



# LNG Power Plant (Ahlone) Project in Yangon, Myanmar

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**ESIA** Report

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#### Acronyms and Abbreviations

hđ	Microgram
A.I.P.T	Ahlone International Port Terminal
ACS	Auxiliary Cooling Water Supply
ADB	Asian Development Bank
AERMOD	USEPA AERMOD Dispersion Model Software
Ag	Silver
AIDs	Acquired Immune Deficiency Syndrome
ALARP	as low as reasonably practicable
ANSI	American National Standards Institute
Aol	Area of Influence
API	American Petroleum Institute
AQIA	Air Quality Impact Assessment
AQM	Air Quality Monitoring
AQS	Air Quality Standard
AR	Assessment Report
As	Arsenic
ASEAN	The Association of Southeast Asian Nations
ASME	The American Society of Mechanical Engineers
ASRs	Air Sensitive Receivers
ASTM	American Society for Testing and Materials
AWP	Asia World Port
AY	Academic Year
AZE	Alliance for Zero Extinction
BANCA	Biodiversity and Nature Conservation Association
BAT	Best Avaliable Technology
BCG	Bacillus Calmette-Guerin
Be	Beryllium
BOD	Biochemical Oxygen Demand
BOG	Boil-off gas
ВОТ	Build-Operate-Transfer
BREEZE	BREEZE Incident Analyst Modelling Software
Са	Calcium
CAPEX	Capital Expenditure
CCGT	Combined Cycle Gas Turbine
ССРР	Combined Cycle Power Plant
CCR	Central Control Room
CCTV	Closed Circuit Television
CCW	Closed Circuit Water
Cd	Cadmium

CEDAW	Convention on Elimination of All Forms of Discrimination against Women
CEMS	Continuous Emission Monitoring system
CFR	Code of Federal Regulations
CGS	China Geological Survey
CH <sub>4</sub>	Methane
CIA	Cumulative Impact Assessment
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CI	Chloride
CLO	Community Liaison Officer
CN	Cyanide
COD	Chemical Oxygen Demand
COD	Commercial Operation Date
CORMIX	Cornell Mixing Zone Expert System
Cr	Chromium
CR	Critically Endangered
Cu	Copper
CW	Cooling Water
DA	Degraded Airshed
DAS	Data Acquisition System
dB	Decibel
dB(A)	A-weighted Decibel
DC	Direct Current
DCIS	Distributed Control and Information System
DCMA	Double Counter weighted Marine Arm
DD	Data Deficient
DDD	Dichloro-Diphenyl-Dichloroethane
DDE	Dichloro-Diphenyl-Dichloroethylene
DDT	Dichloro-Diphenyl-Trichloroethane
DEA	Decommissioning Environmental Assessment
DEDE	Department of Alternative Energy Development and Efficiency Ministry of Energy
DEFRA	Department of Environment, Food and Rural Affairs
DEPP	Department of Electrical Power Planning
DLN	Dry Low NOx
DM	Demineralized
DMP	Dust Management Plan
DO	Dissolved Oxygen
DTP	Diphtheria and Tetanus Toxoids and Pertussis
DWT	Deadweight Tonnage
EA	Environmental Assessment
EBRD	European Bank for Reconstruction and Development

ECC	Environmental Compliance Certificate
ECCDI	Ecosystem Conservation and Community Development Initiative
ECD	Environmental Conservation Department
ECe	Electrical Conductivity
ECLOF	Environmental Conservation and Livelihood Outreach Foundation
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
ENSO	El Niño/Southern Oscillation
EPA	United States Environmental Protection Agency
EPAS	Environmental Perimeter Air Station
EPC	Engineering, Procurement, and Construction
EPGE	Electric Power Generation Enterprise
EPPRPs	Emergency Prevention, Preparedness and Response Plans
ERL	Corresponds to Effects Range-Low
ERM	ERM-Siam Company Limited
ERM	Corresponds to Effects Range-Medium
ERP	Emergency Response Plan
ESG	Environmental, Social and Governance
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
F	Fluoride
FAO	Food and Agriculture Organization of the United Nations
Fe	Iron
FGDs	Focus Group Discussions
FHWA	Federal Highway Administration
FPIC	Free, Prior and Informed Consent
FSRUs	Floating Storage Regasification Unit
GAD	General Administration Department
GCMs	General Circulation Model
GDP	Gross Domestic Product
GEG	Gas Engine Generator
Gg	Gigagram
GHG	Greenhouse Gas
GIIP	Good International Industry Practice
GIS	Gas Insulated Switchyard
GISD	Global Invasive Species Database
GN	Guidance Note

GPS	Global Positioning System
GRT	Gross Registered Tonnage
GT	Gas Turbine
GWPs	The global warming potentials
h	hour
HDD	Horizontal Directional Drilling
Hg	Mercury
HIV	Human Immunodeficiency Virus Infection
HP	High Pressure
HPGE	Hydropower Generation Enterprise
HRSG	Heat Recovery Steam Generator
HSE	Health, Safety, and Environment
IA	Impact Assessment
IAQM	Institute of Air Quality Management
IBA	Important Bird Areas
IBAT	The Integrated Biodiversity Assessment Tool
ICAO	International Civil Aviation Organization
ICP	Informed Consultation and Participation
IFC	International Finance Corporation
IFR	Incidence frequency rates
IFV	Intermediate fluid vaporizers
ILO	International Labour Organisation
INDC	Intended Nationally Determined Contribution
IP	Industrial Processes
IPA	Important Plant Areas
IPCC	Intergovernmental Panel on Climate Change
IPs	Indigenous People
ISO	International Organization for Standardization
ISQG	Interim Sediment Quality Guidelines
ISR	Incidence severity rates
ITD	Italian-Thai Development Public Company Limited
ITTA	International Tropical Timber Agreement
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
К	Potassium
KBAs	Key Biodiversity Areas
Kg	Kilogram
Klls	Key Informant Interviews
km	Kilometre
kV	Kilovolt

kW	Kilowatt
kWh	Kilowatt Hour
L	Litre
L&FS	Life and Fire Safety
LAeq	A-weighted equivalent continuous sound level in decibels
LC	Least Concern
LNG	Liquefied Natural Gas
LNGC	Liquefied Natural Gas Carrier
LOA	Length Overall
LP	Low Pressure
LPG	Liquefied Petroleum Gas
LTSA	Long Term Service Agreement
LUCF	Land Use Change and Forestry
m	Meter
M&E	Monitoring and Evaluation
m <sup>3</sup>	Cubic Metre
MALI	Ministry of Agriculture, Livestock and Irrigation
MARPOL	The International Convention for the Prevention of Pollution from Ships
MERN	Myanmar Environment Rehabilitation-Conservation Network
mg	Milligrams
Mg	Magnesium
MIC	Myanmar Investment Commission
MIMU	Myanmar Information Management Unit
MIP	Myanmar Industrial Port
MITT	Myanmar International Terminal Thilawa
MLIP	Ministry of Labour, Immigration and Population
mm	Millimetre
MMSCFD	Million Standard Cubic Feet per Day
Mn	Manganese
MNPED	Ministry of National Planning and Economic Development
MOECAF	Ministry of Environmental Conservation and Forestry
MOEE	Ministry of Electricity and Energy
MOGE	Myanmar Oil & Gas Entreprise
MONREC	Ministry of Natural Resources and Environmental Conservation
MPA	Myanmar Port Authority
MPN	Most Probable Number
MSDS	Material Safety Data Sheet
MSS	Manufacturers Standardization Society
MSWRR	Ministry of Social Welfare, Relief and Resettlements
MtCO <sub>2</sub> e	million metric tons of carbon dioxide equivalent

MUPA	Myanmar United Power Asia Public Company Limited
MW	Megawatt
MWth	Megawatt Thermal
Ν	Nationally Significant
N/A	Not applicable
Na	Sodium
NCEA	National Commission for Environmental Affairs
NCV	Net Calorific Value
NCV	Net Calorific Value
NDA	Non Degraded Airshed
NE	Not Evaluated
NEMC	National Energy Management Committee
NEP	National Environment Policy
NEQEG	National Environmental Quality Emission Guideline
NFPA	National Fire Protection Association
NG	Natural Gas
Ni	Nickel
NL	Not Listed
Nm <sup>3</sup>	Normal Cubic Meter
NO <sub>2</sub>	Nitrogen Oxide
NO <sub>3</sub>	Nitrate
NOAA	National Oceanic and Atmospheric Administration
NOx	Oxides of Nitrogen
NPi	Australian National Pollution Inventory
NSDS	National Sustainable Development Strategy
NSRs	Noise Sensitive Receivers/Receptors
NTP	Notice to Proceed
NYDC	New Yangon Development Company Limited
O&M	Operation and Maintenance
O <sub>2</sub>	Oxygen
OBE	Operating Basis Earthquake
OECD	Organization for Economic Cooperation and Development
OHS	Occupational Health and Safety
OHSMP	Construction Occupational Health and Safety Management Plan
OPEX	Operational Expenditure
PAHs	Polycyclic Aromatic Hydrocarbons
PAP	Project Affected People
PAs	Protected Areas
Pb	Lead
PC	Process Contribution

PCBs	Polychlorinated Biphenyl
PEC	Predicted Environmental Concentration
PFD	Process Flow Diagram
PM	Particulate Matter
<b>PM</b> <sub>10</sub>	Particulate Matter <10 micrometres
POPs	Stockholm Convention on Persistent Organic Pollutants
PPA	Power Purchase Agreement
PPE	Personal Protective Equipment
PPM	Part per Million
PPR	Project Proposal Report
PS	IFC Performance Standards
PS6	IFC Performance Standard 6
PVC	Poly Vinyl Chloride
R	Regional Significance
ROW	Right of Way
RU	Regasification Unit
SAol	Social Area of Influence
Sb	Antimony
SCADA	Supervisory Control And Data Acquisition
SCOD	Scheduled Commercial Operating Date
Se	Selenium
SEM	Sustainable Environment Myanmar Company Limited
SEP	Stakeholder Engagement Plan
Sn	Tin
SO <sub>2</sub>	Sulphur Dioxide
SO <sub>4</sub>	Sulphate
SPS	Safety Policy Statement
SSPC	The Society for Protective Coatings
STG	Sciences, Technology and Globalization
SW	Surface Water
ТВ	Tuberculosis
TDS	Total Dissolved Solid
TEC	Toyo Engineering Corporation
Ті	Titanium
TJ	Terajoules
TPMC	TTCL Power Myanmar Company Limited
TSP	Total Suspended Particulate
TSS	Total Suspended Solid
UNCCD	United Nations Convention to Combat Desertification

UNDHR	Universal Declaration of Human Rights
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UN-HABITAT	United Nations Human Settlements Programme
UNICEF	United Nations International Children's Emergency Fund
UPS	Uninterruptible power supply
USEPA	United States Environmental Protection Agency
VEC	valued environmental and social component
VKT	Vehicle kilometre Travelled
VU	Vulnerable
WBG	World Bank Group
WHO	World Health Organization
WMP	Waste Management Plan
WRI CAIT	World Resources Institute Climate Analysis Indicators Tool
WWF	World Wildlife Fund
YCDC	Yangon City Development Committee
YESC	Yangon City Electricity Supply Cooperation
Zn	Zinc

## ၁ အကျဉ်းချုပ်အစီရင်ခံစာ

### ၁.၁ နိဒါန်း

TTCL Power Myanmar Company Limited ('TPMC' နှင့်/သို့မဟုတ် 'စီမံကိန်းအဆိုပြုသူ') သည် LNG Power Plant (Ahlone) Project (`စီမံကိန်း´ ဟုလည်း ရည်ညွှန်းထားပါသည်) ကို ဆောင်ရွက်ရန် စီစဉ်လျက်ရှိပါသည်။ စီမံကိန်းတွင် အဓိက အစိတ်အပိုင်းသုံးခုပါဝင်သည်။ ၎င်းတို့မှာ LNG ဓာတ်အားစက်ရုံ (အလုံ) (နောက်ပိုင်းတွင် 'စွမ်းအားစက်ရုံ' အဖြစ် သုံးနှုန်းသွားမည်)၊ LNG လက်ခံရေးဂိတ် (နောက်ပိုင်းတွင် LNG လက်ခံရေးဂိတ် ဟု သုံးနှုန်းသွားမည်၊ ၎င်းတွင် ဆိပ်ခံတံတား၊ LNG သိုလှောင်ရေးတိုင်ကီ(များ) နှင့် သဘာဝဓာတ်ငွေ့ပြန်လည်ပြုလုပ်သည့်ယူနစ် တို့ပါဝင် ကြပါ သည်)၊ နှင့် သဘာဝဓာတ်ငွေ့ပိုက်လိုင်း (နောက်ပိုင်းတွင် `ပိုက်လိုင်း' ဟုသုံးနှုန်းသွားပါမည်) တို့ ပေါင်းစပ်ဝင်ပါကြ ပါသည်။ ပိုက်လိုင်းသည် LNG လက်ခံရေးဂိတ်ရှိ သဘာဝဓာတ်ငွေ့ပြန်လည်ပြုလုပ်သည့်ယူနစ်မှ ဓာတ်အားစက်ရုံ သို့ဆက်သွယ်ထားသော အရှည် ၂၄.၉ ကီလိုမီတာခန့်ရှိမည် ဖြစ်ပါသည်။ စီမံကိန်းအဆိုပြုသူသည် လောင်စာရင် းမြစ်အဖြစ် တင်သွင်းသော အရည်ဖြစ်အောင်လုပ်ထားသောသဘာဝဓာတ်ငွေ့ (LNG) ကို အသုံးပြုရန် စီစဉ်ထား ပါသည်။ ပေါင်းစပ်လည်ပတ်ဓာတ်အားစက်ရုံ (CCPP) ဖြစ်သည့် ဓာတ်အားစက်ရုံအတွက် ရွေးချယ်ထားသော နည်းပညာကို ဓာတ်အားထွက်ရှိမှုထိရောက်လုံလောက်သည့်ပုံစံ၊ ၎င်း၏ ထိရောက်လုံလောက်သော ဓာတ်ငွေ့အ ပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှုနိမ့်ခြင်းတို့ကြောင့် သုံးပြုမူ နင့် သဘာဝဓာတ်ငွေ့ဓာတ်အားထွက်ရှိမှု၏ သန့်ရှင်း သောပုံစံတို့အဖြစ် သက်သေထူအသိအမှတ်ပြုထားပါသည်။

စီမံကိန်းအဆိုပြုလွှာ (PPR) ကို လျှပ်စစ်နှင့် စွမ်းအင်ဝန်ကြီးဌာန (MOEE)၊ နှင့် သယံဇာတနှင့် သဘာဝပတ်ဝန်းကျင် ထိန်းသိမ်းရေးဝန်ကြီးဌာန (MONREC) တို့ထံသို့ ၂၀၁၇ ဒီဇင်ဘာလ ၁၄ ရက်နေ့တွင် တင်သွင်းခဲ့ပြီး၊ ၂၀၁၈ ဇန်နဝါရီ လတွင် စီမံကိန်းသည် ဆက်လက်လုပ်ဆောင်ရန် အသိပေးစာကို မြန်မာနိုင်ငံအစိုးရထံက လက်ခံရရှိခဲ့ပါသည်။

ပြည်ထောင်စုသမ္မတ မြန်မာ နိုင်ငံတော်မှ ပြဋ္ဌာန်းထားသော *ပတ်ပန်းကျင်ထိန်းသိမ်းရေးဥပဒေ* ၏ *ပုဒ်မ ၇* နှင့် *ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးနည်းဥပဒေများ* ၏ *ပုဒ်မ ၅၂* နှင့် *၅၃* တို့အရ၊ TPMC သည် အဆိုပြု စီမံကိန်းအတွက် ပတ်ပန်းကျင်ထိန်းသိမ်းရေးဆိုင်ရာလိုက်နာဆောင်ရွက်မှု သက်သေခံ လက်မှတ် (ECC) ရရှိရန် ကနဦး ပတ်ဝန်း ကျင်ဆန်းစစ်ခြင်း (IEE) <u>သို့မဟုတ်</u> ပတ်ပန်းကျင်ထိခိုက်မှု ဆန်းစစ်ခြင်း (EIA) ကို ဆောင်ရွက်ရန် လိုအပ်ပါသည်။ PPR သည် စီမံကိန်းအဆိုပြုသူအနေဖြင့် သင့်လျော်သောခွင့်ပြုချက်ရရှိရန်အတွက် သက်ဆိုင်ရာအာကာပိုင် အဖွဲ့ အစည်းများထံသို့ EIA လေ့လာချက် (ယခုအစီအရင်ခံစာ) ကို ပြင်ဆင်တင်သွင်းရမည် ဖြစ်ကြောင်း အကြံပေး ထားခဲ့ပါသည်။

စီမံကိန်းအဆိုပြုသူသည် နိုင်ငံတကာငွေချေးသူများထံမှ စီမံကိန်းလုပ်ငန်းဆောင်ရွက်မှုအဆင့်အတွက် အပြည်ပြည် ဆိုင်ရာဘဏ္ဍာရေးကို ရယူနိုင်ပါသည်။ ထို့ကြောင့်၊ ယခု EIA (ပတန်ဝန်းကျင် နှင့် လူမှု ထိခိုက်မှုဆန်းစစ်ခြင်း - ESIA ဟုလည်း သုံးနှုန်းသည် )လေ့လာချက်ကို မြန်မာနိုင်ငံ EIA သတ်မှတ်ချက်များနှင့်အညီဖြစ်ပြီး၊ အပြည်ပြည်ဆိုင်ရာ စံနှုန်းများဖြစ်သော IFC PS နှင့် ၎င်းနှင့်ဆက်နွှယ်သော လမ်းညွှန်ချက်များနှင့်အညီ ပြုစုထားခြင်း ဖြစ်ပါသည်။

TPMC က PPR အစီရင်ခံစာတွင် အဆိုပြုထားသည့် EIA လေ့လာချက်ကို ဆောင်ရွက်ရန် **ERM-Siam Company** Limited ('ERM' နှင့်/သို့မဟုတ် 'အတိုင်ပင်ခံ') အား တတိယပုဂ္ဂိုလ်အဖြစ် အဆိုပြုခဲ့ပြီး ဖြစ်ပါသည်။ ယခု EIA သည် LNG လက်ခံရေးဂိတ်၊ သဘာဝဓာတ်ငွေ့ပိုက်လိုင်း၊ နှင့် LNG ဓာတ်အားစက်ရုံ (အလုံ) တို့အပေါ် အလေးပေးထား ပါသည်။ ဓာတ်အားစက်ရုံမှ လှိုင်သာယာမြို့နယ်ရှိ ဓာတ်အားနွဲရုံသို့ ဆက်သွယ်ထားသော ၂၃၊ ကေဗီရှိ သွယ်ယူ ရေးလိုင်းအတွက် သီးခြား ကနဦးပတ်ဝန်းကျင်ဆန်းစစ်ခြင်း (IEE) အစီရင်ခံစာကို ပြင်ဆင်ရေးသား သွားမည် ဖြစ်ပါသည်။
#### ၁.၂ စီမံကိန်း၏နောက်ခံအကြောင်းအရာ

TPMC သည် မြန်မာနိုင်ငံ၊ ရန်ကုန်ရှိ ဓာတ်အားစက်ရုံတစ်ခုကို ဆောက်လုပ်ရန် စီစဉ်လျက်ရှိပါသည်။ **ပေါင်းစပ်လည် ပတ်ဓာတ်အားစက်ရုံ** (CCPP) (ထုတ်လုပ်မှုပမာဏ ၃၈၈ MW) ကို ပြည်ထောင်စု သမ္မတ မြန်မာနိုင်ငံသို့ ဓာတ်အား ပေးရန် ဆောက်လုပ်သွားမည် ဖြစ်ပါသည်။

၂၀၁၈ ဇန်နဝါရီလတွင်၊ လျှပ်စစ် နှင့် စွမ်းအင် ဝန်ကြီးဌာန (MOEE) သည် စီမံကိန်း လေး (၄) ခုအတွက် `ဆက် လက် ဆောင်ရွက်ရန်အသိပေးစာ' (NTP) လက်မှတ်ထိုးပွဲကို ဆောင်ရွက်ခဲ့ပါသည်။ ၎င်းတွင် LNG ဓာတ်အားစက်ရုံ (အလုံ) စီမံကိန်းပါဝင်ပြီး၊ မြန်မာနိုင်ငံအစိုးရ နှင့် TPMC တို့အကြား NTP ကို လက်မှတ်ရေးထိုးခဲ့ကြပါသည်။ စီမံကိန်းအဆို ပြုသူသည် ၂၀၁၇ ဒီဇင်ဘာလ ၁၄ ရက်နေ့တွင် စီမံကိန်းအဆိုပြုလွှာ (PPR) ကို MOEE နှင့် ECD တို့ထံသို့ ပြုစု တင်သွင်းခဲ့ပါသည်။ PPR သည် ပတ်ဝန်းကျင် နှင့် လူမှု လျှော့ချရေး နှင့် စီမံခန့်ခွဲမှုအစီအမံများအတွက် ၎င်း၏ ကတိကဝတ်များကို ရှေ့ဆက်ဆောင်ရွက်စေရန် စီမံကိန်း၏ ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း (EIA) ကို ဆက်လက် ဆောင်ရွက်ရန် နှင့် ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုအစီအစဉ် (EMP) ကို ရေးသားရန် အကြံပြုခဲ့ပါသည်။

ထို့ပြင်၊ နယ်ပယ်အတိုင်းအတာသတ်မှတ်ခြင်း အစီရင်ခံစာကို MOEE နှင့် ECD တို့ထံသို့ ၂၀၁၉ ဇန်နဝါရီလ ၉ ရက်နေ့ တွင် တင်သွင်းခဲ့ပါသည်။ ၂၀၁၉ ဧပြီလ ၉ ရက်နေ့တွင် နယ်ပယ်အတိုင်းအတာသတ်မှတ်ခြင်းအစီရင်ခံစာနှင့် ပတ် သက်၍ သဘောထားမှတ်ချက်များကို ECD က ပေးခဲ့ပါသည်။ ECD က သဘောထားမှတ်ချက်များကို ယခု EIA အစီရင်ခံစာတွင် ထည့်သွင်းစဉ်းစားတင်ပြထားပြီး၊ နောက်ထပ်အသေးစိတ်အတွက် *နောက်ဆက်တွဲ (ဂ)* တွင်ကြည့်ရှု နိုင်ပါသည်။

ယခု ပတ်ဝန်းကျင် နှင့် လူမှု ထိခိုက်မှုဆန်းစစ်ခြင်း (ESIA) သည် LNG လက်ခံရေးဂိတ်၊ ပိုက်လိုင်း နှင့် ဓာတ်အားစက် ရုံ တို့ကိုသာ ထည့်သွင်းထားခြင်းပြီး၊ သွယ်ယူရေးလိုင်းအတွက် ကနဦးပတ်ဝန်းကျင်ဆန်းစစ်ခြင်း (IEE) ကို သီးခြားစာ တမ်းအနေဖြင့် ပြင်ဆင်ရေးသားသွားမည် ဖြစ်ပါသည်။

#### ၁.၃ စီမံကိန်းအဆိုပြုသူ၏ နောက်ခံအကြောင်းအရာ

TPMC သည် TTCL အများပြည်သူပိုင်ကုမ္ပကီလိမီတက်က ဖွဲ့စည်းထားသော စီမံကိန်းကုမ္ပကီဖြစ်ပြီး၊ အဆိုပြုစီမံကိန်း အတွက် အဓိက စီမံကိန်းအဆိုပြုသူဖြစ်ပါသည်။ စီမံကိန်း၏ တည်ဆောက်ရေးလုပ်ငန်း၊ လည်ပတ်ရေးလုပ်ငန်း နှင့် ပြုပြင်ထိန်းသိမ်းရေးလုပ်ငန်းတို့အတွက် TPMC ကို ၂၀၁၈ ခုနှစ်တွင် တည်ထောင်ခဲ့ပါသည်။

ထိုင်းနိုင်ငံ၎င်း ပထမဆုံးပေါင်းစပ်ထားသော အင်ဂျင်နီးယားရင်း၊ ဝယ်ယူရေး နှင့် တည်ဆောက်ရေး (ပေါင်းစပ်ထား သော EPC) ကုမ္ပကီဖြစ်သည့် TTCL Public Company Limited (TTCL) သည် ဘတ်သန်း ၂၀ အရင်းအနှီးဖြင့် ၁၉၈၅ ဧပြီလ ၂၄ ရက်နေ့တွင် ပူးပေါင်းတည်ထောင်ခဲ့ပါသည်။ TTCL ကို ဂျပန် နှင့် ထိုင်းနိုင်ငံတို့က အထင်ကရ နိုင်ငံတကာ အင်ဂျင်နီးယားရင်း နှင့် ဆောက်လုပ်ရေးကုမ္ပကီ (၂) ခုက အကျိုးတူလုပ်ငန်းအနေဖြင့် ဖွဲ့စည်းခဲ့ခြင်း ဖြစ်ပါသည်။ TTCL သည် စက်မှု နှင့် ထုတ်လုပ်စနစ် စက်ရုံများ၊ အထူးသဖြင့် စွမ်းအင်၊ ရေနံဓာတု၊ ဓာတု နှင့် စွမ်းအင်စက်မှုလုပ်ငန်းများအတွက် အသုံးပြုရန်အသင့် ဝန်ဆောင်မှု နှင့် ထုတ်ကုန် (turnkey) စီမံကိန်းများ၏ ပေါင်းစပ်ဒီဇိုင်း နှင့် အင်ဂျင်နီးယားရင်း၊ စက်ပစ္စည်း နှင့် ကိရိယာတို့ ဝယ်ယူရေး နှင့် တည်ဆောက်ရေး (ပေါင်းစပ်ထား သော EPC) တို့အား ဆောင်ရွက်ပေးရာတွင် အတွေ့အကြုံနှင့် ကျွမ်းကျင်မှုတို့ရှိပါသည်။

TTCL သည် ပြည်ထောင်စု သမ္မတ မြန်မာနိုင်ငံ၊ ရန်ကုန်၊ အလုံ မြို့နယ်၌ ၁၂၀ မီဂါဝပ် ဓာတ်ငွေ့သုံးဓာတ်အားစက်ရုံ တစ်ခု ဆောက်လုပ်ရန်အတွက် ၂၀၁၂ တွင် TTPMC ကို ဖွဲ့စည်းတည်ထောင်ခဲ့ပါသည်။ အဓိက စီမံကိန်းအဆိုပြုသူ၏ အချက်အလက်များမှာ အောက်ပါအတိုင်းဖြစ်ပါသည် -

TTCL Power Myanmar Company Limited (TPMC)
၁၆ဘီ၊ ၁၆ လွှာ၊ စင်တာပွိုင့်တာဝါ၊
အမှတ် (၆၅)၊ ဆူးလေဘုရားလမ်း နှင့် ကုန်သည်လမ်းထောင့်၊ ကျောက်တံတားမြို့နယ်၊
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# ၁.၄ မူဝါဒ၊ ဥပဒေ နှင့် အဖွဲ့ အစည်းဆိုင်ရာမူဘောင်

ပြည်ထောင်စုသမ္မတ မြန်မာ နိုင်ငံတော်မှ ပြဋ္ဌာန်းထားသော *ပတ်ဂန်းကျင်ထိန်းသိမ်းရေးဥပဒေ* ၏ *ပုဒ်မ ၇* နှင့် *ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးနည်းဥပဒေများ* ၏ *ပုဒ်မ ၅၂* နှင့် *၅၃* တို့အရ၊ TPMC သည် အဆိုပြု စီမံကိန်းအတွက် ပတ်ဂန်းကျင်ထိန်းသိမ်းရေးဆိုင်ရာလိုက်နာဆောင်ရွက်မှု သက်သေခံ လက်မှတ် (ECC) ရရှိရန် ကနဦးပတ်ဝန်းကျင် ဆန်းစစ်ခြင်း (IEE) <u>သို့မဟုတ်</u> ပတ်ဂန်းကျင်ထိခိုက်မှု ဆန်းစစ်ခြင်း (EIA) ကို ဆောင်ရွက်ရန် လိုအပ်ပါသည်။

ယခုစီမံကိန်းကို နိုင်ငံတော်အဆင့်နှင့် ဒေသအဆင့် စံနှုန်းများ ဥပဒေများနှင့်အညီ လုပ်ကိုင် ဆောင် ရွက်သွားမည် ဖြစ်ပါသည်။ ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း (EIA) နှင့်ပတ်သက်သည့် ဒေသ အဆင့်စံနှုန်းများတွင် ပတ်ဂန်း ကျင်ထိန်းသိမ်းရေးဥပဒေ (၂၀၁၂)၊ ပတ်ဂန်းကျင်ထိန်းသိမ်းရေး နည်းဥပဒေများ (၂၀၁၄)၊ အမျိုးသား ပတ်ဂန်းကျင် ဆိုင်ရာအရည်အသွေး(ထုတ်လွှတ်မှု) လမ်းညွှန်ချက်များ (၂၀၁၅) နှင့် ပတ်ဂန်းကျင် ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာ လုပ်ထုံးလုပ်နည်း (၂၀၁၅) တို့ပါဝင်သည်။

၂၀၁၅ ဒီဇင်ဘာလတွင် မြန်မာနိုင်ငံ၏ အပြီးသတ် EIA လုပ်ထုံးလုပ်နည်းထုတ်ပြန်မှုနှင့်အတူ၊ အမျိုးသား ပတ်ဝန်းကျင် အရည်အသွေး (ထုတ်လွှတ်မှု) လမ်းညွှန်များကိုလည်း ထုတ်ပြန်ခဲ့ပါသည်။ ဤလမ်းညွှန်များသည် ညစ်ညမ်းမှုကို ကာကွယ်ရန်နှင့် ပတ်ဝန်းကျင် နှင့် အများပြည်သူကျန်းမာရေးတို့ကို ကြိုတင်ကာကွယ်ရန် စီမံကိန်းများမှ ဆူညံသံ နှင့် အခိုးအငွေ့ထုတ်လွှတ်မှုများ နှင့် ညစ်ညမ်းရေစွန့်ထုတ်မှုများကို ထိန်းချုပ်ရန် ကြီးကြပ်ရေးအတွက်အခြေခံများကို ပြဋ္ဌာန်းပေးပါသည်။ ၎င်းစံသတ်မှတ်ချက်များမှာ ကမ္ဘာ့ဘက်အုပ်စု အထွေထွေ ပတ်ဝန်းကျင် ကျန်းမာရေး နှင့် ဘေး ကင်းရေး (EHS) လမ်းညွှန်များ (၂၀၀၇) နှင့် တူညီပါသည်။

# ၁.၅ စီမံကိန်းအကြောင်းအရာဖော်ပြချက်

## ၁.၅.၁.၁ စီမံကိန်းတည်နေရာ

စီမံကိန်းတည်နေရာသည် မြန်မာနိုင်ငံ၊ ရန်ကုန်တိုင်းဒေသကြီးအတွင်း တည်ရှိပါသည်။ LNG လက်ခံရေးဂိတ်သည် ဒလမြို့နယ်၏ အရှေ့တောင်ဘက်ဒေသရှိ ရန်ကုန်မြစ်၏ အနောက်ဘက်ကမ်းပေါ်တွင် တည်ရှိပါသည်။ ဓာတ်အား စက်ရုံသည် တည်ရှိနေပြီးသော ၁၂၀ မီဂါဝပ် သဘာဝဓာတ်ငွေ့ဓာတ်အားစက်ရုံ Toyo Thai Power Myanmar Co.Ltd (TTPMC) နံဘေး၊ အလုံမြို့နယ်၏ တောင်ဘက်ဒေသရှိ ရန်ကုန်မြစ်၏ အရှေ့ဘက်ကမ်းတစ်လျှောက် တည်ရှိပါသည်။ သဘာဝဓာတ်ငွေ့ (NG) ကို LNG လက်ခံရေးဂိတ်မှ ဓာတ်အားစက်ရုံသို့ လွှဲပြောင်းမည့် သဘာဝ ဓာတ်ငွေ့ပိုက်လိုင်းသည် ဒလ၊ ဆိပ်ကြီးစနောင်တို နှင့် အလုံမြို့နယ်တို့ကို ဖြတ်သွားမည် ဖြစ်ပါသည်။ ပိုက်လိုင်းသည် တွံတေးတူးမြောင်း နှင့် ရန်ကုန်မြစ်တို့ဖြစ်သည့် ရေလမ်းကြောင်း နှစ် (၂) ခုကို ဖြတ်သွားမည် ဖြစ်ပါသည်။ စီမံကိန်းအတွက် ယေဘုယျတည်နေရာကို ဒေသစကေးဖြင့် *ပုံ ၁.၁* တွင် ပြထားပါသည်။ အဓိကပါဝင်သော အစိတ်အ ပိုင်းသုံးခုအတွက် တည်နေရာကို *ပုံ ၁.၂* တွင် တင်ပြထားပါသည်။



ကိုးကား - TPMC, 2018. (Modified by ERM)



ကိုးကား - TPMC, 2019. (Modified by ERM)

## ၁.၅.၂ LNG လက်ခံရေးဂိတ်

## ၁.၅.၂.၁ အဓိကအစိတ်အပိုင်းများ

LNG လက်ခံရေးဂိတ်သည် LNG တင် သင်္ဘော (LNGC)၊ LNG သိုလှောင်မှု၊ နှင့် LNG မှ NG သဘာဝဓာတ်ငွေ့ပြန် လည်ပြုလုပ်မှု အတွက် အရည်ဖြစ်အောင်လုပ်ထားသောသဘာဝဓာတ်ငွေ့ (LNG) ချယူရန် နေရာအဆောက် အအုံဖြစ် ပါသည်။ LNG လက်ခံရေးဂိတ်အစိတ်အပိုင်းများကို *ဖယား ၁.၁* တွင် စာရင်းချပြထားပါသည်။

အစိတ်အပိုင်း	ဖော်ပြချက်
တစ်လလျှင် LNG တင် သင်္ဘောအရေအတွက် (ကြိမ်နှုန်း)	တစ်လလျှင် ၂-၄ LNGCs
LNG တင်သင်္ဘော ဆံ့သည့်ပမာက	တန် ၁၆၀၀၀ ခန့်
LNG တင်သင်္ဘော အမျိုးအစား	Moss, Membrane
LNG သုံးစွဲမှု (တစ်ရက်လျှင်)	တန် ၁၃၀၀ ခန့် @ 100% Load
LNG ချယူရေး ဆိပ်ခံတံတား	မြစ်ကမ်းမှ မီတာ ၁၀၀ ရှိ၊ လျှောက်လမ်း၊ ကြိုးဆွဲမြင်းခုံပါ ဗဟိုဘလက်ဖောင်း ကွန်ကရိတ်ဖြင့်ဖွဲ့စည်းခြင်း
LNG ကုန်ချရေးလက်တံများ	အရည်ကုန်ချလက်တံ နှစ် (၂) ခု + ကုန်ချဆိပ်ခံတံထားတွင် အခိုးအငွေ့ဆည်ယူရေး ကုန်တင်လက်တံ တစ်(၁) ခု
LNG အအေးလွန်ပိုက်လိုင်း	<ul> <li>အအေးကာကွယ်သော အစွန်းခံသံမကိုပိုက်</li> <li>၂၉၁ မီတာခန့် - ကုန်ချလက်တံမှ LNG သိုလှောင်တိုင်ကီအထိ၊</li> <li>၁၆၊ မီတာခန့် - LNG သိုလှောင်တိုင်ကီမှ BOG အရည်ဖွဲ့ကိရိယာအထိ၊</li> <li>၈၆ မီတာခန့် - BOG အရည်ဖွဲ့ကိရိယာမှ သဘာ၀ ဓာတ်ငွေ့ ပြန်လည်ပြုလုပ်သည့် ယူနစ် အထိ။</li> </ul>
LNG သိုလှောင်ရေးတိင်ကီများ (ကုန်းပေါ် )	တစ်ခုချင်း ကုဗမီတာ ၂၅၀၀၀ ပမာက (အလုပ်လုပ်နိုင်သောထုထည်) ရှိ ထည့်စရာတိုင်ကီ နှစ် (၂) ခု
သဘာဝဓာတ်ငွေ့ ပြန်လည်ပြုလုပ်သည့် ယူနစ်	တစ်ရက်လျှင် ကုဗပေ ၆၃ သန်းစံနှုန်း (MMSCFD) ခန့်၊ မြစ်ရေမှ အပူရင်းမြစ်ယူခြင်း အလတ်စားအရည်ငွေပြန်ကိရိယာများ (IFV)
လေဝင်လေထွက်တိုင်	HP လေဝင်လေထွက်တိုင် တစ် (၁) တိုင် အအေးလေဝင်လေထွက်တိုင် တစ် (၁) တိုင်
ရေအေးစွန့်ထုတ်ရန် ပြင်ဆင်မှု	၃၃၆ အချင်းရှိပိုက် ရေလက်ကြားအောက်ထားရှိသော ပိုက် တစ်နာရီလျှင် ကုဗမီတာ ၁၃၀၀၀ စီးဆင်းမှုနှုန်း
ဓာတ်ငွေ့ အင်ဂျင် ဂျင်နရေတာ	စုစုပေါင်း သဘာဝဓာတ်ငွေ့အင်ဂျင် ဂျင်နရေတာ (GEG) လေး (၄) လုံး ဆက်တိုက်လည်ပတ်မှုအတွက် GEG သုံး (၃) လုံး၊ အသင့်ပြင်ထားသော GEG တစ် (၁) လုံး ဆက်တိုက်ထုတ်နိုင်မှုပမာက တစ်ခုလျှင် ၁၁၆၊ ကီလိုဝပ်
LNG သိုလှောင်မည့်တိုင်ကီများ နှင့် RU တပ်ဆင်တည်ဆောက် လည်ပတ်မည့် မြေဧရိယာ	၁၅.၀ ဖကခန့်
အထွေထွေပြင်ဆင်မှု	🔳 လျှပ်စစ်အခန်း၊

## ဇယား ၁.၁ - LNG လက်ခံရေးဂိတ် အဓိကအစိတ်အပိုင်းများ

အစိတ်အပိုင်း	ဖော်ပြချက်
	<ul> <li>ထိန်းချုပ်ရေးအခန်းအဆောက်အအုံ၊</li> <li>အဓိက ဂိတ်ပေါက်ဝ လုံခြုံရေးအဆောင်၊ နှင့်</li> <li>ဆိပ်ခံတံတားလုံခြုံရေးအဆောက်အအုံ။</li> </ul>

ကိုးကား - TPMC, 2018.

၁.၅.၂.၂ တည်ဆောက်ရေးအဆင့်

LNG လက်ခံရေးဂိတ်အတွက် တည်ဆောက်ရေးအဆင့်သည် ၂၃ လခန့်ကြာမြင့်နိုင်ပါသည်။ EPC ကန်ထရိုက်တာ သည် စီမံကိန်းအစိတ်အပိုင်းများ၏ တည်ဆောက်ရေး၊ ဆောက်လုပ်ရေး နှင့် တပ်ဆင်မှုတို့အတွက် လုပ်ငန်းခွင်ကို ပြင်ဆင်ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။ တည်ဆောက်ခြင်း၊ ဒီဇိုင်း နှင့် စမ်းသပ်ခြင်းတို့မှ ထုတ်လွှတ်မှုများ၊ စွန့်ထုတ်မှုများ နှင့် အခြားထွက်ရှိမှုများအားလုံးသည် မြန်မာနိုင်ငံ NEQ (ထုတ်လွှတ်မှု) လမ်းညွှန်များ နှင့် WB/IFC EHS လမ်းညွှန်များတွင် ချမှတ်ထားသည့် လမ်းညွှန်ကန့်သတ်ချက်များနှင့်အညီ ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။ လုပ်ငန်းခွင်ပြင်ဆင်မှုတွင် အောက်ပါလုပ်ငန်းများအဓိကပါဝင်သည် -

- မြေမျက်နှာပြင်အရည်အသွေးထိန်းသိမ်းပြုရေးလုပ်ငန်းများ
  - မြေမျက်နှာပြင်အရည်အသွေးထိန်းသိမ်းပြုရေးလုပ်ငန်းများတွင် အပင်များရှင်းလင်းခြင်း နှင့် စီမံကိန်း လုပ်ငန်းခွင်အဆင့်မြှင့်မှုတို့ ပါဝင်သွားမည် ဖြစ်ပါသည်။ စီမံကိန်းလုပ်ငန်းခွင်မှ တူးယူသွားမည့် အောက်ခံ မြေဆီလွှာကို မြေညှိခြင်း /မြေဖို့ခြင်းတို့တွင် အသုံးပြုသွားမည်ဖြစ်ပြီး၊ ဖို့ရမည့်အရာပမာဏမှာ ကုဗမီတာ ၁၀၀၀၀၀ လိုအပ်မည် ဖြစ်ပါသည်။ ရေကြီးမှုအပေါ် မူတည်၍ ဧရိယာအစိတ်အပိုင်းရှိ ဂိတ်တည်ဆောက် ရေးလုပ်ငန်းခွင်အတွက် ဖြစ်နိုင်ခြေရှိသော အမြင့်ထားရှိမှုနှင့် ရေကြီးမှုအတွက် အတားအဆီးများတို့နှင့် ပတ်သက်သော လေ့လာချက်ကို လိုအပ်ပါသည်။
- မြစ်နှင့်သက်ဆိုင်သော ဆောင်ရွက်မှု
  - လက်ရှိ ရှိနေသောလမ်းများသည် LNG လက်ခံရေးဂိတ်တည်ဆောက်ရေးအဆင့်အတွက် လိုအပ်သည့် ယာဉ်အမျိုးအစားများသွားရန် အဆင့်မပြေနိုင်သဖြင့်၊ တည်ဆောက်ရေးပစ္စည်းများ၊ ကိရိယာများ၊ နှင့် အလုပ်သမားများအားလုံးကို တည်ဆောက်ရေးလုပ်ငန်းခွင်မှ သယ်ယူရေးဝမ်းပြားရေယာဉ်ဖြင့် အသွား အပြန် သယ်ယူပို့ဆောင်သွားမည် ဖြစ်ပါသည်။
  - ကုန်းပေါ် မှချဲ့ထားသော စီမံကိန်းအဆောက်အအုံနေရာများတပ်ဆင်မှုသည် ကမ်းနားပိုင်းတစ်လျှောက် တည်ရှိပြီး၊ ကုန်ရျသည့်ဆိပ်ခံတံတားငယ်သည် အပေါ်ပိုင်းတပ်ဆင်မှုမတိုင်မီ အောက်ခံတိုင်လုပ်ငန်းများကို လိုအပ်မည် ဖြစ်ပါသည်။
  - တည်ဆောက်ရေးရေယာဉ်များအကြား ဘေးကင်းရေးကို သေချာစေရန် တည်ဆောက်ရေးဧရိယာတစ်ဝိုက် ဘေးကင်းရေးဇုန်တည်ဆောက်မှုကို လိုအပ်ပါသည်။
- စုစည်းဆောင်ရွက်မှု
  - လက်ရှိ ရှိနေသောလမ်းများသည် LNG လက်ခံရေးဂိတ်တည်ဆောက်ရေးအဆင့်အတွက် လိုအပ်သည့် ယာဉ်အမျိုးအစားများသွားရန် အဆင့်မပြေနိုင်သဖြင့်၊ တည်ဆောက်ရေးပစ္စည်းများ၊ ကိရိယာများ၊ နှင့် အလုပ်သမားများအားလုံးကို တည်ဆောက်ရေးလုပ်ငန်းခွင်မှ သယ်ယူရေးဝမ်းပြားရေယာဉ်ဖြင့် အသွား အပြန် သယ်ယူပို့ဆောင်သွားမည် ဖြစ်ပါသည်။

#### ထောက်ပို့ရေးအဆောက်အအုံနေရာများ

အထက်ပါတို့အပြင် တည်ဆောက်ရေးအဆင့်ကာလအတွင်း အောက်ပါတို့ကို လိုအပ်မည် ဖြစ်ပါသည် -

- ခင်းကျင်းထားသောဧရိယာ
  - ခင်းကျင်းထားသောဧရိယာကို တည်ဆောက်ရေးပစ္စည်းများ နှင့် ကိရိယာများကို အမှန်တကယ်အသုံးမပြုမီ၊ ၎င်းတို့ကို သိုလှောတ်ရန်အတွက် အသုံးသွားမည်ဖြစ်ပါသည်။ ၎င်းသည် LNG လက်ခံရေးဂိတ်တည် ဆောက်ရေးဧရိယာအတွင်း တည်ရှိမည် ဖြစ်ပါသည်။
- တည်ဆောက်ရေးစခန်း
  - တည်ဆောက်ရေးလုပ်သားများ နှင့် အခြားသက်ဆိုင်ရာဝန်ထမ်းများကို နေရာချထားပေးရန် LNG လက်ခံ ရေး ဂိတ်တည်ဆောက်ရေးဧရိယာအတွင်း ယာယီတည်ဆောက်ရေးစခန်းကိုလည်း ထားရှိမည် ဖြစ်ပါသည်။ ဧရိယာမှာ တစ်ခုနှင့်တစ်ခု နီးကပ်နေသောကြောင့် ဤတည်ဆောက်ရေးစခန်းသည် ပိုက်လိုင်းတည် ဆောက်ရေး လုပ်သားများကိုလည်း နေရာချထားပေးမည်ဖြစ်ပါသည်။

## ၁.၅.၂.၃ လည်ပတ်ရေးအဆင့်

LNG လက်ခံရေးဂိတ်နှင့်ဆက်နွှယ်သော လည်ပတ်ရေးလုပ်ငန်းများသည် LNGC မှတစ်ဆင့် LNG ကို အချိန်ဇယားအတိုင်းရယူမှု၊ LNGC မှ LNG ချယူ၍ သိုလှောင်ရေးတိုင်ကီများသို့ပို့ခြင်း၊ နှင့် LNG ကို ပိုက်လိုင်းမှ တစ်ဆင့် ဓာတ်အားစက်ရုံသို့ပို့သွားမည့် NG အဖြစ် သဘာဝဓာတ်ငွေ့ ပြန်လည်ပြုလုပ်ခြင်းတို့ ပါဝင်ပါသည်။

သဘာဝဓာတ်ငွေ့ပြန်လည်ပြုလုပ်ခြင်းလုပ်ငန်းစဉ်သည် ရန်ကုန်မြစ်မှ အပူဖလှယ်မှုအဖြစ် တစ်နာရီလျှင် ကုဗမီတာ ၁၃ဂဂ ခန့်ရှိ ရေကို တောက်လျှောက်ရယူမှုကိုလိုအပ်မည် ဖြစ်ပါသည်။ ဓာတ်ငွေ့စက်ဂျင်နရေတာများ (GEG) သည် LNG လက်ခံရေးဂိတ်နေရာအဆောက်အအုံအတွက် လျှပ်စစ်ထုတ်ပေးရန် လောင်စာအဖြစ် သဘာဝဓာတ်ငွေ့ကို အသုံးပြုသွားမည် ဖြစ်ပါသည်။ စုစုပေါင်း ယူနစ် လေး (၄) ခုကို တပ်ဆင်သွားမည်ဖြစ်ပြီး၊ တစ်ခုချင်းစီသည် ၁၁၆ဂ ကီလိုဝပ်ပမာဏရှိမည် ဖြစ်ပါသည်။ မျှော်မှန်းထားသော လည်ပတ်ရေးကာလသည် ကူးသန်းရောင်းဝယ်လည် ပတ်ရေးနေ့စွဲ (COD) မှစ၍ ၂၅ နှစ်ကြာမည် ဖြစ်ပါသည်။

# ၁.၅.၃ రိုက်လိုင်း

#### ၁.၅.၃.၁ အဓိကအစိတ်အပိုင်းများ

သဘာဝဓာတ်ငွေ့ဖြန့်ဝေရေးပိုက်လိုင်းသည် (သဘာဝဓာတ်ငွေ့ပြန်လည်ပြုလုပ်သည့်ယူနစ်ပြီးနောက် ထုတ်လွှတ်ရေး နေရာမှ) LNG လက်ခံရေးဂိတ် မှ သဘာဝဓာတ်ငွေ့ (NG) ကို ဓာတ်အားစက်ရုံသို့ လွှဲပြောင်းပေးမည် ဖြစ်ပါသည်။ ပိုက်လိုင်းကို စက်ပစ္စည်းအင်ဂျင်နီယာများ အမေရိကန်လူ့အဖွှဲ့အစည်း(ASME) B31.8 - ဓာတ်ငွေ့သယ်ယူရေး နှင့် ဖြန့်ဝေရေးစနစ်များအရ ဒီဇိုင်းဆင်မည် ဖြစ်ပါသည်။ ထို့ပြင် မြှပ်ထားသောပိုက်လိုင်းအပိုင်းအတွက် ကက်သိုဒစ်ကာ ကွယ်မှုကို နေရာချထားမည် ဖြစ်ပါသည်။ ပိုက်လိုင်းအတွက် အကျဉ်းဖော်ပြချက်ကို *ဖေသား ၁.၂* တွင် ဖော်ပြထား ပါသည်။

အစိတ်အဝိုင်း	ဖော်ပြချက်
အရှည်	၂၄.၉ ကီလိုမီတာ
အရင်း	လက်မ ၂၀
ပိုက်သားအထူ	≥ ၉.၅၃ မီလီမီတာ
ပစ္စည်းအသား	ကာဗွန်သံမကိ
ဒီဖိုင်းဖိအား	ခန့်မှန်းခြေ ၆၄ barG
အနိမ့်ဆုံးထုတ်လွှတ်မှုအား	၄၄၈၁.၆ barG
အုပ်ထားသောအလွှာ	3LPE အလွှာဖြင့် API 5L X65
အနိမ့်ဆုံးဒီဇိုင်းအပူချိန်	0.0 °C
လည်ပတ်ရေးဒီဇိုင်းအပူချိန်	⊃° 0C
အမြင့်ဆုံးဒီဇိုင်းအပူအချိန်	൭൭. <b>റ</b> ℃
ဒီဇိုင်းဝံနှုန်း	ASME B31.8
	ASME B31.8s ASME B31.3
ပစ္စည်းဒီဇိုင်း	ANSI <sup>a</sup> / ASME / ASTM <sup>b</sup>
	API
	SSPC <sup>c</sup>
886:mobas mmmb	
ဒမိုင်းလည်စုစရာအတွင်	၃ နှင့် ၄ (ဒီမိုင်းဗက်တာများ ၀.၅ နှင့် ၀.၄ အသီးသီးဖြစ်ကြသည်)
အုပ်ထားသောအလွှာ	၃ လွှာ ဝိုလီသီလင်း
ကက်သိုဒစ်ကာကွယ်မှု	လက်ရှိကက်သိုဒစ်ကာကွယ်မှုကို စတ်နှိပ်ခြင်း
ပိတ်သည့်ဗားခလုတ်များ	ဗားခလုတ် နှစ် (၂) ခု (အစွန်းတစ်ခုချင်း၌)
လည်ပတ်ရေးကာလ	COD မှစ၍ ၂၅ နှစ်

# ဇယား ၁.၂ - ဓာတ်ငွေ့ပိုက်လိုင်း အဓိက အစိတ်အပိုင်းများ

ကိုးကား - TPMC, 2018.

မှတ်ချက်-

³ အမေရိကန်အမျိုးသားစံသတ်မှတ်ချက်များအင်စတီကျူ

<sup>b</sup> စမ်းသပ်မှု နှင့် ပစ္စည်းများအတွက် အမေရိကန်လူ့အဖွဲ့ အစည်း

<sup>c</sup> ကာကွယ်အုပ်ထားသောအလွှာအတွက် လူ့အဖွဲ့ အစည်း <sup>d</sup> ထုတ်လုပ်သူများ စံသတ်မှတ်ရေးလူ့အဖွဲ့ အစည်း

# ၁.၅.၃.၂တည်ဆောက်ရေးအဆင့်

ပိုက်လိုင်းအတွက် တည်ဆောက်ရေးအဆင့်သည် ၁၈ လခန့်ကြာမြင့်သွားမည် ဖြစ်ပါသည်။ EPC ကန်ထရိုက်တာသည် စီမံကိန်းအစိတ်အပိုင်းများ၏ တည်ဆောက်ရေး နှင့် တပ်ဆင်ရေးတို့အတွက် ပြင်ဆင်သွားပါမည်။ တည်ဆောက်ခြင်း၊ ဒီဇိုင်း နှင့် စမ်းသပ်ခြင်းတို့မှ ထုတ်လွှတ်မှုများ၊ စွန့်ထုတ်မှုများ နှင့် အခြားထွက်ရှိမှုများအားလုံးသည် မြန်မာနိုင်ငံ NEQ (ထုတ်လွှတ်မှု) လမ်းညွှန်များ နှင့် WB/IFC EHS လမ်းညွှန်များတွင် ချမှတ်ထားသည့် လမ်းညွှန်ကန့်သတ်ချက်များနှင့် အညီ ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။ လုပ်ငန်းခွင်ပြင်ဆင်မှုတွင် အောက်ပါလုပ်ငန်းများအဓိကပါဝင်သည် -

- မြေမျက်နှာပြင်အရည်အသွေးထိန်းသိမ်းပြုရေးလုပ်ငန်းများ
  - မြေမျက်နှာပြင်အရည်အသွေးထိန်းသိမ်းပြုရေးလုပ်ငန်းများတွင် အပင်များရှင်းလင်းခြင်း နှင့် ပိုက်လိုင်း၏ ROW အတွက်သတ်မှတ်ခြင်းတို့ပါဝင်မည် ဖြစ်ပါသည်။ ပိုက်လိုင်းတန်းညှိမှုတွင် တိုက်ရိုက်တည်ရှိနေသော အောက်ခံမြေဆီလွှာကို ပိုက်လိုင်း၏ ဒီဇိုင်းလုပ်ထားသည့်အနက်အထိ တူးယူပြီး၊ ပိုက်လိုင်းထားရှိပြီးသည် နှင့်တစ်ပြိုင်နက်၊ တူးထားသော မြေသားများကိုပြန်ဖို့မည် ဖြစ်ပါသည်။ တူးယူပြီး ပြန်ဖို့မည့် မြေသားပမာက မှာ ကုဗမီတာ ၇၅၀၀၀ နှင့် ကုဗမီတာ ၅၆၀၀၀ အသီးသီးရှိမည် ဖြစ်ပါသည်။
- ထောင်လိုက်ဦးတည်တူးဖော်ခြင်း (HDD)
  - ထောင်လိုက်ဦးတည်တူးဖော်ခြင်း (HDD) မှာ မြေသားကို မတူး၊ မဇို့ရဘဲ ပိုက်လိုင်းတပ်ဆင်သည့်နည်းလမ်း တစ်ရပ်ဖြစ်ပါသည်။ ဤနည်းလမ်းသည် အထူးသဖြင့် မြေသားတူးဖော်မှုအတွက် မဖြစ်နိုင်သည့် ဧရိယာတို့ တွင် အကျိုးရှိပါသည်။ ဤစီမံကိန်းအရကြည့်လျှင်၊ တွံတေးတူးမြောင်း (~ ၅ဂဂ မီတာ) နှင့် ရန်ကုန်မြစ် (~ ၅၅ဂ မီတာ) တို့ ပွိုင့်နှစ် (၂) ခုကို ဖြတ်သွားမည့် ပိုက်လိုင်းအပိုင်းများအတွက် တူးယးမှုမှာ လက်တွေ့ မကျနိုင်ပါ။
  - ဘက်တိုနိုက် အထူးသဖြင့် ဆိုဒီယမ်ဘက်တိုနိုက်သည် တွင်းနက်များတူးဖော်ရာတွင် အထောက်အကူဖြစ် ရန် တူးဖော်ရေးအရည်အဖြစ်အသုံးပြုသည့် အရည်တစ်မျိုးဖြစ်ပါသည်။ HDD နည်းလမ်းသုံးသည့်ကာလ တွင်၊ ဘက်တိုနိုက်ကို HDD တူးစင်အတွက် တူးဖော်ရေးအရည်အဖြစ် အသုံးပြုသွားမည် ဖြစ်ပါသည်။ HDD လုပ်ငန်းများမှ ထွက်ရှိမည် ဘက်တိုနိုက်ပမာဏမှာ ကုဗမီတာ ၁၀၀၀ ခန့် ဖြစ်ပါမည်။
- 🔹 ရေဇိအားစမ်းသပ်မှု
  - ရေဖိအားစမ်းသပ်မှုတွင် ခိုင်နိုင်မှုစမ်းသပ်ရန် နှင့် ယိုစိမ့်မည့်နေရာများကို ဖော်ထုတ်သတ်မှတ်ရန် ဖိအား စနစ် (ဝိုက်လိုင်းကဲ့သို့သော) သို့ အရည်ထိုးသွင်းမှု ပါဝင်ပါသည်။ ဝိုက်လိုင်းတည်ဆောက်ပြီးသည်နှင့် တစ်ပြိုင်နက်၊ လည်ပတ်ရေးဆက်မလုပ်မီ ရေဖိအားစမ်းသပ်မှုကို ဆောင်ရွက်ရန် လိုအပ်ပါသည်။ ဝိုက်လိုင်း တပ်ဆင်မှုကို ရှည် ၃ - ၅ ကီလိုမီတာရောက်ရှိသည်နှင့်တစ်ပြိုင်နက်၊ ရေဖိအားစမ်းသပ်မှုကို စတင်သွား မည်။ စမ်းသပ်မှုပြီးမြောက်အောင်မြင်သွားသောအခါ၊ မြေသားကို ပြန်ဖို့မည် ဖြစ်ပါသည်။ စမ်းသပ်မှုအတွက် လိုအပ်သည့် ရေဖိအားစပ်းသပ်မှုအရည်ပမာကမှာ ကုဗမီတာ ၂၅ပဂ ခန့် ဖြစ်ပါသည်။

#### ထောက်ပို့ရေးအဆောက်အအုံနေရာများ

အထက်ပါအကြောင်းအရာများအပြင်၊ တည်ဆောက်ရေးအဆင့်ကာလအတွင်း အောက်ပါတို့ကို လိုအပ်သည် -

ခင်းကျင်းထားသောဖရိယာ

- ခင်းကျင်းထားသောဧရိယာကို တည်ဆောက်ရေးပစ္စည်းများ နှင့် ကိရိယာများကို အမှန်တကယ်အသုံးမပြုမီ၊ ၎င်းတို့ကို သိုလှောတ်ရန်အတွက် အသုံးသွားမည်ဖြစ်ပါသည်။ ခင်းကျင်းထားသောဧရိယာသည် တွံ့တွေး တူးမြောင်းအတွက် HDD တည်နေရာအနီးတွင် တည်ရှိမည် ဖြစ်ပါသည်။
- တည်ဆောက်ရေးစခန်း
  - ပိုက်လိုင်းတည်ဆောက်ရေးအတွက် တည်ဆောက်ရေးလုပ်သားများသည် LNG လက်ခံရေးဂိတ်ရှိ ယာယီ
     တည်ဆောက်ရေးစခန်းတွင် ဝေမှုနေထိုသွားကြမည် ဖြစ်ပါသည်။ ထို့ကြောင့်၊ ပိုက်လိုင်းတည်ဆောက်ရေး
     စခန်းတည်နေရာသည် LNG လက်ခံရေးဂိတ် တည်ဆောက်ရေးဧရိယာအတွင်း တည်ရှိပါသည်။

#### ၁.၅.၃.၃ လည်ပတ်ရေးအဆင့်

ပိုက်လိုင်းနှင့် ဆက်နွှယ်သော လည်ပတ်ရေးလုပ်ငန်းများတွင် ဓာတ်ငွေ့လွှဲပို့မှု အချိန်းဇယားအတိုင်းရှိမည့်အကြိမ်များတွင် လျှောက်ပို့လွှတ်နေသော တောက် နင့် ဓာတ်ငွေ့ ဖိသိပ်မှုတို့ လည်ပတ်ရေးအဆင့်ကာလအတွင်း ပါဝင်သည်။ ပိုက်လိုင်းတစ်ခုတည်းမှ မြေယာဆိုင်ရာအနောင့်အယှက်ဖြစ်မူ နှင့် စွန့်ပစ်ပစ္စည်းထွက်ရှိမှုတို့ဖြစ်ပေါ် မည်ဟု မမျော် လင့်ပါ။ ပိုက်လိုင်းတည်ဆောက်ရေးပြီးမြောက်သောအခါ၊ လည်ပတ်ရေး ထိန်းသိမ်းပြုပြင်မှုတို့ကို နင့် TPMC က ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။ ထို့ကြောင့်၊ တတိယအုပ်စုလုပ်ငန်းဆောင်ရွက်သူနှင့် လည်ပတ်ရေး နှင့် ထိန်းသိမ်း ပြုပြင်ရေး (O&M) ကန်ထရိုက်ကို မလိုအပ်ပါ။ မျှော်လင့်ထားသော လည်ပတ်ရေးကာလမှာ COD မှစ၍ ၂၅ နစ် ဖြစ်ပါသည်။

# ၁.၅.၄ ဓာတ်အားစက်ရုံ

## ၁.၅.၄.၁ အဓိကအစိတ်အပိုင်းများ

အဆိုပြု ဓာတ်အားစက်ရုံအမျိုးအစားမှာ ပေါင်းစပ်လည်ပတ်ဓာတ်အားစက်ရုံ (CCPP) ဖြစ်ပါသည်။ ပုံမှန် ပေါင်းစပ် လည်ပတ်လုပ်ငန်းကာလအတွင်း၊ လျှပ်စစ်ကို ဓာတ်ငွေ့တာဘိုင်များမှ ထုတ်လွှတ်မမည်ဖြစ်ပါသည်။ ထို့ပြင်၊ ဓာတ်ငွေ့ တာဘိုင်အိပ်ဇောဓာတ်ငွေ့ပူများကို အလွန်ပူသောရေငွေ့ထားထွက်ရှိမည့် အပူပြန်ဆယ်ယူရေးရေငွေ့ဂျင်နရေတာ (HRSG) မှ လက်ခံရယူသွားမည်။ ၎င်းသည် လျှပ်စစ်ဓာတ်အားထွက်ရှိရန် ရေငွေ့တာဘိုင်ကို မောင်းနှင့်မည် ဖြစ်ပါ သည်။ အဓိကအစိတ်အပိုင်းများ နှင့် ဖော်ပြချက်များကို *ဖယား ၁.၃* တွင် ဖော်ပြထားပါသည်။

အစိတ်အဝိုင်း	ဖော်ပြချက်
မြေဧရိယာ	၈.၉၇ ဖကခန့်
ဓာတ်အားစက်ရုံ ထုတ်လုပ်မှု ပမာဏ	දාවේ ප්රාවර්
စက်ရုံအသေးစိတ်ဖော်ပြချက်	ဓာတ်ငွေ့တာဘိုင် နှစ် (၂) လုံး၊ HRSG နှစ် (၂) လုံး နှင့် ရေငွေ့ တာဘိုင် တစ် (၁) လုံး
ရေငွေ့တာဘိုင်	ငွေ့ရည်ဖွဲ့ ရေငွေ့တာဘိုင် (အဖုံးဖုံးထားသောတာဘိုင်တစ်လုံး)
HRSG	ပြင်ညီဒရမ်ယူနစ်များ
အအေးပေးစနစ်	ဆဲလ်အမျိုးအစား အစိုအအေးတာဝါတိုင် (ပန်ကာပါသည်)
လျှပ်စစ်ဂျင်နရေတာ	အလုံပိတ်ထားသောရေ မှ လေအေးခံလျှပ်စစ်ဂျင်နရေတာ သုံး (၃) လုံး (တာဘိုင်တစ်လုံးအတွက် တစ်လုံးကျ)
ထရန်စဖော်မာများ	လျှပ်ကူးထရန်စဖော်မာ (၂) ခု ( ၁ ဂျင်နရေတာအတွက် ၁ ထရန်စဖော်မာ)
ဖြတ်တောက်ရေးရုံ	ဓာတ်ငွေ့တားဆီးသည်ဖြတ်တောက်ရေးရုံ (GIS) (MOEE မှ ဆောင်ရွက်သည့် လျှပ်ကြောများ (busbar) အသေးစိတ်ဖော်ပြချက်တစ်ခု)
ပတ်ဝန်းကျင်ဆိုင်ထိန်းချုပ်မှု	<ul> <li>ပေါက်လောင်ခန်းမျိုးစုံစနစ်</li> <li>DLN လောင်ကျွမ်းကိရိယာပါ ဓာတ်ငွေ့လောင်စာလောင်ကျွမ်းမှုစနစ်တစ်ခု</li> <li>မီးပွားပလတ်များပါ ခလုတ်စနစ် နှင့် U.V. မီးတောက်အချက်ပြကိရိယာများ</li> </ul>
မီးခိုးတိုင်	<ul> <li>အချင်း ၅ မီတာခန့်</li> <li>အမြင့် မီတာ ၄() ခန့်</li> <li>အတွင်းပိုင်းဆေးသုတ်ထားသည့် ကာဗွန်သံမကိ</li> </ul>
လည်ပတ်ရေးကာလ	COD မှစ၍ ၂၅ နှစ်

#### «ယား ၁.၃ - ဓာတ်အားစက်ရုံအဓိကအစိတ်အပိုင်းများ

ကိုးကား - TPMC, 2018.

## ၁.၅.၄.၂တည်ဆောက်ရေးအဆင့်

ဓာတ်အားစက်ရုံအတွက် တည်ဆောက်ရေးအဆင့်သည် ၂၈ လခန့် ကြာမြင့်မည် ဖြစ်ပါသည်။ EPC ကန်ထရိုက်တာ သည် စီမံကိန်းအစိတ်အပိုင်းများ၏ တည်ဆောက်ရေး နှင့် တပ်ဆင်ရေးတို့အတွက် ပြင်ဆင်သွားပါမည်။ တည်ဆောက် ခြင်း၊ ဒီဇိုင်း နှင့် စမ်းသပ်ခြင်းတို့မှ ထုတ်လွှတ်မှုများ၊ စွန့်ထုတ်မှုများ နှင့် အခြားထွက်ရှိမှုများအားလုံးသည် မြန်မာနိုင်ငံ NEQ (ထုတ်လွှတ်မှု) လမ်းညွှန်များ နှင့် WB/IFC EHS လမ်းညွှန်များတွင် ချမှတ်ထားသည့် လမ်းညွှန်ကန့်သတ်ချက် များနှင့် အညီ ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။ လုပ်ငန်းခွင်ပြင်ဆင်မှုတွင် အောက်ပါလုပ်ငန်းများအဓိကပါဝင်သည် -

- မြေမျက်နှာပြင်အရည်အသွေးထိန်းသိမ်းပြုရေးလုပ်ငန်းများ
  - မြေမျက်နှာပြင်အရည်အသွေးထိန်းသိမ်းပြုရေးလုပ်ငန်းများတွင် အပင်များရှင်းလင်းခြင်း နှင့် စီမံကိန်း လုပ် ငန်းခွင်အဆင့်မြှင့်မှုတို့ ပါဝင်သွားမည် ဖြစ်ပါသည်။ စီမံကိန်းလုပ်ငန်းခွင်မှ တူးယူသွားမည့် အောက်ခံ မြေဆီလွှာကို မြေညှိခြင်း /မြေဖို့ခြင်းတို့တွင် အသုံးပြုသွားမည်ဖြစ်သည်။ တူးယူပြီးပြန်ဖို့သွားမည့် မြေသား ပမာဏမှာ ကုဗမီတာ ၂၉၆၀၀ ခန့် ဖြစ်ပါသည်။ လုပ်ငန်းခွင်အဆင့်မြင့်တင်ခြင်းကို မြင့်တင်နိုင်သည့်ရေ နှင့် ဒီရေ/ရေကြီးမှုဆိုင်ရာ အပျက်အစီများမှ ဓာတ်အားစက်ရုံကို ကာကွယ်ရန် လုံလောက်သောအမြင့်ကို ထည့်သွင်းစဉ်းစားလျက် ဒီဖိုင်းလုပ်သည့်အဖွဲ့က ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။
- မြစ်နှင့်သက်ဆိုင်သော ဆောင်ရွက်မှု
  - စီမံကိန်းတွင် ခင်းတံတားအသစ် နှင့် လက်ရှိ ရှိနေသောလျှောက်လမ်းသို့ ချိတ်ဆက်ထားမည့် လျှောက်လမ်း တည်ဆောက်မှုတို့ ပါဝင်မည်။ တည်ဆောက်ရန်လိုအပ်သည့် ခင်းတံတားနှင့် လျှောက်လမ်းအရွယ်အစား အရ၊ လျှောက်လမ်းကို တပ်ဆင်ရန် မြေအခြေပြုကိရိယာကို တပ်ဆင်သွားမည်။ ကရိန်းဝမ်းပြားရေယာဉ် သည် ခင်းတံတား နှင့် သံမကိအောက်ခံတိုင်တို့ကို တပ်ဆင်သွားမည်။

#### ထောက်ပို့ရေးနေရာအဆောက်အအုံများ

အထက်ပါအကြောင်းအရာတို့အပြင်၊ တည်ဆောက်ရေးအဆင့်ကာလအတွင်း အောက်ပါတို့ကို လိုအပ်မည် ဖြစ်သည် -

- ခင်းကျင်းထားသောဧရိယာ
  - ခင်းကျင်းထားသောဖရိယာကို တည်ဆောက်ရေးပစ္စည်းများ နှင့် ကိရိယာများကို အမှန်တကယ်အသုံးမပြုမီ၊ ၎င်းတို့ကို သိုလှောတ်ရန်အတွက် အသုံးသွားမည်ဖြစ်ပါသည်။ ခင်းကျင်းထားသောဖရိယာကို သီးခြား နေရာနှစ် (၂) နေရာတွင် ရှိမည်။ တစ်ခုမှာ TPMC ၏ ရှိနေပြီးသော ဓာတ်အားစက်ရုံခြံဝန်း ဝင်ပေါက် အနီးနှင့် နောက်တစ်ခုမှာ ဓာတ်အားစက်ရုံတည်ဆောက်ရေးဖရိယာအတွင်း ရှိမည် ဖြစ်ပါသည်။
- တည်ဆောက်ရေးစခန်း
  - တည်ဆောက်ရေးလုပ်သားများ နှင့် အခြားသက်ဆိုင်ရာ ဝန်ထမ်းများ နေထိုင်နိုင်ရန် ဓာတ်အားစက်ရုံ တည်ဆောက်မှုအတွက် ယာယီတည်ဆောက်ရေးစခန်းကို ရန်ကုန်မြို့တော်အတွင်း တည်ရှိမည် ဖြစ်ပါ သည်။

#### ၁.၅.၄.၃ လည်ပတ်ရေးအဆင့်

ဓာတ်အားစက်ရုံနှင့်ဆက်နွှယ်သော လည်ပတ်ရေးလုပ်ငန်းများတွင် လျှပ်စစ်ထုတ်ရန် သဘာဝဓာတ်ငွေ့ (NG) လောင် စာကို တောက်လျှောက်လောင်ကျွမ်းအသုံးပြုမှု ပါဝင်မည် ဖြစ်ပါသည်။ NG ကို LNG လက်ခံရေးဂိတ်မှ ပိုက်လိုင်းမှ တစ်ဆင့် ပို့လွှတ်မည် ဖြစ်ပါသည်။ ရေအေးအတွက် ရေတောက်လျှောက်ရယူမှုကို ဆောင်ရွက်ရန်မျှော်မှန်း ထား သည်။ ရေငွေ့ထုတ်လွှတ်ရန် ဓာတ်ငွေ့တာဘိုင်များ၏ အိပ်ဇောဓာတ်များမှ ထွက်သည့်အပူကို အပူပြန်ဆယ်ရေး ရေငွေ့ဂျင်နရေတာ (HRSG) မှတစ်ဆင့် ပို့လွှတ်သွားမည်ဖြစ်သည်။ ထို့နောက် ၎င်းကို လျှပ်စစ်ထုတ်ရန် ရေငွေ့ ဂျင်နရေတာ မှ တစ်ဆင့် ပို့လွှတ်မည် ဖြစ်ပါသည်။ မျှော်မှန်းထားသည့် လည်ပတ်ရေးကာလမှာ COD မှစ၍ ၂၅ နှစ် ဖြစ်ပါသည်။

#### ၁.၅.၅ အချိန်ဇယား

တည်ဆောက်ရေးအချိန်ဇယားကို *ဇယား ၁.၄* တွင် ဖော်ပြထားပါသည်။

အကြို EPC အဆင့်	လျာထားသည့် နေ့စွဲ
ဖြစ်နိုင်ခြေရှိမှုလေ့လာချက်ပြီးမြောက်မှု	၂၀၁၇ ဒီဇင်ဘာ
လုပ်ငန်းခွင်ပြင်ဆင်မှု	၂၀၁၈ ဖပြီ-ဇွန်
သက်ဆိုင်သူများနှင့် ထိတွေ့ရိတ်ဆက်တိုင်ပင်ခြင်း - ၁	၂၀၁၈ ဒီဇင်ဘာ
နယ်ပယ်အတိုင်းအတာသတ်မှတ်ခြင်း	၂၀၁၉ ဇန်နဝါရီ
သက်ဆိုင်သူများနှင့် ထိတွေ့ရိတ်ဆက်တိုင်ပင်ခြင်း - ၂	၂၀၁၉ ဖေဖော်ဝါရီ-မတ်
အပြီးသတ် EIA ကို MONREC သို့တင်သွင်းမှု	၂၀၁၉ ဩဂုတ်
အသေးစိတ် အင်ဂျင်နီးယားရင်း	၂၀၁၉ ဇွန် - ၂၀၂၀ စက်တင်ဘာ
ဝယ်ယူခြင်း	၂၀၁၉ နိုဝင်ဘာ - ၂၀၁၀ မေ
LNG ဂိတ်တည်ဆောက်ခြင်း	၂၀၂၀ ဇန်နဝါရီ - ၂၀၂၁ ဩဂုတ်
ပိုက်လိုင်းတည်ဆောက်ခြင်း	၂ဂ၂ဂ မတ် - ၂ဂ၂၁ ဩဂုတ်
ဓာတ်အားစက်ရုံ တည်ဆောက်ခြင်း	ဇန်နဝရီ ၂၀ - နိုဝင်ဘာ ၂၁
ဓာတ်အားစက်ရုံ ဆောင်ရွက်ခြင်း	ဒီဇင်ဘာ ၂၁ - ဖပြီ ၂၂
ဓာတ်အားစက်ရုံ COD	ပိုခ် (၂၀)

## ဇယား ၁.၄ - စီမံကိန်းအချိန်ဇယားအကြမ်း

ကိုးကား - TPMC, 2019.

*စီမံကိန်းအရိုန်ဇယားမှာ လျာထားခြင်းသာဇြစ်ပြီး အပြောင်းအလဲ နှင့် နောက်ထပ်မှုတို့ရှိနိုင်ကြောင်း မှတ်သားပါရန်။* အစိတ်အပိုင်း သုံး (၃) ခုလုံး၏ လည်ပတ်မှုကို စုစုပေါင်း ၂၅ နှစ်ကြာမည်ဟု မျှော်မှန်းပါသည်။

## ၁.၅.၆ လုပ်သားများ

စီမံကိန်းအတွက် အဓိကအစိတ်အပိုင်းတစ်ခုချင်း၏ တည်ဆောက်ရေးအဆင့်ကာလအတွင်း လုပ်ငန်းခွင်တွင် အလုပ်လုပ်သွားကြမည့် ခန့်မှန်းခြေ အလုပ်သမားဦးရေကို *ဖယား ၁.၅* တွင် ဖော်ပြထားပါသည်။

$\alpha_{\rm constants} \sim \alpha - \alpha_{\rm constants} \sim \alpha_{\rm c$	မ္ကာက္ကေရာက္လမ္း ၁၉၇	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	က်ကားသော လုပ်သွားပ	n
ami 2.9 - 0. mami 1.00	ျပားလားလားလား စာရာ	အလွှင်ကရှင်	ယာဖသာ (ပုံသားမျ	20

မူလလုပ်သား	ကျွမ်းကျင်လုပ်သား အရေအတွက် ပျမ်းမှု	ကျွမ်းကျင်မကျ တကျ လုပ်သား အရေအတွက် ပျမ်းမျှ	မကျွမ်းကျင်လုပ်သား အရေးအတွက် ပျမ်းမှု	ပျမ်းမှု စုစုပေါင်းလုပ်သား (တစ်ရက်လျှင်)	အများဆုံး စုစုပေါင်းလုပ်သား (တစ်ရက်လျှင်)
LNG လက်ခံရေးဂိတ်	+ ကုန်ချဆိပ်ခံတံတား				
ဒေသခံလုပ်သား	၈၃	JJ	၂၂၀	990	၆၅၀

မူလလုပ်သား	ကျွမ်းကျင်လုပ်သား အရေအတွက် ပျမ်းမှု	ကျွမ်းကျင်မကျ တကျ လုပ်သား အရေအတွက် ပျမ်းမှု	မကျွမ်းကျင်လုပ်သား အရေးအတွက် ပျမ်းမှု	ပျမ်းမှု စုစုပေါင်းလုပ်သား (တစ်ရက်လျှင်)	အများဆုံး စုစုပေါင်းလုပ်သား (တစ်ရက်လျှင်)
ရွှေ့ပြောင် းလုပ်သား	۶J	ಎಂ	0		
ပိုက်လိုင်း		1	1	1	
ဒေသခံလုပ်သား	୧୭	၃၆	6J		၁၁၇
ရွှေ့ပြောင် းလုပ်သား	୦၄	ତେ	0	ຄວ	
ဓာတ်အားစက်ရုံ + ခင်းတံတား					
ဒေသခံလုပ်သား	ຄບ	၁၂	ეიი		
ရွှေ့ပြောင် းလုပ်သား	ço	G	0	900	၆၀၀
စုစုပေါင်း	JC9	၁၄၇	୨୭၂	၉၂၁	၁၃၆၇

ကိုးကား - TPMC, 2019.

# ၁.၅.၇ အခြားဆောင်ရွက်နိုင်သောနည်းလမ်းများရွေးချယ်ခြင်း

#### ၁.၅.၇.၁ LNG လက်ခံရေးဂိတ်

LNG လက်ခံရေးဂိတ် သုံး (၃) နေရာကို ထည့်သွင်းစဉ်းစားခဲ့ပါသည်။ နေရာ နှစ်ခုမှာ သံလျင်မြို့နယ် ကမ်းတစ် လျှောက် တည်ရှိ (မြောက်ဘက် နှင့် တောင်ဘက် ရွေးချယ်စရာများအဖြစ် သတ်မှတ်နိုင်သည်) ပြီး၊ နောက်တစ်နေရာ သည် ဒလမြို့နယ် အရှေ့တောင်ဘက်ကမ်းတစ်လျှောက်တွင် တည်ရှိပါသည်။

သံလျင်ဘက်ရွေးချယ်စရာများ၏ သိသာသည့်အားနည်းချက်မှာ ပိုက်လိုင်းများကို HDD နည်းလမ်းအသုံးပြုလျက် တပ်ဆင်ရန် လိုအပ်ခြင်းဖြစ်ပါသည်။ မြောက်ဘက်ရွေးချယ်စရာမှာ HDD နည်းလမ်းအသုံးပြုလျက် တပ်ဆင်ရမည့် ပိုက်လိုင်းအရှည်မှာ ၃.၁၄ ကီလိုမီတာခန့်ဖြစ်ပြီး၊ တောင်ဘက်ရွေးချယ်စရာအတွက် ၄.၄ ကီလိုမီတာခန့်လိုအပ်မည် ဖြစ်ပါသည်။ ၎င်းအကွာအဝေးအတွက် HDD နည်းလမ်းကို အသုံးပြုရန် ဖြစ်နိုင်သော်လည်း၊ ကုန်ကျစရိတ်မှာ သိသိသာသာများပြားနိုင်ပြီး၊ ထိန်းသိမ်းပြုပြင်နိုင်မှုများကို အကန့်အသတ်ဖြစ်စေနိုင်ပါသည်။ ထို့ပြင်၊ လက်ရှိ မြေယာ အသုံးပြုမှုကြောင့်၊ ဤစီမံကိန်းအတွက် အသုံးပြုရန် မြေမရရှိနိုင်ပါ။

ထို့ကြောင့်၊ ဒလမြို့နယ်၏ အရှေ့တောင်ဘက်ရှိ ကမ်းတစ်လျှောက်တည်ရှိမှုကိုသာ ရွေးချယ်မှုအဖြစ် ထည့်သွင်းစဉ်း စား ပါသည်။

# ၁.၅.၇.၂ ပိုက်လိုင်း

ပိုက်လိုင်းအတွက် လမ်းကြောင်းနစ် (၂) ခုကို ကနဦးစဉ်းစားခဲ့ပါသည်။ တစ်ခုမှာ ဒလမြို့နယ် အလယ်ရှိ လမ်းအတိုင်း အပြိုင်သွားရန် နှင့် ဒုတိယတစ်ခုမှာ အရှေ့ကမ်းတစ်လျှောက်သွားရန် ဖြစ်ပါသည်။ ဒုတိယလမ်းကြောင်းမှာ ထိခိုက် လွယ် ပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှုရှိနိုင်သဖြင့်၊ ပထမလမ်းကြောင်းအား ပိုမိုကောင်းမွန်သောရွေးချယ်မှုအဖြစ် စဉ်းစားပါသည်။

#### ၁.၅.၇.၃ ဓာဝာ်အားစက်ရုံ

ဓာတ်အားစက်ရုံရွေးချယ်မှုအတွက် ရွေးချယ်စရာများကို ရှာဖွေနိုင်သော်လည်း၊ လက်ရှိ ရှိနေသော ဓာတ်အားစက်ရုံနှင့် ကပ်လျက် အဆိုပြု ဓာတ်အားစက်ရုံကို အကောင်အထည်ဖော်မည်အစီအစဉ်မှာ လက်ရှိအချိန်အထိ အကောင်းဆုံး အနေအထားဖြစ်ပါသည်။ ဤတည်နေရာ၌ အဆိုပြု ဓာတ်အားစက်ရုံကို ထားခြင်းမှာ အဆိုပြုဓာတ်အားစက်ရုံ နှင့် လက်ရှိ ရှိနေသော ဓာတ်အားစက်ရုံတို့အကြား နေရာအဆောက်အအုံများ နှင့် အခြားဝန်ဆောင်အသုံးပြုမှုများကို ဝေမှုသုံးစွဲစေနိုင်မည် ဖြစ်ပါသည်။ အထူးသဖြင့်၊ ဖြတ်တောက်ရေးရုံ ဖြစ်ပါသည်။ ထို့ကြောင့်၊ အချို့နေရာအဆောက် အအုံများ တည်ဆောက်ခြင်းကို မလိုအပ်သဖြင့်၊ ကုန်ကျစရိတ်လည်း သက်သာမည် ဖြစ်ပါသည်။ လက်ရှိ ရှိနေသော ဓာတ်အားစက်ရုံတည်ဆောက်မှုကို ဆောင်ရွက်ခဲ့ပြီး ဖြစ်သဖြင့်၊ တစ်နေရာတည်း၌ တည်ဆောက်ရေးလုပ်ငန်းများမှ ရရှိသည့် အတွေ့အကြုံများသည် ကုန်ကျစရိတ်၊ ထောက်ပံ့ပို့ဆောင်ရေး နှင့် လမ်းရှိနေမှုတို့ကဲ့သို့သော အကြောင်း အရာများကို လွယ်ကူစွာ စဉ်းစားအစီအစဉ်ချနိုင်မည် ဖြစ်ပါသည်။

## ၁.၆ ပတ်ဝန်းကျင်ဆိုင်ရာ ဖော်ပြချက်

စီမံကိန်းအတွက် သက်ရောက်မှုရှိစေမည့် နယ်မြေစရိယာ (AoI) (နှင့် သင့်လျော်သော စီမံကိန်းလေ့လာမှုနယ်မြေ ဖရိယာ) ကို တည်ဆောက်မှု ကို ထိခိုက်မှုဆန်းစစ်ခြင်း (AI) သည် ဒီဇိုင်း၊ ဆုံးဖြတ်ချက်ချမှတ်မှု နှင့် သက်ဆိုင်သူများ ၏ အကျိုးတို့အတွက် အရေးအကြီးဆုံး ကိစ္စရပ်များများအပေါ် အလေးထားစေရန် ရည်ရွယ်ပါသည်။

စီမံကိန်း လုပ်ငန်းခွင်နယ်နိမိတ်မှ ၅ ကီလိုမီတာရှိ AoI ကို ဓာတ်အားစက်ရုံ နှင့် LNG လက်ခံရေးအဆောက်အအုံများ အတွက် အထူးသဖြင့် လေထုအရည်အသွေးပတ်ဝန်းကျင်များ သို့မဟုတ် လူမှုပတ်ဝန်းကျင်များအတွက် တည် ဆောက်ခဲ့ပါသည်။ သဘာဝဓာတ်ငွေ့ပိုက်လိုင်းအတွက် ပိုက်လိုင်း ဗဟိုလိုင်း၏ အနားတစ်ခုချင်းမှ မီတာ ၅၀၀ ရှိ ကြားခံနယ်မြေစရိယာကို ထည့်သွင်းစဉ်းစားခဲ့ပါသည်။ အထူးသဖြင့် လူမှုပတ်ဝန်းကျင်များအတွက် ဖြစ်ပါသည်။

စီမံကိန်းလေ့လာမှုနယ်မြေစရိယာ (နောက်ပိုင်းတွင် 'လေ့လာမှုနယ်မြေစရိယာ' အဖြစ် သုံးနှုန်းသွားပါမည်) သည် စီမံကိန်းက သက်ရောက်နိုင်ခြေရှိသော အခြေခံအချက်အလက်များကို လုံလောက်စွာ နားလည်သဘောပေါက်ရန် နှင့် ဖော်ပြရန် လေ့လာဖို့လိုအပ်သည့် နယ်မြေစရိယာကို ဆိုလိုပါသည်။ AoI တည်ဆောက်မှုနှင့်အတူ၊ လေ့လာမှု နယ် မြေဓရိယာ (*ပုံ ၁.၃* တွင်ကြည့်ပါ) သည် စီမံကိန်းလုပ်ငန်းခွင်နေရာ (ဓာတ်အားစက်ရုံ၊ နှင့် LNG လက်ခံရေးဂိတ်) ၏ အချင်းဝက် ၅ ကီလိုမီတာ နှင့် သဘာဝဓာတ်ငွေ့ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ မီတာ ၅ပပ တို့ ပေါင်းစပ်ပါ ဝင်သည်။ သက်ရောက်မှုရှိစေမည့်နေရာတွင် သတ်မှတ်ထားသောလမ်းညွှန်းများမရှိပါ။ သို့ရာတွင်၊ ၎င်းမှာ အလေ့အကျင့်ကောင်း များ နှင့် ကိုက်ညီပြီး၊ တည်ဆောက်ရေး နှင့် လည်ပတ်ရေးအဆင့်များအတွင်း ဖြစ်ပေါ်လာနိုင်သော ထိခိုက်လွယ် ပတ်ဝန်းကျင်များအားလုံးကို ထည့်သွင်းရန် ဒီဇိုင်းလုပ်ထားပါသည်။ လေ့လာမှုနယ်မြေစရိယာတွင် ပတ်ဝန်းကျင် နှင့ ပတ်ဝန်းကျင်၏ ဇီဝဲချိုးစုံမျိုးကွဲကဏ္ဍတို့တွက် စီမံကိန်း၏ သက်ရောက်မှုရှိစေမည့်နယ်မြေစရိယာ (ဆိုလိုသည်မှာ စီမံကိန်းကြောင့် ထိခိုက်ခံရနိုင်သော နယ်မြေစရိယာ ဖြစ်သည်) တစ်ခုလုံး အကျုံးဝင်ပါသည်။ ၎င်းမှာ စီမံကိန်းမှ တိုက်ရိုက်သက်ရောက်နိုင်သည့် လူမှုပတ်ဝန်းကျင်များအားလုံးလည်း ပါဝင်ပါသည်။ သို့ရာတွင်၊ လူမှုအချေခံ အချက်အလက်များတွင် စီမံကိန်း၏ AoI ၌ ရှိနေသော လူမှုစီးပွား၊ ကျန်းမာရေး နှင့် ယဉ်ကျေးမှုအမွေအနစ် ကဏ္ဍများကို ထည့်သွင်းထားပါသည်။ လေ့လာမှုနယ်မြေစရိယာကို *ပုံ ၁.၃*တွင် ပြထားပါသည်။



ပုံ ၁.၃ - စီမံကိန်းလေ့လာမှုနယ်မြေဧရိယာ

ကိုးကား - ERM, 2018.

## ၁.၆.၁ ဇီဝရူပအခြေခံအချက်အလက်များ

# ၁.၆.၁.၁ ရာသီဥတု နှင့် မိုးလေဝသ

များသောအားဖြင့်၊ မြန်မာနိုင်ငံသည် ရာသီဥတုသုံးမျိုးဟု သတ်မှတ်ထားသော နွေ၊ မိုး နှင့် ဆောင်း ရာသီများရှိသည့် အပူပိုင်းမုတ်သုံရာသီဖြင့် ဖော်ပြသည့် အပူပိုင်းဒေသတွင် တည်ရှိပါသည်။ နွေရာသီလများသည် မတ်လ မှ မေလ လယ် အထိဖြစ်ပါသည်။ မိုးရာသီမှာ ပုံမှန်အားဖြင့် မေလလယ်မှ အောက်တိုဘာလကုန်ထိဖြစ်ပြီး၊ ဆောင်းရာသီမှာ နိုဝင်ဘာလမှ စတင်၍ ဖေဖော်ဝါရီလအထိ ဖြစ်ပါသည်။ ဤအချက်အလက်များမှာ လေ့လာမှုနယ်မြေဧရိယာအတွက် သင့်လျော်မှုရှိပါသည်။

အနောက်တောင်မုတ်သုံသည် မတ်လကုန် သို့မဟုတ် ဧပြီလအစောပိုင်းတွင် တစ်နာရီလျှင် ကီလိုမီတာ ၂၀၀ - ၃၀၀ ထိရောက်နိုင်သော လေဆင်နှာမောင်းများ၊ ဆိုင်ကလုန်းများ နှင့် လေပြင်တိုက်ခတ်မှုများဖြင့် ဒေသတွင်းလှုပ်ခတ်မှုများ ဖြင့် စတင်တတ်ပါသည်။ အောက်တိုဘာလမှ မတ်လအလယ်အထိ အရှေ့မြောက်မုတ်သုံသည် ခြောက်သွေ့အေးစက် သောရာသီကို ဖြစ်ပေါ် စေပါသည်။ မြန်မာနိုင်ငံအနှံ့ မတူကွဲပြားသော မြေမျက်နာသွင်ပြင်အနေအထားများ နှင့် ၎င်း၏ လတ္တီတွဒ်အပိုင်းအခြားများကြောင့်၊ ၎င်း၏ ရာသီဥတုအခြေအနေများမှာ တစ်နေရာ နှင့် တစ်နေရာ များစွာ ကွဲပြားပါ သည် (UNCCD, 2005).

## ၁.၆.၁.၂ လေထုအရည်အသွေး

NO<sub>2</sub> ဆိုင်ရာ စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးမှုကို စောင့်ကြည့်ရေးနေရာ (၁၃) ခုတွင် ဆောင်ရွက်ခဲ့ပါသည်။ ပျံ့နှံ့ရေး ပြွန်များ (Passive diffusion tubes)ကို ၂၀၁၈ ဖေဖော်ဝါရီ ၂၇ ရက် မှ မေလ ၂ ရက်နေ့ နှင့် ၂၀၁၈ ဇွန်လ ၁၂ ရက် နေ့မှ ဇွန်လ ၂၆ ရက်နေ့အထိ နေရာသုံးခု၌ မိတ္တူသုံးခုဖြင့် လွှတ်ခဲ့ပါသည်။ အလိုအလျောက်ဖြစ်သော Haz-Scanner Environmental Perimeter Air Station (EPAS) ကို မိုးရာသီ နှင့် နွေရာသီနှစ်ခုလုံးတွင် ဆက်တိုက် ၇၂ နာရီကာလ အကြာအတွက် လေ့လာမှုနယ်မြေစရိယာတါင် နောက်ထပ် နေရာ (၁ဂ) ခုတွင် လွှတ်ခဲ့ပါသည်။

အချို့နေရာများတွင် လေထုစောင့်ကြပ်ကြည့်ရှုစစ်ဆေးမှုသည် မိုးရာသီ နှင့် နွေရာသီနှစ်ခုလုံး၌ အနည်းဆုံး ပါရာမီတာ သုံးခု ((PM<sub>2.5</sub>, PM<sub>10</sub>, နှင့် SO<sub>2</sub>)) သည် မြန်မာနိုင်ငံ ထုတ် လွှတ်မှု အရည်အသွေးလမ်းညွှန်များ (NEQG) ကို ကျော် လွန်ကြောင်း ဖော်ပြပါသည်။ ၎င်းမှာ အခြားဒေသတွင် ယခင်ဆောင်ရွက်ခဲ့သည့် လေထုအရည်အသွေး စောင့်ကြည့်မှု ရလဒ်များနှင့် ကိုက်ညီမှုရှိပါသည်။

#### ఎ.6.ఎ.२ భానుమ

ဆူညံသံအဆင့်တိုင်းတာမှုများကို စံနှုန်းသတ်မှတ်မှုနှင့်ပတ်သက်သည့်အပြည်ပြည်ဆိုင်ရာအဖွဲ့ အစည်း (ISO) (၎င်း တွင် ISO 1996-1:2003 နှင့် ISO 1996-2:2007 တို့ပါဝင်သည်) ၏ သက်ဆိုင်ရာ နည်းလမ်းများနှင့်အညီ ဆောင် ရွက်ခဲ့ပါသည်။ တိုင်းတာရန်မှုအတွက် အသုံးပြုသည့် ကိရိယာသည် မော်ဒယ် SL-4023SD အသံအဆင့်တိုင်းတာမှု ကိရိယာဖြစ်ပါသည်။ ၂၀၁၈ မေလ ၂ ရက်နေ့ နှင့် မေလ ၁၄ ရက်နေ့တို့အကြား အခြေခံစစ်တမ်းကောက်ယူသည့် ကာလ အတွင်း SEM က နမူနာ စခန်း (၁၀) နေရာတွင် ပြုလုပ်ဆောင်ရွက်ခဲ့ပါသည်။ ၎င်းတို့မှာ လေထုအရည်အသွေး အတွက် နမူနာစခန်းများတွင် ရှိကြပါသည်။ နေရာတစ်ခုချင်းအတွက် စစ်တမ်းကို ၄၈ နာရီအကြာ အစဉ်လိုက် ဆောင်ရွက်ခဲ့ပါသည်။

ဆူညံသံအခြေခံအချက်အလက်ရလဒ်များအရ၊ ဆူညံသံစောင့်ကြည့်သည့် စခန်း ဆယ်ခုအနက် ကိုးခုသည် အနည်း ဆုံး အချိန်ကာလတစ်ခုတွင် မြန်မာနိုင်ငံစံနှုန်းကို ကျော်လွန်ခဲ့ပါသည်။ ဆူညံသံမြင့်သည့်ဖြစ်နိုင်သောရင်းမြစ်များမှာ လက်ရှိ ရှိနေသော ဓာတ်အားစက်ရုံ၊ ယာဉ်အသွားမလာများ၊ လူများ၏လုပ်ငန်းများ နှင့် မိုး/ရာသီဥတု ဖြစ်ရပ်များပါဝင် ပါသည်။

## ୦.၆.୦.၄ ବ୍ରୋଦେର୍ଥି ବେ

နွေရာသီ မြေပေါ် ရေနမူနာများကို ၂၀၁၈ မေလ ၃ ရက်နေ့မှ ၄ ရက်နေ့အထိ နေရာ ဆယ့်လေး (၁၄) ခုတွင် ERM-Siam နှင့် SEM တို့က ကောက်ယူခဲ့ပြီး၊ မိုးရာသီ မြေပေါ် ရေနမူနာများကို ၂၀၁၈ ဇွန်လ ၂၇ ရက်နေ့မှ ၂၈ ရက်နေ့အထိ နေရာ ဆယ့်လေး (၁၄) ခုတါင် ကောက်ယူခဲ့ပါသည်။ ရန်ကုန်မြစ် နင့် တွံတေးတူးမြောင်းတို့တွင် ရှိသည့် နမူနာ ကောက်ယူသည့် နေရာများအတွက်၊ ကမ်း နှင့် နမူနာကောက်ယူသည့်နေရာသည်တို့အကြား သွားလာရန် ဒေသရှိ စက်လှေကိုအသုံး ပြုခဲ့ပြီး၊ နမူနာကောက် ကိရိယာများကို စက်လှေပေါ် တင်၍ နမူနာများကို စက်လှောပေါ်တွင် တိုက်ရိုက် ကောက်ယူခဲ့ ပါသည်။ ကုန်းပေါ်ရှိ နမူနာကောက်ယူသည့်နေရာအတွက်၊ နေရာတစ်ခုချင်းသို့ သွားရောက် ရန် ယာဉ်တစ်စီးကို အသုံးပြုပြီး၊ နမူနာများကို မြစ်ကမ်းတွင် သို့မဟုတ် တံတားပေါ်မှ ကောက်ယူခဲ့ပါသည်။ ရေနမူနာ အယ်လဗာပြင်ညီရေပုံစံဖြင့် ယူဆောင်ပြီး၊ များကို ပလတ်စတစ် နင့် ပိုးသတ်ထားသော နမူနာ ထည့်စရာဗူးတို့ဖြင့် ကောက်ယူပါသည်။ အသိအမှတ်ပြုထားသည့် နမူနာများအားလုံးကို စံနှန်းလုပ်နည်းများနှင့်အညီ ဆောင်ရွက်ခဲ့ ပါသည်။

နမူနာကောက်ယူသောနေရာများအားလုံး တွင် အစိုင်အခဲပါဝင်မှု (TDS) (4,052 – 12,760 mg/L) မှာ အမေရိကန် ပြည်ထောင်စု ပတ်ဝန်းကျင်ကာကွယ်ရေးအေဂျင်စီ (EPA) စံနှုန်း (250 mg/L) ကို ကျော်လွန်ပါသည်။ နမူနာ ကောက်ယူသည့် နေရာအားလုံးရှိ SW9 နှင့် SW10 လွဲ၍ မန်ဂနိပါဝင်မှု (0.22 – 1.40 mg/L) မှာ EPA စံနှုန်း (0.05 mg/L) ကို ကျော်လွန်ပါသည်။

အခြားပါရာမီတာများအားလုံးမှာ မြန်မာနိုင်ငံ၊ IFC နှင့် EPA စံနှုန်းများအတွင်း ကျရောက်ကြောင်း တွေ့ရပါသည်။

## ၁.၆.၁.၅ မြေဆီလွှာ

၂၀၁၈ မေလ ၃ ရက်နေ့ နှင့် ၄ ရက်နေ့တို့တွင် လေ့လာမှုနယ်မြေစရိယာရှိ နမူနာနေရာ ကိုး (၉) နေရာမှ မြေဆီလွှာ နမူနာများကို ကောက်ယူခဲ့ပါသည်။ ၎င်းတို့ကို အောက်တွင်ပြထားသည့် ရလဒ်များနှင့်အတူ စာရင်းလုပ်ထားသည့် ပါရာမီတာများအမျိုးအစားအတော်များများအတွက် စမ်းသပ်ခဲ့ပါသည်။ မြေဆီလွှာနမူနာများကို လက်တူးကိရိယာ အသုံးပြုလျက် ကောက်ယူခဲ့ပြီး၊ နမူနာများကို အပေါ်အပိုင်းမြေဆီလွှာ (အနက် စင်တီမီတာ ၃၀ - ၅၀) နှင့် အောက်ခံမြေဆီ လွှာ (အနက်စင်တီမီတာ ၈၀ - ၁၀၀) တို့မှ ကောက်ယူခဲ့ပါသည်။

နမူနာနေရာ SO 2 သည် အပေါ်ပိုင်းမြေဆီလွှာရှိ ကြေးနီအတွက် ဦးတည်တန်ဖိုးထက် ကျော်လွန်ပြီး၊ နမူနာနေရာ SO 4 သည် အောက်ခံမြေဆီလွှာရှိ ကြေးနီအတွက် ဒက်ချ (Dutch) စံနှုန်း (37.44 နှင့် 38.29 mg/kg အကြား) ကို ကျော် လွန်ပါသည်။ နေရာ SO 2 ရှိ အောက်ခံမြေဆီလွှာ သည် ပြဒါးအတွက် ဦးတည်တန်ဖိုး (1.04 mg/kg) ကိုလည်း ကျော်လွန်ပါသည်။

အခြားကျန်ရှိသော နမူနာနေရာများ နှင့် ပါရာမီတာများသည် Dutch စံနှုန်းအတွင်းကျရောက်ကြောင်း တွေ့ရပါသည်။

# ၁.၆.၁.၆ မြေအောက်ရေ

လေ့လာမှုနယ်မြေစရိယာအနီးရှိ ရေအောင်းလွှာ ထုတ်လွှတ်မှုမှာ "အားကောင်းသောရေစိမ့်ပေါက်" သို့မဟုတ် "အား နည်းသောရေပပ်ကြား" အဖြစ် အမျိုးအစားသတ်မှတ်နိုင်ပြီး၊ မြေအောက်ရေအရည်အသွေးကို "မြေအောက် ရေရိုျ" ဟု စဉ်းစားပါသည်။ မြေအောက်ရေအမျိုးအစားမှာ "စိမ့်ရေ" မှ "ပပ်ကြားရေ" အထိ အပိုင်းအခြားရှိပါသည်။ မြေအောက် ရေအရင်းအမြစ်အမျိုးအစားများတွင် ၂၀၀၀၀၀ - ၅၀၀၀၀၀ m³/km²-yr အပိုင်းအခြားရှိ သဘာဝက ပြန်ဖြည့်သည့် "တောင်ကုန်းဖရိယာရှိ ပြတ်တောင်းရေအောင်းလွှာ" နှင့် "မြေညီ နှင့် တောင်ကြားရိူင့်ဝှမ်းတို့ရှိ ဆက်တိုက်ရှိသော ရေအောင်းလွှာ" တို့ ပါဝင်ကြပါသည်။

မြေအောက်ရေနမူနာများကို SEM နှင့် ERM-Siam တို့က ၂၀၁၈ မေလ ၃ ရက်နေ့ နှင့် ၄ ရက်နေ့တို့တွင် ကောက်ယူ ခဲ့ပါသည်။ မြေအောက်ရေနမူနာများကို အချို့ရေတွင်းများအတွက် အယ်လဖာပြင်ညီရေပုံစံဖြင့် ယူခဲ့ပြီး၊ ပလတ်စတစ် နှင့် ပိုးသတ်ထားသောဖန်ခွက် နမူနာထည့်စရာခွက်များဖြင့် ကောက်ယူခဲ့ပါသည်။ နမူနာများအားလုံးကို အသိအမှတ် ပြုထားသည့် စံနှုန်းလုပ်နည်းများနှင့်အညီ ဆောင်ရွက်ခဲ့ပြီး၊ အောက်တွင် နမူနာရလဒ်များနှင့်အတူ စာရင်းချပြ ထားပါ သည်။ ပါရာမီတာ pH၊ အပူချိန်၊ အောက်ဆီဂျင်ပါဝင်မှု (DO)၊ လျှပ်စစ်စီးကူးမှု (EC)၊ အစိုင်အခဲပါဝင်မှု၊ အနံ နှင့် အရောင်များကို နေရာတစ်ခုချင်း၌ ၎င်းအတိုင်း တိုင်းတာခဲ့ပါသည်။ ဓာတ်ခွဲစမ်းသပ်ခန်းတွင် တိုင်းတာခဲ့သည့် ပါရာမီတာများ ကို အောက်တွင် ရလဒ်များနှင့်အတူ စာရင်းပြထားပါသည်။

သက်ဆိုင်ရာ စံနှုန်းများ/ လမ်းညွှန်များကို ကျော်သွားသည့် ပါရာမီတာတို့မှာ အစိုင်အခဲပါဝင်မှု (TDS)၊ နိုက်ထရိတ် (NO<sub>3</sub>)၊ သံ (Fe)၊ မန်ဂနိ (Mn) နှင့် ကလိုရိုက် (Cl) တို့ဖြစ်ကြပါသည်။

အခြားပါရာမီတာများအားလုံးသည် မြန်မာနိုင်ငံစံနှုန်းများ၊ EPA နှင့် WHO လမ်းညွှန်များအတွင်း ကျရောက်ကြောင်း တွေ့ရှိရပါသည်။

## ၁.၆.၁.၇ နန်းအနည်အနစ်

နန်းအနည်အနစ်နမူနာများကို ၂၀၁၈ မေလ ၃ ရက်နေ့ မှ ၅ ရက်နေ့အထိ နေရာ ခြောက် (၆) ခုတွင် SEM နှင့် ERM-Siam တို့က ကောက်ယူခဲ့ပါသည်။ နန်းနမူနာများကို Grab Sampler ကို သုံးလျက် ကောက်ယူခဲ့ပါသည်။ စခန်းတစ်ခု ချင်း၌၊ နန်းများကို ပယင်းရောင်ဖန်ပုလင်းတွင် ကောက်ယူစုဆောင်းခဲ့ပါသည်။ ကြမ်းပြင်နမူနာတစ်ခုချင်းကို ပိုက် ကွက် အရွယ်အစား ၂.၀ မီလီမီတာ၊ ၁ မီလီမီတာ နှင့် ၀.၅ မီလီမီတာတို့ဖြင့် ဖြည်းညင်းစွာ စစ်ယူခဲ့ပါသည်။ ဦးစွာ၊ ကြမ်းပြင်နမူနာများကို ၂.၀ မီလီမီတာ နှင့် ၁.၀ မီလီမီတာ ပိုက်ကွက်အရွယ်အစားဖြင့် စစ်ယူပြီးနောက်၊ နမူနာများကို ၀.၅ မီလီမီတာပိုက်ကွက်အရွယ်ဖြင့် စစ်ယူပါသည်။ နောက်ဆုံးတွင်၊ ၁.၀ မီလီမီတာ နှင့် ၀.၅ မီလီမီတာ ပိုက်ကွက် အရွယ်အစား တွင် မိသော ကြမ်းပြင်နမူနာများကို ကောက်ယူခဲ့ပါသည်။ နမူနာများကို ၁၀% ဖော်မလင်ဆေးရည်ဖြင့် ထိန်းသိမ်းခဲ့ပါသည်။

ပြဒါးသည် နိမ့်သည့်အဆင့်စံနှုန်းကို ကျော်ကြောင်းတွေ့ရပါသည်။ သို့ရာတွင် မြင့်သည့် အဆင့်စံနှုန်းအတွင်း ကျ ရောက်ပါသည်။ ဤရလဒ်များမှ ပါဝင်မှုအဆင့်သည် ရေသက်ရှိဘဝအပေါ် ဆိုးကျိုးသက်ရောက်မှုဖြစ်ပေါ် စေနိုင် ကြောင်းညွှန်ပြပါသည်။ သို့ရာတွင်၊ ဖြစ်ပေါ် မှုမှာ သိသိသာသာနည်းမည် ဖြစ်ပါသည်။

နီကယ်သည် အနိမ့် နှင့် အမြင့် အဆင့်စံနှုန်းနှစ်ခုစလုံးကို ကျော်လွန်ကြောင်း တွေ့ရပါသည်။ သို့ရာတွင်၊ ပါဝင်မှုများ သည် နွေရာသီတွင် နိမ့်ကြောင်း တွေ့ရပါသည်။ ၎င်းခြားနားမှုသည် ရေစီးမြန်မှုကြောင့် ဖြစ်နိုင်ပါသည်။

အခြားပါရာမီတာများအားလုံးသည် ဩစတေးလျ နှင့် နယူးဇီလန် ကြားကာလ နန်းအရည်အသွေးလမ်းညွှန်များ အ တွင်း ကျရောက်ကြောင်း တွေ့ရပါသည်။

#### ၁.၆.၁.၈ မြေယာရှုခင်း နှင့် ရှုခင်းရှုကွက်

မြန်မာနိုင်ငံ အလယ်ပိုင်း အထူးသဖြင့် ရန်ကုန်တိုင်းဒေသကြီး နှင့် ဧရာဝတီတိုင်းဒေသကြီးတို့တွင် ကုန်းမြင့်များ အ နည်းငယ်မှ ကုန်းမြင့်မရှိသည့်နေရာတို့ အဓိက ပါဝင်ကြပါသည်။ ၎င်းမှာ ကမ်းရိုးတန်းဧရိယာများအနီးတည်ရှိသည့် နေရာအတွက် ပုံမှန်ဖြစ်သော်လည်း၊ မြန်မာနိုင်ငံ၏ အခြားမြောက်ဘက်ဒေသများတွင် ကြီးမားသည့် တောင်တန်း နေရာများ နှင့် အမြင့်ဒီဂရီအမျိုးမျိုးတို့ရှိကြသည်။ အထူးသဖြင့် ကယားပြည်နယ် နှင့် ရှမ်းပြည်နယ်တို့ ဖြစ်ကြသည်။

LNG လက်ခံရေးဂိတ် ရှိ မြေမျက်နှာသွင်ပြင်တွင် တောင်ကုန်းများမရှိပါ။ နေရာအဆောက်အအုံတစ်ဝိုက်ဧရိယာတွင် အဓိကအားဖြင့် စိုက်ပျိုးမြေများ နှင့် အနီးကျေးရွာများဖြစ်ကြပါသည်။ LNG လက်ခံရေးဂိတ်၏ ဆန့်ကျင်ဘက်တည့် တည့် နေရာမှာ ရန်ကုန်မြစ်ကိုဖြတ်လိုက်လျှင်၊ Myanmar Integrated Port Limited ဂိတ်ဖြစ်ပါသည်။ LNG လက်ခံရေးဂိတ်အနီးတွင် သက်ကယ်ကွင်း (၁.၂ ကီလိုမီတာ၊ အနောက်မြောက်ဘက်) နှင့် ရှမ်းကော (၁.၆ ကီလို မီတာ၊ အနောက်ဘက်) ကျေးရွာများကဲ့သို့သော ဖြစ်ပေါ် လာနိုင်သည့် ထိခိုက်လွယ်ရှုခင်းရှုကွက်ပတ်ဝန်းကျင်များ တည်ရှိပါသည်။

သဘာဝဓာတ်ငွေ့ ပိုက်လိုင်းတန်းတစ်လျှောက်ရှိ မြေမျက်နှာသွင်ပြင်တွင် တောင်ကုန်းများရှိမနေပါ။ ပိုက်လိုင်းတန်း တစ်လျှောက်ဧရိယာတွင် စိုက်ပျိုးမြေ နှင့် ကျေးရွယ်ငယ်များ အဓိက ရှိကြပါသည်။ ဓာတ်အားစက်ရုံရှိ မြေမျက်နှာသွင်ပြင်မှာ များသောအားဖြင့် သိသာထင်ရှားသော တောင်ကုန်းများမရှိသည့် ပြင်ညီမြေ ဖြစ်ပါသည်။ သို့ရာတွင်၊ ဓာတ်အားစက်ရုံ၏ အရှေ့မြောက်ဘက်တွင် ရွှေတိဂုံဘုရားတည်ရှိသည့် (၅၇ - ၆၂ မီတာခန့် အမြင့်) တည့်တည့် အမြင့်ဆုံးအမှတ်အဖြစ် မြင့်တက်သွားသည့် တောင်ကုန်းများ ရှိပါသည်။ ဓာတ်အားစက်ရုံအတွက် လျာထားသော မြေတွင် မြက်တောများ နှင့် ဒီရေတော အကွက်ငယ်များပါဝင်ပြီး၊ လက်ရှိ ရှိနေသော ဓာတ်အားစက်ရုံ နှင့် အလုံသင်္ဘောကျင်းတို့ဖြင့် ဝန်းရံထားပါသည်။

# ၁.၆.၁.၉ စွန့်ပစ်ပစ္စည်း

မြန်မာနိုင်ငံရှိ အစိုင်အခဲစွန့်ပစ္စည်းထွက်ရှိမှုမှာ တစ်ရက်လျှင် ၅၆၁၆ တန် ရှိခဲ့ပြီး၊ ၂၀၂၅ ရောက်သောအခါ တစ်ရက် လျှင် ၂၁၀၁၂ တန်ရှိမည်ဟု တွက်ချက်ထားပါသည်။ မန္တလေး၊ ရန်ကုန် နှင့် နေပြည်တော် တို့က မြန်မာနိုင်ငံ၏ ထွက်ရှိသောစွန့်ပစ်ပစ္စည်း၏ အများစု (၅၅%) ရှိပြီး၊ ရန်ကုန်သည် စွန့်ပစ်ပစ္စည်းအများစု (တစ်ရက်လျှင် ၁၉၈၁ တန်) ထွက်ရှိပါသည်။

နိုင်ငံ၏ စည်ပင်သာယာရေးအစိုင်အခဲစွန့်ပစ်ပစ္စည်းကို အိမ်ထောင်စုများမှ (၆ဂ%)၊ စျေးများမှ (၁၅%)၊ ကုန်သွယ်စီး ပွားမှ (၁ဂ%)၊ ဟိုတယ်များမှ (၂%)၊ ဥယျာဉ်များမှ (၅%) နှင့် အခြား (၈%) တို့ ထွက်ရှိပါသည်။ ရန်ကုန်၊ မွန္တလေး နှင့် နေပြည်တော်အပြင်ဘက်ရှိ နေရာများတွင်၊ စွန့်ပစ်ပစ္စည်းကောက်ယူမှုသည် ဒေသစည်ပင်အာဏာပိုင်များ၏ တာဝန်ဖြစ်ပြီး၊ ဒေသအစိုးရအောက်ရှိ သက်ဆိုင်ရာ မြို့နယ်စည်ပင်သာယာရေးကော်မတီများမှ ပုံမှန်အားဖြင့် စွန့်ပစ် ပစ္စည်းကောက်ယူပြီး စွန့်ပစ်ကြပါသည်။

ရန်ကုန်မြို့တော်စည်ပင်သာယာရေးကော်မတီ (YCDC) အဆိုအရ၊ ရန်ကုန်တွင် လက်ရှိလည်ပတ်နေသော အဓိက မြေဖို့သည့်နေရာများ နှင့် ၎င်းတို့၏ သက်ဆိုင်ရာ ပမာဏများကို *ဇယား ၁.၆* တွင် တင်ပြထားပါသည်။

တည်နေရာ	ပမာဏ (တန်/နေ့)
ထိန်ပင်	ວດຄດ
ထားဝယ်ခြံ	୭၄၃
ရွှေပြည်သာ	၆၁
မင်္ဂလာဒုံ	<i>\$</i> ?
ತಿಂ	99
ဆိပ်ကြီးခနောင်တို	9

ဇယား ၁.၆ - ရန်ကုန်ရှိအဓိက မြေဖို့သည်နေရာများ

ကိုးကား - YCDC, 2016.

# ၁.၆.၁.၁၀ ကုန်းပေါ် နှင့် ရေထဲရှိ ဇီဝမျိုးစုံမျိုးကွဲ

လုပ်ထုံးလုပ်နည်းတွင် ဇီဝမျိုးစုံမျိုးကွဲတန်ဖိုးများကို ဆန်းစစ်ရန် ချဉ်းကပ်နည်းနှင့်ပတ်သက်သော လမ်းညွှန်မှု မပါဝင် သော်လည်း၊ မြန်မာနိုင်ငံ EIA လုပ်ထုံးလုပ်နည်း (၂၀၁၅) သည် ဇီဝမျိုးစုံမျိုးကွဲတန်ဖိုးများဆန်းစစ်ခြင်းကို လိုအပ်ပါ သည်။ ERM သည် အပြည်ပြည်ဆိုင်ရာ ဘဏ္ဍာရေးကော်ပိုရေးရှင်း (IFC) ၏ *လုပ်ဆောင်မှုစံသတ်မှတ်ချက် (၆) - ဇီဝမျိုးစုံမျိုးကွဲများကို ထိန်းသိမ်းစောင့်ရှောက်ခြင်း နှင့် သက်ရှိသဘာဝရင်းမြစ်များကို ရေရှည်တည်တံ့အောင် စီမံ ခန့်ခွဲခြင်း* (PS6) ကို ဆန်းစစ်ခြင်း၏ ချဉ်းကပ်မှုနည်းလမ်းအဖြစ် အသုံးပြုခဲ့ပါသည်။

ဇီဝမျိုးဝုံမျိုးကွဲကဏ္ဍတစ်ခုချင်း၏ အဓိကတွေ့ရှိချက်များမှာ အောက်ပါတို့ဖြစ်ကြပါသည် -

#### റെഗ്നദ്ദോപ്പാഃ (EcoRegion)

စီမံကိန်းလေ့လာမှုနယ်မြေဧရိယာသည် မြန်မာနိုင်ငံ ကမ်းရိုးတန်းဒီရေတော [IM1404] ဂေဟဒေအတွင်း ကျရောက် ပါသည်။ ဤဂေဟဒေသ၊ အထူးသဖြင့် ဧရာဝတီဒီရေတောဒေသသည် သဘာဝ ဒီရေတောအပင်များဖြင့် လွှမ်းခြုံနေ ခဲ့သော်လည်း၊ မကြာသေးမီကာလအထိ ဆိုးရွားစွာပျက်စီးသွားခဲ့သည်။ ဒီရေတောသည် အငံဓာတ်ကိုခံနိုင်ရည်ရှိပြီး၊ မြစ်ဝရှိပင်လယ်ရေဇုန်ရှိ ငံရိရိရေတွင် ရှင်သန်သည်။ ၎င်းတို့သည် လယ်ယာလုပ်ငန်း၊ မွေးမြူရေးလုပ်ငန်း၊ မြေဖော် ယူခြင်း နှင့် ဇွံ့ဖြိုးမှုလုပ်ငန်းတို့အတွက် မြေရှင်းလင်းမှုတို့ကြောင့် ကမ္ဘာပေါ်တွင် ဖြုန်းတီးမှုခံရဆုံး သဘာဝစနစ်များ ထဲက အချို့ဖြစ်ကြပါသည်။

ဂေဟဒေသသည် လက်ရှိတွင် အထူးအရေးပါသော/ငြိမ်းခြောက်ခံနေရာသောအဆင့်အဖြစ်သတ်မှတ်ထားပါသည်။ သို့ရာတွင် ၎င်းမှာ ကြီးမားသောဧရိယာ (၂၁၂၃၉ စတုရန်းကီလိုမီတာ) ကို ခြုံငုံမှုဖြစ်ပြီး၊ ဧရိယာအတွင်းရှိ နေရင်း ဒေအမျိုးအစားများ နှင့် အခြေအနေများရှိ အသေးစိတ်ခြားနားချက်များကို ကိုယ်စားမပြုနိုင်ပါ။ အဆိုပြုစီမံကိန်းသည် ၎င်းဂေဟဒေသ၏ ဝိသေသလက္ခဏာများကို မသတ်မှတ်နိုင်သော အရေးကြီးသည့် သဘာဝနေရင်းဒေသများ ပါဝင်သည့် ဧရိယာများတွင် မတည်ရှိပါ။ ဧရိယာကို လူများ၏လုပ်ငန်းများကြောင့် သိသိသာသာအရည်အသွေး နိမ့်သည့် ဧရိယာဖြစ်သည်ဟု စဉ်းစားပါသည်။

#### အဓိကအရေးပါသောဇီဝမျိုးစုံမျိုးကွဲနယ်မြေဧရိယာများ

မြန်မာနိုင်ငံတွင် အရေးပါသောဇီဝမျိုးစုံမျိုးကွဲနယ်မြေဧရိယာများ (KBAs) တို့သည် ထိန်းသိမ်းကာကွယ်ထားသော နယ်မြေဧရိယာများ၊ အများပြည်သူကာကွယ်ထားသည့်သစ်တောများ၊ ရပ်ရွာပိုင်ကာကွယ်သစ်တောများ၊ အစု အဖွဲ့ သစ်တောများ၊ ထိန်းသိမ်းရေးသစ်တောများ နှင့်အခြား အရင်းအမြစ် နှင့် မြေအသုံးပြု နယ်မြေဧရိယာများ အပါအဝင် ကွဲပြားသော မြေစီမံခန့်ခွဲမှုအမျိုးအစားများအတွင်း ကျရောက်ပါသည်။ ထို့ကြောင့်၊ သူတို့သည် အစိုးရ၊ ပုဂ္ဂလိက၊ ရပ်ရွာဦးဆောင်မှု နှင့် ပူးပေါင်းစီမံခန့်ခွဲမှုတို့ကဲ့သို့သော ကွဲပြားသော စီမံခန့်ခွဲမှုစနစ်များကို ထည့်သွင်းစဉ်း စားသည်။ လွန်ခဲ့သော ဆယ်စုနှစ်အတွင်း၊ ဇီဝမျိုးစုံမျိုးကွဲထိန်းသိမ်းရေးအတွက် ရင်းနှီးမြှုပ်နှံမှုအခွင့်အလမ်းများကို ဖော်ထုတ်ရန် နှင့် ဦးစားပေးဆောင်ရွက်ရန် မြန်မာနိုင်ငံရှိ KBA များကို ပြန်လည်သုံးသပ်၍ စေတ်နှင့်အညီဆောင်ရွက် ခဲ့ကြပါသည်။

အရေးပါသောဇီဝမျိုးစုံမျိုးကွဲနယ်မြေဧရိယာများ (KBA)တွင် အရေးကြီးသောငှက်နယ်မြေဧရိယာ (IBA)၊ သုညမျိုးသုဉ်း မှုအတွက် မဟာမိတ်အဖွဲ့ (AZE)၊ အရေးကြီးသော အပင် နယ်မြေဧရိယာများ (IPA) နှင့် ရေချို ဇီဝမျိုးစုံမျိုးကွဲအတွက် အရေးကြီးသော နေရာများ

စီမံကိန်းလုပ်ငန်းနေရာမှ ကီလိုမီတာ ၃၊ အတွင်း အရေးပါသော ဇီဝမျိုးစုံမျိုးကွဲနယ်မြေစရိယာ သုံး (၃) နေရာ တည်ရှိ ပါသည်။ ၎င်းနေရာများမှာ လှော်ကားဥယျာဉ်၊ မလက်တိုအင်း နှင့် ဘုရားကြီး KBA တို့ဖြစ်ကြပြီး၊ ၎င်းနေရာတို့၌ ထိန်း သိမ်းရေး နှင့် ပတ်သက်၍ အထူးအရေးပါသောပျောက်သုဉ်းလုဆဲ၊ ပျောက်သုဉ်းလုဆဲ နှင့် ထိခိုက်လွယ် မျိုးစိတ်များ ရှိကြ ပါသည်။ ဤ KBA များသည် စီမံကိန်းမှ သိသိသာသာ ကွာဝေးသည့်နေရာတွင် တည်ရှိပါသည်။ စီမံကိန်းနယ်မြေ ဧရိယာ၏ မြောက် နှင့် အရှေ့ဘက်သို့ အကွာအဝေးမှာ ၂၁ ကီလိုမီတာခန့်၊ ၂၇ ကီလိုမီတာခန့် နှင့် ၃၁ ကီလိုမီတာခန့် အသီးသီးရှိကြပါသည်။

## ထိန်းသိမ်းကာကွယ်ထားသောနယ်မြေဧရိယာ

မြန်မာနိုင်ငံ၌ လက်ရှိအခြေအနေတွင် စုစုပေါင်း ထိန်းသိမ်းကာကွယ်ထားသည့်နယ်မြေဖရိယာ (PA) ၅၈ ခုရှိပြီး၊ နိုင်ငံ၏ စုစုပေါင်း မျက်နှာပြင်နယ်မြေဖရိယာ၏ ၆.၃၇% ရှိပါသည်။

လေ့လာမှုနယ်မြေရေိယာ၏ ကီလိုမီတာ ၅၀ အတွင်းရှိသည့်၊ ထိန်းသိမ်းကာကွယ်ထားသည့် နယ်မြေရေိယာ တစ် (၁) ခုဖြစ်သော လှော်ကားဥယျာဉ်သည် စီမံကိန်း၏ မြောက်ဘက် ၂၈ ကီလိုမီတာအကွာတည်ရှိပါသည်။

#### ထိန်းသိမ်းရေးအတွက်အရေးပါသောမျိုးစိတ်များ

စုပေါင်းဇီဝမျိုးစုံမျိုးကွဲဆန်းစစ်ခြင်းနည်းလမ်း (IBAT) မှ မျိုးစိတ်လိုင်းတည်နေရာအတွင်း တွေ့ရှိရသော ထိန်းသိမ်းရေး အတွက်အရေးပါသော မျိုးစိတ်များမှာ ငှက်မျိုးစိတ် ၁၅ မျိုး၊ ငါးမျိုးစိတ် ၄၀ မျိုး၊ ကျောရိုးမဲ့တိရွစွာန်မျိုး ၅၀ မျိုး၊ နို့တိုက် သတ္တဝါ ၁၁ မျိုး၊ အပင်မျိုးစိတ် ၃ မျိုး နှင့် တွားသွားသတ္တဝါ ၅ မျိုးတို့ ပါဝင်ကြပါသည်။ ဤမျိုးစိတ်များကို IUCN အနီရောင်စာရင်း အရ ထိခိုက်လွယ် (VU)၊ ပျောက်သုဉ်းလုဆဲ (EN) သို့မဟုတ် အထူးအရေးပါသောပျောက်သုဉ်း လုဆဲ (CR) အဖြစ် သတ်မှတ်ထားပါသည်။ ဖော်ထုတ်ထားသည့် မျိုးစိတ်များ၏ အပြည့်အစုံစာရင်းကို **ဖေသား ၅.၅၀** တွင် ပြထားပါသည်။

## မျိုးစိတ်များထိုးဖောက်ဝင်ရောက်မှု

ထိုးဖောက်ဝင်ရောက်လာသောမျိုးစိတ်များမှာ အထူးဂေဟစနစ်တစ်ခုသို့ ဒေသမျိုးမဟုတ်သည့် မျိုးစိတ်များကိုဆို လိုပြီး၊ ၎င်းတို့စတင်ရောက်ရှိလာခြင်း နှင့် ပျံ့နှံ့ခြင်းသည် လူမှုယဉ်ကျေးမှု၊ စီးပွားရေး သို့မဟုတ် ပတ်ဝန်းကျင်ထိခိုက်မှု သို့မဟုတ် လူ့ကျန်းမာရေးအပေါ် ထိခိုက်မှု သို့မဟုတ် ထိခိုက်နိုင်မှုရှိနိုင်သည် (FAO, 2013)။ ထိုးဖောက်ဝင်ရောက် လာသော မျိုးစိတ်များသည် ဒေရင်းဒေသပြောင်းလဲမှု၊ ဂေဟစနစ်အရင်းအမြစ်များ နှင့် ညစ်ညမ်းမှုဆိုင်ရာ အလွန် အကျွံဆောင်ရွက်မှုတို့ကြောင့် ရာသီဥတုပြောင်းလဲမှုတို့ဖြစ်စေလျက် ပေါင်းစပ် ခြိမ်းခြောက်မှုများဖြင့် ဂေဟစနစ် အရည်အသွေးကျဆင်းမှု၌ သူတို့၏အခန်းကဏ္ဍကို ပိုမိုဆိုးရွားနိုင်စွမ်းရှိပြီး၊ ၎င်းမှ ဇီဝမျိုးစုံမျိုးကွဲ နှင့် လူမှုအနေအ ထားအပေါ် သူတို့၏ ခြိမ်းခြောက်မှုကို နောက်ထပ် တိုးမြင့်စေပါသည် (Emerton နှင့် Howard, 2008).

ကမ္ဘာလုံးဆိုင်ရာ ထိုးဖောက်ဝင်ရောက်လာသောမျိုးစိတ်အချက်အလက် (GISD) (2015) များအရ၊ မြန်မာနိုင်ငံတွင် မျိုးစိတ် ၉၇ မျိုးကို ထိုးဖောက်ဝင်ရောက်လာသော မျိုးစိတ်အဖြစ် ဖော်ထုတ်ထားပါသည်။ ထိုးဖောက်ဝင်ရောက်လာ သော မျိုးစိတ်စာရင်းကို *နောက်ဆက်တွဲ (O)* တွင် တင်ပြထားပါသည်။ သို့ရာတွင်၊ အချက်အလက်များတွင် ထိုး ဖောက်ဝင်ရောက်လာသော မျိုးစိတ်များသည် မြန်မာနိုင်ငံ၏ မည်သည့်အစိတ်အပိုင်းတွင် စတင်ဝင်ရောက်လာ ကြောင်း အသေးစိတ် မဖော်ပြထားပါသည်။

# ဇီဝမျိုးစုံမျိုးကွဲတန်ဖိုးအတွက် သက်ရောက်မှုရှိစေမည့်နယ်မြေဧရိယာ

သက်ရောက်မှုရှိစေမည့်နယ်မြေစရိယာ (AoI) ကို လေ့လာမှုနယ်မြေစရိယာ၏ ၅ ကီလိုမီတာအချင်းဝက်၊ ပိုက်လိုင်း တစ်ဖက်ချင်း၏ မီတာ ၅၀၀ နှင့် LNG ဂိတ်၏ အချင်းဝက် ၁ ကီလိုမီတာတို့အပေါ် အခြေပြု၍ သတ်မှတ်ပါသည်။ အချင်းဝက်ကို တည်ဆောက်ရေး နှင့် လည်ပတ်ရေးကာလတို့အတွင်း စီမံကိန်း လုပ်ငန်းများ၏ သဘောသဘာဝ အပေါ်အခြေပြုလျက် ဆုံးဖြတ်ပြီး၊ လေ့လာမှုစရိယာအနီးအတွင်း သတ်မှတ်ထားသော သဘာဝစရိယာများ နှင့် စီမံကိန်လေ့လာမှုစရိယာတို့နှင့် ကိုက်ညီမှုရှိပါသည်။

## ီငမျိုးစုံမျိုးကွဲစစ်တမ်း

မေလ ၄ ရက်နေ့မှ ရက်နေ့အထိ ရောက်သွေ့ရာသီကာလအတွင်း ERM သည် ၂၀၁၈ ၅ ဆောင်ရွက်ခဲ့ပါသည်။ ကွင်းဆင်းစစ်တမ်းကို ဤစစ်တမ်းများကို လေ့လာမူနယ်မြေဧရိယာ şĘ သက်ရောက်မှုရှိစေမည့်နယ်မြေဖရိယာတို့ အတွင်း ဦးစားပေးဇီဝမျိုးစုံမျိုးကွဲနေရာကို ဆုံးဖြတ်နိုင်ရန်ဆောင်ရွက်ခဲ့ခြင်း အရေးပါသောနေရင်းဒေသမျးာ ၎င်းဦးစားပေးတန်ဖိုးများသည် ဖြစ်ပါသည်။ နင့် ထိန်းသိမ်းရေးဆိုင်ရာ အရေးပါသောမျိုးစိတ်များအပေါ် အလေးပေးခဲ့ပါသည်။ စစ်တမ်းအတွက် ဦးစားပေးနိင်မည့် မျိုးစိတ်များ နှင့် နေရင်းဒေသများကို ဖော်ထုတ်နိုင်ရန် နမူနာနေရာများ (ဒေသခံ ကျေးရွာသူ/သားများအား အင်တာဗျူးခြင်းအပါအဝင်)၊ ကွင်းဆင်းစစ်တမ်းဆိုင်ရာ ဦးတည် အပင် နှင့် သက်ရှိသတ္တဝါ အုပ်စုများ၊ ဖော်ထုတ်ထာသော အပင် နှင့် သက်ရှိသတ္တဝါမှတ်တမ်းများ၏ မျိုးခွဲမှု နှင့် ပုံဖော်မူတို့အတွက် ရှိနေပြီးသော စာရွက်စာတမ်း အချက်အလက်များပြီးမှ စစ်တမ်းများကို ဆောင်ရွက်ခဲ့ပါသည်။ IFC PS6 ၏ သတ်မှတ်ချက်အရ၊ သဘာဝနေရင်းဒေသ နှင့် ပြုပြင်ထားသော နေရင်းဒေသတို့ကို သိရှိရန် နေရင်းဒေသဆန်းစစ်မှုများကိုလည်း ဆောင်ရွက်ခဲ့ပါသည်။

#### မြေအမျိုးအစား ပုံဖော်ကြည့်ခြင်း

လေ့လာမှုနယ်မြေစရိယာ နှင့် သက်ရောက်မှုရှိစေမည့်နယ်မြေစရိယာတို့အတွင်း ဖော်ထုတ်ထားသော မြေအမျိုးအစား ကို ပုံဖော်ယူရန် ဂြိုဟ်တုဓာတ်ပုံများကို အသုံးပြုခဲ့ပါသည်။ ဤမြေအမျိုးအစားများမှာ ကွင်းဆင်းလေ့လာမှုကာလတွင်း အတည်ပြုထားသည့် မြေအမျိုးအစားများ ဖြစ်ကြပါသည်။ ဖော်ထုတ်ခဲ့သည့် အဓိကမြေအမျိုးအစားများမှာ စိုက်ပျိုးမြေ၊ ဒီရေတော၊ ခြုံထူမြေ နှင့် မြက်ခင်း၊ မြို့ပြ နှင့် လူနေသောမြေ၊ ရေသေ/ရေပြည့်နေရာများ နှင့် မြစ်ကမ်းပါးနေရာတို့ ပါဝင်ပါသည်။

#### သဘာဝနေရင်းဒေသ နှင့် ပြုပြင်ထားသော နေရင်းဒေသ

IFC PS6 အရ၊ ထိခိုက်မှုဆန်းစစ်ခြင်းအဆင့်ကာလအတွင်း ဇီဝမျိုးစုံမျိုးကွဲတန်ဖိုးများအပေါ် အန္တရာယ်များ နှင့် လျှော့ချရေးများကို ဖော်ထုတ်နိုင်ရန် သဘာဝနေရင်းဒေသ နှင့် ပြုပြင်ထားသော နေရင်းဒေတို့ ပျံ့နှံ့မှုဆိုင်ရာ ဆန်းစစ်ခြင်းကို ဆောင်ရွက်ရန်လိုအပ်ပါသည်။ လက်ရှိအခြေအနေတွင် ၎င်းနေရင်းဒေသများ၏ ပျံ့နှံ့မှုကို ဆန်းစစ်ရန် ချဉ်းကပ်မှုနည်းလမ်းနှင့်ပတ်သက်၍ IFC PS6 နှင့် ၎င်းနှင့်ဆက်နွှယ်သော လမ်းညွှန်မှတ်ချက် (GN) တို့အတွင်း လုပ်နည်းလုပ်ဟန်နည်းလမ်းရှိမနေသေးပါ။

ဖော်ထုတ်ထားသော မြေယာအမျိုးအစားအပေါ် ရရှိနိုင်သော စာရွက်စာတမ်း နှင့် ကွင်းဆင်းအချက်အလက်များအရ၊ မြေယာအသုံးပြုမှုသမိုင်းကြောင်းနားလည်သဘောပေါက်မှု နှင့် နေရင်းဒေသတစ်ခုချင်းအတွင်းရှိ မျိုးစိတ်များ နှင့် အစုအဝေးများအပေါ် အခြေပြု၍ မြေယာအမျိုးအစားခွဲခြားမှုကို ဆောင်ရွက်ခဲ့ပါသည်။ အမျိုးအစားခွဲခြားမှုအတွက် အကြောင်းအရင်းကို *ဖယား ၅.၅၃* တွင် ဖော်ပြထားပါသည်။

လေ့လာမှုနယ်မြေဖရိယာ နှင့် သက်ရောက်မှုရှိစေမည့်နယ်မြေဖရိယာတို့အတွင်းရှိ သဘာဝ နေရင်းဒေသ နှင့် ပြုပြင် ထားသော နေရင်းဒေသတို့၏ စုစုပေါင်း နယ်မြေဧရိယာကို *ဖယား ၁.၇* တွင် ပြထားပါသည်။

ဇယား ၁.၇ - လေ့လာမှုနယ်မြေဒရိယာ နှင့် AoI အတွင်းရှိ သဘာဝနေရင်းဒေသ နှင့် ပြုပြင်ထားသော နေရင်းဒေသတို့၏ ဒရိယာများ

နေရင်းဒေသအမျိုးအစား	လေ့လာမှုနယ်မြေဒရိယာ (ဟက်တာ)	သက်ရောက်မှုရှိစေမည့် နယ်မြေစရိယာ (ဟက်တာ)	
သဘာဝနေရင်းဒေသ	റ.പ്ര	၁ဂ၂၈.၁၆	
ပြုပြင်ထားသော နေရင်းဒေသ	၃.၀၂	୧୨୬୦ ୧୦୦	

ကိုးကား - ERM, 2018.

#### ဒေသရင်းအပင်များ

AoI တစ်ဝိုက် နမူနာနေရာအမှတ်များအကြား ကော်ဩဒိနိတ်များကို ထောက်လှမ်းအမှတ်အသားပြုရန် ကမ္ဘာလုံး ဆိုင်ရာ နေရာချစနစ် (GPS) ကို အသုံးပြုခဲ့ပါသည်။ တည်နေရာတစ်ခုချင်း၌၊ အပင်မျိုးစိတ်များကို ထိုးဖောက်ဝင် ရောက်လာသော မျိုးစိတ်၊ မျိုးသုဉ်းလုဆဲမျိုးစိတ်၊ အရေးပါဒေသရင်းနေရာ နှင့် သဘာဝနေရင်းဒေသတိုးချဲ့မှုတို့ သတ်မှတ်မှုအပေါ် အထူးအလေးပေးမှုဖြင့် စာရင်းပြုစုခဲ့ပါသည်။ ထိန်းသိမ်းရေးအရ အကျိုးများနိုင်သော မျိုးစိတ် ပါဝင်နိုင်သည့် စိုးရိမ်ရသော ဒေသရင်းဒရိယာများ ဖော်ထုတ်ခြင်းကို မှတ်သားခဲ့ပါသည်။

စစ်တမ်းကာလအတွင်း ဒေသရင်းအပင်မျိုးစိတ် နှစ်ဆယ့်သုံး (၂၃) မျိုးကို ဖော်ထုတ်သတ်မှတ်ခဲ့ပါသည်။ သတ်မှတ် ခဲ့သော အခြား ဒေသရင်းအပင်အများစုမှာ စိုးရိမ်ရမှုအနိမ့်ဆုံး (LC)၊ အချက်အလက်မပြည့်စုံမှု (DD) သို့မဟုတ် တွက်ချက်မှုထဲမပါဝင်မှု (NE) တို့အဖြစ် သတ်မှတ်ခဲ့ပါသည်။ အရေးပါသောနေရင်းဒေသဆန်းစစ်ခြင်းအစပျိုးမှု ဖြစ်စေသည့် ထိန်းသိမ်းရေးဆိုင်ရာ အရေးပါသော မျိုးစိတ်များကို မတွေ့ရှိခဲ့ရပါ။ မှတ်တမ်းယူခဲ့သည့် မျိုးစိတ်များစာ ရင်း အပြည့်အစုံကို *ထေား ၅.၅၅* တွင် ပြထားပါသည်။ ဒေသရင်းအပင်များဆိုင်ရာ စစ်တမ်းကာလအတွင်း၊ ထိခိုက်မှု ရှိစေမည့်နယ်မြေစရိယာအတွင်း ထိုးဖော်ဝင်ရောက်လာသည့် မျိုးစိတ် ခုနှစ် (၇) မျိုးကို ဖော်ထုတ်ခဲ့ပါသည်။

#### သက်ရှိသတ္တဝါများ

ငှက်မျိုးစိတ်များ စောင့်ကြည့်လေ့လာမှုကို ခြောက်သွေ့ရာသီ စစ်တမ်းကာလအတွင်း ဆောင်ရွက်ခဲ့ပါသည်။ စောင့် ကြည့် လေ့လာမှုများကို နှစ်လုံးပြူး မှန်ပြောင်းများအသုံးပြုလျက် ပြုလုပ်ခဲ့ပါသည်။ စစ်တမ်းကာလအတွင်း ကြားခဲ့ ရသော ငှက်အော်မြည်သံများမှ ငှက်များကိုလည်း သင့်လျော်သလို ဖော်ထုတ်ခဲ့ပါသည်။ စစ်တမ်းကာလအတွင်း စုစုပေါင်း ငှက်မျိုးစိတ် ဆယ့်လေး (၁၄) မျိုးကို တွေ့ရှိခဲ့ရပါသည်။ မျိုးစိတ်များအားလုံးမှာ IUCN အနီရောင်စာရင်းတွင် စိုးရိမ်မှုအနိမ့်ဆုံးရှိသည့်အဆင့်အဖြစ် သတ်မှတ်ထားပါသည်။

နို့တိုက်သတ္တဝါမှတ်တမ်းများကို နှစ်လုံးပြူးမှန်ပြောင်းများ နှင့် ခြေရာခံမှု နှင့် ကွင်းထဲရှိ သင်္ကေတအမှတ်အသားများ အသုံးပြုလျက် ကွင်းဆင်းစစ်တမ်းကာလအတွင်း ဆောင်ရွက်ခဲ့ပါသည်။ စစ်တမ်းကာလအတွင်း နို့တိုက်သတ္တဝါ မျိုးစိတ် တစ်မျိုးကို မှတ်တမ်းယူခဲ့ပါသည်။ ၎င်းမှာ လယ်ကြွက်မျိုး (*Oligoryzomys nigripes*) ဖြစ်ပါသည်။ မြွေပါ မျိုးစိတ် (*Herpestes edwardsii*) မှာ လုပ်ငန်းအနီးတွင်ရှိကြောင်း သိရှိရသော်လည်း၊ စစ်တမ်းကာလအတွင်း မှတ်တမ်းမတွေ့ရှိခဲ့ရပါ။ မျိုးစိတ်များမှာ ထိန်းသိမ်းရေးတွက် အရေးပါကြောင်း မသတ်မှတ်ပါ။ ထို့ကြောင့် အရေးပါ သော နေရင်းဒေသဆန်းစစ်ခြင်းကို အစပျိုးမည် ဖြစ်ပါသည်။

တွားသွားသတ္တဝါ၊ ကုန်းနေရေနေသတ္တဝါမှတ်တမ်းများကိုလည်း ကွင်းဆင်းစစ်တမ်းကာလအတွင်း ကောက်ယူခဲ့ပါ သည်။ စစ်တမ်းများကာလအတွင်း စုစုပေါင်း တွားသွားသတ္တဝါမျိုးစိတ် နှစ် (၂) မျိုးကိုတွေ့ရှိခဲ့ရပြီး၊ ကုန်းနေရေနေမျိုး စိတ်များကို မတွေ့ရှိခဲ့ရပါ။ မျိုးစိတ်များအားလုံးမျာ IUCN အနီရောင်စာရင်းအရ စိုးရိမ်မှုအနိမ့်ဆုံးရှိသည့်အဆင့် သို့မဟုတ် အကဲဖြတ်မတွက်ရက်သည့်အဆင့်အဖြစ် သတ်မှတ်ထားပါသည်။

ငါးမျိုးစိတ်များကို ERM ရုံးတွင်းရှိ အချက်အလက်များမှ ယူခဲ့ပါသည်။ ဒလတွင် တံငါသည်များက များသောအားဖြင့် ဖမ်းမိသည်ဟု ဖော်ထုတ်ထားသည့် မျိုးစိတ် သုံး (၃) မျိုးတွင် ငါးပုတ်သင်မျိုး (Nibea soldado)၊ ငါးတန်မျိုး (Cryptarius truncatus)၊ နှင့် ကကူရံမျိုး (Polynemus paradiseus) တို့ပါဝင်ကြပါသည်။ ၎င်းမျိုးစိတ်များသည် IUCN အနီရောင်စာရင်း (၂၀၁၆) တွင် ဆန်းစစ်ခဲ့သည့် မျိုးစစ်များမဟုတ်ကြပါ။ စီမံကိန်းလုပ်ငန်းနေရာအနီးရှိ ရေ နေရင်းဒေသသည် မပြောပလောက်သော ဂေဟဆိုင်ရာတန်ဖိုးရှိသည်ဟု တွက်ချက်ပါသည်။

## အလွန်အရေးပါသောနေရင်းဒေသ စိစစ်မှု ဆန်းစစ်ခြင်း

အရေးပါသောနေရင်းဒေသဆန်းစစ်ခြင်းတွင် စီမံကိန်းနယ်မြေဧရိယာ၊ သက်ရောက်မှုရှိစေမည့်နယ်မြေဧရိယာ၊ တန်ဖိုး မြင့် ဇီဝမျိုးစုံမျိုးကွဲနေရင်းဒေသ၊ ထိန်းသိမ်းရေးအတွက်အရေးပါသော မျိုးစိတ်များ နှင့် အထွေထွေ သဘာဝပေါက် ပင်များ နှင့် သက်ရှိသတ္တဝါများအတွင်း ဇီဝမျိုးစုံမျိုးကွဲတန်ဖိုး လေ့လာအကဲဖြတ်မှုပါဝင် ပါသည်။ ၎င်းတွင် GIS အကဲ ဖြတ်ချက်၊ ယခင် EIA များကို ပြန်လည်သုံးသပ်မှုအပါအဝင် စာရွက်စာတမ်းများအခြေပြု အချက်အလက်စုဆောင်း ခြင်း နှင့် ကတ်မြေသားမျက်နှာပြင် နှင့် ဂူနေရင်းဒေသများ၌ ဦးတည်သော ကွင်းဆင်း စစ်တမ်းများပါဝင်ခဲ့ပါသည်။ လမ်းညွှန်ချက် အမှတ် (၆) (GN6) တွင် ဖွင့်ဆိုထားသော အရေးပါသော နေရင်းဒေသစံအညွှန်း၊ အဝိုဒ် GN69 မှ 97 အထိ ရှိပါသည်။

#### အရေးပါသော နေရင်းဒေသများ (စံအညွှန်း ၁ – ၃)

စံအညွှန်းငါးခုအနက် တစ်ခုခုနှင့် ကိုက်ညီမှုရှိသည့် နေရင်းဒေသနေရာရှိခြင်းဖြစ်ပြီး၊ ၎င်းသည် အခြားစံအညွှန်းနှင့် မကိုက်ညီသည့်တိုင်အောင် အရေးပါသော နေရင်းဒေအဖြစ် စဉ်းစားခြင်း ဖြစ်ပါသည်။ ထို့ကြောင့်၊ စံအညွှန်းတစ်ခုခု နှင့်ကိုက်ညီမှုရှိလျှင် သို့မဟုတ် စံအညွှန်းငါးခုလုံးနှင့် ကိုက်ညီသည့် ဇီဝမျိုးစုံမျိုးကွဲရှိသည့် နေရင်းဒေသဖြစ်လျှင် ၎င်းကို အရေးပါသော နေရင်းဒေသအဖြစ် ဆုံးဖြတ်နိုင်ပါသည်။ ဤချဉ်းကပ်မှုနည်းလမ်းမှာ ယေဘုယျအားဖြင့် ပိုမိုသတိထားရသော်လည်း၊ ထိန်းသိမ်းရေးပိုင်းတွင် ပိုမိုကျယ်ပြန့်စွာ အသုံးပြုကြပါသည်။ ထို့ကြောင့်၊ အရေးပါသော နေရင်းဒေသ စံအညွှန်းတွင် မတူကွဲပြားသော ဝိသေသလက္ခကာ နှစ်ရပ်ရှိပါသည်။ ပထမတစ်ခုမှာ ဇီဝမျိုးစုံမျိုးကွဲ၏ အစိတ်အပိုင်းများသည် အရေးပါသော နေရင်းဒေသ ဖြစ်သည့်၊ မဖြစ်သည့် ထိန်းသိမ်းရေးဆိုင်ရာ အရေးပါသော အဆင့် နှစ်ဆင့်သာ မဖြစ်မနေ ချမှတ်ပေးခြင်း ဖြစ်ပါသည်။ ဒုတိယတစ်ခုမှာ၊ စံအညွှန်းတစ်ခုချင်းကို မပေါင်းစပ်ဘဲ သီးခြားအသုံးပြုခြင်းဖြစ်သည်။ အဓိပ္ပါယ်မှာ အမှတ်များကို စုပေါင်း၍ပေါင်းစပ်ခြင်း မဟုတ်ပါ။

#### အရေးပါသောနေရင်းဒေသ နှင့် သင့်လျော်သော မျိုးစိတ်

စံအညွှန်း (၁) မှ (၃) အထိ အရ၊ ဆန်းစစ်ခြင်းကို အစပိုုးနိင်သည့် စစ်တမ်းများမှ မည်သည့်မျိုးစိတ်ကိုမှ ဖော်ထုတ် မတွေ့ရှိရပါ။

#### ရှိနေနိုင်သော အရေးပါသည့် နေရင်းဒေသ မျိုးစိတ် (စံအညွှန်း (၁) မှ (၃) အထိ)

စံအညွှန်း (၁) မှ (၃) အထိ အရ၊ ရှိနေနိုင်သော CH မျိုးစိတ်ဖြစ်နိုင်သည့် မည်သည့်မျိုးစိတ်ကိုမှ ဖော်ထုတ် မတွေ့ရှိရ ပါ။

## စံအညွှန်း (၅) – အရေးပါသော ဆင့်ကဲဖြစ်စဉ်များ

သက်ရောက်မှုရှိစေမည့် နယ်မြေဧရိယာ သို့မဟုတ် လေ့လာမှုနယ်မြေဧရိယာအတွင်းရှိ ဂေဟစနစ်အတွင်း၌ မည်သည့် အရေးပါသော ဆင့်ဖြစ်စဉ်များကိုမှ ဖော်ထုတ်မတွေ့ရှိရပါ။

# ၁.၆.၂ လူမှု-စီးပွားအခြေခံအချက်အလက်များ

## ၁.၆.၂.၁ အချက်အလက်များကောက်ယူခြင်း

စီမံကိန်းအခြေခံအဆောက်အအုံနှင့်အနီးတွင်ရှိသော နေထိုင်အခြေချထားမှုများသည် စီမံကိန်းလုပ်ငန်းများကြောင့် စီးပွားရေးအခွင့်အလမ်းများ၊ လူမှု နှင့် ပတ်ဝန်းကျင်အပြောင်းအလဲများ၊ ဘဝနေထိုင်မှုပုံစံအပြောင်းအလဲများ နှင့် ရပ်ရွာလူထု ကျန်းမာရေး နှင့် ဘေးကင်းရေးဆိုင်ရာ အပြောင်းအလဲများအပါအဝင် ဆိုးကျိုး နှင့် ကောင်းကျိုးတို့ကို ခံစားရနိုင်ဖွယ်ရှိပါသည်။ စီမံကိန်းမှ အဝေးတွင် တည်ရှိသော အခြား လူမှုပတ်ဝန်းကျင်များသည် စီမံကိန်းကြောင့် အကျိုးအမြတ် သို့မဟုတ် ဆိုးကျိုးသက်ရောက်မှုတို့ကိုလည်း ခံစားရနိုင်သည်။

#### လူမှုစီးပွားအခြေခံအချက်အလက်များတည်ဆောက်ရန်အထောက်အကူပြုသည့်

အချက်အလက်များကောက်ယူ ဆောင်ရွက်ခဲ့သောနေရာဖြစ်သည့် လူမှုဆိုင်ရာ သက်ရောက်မှုရှိစေနိုင်သည့်နယ်မြေဧရိယာ (SAoI) ကို သက်ဆိုင် သူများ နေထိုင်သော သို့မဟုတ် အသုံးပြုသော နေရာအဖြစ်သတ်မှတ်ပြီး၊ ၎င်းတို့အပေါ် စီမံကိန်းကြောင့် ကျောင်းကျိုး သို့မဟုတ် ဆိုးကျိုးတို့ကို ဖြစ်ပေါ် စေနိုင်ပါသည်။

ဤအပိုင်းတွင် တင်ပြထားသည့် သတင်းအချက်အလက်များမှာ အများပြည်သူများ ရရှိနိုင်သော အရင်းအမြစ်များ စာရွက်စာတမ်းကို ပြန်လည်သုံးသပ်ခြင်းဖြင့် ကောက်ယူထားခြင်း ဖြစ်ပါသည်။ စီမံကိန်းနယ်မြေဧရိယာရှိ လူမှု၊ နင့် ယဉ်ကျေးမူအမွေအနစ်ဆိုင်ရာ အခြေအနေများကို ပိုမိုတိကျစွာ လူမူစီးပွား၊ ကျန်းမာရေး နားလည်သဘော ပေါက်နိင်ရန်၊ ၂၀၁၈ နိဝင်ဘာလ ၁၅ မှ ၁၉ ရက်နေ့အထိ ပထမအကြိမ် အများပြည်သူနင့် ာ အဝေးပြီးနောက် တိုင်ပင်ဆွေးနွေးမှုအစည်း မူလအချက်အလက်များကို ကောက်ယူခဲ့ပါသည်။ မူလအချက်အလက်များကောက်ယူသည့် နည်းလမ်းများတွင် အိမ်ထောင်စုဆိုင်ရာမေးခွန်းများ၊ အရေးပါသော သတင်း အချက်အလက်များပေးနိင်သူများနှင့် မျက်နာချင်းဆိုင် အင်တာဗျူးများ နှင့် သတ်မှတ်ထားသော အင်တာဗျူးဖြေဆို ටේරිාවේග් အရေးပါသော နင့် အဖွဲ့လိုက်ဆွေးနွေးမှုတို့ ပါသည်။ သူများ သက်ဆိုင်သူများတွင် ကျေးရွာခေါင်း ဆောင်၊ အမျိုးသမီး၊ တံငါသည်၊ သူနာပြုဆရာမ/ကျန်းမာရေးလုပ်သားများ နှင့် ဒေသတွင်းကျေးရွာများရှိ တောင်သူ များ ပါဝင်ကြပါသည်။ ဒလ၊ ဆိပ်ကြီးခနောင်တို နှင့် အလုံမြို့နယ်တို့တွင် အိမ်ထောင်စုဆိုင်ရာမေးခွန်းများမေးမြန်မှု ၁၅ပ၊ အုပ်စုလိုက်ဆွေးနွေးမှု အရေးပါသော ၁၁ ခု၊ နင့် သတင်းအချက်အလက်များပေးနိုင်သူများနှင့် အင်တာဗျူးများ ကို ဆောင်ရွက်ခဲ့ပါသည်။

#### လူမှုပတ်ဝန်းကျင်များ

မြန်မာနိုင်ငံသည် ပြည်နယ် နှင့် တိုင်းဒေသကြီးများ (တစ်ခါတစ်ရံတွင် တိုင်းဟုလည်း ခေါ်သည်) ဖြစ်ဖွဲ့စည်းထားပြီး၊ အုပ်အုပ်ရေးဆိုင်ရာနည်းလမ်းများအတွက် နောက်ထပ်မြို့နယ်များအဖြစ် ပိုင်းရြားထားပါသည်။ စီမံကိန်းနေရာသည် ရန်ကုန်တိုင်းဒေသကြီးရှိ ရန်ကုန်၊ ဆိပ်ကြီးခနောင်တို နှင့် ဒလမြို့နယ်တို့၌ တည်ရှိပါသည်။ အခြေခံအချက်အ လက် များကို စီမံကိန်းနေရာ နှင့် / သို့မဟုတ် စီမံကိန်းနှင့်ဆက်နွှယ်သောနေရာအဆောက်အအုံများနှင့် နီးကပ်မှုကြောင့် စီမံကိန်းမှ သက်ရောက်မှုရှိနိုင်သည့် ပတ်ဝန်းကျင်များအပေါ် အလေးပေးဆောင်ရွက်ခဲ့ပါသည်။ နေရာများမှာ အောက် ပါတို့ပါဝင်ပါသည် -

- ဒလကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅၀၀ အတွင်း တည်ရှိသည်၊
- သပြေကုန်းကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅၀၀ နှင့် ဓာတ်အားစက်ရုံမှ ၃ ကီလိုမီတာအတွင်း တည်ရှိသည်၊
- ညောင်ငုတ်တိုကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅ဂဂ နှင့် ဓာတ်အားစက်ရုံမှ ၃ ကီလိုမီတာအတွင်း တည်ရှိသည်၊
- ရဲချောင်းဝကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅ဂဂ အတွင်း
   တည်ရှိသည်၊
- ပျော်ဘွယ်ကြီးကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅၀၀ အတွင်း
   တည်ရှိသည်၊
- ရွှေလှေချောင်းကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅ပပ အတွင်း
   တည်ရှိသည်၊
- တုံးတင်ဂန် (မြောက်) ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅၀၀ အတွင်း တည်ရှိသည်၊
- တုံးတင်ဂန် (တောင်) ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅၀၀ နှင့် LNG ဂိတ်၏ ၃ ကီလိုမီတာအတွင်း တည်ရှိသည်၊
- ရခင်ချောင်း (မြောက်) ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅ပပ
   နှင့် LNG ဂိတ်၏ ၃ ကီလိုမီတာအတွင်း တည်ရှိသည်၊
- ညောင်ရောင်းကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅၀၀ အတွင်း နှင့် LNG ဂိတ်တည်နေရာတွင်တည်ရှိသည်၊
- ဆိပ်ကြီးခနောင်တိုကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ပိုက်လိုင်း၏ အနားတစ်ခုချင်းမှ ထောင့်မှန် မီတာ ၅ပပ နှင့် ဓာတ်အားစက်ရုံမှ ၃ ကီလိုမီတာအတွင်း တည်ရှိသည်၊
- အလုံကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုမှာ ဓာတ်အားစက်ရုံရှိသည့်နေရာတွင် တည်ရှိသည်၊
- ထော (အောက်) ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ကျောင်းဝိုင်းကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ကျွန်းကလေး ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- အလတ်ချောင်း ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ကြည့်မြင်တိုင် ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊

- စမ်းချောင်းကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ဒဂုံကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ကမာရွတ် ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ဗဟန်းကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- မင်္ဂလာတောင်ညွှန့် ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- လသာ ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- လမ်းမတော် ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ဆိပ်ကမ်းကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ပန်းပဲတန်းကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ကျောက်တံတားကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ပုဇွန်တောင်ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်၊
- ဘိုတစ်ထောင်ကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်။ ထို့ပြင်၊
- ဗဟန်းကျေးရွာအုပ်စု။ ကျေးရွာအုပ်စုသည် ဓာတ်အားစက်ရုံ၏ ၃ ကီလိုမီတာအတွင်း ရှိသည်။

## ၁.၆.၂.၂ မွေးဖွားမှု၊ သေဆုံးမှုလေ့လာချက်

တိုင်းဒေသကြီးသည် ၁၀၁၇၁.၃၀ စတုရန်းကီလိုမီတာခန့်ရှိပြီး၊ ခရိုင် (၄) ခု (မြောက်ရန်ကုန်၊ အရှေ့ရန်ကုန်၊ အ နောက်ရန်ကုန် နှင့် တောင်ရန်ကုန်)၊ မြို့နယ် ၃၃ ခု၊ ရပ်ကွက် ၇၄၂ ခု နှင့် ကျေးရွာ ၂၁၇၀ အဖြစ် ခွဲထားပါသည်။ စုစုပေါင်းလူဦးရေမှာ ၇ သန်းရှိပြီး၊ အမျိုးသမီး ၅၂.၂% ရှိပါသည်။ နိုင်ငံသားများ၏ အများစုအသက်ရွယ်မှာ ၁၅-၆၄ နှစ်ရှိသူများဖြစ်ပါသည်။

လေ့လာမှုနယ်မြေစရိယာရှိ လူဦးရေအများစုမှာ ဗမာလူမျိုးများဖြစ်ပြီး၊ ဗမာလူမျိုးများသည် မြန်မာနိုင်ငံတွင် လူများစု တိုင်းရင်းသားအုပ်စုဖြစ်ပါသည်။ လူဦးရေမှာ ၃၀၁၁၀၀၀၀ ကျော်ရှိပါသည်။ သို့ရာတွင်၊ လေ့လာမှုဖရိယာအတွင်း ကရင်၊ မွန် နှင့် ရခိုင်အနည်းငယ် ရှိပါသည်။

## ၁.၆.၂.၃ အသက်မွေးဝမ်းကျောင်း နှင့် စီးပွားရေး

စိုက်ပျိုးရေးလယ်ကွင်းများတွင် ပဲတောင့်များ နှင့် ပဲများမှာ အဓိကကောက်ပဲသီးနှံထွက်ကုန်များဖြစ်ကြသည်။ အခြား စိုက်ပျိုးရေးလုပ်ငန်းများတွင် ဂုန်လျှော်၊ ရာဘာ၊ မြေပဲ နှင့် ကြံပင်များ ပါဝင်ကြပါသည်။ ရန်ကုန်မြစ်တစ်လျှောက်တွင် ဆန်စက်များ နှင့် သစ်စက်များကို တွေ့ရှိရပါသည်။

အသေးစားငါးဖမ်းလုပ်ငန်းများသည် စီမံကိန်းလုပ်ငန်းနေရာများအပါအဝင် ရန်ကုန်မြစ်အတွင်း ဆောင်ရွက်ကြပါသည်။ တံငါသည်များသည် ရိုးရာပိုက်ကွန်များအသုံးပြု၍ ငါးဖမ်းဆောင်ရွက်မှုမှ တစ်ရက်လျှင် ၂၀၀၀၀ ကျပ်ခန့် (အမေရိကန် ဒေါ်လာ ၁၇ ဒေါ်လာခန့်) ရရှိကြောင်း သိရှိရပါသည်။ မြန်မာနိုင်ငံ၌ ရန်ကုန်သည် စီမံကိန်းလုပ်ငန်းနေရာအနီးရှိ အလုံ မြို့နယ်ရှိ စံပြတွင် ငါးဈေးတို့ဖြင့် ငါးအတင်အချပြုလုပ်လုပ်သည့် အဓိကနေရာဖြစ်ပါသည်။

ရန်ကုန်ရှိ အမျိုးသား (၄.၃%) နှင့် အမျိုးသမီး (၃.၉%) တို့အကြား အလုပ်လက်မဲ့နှုန်းမှာ တူညီမှုရှိသလောက်ဖြစ်ပြီး၊ လုပ်အားရှိ အမျိုးသားရာခိုင်နှုန်း (၈၁.၈%) သည် အမျိုးသမီးရာခိုင်နှုန်း (၄၆.၄%) ထက် သိသိသာသာ ပိုများပါသည်။ အကြောင်းမှာ ရန်ကုန်သည် မြန်မာနိုင်ငံတွင် နိုင်ငံခြားကုန်သွယ်မှုများစွာအတွက် ကိုင်တွယ်မှု နှင့် ကုန်သွယ်မှုအတွက် အဓိကဗဟိုဖြစ်သောကြောင့် ဖြစ်ပါသည်။

# ၁.၆.၂.၄ အသုံးဝန်ဆောင်လုပ်ငန်းများ

# လျှပ်စစ်မီး

၂၀၁၇ တွင် ရန်ကုန်တိုင်းဒေသ၏ အိမ်ထောင်စု၏ ၈% တွင် မဟာဓာတ်အားလိုင်းကို မရရှိကြပါ။ ၁၃% မှာ ဓာတ်အား လိုင်းနှင့်မရိုတ်ဆက်ဘဲ လျှပ်စစ်မီးကို အသုံးပြုကြပါသည်။ ၇၉% မှာ ဓာတ်အားလိုင်းကို ချိတ်ဆက်နိုင်ပြီး လျှပ်စစ်မီး ရရှိကြကြောင်း သိရပါသည်။

ရန်ကုန် ပုံမှန် အိမ်ထောင်စုများ၏ အများစုသည် မီးအလင်းရင်းမြစ်အဖြစ် လျှပ်စစ်ကို အသုံးပြုကြပါသည်။ ၎င်းတို့ထဲမှ အလုံတွင် မီးအလင်းအတွက် လျှပ်စစ်မီးအသုံးပြုမှု အမြင့်ဆုံးရာခိုင်နှုန်းရှိပါသည်။ ဒလတွင်၊ မြို့ပြဇရိယာ (၆၂%) နှင့် ကျေးလက်ဧရိယာ (၁၈.၇%) တို့အကြား လျှပ်စစ်အသုံးပြုမှု၏ သိသာသောကွာဟချက်ရှိပါသည်။ အကြောင်းမှာ၊ ကျေးလက်ဧရိယာရှိ အိမ်ထောင်စုများမျာ မီးအလင်းရင်းမြစ် (၂၇.၆%) အဖြစ် အဓိက ဘက်ထရီကို အသုံးပြုကြသော ကြောင့်ပါသည်။

## ရေသွင်းစိုက်ပျိုးရေးအတွက်ရေ

စိုက်ပျိုးရေး နှင့် ဆည်မြောင်းဝန်ကြီးဌာန၏ ဆည်မြောင်းဦးစီးဌာသည် ရေလှောင်ကန်များ၊ ဧရာဝတီမြစ် နှင့် မြေ အောက်ရေအောင်းလွှာများအပါအဝင် ရန်ကုန်ရှိ ရေရင်းမြစ်သုံးနေရာကို ဖော်ထုတ်ထားပါသည် (ဆည်မြောင်း ဦးစီးဌာန၊ စိုက်ပျိုးရေး နှင့် ဆည်မြောင်းဝန်ကြီးဌာန၊ မြန်မာနိုင်ငံ၊ ၂၀၁၀)။ ရေရင်းမြစ်စနစ်၏ ၉၀% ခန့်မှာ ရေလှောင် ကန်မှ မြေပေါ်ရေဖြစ်ပြီး၊ ကျန်ရေများမှာ ရေဖြန့်ဝေရေးစနစ်ဖြင့် ဖြည့်စွက်ထားသည့် အဝီစိတွင်းများမှ မြေအောက်ရေ များဖြစ်ကြပါသည်။

#### သုံးရေ

သုံးရေများမျာ မိုးရေ၊ ပြည်လည်အသုံးပြုသည့်ရေ နှင့် စွန့်ပစ်ရေတို့ဖြစ်ကြသည်။ ၎င်းရေမှာ လူသောက်သုံးရန် မသင့် လျော်ပါ။ သို့ရာတွင်၊ ၎င်းကို အဝတ်လျှော်ခြင်း၊ အိမ်သာဆေးခြင်း၊ အညစ်များဆေးချခြင်း၊ သို့မဟုတ် အပင်များရေ လောင်းခြင်းတို့အတွက် အသုံးပြုနိုင်ပါသည်။ ရန်ကုန်တိုင်းဒေသကြီးတွင်၊ အိမ်ထောင်စုများသည် များသောအားဖြင့် သုံးရေကို အဝီစိတွင်း သို့မဟုတ် တွင်းနက်များမှတစ်ဆင့် ရယူကြပါသည်။

#### သောက်ရေ

၂၀၁၄ ခုနှစ် MIMU အချက်အလက်များအရ၊ ရန်ကုန်သည် မြန်မာနိုင်ငံတွင် သောက်သုံးရေးကို လက်လမ်းမီရရှိနိုင် (၈၂%) သော လူဦးရေရာခိုင်းနှုန်းအမြင့်ဆုံးရှိသည့် ဒေသများအနက် တစ်ခုဖြစ်ကြောင်း ဖော်ပြထားပါသည်။ တစ်ချိန် တည်းမှာပင်၊ ရေရင်းမြစ်သို့ရောက်ရှိရန် ရန်ကုန်ရှိ နိုင်ငံသားများ၏ ၁၄%သည် ၁၀ မိနစ်အောက် အချိန်ကုန်ပြီး၊ ၃% နှင့် ၁% တို့မှာ ၁၁ မိနစ် မှ မိနစ် ၂၀ နှင့် မိနစ် ၂၀ အထက် အသီးသီး အချိန်ယူကြရပါသည်။

#### မိလ္လာရေးဆိုးနတ်စနစ် နှင့် အိမ်သာအဆောက်အအုံများ

ရန်ကုန်တွင် စုစုပေါင်းအိမ်ထောင်စု၏ ၆၈%မှာ အခြေခံမိလ္လာစနစ်ကို အသုံးပြုနိုင်သည်။ ၎င်းမှာ တိုးတက်ကောင်းမွန် သော ကိုယ်ပိုင်အိမ်သာ နှင့် သန့်စင်ရေးအဆောက်အအုံများကို ရည်ညွှန်းသည်။ ၂၀၁၄ တွင်၊ ရေလုံအိမ်သာ (ကောင်း မွန်သည့်တွင်းသုံးအိမ်သာ) မှာ ရန်ကုန်တိုင်းဒေသကြီး၌ အသုံးအများဆုံးအဆောက်အအုံအမျိုးအစားဖြစ်ပါသည်။ ထို့ပြင်၊ လူဦးရေ၏ ၉၀% သည် ဆပ်ပြာ နှင့် ရေသုံးလျက် လက်ဆေးနိုင်သောနေရာ အသုံးပြုနိုင်ကြပါသည်။

## ၁.၆.၂.၅ သယ်ယူပို့ဆောင်ရေး

ရန်ကုန်တွင် ကွန်ကရိတ်လမ်းမကြီး၊ လမ်းကျဉ်း၊ ကတ္တရာလမ်း သို့မဟုတ် မြေသားလမ်းများ၊ ရန်ကုန်မြစ်ကိုဖြတ်သည့် တံတားငါးစင်း၊ ဂိတ်နှစ်ခုပါသည့် အပြည်ပြည်ဆိုင်ရာလေဆိပ် နှင့် ပြည်တွင်းလေဆိပ်၊ မီးရထားလမ်းများ၊ ဆိပ်ကမ်း လေးခု၊ ဘတ်စ်ကားလိုင်းများ နှင့် တက္ကစီများအပါအဝင် သယ်ယူပို့ဆောင်မှုအဆောက်အအုံမှာ များပြားပါသည်။

ဒလ နှင့် ဆိပ်ကြီးခနောင်တိုမှ ရန်ကုန်သို့ မနက် ၅း၃၀ မှ ညနေ ၈း၀၀ အထိ နေ့စဉ် ဖြတ်ကူးသည် ရေယာဉ်အစီး ၁၀၀ ခန့် ရှိပါသည်။ ခရီးမှာ ဆိပ်ကြီးကနောင်တိုမှ ရန်ကုန်သို့ ၁၅ မိနစ်ခန့် ကြာမြင့်ပါသည်။ ဒလ သို့မဟုတ် ဆိပ်ကြီး ခနောင် တို မှ ရန်ကုန်သို့ ကားဖြင့်သွားလျှင် (ယာဉ်ကြောပိတ်မှုအပေါ် မူတည်၍) အချိန် ၂ နာရီခန့်ကြာမြင့်ပါသည်။

## ၁.၆.၂.၆ ယဉ်ကျေးမှုအမွေအနစ်

ရန်ကုန်တိုင်းဒေသကြီးတွင် ယဉ်ကျေးမှုအရ အထင်ကရဇရိယာများရှိပါသည်။ အထူးသဖြင့် ဗုဒ္ဓဘာသာနေရာ အ ဆောက် အအုံများဖြစ်ကြပါသည်။ ဤဇရိယာများတွင် ဘုရားပုထိုးများ နှင့် ဘုန်းကြီးကျောင်းများကို တွေ့ရှိရပြီး၊ ၎င်းတို့မှာ ဒေသခံရပ်ရွာများအတွက် အရေးပါသောယဉ်ကျေးမှုနေရာများအဖြစ် စဉ်းစားပါသည်။ စီမံကိန်းလုပ်ငန်းခွင် နေရာ၏ ၅ ကီလိုမီတာအတွင်း ရွှေတိဂုံ သို့မဟုတ် ဆူးလေဘုရားတို့တို့ကဲ့သို့သော အရေးပါသော ယဉ်ကျေးမှုအမွေ အနှစ်နေရာအဆောက်အအုံအတော်အတန်ရှိပါသည်။ စီမံကိန်းလုပ်ငန်းခွင်နေရာများတွင် ယဉ်ကျေးမှုအမွေအနှစ် နေရာများ မရှိပါ။

# ၁.၆.၂.၇ ပညာရေး

အထက်ဖော်ပြပါစရိယာများရှိ အခြေခံပညာရေးစနစ်သည် မြန်မာနိုင်ငံ၏အခြားနေရာနှင့် တစ်ထပ်တည်းကျပြီး၊ အမျိုး သား ပညာရေးစနစ်နှင့်အညီ ဖြစ်ပါသည်။ ကျောင်းတက်ကာလမှာ ဆယ်တစ်နှစ်ဖြစ်ပြီး၊ ပညာရေးစနစ်ကို ၅-၄-၂ ဟု ခေါ်ပါသည်။ ၎င်းမှာ မူလတန်းကို ၅ နှစ်၊ အလယ်တန်းကို ၄ နှစ် နှင့် အထက်တန်းကို ၂ နှစ် တို့ဖြစ်ကြသည်။ ၂၀၁၇ တွင်၊ မြန်မာနိုင်ငံသည် အာဆီယံနိုင်ငံများနှင့်တူညီစေရန် ၅-၄-၃ စနစ်သို့ပြောင်းရန် အစီအစဉ်ရှိပါသည်။ ဤအစီအ စဉ် သည် ကျောင်းတက်ကာလကို ၁၁ နှစ် မှ ၁၂ နှစ် အထိ ဖြစ်သွားမည် ဖြစ်ပါသည်။

ရန်ကုန်တိုင်းဒေသကြီးရှိ ၂၊၁၄ အချက်အလက်များအရ၊ အသက် ၁၅ နှစ် နှင့် အထက်ရှိ နိုင်ငံသားများ၏ စာတတ် မြောက်မှုနှုန်း မှာ ၉၆% ရှိပြီး၊ ၎င်းမှာ အမျိုးသား စာတတ်မြောက်မှုနှုန်း (၉၈%) နှင့် အမျိုးသမီး စာတတ်မြောက်မှုနှုန်း (၉၅%) တို့မှ တွက်ချက်ထားခြင်း ဖြစ်ပါသည်။ ကျောင်းအရေအတွက် စုစုပေါင်းမှာ ၂၇၁၇ ကျောင်းရှိပြီး၊ အထက်တန်း ၁၉၈ ကျောင်း၊ အလယ်တန်း ၂၂၅ ကျောင်း နှင့် မူလတန်း ၂၂၆၄ ကျောင်းတို့ ဖြစ်ကြပါသည်။ ၂၀၁၄ တွင် MIMU အချက်အလက်များအရ နိုင်ငံသားအများစုသည် မူလတန်းအဆင့်ကို ပြီးမြောက်ခဲ့သူများ ဖြစ်ကြသည်။

# ၁.၆.၂.၈ ကျန်းမာရေး၊ ကျန်းမားရေးဆိုင်ရာနေရာအဆောက်အအုံများ နှင့် လုံခြုံရေး

၂၀၁၆ တွင်၊ ရန်ကုန်တိုင်းဒေသကြီး၌ ဆေးရုံ ၈၅ ရုံ၊ ခွင့်ပြုသည့်ကုတင် ၁၁၆၁၀ လုံး၊ ရှိသောကုတင် ၁၂၂၆၀ လုံး၊ ဝင်ခွင့်ပြုသူဦးရေ ၅၂၇၃၀၈ ဦး၊ ဆေးရုံမှဆင်းသူ နှင့် သေဆုံးသူ ၅၂၅၈၅၁ နှင့် လူနာရက်များ ၃၅၃၇၂၇၆၊ သေဆုံးမှု အရေအတွက် ၁၆၆၅၆ နှင့် ဆေးရုံတွင်းသေဆုံးမှုနှုန်း ၃.၂% နှင့် အပြင်လူနာ ၂၅၁၆၇၆၇ ဦးတို့ဖြစ်ကြပါသည်။ ဤနေရာတွင် ဆေးရုံတွင်းသေဆုံးမှုနှုန်းကို သေဆုံးသည့်အရေအတွက် နှင့် ဆေးရုံမှဆင်းသူ နှင့် သေဆုံးသူအရေ အတွက်တို့အကြား တွက်ချက်ထားမှုဖြစ်ပါသည်။ ခွင့်ပြုသည့်ကုတင်မှာ ဆေးရုံ၏ တရားဝင်ကုတင်ပမာဏဖြစ်ပါသည်။ ကျန်းမာရေးအဆောက်အအုံများ နှင့် ဆေးရုံများနှင့်ပတ်သက်၍၊ ရန်ကုန်ရှိ ကလေးငယ် ၇၀ ရာခိုင်နှုန်းမှာ ကျန်းမာရေး အဆောက်အအံများအတွင်း မွေးဖွားခဲ့ကြခြင်း ဖြစ်ပါသည်။

# ၁.၆.၂.၉ အခြေခံအဆောက်အအုံ နှင့် သာယာအဆင်ပြေမှုများ

ရန်ကုန်တွင် ဆိပ်ကမ်း၊ သီလဝါရေနက်ဆိပ်ကမ်း၊ လေဆိပ်၊ လမ်းများ၊ တံတားများ၊ ကုန်းကျော်တံတားများ၊ အမြန် လမ်း၊ နှင့် ရန်ကုန်မြစ် နှင့် ဧရာဝတီမြစ်ကိုဆက်ထားသော တွံတေးတူးမြောင်းတို့အပါအဝင် သယ်ယူပို့ဆောင်ရေးအ ခြေခံ အဆောက်အအုံအမျိုးမျိုးရှိပါသည်။ အရေးကြီးသည်မှာ အမြန်လမ်းလိုင်းငါးခု၏ဂိတ်ဖြစ်သည်။ ရန်ကုန်တိုင်းဒေ သကြီးနှင့် မြန်မာနိုင်ငံရှိ အခြားဒေသတို့ကို ချိတ်ဆက်ထားသော လမ်းများစွာရှိပါသည်။ ထို့ပြင်၊ ရန်ကုန်သို့ကျေးလက် မှ လာရောက်နိုင်ကြသည်မှာ ၆၀% ရှိကြောင့် အစီရင်ခံစာအရသိရပါသည်။ အာဆီယံဇွံ့ဖြိုးရေးဘက်အရ၊ ကျေးလက်မှ လာရောက်နိုင်သည့်အညွှန်းကိန်း (RAI) သည် "ရာသီဥတုမရွေးအသုံးပြုနိုင်သောလမ်း၏ ၂ ကီလိုမီတာ အကွာအောက် နေထိုင်ကြသော ကျေးလက်လူဦးရေပမာဏဖြစ်ကြောင်းပြသည့် နိုင်ငံတကာအသုံးပြုသည့် အညွှန်း ကိန်း" ဖြစ်ပါ သည်။

#### ၁.၇ အဓိကအရေးပါသော ပတ်ဝန်းကျင် နှင့် လူမှု ဆိုင်ရာ ထိခိုက်မှုဆန်းစစ်ခြင်း

တည်ဆောက်ရေး နှင့် လည်ပတ်ရေးလုပ်ငန်းများအားလုံးသည် ဖြစ်နိုင်ခြေရှိသော ပတ်ဝန်းကျင် နှင့် လူမှုဆိုင်ရာ သက်ရောက်မှုများကို ဖော်ထုတ်သတ်မှတ်ခဲ့ပြီး၊ ၎င်းတို့၏ ပမာဏ၊ ကာလ နှင့် ဖြစ်ပေါ် လာနိုင်သော ဇီဝပတ်ဝန်း ကျင်တို့ကို ဆန်းစစ်ရန် အကဲဖြတ်ဆောင်ရွက်ခဲ့ပါသည်။ LNG လက်ခံရေးဂိတ်၊ ပိုက်လိုင်း၊ နှင့် ဓာတ်အားစက်ရုံတို့ အတွက် ပတ်ဝန်းကျင် နှင့် လူမှု ဆိုင်ရာ သက်ရောက်မှုများကို **အခန်း ၇၊ စ** နှင့် ၉ တို့တွင် ဆန်းစစ်ထားပါသည်။

#### ၁.၇.၁ LNG လက်ခံရေးဂိတ်

သဘာဝမျက်နှာသွင်ပြင် နှင့် လူမှု ပတ်ဝန်းကျင်တို့အားလုံးအတွက် သက်ရောက်မှု၏အရေးပါမှုကို *ဖယား ၁.၈* တွင် အကျဉ်းဖော်ပြထားပါသည်။

	သက်ရောက်မှုအမည်		သက်ရောက်မှု၏အရေးပါမှု		
ပတဝနးကျငများ		အဆင့	မလျှော့ချမီ	လျှော့ခ <mark>ျပ</mark> ြီးနောက်	
လေထု	မြေဖုန်ထခြင်း	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်	
	လူကျန်းမာရေး	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်	
	ဂေဟစနစ်	တည်ဆေ ာက်ရေး	အတန်အသင့်	မပြောပလောက်	
	မြေဖုန်ထခြင်း	လည်ပတ်ရေး	သာမည	မပြောပလောက်	
	လူကျန်းမာရေး	လည်ပတ်ရေး	သာမည	မပြောပလောက်	
	ဂေဟနစ်	လည်ပတ်ရေး	အတန်အသင့်	မပြောပလောက်	
GHG	GHG ထုတ်လွှတ်မှုများ	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်	
	GHG ထုတ်လွှတ်မှုများ	လည်ပတ်ရေး	သာမည	သာမည	

## ဇယား ၁.၈ - သဘာဝမျက်နှာသွင်ပြင် နှင့် လူမှု ပတ်ဝန်းကျင်များအတွက် သက်ရောက်မှု၏ အရေးပါမှု အကျဉ်းဖော်ပြချက်

	20050000	အဆင့်	သက်ရောက်မှု၏အရေးပါမှု	
ပိုင်ငံစုလိုရှင်များ	200000000439900		မလျှော့ချမီ	လျှော့ခ <mark>ျပ</mark> ြီးနောက်
ဆူညံသံ	သယ်ယူပို့ဆောင်ရေး	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	အုတ်မြစ်ချခြင်း နှင့် တည်ဆောက်ခြင်း	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	လည်ပတ်ခြင်း	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်
မြေပေါ် ရေ	ရေရယူခြင်းသတ်မှတ်ချက်	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	ရေရယူခြင်းသတ်မှတ်ချက်	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်
	စွန့်ပစ်ငရ	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်
	ရေအေးစွန့်ထုတ်ခြင်း	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်
	တိုက်စားမှုကြောင့် ဖြစ်ပေါ် သည့် နန်းအနည်ကျခြင်း	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	အောက်ခံလုပ်ခြင်းကြောင့် ဖြစ်ပေါ် သည့် နန်းအနည်ကျခြင်း	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
မြေဆီလွှာ	ရေအေးမတော်တဆယိုစိမ့်မှုများ	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်
နှင့် မြေအောက်ရေ	လုပ်ငန်းခွင်ရှင်းလင်းမှု နှင့် တူးဖော်မှုကာလအတွင်း စိမံခန့်ခွဲမှု စနစ်မကျခြင်းကြောင့် မြေဆီလွှာ ဆုံးရှုံးခြင်း	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
<u>စွန့်</u> ပစ်ပစ္စည်း	စနစ်မကျသော ဇီဝပမာက (biomass) စီမံခန့်ခွဲခြင်း	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	အန္တရာယ်ရှိသော စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	တည်ဆေ ာက်ရေး	အတန်အသင့်	သာမည
	အွန္တရာယ်ရှိသော စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	လည်ပတ်ရေး	သာမည	မပြောပလောက်
	အွန္တရာယ်မရှိသော စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	တည်ဆေ ာက်ရေး	အတန်အသင့်	သာမည
	အွန္တရာယ်မရှိသော စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	လည်ပတ်ရေး	သာမည	မပြောပလောက်
	အိမ်တွင်း အစဉ်အခဲ စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	လည်ပတ်ရေး	အတန်အသင့်	သာမည
	အိမ်တွင်း အရည် စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	လည်ပတ်ရေး	သာမည	မပြောပလောက်
ရှုခင်းရှုကွက်	တည်ဆောက်ရေး	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	လည်ပတ်ရေး	လည်ပတ်ရေး	သာမည	မပြောပလောက်

2 - 2 - 2 - 2	သက်ရောက်မှုအမည်	အဆင့်	သက်ရောက်မှု၏အရေးပါမှု	
ပတ္ေျငများ			မလျှော့ချမီ	လျော့ချပြီးနောက်
ဇီဝမျိုးစုံမျိုးကွဲ	နေရင်းဒေသ အမြဲတမ်း နှင့် ယာယီ ဆုံးရှုံးမှု	N/A	သာမည	မပြောပလောက်
	သက်ရှိသတ္တဝါများ ယာယီ အနောင့်အယှက်ဖြစ်မှု သို့မဟုတ် နေရာပြောင်းရွှေ့ရမှု	N/A	မပြောပလောက်	မပြောပလောက်
	နေရင်းဒေသ အရည်အသွေးကျဆင်းခြင်း	N/A	မပြောပလောက် အဆင့် မှ သာမည အဆင့်	မပြောပလောက်
	ဒေသရှိ မျိုးစိတ်သေစေနိုင်ခြင်း	N/A	မပြောပလောက် အဆင့် မှ သာမည အဆင့်	မပြောပလောက်
လူမှု	အလုပ်အကိုင်	တည်ဆေ ာက်ရေး	အပြုသဘော	-
	အလုပ်အကိုင်	လည်ပတ်ရေး	အပြသဘော	-
	ငါးဖမ်းလုပ်ငန်း	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	ငါးဖမ်းလုပ်ငန်း	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်
	စီးပွားခေး ဖယ်ရှားပစ်ခြင်း	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	ရှိနေပြီးသော နေရာအဆောက် အအုံ များ နှင့် ဝန်ဆောင်လုပ်ငန်းများ	တည်ဆေ ာက်ရေး	အတန်အသင့်	သာမည
	ရှိနေပြီးသော နေရာအဆောက်အအုံ များ နှင့် ဝန်ဆောင်လုပ်ငန်းများ	လည်ပတ်ရေး	အတန်အသင့်	မပြောပလောက်
	ပတ်ဝန်းကျင်ဆိုင်ရာ ထုတ်လွှတ်မှု	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	ရပ်ရွာလူထု ကျန်းမာရေး နှင့် ဘေးကင်းရေး	တည်ဆေ ာက်ရေး	အတန်အသင့်	သာမည
	ရပ်ရွာလူထု ကျန်းမာရေး နှင့် ဘေးကင်းရေး	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်
	လုပ်ငန်းခွင် ကျန်းမာရေး နှင့် ဘေးကင်းရေး	တည်ဆေ ာက်ရေး	အတန်အသင့်	သာမည
	လုပ်ငန်းခွင် ကျန်းမာရေး နှင့် ဘေးကင်းရေး	လည်ပတ်ရေး	သာမည	သာမည
	ရေကြောင်းသွားလာမှု	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	ရေကြောင်းသွားလာမှု	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်
	ယာဉ်အသွားအလာ နှင့် သယ်ယူပို့ဆောင်ရေး	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်

ပတ်ဝန်းကျင်များ	သက်ရောက်မှုအမည်	အဆင့်	သက်ရောက်မှု၏အရေးပါမှု	
			မလျော့ချမီ	လျှော့ချပြီးနောက်
	ယဉ်ကျေးမှုအမွေအနစ်	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
စီစဉ်မထားသည့် ဖြစ်ရပ်	ရေယာဉ်တိုက်မိမှု	အားလုံး	အတန်အသင့်	သာမည
	ဓာတု ယိုဖိတ်မှု သို့မဟုတ် ယိုစိမ့်မှု	အားလုံး	သာမည	မပြောပလောက်
	မီးလောင်းခြင်း နှင့် ပေါက်ကွဲခြင်း	အားလုံး	အရေးပါ	သာမည
	ဆိုက်စမစ် နှင့် မြေငလျင်	အားလုံး	အရေးပါ	အရေးပါ
	အပူပိုင်းမုန် တိုင်း နှင့် ပြင်းထန်သော ရာသီဥတုအခြေအနေများ	အားလုံး	အတန်အသင့်	သာမည
	လုပ်ငန်းခွင်အတွင်း ဓာတုသိုလှောင် သည့် နေရာအဆောက်အအုံများ ကန့်သတ်ထိန်းချုပ်မှု ပျက်စီးခြင်း	အားလုံး	သာမညအဆင့်မှ အတော်အသင့် အဆင့်	မပြောပလောက် အဆင့် မှ သာမည အဆင့်

# ၁.၇.၂ రိုက်လိုင်း

သဘာဝမျက်နာသွင်ပြင် နှင့် လူမှု ပတ်ဝန်းကျင်တို့အားလုံးအတွက် သက်ရောက်မှု၏အရေးပါမှုကို *ဖယား ၁.၉ တွင်* အကျဉ်းဖော်ပြထားပါသည်။

## ဇယား ၁.၉ - သဘာဝမျက်နှာသွင်ပြင် နှင့် လူမှု ပတ်ဝန်းကျင်များအတွက် သက်ရောက်မှု၏ အရေးပါမှု အကျဉ်းဖော်ပြချက်

ပတ်ဝန်းကျင်များ	သက်ရောက်မှုအမည်	အဆင့်	သက်ရောက်မှု၏ အရေးပါမှု	
			မလျော့ချမီ	လျှော့ချပြီးနောက်
လေထု	မြေဖုန်ထခြင်း	တည်ဆေ ာက်ရေး	အရေးပါ	မပြောပလောက်
	လူကျန်းမာရေး	တည်ဆေ ာက်ရေး	အရေးပါ	မပြောပလောက်
	ဂေဟနစ်	တည်ဆေ ာက်ရေး	အရေးပါ	မပြောပလောက်
	မြေဖုန်ထရြင်း	လည်ပတ်ရေး	N/A	N/A
	လူကျန်းမာရေး	လည်ပတ်ရေး	N/A	N/A
	ဂေဟနစ်	လည်ပတ်ရေး	N/A	N/A
GHG	GHG ထုတ်လွှတ်မှုများ	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
ဆူညံသံ	သယ်ယူပို့ဆောင်ရေး	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	တူးဖော်ရေးလုပ်ငန်း	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်

ပတ်ဝန်းကျင်များ	သက်ရောက်မှုအမည်	အဆင့်	သက်ရောက် <mark>မှု၏</mark> အရေးပါမှု	
			မလျှော့ချမိ	လျှော့ချပြီးနောက်
မြေပေါ် ရေ	ရေရယူခြင်းသတ်မှတ်ချက်	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	ရေဇိအား စမ်းသပ်စွန့်ထုတ်မှု	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	နန်းအနည်ကျခြင်း	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
မြေဆီလွှာနှင့် မြေအောက်ရေ	ရေဇိအား စမ်းသပ်ရေယိုစိမ့်မှု	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	HDD အတွက် ပို့လွှတ်မှု နှင့် လက်ခံမှု ထိန်းချုပ်မှု ပျက်စီးဆုံးရှုံးမှု	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
မြေဆီလွှာနှင့် မြေအောက်ရေ	စွန့်ပစ်ဘက်တိုနိုက်မြေစေးသိုလှောင်မှု ထိန်းချုပ်မှု ပျက်စီးဆုံးရှုံးမှု	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	လုပ်ငန်းခွင်ရှင်းလင်းမှု နှင့် တူးဖော်မှုကာလအတွင်း စီမံခန့်ခွဲမှု စနစ်မကျခြင်းကြောင့် မြေဆီလွှာ ဆုံးရှုံးခြင်း	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
စွန့်ပစ်ပစ္စည်း	စနစ်မကျသော ဇီဝပမာက (biomass) စီမံခန့်ခွဲခြင်း	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	အွန္တရာယ်ရှိသော စွန့်ပစ်ပစ္စည်း ထွက် ရှိမှု နှင့် စီမံခန့်ခွဲမှု	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	အွန္တရာယ်မရှိသော စွန့်ပစ်ပစ္စည်း ထွ က်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	အိမ်တွင်း အစဉ်အခဲ စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	အိမ်တွင်း အရည် စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
ဇီဝမျိုးစုံမျိုးကွဲ	နေရင်းဒေသ အမြဲတမ်း နှင့် ယာယီ ဆုံးရှုံးမှု	N/A	သာမည	မပြောပလောက်
	သက်ရှိသတ္တဝါများ ယာယီ အနော င့်အယှက်ဖြစ်မှု သို့မဟုတ် နေရာဖ ပြာင်းရွှေ့ရမှု	N/A	မပြောပလောက်	မပြောပလောက်
	နေရင်းဒေသ အရည်အသွေးကျဆင် းခြင်း	N/A	မပြောပလောက် အဆင့် မှ သာမည အဆင့်	မပြောပလောက်
	ဒေသရှိ မျိုးစိတ်သေစေနိုင်ခြင်း	N/A	မပြောပလောက် အဆင့် မှ သာမည အဆင့်	မပြောပလောက်
လူမှု	အလုပ်အကိုင်	တည်ဆေ ာက်ရေး	အပြုသဘော	-

ပတ်ဝန်းကျင်များ	and a main and a main a	2005	သက်ရောက်မှု၏ အရေးပါမှု	
	သကရောက်မှုအသေ	3990Ç	မလျော့ချမီ	လျှော့ချပြီးနောက်
	ငါးဖမ်းလုပ်ငန်း နှင့် ရေကြောင်းသွားလာမှု	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	စီးပွားရေး ဖယ်ရှားပစ်ခြင်း	တည်ဆေ ာက်ရေး	အရေးပါ	သာမည
	စီးပွားခေုး ဖယ်ရှားပစ်ခြင်း	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်
	ယာဉ်အသွားအလာ နှင့် သယ်ယူပို့ဆောင်ရေး	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	ရှိနေပြီးသော နေရာအဆောက် အအုံ များ နှင့် ဝန်ဆောင်လုပ်ငန်းများ	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
	ပတ်ဝန်းကျင်ဆိုင်ရာ ထုတ်လွှတ်မှု	တည်ဆေ ာက်ရေး	သာမည	မပြောပလောက်
	ရပ်ရွာလူထု ကျန်းမာရေး နှင့် ဘေးကင်းရေး	တည်ဆေ ာက်ရေး	အတန်အသင့်	သာမည
	လုပ်ငန်းခွင် ကျန်းမာရေး နှင့် ဘေးကင်းရေး	တည်ဆေ ာက်ရေး	အတန်အသင့်	သာမည
	ယဉ်ကျေးမှုအမွေအနှစ်	တည်ဆေ ာက်ရေး	မပြောပလောက်	မပြောပလောက်
စီစဉ်မထားသည့် ဖြစ်ရပ်	မီးလောင်းခြင်း နှင့် ပေါက်ကွဲခြင်း	အားလုံး	အရေးပါ	အရေးပါ
	ဆိုက်စမစ် နှင့် မြေငလျင်	အားလုံး	အတန်အသင့်	သာမည
	ဓာတုသိုလှောင် သည့် ကန့်သတ်ထိန်းချပ်မှု ပျက်စီးခြင်း	အားလုံး	သာမညအဆင့်မှ အတော်အသင့် အဆင့်	မပြောပလောက် အဆင့် မှ သာမည အဆင့်

# ၁.၇.၃ ဓာတ်အားစက်ရုံ

သဘာဝမျက်နှာသွင်ပြင် နှင့် လူမှု ပတ်ဝန်းကျင်တို့အားလုံးအတွက် သက်ရောက်မှု၏အရေးပါမှုကို *ဇယား ၁.၁၀* တွင် အကျဉ်းဖော်ပြထားပါသည်။

ဇယား ၁.၁ဂ – သဘာဝမျက်နှာသွင်ပြင် နှင့် လူမှု ပတ်ဝန်းကျင်များအတွက် သက်ရောက်မှု၏ အရေးပါမှု အကျဉ်းဖော်ပြချက်

		အဆင့်	သက်ရောက်မှု၍ အရေးပါမှု		
ပိပ်ပန်းပါင်များ			မလျော့ချမီ	လျော့ချပြီးနောက်	
လေထု	မြေဖုန်ထခြင်း	တည်ဆောက်ရေး	သာမည	မပြောပလောက်	
	လူကျန်းမာရေး	တည်ဆောက်ရေး	သာမည	မပြောပလောက်	
	ဂေဟစနစ်	တည်ဆောက်ရေး	အတန်အသင့်	မပြောပလောက်	
	မြေဖုန်ထခြင်း	လည်ပတ်ရေး	သာမည	မပြောပလောက်	
	လူကျန်းမာရေး	လည်ပတ်ရေး	သာမည	မပြောပလောက်	
	ဂေဟနစ်	လည်ပတ်ရေး	အတန်အသင့်	မပြောပလောက်	
GHG	GHG ထုတ်လွှတ်မှုများ	တည်ဆောက်ရေး	မပြောပလောက်	မပြောပလောက်	
	GHG ထုတ်လွှတ်မှုများ	လည်ပတ်ရေး	အတန်အသင့်	အတန်အသင့်	
ဆူညံသံ	သယ်ယူပို့ဆောင်ရေး	တည်ဆောက်ရေး	သာမည	မပြောပလောက်	
	အုတ်မြစ်ချခြင်း နှင့် တည်ဆောက်ခြင်း	တည်ဆောက်ရေး	အတန်အသင့်	မပြောပလောက်	
	မဆောင်ရွက်မီ၊ ဆောင်ရွက ်ခြင်း နှင့် စမ်းသပ်ခြင်း	တည်ဆောက်ရေး	သာမည	မပြောပလောက်	
	လည်ပတ်ရေး	လည်ပတ်ရေး	အတန်အသင့်	မပြောပလောက် အဆင့် မှ သာမည အဆင့်	
မြေပေါ် ရေ	ရေရယူခြင်းသတ်မှတ်ချက်	တည်ဆောက်ရေး	မပြောပလောက်	မပြောပလောက်	
	ရေရယူခြင်းသတ်မှတ်ချက်	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်	
	သတ္တုစင်စက်၏ အာနိသင်ပျက်ရေ စွန့်ထုတ်မှု	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်	
	ရေအေးစွန့်ထုတ်ခြင်း	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်	
	တိုက်စားမှုကြောင့် ဖြစ ်ပေါ် သည့် နန်းအနည်ကျခြင်း	တည်ဆောက်ရေး	မပြောပလောက်	မပြောပလောက်	
	အောက်ခံလုပ်ခြင်းကြော င့် ဖြစ်ပေါ် သည့် နန်းအနည်ကျခြင်း	တည်ဆောက်ရေး	မပြောပလောက်	မပြောပလောက်	
	තාන්තානාගති	ითე	သက်ရောက်မှု၏ အရေးပါမှု		
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ပတ္ဝနးကျငများ	သင္တာေရာက္ရန္အခမည	39000	မလျှော့ချမီ	လျှော့ချပြီးနောက်	
မြေဆီလွှာ နှင့် မြေအောက်ရေ	သတ္တုစင်စက်၏ အာနိသင်ပျက်ရေ မတော်တဆ ယိုစိမ့်မှုများ	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်	
	ရေအေးမတော်တဆယိုစိမ် ့ မှုများ	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်	
	လုပ်ငန်းခွင်ရှင်းလင်းမှု နှင့် တူးဖော်မှုကာလအတွင်း စ ီမံခန့်ခွဲမှု စနစ်မကျခြင်းကြောင် ့ မြေဆီလွှာ ဆုံးရှုံးခြင်း	တည်ဆောက်ရေး	မပြောပလောက်	မပြောပလောက်	
စွန့်ပစ်ပစ္စည်း	စနစ်မကျသော ဇီဝပမာက (biomass) စီမံခန့်ခွဲခြင်း	တည်ဆောက်ရေး	အတန်အသင့်	သာမည	
	အွန္တရာယ်ရှိသော စွန့်ပစ် ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	တည်ဆောက်ရေး	အတန်အသင့်	သာမည	
	အွန္တရာယ်ရှိသော စွန့်ပစ် ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	လည်ပတ်ရေး	အတန်အသင့်	သာမည	
	အွန္တရာယ်မရှိသော စွန့်ပစ် ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	တည်ဆောက်ရေး	အတန်အသင့်	သာမည	
	အွန္တရာယ်မရှိသော စွန့်ပစ် ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	လည်ပတ်ရေး	သာမည	မပြောပလောက်	
	အိမ်တွင်း အစဉ်အခဲ စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	လည်ပတ်ရေး	သာမညအဆင့်မှ အတော်အသင့် အဆင့်	မပြောပလောက်	
	အိမ်တွင်း အရည် စွန့်ပစ်ပစ္စည်း ထွက်ရှိမှု နှင့် စီမံခန့်ခွဲမှု	လည်ပတ်ရေး	သာမည	မပြောပလောက်	
ရှုခင်းရှုကွက်	တည်ဆောက်ရေး	တည်ဆောက်ရေး	သာမည	မပြောပလောက်	
	လည်ပတ်ရေး	လည်ပတ်ရေး	သာမည	မပြောပလောက်	
ဇီဝမျိုးစုံမျိုးကွဲ	နေရင်းဒေသ အမြဲတမ်း နှင့် ယာယီ ဆုံးရှုံးမှု	N/A	သာမည	မပြောပလောက်	
	သက်ရှိသတ္တဝါများ ယာယီ အနောင့်အယှက်ဖြစ်မှု	N/A	မပြောပလောက်	မပြောပလောက်	

	000000000000000000000000000000000000000	ითე	သက်ရောက်မှု၏ အရေးပါမှု		
ပိတ္၀နားကျငများ	သတရောက်ရှုအသေ	3990Ç	မလျှော့ရမြ	လျှော့ခ <mark>ျပ</mark> ီးနောက်	
	သို့မဟုတ် နေရာပြောင်းရွှေ့ရမှု				
	နေရင်းဒေသ အရည်အခ သွးကျဆင်းခြင်း	N/A	မပြောပလောက် အဆင့် မှ သာမည အဆင့်	မပြောပလောက်	
	ဒေသရှိ မျိုးစိတ်သေစေ နိုင်ခြင်း	N/A	မပြောပလောက် အဆင့် မှ သာမည အဆင့်	မပြောပလောက်	
လူမှု	အလုပ်အကိုင်	တည်ဆောက်ရေး	အပြသဘော	-	
	အလုပ်အကိုင်	လည်ပတ်ရေး	အပြသဘော	-	
	ရေကြောင်းသွားလာမှု	တည်ဆောက်ရေး	မပြောပလောက်	မပြောပလောက်	
	ယာဉ်အသွားအလာ နှင့် သယ်ယူပို့ဆောင်ရေး	တည်ဆောက်ရေး	မပြောပလောက်	မပြောပလောက်	
	ရှိနေပြီးသော နေရာ အဆောက် အအုံ များ နှင့် ဝန်ဆေ ာင်လုပ်ငန်းများ	တည်ဆောက်ရေး	အတန်အသင့်	မပြောပလောက်	
	ထုတ်လွှတ်မှုများ	တည်ဆောက်ရေး	သာမည	မပြောပလောက်	
	ရပ်ရွာလူထု ကျန်းမာရေး နှင့် ဘေးကင်းရေး	တည်ဆောက်ရေး	အတန်အသင့်	သာမည	
	ရပ်ရွာလူထု ကျန်းမာရေး နှင့် ဘေးကင်းရေး	လည်ပတ်ရေး	မပြောပလောက်	မပြောပလောက်	
	လုပ်ငန်းခွင် ကျန်းမာရေး နှင့် ဘေးကင်းရေး	တည်ဆောက်ရေး	အတန်အသင့်	သာမည	
	လုပ်ငန်းခွင် ကျန်းမာရေး နှင့် ဘေးကင်းရေး	လည်ပတ်ရေး	သာမည	သာမည	
	ရေကြောင်းသွားလာမှု	တည်ဆောက်ရေး	မပြောပလောက်	မပြောပလောက်	
	ယဉ်ကျေးမှုအမွေအနစ်	တည်ဆောက်ရေး	မပြောပလောက်	မပြောပလောက်	
စီစဉ်မထားသည့် ဖြစ်ရပ်	ဓာတု ယိုဖိတ်မှု သို့မဟုတ် ယိုစိမ့်မှု	အားလုံး	သာမည	မပြောပလောက်	
	မီးလောင်းခြင်း နှင့် ပေါက်ကွဲခြင်း	အားလုံး	အရေးပါ	မပြောပလောက်	
	အပူပိုင်းမုန် တိုင်း နှင့် ပြင်းထန်သော ရာသီဥတ ုအခြေအနေများ	အားလုံး	အတန်အသင့်	သာမည	

	3		သက်ရောက်မှု၏ အရေးပါမှု	
ပတ္ဝနားကျငများ	သင္တာရောက္ရမွာသည	3990¢	မဇလျှာ့ချမီ	လျှော့ခ <mark>ျပ</mark> ြီးနောက်
	ဓာတုသိုလှောင် သည့် နေရာအဆောက်အအုံများ ကန့်သတ်ထိန်းချုပ်မှု ပျက်စီးခြင်း	အားလုံး	သာမညအဆင့်မှ အတော်အသင့် အဆင့်	မပြောပလောက် အဆင့် မှ သာမည အဆင့်

# ၁.၈ ပတ်ဝန်းကျင် နှင့် လူမှု စီမံခန့်ခွဲမှုအစီအစဉ်

# ၁.၈.၁ လျှော့ချခေးအစီအမံများ

ကောင်းမွန်သော တည်ဆောက်ရေး နှင့် သန့်ရှင်းရေးအလေ့အကျင့်ကောင်းနှင့်ဆက်နွှယ်သော စီမံကိန်း၏ တည် ဆောက်ရေးအဆင့်ကာလအတွင်း အကြံပြုထားသည့် လျှော့ချရေးအစီအမံအများအပြားကို ပတ်ဝန်းကျင် နှင့် လူမှု စီမံခန့်ခွဲမှုအစီအစဉ် (ESMP) တွင် ထည့်သွင်းထားပါသည်။

စီမံကိန်း၏ လည်ပတ်ရေးအဆင့် (အခိုးအငွေ့ထုတ်လွှတ်မှု နှင့် ဆူညံသံထွက်ရှိမှုတို့ကဲ့သို့သော) အတွက် လျှော့ချရေး အစီအမံများသည် ဒီဇိုင်း၏ အစိတ်အပိုင်းဖြစ်ပြီး၊ စီမံကိန်းဒီဇိုင်းအသေးစိတ်ဖော်ပြချက်များသို့ ပေါင်းစပ်သွားမည် ဖြစ်ပါသည်။

LNG လက်ခံရေးဂိတ်၊ ပိုက်လိုင်း နှင့် ဓာတ်အားစက်ရုံတို့၏ တည်ဆောက်ရေးအဆင့်တို့သည် ၂၃ လ၊ ၁၈ လ၊ နှင့် ၂၈ လ အသီးသီးကြားမြင့်မည်ဟု တွက်ချက်ထားပါသည်။ အစိတ်အပိုင်း သုံး (၃) ရပ်လုံး၏ လည်ပတ်ရေးအဆင့်သည် ၂၅ နှစ် ကြာမြင့်မည် ဖြစ်ပါသည်။

LNG လက်ခံရေးဂိတ်၊ ပိုက်လိုင်း၊ နှင့် ဓာတ်အားစက်ရုံတို့၏ တည်ဆောက်ရေး နှင့် လည်ပတ်ရေးအဆင့်များအတွက် ဖော်ထုတ်ထားသည့် လျှော့ချရေးအစီအမံများအကျဉ်းကို ESMP (*အစန်း ၁၂.၅.၂.၁၊ အစန်း ၁၂.၅.၂.၂* နှင့် *အစန်း ၁၂.၅.၂.၃* အသီးသီးတို့တွင်) တွင် တင်ပြထားပါသည်။ ၎င်းသည် လျှော့ချရေးအစီအမံများ အကောင်အထည်ဖော် ဆောင်မှု အတွက် ဦးဆောင်တာဝန်ရှိသူ နှင့် အစီရင်ခံရေး သတ်မှတ်ချက်များ နှင့် ယင်းကဲ့သို့ အကောင်အထည် စောင်မှု အတွက် ဦးဆောင်တာဝန်ရှိသူ နှင့် အစီရင်ခံရေး သတ်မှတ်ချက်များ နှင့် ယင်းကဲ့သို့ အကောင်အထည် ဖော်မူအတွက် ရန်ပုံငွေရင်းမြစ်များနှင့်အတူ ၎င်း၏ ခိုင်ခံမှုကိုလည်း ဖော်ထုတ်သတ်မှတ်ပေးထားပါသည်။

ကူညီထောက်ပံ့ပေးသူသည် ESMP ၌ တင်ပြထားသည့် လျှော့ချရေးအစီအမံများကို စီမံကိန်းသက်တမ်းတစ်လျှောက် အကောင်အထည်ဖော်သွားစေရန် သေချာအောင်ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။

# ၁.၈.၂ စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးရေးအစီအစဉ်

ကူညီထောက်ပံပေးသူ နှင့် ခန့်အပ်ထားသော EPC ကန်ထရိုက်တာတို့၏ အဓိက အခန်းကဏ္ဍများ နှင့် တာဝန်များကို ပတ်ဝန်းကျင် နှင့် လူမှု သက်ရောက်မှုများနှင့်ပတ်သက်၍ အကောင်အထည်ဖော်ခြင်း နှင့် စောင့်ကြပ်ကြည့်ရှုစစ် ဆေး ခြင်း တို့အတွက် သတ်မှတ်ထားပြီးဖြစ်ပါသည်။ အထူးအရေးပါမှုနှင့်စပ်လျဉ်း၍ ပတ်ဝန်းကျင်စောင့်ကြပ်ကြည့်ရှ စစ် ဆေးမှု၊ သဘာဝမြေမျက်နာသွင်ပြင်၊ ဇီဝ နှင့် လူမှု ပတ်ဝန်းကျင် စီမံခန့်ခွဲမှုအစိတ်အပိုင်းများအတွက် လုပ်ဆောင်မှု အညွှန်းကိန်းများအဖြစ် ဖော်ထုတ်သတ်မှတ်ပြီး ဖြစ်ပါသည်။ လုပ်ဆောင်မှုအညွှန်းကိန်းတစ်ခုချင်းအတွက် ပြည့်ဝုံသော စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးရေး အစီအစဉ်ကို စီမံကိန်း၏ အဆင့်များအားလုံးအတွက် ပြင်ဆင်သွားမည် ဖြစ်ပါသည်။ ၎င်းတွင် အကောင်အထည်ဖော်မှု နှင့် ကြီးကြပ်မှုတို့အတွက် တိုင်းတာမည့် ပါရာမီတာများ၊ အသုံးပြုမည့် နည်းလမ်း များ၊ နမူနာကောက်ယူသည့် နေရာများ၊ တိုင်းတာမှု၏ ကြိမ်နှုန်း၊ ရှာဖွေတွေ့ရှိမှုအကန့်အသတ်များ၊ ကုန်ကျစရိတ် နှင့် တာဝန်များကို ပေးထားမည် ဖြစ်ပါသည်။ LNG လက်ခံရေးဂိတ်၊ ပိုက်လိုင်း၊ နှင့် ဓာတ်အား စက်ရုံတို့၏ တည်ဆောက် ရေး နှင့် လည်ပတ်ရေးအဆင့်များအတွက် စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးရေး အစီအစဉ် အကျဉ်းကို ESMP (**အဝန်း ၁၂.၅.၂.၄၊ အစန်း ၁၂.၅.၂.၇** နှင့် **အဝန်း ၁၂.၅.၂.၆** အသီးသီးတို့တွင် **)**တွင် တင်ပြထား ပါသည်။

# ၁.၈.၃ လေ့ကျင့်သင်ကြားမှုအစီအစဉ်

လုပ်ငန်းခွင်တွင် တည်ဆောက်ရေးလုပ်ငန်းများမစတင်မီ၊ ESMP အကောင်အထည်ဖော်မှုနှင့်ပတ်သက်၍ လေ့ကျင့် သင်ကြားမှု အစီအစဉ်ကို ပြင်ဆင်ပို့ချရန် သင့်လျော်သော ရုံးတွင်း / ရုံးပြင် ကျွမ်းကျင်သူကို ကူညီထောက်ပံ့ပေးသူနှင့် တိုင်ပင်၍ EPC ကန်ထရိုက်တာက ခန့်အပ်သွားမည် ဖြစ်ပါသည်။ ပတ်ဝန်းကျင် နှင့် လူမှုစောင့်ကြပ်ကြည့်ရှုစစ်ဆေးမှု အစီအစဉ် နှင့် အစီရင်ခံမှုတို့ကို စီမံကိန်းအတွက် သက်ဆိုင်ရာကိုးကားမူဘောင်နှင့်အညီ အကောင်အထည်ဖော် ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။

စက်ရုံလည်ပတ်မှုမစတင်မီ လည်ပတ်ရေးအဆင့် ပတ်ဝန်းကျင်စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးမှု နှင့် အစီရင်ခံမှုတို့နှင့် ပတ်သက် သော လေ့ကျင့်သင်ကြားမှုအစီအစဉ်ကို ပြင်ဆင်ပို့ချရန် ကူညီထောက်ပံ့ပေးသူက သင့်လျော်သော ရုံးတွင်း / ရုံးပြင် သဘာဝပတ်ဝန်းကျင်ကျွမ်းကျင်ပညာရှင်နှင့် ချိတ်ဆက်ဆောင်ရွက် သွားမည် ဖြစ်ပါသည်။ ခေါင်းစဉ်များမှာ များသောအားဖြင့် တည်ဆောက်ရေးအဆင့်ကာလအတွင်းက ခေါင်းစဉ်များနှင့် တူညီမည် ဖြစ်ပါသည်။ ခေါင်းစဉ်များမှာ များသောအားဖြင့် တည်ဆောက်ရေးအဆင့်ကာလအတွင်းက ခေါင်းစဉ်များနှင့် တူညီမည် ဖြစ်ပါသည်။ အစီရင်ခံရေး နှင့် အတည်ပြုရေးကို တည်ဆောက်ရေးကာလအတွင်း နှစ်ဝက်တစ်ကြိမ် နှင့် လည်ပတ်ရေးကာလအတွင်း တစ်နှစ် တစ်ကြိမ် (ESMP တွင် မဖော်ပြထားလျှင်) ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။ အစီရင်ခံစာများကို သက်ဆိုင်ရာ အာဏာပိုင်အဖွဲ့ အစည်းများ (ဆိုလိုသည်မှာ MOEE၊ MONREC စသည်ဖြင့်) နှင့် ငွေထုတ်ချေးသူများထံသို့ တင်သွင်း သွားမည် ဖြစ်ပါသည်။

# ၁.၉ အများပြည်သူနှင့် တိုင်ပင်ဆွေးနွေးမှု နှင့် ထုတ်ဖော်ပြတင်မှု

သက်ဆိုင်သူများနှင့်ထိတွေ့တိုင်ပင်ဆွေးနွေးမှုကို စီမံကိန်းကြောင့် ထိခိုက်ခံစားရနိုင်သူများ သို့မဟုတ် စီမံကိန်းကို စိတ်ဝင်စားသူများနှင့် ESIA လုပ်ငန်းစဉ်တစ်လျှောက် ဆောင်ရွက်ခဲ့ပါသည်။ သက်ဆိုင်သူများ၏ အမြင်များကို အဆိုပြုစီမံကိန်းကို တိုးတက်ကောင်းမွန်စေရန် နှင့် သင့်လျော်သကဲ့သို့ လျှော့ချရေးအစီအမံများတွင် ထည့်သွင်းထား ပါသည်။ သက်ဆိုင်သူများနှင့် တိုင်ပင်ဆွေးနွေးမှုကို ERM ၏ ဝိုင်းဝန်းကူညီမှုဖြင့် စီမံကိန်းအဆိုပြုသူက လူအားလုံး အထူးသဖြင့် အဆိုပြုစီမံကိန်းကြောင့် ထိခိုက်ခံစားရနိုင်သူများ အတွက် ဖွင့်ထားလျက် ယဉ်ကျေးမှုအရသင့်လျော် သော ပုံစံ နှင့် ဆောင်ရွက်ခဲ့ပါသည်။

တိုင်ပင်ဆွေးနွေးမှုလုပ်ငန်းစဉ်ကို ပူးပေါင်းပါဝင်မှုအတွက် မြန်မာနိုင်ငံဉပဒေ သတ်မှတ်ချက်များ (ပတ်ဝန်းကျင်ထိ ခိုက်မှု ဆန်းစစ်ခြင်းဆိုင်ရာလုပ်ထုံးလုပ်နည်း အမှတ် ၆၁၆/၂၀၁၅ အရ) နှင့် IFC လုပ်ဆောင်မှုစံသတ်မှတ်ချက်များ တွင် ဖော်ပြထားသည့် တိုင်ပင်ဆွေးနွေးမှုဆိုင်ရာ နိုင်ငံတကာသတ်မှတ်ချက်တို့ကို ပြည့်မီရန် ဒီဇိုင်းရေးဆွဲခဲ့ပါသည်။

ခိုင်ယာလော့တည်ဆောက်မှုတွင် ပထမအဆင့်သည် စီမံကိန်နှင့် သက်ဆိုင်သူများကို ဖော်ထုတ်သတ်မှတ်ခြင်း ဖြစ်ပါသည်။ သက်ဆိုင်သူများမှာ စီမံကိန်းတစ်ခုကြောင့် တိုက်ရိုက် သို့မဟုတ် သွယ်ဝိုက်၍ ထိခိုက်ခံရနိုင်သူများ သို့မဟုတ် အုပ်စုများ နှင့် စီမံကိန်း အပေါ် စိတ်ဝင်စား သူများ နှင့်/သို့မဟုတ် စီမံကိန်း၏ ရလဒ်များကို (အပြုသ ဘောဖြင့် သို့မဟုတ် အနတ်သဘောဖြင့်) လွှမ်းမိုးနိုင်စွမ်းရှိသူများ ဖြစ်ကြပါသည်။

စီမံကိန်းအဖွဲ့သည် ESIA ကာလအတွင်း စီမံကိန်း သက်ဆိုင်သူများနှင့် ပူးပေါင်းပါဝင်ပြီး ဆက်တိုက်ဖြစ်သော ဒိုင်ယာလော့ တစ်ရပ်ဖြစ်ထွန်းသည် လုပ်ငန်းစဉ်တစ်ရပ်ကို ဆောင်ရွက်ရန် ကတိကဝတ်ထားရှိခဲ့ပါသည်။ တိုင်ပင် ဆွေးနွေးမှု၏ ရည်ရွယ်ချက်များမှာ အောက်ပါအတိုင်း ဖြစ်သည် -

- တိုင်ပင်ဆွေးနွေးသည့်လုပ်ငန်းစဉ်တွင် စီမံကိန်းကြောင့် ထိခိုက်ခံစားရနိုင်သူများ နှင့် စီမံကိန်းအပေါ် စိတ်ဝင် စားသူများ အသေအချာ ပါဝင်စေရန် သူတို့အားလုံးအား ဖော်ထုတ်သတ်မှတ်ရန်၊
- ပွင့်လင်း၍ ယဉ်ကျေးမှုနှင့်သင့်လျော်သည့် ပူးပေါင်းပါဝင်ကာ ပွင့်လင်းမြင်သာမှုရှိသည့် တိုင်ပင်ဆွေးနွေးမှု လုပ်ငန်းစဉ်ဖြင့် နားလည်သဘောပေါက်စေရန်။ သတင်းအချက်အလက်များကို စောနိုင်သမျှစော၍ ထုတ်ပြန်ပြီး ဖြစ်နိုင်သမျှ ပြည့်စုံအောင် တင်ပြခြင်း၊
- သက်ရောက်မှုများဆန်းစစ်ရာတွင်လည်းကောင်း၊ လျှော့ချရေး နှင့် စီမံခန့်ခဲရေး အစီအမံများ ထွက်ရှိစေရာတွင် လည်းကောင်း၊ IEE အစီရင်ခံစာ အပြီးသတ်ရာတွင် လည်းကောင်း သက်ဆိုင်သူများ ပါဝင်စေရန်။ သက်ဆိုင်သူ

များသည် ထိခိုက်မှုဆန်းစစ်ခြင်းကို အသိပေးစေမည့် အခြေခံအချက်အလက်များအတွက် ဒေသအသိပညာများ နှင့် သတင်းအချက်အလက်များထောက်ပံ့ရာတွင် အရေးပါသောအခန်းကဏ္ဍတွင်လည်း ပါဝင်ကြပါသည်၊

- ပွင့်လင်းသော ဒိုင်ယာလော့ နှင့် တိုင်ပင်ဆွေးနွေးမှုမှတစ်ဆင့် ဆက်ဆံရေး နှင့် ယုံကြည်မှုတို့ကို တည် ဆောက် ရန်။ သက်ဆိုင်သူများနှင့် ယုံကြည်မှုတည်ဆောက်ရန် TPMC လုပ်ငန်းများနှင့်ပတ်သက်၍ ပွင့်လင်းမြင်သာမှု တည်ဆောက်ရန်၊
- တိုင်ပင်ဆွေးနွေးမှုအတွက် အားလုံးပါဝင်သောချဉ်းကပ်မှုနည်းလမ်းရှိစေရန် အားနည်းချက် (vulnerable) ရှိသူများ နှင့် အုပ်စုများနှင့် ရိုတ်ဆက်ရန်။ အချို့ သက်ဆိုင်သူများသည် သူတို့၏ အားနည်းချက်ကြောင့် ဤကဲ့သို့လုပ်ငန်းစဉ်တွင် အထူးအလေးပေးမှုရှိရန် လိုအပ်သည်၊
- အဆိုပြုစီမံကိန်းအကျိုးရလဒ်များနှင့်စပ်လျဉ်း၍ မျှော်လင့်ချက်များကို စီမံခန့်ခွဲရန်။ တိုင်ပင်ဆွေးနွေးမှုလုပ်ငန်းစဉ် သည် သက်ဆိုင်သူများ နှင့် ရပ်ရွာလူထုမျှော်လင့်ချက်များကို နားလည်မှု နှင့် စီမံမှုတို့အတွက် ယွန္တရားတစ်ရပ် ဖြစ်ပြီး၊ မျှော်လင့်ချက်များကိုလည်း လက်လှမ်းမီနိုင်သောနည်းလမ်းဖြင့် တိကျမှန်ကန်သော သတင်းအချက် အလက်များကို ဖြန့်ဝေရာတွင် အောင်မြင်သွားမည် ဖြစ်ပါသည်၊ ထို့ပြင်၊
- လေးစားလိုက်နာစေရန်။ လုပ်ငန်းစဉ်သည် မြန်မာနိုင်ငံ ကြီးကြပ်ရေး ဆိုင်ရာ သတ်မှတ်ချက်များ နှင့် အပြည်ပြည်
   ဆိုင်ရာ နည်းလမ်းကောင်းများကို လေးစားလိုက်နာစေရန် ဒီဖိုင်းရေးဆွဲခဲ့ပါသည်။

EIA လုပ်ထုံးလုပ်နည်း (၂၀၁၅) ၏ ပုဒ်မ ၅၀ နှင့် ၆၁ တို့အရ၊ စီမံကိန်းအဆိုပြုသူက အများပြည်သူနှင့် တိုင်ပင်ဆွေး နွေးမှု နှင့် ပါဝင်ဆောင်ရွက်မှုလုပ်ငန်းစဉ်ကို နယ်ပယ်အတိုင်းအတာသတ်မှတ်ခြင်းဆောင်ရွက်မှု နှင့် EIA စူးစမ်းလေ့ လာမှုတို့တွင် အသေအချာ ပြုလုပ်ဆောင်ရွက်ရမည် ဖြစ်ပါသည်။ နယ်ပယ်အတိုင်းအတာသတ်မှတ်ခြင်းဆောင်ရွက်မှု နှင့် EIA စူးစမ်းလေ့လာမှုတို့ အတွက် အများပြည်သူနှင့် တိုင်ပင်ဆွေးနွေးမှုတို့ကို **အခန်း ၁.၉.၁** နှင့် **အဓန်း ၁.၉.၂** အသီးသီးတို့တွင် အကျဉ်းဖော်ပြထားပါသည်။

# ၁.၉.၁ နယ်ပယ်အတိုင်းအတာ သတ်မှတ်ခြင်းလုပ်ငန်းစဉ် တိုင်ပင်ဆွေးနွေးမှုလုပ်ငန်းများ အကျဉ်းဖော်ပြချက် (အများပြည်သူနှင့်တိုင်ပင်ဆွေးနွေးမှု - ၁)

အစည်းအဝေးများကို ၂၀၁၈ အောက်တိုဘာ ၃၀ မှ ဒီဇင်ဘာ ၁၁ ရက်နေ့အထိ ဆောင်ရွက်ခဲ့ပါသည်။ ဝန်ကြီးချုပ် နှင့် နိင်ငံတော်အစိုးရ၊ သက်ဆိုင်ရာ တိုင်းဒေသကြီးအဆင့် ECD နှင့် GAD၊ လွှတ်တော်ကိုယ်စားလှယ်များ၊ မြို့နယ် GAD၊ ကျေးရွာအုပ်ချုပ်ရေးမှူးများ နှင့် ဒေသခံရပ်ရွာလူထုတို့အပါအဝင် အမျိုးမျိုးသော သက်ဆိုင်သူများကို ဖိတ်ကြားခဲ့ပါ သည်။

အများပြည်သူနှင့်တိုင်ပင်ဆွေးနွေးမှုအစည်းအဝေးသို့ မြို့နယ် ၁၇ မြို့နယ်မှ ကိုယ်စားလှယ်များ နှင့် ကျေးရွာများကို ဖိတ်ခေါ်ခဲ့ပါသည် - သံလျင်၊ ကျောက်တန်း၊ ရွှေပြည်သာ၊ အလုံ၊ လမ်းမတော်၊ ဆိပ်ကမ်း၊ ဒဂုံ၊ မင်္ဂလာဒုံ၊ ပုဇွန်တောင်၊ ကမာရွတ်၊ တာမွေ၊ ဒလ၊ ဆိပ်ကြီးခနောင်တို၊ ရွှေပြည်သာ၊ ပုဇွန်တောင်၊ သာကေတ နှင့် သခင်ဘသောင်း တို့ဖြစ်ကြ ပါသည်။

အစည်းအဝေးတစ်ခုချင်း၏ နေ့စွဲ၊ အချိန်၊ တည်နေရာ၊ သက်ဆိုင်သူ နှင့် တက်ရောက်သူအရေအတွက်တို့ကို *ဇယား ၁.၁၁* တွင် တင်ပြထားပါသည်။

# ဇယား ၁.၁၁ - အများပြည်သူနှင့်တိုင်ပင်ဆွေးနွေးမှု (၁) ကာလအတွင်း ဆောင်ရွက်ခဲ့သည့် တိုင်ပင်ဆွေးနွေးမှုလုပ်ငန်းများ

နေ့စွဲ	တည်နေရာ	သက်ဆိုင်သူများ	တက်ရောက်သူအရေအတွက်
၂၉/၈/၂၀၁၈	အလုံ မြို့နယ် ခန်းမ	GAD (သစ်တော နှင့် မီးသတ် ဦးစီးဌာန)၊ လွှတ်တော် ကိုယ်စားလှယ် (တိုင်းဒေသကြီး အစိုးရ)၊ တိုင်းဒေသကြီး ECD၊ ကျေးရွာခေါင်းဆောင်၊ ရပ်မိရပ်ဖများ၊ ကျေးရွာ သူ/သားများ၊ ဂျာနယ်လစ်များ၊ သတင်ထောက်များ၊ ရန်ကုန်လျပ်စစ် ထောက်ပံ့ရေးကော်ပိုရေးရှင်း (YESC)၊ ကော်ပိုရေးရှင်းများ၊ နှင့် အင်ဂျင်နီးယားရင်း ဝယ်ယူမှု နှင့် တည်ဆောက်ရေး EPC)	ວຄູ
၁၀/၁၂/၂၀၁၈	ဒလ မြို့နယ် ခန်းမ	လွှတ်တော် ကိုယ်စားလှယ်၊ GAD၊ သက်ဆိုင်ရာ ဌာနများ၊ ရပ်ကွက်အုပ်ချုပ်ရေးမှူး၊ ကျေးရွာခေါင်းဆောင်၊ ကျေးရွာ သူ/သာများ၊ အားကစား နှင့် ကာယပညာရေး ဝန်ကြီးဌာန၊ YESC၊ ဂျာနယ်လစ်များ၊ သတင်းထောက်များ၊ နှင့် ရန်ကုန်မြို့တောင်စည်ပင်သာယာရေးကော်မတီ (YCDC)	၂၁၁
ວວ/ວ၂/၂ບວຄ	သံလျင် မြို့နယ် ခန်းမ	GAD၊ သက်ဆိုင်ရာ ဌာနများ၊ ကျေးရွာခေါင်းဆောင်၊ ရပ်မိရပ်ဖများ၊ ကျေးရွာသူ/သားများ၊ ဂျာနယ်လစ်၊ EPC၊ နှင့် ကော်ပိုရေးရှင်း	၂၀၈

အများပြည်သူနှင့် တိုင်ပင်ဆွေးနွေးမှု (၁) ကာလအတွင်း မေးမြန်းခဲ့သည့် အဓိက စိုးရိမ်မှုများ နှင့် မေးခွန်းများ ဉပမာအချို့ နှင့် ၎င်းစိုးရိမ်မှုများ နှင့် မေးခွန်းများကို ဖြေကြားခဲ့သည့် တုံ့ပြန်မှုများကို *ဖယား ၁.၁၂* တွင် ဖော်ပြထား ပါသည်။ အဓိကစိုးရိမ်မှုများ နှင့် မေးခွန်းများ အပြည့်အစုံကို *အစန်း ၁၃.၂.၃* တွင် ဖော်ပြထားပါသည်။

# ဇယား ၁.၁၂ - အများပြည်သူနှင့်တိုင်ပင်ဆွေးနွေးမှု (၁) ကာလအတွင်း အဓိက စိုးရိမ်မှုများ နျင့် မေးခွန်းများ

မေးခွန်းများ	အဖြေများ	ESIA ၌ ဆီတာကက္က (ဆန်ကြန်းရာကြ
		ကူးကားမှုများ/တုန္ဒပြနအဖြေ
		ශ්රා
မတော်တဆမှုများကို မည်သို့	ERM – ESIA အတွင်း၌ မတော်တဆမှုများကို	စီမံကိန်းအကြောင်းအရာဓ
ကြိုတင်ကာကွယ် မည်နည်း။	မစီစဉ်ထားသည့် ဖြစ်ရပ် များ အဖြစ်	ဗာ်ပြချက် အခန်း
	ရည်ညွှန်းထားပါသည်။ ESIA သည် ဖြစ်ပေါ် လာနိုင်သည့်	မစီစဉ်ထားသည့် ဖြစ်ရပ် အခန်း
	မစီစဉ်ထားသည် ဖြစ်ရပ်အမျိုးအစားများ နှင့် ၎င်းတို့ကို	ပတ်ဝန်းကျင် နှင့် လူမှု
	စနစ်တကျ မည်သို့ စီမံခန့်ခွဲနိုင်သည်ကို လေ့လာသွား	စီမံခန့်ခွဲမှု အစီအစဉ်များ
	မည် ဖြစ်ပါသည်။ ထို့ပြင်၊ စီမံခန့်ခွဲရေးအစီအစဉ်တွင်	(ESMP) အခန်း။
	အရေးပေါ်	
	တုံ့ပြန်မှုဆိုင်ရာ လေ့ကျင့်သင်ကြားမှုအပိုင်းများကို	
	ထည့်သွင်း ထားပါသည်။	
	မစီစဉ်ထားသည့်ဖြစ်ရပ်များအတွက် လျှော့ချရေး	
	အစီအမံများကို ESIA အစီရင်ခံစာ၏	
	အစိတ်အပိုင်းတစ်ရပ် အနေဖြင့် ထည့်သွင်းထားပါသည်။	
	TTCL တွင် ဘေးကင်းရေး ဆိုင်ရာ စီမံခန့်ခွဲမှုအတွက်	
	သီးခြား EHS အဖွဲ့ အစည်းရှိပါသည်။	
	အဖွဲ့အစည်းသည် ဘေးအွန္တရာယ်ဆန်းစစ်ခြင်းေ	

မေးခွန်းများ	အဖြေများ	ESIA ၌
		ကိုးကားမှုများ/တုန္ဒပြန်အဓြ ဖများ
	ဆာင်ရွက်မှု နှင့် ဘေးအွန္တရာယ်ဆိုင်ရာ အကြောင်းအရင်းများဖော်ထုတ်ခြင်း တို့အတွက် တာဝန်လုပ်ငန်းများရှိပါသည်။ ဘေးကင်းရေး စီမံခန့်ခွဲမှု အစီအစဉ်ကို အပြည်ပြည်ဆိုင်ရာ ဘေးကင်းရေး အဖွဲ့အစည်း နှင့် အထူးပြုပညာရှင်တို့နှင့် စဉ်ဆက်မပြတ် ပူးပေါင်း၍ ရေးဆွဲသွားမည် ဖြစ်ပါသည်။ TTCL ကုမ္ပကီသည် ISO-9001 နှင့် ISO-14001 သက်သေခံလက်မှတ်များကို ကိုင်ဆောင်ထားပါသည်။	
ကျွန်ုပ်အတွေ့ အကြံ၊ အရ ဆိုရလျင်၊ ဓာတ်ငွေ ပိုက်လိုင်း တည်ဆောက်ရေး ကာလအတွင်း လယ် မြေပေါ် တည်ဆောက် ရေး ပစ္စည်း ပို့သဖြင့် တောင်သူများ အနေဖြင့် သူတို့၏ အပင်စိုက်ပျိုး မှု ကို မဆောင်ရွက်နိုင် ခဲ့ကြ ပါ။ ဒါ့အပြင်၊ ဓာတ်ငွေ့ ပိုက်လိုင်း အဟောင်းမှ ယိုစိမ့်မှုကို မိုးရာသီ၌ သတိထားမိခဲ့ပါသည်။	TPMC - ကျွန်ုပ်တို့အနေဖြင့် စနစ်ကျသော ဓာတ်ငွေ့ပိုက်လိုင်း လမ်းကြောင်း ရွေးချယ်မှုကို ဆောင်ရွက်လျက် ရှိပါသည်။ ဓာတ်ငွေ့ပိုက်လိုင်းလမ်းကြောင်းကို သက်ဆိုင်ရာ ဝန်ကြီးဌာန များနှင့် ဆောင်ရွက်ပြီးသည်နှင့် တစ်ပြိုင်နက်၊ ကျွန်ုပ်တို့အနေဖြင့် ထိခိုက်ခံရမည့် မြေပိုင်ရှင်များကို တိုက်ရိုက် ဆက်သွယ်ချိတ် ဆက်သွာမည် ဖြစ်ပါသည်။ ထို့ပြင်၊ ဓာတ်ငွေ့ပိုက်လိုင်းအတွက် အသုံးပြုသည့် ပစ္စည်း အရည်အသွေးသည် ကျွန်ုပ်တို့ ကုမ္ပဏီ၏ မဖြစ်မနေ ဆောင်ရွက် ရမှုလည်း ဖြစ်ပါသည်။ အကယ်၍ လောင်စာ မလုံလောက်မှုဖြစ် ပေါ် လျှင်၊ ကျွန်ုပ်တို့သည်လည်း ကတိပြုထား သည့် ဓာတ်အား ပမာဏကို မပြည့်မီသည့်အတွက် ဒုက္ခရောက် ပါမည်။ ထို့ကြောင့်၊ ကျွန်ုပ်တို့အနေဖြင့် ဤကိစ္စကိုလည်း အပြည့်အဝ သတိမူထား ပါသည်။	စီမံကိန်းအကြောင်းအရာေ ဗာ်ပြချက် အခန်း မစီစဉ်ထားသည့် ဖြစ်ရပ် အခန်း
ထိခိုက်ခံရသည့် ရပ်ရွာလူထုအတွက် လျေ ာ်ကြေးကို မည်သို့ စီမံခန့်ခွဲမည်နည်း။	TPMC - အကယ်၍ ထိနိုက်မှုများရှိလျှင်၊ အထူးသဖြင့် သဘာဝ ဓာတ်ငွေ့ပိုက်လိုင်းတည်ဆောက်မှုကြောင့် ထိနိုက်မှုများရှိလျှင်၊ ကျွန်ပ်တို့အနေဖြင့် လျော်ကြေးပေးရေးလုပ်ငန်းစဉ်ကို ဆောင်ရွက် ရန် လိုအပ်မည် ဖြစ်ပါသည်။ သို့ရာတွင်၊ သက်ဆိုင်သူများ အတွက် ကျွန်ုပ်တို့၏ လျော်ကြေးကို မြန်မာဥပဒေများ နှင့် သက်ဆိုင်ရာ အာဏာပိုင်များမှ လမ်းညွှန်ချက်များ နှင့် အညီ ပေးသွားမည် ဖြစ်ပါသည်။	လူမှုထိခိုက်မှုဆန်းစစ်ခြင်း (SIA) အခန်း
ရာညံသံ၊ အနိးအငွေ့ နှင့် ရေညစ်ညမ်းမှု တို့ကို မည်သို့ ထိန်းချုပ်မည်နည်း။ ကျွန်ုပ်တို့ အနေဖြင့် သီလဝါဇုန်ရှိ ဓာတ်အားစက်ရုံ တစ်ခုမှ ရာညံသံကို ဆက်တိုက်ကြား နေရပါသည်။	ERM - စီမံကိန်းမှ သက်ရောက်မှုကို ဆုံးဖြတ်နိုင်ရန်၊ လေ့လာမှု နယ်မြေစရိယာမှ ကျွန်ပ်တို့အနေဖြင့် လက်ရှိ ရှိနေသော မြေဆီ လွှာ၊ လေထုအရည်အသွေး နှင့် ဆူညံသံအချက်အလက်တို့ကို ကောက်ယူရမည်ဖြစ်ပြီး၊ စီမံကိန်းမှ ဖြစ်ပေါ် လာနိုင်သည့် သက် ရောက်မှုများကိုလည်း လေ့လာရမည် ဖြစ်ပါသည်။ လက်ရှိ ရှိနေသော လေထု၊ မြေဆီလွှာ၊ ရေအရည်အသွေး နှင့် ဖြစ်ပေါ် လာနိုင်သည့် သက်ရောက်ဆိုင်ရာလေ့လမှုတို့အပေါ် မူတည်၍၊ လိုအပ်လျှင်၊ လျှော့ချရေး အစီအမံများ	ထိရိုက်မှုဆန်းစစ်ခြင်း အခန်းများ

မေးခွန်းများ	အဖြေများ	ESIA ၌ ကိုးကားမှုများ/တုန့်ပြန်အြေ ဖများ
	နှင့် စောင့်ကြပ်ကြည့်ရှု စစ်ဆေးရေး အစီအစဉ်ကို အဆိုပြုမည် ဖြစ်ပါသည်။ စောင့်ကြပ် ကြည့်ရှုစစ်ဆေးအစီအစဉ်အပါအဝင် ESIA အစီရင်ခံစာကို ခွင့်ပြုချက်ရယူရန် MONREC ထံသို့ တင်သွင်းရမည် ဖြစ်ပါသည်။ စီမံကိန်းအဆိုပြုသူကုမ္ပကီသည် ကျွန်ုပ်တို့၏ အဆိုပြု သက်ရောက်မှု စီမံခန့်ခွဲမှုအစီအစဉ်နှင့် အညီ ဖြစ်ရပါမည်။ ပတ်ဝန်းကျင် စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးမှုအစီရင်ခံစာကို MONREC ထံသို့ အနည်းဆုံး ခြောက်လတစ်ကြိမ် တင်သွင်းရန် လိုအပ်ပါသည်။ အကယ်၍ စီမံကိန်းကို ဆောင်ရွက်နေပြီး၊ လျှော့ချမှုကိုလည်း အကောင်အထည်ဖော်သည့်တိုင်၊ သင့်အနေဖြင့် သက်ရောက်မှုကို ခံစားနေရသေးလျင်၊ TPMC ထံသို့ ၎င်းကိစ္စရပ်ကို အစီရင်ခံနိုင်ရန် တိုင်ကြားရေး ယွန္တရားသို့ သင်ချိတ်ဆက်ရမည် ဖြစ်ပါသည်။	

# ၁.၉.၂ ESIA တင်ပြချက် တိုင်ပင်ဆွေးနွေးမှုလုပ်ငန်းများအကျဉ်းဖော်ပြချက် (အများပြည်သူနှင့် တိုင်ပင်ဆွေးနွေးမှု - ၂)

အစည်းအဝေးများကျင်းပမှုကို ၂၀၁၉ ဇွန်လ ၁၂ မှ ၁၄ ရက်နေ့အထိ ပြုလုပ်ခဲ့ပါသည်။ ဝန်ကြီးချုပ် နှင့် နိုင်ငံတော် အစိုးရ၊ သက်ဆိုင်ရာ တိုင်းဒေသကြီးအဆင့် ECD နှင့် GAD၊ လွှတ်တော်ကိုယ်စားလှယ်၊ မြို့နယ် GAD၊ ကျေးရွာ အုပ်ချုပ်ရေမှူးများ၊ နှင့် ဒေသခံ ရပ်ရွာလူထုများအပါအဝင် အမျိုးမျိုးသော သက်ဆိုင်သူများကို ဖိတ်ကြားခဲ့ပါသည်။

၃၂ မြို့နယ် နှင့် ကျေးရွာများမှ ကိုယ်စားလှယ်များအား အများပြည်သူနှင့် တိုင်ပင်ဆွေးနွေးသည့်အစည်းအဝေးသို့ တက်ရောက်ရန် ဖိတ်ကြားခဲ့ပါသည် – ဒလ၊ သင်္ကန်းကျွန်း၊ သံလျင်၊ ပါးဒါကြီး၊ ဆင်ကန်၊ ကျောက်တန်း၊ အုတ်ဖိုစု၊ ဘောက်ထော်တွင်း၊ မြို့မ (တောင် နှင့် မြောက်)၊ ပဲခူးစု၊ ညောင်သုံးပင်၊ မြို့ဟောင်း (အနောက်၊ အရှေ့ နှင့် အလယ်)၊ ရွှေပြောက်၊ ညောင်ဝိုင်း၊ ရွှေပြည်သာယာ၊ ရွှေကုန်း၊ သီတာမြိုင်၊ ဘုရားကုန်း၊ အုတ်ဖို၊ အမှုထမ်း၊ သောက်တော်တွင်း၊ အလွမ်းစု၊ ရေနံ၊ ထန်းပင်ကုန်း၊ မြို့သစ် (အနောက်)၊ ကျောင်းအုတ်ဆိပ်၊ အလွမ်းစု၊ သာကေတ၊ အောင်မင်္ဂလာ၊ အလုံ၊ လသာ၊ သုဝက၊ နှင့် ဒဂုံ တို့ ဖြစ်ကြပါသည်။

အစည်းအဝေးတစ်ခုချင်းအတွက် နေ့စွဲ၊ အချိန်၊ တည်နေရာ နှင့် သက်ဆိုင်သူ တို့ကို *ဇယား ၁.၁၃* တွင် ဖော်ပြထား ပါသည်။

# ဇယား ၁.၁၃ - ESIA မူကြမ်း တင်ပြမှုကာလအတွင်း ဆောင်ရွက်ခဲ့သည့် တိုင်ပင်ဆွေးနွေးမှုလုပ်ငန်းများ

နေ့စွဲ	တည်နေရာ	သက်ဆိုင်သူများ	တက်ရောက်သူအရေအတွက်
၁၂/၀၆/၂၀၁၉	အလုံမြို့နယ်ခန်းမ၊	GAD (စီမံကိန်း)၊ ECD၊ ကျေးရွာခေါင်းဆောင်၊	၁၈၇
	အလုံမြို့နယ်	CSOs၊ ရပ်မိရပ်ဖများ၊ ကျေးရွာသူ/သားများ၊	
		MOGE၊ ပညာရေး ဝန်ကြီးဌာန၊	
		စိုက်ပျိုးရေး၊ မွေးမြူရေး နှင့် ဆည်မြောင်း	
		ဝန်ကြီးဌာန၊ လျှပ်စစ် နှင့် စွမ်းအင် ဝန်ကြီးဌာန၊	

နေ့စွဲ	တည်နေရာ	သက်ဆိုင်သူများ	တက်ရောက်သူအရေအတွက်
		သတင်းထောက်၊ မြန်မာ စက်မှုဆိပ်ကမ်း၊ YCDC၊ NGO၊ ကော်ပိုရေးရှင်းများ နှင့် EPC	
၅၀၀၂/ခိပ/၄င	သာဿနဗိမာန်ခန်းမ၊ သံလျင်မြို့နယ်	GAD (ကျန်းမာရေးစောင့်ရှောက်မှု၊ ဘဏ္ဍာရေး၊ MONREC၊ မီးသတ်ဦးစီးဌာန)၊ စိုက်ပိုူးရေး၊ မွေးမြူရေး နှင့် ဆည်မြောင်း ဝန်ကြီးဌာန၊ EPC၊ YCDC၊ လွှတ်တော်ကိုယ်စားလှယ်၊ ECD၊ ရပ်ကွက် အုပ်ချုပ်ရေးမှူး၊ ကျေးရွာခေါင်းဆောင်၊ နှင့် ကျေးရွာသူ/သားများ	ວດເ
၁၄/၀၆/၂၀၁၉	သင်ဇေယျနော်ရထာ ခန်းမ၊ ဒလမြို့နယ်	GAD (ဆောက်လုပ်ရေး၊ စီမံကိန်း၊ ကျန်းမာရေး စောင့်ရှောက်မှု၊ ပိုက်သွယ်ယူရေး၊ စိုက်ပျိုးရေး၊ အုပ်ချုပ်ရေး၊ မီးသတ်၊ ရေ နှင့် သန့်ရှင်းရေး၊ MONRE၊ နှင့် ရပ်ကွက် အုပ်ချုပ်ရေး ဦးစီးဌာန)၊ MOE၊ လွှတ်တော်ကိုယ်စားလှယ်၊ (တိုင်းဒေသကြီး အစိုးရ)၊ တိုင်းဒေသကြီး ECD၊ ရှေးဦးသူနာပြုအဖွဲ့၊ ကျေးရွာ ခေါင်းဆောင်၊ ရပ်မိရပ်ဖများ၊ ကျေးရွာသူ/သားများ	၁၄၃

အများပြည်သူနှင့် တိုင်ပင်ဆွေးနွေးမှု (၂) ကာလအတွင်း မေးမြန်းခဲ့သည့် အဓိက စိုးရိမ်မှုများ နှင့် မေးခွန်းများ ဥပမာ အချို့ နှင့် ၎င်းစိုးရိမ်မှုများ နှင့် မေးခွန်းများကို ဖြေကြားခဲ့သည့် တုံ့ပြန်မှုများကို *ဖယား ၁.၁၄* တွင် ဖော်ပြထား ပါသည်။ အဓိကစိုးရိမ်မှုများ နှင့် မေးခွန်းများ အပြည့်အစုံကို *အဓန်း ၁၃.၃.၃* တွင် ဖော်ပြထားပါသည်။

# ဇယား ၁.၁၄ - အများပြည်သူနှင့် တိုင်ပင်ဆွေးနွေးခြင်း (၂) ကာလအတွင်း မေးမြန်းခဲ့သည့် အဓိက စိုးရိမ်မှုများ နှင့် မေးခွန်းများ

မေးရွန်းများ	အဖြေများ	ESIA ၌ ကိုးကားမှုများ/ တုန့်ပြန်အဖြေများ
LNG လည်ပတ်မှုမှ မည်သည့် သက်ရောက်မှု များ ကို မျှော်မှန်းထား သနည်း။	LNG ကုန်ချမှု နှင့် သိုလှောင်မှုလုပ်ငန်းစဉ်ကို NFPA ကဲ့သို့သော အပြည်ပြည် ဆိုင်ရာ မီးကာကွယ်ရေး နှင့် ဘေးကင်းရေး လမ်းညွှန်ချက်တို့နှင့် အညီ ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။ မည်သည့်ဖြစ်ရပ်မဆို ချက်ချင်း အရေးယူဆောင်ရွက်မှုကိုပြင်ဆင်ရန် မီးကာကွယ်မှု နှင့် ယိုစိမ့်မှုစူးစမ်းရေး အာရုံခံကိရိယာများကို ဂိတ်တွင် တပ်ဆင်ထားမည်ဖြစ်ပါသည်။ စီစဉ်မထားသည့် ဖြစ်ရပ်မျိုး အခြေအ နေတွင်၊ LNG သိုလှောင်မှုအသေးစိတ်ကို ဂိတ်ရရိယာအတွင်း သက်ရောက်မှုကို ကိုင်တွယ်ရန် စနစ်တကျ ဒီဖိုင်းလုပ်ထားပါသည်။	ထိခိုက်မှုဆန်းစစ် ခြင်း အခန်းများ
ကုမ္ပကီ၏ လုပ်ငန်းများကို စောင့်ကြပ်ကြည့်ရှစစ် ဆေ းရန် မည်သို့ သေရာ စေမည်နည်း။ စီမံကိန်း	မြန်မာနိုင်ငံ ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဥပဒေ၊ ပတ်ဝန်းကျင်ထိန်း သိမ်းရေး နည်းဥပဒေ နှင့် ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာ	ESMP အခန်း

မေးခွန်းများ	အဖြေများ	ESIA ၌ ကိုးကားမှုများ/ တုန့်ပြန်အဖြေများ
ကုမ္ပဏီသည် ESIA ဥပဒေအား မလိုက်နာပါက၊ ပြစ်မှု ပြစ်ဒဏ်များမှာ အဘယ်နည်း။	လုပ်ထုံးလုပ်နည်း (၂၀၁၅) ဟူ၍ ရှိပါသည်။ ECD ဌာနသည် အဆိုပြုစီမံကိန်းအတွက် ပတ်ဝန်းကျင်ဆန်းစစ်ခြင်း၏ လိုအပ်သော အဆင့်ကို ဆုံးဖြတ်မည် ဖြစ်ပါသည်။ စီမံကိန်း အဆိုပြုကုမ္ပကီသည် သက်ဆိုင်ရာ ပတ်ဝန်းကျင်ဥပဒေကို လေးစားလိုက်နာရန် တာဝန်ရှိပါသည်။ အကယ်၍ ကုမ္ပကီသည် ပတ်ဝန်းကျင် စီမံခန့်ခွဲမှုကို လိုက်နာရန် ပျက်ကွက်ပါက၊ ဥပဒေအရ ကုမ္ပကီအား ငွေဒက် သို့မဟုတ် အခြားပြင်းထန်သောပြစ်ဒက်ကို ရမှတ်ပါသည်။	
ဓာတ်ငွေ့ ယိုစိမ့်သည် ဖြစ်ရပ်၌ အစီအမံများမှာ အဘယ်နည်း။	ဓာတ်ငွေ့ ယိုစိမ့်မှုကို သိရှိနိုင်ရန် ဓာတ်ငွေ့ ပိုက်လိုင်းဒီဇိုင်းတွင် စူးစမ်း ရေးစနစ်ကို အကောင်အထည်ဖော်မည် ဖြစ်ပါသည်။ အရေးပေါ် တုံ့ပြန်မှုအတွက် ဂိတ် နှင့် ဓာတ်အားစက်ရုံတို့အကြား တည်ရှိသည့် ပိတ်ဆို့ရေးခလုတ်စခန်းများကိုလည်း အကောင်အထည်ဖော်မည် ဖြစ်ပါသည်။ ဓာတ်ငွေ့ ယိုစိမ့်မှုကို စူးစမ်းမိသောအခါ၊ ကုမ္ပကီသည် လူများ နှင့် ပတ်ဝန်းကျင်တို့ကို ကာကွယ်ရန် ချက်ချင်းအရေးယူ ဆောင်ရွက်သွားနိုင်မည် ဖြစ်ပါသည်။	ESMP အခန်း
အများပြည်သူသုံး လမ်းများ အပေါ် သက်ရောက်မှု ကို ကုမ္ပကီက ပြန်လည် ပြုပြင်ရန် အကြံပေးခဲ့ သည်။	ကျွန်ုပ်တို့၏ ဓာတ်ငွေ့ပိုက်လိုင်းလမ်းကြောင်းသည် Dala-Danote ပင်မလမ်းမကြီးတစ်လျှောက် ဒီဇိုင်းလုပ်ထားပါသည်။ သို့ရာတွင်၊ သက်ဆိုင်ရာအစိုးရ ဌာနများနှင့် ပူးပေါင်းဆောင်ရွက်သွားမည့် အသေးစိတ်စစ်တမ်းအပေါ် မူတည်၍ ပြောင်းလဲနိ င်ပါသည်။ ပိုက်လိုင်း တည်ဆောက်ရေးတွင် အသုံးပြုသည် စက်ကြီး/ယာဉ်များကြောင့် ဖြစ်ပေါ် သည့် လမ်းပျက်စီးမှုအတွက် ကုမ္ပဏီက ပြန်လည်ပြုပြင်ပေးရန် တာဝန်ရှိပါသည်။	SIA အခန်း ESMP အခန်း

# ၁.၁၀ နိဂုံး

ဆောင်ရွက်ခဲ့သည့် ESIA လုပ်ငန်းစဉ်သည် မြန်မာနိုင်ငံရှိ အဆိုပြု LNG လက်ခံရေးဂိတ်၊ ပိုက်လိုင်း၊ နှင့် ဓာတ်အား စက်ရုံတို့နှင့်ဆက်နွှယ်သော ဖြစ်ပေါ်လာနိုင်သည့် သဘာဝမျက်နာသွင်ပြင်၊ ဇီဝ နှင့် လူမှုစီးပွားဆိုင်ရာ သက်ရောက်မှု များကို ဖော်ထုတ်ဆန်းစစ်ခဲ့ပြီ ဖြစ်ပါသည်။ သို့ရာတွင်၊ ယခု ESIA ၌ တင်ပြထားသည့် လျှော့ချရေး/စီမံခန့်ခွဲရေး အစီအမံများကို အကောင်အထည်ဖော်ခြင်းဖြင့်၊ *၎င်းသက်ရောက်မှုအများစုသည် အရေးပါမှုနှင့်ပတ်သက်၍ သာမည မှ မပြောပလောက်သော အဆင့်အထိလျှော့ချသွားနိုင်မည် ဖြစ်ပါသည်။* ESMP နှင့် မြန်မာနိုင်ငံ NEQ၊ အပြင် IFC လမ်း ညွှန်များကို ထိရောက်စွာအကောင်အထည်ဖော်မှုသည် ပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှုများကို လက်ခံနိုင် ဖွယ် အဆင့်များအထိ လျှော့ချရာတွင် အထောက်အကူဖြစ်သွားမည် ဖြစ်ပါသည်။

ဖြစ်ပေါ် လာနိုင်သော ပတ်ဝန်းကျင်၊ လူမှု နှင့် ကျန်းမာရေးဆိုင်ရာ သက်ရောက်မှုများကို ဖော်ထုတ်သတ်မှတ်ခဲ့သော် လည်း၊ သက်ရောက်မှုများမှာ ပုံမှန်အားဖြင့် ယာယီသာဖြစ်ပြီး၊ လျှော့ချရေးအစီအမံများကို အကောင်အထည်ဖော်ပြီး နောက် သာမည ကြွင်းကျန်အရေးပါမှုရှိမည် ဖြစ်ကြောင်း ဆန်းစစ်ခြင်းမှ တွေ့ရှိရပါသည်။ ထိန်းချုပ်မှုများ နှင့်/သို့မ ဟုတ် လျှော့ချရေးအစီအမံများကို အကောင်အထည်ဖော်ခြင်းဖြင့်၊ သက်ရောက်မှုများဖြစ်ပေါ် လာနိုင်မှုသည် ပတ်ဝန်း ကျင်၊ လူမှု သို့မဟုတ် ကျန်းမာရေးဆိုင်ရာ အဓိကနေရာများပေါ် ဆိုးကျိုးသက်ရောက်မှုများမှာ အနည်းငယ် သို့မဟုတ် မရှိဟု ကောင်းစွာ နားလည်ပါသည်။ ESMP ပါ အကြံပြုထားသည့် လျှော့ချရေးအစီအမံများသည် အပြည်ပြည်ဆိုင်ရာ အလေ့အကျင့်များအကြား ကောင်းစွာတည်ဆောက်ထားခြင်းဖြစ်ပြီး၊ အလားတူအနေအထားများ၌ အလားတူစီမံကိန်း များ အတွက် အပါအဝင် ဖြစ်ပေါ် လာနိုင်သော သက်ရောက်မှုများကို လက်ခံနိုင်ဖွယ်ရှိသော အဆင့်များအထိ စီမံခန့်ခွဲ ရာတွင် ထိရောက်ကြောင်း သက်သေထူပြီး ဖြစ်ပါသည်။

လူမှုရှုထောင့်မှကြည့်လျှင်၊ ကနဦး သက်ဆိုင်သူများနှင့်တိုင်ပင်ဆွေးနွေးရာတွင် ဒေသခံလူထု နှင့် အခြားသက်ဆိုင်သူ များ ထံမှ လက်ခံသော အားပေးမှုကို ရရှိကြောင်း တွေ့ရပါသည်။ သက်ဆိုင်သူများသည် ဒေသတွင်းသို့ အားကိုး နိုင်သော ဓာတ်အားထောက်ပံ့မှုရရှိမှုကို ကြိုက်နှစ်သက်ကြပါသည်။ စီမံကိန်းသည် ဒေသတွင်း စီးပွားရေးဖွံ့ဖြိုးမှု၊ အလုပ်အကိုင် (တိုက်ရိုက် နှင့် သွယ်ဝိုက်၍) ကဲ့သို့သော အခြားအကျိုးကျေးဇူးများလည်းရှိပြီး၊ စီမံကိန်းအဆိုပြုသူ အနေဖြင့် အဆိုပြု လျှော့ချရေး အစီအမံများအားလုံးကို အကောင်အထည်ဖော်ခြင်းဖြင့်၊ ဆိုးကျိုးသက်ရောက်မှုများကို လျှော့ချသွားနိုင်မည် ဖြစ်ပါသည်။

ယခု ESIA တွင် တင်ပြထားသည့် လူမှု နှင့် ပတ်ဝန်းကျင် လျှော့ချရေး/စီမံခန့်ခွဲရေး အစီအမံများအားလုံးကို အကောင် အထည်ဖော်ခြင်းဖြင့်၊ မြန်မာနိုင်ငံရှိ အဆိုပြု LNG ဓာတ်အားစက်ရုံ (အလုံ) ခွင့်ပြုချက်ကို တားဆီးမည့် ပတ်ဝန်းကျင် သို့မဟုတ် လူမှုဆိုင်ရား ဆိုးဆိုးရွားရွား ချွတ်ယွင်းချက်ရှိမည် မဟုတ်ဟု ERM က မြင်ပါသည်။

ယခု ESIA သည် ဒီဇိုင်း နှင့် အစီအစဉ်ချရေးအဆင့်အပေါ် အခြေပြု ပြီးမြောက်ခဲ့သောကြောင့်၊ စီမံကိန်းအနေအထား၊ တည်ဆောက်ရေးနည်းလမ်းများ နှင့် လည်ပတ်မှုများနှင့်ပတ်သက်သော အပြောင်းအလဲများသည် ဒီဇိုင်း နှင့် အစီအ စဉ်ချရေး နောက်ပိုင်းအဆင့်များတွင် ပေါ် လာနိုင်ပါသည်။ ထို့ပြင်၊ တည်ဆောက်ရေးအတွက် EPCကို အဓိကအစိတ် အပိုင်း သုံးရပ်အတွက် မခန့်အပ်ရသေးသောကြောင့်၊ အပြီးသတ် စီမံကိန်းတည်နေရာများတွင် ပကတိအခြေအနေများ နှင့် ပတ်သက်သော နောက်ထပ်လေ့လာမှုများ၊ ကျယ်ပြန့်သော သက်ဆိုင်သူများနှင့်ချိတ်ဆက်ထိတွေ့မှု နှင့် ခန့်အပ် သည့် EPC၏ လေ့ကျင့်သင်ကြားမှုတို့ကို နောက်ပိုင်း အစီအစဉ်ချသည့်အဆင့်ကာလ နှင့် တည်ဆောက်ရေး နှင့် လည်ပတ်ရေးအဆင့်များတစ်လျောက် လိုအပ်မည် ဖြစ်ပါသည်။ TPMC သည် နောက်ထပ် စစ်တမ်းများ နှင့် လေ့လာမှု များဆောင်ရွက်ခြင်းအပါအဝင် အကြံပြုထားသည့် လျှော့ချရေး နှင့် စီမံခန့်ခွဲမှုနည်းလမ်းများအားလုံး အကောင် အထည်ဖော်ရေး အတွက် နှင့် သက်ဆိုင်ရာ သက်ဆိုင်သူများ နှင့် အာဏကာပိုင်အဖွဲ့အစည်းများထံသို့ လုပ်ဆောင်မှုနှင့် ပတ်သက်သော အစီရင်ခံစာများအတွက် တာဝန်ရှိပါသည်။

## 1. EXECUTIVE SUMMARY

### 1.1 Introduction

**TTCL Power Myanmar Company Limited ('TPMC' and/or 'the Project Proponent')** is planning to develop the **LNG Power Plant (Ahlone) Project** (also referred to as 'the Project'). The Project will consist of three main components; the LNG Power Plant (Ahlone) (hereafter referred to as 'Power Plant'), LNG Receiving Terminal (hereafter referred to as 'LNG Receiving Terminal' which include Jetty, LNG Storage Tank(s) and Regasification Unit), and the Natural Gas Pipeline (hereafter referred to as 'Pipeline'). The Pipeline will have an approximate length of 24.9 km connecting the Regasification Unit at the LNG Receiving Terminal to the Power Plant. The Project Proponent has planned to use imported Liquefied Natural Gas (LNG) as the fuel source. The selected technology for the Power Plant, combined cycle power plant (CCPP), is an efficient form of power generation, proven and acknowledged as a clean form of natural gas power generation due to its efficient gas utilisation and lower environmental impact.

The Project Proposal Report (PPR) was submitted to Ministry of Electricity and Energy (MOEE), and Ministry of Natural Resources and Environmental Conservation (MONREC) on 14<sup>th</sup> December 2017 and the Project received the Notice to Proceed from the Myanmar Government in January 2018.

Under Section 7 of the Environmental Conservation Law and Articles 52 and 53 of the Environmental Conservation Rules of the Republic of the Union of Myanmar, TPMC is required to undertake an Initial Environmental Evaluation (IEE) Study <u>OR</u> an Environmental Impact Assessment (EIA) Study to obtain an Environmental Compliance Certificate (ECC) for the proposed Project. The PPR recommended that the Project Proponent shall prepare and submit the EIA Study (this Report) to the relevant authorities for appropriate approval.

The Project Proponent may seek international financing for the Project development phase from international lenders. Therefore, this EIA Study, also referred to as Environmental and Social Impact Assessment (ESIA) study, is developed in compliance with Myanmar EIA requirements and in line with International Standards, namely IFC PS and Associated Guidelines.

**ERM-Siam Company Limited** ('ERM' and/or 'the Consultant') has been proposed by TPMC as third party consultant to undertake the EIA study as proposed in the PPR report. This EIA will focus on the LNG Receiving Terminal, Natural Gas Pipeline, and the LNG Power Plant (Ahlone). A separate Initial Environmental Examination (IEE) report will be developed for the 230 kV transmission line connecting the Power Plant to a sub-station in Hlaingthayar Township.

## **1.2 Context of the Project**

TPMC is planning to develop a Power Plant in Yangon, Myanmar. A Combined Cycle Power Plant (CCPP) (installed capacity 388MW) will be developed to supply the power to the Republic of the Union of Myanmar.

In January 2018, the Ministry of Electricity and Energy (MOEE) hosted the 'Notice to Proceed' (NTP) signing ceremony for four (4) projects, which included the LNG Power Plant (Ahlone) Project and the NTP was signed between the Myanmar Government and TPMC. The Project Proponent has prepared and submitted the Project Proposal Report (PPR) to MOEE and ECD on 14<sup>th</sup> December 2017. The PPR recommended that TPMC shall proceed with an Environmental Impact Assessment (EIA) Study of the Project and prepare an Environmental Management Plan (EMP) to put forward its commitments for environmental and social mitigation and management measures.

In addition, the Scoping Report has also been prepared and submitted to MOEE and ECD on 9<sup>th</sup> January 2019. ECD has provided the comments on the Scoping Report on 9<sup>th</sup> April 2019. The comments from ECD are addressed in this EIA Report, please refer to **Appendix C** for further details.

This Environmental and Social Impact Assessment (ESIA) will only cover the LNG Receiving Terminal, Pipeline, and Power Plant; while an Initial Environmental Examination (IEE) for the Transmission Line has been prepared as a separate document.

## 1.3 Background of Project Proponent

TPMC is a project company set up by TTCL Public Company Limited and the main Project Proponent for the proposed Project. TPMC was established in 2018 to carry out the development, operation and maintenance of the Project.

TTCL Public Company Limited (TTCL), the first integrated Engineering, Procurement and Construction (Integrated EPC) company in Thailand, was incorporated on 24 April 1985 with a start-up capital of 20 Million Baht. TTCL was formed by a joint venture between two (2) leading international engineering and construction companies from Japan and Thailand. TTCL has experience and expertise in providing integrated design and engineering, procurement of machinery & equipment, and construction (Integrated EPC) of turnkey projects for industrial and process plants, mainly in energy, petrochemical, chemical and power industries.

TTCL has set up TTPMC in 2012 for the development of a 120 MW Gas-fired power plant in Ahlone Township, Yangon, the Republic of the Union of Myanmar.

Details of the main Project Proponent are as follows:

Company Name:	TTCL Power Myanmar Company Limited (TPMC)
Address.	
	NO. 65, Corner of Sule Pagoda Road and Merchant Street. Kyauktada
	Township, Yangon, Myanmar
Contact Person:	Ms. Nini San
Telephone:	+95 [0] 9 254 311058
	+95 [0] 1 371 962
Fax:	+95 [0] 1 371 963
Email:	nini.s@ttcl.com

## 1.4 Policy, Legal and Institutional Framework

Under Section 7 of the Environmental Conservation Law and Articles 52 and 53 of the Environmental Conservation Rules of the Republic of the Union of Myanmar, TPMC is required to undertake an Initial Environmental Evaluation (IEE) Study <u>OR</u> an Environmental Impact Assessment (EIA) Study to obtain an Environmental Compliance Certificate (ECC) for the proposed Project.

The Project will be undertaken in line with national regulation and international standards. Local laws relating to the ESIA include: Environmental Conservation Law (2012); Environmental Conservation Rules (2014); National Environmental Quality (Emission) Guidelines (2015); and the Environmental Impact Assessment (EIA) Procedure (2015).

With the release of the final Myanmar EIA Procedure in December 2015, the National Environmental Quality (Emissions) Guidelines were also released. These Guidelines provide the basis for regulation and control of noise and air emissions and effluent discharges from projects in order to prevent pollution and protect the environment and public health. These standards are equivalent to the World Bank Group General Environmental Health & Safety (EHS) Guidelines (2007).

## 1.5 **Project Description**

### 1.5.1.1 Project Location

The Project location is located within the Yangon Region, in Myanmar. The LNG Receiving Terminal is located on the west bank of the Yangon River, in the southeastern regions of Dala Township. The Power Plant is located along the east bank of the Yangon River, in the southern regions of Ahlone Township, beside Toyo Thai Power Myanmar Co. Ltd (TTPMC) existing 120 MW Natural Gas Power Plant. The Natural Gas Pipeline, which will transfer natural gas (NG) from the LNG Receiving Terminal to the Power Plant, will run through Dala, Seikgyikanaungto, and Ahlone Townships. The pipeline will need to cross two (2) waterways, which include the Twante Canal, and the Yangon River. The general location for the Project, on a regional scale, is shown in *Figure 1.1*. The location for all three main components is presented in *Figure 1.2*.



Figure 1.1: Project Location

Source: TPMC, 2018. (Modified by ERM)





Source: TPMC, 2019. (Modified by ERM)

## 1.5.2 LNG Receiving Terminal

## 1.5.2.1 Key Components

The LNG Receiving Terminal is a facility for unloading liquefied natural gas (LNG) from the LNG Carrier (LNGC), LNG storage, and regasification of LNG to NG. The LNG Receiving Terminal components are listed in *Table 1.1*.

Component	Details	
Number of LNG Carrier per month (frequency)	2-4 LNGCs per month	
LNG Carrier Capacity	16,000 ton (approx.)	
LNG Carrier Type	Moss, Membrane	
LNG Consumption (per day)	1,300 ton (approx.) @ 100% Load	
LNG Unloading Jetty	Centre Platform with walkway, mooring dolphin and Trestle, 100 metres from river shore line Concrete Structure	
LNG Unloading Arms	Two (2) liquid Unloading Arms + One(1) vapour return loading arm at the Unloading Jetty	
LNG Cryogenic Pipeline	<ul> <li>Stainless steel pipe with cold insulation;</li> <li>291 metres (approx.); from unloading arm to a LNG storage tank;</li> <li>160 metres (approx.); from LNG storage tank to the BOG recondenser;</li> <li>86 metres (approx.); from BOG recondenser to regasification unit.</li> </ul>	
LNG Storage Tanks (onshore)	Two (2) Full containment tanks with 25,000 $m^3$ capacity each (working volume)	
Regasification Unit	Appx. 63 million standard cubic feet per day (MMSCFD), Heating source by river water Intermediate fluid vaporizers (IFV)	
Vent Stack	One (1) HP Vent Stack One (1) Cold Vent Stack	
Cold Water Discharge Arrangement	336 mm pipe diameter Pipe resting on the channel bottom Flow rate 1,300 m <sup>3</sup> /h	
Gas Engine Generator	Four (4) natural Gas Engine Generators (GEG) total Three (3) GEG continuous operation, one (1) GEG on standby 1,160 kW Continuous capacity each	
Area of land where the LNG Storage Tanks and RU are to be set up and operated	15.0 acres (approx.)	
General Arrangement	<ul> <li>Electrical room;</li> <li>Control room building;</li> <li>Main gate guard house; and</li> <li>Jetty guard house.</li> </ul>	

## Table 1.1: LNG Receiving Terminal Key Components

Source: TPMC, 2019.

#### 1.5.2.2 Construction Phase

The construction phase will take approximately 23 months for the LNG Receiving Terminal. The EPC Contractor will prepare the site for construction, erection and installation of the Project components. All emissions, discharges, and other releases from construction, design and testing will adhere to the guideline limits set out in the Myanmar NEQ (Emission) Guidelines and WB/IFC EHS Guidelines. Site preparation will include, but not be limited to, the following activities:

- Earthwork
  - Earthworks will include clearing of vegetation and grading of the Project site. It is expected that the subsoil, which will be stripped and removed from the Project site, shall be utilised for levelling/ backfilling; the amount of fill material required is 100,000 m<sup>3</sup>. The terminal construction site, being partially in an area subjected to flooding will require careful study of potential placement of elevation and flood barriers.
- River Work
  - The existing roads do not support the types of vehicles required for the LNG Receiving Terminal construction phase; therefore, all construction materials, equipment, and workforce will be transported to and from the construction site via transport barge.
  - Installation of Project facilities that extend from onshore and are located alongside the waterfront; the unloading jetty will require pilling activities prior to topside installation.
  - Establishing a safety zone around the construction area will be required to ensure safety among the construction vessels
- Mobilization
  - The existing roads do not support the types of vehicles required for the LNG Receiving Terminal construction phase; therefore, all construction materials, equipment, and workforce will be transported to and from the construction site via transport barge.

## Supporting Facilities

In addition to the above, the following will be required during the construction phase:

- Laydown Area
  - The laydown area will be used for storing construction materials and equipment prior to actual usage. This will be located within the LNG Receiving Terminal construction area.
- Construction Camp
  - A temporary construction camp will also be placed within the LNG Receiving Terminal construction area, to accommodate the construction workforce, and other applicable staff. This construction camp will also accommodate the pipeline construction workforce, since the area is located nearby each other.

#### 1.5.2.3 Operation Phase

Operation activities associated with the LNG Receiving Terminal include scheduled delivery of LNG via LNGC, unloading of LNG from the LNGC to the storage tanks, and regasification of LNG to NG, which will then be sent to the Power Plant via the pipeline.

The regasification process will require continuous water intake from the Yangon River as a heat exchanger, approximately 1,300 m<sup>3</sup> per hour. Gas Engine Generators (GEG) will utilize natural gas as fuel to produce electricity for the LNG Receiving Terminal facility; a total of four (4) units will be installed, and each with a capacity of 1,160 kW continuous. The expected operation period is 25 years from Commercial Operation Date (COD).

## 1.5.3 Pipeline

## 1.5.3.1 Key Components

The natural gas supply pipeline will transfer the natural gas (NG) from the LNG Receiving Terminal (from the send-out facility after regasification unit) to the Power Plant. The pipeline will be designed as per The American Society of Mechanical Engineers (ASME) B31.8: Gas Transmission and Distribution Systems. In addition, Cathodic Protection will be placed for the buried section of the pipeline. The brief specification for the Pipeline are included in *Table 1.2*.

Component	Details	
Length	24.9 km	
Diameter	20 inches	
Pipe Wall Thickness	≥ 9.53 mm	
Material	Carbon steel	
Design Pressure	Appx. 64 barG	
Minimum Yield Strength	4,481.6 barG	
Coating	API 5L X65 with 3LPE coating	
Minimum Design Temperature	0.0 °C	
Operating Design Temperature	10 °C	
Maximum Design Temperature	55.0 °C	
Design Standard	ASME B31.8	
	ASME B31.8s ASME B31.3	
Material Design	ANSI <sup>a</sup> / ASME / ASTM <sup>b</sup>	
	API	
	SSPC° MSSd	
Design Location Class	3, and 4 (Design factor 0.5, and 0.4 respectively)	
	3 Laver Polvethylene	
Cathodic Protection	Impressed current cathodic protection	
Block Valves	Two (2) Valves (at each extremity)	
Operation Period	25 years from COD	

#### **Table 1.2: Gas Pipeline Key Components**

Source: TPMC, 2019.

Note: <sup>a</sup> American National Standards Institute

- <sup>b</sup> American Society for Testing and Materials
- <sup>c</sup> The Society for Protective Coatings
- <sup>d</sup> Manufacturers Standardization Society

### 1.5.3.2 Construction Phase

The construction phase will take approximately 18 months for the pipeline. The EPC Contractor will prepare the site for construction, and installation of the Project component. All emissions, discharges, and other releases from construction, design and testing will adhere to the guideline limits set out in the Myanmar NEQ (Emission) Guidelines and WB/IFC EHS Guidelines. The key construction activities will include, but not be limited to, the following:

- Earthwork
  - Earthworks will include clearing of vegetation and grading for the ROW of the pipeline. The subsoil located directly in the pipeline alignment will be excavated to the designed depth of the pipeline, once the pipeline is in place, the excavated soil will be backfilled. The amount of soil that will be cut and filled is approximately 75,000 m<sup>3</sup> and 56,000 m<sup>3</sup> respectively.
- Horizontal Directional Drilling (HDD)
  - Horizontal directional drilling (HDD) is a method of installing pipeline without having to cut and fill soil. This method is particularly advantageous in areas where excavation is not practical; for this Project's case, an open-cut method will not be practical for pipeline sections that will cross two (2) points, the Twante Canal (~500 m), and the Yangon River (~550 m).
  - Bentonite, specifically known as Sodium Bentonite, is a liquid solution that is used as drilling fluid to assist the drilling of boreholes. During HDD method, bentonite will be used as drilling fluid for the HDD rig. It is expected that the amount of bentonite produced from HDD activities is approximately 1,000 m<sup>3</sup>.
- Hydrostatic Testing
  - Hydrostatic testing involves pumping liquid into pressure system (such as a pipeline) to perform strength test and identify leak points. Once the Pipeline has been constructed, the Pipeline system will need to undergo Hydrostatic testing before proceeding with operation. Once pipeline installation reaches 3 5 km completion length, hydrostatic testing will commence; once testing is completed and passed, soil is then backfilled. The amount of hydrostatic testing fluid required for testing is approximately 2,500 m<sup>3</sup>.

## Supporting Facilities

In addition to the above, the following will be required during the construction phase:

- Laydown Area
  - The laydown area will be used for storing construction materials and equipment prior to actual usage. The laydown area will be located near a HDD location for the Twante Canal.
- Construction Camp
  - The construction workforce for the pipeline construction will share the same temporary construction camp with the LNG Receiving Terminal; therefore, the location of the pipeline construction camp is located within the LNG Receiving Terminal construction area.

## 1.5.3.3 Operation Phase

Operation activities associated with the pipeline include constant gas shipping and gas compressing at scheduled intervals. No land disturbance or waste generation is expected from pipeline alone during operation phase. After the construction of the pipeline is completed, operation and maintenance will be carried out by TPMC; therefore, there will be no Operation and Maintenance (O&M) contract with any third party operator. The expected operation period is 25 years from COD.

## 1.5.4 Power Plant

## 1.5.4.1 Key Components

The proposed Power Plant type is a Combined Cycle Power Plant (CCPP). During normal combined cycle operation, electricity will be generated by the gas turbines; additionally, the heat of gas turbine exhaust gas will be admitted to the Heat Recovery Steam Generator (HRSG) where superheated steam will be produced, which will drive the steam turbine to generate electrical power. The key components and details are listed below in *Table 1.3*.

Component	Details	
Land Area	8.97 acres (approx.)	
Power Plant Installed Capacity	388 MW	
Plant Configuration	Two (2) Gas Turbines, two (2) HRSGs, and one (1) steam turbine	
Steam Turbine	Condensing Steam Turbine (single casing turbine)	
HRSG	Horizontal Drum Units	
Cooling System	Cell Type Wet Cooling Tower (with induced draft)	
Electrical Generators	Three (3) Totally Enclosed Water to Air Cooled Electrical Generators (One for each Turbine)	
Step Up Transformers	2 Winding Transformers Preferred (1 Transformer for 1 generator)	
Switchyard	Gas Insulated Switchyard (GIS) (Single Busbar Configuration, operated by MOEE)	
Embedded Environmental Control	<ul> <li>Multi-chambers combustion system</li> <li>Single gas fuel combustion system with DLN combustors</li> <li>Ignition system with spark plugs and U.V. flame detectors</li> </ul>	
Stacks	<ul><li>Diameter 5 meters appx.</li><li>Height 40 meters appx.</li><li>Carbon Steel with internal painting</li></ul>	
Operation Period	25 years from COD	

#### Table 1.3: Power Plant Key Components

Source: TPMC, 2019.

#### 1.5.4.2 Construction Phase

The construction phase will take approximately 28 months for the Power Plant. The EPC Contractor will prepare the site for construction, erection and installation of the Project components. All emissions, discharges, and other releases from construction, design and testing will adhere to the guideline limits set out in the Myanmar NEQ (Emission) Guidelines and WB/IFC EHS Guidelines. Site preparation will include, but not be limited to, the following activities:

- Earthwork
  - Earth works will include clearing of vegetation and grading of the Project site. It is anticipated that the subsoil, which will be stripped and removed from the Project site, shall be utilised for levelling/ backfilling. The amount of soil that is expected to be excavated then backfilled is approximately 29,600 m<sup>3</sup>. Grading of the site will be done by the design team, considering sufficient height to protect the power plant from potential water and tidal/ flood damage.
- River Work
  - The project will involve the construction of a new pontoon and walkway to connect the pontoon to an existing walkway. Given the size of the pontoon and walkway that is required to be constructed, land based equipment will be used to install the walkway, whereas the crane barge will install the pontoon and steel piles.

## Supporting Facilities

In addition to the above, the following will be required during the construction phase:

- Laydown Area
  - The laydown area will be used for storing construction materials and equipment prior to actual usage. The laydown area will be located at two (2) separate location, one near the entrance to TPMC's existing Power Plant compound, and the second located within the Power Plant construction area.
- Construction Camp
  - The temporary construction camp for the Power Plant construction will be located within Yangon City, to accommodate the construction workforce, and other relevant staff.

## 1.5.4.3 Operation Phase

Operation activities associated with the Power Plant include continuous combustion of natural gas (NG) fuel to generate electricity. NG will be provided by the LNG Receiving Terminal, which is sent via the pipeline. Continuous water intake is expected for cooling water. Heat generated from the gas turbines' exhaust will be sent through a heat recovery steam generator (HRSG) to produce steam, which is then sent through a steam generator to produce electricity. The expected operation period is 25 years from COD.

## 1.5.5 Schedule

The construction schedule is detailed in Table 1.4.

Table 1.4:	Tentative	Project	Schedule
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Pre-EPC Phase	Tentative Date	
Completion of Feasibility Study	Dec 2017	
Site Preparation	Apr-Jun 2018	
Stakeholder Engagement 1	Dec 2018	
Scoping	Jan 2019	
Stakeholder Engagement 2	Feb-Mar 2019	
Final EIA submission to MONREC	Aug 2019	
Detail Engineering	Jun 2019- Sep 2020	
Procurement	Nov 2019- May 2020	
LNG Terminal Construction	Jan 2020-Aug 2021	
Pipeline Construction	Mar 2020-Aug 2021	
Power Plant Construction	Jan 20-Nov 21	
Power Plant Commissioning	Dec 21-Apr-22	
Power Plant COD	Apr 2022	

Source: TPMC, 2019.

It is noted the above Project Schedule is tentative and subject to be changed and updated

The operation of all three (3) components are expected to last 25 years in total.

#### 1.5.6 Workforce

The indicative number of workers estimated to be working on-site during the construction phase of each main component for the Project is shown in *Table 1.5*.

Workforce Origin	Average No. of Skilled Workers	Average No. of Semi-Skilled Workers	Average No. of Unskilled Workers	Total Average Workforce (per day)	Total Peak Workforce (per day)
LNG Receiving	Terminal + Unload	ling Jetty			
Local Workforce	83	22	220	440	650
Migrant Workforce	42	11	0	440	850
Pipeline					
Local Workforce	35	36	32	04	447
Migrant Workforce	14	60	0	81	117

#### **Table 1.5: Anticipated Workforce during Construction**

Workforce Origin	Average No. of Skilled Workers	Average No. of Semi-Skilled Workers	Average No. of Unskilled Workers	Total Average Workforce (per day)	Total Peak Workforce (per day)
Power Plant + P	ontoon				
Local Workforce	80	12	200		<u> </u>
Migrant Workforce	40	6	0	400	000
Total	294	147	452	921	1,367

Source: TPMC, 2019.

## 1.5.7 Project Alternatives

## 1.5.7.1 LNG Receiving Terminal

There were three (3) LNG Receiving Terminal locations that were considered, two locations were located along the shoreline of Thanlyin Township (which can be categorized as North, and South options), and one location along the Southeast shoreline of Dala Township.

A significant disadvantage of the Thanlyin options is that pipelines will need to be installed using HDD method. The North option will require a pipeline length of approximately 3.14 km to be installed using HDD method, and the South option will require approximately 4.4 km. Although it is possible to use HDD method for these distances, this may increase costs significantly, and limit maintenance capabilities. In addition, the land was not available for use for this Project, due to ongoing land use.

Therefore, the location along the southeast shoreline of Dala Township was considered as the only option.

## 1.5.7.2 Pipeline

Two (2) routes for the pipeline were initially considered, one route going in parallel with a road in the centre of Dala Township, whereas the second route going along the east shoreline. Since the second route is expected to have impact on more sensitive receptors, the first route was considered as best option.

## 1.5.7.3 Power Plant

Although options for selecting the Power Plant site can be explored, the plan to implement the proposed Power Plant next to the existing Power Plant is currently the best scenario. Placing the proposed power plant at this location will allow for the facilities and other utilities to be shared between the proposed and existing power plants, specifically the switchyard; therefore, construction of certain facilities will not be needed, which lowers costs. Given that construction of the existing Power Plant has already taken place, experience acquired from construction activities in the same area will allow for factors such as cost, logistics and access roads to be easily considered and planned.

## **1.6 Description of the Environment**

The establishment of the Area of Influence (AoI) for the Project (and thus the appropriate Project Study Area) is intended to ensure that the Impact Assessment (IA) focuses on those issues that are most important for design, decision-making and stakeholder interest.

An Aol of 5 km from the Project site boundary has been established for Power Plant and for the LNG Receiving Facilities, in particular air quality receptors or social receptors. For the natural gas pipeline a buffer area of 500 m from each side of the centre line of the pipeline has been consider, in particular for social receptors.

The Project Study Area (hereinafter also referred to as 'Study Area') refers to the area that needs to be studied in order to adequately understand and describe the baseline conditions likely to be affected by the Project. With the AoI established, the Study Area (see *Figure 1.3*) comprises a 5 km radius of the Project site (Power Plant, and LNG Receiving Terminal) as well as a 500 m from each side of the Natural Gas Pipeline. There are no set guidelines on the sphere of influence; however, this is in line with best practices in the industry and is designed to include all potentially impacted sensitive receivers during both construction and operation phases. The Study Area encompasses the entire Area of Influence of the Project (i.e. area potentially impacted by the Project) for environmental and biodiversity component of the environment. It also covers all social receptors that might be directly impacted by the Project; nevertheless, the social baseline covered a larger area in order to ensure inclusiveness of all potential socioeconomic, health and cultural heritage components present in the Project's AoI. The Study Area is shown in *Figure 1.3*.







## 1.6.1 Biophysical Baseline

### 1.6.1.1 Climate and Meteorology

Most of Myanmar is located in the tropical region characterised by a tropical monsoon climate with three well-defined seasons: summer, rainy and cold seasons. The summer months are from March to Mid-May. The rainy season typically lasts from mid-May to the end of October and the cold season starts in November and lasts until the end of February. These data are relevant for the Study Area.

The southwest monsoon starts in late March or early April with local turbulence that includes tornados and cyclones, bringing winds that can reach up to 200 - 300 km/h. From October to mid-March, the northeast monsoon brings a dry and cool climate. Due to widely differing topographical profiles throughout Myanmar and its range of latitudes, its climate conditions differ widely from one place to another (UNCCD, 2005).

### 1.6.1.2 Air Quality

Monitoring of NO<sub>2</sub> was conducted in 13 monitoring locations. Passive diffusion tubes were deployed in triplicate at three locations from 27 February to 2 May 2018 and from 12 to 26 June 2018. The automatic Haz-Scanner Environmental Perimeter Air Station (EPAS) was deployed at a further 10 locations in the Study Area for a continuous 72-hour period in both the wet and dry season.

Air quality monitoring for both dry and wet seasons indicates at least three different parameters (PM<sub>2.5</sub>, PM<sub>10</sub>, and SO<sub>2</sub>) exceed the Myanmar Emission Quality Guidelines (NEQG) in some locations. This is consistent with other air quality monitoring previously carried out in the region.

#### 1.6.1.3 Noise

Noise level measurements were conducted according to the relevant methods of the International Organization for Standardization (ISO), which include ISO 1996-1:2003, and ISO 1996-2:2007. The equipment used for measurement is a Model SL-4023SD sound level meter. Ten (10) sampling stations were carried-out by SEM during a baseline survey conducted 2 to 14 May 2018, which are located at the same sampling station as air quality. The survey was conducted for 48 hours consecutively for each location.

According to the noise baseline results, nine out of ten noise monitoring stations exceeded the Myanmar standard for at least one time period. Possible sources of high noise levels include the existing Power Plant, traffic activities, human activities, and rain/weather events.

## 1.6.1.4 Surface Water

Dry season surface water samples were collected by ERM-Siam and SEM from 3 to 4 May 2018, in fourteen (14) locations, and wet season surface water samples were collected from 27 to 28 June 2018, in fourteen (14) locations. For sampling sites located in the Yangon River and the Twante Canal, a local boat was used to travel between shore and sampling site; sampling equipment was brought on-board and samples were collected directly on the boat. For sampling sites located in-land, a vehicle was used to travel to each site, and samples were collected on the sides of the river, or from a bridge. Water samples were taken by an Alpha horizontal water sampler and collected in plastic and sterilized glass sample containers. All sampling was conducted in strict accordance with recognized standard procedures

Total Dissolved Solid (TDS) concentrations at all sampling locations (4,052 - 12,760 mg/L) exceeded the United States Environmental Protection Agency (EPA) Standard (250 mg/L). Manganese concentrations at all sampling locations (0.22 - 1.40 mg/L), excluding SW9 and SW10, exceeded the EPA Standard (0.05 mg/L).

All other parameters are found to be within the Myanmar, IFC, and EPA Standards.

## 1.6.1.5 Soil

Soil samples were collected from nine (9) sample points in the Study Area on 3 and 4 May 2018, and were tested for several types of parameters that are listed together with the results below. The soil samples were collected using a manual hand auger tool; the samples were collected from top soil (30 cm - 50 cm depth) and sub soil (80 cm - 100 cm depth).

Sampling site SO 2 exceeded the target value for copper in top soil, and sampling site SO 4 exceeded the Dutch Standard for copper in subsoil (between 37.44 and 38.29 mg/kg). Sub-soil at site SO 2 also exceeded the target value for mercury (1.04 mg/kg).

Other remaining sampling sites and parameters were found to be within the Dutch Standard.

### 1.6.1.6 Groundwater

The productivity of aquifers near the Study Area can be classified as "Strong Pore Water", or "Weak Fissure Water", and groundwater quality is considered "Fresh Groundwater". The groundwater type ranges from "Pore Water" to "Fractured Water". Groundwater resources classifications consist of "Discontinuous Aquifer in Hilly Area" and "Continuous Aquifer in Plain and Intermontaine Basin", with Natural Recharge Modulus ranging from 200,000 - 500,000 m<sup>3</sup>/km<sup>2</sup>-yr.

Groundwater samples were collected by SEM and ERM-Siam on 3 and 4 May 2018, at three (3) locations. Groundwater samples were taken by an Alpha horizontal water sampler for some wells and collected in plastic and sterilized glass sample containers. All sampling was conducted in strict accordance to recognized standard procedures as listed together with the sampling results below. The parameters pH, temperature, dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids, odour, and colour were measured at each site in-situ. The parameters that were measured by laboratory analysis are listed together with the results below.

Parameters that exceeded the relevant standards/guidelines include Total Dissolved Solids (TDS), Nitrate (NO<sub>3</sub>), Iron (Fe), Manganese (Mn), and Chloride (Cl).

All other parameters were found to be within the Myanmar standards, EPA, and WHO guidelines.

## 1.6.1.7 Sediment

Sediment samples were collected by SEM and ERM-Siam from 3 to 5 May 2018, at six (6) locations. Sediment samples were collected using a Grab Sampler. At each station, sediment was collected in an amber glass bottle. Each benthic sample was then slowly sieved through a mesh size of 2.0 mm, 1 mm, and 0.5 mm. Firstly, benthic samples were sieved by 2.0 mm and 1.0 mm mesh size, next the samples were sieved by a 0.5 mm mesh. Finally, the benthic samples caught in the 1.0 mm and 0.5mm mesh were collected. The specimens were preserved in 10% formalin solution.

Mercury has been found to exceed the Low level standards, but still within the High level standards. This result indicates that the level of concentration can cause adverse effects on aquatic life; however, the occurrence is still considerably low.

Nickel has been found to exceed both low and high level standards; however, concentrations were found to be lower than that of the dry season. This difference may be due to a higher flow rate.

All other parameters are found to be within the Australian and New Zealand interim sediment quality guidelines.

#### 1.6.1.8 Landscape and Visual

The centre part of Myanmar, specifically within the Yangon Region and Ayeyarwady Region mainly consists of plains with little to no elevation. Although this characteristic is normal for land located near coastal areas, other northern regions of Myanmar have a large range of mountainous areas, and varying degrees of elevation, which are particularly pronounced in the Kayah State, and Shan State.

The topography at the LNG Receiving Terminal suggests no elevation. The area surrounding the facility consists mainly of agricultural land and nearby villages. Across the Yangon River, directly opposite of the LNG Receiving Terminal is the Myanmar Integrated Port Limited Terminal. Potential sensitive visual receivers are located nearby the LNG Receiving Terminal, such as Thet Kei Kwin (1.2 km, northwest), and Shan Kaw (1.6 km, west) villages.

The topography along the Natural Gas Pipeline alignment suggests no elevation. The area along the pipeline alignment will mainly consist of agricultural land and small villages

The topography at the Power Plant is primarily flat land with no noticeable elevations; however, towards the northeast of the Power Plant, there are high elevations leading up to the highest point exactly where the Shwedagon Pagoda is located (approximately 57 - 62 metre elevation). Land allocated for the Power Plant currently consists of grasslands and small patches of mangrove, and is currently surrounded by the existing Power Plant and the Ahlone Shipyard.

### 1.6.1.9 Waste

Solid waste generation in Myanmar was 5,616 tonnes/day and is anticipated to increase to 21,012 tonnes/day by 2025. Mandalay, Yangon and Nay Pyi Taw generate the majority of Myanmar's produced waste (55%); Yangon produces most of the waste (1,981 tonnes/day).

The country's municipal solid waste is generated from households (60%), markets (15%), commercial (10%), hotel (2%), garden (5%) and others (8%). In areas outside of Yangon, Mandalay and Nay Pyi Taw, where waste collection is the responsibility of local municipal authorities, the respective Township Development Committees under the local government typically manage municipal waste collection and disposal.

According to the Yangon City Development Committee (YCDC), the major landfill sites in Yangon currently operating and their respective capacities are shown in *Table 1.6*.

Location	Capacity (tonnes/day)	
Hteinpin	1,080	
Dawai Chang	843	
Shwepyithar	61	
Mingalardon	43	
Dala	33	
SeikyiKhanaungato	4	

## Table 1.6: Major Landfill Sites in Yangon

Source: YCDC, 2016.

## 1.6.1.10 Terrestrial and Aquatic Biodiversity

The Myanmar EIA Procedures (2015) requires the assessment of biodiversity values, although the Procedure does not include guidance on the approach to assess those values. ERM has used the International Finance Corporation (IFC) *Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources* (PS6) to guide the approach of assessment.

The main findings of each biological aspects are as follows:

## EcoRegion

The Project Study Area resides within the Myanmar Coastal Mangrove [IM1404] EcoRegion. This ecoregion, specifically the Irrawaddy (Ayeyarwady) mangrove region, would naturally be dominated by mangrove flora but has been seriously degraded in recent history. Mangrove forest are salt tolerant

ecosystems that survive in brackish water around the intertidal zone, particularly in estuaries. They are some of the most exploited natural systems in the world, under pressure from land clearance for farming, aquaculture, land reclamation and development.

The EcoRegion is currently classified as Critical/Endangered; however, this is a generalization of a large area (21,238 km<sup>2</sup>) and may not represent specific differences in habitat types and conditions within the area. The proposed Project is located in areas that do not contain any important natural habitat that defines the characteristics of this EcoRegion, considering the area has been considerably degraded by human activities.

## Key Biodiversity Areas

In Myanmar, Key Biodiversity Areas (KBAs) fall in different land management categories including protected areas, public protected forests, community-conserved forests, community forests, reserve forests and other resource and land use areas. Therefore, they accommodate different management systems such as government, private, community-led and joint management. Within the last decade, KBAs were reviewed and updated in order to identify and prioritize investment opportunities for biodiversity conservation in Myanmar.

Key Biodiversity Areas (KBA) include Important Bird Areas (IBA), Alliance for Zero Extinction (AZE), Important Plant Areas (IPA) and Important Sites for Freshwater Biodiversity.

Three (3) Key Biodiversity Areas are located within 30 km from the Project Site. These sites are the Hlawga Reservoir, Maletto Inn and Payagyi KBAs which contain critically endangered, endangered and vulnerable species of conservation concern. These KBAs are located considerably far from the Project, approximately 21km, 27km and 31km respectively to the north and east of the Project Area.

#### Protected Area

Currently, Myanmar there is a total of 58 Protected Areas (PAs), which account for 6.37% of the country's total surface area.

One (1) protected area lies within 50 km of the Study Area, The Hlawga Park, which is located 28 km to the north of the Project.

#### Species of Conservation Significance

Species of conservation significance found within the species grid location from the Integrated Biodiversity Assessment Tool (IBAT) include 19 bird species, 40 fish species, 50 invertebrate species, 11 mammal species, 3 plant species, and 5 reptile species. These species are evaluated as either Vulnerable (VU), Endangered (EN), or Critically Endangered (CR), according to the IUCN Red List. The full list of identified species is shown in *Table 5.50*.

#### Invasive Species

Invasive species are any species that are non-native to a particular ecosystem and whose introduction and spread causes, or are likely to cause, socio-cultural, economic or environmental harm or harm to human health (FAO, 2013). Invasive species have the capacity to exacerbate their role in ecosystem degradation through combination threats by habitat change, climate change over-exploitation of ecosystem resources and pollution, which further enhances their threat to biodiversity and the human condition (Emerton and Howard, 2008).

According to the Global Invasive Species Database (GISD) (2015), 97 species have been identified as invasive species in Myanmar. A checklist of invasive species is provided in *Appendix O*. However, the database does not specifically mention on which part of Myanmar the invasive species are being introduced.

## Area of Influence for Biodiversity Value

The Project Area of Influence (AoI) was defined based on a 5 km radius of the Study Area, 500 m either side of the pipeline and 1 km radius of the LNG terminal. The radius was determined based on the nature of the activities of the Project during construction and operation as well as identified natural areas within the vicinity of the Study Area and is consistent with the Project Study Area.

## Biodiversity Survey

ERM undertook site surveys during the dry season, between 4 and 5 May 2018. These surveys were conducted to determine the location of any priority biodiversity values within the Study Area and Area of Influence. These priority values focused on Critical Habitat triggers as well as species of conservation significance. The surveys were conducted after a desktop assessment to identify species and habitats to be prioritised for survey; identification of sampling locations (including local villager interviews); field survey targeted major flora and fauna groups; and taxonomy and mapping of flora and fauna records identified. Habitat assessments were also undertaken to inform Natural Habitat and Modified Habitat mapping as required by IFC PS6.

#### Land Class Mapping

Satellite imagery was used to map the land classes identified within the Study Area and Area of Influence. These land classes were field verified during the field visit. The major land classes identified include agriculture, mangrove, scrub land and grassland, Urban and residential, standing water/waterlogged and riverine.

#### Natural Habitat and Modified Habitat

IFC PS6 requires the assessment of the distribution of Natural Habitat and Modified Habitat in order to identify risks and mitigations to biodiversity values during the impact assessment phase. There is currently no methodology within IFC PS6 and the associated Guidance Note (GN) on the approach to assess the distribution of these habitat types.

Given the desktop and field information available on the land classes identified, a categorization of the land classes has been made based on the understanding of the history of land use, and species assemblages within each habitat. The justification for the classification is shown in *Table 5.53*.

The total area of natural habitat and modified habitat within the study area and area of influence is shown in *Table 1.7*.

Table 1.7: Areas of Natural Habitat and Modified Habitat within the Study Area
and Aol

Habitat Type	Study Area (ha)	Area of Influence (ha)
Natural Habitat	0.20	1,028.16
Modified Habitat	3.02	7,457.86

Source: ERM, 2018.

#### Flora

A Global Positioning System (GPS) was used to navigate and mark coordinates between sample plots around the AoI. In each location, plant species were listed with particular attention to the identification of invasive species, threatened species, Critical Habitat triggers and the extent of Natural Habitat. Identification of any areas of habitats of concern that may contain species of conservation interest were noted.

Twenty-three (23) flora species were identified during the surveys. The majority of other flora identified was identified as Least Concern (LC), Data Deficient (DD) or Not Evaluated (NE). No species of conservation significance were detected that would trigger a Critical Habitat assessment. The full list of recorded species is shown in **Table 5.55**. During the flora survey, seven (7) invasive species were identified within the Area of Influence.

#### Fauna

Observations of bird species were undertaken during the dry season survey. Observations were made opportunistically using binoculars. Where possible, birds were identified from calls heard during the surveys. Total of fourteen (14) bird species were detected during the survey. All species were identified as Least Concern on the IUCN Red list.

Records of mammals were taken opportunistically during the site survey using binoculars and observation of tracks and field signs. One mammal species was recorded during the survey, the delta pigmy rice rat (*Oligoryzomys nigripes*). The common grey mongoose (*Herpestes edwardsii*) is known to be in the vicinity of the site but was not recorded during the survey. No species were determined to be conservation significant and would hence trigger a Critical Habitat assessment.

Records of herpetofauna were taken opportunistically during the site survey. A total of two (2) species of reptile and no amphibian species detected during the surveys. All species were classed as Least Concern or Not Evaluated under the IUCN Red List.

Fish species were taken from ERM's in-house database. Three (3) species have been identified as commonly caught fish species by fishermen in Dala, which includes the soldier croaker (Nibea soldado), truncated estuarine catfish (Cryptarius truncatus), and the paradise threadfin (Polynemus paradiseus). None of these species has been assessed on the IUCN Red List (2016). Aquatic habitat in the vicinity of the Project Site appears to have negligible ecological value.

## Critical Habitat Screening Assessment

The Critical Habitat assessment comprised an analysis of biodiversity values within the project area and area of influence, habitats of high biodiversity value, species of conservation concern and general flora and fauna assemblages. This involved GIS analysis; desk based data collection including a review of previous EIAs, and targeted field surveys at karst surface and cave habitats. Critical Habitat criteria are defined in PS6 Guidance Note 6 (GN6), Paragraphs GN69 to 97.

#### **Critical Habitat Triggers (Criterion 1-3)**

The five criteria are 'triggers' in that if an area of habitat meets any one of the criteria, it will be considered Critical Habitat irrespective of failing to meet any other criterion. Therefore, Critical Habitat can be determined through a single criterion or where a habitat holds biodiversity meeting all five criteria. This approach is generally more cautious but is used more widely in conservation. Critical Habitat criteria therefore have two distinctive characteristics. First, components of biodiversity are essentially assigned to only two levels of conservation significance, those that trigger Critical Habitat and those that do not. Second, each criterion is applied separately and not in combination, meaning that the scores are not cumulative.

#### **Critical Habitat Candidate Species**

No species were identified from surveys that would trigger assessment under Criterion 1 to 3.

#### Potential Critical Habitat Species (Criterion 1 to 3)

No species have been identified to be potential CH species under Criterion 1 to 3.

#### **Criterion 5 – Key Evolutionary Processes**

No key evolutionary processes have been identified within the ecosystems within the Area of Influence or Study Area.

### 1.6.2 Social-Economic Baseline

#### 1.6.2.1 Data Collection

Settlements located closest to the Project infrastructure are likely to experience negative and positive impacts because of the Project activities, including economic opportunities, social and environmental changes, lifestyle changes, and changes to community health and safety. Other social receptors located further from the Project may also benefit or experience negative impacts from the Project.

The Social Area of Influence (SAoI), where data collection has been conducted to help establish the socioeconomic baseline, is defined as the area inhabited or used by stakeholders and likely to be positively or negatively affected by the Project.

The information presented in this Section was gathered through a desktop review of publicly available sources. To provide a more precise understanding of the social, socioeconomic, health and cultural heritage conditions in the Project area, primary data have been collected just after the first Public Consultation session from November 15th to the 19<sup>th</sup>, 2018. The methods for gathering primary data are comprised of household questionnaires, face-to-face interview with key informants and focus group discussions with designated interviewees. Key stakeholder groups includes village leader, women, fisherman, nurse/ medical/ health officers and famers within the local villages. A total of 150 household questionnaires, 11 Focus Group Discussions, and Key Informant Interviews were conducted in Dala, Seikgyikanaungto and Ahlone townships.

#### Social Receptors

Myanmar is divided into a number of States and Regions (also referred to as Divisions), which are further divided into Townships for governance purposes. The Project site is located in Yangon, Seikgyikanaungto, and Dala Township in the Yangon region. The baseline focuses on the receptors that may be impacted or influenced by the Project due to their proximity to the Project site and/ or Project associated facilities, which include the following:

- Dala village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Tha Pyay Kone village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and within 3 km of the Power Plant;
- Nyaung Ngoke To village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and within 3 km of the Power Plant;
- Ye Chaung Wa village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Pyawbwe Gyi village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Shwe Hlay Chaung village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Tone Tin Gan (North) village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Tone Tin Gan (South) village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline and within 3 km of LNG Terminal;

- Rakhin Chaung (North) village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and within 3 km of LNG Terminal;
- Nyaung Chaung village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and at location of LNG Terminal;
- Seikgyikanaungto village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and within 3 km of the Power Plant;
- Ahlone village tract. The village tract is where the Power Plant is located;
- Htaw (Lower) village tract. The village tract is within 3 km of the Power Plant;
- Gyaung Waing village tract. The village tract is within 3 km of the Power Plant;
- Kyun Ka Lay village tract. The village tract is within 3 km of the Power Plant;
- Ah Lat Chaung village tract. The village tract is within 3 km of the Power Plant;
- Kyeemyindaing village tract. The village tract is within 3 km of the Power Plant;
- Sanchaung village tract. The village tract is within 3 km of the Power Plant;
- Dagon village tract. The village tract is within 3 km of the Power Plant;
- Kamaryut village tract. The village tract is within 3 km of the Power Plant;
- Bahan village tract. The village tract is within 3 km of the Power Plant;
- Mingalartaunginyung village tract. The village tract is within 3 km of the Power Plant;
- Lathat village tract. The village tract is within 3 km of the Power Plant;
- Lanmadaw village tract. The village tract is within 3 km of the Power Plant;
- Seikkan village tract. The village tract is within 3 km of the Power Plant;
- Pabedan village tract. The village tract is within 3 km of the Power Plant;
- Kyaukatada village tract. The village tract is within 3 km of the Power Plant;
- Pazundaung village tract. The village tract is within 3 km of the Power Plant;
- Botahtaung village tract. The village tract is within 3 km of the Power Plant; and
- Bahan village tract. The village tract is within 3 km of the Power Plant.

#### 1.6.2.2 Demographics

The region covers an area of approximate 10,171.30 sq. km, which is divided into 4 districts (Yangon North, Yangon East, Yangon West and Yangon South), 33 townships, 742 wards and 2,170 villages. The total population is around 7 million people, with 52.2% female. Citizens are mostly aged between 15 - 64 years old.

The majority of the population in the Study Area are Bamar people; Bamar people are the dominant ethnic group in Myanmar, with a population of more than 30,110,000 people. There are, however, small numbers of Kayin, Mon, and Rakhine living in the Study Area.

#### 1.6.2.3 Livelihood and Economy

In the agricultural field, rice, beans and pulses are the main crops, produced. Other agricultural activities consist of jute, rubbers, groundnut and sugarcane. Along the Yangon River, rice mills and sawmills can be found.

Small-scale artisanal fishing takes place in the Yangon River, including around the Project sites. It is reported that fishermen make around 20,000 kyats (~17 USD) daily from fishing which is conducted

using traditional cast-nets. Yangon is a main landing site for fish in Myanmar with a fish market at San Pya in Ahlone Township near the Project Site.

In the Yangon region, unemployment rate between men (4.3%) and women (3.9%) in Yangon is almost similar, and the percentage of men in labour force (81.8%) is significantly larger than percentage of women (46.4%). This is because Yangon is the main centre for trading and handling for many foreign commerce in Myanmar

#### 1.6.2.4 Utilities

## Electricity

It is reported that in 2017, 8% of households in Yangon region did not have access to public grid, while 13% had access to electricity without being connected to the grid, and 79% had access and were connected to the grid.

The majority of Yangon conventional households use electricity as source of lighting. Among them, Ahlone has highest percentage of use of electricity for lighting. In Dala, there is a significant gap of electricity usages between urban area (62.8%) and rural area (18.7%), since households in rural area use mainly battery as source of lighting (27.6%).

### Water for Irrigation

The Irrigation Department of the Ministry of Agriculture and Irrigation has identified three main sources of water in Yangon, including reservoirs, Irrawaddy River and ground water aquifers (Union of Myanmar Ministry of Agriculture and Irrigation, Irrigation Department, 2010). Approximately 90% of the water source of the system is surface water from reservoirs and the rest is ground water from tube wells supplemented by the water supply system.

#### Non-Drinking Water

Non-drinking water or non-potable water are rainwater, reclaimed/ recycled water, and grey water. This water is not appropriate for human consumption, but it can be used for laundry, toilet, urinal flushing, or watering plants. In Yangon region, households mainly access non-drinking water via tube well or borehole.

#### Drinking Water

MIMU data, from 2014, indicate that Yangon is one of the regions in Myanmar that has the highest percentage of people who can access to source of drinking water on premise (82%). At the same time, to reach water source, 14% of Yangon citizens spend less than 10 minute, while 3% and 1% of them spend 11 to 20 minute, and more than 20 minute respectively.

#### Sanitation and Toilet Facilities

In Yangon, 68% of total households have access to basic sanitation, which is referred to improved nonshared toilet and hand washing facilities. In 2014, water seal (improved pit latrine) was the most common toilet facility type in Yangon region. Moreover, more than 90% of population have access to a place in which they can wash hands with soap and water.

## 1.6.2.5 Transportation

Yangon has varied transport infrastructure, including various large to small concrete, paved or dirt roads, five bridges over the Yangon river, one international airport with two terminals and a domestic terminal, railway lines, four ports, buses lines and local taxi services.

Around 100 boats travel across the river to Yangon daily between 5:30 am to 8:00 pm between Dala and Seikgyikanaungto to Yangon. The journey takes around 15 minutes from Seikgyikanaungto to

Yangon. Travelling from Dala or Seikgyikanaungto to Yangon by car can take around 2 hours (depending on traffic).

## 1.6.2.6 Cultural Heritage

Yangon Region has a number of culturally significant areas, particularly Buddhists sites. Pagodas and monasteries found in these areas are considered as important cultural centres for the local communities. There are a number of important designated heritage buildings within 5 km of the Project Site such as the Shwedagon or Sule Pagoda. There is no cultural heritage in the footprint of the Project sites.

## 1.6.2.7 Education

Basic education system in aforementioned areas is identical to other parts of Myanmar and in compliance with the national education system. Eleven is the number of schooling years and the education system is called 5-4-2. It is comprised of 5 years of primary school, 4 years of lower secondary school and 2 years of upper secondary school. In 2017, Myanmar had a plan to change this education system to be 5-4-3 system in order to be in the same line with most ASEAN countries. This plan extends years of schooling from 11 years to 12 years.

Data from 2014 shows that, in Yangon region, literacy rate of citizens aged of 15 years old and above is 96.6%, which is calculated from literacy rate in men (98%) and women (95.5%). The total number of schools is 2,717, which includes 198 high schools, 225 middle schools and 2,264 primary schools. MIMU data from 2014 show that majority of citizens accomplished primary schools.

## 1.6.2.8 Health, Health Facilities, and Security

In 2016, in Yangon region, there were 85 hospitals, 11,610 sanctioned beds, 12,260 available beds, 527,308 admissions, 525,851 discharges and deaths, 3,537,276 patient days, 16,656 numbers of death, hospital death rate at 3.2%, and 2,516,767 outpatient attendance. Here, hospital death rate is the calculation between number of deaths, and number of discharges and deaths. Sanctioned bed is the official bed capacity of the hospital. Regarding to health facilities and hospitals, almost 70 percent of children in Yangon are born in health facilities.

## 1.6.2.9 Infrastructure, and Amenities

Yangon has various transport infrastructures, including port, Thilawa deep-water port, airport, roads, bridges, flyovers, highway and Twantay Canal, which connects Yangon River with Irrawaddy River. Importantly, Yangon is the terminus of five railway lines. There are number of roads, connecting Yangon region with other regions in Myanmar as well. In addition, it is reported that rural access index of Yangon is 60%. According to Asian Development Bank, the Rural Access Index (RAI) is "an internationally used indicator that shows the portion of the rural population that lives less than 2 km away from an all-season road".

## 1.7 Key Environmental and Social Impact Assessment

All construction and operation activities likely to cause environmental and social impacts were identified and evaluated to assess their magnitude, duration, and potential receptors. The environmental and social impact assessment for the LNG Receiving Terminal, pipeline, and Power Plant, is assessed in *Chapter 7*, *8*, and *9*.

## 1.7.1 LNG Receiving Terminal

The significance of impact for all physical and social receptors are summarized in Table 1.8.
Decenters	Impact Namo	Dhasa	Impact Significance	
Receptors	Impact Name	Phase	Pre-mitigation	Post-mitigation
Air	Dust soiling	Construction	Minor	Negligible
	Human health	Construction	Minor	Negligible
	Ecology	Construction	Moderate	Negligible
	Dust soiling	Operation	Minor	Negligible
	Human health	Operation	Minor	Negligible
	Ecology	Operation	Moderate	Negligible
GHG	GHG Emissions	Construction	Negligible	Negligible
	GHG Emissions	Operation	Minor	Minor
Noise	Transportation	Construction	Minor	Negligible
	Foundation and construction	Construction	Negligible	Negligible
	Operation	Operation	Negligible	Negligible
Surface Water	Water intake requirement	Construction	Negligible	Negligible
	Water intake requirement	Operation	Negligible	Negligible
	Wastewater	Operation	Negligible	Negligible
	Cold water discharge	Operation	Negligible	Negligible
	Sedimentation caused by erosion	Construction	Negligible	Negligible
	Sedimentation caused by piling	Construction	Negligible	Negligible
Soil and	Accidental leaks of cold water	Operation	Negligible	Negligible
Groundwater	Loss of soil due to improper management during site clearance and excavation	Construction	Negligible	Negligible
Waste	Improper biomass management	Construction	Minor	Negligible
	Generation and Management of Hazardous Waste	Construction	Moderate	Minor
	Generation and Management of Hazardous Waste	Operation	Minor	Negligible
	Generation and Management of Non-Hazardous Waste	Construction	Moderate	Minor
	Generation and Management of Non-Hazardous Waste	Operation	Minor	Negligible
	Generation and Management of Domestic Solid Waste	Operation	Moderate	Minor

# Table 1.8: Summary of the Significance of Impact for Physical and SocialReceptors

	luure ( Mana		Impact Significance	
Receptors	Impact Name	Phase	Pre-mitigation	Post-mitigation
	Generation and Management of Domestic Liquid Waste	Operation	Minor	Negligible
Visual	Construction	Construction	Minor	Negligible
	Operation	Operation	Minor	Negligible
Biodiversity	Permanent and Temporary Habitat Loss	N/A	Minor	Negligible
	Temporary disturbance or displace of fauna	N/A	Negligible	Negligible
	Degradation of Habitat	N/A	Negligible to Minor	Negligible
	Mortality of resident species	N/A	Negligible to Minor	Negligible
Social	Employment	Construction	Positive	-
	Employment	Operation	Positive	-
	Fishing	Construction	Negligible	Negligible
	Fishing	Operation	Negligible	Negligible
	Economical displacement	Construction	Minor	Negligible
	Existing facilities and utilities	Construction	Moderate	Minor
	Existing facilities and utilities	Operation	Moderate	Negligible
	Environmental emission	Construction	Minor	Negligible
	Community health and safety	Construction	Moderate	Minor
	Community health and safety	Operation	Negligible	Negligible
	Occupational health and safety	Construction	Moderate	Minor
	Occupational health and safety	Operation	Minor	Minor
	Navigation	Construction	Minor	Negligible
	Navigation	Operation	Negligible	Negligible
	Traffic and Transport	Construction	Negligible	Negligible
	Cultural Heritage	Construction	Negligible	Negligible
Unplanned Event	Vessel Collision	All	Moderate	Minor
	Chemical Spill or Leak	All	Minor	Negligible
	Fire and Explosion	All	Major	Minor
	Seismic and Earthquake	All	Major	Major
	Tropical Storm and Extreme Weather Conditions	All	Moderate	Minor
	Loss of Containment of Chemical Storage Facilities On-site	All	Minor to Moderate	Negligible to Minor

# 1.7.2 Pipeline

The significance of impact for all physical and social receptors are summarized in Table 1.9.

# Table 1.9: Summary of the Significance of Impact for Physical and SocialReceptors

Decentero	Impact Name	Dhace	Impact Significance	
Receptors	impact Name	Phase	Pre-mitigation	Post-mitigation
Air	Dust soiling	Construction	Major	Negligible
	Human health	Construction	Major	Negligible
	Ecology	Construction	Major	Negligible
	Dust soiling	Operation	N/A	N/A
	Human health	Operation	N/A	N/A
	Ecology	Operation	N/A	N/A
GHG	GHG Emissions	Construction	Negligible	Negligible
Noise	Transportation	Construction	Minor	Negligible
	Excavation work	Construction	Minor	Negligible
Surface Water	Water intake requirement	Construction	Negligible	Negligible
	Hydrostatic Testing Discharge	Construction	Negligible	Negligible
	Sedimentation	Construction	Negligible	Negligible
Soil and	Hydrostatic Testing Water Leakage	Construction	Negligible	Negligible
Groundwater	Loss of containment of the sending and receiving station for HDD	Construction	Negligible	Negligible
Soil and Groundwater	Loss of containment of waste bentonite storage	Construction	Negligible	Negligible
	Loss of soil due to improper management during site clearance and excavation	Construction	Negligible	Negligible
Waste	Improper biomass management	Construction	Minor	Negligible
	Generation and Management of Hazardous Waste	Construction	Minor	Negligible
	Generation and Management of Non-Hazardous Waste	Construction	Minor	Negligible
	Generation and Management of Domestic Solid Waste	Construction	Minor	Negligible
	Generation and Management of Domestic Liquid Waste	Construction	Minor	Negligible
Biodiversity	Permanent and Temporary Habitat Loss	N/A	Minor	Negligible

Decentera	Imment Name	Dises	Impact Sig	ignificance	
Receptors	Impact Name	Phase	Pre-mitigation	Post-mitigation	
	Temporary disturbance or displace of fauna	N/A	Negligible	Negligible	
	Degradation of Habitat	N/A	Negligible to Minor	Negligible	
	Mortality of resident species	N/A	Negligible to Minor	Negligible	
Social	Employment	Construction	Positive	-	
	Fishing and navigation	Construction	Negligible	Negligible	
	Economical displacement	Construction	Major	Minor	
	Economical displacement	Operation	Negligible	Negligible	
	Traffic and transportation	Construction	Negligible	Negligible	
	Existing facilities and utilities	Construction	Negligible	Negligible	
	Environmental emission	Construction	Minor	Negligible	
	Community health and safety	Construction	Moderate	Minor	
	Occupational health and safety	Construction	Moderate	Minor	
	Cultural Heritage	Construction	Negligible	Negligible	
Unplanned	Fire and Explosion	All	Major	Major	
Event	Seismic and Earthquake	All	Moderate	Minor	
	Loss of Containment of Chemical Storage	All	Minor to Moderate	Negligible to Minor	

### 1.7.3 Power Plant

The significance of impact for all physical and social receptors are summarized in Table 1.10.

# Table 1.10: Summary of the Significance of Impact for Physical and Social Receptors

Receptors	Impact Name	Dhase	Impact Sig	gnificance
		Phase	Pre-mitigation	Post-mitigation
Air	Dust soiling	Construction	Minor	Negligible
	Human health	Construction	Minor	Negligible
	Ecology	Construction	Moderate	Negligible
	Dust soiling	Operation	Minor	Negligible
	Human health	Operation	Minor	Negligible
	Ecology	Operation	Moderate	Negligible
GHG	GHG Emissions	Construction	Negligible	Negligible
	GHG Emissions	Operation	Moderate	Moderate

			Impact Sig	gnificance
Receptors	Impact Name	Phase	Pre-mitigation	Post-mitigation
Noise	Transportation	Construction	Minor	Negligible
	Foundation and construction	Construction	Moderate	Negligible
	Pre-commissioning, commissioning and testing	Construction	Minor	Negligible
	Operation	Operation	Moderate	Negligible to Minor
Surface Water	Water intake requirement	Construction	Negligible	Negligible
	Water intake requirement	Operation	Negligible	Negligible
	Demineralized plant neutralized water discharge	Operation	Negligible	Negligible
	Cooling water discharge	Operation	Negligible	Negligible
	Sedimentation caused by erosion	Construction	Negligible	Negligible
	Sedimentation caused by piling	Construction	Negligible	Negligible
Soil and Groundwater	Accidental leaks of demineralized plant neutralized water	Operation	Negligible	Negligible
	Accidental leaks of cooling water	Operation	Negligible	Negligible
	Loss of soil due to improper management during site clearance and excavation	Construction	Negligible	Negligible
Waste	Improper biomass management	Construction	Moderate	Minor
	Generation and Management of Hazardous Waste	Construction	Moderate	Minor
	Generation and Management of Hazardous Waste	Operation	Moderate	Minor
	Generation and Management of Non- Hazardous Waste	Construction	Moderate	Minor
	Generation and Management of Non- Hazardous Waste	Operation	Minor	Negligible

		51	Impact Sig	gnificance
Receptors	Impact Name	Phase	Pre-mitigation	Post-mitigation
	Generation and Management of Domestic Solid Waste	Operation	Minor to Moderate	Negligible
	Generation and Management of Domestic Liquid Waste	Operation	Minor	Negligible
Visual	Construction	Construction	Minor	Negligible
	Operation	Operation	Minor	Negligible
Biodiversity	Permanent and Temporary Habitat Loss	N/A	Minor	Negligible
	Temporary disturbance or displace of fauna	N/A	Negligible	Negligible
	Degradation of Habitat	N/A	Negligible to Minor	Negligible
	Mortality of resident species	N/A	Negligible to Minor	Negligible
Social	Employment	Construction	Positive	-
	Employment	Operation	Positive	-
	Navigation	Construction	Negligible	Negligible
	Traffic and transport	Construction	Negligible	Negligible
	Existing facilities and utilities	Construction	Moderate	Negligible
	Environmental emission	Construction	Minor	Negligible
	Community health and safety	Construction	Moderate	Minor
	Community health and safety	Operation	Negligible	Negligible
	Occupational health and safety	Construction	Moderate	Minor
	Occupational health and safety	Operation	Minor	Minor
	Navigation	Construction	Negligible	Negligible
	Cultural Heritage	Construction	Negligible	Negligible
Unplanned Event	Chemical Spill or Leak	All	Minor	Negligible
	Fire and Explosion	All	Major	Negligible
	Tropical Storm and Extreme Water Conditions	All	Moderate	Minor

Receptors	Impact Name	Dhace	Impact Significance Pre-mitigation Post-mitigatior	
		Phase		
	Loss of Containment of Chemical Storage	All	Minor to Moderate	Negligible to Minor

### 1.8 Environmental and Social Management Plan

### 1.8.1 Mitigation Measures

Many of the mitigation measures suggested during the construction phase of the Project associated with good construction and housekeeping practices and are included in the Environmental and Social Management Plan (ESMP).

Mitigation measures for the operation phase (such as those for air emissions and noise generation) of the Project are part of the design and will be incorporated into the Project design specifications.

The construction phase of the LNG Receiving Terminal, pipeline, and Power Plant is anticipated to be 23 months, 18 months, and 28 months respectively; whereas the operation phase of the all three (3) components is 25 years.

A summary of mitigation measures identified for the construction and operation phases of the LNG Receiving Terminal, pipeline, and Power Plant is presented in the ESMP (*Section 12.5.2.1*, *Section 12.5.2.2*, and *Section 12.5.2.3* respectively). This also identifies lead responsibility for implementing of the mitigation measures and its verification along with reporting requirements and sources of funds for such implementation.

The Sponsor will ensure that the mitigation measures stated in the ESMP are implemented throughout the life span of the Project.

### 1.8.2 Monitoring Program

Key roles and responsibilities of the Sponsor and the appointed EPC contractor have been defined for implementation and monitoring of environmental and social impacts. For environmental monitoring, physical, biological and social environmental management components of particular significance have been identified as performance indicators. A comprehensive monitoring plan for each performance indicator will be prepared for all phases of the Project which gives parameters to be measured, methods to be used, sampling locations, frequency of measurements, detection limits, cost and responsibilities for implementation and supervision. A summary of the monitoring program for the construction and operation phases of the LNG Receiving Terminal, pipeline, and Power Plant is presented in the ESMP (Section 12.5.2.4, Section 12.5.2.5, and Section 12.5.2.6 respectively).

### 1.8.3 Training Program

Prior to commencement of construction activities at site, a suitably qualified in-house/ external expert will be appointed by the EPC contractor in consultation with the Sponsor to develop and deliver a training programme on implementation of the ESMP. Environmental and social monitoring program and reporting will be implemented in line with the applicable reference framework for the Project.

Prior to the commencement of the Plant operation, a suitably qualified in-house/ external environmental expert will be engaged by the Sponsor to develop and deliver a training programme on operation phase environmental monitoring and reporting. The topics will be mostly same as that during the construction phase. The reporting and verification will be semi-annual during construction phase and annual during operation phase (unless specify otherwise in the ESMP) and the reports will be submitted to the relevant authorities (i.e. MOEE, MONREC, etc.) and the Lenders.

### **1.9 Public Consultation and Disclosure**

Stakeholder Engagement, the process of engaging with people who may be affected by or interested in the Project, has been undertaken throughout the ESIA process. Stakeholder views have been considered to improve the proposed Project and mitigation measures where possible. Stakeholder Engagement was conducted in a culturally appropriate manner by the Project proponent with the support from ERM, open to all people, especially those who will be affected by the proposed Project.

The engagement process has been designed to meet both Myanmar legal requirements (per the Environmental Impact Assessment Procedure No. 616/2015) for public participation, and international requirements for engagement as outlined by the IFC Performance Standards.

The first step in establishing a dialogue was identifying the Project stakeholders. Stakeholders are persons or groups who are directly or indirectly affect by a project, and those who may have interest in and/or the ability to influence a project's outcomes (either positively or negatively).

The Project team committed to undertake a process that delivers an inclusive and continuous dialogue with the Project stakeholders during the ESIA. The objectives of the engagement were to:

- Identify all those affected or interested in the Project to ensure they were included in the engagement process;
- Ensure understanding through an open, inclusive culturally appropriate and transparent engagement process. Information has been disclosed as early and as comprehensively as possible;
- Involve stakeholders in the assessment of impacts, the generation of mitigation and management measures and the finalization of IEE Report. Stakeholders also played an important role in providing local knowledge and information for the baseline to inform the impact assessment;
- Build relationships and trust through open dialogue and engagement. Establish transparency of TPMC activities to build trust with stakeholders;
- Engage vulnerable people and groups by having an inclusive approach to consultation. Some stakeholders need special attention in such a process due to their vulnerability;
- Manage expectations with respect to proposed Project benefits. The engagement process served as a mechanism for understanding and managing stakeholder and community expectations, where the latter will be achieved disseminating accurate information in an accessible way; and
- Ensure compliance. The process was designed to ensure compliance with both Myanmar regulatory requirements and international best practice.

According to Article 50 and 61 of the EIA procedure (2015), the Project proponent shall ensure that public consultation and participation process are carried out during the Scoping exercise, and the EIA investigations. The public consultation for the Scoping exercise and EIA investigations are summarized in *Section 1.9.1*, and *Section 1.9.2* respectively.

# 1.9.1 Summary of Scoping Process Consultation Activities (Public Consultation 1)

The meetings were conducted from October 30<sup>th</sup> to December 11<sup>st</sup>, 2018. Various stakeholders were invited including Chief Minister and State Government, concerned Regional level ECD and GAD, Members of Parliament, Township GAD, village administrators, and local communities.

Representatives from 17 Townships and villages were invited to attend public consultation meeting – Thanlyin, Kyauk Tan, Shwe Pyi Thar, Ahlone, Lanmadaw, Seik Kan, Dagon, Mingalardon, Pazundaung, Kamaryut, Tarmwe, Dala, Seikgyikanaungto, Shwe Pyi Thar, Pu Zun Daung, Tha Ke Ta, and Tha Khin Ba Thaung.

The date, time, location, stakeholder and number of participants of each meeting is provided in Table 1.11.

Date	Location	Stakeholder	Number of Participants
29/10/2018	Ahlone Township hall	GAD (Forestry and Fire Department), Parliament Member (Regional Gov't), Regional ECD, Village Leader, Elder people, Villagers, Journalist, Reporter, Yangon Electricity Supply Corporation (YESC), Corporations, and Engineering Procurement Construction (EPC)	182
10/12/2018	Dala Township hall	Parliament Member, GAD, Concerned Departments, Ward Administrator, Village Leader, Villagers, Ministry of Sports and Physical Education, YESC, Journalists, Reporters, and Yangon City Development Committee (YCDC)	211
11/12/2018	Thanlyin Township hall	GAD, Concerned Departments, Village Leader, Elder people, Villagers, Journalist, EPC, and Corporation	208

## Table 1.11: Consultation Activities Undertaken during Public Consultation 1

Some examples of key concerns and questions raised during public consultation 1, and responses taken to address these concerns and questions are listed in Table 1.12. The full list of key concerns and questions can be found in Section 13.2.3.

Table 1.12: Key C	Concerns and Question Raised during	Public Consultation 1

Questions	Response	Reference/Response in ESIA
How will you prevent accidents?	ERM: Within the ESIA, accidents are referred to as unplanned events. ESIA will study what types of unplanned events are likely to occur, and how the Project can manage them properly. In addition, emergency response training sessions are included in the management plan. The mitigation measures for unplanned events are included as a part of the ESIA report. TTCL has a separate EHS organization for safety management. The organization has the function in developing risk assessment and identifying risk factors. The safety management plan will always be developed in cooperation with international safety organization and specialist. TTCL Company holds ISO-9001 and ISO-14001 certificates	Project Description Chapter Unplanned Event Chapter Environmental and Social Management Plans (ESMP) Chapter.
In my experience, local farmers were not able to carry on their plantation due to construction material deposit in farmland during gas pipe construction. Moreover, leakage from old gas pipeline	TPMC: We are working on selection of proper gas pipeline right of way. Once we have concluded the gas pipe right of way with relevant ministries, we will directly engage with impacted landowner. In addition, using quality material for gas pipe is also mandatory for our company. If there is fuel shortage occur, we will also have to suffer for not meeting promised power capacity. Therefore, we are fully aware of this matter.	Project Description Chapter Unplanned Event Chapter

Questions	Response	Reference/Response in ESIA
are noticed during wet season.		
How will you manage compensation to affected community?	TPMC: We will need to conduct the compensation process, if there are any impacts, especially impacts generated from the natural gas pipeline construction. Nevertheless, our compensation for stakeholders will be provided in accordance with Myanmar Laws and guidelines from relevant authorities.	Social Impact Assessment (SIA) chapter
How will you control for the noise, air & water pollution? We are experiencing constantly the noise from one of the power plant from Thilawa Zone.	ERM: To determine impacts from project, we have to collect the existing soil, air quality and noise data from study area as well as need to study the potential impact from project. Depends on the existing air, soil, water quality and potential impact study, mitigation measures and monitoring plan will proposed if necessary. ESIA report including monitoring plan have to submit to MONREC for approval. Project proponent company have to comply with our proposed impact management plan. Environmental monitoring report is required to submit to MONREC department minimum every six month. If after the Project is running and mitigation are implemented, you still experience impact; you have access to the grievance mechanism to report issues to TPMC.	Impact Assessment Chapters

# 1.9.2 Summary of ESIA Presentation Consultation Activities (Public Consultation 2)

The meetings held were conducted from June 12<sup>nd</sup> to the 14<sup>th</sup>, 2019. Various stakeholders were invited including Chief Minister and State Government, concerned Regional level ECD and GAD, Members of Parliament, Township GAD, village administrators, and local communities.

Representatives from 32 Townships and Villages were invited to attend public consultation meeting – Dala, Thingangyung, Thanlyin, Pardagyi, Sin Kan, Kyauktan, Oak Pho Su, Bauk Htaw Twin, Myoma (South & North), Bago Su, Nyaung Thone Pin, Myo Haung (West, East, and Middle), Shwe Pyout, Nyaung Wine, Shwe Pyi Thar Yar, Shwe Kone, Thidar Myine, Phayar Kone, Oak Pho, Amhuhtan, Thout Taw Twin, A Lwan Swut, Yaynan, Htan Pin Kone, Myo Thit (west), Kyaung Oak Sake, A Lwan Swut, Thar Kya Ta, Aungmingalar, Ahlone, Latha, Thuwana, and Dagon.

The date, time, location, stakeholder and purpose of each meeting is provided in Table 1.13.

Date	Location	Stakeholder	Number of Participants
12/06/2019	Ahlone Township hall, Ahlone Township	GAD (Project), ECD, Village Leader, CSOs, Elder people, Villagers, MOGE, Ministry of Education, Ministry of Agriculture, Livestock and Irrigation, Ministry of Electricity & Energy, Reporter, Myanmar Industrial Port, YCDC, NGO, Corporations, and EPC	187
13/06/2019	Thardana Beikmann Hall,	GAD (Health Care, Finance, MONREC, Fire service Department), Ministry of Agriculture, Livestock and Irrigation, EPC, YCDC,	180

### Table 1.13: Consultation Activities Undertaken during draft ESIA presentation

Date	Location	Stakeholder	Number of Participants
	Thanlyin Township	Parliament Member, ECD, Ward Administrator, Village Leader, and Villagers	
14/06/2019	Thin Zaya Naw Ya Htar Hall, Dala Township	GAD (Construction, Project, Health Care, Piping, Agriculture, Administration, Fire service, Water and Sanitation, MONREC, and Ward Administration Department), MOE, Parliament Member (Regional Gov't), Regional ECD, Red Cross Society, Village Leader, Elder people, and Villagers	143

Some examples of key concerns and questions raised during public consultation 2, and the responses taken to address these concerns and questions are listed in *Table 1.14*. The full list of key concerns and questions can be found in *Section 13.3.3*.

### Table 1.14: Key Concerns and Question Raised during Public Consultation 2

Questions	Response	Reference/Response in ESIA
What sort of impacts are expected from LNG operation?	LNG unloading and storage process will be complied with the International fire prevention and safety guideline such as NFPA. Equipment such as fire prevention and leakage detection sensors will be equipped in terminal to prepare for the immediate actions of any event. In the case of unplanned event, LNG storage layout is properly designed to handle the impact within the terminal area only.	Impact Assessment Chapters
How will the company activities will be verified or monitor? What would be the punishment and penalties if Project Company does not follow the ESIA law?	There are Myanmar Environmental conversation law, Environmental Conversation Rule & Environment Impact Assessment procedure 2015. ECD department will determined the necessary level of environmental assessment for the proposed project. Project proposed company is responsible to comply with the applicable environmental law. If company fail to follow environmental management, the company is punishable to pay fine or other severe punishment according to law.	ESMP Chapter
What are the measures in the case of gas leakage?	Detection system is implemented in gas pipeline design to detect the gas leakage. Block valve stations located between terminal and power plant will also implemented for emergency response. When the gas leakage is detected, company will be able to take immediate action to prevent the people and environment	ESMP Chapter
Suggested the impact to public road should be repair by the company	Our gas pipeline route is currently designed to be along the Dala-Danote main road. However, it is subjected to change depending to detail survey that we are about to do with the cooperation from relevant government departments. In the case of road damage occurred by Machinery/Vehicles used in pipeline construction, company will be responsible to repair.	SIA Chapter ESMP Chapter

### 1.10 Conclusion

The ESIA process undertaken has identified and assessed a range of potential physical, biological and socioeconomic impacts associated with the proposed LNG Receiving Terminal, Pipeline, and Power Plant in Myanmar; however, given that the mitigation/management measures provided in this ESIA are implemented, *the majority of these impacts will be reduced to a minor to negligible level of significance*. The effective implementation of the ESMP and adherence with the Myanmar NEQ, and IFC guidelines will assist in minimising the environmental impacts to acceptable levels.

Although a number of potential environmental, social and health impacts were identified, the assessments found that impacts are typically short term in duration and have minor residual significance after implementation of mitigation measures. The potential for impacts is well understood with little or no evidence of adverse consequences on the majority of environmental, social or health receptors provided that adequate in-place controls and/or mitigation measures are implemented. The suggested mitigation measures in the ESMP are well established amongst international practice, and proven to be effective in managing any impacts that might occur to acceptable levels, including for similar projects in similar settings.

In terms of social aspects, the results from initial stakeholder engagement indicate that the Project has received favourable support from local people and other stakeholders. Stakeholders appreciated that in addition to providing a reliable power supply to the region, the Project will have several other benefits such as supporting economic growth in the region, potential employment (direct and indirect) and that the negative impacts can be mitigated, provided the Project proponent implement all the proposed mitigation measures.

Provided that all the social and environmental mitigation/management measures provided in this ESIA are implemented, it is the opinion of ERM that there are no environmental or social fatal flaws that prevent authorisation of the proposed LNG Power Plant (Ahlone) Project in Myanmar.

Since this ESIA is completed based on the mid-stage of the design and planning phase, changes to the project sitting, construction methods, and operations may occur in the later phases of design and planning. In addition, since the EPC for construction has not been appointed for all three main components, further studies on actual conditions at final project locations, extensive stakeholder engagement and hands-on training of the appointed EPC will be required during the later planning phase and throughout construction and operation phases. TPMC will be responsible for the implementation of all recommended mitigations and management methods, including the conduct of additional surveys and studies, and for reporting on performances to the relevant stakeholders and authorities.

## 2. INTRODUCTION

### 2.1 Project Background and Overview

TTCL Power Myanmar Company Limited (**'TPMC'** or **'the Project Proponent'**) is planning to develop a Power Plant in Yangon, Myanmar. A Combined Cycle Power Plant (CCPP) (installed capacity 388MW) will be developed to supply the power to the Republic of the Union of Myanmar (the 'Project').

The Project (also referred to as 'LNG Power Plant (Ahlone) Project'), will consist of three main components; the LNG Ahlone Power Plant (hereafter referred to as 'Power Plant'), LNG Receiving Terminal (hereafter referred to as 'LNG Receiving Terminal' including Jetty, LNG Storage Tank(s) and Regasification Unit), and the Natural Gas Pipeline (hereafter referred to as 'Pipeline'). The Pipeline will have an approximate length of 24.4 km connecting the Regasification Unit at the LNG Terminal to the Power Plant. The Project Proponent has planned to use imported Liquefied Natural Gas (LNG) as the fuel source. The selected technology for the Power Plant, combined cycle power plant (CCPP), is an efficient form of power generation, proven and acknowledged as a clean form of natural gas power generation due to its efficient gas utilisation and lower environmental impact.

The Project Proponent has prepared and submitted the Project Proposal Report (PPR) on 14<sup>th</sup> December 2017 to the Ministry of Electricity and Energy (hereinafter referred to as 'MOEE') and the Ministry of Natural Resources and Environmental Conservation (hereinafter referred to as 'MONREC') and had several discussions with MOEE, and the Government of the Republic of the Union of Myanmar to develop the Project. The electricity generated by the Project will be sold to MOEE via a new 230kV Transmission Line going from the Power Plant to the Hlaingtharya sub-station.

At the end of January 2018, the MOEE hosted the Notice to Proceed' (NTP) signing ceremony for four (4) projects, which included the LNG Power Plant (Ahlone) Project and the NTP, was signed between the Myanmar Government and TPMC.

The Project Proponent has prepared and submitted the Project Proposal Report (PPR) to MOEE and (MONREC) on 14<sup>th</sup> December 2017. The PPR recommended that TPMC shall proceed with an Environmental Impact Assessment (EIA) Study of the Project and prepare an Environmental Management Plan (EMP) to put forward its commitments for environmental and social mitigation and management measures. The submission letter of the PPR is attached in *Appendix A* for reference.

As per the Environmental Impact Assessment (EIA) Procedure and promulgated on 29<sup>th</sup> December 2015, it is understood that proposed Project requires the Scoping Study and the EIA Study to be conducted and submitted to the Ministry of Natural Resources and Environmental Conservation (MONREC) in order to obtain an Environmental Compliance Certificate (ECC).

In addition, the Scoping Study (prepared by ERM) for this Project has been submitted to MOEE and MONREC on 9<sup>th</sup> January 2019. The submission letter of the Scoping Report is attached in *Appendix B* for reference.

The comments from the Environmental Conservation Department (hereinafter referred to as 'ECD') of MONREC on Scoping Report have been received on 10 April 2019, and ECD's comments have been addressed and incorporated into the ESIA report (this report), as attached in *Appendix C*.

## 2.1.1 Project Name

LNG Power Plant (Ahlone) Project

### 2.1.2 Project Sponsor / Project Proponent

TPMC, the main Project Proponent for the proposed Project, is a project company set up by TTCL Public Company Limited (TTCL). TPMC was established in 2018 to carry out the development, operation and maintenance of the Project.

TTCL, the first integrated Engineering, Procurement and Construction (Integrated EPC) company in Thailand, was incorporated on 24 April 1985 with a start-up capital of 20 Million Baht. TTCL was formed by a joint venture between two (2) leading international engineering and construction companies from Japan and Thailand. TTCL has experience and expertise in providing integrated design and engineering, procurement of machinery & equipment, and construction (Integrated EPC) of turnkey projects for industrial and process plants, mainly in energy, petrochemical, chemical and power industries.

TTCL has set up TTPMC in 2012 for the development of a 120 MW Gas-fired power plant in Ahlone Township, Yangon, the Republic of the Union of Myanmar.

Details of the main Project Proponent are as follows:

Company Name:	TTCL Power Myanmar Company Limited
Address:	16B, 16th Floor, Centre Point Tower,
	NO. 65, Corner of Sule Pagoda Road and Merchant Street. Kyauktada
	Township, Yangon, Myanmar
Contact Person:	Ms. Nini San
Telephone:	+95 [0] 9 254 311058
	+95 [0] 1 371 962
Fax:	+95 [0] 1 371 963
Email:	nini.s@ttcl.com

TTCL's key facts are highlighted in *Table 2.1*.

### Table 2.1: Key Facts of TTCL

Key Facts	Description
Year of Incorporation	Founded on 24th April, 1985 listed in 2009
Listing	The Stock Exchange of Thailand
Market Capitalisation	896 million Baht in 2018
Major Shareholders	SOJITZ CORPORATION; GLOBAL BUSINESS MANAGEMENT CO., LTD.
Key Business	Engineering, Procurement, and Construction (EPC), and Power
Global Presence	Thailand, Myanmar, Singapore, Malaysia, Philippines, Vietnam, and Qatar

Source: TTCL, 2019.

# 2.2 **Project Site and Location**

### 2.2.1 Proposed Project Facilities

The proposed Project is located in Ahlone Township for the Power Plant with the gas pipeline running along the Dala and Seikgykanaungto Townships, Yangon Region in the Republic of the Union of Myanmar.

The LNG Receiving Terminal will be located on the West bank of the Yangon River near the Yakainggyaung village in the Dala Township on the Yangon River downstream of the Power Plant. It I will also be located within agricultural land; therefore, it is understood that the current land belongs to TPMC after purchase from private landowners.

A total of 8.97 acres of land is allocated for the proposed Power Plant and 15 acres for the LNG Receiving Terminal (23.97 acres total).

The Natural Gas Pipeline will start from the LNG Receiving Terminal in Dala Township, follows the existing road before passing to Dala Township, cross the Twante canal to Seikgykanaungto Township and cross the Yangon River again to the landfall at Ahlone Township, connecting with the Power Plant.

The proposed Power Plant is located near a shipwreck area and within the existing Power Plants (Ahlone TPMC CCPP and MOEE Power Plant) to the North, Yangon port to the East, the Yangon River to the South and a shipwreck/unused area to the West. It is understood that the current land belongs to MOEE. Land Lease Agreement between the Project Proponent and MOEE is being proceeded.

The proposed Transmission Line is located in Ahlone, Seikgykanaungto, Twantay and Hlaingthayar Townships, which will mainly run in parallel with the existing 230 kV transmission line transferring power for the existing Ahlone CCPP to the existing sub-station in Hlaingthayar for a total length of approximately 28 km.

The proposed Project locations are shown in *Figure 2.1*, and *Figure 2.2*. The proposed Power Plant in relation to the existing power plant is shown in *Figure 2.4*. The proposed Transmission Line is shown in *Figure 2.4*.





Source: TPMC, 2018. (Modified by ERM)

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Source: TPMC, 2019. (Modified by ERM)





Source: TPMC, 2018. (Modified by ERM)

### 2.2.2 Existing Natural Gas Power Plant

There is an existing 120 MW natural gas power plant located within the Project site boundary (see *Figure 2.4*) currently operated and owned by the Project Proponent, which began operation in April 2013.

The existing CCPP was given a 30-year concession period for Build-Operate-Transfer (BOT) with the Myanmar Electric Power Enterprise; the generated power is supplied to the Hlaingthayar sub-station via a 230 kV overhead transmission line.

Between the existing CCPP and the proposed location for the new Power Plant, there is a MOEE own combined cycle power plant producing 154.2 MW with 3 gas turbine and 1 steam turbine. Commercial running date started between 1995 and 1999.

### Figure 2.4: Proposed Power Plant Project Site and Existing Power Plant Locations



Source: TPMC, 2018. (Modified by ERM)

Note: Green Outline: Existing Natural Gas Power Plant Yellow Line: Proposed Natural Gas Pipeline Red line: Existing MOEE CCPP Purple Outline: Proposed Power Plant

### 2.3 Purposes and Objectives of this ESIA Report

This Environmental and Social Impact Assessment (ESIA) Report (also referred to as 'Environmental Impact Assessment (EIA) Study') presents an assessment of the potential environmental and social impacts associated with the proposed Power Plant, LNG Receiving Terminal, and Natural Gas (NG) Pipeline in Yangon Region, Myanmar ('the Project').

The specific objectives of this ESIA report are as follows:

- Facilitate an understanding of the elements of the existing baseline conditions that are relevant to resources/receptors that could be potentially impacted by the Project;
- Identify the aspects of the Project that could potentially result in significant environmental and social impacts on resources/receptors;
- Document how stakeholders have been engaged during the ESIA Process, and how stakeholder feedback has been considered in the ESIA study;
- Predict and evaluate the significance of the potential environmental and social impacts of the Project;
- Identify the aspects of the Project that need to be managed, and recommend appropriate and justified mitigation and enhancement measures;
- Determine the significance of residual impacts, taking into account the implementation of mitigation measures; and
- Generate plans for the management and monitoring of impacts, including plans for ongoing stakeholder engagement.

### 2.3.1 Environmental, Social and Health Experts

**ERM-Siam Company Limited** has been assigned by TPMC to conduct an Environmental and Social Impact Assessment (ESIA) Study for the Project. ERM has been approved by the Environment Conservation Department (ECD) of the Ministry of Natural Resources and Environmental Conservation (MONREC) as third party consultant on the 24<sup>th</sup> of August 2018 (*Appendix D*). The outcomes of the ESIA Study will be submitted to relevant Myanmar authorities for assessment in order to inform the decision for the Project Proponent to obtain an ECC.

ERM is a leading global provider of environmental, health, safety, risk, social consulting and sustainability related services. ERM has more than 5,000 employees in over 40 countries and territories working out of more than 150 offices.

ERM is committed to providing a service that is consistent, professional and of high quality. ERM are approved by the Ministry of Natural Resources, Environment and Conservation (MONREC), and have recently registered our Company as a separate ERM Myanmar entity and opened an office in Yangon.

ERM has high international standing, and an unrivalled track record in preparing successful ESIAs for high profile and often controversial development projects. ERM has over 20 years' experience undertaking ESIA Studies for the power sector worldwide, including many high profile power projects.

ERM has been working in Myanmar since 1994 and has already been involved in the development of several power plant in Myanmar.

The key personnel from ERM involved in the preparation of this ESIA Study are presented in Table 2.2.

# Table 2.2: ERM Key Personnel involved in Preparation of the ESIA Study (and<br/>Scoping Study)

Name	Project Role
Ms Kamonthip Ma-oon	Partner in Charge
Dr Robin Kennish	Project Technical Director
Mr Vincent Lecat	Project Manager and Social Specialist
Mr Chris Brown	Soil / Water Specialist
Mr David Nicholson	Biodiversity Specialist
Mr Edmund Taylor	Air Quality Specialist
Ms Sarinya Rangsipatcharayut	GHG Specialist
Ms Sylvia Jagerroos	Marine Specialist
Ms Mandy To	Noise Specialist
Ms Peggy Wong	Cultural Heritage Specialist
Ms Kanokphorn Chaivoraphorn	Health Specialist
Ms Khinsusu Naing	Social Expert
Ms AyeMya Thinzar	Social Consultant
Ms Sutawan Chittham	Visual and Unplanned Events Specialist
Mr Aung Myowin	Environmental Consultant
Mr Shwet Prakash	Thermal Discharge and Sedimentation Specialist/ Modeller
Mr Aniket Jalgaonkar	Flooding Risks Specialist

Note: CVs of all ERM staff have been provided in the third party registration letter

For this Project, ERM has selected the qualified sub-consultant, **Sustainable Environment Myanmar Co., Ltd (SEM)**, who has experience in carrying out the environmental and social baseline survey and public consultation meetings in the local context. Note that all the works provided by SEM are under ERM supervision.

SEM is a leading resource and environmental consultancy firm based in Myanmar, consisting of former and current university faculty members of various disciplines relating to environmental and social management.

They have worked extensively across Myanmar undertaking Environmental Impact Assessment related works including terrestrial biodiversity surveys, habitat and land use mapping, health and social impact surveys and development of post project monitoring surveys.

SEM has been involved in all the field activities related to environmental baseline data collection, in particular the biodiversity study, air quality and noise data collection, surface / ground water and soil sampling. SEM also supported ERM in the socioeconomic and cultural heritage data collection and the stakeholder engagement process.

The key personnel from SEM involved in the Project are presented in Table 2.3.

# Table 2.3: SEM Key Personnel involved in Preparation of the ESIA Study (and<br/>Scoping Study)

Name	Project Role
Mr Zaw Naing Oo	Managing Director
Mr Maung Chit	Project Manager
Ms Nan Cherry	Social Specialist
Daw Naing Naing Win	Local Ecology Expert

Note: CVs of all SEM staff have been provided in the third party registration letter

### 2.4 Structure of this ESIA Report

Following the Executive Summary in Myanmar language and English are presented as *Chapter 1*, the remainder of this ESIA Report is presented as follows:

- Chapter 3 presents an overview of the environmental and social policy, legal and institutional framework related to the proposed Project;
- Chapter 4 provides details on the Project description and alternatives considered;
- Chapter 5 provides a description of the existing biophysical and socioeconomic environment;
- Chapter 6 presents the Impact Assessment Methodology used for this study;
- Chapter 7 presents the key potential environmental and social impacts, and potential mitigation measures for the LNG Receiving Terminal;
- Chapter 8 presents the key potential environmental and social impacts, and potential mitigation measures for the Pipeline;
- Chapter 9 presents the key potential environmental and social impacts, and potential mitigation measures for the Power Plant;
- Chapter 10 presents the key potential biodiversity impacts, and potential mitigation measures for all three (3) main components (LNG Receiving Terminal, Pipeline, and Power Plant);
- Chapter 11 presents the Cumulative Impact Assessment (CIA);
- Chapter 12 provides the Environmental and Social Management Plan (ESMP);
- Chapter 13 highlights the stakeholder identification, stakeholder engagement activities, including Project disclosure and results from Public Consultation meetings;
- Chapter 14 provides conclusions and recommendations, and the Statement of Commitment; and
- Chapter 15 present the references used for the study.

The supporting documents are inserted as Appendices, as follows:

- Appendix A: PPR Submission Letter;
- Appendix B: Scoping Report Submission Letter;
- Appendix C: ECD Comments on Scoping Report;
- Appendix D: Third party Confirmation Letter;
- Appendix E: TPMC's HSE Plan Procedure;
- Appendix F: Preliminary Project Master Schedule;
- Appendix G: Fire Prevention Plan for the LNG Receiving Terminal;

- Appendix H: Project Incident and Emergency Response Plan;
- Appendix I: Site Security Procedure;
- Appendix J: Personale Protective Equipment Procedure;
- Appendix K: Physical In-Situ Sampling During Dry Season from SEM;
- Appendix L: Physical Baseline Data Analysis for Dry Season from STS Green;
- Appendix M: Physical In-Situ Sampling During Wet Season from SEM;
- Appendix N: Physical Baseline Data Analysis for Wet Season from STS Green;
- Appendix O: Invasive Species in Myanmar;
- Appendix P: Example Tools used for Social Baseline Primary Data Collection;
- Appendix Q: Full Air Quality Impact Assessment (AQIA);
- Appendix R: CORMIX Modelling Report;
- Appendix S: Public Participation No.1 Presentation (Burmese);
- Appendix T: Business Information Document (Burmese);
- Appendix U: Public Consultation Minutes of Meeting (Scoping Process);
- Appendix V: Public Participation No.2 Presentation (English);
- Appendix W: Public Consultation Minutes of Meeting (Draft ESIA Presentation);
- Appendix X: High Level Flood Likelihood Evaluation (FLE); and
- **Appendix Y**: ESIA Study Terms of Reference.

# 3. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

### 3.1 Introduction

This chapter summarises the relevant legal and policy context in Myanmar and documents the environmental and social standards with which the Project will achieve compliance. It also includes the international standards that the Project will follow as well as applicable international treaties and conventions, and internal guidelines and standards voluntarily committed to by the Project Proponent.

## 3.2 TPMC Health, Safety, and Environment (HSE) Plan Procedure

The purpose of the HSE Plan is to provide the necessary rules, regulations, and guidelines to prevent incidents and injuries from occurring, and minimizing adverse environmental impacts.

It is stated by TPMC's HSE Plan Procedure that the Project HSE objectives are as follows:

- 1. TPMC shall carry out project management and construction management activities in compliance with the applicable regulatory and other related HSE requirements as specified in the contract.
- 2. TPMC shall perform and manage construction work in safe manner to achieve the safety target of "No Lost time Accident"
- 3. Project incidence rates should not exceed the following values;

IFR (incidence frequency rates), 3.7

ISR (incidence severity rates), 37

4. TPMC shall perform construction work by taking into account for the Environmental impact protection and complaint from the community shall be "Zero".

TPMC's HSE Plan Procedure is shown in Appendix E.

### 3.3 Overview of Myanmar Regulatory Framework

### 3.3.1 Myanmar Regulatory Authorities

Matters pertaining to Health, Safety and Environmental (HSE) requirements for this Project are under the jurisdiction of the ministries and state-owned enterprises in the electricity and energy sector, environment and port authorities. Key ministries, agencies and state-owned enterprises that have jurisdiction over environment, port, electricity and energy matters are included in **Table 3.1**.

# Table 3.1: Key Ministries, Agencies and State-Owned Enterprises Involved in HSE for this Project

Ministry/Agency	Responsibility
Ministry of Natural Resources and Environmental Conservation (MONREC)	The Environmental Conservation Department (ECD) of MONREC has ultimate responsibility in the review and approval, or otherwise, of submissions under the ESIA process.
Ministry of Electricity and Energy (MOEE)	Primary responsible for electricity planning, generating and transmission. MOEE is also the sole supplier of natural gas for power generation and is responsible for issuing regulations on the generation, transmission and delivery of electric power in Myanmar.
Electric Power Generation Enterprise (EPGE)	Responsible for purchasing power from public and private power producers, including Build, Operate Transfer (BOT) project companies and reselling that power. In addition, the EPGE controls all transmission lines and substations.
Myanma Oil & Gas Enterprise (MOGE)	Responsible for overseeing the Oil & Gas sector in Myanmar and involved in the import of LNG in the country.

Ministry/Agency	Responsibility
Myanmar Investment Commission (MIC)	MIC is a government agency responsible for coordinating with ministries (such as the MOEE) and other state entities to facilitate foreign investment in Myanmar. The MIC is also responsible for granting MIC permits, which enable foreign investors to carry out business activities under the Myanmar Investment Law (18 October 2016).
Department of Electrical Power Planning (DEPP)	Formed in 2012 from a combination of the Power Department, and the Ministry for Planning Policies Mission planning. Main responsibilities are implementing Power Projects on behalf of the Ministry.
Myanmar Port Authority (MPA)	Created in 1989, the Myanmar Port Authority is a government agency vested with the responsibility to regulate and administer the coastal ports of Myanmar. It is a department of the Ministry of Transport and Communications (MOTC) and is located in Yangon
Department of Power Transmission and System Control (DPTSC)	Specifically the Department of Power Transmission Projects Department (PTP), under the DPTSC, are responsible for overseeing transmission lines and substation projects in Myanmar.

Source: ERM, 2019.

# 3.3.2 Myanmar Legislation Potentially Relevant

Laws related to environmental and social issues and hence potentially relevant to the ESIA Study for the proposed Project are included in *Table 3.2*.

Sector	Relevant Laws in Myanmar
Administration	Myanmar Investment Law, October 2016 & Myanmar Investment Commission Notification No. 15 /2017, April 2017
	The Private Industrial Enterprise Law - SLORC Law No. 22/90
	The Law on Standardisation (2014)
	National Sustainable Development Strategy (2009)
	Myanmar Insurance Law (1993) Myanmar Insurance Business Law (1996) Myanmar Insurance Rule (1997)
	Myanmar Fire Services Law (2015)
	The Emergency Provisions Act, 1950
	Myanmar Insurance Law, 1993
	The Essential Supplies and Services Act, 1947
	Import and Export Law, 2015
	The Private Industrial Enterprise Law, 1990
	The Embankment Act, 1909
	Myanmar Fire Brigade Law, 2015
	The Emergency Provisions Act, 1950
	The Penal Code of Offences Affecting the Public Health, Safety, Convenience, Decency and Morals, 1861
	Electricity Law, 2014
	Petroleum Rules, 1937

# Table 3.2: Myanmar Legislation Relevant to the Project

Sector	Relevant Laws in Myanmar	
	The Water Power Act, 1927	
	The Underground Water Act, 1930	
	Anti-Corruption Law No.23/2013	
Agriculture and Irrigation	Farmland Rules – Notification No 62/2012 (English)	
	Vacant, Fallow and Virgin Lands Management Rules – Notification No. 1/2012	
	Vacant, Fallow and Virgin Land Management Act – Pyidaungsu Hluttaw Law No. 10/2012	
Culture	The Protection and Preservation of Cultural Heritage Region law, 1998 (Revised in 2009 and Supplemented in 2011)	
	Antiquities Act, 1957 (Revised 1962)	
	The Protection and Preservation of Ancient Building Law, 2015	
	The Protection and Preservation of Ancient Monuments Law, 2015	
	Law Protecting Ancient Objects Law No.43/2015	
Forestry, Environment and Natural Resources	The Protection of Wildlife and Conservation of Natural Areas Law, 1994 (No. 6/94) and Rules on Protection of Wildlife	
	Protected Area Conservation Law (2003) and the Protection of Wildlife, and Wild Plant and Conservation of Natural Areas Rules (2002)	
	The Forest Law, 1992	
	The Conservation of Water Resources and Rivers Law, 2006	
	The Burma Wildlife Protection Act 1936 and Burma Wild Life Protection Rules, 1941	
	Myanmar Forest Policy, 1995	
	The Forest Department Notification No. 583/94	
	Environmental Impact Assessment Procedures (December 2015)	
	Environmental Conservation Law (March 2012) and associated Rules (June 2014)	
	National Environmental Quality (Emission) Standards Guideline, 2015	
	Myanmar Agenda 21 (1997)	
	National Environmental Policy (1994)	
	Constitution of the Republic of the Union of Myanmar, 2008	
Public Health	The Union of Myanmar Public Health Law, 1972	
	Private Health Act, 2007	
	Prevention from Danger of Chemical and Associated Material Law (2013)	
	The Prevention and Control of Communicable Disease Law (1995), 2011	
	Control of Smoking and Consumption of Tobacco Product Law, 2006	
	Ministry of Health Notification No. 5/2014, Order Stipulating the Caption, Sign and Marks Referring to the "No Smoking Area"	
	Ministry of Health Notification No. 6/2014, Order Stipulating the Requirements to be Managed at the Specific Area where Smoking is Allowed.	

Sector	Relevant Laws in Myanmar
Labour and Occupational Health and Safety	Employment and Training Act 1950, replaced by Employment and Skill Development Law, 2013
	Employment Restriction Act (1959)
	Protection of the citizen for the personal freedom and personal security Law No. 5/2017
	Workmen's Compensation Act
	Leave and Holidays Act, 1951
	Minimum Wage Act 2013
	Occupational Safety and Health Law, 2012
	Payment of Wages Act 2016
	Standing Order 2_95 Occupational Health Plan, 1995
	Social Security Act 2012
	Settlement of Labour Dispute Law (2012)
	Employment and Skill Development Law (2013)
	Employment Statistics Act (1948)
	Electricity Law (44/2014)
	Import and Export Law (2015)
	The Factories Act (1951)
	The Petroleum Act (1934)
Fisheries, Aquaculture, and	The Freshwater Fisheries Law, 1991
Water	The Myanmar Marine Fisheries Law, 1990
	The Law Relating to Aquaculture, 1989
	The Law Amending Marine the Marine Fisheries Law, 1993
	The Conservation of Water Resources and Rivers Law - SPDC Law No. 8/2006
	Territorial Sea and Maritime Law, 1977
Transportation	Highways Law No.24/2015
	Automobile Law No.55/2015
	The Ports Act, 1907
	Coastal and Marine Transportation Law, 2015
	Myanmar Port Authority Law, 2015
	The Yangon Port Act, 1905
	Inland Water Transportation Law No. 13/2017
	Law regarding inland water transport vessels Law No.29/2015
Land Use	Land Acquisition Act, 1894
	The Towns Act, 1907
	The Village Act, 1907
	Farmland Law and Farmland Rules, 2012
	Vacant, Fallow and Virgin Land Management Law, 2012

Sector	Relevant Laws in Myanmar
Oil and Gas	Oil and Petroleum Products Law (2017)

Source: ERM, 2018.

## 3.4 National Administrative Requirements

### 3.4.1 Overview of Myanmar Legislation

### 3.4.1.1 The Constitution

The latest enacted Constitution (May 2008) provides information on governing laws and regulations in Myanmar. The Constitution takes precedence over any other national legislation or international agreements. The general provisions of the Constitution that relate to the Project are the requirement for Myanmar citizens to assist in:

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

### 3.4.1.2 Administrative Divisions of Myanmar

Myanmar is divided into twenty-one (21) main administrative subdivisions, which include:

- Seven states;
- Seven regions (note that regions were previously referred to as "divisions", prior to August 2010);
- Five self-administered zones;
- One self-administered division; and
- One union territory.

The administrative subdivisions are detailed in *Table 3.3*, and an administrative map is presented in *Figure 3.1*.

Name	Capital	Population	Area (km <sup>2</sup> )
Ayeyarwady Region	Pathein	6,184,829	35,032
Bago Region	Bago	4,867,373	39,402
Chin State	Hakha	478,801	36,019
Kachin State	Myitkyina	1,689,441	89,041
Kayah State	Loikaw	286,627	11,732
Kayin State	Pa-an	1,574,079	30,383
Magway Region	Magwe	3,917,055	44,821
Mandalay Region	Mandalay	6,165,723	37,946
Mon State	Mawlamyaing	2,054,393	12,297
Rakhine State	Sittwe	3,188,807	36,778

#### Table 3.3: Administrative Regions of Myanmar

Name	Capital	Population	Area (km <sup>2</sup> )
Sagaing Region	Sagaing	5,325,347	93,705
Shan State	Taunggyi	5,824,432	155,801
Tanintharyi Region	Dawei	1,408,401	43,345
Yangon Region	Yangon	7,360,703	10,277
Naypyidaw Union Territory	Naypyidaw	1,160,242	N/A
Danu Self-Administered Zone	Pindaya	N/A	N/A
Kokang Self-Administered Zone	Laukkai	N/A	N/A
Naga Self-Administered Zone	Lahe	N/A	N/A
Pa-O Self-Administered Zone	Hopong	N/A	N/A
Pa Laung Self-Administered Zone	Namhsan	N/A	N/A
Wa Self-Administered Division	Hopang	N/A	N/A

Source: The Union Report: Census Report Volume 2. The 2014 Myanmar Population and Housing Census. Nay Pyi Taw: Ministry of Immigration and Population. 2015. p. 12.

States and regions are divided into districts. Districts consist of townships, which are composed of towns, wards and village-tracts. Village-tracts are groups of adjacent villages. The administrative structure of the states, regions and self-administering bodies is defined in the Constitution.

Each region and state has a Regional/State Government, consisting of a Chief Minister, Ministers and an Advocate General. Legislative authority resides with the State/Regional "Hluttaw" (a parliament or legislative body), which are made up of elected civilian members and representatives of the military.

The Constitution states that Naypyidaw is a Union Territory under the direct administration of the President. The Naypyidaw Council, led by a Chairperson, carries out general functions on behalf of the President. The Chairpersons of the Naypyidaw Council are appointed by the President, and include civilians and representatives of the military.

Self-Administered Zones and Self-Administered Divisions are administered by a Leading Body, which is headed by a Chairperson, and has executive and legislative powers. The Leading Body consists of elected State/Regional Hluttaw members and military personnel.



Figure 3.1: Myanmar States/Regions and Townships

Source: ERM, 2017.

Articles in the Constitution relevant to environmental protection are Articles 37, 42 and 390. These three Articles in the Constitution provide a basis for legalizing and institutionalizing environmental health impact assessment and social impact assessment. They are quoted below in *Table 3.4.* 

Article	Content	
Article 37	<ul> <li>(a) The Union is the ultimate owner of all lands and all natural resources above and below the ground, above and beneath the water and in the atmosphere in the Union;</li> <li>The Union shall enact necessary law to supervise extraction and utilization of State owned natural resources by economics forces;</li> </ul>	
Article 42	The Union shall protect and conserve natural environment.	
Article 390	<ul> <li>Every citizen has the duty to assist the Union in carrying out the following matters:</li> <li>(a) preservation and safeguarding of cultural heritage;</li> <li>(b) environmental conservation;</li> <li>(c) striving for development of human resources;</li> <li>(d) protection and preservation of public property.</li> </ul>	

Table 3.4: Articles in the Constitution Relevant to Environmental Protection.

Source: ERM, 2018.

### 3.4.1.3 EIA Requirements in Myanmar

Laws in Myanmar related to EIA requirements are as follows:

# Environmental Policy, 1994; Myanmar Agenda 21, 1997; and National Sustainable Development Strategy, 2009.

Myanmar issued an Environmental Policy in 1994, which was as follows:

".... The wealth of the nation is its people, its cultural heritage, its environment and its natural resources. The objective of Myanmar's Environment Policy is aimed at achieving harmony and balance between these, through the integration of environmental considerations into the development process to enhance the quality of life of all its citizens. Every nation has the sovereign right to utilize its natural resources in accordance with its environmental policies, but great care must be taken not to exceed its jurisdiction or infringe upon the interests of other nations. It is the responsibility of the State and every citizen to preserve its natural resources in the interest of present and future generations. Environmental protection should always be the primary objective in seeking development".

With a view to implementing a National Environment Policy (NEP), the National Commission for Environmental Affairs (NCEA) formulated Myanmar Agenda 21 in 1997 under the guiding principles established at the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992. The Agenda 21 provided the first framework for integrating environmental considerations into national development plans in Myanmar. The purpose of Agenda 21 is to mobilize and focus national efforts to achieve sustainable development, and is intended to have the following functions:

- 1. To define the choices, set the goals and targets, and establish the standards for sustainable development in Myanmar;
- 2. To illuminate the environmental and ethical dimensions underlying the choices to be made and goals to be achieved in sustainable development;
- 3. To analyse the ecological, economic and social issues in the country in a comprehensive and integrated fashion, clarifying the links between them, identifying the policy gaps, and showing how to reduce conflicts between environment and development;

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- 4. To identify and evaluate options for addressing priority issues, problems and opportunities, including the identification of appropriate programmes for legal reform, development of economic instruments, institutional development, capacity-building and other measures;
- 5. To set out sectoral and cross-sectoral policies and plans which rationalize the responsibilities for sustainable development, reduce duplication, close gaps, prevent or reduce conflicts, and take advantage of compatibilities and synergies among sectors and interest groups;
- To improve decision-making and policy formulation through better information and analytical techniques, and by enabling those most affected by decisions to participate in the decision-making process;
- 7. To develop understanding and build consensus so that decisions have strong support;
- 8. To identify, promote and support actions leading to sustainable development and to reduce, abate and put a stop to actions impeding sustainable development;
- To identify and apply practices which sustain the resource base of the economy, achieve sustainable levels of resource use, restore degraded natural resources, make use of unused or under-used resource potential, improve the efficiency of existing resource use, and diversify the use or seek substitution of existing resources;
- 10. To determine priorities for action, evaluating costs and benefits and the trade-offs between the different concerns affecting all levels of society;
- 11. To provide a basis for the allocation and optimal use of limited resources;
- 12. To develop and strengthen institutions for sustainable development; and
- 13. To build up the capacity of institutions and the population of the country to handle complex and inter-related issues through frameworks which integrate environmental concerns with planning.

Subsequently in 2007, the NCEA developed the National Sustainable Development Strategy (NSDS) for Myanmar. It incorporated the aspirations of the Agenda 21 as well as Myanmar's Millennium Development Goals. The NSDS was approved in 2009 and served as the main guiding principal on environmental protection in the country.

Specific strategies are outlined under each goal. For example, the goal for Sustainable Management of Natural Resources suggests strategies for forest resource management, sustainable energy production and consumption, biodiversity conservation, sustainable freshwater resources management, sustainable management of land resources, sustainable management for mineral resources utilization, etc.

The aim of NSDS is to achieve sustainable development through three sectors, focused on natural resource management, economic development, and social development. Relevant government ministries are expected to institutionalize NSDS principles into their sectoral development through short-term, medium-term and long-term actions.

Although much of the NSDS guidelines are for adoption and integration into the government legislation and regulation body, some are targeted at the private sector, such as the polluter pay principle, and reduction of energy consumption and greenhouse gas emission from industries.

### The Environmental Conservation Law, 2012

The legal mechanism for EIA has been put in place with the 2012 Environmental Conservation Law. The Pyidaungsu Hluttaw enacted this law by Law No. 9 of 2012 on the date of 30 March 2012. The legal mechanism for EIA has been described in this law. According to the text of The Environmental Conservation Law, the main objectives of the Law are as follows:

1. to enable to implement the Myanmar National Environmental Policy;

- 2. to enable to lay down the basic principles and give guidance for systematic integration of the matters of environmental conservation in the sustainable development process;
- 3. to enable to emerge a healthy and clean environment and to enable to conserve natural and cultural heritage for the benefit of present and future generations;
- 4. to reclaim ecosystems as may be possible which are starting to degenerate and disappear;
- 5. to enable to manage and implement for decrease and loss of natural resources and for enabling the sustainable use beneficially;
- 6. to enable to implement for promoting public awareness and cooperation in educational programmes for dissemination of environmental perception;
- 7. to enable to promote international, regional and bilateral cooperation in the matters of environmental conservation;
- 8. to enable to cooperate with Government departments, Government organizations, international organizations, non-government organizations and individuals in matters of environmental conservation.

The following articles are particularly relevant to EIA requirements and this project:

*"7. The duties and powers relating to the environmental conservation of the Ministry are as follows:* 

(*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;"

Also in this law, Article 14 and Article 15 are related with waste disposal in accordance with environmental standards:

*"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.* 

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."

Article 19 is related to maintenance of cultural heritage:

"19. The Ministry shall cooperate with the relevant Government departments and Government organizations in the matters of environmental conservation for perpetual existence of cultural heritage sites and natural heritage sites, cultural monuments and natural areas stipulated under any existing law."

For violations of bylaws, regulations and directives issued under this law, punishment is not more than one year or fine (unspecified amount), or both, under Article 32.

### Environmental Conservation Rules (2014)

The Ministry of Natural Resources and Environmental Conservation, in exercise of power conferred under sub-section (a) of section 42 of the Environmental Conservation Law, issues this rules by No. 50 of 2014 on the date of 5 June 2014, as shown in *Table 3.5*.

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

#### Table 3.5: Section 42 of the Environmental Conservation Law

#### Source: ERM, 2018.

# Foreign Investment Law, 2012, Foreign Investment Rules, 2013, and Notifications for Investment, 2013

Myanmar passed a new Foreign Investment Law on 2 November 2012, which replaced the Myanmar Foreign Investment Law of 1988. The recently enacted rules require EIA for large projects according to the rules of MONREC.

Although the law does not specifically define legislation for EIAs, Notification 1/2013 provides a categorization of the business activities in which foreigners will be allowed to engage. Under this, "Electrical power production" projects fall under "Category 3.3: activities allowed only following an Environmental Impact Assessment". Specifically, electrical power production projects "must conduct Environmental Impact Assessment and obtain and follow MONREC's terms and conditions".

### Environmental Impact Assessment Procedures 2015

The Environmental Impact Assessment Procedure was promulgated on December 29<sup>th</sup>, 2015, and sets out the procedures for completing an IEE, EIA and/or EMP in Myanmar. This includes information on project categorization, responsibilities of project developers and ministries, IEE/EIA review, monitoring and auditing, among other issues, under the Environmental Conservation Law 2012 and Environmental Conservation Rules 2014 of the National Environmental Policy for Myanmar 1994. The Procedure states that:

"....all Projects and Project expansions undertaken by any ministry, government department, organization, corporation, board, development committee and organization, local government or authority, company, cooperative, institution, enterprise, firm, partnership or individual (and/or all Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses including expans

Rules) having the potential to cause Adverse Impacts, are required to undertake IEE or EIA or to develop an EMP, and to obtain an ECC in accordance with this Procedure."

According to the EIA Procedure, based on the criteria indicated in Annex 1 'Categorization of Economic Activities for Assessment Purposes', natural gas power plants with an installed capacity of equal to or greater than 50 MW requires an EIA.

The EIA Procedure also outlines requirements for Scoping for all EIA Projects, which are required to be undertaken according to Article 49 and Article 50, as follows:

- "49. The Scoping shall, in respect of the proposed Project:
  - a. define the study area, area of influence, time boundaries, project phases, and potential stakeholders;
  - b. start the process of understanding the applicable regulations and standards, and their context for Project design and completion of the EIA;
  - c. make a provisional identification of Environmental Impacts, focusing on the environmental, social and health issues that need to be addressed in subsequent EIA studies;
  - d. provide an indication of the depth and breadth of subsequent EIA investigations including what baseline data and information are required, what further studies and investigations must be carried out, and how such data collection, studies and investigations shall be undertaken;
  - e. provide an opportunity for consultants, relevant authorities, project developers, and interested and affected parties to express their views and concerns regarding the proposal before an EIA proceeds;
  - f. enable an efficient and comprehensive assessment process that saves time, resources, costs and delays; and
  - g. identify potentially affected communities and other stakeholders with an interest in the Project.
- 50. As part of the Scoping, the Project Proponent shall ensure that the following public consultation and participation process is carried out:
  - a. disclose information about the proposed Project to the public and civil society through posting on the Project or Projects Proponent's website(s) and local media, including by means of the prominent posting of legible sign boards and advertising boards at the Project site which are visible to the public; and
  - b. arrange the required complement of consultation meetings as advised by the Ministry, with local communities, potentially PAPs, local authorities, community based organizations, and civil society, and provide appropriate and timely explanations in press conferences and media interviews."

Furthermore, EIA Investigation shall encompass the requirements of Article 56 through 61:

- "56. An EIA investigation shall consider all biological, physical, social, economic, health, cultural and visual components of the environment, together with all pertinent legal matters relating to the environment, people and communities (including land use, resources use, and ownership of and rights to land and other resources) that may be affected by the Project during all project phases including pre-construction, construction, operation, decommissioning, closure, and post-closure; and shall identify and assess all Adverse Impacts, risks, Cumulative Impacts and Residual Impacts for environment, social and, if relevant, health that potentially could arise from the Project.
- 57. The investigations shall include all necessary data collection, technical studies, modelling, field surveys, field sampling, laboratory analysis, engineering designs and calculations, and consultations to determine and document that all feasible measures are taken to ensure that all Residual Impacts are within standards and are acceptable to the Ministry and interested and affected persons.

- 58. The investigation shall also include an analysis of Alternatives. Such analysis shall include a description of each Alternative, and an assessment and comparison of the Adverse Impacts, required mitigation measures and Residual Impacts of the Alternatives.
- 59. The Project Proponent is obliged to use, comply with and refer to applicable national standards, international standards adopted by the Union Government and/or the Ministry, or, in the absence of relevant national or adopted international standards, such standards as may be agreed with the Ministry.
- 60. The EIA shall consider the views, concerns, and perceptions of stakeholders, communities and individuals that could be affected by the Project or who otherwise have an interest in the Project. The EIA should include the results of consultations with the public, affected population and other stakeholders on the environmental and social issues. The concerns raised during such consultations shall be considered in assessing impacts, designing mitigation measures, and in the development of management and monitoring plans.
- 61. As part of the EIA investigations, the Project Proponent shall undertake the following consultation process:
  - a. timely disclosure of all relevant information about the proposed Project and its likely Adverse Impacts to the public and civil society through local and national media, the website(s) of the Project or Project Proponent, at public places such as libraries and community halls, and on sign boards at the Project site visible to the public, and provide appropriate and timely explanations in press conferences and media interviews;
  - b. arrange consultation meetings at national, regional, state, Nay Pyi Taw Union Territory and local levels, with PAPs, authorities, community based organizations, and civil society;
  - c. consultations with concerned government organizations including the Ministry, the concerned sector ministry, regional government authorities, and others; and
  - d. field visits for the Ministry and concerned government organizations."

#### 3.4.1.4 Myanmar Protected Areas

The first legal instrument related to protected areas, which designated a wildlife sanctuary in the environs of the Royal Mandalay City, was promulgated in 1859. The first piece of wildlife legislation to be enacted was the Wild Elephant Protection Act of 1879. The Forest Act of 1902 gave responsibility for wildlife management to the Forest Department. Legislation specific to wild animals followed in 1927, and broader legislation followed nine years later with The Burma Wildlife Protection Act 1936 and The Burma Wildlife Protection Rules 1941 (Burma Act No. Vii of 1936). This provided for designation of wildlife sanctuaries with species-specific conservation objectives. Legislation was revised in 1994 with issue of the Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law. The 1994 Law, which was issued by the State Law and Order Restoration Council, provides for:

- A Committee for the Protection of Wildlife and Wild Plants and Conservation of Natural Areas, which is to serve as an advisory body to the Minister of Forestry; supervise implementation of the Law; give guidance in matters of research, conserving species in danger of extinction and international cooperation;
- Categories of 'natural areas' and zoological and botanical gardens, their declaration and uses;
- Categories of protected wild animals (almost the same as provided for under earlier law): completely protected, normally protected and seasonally protected;
- Hunting licenses;
- Establishment of zoological and botanical gardens;
- Registration of ownership of completely protected animals or trophies thereof;
- Administrative actions;
- Appeals; and
- Offences and penalties.

The categories of so-called 'natural areas' are defined in the Law described above as:

- Scientific Nature Reserve;
- National Park;
- Marine National Park;
- Nature Reserve;
- Wildlife Sanctuary;
- Geo-Physically Significant Reserve; and
- Other Nature Reserve Determined by the Minister.

A total of 43 protected areas have been established or proposed in Myanmar, and are shown in *Figure* **3.2.** The nearest protected area to the Project is the Hkawga wildlife park, which is located approximately 16 km North of the Project.





Source: Taw, N.P., 2014.<sup>1</sup>

<sup>&</sup>lt;sup>1</sup> Taw, N.P. (2014). Fifth National Report to the United Nations Convention on Biological Diversity. Ministry of Environmental Conservation and Forestry of the Republic of the Union of Myanmar. Retrieved from https://www.cbd.int/doc/world/mm/mm-nr-05-en.pdf

# 3.4.2 Rules on Protection of Wildlife, and Protected Area Conservation Law (2003) and the Protection of Wildlife, and Wild Plant and Conservation of Natural Areas Rules (2002)

The objectives of this Law are as follows:

- 1. to implement the Government policy for wildlife protection;
- 2. to implement the Government policy for natural areas conservation;
- 3. to carry out in accordance with the International Conventions acceded by the State in respect of the protection and conservation of wildlife, ecosystems and migratory birds;
- 4. to protect endangered species of wildlife and their natural habitats.

#### Article 15 states that:

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

- a. determine and declare endangered species of wild animal which are to be protected according to the following categories:
  - i. completely protected species of wild animals;
  - ii. normally protected species of wild animals;
  - iii. seasonally protected species of wild animals;
- b. determine and declare the endangered species of wild plants and their nature habitats thereof;
- c. lay down and carry out measures for the preservation of protected wildlife species;

Moreover, article 31 that a Forest Officer may pass an administrative order causing a fine that may extend to Kyat 10,000 to be paid, on a person who kills, hunts, wounds or raises a seasonally protected wild animal without permission during the closed season.

## 3.4.3 Myanmar Legislation Specific to the Electricity and Energy Sector

The existing legislation governing electricity and energy in Myanmar is Electricity Law (2015) Pyidaungsu Hluttaw Law No. 44/2014 dated 27<sup>th</sup> October 2014.

The objectives of this Law are as follows:

- 1. To systematically manage, in accordance with the present policies of the Union government, electricity activities in order to better develop the electric power sector, to satisfy the country's need for electric power and to supervise and control electricity activities;
- 2. To encourage more large-scale electric power generation and distribution projects which the Union may manage, and mid-sized and small-scale electric power generation and distribution projects in the regions and states;
- 3. To enable the wider use of electric power without the occurrence of electrical hazards;
- 4. To perform electricity activities in conformity with the prescribed standards and norms;
- 5. To increase foreign and local investments in electricity activities;
- 6. To write and promulgate equitable, transparent and reasonable rules and regulations for fixing electric power rates depending on the area;
- 7. To enable power consumers to use electric power with a voltage and frequency conforming to the standards and norms, and to prevent damage and loss to their electrical appliances due to electric power which is not in conformity with the standards and norms;

8. To respect and comply with the international conventions on environmental conservation, approved and signed by Myanmar.

#### Chapter (5) Right to engage in electricity activities states that:

- 11. Any local or foreign person desirous to invest in any electricity activity must, in accordance with the stipulations, apply to the person authorized to issue the license in order to acquire it.
- 12. The relevant ministry which is authorized to issue the license may, with the consent of the Union government, issue the license to any local or foreign person or organization desirous to invest in large-scale power projects, which may only be managed by the Union.
- 13. The region or state government which is authorized to issue the license may issue the license in accordance with the existing laws to any local or foreign person or organization desirous to invest in mid-size or small-scale electricity generation and distribution projects which may only be managed by the Union.
- 14. A license holder may apply to the ministry if he wants to sell electric power to the national grid. The ministry may allow or refuse the application after scrutinizing.
- 15. The head ("oozi") of the relevant self-administered division or zone may, after having negotiated with the relevant region or state government, issue licenses to any local or foreign person or organization desirous to invest in the electrification of the towns and villages situated in his area in accordance with the existing laws.
- 18. The license holder has the right to engage in electric power generation and distribution only after having received the electrical hazards safety certificate from the chief inspector.
- 19. (a) The license holder must apply to the relevant authorized ministry or organization if he desires to cooperate, with regard to the entire licensed project or some portion thereof, with other organizations, or transfer, sell, mortgage, lease or exchange licensed project or some portion thereof;

(b) The authorized ministry may, after having received the application under sub-section (a) and having scrutinized it, grant the application or refuse it.

- 20. The license holder abide by the rules, regulations, notifications, orders, directives and procedures issued by the relevant ministry relating to the licensed electricity activities.
- 21. (a) The license holder shall, if he fails to comply with the law, rules, regulations, procedures, orders and directions or the specified quality, standards and norm, be responsible in accordance with the law if any person or organization is affected of suffers a loss as a result.
  - (b) The relevant ministry must stipulate the rules and procedures for taking action relating to the matters under sub-section (a)
- 22. (a) The license holder shall be responsible in accordance with the law if any person or organization is affected or suffers a loss due to his negligence in performance;

(b) The relevant ministry must stipulate the rules and procedures for taking action relating to the matters under sub-section (a)

23. (a) The license holder shall not be responsible in accordance with the law if any person or any enterprise is affected or suffers a loss due to any force majeure event due to natural disaster including damages and losses to electricity activities;

(b) The relevant ministry must stipulate the rules and procedures relating to force majeure events with regard to electricity activities.

24. A power consumer must, if damage or loss occurs to other electric power consumers or any electricity activities due to his negligence, pay compensation calculated in accordance with the specified method of the ministry.

- 25. The license holder shall, upon expiry of the term of license, transfer the project to the concerned part in accordance with the agreement or the regulations in place at the time of receiving the license.
- 26. The license holder must comply with the following-
  - (a) Electricity exploration must be done in accordance with the law;
  - (b) In electric power generation, transmission and distribution-
  - i. Electrical power must be generated as specified in the license;
  - *ii.* Instruments for measuring electric power and protective equipment must be systematically used and *maintained in accordance with the stipulations.*
- 27. The license holder and the authorized person must inform the chief inspector and the relevant department in charge immediately if an electrical hazard has accidentally occurred when generating, transmitting, distributing or consuming electric power.

#### Chapter (10) Electrical power rates and service charges states that:

- 41. The relevant ministry shall, with the consent of the Union government, have the right to fix suitable electric power rates that are to be changed to the power consumers according to the region. The electric power rates may be changed from time to time.
- 42. The governments of the regions and states and the heads ("oozi") of the self-administered divisions and self-administered zones shall have the right to fix, after consultation with the relevant ministry, suitable electric power rates that are to be charged for electric power under their own management in the electric power system of their area. The electric power rates may be changed from time to time.

Those who violate a specific section under Chapter (12) Prohibition can be punished with a fine ranging from 50,000 to 3,000,000 kyats, and/or imprisoned for 1 year at least up to 3 years at most.

## 3.4.3.2 Government Administration of Myanmar Electricity and Energy

The electricity and energy sector in Myanmar is governed primarily by the Ministry of Electric and Energy (MOEE). MOEE supervises the sector and governs power generation, transmission and distribution. Various other ministries play a role, as follows:

- Ministry of Electricity and Energy (MOEE) primary responsible for electricity planning, generating and transmission. MOEE is also the sole supplier of natural gas for power generation and is responsible for issuing regulations on the generation, transmission and delivery of electric power in Myanmar.
- Electric Power Generation Enterprise (EPGE) solely responsible for purchasing power from public and private power producers, including Build, Operate Transfer (BOT) project companies, and reselling that power on to the Electricity Supply Enterprise (ESE) and the Yangon Electricity Supply Board (YESB). In addition, the EPGE controls all transmission lines and substations.
- Hydropower Generation Enterprise The Hydropower Generation Enterprise (HPGE) government partner for all hydro-generation BOT projects, and operates and maintains all largescale public sector hydro-generation facilities.
- Yangon City Electricity Supply Cooperation (YESC) plans, develops and maintains the Yangon electricity distribution system.
- National Energy Management Committee (NEMC) recently implemented body that will, among other duties, coordinate with the Privatization Commission and the Myanmar Investment Commission in order to facilitate development of the energy and electricity sectors through private investments.

Ministry of Planning and Finance (the successor of Ministry of National Planning and Economic Development (MNPED)) – oversees the Directorate of Investment and Company Administration (DICA) and its sub-agency, the Myanmar Investment Commission (MIC). DICA oversees the process of company registration in Myanmar, and oversees the Foreign Investment Department (FID), who has a role in reviewing applications and is responsible for issuing the relevant licenses and permits after MIC and DICA approval. MIC is responsible for interfacing with foreign investors incorporated under the FIL.

## 3.4.4 Other Project-Relevant Legislation in Myanmar

*Table 3.6* provides a list of major laws relevant to the Project, which forms part of the Project commitments.

#### Table 3.6: Project-Relevant Legislation in Myanmar

Laws and Regulations	Description

#### NEQ Guidelines (2015)

The NEQ sets out emission standards for air, noise and effluent discharges for oil and gas operations. The project shall consider emissions standards in its environment impact assessment and environmental management plan.

#### Myanmar Investment Law (2016)

- 3. The objectives of this Law are as follows:
  - a. To develop responsible investment businesses which do not cause harm to the natural;
  - b. Environment and the society for the benefit of the Union and its citizens;
  - c. To protect the investors and their investments in accordance with the law;
  - d. To create job opportunities for the people;
  - e. To develop human resources;
  - f. To develop high functioning production, service, and trading sectors.
  - g. To develop technology and the agriculture, livestock and industrial sectors;
  - h. To develop various professional fields including infrastructure across the Union;
  - i. To enable the citizens to be able to work alongside with the international community; and
  - j. To develop businesses and investments that meet international standards.

#### Conservation of Water Resources and Rivers Law (2006)

Section 6 outlines prohibitions for the following activities:

- "No person shall anchor the vessels where vessels are prohibited from anchoring in the rivers and creeks.
- No person shall 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.

No one shall dispose of any substance into the rivercreek that may cause damage to waterway or change of watercourse from the bank or vessel."

The aims of this Law are as follows:

- to conserve and protect the water resources and river systems for beneficial utilization by the public;
- to smooth and enhance safety of waterways navigation along rivers and creeks;
- to contribute to the development of State economy through improving water resources and river systems; and
- to protect environmental impact.

The empowerment of this Law is provided to the Ministry of Transport for controlling navigation of vessels in the rivers and creeks as well as communicating with local and foreign government and organizations for conservation of water resources, rivers and creeks. Also, to carry out conservation works for water resources, rivers and creeks, in accordance with the relevant international conventions, regional agreements and bilateral agreements for environmental conservation.

#### The Forest Law (1992)

The State Law and Order Restoration Council had enacted the following Law in 3rd November, 1992 as Forest Law

Chapter II: Basic Principles	3.	<ul><li>This Law shall be implemented in accordance with the following basic principles:</li><li>a. to implement the forestry policy of the Government;</li><li>b. to implement the environmental conservation policy of the Government;</li><li>c. to promote the sector of public co-operation in implementing the forestry policy and the environmental</li></ul>
		implementing the forestry policy and the environmental conservation policy of the Government.

Laws and Regulations	Description
Chapter IV: Management of Forest Land	<ul> <li>9. The functions and responsibilities of the Forest Department are as follows:-</li> <li>a. implementation of the forestry policy of the Government;</li> <li>b. implementation of the plans relating to conservation of water, bio-diversity and environment, sustained yield of forest produce and protection of forest covered land;</li> <li>c. management of forest land in accordance with the provision of this Law;</li> <li>d. submitting proposals to the Minister for the determination, alteration or cancellation of reserved forest, protected public forest and species of reserved trees;</li> <li>Whoever, within a forest land and forest covered land at the disposal of the Government: is desirous of carrying out any development work or economic scheme shall obtain the prior approval of the MONREC.</li> </ul>
Chapter XII: Offences and Penalties	<ul> <li>40. Whoever commits any of the following acts shall, on conviction be punished with fine which may extend to Kyat 5,000 or with imprisonment for a term which may extend to 6 months or with both: <ul> <li>a. trespassing and encroaching in a reserved forest;</li> <li>b. pasturing domestic animals or permitting domestic animals to trespass in a reserved forest;</li> <li>c. breaking up any land, clearing, digging or causing damage to the original condition of the land without a permit in a reserved forest;</li> <li>d. causing damage to a water-course, poisoning in the water, using chemicals or explosives in the water in a reserved forest;</li> <li>e. catching animals, hunting or fishing in a reserved forest;</li> <li>f. kindling, keeping, carrying any fire or leaving any fire burning which may set fire to the forests in a reserved forest;</li> <li>g. violating any provision of the rule, procedure, order, directive or notification issued under this Law.</li> </ul> </li> </ul>

## The Burma Wildlife Protection Act 1936 and The Burma Wildlife Protection Rules 1941 (Burma Act No. Vii Of 1936)

This legislation makes provision for the establishment of sanctuaries (game sanctuaries) on any land at the disposal of the government or, subject to the consent of the owner, any land which is private property. It also provides for the protection of a number of named species outside sanctuaries and reserved forests.

#### The Protection and Preservation of Cultural Heritage Regions Law (1998)

The State Peace and Development Council Law enacted this law by Law No. 9/ 98 on the date of 10 September, 1998. The Ministry of Culture may, with the approval of the Government issue notification for the protection of cultural heritage areas are categorized as following kinds of zones / region:

- a. Ancient monumental zone;
- b. Ancient site zone.

#### Objectives:

- a. to implement the protection and preservation policy with respect to perpetuation of cultural heritage that has existed for many years;
- b. to protect and preserve the cultural heritage regions and the cultural heritage therein so as not to deteriorate due to natural disaster or man-made destruction;

Laws and Regulations	Description
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- c. to uplift hereditary pride and to cause dynamism of patriotic spirit of citizens by protecting and preserving the cultural heritage regions;
- d. to promote public awareness and will as to the high value of the protection and preservation of the cultural heritage regions;
- e. to protect the cultural heritage regions from destruction;
- f. to carry out protection and preservation of the cultural heritage regions in conformity with the International Convention approved by the State.

#### The Conservation of Antique Objects Law (2016)

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.

#### The Protection and Preservation of Ancient Monuments Law (2016)

- 3. The objectives of this law are as follows:
  - a. To implement the protection and preservation policy for the perpetuation of ancient monuments which have existed for many years;
  - b. To protect and preserve cultural heritage regions and ancient monuments so that they are not destroyed by natural disaster or man;
  - c. To uplift hereditary pride and to cause dynamism of patriotic spirit of citizens by protecting and preserving cultural heritage regions;
  - d. To promote public awareness and will as to the high value of the protection and preservation of cultural heritage regions;
  - e. To explore and preserve new ancient monuments;
  - f. To protect cultural heritage regions from destruction;
  - g. To implement protection and preservation of ancient monuments in conformity with international conventions and regional agreements.
- 15. Every person desirous to engage in the following within the area of certain ancient monuments has to apply for the permission of the administration department:
  - (d) (e) digging a well, pond or fish-breeding pond;

(f) (f) **mining** for gold, producing sand, digging stones, brickworks and other works which can impact the soil density and ground structure;

#### The Private Industrial Enterprise Law (1990)

The State Law and Order Restoration Council enacted this law by Law No.22/90 on 26<sup>th</sup> November, 1990.According to this law; all private industrial enterprises shall avoid or reduce the use of polluting technology. The Supervisory Body supervises and inspects the enterprise to ensure the following:

- No health threats from the industrial enterprise to the nearby residence;
- No fire threats or hazards;
- No source of nuisance or pollution originating from the enterprise;
- No occupational hazard to the workers and Compliance with the existing law.

#### Myanmar Fire Force Law (2015)

The objectives of Myanmar Fire Force Law are:

- a. To take precautionary and preventive measure and loss of state own property, private property, cultural heritage and the lives and property of public due to fire and other natural disasters
- b. To organize fire brigade systemically and to train the fire brigade

Laws and Regulations	Description
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- c. To prevent from fire and to conduct release work when fire disaster, natural disaster, epidemic disease or any kind of certain danger occurs
- d. To educate, organize an inside extensively so as to achieve public corporation
- e. To participate if in need for national security, peace for the citizens and law and order

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

- a. Constructing three-storied and above buildings market and condominium buildings,
- b. Operating hotel ,motel, guest house enterprise
- c. Constructing factory, workshop ,storage facilities and warehouse
- d. Operating business expose to fire hazard by using in inflammable materials or explosive materials
- e. Producing and selling fire-extinguishing apparatuses

Doing transport business, public utility vehicles train, airplane, helicopter, vessel, ship, etc.

The relevant government department or organization shall obtain the opinion of the Fire Services Department for the purpose of fire precaution and prevention, when laying down plans for construction for town, village and downtown or village development plans.

#### **Underground Water Act (1930)**

The underground water act enacted on the date of 21<sup>st</sup> June in 1930 whereas it is expedient to conserve and protect underground sources of water supply in the Union of Myanmar. This act prohibits sinking of a tube for the purpose of obtaining underground water except under and in accordance with the terms of a license granted by the water officer. Township Officer or sub-divisional officer had power to close a license tube after exercising jurisdiction over the local area concerned and the expense of such closure shall be recoverable from the owner of the tube as if it were an arrear of land-revenue.

#### Land Acquisition Act (1984)

To determine how land is acquired for projects and how compensation is paid for the land. This includes compensation for things attached to the earth or permanently fastened.

#### Public Health Law (1972)

Purpose: to ensure the public health include not only employees but also resident people and cooperation with the authorized person or organization of health department. It is concerned with the protection of people' health by controlling the quality and cleanliness of food, drugs, environmental sanitation, epidemic diseases and regulation of private clinics. The project owner will cooperate with the authorized person or organization in line with the section 3 and 5 of said law.

Section 3: The project owner will abide by any instruction or stipulation for public health.

Section 5: The project owner will accept any inspection, anytime, anywhere if it is needed.

#### The Protection and Prevention of Communicable Disease Law (1995)

Chapter 5 of this law states that all persons are responsible for reporting an outbreak of a communicable disease to the nearest Health Officer.

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

- 3. The objectives of this Law are as follows;
  - a. to convince the public that health can be adversely affected due to smoking and consumption of tobacco product and to cause refraining from the use of the same;
  - b. to protect from the danger which affects public health adversely by creating tobacco smoke-free environment;
  - c. to obtain a healthy living style of the public including child and youth by preventing the habit of smoking and consumption of tobacco product;
  - d. to uplift the health, economy and social standard of the public through control of smoking and consumption of tobacco product;
  - e. to implement measures in conformity with the international convention ratified by Myanmar to control smoking and consumption of tobacco product;

Laws and Regulations	Description
The Development of Employees and Expertise (Skill) (2013)	

- 5. (a)(1) If the employer has appointed the employee to work for an employment, the employment agreement shall be made within 30 days. But it shall not be related with government department and organization for a permanent employment.
  - (2) If pre training period and probation period are stipulated before the appointment the said trainee shall not be related with the stipulation of sub- section (1).
  - (b) The following particulars shall be included in the employment agreement:
    - (1) the type of employment;
    - (2) the probation period;
    - (3) wage, salary;
    - (4) location of the employment;
    - (5) the term of the agreement;
    - (6) working hour;
    - (7) day off, holiday and leave;
    - (8) overtime;
    - (9) meal arrangement during the work hour;
    - (10) accommodation;
    - (11) medical treatment;
    - (12) ferry arrangement to worksite and travelling;
    - (13) regulations to be followed by the employees;
    - (14) if the employee is sent to attend the training, the limited time agreed by the employee to continue to work after attending the training;
    - (15) resigning and termination of service;
    - (16) termination of agreement;
    - (17) the obligations in accord with the stipulation of the agreement;
    - (18) the cancellation of employment agreement mutually made between employer and employee;
    - (19) other matters;
    - (20) specifying the regulation of the agreement, amending and supplementing;
    - (21) miscellaneous.
  - (c) The worksite regulations contained in the employment agreement shall be in compliance with any existing law and the benefits of the employee shall not be less than those of the any existing law.
  - (d) According to the employment agreement, the Ministry shall issue the notification for paying the stipulated compensation to the employee by the employer, if the work is completed earlier than the stipulated period or the whole work or any part of it have to be terminated due to unexpected condition or the work has to be terminated due to various conditions.
  - (e) The employment agreement made under sub- section (a) shall be related with daily wage workers, piece rate workers who are appointed temporarily in the government department and organization.
  - (f) The worksite regulations and benefits contained in the employment agreement mutually made between the employer and employee or among the employees shall be amended as necessary, in accord with the existing law.
  - (g) The employer shall send a copy of the employment agreement made between the employer and employee, to the relevant employment and labour exchange office within the stipulated period and shall get the approval of it.
  - (h) The employment agreement made before the enforcement of this law shall be confirmed up to the end of the term of the original agreement.
- 14. The employer shall carry out the training program in accord with the work requirement in line with the policy of the skill development team to develop the skill relating to the employment for the workers who are proposed to appoint and working at present.
- 15. The Employer:
  - (a) shall carry out the training for each work or compounding the work individually or group- wise by opening on- job training, training systematically at worksite, sending outside training and training by

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using information technology system, for arranging the training program to enhance the employment skill of the workers;

- (b) appointing the youths of 16 years as apprentice, shall arrange the training for technology relating to the employment systematically in accord with the regulations prescribed by the skill development team.
- 30. (a) The employer of the industry and service business shall put in to the fund monthly as put in fees without fail for the total wages of the subordinates and the supervisors' salary for not less than 0.5%;

(b) Put in money paid under sub- section (a) shall not be deducted from the wage and salary of the employees.

#### The Settlement of Labour Dispute Law (2012)

The Pyidaungsu Hluttaw hereby had enacted this Law for safeguarding the right of workers or having good relationship between employer and workers and making peaceful workplace or obtaining the rights fairly, rightfully and quickly by settling the dispute of employer and worker justly.

#### The Workmen Compensation Act (1923), (amended 2005)

In the Workmen's compensation Act, 1923, the expression" Kyats 2,160 and Kyats 7,200" contained in clause A (i) of sub-section (1) of section 4, the expression "two hundred Kyats" contained in clause A (ii) of sub-section (1) of section 4, the expression "Kyats 3,024and Kyats 10,080" contained in clause B (i) of sub-section (1) of section 4, the expression "twelve hundred Kyats" contained in clause B (ii) of sub-section (1) of section 4, the expression "twelve hundred Kyats" contained in clause B (ii) of sub-section (1) of section 4, the expression "twelve hundred Kyats" contained in clause B (ii) of sub-section (1) of section 4, the expression "one hundred Kyats" contained in the proviso of sub-section (1) of section 8 shall be substituted respectively by the expression "the amount of compensation prescribed by notification by the Ministry of Labour, with the approval of the Government."

The expression "subject to a maximum of thirty Kyats" contained in clause D (ii) of sub-section (1) of section 4 of the Workmen's Compensation Act, 1923 shall be deleted.

The expression "ten Kyats" contained in sub-section (2) of section 8, the expression "twenty five Kyats" contained in sub-section (4) of section 8, the expression "three hundred Kyats" contained in the first proviso of sub-section (1) of section 30 of the Workmen's Compensation Act, 1923 shall be substituted respectively by the expression "the amount of money prescribed by notification by the Ministry of Labour, with the approval of the Government.

The expression "shall be punishable with fine which may extend to one hundred Kyats" contained in sub-section (1) of section 18 A of the Workmen's Compensation Act, 1923 shall be substituted by the expression "shall be punishable with fine which may extend to Kyats 10,000."

#### Labour Organization Law (2012)

This Law was enacted, to protect the rights of the workers, to have good relations among the workers or between the employer and the worker, and to enable to form and carry out the labour organizations systematically and independently.

#### Minimum Wages Law (2013)

This Law was enacted to meet with the essential needs of the workers, and their families, who are working at the commercial, production and service, agricultural and livestock breeding businesses and with the purpose of increasing the capacity of the workers and for the development of competitiveness.

#### Payment of Wages Law (2016)

Salaries are to be paid at the end of the month or, depending on the size of the employing enterprise, between 5-10 days before the end of the month. The employer is permitted and required to withhold income tax and social security payments. Other deductions, e.g. for absence, may only be withheld in accordance with the law. **Section 3** The employer (a) will pay for salary either Myanmar Kyats or Foreign Cash permitted by National Bank of Myanmar. When delivery the salary (b) If the employer needs to pay the other opportunities or advantages, he can pay cash together with other materials according employee's attitude.

**Section 4** When the contract finish, employer need to pay the salary (not more than one month) to employees. For the permanent worker, need to pay per monthly. If more than 100 employees, need to pay within the 5 days

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from the end of month. If fire the employees, need to pay salary within two days after fire. When employee dies due to the accident, need to pay money as an insurance to employee's family within two days.

Section 9 When cut the salary due to the employees' absence, total cut salary not more than 50 % of his salary. Section 10 Employer need to approval form the department as a penalty and cannot more than actual ravage rate when cut salary. No cut salary from the employees under 16 age.

#### Social Security Law (2012)

#### The Establishments Applied

#### Section 11.

(a) The following establishments shall be applied with the provisions for compulsory registration for social security system and benefits contained in this Law if they employ minimum number of workers and above determined by the Ministry of Labour in co-ordination with the Social Security Board:

- production industries doing business whether or not they utilize mechanical power or a certain kind of power, works of production, repairing or services, or engineering works, mills, warehouses, establishments;
- ii. Government departments, Government organizations and regional administrative organizations doing business;
- iii. development organizations;
- iv. financial organizations,
- v. companies, associations, organizations and their subordinate departments and branch offices doing business;
- vi. shops, commercial establishments, public entertaining establishments;
- vii. Government departments and Government organizations doing business or transport businesses owned by regional administrative body, and transport businesses carried out with the permission of such department, body or in joint venture with such department or body;
- viii. construction works carried out for a period of one year and above under employment agreement;
- ix. works carried out with foreign investment or citizen investment or joint ventured businesses;
- x. works relating to mining and gemstone contained in any existing law;
- xi. works relating to petroleum and natural gas contained in any existing law;
- xii. ports and out-ports contained in any existing law;
- xiii. works and organizations carried out with freight handling workers;
- xiv. Ministry of Labour and its subordinate departments and organizations;
- xv. establishments determined by the Ministry of Labour from time to time, in co-ordination with the Social Security Board and with the approval of the Union Government; that they shall be applied with the provisions of compulsory registration for Social Security System and benefits contained in this Law.

(b) Any establishment which is applied with the provisions of compulsory registration under sub-section (a) shall continue to be applied by this Law even though any of the following situations occurs if it continues to carry out such work:

- xvi. carrying out work by employing under stipulated minimum number of workers but more than one worker;
- xvii. changing the employer or changing the type of business.

#### Section 48

(a) The employer shall effect insurance by registering for employment injury benefit insurance system contained in section 45 at the relevant township social security office and pay contribution to employment injury benefit fund in accord with stipulations in order that workers applied to provisions of compulsory registration may obtain the employment injury benefits.

#### Section 51

The employer (a) shall pay contribution monthly to Employment Injury Benefit Fund at the rates stipulated under section 50. Moreover he shall also bear the expenses for paying as such; (b) shall pay defaulting fee stipulated under section 88, in addition to the contribution if fails to contribute after effecting insurance for employment injury benefit.

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#### Section 53

(a) The employers and workers shall co-ordinate with the Social Security Board or insurance agency in respect of keeping plans for safety and health in order to prevent employment injury, contracting disease and decease owing to occupation and in addition to safety and educational work of the workers and accident at the establishment;

#### Section 54

(a) The employer shall report to the relevant township social security office immediately if a serious employment accident occurs to his insured worker. There shall not be any delay without sufficient cause to report as such.(b) A team of officers and other staff who inspect the establishments, if it is found out the employment injury, death, and contracting disease, shall report to the relevant township social security office in accord with the stipulations.

#### Leaves and Holidays Act (1951)

Under the Leave and Holidays Act (1951), every employee shall be granted paid public holidays as announced by the Government in the Myanmar Gazette. On average, Myanmar has 26 public holidays per year, depending on the date of the variable holidays. Myanmar law recognizes various types of leave. Leave is governed by the Leave and Holidays Act (1951), but additional rules may apply in accordance with other laws, such as the Social Security Law (2012) for employees contributing to the Social Security Fund.

#### The Import and Export Law (2012)

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

Source: ERM, 2018.

## 3.4.5 Institutional Framework

## 3.4.5.1 Central EIA Authority

MONREC is the authority that is responsible for implementing EIA. In 2011, MONREC became the coordinating agency responsible for the country environmental management.

## 3.4.5.2 Other Governmental Parties Involved in EIA

MONREC has assigned responsibilities with regards to EIA to the Environmental Conservation Department (ECD), which is one of the 6 departments of the MONREC. The ECD was set up in October 2012 and is mainly responsible for implementing the National Environmental Policy, strategy, framework, planning and action plan for the integration of environmental consideration into the national sustainable development process.

In addition, an EIA Report Review Body, consisting of individual experts and/or experts from relevant government departments and organizations, may support MONREC with the review process.

The Myanmar Investment Commission (MIC) has responsibility for making decisions regarding project approval. MIC is a government-appointed body under the Ministry of National Planning and Economic Development, formed in 1994, that appraises investment proposals in Myanmar.

## 3.4.5.3 EIA Review and Approval Process

Based on the EIA Procedure, articles relevant to the submission and approval of an EIA Report are presented below. In addition, an overview of the process (from the EIA Procedure) is shown in *Figure* **3.3**.

#### Submission of EIA Report

64. After completing all investigations and public consultation and participation processes required for EIA Type Projects, the Project Proponent shall submit the EIA Report to the Department in both digital form and complete paper copies, together with the required service fee as prescribed by the Department.

- 65. Not later than fifteen (15) days after submission of the IEE Report to the Department, the Project Proponent shall disclose the EIA Report to civil society, PAPs, local communities and other concerned stakeholders: (i) by means of national media (i.e. newspapers), (ii) the website(s) of the Project or Project Proponent, (iii) at public meeting places (e.g. libraries, community halls); and (iv) at the offices of the Project Proponent.
- 66. Upon receipt of the EIA Report, the Department will make the EIA Report publically available.

#### Review and Approval Process for EIA Report

- 67. Upon receipt of the EIA Report from the Project Proponent, the Department shall:
  - a. submit the EIA Report to the EIA Report Review Body for comment and recommendations;
  - b. invite comments and suggestions on the EIA Report from all relevant parties including relevant government organizations, institutions, civil society organizations, and PAPs, as appropriate;
  - c. arrange public consultation meetings at national, regional, state, Nay Pyi Taw Union Territory and local levels where the Project Proponents shall present the EIA Report; and
  - d. collect and review all comments and recommendations received, and forward the same to the Ministry to enable it to make a final decision on approval of the EIA Report.
- 68. If it is determined by the Ministry that the EIA Report does not satisfy requirements, then the Project Proponent shall be called upon by the Department to undertake necessary amendments as directed by the Ministry. The Ministry shall deliver its final decision within ninety (90) working days of receipt of the EIA Report. In case of Complex Projects, or if the Ministry requires the EIA Report to be amended, then the timeline will be extended accordingly.
- 69. All costs incurred in completing the EIA Report disclosure and review, including the public consultation process, shall be borne by the Project Proponent.
- 70. Upon completion of its review of the EIA Report, the Ministry shall;
  - a. approve the EIA Report with the guidance of the Committee, subject to any conditions as may be prescribe, and issue an ECC; or
  - b. inform the Project Proponent of its decision to reject the EIA and cite reasons for doing so (grounds for rejection of and EIA Report shall be in accordance with guidance from the Ministry); and, in either case
  - c. publicly and timely disclose its decision by appropriate means.





Source: MOECAF, 2015.<sup>2</sup>

<sup>&</sup>lt;sup>2</sup> MOECAF (2015) Environmental Impact Assessment Procedure. Ministry of Environmental Conservation and Forestry Notification No. 616 / 2015.

## 3.4.6 Summary of Applicable Standards and Project Commitments

## 3.4.6.1 National Environmental Quality (Emission) Guidelines

Myanmar's National Environmental Quality (Emission) Guidelines (NEQG) (hereafter referred to as "the Myanmar Standard") were promulgated on December 29th, 2015. The Guidelines are largely based on International Finance Corporation (IFC) Environmental Health and Safety (EHS) Guidelines, and provide the basis for regulation and control of various environmental parameters, including noise and vibration, air emissions, and effluent discharges, from various sources. The Project is committed to comply with the emission standards presented in this section.

Relevant excerpts from the guidelines are as follows:

"6. Provisions of the general and applicable industry-specific Guidelines shall be reflected in project EMP and ECC and together constitute a project's commitment to take necessary measures to avoid, minimize and control adverse impacts to human health, safety, and the environment through reducing the total amount of emissions generation; adopting process modifications, including waste minimization to lower the load of pollutants requiring treatment; and as necessary, application of treatment techniques to further reduce the load of contaminants prior to release or discharge.

7. Further reference should be made by projects to applicable industry-specific IFC EHS guidelines for advice on means of achieving limit values specified in Annex 1.

8. These Guidelines supersede any existing national guideline or standard provision relating to regulation and control of noise, air, and water emissions from activities and projects subject to the EIA Procedure.

9. As specified in Article 56 of the EIA Procedure, all projects are obliged to use, comply with and refer to applicable national guidelines or standards or international standards adopted by the Ministry.

These Guidelines will henceforth be applied by the Ministry in satisfying this requirement until otherwise modified or succeeded by other guidelines or standards.

12. As specified in Article 95 of the EIA Procedure, projects shall engage in continuous, proactive and comprehensive self monitoring of the project and comply with applicable guidelines and standards. For purposes of these Guidelines, projects shall be responsible for the monitoring of their compliance with general and applicable industry-specific Guidelines. Projects shall be responsible for ensuring compliance at the point of compliance specified in the applicable Guidelines.

13. To demonstrate compliance with these monitoring requirements as specified in articles 97 and 98 of the EIA Procedure, projects shall submit monitoring reports to the Ministry at least every six months or more frequently as provided in the EMP and ECC. Monitoring reports shall inter alia document compliance, difficulties encountered in complying with EMP and ECC conditions, number and type of non-compliance with EMP and ECC, and monitoring data of prescribed environmental parameters as detailed in the EMP and ECC."

## General

## **Air Emissions**

"Projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that: (i) emissions do not result in pollutant concentrations that reach or exceed ambient quality guidelines and standards, or in their absence the current World Health Organization (WHO) Air Quality Guidelines; and emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards (i.e. not exceeding 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed."

The Government of Myanmar has established numerical standard for ambient air quality in the Myanmar National Environmental Quality (NEQ) (Emission) Guidelines (2015) based on the IFC's Environmental, Health and Safety Guidelines: Air Emissions and Ambient Air Quality (2007) which adopted the WHO Ambient Air Quality Guidelines (2005). The Myanmar NEQ Guidance Values shown in *Table 3.7* have been adopted as the ambient air quality guidelines for this Project.

Parameter	Averaging Period (mean)	Myanmar NEQ Guidance Value (μg/m <sup>3</sup> ) <sup>(a)</sup>	WHO Guidance Value (μg/m³) <sup>(b)</sup>
Nitrogen dioxide	1-year 1-hour	40 200	40 (guideline) 200 (guideline)
Ozone	8-hour daily maximum	100	160 (Interim target-1) 100 (guideline)
Particulate matter PM <sub>10</sub>	1-year	20	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline)
	24-hour	50	150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Particulate matter PM <sub>2.5</sub>	1-year	10	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)
	24-hour	25	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
Sulphur dioxide	24-hour	20	125 (Interim target-1) 50 (Interim target-2) 20 (guideline)
	10-minute	500	500 (guideline)

## Table 3.7: Ambient Air Quality Guidelines

Note: (a) Extracted from Myanmar's National Environmental Quality (Emission) (NEQ) Guidelines (2015)
 (b) Extracted from WBG EHS General Guidelines, Environmental Chapter, Section 1.1, Table 1.1.1 based on World Health Organization (WHO). Air Quality Guidelines Global Update, 2005. PM 24-hour value is the 99th percentile.

Emission guidelines used in this study include the Myanmar's NEQ Guidelines (2015) as well as the IFC (2007) Environmental, Health and Safety Guidelines for Thermal Power Plant. *Table 3.8* shows the criteria included in these guidelines.

Combustion Technology/Fuel	Particulate Matter (PM)		Sulphur Dioxide (SO2)		Nitrogen Oxides (NOx)		Dry Gas, excess O <sub>2</sub>
Combustion Turbine	NDA(1)	DA(2)	NDA(1)	DA(2)	NDA(1)	DA(2)	content (%)
Natural Gas (all turbine types of unit > 50MWth)	n/a		n/a	n/a	51 mg/ľ 100 mg/	Nm <sup>3</sup> (3) Nm <sup>3</sup> (4)	15%

#### **Table 3.8: Criteria Levels for Emissions**

Source: ERM, 2018.

Note: (1) Non-degraded airshed

(2) Degraded airshed

(3) International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guidelines for Thermal Power Plant

(4) Myanmar National Environmental Quality (NEQ) Emission Guidelines (2015)

#### Wastewater and Effluent

The relevant guidelines for properly managing the wastewater generated from the construction of the Project are the *Myanmar NEQ Emission Guidelines (2015)* for site runoff and wastewater discharges (construction phase) and the *IFC General EHS Guidelines: Environmental – Wastewater and Ambient Water Quality (2007)* shown in **Table 3.9.** 

In addition, IFC Effluent Guidelines Standards for Thermal Power Plants (2008) in *Table 3.10* have been included.

Pollutants	Units	Guideline Value
pH	рН	6 – 9
Biochemical Oxygen Demand (BOD)	mg/l	30
Chemical Oxygen Demand (COD)	mg/l	125
Total Nitrogen	mg/l	10
Total Phosphorous	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN <sup>a</sup> /100 ml	400

## Table 3.9: Site Runoff and Wastewater Discharges

Source: IFC General EHS Guidelines: Wastewater and Ambient Water Quality.

Note: <sup>(a)</sup> MPN = Most Probable Number

Parameter	mg/L, except pH and temp.
рН	6 -9
Total Suspended Solid (TSS)	50
Oil and Grease	10
Chromium – Total (Cr)	0.5
Copper (Cu)	0.5
Iron (Fe)	1
Zinc (Zn)	1
Lead (Pb)	0.5
Cadmium (Cd)	0.1
Mercury (Hg)	0.005
Arsenic (As)	0.5
Temperature increase by thermal discharge from cooling system	Site specific requirement to be established by the Environmental Assessment (EA). Elevated temperature areas due to discharge of once-through cooling water (e.g., 1 Celsius above, 2 Celsius above, 3 Celsius above ambient water temperature) should be minimized by adjusting intake and outfall design through the project specific EA depending on the sensitive aquatic ecosystems around the discharge point.

## Table 3.10: IFC Effluent Guidelines Standards for Thermal Power Plants

Source: IFC Environmental, Health, and Safety Guidelines for Thermal Power Plants.

#### Noise Levels

The Myanmar NEQ (Emission) Guidelines (2015) for noise, IFC General EHS Guidelines: Environmental – Noise Management (2007) and the IFC General EHS Guidelines: Construction and Decommissioning (2007) are relevant to the Project. *Table 3.11* below presents the prescribed standards on noise impacts in the surrounding industrial and residential areas of the Project.

## Table 3.11: Myanmar NEQ and IFC General EHS Guidelines for Noise Levels at Receptors

Area	Maximum Allowable Noise Level (1 hour) <sup>(a)</sup> dB(A)	
	Daytime 0700 – 2200 hours	Night-time 2200 – 0700 hours
Residential, institutional, educational	55	45
Industrial/commercial areas	70	70

Source: Myanmar's National Environmental Quality (Emission) (NEQ) Guidelines (2015).

Note: <sup>(a)</sup> Equivalent continuous sound level in decibels

Noise impacts should not exceed the levels presented in this table, or result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location off-site.

#### Odour

"Point and diffuse source odours 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 odour 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 odour (e.g. intensive agricultural activities) and which can be more difficult to control. Projects should control odours to ensure that odours that are offensive or unacceptable to neighbours do not occur. Generally, odour levels should not exceed five to ten odorant units at the edge of populated areas in the vicinity of a project. Projects with multiple odorous point or diffuse releases, or emitting complex odours should conduct an odour impact assessment to determine ground-level maximum concentrations taking into account site-specific factors including proximity to populated areas."

## Industry Specific Standards for Thermal Power Projects

The *Myanmar National (NEQ) Guidelines (2015)* specify effluent guidelines in relation to "Thermal Power". In addition, the *IFC Effluent Guidelines Standards for Thermal Power Plants (2008)* are applicable to the Project. The operational effluent standards for the Project are shown in **Table 3.12**.

Parameter	Unit	NEQ Guideline Value	IFC EHS Guideline
Arsenic	mg/L	0.5	0.5
Cadmium	mg/L	0.1	0.1
Chromium (total)	mg/L	0.5	0.5
Copper	mg/L	0.5	0.5
Iron	mg/L	1	1
Lead	mg/L	0.5	0.5
Mercury	mg/L	0.005	0.005
Oil and grease	mg/L	10	10
рН	S.U.ª	6-9	6-9
Temperature increase	°C	<3°	Elevated temperature areas should be minimized by adjusting intake and outfall design through the project specific EA depending on the sensitive aquatic ecosystems around the discharge point.
Total residual chlorine	mg/L	0.2	0.2
Total suspended solids	mg/L	50	-
Zinc	mg/L	1	1

## Table 3.12: Effluent Standards for Thermal Power

Source: Myanmar's National Environmental Quality (Emission) (NEQ) Guidelines (2015).

Note: <sup>a</sup> Standard Unit

<sup>b</sup> Temperature increase due to discharge of once-through cooling water.

Applicability of heavy metals should be determined in the EA. Guideline limits in the Table are from various references of effluent performance by thermal power plants

Myanmar's air emission standards shown in **Table 3.13** are for non-degraded air sheds and are less stringent than the IFC Emissions Guidelines for Combustion Turbines shown in **Table 3.14**. Therefore, the Project will adopt the IFC Emission Guidelines for Combustion Turbines (highlighted in bold) shown in **Table 3.14**.

## Table 3.13: Myanmar NEQ Air Emission Standards for Thermal Power (applicable to non-degraded airsheds)

Combustion Technology/Fuel	Parameter/Guideline Values		
	Particulate Matter PM <sub>10</sub> ª	Sulfur Dioxide	Nitrogen Oxides
Combustion Turbine			

Natural gas (all turbine types; unit > 50 MW)	N/A	N/A	100 mg/Nm <sup>3</sup>
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Source: Myanmar's National Environmental Quality (Emission) (NEQ) Guidelines (2015).

Note: <sup>a</sup> Particulate matter 10 micrometres or less in diameter.

## Table 3.14: IFC Emission Guidelines for Combustion Turbine (in mg/Nm3 or asindicated) (a)

Combustion Technology /Fuel	Particulate	culate Matter (PM) Sulphur Dioxide (SC		Sulphur Dioxide (SO <sub>2</sub> )		Dry Gas, Excess O <sub>2</sub> Content (%)
	NDA <sup>(b)</sup>	DA <sup>(b)</sup>	NDA/DA	NDA/DA	NDA/DA	NDA/DA
Natural Gas (all turbine types of Unit > 50MWth)	N/A	N/A	N/A	N/A	51 (25 ppm)	15%

Notes: (a) Extracted from IFC EHS General Guidelines for Thermal Power Plant, Table 6(B), p21 dated December 19, 2008.

(b) NDA: Non Degraded Airshed

DA: Degraded Airshed (poor air quality)

Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly. For detailed notes and explanation refer to IFC EHS General Guidelines for Thermal Power plants, Table 6(B).

## Table 3.15: IFC Emission Guidelines for Liquefied Natural Gas Facilities

Parameter	IFC Guideline
Hydrotest Water	Treatment and disposal as per guidance in Section 1.1 of this document (IFC Guideline Environmental, Health, and Safety Guidelines Liquefied Natural Gas Facilities). For discharge to surface waters or to land: Total hydrocarbon content: 10 mg/L pH: 6-9 BOD: 25 mg/L COD: 125 mg/L TSS: 35 mg/L Phenols: 0.5 mg/L Sulfieds: 1 mg/L Priority pollutant metals <sup>a</sup> (total): 5 mg/L Chlorides: <sup>b</sup> 600 mg/L (average), 1200 mg/L (maximum)
Contaminated storm water drainage	Contaminated storm water runoff should be treated through an oil/water separation system able to achieve oil & grease concentration not exceeding 10 mg/L.
Cooling or cold water	The effluent should result in a temperature change of no more than 3°C at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors, and assimilative capacity. Free chlorine (total residual oxidant in

Guideline	Parameter
ation in cooling/cold water discharges rge) should be maintained below 0.2	
General EHS Guidelines, including on of facilities to receive LNG tanker HS Guidelines for Ports and Harbors).	Sewage
=	Notes <sup>a</sup> These are: Ag. As. Be. Cd. (

<sup>b</sup> For discharge to freshwater.

Source: IFC, 2017.3

## 3.5 International Standards and Guidelines

In addition to national legislation, the Project will be undertaken to comply with a range of international standards, including IFC Performance Standards (IFC PS), and the World Bank Guidelines. These standards are set to complement and reinforce national legislation and ensure the Project is conducted under best practices in a way that minimizes risks, impacts and ensures compliance and fair practices. The international performance standards and guidelines provide guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities.

The applicable guidelines and standards for the Project are as follows:

- The IFC's Performance Standards (IFC's PSs) (2012);
- IFC/World Bank Group (WBG) EHS Guidelines, WBG EHS Guidelines for Thermal Power (2007 and 2008) IFC/World Bank Group (WBG) EHS Guidelines for Gas Distribution Systems and IFC/World Bank Group (WBG) EHS Guidelines for Liquefied Natural Gas Facilities (2017);
- IFC's Stakeholder engagement handbook and other relevant Good Practice Notes;
- IFC's Handbook for Preparing a Resettlement Action Plan (if applicable)
- Kyoto Protocol to the UNFCC on Climate Change (1997);
- United Nations Convention on Biological Diversity (1992);
- Basel Convention (1989);
- Ramsar Convention on Wetland (1971); and
- International Union for Conservation of Nature and Natural Resources, Red List of Threatened Species (1964).

## 3.5.1 International Finance Corporation (IFC) and World Bank Performance Standards

The IFC updated its Sustainability Framework in January 2012. This included revising the Performance Standards; which replace the previous safeguard policies and will be used to evaluate any project seeking funding through the IFC.

The Performance Standards represent the 'policy framework' for the ESIA and sustainable social and environmental management for the Project, whereas the IFC EHS Guidelines provide guidance on

<sup>&</sup>lt;sup>3</sup> IFC. (2017). Environmental, Health, and Safety Guidelines for Liquefied Natural Gas Facilities. International Finance Corporation. World Bank Group. Retrieved from https://www.ifc.org/wps/wcm/connect/edb102c5-ca61-4561-8b8e-8124fa2060af/20170406-FINAL+LNG+EHS+Guideline\_April+2017.pdf?MOD=AJPERES

general and industry best practice as well as recommended numerical limits for emissions to the atmosphere, noise, liquid and solid wastes, hazardous wastes, health and safety, and other aspects of industrial facilities and other types of development projects. The relevant IFC Performance Standards are listed in *Table 3.16* and the EHS Guidelines are discussed further in *Section 3.5.1*.

Performance Standards	Objectives
Performance Standard 1 - Assessment and Management of Environmental and Social Risks and Impacts underscores the importance of managing social and environmental performance throughout the life of a project (any business activity that is subject to assessment and management).	<ul> <li>Impact identification and assessment. To identify and assess social and environmental impacts, both adverse and beneficial, in the project's area of influence</li> <li>Mitigation. To avoid, or where avoidance is not possible, minimize, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment</li> <li>Stakeholder engagement. To ensure that affected communities are appropriately engaged on issues that could potentially affect them</li> <li>Effective management. To promote improved social and environment performance of companies through the effective use of management systems.</li> </ul>
<b>Performance Standard 2 - Labour and Working</b> <b>Conditions</b> recognizes that the pursuit of economic growth through employment creation and income generation should be balanced with protection for basic rights of workers.	<ul> <li>To promote fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labor and employment laws</li> <li>To establish, maintain and improve the worker management relationship.</li> <li>To promote compliance with national employment and labour laws.</li> <li>To protect the workforce by addressing child labor and forced labor.</li> <li>To promote safe and healthy working conditions, and to protect and promote the health of workers.</li> </ul>
Performance Standard 3 - Resource Efficiency and Pollution Prevention recognizes that increased industrial activity and urbanization often generate increased levels of pollution to air, water, and land that may threaten people and the environment at the local, regional, and global level.	<ul> <li>To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities</li> <li>To promote more sustainable use of resources, including energy and water.</li> <li>To reduce project –related GHG emissions.</li> </ul>
<b>Performance Standard 4 - Community Health,</b> <b>Safety and Security</b> recognizes that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development.	<ul> <li>To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non routine circumstances</li> <li>To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.</li> </ul>

## **Table 3.16: IFC Performance Standards**

Performance Standards	Objectives
Performance Standard 5 - Land Acquisition and Involuntary Resettlement outlines that involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or means of livelihood) as a result of project-related land acquisition	<ul> <li>To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.</li> <li>To avoid forced eviction</li> <li>To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation and the informed participation of those affected.</li> <li>To improve, or restore, the livelihoods and standards of living of displaced persons.</li> <li>To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.</li> </ul>
Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources recognizes that protecting and conserving biodiversity—the variety of life in all its forms, including genetic, species and ecosystem diversity—and its ability to change and evolve, is fundamental to sustainable development	<ul> <li>To protect and conserve biodiversity</li> <li>To maintain the benefits from ecosystem services</li> <li>To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities</li> </ul>
Performance Standard 7 - Indigenous People recognizes that Indigenous People, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population.	<ul> <li>To ensure that the development process fosters full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of Indigenous People</li> <li>To anticipate and avoid adverse impacts of projects on communities of Indigenous People, or when avoidance is not feasible, to minimize, mitigate, or compensate for such impacts, and to provide opportunities for development benefits, in a culturally appropriate manner</li> <li>To promote sustainable development benefits and opportunities for Indigenous People in a culturally appropriate manner</li> <li>To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous People (IPs) affected by a project throughout the life of the project</li> <li>To ensure the Free, Prior and Informed Consent (FPIC) of the Affected Communities of the IPs when the circumstances described in this Performance Standard are present.</li> <li>To respect and preserve the culture, knowledge and practices of Indigenous People</li> </ul>
<b>Performance Standard 8 - Cultural Heritage</b> recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities.	<ul> <li>PS 8 aims to protect the irreplaceable cultural heritage and to guide clients on protecting cultural heritage in the course of their business operations. In addition, the requirements of this PS on a project's use of cultural heritage are based in part on standards set by the Convention on Biological Diversity. PS 8 recognizes the importance of cultural heritage with an objective to:</li> <li>Protect cultural heritage from the adverse impacts of project activities and support its preservation; and</li> </ul>

Performance Standards	Objectives
	<ul> <li>Promote the equitable sharing of benefits from the use of cultural heritage in business activities.</li> <li>The PS requires the project proponent to comply with relevant national law on the protection of cultural heritage, including national law implementing the host country's obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage and other relevant international law.</li> </ul>

Source: IFC, 2012.4

## 3.5.2 International Finance Corporation (IFC)/World Bank Environmental, Health, and Safety (EHS) Guidelines

The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent.

Due to the technical nature of the standards, the limits and levels are not included here in the regulatory review. However the standards, where applicable, will be assessed and complied with as per the technical requirements set out in the original document.

Applicable IFC General EHS Guidelines are shown in *Table 3.17* and IFC/World Bank EHS Guidelines for Thermal Plants are shown in *Table 3.20.* 

Applicable IFC EHS Guidelines
General Environmental Guidelines
1.1 Air Emissions and Ambient Air Quality
1.2 Energy Conservation
1.3 Wastewater and Ambient Water Quality
1.4 Water Conservation
1.5 Hazardous Materials Management
1.6 Waste Management
1.7 Noise
1.7 Noise

<sup>&</sup>lt;sup>4</sup> IFC. (2012). Performance Standards on Environmental and Social Sustainability. International Finance Corporation. World Bank Group. Retrieved from

https://www.ifc.org/wps/wcm/connect/115482804a0255db96fbffd1a5d13d27/PS\_English\_2012\_Full-Document.pdf?MOD=AJPERES

Applicable IFC EHS Guidelines
1.8 Contaminated Land
General Occupational Health and Safety Guidelines
2.1 General Facility and Design and Operation
2.2 Communications and Training
2.3 Physical Hazards
2.4 Chemical Hazards
2.5 Biological Hazards
2.6 Radiological Hazards
2.7 Personal Protective Equipment (PPE)
2.8 Special Hazards Environments
2.9 Monitoring
General Community Health and Safety
3.1 Water Quality and Availability
3.2 Structural Safety and Project Infrastructure
3.3 Life and Fire Safety (L&FS)
3.4 Traffic Safety
3.5 Transport of Hazardous Materials
3.6 Disease Prevention
3.7 Emergency Preparedness and Response
General Construction and Demolition Guidelines
4.1 Environment
4.2 Occupational Health and Safety
4.3 Community Health and Safety
Sectors Specific EHS Guidelines
EHS Guidelines for Thermal Power Plants

Source: IFC, 2007.5

<sup>&</sup>lt;sup>5</sup> IFC. (2007). Environmental, Health, and Safety (EHS) General Guidelines. International Finance Corporation (IFC). World Bank Group. Retrieved from https://www.ifc.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES

Where different standards are prescribed by the different agencies, the most stringent of the national and international standards will apply to the Project:

"When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment." (IFC General EHS Guidelines, page 1).

In general, the IFC's EHS Guidelines are the more comprehensive and stringent. Compliance with national standards is always required. It should be noted that the IFC's EHS Guidelines are now under revision and the first batch of revised guidelines (including the General EHS Guidelines), will tentatively be finalised in 2016.

## 3.5.3 International Finance Corporation (IFC)/Environmental, Health, and Safety Guidelines for Liquefied Natural Gas Facilities

The EHS Guidelines for Liquefied Natural Gas (LNG) Facilities include information relevant to LNG base load liquefaction plants, transport (by sea and land), storage, regasification (including floating storage regasification units), peak shaving terminals, and LNG fuelling facilities. For coastal LNG facilities-including harbors, jetties, and in general coastal facilities (e.g., coastal terminals, marine supply bases, loading/offloading terminals), additional guidance is provided in the EHS Guidelines for Ports, Harbors, and Terminals. For EHS issues related to vessels and floating storage units, additional guidance is provided in the EHS Guidelines for Ports, Harbors, and Terminals. For EHS Guidelines for Shipping. EHS issues associated with road transportation of LNG are addressed in the General EHS Guidelines. Issues related to liquefied petroleum gas/condensate production and storage in liquefaction plants are not covered in this Guideline.

The EHS guidelines for liquefied natural gas facilities are listed in Table 3.18.

## Table 3.18: IFC/World Bank EHS Guidelines for Liquefied Natural Gas Facilities

	EHS Guidelines for Liquefied Natural Gas Facilities
1	Industry-Specific Impacts and Management
1.1	Environment
•	Hazardous material management
	Wastewater discharges
	Air emissions
	Waste management
	Noise generation
	LNG transport related issues
•	LNG fueling related issues
1.2	Occupational Health and Safety (OH&S)
•	Fire and Explosion
	Roll-over
•	Contact with cold surfaces
•	Chemical hazards
•	Confined spaces
1.3	Community Health and Safety
	Security
2	Performance Indicators and Monitoring
2.1	Environment
	Emission and Effluent Guidelines
	Resource Use and Energy Consumption
	Environmental Monitoring
2.2	Occupational Health and Safety (OH&S)
	OH&S Guidelines
	Accident and Fatality Rates
	OH&S Monitoring

Source: Environmental, Health and Safety Guidelines for Liquefied Natural Gas Facilities.<sup>6</sup>

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<sup>&</sup>lt;sup>6</sup> IFC. (2017). Environmental, Health, and Safety Guidelines for Liquefied Natural Gas Facilities. International Finance Corporation (IFC). World Bank Group. Retrieved from https://www.ifc.org/wps/wcm/connect/edb102c5-ca61-4561-8b8e-8124fa2060af/20170406-FINAL+LNG+EHS+Guideline\_April+2017.pdf?MOD=AJPERES

## 3.5.4 International Finance Corporation (IFC)/Environmental, Health, and Safety Guidelines for Ports, Harbours, and Terminals

The EHS Guidelines for Ports, Harbors, and Terminals are applicable to marine and freshwater ports, harbors, and terminals for cargo and passengers. Shipping (including repair and maintenance of ships), fuel terminals, and railways are addressed in the EHS Guidelines for Shipping; Crude Oil and Petroleum Product Terminals; and Railways, respectively. Annex A provides a summary of industry sector activities.

The EHS guidelines for liquefied natural gas facilities are listed in Table 3.19.

## Table 3.19: IFC/World Bank EHS Guidelines for Ports, Harbours, and Terminals

	EHS Guidelines for Ports, Harbours, and Terminals		
1	Industry-Specific Impacts and Management		
1.1	Environment		
	Terrestrial and aquatic habitat alteration and biodiversity		
	Climate change resilience		
	Water quality		
	Air emissions		
	Waste management		
	Hazardous materials and oil management		
	Noise and vibration (including underwater)		
1.2	Occupational Health and Safety (OH&S)		
	Physical hazards		
	Chemical hazards		
	Confined spaces		
	Exposure to organic and inorganic dust		
	Exposure to noise		
1.3	Community Health and Safety		
	Port marine safety		
	Port security		
•	Visual impacts		
2	Performance Indicators and Monitoring		
2.1	Environment		
	Emission and Effluent Guidelines		
	Environmental Monitoring		
2.2	Occupational Health and Safety (OH&S)		
	OH&S Guidelines		
	Accident and Fatality Rates		
	OH&S Monitoring		

Source: Environmental, Health and Safety Guidelines for Ports, Harbours, and Terminals.<sup>7</sup>

With regards to industry activities that apply to this guideline, the guideline states that "A harbor is a stretch of water where vessels can anchor or secure to buoys or alongside wharves to obtain protection

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<sup>&</sup>lt;sup>7</sup> IFC. (2017). Environmental, Health, and Safety Guidelines for Ports, Harbours, and Terminals. International Finance Corporation (IFC). World Bank Group. Retrieved from https://www.ifc.org/wps/wcm/connect/d2f2cf88-ce22-4a48-86fc-45ee3b8e9e45/20170201-FINAL\_EHS+Guidelines+for+Ports+Harbors+and+Terminals.pdf?MOD=AJPERES

(by natural or artificial features) from storms and rough water. A port is a commercial harbor or commercial part of a harbor with terminals, quays, wharves, enclosed docks, and facilities for transferring cargo from shore-to-vessel or vessel-to-shore. This includes onshore facilities and structures for receiving, handling, storing, consolidating, and loading or delivering waterborne shipments or passengers. Ports may include terminals, which generally serve a specific function, such as for containers, bulk shipments of cement, iron ore, grain, etc., and these terminals maybe be operated by a third party. Ports also may provide ship support facilities and services, including waste management and effluent discharge facilities, maintenance of vehicles and equipment, painting and other vessel maintenance."

## 3.5.5 Projects Located in Degraded Airsheds

To determine whether the airshed of the Project Location is degraded or not, appropriate air monitoring will be required. The result will then be compared against relevant and available standards. However, Myanmar NEQ (2015) does not provide any description or guidelines for a Non-Degraded Airsheds and therefore this Project will adopt IFC General EHS Guideline instead. The IFC's General EHS Guidelines state that 'Facilities or projects located within poor quality airsheds should ensure that any increase in pollution levels is as small as feasible, and amounts to a fraction of the applicable short-term and annual average air quality guidelines or standards as established in the project-specific environmental assessment. Suitable mitigation measures may also include the relocation of significant sources of emissions outside the airshed in question, use of cleaner fuels or technologies, application of comprehensive pollution control measures, offset activities at installations controlled by the project sponsor or other facilities within the same airshed, and buy-down of emissions within the same airshed. Specific provisions for minimizing emissions and their impacts in poor air quality airsheds should be established on a project-by-project or industry-specific basis. Offset provisions outside the immediate control of the project sponsor or buy-downs should be monitored and enforced by the local agency responsible for granting and monitoring emission permits. Such provisions should be in place prior to final commissioning of the facility / project.' (IFC General EHS Guidelines, page 5).

	EHS Guidelines for Thermal Power Plants
1.0	Industry-Specific Impacts and Management
1.1	Environment
	Air emissions
•	Effluents
	Solid wastes
•	Hazardous Materials and Oil
	Noise
1.2	Occupational Health and Safety (OH&S)
	Non-ionizing radiation
	Heat
•	Noise
•	Confined Spaces
•	Electrical Hazards
•	Fire and Explosion Hazards

#### Table 3.20: IFC/World Bank EHS Guidelines for Thermal Power Plants

•	Chemical Hazards
•	Dust
1.3	Community Health and Safety
•	Water consumption
•	Traffic Safety
2.0	Performance Indicators and Monitoring
2.1	Environment
•	Emission and Effluent Guidelines
•	Environmental Monitoring
2.2	Occupational Health and Safety (OH&S)
	OH&S Guidelines
•	Accident and Fatality Rates

**OH&S** Monitoring

Source: Environmental, Health and Safety Guidelines for Thermal Power Plants.<sup>8</sup>

## 3.5.6 Australian and New Zealand Interim Sediment Quality Guidelines

Considering there are no national sediment quality guidelines in Myanmar, sediment quality will be compared against the Australian and New Zealand interim sediment quality guidelines<sup>9</sup> (hereafter referred to as "the ISQG"). As stated in the guidelines, "Sediments are important, both as a source and as a sink of dissolved contaminants, as has been recognised for some time. As well as influencing surface water quality, sediments represent a source of bioavailable contaminants to benthic biota and hence potentially to the aquatic food chain. Therefore it is desirable to define situations in which contaminants associated with sediments represent a likely threat to ecosystem health. While costly remediation or restoration might not represent a management option, sediment guidelines can usefully serve to identify uncontaminated sites that are worthy of protection. Sediment quality guidelines are being actively considered by regulatory agencies worldwide."

The Sediment Quality Guidelines will serve three purposes:

- To identify sediments where contaminant concentrations are likely to result in adverse effects on sediment ecological health;
- To facilitate decisions about the potential remobilisation of contaminants into the water column and/or into aquatic food chains; and
- To identify and enable protection of uncontaminated sediments.

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<sup>&</sup>lt;sup>8</sup> IFC. (2008). Environmental, Health, and Safety Guidelines for Thermal Power Plants. International Finance Corporation (IFC). World Bank Group. Retrieved from

https://www.ifc.org/wps/wcm/connect/dfb6a60048855a21852cd76a6515bb18/FINAL\_Thermal%2BPower.pdf?MOD=AJPERES &id=1323162579734

<sup>&</sup>lt;sup>9</sup> ANZECC, & ARMCANZ. (2000). Sediment Quality Guidelines. National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Retrieved from http://www.waterquality.gov.au/anz-guidelines/Documents/ANZECC-ARMCANZ-2000-guidelines-vol1.pdf

The recommended guideline values for metals, metalloids, organometallic and organic sediment contaminants are shown in *Table 3.21*. For the purposes of analysing sediment quality from baseline sampling, the results will be compared to the ISQG-Low (Trigger value); values that exceed ISQG-High values can be discussed further.

Contaminant	ISQG-Low (Trigger value)	ISQG-High
Metals (mg/kg dry weight)		
Antimony	2	25
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Mercury	0.15	1
Nickel	21	52
Silver	1	3.7
Zinc	200	410
Metalloids (mg/kg dry weight)		
Arsenic	20	70
Organometallics		
Tributyltin (µg Sn/kg dry weight)	5	70
Organics (µg/kg dry weight) <sup>b</sup>		
Acenaphthene	16	500
Acenaphthalene	44	640
Anthracene	85	1,100
Flourene	19	540
Naphthalene	160	2,100
Phenanthrene	240	1,500
Low Molecular Weight PAHs <sup>c</sup>	552	3,160
Benzo(a)anthracene	261	1,600
Benzo(a)pyrene	430	1,600
Dibenzo(a,h)anthracene	63	260
Chrysene	384	2,800
Fluoranthene	600	5,100
Pyrene	665	2,600
High Molecular Weight PAHs <sup>c</sup>	1,700	9,600
Total PAHs	4,000	45,000
Total DDT	1.6	46
p.p'-DDE	2.2	27
o,p'- + p,p'-DDD	2	20
Chlordane	0.5	6

## Table 3.21: Recommended Sediment Quality Guidelines<sup>a</sup>

Contaminant	ISQG-Low (Trigger value)	ISQG-High
Dieldrin	0.02	8
Endrin	0.02	8
Lindane	0.32	1
Total PCBs	23	-

Note: a - Primarily adapted from Long et al. (1995);

b - Normalised to 1% organic carbon;

## 3.6 International Conventions

Myanmar has ratified several international conventions. Highlights of key conventions are provided below.

## 3.6.1 The Kyoto Protocol on Climate Change (UNFCC)

Myanmar achieved full accession to the UNFCC in 2003. This obligates Myanmar to assure that future development in the country meets the conditions of the Convention. Relevant to this Project are the requirements associated with the potential generation of greenhouse gas from the operation of the coal-fired power plant; further conditions of relevance include:

- Enhancement of energy efficiency in relevant sectors;
- Protection and enhancement of sinks and reservoirs of greenhouse gases;
- Promotion of sustainable forest management practices, afforestation and reforestation;
- Promotion of sustainable forms of agriculture;
- Implementation of measures to limit and/ or reduce emissions of greenhouse gases; and
- Limitation and/ or reduction in methane emissions.

## 3.6.2 The United Nations Convention on Biodiversity 1992

This Convention seeks to conserve biodiversity and promote its sustainable use. It requires the identification and monitoring of the biodiversity in an area and adopting the necessary conservation measure. Myanmar became party to this Convention in 1994.

## 3.6.3 The Basel Convention 1989

This was developed under the auspices of the United Nations Environmental Programme (UNEP) in response to the growing worldwide awareness of the problem of international traffic in hazardous waste. The Basel Convention 1989 is the first and foremost global environmental treaty that strictly regulates the trans-boundary movement of hazardous wastes. It obligates parties to ensure environmentally sound management, especially during the disposal process.

The objectives of the Convention are to:

- Ensure that waste is disposed of as near as possible to the place or source of its generation;
- Reduce trans-boundary waste and where it cannot be avoided, to be disposed of in an environmentally sound and efficient manner; and
- Provide assistance to developing countries in the management of hazardous waste and the generation.

c - Low molecular weight PAHs are the sum of concentrations of acenaphthene, acenaphthalene, anthracene, fluorene, 2-methylnaphthalene, naphthalene and phenanthrene; high molecular weight PAHs are the sum of concentrations of benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene and pyrene.

The Convention places a ban on the export of hazardous waste from Organization for Economic Cooperation and Development (OECD) countries to non-OECD countries.

## 3.6.4 International Labour Organisation (ILO)

Myanmar ratified several ILO Fundamental and Technical conventions relevant to the Project. This includes:

- C1 Hours of Work (Industry), relative to the maximum working hours for the industrial sector (private and public) and the exceptions that can be applied to the maximum of 8 hours per day and 48 hours per week stated in this convention and under what conditions.
- C14 Weekly Rest (Industry), relative to the minimum of 24 consecutive hours of rest every period of seven days and the exceptions that can be applied and under what conditions.
- C17 Workmen's Compensation (Accidents), relative to compensation to be provided to workmen who suffer personal injury due to an industrial accident, or their dependents.
- C19 Equality of Treatment (Accident Compensation), relative to the equality of treatment for compensation between citizen of every country that has ratified this Convention.
- C26 Minimum Wage Fixing Machinery, relative to the creation or maintenance of machinery whereby minimum rates of wages can be fixed for workers employed in certain of the trades or parts of trades in which no arrangements exist for the effective regulation of wages by collective agreement or otherwise and wages are exceptionally low.
- C29 Forced Labour Convention, relative to the suppression in the shortest possible delay of every kind of forced or compulsory labour.
- C42 Workmen's Compensation (Occupational Diseases) Revised 1934, relatives to the payment
  of compensation to workmen, or their relatives in case of death, incapacitated by occupational
  diseases. The convention also includes a list of diseases and toxic substances and corresponding
  trades.
- C52 Holidays with Pay, relative to the minimum of 6 working days of paid holiday due to employee having work a minimum of one year of continuous service. The convention includes a list of exceptions that can be applied and under what conditions.
- C87 Freedom of Association and Protection of the Right to Organize, relative to the right of workers and employees to establish and join organisations of their own choosing without previous authorisation and the rights of these organisations.

A list of Project-relevant international treaties of which Myanmar is a signatory are provided in **Table 3.22**.

Na	Convertions	Year
NO.	Conventions	(Ratified/Acceded/Accepted)
Environn	nent	
1	Plant Protection Agreement for the Southeast Asia and Pacific Region, Rome 1956	1959 (Ratified)
2	MARPOL: International Convention for the Prevention of Pollution from Ships 1973 and MARPOL Protocol of 1978	1988 (Accession)
3	ICAO: ANNEX 16 to the Convention on International Civil Aviation Environmental Protection Vol. I and II, Aircraft Noise and Aircraft Engine Emission	Accession
4	Agreement on the Networks of Aquaculture Centres in Asia and the Pacific, Bangkok 1988	1990 (Accession)
5	Vienna Convention for the Protection of the Ozone Layer, Vienna 1985	1993 (Ratification)
6	Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal 1987	1993 (Ratification)
7	London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London 1990	1993 (Ratification)
8	United Nations Framework Convention on Climate Change (UNFCCC), New York 1992	1994 (Ratification)
9	Convention on Biological Diversity, Rio de Janeiro 1992	1994 (Ratification)
10	The Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris 1972	1994 (Acceptance)
11	International Tropical Timber Agreement (ITTA), Geneva 1994	1996 (Ratification)
12	United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought, Paris 1994	1997 (Accession)
13	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington DC 1973; and as amended in Bonn, Germany 1979	1997 (Accession)
14	ASEAN Agreement on Conservation of Nature and Nature Resources, Kuala Lumpur, 1985	1997 (Signatory)
15	Kyoto Protocol to the Convention on Climate Change, Kyoto 1997	2003 (Accession)
16	ASEAN Agreement on Trans-boundary Haze Pollution	2003 (Ratification)
17	Stockholm Convention on Persistent Organic Pollutants (POPs), 2001	2004 (Accession)
18	Ramsar Convention on Wetlands of International Importance	2005 (Accession)
19	Establishment of ASEAN Regional Centre for Biodiversity	2005 (Signatory)
20	Declaration on ASEAN Heritage Parks	2003 (Signatory)
21	International Treaty on Plant Genetic Resources for Food and Agriculture, 2001	2004 (Ratification)
22	Catagena Protocol on Biosafety, Cartagena, 2000	2001 (Signatory)

## Table 3.22: International Conventions Ratified by Myanmar
No.	Conventions	Year (Ratified/Acceded/Accepted)
23	Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, Rome, 1973	1994 (Acceptance)
24	United Nations Convention on the Law of the Sea, Montego Bay, 1982	1996 (Ratified)
25	Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, New York, 1994	1996 (Accession)
26	Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and their Destruction, Paris, 1993	1993 (Signatory)
27	Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea Bed and Ocean Floor and in the Subsoil there of, London, Moscow, Washington, 1971	1971 (Signatory)
Social, L	abour and Health	

28	Universal Declaration of Human Rights (UNDHR)	signed
29	Convention on the Rights of the Child	1991 (acceded)
30	Convention on Elimination of All Forms of Discrimination against Women (CEDAW)	1997 (acceded)
31	<ul> <li>Relevant ILO Conventions in force in Myanmar:</li> <li>C1 Hours of Work (Industry)</li> <li>C14 Weekly Rest (Industry)</li> <li>C17 Workmen's Compensation (Accidents)</li> <li>C19 Equality of Treatment (Accident Compensation)</li> <li>C26 Minimum Wage Fixing Machinery</li> <li>C29 Forced Labour Convention</li> <li>C42 Workmen's Compensation (Occupational Diseases) Revised 1934</li> <li>C52 Holidays with Pay</li> <li>C87 Freedom of Association and Protection of the Right to Organize</li> </ul>	Ratified: 1921 1923 1956 1927 1954 1955 1957 1954 1955

### 4. **PROJECT DESCRIPTION AND ALTERNATIVES**

### 4.1 Introduction

This Chapter presents an overview of the Project description as relevant for the understanding and implications of potential impacts on the environmental and socioeconomic components. The information provided by TPMC is the main source of information at this stage of the ESIA report.

### 4.2 **Project Background**

TTCL Power Myanmar Company Limited (TPMC) as 'the Project Proponent' is planning to develop a Power Plant in Yangon, Myanmar. A 388 MW Combined Cycle Power Plant ('CCPP' and/or 'LNG Ahlone CCPP) will be developed to supply the power to the Republic of the Union of Myanmar.

The Project Proponent is planning to use the Liquefied Natural Gas (LNG) as fuel supply for the proposed CCPP. The LNG supply will be imported from oversea LNG sources (LNG sources will be determined at a later stage). The LNG Receiving Terminal (including Jetty, LNG Storage Tank(s) and Regasification Unit) will be installed on the Yangon River bank in order to convert the LNG to Natural Gas (NG) and provide NG as fuel supply to Ahlone CCPP through a Natural Gas Pipeline ('the Project').

It shall be noted that the Project Proponent has prepared and submitted the Project Proposal Report (PPR) to MOEE and MONREC on 14<sup>th</sup> December 2017. The PPR recommended that TPMC shall proceed with an Environmental and Social Impact Assessment (ESIA) Study (also referred to as "Environmental Impact Assessment (EIA) Study") of the Project and prepare an Environmental Management Plan (EMP) to put forward its commitments for environmental and social mitigation and management measures. Furthermore, the Scoping Study has also been prepared and submitted to MOEE and MONREC on 9<sup>th</sup> January 2019.

In addition, as per the Environmental Impact Assessment (EIA) Procedure, promulgated on 29<sup>th</sup> December 2015, it is understood that proposed Project requires the Scoping Study and the ESIA Study to be conducted and submitted to the Ministry of Natural Resources and Environmental Conservation (MONREC) in order to obtain an Environmental Compliance Certificate (ECC).

The Project consist of three main components as follows:

- the LNG Receiving Terminal including Jetty, LNG Storage Tank(s) and Regasification Unit;
- the Natural Gas Pipeline with an approximate length of 24.9km connecting the Regasification Unit to the LNG Power Plant (Ahlone) to transfer the NG as fuel supply for the proposed 388 MW CCPP; and
- the LNG Ahlone Power Plant (388MW CCPP), which consists of 2 x 128.5MW Gas Turbines and 1 x 131 MW Steam Turbine (2 on 1 Configuration).

The electricity generated by the Project will be sold to MOEE via Myanmar National Grid using the existing Ahlone Power Plant sub-station.

It should be noted that the proposed overhead transmission line from the Project Site connecting to the Hlaingthayar Sub-Station is outside the scope of this ESIA Study. A separate IEE study will be prepared for the proposed transmission line.

The technology of the Project is an efficient form of combined cycle power generation, which was designed for high reliability and efficiency operation with lower environmental impact. The Project will operate on natural gas as its only fuel.

The electrical capacity and electricity generated will be sold under a 25 year PPA, as agreed with Electric Power Generation Enterprise (EPGE). The organizational structure for the Project Proponent, is shown in *Figure 4.1*.





Source: TPMC, 2018.

Note that the Pipeline team will be shared with the LNG Receiving Terminal team during both construction and operation and therefore will use the same Organisation Chart.

### 4.3 **Project Facilities**

The Project components are presented below and include Project Facilities and Associated Facilities. A total are of approximately 23.97 acres of land is allocated for the Project Facilities. The LNG Receiving Terminal will be located on the West bank of the Yangon River in the Dala Township, Yangon Region, Myanmar, as shown in *Figure 4.4*. A total of 15 acres of land is allocated for the proposed LNG Receiving Terminal. The site layout of the LNG Receiving Terminal is shown in *Figure 4.9*.

### 4.3.1 Project Main Facilities

The Project will consist of three (3) main components, namely LNG Receiving Terminal, the Natural Gas Pipeline and the CCPP. The high level information of the main facilities are provided below.

The **LNG Receiving Terminal** consists of the following main components:

- LNG Unloading Jetty including LNG Unloading Arms;
- LNG Cryogenic Pipeline;
- LNG Storage Tanks; and
- Regasification Unit.

The **<u>Natural Gas Pipeline</u>** connecting the LNG Receiving Terminal to the Ahlone CCPP with approximately 24.9 km in length and two (2) Block Valves (one at each extremity)

The **<u>Combined Cycle Power Plant</u>** (CCPP) consists of the following main components:

- Main power plant area with two (2) units of Gas Turbine (128.5 MW each) and one (1) unit of Steam Turbine (131 MW);
- Two (2) units of Heat Recovery Steam Generation;
- Raw Water Treatment Facility;
- River Water Intake Pumping Station; and
- Seven (7) Cooling Towers.

### 4.3.2 Associated Facilities

### 4.3.2.1 Transmission Line

The electricity generated by the proposed Power Plant will be transferred to a sub-station in Hlaingthayar via a 230 kV transmission line which will mainly run in parallel with the existing 230 kV transmission line transferring power for the existing Ahlone CCPP. However, the mid-section of the proposed transmission line will deviate away from the existing transmission line and will follow a proposed road of the New Yangon City Project (located at the east of Twantay Township), driven by the New Yangon Development Company Ltd. (NYDC). The length of the proposed transmission line is approximately 28 km as shown in *Figure 4.2*. Given the Myanmar EIA Procedures (2015), a 230 kV transmission line will require an Initial Environmental Examination (IEE) Study.

It should be noted that the IEE Study for the 230 kV transmission line connecting the proposed Power Plant to the Hlaingthayar sub-station will be prepared as a separate document, and will not be included in this ESIA report.





Source: TPMC, 2018. (Modified by ERM)

For the purposes of this ESIA Study, the remaining of the sub-section within this Chapter is organised as follows:

- Section 4.4: Overall Project Location;
- Section 4.5: Project Life Cycle Overview;
- Section 4.6: LNG Terminal and Associated Facilities;
- Section 4.7: Natural Gas (NG) Pipeline;
- Section 4.8: Power Plant; and
- Section 4.9: Overall Project Alternatives.

### 4.4 Overall Project Location

The overall Project is located across three (3) townships, which include Ahlone, Seikgykanaungto, and Dala; the overall location of the Project is shown in *Figure 4.3*. The LNG Receiving Terminal is located southeast of Dala Township, on the West bank of Yangon River; the location of the LNG Receiving Terminal is shown in *Figure 4.4*. The NG Pipeline, connecting the LNG Receiving Terminal to the proposed Power Plant, stretches across all three township; the pipeline location is shown in *Figure 4.3*. The Power Plant is located on the North bank of the Yangon River, next to the Myanmar Industrial Port in the south of Ahlone Township; the Power Plant location is shown in *Figure 4.5*.



Figure 4.3: Overall Project Location

Source: TPMC, 2019. (Modified by ERM).



### Figure 4.4: LNG Receiving Terminal Location

Source: TPMC, 2019. (Modified by ERM)



### **Figure 4.5: Power Plant Location**

Source: TPMC, 2019. (Modified by ERM)

### 4.5 Project Life Cycle Overview

Project life cycle analysis identifies the key issues and concerns that are likely to evolve over the entire lifespan of a project.

In the case of the proposed Project, these issues may arise during the construction, operation and maintenance, and decommissioning. These issues have been considered in this ESIA, prior to any irreversible actions being undertaken by the Project Proponent, Contractors and other Project associates. The structure of this Chapter will place the Project's three (3) main components into their individual sections; each component section will be further categorized on four (4) sub-sections, which include, Key Components, Construction, Operation, and Decommissioning. The following sub-sections identify the key activities to be completed and facilities to be constructed and operated over the lifetime of the Project.

### 4.5.1 Overall Project Schedule

Based on the information from the feasibility study report, the Schedule Commercial Operation Date is planned for end 2021 (see *Table 4.1*).

The necessary implementation had been scheduled and summarised below:

- Notice to Proceed signed by the Myanmar Government on 30<sup>th</sup> January 2018;
- Submission of PPR and Scoping Report on 14<sup>th</sup> December 2017 and 9<sup>th</sup> January, 2019 respectively;
- The EIA Study is anticipated to be submitted to the relevant authorities in August 2019;
- The Engineering & Procurement Contractor (EPC) Execution Phase is anticipated to commence from May 2019 on the detailed design and procurement process only. The initial activities will include pre-engineering/ detailed design, verification of geo-mechanical information. The EPC activities are expected to be completed by June 2021; and
- Commercial operation date of LNG Power Plant (Ahlone) Project assumed to be from June 2021.

The preliminary Project master schedule is shown in Appendix F.

Project Schedule	Tentative Date
Completion of Feasibility Study	Dec 2017
Site Preparation	Apr-Jun 2018
Stakeholder Engagement 1	Dec 2018
Scoping	Jan 2019
Stakeholder Engagement 2	June 2019
Final EIA submission to MONREC	Aug 2019
Detail Engineering	Jun 2019- Sep 2020
Procurement	Nov 19- May 20
LNG Terminal Construction	Jan 2020-Aug 2021
Pipeline Construction	Mar 2020-Aug 2021
Power Plant Construction	Jan 2020-Nov 2021
LNG Terminal COD (Initial Acceptance)	Nov 2021
Pipeline COD (Initial Acceptance)	Nov 2021
Power Plant Commissioning	Dec 21-Apr-22
Power Plant COD	Apr 2022

## Table 4.1: Tentative Project Schedule

Source: TPMC, 2019.

It is noted the above Project Schedule is tentative and subject to be changed and updated

### 4.6 LNG Receiving Terminal and Associated Facilities

### 4.6.1 Key Components

The LNG Receiving Terminal is a facility that is responsible for unloading LNG from the LNG Carrier (LNGC), providing LNG storage, and regasification process to convert LNG to NG. The indicative layout for the LNG Receiving Terminal is shown in *Figure 4.9*. The LNG Receiving Terminal components are listed in *Table 4.2*.

Component	Details
Number of LNG Carrier per month (frequency)	2-4 LNGCs per month
LNG Carrier Capacity	16,000 ton (approx.)
LNG Carrier Type	Moss, Membrane
LNG Consumption (per day)	1,300 ton (approx.) @ 100% Load
LNG Unloading Jetty	Centre Platform with walkway, mooring dolphin and Trestle, 100 metres from river shore line Concrete Structure
LNG Unloading Arms	Two (2) liquid Unloading Arms and One(1) vapour return loading arm at the Unloading Jetty
LNG Cryogenic Pipeline	<ul> <li>Stainless steel pipe with cold insulation;</li> <li>291 metres (approx.); from unloading arm to a LNG storage tank;</li> <li>160 metres (approx.); from LNG storage tank to the BOG recondenser;</li> <li>86 metres (approx.); from BOG recondenser to regasification unit.</li> </ul>
LNG Storage Tanks (onshore)	Two (2) Full containment tanks with 25,000 m <sup>3</sup> capacity each (working volume)
Regasification Unit (RU)	Appx. 63 million standard cubic feet per day (MMSCFD), Heating source by river water Intermediate fluid vaporizers (IFV)
Vent Stack	One (1) HP Vent Stack One (1) Cold Vent Stack
Cold Water Discharge Arrangement	336 mm pipe diameter Pipe resting on the channel bottom Flow rate 1,300 m <sup>3</sup> /h
Gas Engine Generator	Four (4) natural Gas Engine Generators (GEG) Three (3) GEG continuous operation, one (1) GEG on standby 1160 kW Continuous capacity each
Area of land where the LNG Storage Tanks and RU are to be set up and operated	15.0 acres (approx.)
General Arrangement	<ul> <li>Electrical room;</li> <li>Control room building;</li> <li>Main gate guard house; and</li> <li>Jetty guard house.</li> </ul>

Source: TPMC, 2019









Figure 4.7: Pipeline Route from LNG Storage Tanks to BOG Recondenser





Figure 4.8: Pipeline Route from BOG Recondenser to Regasification Units

### 4.6.1.1 LNG Receiving Terminal

This section will describe the main components of the LNG Receiving Terminal, the layout of the LNG Receiving Terminal is shown in *Figure 4.9*. The Process Flow Diagram (PFD) for the LNG Receiving Terminal is shown in *Figure 4.10*.



## Figure 4.9: Layout of LNG Receiving Terminal

### PROJECT DESCRIPTION AND ALTERNATIVES



Figure 4.10: Process Flow Diagram of LNG Receiving Terminal

Source TPMC, 2019.

(LNG RECEIVING TERMINAL)



### 4.6.1.2 LNG Unloading Jetty

The unloading jetty is a single berthing type with two (2) breasting dolphins, and four (4) mooring dolphins. The size of the jetty is approximately 20 m long, and 15 m wide. The Jetty structure will consist of a concrete slab, with topside equipment. The LNG Carrier (LNGC) docking method is expected to use a minimum of two (2) standard tugboats for push and pull operations. The rubber fenders will be used to prevent the LNGC from making direct hull contact with the Jetty. An example of the Unloading Jetty is shown in *Figure 4.12*.

The Unloading Jetty is comprised of the following equipment, required for safe LNG unloading:

- Two (2) LNG unloading arms;
- One (1) vapour return-loading arm;
- Unloading/Loading arm power packs and controls;
- LNG and vapour transfer piping and manifolds;
- Gas detection, fire monitor towers, and firefighting facilities;
- Foam Tank;
- Life-saving equipment;
- Telecommunications equipment;
- Access Gangway; and
- Small Crane.

The unloading and vapour return arms will have a diameter of 10 inches, and will utilize a Double Counter weighted Marine Arm (DCMA). The arm structure will be attached to the jetty, near the edge where the berthing point for the LNGC is located.

The pile specifications are as follows:

- Material: Steel Jacket, Concrete pile;
- Diameter 0.8 1.0 m; and
- Length: 38 m (total), 25 m beneath sediment.

The Unloading Jetty is expected to require approximately 70 - 80 piles. The different types of pile composites are shown in *Figure 4.11*.



Figure 4.11: Types of Pile Composites

Source: TPMC, 2018.

Examples of an Unloading Jetty is shown in *Figure 4.12*. An example of an LNG Unloading arm is shown in *Figure 4.13*. The technical drawing of the Unloading Jetty is shown in *Figure 4.14*, *Figure 4.15*, and *Figure 4.16*.



Figure 4.12: Unloading Jetty Examples

Source: Avigator Thailand / Shutterstock.com; Retrieved January 16<sup>th</sup>, 2019.



Source: Chris Gaborit / Shutterstock.com; Retrieved September 21st, 2018.



Figure 4.13: LNG Unloading Arm Examples

Source: Oleksandr Kalinichenko / Shutterstock.com; Retrieved January 16<sup>th</sup>, 2019.



Source: Rob Bouwman / Shutterstock.com; Retrieved January 16th, 2019.



Figure 4.14: Technical Drawing of Unloading Jetty (Top view)



Figure 4.15: Technical Drawing of Unloading Jetty (Section view)



Figure 4.16: Technical Drawing of Unloading Jetty (Side view)

### LNG Storage Tank

The LNG Receiving Terminal will contain two (2) Full-containment LNG storage tanks, each with a working volume of 25,000 m<sup>3</sup>. Each tank can hold enough LNG to serve the Power Plant for 12-17 days. Both storage tanks will store LNG at a temperature of -160 °C, at atmospheric pressure. Each storage tank consists of the following layers:

- Layer 1: Stainless steel primary barrier constructed of chromium nickel stainless steel; the primary barrier would be corrugated to allow for expansion and contraction associated with heat changes;
- Layer 2: A secondary barrier comprised of laminated glass cloth and aluminium foil; as well as chromium nickel stainless steel barrier filled with perlite insulation, designed to contain LNG in case of leakage through the primary barrier.

Each storage tank is equipped with two (2) LNG transfer pumps to transfer LNG from the storage tank to the LNG re-condenser, before proceeding to the regasification unit. Both storage tanks are connected to a High Pressure Vent Stack and a Cold Vent Stack. This system is used instead of a flare system for emergency case only. The LNG storage tank materials, testing procedures, and component manufacturers will be in accordance with the API 620 Annex Q and API 625. The technical drawing for the LNG Storage Tank is shown in *Figure 4.17*.



Figure 4.17: Technical Drawing of LNG Storage Tank

LNG FULL CONTAINMENT TANK ID42m, 21.90mH WORKING VOLUME 25,000m3

# TUAL ELEVATION VIEW OF LNG TANK P

THE CONCEPTUAL ARE SUBJECT TO BE CHANGED DURING DESIGN NEXT STAGE

Source: TPMC, 2019.

PROJECT DESCRIPTION AND ALTERNATIVES

### Regasification Unit (RU)

The regasification unit is responsible for vaporizing the LNG in order to provide natural gas for the proposed Power Plant as fuel.

The regasification unit consists of two (2) Intermediate fluid vaporizers (IFV) units, each with 63 million standard cubic feet per day (MMSCFD), and utilizes river water from the Yangon River to warm up the LNG, in order to transform it to a gaseous state. Three (3) water pumps located on the LNG Unloading Jetty will pump river water to the regasification units. An example of an IFV is shown in *Figure 4.18*.

River water that is used for the regasification process may have small particulates or debris that may potentially damage the internal components of the regasification units. To prevent damage of this nature, a debris filter is connected to the system, and will filter out debris from the river water before feeding through the RU. Consumption of river water will be 1,300 m<sup>3</sup> per hour for the regasification process.

Once the LNG has undergone regasification, the natural gas will be sent through the Pipeline connecting the LNG Receiving Terminal to the Power Plant. Cold water will be release into the Yangon River. The water will be released 10 degrees Celsius below the Yangon River water average temperature at a flow rate of 1,300 m<sup>3</sup> per hour.

The specifications for the regasification unit are shown in Table 4.3.

### Table 4.3: Specifications for Regasification Unit

Features	Specifications	
Туре	Intermediate Fluid Vaporizer (IFV)	
Design Capacity	56.9 T/hr	



Figure 4.18: Example Intermediate Fluid Vaporizer (IFV) for RU

Example of IFV



**Diagram of IFV (Example)** 

Source: Kobelco, 2019.10

<sup>&</sup>lt;sup>10</sup> Kobelco (2019) IFV (Intermediate Fluid Vaporizer). Kobe Steel Limited.

### Gas Engine Generator (GEG)

The LNG Receiving terminal is expected to have four (4) GEGs to produce electricity for in-house operations. The specification for the GEG is listed in *Table 4.4*.

Features	Specifications
Fuel system	Natural gas single fuel
Capacity	1160 kW Continuous
Gross Engine Power Output, kWm (hp)	1196 (1603)
Displacement, L (cu.in)	60.3 (3683)
Configuration	V16
Aspiration	Turbocharged
Starting Means	Electric Starter, 24 volts
Air filtration	Static type
BMEP (Brake Mean Effective Pressure, bar (psi)	16.1 (233)
Exhaust System	Vertical Stack
Emissions Control	Gas – Dry Low Emission (3rd Generation)
Fire Detection	Smoke Detectors
Gas Leak Detection	Gas detectors
Fire Protection	Fire extinguishing CO2
On-Base Acoustic Enclosure	Lube oil and Gas module Compartments

### Table 4.4: Specifications for Gas Engine Generator



Figure 4.19: Example of Natural Gas Engine Generator

Source: MTU Onsite Energy Corp.



Source: Cummins Power Generation Limited.

### BOG Recondenser

Boil-off gas (BOG) is LNG that evaporates into vapour due heat leakage from the outer environment into the system, during storage and transportation of LNG. BOG, if left alone, will cause increase in pressure, which can lead to potential damage to internal systems. A BOG Recondenser is a machine that recondenses BOG back into LNG and recirculates it back into the LNG system. The specifications of the BOG recondenser is shown in **Table 4.5**. An example and size comparison of an In-Line BOG Recondenser compared to other conventional types is shown in **Figure 4.20**.

### Table 4.5: Specifications for BOG Recondenser

Features	Specifications
Model/Type	Static Mixer
Material	Stainless Steel
Capacity	Maximum flow rate of BOG 3,600 Kg/hr
Noise	N/A

### Figure 4.20: Example and Size Comparison of an In-Line BOG Recondenser



An In-Line BOG Recondenser designed by JFE Engineering Corp.



Size Comparison between Conventional and New In-Line BOG Recondenser Source: JFE, 2017.

### 4.6.1.3 LNG Carrier (LNGC)

The LNGC is a LNG transport vessel and consists of a LNG containment system that is comprised of a series of layers, which also depend on the specifications of the LNGC. On-board the LNGC are also equipped with necessary equipment for storing LNG, such as the cargo monitoring, and control and safety systems.

There are three (3) common types of LNGC designs that are currently being used, which include Moss Tank, Membrane Tank and Type C Tank. A Moss Tank uses a spherical tank design that is comprised of an unstiffened, spherical, aluminium alloy tank. A Membrane Tank utilizes the ship's outer hull as the outer tank wall, the inner membrane tank and the outer tank wall is separated by insulation. A Type C Tank are normally spherical or cylindrical pressure vessels having design pressures higher than 2 barg. It is expected that a type C tank LNGC with a capacity of 35,000 m<sup>3</sup> will be used to import LNG to the LNG Receiving Terminal. The LNGC is equipped with four (4) cargo tanks, and two (2) pumps, each with a capacity of 850 m<sup>3</sup>/h.

Currently LNGC with capacity range of 18,000 -45000 m<sup>3</sup> being considered for this Project

Each LNGC shall have the following maximum dimension and capacities:

- 1. Operating draft (arrival): up to nine (9) metres;
- 2. Beam: up to 40 metres;
- 3. Length overall: up to two hundred (200) metres;
- 4. **DWT**: twenty thousand (20,000)

The types of vessels and their specifications are listed in Table 4.6.

Regardless of the LNGC type used, the containment system is expected to be a double-hulled design, which greatly increase containment reliability during a grounding or collision event. Examples of different types of LNGCs is shown in *Figure 4.21*.

### Table 4.6: Vessel Layout and Specifications (For Reference)

Specification		Vessel Type and Details	
General Arrangement			
Cargo Capacity	20,000 m <sup>3</sup>	30,000 m <sup>3</sup>	30,000 m <sup>3</sup>
Length Overall (LOA)	148 m	181 m	173 m
Beam	25.3 m	28.0 m	27.0 m
Moulded Depth	17.6 m	19.0 m	17.5 m
Draft	7.8 m	7.8 m	8.5 m
Deadweight Tonnage (DWT)	12,500 tonnes	16,200 tonnes	16,500 tonnes



Figure 4.21: Example of Different LNGC Types

### Moss Tank

Source: VladSV / Shutterstock.com; Retrieved January 16<sup>th</sup>, 2019.



### Membrane Tank

Source: Oleksandr Kalinichenko / Shutterstock.com; Retrieved January 16<sup>th</sup>, 2019.



### Type C Tank

Source: The Rolls-Royce Marin, Retrieved from: www.skipsrevyen.no/article/rolls-royce-Ing-carrier-design/, 2019.
#### 4.6.2 Construction Phase

#### 4.6.2.1 Construction Schedule

The construction phase of the LNG Receiving Terminal is expected to take approximately 23 months. The EPC Contractor will prepare the site for construction, erection and installation of the Project facilities, which will include earthwork activities, such as site clearing and soil excavation, and River work activities, such as the piling, installation of the underground structure and installation of the over ground component of the Jetty. The construction, design and testing will be undertaken in accordance with the appropriate construction standards and Myanmar NEQ (Emission) Guidelines and WB/IFC EHS Guidelines.

#### 4.6.2.2 Mobilization

Site construction work will start once civil design of sites preparation is finalised. All work will be conducted in accordance with the detailed master construction schedule, provided by the EPC Contractor. Prior to commencement of work, all contractors would be required to provide detailed site specific plans related to:

- Equipment use;
- Excavation and backfilling management;
- Soil erosion management;
- Traffic management (including vessels operation/ movement);
- Storm water pollution prevention plan;
- Dust prevention plan;
- Environmental and Social Management Plan;
- Waste Management Plan; and
- Plan drawings of laydown, traffic flow, parking, trash storage, and recycling areas.

It is assumed that as a part of the mobilisation phase the Project site including laydown areas, etc. will be fenced and a construction worker camp(s) will be located inside the Project boundary.

Considering that the LNG Receiving Terminal does not have any suitable access roads, all materials, equipment, workers, etc. will be transported to the LNG Receiving Terminal site by landing barges. Some workers may travel to the construction site by motorcycles, in which the existing access road is capable of supporting this type of vehicle.

#### 4.6.2.3 LNG Receiving Terminal

#### Earthwork

Earthworks will include clearing of vegetation and grading of the Project site. It is expected that the subsoil, which will be stripped and removed from the Project site, shall be utilised for levelling/ backfilling. The LNG Receiving Terminal construction site, being partially in an area subjected to flooding will require careful study of potential placement of elevation and flood barriers.

Grading of the site will be done by the design team, considering sufficient height to protect the terminal from potential water and tidal/ flood damage. Such elevation will be studied further as part of the detailed design stage in order to confirm that the site elevation does not pose a flood threat to the surrounding areas.

The anticipated amount of soil that will be cut and filled during the LNG Receiving Terminal construction phase is listed in *Table 4.7*. The amount of earthwork machinery that will be used during the LNG earthworks is listed in *Table 4.8*.

Considering no soil will be excavated, and additional fill soil is required for site elevation, the addition fill soil will be provided by a local supplier in Myanmar.

#### Table 4.7: Indicative Earthworks Estimated for the LNG Receiving Terminal

Area	Cut (m <sup>3</sup> )	Fill (m <sup>3</sup> )	Balance (m <sup>3</sup> )
Onshore LNG Terminal	-	100,000	100,000

Source: TPMC, 2019.

Machinery Type	Amount
Piling Rig	3
Excavator	3
Bulldozer	2
Scraper	1
Light-duty vehicle	2
Water truck	2
Cranes	2
Transit mixer	500 Trips
Air Compressor	1
Diesel Generator	10
Compactor	2
Tipper trucks/trailer	3
Fuel and lube track	1
Pump	3

#### **Table 4.8: Amount of Earthwork Machinery**

Source: TPMC, 2019.

#### Site Foundation

The geological conditions of the Project site will be studied in the detailed design stage however, it is proposed that lightly loaded structures with equipment not sensitive to settlement may be supported on spread footings and/or mat foundations, provided the sub grade is adequately compacted. Other structures and/or settlement sensitive equipment shall be supported on piles; pile drivers will be used to install the piles at the required points.

#### 4.6.2.4 Unloading Jetty

#### River Work

River works will include the installation of Project facilities that extend from onshore and are located alongside the waterfront. During the construction of the Unloading Jetty, specific types of vessels will be used to install the various structures and components. During these activities, establishing a safety zone around the construction area will be required to ensure safety among the construction vessels, and other non-project related vessels that navigate the Yangon River. Dredging of the Yangon River at

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the location of the Unloading Jetty will not be require as the water depth is suitable for vessels to operate in the area. Further details regarding river works will be mentioned under Jetty Construction (*Section 4.6.2.9*). Considering the Unloading Jetty will be constructed using concrete, piling will be required approximately 70-80 piles for jetty and trestle.

#### Unloading Arms

The complete set of hydraulics and electronics part of the unloading arm can be either barge crane or mobile crane (Stand on jetty platform) depending on the access and the capacity of the crane with regards to lifting load and operating radius.

#### 4.6.2.5 Major Project Works

Table 4.9 presents major Project works to be undertaken as a part of the construction phase.

ltem	Description
Electrical and Control Building	<ul><li>Concrete structure construction for Electrical room.</li><li>Reinforced concrete construction for Control room.</li></ul>
Fire pump	<ul> <li>Concrete Foundation with Steel Structure Roof</li> </ul>
Gas Engine Generator	<ul> <li>Reinforced concrete frame construction</li> </ul>
Administration	<ul> <li>Reinforced concrete frame structure</li> </ul>
LNG unloading Jetty	<ul> <li>Centre Platform with walkway, mooring dolphin and Trestle</li> </ul>
LNG Cryogenic Pipeline	<ul> <li>Stainless steel pipe with cold insulation</li> </ul>
LNG Storage Tanks	<ul> <li>Full containment, steel primary and steel secondary containment</li> </ul>
Regasification Unit	<ul> <li>Equip on Reinforced concrete foundation</li> </ul>

Table 4.9: Major Project Works for the LNG Receiving Terminal

Source: TPMC, 2018

Reinforced concrete structures shall be used for primary terminal facilities and facilities exposed to an aggressive environment. These facilities are primarily low-rise buildings/structures that have a large footprint area relative to their height. Conversely, steel is used for large expansive structures. The construction methods will be provided by the EPC Contractor.

The LNG Receiving Terminal will be built alongside with the waterfront to unload the imported LNG with sufficient space to cater for 16,000 tonnes LNG Carriers as shown in *Figure 4.9*. From the LNG Carrier(s), the LNG will be transferred to the LNG storage tanks before moving to the regasification unit.

#### 4.6.2.6 Construction Material

TPMC will utilize ready mixed concrete from a local supplier in Myanmar. Piping material and steel structures will be imported to the Asia World Port Terminal (AWP), which will then be transported to the laydown area via trucks, which will also utilize public ferries, and contracted ferries (by a transportation service company) to transport the trucks from Ahlone-Dala car ferry to the laydown area. Other materials will be delivered to the Myanmar International Terminal Thilawa (MITT), which will then be transported by trucks to a barging location nearby and then to the laydown area by barges. Finally, piping material will be delivered to MITT, transported by trucks to the fabrication shops in South Dagon, transported back to the barge loading area and then to the laydown area. The transportation plan for materials used for the LNG Receiving Terminal is shown in *Figure 4.22*. It is estimated the total number of trips required for piping material transportation is approximately 115 trips, which includes piping material for both LNG Receiving Terminal, and Pipeline.



#### Figure 4.22: Transportation Plan for LNG Terminal

Source: TPMC, 2019.

- \*1 Transportation route from AWP to Yangon-Dala car ferry via trucks or trailers and delivery to laydown area at the LNG Receiving Terminal by barge; \*2 Transportation route from MITT to barging location nearby of MITT and delivery to laydown area at LNG Receiving Terminal by barge; \*3 Transportation route from MITT to fabrication shop at South Dagon Township (piping material), then send back to barging location nearby of MITT for delivery to laydown area at the LNG Receiving Terminal by barge Note:

laydown area at the LNG Receiving Terminal by barge.

#### LNG Receiving Terminal

The majority of materials will be transported by vehicles from ports or local supplier using the existing local roads. Cranes, forklifts, trucks and trailers will also be mobilized at site, from the existing local roads. Transportation of heavy, large volume and super-sized materials such as Regasification Units, generators, transformers, etc. will be made by river transportation using barges from a nearby port/shore base. A small barge/ferry vessel loading jetty will be constructed as part of the LNG Receiving Terminal (as shown in *Figure 4.9*); the barge will transport heavy, large volume materials to this jetty.

#### Unloading Jetty

Considering the unloading jetty will first be pre-fabricated at the Thilawa Industrial zone, the required construction materials will be transported by vehicles from local suppliers or ports, by using the existing roads and barges transportation. Other machines/equipment, such as cranes, trucks, and forklifts will be mobilized at site. Once pre-fabrication is complete, barges will transport the unloading jetty to the designated location to be installed.

#### 4.6.2.7 Construction Workforce

The anticipated workforce for LNG Receiving Terminal construction is shown in **Table 4.10**, and the anticipated workforce for the Unloading Jetty construction is shown in **Table 4.11**. The anticipated number of vessels used for the Unloading Jetty Construction is shown in **Table 4.12**.

Wastewater management systems of all construction vessels will comply the International Convention for the Prevention of Pollution from Ships (MARPOL).

Workforce Origin	Average No. of Skilled Workers	Average No. of Semi-Skilled Workers	Average No. of Unskilled Workers	Total Average Workforce (per day)	Total Peak Workforce (per day)
Local Workforce	80	12	200	100	000
Migrant Workforce	40	6	0	400	600

#### Table 4.10: Anticipated Workforce for Onshore LNG Receiving Terminal Construction

Source: TPMC, 2018

#### Table 4.11: Anticipated Workforce for Unloading Jetty Construction

Workforce Origin	Average No. of Skilled Workers	Average No. of Semi-Skilled Workers	Average No. of Unskilled Workers	Total Average Workforce (per day)	Total Peak Workforce (per day)
Local Workforce	3	10	20	40	50
Migrant Workforce	2	5	0	40	50

Source: TPMC, 2018

Type of Vessel	Number of Vessels	Number of Workers per Vessel
Crane Barge	1	3
Transport Barge	2	20-25
Support Tug	2	These vessels will be provided by the Myanmar Port Authority

#### Table 4.12: Anticipated Number of Vessels during Construction

Source: TPMC, 2018

#### 4.6.2.8 Temporary Construction Camp and Laydown Area

The EPC contractor is expected to provide temporary work camps and other necessary facilities to accommodate construction personnel. Construction personnel that live nearby are allowed to travel to work by public transportation, or other means of safe transport. The location of the temporary construction camp for the LNG Receiving Terminal will be located within the construction boundaries of the LNG Receiving Terminal.

#### 4.6.2.9 Jetty Construction

The Unloading Jetty construction is expected to take approximately twelve (12) months, and will be installed alongside with the waterfront to unload the imported LNG with sufficient space to cater for 16,000 tons LNG Carriers as shown in *Figure 4.9*. From the LNG Carrier(s), the LNG will be transferred to the LNG storage tanks before moving to the regasification unit.

Prior to any river construction activities, an exclusion zone of 200 meters and a safe zone of 250 metres from the LNG unloading jetty will be established to ensure safety among the Project vessels. This is to reduce the impact towards river navigation and potential ship collisions. Signalling buoys will be installed around the alignment of the safe zone to indicate the restricted area to other vessels. If a vessel enters the safe zone, the support tug vessels will assist to warn off the vessel.

It is expected that the Unloading Jetty structure will be constructed using steel jackets, and concrete and steel reinforcements for cast in-situ. The process for constructing piles are as follows:

- 1. A pile driver will position the jacket at the intended location for installing the pile (Spotting);
- 2. A pile driver will bore the jacket vertically down into the sediment (Driving);

a. Any excavated sediment will be discharge onshore, and will not be discharged back into the river, or riverbank.

- 3. Once the jacket is in position, steel reinforcements will be lowered into the casing to provide structural integrity (Reinforcement);
- 4. Concrete is poured into the casing and is left to solidify (Concrete placement);
- 5. Once the concrete has been solidified, the jacket will be removed by pulling it out vertically (Working tube extraction).

A visual process for conducting cast in-situ piling is shown in *Figure 4.23*; to note, this method is currently tentative during this stage.





#### Figure 4.23: Cast In-situ Pilling Method (Tentative)

Source: TPMC, 2018.

Once the piles and top foundation for the jetty is complete, construction can proceed with installation of topside equipment, such as unloading/vapour arms, river water pumps, foam tank, pipelines, etc. The topside equipment will be installed using truck loader crane or barge crane depend on access lifting load and lifting radius, which will transport the equipment from onshore to the Unloading Jetty, and moved into place using the truck's built in crane. TPMC expects prefabrication activities to occur in Myanmar, potential locations for prefabrication includes South Dagon Township, and Thilawa Township.

The design of the Unloading Jetty is shown in Figure 4.14.

Other components such as the breasting/mooring dolphins and LNG spill pit will also be pre-fabricated onshore, then installed in-place with the crane barges. All construction vessels will comply with MARPOL 73/78, developed by the International Maritime Organization for pollution prevention from ships.

#### 4.6.2.10 Ancillary Structures

In addition to the main infrastructure on site, and as described above, the following ancillary buildings will be constructed:

- Admin, First aid and canteen building;
- Electrical room, GEG, and control room building;
- Gatehouse at the main gate of the site;
- Jetty guard house
- Staff canteen; and
- Firefighting pumps.

#### 4.6.2.11 Power and Water Supply

Approximately 3,000 kW of electricity will be required during the peak construction period, with an average consumption rate of 300 MWh/month. The electricity will be sourced from the existing 33kV distribution line. The Contractor shall provide 33 kV/380 V box-type transformer and 300 kW diesel generator for emergencies.

During construction, water supply is required for both construction worker consumption and for other construction activities. The maximum number of workers onsite during construction is anticipated to be 600 persons and each worker is estimated to consume approximately 33.3 litres of water per day<sup>11</sup>. Prefabricated concrete activities are estimated to consume 180 litre of water per day per litre of concrete and take another 50 litre for washing of concrete work 1 cubic meter. Average 18.42 cubic meter of concrete work per day shall consume water 4,236 litres per day.

The average water consumption rate during construction is anticipated to be 900 m<sup>3</sup> per month (approximately 30 m<sup>3</sup> (30,000 L) per day).

The raw water required during construction will be obtained from the local water distribution services. The raw water will be treated and purified to supply for construction.

#### 4.6.2.12 Construction Waste

#### Solid Waste

During the construction phase, non-hazardous solid waste material is likely to be produced from concrete, steel pipes, steel plates, structural steel and wooden crates. Opportunities will be explored for selling any waste steel plates, structural steel, wood, and other valuable scrap. It is anticipated that the amount of non-hazardous waste produced during the construction phase is approximately 2,450 kg.

There will also be biomass waste associated with the clearance of tree, shrubs and grass. Approximately 4,680 m<sup>3</sup> of biomass waste is anticipated during construction. Biomass waste will either be disposed of by an appropriate or a licensed waste contractor, or by burying on-site.

Appropriate storage and disposal facilities for waste shall be constructed on-site. Bunded, hardstand and roofed areas are a general requirement for hazardous waste such as waste oils, paints and chemicals.

*Table 4.13* presents details of domestic waste and approximate capacities anticipated during construction. TPMC will utilize services from the Yangon City Development Committee (YCDC) for domestic waste disposal.

Waste Type	Anticipated Quantity	# Workers	Total Solid Waste
Domestic Solid Waste	1.65kg per employee per week	600	990 kg/week

#### Table 4.13: Domestic Waste during LNG Receiving Terminal Construction

There will also be minimal other waste such as wood crates which will be provided to the local community as firewood.

*Table 4.14* presents details of the construction waste and approximate capacities anticipated during construction. Concrete waste will be disposed by the concrete supplier.

<sup>&</sup>lt;sup>11</sup> Tchobanoglous, G., Burton, F. L., & Metcalf & Eddy. (1991). Wastewater engineering: Treatment, disposal, and reuse. New York: McGraw-Hill.

#### Table 4.14: Construction Waste during LNG Receiving Terminal Construction

Waste Type	Amount
Concrete	720 Tons
Steel Pipes	6 Tons
Steel Plates	6 Tons
Structural Steel	2 Tons
Wooden Crates	30 Tons

Source: TPMC, 2019.

#### Wastewater

Wastewater typically produced during construction includes sanitary/domestic wastewater, cement wash down, other plant cleaning/rinsing effluents, vehicle maintenance and the mixing of oils/lubricants in the wastewater (i.e. as a result of equipment washing).

Non-Hazardous wastewater will be generated from the toilet facilities and workers accommodation (sewage). Non-hazardous wastewater will also be generated from the canteen. The sewage generated onsite will be treated in a septic tank before being discharged.

The increased presence of the labour force in the local areas may also place pressure upon any existing sewage systems and wastewater treatment systems or may result in additional untreated discharges of sanitary and domestic wastewater to the local environment.

#### Sewage/Sanitary Wastewater

During construction, it is anticipated that the maximum number of workers will peak at 600. The quantities of sanitary wastewater can be estimated as an average of 50 litres/person/day, and considering sanitary wastewater production to be 80% of water consumption per person (for non-continuous use), this equates to a predicted 24,000 litres of sanitary wastewater per day at peak construction periods. The EPC contractor will establish a management system for sanitary wastewater before construction.

#### Hazardous Waste

During the construction phase, hazardous waste material can originate from used paint, engine oils, hydraulic fluids, spent solvents, spent batteries, etc. It is anticipated that the amount of hazardous waste produced during the construction phase is listed in *Table 4.15*.

Hazardous Material	Amount
Diesel oil	10 L per day
Hydraulic fluids	5 L per day
Paint	10 L per day (painting work period 90 days)
Battery	1 kg per day
Concrete	1 m³ per day

#### **Table 4.15: Hazardous Waste Quantities**

Source: TPMC, 2019.

Hazardous wastewater will be generated from chemical cleaning of the equipment during the precommissioning process. Hazardous wastewater from chemical cleaning will be disposed by a contractor certified by TPMC.

Medical emergency - mass food

Medical emergency - contagious disease;

Uncontrolled flammable/toxic release; Adverse weather conditions (flooding,

Loss of services (water, sewerage,

Radiation (Radiation Source Exposition);

Other (Earthquake, terrorist act, bomb

poisoning/bird flu;

lighting strike);

threat, trespassers).

electricity);

and

#### 4.6.2.13 Health and Safety

#### Emergency Response Plan

TPMC has in place a Project Incident and Emergency Response Plan to provide the necessary course of action during an unplanned event, during the construction and operation phase.

The potential emergency scenarios that apply to this plan are as follows:

- Person(s) fall from height on land;
- Material fall from height;
- Vehicle collision with plant/equipment/pedestrian(s);
- Vehicle incident offsite;
- Collapse of scaffold no person(s) present/person(s) present;
- Collapse of structure no person(s) present/person(s) present;
- Collapse of deep excavations person(s) present;
- Fire/Explosion electrics, substances;
- Chemical spillage on land;

The full Project Incident and Emergency Response Plan is shown in Appendix H.

#### Site Security Procedure

The site security procedure is designed to provide a secure environment for employees that are on site, during the construction phase.

The main topics that this procedure covers are as follows:

- Physical barriers (Fence, Gates);
- Badge (Personal access control);
- Mobilization and demobilization of employees;
- Guards;
- Vehicle policy;
- Security supervision; and
- Photography control.

Asset control;

The full Site Security Procedure is shown in Appendix I.

#### Personnel Protective Equipment Procedure

The purpose of this procedure is to establish specifications, decision criteria, and guidance for Personal Protective Equipment (PPE) to ensure the proper level of safety is met and to protect workers from injuries and occupational health illnesses, during the construction phase. The full Personnel Protective Equipment Procedure is shown in *Appendix J*.

#### 4.6.3 Operation Phase

The main features of the LNG Receiving Terminal have been summarised in Section 4.6.1.

For the LNG Receiving Terminal, TPMC will proceed with an Own Operation and Maintenance (O&M) contract with a third party specialist Operation support.

O&M staff with relevant experience of operating similar facilities and with adequate knowledge of comparable technology will be deployed prior to commercial operation date (COD) to commission and take over the Project from the EPC Contractor. Approximately 30 staff will work on the operational phase of the Project.

The below sections will discuss further the key activities during Operation Phase.

The fuel supply for this Project will be based on imported LNG from overseas. The LNG will then be regasified to NG (gas form) using the proposed Regasification units. The amount of NG required from the Power Plant is 440,000 tonnes per year, and the capacity of the LNG Receiving Terminal to store LNG is 30,000 m<sup>3</sup> plus 20,000 m<sup>3</sup> (buffer storage).

The LNG will be transported via 16,000 tonne (approx.) LNG Carrier to the proposed LNG Receiving Terminal. Once re-gasified, the NG will then be transported by the proposed NG pipeline to the proposed Power Plant. It is expected that the LNG Carrier will arrive at the LNG facilities (unloading jetty) approximately every 12 days (approximately 2-4 LNG Carriers per month).

#### 4.6.3.1 LNG Carrier (LNGC)

LNG will be transported to the receiving terminal by LNG carriers. The transit of the LNG carrier to the receiving terminal will be from pilot embarkation at the mouth of Yangon River. It is envisaged, based on preliminary terminal throughput, that one LNG carrier will berth at the terminal approximately every twelve (12) days (approximately 2-4 LNG Carriers per month).

The LNG carrier will be self-propelled when entering or leaving the Yangon River, and two (2) support tug boats will assist in LNG carrier's docking. The vessel traffic of the Yangon River is shown in *Figure 4.24*, vessel traffic is also indication of the common navigation routes that vessels take; therefore, the LNGC will also follow the same traffic route when entering or leaving. Given the large width of the Yangon River at the LNG Receiving Terminal location (approximately 1.9 km), a turning basin is not required. At the jetty, the LNG carrier will be connected with the receiving terminal through the unloading arms. Two (2) unloading arms will unload LNG from the LNGC to the storage tanks at a rate of approximately 2,500 m<sup>3</sup>/hr, using the carrier's own pumps, at the same time, one (1) vapour arm will send vapour from the storage tank back into the LNGC; this is to counteract the increase in pressure from unloading.

The unloading of LNG from the carrier takes approximately 12-16 hours. In addition, approximately 3 hours for mooring, cool down, connecting unloading arms, and cargo measurement, and approximately 3 hours for cargo measurement, arm purging, disconnecting arms, and unmooring; therefore, it is expected that the overall process will require 18-22 hours.

During the LNG unloading operation, ballast water will be taken on-board from the surrounding water into the double hull compartments to compensate for cargo discharge. No ballast water will be discharged in the Yangon River waters.





Source: MarineTraffic, 2017.<sup>12</sup> (Modified by ERM)

<sup>&</sup>lt;sup>12</sup> MarineTraffic (2017) https://www.marinetraffic.com/

#### 4.6.3.2 LNG Receiving Terminal

The LNG Receiving Terminal will serve as fuel storage and regasification.

Operation of the terminal facilities will include the following significant process operations:

- LNG carrier approach, berthing and departure;
- LNG unloading from LNG carriers at the LNG Unloading Jetty via unloading arms and transfer to onshore LNG Storage Tanks via Cryogenic pipeline;
- LNG storage in onshore LNG Storage Tanks;
- Re-gasification of the LNG to Natural Gas (NG) ; and
- Final send out of natural gas via a NG pipeline.

At the receiving terminal, the LNG will be stored at near atmospheric pressure in cryogenic full containment LNG storage tanks and, when required, brought back to a gaseous state prior to being dispatched via pipeline to the proposed Power Plant.

#### 4.6.3.3 Control of LNGC Berthing Operations and Safety Zone

The LNG unloading jetty will be designed to accommodate the size and type of LNG carrier that are required to meet the cargo volume requirements. Each LNG carrier will be compared against predetermined acceptance criteria before being approved for the terminal. Once berthed, staff will complete various safety checks collectively and unloading operations will not commence until the Ship/Shore Safety Checklist included in the "International Guide for Oil Tankers and Terminals" has been completed satisfactorily. In addition, the requirements of the carrier's security plan shall be implemented consistent with the "International Ship & Port Facility Security Code".

While an LNG carrier is moored, the waters and waterfront facility located within a defined boundary to be constituted as a safety zone to avoid potential collision from passing traffic. The extent of this area is under examination and will depend on the findings of detailed design studies to be conducted under separate permitting exercises.

#### 4.6.3.4 LNG Storage Tanks

The storage of Liquefied Natural Gas is a specialised Storage tank, the storage type to be used for this Project are full containment tanks, where the inner contains LNG and the outer container contains insulation materials. The common characteristics of LNG Storage tanks is the ability to store LNG at the very low temperature, approximately -160 °C. In the event where the natural gas quality is below standard, or if pressure within the storage tanks / vaporizers increases unusually due to a malfunction, the HP / Cold vent stacks will vent out LNG.

At working volume, the stored LNG in both storage tanks is capable of supplying natural gas to the Power Plant for 17.6 days. In order to maintain the required temperature within the storage tanks, the minimum volume of LNG that remains in each storage tank is approximately 1,600 m<sup>3</sup>.

As such, two (2) tanks of full containment type, each with a working capacity of 25,000 m<sup>3</sup> will be considered for the Project. The secondary liquid container is designed to hold all the liquid contents of primary container in the event of leaks from the primary container. The indicative design of the LNG Storage Tank is shown in *Figure 4.17*.

In a situation where LNG is not supplied on-time, the storage tanks can provide a supply buffer for seven (7) days to maintain the operation of the proposed Power Plant.

#### 4.6.3.5 Re-gasification Units

Firstly, LNG transfer pumps (two (2) pumps attached to each storage tank) will pump LNG from the storage tanks, through the BOG recondenser, then into the Booster Pump Suction Drum, while simultaneously pumping Boil-off Gas (BOG) from the storage tanks through the BOG compressor, and the In-Line BOG recondenser, then into the Booster Pump Suction Drum. Next, three (3) booster pumps will pump LNG within the Booster Pump Suction Drum directly to the two (2) Regasification Units.

River water will be used as cooling water for the regasification process, three (3) pumps will pump water through the debris filter, then into the RU.

Re-gasification is a process of converting liquefied natural gas (LNG) at -160 °C temperature back to natural gas at atmospheric temperature and its capacity is 63 MMSCFD.

A Vaporizer is a heat exchanger in Re-gasification unit that uses river water as the source of heat. The Intermediate Fluid Vaporizers (IFV) types of vaporizers are used for LNG re-gasification.

#### 4.6.3.6 Water Supply

The main freshwater supply source will be taken from Yangon River. However, the use of surface water will be determined and assessed at the later stage to ensure no disruption to the local communities.

River water supply for the LNG Receiving Terminal will be used for heat transfer during regasification, and for domestic water use.

Table 4.16 presents the water requirements and their volumes during operation.

Water Requirement	Situation	Volume
Regasification heat transfer	Normal Operation	1300 m <sup>3</sup> /hr
Domestic water (local authorized)	Normal Operation	4 m <sup>3</sup> /h
Fire water	Normal Operation (Annual fire drill)	Fire water = 2,896 m³/h (≤2 hours) Foam = 0.382 m³
	Emergency (Largest fire scenario)	3,450 m³/h (≤2 hours)

Table 4.16: Water Requirement during Operation

Source: TPMC, 2018

The raw water will be taken from Yangon River, using the Water Intake Pumping station at the flow rate of approximately 1,300 m<sup>3</sup>/hr.

The lowest flow rate estimated from flow velocity measurements in the dry season in the intake location of the Yangon River, where the Project will withdraw from, is estimated to be 28.5 m<sup>3</sup>/s (based on lowest flow velocity of 0.9 m/s, shallowest depth of 1.9 m, and average width of river of 150 m at intake location), which would be equivalent to 102,600 m<sup>3</sup>/hr. The maximum intake requirement for the Project is expected to be1,300 m<sup>3</sup>/hr. This is equivalent to approximately 0.83% of the lowest dry season flow in the river at the intake location. This is based on a worst case scenario, comparing the Project's maximum expected water withdrawal requirements, with a constant withdrawal over a 24-hour period, during the lowest measured flow rate in the dry season.

Based on the above comparison of the Project's water intake requirements with the estimated flow rates of the river during the dry season, it is expected that there will be adequate flow to support the Project's water withdrawal, and the Project is not expected to have any significant impacts on current water users for the Yangon River.

#### 4.6.3.7 Electricity Supply

The LNG Receiving Terminal will be connected to an 11 kV transmission line that runs parallel along the access road and the pipeline. The LNG Receiving Terminal is expected to consume 1.6 MW; however, considering a portion of electricity will be provided by the GEGs, the amount of electricity that will be consumed from the 11 kV transmission line is approximately 10 KW.

#### 4.6.3.8 Anticipated Workforce

The anticipated workforce during operation is shown in *Table 4.17*, and the anticipated number of vessels during operation is shown in *Table 4.18*.

#### Table 4.17: Anticipated Workforce for LNG Receiving Terminal

Description	Staff Number
Permanent Staff	30 (O&M + Back Office)
Security (external)	12
Contract staff: Cleaners, Gardeners and helpers	10
Contract staff: Technical hands	10
Maintenance (once every 3 years)	90 for 30 days

Source: TPMC, 2018

#### Table 4.18: Anticipated Number of Vessels during Operation

Type of Vessel	Number of Vessels	Amount of Workers per Vessel
LNG Carrier	1 (every 12 days)	2
Navigation Boat	1	These vessels will be provided by
Support Tug	2	the Myanmar Port Authority

Source: TPMC, 2018

#### Workforce Shift Structure

The Operational and Maintenance (O&M) working will use 4 shift teams to provide 24/7 coverage for plant operation and 8 hours per day, 7 days per week for general corrective and preventive maintenance work.

The shift structure will be as follows:

- 8 hours per shift (3 shift operate and 1 shift off)
- 2 days shift (D,7am- 4pm), 2 days shift (A,4 pm-12pm), 2 night shift (N-12 pm-7am) and 1 day off (O) (DDNNAAO shift patterns); the shift pattern will change every 14 days;
- 1 shift charge, 1 unit controller and 2 field technicians per shift; and
- 32 staffs will be in the shift roaster

The mentioned shift patterns with proven record of rotational shift work should reduce circadian rhythm impacts and mental health impacts of shift work.

The rotational shift work between operation staffs and maintenance staffs are required for every 24week cycle. Additionally, special non-allowable vacation 4-week period reserve for plant major outage is also provided; this is with accordance to a set schedule to equally distribute workload and average 1,488 working hours for every O&M staff for a 52-week cycle.

#### 4.6.3.9 Operational Waste

#### **Operational Solid Waste**

During operation the re-use, recycle and minimization of waste ethic shall be adopted. A waste management plan will incorporate strategies for the re-use, recycle and minimization of waste on Site. Management strategies for regulated and hazardous waste shall also be included, including a methodology for tracking regulated/hazardous waste generation and disposal.

Appropriate storage and disposal facilities for waste shall be constructed on Site. Bunded, hardstand and roofed areas are a general requirement for hazardous waste such as waste oils, paints and chemicals.

Table 4.19 presents details of the solid waste and approximate capacities anticipated during operation.

Waste Type	Anticipated Quantity	# Employees	Total Solid Waste
Domestic Solid Waste	1.65kg per employee per week	62	102.3 kg/week

### Table 4.19: Solid Waste during LNG Receiving Terminal Operation

The solid waste generated during the operation phase will be collected and segregated for recycle and non-recycle waste (i.e. paper, plastic). Project will use incineration on site and compost.

There will also be minimal other waste such as wood crates from maintenance activities which will be provided to the local community as firewood.

#### **Operational Hazardous Materials**

The hazardous materials to be stored on site during operation are presented in **Table 4.20**. The chemicals will be transported appropriately to the Project site and Material Safety Data Sheets (MSDS) will be prepared from chemical suppliers in Myanmar.

#### Table 4.20: Hazardous Materials during Operation

Hazardous Material	Use of Hazardous	Storage Location	Quantities to be Stored
	Materials	Onsite	Onsite*
Diesel oil	Liquid fuel for emergency diesel engine generator, emergency diesel generator	Storage Tank	Estimate at 2 x 7200 litres x 3 days for fuel tank = 43,200 litres.

Note: \*Estimated figures only for 2 months in chemical storage house

#### 4.6.3.10 Operational Wastewater and Cold Water Discharge

The LNG Receiving Terminal will be equipped with a septic tank to treat domestic wastewaters.

*Table 4.21* presents details of the wastewater and approximate capacities which will be generated during operation.

Table 4.21: Wastewater	during Operation
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ltem	Timing of Wastewater Generation	Capacity*
Cold water discharge from LNG	Receiving Terminal	
Regasification Unit	Normal Operation	1,300 m <sup>3</sup> /h (Difference temperature between inlet and outlet of river water is 10 °C)
Domestic Wastewater		
Sanitary/ Sewage Wastewater	Normal Operation	4 m <sup>3</sup> / hour

Note: \*estimate figures only

#### 4.6.3.11 Storm Water

Storm water will be collected with the appropriate placement of drainage systems to prevent contaminated direct discharge of storm water into the surrounding environment; drainage systems will be installed around the LNG Receiving Terminal and on the Unloading Jetty. Non- contaminated storm water will be discharge directly to storm water drainage. The drainage system for storm water at areas where lubricating oils are handled will be connected to an oil and grease pit (interceptor). The contaminants will be captured in the pit and removed manually. Contaminated storm water will be sent to the oil-water separator system before discharge to the final checking pond while uncontaminated storm water will be discharged offsite into the small water channel discharge point to the North West side of the Project Site. The estimated amount of discharge storm water is shown in **Table 4.21**.

#### 4.6.3.12 Gas Engine Generator (GEG)

The four GEGs will operate continuously to generate electricity for in-house operations. The GEGs will use BOG that is generated from storage tanks and other processes as fuel to operate. All four (4) generators are expected have a total capacity of 1,800 kW (1,160 kW each at 60%), enough to operate all functions within the LNG Receiving Terminal.

#### 4.6.3.13 Fire Protection System

The LNG Receiving Terminal's fire protection system will provide personnel safety and plant protection through prompt detection, alarm and suppression of a fire. The system will be designed for any single design basis fire and will be in accordance with all local applicable codes and standards. Fire and leakage detection systems will be installed appropriately to ensure fast response. The primary source of water for the system shall be from a firewater pond within the LNG Receiving Terminal, firewater monitor will be installed around various points of the LNG Receiving Terminal and Unloading Jetty. Six (6) diesel fire pumps will pump water from the firewater pond to the necessary fire protection systems such as the firewater monitor, and will ensure adequate water pressure for water fire suppression. Foam fire extinguisher systems is also used to suppress the spread of leaked LNG in the LNG spill pit, there are two (2) foam storage tanks in total, one located on the unloading Jetty and another close by the BOG compressor, as shown in *Figure 4.9*.

The fire protection system will be designed in accordance with the national fire protection association (NFPA) code and standards. The specific NFPA codes that TPMC will follow are as follows:

- NFPA 10: Standard for Portable Fire Extinguishers;
- NFPA 11: Standard for Low-, Medium-, and High-Expansion Foam;
- NFPA 15: Standard for Water Spray Fixed Systems for Fire Protection;
- NFPA 20: Standard for the Installation of Stationary Pumps for Fire Protection;
- NFPA 24: Standard for the Installation of Private Fire Service Mains and their Appurtenances; and

NFPA 59A: Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG).

Different types of fire protection systems will be used throughout the LNG Receiving Terminal. A summary of the systems used in specific locations are shown in **Table 4.22**.

# Table 4.22: Preliminary Summary Table of active Fire Protection System forBuilding and Equipment

Fire Hazardous Source	Fire Water Hydrant	Fire Water Hydrant with Monitor	Fixed Water Spray System	Fixed Foam System	Fire Alarm Detector	Fire Extinguisher
Jetty						
Jetty Platform		Х		Х		Х
Walkway & Mooring Dolphin						
Loading Arm(s)			Х			Х
River Intake Pump						Х
Other (if any)						
Process Area						
LNG Storage Tank(s), transfer pump(s), LNG spill pit		Х	Xa	Xb		Х
BOG Compressor(s)	Х					Х
Regasification Unit(s)	Х		Х			Х
HP LNG Booster pump suction drum	Х		Х			Х
NG pre-heater	Х					Х
Vent Stack	Х					Х
Gas Engine Generator	Х					Х
Air Compressor and Nitrogen System	Х					Х
Fire Water Pumps	Х					Х
Central Control Building						
Electrical Room					Х	Х
Control Room					Х	Х
Transformer			Х			Х
Common Facility Area						
Administration, First Aid and Canteen Building	Х				Х	Х
Main Gate Guardhouse	Х				Х	Х
Jetty Guardhouse	Х				Х	Х

Source: TPMC, 2019.

Note: <sup>a</sup> Water spray system applies for roof and shell of LNG storage tanks. <sup>b</sup> Fixed foam system applies only on LNG spill pit for any LNG spillage.

The detailed fire prevention plan can be found in Appendix G.

#### 4.6.3.14 Health and Safety

TPMC has in place a Project Incident and Emergency Response Plan to provide the necessary course of action during an unplanned event.

The potential emergency scenarios that apply to this plan are as follows:

- Person(s) fall from height on land;
- Material fall from height;
- Vehicle collision with plant/equipment/pedestrian(s);
- Vehicle incident offsite;
- Collapse of scaffold no person(s) present/person(s) present;
- Collapse of structure no person(s) present/person(s) present;
- Collapse of deep excavations person(s) present;
- Fire/Explosion electrics, substances;
- Chemical spillage on land;

- Medical emergency mass food poisoning/bird flu;
- Medical emergency contagious disease;
- Uncontrolled flammable/toxic release;
- Adverse weather conditions (flooding, lighting strike);
- Loss of services (water, sewerage, electricity);
- Radiation (Radiation Source Exposition); and
- Other (Earthquake, terrorist act, bomb threat, trespassers).
- The full Project Incident and Emergency Response Plan is shown in Appendix H.

#### 4.6.3.15 Maintenance

During operation, maintenance will be associated with the following:

- Routine Maintenance;
- Planned Preventive Maintenance; and
- Breakdown Maintenance.

#### 4.6.4 Decommissioning

Decommissioning is the term used to describe all the stages involved in the closure and rehabilitation of the power plant site. The process can generally be categorized into three (3) key phases as follows:

- Pre-decommissioning activities: includes the detailed planning (development of the decommissioning plan) and approval procedures;
- Decommissioning activities: removal of plant machinery & equipment and demolition, decommissioning of facilities, turbines and infrastructure, decontaminated land assessment and rehabilitation; and
- Post-decommissioning activities: site survey, close-out report and field monitoring as necessary.

#### 4.6.4.1 Decommissioning Phase of the Project

At present, there are no plans or schedule for decommissioning of the proposed Project. It is likely that the Project facilities will only be decommissioned/ abandoned once it is no longer economical to continue operation, the plant is rendered redundant and/or no longer required for various reasons or is unsafe to operate. As the development process of the site is yet to fully begin, detailed decommissioning plans have not yet been formulated.

The Project facilities will be designed with decommissioning in mind. In general, facilities and machinery will be designed so that they can be isolated and decommissioned in steps which are in reverse of the

installation procedure or which are most convenient to do so. The decommissioning phase activities will therefore be similar to those associated with the excavation/foundation work, installation and civil construction phases. The decommissioning plant will also take into account environmental rehabilitation, which includes the removal of all surface facilities and excess hydrocarbon waste, as well as re-vegetation of localized natural flora.

Associated decommissioning activities in accordance with environmental measures and standards of good practice are as follows:

- Removal of site infrastructure and waste;
- All civil structures and associated infrastructure will be removed;
- All remaining materials and hydrocarbons and hazardous waste will be removed;
- All pilings and trestles will be removed;
- All waste will be disposed of in an appropriate manner; and
- Reusable materials to be resold or recycled.

Hazardous Waste Clean Up and Transport:

- When decommissioned, all products within piping and storage infrastructure shall be removed from said system along with all associated infrastructure and possible contaminated soils; and
- All hazardous wastes shall be transported to approved hazardous waste storage facilities or disposal sites.

Site Rehabilitation:

- all disturbed areas due to ROWs, transmission lines, etc. shall be rehabilitated and revegetated;
- native flora shall be used to re-vegetate the rehabilitated sites;
- Roadways will be scarified; and
- Natural drainage patterns will be reinstated where practical.

#### 4.7 Natural Gas (NG) Pipeline

#### 4.7.1 Key Components

The natural gas supply pipeline will be designed as per ASME B31.8: Gas Transmission and Distribution Systems. In addition, Cathodic Protection will be placed for the buried section of the pipeline. The brief specification for the Pipeline are included in *Table 4.23* below.

Component	Details		
Length	24.9 km		
Diameter	20 inches		
Pipe Wall Thickness	≥ 9.53 mm		
Material	Carbon steel		
Design Pressure	Appx. 64 barG		
Minimum Yield Strength	4481.6 barG		
Coating	API 5L X65 with 3LPE coating		
Minimum Design Temperature	0.0 °C		
Operating Design Temperature	10 °C		

#### Table 4.23: Gas Pipeline Key Components

Component	Details
Maximum Design Temperature	55.0 °C
Design Standard	ASME B31.8 ASME B31.8s ASME B31.3
Material Design	ANSI / ASME / ASTM API SSPC MSS
Design Location Class	3, and 4 (Design factor 0.5, and 0.4 respectively)
Coating	3 Layer Polyethylene
Cathodic Protection	Impressed current cathodic protection
Block Valves	Two (2) Valves (at each extremity)
Operation Period	25 years from COD

Source: TPMC, 2019

A natural gas supply and treatment system will be installed at the Power Plant to meet the required gas quality specified by the gas turbine manufacturer. The natural gas system will include equipment and all necessary gas filter-separators, isolation and safety valves, and other equipment.

Pipeline sections that are expected to be aboveground are located at block valves (maximum of 15 - 30 metres of aboveground pipeline length at each block valve), and small canal crossings which do not require pipelines to be routed underground.

#### 4.7.1.1 Open-Cut Pipeline Sections

Pipelines sections will utilize an open-cut method. To provide protection from non-project related drilling/excavating activities from damaging the pipeline, two (2) protection layers are applied. The first protective layer is a PVC Pipeline warning sign, which will advise not to drill/excavate any further, an example of the warning sign is shown in *Figure 4.25*. The second layer is a concrete slab, which protects the pipeline from any drilling/excavation that pass the first layer. An example image of the concrete slab is shown in *Figure 4.26*. The open-cut design for the pipeline is shown in *Figure 4.28*. In addition the pipeline will be marked on the surface with sign posts clearly indicating the restriction in that area. These sign posts will be installed along the pipeline.



## Figure 4.25: Example of PVC Pipeline Warning Sign

Source: TPMC, 2018.

#### Figure 4.26: Example of Concrete Slab



#### 4.7.1.2 Horizontal Directional Drilling (HDD) Pipeline Sections

HDD pipeline sections will not have PVC pipeline warning signs, and concrete slabs. The pipeline sections that will utilize HDD to cross the Twante Canal will have a length of approximately 500 metres, whereas sections that cross the Yangon River will have a length of approximately 550 metres. The pipeline installation using the HDD method will be located under the river bed.

#### 4.7.1.3 Above Ground Pipeline Sections

Although the majority of the pipeline will be placed below ground, small sections of the pipeline will be placed above ground. These include sections located at each extremity of the pipeline where each block valve is located, this is to allow easier access to the block valve that will also be placed above ground; it is expected that only approximately 15 - 30 m of pipeline will be above ground, at each block valve. Some sections of the pipeline is expected to cross above small canals as the size of these canals allow for an above ground crossing; each of these sections are not expected to be over 30 m in length.

#### 4.7.1.4 Anti-Corrosion Coating

All pipeline sections will be coated with a suitable anti-corrosion material to prevent corrosion from occurring. Any pipeline sections that are located above ground will be designed to withstand higher temperatures of up to 55 °C; both underground and above ground pipeline sections will be applied with a 3 Layer Polyethylene as an external protection. The parts of NG pipeline that are aboveground are:

- at transition between aboveground pipe to underground pipe at block valves near RU at LNG terminal and around block valve at Power plant. Each section should not be more than 30 m in length.
- at some small canal crossing in Dala Township. Each section should not be more than 30 m in length.

#### 4.7.1.5 Block Valve

Block valves are used to stop the flow of natural gas through the pipeline during maintenance, or a leakage. There will be two (2) block values located on each end of the pipeline; therefore, one block valve will be located at the LNG terminal, near the regasification unit, and the other will be located at the Power Plant. Both block valves will utilize a ball valve design with an electric valve actuator. The valve will communicate with the LNG Receiving Terminal/Power Plant control room, when a leak is detected or maintenance is required. The block valve specifications are shown in **Table 4.24**. An example of a block valve is shown in **Figure 4.27**. An operator from the control room can issue a command to close the value when required.

Components	Details	
Model/Type	Ball Valve	
Communication	Hardwire	
Material	Carbon Steel, Stainless Steel	
Design Standard	API 6D/6A	
Fire Safe Standard	ISO 10497/API 6FA, API 607	

#### **Table 4.24: Block Valve Specifications**



## Figure 4.27: Example of Block Valve





#### 4.7.1.6 Sign Post

Sign posts are used for providing information, guidance, or warning. Throughout the pipeline alignment, specific types of sign post will be installed to protect public health and safety and pipeline integrity.

There are five (5) sign post configurations, each differ from each other with regards design and/or placement. Each sign post is listed and described in *Table 4.25*.

Type No.	Sign Post Type	Description
1	Aerial marker	Aerial marker for every kilometre of pipeline.
2	Pipeline & Facility Warning Sign (A)	Warning sign on each end of a crossing (which include roads, water way, property line/fence owned by others). Placed 300 mm from pipeline Outside Diameter.
3	Pipeline & Facility Warning Sign (B)	Warning sign for remaining part of pipeline. Placed 300 mm from pipeline Outside Diameter.
4	Direction marker	Used for indicating any changes in pipeline direction.
5	Navigable Waterway Pipeline	Sign placed on each end of a navigable waterway pipeline crossing.

#### Table 4.25: Sign Post Type

Source: TPMC, 2018.

The design for each sign post is shown in *Figure 4.29*; note that some sign post type may share identical designs, and differ only with placement requirements.

#### Figure 4.29: Sign Post Design

GENERAL ARRANGEMENT OF PIPELINE MARKER AT RIVER TO INTERNATIONAL PORT

REWARK, TEXT SHOWN IN RED COLOR SHALL BE IN MYANWAR LANGUAGE PLEASE REFER ATTACHMENT-10 FOR MYANWAR LANGUAGE



Source: TPMC, 2019. (Modified by ERM)

Figure 4.30: Sign Post Placement



Source: TPMC, 2018. (Modified by ERM)

#### 4.7.1.7 Right of Way (ROW)

ROW is a specific area of land of various widths, surrounding a specific components, such as pipelines. The purpose of the ROW, with regards to the pipeline is to allow for the construction of the pipeline, allow workers to adequately inspect, provide maintenance and testing, or provide a level of safety during an emergency. The ROW is also used to identify areas which will prohibit certain activities, to ensure public health & safety, and pipeline integrity.

According to the Myanma Oil and Gas Enterprise (MOGE); the requirements for the pipeline ROW is specified at 20 m on each side of the pipeline, for the construction ROW. The Project Propoenent will not retain the permanent ROW, as land will be returned to the land owners after construction is complete. The Construction right of way required for the construction of the pipeline is shown in *Figure 4.31*.



Figure 4.31: Construction Right of Way

#### 4.7.2 Construction Phase

#### 4.7.2.1 Construction Schedule

The construction phase for the Natural Gas Pipeline installation is expected to take 18 months. The EPC Contractor will prepare the site for construction, erection/burying and installation of the Project facilities. The construction, design and testing will be undertaken in accordance with the Myanmar NEQ (Emission) Guidelines and WB/IFC EHS Guidelines.

#### 4.7.2.2 Mobilization

Site construction work will start once civil design of pipeline route and installation method is finalised. All work will be conducted in accordance with the detailed master construction schedule, provided by the EPC Contractor. Prior to commencement of work, all contractors would be required to provide detailed site specific plans related to:

- Equipment use;
- Excavation and backfilling management;
- Soil erosion management;
- Traffic management (including vessels operation/ movement, during material and equipment transportation);
- Storm water pollution prevention plan;
- Dust prevention plan;
- Environmental and Social Management Plan;
- Waste Management Plan; and
- Plan drawings of laydown, traffic flow, parking, trash storage, and recycling areas.

All materials, equipment, and workers will be transported to the construction site.

#### 4.7.2.3 Earthwork

Earthworks will include clearing of vegetation and grading for the ROW of the pipeline. The subsoil located directly in the pipeline alignment will be excavated to the designed depth of the pipeline, once the pipeline is in place, the excavated soil will be backfilled. The amount of soil that will be removed due to excavation activities for the pipeline and then backfilled is approximately 75,000 m<sup>3</sup>. The pipeline construction site, being partially located under water channels will require careful study of construction method, specifically during horizontal directional drilling (HDD). Other sections of the pipeline that are located near other public utilities will also require careful planning.

The anticipated amount of soil that will be cut and filled during the pipeline construction phase is listed in *Table 4.26*. The amount of earthwork machinery that will be used during the pipeline earthworks is listed in *Table 4.27*.

Area	Cut (m <sup>3</sup> )	Fill (m <sup>3</sup> )	Balance (m <sup>3</sup> )
Onshore Pipeline	75,000	56,000	19,000

#### Table 4.26: Indicative Earthworks Estimated for the Pipeline

Machinery Type	Number
Horizontal Directional Drilling Rig	1
Excavator	4
Auger Drill	2
Bulldozer	1
Light-duty vehicle	8
Water truck	2
Cranes	2
Diesel Generator 200KW	1
Diesel Generator 100KW	1
Diesel Generator 50KW	2
Tipper trucks/trailer	14
Fuel and lube truck	1
Pump	6

## Table 4.27: Number of Earthwork Machinery

#### 4.7.2.4 Major Project Works

Table 4.28 presents major Project works to be undertaken as a part of the construction phase.

Table 4.28:	Major Pro	ject Works f	or the Pipeline
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ltem	Description
NG Pipeline	<ul> <li>HDD for underwater sections in Yangon River/ canals</li> <li>Boring for small water crossing or road/ junction crossing</li> <li>Open cut pipeline sections will have a minimum depth of 1.5 metres</li> <li>Pipeline diameter of 20 inches</li> <li>Block Valves</li> </ul>

Source: TPMC, 2018.

#### 4.7.2.5 Construction Material

During the pipeline construction phase, materials that will be used to construct the pipeline is listed in *Table 4.29*. All carbon steel pipes will be imported to the AWP and will be transported by trucks to the Yangon-Dala car ferry. Public ferries, and contracted ferries (by a transportation service company) will then transport the trucks 2.6 km from Yangon over to Dala, approximately 15 minutes; once the trucks have arrived at Dala, the trucks will travel alongside the Yangon River to the laydown area, as shown in *Figure 4.32*. It is estimated the total number of trips required for piping material transportation is approximately 115 trips, which includes piping material for both LNG Receiving Terminal, and Pipeline.

Material	Specification/Standard
Carbon Steel Pipe	API 5L,(PSL2)45 edition Base on ASME B31.8
Coating	Internal -API RP 5L2 External -CAN/CSA Z245.20-M92 or DIN30670 Base on ASME B31.8
Concrete Slab	Pre-cast concrete Base on ASME B31.8
PVC Pipeline Warning Sign	PVC plastic Base on ASME B31.8 / ASME B31.8S
Sign Posts + Markers	Sign Post -Steel :A36 / SS400 /A283 or equivalent material with Galv. Coating -Foundation : Concrete Marker Concrete Base on ASME B31.8/ API RP 1102 / API RP 1109

#### Table 4.29: Construction Materials for Pipeline



Figure 4.32: Transportation Plan for the Pipeline

#### 4.7.2.6 Open-Cut Construction Method

An open cut construction method for the pipeline will involve primarily earthworks, which consists of excavating soil from the planned pipeline alignment. Once the soil has been excavated to the designed depth, the proper native soil or padding sand (if necessary) will be filled at the bottom. Backhoes, or other appropriate machinery will then lower the pipeline on top of the bottom layer; once aligned, proper native soil or sand (if necessary) will be used to cover the entire pipeline. Soil will gradually be backfilled, this is to allow placement of the concrete slab, and PVC pipeline warning sign at the appropriate depth, as shown in *Figure 4.28*.

Example images of open-cut construction is shown in *Figure 4.33*. The open-cut construction method for the pipeline is shown in *Figure 4.34*.



Figure 4.33: Example of Open-Cut Construction Method for Pipeline

Source: Photo ID: 531889711; shinobi / Shutterstock.com; Retrieved September 21st, 2018.



Source: Photo ID: 1202070952; RachenStocker / Shutterstock.com; Retrieved January 31st, 2019.



#### Figure 4.34: Pipeline Construction Method by Open-Cut

## CONSTRUCTION METHOD BY OPEN-CUT
# 4.7.2.7 Horizontal Directional Drilling (HDD)

## HDD Method

Horizontal directional drilling (HDD) is a method of installing pipeline without having to cut and fill soil. This method is particularly advantageous in areas where excavation is not practical; for this Project's case, an open-cut method will not be practical for pipeline sections that will cross two (2) points, the Twante Canal, and the Yangon River.

The HDD method follows three (3) principle phases, which are listed below:

- 1. Pilot Hole Directional Drilling: A small diameter hole is drilled within the intended path of the pipeline, from one surface point to another each side of the water body;
- 2. Prereaming: The small diameter hole is then enlarged to a diameter in which the hole can facilitate the pipeline; and
- 3. Pull Back Process: The pipeline is pulled from one opening to another.

During the Pilot Hole Directional Drilling process, location and guidance of the drill head is required to drill accurately and prevent damage towards other underground utilities/infrastructure. The system that will be used for this process will be a Gyro-base locating system, which is fully autonomous and offers the best drilling accuracy.

Given the pipeline distance that will require HDD method is approximately 500, and 550 metres, at each cross point of the Twante Canal, and Yangon River respectively, the HDD method will require a HDD rig; compared to a directional boring unit, a HDD rig is intended for large diameter drilling, and distances of several hundred meters. An example of a HDD rig is shown in *Figure 4.35*.

The construction of the pipeline will also include the use of HDD method, in order to install pipelines that cross under the Yangon River, as shown in *Figure 4.36*. Considering pipeline sections that will undergo HDD method, and sections that will cross over short width canals (in parallel to road bridges), river work activities, such as dredging, will not take place during the Pipeline construction.

The locations for pipeline that will undergo HDD method are shown in Figure 4.37.

## Bentonite

Specifically known as Sodium Bentonite, this liquid solution is used as drilling fluid to assist the drilling of boreholes. During HDD method, bentonite will be used as drilling fluid for the HDD rig. It is expected that the amount of bentonite produced from HDD activities is approximately 1,000 m<sup>3</sup>. The produced bentonite will first be stored in appropriate containers, to await for treatment and disposal offsite; a tank truck will be used to transport the bentonite off-site to the appropriate or licensed Hazardous Waste Treatment facilities, available in Myanmar. The amount of produced bentonite is listed in **Section 4.7.2.12**, under the **Hazardous Waste** subsection.



Figure 4.35: Horizontal Directional Drilling Rig Example

Source: Vermeer Corporation, 2019.



Source: Power Dynamics Innovations Limited Liability Company, 2019.



Figure 4.36: HDD Construction Method

# Figure 4.37: HDD Location









## Piping Crossing Twante Canal (500 M)





Location and number of barring shall continued by Civil Departs
 Key word 199-8 - 104620x REER/VOIEX PLANT)-BORE



Piping Crossing Yangon River (550 M)

## 4.7.2.8 Hydrostatic Testing

Once pipeline installation reaches 3-5 km completion length, hydrostatic testing will commence; once testing is completed and passed, soil is then backfilled. This is to allow visual identification of leak points along the pipeline.

Hydrostatic testing involves pumping liquid into pressure system (such as a pipeline) to perform strength test and identify leak points. Once the Pipeline has been constructed, the Pipeline system will need to undergo Hydrostatic testing before proceeding with operation.

The hydrostatic test will involve placing a water feeder and pressure gauge system at the header of the Pipeline, and a water outlet channel at the receiving end of the Pipeline. The water feeder will pump liquid into the Pipeline and the gauge system will detect the water pressure during testing. Once both ends of the Pipeline are sealed, liquid is pumped into the system until the pressure within the system is approximately 1.5 times of the Pipeline's design pressure. The Pipeline is left in this condition for at least 2 hours for strength test, and another 24 hours for leak test; if pressure does not drop, or still within acceptable pressure range, the testing is complete.

The hydrostatic testing fluid will utilize water provided from the river or canal near the construction site location, no chemicals will be added to the water before or after testing; therefore, the fluid is considered non-hazardous. The amount of hydrostatic testing fluid required for testing is approximately 2,500 m<sup>3</sup>.

Considering that the fluid is non-hazardous, the fluid will be discharged directly into the Yangon River. The discharge method will involve opening the pipeline at a point closest to the Yangon River.

# 4.7.2.9 Construction Workforce

The overall anticipated workforce for pipeline construction is shown in *Table 4.30*. The anticipated workforce per main construction activity is shown in *Table 4.31*.

Workforce Origin	Average No. of Skilled Workers	Average No. of Semi-Skilled Workers	Average No. of Unskilled Workers	Total Average Workforce (per day)	Total Peak Workforce (per day)
Local Workforce	35	36	32	04	447
Migrant Workforce	14	60	0	81	117

# Table 4.30: Anticipated Workforce for Pipeline Construction

Source: TPMC, 2019.

## Table 4.31: Anticipated Workforce for HDD, Open Cut, and Hydrostatic Testing

Activity	Workforce
HDD	64
Open Cut	39
Hydrostatic Testing	14

Source: TPMC, 2019.

# 4.7.2.10 Temporary Construction Camp and Laydown Area

In addition, the EPC contractor shall utilize the laydown area indicated in *Figure 4.32* to receive construction material, as well as utilize the available space along to pipeline (Construction Right of way) as a laydown area for each ongoing pipeline section construction. Trucks will be used to transport materials from the supplier to the laydown area. The laydown area is used for storage of materials and equipment that will be used for the construction Project. Trucks will be used to transport material/equipment from the laydown area to the pipeline construction area.

# 4.7.2.11 Power and Water Supply

It is expected that most machinery/equipment used during pipeline construction phase will have their own power source and will not require an external supply from nearby public utilities. Other machinery/equipment that requires an external power supply will be sourced from the existing 11 kV distribution line. The Contractor shall provide 11 kV/380 V box-type transformer and 450 kW diesel generator for emergency. Approximately 450 kW of electricity will be required during the peak construction period, with an average consumption rate of 80 MWh/month.

During construction, water supply is required for both construction worker consumption and for other construction activities. The maximum number of workers onsite during construction is anticipated to be 117 persons and each worker is estimated to consume approximately 33.3 litres of water per day<sup>13</sup>. Cover Slab concrete are estimated to consume 230 litres of water per day per m<sup>3</sup> of concrete/ total water volume 143.75 m<sup>3</sup>. All construction activities including the ones described above, are estimated to consume 3 m<sup>3</sup> of water per day.

The average water consumption rate during construction is anticipated to be 78 m<sup>3</sup> per month (approximately  $3 m^3 (3,000 L)$  per day).

The raw water required during construction will be obtained from the local water distribution services. The raw water will be treated and purified to supply for construction.

# 4.7.2.12 Construction Waste

# Solid Waste

During the construction phase, non-hazardous solid waste material is likely to be produced from concrete, steel pipes, and wooden crates. Opportunities will be explored for selling the steel pipes. The wooden crates will be disposed of by an appropriate or a licensed waste contractor. It is anticipated that the amount of non-hazardous waste produced during the construction phase is approximately 92,000 kg.

There will also be biomass waste associated with the clearance of tree, shrubs and grass for the pipeline's ROW. Approximately 2,500 m<sup>3</sup> of biomass waste is anticipated during construction. Opportunities for providing biomass waste to the local community will be explored or biomass waste will be disposed of by an appropriate or a licensed waste contractor.

All excavated material will be backfilled with no surplus.

Appropriate storage and disposal facilities for waste shall be constructed at the laydown area. Bunded, hardstand and roofed areas are a general requirement for hazardous waste such as waste oils, paints and chemicals.

*Table 4.32* presents details of domestic waste and approximate capacities anticipated during construction.

<sup>&</sup>lt;sup>13</sup> Tchobanoglous, G., Burton, F. L., & Metcalf & Eddy. (1991). Wastewater engineering: Treatment, disposal, and reuse. New York: McGraw-Hill.

Waste Type	Anticipated Quantity	# Workers	Total Solid Waste
Domestic Solid Waste	1.65kg per employee per week	117	193.05 kg/week

# Table 4.32: Domestic Waste during Pipeline Construction

The solid waste generated during the construction phase will be collected and segregated for recycle and non-recycle waste (i.e. paper, plastic). Project will use incineration on site and compost.

There will also be minimal other waste such as wood crates which will be provided to the local community as firewood.

*Table 4.33* presents details of the construction waste and approximate capacities anticipated during construction.

## Table 4.33: Construction Waste during Pipeline Construction

Waste Type	Amount
Concrete	75,000 kg
Steel Pipes	17,000 kg
Bentonite	1,000 m <sup>3</sup> total

Source: TPMC, 2019.

## Hazardous Waste

During the construction phase, hazardous waste material can originate from used paint, engine oils, hydraulic fluids, spent solvents, spent batteries, etc. Hazardous wastewater will be generated from chemical cleaning of the equipment during the pre-commissioning process.

The hazardous solid waste, and wastewater from construction activities will be transported off-site to the appropriate or licensed Hazardous Waste Treatment facilities, available in Myanmar.

*Table 4.34* presents the details of the hazardous construction waste and approximate capacities anticipated during construction.

Hazardous Material	Amount
Diesel oil	2 L per day
Hydraulic fluids	2 L per day
Paint	0.2 L per day
Battery	0.05 kg per day

## **Table 4.34: Hazardous Waste Quantities**

Source: TPMC, 2019.

#### Wastewater

Wastewater typically produced during construction includes sanitary/domestic wastewater, cement wash down, other plant cleaning/rinsing effluents, vehicle maintenance and the mixing of oils/lubricants in the wastewater (i.e. as a result of equipment washing).

Non-Hazardous wastewater will be generated from the toilet facilities and workers accommodation (sewage). Non-hazardous wastewater will also be generated from the canteen. The sewage generated onsite will be collected through underground pipes into a holding tank, from where the sewage will be

routed to an onsite sewage treatment plant or alternatively transported periodically by vacuum trucks and transferred to a septic tank or discharge to common drain.

The increased presence of the labour force in the local areas may also place pressure upon any existing sewage systems and wastewater treatment systems or may result in additional untreated discharges of sanitary and domestic wastewater to the local environment.

#### Sewage/Sanitary Wastewater

During construction, it is anticipated that the maximum number of workers will peak at 117. The quantities of sanitary wastewater can be estimated as an average of 50 litres/person/day, and considering sanitary wastewater production to be 80% of water consumption per person (for continuous use), this equates to a predicted 4,680 litres of sanitary wastewater per day at peak construction period. The EPC contractor will establish a management system for sanitary wastewater before construction.

## Hydrostatic Testing

Hydrostatic testing fluid is comprised of river water from the Yangon River, and there will not be any chemical dosing. Once hydrostatic testing is completed, the fluid will be discharged back into the Yangon River. The fluid will not contain any chemical dosing; therefore, it will not be considered hazardous. It is expected that the amount of discharged hydrostatic testing fluid is approximately 2,500 m<sup>3</sup>.

# 4.7.2.13 Health and Safety

# Emergency Response Plan

TPMC has in place a Project Incident and Emergency Response Plan to provide the necessary course of action during an unplanned event, during the construction and operation phase.

The potential emergency scenarios that apply to this plan are as follows:

- Person(s) fall from height on land;
- Material fall from height;
- Vehicle collision with plant/equipment/pedestrian(s);
- Vehicle incident offsite;
- Collapse of scaffold no person(s) present/person(s) present;
- Collapse of structure no person(s) present/person(s) present;
- Collapse of deep excavations person(s) present;
- Fire/Explosion electrics, substances;
- Chemical spillage on land;

- Medical emergency mass food poisoning/bird flu;
- Medical emergency contagious disease;
- Uncontrolled flammable/toxic release;
- Adverse weather conditions (flooding, lighting strike);
- Loss of services (water, sewerage, electricity);
- Radiation (Radiation Source Exposition); and
- Other (Earthquake, terrorist act, bomb threat, trespassers).

The full Project Incident and Emergency Response Plan is shown in Appendix H.

## Site Security Procedure

The site security procedure is designed to provide a secure environment for employees that are on site, during the construction phase.

The main topics that this procedure covers are as follows:

- Physical barriers (Fence, Gates);
- Badge (Personal access control);
- Mobilization and demobilization of employees;
- Guards;
- Vehicle policy;
- Security supervision; and
- Photography control.

Asset control;

The full Site Security Procedure is shown in Appendix I.

#### Personnel Protective Equipment Procedure

The purpose of this procedure is to establish specifications, decision criteria, and guidance for Personal Protective Equipment (PPE) to ensure the proper level of safety is met and to protect workers from injuries and occupational health illnesses, during the construction phase. The full Personnel Protective Equipment Procedure is shown in *Appendix J*.

## 4.7.3 Operation

The main features of the pipeline have been summarised in Section 4.7.1.

After the construction of the pipeline is completed, operation and maintenance will be carried out by TPMC; therefore, there will be no Operation and Maintenance (O&M) contract with any third party operator, as the Project will be owned and operated by the Project Proponent.

O&M staff with relevant experience of operating similar Project component and with adequate knowledge of comparable technology will be deployed prior to commercial operation date (COD) to commission and take over the Project from the EPC Contractor.

During normal operations, the pipeline will transfer natural gas from the RU (located at the LNG Receiving Terminal) to the Power Plant.

#### 4.7.3.1 Maintenance

Given that TPMC will follow ASME B31.8, and other standards for the Pipeline, the following maintenance criteria and procedures will be followed to ensure safe operations:

- ASME B31.8 Chapter V Operating and Maintenance Procedures;
- ASME B31.8 Chapter VI Corrosion Control;
- ASME B31.8 Appendix K Criteria for Cathodic Protection;
- ASME B31.8 Appendix L Determination of Remaining Strength of Corroded Pipe; and
- ASME B31.8 Appendix M Gas Leakage Control Criteria.

The indicative pipeline maintenance plan is listed in *Table 4.35*.

Maintenance Description	Standard	Frequency
Conduct internal cleaning, using a Pigging System	ASME B31.8, 860.2, 864.1	Once every 1 year
Inline inspection for corrosion (internal and external) and pipeline alignment	ASME B31.8, 860.2, 863.2	Once every 5 years
Pipeline warning sign condition	ASME B31.8, 851.7	Four (4) times per year
Pipeline Settlement and Soil Erosion	ASME B31.8, 841.1.10, 841.1.11	Once every 1 year
Pipeline Leakage Surveys	ASME B31.8, 851.3, 852.2, Appendix M	Once every 1 year
Pipe to Soil Potential Survey	ASME B31.8, 62.1, Appendix K, NACE RP-0169 If corrosion is found: ASME B31G and ASME B31.8, 863	Two (2) times per year
Close Interval Pipe to Soil Survey	NACE RP-0169	Two (2) times per year (Only significant areas)
Coating Defect Survey	ASME B31.8, 852.6.1	Once every 10 years

Table 4.35: Indicative Pi	peline Maintenance Plan

Source: TPMC, 2019.

#### 4.7.3.2 Operational Workforce

The only personnel expected to be involved with pipeline operation, are those within the control room supervising the SCADA system, and those involved with maintenance. Given that the control room is located at the Power Plant, and maintenance planning/scheduling will be given from the control room; all personnel involved with pipeline operations will be considered in the Power Plant workforce section.

## 4.7.3.3 Health and Safety

TPMC has in place a Project Incident and Emergency Response Plan to provide the necessary course of action during an unplanned event.

The potential emergency scenarios that apply to this plan are as follows:

- Person(s) fall from height on land;
- Material fall from height;
- Vehicle collision with plant/equipment/pedestrian(s);
- Vehicle incident offsite;
- Collapse of scaffold no person(s) present/person(s) present;
- Collapse of structure no person(s) present/person(s) present;
- Collapse of deep excavations person(s) present;
- Fire/Explosion electrics, substances;
- Chemical spillage on land;

- Medical emergency mass food poisoning/bird flu;
- Medical emergency contagious disease;
- Uncontrolled flammable/toxic release;
- Adverse weather conditions (flooding, lighting strike);
- Loss of services (water, sewerage, electricity);
- Radiation (Radiation Source Exposition); and
- Other (Earthquake, terrorist act, bomb threat, trespassers).

The full Project Incident and Emergency Response Plan is shown in *Appendix H*.

## 4.7.3.4 Block Valves

During normal operation, the block valves will remain open to allow uninterrupted flow of NG from the Regasification Unit to the Power Plant. During any unplanned events, particularly pipeline leakage, the block valves will close the pipeline, preventing any NG from passing through; therefore, limiting the amount of leaked NG.

# 4.7.4 Decommissioning

Decommissioning is the term used to describe all the stages involved in the closure and rehabilitation of the Pipeline. The process can generally be categorized into three (3) key phases as follows:

- Pre-decommissioning activities: includes the detailed planning (development of the decommissioning plan) and approval procedures;
- Decommissioning activities: removal of plant machinery & equipment and demolition, decommissioning of facilities, turbines and infrastructure, decontaminated land assessment and rehabilitation; and
- Post-decommissioning activities: site survey, close-out report and field monitoring as necessary.

# 4.7.4.1 Decommissioning Phase of the Project

At present, there are no plans or schedule for decommissioning of the proposed Project. It is likely that the Project facilities will only be decommissioned/ abandoned once it is no longer economical to continue operation, the plant is rendered redundant and/or no longer required for various reasons or is unsafe to operate. As the development process of the site is yet to fully begin, detailed decommissioning plans have not yet been formulated.

The Project facilities will be designed with decommissioning in mind. In general, facilities and machinery will be designed so that they can be isolated and decommissioned in steps which are in reverse of the installation procedure or which are most convenient to do so. The decommissioning phase activities will therefore be similar to those associated with the excavation/foundation work, installation and civil construction phases. The decommissioning plant will also take into account environmental rehabilitation, which includes the removal of all surface facilities and excess hydrocarbon waste, as well as re-vegetation of localized natural flora.

Associated decommissioning activities in accordance with environmental measures and standards of good practice are as follows:

- Removal of site infrastructure and waste;
- All civil structures and associated infrastructure will be removed;
- All remaining materials and hydrocarbons and hazardous waste will be removed;
- All pilings and trestles will be removed;
- All waste will be disposed of in an appropriate manner; and
- Reusable materials to be resold or recycled.

Hazardous Waste Clean Up and Transport:

- When decommissioned, all products within piping and storage infrastructure shall be removed from said system along with all associated infrastructure and possible contaminated soils; and
- All hazardous wastes shall be transported to approved hazardous waste storage facilities or disposal sites.

Site Rehabilitation:

- all disturbed areas due to ROWs, transmission lines, etc. shall be rehabilitated and revegetated;
- native flora shall be used to re-vegetate the rehabilitated sites;
- Roadways will be scarified; and
- Natural drainage patterns will be reinstated where practical.

#### 4.8 **Power Plant**

#### 4.8.1 Key Components

The Power Plant is designed to operate continuously, in combined cycle mode, this type of power plant is known as a Combined Cycle Power Plant (CCPP). During normal combined cycle operation, the heat of Gas Turbine exhaust gas will be admitted to the Heat Recovery Steam Generator (HRSG) where superheated steam will be produced which will drive the steam turbine to generate electrical power. The Gas Turbine, equipped with a generator, is generating electrical power as well. The exhaust gas from the HRSG will be released from the main stack of the HRSG to the atmosphere. It is anticipated that the Power Plant will operate at full load for the majority of the time.

The HRSG is designed for dual pressures steam generation (High Pressure (HP) and Low Pressure (LP)) used to maximize energy transfer from the exhaust gas of the gas turbine. The HP steam generated by the HRSG will be fed to the HP steam turbine and the LP steam will be fed to the LP steam turbine. The power output is net 388 MW during combined cycle operation. The Power Plant will use natural gas as the only fuel.

The indicative general layout of the Power Plant is shown in *Figure 4.38*. In addition, the Power Plant's Process Flow Diagram (PFD) is shown in *Figure 4.39*. The project components and details are listed below in *Table 4.36*.

Component	Details	
Land Area	8.97 acres (approx.)	
Power Plant Installed Capacity	388 MW	
Plant Configuration	Two (2) Gas Turbines, two (2) HRSGs, and one (1) steam turbine	
Steam Turbine	Condensing Steam Turbine (single casing turbine)	
HRSG	Horizontal Drum Units	
Cooling System	Cell Type Wet Cooling Tower (with induced draft)	
Electrical Generators	Three (3) Totally Enclosed Water to Air Cooled Electrical Generators (One for each Turbine)	
Step Up Transformers	2 Winding Transformers Preferred (1 Transformer for 1 generator)	
Switchyard	Gas Insulated Switchyard (GIS) (Single Busbar Configuration, operated by MOEE)	
Embedded Environmental Control	<ul> <li>Multi-chambers combustion system</li> <li>Single gas fuel combustion system with DLN combustors</li> <li>Ignition system with spark plugs and U.V. flame detectors</li> </ul>	
Stacks	<ul> <li>Diameter 5 meters appx.</li> <li>Height 40 meters appx.</li> <li>Carbon Steel with internal painting</li> </ul>	
Operation Period	25 years	

#### Table 4.36: Power Plant Key Components

Source: TPMC, 2019.



# Figure 4.38: Power Plant Layout

Source: TPMC, 2019. (Modified by ERM)

#### PROJECT DESCRIPTION AND ALTERNATIVES

	L M TN	ŀ
	270 PN 180' 90'	9
	STG Area	
	GTG Area for Unit 1 & 2	
	HRSG Area for Unit 1 & 2	2 <sup>8</sup>
	📟 River Pontoon Area	_
	Water Treatment Area and Demin Area	7
	ExistingSettling Pond Area	
		6
		5
		4
	TOTAL REQUIRED AREA 36,300 m2 or 8.97 Acres	3
	2         APPROED FOR PLANNO-2         PSUT         0         0         √ <td>2</td>	2
	TTCL Power Myanmar Company Limited	_
	Not Seemed and the network of network network is allowed and the network of the network	1
METERS	GENERAL PLOT PLAN	
1	SCALE : 1/400 DWG. NO. F050-AD-010-02	-



# Figure 4.39: Process Flow Diagram (PFD) of the Power Plant

Source: TPMC, 2019.

#### 4.8.1.1 Gas Turbine

Two (2) gas turbine units will be installed for the Project. The gas turbine will be installed within an acoustic, ventilated enclosure with fire detection and protection systems. The gas turbine will have all associated ancillary equipment and systems required for the safe, efficient and reliable operation of the unit under combined cycle operation. The gas turbine specification for each unit is shown in **Table 4.37**.

Features	Specifications
Fuel system	Gas only
Starting Means	Medium Voltage starting AC motor with Hydraulic torque converter
Air filtration	Static type
Compressor/Turbine Cleaning	On and Off-line Compressor Water Wash
Exhaust System	Side
Emissions Control	Gas – Dry Low Emission
Fire Detection	Heat Detectors
Gas Leak Detection	Gas detectors
Fire Protection	High pressure CO <sub>2</sub> System

## Table 4.37: Gas Turbine Specification

Source: TPMC, 2018.

The gas turbine will be capable of operation with its exhaust gases passing into the associated heat recovery steam generator, located on the exhaust ducting upstream of the heat recovery boiler.

All cooling requirements for the turbine shall be met using heat exchangers, fed from the Closed Circuit Water (CCW) system.

Control of emissions of NOx will be achieved by Dry Low NOx (DLN) burners. The detailed of embedded emission controls are described in a subsequent section.

## 4.8.1.2 Heat Recovery Steam Generator (HRSG)

The HRSG shall be a dual pressure drum type. The HRSG shall be designed to match the gas turbine which fires natural gas. The HRSG shall be able to follow load changes of the gas turbine. Given that one (1) HRSG unit is designed to be paired with one (1) gas turbine, and the Project is designed to have two (2) gas turbines, the Project is also designed to have two (2) HRSG units.

The HRSG and associated equipment shall be designed for base load operation, but with provision for cyclic operation. The heating surfaces shall be optimised to achieve a high and economical steam output without creating any operation problems such as evaporation in the economisers or unstable conditions in the evaporators.

The HRSG consists of an economizer, evaporator, and super-heater tube bank section(s) with finned tubing, as appropriate, to maximize heat transfer. No supplemental firing facilities will be installed.

All pressure parts will be designed, manufactured and tested in accordance with "ASME Boiler and Pressure Vessel Code, Section 1, Power Boilers" or equivalent standards.

The HRSG specification is provided in *Table 4.38*.

Feature	Specifications
HP steam flowrate	187 t/h (to be determined)
HP steam pressure	77.5 bar(a) (to be determined)
HP steam temperature	513°C (to be determined)
LP steam flowrate	37 t/h (to be determined)
LP steam pressure	6.5 bar(a) (to be determined)
LP steam temperature	217°C (to be determined)

#### Table 4.38: HRSG Specification (at design condition)

Source: TPMC, 2018.

## 4.8.1.3 Steam Turbine

Given that the Project is designed to have two (2) gas turbines, and two (2) HRSG units, to achieve optimal efficiency from this configuration, the Project is also designed to have one (1) steam turbine.

Steam turbine is a single casing, axial exhaust, direct drive turbine. The steam turbine will be of proven design and complete with all auxiliary oil and steam systems. The steam turbine specification is outlined in *Table 4.39*.

The steam turbine shall be designed with provisions to enable the combined cycle plant. The cooling system for the steam turbine condenser will be a mechanical draft cooling tower cooling system using river water as cooling medium.

Feature	Specifications
Rated out power	131 MW (to be determined )
Rated power factor	0.85 (lagging)
Rated rotation	3000 r/min
Rated frequency	50 Hz
Phase number	3
Cooling mode	TEWAC (Totally Enclosed Water-To-Air Cooled)
Insulation class	Class F (temperature rise as per Class B)
Exciting mode	Brushless Excitation System

#### **Table 4.39: Steam Turbine Specifications**

Source: TPMC, 2018.

#### 4.8.1.4 Condensers and Auxiliaries

The condensate system, which consists of the condensate extraction pump, returns the exhaust steam from the steam turbine to be condensed and returned back into the water-steam cycle. When the condensate extraction pump is operated, the recirculation control valve regulates the minimum flow required for the condensate extraction pump, and the condensate level control valve regulates the condensate level in hotwell of the main condenser.

The condensate flow is passed through the gland condenser, HRSG external heat exchanger, and make up to the deaerator and storage tank.

## 4.8.1.5 Feed Water System

The feed water system will provide sufficient and reliable feed water to the HRSG from the demineralization plant. The HP/LP Boiler Feed water flow rate shall be approximately 445.7 t/h and the quality shall be in accordance with STG and HRSG Original Equipment Manufacturer recommendations.

The feed water system will include necessary feed water heaters, de-aerators, feed water pumps, control valves and auxiliaries.

#### 4.8.1.6 Circulating Water System

A wet evaporative cooling system shall be provided with Cooling Water (CW) flow to remove heat from the condenser to the atmosphere using a cooling tower. The main CW system shall incorporate the condenser, CW pumps, one cold CW supply pipe feeding the condenser and one hot CW return pipe to return the water to a single mechanical draught wet cooling tower. All valves, instruments and controls shall be included. The layout of the system shall facilitate unrestricted airflow into the cooling tower and access for lifting equipment for maintenance.

The auxiliary cooling water supply (ACS) shall be an integral part of the main CW system. Cooling of auxiliary equipment is through a closed cycle cooling water heat exchanger. The ACS shall be operated for start-up period and shut down period. During normal operation, after the main condenser is ready for operation, the main CW pump will supply cooling water to the closed cycle cooling water heat exchanger and HRSG Blowdown tanks, instead of the Auxiliary cooling water pump by switching the manual valve. A complete water management diagram shall be provided showing CW, ACW and CCCW systems during the design review phase of the Project.

A make-up water system, blowdown system and automatic chemical dosing system shall be provided to maintain CW quality and concentrations of controlled chemicals.

# 4.8.1.7 Closed Cooling Water System

The Closed Cooling Water System is designed to provide reliable cooling water (demineralized water) to the CCPP over the range of ambient and operating condition. The closed cooling water system is of the closed type with indirect coolers. The heat is transferred to the closed loop cooling water by typical heat exchanger equipment and is removed from the closed system by an exchanger with aux circulating cooling water. Normally, closed cooling water will supply to the following users;

- ST Generator Air Coolers
- ST Lube Oil Coolers
- ST Vacuum Unit Heat Exchanger
- Sampling Coolers Unit
- HP/LP Boiler Feed Water Pumps
- GT Generator Air Coolers
- GT Lube Oil Coolers
- Air Compressors

The system shall have a make-up line which is connected from the demineralized water supply header. The closed cooling water head tank provided as part of the closed cooling water system shall be fitted with overflow vent and drain valve.

# 4.8.1.8 Water Intake Pumping Station

The raw water will be taken from the Yangon River, using the Water Intake Pumping station at the flow rate of approximately 916 m3/hr. There are existing water intake pumps located on the existing pontoon,

which supplies water to the existing 121 MW Ahlone Power Plant. A pontoon is a floating structure that is anchored to a specific location; however, it is allowed to move vertically, depending on water level. For this Project, an additional pontoon and walkway will be constructed, with the new walkway to be connected to the existing walkway. The materials that will be used for the construction of the pontoon and walkway is listed in *Table 4.40*. The proposed, and existing pontoon and walkway is shown in *Figure 4.40*. The proposed pontoon is approximately 8 m long, and 5 m wide.

## Table 4.40: Pontoon and Walkway Material

Structure	Material
Pontoon	Steel Flooring, PVC Floatation Device
Piles (for Pontoon Anchor)	Steel
Walkway	Wood

Source: TPMC, 2019.



#### 4.8.1.9 Water Treatment System

Water treatment system shall be located within the CCPP. Service water supply from raw water treatment plant shall be stored in one carbon steel welded construction. Service water storage tank shall be sufficient to allow continuous operation of the CCPP at Maximum Power Output Cogeneration for a period of at least 16 hours under all conditions, and still contain minimum fire water reserve volume for the time required for firefighting purposes.

Service water shall be used to further produce treated water and demineralized water. EPC Contractor shall be responsible for providing and connecting the facilities required for water treatment including any required equipment until sending the treated water to store at the storage tank (e.g. treated water storage tank and demineralized water storage tank).

A demineralized water treatment system and storage tank shall be provided with adequate capacity to supply the CCPP for a minimum of 20 m<sup>3</sup> of treated water consumption. The treated water storage and pumping systems shall be of adequate capacity to ensure secure supply to all users without disruption.

Electrodeionization process shall be applied for demineralized water treatment system. It shall be provided to supply demineralized make-up water to the steam cycle and the closed circuit cooling water as required. The system shall be capable to produce of demineralized water without any limitation on the fresh water compositions delivered to the water treatment plant for processing into demineralized water. Quality of demineralized water produced shall be such that it meets the quality requirements for water and steam after chemical dosing in accordance with recognized international codes and operation and maintenance guidelines for HRSG and steam turbines.

A demineralized water storage tank shall be provided with adequate capacity to supply the CCPP for a minimum of 72 hours of demineralized water consumption under highest consumption operating conditions. The demineralized water storage and pumping systems shall be of adequate capacity to ensure secure supply to the CCPP for all CCPP operating conditions.

The location of the Water Storage Tank is shown in the Indicative Site Layout (Figure 4.38).

## 4.8.1.10 Wastewater Treatment System

The wastewater system will collect and dispose of the following plant wastes:

- HRSG blowdown;
- Water treatment plant(s) wastewater;
- Other contaminated water including, but not limited to, contaminated rainwater, process water and spillages, plant and equipment wash water, water with oily substances; and
- Domestic sewage.

Continuous monitoring equipment for the continuous monitoring of key parameters in the wastewater discharge stream will be installed as well as manual sampling equipment to allow daily laboratory analysis of other parameters in the waste water discharge stream. The wastewater effluent quality of pH, temperature and flow shall be monitored by on-line analyser while others shall be by laboratory analysis using laboratory equipment. Wastewater effluent pH, temperature and flow will be measured in waste water effluent piping immediately upstream of waste water terminal point. HRSG blowdown shall be supported to make up cooling water system to minimize service water consumption. Cooling water blowdown can be discharge directly to natural floodway.

Waste from the water treatment plant shall be treated as required prior to being sent to the final pit.

All site drainage from the main plant area shall be piped to a "contaminated drains" area for treatment. Other contaminated water shall also be treated as required and collected in the final pit.

Where contaminated water includes oily substances such as oily water from the transformer area, etc. oil interceptors shall be included in the drains of the proposed development. The oily water shall then

be sent to an oil collection pit. After douched from raining (15 minutes), the operator will switch the bypass valve (open), and valve to oil collection pit (closed) respectively for change direction of rain water to storm drain. The separated oil will form at the top of the oil collection pit and will be removed and disposed by the operator accordingly.

On Site sewage shall be collected separately from the uncontaminated storm water and contaminated water streams and discharged into a standalone septic tank system.

The EPC Contractor will ensure that all wastewater streams meet the discharge requirements stipulated in the effluent level guideline limit. The EPC Contractor will address in the design review phase of the project the means in which it achieves compliance with the wastewater discharge in respect to discharge temperature, flows and qualities for all ambient temperatures and CCPP operating conditions.

The Project will be equipped with a fully operational wastewater treatment plant capable of treating all process effluents and other wastewater streams. A septic tank will also be installed for domestic wastewaters.

The Power Plant will have two (2) discharge locations. The first discharge point is for storm drainage, whereas the second discharge point is for continuous process drain and storm drainage (intermittent), as shown in *Figure 4.41*. A section view of the discharge pipe design is shown in *Figure 4.42*.



Figure 4.41: Power Plant Discharge Locations

Source: TPMC, 2018.



Figure 4.42: Section View of Discharge Pipe Design

Source: TPMC, 2018.

PROJECT DESCRIPTION AND ALTERNATIVES

# 4.8.2 Construction Phase

## 4.8.2.1 Construction Schedule

The construction phase for the Power Plant will take approximately 28 months. The EPC Contractor will prepare the site for construction, erection and installation of the Project facilities. Site preparation may include additional earthwork activities after the site is levelled like installation of circulating water intake structure. The construction, design and testing will be undertaken in accordance with the Myanmar NEQ (Emission) Guidelines and WB/IFC EHS Guidelines.

#### 4.8.2.2 Mobilization

Site construction work will start once civil design of sites preparation is finalised. All work will be conducted in accordance with the detailed master construction schedule, provided by the EPC Contractor. Prior to commencement of work, all contractors would be required to provide detailed site specific plans related to:

- Equipment use;
- Excavation and backfilling management;
- Soil erosion management;
- Traffic management (including vessels operation/ movement);
- Storm water pollution prevention plan;
- Dust prevention plan;
- Environmental and Social Management Plan;
- Waste Management Plan; and
- Plan drawings of laydown, traffic flow, parking, trash storage, and recycling areas.

It is expected as a part of the mobilisation phase the Project sites will be fenced and a construction camp will be located inside the Project boundary.

## 4.8.2.3 Earthwork

Earth works will include clearing of vegetation and grading of the Project site. It is anticipated that the subsoil, which will be stripped and removed from the Project site, shall be utilised for levelling/ backfilling, it is also anticipated that the amount of soil that will be removed due to excavation activities and then backfilled is approximately 29,600 m<sup>3</sup>. The Plant construction site, being partially in an area subjected to flooding will require careful study of potential placement of elevation and flood barriers.

Grading of the site will be done by the design team, considering sufficient height to protect the power plant from potential water and tidal/ flood damage. Such elevation will be studied further as part of the detailed design stage in order to confirm that the site elevation does not pose a flood threat to the surrounding areas.

## 4.8.2.4 River Work

The Project will involve the construction of a new pontoon and walkway to connect the pontoon to an existing walkway. Given the size of the pontoon and walkway that is required to be constructed, land based equipment will be used to install the walkway, whereas the crane barge will install the pontoon and steel piles. Dredging will not be required for the construction of the pontoon. Further details regarding the pontoon and walkway will be discussed further in **Section 4.8.2.9**.

# 4.8.2.5 Site Foundation

The geological conditions of the Project site will be studied in the detailed design stage however, it is proposed that lightly loaded structures with equipment not sensitive to settlement may be supported on spread footings and/or mat foundations, provided the sub grade is adequately compacted. Other structures and/or settlement sensitive equipment shall be supported on piles.

# 4.8.2.6 Major Project Works

Table 4.41 presents major Project works to be undertaken as a part of the Project construction.

Item	Description
Gas turbine and generators (GTGs)	<ul> <li>Separate structure for both units</li> <li>Separate acoustic enclosure with ventilation of turbine and generator</li> <li>Removable panels for maintenance access</li> </ul>
Heat Recovery steam generators (HRSGs)	<ul> <li>Separate structures for each unit</li> <li>Deaerator is common for both unit</li> </ul>
Steam turbine and generator (STG)	<ul> <li>Common weather enclosure of turbine and generator</li> <li>Removable panels for maintenance access</li> </ul>
Electrical and Control Building	<ul> <li>Steel structure construction for Electrical room</li> <li>Reinforced concrete construction for Control room.</li> </ul>
Stacks	<ul> <li>Diameter 5 meters appx.</li> <li>Height 40 meters appx.</li> <li>Carbon Steel with internal painting</li> </ul>
Cooling water intake system	Make up water for cooling tower will be service water. Raw water will be sourced from Yangon River pass through existing settling pond and Raw water treatment package for cooling tower make and for all the other uses in the power plant. Demineralise water will be needed for feed water make up.
Water treatment facility	<ul><li>Demineralised unit</li><li>Designed to house the pre-treatment and associated equipment</li></ul>
Fire pump	Steel structure construction
Diesel generator building	<ul> <li>Reinforced concrete frame construction</li> </ul>
Equipment control building	<ul> <li>Separate structures for gas turbine package</li> </ul>
Environmental Embed control (Low NOx Burner)	<ul> <li>Multi-chambers combustion system</li> <li>Single gas fuel combustion system with DLN combustors</li> <li>Ignition system with spark plugs and U.V. flame detectors</li> </ul>
CEMS	Monitor: SOx as SO2, NOx as NO2, O2, and CO
Support facilities	Workshop
Administration	<ul> <li>Reinforced concrete frame structure</li> </ul>
Operator housing	<ul> <li>Constructed of 4 buildings within the Project area to accommodate approximately 250 person</li> </ul>
Pontoon	<ul> <li>Steel pontoon, with steel piles for anchoring pontoon.</li> <li>Wooden walkway linking proposed pontoon to existing walkway.</li> </ul>

## Table 4.41: Major Project Works for the Power Plant

Source: TPMC, 2018.

Reinforced concrete structures shall be used for primary plant facilities and facilities exposed to an aggressive environment. These facilities are primarily low-rise buildings/structures that have a large

footprint area relative to their height. Conversely, steel is used for large expansive structures. The construction methods will be provided by the EPC Contractor.

# 4.8.2.7 Construction Workforce

The overall anticipated workforce during construction is shown in *Table 4.42*. The anticipated work for Power Plant and Pontoon area is shown in *Table 4.43*. The anticipated number of vessels used for the pontoon is shown in *Table 4.44*.

Wastewater management systems of all construction vessels will comply the International Convention for the Prevention of Pollution from Ships (MARPOL).

Workforce Origin	Average No. of Skilled Workers	Average No. of Semi-Skilled Workers	Average No. of Unskilled Workers	Total Average Workforce (per day)	Total Peak Workforce (per day)
Local Workforce	80	12	200	400	600
Migrant Workforce	40	6	0	400	600

## **Table 4.42: Anticipated Workforce during Construction**

Source: TPMC, 2019.

## Table 4.43: Anticipated Workforce for Power Plant, and Pontoon Construction

Component	Workforce	
Power Plant	580	
Pontoon	20	

Source: TPMC, 2019.

## Table 4.44: Anticipated Number of Vessels during Construction

Type of Vessel	Number of Vessels	Number of Workers per Vessel
Crane Barge	1	3

Source: TPMC, 2019.

## 4.8.2.8 Temporary Construction Camp and Laydown Area

The EPC contractor has selected available space within the Ahlone Power Plant compound to use for the laydown area for the Power Plant construction. Imported materials is expected to shipped to the AWP; Trucks will be used to transport the materials from the AWP to the laydown area. The laydown area is used for storage of materials and equipment that will be used for the construction Project. Trucks will be used transport material/equipment from the laydown area to the Power Plant construction area. The laydown area for the construction of the Power Plant shown in *Figure 4.43*.





Source: TPMC, 2019.

#### 4.8.2.9 Pontoon and Walkway Construction

The pontoon and walkway construction is expected to take approximately three (3) months, and will be installed alongside with the waterfront for placement of the water intake pumps.

The warning light shall be installed on Pontoon and walkway structure. A crane barge will be used to install the piles and pontoon structure; whereas the walkway will be constructed by land-based tools and equipment.

Once the piles and pontoon is complete, installation of the water intake pumps, and other topside equipment will proceed; a crane barge will lower the pumps directly onto the pontoon. Other topside equipment such as the electrical boxes will be installed by moving the equipment from onshore directly onto the walkway.

All construction vessels will comply with MARPOL 73/78, developed by the International Maritime Organization for pollution prevention from ships.

## 4.8.2.10 Power and Water Supply

Approximately 3,000 kW of electricity will be required during the peak construction period, with an average consumption rate of 300 MWh/mth. The electricity will be sourced from the existing 33 kV distribution line. The Contractor shall provide 33 kV/380 V box-type transformer and 300kW diesel generator for emergency.

During construction, water is required for construction worker activities and prefabricated concrete activities. The maximum number of workers onsite during construction is anticipated to be 600 persons and each worker is estimated to consume approximately 33.3 litres of water per day<sup>14</sup>. Prefabricated concrete activities are estimated to consume 40 m<sup>3</sup> of water per day per litre of concrete. All construction activities are estimated to consume 65 m<sup>3</sup> of water per day.

The average water consumption rate during construction is anticipated to be 624 m<sup>3</sup> per month (approximately 30 m<sup>3</sup> (30,000 L) per day).

The raw water required during construction will be obtained from the local water distribution services. The raw water will be treated and purified to supply for construction.

# 4.8.2.11 Construction Waste

## Solid Waste

During the construction phase, non-hazardous solid waste material is likely to be produced from concrete, steel pipes, steel plates, structural steel and wooden crates. Opportunities will be explored for selling the steel plates and structural steel. The wooden crates will be disposed of by an appropriate or a licensed waste contractor. It is anticipated that the amount of non-hazardous waste produced during the construction phase is approximately 4,437 tons.

There will also be biomass waste associated with the clearance of tree, shrubs and grass. Approximately 10,560 m<sup>3</sup> of biomass waste is anticipated during construction. Opportunities for providing biomass waste to the local community will be explored or biomass waste will be disposed of by an appropriate or a licensed waste contractor.

All excavated material will be backfilled with no surplus.

Appropriate storage and disposal facilities for waste shall be constructed on Site. Bunded, hardstand and roofed areas are a general requirement for hazardous waste such as waste oils, paints and chemicals.

<sup>&</sup>lt;sup>14</sup> Tchobanoglous, G., Burton, F. L., & Metcalf & Eddy. (1991). Wastewater engineering: Treatment, disposal, and reuse. New York: McGraw-Hill.

*Table 4.13* presents details of domestic waste and approximate capacities anticipated during construction.

Waste Type	Anticipated Quantity	# Workers	Total Solid Waste
Domestic Solid Waste	1.65kg per employee per week	600	990 kg/week

#### Table 4.45: Domestic Waste during Power Plant Construction

The solid waste generated during the construction phase will be collected and segregated for recycle and non-recycle waste (i.e. paper, plastic). Project will use incineration on site and compost.

There will also be minimal other waste such as wood crates which will be provided to the local community as firewood.

*Table 4.14* presents details of the construction waste and approximate capacities anticipated during construction.

#### Table 4.46: Construction Waste during Power Plant Construction

Waste Type	Amount	
Concrete	4,331 Tons	
Steel Pipes	11.6 Tons	
Structural Steel	3.9 Tons	
Wooden Crates	90 Tons	

Source: TPMC, 2019.

## Hazardous Waste

During the construction phase, hazardous waste material can originate from used paint, engine oils, hydraulic fluids, spent solvents, spent batteries, etc. It is anticipated that the amount of hazardous waste produced during the construction phase is listed in *Table 4.47*.

#### Table 4.47: Hazardous Waste Quantities

Hazardous Material	Amount
Diesel oil	10 L per day
Hydraulic fluids	5 L per day
Paint	10 L per day
Battery	0.2 kg per day

Source: TPMC, 2019.

The hazardous waste from chemical cleaning will be transported off-site to the appropriate or licensed Hazardous Waste Treatment facilities, available in Myanmar. Solid hazardous waste from the construction phase will be properly contained and transported off-site to an appropriate or licensed waste disposal contractor.

#### Wastewater

Wastewater typically produced during construction includes sanitary/domestic wastewater, cement wash down, other plant cleaning/rinsing effluents, vehicle maintenance and the mixing of oils/lubricants in the wastewater (i.e. as a result of equipment washing).

Non-Hazardous wastewater will be generated from the toilet facilities and workers accommodation (sewage). Non-hazardous wastewater will also be generated from the canteen. The sewage generated onsite will be collected through underground pipes into a holding tank, from where the sewage will be routed to an onsite sewage treatment plant or alternatively transported periodically by vacuum trucks and transferred to a septic tank or discharge to common drain.

The increased presence of the labour force in the local areas may also place pressure upon any existing sewage systems and wastewater treatment systems or may result in additional untreated discharges of sanitary and domestic wastewater to the local environment.

Hazardous wastewater will be generated from chemical cleaning of the equipment during the precommissioning process.

The hazardous wastewater from chemical cleaning will be transported off-site to the appropriate or licensed Hazardous Waste Treatment facilities, available in Myanmar. Solid hazardous waste from the construction phase will be properly contained and transported off-site to an appropriate or licensed waste disposal contractor.

#### Sewage/Sanitary Wastewater

During construction, it is anticipated that the maximum number of workers will peak at 600. The quantities of sanitary wastewater can be estimated as an average of 50 litres/person/day. Considering the expected amount of sanitary wastewater produced is approximately 80% of the total water consumption per person (for non-continuous use), this equates to a predicted 24,000 litres of sanitary wastewater per day at peak construction periods. The EPC contractor will establish a management system for sanitary wastewater before construction.

# 4.8.2.12 Health and Safety

# Emergency Response Plan

TPMC has in place a Project Incident and Emergency Response Plan to provide the necessary course of action during an unplanned event, during the construction and operation phase.

The potential emergency scenarios that apply to this plan are as follows:

- Person(s) fall from height on land;
- Material fall from height;
- Vehicle collision with plant/equipment/pedestrian(s);
- Vehicle incident offsite;
- Collapse of scaffold no person(s) present/person(s) present;
- Collapse of structure no person(s) present/person(s) present;
- Collapse of deep excavations person(s) present;
- Fire/Explosion electrics, substances;
- Chemical spillage on land;

- Medical emergency mass food poisoning/bird flu;
- Medical emergency contagious disease;
- Uncontrolled flammable/toxic release;
- Adverse weather conditions (flooding, lighting strike);
- Loss of services (water, sewerage, electricity);
- Radiation (Radiation Source Exposition); and
- Other (Earthquake, terrorist act, bomb threat, trespassers).

The full Project Incident and Emergency Response Plan is shown in *Appendix H*.

# Site Security Procedure

The site security procedure is designed to provide a secure environment for employees that are on site, during the construction phase.

The main topics that this procedure covers are as follows:

- Physical barriers (Fence, Gates);
- Badge (Personal access control);
- Mobilization and demobilization of employees;
- Guards;
- Vehicle policy;
- Security supervision; and
- Photography control.

Asset control;

The full Site Security Procedure is shown in Appendix I.

## Personnel Protective Equipment Procedure

The purpose of this procedure is to establish specifications, decision criteria, and guidance for Personal Protective Equipment (PPE) to ensure the proper level of safety is met and to protect workers from injuries and occupational health illnesses, during the construction phase. The full Personnel Protective Equipment Procedure is shown in *Appendix J*.

## 4.8.3 Operation Phase

The main features of the power plant have been summarised in Section 4.8.1.

There will be no Operation and Maintenance (O&M) contract with any third party operator, as the Project will be owned and operated by the Project Proponent. The O&M of the Project will be undertaken by the Project Proponent with the support of a long term service agreement (LTSA) for the GT with the manufacturer and external expertise on each function to counterpart and provide the intensive in house training during commission until 3 years after SCOD. The LTSA will cover the supply of spare parts, supervision and specialized technicians for inspections, major and minor overhauls.

O&M staff with relevant experience of operating similar plants and with adequate knowledge of comparable technology will be deployed prior to commercial operation date (COD) to commission and take over the Project from the EPC Contractor. Approximately 50 staff will work on the operational phase of the Project.

The below sections will discuss further the key activities during Operation Phase.

## 4.8.3.1 Water Supply

The main freshwater supply source will be taken from Yangon River. However, the use of surface water will be determined and assessed at the later stage to ensure no disruption to the local communities. In addition, the pre-water treatment plant will be installed to provide freshwater for operation phase.

The raw water will be passed through a coagulation mixer, flocculation tank and clarifier prior to collection in Service water and Firefighting storage tank as service water. Service water is majority of the water will be supplied to meet the plant water users and demineralized water requirement.

Table 4.48 presents the water requirements and their volumes during operation.

Water Requirement	Volume	
Cooling water system	601 m <sup>3</sup> /h	
Domestic water (local authorized)	4 m³/h	

## Table 4.48: Water Requirement during Operation

Source: TPMC, 2018.

The raw water will be taken from Yangon River, using the Water Intake Pumping station at the flow rate of approximately 916 m<sup>3</sup>/hour.

The lowest flow rate estimated from flow velocity measurements in the dry season in the intake location of the Yangon River. The maximum intake requirement for the Project is expected to be 916 m<sup>3</sup>/hr. This is equivalent to approximately 0.83% of the lowest dry season flow in the river at the intake location. This is based on a worst case scenario, comparing the Project's maximum expected water withdrawal requirements, with a constant withdrawal over a 24-hour period, during the lowest measured flow rate in the dry season.

Based on the above comparison of the Project's water intake requirements with the estimated flow rates of the river during the dry season, it is expected that there will be adequate flow to support the Project's water withdrawal, and the Project is not expected to have any significant impacts on current water users for the Yangon River.

## 4.8.3.2 Storm Water

The rainwater, if not contaminated will be discharge directly to storm water drainage.

The Power Plant drain for storm water at areas of where lubricating oils are handled will be connected to an oil and grease pit (interceptor). The contaminants will be captured in the pit and removed manually. Contaminated storm water will be sent to the oil-water separator system before discharge to the final checking pond while uncontaminated storm water will be discharged offsite into the small water channel discharge point to the North West side of the Project Site. The estimated amount of discharge storm water is shown in **Table 4.52**.

The Power Plant will have two (2) discharge locations. The first discharge point is for storm drainage, with a total flow rate of 271 m<sup>3</sup>/h (intermittent) at ambient temperature. The second discharge point is for continuous process drain and storm drainage (intermittent), with a total flow rate of 210 m<sup>3</sup>/h (continuous) at 42 °C, and a total flow rate of 630 m<sup>3</sup>/h (intermittent) at ambient temperature.

# 4.8.3.3 The Anticipated Workforce

The anticipated workforce during operation is shown in Table 4.49.

Description	Staff Number
Permanent Staff	50 (O&M + Back Office)
Security (external)	12
Contract staff: Cleaners, Gardeners and helpers	10
Contract staff: Technical hands	10
Maintenance (once every 3 years)	90 for 30 days

## Table 4.49: Anticipated Workforce for the Power Plant

Source: TPMC, 2018.

# The Operational and Maintenance Workforce

The Operational and Maintenance (O&M) working will use 4 shift teams and additional daywork team to provide 24/7 coverage for plant operation and 8 hours per day.

The shift structure will be as follows:

- 8 hours per shift
- 32 staffs will be in the shift roster

Maintenance staffs are typically not rostered on shift work except for planned maintenance period.

## 4.8.3.4 Operational Waste

## **Operational Solid Waste**

During operation the re-use, recycle and minimization of waste ethic shall be adopted. A waste management plan will incorporate strategies for the re-use, recycle and minimization of waste on Site. Management strategies for regulated and hazardous waste shall also be included, including a methodology for tracking regulated/hazardous waste generation and disposal.

Appropriate storage and disposal facilities for waste shall be constructed on Site. Bunded, hardstand and roofed areas are a general requirement for hazardous waste such as waste oils, paints and chemicals.

Table 4.50 presents details of the solid waste and approximate capacities anticipated during operation.

Waste Type	Anticipated Quantity	# Employees	Total Solid Waste
Domestic Solid Waste	1.65kg per employee per week	50	82.5 kg/week

## Table 4.50: Solid Waste during Operation

Source: TPMC, 2019

The solid waste generated during the operation phase will be collected and segregated for recycle and non-recycle waste (i.e. paper, plastic). Project will use incineration on site and compost.

There will also be minimal other waste such as wood crates from maintenance activities which will be provided to the local community as firewood.

## **Operational Hazardous Materials**

The hazardous materials to be stored on site during operation are presented in **Table 4.51**. The chemicals will be transported appropriately to the Project site and Material Safety Data Sheets (MSDS) will be prepared from chemical suppliers in Myanmar.

Hazardous Material	Use of Hazardous Materials	Storage Location Onsite	Quantities to be Stored Onsite*
Oxygen Scavenger	Chemical Dosing System	Chemical Storage House	Estimate 1 m <sup>3</sup>
Phosphates	Chemical Dosing System	Chemical Storage House	Estimate 1 m <sup>3</sup>
Condensate Treatment	Chemical Dosing System	Chemical Storage House	Estimate 1 m <sup>3</sup>
Corrosion Inhibitor	Chemical Dosing System	Chemical Storage House	Estimate 4 m <sup>3</sup>
Biocides	Chemical Dosing System	Chemical Storage House	Estimate 34 m <sup>3</sup>
Sulfuric Acid	Chemical Dosing System	Chemical Storage House	Estimate 103 m <sup>3</sup>
Scale Inhibitor	Chemical Dosing System	Chemical Storage House	Estimate 4 m <sup>3</sup>
Sodium Hydroxide	Water Treatment System and Demineralised Water System	Chemical Storage House	Estimate 58 m <sup>3</sup>
Sulfuric Acid	Water Treatment System and Demineralised Water System	Chemical Storage House	Estimate 2 m <sup>3</sup>
Sodium Hypochlorite	Water Treatment System	Chemical Storage House	Estimate 115 m <sup>3</sup>
Poly Aluminium Chloride	Water Treatment System	Chemical Storage House	Estimate 39 tonne
Anion Polymer	Water Treatment System	Chemical Storage House	Estimate 2 tonne
RO Antiscalant	Water Treatment System and Demineralised Water System	Chemical Storage House	Estimate 1 m <sup>3</sup>
Sodium metabisulfite	Water Treatment System and Demineralised Water System	Chemical Storage House	Estimate 1 ton
Citric Acid	Water Treatment System and Demineralised Water System	Chemical Storage House	Estimate 1 ton
Diesel oil	Liquid fuel for emergency diesel engine generator, emergency diesel	Storage Tank	Estimate at 2 x 7200 litres x 3 days for fuel tank = 43,200 litres.

## Table 4.51: Hazardous Materials during Power Plant Operation

 generator

 Note: \*Estimated figures only for 2 months in chemical storage house

## 4.8.3.5 Operational Wastewater

The Power Plant will be equipped with a fully operational wastewater treatment plant capable of treating all process effluents and other wastewater streams. A septic tank will also be installed for domestic wastewaters.

*Table 4.52* presents details of the wastewater and approximate capacities which will be generated during operation.

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Item	Timing of Wastewater Generation	Capacity*
Wastewater from Power Plant	· · ·	
Sludge cake from river water pre- treatment	Normal Operation	Estimate 3 ton/day
DM plant neutralized water	Normal Operation	Estimate 20 m <sup>3</sup> / hour
Cooling tower blowdown	Normal Operation	210 m <sup>3</sup> / hour (Intermittent)
Storm water	Normal Operation	<b>Power Plant (Intermittent):</b> Discharge Point 1: 271 m <sup>3</sup> /h Discharge Point 2**: 630 m <sup>3</sup> /h
Washing water from Main Block	Normal Operation	Intermittent
Fire protection system	Emergency	-
Domestic Wastewater		
Kitchen	Normal operation	-
Wash room	Normal operation	-
Plant control room	Normal operation	-
Condensate polisher / safety shower	Emergency	-
Battery room/eye wash	Emergency	-
Water treatment plant/safety shower	Emergency	-
Sanitary/ Sewage Wastewater	Normal Operation	4 m <sup>3</sup> / hour

## Table 4.52: Wastewater during Operation

Note: \*estimate figures only

\*\*Value also contains process flow drain of 210 m<sup>3</sup>/h (continuous)

Wastewater from the plant process will be treated with pH control within a pH range of 6 to 9 in the neutralization treatment system and oil-water separator system. The treated wastewater will be discharge into final checking pond before discharge to the small water channel. Sewage will be treated in a package sewage treatment and discharged into the wastewater discharge system to the North West side of the Project site. The sludge will be dewatered and disposed off-site by an appropriate waste contractor.

## 4.8.3.6 Ancillary Structures

In addition to the main infrastructure on site, and as described above, the following ancillary buildings will be constructed:

- Administration building (incorporated of the Central Control Room);
- Gatehouse at the main gate of the site;
- Staff canteen; and
- Firefighting pump.

## 4.8.3.7 Emergency / Black Start Diesel Generators

The Power Plant will have combined emergency/black start diesel generator with a capacity 9,600 kW (to be determined) that will only be used during plant safe shutdown as well as for black start. The diesel will be transported appropriately to the Project site from diesel suppliers in Myanmar. Material Safety

Data Sheets (MSDS) will be completed for the diesel to ensure appropriate transportation. The diesel generator will be the stationary emergency type and will consist of control gear, lubricating oil system, fuel day tank, cooling system, direct current (DC) starting power and synchronizing equipment, and electrical protection system equipment. Following an emergency shutdown of the power plant, the diesel generators will provide electrical power to maintain the turbine generator unit and its auxiliaries in safe conditions. During area-wise blackout, the diesel generators will provide electrical power to start the CCPP.

# 4.8.3.8 Fire Protection System

The Power Plants fire protection system will provide personnel safety and plant protection through prompt detection, alarm and suppression of a fire. The system will be designed for any single design basis fire and will be in accordance with all local applicable codes and standards. The primary source of water for the system shall be from the plant's water system.

# 4.8.3.9 Health and Safety

TPMC has in place a Project Incident and Emergency Response Plan to provide the necessary course of action during an unplanned event.

The potential emergency scenarios that apply to this plan are as follows:

- Person(s) fall from height on land;
- Material fall from height;
- Vehicle collision with plant/equipment/pedestrian(s);
- Vehicle incident offsite;
- Collapse of scaffold no person(s) present/person(s) present;
- Collapse of structure no person(s) present/person(s) present;
- Collapse of deep excavations person(s) present;
- Fire/Explosion electrics, substances;
- Chemical spillage on land;

- Medical emergency mass food poisoning/bird flu;
- Medical emergency contagious disease;
- Uncontrolled flammable/toxic release;
- Adverse weather conditions (flooding, lighting strike);
- Loss of services (water, sewerage, electricity);
- Radiation (Radiation Source Exposition); and
- Other (Earthquake, terrorist act, bomb threat, trespassers).

The full Project Incident and Emergency Response Plan is shown in Appendix H.

# 4.8.3.10 Power Plant Maintenance

During operation, maintenance will be associated with the following:

- Routine Maintenance;
- Planned Preventive Maintenance; and
- Breakdown Maintenance.

# 4.8.3.11 Embedded Controls included in the Project Design to Control Impacts

The Project intends to include the additional emission control technologies to reduce air pollutant emissions to comply with applicable international standards; these are summarised in turn below:
# 4.8.3.12 Dry Low NOx Burners

The proposed power plant will be equipped with Dry Low NOx burners developed to achieve low NOx emissions.

The Project will provide Dry Low NOx burners which are Best Available Technology (BAT) for CCPP to guarantee NOx emission levels at the exhaust chimney of 25ppm by volume (dry) at 15% O2 levels (at base load of gas turbine).

# 4.8.3.13 Continuous Emissions Monitoring Systems (CEMS)

In addition to the emission reduction technologies, the proposed power plant will be installed with both manual stack sampling facilities and Continuous Emission Monitoring System (CEMS) including thermocouple and manual sampling ports.

Both manual stack sampling facilities and Continuous Emission Monitoring system (CEMS) shall be provided across the HRSG stack for continuous on-line monitoring the flue gas at CCR. The CEMS shall measure emissions from the flue gas at each HRSG stack.

The CEMS controller, Data Acquisition System (DAS) and report generation terminal shall be provided to collect and store the CEMS data and log alarms, generate periodic report, perform and edit CEMS functions, communicate with plant DCIS. All information, alarm and reporting functions shall be available through DCIS System.

The CEMS system will be common use for both HRSG stack and should be located adjacent to the HRSG stack and sized to contain all the analysers the DCIS interface. The CEMS system shall be completed with an environment control lighting and electrical distribution system. Electric power for all CEMS equipment shall be supplied from a UPS system. Power will be provided to the CEMS system container at 220 VAC 50 Hz.

All equipment in CEMS system shall be completely accessible. The CEMS shall be in accordance with the requirements of the US Environmental Protection Agency as stated in Title 40 Code of Federal Regulations (40 CFR) Part 60 "Standards of Performance for New Stationary Sources," and 40 CFR Part 60 Appendix B "Performance Specifications 1, 2, 3, 4 and 6" and Myanmar Local Regulation of Pollution and Environment.

The power plant shall furnish the oxides of nitrogen (NOx) analysers as per IFC and Myanmar NEQ Guidelines (2015). All equipment necessary to draw, filter, condition, or transport samples, or to periodically purge sample lines and probes shall be furnished

The emission data received from each analysing equipment via the data acquisition station shall be calculated and converted into the required values such as ppm, etc.

Its software shall be especially designed for emission evaluation. Reports shall be printed on dedicated printers.

# 4.8.4 Decommissioning

Decommissioning is the term used to describe all the stages involved in the closure and rehabilitation of the power plant site. The process can generally be categorized into three (3) key phases as follows:

- Pre-decommissioning activities: includes the detailed planning (development of the decommissioning plan) and approval procedures;
- Decommissioning activities: removal of plant machinery & equipment and demolition, decommissioning of facilities, turbines and infrastructure, decontaminated land assessment and rehabilitation; and
- Post-decommissioning activities: site survey, close-out report and field monitoring as necessary.

#### 4.8.4.1 Decommissioning Phase of the Project

At present, there are no plans or schedule for decommissioning of the proposed Project. It is likely that the Project facilities will only be decommissioned/ abandoned once it is no longer economical to continue operation, the plant is rendered redundant and/or no longer required for various reasons or is unsafe to operate. As the development process of the site is yet to fully begin, detailed decommissioning plans have not yet been formulated.

The Project facilities will be designed with decommissioning in mind. In general, facilities and machinery will be designed so that they can be isolated and decommissioned in steps which are in reverse of the installation procedure or which are most convenient to do so. The decommissioning phase activities will therefore be similar to those associated with the excavation/foundation work, installation and civil construction phases. The decommissioning plant will also take into account environmental rehabilitation, which includes the removal of all surface facilities and excess hydrocarbon waste, as well as re-vegetation of localized natural flora.

Associated decommissioning activities in accordance with environmental measures and standards of good practice are as follows:

- Removal of site infrastructure and waste;
- All civil structures and associated infrastructure will be removed;
- All remaining materials and hydrocarbons and hazardous waste will be removed;
- All pilings and trestles will be removed;
- All waste will be disposed of in an appropriate manner; and
- Reusable materials to be resold or recycled.

Hazardous Waste Clean Up and Transport:

- When decommissioned, all products within piping and storage infrastructure shall be removed from said system along with all associated infrastructure and possible contaminated soils; and
- All hazardous wastes shall be transported to approved hazardous waste storage facilities or disposal sites.

Site Rehabilitation:

- all disturbed areas due to ROWs, transmission lines, etc. shall be rehabilitated and revegetated;
- native flora shall be used to re-vegetate the rehabilitated sites;
- Roadways will be scarified; and
- Natural drainage patterns will be reinstated where practical.

#### 4.9 **Project Alternatives**

IFC Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts) ("PS1") requires an assessment process that identifies the risk and potential impacts associated with a project. Specifically, "the process may comprise a full scale environmental and social impact assessment, a limited or focused environmental assessment or straight forward application of environmental siting, pollution standards, design criteria or construction standards". PS1 states that for greenfield developments or large expansions with specifically identified physical elements, aspects and facilities that are likely to generate potential environmental or social impacts, the client will conduct a comprehensive ESIA, including an examination of alternatives, where appropriate.

This section presents an overview of the alternatives considered as part of the ESIA study. The main design criteria, plant technology, Project type, and Project Location were determined by MOEE, and

the Project Proponent will have to comply with MOEE requirements are therefore beyond the remit of this ESIA study, and are not included in this review.

# 4.9.1 Alternatives of Different Power Generation Options

#### 4.9.1.1 Overview

Electricity generation may be achieved from renewable and non-renewable sources. Renewable sources include solar, wind, hydroelectric sources, and biomass while non-renewable sources include fossil fuels such as coal and natural gas. The following section describes the energy mix in Myanmar.

#### 4.9.1.2 Hydroelectric

Myanmar has 25 grid-connected hydroelectric power plants; all operated by Hydropower Generation Enterprise (HPGE). Their installed combined capacity is 3,151 MW (2016). Off-grid supply from mini hydropower stations is provided by ESE and IPPs and contributes 33 MW.

Table 4.53 shows the existing hydroelectric power plant in Myanmar (> 50 MW).

#### Table 4.53: Existing Hydroelectric Power Plant in Myanmar (> 50 MW)

Station	Installed Capacity (MW)					
Үеуwа	790					
Shweli-1	600					
Paunglaung	280					
Dapein-1	240					
Baluchaung-2	168					
Thauk-ye-khat	120					
Mone	75					
Shwegyin	75					
Kyee on Kyee wa	74					
Kun	60					
Kinda	56					
Keng Taung	54					
All Others	559					
Total	3,151					

Source: IHA, 2016.15

During the wet season (June-September), the power plants are capable of generating more electricity than the maximum estimates from the MOEE, which amount to approximately 2,000 kWh per capita; although less than Thailand's current generation, it is equivalent to Vietnam's per capita generation. Given the prolonged construction time for hydro projects, it is important to negotiate the ability to purchase significant amounts of power for domestic use, even from dams invested with foreign capital and initially destined for export.

Another 46 GW of potential electricity capacity, derived from 302 potential sites which has been identified so far, and a number of these projects are now under construction or at the advanced planning stage. The potential Myanmar Hydropower resources are illustrated in (*Table 4.54*).

<sup>&</sup>lt;sup>15</sup> IHA. (2016). Myanmar. International Hydropower Association (IHA). Retrieved from https://www.hydropower.org/country-profiles/myanmar

Capacity	Number of Potential Sites	Potential Capacity (MW)
Less than 10 MW	210	231.25
Between 10 MW and 50 MW	32	806.30
More than 50 MW	60	45,293.00
Total	302	46,330.55

#### Table 4.54: Myanmar Hydropower Resources

Source: WEF et al, 2013.<sup>16</sup>

#### 4.9.1.3 Gas Fired

Myanmar has 10 gas-fired power plants; all operated by EPGE. Their installed capacities of 996 MW account for 20.5% of national grid capacity. Ahlone is the biggest plant with a capacity of 275 MW. These plants use gas produced in the offshore fields of Yadana and Yetagun, and onshore fields operated by the MOEE. The output from these plants has been below expectations owing to low calorific value of local gas (high Nitrogen content) and low pressure without compression.

The gas-fired power plants in Myanmar use both liquefied petroleum gas (LPG) and liquefied natural gas (LNG) as fuels, however, the differences between LPG and LNG are not always clear. LPG is propane or butane gas under slight pressure which turns into a liquid at normal temperatures. It is often used for household cooking and delivered in small cylinders, but can be used in place of natural gas in many generators. It currently sells for 15 to 16 USD per million BTU (import price) and can be delivered in small ships of 10-30 thousand tons. It does not require elaborate or costly ports or handling equipment. LPG is a plausible transition fuel for gas-fired generators that will be commissioned in 2015-2018 but not able to use domestic natural gas until a few years later when extra domestic gas supplies should become available. LPG is also cheaper than kerosene or diesel alternatives.

LNG is super-cold natural gas which has turned into a liquid. It is typically delivered in specialized ships which are essentially floating thermos bottles, specially designed to handle the very cold liquid. Recently, most LNG tankers have been very large – up to 12 meters (39 feet) in draft and require costly specialised storage facilities on shore, which take several years to build. Due to the cost of the ships and the onshore facilities that need to be repaid over an extended period, most LNG contracts are for many years, usually at least twenty. If Myanmar will produce more domestic natural gas for its own use starting in 2020, the cost of domestic natural gas would be less than that of LNG. This would make the large onshore investment in equipment unattractive. Besides this, there are no deep water ports capable of handling large LNG ships close to population centres where electricity is needed.

Table 4.55 shows the existing gas-fired power plants in Myanmar.

Station	Installed Capacity (MW)
Kyungchaung	54.3
Mann	36.9
Shwedaung	55.3
Mawlamyaing	12.0
Myanaung	34.7
Hilawga	208.7

#### Table 4.55: Existing Gas-Fired Power Plants in Myanmar

<sup>&</sup>lt;sup>16</sup> WEF, ADB, & Accenture. (2013). New Energy Architecture: Myanmar. World Economic Forum (WEF). Retrieved from http://www3.weforum.org/docs/WEF\_EN\_NewEnergyArchitecture\_Myanmar\_2013.pdf

Station	Installed Capacity (MW)				
Ywama	122.3				
Ahlone	275.2				
Thaketa	145.6				
Thaton	51.0				
Total	996				

Source: Vikas Sharma, 2013

#### 4.9.1.4 Coal-Fired

Currently, Myanmar has one coal-fired power plant named Tigyit with an installed capacity of 120 MW. Efficiency of the power plant is low, generating power at an average capacity factor of approximately 30%.

Historically, coal-fired power plants emitted significant amounts of soot and sulphur, and sulphur may led to acid rain. In addition, certain coals are also high in mercury, which can be toxic and cause pollution. However, technology has evolved considerably and new coal-fired power plants can be designed to use low-sulphur coal and catch almost all of the ash particles generated from burning. Processing of coal before burning can also remove over half of the mercury.

A single coal unit has a usual capacity of 400 to 600 MW and most coal stations have at least two units. A typical station has a capacity of 1,000 MW (1 million kilowatts) and operates for 6,000 hours a year, producing six billion kWh a year. Since a ton of good steam coal produces approximately 3,000kWh, the annual coal consumption of one station is in the order of two million tons a year or 5-6 thousand tons a day. If the coal is of lower thermal quality, even larger amounts must be used. Handling such large amounts of coal requires ocean transport on large ships that need deep channels and ports with specialised unloading facilities. These are major investments and there is the potential for significant impact on the area in which they operate.

It should be noted that coal-fired plants in general have higher CO<sub>2</sub> emissions compared to gas turbines. Gas turbines have relatively low CO<sub>2</sub> compared with other fossil fuel energy generation technologies. The Project has employed a CCPP technology which was designed for high reliability and efficiency operation with lower environmental impact. CCPP plant offer half as much CO<sub>2</sub> per kWh compared to other power generation technology. Natural gas provides more efficiency than coal because of higher operating temperatures, and when used together with the more efficient combined-cycle results in even higher efficiencies (IEA, 2006).<sup>17</sup>

# 4.9.1.5 FRSU (Floating Storing Regasification Unit)

FSRU can be termed as a special type of ship used for LNG transfer. Transported in a semi-cooled state of -160 C°, it needs to be heated up to its original gaseous state. This reheating needs to be carried out before the gas is pumped into its storage systems. The whole process of freezing and then re-heating the fuel is extremely expensive and time-consuming. FSRU vessels can be classified either as ships or offshore installations depending upon the design they incorporate. Floating Storage Regasification Unit (FSRUs) can be equipped in two ways:

- either they can be installed as a separate unit aboard the LNG carrier itself or,
- an old gas carrier can be converted into an independent unit and placed in a particular destination as an offshore installation

<sup>&</sup>lt;sup>17</sup> IEA, 2006a: Energy Technology Perspectives 2006: Scenarios and strategies to 2050. International Energy Agency, Paris, 484 pp.

When the FSRU unit is installed in the ship itself, the major advantage of such installation is that the heating and liquefaction process can be carried out within the vessel itself without having to unload the fuel in its semi-frozen state. For the 2nd method, an old LNG tanker is modified with offshore installations as floating LNG unit, which can be either with the propulsion unit (mobile) or without the propulsion unit (fixed offshore unit). The former gives the flexibility to operate the unit as a floating storage unit and as an LNG tanker when required.

In case of the former, the process can be carried out within the vessel itself without having to unload the fuel in its semi-frozen slushy state, whereas in the latter option, however, promises to be more viable as docking a refurbished regasification unit would ensure that the supply and demand chains are adequately balanced. Since the refurbished Floating Storage Regasification Unit (FSRU) would also be able to provide storing feasibilities of LNG, constant transference of the LNG cargo from LNG vessels would ensure that there is no storage depletion whatsoever. Generally, such kinds of Floating Storage Regasification Unit or FSRUs are found near the harbor to prevent time-consumption. But while utilising a refurbished gas carrier as a Floating Storage Regasification Unit, care needs to be taken to suitably positioning these refurbished vessels to prevent any emergency arising near a particular port or harbor.

In addition, seawater is generally used as a heat source. This system is known as an open loop system. Strict environmental regulations must be followed for the cold seawater discharged after the heat exchange with LNG.

However, it shall be noted that at the time of preparing this ESIA Report, there is no FSRU operating in Myanmar.

#### 4.9.1.6 Non-hydro Renewable Sources

Using non-hydro renewable sources for power generation is still in its infancy in Myanmar and constitutes a small percentage of total installed capacity and generation. While Myanmar is rich in renewable resources, the development remains severely limited by availability of funds to support the research and development, lack of a clear renewable energy policy and lack of talented manpower.

The following provides a brief summary of the limited publically available information concerning nonhydro renewable projects in Myanmar.

#### 4.9.1.7 Biomass

Biomass is a process of generating energy from organic matter, which can be derived from a few different methods, such as burning, chemical conversion, and biochemical conversion. Burning biomass is the most common method for generating energy. There are 265 MW of biomass power projects in operation in Myanmar in 2015.

#### 4.9.1.8 Wind Energy

Wind power projects in Myanmar are either in experimental phase or undergoing feasibility studies. There are some very small operational projects off the grid (Dattaw Mountain in Kyauske, and Government Technical High School in Ahmar, Ayeyarwaddy). Gunkul Engineering Public Company Limited and China Three Gorges Corporation, both foreign, signed a MOU with the MOEE in 2011 to conduct feasibility studies for the development of 4,032 MW of wind energy in Myanmar.

#### 4.9.1.9 Solar Energy

Some pilot PV cell projects financed by the MOEE and university research departments are underway in rural areas; being used to charge batteries and pump water for irrigation. Another example is the installation of 3 kW PV systems in remote schools by Mandalay Technological University. Overall, however, at current costs, solar energy is unaffordable and only have a production capacity of 10.94 GWh in from 2015-2016 (MOEE, 2017).

# 4.9.2 Alternative Layouts, Process Technology and Supply Source

#### 4.9.2.1 Layout

The Project Proponent has considered a number of different layouts for the Project. The main issues influencing the Project layout include:

- The availability of land;
- Road access and access arrangements;
- Connection to water supply;
- Provisions to minimise environmental impacts;
- Occupational and Public Health and Safety;
- Technical requirements; and
- Financial considerations.

The layout which has been assumed for the purposes of the EIA has been developed through preliminary engineering studies and has also considered different plant configurations.

The Project Proponent has selected a layout with: two (2) gas turbines, one (1) HRSG's and one (1) steam turbine i.e. 2-2-1. Therefore, this 2-on-1 plant configuration will be used for the purposes of this EIA Study. If there are changes to the configuration/layout, this will be notified to the ECD.

#### 4.9.2.2 Selection between LNG Receiving Terminal and FSRU

A Floating Storage Regasification Unit (FSRU) can be termed as a special type of ship used for LNG transfer. Transported in a semi-cooled state of -160°, it needs to be heated up to its original gaseous state. This reheating needs to be carried out before the gas is pumped into its storage systems. The whole process of freezing and then re-heating the fuel is extremely expensive and time-consuming. FSRU vessels can be classified as either ships or offshore installations depending upon the design they incorporate. FSRUs can be equipped in two ways:

- Installed as a stand-alone unit aboard the LNG carrier itself; or
- Overhauling an old gas carrier into an independent unit and placed at a particular destination as an offshore installation.

When the FSRU unit is installed in the ship itself, the major advantage of such installation is that the heating and liquefaction process can be carried out within the vessel itself without having to unload the fuel in its semi-frozen state. For the 2nd method, an old LNG tanker is modified with offshore installations as floating LNG unit, which can be either with the propulsion unit (mobile) or without the propulsion unit (fixed offshore unit). The former gives the flexibility to operate the unit as a floating storage unit and as an LNG tanker when required.

In case of the former, the process can be carried out within the vessel itself without having to unload the fuel in its semi-frozen slushy state, whereas in the latter option, however, promises to be more viable as docking a refurbished regasification unit would ensure that the supply and demand chains are adequately balanced. Since the refurbished Floating Storage Regasification Unit (FSRU) would also be able to provide storing feasibilities of LNG, constant transference of the LNG cargo from LNG vessels would ensure that there is no storage depletion whatsoever. Generally, such kinds of Floating Storage Regasification Unit or FSRUs are found near the harbour to prevent time-consumption. But while utilising a refurbished gas carrier as a Floating Storage Regasification Unit, care needs to be taken to suitably positioning these refurbished vessels to prevent any emergency arising near a particular port or harbour.

In addition, seawater is generally used as a heat source. This system is known as an open loop system. Strict environmental regulations must be followed for the cold seawater discharged after the heat exchange with LNG.

The selection between these two options are often based upon factors such as location, land availability and economics. Location is most likely the important factor for this Project; given the proposed Power Plant is located within Ahlone Township, next to the existing CCGT Power Plant, the river width at this location is only approximately 500 meters. To take into consideration the length required for the jetty, potential FSRU, and the area to berth the LNGC to the FSRU, the river width at this location would be too narrow to allow for the proposed layout, as well as prevent any impacts to existing river navigation.

Considering the Project operational period is expected to be longer than ten (10) years, it is more economically feasible to select the LNG Receiving Terminal option<sup>18</sup>. This is because compared to a FSRU, a LNG Receiving Terminal does not have any charter costs for storage and regasification, which is considered part of the Capital Expenditure (CAPEX). A FSRU will have a lower CAPEX; however, given the long-term operational period, the Operation Expenditure (OPEX) of a FSRU will out-weigh a LNG Receiving Terminal's cost; therefore, making a LNG Receiving Terminal a cheaper option for long-term projects.

A LNG Receiving Terminal offers expandability, as it is possible to expand the capacity of the LNG Receiving Terminal if required. The FSRU on the other hand will have a fixed capacity; increasing an FSRU capacity will require either refitting/overhauling or constructing a new FSRU.

A LNG Receiving Terminal also has the advantage of multi-functionality. In addition to LNG off-loading, it may also be capable of LNG reloading, bunkering of vessels, and LNG truck loading; this allows for multiple options to compliment other land-based infrastructures that currently exists, or for future developments.

#### 4.9.2.3 LNG Receiving Terminal Location Options

There were three (3) LNG Receiving Terminal locations that were considered, two locations were located along the shoreline of Thanlyin Township (which can be categorized as North, and South options), and one location along the Southeast shoreline of Dala Township. The three locations are shown in *Figure 4.44*. The two options in Thanlyin propose to utilize existing infrastructure at the location, this can allow for reduced construction costs. Although the North option has more existing facilities than the South option, the South option is located at a part of the Yangon River which curve inland; this allows for the jetty and LNGC to have less impact towards the river navigation. The land use at the option in Dala only consists of agriculture; there are no existing facilities that can contribute as a LNG Receiving Terminal facility. The Thanlyin options are located closer to the proposed Power Plant, which reduces the length of the pipeline needed to connect the LNG Receiving Terminal to the proposed Power Plant.

One significant disadvantage of the Thanlyin options is that pipelines will need to be installed using HDD method. The North option will require a pipeline length of approximately 3.14 km to be installed using HDD method, and the South option will require approximately 4.4 km. Although it is possible to use HDD method for these distances, this may increase costs significantly, and limit maintenance capabilities. In addition, the land was not available for use for this Project, due to ongoing land use.

TPMC has selected Option 3 as the final location for the LNG Receiving Terminal as shown in *Figure* **4.45**.

<sup>&</sup>lt;sup>18</sup> Norrgård, J. (2018). LNG terminals – land-based vs. floating storage and regasification technology. Wartsila. Retrieved from https://www.wartsila.com/twentyfour7/in-detail/Ing-terminals-land-based-vs-floating-storage-and-regasification-technology





Source: TPMC, 2018. (Modified by ERM)





Source: TPMC, 2019. (Modified by ERM)

#### 4.9.2.4 Pipeline Route Options

The two (2) available options for the natural gas pipeline route is shown in *Figure 4.46*. The purple option indicates a route that goes in-land and follows the existing road network towards the proposed Power Plant. The green option follows the shoreline along the west side of the Yangon River until reaching the same river crossing point as with the purple route.

The green route currently has an advantage with regards to pipeline length at approximately 19.29 km, compared to the purple route with a length of approximately 24.9 km; however, the purple route does have other advantages which out-weigh the benefits of the green route.

The purple route is located along the existing road network, this allows for the pipeline to be accessed easier, with regards to construction and maintenance. The green route partially follows existing roads; however, there are some areas that will require crossing agricultural land, this will require constructing access roads during the construction and maintenance of the pipeline.

The purple route will only cross a small section of the dense populated area of Northern Dala to reduce the impacts towards the community; whereas the green route will cross the entire area of Northern Dala. The green route will have a bigger social impact towards the community, and may lead to increased public disputes.

Although the cost of implementing the green route is potentially lower than the purple route, public opinion and concerns of the impacts towards the community limit the feasibility of the green route; increased mitigation measures, or compensation may further increase the cost of implementing the green route. The purple route is preferable as it has lower potential impacts; therefore, the selected pipeline route is shown in *Figure 4.47*.





Source: TPMC, 2018. (Modified by ERM)





Source: TPMC, 2019. (Modified by ERM)

#### 4.9.2.5 Power Plant Location and Technology Options

Although options for selecting the Power Plant site can be explored, the plan to implement the proposed Power Plant next to the existing Power Plant is currently the best scenario. The layout of the proposed Power Plant and the existing Power Plant is shown in *Figure 4.48*.

Placing the proposed power plant at this location will allow for the facilities and other utilities to be shared between the proposed and existing power plants, specifically the switchyard; therefore, construction of certain facilities will not be needed, which lowers costs. Given that construction of the existing Power Plant has already taken place, experience gained from construction activities in the same area can allow for certain factors, such as cost, logistics, access roads, to be easily considered and planned.

Considering the existing Power Plant uses CCGT technology, it is also appropriate to utilize the same technology for the proposed Power Plant. A CCPP can reach thermal efficiency of approximately 50-60%, which compared to a single cycle of approximately 35-42%, a CCPP has improved overall efficiency, and reduces fuel costs. Having the same technology can also allow for the interchangeable operating knowledge/experience between the employees from the proposed and existing Power Plants.

Placing the proposed Power Plant at this location allows for better convenience and lowered costs, compared to any other location outside the existing area. The final location for the proposed Power Plant is shown in *Figure 4.49*.



Figure 4.48: Layout of Proposed (Purple) and Existing (Green) Power Plants

Source: TPMC, 2018. (Modified by ERM)





Source: TPMC, 2019. (Modified by ERM)

#### 4.9.2.6 Supply Source

The supply from domestic gas production will be unable to meet the needs of the Ahlone CCPP, as such, it is anticipated that the fuel supply for this Project will be based on imported LNG from overseas. The imported fuel supply from oversees is also part of Myanmar's Power Development objectives.

#### 4.9.2.7 Conclusion

For the LNG Receiving Terminal, the final location is located towards the southeast of Dala Township, along the west-bank of the Yangon River (option 3). This option has been selected over options 1 and 2 because the area are not available for use, the construction cost is potentially higher, and the additional HDD activities may potentially cause more environmental and social impacts.

For the Power Plant, the final location will be located next to the existing Power Plant in Ahlone Township, along the east-bank of the Yangon River. This location has been selected because of the convenience of sharing utilities with the existing facilities, and no additional requirements for land procurement, which subsequently eliminates any resettlement and economic displacement on the Power Plant area.

The pipeline alignment will follow the first option that connects the LNG Receiving Terminal and the Power Plant through the centre of Dala Township, along the existing road, and cross under the Twante Canal and Yangon River; the second option that runs along the river back will lead to more social impacts.

The selected technology that will be used for unloading LNG from the LNGC will be a land-based LNG Receiving Terminal; this is to allow for lowered OPEX over time and allows for potential ease in expansion of the facility.

Given the environmental and social factors involved, as well as the processing technology that has been discussed, the location for each main component is shown in *Figure 4.50*.





Source: TPMC, 2019. (Modified by ERM)

#### 4.9.3 Alternative Cooling Technologies

CCPP utilise the heat from the exhaust gases leaving the gas turbine to generate steam in a heat recovery steam generator (HRSG). This steam is then used in a steam turbine to generate further electricity. The steam leaving the steam turbine is condensed by either water or air, producing condensate that is then reused in the HRSG. Potential cooling techniques for the condensing of steam leaving the steam turbine equipment include:

- Wet Cooling Systems:
  - Once Though Cooling System power stations with an open cooling system (once through cooling) take cooling water from the river/sea. Cooling water is pumped via an intake pipe through the condenser and after heat transfer via a pipe back to the source. If the water source is close enough this is considered the most economical option and also provides the best plant performance due to the low cooling water temperature. As large water quantities are required this can only be used where large water sources are available. Furthermore, the cooling water reintake and outlet need to be located far enough from each other to avoid heated water reentering the cooling cycle. The discharged water will need to comply with the applicable standards regarding water quality.
  - Closed Cycle Wet Cooling Towers Cooling water is recirculated between a surface type condenser and a cooling tower where it is sprayed into air which cools the water droplets by evaporating a part of the water. This option is preferable where the required volumes of water are not available near the power plant site, or are in sufficient amount.
  - Hybrid Cooling System these towers are an improved on forced draft wet cooling towers and are characterised by a heat exchange between air and water without direct contact before the water is sprayed in the tower. This option reduces the visibility of the emitted plume from the tower and is often used where the visual impact of the plume on inhabited areas must be avoided. The hybrid option also reduces water consumption by an approximately 10 – 15%.
- Wet / Dry Parallel Cooling Systems this system uses a mix of wet and dry cooling technologies and is implemented at sites where water is partially or seasonally available. This has advantages over the wet and hybrid towers as the towers and plume emitted are smaller and so has less visual impact.
- Dry Cooling Systems:
  - Direct Dry Cooling System these cooling systems are used in remote dry areas without economic water supplies where the heat transfer is performed by air to finned tubes. This method is affected by the ambient air temperature and so is only used where the availability of cooling water is limited. This option also requires significant land space for cooling and therefore is not applicable in areas where land availability is limited, such as the CCPP Project.
  - Indirect Cooling Systems these systems can either be used with a surface condenser or with a direct contact jet condenser. The process involves cooled condensate water coming from the cooling tower and being in direct contact with the jet condenser to condensate the exhaust steam of a steam turbine.

The induced draft cell type with wet cooling tower has been selected for further investigation during the EIA Study. This type of cooling system has been selected based on the requirements for water consumption, plant output and efficiency, operation and maintenance costs and land availability.

# 5. DESCRIPTION OF THE ENVIRONMENT

#### 5.1 Biophysical Baseline

#### 5.1.1 Introduction

This Chapter provides an overview of the environment-biophysical baseline conditions within the Project Study Area based on secondary data from published sources as well as primary data collected to fill data gaps. This Section of the ESIA (Environmental and Social Impact Assessment) Report is organized by different biophysical parameters and also includes a discussion of the baseline conditions and any additional methods used to fill in the gaps during primary data gathering at the Project Study Area.

#### 5.1.1.1 Project Study Area

The establishment of the Area of Influence (AoI) for the Project (and thus the appropriate Project Study Area) is intended to ensure that the Impact Assessment (IA) focuses on those issues that are most important for design, decision-making and stakeholder interest.

This Project covers the activities associated with the construction, operation and decommissioning of the proposed Ahlone Combined Cycle Thermal Power Plant (CCPP), Liquefied Natural Gas (LNG) Receiving Facilities and Natural Gas Pipeline in Yangon Region, Myanmar. The AoI for this Project consists of the following aspects:

- Construction of Power Plant and associated infrastructure;
- Construction of the Natural Gas Pipeline;
- Construction of the LNG Receiving Terminal and associated infrastructures;
- Operation of the Power Plant and associated infrastructure;
- Operation of the Natural Gas Pipeline; and
- Operation of the LNG Receiving Terminal.

An Aol of 5 km from the Project site boundary has been established for Power Plant and for the LNG Receiving Facilities, in particular air quality receptors or social receptors. For the natural gas pipeline a buffer area of 500 m from each side of the centre line of the pipeline has been consider, in particular for social receptors.

The AoI for a particular resource/receptor may vary depending on the nature of the change caused by the Project activities and the type of effect being considered, but in each case it is defined to include all the area within which it is likely that significant impacts could result.

The Project Study Area (hereinafter also referred to as 'Study Area') refers to the area that needs to be studied in order to adequately understand and describe the baseline conditions likely to be affected by the Project. With the AoI established, the Study Area (see *Figure 5.1*) comprises a 5km radius of the Project site (Ahlone CCPP expansion, and LNG Receiving Terminal) as well as a 500m from each side of the Natural Gas Pipeline.

There are no set guidelines on the sphere of influence; however, taking into account the nature of activities during the construction and operation phases, a Study Area of 500 m and 5,000 m has been established for the respective assessments. The Study Area has been determined so that all potentially impacted sensitive receivers during both construction and operation phase have been identified.



# Figure 5.1: Project Study Area



Since the summer months are from March to Mid-May and the rainy season typically lasts from mid-May to the end of October the baseline sampling for dry season was planned in the beginning of May 2018 while wet season baseline sampling was taken place in the end of June 2018. However, some parameters were only required to be sampled during one season (such as noise levels) and therefore will only show result for one season.

# 5.1.2 Ambient Air Quality

# 5.1.2.1 Overview

A critical part of the ESIA is to establish the state of the existing environment (referred to as the baseline). In accordance with IFC guidelines<sup>19</sup>, measurement of existing air quality is required for emissions associated with the Project processes that have the potential to affect the surrounding land use. As discussed in *Appendix K*, the primary focus of the Air Quality Impact Assessment (AQIA) relates to NO<sub>x</sub> emissions resulting from the combustion of natural gas. On this basis, a project specific monitoring survey was commissioned to provide an indication of ambient concentrations of NO<sub>2</sub> in the Study Area and to inform the AQIA presented in *Appendix K*.

# 5.1.2.2 Monitoring Methodology

Monitoring of NO<sub>2</sub> was conducted at 13 monitoring locations. Passive diffusion tubes were deployed in triplicate at three locations between the 27 February 2018 and the 2 May 2018, and again from the 12 June 2018 to the 26 June 2018. The automatic Haz-Scanner Environmental Perimeter Air Station (EPAS) was deployed at a further 10 locations in the Study Area for a continuous 72-hour period in both the wet and dry season.

The detailed monitoring methodology is provided in *Appendix K*.

#### 5.1.2.3 Monitoring Locations

Monitoring locations were chosen to determine general background concentration levels. Monitoring locations were initially selected using aerial photography, local available knowledge about villages, accessibility and security to determine the location of operations and nearby sensitive receptors. The final decision on locations was then made while in the field to determine the most suitable and representative locations for monitoring equipment to be deployed. The monitoring locations are presented in *Figure 5.2*, and a detailed summary is provided in *Appendix K*.

<sup>&</sup>lt;sup>19</sup> International Finance Corporation (IFC) (2007) Environmental, Health and Safety Guideline: Air Emissions and Ambient Air Quality [ Online] Available at:

https://www.ifc.org/wps/wcm/connect/Topics\_Ext\_Content/IFC\_External\_Corporate\_Site/Sustainability-At-IFC/Policies-Standards/EHS-Guidelines/ [Accessed 07 February 2019]







# 5.1.2.4 Baseline Monitoring Results and Discussion

The ambient air quality data collected for the Project has been reviewed and interpreted and the detailed findings are presented in *Appendix K* for dry season and in *Appendix M* for wet season. *Figure 5.3* shows photos of field team setting up air quality monitoring stations during dry season.

# Figure 5.3: Photos of Air Quality and Noise Level Monitoring Machine Setup during Dry Season





AQ1/N1

AQ2/N2



AQ3/N3





AQ4/N4

AQ6/N6



AQ5/N5

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AQ7/N7

AQ8/N8



AQ9/N9



AQ10/N10

Source: SEM, 2018.

*Figure 5.4* shows photos of field team setting up air quality monitoring stations during wet season.

# Figure 5.4: Photo of Air Quality and Noise Level Monitoring Machine Setup during Wet Season





AQ1/N1

AQ2/N2



AQ3/N3

AQ4/N4



AQ5/N5



AQ6/N6



AQ7/N7

AQ8/N8



AQ9/N9

AQ10/N10

Source: SEM, 2018.

Figure 5.5 shows photos of field team collecting diffusion tubes during wet season.



#### Figure 5.5: Photo of Diffusion Tube Collection during Wet Season

Source: SEM, 2018.

The maximum 1-hour average baseline concentration recorded at each monitoring site using the automatic EPAS is compared to the National Environmental Quality Emission Guideline (NEQEG) 1-hour air quality standard and the findings are presented in *Table 5.1* and *Figure 5.6*. The data indicates that the maximum 1-hour average concentration at any monitoring location is below the NEQEG air quality standard. On this basis, the air shed is considered non-degraded with regard to the short-term standard.

The diffusion tube data is considered indicative of the long-term NO<sub>2</sub> concentration at the monitoring locations. The diffusion tube results presented in *Table 5.2* are below the annual mean air quality standard and suggest that the air shed is non-degraded.

*Table 5.3* to *Table 5.12* shows continuous air quality monitoring measured over 72 hours at the 10 selected site during the dry season. The detailed study of air quality is presented in the *Appendix L*, and *Appendix N*.

Site	NO <sub>2</sub> 1-hour Ma	aximum (µg/m³)	1-hour Mean Air Quality	NO <sub>2</sub> Maximum as % of
	Wet Season	Dry Season	Standard (AQS) (µg/m <sup>3</sup> )	AQS
AQM1	170	68.5	200	85%
AQM2	22.8	68.6	200	34%
AQM3	144	108	200	72%
AQM4	26.4	97.9	200	49%
AQM5	25.9	128	200	64%
AQM6	9.30	74.3	200	37%
AQM7	35.5	35.9	200	18%
AQM8	33.5	129	200	65%
AQM9	41.2	106	200	53%
AQM10	23.3	100	200	50%

# **Table 5.1: EPAS Monitoring Summary**





#### Table 5.2: Diffusion Tube Monitoring Summary

Location	Season	Tube Number	Date on	Date off	NO₂ (μg/m³)	Annual Mean AQS <sup>a</sup>	% of AQS
DT1	Dry	1	27/02/2018	02/05/2018	19.0	40	48%
		2	27/02/2018	02/05/2018	18.9	40	47%
		3	27/02/2018	02/05/2018	17.6	40	44%
	Wet	1	12/06/2018	26/06/2018	3.02	40	7.6%
		2	12/06/2018	26/06/2018	0.853	40	2.1%
		3 <sup>b</sup>	12/06/2018	26/06/2018	-	40	-
DT2	Dry	1	27/02/2018	02/05/2018	24.6	40	61%
		2	27/02/2018	02/05/2018	21.6	40	54%
		3	27/02/2018	02/05/2018	22.4	40	56%
	Wet	1	12/06/2018	26/06/2018	2.48	40	6.2%
		2	12/06/2018	26/06/2018	2.27	40	5.7%

Location	Season	Tube Number	Date on	Date off	NO₂ (μg/m³)	Annual Mean AQS <sup>a</sup>	% of AQS
		3	12/06/2018	26/06/2018	3.24	40	-
DT3	Dry	1	27/02/2018	02/05/2018	19.8	40	50%
		2	27/02/2018	02/05/2018	15.3	40	38%
		3	27/02/2018	02/05/2018	15.7	40	39%
	Wet	1	12/06/2018	26/06/2018	0.960	40	8.1%
		2	12/06/2018	26/06/2018	1.54	40	2.4%
		3 <sup>b</sup>	12/06/2018	26/06/2018	-		-

Note: <sup>a</sup> National Environmental Quality (Emission) Guidelines (NEQEG) (2015) <sup>b</sup> Tubes 1177604 & 1177610 could not be analysed as they did not contain any grids upon arrival in the laboratory.

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
2-3 May, 2018	24	61.16	20.94	0.01	11.78	17.91	79.28	12.18	28.60
3-4 May, 2018	24	60.26	28.58	0.01	30.04	41.39	83.57	4.52	29.56
4-5 May, 2018	24	110.66	25.79	0.01	47.44	49.14	82.41	9.52	29.30
Myanmar emission guideline value (24 hours)		-	200 (1 hour)	-	25	50	-	20	-

#### Table 5.3: Daily Ambient Air Quality Results at AQ1 during Dry Season

Source: SEM, 2018.

# Table 5.4: Daily Ambient Air Quality Results at AQ2 during Dry Season

Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
2-3 May, 2018	24	60.15	20.93	15.32	8.38	9.16	68.07	5.96	28.99
3-4 May, 2018	24	59.36	28.34	13.93	25.79	30.15	74.12	4.49	29.26
4-5 May, 2018	24	80.28	25.64	18.71	35.76	42.63	73.62	8.66	28.60
Myanmar emission gu (24 hours)	ideline value	-	200 (1 hour)	-	25	50	-	20	-

Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
2-3 May, 2018	24	230.34	71.42	0.00	24.36	29.24	74.19	12.54	28.62
3-4 May, 2018	24	291.27	62.96	0.05	2.25	7.28	80.48	19.88	27.51
4-5 May, 2018	24	313.26	43.47	0.06	2.20	7.69	73.45	28.03	28.47
Myanmar emission gu (24 hours	ideline value )	-	200 (1 hour)	-	25	50	-	20	-

# Table 5.5: Daily Ambient Air Quality Results at AQ3 during Dry Season

Source: SEM, 2018.

# Table 5.6: Daily Ambient Air Quality Results at AQ4 during Dry Season

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
12-13 May, 2018	24	344.42	47.60	0.00	2.24	7.21	84.04	27.68	25.77
13-14 May, 2018	24	183.65	56.95	0.0004	2.45	8.57	74.62	10.36	28.08
14-15 May, 2018	24	224.91	60.19	0.036	2.12	7.57	82.28	14.89	26.76
Myanmar emission gu (24 hours)	ideline value	-	200 (1 hour)	-	25	50	-	20	-

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
6-7 May, 2018	24	121.72	50.59	0.018	2.15	7.10	73.13	8.77	29.55
7-8 May, 2018	24	143.51	58.58	0.025	2.38	9.45	71.73	5.94	30.11
8-9 May, 2018	24	147.02	59.53	0.026	2.44	7.65	71.52	6.50	30.25
Myanmar emission guideline value (24 hours)		-	200 (1 hour)	-	25	50	-	20	-

# Table 5.7: Daily Ambient Air Quality Results at AQ5 during Dry Season

Source: SEM, 2018.

# Table 5.8: Daily Ambient Air Quality Results at AQ6 during Dry Season

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
6-7 May, 2018	24	58.92	19.94	22.13	20.59	22.06	70.36	12.82	30.72
7-8 May, 2018	24	80.74	26.89	21.70	21.05	22.62	66.67	11.36	30.16
8-9 May, 2018	24	77.61	26.67	19.98	25.08	26.74	68.06	8.78	31.95
Myanmar emission gui (24 hours)	ideline value	-	200 (1 hour)	-	25	50	-	20	-

Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
6-7 May, 2018	24	114.96	58.86	0.010	24.36	29.24	75.99	2.77	32.23
7-8 May, 2018	24	129.54	59.82	0.569	24.18	24.89	74.43	5.15	33.17
8-9 May, 2018	24	144.84	74.29	0.012	21.73	29.09	74.01	7.48	33.68
Myanmar emission gu (24 hours)	ideline value	-	200 (1 hour)	-	25	50	-	20	-

# Table 5.9: Daily Ambient Air Quality Results at AQ7 during Dry Season

Source: SEM, 2018.

# Table 5.10: Daily Ambient Air Quality Results at AQ8 during Dry Season

Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
9-10 May, 2018	24	109.20	63.04	0.02	2.12	8.63	79.19	6.63	28.28
10-11 May, 2018	24	128.88	59.94	0.01	2.35	7.33	85.17	5.51	26.07
11-12 May, 2018	24	152.42	76.32	0.01	2.94	8.51	89.38	6.43	25.00
Myanmar emission guideline value	200 (1 hour)	-	25	50	-	20	-		

Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
9-10 May, 2018	24	69.01	40.10	0.01	20.63	25.93	72.89	9.09	35.41
10-11 May, 2018	24	111.79	23.69	0.01	25.82	40.89	84.30	11.51	29.17
11-12 May, 2018	24	66.81	41.46	0.00	22.47	26.46	86.00	3.42	29.72
Myanmar emission gui (24 hours)	ideline value	-	200 (1 hour)	-	25	50	-	20	-

#### Table 5.11: Daily Ambient Air Quality Results at AQ9 during Dry Season

Source: SEM, 2018.

#### Table 5.12: Daily Ambient Air Quality Results at AQ10 during Dry Season

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
9-10 May, 2018	24	60.90	36.20	15.75	28.10	27.31	71.55	15.64	30.28
10-11 May, 2018	24	48.27	24.16	13.20	20.86	26.63	75.56	4.94	28.42
11-12 May, 2018	24	54.16	43.83	13.09	25.22	31.68	74.12	10.50	28.60
Myanmar emission gui (24 hours)	deline value	-	200 (1 hour)	-	25	50	-	20	-

Source: SEM, 2018.

Table 5.13 to Table 5.22 shows continuous air quality monitoring measured over 72 hours at the 10 selected site during the wet season.

Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
27-28 June, 2018	24	107.81	111.79	0.02	5.38	14.42	85.07	8.37	25.26
28-29 June, 2018	24	106.83	50.56	0.03	10.65	11.53	72.40	1.83	28.21
29-30 June, 2018	24	37.30	26.99	0.01	24.94	16.61	79.44	6.84	27.78
Myanmar emission gui (24 hours)	deline value	-	200 (1 hour)	-	25	50	-	20	-

#### Table 5.13: Daily Ambient Air Quality Results at AQ1 during Wet Season

Source: SEM, 2018.

# Table 5.14: Daily Ambient Air Quality Results at AQ2 during Wet Season

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> <sub>10</sub>	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
27-28 June, 2018	24	42.16	8.072	11.86	24.36	29.24	81.24	4.65	25.73
28-29 June, 2018	24	56.02	10.63	12.93	15.34	19.54	73.99	8.67	28.37
29-30 June, 2018	24	51.18	6.35	28.82	15.96	24.69	76.16	28.79	26.88
Myanmar emission gui (24 hours)	deline value	-	200 (1 hour)	-	25	50	-	20	-

Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
27-28 June, 2018	24	127.06	53.13	0.03	26.26	29.50	84.45	10.04	26.33
28-29 June, 2018	24	150.23	40.52	0.04	28.15	29.05	76.17	11.74	27.56
29-30 June, 2018	24	201.10	59.36	0.08	19.93	21.31	77.79	11.63	27.67
Myanmar emission gui (24 hours)	ideline value	-	200 (1 hour)	-	25	50	-	20	-

# Table 5.15: Daily Ambient Air Quality Results at AQ3 during Wet Season

Source: SEM, 2018.

# Table 5.16: Daily Ambient Air Quality Results at AQ4 during Wet Season

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
6-7 July, 2018	24	155.50	27.34	0.0028	2.06	6.66	97.27	8.29	23.42
7-8 July, 2018	24	117.24	14.33	0.0120	2.13	8.17	94.18	12.41	23.81
8-9 July, 2018	24	139.70	14.12	0.0011	2.21	8.08	93.39	8.62	24.16
Myanmar emission gui (24 hours)	ideline value	-	200 (1 hour)	-	25	50	-	20	-
Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
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D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
30-1 June, 2018	24	123.51	13.55	0.0376	2.27	7.63	87.48	22.88	26.35
1-2 June, 2018	24	135.33	15.21	0.0161	2.10	6.55	95.29	12.00	24.56
2-3 June, 2018	24	123.13	14.20	0.0280	2.15	8.41	88.80	13.91	25.99
Myanmar emission gu (24 hours)	ideline value	-	200 (1 hour)	-	25	50	-	20	-

# Table 5.17: Daily Ambient Air Quality Results at AQ5 during Wet Season

Source: SEM, 2018.

# Table 5.18: Daily Ambient Air Quality Results at AQ6 during Wet Season

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
30-1 June, 2018	24	33.93	3.88	14.52	5.354	11.01	86.45	8.93	26.91
1-2 June, 2018	24	34.30	5.35	11.10	12.37	15.10	85.54	8.04	26.41
2-3 June, 2018	24	21.53	3.54	7.82	9.26	59.72	93.21	5.09	25.64
Myanmar emission gui (24 hours)	deline value	-	200 (1 hour)	-	25	50	-	20	-

Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
30 June- 1 July, 2018	24	41.53	20.04	0.0083	24.36	29.24	86.51	9.84	28.42
1 - 2 July, 2018	24	38.95	17.96	0.0158	17.81	19.85	90.50	5.90	24.29
2 - 3 July, 2018	24	51.78	18.68	0.0116	24.81	70.65	89.48	4.38	27.61
Myanmar emission gui (24 hours)	deline value	-	200 (1 hour)	-	25	50	-	20	-

## Table 5.19: Daily Ambient Air Quality Results at AQ7 during Wet Season

Source: SEM, 2018.

# Table 5.20: Daily Ambient Air Quality Results at AQ8 during Wet Season

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
3-4 June, 2018	24	49.85	13.56	0.0081	19.34	36.46	94.64	5.45	25.34
4-5 June, 2018	24	71.30	21.63	0.0044	21.92	20.33	94.71	6.64	25.63
5-6 June, 2018	24	65.37	15.28	0.0030	3.62	23.63	98.64	0.0052	24.24
Myanmar emission gu (24 hours)	ideline value	-	200 (1 hour)	-	25	50	-	20	-

Date	Time	СО	NO <sub>2</sub>	NO	<b>PM</b> <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
3-4 July, 2018	24	25.09	8.00	3.14	24.36	29.24	97.72	1.22	24.72
4-5 July, 2018	24	21.39	1.29	5.42	8.08	17.89	98.05	2.11	24.65
5-6 July, 2018	24	4.53	30.35	0.399	19.35	32.57	88.21	0.51	25.06
Myanmar emission gu (24 hours)	ideline value )	-	200 (1 hour)	-	25	50	-	20	-

## Table 5.21: Daily Ambient Air Quality Results at AQ9 during Wet Season

Source: SEM, 2018.

# Table 5.22: Daily Ambient Air Quality Results at AQ10 during Wet Season

Date	Time	СО	NO <sub>2</sub>	NO	PM <sub>2.5</sub>	<b>PM</b> 10	RH	SO <sub>2</sub>	Temp.
D.M.Y	Hours	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	°C
3-4 July, 2018	24	67.18	15.20	0.0269	24.36	29.24	92.99	5.70	25.11
4-5 July, 2018	24	71.02	16.93	0.0081	2.36	8.91	95.50	3.66	24.56
5-6July, 2018	24	68.89	14.21	0.0077	2.37	7.69	98.90	2.79	23.63
Myanmar emission gu (24 hours)	ideline value )	-	200 (1 hour)	-	25	50	-	20	-



Figure 5.7: Wind Speed and Direction at AQ1 to AQ10 during Wet Season





AQ6



AQ7



Source: SEM, 2018.







AQ2

AQ3



	Start Date: 6/30/2018 - 00:00 End Date: 7/3/2018 - 12:00	SEM Co.,Itd				
		MODELER.				
		De Hlaing Zaw				
	CALM WINDS:	TOTAL COUNT:				
	50.00%	72 hrs.	SE/MV			
	AVG. WIND SPEED:	DATE:	PROJECT NO:			
	0.97 m/s	9/3/2018				
akes Environmental Softwa	re					



PLOT Vew

AQ8

MODELER: De Hlaing Zaw

OTAL

72 hrs.

DATE: 9/4/2018

CALM WIND

48.61%

AVG. WIND

0.92 m/s

SEM



AQ10

Source: SEM, 2018.

# 5.1.3 Climate and Meteorology

Most of Myanmar belongs to the tropical region characterised by a tropical monsoon climate with three well-defined seasons: summer, rainy and cold seasons. The summer months are from March to Mid-May. The rainy season typically lasts from mid-May to the end of October and the cold season starts in November and lasts up to the end of February.

The southwest monsoon starts in late March or early April with local turbulence that includes tornados and cyclones, bringing winds that can reach up to 200 – 300 km/h. From October to mid-March the northeast monsoon brings a dry and cool climate. Due to widely differing topographical profiles throughout Myanmar and its range of latitudes, its climate conditions differ widely from one place to another (UNCCD, 2005).

In Yangon, the average annual temperature is 27.3 °C while the average annual rainfall is 2,370 mm. The warmest month of the year is April with an average temperature of 30.5 °C while the coolest month of the year is January with an average temperature of 24.7 °C. January is also the driest month with 3 mm of rainfall. The wettest month is August with an average precipitation of 602 mm (Climatemps, 2017). The predominant annual wind direction is south westerly (Windfinder Website). Relative humidity ranges approximately from 52 to 89% (Climate Data Website).

# 5.1.3.1 Climate Change Projections

Projected climate changes across Myanmar have been studied based on both General Circulation Model (GCMs) used in the Intergovernmental Panel on Climate Change (IPCC's) fourth assessment, and using dynamic downscaling with regional climate models forced by the GCMs<sup>20</sup>.

<sup>&</sup>lt;sup>20</sup> IPCC. (2007). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A.

Myanmar has been witnessing changing weather events in almost every year during the last two three decades. These include the onset, withdrawal, duration and intensity of monsoon, and the frequency of the monsoon depressions<sup>21</sup>. The frequency of hot days and nights is expected to increase, while the frequency of cold days/nights will decrease.

According to data from the World Resources Institute (2014), Myanmar's total GHG emissions (excluding land use change and forestry) in 2013 were 98.75 million tons of CO2 equivalent  $(MtCO_2)^{22}$ . The major sectors producing CO<sub>2</sub> emissions are agriculture (65%) and energy (22%).

# 5.1.4 Noise

#### 5.1.4.1 Overview

Information on the ambient noise conditions for the Study Area is not publicly available. The background noise levels are expected to be typical of an urban and/or semi-urban environment in Myanmar. Sources of noise are likely to include local traffic (e.g. motorbikes, scooters and less so private cars), human activity (e.g. schools, barangay halls, local markets) and animals (e.g. dogs, cockerels).

Potential noise sensitive receivers in the area will include settlements and schools. These receivers will be sensitive to noise from both the construction and operation activities of the Project.

In accordance with IFC General EHS Guidelines, noise monitoring was carried out for the purpose of establishing existing ambient noise levels around the Study Area in the absence of the facility or other noise sources. The baseline noise levels are compared with noise level guidelines to characterize the baseline noise in the Study Area. This information will then be used to assess the significance of the Project's impact at the noise sensitive receivers (NSR) during construction and operational phases in *Chapter 7, Chapter 8*, and *Chapter 9*.

## 5.1.4.2 Baseline Noise Methodology

Noise level measurements were conducted according to the relevant methods of the International Organization for Standardization (ISO), which include ISO 1996-1:2003, and ISO 1996-2:2007. The equipment used for measurement is a Model SL-4023SD sound level meter. Measurements were carried-out by SEM during a baseline survey between the dates of May 2 and May 14, 2018. The survey was conducted for 48 hours consecutively for each location. The sampling periods are shown in *Table 5.23*.

<sup>(</sup>eds.)]. IPCC, Geneva, Switzerland, 104 pp. Retrieved from

https://www.ipcc.ch/site/assets/uploads/2018/02/ar4\_syr\_full\_report.pdf

<sup>&</sup>lt;sup>21</sup> Tun Lwin, Khin and Cho Cho Shein., 2006. Hydrology and Meteorology report of Myanmar.

<sup>&</sup>lt;sup>22</sup> WRI. (2014). Myanmar. CAIT Climate Data Explorer. World Resources Institute (WRI). Retrieved May 15, 2017 from http://cait.wri.org/profile/Myanmar

Sampling Station	Period
N1, N2, N3	May 2nd – 4th, 2018 (48 hours)
N5, N6, N7	May 6th – 8th, 2018 (48 hours)
N9	May 10th – 12nd, 2018 (48 hours)
N8, N10	May 9th – 11st, 2018 (48 hours)
N4	May 12nd – 14th, 2018 (48 hours)

# Table 5.23: Noise Sampling Period

## 5.1.4.3 Baseline Noise Monitoring Locations

Noise monitoring was undertaken at ten (10) locations, at the same location as the air quality sampling stations. Details of the noise monitoring stations are shown in *Table 5.24*. The locations of each noise monitoring station is shown in *Figure 5.9*.

#### Table 5.24: Ambient Air and Noise Monitoring Locations

Sampling Station	Coordination	Location Description
AQ1/N1	16°46'30.69"N 96° 7'41.11"E	In the compound of Combined Cycle Power Plant (at project area) located in Ahlone Township, Yangon Region
AQ2/N2	16°46'39.33"N 96° 7'49.79"E	Same as AQ1/N1 sampling point
AQ3/N3	16°46'55.17"N 96° 7'44.70"E	In the compound of Aung Mingalar Monastery (near the Kannar Road) located in Ahlone Township, Yangon Region
AQ4/N4	16°46'56.00"N 96° 8'10.00"E	In the compound of Church (near the Thakhinmya Park) which located in Ahlone Township, Yangon Region
AQ5/N5	16°45'46.67"N 96° 8'8.97"E	In the compound of No. (22) Basic Education Primary School which located in Dala Township, Yangon Region
AQ6/N6	16°45'11.99"N 96° 8'6.46"E	In the compound of Yadanarayeyeikthar Monastery located in Kyansitthar Ward, Dala Township, Yangon Region
AQ7/N7	16°43'26.10"N 96° 8'18.40"E	In the Nuaung Ngok To Village, in Dala Township, Yangon Region
AQ8/N8	16°40'59.48"N 96° 8'38.41"E	In the compound of Pyasu Monastery which located in Pyaw Bwe Gyi Village, Dala Township, and Yangon Region
AQ9/N9	16°39'36.00"N 96°13'25.32"E	In the compound of Aung Mingalar Monastery which located in That Kai Kwin Village, Dala Township, and Yangon Region
AQ10/N10	16°38'53.04"N 96°14'32.48"E	In the Chaung Oo Village which located in Dala Township, Yangon Region







#### 5.1.4.4 Baseline Monitoring Results and Discussion

According to the noise baseline results, as shown in *Table 5.25*, stations that exceeded the Myanmar standard for at least one time period, includes station N1, N2, N3, N4, N5, N6, N8, N9, and N10. Photos of the noise level monitoring station is shown in *Figure 5.3* and *Figure 5.4*.

Possible sources of high noise levels include the existing Power Plant, traffic activities, human activities, and rain/weather events.

With regards to the noise station at the existing Power Plant and other nearby sampling stations, as shown in *Figure 5.10*, the existing power plant (N2) has the highest noise measurement. The noise station at the Project site (N1) has relatively lower noise emissions; however, transportation activities by river and the existing power plant may still contribute to the station exceeding the standard. Station N3 has relatively high noise levels, averaging just below N2; this is likely due to traffic activities from the main road. Station N4 has lower noise levels, as the station is located within residential areas.

With respect to monitoring station within the Pipeline Study Area (including monitoring station N1, N2, N5, N6, N7, N8 and N9). The lowest noise levels trend is evident to be at N7 with the reasoning of the station being situated in the green field and agricultural area with a small community settlements located within 50 meters from the station. The loudest recorded station is found at N2 station whereby the station is located in partial industrial and residential area with high traffic activities.

For noise monitoring station within LNG Receiving Terminal Study Area (N9 and N10), the noise level (LAeq) during daytime and night-time both exceed the NEQG standard. The highest noise level monitored was recorded at 69 dBA while the lowest noise level recorded at 44 dBA where both are located at N10. The sources of these noises are potentially from surrounding traffics with the closest receptors located approximately 1 km southeast of the LNG Terminal.

The detailed study of noise level monitoring is presented in the Appendix K and Appendix M.

# Table 5.25: Results of A-Weighted Loudness Equivalent (LAeq) Level

	A-Weighted Loudness I	Equivalent (LAeq) Level
Time Period	Day time	Night time
N1 (2nd -3rd, May 2018)	59	57
N1 (3rd - 4th, May 2018)	59	59
N2 (2nd -3rd, May 2018)	74	73
N2 (3rd - 4th, May 2018)	72	73
N3 (2nd -3rd, May 2018)	71	66
N3 (3rd - 4th, May 2018)	70	67
N4 (12th -13th, May 2018)	55	49
N4 (13th -14th, May 2018)	54	48
N5 (6th -7th, May 2018)	51	49
N5 (7th -8th, May 2018)	52	48
N6 (6th -7th, May 2018)	58	53
N6 (7th -8th, May 2018)	57	49
N7 (6th -7th, May 2018)	48	45
N7 (7th -8th, May 2018)	46	40
N8 (9th -10th, May 2018)	54	47
N8 (10th -11st, May 2018)	58	55
N9 (10th -11nd, May 2018)	60	53
N9 (11th -12nd, May 2018)	60	54
N10 (9th -10th, May 2018)	63	47
N10 (10th -11st, May 2018)	63	51
NEQG standard	55	45

Source: SEM, 2018.

Note: Bold indicates values above the NEQG standard.





Source: SEM, 2018. (Modified by ERM)



Figure 5.11: Noise Measurement Graph of Station N1, N2, N5, N6, N7, N8 and N9 (Monitoring Stations That Are Within Pipeline Study Area)

Source: SEM, 2018. (Modified by ERM)





Source: SEM, 2018. (Modified by ERM)

# 5.1.5 Surface Water

## 5.1.5.1 Hydrology

The Study Area is located 40 km upstream from the mouth of the Yangon River. The average tidal range of the Yangon River is about 5.85 m at spring tide and 2.55 m at neap tide. Modelling of the discharge of Yangon River indicates discharges ranging from <  $500 \text{ m}^3$ /s in April to approximately 7,000 m<sup>3</sup>/s in August, with tidal water level variations of ~1 m to ~6 m based on water level measurements at Monkey Point downstream of Project Site (De Koning & Janssen, 2015)<sup>23</sup>. In the Irrawaddy Delta which includes the Yangon River, drainage, salt intrusion and flood protection are major concerns (EO Earth Website, 2016). According to mapping of the August 2015 floods in Yangon (Yangon Delineation Overview)<sup>24</sup>, the riverbanks adjacent to the Power Plant as well as part of the pipeline were impacted by the flooding (*Figure 5.14* and *Figure 5.15*), while LNG Terminal is located on flood-free zone (*Figure 5.13*).

 <sup>&</sup>lt;sup>23</sup> De Koning, R.J. & Janssen, M.P.J. (2015) Delft3D-FLOW Model of the Yangon Port Area. Delft University of Technology.
 <sup>24</sup> Copernicus. (2015). EMSR130: Flood in Myanmar. Copernicus: Emergency Management Service – Mapping. European Commission. Retrieved from https://emergency.copernicus.eu/mapping/list-of-components/EMSR130





Source: Copernicus, 2015.<sup>24</sup> (Modified by ERM)





Source: Copernicus, 2015.<sup>24</sup> (Modified by ERM)





Source: Copernicus, 2015.<sup>24</sup> (Modified by ERM)

#### 5.1.5.2 Surface Water Quality

A number of baseline surface water quality sampling surveys have been conducted in the Study Area as part of this ESIA report. An overview of the surveys and their results are presented in this section.

#### Baseline Surface Water Sampling Methodology

For sampling sites located in the Yangon River, and the Twante Canal, a local boat was used to travel between shore and sampling site; sampling equipment was brought on-board and samples were collected directly on the boat. For sampling sites located in-land, a vehicle was used to travel to each site, and samples were collected on the sides of the river, or from a bridge. Water samples were taken by an Alpha horizontal water sampler and collected in plastic and sterilized glass sample containers. All sampling was conducted in strict accordance with recognized standard procedures, as listed together with the sampling results in *Appendix K* and *Appendix M*. Surface water sampling has been conducted for both dry and wet seasons; parameters that were selected for sampling are listed below.

The parameters mentioned above were selected to align with both the Myanmar NEQG Standards and IFC General EHS guideline. Please refer to *Appendix K*, *Appendix L*, *Appendix M*, and *Appendix N* for the testing parameters.

All samples were kept in iced boxes and were transported to the laboratory within 24 hours (under all recommended holding time). Additionally, flow rate, width and depth of river were measured using a Vale port Flow Meter equipment and depth sounder.

The in-situ parameters have been measured using equipment listed in *Table 5.26*.

No.	Equipment	Manufacturer	Originate Country	Model/Serial No.
1	SMART TROLL MP _Multi parameter for water	In Situ Inc.	USA	SN - 346054
2	Multi Parameters for water quality	HANNA	USA	H17609823 (Turbidity Sensor)
3	Alpha Bottle (Water Sampler)	Wildlife Supply Company	Indonesia	Wildco P/N-1120-G45
4	Flow meter	GLOBAL WATER 800- 876-1172	USA	FB211 Serial -1449006336
5	Depth Sounder	Japan	Japan	FP211/1136160536

#### Table 5.26: Field Equipment for Surface Water Quality Survey

#### Baseline Surface Water Sampling Locations

Dry season surface water samples were collected by ERM-Siam and SEM from the 3rd - 4th May, 2018, at fourteen (14) locations, and wet season surface water samples were collected from the 27th to the 28th June 2018 at fourteen (14) locations. The description for each of the sampling locations is shown in *Table 5.27*, and the locations of each sampling site is shown in *Figure 5.16*. In-situ testing was conducted on site by the data collection team (SEM and ERM), and samples were sent for laboratory testing, which was conducted by STS Green in Bangkok.

Sampling Point	Coordinates	Description of Sampling Points
SW 1	16°46'16.39"N 96° 7'26.42"E	Upstream of Project, Yangon River, and approximately 0.25 kilometres west of the proposed pipeline and south of project area. The Yangon River width at SW 1 is approximately 512.47 meters (measured in Google Earth). Visual observation indicated that the turbidity is high.
SW 2	16° 46' 11.25"N 96° 7' 44.26"E	Upstream of Gas Turbine, Yangon River, about 0.3 kilometres east of the proposed pipeline. SW 2 is near the mouth of Twantae Canal and the turbidity was high.
SW 3	16° 45' 55.62"N 96° 7' 50.73"E	At the mouth of Twantae Canal and near the proposed pipeline. The canal width of SW 3 is approximately 387.95 meters and the sampling point is located downstream of Thandwe Canal. The turbidity is high.
SW 4	16° 46' 3.46"N 96° 8' 2.27"E	Downstream of Twantae Canal, near the proposed pipeline. The channel width of SW 4 is approximately 459.09 meters.
SW 5	16°43'44.85"N 96° 8'14.10"E	Downstream of Naung Ngok To Chaung, near the proposed pipeline. The canal width of SW 5 is approximately 5.36 meters in the dry season. The turbidity is moderate to high.
SW 6	16°43'46.82"N 96° 8'15.25"E	Upstream of Nyaung Ngok To Chaung, and near the pipeline. The sampling point is located up stream of proposed pipeline and beside the road. There are many waste disposal sites near the sampling point. The turbidity is moderate and transparency is low to medium.
SW 7	16°40'57.67"N 96° 8'54.64"E	Downstream of Pyaw Bwe Chaung, and near the pipeline (Pyaw Bwe Gyi village). The channel width of SW7 is approx. 5.56 meters and the sampling point is located 0.01 kilometre from the proposed pipeline. The water has medium transparency and turbidity is moderate.
SW 8	16°40'58.36"N 96° 8'56.10"E	Upstream of Pyaw Bwe Chaung, near the pipeline (Pyaw Bwe Gyi village). It is located approximately 20 meters southeast of the proposed pipeline. Width is approximately 5.56 meters (measured in Google Earth). The turbidity is moderate and the transparency of water is medium.
SW 9	16°40'14.17"N 96°10'19.41"E	Upstream from pipeline alignment in Tha Nat Pin Chaung, near the Tha Nat Pin bridge. The width is approximately 5.56 meters (measured in Google Earth), near Tha Net Pin bridge. The turbidity is moderate.
SW 10	16°40'14.04"N 96°10'18.72"E	Downstream from pipeline alignment in Tha Nat Pin Chaung, near the Tha Nat Pin bridge. It is located just after SW 9. The turbidity is moderate and the transparency of water is medium.

# Table 5.27: Surface Water Sampling Locations

Sampling Point	Coordinates	Description of Sampling Points
SW 11	16°39'39.81"N 96°11'9.78"E	Upstream of Ya Kaing Chaung, approximately 20 metres southwest of the pipeline. SW 11 was sampled at the middle of the Ya Khaing Chaung river, from the Ya Khaing Chaung Bridge. The turbidity is moderate and transparency is medium.
SW 12	16°39'40.99"N 96°11'10.60"E	Downstream of Ya Kaing Chaung, approximately 0.02 kilometers noutheast of pipeline. The Ya Khaing Chaung width at SW 12 is approximately 45.87 meters width (measured in Google Earth). The turbidity is high and transparency is low.
SW 13	16°39'42.26"N 96°13'49.15"E	Upstream of LNG Receiving Terminal and approximately 1.05 kilometres north of the pipeline, in Yangon River. The Yangon River width of SW 13 is approximately 2,171.77 meters (measured in Google Earth). The turbidity is high.
SW 14	16°38'56.46"N 96°14'47.50"E	Downstream of LNG Receiving Terminal and approximately 250 metres from the pipeline, in Yangon River. The location of SW14 is located near Chaung Oo village, and the turbidity and transparency of water are high and low



Figure 5.16: Surface Water Sampling Locations (Dry and Wet Season 2018)



## Summary of Baseline Sampling Results

#### **Dry Season Survey**

According to the dry season results from STS Green, Total Suspended Solid (TSS) was found at levels above the Myanmar standards (50 mg/L) at SW1, SW2, SW3, SW4, SW13, and SW14 (between 55.9 and 1,211 mg/L); this is likely due to soil erosion and sediment carried down from upstream. Considering that the Ayeyarwaddy River deposits more than 360 million tons of sediment onto the continental shelf of the Northern Andaman Sea each year, it is a likely cause for the Yangon River (an eastern branch of the Ayeyarwaddy River) to have a significantly high background TSS<sup>25</sup>. Iron was also found to have exceeded the Myanmar Emission Standard (3.5 mg/L), and/or IFC Standard (1.0 mg/L) at SW1, SW2, SW3, SW4, SW5, SW6, SW7, SW8, SW9, SW10, SW13, and SW 14 (between 1.18 and 75.29 mg/L). According to soil quality in **Section 5.1.6.2**, given that iron content in soil are considerably high, the high iron content is surface water is most likely due to soil erosion.

Given that the wet season also has high TSS concentrations, this can be a natural reoccurring condition for the Yangon River, or a condition that has been established for quite some period.

Total Dissolved Solid (TDS) concentrations at all sampling locations (4,052 - 12,760 mg/L) exceeded the United States Environmental Protection Agency (EPA) Standard (250 mg/L). Manganese concentrations at all sampling locations (0.22 - 1.40 mg/L), excluding SW9 and SW10, exceeded the EPA Standard (0.05 mg/L)

All other parameters are found to be within the Myanmar Standard, IFC Standards, and EPA Standards.

Photographs of the baseline sampling operations are shown in Figure 5.17.

The results from in-situ sampling is shown in *Table 5.28*, and *Table 5.29*. The summary of laboratory results is shown in *Table 5.30*; the full results with individual station results is shown in *Appendix L*.

<sup>&</sup>lt;sup>25</sup> Aung, T.T., Shimozono, T. & Okayasu, A. (2013) Numerical simulation on sedimentation in Yangon River and its navigation channel. Mer. 51. 91-104.

# Figure 5.17: Photographs of Surface Water Sampling during Dry Season



No.	Sample No./ Physical Parameter	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	Myanmar Standards	EPA Standards <sup>a</sup>
1	Location	Up stream of Yangon River	Downstream of Yangon River	At mouth of Twantae Canal (up)	At mouth of Twantae Canal (below)	Nuaung Ngok To Chaung (down)	Up stream of Nuaung Ngok To Chaung	Downstream of Pyaw Bwe Chaung	Up stream of Pyaw Bwe Gyi Chaung	-	-
2	Date/Time	4/5/2018 8:17	4/5/2018 9:30	3/5/2018 15:30	4/5/2018 10:17	5/5/2018 15:10	5/5/2018 15:20	5/5/2018 15:30	5/5/2018 15:35	-	-
3	Weather	Sunny	Sunny	Sunny	Sunny	Slightly Cloud	Slightly Rain	Sunny	Sunny	-	-
4	Transparency	Low	Low	Low	Low	Low to Medium	Low to Medium	Medium	Medium	-	-
5	Colour	Buff	Buff	Buff	Buff	Yellowish Brown	Yellowish Brown	Light Green	Light Green	-	-
6	Water Depth (m)	10.5	3.5	11.5	5.5	-	-	-	-	-	-
7	Depth (of sample taken) (m)	1	1	1	1	-	-	-	-	-	-
-	Flow rate/velocity (m/s)	0.069	0.15	0.057	0.135	-	-	-	-	-	-
9	Tem (°C) (air & water)	30.7	30.9	31.8	31.0	34.7	35.4	34	34.2	-	-
10	рН	7.73	7.65	7.53	7.75	7.5	7.74	7.55	7.76	6-9	5-9
11	DO (mg/l)	5.2	5.19	4.02	5.01	3.38	5.18	8.02	8.05	-	-
12	EC (μs/m)	1,061.3	1,053.4	662.6	1,087.3	11,861.7	12,502.4	23,615.9	24,067.1	-	-
13	TDS (ppm)	1,229.3	1,152.7	383.9	1,078.8	6,559.64	6,864.89	13,087.5	13,240.85	-	-
14	Turbidity (FNU)	30.14	30.62	33.00	32.72	-	-	-	-	-	-

Table 5 28: In-Situ Results of Surface Water Dry Seaso	on Sampling (1	of 2)
Table J.20. III-Situ Results of Surface Water Dry Seast	on Samping (T	01 2)

No.	Sample No./ Physical Parameter	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	Myanmar Standards	EPA Standards <sup>a</sup>
15	Remark	Sampling	Sampling	Sampling	Sampling	Sampled	Sampled	Sampled on	Sampled	-	-
		and Insitu	and Insitu	and Insitu	and Insitu	on	on	3/5/2018	on		
		test	test	test	test	3/5/2018	3/5/2018	13:40	3/5/2018		
						14:45	15:00		14:00		

# Table 5.29: In-Situ Results of Surface Water Dry Season Sampling (2 of 2)

No.	Sample No./ Physical Parameter	SW 9	SW 10	SW 11	SW 12	SW 13	SW 14	Myanmar Standards	EPA Standards <sup>a</sup>
1	Location	Up stream of	Downstream of	Up stream of	Downstream	Near FSRU	Near FSRU	-	-
		Tha Nat Pin	Tha Nat Pin	Ya Kaing	of Ya Kaing	Option 2,	Option 2,		
		Chaung	Chaung	Gyaung	Gyaung	Yangon River	Yangon River		
2	Date/Time	5/5/2018	5/5/2018	5/5/2018	5/5/2018	3/5/2018	3/5/2018	-	-
		14:05	14:18	13:10	13:30	11:17	12:00		
3	Weather	Sunny	Sunny	Sunny	Sunny	Sunny	Slightly Cloud	-	-
4	Transparency	Medium	Medium	Medium	Medium	Low	Low	-	-
5	Colour	Light Green	Light Green	Light Green	Light Green	Buff	Buff	-	-
6	Water Depth (m)	-	-	-	-	8.9	7.1	-	-
7	Depth (of sample taken) (m)	-	-	-	-	1	1	-	-
8	Flow rate/velocity (m/s)	-	-	-	-	0.25	0.27	-	-
9	Tem (°C) (air & water)	34.1	34.5	33.2	34.2	31.9	31.7	-	-
10	рН	8.14	8.13	7.83	7.65	7.5	7.4	6-9	5-9
11	DO (mg/l)	5.32	5.19	5.21	5.31	5.68	5.87	-	-
12	EC (µs/m)	22,858.8	23,091.6	22,626.7	22,885.5	2,365	1,373	-	-
13	TDS (ppm)	12,702.8	12,817.4	12,724.7	12,802.45	1,370	1,306	-	-
14	Turbidity (FNU)	-	-	-	-	38	36	-	-

No.	Sample No./ Physical Parameter	SW 9	SW 10	SW 11	SW 12	SW 13	SW 14	Myanmar Standards	EPA Standards <sup>a</sup>
15	Remark	Sampled on 3/5/2018 12:40	Sampled on 3/5/2018 12:20	Sampled on 3/5/2018 12:00	Sampled on 3/5/2018 12:10	Sampling and Insitu test	Sampling and Insitu test	-	-

Source: SEM, 2018.

Note: <sup>a</sup> United States Environmental Protection Agency (EPA), National Primary Drink Water Regulations & National Secondary Drinking Water Regulation, 2009.

## Table 5.30: Summary of Surface Water Dry Season Sampling Laboratory Results

Parameter	Unit	LOQ	Results	Myanmar Standards	IFC Standards <sup>a</sup>	EPA Standards <sup>b</sup>
Alkalinity	mg/L as CaCO₃	1.0	82.1 – 149	-	-	-
Biochemical Oxygen Demand (BOD)	mg/L	-	0.2 - 3.0	50	30	-
Total Suspended Solids (TSS)	mg/L	10.0	<10.0 – <b>1,211</b>	50	50	-
Total Dissolved Solids (TDS)	mg/L	50.0	4,052 – 12,760	-	-	250
Turbidity	NTU	0.02	4.32 – 646	-	-	-
Hardness as CaCO₃	mg/L as CaCO₃	5.0	703 – 1,945	-	-	-
Cyanide (CN)	mg/L	0.005	<0.005	0.1 (Free) 1.0 (Total)	-	0.004
Fluoride (F)	mg/L	0.1	< 0.1 - 0.4	20	-	-
Sulphide	mg/L	1.0	<1.0	1	-	-
Total Organic Carbon	mg/L	0.05	1.63 – 6.86	-	-	-
Ammonium-Nitrogen	mg/L	0.010	0.035 – 0.499	10	-	-
Sulphate (SO <sub>4</sub> )	mg/L	1.0	105 – 579	-	-	-
Nitrate (NO <sub>3</sub> )	mg/L	0.005	<0.040 - 2.38	-	-	10
Chromium (Cr)	mg/L	0.0005	0.0007 – 0.0391	0.1 (Cr <sup>6+</sup> ) 0.5 (Total)	0.5 (Total)	0.1 (Total)

Parameter	Unit	LOQ	Results	Myanmar Standards	IFC Standards <sup>a</sup>	EPA Standards <sup>ь</sup>
Calcium (Ca)	mg/L	0.02	59.90 – 185.98	-	-	-
Magnesium (Mg)	mg/L	0.003	92.04 - 386.15	-	-	-
Sodium (Na)	mg/L	0.01	836.20 – 2,651	-	-	-
Potassium (K)	mg/L	0.01	37.89 – 123.68	-	-	-
Mercury (Hg)	mg/L	0.0003	<0.0003 - 0.0006	0.01	0.005	-
Lead (Pb)	mg/L	0.0020	<0.0020 - 0.0079	0.1	0.5	-
Cadmium (Cd)	mg/L	0.00005	<0.00005 - 0.00014	0.1	0.1	0.005
Copper (Cu)	mg/L	0.05	< 0.05 - 0.06	0.5	0.5	1.3
Iron (Fe)	mg/L	0.10	0.036 – <b>75.29</b>	3.5	1.0	-
Tin (Sn)	mg/L	0.0001	<0.0001 - 0.001	-	-	-
Manganese (Mn)	mg/L	0.04	0.05 – <b>1.40</b>	-	-	0.05
Total Nitrogen	mg/L	1.0	<1.0	-	-	-
Total Phosphorous	mg/L	0.005	0.005 – 0.347	2	2	-
Zinc (Zn)	mg/L	0.02	< 0.02 - 0.17	2	1.0	7.4
Nickel (Ni)	mg/L	0.0005	0.0014 – 0.0275	0.5	-	0.61
Chloride (Cl)	mg/L	1.0	2,094 – 6,511	-	-	-
Oil and Grease	mg/L	2.0	3.9 – 7.0	10	10	-
Chemical Oxygen Demand (COD)	mg/L	5.0	13.0 – 81.0	250	125	-

Source: STS Green, 2018.

Note: <sup>a</sup> World Health Organization (WHO), Guidelines for Drinking-Water Quality, Fourth Edition Incorporating the First Addendum, Annex 3: Chemical summary tables. <sup>b</sup> United States Environmental Protection Agency (EPA), National Primary Drink Water Regulations & National Secondary Drinking Water Regulation, 2009.

#### Wet Season Survey

According to the wet season results from STS Green, TSS and iron was found at levels above Myanmar Standard / IFC Standards at all sampling stations. This is most likely due to soil erosion that occurs upstream from the sampling locations; however, compared to dry season there are more sampling locations in the wet season that exceeded the standard. This variation is most likely due to increased precipitation during the wet season, resulting in increased soil erosion.

It should also be noted that mercury at SW9 (0.0053 mg/L) slightly exceeds the IFC standards (0.005 mg/L); however, is still within the Myanmar Standards (0.01). Manganese concentrations at all sampling locations (0.14 - 0.85 mg/L) exceed the EPA Standard (0.05 mg/L).

All other parameters were found to be within the Myanmar standards, IFC Standards, and EPA Standards.

Photographs of the baseline sampling operations are shown in Figure 5.18.

The results from in-situ sampling is shown in *Table 5.31*, and *Table 5.32*. The summary of laboratory results is shown in *Table 5.33*; the full results with individual station results is shown in *Appendix N*.

# Figure 5.18: Photographs of Surface Water Sampling during Wet Season



No.	Sample No./ Physical Parameter	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	Myanmar Standards	EPA Standards <sup>a</sup>
1	Location	Up stream of Yangon River	Downstream of Yangon River	At mouth of Twantae Canal (up)	At mouth of Twantae Canal (below)	Ka Ma Aung Stream (down)	Up stream of Ka Ma Aung Stream	Downstream of Pyaw Bwe Stream	Up stream of Pyaw Bwe Stream	-	-
2	Date/Time	27/6/2018 13:04	27/6/2018 12:35	27/6/2018 11:30	27/6/2018 11:15	29/6/2018 13:20	29/6/2018 13:20	29/6/2018 12:10	29/6/2018 12:15	-	-
3	Weather	Rainy	Cloudy	Cloudy	Cloudy	Cloudy	Cloudy	Sunny	Sunny	-	-
4	Transparency	Medium to high	Medium to high	Medium to high	Medium to high	Medium	Medium	Medium	Medium	-	-
5	Colour	-	-	-	-	Light Yellow	Light Yellow	Light Yellow	Light Yellow	-	-
6	Water Depth (m)	14	8.1	8.6	8.0	-	-	-	-	-	-
7	Depth (of sample taken) (m)	1	1	1	1	-	-	-	-	-	-
8	Flow rate/velocity (m/s)	0.2	0.1	1.5	0.2	-	-	-	-	-	-
9	Tem (°C) (air & water)	27.54	27.49/31.20	29.82/32	27.61/32	33.00/30.05	32.30/31.59	37.50/29.95	37.60/30.43	-	-
10	рН	7.53	7.50	7.86	7.11	6.58	6.68	6.71	6.39	6-9	5-9
11	DO (mg/l)	7.14	7.26	7.11	76.01	1.29	1.22	3.45	3.65	-	-
12	EC (µs/m)	121.0	126.23	241.7	135.51	190.8	129.0	66.4	54.1	-	-
13	TDS (ppm)	75.02	76.85	154.74	121.62	113.26	74.33	39.44	31.83	-	-

# Table 5.31: In-Situ Results of Surface Water Wet Season Sampling (1 of 2)

No.	Sample No./ Physical Parameter	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	Myanmar Standards	EPA Standardsª
14	Remark	Sampling	Sampling	Sampling	Sampling	Sampled on	Sampled on	Sampled on	Sampled on	-	-
		and In-	and In-situ	and In-	and In-	28/6/2018	28/6/2018	28/6/2018	28/6/2018		
		situ test	test	situ test	situ test	13:15	13:30	12:35	12:50		

# Table 5.32: In-Situ Results of Surface Water Wet Season Sampling (2 of 2)

No.	Sample No./ Physical Parameter	SW 9	SW 10	<b>SW</b> 11	SW 12	SW 13	SW 14	Myanmar Standards	EPA Standards <sup>a</sup>
1	Location	Up stream of Pyaw Bwe Stream	Downstream of Pyaw Bwe Stream	Up stream of Ya Kaing Gyaung Stream	Downstream of Ya Kaing Gyaung Stream	Near FSRU Option 2, Yangon River	Near FSRU Option 2, Yangon River	-	-
2	Date/Time	29.6.2018 12:00	29.6.2018 11:50	29.6.2018 11:30	29.6.2018 11:40	28.6.2018 12:41	3.5.2018 12:00	-	-
3	Weather	Sunny	Sunny	Sunny	Sunny	Cloudy	Cloudy	-	-
4	Transparency	Medium	Medium	Medium	Medium	Medium to high	Medium to high	-	-
5	Colour	Light Yellow	Light Yellow	Light Yellow	Light Yellow	-	-	-	-
6	Water Depth (m)	-	-	-	-	10.5	7.9	-	-
7	Depth (of sample taken) (m)	-	-	-	-	1	1	-	-
8	Flow rate/velocity (m/s)	-	-	-	-	0.5	1.2	-	-
9	Tem (°C) (air & water)	39.00/29.44	37.90/29.29	40.10/29.37	39.50/29.10	32/28	31/28.1	-	-
10	рН	6.41	6.54	6.25	6.38	7.58	7.12	6-9	5-9
11	DO (mg/l)	3.76	4.18	3.65	3.45	6.38	5.65	-	-
12	EC (µs/m)	122.1	125.0	221.7	230.4	125.6	135	-	-
13	TDS (ppm)	73.19	75.11	132.93	138.89	77.20	64	-	-

No.	Sample No./ Physical Parameter	SW 9	SW 10	SW 11	SW 12	SW 13	SW 14	Myanmar Standards	EPA Standards <sup>a</sup>
14	Remark	Sampled on	Sampled on	Sampled on	Sampled on	Sampling and	Sampling and	-	-
		28/6/2018	28/6/2018	28/6/2018	28/6/2018	Insitu test	Insitu test		
		11:15	11:30	10:25	10:47				

Source: SEM, 2018.

Note: <sup>a</sup> United States Environmental Protection Agency (EPA), National Primary Drink Water Regulations & National Secondary Drinking Water Regulation, 2009.

## Table 5.33: Summary of Surface Water Wet Season Sampling Laboratory Results

Parameter	Unit	LOQ	Results	Myanmar Standards	IFC Standards <sup>a</sup>	EPA Standard <sup>b</sup>
Alkalinity	mg/L as CaCO3	1.0	8.2 – 49.3	-	-	-
Biochemical Oxygen Demand (BOD)	mg/L	-	0.5 – 2.8	50	30	-
Total Suspended Solids (TSS)	mg/L	10.0	117 – 904	50	50	-
Total Dissolved Solids (TDS)	mg/L	50.0	76.0 – 246	-	-	250
Turbidity	NTU	0.02	295 – 968	-	-	-
Hardness as CaCO3	mg/L as CaCO3	5.0	15.2 – 70.0	-	-	-
Cyanide (CN)	mg/L	0.005	<0.005	0.1 (Free) 1.0 (Total)	-	0.004
Fluoride (F)	mg/L	0.1	<0.1	20	-	-
Sulphide	mg/L	1.0	<1.0	1	-	-
Total Organic Carbon	mg/L	0.05	3.12 – 9.61	-	-	-
Ammonium-Nitrogen	mg/L	0.010	0.047 – 0.621	10	-	-
Sulphate (SO4)	mg/L	1.0	<1.0 - 14.4	-	-	-
Nitrate (NO3)	mg/L	0.005	0.420 - 2.40	-	-	10
Chromium (Cr)	mg/L	0.0005	0.02 - 0.0798	0.1 (Cr <sup>6+</sup> ) 0.5 (Total)	0.5 (Total)	0.1 (Total)
Parameter	Unit	LOQ	Results	Myanmar Standards	IFC Standards <sup>a</sup>	EPA Standard <sup>b</sup>
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Calcium (Ca)	mg/L	0.02	<0.02 – 10.56	-	-	-
Magnesium (Mg)	mg/L	0.003	2.01 – 14.85	-	-	-
Sodium (Na)	mg/L	0.01	4.43 – 18.61	-	-	-
Potassium (K)	mg/L	0.01	1.46 – 3.25	-	-	-
Mercury (Hg)	mg/L	0.0003	0.0019 – <b>0.0053</b>	0.01	0.005	-
Lead (Pb)	mg/L	0.0020	0.0062 – 0.0155	0.1	0.5	-
Cadmium (Cd)	mg/L	0.00005	<0.00005 - 0.00031	0.1	0.1	0.005
Copper (Cu)	mg/L	0.05	<0.05	0.5	0.5	1.3
Iron (Fe)	mg/L	0.10	22.15 - 44.89	3.5	1.0	-
Tin (Sn)	mg/L	0.0001	<0.0001 - 0.0008	-	-	-
Manganese (Mn)	mg/L	0.04	0.14 – 0.85	-	-	0.05
Total Nitrogen	mg/L	1.0	<1.0 – 1.6	-	-	-
Total Phosphorous	mg/L	0.005	0.155 – 0.456	2	2	-
Zinc (Zn)	mg/L	0.02	<0.02 - 0.10	2	1.0	7.4
Nickel (Ni)	mg/L	0.0005	0.0160 – 0.1297	0.5	-	0.61
Chloride (Cl)	mg/L	1.0	3.3 – 31.5	-	-	-
Oil and Grease	mg/L	2.0	<2.0 - 5.0	10	10	-
Chemical Oxygen Demand (COD)	mg/L	5.0	18.9 – 81.9	250	125	-

Note: <sup>a</sup> World Health Organization (WHO), Guidelines for Drinking-Water Quality, Fourth Edition Incorporating the First Addendum, Annex 3: Chemical summary tables. <sup>b</sup> United States Environmental Protection Agency (EPA), National Primary Drink Water Regulations & National Secondary Drinking Water Regulation, 2009.

## 5.1.6 Soil

#### 5.1.6.1 Soil Type

The Study Area is located on Meadow (Gleysol) and Meadow Alluvial soil (Fluvic Gleysols). The Meadow soil distributes near the river plains where occasional tidal floods occur and are typically non-carbonate, and they usually contain large amount of salts. Meadow Alluvial soil can be found in the flood plains. They have the texture of silty clay loam and are rich in plant nutrients (Union of Myanmar, 2009).

The soil types in Myanmar can generally be divided into ten (10) dominant subsoil types as presented in *Figure 5.19*. The Project is located on soil identified as Gleysol. This soil type is described as follows<sup>26</sup>:

- Hydromorphic properties within 50 cm of the surface; and
- No diagnostic horizons other than (unless buried by 50 cm or more new material) an A horizon, an H horizon, a cambic B horizon, a calcic or a gypsic horizon.

<sup>&</sup>lt;sup>26</sup> FAO. (1974). Key to the FAO Soil Units (1974). Food and Agriculture Organization of the United Nations (FAO). Retrieved April 12, 2017 from http://www.fao.org/soils-portal/soil-survey/soil-classification/fao-legend/key-to-the-fao-soil-units/en/



Figure 5.19: Soil Types and Distribution in Myanmar



<sup>&</sup>lt;sup>27</sup> FAO. (2008). Geographical distribution of 10 dominant soil types in Myanmar. Myanmar – FAO/NR Data, Tools and Maps (General). Food and Agriculture Organization of the United Nations (FAO). Retrieved from http://www.fao.org/nr/myanmar/page4\_en.htm

## 5.1.6.2 Soil Quality

## Baseline Soil Sampling Methodology

Soil samples were collected from nine (9) sample points in the Study Area on the 3rd – 4th May 2018, and were tested for several types of parameters which are listed together with the results below. All sampling was conducted in strict accordance with recognized standard procedures, as listed together with the sampling results in *Appendix L*. Soil sampling has been conducted during dry season; parameters that were selected for sampling are listed below.

The soil samples were collected using a manual hand auger tool, and the samples were collected from top soil (30 cm – 50 cm depth) and sub soil (80 cm – 100 cm depth). The location of each sampling point is shown in *Figure 5.20*. The results of the analysis are presented in *Table 5.36* and *Table 5.37*, and have been compared against USEPA Regional Screening Levels (RSL), which are risk-based concentrations derived from standardized equations combining exposure information with EPA toxicity data.

## Baseline Soil Sampling Locations

The description of the soil sampling locations can be found in *Table 5.34*. The location of each soil sampling site is shown in *Figure 5.20*.

Sampling Point	Coordinates	Description of Sampling Point
SO 1	16°46'29.86"N 96° 07'41.17"E	Located within the Combined Cycle Power Plant, in AhloneTownship, Yangon Region. Area mainly covered by shrub land mangrove forest.
SO 2	16°46'7.14"N 96° 7'31.01"E	Located within Seikgyikanaungto Township, on the corner of Yangon River and Twan Te Canal. Approximately 60 meters southeast of the proposed gas pipeline.
SO 3	16°45'59.11"N 96° 8'0.06"E	Located within Dala Township, on the right back of the left bank of Twan Te Canal. Approximately 100 meters northeast of the proposed gas pipeline.
SO 4	16°45'9.01"N 96° 7'55.77"E	Beside the street which is located in Kyansitthar Ward, Dala Township, Yangon Region. Approximately 30 meters west of the proposed gas pipeline.
SO 5	16°44'59.06"N 96° 8'30.30"E	Beside the road (near the paddy field), in Tapinshwehtee Ward, Dala Township, Yangon Region. Approximately 20 meters southwest of the proposed gas pipeline.
SO 6	16°43'47.49"N 96° 8'15.41"E	In the paddy field which located west of Gwa & Nuaung Ngok To Village, Dala Township, Yangon Region. Approximately 30 meters East of the proposed gas pipeline.
SO 7	16°40'57.68"N 96° 8'55.93"E	In the paddy field (near Pyaw Bwe Gyi Village) which located in Dala Township, Yangon Region. The location has a flat terrain, consisting of agricultural land.
SO 8	16°38'28.81"N 96°12'13.19"E	In the stream (the stream was run dry for now) which located in Shan Gan Village, Dala Township, Yangon Region. Approximately 10 meters southwest of the proposed gas pipeline.
SO 9	16°39'4.89"N 96°14'20.95"E	In the paddy field (near FSRU Option 2), right bank of river, Chaung Oo Village, Dala Township, Yangon Region. This location has a flat terrain, consisting of agricultural land.

#### Table 5.34: Soil Sampling Locations







## Summary of Baseline Sampling Results

There are no Myanmar regulations/standards for ambient soil or groundwater quality. In the absence of local country standards, it is ERM's practice to use globally recognized 'Dutch Target and Intervention Values, 2000 (the New Dutch List)' (hereafter referred to as "the Dutch Standard") to assess soil quality and to determine the need, if any, for remedial action.

According to the soil sampling results, sampling site SO 2 exceeded the target value for copper in top soil, and SO 4 exceeded the Dutch Standard for copper in subsoil (between 37.44 and 38.29 mg/kg). Sub-soil at site SO 2 also exceeded the target value for mercury (1.04 mg/kg).

Other remaining sampling sites and parameters were found to be within the Dutch Standard.

SEM also conducted in-situ observations and analysis of soil characteristics at each sampling site, and the results are shown in *Table 5.35*.

Sampling Site	Soil Characteristics
SO 1	The top soil and sub soil are mainly composed of organic materials and mud with dark grey colour. The typical soil type is clayey soil.
SO 2	The top soil and sub soil colour are light grey to reddish brown and mainly composed of residual organic materials. The soil type is silty clay.
SO 3	The top soil and sub soil are brownish grey colour, and the soil type is clay.
SO 4	The top soil and sub soil are light brown colour, and the soil type is silty clay.
SO 5	The top soil and sub soil are greyish brown colour, and the soil type is clayey soil.
SO 6	The top soil and sub soil are light brown colour, and the soil type is silty clay.
SO 7	The top soil and sub soil are light brown colour, and the soil type is silty clay.
SO 8	The top soil and sub soil are dark brown colour, and the soil type is clayey soil.
SO 9	The top soil and sub soil colour are light brown colour, and the soil type is silty clays.

#### Table 5.35: Soil Characteristics

Source: SEM, 2018.

*Table 5.36*, and *Table 5.37* presents the baseline results for laboratory analysis from the surveys conducted in May 2018.

			Results							Dutch Standard <sup>a</sup>			
Parameter	Unit	so	01	so	2	so	) 3	SC	04	so	0 5	Target	Intervention
i ulullotoi	Unit	Top Soil	Sub Soil	Top Soil	Sub Soil	Top Soil	Sub Soil	Top Soil	Sub Soil	Top Soil	Sub Soil	values	Value
рН	-	7.3	7.2	7.7	7.3	7.6	7.2	8.0	7.8	7.4	7.4	-	-
Arsenic (As)	mg/kg	0.30	<0.04	<0.04	<0.04	<0.04	<0.04	3.80	5.90	<0.04	<0.04	29	55
Cadmium (Cd)	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.8	12
Chromium (Cr)	mg/kg	47.54	36.82	74.99	73.34	63.39	71.71	66.66	70.60	56.20	56.87	100	380
Copper (Cu)	mg/kg	25.13	9.03	38.29	27.29	36.07	34.78	35.12	37.44	27.74	23.70	36	190
Iron (Fe)	mg/kg	35,912	25,382	67,059	62,391	62,995	57,391	7,449	6,942	8,684	6,068	-	-
Lead (Pb)	mg/kg	31.59	8.53	25.51	26.92	26.04	25.62	26.84	33.20	28.74	<5.00	85	530
Manganese (Mn)	mg/kg	461.10	229.01	894.26	873.51	1,209	1,448	1,039	536.19	947.18	737.08	-	-
Mercury (Hg)	mg/kg	<0.10	<0.10	1.04	0.12	0.13	0.15	0.10	0.10	<0.10	0.10	0.3	10
Zinc (Zn)	mg/kg	70.30	39.10	103.96	107.18	105.59	101.36	101.81	100.64	84.50	70.81	140	720

Note: a Earth Intervention value, Dutch Target and Intervention Values, 2000

		Results							Sta	ndard <sup>a</sup>	
Parameter	Unit	SO	6	SC	7	sc	8	so	9	Target	Intervention
		Top Soil	Sub Soil	Top Soil	Sub Soil	Top Soil	Sub Soil	Top Soil	Top Soil	values	Value
рН	-	6.8	8.1	6.7	7.5	7.6	7.8	7.8	7.5	-	-
Arsenic (As)	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	29	55
Cadmium (Cd)	mg/kg	<1.00	<1.00	<0.10	<1.00	<1.00	<1.00	<1.00	<1.00	0.8	12
Chromium (Cr)	mg/kg	64.97	68.02	60.84	64.10	63.83	64.62	72.61	74.00	100	380
Copper (Cu)	mg/kg	29.34	31.95	30.01	29.04	<1.50	29.26	33.64	31.93	36	190
Iron (Fe)	mg/kg	11,140	9,738	5,703	9,995	59,965	53,394	54,513	55,400	-	-
Lead (Pb)	mg/kg	24.56	22.94	23.81	24.05	16.43	21.16	32.49	26.95	85	530
Manganese (Mn)	mg/kg	1,196	1,662	651.12	829.18	783.22	628.56	641.31	566.36	-	-
Mercury (Hg)	mg/kg	0.12	<0.10	<0.10	0.12	0.10	0.10	0.12	<0.10	0.3	10
Zinc (Zn)	mg/kg	87.05	93.86	83.44	84.73	79.25	86.06	96.16	89.28	140	720

Note: a Earth Intervention value, Dutch Target and Intervention Values, 2000

## 5.1.7 Groundwater

#### 5.1.7.1 Hydrogeology

On the basis of stratigraphy, there are 13 different types of aquifers in Myanmar, namely Alluvium, Irrawaddian, Peguan, Limestone, Igneous (or Volcanic) and Other Minor Aquifers. The Study Area is underlain by Alluvium aquifers (*Figure 5.21*).

In general, groundwater aquifers are prone to leaching during the monsoon periods, especially on impervious surfaces, e.g. clay seams, clay layers, bedrocks, etc. Rising groundwater can cause saturation of the soil and can cause very high pore-water pressure in slopes in sedimentary deposits.

The estimated groundwater potential in the Ayeyarwady (Lower) Region, where the Project is located, is 153.25 km<sup>3</sup>, as shown in *Table 5.38*.

River Basin	Catchment Area (km <sup>2</sup> )	Groundwater Potential (km <sup>3</sup> )
Chiuindwin	115,300	57.58
Ayeyarwady (Upper)	193,300	92.60
Ayeyarwady (Lower)	95,600	153.25
Sittoung	48,100	28.40
Rivers in Rakhine State	58,300	41.77
Rivers in Tanintharyi Region	40,600	39.28
Thanlwin (within Myanmar)	158,000	74.78
Mekong (within Myanmar)	28,600	7.05
Total	737,800	494.71

#### Table 5.38: Estimated Groundwater Potential across Myanmar

Source: Zaw et al, 2017.28

The China Geological Survey has organized the publication of a document titled "Groundwater Serial Maps of Asia", which was compiled by the Institute of Hydrogeology and Environmental Geology of CAGS in 2012, and summarizes research on groundwater systems in Asian countries, including Myanmar. Excerpts of two useful maps from this document, a Hydrogeological Map, and Groundwater Resources Map, are presented in *Figure 5.22* and *Figure 5.23*, respectively.

Based on these maps, the productivity of aquifers near the Study Area can be classified as "Strong Pore Water", or "Weak Fissure Water", and groundwater quality is considered "Fresh Groundwater". The groundwater type ranges from "Pore Water" to "Fractured Water". Groundwater resources classifications consist of "Discontinuous Aquifer in Hilly Area" and "Continuous Aquifer in Plain and Intermontaine Basin", with Natural Recharge Modulus ranging from 200,000-500,000 m<sup>3</sup>/km<sup>2</sup>-yr.

<sup>&</sup>lt;sup>28</sup> Zaw, T., Than, M.M. (2017). Climate change and groundwater resources in Myanmar. Journal of Groundwater Science and Engineering. Retrieved from http://gwse.iheg.org.cn/EN/abstract/abstract/260.shtml#



Figure 5.21: Major Aquifers of Myanmar

Source: Zaw, 2017.28



Figure 5.22: Hydrogeological Map of Myanmar



Major Subterranean River

🌑 🛛 Salt-Water Lake

1-

Fresh Groundwater (Blank Area)

Fresh Water Lens

Fresh Water Underlain by Brackish Water and Saline Water

Source: CGS, 2012.29

<sup>&</sup>lt;sup>29</sup> CGS. (2012). Groundwater Serial Maps of Asia. China Geological Survey (CGS). Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000220768





Source: Adapted from Groundwater Serial Maps of Asia", which was compiled by the Institute of Hydrogeology and Environmental Geology of CAGS in 2012.

#### 5.1.7.2 Groundwater Use

Exploitation of Myanmar's aquifers has thus far been limited to municipal water supply and intensive irrigation of vegetables and other high value crops from hand-dug wells<sup>30</sup>. Water use in Myanmar has been increasing, particularly in the agricultural and industrial sectors. **Table 5.39** shows the water use in different sectors for the year 2008-09. As much as 89% of water use is tapped for irrigation purposes, while about 8% is for domestic consumption and 3% is for industry.

Sector	Surface Water	Groundwater	Total
Domestic	1.15 (3%)	2.55 (68%)	3.7 (8%)
Industrial	1.17 (3%)	0.33 (9%)	1.5 (3%)
Irrigation	41.97 (94%)	0.85 (23%)	42.82 (89%)
Total	44.29	3.73	48.02

Table 5.39: Water Use b	y Different Sectors in	Myanmar
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Source: FAO, 2012.31

#### 5.1.7.3 Groundwater Quality

Baseline groundwater quality sampling surveys in the Study Area have been conducted, as part of this ESIA study. An overview of the surveys and their results are presented in this section.

#### Baseline Groundwater Sampling Methodology

Groundwater samples were taken by an Alpha horizontal water sampler for some wells and collected in plastic and sterilized glass sample containers. All sampling was conducted in strict accordance to recognized standard procedures as listed together with the sampling results below. The parameters pH, temperature, dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids, odour, and colour were measured at each site in-situ. The parameters that were measured by laboratory analysis are listed together with the results below.

Full detail of sampling methods and in-situ measurement results is shown in *Appendix K* and *Appendix M*. Groundwater sampling has been conducted for both dry and wet seasons; parameters that were selected for sampling are listed below.

According to the sample's storage requirements as instructed by STS Green, some samples were preserved using appropriate preservation chemicals. All samples were kept in iced boxes and were transported to the laboratory within 24 hours. The detailed study of groundwater quality is presented in the *Appendix L* and *Appendix N*.

The equipment that were used to collect groundwater quality samples are listed in Table 5.40.

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 <sup>&</sup>lt;sup>30</sup> FAO. (1999), AQUASTAT Country-profile: Myanmar. Retrieved from http://www.fao.org/nr/myanmar/aquastat-myanmar.pdf
 <sup>31</sup> FAO. (2012). Myanmar: Water use. Food and Agriculture Organization of the United Nations (FAO). Retrieved from http://www.fao.org/nr/water/aquastat/countries\_regions/MMR/

No.	Equipment	Manufacturer	Originate Country	Model/Serial No.
1	SMART TROLL MP _Multi parameter for water	In Situ Inc.	USA	SN - 346054
2	Multi Parameters for water quality	HANNA	USA	H17609823 (Turbidity Sensor)
3	Alpha Bottle (Water Sampler)	Wildlife Supply Company	Indonesia	Wildco P/N-1120-G45

## Table 5.40: Field Equipment for Groundwater Quality Survey

Source: SEM, 2018.

## Baseline Groundwater Sampling Locations

Groundwater samples were collected by SEM and ERM-Siam on the 3<sup>rd</sup> - 4<sup>th</sup> May, 2018, at three (3) locations as shown in *Figure 5.24*, and each location is described in *Table 5.41*.

Sampling Point	Coordinates	Description of Sampling Point
GW 1	16°40'59.81"N 96° 8'41.28"E	The sampling point is a domestic well within Pyaw Bwe Gyi Village, and is located 90 meters south of the proposed pipeline. Although there are rice mills and houses surrounding the sampling point, the well is only used for domestic, non-drinking use. The sample from this point has been collected from a depth of 6 m and the transparency of the water is high.
GW 2	16°45'0.67"N 96° 8'30.66"E	The sampling point is a well located beside the Botaza road, in Dala Township, and approximately 40 meters south of the pipeline. The well is only used for domestic purpose and not for drinking. The well has a depth of approximately 15 metres. Water samples collected from the well was colourless; however, after a few minutes it turned yellowish.
GW 3	16°46'48.11"N 96° 8'11.26"E	The sampling point is a well located in Tha Khin Mya park, in Ahlone Township, and approximately 1.01 km northeast of the Power Plant. It is also positioned at the corner of Lower Kyeemyindaing Road and Aung Yadana Street. This well is mainly used for domestic purposes. Water samples were collected from a depth of approximately 13.7 metres. The water sample has high transparency.

#### Table 5.41: Groundwater Sampling Locations

Source: SEM, 2018.







## Summary of Baseline Sampling Results

#### **Dry Season Survey**

The dry season sampling results are shown in Table 5.42, and Table 5.43.

The iron (Fe) concentration at GW1 (9.68 mg/L), and GW2 (3.86 mg/L) exceeds the Myanmar Standard (1 mg/L) and EPA Standard (0.3 mg/L). This is most likely due to the natural process of leaching.

The TDS concentrations at GW1 (14,170 mg/L), and GW2 (3,242 mg/L) exceeded the EPA Standard (500 mg/L). This correlation may also explain the noticeably high Electrical Conductivity (EC) values in GW1.

Although the Myanmar Standard does not specify any limits to Nitrate ( $NO_3$ ), the standards specified by the World Health Organization (WHO), and/or the EPA Standard indicates that Nitrate ( $NO_3$ ) exceeds the limit for all three sampling locations.

The Manganese concentration at GW1 (0.4 mg/L), and GW2 (2.94 mg/L) exceeds the EPA Standard (0.05 mg/L). Chloride concentrations at GW1 (7,103 mg/L), and GW2 (1,438 mg/L) exceeds the EPA Standard (250 mg/L).

All other parameters were found to be within the Myanmar standards, EPA, and WHO guidelines.

It should also be noted that most parameters follow a trend whereby GW1 has the highest concentration of the measured parameters, followed by GW2, with GW3 having the lowest concentration of the three measured stations.

# Table 5.42: Results of In-situ Groundwater Quality Measurement and Analysisfor Dry Season

No.	Sample No./ Physical Parameter	GW1	GW2	GW3	Myanmar Standards	EPA Standards <sup>a</sup>
1	Location	Pyaw Bwe Gyi Village	Beside the Botaza Road, Dala	Tha Khin Mya Park	-	-
2	Date/Time	5/5/2018 14:45	5/5/2018 15:32	5/5/2018 17:10	-	-
3	Weather	Sunny	Slightly Cloud	Slightly Sunny	-	-
4	Transparency	High	Low to High	High	-	-
5	Colour	Colourless	Slightly Yellow	Colourless	-	-
6	Water Depth (m)	6	15	34	-	-
7	Depth (of sample taken) (m)	-	-	-	-	-
8	Flow rate/velocity (m/s)	-	-	-	-	-
9	Tem (°C) (air & water)	30.4	28.4	25.1	-	-
10	рН	7.37	6.7	7.04	6-9	6.5-8.5
11	DO (mg/l)	1.25	1.15	2.32	-	-
12	EC (µs/m)	25,986.5	5,599.5	184	-	-
13	TDS (ppm)	15,266.76	3,367.46	111.41	-	-
14	Turbidity (FNU)	-	-	-	-	-
	Remark	Sampled	Sampled	Sampled		
		on	on	on		
		3/5/2018	3/5/2018	4/5/2018		
		14:15	15:15	14:30		

Source: SEM, 2018.

Note: <sup>a</sup> United States Environmental Protection Agency (EPA), National Primary Drink Water Regulations & National Secondary Drinking Water Regulation, 2009

Parameter	Unit	Mothed Applysic	1.00	Results			Myanmar			
Parameter	Unit	Method Analysis	LUQ	GW1	GW2	GW3	Myanmar Standards	WHO Guidelines <sup>a</sup>	EPA Standards <sup>b</sup>	Laboratory
	San	npling Date		3/5/2018	3/5/2018	4/5/2018	Otandarda	Guidennes	otandarus	
Alkalinity	mg/L as CaCO₃	5-Day BOD Test, Azide Modification Method	1.0	650	152	17.1	-	-	-	STS Green Co., Ltd.
Biochemical Oxygen Demand (BOD)	mg/L	Dried at 103-105 °C Method	-	0.2	0.4	0.2	50	-	-	STS Green Co., Ltd.
Total Suspended Solids (TSS)	mg/L	Dried at 180 °C Method	10.0	48.6	<10.0	<10.0	50	-	-	STS Green Co., Ltd.
Total Dissolved Solids (TDS)	mg/L	Nephelometric Method	50.0	14,170	3,242	291	-	-	500	STS Green Co., Ltd.
Turbidity	NTU	EDTA Titrimetric Method	0.02	94.5	47.2	1.01	-	-	-	STS Green Co., Ltd.
Total Hardness as CaCO₃	mg/L as CaCO₃	APHA (2012), 4500- CN (C),(E)	5.0	2,117	511	80.4	-	-	-	STS Green Co., Ltd.
Cyanide (CN)	mg/L	APHA (2012), 4110B	0.005	<0.005	<0.005	<0.005	0.1	-	0.2	ALS Laboratory Group (Thailand)
Fluoride (F)	mg/L	lodometric Method	0.1	<0.1	<0.1	<0.1	20	1.5	4.0	ALS Laboratory Group (Thailand)

Parameter	Unit	Mothod Analysis	1.00	Results			Myanmar	W(10		
Parameter	Unit	Method Analysis	LUQ	GW1	GW2	GW3	Myanmar Standards	WHO Guidelines <sup>a</sup>	EPA Standards <sup>b</sup>	Laboratory
	San	npling Date		3/5/2018	3/5/2018	4/5/2018	otandarda	Guidennes	otandarus	
Sulphide	mg/L	Based on APHA (2012), 5310 B	1.0	<1.0	<1.0	<1.0	1	-	-	STS Green Co., Ltd.
Total Organic Carbon	mg/L	Phenate Method	0.05	4.65	0.55	0.09	-	-	-	ALS Laboratory Group (Thailand)
Ammonium- Nitrogen	mg/L	Turbidimetric Method	0.010	2.85	2.32	0.151	10	-	-	STS Green Co., Ltd.
Sulphate (SO <sub>4</sub> )	mg/L	Cadmium Reduction Method	1.0	320	15.0	8.7	-	-		STS Green Co., Ltd.
Nitrate (NO <sub>3</sub> )	mg/L	Electrothermal AAS Method	0.005	0.293	0.222	18.61	-	0.05	10	STS Green Co., Ltd.
Chromium (Cr)	mg/L	Direct Nitrous Oxide- Acetylene Flame Method	0.0005	<0.0005	<0.0005	0.0042	0.5	0.05	0.1	STS Green Co., Ltd.
Calcium (Ca)	mg/L	Direct Air-Acetylene Flame Method	0.02	206.05	18.35	11.14	-	-	-	STS Green Co., Ltd.
Magnesium (Mg)	mg/L	Direct Air-Acetylene Flame Method	0.003	153.65	74.94	12.46	-	-	-	STS Green Co., Ltd.
Sodium (Na)	mg/L	Direct Air-Acetylene Flame Method	0.01	3,198	644.80	17.90	-	-	-	STS Green Co., Ltd.
Potassium (K)	mg/L	Cold-Vapour AAS Method	0.01	177.57	59.95	3.69	-	-	-	STS Green Co., Ltd.
Mercury (Hg)	mg/L	Electrothermal AAS Method	0.0003	<0.0003	<0.0003	<0.0003	0.005	0.006	0.002	STS Green Co., Ltd.

Description	Unit	Mothed Applysic	1.00		Results					
Parameter	Unit	Method Analysis	LOQ	GW1	GW2	GW3	Myanmar Standards	WHO Guidelines <sup>a</sup>	EPA Standards <sup>b</sup>	Laboratory
	Sar	npling Date		3/5/2018	3/5/2018	4/5/2018	Otanuarus	Ouldennes	Otanuarus	
Lead (Pb)	mg/L	Electrothermal AAS Method	0.0020	<0.0020	<0.0020	<0.0020	0.5	0.01	0.015	STS Green Co., Ltd.
Cadmium (Cd)	mg/L	Direct Air-Acetylene Flame Method	0.00005	<0.00005	0.00010	0.00005	0.1	0.003	0.005	STS Green Co., Ltd.
Copper (Cu)	mg/L	Direct Air-Acetylene Flame Method	0.05	<0.05	<0.05	<0.05	0.5	2	1.3	STS Green Co., Ltd.
Iron (Fe)	mg/L	Based on APHA (2012), 3125	0.10	9.68	3.86	<0.10	1	-	0.3	STS Green Co., Ltd.
Tin (Sn)	mg/L	Direct Air-Acetylene Flame Method	0.0001	<0.0001	<0.0001	<0.0001	-	-	-	ALS Laboratory Group (Thailand)
Manganese (Mn)	mg/L	Based on APHA (2012), Calculated	0.04	0.40	2.94	<0.04	-	-	0.05	STS Green Co., Ltd.
Total Nitrogen	mg/L	Acid Digestion/Ascobic Acid Method	1.0	12.7	1.3	5.1	-	-	-	ALS Laboratory Group (Thailand)
Total Phosphorous	mg/L	Direct Air-Acetylene Flame Method	0.005	0.405	0.051	0.030	-	-	-	STS Green Co., Ltd.
Zinc (Zn)	mg/L	Electrothermal AAS Method	0.02	0.02	0.07	<0.02	1	-	5	STS Green Co., Ltd.
Nickel (Ni)	mg/L	Mercuric Nitrate Method	0.0005	<0.0005	0.0079	0.0141	0.5	0.07	-	STS Green Co., Ltd.

Parameter	Unit	Method Analysis	1.00	Results						
			LOQ	GW1	GW2	GW3	Myanmar Standards	WHO Guidelines <sup>a</sup>	EPA Standards <sup>b</sup>	Laboratory
	San	npling Date		3/5/2018	3/5/2018	4/5/2018	otandardo	Guideinies	otandardo	
Chloride (Cl)	mg/L	5-Day BOD Test, Azide Modification Method	1.0	7,103	1,438	16.0	-	-	250	STS Green Co., Ltd.

Note: <sup>a</sup> World Health Organization (WHO), Guidelines for Drinking-Water Quality, Fourth Edition Incorporating the First Addendum, Annex 3: Chemical summary tables. <sup>b</sup> United States Environmental Protection Agency (EPA), National Primary Drink Water Regulations & National Secondary Drinking Water Regulation, 2009

#### Wet Season Survey

The wet season sampling results are shown in Table 5.44, and Table 5.45.

The pH level at GW3 (pH 5.24) exceeds the Myanmar Emission Standard (pH 6 – 9), and additionally, both GW2 (pH 6.19), and GW3 exceed the EPA Standard (pH 6.5 – 8.5); this can be a result of rock / sediment weathering; considering the increased precipitation during the wet season, the weathering process may also increase.

Nitrate (NO<sub>3</sub>) concentrations at GW1 (0.612 mg/L), GW2 (0.280 mg/L), and GW3 (18.65 mg/L) exceed the WHO Drinking Water Guidelines (0.05 mg/L), and EPA Standard (10 mg/L). Iron (Fe) concentrations for GW1 (0.31 mg/L), and GW2 (1.28 mg/L) also exceed the Myanmar Emission Standard (1.00 mg/L) and EPA Standard (0.3 mg/L).

Manganese concentrations at GW1 (0.41 mg/L), and GW2 (1.90 mg/L) exceed the EPA Standard (0.05 mg/L). Chloride concentrations at GW1 (6,861 mg/L), and GW2 (1,516 mg/L) exceed the EPA Standard.

All other parameters were found to be within the Myanmar standards and WHO guidelines.

## Table 5.44: Results of In-situ Groundwater Quality Measurement and Analysis for Wet Season

No.	Sample No./ Physical Parameter	GW1	GW2	GW3	Myanmar Emission Standards	EPA Standards <sup>a</sup>
1	Location	Pyaw Bwe Gyi Village	Beside the Botaza Road, Dala	Tha Khin Mya Park	-	-
2	Date/Time	30.6.2018 14:21	29.6.2018 13:30	29.6.2018 14:53	-	-
3	Weather	Sunny	Slightly Rain	Cloudy	-	-
4	Transparency	High	High	High	-	-
5	Colour	Colourless	Colourless	Colourless	-	-
6	Water Depth (m)	6	15	13.7	-	-
7	Depth (of sample taken) (m)	-	-	-	-	-
8	Flow rate/velocity (m/s)	-	-	-	-	-
9	Tem (°C) (air & water)	30.71/34.3 0	28.63	28.31/31.7 0	-	-
10	рН	6.93	6.19	5.24	6-9	6.5-8.5
11	DO (mg/l)	0.00	1.98	0.00	-	-
12	EC (µs/m)	26,022.6	5,459.5	368.0	-	-
13	TDS (ppm)	15,249.64	3,318.18	224.99	-	-
14	Turbidity (FNU)	-	-	-	-	-
15	Remark	Sampled on 28/6/2018 12:15	Sampled on 28/6/2018 13:50	Sampled on 27/6/2018 11:20		

Source: SEM, 2018.

Devementer	Unit	Method Analysis	1.00	Results					554	
Parameter	Unit	Method Analysis	LUQ	GW1	GW2	GW3	Myanmar Standards	WHO Guidelines <sup>a</sup>	EPA Standards <sup>b</sup>	Laboratory
	Sam	pling Date		28/6/2018	28/6/2018	27/6/2018		Guideinies	otandardo	
Alkalinity	mg/L as CaCO₃	5-Day BOD Test, Azide Modification Method	1.0	596	199	11.5	-	-	-	STS Green Co., Ltd.
Biochemical Oxygen Demand (BOD)	mg/L	Dried at 103-105 °C Method	-	0.1	0.2	0.2	50	-	-	STS Green Co., Ltd.
Total Suspended Solids (TSS)	mg/L	Dried at 180 °C Method	10.0	42.2	12.4	<10.0	50	-	-	STS Green Co., Ltd.
Total Dissolved Solids (TDS)	mg/L	Nephelometric Method	50.0	14,440	3,722	246	-	-	500	STS Green Co., Ltd.
Turbidity	NTU	EDTA Titrimetric Method	0.02	265	236	0.36	-	-	-	STS Green Co., Ltd.
Total Hardness as CaCO <sub>3</sub>	mg/L as CaCO₃	APHA (2012), 4500- CN (C),(E)	5.0	2,816	417.0	75.9	-	-	-	STS Green Co., Ltd.
Cyanide (CN)	mg/L	APHA (2012), 4110B	0.005	<0.005	<0.005	<0.005	0.1	-	0.2	ALS Laboratory Group (Thailand)
Fluoride (F)	mg/L	lodometric Method	0.1	<0.1	<0.1	<0.1	20	1.5	4.0	ALS Laboratory Group (Thailand)

Table F 45. Desults from	One was developed on Ore		for Wet Coose	
Table 5.45: Results from	Groundwater Qua	ality Analysis	for wet Seasc	on Survey

Devenuetor	Umit	Method Analysis	1.00		Results				FDA	
Parameter	Unit	Method Analysis	LUQ	GW1	GW2	GW3	Myanmar Standards	WHO Guidelines <sup>a</sup>	EPA Standards <sup>b</sup>	Laboratory
	San	npling Date		28/6/2018	28/6/2018	27/6/2018	-	Guidennes	otandardo	
Sulphide	mg/L	Based on APHA (2012), 5310 B	1.0	<1.0	<1.0	<1.0	1	-	-	STS Green Co., Ltd.
Total Organic Carbon	mg/L	Phenate Method	0.05	4.79	0.90	0.32	-	-	-	ALS Laboratory Group (Thailand)
Ammonium- Nitrogen	mg/L	Turbidimetric Method	0.010	2.51	1.91	0.081	10	-	-	STS Green Co., Ltd.
Sulphate (SO <sub>4</sub> )	mg/L	Cadmium Reduction Method	1.0	322	11.6	17.6	-	-		STS Green Co., Ltd.
Nitrate (NO <sub>3</sub> )	mg/L	Electrothermal AAS Method	0.005	0.612	0.280	18.65	-	0.05	10	STS Green Co., Ltd.
Chromium (Cr)	mg/L	Direct Nitrous Oxide- Acetylene Flame Method	0.0005	<0.0005	<0.0005	0.0049	0.5	0.05	0.1	STS Green Co., Ltd.
Calcium (Ca)	mg/L	Direct Air-Acetylene Flame Method	0.02	150.77	19.91	13.57	-	-	-	STS Green Co., Ltd.
Magnesium (Mg)	mg/L	Direct Air-Acetylene Flame Method	0.003	494.94	66.97	6.21	-	-	-	STS Green Co., Ltd.
Sodium (Na)	mg/L	Direct Air-Acetylene Flame Method	0.01	3,694	780.63	29.43	-	-	-	STS Green Co., Ltd.
Potassium (K)	mg/L	Cold-Vapour AAS Method	0.01	111.62	33.63	3.49	-	-	-	STS Green Co., Ltd.
Mercury (Hg)	mg/L	Electrothermal AAS Method	0.0003	<0.0003	<0.0003	<0.0003	0.005	0.006	0.002	STS Green Co., Ltd.

Demonstern	Unit	Mothod Analysis	1.00	Results					504	
Parameter	Unit	Method Analysis	LUQ	GW1	GW2	GW3	Myanmar Standards	WHO Guidelines <sup>a</sup>	EPA Standards <sup>b</sup>	Laboratory
	San	npling Date		28/6/2018	28/6/2018	27/6/2018		Guidennes	otandardo	
Lead (Pb)	mg/L	Electrothermal AAS Method	0.0020	<0.0020	<0.0020	<0.0020	0.5	0.01	0.015	STS Green Co., Ltd.
Cadmium (Cd)	mg/L	Direct Air-Acetylene Flame Method	0.00005	0.00006	<0.00005	<0.00005	0.1	0.003	0.005	STS Green Co., Ltd.
Copper (Cu)	mg/L	Direct Air-Acetylene Flame Method	0.05	<0.05	<0.05	<0.05	0.5	2	1.3	STS Green Co., Ltd.
Iron (Fe)	mg/L	Based on APHA (2012), 3125	0.10	0.31	1.28	<0.10	1	-	0.3	STS Green Co., Ltd.
Tin (Sn)	mg/L	Direct Air-Acetylene Flame Method	0.0001	0.0002	<0.0001	<0.0001	-	-	-	ALS Laboratory Group (Thailand)
Manganese (Mn)	mg/L	Based on APHA (2012), Calculated	0.04	0.41	1.90	<0.04	-	-	0.05	STS Green Co., Ltd.
Total Nitrogen	mg/L	Acid Digestion/Ascobic Acid Method	1.0	12.1	1.1	5.2	-	-	-	ALS Laboratory Group (Thailand)
Total Phosphorous	mg/L	Direct Air-Acetylene Flame Method	0.005	1.63	0.036	0.036	-		-	STS Green Co., Ltd.
Zinc (Zn)	mg/L	Electrothermal AAS Method	0.02	<0.02	0.53	0.02	1	-	5	STS Green Co., Ltd.
Nickel (Ni)	mg/L	Mercuric Nitrate Method	0.0005	<0.0005	0.0036	0.0191	0.5	0.07	-	STS Green Co., Ltd.

Parameter	Unit	t Method Analysis	LOQ	Results						
				GW1	GW2	GW3	Myanmar Standards	WHO Guidelines <sup>a</sup>	EPA Standards <sup>b</sup>	Laboratory
Sampling Date					28/6/2018	27/6/2018		Guidelines	otandarus	
Chloride (Cl)	mg/L	5-Day BOD Test, Azide Modification Method	1.0	6,861	1,516	73.6	-	-	250	STS Green Co., Ltd.

Note: \* World Health Organization (WHO), Guidelines for Drinking-Water Quality, Fourth Edition Incorporating the First Addendum, Annex 3: Chemical summary tables.

## 5.1.8 Sediment

A number of baseline sediment quality sampling surveys in the Study Area have been conducted, as part of this ESIA report. An overview of the surveys and their results are presented in this section.

## 5.1.8.1 Baseline Sediment Sampling Methodology

Sediment samples were collected by SEM and ERM-Siam on the 3<sup>rd</sup> - 5<sup>th</sup> May, 2018, at six (6) locations. Sediment samples were taken by a Grab Sampler. At each station, sediment was collected in an amber glass bottle. Each benthic sample was then slowly sieved through a mesh size of 2.0 mm, 1 mm, and 0.5 mm. Firstly, benthic samples were sieved by 2.0 mm and 1.0 mm mesh size, then the samples were sieved by a 0.5 mm mesh. Finally, the benthic samples caught in the 1.0 mm and 0.5mm mesh were collected. The specimens were preserved in 10% formalin solution.

All sampling was conducted in strict accordance with recognized standard procedures, as listed together with the sampling results in *Appendix L* and *Appendix N*. Sediment sampling has been conducted during both wet and dry seasons; parameters that were selected for sampling are listed below.

The Myanmar Guidelines does not contain ambient standards for sediment quality; therefore, the baseline sampling results will be compared to the Australian and New Zealand interim sediment quality guidelines<sup>32</sup>. Parameters that were measured by laboratory analysis are listed together with the results below.

## 5.1.8.2 Baseline Sediment Sampling Locations

Sediment samples were collected by SEM and ERM-Siam on the 3<sup>rd</sup> - 5<sup>th</sup> May, 2018, at six (6) locations, which are shown in *Figure 5.25*, and each location is described in *Table 5.46*.

Sampling Point	Coordinates	Description of Sampling Point
SE 1	16°46'16.68"N 96° 7'29.64"E	Approximately 0.16 kilometres away from the left bank of Yangon River (Upstream), Dala Township, Yangon Region. It is located at south of project area and southwest of Asia Terminal port.
SE 2	16°46'12.72"N 96° 7'41.88"E	Approximately 0.22 kilometres away from the left bank of Yangon River (Downstream), Dala Township, Yangon Region.
SE 3	16°45'56.19"N 96° 7'47.98"E	Approximately 0.19 kilometres away from the right bank of Twantae Canal, which is located near the mouth of Twantae Canal, Dala Township, Yangon Region.
SE 4	16°39'40.66"N 96°13'34.87"E	Approximately 0.05 kilometres away from the left bank of Yangon River, which is located near That Kai Kwin Village, Dala Township, Yangon Region.
SE 5	16°39'21.60"N 96°14'21.48"E	Approximately 0.09 kilometres away from the left bank of Yangon River, which is located in Dala Township, Yangon Region.
SE 6	16°39'3.28"N 96°14'36.81"E	Approximately 0.03 kilometres away from the left bank of Yangon River, which is located near Chaung Oo Village, Dala Township, Yangon Region.

#### **Table 5.46: Sediment Sampling Locations**

<sup>&</sup>lt;sup>32</sup> ANZECC, & ARMCANZ. (2000). Sediment Quality Guidelines. National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Retrieved from http://www.waterquality.gov.au/anzguidelines/Documents/ANZECC-ARMCANZ-2000-guidelines-vol1.pdf







#### 5.1.8.3 Summary of Baseline Sampling Results

## Dry Season Survey

According to the dry season results for sediment quality, as shown in *Table 5.47*, two (2) parameters exceeded the standard, which include mercury for sampling stations SE3, SE5, and SE6; and Nickel at all sampling stations.

Mercury has been found to exceed the Low level standards, but still within the High level standards of the Interim Sediment Quality Guidelines (ISQG). Values that are below the ISQG-low indicates that the frequency of adverse effects is expected to be very low; where as concentrations above ISQG-high indicates a level of concentration where adverse biological effects are expected occur more frequently<sup>33</sup>. This result indicates that the level of concentration can cause adverse effects; however, the occurrence is still considerably low.

Nickel has been found to exceed both low and high level standards. Although iron in sediment was not measured, surface water quality indicates high iron concentrations, which could contribute to high concentrations of Nickel in the surface water (and therefore also potentially the nearby sediment), as studies have found Nickel to attach to particles containing iron.

All other parameters were found to be within the Australian and New Zealand interim sediment quality guidelines.

#### Wet Season Survey

According to the dry season results for sediment quality, as shown in *Table 5.48*, two (2) parameters exceeded the standard: Mercury for sampling stations SE2 to SE6; and Nickel at all sampling stations.

Mercury has been found to exceed the Low level standards, but still within the High level standards. This result indicates that the level of concentration can cause adverse effects on aquatic life; however, the occurrence is still considerably low.

Nickel has been found to exceed both low and high level standards; however, concentrations were found to be lower than that of the dry season. This difference may be due to a higher flow rate.

All other parameters are found to be within the Australian and New Zealand interim sediment quality guidelines.

<sup>33</sup> DEC. (2010). Contaminated Sites Management Series: Assessment levels for Soil, Sediment and Water. Department of Environment and Conservation (DEC), Government of Western Australia. Version 4, Revision 1, Pp 26. https://www.der.wa.gov.au/images/documents/your-environment/contaminated-sites/guidelines/2009641\_-\_assessment\_levels\_for\_soil\_sediment\_and\_water\_-\_web.pdf

Parameter	Unit	Method of Analysis	LOQ			Resu	ilts	Standar	Laboratory			
				SE1	SE2	SE3	SE4	SE5	SE6	Low <sup>a</sup>	High <sup>b</sup>	
Particle Size Di	stribution	I					·	·	· · · · · ·		·	
Sand	%		-	43.7	48.2	1.2	2.3	5.3	7.1	-	-	
Silt	%	Hydrometer Analysis	-	32.1	27.6	61.8	44.5	42.6	39.9	-	- STS	STS Instrument
Clay	%		-	.242	24.2	37.0	53.2	52.1	53.0	-	-	00., Ltd.
Total Organic Carbon (TOC)	%	Based on US EPA, Method 9060	0.01	0.16	<0.10	0.25	0.20	0.27	0.47	-	-	ALS Laboratory Group (Thailand)
TPH (C10 – C36	6)											
C10-C14	mg/kg	Based on US EPA,	5	<5	<5	<5	<5	<5	<5	-	-	ALS Laboratory
C15-C28	mg/kg	Method 3570 and	10	<10	<10	<10	<10	<10	<10	-	-	Group
C29-C36	mg/kg	8015B	10	<10	<10	<10	<10	<10	<10	-		(Thailand)
Total Oil	mg/kg	Soxhlet Extraction Method	20.0	508	358	105	443	419	132	-	-	STS Green Co., Ltd.
Arsenic	mg/kg	Hydride Generation AAS Method	0.04	<0.04	<0.04	<0.04	0.10	<0.04	<0.04	20	70	STS Green Co., Ltd.
Barium	mg/kg	Direct Nitrous Oxide- Acetylene Flame Method	5.00	23.17	35.09	39.70	51.17	38.05	49.10	-	-	STS Green Co., Ltd.
Cadmium	mg/kg	Direct Air-Acetylene Flame Method	1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.5	10	STS Green Co., Ltd.
Chromium	mg/kg	Direct Air-Acetylene Flame Method	2.50	34.44	48.33	53.98	75.67	64.86	67.65	80	370	STS Green Co., Ltd.
Copper	mg/kg	Direct Air-Acetylene Flame Method	1.50	15.28	22.68	23.55	31.14	30.24	31.47	65	270	STS Green Co., Ltd.

## Table 5.47: Results of Sediment Quality Analysis for Dry Season Survey

Parameter	Unit	Method of Analysis	LOQ			Resu	ılts	Standar	Laboratory			
				SE1	SE2	SE3	SE4	SE5	SE6	Low <sup>a</sup>	High <sup>b</sup>	
Lead	mg/kg	Direct Air-Acetylene Flame Method	5.00	<5.00	7.17	<5.00	7.23	12.70	15.58	50	220	STS Green Co., Ltd.
Mercury	mg/kg	Cold-Vapour AAS Method	0.10	0.12	0.14	0.18	0.14	0.16	0.16	0.15	1	STS Green Co., Ltd.
Nickel	mg/kg	Direct Air-Acetylene Flame Method	2.00	68.12	85.75	101.11	131.96	114.52	127.78	21	52	STS Green Co., Ltd.

Source: STS Green, 2018. <sup>1</sup> ANZECC / ARMCANZ, 2000.

<sup>1</sup> Interim Sediment Quality Guidelines (ISQG) <sup>a</sup> Corresponds to Effects Range-Low (ERL) Note:

<sup>b</sup> Corresponds to Effects Range-Medium (ERM)

Parameter	Unit	Method of Analysis	LOQ			Res	sults	Standa	rd (ISQG) <sup>1</sup>	Laboratory		
				SE1	SE2	SE3	SE4	SE5	SE6	Low <sup>a</sup>	High <sup>b</sup>	
Particle Size	Distribution	·									·	
Sand	%	Hydrometer Analysis	-	51.7	6.5	2.4	1.3	1.0	5.7	-	-	STS Instrument
Silt	%		-	27.4	69.4	60.6	61.7	49.2	38.2	-	-	Co., Ltd.
Clay	%		-	20.9	24.1	37.0	37.0	49.8	56.1	-	-	
Total Organic Carbon (TOC)	%	Based on US EPA, Method 9060	0.01	0.15	0.19	0.30	0.29	0.37	0.63	-	-	ALS Laboratory Group (Thailand)
TPH (C10 – C	36)											
C10-C14	mg/kg	Based on US EPA,	5	<5	<5	<5	<5	<5	<5	-	-	ALS Laboratory
C15-C28	mg/kg	Method 3570 and	10	<10	<10	<10	<10	<10	<10	-	-	Group (Thailand)
C29-C36	mg/kg	00100	10	<10	<10	<10	<10	<10	<10	-		
Total Oil	mg/kg (Wet)	Soxhlet Extraction Method	20.0	34.97	264	125	145	200	232	-	-	STS Green Co.,
	mg/kg (Dry)	-	20.0	70.72	431	198	273	321	410	-	-	Ltd.
Arsenic	mg/kg	Hydride Generation AAS Method	0.04	0.34	0.40	0.35	0.39	0.30	0.42	20	70	STS Green Co., Ltd.
Barium	mg/kg	Direct Nitrous Oxide- Acetylene Flame Method	5.00	12.65	24.39	25.72	24.99	17.06	12.41	-	-	STS Green Co., Ltd.
Cadmium	mg/kg	Direct Air-Acetylene Flame Method	1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.5	10	STS Green Co., Ltd.

## Table 5.48: Results of Sediment Quality Analysis for Wet Season Survey

Parameter	Unit	Method of Analysis	LOQ		Results						rd (ISQG) <sup>1</sup>	Laboratory
				SE1	SE2	SE3	SE4	SE5	SE6	Low <sup>a</sup>	High <sup>b</sup>	
Chromium	mg/kg	Direct Air-Acetylene Flame Method	2.50	16.49	26.96	30.99	32.74	31.47	31.04	80	370	STS Green Co., Ltd.
Copper	mg/kg	Direct Air-Acetylene Flame Method	1.50	14.12	21.61	27.21	24.04	26.09	28.99	65	270	STS Green Co., Ltd.
Lead	mg/kg	Direct Air-Acetylene Flame Method	5.00	14.57	20.84	23.96	24.08	21.92	26.50	50	220	STS Green Co., Ltd.
Mercury	mg/kg	Cold-Vapour AAS Method	0.10	0.14	0.18	0.23	0.21	0.24	0.27	0.15	1	STS Green Co., Ltd.
Nickel	mg/kg	Direct Air-Acetylene Flame Method	2.00	47.63	68.88	81.12	78.37	80.58	78.57	21	52	STS Green Co., Ltd.

<sup>1</sup>ANZECC / ARMCANZ, 2000.

Note:

<sup>1</sup> Interim Sediment Quality Guidelines (ISQG)
 <sup>a</sup> Corresponds to Effects Range-Low (ERL)
 <sup>b</sup> Corresponds to Effects Range-Medium (ERM)

#### 5.1.9 Landscape and Visual

According to *Figure 5.26*, the centre part of Myanmar, specifically within the Yangon Region and Ayeyarwady Region consists of mainly plains with little to no elevation. Although this characteristic is normal for land located near coastal areas, other northern regions of Myanmar have a large range of mountainous areas, and varying degrees of elevation, which are particularly pronounced in the Kayah State, and Shan State.

Look at the low land areas of Myanmar, it is possible to see that Yangon primarily consists of plains with low elevation; however, the Northern Region of Yangon contains mountainous areas with high elevation of approximately 500 - 1,000 meters, as shown in *Figure 5.27*. It is also possible to notice the slight elevation the stretches from the northern region down to Yangon City, this will be further discussed in *Section 5.1.9.1*.



## Figure 5.26: Topographic Map of Myanmar

#### Source: MIMU, 2013.

Figure 5.27: Topographic Map of Myanmar Coastal Low Land Area



Disclaimer: The names shown and the boundaries used on this map do not imply official endorsement or acceptance by the IASC membership.

Source: MIMU, 2012.
## 5.1.9.1 Power Plant

The topography at the Power Plant are primarily flat land with no noticeable elevations; however, towards the northeast of the Power Plant, there is high elevations that lead up the highest point exactly where the Shwedagon Pagoda is located (approximately 57 – 62 metre elevation), as shown in *Figure 5.28*. Land allocated for the Power Plant currently consists of grasslands and small patches of mangrove, however the land is surrounded by the existing Power Plant and the Ahlone Shipyard, as shown in *Figure 5.29*. The closest receptor to the Power Plant is a small household area approximately 80 metres north of the Power Plant; and the medium density residential area approximately 670 metres northeast of the Power Plant, within Ahlone Township.



## Figure 5.28: Elevation of Yangon City

Source: FloodMap.net, 2018.



Figure 5.29: Landscape In and Around the Power Plant Area

Source: ERM, 2018. Note: Photograph taken in the proposed Power Plant area, viewing southwest towards the Yangon River.



Source: ERM, 2018.

Note: Photograph taken from the Yangon River, viewing northeast towards the proposed Power Plant shoreline and existing Transmission Line connected to the existing Power Plant.

## 5.1.9.2 LNG Receiving Terminal

The topography at the LNG Receiving Terminal suggests no elevation. The area surrounding the facility consists of mainly agricultural land and nearby villages. Across the Yangon River, directly opposite of the LNG Receiving Terminal is the Myanmar Integrated Port Limited Terminal. Potential sensitive visual receivers are located nearby the LNG Receiving Terminal, such as Thet Kei Kwin (1.2 km, northwest), and Shan Kaw (1.6 km, west) villages.

## 5.1.9.3 Natural Gas Pipeline

The topography along the Natural Gas Pipeline alignment suggests no elevation. The area along the pipeline alignment will mainly consist of agricultural land and other small villages; however, the northern section of the pipeline will be located near the dense residential area of Dala, Seikgyikanaungto, and Ahlone Townships.

## 5.1.10 Waste

According to the World Bank<sup>34</sup> in 2012, the solid waste generation in Myanmar was 5,616 tonnes/day, and is anticipated to increase to 21,012 tonnes/day by 2025. Mandalay, Yangon and Nay Pyi Taw generate the majority of Myanmar's produced waste (55%); Yangon produces most of the waste (1,981 tonnes/day).

The country's municipal solid waste is generated from households (60%), markets (15%), commercial (10%), hotel (2%), garden (5%) and others (8%). In areas outside of Yangon, Mandalay and Nay Pyi Taw, where waste collection is the responsibility of local municipal authorities, the respective Township Development Committees under the local government typically manage municipal waste collection and disposal<sup>35</sup>.

In 1995, the government made efforts to encourage the industrial sector to minimize impacts on the environment from industrial waste by issuing the Water and Air Pollution Control Plan (Standing Order No.3) which stated that actions to control, reduce and eliminate waste must be developed and carried out. However, Myanmar today faces substantial challenges with regard to managing their industrial waste with high volumes transported to landfill sites without prior treatment<sup>36</sup>.

According to the Yangon City Development Committee (YCDC), the major landfill sites in Yangon that are currently in operation and their respective capacities are shown in *Table 5.49*.

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<sup>&</sup>lt;sup>34</sup> Hoornweg, D., & Bhada-Tata, P. (2012). What a Waste: A Global Review of Solid Waste Management. Word Bank. Urban Development & Local Government Unit. Retrieved from

http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-

<sup>1334852610766/</sup>What\_a\_Waste2012\_Final.pdf

<sup>&</sup>lt;sup>35</sup> Premakumara, D.G.J., & Hengesbaugh, M. (2016). Quick Study on Waste Management in Myanmar. Institute for Global Environmental Strategies (IGES). Retrieved from

https://www.iges.or.jp/files/research/scp/PDF/20160613/17\_Quick\_study\_Web.pdf

<sup>&</sup>lt;sup>36</sup> Theilen-Willige, B., & Pararas-Carayannis, G. (2009). Natural Hazard Assessment of SW Myanmar – A Contrubution of Remote Sensing and GIS Methods to the Detection of Areas Vulnerable to Earthquakes and Tsunami / Cyclone Flooding. Tsunami Society. Retrieved from http://tsunamisociety.org/282ThielenGPCa.pdf

Location	Capacity (tonnes/day)	
Hteinpin	1,080	
Dawai Chang	843	
Shwepyithar	61	
Mingalardon	43	
Dala	33	
SeikyiKhanaungato	4	

### Table 5.49: Major Landfill Sites in Yangon

Source: YCDC, 2016.

#### 5.1.11 Terrestrial and Aquatic Biodiversity

The Myanmar EIA Procedures (2015) requires the assessment of biodiversity values however the Procedure does not include guidance on the approach to assess those values. ERM has used the International Finance Corporation (IFC) *Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources* (PS6) to guide the approach of assessment. Reference is therefore made to certain requirements of IFC PS6 in this Chapter.

### 5.1.11.1 EcoRegion Description

The Project Study Area resides within the Myanmar Coastal Mangrove [IM1404] EcoRegion. This ecoregion, specifically the Irrawaddy (Ayeyarwady) mangrove region, would naturally be dominated by mangrove flora but has been seriously degraded in recent history.

Mangrove forest are salt tolerant ecosystems that survive in brackish water around the intertidal zone, particularly in estuaries. They are some of the most exploited natural systems in the world, under pressure from land clearance for farming, aquaculture, land reclamation and development. The mangrove forests in this ecoregion are some of the most degraded or destroyed mangrove systems in the Indo-Pacific area<sup>37</sup>. The Irrawaddy mangroves consists primarily of *Rhizophora mucronata*, *R. conjugata*, *Bruguiera parviflora*, *B. gymnorhiza*, *B. cylindrica*, *Heritiera formes*, *Sonneratia apetala*, *S. griffithii*, *S. caseolaris*, *Xylocarpus granatum*, *X. molluccensis*, *Ceiops roxburghiana*, *C. mimosoides*, *Avicennia officinalis*, *Kanddelia rheedii*, and *Excoecaria agallocha*.

The larger mammals historically found in this ecoregion have been extirpated including the Asian elephant *Elephas maximus* and tiger *Panthera tigris*. A few wild elephants survive in the neighbouring Rakhine mangrove region to the north. Other large mammals including leopard *Panthera pardus*, wild dog *Cuon apinus*, and otter *Lutra spp.* are largely absent. Sambar *Cervus unicolor*, hog deer *Cervus porcinus*, mouse deer *Tragulus javanicus*, barking deer *Muntiacus muntjak*, tapir *Tapirus malayanus*, and wild boar *Sus scrofa*, are abundant only in reserved forests.

Mangrove habitats are rich in migrants and resident waterbirds including the oriental darter Anhinga melanogaster, little cormorant Phalacrocorax nigers, reef heron Egretta sacra, dusky gray heron Ardea sumatrana, ruddy shelduck Tadorna ferruginea, bronze-winged jacana Metopidius indicus, lesser sand plover Charadrius mongolus, great stone plover Esacus magnirostris, black-winged stilt Himantopus himantopus, spotted greenshank Tringa guttifer, lesser black-back gull Larus fuscus, and common moorhen Gallinula chloropus.

Among reptiles, the southern part of the Ayeyarwady Delta contains the last population of crocodiles (*Crocodylus porosus*) in the ecoregion. The river terrapin (*Batagur baska*) now exists only in small isolated populations on offshore islands.

<sup>&</sup>lt;sup>37</sup> WWF. (2019). Southern Asia: Along the coasts of India, Myanmar, Malaysia, and Thailand. World Wildlife Fund (WWF). Retrieved from https://www.worldwildlife.org/ecoregions/im1404

The EcoRegion is currently classified as Critical/Endangered.

### 5.1.11.2 Key Biodiversity Areas

In Myanmar, Key Biodiversity Areas (KBAs) fall in different land management categories including protected areas, public protected forests, community-conserved forests, community forests, reserve forests and other resource and land use areas. Therefore, they accommodate different management systems such as government, private, community-led and joint management. Within the last decade, KBAs were reviewed and updated in order to identify and prioritize investment opportunities for biodiversity conservation in Myanmar.

A total of 132 KBAs were identified for Myanmar and prioritized based on Species-based Vulnerability and Site-based Vulnerability. A total of three KBAs were identified under Alliance for Zero Extinction (AZE), one as a Ramsar site, 53 important bird areas, and six ASEAN Heritage Parks.

Key Biodiversity Areas (KBA) include Important Bird Areas (IBA), Alliance for Zero Extinction (AZE), Important Plant Areas (IPA) and Important Sites for Freshwater Biodiversity. Three (3) Key Biodiversity Areas are located within 30km from the Project Site. These sites are the Hlawga Reservoir, Maletto Inn and Payagyi KBAs which contain critically endangered, endangered and vunerable species of conservation concern. These KBAs are located approximately 21km, 27km and 31km respectively to the north and east of the Project Area. The location of the KBA in relation to the Project Site is shown in *Figure 5.30*.

## 5.1.11.3 Protected Area

Myanmar currently has a total of 58 Protected Areas (PAs), which account for only 6.37% of the country's total surface area (Protected Planet, 2018)<sup>38</sup>.

One (1) protected area lies within 50km of the Study Area, The Hlawga Park 28km to the north.

## 5.1.11.4 Species of Conservation Significance

Species of conservation significance found within the species grid location from the Integrated Biodiversity Assessment Tool (IBAT) are outlined in *Table 5.50*.

Taxonomic group	Species	Common name	IUCN Red List Category
Birds	Aquila nipalensis	Steppe Eagle	EN
Birds	Asarcornis scutulata	White-winged Duck	EN
Birds	Calidris pygmaea	Spoon-billed Sandpiper	CR
Birds	Chrysomma altirostre	Jerdon's Babbler	VU
Birds	Ciconia episcopus	Asian Woollyneck	VU
Birds	Clanga clanga	Greater Spotted Eagle	VU
Birds	Emberiza aureola	Yellow-breasted Bunting	CR
Birds	Gallinago nemoricola	Wood Snipe	VU
Birds	Gracula robusta	Nias Hill Myna	CR
Birds	Gracula venerata	Tenggara Hill Myna	EN

#### Table 5.50: Species of Conservation Significance (IBAT species grid)

<sup>38</sup> UNEP-WCMC. (2019). Protected Area Profile for Myanmar from the World Database of Protected Areas. Protected Planet. Retrieved from https://www.protectedplanet.net/country/MM

Taxonomic group	Species	Common name	IUCN Red List Category
Birds	Gyps bengalensis	White-rumped Vulture	CR
Birds	Gyps tenuirostris	Slender-billed Vulture	CR
Birds	Haliaeetus leucoryphus	Pallas's Fish-eagle	EN
Birds	Heliopais personatus	Masked Finfoot	EN
Birds	Leptoptilos dubius	Greater Adjutant	EN
Birds	Leptoptilos javanicus	Lesser Adjutant	VU
Birds	Pavo muticus	Green Peafowl	EN
Birds	Rynchops albicollis	Indian Skimmer	VU
Birds	Sarcogyps calvus	Red-headed Vulture	CR
Fish	Aetobatus ocellatus	Spotted Eagle Ray	VU
Fish	Aetomylaeus maculatus	Mottled Eagle Ray	EN
Fish	Aetomylaeus nichofii	Banded Eagle Ray	VU
Fish	Alopias pelagicus	Pelagic Thresher	VU
Fish	Alopias superciliosus	Bigeye Thresher Shark	VU
Fish	Alopias vulpinus	Common Thresher Shark	VU
Fish	Anoxypristis cuspidata	Narrow Sawfish	EN
Fish	Carcharhinus falciformis	Silky Shark	VU
Fish	Carcharhinus hemiodon	Pondicherry Shark	CR
Fish	Carcharhinus longimanus	Oceanic Whitetip Shark	VU
Fish	Carcharias taurus	Sand Tiger Shark	VU
Fish	Carcharodon carcharias	Great White Shark	VU
Fish	Glaucostegus granulatus	Sharpnose Guitarfish	VU
Fish	Glaucostegus obtusus	Widenose Guitarfish	VU
Fish	Glaucostegus typus	Giant Shovelnose Ray	VU
Fish	Glyphis siamensis	Irrawaddy River Shark	CR
Fish	Hemigaleus microstoma	Sickelfin Weasel Shark	VU
Fish	Hemipristis elongata	Snaggletooth Shark	VU
Fish	Himantura uarnak	Reticulate Whipray	VU
Fish	Hippocampus histrix	Thorny Seahorse	VU
Fish	Hippocampus kelloggi	Great Seahorse	VU
Fish	Hippocampus spinosissimus	Hedgehog Seahorse	VU
Fish	Hippocampus trimaculatus	Three-spot Seahorse	VU
Fish	Isurus oxyrinchus	Shortfin Mako	VU

Taxonomic group	Species	Common name	IUCN Red List Category
Fish	Isurus paucus	Longfin Mako	VU
Fish	Lamiopsis temminckii	Broadfin Shark	EN
Fish	Maculabatis gerrardi	Whitespotted Whipray	VU
Fish	Manta birostris	Giant Manta Ray	VU
Fish	Mola mola	Ocean Sunfish	VU
Fish	Omobranchus smithi	None	VU
Fish	Pateobatis jenkinsii	Jenkins' Whipray	VU
Fish	Pateobatis uarnacoides	Bleeker's Whipray	VU
Fish	Rhina ancylostoma	Bowmouth Guitarfish	VU
Fish	Rhincodon typus	Whale Shark	EN
Fish	Rhinoptera javanica	Javanese Cownose Ray	VU
Fish	Sphyrna lewini	Scalloped Hammerhead	EN
Fish	Sphyrna mokarran	Great Hammerhead	EN
Fish	Taeniurops meyeni	Blotched Fantail Ray	VU
Fish	Urogymnus asperrimus	Porcupine Ray	VU
Fish	Urogymnus polylepis	None	EN
Invertebrates	Acropora aculeus	None	VU
Invertebrates	Acropora acuminata	None	VU
Invertebrates	Acropora aspera	None	VU
Invertebrates	Acropora dendrum	None	VU
Invertebrates	Acropora donei	None	VU
Invertebrates	Acropora echinata	None	VU
Invertebrates	Acropora hoeksemai	None	VU
Invertebrates	Acropora horrida	None	VU
Invertebrates	Acropora listeri	None	VU
Invertebrates	Acropora lovelli	None	VU
Invertebrates	Acropora multiacuta	None	VU
Invertebrates	Acropora palmerae	None	VU
Invertebrates	Acropora rudis	None	EN
Invertebrates	Acropora turaki	None	VU
Invertebrates	Acropora vaughani	None	VU
Invertebrates	Acropora verweyi	None	VU
Invertebrates	Actinopyga echinites	Deep Water Redfish	VU
Invertebrates	Actinopyga miliaris	Harry Blackfish	VU

Taxonomic group	Species	Common name	IUCN Red List Category
Invertebrates	Alveopora allingi	None	VU
Invertebrates	Astreopora moretonensis	None	VU
Invertebrates	Euphyllia ancora	None	VU
Invertebrates	Galaxea astreata	None	VU
Invertebrates	Goniopora burgosi	None	VU
Invertebrates	Goniopora planulata	None	VU
Invertebrates	Heliopora coerulea	Blue Coral	VU
Invertebrates	Holothuria fuscogilva	None	VU
Invertebrates	Holothuria lessoni	Golden Sandfish	EN
Invertebrates	Holothuria scabra	Golden Sandfish	EN
Invertebrates	Isopora cuneata	None	VU
Invertebrates	Leptastrea aequalis	None	VU
Invertebrates	Lobophyllia diminuta	None	VU
Invertebrates	Montipora angulata	None	VU
Invertebrates	Montipora crassituberculata	None	VU
Invertebrates	Pachyseris rugosa	None	VU
Invertebrates	Pavona cactus	None	VU
Invertebrates	Pavona decussata	Cactus Coral	VU
Invertebrates	Pavona venosa	None	VU
Invertebrates	Pectinia alcicornis	None	VU
Invertebrates	Pectinia lactuca	Lettuce Coral	VU
Invertebrates	Physogyra lichtensteini	None	VU
Invertebrates	Pocillopora ankeli	None	VU
Invertebrates	Porites aranetai	None	VU
Invertebrates	Porites nigrescens	None	VU
Invertebrates	Stichopus herrmanni	Curryfish	VU
Invertebrates	Symphyllia hassi	None	VU
Invertebrates	Thelenota ananas	Prickly Redfish	EN
Invertebrates	Turbinaria mesenterina	None	VU
Invertebrates	Turbinaria peltata	None	VU
Invertebrates	Turbinaria reniformis	None	VU
Invertebrates	Turbinaria stellulata	None	VU
Mammals	Arctonyx collaris	Greater Hog Badger	VU
Mammals	Balaenoptera musculus	Blue Whale	EN

Taxonomic group	Species Common name		IUCN Red List Category
Mammals	Cuon alpinus	Dhole	EN
Mammals	Dugong dugon	Dugong	VU
Mammals	Lutrogale perspicillata	Smooth-coated Otter	VU
Mammals	Neophocaena phocaenoides	Indo-Pacific Finless Porpoise	VU
Mammals	Nycticebus bengalensis	Bengal Slow Loris	VU
Mammals	Physeter macrocephalus	Sperm Whale	VU
Mammals	Rusa unicolor	Sambar	VU
Mammals	Sousa chinensis	Indo-Pacific Humpback Dolphin	VU
Mammals	Trachypithecus phayrei	Phayre's Leaf-monkey	EN
Plants	Halophila beccarii	Ocean Turf Grass	VU
Plants	Heritiera fomes	None	EN
Plants	Sonneratia griffithii	None	CR
Reptiles	Enhydris vorisi	None	EN
Reptiles	Eretmochelys imbricata	Hawksbill Turtle	CR
Reptiles	Lepidochelys olivacea	Olive Ridley	VU
Reptiles	Ophiophagus hannah	King Cobra	VU
Reptiles	Python bivittatus	Burmese Python	VU





## 5.1.11.5 Invasive Species

Invasive species are any species that are –non-native to a particular ecosystem and whose introduction and spread causes, or are likely to cause, socio-cultural, economic or environmental harm or harm to human health (FAO, 2013). Invasive species are naturalized species that reproduce often in large numbers and are spread over a large area, damaging native species (FAO, 2005).

Invasive species have the capacity to exacerbate their role in ecosystem degradation through combination threats by habitat change, climate change over-exploitation of ecosystem resources and pollution, which further enhances their threat to biodiversity and the human condition (Emerton and Howard, 2008).

According to the Global Invasive Species Database (GISD) (2015), 97 species have been identified as invasive species in Myanmar. A checklist of invasive species is provided in *Appendix O*. However, the database does not specifically mention on which part of Myanmar that the invasive species are being introduced.

## 5.1.11.6 Area of Influence for Biodiversity Value

The Project Area of Influence (AoI) was defined based on a 5 km radius of the Study Area, 500 m either side of the pipeline and 1 km radius of the LNG terminal. The radius was determined based on the nature of the activities of the Project during construction and operation as well as identified natural areas within the vicinity of the Study Area and is consistent with the Project Study Area defined earlier in this report (*Figure 5.1*). From satellite imagery interpretation, the Study Area is mostly disturbed land classes (Agriculture and urban areas). Some remnant or successional mangrove patches are located within the 5km radius of the Study Area and may contain habitat for species of conservation significance. The Area of Influence for biodiversity values is shown in *Figure 5.31*.

## 5.1.11.7 Biodiversity Surveys

ERM undertook site surveys during the dry season on the 4th to the 5th May 2018. These surveys were conducted to determine the location of any priority biodiversity values within the Study Area and Area of Influence. These priority values focused on Critical Habitat<sup>39</sup> triggers as well as species of conservation significance. The surveys were conducted after a desktop assessment to identify species and habitats to be prioritised for survey; identification of sampling locations (including local villager interviews); field survey targeted major flora and fauna groups; and taxonomy and mapping of flora and fauna records identified. Habitat assessments were also undertaken to inform Natural Habitat<sup>40</sup> and Modified Habitat<sup>41</sup> mapping as required by IFC PS6. *Figure 5.32* shows the areas where surveys were conducted.

<sup>&</sup>lt;sup>39</sup> Critical Habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregator species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes

<sup>&</sup>lt;sup>40</sup> Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.

<sup>&</sup>lt;sup>41</sup> Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition.





Source: ERM, 2019.



Figure 5.32: Biodiversity Survey Area

## Pre-Field Desktop

Publicly available sources of information as well as ERM in-house data were analysed to determine likely priority biodiversity values within the Study Area and Area of Influence. Aerial imagery was used to provide a spatial understanding of the pattern of vegetation communities and human uses on the site, and to map access routes and internal tracks.

Consultation occurred with local ecologists with experience of the Area of Influence to obtain information about species known to be present or previously recorded from the site, and other ecological values considered to be relevant.

### Sampling Site

A site reconnaissance was carried out over two sampling areas at the proposed Power Plant and Terminal and along the proposed pipeline route and is detailed in *Figure 5.32*. The site reconnaissance targeted the following specific ecological objectives:

- Identification of invasive species,
- Identification of threatened species,
- Critical Habitat triggers,
- The extent of Natural Habitat

Identification of any areas of habitats of concern that may contain species of conservation interest (e.g. species protected by local legislation, endemic to Myanmar, listed in international conventions for conservation of habitat or listed in International Union for Conservation of Nature (IUCN) Red Data Book.

- Field survey will use techniques including:
- Spot observation,
- Flora survey of all representative vegetation communities; and
- Villager/ stakeholder engagement to determine the local experience in sighting of species (secondary records as part of the socioeconomic survey)
- Fishermen consultations to establish, if any, fishing activity is undertaken in the water body (as part of the socioeconomic survey).

In addition, where possible local people were consulted about the species known to utilize the Study Area, and how the Study Area is affected by seasonal variations (e.g. flooding levels, whether water bodies dry up in driest seasons, etc.).

#### Land Class Mapping

Satellite imagery was used to map the land classes identified within the Study Area and Area of Influence. These land classes were field verified during the field visit. The major land classes identified include agriculture, mangrove, scrub land and grassland, Urban and residential, standing water/waterlogged and riverine. Land class descriptions identified are described in **Table 5.51** below. **Table 5.52** outlines the areas of land classes within the AoI and Study Area. **Figure 5.33** shows the distribution of the land classes within the AoI and Study Area.

Land Class	Description	Photograph
Roads	Roads consist of bare areas that have been cleared of vegetation to facilitate the movement of vehicles between residential and agricultural areas. Small tracks have also been constructed for use by motorbikes within the project area.	
Agricultural land	Agricultural land is area that has been predominately cleared and is used for agricultural production. The agricultural land use identified with the project area is mainly rice farming with some grazing areas for livestock such as cattle and goats and lotus ponds.	
Mangrove	A riparian forest or riparian woodland is a forested or wooded area of land adjacent to a body of water such as a river, stream, pond, lake, marshland, estuary, canal, sink or reservoir. Plant habitats and communities along the river margins and banks are called riparian vegetation, characterized by hydrophilic plants. The Natural riparian habitat in the Study Area is mangrove with dominant salt water tolerant species including <i>Sonneratia caseolaris</i> and <i>Sonneratia apetala</i> .	
Scrub land, grassland and disturbed land	Scrub land habitats contain thickets of shrubs and young trees mixed with scattered grasses and wildflowers. A proportion of the site can be classed as disturbed habitat associated with derelict urban sites. Vegetation communities are varied, consisting of taller ruderal plants and lower (often grazed) grasses and herbs.	

## Table 5.51: Land Class Descriptions within the Project Aol

Land Class	Description	Photograph
Urban and residential areas	Residential areas are used by local people and contain dwellings, gardens and small agricultural patches. Some natural vegetation including large trees may be exist for shade cover for houses. Areas around the project site contain residential areas associated with Yangon City to the north and Dala village on the southern bank of the Yangon river. The rest of the area around the site consists of small villages and isolated rural dwellings.	
Standing water/waterl ogged areas	Ditches and depressions in and around the site contain standing water or are permanently waterlogged. Vegetation present is characterised by aquatic plants including the invasive <i>Eichhornia crassipes</i> and <i>Alternanthera philoxeroides</i> .	
The Yangon River (and its associated tributaries) and river bank	The Yangon River is an open water riverine aquatic environment located to the South of the Study Area. The river at the location of the Project Site is a tidal, estuarine system with mangrove (see above), mud banks and scrub (see above) along its banks. The photograph on the right shows the project site from the opposite river bank.	





Table 5.52: Areas of Land Class within the Study Area and Project Area of
Influence

Land use	Study Area (ha)	Area of Influence (Aol) (ha)
Agricultural land		3,146.47
Bare land		
Urban and residential areas	0.53	4,115.73
Standing water/waterlogged areas		41.81
Scrub land	2.49	93.21
and disturbed land		
The Yangon River (and its associated tributaries)		1,005.91
Mangrove	0.20	22.25
Roads		60.64
Total	3.22	8,486.02

## Natural Habitat and Modified Habitat

IFC PS6 requires the assessment of the distribution of Natural Habitat and Modified Habitat in order to identify risks and mitigations to biodiversity values during the impact assessment phase. There is currently no methodology within IFC PS6 and the associated Guidance Note (GN) on the approach to assess the distribution of these habitat types.

Given the desktop and field information available on the land classes identified, a categorization of the land classes has been made based on the understanding of the history of land use, and species assemblages within each habitat. Each land class has been assigned habitat classifications according to the definitions of IFC PS6. The justification for the classification is shown in *Table 5.53* below. The results of the Natural Habitat and Modified Habitat assessment are detailed in *Figure 5.34*. The areas of Natural Habitat and Modified Habitat within the AoI and Study Area are shown in *Table 5.54*.

## Table 5.53: Natural and Modified Habitats within the Study Area and Area ofInfluence

Land Class	IFC PS Habitat Classification	Justification
Roads	Modified Habitat	Roads are considered to be modified habitat. The ecological functions of the areas have been totally removed.
Agricultural land	Modified Habitat	Agricultural land is considered modified habitat. Little if any natural vegetation remains in these areas with predominately rice paddies or grazing land. Human use has substantially modified the condition of the habitat.
Mangrove	Natural Habitat	There are small areas of mangrove on the Yangon River and small waterways within the Study Area which are in a predominately natural state. The structure of vegetation remains, however human disturbance has modified the ground level vegetation in places and the faunal diversity is heavily impacted from its natural state.

Land Class	IFC PS Habitat Classification	Justification
Scrub land, grassland and disturbed land	Modified Habitat	Scrub land and grassland is considered to be modified habitat in the Study Area. Historic clearing of the mid storey and canopy has removed the forest structure. The habitat is in a substantially modified state. On recently disturbed land, pioneer vegetation communities (including invasive species) have recently colonised areas of human disturbance.
Urban and residential areas	Modified Habitat	Urban and residential areas are considered as modified habitat. Human use has substantially modified the condition of the habitat.
Standing water/waterlogged areas	Modified Habitat	Standing/waterlogged areas around the site remain wet for the majority of the year. Man-made ditches for drainage, heavily modified watercourses and waterlogged depressions within the disturbed site which are considered to be modified habitat.
The Yangon River (and its associated tributaries)	Natural Habitat	The Yangon River and its associated tributaries are considered to be natural habitat. Although containing sediment loads, the aquatic ecosystem contains naturally occurring species and is not in a substantially modified state.

# Table 5.54: Areas of Natural Habitat and Modified Habitat within the Study Areaand Aol

Habitat Type	Study Area (ha)	Area of Influence (ha)
Natural Habitat	0.20	1,028.16
Modified Habitat	3.02	7,457.86

Source: ERM, 2018.





#### Flora

#### Survey Method

A Global Positioning System (GPS) was used to navigate and mark coordinates between sample plots around the AoI.

In order to obtain ecological data for predicting flora of shrubs and herbs a site reconnaissance was conducted in the locations detailed in *Figure 5.32*. In each location, plant species were listed with particular attention to the identification of invasive species, threatened species, Critical Habitat triggers and the extent of Natural Habitat. Identification of any areas of habitats of concern that may contain species of conservation interest were noted.

#### Results

Twenty-three (23) flora species were identified during the surveys.

The majority of other flora identified was identified as Least Concern (LC); Data Deficient (DD) or Not Evaluated (NE). No species of conservation significance were detected that would trigger a Critical Habitat assessment.

Table 5.55 lists the flora species identified during field surveys in the AoI and Study Area.

No.	Family Name	Scientific Name	Common Name	IUCN Listing
1	Myrsinaceae	Aegiceras corniculatum	Black mangrove	LC
2	Amaranthaceae	Alternanthera sessilis	Sessile joyweed	LC
3	Poaceae	Arundo donax	Giant reed	LC
4	Poaceae	Chloris barbata	-	NE
5	Combretaceae	Terminalia catappa	Indian almond, Badan	NE
6	Verbenaceae	Volkameria inermis (Clerodendrum inerme)	Glory bower	NE
7	Tiliaceae	Corchorus olitorius	Jute, Jew's Mallow	NE
8	Cyperaceae	Cyperus corymbosus	-	LC
9	Moraceae	Ficus benghalensis	Banyan tree	NE
10	Heliotropiaceae	Heliotropium ovalifolium	-	LC
11	Verbenaceae	Lantana trifolia	Common lantana	NE
12	Arecaceae	Nypa fruticans	Nipa palm	LC
13	Fabaceae/ Mimosaceae	Pithecellobium dulce	Madras thorn, Jerusalem thorn	NE
14	Lythraceae	Sonneratia apetala	-	LC
15	Lythraceae	Sonneratia caseolaris	-	
16	Malvaceae	Hibiscus tiliaceus	Sea hibiscus	NE
17	Convolvulaceae	Argyreia nervosa	Elephant creeper	NE
18	Acanthaceae	Acanthus ilicifolius	Sea holly	LC
19	Fabaceae	Albizia lebbeck	Black siris, Kokko	NE

#### Table 5.55: Flora Species Recorded

No.	Family Name	Scientific Name	Common Name	IUCN Listing
20	Musaceae	Musa sanguinea	Red banana, Nget-pyaw	NE
21	Fabaceae	Albizia saman	Rain tree	NE
22	Asteraceae	Enhydra fluctuans	-	NE
23	Mimosaceae	Acacia auriculiformis	Ear-leaf acacia	LC

Notes: NE – Not Evaluated VU – Vulnerable DD – Data Deficient LC – Least Concern NL – Not Listed

## **Invasive Species**

During the flora survey, seven (7) invasive species were identified within the Area of Influence. These species are shown in *Table 5.56* below.

No.	Scientific Name	Common Name	Origin	Threat Level
1	Ficus religiosa L.	Bo tree, Lagat, Pipal, Bawdi- nyaung	India/ Native	N
2	<i>Mimosa invisa</i> Martius ex Colla M.pigra M.pudica	Senstitive plant, Tigayon	South America. Mexico, Amazon. Tropical America	Ν
3	Alternanthera philoxeroides	Alligator weed	Temperate South America	Ν
4	Leucaena leucocephala	white leadtree, jumbay, river tamarind, subabul,white popinac, Bawza-gaing, Awai- yar	Mexico and northern Central America	Ν
5	Eichhornia crassipes	common water hyacinth	Amazon Basin	Ν
6	Acacia auriculiformis	Ear-leaf acacia	Papua New Guinea, Indonesia and Australia	N
7	Albizia saman	Rain tree	Central America, northern South America	N

## Table 5.56: Invasive Species Identified found within the Area of Influence

Notes: R: Regional Significance N: Nationally Significant

### Fauna

#### Birds

#### **Methods**

Observations of bird species were undertaken during the dry season survey. Observations were made opportunistically using binoculars. Where possible, birds were identified from calls heard during the surveys.

#### **Results**

A total of fourteen (14) bird species were detected during the survey. All species were identified as Least Concern on the IUCN Red list. No species were determined to be conservation significant and hence would trigger a Critical Habitat assessment.

The results of the mammal survey are shown in Table 5.57.

No.	Scientific Name	Common Name	Family	IUCN Status
1	Corvus splendens	House Crow	Covidae	LC
2	Aegithina tiphia	Common Iora	Aegithinidae	LC
3	Passer domesticus	House Sparrow	Passeridae	LC
4	Lonchua punctulata	Scaly-Breasted Munia	Ploceidae	LC
	Streptopelia chinensis	Spotted Dove	-	-
5	Acridotheres tristis	Common Myna	Sturnidae	LC
6	Columba livia	Rock Pigeon	Columbidae	LC
7	Pycnonotus blanfordi	Streak Eared Bulbul	Pycnonotidae	LC
8	Lanius bucephalus	Bull-Headed Shrike	Laniidae	LC
9	Riparia paludicola	Plain Martin	Hirundinidae	LC
10	Cypsiurus balasiensis	Asian Palm Swift	Apodidae	LC
11	Haliastur indus	Brahminy Kite	Accipitridae	LC
12	Milvus migrans	Black Kite	Accipitridae	LC
13	Egretta garzetta	Little Egret	Ardeidae	LC
14	Ardeola grayii	Indian Pond Heron	Ardeidae	LC

## Table 5.57: Bird Species Identified within Sample Areas

Notes: NE – Not Evaluated VU – Vulnerable DD – Data Deficient LC – Least Concern

NL – Not Listed

### Mammals

#### <u>Methods</u>

Records of mammals were taken opportunistically during the site survey using binoculars and observation of tracks and field signs.

### <u>Results</u>

One mammal species was recorded during the survey, the delta pigmy rice rat *Oligoryzomys nigripes*. The common grey mongoose (*Herpestes edwardsii*) is known to be in the vicinity of the site but was not recorded during the survey. No species were determined to be conservation significant and would hence trigger a Critical Habitat assessment.

#### Herpetofauna

#### <u>Methods</u>

Records of herpetofauna were taken opportunistically during the site survey.

#### <u>Results</u>

A total of two (2) species of reptile and no amphibian species detected during the surveys. All species were classed as Least Concern or Not Evaluated under the IUCN Red List. No species were determined to be conservation significant and hence would trigger a Critical Habitat assessment.

The results of the survey are shown in Table 5.58.

## Table 5.58: Herpetofauna Species Recorded

No.	Family Name	Scientific Name	Common Name	Observation	IUCN status
1	Squamata	Gekkonidae	Hemidactylus frenatus	Asian house Gecko	LC
4	Squamata	Agamidae	Calotes versicolor	Garden fence lizard	NE
Noton: I.C. Logat Concern (ILICN)					

Notes: LC – Least Concern (IUCN) NE – Not Evaluated

#### Fish

#### <u>Methods</u>

The ERM in house database was consulted.

#### <u>Results</u>

From ERM in-house database, numerous black-headed gulls (*Chroicocephalus ridibundus*) were observed at waters neighbouring the Project Site. This bird species are considered common all over the world and are listed as of Least Concern (LC) on the IUCN Red List (IUCN, 2016). It is also noted that the commonly caught fish species by fishermen in Dala include;

- Soldier croaker (Nibea soldado): known as Nga Pote Thin in Myanmar;
- Truncated estuarine catfish (Cryptarius truncatus): known as Nga Zin Yaing in Myanmar; and
- Paradise threadfin (Polynemus paradiseus): known as Nga Pon Nar in Myanmar.

None of these species have been assessed on the IUCN Red List (2016). Aquatic habitat in the vicinity of the Project Site appears to have negligible ecological value.

## 5.1.11.8 Critical Habitat Screening Assessment

## Criterion for Critical Habitat

The Critical Habitat assessment comprised an analysis of biodiversity values within the project area and area of influence, habitats of high biodiversity value, species of conservation concern and general flora and fauna assemblages. This involved GIS analysis; desk based data collection including a review of previous EIAs, and targeted field surveys at karst surface and cave habitats.

Critical Habitat criteria are defined in PS6 Guidance Note 6 (GN6), Paragraphs GN69 to 97. *Table 5.59* provides detail of the qualifying requirements for Criteria 1 to 3 (i.e. thresholds), while details of the likely qualifying interests for Criterion 4 and 5 will be defined based on research and expert opinion. The criteria listed have been used to complete this assessment (IFC, 2018).

Criteria	Tier 1 <sup>(1)</sup>
Criterion 1: Critically Endangered (CR) / Endangered (EN) species:	<ul> <li>(a) Areas that support globally-important concentrations of an IUCN Red- listed EN or CR species (0.5% of the global population AND 5 reproductive units15 of a CR or EN species);</li> <li>(b) Areas that support globally-important concentrations of an IUCN Red- listed VU species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in (a).</li> <li>(c) As appropriate, areas containing nationally/regionally-important concentrations of an IUCN Red-listed EN or CR species.</li> </ul>
Criterion 2: Habitat of significant importance to endemic and/or restricted-range species;	(a) areas that regularly hold $\geq$ 10% of the global population size AND $\geq$ 10 reproductive units of a species.
Criterion 3: Habitat supporting globally significant concentrations of migratory species and/or congregatory species;	<ul> <li>(a) areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle.</li> <li>(b) areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.</li> </ul>
Criterion 4: Highly threatened and/or unique ecosystems; and/or	<ul> <li>(a) areas representing ≥ 5% of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN.</li> <li>(b) other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.</li> </ul>
Criterion 5: Areas associated with key evolutionary processes	No set criteria

## Table 5.59: Criteria Habitat Criteria

Note: <sup>(1)</sup> No Tier system is in place for Criterion 5

## Critical Habitat Triggers (Criterion 1-3)

The five criteria are 'triggers' in that if an area of habitat meets any one of the criteria, it will be considered Critical Habitat irrespective of failing to meet any other criterion<sup>42</sup>. Therefore, Critical Habitat can be determined through a single criterion or where a habitat holds biodiversity meeting all five criteria. This approach is generally more cautious but is used more widely in conservation<sup>43</sup>. Critical Habitat criteria therefore have two distinctive characteristics. First, components of biodiversity are essentially assigned to only two levels of conservation significance, those that trigger Critical Habitat and those that do not. Second, each criterion is applied separately and not in combination, meaning that the scores are not cumulative.

### Critical Habitat Candidate Species

No species were identified from surveys that would trigger assessment under Criterion 1 to 3.

## Potential Critical Habitat Species (Criterion 1 to 3)

No species have been identified to be potential CH species under Criterion 1 to 3.

#### Ecosystems at Risk of Significantly Decreasing in Area or Quality

The ecosystems in the AoI are generally widely distributed. The habitat within the Area of Influence and Study Area are not considered to be significant and hence would not trigger Critical Habitat under Criterion 4.

#### **Ecosystems with a Small Spatial Extent**

All ecosystems present within the AoI and Study Area are generally widely spread throughout Myanmar.

## Ecosystems Containing Unique Assemblages of Species Including Assemblages or Concentrations of Biome-Restricted Species

All ecosystems present within the AoI and Study Area are not unique or contain assemblages of biome restricted species.

## Criterion 5 – Key Evolutionary Processes

Criterion 5 recognises the attributes of a region that that can influence evolutionary processes and give rise to regional configuration of species and ecological properties. Examples can include isolated areas where populations are phylogenetically distinct, areas of high endemism, environment gradients or ecotones and biological corridors.

No key evolutionary processes have been identified within the ecosystems within the Area of Influence or Study Area.

 <sup>&</sup>lt;sup>42</sup> The Biodiversity Consultancy (TBC) (2013) Getting through PS6: Critical Habitat and its requirements. Case Studies from Guinea and Mongolia.Whitmore, T.C. (1984) Tropical Rain Forests of the Far East. Oxford University Press. Second Edition.
 <sup>43</sup> McDonald-Madden, E. Gordon, A. Wintle, B. Walker, S. Grantham, H. Carvalho, S. Bottrill, M. Joseph, L. Ponce, R. Stewart,

R. & Possingham, H. P. (2009). "True" Conservation Progress. Science 323: 43-44.

#### 5.2 Socioeconomic Baseline

The following chapter provides an overview of the social, socioeconomic, health and cultural heritage conditions of the Project area.

## 5.2.1 Data Collection

Settlements located closest to the Project infrastructure are likely to experience negative and positive impacts as a result of the Project activities, including economic opportunities, social and environmental changes, lifestyle changes, and changes to community health and safety. Other social receptors located further from the Project may also benefit or experience negative impacts from the Project.

The Social Area of Influence (SAoI), where data collection has been conducted to help establish the socioeconomic baseline, is defined as the area inhabited or used by stakeholders and likely to be positively or negatively affected by the Project. This includes short, long term or permanent changes, as well as direct, induced or indirect impacts. The SAoI includes:

- The Project site(s) and related facilities developed or controlled by TPMC and the additional areas in which aspects of the environment could conceivably experience significant impacts.
- Associated facilities that are not developed and funded as part of the proposed Project, but are essential for the Project and without which the Project cannot proceed, and the associated areas in which the environment could conceivably experience significant impacts.
- Areas potentially affected by cumulative impacts resulting from other developments known at the time of the ESIA, further planned phases of the Project or any other existing circumstances.
- Areas potentially affected by impacts from predictable (but unplanned) developments as a result of the proposed Project (i.e., induced activities), occurring at a later stage or at a different location.

The information presented in this Section was gathered through desktop review of publicly available sources. To provide a more precise understanding of the social, socioeconomic, health and cultural heritage conditions in the Project area, primary data have been collected just after the first Public Consultation session, from 15 to 19 November 2018. The methods for gathering primary data are comprised of household questionnaires, face-to-face interview with key informants and focus group discussions with designated interviewees. Key stakeholder groups include village leaders, women, fishermen, health care professionals and famers from the local villages. A total of 150 household questionnaires as well as 11 Focus Group Discussions and Key Informant Interviews have been administered in Dala, Seikgyikanaungto and Ahlone townships. Examples of the tools used for primary data collection for social baseline are included in *Appendix P*.

The collection of secondary and primary data provided an opportunity to triangulate the data to confirm the accuracy of the information presented. Given the limited secondary data available at the local level, it also ensured a more robust baseline against which the likely impacts associated with the Project could be assessed. The data at local level indicated without specific footnote that refers to publicly available sources is extracted from ERM's interview processes, which were conducted in November 2018.

The Project Site and its surrounding area will be referred to as the 'study area', which will have a radius of 5 km from the LNG Receiving Terminal and Power Plant. The natural gas pipeline will have a study area that stretches 500 m perpendicular on each side, and along the entire pipeline alignment.



## Figure 5.35: Social Baseline Data Collection in the Project SAoI

## 5.2.2 Social Receptors

The baseline focuses on the receptors that may be impacted or influenced by the Project due to their proximity to the Project site and/ or Project associated facilities. As shown in (*Figure 5.36*), this includes people living in:

- Dala village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Tha Pyay Kone village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and within 3 km of the Power Plant;
- Nyaung Ngoke To village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and within 3 km of the Power Plant;
- Ye Chaung Wa village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Pyawbwe Gyi village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Shwe Hlay Chaung village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Tone Tin Gan (North) village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline;
- Tone Tin Gan (South) village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline and within 3 km of LNG Terminal;

- Rakhin Chaung (North) village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and within 3 km of LNG Terminal;
- Nyaung Chaung village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and at location of LNG Terminal;
- Seikgyikanaungto village tract. The village tract is located within 500 m perpendicular on each side of the Pipeline, and within 3 km of the Power Plant;
- Ahlone village tract. The village tract is where the Power Plant is located;
- Htaw (Lower) village tract. The village tract is within 3 km of the Power Plant;
- Gyaung Waing village tract. The village tract is within 3 km of the Power Plant;
- Kyun Ka Lay village tract. The village tract is within 3 km of the Power Plant;
- Ah Lat Chaung village tract. The village tract is within 3 km of the Power Plant;
- Kyeemyindaing village tract. The village tract is within 3 km of the Power Plant;
- Sanchaung village tract. The village tract is within 3 km of the Power Plant;
- Dagon village tract. The village tract is within 3 km of the Power Plant;
- Kamaryut village tract. The village tract is within 3 km of the Power Plant;
- Bahan village tract. The village tract is within 3 km of the Power Plant;
- Mingalartaunginyung village tract. The village tract is within 3 km of the Power Plant;
- Lathat village tract. The village tract is within 3 km of the Power Plant;
- Lanmadaw village tract. The village tract is within 3 km of the Power Plant;
- Seikkan village tract. The village tract is within 3 km of the Power Plant;
- Pabedan village tract. The village tract is within 3 km of the Power Plant;
- Kyaukatada village tract. The village tract is within 3 km of the Power Plant;
- Pazundaung village tract. The village tract is within 3 km of the Power Plant;
- Botahtaung village tract. The village tract is within 3 km of the Power Plant; and
- Bahan village tract. The village tract is within 3 km of the Power Plant.

The study area of the Project covers 36 village tracts and 3 townships (Ahlone, Dala and Seikgyikanaungto). There are 6 overlapped village tracts and 3 overlapped townships from 3 project components.

## Table 5.60: Conclusion on Number of Townships and Village Tractsin the Study Area

	LNG Terminal (within 3 km)	Power Plant (within 3 km)	Natural Gas Pipeline (within 100 m perpendicular on each side)
Total Township	1	1	3
Total Village Tract	3	22	11



## Figure 5.36: Social Receptors

Source: ERM, 2018.

## 5.2.3 Overview of Project Area and Study Area

### 5.2.3.1 Myanmar

Myanmar is located in Southeast Asia. The country is bordered to the east by Thailand and Laos, to the north by China and to the west by India and Bangladesh. Myanmar has a lengthy coastline that extends for approximately 2,400 km along the Andaman Sea and Bay of Bengal.

There are a number of mountain ranges and river systems, which run north to south through the country – creating natural divisions. There are four distinct seasons in Myanmar. The cold and dry season runs from November to February, while the hot season is March and April, and the rainy season extends from May to October. During the rainy season, monsoons can occur, causing flooding and landslides.

Myanmar is divided into States and Regions (also referred to as Divisions), which are further divided into Townships for administrative or governance purposes. Yangon or Rangoon, former capital of Myanmar, is divided into 33 townships. The Project site is located within the Ahlone, Seikgyikanaungto and Dala Townships of Yangon. Therefore, the information presented hereafter will cover both primary and secondary data of these three townships.

### 5.2.3.2 Yangon region

Yangon, formerly known as Rangoon, is the most urbanized region of Myanmar. The region is located in the southern central part of Myanmar on the west bank of Hlaing River. It was the administrative capital of Myanmar until 2006 when government proclaimed Nay Pyi Taw has the new administrative capital of Myanmar<sup>44</sup>. In the city, structures of building are mixed between old colonial and modern structures. Although most buildings are constructed with bricks, wooden places can be commonly found in outskirt and distant areas.

#### 5.2.3.3 Seikgyikanaungto Township

This township is located in the Southern district of Yangon<sup>45</sup>, and isolated from the main Yangon area by the Yangon River, with less tourists and transport infrastructures<sup>46</sup>. In 2017, this township was awarded with the cleanest township award<sup>47</sup>. In this township, land is used for industrial area (2%), under development area (2%), open space (14%), water surface (15%), residential area (21%), and agricultural area (47%)<sup>48</sup>.

## 5.2.3.4 Ahlone Township

Ahlone Township is located in the Western district of Yangon on the left bank of the Yangon River. This township is home to industrial activities (Yangon Port) and city like business as well as residential areas. The area of the proposed power plant is an unused area, subject to flooding. Ahlone can be reached by taking trains, buses and special buses from Yangon<sup>49</sup>. Land use in Ahlone Township consists of water surface (1%), public facilities area (3%), business area (5%), open space (9%), industrial area (20%), and residential area (62%)<sup>48</sup>.

- <sup>45</sup> The 2014 Myanmar Population and Housing Census (Seikgyikanaungto Township). Accessed on 24 October 2018 at https://themimu.info/sites/themimu.info/files/documents/TspProfiles\_Census\_Seikkyi-Khanaungto\_2014\_ENG.pdf
- <sup>46</sup> 7 day trip ideas for getting out of Yangon. Accessed on 24 October 2018 at https://frontiermyanmar.net/en/7-day-trip-ideasfor-getting-out-of-yangon

<sup>&</sup>lt;sup>44</sup> Yangon (Myanmar). Accessed on 24 October 2018 at https://www.britannica.com/place/Yangon

<sup>&</sup>lt;sup>47</sup> Volunteers determined to clean up Yangon. Accessed on 24 October 2018 at https://www.mmtimes.com/lifestyle/26332-volunteers-determined-to-clean-up-vangon.html

<sup>&</sup>lt;sup>48</sup> The Project for the Strategic Urban Development Plan of the Greater Yangon (Final Report I). Accessed on 31 October 2018 at http://open\_jicareport.jica.go.jp/pdf/12122529\_02.pdf

<sup>&</sup>lt;sup>49</sup> Ahlone, Yangon, Myanmar (Burma). Accessed on 24 October 2018 at https://www.latlong.net/place/ahlone-yangonmyanmar-burma-24788.html

## 5.2.3.5 Dala Township

Dala Township is located in the Southern district of Yangon Region south of the Yangon River, Dala's land use consists of under development area (1%), open space (1%), water surface (2%), residential area (8%), and agricultural area (87%)<sup>48</sup>.

## 5.2.4 Demographic Profile

### 5.2.4.1 Yangon Region

The region covers an area of approximately 10,171.30 sq. km<sup>50</sup>, divided into 4 districts (Yangon North, Yangon East, Yangon West and Yangon South), 33 townships, 742 wards and 2,170 villages<sup>51</sup> Total population is around 7 million people, with 52.2% female. (*Table 5.61*). Citizens are mostly aged between 15 - 64 years old (*Table 5.62*). More than 3 million of Yangon citizens are married (*Table 5.63*). Out of the total Yangon population, approximately 1,869,787 people (25%) are considered vulnerable population<sup>52</sup>.

The majority of the population in the Study Area are Bamar people; Bamar people are the dominant ethnic group in Myanmar, with a population of more than 30,110,000 people. There are, however, small numbers of Kayin, Mon, and Rakhine living in the Study Area. *Figure 5.37* shows that in Yangon, ethnic groups also comprise Indians, Chinese, Kayin, Rakhine and Mon. The Myanmar Government recognizes Mon. Kayin and Rakhine as national ethnic group<sup>53</sup>. The dominant religion is Buddhism, although Christianity, Islam and Hinduism are also present.<sup>54</sup>

As shown in **Table 5.64**, majority of Yangon population lives in conventional households (a place where one or more persons share living quarter and meals, regardless of whether they are related or unrelated), which are mostly headed by men<sup>51</sup>. Many of them generally own conventional type of houses<sup>51</sup>, which are mostly wooden houses (**Table 5.65**). The utmost popular materials for constructing households in Yangon consist of brick/ tile/ concrete for wall, wood for floor, and corrugated sheet for roof (**Table 5.66**). The average size of a household is 4 persons<sup>51</sup>.

Region	Total	Male	Female	Gender ratio
Yangon	7,360,703	3,516,403 (47.77%)	3,844,300 (52.23%)	92 males per 100 females

## Table 5.61: Population in Yangon Region

Source: The 2014 Myanmar Population and Housing Census (Yangon Region), May 2015.<sup>51</sup>

MIMU\_Jun2018\_ENG\_Print\_version.pdf. Note: the "approximate number of vulnerable population" is the number of persons in the area particularly affected by some of the aspect/aspects of vulnerability covered in the Vulnerability Index, namely low levels of literacy, sanitation, electricity, access to improved drinking water, housing quality, access to services/opportunities requiring identity documents, and high child dependency.

<sup>&</sup>lt;sup>50</sup> Yangon Region, A Snapshot of Child Wellbeing. Accessed on 24 October 2018 at

https://www.unicef.org/myanmar/Yangon\_Region\_Profile\_30-07-15.pdf

<sup>&</sup>lt;sup>51</sup> The 2014 Myanmar Population and Housing Census (Yangon Region). Accessed at 24 October 2018 at

http://www.dop.gov.mm/sites/dop.gov.mm/files/publication\_docs/yangon\_region\_census\_report\_-\_english.pdf <sup>52</sup> Vulnerability in Myanmar. Accessed on 24 October 2018 at

https://themimu.info/sites/themimu.info/files/documents/Report\_Vulnerability\_in\_Myanmar\_HARP-

<sup>&</sup>lt;sup>53</sup> The State of Local Governance: Trends in Yangon. Accessed on 25 October 2018. At

https://www.themimu.info/sites/themimu.info/files/documents/Report\_Local\_Governance\_Mapping\_Yangon\_UNDP\_Feb2015.p df

<sup>&</sup>lt;sup>54</sup> The 2014 Myanmar Population and Housing Census (Dala Township). Accessed on 24 October 2018 at https://themimu.info/sites/themimu.info/files/documents/TspProfiles\_Census\_Dala\_2014\_ENG.pdf



Figure 5.37: Religions in Myanmar and Yangon Region

Source: The 2014 Myanmar Population and Housing Census (Dala Township).<sup>54</sup>

## Table 5.62: Population Sizes, Categorized by Age

Types of population	Yangon region
Children (0 – 14 years)	23.4%
Adults (15 – 64years)*	70.9%
Elders (65+ years)	5.7%

Source: The 2014 Myanmar Population and Housing Census (Yangon Region).<sup>51</sup>

Note: Adults are referred to economically productive group of people in the source.

## Table 5.63: Marital Status in Yangon Region

Region/	Region/		Total (	person)	
districts	townships	Single	Married	Widowed	Divorced / separated
Region	Yangon	2,040,730	3,066,094	361,796	103,934

Source: The 2014 Myanmar Population and Housing Census (Yangon Region).<sup>51</sup>

## Table 5.64: Numbers of Citizens in Conventional Households and InstitutionalHouseholds in Yangon Region

Types of dwellings	Total (person)
	Yangon region
Conventional households	6,949,440
Institutional households	411,263

Source: The 2014 Myanmar Population and Housing Census (Yangon Region).<sup>51</sup>

## Table 5.65: Housing Units of Conventional Households in Yangon Region

Housing Units	Total (household)		
	Yangon region		
Wooden houses	659,423		
Bamboo	344,419		
Apartment/condominium	266,864		
Semi-pacca house	150,641		
Bungalow/brick house	117,047		
Hut 2 – 3 years	17,039		

Source: The 2014 Myanmar Population and Housing Census (Yangon Region).<sup>51</sup>

## Table 5.66: Material for House Structures in Yangon Region

Materials	Percentage (%) Yangon region			
	Wall	Floor	Roof	
Brick/Tile/ Concrete	32	30.7	5.2	
Wood	24	52	5.2	
Bamboo	31.8	15.6	0.2	
Dhani/Theke/ In leaf	9.2	-	17.8	
Corrugated sheet	1.5	-	76.3	
Earth	Less than 0.1	0.5	-	
Other	1.5	1.2	0.3	

Source: The 2014 Myanmar Population and Housing Census (Yangon Region).<sup>51</sup>

#### 5.2.4.2 Seikgyikanaungto Township

Seikgyikanaungto Township covers an area of approximate 7.9 sq. km, divided into 9 wards<sup>45</sup>. **Table 5.67** shows that there are 34,003 citizens of which 17,068 are males and 16,935 are females. Majority of them are aged between 15 - 64 years old<sup>51</sup>, similar to the rest of Yangon. Based on **Table 5.68**, 14,461 persons are married (under 50%). The largest ethnic group in this township is also Bamar (**Table 5.69**).

In this township, most people (33,251 persons) lives in conventional households (*Table 5.70*), which are largely male-headed and a majority of people live in conventional houses<sup>45</sup>, mostly wooden houses (*Table 5.71*). *Table 5.72* illustrates the most popular materials used for construction (wall, floor and roof): bamboo for wall, wood for floor, and corrugated sheet for roof. Primary data indicates that the average size of a household in Seikgyikanaungto Township is five people.

Limited number of people present vulnerability in term of physical disability, chronic or critical diseases, or paralytic stroke (*Table 5.73*).

## 5.2.4.3 Ahlone Township

Ahlone Township covers an area of approximately 2.7 sq. km, divided into 11 wards<sup>55</sup>. As shown by *Table 5.67*, there are 55,482 people living in the Township, of which 29,931 are females, and 25,551 are males. Majority of them are aged between 15 - 64 years old<sup>51</sup>. *Table 5.68* shows that majority of Ahlone population are married. In addition, the majority of Ahlone citizens is Bamar (*Table 5.69*).

As shown in *Table 5.70*, in Ahlone Township, most people (48,612 persons) live in conventional households, which are mostly headed by males<sup>55</sup>. The majority of Ahlone citizens have ownerships over conventional households<sup>55</sup>, such as apartment/ condominium (*Table 5.71*). *Table 5.72* shows that brick/ tile/ concrete are mostly used for wall and floor, but corrugated sheet is utmost used for roof. Primary data indicates that the average size of a household in Ahlone Township is five people.

## 5.2.4.4 Dala Township

Dala Township covers an area of approximately 2,24.1 sq. km, divided into 23 wards and 23 village tracts.<sup>54</sup> *Table 5.67* shows that in these areas, there are 172,857 persons, of which 88,186 persons are females and 84,671 are males, who are mostly aged between 15 – 64 years old.<sup>51</sup> Majority of Dala citizens are married (*Table 5.68*) and the majority of people is Bamar (*Table 5.69*).

Majority of Dala citizens (170,363 persons) are living in conventional households (*Table 5.70*), which are mostly male-headed.<sup>54</sup> The majority of Dala citizens have ownerships over conventional houses,<sup>54</sup> which are mostly wooden houses (*Table 5.71*). *Table 5.72* illustrates the most popular materials used for construction (wall, floor and roof): bamboo for wall, wood for floor, and corrugated sheet for roof. Primary data indicates that the average size of a household in Dala Township is four people.

<sup>&</sup>lt;sup>55</sup> The 2014 Myanmar Population and Housing Census (Ahlone Township). Accessed on 24 October 2018 at https://themimu.info/sites/themimu.info/files/documents/TspProfiles\_Census\_Ahlone\_2014\_ENG.pdf

District	Township	Male	Female	Total	Gender ratio
Southern District	Dala Township	84,671 (48.5%)	88,186 (51%)	172,857	96 males per 100 females
Southern District	Seikgyikanaungto Township	17,068 (50.2%)	16,935 (49.8%)	34,003	101 males per 100 females
Western District	Ahlone Township	25,551 (46.1%)	29,931 (53.9%)	55,482	85 males per 100 females

## Table 5.67: Population in Dala, Seikgyikanaungto and Ahlone Townships

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

# Table 5.68: Marital Status in Dala, Seikgyikanaungto and Ahlone Townships(2014)

Districts	Townships	Total (person)			
		Single	Married	Widowed	Divorced / separated
Southern District	Dala Township	37,446	72,464	8,965	3,064
Southern District	Seikgyikanaungto Township	6,761	14,461	1,775	652
Western District	Ahlone Township	20,995	21,868	2,578	554

Source: The 2014 Myanmar Population and Housing Census (Yangon Region).<sup>51</sup>

## Table 5.69: Ethnicity in Dala, Seikgyikanaungto and Ahlone Townships

Ethnicity	Percentage (%)				
	Dala township	Seikgyikanaungto Township	Ahlone Township		
Bamar	92.3	96.6	79.4		
Rakhine	0.3	0.2	1.3		
Kachin	-	-	1		
Shan	-	-	0.8		
Kayah	-	-	0.2		
Kayin	1.5	0.3	5.7		
Indian and Chinese	3.8	0.1	-		
Chin	Chin -		0.7		
Mon	0.1	0.6	1		
Other	2	2.2	9.9		

Source: ERM, 2018.
# Table 5.70: Numbers of Citizens in Conventional Households and InstitutionalHouseholds in Dala, Seikgyikanaungto and Ahlone Townships

Types of dwellings	Total (person)				
	Dala township Seikgyikanaungto Township Ahlone Towns				
Conventional households	170,363	33,251	48,612		
Institutional households	2,494	752	6,870		

Source: The 2014 Myanmar Population and Housing Census (Yangon Region).<sup>51</sup>

# Table 5.71: Housing Units of Conventional Households in Dala,Seikgyikanaungto and Ahlone Townships

Housing Units	Dala township	Seikgyikanaungto Township	Ahlone Township
Wooden houses	18,949	5,153	1,770
Bamboo	15,198	2,246	366
Apartment/condominium	421	22	7,556
Semi-pacca house	1,278	186	652
Bungalow/brick house	636	43	531
Hut 2 – 3 years	489	32	12

Source: The 2014 Myanmar Population and Housing Census (Yangon Region).<sup>51</sup>

# Table 5.72: Materials for House Structures in Dala, Seikgyikanaungto andAhlone Townships

Materials	Percentage (%)								
	Dala township		Seik	Seikgyikanaungto Township			Ahlone Township		
	Wall	Floor	Roof	Wall	Floor	Roof	Wall	Floor	Roof
Brick/Tile/ Concrete	5.6	5	0.6	2.9	2.9	0.2	77.9	77.3	28.1
Wood	30.8	61.1	0.1	25.9	72.6	0.2	13.2	19.3	0.3
Bamboo	37.2	32.5	0.2	43.3	23.5	0.1	4.5	2.5	less than 0.1
Dhani/Theke/ In leaf	22.4	-	32.1	19.3	-	19	0.4	-	2
Corrugated sheet	2.5	-	66.8	6.2	-	80.3	1.7	-	28.1
Earth	0.1	-	0.4	0.1	0.2	-	less than 0.1	0.2	less than 0.1
Other	1.4	1	0.2	2.4	0.8	0.2	0.4	0.7	0.4

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

Type of vulnerability	Dala township	Seikgyikanaungto Township	Ahlone Township
No vulnerability	99.4%	96.4%	100%
Autism	0.3%	-	-
Kidney	0.3%	-	-
Physically disabled	-	0.7%	-
Paralytic stroke	-	1.4%	-
Chronic or critical disease	-	1.4%	-

#### Table 5.73: Vulnerabilities of Households in Project Study Area (2018)

Source: ERM, 2018.

# 5.2.5 Livelihood and Economy

#### 5.2.5.1 Income

#### Yangon Region

In urban areas of Yangon, many citizens are hired to work in industrial, commercial and trading sectors, while those living in rural areas work in the livestock rearing, fisheries and agricultural fields. Yangon main exports are rice, teak, and metal ores<sup>44</sup>. Revenue and expenditure for 2017-2018 fiscal year in Yangon are 382,585.316 million Kyats and 424,280.667 million Kyats respectively<sup>56</sup>.

Poverty incidence in Yangon region is 16%, estimated by UNICEF (United Nations International Children's Emergency Fund<sup>56</sup>. In 2014, UN-HABITAT (United Nations Human Settlements Programme). It is also estimated that around 2.38 million of Yangon citizens were poor or extremely poor and living in substandard housing or illegal dwellings. Ten percent of them were also estimated to live in slum dwellings<sup>50</sup>.

During the initial site visit, the primary human use and occupancy of the site was examined. Although Dala and Seikgyikanaungto Townships are within the Yangon Region, the business development rate in these townships is slow compared to the city across the river. Their businesses include agriculture, river transportation and casual workers who work in Yangon. In addition, in the Study Area there are small scale fishing and dredging activities. Communities in those townships raise livestock mostly for domestic consumption, including chicken, pig and goat. Information on agriculture, sand dredging and fishing is presented in the next subsections.

# Seikgyikanaungto Township

In Seikgyikanaungto Township, the highest monthly income is 1,300,000 Kyats, but the lowest monthly income is at zero (no income) Kyats. Based on **Table 5.74**, average household's income per year is approximately 3,802,439 Kyats, which is mostly generated by businesses. However, as shown in **Table 5.75**, average household's expenditure per year is approximately 809,864 Kyats. Regarding to negative net income, 58% of interviewees stated that housing expense creates negative income (*Figure 5.38*). In the last 12 month, 23.3% of interviewees borrow money mostly from microfinance (i.e. BNK microfinance).

<sup>&</sup>lt;sup>56</sup> Budget information for 2017-2018 Fiscal Year (Citizen's budget). Accessed on 24 October 2018 at https://themimu.info/sites/themimu.info/files/documents/Core\_Doc\_Citizens\_Budget\_Information\_for\_2017-2018\_31May2017.pdf

# Ahlone Township

According to primary data, the highest monthly income is at 5,000,000 Kyats, but the lowest monthly income is at 200 Kyats. According to **Table 5.74**, average household's income per year is approximately 4,617,461.5 Kyats, which is largely generated by businesses. Primary data shows that average household's expenditure per year is around 950,216 Kyats (**Table 5.75**). When interviewees were asked about underlying causes of negative net income, housing expense is referred by 72.7% of interviewees (*Figure 5.38*). In the last 12 month, 13% of Ahlone interviewees borrow money mostly from either friends or neighbours.

#### Dala Township

From primary data, the highest monthly income is at 2,000,000 Kyats, but the lowest monthly income is at 30,000 Kyats. *Table 5.74* shows that average household's income per year is approximately 6,947,756.5 Kyat, which is generated significantly by part-time job. However, average household's expenditure per year is around 1,244,464 Kyats (*Table 5.75*). For causes of negative net income, 59.2% of interviewees referred to housing expense (*Figure 5.38*). In the last 12 month, 23% of Dala interviewees borrowed money, mostly from banks (i.e. agricultural bank or agricultural development bank).

# Table 5.74: Average Household's Income Per Year in Dala, Seikgyikanaungto,and Ahlone townships

Source of household's	Average households' income per year (Kyats)			
income	Dala Township	Seikgyikanaungto Township	Ahlone Township	
Crop farming	955,217.4	-	-	
Fishing/ fish farming	158,260.9	-	-	
Livestock raising	37,043.5	-	-	
Forestry	-	-	-	
Business	1,174,434.8	2,066,341.5	3,117,307.7	
Local wage employment	857,843.5	980,000	1,248,076.9	
Part-time job	2,161,130.4	703,414.6	83,230.8	
Government assistance	53,217.4	-	88,076.9	
Other	1,550,608.7	52,682.9	80,769.2	
Total	6,947,756.5	3,802,439	4,617,461.5	

Source: ERM, 2018.

Note: government assistance is referred to pension or other government benefits

# Table 5.75: Average Household's Expense Per Year in Dala, Seikgyikanaungto,and Ahlone townships

Source of household's expenditure	Average households' income per year (Kyats)			
	Dala Township	Seikgyikanaungto Township	Ahlone Township	
Farming cost	187,543.4	-	-	
Fishing costs	8,436.7	-	-	
Livestock input	5,836.2	-		

Source of household's	Average households' income per year (Kyats)			
expenditure	Dala Township	Seikgyikanaungto Township	Ahlone Township	
Business costs	74,044.7	80,536.9	58,111.1	
Housing	6,639.2	6,555.7	35,600	
Medical care	58,148.9	43,892.6	42,311.1	
Education	40,657.6	100,503.4	67,000	
Family ceremonies	16,265.5	17,583.9	14,833.3	
Transportation	57,053.3	80,389.3	31,722.2	
Food	734,069.5	448,187.9	663,611.1	
Donations	40,880.9	32,214.8	30,361.1	
Others	14,888.3	-	6,666.7	
Total	1,244,464.2	809,864.5	950,216.6	

Source: ERM, 2018.

Note: farming cost includes fertilizer, pesticides, feeds, seeds, irrigation etc.





Source: ERM, 2018.

# 5.2.5.2 Agriculture

# Yangon Region

In the agricultural field, rice, beans and pulses are the main crops, produced. Other agricultural activities consist of jute, rubbers, groundnut and sugarcane<sup>53</sup>. Along the Yangon River, rice mills and sawmills can be found<sup>44</sup>.

# Seikgyikanaungto Township

In Seikgyikanaungto Township, none of interviewees own land resource or participate in collection of forest products, but village leader from Seikgyikanaungto Township stated that small number of households engage in cultivation of monsoon paddy outside the village. Paddy was the main crop and was grown only during the rainy season.

Small number of interviewees raise livestock, which is chickens (*Figure 5.39*). They are raised for both meat production and household consumption.

### Ahlone Township

None of Ahlone interviewees own land resources, raise livestock, participate in collection of forest products, or engage in agriculture. None of the interviewees mentioned revenues from agricultural activities. These results are not surprising as Ahlone is located in the urban part of Yangon and people's livelihoods are based on administrative, services, industrial and business sector employment.

#### Dala Township

In Dala Township, the LNG Receiving Terminal will be located in an agricultural area, mainly paddy fields. Primary data shows that 64% of interviewees own paddy fields with legal title to the land that they occupy. According to Dala's village leader, most crops grown outside the village consist of monsoon paddy and summer paddy.

Farmers mentioned that rice is cultivated during July to November, with sewing period in July and harvesting in November. The average size of paddy fields is 16.3 acres; 62.5% of interviewees said that there is no irrigation system in their lands. As displayed in *Table 5.74*, average annual income from crop farming is around 955,217.4 Kyats.

A few interviewees in Dala Township (1.25%) go into the nearest forest every few day to collect fuelwood. *Figure 5.39* shows that 33.8% of interviewees raise livestock such as pig (28.1%), chicken (25%) and cattle (18.8%). They are mainly raised for meat production. The livestock is then used for commercialization (57.1%), self-consumption (14.3%), farming (14.3%), working (9.5%), both commercialization and self-consumption (4.8%). Average annual income from sale of livestock products is 445,454.5 Kyats.



Figure 5.39: Livestock in Dala, Seikgyikanaungto and Ahlone

Source: ERM, 2018.

#### 5.2.5.3 Fisheries

#### Yangon Region

Small scale artisanal fishing takes place in the Yangon River, including around the Project sites. It is reported that fishermen make around 20,000 kyats (~17 USD) daily from fishing, which is conducted using traditional cast-nets. Yangon is a main landing site for fish in Myanmar with a fish market at San Pya in Ahlone Township near the Project Site.

#### Dala Township

According to Dala's village leader, 518 households engage in fishing activities by using small boats. Only 7.6% of people interviewed in Dala catch fish in the Yangon River for self-consumption and commercialization. He majority catches fishes daily, while some go fishing every few days. Dala fishermen stated that fishes can be caught throughout the year. The months with maximum fish catch are August, September, October and November, and the months with less fish catch are January, February, March and April. As imposed by the Fisheries Department, there are restricted days for fishing in April, May and June. Restricted species for being caught is butter catfish. As shown in *Figure 5.40*, Dala interviewees catch hilsa (23.8%), Indian salmon (23.8%) and croaker (23.8%) by using drift netting or seine net. Average fish caught per season is 1,068.4 Kg. Also, average annual income from fishing activities is approximately 158,260.9 Kyats (*Table 5.74*).

None of the interviewees in Ahlone and Seikgyikanaungto townships engages in fishing activities.





Source: ERM, 2018.

#### 5.2.5.4 Market

#### Seikgyikanaungto Township

All of interviewees stated that they normally go to Myoma Market, located in the township, and where more than one hundred shops are located<sup>57</sup>. More than 73% of interviewees go to the market daily, while 13.3% go every few days and 13.3% once a week.

#### Ahlone Township

Based on primary data, 97.5% of interviewees usually go to Ahlone market, while the remaining 2.5% go to Sinmin market. On frequency, 62.5% go to the market on a daily basis and 35% once a week.

#### Dala Township

Interviewees normally go to Dala market (93.5%), Nyaung Pin Lay Market in Yangon (2.6%), Kyansisthar (2.6%), and Khamarkasit (1.3%). On frequency, 52% go to the market every few days and 18.7% once a week.

<sup>&</sup>lt;sup>57</sup> Travel Naypyitaw. Accessed on 24 October 2018 at http://travelnaypyitaw.org/index.php/ar/destinations/shopping/201myoma-market





Source: ERM, 2018.

## 5.2.5.5 Private Business

#### Yangon Region

In Yangon, there are three types of business ownerships, including state-owned, private-owned and cooperative-owned types. Whilst small industries in food processing, and clothing manufacturing are owned privately or cooperatively, major industries that manufacture soap, rubber, aluminium, iron, steel sheet and textiles are owned by the state<sup>44</sup>.

# Seikgyikanaungto Township

In Seikgyikanaungto Township, *Figure 5.42* shows that majority of interviewees are operating smallscale businesses shop/ market in the village/ ward. Average annual income from business operation is 2,066,341.5 Kyats (*Table 5.74*).

#### Ahlone Township

Majority of Ahlone interviewees are operating shop/ market (*Figure 5.42*) in the township or in the village/ ward. As shown in *Table 5.74*, average annual income from business operation is 3,117,307.7 Kyats.

#### Dala Township

*Figure 5.42* shows that in Dala Township, majority of interviewees are operating shop/ market. Their businesses are located in the village/ ward or in the township. The average annual income from business operation is 1,174,434.8 Kyats (*Table 5.74*).



Figure 5.42: Type of Private Businesses in Dala, Seikgyikanaungto and Ahlone

Source: ERM, 2018.



### 5.2.5.6 Employment, Skill and Qualification

#### Yangon Region

Unemployment rate between men (4.3%) and women (3.9%) in Yangon is almost similar, however, percentage of men in labour force (81.8%) is significantly larger than percentage of women (46.4%) (*Table 5.76*). Yangon is the main centre for trading and handling for many foreign commerce in Myanmar<sup>44</sup>, and the most popular job industry is wholesale and retail trade<sup>58</sup> (*Table 5.77*).

Region	Percentage of Population aged between 15 – 64 years old					d
	Labour	Force Particip	ation (%)	Unemployment Rate (%)		te (%)
	Total	Men	Women	Total	Men	Women
Yangon Region	63.1	81.8	46.4	4.1	4.3	3.9
Dala Township	58.6	82.4	36.1	7.8	6.7	10
Seikgyikanaungto Township	62.3	87.4	37.1	4.6	4.8	4.2
Ahlone Township	63	79.2	49.4	4.8	4.8	4.8

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

### Seikgyikanaungto Township

Unemployment rate of men and women in this township is under 5% (*Table 5.76*). Percentage of men in labour force (87.4%) is larger than percentage of women (37.1%). Among participants in labour force, majority of Seikgyikanaungto workers are aged of 20 - 24 years old.<sup>45</sup> MIMU data from 2014 states that the most people were services and sales workers (*Table 5.78*). Primary data reveals that 21.8% of interviewees are operating business or participating in dependent occupations (*Table 5.79*). They are working within the village/ ward (*Figure 5.43*) with average working months at approximately 10.7 months. The longest duration for working is 12 months and the shortest duration for working is 3 months.

As provided in *Table 5.79*, some of Seikgyikanaungto interviewees are vulnerable because they are day labour (16.8%) or unemployed (13.9%).

With regards to formal vocational training and qualification, 25% have computer certificate (*Table 5.80*), and 19.7% have skill/ experience in trading and shop keeping (*Table 5.81*).

#### Ahlone Township

**Table 5.76** shows that unemployment rate of men and women in this township is under 5%, but percentage of men in labour force (79.2%) is significantly larger than percentage of women (49.4%). Among those in labour force, majority of them are aged of 25 - 29 years old.<sup>55</sup> In Ahlone Township, MIMU data show in 2014 that the largest number of citizens were services and sales worker (**Table 5.78**). **Table 5.79** relatively points out that 23.9% of interviewees are wage employees. They are working within township (**Figure 5.43**) with average working months at approximately 12 months, which is also the longest duration of working in this township. **Table 5.79** illustrates that vulnerability in terms of employment can be observed because 18.1% and 7.7% of interviewees are unemployed and working as day labor respectively.

<sup>&</sup>lt;sup>58</sup> The 2014 Myanmar Population and Housing Census (Occupation and Industry). Accessed on 24 October 2018 at http://www.burmalibrary.org/docs22/2B\_Occupation\_and\_Industry\_EN.pdf

Based on *Table 5.80*, majority of interviewees (31.3%) have a driver license and 20.2% of total interviewees have skill/ experience in trading and shop keeping *Table 5.81*.

## Dala Township

**Table 5.76** showns that unemployment rate of men and women in this township is above 5%. Percentage of men in labour force (82.4%) is significantly larger than percentage of women (36.1%). Among those in labour force, majority of them are aged of 25 - 29 years old<sup>54</sup>. Based on MIMU data, in 2014 the largest number of Dala citizens were services and sales workers (**Table 5.78**). As shown in **Table 5.79**, 24.8% of interviewees are operating businesses. They are mostly working within the village tract/ ward (**Figure 5.43**) with average working months at approximately 11.4 months. The longest duration for working per year is 12 months, but the shortest duration for working per year is 6 months.

Based on *Table 5.79*, vulnerability in terms of employment can be observed in Dala because some of Dala interviewees are unemployed (19.7%), day labor (15.7%), or lackf work capacity (1.6%).

According to **Table 5.80**, 30.4% of Dala interviewees own teacher certification. However, majority of interviewees (14.4%) have skill/ experience in carpentry (**Table 5.81**).

Industries	Number of Population (persons)
Wholesale and retail trade; repair and motorcycles of motor vehicles and motorcycles	476,047
Manufacturing	445,401
Agriculture, forestry and fishing	444,420
Accommodation and food service activities	282,883
Transportation and storage	274,751
Construction	263,880
Administrative and support service activities	150,777
Public administration and defence; compulsory social security	138,229
Other service activities	97,453
Education	64,680
Human health and social work activities	32,670
Activities of households as employers; undifferentiated goods- and services	32,399
Information and communication	26,799
Electricity gas steam and air conditioning supply	22,270
Arts entertainment and recreation	19,976
Financial and insurance activities	17,554
Professional scientific and technical activities	10,758
Water supply; sewerage waste management and remediation activities	8,234
Real estate activities	7,065
Mining and quarrying	3,955
Activities of extraterritorial organizations and bodies	1,598

### Table 5.77: Job Industries in Yangon Region

Source: The 2014 Myanmar Population and Housing Census (Occupation and Industry).58

Occupations	Number of population				
	Dala Township	Seikgyikanaungto Township	Ahlone Township		
Services and Sales Workers	18,378	3,754	5,859		
Craft and Related Trades Workers	11,689	3,533	2,145		
Elementary Occupations	11,106	1,844	1,527		
Skilled Agricultural, Forestry and Fishery Workers	6,847	306	286		
Plant and Machine Operators and Assemblers	5,429	2,019	1,998		
Clerical Support Workers	2,939	522	2,435		
Technicians and Associate Professionals	1,348	297	1,747		
Professionals	1,197	253	2,115		
Managers	277	96	1,112		

# Table 5.78: Types of Occupation

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

Occupations	Percentage (%)				
	Dala Township	Seikgyikanaungto Township	Ahlone Township		
Wage employee	7.5%	18.8%	23.9%		
Unemployed	19.7%	13.9%	18.1%		
Own business	24.8%	21.8%	23.2%		
Dependent	17.7%	21.8%	23.2%		
Day labour	15.7%	16.8%	7.7%		
Waiter	-	-	0.6%		
Student	2%	4%	2.6%		
Farmer	6.7%	-	-		
Retired	0.8%	-	0.6%		
Sale	0.4%	-	-		
Fisherman	3.1%	-	-		
N/A	1.6%	3%	-		

# Table 5.79: Specific Occupations

Source: ERM, 2018.

Note: N/A is referred to those, who are aged above 18 years old without capacity to work.



# Figure 5.43: Location of Employment of Citizens in the Study Area

Source: ERM, 2018.

Formal vocational	Percentage (%)			
training/ qualification	Dala Township	Seikgyikanaungto Township	Ahlone Township	
Teacher certificate	30.4	25	6.2	
Computer certificate	17.4	25	18.8	
Accountant certificate	-	-	12.5	
Diver license	4.3	-	18.8	
Driver license	4.3	-	31.3	
Shipping	0	-	6.2	
Welding certificate	13	-	-	
Nurse license	21.7	-	-	
Handicraft	4.3	-	-	
Mechanic	4.3	-	-	
Sewing certificate	-	-	6.2	

# Table 5.80: Formal Vocational Training and Qualification

Source: ERM, 2018.

# Table 5.81: Skills and Experiences

Skill/experience	Percentage (%)			
	Dala Township	Seikgyikanaungto Township	Ahlone Township	
Government staff	-	-	2	
Driver	1.1	-	12.1	
Shop keeping	8	19.7	20.2	
Cooking	0	1.3	1	
Teaching	1.1	-	1	
Manual labour	10.2	6.6	10.1	
Retired	0.5	-	1	
Cleaning	-	1.3	3	
Waiter/waitress in restaurant or supermarket	4.8	3.9	8.1	
Taxi driver	-	-	2	
Trading	8	19.7	16.2	
Shipper	0.5	-	1	
Government officer	-	3.9	9.1	
Vehicle/ machinery maintenance	-	1.3	1	
Hair dressing	-	-	1	
Bank	0.5	1.3	1	

Skill/experience	Percentage (%)		
	Dala Township	Seikgyikanaungto Township	Ahlone Township
Office staff	-	1.3	1
Teacher	4.8	-	1
Machinery maintenance	-	2.6	3
Private staff	1.6	1.3	3
Carpentry	14.4	3.9	2
Sewing	4.3	2.6	-
Selling	4.8	-	-
Film	0.5	-	-
Security	1.1	-	-
Welding	0.5	3.9	-
Others	1.1	6.6	-
Cycle carried/carry	1.1	2.6	-
Purified water business	0.5	-	-
Livestock	1.6	-	-
Construction	1.1	-	-
Mechanic	0.5	-	-
Nurse	1.1	-	-
Municipal staff	1.1	-	-
Painter	0.5	-	-
Clerk	1.6	-	-
Agriculture	8	-	-
Buying	1.1	-	-
Furniture	1.1	-	-
NGO	0.5	-	-
Shipment	0.5	-	-
General construction	1.1	1.3	-
Shop	1.6	0	-
Administrator	0.5	2.6	-
Fishing	4.8	-	-
Fireman	0.5	-	-
Seaman	0.5	-	-
Farmer	1.1	-	-
Village head	0.5	-	-
Company staff	1.1	-	-
Accountant	-	1.3	-
Agent	-	1.3	-
Household leader	-	1.3	

Skill/experience	Percentage (%)			
	Dala Township	Seikgyikanaungto Township	Ahlone Township	
Tourist guide	-	1.3	-	
Small microfinance	-	1.3	-	
Beauty salon	-	1.3	-	
Sell ticket	-	1.3	-	
Trishaw driver	-	1.3	-	
Fisherman	-	1.3	-	

Source: ERM, 2018.

# 5.2.6 Utilities

#### 5.2.6.1 Electricity

#### Yangon Region

It is reported that in 2017, 8% of households in Yangon region did not have access to public grid, while 13% had access to it without being connected, and 79% had access and were connected to it<sup>53</sup>.

As shown in *Table 5.82*, majority of Yangon conventional households use electricity as source of lighting. Among them, Ahlone has highest percentage of using electricity for lighting<sup>55</sup>. However, Dala is the only township that was reported about the gap of electricity usages between urban area (62.8%) and rural area (18.7%) since in rural area, households mainly use battery as source of lighting (27.6%)<sup>54</sup>.

*Table 5.83* shows that nine sources of fuel are used for cooking. In Yangon, majority of households use electricity as main fuel for cooking.

#### Seikgyikanaungto Township

In this township, majority of conventional households use electricity as source of lighting (*Table 5.82*), and fuel for cooking (*Table 5.83*).

Village leader from Seikgyikanaungto Township stated that there are 10,941 households utilizing government electricity/ national grid. In this township, all interviewees can access to grid generation during 24 hours (*Figure 5.44*).

#### Ahlone Township

In Ahlone Township, electricity is not only utmost used by conventional households as source of lighting (*Table 5.82*), but also as fuel for cooking (*Table 5.83*). All Ahlone interviewees can access to grid generation during 24 hours (*Figure 5.44*).

#### Dala Township

In Dala Township, majority of conventional households use electricity as source of lighting (*Table 5.82*). However, majority of them use charcoal as a fuel for cooking (*Table 5.83*). Moreover, village leader from Dala Township stated that 21,897 households are utilizing government electricity/ national grid. As shown in *Figure 5.44*, 88.8% of interviewees have access to grid generator, and 95.7% have access to it during the whole day. Power consumption for a regular household in this township is at 7 MW per day. Power consumption for business in this township is at 9.6 MW per day.



Figure 5.44: Duration of Accessibility to Grid Generation

Source: ERM, 2018.

Sources of energy for lighting	Yangon region	Dala township	Seikgyikanaungto Township	Ahlone Township
Electricity	69.3%	48.2%	76.4%	99%
Battery	11.8%	20%	5.5%	0.6%
Candle	7.2%	10.3%	17.4%	0.2%
Kerosene	5.7%	3%	0.2%	0.1%
Generator (private)	4%	16.4%	0.2%	-
Solar system/energy	1.6%	1.7%	0.2%	less than 0.1%
Other	0.4%	0.3%	0.2%	less than 0.1%
Water mill (private)	less than .1%	0.2%	-	-

# Table 5.82: Sources of Energy for Lighting

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

LNG POWER PLANT (AHLONE) PROJECT IN YANGON,	MYANMAR
ESIA Report	

Sources of energy for cooking	Yangon region	Dala township	Seikgyikanaungto Township	Ahlone Township
Electricity	47.1%	21.8%	47.8%	82.4%
Firewood	26.2%	25.9%	24.6%	1%
Charcoal	21%	45.3%	27%	8.9%
Other	2.6%	6.2%	0.3%	0.5%
LPG	2%	0.2%	less than 0.1%	0.4
Biogas	0.5%	0.2%	0.1%	0.8%
Coal	0.4%	0.4%	0.2%	0.2%
Kerosene	0.1%	0.1%	-	-
Straw/Grass	less than 0.1%	-	-	-

### Table 5.83 Sources of Energy for Cooking

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

### 5.2.6.2 Water

#### Water for Irrigation

#### **Yangon Region**

The Irrigation Department of the Ministry of Agriculture and Irrigation has identified three main sources of water in Yangon, including reservoirs, Irrawaddy River and ground water aquifers (Union of Myanmar Ministry of Agriculture and Irrigation, Irrigation Department, 2010). As shown in **Table 5.84**, about 90% of the water source of the system is surface water from reservoirs and the rest is ground water from tube wells supplemented by the water supply system.

Most households on the south bank of the Yangon River purchase drinking water. Local people use ponds and lakes for domestic water.

#### Seikgyikanaungto Township

In the summer (especially around March to April), nearly all households in Seikgyikanaungto depend on the Aung Mingalar Lake due to the scarcity of water. Some poor households use water from the lakes/ ponds within Seikgyikanaungto Township' area in the rainy seasons as well. Result of interviews also shows that there is no availability of irrigation water in Seikgyikanaungto Township.

#### **Ahlone Township**

As there is no agricultural activity in the Township, primary data confirm that there is no irrigation system in place.

#### Dala Township

Some poor households use water from the lakes/ ponds within Dala Township' area in the rainy seasons. Moreover, result of interviews shows that there is no availability of irrigation water in Dala Township.

Water Sources	Daily Capacity	Water Source	Start-up Year
Hlawga Reservoir	14 MGD	Surface water	1904
Gyobyu Reservoir	27 MGD	Surface water	1940
Phugyi Reservoir	54 MGD	Surface water	1992
Ngamoeyeik WTP (Phase 1)	45 MGD	Surface water	2005
Ngamoeyeik WTP (Phase 2)	45 MGD	Surface water	2014
Yangon Pauk	1 MGD	Ground water	2000
South Dagon	2 MGD	Ground water	2009
Thaephyu	1 MGD	Ground water	2009
YCDC tube wells	16 MGD	Ground water	-
Total	205 MGD	90% Surface Water + 10% Groundwater	

#### Table 5.84: Current Water Sources of Yangon City Water Supply System

Source: Zaw Win Aung, 2014.59

#### Non-Drinking Water

Non-drinking water or non-potable water are rainwater, reclaimed/ recycled water, and grey water. This water is not appropriate for human consumption, but it can be used for laundry, toilet, urinal flushing, or watering plants<sup>60</sup>.

#### Yangon Region

In Yangon region, households mainly access non-drinking water via tube well or borehole (Table 5.85).

#### Seikgyikanaungto Township

In Seikgyikanaungto Township, **Table 5.85** points out that pond and lake are popular sources of nondrinking water. Moreover, primary data provides that 73.3% of interviewees use sources of purified drinking water as source of water for domestic use, but 26.7% of them use rainwater as non-drinking water. 62.5% of interviewees stated that water from rainwater is sufficient and of good quality, but 37.5% of them said that water from rainwater is insufficient and has only a fair quality. Periods of insufficient water are February (11.2%), March (33.3%), April (33.3%) and May (22.2%).

#### Ahlone Township

*Table 5.85* shows that tube well or borehole is the main sources for non-drinking water in Ahlone Township. Based on primary data, 15% of interviewees use sources of purified drinking water as source

of non-drinking water, but 85% of interviewees access other sources for non-drinking water, which are tube well, tap water, and well. These sources contain sufficient water. For quality of water, majority of interviewees (76.5%) stated that quality of water is good, but 20.6% of them stated that water is salty and 3% of them think that quality of water is fair.

<sup>&</sup>lt;sup>59</sup> Water Supply Options For The Growing Megacity Of Yangon - Scenarios With The WEAP Model. Accessed on 24 October 2018 at https://www.weap21.org/Downloads/Yangon.pdf

<sup>&</sup>lt;sup>60</sup> Online Piping and Usage Specification (System Non-potable Water). Accessed on 12 March 2019 at http://opus.mcerf.org/application.aspx?id=-6228344935996635278

#### Dala Township

In Dala Township, *Table 5.85* illustrates that majority of Dala population access non-drinking water via pond and lake. In addition, result of interviews shows that 91.3% of interviewees use source of purified drinking water as source of non-drinking water, but 8.7% of interviewees access non-drinking water via rainwater, well, and tap water. These sources contain sufficient water with good quality.

# Table 5.85: Sources of Non-Drinking Water of Households in Yangon, Dala,Seikgyikanaungto and Ahlone Townships

Sources of non- drinking water	Yangon region <sup>1</sup>	Dala township <sup>2</sup>	Seikgyikanaungto Township <sup>3</sup>	Ahlone Township <sup>4</sup>
Pool/pond/lake	15.7%	85.8%	99%	-
Tap water/piped	24.4%	10.2%	0.1%	19.9%
Tube well/borehole	51.1%	3%	0.7%	79.6%
Protected well/spring	4.3%	0.5%	0.1%	0.1%
Unprotected well/spring	1.9%	0.1%	0.1%	-
Waterfall/rainwater	less than 0.1%	0.1%	0.1%	-
River/stream/canal	1.5%	0.1%	0.1%	less than 0.1%
Other	0.9%	0.1%	-	0.1%
Bottled/purifier water	0.2%	less than 0.1%	less than 0.1%	0.2%

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

# Drinking Water

#### Yangon Region

Yangon is one of the regions in Myanmar with the highest percentage of people with access to source of drinking water on premise (82%). At the same time, to reach water source, 14% of Yangon citizens spend less than 10 minutes, while 3% and 1% of them spend 11 to 20 minutes, and more than 20 minutes respectively<sup>61</sup>.

Households in Yangon access drinking water through two main sources (improved sources and unimproved sources); the percentage of people's usages for each type of source fluctuates based on seasonality. Both in dry and rainy seasons, bottled water is the main source of drinking water; during the rainy season, rainwater collection increases significantly, as shown in **Table 5.86**.

<sup>&</sup>lt;sup>61</sup> The 2017 Myanmar Living Conditions Survey. Accessed on 24 October 2018 at

https://themimu.info/sites/themimu.info/files/documents/Report\_Myanmar\_Living\_Conditions\_Survey\_2017\_Jun2018.pdf

Table 5.86: Sources of Drinking	Water of Households in	Yangon Region,	Based
	on Seasonality		

	Sources of Drinking Water	Yangon region			
Dry Season					
Irces	Bottled water	49.7%			
	Tube well or borehole	19.2%			
	Piped water into yard	4.6%			
Sol	Tanker/truck	4.2%			
oved	Piped water into dwelling	3.4%			
mpre	Rain water collection	2.3%			
-	Protected dug-well	1.9%			
	Public tab	0.5%			
ed	Pool	10.8%			
orovo	Other	2.8%			
Sou	River	0.6%			
5	Unprotected well	0.2%			
	Rainy Se	eason			
	Bottled water	45.7%			
S	Tube well or borehole	17.3%			
urce	Piped water into yard	3.6%			
I Sol	Tanker/truck	3.3%			
ovec	Piped water into dwelling	3.1%			
mpr	Rain water collection	20.8%			
-	Protected dug-well	1.1%			
	Public tab	0.5%			
eq	Pool	1.7%			
orov rces	Other	2.3%			
nim sou	River	0.4%			
D	Unprotected well	0.2%			

Source: The 2017 Myanmar Living Conditions Survey.<sup>61</sup>

#### Seikgyikanaungto Township

In this township, majority of citizens access drinking water via pool, pond or lake, which is unimproved source of drinking water (*Table 5.87*). In 2018, 73.3% of interviewees used rainwater as drinking water (*Figure 5.45*); 68.2% of them thought that quality of drinking water was good, and 31.8% of them perceived that quality of water as fair. Although 81.8% of interviewees stated that water is sufficient, 18.2% of them stated that water is insufficient during January, February, March, April and May (*Figure 5.46*). When water is not supplied to households, the next water source is the donation by associations.

#### **Ahlone Township**

MIMU data show in 2014 that Ahlone citizens mainly consumed drinking water via bottled/purifier water (*Table 5.87*). *Figure 5.45* shows that in 2018, 80% of Ahlone interviewees accessed drinking water via

purified drinking water, but some of interviewees accessed it via other sources: well (5%), tap water (7.5%) and tube well (7.5%). These sources contain sufficient amount of water with good quality.

#### Dala Township

According to the data in **Table 5.87**, majority of Dala citizens accessed drinking water via pool, pond or lake, which is unimproved source of drinking water. However, **Figure 5.45** shows that in 2018, 95% of Dala interviewees use rainwater as drinking water with belief that quality of drinking water is good. Moreover, 73.7% of interviewees stated that amount of water is sufficient, and 26.3% stated that water is insufficient in March, April and May (**Figure 5.46**). When water is not supplied to households, the nearest water source is the donation by association.

	Sources of Drinking Water	Dala Township	Seikgyikanaungto Township	Ahlone Township
-	Bottled/purifier water	5.8%	3.2%	72.6%
ovec urce	Tap water/piped	1.7%	less than 0.1%	3.7%
Impr	Tube well/borehole	0.2%	0.1%	23.2%
	Protected well/spring	0.1%	less than 0.1%	0.1%
ð	Pool/pond/lake	85.4%	91.9%	0.1%
prove	Waterfall/rainwater	5.7%	0.9%	-
Sot	Other	0.9%	3.9%	0.3%
$\supset$	River/stream/canal	0.1%	-	less than 0.1%

#### Table 5.87: Sources of Drinking Water of Households in Dala, Seikgyikanaungto and Ahlone Townships

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

# Figure 5.45: Source of Drinking Water in Dala, Seikgyikanaungto, and Ahlone Townships



Source: ERM, 2018.





Source: ERM, 2018.

## 5.2.6.3 Sanitation and Toilet Facilities

#### Yangon Region

In Yangon, 68% of households have access to basic sanitation, which is referred to improved, nonshared toilet and hand washing facilities<sup>61</sup>. **Table 5.88** shows that in 2014, water seal (improved pit latrine) was the most common toilet facility type in Yangon region. Moreover, more than 90% of population have access to a place in which they can wash hand with soap and water<sup>61</sup>.

## Seikgyikanaungto Township

As shown in *Table 5.88*, in 2014, the majority of citizens had water seal (improved pit latrine). Primary data shows that in 2018, all of interviewees had flush toilet that confirm local people's access to improved toilet facilities.

#### Ahlone Township

*Table 5.88* shows that in 2014, majority of Ahlone citizens have water seal (improved pit latrine). Result of interviews shows that in 2018, all of interviewees had flush toilet, highlighting Ahlone citizens' access to improved toilet facilities.

#### Dala Township

Based on *Table 5.88*, in 2014, majority of population had water seal (improved pit latrine). Primary data shows that in 2018, 98.75% of interviewees had flush toilet, which confirm Dala population' access to improved toilet facilities.

Types of toilet facilities	Yangon region	Dala township	Seikgyikanaungto Township	Ahlone Township
Water seal (improved pit latrine)	84.8%	84.3%	86.1%	72%
Flush	6.3%	0.6%	0.2%	25.6%
None	3.3%	6.9%	3.9%	0.4%
Bucket (surface latrine)	2.7%	5.7%	9%	1.6%
Pit (traditional pit latrine)	2.6%	2.3%	0.8%	0.1%
Other	0.3%	0.2%	less than 0.1%	0.3%

### Table 5.88: Toilet Facilities

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

# 5.2.7 Transportation

#### 5.2.7.1 Yangon Region

Yangon has a varied transport infrastructure, including many large to small concrete, paved or dirt roads, five bridges over the Yangon river, one international airport with two terminals and a domestic terminal, railway lines, four ports, buses lines and local taxi services. Details are provided in **Section 5.2.11**.

Approximately 100 boats travel across the river to Yangon daily, between 5:30 am to 8:00 pm, from Dala and Seikgyikanaungto to Yangon. The journey takes around 15 minutes from Seikgyikanaungto

to Yangon. Travelling from Dala or Seikgyikanaungto to Yangon by car can take around 2 hours (depending on traffic). In 2014, there are seven types of transportations, which households had and used for travelling from place to place. Among these types, bicycle was utmost available in Yangon (*Table 5.89*).

# 5.2.7.2 Seikgyikanaungto Township

During a previous study conducted in January 2017, nearly 500 boats were observed in Seikgyikanaungto Township alone. Given the difficulty to use car and the relatively cheap cost and ease of use of boat transport, local community depends on boat transport to reach Yangon City.

*Table 5.89* shows that in 2014, bicycle was the main owned and used transport by population in this township. However, primary data shows that, in 2018, motorbike became the most popular in Seikgyikanaungto (*Table 5.90*). Interviewees in this township also stated that walking is another mode of transportation often used.

It was raised during focus group discussion with women that the main problem they are encountering is related to security issue due to poor transportation system.

# 5.2.7.3 Ahlone Township

In 2014, majority of population in Ahlone Township used and owned car, truck or van (*Table 5.89*). Primary data in 2018 indicates that majority of citizens still use and own car (*Table 5.90*). Walking is another mode of transportation, referred by Ahlone interviewees.

# 5.2.7.4 Dala Township

The 2014 data shows that from seven types of transportation, bicycle was the most popular transport mode in Dala Township (*Table 5.89*), but motorbike becomes the highest popular transport mode in 2018 (*Table 5.90*). Dala interviewees also referred walking as another mode of transportation.

# Table 5.89: Types of Transportation in Yangon, Dala, Seikgyikanaungto andAhlone Townships

Types of	Percentage of households				
transportation	Yangon region	Dala township	Seikgyikanaungto Township	Ahlone Township	
Bicycle	46.2%	42.4%	45.7%	16.3%	
Motorcycle/moped	13.6%	17.7%	8.3%	1.3%	
Car/truck/van	7.8%	1%	0.5%	22.9%	
Cart (bullock)	4.8%	6.2%	0.7%	Less than 0.1%	
Canoe/boat	1.2%	1.2%	2.9%	Less than 0.1%	
4-wheel tractor	1.2%	1.6%	Less than 0.1%	Less than 0.1%	
Motor boat	1%	1.7%	0.5%	0.2%	

Source: The 2014 Myanmar Population and Housing Census. (Modified by ERM)

# Table 5.90: Types of Transportation in Dala, Seikgyikanaungto and AhloneTownships

Types of transportation		Percentage of households		
	Dala Township	Seikgyikanaungto Township	Ahlone Township	
Motorbike	84.8	100	12.5	
Tractor	12.6	-	-	
Car	1.3	-	87.5	
Van/ truck	1.3	-	-	

Source: ERM, 2018.

# 5.2.8 Cultural Heritage

# 5.2.8.1 Yangon Region

Yangon Region has a number of culturally significant areas, particularly Buddhists sites. Pagodas and monasteries found in these areas are considered as important cultural centres for the local communities. There are a number of important designated heritage buildings within 5 km of the Project Site such as the Shwedagon or Sule Pagoda. There is no cultural heritage in the footprint of the Project sites.

The most important and closest cultural heritages are Shwedagon pagoda and Sule pagoda. Shwedagon pagoda is constructed on the west bank of the Royal Lake on 114-acre Singuttara Hill in Yangon. Covered with number of gold plates and diamonds, this pagoda is representing architectures 2,500 years ago, and being recognized by Myanmar citizens as the most sacred Buddhist site in the country<sup>62</sup>. Shwedagon Pagoda is located approximately 3.37 km from the proposed Power Plant site.

<sup>&</sup>lt;sup>62</sup> Shwedagon Pagoda. Accessed on 24 October 2018 at http://www.shwedagonpagoda.com/



#### Figure 5.47: Shwedagon Pagoda

Source: Shwedagon Pagoda.62

Sule pagoda was founded 2,500 year ago in the centre of Yangon, and is connected to two main roads: Sule Pagoda road and the Mahabandoola road. There is belief that a powerful Nat spirit, named Sularata is dwelling in this place. Historically, this cultural area was a highly crucial location, which was used as meeting point of notable movements of activists in Myanmar such as, 1988 uprising and the Saffron Revolution in 2007<sup>63</sup>. Sule Pagoda is located approximately 3.23 km from the proposed Power Plant site.

<sup>&</sup>lt;sup>63</sup> Sule Pagoda. Accessed on 24 October 2018 at https://www.bestpricevn.com/travelguide/destinations-1/Sule-Pagoda-421.html

## Figure 5.48: Sule Pagoda



Source: Sule Pagoda.63

#### 5.2.8.2 Dala Township

According to interview with a village leader from Dala Township, there are two heritage and sacred sites. Danot pagoda is located three miles away out of the village; and Ah Nar Gan Sayar Thetgyi, meditation station, is located two miles away out of the village.

# 5.2.9 Education

#### 5.2.9.1 Yangon Region

Basic education system in aforementioned areas is identical to other parts of Myanmar in compliance with the national education system. Thus, years of schooling of people are 11 years, which is so-called 5-4-2 education system. 5-4-2 education system is comprised of 5 years of primary school, 4 years of lower secondary school and 2 years of upper secondary school. However, Myanmar had a 2017 plan to change this education system to be 5-4-3 system in order to be in the same line with most ASEAN countries. This plan extend years of schooling from 11 years to 12 years. Due to this plan, starting age for schools has changed from 5 years old to 6 years old because students aged 6 - 10 will be in primary school, while those aged 11 - 14 years old will be in lower secondary school, and aged 15 - 17 years old will be in high or upper secondary schools<sup>64</sup>. This new educational system started from the academic year (AY) 2016-2017<sup>65</sup>.

The 2014 data shows that in Yangon region, literacy rate of citizens aged of 15 years old and above was 96.6%, which is calculated from literacy rate in men (98%) and women (95.5%)<sup>51</sup>. The total number

<sup>65</sup> Reform of the Education System: Case Study of Myanmar. Accessed on 24 October 2018 at

www.erm.com Version: 1.0 Project No.: 0439461 Client: TTCL Power Myanmar Company Limited (TPMC) 2 September 2019 Page 378

<sup>&</sup>lt;sup>64</sup> The 2014 Myanmar Population and Housing Census (Thematic report on education). Accessed on 24 October 2018 at https://reliefweb.int/sites/reliefweb.int/files/resources/4G\_Labour%20Force%209JUNE\_forWEB.pdf

https://www.pic.org.kh/images/2017Research/20170523%20Education\_Reform\_Myanmar\_Eng.pdf

of schools is 2,717 schools, which include 198 high schools, 225 middle schools and 2,264 primary schools<sup>66</sup>. MIMU data show, in 2014, that majority of citizens accomplished primary schools (*Table 5.91*).

# 5.2.9.2 Seikgyikanaungto Township

In 2014, literacy rate was recorded at 97%, consisting of literacy rate of men (98.5%) and of women (95.6%)<sup>45</sup>. In this township, there were 17 schools, comprising 14 primary schools, 2 middle schools and 1 high school<sup>67</sup>. The majority of population in this township achieved primary education (*Table 5.91*). Primary data shows that in 2018, majority of interviewees also finished high school (*Table 5.92*). Data from focus group discussion with women shows that they perceived that girls are more educated than boys.

# 5.2.9.3 Ahlone Township

In 2014, literacy rate of men and of women were 99.2% and 97.9% respectively. In combination, literacy rate is 98.5%<sup>55</sup>. In Ahlone, there were 17 schools, comprising of 9 primary schools, 2 middle schools, and 6 high schools<sup>67</sup>. As provided in *Table 5.91*, in this township, majority of citizens graduated from university/ college. Based on information from focus group discussion with women, girls are perceived to be more educated than boys.

# 5.2.9.4 Dala Township

In 2014, literacy rate was recorded at 93.1%, comprising of literacy rate of men (95.6%) and of women (90.8%). In Dala, there were 73 schools, comprising of 61 primary schools, 8 middle schools and 4 high schools<sup>67</sup>. As shown in **Table 5.91**, the majority of Dala citizens accomplished primary schools. **Table 5.92** indicates, in 2018, that majority of interviewees in Dala accomplished middle school. Data from focus group discussion with women show that they perceive girls are more educated than boys.

Levels of education completed	Yangon region	Dala Township	Seikgyikanaungto Township	Ahlone Township
None	243,812	10,048	805	718
Primary school (Grade 1 – 5)	1,324,522	42,801	8,103	4,995
Middle school (Grade 6 – 9)	978,392	20,560	4,832	6,365
High school (Grade 10 – 11)	751,724	9,743	2,270	8,052
Diploma	18,254	144	19	242
University / college	729,473	6,407	1,292	12,420
Post-graduate and above	43,947	187	73	969
Vocational training	9,746	62	8	142

# Table 5.91: Levels of Education Completed by Population (2014)

<sup>&</sup>lt;sup>66</sup> Total Number of Government Schools in States/Regions. Accessed on 24 October 2018 at

 $https://relief web.int/sites/relief web.int/files/resources/Sector\_Map\_Edu\_Government\_Schools\_in\_ST-int_schools\_int_schools\_int\_schools\_$ 

RGN\_2014\_MIMU1479v01\_7Nov2016\_A4.pd

<sup>&</sup>lt;sup>67</sup> Number of Basic Education School in Yangon Region. Accessed on 24 October 2018 at

https://reliefweb.int/sites/reliefweb.int/files/resources/Number%20of%20Basic%20Education%20School%20in%20Yangon%20 Region.pdf

Levels of education completed	Yangon region	Dala Township	Seikgyikanaungto Township	Ahlone Township
Others	42,723	556	371	166

Source: The 2014 Myanmar Population and Housing Census (Yangon Region)<sup>51</sup>

Note: The number in the table represents number of population aged 25 years old and over.

# Table 5.92: Level of Education Completed by Population (2018)

Levels of education completed	Dala Township	Seikgyikanaungto Township	Ahlone Township
None	6.5%	9.4%	9.9%
Illiterate	-	-	0.5%
Kindergarten	2.9%	2.1%	0.5%
Primary school (Grade 1 – 5)	25%	21.6%	15.4%
Middle school (Grade 6 – 9)	30%	27.3%	18.8%
High school (Grade 10 – 11)	21.2%	30.2%	31.7%
University / college	10.9%	9.4%	23.3%
Monastery	3.5%	-	-

Source: ERM, 2018.

Notes: In questionnaire, senior high school and junior high school choices are given instead of middle school and high school. Percentage for university/ college is the result of combination between percentage of university, graduate and college as selected by interviewees in questionnaires.

# 5.2.10 Health, Health Facilities, and Security

# 5.2.10.1 Myanmar

The Department of Health in Myanmar is responsible for providing health services to all population in the country<sup>68</sup>. In 2013, the Irrawaddy published in an article that "patients in the government's public hospitals have been forced to foot the bill" by giving Yangon General Hospital as an example for requiring patients to pay a bill for equipment, used during their treatment<sup>69</sup>. UNDP (United Nations Development Programme) similarly reports that citizens in Yangon bear more than 80% of costs on health services at public health care facilities<sup>53</sup>. Consequently, many citizens tend to fly to other countries in order to receive accurate diagnosis and treatment since they cannot get correct diagnosis and treatment at hospitals and health care centres in the country<sup>69</sup>. Moreover, in Myanmar, main diseases and health problems consist of tuberculosis, underweight in children, malnutrition, Malaria, and AIDs<sup>70</sup>.

<sup>70</sup> Health, Health Care and Diseases in Myanmar. Accessed on 24 October 2018 at http://factsanddetails.com/southeastasia/Myanmar/sub5\_5f/entry-3118.html

<sup>&</sup>lt;sup>68</sup> Health in Myanmar 2012. Accessed on 24 October 2018 at

http://mohs.gov.mm/ckfinder/connector?command=Proxy&lang=en&type=Main&currentFolder=%2FPublications%2FHealth%2 0In%20Myanmar%2F&hash=a6a1c319429b7abc0a8e21dc137ab33930842cf5&fileName=Health%20in%20Myanmar%20(2012).pd

<sup>&</sup>lt;sup>69</sup> Myanmar Patients Pays The Price. Accessed on 24 October 2018 at

https://www.irrawaddy.com/news/environment/myanmar-patients-pay-the-price.html

# 5.2.10.2 Yangon Region

In 2016, in Yangon region, there were 85 hospitals, 11,610 sanctioned beds, 12,260 available beds, 527,308 admissions, 525,851 discharges and deaths, 3,537,276 patient days, 16,656 numbers of death, hospital death rate at 3.2%, and 2,516,767 out-patient attendance. Here, hospital death rate is the calculation between number of deaths, and number of discharges and deaths<sup>71</sup>. Sanctioned bed is the official bed capacity of the hospital<sup>72</sup>. Regarding to health facilities and hospitals, almost 70 percent of children in Yangon are born in health facilities<sup>50</sup>. **Table 5.93** shows that in 2016, there were fifteen health conditions that caused Yangon citizens to use hospital services.

Causes of hospitalization	Number of population
Single spontaneous delivery	36,567
Other cataract	19,352
Other and unspecified injuries of head	18,080
Single delivery by caesarean section	15,662
Diarrhoea and gastroenteritis of presumed infectious origin	14,713
Mental and behavioural disorders due to use of alcohol	12,418
Viral infection of unspecified site	11,160
Neonatal jaundice from other and unspecified causes	10,107
Gastritis and duodenitis	8,079
Unspecified abortion	7,324
Pneumonia, organism unspecified	7,165
Stroke, not specified as haemorrhage or infarction	6,911
Unspecified mood [affective] disorder	6,608
Respiratory tuberculosis, not confirmed bacteriologically or histologically	6,135
Acute appendicitis	5,795
All other Causes	339,775

#### Table 5.93: Causes of Hospitalization in Yangon Region

Source: Hospital Statistics Report 2014-1671

Most of health problems in Yangon region are related to the aforementioned national health issues. In 2017, number of Yangon patients with tuberculosis and being treated under the National Tuberculosis Programme, was more than 32,000 persons<sup>73</sup>.

UNICEF reports that in 2015, 24% of children in Yangon region experienced stunting, while 20% and 8% of them were underweight and wasting respectively<sup>50</sup>. WHO wrote, "stunting is the impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate

<sup>&</sup>lt;sup>71</sup> Hospital Statistics Report 2014-16. Accessed on 24 October 2018 at

https://themimu.info/sites/themimu.info/files/documents/Report\_Hospital\_Statistics\_Report\_2014-16\_MOHS\_Jun2018.pdf

<sup>&</sup>lt;sup>72</sup> Hospital Statistics. Accessed on 24 October 2018 at https://www.slideshare.net/zulfiquer732/hospital-statistics-79835548

<sup>&</sup>lt;sup>73</sup> TB Still A Serious Threat, Says Doctors. Accessed on 24 October 2018 at https://www.mmtimes.com/news/tb-still-serious-threat-say-doctors.html

psychosocial stimulation<sup>74</sup>. Wasting is "a symptom of acute undernutrition, usually as a consequence of insufficient food intake or a high incidence of infectious diseases, especially diarrhoea<sup>75</sup>.

Apart from that, 5.7% of Yangon households had at least one insecticide-treated net.

In Yangon region, HIV prevalence was 24.6%, causing this region to be recognized as one of locations with the highest percentage of HIV prevalence in the Southeast Asia Pacific region<sup>76</sup>. The study shows that even though 76.4% of women and 81.7% of men in Yangon acknowledge where they can get diagnosis for HIV, 76.6% of women and 67.3% of men never tested for HIV. They also have knowledge, regarding to HIV/AIDs-preventative methods, including of using condoms and limiting sexual intercourse to one uninfected partners<sup>76</sup>.

In 2015, Yangon region was one of locations with the lowest rate in infant mortality in the country – 44 per 1000 live births<sup>51</sup>. Only 67% of total children aged of 12 to 23 year old in Yangon received all basic vaccinations, which are referred to one dose each of BCG and measles, and three doses each of DPT-containing vaccine and polio<sup>77</sup>. Around 18% of admissions in the Yangon Children's Hospital is due to diarrhoea<sup>78</sup>. During FGD with health officer, senior nurse and medical officer, it was found that in Dala, Seikgyikanaungto, and Ahlone townships, most of citizens are vaccinated at childbirth.

Moreover, in this region, there are four forms of disabilities (*Table 5.94*). Among them, visual issues was the most dominant type of disability.

Types of disabilities	Yangon region	Dala Township	Seikgyikanaungto Township	Ahlone Township
Visual	125,844	3,574	825	484
Locomotion	109,976	2,974	665	807
Memory	78,895	2,045	425	470
Hearing	62,748	1,634	381	432

#### Table 5.94: Disabilities

Source: The 2014 Myanmar Population and Housing Census (Yangon Region).<sup>51</sup>

# 5.2.10.3 Seikgyikanaungto Township

In Seikgyikanaungto Township, based on **Table 5.94**, majority of disabled people are dealing with visual disability. However, **Figure 5.49** shows that 84.5% of interviewees have a good health status. In addition to dengue fever outbreaks during rainy season, fever is the disease that most of interviewees have dealt with (**Table 5.95**). None of interviewees had diarrhea last year. Women in Seikgyikanaungto faced several main problems, including cervical cancer, diabetes and hypertension.

In the township, traditional/ private/ mobile clinics can be found. Interviewees travel to these clinics by walking because average distance between their houses and clinics is around 0.6 km. Moreover, township/ station hospitals are available in this township. Citizens reach there by riding a bike or using

https://www.who.int/nutrition/nlis\_interpretation\_guide.pdf

https://dhsprogram.com/pubs/pdf/FR324/FR324.pdf

<sup>&</sup>lt;sup>74</sup> Nutrition (Stunning In A Nutshell). Accessed on 12 March 2019 at

https://www.who.int/nutrition/healthygrowthproj\_stunted\_videos/en/

<sup>&</sup>lt;sup>75</sup> Country Profile Indicators (Interpretation Guide). Accessed on 12 March 2019 at

<sup>&</sup>lt;sup>76</sup> HIV and AIDs in Myanmar. Accessed on 24 October 2018 at https://www.avert.org/professionals/hiv-around-world/asia-pacific/myanmar

<sup>&</sup>lt;sup>77</sup> Myanmar 2015-16 Demographic and Health Survey (Key Findings). Accessed on 24 October 2018 at

<sup>&</sup>lt;sup>78</sup> Diarrhea Among Children Under Five In Myanmar: A Systematic Review. Accessed on 12 March 2019 at https://tci-thaijo.org/index.php/jhealthres/article/download/78346/62760/

trishaw with average distance of 0.8 km. Some of interviewees visit doctors at Yangon Child Hospital by using boat services.

# 5.2.10.4 Ahlone Township

In Ahlone Township, **Table 5.94** shows that from four types of disability, the main one is locomotion issues. *Figure 5.49* shows that 94.1% of interviewees have a good health conditions, but some of them experience diabetes **Table 5.95**. It was also found that none of the interviewees had dealt with diarrhea last year.

In this township, there are three hospitals, consisting of the Academy Hospital, the West Yangon General Hospital<sup>79</sup> and the Yangon Children Hospital<sup>80</sup>. Apart from this, traditional/ private and mobile clinics can also be found. Interviewees walk, drive a car or use bus services to see a doctor in these clinics. Average distance between their houses and those places is approximately 0.9 km. In addition, township/ station hospitals are also available in the township. To see a doctor at these hospitals, interviewees walk around 1 km.

# 5.2.10.5 Dala Township

**Table 5.94** indicates that the largest number of disabled people are dealing with visual disability. As shown in *Figure 5.49*, 95.3% of interviewees have good health condition. Among various diseases occurring, fever is the main disease that most of them have encountered (*Table 5.95*). Moreover, main health problems, faced by women in Dala Township consist of cancer, sexually transmitted infections (HIV and AIDs), and lack of nutrition. Dengue fever outbreak have been experienced from June until July. However, none of interviewees experienced with diarrhea last year.

In this township, rural/ sub-rural health centers can be found. Interviewees go there by walking, and riding motorbike in order to see a doctor. Average distance between their houses and those centers is approximately 0.4 km. There are also traditional and private clinics, where interviewees visit by riding motorbike/ motorcycle or walking. Average distance between their houses and those clinics is approximately 2.7 km. Moreover, township/ station hospital is another alternative that interviewees ride motorbike in order to go to those hospitals. Average distance between their houses and those hospitals is around 10.4 km. Other hospitals in Yangon region consist of Yangon hospital, Parrami clinic, SSC hospital and N/Oak hospital, where interviewees use bus services and transport via waterway to visit those places. Average distance between their houses is approximately 9.1 km.

Based on primary data, the main problem that women in the township experience is related to security issue from drunkard persons as there are many pubs in the surrounding areas, beer restaurants and market of illegal drugs. Another cause of insecurity is the lack of facilities, including lighting infrastructure, and bridge. Concurrently, causes of deaths in men are diseases associated with drinking alcohol, which leads to other impacts including income issues and conflict between family members. However, causes of deaths in women are breast cancer and cervical cancer.

<sup>&</sup>lt;sup>79</sup> Healthcare. Accessed on 24 October 2018 at https://www.myanmore.com/2015/02/healthcare/

<sup>&</sup>lt;sup>80</sup> Medical Assistance. Accessed on 24 October 2018 at https://mm.usembassy.gov/u-s-citizen-services/doctors/



Figure 5.49: Health Status

Source: ERM, 2018.

Table 5.95: Diseases in	n the Last 6 Months
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	Percentage (%)		
Name of disease	Dala Township	Seikgyikanaungto Township	Ahlone Township
High blood pressure	16.7	8.3	-
Women disease	2.8	-	-
Kidney	2.8	-	-
Diabetes	5.6	-	30.8
Respiratory tract infection	5.6	8.3	-
Autism	2.8	-	-
Neutral	2.8	-	-
Fever	38.9	16.7	15.4
Gout	5.6	4.2	7.7
Bronchitis	5.6	4.2	-
Heart disease	5.6	8.3	15.4
Stomach	2.8	8.3	-
Diarrhea	-	4.2	-
Eye disease	-	8.3	-
Tuberculosis	-	4.2	7.7
Paralytic stroke	-	12.5	-

	Percentage (%)			
Name of disease	Dala Township	Seikgyikanaungto Township	Ahlone Township	
Indigestion	-	4.2	-	
Cancer	-	4.2	-	
Critical disease	-	4.2	-	
Skin rash/ itches	-	-	15.4	
Hepatitis	-	-	7.7	
Others	2.8	-	-	

Source: ERM, 2018.

# 5.2.11 Infrastructure, and Amenities

# 5.2.11.1 Infrastructure

### Yangon Region

Yangon has various transport infrastructures, including port, Thilawa deep-water port, airport, roads, bridges, flyovers, highway and Twantay Canal, which connects Yangon River with Irrawaddy River. Importantly, Yangon is the terminus of five railway lines<sup>53</sup>. There are number of roads, connecting Yangon region with other regions in Myanmar as well<sup>81</sup>. In addition, it is reported that rural access index of Yangon is 60%. According to Asian Development Bank, the rural access Index (RAI) is "an internationally used indicator that shows the portion of the rural population that lives less than 2 km away from an all-season road"<sup>82</sup>.

# Seikgyikanaungto Township

In Seikgyikanaungto Township, there is one road connecting to the rest of city. This road starts from Hlaingtharyar Township and passes through Twantay Township. There is also the bridge, allowing citizens to cross from Seikgyi to Kanaungto. Harbour where boats from other areas, including Maw Tin Harbour or Wardan Jetty will dock can also be found<sup>46</sup>. Moreover, *Figure 5.50* shows that majority of interviewees (60%) stated that type of road surface is concrete. Some of them have paved road connecting to their houses. Overall quality and condition of transportation system of this township is mostly good.

# Ahlone Township

In Ahlone Township, there are four main roads – Baho Road, Heavy-Duty Vehicle Commercial Bypass Road, Kyimyindine Kannar Road, and Ahlone Road<sup>83</sup>.Yangon circular train can be also found on Ahlone road<sup>84</sup>. Along the road, there are total five bus stops. Ahlone Post Office is located near to Ahlone post office bus stop<sup>49</sup>. Ahlone Township also has nine streets as listed below:

- 1. Min Street;
- 2. Pa-Day-Thar Street;

<sup>&</sup>lt;sup>81</sup> Myanmar Road Network. Accessed on 24 October 2018 at

https://dlca.logcluster.org/display/public/DLCA/2.3+Myanmar+Road+Network

<sup>&</sup>lt;sup>82</sup> Rural Road And Access. Accessed on 24 October 2018 at https://www.adb.org/sites/default/files/publication/189079/myarural-roads.pdf

<sup>&</sup>lt;sup>83</sup> Ahlone Street. Accessed on 24 October 2018 at https://myanmar-streets.openalfa.com/streets?q=AHLONE

<sup>&</sup>lt;sup>84</sup> Circular Train, The Cheapest Way to See Yangon. Accessed on 24 October 2018 at http://yangon-rangoon.com/yangoncircular-train.html
- 3. Shan Yeik Thar Street;
- 4. Sin Yae Kan Street;
- 5. Tha-Mar-Daw Street;
- 6. Thakhin Mya Garden Street;
- 7. Theint De Street;
- 8. U Lu Maung Street; and
- 9. Yama Street<sup>83</sup>.

As shown in *Figure 5.50*, majority of interviewees (72.5%) stated that type of road surface is concrete. Some of them have paved road that connects to their home. Overall quality and condition of transportation system of this township is good.

In the area of Ahlone, three ports can be found near to the Yangon River. Those ports are Asia World Port Terminal<sup>85</sup>, Myanmar Industrial Port (MIP)<sup>86</sup> and Ahlone International Port Terminal (A.I.P.T)<sup>87</sup>. Four wharfs can also be discovered as well<sup>86</sup>.

#### Dala Township

Within Dala Township, there is a road and Dala pier, in which ferries from Pansodan Pier of Yangon will dock, and passenger will embark<sup>88</sup>. Dala pier can be also called as Dala Ferry Terminal, in which ferries transport approximately 30,000 passengers daily<sup>89</sup>. There is a plan for bridge construction in Dala Township, which is being on process since 2016 until 2020<sup>90</sup>. *Figure 5.50* shows that majority of interviewees (92.5%) stated that type of road surface is concrete. Some of them have paved road that connects to their houses. Overall quality and condition of transportation system of this township is good.

<sup>&</sup>lt;sup>85</sup> Asia World Port Terminal. Accessed on 24 October 2018 at http://www.yangondirectory.com/en/categories-index/yangon-region/ahlone/716-ports/L456\_00000000\_asia-world-port-terminal\_16851

<sup>&</sup>lt;sup>86</sup> Yangon port. Accessed on 24 October 2018 at http://www.mpa.gov.mm/yangon-port

<sup>&</sup>lt;sup>87</sup> Ports in Yangon, Myanmar. Accessed on 24 October 2018 at http://www.globalmarsshipping.com/ports-in-ygn.htm

<sup>&</sup>lt;sup>88</sup> Day Trip to Dala Village near Yangon, Myanmar. Accessed on 24 October 2018 at https://drifterplanet.com/dala-village-nearyangon-myanmar/

<sup>&</sup>lt;sup>89</sup> The Project for the Strategic Urban Development Plan of the Greater Yangon (Final Report I). Accessed on 24 October 2018 at http://open\_jicareport.jica.go.jp/pdf/12122529\_03.pdf

<sup>&</sup>lt;sup>90</sup> The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar (Final Report). Accessed on 24 October 2018 at http://open\_jicareport.jica.go.jp/pdf/12230728\_02.pdf





Source: ERM, 2018.

#### 5.2.11.2 Amenities

#### Yangon Region

From certain proportions of Myanmar citizens, who are aged of 15 and above have access to internet, those in Yangon access internet more frequently than those in other regions because 42% of Yangon population used internet in last 7 days, but 37% of them used internet daily in last 7 days<sup>61</sup>. As shown in *Table 5.96*, majority of Yangon households widely own smartphones.

Among various regions of Myanmar, Yangon is the location with the highest percentage of households, owing computers (10.9%)<sup>61</sup>.

#### Seikgyikanaungto Township

53.3% of interviewees have access to the internet. **Table 5.97** shows that in this township, cell phone is the widest available amenity in households.

#### Ahlone Township

In this township, 80% of interviewees have access to the internet. Based on *Table 5.97*, majority of households own cell phone.

#### Dala Township

73.42% of interviewees have access to the internet. Cell phone is widely owned by majority of Dala citizen (*Table 5.97*).

Types of amenities	Households in Yangon region
Smart phone	91%
Television	75%
Rice cooker	73%
Electric fan	68%
Refrigerator	43%
Charcoal stove	42%
Gas stove	17%
Air conditioner	16%
Keypad phone	11%
Car	10%

# Table 5.96: Amenities in Yangon

Source: The 2017 Myanmar Living Conditions Survey.<sup>61</sup>

Note: above percentage for each type of amenity is individually calculated from total percentage of households

## Table 5.97: Amenities in Dala, Seikgyikanaungto, and Ahlone Townships

Types of amenities	Percentage (%)									
	Dala township	Seikgyikanaungto Township	Ahlone Township							
Digital TV	22.1	20.1	16.7							
Cell phone	52.9	51.5	54							
Landline	0.6	1.5	2.5							
Air Conditioner	0.9	3	6.3							
Laundry Machine	2.1	5.2	4.2							
Sewing Machine	6.6	5.2	1.7							
Gas Cooker	5.1	1.5	2.5							
Refrigerator	9.7	11.9	12.1							

Source: ERM, 2018.

# 6. IMPACT ASSESSMENT METHODOLOGY

#### 6.1 Introduction

This Chapter presents the methodology used to conduct the ESIA. The ESIA methodology follows the overall approach illustrated in *Figure 6.1*. The ESIA has been undertaken following a systematic process that evaluates the potential impacts the Project could have on aspects of the physical, biological, social/ socioeconomic and cultural environment; identifies preliminary measures that the Project will take to avoid, minimise/reduce, mitigate, offset or compensate for potential adverse impacts; and identifies measures to enhance potential positive impacts where practicable.





Source: ERM, 2019.

This section also details the methodology applied in the collection and analysis of primary and secondary data used in this report. Primary and secondary information from TPMC, government sources, non-government organizations (NGOs) and other Project-related stakeholders have been collected to support the preparation of this report.

# 6.2 Screening

At the initial stage of the ESIA, preliminary information was provided to aid in the determination of what legal and other requirements apply to the Project. This step was conducted utilising a high level description of the Project and its associated facilities.

#### 6.3 Scoping

The Scoping study was undertook as a means to ensure that there is a focus on the issues that are most important for Project planning, decision-making and stakeholder interests. During the scoping study, potential interactions between the Project, environmental and human resources/receptors were identified, and prioritised in terms of their potential to cause impacts of concern. **Table 6.1** presents the resources/receptors considered in the scoping stage, together with the changes that might indicate a potential Project-related impact.

In addition, it shall be noted that the Scoping Report for this Project has been prepared and submitted to ECD on 27<sup>th</sup> January 2019.

Resources/Receptors	Changes that May Indicate Potential Impacts						
Environmental							
Geology	Changes to geology, geomorphology, topography						
Soil	Changes to physical and chemical properties and soil ecology						
Surface Water	Changes to physical, chemical or biological quality of rivers and other surface water bodies; Introduction of exotic species, changes in habitat quality, abundance, diversity; Effluent discharge						
Groundwater	Contamination of shallow or deep groundwater resources, change in ground water resources						
Fisheries	Changes in fisheries productivity						
Vegetation	Changes to vegetation population, health, species abundance and diversity and impact on endangered and economic species, food chain effects						
Wildlife	Changes to wildlife assemblages, impact on endangered and economic species, food chain effects						
Air	Emissions of NOx, SOx, PM, CO, VOC, greenhouse gases (CO <sub>2</sub> , CH <sub>4</sub> , and N <sub>2</sub> O), ozone, TSP etc.						
Noise and Vibration	Change in noise or vibration levels						
Aesthetics	Physical presence of facilities, increased night time light						
Waste	Generation of wastes - hazardous and non-hazardous						
Social / Socioeconomic							
Population and physical displacement	Changes in total population, gender ratio, age distribution. Physical displacement from residence as a result of Project land take, or activities						
Social and Cultural Structure	Disruption in local authority and governance structure; change in social behaviours; alterations to social and cultural networks; intra and inter-ethnic conflict						
Economy and employment	Change in national/local economy, employment, standard of living, occupation						

#### Table 6.1: Resources/Receptors and Potential Impacts Considered in Scoping

Resources/Receptors	Changes that May Indicate Potential Impacts
Resource ownership and use	Temporary or permanent restriction for accessing or using land or water, changes in livelihood activities based on natural resources; changes in ownership of such resources.
Cultural Resources	Physical disturbance of shrines, burial grounds, archaeological resources or other desecration or change in access to cultural resources, rituals or celebrations carried out in their premise.
Education and skills	Change in availability or quality of education or skills provision, supply and demand in certain skill sets etc.
Infrastructure and public services	Improvement or pressure on existing urban/rural infrastructure or services including: transportation; power, water, sanitation, security, waste handling facilities etc.
Community Health and Safety	·
Mortality and Key Health Indicators	Change in the mortality profile of the community; changes in life expectancy, birth rates, death rates, maternal mortality rates etc.
Environmental Change	Decreased air quality (e.g. NOx, SOx, VOC, CO, PM), contamination of surface waters and potable ground water, increased vibration and noise, increased night time light beyond acceptable limits, changes to the visual environment.
Communicable and Non Communicable Diseases	Change in incidence and /or prevalence of communicable and non-communicable diseases or disease causing factors
Vector Borne Diseases	Changes in the incidence and or prevalence of vector borne diseases, the density of these vectors and their breeding grounds.
Sexually Transmitted Diseases	Changes in the incidence and /or prevalence of sexually transmitted diseases and the factors that contribute to this (external workforce, transport routes etc.)
Nutritional Status	Changes to nutritional status and food security
Health Care/ Recreational Facilities	Changes in availability of and access to health care and recreational facilities including green space
Psychosocial /Lifestyle Factors	Drug use/abuse, prostitution, communal violence, crime, suicide and depression; changing expectations of quality of life
Community Safety	Risk to community safety from gas leaks from the gas supply pipeline

# Table 6.2: Scoping Matrix

	Resource/ Receptors	Physi	ical										Ecolo					Socio	-acon	omic						
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		(SHG)			tion									λĒ					ort		afety		0			
Project Activity Materials       Project Activity Materials <td< td=""><td></td><td>ding (</td><td></td><td>ofile</td><td>isodu</td><td></td><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>colo</td><td></td><td></td><td></td><td></td><td>ransp</td><td>ţŊ</td><td>nd Sa</td><td></td><td>tilities</td><td>t</td><td></td><td></td></td<>		ding (		ofile	isodu		0							colo					ransp	ţŊ	nd Sa		tilities	t		
		inclu		s/ Pr	/ Con	ity	egime		isual		ç	ion	۲	artic E					c & T	Safe	alth ai	Use	and u	men		
		nge (		ature	uality,	Qual	nic R	L	V bue		inatio	/ibrat	colog	Aqua		a		/ities	Traffi	n and	al Hea	River	lities	place	tage	
		Cha	lity	d Fe	nt Ql	ater	/nam	watei	ape a	sion	itami	V pue	ial E	ater/	ves	Faun	B	Activ	L /uoi	lealt	tiona	se/F	facil	al Dis	Heri	ment
Proper Adversaries       Proper Ad		mate	Qua	/erbe	dime	/er W	drod	puno	ndsca	il Ero	il Cor	oise a	rrestr	shwi	angro	ıra &	ifaun	hing	vigat	blic F	cupa	nd U	isting	ysica	ltural	Yolqr
with a control and a second and a second a sec	Project Activity/ Hazards	CI	Air	R'n	Se	Riv	H	Ū	La	So	So	ž	Те	Fre	Ma	Flo	Av	Fis	Na	Ρn	ő	Lai	Ex	РЧ	Ü	Ш
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Note storage and deposed (haundoub) Power Merican Construction   Power Merican Construction Power Merican Construction   Power Name Construction Power Name Construction   Power Name Construction <td< td=""><td>Waste storage and disposal (non-hazardous)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	Waste storage and disposal (non-hazardous)																									
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Reprint of Way Clearance & Access Roads Image: Clearance &	Gas Pipeline Construction																									
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hydrostatic Testing I <td>Open cut</td> <td></td>	Open cut																									
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LNG Reaciving Facilities Construction       Equipment Material worker transport       Image: Construction of the cons	Rehabilitation on surface																									
Equipment/material/worker transport Image: solution and discharges	LNG Receiving Facilities Construction												_													
Vessel anchoring I	Equipment/ material/ worker transport																									
Vessel anchoring Image: Construction exclusion zone Image: Construction exclusion	Vessel operational discharges																									
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Disposal of dredged materials       Image: Control of the control of th	Berth construction (eg piling, dredging, reclamation)																									
Labor equipment services supply       Image: Control of the control of	Disposal of dredged materials																									
Operation of power plant/turbine       Image: Strategy and Disposal       Image: Strategy and Disposal <td>Labour, equipment &amp; services supply</td> <td></td>	Labour, equipment & services supply																									
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Storm water discharge and run-off on site       I </td <td>Waste Storage and Disposal</td> <td></td>	Waste Storage and Disposal																									
Structure at site       Image: Structure at si	Storm water discharge and run-off on site																									
Unplanned events (spill, uncontrolled releases)       Image: Control of the control of	Structure at site																									
Cooling water withdrawal       Image: Cooling Water Discharge to River	Unplanned events (spill, uncontrolled releases)																									
Operation & Cooling Water Discharge to River       Image: Cooling Water Discharge	Cooling water withdrawal																									
Gas Pipeline Operation       Regular Maintenance       Image: Constraint of the constrain	Operation & Cooling Water Discharge to River																									
Regular Maintenance       Image: Constraint of the set of t	Gas Pipeline Operation																									
Unplanned events (Leaks, uncontrolled release)       Image: Controlled rel	Regular Maintenance																									
LNG Receiving Facilities Operation         Flaring, venting & fugitive emissions         River Water Intake (for Re-gasification process)         Operational of LNGC - River traffic	Unplanned events (Leaks, uncontrolled release)																									
Interruption of LNGC - River traffic     Interruption     Int	LNG Receiving Facilities Operation																									
Operational of LNGC - River traffic	River Water Intake (for Re-gasification process)																									
	Operational of LNGC - River traffic																									

LNGC Vessel operational discharges																	
LNGC Vessel anchoring																	1
FLNG discharges to River (ie. produced water, cooling water etc)																	
Facilities presence at site and Safety Zone																	
Lighting for night time operation / navigational safety																	
Labour, equipment & services supply																	
Waste storage and disposal (non-hazardous)																	
Waste storage and disposal (hazardous)																	
Unplanned events/ spills/ dropped objects																	
Кеу																	
An interaction is not reasonably expected (white) An interaction is reasonably possible but the resulting impact is unlikely to lead to significant effects (grey) An interaction is reasonably possible and the resulting impact is likely to lead to an effect that is significant (black)																	

Source: ERM, 2018.

#### 6.4 **Project Description**

In order to set out the scope of the Project features and activities, with particular reference to the aspects which have the potential to impact the environment, a Project Description has been prepared. Details of the Project facilities' design characteristics, as well as planned and possible unplanned Project activities, are provided in *Chapter 4* of this ESIA Report.

#### 6.5 **Baseline Conditions**

To provide a context within which the impacts of the Project can be assessed, a description of physical, biological, social / socioeconomic and cultural conditions that would be expected to prevail in the absence of the Project is presented. The Baseline includes information on all resources/receptors that were identified during scoping as having the potential to be significantly affected by the Project.

The baseline characterization is reported in *Chapter 5* of this Report.

## 6.6 Stakeholder Engagement

An effective ESIA Process requires engagement with relevant stakeholders throughout the key stages. This assists in understanding stakeholder views on the Project and in identifying issues that should be taken into account in the prediction and evaluation of impacts.

Stakeholder Engagement activities have been undertaken for this Project and these are presented in *Chapter 13* of this Report.

#### 6.7 Impact Assessment

Impact identification and assessment starts with scoping and continues through the remainder of the ESIA Process covering all phases of the Project from Pre-construction to Post-closure. The principal ESIA steps are summarized in *Figure 6.2* and comprise:

- Impact Prediction: to determine what could potentially happen to resources/receptors as a consequence of the Project and its associated activities;
- Impact Evaluation: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor;
- Mitigation and Enhancement: to identify appropriate and justified measures to mitigate potential negative impacts and enhance potential positive impacts; and
- Residual Impact Evaluation: to evaluate the significance of potential impacts assuming effective implementation of mitigation and enhancement measures.



#### Figure 6.2: Impact Assessment Process

## 6.7.1 Prediction of Impacts

Prediction of impacts is essentially an objective exercise to determine what is likely to happen to the environment as a consequence of the Project and its associated activities. From the potentially significant interactions identified in Scoping, the impacts to the various resources/receptors are elaborated and evaluated. The diverse range of potential impacts considered in the ESIA process typically results in a wide range of prediction methods being used, including quantitative, semiquantitative and qualitative techniques.

#### 6.7.2 Evaluation of Impacts

Once the prediction of potential impacts is complete, each potential impact is described in terms of its various relevant characteristics (e.g., type, scale, duration, frequency, extent). The terminology and designations used to describe impact characteristics are shown in *Table 6.3*.

Characteristic	Definition	Designations
Туре	A descriptor indicating the relationship of the potential impact to the Project (in terms of cause and effect).	<ul><li>Direct</li><li>Indirect</li><li>Induced</li></ul>
Extent	The "reach" of the potential impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	<ul><li>Local</li><li>Regional</li><li>International</li></ul>
Duration	The time period over which a resource / receptor is potentially affected.	<ul><li>Temporary</li><li>Short term</li><li>Long term</li></ul>
Scale	The size of the potential impact (e.g., the size of the area with the potential to be damaged or impacted, the fraction of a resource that could potentially be lost or affected, etc.).	[no fixed designations; intended to be a numerical value or a qualitative description of "intensity"]

Fable 6.3: Impa	t Characteristics	Terminology
-----------------	-------------------	-------------

Characteristic	Definition	Designations
Frequency	A measure of the constancy or periodicity of the potential impact.	[no fixed designations; intended to be a numerical value or a qualitative description]

The definitions for the *type* designations are shown in **Table 6.4.** Definitions for the other designations are resource/receptor-specific, and are discussed in the resource/receptor-specific impact assessment chapters presented later in this Report.

# Table 6.4: Impact Type Definitions

Туре	Definition
Direct	Potential impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Potential impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Potential impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).

The above characteristics and definitions apply to planned and unplanned events. An additional characteristic that pertains <u>only to unplanned events</u> is *likelihood*. The *likelihood* of an unplanned event occurring is designated using a qualitative scale, as described in **Table 6.5**.

# Table 6.5: Definitions for Likelihood Designations

	Likelihood	Definitions
1	Incidental	Very unlikely, not known in the industry.
2	Minor	Unlikely to occur but known of in the industry.
3	Moderate	Likely to occur once or more in life of the Project.
4	Major	Likely to occur once or twice per year.
5	Severe	Will likely occurs more than twice per year, or is continuous or certain to occur.

Once impact characteristics are defined, the next step in the impact assessment phase is to assign each potential impact a 'magnitude'. Magnitude is typically a function of some combination (depending on the resource/receptor in question) of the following impact characteristics:

- Extent;
- Duration;
- Scale; and
- Frequency.

For unplanned events, impact 'consequence' is used instead of Magnitude. Although determining the Consequence uses the same impact characteristics as of Magnitude, additional characteristics are considered based on the definitions provided for the physical, biological, and social environment, as shown in *Table 6.6*.

	Incidental	Minor	Moderate	Major	Severe
Physical Environment	Impacts such as localised or short term effects or environmental media, meeting all environmental standards	Impacts such as widespread, short-term impacts to environmental media, meeting all environmental standards	Impacts such as widespread, long-term effects on environmental media, meeting all environmental standards	Impacts such as significant, widespread and persistent changes in environmental media OR Exceedance of environmental standards	Exceedance of environmental standards and fine/ prosecution
Biological Environment	Impacts such as localised or short term effects on habitat or species	Impacts such as localised, long term degradation of sensitive habitat or widespread, short-term impacts to habitat or species	Impacts such as localised but irreversible habitat loss or widespread, long-term effects on habitat or species	Impacts such as significant, widespread and persistent changes in habitat or species	Impacts such as persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.
Social Environment	Slight, temporary, adverse impact on a few individuals	Temporary (<1 year), adverse impacts on community which are within international health standards	Adverse specific impacts on multiple individuals that can be restored in <1 year OR One or more injuries, not lost-work injuries.	Adverse long-term, multiple impacts at a community level, but restoration possible. OR One or more lost-work injuries to a member of the public including permanently disabling injuries.	Adverse long-term, varied and diverse impacts at a community level or higher – restoration unlikely. OR Fatalities of public.

# Table 6.6: Impact Scale of Consequence for Unplanned Events

Source: ERM.

Magnitude essentially describes the intensity of the change that is predicted to occur in the resource/receptor as a result of the potential impact. The magnitude designations themselves are universally consistent, but the definitions for these designations vary depending on the resource/receptor. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

In the case of a potential positive impact, no magnitude designation (aside from 'positive') is assigned. It is considered sufficient for the purpose of the ESIA to indicate that the Project is expected to result in a potential positive impact, without characterizing the exact degree of positive change likely to occur.

In the case of potential impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilized. However, the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation.

In addition to characterizing the magnitude of impact, the other principal impact evaluation step is definition of the sensitivity/vulnerability/importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Other factors may also be considered, such as legal protection, government policy, stakeholder views and economic value. As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations vary on a resource/receptor basis.

The sensitivity/vulnerability/importance designations used herein for all resources/ receptors are:

- Low;
- Medium; and
- High.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterized, the significance can be assigned for each impact. Impact significance is designated using the matrix shown in **Table 6.7**. Whereas for unplanned events, impact significance is designated with a different matrix, shown in **Table 6.8**.

		Sensitivity/Vulnerability/Importance of Resource/Receptor					
		Low	High				
of	Negligible	Negligible	Negligible	Negligible			
ude	Small	Negligible	Minor	Moderate			
agnit Imp	Medium	Minor	Moderate	Major			
Ma	Large	Moderate	Major	Major			

#### **Table 6.7: Impact Significance**

		Likelihood of Occurrence								
		1	2	3	4	5				
Ø	Incidental	Negligible	Negligible	Negligible	Negligible	Negligible				
ence	Minor	Negligible	Minor	Minor	Minor	Moderate				
nbəş	Moderate	Minor	Minor	Moderate	Moderate	Major				
Cons	Major	Moderate	Moderate	Major	Major	Major				
0	Severe	Major	Major	Major	Major	Major				

#### Table 6.8: Impact Significance for Unplanned Events

Source: ERM.

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/importance designations that enter into the matrix. **Box 6.1** provides a context for what the various impact significance ratings signify.

It is important to note that impact prediction and evaluation take into account any embedded controls (i.e., physical or procedural controls that are already planned as part of the Project design, regardless of the results of the ESIA Process). This avoids the situation where an impact is assigned a magnitude based on a hypothetical version of the Project that considers none of the embedded controls.

The evaluation of impacts, as discussed above, are to be conducted within an Impact Assessment Table; a template is shown in **Table 6.9**; however, Impact Assessments conducted for unplanned events are to follow a different template, as shown in **Table 6.10**.

Significance of I	mpact							
Impact	A descriptor indica impacted.	ating the	activity and	the resource/re	eceptor th	nat may	potentially be	
Impact Nature	Negative		Positive		Neut	tral		
	A descriptor indicati receptor.	ing the ba	asic characteris	tics of the pote	ntial impa	ct toward	s the resource/	
Impact Type	Direct Indirect Induced							
	A descriptor indicat cause and effect).	ing the re	elationship of th	ne potential imp	act to the	Project (	in terms of	
Impact	Temporary	Short-te	erm	Long-term		Perma	nent	
Duration	The time period ove	er which a	a resource / ree	ceptor is potent	ially affect	ted.		
Impact Extent	Local		Regional		Intern	ational		
	The "reach" of the Footprint, projected	e potentia I for seve	al impact (e.g. ral kilometres,	, confined to a etc.).	a small ai	rea arou	nd the Project	
Impact Scale	The size of the pote or impacted, the fra	The size of the potential impact (e.g., the size of the area with the potential to be damaged or impacted, the fraction of a resource that could potentially be lost or affected, etc.).						
Frequency	A measure of the c	onstancy	or periodicity of	of the potential	mpact.			
Impact	Positive N	egligible	Sma	II M	edium		Large	
Magnitude	Magnitude essentia resource/receptor themselves are ur depending on the characteristics: Extent Duration Scale Frequency	ally descri as a re niversally resource	ibes the intens sult of the p consistent, b e/receptor. Ma	ity of the chang otential impac ut the definitic gnitude is a f	e that is p t. The m ons for th unction c	predicted hagnitude hese des of the fol	to occur in the designations ignations vary llowing impact	
Receptor	Low		Medium		High			
Sensitivity	There are a range of factors to be taken into account when defining the sensitivity/ vulnerability/ importance of the resource/ receptor, which may be physical, biological, cultural or human. Other factors may also be considered, such as legal protection, government policy, stakeholder views and economic value. As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations vary on a resource/receptor basis.							
Impact	Negligible	Minor		Moderate		Major		
Significance	The significance of and Receptor Sens is shown in <i>Table 6</i>	Negligible         Minor         Moderate         Major           The significance of the impact is determined by the designation given to Impact Magnitude, and Receptor Sensitivity. The method to determine the designation for Impact Significance is shown in Table 6.7         Impact Significance						

# Table 6.9 Impact Assessment Table Template

Significance of I	mpact							
Impact	A descriptor indic impacted.	ating the	activity and	the reso	ource/rece	ptor that	at may potentially be	
Impact Nature	Negative		Positive			Neutral		
	A descriptor indica receptor.	ting the basic characteristics of the potential impact towards the resourc					t towards the resource/	
Impact Type	Direct		Indirect			Induc	ed	
	A descriptor indicated cause and effect).	ating the re	lationship of	the pote	ntial impa	act to th	ne Project (in terms of	
Impact	Temporary	Short-ter	m	Long-te	erm		Permanent	
Duration	The time period ov	ver which a	resource / rec	ceptor is	potentially	/ affecte	ed.	
Impact Extent	Local		Regional			Interna	tional	
	The "reach" of th Footprint, projecte	e potential d for severa	impact (e.g., al kilometres,	confine etc.).	ed to a si	mall are	ea around the Project	
Impact Scale	The size of the po or impacted, the fr	The size of the potential impact (e.g., the size of the area with the potential to be damaged or impacted, the fraction of a resource that could potentially be lost or affected, etc.).						
Frequency	A measure of the	constancy c	or periodicity c	of the pot	ential imp	act.		
Impact	Incidental	Minor	Mode	rate	Мајс	or	Severe	
Consequence	Indicative levels of is a function of the Extent Duration Scale Frequency The function also i	consequen following ir ncludes the	ce for potentianpact charact	al impact eristics: rovided in	s from un n <b>Table 6</b>	planned <b>.6</b> .	events. Consequence	
Likelihood	Very Unlikely	Unlikely	Likely to occur Likely to occur ely once or more in once or twice life of the Project per year			Will likely occurs more than twice per year, or is continuous or certain to occur		
	Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred. It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, not the degree to which an impact or effect is expected to occur as a result of the unplanned event.							
Impact	Negligible	Minor		Modera	ate		Major	
Significance	The significance of the impact is determined by the designation given to Impact Consequence, and :Likelihood. The method to determine the designation for Impact Significance is shown in <i>Table 6.7</i> .							

# Table 6.10: Impact Assessment Table Template for Unplanned Events

## **Box 6.1: Context of Impact Significances**

An impact of **negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity/vulnerability/importance. In either case, the magnitude should be well within applicable standards.

An impact of **moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its' effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of EIA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholder to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

## 6.7.3 Identification of Mitigation and Enhancement Measures

Once the significance of a potential impact has been characterised, the next step is to evaluate what mitigation and enhancement measures are warranted. For the purposes of this ESIA, ERM has adopted the following Mitigation Hierarchy:

- Avoid at Source, Reduce at Source: avoiding or reducing at source through the design of the Project (e.g., avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity);
- **Abate on Site**: add something to the design to abate the impact (e.g., pollution control equipment, traffic controls, perimeter screening and landscaping);
- Abate at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site (e.g., noise barriers to reduce noise impact at a nearby residence or fencing to prevent animals straying onto the site);
- Repair or Remedy: some impacts involve unavoidable damage to a resource (e.g. agricultural land and forestry due to creating access, work camps or materials storage areas) and these impacts can be addressed through repair, restoration or reinstatement measures; and
- Compensate in Kind, Compensate Through Other Means: where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g., planting to replace damaged vegetation, financial compensation for damaged crops or providing community facilities for loss of fisheries access, recreation and amenity space).

The priority in mitigation is to first apply mitigation measures to the source of the potential impact (i.e., to avoid or reduce the magnitude of the potential impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or

offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

# 6.7.4 Residual Impact Evaluation

Once mitigation and enhancement measures are declared, the next step in the EIA Process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the implementation of the proposed mitigation and enhancement measures.

## 6.8 Management, Monitoring and Audit

The final stage in the EIA Process is definition of the basic management and monitoring measures that are needed to identify whether: a) impacts or their associated Project components remain in conformance with applicable standards; and b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted.

A Register of Commitments, which is a summary of all actions which the Project Proponent has committed to executing with respect to environmental/social/health performance for the Project, is also included as part of this report (*Chapter 14*). The Register of Commitments includes mitigation measures, compensatory measures and offsets and management and monitoring activities.

## 6.9 Decommissioning

The design lifespan of the Project is estimated to be 30 years. The Project facilities will be designed with decommissioning in mind. In general, facilities and machinery will be designed so that they can be isolated and decommissioned in steps which are in reverse of the installation procedure or which are most convenient to do so. The decommissioning phase activities will therefore be similar to those associated with the excavation/foundation work, installation and civil construction phases.

The decommissioning phase will consider three potential options for the method of decommissioning a facility. Which include the following:

- Left in Place All components/facilities of concern will be left as is, without any removal off-site.
- Total Removal All components/facilities of concern will be removed, none shall be left in place.
- Partial Removal The Components/facilities of concern will undergo selection of which will be left in place or removed.

At present, there are no plans or schedule for decommissioning the proposed LNG Receiving Terminal, Pipeline, and Power Plant components. It is likely that the Project components will only be decommissioned/ abandoned once it is no longer economical to continue operation, the plant is rendered redundant and/or no longer required for various reasons, or is unsafe to operate. Given the current stage of the Project components, detailed decommissioning plans have not yet been formulated. Impacts during decommissioning is expected to be assessed in detail in the Decommissioning Environmental Assessment (DEA) Report; therefore, this ESIA Study will not provide a detailed assessment of impacts for the decommissioning phase.

# 7. LNG RECEIVING TERMINAL IMPACT ASSESSMENT

## 7.1 Air Quality Impact Assessment

## 7.1.1 Introduction

The following section presents an assessment of potential impacts from the LNG Receiving Terminal to ambient air quality and identifies whether any additional mitigation or management procedures are needed to maintain residual impacts at environmentally or socially acceptable levels. Such measures are presented where appropriate and elaborated further within the Environmental Social Management Plan (ESMP).

The full Air Quality Impact Assessment (AQIA) containing the detailed methodology and results for each element of the assessment is presented in *Appendix Q* and is referred to throughout this section where necessary to avoid repetition.

The AQIA has been undertaken in line with guidelines set out by the International Finance Corporation (IFC) and in line with international best practice as advocated by the IFC guidance.

# 7.1.2 Assumptions and Limitations

The automatic Haz-Scanner Environmental Perimeter Air Station (EPAS) was deployed at 10 locations in the Study Area for a continuous 72-hour period in both the wet and dry season. The Haz-Scanner monitors a number of air quality parameters including nitrogen dioxide (NO<sub>2</sub>) using electrochemical sensors. Electrochemical NO<sub>2</sub> sensors can be susceptible to temperature, relative humidity and interfering gases that can affect the measurement. The NO<sub>2</sub> measurements from the EPAS were therefore analysed and outlying values removed to increase confidence in the results.

Passive diffusion tubes were deployed in triplicate at three locations between the 27 February 2018 and the 2 May 2018, and again from the 12 June 2018 to the 26 June 2018. Monitoring of NO<sub>2</sub> was conducted at 13 monitoring locations. It should be noted that due to unforeseen circumstances the first round of diffusion tubes were deployed beyond the recommended exposure period. The results may therefore be compromised however; they were still used to inform the assessment.

# 7.1.3 Assessment Methodology

The International Finance Corporation (IFC) Environmental, Health and Safety (EHS) guidelines are considered throughout this AQIA. The IFC guidelines provide the overarching guidance and principles for undertaking the assessment. The key documents considered are:

- IFC General EHS Guidelines for Air Emissions and Ambient Air Quality;
- IFC General EHS Guidelines for Construction and Decommissioning;
- IFC EHS Guidelines for Liquefied Natural Gas Facilities; and
- IFC EHS Guidelines for Ports, Harbours, and Terminals.

Where necessary, reference is made to other internationally recognised sources of information. These include, but are not necessarily limited to guidelines published by:

- the World Health Organisation (WHO);
- the European Union (EU);
- the United States Environmental Protection Agency (USEPA);
- the Australian National Pollution Inventory (NPi);
- the Department of Environment, Food and Rural Affairs (DEFRA); and

 reputable air quality institutes and working groups such as the Institute of Air Quality Management (IAQM).

The assessment of potential air quality impacts associated with the Project considers:

- sources, nature and quantity of emissions to air;
- a qualitative assessment of construction and decommissioning phase impacts;
- a detailed quantitative assessment of process emissions;
- an assessment of potential impacts on relevant sensitive receptors; and
- mitigation measures to reduce the impacts where necessary.

## 7.1.4 Baseline Summary

A project specific air quality monitoring survey was undertaken and the detailed methodology, results and interpretation is presented in *Appendix Q* and summarised in *Chapter 5*. The Study Area for the LNG Receiving Terminal for air quality include a 5 km radius from the facility. The baseline assessment indicates that the existing ambient concentrations of relevant substances in the study area are below the relevant air quality standards. On this basis, the air shed is considered 'non-degraded'.

## 7.1.5 Receptor Identification and Sensitivity

## 7.1.5.1 Construction Phase

The study area and receptors were specifically defined using the IAQM guidance on the assessment of dust from demolition and construction. The IAQM define the sensitivity of the area based on receptor type and the number of receptors within a certain distance from the source. Residential properties, schools, and hospitals are classified as high sensitivity to dust soiling and health effects. Locations where there are particularly important plant species (i.e. rice paddy) are classified as medium sensitivity. The criteria for estimating the sensitivity of the area as per the IAQM guidance is presented in *Appendix Q*. The guidance provides a screening criterion of 350 m and 50 m from the construction site and access road respectively beyond which impacts are not considered likely.

## 7.1.5.2 Operation Phase

The continuous emission to air generated from four-1160-kilowatt (kW) gas fired generators at the LNG terminal has the potential to affect ambient air quality at sensitive receptor locations. A number of representative air sensitive receptors were identified for the assessment and are presented in *Appendix Q*.

# 7.1.6 Summary of Project Activities with Potential Impacts

A preliminary screening assessment was undertaken to identify project activities that have the potential to affect ambient air quality and that subsequently require detailed assessment to inform the level of mitigation necessary to reduce impacts to an acceptable level throughout the lifetime of the Project. The assessment was completed using a combination of quantitative and semi quantitative techniques, project specific information, international guidelines and methodologies, and professional experience (refer to *Appendix Q*).

## 7.1.6.1 Construction Phase

The screening assessment found that ground preparation, ground excavation, material transfer, material stockpiling, construction of the main infrastructure and vehicles operating on unpaved road surfaces require detailed assessment and are considered further in this section.

## 7.1.6.2 Operation Phase

The screening assessment found that the continuous operation of four-1160 kW natural gas fired engines require detailed assessment and are therefore considered further in this chapter.

#### 7.1.7 Assessment of Impacts to Air Quality

#### 7.1.7.1 Construction Phase

#### Overview

During the construction phase of the LNG Receiving Terminal, a number of activities have been identified that will potentially result in adverse impacts to ambient air quality due to the generation of total suspended particulate (TSP) and particulate matter (PM<sub>10</sub>). The key construction phase activities considered include:

- Demolition of existing infrastructure;
- Earthworks including ground excavation; material removal, transfer and stockpiling;
- Construction of the main infrastructure including the power plant and associated facilities; and
- Track out of dusty materials onto the public road network.

The associated impacts that may arise from construction activities include:

- Dust deposition resulting in the soiling of surfaces including homes and places of business;
- Elevated PM<sub>10</sub> concentrations at air sensitive receptors.

Exhaust emissions from on-site plant (also known as non-road mobile machinery or NRMM) and site traffic are unlikely to impact ambient air quality significantly and have not been considered further.

#### Assessment of Impacts

Dust emissions during the construction phase can vary substantially and will largely depend on the activity being undertaken; the duration of the activity; the size of the site; the meteorological conditions; the proximity and sensitivity of the receptors; and the adequacy of the mitigation measures in place to reduce emissions.

The Institute of Air Quality Management (IAQM)<sup>91</sup> provide specific guidance for defining the dust impact risk from construction sites based on a) the scale and nature of the works; and b) the sensitivity of the receiving area (refer to *Appendix Q*). The premise of the IAQM guidance is that with the implementation of effective site-specific mitigation and management measures, the environmental effect will not be significant in most cases. The guidance also provides screening criteria of 350 m and 50 m from the construction site and access road respectively beyond which impacts are not considered likely.

A summary of the impact significance associated with the construction of the LNG Receiving Terminal (pre-mitigation) is presented in *Table 7.1*, *Table 7.2*, and *Table 7.3*.

<sup>&</sup>lt;sup>91</sup> Institute of Air Quality Management (IAQM) (2014) Guidance on the Assessment of Dust from Demolition and Construction [Online] Available at: http://iaqm.co.uk/guidance/ [Accessed 13 February 2019]

# Table 7.1: Summary of Dust Risk from the LNG Receiving TerminalConstruction (Pre-Mitigation)

Potential Impact	Risk <sup>a</sup>								
	Demolition <sup>b</sup>	Earthworks	Construction	Track out					
Dust Soiling	n/a	Low	Low	Low					
Human Health	n/a	Low	Low	Low					
Ecological	n/a	Medium	Medium	n/a					

<sup>a</sup> As per IAQM approach

<sup>b</sup> No demolition required so assessment of risk is considered 'not applicable'.

# Table 7.2: Assessment of Impact on Human Health and Nuisance Relating to LNG Receiving Terminal Construction (Pre-Mitigation)

Significance of Impact									
Impact	Potential impacts o	n Ambien	t Air Qu	ality					
Impact Nature	Negative		Positiv	e			Neut	ral	
	Impacts to ambient	Impacts to ambient air quality are considered adverse (negative).							
Impact Type	Direct		Indire	ect			Induc	ced	
	Impacts to ambient	air qualit	y are co	nsidere	ed direct.				
Impact	Temporary	Short-te	erm		Long-tern	n		Perma	nent
Duration	Potential impacts to air quality will occur throughout the construction phase only. The duration is therefore short term.								
Impact Extent	Local		Regior	nal			Interna	ational	
	Construction activit and 50m from the o extent is therefore I	ies at the constructi local.	site hav on site t	e the p bounda	otential to any and unp	result ir baved a	n emiss access I	ions of d roads res	ust up to 350m spectively. The
Impact Scale	Potential impact wi unpaved access ro	ll occur up ads respe	o to 350ı ectively.	m and	50m from t	he con	structio	n site bo	undary and
Frequency	The impact will of construction phase	occur du	ring da	ytime	working h	iours (	(08:00-′	18:00) tl	hroughout the
Impact	Positive N	egligible		Sma	1	Medi	ium		Large
Magnitude	The expected dust emission magnitude during construction phase activities is predicted to be large from earthworks; and medium from construction and track out.								
Receptor	Low		Mediu	n			High		
Sensitivity	ty There are 1-10 residential receptors <350m from the site boundary, and only one <50m from the road up to 500m from the site entrance. The sensitivity of the area is considered low.							y one receptor rea is therefore	
Impact	Negligible	Minor			Moderate			Major	
Significance	The significance of	the impa	ct is exp	ected t	o be minor	at wor	st.		

# Table 7.3: Assessment of Impact on Ecology Relating to LNG Receiving Terminal Construction (Pre-Mitigation)

Significance of I	mpact								
Impact	Potential impacts o	Potential impacts on Ambient Air Quality							
Impact Nature	Negative		Positiv	Positive		Neutral			
	Impacts to ambient air quality would be considered adverse (negative).								
Impact Type	Direct		Indire	ect			Induc	ced	
	Impacts to ambient	air qualit	y are co	nsidere	ed direct.				
Impact	Temporary	Short-t	erm		Long-term	n		Perma	nent
Duration	Potential impacts duration is therefore	to air qu e short te	ality will rm.	occur	throughou	it the	constru	ction ph	ase only. The
Impact Extent	act Extent Local Regional In					Interna	ational		
	Construction activit from the construction is therefore local.	ies at the on site bo	site hav undary a	e the p and any	ootential to / unpaved a	result i access	n emiss roads r	sions of o espectiv	dust up to 50 m ely. The extent
Impact Scale	Potential impact wi access roads respe	ll occur up ectively.	o to 50 n	n from	the constru	iction s	ite bour	ndary an	d any unpaved
Frequency	The impact will of construction phase	occur du	ring da	ytime	working h	ours	(08:00-1	18:00) t	hroughout the
Impact	Positive N	legligible		Smal	I	Med	ium		Large
Magnitude	The expected dust emission magnitude during construction phase activities is predicted to be large from earthworks; and medium from construction and track out.								
Receptor	Low		Mediu	m			High		
Sensitivity	Agriculture exists <20 m from the site boundary and <50 m from the access road up to 500 m from the site entrance. The sensitivity of the area is therefore considered medium.								
Impact	Negligible	Minor			Moderate	•		Major	
Significance The significance of the impacts is expected to be moderate at worst.									

## Mitigation Measures

The mitigation measures required during the construction of the LNG Receiving Terminal based on the outcome of the dust risk assessment summarised in *Table 7.1* include:

- Develop and Implement a Dust Management Plan (DMP) detailing mitigation measures and a plan for implementation.
- Watering will be used to suppress wind and physical disturbance dust generation.
- Ensure an adequate water supply on site for effective dust suppression and mitigation.
- The site layout will be planned so that dust-causing activities are located away from receptors as far as is possible.
- Screens or barriers will be erected around dusty activities or the site boundary that are at least the height of any stockpile on site.
- All stockpiles will be covered or fenced off to prevent wind whipping.
- Only cutting, grinding, or sawing equipment fitted with suitable dust suppression techniques such as water sprays will be used.

- All chutes, conveyors and skips will be covered at all times.
- Drop heights from conveyors, loading shovels and hoppers will be minimised.
- No waste will be burned on site.
- Re-vegetate earthwork and exposed areas as soon as is practicable.
- Use hessian, mulches or trackifiers where it is not possible to revegetate, or cover with top soil as soon as is practicable.
- Sand and other aggregates will be stored in bunded areas and will not be allowed to dry out unless this is required for a particular process, in which case additional control measures such as those detailed in this section will be applied.
- Ensure that all vehicles entering and leaving the site are covered to avoid fugitive emissions during transport.
- Inspect on-site haul roads for integrity and instigate the necessary repairs to the surfaces as soon as reasonable practicable.
- Implement a wheel washing system.
- Regularly dampen and clean the site access and local roads to remove any materials tracked out of the site.
- All site access gates will be located at least 10m away from air sensitive receptors where possible.
- The site layout will be planned so that machinery is located away from receptors as far as is possible.
- All vehicles will switch off engines when stationary.
- A regular vehicle and machinery maintenance and repair programme will be implemented.
- Mains electricity or battery powered equipment will be used instead of diesel/petrol generators where practicable.

#### Residual Impact

The IAQM guidance suggest that when correctly applying and actively managing the prescribed mitigation and management measures the impacts to receptors located within 350m downwind of any construction activity are not likely to be significant for the large majority of the time. However, due to the nature of construction activities, the scale and duration of the construction phase, and the possibility of extreme weather conditions, it is possible that communities will experience occasional, short-term dust annoyance. The IAQM states, "the likely scale of this would not normally be considered sufficient to change the conclusion that with mitigation the effects will be 'not significant'. On this basis, it can be concluded that construction phase activities are likely to result in a **Negligible** impact at worst post mitigation.

#### Monitoring Plan

TPMC are required to implement the following monitoring procedures:

- Regular site inspections to monitor compliance with the DMP. All inspection results will be recorded and corrective actions taken where mitigation and management measures are not being implemented effectively (i.e. to reduce dust emissions).
- Daily onsite and offsite inspections to visually assess the dust emissions from earthwork and construction activities, and from vehicles exiting the construction sites. Results from the inspection will be recorded and mitigation measures intensified where necessary to reduce emissions. The frequency of site inspections will be increased when activities with a high potential to produce dust are being carried out and during prolonged dry and windy conditions.

# 7.1.7.2 Operation Phase

#### Overview

During the operation of the LNG Receiving Terminal the continuous operation of four-1160 kW natural gas fired engines will potentially result in adverse impacts to ambient air quality and are considered further in this chapter.

#### Assessment of Impacts

Processes associated with the operation of the LNG Receiving Terminal including the combustion of natural gas will result in elevated ambient concentrations of nitrogen dioxide (NO<sub>2</sub>) in the atmosphere. The resulting impact to ambient air quality at sensitive receptor locations during the operation phase was quantitatively assessed using the latest USEPA AERMOD dispersion model version 18081. AERMOD is a state of the art detailed dispersion model that can represent complex multiple emission sources and predict air quality at receptor locations taking into account meteorology. The model is widely recognised for use in this type of application, including by the IFC, United States Environmental Protection Agency (USEPA), UK Environment Agency and state based EPA's throughout Australia. Three years of hourly sequential meteorological data was used so that inter annual variability was incorporated into the model. The detailed modelling and assessment methodology including the approach for determining the magnitude and the significance of impacts, receptor grid spacing, meteorological data information, NO<sub>x</sub> to NO<sub>2</sub> conversion and the treatment of buildings, land use and terrain is discussed in *Appendix Q*.

The LNG Gas Receiving Terminal modelling scenario considered the continuous operation of four-1160kW natural gas fired engines. The modelling scenario assumes continuous emissions for 365 days per year. The emissions from the generators are based on the Cummins C1160 N5C natural gas fired generator at 100% rated load.

The IFC's General EHS guideline for air emissions and ambient air quality states that:

 Projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that:

- emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines, or other internationally recognised source; and

- emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed.

A summary of the maximum-modelled NO<sub>2</sub> concentrations found anywhere on the modelling grid and their impact significance is provided in **Table 7.4**; the contour figures showing dispersion are provided in **Figure 7.1** and **Figure 7.2**, and the summary of the impacts is presented in **Table 7.5**. The assessment finds that the maximum PC and PEC is likely to be below 25% and 100% of the relevant air quality standard respectively throughout the study area. On this basis, the impact to ambient air quality from the LNG Receiving Terminal is expected to be negligible.

Table 7.4: Summar	y of LNG Re	ceiving Term	inal Modelling	Results
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Substance	Averaging Period	Baselineª (µg/m³)	Max. PC <sup>b</sup> (µg/m³)	Max. PEC <sup>c</sup> (μg/m³)	AQS <sup>d</sup>	Significance of Impact
NO <sub>2</sub>	1-hour	129	37.7	167	200	Negligible
	Annual	24.6	4.14	29.2	40	Negligible

<sup>a</sup> Refer to the baseline assessment in the air quality impact assessment presented in Appendix Q.

 <sup>b</sup> Process Contribution is the impact arising solely from project related emissions
 <sup>c</sup> Predicted Environmental Concentration is the PC added to the existing baseline
 <sup>d</sup> Air Quality Standard as prescribed in the National Environmental Quality (Emission) Guidelines (NEQEG) (2015)



Figure 7.1: LNG Receiving Terminal Modelling Results (NO<sub>2</sub> 1-hour Average)

Source: ERM, 2019.





Source: ERM, 2019.

# Table 7.5: Assessment of Impact on Ambient Air Quality Relating to LNG Receiving Terminal Operation (Pre-Mitigation)

Significance of I	mpact									
Impact	Potential impacts of	Potential impacts on Ambient Air Quality								
Impact Nature	Negative		Positive			Neut	Neutral			
	Impacts to ambien	t air qualit	y would	be con	sidered adv	verse	(negativ	′e).		
Impact Type	Direct		Indire	ect			Induc	ced		
	Impacts to ambient air quality are considered direct.									
Impact	Temporary	Short-te	erm		Long-terr	n		Perma	nent	
Duration	Potential impacts to air quality will occur throughout the operation phase is therefore long-term.					nase only	v. The duration			
Impact Extent	Local		Regior	nal			Interna	International		
	Potential impacts were considered up to 5km from the LNG Receiving terminal and are considered local in their extent.									
Impact Scale	The scale of the im	npacts is li	kely to b	e withi	n 5 km fron	n the p	point of I	release.		
Frequency	The impact will occ	curs 24/7 (	during th	e oper	ation phase	e assu	ming co	ontinuous	operation.	
Impact	Positive N	legligible		Smal	I	Med	lium		Large	
Magnitude	The expected impact magnitude is negligible.									
Receptor	Low		Mediu	m			High			
Sensitivity	The approach assumes that sensitivity within the general study area is medium for human health.									
Impact	Negligible	Minor			Moderate			Major		
Significance	The significance of	the impa	ct is exp	ected t	o be neglig	ible at	worst.			

## Mitigation and Management

The impact assessment defines the impacts on ambient air quality during operation as negligible. However, to minimise and control impacts to air quality during the operation of the Project the gas fired generators at the LNG receiving terminal will be serviced and maintained in accordance with the manufacturer's specification to maintain high performance throughout the lifetime of the Project.

## **Residual Impact**

The predicted residual impact to ambient air quality during normal operation is **Negligible**.

## Monitoring Plan

Based on the outcome of the impact assessment, monitoring of emissions from the generators or monitoring ambient air quality is not considered necessary.

## 7.2 Greenhouse Gas Impact Assessment

## 7.2.1 Introduction

During the construction and operation phases, there are activities that have the potential to increase greenhouse gas emissions. The main emission sources are released from fuel combustion (for example, diesel fuel combustion in mobile vehicles).

This chapter provides estimation of the greenhouse gas (GHG) emissions that are likely to be released from LNG Terminal of LNG Power Plant (Ahlone) Project (also referred to as 'Project'), as related to the issue of climate change. GHGs are assessed in order to provide an indication of the amount of GHG emission of the Project, and to provide mitigation measures early during the development process.

## 7.2.2 Assumption and Limitation

It is noted that all greenhouse data in this report cannot yet be used for official greenhouse gas inventory reporting<sup>92</sup> until the site is operational and actual operational data would be used for a more precise GHG inventory calculation.

All greenhouse gas calculation methodologies have been formulated using accurate calculation methodologies sourced from Intergovernmental Panel on Climate Change (IPCC). These methodologies can be replicated for GHG inventory use when the Project becomes operational.

In this chapter, some assumptions are made, as below:

- Equator Principles (June 2013) stated that Quantification of GHG emissions will be conducted by the client in accordance with internationally recognised methodologies and good practice, for example, the GHG Protocol. The client will quantify Scope 1 and Scope 2 emissions. Therefore, quantification of GHG emissions for the Project will consider Scope 1 (direct emissions from the facilities owned or controlled within physical Project boundary) and Scope 2 (indirect emissions associated with the off-site production of energy used by the Project), and excluding Scoping 3 emissions.
- The GHG assessment for the Project will focus on the construction and operation phases, excluding pre-work and land development phases, as the majority of the Project emissions will occur during these periods. A total area of the Project is approximately 8.97 acres or about 36,300 m2 with the current land use of scrubland with thickets of shrubs, young trees, degraded mangrove trees, and agricultural land for rice farming with some grazing areas for livestock, in which are not biomass-rich areas. The change in land use characteristics for development of the Project would alter the carbon stock due to removal of vegetation, but the effect is considered to be small.
- This document focuses on CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions, because these are the most prevalent GHGs emitted from power industry operations.

## 7.2.3 Assessment Methodology

According to the Greenhouse Gas Protocol, greenhouse emissions fall under the following three scopes:

Scope 1 - Direct GHG emissions: Direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.; emissions from chemical production in owned or controlled process equipment. Direct CO<sub>2</sub> emissions from the combustion of biomass shall not be included in scope 1 but reported separately.

<sup>&</sup>lt;sup>92</sup> Official greenhouse gas inventory reporting includes Sustainability Reporting, CDP, DJSI or other nationally relevant greenhouse reporting schemes.

- Scope 2 Electricity indirect GHG emissions. Scope 2 accounts for GHG emissions from the power generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.
- Scope 3 Other indirect GHG emissions. Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

Scope 1 and 2 have been considered for this Project, which were quantified according to the following standards:

- GHG Protocol Corporate Accounting and Reporting Standard; and
- GHG Protocol Scope 2 Guidance
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories

The assessment of impact magnitude and significance related to GHG is based on the methodology described in *Chapter 6*. The mitigation measures are based on international good practice (as recommended under the IFC EHS Guidelines), and good practice relevant to GHG emissions.

## 7.2.3.1 Global Warming Potentials

The global warming potentials (GWPs) used in this assessment are sourced from the 2007 IPCC Fourth Assessment Report (AR4). Although the 2013 Fifth Assessment Report (AR5) provides the latest GWPs, the GWPs from the AR4 are more commonly adapted.

The global warming potential is used to evaluate the potency of non-CO<sub>2</sub> greenhouse gases compared to CO<sub>2</sub> as a baseline. For example, methane (CH<sub>4</sub>) is 25 times more potent than CO<sub>2</sub> in its global warming effect, meaning that 1 kg of CH<sub>4</sub> emitted is equivalent to 25 kg of CO<sub>2</sub> emitted. The 100 years' time horizon is used in line with greenhouse gas inventory best practices. Detail of GWP factors are in *Table 7.6*.

Industrial Designation or Common Name	Chemical Formula	Global Warming Potential for 100-years' Time Horizon from IPCC Fourth Assessment Report
Carbon Dioxide	CO <sub>2</sub>	1
Methane	CH <sub>4</sub>	25
Nitrous oxide	N <sub>2</sub> O	298

## **Table 7.6: Global Warming Potentials**

Source: IPCC Fourth Assessment Report Working Group I https://www.ipcc.ch/publications\_and\_data/ar4/wg1/en/ch2s2-10-2.html

# 7.2.3.2 Emission Factor

An emission factor represents an average emission rate for a given source, and is generally expressed as mass or volume of emissions per source type or measure of activity related to the source.

The 2006 IPCC Guidelines provide emission factors for stationary and mobile combustion, Default emission factors provided in Table 7.7 and Table 7.8 below, are related to the Project activities and used for the purposes of this report.

#### Table 7.7: Default IPCC Emission Factors for Stationary Combustion

Fuel	kgCO₂/TJ (default)	kgCH₄/TJ (default)	kgN₂O/TJ (default)
Motor Gasoline	69,300	3	0.6
Gas/ Diesel Oil	74,100	3	0.6
Natural Gas	56,100	1	0.1

Source: IPCC 2006 V.2 Ch.2 Table 2.2

## Table 7.8: Default IPCC Emission Factors for Mobile Combustion

Fuel	kgCO <sub>2</sub> /TJ (default)	kgCH₄/TJ (default)	kgN <sub>2</sub> O/TJ (default)
Equipment/ Machineries		· · · · · · · · · · · · · · · · · · ·	
Gas/ Diesel Oil	74,100ª	4.15 <sup>a</sup>	28.6 <sup>a</sup>
Motor Gasoline (4-stroke)	69,300 <sup>a</sup>	50 <sup>a</sup>	2 <sup>a</sup>
Road Transportation	,		
Gas/ Diesel Oil	74,100 <sup>b</sup>	3.9 <sup>c</sup>	3.9 <sup>c</sup>
Source: a IPCC 2006 Vol. 2 Ch. 3 Table 3.3.1.			

<sup>b</sup> IPCC 2006 Vol. 2 Ch. 3 Table 3.2.1.

° IPCC 2006 Vol. 2 Ch. 3 Table 3.2.2.

## 7.2.3.3 Net Calorific Values and Density

Energy data, consumption of solid, liquid and gaseous fuel are sometimes expressed in physical units, e.g. in litres, tonnes or cubic metres. For the purposes of greenhouse gas calculations, the apparent consumption should be converted to terajoules (TJ) on a Net Calorific Value (NCV) basis.

To convert these data to common energy units, this report uses conversion factors from the energy content of fuel provided in Table 7.9.

Table	7.9:	Default	Net	Calorific	Values
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Fuel Type	Net Calorific Value	Typical Density
Gas/ Diesel Oil	43.0 TJ/Gg <sup>a</sup>	874.31 kg/m <sup>3 b</sup>
Gasoline	44.3 TJ/Gg <sup>a</sup>	742.39 kg/m <sup>3 b</sup>
Natural Gas	48.0 TJ/Gg <sup>a</sup>	0.6728 kg/m <sup>3 b</sup>

Source: a IPCC 2006 Vol. 2 Ch. 1 Table 1.2.

<sup>b</sup> API 2009 Compendium of Greenhouse Gas Emissions Methodologies for Oil and Natural Gas Industry Table 3-8.

# 7.2.4 Baseline Summary

Myanmar's total GHG emissions in 2013 were 201.5 million metric tons of carbon dioxide equivalent (MtCO2e), totalling 0.42 percent of global GHG emissions.<sup>93</sup>

According to the World Resources Institute Climate Analysis Indicators Tool (WRI CAIT), and Land Use Change and Forestry (LUCF) activities, were the leading sources of Myanmar's<sup>94</sup> GHG emissions in 2013, accounting for 51.0% of the country's total emissions.<sup>95</sup> Within the LUCF sector, changes in forest land contributed 73% of emissions.<sup>96</sup> Agriculture was the second most significant source (32.1%) with rice cultivation and enteric fermentation from livestock contributing 67% of agriculture emissions.<sup>97</sup> Energy was responsible for 10.9% of emissions, of which 50% were due to fugitive emissions and other fuel combustion. Waste and Industrial Processes (IP) contributed 5.8% and 0.2% of total emissions respectively.

## 7.2.5 Receptor Identification and Sensitivity

The direct receptor in the scope of this impact assessment is the global atmosphere. The indirect receptors from climate change due to an increase global greenhouse gas emissions include Myanmar's weather.

In accordance to National Oceanic and Atmospheric Administration (NOAA), *Global Climate Report – Annual 2018*, describes that 11 of 12 months of global land and ocean average temperature departures ranked among the five warmest for the respective years, becoming the fourth warmest year in NOAA's 139-year records, in which the top warmest years are all from the recent years (2015-2017) since the pre-industrial time. The year 2018 began with a La Niña episode present across the tropical Pacific Ocean, transitioning to ENSO-neutral by April 2018.<sup>98</sup> The frequency and intensity of extreme high temperature events are virtually certain to increase in the future as global temperature increases (high confidence). Extreme precipitation events will also very likely continue to increase in frequency and intensity throughout most of the world (high confidence).

Myanmar's Intended Nationally Determined Contribution (INDC) reported that Myanmar is extremely vulnerable to the negative effects of climate change. In 2015, for the third year, Myanmar was ranked globally by studies, as the second most vulnerable country in the world to extreme weather events over the last 20 years. In addition, climate models predict further sustained impacts from climate change in the future, which will further expose Myanmar to the negative impacts of climate change. Thus global GHG emission would highly influence the negative impact on Myanmar.

## 7.2.6 Summary of Project Activities with Potential Impacts

Based on the Scoping Study, and the Project Description and Alternatives (presented in *Chapter 4*), the key potential impacts on greenhouse gas identified come from the following activities.

# 7.2.6.1 Construction Phase

The main equipment and machineries used in contributing to Scope 1 and Scope 2 of greenhouse gas emissions at the Project site are illustrated in *Table 7.10*. By which, the majority of GHG emission sources come from mobile combustion devices, including transportation. GHG is estimated under the assumption that most of the fuel consumed by the construction machineries would be diesel, except for

<sup>93</sup> https://www.climatelinks.org/resources/greenhouse-gas-emissions-factsheet-burma

<sup>&</sup>lt;sup>94</sup> Burma ratified the UNFCCC as Myanmar. UNFCCC Status of Ratification, viewed on March 20, 2017.

<sup>&</sup>lt;sup>95</sup> World Resources Institute Climate Analysis Indicators Tool (WRI CAIT 2.0, 2017). Global Warming Potentials (GWPs) are from the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (SAR).

<sup>&</sup>lt;sup>96</sup> Food and Agriculture Organization of the United Nations Statistics Division (FAOSTAT). Myanmar, Emissions – Land use total, viewed on March 18, 2017.

<sup>&</sup>lt;sup>97</sup> FAOSTAT. Myanmar, Emissions – Agriculture total, viewed on March 18, 2017.

<sup>&</sup>lt;sup>98</sup> https://www.ncdc.noaa.gov/sotc/global/201813