudusia variegata

(Burmese River shad)

Puntius sophore

(Spotfin Swamp barb)

Systomus sarana

(Olive-barb)

Salmophasia sardinella

(Sardinella razobelly)

Mystus cavasius

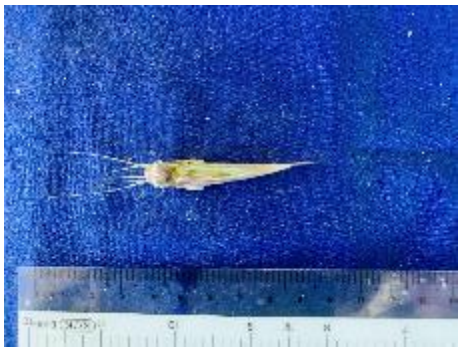
(Genetic mystus)

Parambassis ranga

(Indian glassy fish)

Labeo boga

(Boga labeo)



Mystus pulcher

(Genetic mystus Pulcher)

Glossogobius giuris

(Tank goby)

Channa striata

(Striped snakehead)

Clarias batrachus

(Philippine catfish)

Xenentodon cancila

(Freshwater garfish)

Osteobrama belangeri

)Manipur osterobrama)

Osteobrama cunma

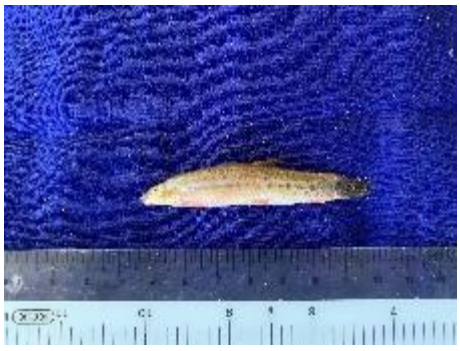
(Cunma osteobrama)

Gagata cenia

(India Gagata)

Macrognathus aral

(one-stripe spiny eel)



Lepidocephalichthys thermalis

)Mulabar-loach)

Mystus leucophasis

(Sittaung mystus)

Labeo stoliczkae

(Moulmeinlabeo)

Wallago attu

(Boal)

Amblypharyngodon atkinsonii

(Burmese Carplet)

Macrognathus zebrinus

(Zebra-spinyeel)

Gibelion catla

(Gibelion catla)

Notopterus notopterus

)Bronce Feather back)

Ompok pabo

)Indian butter catfish)

Sperata aor

)Long whiskered catfish)

Leiodon cutcutia

(Ocellated pufferfish)

Figure 4-176 Record Fish Species

4.8.5.4.3.3 Discussion and Conclusion

During the study period, a total of 40 species were recorded from six study sites in Amarapura Township. Cypriniformes is the most abundance order at all study sites. Regarding the highest number of species, there are total of 28 species are observed at Site I (Thayetkoepin), followed by 21 species at Site II (Shankalaykyun) because the specimens from those sites are caught by local fishermen from Ayeyarwaddy river. Ayeyarwaddy river plays a crucial role as social and economic of local fishermen and provides an important food source, income and employment for consumers of the surrounding environs.

Among recorded orders, the Order Cypriniformes and Siluriformes are the highest number of fish species. Compare with these two orders, the individual number of species of Cypriniformes is higher than Siluriformes. Various workers reported that the similar result in their studies of fish communities in adjacent country. Bakalial *et al* (2014) reported that family Cyprinidae was dominant over other families in lower Subansiri River, Northeast India, Vishwakarma and Vyas (2014) recorded that family Cyprinidae was dominant in Jamner River, India. Acharjee *et al*. (2012), Stated that Cypriniformes was the dominant

order in Dhansiri River, India. During the study period, the result of present study was similar to the statements of the previous authors.

Cyprinids are unique in having a number of small bones that connect the swim bladder to the hearing apparatus in the skull. Most of them are freshwater fish; some occur on all of the continents. (ScienceDirect, Cypriniformes)

Generally, Cypriniformes is divided into two monophyletic groups: the family Cyprinidae and the non-cyprinid cypriniforms. The Cyprinidae includes different kinds of minnows and carps. The non-cyprinid cypriniforms are composed of the family Catostomidae (suckers), family Gyrinocheilidae (algae eaters), and many different loaches. The relationships among the non-cyprinid cypriniforms are still in debate. Recent molecular data suggest that suckers could be at the basal position of this group, followed by the algae eaters and then the different loaches. This chapter focuses on the family Cyprinidae. (Grzimek's Animal Life Encyclopedia. 2023)

Cyprinids comprise a wide variety of specialists and generalists feeding on all trophic levels. Most feed on secondary producers: zooplankton, crustaceans, larvae, pupae and adults of insects, oligochaetes, bryozoans, snails, and mussels. Some also consume primary (macrophytes and phytoplankton) or tertiary (fishes) producers. According to feeding behavior, cyprinids can be categorized into three modes: herbivores, pelagic feeders, and benthic feeders. Herbivores like grass carp eat not only aquatic plants but also the land grasses submerged by flood water. (Grzimek's Animal Life Encyclopedia. 2023)

By contrast, the least number of species was found at Site VI (Taung Tha Man Lake) with the total number of 6 species. Likewise, 9 species are found at site V (Kan Taw Gyi Lake). The water temperature influence on aquatic life cycle, metabolism and behavior of fish and high-water temperature leads to the thermal 5stratification in the river and lake which may lead reduction in diversity and unequal distribution of fish (Jain et al. 2013).

The study shows that the numbers of species vary with different type of habitats (study sites). *Hypophthalmichthys molitrix, Ompok pabo, Osteobrama belangeri* species are nearly threatened and *Wallago attu, Cyprinus carpio* species are vulnerable according to IUCN Red list. The fish species recorded from all study sites, the following are considers as economically important fishes including, *,Notopterus notopterusCirrhinus mrigala, Ompok pabo, Wallago attu, Labeo rohita, Glossogobius giuris, Eutropiichthys vacha.* Therefore, it appeared that the study sites provide an important food source for consumers of the local people.

4.8.5.4.4 Herpetofauna

4.8.5.4.4.1 Introduction

Myanmar stands the most biologically diverse country in mainland Southeast Asia and also very colorful diverse species live in different habitats in which some of the species become endangered species as their habitat destruction and climate changes. Amphibians and reptiles stand for both important members of aquatic and terrestrial

ecosystems. Amphibians are also serving as indicators of wetland ecosystem health as their sensitivity to a variety of threats and, thus, can point out the ecosystem change when monitored over long-time scales. Populations of amphibians can be linked to the pollution, drought, habitat destruction, disease, and ultraviolet radiation in their habitat area. These facts can reflect the ecosystem such as predator, prey and competitor population, energy flow, and nutrient cycling in nature. Therefore, the occurrence of both amphibians and reptiles can predict the ecosystem of the study area.

Herpetofauna includes two groups of tetrapod vertebrates: Amphibians are ectothermic animals characterized by permeable skin, eggs without shells, and complex life cycles often but not always including an aquatic larval stage. They have a high diversity of reproductive modes. There are ~7,528 species comprising: frogs (~6,640 species), salamanders (~683 species) and caecilians (205 species). Reptiles are predominantly oviparous ectotherms characterized by scaly skin and eggs with shells. (Larsen, T.H., 2016)

4.8.5.4.4.2 Methodologies

The specimens were collected during the study period with the help of the local guide at the study area. Some specimens were collected from hunter and local people. Amphibians were usually caught by hand. The morphological characters, coloration, location and habitat were recorded. The photographic records were taken immediately at fresh state at study sites.

Identification of specimens

Identification of collected specimens was done following the Field Guide to the Reptiles of South-East Asia (2010), The Amphibian Fauna of Sri Lanka (Sushil and Kelum, 1996) and Pictorial Guide to frogs and toads of the Western Ghats (Gururaja, 2012).

4.8.5.4.4.3 Results

Herpetofauna species were photographed and documented while avifauna and insect were studied. The species as Banded Bullfrog, Asian Toad, Oriental Garden Lizard, and Checkered Keelback are recorded. Toads and frogs are found hiding in thick grass and shrubs. Toads and frogs are found hiding in thick grass and shrubs. The Oriental Garden Lizard has recently been discovered to be hidden in *Crateva magna*, where it camouflages with the trees. Checkered Keelback, a semi-aquatic snake master of freshwater ponds, lakes, and streams, inhabits crop fields, rivers, lakes, ponds, gardens, and bushes. It feeds on fish and frogs and manages to live a very adaptable life.

*Kaloula pulchra (*Banded Bullfrog)

*Duttaphrynus melanostictus (*Asian Toad)

Duttaphrynus sp. *(*Asian Toad)

Calotes versicolor (Oriental Garden Lizard)

Fowlea piscator (Schneider 1799)

Checkered keelback, Asiatic Water Snakes

Figure 4-177 Recorded Species of Herpetofuna

Table 4-122 List of Recorded Species

Class	Order	Family	Genus	Species	Common Name	IUCN Status
Amphibia	Anura	Microhylidae	*Kaloula*	*Kaloula pulchra*	Banded Bullfrog	LC
Amphibia	Anura	Bufonidae	*Duttaphrynus*	*Duttaphrynus melanostictus*	Asian Toad	LC
Amphibia	Anura	Bufonidae	*Duttaphrynus*	*Duttaphrynus* sp.	Asian Toad	LC
Reptilia	Squamata	Agamidae	*Calotes*	*Calotes versicolor*	Oriental Garden Lizard	LC
Reptilia	Squamata	Colubridae	*Fowlea*	*Fowlea piscator* (Schneider 1799)	Checkered keelback	LC

4.8.5.4.4.4 Discussion and Conclusion

Regarding with the facts of Myanmar amphibian fauna, the information was very less compared to other fauna. Very few studies were conducted by local and aboard researchers spatially and temporally. The species, *Kaloula pulchra*, Banded Bullfrog is native to Southeast Asia. It is common over a range from northeastern India and Nepal to southern India and Sri Lankato southern China (especially Hainan) and Myanmar, and south to the islands of maritime Southeast Asia. In many regions, the banded bullfrog is captured for consumption, but this does not appear to have a substantial impact on its population Christopher (2003). Based on the IUCN Red List, species *Duttaphrynus melanostictus*, Asian Toad was Least Concern due to their wide distribution, tolerance of a broad range of microhabitats and large population.

Species in the genus *Calotes* are native to South Asia, southern China, mainland Southeast Asia and Ambon. Additionally, *C. versicolor* has been introduced to Florida (USA), Borneo, Sulawesi, the Seychelles, Mauritius and Oman. The greatest species richness of the genus is from the Western Ghats, northeast India, Myanmar, Bangladesh and Sri Lanka. *Calotes versicolor* and *Calotes mystaceus* are the most commonly seen diurnal lizards in Myanmar (Zug et al, 2006).

The checkered keelback (*Fowlea piscator*), also known commonly as the Asiatic water snake, is a common species in the subfamily Natricinae of the family Colubridae. The species is endemic to Asia. It is non-venomous. The preferred habitat of *F. piscator* is in or near freshwater lakes or rivers. *F. piscator* is found in Afghanistan, Bangladesh, Pakistan, Sri Lanka, India, Myanmar, Nepal, Thailand, Laos, Cambodia, Vietnam, West Malaysia and China. This wide-ranging species mainly inhabits flooded lowlands including marshes, seasonal lakes, rice paddies and slow-flowing rivers. It feeds on fishes and frogs, and is both diurnal and nocturnal. In this study, the checkered keel back (*Fowlea piscator*) was found near Ayeyarwady River.

4.9. SOCIO ECONOMIC COMPONENT

This section describes the baseline data to define socio-economic profile and primary survey of the study area. The project area is situated in Amarapura Township, Mandalay Region, Myanmar.

4.9.1. Field Survey Approach

The primary surveys are undertaken afresh and the field survey team collects data directly from the field. In primary surveys, the survey team has got the liberty to set the goals for procuring the relevant facts. During survey period, survey team conducted together with some authorities including village administrators and Mandalay Business Capital City Development (MBCCD) representatives under limited situation and COVID-19 restrictions Table 4-19. On the contrary, in the secondary surveys, the overview and combined data of the whole township only examines the facts which are already available but some are missing information that related to the project area. If considered from the view point of reliability, primary surveys are always more reliable than, the secondary type of surveys especially in Myanmar.

Desk review and most of secondary data have been collected by Administrative Department, Amarapura Township, Mandalay Division in September 2019 to get Township and village level general information in study area and households general socio-economic situation including transportation, access roads for their education, heath situation and business etc. in the study area. Questionnaires are attached in **Appendix G**. Almost all local community have positive point of views on the proposed project that are good for their region and new generation. Local communities will boom, better transportation and infrastructure will be developed, and there will be an advantage for business and health care emergency cases. The project is good for local and national development, and the preference to implement it faster is better.

4.9.1.1. Limitation

During survey, most villagers have not conducted face to face interview with household members because of limitation and political condition of the country. Moreover, village leaders, elder persons are afraid to organize as a group meeting. Survey team hence met with village administrators and one or two committee members to answer some general information related to their residential areas and environs in the question papers. Survey team has not chance to meet with in Pae Nga Sal village, Hta Taw village from Sagaing and Sa Lone ward from Chan Mya Tharzi and Warkote, San Yawe, Koe Thinn and Ka Tipar village. Socio-economic survey activity in the study villages is presented Table 4-123 and socio-economic survey activities are as shown in Figure 4-178**.**

Table 4-123 List of Local Communities near the Study Area

No.	Township	Village	Village Tract	Ward
1.	Amarapura	Shan Ka Lay Kyun	Shwe Kyat Yet	Pauk Pauk Tan
		Moe Kaung	-	-
		Yin Taw	-	-
		Khauk Thwe Thauk	-	-
		Ka Tipar	-	-
		Tike Soe	-	-
		Khawar	-	-
		Kan Taw	-	-
		Kyan Tan	-	-
		Thapyaytan	-	-
		That Kal Taw	-	-
		Mya Hninthar	-	-
		Laat Yawe	-	-
		Koe Thinn	-	-
		San Yawe	-	-
		Tharyar Shweku	-	-
		Hman Tan	-	-
		Warkote	-	-
		Padamyar	-	-
2.	Chan Mya Thazi	-	-	Ayartun
		-	-	Sa Lone
		-	-	Thar Yar Shweku

No.	Township	Village	Village Tract	Ward
3.	Sagaing Township	War Chat	-	-
		Pae Nga Sal	-	-
		Arr Laung	-	-
		Hta Taw	-	-

Source: HA survey team, December, 2022

Shwe Kyat Yat Village, Amarapura Township

Mhan Tan Ward, Amarapura Township

Shan Kalay Kyun Village, Amarapura Township

Yin Taw Village, Amarapura Township

Ayar Tun Ward, Amarapura Township

Warchat Village, Amarapura Township

	
Ar Laung Village, Amarapura Township	Amarapura Township

Figure 4-178 Socio-economic Survey Activity in the Study Villages Demographic Information of Amarapura Township

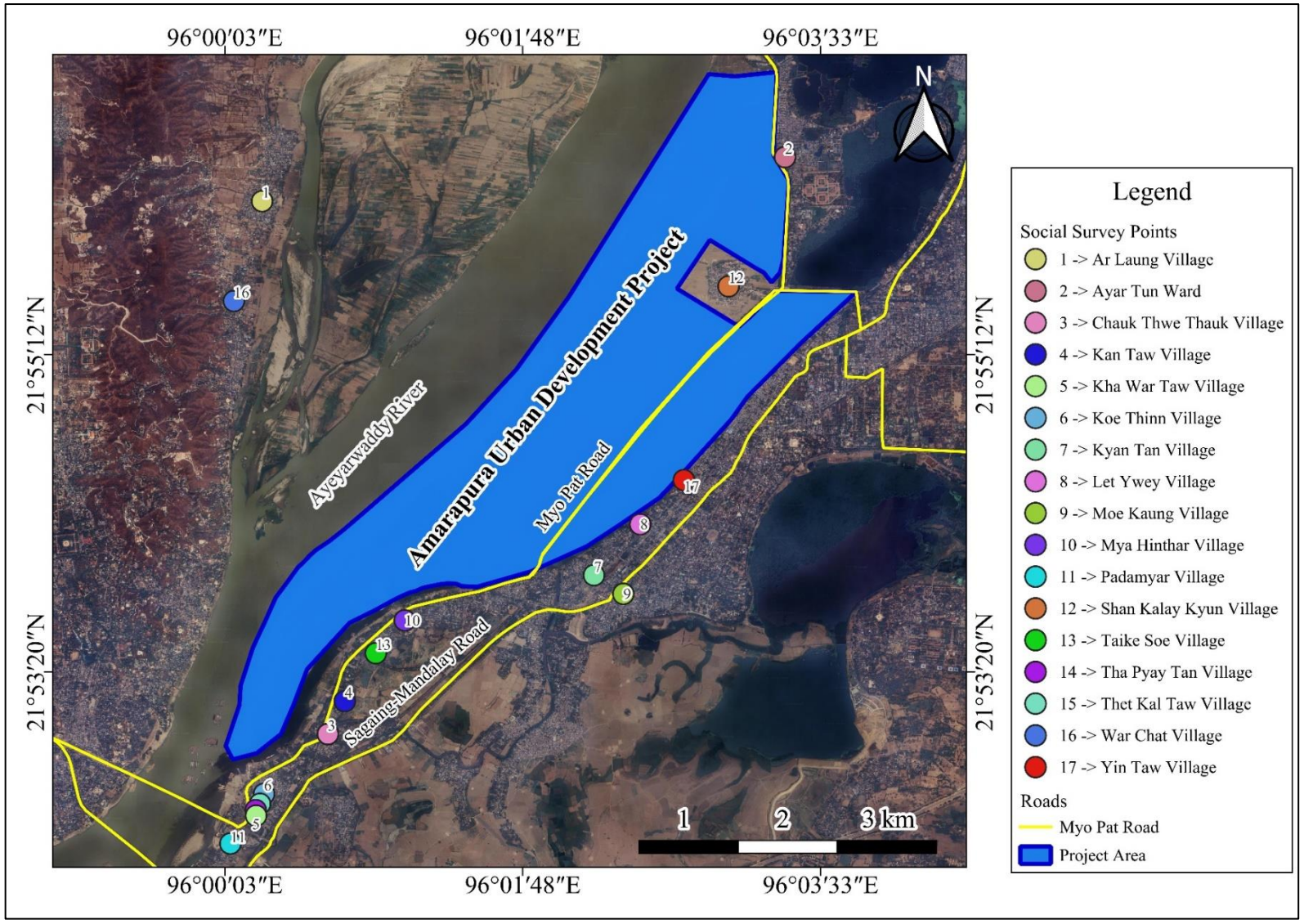


Figure 4-179 Socio Survey Map of Study Villages

4.9.2. Demography

Amarapura township covers (80.11) square miles which have (9) wards, (42) village groups and (170) villages. The demography of the township including statistics such as population, ethnicity, age and gender issues.

4.9.2.1. Population

The updated number of populations and religions comprised in September 2019 data of Administrative Department, Amarapura Township, Mandalay Division. Amarapura Township includes (9) wards, (42) village groups and (170) villages. Total household number of the township is 42984 and the total population number is 200765. The number of households are as shown in Table 4-124.

Table 4-124 List of the number of households in Amarapura Township

Item	Number of House	Household	Quarter	Village Tract	Village
Town	11235	14190	9	-	-
Village	24110	28758	-	42	170
Total	35345	42948	9	42	170

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

During field survey in the study villages, there are 56,440 populations and 15,819 household will be beneficiary group of the project development as described in Table 4-125. Some villages missing to report data of population and households because of the political condition near the villages.

The survey team met with the villagers to cover ten percent of the villages among the 18 villages and answer some general information related to their residential areas and environs in the question papers for household records. Household survey records are described in Table 4-126.

Table 4-125 List of the number of households in Amarapura Township

No	Township	Village	Population	Households
1	Amarapura	Mya Hinthar	477	138
2	Amarapura	Hman Tan	25,068	5,475
3	Amarapura	Ayeyar Htun*	-	-
4	Amarapura	Thet Kal Taw	291	66
5	Amarapura	Chauk Thway Thouk	1,164	325
6	Amarapura	Padamyar	1,036	284
7	Amarapura	Kan Taw	394	86
8	Amarapura	Tha Pyay Tan	259	60
9	Amarapura	Tharyar, Say Yoe Latyway	-	550
10	Amarapura	Tike Soe Village	401	123
11	Amarapura	Moe Kaung	1,398	397
12	Amarapura	Kha War Taw	484	115
13	Amarapura	Yin Taw Village	2,021	705
14	Amarapura	Kyan Tan+Pauk Pauk Tan	6,555	1,762
15	Amarapura	Shwe Kyat Yat	12,444	3,321
16	Amarapura	Shan Kalay Kyun	4,448	1,102
17	Amarapura	Warchat	-	910
18	Amarapura	Ahr Laung	-	400
		Total	56,440	15,819

(Source: HA survey team, December, 2022), * Data missing during field visit

Table 4-126 Household Survey in the Study Area

No	Township	Village	Households	Recorded households
1	Amarapura	Mya Hinthar	138	10
2	Amarapura	Hman Tan	5,475	50
3	Amarapura	Ayeyar Htun*	-	-

No	Township	Village	Households	Recorded households
4	Amarapura	Thet Kal Taw	66	5
5	Amarapura	Chauk Thway Thouk	325	10
6	Amarapura	Padamyar	284	10
7	Amarapura	Kan Taw	86	5
8	Amarapura	Tha Pyay Tan	60	5
9	Amarapura	Tharyar, Say Yoe Latyway	550	10
10	Amarapura	Tike Soe Village	123	7
11	Amarapura	Moe Kaung	397	10
12	Amarapura	Kha War Taw	115	8
13	Amarapura	Yin Taw Village	705	25
14	Amarapura	Kyan Tan+Pauk Pauk Tan	1,762	30
15	Amarapura	Shwe Kyat Yat*	3,321	45
16	Amarapura	Shan Kalay Kyun	1,102	35
17	Amarapura	Warchat	910	35
18	Amarapura	Ahr Laung	400	25
		Total	15,819	325

(Source: HA survey team, December, 2022), * Data missing during field visit

4.9.2.2. Age Group and Gender Issues

In Myanmar, population is disaggregated by age for election purposes (i.e., under and over 18 years old). Based on the data provided by GAD, generally in township, village tract and village administrators have two age group as under 18 years, above 18 years including over 85 years old. The population of Amarapura township is as mentioned in Table 4-127.

Table 4-127 Population of Amarapura Township

No	Location	Age above (18) year			Age number (18) year			Total		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
1	Town	21286	25520	46806	9559	10090	19649	30845	35610	66455
2	Village	37443	43464	80907	26052	27351	53403	63495	70815	134310
Total		58729	68984	127713	35611	37441	73052	94340	106425	200765

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

According to field survey data, the total number of male and female population is almost the same as 26,711 and 29,729 in total 56,440 in the study area. It is difficult to make a ratio by age because disaggregated data were missing in some villages. The survey team found that there are no gender issues in the study area and the population by age group in study area are shown in Table 4-128.

Based on survey data, there are 10 percent of the population by age group were collected to cover 18 villages and data are shown in Table 4-129.

Table 4-128 Population by Age Group and Gender Disaggregation in the Study Area

No	Township	Village	Sex		Age		
			Male	Female	Under 18 Years	Over 18 Years	Over 85 Years
1	Amarapura	Mya Hinthar	216	261	0	0	0
2	Amarapura	Hman Tan	11,526	13,542	7,025	18,043	140
3	Amarapura	Ayeyar Htun*	0	0	0	0	10
4	Amarapura	Thet Kal Taw	145	146	90	100	1
5	Amarapura	Chauk Thway Thouk	555	609	0	0	0
6	Amarapura	Padamyar	499	537	0	0	10
7	Amarapura	Kan Taw	199	195	0	0	0
8	Amarapura	Tha Pyay Tan	125	134	0	0	0
9	Amarapura	Tharyar, Say Yoe Latyway*	0	0	0	0	15
10	Amarapura	Tike Soe Village	186	215	100	250	0
11	Amarapura	Moe Kaung	654	744	600	600	6
12	Amarapura	Kha War Taw	245	239	0	0	0
13	Amarapura	Yin Taw Village	957	1,064	501	1520	12
14	Amarapura	Kyan Tan+Pauk Pauk Tan	3,114	3,441	2,260	4,284	0
15	Amarapura	Shwe Kyat Yat	5,909	6,535	3,232	9,104	72
16	Amarapura	Shan Kalay Kyun	2,381	2,067	0	0	30
17	Amarapura	Warchat*	0	0	0	0	30
18	Amarapura	Ahr Laung*	0	0	0	0	30
		Total	26,711	29,729	13,808	33,901	356

(Source: HA survey team, December, 2022), * Data missing during field visit

Table 4-129 Population by Age Group and Gender Disaggregation during Household Survey in the Study Area

No	Township	Village	Sex		Age		
			Male	Female	Under 18 Years	Over 18 Years	Over 85 Years
1	Amarapura	Mya Hinthar	8	15	4	15	4
2	Amarapura	Hman Tan	30	45	26	35	14
3	Amarapura	Ayeyar Htun	-	-	-	-	-
4	Amarapura	Thet Kal Taw	8	9	5	10	2
5	Amarapura	Chauk Thway Thouk	19	25	17	17	10
6	Amarapura	Padamyar	7	16	6	13	4
7	Amarapura	Kan Taw	13	17	9	15	6
8	Amarapura	Tha Pyay Tan	14	17	11	16	4
9	Amarapura	Tharyar, Say Yoe Latyway	24	28	23	22	7
10	Amarapura	Tike Soe Village	22	20	15	17	10
11	Amarapura	Moe Kaung	25	30	12	30	13
12	Amarapura	Kha War Taw	17	16	9	20	4
13	Amarapura	Yin Taw Village	35	48	34	36	13
14	Amarapura	Kyan Tan+Pauk Pauk Tan	46	58	46	51	7
15	Amarapura	Shwe Kyat Yat	60	78	25	70	43
16	Amarapura	Shan Kalay Kyun	55	49	26	61	17
17	Amarapura	Warchat	61	75	30	90	16
18	Amarapura	Ahr Laung	45	60	20	70	15
		Total	489	606	318	588	189

(Source: HA survey team, December, 2022), * Data missing during field visit

4.9.2.3. Vulnerable Groups

There are many vulnerable types in the study area such as disable persons including handicap, blind, deaf and dump etc. also in total number 265. Some villages missing to report data of women headed households (WHH) live alone and older persons of senior citizens who age over 65 years etc. It was shown in Table 4-130. It seems that the figure of vulnerable group is the nearest number in the study area. Although some data were not reported from the community, most villages possess household head over 65 years old of senior citizens and women headed households are higher than other groups of disable like handicap and live alone.

Table 4-130 Vulnerable Groups in study area

No.	Village	Disabled in family	Head of households over 60 years old	Women headed household	Only one person lives alone in a household	Homeless	Others (Specified)
1	Mya Hinthar	8	20	10	1	0	0
2	Hman Tan	60	0	1,000	70	15	0
3	Ayeyar Htun	12	60	150	8	150	0
4	Thet Kal Taw	15	50	15	4	20	0
5	Chauk Thway Thouk	5	100	100	20	0	0
6	Padamyar	20	250	300	20	80	200
7	Kan Taw	4	45	10	10	15	0
8	Tha Pyay Tan	15	20	15	5	35	0
9	Tharyar, Say Yoe Latyway	12	70	80	12	200	0
10	Tike Soe Village	3	50	20	7	20	0
11	Moe Kaung	4	150	30	0	100	0
12	Kha War Taw	5	45	30	8	12	0
13	Yin Taw Village	5	200	50	1	10	0
14	Kyan Tan+Pauk Pauk Tan	20	800	100	10	750	0
15	Shwe Kyat Yat*	0	0	0	0	0	0
16	Shan Kalay Kyun	65	430	120	11	0	0

No.	Village	Disabled in family	Head of households over 60 years old	Women headed household	Only one person lives alone in a household	Homeless	Others (Specified)
17	Warchat*	12	0	0	0	0	0
18	Ahr Laung	0	80	0	8	0	0
	Grand Total	265	2,370	2,030	895	1407	200

(Source: HA survey team, December, 2022), * Data missing during field visit

4.9.3. Minority and Religious

According to secondary data from Township General Administration Department most of the people who live in Amarapura are Burma and relatively small numbers of other races are listed in the area. The remaining population is composed of Christian 0.23 %, Hindu 0.22% and Islam 6.23%. The number of religions and nationality in Amarapura township are as shown in Table 4-131 and Table 4-132.

When field survey in December 2022, existing primary population from local village administrators not reported yet because of the weak documentation. Based on their conversation and knowledge, it was found that majority of people are Burma Buddhists but some are Christian community and less are Hindu and Muslims in the project villages.

Table 4-131 List of the religions in Amarapura Township

Township	Buddhist	Christian	Hindu	Islam	Other	Total
Amarapura Township	179,923	358	363	12,430	-	193,024
Myit Nge	7,354	111	83	143	-	7,741
Total	187,277	469	446	12,573	-	200,765

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-132 Ethnicity of Amarapura Township

No.	Nationality	Population	Township Population	Percent of Nationality
1	Kachin	15	200765	0.007
2	Kayar	-	200765	-
3	Kayin	8	200765	0.003
4	Chin	36	200765	0.017
5	Mon	-	200765	-
6	Burma	200680	200765	99.95
7	Rakhine	14	200765	0.006
8	Shan	12	200765	0.005
Total		200765	200765	99.99

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

4.9.3.1. Culture Heritage

There are no historical places or buildings that have been approved by Ministry of Religious Affairs and Culture rules.The list of major historical monuments of Amarapura Township is shown in Table 4-133 and Table 4-134.

Table 4-133 List of Historical Pagoda and Buddhist Temple in Amarapura Township

No.	Historical Pagoda	Address
1	Swel Taw Myat Pagoda	Nat Yay Kan Village
2	Taung Min Gyi	Sin Swel Pwat Ward
3	Shwe Kuu Gyi	Mhan Tan Ward
4	Pa Htoe Taw Gyi	Mhan Tan Ward
5	Kyauk Taw Gyi	Taung Tha Man Village
6	Shwe Kyat Yat Pagoda	Shwe Kyat Yat Village
7	Shwe Kyat Kya Pagoda	Shwe Kyat Yat Village
8	Way Yaw Sana Jade Pagoda	Sin Yaw Myin Mu
9	Than Thay Kat Kyaw Pagoda	Mhan Tan Ward

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-134 List of Historical Monuments in Amarapura Township

No.	Historical Monuments	Address
1	Mahar Gandar Yone	Sin Swel Pwat Ward
2	Tuu Maung	Shwe Goon Htote
3	Mingalar Tike	Oh Taw

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-135 Religious Places in the Project Area

No.	Name of Village	Historic Places	Archeological Places	Religious Places
1	Mya Hinthar	-	Ti Law Ka SuHtar Pagoda	-
2	Hman Tan	Barkaya, Shwe Gu Gyi, Pa Htoe Taw Gyi	-	-
3	Ayeyar Htun*	-	-	-
4	Thet Kal Taw	-	-	Kyan Khin Monastery, Religious Hall
5	Chauk Thway Thouk*	-	-	-
6	Padamyar	Thapyay Tan Fort	-	Zaw Ti Ka Yone Monastery
7	Kan Taw	-	Nan Oo Monastery, Mi Dwe Taw Religious Hall	-
8	Tha Pyay Tan	Kin Kyaung Monastery	-	Monastery (eastern of the village)
9	Tharyar, Say Yoe Latyway*	-	-	-
10	Tike Soe Village	-	-	Religious Hall and Shwe Bon Thar Myet Taung Taw Pagoda
11	Moe Kaung*	-	-	-
12	Kha War Taw	Karen Monastery, Min King Monastery	-	Ti Law Ka SuHtar Pagoda
13	Yin Taw Village*	-	-	-
14	Kyan Tan+Pauk Pauk Tan	Mogok's Mingalar Dartu Stupa	-	-
15	Shwe Kyat Yat	Shwe Kyet Kya Pagoda, Shwe Kyet Yak Pagoda, Thapyaytan Fort	Thapyaytan Fort	Pagodas
16	Shan Kalay Kyun	-	In 2018, ancient human skeletons were found.	-

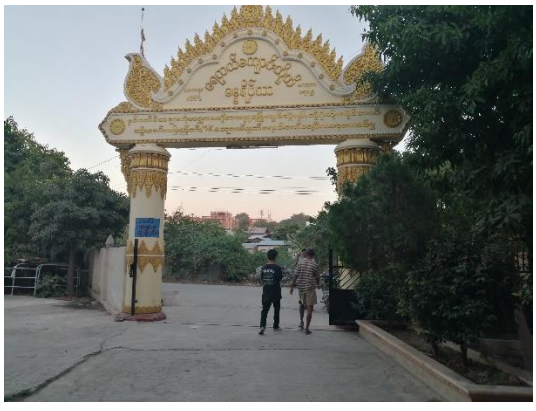
No.	Name of Village	Historic Places	Archeological Places	Religious Places
17	Warchat	Rudy Pagoda, ShinPyuShinHla Pagoda, PyinnyarThiha Ordination Hall	-	More than 300 Monastery
18	Ahr Laung	-	-	Regilious Hall
	Grand Total	14	5	-

(Source: HA survey team, December, 2022), * Data missing during field visit

When field survey in December 2022, the archaeology sites were examined in and around the proposed project site. During the field period, local and regional information from local people were collected all possible cultural sites and examined their importance or accessed cultural values as listed in Table 4-135. The photo of historical monuments of Amarapura Township is shown in Figure 4-180. In addition, the distance between the project stie and famous buildings, historical places and infrastructure of the Mandalay is shown in Table 4-136 and Figure 4-182.

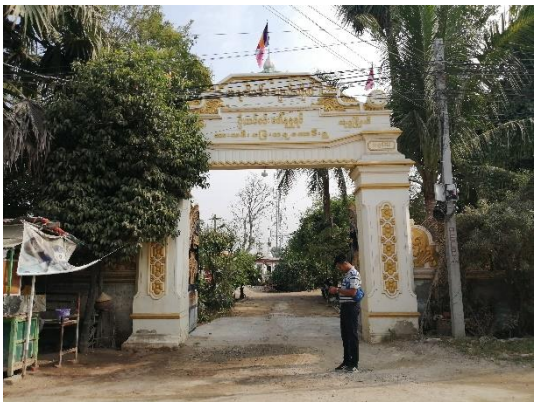
Shwe Kyat Yat Pagoda

Shwe Kyat Kya Pagoda



Yay Lal Monastery

Shwe Gu Gyi Pagoda

	
Shwe Hinthar Monastery	Mingalar Nyaung Zin Monastery
	
Shwe Taung Monastery	Thukha Waddy Monument
	
Tha Yat Pin Monestry	Aung Nan Theingi Monestry
	
Lay Kyun Satkyar Monastery	Aung Theitdi Pagoda

Thamar Thadi Monastery

Shit Myat Nar Monastery

Figure 4-180 Historical Pagodas and Monuments in the Study Village

Table 4-136 Distance between the project site and famous infrastructure of the Mandalay

No.	Name	Distance
1.	Kaungmhudaw Pagoda	9.51km
2.	Minkun Pagoda	13.06km
3.	Hsinbyume Pagoda (Myatheindan Pagoda)	12.23km
4.	U Bein Bridge	2.26km
5.	Mahamuni Pagoda	3.61km
6.	Mandalay Kyone	5.63km
7.	Mandalay Hill	9.10km

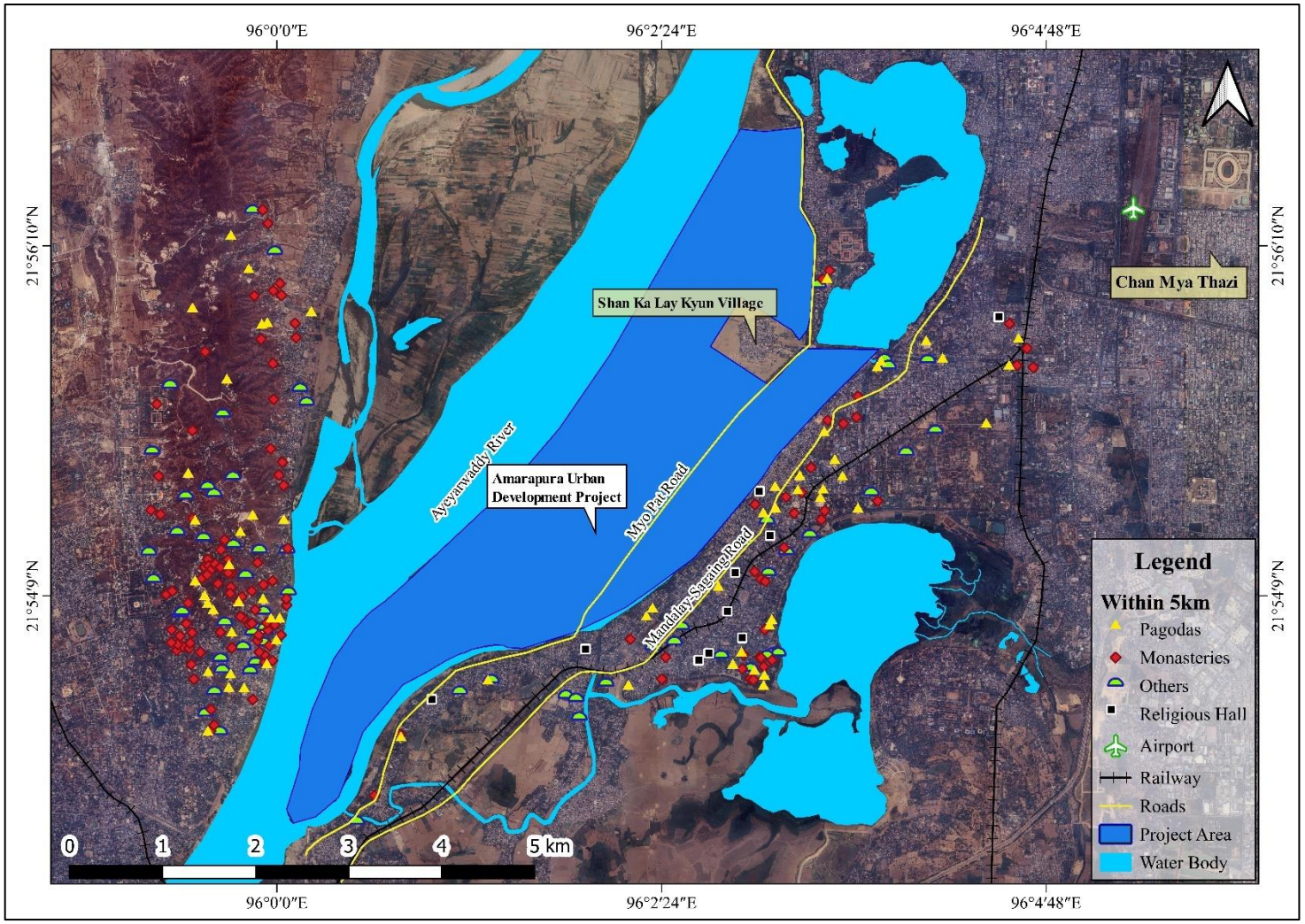


Figure 4-181 Historical Pagodas and Monuments in the Study Village

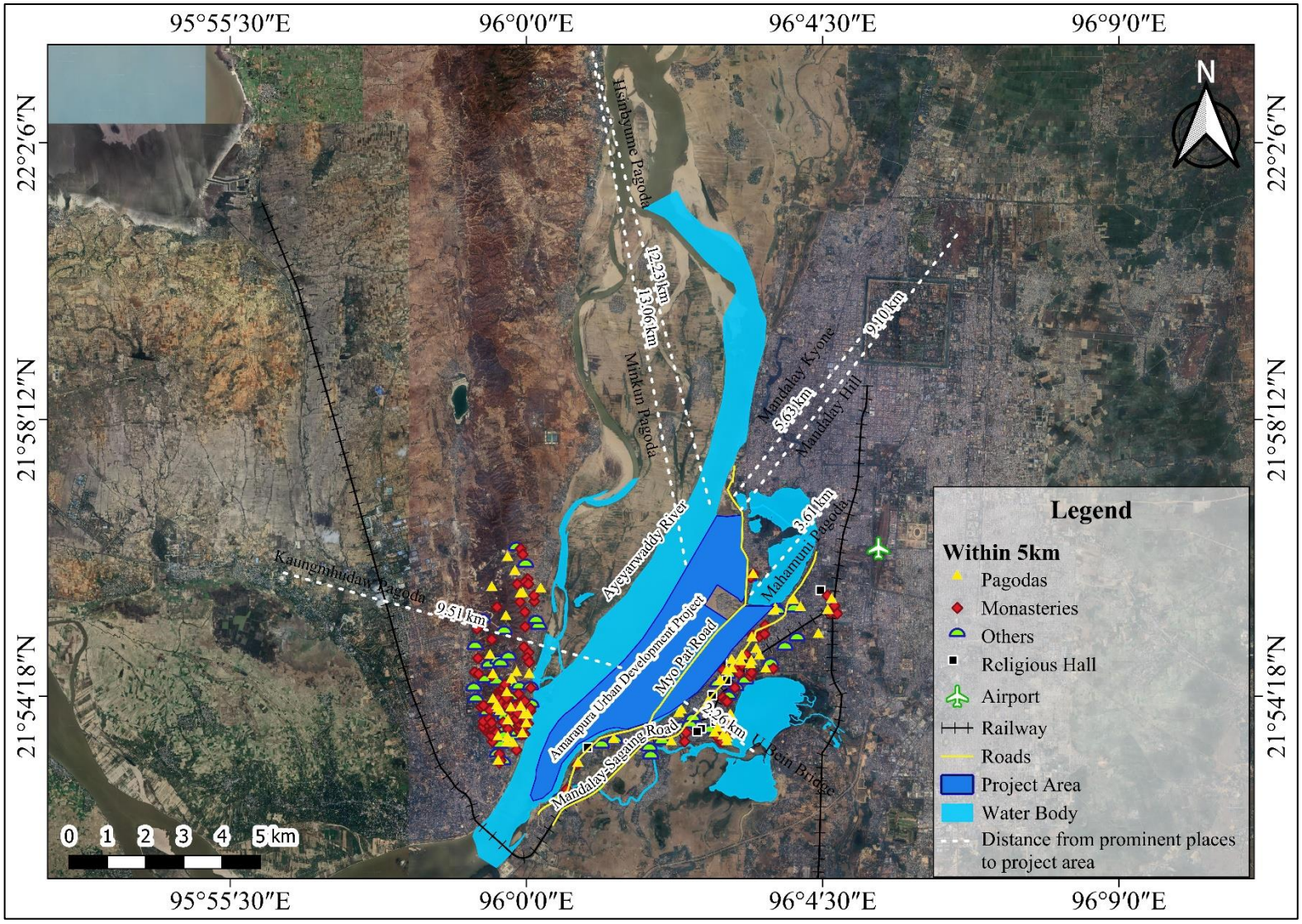


Figure 4-182 Distance Map of Historical buildings and Monuments in the Study Area

4.9.3.2. Visual Components

Apart from many tourists' attractive places including historical pagodas and monasteries, there are some other places to visit and enjoy the closeness to nature such as Taung Thaman Inn and U Bein Bridge where suite for relaxing. In addition, Thapyatan fortress and Sinkyone fortress are built by King Mindon around 1875 in an attempt to stop the British naval forces from sailing up the Irrawaddy (Ayeyarwady) River to attack the royal capital of Mandalay[1]. The list of visual components and photos are as shown in Figure 4-183 and Table 4-137.

Table 4-137 List of Visual Component the Project Area

No.	Name of Village	Tourist Attraction Places	Aesthetics
1	Mya Hinthar	-	Sagaing Hill
2	Hman Tan	Barkaya	Taung Thaman Lake, Sagaing Hill
3	Ayeyar Htun*	-	-
4	Thet Kal Taw	Yadanabon Bridge Shwe Kyat Yat Pagoda Shwe Kyat Kya Pagoda	-
5	Chauk Thway Thouk*	-	-
6	Padamyar	Thapyay Tan Fort	River view
7	Kan Taw	-	Sagaing Hill View
8	Tha Pyay Tan	Fort near the old bridge	-
9	Tharyar, Say Yoe Latyway	Ku Thi Nar Yone (middle water), Tharyar Shwe Gu pagoda	-
10	Tike Soe Village	Shwe Bon Thar Myet Taung Taw Pagoda	Shwe Bon Thar Myet Taung Taw Pagoda
11	Moe Kaung-2	-	-
12	Kha War Taw	Shwe Kyat Yat Pagoda, Yadanar Pon Bridge	-
13	Yin Taw Village	Sagaing Hill	-

No.	Name of Village	Tourist Attraction Places	Aesthetics
14	Kyan Tan+Pauk Pauk Tan	-	Mingalar Dartu Stupa, Pwel Taw Chaung
15	Shwe Kyat Yat	Bridge scenery (3 places)	-
16	Shan Kalay Kyun	Sagaing Hill, Yadanabon Bridge	-
17	Warchat	PyinnyarThiha Ordination Hall (Crowded)	-
18	Ahr Laung*	-	-
	Grand Total	18	8

(Source: HA survey team, December, 2022), * Data missing during field visit

U Bein Bridge[1]

Taung Thaman Lake[1]

Thapyatan Fortress[2]

Sinkyone Fortress[2]

Figure 4-183 Visual Component of Amarapura Township

[1]https://en.wikipedia.org/wiki/Amarapura

[2]https://www.visitmyanmar.com.au/mandalay/inwa/thapyatan-fortress

4.9.4. Education level

Schools and institutes of higher education have been considerable in township. There are four universities and 12 high schools, 10 middle schools, 64 primary schools and 6 monastic schools as mentioned in Table 4-139. The literacy rate of those aged 15 and over in

Amarapura Township is 100 per cent. In Amarapura Township, the literacy rate for youth aged over 15 is 128736 persons of total population are listed in Table 4-138.

Table 4-138 List of Literacy Rate

No	Township	Township Population	Population of aged over 25	Literacy Rate (Person)	Literacy Rate (Percent)
1	Amarapura	193024	128736	128736	100%
2	Myit Nge	7741	5528	5528	100%
	Total	200765	134264	134264	100%

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-139 List of School in Amarapura Township

No	School	Number of School
1	University	4
2	Basic Education High School	7
3	Basic Education High School (Branch)	5
4	Basic Middle School	8
5	Basic Middle School (Branch)	2
6	Basic Primary School	19
7	Basic Primary School (Branch)	64
8	Monastic School	6

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

During field survey, there are many education centers including pre-schools in the study area as described in **Table 4-141**. Most of the villages have primary or post primary school and students can access higher education within the study area. Almost all residents have received basic education and are literate. The average ratio of teacher and students is 1:35 but the lowest ratio in Padamyar ward while the highest in Shwe Kyat Yat village as 1:65 respectively. The ratio of teacher and student in the study area is listed in Table 4-140. Field survey in December, 2022, some of the school's data were missing under the political situation and existing number of school teachers and students were hard to update in the project villages. The photos of education infrastructure in the study are as shown in Figure 4-184.

Table 4-140 Ratio of Teacher and Student in the Study Area

No.	Name of Village	Total Number of Teachers	Total Number of Students	Teacher to Student Ratio
1	Mya Hinthar*	-	-	-

No.	Name of Village	Total Number of Teachers	Total Number of Students	Teacher to Student Ratio
2	Hman Tan	7	-	-
3	Ayeyar Htun	12	-	-
4	Thet Kal Taw	25	780	1:31
5	Chauk Thway Thouk*	6	-	-
6	Padamyar	3	40	1:13
7	Kan Taw*	-	-	-
8	Tha Pyay Tan	25	700	1:28
9	Tharyar, Say Yoe Latyway	23	623	1:27
10	Tike Soe Village	3	100	1:33
11	Moe Kaung-2	7	215	1:31
12	Kha War Taw*	-	-	-
13	Yin Taw Village	6	274	1:46
14	Kyan Tan+Pauk Pauk Tan	8	390	1:49
15	Shwe Kyat Yat	13	850	1:65
16	Shan Kalay Kyun	7	231	1:33
17	Warchat*	-	-	-
18	Ahr Laung	6	170	1:28
	Grand Total	126	4373	1:35

(Source: HA survey team, December, 2022), * Data missing during field visit

Table 4-141 Education Centers in the Study Area

No.	Name of Village	Kindergarten	Primary School	Post Primary School	Middle School	High School	Private School
1	Mya Hinthar*	-	-	-	-	-	-
2	Hman Tan	-	2	1	2	1	2
3	Ayeyar Htun	-	1	-	-	-	-
4	Thet Kal Taw	-	-	-	-	1	-
5	Chauk Thway Thouk*	-	-	-	-	-	-
6	Padamyar	1	-	-	-	-	-
7	Kan Taw*	-	-	-	-	-	-
8	Tha Pyay Tan	1	-	-	-	-	-
9	Tharyar, Say Yoe Latyway	-	-	-	-	1	-
10	Tike Soe Village	-	1	-	-	-	-
11	Moe Kaung-2	-	1	-	-	-	-
12	Kha War Taw	-	-	-	-	1	-
13	Yin Taw Village	-	1	-	-	-	-
14	Kyan Tan+Pauk Pauk Tan	2	-	1	-	-	-
15	Shwe Kyat Yat	4	4	-	-	1	-
16	Shan Kalay Kyun	-	-	1	-	-	-
17	Warchat	-	-	-	-	1	-

No.	Name of Village	Kindergarten	Primary School	Post Primary School	Middle School	High School	Private School
18	Ahr Laung	-	1	-	-	-	-
	Grand Total	8	11	3	2	6	2

(Source: HA survey team, December, 2022), * Data missing during field visit

Primary School, Shan Kalay Kyun Village

Primary School, Yin Taw Village

Private School

High School, Lat Ywae

High School, War Chat Village

Primary School, Ka Tipar Village

Figure 4-184 Education Infrastructure in the Study Village

4.9.5. Economic Condition

Amarapura Township is located in Mandalay Region and is an economically developed township. The local people in the township are mainly engaged in agriculture and weaving businesses. In addition, they also engage in commercial farming activities. The main products of the township are agricultural products, fish products, industrial products, cotton and silk products which are marketed to other regions. In some villages near the proposed project area made handicrafts, bronze Buddha statues and have looming machines for production of clothes and longyi made from cotton and silk. The product of looming workshops is well-known in Myanmar. Some seasonal lakes or wetlands are found nearby areas of the project area. Therefore, fish and fish products are one of the important socio-economic items of the project area. There is no industrial zone in Amarapura Township. The list of home industry, agriculture and livestock farming are described in Table 4-142 to Table 4-147.

Table 4-142 List of Home Industry Business

No.	Township	Type of Home Industry	Number	Workforce
1	Amarapura	Weaving Business (Machine)	12312	12312
2	Amarapura	Weaving Business (Handmade)	531	531
3	Amarapura	Sewing	200	200
4	Amarapura	Food	31	155
5	Amarapura	Blacksmithing	2	10
6	Amarapura	Painting	3	6
7	Amarapura	Turnery	3	15
8	Amarapura	Pottery	100	190
9	Amarapura	Threading	4	20
Total			13186	13439

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-143 List of Agriculture Sector

No.	Name of Harvested	2018-2019 Proposed Acres		2018-2019			
				Grow	Harvest	Product Rate	Total Product (Basket)
1	Paddy	Summer	8000	7480	7480	101.18	756863
		Rainy	11650	11452	11452	94.81	1085764
2	Peanut	Rainy	-	-	-	-	-
		Winter	1080	926	926	65.56	60708
3	Sesame	Rainy	502	92	92	7.55	695

No.	Name of Harvested	2018-2019 Proposed Acres		2018-2019			
				Grow	Harvest	Product Rate	Total Product (Basket)
		Summer	5000	5015	4840	9.50	45980
4	Sunflower	Rainy	25	35	35	21.30	745
		Winter	80	71	71	22.77	1517
5	Mung Bean	Rainy	-	-	-	-	-
		Winter	-	-	-	-	-
6	Green Gram	Rainy	21	35	35	10.14	354
		Winter	-	-	-	-	-
7	Pigeon Pea	Rainy	-	6	6	12.00	72
8	Cotton	Pre-Rainy	20	8	-	-	-
		Post-Rainy	21	5	5	404.01	2020
9	Sugarcane	-	-	-	-	-	-
10	Maize & Grain	Winter	200	336	336	13973	4695030

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-144 List of Long-Term Crop

No.	Name of Crop	Grow	Harvest	Product Rate	Total Production Rate (basket)
1	Balearic	-	-	-	-
2	Rubber	-	-	-	-
3	Pepper	-	-	-	-
4	Sugarcane	-	-	-	-
5	Coffee	-	-	-	-
6	Tea Leaf	-	-	-	-
7	Betel	19	19	2830	53770
8	Coconut	5	5	683.05	3417
9	Mango	6211	5213	11347	59154512
10	Plum	736	736	1835.00	1350560
11	Lime	968	968	13756	13315808
Total		7939	6941	-	-

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-145 List of Commercial Harvested Crop

No.	Name of Crop	Grow	Harvest	Product Rate	Total Production Rate (basket)
1	Onion	-	-	-	-
2	Chilli	6	6	557.18	3343
Total		6	6	557.18	3343

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-146 List of Farming Sector in Amarapura Township

No.	Township	Year	Buffalo	Cow	Pig	Sheep/Goat	Chicken	Duck	Quail
1	Amarapura	2018-2019	31664	518589	1178601	667800	6070503	474217	332210
Total			31664	518589	1178601	667800	6070503	474217	332210

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-147 List of Fish and Shrimp Farming in Amarapura Township

No.	Township	Year	Fish			Shrimp		
			No of Lake	Acre	Production (Viss)	No of Lake	Acre	Production (Viss)
1	Amarapura	2018-2019	87	132.09	185000	-	-	-
Total			87	132.09	185000	-	-	-

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-148 Cropping Pattern in the Study Villages

No	Name of Village	Type of Crop	Farming Period (Month)	Harvest Period (month)	Area (Acres)	Yield
1	Mya Hinthar*	-	-	-	-	-
2	Hman Tan	Lettuce, Kale, Lady finger, Spearmint, Beans	September	-	Total over 30 acres	-
3	Ayeyar Htun*	-	-	-	-	-
4	Thet Kal Taw	Peanut Been Millet and corn	Tazaung Mone	Tabodwe	Total-20 Acres	40 baskets per acres 25 baskets per acres 4 baskets per acres
5	Chauk Thway Thouk*	-	-	-	-	-
6	Padamyar	Butter bean, Gourd, Roselle, Water green, Peanut, Black-eyed pea, Sesame	Tazaung Mone	Kason	Total 30 acres	-

No	Name of Village	Type of Crop	Farming Period (Month)	Harvest Period (month)	Area (Acres)	Yield
7	Kan Taw	Corn, gourd and cucumber	October	Waso and WaKhaung	-	a little
8	Tha Pyay Tan	Peanut, bean	Tazaung Mone	Ta Bo Dwe	10 acres	50-60 baskets 30-40 baskets
9	Tharyar, Say Yoe Latyway	Peanut, green bean, parsley, Broccoli	February	May	5 (3 acres per house)	-
10	Tike Soe Village	Beans, Roselle	Thadingyut	Tabodwe, Tabaung	For household farming	-
11	Moe Kaung	Peanut butter, Gourds, Eggplant, Beans, Roselle	Autumn	Summer	10	Family business
12	Kha War Taw	Rice Beans, Peanut Butter, Sunflower	Tazaungmon	Spring	15	15 baskets per acre
13	Yin Taw Village	Rice Beans, Butter beans, Lettuce, Sweet Basil,	September	March/April	-	30 baskets per acre 50 baskets per acre

No	Name of Village	Type of Crop	Farming Period (Month)	Harvest Period (month)	Area (Acres)	Yield
		Parsley Roselle, Water green				
14	Kyan Tan+Pauk Pauk Tan*	-	-	-	-	-
15	Shwe Kyat Yat	Beans Sunflower	Tazaungmone	Tapaung	-	-
16	Shan Kalay Kyun	Peanut, Gourd, Roselle, Butter beans, Eggplant, Water green, lettuce, Parsley, Sweet Basil	September 12 months	February 12 months except Waso & Wakhaung	342.66, 26	80 baskets
17	Warchat	Peanut Lima beans/ Lentil Roselle, Gourd, Cucumber	December	March	180	60-70 baskets
18	Ahr Laung	Peanut, Corn, Roselle, Tomato,	September, October	March	-	-

No	Name of Village	Type of Crop	Farming Period (Month)	Harvest Period (month)	Area (Acres)	Yield
		Eggplant, Radish				

(Source: HA survey team, December, 2022), * Data missing during field visit

4.9.5.1. Tourism

Tourism attractive places around Amarapura township are famous not only for local people but also for foreigners. The landmark including Taungthaman Inn, U Bein Bridge, historical monuments and pagodas such as Shwe Kyat Yat, Shwe Kyat Kya, Mahar Wai Yan Bon Thar Monastery, Pahtodawgyi Pagoda, Shwe Gu Gyi Pagoda, Mahar Gandaryone Monestary and silk weaving workshops. Weaving industry is one of the main professions of the Amarapura people. Over one hundred looms are used to obtain beautiful and intricate design and patterns as silk are worn in very special and ceremonial occasions.

4.9.5.2. Income and Livelihoods

The township is known today for its traditional silk and cotton weaving and bronze casting. There are many small-scale industries to enable people to earn income and to be able to operate businesses that they can own and produce in their homes. In Amarapura Township, the proportion of livelihood persons working in the sector of "Commercial" is the highest with 39545.The second highest sector is "Technical Sector" at 21056 persons as described in Table 4-150. The per capita income and type of livelihoods of Amarapura Township is as mentioned in Table 4-149.

Table 4-149 Capita Per Income of Amarapura Township

No.	2016-17	2017-2018	2018-2019
1	1337835	1413500	1838229

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-150 Type of Livelihood in Amarapura Township

No	Township	Civil Servant	Service Activities	Water Sector	Agriculture Sector	Farming Sector	Commercial and Trade Sector	Technical Sector	Random	Other
1	Amarapura Township	2743	-	-	20038	20300	38045	20956	9544	113605
2	Myit Nge	1785	217	-	-	100	1500	100	600	700
		4528	217	-	20038	20400	39545	21056	10144	2679

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

In the study area, the highest population represented general wage laborer as more than 2000 in Hman Tan ward, follow by agricultural sector over 200 in Kyan Tan, Warchat and Ahr Laung village including livestock activities. The government staff in Hman Tan ward is more than 1500 while company employee about 1700 respectively in Table 4-151. The photo of economic in the study area is as shown in Figure 4-185.

Table 4-151 Occupations in the Study Villages

No.	Name of Village	Agriculture	Small Trading	Trade	Government Services	General Wage Labour	Company Employee	Others
1	Mya Hinthar	-	10	-	-	-	5	-
2	Hman Tan	40	-	4	1500>	2000>	1700	-
3	Ayeyar Htun	-	-	-	30	-	500>	-
4	Thet Kal Taw	15	25	-	-	30	-	-
5	Chauk Thway Thouk	yes	-	-	-	-	-	50-60 (looms)
6	Padamyar	30	30	6	25	900	10	50
7	Kan Taw	7	15	2	10	-	10	-
8	Tha Pyay Tan	5	15	-	15	50	20	-
9	Tharyar, Say Yoe Latyway	peanut, sesame, bean	-	peanut trading	20		over 100	-
10	Tike Soe Village	-	7	-	15	14-15	5	-

No.	Name of Village	Agriculture	Small Trading	Trade	Government Services	General Wage Labour	Company Employee	Others
11	Moe Kaung-2	15	30-40	-	10	-	10	"50 - weaving workers
12	Kha War Taw	50 - Casual workers"	-	-	-	-	-	-
13	Yin Taw Village	5	35	-	5	1	-	Casual workers - 400
14	Kyan Tan+Pauk Pauk Tan	200 farmers	-	-	50	-	30	-
15	Shwe Kyat Yat*	5	-	-	Over 70	Over 80	Over 80	-
16	Shan Kalay Kyun	About 40	-	-	About 100	-	About 1000	Brick Business - 10
17	Warchat*	222	35	-	20-25	-	30	Home business (Furniture - 32)
18	Ahr Laung	Over 200	12	-	5 female teachers	-	-	Pan-tot, masonry, pagoda building

(Source: HA survey team, December, 2022), * Data missing during field visit

Cultivated Land

Cultivated Land

Cultivated Land

Cultivated Land

Agriculture

Fishery

Small Trading

Looming Workshop

Brick Work

Figure 4-185 Main Economic Activities in the Study Villages

4.9.5.3. Employment

In Amarapura Township, the proportion of employed persons working is 127713 persons and the unemployment percentage is 6.77 percent. The rate of employment in Amarapura Township is as shown in Table 4-152. During the field survey, the survey team listed the work force and unemployment population in the study area as described in Table 4-152 and Table 4-153.

Table 4-152 Rate of Employment Person in Amarapura Township

No	Township	Employment Person	Skill Worker	Rate of Unemployment Person	Rate of Unemployment Percent
1	Amarapura Township	121855	113605	8250	6.77
2	Myit Nge	5858	5002	856	14.61
Total		127713	118607	9106	7.13

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-153 Work Force and Unemployment Population in the Study Area

No	Name of Village	Young People (Male) (Age - 18 to 25)		Young People (Female) (Age - 18 to 25)		Middle Aged (Male) (Age - 25 to 45)		Middle Aged (Female) (Age - 25 to 45)		Elderly Male (Age above 45)		Elderly Female (Age above 45)	
		Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour
1	Mya Hinthar	masonary - 12000 handloom-5000	masonary - 8000 handloom-4000	masonary - 12000 handloom-5000	-	masonary - 12000 handloom-5004	-	masonary - 12000 handloom-5006	-	masonary - 12000 handloom-5008	-	masonary - 12000 handloom-5010	-
2	Hman Tan	10,000	5,000-6,000	6,000	4,000	6,000	4,000	6,000	4,000	6,000	4,000	6,000	4,000
3	Ayeyar Htun	8,000	5,000	6,000	4,000-5,000	6,000	4,000-5,000	6,000	4,000-5,000	6,000	4,000-5,000	6,000	4,000-5,000
4	Thet Kal Taw	10,000/ Masonary and Carpenter	7,000	7,000	7,000	-	-	-	-	-	-	-	-
5	Chauk Thway Thouk	carpenter-10000 looms-5000-6000 cargo workers-10000-20000	-	carpenter-10000 looms-5000-6000 cargo workers-10000-20000	-	carpenter-10000 looms-5000-6000 cargo workers-10000-20000	-	carpenter-10000 looms-5000-6000 cargo workers-10000-20000	-	carpenter-10000 looms-5000-6000 cargo workers-10000-20000	-	carpenter-10000 looms-5000-6000 cargo workers-10000-20000	-
6	Padamya r	100,000 per month	80,000 per month	100,000 per month	80,000 per month	10,000	5,000	10,000	5,000	10,000	-	3,000	2,000
7	Kan Taw	10,000 Masonary, 7000-8000 looms	-	10,000 Masonary, 7000-8000 looms	-	10,000 Masonary, 7000-8000 looms	-	10,000 Masonary, 7000-8000 looms	-	5000 Night Guard	-	-	-

No	Name of Village	Young People (Male) (Age - 18 to 25)		Young People (Female) (Age - 18 to 25)		Middle Aged (Male) (Age - 25 to 45)		Middle Aged (Female) (Age - 25 to 45)		Elderly Male (Age above 45)		Elderly Female (Age above 45)	
		Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour
8	Tha Pyay Tan	10,000 Masonary/ Carpenter	5,000	4,000	4,000	-	-	-	-	-	-	-	-
9	Tharyar, Say Yoe Latyway	8,000	5,000	6,000	5,000	9,000	4,500	9,000	4,500	6,000	4,000	5,000	4,000
10	Tike Soe Village	1000-8000 Mason, carpenter, coolie	6000-8000	6000	6000	-	-	-	-	-	-	-	-
11	Moe Kaung*	-	-	-	-	-	-	-	-	-	-	-	-
12	Kha War Taw	5,000	-	5000 For weavers, 4000-5000	-	6000	-	6000	-	-	-	-	-
13	Yin Taw Village	10,000	7,500	5,000	-	10000	7500	5,000	-	3500-4000	3500-4000 (Small-scale)	3500-4000	3500-4000 (Small-scale)
14	Kyan Tan+Pauk Pauk Tan	Masons - 6000-12000	6000-8000 for masons	4000	4000	Masons - 6000-12000	6000-8000 for masons	4000	4000	Masons - 6000-12000	6000-8000 for masons	4000	4000
15	Shwe Kyat Yat	Mason leader - 5000/7000/10000	3000-5000	6000-10000	Below 6000	-	-	-	-	-	-	-	-

No	Name of Village	Young People (Male) (Age - 18 to 25)		Young People (Female) (Age - 18 to 25)		Middle Aged (Male) (Age - 25 to 45)		Middle Aged (Female) (Age - 25 to 45)		Elderly Male (Age above 45)		Elderly Female (Age above 45)	
		Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour	Skilled Labour	Unskilled Labour
16	Shan Kalay Kyun	15000	8000	10000	5000	10000	5000	10000	5000	10000	5000	10000	5000
17	Warchat	10000	8000-10000	5000	4500	10000	8000-10000	5000	4500	10000	8000-10000	5000	4500
18	Ahr Laung	12000-15000	7000-8000	12000-15000	7000-8000	12000-15000	7000-8000	12000-15000	7000-8000	12000-15000	7000-8000	12000-15000	7000-8000

(Source: HA survey team, December, 2022), * Data missing during field visit

4.10. CHARACTERISTICS OF RESIDENTIAL AREA

4.10.1. Type and Size of Infrastructure

Road construction, a storm drainage system, a water supply system, a wastewater system, a solid waste system, a power supply system, and communication are the infrastructure projects.

Between the Ayeyarwady River and the Mandalay city circular road is where the project is located. As a result, the project area and its surroundings are included in the region of influence. The Ayeyarwady River is assumed to have a 40 km total segment length, with each upstream and downstream segment measuring 20 km from the project's total border. The area of effect for the land area was calculated to be within a 5 km radius of the project's total area boundary. Five kilometers from the project's overall border is regarded to be the region of influence for the socioeconomic environment. The project is a well-planned, environmentally friendly urban core for residential and commercial purposes that will be harmoniously integrated with the local environment and cultures.

According to survey information in the study area, survey team listed the existing infrastructure in the study area such as commercial spaces, factory, market, dump site, drainage, residential spaces, retail shops and religious infrastructure as described in Table 4-154. There is one cemetery in each village such as Thet Kal Taw, Tha Pyay Tan, Tike Soe, Kha War Taw, Yin Taw, Shwe Kyat Yat and Ahr Laung.

Table 4-154 Community Services

No.	Name of Village	Water Point	Tube Wells	Commercial Space	Residential Spaces	Recreation Space	Drainage	Dump Site	Market	Retail Shops	Factory	Cemetery	Village Meeting Hall/ Religious Hall
1	Mya Hinthar	1	20	5	0	0	0	0	0	5	0	0	1
2	Hman Tan	0	<3000	0	24	2	2	4	1	0	25	1	33
3	Ayeyar Htun	0	300	0	2	2	0	3	1	13	2	0	2
4	Thet Kal Taw	0	70	3	1	1	0	0	1	2	0	1	1
5	Chauk Thway Thouk	3	>100	50-60	0	0	0	0	0	50 to 60	50-60	0	1
6	Padamyar	5	every house	0	0	0	1	1	1	0	0	0	0
7	Kan Taw	3	80-90	20	0	0	0	0	0	5	1	0	1
8	Tha Pyay Tan	0	30	0	0	0	0	0	1	15	0	1	0

No.	Name of Village	Water Point	Tube Wells	Commercial Space	Residential Spaces	Recreation Space	Drainage	Dump Site	Market	Retail Shops	Factory	Cemetery	Village Meeting Hall/ Religious Hall
9	Tharyar, Say Yoe Latyway	0	350	0	3	1	0	2	1	12	0	0	2
10	Tike Soe Village	0	30	15	0	0	1	1	0	7	0	1	1
11	Moe Kaung	2	150	8	0	7	0	0	1	15	0	0	0
12	Kha War Taw	0	50	9	0	0	0	0	0	9	0	1	0
13	Yin Taw Village	13	490	0	0	0	0	0	0	13	0	1	3
14	Kyan Tan+Pauk Pauk Tan	0	402	450	8	1	1	1	0	14	1	0	0
15	Shwe Kyat Yat	0	0	0	21	6	0	0	1	0	0	1	12
16	Shan Kalay Kyun	15	0	0	0	0	0	4	1	6	0	0	1

No.	Name of Village	Water Point	Tube Wells	Commercial Space	Residential Spaces	Recreation Space	Drainage	Dump Site	Market	Retail Shops	Factory	Cemetery	Village Meeting Hall/ Religious Hall
17	Warchat	2	2	1	0	0	0	0	0	12	0	0	2
18	Ahr Laung	1	8	1	0	0	0	1	0	12	0	1	1

(Source: HA survey team, December, 2022)

4.10.1.1. Public Health Components

In implementing the objective of uplifting the health status in township, the Ministry of Health is taking the responsibility of providing comprehensive health care services covering activities for promoting health, preventing diseases, providing effective treatment and rehabilitation to raise the health status of the population. The list of hospital in Amarapura township is described in Table 4-155. The diseases of high prevalence reported in 2019 are Diarrhea. The common diseases, and rate of morbidity and mortality is mentioned in Table 4-156 and Table 4-157.

Table 4-155 List of Hospitals in Amarapura Township

Hospital Name	Beds	Responsible
General Hospital	25	Government
Ye Loon Kyaw Hosipital	16	Government
Ta Linn Gyi Hospital	16	Government
Ta Mote Soe Hospital	16	Government
Railway Hospital	50	Government
Total	123	

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-156 Common Diseases in Amarapura Township

Diseases	Morbidity	Mortality
Malaria	3	-
Diarrhea	1450	-
Tuberculosis (TB)	193	1
Dysentery	342	27
Hepatitis B virus (HBV)	6	-

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-157 HIV/AIDS Diseases in Amarapura Township

Diseases	Morbidity	Mortality
HIV/AIDS (April to September, 2018)	27	3
HIV/AIDS (2018-2019)	57	6

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

During field survey period, survey team collected health care access, infrastructures and health service access in the study area as shown in Table 4-158. In 18 study villages, there are 4 hospital and 5 government healthcare centers. In addition, 8 private clinic and 21 pharmacies are in the study area. Therefore, community peoples highly dependency on government health care services when they face the health problems.

According to the village headmen, no serious health problem is present in the study area as shown in Table 4-159. A low mortality and morbidity rate compared as a whole. When serious cases happen, these are transferred to better healthcare access in Mandalay.

Household data on common diseases was collected to survey 10% of the 18 villages, and the most common disease is tuberculosis in households in Padamyar ward. It presented in Table 4-160.

Table 4-158 Health Service in the Study Area

No.	Name of Village	Hospital (Public)	Hospital (Private)	Clinic	Rural health centre	Pharmacy	Other
1	Mya Hinthar*	0	0	0	0	0	0
2	Hman Tan	0	2	0	1	15	0
3	Ayeyar Htun	0	0	1	1	3	0
4	Thet Kal Taw	0	0	0	1	0	0
5	Chauk Thway Thouk*	0	0	0	0	0	0
6	Padamyar*	0	0	0	0	0	0
7	Kan Taw	0	0	0	1	0	0
8	Tha Pyay Tan	0	0	0	1	0	0
9	Tharyar, Say Yoe Latyway	0	1	0	0	0	0
10	Tike Soe Village*	0	0	0	0	0	0
11	Moe Kaung	0	0	2	0	1	0
12	Kha War Taw	0	2	2	0	2	0

No.	Name of Village	Hospital (Public)	Hospital (Private)	Clinic	Rural health centre	Pharmacy	Other
13	Yin Taw Village*	0	0	0	0	0	0
14	Kyan Tan+Pauk Pauk Tan	0	0	1	0	0	0
15	Shwe Kyat Yat	0	1	0	1	15	2
16	Shan Kalay Kyun	0	0	1	0	0	0
17	Warchat*	0	0	0	0	0	0
18	Ahr Laung	0	0	1	0	0	0
	Grand Total	0	6	8	6	26	2

(Source: HA survey team, December, 2022), * Data missing during field visit

Table 4-159 Common Diseases in the Study Area

No.	Name of Village	Diarrhea	Dysentery	Pruritus	Malaria	Conjunctivitis	Typhoid	Gastric Disease	COVID-19	Respiratory Disease	Dengue Fever	Tuberculosis
1	Mya Hinthar	0	0	0	0	0	0	0	3	0	0	0
2	Hman Tan	0	0	0	0	0	0	0	3	0	1 year (10-15 deaths)	3 or 4
3	Ayeyar Htun	1 (during rainy season)	0	0	0	0	0	0	3	0	0	0-Jan
4	Thet Kal Taw	1 for a long time	1 for a long time	0	0	1 (a few)	0	0	10 pepole (Third wave)	0	0	0-Jan
5	Chauk Thway Thouk*	0	0	0	0	0	0	0	0	0	0	0
6	Padamyar	15	0	0	50	0	0	0	50	0	4	15
7	Kan Taw	0	0	0	0	0	0	0	3	0	0	0
8	Tha Pyay Tan	0	0	0	0	0	0	0	5 (first wave)	0	0	0

No.	Name of Village	Diarrhea	Dysentery	Pruritus	Malaria	Conjunctivitis	Typhoid	Gastric Disease	COVID-19	Respiratory Disease	Dengue Fever	Tuberculosis
9	Tharyar, Say Yoe Latyway	1	0	0	0	4 people	0	0	0	0	0	0
10	Tike Soe Village	Once occurred, long time ago	Once occurred, long time ago	0	0	0	0	0	0	0	0	0
11	Moe Kaung*	0	0	0	0	0	0	0	0	0	0	0
12	Kha War Taw	0	0	0	0	0	0	0	4 times	0	0	0
13	Yin Taw Village*	0	0	0	0	0	0	0	0	0	0	0
14	Kyan Tan+Pauk Pauk Tan	0	0	0	0	0	0	0	0	0	1	0
15	Shwe Kyat Yat	Once	0	0	0	A few people	0	0	About 70 people within 2 years	0	0	A few
16	Shan Kalay Kyun	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes

No.	Name of Village	Diarrhea	Dysentery	Pruritus	Malaria	Conjunctivitis	Typhoid	Gastric Disease	COVID-19	Respiratory Disease	Dengue Fever	Tuberculosis
17	Warchat	0	0	0	0	0	0	0	0	0	0	Once (Currently 3 patients)
18	Ahr Laung	0	0	0	0	0	0	0	3	0	0	0

(Source: HA survey team, December, 2022), * Data missing during field visit

Table 4-160 Common Diseases in the Study Area During Household Survey

No.	Name of Village	Diarrhea	Dysentery	Pruritus	Malaria	Conjunctivitis	Typhoid	Gastric Disease	COVID-19	Respiratory Disease	Dengue Fever	Tuberculosis
1	Mya Hinthar	1	1	0	1	1	0	1	4	1	0	1
2	Hman Tan	2	1	1	2	0	0	2	5	1	0	3
3	Ayeyar Htun	1	0	0	0	0	0	0	2	3	1	0
4	Thet Kal Taw	1	2	1	1	1	0	0	2	1	0	0
5	Chauk Thway Thouk*	0	1	0	2	0	1	1	2	1	1	0

No.	Name of Village	Diarrhea	Dysentery	Pruritus	Malaria	Conjunctivitis	Typhoid	Gastric Disease	COVID-19	Respiratory Disease	Dengue Fever	Tuberculosis
6	Padamyar	5	1	1	5	0	0	0	5	0	4	5
7	Kan Taw	0	1	1	4	0	1	0	3	0	0	0
8	Tha Pyay Tan	0	1	2	1	1	0	0	5	0	0	0
9	Tharyar, Say Yoe Latyway	1	1	0	0	4	1	1	0	0	0	0
10	Tike Soe Village	1	2	1	0	1	1	0	0	0	0	0
11	Moe Kaung	0	0	0	0	0	2	0	2	0	0	0
12	Kha War Taw	0	0	0	0	0	0	0	4	0	0	0
13	Yin Taw Village*	1	1	2	1	0	0	1	0	0	0	0
14	Kyan Tan+Pauk Pauk Tan	2	1	1	1	1	0	0	0	0	1	0

No.	Name of Village	Diarrhea	Dysentery	Pruritus	Malaria	Conjunctivitis	Typhoid	Gastric Disease	COVID-19	Respiratory Disease	Dengue Fever	Tuberculosis
15	Shwe Kyat Yat	1	1	1	2	1	0	1	6	0	0	2
16	Shan Kalay Kyun	1	2	1	0	1	0	2	1	2	1	2
17	Warchat*	0	0	0	0	0	0	0	0	0	0	3
18	Ahr Laung*	0	0	0	0	0	0	0	3	0	0	0

(Source: HA survey team, December, 2022), * Data missing during field visit

Figure 4-186 Rural Health Care Center in the Study Villages

4.10.1.2. Health Survey

Despite during field survey period, survey team have challenges to meet with health care staff and to visit to health care center in Shwe Kyat Yat village. According to the head of Shwe Kyat Yat health department, Shwe Kyat Yat rural healthcare center, Shan Kalay Kyun, Nge Toe (sub-rural healthcare center), Kadipar (sub-rural healthcare center), Ta Line Su (sub-rural healthcare center) and Taung Thaman (sub-rural healthcare center) are in the township for health service. The common pharmaceuticals are maternal operation equipment, paracetamol, burmeton, cetirizine, and metformin. Table presented detail cases of information common disease that have been happened in study villages. But the death cases by Covid 19 were not reported yet. The most cases happening in village are diarrhea during as seasonal disease, skin diseases especially in school, respiratory diseases and hyper tension. The total fertility rate is 1.6 percent in 100 live births and mortality rate is 0.4 percent in 100 live births. When serious cases happen, these are transferred to better healthcare access in Mandalay. Health educational awareness provides which can inspire changes in the behavior leading to improved health and well-being such as vaccination program, awareness arising program for maternal and child health, sharing information about obesity, diabetes, hyper tension, heart disease and posting leaflets. Health infrastructures information can be collected as shown in Table 4-161.

Table 4-161 Common Diseases in the Study Area

No	Health Department	Diarrhoea	Dysentery	Sore Eye	Typhoid	Gastroenteritis	Covid 19	Skin Diseases	Malaria	Respiratory Diseases	Dengue	Tuberculosis	Hyper Tension	HIV/AIDS
1	Shwe Kyat Yat Health Department	25 (In 2022)	No	No	No	No	No data available	40 (In School)	No	150	No	No	40	2 (ART)

(Source: HA survey team, December, 2022)

Table 4-162 Common Diseases in the Study Area

No	Description	Type
1	Common Disease in Village	Hyper Tension, Heart Diseases, Diabetes
2	Common Disease in Family	Hyper Tension, Heart Diseases, Diabetes
3	Common Season	Dry season, Wet Season, Cold Season
4	Case History	Allergy, Infectious Diseases
5	Disabled Person in Family	One Blind, One Disabled Person
6	Family Health Care System	Exercise, Medical Checkup
7	Accident Case	4-5 Minor Injuries

(Source: HA survey team, December, 2022)

4.10.1.3. Recommendation from Health Officer

During the survey with the public health head officer, they were keen to collaborate in the health sector if the workers arrived for the project. In collaboration with local people, health care activities and vaccine programs should be at the forefront of any campaign to address health diseases. They would like to encourage providing a list of pregnant and child-related concerns to employees. Air pollution can occur, and it is important to ensure that it does not produce dust emissions.

4.10.1.4. Water Supply System

River water, municipal water supply and ground water sources are main water source for the people in Amarapura Township. The water supply sources are as described in Table 4-163.

Table 4-163 Water supply Industry

No	Township	Factory Name	Location	Type	Production per day	Number of Distribution Households
1	Amarapura Township	BPS (10)	Lin Sin Kone	ET (Elevate Tank)	16500	-
2	Amarapura Township	Mhan Tan	Mhan Tan Ward	Water Storage Tank	4000	-
3	Amarapura Township	BPS (10)	Lin Sin Kone	Water Distribution Plant	-	-
4	Amarapura Township	Kyan Tan	Kyan Tan	Water Distribution Plant	-	-
5	Amarapura Township	Pyi Gyi Mingalar Water Plant	Pyi Gyi Mingalar Water Plant	Water Distribution Plant	220000	-
	Total	5			240500	1200

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Based on survey team in order to get detail information from the community, almost all villages depend on rivers, streams, wells and tube well in both wet and dry seasons. As dominant agricultural activity areas every village use water not only in agriculture and livestock but also in some villages face insufficient water especially during dry season.

Table 4-164 shows that different purpose of domestic and drinking water supply in study area. Some communities fetching not only from the natural water sources such as

Ayeyarwady River but also from tube well of ground water. In addition, drinking water is mostly rely on purified water bottles. In some villages can access drinking and domestic water from Government tube well. But the water quality test especially drinking water is still a big challenge. The water source needs to be big enough to allow for pumping and storage within a reasonable time.

The survey team met with the villagers to cover ten percent of the villages among the 18 villages and households of water supply are almost the same in the project area as shown in Table 4-165.

Table 4-164 Water Supply in the Study Villages

No.	Name of Village	Domestic Water Resource	Drinking Water Source	Water Scarcity Problem	Water usage from Ayeyarwady River
1	Mya Hinthar	Tube Well	Purified water bottles	Yes	-
2	Hman Tan	Tube Well/ Well	Purified water bottles	No	-
3	Ayeyar Htun	Tube Well	Purified water bottles	No	-
4	Thet Kal Taw	Tube Well	Purified water bottles	No	-
5	Chauk Thway Thouk	Tube Well	Purified water bottles	No	-
6	Padamyar	Tube Well/ River Water	Purified water bottles Tube Well, River Water	Yes	For washing
7	Kan Taw	Tube Well	Purified water bottles	Yes	-
8	Tha Pyay Tan	Tube Well	Purified water bottles	No	-
9	Tharyar, Say Yoe Latyway	Tube Well	Purified water bottles	-	-
10	Tike Soe Village	Tube Well	Purified water bottles	No	-
11	Moe Kaung*	-	-	-	-
12	Kha War Taw	Tube Well	Tube well, purified water	No	Domestic Use
13	Yin Taw Village	Tube Well and Ayeyarwady River	Tube well, purified water	No	domestic, cooking, taking bath

No.	Name of Village	Domestic Water Resource	Drinking Water Source	Water Scarcity Problem	Water usage from Ayeyarwady River
14	Kyan Tan+Pauk Pauk Tan	Tube Well	Purified water	No	-
15	Shwe Kyat Yat	Tube Well and Water treatment plant	Water Treatment Plant	No	-
16	Shan Kalay Kyun	Tube Well and River water	Purified water bottles	No	-
17	Warchat	Tube Well	Purified water bottles	No	Agriculture & domestic use
18	Ahr Laung	water meter and water pipe line	Purified water bottles	Yes	Agriculture & domestic use

(Source: HA survey team, December, 2022), * Data missing during field visit

Table 4-165 Water Supply Information During Household Survey

No.	Name of Village	Domestic Water Resource	Drinking Water Source	Water Scarcity Problem
1	Mya Hinthar	-Tube Well -River -Ayeyarwady River	-Purified water bottles -boiling river water -rainwater	Yes
2	Hman Tan	-Tube Well/ Well - Ayeyarwady River -Rainwater pond	-Purified water bottles -boiling River water -rainwater	No
3	Ayeyar Htun	-Tube Well - Ayeyarwady River	-Purified water bottles -boiling River water	No
4	Thet Kal Taw	-Tube Well - Ayeyarwady River	-Purified water bottles -Boiling tube well water	No
5	Chauk Thway Thouk	-Tube Well	-Purified water bottles	No
6	Padamyar	-Tube Well/ River Water -Water pipe line	-Purified water bottles -Tube Well,	Yes

No.	Name of Village	Domestic Water Resource	Drinking Water Source	Water Scarcity Problem
			River Water -Water meter & water pipe line	
7	Kan Taw	-Tube Well	-Purified water bottles -boiling tube well water	Yes
8	Tha Pyay Tan	-Tube Well	-Purified water bottles - boiling tube well water	No
9	Tharyar, Say Yoe Latyway	-Tube Well	-Purified water bottles - boiling tube well water	-
10	Tike Soe Village	-Tube Well	-Purified water bottles	No
11	Moe Kaung*	-	-	-
12	Kha War Taw	-Tube Well - Ayeyarwady River	-Tube well, purified water	No
13	Yin Taw Village	-Tube Well and Ayeyarwady River	-Tube well, purified water	No
14	Kyan Tan+Pauk Pauk Tan	-Tube Well -Well water	-Purified water	No
15	Shwe Kyat Yat	-Tube Well and Water treatment plant	-Water Treatment Plant	No
16	Shan Kalay Kyun	-Tube Well and River water	-Purified water bottles	No
17	Warchat	-Tube Well	-Purified water bottles	No
18	Ahr Laung	-water meter and water pipe line	-Purified water bottles	Yes

(Source: HA survey team, December, 2022), * Data missing during field visit

Ahr Laung Village

War Chat Village

Figure 4-187 Water Resources in the Study Villages

4.10.1.5. Electricity and Energy Consumption

In Amarapura Township, the electricity is supplied by the government and the households use electricity for lighting. Based on survey data, Table 4-166 and Figure 4-188 showed that most of the villages have Government Grid of Electricity with government payment rate.

Household data on electricity was collected to survey 10% of the 18 villages, and most of the villagers can be accessed by government grid of electricity with payment. It presented in Table 4-167.

Ayar Tun Village

Ahr Laung Village | Warchat Village

Figure 4-188 Electricity in the Study Villages

Table 4-166 Electricity and Energy Consumption

No	Name of Village	Available Electricity	Source of Electricity	Electricity	Firewood	Charcoal	Gas	Other
1	Mya Hinthar	Yes	Bakaya Electrical Substation	Yes	Yes	Yes	-	Yes
2	Hman Tan	Yes	Tagundaing Substation	Yes	Yes	Yes	Yes	Yes
3	Ayeyar Htun	Yes	Tagundaing Substation	Yes	Yes	Yes	Yes	Yes
4	Thet Kal Taw	Yes	Amarapura Substation	Yes	Yes	Yes	-	Yes
5	Chauk Thway Thouk	Yes	Tagundaing Substation/ Amarapura Substation	Yes	Yes	Yes	-	Yes
6	Padamyar	Yes	Amarapura Substation	Yes	Yes	Yes	Yes	Yes
7	Kan Taw	Yes	Bakaya Electrical Substation	Yes	Yes	Yes	-	Yes
8	Tha Pyay Tan	Yes	Amarapura Substation	Yes	Yes	Yes	-	Yes
9	Tharyar, Say Yoe Latyway	Yes	Tagundaing Substation	Yes	Yes	Yes	-	Yes

No	Name of Village	Available Electricity	Source of Electricity	Electricity	Firewood	Charcoal	Gas	Other
10	Tike Soe Village	Self-help	Derived from Amarapura EPC	Yes	Yes	Yes	-	Self-help
11	Moe Kaung	Yes	Self-help	Yes	Yes	Yes	-	Yes
12	Kha War Taw	Yes	MOEE	Yes	Yes	Yes	-	Yes
13	Yin Taw Village	Yes	Bakaya Electrical Substation	Yes	-	Yes	Yes	Yes
14	Kyan Tan+Pauk Pauk Tan	Yes	Township Electricity	Yes	Yes	Yes	-	Yes
15	Shwe Kyat Yat	Yes	Amarapura Substation	Yes	Yes	Yes	-	Yes
16	Shan Kalay Kyun	Yes	Bakaya Electrical Substation	Yes	-	Yes	-	Yes
17	Warchat	Yes	ZeyarKwetThit EPC, MOEE	Yes	Yes	-	-	Yes
18	Ahr Laung	Yes	Sagaing	Yes	Yes	Yes	-	Yes

(Source: HA survey team, December, 2022)

Table 4-167 Electricity and Energy Consumption Information During Household Survey

No	Name of Village	Available Electricity	Source of Electricity	Firewood	Charcoal	Gas	Other
1	Mya Hinthar	Yes	-Bakaya Electrical Substation -Solar Power	5	3	-	2
2	Hman Tan	Yes	-Tagundaing Substation -Solar Power -Generator	25	20	3	2
3	Ayeyar Htun	Yes	-Tagundaing Substation --Solar Power	-	-	-	-
4	Thet Kal Taw	Yes	-Amarapura Substation	3	1	-	1
5	Chauk Thway Thouk	Yes	-Tagundaing Substation/ Amarapura Substation -Solar Power -Generator	5	3	-	2
6	Padamyar	Yes	-Amarapura Substation -Solar Power -Generator	4	4	1	1
7	Kan Taw	Yes	-Bakaya Electrical Substation	3	1	-	1
8	Tha Pyay Tan	Yes	-Amarapura Substation	3	1	-	1

No	Name of Village	Available Electricity	Source of Electricity	Firewood	Charcoal	Gas	Other
9	Tharyar, Say Yoe Latyway	Yes	-Tagundaing Substation	5	4	-	1
10	Tike Soe Village	Self-help	-Derived from Amarapura EPC	3	2	-	2
11	Moe Kaung	Yes	-Self-help -Solar power	5	3	-	2
12	Kha War Taw	Yes	-MOEE -Solar power	4	2	-	2
13	Yin Taw Village	Yes	-Bakaya Electrical Substation -Generator	7	9	4	5
14	Kyan Tan+Pauk Pauk Tan	Yes	-Township Electricity -Solar	15	10	-	5
15	Shwe Kyat Yat	Yes	-Amarapura Substation -Solar power -Generator	20	15	-	10
16	Shan Kalay Kyun	Yes	-Bakaya Electrical Substation -Solar power -Generator	15	10	-	10
17	Warchat	Yes	-ZeyarKwetThit EPC, MOEE -Solar power	20	10	-	5

No	Name of Village	Available Electricity	Source of Electricity	Firewood	Charcoal	Gas	Other
18	Ahr Laung	Yes	-Sagaing	10	7	-	8

(Source: HA survey team, December, 2022)

4.10.1.6. Major Access Road

The Amarapura Township is situated at the junction of land and water transportations and therefore, it has good transportation and communication. In Amarapura Township, the households have motorcycle as a means of transport and it is the highest proportion having bicycle.

4.10.1.7. Public Utilities and Services

Public transportation systems include a variety of transit options such as airways, highways, major roads, streets, railways, and marine transport. These systems are available to the general public. The available public transport services of Amarapura township are shown in Table 4-168 and Table 4-169.

Table 4-168 List of Highway Roads in Amarapura Township

No.	Road	Township		Length (mile)
		From	To	
1	Sagaing - Mandalay	Sagaing	Mandalay	6.3
2	Myit Nge - Sagaing	Myit Nge	Sagaing	4.6
3	Myit Nge – Htone Bo	Myit Nge	Htone Bo	9.3
4	Highway Road	Taung Thaman	Say Oo Pho	5.0
	Total	4	4	25.2

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Table 4-169 Railway and Train Stations

No.	Route	Township		Length	Number of Station
		From	To		
1	Mandalay-Myit Kyi Nar	-	-	3	1
2	Yangon-Mandaly	-	-	-1	1

(Source: Regional Data, Administrative Department, Amarapura Township, Mandalay Region, September 2019)

Land road transportation is only reliable and accessible way not only within the region but also to connect other adjacent regions. But in some areas could be allowed on earthen and gravel roads which are connected towns and villages as well. Roads are necessary to renovate in some village because if the road in rural areas were good, there would be improvements in economic conditions, education standards and healthcare facilities. There were some roads that were paved on self-help bases with the arrangements of Amarapura township. Majority of the local people use motorbike to go other villages or towns. The transportation facilities in the study area are as shown in Figure 4-189 and Table 4-170.

Table 4-170 Transportation Facilities in the Study Area

No.	Name of Village	Types of vehicles used in the village / quarter	Classification of roads in the village / quarter
1	Mya Hinthar	Motor Cycle	Concrete and Asphalt
		Mini Oway	Concrete and Asphalt
2	Hman Tan	Motor Cycle	Concrete and Asphalt
		Mini Oway	Concrete and Asphalt
		Light Truck and Hijet	Concrete and Asphalt
3	Ayeyar Htun	Motor Cycle	Concrete road (self-reliance)
		Mini Oway	Concrete road (self-reliance)
		Bicycle	Concrete road (self-reliance)
		Car	Concrete road (self-reliance)
4	Thet Kal Taw	Motor Cycle	Earth road and concrete road
		Mini Oway	Earth road and concrete road
		Car	Earth road and concrete road
5	Chauk Thway Thouk	Motor Cycle	Concrete road
		Bicycle	Concrete road
6	Padamyar	Motor Cycle	Earth road and concrete road
		Mini Oway	Earth road and concrete road
		Car	Earth road and concrete road
		Trishaw	Earth road and concrete road
7	Kan Taw	Motor Cycle	concrete road, municipal road and self-reliance road
		Bicycle	concrete road, municipal road and self-reliance road
8	Tha Pyay Tan	Trishaw	Earth road
		Motor Cycle	Earth road
9	Tharyar, Say Yoe Latyway	Car	asphalt road, concrete road and earth road
		Motor Cycle	asphalt road, concrete road and earth road
10	Tike Soe Village	Trishaw	Concrete road
		Motor Cycle	Concrete road
		Car	Concrete road
11	Moe Kaung	Motor Cycle	Stone paving stone
		Mini Oway	Stone paving stone
		Trishaw	Stone paving stone

No.	Name of Village	Types of vehicles used in the village / quarter	Classification of roads in the village / quarter
		Tolaji	Stone paving stone
12	Kha War Taw	Motor Cycle	Concrete road
		Mini Oway	Concrete road
		Bicycle	Concrete road
		Tolaji	Concrete road
13	Yin Taw Village	Motor Cycle	Concrete road
		Bicycle	Concrete road
		Car	Concrete road
14	Kyan Tan+Pauk Pauk Tan	Motor Cycle	Concrete road
		Mini Oway	Concrete road
		Trishaw	Concrete road
15	Shwe Kyat Yat	Motor Cycle	Earth road and concrete road
		Car	Earth road and concrete road
		Boat	Earth road and concrete road
16	Shan Kalay Kyun	Car	Concrete road
		Motor Cycle	Concrete road
		Mini Oway	Concrete road
17	Warchat	Car	Concrete road
		Motor Cycle	Concrete road
18	Ahr Laung	Car	Concrete road
		Motor Cycle	Concrete road

(Source: HA survey team, December, 2022), * Data missing during field visit

Ahr Laung Village

Warchat Village

	
Shwe Kyat Kyat Village	Yin Taw Village

Figure 4-189 Transportation System in the Study Villages

4.10.2. Land use

The land is located in Amarapura Township, Mandalay. The total aggregate area is 2500 acres. The most part of land cover is open herb and grass land and seasonal crop-land. The area is seasonally flooded due to the river water rise and urban drainage water in monsoon season. The nearby areas are various private owned lands and certain villages like Shan Kalay kyun village. The proposed area is found in connection with Mandalay urban area, and river front area is observed along the east bank of the Ayeyarwady River.

4.10.2.1. Methodology

Information about land use collected from secondary sources in combination with ground truth surveys. The survey helps to verify and fill gaps of the secondary information. The land use is investigated 5 km radius from the project area because current report is EIA report. It was investigated to know the different types of land surrounding the project area. GPS device was used to mark the points of surrounding area during the land use investigation. The points and data acquired from the GPS was analyzed and separated dependence on the types of each land use.

4.10.2.2. Secondary Data Collection

Secondary data on land use compiled from the following sources:

- Satellite image of GOOGLE EARTH PRO
- Geographic Information System Map of Amarapura Township, Mandalay Region
- Layout Plan by using AutoCAD Drawing Software

Based on the secondary data, initial land use map was prepared and used as a basis for subsequent ground truth surveys.

4.10.2.3. Field Survey

Field survey was performed by the study team at the project on 20th October 2022 and the study of surrounding environment within 5 km radius marginal area around the project area, was performed by the study team on that day. It is used to verify the land use information in identifying land use types. QGIS mapping software was used to produce the results for rechecking, revising, and modifying the accuracy of each type of land use. Eventually, the land use map generated accordingly is as shown in Figure 4-190.

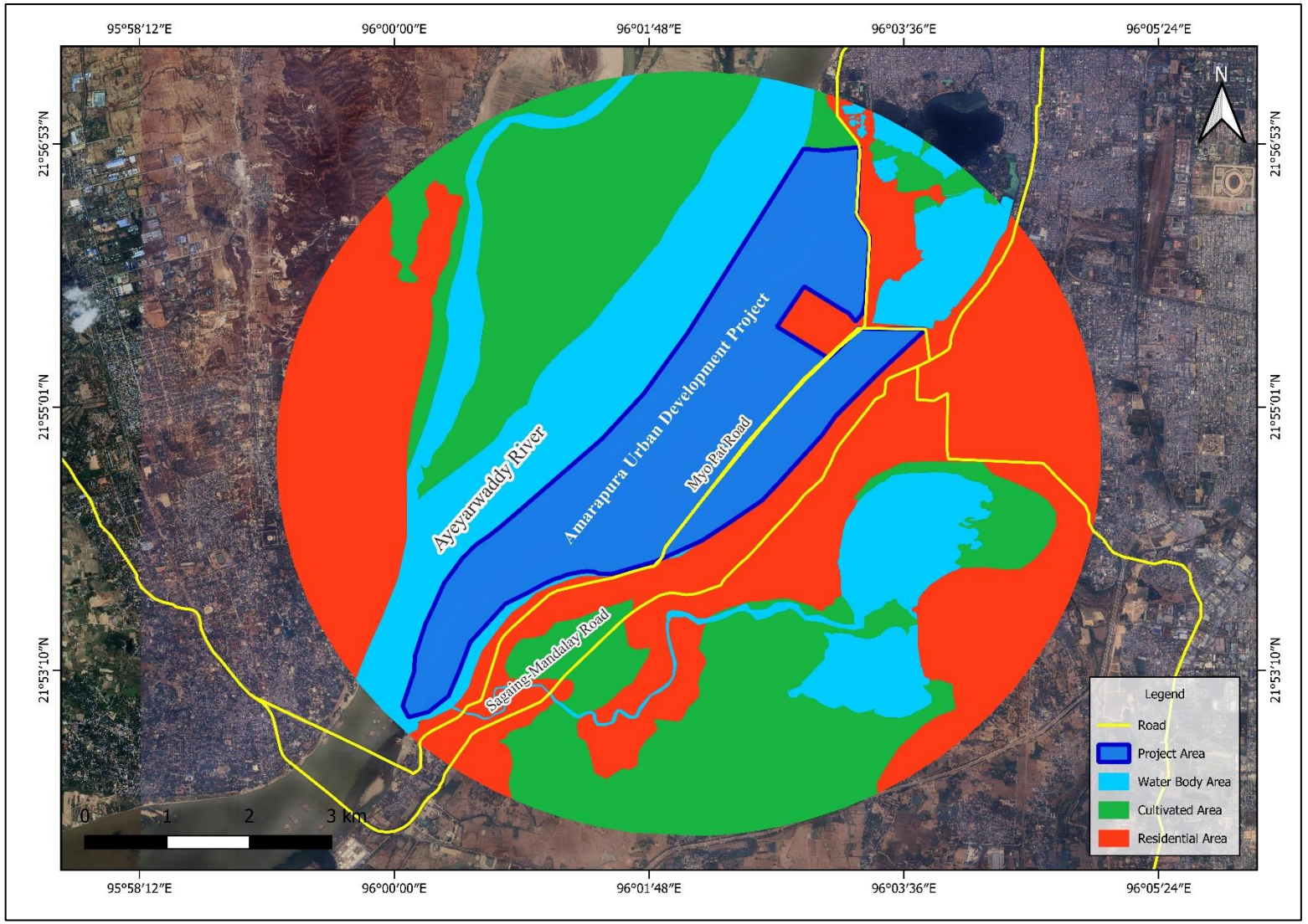


Figure 4-190 Land Use Map of Project Area

4.10.2.4. Result of the Study

Result of land use type investigation on project site by the study area of 5 km radius are described in this section. As the project is located in Mandalay, the project site is surrounded by residential area, cultivated area and water body.

The study area consists of the proposed project for about 2500 acres and three types of land use are recognized in the study area, 5 km radius. First of all, the project area occupies a total of 13%. The residential area follows as largest portion with occupancy of 35.85 % of study area and 28.47 % of the study area is cultivated area. The water body is occupying of 22.7 % of study area. Area and different types of land use within the study area are shown in Table 4-171.

Table 4-171 Type of Land use in the Project Area

Name	Area (Acres)	Percentage (%)
Project Area	2500	13 %
Cultivated Area	5507.03	28.5 %
Residential Area	6917.7	35.8 %
Water Body	4383.41	22.7 %
Total	19308.14	100 %

4.10.2.5. Existing Land Use within Project Area

The proposed project site is in Amarapura Township, which is surrounded by the Ayeyarwady River, private lands, and villages. The area is flat, and there are no protected areas nearby. As a result, the landscape can be classified as a flat area covered in waterbody and scattered vegetation.

The proposed project area is an alluvial plain that floods during the monsoon season. Local farmers cultivate various crops such as pulses, beans, sunflower, and maize during the dry season when the land is exposed. Small-scale fishing takes place in the small wetlands that form when monsoon water returns to the river. The field observation photos taken during the field visit on 20th October, 2022 and 1st March, 2023 for specific land use types is displayed in Figure 4-191. The 2,500 acres of the project are primarily low-lying, flooded alluvial land; hence, the project's potential impact on farming may range from 100 to 300 acres.

Proposed Project Area

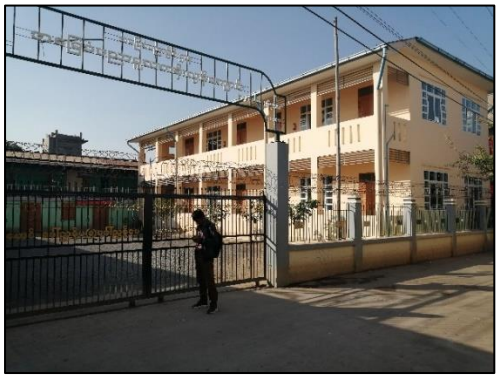
Water Body Area

Residential Area

Cultivated Area

Cultivated Area

Myahinthar Village | Shan Kalay Village



Ar Laung Village

Warchat Village

Figure 4-191 Existing Land Use within the Study Area

4.10.3. Suggestion from Local People

Based on survey team has made discussion with some of these villagers suggested from their needs are collected as described in Table 4-172. According to their answers and suggestions, they suggest priority village development needs such as road improvement, creating public spaces, designing drainage systematically, mitigation measure for dust emissions and assessing the impacts on local people, the natural environment and religious culture. When discussing with villagers, most of the local people are willing to support the development of the village and expect to get job opportunities. Therefore, they would like to encourage the project development since the potential benefits is mor than negative impacts by the project.

The survey team met with the villagers to cover ten percent of the villages among the 18 villages and 62 persons answered some general information related to their residential areas and environs in the question papers for household records. When discussing with villagers, the majority of residents are eager to aid in the village's growth and anticipate finding employment opportunities. Suggestion from household survey records are described in Table 4-173.

Table 4-172 Suggestion from Local People in Study Area

No	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
1	Mya Hinthar	exact village border volley ball stadium	From the meeting and committee	Not to impact to the village	Yes, to support for the development of the village
2	Hman Tan	Drainage Street Places for exercise	by legally information	dust dispersion, damage to the roads	Yes, they think the land value will increase and other wards will develop.
3	Ayeyar Htun	Drainage Business Loan Electricity School for children	by self because of land-loss	concern about the project because the slum can be removed.	It is good for the civilization
4	Thet Kal Taw	modify the earth road for available of hospital and clinic houses for the encroach kitchenware and chairs	Yes, by himself	effect to the water flow	Yes, it will have job opportunities for the manual labor.
5	Chauk Thway Thouk	Health care (Clinic) Business (Job	Yes, civilization	concern about the river water for usage	Yes, it will have job opportunities for the manual labor.

No	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
		Opportunities)			
		Transportation (Chauk Thway Thouk Bridge)			
6	Padamyar	Kindergarten	Yes, by himself		Job opportunities
		Water Storage tank for fire safety			
7	Kan Taw	Village Road	-	not to impact to the environment of the village, to preserve natural resources, to treat wastewater of Shwe Ta Chaung	-
		Clinic			
		Library			
8	Tha Pyay Tan	solution for economic crisis and job opportunities	Yes,from the meeting of Government of Administration	-	Yes, to have job opportunities for the villagers
9	Tharyar, Say Yoe Latyway	Drainage	by himself	concern about being removed the ward because of the project	improvement of standard of livings
		Electricity			
		Loan Service Company			
		Educational Plan			
10	Tike Soe Village	Continue constructing the drainage and the road	Yes. From the administrator	-	If the project is complied with religion and culture, it is fine.

No	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
11	Moe Kaung	Library Concrete Road	Self-awareness	Water can't be used due to the project factory, so that it needs to be clean	Yes, agree. Want to get a lot of job opportunities The project can lead to village development
12	Kha War Taw	Road Construction Village common item (Chair, Plates)	Self-awareness	It leads to village development, less disadvantages and good advantages	Yes Job opportunities will increase.
13	Yin Taw Village	Fire Engine Road for farming Ambulance	Yes. In 2010, aware at the monastery	A lot of encroached houses in the village due to the project factory It becomes more and more thugs. The farmers lost their lands and their farming chance (over 2500-3000)	It will lead to development in social, education, health of the village
14	Kyan Tan+Pauk Pauk Tan	Concrete Road To mitigate wastewater	Self-awareness	Worried about the agriculture land, administration and fire	Yes, hope for increasing job opportunities
15	Shwe Kyat Yat	Road construction	Self-awareness	To upgrade the social lives Headwater erosion to one bank Bad water quality	Hope the project factory will discharge wastewater after treatment and will need to be tackled in excellent mode
16	Shan Kalay Kyun	Having the cremation machine in the graveyard sewage drain dumpsite	In 2017, from the company's inform	It will lead to the river outlet block due to the increasing sewage drain, and to lose the subsoil land for the farmers.	Advantages and excellent transportation

No	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
17	Warchat	Water Supply Road Construction School for children	The construction was seen by self from Sagaing side.	Since the project factory is on the other side of the village, there will not be much disadvantages on the village.	Seen as a development
18	Ahr Laung	Village Road	Yes From landfilling & embarkment	Since the project factory is on the other side of the village, there will not be much disadvantages on the village.	Yes

(Source: HA survey team, December, 2022), * Data missing during field visit

Table 4-173 Suggestion from Household Survey Approach

No	Name	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
1	U Tin Tun	Mya Hinthar	Education, Economic and Social	Yes, by himself	Need to manage the impacts	Yes, Agree
2	U San Thein	Hman Tan	Health, Electricity	Yes, Self- awareness	Need to manage no impact on Villagers	Yes, Agree, If the project has no impact on villagers, it is fine.
3	U Moe Hein Zaw	Hman Tan	-	-	-	-
4	U Win Myint	Hman Tan	Development of living	Self-awareness	-	Yes, Agree,

No	Name	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
			standard			Hoping Development of Amarapura, and job opportunities
5	U Khin Zaw Naing	Hman Tan	Price of land, Job	Yes, from friend	-	Yes, agree It will have job opportunities and higher amount of land price
6	U Thet Cho	Hman Tan	Electricity, Drain	Yes, by himself	Need to make sewage drain	It is good project, Hoping to make electricity for development of living standard
7	U Thein Htay	Hman Tan	Drain	Yes, self-awareness	-	Improvement of standard of livings, Good for Villages, Abundance of job opportunities
8	U Myo Aung	Thet Kal Taw	Job and Health	Yes, by himself	-	Good if no impacts on the environment, Job opportunities
9	U Tun Tun Win	Chauk Thway Thouk	Job Opportunities	Yes, civilization	To treat wastewater and no impacts on the environment	Yes, it will have job opportunities for villagers
10	U Maung Maung Htwe	Padamyar	Kindergarten, Monastery Building, Clinic, Toilets	Yes, by himself	Concern about systematic waste system	Improvement of standard of livings Health Knowledge Sharing
11	U Thiha	Kan Taw	Village Roads and	Yes, from friend	No impacts near the village and to	Good for village

No	Name	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
			Drains		treat wastewater To replace shower places along the banks of Ayeyarwaddy River	
12	U Myint Mar	Tha Pyay Tan	Drainage system	Yes, from the administrator	-Not to contaminate Ayeyarwaddy River	Yes, to have job opportunities for the villagers
13	Daw Khaing	Tharyar, Say Yoe Latyway	Development of Wards and Villages	by himself	-	Improvement of standard of livings
14	Daw Myat Thu Tun	Tharyar, Say Yoe Latyway	-	-	-	-
15	Daw Than Htay	Tharyar, Say Yoe Latyway	-	-	-	-
16	Daw Zar Chi	Tharyar, Say Yoe Latyway	Development of living	Self-awareness	Concern about being removed the ward because of the project	Hoping for the development of living
17	U Aung Khaing Myint	Amarapura	Jobs	Yes, from the administrator	Landslide due to the project	Job opportunities
18	U Myo Khaing	Tike Soe Village	Continue constructing the drainage and the road	Yes. From the administrator	-To reduce bad smell of Drain	Job Opportunities and good for villages
19	U Htay Lwin	Moe Kaung	-	-	-	-

No	Name	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
20	U Than Aung	Moe Kaung	Education, Health, Economic and Social Job opportunities	Self-awareness	-Water used impurify water so that it needs to help to be clean -Concern about the impact and changing from disadvantages to advantages	Yes, agree. -Want to get a lot of job opportunities -The project can lead to village development -Want to help to use Ayeyarwaddy river water
21	U Min Swe	Kha War Taw	Economic	Self-awareness	It leads to village development, less disadvantages and good advantages	Yes Job opportunities will increase and Village development
22	U Aung Myo	Wat Kone	Water Supply, Drain	Yes, from friend	To treat drain	-
23	U Myo Myint	Wat Kone	Water Supply, Drain	Yes, himself	To treat drain	-
24	U Win Myint	Ywar Thar	-	-	-	-
25	U Myo Oo	Yin Taw Village	-	-	-	-
26	U Ko Ko Naing	Yin Taw	-Good Transportation -Bridge	Self-awareness	Warried about the abundance of mosquito	-
27	Daw Thein Thein Aye	Yin Taw	Good Drainage System	Yes, self-awareness	-	-
28	U Khin Maung Myint	Yin Taw	-Drains -Roads	Yes, himself	Warried about Traffic	Hope for providing Good Drainage system of village
29	Daw Su Hlaing Win	Yin Taw	-Bridge	Yes, from friend	-	-

No	Name	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
30	U Aung Ko	Yin Taw	-	Yes, Self-awareness	Warried about abundance of mosquito because of bad drainage system Warried about the decreasing biodiversity richness	-
31	Daw Nwe Nwe Aye	Yin Taw	-	Self-awareness	Warried about the health of villagers because of bad drainage system	-
32	U Win Min Thu	Yin Taw	Suitable price of land, Economic, Education and Health	Yes, from friend	-	Hope for the improving price of land
33	U Nyunt Tin	Kyan Tan+Pauk Pauk Tan	Concrete Road To mitigate wastewater	Self-awareness	Worried about the agriculture land, administration and fire	Yes, hope for increasing job opportunities and pleasant environment Good Transportation and Prevention of dense population
34	Daw Than Yin	Kyan Tan+Pauk Pauk Tan	Health, Schools	Yes, from friend	To inform the project information And to dispose of waste systematically	Hope for improving education System, Job opportunities
35	Daw Nwe Ni Aye	Kyan Tan+Pauk Pauk Tan	Schools	Yes, from friend	To provide security	Hope for improving education System
36	U Zaw Naung	Than Hlat Maw Taung	-	-	-	-
37	U Ye Naung Htwe	Chan Mya Tharsi	-	-	-	-

No	Name	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
38	U Thein Naing	Plot 460	-	-	-	-
39	Daw Thi Thi Aung	Plot 460	-	-	-	-
40	U Thaw Zin Oo	Plot 460	-	-	-	-
41	U Khaing Htoo	Plot 460	Roads, Drainage, Jobs, Loan Service	Self-awareness	To upgrade the social lives	Hope the project factory will discharge wastewater after treatment,
42	U Maung Min Myat	Plot 460	Development of Living Standard	Self-awareness	Not to impact to the environment of the village, to preserve natural resources,	Yes, agree and we will participate for the development of the village
43	Daw San Myint	Plot 460	-	-	-	-
44	Daw Thet Thet Oo	Plot 460	Drainage, Roads, Loan Service	Self-awareness	concern about being removed the ward because of the project	Hoping the development of social lives
45	Daw Aye Kyi	Plot 460	-	-	-	-
46	Daw Thin Thin Mar	Plot 460	-	-	-	-
47	Daw Hla	Plot 460	Development	Yes, from administrator	-	Yes, agree, Hoping the development of social lives, We will participate in the project for development
48	Daw Zarli Tun	Plot 460	-	-	-	-
49	Daw Zin Mar Htay	Plot 460	-	-	-	-

No	Name	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
50	U Paw Aung	Plot 460	-	-	-	-
51	U Win Naing	Thar Yar Kone/ Thar Yar Shwe Ku	-	-	-	-
52	U Zarni Aung	Thar Yar Kone/ Thar Yar Shwe Ku	-	-	-	-
53	Daw Khin Myo	Thar Yar Kone/ Thar Yar Shwe Ku	Electricity	Yes, self-awareness	Concern about being removed the ward because of the project	-
54	Daw Su	Thar Yar Kone/ Thar Yar Shwe Ku	-	-	-	-
55	Daw Myint Ye	Thar Yar Kone/ Thar Yar Shwe Ku	-	-	-	-
56	Daw Khin Thwe Oo	Thar Yar Kone/ Thar Yar Shwe Ku	-	-	-	-
57	Daw Aye Mi San	Thar Yar Kone/ Thar Yar Shwe	Education	Yes, from friend	Concern about being removed the ward because of the project	-

No	Name	Name of Village	Priority village development needs	Do you know about the project? If so, how do you know? (From friends, self or others)	Awareness of the potential for the project development and of the type of social impacts that may ensue	Are you pleased with how the project developed? Please describe your expectations for the project.
		Ku				
58	Daw Cho Cho Oo	North Nan Nan	-	-	-	-
59	U Aung Aung	Shan Kalay Kyun	-	-	-	-
60	U Win Tint	Shan Kalay Kyun	Good plan for Land Owners	Yes, the construction was seen by self	It will lead to the river outlet block due to the increasing sewage drain, and to lose the subsoil land for the farmers.	Seen as a development
61	U Thein Aung	Shan Kalay Kyun	Jobs, Drains	Yes, Self-awareness	-	Advantages and Job opportunities
62	Daw Than Than Hla	Shan Kalay Kyun	-Job, Clinic, Markets, Schools, Roads	Yes, From friend	-	Advantages and excellent transportation and seen as a development

(Source: HA survey team, December, 2022), * Data missing during field visit

4.10.4. Traffic

4.10.4.1. Review on Current Condition

The township of Amarapura, located in Mandalay Region, is one of the townships in Myanmar with various cultural and historical significance. In this township, there are several prominent attractions and landmarks, including the U Bein Bridge, which is the world's longest teakwood bridge, and various monasteries and pagodas that showcase the rich Buddhist heritage of the region. According to Stastical data, this township is occupied 13% of total population in Mandalay City. Amarapura is known for its traditional textile and silk weaving industries, which have been practiced by the local communities for generations. The township is also home to numerous workshops and factories where traditional handicrafts, such as wood carving and bronze casting, are produced. Two major rail networks can be used in transportation sector. Moreover, there are three highway terminals are located in this township. Four major expressways such as Sagaing-Mandalay expressway, MyitNge-Sagaing expressway, MyitNge-Htonebo expressway and Yangon-Mandalay Expressway are passed through in this township.

The project is located in Amarapura Township and this area is surrounded by Ayeyarwaddy River on the west and Sagaing-Mandalay Expressway on the east. The project area can be mainly accessed from Myo Patt Road which is connected from Yangon-Mandalay expressway and Mandalay-Myintkyinar highway. Minor access roads such as Kandawgyi Pat Road, Yandanarpon Kyaung street, 35th street and Ayeyarwun street can also be used to approach this project area.

4.10.4.2. Problem Statements

Some transport related problems may arise during and after construction phases.

Most residents in this project area are merchants and their economic conditions rely on marketing and production of crops, traditional handicrafts wood carving and bronze. For trading these products, transportation becomes a major sector. As already mentioned, two transport modes can be applied in this area. However, due to the restriction of land use, rail transport cannot be widely used for transporting goods and passengers. Therefore, highway roads become the major transport role for landusers in this area.

According to statical data in Mandalay, the rapid growth of vehicle registration affects traffic volume and traffic growth condition. Furthermore, 108679 persons are targeted to accommodate in this area in which most of residents in this compound are medium and high income-person households. As a complex project planning with residential areas, commercial areas, business areas and recreational area, the number of road users (users who apply roads with any type of transport mode) must increase dramatically.

As previous known, the most popular transport modes in urban area are bicycles and motorcycles. According to the project goal, people from urban and suburban area will be attractive to come and visit. At that time, two wheeled vehicles are overcrowded around project compound.

If there is no a systematic plan in traffic condition, major and minor traffic accidents will cause around the compound. Parking lots, traffic signs and signals should also be considered.

During construction phase, roadbed conditions should be considered due to the use of heavy machines on Myo Patt Road. Due to the poor site layout plan, traffic congestion problems will face not only within area but also outside of the compound. If site safety warnings signs are not instructed at outside of compound, road users (especially heavy lorries) will slip and overturn.

4.10.4.3. Data Collection

To estimate future traffic volume, current traffic volume is counted firstly. Among various methods of counting, manual traffic count was used. This collection was done on 3rd March 2023 and 4th March 2023 at five locations on Myo Patt Road around the project area. The specific traffic surveying locations and records are shown in Table 4-174 and Figure 4-192,Figure 4-193.

Table 4-174 Traffic Surveying Locations

No	Station	Direction	Coordinates
1	Point 1	Ayeyar Tun to Shan Kalay Kyun, Shan Kalay Kyun to Ayeyar Tun	21°56’ 51.43” 96°3’17.15”
2	Point 2	Shan Kalay Kyun to Ayeyar Tun, Ayeyar Tun to Shan Kalay Kyun	21°55’ 37.06” 96°3’18.93”
3	Point 3	Kandawgyi to Shan Kalay Kyun, Shan Kalay Kyun to Kandawgyi	21°55’ 37.34” 96°3’21.63”
4	Point 4	Amarapura to Shan Kalay Kyun, Shan Kalay Kyun to Amarapura	21°55’ 35.21” 96°3’21.83”
5	Point 5	Shan Kalay Kyun to Daw Aye Kyin, Daw Aye Kyin to Shan Kalay Kyun	21°53’ 55.6” 96°1’51.81”

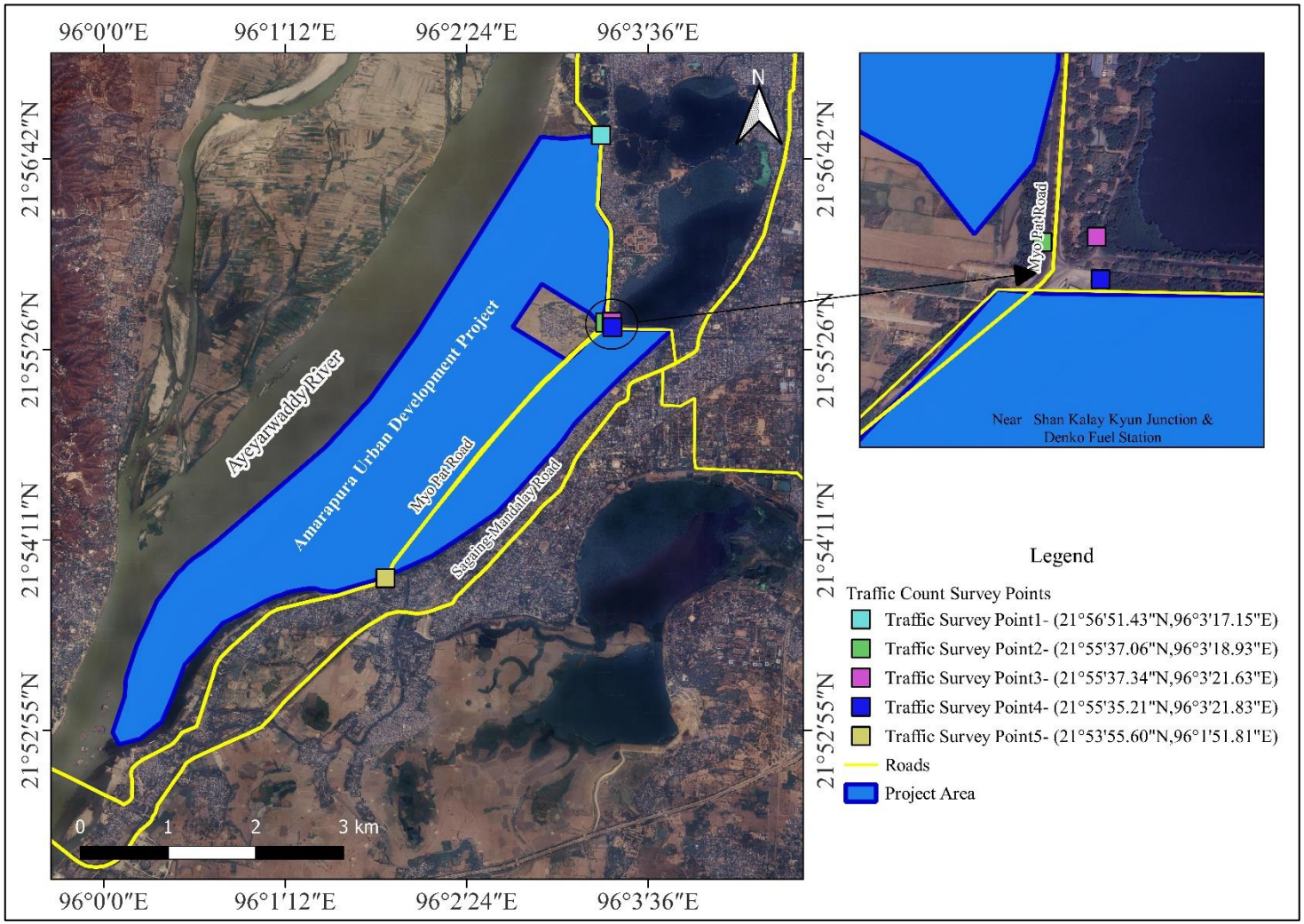


Figure 4-192 Traffic Surveying Locations

Figure 4-193 Traffic Surveying Records

Traffic survey was conducted by manually by 5 surveyors and the surveying period is from 6 a.m. to 6 p.m. During the surveying period, the number and type of vehicles were recorded by talley method. Vehicles are classified as six group such as (1) Saloon, Van, Light Truck, Taxi, (2) Small Passenger Car, (3) 6/8/9 Wheels Truck, (4) 12 Wheels Truck, (5) 22/24 Wheel Truck, (6) Express, (7) Motor Cycle.

4.10.4.4. Methodology

4.10.4.4.1 Traffic Volume

To forecast future traffic volume, the following equations can be used.

$$\textbf{Future ADT= Current ADT +Traffic increase} \quad (1)$$

-ADT = Average Daily Traffic

-Traffic increase depend on Normal traffic growth, Development in traffic, Generated traffic

$$\textbf{Future ADT = Current ADT x Traffic Projection Factor} \quad (2)$$

$$\textbf{Traffic Projection Factor = (1+ r)}^{n+x} \quad (3)$$

n= traffic analysis period (design life)

r= rate of annual growth in traffic

x= years required for design & construction

4.10.4.4.2 Volume/Capacity Ratio

The counted traffic data are used to calculate the V/C ratios which is traffic volume relative to road capacity. This ratio will be used to measure the effects of the project's impact on local traffic and is thought of as a baseline for traffic flow conditions.

$$\mathbf{V/C} = \frac{\textbf{Traffic Volume}}{\textbf{Carrying Capacity of Respective Road}} \quad (4)$$

4.10.4.4.3 Level of Service (LOS)

Traffic conditions that influence capacities and service levels include vehicle type of lane and directional distribution.

According to Highway Capacity Manual,

Base conditions assume good weather, good pavement conditions, users familiar with the facility, and no impediments to traffic flow.

Table 4-175 Level of Service

Level of Service (LOS)	Volume/ Capacity Ratio (V/C)	Natuer of flow
A	<0.3	Free flow
B	0.3 – 0.5	Reasonably free flow
C	0.5 – 0.7	Stable flow
D	0.7 – 0.9	Approaching unstable flow
E	1	Unstable flow
F	>1	Forced flow

Source: Gaijar R, and Mohandas D (2016)

Before LOS determination, it is required to confirm highway type.

• Freeways - functional system is one or two, and full access control exists, then the section is a freeway

• Multilane highways - stop signs exist, then the section is stop controlled

• Rural two-lane highways - signals exist, the section is signalized

• Signalized highways - through lanes are greater than or equal to four, the section is multilane

• Stop-controlled highways -through lanes are equal to two or three and the urban code indicates rural, the section is rural two lanes

4.10.4.5. Analysis

4.10.4.5.1 Traffic Volume

Point 1 - Roadway is a 4-lane in two-direction. This point was selected to review the current traffic conditions from Ayeyar Tun to Shan Kalay Kyun in both directions.

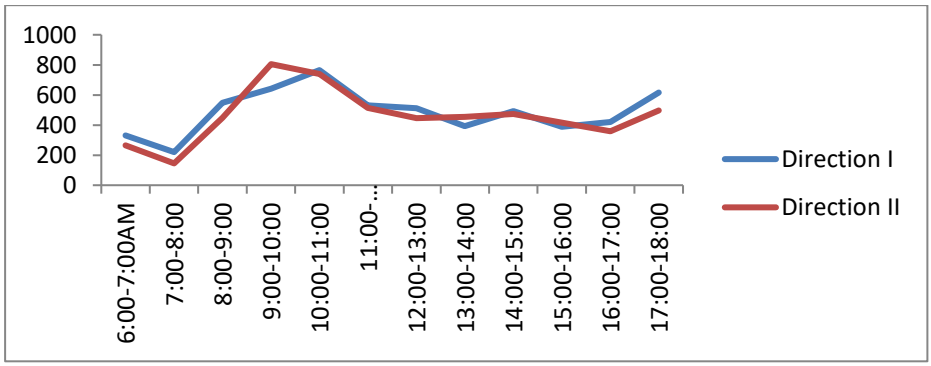


Figure 4-194 Traffic Flow at point 1

The inbound (direction I) and outbound (direction II) traffic were not slightly different each other. According to figure 1.4, the traffic volume was increased double from morning 8 to 9 a.m. The highest volume could be seen within 9am to 1 pm. Morning volume is higher than evening one. Interestingly, the traffic trend was speed up at 5-6 p.m.

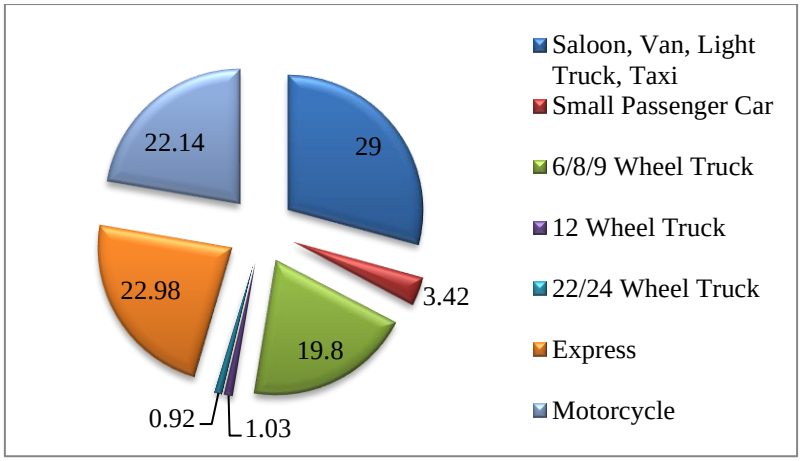


Figure 4-195 Vehicle Composition at point 1

From theFigure 4-195, type 1 (saloon, van, light truck, taxi) occupied the highest percentage among the other type of vehicles. However, type 1, type 6 and type 7 are not slightly different and these types share 0.75% in vehicle composition.

Point 2- The road is a 4-lane in two-direction. This point was selected to review the current traffic conditions from Ayeyar Tun to Shan Kalay Kyun in both directions.

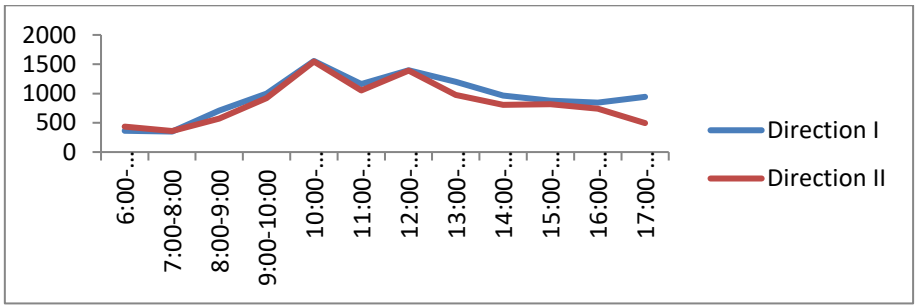


Figure 4-196 Traffic Flow at point 2

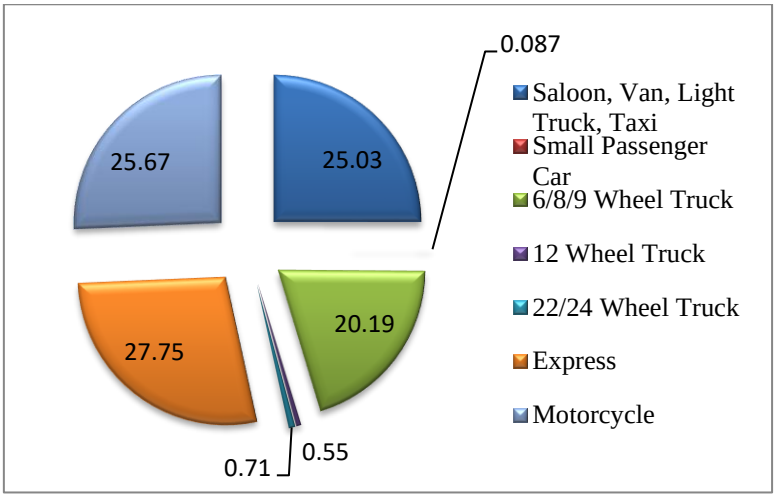


Figure 4-197 Vehicle Composition at point 2

The highest traffic volume was collected during 10-11 a.m. The morning peak traffic was 1.6 time higher than the evening traffic. The inbound and outbound flow is no significant change in this traffic stream. Among seven types of vehicles, type 2 (small passenger car) stand the lowest rate whereas express car (type 6) is the highest share.

Point 3- The road is a 4-lane in two-direction. This point was selected to review the current traffic conditions from Kandawgyi to Shan Kalay Kyun in both directions.

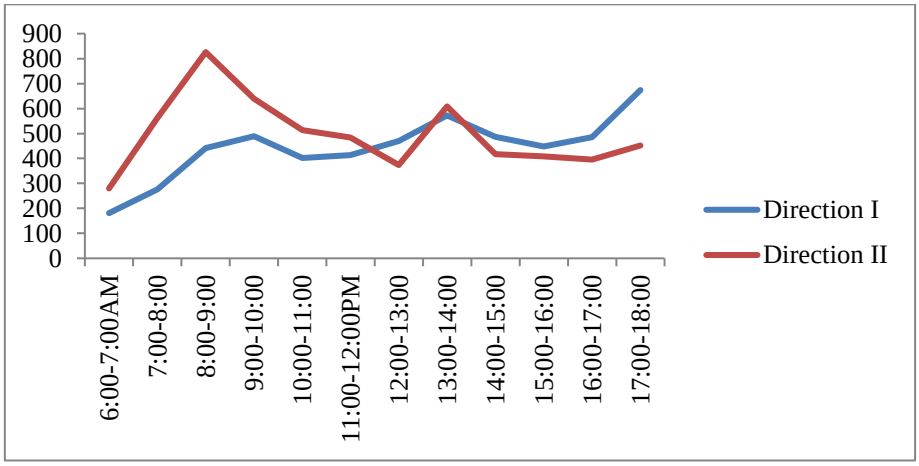


Figure 4-198 Traffic Flow at point 3

According to Figure 4-198, outbound traffic (Shan Kalay to Kandawgyi) is 1.14% time more than the inbound traffic. Moreover, the inbound traffic is gradually increased within 12- hours period. At inbound traffic, the highest traffic occurred at mid-day and evening time. For outbound traffic, the volume was gradually increased from 6 am to 10 am and decreased steadily at mid-day.

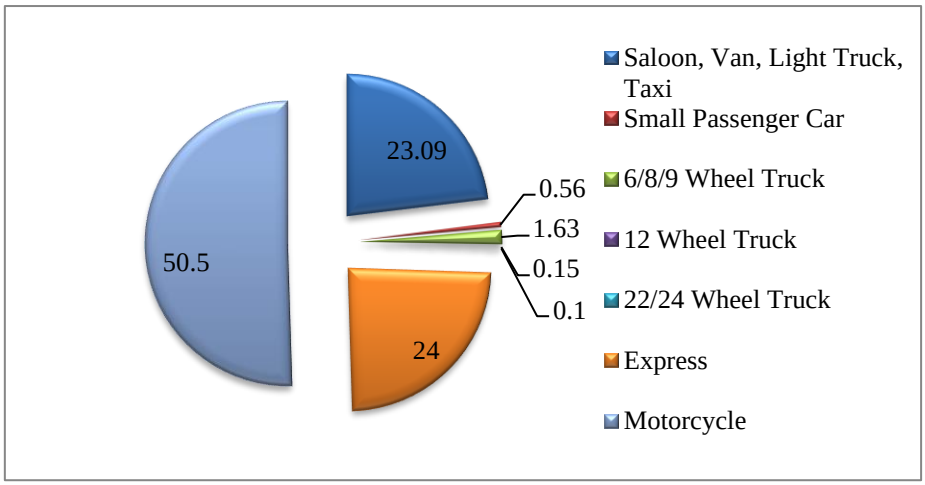


Figure 4-199 Vehicle Composition at point 3

Among various compositions, motorcycle (type 7) was occupied 0.5 % whereas 0.2% of express and 0.18% of saloon, van, light truck and taxi.

Point 4- Roadway is a 4-lane in two-direction. This point was selected to review the current traffic conditions from Amarapura to Shan Kalay Kyun in both directions.

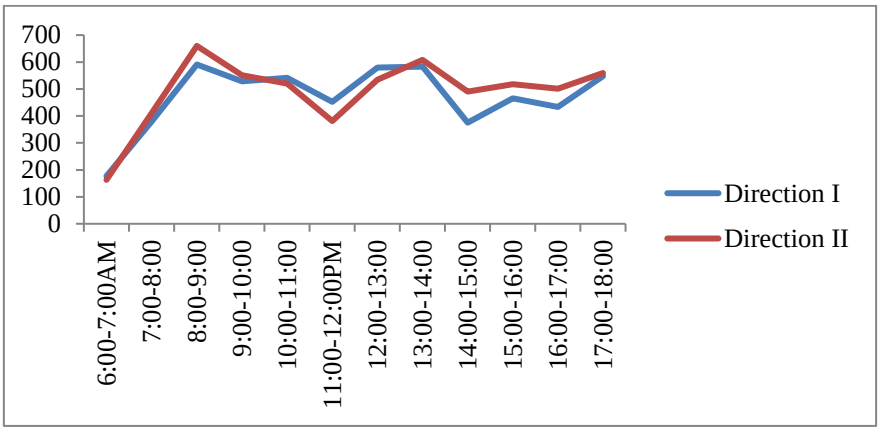


Figure 4-200 Traffic Flow at point 4

The maximum traffic volume varies from 400 to 600 vehicles within 8-9 am and 1-2 pm. The inbound and outbound rates weren't slightly different. However, the volume was still increased (over 500) at end of 12-hour period.

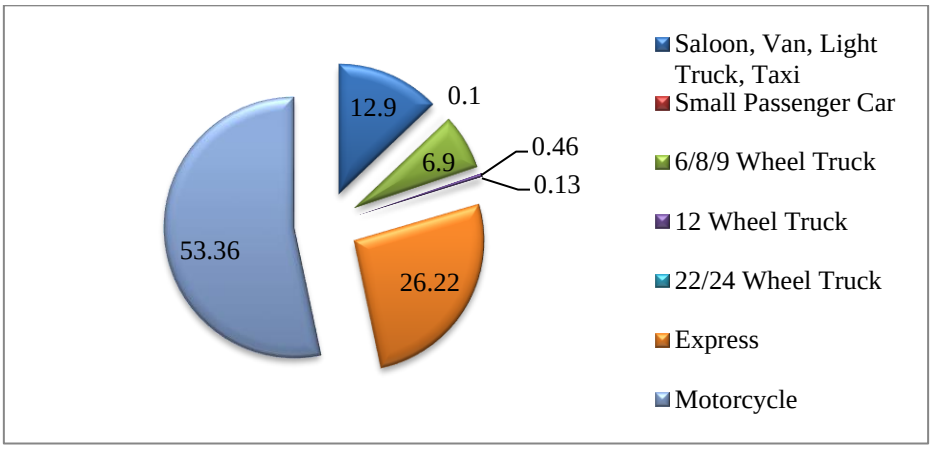


Figure 4-201 Vehicle Composition at point 4

From above figure, 0.5% of motorcycle users were found in this stream. The second largest was 26.22 % of express and the lowest one was small passenger car.

Point 5- Roadway condition was 4-lane in two-direction. This point was selected to review the current traffic conditions from Daw Aye Kyin to Shan Kalay Kyun in both directions.

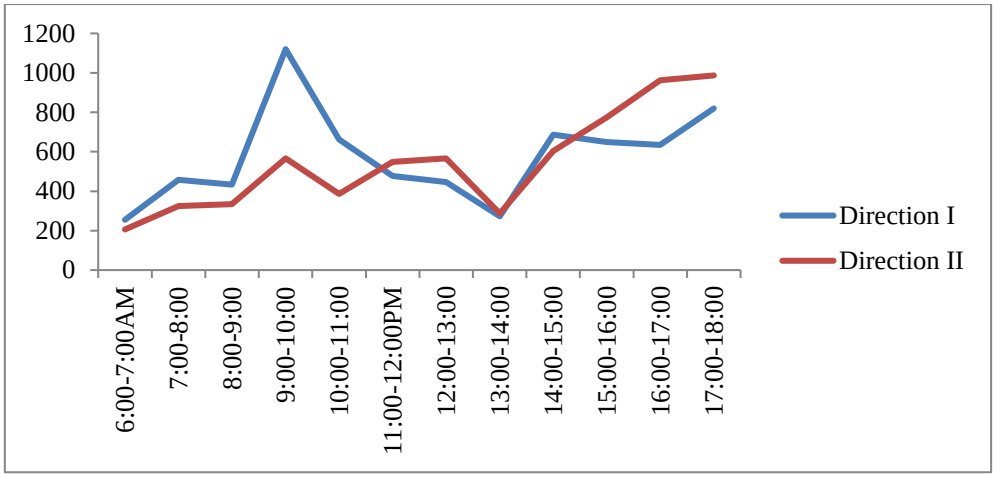


Figure 4-202 Traffic Flow at point 5

According to Figure 4-202, inbound traffic is double than the bound flow during 9-11 pm. The range of minimum and maximum flow was nearly 900 vehicles. At evening period, especially after 4 p.m, the volume was increased dramatically.

From vehicle composition figure at point 5, wheel trucks were lowest percentage and motorcycle was the highest one. Type 1 and type 6 were not differing significantly.

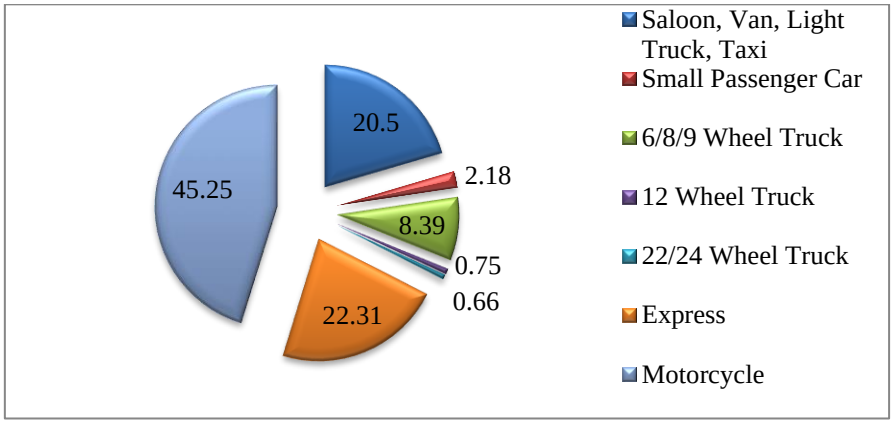


Figure 4-203 Vehicle Composition at point 5

4.10.4.5.2 Comparison of Weekend and Weekday Volume

To review the current condition, it is difficult to conclude on weekday traffic. So, the other weekend traffic (Saturday) flow was collected and compared two days traffic.

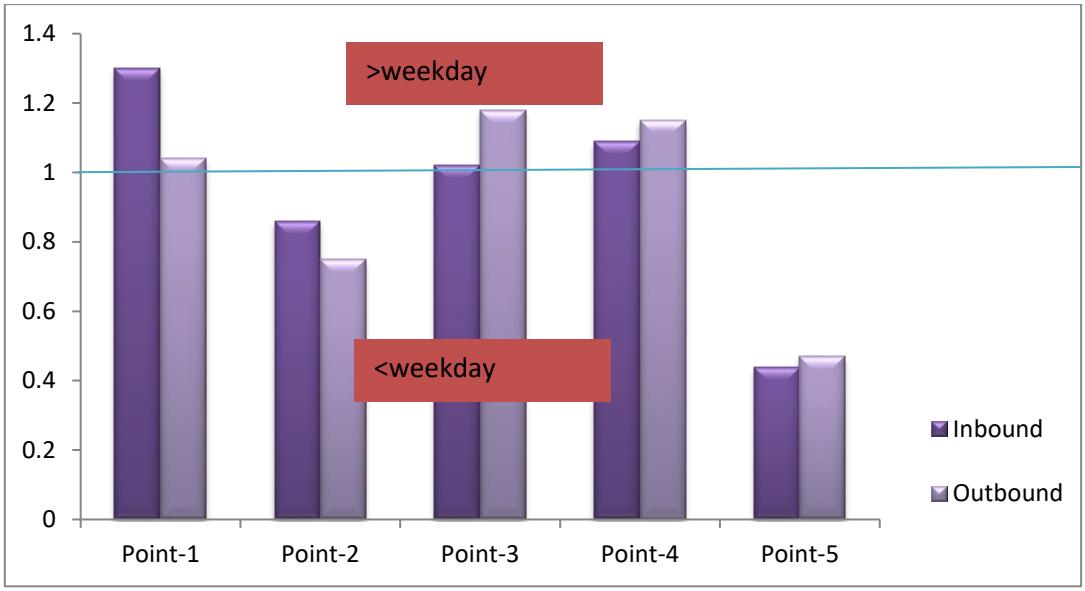


Figure 4-204 Variations between Weekend and Weekday Traffic Volume

From comparison Figure 4-204, three points were the highest volume at weekday and the other two points were the highest volume at weekend. However, at point 2, the rate was not slightly different and could be taken as the same volume on both days. At point 5, weekend volume was double than weekday volume.

4.10.4.5.3 Calculation of Future Traffic Volume

To forecast future traffic, the following should be made-

Firstly, it was needed to take current ADT. The term ADT is the average number of vehicles traveling through a location during a period shorter than a year. From Point 1 to Point 4, the weekday traffic volumes were taken as current ADT whereas the weakened traffic of Point 5 was considered as current ADT.

Table 4-176 Future Traffic Volume

Location	2023	2028	2033	2038	2043
Point 1	11095	14054	16293	18888	21896
Point 2	21779	27588	31983	37077	42982
Point 3	11466	14524	16838	19520	22629
Point 4	11235	14232	16498	19126	22173
Point 5	28768	36442	42246	48975	56776

The rate of annual growth in annual traffic depends on population growth, economic development, urbanization, land use and development patterns, infrastructure development, vehicle ownership and usage, demographics changes and so on. In this case, growth rate was

calculated based on population growth. Based on 2021 statistical data, the population growth rate was 2 to 3 % per year. So, the rate of annual growth rate in traffic was assumed as 3%.

The volume was calculated based on 5-year, 10-year, 15 year and 20 year of traffic analysis periods. At present, major repair was not required and design year or maintenance year was assumed as 5 year interval.

4.10.4.5.4 Volume/Capacity Ratio

The following table was used to calculate V/C ratio of Myo Patt Road from five points.

Table 4-177 Referenced Capacity for Urban Roads

No	Types of Carriageways	Total Design Service Volumes for Different Categories of Urban Roads		
		Arterial	Sub-Arterial	Collector
1	2- Lane (One way)	2,400	1,900	1,400
2	2- Lane (Two way)	1,500	1,200	900
3	3- Lane (One way)	3,600	2,900	2,200
4	4-Lane Undivided (Two way)	3,000	2,400	1,800
5	4-Lane Divided (Two way)	3,600	2,900	-
6	6- Lane Undivided (Two way)	4,800	3,800	-
7	6-Lane Divided (Two way)	5,400	4,300	-
8	8-Lane Divided (Two way)	7,200	-	-

Source: IRC 106:1990

The proposed project area could be accessed on only Myo Patt Road which wasn't required frontage access, not required to give space for standing vehicles and was permitted very little cross traffic. Therefore, the ideal road is arterial road and 4-lane undivided in two-direction.

By application of equation (4), the results were as follow;

Table 4-178 V/C Ratio on Myo Patt Road

Points	V/C Ratio	Remark
1	0.27	<1
2	0.52	
3	0.22	
4	0.193	
5	0.37	

According to Table 4-178, V/C ratio was less than 1 that it means capacity was greater than current volume. The current traffic could flow freely without disturbance.

4.10.4.5.5 Level of Service Determination

The level of service was determined using V/C ratio and Table 4-179.

Table 4-179 LOS on each point

Points	V/C ratio	Remark	LOS
Pt.1- Ayeyar Tun to Shan Kalay Kyun	0.27[<0.3]	Free flow	A
Pt.2 - Ayeyar Tun to Shan Kalay Kyun	0.52[0.5-0.7]	Steady flow	C
Pt.3 - Kandawgyi to Shan Kalay Kyun	0.22[<0.3]	Free flow	A
Pt.4- Amarapura to Shan Kalay Kyun	0.193[<0.3]	Free flow	A
Pt.5 – Daw Aye Kyin to Shan Kalay Kyun	0.37[0.3-0.5]	Reasonably free flow	B

From the results of LOS, three flow conditions were be seen whereas free flow, reasonably free flow and steady flow.

4.10.4.6. Results and Conclusion

4.10.4.6.1 Traffic Volume Analysis

From current traffic volume study, the following factors could be pointed outs-

- The average traffic flow was nearly 900 vehicles/hr. (max-1,500, min.- 180)
- The maximum point was point 2 (From Shankalay to Ayeyar Tun)
- The minimum point was point 3 (From Kandawgyi to Shankalay)
- After 5 p.m, the traffic volume trend was upward again at all points.
- The peak hour was 8 a.m to 2 p.m.
- At mid-day, the traffic volume was decreased varying from 2 to 1.5 times of peak volume.
- Motorcycles were seen as the highest demand around project area.
- Saloon, Van, light truck and taxi were used as second highest vehicle type.
- Among wheel trucks, six-wheeled, eight-wheeled and nine-wheeled trucks were more applied than the other trucks.
- Being the third place of vehicle application, Express buses should be considered as major factor in geometric design considerations.
- The inbound and outbound flow was not significantly differ on each point.
- Except point 5 (Daw Aye Kyin to Shan Kalay Kyun), the weekday traffic could be used in calculating future traffic volume.

4.10.4.6.2 Future ADT

Concerning with future ADT,

- Traffic demand on Daw Aye Kyin to Shan Kalay Kyun would be increased 2 to 3 times within 10 years over.
- Point 2 and Point 5 were the highest potential to increase traffic growth rate than the other points.
- Major repair was not required on current situations.
- Minor repair was not significantly influenced on Future ADT.
- If natural hazards (earthquake, strong wind), geometric conditions would be changed and V/C ration will be varied.
- Due to the limitation of factors, future ADT could be varied on other factors.

4.10.4.6.3 V/C Ratio

Traffic conditions related with V/C ratio; it could be pointed out that

- Current roadway capacity was higher than actual running vehicles.
- Although roadway geometry was 4-lane in two-direction, the actual land usage for traffic was 2-lane in two-direction.
- V/C ratio was calculated based on 2-lane in two-direction.
- The ratio between volume and capacity would be changed if lane widths were restricted.
- On Myo Patt road, Ayeyar Tun to Shan Kalay Kyun Point and Daw Aye Kyin to Shan Kalay Kyun would be given the first priority to maintain less than 1.

4.10.4.6.4 Level of Service

Due to the implementation of new project, LOS was determined whether the provision of new road or road facilities. Regarding with LOS on Myo Patt Road,

- Traffic was freely flow around the project compound.
- Traffic flow pattern would be changed after developing a new extension project.
- LOS level at Daw Aye Kyin and Aye Yar Tun points would be changed to next level because these points were major arterial roads from downtown to pilot area.

4.10.4.6.5 Conclusion

Based on the results of study, the usage of motorcycles was the highest demand. Express buses should be considered in major sector on Myo Patt Road. Myo Patt road around project area should be designed minimum of 1500 vph. Due to the increase in vehicle growth rate, lane widths should be controlled. Although current capacity was adequate, traffic flow would be changed within 10 years where v/c ratio could be varied (>1).; especially, Aye Yar Tun to Shan Kalay and Daw Aye Kyin to Shan Kalay. After 10 years, level of service would be changed due to traffic growth and inadequate land use.

4.10.4.7. Recommendation

In this study, it would like to be recommended as

- Lanes: The road will have four lanes, with two lanes in each direction. Each lane is typically designated for a specific type of vehicle, such as cars, motorcycles, or trucks.
- Median: A median, often referred to as a central reservation, separates the two directions of traffic. The median can be a physical barrier, such as a concrete wall or a grassy strip, or it can be a painted area.
- Shoulders: Shoulders are the areas on the sides of the road that provide additional space for vehicles to pull over or for emergency purposes. They are typically paved and can be used for stopping, parking, or as a buffer zone.
- Lane Markings: Lane markings are used to clearly define the boundaries of each lane. They include painted lines, arrows, and symbols that guide drivers and indicate lane assignments, merge points, and exit ramps.
- Signage: Traffic signs are placed along the road to provide important information to drivers, such as speed limits, lane usage, upcoming exits, and warnings for curves or hazards.
- Traffic Signals: At intersections or areas where traffic needs to be controlled, traffic signals, such as traffic lights, may be installed. These signals regulate the flow of traffic, indicating when to stop, go, or yield.
- Street Lighting: Street lights are installed along the road to provide visibility and improve safety during nighttime driving. They illuminate the road and surrounding areas, enhancing visibility for drivers.
- Drainage Systems: Proper drainage is essential for road maintenance. Drainage systems, including gutters, stormwater drains, and culverts, are designed to collect and channel water away from the road surface to prevent flooding or water damage.
- Roadside Features: Additional features may be present along the road, such as guardrails, barriers, noise barriers, and landscaping, to ensure safety and aesthetics.

- Road Safety Sign: They play a crucial role in maintaining order and safety on the roads. They include regulatory sign, warning sign, informational sign, and construction and work zone signs.

4.11.NATURAL DISASTER

4.11.1. Earthquake

The Project area is about 4 to 8 km far from the Sagaing Fault. In the historical records, about ten major earthquakes struck in and around this area in 1429, 1467, 1501, 1602, 1696, 1762, 1771, 1776, 1830 and 1839. Among them, the most destructive and deadliest one is 1839 Innwa (Ava) earthquake and that caused several pagodas destroyed and 300 – 400 deaths. Based on the current research works, the magnitude of this event is ~ 8 (Wang Yu et al., 2015). In the instrumental record, the most recent event around this area is 1956 Sagaing earthquake that struck on July 16 and the magnitude is Mw 7.0. Due to this earthquake 50 peoples dead in Sagaing and several pagodas were severely damaged. All of these events are generated by Sagaing Fault, 1839 event from Innwa (Ava) Segment and 1956 event from Sagaing Segment. The past earthquakes happened in the around project area is described in Section (4.3.6.2), Table 4-3 to 4-4. The record of earthquake near project is can be seen in Table 4-180.

Table 4-180 Earthquake Record of Surrounding area of the Project

No	Name of Villge	Earthquake Period
1	Mya Hinthar	-
2	Hman Tan	2012,2021
3	Ayar Htun	2017,2022
4	Thet Kal Taw	-
5	Chauk Thway Thouk	2015
6	Padamyar	-
7	Kan Taw	-
8	Tha Pyay Tan	-
9	Tharyar Shwe Gu, Say Yoe, Lat Yway	-
10	Tike Soe Village	-
11	Moe Kaung	2018, Once a year (a little)
12	Kha War Taw	Thrice time per year
13	Yin Taw Village	2006
14	Kyan Tan+Pauk Pauk Tan	-
15	Tike Nal SarYay	-
16	Shan Kalay Kyun	-

No	Name of Villge	Earthquake Period
17	Warchat	June, 2022 (moderate level earthquake)
18	Ahr Laung	No serious cases

Source : survey team (HA)

4.11.2. Flooding

The natural hazards, namely floods have been recorded in Mandalay. The Ayeyarwady Rive water level has raised due to heavy rainfall especially in Amarapura township. Many floods are caused by storm rainfalls from the southwest monsoons in July to October. The topography of Mandalay is characterized by the central plain (delta) which flooding spanned over the long term at the delta near the river mouth. More than 4,000 households and about 20,000 residents in Mandalay,

Amarapura township have been hit by flashfloods caused by a river embankment failure. The danger level of the Ayeyarwady River near Mandalay city is 12.6 meters, and villages in Amarapura township that are located near the river suffer flooding annually. Water has reached 16 of Amarapura Township's 24 villages, including the Shwe Kyat Yat group of villages in 2016 and 14 villages in 2019. It is estimated that more than 1200 households and over 5000 people are already suffering from the floods. Shan Kalay Kyun village suffered from the flooding frequently before the project construction. Since the project's dyke wall and implementation will prevent water flooding from the river to the village, Shan Kalay Kyun village won't be impacted by flooding either now or in the future. According to the survey result, record of the flooding in Mandalay and surrounding area of the project are described in Table 4-181, 4-182 and Figure 4-205.

Table 4-181 Record of Flooding in Mandalay

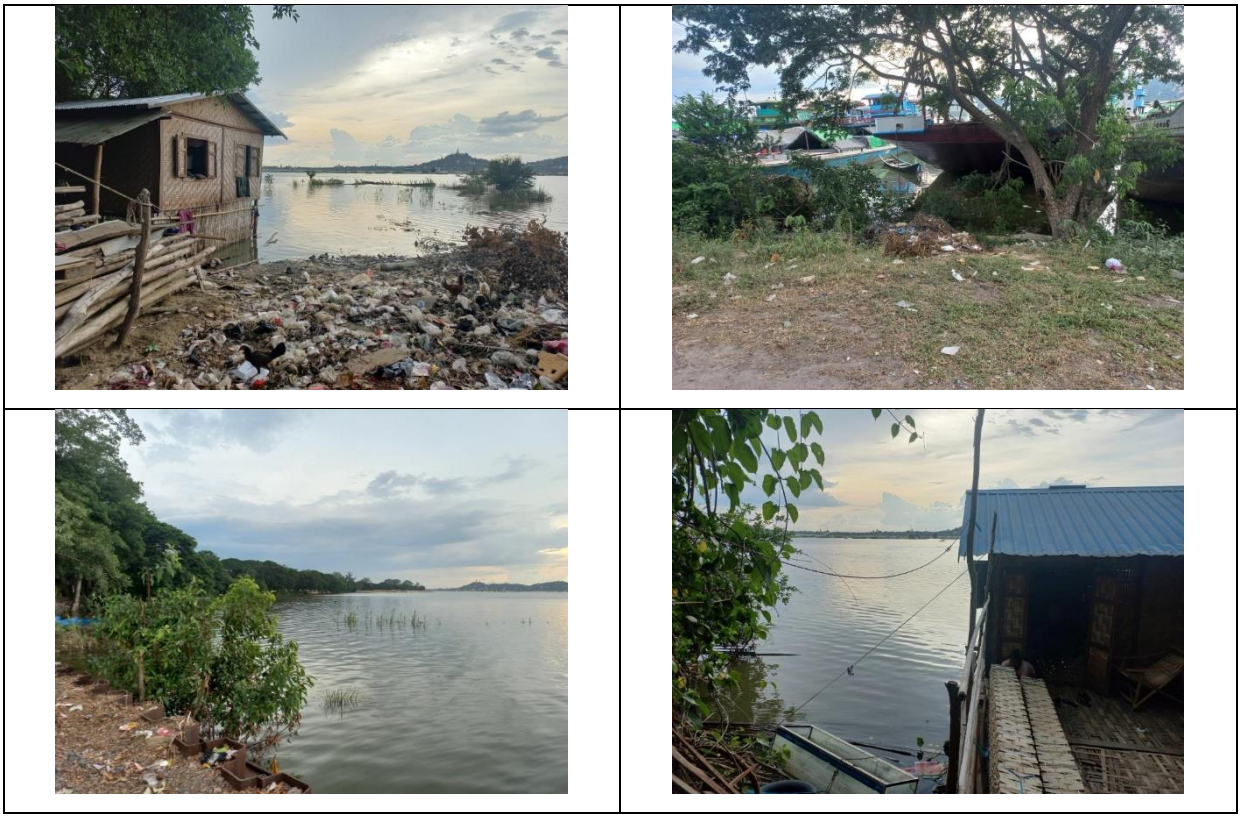
No	Years	Water level	Remark
1	2004	1382 cm	flooding
2	July,2016	1248 cm	flooding
3	August,2016	1325 cm	flooding
4	2019	-	flooding
5	2020	±1191 cm	Embankment collapse near Shwegae new pumping station construction.
6	2024	±1300 cm	River Water level increase

Source : survey team (HA)

Table 4-182 Flooding Record of Surrounding Area of the Project

No	Name of Villge	Significant Flooding Period	Annual Flooding Period
1	Mya Hinthar	-	Every year
2	Hman Tan	-	-
3	Ayar Htun	-	-
4	Thet Kal Taw	2004	Every year
5	Chauk Thway Thouk	1994 and 2019 (Shwe Ge)	-
6	Padamyar	-	Every year
7	Kan Taw	2004	Every year
8	Tha Pyay Tan	2004, 2007,2020	-
9	Tharyar Shwe Gu, Say Yoe, Lat Yway	-	-
10	Tike Soe Village	2004	every time when Ayeyarwady River overflows
11	Moe Kaung	2004, 2010	every year
12	Kha War Taw	2004	every year
13	Yin Taw Village	2004, 2020	-
14	Kyan Tan+Pauk Pauk Tan	2004,2019, 2020	-
15	Tike Nal SarYay	-	Every year
16	Shan Kalay Kyun	In 2004, Ayeyarwady River rises to about 15 feet	-
17	Warchat	-	River overflows about 11 feet No serious cases
18	Ahr Laung	-	-

Source : survey team (HA)



Source : survey team (HA)

Figure 4-205 Flooding in Mandalay

CHAPTER 5

ENVIRONMENTAL, SOCIAL AND HEALTH IMPACT ASSESSMENT AND MITIGATION MEASURES

5.1. INTRODUCTION

Environmental Impact Assessment (EIA) mainly focuses on physical, biological and social dimension along with their complex interactions, which affects individuals, communities and ultimately determines their forms, character, relationship, and survival. In EIA context, impact can be defined as adverse impact or positive impact. The project activity process may cause the potential environmental impacts. In this chapter, the potential impact and mitigation measures of the construction, operation/ maintenance phase of the project are described.

5.2. OBJECTIVES OF ENVIRONMENTAL IMPACT ASSESSMENT

The following are the objectives of an environmental impact assessment and a description of potential environmental impacts:

- To ensure that the environmental considerations are explicitly addressed and incorporated into the development and decision-making process;
- To anticipate and avoid, minimize or offset the adverse significant physical, biological, social and other relevant effects of development;
- To protect the natural systems like water flow and ecosystem services
- To promote development that is sustainable and optimizes resource use as well as management opportunities.

The environments which could be affected by the proposed project include physical environment, biological environment and social environment. The receptors of the physical environment are air, noise, water and soil, whereas those of biological environment are flora, fauna and ecosystem. Social environment includes livelihood of the people, cultural and health sectors.

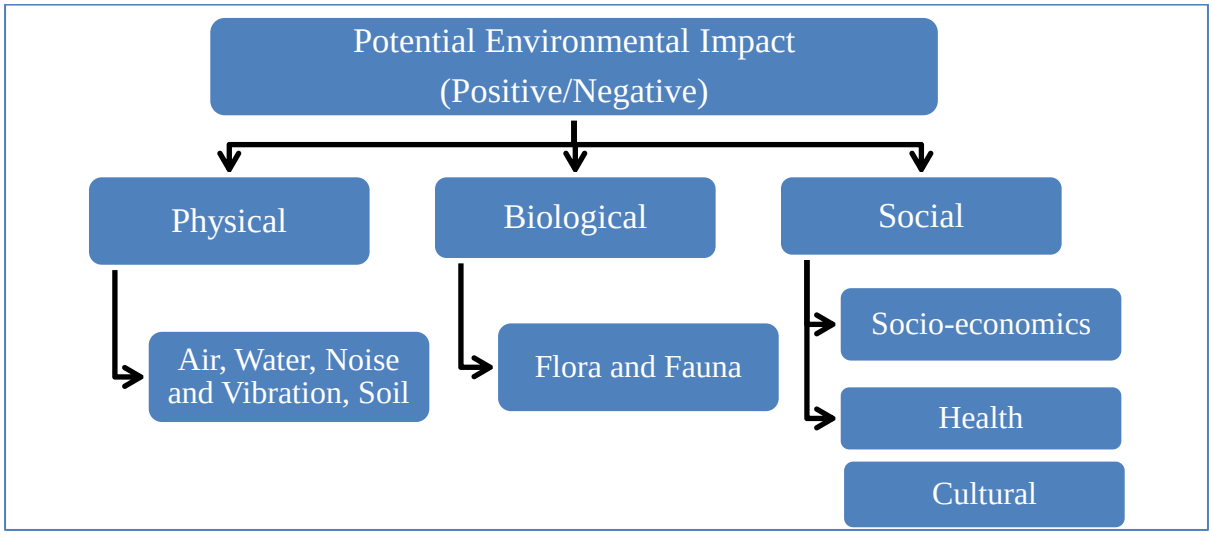


Figure 5-1 Potential Impacts of the Proposed Project

5.3. MITIGATION METHOD

Firstly, the impacts of project implementation are identified and classified. And mitigation measures (Avoid, Management and Monitoring) are conducted. In other way, it is identifying the best method to avoid and reduce the negative impacts. The steps of mitigation measure are shown in below.

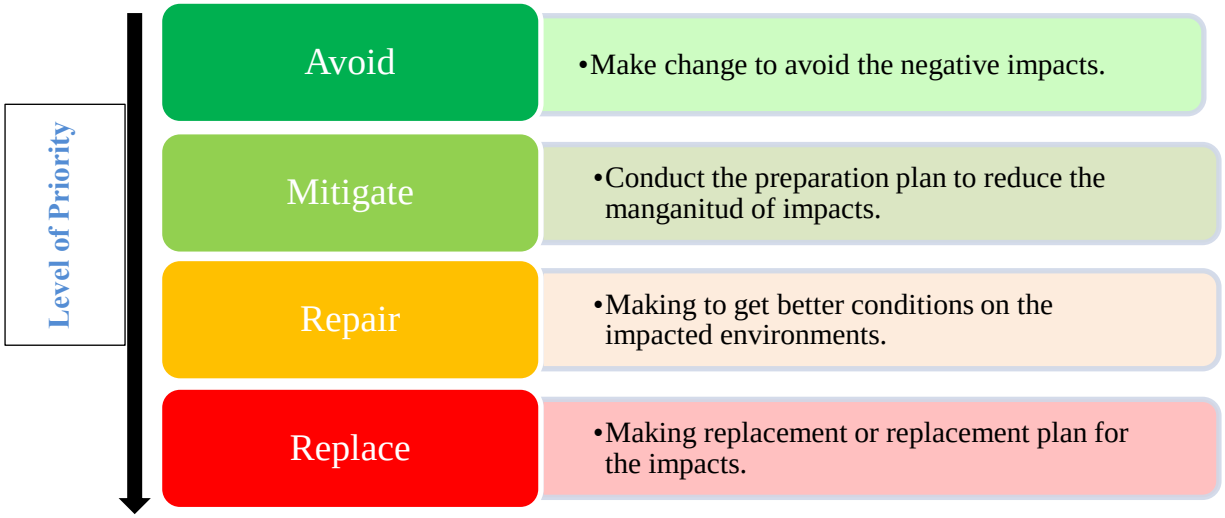


Figure 5-2 The steps of mitigation measure

5.4. ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

An impact can be defined as any change in the physical, biological and social environment that can be attributed to human activities related to alternatives under study for meeting a project need.

The impact assessment methodology is guided by the requirements of the NEMA EIA Regulations (2010), South Africa. The broad approach to the significance rating methodology is to determine the environmental impact (EI) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. This determines the environmental risk. In addition, other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

The criteria for assessment of environmental impacts are as shown in the following table. Typically, the following steps are need to determine the impact assessment.

- Identifying the potential impacts due to implementation of the project.
- Making quantification and prediction of the basis and times of the impact.
- Evaluation the impacts

Impact assessment process are shown in Figure 5-1.

This impact methodology is suitable for impact assessment for the project because this methodology can be assessed for the detail environmental risk and cumulative impact of the project. Due to the type of project is urban development project, it must be assessed for

environmental impacts such as air, water, traffic, solid waste, wastewater, biodiversity and social issue. This methodology will be determined for impact level with value & description of pre-mitigation and post-mitigation. Moreover, it can be calculated the level of final environmental significance rating to detail assess for environmental impact.

5.4.1. Identifying the potential environmental impacts

National guidelines, related environmental rules and regulations as well as recording the potential impacts are need to make a list in identifying the potential environmental impacts as shown in Table 5-1.

Table 5-1 Lists of impacts to identify and classify

Group Type	Potential Impacts
(1) Physical Components	(1) Air Pollution (2) Water Pollution (3) Waste Pollution (4) Noise and Vibration (5) Soil and Landscape
(2) Biological Components	(1) Flora and Fauna (2) Biodiversity
(3) Social Components	(1) Livelihood (2) Local Population (3) Visual Aesthetics (4) Traffic Congestion (5) Livelihood and Socio-economic (6) Job opportunity

5.4.2. Determination of Environmental Impact

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental impact (EI).

The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extend (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C=\frac{(E+D+I+R)}{4} \text{ X } N$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 5-2 to Table 5-6.

Table 5-2 Criteria for determination of impact Nature

Aspect	Score	Definition
Nature	-1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact

Table 5-3 Criteria for determination of impact Extent

Aspect	Score	Definition
Extent	1	Activity (i.e., limited to the area applicable to the specific activity)
	2	Site (i.e., within the development property boundary)
	3	Local (i.e., the area within 5km of the site)
	4	Regional (i.e., extends between 5 and 50km from the site)
	5	Provincial/ National (i.e., extends beyond 50km from the site)

Table 5-4 Criteria for determination of impact Duration

Aspect	Score	Definition
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years)
	3	Medium term (6-15 years)
	4	Long term (the impact will cease after the operational life span of the project)
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction)

Table 5-5 Criteria for determination of impact Magnitude/ Intensity

Aspect	Score	Definition
Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected)
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected)
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way)

	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high/ don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease)

Table 5-6:Criteria for determination of impact Reversibility

Aspect	Score	Definition
Reversibility	1	Impact is reversible without any time and cost
	2	Impact is reversible without incurring significant time and cost
	3	Impact is reversible only by incurring significant time and cost
	4	Impact is reversible only by incurring prohibitively high time and cost
	5	Irreversible Impact

Once the C has been determined the EI is determined in accordance with the standard impact assessment relationship by multiplying the C and the P (refer to Figure 1). Probability is rated/scored as per **Table 5-7**.

Table 5-7: Probability scoring

Aspect	Score	Definition
Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),
	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

The result is a qualitative representation of relative EI associated with the risk. EI is therefore calculated as follows:

EI= C× *P*

Figure 1: Determination of environmental risk

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These EI scores are then grouped into respective classes as described in **Table 5-8**.

Table 5-8 Significance classes

Value	Description
< 9	Low (i.e., where this impact is unlikely to be a significant environmental risk)
≥9; <17	Medium (i.e., where the impact could have a significant environmental risk),
≥ 17	High (i.e., where the impact will have a significant environmental risk).

The impact EI will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/ mitigated.

5.4.3. Impact Prioritization

In accordance with the requirements of Regulation 31 (2)(l) of the South Africa, EIA Regulations (GNR 543), and further to the assessment criteria presented in Section 0 it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

In addition, it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision-making process.

In an effort to ensure that these factors are considered, an impact prioritization factor (PF) will be applied to each impact EI (post-mitigation). This prioritization factor does not aim to detract from the impact ratings but rather to focus the attention of the decision-making authority on the higher priority/ significance issues and risks. The PF will be applied to the EI score based on the assumption that relevant suggested management/ mitigation impacts are implemented.

Consequence						
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

Table 5-9 Criteria for the determination of public response (PR)

Aspect	Score	Definition
Public response (PR)	Low (1)	Not raised as a concern by the I&AP's
	Medium (2)	Issue/ impact raised by the I&AP's
	High (3)	Significant and meaningful response from the I&AP's

Table 5-10 Criteria for the determination of Cumulative Impact (CI)

Aspect	Score	Definition
Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change

Table 5-11 Criteria for the determination of Irreplaceable loss of resources (LR)

Aspect	Score	Definition
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (service and/or functions) of these resources is limited
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions)

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in **Table 5-9**,**Table 5-10** and **Table 5-11**. The impact priority is therefore determined as follows:

Priority = $PR + CI + LR$

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (refer to **Table 5-12**).

Table 5-12 Determination of prioritisation factor

Priority	Ranking	Prioritisation Factor
=3	Low	1
3-8	Medium	1.5
=9	High	2

In order to determine the final impact significance, the prioritisation factor (PF) is multiplied by the EI of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental impact rating by a full rankin class, if all the priority attributes are high (i.e., if an impact comes out with a medium environmental impact after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be too upscale the impact to a high significance). The result is the environmental significance rating (ESR) as shown in **Table 5-13**.

ESR= PF× $EI(Post - Mitigation\ Score)$

Table 5-13 Environmental Significance Rating

Value	Description
<15	Low (i.e., where this impact would not have a direct influence on the decision to develop in the area),
≥15; <30	Medium (i.e., where the impact could influence the decision to develop in the area),
≥ 30	High (i.e., where the impact must have an influence on the decision process to develop in the area)

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

5.5. IDENTIFYING THE POTENTIAL ENVIRONMENTAL IMPACTS OF THE PROJECT

Project activities and requirements that could cause changes to the on-site and off-site environment were identified to the basis of information on the field survey and the baseline environmental conditions of the project area. The table below lists the potential impact and sources of pre-construction, construction and operation/maintenance and decommission phase for environmental and biological components that could result from the Project. The survey results and nature of the proposed project implied that there will be some negative impacts particularly due to the solid waste, wastewater and traffic volume due to the

project. In general, the occurrence of negative impacts is concerned with the following project implementation:

5.5.1. Pre-construction Phase

Document preparation occurs during the pre-construction phase. It includes purchasing and owning land, creating design plans, determining river levels, and analyzing project elevation. Therefore, according to the assessment made by the environmental consultants (EIA) team, there are no negative impacts on physical, biological and social environment impact for the pre-construction phase of the project.

5.5.1.1. Positive Impact of pre-construction phase

- ✓ During a development's pre-construction phase, temporary employment opportunities are usually created.

5.5.2. Construction Phase

During Construction phase, the impacts resulting from construction activities including site clearance, land reclaiming, leveling process, sand filling activities, construction activities for dyke wall, drainage system and road, transportation vehicles and civil works, etc.

5.5.2.1. Positive Impact of Construction Phase

- ✓ During a development's pre-construction phase, temporary employment opportunities are usually created.
- ✓ Surface water discharge rates and the risk of localized flooding are frequently reduced.

5.5.3. Operation Phase

During Operation/Maintenance phase, the impacts associated with the Operation and Maintenance of the infrastructure built in the project.

5.5.3.1. Positive Impact of Operation Phase

- ✓ During a development's pre-construction phase, permeant employment opportunities are usually created.
- ✓ The local network of Public Rights of Way can be improved by extending the foot and motorcycle pathways.
- ✓ Building new homes that meet a particular housing need, like retirement or affordable housing, can help improve the community.
- ✓ Growth economic aspect in the local.
- ✓ Revenue to Union and State and Region governments

5.5.4. Decommission Phase

The proposed project is long-term and life time. There are no decommission phase because of the new urban project with complete infrastructure in accordance with the green growth and green economy. Therefore, there is no positive and negative impacts for decommission phase.

5.6. POTENTIAL IMPACTS AND SOURCES FOR EACH PROJECT PHASE

Potential Impacts and sources of them on construction and operation/maintenance phases are identified and classified as shown in Table 5-14.

Table 5-14 Potential Impacts on Construction and Operation/Maintenance phases

Group Type	Potential Impacts	Source/ Context
Physical Components	(1) Air Pollution (Particulate Matters and Other gases)	**Construction Phase** ❖ Site Clearance ❖ Earth work and civil work activities ❖ Ground levelling activities ❖ Land reclaiming and leveling process ❖ Temporary access road construction ❖ Emissions from construction equipment and vehicles ❖ Loading/ Unloading process ❖ Sand filling activities ❖ Transportation vehicles ❖ Dust arising from construction activities **Operation/Maintenance Phase** ❖ Emissions from household machinery and vehicles ❖ Infrastructure operation and maintenance of the project ❖ Dust arising from operation activities ❖ Loading/ Unloading process ❖ Transportation vehicles
	(2) Water Pollution	**Construction Phase** ❖ Temporary toilet of the worker's camp

Group Type	Potential Impacts	Source/ Context
		❖ Improper handling of lubricants and fuel ❖ Muddy water and polluted water from construction inflows to outside ❖ Lubricant and fuel spill ❖ Water polluted from temporary toilet ❖ Civil work activities **Operation/Maintenance Phase** ❖ Wastewater from the households and urban infrastructures of the project will enter into nearby water body ❖ Wastewater from worker's usage and drink (Basin) ❖ Wastewater from staff accommodation and toilet ❖ Sewage water from septic tank ❖ Storm water running out
	(3) Waste Pollution	**Construction Phase** ❖ Site clearing activities ❖ Removal of vegetation and tree for access road in the project area ❖ Disposal of ground-leveling waste ❖ Earth work activities ❖ Generation of solid waste by land clearance and cut earth work, soil erosion may occur ❖ Solid waste generated from construction activities such as wood and metal debris, concrete blocks, empty cement bags and empty paint containers etc. ❖ Domestic solid waste from worker **Operation/Maintenance Phase** ❖ Wastes from households, infrastructure units, and business activities ❖ Chemical waste (Pes bags) ❖ Electronic wastes (electrical lamp and bulb) ❖ Domestic solid waste from worker

Group Type	Potential Impacts	Source/ Context
	(4) Noise and Vibration	**Construction Phase** ❖ Construction activities mainly site leveling and excavation ❖ Civil work activities using vehicle and equipment ❖ Transportation activities include the delivery of raw material ❖ Loading/ Unloading process **Operation/Maintenance Phase** ❖ Noise and vibration from urban transport, activities of the infrastructure maintenance, urban business activities ❖ Noise generated from the operation of machinery such as pumps, generators and sludge thickening rooms etc. ❖ Loading/ Unloading process
	(5) Soil and Landscape	**Construction Phase** ❖ Construction activities mainly site leveling and excavation ❖ Oil and chemical spills at equipment washing yards, camp sites and ❖ Temporary construction site office ❖ Civil work activities using vehicle and equipment ❖ Concrete residue during construction phase **Operation/Maintenance Phase** ❖ Leakage of oil & grease due to the intense use of heavy machinery and vehicles ❖ Oil spill from vehicles and equipment used in maintenance ❖ Residue of paint during operation process ❖ Solid waste and liquid waste generated during operation period
Biological Conponents	Biodiversity	**Construction Phase** ❖ Loss of all plant and animal species due to the land leveling and excavation ❖ Cutting activities of bushes and small trees

Group Type	Potential Impacts	Source/ Context
		❖ Vegetation loss for soil contamination due to disposal of oils and waste ❖ Habitat loss or destruction during construction works ❖ Loss of individuals through emigration ❖ Changes in abiotic conditions and habitats **Operation/Maintenance Phase** ❖ Vegetation loss due to the disposal of waste ❖ Disturbance to the flora and fauna carried on by noise, traffic, or human presence during the operation period
Socio-Economical Conponents	Random Relocation	No
	Regional Economy (Employment and Vocational)	**Construction Phase/Operation/Maintenance Phase** ❖ Agricultural land will be lost due to the implementation of Proposed Project ❖ Job creation and employment opportunities for local people ❖ Economy and livelihood ❖ Social infrastructure and services, Children's right ❖ Community development ❖ Safe working environment, accidents, and health provisions ❖ Conflict or tension between migrant workers and local communities
	Local population	**Construction Phase/Operation/Maintenance Phase** ❖ locals and their livestock in and around the project area is expected to be affected ❖ local residents may have security issues ❖ noise and dust issues in the surrounding area
	Indigenous Peoples and Tribes	No
	Existing social services and infrastructures	**Construction Phase/Operation/Maintenance Phase** ❖ Project area is free from road area, electricity lines and driange channels.

Group Type	Potential Impacts	Source/ Context
	Occurrence of local in the project area	No
	Cultural Heritage	**Construction Phase/Operation/Maintenance Phase** ❖ fugitive dust, on-site storage of construction materials, storage of construction waste, physical presence, and operation of labor camp are all potential visual impacts ❖ particularly nearby Sagaing Pagoda and mountain site
	Benefits and Damages	**Construction Phase/Operation/Maintenance Phase** **Benefits** ❖ Improving Local economy ❖ Development of technologies according to business sector in the region ❖ Getting employment for locals. ❖ Earning foreign income. ❖ Increase in national budget due to tax revenue. ❖ Development in nearby villages or quarters due to CSR programs. **Damages** ❖ Air pollution, water pollution and noise pollution due to project implementation ❖ Harm to aquatic life from waste and fuel spills without proper supervison. ❖ Accidental injury in the workplace. ❖ Can block traffic near the project.

5.7. ASSESSMENT OF POTENTIAL ENVIRONMENTAL IMPACTS FOR EACH PROJECT PHASE

Based on the methodology, the various impacts of the project are assessed according to the phase by phase of the project activity. During the construction and operation/ maintenance phases has been analyzed and identified, so at this stage, the impact levels of these impacts are calculated as shown in Table 5-15.

Table 5-15 Calculating the Level of Significance Classes of Environmental Impact During Construction and Operation/Maintenance Phase

No	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Pre-Mitigation of Air Pollution										
Construction Phase	2	3	3	3	-1	-2.75	4	-11	Medium	Negative
Operation/Maintenance Phases	2	5	3	3	-1	-3.25	3	-9.75	Medium	
Post-Mitigation of Air Pollution										
Construction Phase	1	3	2	2	-1	-2	2	-4	Low	Negative
Operation/Maintenance Phases	1	5	2	2	-1	-2.5	2	-5	Low	
Pre-Mitigation of Water Pollution										
Construction Phase	3	3	3	3	-1	-3	3	-9	Medium	Negative
Operation/Maintenance Phases	3	5	4	4	-1	-4	5	-20	High	
Post-Mitigation of Water Pollution										
Construction Phase	2	3	2	2	-1	-2.25	2	-4.5	Low	Negative
Operation/Maintenance Phases	2	5	3	3	-1	-3.25	3	-9.75	Medium	
Pre-Mitigation of Water Consumption										
Construction Phase	3	3	3	3	-1	-3	4	-12	Medium	Negative
Operation/Maintenance Phases	3	5	3	4	-1	-3.75	5	-18.75	High	

No	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Post-Mitigation of Water Consumption										
Construction Phase	2	3	2	2	-1	-2.25	2	-4.5	Low	Negative
Operation/Maintenance Phases	2	5	3	3	-1	-3.25	3	-9.75	Medium	
Pre-Mitigation of Waste **Pollution**										
Construction Phase	2	3	3	3	-1	-2.75	4	-11	Medium	Negative
Operation/Maintenance Phases	3	5	3	4	-1	-3.75	4	-15	Medium	
Post-Mititagation of Waste Pollution										
Construction Phase	2	3	2	2	-1	-2.25	3	-6.75	Low	Negative
Operation/Maintenance Phases	2	5	2	3	-1	-3	2	-6	Low	
Pre-Mitigation of Noise and Vibration										
Construction Phase	3	3	4	4	-1	-3.5	5	-17.5	High	Negative
Operation/Maintenance Phases	3	5	3	3	-1	-3.5	4	-14	Medium	
Post – Mitigation of Noise and Vibration										
Construction Phase	2	3	3	3	-1	-2.75	4	-11	Medium	Negative
Operation/Maintenance Phases	2	5	2	2	-1	-2.75	3	-8.25	Low	
Pre-Mitigation of Soil and Landscape										

No	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Construction Phase	3	3	3	3	-1	-3	4	-12	Medium	Negative
Operation/Maintenance Phases	3	5	3	3	-1	-3.5	4	-14	Medium	
Post – Mitigation of Soil and Landscape										
Construction Phase	2	3	2	2	-1	-2.25	3	-6.75	Low	Negative
Operation/Maintenance Phases	2	5	2	2	-1	-2.75	3	-8.25	Low	
Pre-Mitigation of Biodiversity										
Construction Phase	2	3	3	3	-1	-2.75	4	-11	Medium	Negative
Operation/Maintenance Phases	2	4	3	3	-1	-3	4	-12	Medium	
Post – Mitigation of Biodiversity										
Construction Phase	2	3	2	3	-1	-2.5	4	-10	Medium	Negative
Operation/Maintenance Phases	2	4	3	3	-1	-3	3	-9	Medium	
Pre-Mitigation of Livelihood										
Construction and Operation/Maintenance Phases	3	5	4	3	-1	-3.75	5	-15	High	Negative
Post – Mitigation of Livelihood										
Construction and	2	5	3	3	-1	-3.25	3	-9.75	Medium	Negative

No	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation/Maintenance Phases										
Pre-Mitigation of Local Population										
Construction and Operation/Maintenance Phases	3	5	3	3	-1	-3.5	4	-14	Medium	Negative
Post – Mitigation of Livelihood										
Construction and Operation/Maintenance Phases	2	5	2	2	-1	-2.75	3	-8.25	Low	Negative
Pre-Mitigation of Visual and Aesthetics										
Construction and Operation/Maintenance Phases	3	5	3	3	-1	-3.5	4	-14	Medium	Negative
Post – Mitigation of Visual and Aesthetics										
Construction and Operation/Maintenance Phases	2	5	2	2	-1	-2.75	3	-8.25	Low	Negative
Pre-Mitigation of Traffic Congestion										
Construction Phase	3	3	4	3	-1	-3.25	5	-16.25	Medium	Negative
Operation/Maintenance Phases	3	5	4	3	-1	-3.75	4	-15	Medium	
Post – Mitigation of Traffic Congestion										
Construction Phase	2	3	3	2	-1	-2.5	3	-7.5	Low	

No	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation/Maintenance Phases	2	5	3	2	-1	-3	3	-9	Low	
Livelihood and Socio-economic										
Construction and Operation/Maintenance Phases	3	5	4	3	+1	+3.75	5	+ 18.75	High	positive
Pre-Mitigation of Drainage System Impact										
Construction Phase	3	3	4	3	-1	-3.25	4	-13	Medium	Negative
Operation/Maintenance Phases	3	5	3	2	+1	+3.25	4	+13	Medium	Positive
Post – Mitigation of Drainage System Impact										
Construction Phase	2	3	3	3	-1	-2.75	3	-8.25	Low	Negative
Operation/Maintenance Phases	3	5	3	2	+1	+3.25	4	+13	Medium	Positive
Pre-Mitigation of Aquatic & Navigation Impact due to sand dredging										
Construction Phase	4	3	4	4	-1	-3.75	5	-18.75	High	Negative
Operation/Maintenance Phases	2	5	2	2	-1	-2.75	2	-5.5	Low	Negative
Post – Mitigation of Aquatic & Navigation Impact due to sand dredging										
Construction Phase	3	3	3	3	-1	-3	3	-9	Low	Negative
Operation/Maintenance	1	5	2	2	-1	-2.5	2	-5	Low	Negative

No	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Phases										

Table 5-16 Calculating the Level of Final Environmental Significance Rating of Environmental Impact During Construction and Operation/Maintenance Phase

No	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Air Pollution									
Construction Phase	1	2	1	4	Medium	1.5	-6	Low	Negative
Operation/Maintenance Phases	1	2	1	4	Medium	1.5	-7.5	Low	
Water Pollution									
Construction Phase	1	3	3	7	Medium	1.5	-6.75	Low	Negative
Operation/Maintenance Phases	1	3	3	7	Medium	1.5	-14.6	Low	
Water Consumption									
Construction Phase	1	2	3	6	Medium	1.5	-6.75	Low	Negative
Operation/Maintenance Phases	2	3	3	8	Medium	1.5	-14.6	Low	
Waste Pollution									
Construction Phase	1	3	2	6	Medium	1.5	-10.12	Low	Negative
Operation/Maintenance	2	3	3	8	Medium	1.5	-9	Low	

No	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Phases									
Noise and Vibration									
Construction Phase	1	3	2	6	Medium	1.5	-16.5	Medium	Negative
Operation/Maintenance Phases	2	3	2	7	Medium	1.5	-12.38	Low	
Soil and Landscape									
Construction Phase	1	2	2	5	Medium	1.5	-10.12	Low	Negative
Operation/Maintenance Phases	1	2	2	5	Medium	1.5	-12.38	Low	
Biodiversity									
Construction Phase	1	2	3	6	Medium	1.5	-15	Medium	Negative
Operation/Maintenance Phases	1	2	3	6	Medium	1.5	-13.5	Low	
Livelihood									
Construction Phase and Operation/Maintenance Phases	1	2	2	5	Medium	1.5	-14.62	Low	Negative
Local population									
Construction and Operation/Maintenance Phases	1	2	2	5	Medium	1.5	-12.37	Low	Negative
Visual and Aesthetics									

No	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Construction and Operation/Maintenance Phases	1	2	2	5	Medium	1.5	-12.38	Low	Negative
Traffic Congestion									
Construction Phase	2	2	2	6	Medium	1.5	-11.25	Low	Negative
Operation/Maintenance Phases	2	2	2	6	Medium	1.5	-12.38	Low	
Livelihood and Socio-economic									
Construction and Operation/Maintenance Phases	2	2	2	6	Medium	1.5	+ 28.13	High	Positive
Drainage System Impact									
Construction Phase	2	3	2	7	Medium	1.5	-12.375	Low	Negative
Operation/Maintenance Phases	1	2	2	5	Medium	1.5	+19.5	Medium	Positive
Aquatic & Navigation Impact due to Sand Dredging									
Construction Phase	3	3	3	9	High	2	-18	Medium	Negative
Operation/Maintenance Phases	1	2	1	4	Medium	1.5	-7.5	Low	Negative

5.8. POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Based on the methodology, the various impacts of the project are assessed according to the phase by phase of the project activity. The potential environmental impacts from project activities include soil and landscape, noise pollution, waste pollution, water and air pollution and traffic congestion during construction and operation/maintenance phases. Also, a calculation will be made to assess the potential environmental impact during various project-related activity phases.

There can be an effect on the environment if the proponent will not systematically mitigate this impact from the project phases. Mitigation measures for only "High" and "Moderate "levels and recommendation for "Minor" and "Negligible" Level of impacts that may occur from the implementation of the project are described below.

5.8.1. Impact on Ambient Air Quality

Impacts on ambient air are expected during construction and operation phases. Emissions from construction equipment and vehicles, dust arising from construction and operation activities may cause some impacts on the ambient air quality. Ambient air quality is measured using AQM-09 equipment. The air quality standard guidelines of Myanmar Emission Guidelines (2015), World Bank/IFC are used in the study for Baseline data.

The primary sources of air pollutants from the various Project activities (construction and operation/maintenance phase) consist of:

- Combustion and exhaust emissions from equipment and vehicles for materials transport, and airborne particulates (dust) from soil disturbance of site clearance, ground leveling and land excavations during the construction phase;
- Combustion and exhaust emissions from vehicular traffic during operation phase; and
- Air pollution and Odor emission from temporary operation.

5.8.1.1. Construction Phase

5.8.1.1.1 Significance of Impact

During the construction phase, the impact on air quality is identified by the recorded data. In this construction phase, site clearance, land reclaiming, leveling process, sand filling activities, construction activities for dyke wall, drainage system and road, transportation vehicles and civil works, etc. are included. In addition, the movement of bulldozers, backhoes and dozers can be used for clearing the site and are used for digging, earthmoving, and removing debris for leveling the ground, and building access roads will be the primary source of air pollution.

Construction is a source of dust emissions and gases that can have temporary impacts on local air quality. Construction emissions would result from earthmoving (fugitive dust) and heavy equipment use (vehicle exhaust). These emissions would be generated from land clearing, ground excavation, cut and fill operations, and the construction of the project

facilities in addition to vehicular movement. Dust emissions would vary from day to day depending on the level of activity, the specific operations, and the prevailing weather. In addition to particulate emissions from earth moving, combustion emissions from fuel-powered construction equipment, such as PM_{10}, $PM_{2.5}$, NO_2 SO_2 and CO, may create a temporary impact on local air quality.

Potential combustion emission sources for the construction phase of the Project are listed in the following table. Any electric power needs during the construction phase shall be supplied by Electric Power Cooperation (EPC); but the Project will have generator associated emissions during this phase. The environmental impact (EI) will be determined for air quality without relevant management and mitigation measures (pre-mitigation) during construction phase as shown in Table 5-17.

Table 5-17 Significance Classes of Air Quality During Construction Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Dust and Gas emission from construction activities	2	3	3	3	-1	-2.75	4	-11	Medium	Negative

The significant classes of air quality during pre- mitigation measures are calculated based on construction activities. Assumed that for extend of impact is within site boundary area at site clearing, earth work activities and heavy machine and equipment. But this impact is a medium-term period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way and it is reversible only by incurring significant time and cost. Additionally, there is a high possibility that the impact will happen (> 75% probability).

According to the assessment, mitigation measures are needed due to this impact is medium. In addition, this immediate effect will also have an impact on nearby residents, workers, and pedestrians who are walking by the project site. Also, the following mitigation measure needs to be followed by the project proponent.

5.8.1.1.2 Mitigation Measures

Localized air pollution is predicted, and higher pollutant concentrations can be observed close to locations where construction is occurring rapidly. To reduce the impact of construction activities on air quality, the following describe below mitigation measures need to be implemented:

(a) Sprinkle with water on un-paved road and any areas that are currently under construction at least four time per day especially during dry season because of wet suppression can greatly reduce dust emission up to 70%.
(b) In addition, spray water on un-paved road and construction area at least twice per day during wet and cool seasons.
(c) Maintain a minimum of 60 cm of free board and cover any vehicles transporting soil, sand, and other loose materials.
(d) Maintain the interior roads compact to reduce dust emission from moving vehicles.
(e) The speed limit for trucks will be reduced from 30 km/h to 15 km/h to minimize dust emissions by 50%.
(f) Regular checking the pave, to the extent possible, unpaved access roads, parking areas, and staging areas at construction sites.
(g) The flooding caused by the silt into public roadways can be prevented by using sandbags or other erosion control measures.
(h) Stockpiles that are exposed should be sealed, covered, sprinkle with water twice a day, or have non-toxic soil binders used (dirt, sand, etc.).
(i) By properly operating and maintaining vehicles and other oil-operated machinery, it is possible to maintain and minimize the emission of particulate matter (PM), SO2, NO2, and hydrocarbons from moving vehicles.
(j) Consistent use by the contractor of equipment/vehicles that are properly created, maintained, and operated, including the use of proper engine fuel mixes, routinely serviced exhaust emission systems, and proper engine tuning.
(k) Periodically inspect all machinery, including heavy equipment and pumps, as well as the engines of vehicles. Engines that are properly maintained, lubricated, and operated emit reduced smoke.
(l) Avoid running the engines of vehicles and equipment unnecessarily.
(m) On construction equipment, install diesel particulate filters.
(n) Suspend construction activities that cause visible dust plumes to extend beyond the construction site.
(o) Maintain a record of the monthly fuel consumption.
(p) In order to prevent excessive emission of sulfur dioxides, the contractor shall, if possible, purchase diesel fuel with less than 5% sulfur content by weight.

The environmental impact will be predicated for air quality with post implementation of relevant management and mitigation measures (post-mitigation) during

construction phase. According to the result, the significance of classes of air quality with post- mitigation measures is low as shown in Table 5-18.

Table 5-18 Significance Classes of Air Quality During Construction Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Dust and Gas emission from construction activities	1	3	2	2	-1	-2	2	-4	Low	Negative

5.8.1.1.3 Impact Prioritization

The environmental impact (post-mitigation) on air quality will be given priority under the impact prioritization. The goal of this prioritizing factor is to focus the decision-making authority's attention to the impacts and issues that are of higher priority and significance rather than to reduce the impact ratings. When applying the prioritizing factors (PF) to the environmental impact score, the appropriate suggested management/mitigation impacts must be implemented.

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. The ultimate objective of the prioritization factor (PF) is to be able to increase the environmental impact rating by an entire ranking class following mitigation. As a result, the final environmental significance rating for ambient air quality during construction phase is low as shown in Table 5-19.

Table 5-19 Final Environmental Significance Rating of Air Quality During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Dust and Gas emission from construction activities	1	2	1	4	Medium	1.5	-6	Low	Negative

5.8.1.2. Operation Phase

5.8.1.2.1 Significance of Impact

Gas emissions will be generated during project operation from vehicle traffic. Most CO and CO_2 emissions typically come from automobile exhausts. Ambient CO concentrations often follow the spatial and temporal distributions of automobile traffic since CO is a non-reactive air contaminant that dissipates rather quickly.

Dust is generated by the general transportation of the project during operation phase. Number of vehicles is expected to be large due to the increasing visitors in and around of the project site. The environmental impacts of major air pollutants from gas emission and potential impact from dust emission are described as Table 5-20 and Table 5-21 especially. The environmental impact (EI) will be determined for air quality without relevant management and mitigation measures (pre-mitigation) during operation phase as shown in Table 5-22.

Table 5-20 Environmental Impacts of Major Air pollutants from Gas Emission

Emission	Environmental Impacts
Oxides of NO_2	Even in relatively low amounts, NO2 is a poisonous gas. Acidic species, which can be deposited by wet and dry processes, are also formed in part by NOx. When combined with VOCs in the atmosphere illuminated by the sun, NO2 can also promote the creation of ozone at ground level. The relatively harmless species NO is of relevance because it serves as a precursor to NO2.
Sulphur Dioxide – SO_2	It is recognized that SO2 contributes to acid deposition, both wet and dry, which may have an effect on ecosystems. SO2 is a harmful gas. The direct effect on health consequences that could result in respiratory disease.
Particulates $PM_{10}/PM_{2.5}$	Particulate matter is a complex mixture of solid or liquid organic and inorganic materials found in the atmosphere. The inhalation and deposit of particulate matter within the respiratory passages has a number of negative health repercussions. Deep lung penetration is possible for PM10 (i.e., particulate matter with a diameter of less than 10 μg/m3). There is a connection between excessive short-term mortality and morbidity rates and increased PM10 concentrations.
Carbon Monoxide – CO	Colorless and odorless carbon monoxide (CO) is a gas that is slightly less dense than air. When breathed in, the gas enters the bloodstream and reacts with the blood's hemoglobin to create carboxyhemoglobin (COHb). Hemoglobin has an affinity for CO that is more than 200 times larger than its affinity for oxygen. As a result, less O2 can bind with hemoglobin, which makes CO act poisonously.

Table 5-21 Potential Impacts from Dust Emission

Target	Potential Impact
Human Health	• Asthma • Nose and throat diseases • Eyes irritation • Skin irritation
Environment	• Low visibility and haze formation
Infrastructure	• Grime deposits • Metal corrosion • Material deterioration

Table 5-22 Significance Classes of Air Quality During Operation Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Dust and Gas emission from operation activities	2	5	3	3	-1	-3.25	3	-9.75	Medium	Negative

The significant classes of air quality pre- mitigation measures are calculated based on operation activities. Assumed that for extend of impact is within site boundary area because the air quality can be chiefly impacted by the emission of the vehicular movement and visitor's car within the project area. But this impact is a permanent period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way and it is reversible only by incurring significant time and cost. Additionally, there is a medium possibility that the impact will happen (> 50% and > 75% probability).

According to the assessment, mitigation measures are needed due to the significant impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.1.2.2 Mitigation Measures

During operation phase, the significant impact on ambient air quality is moderate impact. The basic infrastructures in the project area such as dike wall, drainage channels, roads, power supply facilities, water supply facilities and communication facilities will be maintained during operation phase. Therefore, this impact to be reduced the following mitigation measures will be follow:

a) Water should be sprayed as suppressants to increase the moisture content at least one time per day (it can be applied in the morning or evening).
b) Regular maintenance of equipment and vehicles, particularly when operating commercial vehicles in project zones.
c) Limit traffic speeds on any unpaved roads to 30 km/h.
d) Consistent preservation and daily checking of the basic infrastructure, wastewater system, sludge disposal site and solid waste collection system.
e) Regular maintain the installed ventilation system especially air-cooling system, fans, and window in the office room.
f) Regular monitoring for air quality parameters ($PM_{2.5}$ and PM_{10}, TSP, SO_2, NO_2, CO_2, VOC, O_3) mentioned in the monitoring program.
g) Grow efficient air-purifying plants, e.g., areca palm, Aloe Vera, fast-growing tree species and so on.
h) Enforce PPE to employees who are working in the project area, loading/ unloading area that it must wear the 95 mask or surgical mask in their working time.

The environmental impact will be predicated for air quality with post implementation of relevant management and mitigation measures (post-mitigation) during

operation phase. According to the result, the significance of classes of air quality with post-mitigation measures is low as shown in Table 5-23.

Table 5-23 Significance Classes of Air Quality During Operation Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Dust and Gas emission from operation activities	1	5	2	2	-1	-2.5	2	-5	Low	Negative

5.8.1.2.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for ambient air quality during operation phase is low as shown in Table 5-24.

Table 5-24 Final Environmental Significance Rating of Air Quality During Operation Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Dust and Gas emission from operation activities	1	2	1	4	Medium	1.5	-7.5	Low	Negative

5.8.1.3. Greenhouse Gas Emission

A greenhouse gas (abbreviated as GHG) is a gas that absorbs radiant energy at thermal infrared wavelengths. Greenhouse gases cause the greenhouse effect by trapping some of the heat a planet's surface radiates in response to light from its host star (which is the sun in the case of planet Earth). Basically, in calculating greenhouse gas emissions, carbon dioxide, Methane and nitrous oxide are calculated.

In implementation of Amarapura Urban Development project, various types of vehicles and machineries such as sand ships, vessels, etc. are used. The current usage of sand ships and ships are 58 Nos and will be increased to 119 Nos. The current usage of vehicle/ machinery is 48 Nos and will increase to 65 Nos as well as the current usage of vessel are 21 Nos and will increase to 42 Nos. Diesel fuel is used for all type of vehicles and machineries. The fuel consumption for the vehicles is a lot specifically 3,840 liters/ per day for sand ships and ships, 1,449 liters/ per day for vehicle/ machinery and 2,439 liters/ per day for vessel.

Main source of the gas emission is from the vehicles and machineries usage. Therefore, greenhouse gas emission for the Amarapura Urban Development project is

calculated as the mobile combustion emission. GREENHOUSE GAS PROTOCOL Calculation Tool is used to calculate the greenhouse gas emission for the project.[1] IPCC's Guidelines for National Greenhouse Gas Inventories is based for calculating of greenhouse gas as the data source. The method used in the calculation tool is follow.

Emissions $_{GHG, Fuel}$ = Fuel Consumption $_{Fuel}$ * Emission Factor $_{GHG, Fuel}$

The current result of the Greenhouse gas emission calculation according to the fuel usage in sand ships and ships is 10.48 Tonnes CO_2e/unit per day. The current results of greenhouse gas emission for the vehicle/ machinery and vessel are 3.913 Tonnes CO_2e/unit per day and 6.656 Tonnes CO_2e/unit per day respectively.

5.8.1.4. Dust Emission

Calculating dust emission involves estimating the amount of dust released into the air from various sources. This calculation is important for understanding air quality, environmental impact, and potential health hazards. Use the emission factor and activity level to calculate the dust emissions. The formula is as follow.

$$C = \frac{Q}{d \times W \times M}$$

Where,

C = Dust Concentration (mg/m^3)

Q = Emissions at Source (mg/s)

d = Width (the smallest dimension is used for worst case scenario) (m) = 500 m

W = Average maximum wind speed (m/s)

M = Mixing Height (m)

From USEPA 1975, Take Area = 1000 hectares = 2470 acres

$$Q(mg/s) = \frac{40\ (kg/acre/day) \times area \times 106/(mg/kg)}{24 \times 60 \times 60(s/d)}$$

$$= \frac{40 \times 2470 \times 10\text{^}6}{24 \times 60 \times 60}$$

= 1143519 (mg/s)

From Data collection, W = 1.7 m/s = 2 m/s

$$C = \frac{1143519}{500 \times 2 \times M}$$

[1] https://ghgprotocol.org/calculation-tools

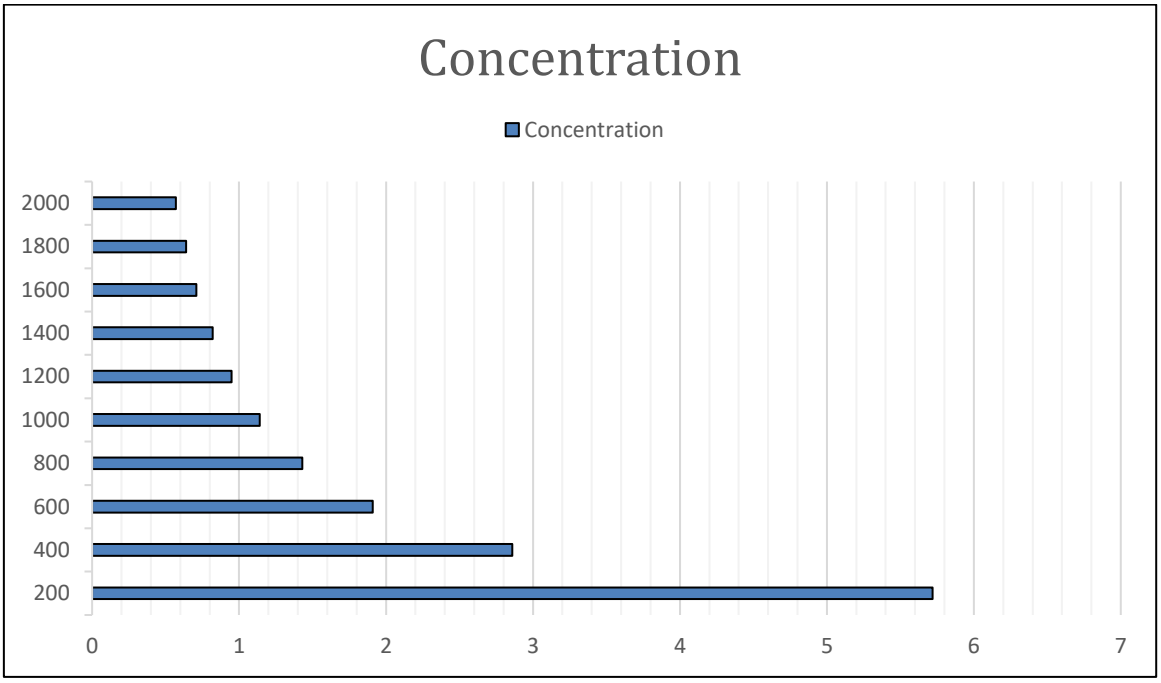


Figure 5-3 Concentration Graph

5.8.1.5. Particulate Matter Emission

Calculating particulate matter (PM) emissions involves estimating the release of solid particles suspended in the air. Particulate matter emissions can come from various sources, including combustion processes, construction activities, vehicular emissions, and natural sources. Use the emission factor and activity level to calculate the particulate matter emissions. The formula is as follow.

$$Em = Fc \times EF$$

Where, Em = Emission rate

Fc = Fuel consumption

EF = Emission factor

A large portion of the emissions results from equipment traffic over temporary roads at the construction site.

Table 5-25 List of Emission Result

Construction Phase	Dust Generating Activities	Emission Sources
Demolition and Debris	Drill	Tractor

Removal		Loader backhoes Bulldozer Excavator Scraper Compactor Grader Fork Lifts Generator Hole Trencher Cement Mixer Crane
	Blasting	
	Implosion	
	Land Clearing	
	Loading & Unloading	
	Transporting	
Site Preparation (Earth Moving)	Bulldozing	
	Scrapers unloading topsoil	
	Scrapers in travel	
	Scrapers removing topsoil	
	Loading & Unloading	
	Dumping	
	Compacting	
	Motor Grading	
General Construction	Vehicular Traffic	
	Crushing	
	Screening	
	Material Transfers	
	Miscellaneous	

$$E = k(s/12)^{a} (W/3)^{b}$$

E= size specific emission factor

s = surface material silt content

W=mean vehicle weight

a , b, k = empirical constant

For this calculation,

Taken as s = 8.5 %, W = 6.515 Ton, a,b and k are constants and a= 0.9, 0.9 and 0.7

b = 0.45

k= 0.15, 1.5, 4.9

After calculation, For $PM_{2.5,}$ E = 0.1559

PM_{10}, E = 1.559

PM $_{30}$, E = 5.457

Table 5-26 Fuel Consumption depending on types of vehicles

Vehicles	Wt. (Ton)	Units	Fuel Consumption (liter per hour)	Total Fuel Consumption
Excavator	30	2	20	40
Excavator	25	2	20	40
Excavator	21	2	20	40
Dozer	16	2	24.6052	49
Roller Compactor	14	2	18.7	37
Grader	14	1	20	20
Wheel Loader	11	1	12	12
Dump Truck		10	23.47	235
Trailer		2	2.89	5.78

Table 5-27 Gaseous Emission on various types of vehicles

Vehicles	Emission		
	PM $_{2.5}$	PM $_{10}$	PM $_{30}$
Excavator (30 T)	6.236	62.36	218.28
Excavator (25 T)	6.236	62.36	218.28
Excavator (21 T)	6.236	62.36	218.28
Dozer	7.6391	76.391	267.393
Roller Compactor	5.7683	57.683	201.909
Grader	3.118	31.18	109.14
Wheel Loader	1.8708	18.708	65.484
Dump Truck	36.6365	366.365	1282.395

Trailer	0.9	9	31.54146

5.8.2. Impact on Water Pollution

5.8.2.1. Surface Water and Ground Water

Surface water and ground water may be impacted by the project due to waste water released from the construction activities and operation process. The process of collecting sample water in the project area was carried out from five locations for surface water and two locations for groundwater of the existing tube wells. The water samples are sent to the laboratory for measuring the water quality parameters.

5.8.2.1.1 Construction Phase

1) Significance of Impact

The surface water body can be affected by muddy water and polluted water from construction activities such as land reclaiming and leveling, retaining structure. Surface water quality could be affected by several factors during construction on site. Construction activities may encourage soil erosion and increase the sediment loads of nearby streams.

Surface water pollution is brought on by workers' domestic wastewater discharge. If they are not adequately managed, all the construction waste could pollute surface waters. During the rainy season, drainage, and seepage from disposal sites for construction waste could pollute surface waters.

Groundwater distribution and flow may alter because of excavation and site drainage. Groundwater and quality may be significantly impacted by construction activities as well. Oil and fuel leaks have the potential to go into the groundwater. The site could require that it be drained to create the perfect situations for the engineering work to take place, which would temporarily change ground flow. Moreover, during construction activities, contaminated soil from prior land use may be disturbed, resulting in the entry of contaminants like heavy metals into ground water. The environmental impact (EI) will be determined for water pollution without relevant management and mitigation measures (pre-mitigation) during construction phase as shown in Table 5-28.

Table 5-28 Significance Classes of Water Pollution During Construction Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Surface water and ground water pollutant from construction activities	3	3	3	3	-1	-3	3	-9	Medium	Negative

The significant classes of water pollution during pre- mitigation measures are calculated based on construction activities. Assumed that for extend of impact is the area within 5 km of the site because of the water pollution may be affected by the muddy water and polluted water from construction activities can flow into the Ayeyarwady river. But this impact is a medium-term period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way and it is reversible only by incurring significant time and cost. Additionally, there is a medium possibility that the impact will happen (> 50% and > 75% probability). According to the assessment, mitigation measures are needed due to this impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

2) Mitigation Measures

During construction phase, the potential impact on water pollution (surface water and ground water body) can be impacted by muddy water and polluted water from construction activities. The significant impact on water pollution is moderate impact. But, this impact to be preserved the following mitigation measures will be follow:

a) Access roads should be constructed with the proper materials and avoid riparian areas.

b) During the construction period, a suitable water management system is implemented, such as effective land drainage and the usage of artificial ponds for receiving site runoff to reduce the effect of runoff on surrounding watercourses.

c) Prevent producing excessive wastewater.

d) If at all possible, use a water meter to reduce the generation of unnecessary wastewater.

e) Systematic measures will be taken to control seepage water from the waste disposal facility.

f) Manage the fuel, oil, and lubricant leaks from the construction site.

g) To ensure that sewage does not leak out of sewage tanks.

h) To connect City Development Committee and dispose the sewage water produced from the demolition of toilets and sewage water produced from temporary toilets.

The environmental impact will be predicated for water pollution with post implementation of relevant management and mitigation measures (post-mitigation) during construction phase. According to the result, the significance of classes of water pollution with post- mitigation measures is low as shown in Table 5-29.

Table 5-29 Significance Classes of Water Pollution During Construction Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N	Probability (P)	Environmental Impact Score	Significance Classes	Status of Impact

	E	D	I	R	N	C		(EI = C x P)		
Surface water and ground water pollutant from construction activities	2	3	2	2	-1	-2.25	2	-4.5	Low	Negative

1) Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for water pollution during construction phase is low as shown in Table 5-30.

Table 5-30 Final Environmental Significance Rating of Water Pollution During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Surface water and ground water pollutant from construction activities	1	3	3	7	Medium	1.5	-6.75	Low	Negative

5.8.2.1.2 Operation Phase

1) Significance of Impact

During operation phase, wastewater from the households and urban infrastructures of the project will enter into nearby surface water body. Surface water may have been polluted by maintenance vehicles. It might also have an impact on the neighborhood close to the project site. In addition, domestic wastewater from usage, toilets, storm water and sewage water can be found at the office building of the project area. The storm water can be polluted by roofs contaminated with dust, open space and work areas etc. The surface water is flow into the drainage channels of the project area. Diseases caused by bacteria, typhoid and cholera, etc., are introduced by the wastewater. If they are not adequately managed, all of the waste storage area and waste water treatment may be polluted by surface waters body. The environmental impact (EI) will be determined for water pollution without relevant management and mitigation measures (pre-mitigation) during operation phase as shown in Table 5-31.

Table 5-31 Significance of Classes of Water Pollution During Operation Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation activities	3	5	4	4	-1	-4	5	-20	High	Negative

The significant classes of water pollution pre- mitigation measures are calculated based on operation activities. Assumed that for extend of impact is the area within 5 km of the site because of the water pollution may be affected by the operation/maintenance activities in the project area. Also, a water treatment system will be installed in the project area, and it is a permanent period where natural, cultural, or social functions or processes are altered to the extent that it will temporarily cease. Additionally, the impact is reversible only by incurring prohibitively high time and cost and it is a definite probability that the impact will occur.

Moreover, according to the assessment, mitigation measures are needed because of significant impact is high. Therefore, the following mitigation measure needs to be followed by the project proponent.

2) Mitigation Measures

The significance of impact on water pollution may be affected by operation/maintenance activities. The impact level on water pollution is major. Therefore, project proponent must follow the mitigation measure as to reduce the impacts in mention below.

a) Reduce the amount of water utilized for domestic uses at the project area to a minimum.
b) Avoid generating unnecessary wastewater.
c) Use water meter to control the unnecessary wastewater production if possible.
d) Separate the drainage and pipeline system for sewer line and surface runoff.
e) Regularly check the septic tank to avoid leakage of sewage.
f) Control oil and grease generating from the operation/maintenance activities.
g) Regular cleaning and checking of all drainage channels in the project area.
h) All drainage systems are covered and liquid wastes are disposed to the septic to avoid soil contamination.
i) Make wastewater filtration system before disposing of into the drainage channel.

The environmental impact will be predicated for water pollution with post implementation of relevant management and mitigation measures (post-mitigation) during operation phase. According to the result, the significance of classes of water pollution with post- mitigation measures is medium as shown in Table 5-32 and Table 5-23.

Table 5-32 Significance of Classes of Water Pollution During Operation Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation activities	2	5	3	3	-1	-3.25	3	-9.75	Medium	Negative

2) Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for water pollution during operation phase is low as shown in Table 5-33.

Table 5-33 Final Environmental Significance Rating of Water Pollution During Operation Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Operation activities	1	3	3	7	Medium	1.5	-14.6	Low	Negative

5.8.2.2. Water Consumption

5.8.2.2.1 Construction Phase

1) Significance of Impact

During construction phase, water consumption will be required for construction activities. Construction uses a little amount of water, and the effects are regarded as minor. Ground and surface water bodies will provide the necessary water. The environmental impact (EI) will be determined for water consumption without relevant management and mitigation measures (pre-mitigation) during construction phase as shown in Table 5-34.

Table 5-34 Significance Classes of Water Consumption During Construction Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Construction activities	3	3	3	3	-1	-3	4	-12	Medium	Negative

The significant classes of water consumption during pre- mitigation measures are calculated based on construction activities. Assumed that for extend of impact is the area within 5 km of the site because of the water consumption may be affected by the construction activities in the project area. But this impact is a medium-term period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way and it is reversible only by incurring significant time and cost. Additionally, there is a high possibility that the impact will happen (> 75% probability). According to the assessment, mitigation measures are needed due to this impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

2) Mitigation Measures

Although the construction activities will have a minor impact on local water resources, the highest possible efficiency of water use shall be ensured by;

a) Encouraging employees to practice water conservation

b) By recycling water whenever possible, such as using wash water to dampen down unsealed roads and reduce the emission of airborne dust.

The environmental impact will be predicted for water consumption with post implementation of relevant management and mitigation measures (post-mitigation) during construction phase. According to the result, the significance of classes of water consumption with post- mitigation measures is low as shown in Table 5-35 and Table 5-29.

Table 5-35 Significance Classes of Water Consumption During Construction Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Construction activities	2	3	2	2	-1	-2.25	2	-4.5	Low	Negative

3) Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for water consumption during construction phase is low as shown in Table 5-36.

Table 5-36 Final Environmental Significance Rating of Water Consumption During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Construction activities	1	2	3	6	Medium	1.5	-6.75	Low	Negative

5.8.2.2.2 Operation Phase

1) Significance of Impact

During operation phase, large amount of water is required during operation for different purposes like use in laundry, kitchen, watering at lawn and garden, swimming pool etc. Required water is extracted from ground and surface water bodies. The environmental impact (EI) will be determined for water consumption without relevant management and mitigation measures (pre-mitigation) during operation phase as shown in Table 5-37.

Table 5-37 Significance of Classes of Water Consumption During Operation Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation activities	3	5	3	4	-1	-3.75	5	-18.75	High	Negative

The significant classes of water consumption pre- mitigation measures are calculated based on operation activities. Assumed that for extend of impact is the area within 5 km of the site and it is a permanent period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way. Additionally, the impact is reversible only by incurring prohibitively high time and cost and it is a definite probability that the impact will occur. Moreover, according to the assessment, mitigation measures are needed because the significant impact is high. Therefore, the following mitigation measure needs to be followed by the project proponent

2) Mitigation Measures

The operation phase will have an impact on local water resources, the highest possible efficiency of water use shall be ensured by

a) Encouraging residents to practice water conservation.

b) By reusing water whenever possible, such as by dampening down unsealed roadways to reduce the production of airborne dust.

c) For the project area, the project proponent will set up a water treatment system and regular water supply system. The committee that oversees the residents' water use and the water delivery system will be established by the project's promoter.

The environmental impact will be predicated for water consumption with post implementation of relevant management and mitigation measures (post-mitigation) during operation phase. According to the result, the significance of classes of water consumption with post- mitigation measures is medium as shown in Table 5-38 and Table 5-23.

Table 5-38 Significance of Classes of Water Consumption During Operation Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation activities	2	5	3	3	-1	-3.25	3	-9.75	Medium	Negative

1) Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for water consumption during operation phase is low as shown in Table 5-39.

Table 5-39 Final Environmental Significance Rating of Water Consumption During Operation Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Operation activities	2	3	3	8	Medium	1.5	-14.6	Low	Negative

5.8.3. Impact on Waste Pollution

The following have been recognized as the project's sources of both liquid and solid waste generation:

- ❖ Construction activities and workers and contractors
- ❖ Waste generation from Households and commercial activities
- ❖ Waste caused by the project operation like chemicals and other hazardous wastes

5.8.3.1. Construction Phase

5.8.3.1.1 Significance of Impact

The generation of solid and liquid waste during the construction phase affects the identification of waste pollution. Littering (wood and metal debris, concrete blocks, empty cement bags, empty paint containers and canisters, plastics from extension of electricity cables, etc.), which can be prevented by good housekeeping and behavioral practices, may also have an impact on waste pollution during the construction phase. In addition, hazardous

waste should be strictly avoided, and it should be disposed of systematically and with the greatest of precautions. The majority of the development area is covered in sandy soil, which has a high rate of infiltration and absorption. Waste pollutants that are leached will therefore easily bind to the soil. With a decreasing viscosity and surface tension, waste spillages may either become retained within the top soil layer or pierce to the subsurface formations. The environmental impact (EI) will be determined for waste pollution without relevant management and mitigation measures (pre-mitigation) during construction phase as shown in Table 5-40.

Table 5-40 Significance Classes of Waste Pollution During Construction Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
solid and liquid waste generation	2	3	3	3	-1	-2.75	4	-11	Medium	Negative

The significant classes of waste pollution during pre- mitigation measures are calculated based on construction activities. Assumed that for extend of impact is within the site boundary because of the water consumption may be affected by the construction activities in the project area. But this impact is a medium-term period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way and it is reversible only by incurring significant time and cost. Additionally, there is a high possibility that the impact will happen (> 75% probability). According to the assessment, mitigation measures are needed because this impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.3.1.2 Mitigation measure

The significance of impact on solid and liquid waste pollution may be affected by construction activities and the impact level is moderate. Therefore, project proponent must follow the mitigation measure as to reduce the impacts in the following below.

a) Dispose the wastes from construction phase as wet waste, dry waste, hazardous waste in orderly manner.

b) As part of the environmental policy, the loads of all waste streams will be monitored and reported on a monthly basis.

c) Construction debris, packaging materials, scraps, and metal fragments are correctly disposed of without being left lying around on the ground.

d) The project's proponent and contractor are responsible for supervising the waste's transfer from the site to the disposal facility.

e) To prevent garbage loss during transportation, dump trucks may not be fully loaded.

f) To make recycling, reuse, and disposal easier and to stop interactions between different forms of garbage, waste is separated and avoided mixing, such as organic waste (food scraps), non-hazardous waste (metal, glass, concrete, plastic, etc.), inert waste (cleaned soil), and hazardous waste (Paints, solvents, oils, batteries, medical waste).

g) For the safe collection, segregation, and management of all waste streams collected, household and general garbage must be separated on site into combustible (paper, food, cardboard, and wood) and non-combustible (metals, glass, rubble) streams using appropriately designated containers.

h) To set up temporary disposal tanks and trash cans in the project area.

i) Food scraps can be used as organic fertilizer to produce plants and feed animals.

j) When handling the hazardous waste, wear rubber gloves. After handling chemicals, wash your hands with soap.

k) Informing and training employees on how to handle chemicals.

l) Creating warning sign boards for the area where hazardous and chemical wastes are stored.

m) No wastewater or sanitary waste that hasn't been treated shall be dumped on the ground.

n) To prevent wastewater overflow, mixed wastewater must be stored in holding tanks, and sewage must be transported away whenever the tanks are filled.

The environmental impact will be predicted for waste pollution with post implementation of relevant management and mitigation measures (post-mitigation) during construction phase. According to the result, the significance of classes of waste pollution with post- mitigation measures is low as shown in Table 5-41.

Table 5-41 Significance Classes of Waste Pollution During Construction Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
solid and liquid waste generation	2	3	2	2	-1	-2.25	3	-6.75	Low	Negative

5.8.3.1.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for waste pollution during construction phase is low as shown in Table 5-42.

Table 5-42 Final Environmental Significance Rating of Waste Pollution During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
solid and liquid waste generation	1	3	2	6	Medium	1.5	-10.12	Low	Negative

5.8.3.2. Operation Phase

5.8.3.2.1 Significance of Impact

Non-Hazardous Waste

In the operation phases, the solid wastes and liquid wastes are generated from operation, maintenance process and worker of the project area such as organic, plastic, tissues, glass, sanitary pads and leftovers are generated from workers. Sanitary pads are a type of biological or plastic waste that generates when women use toilets. This waste may cause environmental and social impacts if the process is not managed systematically.

Moreover, solid waste has the adverse effect (blocking the drainage channels) as a result flooding and groundwater pollution can be faced. Some liquid and solid wastes may have negative effects on humans, plants, and other animals. Such toxic wastes have the potential to contaminate the soil, surface waters, and ground waters.

Hazardous Waste

The chemical containers for storage (PES, Ammonium Hydroxide) must be organized and kept separate. Additionally, the planned project location can produce hazardous wastes such as metal scraps, broken glass rods, abandoned electrical containers, and motor oil. In the event that the remainder spills into water bodies that may contaminate groundwater, they can float into watercourses. Used diesel filters and containers have the potential to contaminate soil due to leftover spillage. As a result, surface water bodies (such as rivers and canals) become contaminated by subterranean water. To reduce the solid waste impacts, project proponent must follow the recommendations as mention below. The environmental impact (EI) will be determined for waste pollution without relevant management and mitigation measures (pre-mitigation) during operation phase as shown in Table 5-43.

Table 5-43 Significance Classes of Waste Pollution During Operation Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
solid and liquid waste generation	3	5	3	4	-1	-3.75	4	-15	Medium	Negative

The significant classes of waste pollution pre- mitigation measures are calculated based on operation activities. Assumed that for extend of impact is the area within 5 km of the site and it is a permanent period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way. Additionally, the impact is reversible only by incurring prohibitively high time and cost and there is a high possibility that the impact will happen (> 75% probability). Moreover, according to the assessment, mitigation measures are needed because the significant impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.3.2.2 Mitigation measure

The significance of impact on solid and liquid waste pollution may be affected by operation and maintenance activities and the impact level is moderate. Therefore, project proponent must follow the mitigation measure as to reduce the impacts in the following below.

Mitigation Measures

a) Provide a separate place for storage where waste can be collected and disposed of at the allowed damping place.
b) Build a suitable tent or safe disposal area to avoid liquid leakage from it.
c) The project supervisor is responsible for supervising the transportation of waste from the site to the disposal facility.
d) Avoid filling vehicles with too much waste in order to prevent loss of waste during transportation.
e) To separate hazardous and non-hazardous waste, use designated bins.
f) Waste must be systematically disposed of into containers after being sorted by type.
g) The female employee's sanitary pad needs to be packed in paper and disposed of in a timely manner in the trash cans.
h) No sanitary waste or wastewater that has not been treated will be dumped on the ground.
i) Recyclable waste bins need to be available, and recycling trash needs to be sorted properly as a habit.
j) As part of the spill response strategy, the chemicals will be soaked in sawdust and sand.
k) Reuse, reduce, and recycle (or 3R) should be encouraged among employees through environmental education programs and awareness-raising efforts.
l) Chemical wastes should be appropriately disposed of and collected in separate bins (chemical bags, containers, etc.).
m) Awareness to workers on how to deal with hazardous chemicals and waste.
n) Prohibition of incineration wastes in the project area.

The environmental impact will be predicated for waste pollution with post implementation of relevant management and mitigation measures (post-mitigation) during

operation phase. According to the result, the significance of classes of waste pollution with post- mitigation measures is low as shown in Table 5-44.

Table 5-44 Significance Classes of Waste Pollution During Operation Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
solid and liquid waste generation	2	5	2	3	-1	-3	2	-6	Low	Negative

5.8.3.2.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for waste pollution during operation phase is low as shown in Table 5-45.

Table 5-45 Final Environmental Significance Rating of Waste Pollution During Operation Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Operation activities	2	3	3	8	Medium	1.5	-9	Low	Negative

5.8.4. Impact on Noise and Vibration

The noise and vibration impact level have been evaluated as the following:

- Earth work and construction activities, and equipment from construction phase
- Transportation, packing slot, residential, market and commercial area from operation phase

5.8.4.1. Construction Phase

5.8.4.1.1 Significance of Impact

The noise and vibration generate from loading and unloading activities, use of heavy machinery and vehicles, dyke wall and road construction, and other civil works during the construction phase. The main sources of noise generate from transportation activities which is delivery of raw material and loading and unloading process. Typical noise levels associated with trucks are reported at 74 dBA according to the British Standard for Noise and Vibration Control on Construction and Operation Sites (BS5228:1997). These levels are normal in general construction sites (that can go up to 85-90 dBA).

Moreover, noise generate from the use of heavy machinery and equipment associated with the construction activities mainly sand filling, site leveling and excavation. The impacts are also temporary in nature. Most construction phases would generate average noise levels that would be about 10 to 19 dBALeq (h) higher than ambient daytime or nighttime traffic noise when these activities occurred within about 20 meters of an adjacent land use. Pile driving activities would generate average noise levels approximately 26-29 dBA higher than ambient daytime or nighttime noise conditions. Maximum instantaneous noise levels generated by construction would typically be 5 to 10 dBA above existing maximum noise levels generated by traffic with the exception of construction phases including the use of a hoe ram or impact pile driver when maximum instantaneous noise levels could exceed existing conditions by 20 to 25 dBA. The environmental impact (EI) will be determined for noise and vibration without relevant management and mitigation measures (pre-mitigation) during construction phase as shown in Table 5-46.

Table 5-46 Significance Classes of Noise and Vibration During Construction Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
process and ships, dike wall construction and road construction, and other civil works	3	3	4	4	-1	-3.5	5	-17.5	High	Negative

The significant classes of noise and vibration during pre- mitigation measures are calculated based on construction activities. Assumed that for extend of impact is the area within 5 km of the site because of the noise pollution may be affected by the construction activities in the project area. But this impact is a medium-term period where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease, and it is reversible only by incurring prohibitively high time and cost. Additionally, there is a definite possibility that the impact will occur. According to the assessment, mitigation measures are needed because this impact is high. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.4.1.2 Mitigation measure

The significance of impact on noise and vibration may be affected by construction activities and the impact level is major. Therefore, project proponent must follow the mitigation measure as to reduce these impacts in the following below.

a) Contractor will take measures to reduce noise levels from construction machinery that exceed the NEQG guideline limitations.

b) To prevent disturbing the surrounding area, movements of trucks and other construction equipment that generate loud noises must be limited at night. Truck drivers should be instructed not to use their horns at night and to stop playing loud music.

c) Avoiding the construction activities at night within 150 meters of sensitive land uses where feasible.

d) Proper soundproofing boundary walls must be constructed in locations where asphalt/concrete plants generate noise and are adjacent to any locality within 35 meters of residences should be strictly prohibited.

e) Avoid staging of construction equipment within 60 meters of residences and locate all stationary noise-generating construction equipment, such as air compressors and portable power generators, as far practical from noise sensitive receptors.

f) Substitution of low noise devices and equipment.

g) Shutting down unused vehicles and machinery.

h) Regular inspection and rotation of equipment and machinery.

i) Reduce speed when driving vehicles and machinery.

j) Avoid vehicles idling during loading/ unloading operations.

k) Providing the workers in the construction area appropriate hearing protection, such as ear plugs or earmuffs, and training them in how to use it.

l) Contractors must adhere to the provided work schedule, keep noisy operations away from sensitive areas, perform routine maintenance and repairs, and strictly follow operation procedures.

The environmental impact will be predicted for noise and vibration with post implementation of relevant management and mitigation measures (post-mitigation) during construction phase. According to the result, the significance of classes of noise and vibration with post- mitigation measures is medium as shown in Table 5-47.

Table 5-47 Significance Classes of Noise and Vibration During Construction Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
process and ships, dike wall construction and road construction, and other civil works	2	3	3	3	-1	-2.75	4	-11	Medium	Negative

5.8.4.1.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for noise and vibration during construction phase is medium as shown in Table 5-48.

Table 5-48 Final Environmental Significance Rating of Noise and Vibration During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
process and ships, dike wall construction and road construction, and other civil works	1	3	2	6	Medium	1.5	-16.5	Medium	Negative

5.8.4.2. Operation Phase

5.8.4.2.1 Significance of Impact

Noise can be generated from the project's operation and maintenance activities such as transportation, packing slot, residential, market and commercial area and other activities. In addition, the noise generation from operation of machinery such as pumps, generators and sludge thickening rooms generators.

The negative affect of noise can impact on the employees for occupational health and safety during operation phase including auditory problems, health impacts associated with exposure to noise include non-auditory repercussions such as fatigue, stress, emotional disturbances, vertigo, and vasoconstriction of the blood vessels in the extremities. If administrative or engineering controls do not reduce levels to the acceptable limit, hearing protection must be provided to employees by the employer. The environmental impact (EI) will be determined for noise and vibration without relevant management and mitigation measures (pre-mitigation) during operation phase as shown in Table 5-49.

Table 5-49 Significance of Classes of Noise and Vibration Pre-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation and Maintenance activities	3	5	3	3	-1	-3.5	4	-14	Medium	Negative

The significant classes of noise and vibration pre- mitigation measures are calculated based on operation activities. Assumed that for extend of impact is the area within 5 km of

the site and it is a permanent period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way. Additionally, the impact is reversible only by incurring significant time and cost and there is a high possibility that the impact will happen (> 75% probability). Moreover, according to the assessment, mitigation measures are needed because the significant impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.4.2.2 Mitigation measure

The significance of impact on noise pollution may be affected by operation and maintenance activities and the impact level is moderate. Therefore, project proponent must follow the mitigation measure as to reduce the impacts in the following below.

a) Use equipment and machines which generate low noise levels.
b) Regular maintenance for noise generation machines such as unwinding machines from the operation process.
c) Record and inspection maintenance for each machine and change the good quality product (if necessary).
d) Provide adequate ear protection (ear plugs or muffs, Figure 5-4) to workers working in the excessive noise areas. To make sure workers wear ear plug two times a day with 1hour period each time.
e) No employee should be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hour per day without hearing protection. In addition, no unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dB (C).
f) Follow noise control hierarchy (Figure 5-5).
g) Arrange employees on a rotating basis in noisy places.

Figure 5-4 Noise control Equipment

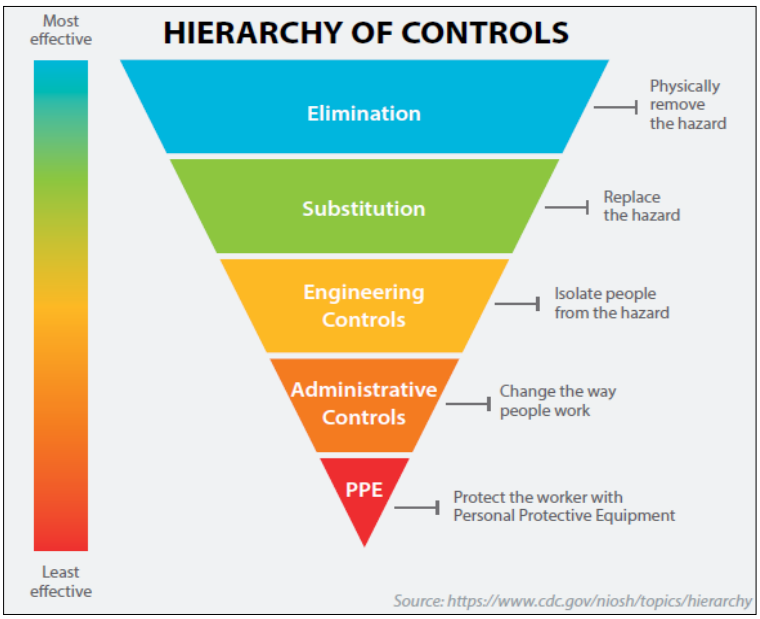


Figure 5-5 Noise control Hierarchy

The environmental impact will be predicated for noise and vibration with post implementation of relevant management and mitigation measures (post-mitigation) during operation phase. According to the result, the significance of classes of noise and vibration with post- mitigation measures is low as shown in Table 5-50.

Table 5-50 Significance of Classes of Noise and Vibration Post-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation and Maintenance activities	2	5	2	2	-1	-2.75	3	-8.25	Low	Negative

5.8.4.2.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for noise and vibration during operation phase is low as shown in Table 5-51.

Table 5-51 Final Environmental Significance Rating of Noise and Vibration During Operation Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Operation and Maintenance activities	2	3	2	7	Medium	1.5	-12.38	Low	Negative

5.8.4.3. Noise Emission Calculation

Calculating the noise impact of a specific activity, process, or facility involves assessing the potential noise levels generated and their effects on the surrounding environment and community. The formula is as follow.

$$SPL_{Total} = 10\log\sum_{i=1}^{n} 10^{(SPL_i)/10}$$

is the equivalent sound exposure level in 8 hours,

∑ is the sum of the values in the enclosed expression for all activities from i = 1 to i = n,

i is a discrete activity of a worker exposed to a sound level,

ti is the duration in hours of i,

SPLi is the sound level of i in dB(A),

n is is the total number of discrete activities in the worker's total workday.

Table 5-52 Construction Noise

Heavy Equipment	Excavators, Backholes, Front Loaders, Graders, Pavers, Rollers, Dump Trucks	73 dB to 101 dB
Stationary	Equipment (Pumps, Power Generators, Air Compressors)	68 to 88 dB
Impact	Drivers, Jackhammers, Pavement Breakers, Rock Drill, Pneumatic ools	79 to 110 dB

$$L_{den} = 10log\left(\frac{1}{24}\right)\left(12 * \left(10^{\frac{Lday}{10}}\right) + 4 * \left(10^{\frac{Levening+5}{10}}\right) + 8 * \left(10^{\frac{Lnight+10}{10}}\right)\right)$$

- Lday is the A-weighted long-term average sound level as defined in ISO 1996-2, determined overall the day periods of a year. The 12-hour daytime period is between 07:00hrs and 19:00hrs
- Levening is the A-weighted long-term average sound level as defined in ISO 1996-2, determined overall the evening periods of a year. The four-hour evening period is between 19:00hrs and 23:00hrs;
- Lnight is the A-weighted long-term average sound level as defined in ISO 1996-2, determined overall the night periods of a year. The eight-hour night-time period is between 23:00hrs and 07:00hrs

Source: FTA (2006).

Table 5-53 Noise Level Standard

Population Density (people per square mile)	L_{eq} [a] Day Time Noise Levels Exclusive of Traffic (dBA)
1 - 100	35
100 - 300	40
300 – 1,000	45
1,000 – 3,000	50
3,000 – 10,000	55
10,000 – 30,000	60
30,000 and up	65

[A] Where L_{eq} is the *equivalent sound pressure level:* the steady noise level that, over a specified period of time, would produce the same energy equivalence as the fluctuating noise level actually occurring.

$$L_{max} = \text{Construction } L_{max} \text{ at 50 feet} - 25 * \text{Log}(D/D_o)$$

$$D = Do * 10^{((\text{Construction Noise} - \text{Ambient Sound Level in dBA})/\alpha)}$$

Where L max = highest A-weighted sound level occurring during a noise event during the time that noise is being measured.

At 50 feet = the reference measurement distance (standard is 50 feet)

D = the distance from the noise source

Do = the reference measurement distance (50 feet in this case)

$$L_{den} = 10log\left(\frac{1}{24}\right)\left(12 * \left(10^{\frac{Lday}{10}}\right) + 4 * \left(10^{\frac{Levening+5}{10}}\right) + 8 * \left(10^{\frac{Lnight+10}{10}}\right)\right)$$

Table 5-54 Result of Noise Level

	1st time			2nd time		
	L_{day}	$L_{evening}$	L_{night}	L_{day}	$L_{evening}$	L_{night}
Point I	49.55	47.93	47.25	46.06	41.09	38.66
Point II	48.26	46.67	52.47	45.86	46.22	41.91
Point III	46.89	45.88	46.08	45.57	43.95	42.95
Point IV	50.07	48.67	48.97	46.85	44.74	40.55

Point V	45.18	45.71	45.58	45.51	44.41	40.88

5.8.5. Impact on Soil and Landscape

The main impacts on the soil and landscape generated by the construction and operation activities of the project include:

(1) Physical disturbance of the soil during site leveling and excavation activities;

(2) Soil contamination associated with waste generation/management during construction;

(3) Soil contamination from oil spill from vehicles;

The impacts on soil include physical compaction, erosion, and reduction in productivity and loss of permeability.

Excavation works would result in direct disturbance of soil including localized alteration of the soil profile within the excavation footprint, soil compaction in the immediate vicinity as a result of vehicle and construction equipment operations.

However, since the excavated soil will be reused for leveling/ land re-fills, it will significantly reduce the soil transportation trips and impacts of soil dumping outside the project area.

5.8.5.1. Construction Phase

5.8.5.1.1 Significance of Impact

The identification of soil and landscape is impacted by the excessive site preparation and excavation during the construction phase. Soil contamination from spillage of diesel oil, chemical and oil products (from machinery, equipment washing yards, and vehicles) can potentially cause soil pollution during construction activities. In addition, possible soil contamination may also be related to how garbage is handled and disposed of while development is taking place. The project area is a type of sandy soil that can easily cause soil pollution. Moreover, the concrete residue can be generated from dyke and road construction activities and wastewater can be generated from temporary septic tank. The environmental impact (EI) will be determined for soil and landscape without relevant management and mitigation measures (pre-mitigation) during construction phase as shown in Table 5-55.

Table 5-55 Significance Classes of Soil and Landscape Pre- Mitigation Measures During Construction Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Civil works activities	3	3	3	3	-1	-3	4	-12	Medium	Negative

The significant classes of soil and landscape during pre- mitigation measures are calculated based on construction activities. Assumed that for extend of impact is the area within 5 km of the site because of the soil and landscape may be affected by the construction activities in the project area. But this impact is a medium-term period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way and it is reversible only by incurring significant time and cost. Additionally, there is a high possibility that the impact will happen (> 75% probability). According to the assessment, mitigation measures are needed because this impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.5.1.2 Mitigation measure

The significance of impact on soil, geology and landscape may be affected by construction activities and the impact level is moderate. Therefore, project proponent must follow the mitigation measure as to reduce these impacts in the following below.

a) Planting will be conducted at the base of the embankment to protect the slope, consisting of quickly growing native trees with strong roots that can anchor in the soil.

b) Avoiding excessive excavations and limiting excavations to the approved engineering drawings' mentioned sites.

c) When feasible, extra dirt should be reused, and any remaining soil can be dumped at a designated location to prevent erosion.

d) By maintaining construction vehicles in good condition and containing other contaminants in storage tanks and other places, it is possible to prevent soil contamination by minimizing oil spills from vehicles of visitors and staff in the project construction sites.

e) Additionally, construction camp wastewater disposal should be regularly inspected.

f) To prevent soil contamination, septic tanks with sufficient capacities should be built to receive and treat wastewater from all temporary worksite toilets and construction camps.

The environmental impact will be predicted for soil and landscape with post implementation of relevant management and mitigation measures (post-mitigation) during construction phase. According to the result, the significance of classes of soil and landscape with post- mitigation measures is low as shown in Table 5-56.

Table 5-56 Significance Classes of Soil and Landscape Post-Mitigation Measures During Construction Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Civil works activities	2	3	2	2	-1	-2.25	3	-6.75	Low	Negative

5.8.5.1.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for soil and landscape during construction phase is low as shown in Table 5-57.

Table 5-57 Final Environmental Significance Rating of Soil and Landscape During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Civil works activities	1	2	2	5	Medium	1.5	-10.12	Low	Negative

5.8.5.2. Operation Phase

5.8.5.2.1 Significance of Impact

The soil and landscape as mainly affected by the operation and maintenance activities. The Soil contamination can be caused as a result of oil & grease leakage and spill due to the intense use of heavy machinery and vehicles used in maintenance during operation period. In addition, the impacts on soil include contamination due to solid and liquid waste generation and residue of paint generation after maintenance process during operation period. The environmental impact (EI) will be determined for soil and landscape without relevant management and mitigation measures (pre-mitigation) during operation phase as shown in Table 5-58.

Table 5-58 Significance of Classes of Soil and landscape Pre-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation and Maintenance activities	3	5	3	3	-1	-3.5	4	-14	Medium	Negative

The significant classes of soil and landscape pre- mitigation measures are calculated based on operation and maintenance activities. Assumed that for extend of impact is the area within 5 km of the site and it is a permanent period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way. Additionally, the impact is reversible only by incurring significant time and cost and there is a high possibility that the impact will happen (> 75% probability). Moreover, according to the assessment, mitigation measures are needed because the significant impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.5.2.2 Mitigation measure

The significance of impact on soil and landscape may be affected by operation and maintenance activities and the impact level is moderate. Therefore, project proponent must follow the mitigation measure as to reduce the effect of physical soil disturbance impacts in the following below.

a) Maintaining the company's vehicles' engines will help prevent oil spills, and proper management will prevent visitors' and residents' cars from picking up any stray oil.

b) Control proper oil and paint leakage when doing maintenance tasks.

c) After the maintenance operation, properly dispose of the waste and paint remains.

d) Solid waste should only be dumped in the designated locations to avoid hazardous waste contaminating the surroundings.

The environmental impact will be predicated for soil and landscape with post implementation of relevant management and mitigation measures (post-mitigation) during operation phase. According to the result, the significance of classes of soil and landscape with post- mitigation measures is low as shown in Table 5-59.

Table 5-59 Significance of Classes of Soil and landscape Post-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation and Maintenance activities	2	5	2	2	-1	-2.75	3	-8.25	Low	Negative

5.8.5.2.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for soil and landscape during operation phase is low as shown in Table 5-60.

Table 5-60 Final Environmental Significance Rating of Soil and Landscape During Operation Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Operation and Maintenance activities	1	2	2	5	Medium	1.5	-12.38	Low	Negative

5.8.6. Impact on Biodiversity

5.8.6.1. Flora and Fauna

The phases of construction and operation are anticipated to have an impact on existing biodiversity. Existing biodiversity may be impacted by land clearing, leveling, and pollution from automobiles and construction equipment, and dust from construction and operational activities. Chapter 4 discusses the findings of an investigation on the project's potential impact on biodiversity. All components of the floral and faunal ecosystem thought to be likely to be impacted by the activities of the pre-construction and construction were subjected to the impact assessment. The following are some of the probable pollution-causing project activities during the phases of construction, operation, and maintenance phases.

- Expansion of urbanization on agricultural and natural grassland.
- Land clearance, leveling, and excavation activities during the construction stage
- Buildings, cities, and infrastructure construction

5.8.6.1.1 Construction Phase

1) Significance of Impact

Placement of infrastructure and construction activities within the floral habitat in the proposed implemented area can cause more or less impact on the natural vegetation and fauna species. Activities which are likely to negatively affect the floral habitat integrity of the study area are described in the following:

- Destruction of floral habitat during construction and operational activities
- Placement of urban infrastructure within the floral habitat
- Soil erosion and dewatering in disturbed areas
- Altered flood plains due to construction activities leading to pollution and disturbance.
- Pollution of watercourses leads to the loss of floral and faunal habitats.
- Particulate matter generated by construction activities
- Exotic floral species invasion in the proposed project area

The assessment of impact level on biodiversity during construction phase is **Medium** as shown in Table 5-61.

Table 5-61 Significance Classes of Impact on Biodiversity During Construction Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Land clearance, leveling Construction Activities	**2**	**3**	**3**	**3**	**-1**	**-2.75**	4	-11	Medium	Negative

Certain amount of biodiversity can be impacted a result of changes in land, and water. Natural habitats and feeding ground are going to be transformed into cities and urbanized area. Cities and urban areas have historically been a danger to biodiversity and natural ecosystems, but they may also contribute to the solution. The proposed mitigating actions for preserving biodiversity and improving the state of green space are as follows.

2) Mitigation Measures

- Implement large landscaping area for rehabilitation of ecosystem for improving vegetation coverage, which could provide harbor insects and animals, served as feeding ground for birds, reptiles, and small mammals.
- Floral habitat and related buffer zones outside of the operating areas must be marked as no-go zones, and no construction-related activities, employees, or vehicles are allowed to break into these regions.
- Monitoring of flora and fauna species during construction phase.
- Discharge wastewater through treatment system and monitored regularly.
- There must be a drainage system in place to catch stormwater runoff from paved surfaces, access roads, and cleared areas.
- To mitigate topsoil erosion and the destruction of floral habitat, appropriate drainage systems must be integrated into the design of the proposed construction at every stage.
- The construction workers and sub-contractors will be trained to understand and get awareness of nature and biodiversity conservation.
- As far as possible, any disruption of sensitive floral habitat and species of conservation significance must be avoided.
- During land clearing, avoid clearing of rare species and nesting sites.
- Prohibition of bird shooting and hunting of animals within the project area. (According to the results of the field study, the bird species were mostly found among the collected fauna species, and those species of birds include endemic bird species and winter visitor bird species, so their habitats should not be completely cleared and some grassland areas and flood plains should be left for water birds.)

- When cleaning the land, if any animals or reptiles (such as snakes) come across, call the related government department (such as the fire department), who will take them into custody and release them in a secure location.
- Throughout all phases, a plan must be developed and put into practice to reduce the effect of dust on the environment.
- A control plan for exotic floral species must be developed and implemented in order to monitor and regulate foreign floral recruitment in disturbed habitats.
- It is recommended that the exotic floral management method be used for five years following decommissioning and closure of the construction phase.
- A nursery must be developed in cooperation with a related forest department where indigenous/endemic plant species must be planted with a focus on rehabilitation in degraded and building areas.
- The various kinds of animals cannot be trapped, collected, or hunted at any stages of the proposed urban development;
- Limit vehicle traffic to designated roads to lessen the environmental effect of building and maintenance work as well as the risk of animal species accidents.
- Prohibit open fire within the operation area
- Large trees must be preserved wherever possible since they serve as nesting and resting places for species found in the area.

The environmental impact will be predicated for biodiversity with post implementation of relevant management and mitigation measures (post-mitigation) during construction phase. According to the result, the significance of classes of impact with post-mitigation measures is low as shown in Table 5-62.

Table 5-62 Significance Classes of Biodiversity During Construction Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Land clearance, leveling Construction Activities	2	3	2	3	-1	-2.5	3	-7.5	Low	Negative

3) Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for biodiversity during construction phase is low as shown in **Table 5-63**.

Table 5-63 Final Environmental Significance Rating of Biodiversity During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*EI)	Rating	Status of Impact
	PR	CI	LR	P					
Land clearance, leveling, Construction Activities	1	2	3	6	Medium	1.5	-11.25	High	Negative

5.8.6.1.2 Operation Phase

1) Significance of Impact

During the construction phase, the existing grasslands and some floodplains would have been cleared, and land leveling and excavation work would have been carried out, so there would be only ornamental plants and trees in the urbanized or residential area, housing, hotels, playgrounds, and gardens during the maintenance phase and operation phase. Due to the presence of these buildings, shops and industries, many species of birds that previously migrated and foraged in the pastures will no longer come to graze. Biodiversity richness will not reach as high as before, and only some species (e.g., rock pigeons, house crow and house sparrow) with good adaptation will graze in modernized urban habitats.

Light pollution can affect insects such as fireflies, and beetle, disruption reproductive behavior, altered their circadian rhythms, attracting to light sources, causing disorientation, and exhausted them as they circle around artificial lights, thereby wasting valuable energy and shortening their lifespans.

Noise pollution can disrupt communication, foraging, navigation, and cause stress and behavioral changes insects. Insects rely on sound for communication, and mating which could be affected by traffic and construction. Noisy environments can disrupt insect's ability to forage for food and navigate. Prolong exposure to loud noise can induce behavior changes, including alternations in feed patterns, and reduce reproductive success. For example, crickets and grasshoppers use sound cues to locate food and avoid predators. Birds also rely on vocalizations for communication, and mate attraction. Noise pollution could lead to reduce reproductive success, difficulty in finding mates. Loud noises can disturb nesting birds, leading to nest abandonment, a reduced hatching success rate and increased chick mortality.

Air pollution can also impact respiratory issues on insects, which have tiny trachea to exchange gases, and particulate matter can clog and disrupt the insect's respiratory functions.

The assessment of impact level on biodiversity during operation phase before mitigation measures is moderate as shown in Table 5-64.

Table 5-64 Significance Classes of Impacts on Biodiversity During Operation Phase Pre-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Vehicle Movement, Urbanization, Air Pollution Light Pollution, Noise Pollution Water Pollution	**2**	**4**	**3**	**3**	**-1**	**-3**	4	-12	Medium	Negative

Therefore, the impact on biodiversity during the operation of the project is medium. The following actions must be taken during the operation and maintenance phase to ensure that birds and other species that could graze and dwell without affect by the proposed project.

2) Mitigation Measures

- Establishing linear parks and greenspaces to connect urban green areas would help to preserve biodiversity by maintaining a healthy ecology and a diverse population.
- Avoid using chemical pesticides and herbicides in the parks and green spaces; instead use organic pesticides derived form neem, pyrethrum, rotenone or ryania (botanical insecticides).
- Developed a nursery in cooperation with a related forest department where indigenous/endemic plant species must be planted.
- Monitoring of flora and fauna species during operation/maintenance phase.
- Preservation and cultivation of endangered and rare plant species in the project area.
- Even if exotic species of plants have been planted to create landscaping in the gardens and residential building and houses, keeping these species from spreading outside the area of the project.
- If any migratory birds or animals are found entering and sheltering in the project property, avoid arrest and move to safe location in cooperation with the related departments.
- Avoidance of bird shooting and hunting of animals in the project area.
- To mitigate light pollution in the urbanized areas, should use motion sensors and timers to ensure that outdoor lighting is only active when needed.
- Install dimmable light systems that can be adjusted based on the time of night and the level of activity in the area such as parks, green spaces, and walk ways.
- Install shields or hoods around outdoor lights to focus light downward and prevent it from scattering in unwanted directions.
- Choose warm-colored (2700K-3000K) LED lights instead of bright and strong beam blue-white light. (Warm-colored lights are less disruptive to natural ecosystems)

To mitigate the impacts of noise and air pollution on biodiversity, it's important to implement policies and practices to reduce pollution levels and promote environmental conservation works. These include regulating noise levels in sensitive traffic (for example, no horn zone in green areas and parks), improving air qualities (monitoring air quality, growing plants, install enough stack height in generators), and creating buffer zones.

Table 5-65 Significance Classes of Biodiversity During Operation Phase Post-Mitigation Measures

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Vehicle Movement, Urbanization, Air Pollution Light Pollution, Noise Pollution Water Pollution	**2**	**4**	**3**	**3**	**-1**	**-3**	3	-9	Medium	Negative

3) Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for biodiversity during operation phase is low as shown in **Table 5-66**.

Table 5-66 Final Environmental Significance Rating of Biodiversity During Operrn Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*EI)	Rating	Status of Impact
	PR	CI	LR	P					
Vehicle Movement, Urbanization, Air Pollution Light Pollution, Noise Pollution Water Pollution	1	2	3	6	Medium	1.5	-13.5	High	Negative

5.8.7. Impact on Drainage System

5.8.7.1. Construction Phase

5.8.7.1.1 Significance of Impact

In the construction phase, the impact of land leveling is relatively low on the drainage system in the village and public areas because of the dyke construction and land leveling is still being conducted. In addition, land filling is conducted since the ground level in the project area is low. As for the project, in the current situation, the environment of Shan

Ka lay Kyun village will be upgraded and excluded, and in order to properly discharge the rainwater and wastewater that will flow from the village, water collection tank and Main U Ditch will be built and will flow through the main sewers of the project with a mobile pump. But seasonal flood occurs in the rainy season at the village area and public area in construction phase.

The environmental impact (EI) will be determined on drainage system on village without relevant management and mitigation measures (pre-mitigation) during construction phase as shown in Table 5-67.

Table 5-67 Significance Classes of impact on drainage system Pre- Mitigation Measures During Construction Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Land Levelling	3	3	4	3	-1	-3.25	4	-13	Medium	Negative

The significant classes of impact on drainage system during pre- mitigation measures are calculated based on construction activities. This impact is a medium-term period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way and it is reversible only by incurring significant time and cost. Additionally, there is a high possibility that the impact will happen (> 75% probability). According to the assessment, mitigation measures are needed because this impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.7.1.2 Mitigation measure

The significance of impact on drainage system may be affected by construction activities and the impact level is moderate. Therefore, project proponent must follow the mitigation measure as to reduce these impacts in the following below.

g) Construct dyke wall to reduce the seasonal flood according to the master plan.

h) Construct water collection tank and Main U Ditch which can flow water from village.

The environmental impact will be predicted for impact on drainage system with post implementation of relevant management and mitigation measures (post-mitigation) during construction phase. According to the result, the significance of classes of soil and landscape with post- mitigation measures is low as shown in Table 5-56.

Table 5-68 Significance Classes of impact on drainage system Post-Mitigation Measures During Construction Phase

Sources	Consequence C = ((E + D + I + R)/4) *N	Probability (P)	Environmental Impact Score	Significance Classes	Status of Impact

	E	D	I	R	N	C		(EI = C x P)		
Land Leveling	2	3	3	3	-1	-2.75	3	-8.25	Low	Negative

5.8.7.1.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for soil and landscape during construction phase is low as shown in **Table 5-69**.

Table 5-69 Final Environmental Significance Rating of impact on drainage system During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Land Leveling	2	3	2	7	Medium	1.5	-12.375	Low	2

5.8.7.2. Operation Phase

5.8.7.2.1 Significance of Impact

In the operation phase, the impact on drainage system is positive since the pre-arrange construction structure such as dyke wall, water collection tank and Main U Ditch are already constructed. In consequence, the seasonal flood will not occur and wastewater from the village and public area will flow to the arranged cannel in the project area. The environmental impact (EI) will be determined for impact on drainage system without relevant management and mitigation measures (pre-mitigation) during operation phase as shown in **Table 5-70**.

Table 5-70 Significance of Classes of impact on drainage system Pre-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation and Maintenance activities	3	5	3	2	+1	+3.25	4	+13	Medium	Positive

The significant classes of impact on drainage system pre- mitigation measures are calculated based on operation and maintenance activities. Assumed that for extend of impact is the area within 5 km of the site and it is a permanent period where the affected

environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way. Additionally, the impact is reversible only by incurring significant time and cost and there is a high possibility that the impact will happen (> 75% probability). According to the assessment, the significant impact is medium and positive. But the project proponent needs to maintain the drainage channel, water collection tank and Main U Ditch.

The environmental impact will be predicated for impact on drainage system with post implementation of relevant management and mitigation measures (post-mitigation) during operation phase. According to the result, the significance of classes of impact on drainage system with post- mitigation measures is medium as shown in **Table 5-71**.

Table 5-71 Significance of Classes of impact on drainage system Post-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation and Maintenance activities	3	5	3	2	+1	+3.25	4	+13	Medium	Positive

5.8.7.2.2 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for impact on drainage system during operation phase is low as shown in **Table 5-72**.

Table 5-72 Final Environmental Significance Rating of Impact on drainage system During Operation Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Operation and Maintenance activities	1	2	2	5	Medium	1.5	+19.5	Medium	Positive

5.8.8. Impact on Aquatic & Navigation due to Sand Dredging

5.8.8.1. Construction Phase

5.8.8.1.1 Significance of Impact

The impact on the aquatic & navigation on Ayeyarwaddy River can caused by sand dredging. The environmental impact (EI) will be determined for impact on aquatic and

navigation without relevant management and mitigation measures (pre-mitigation) during the construction phase as shown in **Table 5-73**.

Table 5-73 Significance Classes of Impact on Aquatic and Navigation Pre-Mitigation Measures During Construction Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Sand Dredging	4	3	4	4	-1	-3.75	5	-18.75	High	Negative

The significant classes of impact on the aquatic & navigation during pre- mitigation measures are calculated based on construction activities. Assumed that for extend of impact is the area within 5 km of the site because of the soil and landscape may be affected by the construction activities in the project area. But this impact is a medium-term period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way and it is reversible only by incurring significant time and cost. Additionally, there is a high possibility that the impact will happen definitely. According to the assessment, mitigation measures are needed because this impact is high. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.8.1.2 Mitigation measure

The significance of impact on the aquatic & navigation may be affected by sand dredging and the impact level is high. Therefore, project proponent must follow the mitigation measure as to reduce these impacts in the following below.

a) To deploy the sediment curtains (turbidity barriers) around the dredging area to contain and settle suspended sediments.
b) Regular monitoring of sediment concentration to assess the environmental impact of dredging activities.
c) Consult with respective consultants for river sand dredging to not impact to aquatic.
d) Use noise-reducing technologies, quieter equipment to minimize the noise impact on aquatic.
e) Arrange proper schedule dredging activities to manage and reduce the navigation traffic.

The environmental impact will be predicted for impact on the aquatic & navigation with post implementation of relevant management and mitigation measures (post-mitigation) during construction phase. According to the result, the significance of classes of soil and landscape with post- mitigation measures is low as shown in **Table 5-74**.

Table 5-74 Significance Classes of Impact on the aquatic & navigation Post-Mitigation Measures During Construction Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Sand Dredging	3	3	3	3	-1	-3	3	-9	Low	Negative

5.8.8.1.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for impact on the aquatic & navigation during construction phase is low as shown in **Table 5-75**.

Table 5-75 Final Environmental Significance Rating of Impact on the aquatic & navigation During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Sand Dredging	3	3	3	9	High	2	-18	Medium	Negative

5.8.8.2. Operation Phase

5.8.8.2.1 Significance of Impact

In the operation phase, sand dredging will be conducted to reduce the possibility of flood risk. Therefore, the impact on the aquatic & navigation on Ayeyarwaddy River can caused by sand dredging. But the frequency of sand dredging in the operation phase will be lower than the construction phase. The environmental impact (EI) will be determined for impact on the aquatic & navigation without relevant management and mitigation measures (pre-mitigation) during operation phase as shown in **Table 5-76**.

Table 5-76 Significance of Classes of Impact on the aquatic & navigation Pre-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Sand Dredging	2	5	2	2	-1	-2.75	2	-5.5	Low	Negative

The significant classes of impact on the aquatic & navigation pre- mitigation measures are calculated based on sand dredging activities. Assumed that for extend of impact is the area within the site and it is a permanent period where the affected environment is altered but natural, cultural, and social functions and processes continue albeit in a modified way. Additionally, the impact is reversible only by incurring significant time and cost and there is a high possibility that the impact will happen (>25% and <50%). Moreover, according to the assessment, mitigation measures are needed because the significant impact is low. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.8.8.2.2 Mitigation measure

The significance of impact on the aquatic & navigation may be affected by sand dredging activities and the impact level is low. Therefore, project proponent must follow the mitigation measure as to reduce the effect of physical soil disturbance impacts in the following below.

e) To deploy the sediment curtains (turbidity barriers) around the dredging area to contain and settle suspended sediments.
f) Regular monitoring of sediment concentration to assess the environmental impact of dredging activities.
g) Consult with respective consultants for river sand dredging to not impact to aquatic.
h) Use noise-reducing technologies, quieter equipment to minimize the noise impact on aquatic.
i) Arrange proper schedule dredging activities to manage and reduce the navigation traffic.

The environmental impact will be predicated for impact on the aquatic & navigation with post implementation of relevant management and mitigation measures (post-mitigation) during operation phase. According to the result, the significance of classes of impact on the aquatic & navigation with post- mitigation measures is low as shown in **Table 5-77**.

Table 5-77 Significance of Classes of Impact on the aquatic & navigation Post-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Sand Dredging	1	5	2	2	-1	-2.5	2	-5	Low	Negative

5.8.8.2.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for soil and landscape during operation phase is low as shown in **Table 5-78**.

Table 5-78 Final Environmental Significance Rating of Impact on the aquatic & navigation During Operation Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Sand Dredging	1	2	1	4	Medium	1.5	-7.5	Low	Negative

5.9. SOCIAL IMPACTS AND MITIGATION MEASURES

5.9.1. Impact on Loss of Livelihood During Construction and Operation/ Maintenance Phases

One of the main assets and sources of income for local people in the surrounding area is farmers, moreover bronze statue businesses are operating successfully. A few villagers are living on fisheries. Farmers mainly grow Peanut, watermelon and other seasonal crops. Total growing land is about 563 acres of agricultural land will be lost due to the implementation of Proposed Urban Development Project. River water, underground water, and rainwater are used for agricultural purposes. The impact is significant as most people will lose their livelihood by loss of the agriculture land. The environmental impact (EI) will be determined for loss of livelihood without relevant management and mitigation measures (pre-mitigation) during construction and operation/maintenance phases as shown in Table 5-79.

Table 5-79 Significance Classes of Loss of Livelihood Pre-Mitigation Measures during Construction and Operation/ Maintenance Phases

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Loss of livelihood	3	5	4	3	-1	-3.75	5	-15	High	Negative

The significant classes of loss of livelihood with pre- mitigation measures are calculated based on project activities. Assumed that for extend of impact is the area within 5 km of the site because of the loss of livelihood may be affected by the local people in the surrounding area. But this impact is a permanent period where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease and it is reversible only by incurring significant time and cost. Additionally, there is a definite possibility that the impact will occur. According to the assessment, mitigation measures are

needed because this impact is high. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.9.1.1. Mitigation measure

The loss of livelihoods can affect local people and the impact level is moderate. Therefore, project proponents must follow the mitigation measure to reduce these impacts in the following below.

a) It is important that land ownership and purchasing arrangements are made prior to the pre-construction phase of the project.

b) Effective replacement actions must be taken for their lost income.

c) To prepare a livelihood restoration plan (LRP) in order to restore local people's livelihoods.

d) To create a job opportunity for the local people's livelihood in the surrounding area.

The environmental impact will be predicted for loss of livelihood with post implementation of relevant management and mitigation measures (post-mitigation) during construction and operation/maintenance phases. According to the result, the significance of classes of loss of livelihood with post- mitigation measures is medium as shown in Table 5-80.

Table 5-80 Significance Classes of Loss of Livelihood Post-Mitigation Measures during Construction and Operation/ Maintenance Phases

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Loss of livelihood	2	5	3	3	-1	-3.25	3	-9.75	Medium	Negative

5.9.1.2. Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for loss of livelihood during construction and operation/maintenance phases is low as shown in Table 5-81.

Table 5-81 Final Environmental Significance Rating of Loss of Livelihood during Construction and Operation/ Maintenance Phases

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Loss of livelihood	1	2	2	5	Medium	1.5	-14.62	Low	Negative

5.9.2. Impact on Local Population During Construction and Operation/Maintenance Phases

During the construction and operation/maintenance period, the following will have an impact on the local community and its surroundings:

- The general mobility of the locals and their livestock in and around the project area is expected to be affected during the construction phase.
- Due to the Contractor's employees, local residents may have security issues during the construction phase.
- It may have noise and dust issues in the surrounding area.
- Because to their high traffic volumes, Myo Patt Road is connected with expressway such as Mandalay-Sagaing expressway which is connected with Yangon-Mandalay expressway and Mandalay-Myintkyinar highway and other secondary roads such as Kandawgyi Pat Road, Yandanarpon Kyaung street, and 35th street may have traffic congestion while the project is being constructed The environmental impact (EI) will be determined for local population without relevant management and mitigation measures (pre-mitigation) during construction and operation/maintenance phases as shown in Table 5-82.

Table 5-82 Significance Classes of Local Population Pre-Mitigation Measures during Construction and Operation/ Maintenance Phases

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Construction and operation/ maintenance activities	3	5	3	3	-1	-3.5	4	-14	Medium	Negative

The significant classes of local population during pre- mitigation measures are calculated based on project activities. Assumed that for extend of impact is the area within 5 km of the site because of the construction and operation/maintenance activities may be affected by the local people in the surrounding area. But this impact is a permanent period where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way and it is reversible only by incurring significant time and cost. Additionally, there is a high possibility that the impact will happen (> 75% probability). According to the assessment, mitigation measures are needed because this impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.9.2.1. Mitigation measure

During the construction and operation/maintenance phases, it can be affected local people and the impact level is moderate. Therefore, project proponent must follow the mitigation measure as to reduce these impacts in the following below.

a) Considering that the population is most active particularly during peak hours, the contractor and project proponent should choose specified times for heavy machinery operation.

b) Effective construction controls may be made by the Contractor to avoid inconvenience to the population due to noise, fugitive dust and gas emission.

c) In order to help contain the construction materials being delivered to the specified site, trucks carrying concrete, aggregate, and sand fill supplies will be kept covered with tarpaulin.

d) The contractor and project proponent should issue a warning to the employees saying that engaging in theft-related activities will result in severe punishment and eventual submission to law enforcement.

e) Similar to this, the contractor and project proponent must guarantee that the laborers/workers are of good character/reputation while recruiting them.

f) Contractors and project proponent should use local unskilled and semi-skilled workers on projects during the construction phase to increase local people' experience of project ownership.

g) To ensure that the movement of the residents is not restricted, proper measures in the form of alternate routes should be developed.

h) To minimize the issues with traffic congestion during construction and operation/ maintenance activities, the contractor and project proponent must to be prepared a thorough traffic management strategy in conjunction with the Traffic Police Department.

The environmental impact will be predicted for local population with post implementation of relevant management and mitigation measures (post-mitigation) during construction and operation/maintenance phases. According to the result, the significance of classes of local population with post- mitigation measures is low as shown in Table 5-83.

Table 5-83 Significance Classes of Local Population Post-Mitigation Measures during Construction and Operation/ Maintenance Phases

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Construction and operation/ maintenance activities	2	5	2	2	-1	-2.75	3	-8.25	Low	Negative

5.9.2.2. Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for local population during construction and operation/maintenance phases is low as shown in Table 5-84.

Table 5-84 Final Environmental Significance Rating of Local Population during Construction and Operation/ Maintenance Phases

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Construction and Operation activities	1	2	2	5	Medium	1.5	-12.37	Low	Negative

5.9.3. Impact on Visual and Aesthetics During Construction and Operation/ Maintenance Phases

The fugitive dust, on-site storage of construction materials, storage of construction waste, physical presence, and operation of labor camp are all potential visual impacts during construction phase that could affect the proposed project area, particularly nearby Sagaing Pagoda and mountain site. This effect is temporary and slightly negative. The environmental impact (EI) will be determined for visual and aesthetics without relevant management and mitigation measures (pre-mitigation) during construction and operation/maintenance phases as shown in Table 5-85.

Table 5-85 Significance Classes of Visual and Aesthetics Pre-Mitigation Measures during Construction and Operation/ Maintenance Phases

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Construction and operation/ maintenance activities	3	5	3	3	-1	-3.5	4	-14	Medium	Negative

The significant classes of visual and aesthetics during pre- mitigation measures are calculated based on project activities. Assumed that for extend of impact is the area within 5 km of the site and this impact is a permanent period where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way. In addition, it is reversible only by incurring significant time and cost and there is a high possibility that the impact will happen (> 75% probability). According to the assessment, mitigation measures are needed because this impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.9.3.1. Mitigation measure

During the construction phase, it can affect local people and the impact level is moderate. Therefore, project proponents must follow the mitigation measure to reduce these impacts in the following below.

a) All construction activities should be limited to the designated site and the construction site should be fenced.

b) Dust control methods should be used to keep the project site approach road as clean and clear of mud and dust as possible.

c) In addition, spray water on approach roads and construction area at least twice per day during construction period.

d) Upon the project's construction completion, all temporary buildings, excess materials, and waste should be fully removed.

The environmental impact will be predicted for visual and aesthetics with post implementation of relevant management and mitigation measures (post-mitigation) during construction and operation/maintenance phases. According to the result, the significance of classes of visual and aesthetics with post- mitigation measures is low as shown in Table 5-86.

Table 5-86 Significance Classes of Visual and Aesthetics Post-Mitigation Measures during Construction and Operation/ Maintenance Phases

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Construction and operation/ maintenance activities	2	5	2	2	-1	-2.75	3	-8.25	Low	Negative

5.9.3.2. Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for visual and aesthetics during construction and operation/maintenance phases is low as shown in Table 5-87.

Table 5-87 Final Environmental Significance Rating of Visual and Aesthetic during Construction and Operation/ Maintenance Phases

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Construction and Operation activities	1	2	2	5	Medium	1.5	-12.38	Low	Negative

5.9.4. Impact on Traffic Congestion

The movement of waste and raw materials during the construction phase, as well as an increase in vehicle traffic during operation as a result of commercial activity, are the key factors contributing to traffic congestion.

5.9.4.1. Construction Phase

5.9.4.1.1 Significance of Impact

Due to the transportation of construction materials and raw materials, impacts are anticipated during the construction phase. The temporary and limited traffic effects during the construction phase will not be significant. Even so, appropriate measures must be taken to minimize the impact of traffic, such as setting up an effective timetable for operations and managing the timing of the delivery of supplies to avoid traffic wherever possible. The environmental impact (EI) will be determined for traffic congestion without relevant management and mitigation measures (pre-mitigation) during construction phase as shown in Table 5-88.

Table 5-88 Significance Classes of Traffic Congestion Pre-Mitigation Measures During Construction Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Civil works activities	3	3	4	3	-1	-3.25	5	-16.25	Medium	Negative

The significant classes of traffic congestion during pre- mitigation measures are calculated based on construction activities. Assumed that for extend of impact is the area within 5 km of the site and this impact is a medium-term period where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease. In addition, it is reversible only by incurring significant time and cost, and there is a definite possibility that the impact will occur. According to the assessment, mitigation measures are needed because this impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.9.4.1.2 Mitigation measure

The significance of impact on traffic congestion may be affected by construction activities and the impact level is moderate. Therefore, project proponents must follow the mitigation measure as to reduce these impacts in the following below.

a) With the project's assistance, the roads are maintained, and new access roads are built.

b) Within the project's boundaries, a systematic traffic control system and regulation will be put in place, and enough employees will be deployed to handle the traffic.

c) A proper activity schedule and timing management for the transportation of materials will be set up.

The environmental impact will be predicted for traffic congestion with post implementation of relevant management and mitigation measures (post-mitigation) during construction phase. According to the result, the significance of classes of traffic congestion with post- mitigation measures is low as shown in Table 5-89.

Table 5-89 Significance Classes of Traffic Congestion Post-Mitigation Measures During Construction Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Civil works activities	2	3	3	2	-1	-2.5	3	-7.5	Low	Negative

5.9.4.1.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for traffic congestion during construction phase is low as shown in Table 5-90.

Table 5-90 Final Environmental Significance Rating of Traffic Congestion During Construction Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Civil works activities	2	2	2	6	Medium	1.5	-11.25	Low	Negative

5.9.4.2. Operation Phase

5.9.4.2.1 Significance of Impact

Due to the high volume of visitors to the project site during the operation period, the number of cars increases. The movement of goods is probably going to affect traffic on the project site. The environmental impact (EI) will be determined for traffic congestion without relevant management and mitigation measures (pre-mitigation) during operation phase as shown in Table 5-91.

Table 5-91 Significance of Classes of Traffic Congestion Pre-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N	Probability (P)	Environmental Impact Score	Significance Classes	Status of Impact

	E	D	I	R	N	C		(EI = C x P)		
Operation and Maintenance activities	3	5	4	3	-1	-3.75	4	-15	Medium	Negative

The significant classes of traffic congestion pre- mitigation measures are calculated based on operation and maintenance activities. Assumed that for extend of impact is the area within 5 km of the site and it is a permanent period where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease. Additionally, the impact is reversible only by incurring significant time and cost, and there is a high possibility that the impact will happen (> 75% probability). Moreover, according to the assessment, mitigation measures are needed because the significant impact is medium. Therefore, the following mitigation measure needs to be followed by the project proponent.

5.9.4.2.2 Mitigation measure

The significance of impact on traffic congestion may be affected by operation/ maintenance activities and the impact level is moderate. Therefore, project proponent must follow the mitigation measure as to reduce the effect of these impacts in the following below.

a) With the support of the project, the roads are maintained up and new access roads are built.

b) Within the project's boundaries, the traffic management system and regulations will be methodically set up, and enough people will be given to it.

c) Activities will be scheduled properly, and transportation of materials will be controlled in terms of scheduling.

The environmental impact will be predicated for traffic congestion with post implementation of relevant management and mitigation measures (post-mitigation) during operation phase. According to the result, the significance of classes of traffic congestion with post- mitigation measures is low as shown in Table 5-92.

Table 5-92 Significance of Classes of Traffic Congestion Post-Mitigation Measures During Operation Phase

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Operation and Maintenance activities	2	5	3	2	-1	-3	3	-9	Low	Negative

5.9.4.2.3 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for traffic congestion during operation phase is low as shown in Table 5-93.

Table 5-93 Final Environmental Significance Rating of Traffic Congestion During Operation Phase

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Operation and Maintenance activities	2	2	2	6	Medium	1.5	-12.38	Low	Negative

5.9.5. Positive Impacts

The socio-economic impacts considered positive, as more jobs will create during construction and operation/ maintenance phases of the project. The workers comprising both skilled and unskilled will be recruited from the local population.

5.9.5.1. Livelihood and Socio-economic Impact During Construction and Operation/ Maintenance Phases

The environmental impact (EI) will be determined for livelihood and socio-economic during construction and operation/maintenance phases as shown in Table 5-94.

Table 5-94 Significance Classes of Livelihood and Socio-economic during Construction and Operation/ Maintenance Phases

Sources	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Construction and Operation/ Maintenance activities	3	5	4	3	+1	+3.75	5	+ 18.75	High	Negative

The significant classes of livelihood and socio-economic impacts are calculated based on project activities. Assumed that for extend of impact is the area within 5 km of the site. But this impact is a permanent period where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease and it is reversible only by incurring significant time and cost. Additionally, there is a definite possibility that the impact will occur. According to the assessment, the livelihood and socio-economic impacts is high positive, as more jobs will be created during construction and operation/maintenance phases of the project. In the project area, workers comprising both skilled and unskilled will be recruited from the local population.

The project proponent will implement the following practices during the construction and operation/maintenance phases to get better results within the project area.

- Promote fair treatment, non-discrimination (gender, religion & skin colour, etc.) and equal opportunity for workers.
- The Project plans to increase the production capacity in this years, nearby communities will get benefit by being the source of work force for the project.
- Ensure total compliance with national labor and employment laws.

- To avoid exploitation of child labor by contractor, sub-contractor, and supply chain.
- Promote safe and healthy working conditions.
- Commitments upon the safety of workers by the management level and providing appropriate the amount of budget.
- The company will continue to implement CSR programs.
- The project proponent should try to eliminate or at least mitigate negative impacts, on the other hand, enhance and maximize the positive impacts to their optimum.

5.9.5.1.1 Impact Prioritization

The prioritization factor (PF) and environmental impact (EI) of the post mitigation scoring are multiplied to determine the final impact significance. As a result, the final environmental significance rating for livelihood and socio-economic during construction and operation/ maintenance phases is high as shown in Table 5-95.

Table 5-95 Final Environmental Significance Rating of Livelihood and Socio-economic During Construction and Operation/ Maintenance Phases

Sources	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*ER)	Rating	Status of Impact
	PR	CI	LR	P					
Construction and Operation/ Maintenance activities	2	2	2	6	Medium	1.5	+ 28.13	High	Negative

5.10. RISK ASSESSMENT METHODOLOGY

It is important to identify and reduce risks that may arise from the operation activities in the workplace. Risk assessment needs to be done in detail for each type of business and each process. Risk assessment helps to achieve business organizational goals, improving business performance, operational efficiency and it helps to improve occupational safety and health as well as protect the natural environment.

The risk assessment methodology used for the Occupational Safety Risk, Health Impact Assessment and Fire risk is from "General Environmental Impact Assessment Guidelines (September, 2017) issued by the Ministry of Natural Resources and Environmental Conservation[2]. The steps involved in risk assessment are Hazard Identification, Risk evaluation and Risk control.

[2] Ministry of Natural Resources and Environmental Conservation, September, 2017. General Environmental Impact Assessment Guideline. The Republic of the Union of Myanmar, Version 3. pp (25)

5.10.1. Hazard Identification

Risk may occur in operations during the implementation of the project. There is no such thing as a non-hazardous operation. Only a small difference. Potential risks for each process need to be identified and documented in a risk assessment. Information that need to consider when identifying potential risk situation are described below.

- Occupational Safety Risk
- Health Impact
- Fire Hazard

5.10.2. Risk Evaluation

The risk level is calculated based on the severity and likelihood. To get a risk level, multiply the severity and likelihood of the risk and analysis on the resulting answer.

By formula

Risk Assessment =Severity ×Likelihood

5.10.2.1. Severity

Determining the severity of potential risk considers existing risk controls and remaining risks. The description of the severity level is as shown in Table 5-96.

Table 5-96 Criteria for rating the status of severity

Level	Severity	Description
5	Catastrophic	Death, fatal occupational disease or exposure, or multiple major injuries
4	Major	Serious injuries, serious occupational diseases or exposure (includes amputations, major fractures, multiple injuries, occupational cancers, diagnosed mental illnesses, acute poisoning, disabilities, and noise-induced hearing loss)
3	Moderate	Injury or ill-health (including mental well-being) requiring medical treatment (includes lacerations, burns, sprains, minor fractures, psychosocial stress, dermatitis, and work-related musculoskeletal disorders)
2	Minor	Injury or ill-health (including mental well-being) requiring first-aid only (includes minor cuts and bruises, irritation, ill-health with temporary discomfort, fatigue)
1	Negligible	Negligible injury

5.10.2.2. Likelihood

Risk assessment considers existing risk controls and remaining risks. The level descriptions that determine likelihood are shown in Table 5-97.

Table 5-97 Criteria for rating the status of likelihood

Level	Severity	Description
5	Almost Certain	Continual or repeating experience.
4	Frequent	Common occurrence.
3	Occasional	Possible or known to occur.
2	Remote	Not likely to occur under normal circumstances.
1	Rare	Not expected to occur but still possible.

5.10.2.3. Risk classification (Risk Matrix)

Control and protection must be done to not include in the red zone (High Risk) before starting work. Additionally, additional risk controls should be implemented. The risk level in the yellow zone (Medium Risk) is medium level and appropriate risk control and protection must be implemented. The level of risk in the green zone (Low Risk) is low-level risks.

Table 5-98 Risk Assessment Matrix

		Likelihood				
		Improbable/ Rare (1)	**Remote/ Unlikely (2)**	**Occasional (3)**	**Probable/ Likely (4)**	**Almost Certain/ Frequent (5)**
Severity	**Catastrophic (5)**	5	10	15	20	25
	Critical (4)	4	8	12	16	20
	Moderate (3)	3	6	9	12	15
	Minor (2)	2	4	6	8	10
	Negligible (1)	1	2	3	4	5

Table 5-99 Criteria for rating the status of Risk Assessment

Risk Reading		Require Action
Index	**Rating**	
1-3	Low	Acceptable (No additional risk control measure required)
4-12	Medium	Tolerable

Risk Reading		Require Action
Index	Rating	
		(Management attention require Reduce risk to as low as reasonably practical)
>12	High	Not acceptable (Reduce to at least medium risk level before start work commence)

5.10.3. Risk Control

Risk control measures should be based on risk control methods (Hierarchy of Control). In possible situations, the risk should be eliminated (Elimination). Substitution, Engineering Control, Administrative Control and Personal Protective Equipment should be used according to this level shown in Figure 5-6 if elimination is not possible.

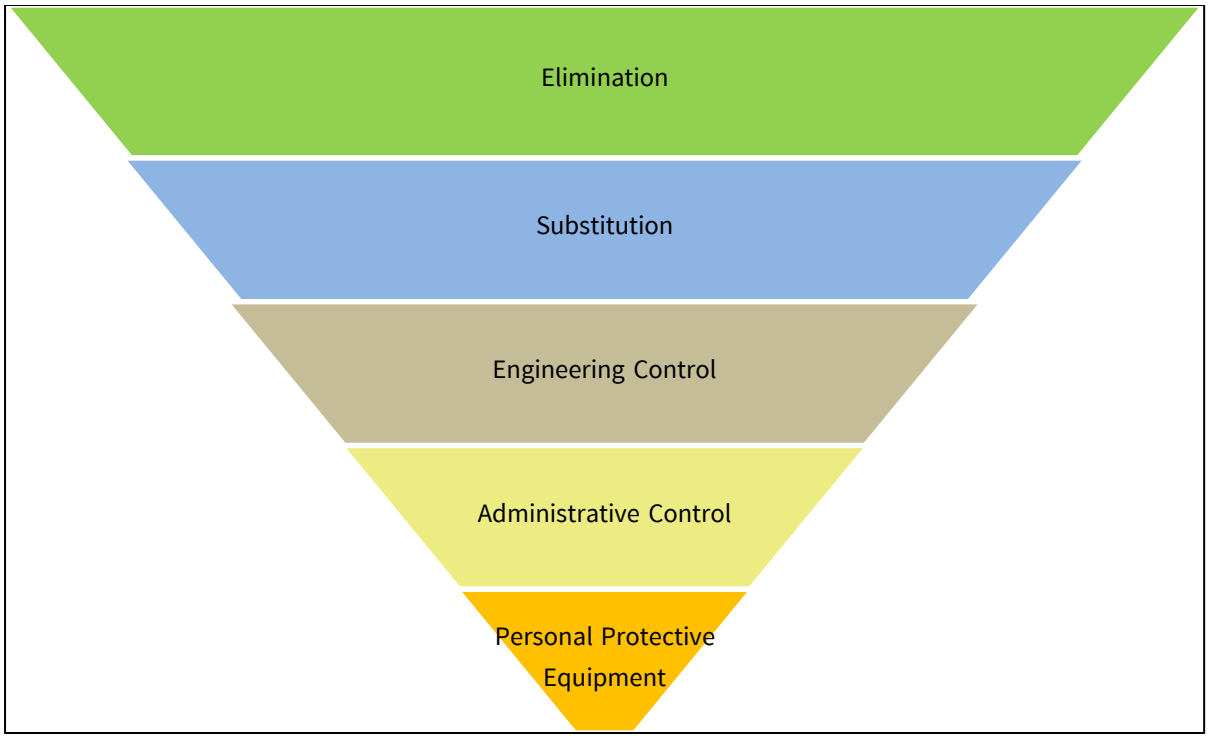


Figure 5-6 Hierarchy of Control

5.11. ASSESSING AND MITIGATING THE RISKS OF THE PROPOSED PROJECT

In the assessment of the risks that may occur during implementation of the project, each project process will be considered and mitigation measures also will be mentioned together. But document preparation occurs during the pre-construction phase and it also includes purchasing and owning land, creating design plans, determining river levels, and analyzing project elevation. Therefore, according to the assessment made by the environmental consultants (EIA) team, there are no significant risk factor for the pre-construction phase of the project.

5.11.1. Occupational Safety Risk

5.11.1.1. Construction Phase

Physical risks may occur from the operation process during construction phase due to failure of equipment & machineries, careless using equipment & machineries, etc. Therefore, the risks of each process step are analyzed to reduce the risk level as below.

5.11.1.1.1 Land Reclaiming and Leveling

Land reclaiming and leveling is the first step of the construction phase. In this stage, machineries and equipment are used to remove bush, grass, shrubs and transport sand from the river to level the project ground level. The potential physical risks are accidents caused by venomous animals, accidents caused by machineries and equipment, foot injury due to not wearing proper shoes. These risks can cause strain on workers, injure worker body, and can cause severe or may be dead.

The level of severity is assumed as "level 5" due to worker can caused death and fatal as well as the level of likelihood is assumed as "level 3" because the risk is possible or known to occur. The calculated risk level is "High" and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of risk level during land reclaiming and leveling process is shown in Table 5-100.

Table 5-100 Assessment of Risk Level during Land Reclaiming and Leveling

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Likelihood	Risk Priority Number (RPN)	
1	Land Reclaiming and Leveling	• Accidents caused by venomous animals • Accidents caused by machineries and equipment • Foot injury due to not wearing proper shoes.	• Strain to workers • Injury worker body. • Can cause severe or dead.	5	3	15	High

Mitigation Measure

- ✓ To wear long boots from preventing venomous animals.
- ✓ To wear on a safety vest while working in order to see the situation properly.

- ✓ Carefully inspection before driving the machineries and using equipment.
- ✓ Permit only the qualified or certified workers to drive the machineries.
- ✓ Do not permit to enter the irresponsible person in the working area.
- ✓ Check the first aid box every 6 month if medicine is necessary.
- ✓ Plan ahead to send the nearest clinic or hospital if the major injury is happened.
- ✓ Sharing knowledge about health & safety in working area between workers.
- ✓ Arrange first-aid training to worker.

5.11.1.1.1.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 2", not likely to occur under normal circumstances. Therefore, the residual risk level is "Medium" as shown in Table 5-101.

Table 5-101 Residual Risk Level during Land Reclaiming and Leveling

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Land Reclaiming and Leveling	• Accidents caused by venomous animals • Accidents caused by machineries and equipment • Foot injury due to not wearing proper shoes.	• Strain to workers • Injury worker body. • Can cause severe or dead.	5	2	10	Medium

5.11.1.1.2 Retaining Structure Construction

Retaining structures have been built and are still being constructed along the river bank in the project area to protect against flooding. The potential risks can cause in this stage are accident due to carrying raw materials, injury during loading/ unloading of raw materials (stone) and accidents caused by machineries. Workers can get injured by falling materials from trucks, by flying small stones during the loading/unloading operation, or by machinery.

The level of severity is assumed as "level 3" due to worker can caused injury that require medical treatment as well as the level of likelihood is assumed as "level 2" because

the risk potential is not likely to occur under normal circumstances. The calculated risk level is "Medium" and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of risk level during retaining structure construction process is shown in Table 5-102.

Table 5-102 Assessment of Risk Level during Retaining Structure Construction

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Retaining Structure Construction	• Accident due to carrying raw materials. • Injury during loading/unloading of raw materials (stone) • Accidents caused by machineries in retaining structure construction	• Injury to people due to falling materials from trucks. • Injury to workers by flying small stone in loading/ unloading process. • Injury by machineries	3	2	6	Medium

Mitigation Measure

- ✓ Cover with tarpaulin or strictly tied up the materials before carrying with truck.
- ✓ Carefully inspection before driving the machineries and using equipment.
- ✓ Permit only the qualified or certified workers to drive the machineries.
- ✓ To wear on a safety vest while working in order to see the situation properly.
- ✓ Do not permit to enter the irresponsible person in the working area.
- ✓ To put the emergency contact numbers in public area of project area.
- ✓ Plan ahead to send the nearest clinic or hospital if the major injury is happened.

5.11.1.1.2.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Low" as shown in Table 5-103.

Table 5-103 Residual Risk Level during Retaining Structure Construction

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			**Risk Evaluation**				**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Severity**	**Like-lihood**	**Risk Priority Number (RPN)**	
1	Retaining Structure Construction	• Accident due to carrying raw materials. • Injury during loading/unloading of raw materials (stone) • Accidents caused by machineries in retaining structure construction	• Injury to people due to falling materials from trucks. • Injury to workers by flying small stone in loading/ unloading process. • Injury by machineries	3	1	3	Low

5.11.1.1.3 Soil Improvement

Soil improving is an important step in construction to reduce the land subsidence. Soil improving is conducted with machineries thus it can cause accident by machineries to workers. The calculated risk level is “Medium”. The follow mitigation measures are need to follow to reduce the risk level.

The level of severity is assumed as “level 3” due to worker can caused injury that require medical treatment as well as the level of likelihood is assumed as “level 2” because the risk potential is not likely to occur under normal circumstances. The calculated risk level is “Medium” and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of risk level during land soil improvement process is shown in Table 5-104.

Table 5-104 Assessment of Risk Level during Soil Improvement

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			**Risk Evaluation**				**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Severity**	**Like-lihood**	**Risk Priority Number (RPN)**	

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Soil Improvement	• Accidents caused by machineries	• Strain to workers • Injury to workers	3	2	6	Medium

Mitigation Measure

- ✓ To wear on a safety vest while working in order to see the situation properly.
- ✓ Carefully inspection before driving the machineries and using equipment.
- ✓ Permit only the qualified or certified workers to drive the machineries.
- ✓ Do not permit to enter the irresponsible person in the working area.

5.11.1.1.3.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Low" as shown in Table 5-105.

Table 5-105 Residual Risk Level during Soil Improvement

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Soil Improvement	• Accidents caused by machineries	• Strain to workers • Injury to workers	3	1	3	Low

5.11.1.1.4 Infrastructure Construction (Drainage System, Road, Communication)

During the infrastructure construction stage, the potential risks are accident due to carrying raw materials used in construction, injury during loading/ unloading of raw materials and accidents caused by machineries and equipment. Worker can injury due to falling materials from truck when the materials are carried with truck. Furthermore, workers may be

injured as a result of carrying too much weight and inappropriate handling, as well as being hit by machinery and equipment.

The level of severity is assumed as "level 3" due to worker can caused injury that require medical treatment as well as the level of likelihood is assumed as "level 2" because the risk potential is not likely to occur under normal circumstances. The calculated risk level is "Medium" and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of risk level during infrastructure construction process is shown in Table 5-106.

Table 5-106 Assessment of Risk Level during Infrastructure Construction (Drainage System, Road, Communication)

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Drainage System Construction, Road Construction, Communication System Construction	• Accident due to carrying raw materials used in construction. • Injury during loading/unloading of raw materials • Accidents caused by machineries and equipment	• Injury to people due to falling materials from trucks. • Injury to workers due to carrying over weight and improper handling • Injury worker body.	3	2	6	Medium

Mitigation Measure

- ✓ Cover with tarpaulin or strictly tied up the materials before carrying with truck.
- ✓ To carry the materials in waist with safe posture.
- ✓ Carefully inspection before driving the machineries.
- ✓ Permit only the qualified or certified workers to drive the machineries.
- ✓ To wear on a safety vest while working in order to see the situation properly.
- ✓ Do not permit to enter the irresponsible person in the working area.
- ✓ Enforce worker to wear the mask and eyes protection glass working in high dust emission.
- ✓ To put the emergency contact numbers in public area of project area.

✓ Plan ahead to send the nearest clinic or hospital if the major injury is happened.

5.11.1.1.4.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Low" as shown in Table 5-107.

Table 5-107 Residual Risk Level during Infrastructure Construction (Drainage System, Road, Communication)

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Drainage System Construction, Road Construction, Communication System Construction	• Accident due to carrying raw materials used in construction. • Injury during loading/unloading of raw materials • Accidents caused by machineries and equipment	• Injury to people due to falling materials from trucks. • Injury to workers due to carrying over weight and improper handling • Injury worker body.	3	1	3	Low

5.11.1.2. Operation/ Maintaining Phase

Physical risks may occur from the operation process during operation/ maintaining phase due to electrical hazard, fire hazard, health & safety. Therefore, the risks of each process step are analyzed to reduce the risk level as below.

5.11.1.2.1 Maintaining Basic Infrastructure

In the operation phase, basic infrastructure will be regular maintenance. In these processes such as maintaining roads and drainages system, injuries and accidents such as slips, injury from falling height in maintaining and careless mistakes. Maintaining power supply system, maintaining building and similar process can cause health & safety problem, electrical hazard and fire hazard.

In assessment of physical risk during operation/ maintaining phase, the level of severity is assumed as "level 5" due to worker can caused death and fatal as well as the level of likelihood is assumed as "level 2" because the risk is not likely to occur under normal

circumstances. The calculated risk level is "Medium" and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of risk level during maintaining basic infrastructure is shown in Table 5-108.

Table 5-108 Assessment of Risk Level during Maintaining Basic Infrastructure

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Likeli -hood	Risk Priority Number (RPN)	
1	Maintaining Basic Infrastructure	• Electrical Hazard • Fire Hazard • Health & Safety	• Death • Bodily injury. • Damage to project properties	5	2	10	Medium

Mitigation Measure

- ✓ Use PPE such as safety helmet, safety shoe, safety belt while working at high places.
- ✓ To maintain the electrical wire and devices with electrician.
- ✓ To repair immediately the damage wire and electrical devices.
- ✓ Sufficient fire protection equipment and fire extinguishers are provided.
- ✓ Combustible wastes are disposed regularly and stored separately.
- ✓ Awareness about do's and don'ts for waste storage and fuel storage is given.
- ✓ To train the fire drill for emergency cases every 6 month.
- ✓ To put the emergency contact numbers in public area of project area.
- ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box).
- ✓ Arrange for delivery to the clinic or nearest hospital for emergency
- ✓ To plan for fire training every 6 months.

5.11.1.2.1.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Medium" as shown in Table 5-109.

Table 5-109 Residual Risk Level during Land Reclaiming and Leveling

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Maintaining Basic Infrastructure	• Electrical Hazard • Fire Hazard • Health & Safety	• Death • Bodily injury. • Damage to project properties	5	1	5	Medium

5.11.2. Community Risk

5.11.2.1. Accident from vehicles (Construction & Operation/ Maintaining Phase)

People near the project area can injury due to falling materials from trucks that carries raw materials and other materials. In addition, accident can cause to people near the project area due to the vehicles.

According to the assessment, the level of severity is assumed as "level 3" due to the resident near the project area can caused ill-health with (including mental well-being) as well as the level of likelihood is assumed as "level 2" because the risk potential is not likely to occur under normal circumstances. The calculated risk level is "Medium" and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of public health & safety impact level for accident from vehicles is shown in Table 5-110.

Table 5-110 Assessment of Public Health & Safety Impact level

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Accident from vehicles	• Accident due to carrying materials	• Injury to people due to falling materials from trucks. • Accident by vehicle	3	2	6	Medium

Mitigation Measure

- ✓ Cover with tarpaulin or strictly tied up the materials before carrying with truck.
- ✓ Inspect the truck to not overload in transportation.
- ✓ To enforce vehicles that carry materials not to drive more than the specified kilometer on the roads.
- ✓ Regular maintenance the vehicles every 6 months.

5.11.2.1.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Low" as shown in Table 5-111.

Table 5-111 Residual Public Health & Safety Impact level

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Accident from vehicles	• Accident due to carrying materials	• Injury to people due to falling materials from trucks. • Accident by vehicle	3	1	3	Low

5.11.3. Health Impact Assessment

Health Impact Assessment (HIA) is a practical approach used to judge the potential health effects of the project on a population, particularly on vulnerable or disadvantaged groups. Health impact assessment is divided into two sectors which is occupational health and public health.

5.11.3.1. Occupational Health

Occupational health is focus on the residents, staff and worker's health issues in the project area due to operation processes. In the construction phase, construction activities, soil improvement and infectious diseases can effect on the staff and worker's health.

5.11.3.1.1 Construction activities (Construction Phase)

Construction processes activities such as land reclaiming and leveling processes, retaining structure and infrastructure construction processes can cause dust and noise emission. Worker's health can affect if there is a large amount dust emission is exceeded. Worker can irritate the nose, throat and eyes due to large particles. Small particles less than 2.5 micrometers ($PM_{2.5}$) and small particles less than 10 micrometers (PM_{10}) can cause eye damage and respiration problems such as coughing, difficulty breathing, reduced lung function, etc. In addition, worker hearing can also damage due to noise operation process if the noise level is exceeded. According to the air and noise measurements, the results of air and noise are within the National Environmental Quality (Emission) Guidelines.

According to the health impact assessment, the level of severity is assumed as "level 2" due to worker can caused irritation, ill-health with temporary discomfort, fatigue as well as the level of likelihood is assumed as "level 2" because the risk potential is not likely to occur under normal circumstances. The calculated risk level is "Medium" and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of risk level during construction activities is shown in Table 5-112.

Table 5-112 Assessment of Health Impact level during Construction activities

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Construction Activities	• Eye damage and respiration problem due to dust emission in land reclaiming and leveling process activities	• Damage to worker eyes and respiration	2	2	4	Medium

Mitigation Measure

- ✓ Enforce worker to wear the mask and eyes protection glass working in high dust emission area.
- ✓ Repair and maintain machinery every (6) months to prevent noise due to equipment failure.
- ✓ Do not operate equipment and machinery simultaneously unless necessary.
- ✓ Monitor machinery to ensure that it is not left on unnecessarily.
- ✓ Providing earplugs or ear muffs to workers working in noisy areas and enforce to wear the PPEs that provided.

5.11.3.1.1.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Low" as shown in Table 5-113.

Table 5-113 Residual Health Impact Level during Construction activities

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Constructio n Activities	• Eye damage and respiration problem	• Damage to worker eyes and	2	1	2	Low

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
		due to dust emission in land reclaiming and leveling process activities	respiratio n				

5.11.3.1.2 Heat Stress (Construction Phase)

Heat stress is also consideration factor for the occupational health. Since most of the construction works are conducted in the outside area, worker can cause heat-related health problems such as exhaustion, sleep disturbances, dehydration, heat edema during high temperature period days.

According to the health impact assessment, the level of severity is assumed as “level 2” due to worker can caused irritation, ill-health with temporary discomfort, fatigue as well as the level of likelihood is assumed as “level 3” because the risk potential is not likely to occur under normal circumstances. The calculated risk level is “Medium” and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of risk level for heat stress is shown in Table 5-114.

Table 5-114 Assessment of Health Impact level for heat stress

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Heat Stress	• Heat edema, heat rashes, heat cramps, heat syncope, heat stroke and so on. • Chronic heat exhaustion, sleep disturbances	• Strain to workers • Dehydration • Eye damage	2	3	6	Medium

Mitigation Measure

- ✓ Enforce worker to wear the mask and eyes protection glass working in high dust emission area.
- ✓ Supply the sufficient drinking water and Oral Rehydration salt pack.
- ✓ Construct the rest places near the working area.
- ✓ Worker who work under the sun must wear long-sleeved shirts, long pants, hats. (Applying Thanaka and sun cream, wearing sunglass can also be used)
- ✓ Assign the worker with working shift when day temperature is high.

5.11.3.1.2.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Low" as shown in Table 5-115.

Table 5-115 Residual Health Impact Level for Heat Stress

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			**Risk Evaluation**				**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Severity**	**Like-lihood**	**Risk Priority Number (RPN)**	
1	Heat Stress	• Heat edema, heat rashes, heat cramps, heat syncope, heat stroke and so on. • Chronic heat exhaustion, sleep disturbances	• Strain to workers • Dehydration • Eye damage	2	1	3	Low

5.11.3.1.3 Soil Improvement (Construction Phase)

Soil improvement is one of the main steps in the construction phase. In this stage, soil improvement conducted with Vibroflotation compaction method therefore nearby worker can impact due to vibration. If the vibration level is exceeding the standard, worker may damage to tendons, muscles, bones and joints, damage to the nervous system. According to the vibration measurement result in project area, the result is within the vibration guideline.

According to the health impact assessment, the level of severity is assumed as "level 3" due to worker can caused ill-health with (including mental well-being) as well as the level

of likelihood is assumed as “level 2” because the risk potential is not likely to occur under normal circumstances. The calculated risk level is “Medium” and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of risk level for soil improvement process is shown in Table 5-116.

Table 5-116 Assessment of Health Impact level for soil improvement

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			**Risk Evaluation**				**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Severity**	**Like-lihood**	**Risk Priority Number (RPN)**	
1	Soil Improvement	• Harm to nearby worker due to vibration used to compact the ground of the project area	• Strain to workers • Damages to tendons, muscles, bones and joints. • Damage to the nervous system	3	2	6	Medium

Mitigation Measure

- ✓ To announce in advance before the soil improvement process.
- ✓ Do not permit to enter the irresponsible person in the working area.
- ✓ Provide close supervision.

5.11.3.1.3.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as “level 1”, not expected to occur but still possible. Therefore, the residual risk level is “Low” as shown in Table 5-117.

Table 5-117 Residual Health Impact Level for soil improvement

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			**Risk Evaluation**				**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Severity**	**Like-lihood**	**Risk Priority Number (RPN)**	
1	Soil Improvement	• Harm to nearby worker due to	• Strain to workers • Damages to	3	1	3	Low

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
		vibration used to compact the ground of the project area	tendons, muscles, bones and joints. • Damage to the nervous system				

5.11.3.1.4 Infectious disease risks (Construction Phase & Operation/ Maintaining Phase)

Operation area can expose workers to various biological hazards due to exposure to bacteria, viruses, insects, plants, birds, animals, and even humans. These biological hazards can result in various health issues, such as skin irritations, allergies and serious infectious diseases.

According to the health impact assessment, the level of severity is assumed as "level 3" due to worker can caused ill-health with (including mental well-being) as well as the level of likelihood is assumed as "level 2" because the risk potential is not likely to occur under normal circumstances. The calculated risk level is "Medium" and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of risk level for infectious disease risk is shown in Table 5-118.

Table 5-118 Assessment of Health Impact level for Infectious disease risk

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Infectious disease risks	• Cholera diseases • Hepatitis • Covid-19 disease, etc.	• Worker fatigue due to disease. • Affecting workers.	3	2	6	Medium

Mitigation Measure

- ✓ Provide workers with clean drinking water to prevent diarrheal diseases caused by impure drinking water.

- ✓ Sharing health education knowledge to workers about communicable diseases such as Covid-19, Hepatitis.
- ✓ Supply hand washing soap, hand sanitizers, masks and oral rehydration salt.

5.11.3.1.4.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Low" as shown in Table 5-119.

Table 5-119 Residual Health Impact Level for Infectious disease risk

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			**Risk Evaluation**				**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Severity**	**Like-lihood**	**Risk Priority Number (RPN)**	
1	Infectious disease risks	• Cholera diseases • Hepatitis • Covid-19 disease, etc.	• Worker fatigue due to disease. • Affecting workers.	3	1	3	Low

5.11.3.2. Community Health

Public health & safety is focus on the health and safety issues of the people near the project area due to operation processes.

5.11.3.2.1 Air Pollution/ Noise Pollution to Surrounding area

One of the potential impacts is that air pollution from construction process (dust and gas) and noise from construction process can disperse with wind to residents near the project area. It can be caused respiratory problems and hearing problem to residents near the project area but the probability is few since the project area is wide.

According to the assessment, the level of severity is assumed as "level 2" due to the resident near the project area can caused ill-health with temporary discomfort, fatigue as well as the level of likelihood is assumed as "level 1" because the risk potential is not likely to occur but still possible. The calculated risk level is "Low" and thus, the following mitigation measures should be followed to avoid or reduce causing unwanted harm and damage to the environment and the residents. The assessment of public health & safety impact level due to air pollution/ noise pollution to surrounding area is shown in Table 5-120.

Table 5-120 Assessment of Public Health & Safety Impact level

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	Air Pollution/ Noise Pollution to Surrounding area	• Impact on the surrounding environment due to dust and noise generated from operations.	• Dispersing particles in the surrounding air and affecting the respiratory tract. • Particles can pollute the surrounding water and harm people who use it. • Disturbing nearby people, insomnia hearing damage due to noise.	2	1	2	Low

Mitigation Measure

- ✓ Spraying water twice a day on dusty area near the working site and the roads with high traffic.
- ✓ Protect with green filter cloth in windy and dusty areas.
- ✓ Slow down the speed of machinery and transport vehicles.
- ✓ Do not operate till night.

5.11.3.2.1.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Low" as shown in Table 5-121.

Table 5-121 Residual Public Health & Safety Impact level

Risk Evaluation for Occupational Health and Safety		
Hazard Identification	Risk Evaluation	Status

No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	of Risk
1	Accident from vehicles	• Accident due to carrying raw materials used in construction.	• Injury to people due to falling materials from trucks. • Accident by vehicle	2	1	2	Low

5.11.4. Fire from fuel storage area and waste storage area

Fire risk is the important factor to consider in analyzing risk factor. During the project establishment, the source places of fire in project area are fuel storage area and waste storage area. The behaviors of workers (e.g, smoking, careless using electricity & electronic devices) and arson are also sources of fire. Fire hazard can cause damage to workers and project properties and even death. However, the fire risk potential is considered little because the construction and operation works does not include large-scale works using fire-arms and explosives.

The level of severity is assumed as "level 5" due to worker can caused death and fatal as well as the level of likelihood is assumed as "level 2" because the risk potential is not likely to occur under normal circumstances. The calculated risk level is "Medium" and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of fire risk level is shown in Table 5-122.

Table 5-122 Assessment of Fire Risk Level

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	• Fire from fuel storage area, generator and waste storage area • Worker behaviors (e.g, Smoking, careless using electricity & electronic devices)	• Fire hazard	• Can cause death • Damage to worker and project properties due to fire	5	2	10	Medium

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
	• Arson						

Mitigation Measure

- ✓ Sufficient fire protection equipment and fire extinguishers are provided.
- ✓ Combustible wastes are disposed regularly and stored separately.
- ✓ Awareness about dos and don'ts for waste storage and fuel storage is given.
- ✓ To train the fire drill for emergency cases every 6 month.
- ✓ To put the safety & warning signs at fuel storage areas, generator, etc.
- ✓ To repair the broken electronic devices and wires immediately by electrician.
- ✓ Only permit person allow to access to fuel storage area.
- ✓ To put the emergency contact numbers in public area of project area.
- ✓ To plan for fire training every 6 months.

5.11.4.1. Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "level 1", not expected to occur but still possible. Therefore, the residual risk level is "Medium" as shown in Table 5-123.

Table 5-123 Residual Fire Risk Level

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	

Risk Evaluation for Occupational Health and Safety							
Hazard Identification			Risk Evaluation				Status of Risk
No.	Source	Hazard	Possible injury	Severity	Like-lihood	Risk Priority Number (RPN)	
1	• Fire from fuel storage area, generator and waste storage area • Worker behaviors (e.g, Smoking, careless using electricity & electronic devices) • Arson	• Fire hazard	• Can cause death • Damage to worker and project properties due to fire	5	1	5	Medium

5.12. RISK ASSESSMENT METHODOLOGY FOR NATURAL DISASTER RISK

A qualitative or quantitative approach to determine the nature and extent of disaster risk by analyzing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend. The risk assessment methodology for natural disaster risk is 5 × 5 Matrix Risk assessment methodology based on likelihood and consequences. [3] A type of risk matrix that is visually represented as a table or a grid, a 5x5 risk matrix has 5 categories each for consequences (along the X axis) and likelihood (along the Y axis), all following a scale of low to high.

5.12.1. Consequences

Consequences are used to determine the criticality of the risk. The consequences of this methodology are based on the number of injuries, potential damages and financial impacts. The level of consequences is insignificant, minor, moderate, major and catastrophic. The specific criteria of each level are shown in Table 5-124.

Table 5-124 Criteria for rating the status of consequences

Severity	Description
Catastrophic	Death or Major Injuries Toxic Environmental Damage >> $1,000,000 Damage
Major	Extensive Injures High Environmental Damage << $ 1,000,000 Damage
Moderate	External Medical Medium Environmental Damage << $ 100,000 Damage
Minor	Some First Aid required Low Environmental Damage <<$10,000 Damage
Insignificant	No injuries First Aid No Environmental Damage << $ 1,000 Damage

[3] *kevinian.com*

5.12.2. Likelihood

Likelihood is the probability that something might happen. The level of likelihood is rare, unlikely, possible, likely and almost certain. The specific criteria of each level is shown in Table 5-125.

Table 5-125 Criteria for rating the status of likelihood

Severity	Description
Almost Certain	Expected in normal circumstances (100%)
Likely	Probably occur in most circumstances (10%)
Possible	Might occur at some time. (1%)
Unlikely	Could occur at some future time. (0.1 %)
Rare	Only in exceptional circumstances (0.01 %)

5.12.3. Risk Classification (5 × 5 Risk Matrix)

The first step is to assign the value from insignificant to catastrophic in consequence and the value from rare to almost certain in likelihood. Insignificant is the lowest and catastrophic is the highest value in consequence. Rare is the lowest and almost certain is the highest value in likelihood.

The green zone is a low danger level, the yellow zone is a moderate risk level, the orange zone is a high-risk level, and the red zone is a critical risk level. The detail descriptions are shown in Table 5-126.

Table 5-126 Risk Assessment Matrix for Natural Disasters

		CONSEQUENCES				
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
LIKELIHOOD	**Almost Certain**	Moderate Risk	High Risk	High Risk	Critical Risk	Critical Risk
	Likely	Moderate Risk	Moderate Risk	High Risk	High Risk	Critical Risk
	Possible	Low Risk	Moderate Risk	High Risk	High Risk	Critical Risk

		CONSEQUENCES				
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
	Unlikely	Low Risk	Moderate Risk	Moderate Risk	High Risk	High Risk
	Rare	Low Risk	Low Risk	Moderate Risk	Moderate Risk	High Risk

5.13. ASSESSING AND MITIGATING NATURAL DISASTER RISK

5.13.1. Earthquake

The major tectonics of Myanmar comprises of the subduction zone of Indian Plate beneath Burma Plate in the west, and the collision zone of Indian Plate with Eurasia Plate in the north. The rate of subduction is 35 – 50 mm/yr and the direction of subduction is NE to NNE [1]. The other major structures present within Myanmar are the major fault systems of well-known Sagaing fault, Kyaukkyan fault, Gwegyo thrust, and West BagoYoma fault. Most of the earthquakes, which occurred in the central region of Myanmar, are related with Sagaing fault, and in the eastern part, the focal depth is not greater than 40 km while the earthquakes in the western portion include from shallow, through intermediate to deep focus earthquakes.

The Sagaing fault is an active right lateral strike slip fault crossing from north to south through Myanmar. Shallow strong earthquakes occur along the Sagaing fault. Based on the seismicity and the records of the previous considerably high magnitude earthquakes, the region which includes the proposed Amarapura urban development project site can be assumed as medium to high seismicity region. Some of the large earthquakes that caused the considerable damages to some buildings and some casualties in and around Mandalay can be recognized in the past records.

5.13.1.1. Construction Phase

In the construction phase, worker can cause injuries and damage to project properties by earthquake. Liquification and ground subsidence can also occur due to the earthquake. The level of consequence is assumed as “Minor” due to low environmental damage and some first aid required. The level of likelihood is assumed as “Likely” because the risk potential is probably occurred in most circumstances. The calculated risk level is “Moderate” and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of earthquake risk level is shown in Table 5-127.

Table 5-127 Assessment of Earthquake Risk Level on construction phase

Risk Evaluation for Occupational Health and Safety						
Hazard Identification			Risk Evaluation			Status of Risk
No.	Source	Hazard	Possible injury	Consequence	Like-lihood	
1	• Natural Hazard	• Earthquake • Liquification and ground subsidence due to Earthquake	• Worker Injuries • Damage to project properties	Minor	Likely	Moderate Risk

Mitigation Measure

- ✓ Make and follow the emergency plan for the evacuation and rescue of individuals.
- ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box).
- ✓ Arrange for delivery to the clinic or nearest hospital for emergency.
- ✓ Greater focus on geotechnical investigations to reduce the risk of unsatisfactory foundation performance of each building site.
- ✓ Since this area is close to the Sagaing Fault, when constructing the buildings, it should be made in an accordance with detailed earthquake micro-zonation maps and chosen the type of foundation that can withstand earthquake.
- ✓ In Geotechnical conceptual design report, the calculated LPI values showing that after densification and landfill construction, full liquefaction during design earthquake conditions is not to be expected. Hence, the new CPTu measurements should be done to explore engineering properties of subsoils and the situation of liquefaction potential after densification and construction of the landfill.
- ✓ In case of an earthquake, liquefaction potential analysis and settlement probability based on new CPTu measurements after landfilling should be provided with detailed layer by layer calculations.
- ✓ Deep piles should be designed to accommodate an appropriate level of lateral movement of the surface crust even if they are far from any watercourse where there is a possibility of severe liquefaction.

- ✓ Long term and short-term earthquake monitoring system or earthquake warning system should be installed in place based on the precursors of an earthquake such as the sudden rise of groundwater, the changes of elasticity in rocks and soils, etc.

5.13.1.1.1 Residual Risk

The likelihood of the risk will not be decrease after implement the mitigation measures but consequence of the risk will be decrease. The residual consequence for this process is assumed as "Insignificant", no injuries first aid and no environmental damage. Therefore, the residual risk level is "Moderate" as shown in Table 5-128.

Table 5-128 Residual Earthquake Risk Level

Risk Evaluation for Occupational Health and Safety						
Hazard Identification			**Risk Evaluation**			**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Consequence**	**Like-lihood**	
1	• Natural Hazard	• Earthquake • Liquification and ground subsidence due to Earthquake	• Worker Injuries • Damage to project properties	Insignificant	Likely	Moderate Risk

5.13.1.2. Operation/ Maintaining Phase

In the operation/ maintaining phase, worker and resident can cause injuries as well as damage to project properties by earthquake due to collapse of building. The level of consequence is assumed as "Major" due to high environmental damage and extensive injuries can cause. The level of likelihood is assumed as "Likely" because the risk potential is probably occurred in most circumstances. The calculated risk level is "High" and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of earthquake risk level is shown in Table 5-129.

Table 5-129 Assessment of Earthquake Risk Level on operation/ maintaining phase

Risk Evaluation for Occupational Health and Safety		
Hazard Identification	**Risk Evaluation**	**Status of**

No.	Source	Hazard	Possible injury	Consequence	Like-lihood	Risk
1	• Natural Hazard	• Earthquake • Liquification and ground subsidence due to Earthquake	• Extensive Injuries/ High Environmental Damage • Damage to project properties	Major	Likely	High Risk

Mitigation Measure

- ✓ Long term and short-term earthquake monitoring system or earthquake warning system should be installed in place based on the precursors of an earthquake such as the sudden rise of groundwater, the changes of elasticity in rocks and soils, etc.
- ✓ Make and follow the emergency plan for the evacuation and rescue of individuals.
- ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box).
- ✓ Arrange for delivery to the clinic or nearest hospital for emergency.

5.13.1.2.1 Residual Risk

The likelihood of the risk will not be decrease after implement the mitigation measures but consequence of the risk will be decrease. The residual consequence for this process is assumed as "Insignificant", no injuries first aid and no environmental damage. Therefore, the residual risk level is "Moderate" as shown in Table 5-130.

Table 5-130 Residual Earthquake Risk Level

Risk Evaluation for Occupational Health and Safety						
Hazard Identification			Risk Evaluation			Status of Risk
No.	Source	Hazard	Possible injury	Consequence	Like-lihood	
1	• Natural Hazard	• Earthquake • Liquification and ground subsidence due to Earthquake	• Worker Injuries • Damage to project properties	Insignificant	Likely	Moderate Risk

5.13.2. Floods Risk Assessment

Since the project area is established, this low -land area will be fill up and raised the elevation to and existing City Circular Road level flooding from river will no longer affect the project and will also act as flood protection to nearby residential areas which were previously flood prone in the future. In the construction phase, some part of the project area is still need to land fill and construct dike wall to protect the floods. Therefore, the flood may happen in construction phase. To reduce the flood risk, land filling will take place during the dry season as well as the monsoon season in regions where flood protection structures such as revetments have been constructed.

As another reason of flooding, river morphology specifically sedimentation is one of the reasons. The project area lies between the sediment production zone and sediment deposition zone of the Ayeyarwady river. Therefore, a large amount of sediment enters from upstream, causing the development of slowly moving sand bars and islands that migrate through the Mandalay reach. Consequences, the changes in the shape or morphology of the river bed and it can become the flood. Particularly, since the duration of operation/ maintaining phase is long, the potential flood risk may occur.

For Amarapura Urban Development Project, River Engineering Assessments was carried out by Dr. Kees Sloof (Deltares) and pier reviewed by Henery Opdam. Some main parts of their assessments and recommendations are shown in EIA Report (Section 4.5, Pg 4-57~Pg 4-73). To determine the relevant flood conditions for risk-assessment of Mandalay - analysis of historical development of channels and bars from satellite imagery, and detailed morpho dynamic and hydrodynamic Delft3D model simulations have been used to explain the changes in morphology and flow that affect the project area.

The simulations show that the bed-level changes are within the range of natural variations, and do not pose any risk to the surrounding areas and the project. The project stabilizes the main channel. Maximum rise of flood-levels just upstream the project, at Mandalay, is found to be 0.1 m to 0.2 m and that may occur within short term first year. This affect upstream over a distance of several tenths of kilometers, gradually decaying in upstream direction (backwater). There are no impacts on flood levels downstream. The effect is limited because the largest effects occur in the wide part of the river (islands and channels opposite of Mandalay water front). Also, its (backwater) extension in upstream direction is located on the very wide flood plain section that extends upstream of Mandalay. In time, the water level rise at floods will reduce and disappear due to the deepening of the river bed by erosion (as an effect of the project). When the river bed has eroded to its final level (dynamic equilibrium) after some decades, the flood levels will be equal or lower than the situation without project. The (initial) flood-level rise can be reduced by dredging of the river channel next to the plan to set-it more quickly to its final equilibrium level. The assessment of flood risk is described in Table 5-131.

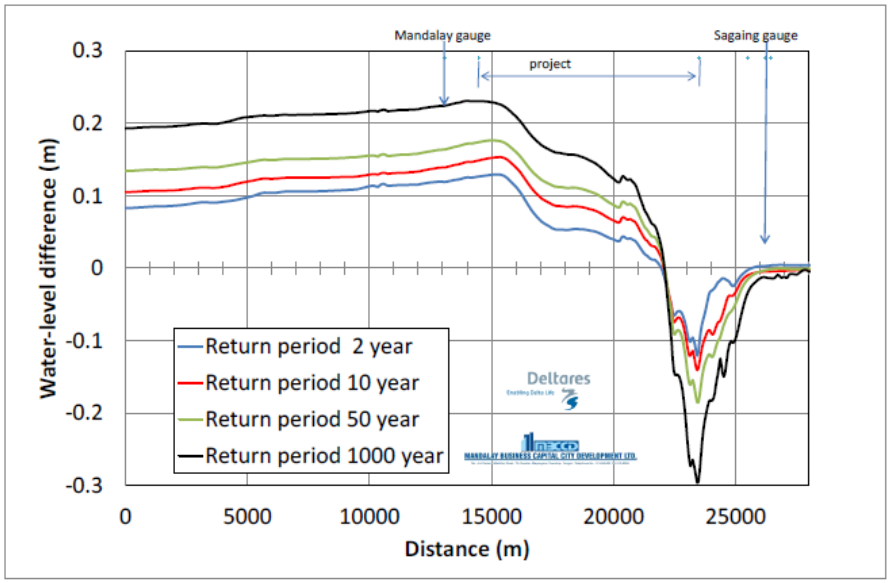


Figure 5-7 Computed water-level difference plotted along the river axis for different return periods

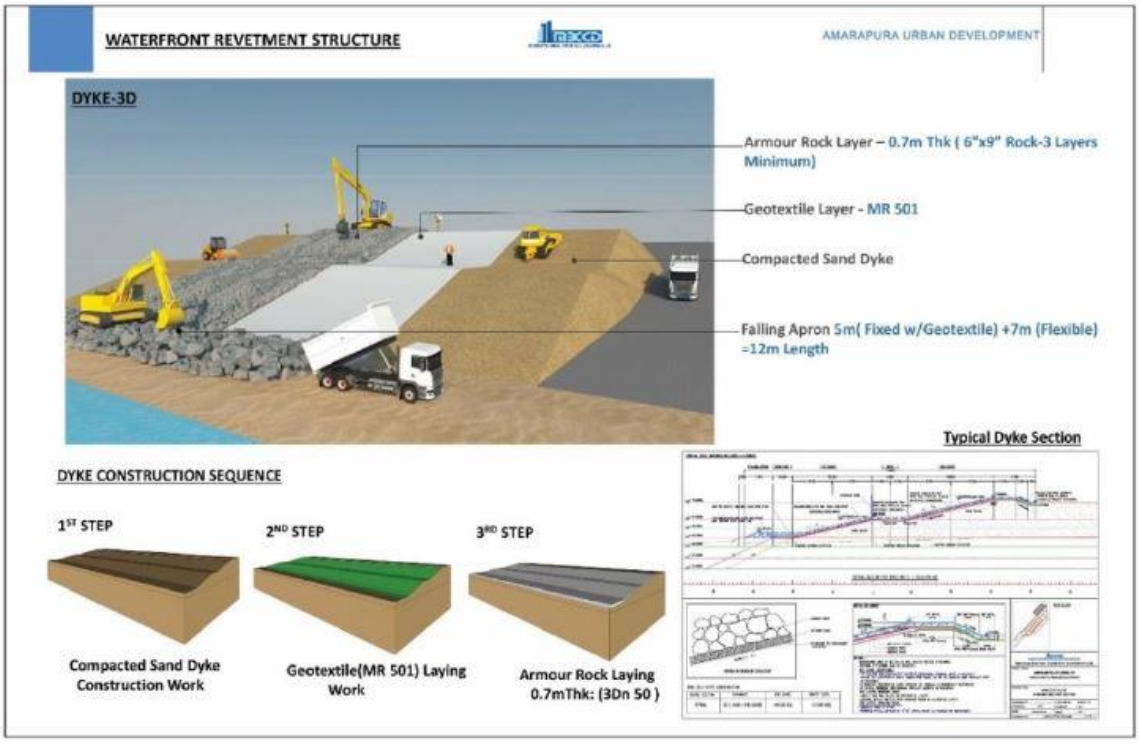


Figure 5-8 Flood Protection Dyke Design

Table 5-131 Assessment of Flood Risk

Hazard Identification			Risk Evaluation			Status of Risk
No.	**Source**	**Hazard**	**Possible Effect**	**Consequence**	**Like-lihood**	
1	**Sand filling**	• Flooding	• Reduce waterlogging in areas prone to flooding • If not properly compacted, it may lead to settlement issue • Disrupt local ecosystems and wildlife habitats. • It may lead to environmental degradation of natural sand resources	Major	Likely	High Risk
2	**Ground level up**	• Flooding	•Improper implementation may occur in water flowing to other locations, raising the possibility of flooding in those places. • It can cause soil erosion • If the ground level is change, it can be changed in the local ecosystem. • It can lead to stability issues •	Moderate	Possible	High Risk
3	**Reclamation**	• Flooding	• Change ecosystem and loss of habitat • Ground subsidence •	Moderate	Possible	High Risk

Hazard Identification			Risk Evaluation			Status of Risk
No.	**Source**	**Hazard**	**Possible Effect**	**Consequence**	**Like-lihood**	
4	**Dykewall Construction**	• Flooding	• It can change natural water flow pattern • The natural floodplains and wetlands may become more difficult to access. • Structural failures might outcome from poorly built systems.	Major	Likely	High Risk

5.13.2.1. Mitigation Measures for flooding due to sand filling, ground level up, reclamation, dykewall construction

A comprehensive approach is needed to mitigate flooding caused by dyke-wall building, ground level rise, reclamation, and sand filling. The mitigation measures are as follow:

- It must be based on detailed River Engineering Assessment reports to understand changes in water flow patterns and flood risks due to sand filling and ground level changes.
- Dyke-walls must be constructed with the capacity to withstand the expected flood levels in consideration, accounting for extreme weather and climate change.
- During dyke-wall construction, strength resistant geotextiles must be used to stabilize the soil and prevent erosion when the dyke-wall construction stage.
- To guarantee the structural integrity of dike walls, perform routine maintenance and inspections.
- Install drains that are an adequate size for efficiently controlling runoff.
- To improve water infiltration and stabilize the soil, grow native trees, shrubs, and grasses.
- Create planted buffers along waterways to filter runoff and reduce sedimentation.
- Make certain that the sand fill is adequately compacted in order to minimize erosion and improve stability.
- Regularly maintain and inspect to dykes, drainage systems, and other flood control infrastructure.
- Develop and implement maintenance plans to ensure the long-term effectiveness of mitigation measures.

By combining these measures, the risk of flooding caused on by dyke-wall building, reclamation, ground level raising, and sand filling can be significantly decreased, protecting the sustainability and safety of the reclaimed areas.

According to the simulation result of the Deltares and current situation of river, there is not any risk to the surrounding areas and the project. As shown in the figure, the result is that before starting the revetment structure (left side of Figure), the main channel bed level was shallow during the dry season and braided sand bars are disturbing the navigation way. The depth may be about 0-2 m from low water level +61.30msl, so it is difficult to trip some Berge and ships. After the construction of revetment structure (right side of figure), it stabilizes the main channel. The depth of the channel (shown in blue color) was greater than 4m and the cyan color between 2~4 m.

The project proponent also regularly conducted hydrographic surveys along the river channel and the results agree well with the simulations. People can see that the revetment structure of the project is acting like a river training structure, rather than eroding sideways, it deepens the river channel and as a result there is significant improvement in the river navigation way.

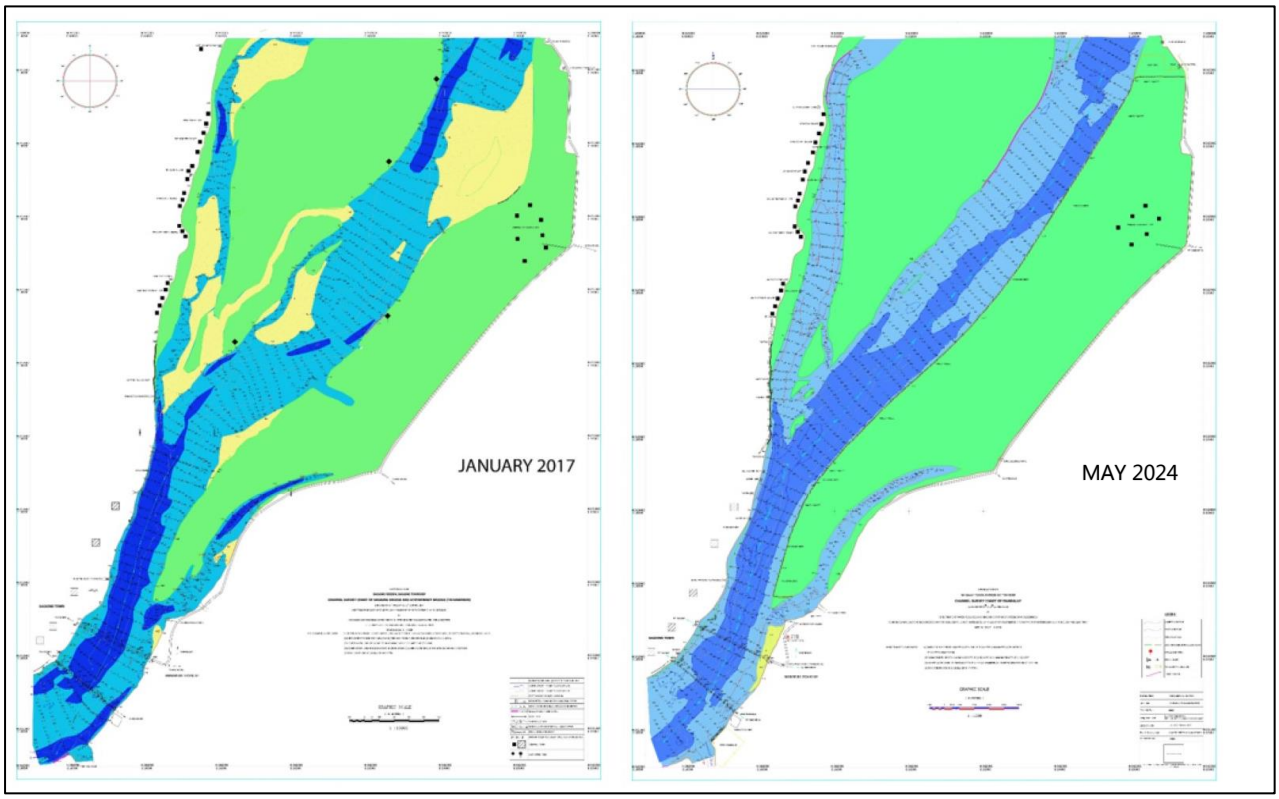


Figure 5-9 The Main Channel Bed of the River

For the neighborhood side of the project area, significant changes are not observed yet in current situation. The construction permits of the revetment structure issued by DWIR instructed that if some significant changes occur in the river channel such as significant bank erosion of the opposite side of the project and deterioration of the navigation channel, the company is responsible for those cases.

For the pre-engineering stage protection and emergency response purposes, MBCCD will handle the following facts promptly in close consultation with DWIR.

They are:

1. Monitoring river bed elevation & bank line with hydro-survey every month
2. Making river training and bank protection such as Steel groynes, Myaw groyne, protection with geotextile by the instructions and technical advices of DWIR
3. Stay alert and keep monitoring during high flood time.
4. Storing geotextile, sand bags and rockfill for emergency cases.

5.13.2.2. Construction Phase

There wil be no impact since the site preparation and construciton will be taken place after the land is raised to non-flooded level. the land filling will be taken place during dry season as well as duirng monsoon season in the areas where construction of flood protection structures such as revetment has been completed.

In assessment of flood risk on construction phase, the level of consequence is assumed as “Minor” due to low environmental damage and some first aid required. The level of likelihood is assumed as “Possible” because the risk potential might occur at some time. The calculated risk level is “Moderate” and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of flood risk level is shown in Table 5-132.

Table 5-132 Assessment of of Occupational Health and Safety on Flood Risk Level

Construciton Phase						
Hazard Identification			Risk Evaluation			Status of Risk
No.	Source	Hazard	Possible injury	Consequence	Like-lihood	

Construciton Phase						
Hazard Identification			**Risk Evaluation**			**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Consequence**	**Like-lihood**	
1	• Natural Hazard	• Flood	• Worker Injuries • Damage to project properties	Minor	Possible	Moderate Risk

Mitigation Measure

- ✓ Strictly checking during land filling process to reach the calculated elevation level according conceptual report. (+73.50 m in northern part and +73.00 m in southern part)
- ✓ Since bank line rises 1 meter above 95% confidence water level (m+MSL), one-meter difference is not a reliable situation if there is a flash flood. When using water level data, it is considered that a more accurate conclusion can be drawn if we calculate using the highest water level data.
- ✓ Since there is not too much variation in elevation between the level of the river and the level of the land where it is necessary to make the landfill with a suitable height and a type of soil having good engineering properties.
- ✓ Make and follow the emergency plan for the evacuation and rescue of individuals.
- ✓ Constantly listening the weather reports to know the possibility of natural disasters such as storms and flood.
- ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box).
- ✓ Arrange for delivery to the clinic or nearest hospital for emergency.
- ✓ River velocity monitoring must be conducting one time per year.
- ✓ Regular monitor and make record the measurement of riverbed level during Dry and Rainy seasons.
- ✓ Monitoring systems for river bank erosion and the stability of retaining walls should be implemented with a long-term plan.

5.13.2.2.1 Residual Risk

The likelihood of the risk will not be decrease after implement the mitigation measures but consequence of the risk will be decrease. The residual consequence for this process is assumed as “Insignificant”, no injuries first aid and no environmental damage. Therefore, the residual risk level is “Low” as shown in Table 5-133.

Table 5-133 Residual Flood Risk Level

Construction Phase						
Hazard Identification			**Risk Evaluation**			**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Consequence**	**Like-lihood**	
1	• Natural Hazard	• Flood	• Worker Injuries • Damage to project properties	Insignificant	Possible	Low Risk

5.13.2.3. Operation/ Maintaining Phase

The dyke wall structure is complete in operation/ maintaining phase thus the flood risk on rainy season is decrease a lot. In assessment of flood risk on operation/ maintaining phase, the level of consequence is assumed as “Insignificant” due to no environmental damage and no injuries first aid. The level of likelihood is assumed as “Possible” because the risk potential might occur at some time. The calculated risk level is “Low” and thus, the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers. The assessment of flood risk level is shown in Table 5-134.

Table 5-134 Assessment of of Occupational Health and Safety on Flood Risk Level

Operation / Maintenance Phase						
Hazard Identification			**Risk Evaluation**			**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Consequence**	**Like-lihood**	
1	• Natural Hazard	• Flood	• Damage to project properties	Insignificant	Possible	Low Risk

Mitigation Measure

- ✓ Make and follow the emergency plan for the evacuation and rescue of individuals.
- ✓ Constantly listening the weather reports to know the possibility of natural disasters such as storms and flood.
- ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box).
- ✓ Arrange for delivery to the clinic or nearest hospital for emergency.
- ✓ River velocity monitoring must be conducting one time per year.
- ✓ Regular monitor and make record the measurement of riverbed level during Dry and Rainy seasons.
- ✓ Monitoring systems for river bank erosion and the stability of retaining walls should be implemented with a long-term plan.

5.13.2.3.1 Residual Risk

The likelihood of the risk will not be decrease after implement the mitigation measures but consequence of the risk will be decrease. The residual consequence for this process is assumed as "Insignificant", no injuries first aid and no environmental damage. Therefore, the residual risk level is "Low" as shown in Table 5-135.

Table 5-135 Residual Flood Risk Level

Operation / Maintenance Phase						
Hazard Identification			**Risk Evaluation**			**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Consequence**	**Like-lihood**	
1	• Natural Hazard	• Flood	• Worker Injuries • Damage to project properties	Insignificant	Possible	Low Risk

5.13.3. Ground Subsidence

Ground Subsidence takes place when loosely packed, water-logged sediments at or near the ground surface lose their strength in response to strong ground shaking. Ground Subsidence and liquefaction occurring beneath buildings and other structures can cause major damage during earthquakes. In addition, overexploitation of groundwater is also a

contributing factor to liquefaction. There is the potential liquefaction risk in the project area if not proper soil compaction because the project area is situated along the river side.

5.13.3.1. Construction Phase

In the construction phase, there is no significant risk in the project area due to ground subsidence and liquefaction. In assessment of ground subsidence risk, the level of consequence is assumed as "Insignificant" due to no injuries first aid and no environmental damage. The level of likelihood is assumed as "Unlikely" because the risk occurs at some future time. The calculated risk level is "Low" but the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers in the operation phase. The assessment of ground subsidence risk level is shown in Table 5-136.

Table 5-136 Assessment of ground subsidence Risk Level

Risk Evaluation for Occupational Health and Safety						
Hazard Identification			Risk Evaluation			Status of Risk
No.	Source	Hazard	Possible injury	Consequence	Likelihood	
1	• Natural Hazard	• Ground Subsidence • Liquefaction	• Damage to project properties	Insignificant	Unlikely	Low Risk

Mitigation Measure

- ✓ Greater focus on geotechnical investigations to reduce the risk of unsatisfactory foundation performance of each building site.
- ✓ Deep piles should be designed to accommodate an appropriate level of lateral movement of the surface crust even if they are far from any watercourse where there is a possibility of severe liquefaction.
- ✓ Groundwater use should not exceed the amount of water that can be extracted based on the results of the pumping test.
- ✓ Strictly checking and conducting soil improving process using Vibro-floatation method to get the necessary relative density.
- ✓ Since clay layers are found near Myo Patt Road, at the east side of the project area where settlement potential can be happened according to the laboratory

measurement mentioned in Geotechnical conceptual design report, the settlement problem should be rechecked and foundation design for buildings should be selected with the suitable settlement resistance design like mat foundation in this area after landfilling.

- ✓ Conduct ground level geotechnical survey every 6 months.

5.13.3.1.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "Rare", not likely to occur under normal circumstances. Therefore, the residual risk level is "Low" as shown in Table 5-137.

Table 5-137 Residual ground subsidence Risk Level

Risk Evaluation for Occupational Health and Safety						
Hazard Identification			**Risk Evaluation**			**Status of Risk**
No.	**Source**	**Hazard**	**Possible injury**	**Consequence**	**Likelihood**	
1	• Natural Hazard	• Ground Subsidence • Liquefaction	• Damage to project properties	Insignificant	Rare	Low Risk

5.13.3.2. Operation/ Maintaining Phase

In the operation/ maintaining phase, water usage in the project area is supply from underground water. Therefore, there is a potential liquification risk along the operation phase due to extraction water from aquifer. In assessment of ground subsidence risk on operation/ maintaining phase, the level of consequence is assumed as "Major" due to it can be high environmental damage and extensive injuries. The level of likelihood is assumed as "Unlikely" because the risk occurs at some future time. The calculated risk level is "High" but the following mitigation measures must be followed to avoid or reduce causing unwanted harm and damage to the environment and workers in the operation phase. The assessment of ground subsidence risk level is shown in Table 5-138.

Table 5-138 Assessment of ground subsidence Risk Level

Industrial Risk Evaluation for Occupational Health and Safety		
Hazard Identification	**Risk Evaluation**	**Status**

No.	Source	Hazard	Possible injury	Consequence	Likelihood	of Risk
1	• Natural Hazard	• Ground Subsidence • Liquefaction	• Damage to project properties	Major	Unlikely	High Risk

Mitigation Measure

- ✓ Conduct ground level geotechnical survey every 6 months.
- ✓ Groundwater use should not exceed the amount of water that can be extracted based on the results of the pumping test.
- ✓ Should use the water from Ayeyarwady river in project area as an alternative domestic water source.

5.13.3.2.1 Residual Risk

The severity of the risk will not be decrease after implement the mitigation measures but the likelihood of the risk will be decrease. The residual likelihood for this process is assumed as "Rare", not likely to occur under normal circumstances. Therefore, the residual risk level is "Moderate" as shown in Table 5-139.

Table 5-139 Residual ground subsidence Risk Level

Risk Evaluation for Occupational Health and Safety						
Hazard Identification			Risk Evaluation			Status of Risk
No.	Source	Hazard	Possible injury	Consequence	Likelihood	
1	• Natural Hazard	• Ground Subsidence • Liquefaction	• Damage to project properties	Major	Rare	Moderate Risk

5.14. CUMULATIVE IMPACT ASSESSMENT

The project area is located in the Amarapura Township as described in previous chapter. There are three locations can be affected on the cumulative impact near project area. The cumulative impacts that could result from a variety of projects operating physically adjacent to the Project in the future must be taken into account when assessing the Project's

effects on a specific resource. The description of affected project' information is presented in Table 5-140.

Table 5-140 Brief description of cumulative impacts

No.	Project Name	Description
1.	Shwege Stormwater Pumping Station	The estimated amount of wastewater generation is 4.75 million gallon per hour[4]
2.	Shwe Kyat Yat Port of Mandalay[5]	• General cargo and fuel port • Mobile crane (25MT, 35 MT, 17 MT) from a barge for loading & off-loading, 20 ft containers use in the port. • The port is accessible for vessels and barges up to 1000 GRT. • Maximum draft in the dry season is around 1.2 m. • There is no connection to the railroad • The maximum draft is 2.1 m (7ft) and average draft along the river is 1.2m (4ft) in the dry season. • Maximum vessel size is 60m (200ft) length, 1000 GRT. • 60 vessels visit average per month, about 720 vessels per year. • Near jetty (1) is a fuel barge with diesel for boats, which is being refueled regularly from a government refinery in Chauk.
3.	Road near project site	• Vehicles passing through the Myo-Patt road • According to the survey result of HA survey team, currently, the average traffic flow was nearly 900 vehicles/hr in the study area. (max-1,500, min.- 180)

[4] https://m.facebook.com/permalink.php?id=326426220895438&story_fbid=1500473270157388

[5] https://dlca.logcluster.org/2115-myanmar-mandalay-port-mandalay

Shwe Kyat Yet Port

Shwege Stormwater pumping station[6]

Vehicles from Myo-Pat Road

Figure 5-10 Adjacent Conditions

[6] The Mandalay News Journal

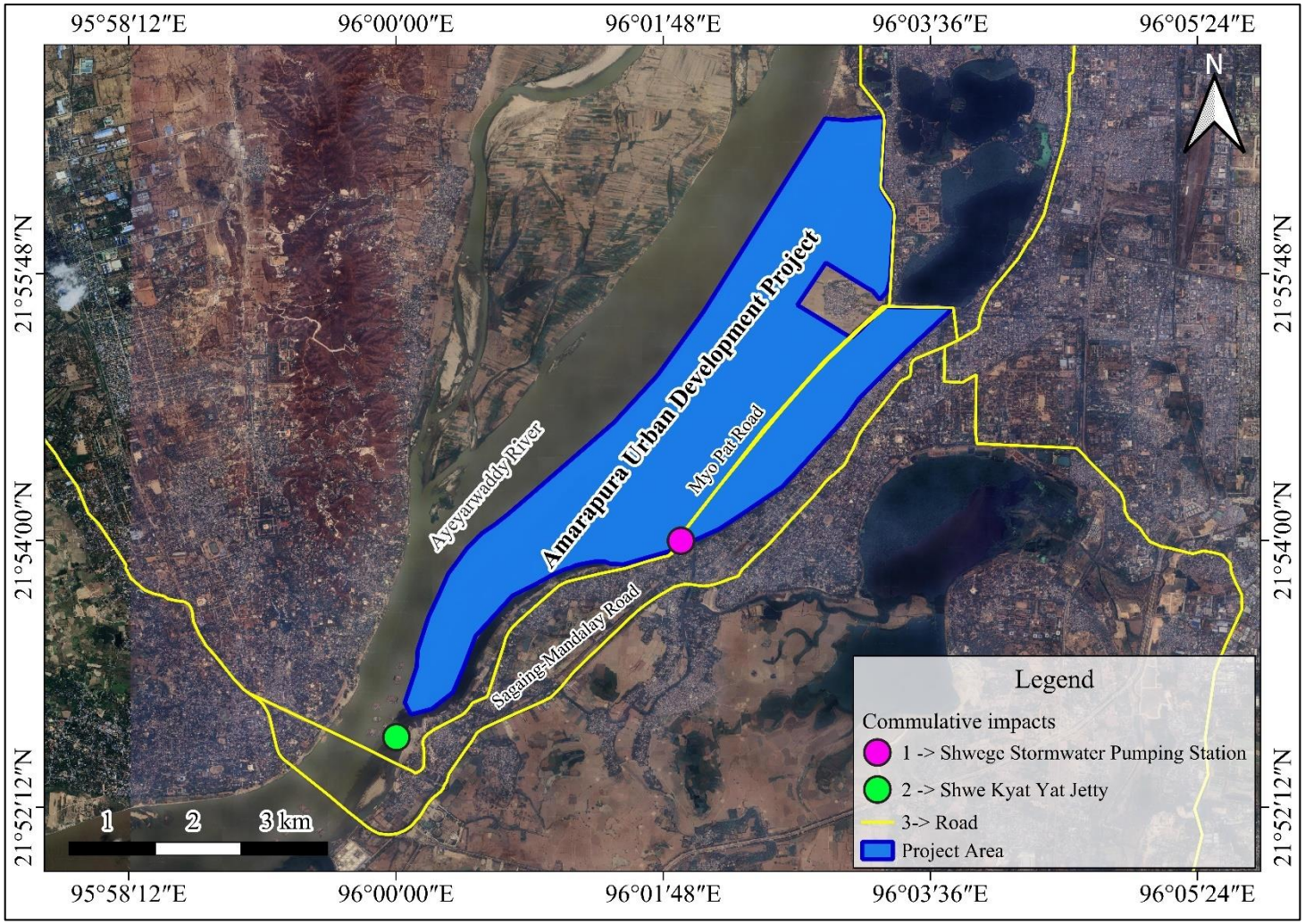


Figure 5-11 Cumulative impacts assessment map

5.14.1. Impact Assessment of the affected projects

The three projects included in the study area were recognized as having the cumulative effects on the following environmental items, which should be taken into account. The methodology of impact assessment is presented in section (5.4) and the result of the assessment is described in Table 5-130. Summarizes the assessment of each item are in the following Table 5-142.

Table 5-141 Significance Classess of all Three Projects

No	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Pre-Mitigation of Air Pollution										
Construction Phase	3	3	4	3	-1	-3	4	-13	Medium	Negative
Operation/Maintenance Phases	3	5	4	3	-1	-3.75	3	-11.25	Medium	
Post-Mitigation of Air Pollution										
Construction Phase	3	3	2	2	-1	-2.5	2	-1.25	Low	Negative
Operation/Maintenance Phases	3	4	3	3	-1	-2.5	3	-1.08	Low	
Pre-Mitigation of Water Pollution										
Construction Phase	3	3	3	3	-1	-3	3	-9	Medium	Negative
Operation/Maintenance Phases	3	5	4	4	-1	-4	5	-20	High	
Post-Mitigation of Water Pollution										
Construction Phase	3	3	2	3	-1	-2.75	3	-8.25	Low	Negative
Operation/Maintenance Phases	3	5	4	4	-1	-4	5	-20	High	
Pre-Mitigation of Waste Pollution										
Construction Phase	3	3	3	3	-1	-3	4	-12	Medium	Negative
Operation/Maintenance Phases	3	5	3	4	-1	-3.75	4	-15	Medium	
Post-Mititagation of Waste Pollution										

No	Consequence C = ((E + D + I + R)/4) *N						Probability (P)	Environmental Impact Score (EI = C x P)	Significance Classes	Status of Impact
	E	D	I	R	N	C				
Construction Phase	3	3	3	3	-1	-3	3	-9	Medium	Negative
Operation/Maintenance Phases	3	5	3	4	-1	-3.75	4	-15	Medium	
Pre-Mitigation of Noise and Vibration										
Construction Phase	3	3	4	4	-1	-3.5	5	-17.5	High	Negative
Operation/Maintenance Phases	3	5	4	3	-1	-3.75	4	-15	Medium	
Post – Mitigation of Noise and Vibration										
Construction Phase	3	3	3	3	-1	-3	4	-12	Medium	Negative
Operation/Maintenance Phases	3	5	3	2	-1	-2.75	3	-9.75	Medium	
Pre-Mitigation of Biodiversity										
Construction Phase	3	3	3	4	-1	-3.25	4	-13	Medium	Negative
Operation/Maintenance Phases	3	4	2	3	-1	-3	3	-9	Medium	
Post – Mitigation of Biodiversity										
Construction Phase	3	3	2	3	-1	-2.75	3	-8.25	Low	Negative
Operation/Maintenance Phases	3	4	2	2	-1	-2.75	3	-8.25	Low	

Table 5-142 Final Environmental Significance Rating of all Three Projects

No	Priority (P = PR + CI+ LR)				Ranking	Prioritization Factor (PF)	Environmental Significance (PF*EI)	Rating	Status of Impact
	PR	CI	LR	P					
Air Pollution									
Construction Phase	1	2	1	4	Medium	1.5	-1.875	Low	Negative
Operation/Maintenance Phases	2	2	1	5	Medium	1.5	-1.62	Low	
Water Pollution									
Construction Phase	1	3	3	7	Medium	1.5	-12.375	Low	Negative
Operation/Maintenance Phases	2	3	3	8	Medium	1.5	-30	High	
Waste Pollution									
Construction Phase	1	3	2	6	Medium	1.5	-13.5	Low	Negative
Operation/Maintenance Phases	2	3	3	8	Medium	1.5	-22.5	Medium	
Noise and Vibration									
Construction Phase	1	3	2	6	Medium	1.5	-18	Medium	Negative
Operation/Maintenance Phases	2	3	2	7	Medium	1.5	-14.625	Low	
Biodiversity									
Construction Phase	1	2	3	6	Medium	1.5	-12.375	Low	Negative
Operation/Maintenance Phases	1	2	3	6	Medium	1.5	-12.375	Low	

Table 5-143 Summarizes the assessment of each item

No.	Environmental Item	Impact Assessment
1.	Air Quality	When all three projects start their operation and all the tenants in the Loading & un loading, logistic, commercial areas and transportation activities of three projects start their operation, the air pollution can impact on the surrounding area. In addition, traffic volume will be increased cumulatively in and around the study area. In this assessment, CO_2, SO_2, NO2 and PM concentration was selected to be estimated due to vehicle traffic and jetty operation's vehicles increased by the port and proposed projects. Therefore, impact on air quality generation from these three projects should be assessed.
2.	Water Quality	In the project plan, drainage water and wastewater from the project area will enter to the wastewater treatment plant and the wastewater will be discharged to Ayeyareaddy River from the (11) outlets. In addition, the wastwewater from Shwege Stormwater Pumping Station will also discharge the Ayeyarwaddy river. Besides, the oil & fuel can leakage from the vehicles form jetty's operation Therefore, cumulative impact should be assessed on water quality of Ayeyarwaddy River when all of three projects start their operation.
3.	Noise and Vibration	When all three projects start their operation and all the tenants in the Logistic from Jetty, operate the water pump from Shwege and residential & commercial areas of the proposed projects start their operation, the noise and vibration pollution can be impacted on the environment. Traffic volume due to transportation system will be increased cumulatively in and around the project area. Therefore, impact of noise and vibration generation from all three projects should be assessed.
4.	Waste	When all three projects operation is going to increase, amount of domestic and operation waste generated from the projects will

No.	Environmental Item	Impact Assessment
		proportionately be increased. Therefore, it is needed to evaluate impact of generated wastes of the projects.
5.	Biodiversity	Change of land use and reduction of the habitat of species in the Project area will impact on ecosystem. Since land reclamation of the project, it had already conducted when this assessment started, cumulative impacts on ecosystem will be assessed by considering the change of each land area including grass land, shrub, and reservoirs caused by the development of whole project. Moreover, the aquatic animals can be mainly impacted due to the three project activities.

CHAPTER 6

PUBLIC CONSULTATION AND DISCLOSURE

6.1. Objective and Approach for Public Consultation and Disclosure

The objective of public consultation and disclosure is to provide project information and potential environmental impacts to the regulators, authorities and stakeholders. In this study, various stakeholders 'participations were made. This chapter will present the results of public consultation and information disclosure conducted for Amarapura Urban Development Project can be considered as the required element of the EIA process. This chapter presents the results of the public consultation and information disclosures, and plans for future public consultation and information disclosure during the period of the Environmental Impact Assessment (EIA) procedure (29 December 2019). The presentation, suggestion letter and relevant documents are sent to the government, villages and surrounding area to do public disclosure process.

The main objective of the meeting was to share project's planned activities and their associated potential impacts on the environment and society. The consultation program, participants feedback was also received which reflected the necessity and demand of the proposed project. Information dissemination and information sharing techniques will be used to inform the stakeholders regarding the action being taken in a program area through personal communication to make them aware about the project. Focused Group Discussions (FGDs) will be conducted in public consultation to cover different components of the project aims to increase local awareness about the forthcoming project as well as to incorporate their views, needs, priorities considering different positive and negative impact of the project. In addition, the comment and suggestion from meeting will be considered during the project implementation process.

There are two times public disclosure and consultation meeting in EIA process which one time in Scoping Stage and another is in EIA stage. In the scoping stage, the public disclosure meeting was held in three townships which are Amarapura, Chan Mya Thazi and Sagaing Townships. The public consultation meeting was also conduct in Swan Hotel, Mandalay in December, 2017. In addition, the disclosure meetings for EIA stage were done in Amarapura and Chan Mya Thazi Townships and public consultation meeting was held in Hotel Mandalay, Mandalay in July, 2023.

6.2. SUMMARY OF PUBLIC CONSULTATION AND DISCLOSURE IN SCOPING STAGE

6.2.1. Methodology of Public Disclosure in Scoping Stage

The methodology for the PD and PCM follows the guidelines of Environmental procedure (2015). Comments form for the PD is developed and printed for distribution. The consultant team and project proponent visited the wards and villages of stakeholders and

inform on the proposed project and potential impacts and mitigation. Necessary documents to distribute at the given places are 1) Notice for public disclosure and 2) Comment forms. The places were disclosed over the project are as follows.

Table 6-1 Lists of Location for the Public Disclosure

Village, Ward and Townships		
Amarapura Township	**Chan Mya Thazi Township**	**Sagaing Township**
Shan Kalay Kyun Village	Ayartun Ward	War Chat Village
Shwe Kyat Yet Village Tract	Sa Lone Ward	Pae Nga Sal Village
Moe Kaung Village	Thar Yar Shweku	Arr :Laung Village
Yin Taw Village		Hta Taw Village
Khauk Thwe Thauk		
Ka Tipar		
Tike Soe Village		
Khawar Village		
Kan Taw Village		
Kyan Tan Village		
Thapyaytan Village		
That Kal Taw Village		
Pauk Pauk Tan Ward		
Mya Hninthar		
Lat Yawe		
Koe Thinn		
San Yawe		
Tharyar Shweku		
Hman Tan		
Warkote		
Padamyar		

6.2.2. Result of Public Disclosure in Scoping Stage

The public disclosure was undertaken in January 2017. There are 10 places in three townships where over one hundred people are attended. A total of 28 villages/wards were interviewed to get the information on their socio-economic conditions related to the proposed project and to get their views, suggestions and perceptions related to the proposed project. There are some comments made from the local people in the comment forms, which were received from the public disclosure. Comments and suggestions were made by the heads of the village and villagers. The major comments and opinions are written in the collected feedback forms. Opinions of the villagers for that project are 90% are like and then other 10% are not like for that project.

According to the public disclosure of Shan Kalay Kyun village around the proposed project area most of the people like the proposed project and a few people do not like. Some of the villagers are worried that they will lose their own lands and agricultural land. Although the project proponent gives the new houses or apartments as compensation for their own

lands and properties, they feel unhappy to move another place. A few people want to improve their living standard therefore they want to get new houses or apartment and they support the proposed urban development project. They asked the project proponent to offer the job opportunities, water supply system, schools, upgraded roads, bridges, playgrounds, clinics and hospitals for the community. They asked to reduce the negative impacts on the community and they wish the project proponent to manage waste and wastewater systematically. They asked to construct a good and safe drainage system. Most people on other locations indicated that they would not worry about the MBCCD project, however some people had worries about it. The villagers wish to develop their villages and urged the project proponent to improve infrastructures like roads, schools, electricity and to provide job opportunities for local people.

Moreover, they asked the project proponent to build embankment to prevent flooding. In the public disclosure meetings, the project proponent discussed on the views, comments and suggestions of the stakeholders related to proposed project and gave the answers. The MBCCD agrees to make consideration on the comments and suggestions in implementing the proposed urban development project. Environment Myanmar Cooperative (EMC) recorded and analyzed the comments and suggestions so that those can be integrated into the EIA report preparation. It is judged that the PD is effective tools to make participation of the stakeholders in determining the impacts, mitigation measures and monitoring program and to incorporate the suggestions and views of the stakeholders into EIA report preparation.

	
Shan Kalay Kyun Village	Yin Taw Village
	
Koe Thaung Village	Kyan Tan Village

	
Shwe Kyet Yet	Ar Laung Village
	
War Chat	Pal Ngar Sal Village

Figure 6-1 Public Disclosure Activity in Scoping Stage

6.3. PUBLIC CONSULTATION MEETING IN SCOPING STAGE

In the scoping stage, the public consultation meeting was held in the following. The description about the meeting, participant and main question & answer and suggestion in the meeting are summarized in the Table 6-2, Table 6-3 and Figure 6-2.

Table 6-2 Description about the meeting

Date & Time	December 21,2016, 1:00 pm
Location	Swan Hotel, Mandalay
Government organizations and villages attending the meeting	1. Parliament Members 2. Government Department 3. Third Party Organization, 4. Local NGOs 5. Township Administration Officers 6. Villagers 7. MBCCD Ltd.
Attendees	Over 250 persons

Participant in the project presentation	1. U Aung Kyaw Myint (Head of MP of Mandalay Region)	
	2. Minster Myo Thein (Ministry of Natural Resource and Environment, Mandalay Region)	
	3. U Maung Weik (The Developer, Amarapura Development Project)	
	4. Dr. Win Maung (Environment Myanmar Cooperative Co., Ltd)	
	5. Mr. Rui (The Master-plan of Amarapura Development Project at Mandalay: Vision and Strategy)	

	6. Dr.Kees Sloff (River Engineering Specialist)	
	7. Dr.C. Zwanenburg (Geotechnical Expert of the Amarapura Urban Development project)	
	8. Mr. Henricus Joseph Opdam (Ayeyarwady inland waterway transport urban development flood control)	
	9. Dr.Myo Thant (Possible Earthquake Analysis and Precautions for Amarapura Development Project)	

Table 6-3 Summary of Questions and Answers and Suggestion from the Meeting

No.	Name	Question, Suggestion and Answers
1	A Memberof Parliament	If Shan Kalay Island is closed is a flood area I want to ask about damage from high flood during rainy season and impacts from Sagaing Fault. Moreover, can the buildings be built on that soil type?
2	Dr. Win Swe (Geological Department)	The Ayeyarwady River is increasing to the east side gradually. Therefore, how to prevent the Shan Kalay Island?
	U Mg Weik (The Developer)	The project will be implemented without any negative impact on two Sagaing Bridges. The buildings will be strong enough to resist the earthquake. Moreover, most of the buildings are two storied buildings and the highest will be six storied buildings so as not to block the scenery of Sagaing Hills.
3	A Member of Parliament	Who will be responsible for the long term maintenance on

No.	Name	Question, Suggestion and Answers
		effects?
	Dr. Win Maung (Environment Myanmar Cooperative Co., Ltd):	We will include Monitoring Plan while preparing Management Plan. We will write to make maintenance by the developer in the report. The Environmental Conservation Department (ECD) will check and monitor the project. They will punish if the developer side do not follow the guidelines. Moreover, I would like to suggest to create a group including, developer, local community and the government departments.
4	Head of Village (Shan Kalay Island)	The island does not face any war and disasters. The villagers do not move out of the village. Now, there are some new lands occurs beside the island and those are belong to the Shan Kalay Island. We want to put those lands in the project as share for the benefit of the village.
	U Mg Weik (The Developer)	We will visit and explain about the detail project at the village. If the new lands are legally own by the Shan Kalay Village, we are very glad to welcome.
5	U Chit Swe (Kyan Tan Ward)	There are water and air pollution around the ward. Since the ward is situated between 2 waste plants, the local community faces pollutions. If the waste water can be treated and reused, it will have benefits to the project and local people.
	U Mg Weik (The Developer)	We have plan to built waste water screening pond. We will come and check the plants and help to assemble larger size waste water pumps.
6	Ma Yin Myo Htwe (Yin Taw Village)	Will you buy the lands with the current price? How will you manage for the transportation and drainage system? There are many unemployed graduated persons in the village. Will you hire the local people?
	U Mg Weik (The Developer)	We will buy the lands with the current price. We will build 6 lane road and 120 feet wide drainage system. The project design includes joint roads with the village. For the job opportunity, we need about 10000 job positions and we will hire them with the priority from the project related communities.
	Dr. Win Maung (Environment Myanmar Cooperative Co., Ltd):	I also want to suggest making the unemployed graduated person list with the village head so that the project can apply effectively.
7	U Win Nyunt (Zay Cho Ward, Amarapura)	If some of the villagers want to continue agriculture, how will you solve?
	U Mg Weik (The Developer)	We will negotiate about the farm land. If the villagers want to continue farming, the lands will be replaced with agreements.
8	U Sat Aung (Village Head from Shwe Kyat Yat Village)	There are some negative impacts from each development. There are 24 villages in Shwe Kyat Yat Village Group. The outflows of waste water are found in the village. There are drinking water difficulties for (9000/10000) villagers who are living beside the Ayeyarwady River. The oil and grease spells in the river.
	U Mg Weik (The Developer)	We will treat waste water up to the acceptable level set by

No.	Name	Question, Suggestion and Answers
		the relative governments. The occurrence of sand bands in the summer season will be dradged with the machines. For oil and grease, we will arrange a drainage system from the Ayeyarwady. If we can, we will provide drinking water to your community from the project by Ayeyarwady River Water treatment.
9	U Zaw Wai Oo (Kyan Tan Ward)	I want to know how you will manage the waste water throw.
	U Mg Weik (The Developer)	I heard that the waste water pumps beside Daw Aye Kyin Restaurant are not big enough to cover the ward's waste amount. Therefore, I will provide 2 waste water pumps there.
	U Zaw Wai Oo (Kyan Tan Ward)	How do you define the price of the agriculture land?
	U Mg Weik (The Developer)	The types and the compensation percentages of the agricultural lands are defined by the government departments. We will the price on the current price.
	U ZawWaiOo (Kyan Tan Ward)	We heard that the resettled agricultural lands will be given after 3 years from the initial state of the project. If the farmers become unemployed without those lands, how you will solve that problem.
	U Mg Weik (The Developer)	The farmers can keep on growing at those areas.
10	U AungKyi (Zay Cho Ward)	We wish to create a monitoring team. That monitoring team should include different kinds of persons from the community. Moreover, there should be joint roads from the old ward and the project site. There should have a HR Department to communicate each other between the local people and the project related persons for the job opportunity.
	U Mg Weik (The Developer)	U Zaw Ye Win is taking responsibility for the job opportunity of the local people. For the monitoring group, we will follow the suggestions of Dr. Win Maung. We will include joint roads in the project design to connect the old wards and the project site.
11	U Aung Mya (Ta Dar Oo Ward)	There are a lot of erosion occur in many places. Those places are connected with Inn Wa Ancient City. I wish to ask for support to prevent erosion as possible as you can.
	U Mg Weik (The Developer)	Since it is the countrywide issue, I will visit and help for erosion as possible as I can.
12	U Soe (Inn Wa)	River water from Ba Maw, Kathar head to Inn Wa. If you build the river bank walls, it will be much more dangerous for the Inn Wa. We have studied the river data concerning with the Inn Wa and that information is used in building river model. Since we have calculated by technical, there are not obvious impacts to the Inn Wa.
13	U Maung Maung Oo (Ever Green (Sein Yaung So) Group)	the project should make more stakeholder consultations and should try to accept criticism from different views. The 2016 flood is very obvious. The data are quite different from Mandalay (Sint Ku) to the west Myin Chan. It is because of the (Flood Inn) around the area. Those Inns are block at that

No.	Name	Question, Suggestion and Answers
		time of flood. I really want to know whether you check those impacts in the river modeling design.
	U Mg Weik (The Developer)	We will try to accept the criticism and explain them since the project is for the good of the Mandalay City. I promise that I will stop any implementation if the original land is getting worse because of the project. According to the river model arrangements, we made detail study on upper stream 20km and downstream 20 km from the project area, the total of 40 km.
	U Maung Maung Oo (Ever Green (Sein Yaung So) Group)	According to my studies, Ayeyarwady River's sedimentation is about 160 feet long within 100 years. If the project will not have impact on Inn Wa, the sedimentation will lead to sagaing.
	U Mg Weik (The Developer)	We will follow the accuracy of detail river model.
	U Maung Maung Oo (Ever Green (SeinYaung So) Group)	The opposite side of the project exist Shwe Taung Oo Maw Pagoda. I wish the river model design should include not leading flood to that area. When it comes to Electricity Power Supply, the project site explained to obtain from the National Grid Line. I have not found that the project includes some public areas. I wish the project include them.
	U Mg Weik (The Developer)	The project will include river bank roads and public entertainment areas such as Playgrounds and Sport Halls. We will follow exactly the river model that we explained today and we will follow the guidance from the Third-Party Organizations.
14	Ko Win Naing (Amarapura)	I wish the project include for disable people. I wonder the project will sell share to create a public company.
	U Mg Weik (The Developer)	Yes, we will think for the disable people in the project. Moreover, we will invite the shares openly after the project gets the permission.
15	Daw Nyein Thet Nwe (MP of Hlut Taw, Mandalay Region)	I like the project very much. But for the compensation plan, the farmer who has (Form 7) for agricultural land will receive 15% and the alluvial soil owners can get 5%. Such kind of discrimination should be done among the farmers? My own suggestion is that not to depend on the agricultural land if the developers do next projects in the future. Thank You.
	Dr. Win Maung (Environment Myanmar Cooperative Co., Ltd)	The report will include the guidelines for the protected areas, which is concerned with Ayeyarwady Dolphins from Upper Region of Min Kon to the Delta Region of Ayeyarwady. Moreover, the Biodiversity can change from the project impacts. These will also be included in the report. Climate change, Earthquake and Flood and so on are the risk for the project. Even though the analysis shows that there will be no obvious risks from the project, the local community can share your knowledge and the developer is responsible to take them into account. One of the positive impacts is the abundant of job opportunity for the local people. Moreover, there is a program called CSR (Corporate Social Responsibility) which

No.	Name	Question, Suggestion and Answers
		is a policy that the developer is responsible for supporting the project related community at least 2% to 5% of project profit annually. We will include that policy in preparing the EMP Report.
16	U Ko Lay (Inn Wa Gone Yi)	tell the closing speech on the Amarapura Development Project at Mandalay/Myanmar and close the stakeholder meeting.

Figure 6-2 Participant of the meeting in the Scoping Stage

6.4. Methodology and Approach in EIA Stage

6.4.1. Methodology for public disclosure

The public disclosure is carried out at the Departments of Government Organization in Amarapura and Chanmyatharsi Townships and local people of villages which are located near the project. The suggestions Box is provided at the disclosure places and the feedbacks can be submitted into the boxes.

The method and approach of conducting Public Disclosure is the followings.

- Discussion with the project proponent to held Public Disclosure
- After that, method to conduct meeting which are date, time and location are selected.
- Preparing presentation slides, inform letter and suggestion letter with Burmese Version for the Public Disclosure
- Sending letters of recommendation and suggestion, presentation slides to relevant government departments and surrounding villages
- Collecting letters of recommendation and suggestion by the specified deadline
- Adding suggestions and comments received from Public Disclosure

Table 6-4 Methodology for the Public Disclosure in EIA Stage

Stage	Item	Description
EIA Report	Announcement	Date will be announced 1 week before the public consultation meeting to conduct public disclosure
	Place	Amarapura Township and Chanmyatharsi Township, Mandalay Division
	Period	13 Days (Including Sat & Sun and Holidays)
	Suggestions Collecting Method	The suggestions Box is provided at the disclosure places and the feedbacks can be submitted into the boxes.

6.4.2. Methodology for Public Consultation Meeting

The public consultation meeting is carried out at the Departments of Government Organization in Amarapura Township and Chanmyatharsi Township and local people of villages which are located near the project. The method and approach of conducting Public Consultation Meeting is the followings.

- Discussion with the project proponent to held Public Consultation Meeting
- Location and Date to hold meeting is chosen.
- Preparing presentation slides with Burmese Version and invitation letters for the meeting
- Inviting local people and governments one week in advance to the meeting
- Then, holding Public Consultation Meeting with PowerPoint presentation about project description, potential impact assessment and management process.
- Discussion with attendees about suggestion and comments for the meeting
- Adding suggestions and comments gotten from Public Consultation Meeting into the reports.

Table 6-5 Methodology for Public Consultation Meeting in EIA Stage

Item	Description
No of Meeting	One Time
Location	Hotel Mandalay, Mandalay Division
Agenda	• Brief explanation on the EIA process • Presentation on the Background Information of Project, Project Description, Environmental Issues and Environmental Management Plan, Impact Assessment and mitigation measure of EIA Report • Receiving questions, feedback and suggestions from participants
Invitation Departments and Organizations	1. General Administrative Department, Amarapura Township and Chanmyatharzi Township

Item	Description
	2. Myanmar Police Force 3. Ministry of Electric Power, Amarapura Township 4. Mandalay City Development Committee, Amarapura Township and Chanmyatharzi Township 5. Urban Environmental Conservation & Cleansing Department Services, Chanmyatharsi Township 6. Ministry of Construction, Department of Urban Housing and Devlopment, Amarapura Township and Chanmyatharsi Township 7. Ministry of Construction, Department of Highway, Amarapura Township and Chanmyatharsi Township 8. Environmental Conservation Department, Mandalay Division 9. Ministry of Agriculture, Livestock and irrigation, Department and Agricultural Land Management and Statistics, Amarapura Township 10. Ministry of Agriculture, Livestock and irrigation, Department and Agriculture, Amarapura Township 11. Ministry of Agriculture, Livestock and irrigation, Irrigation and Water Utilization Management Department, Amarapura Township and Chanmyatharsi Township 12. Ministry of Cooperative and Rural Development, Amarapura Township 13. Ministry of Transport and Communications, Department of Shipping, Mandalay Division 14. Ministry of Transport and Communications, Department of Water Resources and Rivers Development, Mandalay Division 15. Ministry of Health, Department of Medicinal Services, Amarapura Township and Chanmyatharsi Township 16. Ministry of Industry, Department of Industrial Supervision and Inspection, Amarapura Township 17. Myanmar Fire Services Department, Amarapura Township and Chanmyatharsi Township 18. Ministry of Labour, Ministry of Factory and General Labour Laws Inspection, Amarapura Township and Chanmyatharsi Township 19. Mandalay Business Capital City Development Ltd. 20. Hexagonal Angle International Consultants Co., Ltd. 21. Locals and neighbors from Amarapura Township and Chanmyatharzi Township
Language	Burmese

6.5. Activities and Public Disclosure for EIA Stage

6.5.1. Public Disclosure in EIA Stage

The public disclosure is a part of the public consultation. The information of the project, the project background, project description, potential impact assessment and management process was sent to the local people of villages which are located near the project area and organization of relevant department and then, the letters of suggestion and recommendations were collected. For EIA report, organizations and villages sending the letters of suggestions and recommendation are shown in Table 6-6 and name lists and details are shown in **Appendix F**.

Table 6-6 Lists of Organizations and Villages sending letters of suggestions and recommendations

Organization	Address
Local people	1. Kyantann Ward, 2. MyaHinThar Village 3. MoeKaung Village 4. ChaukThwayThauk Village 5. TikeSoe Village 6. Khawar Village 7. KanTaw Village 8. ThetKelTaw Village 9. Phadamyar Village 10. Thapyaythan Village 11. ShankalayKyan Village 12. YinTaw Village 13. Khatipar Village 14. KoeThin Village 15. SanYway Village 16. Hman Tan Ward 17. AyeyarTun Ward
Government Organizations	1. General Administrative Department, Amarapura Township and Chanmyatharzi Township 2. Myanmar Police Force 3. Ministry of Electric Power, Amarapura Township 4. Mandalay City Development Committee, Development Committee, Amarapura Township and Chanmyatharzi Township 5. Urban Environmental Conservation & Cleansing Department Services, Chanmyatharsi Township 6. Ministry of Construction, Department of Urban Housing and Devlopment, Amarapura Township and Chanmyatharsi Township 7. Ministry of Construction, Department of Highway, Amarapura Township and Chanmyatharsi Township 8. Ministry of Natural Resource and Environmental Conservation, Environmental Conservation Department, Mandalay Division

Organization	Address
	9. Ministry of Agriculture, Livestock and irrigation, Department and Agricultural Land Management and Statistics, Amarapura Township 10. Ministry of Agriculture, Livestock and irrigation, Department and Agriculture, Amarapura Township 11. Ministry of Agriculture, Livestock and irrigation, Irrigation and Water Utilization Management Department, Amarapura Township and Chanmyatharsi Township 12. Ministry of Cooperative and Rural Development, Amarapura Township 13. Ministry of Transport and Communications, Department of Shipping, Mandalay Division 14. Ministry of Transport and Communications, Department of Water Resources and Rivers Development, Mandalay Division 15. Ministry of Health, Department of Medicinal Services, Amarapura Township and Chanmyatharsi Township 16. Ministry of Industry, Department of Industrial Supervision and Inspection, Amarapura Township 17. Myanmar Fire Services Department, Amarapura Township and Chanmyatharsi Township 18. Ministry of Labour, Ministry of Factory and General Labour Laws Inspection, Amarapura Township and Chanmyatharsi Township

6.5.2. Summary of Public Disclosure in EIA Stage

After sending the project background, project description, potential impact assessment and management process, suggestions of local people of villages which are located near the project area and relevant government organization were obtained. These suggestions are shown in Table 6-7 and **Appendix (F).** Photos of public disclosure activities are shown in Figure 6-3.

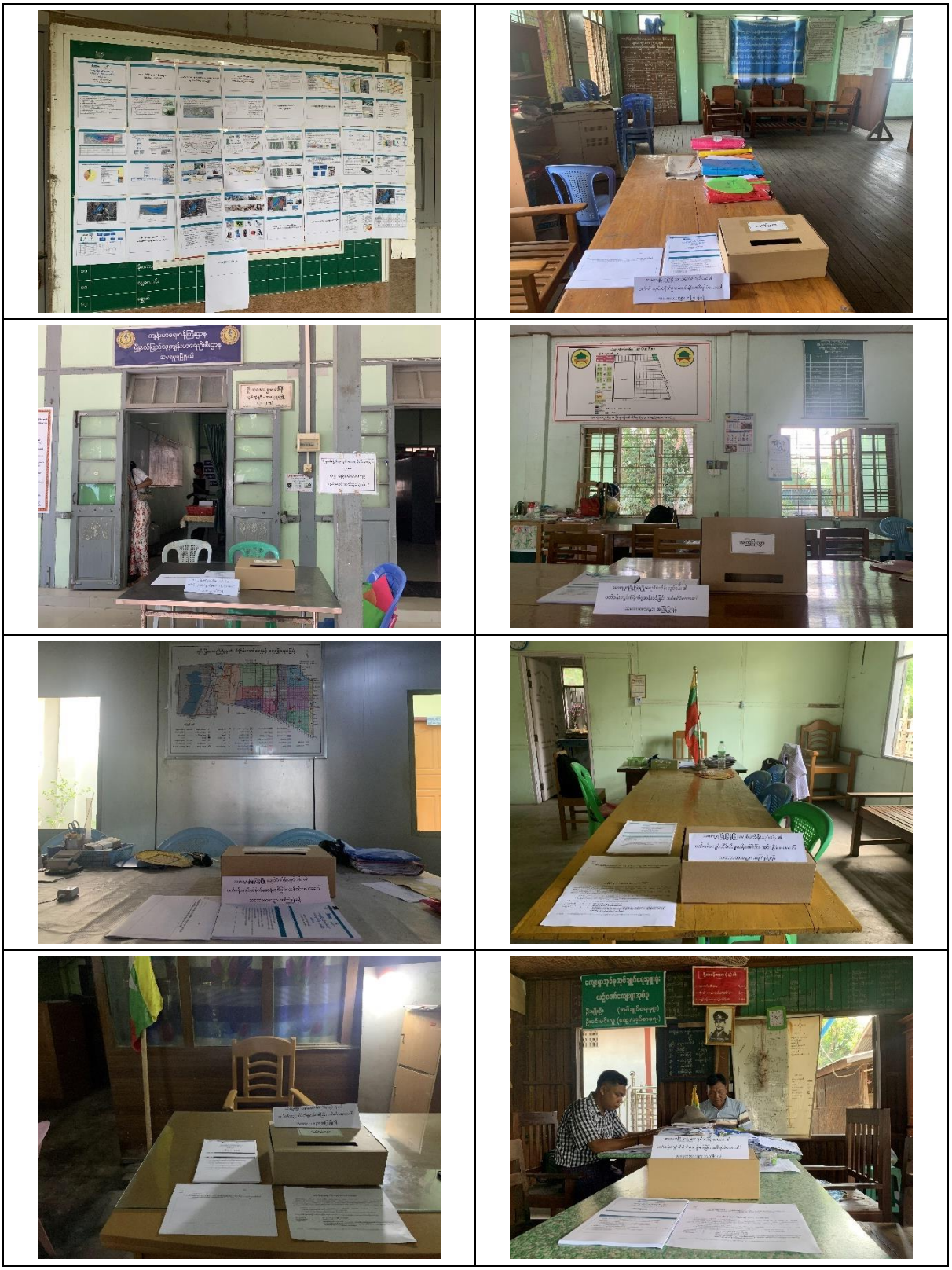


Figure 6-3 Photos of Public Disclosure activities

Table 6-7 Suggestions from Public Disclosure

No.	Participants	Department/Address	Suggestions and Comments
1.	U San Thein	War Tan (North), Hman Tan Ward, Amarapura Township	• Proud of Abundance of opportunities for employments and level up of standard for our Ward • For Neighborhoods, health problems should be considered. • For example, air pollution (dust) during operation and flooding in the environment.
2.	U Khin Maung Win	Myaybetan Ward	• Good drainage system should be improved for good water-flow within the Myaybetan ward.
3.	U Thet Lwin	Hman Tan Ward, Dan Ha Pin	• It is necessary to do drains to improve the water flow in the neighborhood • Transportation should be cleared for traffic roads
4.	U Thein Htay	Hman Tan Ward, Ywar Thar,	• This project may be a helpful project for abundance of opportunities for employments and level up of standards for neighbourhoods. • To make good transportation road & implement good drainage system for wastewater. • It is necessary to provide suitable jobs to the descendants of the farmers who worked in the past • Wishing for the quick completion of the project
5.	U Aung Myo	Wat Kone	• Fewer employment opportunities for farmers who only work in agriculture • It is necessary to do good sewage drains along the project area • To provide suitable jobs for farmers who only work in agriculture
6.	U Aye Min Tun	Hman Tan Ward, Ayemar	• To improve block drains for good water-flow • To improve good transportation for traffic roads
7	U Myo Oo	YinTaw Village	• To support schools in the village • To ensure that there is no harm in land issue for the farmers of the village
8	U Kyaw Win Min	Chauk Tway Thout Village	• It is true that the project is a helpful project for abundance of opportunities for employments and level up of standards for neighborhoods if the project is fully completed • Hoping there will be many changes of standards and opportunities • Wishing for the quick completion of the project

No.	Participants	Department/Address	Suggestions and Comments
9	U Kyaw Thant Zaw	ShankalayKyun Village	• Land plots (20*60) should be given instead to some families of farmers who own village land • The village should be given more area so that the village does not get flooded when it rains heavily • Ceremony of village should be considered • Roads for transportation of village should be considered
10	U Tin Hlaing	ShankalayKyun Village	• To improve the area of the land for ShankalayKyun Village • To prevent flooding • To ensure there is no harm for farmers
11	U Aung Aung	ShankalayKyun Village	• To expend the area of the ShankalayKyun Village to do not have population density for the future • After finishing the defining of the area, to do wastewater drains, 4 entrances to the village and road outside the village • It is good for the village as it becomes an urban project, but only if the farmers of the village make sure that the owners get the appropriate amount of the money for the land and only after negotiation with the guideline of EIA procedure, MBCCD company will be able to do quickly later matters • Villages should be treated with compassion
12	U Thein Aung	ShankalayKyun Village, Head of 100 Households	• To do good transportation for villagers • To make a cemetery land and buildings for the dead • To improve drainage system for village
13	U Tint San	ShankalayKyun Village	• ShankalayKyun Village is a historical village. To maintain traditional for Historical village • To make the wide area of land for the ceremony of village • “From village to city”, it is good to carry out the slogan • This project is good but to determine the boundary of the area for increasing population
14	U Aung Naing	ShankalayKyun Village	• Thank you for this project with no objection • As an environmental impact, we are disturbed by the impure water every year at the time of

No.	Participants	Department/Address	Suggestions and Comments
			inflow • In the project area, the land along the banks of the road owned by local farmers have been fenced off, so this should be done after purchase • I think it should not happen that the land purchased from TW U Thein Win through the local farmers in the project area for 2,200 lakhs per acre and 1,500 lakhs per acre from the actual farmers. • We would like to purchase the land at a rate not less than 2,200 lakhs to the farmers who depend on the annual income from their ancestral lands.
15	Daw Thinzar Htet	Amarapura Township, Department of Factory and General Labour Laws Inspection	• During the Project, health and safety of the workers who is in all relevant workplaces should be take care with the rights and benefits of the labor law in accordance with the relevant labour laws • The project is peaceful with people who is safe, healthy and happy • A successful project is highly anticipated
16	Daw Yi Yi Khin	Amarapura Township, Department of Highways and Bridge	• I would like to support this project if there are no impacts on Environment. • During operation of the project, you should want to consider the damage to the roads if you carry bricks and sand and overload the cars
17	U Aung Myo Htet	Amarapura Township, Myanmar Fire Services Department	• When constructing the houses included in the project area, to build in accordance with Myanmar Fire Safety Code 2020 for fire safety, and in the event of a fire, Fire hydrants need to be installed in every street of every block to be able to extinguish the fire in time and to minimize the cost of the fire, to easily obtain the water needed for fire extinguishing.
18	U Tayzar Myo	Directorate of industrial supervision and inspection, Mandalay Division	• The following facts are my suggestions for suggestions and comments of public disclosure of EIA report of this project, • To identify and obey with the related laws and regulations • To avoid and reduce the using techniques effecting the impacts on environment • To prevent not only health hazards and disturbances on villagers but also environmental impacts • To systematically dispose of hazardous waste • To obey the EIA procedures

No.	Participants	Department/Address	Suggestions and Comments
19	U Phoe Htoo	Plot 460	• Villagers near the project feel more or less impacts • Most of the lower-class doing livestock feel the impacts and loss of their agricultural lands • Villagers near the project should be given the privileges of benefit by doing social surveys
20	Daw Khin Khin Lay	AyeyarTun Ward	• To systematically dispose of hazardous waste and operation waste • To maintain the roads damaged by the cars for the project
21	U Min Min Kyaw	Lat yway Ward	• As a citizen, proud of improving the standards due to this project in Amarapura Township, Mandalay Division • Wanting to complete quickly the project • Wanting to develop the villages near the project and to help the villages
22	Daw Sandar Myint	AyeyarTun Ward	• This project should be do by studying and checking details on the impacts on biodiversity
23	U Thein Zaw	Plot 406	• To do by head officers with no impacts on environment due to this project • To use the roads systematically and carefully • To complete quickly this project
24	U Thein Min	Plot 406	• Want to go down to the bottom and take full responsibility the people whom had been feeling the impacts, loss of their agricultural lands and loss of their livestock
25	U Mya Maung	Plot 465, Than/Taung Ward	• Wanting to help the villages for developing and no impacts on environment
26	Daw Lwin Lwin Tun	Zaycho Ward, Amarapura Township, Ministry of Factory and General Labour Laws Inspection, Ministry of Labour	• To work meet with the relevant laws and regulations
27	Daw Kay Khaing Zaw	Zaycho Ward, Amarapura Township,Ministry of	• To work meet with the relevant laws and regulations

No.	Participants	Department/Address	Suggestions and Comments
		Factory and General Labour Laws Inspection, Ministry of Labour	
28	U Kyaw Oo	Lat yway Ward	• Wanting to do with no impact on agricultural land and cultivation
29	Daw Mya Mya	Latyway Ward	• No harm to the village near the project due to this project and • To take full responsibility the people whom had been feeling the impacts
30	U Thein Oo	AyeyarTun Ward	• Cars and others vehicles using fuels should be used carefully and systematically due to the dust production by cars using in this project • To reduce the dust, Nitrogen and Hydrocarbon production by cars and other vehicles by using carefully and systematically

6.6. PUBLIC CONSULTATION MEETING IN EIA STAGE

The public consultation meeting was held on July 11, 2023. The invitation letters were sent to the government organizations and villages which are located near the project zone. The presentation of the meeting is printed out in Myanmar language and handed out to the invites. Consultations and suggestions were obtained and collected. The attendance lists are shown in **Appendix K**. The list of organization and local people sending invitation letters is shown in Table 6-8.

Table 6-8 List of organization and local people sending invitation letters

No	Organization
	Organization of Government
1.	General Administrative Department • General Administrative Department, Amarapura Township • General Administrative Department, Chanmyatharzi Township
2.	Myanmar Police Force
3.	Ministry of Electric Power • Ministry of Electric Power, Amarapura Township
4.	Mandalay City Development Committee • Development Committee, Amarapura Township • Development Committee, Chanmyatharzi Township
5.	Urban Environmental Conservation & Cleansing Department Services • Chanmyatharsi Township
6.	Ministry of Construction, Department of Urban Housing and Development • Amarapura Township • Chanmyatharsi Township
7.	Ministry of Construction, Department of Highway • Amarapura Township • Chanmyatharsi Township
8.	Ministry of Natural Resource and Environmental Conservation, Environmental Conservation Department • Environmental Conservation Department, Mandalay Division Ministry of Agriculture, Livestock and irrigation, Department and Agricultural Land Management and Statistics • Amarapura Township Ministry of Agriculture, Livestock and irrigation, Department and Agriculture • Amarapura Township Ministry of Agriculture, Livestock and irrigation, Irrigation and Water Utilization Management Department • Amarapura Township • Chanmyatharsi Township

No	Organization
9.	Ministry of Cooperative and Rural Development • Amarapura Township
10.	Ministry of Transport and Communications, Department of Shipping, Mandalay Division Ministry of Transport and Communications, Department of Water Resources and Rivers Development, Mandalay Division
11.	Ministry of Health, Department of Medicinal Services • Amarapura Township • Chanmyatharsi Township
12.	Ministry of Industry, Department of Industrial Supervision and Inspection, • Amarapura Township
13.	Myanmar Fire Services Department • Amarapura Township • Chanmyatharsi Township
14.	Ministry of Labour, Ministry of Factory and General Labour Laws Inspection, • Amarapura Township • Chanmyatharsi Township
15.	• Mandalay Business Capital City Development Ltd. • Hexagonal Angle International Consultants Co., Ltd.
PAPs	
16.	Locals, Neighbors and villages near project In Amarapura Township, • Kyantann Ward, • MyaHinThar Village • MoeKaung Village • ChaukThwayThauk Village • TikeSoe Village • Khawar Village • KanTaw Village • ThetKelTaw Village • Phadamyar Village • Thapyaythan Village • ShankalayKyan Village • YinTaw Village • Khatipar Village • KoeThin Village • SanYway Village • Hman Tan Ward In Chanmyatharsi Township, • AyeyarTun Ward (Salone Ward, Thayar Shweku, Latyway Village)

6.6.1. Summary of Public Consultation Meeting in EIA Stage

Public Consultation Meeting of Mandalay Business Capital City Development Ltd. (MBCCD) was held at White Rose Hall of Hotel Mandalay on July 11, 2023. Hotel Mandalay is located in 78 street, between 37*38 street, Mandalay. The event was planned to be held starting from 10:00 am to 12:00 pm.

Firstly, the announcing the agenda of the meeting was presented by Daw Thandar Kyaw (Environmental Team Leader) from HA Company. Then, the ceremony was started by the introduction speech for the project was given by U San Nyunt Zaw (Deputy Managing Director of Mandalay Business Capital City Development Ltd.) as shown in Figure 6-4. Then, the project background, project description, potential impact assessment and management process was presented by Daw Thu Thu Aung (Managing Director of HA Company) as shown in Figure 6-5. The summary of public consultation meeting can be seen in the following Table 6-9 and presentation slides are shown in **Appendix E**. Photos of Public Consultation Meeting activities are shown as Figure 6-6.

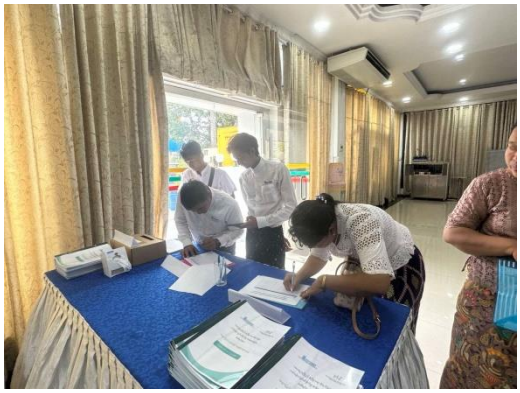
Table 6-9 Summary of Public Consultation Meeting

Agenda	Tuesday, July11, 2023	
	Collecting the attendance lists	10:00-10:15
	Announcing the agenda of the ceremony from HA Company	10:15-10:20
	Talking about the introduction speech for the project by the responsibility person of Mandalay Business Capital City Development Ltd.	10:20-10:30
	Presenting about the project background, project description, potential impact assessment and management process by HA Company	10:30-11:30
	Questions & Answers Session	11:30-12:00
	Announcing the End of the ceremony	12:00-12:05
Location	White Rose Hall, Hotel Mandalay (78street, between 37*38 street, Mandalay)	
Government organizations and villages attending the meeting	• Mandalay City Development Committee • General Administrative Department • Ministry of Factory and General Labor Laws Inspection • Irrigation and Water Utilization Management Department • Myanmar Fire Services Department • Environmental Conservation Department • Department of Industrial Supervision and Inspection • Ministry of Cooperative and Rural Development	

	• Urban Environmental Conservation & Cleansing Department Services • Department of Highway • Department and Agricultural Land Management and Statistics • Department of Medicinal Service • Department of Urban Housing and Development • Salone Ward • ShankalayKyun Village • Hman Tan Ward • ShweKyatYat Village • YinTaw Village • ThanHlatt Maw (South) • HA company • MBCCD Ltd.
Description	• Brief explanation on the EIA process • Presentation on the Background Information of Project, Project Description, Environmental Issues, Potential Impact Assessment and Term of References • Receiving questions, feedback and suggestions from participants
Attendees	• Government – 23 persons • Local People- 11 persons • MBCCD Ltd.- 16 persons • HA Company- 8 persons

Figure 6-4 Photos of introduction speech for the project

Figure 6-5 Photos of presentation of the project background, project description, potential impact assessment and management process



Attendance signation

Announcing for the meeting

Participant in the meeting

Figure 6-6 Photos of Public Consultation Meeting Activities

6.6.2. Questions and Feedbacks Suggestion

After the presenting, questions and suggestion from the participants are as follows. Questions & Answers, Suggestions and Discussions of public consultation meeting can be

seen in Table 6-10. Suggestions letter from the participants can be seen in Table 6-11. These suggestions are attached in **Appendix I**.

Table 6-10 Summary of Questions & Answers, Suggestions and Discussions of Public Consultation Meeting

No	Description	Photo
	Question & Answer	
1	Question Daw Khin Aye Thwe (Assistant Director, Water and Sanitation Department, Mandalay City Development Committee) -Will you treat every water outlet? -How many water outlets will you treat? -How do you use the sewage system of toilet?	
	Answer Daw Thu Thu Aung (Managing Director, Hexagonal Angle International Consultants Co., Ltd.) -Once the wastewater generation starts, the treatment will be done, and each building will be treated and then inserted into the drain line of outlets -Every building will be installed based on the design, so the exact number can't not tell wherever the requirement places	
	Suggestion	

No	Description	Photo
1	<u>Suggestion</u> U Min Swe (Member of Administrative Group of ShweKyatYat Village) -To reduce dust pollution at the villages which are located under the project -Huge and strong stone should be used in building stage of this project near ShweKyatYat Pagoda	
2	U Than Aung (Member of Administrative Group of ShweKyatYat Village) -Welcome to this project with big hope of benefits -To coordinate the impacts and benefits with the villages -want to reduce the negative impact with appropriate mitigation measures due to the project implementation -Want to be held annually Boat race that held over 100 years -This project includes 110 acres of ShweKyatYat village and want to be coordinated the area outside 110 acres -To give job opportunities for the villagers near the project	

No	Description	Photo
3	U Zaw Tun Aung (Deputy Director, Environmental Conservation Department) -The suggestion of local Project Affected Persons (PAPs) from the meeting should describe in the EIA report. -To dispose waste water with the parameter from NEQEG after treatment -To compare the result of 5 km area (AOI) of EIA report with 1km area (AOI) of scoping report -To describe job opportunities for PAPs -To compare and describe impact assessment method referred from Africa method in EIA report and matrix method referred from International Association Impact Assessment (IAIA)	
4	Daw Thinzar Htet (Township Officer, Ministry of Factory and General Labor Laws Inspection) -Glad to requirements for over 3500 people of workers -To get suggestion from 4 departments of Ministry of Labor for employment -To think mainly Health and Safety and Privileges of Benefit for workers -To give pre-work training for workers -To cooperate with Ministry of Labor along the project operation	

No	Description	Photo
5	U Than Zaw Tun (Director of Urban Environmental Conservation & Cleansing Department Services) -To add waste disposal system during construction stage because it is plenty of waste in construction stage although it is good waste disposal system in operation stage - It's good to throw it away once it's sewed waste water -To generate the solid waste and wastewater with MCDC -We are waiting to join the project with our team -Hoping this project will be the best place in the environment -To conduct air quality during project implementation -To provide education and job opportunities for local people -To think the benefits for the local people due to this project	
6	<u>Suggestion</u> U Hlaing Htet Win (Township Officer, Livestock and irrigation, Irrigation and Water Utilization Management Department) -The area of the river may be narrowed so that Ayeyarwady river are filled with soil for the project -If lesser the area of Ayeyarwady river, higher the river level -To add the following information in the EIA report, Are there changes the water route in villages which are located in ground sediments? River bed level may be changed or not.	

No	Description	Photo
	Answer Daw Thu Thu Aung (Managing Director, Hexagonal Angle International Consultants Co., Ltd.) -We will discuss river morphology with relevant experts and insert in the report -We will add the recommendations of the experts of HA Company	
7	U Myo Aung (Head of 100 Households, AyeyarTun Ward) - Villages which are located near the project feels vibration and air population -Hope to give job opportunities for the villages which are located near the project	

No	Description	Photo
	Answer Daw Thu Thu Aung (Managing Director, Hexagonal Angle International Consultants Co., Ltd.) -We will study and discuss speed control of air pollution and vibration near village from the project area and add specific mitigation measures of these facts in the report	
8	Discussion U Than Zaw Tun (Director of Urban Environmental Conservation & Cleansing Department Services) -The water treatment system is so expensive that it cannot be installed much -You should treat by making a compound of a building to treat -How to generate sewage water and wastewater? -Do not want to combine the sewage water line and wastewater drain line -It should be separately generated with specific line in the project area	

No	Description	Photo
	Daw Thu Thu Aung (Managing Director, Hexagonal Angle International Consultants Co., Ltd.) -Each Building will be treated in accordance with the NEQE Guidelines.	
	U Aung Myint Myat (Engineer, Mandalay Business Capital City Development Ltd.) -In the project site, waste treatment system will be used on-site waste treatment system	

No	Description	Photo
	U Tun Aung Kyaw PE (Road), (Road Consultant, Mandalay Business Capital City Development Ltd.) -Underground drainage system making details by Team Company from Thailand will be used We will treat by an underground drainage system each building and will be trying to throw it out if it's too much -We will adjust if we get details of the amount and system from Team -We will summit the detail system and discuss with your department -We will take suggestions of expert of water and sanitation department when operation stage	
9	U Htay Lwin (Head of ward, ShweKyatYat Ward) -This project is good for local people -Hoping to support Health, Social, Economic and Education for local people -To give job opportunities for local people -want to treat the water of Taungthaman Inn	

Table 6-11 Suggestions Letter of Public Consultation Meeting

No.	Participants	Department/Address	Suggestions and Comments
1	U Htet Phyo Aung, Dr. Hnin Zaw Thein, U Kyaw Kyaw Win, Daw Aye Ei Phyu, Daw Thae Thae Mon, Daw Myint Myint Than	Department of Health, Pyigyidagun Township	• Project Material Selection for duality, functionality, sustainability • Safety Measures- for before, during after project • Quality Assurance- Regular inspection, testing of materials and adherence to quality of Management system • Environmental considerations- Water running, environmental pollution, waste management • Risk management- regular risk assessment before, during and after project • Toilet> septic tank Latrine
2	Daw Khin Myo Oo	Administrative Department, Amarapura Township (MCDC)	• Wishing to have more benefits whether this project have the benefits or the impacts
3	Daw Nay Zar Lwin	Department of rural road development	• Needing to Implement the mitigation measures in Construction and Operation Stage of the project • To think upstream and downstream area outside of the project when Ayeyarwady river level rises
4	U Than Aung	MoeKaung Village, ShweKyatYat Ward, Amarapura Township	• Welcome to this project with no objection • Wanting to think the impacts although there are benefits as well as the impacts • To give job opportunities for the villagers near the project • This project includes 110 acres of ShweKyatYat Village and want to be coordinated the area outside 110 acres • Supporting this project with the targets of benefits • To help Social, Education, Economic and Jobs for villagers
5	U Htay Lwin	ShweKyatYat Village Tract, Head Administrative Officer	• To do firstly job opportunities for villagers when starts operation stage • To help economic of officers of Village Administrative Department, and education for villagers
6	U Myo Aung	ShweKyatYat Village, Head of 100 Households	• Glad to develop the city and also to get job opportunities for villagers due to this project • Glad to seriously develop Mandalay and Mandalay Division
7	U Min Swe	ShweKyatYat Village, Amarapura Township	• Huge and strong stone should be used in building stage of this project because water circulation speed is very strong near ShweKyatYat Pagoda

No.	Participants	Department/Address	Suggestions and Comments
			• Development should be reviewed and should be done by rural area near the project • For the viewpoint of the new city, west area of ShweKyatKya Pagoda should be expanded
8	U Aung Aung	ShankalayKyun Village	• Glad to this project with no objection • Very glad to this project if you manage systematically the impacts and benefits of this project • If you explain the project area and plan to the villagers and coordinate with the villagers, I think this project complete quickly • If the purchase of land (7) or solution land(N) is open transparently to the villagers and coordinated the purchase, MBCCD Company will be complete quickly this project
9	U Tayzar Myo	Directorate of industrial supervision and inspection, Mandalay Division	• To manage upon the air pollution and to clean systematically wastewater from this project

6.6.3. Result of the meeting

According to the suggestion and concern of the meeting, the land purchasing problem and wastewater generation is the main issue of the project and local people. Some of the project affected persons are worried that they will lose their own lands and agricultural land. In addition, the local people are worried about for air pollution (dust) that can impact on the near village due to transportation vehicles. However, the job opportunities, social, economic, education developments and CSR activities are the mostly demand for them. Besides, they are wishing to improve their living standard due to the project implementation.

6.6.4. Action Plan of PCM Result for EIA

In relation to the suggestions of the residents of Shan Kalay Kyun Village, if the construction of the Dyke Wall is completed which is being carried out in the Amarapura Urban Development Project, there will be no more inflow of water from the Ayeyarwaddy River in Shan Kalay Kyun Village during the rainy season. Mandalay Business Capital City Development Ltd. will build a drainage system for Shan Kalay Kyun village parameter in order to properly dispose of rainwater and wastewater. In addition, Mandalay Business Capital City Development Ltd., which is implementing the Amarapura Urban Development Project, donates Ka Htein robes to the village head monastery of Shan Kalay Kyung village every year and also donating rice and oil every month and donating money to carry out the necessary activities for the school in Shan Kalay Kyun village. Amarapura Urban Development Project Area Master Plan includes the green land area between the project area and Shan Kalay Kyun village, and the access and exit roads of the village will be improved.

The storm drainage system will be accomplished by calculating plan of TEAM Engineering Group at Thailand. The Shan Kalay Kyun drainage system will be done as conceptual infrastructure design.

6.7. PUBLIC ANNOUNCEMENT

The project proponent, Mandalay Business Capital City Development Ltd., provided a description of the EIA report on their website, which people may view by clicking the link below.

Here is the link for EIA report.

https://mbccd.com/projects/

CHAPTER 7

ENVIRONMENTAL MANAGEMENT PLAN

7.1. INTRODUCTION

In order to manage the environmental impacts identified in the impact assessment, the project proponent is responsible to implement an Environmental Impact Assessment of the project (EIA). This management plan will form the basis for the development of an integrated management system for environmental and community issues. The environmental Management Plan (EMP) ensures that the project implementation is carried out in accordance with the design by taking appropriate mitigation actions to reduce adverse environmental impacts during its life cycle. In addition, this EMP used to ensure compliance with statutory requirement and corporate safety and environmental policies.

The Environmental Management Plan for proposed project mainly includes the following sector.

(a) Environmental Monitoring Plan

(b) Environmental Management Plan

(c) Emergency Response Plan

(d) Fire Safety Management Plan

(e) Corporate Social Responsibility (CSR) Program

7.2. SCOPE OF THE ENVIRONMENTAL MANAGEMENT

The objective of the environmental management is to ensure potential environmental issues managed by proper mitigation measures in compliance with the relevant laws and regulations stipulated by national authorities. Environmental management based on the basic principles of management known as the PDCA cycle (see **Figure** 7-1). Environmental management consists of four related tasks as described below:

- **Plan (P) - What need to be done**

  Mitigation measures for the potential environmental impacts of the project, such as air emission, noise, solid waste, wastewater and health and safety at work are described in this chapter. The Project Proponent will follow the plan for the mitigation measures according to the scheduled time.

- **Do (D) - Implement the plan**

  The Project Proponent as described in this chapter will implement the mitigation measures for the potential environmental impacts appropriately.

- **Check (C) - Monitor and evaluate the results of implementation**

  The effectiveness of the mitigation measures will be monitored, evaluated and documented.

➢ **Act (A) - Taking corrective actions to improve the results, if found inadequate**

If nonconformities noted with reference to the environmental monitoring benchmarks, corrective actions need to plan to mitigate the existing environmental impacts.

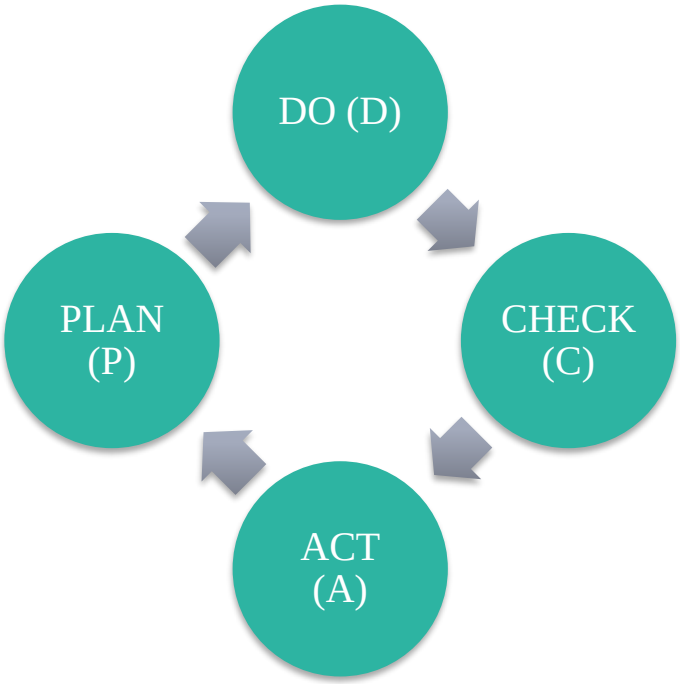


Figure 7-1 P.D.C. A cycle

7.3. MONITORING PROGRAM

The purpose of environmental monitoring is to evaluate the effectiveness of implementation of Environmental Management Plan (EMP) by periodically monitoring the important environmental parameters within the impact area, so that any adverse effects are detected and timely action can be taken. It focuses on the work environment which includes, waste management, health and safety of workers, safety of the facilities and the socio-economic component of the environment. The objectives of environmental monitoring are as followed:

- Monitor discharge sources (gas emission, wastewater and solid waste) in order to ensure that these activities will comply with legislative requirements;
- Check monitoring process in accordance with pollution prevention and control
- Propose appropriate environment protection measures based on results of environmental monitoring.
- Overcome and repair all weak-points based on results of environment monitoring program.
- Determine the effectiveness of mitigation measures and other measures

7.3.1. Environmental Monitoring Team

The environmental monitoring team should be comprised to accomplish regular monitoring and check-up. The leader or coordinator of the team should be fully responsible for the environmental affairs. The responsibility for the monitoring team as shown in Table 7-1 and Estimated Budget for Environmental Monitoring Plan as shown in Table 7-2 respectively. The project proponent will be implementing the sufficient budget till the enough when the estimated budget is insufficient for environmental management plan and monitoring plan implementation.

Table 7-1 Responsibility for Environmental Monitoring Team

No.	Name	Position	Responsibility
1.	U Zaw Ye Win (Director)	Monitoring Leader	✓ Environmental quality measurement planning; ✓ The implementation of mitigation measure in the environmental management plan ✓ complying with the instructions of relevant government departments ✓ Reporting of operational conditions ✓ Providing employees with their basic needs
	U Myo Min Oo	Member	✓ Regular check for air, noise & vibration quality of the project ✓ Monitoring and implementation as environmental monitoring program
	U Pyae Sone Win	Member	✓ Regular check and manage for water quality and waste water quality ✓ Monitoring and implementation as environmental monitoring program
2.	U Aung Myint Myat (Design Manager)	Occupation Health and Safety Leader	✓ Inspection of internal operation process ✓ Reporting of project process ✓ Recording of employees needs ✓ Arranging training on occupational safety ✓ Implementation of waste management plan ✓ Supervision of occupational safety reduction
	Daw Htet Htet Hlaing	Member	✓ Monitoring and reporting Occupational Health and Safety issues to leader ✓ Implementation of mitigation measures
	Daw Aye Chan Moe	Member	✓ Planning to do mitigation measure for

No.	Name	Position	Responsibility
			impact ✓ Planning to do management plan of the project
3.	U Nay Htoo Ko Ko (M&E Coordinator)	Assistant Leader	✓ Inspection and supervising of fire protection equipment, protection measures and emergency response plans ✓ Monitoring of equipment and vehicles ✓ Reporting to the team leader if a workplace accident occurs
	U Aung Zin Mg	Member	✓ Implement the systematic maintenance programmes of equipment, machinery and vehicles ✓ Check firefighting equipment regularly and report to team leader
	U Yan Naing Lin	Member	✓ Firefighting training program support to all staff and worker ✓ Environmental knowledge sharing

Table 7-2 Estimated Budget for Environmental Monitoring Plan

No	Monitoring Items	Annually estimated budget (MMK)
Environmental Monitoring (construction, operation/maintenance)		
1.	Air quality monitoring	3,000,000
2.	Water quality monitoring	1,500,000
3.	Wastewater quality monitoring	1,000,000
4.	Noise quality monitoring	3,000,000
5.	Biodiversity	1,500,000
6.	Occupational health and safety (Project area and Community)	5,000,000
7.	Solid waste management	1,500,000
8.	Natural Disaster Management	3,000,000
9.	Soil Contamination and Landscaping	1,000,000
10.	Community Safety Risk	2,000,000
11.	Health Impact	2,000,000
Total		**24,500,000**

Table 7-3 Estimated Budget for Implementation Environmental Management Plan and Mitigation Measure

No	Items	Annually estimated budget (MMK)
Environmental management (construction, operation/maintenance)		
1.	Air quality management	6,000,000
2.	Water quality management	4,000,000
3.	Wastewater quality management	4,000,000
4.	Noise quality management	2,000,000
5.	Biodiversity	2,000,000
6.	Solid waste management	4,000,000
7.	Soil Contamination and Landscaping	2,000,000
Health and Safety program		
8.	Fire protection	10,000,000
9.	Emergency cases	10,000,000
10.	Conducting relevant trainings	3,000,000
11.	Occupational health and safety (Project area and Community)	10,000,000
12.	Natural Disaster Management	3,000,000
13.	Community Safety Risk	3,000,000
14.	Health Impact	3,000,000
Total		**66,000,000**

Apart from having an Environmental Management Plan, it is necessary to have a permanent staff who is in charge of ensuring its effective implementation of mitigation measures and to conduct environmental monitoring. According to the above table, it is necessary to assign staffs who have the background knowledge for the regular check-up for environmental monitoring items. Training program for safety issues should be completed if necessary. Environmental monitoring can also be done by registered third party monitoring agency. The major duties and responsibilities of the person who is responsible for environmental monitoring of Mandalay Business Capital City Development Ltd. should be as given below:

(a) To ensure regular operation and maintenance of pollution control devices.

(b) To minimize environmental impacts of operations by true dedication to the EMP.

(c) To initiate environmental monitoring as per approved schedule.

(d) Review and interpretation of monitored results and corrective measures in case monitored results are above the specified limit.

(e) Maintain environmental related records.

(f) Coordination with regulatory agencies, external consultants, monitoring laboratories.

(g) Ready to solve any complaints from guest, local people, neighborhood or government authorities about environmental and social issues especially in wastewater and solid waste.

7.3.2. Summary of Environmental Monitoring Program

The following **Table 7-4** described the detailed monitoring plan for operation and decommissions phases of proposed project. According to the baseline monitoring point in Chapter 4, there are 5 monitoring points for air, surface water, noise & vibration quality within 5 km radius of the project site. However, in the monitoring programs, the 3 locations will cover for project implementation. Because, this location is situated at above, middle and below points of the project boundary as well as is situated within 5 km radius of the study area. In addition, there are located at near mainly impact sources of the project. The project proponent must obey it to mitigate impact on the environment and meet with standard and guideline. In addition to monitoring plan, there should be auditing plan in the form of internal and external environmental audit. The audits will assess the environmental performance of the operation in complying with environmental laws, rules and regulations. The environmental monitoring report as per monitoring program must submit to ECD in every six months after receiving the approval letter for EIA from MONREC.

Table 7-4 Environmental Monitoring Program for Construction Phases

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
Outdoor air quality	Construction	**For 24 hours** $PM_{2.5}$ and PM_{10}, TSP, NO_2, SO_2, CO_2, CO, VOC, O_3, Humidity **Guideline** NEQEQ (2015)	**Within the Project Site** Lat:21°56'12.27"N Long: 96°2'59.27"E Lat:21°54'57.92"N Long: 96°2'7.89"E Lat:21°53'55.89"N Long: 96°0'54.32"E	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.
Water Quality	Construction	Surface Water Quality BOD_5, COD, Iron, Oil & Grease, pH, chlorine(free), Total Suspended Solid, Hardness,Total Dissolved Solid, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Phosphorus, Total Coliform Bacteria, Ammonia (as N), Chromium (Hexa), Chromium (Tri), Copper, Cyanide, Manganese, Flouride, Mercury, Nikkel, Nitrate (as N), Nitrite (as N), Phenol compounds and Zinc	**Surface Water** **(1) Ayeyarwaddy River, downstream** Lat:21°53'39.49"N Long: 96°0'13.72"E **(2) Ayeyarwaddy River, upstream** Lat:21°57'47.38"N Long: 96°2'9.03"E **(3) Ayeyarwaddy River, middle stream** Lat:21°55'18.37"N Long: 96°1'33.96"E **(4) Wastewater outlet point, beside the project boundary**	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
		Guideline NEQEQ (2015), TCVN 5942 : 1995 Water Quality Standards (Vietnam)	21°54'32.69"N 96° 1'17.29"E		
Wastewater	Construction	BOD_5, COD, Iron, Oil & Grease, pH, chlorine(free), Total Suspended Solid, Hardness,Total Dissolved Solid, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Phosphorus, Total Coliform Bacteria **Guideline** NEQEQ (2015),	Final water discharge point from construction site	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.
Ground Water	Construction	✓ pH, Iron, Oil and Grease, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform, Fecal Coliform, Manganese, Chloride, Sulphate, Nitrate	21°56'20.22"N 96°03'15.66"E 21°54'45.49"N 96°02'32.26"E	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
		Guideline NEQEQ (2015), National Drinking Water Quality Standards of Myanmar (2019)			
Solid waste and Hazardous waste	Construction	✓ The amount of waste generation and classification ✓ Daily weighing and recording of segregated waste ✓ Recording the quantity and method of waste disposal ✓ Checking whether or not there is a systematic disposal of waste ✓ Checking the waste burning or not	Waste generation source of each operation process at project area (eg. Wood pieces, iron scarp, cement bags, etc) and waste disposal site within the project area	Daily	Contractor/ Mandalay Business Capital City Development Ltd.
Noise and Vibration	Construction	✓ For 24 hours Noise level (dB(A) Pascale) ✓ For Vibration level Acceleration (m/s^2) Velocity (mm/s) **Guideline** NEQEQ (2015), NSW (New South Wales), Australia guideline (2006)	**Within the Project Site** Lat:21°56'12.27"N Long: 96°2'59.27"E Lat:21°54'57.92"N Long: 96°2'7.89"E Lat:21°53'55.89"N Long: 96°0'54.32"E	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
Biodiversity	Construction	✓ Plantation, growing and conservation within the project area ✓ Conservation and checking the species of bird, insect and fish. **<u>Law</u>** The Conservation of Biodiversity and Protected Area Law (2018)	For fish survey, Within the project site 21°53'46.99"N 96° 1'11.37"E and surrounding environment 21°56'12.42"N 96° 2'30.57"E For Flora & Fauna Urban Area (1) 21°55'39.24"N 96° 3'12.65"E Urban Area (2) 21°54'27.74"N 96° 3'7.13"E Cultivated Area (1) = 21°55'38.90"N 96° 2'14.17"E Cultivated Area (2) 21°54'57.61"N 96° 2'36.18"E	3 seasons	Mandalay Business Capital City Development Ltd.
Occupational Health and Safety	Construction	✓ Provide personal protective equipment in the workplace ✓ Determining whether or not protective equipment is present ✓ Keeping work attendance	The whole project area ✓ Condition the supply PPE ✓ Condition the place of warning sign ✓ First aid-kid ✓ Emergency contact numbers	Monthly	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
		records ✓ Placing hazard warning signs ✓ Workplace inspection by a safety monitor ✓ Place emergency contact number in workplace ✓ Conduct regular safety trainings and awareness **Guideline** EHS Guideline for Occupational Health & Safety (2007)			
Community Health and Safety	Construction	✓ Social impact situation ✓ Health issue to the surrounding environment due to the project implementation	Project surrounding area	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.
Fire Hazard	Construction	✓ Monthly inspection of the pressure gauge, and seal on fire extinguishers ✓ Monthly inspection on smoke detector, water sprinklers, fire hydrants, hose reels and fire hydrants system. ✓ Fire training to worker ✓ Addresses of organizations that should be contacted in an emergency; phone numbers should be easily accessible	The whole project area	Quarterly	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
		Law .The Myanmar Fire Brigade Law (2015)			
Emergency Risks	Construction	✓ Practicing emergency drill ✓ Records of emergency plan ✓ Education and training ✓ Provide emergency response and safety training to all staff ✓ Addresses of organizations that should be contacted in an emergency; phone numbers should be easily accessible	The whole project area	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.
Natural Disaster (River Bed Level, flood, ground subsidence, dyke wall erosion)	Construction/ Operation/ Maintenance	✓ Ground level geotechnical survey ✓ Stability of Dyke wall ✓ River bank erosion **Law** Natural Disaster Management Law (2013)	✓ Ground Water extraction source ✓ Ayeyarwaddy River ✓ Along the River bank	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.

Table 7-5 Environmental Monitoring Program for Operation /Maintenance Phases

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
Outdoor air quality	Operation/ Maintenance	**For 24 hours** $PM_{2.5}$ and PM_{10}, TSP, NO_2, SO_2, CO_2, CO, VOC, O_3, Humidity **Guideline** NEQEQ (2015)	**Within the Project Site** Lat:21°56'12.27"N Long: 96°2'59.27"E Lat:21°54'57.92"N Long: 96°2'7.89"E Lat:21°53'55.89"N Long: 96°0'54.32"E	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.
Water Quality	Operation/ Maintenance	Surface Water Quality BOD_5, COD, Iron, Oil & Grease, pH, chlorine(free), Total Suspended Solid, Hardness,Total Dissolved Solid, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Phosphorus, Total Coliform Bacteria, Ammonia (as N), Chromium (Hexa), Chromium (Tri), Copper, Cyanide, Manganese, Flouride, Mercury, Nikkel, Nitrate (as N), Nitrite (as N), Phenol compounds	**Surface Water** **(1) Ayeyarwaddy River, downstream** Lat:21°53'39.49"N Long: 96°0'13.72"E **(2) Ayeyarwaddy River, upstream** Lat:21°57'47.38"N Long: 96°2'9.03"E **(3) Ayeyarwaddy River, middle stream** Lat:21°55'18.37"N Long: 96°1'33.96"E **(4) Wastewater outlet point, beside the**	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
		and Zinc **Guideline** NEQEQ (2015), TCVN 5942 : 1995 Water Quality Standards (Vietnam)	**project boundary** 21°54'32.69"N 96° 1'17.29"E		
Wastewater	Operation/ Maintenance	BOD_5, COD, Iron, Oil & Grease, pH, chlorine(free), Total Suspended Solid, Hardness, Total Dissolved Solid, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Phosphorus, Total Coliform Bacteria **Guideline** NEQEQ (2015),	wastewater discharge points (11 points) from the project site	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.
Ground Water	Operation/ Maintenance	✓ pH, Iron, Oil and Grease, Total Phosphorus, Total Suspended Solid, Total Dissolved Solid, Hardness, Total Nitrogen, Conductivity, Turbidity, Color, Temperature, Arsenic, Dissolved Oxygen, Lead, Total Coliform, Fecal Coliform, Manganese,	21°56'20.22"N 96°03'15.66"E 21°54'45.49"N 96°02'32.26"E	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
		Chloride, Sulphate, Nitrate **Guideline** NEQEQ (2015), National Drinking Water Quality Standards of Myanmar (2019)			
Solid waste and Hazardous waste	Operation/ Maintenance	✓ The amount of waste generation and classification ✓ Daily weighing and recording of segregated waste ✓ Recording the quantity and method of waste disposal ✓ Checking whether or not there is a systematic disposal of waste ✓ Checking the waste burning or not	Waste Transfer Station within the project site	Daily	Contractor/ Mandalay Business Capital City Development Ltd.
Noise and Vibration	Operation/ Maintenance	✓ For 24 hours Noise level (dB(A) Pascale) **Guideline** NEQEQ (2015), NSW (New South Wales), Australia guideline (2006)	**Within the Project Site** Lat:21°56'12.27"N Long: 96°2'59.27"E Lat:21°54'57.92"N Long: 96°2'7.89"E Lat:21°53'55.89"N Long: 96°0'54.32"E	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
Biodiversity	Operation/ Maintenance	✓ Plantation, growing and conservation within the project area ✓ Conservation and checking the species of bird, insect and fish. **Law** ✓ The Conservation of Biodiversity and Protected Area Law (2018)	For fish survey, Within the project site 21°53'46.99"N 96° 1'11.37"E and surrounding environment 21°56'12.42"N 96° 2'30.57"E For Flora & Fauna Urban Area (1) 21°55'39.24"N 96° 3'12.65"E Urban Area (2) 21°54'27.74"N 96° 3'7.13"E Cultivated Area (1) = 21°55'38.90"N 96° 2'14.17"E Cultivated Area (2) 21°54'57.61"N 96° 2'36.18"E	3 seasons	Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
Occupational Health and Safety	Operation/ Maintenance	✓ Provide personal protective equipment in the workplace ✓ Determining whether or not protective equipment is present ✓ Keeping work attendance records ✓ Placing hazard warning signs ✓ Workplace inspection by a safety monitor ✓ Place emergency contact number in workplace ✓ Conduct regular safety trainings and awareness **Guideline** EHS Guideline for Occupational Health & Safety(2007)	The whole project area ✓ Condition the supply PPE ✓ Condition the place of warning sign ✓ First aid-kid ✓ Emergency contact numbers	Monthly	Contractor/ Mandalay Business Capital City Development Ltd.
Community Health and Safety	Operation/ Maintenance	✓ Social impact situation ✓ Health issue to the surrounding environment due to the project implementation	Project surrounding area	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
Fire Hazard	Operation/ Maintenance	✓ Monthly inspection of the pressure gauge, and seal on fire extinguishers ✓ Monthly inspection on smoke detector, water sprinklers, fire hydrants, hose reels and fire hydrants system. ✓ Fire training to worker ✓ Addresses of organizations that should be contacted in an emergency; phone numbers should be easily accessible **Law** .The Myanmar Fire Brigade Law (2015)	The whole project area	Quarterly	Contractor/ Mandalay Business Capital City Development Ltd.
Emergency Risks	Operation/ Maintenance	✓ Practicing emergency drill ✓ Records of emergency plan ✓ Education and training ✓ Provide emergency response and safety training to all staff ✓ Addresses of organizations that should be contacted in an emergency; phone numbers should be easily accessible	The whole project area	Twice a year	Contractor/ Mandalay Business Capital City Development Ltd.

Monitoring Item	Phases	Monitoring Parameter	Area to be Monitored	Frequency	Responsible Organization
Natural Disaster (River Bed Level, flood, ground subsidence, dyke wall erosion)	Operation/ Maintenance	✓ River Level monitoring, **Law** Natural Disaster Management Law (2013)	✓ Ayeyarwaddy River ✓ Along the River bank	every month during rainy season. (Between May and October)	Contractor/ Mandalay Business Capital City Development Ltd.

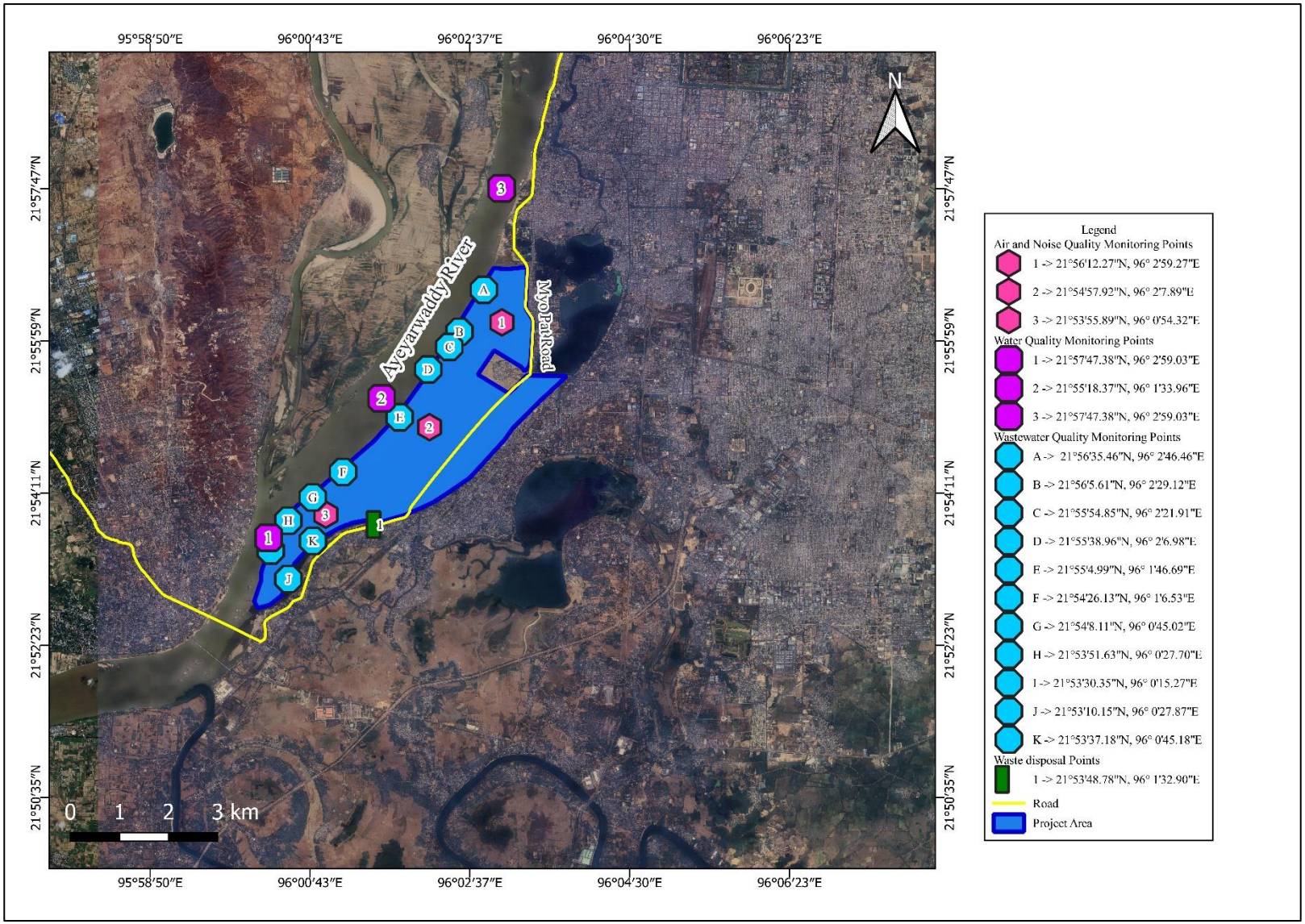


Figure 7-2 Environmental Monitoring Points

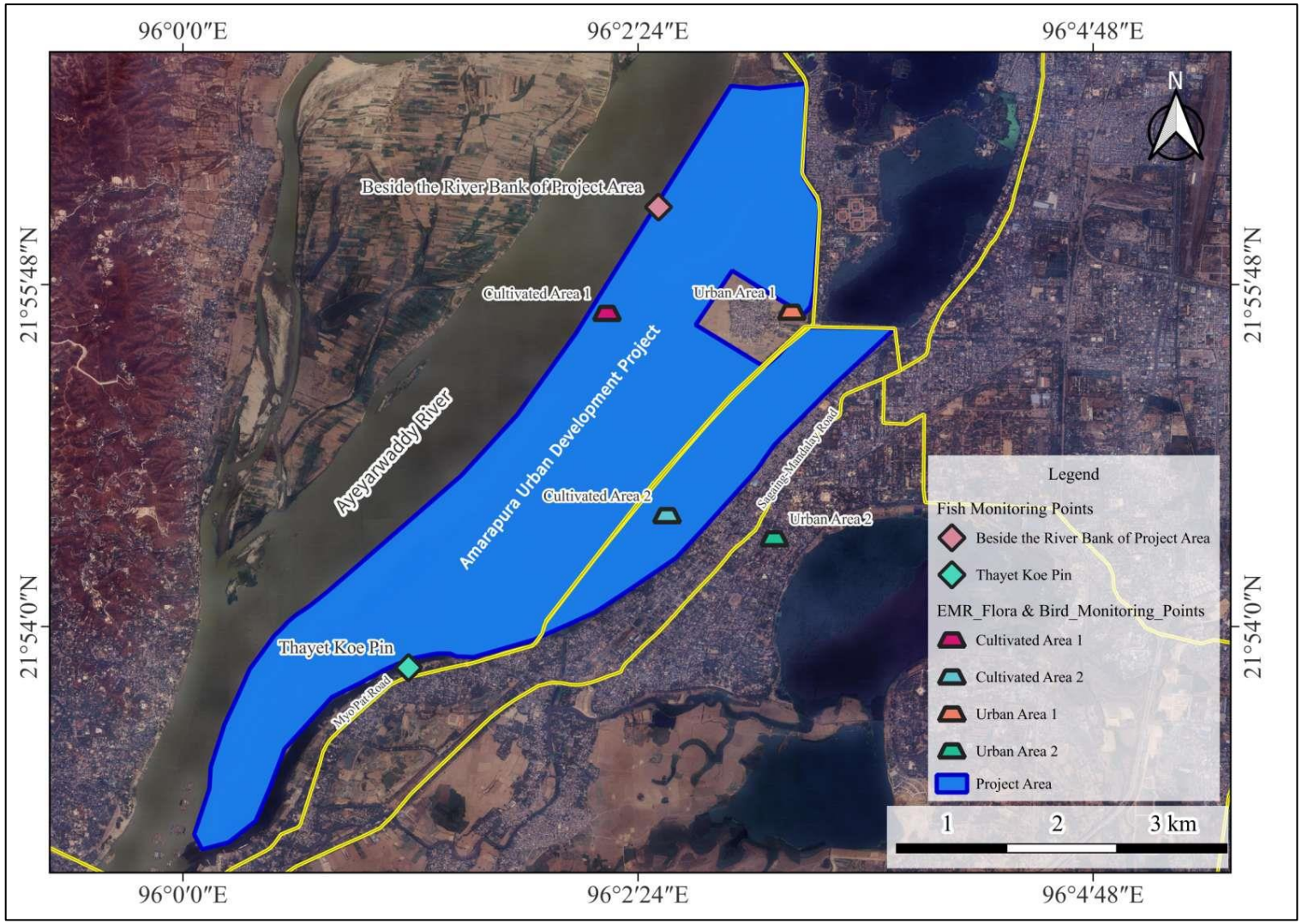


Figure 7-3 Biodiversity Monitoring Points

7.3.3. Important Point for Environmental Monitoring Program

The following factors need to be considered in the environmental monitoring program according to the Article 108, Article 109 and Article 110 described in Environmental Impact Assessment Procedure (2019, December).

Article 108. The Project Proponent shall submit monitoring reports to the Ministry not less frequently than every six (6) months, as provided in a schedule in the EMP, or periodically as prescribed by the Ministry.

Article 109. The monitoring reports shall include:

a) documentation of compliance with all conditions;

b) progress made to date on implementation of the EMP against the submitted implementation schedule;

c) difficulties encountered in implementing the EMP and recommendations for remedying those difficulties and steps proposed to prevent or avoid similar future difficulties;

d) number and type of non-compliance with the EMP and proposed remedial measures and timelines for completion of remediation;

e) accidents or incidents relating to the occupational and community health and safety, and the environment; and

f) monitoring data of environmental parameters and conditions as committed in the EMP or otherwise required.

Article 110. Within ten (10) days of completing a monitoring report as contemplated in Article 108 and Article 109 in accordance with the EMP schedule, the Project Proponent shall make such report (except as may relate to National Security concerns) publicly available on the Project's website, at public meeting places (e.g., libraries, community halls) and at the Project offices. Any organization or person may request a digital copy of a monitoring report and the Project shall, within ten (10) days of receiving such request, submit a digital copy via email or as may otherwise be agreed upon with the requestor.

The project proponent has to implement monitoring program and submit monitoring program to ECD twice a year.

7.4. ENVIRONMENTAL MANAGEMENT PLAN

Based on the project period, the environmental management plan includes the mitigation measure of impact of environmental qualities such as air, noise, wastewater, solid waste, occupational health and safety, natural hazards etc. The project proponent must follow, as practical as possible environmental health and safety guidelines and international standard for the project. There is the own program for capacity building and training covering good working practices and good safety practices. Moreover, the project proponent must obey the monitoring plan and mitigation measure mentioned in the Environmental Impact Assessment Report.

Although the proposed project of the proposed project has a number of adverse impacts on the surrounding environment, all of the impacts will be reduced to some extent by related proper mitigation measures. However, the unavoidable impacts would evolve from Occupational Health and Safety of workers in the aspect of physical hazards with long term and short-term working. Therefore, environmental impacts and mitigation measures plan, and estimated budget of construction, operation phase and maintenance phase are mentioned in the below. These activities shall be carried out to show that the project operations comply with the maximum allowable environmental norms and standards.

7.4.1. Air Quality Management Plan

7.4.1.1. Construction Phase

The construction phase of a project can raise concerns about air pollution. Dust and particle matter can enter the air as a result of clearing vegetation, grading the soil, and excavation. Particularly when it's windy and dry outside, these activities can produce a lot of dust. Transporting supplies, tools, and workers to the construction site is a common part of construction activity. Trucks, excavators, and other equipment employed for these tasks may emit vehicle emissions that contribute to air pollution.

To be able to mitigate the detrimental impacts of air pollution, control measures, such as using water sprays, dust screens, or windbreaks must be implemented to suppress dust emissions from site preparation, and material transportation. Main sources of dust such as soil and other debris should be handled properly. Tarpaulin covering of all dusty vehicle loads transported to, from and between site locations, dusty activities should be re-scheduled where possible if high-wind conditions are encountered and to provide masks to the workers in the construction area if necessary.

7.4.1.2. Operation/Maintenance Phase

Through a number of operations, a working activity can contribute to air pollution. Diesel generators or other fuel-powered equipment are often utilized at operations for a variety of tasks, including loading and unloading process of some project phase and vehicles. Dust and gas emission can be produced from the transportation vehicles which are coming visitors in and around of the project site. Particularly if insufficient dust suppression mechanisms are in working place, these particles may become airborne and contribute to air pollution.

Dust control measures, such as covering or wetting materials must be implemented to reduce the emissions of particulate matters in operation activities. Air quality must be monitored to ensure the project area is compliance with the standards. If not, the project proponent has to mitigate the air pollution by following the mitigation measures. Machines such as generator and machineries as transportation vehicles must be maintained regularly. In addition to that, efficient air-purifying plants must be planted in the vacant area of the project.

The environmental management sub-plan of air quality is shown in Table 7-6.

Table 7-6 Environmental Management Sub-Plan for Air Quality

1	**Objective**	To prevent and mitigate the impacts of air pollution and enhance air quality of the proposed project.	
2	**Legal Framework**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015)	
3	**Maps**	Location Maps are shown in Figure 1-1. Air quality measurement map is shown in Figure 4-43. Monitoring Point Map is shown in Figure 7-2.	
4	**Implementation Schedule**	**Construction Phase**	**Operation Phase/Maintenance**
5	**Management Actions**	✓ Sprinkle with water on un-paved road and any areas that are currently under construction at least four time per day especially during dry season because of wet suppression can greatly reduce dust emission up to 70%. ✓ Maintain a minimum of 60 cm of free board and cover any vehicles transporting soil, sand, and other loose materials. ✓ Maintain the interior roads compact to reduce dust emission from moving vehicles. ✓ The speed limit for trucks will be reduced from 30 km/h to 15 km/h to minimize dust emissions by 50%. ✓ Regular checking the pave, to the extent possible, unpaved access roads, parking areas, and staging areas at construction sites. ✓ By properly operating and maintaining vehicles and other oil-operated machinery, it is possible to	✓ Water should be sprayed as suppressants to increase the moisture content at least one time per day (it can be applied at morning or evening). ✓ Regular maintenance of equipment and vehicles, particularly when operating commercial vehicles in project zones. ✓ Limit traffic speeds on any unpaved roads to 30 km/h. ✓ Consistent preservation and daily checking the basic infrastructure, waste water system, sludge disposal site and solid waste collection system. ✓ Regular maintain the installed ventilation system especially air-cooling system, fans and window in the office room. ✓ Regular monitoring for air quality parameters ($PM_{2.5}$ and PM_{10}, TSP, SO_2, NO_2, CO_2, VOC,

		maintain and minimize the emission of particulate matter (PM), SO2, NO2, and hydrocarbons from moving vehicles. ✓ Consistent use by the contractor of equipment/vehicles that are properly created, maintained, and operated, including the use of proper engine fuel mixes, routinely serviced exhaust emission systems, and proper engine tuning. ✓ Periodically inspect all machinery, including heavy equipment and pumps, as well as the engines of vehicles. Engines that are properly maintained, lubricated, and operated emit reduced smoke. ✓ On construction equipment, install diesel particulate filters. ✓ Suspend construction activities that cause visible dust plumes to extend beyond the construction site. ✓ In order to prevent excessive emission of sulfur dioxides, the contractor shall, if possible, purchase diesel fuel with less than 5% sulfur content by weight.	O_3) mentioned in the monitoring program. ✓ Grow efficient air-purifying plants, e.g., areca palm, Aloe Vera, fast-growing tree species and so on. ✓ Enforce to wear PPE to employees who are working in the project area, loading/ unloading area that it must wear the 95 mask or surgical mask in their working time (if necessary).
6	**Monitoring Frequency**	Twice a year	Twice a year
7	**Responsible Person**	Mandalay Business Capital City Development Ltd./ Contractor	Mandalay Business Capital City Development Ltd.
8	**Estimated budgets**	Implementing mitigation measures – 6,000,000 MMK Monitoring - 3,000,000 MMK	Implementing mitigation measures – 6,000,000 MMK Monitoring - 3,000,000 MMK

7.4.2. Water Pollution Management Plan

7.4.2.1. Construction Phase

During the construction stage to construct a buildings and infrastructures, wastewater can be generated from domestic usage of workers, cleaning machines and surface runoff from heavy rain fall. Surface runoff included sediment, debris, and chemicals could be polluted to nearest waterbody if those are not properly managed. Construction equipment and machinery used during site preparation and construction may require cleaning. The wash water used for this purpose can contain oils, grease, fuel residues, and other contaminants associated with the equipment. Therefore, those discharged amount of water is large, water filtration system must be implemented not to pollute the nearest water body. Sewage tanks must be checked regularly not to leak.

7.4.2.2. Operation /Maintenance Phase

Wastewater will be generated from operation/maintenance phase are the households and urban infrastructures of the project will enter into nearby surface water body. In addition, others are domestic wastewater from worker's usage and drink, wastewater from toilets, storm water and sewage water. Sewage water can cause diarrhea-related diseases. If the wastewater is directly discharged to the public, water bodies will be polluted and health issues will be arisen in the society nearby. So, minimize the amount of water used, avoid generating unnecessary wastewater, separate the drainage and pipeline system for sewer line and surface runoff, regularly check the septic tank to avoid leakage of sewage and avoid discharging wastewater directly to the natural water bodies to minimize the impacts.

Therefore, the mitigation measure for wastewater pollution is that encouraging workers and people to practice water conservation and storage of fuels and hazardous materials, having spill response equipment readily available, and conducting regular inspections. For the domestic wastewater and surface runoff, regularly inspected the drainage channels to collect the garbage from canals so as to improve water flow and to minimize the impact of related drainages. The drainage channel will be inspected for good flow of water. Water pollution must be regularly according to monitoring programs mentioned in Table 7.3 to detect any deviations or potential issues promptly.

The environmental management sub-plan of water quality is shown in Table 7-7.

Table 7-7 Environmental Management Sub-Plan for Water Quality

1	**Objective**	To prevent and mitigate the impacts of water pollution and enhance wastewater quality of the proposed project.	
2	**Legal Framework**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015) Water Resources and Rivers Conservation Act (2016) (Amended 2017)	
3	**Maps**	Location Maps are shown in Figure 1-1. Water quality measurement map is shown in Figure 4-85. Monitoring Point Map is shown in Figure 7-2.	
4	**Implementation Schedule**	**Construction Phase**	**Operation Phase**
5	**Management Actions**	✓ During the construction period, a suitable water management system is implemented, such as effective land drainage and the usage of artificial ponds for receiving site runoff to reduce the effect of runoff on surrounding watercourses. ✓ Prevent producing excessive wastewater. ✓ If at all possible, use a water meter to reduce the generation of unnecessary wastewater. ✓ Systematic measures will be taken to control seepage water from the waste disposal facility. ✓ Manage the fuel, oil, and lubricant leaks from the construction site. ✓ To ensure that sewage does not leak out of	✓ Reduce the amount of water utilized for domestic uses at the project area to a minimum. ✓ Use water meter to control the unnecessary wastewater production if possible. ✓ Separate the drainage and pipeline system for sewer line and surface runoff. ✓ Regularly check the septic tank to avoid leakage of sewage. ✓ Control oil and grease generating from the operation/maintenance activities. ✓ Regular cleaning and checking of all drainage channels in the project area.

		sewage tanks. ✓ To connect Mandalay City Development Committee and dispose the sewage water produced from the demolition of toilets and sewage water produced from temporary toilets.	✓ All drainage systems are covered and liquid wastes are disposed to the septic to avoid soil contamination. ✓ Make wastewater treatment system before disposing of into the drainage channel ✓ To generate wastewater which meet with NEQEG
6	**Monitoring Frequency**	Twice a year	Twice a year
7	**Responsible Person**	Mandalay Business Capital City Development Ltd. / Contractor	Mandalay Business Capital City Development Ltd.
8	**Estimated budgets**	**Implementing mitigation measures** Water quality – 4,000,000 MMK Wastewater quality- 4,000,000 MMK **Monitoring** Water quality – 1,500,000 MMK Wastewater quality- 1,000,000 MMK	**Implementing mitigation measures** Water quality – 4,000,000 MMK Wastewater quality- 4,000,000 MMK **Monitoring** Water quality – 1,500,000 MMK Wastewater quality- 1,000,000 MMK

7.4.3. Solid Waste Management Plan

7.4.3.1. Construction Phase

Trees, plants, and other natural elements may need to be removed from the construction site before construction starts. The organic debris produced by this process may include branches, stumps, and foliage. There may be extra or underutilized materials of things like construction supplies, tools, or temporary buildings during the construction stage that are no longer required for the project. If these items are not adequately managed, recycled, or repurposed, they may enter the solid waste stream. In addition, waste produced by the workers (plastic bags, cans, soft drink cans, plastic ropes, tissues, food remains, etc.) can be generated in construction phase.

Therefore, the recycling and reuse of excess construction materials such as concrete, metal, wood, and plastics should be promoted. Sufficient garbage bins and temporary dispose tank must be provided in the project area. The workers, contractors and other stakeholders must be educated about the importance of proper waste management.

Food leftovers generated from the construction workers must be used as natural fertilizer in planting trees in the project area. If the chemical products are generated from the construction stage, those must be disposed of separately from other non-hazardous wastes. Furthermore, the workers who has to handle the hazardous wastes must wear gloves and other necessary PPE.

7.4.3.2. Operation/ Maintenance Phase

There are two types of solid wastes, wastes from operation process and domestic wastes and maintenance process. Cardboard boxes, wooden crates, plastic wraps, or pallets could be generated from operation of project. In addition, paper, food scrape, leftovers, plastic bottles and tissues, etc. will be generated from domestic waste. If they are not disposed of properly, they cause environmental pollution.

Therefore, the mitigation measure for environmental pollution due to solid waste generation is to minimize it, provide specific storage areas to collect waste, and dispose of it within the project, construct proper tent or protected dumping site to control the liquid leaches from it, use marked bins to segregate hazardous and non-hazardous wastes and waste must be separated by type of waste and systematically disposed into containers.

Recyclable waste bins must be supplied and a good practice of waste sorting habit must introduce and officially legislate the practice within the project, in Figure 7.3. Garbage bins are provided in suitable place nearby canteen, toilet, operation area etc.

Figure 7-4 Solid Waste Generation

The environmental management sub-plan of solid waste is shown in Table 7-8.

Table 7-8 Environmental Management Sub-Plan for solid waste

1	**Objective**	To prevent and mitigate the impacts of solid waste and enhance solid waste management system of the proposed project.	
2	**Legal Framework**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015) National Waste Management Strategy and Master Plan for Myanmar	
3	**Maps**	Location Maps are shown in Figure 1-1. Waste Disposal Site Map is shown in Figure 3-69. Monitoring Point Map is shown in Figure 7-2.	
4	**Implementation Schedule**	**Construction Phase**	**Operation/Maintenance Phase**
5	**Management Actions**	✓ Dispose the wastes from construction phase as wet waste, dry waste, and hazardous waste in orderly manner. ✓ Construction debris, packaging materials, scraps, and metal fragments are correctly disposed of without being left lying around on the ground. ✓ The project's proponent and contractor are responsible for supervising the waste's transfer from the site to the disposal facility. ✓ To make recycling, reuse, and disposal	✓ Provide a separate place for storage where waste can be collected and disposed of at the allowed damping place. ✓ Build a suitable tent or safe disposal area to avoid liquid leakage from it. ✓ The project supervisor is responsible for supervising the transportation of waste from the site to the disposal facility. ✓ Avoid filling vehicles with too much waste in order to prevent loss of waste during transportation. ✓ To separate hazardous and non-hazardous waste, use designated bins. ✓ Waste must be systematically disposed of into

		easier and to stop interactions between different forms of garbage, waste is separated and avoided mixing, such as organic waste (food scraps), non-hazardous waste (metal, glass, concrete, plastic, etc.), inert waste (cleaned soil), and hazardous waste (Paints, solvents, oils, batteries, medical waste). ✓ For the safe collection, segregation, and management of all waste streams collected, household and general garbage must be separated on site into combustible (paper, food, cardboard, and wood) and non-combustible (metals, glass, rubble) streams using appropriately designated containers. ✓ To set up temporary disposal tanks and trash cans in the project area. ✓ Food scraps can be used as organic fertilizer to produce plants and feed animals. ✓ Creating warning sign boards for the area where hazardous and chemical wastes are stored. ✓ No wastewater or sanitary waste that hasn't been treated shall be dumped on the	containers after being sorted by type. ✓ The female employee's sanitary pad needs to be packed in paper and disposed of in a timely manner in the trash cans. ✓ To generate the waste that it connected with MCDC ✓ Recyclable waste bins need to be available and recycling trash needs to be sorted properly as a habit. ✓ As part of the spill response strategy, the chemicals will be soaked in sawdust and sand. ✓ Reuse, reduce, and recycle (or 3R) should be encouraged among employees through environmental education programs and awareness-raising efforts. ✓ Chemical wastes should be appropriately disposed of and collected in separate bins (chemical bags, containers, etc.). ✓ Awareness to workers on how to deal with hazardous chemicals and waste. ✓ Prohibition of incineration wastes in the project area.

		ground. ✓ To generate the waste that it connected with MCDC	
6	**Monitoring Frequency**	Daily	Daily
7	**Responsible Person**	Mandalay Business Capital City Development Ltd. / Contractor	Mandalay Business Capital City Development Ltd.
8	**Estimated budgets**	Implementing mitigation measures – 4,000,000 MMK Monitoring - 1,500,000 MMK	Implementing mitigation measures – 4,000,000 MMK Monitoring - 1,500,000 MMK

7.4.4. Noise and Vibration Management Plan

7.4.4.1. Construction Phase

During construction phase, the operation of various machines such as excavators, cranes, sand ships, heavy vehicles and other civil works can produce noise and vibration. Furthermore, the operation of generators to operate some tasks can contribute to the noise and vibration level of project area. To control noise level, noise control measures such as using noise barriers or enclosures around noisy equipment, utilizing quieter machinery or tools must be installed. It must be avoiding the construction process during specific hour such as night-time or early-morning to reduce the disturbance to nearby residents or sensitive areas.

7.4.4.2. Operation / Maintenance Phase

The movement of motor vehicles, packing slot, residential, market and commercial area and other activities produce a lot of noise. Fish, animals, and other marine life that inhabits the nearby seas can be disturbed by loud noise levels. Their communication, breeding, and natural behavior may all be affected by this disturbance. Long-term exposure to noisy workplaces can cause hearing loss or other health problems in workers, so it's important to take precautions like wearing hearing protection. Residents may experience noise problems from operations close to their homes, which may have an impact on their quality of life, ability to sleep, and general well-being.

Noise barriers such as walls or acoustic enclosures around noisy machinery and equipment such as generators must be installed.

- Regular maintenance of machinery, ensuring proper lubrication and alignment, can minimize noise emissions.
- Upgrading older equipment to newer, quieter models can also help reduce noise pollution.
- Implementing a noise monitoring program can help assess the noise levels around the project area. Compliance with local regulations and noise standards such as NEQEG (2015) should be ensured.
- Training employees on the importance of noise control and how to use personal protective equipment (PPE) correctly can help avoid hearing loss and encourage a quieter workplace.

The environmental management sub-plan of noise quality is shown in Table 7-9.

Table 7-9 Environmental Management Sub-Plan for Noise Quality and Vibration

1	**Objective**	To prevent and mitigate the impacts of noise and vibration pollution	
2	**Legal Requirement**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015)	
3	**Maps**	Location Maps are shown in Figure 1-1. Noise quality measurement map is shown in Figure 4-88. Monitoring Point Map is shown in Figure 7-2.	
4	**Implementation Schedule**	**Construction Phase**	**Operation /Maintenance Phase**
5	**Management Actions**	✓ Contractor will take measures to reduce noise levels from construction machinery that exceed the NEQG guideline limitations. ✓ To prevent disturbing the surrounding area, movements of trucks and other construction equipment that generate loud noises must be limited at night. Truck drivers should be instructed not to use their horns at night and to stop playing loud music. ✓ Avoiding the construction activities at night within 150 meters of sensitive land uses where feasible. ✓ Proper soundproofing boundary walls must be constructed in locations where asphalt/concrete	✓ Use equipment and machines which generate low noise levels. ✓ Regular maintenance for noise generation machines such as unwinding machines from the operation process. ✓ Record and inspection maintenance for each machine and change the good quality product (if necessary). ✓ Provide adequate ear protection (ear plugs or muffs, to workers working in the excessive noise areas. ✓ No employee should be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hour per day without hearing protection. In addition, no unprotected ear should be exposed to a peak sound pressure

		plants generate noise and are adjacent to any locality within 35 meters of residences should be strictly prohibited. ✓ Avoid staging of construction equipment within 60 meters of residences and locate all stationary noise-generating construction equipment, such as air compressors and portable power generators, as far practical from noise sensitive receptors. ✓ Substitution of low noise devices and equipment. ✓ Regular inspection and rotation of equipment and machinery. ✓ Providing the workers in the construction area appropriate hearing protection, such as ear plugs or earmuffs, and training them in how to use it.	level (instantaneous) of more than 140 dB (C). ✓ Arrange employees on a rotating basis in noisy places.
6	**Monitoring Plan**	Twice a year	Twice a year
7	**Responsible Person**	Mandalay Business Capital City Development Ltd. / Contractor	Mandalay Business Capital City Development Ltd.
8	**Projected Budgets**	Implementing mitigation measures – 2,000,000 MMK Monitoring - 3,000,000 MMK	Implementing mitigation measures – 2,000,000 MMK Monitoring - 3,000,000 MMK

7.4.5. Soil Contamination and Landscaping Management Plan

7.4.5.1. Construction/ Operation/ Maintenance Phase

Soil contamination, soil pollution, or land pollution as a part of land degradation is caused by the presence of the chemicals or other alteration in the natural soil environment. It is typically caused by construction activity, agricultural chemicals or improper disposal of waste. During any phase of the project, soil could be contaminated due to the leakage of oil, fuel and other chemical products. Improper wastes disposal could also contribute to soil contamination.

Therefore, the project proponent has to follow soil contamination management plan which involves identifying potential sources of contamination, assessing the extent and nature of contamination, implementing mitigation measures. Firstly, potential sources of soil contamination such as fuel spills, chemical storage area must be identified, checked regularly. If there is spill, soaking spilled chemicals with sawdust and sand will be done as spill response plan. Wastes must be disposed separately. Hazardous wastes such as old engine oil bottle, other chemical products must be disposed by packing completely not to spill.

The environmental management sub-plan of soil contamination is shown in Table 7-10.

Table 7-10 Environmental Management Sub-Plan for Soil Contamination and Landscaping

1	**Objective**	To prevent and mitigate the impacts of project on soil.	
2	**Legal Requirement**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015)	
3	**Maps**	Location maps of project area are shown in Figure 1-1. Measurement of soil is shown in Figure 4-113.	
4	**Implementation Schedule**	**Construction Phase**	**Operation / Maintenance Phase**
5	**Management Actions**	✓ Planting will be conducted at the base of the embankment to protect the slope, consisting of quickly growing native trees with strong roots that can anchor in the soil. ✓ When feasible, extra dirt should be reused, and any remaining soil can be dumped at a designated location to prevent erosion. ✓ By maintaining construction vehicles in good condition and containing other contaminants in storage tanks and other places, it is possible to prevent soil contamination by minimizing oil spills from vehicles of visitors and staff in the project construction sites. ✓ Additionally, construction camp wastewater	✓ Maintaining the company's vehicles' engines will help prevent oil spills, and proper management will prevent visitors' and residents' cars from picking up any stray oil. ✓ Control proper oil and paint leakage when doing maintenance tasks. ✓ After the maintenance operation, properly dispose of the waste and paint remains. ✓ Solid waste should only be dumped in the designated locations to avoid hazardous waste contaminating the surroundings.

		disposal should be regularly inspected. ✓ To prevent soil contamination, septic tanks with sufficient capacities should be built to receive and treat wastewater from all temporary worksite toilets and construction camps.	
6	**Monitoring Plan**	Twice a year	Twice a year
7	**Responsible Person**	Mandalay Business Capital City Development Ltd. / Contractor	Mandalay Business Capital City Development Ltd.
8	**Projected Budgets**	Implementing mitigation measures – 2,000,000 MMK Monitoring - 1,000,000 MMK	Implementing mitigation measures – 2,000,000 MMK Monitoring - 1,000,000 MMK

7.4.6. Biodiversity Management Plan

7.4.6.1. Construction Phase

The pollution such as air, noise and other sediments can harm natural ecosystem. Excessive dust emission can accumulate on the foliage of the trees and it can somehow decrease the rate of photosynthesis. Bird and mammal species that reside close to the project area may be disturbed and stressed by the noise created by construction activities.

Therefore, the project proponent must carry out the management plan. Disposing of wastes which are generated from site preparation and construction into the river. Hunting wildlife animals must be prohibited to the workers. Likewise, over fishing and fishing during breeding season must be avoided by the stakeholders of the proposed project.

7.4.6.2. Operation/ Maintenance Phase

During operation/Maintenance phase, the various operation process such as transportation system of guest and resident, playground, markets, operation of machines and maintenance activities can disturb the existing fauna species nearby the project area. Air and noise pollution from the operation can interrupt the natural cycle of birds and other fauna species. Fishing and hunting by employees of species may cause changes in the occurrence of certain species.

Disposing of wastes and wastewater which are generated from project area into the river that can be polluted to the water body. Hunting animals must be prohibited to the workers. Likewise, over fishing and fishing during breeding season must be avoided by the stakeholders of the proposed project. Trees must be planted in the vacant area of the project to maintain the ecosystem balance as much as possible.

7.4.6.3. Fish Conservation Department

Fishes are the important part of the ecosystem. It balances ecological needs, transfer energy up and down the food chain and fulfill many important ecological roles. The fish conservation has major interest for both the scientific and the aquatic ecosystems. Fish provides essential ecosystem services, such as nutrient cycling, water filtration and supporting the wildlife. They make the major contribution to the ecosystem. And fish are the excellent recycler of the nutrients and they are being threatened by the overfishing and other activities.

The Proposed Project is closely located to the Ayarwaddy River and the sustainability of the environment, fish conservation plays one of the important factors for ecosystem as it provides ecosystem health, biodiversity important, recreational activities and the well-being of the people. To access the fish diversities and conditions of the population of the ecosystem, the monitoring team of project proponent have to conduct the fish surveys at 2 locations within the Proposed Project Area. While performing the field study, all the collected data of fish will be documented, recorded and photographed. With data collection and identifying of the aquatic species at the specific places, the data will be analyzed and monitored the population and diversity of the aquatic lives. This program will be conducted after every four months.

The environmental management sub-plan of biodiversity is shown in Table 7-11.

Table 7-11 Environmental Management Sub-Plan for biodiversity

1	**Objective**	To prevent and mitigate the impacts on biodiversity and enhance the natural ecosystem around the proposed project.	
2	**Legal Framework**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) The Forest Law (2018) Forest Rules (1998) The Conservation of Biodiversity and Protected Areas Law (2018)	
3	**Maps**	Location Map of Monitoring is shown in Figure 1-1. Maps of Biodiversity (Flora survey & Fauna survey) are shown in Figure 4-117 and Figure 4-130.	
4	**Implementation Schedule**	**Construction Phase**	**Operation/Maintenance Phase**
5	**Management Actions**	✓ Implement large landscaping area for rehabilitation of ecosystem for improving vegetation coverage. ✓ Floral habitat and related buffer zones outside of the operating areas must be marked as no-go zones, and no construction-related activities, employees, or vehicles are allowed to break into these regions. ✓ Monitoring of flora and fauna species during construction phase. ✓ Discharge wastewater through treatment system and monitored regularly. ✓ The construction workers and sub-contractors will be trained to understand and get awareness	✓ Establishing linear parks and greenspaces to connect urban green areas would help to preserve biodiversity by maintaining a healthy ecology and a diverse population. ✓ Developed a nursery in cooperation with a related forest department where indigenous/endemic plant species must be planted. ✓ Monitoring of flora and fauna species during operation/maintenance phase. ✓ Preservation and cultivation of endangered and rare plant species in the project area. ✓ Even if exotic species of plants have been planted to create landscaping in the gardens

		of nature and biodiversity conservation. ✓ As far as possible, any disruption of sensitive floral habitat and species of conservation significance must be avoided. ✓ During land clearing, avoid clearing of rare species and nesting sites are found. ✓ Prohibition of bird shooting and hunting of animals within the project area. ✓ Throughout all phases, a plan must be developed and put into practice to reduce the effect of dust on the environment. ✓ A control plan for exotic floral species must be developed and implemented in order to monitor and regulate foreign floral recruitment in disturbed habitats. ✓ A nursery must be developed in cooperation with a related forest department where indigenous/endemic plant species must be planted with a focus on rehabilitation in degraded and building areas. ✓ The various kinds of animals cannot be trapped, collected, or hunted at any stages of the proposed urban development; ✓ Limit vehicle traffic to designated roads to lessen the environmental effect of building and maintenance work as well as the risk of animal species accidents ✓ Large trees must be preserved wherever	and residential building and houses, keeping these species from spreading outside the area of the project. ✓ If any migratory birds or animals are found entering and sheltering in the project property, avoid arrest and move to safe location in cooperation with the related departments. ✓ Avoidance of bird shooting and hunting of animals in the project area.

		possible since they serve as nesting and resting places for species found in the area.	
6	**Monitoring Frequency**	Once a year	Once a year
7	**Responsible Person**	Mandalay Business Capital City Development Ltd. / Contractor	Mandalay Business Capital City Development Ltd.
8	**Estimated budgets**	Implementing mitigation measures – 2,000,000 MMK Monitoring - 1,500,000 MMK	Implementing mitigation measures – 2,000,000 MMK Monitoring - 1,500,000 MMK

7.4.7. Traffic Congestion Management plan

7.4.7.1. Construction Phase

In the construction phase, source of traffic impact is the transportation of construction materials and raw materials. The temporary and limited traffic effects during the construction phase will not be significant. Even so, appropriate measures must be taken to minimize the impact of traffic, such as setting up an effective timetable for operations and managing the timing of the delivery of supplies to avoid traffic wherever possible. Therefore, the roads must be maintained, and new access roads are built, a systematic traffic control system and regulation will be put in place within the project's boundaries.

7.4.7.2. Operation Phase

During the operation period, the high volume of visitors to the project site and the number of cars increases is the main source of traffic congestion. The movement of goods is probably going to affect traffic on the project site. To reduce the traffic congestion, the roads are maintained up in the operation phase. In addition, the traffic management system and regulations will be methodically set up within the project's boundaries, and enough people will be given to it. Furthermore, it is necessary to revolutionize traffic light management, restrict parking near busy intersections, encourage the use of alternative routes and set one-way routes, construct more park- and- rides.

The environmental management sub-plan of traffic congestion is shown in Table 7-12.

Table 7-12 Environmental Management Sub-Plan for traffic congestion

1	**Objective**	To reduce the traffic congestion	
2	**Legal Requirement**	Vehicle Safety and Vehicle Management Law (2020) Vehicle Safety and Vehicle Management Rules (2022)	
3	**Maps**	Location maps of project area are shown in Figure 1-1.	
4	**Implementation Schedule**	**Construction Phase**	**Operation / Maintenance Phase**
5	**Management Actions**	✓ setting up an effective timetable for operations and managing the timing of the delivery of supplies to avoid traffic wherever possible ✓ the roads must be maintained, and new access roads are built ✓ systematic traffic control system and regulation will be put in place within the project's boundaries	✓ the roads are maintained up in the operation phase ✓ traffic management system and regulations will be methodically set up within the project's boundaries and enough people will be given to it ✓ To revolutionize traffic light management ✓ Restrict parking near busy intersections ✓ Encourage the use of alternative routes and set one-way routes ✓ Construct more park- and- rides
6	**Monitoring Plan**	Twice a year	Twice a year
7	**Responsible Person**	Mandalay Business Capital City Development Ltd. / Contractor	Mandalay Business Capital City Development Ltd.
8	**Projected Budgets**	Implementing mitigation measures – 2,000,000 MMK Monitoring - 1,000,000 MMK	Implementing mitigation measures – 2,000,000 MMK Monitoring - 1,000,000 MMK

7.5. RISK MANAGEMENT PLAN

The risk management plan includes two sectors which are occupational health and safety and natural disaster. The occupational health and safety contain occupational safety, community safety, health impact and fire risk. In addition, natural disaster risk comprises earthquake, floods and ground subsidence. The detail management plan and sub-plan of them are following.

7.5.1. Occupational Health and Safety Management Plan

7.5.1.1. Construction Phase

To safeguard the health and safety of workers, occupational health and safety (O.H.S.) is an essential component of the construction process. Construction sites are inherently dangerous places with a range of risks and hazards. On construction sites, heavy equipment, falling debris, or moving vehicles can strike construction workers. Forklift, crane, and construction truck accidents and electrical shock can result in fatalities or severe injuries. Workers may become trapped between pieces of machinery, equipment, or collapsing structures.

People near the project area can injury due to falling materials from trucks that carries raw materials and other materials. In addition, accident can cause to people near the project area due to the vehicles. In the construction phase, construction activities, soil improvement and infectious diseases can affect on the staff and worker's health. Heat stress is also consideration factor for the occupational health. If the vibration level is exceeding the standard during construction phase, worker may damage to tendons, muscles, bones and joints, damage to the nervous system. The air pollution can be caused respiratory problems and noise pollution can cause hearing problem to residents near the project area.

Electrical work is frequently done on construction sites, and accidents can happen when workers get into contact with live wires, use faulty equipment, or lack sufficient grounding. Potential risks include electric burns, electrocution, and electric shocks. Accidents may occur as a result of improper use, device failure, or poor maintenance. The incorrect use of power tools or machines can result in accidents including cuts, amputations, or crush injuries. The fuel storage area and waste storage area are main sources of fire hazard in the project area. Fire hazard can cause damage to workers and project properties and even death.

To reduce the accidents and risks at occupation, the project proponent must provide sufficient PPE for the number of construction workers, display emergency contact numbers in a visible area, train workers on first aid, conduct emergency response team and procedure.

7.5.1.2. Operation/Maintenance Phase

During operation/maintenance phase, regular maintenance process can cause health & safety problem, electrical hazard and fire hazard. In addition, accident can cause to people near the project area due to the vehicles. Operation area can expose workers to various biological hazards due to exposure to bacteria, viruses, insects, plants, birds, animals, and even humans such as contagious disease and serious infectious diseases.

To mitigate the occupational accident in the project area, if accidents happen, someone must notify the appropriate authorities or the company's safety officer, supervisor, or emergency services, depending on the severity of the incident. Training to all workers

involved in operations process including safety procedures, equipment operation, emergency protocols, and awareness of potential hazards must be provided. Warning signs must be displayed on dangerous machine or working area. Before handling machines, training workers on the correct usage of machines to reduce mechanical risk.

The environmental management sub-plan of occupational Risk is shown in Table 7-13.

Table 7-13 Sub-Plan for Occupational risk

1	**Objective**	To prevent and mitigate the injuries and hazard during occupations.	
2	**Legal Requirement**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015) The Occupational Safety and Health Law (2019)	
3	**Maps**	Location maps of project area are shown in Figure 1-1.	
4	**Implementation Schedule**	**Construction Phase**	**Operation/ Maintenance Phase**
5	**Management Actions**	**Land reclamation and leveling/** **Retaining Structure Construction/** **Soil Improvement/** **Infrastructure Construction** ✓ Cover with tarpaulin or strictly tied up the materials before carrying with truck. ✓ To carry the materials in waist with safe posture. ✓ Carefully inspection before driving the machineries. ✓ Permit only the qualified or certified workers to drive the machineries. ✓ In the project site, the supervisor have to do knowledge sharing, training and monitor to safety drive to the drivers weekly or monthly.	**<u>Maintaining Basic Infrastructure</u>** ✓ Use PPE such as safety helmet, safety shoe, safety belt while working at high places. ✓ To maintain the electrical wire and devices with electrician. ✓ To repair immediately the damage wire and electrical devices. ✓ Sufficient fire protection equipment and fire extinguishers are provided. ✓ Combustible wastes are disposed regularly and stored separately. ✓ Awareness about do's and don'ts for waste storage and fuel storage is given.

		✓ To wear on a safety vest while working in order to see the situation properly. ✓ Do not permit to enter the irresponsible person in the working area. ✓ Enforce worker to wear the mask and eyes protection glass working in high dust emission. ✓ To put the emergency contact numbers in public area of project area. ✓ Plan ahead to send the nearest clinic or hospital if the major injury is happened. ✓ Check the first aid box every 6 month if medicine is necessary. ✓ Sharing knowledge about health & safety in working area between workers.	✓ To train the fire drill for emergency cases every 6 month. ✓ To put the emergency contact numbers in public area of project area. ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box). ✓ Arrange for delivery to the clinic or nearest hospital for emergency ✓ To plan for fire training every 6 months.
6	**Monitoring Plan**	Monthly	Monthly
7	**Responsible Person**	Mandalay Business Capital City Development Ltd. / Contractor	Mandalay Business Capital City Development Ltd.
8	**Projected Budgets**	Implementing mitigation measures – 10,000,000 MMK Monitoring - 5,000,000 MMK	Implementing mitigation measures – 10,000,000 MMK Monitoring - 5,000,000 MMK

The environmental management sub-plan of Community Risk is shown in Table 7-14.

Table 7-14 Sub-plan for Community Safety Risk

1	**Objective**	To prevent and mitigate the community safety risk.	
2	**Legal Requirement**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015) The Occupational Safety and Health Law (2019)	
3	**Maps**	Location maps of project area are shown in Figure 1-1.	
4	**Implementation Schedule**	**Construction Phase,**	**Operation/ Maintenance Phase,**
5	**Management Actions**	✓ Cover with tarpaulin or strictly tied up the materials before carrying with truck. ✓ Inspect the truck to not overload in transportation. ✓ To enforce vehicles that carry materials not to drive more than the specified kilometer on the roads. ✓ Regular maintenance the vehicles every 6 months.	
6	**Monitoring Plan**	Twice a year	Twice a year
7	**Responsible Person**	Mandalay Business Capital City Development Ltd. / Contractor	Mandalay Business Capital City Development Ltd.
8	**Projected Budgets**	Implementing mitigation measures – 10,000,000 MMK Monitoring - 5,000,000 MMK	Implementing mitigation measures – 10,000,000 MMK Monitoring - 5,000,000 MMK

The environmental management sub-plan of Health impact is shown in Table 7-15.

Table 7-15 Sub-plan for Health Impact

1	**Objective**	To prevent and mitigate the health impact	
2	**Legal Requirement**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015) The Occupational Safety and Health Law (2019)	
3	**Maps**	Location maps of project area are shown in Figure 1-1.	
4	**Implementation Schedule**	**Construction Phase**	**Operation/ Maintenance Phase**
5	**Management Actions**	**<u>Construction Activities</u>** ✓ Enforce worker to wear the mask and eyes protection glass working in high dust emission area. ✓ Use PPE such as safety helmet, safety shoe, safety belt while working at high places. ✓ Repair and maintain machinery every (6) months to prevent noise due to equipment failure. ✓ Do not operate equipment and machinery simultaneously unless necessary. ✓ Monitor machinery to ensure that it is not left on unnecessarily. ✓ Providing earplugs or ear muffs to workers working in noisy areas and enforce to wear the PPEs that provided.	**<u>Infectious Disease risks</u>** ✓ Provide workers with clean drinking water to prevent diarrheal diseases caused by impure drinking water. ✓ Sharing health education knowledge to workers about communicable diseases such as Covid-19, Hepatitis. ✓ Supply hand washing soap, hand sanitizers, masks and oral rehydration salt.

		Heat Stress ✓ Supply the sufficient drinking water and Oral Rehydration salt pack. ✓ Construct the rest places near the working area. ✓ Worker who work under the sun must wear long-sleeved shirts, long pants, hats. (Applying Thanaka and sun cream, wearing sunglass can also be used) ✓ Assign the worker with working shift when day temperature is high. **Soil Improvement** ✓ To announce in advance before the soil improvement process. ✓ Do not permit to enter the irresponsible person in the working area. ✓ Provide close supervision. **Infectious Disease risks** ✓ Provide workers with clean drinking water to prevent diarrheal diseases caused by impure drinking water. ✓ Sharing health education knowledge to workers about	

		communicable diseases such as Covid-19, Hepatitis. ✓ Supply hand washing soap, hand sanitizers, masks and oral rehydration salt. **<u>Community Health</u>** ✓ Spraying water twice a day on dusty area near the working site and the roads with high traffic. ✓ Protect with green filter cloth in windy and dusty areas. ✓ Slow down the speed of machinery and transport vehicles. ✓ Do not operate till night.	
6	**Monitoring Plan**	Once a year	Twice a year
7	**Responsible Person**	Mandalay Business Capital City Development Ltd. / Contractor	Mandalay Business Capital City Development Ltd.
8	**Projected Budgets**	Implementing mitigation measures – 3,000,000 MMK Monitoring - 2,000,000 MMK	Implementing mitigation measures – 3,000,000 MMK Monitoring - 2,000,000 MMK

The environmental management sub-plan of fire safety management is shown in Table 7-16.

Table 7-16 Environmental Management Sub-Plan for Fire Management

1	**Objective**	To prevent and mitigate the impacts of fire hazard,

2	**Legal Requirement**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015) The Myanmar Fire Brigade Law (2015) Natural Disaster Management Law (2013)	
3	**Maps**	Location maps of project area are shown in Figure 1-1.	
4	**Implementation Schedule**	**Construction phase**	**Operation / Maintenance Phase**
5	**Management Actions**	✓ Sufficient fire protection equipment and fire extinguishers are provided. ✓ Combustible wastes are disposed regularly and stored separately. ✓ Awareness about do's and don'ts for waste storage and fuel storage is given. ✓ To train the fire drill for emergency cases every 6 month. ✓ To put the safety & warning signs at fuel storage areas, generator, etc. ✓ To repair the broken electronic devices and wires immediately by electrician. ✓ Only permit person allow to access to fuel storage area. ✓ To put the emergency contact numbers in public area of project area. ✓ To plan for fire training every 6 months.	
6	**Monitoring Plan**	Quarterly	Quarterly
7	**Responsible Person**	Mandalay Business Capital City Development Ltd./ Contractor	Mandalay Business Capital City Development Ltd.
8	**Projected Budgets**	Mitigation Measure - 10,000,000 MMK	Mitigation Measure - 10,000,000 MMK

Fire hazard could occur in any area of the project site. However, the most subjectable places such as warehouse, generator hours, fuel storage area, market and kitchen of residential area and hotel.

Before occurring fire hazard, the proposed project must keep combustible materials away from fuel storage area, flammable areas, check firefighting equipment's if they are still working properly, practice firefighting procedure regularly, hang emergency contact number in a visible area.

During fire hazard in any phase of the project, the person who first notices about fire must start extinguishing before fire department and relevant sector arrive. The main electricity must be switched off immediately when fire occur and the relevant sectors must be informed about fire as soon as possible, the responsible person must make sure that all the workers are safe from fire and call the medical team if any injuries. Firefighting procedures must be carried out by the firefighting team accordingly. The security staffs must give a guide for direction and help filling water and direct the water storage area.

After fire hazard, debris must be cleaned around the project area, damages must be recorded and reasons of hazard must be pointed out and learned as a lesson.

Furthermore, fire could take place from various accidents; one of them being faulty electricity materials. So, it is important to have a proper fire management system. The regular maintenance of the electrical wiring should be carried out at regular intervals through a professional electrician. The following measures must be taken:

- Posters indicating evacuation routes are displayed in all areas of the project clearly indicating the position of the poster with 'You are here' mark. Route of evacuation should be indicated by way of arrows, leading to the assembly point.
- Water storage tanks having appropriate capacity must be provided for firefighting.
- Fire Hydrants, Fire Hoses and Fire Extinguishers must be installed throughout the project as mandated by the Firefighting Department. Portable fire extinguishers of dry chemical powder must be provided in the electric meter rooms and basements.

The seniors who accomplished the health and safety course must share their knowledge and experience through the juniors. Safety manager must establish internal educational campaign with the purpose of being overwhelming the information.

Periodic inspection of safety relief valve provided with pressure vessels and equipment, preventive maintenance, aware the workers about electric shock by necessary training. Prepare an emergency contact directory consisting contact numbers of nearest fire service, local police station, hospitals etc. and displace that everybody can see it. Declaring the project as a "No Smoking Zone". When plant runs at abnormal situation e.g., if emission level increases than its normal level then immediately inform to HSE officer as well as project manager. Build a safety committee which from firefighting team, rescue team. The committee arranges a meeting every month to discuss about five safety management. Ensure proper training of the employees about the natural disasters' management, fire safety as well

as occupational health and safety. The notification sign for fire protection described in Figure 7-5.

Figure 7-5 Notification Sign for Fire Protection

Table 7-17 Safety Committee and Responsibilities

No	Team	Responsibilities
1	Supervising Team	• To give the workers training on fire-fighting procedures. • To supervise the whole process of fire fighting • To make decision and support another emergency team.
2	Fire Fighting Team	• If fire is not serious, extinguish the fire with nearest fire extinguishers • If fire is huge, go to fire hydrant and prepare fire hose reel to extinguish fire. • To switch off electricity line and power bottom • To follow the instructions of fire department.
3	Evacuation Team	• To make sure all the workers are free from fire scenes. • To search and rescue the remaining person. • To show emergency runway and direct all the workers to the assembly points • To take and help injured people by coordinating with medical response team.
4	Medical Response Team	• To check that all the medicines are assessable and not expired. • To do first aid injured person if injuries are not serious. • If injury is serious, take them to the nearest hospitals • To collaborate with the medical sectors nearby the project area.
5	Resettlement Team	• To move prioritized items away from fire as soon as possible.

No	Team	Responsibilities
		• To place flammable things away from fire hazard. • To clean up or dispose debris under the supervision of supervising team.

7.5.2. Natural Disasters Management Plan

If any natural disasters occur during the project, there may be losses. In the event of a natural disasters such as storm, earthquake etc., it is necessary to have an emergency response plan for natural disasters prevention. For the project area, detail sub-plan for earthquake, flooding and ground subsidence are in the below.

7.5.2.1. Construction/Operation/Maintenance Phase

All phases of the project implementation, worker can cause injuries and damage to project properties by earthquake. In the operation/ maintaining phase, worker and resident can cause injuries as well as damage to project properties by earthquake due to collapse of building. In the construction phase, there is no significant risk in the project area due to ground subsidence and liquefaction. In the operation/ maintaining phase, water usage in the project area is supply from underground water. Therefore, there is a potential liquification risk along the operation phase due to extraction water from aquifer. To reduce the natural disaster risks, the project proponent must follow the disaster relevant rule and regulation of the government and following management action.

The environmental management sub-plan of Natural Disaster is shown in Table 7-18.

Table 7-18 Environmental Management Sub-Plan for Natural Disaster

1	**Objective**	To prevent and mitigate the injuries and hazard during natural disaster.	
2	**Legal Requirement**	National Environmental Quality (Emission) Guideline (2015) Environmental Conservation Rules (2014) Environmental Impact Assessment Procedure (2015) Public Health Law (1972) The Prevention and Control of Communicable Diseases Law (1995) Natural Disaster Management Law (2013)	
3	**Maps**	Location maps of project area are shown in Figure 1-1.	
4	**Implementation Schedule**	**Construction Phase**	**Operation / Maintenance Phase**
5	**Management Actions**	**Earthquake** ✓ Make and follow the emergency plan for the evacuation and rescue of individuals. ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box). ✓ Arrange for delivery to the clinic or nearest hospital for emergency. ✓ Greater focus on geotechnical investigations to reduce the risk of unsatisfactory foundation performance of each building site.	**Earthquake** ✓ Make and follow the emergency plan for the evacuation and rescue of individuals. ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box). ✓ Arrange for delivery to the clinic or nearest hospital for emergency. **Flood** ✓ Make and follow the emergency plan for the evacuation and rescue of individuals. ✓ Constantly listening the weather reports to know

		✓ Since this area is close to the Sagaing Fault, when constructing the buildings, it should be made in an accordance with detailed earthquake micro-zonation maps and chosen the type of foundation that can withstand earthquake. ✓ In case of an earthquake, liquefaction potential analysis and settlement probability based on new CPTu measurements after landfilling should be provided with detailed layer by layer calculations. ✓ Deep piles should be designed to accommodate an appropriate level of lateral movement of the surface crust even if they are far from any watercourse where there is a possibility of severe liquefaction. ✓ Long term and short-term earthquake monitoring system or earthquake warning system should be installed in place based on the precursors of an earthquake such as the sudden rise of groundwater, the changes of elasticity in rocks and soils, etc.	the possibility of natural disasters such as storms and flood. ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box). ✓ Arrange for delivery to the clinic or nearest hospital for emergency. ✓ Monitor river level every month during rainy season. (Between May and October). ✓ Monitor dike wall structure every 6 months especially during rainy season. **<u>Ground Subsidence</u>** ✓ Conduct ground level geotechnical survey every 6 months. ✓ Should use the water from Ayeyarwady river in project area as an alternative water source.

		Food ✓ Strictly checking during land filling process to reach the calculated elevation level according conceptual report. (+73.50 m in northern part and +73.00 m in southern part) ✓ Since bank line rises 1 meter above 95% confidence water level (m+MSL), one-meter difference is not a reliable situation if there is a flash flood. When using water level data, it is considered that a more accurate conclusion can be drawn if we calculate using the highest water level data. ✓ Make and follow the emergency plan for the evacuation and rescue of individuals. ✓ Constantly listening the weather reports to know the possibility of natural disasters such as storms and flood. ✓ Make backup arrangement the Emergency medicine boxes (First-Aid Box). ✓ Arrange for delivery to the clinic or nearest hospital for emergency.	

		✓ Monitor river level every month during rainy season. (Between May and October). ✓ monitoring systems for river bank erosion and the stability of retaining walls should be implemented with a long-term plan. **<u>Ground Subsidence</u>** ✓ Greater focus on geotechnical investigations to reduce the risk of unsatisfactory foundation performance of each building site. ✓ Deep piles should be designed to accommodate an appropriate level of lateral movement of the surface crust even if they are far from any watercourse where there is a possibility of severe liquefaction. ✓ Groundwater use should not exceed the amount of water that can be extracted based on the results of the pumping test. ✓ Strictly checking and conducting soil improving process using Vibro-floatation method to get the necessary relative density.	

		✓ Since clay layers are found near Myo Patt Road, at the east side of the project area where settlement potential can be happened according to the laboratory measurement mentioned in Geotechnical conceptual design report, the settlement problem should be rechecked and foundation design for buildings should be selected with the suitable settlement resistance design like mat foundation in this area after landfilling. ✓ In Geotechnical conceptual design report, the calculated LPI values showing that after densification and landfill construction, full liquefaction during design earthquake conditions is not to be expected. Hence, the new CPTu measurements should be done to explore engineering properties of subsoils and the situation of liquefaction potential after densification and construction of the landfill. ✓ In case of an earthquake, liquefaction potential analysis and settlement probability based on new CPTu measurements after landfilling should be	

		provided with detailed layer by layer calculations. ✓ Conduct ground level geotechnical survey every 6 months.	
6	**Monitoring Plan**	Twice a year	Twice a year River level monitoring – every month during rainy season
7	**Responsible Person**	Mandalay Business Capital City Development Ltd./ Contractor	Mandalay Business Capital City Development Ltd.
8	**Projected Budgets And Responsibilities**	Implementing mitigation measures – 3,000,000 MMK Monitoring - 3,000,000 MMK	Implementing mitigation measures – 3,000,000 MMK Monitoring - 3,000,000 MMK

7.6. FLOOD RESEPONSE PLAN

The Mandalay Business Capital City Development Ltd., tested the soil type of project area for urban structures and for construction of river front and dike wall to prevent the river flood. The upstream (20km) and downstream (20km) of Ayeyarwady River which area is connected with the project area were surveyed including the river floor conditions, the river flows, the sedimentations, and so on.

The Deltares Team from Netherland obtained the yearly river level of Ayeyarwady and Dr. Kees Sloft is building the Technical River Model. This model can explain the comparison of River Flow Condition of Ayeyarwady River with project and without project within the project related 40km. Dyke walls along the river of project related 40 km will be calculated by Dr. Cornells Zwanengurg from Deltares Team. The strength of the dike walls and river flow conditions relating with them will be analyzed in the river model.

In addition, the project proponent was carried out the river engineering assessments for the proposed project by Deltares, 2017. This includes river engineering, land reclamation, river morphology and flood risk.

The project is located in the wide section of the Ayeyarwaddy Reiver at Mandalay, where the flow is constructed towards the narrow control section at Sagaing. Due to its position between "hard points' at Mandalay and the downstream Shwekyet Kya Pagoda, the main flow is mostly directed away from the project. Therefore, the project area has shown to be quite stable historically.

The project area will be raised above flood level by landfill (1/100-year, 73.76 m +MSL with slope $5.169.10^{-5}$ m/m), and the bank will be protected by a stone revetment with toe protection. A smooth line (bund) of the project area has been chosen to guide the main channel smoothly along the bank. As after the completion of the project, the flood flow is no longer diverted into the project area at the top end, the widening and consequent bar formation in the main channel is stopped. The resulting smoother channel geometry in this reach is considered very positive for the navigability.

Flood levels for a wide range of floods will rise between 0.1 to 0.2 m at Mandalay gauge, with decaying influence over a distance of several tenths of kilometers upstream of this point by backwater effects. There are no water-level impacts downstream. In time by erosion of the river bed as well as by dredging operation, the flood levels become slightly lower again. The highest flow velocities during extreme floods can be found along the bank line in the lower section of the project bund.

To reduce the flood risk, land filling take place during the dry season as well as the monsoon season in regions where flood protection structures such as revetments have been constructed. The project proponent has the following flood response strategy:

Current alerts

- Watch and listen to local media stations.

- Check environment awareness and read latest metrological news
- View and check current river level and forecasts
- Follow instructions from local authorities during an emergency

Checking and Monitoring

- Day to day operation, below bank conditions and other flood protection infrastructure
- Weekly dyke inspections regularly
- Review flood supplies
- Monitor weather forecast
- Check drainage system within the project regularly

Preparation

- As needed, the frequency of regular dyke inspections may increase.
- Continue flood control system and dyke monitoring activities
- Activities related to dyke defense start with monitoring and repairs as needed.
- Repair and maintenance of essential infrastructure and facilities commences.

Action Plan

- In the project area, the persons who will be mainly responsible for the emergency situation must be appointed and planned to be managed in the emergency situation.
- Meeting with responsible person of Occupational Health and Safety Team
- Shut off electricity to areas thar are at risk of flooding and move small appliances, electronics and smaller furniture to areas to likely to be affected.
- Ensure vehicle has fuel and is parked away from waterways
- Do not attempt to shut off electricity if water is present and cross rivers or flowing streams.
- Use sandbags to block floor drains and toilets to prevent sewage back-up.
- If people ‘location is flood, abandon it and head to higher ground.
- Supporting community and local recovery
- Arrange to emergency rescue and personnel transfer, material security, emergency medical treatment.

- Provide material allocation for resettlement personnel, control drainage work
- On the basis of the preparation of guideline, the public defense guidelines, and resettlement measures during the response period.
- Educate and train them for health education and workers in First Aid Kit training.
- Setting the assembly point for emergency situation
- Emergency assembly point must be in an open area away from trees, poles, and buildings that could collapse
- In the event of an emergency situation, stop work and go to the assembly point in an orderly manner.
- Training activities for the emergency response plan are regularly practiced twice a year.
- The contact numbers of hospitals, social rescue organizations and other relevant departments must be posted in places visible to all employees.

7.7. GREEN AREA PLANNING

Open space/green area spaces will be included in the project. The areas where the main plants will be planted for greening are in the following.

1. Shady evergreen perennial trees in the 18-ft wide median island on main roads.
2. Shady evergreen perennial trees in the 9-ft wide median island in the blocks within the project
3. Mid-year trees along the sidewalk
4. In the landscape park which 100 feet wide on Grand Avenue in the center of the city, planting large evergreen perennials and medium-sized plants in abundance.
5. Shady evergreen trees, beautiful flowers and green lawns are planned to be planted for public recreation on the (promenade) which is about 1 mile long on the river bank.
6. Determining policies to include evergreen perennial trees and mid-year trees if buildings are built in housing areas.

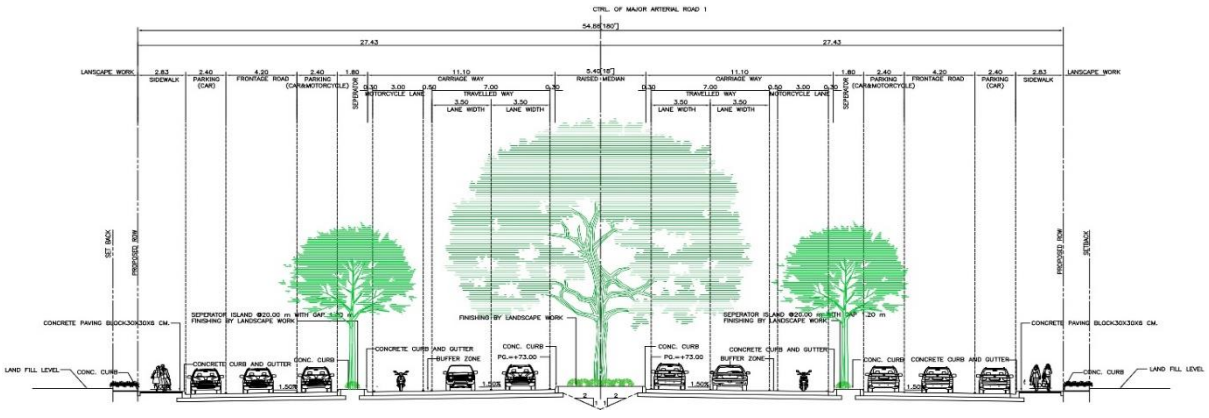


Figure 7-6 The 18-ft wide median island on main roads

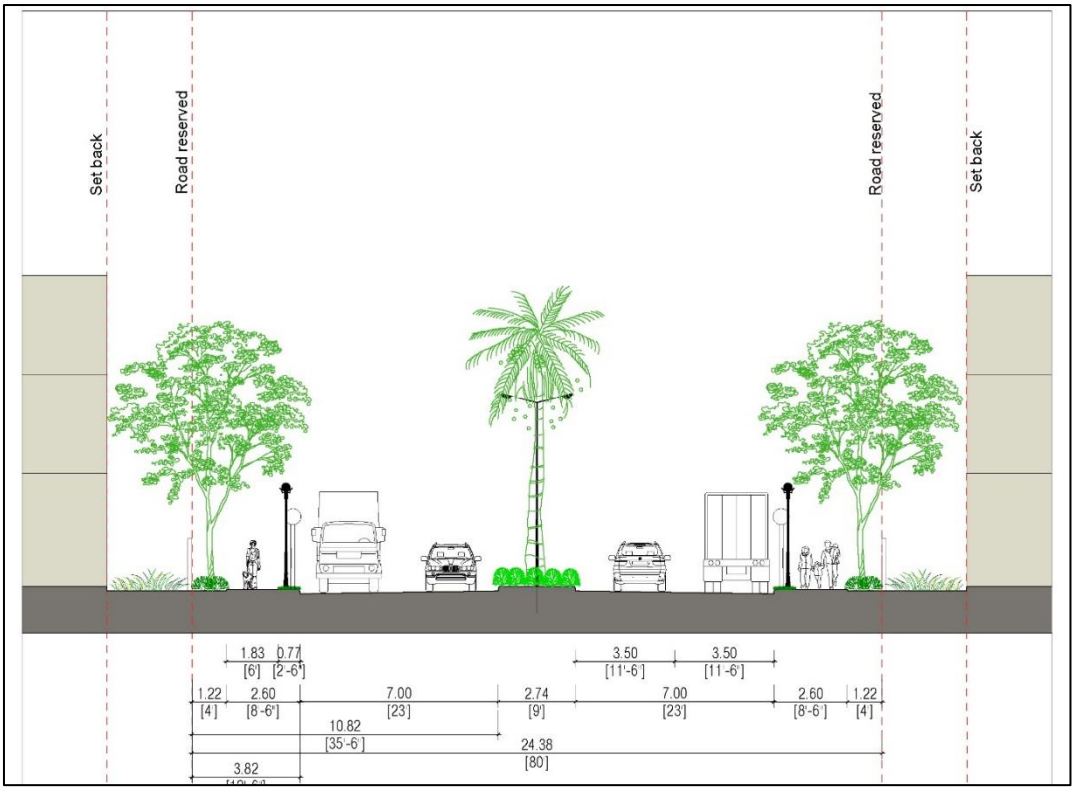


Figure 7-7 The 9-ft wide median island in the blocks within the project

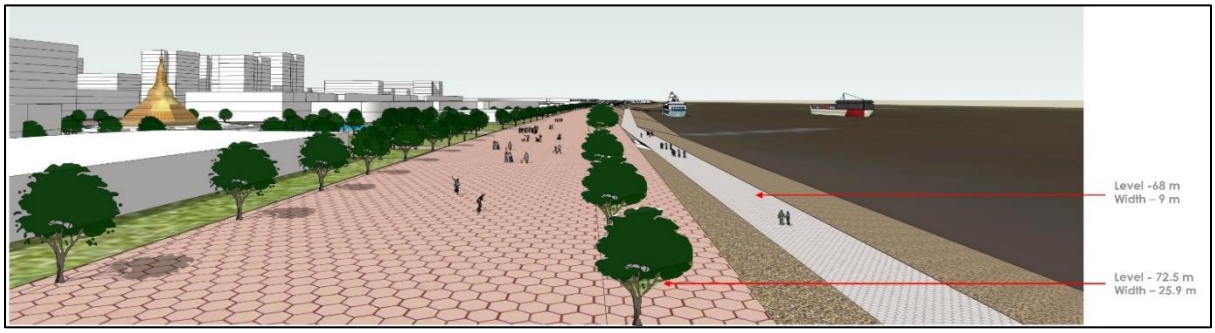


Figure 7-8 1 mile long Public Access Promenade on the river bank

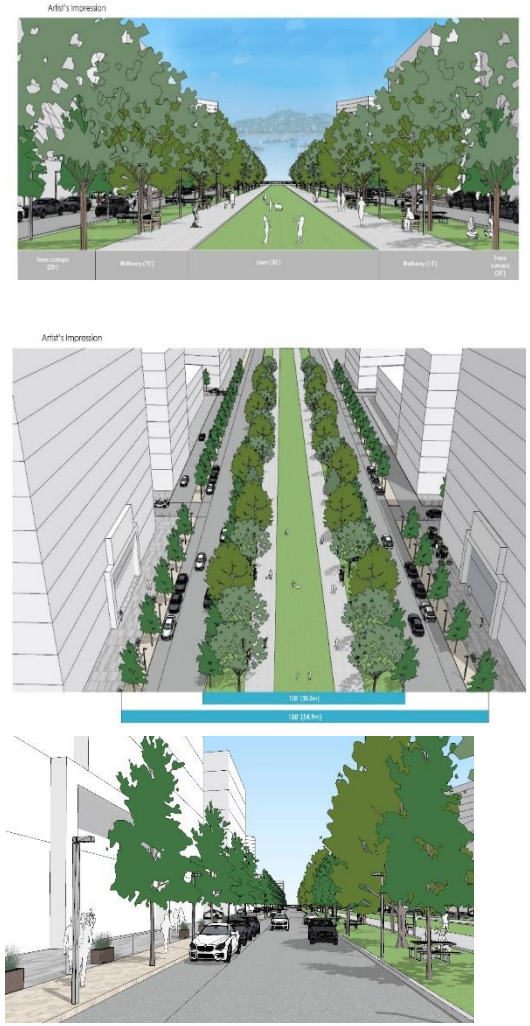


Figure 7-9 In the landscape park which 100 feet wide on Grand Avenue in the center of the city

7.8. EMERGENCY RESPONSE PLAN

In case of emergency due to any type of natural hazards a quick and immediate response is essential. In the project area, the persons who will be mainly responsible for the emergency situation must be appointed and planned to be managed in the emergency situation. This response depends on the actions taken by individuals to avoid or mitigate the adverse effects of a hazard and to undertake search and rescue operations.

In order to be able to respond effectively when natural hazards, it is necessary to prepare for emergency situations in advance. In order to know the possibility of natural disasters such as earthquake, storm etc., it is necessary to constantly listen to weather reports. In addition, providing knowledge to respond to emergency situations; employees will be emergency safety and training.

If natural disasters and emergency situations occur, the following will be constructed in order to respond.

- Appointing a responsible person for occupational health and safety
- Setting the assembly point for emergency situation
- Emergency assembly point must be in an open area away from trees, poles, and buildings that could collapse
- In the event of an emergency situation, stop work and go to the assembly point in an orderly manner.
- Regular practice in twice per year of training activities for emergency response plan
- Training activities for the emergency response plan are regularly practiced twice a year.
- The contact numbers of hospitals, the fire department, and other relevant departments must be posted in places visible to all employees.

In the event of an emergency situation, the emergency exist map and assembly point location must be placed in the project area. In addition, assembly point signboard described in Figure 7-10.

Figure 7-10 Assembly Point Signboard

7.8.1. Record Keeping

Record keeping and reporting of performance is an important management tool for ensuring sustainable operation. Records should be maintained for regulatory, monitoring and operational issues. Typical record keeping requirements for the site is summarized in Table 7-19.

Table 7-19 Record Keeping Requirements

Parameter	Particulars
Resources Use	- Daily quantity of electrical power consumption through power meter - Daily quantity of water utilized for domestic through water meter
Solid Waste Handling and Disposal	- Daily quantity and management of domestic and operation solid waste from the operation process
Monitoring and Survey	- Records of all monitoring carried out as per the finalized monitoring protocol.

Parameter	Particulars
Complaints from Nearest Residents	- Records of all complainants from the nearest villages
Employee Health and Safety Record	- Daily record for accidents at the project
Others	- Equipment inspection and calibration records, where applicable - Vehicle maintenance and inspection records

7.8.2. Reporting Monitoring Results

Results of monitoring will be recorded in files and audit monitoring will be carried out strictly as required by the related national regulations and the monitoring results of required parameters should be reported to Environmental Conservation Department, Mandalay Region in every six months.

7.9. CORPORATE SOCIAL RESPONSIBILITY (CSR)

7.9.1. Purpose

To be the appropriate sector and provide the most benefits for the region in carrying out CSR activities. The goal is to achieve sustainable development.

7.9.2. Detail CSR Plan

The project proponent already has the portion about 2% from the annual profit in order to support all the staffs and workers of social occasional events and corporate social responsibility programs. The following estimated budgets are for the social, education, and health sectors, respectively, for the CSR program of Mandalay Business Capital City Development Ltd., as shown in Table 7-20 below.

Table 7-20 Estimated Budget for CSR Program of Mandalay Business Capital City Development Ltd.

No	Item	Responsible Organization	Frequency	Estimated Budgets (MMK)
	Social			
11	Road construction and make good water drainage system near villages	Mandalay Business Capital City Development Ltd.	Annually	30,000,000
2	Health			

No	Item	Responsible Organization	Frequency	Estimated Budgets (MMK)
	Provide drinking water tank near villages and rural health department in the project area	Mandalay Business Capital City Development Ltd.	Annually	40,000,000
3	Religion			
	Donation to monastery and religious organization near villages	Mandalay Business Capital City Development Ltd.	Annually	90,000,000
4	Education			
	Support to Building construction for schools at near villages	Mandalay Business Capital City Development Ltd.	Annually	50,000,000
Total				210,000,000

The project proponent was carried out the CSR activities in the local. Among them, some are described as followed;

1. Upgrade Shwege Stormwater Pumping Station
2. Building construction for school
3. Participate in Ayeyarwaddy dolphin protection program
4. Donation to Mahar WiZayanthi Pa Htoo Taw Gyi Pagoda
5. Donate in monasteries every month
6. Participate in project relevant religious, social activities and prepare public road
7. Public toilets donation to MCDC
8. Office donation for No. (1), waterway control office in Mandalay Region

9. Mainly participate in flooding problem solution of Shwege Stormwater Pumping Station
10. Help budget and workforce for Quarantine Center operation at Kandawgyi monasteric hospital and Mandalar Degree Collage during Covid-19 pandemic.
11. Medicine, oxygen and concentrator donation during Covid-19 pandemic.
12. Donation to monasteries during Covid-19 pandemic.

Figure 7-11 CSR Activities of the Project Proponent

7.10. ORGANIZATION FOR EMP

A small EMP cell consisting of 2–5 members have formed. In the project, the manager should be the EMP cell leader. Other cell member will be consisting into technicians together with employees. If possible, some of these cell members should deploy for doing monitoring and inspection works effectively implement EMP. The team for implementation environmental management plan of proposed project is described in Table 7-21.

Table 7-21 Team for Implementation Environmental Management Plan

No.	Group Member	Position	Responsibility
1.	U Zaw Ye Win (Director)	Team Leader	Supervise and managed to implement environmental management plan and monitoring program

No.	Group Member	Position	Responsibility
2.	U Aung Myint Myat (Design Manager)	Environmental Management Leader	✓ Supervise and implement the mitigation measures, fire protection system, emergency response plan and management plan. ✓ Follow the instructions of the relevant government departments.
3.	U Nay Htoo Ko Ko (M&E Coordinator)	Monitoring Leader	✓ Supervise and implement the mitigation measures, monitoring plan. ✓ Follow the instructions of the relevant government departments.
4.	U Sai Aung Moe (Admin General Manager)	Occupation Health and Safety Leader	✓ Inspection and implementation measures of occupational health and safety.
5.	U Kyaw Kyaw Tun (General Manager – PDD)	Social Management Leader	✓ Supervise and implement the mitigation measures social issue and CSR programs.
6.	U Sai Aung Moe (Admin General Manager)	Member	✓ Supervise and monitoring of waste management ✓ Monitoring and reporting Occupational Health and Safety issues to leader Implementation of mitigation measures
7.	Daw Htet Htet Hlaing (S.A.E)	Member	✓ Inspection and supervisiong of fire protection equipment, protection measures and emergency response plans ✓ Implement the systematic maintenance programmes of equipment, boiler, machinery and vehicles
8.	Daw Aye Chan Moe (S.A.E)	Member	✓ Reporting to the team leader if a workplace accident occurs ✓ Monitoring of equipment and vehicles

7.11.ENVIRONMENTAL AUDITING

During project implementation period, environmental auditing must take responsibility for all environmental management plan and monitoring program activities. Therefore, the environmental auditing team have to organize in the project.

The responsibilities of environmental auditing team are;

- ✓ Evaluating compliance to relevant internal and legal regulations.
- ✓ Exploring improvement opportunities
- ✓ Supporting environmental management and control
- ✓ Setting up the standard for performance in order to create an Environmental Management System (EMS)
- ✓ Enforcing compliance to departmental environmental guidelines and increasing staff understanding
- ✓ Promoting good environmental management

7.12.LIVELIHOOD RESTORATION PLAN

In Amarapura Urban Development Project, project land acquisition is not by confiscating the land, but by negotiating a fair market price from the owners of the respective land types in the project area, the company purchases and carries out project construction activities. Until today, about 2000 acres of land have been purchased. 500 acres remain to be purchased/exchanged. (The land acquisition plan and all plans for land exchange according to the type of land owned by the developer have been confirmed in the Stakeholder meeting held on 21.12.2016.)-pg 210 (6.6.2022) EIA Scoping Report.

Plans to be implemented by the project proponent.

- ✓ Due to the sale of land for the project, local residents have received a lot of money and income.
- ✓ The company will share the business knowledge necessary for local people to reuse and invest the money for the development of their lives through trainings, educational lectures will be provided.
- ✓ In the many job opportunities created by the implementation of the project, priority will be given to local residents in relevant sectors.
- ✓ CSR activities will be implemented on the local.

7.13. GRIEVANCE REDRESS MECHANISMS (GRMS)

Grievance redress mechanisms (GRMs) are institutions, instruments, methods, and processes by which a resolution to a grievance is sought and provided. In this program, clarification how to submit grievance, appointing negotiator, publishing phone numbers and address where a person could contact and complaint are carried out.

A Negotiator will be appointed as a Central Grievance Collector to file complaints through the Company's Grievance Complaint Form. Arrangements will be made to register grievances. Subsequently, grievances will be resolved from investigating those by contacting the most responsible person of the project or will be continued by forming grievances resolving team. The complaint form is shown in **Appendix (H)**. Negotiator will carry out the grievance redress mechanisms (GRMs) by collaborating with relevant governments and local communities. Amarapura Urban Development Project have formed a team for GRMS and the list of people and responsibilities are shown in Table 7-22 below.

Table 7-22 Team for Grievance Redress Mechanisms

No	Name	Position	Ph No.	Contact
1	U San Nyunt Zaw	Deputy Managaing Director	09-969-988-011	Amarapura Urban Development Project
2	U Zaw Ye Win	Director	09-250-051-169	Amarapura Urban Development Project

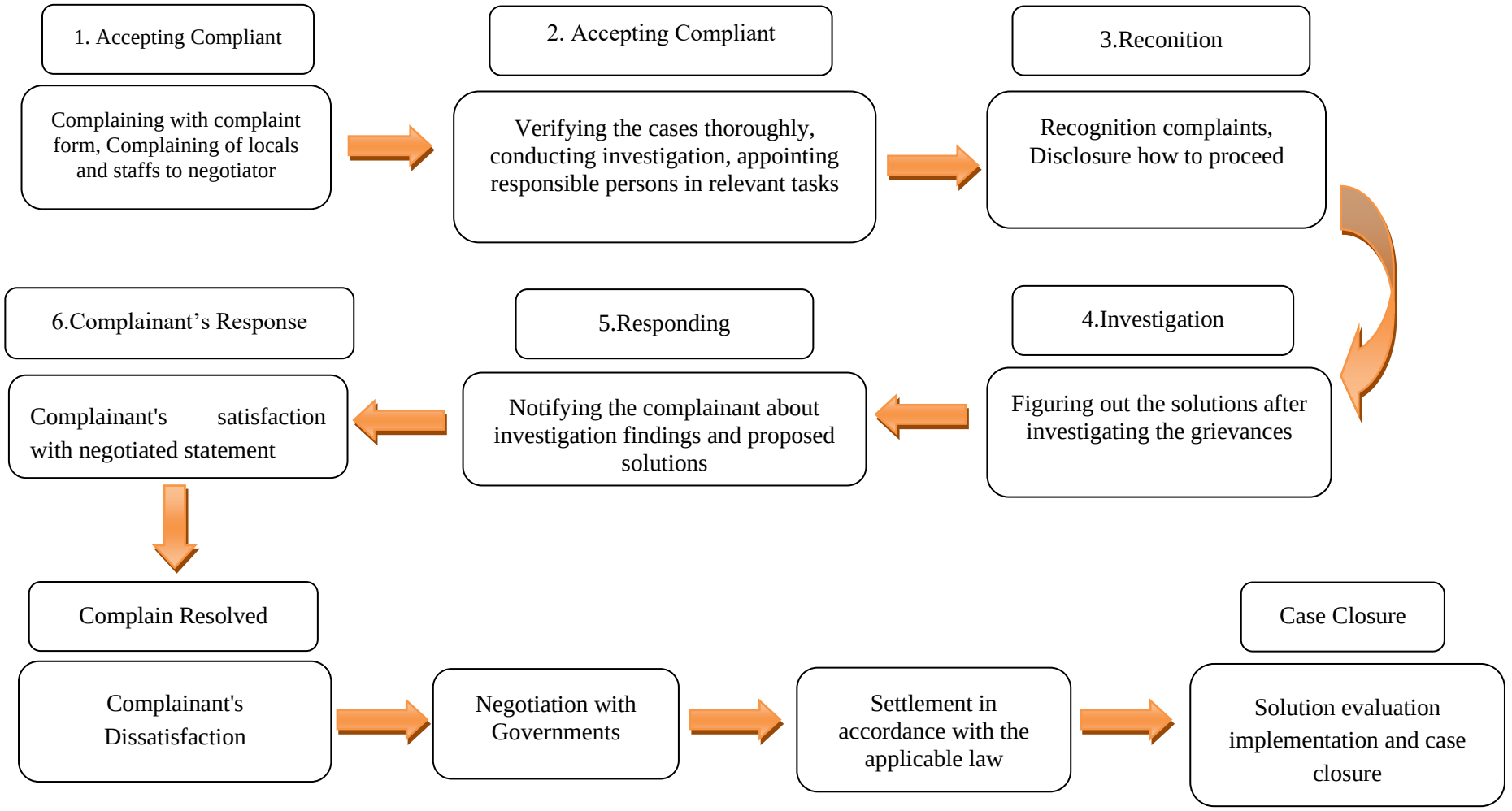


Figure 7-12 Grievance Redress Mechanism

CHAPTER 8

RECOMMENDATION AND CONCLUSION

The project proponent, Mandalay Business Capital City Development Ltd is situated at Mandalay Region. The project proponent requested Hexagonal Angle International Consultants Co., Ltd. to implement the Environmental Impact Assessment (EIA) of the project.

Assessment of potential environmental impacts, risk assessments and preparing of environmental management plan with recommended impact mitigation measures were prepared for construction, and operation/maintenance stages according to the compliance with environmental impact assessment procedure (2015) and National Environmental (Emission) Guidelines (2015). The main objectives of the EIA are;

a) To identify and assess potential impacts on the environment
b) To implement environmental management and mitigation measure plan
c) The environmental quality of the surrounding area will not be affected or decreased by the project activities.

In this EIA report study, baseline environmental data collection and site visit activities was conducted in two seasons which are wet and dry seasons. In wet season, the baseline quality and site visit was conducted in October, 2022 and also conducted on March, 2023 in dry season. The environmental baseline qualities and site visit activities included monitoring for air, water, noise, vibration, and soil and surveyed for biodiversity, socio-economic, traffic counting and project investigation.

According to the data interpretation for outdoor air monitoring results and other environmental baseline quality measurements were compared with National and Environmental Quality (emission) guideline (2015) and other international standards. The detailed description of monitoring activities and results are described in Chapter 4. The outdoor air quality, noise and vibration qualities were conducted 5 points both wet and dry season. According to the results, all results of the outdoor air quality are within the NEQEG (2015) expect PM parameter of Mya Hin Thar village. Besides, all results of noise and vibration qualities were meeting with the guidelines. As water quality monitoring, 5 points for surface water and 2 points for ground water were conducts in the study area.

The color, total coliform bacteria and turbidity parameters of some surface water quality especially Ayeyarwady River are over the guideline and other remaining parameters are within the guidelines in Wet season. However, in dry season, all parameter are within the guideline expect the total coliform bacteria parameter in the some locations. For the soil quality, the results are meeting with the standards in the study area.

For the biodiversity survey, there are 3 seasons which are wet, dry and cold season was conducted. According to the survey result, some flora and fauna species are in the IUCN red list and the detailed information is described in biological section, Chapter 4. As EIA procedure, the socio-economic survey was made in project near villages and townships such as Amarapura, Chan Mya Thazi and Sagaing Townships. Moreover, the traffic volume

counting activities was done in the study area and the results are compared with standard from Thailand.

The assessments of each impact are based on the construction and operation/maintenance process of the project. Evaluation of environmental and social impact assessment and detail consideration can be seen in **Chapter 5**. The assessment of risk and cumulative impact of the project are also presented in this chapter.

In the potential environmental impact assessment during the construction phase, the major impact noise and vibration and biodiversity and the moderate level are water pollution, water consumption, waste pollution, soil and landscape, livelihood, local population, visual and aesthetics and traffic congestion and other are the minor impact levels. During operation/maintenance phase, the major impact level are water pollution and water consumption, moderate level are air, waste, noise, vibration, soil and landscape, biodiversity, livelihood, visual and aesthetics and traffic congestion.

8.1. RECOMMENDATIONS

The following recommendations have been made for efficient and effective implementation of environmental conservation, health and safety and social responsibilities through the lifespan of the proposed project.

- Follow the comments and suggestions made by ECD after reviewing this EIA report.
- Once EIA is approved by concerned authorities, strict implementation is essential.
- For full and proper implementation of environmental management plan in this EIA report, well understanding and supports by proponent and authority is deem necessity.
- Proposed emergency response plan should be implemented strictly both during construction and operation/maintenance phases of the project.
- Well experienced and knowledgeable HSE Manager and HSE Assistants shall be appointed.
- Daily, monthly and annual action plan shall be formulated based on environmental management plan in this EIA and practiced at operation level.
- Necessary care and environmentally sound practices should be taken for activities out of project site particularly on goods and materials transportation.
- Keep full records of environmental management activities and present to annual independent third-party environment audit.
- Follow the audit report and comments.
- Abide environmental policy, laws, rules and instructions of the Republic of the Union of Myanmar.
- All assessments described in this EIA report are based on the conceptual design (up to July 2023) provided by the project proponent. In future, if something is

changed in conceptual design and project plans during construction and operation stage, it is need to inform to ECD and revised this EIA report as per the requirement of ECD.

Finally, the proponent should follow the comments and suggestions made by ECD after reviewing this EIA report study. Once EIA is approved by concerned authorities, effective implementation of EMP by the project proponent is essential. The proponent should abide environmental policy, laws, rules and instructions of the Republic of the Union of Myanmar.

8.2. CONCLUSION

The environmental and social impacts are caused by construction, operation / maintenance process of the project, which is generated by air quality, noise, solid waste, and wastewater. Employees and communities around the project area could suffer from the effects of pollution unless the major impacts are not mitigated. Hence, those impacts must be mitigated according to commitment table and mitigation measures plan mentioned in the report.

Therefore, dust and gas emissions and wastewater generated from the project must be properly cleaned and discharged. In addition, control of noise sources and waste storage and disposal must be done. In addition, providing health education to workers is regarding the handling of hazardous waste and occupational health and safety. It must be controlled by trained professionals with a system of rewards and punishments for proper disposal of waste by employees.

As a project proponent, it is necessary to systematically implement this environmental management plan to minimize environmental and social impact. Consequently, the physical and social environment of the proposed project will be completely acceptable and their socio-economic standard is expected to be improved and undertaking corporate social responsibilities (CSR) as recommended.

In conclusion, it has been figured out that, the proposed project is going to generate local employment opportunities and enhance capabilities and working skills of employees as well as improvement of living standard for local people. The study indicates that further positive impacts would be of immense benefit to the local community and national development as well.

CHAPTER 9

COMMENT RESPONSE

Mandalay Business Capital City Development Ltd. မှ မန္တလေးတိုင်းဒေသကြီး၊ အမရပူရမြို့နယ်၊ မန္တလေးမြို့ပတ်လမ်းနှင့် ဧရာဝတီမြစ်အကြားတွင် အကောင်အထည်ဖော် ဆောင်ရွက်မည့် အမရပူရမြို့ပြဖွံ့ဖြိုးရေး စီမံကိန်းအတွက် တင်ပြလာသော ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း (Environmental Impact Assessment – EIA) အစီရင်ခံစာအပေါ် ကနဦးစိစစ်တွေ့ရှိချက်နှင့် သုံးသပ်အကြံပြုချက်များအား ပြင်ဆင်ဖော်ပြခြင်း

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
(က)	အကျဉ်းချုပ်အစီရင်ခံစာ	
(၁)	အကျဉ်းချုပ် အစီရင်ခံစာတွင် စီမံကိန်းမှ လိုက်နာ ဆောင်ရွက်မည့် ဥပဒေများအပြင် ပတ်ဝန်းကျင် အရည်အသွေး ဆိုင်ရာ လမ်းညွှန်ချက် များကို ထည့်သွင်း ဖော်ပြရန်။	- စီမံကိန်းမှ လိုက်နာ ဆောင်ရွက်မည့် ဥပဒေများအပြင် ပတ်ဝန်းကျင် အရည်အသွေး ဆိုင်ရာ လမ်းညွှန်ချက် များကို အကျဉ်းချုပ်အစီရင်ခံစာ စာမျက်နှာ (၂) နှင့် (၄) တွင် ဖော်ပြထားပါသည်။
(ခ)	နိဒါန်း	
(၁)	နိဒါန်းတွင် အောက်ပါတို့အား ထည့်သွင်းဖော်ပြရန်- • စီမံကိန်း၏ လုပ်ငန်းတည်ဆောက်ခြင်းကာလနှင့် လည်ပတ်သည့် ကာလတို့တွင် အဆိုပြုစီမံကိန်းအား တာဝန်ယူ ဆောင်ရွက်မည့် တာဝန်ခံနှင့် ၎င်းတို့၏ လုပ်ငန်းတာဝန်များ၊ ဆက်သွယ်ရန် လိပ်စာ၊ ဖုန်းနံပါတ်၊ Email လိပ်စာနှင့် ကုမ္ပဏီ၏ Website လိပ်စာတို့ကိုဖော်ပြရန်။ • စီမံကိန်းတည်နေရာနှင့် အဓိကအစိတ်အပိုင်းများပြမြေပုံ၊	• စီမံကိန်း၏ လုပ်ငန်းတည်ဆောက်ခြင်းကာလနှင့် လည်ပတ်သည့် ကာလတို့တွင် အဆိုပြုစီမံကိန်းအား တာဝန်ယူ ဆောင်ရွက်မည့် တာဝန်ခံနှင့် ၎င်းတို့၏ လုပ်ငန်းတာဝန်များ၊ ဆက်သွယ်ရန် လိပ်စာ၊ ဖုန်းနံပါတ်၊ Email လိပ်စာနှင့် ကုမ္ပဏီ၏ Website လိပ်စာတို့ကို အခန်း(၁)၊ အပိုဒ်ခွဲ (၁-၆)တွင် ထည့်သွင်းဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	စီမံကိန်းအနီးပတ်ဝန်းကျင်ကို အသေးစိတ်ပြသောပုံများကို သက်ဆိုင်ရာ အညွှန်းများဖြင့် ထည့်သွင်းဖော်ပြရန်။ • EIA လေ့လာရေးအဖွဲ့၏ ဤအစီရင်ခံစာတွင် မည်သူက မည်သည့်အပိုင်းကို တာဝန်ယူရေးသားထားကြောင်းကို အချက်အလက်များကို ထည့်သွင်းဖော်ပြရန်။	- စီမံကိန်းတည်နေရာနှင့် အဓိကအစိတ်အပိုင်းများပြမြေပုံ၊ စီမံကိန်းအနီးပတ်ဝန်းကျင်ကို အသေးစိတ်ပြသောပုံများကို သက်ဆိုင်ရာ အညွှန်းများဖြင့် ထည့်သွင်းဖော်ပြထားပါသည်။ - EIA လေ့လာရေးအဖွဲ့၏ ဤအစီရင်ခံစာတွင် မည်သူက မည်သည့်အပိုင်းကို တာဝန်ယူရေးသားထားကြောင်းကို အချက်အလက်များကို အခန်း (၁) ၊ အပိုဒ်ခွဲ (၁.၇.၂)၊ ဇယား ၁-၅ တွင် ဖော်ပြထားပါသည်။
(ဂ)	မူဝါဒ၊ ဥပဒေ၊ ကတိကဝတ်များနှင့် အဖွဲ့အစည်းဆိုင်ရာမူဘောင်	
(၁)	အခန်း(၂) Institutional Framework တွင် စီမံကိန်းဆောင်ရွက်သည့် ကုမ္ပဏီအနေဖြင့် စီမံကိန်း လုပ်ငန်း ဆောင်ရွက်မှု အဆင့်ဆင့်တွင် တာဝန်ရှိသော အစိုးရဌာနဆိုင်ရာများ၏ အဖွဲ့အစည်း ဆိုင်ရာမူဘောင်(ဥပမာ- စည်ပင်၊ ECD၊ DWIR etc.)၊ အစိုးရဌာန အဖွဲ့အစည်းများ၏ စီမံကိန်းနှင့် ပတ်သက်သည့် လုပ်ငန်းတာဝန်များကိုထည့်သွင်းဖော်ပြရန်။	- Institutional Framework တွင် စီမံကိန်းဆောင်ရွက်သည့် ကုမ္ပဏီအနေဖြင့် စီမံကိန်း လုပ်ငန်း ဆောင်ရွက်မှု အဆင့်ဆင့်တွင် တာဝန်ရှိသော အစိုးရဌာနဆိုင်ရာများ၏ အဖွဲ့အစည်း ဆိုင်ရာမူဘောင် (ဥပမာ- စည်ပင်၊ ECD၊ DWIR etc.) ၊ အစိုးရဌာန အဖွဲ့အစည်းများ၏ စီမံကိန်းနှင့် ပတ်သက်သည့် လုပ်ငန်းတာဝန်များကို အခန်း (၂)၊ အပိုဒ်ခွဲ (၂.၃) နှင့် ဇယား ၂-၂ တွင် ဖြည့်စွက်ဖော်ပြထားပါသည်။
(၂)	EIAတွင်ဖော်ပြထားသော Environmental Management Plan နှင့် Environmental Monitoring Plan များကို အကောင်အထည်ဖော်ဆောင်ရွက်ခြင်းအပါအဝင် EIA အစီရင်ခံစာတွင် ပါဝင်သည့် ပတ်ဝန်းကျင်နှင့်လူမှုရေးကိစ္စရပ်များအတွက် အဖွဲ့အစည်းဆိုင်ရာ ဖွဲ့စည်းပုံ၊ အုပ်ချုပ်မှု၊ တာဝန်ယူဆောင်ရွက်မှုများနှင့် လုပ်ငန်းတာဝန်များကို ဖော်ပြထားသော စီမံကိန်းအဆိုပြုသူ၏	- Environmental Management Plan နှင့် Environmental Monitoring Plan များကို အကောင်အထည်ဖော်ဆောင်ရွက်ခြင်းအပါအဝင် EIA အစီရင်ခံစာတွင် ပါဝင်သည့် ပတ်ဝန်းကျင်နှင့်လူမှုရေးကိစ္စရပ်များအတွက် အဖွဲ့အစည်းဆိုင်ရာ ဖွဲ့စည်းပုံ၊ အုပ်ချုပ်မှု၊ တာဝန်ယူဆောင်ရွက်မှုများနှင့် လုပ်ငန်းတာဝန်များကို ဖော်ပြထားသော စီမံကိန်းအဆိုပြုသူ၏ အဖွဲ့အစည်းဆိုင်ရာမူဘောင်ကို အခန်း (၂)၊ အပိုဒ်ခွဲ (၂.၃) နှင့် အခန်း (၇)၊ ဇယား ၇-၁ နှင့် ၇-၂၁ တွင်

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	အဖွဲ့အစည်းဆိုင်ရာမူဘောင်ကိုထည့်သွင်းဖော်ပြရန်။	ဖြည့်စွက်ဖော်ပြထားပါသည်။
(၃)	• အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာ အရည်အသွေး(ထုတ်လွှတ်မှု) လမ်းညွှန်ချက်များအပိုင်းတွင် အနှံနှင့်ပတ်သက်၍ အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာ အရည်အသွေး(ထုတ်လွှတ်မှု) လမ်းညွှန်ချက်ပါ လမ်းညွှန်ချက်(၁.၄)ကိုဖော်ပြရန်၊ • တည်ဆောက်ရေးကာလအတွက် လုပ်ငန်းမှ စီးဆင်းရေနှင့် စွန့်ပစ်ရေစွန့်ထုတ်မှုကို ဖော်ပြရန်နှင့် တည်ဆောက်ရေးကာလ စွန့်ပစ်ရေအရည်အသွေးကို စွန့်ပစ်ရာတွင် အဆိုပါသတ်မှတ်စံနှုန်းနှင့်အညီ စွန့်ပစ်ရန်နှင့် Monitoring ဆောင်ရွက်ရာတွင် အဆိုပါစံနှုန်းနှင့် အညီတိုင်းတာစောင့်ကြပ်ကြည့်ရှုစစ်ဆေးရန် ဖြစ်ကြောင်းဖော်ပြရန်။	• အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာ အရည်အသွေး(ထုတ်လွှတ်မှု) လမ်းညွှန်ချက်များအပိုင်းတွင် အနှံနှင့်ပတ်သက်၍ အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာ အရည်အသွေး(ထုတ်လွှတ်မှု) လမ်းညွှန်ချက်ပါ လမ်းညွှန်ချက်(၁.၄)နှင့် ပက်သက်၍ အခန်း(၂)၊ အပိုဒ်ခွဲ (၂.၅)တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ • တည်ဆောက်ရေးကာလအတွက် လုပ်ငန်းမှ စီးဆင်းရေနှင့် စွန့်ပစ်ရေစွန့်ထုတ်မှုကို ဖော်ပြရန်နှင့် တည်ဆောက်ရေးကာလ စွန့်ပစ်ရေအရည်အသွေးကို စွန့်ပစ်ရာတွင် အဆိုပါသတ်မှတ်စံနှုန်းနှင့်အညီ စွန့်ပစ်ရန်နှင့် Monitoring ဆောင်ရွက်ရာတွင် အဆိုပါစံနှုန်းနှင့် နှင့်ပက်သက်၍ အခန်း(၂)၊ အပိုဒ်ခွဲ (၂.၅)၊ ဇယား ၂-၆ တွင်ထည့်သွင်း ဖော်ပြထားပါသည်။
(၄)	စာမျက်နှာ(၂-၅၄) မှ (၂-၆၁)၊ Commitmentsတွင် စီမံကိန်းပိုင်ရှင်မှ လိုက်နာဆောင်ရွက်မည့် ကတိကဝတ်များကိုဖော်ပြထားရာတွင် စီမံကိန်း၏ သဘောသဘာဝအရ လိုက်နာဆောင်ရွက်ရမည့် စံချိန်စံညွှန်းများသည် မြန်မာနိုင်ငံတွင် သတ်မှတ်ထားခြင်း မရှိသေးပါက နိုင်ငံတကာ စံချိန်စံညွှန်းများနှင့် Best Available Practicesများကို လိုက်နာဆောင်ရွက်မည်ဖြစ်ကြောင်း၊ Socio-Economyနှင့် ပတ်သက်၍	- Commitmentsတွင် စီမံကိန်းပိုင်ရှင်မှ လိုက်နာဆောင်ရွက်မည့် ကတိကဝတ်များကိုဖော်ပြထားရာတွင် စီမံကိန်း၏ သဘောသဘာဝအရ လိုက်နာဆောင်ရွက်ရမည့် စံချိန်စံညွှန်းများသည် မြန်မာနိုင်ငံတွင် သတ်မှတ်ထားခြင်း မရှိသေးပါက နိုင်ငံတကာ စံချိန်စံညွှန်းများနှင့် Best Available Practicesများကို လိုက်နာဆောင်ရွက်မည်ဖြစ်ကြောင်း၊ Socio-Economyနှင့် ပတ်သက်၍ စီမံကိန်းမှ လိုက်နာဆောင်ရွက်မည့်

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	စီမံကိန်းမှ လိုက်နာဆောင်ရွက်မည့် ကတိကဝတ်များ (ဥပမာ- မြေယာလျော်ကြေးကိစ္စ၊ သီးနှံလျော်ကြေးကိစ္စ၊ အလုပ်အကိုင်အခွင့်အလမ်းကိစ္စ အစရှိသဖြင့်) ကိုစီမံကိန်းပိုင်ရှင်မှ လိုက်နာဆောင်ရွက် မည်ဖြစ်ကြောင်း လက်မှတ်ရေးထိုး၍ ထည့်သွင်းဖော်ပြရန်၊	ကတိကဝတ်များ (ဥပမာ- မြေယာလျော်ကြေးကိစ္စ၊ သီးနှံလျော်ကြေးကိစ္စ၊ အလုပ်အကိုင်အခွင့်အလမ်းကိစ္စ အစရှိသဖြင့်) ကိုစီမံကိန်းပိုင်ရှင်မှ လိုက်နာဆောင်ရွက် မည်ဖြစ်ကြောင်း လက်မှတ်ရေးထိုး၍ အခန်း (၂)၊ အပိုဒ်ခွဲ (၂.၉) တွင် ဖြည့်စွက်ဖော်ပြထားပါသည်။
(၅)	- ဥပဒေနှင့်အဖွဲ့အစည်းဆိုင်ရာမူဘောင်တွင် ဥပဒေ၊ လုပ်ထုံးလုပ်နည်းများကို ဖော်ပြရာတွင် စီမံကိန်းပိုင်ရှင်က လိုက်နာဆောင်ရွက်မည့် ဥပဒေ၊ ပုဒ်မကို ညွှန်း၍ လိုက်နာဆောင်ရွက်မည်ဖြစ်ကြောင်း ကတိကဝတ်ပြု ဖော်ပြရန်၊ - စီမံကိန်းနှင့် သက်ဆိုင်မှုရှိပြီး စီမံကိန်းမှ လိုက်နာဆောင်ရွက်မည့်ဥပဒေ၊ လုပ်ထုံးလုပ်နည်း၊ လမ်းညွှန်းချက်များကိုသာဖော်ပြရန်၊ - စီမံကိန်းနှင့်သက်ဆိုင်မှုရှိသော Convention နှင့် Agreement များကိုသာဖော်ပြရန်၊ - စီမံကိန်း၏ Design ပိုင်းဆိုင်ရာ လိုက်နာဆောင်ရွက်မည့် Guidelines များ၊ standard များကိုဖော်ပြရန်၊ - - The Boiler Law(2015) ကိုဖော်ပြထားသည့်အတွက် Boiler Law သည် စီမံကိန်းနှင့်မည်ကဲ့သို့ပတ်သက်မှုရှိကြောင်း စိစစ်ပေးရန်၊ - ဥပဒေများဖော်ပြရာတွင် စီမံကိန်းပိုင်ရှင်မှ အမှန်တကယ်လိုက်နာရမည့် ဥပဒေ၊ ပုဒ်မများကိုသာဖော်ပြရန်၊ Un Convention on the law of the Sea(1996)၊ Treaty on the Non-Proliferation of nuclear weapons (1996)၊ Civil Aviation Environmental Protection Vo1.II, Aircraft Noise, 1992 Laws များသည်	- ဥပဒေနှင့်အဖွဲ့အစည်းဆိုင်ရာမူဘောင်တွင် ဥပဒေ၊ လုပ်ထုံးလုပ်နည်းများကို ဖော်ပြရာတွင် စီမံကိန်းပိုင်ရှင်က လိုက်နာဆောင်ရွက်မည့် ဥပဒေ၊ ပုဒ်မကို ညွှန်း၍ လိုက်နာဆောင်ရွက်မည်ဖြစ်ကြောင်း အခန်း (၂)၊ အပိုဒ်ခွဲ (၂.၉) တွင် ဖြည့်စွက်ဖော်ပြထားပါသည်။ - စီမံကိန်းနှင့် သက်ဆိုင်မှုရှိပြီး စီမံကိန်းမှ လိုက်နာဆောင်ရွက်မည့်ဥပဒေ၊ လုပ်ထုံးလုပ်နည်း၊ လမ်းညွှန်းချက်များကိုသာ ဖော်ပြထားပါသည်။ - စီမံကိန်းနှင့်သက်ဆိုင်မှုရှိသော Convention နှင့် Agreement များကိုပြင်ဆင်ဖော်ပြထားပါသည်။ - စီမံကိန်း၏ Design ပိုင်းဆိုင်ရာ လိုက်နာဆောင်ရွက်မည့် Guidelines များ၊ standard များကို အခန်း (၂)၊ အပိုဒ်ခွဲ (၂.၈) တွင် ဖြည့်စွက် ဖော်ပြ ထားပါသည်။ - The Boiler Law (2015) ကို ထည့်သွင်းဖော်ပြခြင်းမပြုတော့ပါ. - ပြင်ဆင်ဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	စီမံကိန်းနှင့်မည်ကဲ့သို့ပတ်သက်မှုရှိကြောင်း စိစစ်ဖော်ပြရန်။	- ပြင်ဆင်ဖော်ပြထားပါသည်။ -
(ဃ)	- စီမံကိန်းအကြောင်းအရာ ဖော်ပြချက်	
(၁)	စာမျက်နှာ(၃-၆) တွင် Project Master Plan နှင့် စာမျက်နှာ(၃-၉) တွင် Tentative Plan of the Project Site တို့ကိုဖော်ပြထားရာတွင် မူလရှိပြီးသော လမ်းများ၊ အခြေခံအဆောက်အဦးများကိုပါ မြင်သာစေရန် နှင့် ပိုမိုကြည်လင်ပြတ်သားစေရန် Scaleချဲ့၍ဖော်ပြရန်၊	- ပြင်ဆင်ဖော်ပြထားပါသည်။
(၂)	Project Schedules အပိုင်းတွင် စီမံကိန်းသည် ၂၀၁၇ မှ ၂၀၂၁ အထိ Phase (1) ဆောင်ရွက်မည်ဖြစ်ပြီး ၂၀၂၂ မှ ၂၀၂၆ အထိ Phase (2) ဆောင်ရွက်မည်ဖြစ်ကြောင်းဖော်ပြထားသည့်အတွက် တည်ဆောက်ခြင်း ကာလ (၁၀) နှစ်ကိုသာဖော်ပြထားပြီး မြေဌားရမ်းအသုံးပြုခွင့်ကာလ၊ စီမံကိန်း လည်ပတ်ဆောင်ရွက်ခွင့်ရှိသည့် အချိန်ကာလများကို ဖော်ပြထားခြင်းမရှိသဖြင့် ထည့်သွင်းဖော်ပြရန်၊	- Project Schedules အပိုင်းတွင် စီမံကိန်းသည် ၂၀၁၇ မှ ၂၀၂၁ အထိ Phase (1) ဆောင်ရွက်မည်ဖြစ်ပြီး ၂၀၂၂ မှ ၂၀၂၆ အထိ Phase (2) ဆောင်ရွက်မည်ဖြစ်ကြောင်းဖော်ပြထားသည့်အတွက် တည်ဆောက်ခြင်း ကာလ (၁၀) နှစ်ကိုသာဖော်ပြထားပြီး မြေဌားရမ်းအသုံးပြုခွင့်ကာလ၊ စီမံကိန်း လည်ပတ်ဆောင်ရွက်ခွင့်ရှိသည့် အချိန်ကာလများကို အခန်း(၃)၊ အပိုဒ်ခွဲ(၃.၄) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
(၃)	- စီမံကိန်းသည်ရေလွှမ်းဧရိယာတွင် တည်ရှိနေသည့်အတွက် Dyke Wallများ တည်ဆောက်ရမည်ဖြစ်ပြီး land Level များ မြှင့်တင်ရန် လိုအပ် ကြောင်း ဖော်ပြထားသဖြင့်Land Levelingသည် Nature Ground Level အထက် မည်မျှမြှင့်ပြီး စီမံကိန်းသည် မြို့ပတ်လမ်းနှင့် စီမံကိန်း အနီးရှိကျေးရွာများထက် မည်မျှမြှင့်မည်ကိုဖော်ပြရန်၊ - Leveling ဆောင်ရွက်ခြင်းကြောင့် စီမံကိန်းအနီးဝန်းကျင်ရှိ ကျေးရွာများနှင့် Public Areaများ၏ Drainage System အပေါ် သက်ရောက်နိုင်မှုနှင့်ရေကြီးရေလျှံနိုင်မှုကို ဆန်းစစ်၍သက်ရောက်မှုများကို လျော့ပါးစေရေး နည်းလမ်းများ၊ Environmental Management Plan၊ Environmental Monitoring Plan တို့ကိုဖော်ပြရန်၊	- Land Levelingနှင် ပက်သက်၍ အခန်း (၃)၊ အပိုဒ်ခွဲ(၃.၄.၃.၂)၊ တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ - Drainage System အပေါ် သက်ရောက်နိုင်မှုနှင့်ရေကြီးရေလျှံနိုင်မှုကို ဆန်းစစ်၍သက်ရောက်မှုများကို အခန်း (၅)၊ အပိုဒ်ခွဲ(၅.၈.၇) ထည့်သွင်းဖော်ပြထားပါသည်။
(၄)	- စာ(၃-၁၇) တွင် Land Reclaiming and levelingဆောင်ရွက်ရာတွင် စီမံကိန်းနေရာအတွက် လိုအပ်သောသဲမြေများကို သောင်တူးစုပ်ယူခြင်းလုပ်ငန်းကို ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများ ဖွံဖြိုးတိုးတက်ရေး မှ ညွှန်ကြားချက်များနှင့် အညီ ဆောင်ရွက်မည်ဖြစ်ကြောင်း ဖော်ပြထားသော်လည်း သောင်တူးဖော်မည့် တည်နေရာ၊ တူးယူမည့် သဲပမာဏ၊ စွန့်ပစ်အနည်အနှစ်များ စုပုံမည့်နေရာများနှင့် တူးဖော်မည့်သဲများတွင် ဓာတ်သတ္တု ပါဝင်မှုစစ်ဆေးချက်များ၊ သဲသယ်ယူမည့် လမ်းကြောင်းများနှင့် သက်ဆိုင်ရာ ဌာန၏ ခွင့်ပြုမိန့်များကိုဖော်ပြရန်၊ - သဲထုတ်ယူခြင်းနှင့် သဲသယ်ယူမည့် ရေယာဉ်များကြောင့် ဇရာဝတီမြစ်ရှိ ရေနေသတ္တဝါများနှင့် ရေကြောင်းသွားလာမှုအပေါ်	- ဤအကြောင်းအရာနှင့် ပက်သက်၍ အခန်း(၃)၊ အပိုဒ်ခွဲ(၃.၄.၃.၂)၊ ပုံ ၃-၁၁ နှင့် အကျဉ်းချုပ်အစီရင်ခံစာ Appendix L တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ သဲထုတ်ယူခြင်းနှင့် သဲသယ်ယူမည့် ရေယာဉ်များကြောင့် ဇရာဝတီမြစ်ရှိ

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	သက်ရောက်နိုင်မှုများ နှင့် သက်ရောက်မှုလျော့ချရန်အတွက် Environmental Management Plan၊ Enviromental Monitoring Plan တို့ကိုဖော်ပြရန်၊	ရေနေသတ္တဝါများနှင့် ရေကြောင်းသွားလာမှုအပေါ် သက်ရောက်နိုင်မှုများကို အခန်း(၅)၊ အပိုဒ်ခွဲ(၅.၈.၈) ထည့်သွင်းဖော်ပြထားပါသည်။
(၅)	- စီမံကိန်းတွင်ဆောင်ရွက်မည့် အခြေခံအဆောက်အဦး တည်ဆောက်ရေးလုပ်ငန်းများအတွက် လိုအပ်သော Asphalt ပမာဏ၊ ရယူမည့်နေရာ၊ Asphalt Batching Plant များ တည်ဆောက်ရန် ရှိ/မရှိ ဖော်ပြထားခြင်းမရှိ၍ ထည့်သွင်းဖော်ပြရန်၊ - Asphalt Plant နှင့် Batching Plant များတည်ဆောက်ပါကတည်ဆောက်မည့် တည်နေရာများနှင့် သက်ရောက်နိုင်သော Impact၊ လျော့ပါးစေရေးနည်းလမ်းများ၊ Environmental Management Plan၊ Environmental Monitoring Plan တို့ကိုဖော်ပြရန်၊	- စီမံကိန်းတွင်ဆောင်ရွက်မည့် အခြေခံအဆောက်အဦး တည်ဆောက်ရေးလုပ်ငန်းများအတွက် လိုအပ်သော Asphalt ပမာဏ၊ ရယူမည့်နေရာ၊ Asphalt Batching Plant များ တည်ဆောက်ရန် ရှိ/မရှိနှင့် ပက်သက်၍ အခန်း(၃)၊ စာပိုဒ်ခွဲ (၃.၄.၃.၅) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ - အခန်း(၅)၊ တွင် စီမံကိန်း၏ တည်ဆောက်ရေးကာလတွင် သက်ရောက်မှုများ ဖော်ပြခြင်းတွင် ထည့်သွင်းစဉ်းစားထားပါသည်။
(၆)	- ရေလိုအပ်ချက်အနေဖြင့် Construction ကာလအတွက် လိုအပ်သော ရေပမာဏနှင့် ရယူရမည့် ရေအရင်းအမြစ်၊ Tube Wellများတူးဖော်မည်ဆိုပါကTube Well အရေအတွက်၊ အသုံးပြုမည့် Water Treatment System ကိုဖော်ပြရန်၊	- ရေလိုအပ်ချက်အနေဖြင့် Construction ကာလအတွက် လိုအပ်သော ရေပမာဏနှင့် ရယူရမည့် ရေအရင်းအမြစ်၊ Tube Wellများတူးဖော်မည်ဆိုပါကTube Well အရေအတွက်၊ အသုံးပြုမည့် Water Treatment System များနှင့်ပက်သက်၍ အခန်း(၃)၊ စာပိုဒ်ခွဲ (၃.၄.၃.၈)တွင် ထည့်သွင်းဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
(၇)	- အစိုင်အခဲစွန့်ပစ်ပစ္စည်းထွက်ရှိမှုကို ဖော်ပြရာတွင် Operation Phase အတွက်သာမက Construction Phase တွင် ထွက်ရှိနိုင်သော စွန့်ပစ်ပစ္စည်းပမာဏနှင့် စွန့်ပစ်မည့်နည်းစနစ်ကိုဖော်ပြရန်၊	- အစိုင်အခဲစွန့်ပစ်ပစ္စည်းထွက်ရှိမှုကို ဖော်ပြရာတွင် Operation Phase အတွက်သာမက Construction Phase တွင် ထွက်ရှိနိုင်သော စွန့်ပစ် ပစ္စည်းပမာဏ နှင့် စွန့်ပစ်မည့်နည်းစနစ် များနှင့် ပက်သက်၍ အခန်း(၃)၊ စာပိုဒ်ခွဲ (၃.၈.၁) တွင် ထည့်သွင်းဖော်ပြ ထားပါသည်။
(၈)	- စီမံကိန်းတစ်ခုလုံး၏ အခြေခံအဆောက်အဦးများတည်ဆောက်ရာတွင် အသုံးပြုမည့် ကုန်ကြမ်းပစ္စည်းများပမာဏ၊ ရယူမည့်အရင်းအမြစ်၊ သယ်ယူမည့်နည်းစနစ်များကို ထည့်သွင်းဖော်ပြရန်၊	- စီမံကိန်းတစ်ခုလုံး၏ အခြေခံအဆောက်အဦးများတည်ဆောက်ရာတွင် အသုံးပြုမည့် ကုန်ကြမ်းပစ္စည်းများပမာဏ၊ ရယူမည့်အရင်းအမြစ်၊ သယ်ယူမည့်နည်းစနစ်များကို အခန်း(၃)၊ အပိုဒ်ခွဲ(၃.၅.၁)၊ တွင် ထည့်သွင်း ဖော်ပြထားပါသည်။
(၉)	စီမံကိန်းနှင့်ပတ်သက်သည့် ပုံများအား ဖော်ပြရာတွင် အောက်ပါအတိုင်းထည့်သွင်းဖော်ပြရန်- - စီမံကိန်းတည်နေရာပြမြေပုံကိုဖော်ပြရာတွင် စီမံကိန်းဧရိယာ၏ထောင့်အမှတ်အားလုံးကို လတ္တီတွဒ်၊ လောင်ဂျီတွဒ်များဖြင့် ဖော်ပြရန်၊	- စီမံကိန်းတည်နေရာပြမြေပုံကိုဖော်ပြရာတွင် စီမံကိန်းဧရိယာ၏ထောင့်အမှတ်အားလုံးကို လတ္တီတွဒ်၊ လောင်ဂျီတွဒ်များဖြင့် အခန်း (၁)၊ ပုံ ၁-၁ တွင် ပြင်ဆင်ဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	- အစီရင်ခံစာတွင်ဖော်ပြထားသောမြေပုံများ၊ အညွှန်းစာသားများအား ရှင်းလင်းစွာ တွေ့မြင်နိုင်သည့်မြေပုံများ၊ အညွှန်းများကို ဖော်ပြရန်၊ - စီမံကိန်း၏ အနီးဝန်းကျင်(၅)ကီလိုမီတာပတ်လည်ကို ရှင်းလင်းစွာတွေ့မြင်နိုင်သော ကောင်းကင်ဓါတ်ပုံကို သင့်လျော်သော စကေး၊ အညွှန်းစာသားများဖြင့်ဖော်ပြရန်၊ - စီမံကိန်းအနီး ပတ်ဝန်းကျင်တွင် ဘာသာရေးအဆောက်အဦးများ၊ ရှေးဟောင်း အမွေအနှစ် အဆောက်အအုံများ၊ ကျောင်းများ၊ ဆေးရုံ/ဆေးခန်းများရှိပါက အဆိုပါအဆောက်အဦးများနှင့် စီမံကိန်းကြားအကွာအဝေးကိုဖော်ပြထားသည့်ပုံများထည့်သွင်းဖော်ပြရန်။	- အစီရင်ခံစာ၏ သက်ဆိုင်ရာ အခန်းများတွင် ပြင်ဆင်ဖော်ပြထားပါသည်။ - စီမံကိန်းအနီး ပတ်ဝန်းကျင်တွင် ဘာသာရေးအဆောက်အဦးများ၊ ရှေးဟောင်း အမွေအနှစ် အဆောက်အအုံများ၊ ကျောင်းများ၊ ဆေးရုံ/ဆေးခန်းများ အဆိုပါအဆောက်အဦးများနှင့် စီမံကိန်းကြားအကွာအဝေးကိုဖော်ပြထားသည့်ပုံများအား - အခန်း (၄)၊ စာပိုဒ်ခွဲ (၄.၉.၃.၁)၊ဇယား ၄-၁၃၆နှင့် ပုံ ၄-၁၈၂ တွင် ပြင်ဆင်ဖော်ပြထားပါသည်။
(c)	အနီးပတ်ဝန်းကျင်အကြောင်းအရာများ ဖော်ပြချက်	
(၁)	- လေထုအရည်အသွေး၊ ရေအရည်အသွေး၊ ဆူညံသံနှင့် တုန်ခါမှု၊ မြေအရည်အသွေးများတိုင်းတာရာတွင် ကောက်ယူသည့်တည်နေရာနှင့် အရေအတွက်သည်Operation နှင့်Construction ကာလတို့အတွက် လုံလောက်မှု ရှိ/မရှိ သုံးသပ်ဖော်ပြရန်၊	- လေထုအရည်အသွေး၊ ရေအရည်အသွေး၊ ဆူညံသံနှင့် တုန်ခါမှု၊ မြေအရည်အသွေးများတိုင်းတာရာတွင် ကောက်ယူသည့်တည်နေရာနှင့် အရေအတွက်သည်Operation နှင့်Construction ကာလတို့အတွက် လုံလောက်မှု အခန်း (၄)၊ စာပိုဒ်ခွဲ (၄.၇) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
(၂)	- စာမျက်နှာ(၄-၄၅၂) တွင်စီမံကိန်းအတွက် လေ့လာမှုဧရိယာ(၅) ကီလိုမီတာအချင်းဝက်အတွင်းရှိ မြေအသုံးချမှုများကို ဖော်ပြထားသော်လည်း စီမံကိန်းဧရိယာ (၂၅၀၀) ဧကအတွင်းရှိ မူလမြေအသုံးချမှု အခြေအနေများ၊ စီမံကိန်းကြောင့်သက်ရောက်ခံရသည့် လယ်ယာမြေပမာဏများကို ဖော်ပြရန်၊	- စီမံကိန်းဧရိယာ (၂၅၀၀) ဧကအတွင်းရှိ မူလမြေအသုံးချမှု အခြေအနေများ၊ စီမံကိန်းကြောင့်သက်ရောက်ခံရသည့် လယ်ယာမြေပမာဏများကို အခန်း (၄)၊ စာပိုဒ်ခွဲ (၄.၁၀.၂.၅) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
(စ)	- ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း၊ လျှော့ချမည့်နည်းလမ်းများ	
(၁)	- စာမျက်နှာ(၅-၂)တွင်Environmental Impact Assessment Methodology သည်NEMA EIA Regulations(2010), South Africa ကို အခြေခံထားကြောင်း၊Impact တစ်ခုစီ၏ Consequence နှင့်Probability တို့ကိုထည့်သွင်းစဉ်းစား၍ Environmental Impactကိုတွက်ချက်သော Significance Rating Methodology ဖြစ်ကြောင်း၊ဖော်ပြထားရာ အဆိုပါ Methodology ကို ရွေးချယ်ရသည့် အကြောင်းရင်း၊ဤစီမံကိန်းအတွက်သင့်တော်မှုတို့ကို ထည့်သွင်းဖော်ပြရန်၊	- Environmental Impact Assessment Methodology သည်NEMA EIA Regulations (2010), South Africa ကို အခြေခံထားကြောင်း၊Impact တစ်ခုစီ၏ Consequence နှင့်Probability တို့ကိုထည့်သွင်းစဉ်းစား၍ Environmental Impactကိုတွက်ချက်သော Significance Rating Methodology ဖြစ်ကြောင်း၊ဖော်ပြထားရာ အဆိုပါ Methodology ကို ရွေးချယ်ရသည့် အကြောင်းရင်း၊ဤစီမံကိန်းအတွက်သင့်တော်မှုတို့ နှင့် ပက်သက်၍ အခန်း (၅) ၊ အပိုဒ်ခွဲ (၅,၄) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
(၂)	- Impact Assessment အပိုင်းတွင်သက်ရောက်မှုများကို ဖော်ပြရာတွင် အကျိုးအကြောင်းခိုင်လုံစွာ ဖော်ပြပေးရန်၊ - Impact များအားတစ်ခုနှင့်တစ်ခု ဖော်ပြရာတွင် စီမံကိန်း၏Activities, Management Plan, Monitoring Plan တို့ကို ကဏ္ဍအလိုက်ချိတ်ဆက်မိစွာဖော်ပြပေးရန်၊	- အကျိုးအကြောင်းခိုင်လုံစွာ ဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
(ဆ)	ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုအစီစဉ်နှင့် စောင့်ကြပ်ကြည့်ရှုမည့်အစီအစဉ်	
(၁)	- စာမျက်နှာ(၇-၅၉မှ ၇-၆၀)တွင် နှင့် ပတ်သက်၍ ဆောင်ရွက်မည့် လုပ်ငန်းစဉ်နှင့် တွင်မကျေလည်မှုများတိုင်ကြားသည့်ပုံစံတို့ကို ဖော်ပြထားသော်လည်း လိပ်မှုတိုင်ကြားနိုင်သည့်တာဝန်ရှိသူ၏အမည်၊ ဖုန်းနံပတ်၊ နှင့် လိပ်စာများကို ထည့်သွင်းဖော်ပြရန်၊	- လိပ်မှုတိုင်ကြားနိုင်သည့်တာဝန်ရှိသူ၏အမည်၊ ဖုန်းနံပတ်၊ နှင့် လိပ်စာများကို ထည့်သွင်းခြင်းနှင့် ပက်သက်၍ အခန်း (၇)၊ အပိုဒ်ခွဲ (၇-၁၂)၊ ဇယား (၇-၂၂)တွင် ထည့်သွင်းဖော်ပြထား ပါသည်။
(၂)	- ဒေသခံပြည်သူများမှာ စိုက်ပျိုးရေးကို အဓိကထားလုပ်ကိုင်ကြပြီး ယခုအခါ လယ်ယာမြေသိမ်းဆည်းခံလိုက်ရခြင်းကြောင့် စိုးရိမ်ပူပန်မှုများ ရှိနေကြောင်းဖော်ပြထားချက်အရ အဆိုပြုစီမံကိန်းအနေဖြင့် Livelihood Restoration Plan ကိုဆောင်ရွက်ထားရှိမှုအခြေအနေကို ထည့်သွင်းဖော်ပြရန်၊	- Livelihood Restoration Plan ကိုအခန်း (၇) ၊ အပိုဒ်ခွဲ (၇-၁၁) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
(၃)	- စီမံကိန်းသည် Green Urban Development Project ဖြစ်သည့်အတွက် စိမ်းလန်းစိုပြေရေးအတွက် အပင်များစိုက်ပျိုးမည့် အစီအစဉ်ကိုထည့်သွင်းဖော်ပြပေးရန်၊	- စီမံကိန်းသည် Green Urban Development Project ဖြစ်သည့်အတွက် စိမ်းလန်းစိုပြေရေး အတွက် အပင်များစိုက်ပျိုးမည့် အစီအစဉ်များနှင့် ပက်သက်၍ အခန်း(၇)၊ အပိုဒ်ခွဲ (၇-၆) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
(၄)	- Construction ကာလနှင့်Operation ကာလအတွက် Traffic Management Planကိုခွဲခြားဖော်ပြပေးရန်၊	- Construction ကာလနှင့်Operation ကာလအတွက် Traffic Management Plan များနှင့်ပက်သက်၍ အခန်း (၇) ၊ အပိုဒ်ခွဲ (၇-၄-၇) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
(၅)	- မြေအောက်ရေအရည်အသွေးအား စောင့်ကြပ်ကြည့်ရှုမည့်အစီအစဉ်အား ထည့်သွင်းဖော်ပြရန်၊	- မြေအောက်ရေအရည်အသွေးအား စောင့်ကြပ်ကြည့်ရှုမည့်အစီအစဉ်များ နှင့်ပက်သက် ၍ အခန်း(၇)၊ ဇယား(၇-၄) နှင့် (၇-၅)တွင် ထည့်သွင်းဖော်ပြ ထားပါသည်။
(၆)	- စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးမည့် အစီအစဉ်တွင်Construction ကာလနှင့် Operation ကာလတို့အတွက်Monitoring Plan သည် မတူညီနိုင်သည့်အတွက် သီးခြားဖော်ပြရန်၊	- စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးမည့် အစီအစဉ်တွင်Construction ကာလနှင့် Operation ကာလတို့အတွက်Monitoring Plan သည် မတူညီနိုင်ခြင်း နှင့်ပက်သက် ၍ အခန်း(၇) ၊ဇယား (၇-၄)နှင့် (၇-၅) တွင် ထည့်သွင်းဖော်ပြထားပါ သည်။
(၇)	- စောင့်ကြပ်ကြည့်ရှုမည့်Parameter များနှင့်တကွGuideline Value ကိုလည်းဖော်ပြပေးရန်၊ - ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုအစီအစဉ်နှင့် စောင့်ကြပ်ကြည့်ရှုမည့်အဖွဲ့၏ Leader များကိုသာ ဖော်ပြထားသဖြင့် ၎င်းတို့၏ ဦးဆောင်မှုအောက်တွင် ဖွဲ့စည်းဆောင်ရွက်မည့်အဖွဲ့နှင့် လုပ်ငန်းတာဝန်များကို ဖော်ပြပေးရန်၊	- စောင့်ကြပ်ကြည့်ရှုမည့်Parameter များနှင့် တကွ Guideline Value နှင့်ပက်သက် ၍ အခန်း(၇) ၊ဇယား (၇-၄)နှင့် (၇-၅) တွင် ထည့်သွင်းဖော်ပြထားပါ သည်။ - ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုအစီအစဉ်နှင့် စောင့်ကြပ်ကြည့်ရှုမည့်အဖွဲ့၏ Leader များကိုသာ ဖော်ပြထားသဖြင့် ၎င်းတို့၏ ဦးဆောင်မှုအောက်တွင် ဖွဲ့စည်းဆောင်ရွက်မည့်အဖွဲ့နှင့် လုပ်ငန်းတာဝန်များကို အခန်း(၇) ၊ဇယား (၇-၁) နှင့် (၇-၂၀) တွင်ထည့်သွင်းဖော်ပြထားပါ သည်။
(၈)	- Baseline ကောက်ယူစဉ်ကတိုင်းတာသည့် အမှတ်များအား Monitoring ကောက်ယူစဉ်တွင်ထည့်သွင်းစောင့်ကြည့်ခြင်းမရှိသည့် အကြောင်းအရင်း ကိုကျိုးကြောင်းခိုင်လုံစွာဖော်ပြပေးရန်၊	- Baseline ကောက်ယူစဉ်ကတိုင်းတာသည့် အမှတ်များအား Monitoring ကောက်ယူစဉ် တွင် ထည့်သွင်းစောင့်ကြည့်ခြင်းမရှိသည့် အ ကြောင်းအရင်း များနှင့်ပက်သက်၍ အခန်း (၇) ၊အပိုဒ်ခွဲ (၇-၃-၂) တွင် ထည့်သွင်းဖော်ပြထားပါ သည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
(၉)	- ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုအစီအစဉ်နှင့် စောင့်ကြပ်ကြည့်ရှုမည့်အဖွဲ့၏ Leader များကိုသာဖော်ပြထားသဖြင့် ၎င်းတို့၏ ဦးဆောင်မှုအောက်တွင် ဖွဲ့စည်းဆောင်ရွက်မည့်အဖွဲ့နှင့်လုပ်ငန်းတာဝန်များကိုဖော်ပြရန်၊	- ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုအစီအစဉ်နှင့် စောင့်ကြပ်ကြည့်ရှုမည့်အဖွဲ့၏ Leadတို့၏ ဦးဆောင်မှုအောက်တွင် ဖွဲ့စည်းဆောင်ရွက်မည့်အဖွဲ့နှင့်လုပ်ငန်းတာဝန်များကိုအခန်း(၇) ၊ဇယား (၇-၁) နှင့် (၇-၂၀) တွင်ထည့်သွင်းဖော်ပြထားပါ သည်။
(၁၀)	- ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုအစီအစဉ်နှင့် စောင့်ကြပ်ကြည့်ရှုခြင်း အစီအစဉ်များအတွက် ရန်ပုံငွေလျာထားချက်နှင့် ပတ်သက်၍ လုံလောက်မှုမရှိပါကထပ်မံဖြည့်သွင်း ဆောင်ရွက်မည်ဖြစ်ကြောင်း ဖော်ပြရန်၊	- ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုအစီအစဉ်နှင့် စောင့်ကြပ်ကြည့်ရှုခြင်း အစီအစဉ်များအတွက် ရန်ပုံငွေလျာထားချက်နှင့် ပတ်သက်၍ လုံလောက်မှုမရှိပါကထပ်မံဖြည့်သွင်း ဆောင်ရွက်ခြင်း နှင့် ပက်သက်၍ အခန်း(၇)၊ အပိုဒ်ခွဲ (၇-၃-၁)တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
(၈)	အများပြည်သူနှင့်တိုင်ပင်ဆွေးနွေးခြင်းနှင့်သတင်းအချက်အလက်များထုတ်ဖော်တင်ပြခြင်း	
(၁)	စာမျက်နှာ(၆-၂)တွင် ရှမ်းကလေးကျွန်းရွာသူရွာသားများအနေဖြင့်ဆုံးရှုံးသည် မြေနှင့် စိုက်ပျိုးမြေများကို လျော်ကြေးအဖြစ် အိမ်အသစ်များ၊တိုက်ခန်းအသစ်များပေးအပ်မည်ဖြစ်ကြောင်း ဖော်ပြထားသောကြောင့် စီမံကိန်းဧရိယာအတွင်းရှိ ကျေးရွာများနှင့် ပတ်သက်၍ ဆောင်ရွက်ပေးမည့်အစီအစဉ်ကိုထည့်သွင်းဖော်ပြရန်၊	- စီမံကိန်းဧရိယာအတွင်းရှိ ကျေးရွာများနှင့် ပတ်သက်၍ ဆောင်ရွက်ပေးမည့်အစီအစဉ်ကို အခန်း(၇)၊ အပိုဒ်ခွဲ (၇-၁၁) နှင့် အခန်း(၆)၊ အပိုဒ်ခွဲ (၆.၆.၄) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
(၂)	စာမျက်နှာ(၆-၃၉) တွင်အများပြည်သူတွေ့ဆုံဆွေးနွေးပွဲတွင် ဆွေးနွေးချက်များအရ စီမံကိန်းနှင့် ဒေသခံပြည်သူများ၏ အဓိကပြဿနာသည် မြေဝယ်ယူရေးနှင့် စွန့်ပစ်ရေဆိုးများ စွန့်ထုတ်ခြင်းတို့ဖြစ်ကြောင်းဖော်ပြထားသဖြင့် အဆိုပါကိစ္စရပ်များနှင့် ပတ်သက်၍ဖြေရှင်း ဆောင်ရွက်မည့်အစီအစဉ်များကို ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှု	- အများပြည်သူတွေ့ဆုံဆွေးနွေးပွဲတွင် ဆွေးနွေးချက်များအရ စီမံကိန်းနှင့် ဒေသခံပြည်သူများ၏ အဓိကပြဿနာသည် မြေဝယ်ယူရေးနှင့် စွန့်ပစ်ရေဆိုးများ စွန့်ထုတ်ခြင်းတို့ဖြစ်ကြောင်းဖော်ပြထားသဖြင့် အဆိုပါကိစ္စရပ်များနှင့် ပတ်သက်၍ဖြေရှင်း ဆောင်ရွက်မည့်အစီအစဉ်များကို အပိုဒ်ခွဲ (၆.၆.၄) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	အစီအစဉ်အခန်းတွင်ထည့်သွင်းဖော်ပြရန်၊	
(၃)	ဒေသခံပြည်သူများမှာ စိုက်ပျိုးရေးကို အဓိကထား လုပ်ကိုင်ကြပြီး ယခုအခါ လယ်ယာမြေသိမ်းဆည်းခံလိုက်ရခြင်းကြောင့် စိုးရိမ်ပူပန်မှုများရှိနေကြောင်း ဖော်ပြထားချက်အရ အဆိုပြုစီမံကိန်းအနေဖြင့် Restoration Planကိုဆောင်ရွက်ထားရှိမှုအခြေအနေကိုထည့်သွင်းဖော်ပြရန်၊	- အဆိုပြုစီမံကိန်းအနေဖြင့် Restoration Planကိုဆောင်ရွက်ထားရှိမှုအခြေအနေကို Livelihood Restoration Plan ကိုအခန်း(၇)၊ အပိုဒ်ခွဲ (၇-၁၁) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
(၄)	စီမံကိန်းကြောင့် ထိခိုက်နစ်နာမှုများ၊ မကျေမနပ်ချက်များကို တိုင်ကြားနိုင်ရန် Grievance Mechanism အား ဆောင်ရွက်ထားကြောင်းကို အများပြည်သူမှ သိရှိနိုင်ရန် တိုင်ကြားနိုင်သည့် အကြောင်း၊ဖြေရှင်းပေးမည့် လုပ်ငန်းစဉ်၊ တာဝန်ယူဆောင်ရွက်မည့် အဖွဲ့တို့ကို အများပြည်သူမြင်သာသည့် နေရာတွင်ကြေညာထားရှိရန်။	- ဤအကြောင်းအရာနှင့် ပက်သက်၍ အခန်း(၇)၊ အပိုဒ်ခွဲ(၇-၁၂)၊ တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ အများပြည်သူမြင်သာသည့် နေရာတွင်ကြေညာထားရှိပါမည်။
(၅)	ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း အစီရင်ခံစာစိစစ်သုံးသပ်ရေးအဖွဲ့ဝင်များ၏ အကြံပြုချက်နှင့် သဘောထားမှတ်ချက်များ	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
(၁)	**(၁) ဥပဒေရေးရာဝန်ကြီးဌာန** (က)စီမံကိန်းပိုင်ရှင်သည် လိုက်နာမည့် ကတိကဝတ်များကို ဖော်ပြရာတွင် စီမံကိန်းနှင့်သက်ဆိုင်သော ဥပဒေ၊ နည်းဥပဒေများနှင့် လုပ်ထုံးလုပ်နည်းများ၏ ပြဋ္ဌာန်းချက်များကိုသာ ကူးယူဖော်ပြထားပြီး စီမံကိန်းပိုင်ရှင်က လိုက်နာရမည့် ကတိကဝတ်များအဖြစ်ထည့်သွင်းဖော်ပြထားခြင်းမရှိသဖြင့် စီမံကိန်းပိုင်ရှင်က စီမံကိန်းနှင့် သက်ဆိုင်သည့် ဥပဒေ၏ ပုဒ်မ၊ နည်းဥပဒေများ၏ နည်းဥပဒေ၊ လုပ်ထုံးလုပ်နည်းများ၏ အပိုဒ်တို့ကို ညွှန်း၍ အကြောင်းအရာတစ်ခုချင်းအလိုက် လိုက်နာမည့် ကတိကဝတ်များအဖြစ် ပြည့်ပြည့်စုံစုံဖြင့် ဖော်ပြရန်၊ (ဥပမာ-စီမံကိန်းပိုင်ရှင်သည်စီမံကိန်းဆောင်ရွက်ရာတွင် ရှေးဟောင်းဝတ္ထုပစ္စည်းများ တွေ့ရှိရလျှင် ရှေးဟောင်းဝတ္ထုများ ကာကွယ်ထိန်သိမ်းရေး ဥပဒေ ပုဒ်မ ၁၂ အရ သက်ဆိုင်ရာရုပ်ကွက်နှင့် ကျေးရွာအုပ်စုအုပ်ချုပ်ရေးမှူးထံ သတင်းပို့မည်ဖြစ်ကြောင်း ဝန်ခံကတိပြုပါသည်ဟုဖော်ပြရန် ဖြစ်ပါသည်။)	- အခန်း (၂) ရှိ သက်ဆိုင်ရာ အပိုင်းများတွင် ပြင်ဆင်ဖော်ပြထားပါသည်။
	(ခ) အကျဉ်းချုပ်အစီရင်ခံစာတွင် သစ်တောဥပဒေ ၁၉၉၂ (၂၀၁၈ ခုနှစ်တွင်ပြင်ဆင်ပြီး) စသည်ဖြင့် ဖော်ပြထားရာ “သစ်တော ဥပဒေ ၁၉၉၂ သည် ရုပ်သိမ်းပြီး ဥပဒေဖြစ်ပါသည်။ ယင်းရုပ်သိမ်းပြီး ဥပဒေများကို ဖော်ပြရန် မလိုအပ်ပါ။ တည်ဆဲဥပဒေဖြစ်သည့် သစ်တောဥပဒေ ၂၀၁၈ ကိုသာဖော်ပြရန်နှင့် အကျဉ်းချုပ် အစီရင်ခံစာတွင် အခြားဖော်ပြချက်များကို အလားတူစိစစ်ရန်၊ (ဂ)အစီရင်ခံစာတွင်ဥပဒေကို ဖော်ပြရာတွင် “Article” ဟုလည်းကောင်း၊ နည်းဥပဒေများနှင့် လုပ်ထုံးလုပ်နည်းများကို ဖော်ပြရာတွင် “section” ဟုလည်းကောင်းသုံးနှုန်းထားရာ မှန်ကန်မှု မရှိသဖြင့် ဥပဒေကို “section” ဟုလည်းကောင်း၊ နည်းဥဒေများကို “Rule” ဟုလည်းကောင်း၊	- အခန်း (၂) ရှိ သက်ဆိုင်ရာ အပိုင်းများတွင် ပြင်ဆင်ဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	လုပ်ထုံးလုပ်နည်းများကို “Article” ဟုလည်းပြင်ဆင်ဖော်ပြရန်၊	
	(ဃ) ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဥပဒေ ပုဒ်မ ၇(ဏ) နှင့်စပ်လျဉ်း၍ လိုက်နာရမည့် အချက်သုံးချက်အနက် သဘာဝသယံဇာတကို ထုတ်ယူသုံးစွဲခြင်းရှိပါက ပေးသွင်းရမည့် ငွေ၊ ပတ်ဝန်းကျင်ကို ထိခိုက်စေပါက ပေးရမည့်လျော်ကြေးငွေတို့ကို ဝန်ကြီးဌာနက သတ်မှတ်သည့်အတိုင်း ပေးသွင်းမည်ဖြစ်ကြောင်း ဖော်ပြရန်၊ (c) The Protection of Wildlife and Conservation of Natural Areas Law (1994) သည် ရုပ်သိမ်းပြီးဖြစ်သဖြင့် ဇီဝမျိုးစုံမျိုးကွဲနှင့် သဘာဝထိန်းသိမ်းရေးနယ်မြေများ ကာကွယ်စောင့်ရှောက်ခြင်း ဆိုင်ရာဥပဒေ ၂၀၁၈ ဟု ပြင်ဆင်ဖော်ပြရန်၊ (စ) စီမံကိန်းပိုင်ရှင်သည် တိုင်းရင်းသားလူမျိုးများ၏ အခွင့်အရေးနှင့် ရပိုင်ခွင့်များကို ခိုင်လုံသော အကြောင်းပြချက်မရှိဘဲ ပိတ်ပင်တားဆီးခြင်းမပြုရန်ရန်နှင့်ယင်းတို့၏အခွင့်အရေးများကို ကာကွယ်စောင့်ရှောက်ပါမည်ဆိုသည့် ကတိကဝတ်ကို တိုင်းရင်းသားလူမျိုးများ၏ အခွင့်အရေးကာကွယ်စောင့်ရှောက်သည့်ဥပဒေ ၂၀၁၅ ပုဒ်မ ၂၅ သာမက တိုင်းရင်းသားလူမျိုးများ၏ အခွင့်အရေးကာကွယ်စောင့်ရှောက်သည့် နည်းဥပဒေများ နည်းဥပဒေ ၂၀ နှင့် ၂၁ တို့အရတိုင်းရင်းသားလူမျိုးများ နေထိုင်ရာဒေသအတွင်း	- အခန်း (၂) ရှိ သက်ဆိုင်ရာ အပိုင်းများတွင် ပြင်ဆင်ဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	ဖော်ဆောင်မည့်စီမံကိန်းနှင့်စပ်လျဉ်း၍ စီမံကိန်းအဆိုပြုသူသည် လိုက်နာရမည့် တာဝန်များကို ကတိကဝတ်များအဖြစ်ဖော်ပြရန်၊ (ဆ)အများပြည်သူ ဘေးအန္တရယ်ဖြစ်စေနိုင်သည့် အင်ဂျင်နီယာဆိုင်ရာလုပ်ငန်းများနှင့် နည်းပညာဆိုင်ရာလုပ်ငန်းများတွင် ကောင်စီကထုတ်ပေးသည့် မှတ်ပုံတင်လက်မှတ်မရှိဘဲ ဆောင်ရွက်ခြင်းမရှိစေရန် စီမံကိန်းအဆိုပြုသူသည် မြန်မာနိုင်ငံ အင်ဂျင်နီယာ ကောင်စီဥပဒေ ပုဒ်မ ၃၄ နှင့် ၃၇ တို့ပါ အချက်များကို လိုက်နာပါမည်ဆိုသည့် ကတိကဝတ်ကို ဖော်ပြရန်၊ (ဇ) စီမံကိန်းတွင် အသုံးပြုမည့် မော်တော်ယာဉ်များနှင့် စပ်လျဉ်း၍ “ယာဉ်အန္တရာယ်ကင်းရှင်းရေးနှင့် မော်တော်ယာဉ် စီမံခန့်ခွဲမှုဥပဒေ၊ ၂၀၂၀” ပုဒ်မ၉(က)၊၁၂(ဂ)၊ ၁၄(ဒ)၊ ၁၈(က)၊ ၈၁(ဆ) တို့ပါ ပြဋ္ဌာန်းချက်ပါ အချက်များကို စီမံကိန်း ပိုင်ရှင်ကလိုက်နာမည့်ကြောင်း ကတိကဝတ်ပြုရမည့်အပြင် ယာဉ်အန္တရယ်ကင်းရှင်းရေးနှင့် မော်တော်ယာဉ်စီမံခန့်ခွဲမှုနည်းဥပဒေ၂၀၂၂ ပါစီးပွားရေး လုပ်ငန်းသုံးမော်တော်ယာဉ် ပြဋ္ဌာန်းချက်များကို လိုက်နာမည့်အကြောင်း ကတိကဝတ်ပြုရန်၊ (ဈ) စီမံကိန်းတွင် စက်သုံးဆီများသိုလှောင်ထိန်းသိမ်းခြင်းနှင့် စပ်လျဉ်း၍ ရေနံနှင့်ရေနံထွက် ပစ္စည်းဆိုင်ရာဥပဒေ ၂၀၁၇ သာမက Petroleum Rules 1937 ပါ အခန်း၃ နှင့်၄ တို့ပါ ပြဋ္ဌာန်းချက်များကိုလည်း လိုက်နာမည့်ကတိကဝတ်ပြုရန်၊ (ည)စီမံကိန်းတွင်အသုံးပြုမည့် ပေါက်ကွဲစေတတ်သော ဝတ္ထုပစ္စည်းများကို သုံးစွဲခြင်းရှိပါက Explosive Substances Act,1908 (ပုဒ်မ၃၊၄၊၅) နှင့်	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	လုပ်ငန်းခွင်သုံး ပေါက်ကွဲစေတတ်သော ဝတ္ထုပစ္စည်းများ ဆိုင်ရာဥပဒေ၊၂၀၁၈(ပုဒ်မဖြ(ဂ)၊ ဂ(ဂ)၊၁၁(ခ)၊ ၁၃၊၁၄(ခ)၊၁၅၊၁၆၊၁၈၊၂၀၊၂၁) တို့ပါ အချက်များကို လိုက်နာမည်ဖြစ်ကြောင်း ကတိကဝတ်ပြုရန်၊ (ဋ)စီမံကိန်းဆောက်လုပ်ရာတွင် အသုံးပြုမည့် ရေအတွက် Underground Water Act နှင့် ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများဖွံ့ဖြိုးတိုးတက်ရေးဥပဒေတို့သာမက ရေအရင်းအမြစ်နှင့် မြစ်ချောင်းများဖွံ့ဖြိုးတိုးတက်ရေးနှင့် မြစ်ချောင်းများညစ်ညမ်းမှုမရှိစေရေး အတွက် ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများ ဖွံ့ဖြိုးတိုးတက်ရေး နည်းဥပဒေပါ သက်ဆိုင်သည့် ပြဋ္ဌာန်းချက်များကို တစ်ချက်ချင်း လိုက်နာမည်ဖြစ်ကြောင်း ကတိကဝတ်ပြုရန်၊ (ဌ) စီမံကိန်းတွင် အလုပ်လုပ်ကိုင်ကြမည့် အလုပ်သမားများနှင့် စပ်လျဉ်း၍ ၁၉၇၂ ခုနှစ်၊ ပြည်ထောင်စု မြန်မာနိုင်ငံပြည်သူ့ကျန်းမာရေး ဥပဒေ (ပုဒ်မ ၃၊၅) နှင့် ကူးစက်ရောဂါများ ကာကွယ်ထိန်းချုပ်ရေး ဥပဒေ၊ ၁၉၉၅(ပုဒ်မ၃(က)(ဇ) ၊၄၊၁၁) တို့သာမက ဆေးလိပ်နှင့်ဆေးရွက်ကြီးထွက်ပစ္စည်းသောက်သုံးမှု ထိန်းချုပ်ရေးဥပဒေ၊ ၂၀၀၆ (ပုဒ်မ ၉) ပါ ပြဋ္ဌာန်းချက်များကို လိုက်နာမည့်ကတိကဝတ်အဖြစ်ဖော်ပြရန်၊ (ဍ) Prevention of Hazard from Chemical and Related Substance Law (2013) ဓာတုပစ္စည်းနှင့် ဆက်စပ်ပစ္စည်းများအန္တရာယ်မှ တာဆီးကာကွယ်ရေးဥပဒေ၊ ၂၀၁၃တွင် လိုက်နာမည့်အချက်ကို ဖော်ပြထားခြင်းမရှိသဖြင့် ယင်းဥပဒေပုဒ်မ (ပုဒ်မ ၁၅(က)၊(ခ)၊၁၆(ခ) မှ(ည)အထိ၊ ၁၇၊၂၂၊၂၇(က)မှ(ဃ) အထိ) တို့ကို လိုက်နာမည်ဖြစ်ကြောင်းဖော်ပြရန်၊	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	(ဃ)စီမံကိန်းတွင် အသုံးပြုမည့် လျှပ်စစ်ဓာတ်အားသုံးစွဲမှုနှင့်စပ်လျဉ်း၍ လျှပ်စစ်ဥပဒေ၊၂၀၁၄(ပုဒ်မ၂၀၊ ၂၁(က)၊ ၂၄၊၂၇၊ ၂၉၊ ၃၃၊ ၄၁၊ ၆၈) တို့ကို လိုက်နာမည့် ကတိကဝတ်အဖြစ်ဖော်ပြရန်၊ (င)အစီရင်ခံစာတွင် မြန်မာနိုင်ငံမီးသတ်တပ်ဖွဲ့ဥပဒေကို ဖော်ပြထားသော်လည်း ယင်းဥပဒေပုဒ်မ ၂၅ နှင့်အညီ သီးသန့်မီးသတ်တပ်ဖွဲ့ ဖွဲ့စည်းမည်ဖြစ်ကြောင်းနှင့် မီးဘေးလုံခြုံရေးဆိုင်ရာ ပစ္စည်းကိရိယာများကိုထားရှိမည် ဖြစ်ကြောင်း ကတိကဝတ်ပြုဖော်ပြရန်၊ (တ)သဘာဝဘေးအန္တရာယ်ဆိုင်ရာ စီမံခန့်ခွဲမှုဥပဒေ ပုဒ်ဝ၄မှ၁၈ ကို လိုက်နာမည်ဖြစ်ကြောင်းကတိကဝတ်ပြုဖော်ပြရန်၊ (ထ)The Protection and Preservation of Cultural Heritage Regions Law (1998) (Amended up to 2009) ကို ယဉ်ကျေးမှုအမွေအနှစ်ဒေသများ ကာကွယ် စောင့်ရှောက်ရေးဥပဒေ ၂၀၁၉ ဖြင့်ရုပ်သိမ်းပြီး ဖြစ်သဖြင့် တည်ဆဲဥပဒေအရ သက်ဆိုင်သည့် ပြဋ္ဌာန်းချက်ကို လိုက်နာမည့် ကတိကဝတ်အဖြစ်ဖော်ပြရန်၊ (ဒ) စီမံကိန်းတွက်လိုအပ်သော စက်ပစ္စည်းများတင်ပို့ခြင်းရှိပါက ပို့ကုန်သွင်းကုန်ဥပဒေ၊၂၀၁၂ပုဒ်မ၅၅နှင့်၆ တို့အပြင် ပုဒ်မ ၇ အရ (ပြည်ပမှပစ္စည်းတစ်စုံတစ်ရာတင်သွင်းခြင်းရှိပါက ထည့်သွင်းဖော်ပြရန်) (ဓ)စီမံကိန်းတွင်အသုံးပြုသည့်မြေတွင် လယ်ယာမြေပါရှိပါက မြေအမျိုးအစားကို “လယ်မြေ” သို့မဟုတ် “လယ်မြေမဟုတ်သည့် လယ်ယာမြေ” အတိအကျဖော်ညွှန်းပြီး မြေအမျိုးအစားလိုက် အခြားနည်းအသုံးပြုခွင့်ပေးနိုင်ခွင့်ရှိသူထံမှ ခွင့်ပြုချက်ရယူမည်ဖြစ်ကြောင်း တိကျစွာဖော်ပြရန်၊	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	(နာ)အလုပ်သမားဥပဒေများနှင့်ပတ်သက်၍ အကျဉ်းမျှသာဖော်ပြထားသဖြင့် ဥပဒေတစ်ခုချင်း၊ ပုဒ်မတစ်ခုချင်း လိုက်နာမည့်ကတိကဝတ်ဖော်ပြရန်၊ (ဝ)စီမံကိန်းနှင့် သက်ဆိုင်သော အောက်ဖော်ပြပါ ဥပဒေများ၊ နည်း ဥပဒေများ၊ EIA Procedureတို့ကို စာရင်းဖော်ပြ၍ သေချာစွာဖတ်ရှုပြီး စီမံကိန်းပိုင်ရှင်က လိုက်နာရမည့် ကတိကဝတ်များကို သက်ဆိုင်ရာ ဥပဒေ၏ ပုဒ်မ၊ နည်းဥပဒေများ၏ နည်းဥပဒေ၊ လုပ်ထုံးလုပ်နည်း၏ အပိုဒ်ကို ညွှန်း၍ တိကျရှင်းလင်းစွာဖော်ပြပါရန်- (၁) ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဥပဒေ၊၂၀၁၂(ပုဒ်မ၇(ဏ)၊၁၄၊၁၅၊၂၄၊၂၉) (၂) ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးနည်းဥပဒေများ၊ ၂၀၁၄(နည်းဥပဒေ ၆၉(က)၊(ခ)) (၃) ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာ လုပ်ထုံးလုပ်နည်း၊၂၀၁၅(အပိုဒ် ၁၀၂မှ၁၁၀ အထိ၊၁၁၃၊၁၁၅၊၁၁၇) (၄) အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာ အရည်အသွေး(ထုတ်လွှတ်မှု) လမ်းညွှန်ချက်များ (၂၀၁၅) (၅) မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှုဥပဒေ၊ ၂၀၁၆ (ပုဒ်မ၅၀၊ ၅၁၊ ၆၅၊ ၇၃) (၆) မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှုနည်းဥပဒေများ၊ ၂၀၁၇ (နည်းဥပဒေ၂၀၂၊ ၂၀၃၊ ၂၀၆၊ ၂၁၂) (၇)ပုဂ္ဂလိက စက်မှုလုပ်ငန်းဥပဒေ၊၁၉၉၀ (ပုဒ်မ၂၇) (၈)လုပ်ငန်းခွင်သုံး ပေါက်ကွဲစေတတ်သော ဝတ္ထုပစ္စည်းများဆိုင်ရာဥပဒေ၊ ၂၀၁၈(ပုဒ်မ၆(ဂ)၊ ၇(ဂ)၊ ၁၁(ခ)၊ ၁၃၊ ၁၄(ခ)၊ ၁၅၊ ၁၆၊ ၁၈၊ ၁၉၊ ၂၀၊၂၁) (၉) The Explosive Substances Act, 1908(ပုဒ်မ ၃၊ ၄၊ ၅) (၁၀) အလုပ်သမားအဖွဲ့အစည်းဥပဒေ၊ ၂၀၁၁(ပုဒ်မ ၁၈ မှ ၂၂ အထိ)	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	(၁၁)အလုပ်သမားရေးရာအငြင်းပွားမှု ဖြေရှင်းရေးဥပဒေ၊ ၂၀၁၂(ပုဒ်မ ၃၈၊ ၃၈-က၊ ၃၉၊ ၄၀၊ ၅၁) (၁၂) အလုပ်အကိုင်နှင့် ကျွမ်းကျင်မှု ဖွံ့ဖြိုးတိုးတက်ရေးဥပဒေ၊ ၂၀၁၃(ပုဒ်မ ၅၊ ၁၄၊ ၃၀) (၁၃) ၂၀၁၃ခုနှစ်၊ အနည်းဆုံးအခကြေးငွေ ဥပဒေ(ပုဒ်မ၁၂၊ ၁၃) (၁၄)၂၀၁၆ခုနှစ်၊ အခကြေးငွေပေးချေရေးဥပဒေ(ပုဒ်မ ၃၊ ၄၊ ၅၊ ၁၄ နှင့် အခန်း(၃)) (၁၅) ခွင့်နှင့်အလုပ်ပတ်ရက်များဥပဒေ၊ ၁၉၅၁ (ခြုံငုံရေးသားရန်) (၁၆)အလုပ်သမားလျော်ကြေးအက်ဥပဒေ၊ ၁၉၂၃(ခြုံငုံရေးသားရန်) (၁၇)လူမှုဖူလုံရေးဥပဒေ၊ ၂၀၁၂(ပုဒ်မ ၁၁(က)၊ ၁၅(က)၊(ခ)၊ ၁၈(ခ)၊ ၄၈(ခ)၊ ၇၅) (၁၈)လုပ်ငန်းခွင်ဘေးအန္တရာယ်ကင်းရှင်းရေးနှင့် ကျန်းမာရေးဆိုင်ရာ ဥပဒေ၊ ၂၀၁၉(ပုဒ်မ၁၂၊ ၁၄၊ ၁၆၊ ၁၇၊ ၁၈၊ ၂၆၊ ၂၇၊ ၃၄၊ ၃၆) (၁၉)ယဉ်ကျေးမှုအမွေအနှစ်ဒေသများ ကာကွယ်စောင့်ရှောက်ရေး ဥပဒေ၊ ၂၀၁၉(ပုဒ်မ ၂၁(ခ)) (၂၀)ရှေးဟောင်းဝတ္ထုပစ္စည်းကာကွယ် စောင့်ရှောက်ရေးဥပဒေ၊ ၂၀၁၅(ပုဒ်မ၁၂) (၂၁)ရှေးဟောင်းအဆောက်အအုံများ ကာကွယ်စောင့်ရှောက်ရေးဥပဒေ၊ ၂၀၁၅(ပုဒ်မ ၁၂၊ ၁၅၊ ၂၀(စ)) (၂၂) ၁၉၇၂ခုနှစ်၊ ပြည်ထောင်စုမြန်မာနိုင်ငံ ပြည်သူ့ကျန်းမာရေး ဥပဒေ(ပုဒ်မ ၃၊ ၅) (၂၃)ကူးစစ်ရောဂါများကာကွယ်ထိန်းချုပ်ရေးဥပဒေ၊ ၁၉၉၅(ပုဒ်မ၃(က)(ဇ)၊၄၊၁၁)	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	(၂၄)ဆေးလိပ်နှင့်ဆေးရွက်ကြီးထွက်ပစ္စည်း သောက်သုံးမှုထိန်းချုပ်ရေး ဥပဒေ၊ ၂၀၀၆(ပုဒ်မ၉) (၂၅)ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများထိန်းသိမ်းရေးဥပဒေ၊ ၂၀၀၆(ပုဒ်မ၈(က)၊ ၁၁ ၊၁၉၊ ၂၁(ခ)၊ ၂၂၊ ၂၄(ခ))(ရေကိုစုပ်တင်ခြင်းရှိ၍ ယင်းအတွက်ပုဒ်မ ၆ နှင့် ၃၀ ကိုပေါင်း၍ထည့်သွင်းဖော်ပြရန်) (၂၆)ရေအရင်းအမြစ်နှင့် မြစ်ချောင်းများထိန်းသိမ်းရေးနည်းဥပဒေများ၊ ၂၀၁၃(ရေကိုစုတ်တင်ခြင်းအတွက် ထည့်သွင်းဖော်ပြရန်) (၂၇) ရေနံနှင့်ရေနံထွက် ပစ္စည်းဆိုင်ရာ ဥပဒေ၊ ၂၀၁၇(ပုဒ်မ ၈(က)၊(ဂ)၊ ၉(က)၊ (ငါ)၊၁၀(က)၊ (ခ)၊ (ဃ)၊ (င)၊ (၁၁)(သက်ဆိုင်သလို ထည့်သွင်းဖော်ပြရန်) (၂၈)The Petroleum Rules, 1937(Chapter III and IV) (၂၉) အင်ဂျင်နီယာကောင်စီဥပဒေ၊ ၂၀၁၃(ပုဒ်မ ၃၄) (၃၀)ဓာတုပစ္စည်းနှင့် ဆက်စပ်ပစ္စည်းများအန္တရာယ်မှ တားဆီးကာကွယ်ရေး ဥပဒေ၊ ၂၀၁၃(ပုဒ်မ၁၅(က)၊ (ခ)၊ ၁၆(ခ)မှ (ည) အထိ၊ ၁၇၊ ၂၂၊ ၂၇(က)မှ(ဃ)အထိ) (၃၁)မြန်မာနိုင်ငံမီးသတ်တပ်ဖွဲ့ ဥပဒေ၊ (ပုဒ်မ ၂၅) (၃၂)ပို့ကုန်သွင်းကုန်ဥပဒေ ၂၀၁၈(ပုဒ်မ၇) (၃၃) သစ်တောဥပဒေ၊ ၂၀၁၈(ပုဒ်မ၁၂(က))(သစ်တောကြိုးဝိုင်းအတွင်းဖြစ်၍) (၃၄)ဇီဝမျိုးစုံမျိုးကွဲနှင့် သဘာဝပတ်ဝန်းကျင်ထိန်းသိမ်းရေးနယ်မြေများ ကာကွယ်စောင့်ရှောက်ခြင်းဆိုင်ရာ ဥပဒေ၊ ၂၀၁၈(ပုဒ်မ ၃၅(က)၊(ဂ)၊ (ဃ)၊ ၂၉(ငါ)၊ ၃၉(ဃ)) (၃၅) ဘွိုင်လာဥပဒေ၊ ၂၀၁၅(ပုဒ်မ ၁၂၊ ၁၄၊ ၁၈၊ ၁၉၊ ၂၀၊ ၂၁၊ ၂၄၊ ၂၉(ခ)၊ ၃၁၊၄၀)(အသုံးပြုပါက)။	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	(၃၆)မြန်မာအာမခံလုပ်ငန်းဥပဒေ၊ ၁၉၉၃(ပုဒ်မ၁၅၊၁၆) (၃၇)မန္တလေးတိုင်းဒေသကြီးအတွင်း ပြဌာန်းထားသည့် စီမံကိန်းနှင့်သက်ဆိုင်သည့်ဥပဒေများ (၃၈)လျှပ်စစ်ဥပဒေ၂၀၁၄(ပုဒ်မ ၂၀၊၂၁(က)၊ ၂၄၊ ၂၇၊ ၂၉၊ ၃၃၊ ၄၀၊ ၆၈)၊ (လျှပ်စစ်ဓာတ်အား ထုတ်လုပ်ခြင်းမဟုတ်ဘဲ ရယူသုံးစွဲခြင်းအတွက် မိမိနှင့်သက်ဆိုင်သလို ကတိကဝတ်ဖော်ရေးရန်) (၃၉)စီမံကိန်းတွင် အသုံးပြုမည့်မြေတွင် လယ်ယာမြေပါဝင်ပါက လယ်ယာမြေဥပဒေပုဒ်မ ၃၀ ထည့်သွင်းဖော်ပြရန်၊ မြေလွတ်၊ မြေလပ်နှင့် မြေရိုင်းများပါဝင်ပါက မြေလွတ်၊မြေလပ်နှင့် မြေရိုင်းများစီမံခန့်ခွဲရေး ဥပဒေပုဒ်မ၁၀(က)၊ ၁၉(က)နှင့် ၁၉(ဃ) တို့ထည့်သွင်းဖော်ပြရန်။ (၄၀)အမြန်လမ်းမကြီးများဥပဒေ(၂၀၀၀)ပုဒ်မ ၈ (၄၁)ယာဉ်အန္တရာယ်ကင်းရှင်းရေးနှင့် မော်တော်ယာဉ်စီမံခန့်ခွဲမှု ဥပဒေ၊ ၂၀၂၀(ပုဒ်မ၉(က)၊ ၁၂(ဂ)၊ ၁၄(ဒ)၊ ၁၈(က)၊ ၈၁(ဆ)) (၄၂) “ယာဉ်အန္တရာယ်ကင်းရှင်းရေးနှင့် မော်တော်ယာဉ်စီမံခန့်ခွဲမှု ဥပဒေ၊ ၂၀၂၂”နည်းဥပဒေ ၂၅၂၊ ၂၅၃၊ ၂၅၄၊ ၂၅၆၊ ၂၆၁၊ ၂၆၂၊ ၂၆၃၊ ၂၆၉၊ ၂၇၁။ (၄၃)တိုင်းရင်းသားလူမျိုးများ၏ အခွင့်အရေးကာကွယ်စောင့်ရှောက်သည့် ဥပဒေ ၂၀၁၅ ပုဒ်မ၅ (၄၄)တိုင်းရင်းသားလူမျိုးများ၏ အခွင့်အရေးကာကွယ်စောင့်ရှောက်သည့် နည်းဥပဒေများ နည်းဥပဒေ ၂၀ နှင့်၂၁ (၄၆)Underground Water Act ပုဒ်မ ၃နှင့်၅ (၄၇)သဘာဝဘေးအန္တရာယ်ဆိုင်ရာ စီမံခန့်ခွဲမှုဥပဒေ ပုဒ်၁၄ မှ၁၈ (၄၈)The Standardization Law(2014)သက်ဆိုင်သည့်ပြဌာန်းချက်	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
(၂)	**(၂) သစ်တောဦးစီးဌာန** (က) စီမံကိန်းဧရိယာအတွင်း မြို့ပြစိမ်းလန်းစိုပြေရေး၊ နေ့အပူချိန်လျော့ချနိုင်ရေးနှင့် လေထုအရည်အသွေး ပိုမိုကောင်းမွန်မှုကို အထောက်အကူဖြစ်စေရန်အတွက် စိမ်းလန်းမြေ(Green Area)များထည့်သွင်း စိုက်ပျိုး ဖော်ဆောင်အစီအစဉ်ထည့်သွင်းပေးရန်၊ (ခ)အထူးသဖြင့်စီမံကိန်းဧရိယာအတွင်းထည့်သွင်းတည်ဆောက်မည့် ရေနုတ်မြောင်းများ၏ ကမ်းနံဘေးများ တစ်လျှောက် မြေဆီလွှာထိန်းသိမ်းနိုင်မည့် သစ်မျိုးများ ကို စနစ်တကျ အကွက်ချစိုက်ပျိုးသွားနိုင်ရေးအတွက် Landscape and Urban Forestry ကျွမ်းကျင်သူများနှင့် ညှိနှိုင်တိုင်ပင် ၍လုပ်ငန်းစီမံချက်တစ်ရပ် ရေးဆွဲ ထည့်သွင်း ပေးရန်၊	- - စိမ်းလန်းမြေ(Green Area)များထည့်သွင်း စိုက်ပျိုး ဖော်ဆောင်အစီအစဉ် နှင့်ပက်သက်၍ အခန်း(၇) အပိုဒ်ခွဲ (၇-၆) တွင်ထည့်သွင်းဖော်ပြထားပါသည်။ - ရေနုတ်မြောင်းများ၏ ကမ်းနံဘေးများ တစ်လျှောက် မြေဆီလွှာထိန်းသိမ်းနိုင်မည့် သစ်မျိုးများ ကို စနစ်တကျအကွက်ချ စိုက်ပျိုး သွားနိုင်ရေးအတွက် Landscape and Urban Forestry ကျွမ်းကျင်သူများနှင့် ညှိနှိုင်တိုင်ပင် ၍လုပ်ငန်းစီမံချက်တစ်ရပ် ရေးဆွဲခြင်း နှင့်ပက်သက်၍ အခန်း(၇) အပိုဒ်ခွဲ (၇-၆) တွင်ထည့်သွင်းဖော်ပြထားပါသည်။
	(က)စီမံကိန်းဖော်ဆောင်မည့်ဧရိယာသည် စစ်ကိုင်း Fault Lineနှင့် ဆက်စပ်လျက် ရှိသောကြောင့် ယခုတည်ဆောက်မည့် မြို့ပြအိမ်ရာ အဆောက်အဦး(Structure)များသည် ရစ်ချ်တာစကေး မည်မျှအထိ ခံနိုင်ရည်ရှိသည်ကို Public အားကြိုတင်အသိပေးထားရှိချက် ဖော်ပြပေးရန်၊	- ယခုတည်ဆောက်မည့် မြို့ပြအိမ်ရာ အဆောက် အဦး (Structure)များသည် ရစ်ချ်တာစကေး မည်မျှအထိ ခံနိုင်ရည်ရှိသည်ကို Public အား ကြိုတင် အသိပေးထားရှိချက် နှင့်ပက်သက်၍ အခန်း(၃)၊ အပိုဒ်ခွဲ (၃-၃-၁)တွင် ထည့်သွင်းဖော် ပြထားပါသည်။
(၃)	**(၃) ငါးလုပ်ငန်းဦးစီးဌာန** (က)ဧယား(၇.၄) ပတ်ဝန်းကျင်ဂေဟစနစ် စောင့်ကြပ်ထိန်းသိမ်းခြင်းအစီအစဉ်တွင် ငါးကဏ္ဍနှင့်ပတ်သက်၍ စီမံကိန်း ကနဦးအစတွင် ရာသီချိန်(၃)ချိန်အား လေ့လာသုတေသနပြုလုပ်၍	- ပတ်ဝန်းကျင်ဂေဟစနစ် စောင့်ကြပ်ထိန်းသိမ်းခြင်းအစီအစဉ်တွင် ငါးကဏ္ဍနှင့်ပတ်သက်၍ စီမံကိန်း ကနဦးအစတွင် ရာသီချိန်(၃)ချိန်အား လေ့လာသုတေသနပြုလုပ်၍ ငါးသယံဇာတတည်ရှိမှုအား စစ်တမ်းကောက် ယူခဲ့ခြင်း ဖြစ်၍ စောင့်ကြပ်စစ်ဆေးသွားရာတွင် ငါးသယံဇာတတည်ရှိမှုအစစ်အမှန်ကို ရရှိနိုင်ရေးတစ်နှစ်တွင်

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	ငါးသယံဇာတတည်ရှိမှုအား စစ်တမ်းကောက်ယူခဲ့ခြင်းဖြစ်၍ စောင့်ကြပ်စစ်ဆေးသွားရာတွင် ငါးသယံဇာတတည်ရှိမှုအစစ်အမှန်ကို ရရှိနိုင်ရေးတစ်နှစ်တွင် ရာသီချိန်(၃)ချိန်၌ လေ့လာစောင့်ကြပ်သွားရန်၊ (ခ)ငါးသယံဇာတများနှင့် ပတ်သက်၍Conservation plan အသေးစိတ်ဖော်ပြထားခြင်းမရှိ၍ ဖြည့်စွက်ဖော်ပြပေးရန်။ (ဂ)စောင့်ကြပ်သွားမည့်နေရာများအားLatitude၊ Longitude များနှင့်တကွ မြေပုံတွင် ဖော်ပြပေးရန်၊	ရာသီချိန်(၃)ချိန်၌ လေ့လာစောင့်ကြပ်သွားရန် နှင့် ပက်သက်၍ အခန်း(၇)၊ ဇယား(၇-၄)နှင့်(၇-၅)တွင် ထည့်သွင်း ဖော်ပြထားပါသည်။
	(က)ဇယား(၇.၁၀)Monitoring of Flora and Fauna Species တွင် Monitoring လုပ်မည့်နေရာCoordinate Point များဖော်ပြပေးရန်၊ ဆောင်ရွက်သွားမည့် အစီအစဉ်အသေးစိတ် ဖော်ပြပေးရန် နှင့် အပင်၊ ၄က်၊ ငါးမျိုးစိတ် အစရှိသဖြင့် ရှင်းလင်းတိကျစွာ အသေးစိတ်စောင့်ကြပ်ထိန်းသိမ်းသွားမည့် အစီအစဉ်များကို ဖော်ပြပေးသွားရန်၊	Monitoring of Flora and Fauna Species တွင် Monitoring လုပ်မည့်နေရာCoordinate Point များဖော်ပြပေးရန်၊ ဆောင်ရွက်သွားမည့် အစီအစဉ်အသေးစိတ် ဖော်ပြပေးရန် နှင့် အပင်၊ ၄က်၊ ငါးမျိုးစိတ် အစရှိသဖြင့် ရှင်းလင်းတိကျစွာ အသေးစိတ်စောင့်ကြပ်ထိန်းသိမ်းသွားမည့် အစီအစဉ်များကို အခန်း(၇)၊ ဇယား(၇-၄)နှင့်(၇-၅)တွင် ထည့်သွင်း ဖော်ပြထားပါသည်။
	(၄) စီမံကိန်းရေးဆွဲရေး ဦးစီးဌာန (က)Chapter-2 Policy,Legal and Institutional Framework အခန်းတွင် - Myanmar Engineering Council Law(2013) - Natural Disaster Management Law(2013) - The Conservation of Water Resources and Rivers Law(2017) - The Conservation of Water Resources and Improvement of River Systems Rules(2013) - Irrigation Laws(2017) - The Embankment Act (1909)	အခန်း (၂) ရှိ သက်ဆိုင်ရာ အပိုင်းများတွင် ပြင်ဆင်ဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	- Draft Guideline in Public Participation in Myanmar's EIA Processes (2017) - The Shop and Establishment Act (1951)တို့ကို ထပ်မံဖြည့်စွက်ဖော်ပြသင့်ပါသည်။ (ခ)Application of International Guidelines and Practices ကိုခေါင်းစဉ်အခွဲတစ်ခုအနေဖြင့် ဖော်ပြ၍ယင်းအောက်တွင် - The EHS Guidelines for Hazardous Materials Management,2007 - General Environmental, Health and Safety Guidelines, 2007 - The EHS Guidelines For Occupational, Health and Safety,2007 - The EHS Guidelines For Tourism and Hospitality Development,2007တို့ကို ထပ်မံဖြည့်စွက် ဖော်ပြသင့်ပါသည်။	
	(က)Objective of Project ကို ခေါင်းစဉ်ခွဲတစ်ခုအနေဖြင့်ထပ်မံဖြည့်စွက်ဖော်ပြသင့်ပါသည်။ ထို့အပြင် လုပ်ငန်းဆောင်ရွက်မည့် အဆင့်တစ်ခုချင်းအလိုက် - (1)Positive impact of construction phase - (2)Positive impact of operation phase - (3)Positive impact of decommissioning များကို ခေါင်းစဉ်တစ်ခုချင်းခွဲ၍ ယင်းခေါင်းစဉ်များအောက်တွင် Positive impact များကို အသေးစိတ်ဖော်ပြသင့်ပါသည်။ ဥပမာ- Positive impact of operation phase (1)Employment opportunities (2)Business growth In the area	Objective of Project ကို ခေါင်းစဉ်ခွဲတစ်ခုအနေဖြင့် အခန်း (၁)၊ စာပိုဒ်ခွဲ (၁.၁.၂) တွင် ဖော်ပြထားပြီး ဖြစ်ပါသည်။ လုပ်ငန်းဆောင်ရွက်မည့် အဆင့်တစ်ခုချင်းအလိုက် Positive impact များကို အခန်း (၅)၊ စာပိုဒ်ခွဲ (၅.၅) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	(3)Revenue to Union and State and Region governments အစီရင်ခံစာ၏ Environmental Management Plan (EMP)ခေါင်းစဉ်အောက်တွင် Envrionmental Auditingကို ထပ်မံထည့်သွင်းဖော်ပြရန်၊	Envrionmental Auditingကို အခန်း (၇)၊ စာပိုဒ်ခွဲ (၇-၁၀) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
	အစီရင်ခံစာတွင် စီမံကိန်းဧရိယာအတွင်း ပါဝင်နေသည့်အိမ်ထောင်စုများ၊ မြေယာနှင့် သစ်ပင် သီးနှံများ အရေအတွက်နှင့် ၎င်းတို့အတွက် ပြန်လည်နေရာချထားရေးအစီအစဉ်(Resettlement Action Plan)နှင့် လျော်ကြေး(Compensations)ပေးအပ်မည့်အစီအစဉ်များကိုပြည့်စုံစွာဖော်ပြရန်၊	Livelihood Restoration Plan ကို အခန်း (၇)၊ စာပိုဒ်ခွဲ (၇-၁၁) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
	(၅) ကုန်းလမ်းပို့ဆောင်ရေးညွှန်ကြားမှုဦးစီးဌာန City Development Project ဖြစ်၍ဌာနက ထုတ်ပြန်ထားသောလမ်းညွှန်များ၊ လမ်းအမှတ်အသားများနှင့် အချက်ပြများ၊ (၂၀၂၂ ခုနှစ်)ကို ထည့်သွင်းဖော်ပြရန်၊	အခန်း (၂) ရှိ သက်ဆိုင်ရာ အပိုင်းများတွင် ပြင်ဆင်ဖော်ပြထားပါသည်။
	- လမ်းမကြီးများဖောက်လုပ်ရာတွင် Motorcycleများအတွက် သီးသန့်လမ်းထည့်သွင်းဖောက်လုပ်သင့်/မသင့်ကို တိုင်းဒေသကြီးအစိုးရ၊ စည်ပင်သာယာအဖွဲ့များနှင့်ဆွေးနွေး၍ဖြစ်နိုင်ပါက ထည့်သွင်းရန် အကြံပြုအပ်ပါသည်။ Traffic Management Plan ကို ပို၍ပြည့်စုံစွာဖော်ပြသင့်ပါသည်။ - Operation ကာလ၌Peoject တွင် အသုံးပြုမည့် ယာဉ်စီးရေအရ ယာဉ်ကြောကြပ်တည်းမှုမရှိစေရေး မည်သည့်လမ်းများမှ	- လမ်းမကြီးများဖောက်လုပ်ရာတွင် Motorcycleများအတွက် သီးသန့်လမ်းထည့်သွင်းဖောက်လုပ်သင့်/မသင့်ကို တိုင်းဒေသကြီးအစိုးရ၊ စည်ပင်သာယာအဖွဲ့ များနှင့်ဆွေးနွေး၍ဖြစ်နိုင်ပါက ထည့်သွင်းရန် နှင့် ပက်သက်၍ အခန်း(၃)၊ အပိုဒ်ခွဲ (၃-၇)တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ - Traffic Management Plan နှင့်ပက်သက်၍ အခန်း(၇)၊ အပိုဒ်ခွဲ (၇-၄-၇)တွင်ထည့်သွင်း ဖော်ပြ ထားပါသည်။ - Operation ကာလ၌Project တွင် အသုံးပြုမည့် ယာဉ်စီးရေအရ ယာဉ်ကြောကြပ်တည်းမှုမရှိစေရေး နှင့် ပက်သက်၍ အခန်း(၃)၊ အပိုဒ်ခွဲ (၃-

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	သွားလာအသုံးပြုမည် စသည်ဖြင့် ဖော်ပြရန်၊ City Development Project ဖြစ်၍ တည်ဆောက်ရေးလုပ်ငန်းတွင် အသုံးပြုလာမည့် ယာဉ်စီးရေ၊ အသုံးပြုမည့် လောင်စာဆီပမာဏကို တွက်ချက်ဖော်ပြရန်၊	၇)တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ - City Development Project ဖြစ်၍ တည်ဆောက် ရေးလုပ်ငန်းတွင် အသုံးပြုလာမည့် ယာဉ်စီးရေ နှင့်ပက်သက်၍ အခန်း(၃)၊ အပိုဒ်(၃-၅-၂) ၊ ဇယား (၃-၁၄ မှ ၃-၁၉) တွင် ဖော်ပြထားပါသည်။
	လုပ်ငန်းခွင်အတွင်းရှိ ယာဉ်မောင်းသူများအား လုပ်ငန်းခွင်နှင့် မြို့အနီးတဝိုက် အန္တရာယ် ကင်းစွာ သွားလာနိုင်ရန်အတွက် ကြီးကြပ်ထိန်းကြောင်းခြင်း၊ အပတ်စဉ်၊ လစဉ် စသည်ဖြင့် အသိပညာပေး၊ သတိပြုရန်အချက်များမှာကြာခြင်းစသည့်အစီအစဉ်များလည်း ထည့်သွင်းဖော်ပြရန်၊	- လုပ်ငန်းခွင်အတွင်းရှိ ယာဉ်မောင်းသူများအား လုပ်ငန်းခွင်နှင့် မြို့အနီးတဝိုက် အန္တရာယ် ကင်းစွာ သွားလာနိုင်ရန်အတွက် ကြီးကြပ်ထိန်းကြောင်းခြင်း၊ အပတ်စဉ်၊ လစဉ် စသည်ဖြင့် အသိပညာပေး၊ သတိပြုရန်အချက်များမှာကြာခြင်းစသည့်အစီအစဉ်များ နှင့်ပက်သက်၍ အခန်း(၇)၊ အပိုဒ်ခွဲ(၇-၅-၁)၊ဇယား ၇-၁၃ တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
(၆)	**(၆) ဟိုတယ် နှင့် ခရီးသွားည့ွန်ကြားမှု ဦးစီးဌာန** စီမံကိန်းနှင့်သက်ဆိုင်သည့်ဥပဒေများကို လိုက်နာဆောင်ရွက်မည်ဖြစ်ကြောင်းပုဒ်မများကို ညွှန်း၍ ဇယားဖြင့် ဖော်ပြပေးရန်၊ အခန်း ၂၊ ဇယား ၂-၁၊ အမှတ်စဉ် ၃၇ နှင့်၃၈ တို့ပါနိုင်ငံသားရင်းနှီးမြှုပ်နှံမှု ဥပဒေနှင့် နိုင်ငံခြားသားရင်းနှီးမြှုပ်နှံမှု ဥပဒေများကို မြန်မာနိုင်ငံ ရင်းနှီးမြှုပ်နှံမှုဥပဒေ(၂၀၁၆) ဖြင့် ရုပ်သိမ်းပြီးဖြစ်ပါသဖြင့် ထည့်သွင်းဖော်ပြခြင်း မပြုရန်၊	စီမံကိန်းနှင့်သက်ဆိုင်သည့်ဥပဒေများကို လိုက်နာဆောင်ရွက်မည်ဖြစ်ကြောင်းပုဒ်မများကို ညွှန်း၍ ဇယားဖြင့် အခန်း (၂)၊ အပိုဒ်ခွဲ(၂-၉)တွင် ပြင်ဆင်ဖော်ပြထားပါသည်။ အခန်း (၂)၊ တွင် ပြင်ဆင်ဖော်ပြထားပါသည်။
(၇)	**(၇) တိုင်းရင်းသားအခွင့်အရေး ကာကွယ် စောင့် ရှောက်ရေး ဦးစီးဌာန** တိုင်းရင်းသားလူမျိုးများ၏ အခွင့်အရေး ကာကွယ်စောင့်ရှောက်သည့်	အခန်း (၂)၊ ရှိ သက်ဆိုင်ရာ အပိုင်းများတွင် ပြင်ဆင်ဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	နည်းဥပဒေများ(၂၀၁၉)၊ The Ethic Rights Protection Rules (2019)ကိုလည်း ထည့်သွင်းဖော်ပြရန်၊ - ဥပဒေပါပုဒ်မများကို ရေးသားဖော်ပြရာတွင် Articles ဟု မသုံးဘဲSection ဟုသာ ရေးသားဖော်ပြရပါမည်။ Articles 22 သည် ထည့်သွင်းဖော်ပြရန်၊ - စီမံကိန်းအဆိုပြုသူသည် တိုင်းရင်းသားလူမျိုးများ၏ အခွင့်အရေးကာကွယ် စောင့်ရှောက်သည့် ဥပဒေပုဒ်မ ၅ (The Ethnic Rights Protection Law (2015) Section 5)နှင့် နည်းဥပဒေများပါ နည်းဥပဒေ ၂၀ နှင့်၂၁(The Ethnic Rights Protection Rules (2019) Rule 20 and 21 တို့နှင့်အညီ လိုက်နာဆောင်ရွက်ရန်၊ - တိုင်းရင်းသားလူမျိုးများကာကွယ်စောင့်ရှောက်သည့် ဥပဒေ၊နည်းဥပဒေများကို ပြဋ္ဌာန်းချက်များအား လေးစားလိုက်နာမည်ဖြစ်ကြောင်း ကတိကဝတ်ကို ဥပဒေရေးရာဝန်ကြီးဌာန၏ အကြံပြုချက်နှင့်အညီ ရေးသားဖော်ပြရန်၊	
	ဒေသခံတိုင်းရင်းသားများအား ဖော်ပြရာတွင် ဥပဒေပြဋ္ဌာန်းချက်နှင့် အညီ Ethnic Groups/Ethnic People ဟုသာဖော်ပြရန်၊	IFC ၏ တရားဝင်ထုတ်ပြန်ထားသော ကြေငြာချက် ဖြစ်၍ ပြောင်းလဲ ဖော်ပြ၍ မရနိုင်ပါ။
	- မြေဧရိယာဝယ်ယူမှုများနှင့်စပ်လျဉ်းသည့် အချက်များအား ပြည့်စုံရှင်းလင်းစွာ ထည့်သွင်းဖော်ပြရန်၊	- မြေဧရိယာဝယ်ယူမှုများနှင့်စပ်လျဉ်းသည့် အချက် များအား ပြည့်စုံရှင်းလင်းစွာ ထည့်သွင်းဖော်ပြရန် နှင့် ပက်သက်၍ အခန်း(၃)၊ အပိုဒ်ခွဲ (၃-၄-၂-၁)တွင် ထည့်သွင်းဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	- ရှမ်းကလေးကျွန်းကျေးရွာဒေသခံများ၏ အကြံပြုစာများအပေါ် ဆောင်ရွက်ပြီးစီးမှု အခြေအနေတို့ကို ထည့်သွင်းဖော်ပြရန်၊	- ရှမ်းကလေးကျွန်းကျေးရွာဒေသခံများ၏ အကြံပြုစာများအပေါ် ဆောင်ရွက်ပြီးစီးမှု အခြေအနေတို့ကို အခန်း(၆)၊ အပိုဒ်ခွဲ (၆-၆-၄)တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
	(၈) ရင်းနှီးမြှုပ်နှံမှုနှင့် ကုမ္ပဏီများ ညွှန်ကြားမှု ဦးစီးဌာန လိုက်နာဆောင်ရွက်မည့် ဥပဒေများ အမှတ်စဉ် (၃၇)(၃၈)(၃၉) တို့မှာ မလိုအပ်သဖြင့် ပယ်ဖျက်ရန်၊ - မြေဧရိယာ ၂၅၀၀ ဧက (ကိုင်းမြေ၊ မြေနုမြေ) အမျိုးအစားကို အခြားနည်းအသုံးပြုခွင့် တင်ပြထားခြင်း မရှိသည့်အပေါ် အခြားနည်းအသုံးပြုခွင့်နှင့် မန္တလေးတိုင်းဒေသကြီးအစိုးရအဖွဲ့မှ ခွင့်ပြုမည့် မြေဂရန်ရရှိပါက ကော်မရှင်သို့ ပြန်လည်တင်ပြရန်၊ - စီမံကိန်း၏ Infrastructure အား ဧရိယာ ၂၅% အစား ၃၀% အဖြစ် တိုးမြှင့်သတ်မှတ်ဆောင်ရွက်ရန်၊ - ဝန်ထမ်းအင်အားနှင့်ပတ်သက်၍ စီမံကိန်းတင်ပြစဉ်က ပြည်တွင်း- ၂၇၆ ဦး၊ ပြည်ပ-၃၀ ဦး (Consultant & Advisor) အစား ပြောင်းလဲခန့်အပ်ထားသည့် ဝန်ထမ်းအင်အားနှင့်ပတ်သက်၍ ကော်မရှင်သို့ တင်ပြရန်၊ ဝန်ထမ်း၏ အခြေခံလစာကိုပါ ယနေ့ကာလနှင့်အညီ	အခန်း (၂)၏ သက်ဆိုင်ရာ အပိုင်း တွင် ပြင်ဆင်ဖော်ပြထားပါသည်။ တင်ပြပါမည်။ အစီရင်ခံစာတွင် ထည့်သွင်းဖော်ပြထားခြင်း မရှိပါ။ ပြင်ဆင်ပါမည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	ပြင်ဆင်ပေးချေရန်၊ - မတည်ငွေရင်းပမာဏ၏ ၂၀.၅၅% ဖြစ်သော ချေးငွေ ကျပ် ၂၆၈၂၃၂.၉ သန်းကို ပြည်တွင်းဘဏ်များမှ ချေးယူမည်ဖြစ်ပြီး တည်ဆောက်ရေးကာလ ၅ နှစ်အတွင်းတွင် အတိုးနှုန်း ၁၃ % ဖြင့် ပြန်လည်ပေးဆပ်မည်ဖြစ်ကြောင်း တင်ပြချက်နှင့်စပ်လျဉ်း၍ ချေးငွေ ပြန်လည်ပေးဆပ်မှုအခြေအနေကို ကော်မရှင်သို့ ပြန်လည်တင်ပြရန်၊	အစီရင်ခံစာတွင် ထည့်သွင်းဖော်ပြထားခြင်း မရှိပါ။
	(၉)ပတ်ဝန်းကျင်အရည်အသွေးနှင့် စံချိန်စံညွှန်းဌာန၊ ပတ်ဝန်းကျင်ထိန်းသိမ်းရေး ဦးစီးဌာန - မြေပေါ်ရေအရည်အသွေးများအား တိုင်းတာမှုနှင့်ပတ်သတ်ပြီး စီမံကိန်းမှ လိုက်နာဆောင်ရွက်မည့် နိုင်ငံတကာမှ မြေပေါ်ရေ အရည်အသွေးစံချိန်စံညွှန်း (Surface Water Quality Standard)၏ Parameter များကို တိုင်းတာစစ်ဆေးရန်နှင့် တိုင်းတာစစ်ဆေးသည့် ရလဒ်များကို အဆိုပါစံချိန်စံညွှန်းများဖြင့် နှိုင်းယှဉ်ပြီး ပြင်ဆင်ဖော်ပြရန်၊ - တိုင်းတာရရှိသည့် မြေပေါ်ရေအရည်အသွေးရလဒ်များသည် သတ်မှတ်စံချိန်စံညွှန်းများထက် ကျော်လွန်မှုရှိပါက ကျော်လွန်ရ သည့် အကြောင်းအရင်း၊ ဖြစ်နိုင်သည့် အကြောင်းအရင်းများကို	မြေပေါ်ရေအရည်အသွေးများအား တိုင်းတာမှုနှင့်ပတ်သတ်ပြီး စီမံကိန်းမှ လိုက်နာဆောင်ရွက်မည့် နိုင်ငံတကာမှ မြေပေါ်ရေ အရည်အသွေးစံချိန်စံညွှန်း (Surface Water Quality Standard)၏ Parameter များကို တိုင်းတာစစ်ဆေးပြီး တိုင်းတာစစ်ဆေးသည့် ရလဒ်များကို အဆိုပါစံချိန်စံညွှန်းများဖြင့် နှိုင်းယှဉ်ပြီး အခန်း (၄)၊ စာပိုဒ်ခွဲ (၄-.၇.၁၃ နှင့် ၄-၇-၁၄) တွင် ပြင်ဆင်ဖော်ပြထားပါသည်။ တိုင်းတာရရှိသည့် မြေပေါ်ရေအရည်အသွေးရလဒ်များသည် သတ်မှတ်စံချိန်စံညွှန်းများထက် ကျော်လွန်မှုရှိပါက ကျော်လွန်ရ သည့် အကြောင်းအရင်း၊ ဖြစ်နိုင်သည့် အကြောင်းအရင်းများကို အခန်း (၄)၊ စာပိုဒ်ခွဲ (၄-

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	ပြည့်စုံစွာထည့်သွင်းဖော်ပြရန်၊	.၇.၁၃.၂ နှင့် ၄-၇-၁၄.၃) တွင် ပြင်ဆင်ဖော်ပြထားပါသည်။
	- မြေအောက်ရေအရည်အသွေးအား တိုင်းတာမှုနှင့် ပတ်သတ်ပြီး တိုင်းတာသည့် Parameter များသည် ကျန်းမာရေးဝန်ကြီးဌာနမှ ထုတ်ပြန်ထားသော သောက်သုံး ရေ အရည်အသွေးစံချိန်စံညွှန်း (Drinking Water Quality Standard) ၏Parameterများကိုတိုင်းတာစစ်ဆေးရန် နှင့် တိုင်းတာစစ်ဆေးသည့်ရလဒ်များကို အဆိုပါ စံချိန်စံညွှန်းများဖြင့် နှိုင်းယှဉ်ပြီး ပြင်ဆင်ဖော်ပြရန်၊	- မြေအောက်ရေအရည်အသွေးအား တိုင်းတာမှုနှင့် ပတ်သတ်ပြီး တိုင်းတာသည့် Parameter များသည် ကျန်းမာရေးဝန်ကြီးဌာနမှ ထုတ်ပြန်ထားသော သောက်သုံး ရေ အရည်အသွေးစံချိန်စံညွှန်း - (Drinking Water Quality Standard) ၏Parameterများကိုတိုင်းတာစစ်ဆေးပြီး တိုင်းတာစစ်ဆေးသည့်ရလဒ်များကို အဆိုပါ စံချိန်စံညွှန်းများဖြင့် နှိုင်းယှဉ်ပြီး အခန်း (၄)၊ စာပိုဒ်ခွဲ (၄-.၇.၁၃ နှင့် ၄-၇-၁၄) တွင် ပြင်ဆင်ဖော်ပြထားပါသည်။
	- မြေပေါ်ရေအရည်အသွေးအား စောင့်ကြည့်တိုင်းတာခြင်းနှင့်ပတ်သက်ပြီး စီမံကိန်းဘေး (၁) နေရာတွင် တိုင်းတာသည့် Sampling Point သည် စီမံကိန်းမှ စွန့်ပစ်ရေ စွန့်ထုတ်သည့်နေရာတွင် တိုင်းတာစစ်ဆေးရန်၊ - မြေပေါ်ရေအရည်အသွေးအား တိုင်းတာမှုနှင့် ပတ်သက်ပြီး စီမံကိန်းမှ လိုက်နာဆောင်ရွက်မည့် နိုင်ငံတကာမှ မြေပေါ်ရေအရည်အသွေး စံချိန်စံညွှန်း(Surface Water Quality Standard) ၏Parameter များဖြင့် ပြင်ဆင်ဖော်ပြရန်၊ - မြေပေါ်ရေအရည်အသွေးအား တိုင်းတာမှုကို Operation Phase တွင် လည်း တိုင်းတာစစ်ဆေးမည်ဖြစ်ပါကြောင်း ထည့်သွင်းဖော်ပြရန်၊	- (၁) နေရာတွင် တိုင်းတာသည့် Sampling Point သည် စီမံကိန်းမှ စွန့်ပစ်ရေ စွန့်ထုတ်သည့် နေရာ တွင် တိုင်းတာစစ်ဆေးရန် နှင့် ပက်သက်၍ အခန်း(၇)၊ အပိုဒ်ခွဲ(၇-၄)နှင့် (၇-၅)တွင် ထည့်သွင်း ဖော်ပြထားပါသည်၊ - နိုင်ငံတကာမှ မြေပေါ်ရေအရည်အသွေး စံချိန်စံညွှန်း(Surface Water Quality Standard) ၏Parameter များဖြင့် ပြင်ဆင်ဖော်ပြရန် နှင့် ပက်သက်၍ အခန်း(၇)၊ အပိုဒ်ခွဲ(၇-၄)နှင့် (၇-၅)တွင် ထည့်သွင်း ဖော်ပြထားပါသည်၊ - မြေပေါ်ရေအရည်အသွေးအား တိုင်းတာမှုကို Operation Phase တွင် လည်း တိုင်းတာစစ်ဆေးမည်ဖြစ်ပါကြောင်း ထည့်သွင်းဖော်ပြရန် နှင့် ပက်သက်၍ အခန်း(၇)၊ အပိုဒ်ခွဲ(၇-၅)တွင် ထည့်သွင်း ဖော်ပြထားပါသည်၊ -

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	- စွန့်ပစ်ရေအရည်အသွေးအား တိုင်းတာမှုနှင့်ပတ်သတ်ပြီး မသန့်စင်မီ စွန့်ပစ်ရေအရည်အသွေးကိုလည်း တိုင်းတာစစ်ဆေးမည် ဖြစ်ပါကြောင်း ထည့်သွင်းဖော်ပြရန်၊	- Onsite wastewater system ဖြစ်၍ စွန့်ပစ်ရေကို အဆောက်အဦအောက်ရှိ drain လိုင်းမှ တဆင့်သန့်စင်ပြီး ရေထုတ်ပေါက် ၁၁ ခုမှ စွန့်ပစ်မည် ဖြစ်သောကြောင့် မသန့်စင်မီနေရာမှာ တိုင်းတာ၍ မရနိုင်ပါ။
	- ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာ လုပ်ထုံးလုပ်နည်း အပိုဒ် ၁၀၈နှင့်အညီ စောင့်ကြပ်ကြည့်ရှုမှု အစီရင်ခံစာကို (၆)လလျှင် (၁)ကြိမ် ပုံမှန်အစီရင်ခံတင်ပြမည် ဖြစ်ပါကြောင်း ထည့်သွင်း ဖော်ပြရန်၊	- ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာ လုပ်ထုံးလုပ်နည်း အပိုဒ် ၁၀၈နှင့်အညီ စောင့်ကြပ်ကြည့်ရှုမှု အစီရင်ခံစာကို (၆)လလျှင် (၁)ကြိမ် ပုံမှန်အစီရင်ခံတင်ပြမည် ဖြစ်ပါကြောင်း ထည့်သွင်း ဖော်ပြရန် နှင့် ပက်သက်၍ အခန်း (၇)၊ အပိုဒ်ခွဲ (၇.၃.၂) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။
	(၁၀) မူဝါဒနှင့် ဥပဒေရေးရာဌာန၊ ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဦးစီးဌာန မူဝါဒ၊ ဥပဒေနှင့် အဖွဲ့အစည်းဆိုင်ရာမူဘောင်အခန်းတွင် အောက်ပါတို့ကို ပြင်ဆင်ဖြည့်စွက် ရေးသားပေးရန် လိုအပ်ပါသည်- (၁) “တိရစ္ဆာန်ကျန်းမာရေးနှင့် မွေးမြူရေးလုပ်ငန်း ဖွံ့ဖြိုး တိုးတက်ရေး ဥပဒေ၊ ၁၉၉၃(၂၀၁၀တွင် ပြင်ဆင်ပြီး)”ဟု ဖော်ပြထားပါသဖြင့် “တိရစ္ဆာန်ကျန်းမာရေးနှင့်မွေးမြူရေး လုပ်ငန်း ဖွံ့ဖြိုးတိုးတက်ရေး ဥပဒေ၊ ၁၉၉၃ (ပြင်ဆင် ၂၀၂၀)”ဟု ပြန်လည်ပြင်ဆင် ဖော်ပြရန်၊ (၂) “တောရိုင်းတိရစ္ဆာန်နှင့် သဘာဝနယ်မြေများ ကာကွယ်ထိန်းသိမ်းရေး ဥပဒေ၊ ၁၉၉၄"သည် ရုတ်သိမ်းပြီး ဖြစ်ပါ၍ ဖော်ပြရန်၊ (၃) “ရေအရင်းအမြစ်နှင့် မြစ်ချောင်းများ ထိန်းသိမ်းရေး ဥပဒေ၊ ၂၀၁၆” ဟု ဖော်ပြထားသဖြင့် “ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများထိန်းသိမ်းရေး ဥပဒေ၊	အခန်း (၂)၊ ၏ သက်ဆိုင်ရာ အပိုင်းများတွင် ပြင်ဆင်ဖော်ပြထားပါသည်။ -

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	၂၀၀၆ (ပြင်ဆင် ၂၀၁၇)" ဟု ပြန်လည်ပြင်ဆင် ဖော်ပြရန်၊ (၄) "ယဉ်ကျေးမှုအမွေအနှစ်ဒေသများ ကာကွယ်ထိန်းသိမ်းရေး ဥပဒေ၊ ၁၉၉၈ (၂၀၀၉ တွင် ပြင်ဆင်ပြီး)" ဟု ဖော်ပြထားပါသဖြင့် “ယဉ်ကျေးမှုအမွေအနှစ်ဒေသများ ကာကွယ်ထိန်းသိမ်းရေး ဥပဒေ၊ ၁၉၉၈ (ပြင်ဆင် ၂၀၁၉)" ဟု ပြန်လည်ပြင်ဆင်ဖော်ပြရန်၊ (၅) "မြေလွတ်၊ မြေလပ်နှင့် မြေရိုင်းများ စီမံခန့်ခွဲရေး ဥပဒေ၊ ၂၀၁၂” ဟု ဖော်ပြထားပါသဖြင့် “မြေလွတ်၊ မြေလပ်နှင့် မြေရိုင်းများ စီမံခန့်ခွဲ ရေး ဥပဒေ၊ ၂၀၁၂ (ပြင်ဆင်၂၀၁၈)" ဟု ပြန်လည်ပြင်ဆင်ဖော်ပြ ရန်၊ (၆) “မန္တလေးမြို့တော် စည်ပင်သာယာရေး ဥပဒေ၊ ၂၀၀၂" ဟု ဖော်ပြထား ပါသဖြင့် “မန္တလေးမြို့တော် စည်ပင်သာယာရေးဥပဒေ၊ ၂၀၀၂ (ပြင်ဆင် ၂၀၁၆)" ဟု ပြန်လည်ပြင်ဆင်ဖော်ပြရန်၊ (၇) အစီရင်ခံစာတွင် အင်္ဂလိပ်ဘာသာဖြင့် ဖော်ပြသည့် ဥပဒေများကို သက်ဆိုင်ရာဌာနတွင်တရားဝင်သုံးနှုန်းထားသည့်အတိုင်း အမည်မှန်များကိုပြင်ဆင်ဖော်ပြရန်၊ (ဥပမာ- The Law on the Protection of the Rights of Ethnic Peoples) (၈) "သိပ္ပံနှင့် နည်းပညာဖွံ့ဖြိုးရေးဥပဒေ၊ ၁၉၉၄" သည် ရုတ်သိမ်းပြီး ဖြစ်ပါသဖြင့် “သိပ္ပံ၊ နည်းပညာနှင့် ဆန်းသစ်တီထွင်မှု ဥပဒေ၊ ၂၀၁၈"ဟု ပြန်လည်ပြင်ဆင် ဖော်ပြသင့်ပါကြောင်း၊	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	(၉) “ဓာတုပစ္စည်းနှင့် ဆက်စပ်ပစ္စည်းများ အန္တရာယ်မှ တားဆီး ကာကွယ်ရေးနည်းဥပဒေ၊ ၂၀၁၃" ဟု ဖော်ပြထားပါသဖြင့် “ဓာတု ပစ္စည်းနှင့် ဆက်စပ်ပစ္စည်းများ အန္တရာယ်မှတားဆီး ကာကွယ်ရေး နည်းဥပဒေ၊ ၂၀၁၆"ဟု ပြန်လည်ပြင်ဆင် ဖော်ပြသင့်ပါကြောင်း၊ (၁၀) “အလုပ်ရုံများ ဥပဒေ၊ ၁၉၅၁” ဟု ဖော်ပြထားပါသဖြင့် “အလုပ်ရုံများ ဥပဒေ၊ ၁၉၅၁ (ပြင်ဆင် ၂၀၁၆)” ဟု ပြန်လည် ပြင်ဆင်ဖော်ပြ သင့်ပါကြောင်း၊ (၁၁) “မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှု ဥပဒေ၊ ၂၀၁၆” ဟု ဖော်ပြထားပါသဖြင့် “မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှု ဥပဒေ၊ ၂၀၁၆ (ပြင်ဆင် ၂၀၁၉)” ဟု ပြန်လည်ပြင်ဆင်ဖော်ပြသင့်ပါကြောင်း၊ (၁၂) "ဝင်ငွေခွန် ဥပဒေ၊ ၁၉၇၄ (၂၀၁၁တွင် ပြင်ဆင်ပြီး)"ဟု ဖော်ပြ ထားပါသဖြင့် “ဝင်ငွေခွန်ဥပဒေ၊ ၁၉၇၄ (ပြင်ဆင် ၂၀၁၆)"ဟု ပြန်လည်ပြင်ဆင် ဖော်ပြသင့်ပါကြောင်း၊ (၁၃) “ပြည်ထောင်စု၏ အခွန်ကောက်ဥပဒေ၊ ၂၀၁၈-၂၀၁၉" ဟု ဖော်ပြ ထားပါသဖြင့် “ပြည်ထောင်စု၏ အခွန်ကောက် ဥပဒေ၊ ၂၀၂၂"ဟု ပြန်လည်ပြင်ဆင်ဖော်ပြသင့်ပါကြောင်း၊ (၁၄) “လူမှုဖူလုံရေး ဥပဒေ၊ ၂၀၁၂" ဟု ဖော်ပြထားပါသဖြင့် “လူမှု ဖူလုံရေးဥပဒေ၊ ၂၀၁၂ (ပြင်ဆင် ၂၀၁၄)" ဟု ပြန်လည် ပြင်ဆင်	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	ဖော်ပြသင့်ပါကြောင်း၊ (၁၅) “အနည်းဆုံးအခကြေးငွေ နည်းဥပဒေ၊ ၂၀၁၃" ဟု ဖော်ပြထားပါ သဖြင့် “အနည်းဆုံးအခကြေးငွေနည်းဥပဒေ၊ ၂၀၁၃ (ပြင်ဆင်၂၀၁၅)" ဟု ပြန်လည်ပြင်ဆင်ဖော်ပြသင့်ပါကြောင်း၊ (၁၆) “အလုပ်သမားအဖွဲ့အစည်းဥပဒေ၊ ၂၀၁၁” ဟု ဖော်ပြထားပါသဖြင့် “အလုပ်သမားအဖွဲ့အစည်းဥပဒေ၊၂၀၁၁ (ပြင်ဆင် ၂၀၁၂) " ဟု ပြန်လည်ပြင်ဆင်ဖော်ပြသင့်ပါကြောင်း၊ (၁၇) “အလုပ်သမားရေးရာ အငြင်းပွားမှုဖြေရှင်းရေးဥပဒေ၊ ၂၀၁၂" ဟု ဖော်ပြ ထားပါသဖြင့် “အလုပ်သမားရေးရာ အငြင်းပွားမှုဖြေရှင်းရေးဥပဒေ၊ ၂၀၁၂(ပြင်ဆင် ၂၀၁၉)"ဟု ပြန်လည်ပြင်ဆင်ဖော်ပြသင့်ပါကြောင်း၊ (၁၈) “တိုင်းရင်းဆေးဝါးဥပဒေ၊ ၂၀၁၄” ဟု ဖော်ပြထားပါသဖြင့် “တိုင်းရင်း ဆေးဝါးဥပဒေကို ပြင်ဆင်သည့် ဥပဒေ ၂၀၁၄” ဟု ပြန်လည် ပြင်ဆင်ဖော်ပြသင့်ပါကြောင်း၊ (၁၉) “ဘက်စုံပို့ဆောင်ရေးဥပဒေ၊ ၂၀၁၄” ဟု ဖော်ပြထားပါ သဖြင့် “ဘက်စုံပို့ဆောင်ရေးဥပဒေ၊ ၂၀၁၅” ဟု ပြန်လည် ပြင်ဆင် ဖော်ပြသင့်ပါကြောင်း၊	

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	(၂၀) စီမံကိန်းအမျိုးအစားနှင့် သက်ဆိုင်ခြင်းမရှိသည့် ဥပဒေများကို ထည့်သွင်းဖော်ပြခြင်း မပြုသင့်ပါကြောင်း၊	
(ည)	အထွေထွေ	
	- အဆိုပြုစီမံကိန်းအတွက် Livelihood Restoration Plan အား ရေးဆွဲတင်ပြရန်၊ - - ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာလုပ်ထုံးလုပ်နည်း၊ အပိုဒ် (၁၀၈) အရ စောင့်ကြပ်ကြည့်ရှုမှုအစီရင်ခံစာကို ဝန်ကြီးဌာန သို့ (၆) လတစ်ကြိမ်တင်ပြမည်ဖြစ်ကြောင်း ဖော်ပြရန်၊ - အစီရင်ခံစာပြန်လည်တင်ပြရာတွင် ပြန်ကြားခဲ့သည့်သဘောထားများအပေါ် အစီရင်ခံစာတွင် ပြင်ဆင်ထည့်သွင်း ဆောင်ရွက်ခြင်းအပြင် ပြင်ဆင်ဆောင်ရွက်မှုအကျဉ်းကို (၁) သဘောထားမှတ်ချက်၊ (၂) ပြန်လည်ဖြည့်စွက်ထည့်သွင်းချက်အကျဉ်း၊ (၃) မှတ်ချက် စသည့် ဇယားဖြင့်အကျဉ်းချုပ်ကို ထည့်သွင်းဖော်ပြရန်၊ - ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာလုပ်ထုံးလုပ်နည်း၊ အပိုဒ်(၁၀၂)အရ အဆိုပြုစီမံကိန်းကြောင့် အသက်မွေးဝမ်းကြောင်းလုပ်ငန်းများနှင့် ပြန်လည်ထူထောင်ရေးလုပ်ငန်းများ ဆောင်ရွက်ရန်၊	- အဆိုပြုစီမံကိန်းအတွက် Livelihood Restoration Plan အားအခန်း (၇)၊ အပိုဒ်ခွဲ (၇.၁၁) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ - ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာလုပ်ထုံးလုပ်နည်း၊ အပိုဒ် (၁၀၈) အရ စောင့်ကြပ်ကြည့်ရှုမှုအစီရင်ခံစာကို ဝန်ကြီးဌာန သို့ (၆) လတစ်ကြိမ်တင်ပြမည်ဖြစ်ကြောင်း အခန်း (၇)၊ အပိုဒ်ခွဲ (၇.၃.၂) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ - အစီရင်ခံစာပြန်လည်တင်ပြရာတွင် ပြန်ကြားခဲ့သည့်သဘောထားများအပေါ် အစီရင်ခံစာတွင် ပြင်ဆင်ထည့်သွင်း ဆောင်ရွက်ခြင်းအပြင် ပြင်ဆင်ဆောင်ရွက်မှု ဇယားဖြင့်အကျဉ်းချုပ်ကို အခန်း (၉) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။ - အဆိုပြုစီမံကိန်းကြောင့် အသက်မွေးဝမ်းကြောင်းလုပ်ငန်းများနှင့် ပြန်လည်ထူထောင်ရေးလုပ်ငန်းများ ဆောင်ရွက်ခြင်းအား Livelihood Restoration Plan အားအခန်း (၇)၊ အပိုဒ်ခွဲ (၇.၁၁) တွင် ထည့်သွင်းဖော်ပြထားပါသည်။

စဉ်	အကြံပြုချက်	ပြင်ဆင်ဖော်ပြချက်
	- အဆိုပြုစီမံကိန်းနှင့်ပတ်သက်သည့် ပတ်ဝန်းကျင်ဆန်းစစ်ခြင်းအစီရင်ခံစာကို စီမံကိန်း အဆိုပြုသူ၏ ဝက်ဘ်ဆိုဒ် သို့မဟုတ် Online Media များတွင် လွှင့်တင်သွားရန်နှင့် လွှင့်တင်ပြီးပါက အဆိုပါဝက်ဘ်ဆိုဒ်သို့ ဝင်ရောက်ကြည့်ရှုနိုင်သည့် Link တင်ပြရန်။	- အဆိုပြုစီမံကိန်းနှင့်ပတ်သက်သည့် ပတ်ဝန်းကျင်ဆန်းစစ်ခြင်းအစီရင်ခံစာကို စီမံကိန်း အဆိုပြုသူ၏ ဝက်ဘ်ဆိုဒ်တွင် တင်ပြထားခြင်းအား အခန်း (၆)၊ အပိုဒ်ခွဲ (၆.၇) တွင် ဖော်ပြထားပါသည်။

Mandalay Business Capital City Development Ltd. မှ အကောင်အထည်ဖော် ဆောင်ရွက်မည့် အမရပူရမြို့ပြဖွံ့ဖြိုးရေး စီမံကိန်း၏ ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း (Environmental Impact Assessment – EIA) အစီရင်ခံစာတွင် လိုအပ်သည့်အချက်များပြင်ဆင်ဖော်ပြခြင်း

စဉ်	ပြင်ဆင်ရမည့် အချက်များ	ပြင်ဆင်ဖော်ပြချက်
(၁)	ယူနက်စကိုမှ အတည်ပြုသတ်မှတ်ထားသည့် ယဉ်ကျေးမှုအမွေအနှစ် မရှိဟု ရေးသားခြင်းမပြုဘဲ သာသနာရေးနှင့်ယဉ်ကျေးမှုဝန်ကြီးဌာနက ထုတ်ပြန်ထားသော ဥပဒေများဖြင့် အတည်ပြု သတ်မှတ် ထားသည့် ရှေးဟောင်းအဆောက်အအုံများ၊ ရှေးဟောင်းနေရာဒေသများမရှိဟု စာသားများ ပြောင်းလဲ ရေးသားရန်၊	- ယူနက်စကိုမှ အတည်ပြုသတ်မှတ်ထားသည့် ယဉ်ကျေးမှုအမွေအနှစ် မရှိဟု ရေးသားခြင်းမပြုဘဲ သာသနာရေးနှင့်ယဉ်ကျေးမှုဝန်ကြီးဌာနက ထုတ်ပြန်ထားသော ဥပဒေများဖြင့် အတည်ပြု သတ်မှတ် ထားသည့် ရှေးဟောင်းအဆောက်အအုံများ၊ ရှေးဟောင်းနေရာဒေသများမရှိဟု စာသားများ ပြောင်းလဲ၍ အခန်း (၄)၊ အပိုဒ်ခွဲ (၄.၉.၃.၁) တွင် ပြင်ဆင်ဖော်ပြထားပါသည်။
(၂)	The Protection and Preservation of Cultural Heritage Regions Law (1998) အားပြင်ဆင်ထားသည့် (2019) တွင်ထွက်ရှိသော တည်ဆဲ ဥပဒေကိုသာ ရေးရန်၊	- The Protection and Preservation of Cultural Heritage Regions Law (1998) အားပြင်ဆင်ထားသည့် (2019) တွင်ထွက်ရှိသော တည်ဆဲ ဥပဒေကိုသာ အစီရင်ခံစတွင် ရေးသားထားခြင်းဖြစ်ပါသည်။

စဉ်	ပြင်ဆင်ရမည့် အချက်များ	ပြင်ဆင်ဖော်ပြချက်
(၃)	ယဉ်ကျေးမှုအမွေအနှစ်ဒေသများကာကွယ်စောင့်ရှောက်ရေးဥပဒေ၊ ရှေးဟောင်းဝတ္ထု ပစ္စည်းများကာကွယ်စောင့်ရှောက်ရေးဥပဒေ နှင့် ရှေးဟောင်း အဆောက်အအုံများ ကာကွယ် စောင့်ရှောက်ရေးဥပဒေ တို့တွင် ရေးသားထားသော “စောင့်ရှောက်” ဟူသော စာသားအစား “ကာကွယ်ထိန်းသိမ်းရေး”ဟုပြင်ဆင်ရေးသားရန်၊	- တရားဝင် English Translation အရ Protect and Preserve ဟုသာ သုံးစွဲထားပါသည်။
(၄)	အစီအရင်ခံစာတွင် ယဉ်ကျေးမှုအမွေအနှစ်၏အဓိပ္ပာယ်၊ ရှေးဟောင်းဝတ္ထု ပစ္စည်း၏ အဓိပ္ပာယ်၊ ရှေးဟောင်းဝတ္ထုပစ္စည်းအဖြစ်သတ်မှတ်ခြင်း၊ ရှေးဟောင်းအဆောက်အုံ၏ အဓိပ္ပာယ်၊ ရှေးဟောင်းစာရင်းဝင် အဆောက်အုံ၏ အဓိပ္ပာယ်၊ ရှေးဟောင်း အဆောက်အုံအဖြစ်သတ်မှတ်ခြင်း တို့အား ထပ်မံဖြည့်စွက်ဖော်ပြရန်၊	- အစီရင်ခံစာတွင် ယဉ်ကျေးမှုအမွေအနှစ်၏အဓိပ္ပာယ်အား အခန်း(၂)၊ အပိုဒ်ခွဲ (၂.၄.၃.၃)၊ ရှေးဟောင်းဝတ္ထု ပစ္စည်း၏ အဓိပ္ပာယ်၊ ရှေးဟောင်းဝတ္ထုပစ္စည်းအဖြစ်သတ်မှတ်ခြင်းအား အခန်း(၂)၊ အပိုဒ်ခွဲ (၂.၄.၃.၄)၊ နှင့် ရှေးဟောင်းအဆောက်အုံ၏ အဓိပ္ပာယ်၊ ရှေးဟောင်းစာရင်းဝင် အဆောက်အုံ၏ အဓိပ္ပာယ်၊ရှေးဟောင်းအဆောက်အုံအဖြစ်သတ်မှတ်ခြင်း တို့အား အခန်း(၂)၊ အပိုဒ်ခွဲ (၂.၄.၃.၅) တို့တွင် ပြင်ဆင် ဖော်ပြထားပါသည်။
(၅)	စီမံကိန်းအဆိုပြုသူမှ တင်ပြသည့် အစီအရင်ခံစာပါ လိုက်နာကျင့်သုံးရမည့် ဥပဒေများ ဖော်ပြထားသည့် အခန်းတွင် မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှုဥပဒေ ၂၀၁၆၊ မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှုနည်းဥပဒေ ၂၀၁၇ နှင့် မြန်မာနိုင်ငံ ကုမ္ပဏီများဥပဒေ ၂၀၁၇	- စီမံကိန်းအဆိုပြုသူမှ တင်ပြသည့် အစီအရင်ခံစာပါ လိုက်နာကျင့်သုံးရမည့် ဥပဒေများ ဖော်ပြထားသည့် အခန်းတွင် - မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှုဥပဒေ ၂၀၁၆၊ မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှုနည်းဥပဒေ ၂၀၁၇ တို့အား အခန်း(၂)၊ အပိုဒ်ခွဲ

စဉ်	ပြင်ဆင်ရမည့် အချက်များ	ပြင်ဆင်ဖော်ပြချက်
	တို့ကို လိုက်နာမည်ဟု ထည့်သွင်းဖော်ပြရန်၊ မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှု နည်းဥပဒေ ၂၀၂၊ ၂၀၃ တို့ကို အလေးထားလိုက်နာ ဆောင်ရွက်မည်ဖြစ်ကြောင်း ကတိကဝတ်များကို ထည့်သွင်းဖော်ပြရန်၊ မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှု နည်းဥပဒေ ၁၉၆ အရ နှစ်စဉ် လုပ်ငန်းဆောင်ရွက်မှု အစီအရင်ခံစာနှင့် ၁၉၇ အရ သုံးလတစ်ကြိမ် လုပ်ငန်းဆောင်ရွက်မှု အစီအရင်ခံစာတင်ပြရန်၊ တိုင်းရင်းသား လူမျိုးများ၏ အခွင့်အရေးကာကွယ်စောင့်ရှောက်သည့်ဥပဒေ ၂၀၁၅ တွင် ပုဒ်မ ၂၂ နှင့် ပုဒ်မ ၂၅ အစား ပုဒ်မ ၅ ကိုသာဖော်ပြရန်၊ The Ethnic Rights Protection Rules (2019)ပါ Rules 20 (d) တွင် indigenous ဟု ရေးသားဖော်ပြမည့်အစား Ethnic ဟုပြင်ဆင်ဖော်ပြရန်၊	(၂.၄.၆.၁ နှင့် ၂.၄.၆.၂) တို့တွင် ဖော်ပြထားပြီး ဖြစ်ပြီး မြန်မာနိုင်ငံ ကုမ္ပဏီများဥပဒေ ၂၀၁၇ တို့ကို လိုက်နာမည်ဟု အခန်း(၂)၊ အပိုဒ်ခွဲ (၂.၄.၆.၃) တွင် ဖော်ပြထားပါသည်။ - မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှု နည်းဥပဒေ ၂၀၂၊ ၂၀၃ တို့ကို အလေးထားလိုက်နာ ဆောင်ရွက်မည်ဖြစ်ကြောင်း ကတိကဝတ်များကို အခန်း(၂)၊ ဇယား၂-၁ တွင် ဖော်ပြထားပါသည်။ - မြန်မာနိုင်ငံရင်းနှီးမြှုပ်နှံမှု နည်းဥပဒေ ၁၉၆ အရ နှစ်စဉ် လုပ်ငန်းဆောင်ရွက်မှု အစီအရင်ခံစာနှင့် ၁၉၇ အရ သုံးလတစ်ကြိမ် လုပ်ငန်းဆောင်ရွက်မှု အစီအရင်ခံစာများအား စီမံကိန်းလုပ်ငန်းမှ ပုံမှန် ဆောင်ရွက်နေပါသည်။
(၆)	ယခုအတည်ပြုကြောင်းစာသည် Mandalay Business Capital City Development Ltd. မှ အကောင် အထည်ဖော် ဆောင်ရွက်သည့် အမရပူရမြို့ပြဖွံ့ဖြိုးစီမံရေးလုပ်ငန်း၏ ပတ်ဝန်းကျင် ထိခိုက်မှု စစ်ဆေးခြင်း (EIA) အစီအရင်ခံစာကိုသာ အတည်ပြုခြင်းဖြစ်ကြောင်း၊ စီမံကိန်းအတွင်း ဆောင်ရွက်မည့် သီးခြား စီမံကိန်းများ အတွက် စီမံကိန်းစတင်ခြင်းမပြုမီ သီးခြား Project Proposal များ တင်ပြ၍ သဘောထားတောင်းခံရန်လို အပ်ကြောင်း၊	- စီမံကိန်းအတွင်း ဆောင်ရွက်မည့် သီးခြား စီမံကိန်းများ အတွက် စီမံကိန်းစတင်ခြင်းမပြုမီ သီးခြား Project Proposal များ တင်ပြ၍ သဘောထားတောင်းခံမှုများ ပြုလုပ်သွားမည်။

စဉ်	ပြင်ဆင်ရမည့် အချက်များ	ပြင်ဆင်ဖော်ပြချက်
(၇)	စီမံကိန်းနေရာတွင် ယခင်ဖြစ်ပွားခဲ့သော သဘာဝဘေးအန္တရာယ်များ ဖြစ်သည့် (ရေကြီး/ ရေလျှံခြင်း /ငလျင်လှုပ်ခတ်ခြင်း) တို့နှင့်စပ်လျဉ်း၍ ဖြစ်ပွားခဲ့မှုမှတ်တမ်းများကို ဖော်ပြရန်၊ အဆို ပါ အချက်အလက်များအပေါ် အခြေခံ၍ အဆိုပြု စီမံကိန်း ဧရိယာအတွင်း မြေဖို့ခြင်း၊ ground level up ပြုလုပ်ခြင်း၊ reclamation ပြုလုပ်ခြင်း၊ မြစ်ရေကာတာနံရံများ တည်ဆောက်ခြင်း တို့ကြောင့် စီမံကိန်းပတ်ဝန်းကျင်တွင် ရေကြီးမှု ပိုမိုဖြစ်ပေါ်လာနိုင်သဖြင့် အဆိုပါ သက်ရောက်မှုကို (စီမံကိန်းနေရာ မြေမြှင့်ခြင်းကြောင့် ပတ်ဝန်းကျင်တွင် ရေကြီးမှုပိုပြင်းထန်လာနိုင်မှု)ကို Flood Risk Assessment for project vicinity ပြုလုပ်ရန်နှင့် အဆိုပါ သက်ရောက်မှု လျော့ကျစေရေး စီမံကိန်းမှ ဆောင်ရွက်ပေးမည့် လုပ်ငန်းများနှင့် flood response plan တို့ကိုဖော်ပြရန်။	- စီမံကိန်းနေရာတွင် ယခင်ဖြစ်ပွားခဲ့သော သဘာဝဘေးအန္တရာယ်များ ဖြစ်သည့် (ရေကြီး/ ရေလျှံခြင်း /ငလျင်လှုပ်ခတ်ခြင်း) တို့နှင့်စပ်လျဉ်း၍ ဖြစ်ပွားခဲ့မှုမှတ်တမ်းများကို အခန်း(၄.၁၁)တွင် ဖြည့်စွက် ဖော်ပြထားပါသည်။ - အဆို ပါ အချက်အလက်များအပေါ် အခြေခံ၍ အဆိုပြုစီမံကိန်း ဧရိယာအတွင်း မြေဖို့ခြင်း၊ ground level up ပြုလုပ်ခြင်း၊ reclamation ပြုလုပ်ခြင်း၊ မြစ်ရေကာတာနံရံများ တည်ဆောက်ခြင်း တို့ကြောင့် စီမံကိန်းပတ်ဝန်းကျင်တွင် ရေကြီးမှု ပိုမိုဖြစ်ပေါ်လာနိုင်သဖြင့် အဆိုပါ သက်ရောက်မှုကို (စီမံကိန်းနေရာ မြေမြှင့်ခြင်းကြောင့် ပတ်ဝန်းကျင်တွင် ရေကြီး မှုပိုပြင်းထန်လာနိုင်မှု)ကို Flood Risk Assessment for project vicinity အခန်း(၅)၊ အပိုဒ်ခွဲ (၅.၁၃.၂) တွင် ဖြည့်စွက် ဖော်ပြထားပါသည်။ - သက်ရောက်မှု လျော့ကျစေရေး စီမံကိန်းမှ ဆောင်ရွက်ပေးမည့် လုပ်ငန်းများကို အခန်း(၅)၊ အပိုဒ်ခွဲ (၅.၁၃.၂.၁ နှင့် ၅.၁၃.၁၂.၂) နှင့် အခန်း(၇)၊ အပိုဒ်ခွဲ (၇.၆) တွင် ဖြည့်စွက် ဖော်ပြထားပါသည်။ - flood response plan အား အခန်း(၇)၊ အပိုဒ်ခွဲ (၇.၆) တွင် ဖြည့်စွက် ဖော်ပြထားပါသည်။
(၈)	စီမံကိန်းအဆိုပြုသူမှ တင်ပြသည့် အစီအရင်ခံစာတွင် ပါဝင်သော တတိယ အဖွဲ့အစည်း အဖွဲ့ဝင် အမည် စာရင်းများနှင့် ပြန်လည်ပြင်ဆင် တင်ပြလာသည့် အစီအရင်ခံစာတွင်ဖော်ပြထားသည့် တတိယအဖွဲ့အစည်း အဖွဲ့ဝင်အမည်စာရင်းနှင့် ကိုက်ညီမှုမရှိကြောင်း၊ဦးဟိန်းလတ်နှင့် ဒေါ်ယွန်းမြတ်သွယ်တို့မှာ ထပ်တိုး ထည့်ဝင်	- မူလတတိယ အဖွဲ့အစည်း အတည်ပြုချက် ရယူခဲ့သည့် လူပုဂ္ဂိုလ်အမည်စာရင်းကို အစီရင်ခံစာ၏ အခန်း(၁)၊ ဇယား (၁-၅) တွင်ပြင်ဆင်ဖော်ပြထားပါသည်။

စဉ်	ပြင်ဆင်ရမည့် အချက်များ	ပြင်ဆင်ဖော်ပြချက်
	ထားသည့် လူပုဂ္ဂိုလ် အမည်စာရင်းများဖြစ်ကြောင်း စိစစ်တွေ့ရှိရသဖြင့် ယခုကဲ့သို့ အဖွဲ့ဝင် အမည်စာရင်းအား အမျိုးမျိုးထပ်တိုးတင်ပြနေခြင်းအား ခွင့်မပြုပါ ကြောင်းနှင့် မူလတတိယ အဖွဲ့အစည်း အတည်ပြုချက် ရယူခဲ့သည့် လူပုဂ္ဂိုလ်အမည်စာရင်းကိုသာ EIA အစီအရင်ခံစာတွင် ရေးသားဖော်ပြရန်၊	
(၉)	ယခုကဲ့သို့ တတိယအဖွဲ့အစည်း အမည်စာရင်းများအား ထပ်တိုး ထည့်သွင်းခြင်းအပေါ် ဤစာထွက်သည့်ရက်မှ တစ်ပတ်အတွင်း စာဖြင့်ရှင်းလင်းတင်ပြသွားရန်၊	- စာဖြင့် ရှင်းလင်းတင်ပြထားပြီးဖြစ်ပါသည်။
(၁၀)	အစီအရင်ခံစာရေးသားပြုစုမည့် ကျွမ်းကျင် ပညာရှင်စာရင်း ပြောင်းလဲခြင်းများ ဆောင်ရွက်လိုပါက လိုင်စင်ရရှိပြီးသော လူပုဂ္ဂိုလ်များဖြင့်သာ ပြောင်းလဲ၍ ဆောင်ရွက်နိုင်မည်ဖြစ်ကြောင်းနှင့် ၎င်းကဲ့သို့ ပြောင်းလဲဆောင်ရွက်မှုအား ပတ်ဝန်းကျင်ထိန်းသိမ်းရေး ဦးစီးဌာနသို့ တင်ပြအတည်ပြုချက် ရယူပြီးမှသာ အစီအရင်ခံစာ ရေးသားဆောင်ရွက်ရန်။	- ကျွမ်းကျင် ပညာရှင်စာရင်း ပြောင်းလဲခြင်းများ ဆောင်ရွက်ခြင်း မပြုလုပ်ပါ။

Mandalay Business Capital City Development Ltd. မှ အကောင်အထည်ဖော် ဆောင်ရွက်မည့် အမရပူရမြို့ပြဖွံ့ဖြိုးရေး စီမံကိန်း၏ ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း (Environmental Impact Assessment – EIA) အစီရင်ခံစာတွင် လိုအပ်သည့်အချက်များပြင်ဆင်ဖော်ပြခြင်း

စဉ်	ပြင်ဆင်ရမည့် အချက်များ	ပြင်ဆင်ဖော်ပြချက်
(၁)	စီမံကိန်းနေရာတွင် ယခင်ဖြစ်ပွားခဲ့သော သဘာဝဘေးအန္တရာယ်များ ဖြစ်သည့် (ရေကြီး/ ရေလျှံခြင်း /ငလျင်လှုပ်ခတ်ခြင်း) တို့နှင့်စပ်လျဉ်း၍ ဖြစ်ပွားခဲ့မှုမှတ်တမ်းများကို ဖော်ပြရန်၊	စီမံကိန်းနေရာတွင် ယခင်ဖြစ်ပွားခဲ့သော သဘာဝဘေးအန္တရာယ်များ ဖြစ်သည့် (ရေကြီး/ ရေလျှံခြင်း /ငလျင်လှုပ်ခတ်ခြင်း) တို့နှင့်စပ်လျဉ်း၍ ဖြစ်ပွားခဲ့မှုမှတ်တမ်းများကို အခန်း(၄)၊ အပိုဒ်ခွဲ (၄.၁၁.၁)နှင့် ဇယား ၄-၁၈၊ အပိုဒ်ခွဲ ၄.၁၁.၂၊ ဇယား ၄-၁၈၁ နှင့် ဇယား ၄-၁၈၂ တို့တွင် ဖြည့်စွက်ဖော်ပြထားပါသည်။
(၂)	စီမံကိန်း ဧရိယာအတွင်း မြေဖို့ခြင်း၊ ground level up ပြုလုပ်ခြင်း၊ reclamation ပြုလုပ်ခြင်း၊ မြစ်ရေကာတာနံရံများ တည်ဆောက်ခြင်း တို့ကြောင့် စီမံကိန်းအနီးဝန်းကျင် Upstream Down stream များတွင် ရေကြီးခြင်းများနှင့် ရေလျှံခြင်းများ မဖြစ်ပေါ်စေနိုင်ရေး၊ ကမ်းပါးတိုက်စားခြင်း ၊ Erosionများ မဖြစ်စေနိုင်ရေးအတွက် လျော့ချရမည့် နည်းလမ်းများအား အစီရင်ခံစာတွင် ထည့်သွင်းဖော်ပြရန်	စီမံကိန်း ဧရိယာအတွင်း မြေဖို့ခြင်း၊ ground level up ပြုလုပ်ခြင်း၊ reclamation ပြုလုပ်ခြင်း၊ မြစ်ရေကာတာနံရံများ တည်ဆောက်ခြင်း တို့ကြောင့် စီမံကိန်းအနီးဝန်းကျင် Upstream Down stream များတွင် ရေကြီးခြင်းများနှင့် ရေလျှံခြင်းများ မဖြစ်ပေါ်စေနိုင်ရေး၊ ကမ်းပါးတိုက်စားခြင်း ၊ Erosionများ မဖြစ်စေနိုင်ရေးအတွက် လျော့ချရမည့် နည်းလမ်းများအား အခန်း(၅)၊ အပိုဒ်ခွဲ (၅.၁၃.၂)နှင့် အပိုဒ်ခွဲ (၅.၁၃.၂.၁) တွင် ဖြည့်စွက်ဖော်ပြထားပါသည်။

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ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာ လုပ်ထုံးလုပ်နည်း၊ ၂၀၁၅ ခုနှစ်၊ ဒီဇင်ဘာလ ၂၉ရက်၊ အမိန့်ကြော်ငြာစာအမှတ် ၆၁၆/၂၀၁၅၊ နေပြည်တော်၊ နတ်တော်လပြည့်ကျော် ၃ရက်နေ့၊ မြန်မာသက္ကရာဇ် ၁၃၇၇ခုနှစ်။

ပြည်ထောင်စုသမ္မတ မြန်မာနိုင်ငံတော်အစိုးရ၊ သယံဇာတနှင့် သဘာဝပတ်ဝန်းကျင် ထိန်းသိမ်းရေး ဝန်ကြီးဌာန၊ ၂၀၁၅ခုနှစ်။ အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာ အရည်အသွေး (ထုတ်လွှတ်မှု) လမ်းညွှန်ချက်များ၊ ၂၀၁၅ခုနှစ်၊ ဒီဇင်ဘာလ ၂၉ရက်၊ အမိန့်ကြော်ငြာစာအမှတ် ၆၁၅/၂၀၁၅၊ နေပြည်တော်၊ နတ်တော်လပြည့်ကျော် ၃ရက်နေ့ မြန်မာသက္ကရာဇ် ၁၃၇၇ခုနှစ်။

သယံဇာတနှင့်သဘာဝပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဝန်ကြီးဌာနသစ်တောဦးစီးဌာန။

အမြဲတမ်းသစ်တောနယ်မြေများ Forest Department. <

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