ABBREVIATIONS

ADB	Asia Development Bank
AIDS	Acquired Immune Deficiency Syndrome
AOI	Area of Influence
ARS	Automatic Route Setting
AS	Air Sample
ASEAN	Association of Southeast Asian Nations
ATP	Automatic Train Protection
BC	Bern Convention
Ca	Calcium
CAPEX	Capital Expenses
CBO	Community Base Organization
CDC	City Development Committee
CH4	Methane
CITIES	Convention on International Trade in Endangered Species
CNEL	Community Noise Equivalent Level
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CP	Construction Phase
CREEC	China Railway Eryuan Engineering Group Co., Ltd
CSO	Civil Society Organization
CSR	Corporate Social Responsibility
CWR	Continuous Welded Rail
DICA	Directorate of Investment and Company Administration
DMU	Diesel Multiple Unit
DO	Dissolved Oxygen
DP	Decommission Phase
DRMP	Disaster Risk Management Plan
DSLR	Department of Settlement and Land Record
DTM	Digital Terrain Model

DWIR	Directorate of Water Resources and Improvement of River System
ECC	Environmental Compliance Certificate
ECD	Environmental Conservation Department, MONREC
EEC	European Union Commissions
EGT	Ever Green Tech Environmental Services and Training Co., Ltd.
EHS	Environmental, Health & Safety
EIA	Environmental Impact Assessment
EMMP	Environmental Monitoring and Management Plan
EMMT	Environmental Management and Monitoring Team
EMP	Environmental Management Plan
EMS	Environmental Management Sysytem
EMU	Electric Multiple Unit Trains
EPA	United States Environmental Protection Agency
EPAS	Environmental Perimeter Air Station
EPRP	Emergency Preparedness and Respond Plan
ERP	Emergency Response Plan
ESIA	Environmental Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FS	Feasibility Study
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHS	Globally Harmonized System
GIS	Geographic Information Systems
GRM	Grievance Redress Mechanism
GN	Guidance Note
GOM	Government of Myanmar
GPS	Global Positioning System
GSS	Gas Sensing Semiconductor
HIA	Health Impact Assessment
HIV	Human Immunodeficiency Virus

H2S	Hydrogen sulfide
HSE	Health and Safety Executive
I&APs	Interested and Affected Parties
IBAS	Important Bird Areas
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labor Organization
INGOs	International Non-Government Organizations
IPPC	Integrated Pollution Prevention and Control
IUCN	International Union for Conservation of Nature
IVI	Importance Value Index
K	Potassium
LER	Local Economic Development
LULC	Land Use Land Cover
MBR	Membrane Bioreactor
MEG	Myanmar Emission Guidline
Mg	Magnesium
MMR	Muse-Mandalay Railway
MOTC	Ministry of Transport and Communications
MOU	Memorandum of Understanding
MR	Myanma Railways
Na	Sodium
NAAQS	National Ambient Air Quality Standard
NAC	Noise Abatement Criteria
NDIR	Nondispersive Infrared
NEQG	National Environmental Quality (Emission) Guidelines
NGOs	Non-Government Organizations
NH	National Highways
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NO_x	Nitrous Oxides
NTS	Non-Technical Summary

O3	Ozone
OHS	Occupational Health and Safety
OP	Operation Phase
OPEX	Operational Expenses
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbons
PAPs	Project Affected Persons
PCA	People Centered Analysis
PCM	Public Consultation Meeting
PCPP	Public Consultation and Public Participation Process
PEA	Preliminary Ecological Assessment
PERI	Public Enterprise for Railway Infrastructure
PM	Particulate Matter
PP	Public Participation
PPE	Personal Protective Equipment
PR	Performance Requirement
PSHO	Principal Safety and Health Officer
QSHE	Quality, Safety and Health, Environmental Management
RA	Relative Abundance
RAP	Resettlement Action Plan
RCC	Remote Control Centre
R.F	Relative Frequency
RMS	Root Mean Square
SEA	Strategic Environmental Assessment
SEP	Stakeholder Engagement Plan
SIA	Strategic Impact Assessment
SMES,	Small Medium Enterprises
SMMP	Social Management and Monitoring Plan
SMP	Social Management Plan
SNAP	Selected Nomenclature on Air Pollutants
SO_2	Sulphur Dioxide
SPL	Sound Pressure Level

SR	Scoping Report
SRP	Socially Responsible Partner
SSEP	Site Specific Environmental Plans
SSHO	Site Safety and Health Officer
SWTP	Solid Waste Treatment Plant
TDS	Total Dissolved Solid
TOR	Terms Of Reference
TSI SRT	Safety in Railway Tunnels
TSP	Total Suspended Particulates
UNFCCC	United Nations Framework Convention on Climate Change
UPS	Uninterruptible Power Supply
USEPA	United States Environmental Protection Agency
VCE	Vapor Cloud Explosion
VIA	Visual Impact Assessment
WEEE	Waste Electronics and Electrical Equipment
WHO	World Health Organization
WRUD	Water Resources Utilization Department
IPP	Indigenous People Plan

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၁.၁။နိဒါန်းအနှစ်ချုပ်

နိုင်ငံတော်အစိုးရ၏ ခရီးသည်နှင့် ပို့ဆောင်ဆက်သွယ်ရေးဖွံ့ဖြိုးတိုးတက်ရေး နည်းဗျူဟာအရ ပို့ဆောင်ရေးနှင့်ဆက်သွယ်ရေးဝန်ကြီးဌာနသည်နိုင်ငံတော်၏ သယ်ယူပို့ဆောင်မှုပမာဏ တိုးမြင့် နိုင်ရေးအတွက် မူဆယ်မြို့မှမန္တလေးမြို့သို့ ရထားလမ်းဖောက်လုပ် တည်ဆောက်မည် ဖြစ်ပါသည်။ ထို့ကြောင့် မြန်မာနိုင်ငံ၊ ပို့ဆောင်ရေးနှင့်ဆက်သွယ်ရေးဝန်ကြီးဌာနနှင့် တရုတ်ပြည်သူ့ သမ္မတနိုင်ငံ၊ China Railway Eryuan Engineering Group Co.Limited (CREEC),China Railway Group Limitedတို့အကြားမူဆယ်-မန္တလေးရထား လမ်းစီမံကိန်း၏ ဖြစ်နိုင်ခြေ လေ့လာမှု အစီရင်ခံစာအတွက် နားလည်မှုစာချွန်လွှာကို ၂၀၁၈ခုနှစ် အောက်တိုဘာလ ၂၂ရက်နေ့တွင် လတ်မှတ်ရေးထိုးခဲ့ပါသည်။ဤနားလည်မှုစာချွန်လွှာအရ CREEC မှမူဆယ်-မန္တလေးမြန်နှုန်းမြင့် လျှပ်စစ် ရထားလမ်းသစ်တည်ဆောက်ရန်အတွက်လုပ်ငန်းဖြစ်နိုင်ခြေလေ့လာခြင်း (Feasibility Study (FS)) ပြုလုပ်သွားမည်ဖြစ်ပါသည်။

ရထားလမ်းသစ်တည်ဆောက်ရေးစီမံကိန်းတွင်ရထားလမ်းတလျှောက်တံတား(bridges) စုစုပေါင်း၁၂၀ကျော် နှင့်မြေအောက်မြောင်း(culverts) အရေအတွက်၇၀၀ကျော်တည်ဆောက်ခြင်း လုပ်ငန်းများပါဝင်သောကြောင့် Environmental Conservation Law, 2012နှင့် Environmental Impact Assessment Procedure, 2015တို့အရအဆိုပါ လုပ်ငန်းများအတွက် ပတ်ဝန်းကျင် ထိခိုက်မှုဆန်းစစ်ခြင်း Environmental Impact Assessment (EIA) ပြုလုပ်ရန်လိုအပ်ပါသည်။ထိုသို့ဆောင်ရွက်နိုင်ရေးအတွက် CREEC အနေဖြင့်ပတ်ဝန်းကျင် ထိခိုက်မှုဆန်းစစ်လေ့လာခြင်း လုပ်ငန်းများဆောင်ရွက်လျက်ရှိသည့် Ever Green Tech Environmental Services and Training Co., Ltd. အားလုပ်ငန်းအပ်နှံခဲ့ပါသည်။ဤပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်း Environmental Impact Assessment (EIA) တွင် ရထားလမ်း သစ်တလျှောက် တံတားများ (bridges)နှင့်မြေအောက်မြောင်း(culverts) ဆောက်လုပ်ရေးလုပ်ငန်းစဉ် နှင့်လုပ်ငန်းလည်ပတ်ရေး လုပ်ငန်းစဉ်များပါဝင်ပါသည်။ ပင်မရထားလမ်း၏ စုစုပေါင်း အလျားမှာ ၄၀၉.၉၆၀ ကီလိုမီတာဖြစ်သည်။ရထားလမ်းတလျှောက်တံတားပေါင်း၁၂၄စုစုပေါင်းအလျားမှာ၆၉.၃၀၉ကီလိုမီတာဖြစ်ပြီး

ပင်မရထားလမ်း၏၁၆.၉ရာခိုင်နှုန်းရှိပါသည်။ မြေအောက်မြောင်း (culverts) ၇၂၉ခု၏ စုစုပေါင်း ရေပြင် ညီအလျားမှာ၃၁၁၉ဂမီတာဖြစ်ပါသည်။

(က) စီမံကိန်းအဆိုပြုသူအကျဉ်းနှင့်ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်လေ့လာခြင်းလုပ်ငန်းများ ဆောင်ရွက်မည့်အဖွဲ့အစည်းအကျဉ်း

အောက်ဖော်ပြပါဇယားသည်မူဆယ်မန္တလေးရထားလမ်း၏လုပ်ငန်းဖြစ်နိုင်ခြေလေ့လာခြင်း(Feasibility Study (FS)) အတွက် စီမံကိန်းအဆိုပြုသူ၏အကျဉ်းဖြစ်ပါသည်။

စီမံကိန်းအဆိုပြုသူ	
စီမံကိန်းအဆိုပြုသူ	ပို့ဆောင်ရေးနှင့်ဆက်သွယ်ရေးဝန်ကြီးဌာန (MOTC) မြန်မာ့မီးရထား(MR)
စီမံကိန်းအမျိုးအစား	တံတားများ(bridges)နှင့်မြေအောက်မြောင်းအဖုံး(culverts)
စီမံကိန်းတည်နေရာ	မူဆယ်- မန္တလေးရထားလမ်းသည်မြောက်ပိုင်းရှိမူဆယ်မှတောင်ပိုင်းရှိမန္တလေးအထိတည်ရှိမည်ဖြစ်သည်။
ဆက်သွယ်ရန်ပုဂ္ဂိုလ်	၁။ဦးမျိုးဝင်း(အထွေထွေမန်နေဂျာ) မြန်မာ့မီးရထား(အထက်မြန်မာပြည်) အထက်မြန်မာပြည်အုပ်ချုပ်ရေးရုံးမန္တလေးဘူတာကြီး၊ မန္တလေးမြို့၊မြန်မာ။ ဖုန်း- +၉၅-၂-၃၅၁၇၂၊ Fax - +၉၅-၂-၃၅၈၂၉ အီးမေးလ် - myowingmupper@gmail.com
	၂။ဦးဖြိုးထက်ကျော်((လက်ထောက်အထွေထွေမန်နေဂျာ)(စီမံကိန်း)) စီမံကိန်းနှင့်အုပ်ချုပ်ရေးဦးစီးဌာန(မြန်မာ့မီးရထား) နေပြည်တော်ဘူတာကြီးဝင်း၊နေပြည်တော်၊မြန်မာ။ ဖုန်း- +၉၅ - ၆၇-၇၇၁၆၄(ရုံး)၊+၉၅-၉-၄၃၁၂၄၈၀ဂ (mobile) Fax - +၉၅-၆၇-၇၇၁၆၄

အောက်ဖော်ပြပါဇယားသည်ပတ်ဝန်းကျင်နှင့်လူမှုရေးထိခိုက်မှုဆန်းစစ်လေ့လာခြင်းလုပ်ငန်းများ ဆောင်ရွက်မည့်တတိယအဖွဲ့အစည်း Ever Green Tech Environmental Services and Training Co.,Ltd., ၏အကျဉ်းဖြစ်ပါသည်။

Ever Green Tech Environmental Services & Training Co., Ltd.	
Companyအမည်	Ever Green Tech Environmental Services & Training Co., Ltd.
Companyမှတ်ပုံတင်အမှတ်(DICA)	3344/2015-2016(Ygn)
Transitional Third Party မှတ်ပုံတင်အမှတ်	0047
ဆက်သွယ်ရန်လိပ်စာ	တိုက်အမှတ်(၁/၉)၊ဗဟိုလမ်း၊၁၆ရပ်ကွက်၊ လှိုင်မြို့နယ်၊ရန်ကုန်မြို့။
ဆက်သွယ်ရန်ဖုန်းနံပါတ်	09-5099230, 5099232
အီးမေးလ်	green.evergreentech@gmail.com 11kyawswar@gmail.com
ဆက်သွယ်ရန်ပုဂ္ဂိုလ်	ဒေါက်တာကျော်စွာတင့် Ph.D. (Mining) အဓိကအကြံပေး 09-797111000

(ခ)ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်လေ့လာခြင်းလုပ်ငန်းများအတွက် ရွေးချယ်ထားသည့် အကြံပေးပုဂ္ဂိုလ်များ

	No.	Name	Degree	Responsibility	Area of Expertise
Our Consultants	1	Dr. Kyaw Swar Tint	Ph.D. (Mining)	Key Consultant	(a) Air Pollution Control (b) Noise and Vibration (c) Socio-Economy (d) Environmental Management and Monitoring
	2	Mr. Min Aung	M.Sc. (Chemistry)	Key Consultant	(a) Water Pollution Control (b) Modelling of Water Quality (c) Soil and Ground Water Pollution Control
	3	Dr. Thein Tun	Ph.D. (Metallurgy)	Senior Consultant	(a) Risk Assessment and Hazard Management (b) Facilitation of Meeting (c) Occupational Safety and Health
	4	Dr. Myo Min Tun	Ph.D. (Metallurgy)	Senior Consultant	(a) Evaluation of Alternatives (b) Resources Utilization and Management (d) Waste Management
	5	Dr. Sao Hone Pha	Ph.D. (Electronics)	Consultant	Map, Google Earth, Remote Sensing and GIS
	6	Ms. Nandar Nwe	M.S. in EIA/EMS (YTU),	Consultant	Social Impact Assessment (Household Survey)
	7	Ms. Thazin Htwe	M.S. in EIA/EMS (YTU), Dip; in Applied Psychology (YU)	Consultant	Social Impact Assessment (Public Consultation and Stakeholder Engagement)

	8	Mr. Yaw Ma Nar	B.Sc. (Forestry); Dip in EIA/EMS	Field Coordinator	Baseline Study (Traffic and Secondary Data Collection)
	9	Mr. Moe Pyi Kyaw	B.Sc. (Forestry)	Surveyor	Baseline Study (Surface Water and Soil Quality)
	10	Dr. Wyne Nwe NweOo	Ph.D. (Boitech)	Consultant	Species Identification
	11	Dr. Nyunt Lwin	Ph.D. (Zoology)	Consultant	Fauna Diversity
	12	Dr. Nyo Nyo Lwin	Ph.D. (Botany)	Freeland Consultant	Flora Diversity
	13	Dr. Khon Aung	M.B.B.S. (Ygn)	Consultant	Health Impact Assessment
	14	Dr. Myo Min Nyunt	Ph.D. (Mining)	consultant	Geotechnical Engineering
	15	Dr. Ohn Thaik	Ph.D. (Mining)	Consultant	Geotechnical Engineering (Slope Stability)
	16	Dr. Tin Aung Myint	Ph.D. (Geology)	Consultant	Engineering Geology
	17	Dr. Win Swe	Ph.D. (Geography)	Consultant	Hydrology and Socio-economic
	18	Ms. Nay Chi Win Maung	M.E. (Civil)	Consultant	Waste management
	19	Ms. May Thet Zaw	M.E. (Civil)	Consultant	Constructional Related Impact Assessmentand Risk Assessment
	20	U Aung Naing Tun	L.L.B MBA	Consultant	Legal Requirement
Foreign Consultant	21	Mr. Cheng Liang shuang	M.Sc. (Conservation of Soil & Water)	Consultant	Water resources and high-speed railway design

(ဂ) သဘာဝပတ်ဝန်းကျင်ထိခိုက်မှု ဆန်းစစ်လေ့လာခြင်း၏ရည်ရွယ်ချက်များ

- လူမှုရေးနှင့် သဘာဝပတ်ဝန်းကျင်ဆိုင်ရာ ကိစ္စရပ်များကို ရှင်းလင်းစွာ ကိုင်တွယ်ဖြေရှင်းရန်နှင့် ဖွံ့ဖြိုးရေးနှင့် ဆုံးဖြတ်ချက်ချခြင်းလုပ်ငန်းစဉ်များတွင် ထည့်သွင်း စဉ်းစား ပေးရန်။
- အဆိုပြုထားသောစီမံကိန်းဖွံ့ဖြိုးတိုးတက်မှုများ၏ ဆိုးရွားသည့် ဇီဝရူပဗေဒဆိုင်ရာလူမှုရေးနှင့် အခြားသက်ရောက်မှုများကို ကြိုတင်ခန့်မှန်းခြင်း၊ ရှောင်ရှားခြင်းနှင့် လျှော့ချခြင်းများ ပြုလုပ်ရန်။
- သဘာဝစနစ်များ၏ ကုန်ထုတ်စွမ်းအားနှင့် စွမ်းဆောင်နိုင်မှုနှင့် လုပ်ငန်းဆောင်တာ များကို ထိန်းသိမ်းသောဂေဟစနစ်လုပ်ငန်းစဉ်များကိုကာကွယ်ရန်။
- ရေရှည်တည်တံ့ခိုင်မြဲ၍ အရင်းအမြစ်အသုံးပြုခြင်းနှင့် စီမံခန့်ခွဲမှု အခွင့်အရေးများကို အကောင်းဆုံးဖြစ်စေသောဖွံ့ဖြိုးတိုးတက်မှုကို မြှင့်တင်ရန်။

(ဃ) ပတ်ဝန်းကျင်ထိခိုက်မှု လေ့လာဆန်းစစ်ခြင်း၏ လေ့လာမှုနယ်ပယ်

အဆိုပြုရထားလမ်း၏ တံတားများနှင့် မြေအောက်မြောင်းဖုံးများစီမံကိန်းအတွက် သဘာဝပတ်ဝန်းကျင် ထိခိုက်မှု လေ့လာဆန်းစစ်ချက်သည် အောက်ပါတို့အတွက် အကျုံးဝင်သည်။

- ရထားလမ်းသစ် လမ်းကြောင်းတစ်လျှောက် တံတားများ နှင့် မြေအောက်မြောင်း များ ဆောက်လုပ်ရေး
- မြန်မာ့မီးရထားတစ်လျှောက် အဓိကရထားလမ်း၏ ၁၆.၉% ရှိသောတံတား ၁၂၄ စင်း၏ စုစုပေါင်းအလျားသည် ၆၉.၃၀၉ ကီလိုမီတာ ဖြစ်ပြီးမြေအောက်မြောင်း ၇၂၉ ခု၏ စုစုပေါင်းအလျားသည် ၃၁,၁၉၀ မီတာ ဖြစ်သည်။

၁.၂။ ဥပဒေများနှင့်စည်းမျဉ်းစည်းကမ်းဆိုင်ရာလိုအပ်ချက်များအကျဉ်းချုပ်

(က) အဆိုပြုစီမံကိန်းနှင့် သက်ဆိုင်သည့် ဥပဒေနှင့် နည်းဥပဒေများ

အဆိုပြုစီမံကိန်းနှင့်တိုက်ရိုက်ဖြစ်စေ ၊သွယ်ဝိုက်၍ဖြစ်စေ သက်ဆိုင်သည့် မြန်မာနိုင်ငံတွင် ထုတ်ပြန်ထားရှိပြီးသောဥပဒေဆိုင်ရာစည်းမျဉ်းစည်းကမ်းများ၊နည်းဥပဒေများ၊လုပ်ထုံးလုပ်နည်းများအားအောက်ဖော်ပြပါဇယားတွင်အကျဉ်းဖော်ပြထားရှိပါသည်။

ဇယား - အလုပ်သမားများ၏အခွင့်အရေး၊ လုပ်ငန်းခွင်ဘေးကင်းလုံခြုံမှုနှင့် ကျန်းမာရေးဆိုင်ရာ ဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
အလုပ်သမားအဖွဲ့အစည်းနည်းဥပဒေ (ဥပဒေအမှတ်၁၇မှ၁၁)	၂၀၁၂
အလုပ်သမားရေးရာအငြင်းပွားမှုဖြေရှင်းရေးဥပဒေကိုဒုတိယအကြိမ်ပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၁၇)	၂၀၁၉
အလုပ်သမားရေးရာအငြင်းပွားမှုဖြေရှင်းရေးနည်းဥပဒေ(ဥပဒေအမှတ်၅)	၂၀၁၄
အလုပ်အကိုင်နှင့်ကျွမ်းကျင်မှုဖွံ့ဖြိုးတိုးတက်ရေးဥပဒေ (ဥပဒေအမှတ်၅၊၁၄၊၃၀(က၊ခ))	၂၀၁၃
ခွင့်ရက်နှင့်အလုပ်ပိတ်ရက်အက်ဥပဒေ၊၁၉၅၁ (ဇူလိုင်၂၀၁၄ဥပဒေပြင်ဆင်ခဲ့သည်)	၂၀၁၄
အနည်းဆုံးအခကြေးငွေဥပဒေ (ဥပဒေအမှတ်၁၂၊၁၃(ကမှဆ))	၂၀၁၃
အခကြေးငွေပေးချေရေးဥပဒေ (ဥပဒေအမှတ်၃၊၄၊၅၊၇၊၈၊၁၀၊၁၄)	၂၀၁၆
လူမှုဖူလုံရေးဥပဒေ (ဥပဒေအမှတ်၁၁(က)၊၁၅(က)၊၁၈(ခ)၊၄၈၊၄၉၊၇၅)	၂၀၁၂
အလုပ်သမားလျော်ကြေးအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ	၂၀၀၅
ကူးစက်ရောဂါကာကွယ်တားဆီးရေးဥပဒေ (ဥပဒေအမှတ်၃၊၄၊၉၊၁၁)	၁၉၉၅
ဆေးလိပ်သောက်ခြင်းနှင့်ဆေးရွက်ကြီးပစ္စည်းသုံးစွဲမှုထိန်းချုပ်ခြင်းဥပဒေ (ဥပဒေအမှတ်၉)	၂၀၀၆
လုပ်ငန်းခွင်ဘေးအန္တရာယ်ကင်းရှင်းရေးနှင့်ကျန်းမာရေးဆိုင်ရာဥပဒေ (ပြည်ထောင်စုလွှတ်တော်ဥပဒေအမှတ်၈)	၂၀၁၉
အလုပ်သမားလျော်ကြေးအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ	၂၀၀၅
တိုင်းရင်းဆေးဝါးဥပဒေ(ဥပဒေအမှတ်၇)	၁၉၉၆
ပြည်ပအလုပ်အကိုင်ဆိုင်ရာဥပဒေ(ဥပဒေအမှတ်၃)	၁၉၉၉
ဓါတုပစ္စည်းနှင့်ဆက်စပ်ပစ္စည်းများအန္တရာယ်မှတားဆီးကာကွယ်ရေးဥပဒေ(ဥပဒေအမှတ်၂၈)	၂၀၁၃

ဇယား- သဘာဝပတ်ဝန်းကျင်ဆိုင်ရာဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
ပိုးသတ်ဆေးဥပဒေ ပြည်ထောင်စုလွှတ်တော်ဥပဒေအမှတ် ၁၄/၂၀၁၆	၂၀၁၆
သစ်တောဥပဒေ	၁၉၉၂
ဇီဝမျိုးစုံမျိုးကွဲများကာကွယ်စောင့်ရှောက်ခြင်းနှင့်ကာကွယ်စောင့်ရှောက်ထားသော ဒေသဥပဒေ	၂၀၁၈

ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများထိန်းသိမ်းရေးဥပဒေ (ဥပဒေအမှတ်၈၊၁၁ (က)၊၁၃၊၁၉၊၂၄ (ခ)၊၃၀)	၂၀၀၆
ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများထိန်းသိမ်းရေးနည်းဥပဒေ	၂၀၁၃
ရေချိုငါးလုပ်ငန်းဥပဒေ (ဥပဒေအမှတ်၃၆၊၄၀၊၄၁)	၁၉၉၁
တိရစ္ဆာန်ကျန်းမာရေးနှင့်ဖွံ့ဖြိုးရေးဥပဒေ(ဥပဒေအမှတ်၁၇)	၂၀၁၀

ဇယား- ယဉ်ကျေးမှုနှင့်အမွေအနှစ်ဆိုင်ရာဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
တိုင်းရင်းသားလူမျိုးများ၏အခွင့်အရေးကာကွယ်စောင့်ရှောက်သည့်ဥပဒေ(ဥပဒေအမှတ်၅)	၂၀၁၅
ယဉ်ကျေးမှုအမွေအနှစ်ဒေသများကာကွယ်ထိန်းသိမ်းရေးဥပဒေ (ဥပဒေအမှတ်၁၅၊၁၆)	၂၀၁၉
ရှေးဟောင်းအဆောက်အအုံများကာကွယ်ထိန်းသိမ်းရေးဥပဒေ(ဥပဒေအမှတ်၁၂၊၁၅၊၂၀)	၂၀၁၅
ရှေးဟောင်းဝတ္ထုပစ္စည်းများကာကွယ်ထိန်းသိမ်းရေးဥပဒေ(ဥပဒေအမှတ်၁၂၊၁၅၊၂၀)	၂၀၁၅
ရှေးဟောင်းအဆောက်အအုံများကာကွယ်ထိန်းသိမ်းရေး (ဥပဒေအမှတ်၅၁)	၂၀၁၅
ရှေးဟောင်းဝတ္ထုပစ္စည်းများကာကွယ်ထိန်းသိမ်းရေးဥပဒေ (ဥပဒေအမှတ်၄၃)	၂၀၁၅
ကိုးကွယ်ရာဘာသာကူးပြောင်းခြင်းဆိုင်ရာဥပဒေ(ဥပဒေအမှတ်၄၈)	၂၀၁၅

ဇယား- လူမှုအသိုင်းအဝိုင်းဖွံ့ဖြိုးတိုးတက်မှု၊ ကျန်းမာရေးနှင့်ဘေးကင်းရေးဆိုင်ရာဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
ကျေးလက်ဒေသဖွံ့ဖြိုးတိုးတက်ရေးဥပဒေ (ဥပဒေအမှတ်၃၉)	၂၀၁၉
လူဦးရေတိုးပွားနှုန်းထိန်းညှိခြင်းဆိုင်ရာကျန်းမာရေးစောင့်ရှောက်မှုဥပဒေ (ဥပဒေအမှတ်၂၈)	၂၀၁၅
တောင်သူလယ်သမားအခွင့်အရေးကာကွယ်ရေးနှင့်အကျိုးစီးပွားမြှင့်တင်ရေးဥပဒေ(ဥပဒေအမှတ်၃၂)	၂၀၁၃
နယ်စပ်ဒေသနှင့်တိုင်းရင်းသားလူမျိုးများဖွံ့ဖြိုးတိုးတက်ရေးဥပဒေကိုဒုတိယအကြိမ်ပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၄၄)	၂၀၁၅
ပုဂ္ဂလိကကျန်းမာရေးစောင့်ရှောက်မှုဝန်ဆောင်မှုများနှင့်သက်ဆိုင်သောဥပဒေ (ဥပဒေအမှတ်၅)	၂၀၀၇
မြန်မာ့ပြည်သူ့ကျန်းမာရေးဥပဒေ (ဥပဒေအမှတ်၃၊၅)	၁၉၇၂
မြေလွတ်၊မြေလပ်နှင့်မြေရိုင်းများစီမံခန့်ခွဲမှုဥပဒေ	၂၀၁၂

ဇယား- သယ်ယူပို့ဆောင်ရေးနှင့်ဆက်သွယ်ရေးဆိုင်ရာဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
မော်တော်ယာဉ်ဥပဒေ	၂၀၁၅
ရထားပို့ဆောင်ရေးလုပ်ငန်းဥပဒေ	၂၀၁၆
အမြန်လမ်းမကြီးများဥပဒေ (ဥပဒေအမှတ်၂၄)	၂၀၁၅
အမြန်လမ်းမကြီးများအက်ဥပဒေကိုပြန်လည်ပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၃၃)	၂၀၁၄
ကုန်းလမ်းသယ်ယူပို့ဆောင်ရေးလုပ်ငန်းများဥပဒေ (ဥပဒေအမှတ်၃)	၂၀၁၆
တံတားကြီးများဥပဒေ(ဥပဒေအမှတ်၁၆)	၂၀၁၉
ဘက်စုံပို့ဆောင်ရေးဥပဒေ (ဥပဒေအမှတ်၃)	၂၀၁၄
တာတမံအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၂)	၁၉၉၈
လမ်းနှင့်တံတားအသုံးပြုခြင်းဆိုင်ရာဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ(ဥပဒေအမှတ်၂၅)	၂၀၁၄

ဇယား- မြေယာရယူခြင်းဆိုင်ရာဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
မြေလွတ်၊မြေလပ်နှင့်မြေရိုင်းများစီမံခန့်ခွဲမှုဥပဒေ	၂၀၁၂
မြေသိမ်းဆည်းခြင်း၊ပြန်လည်နေရာချထားခြင်းနှင့်ပြန်လည်ထူထောင်ခြင်းဆိုင်ရာဥပဒေ (ဥပဒေပုဒ်မ၃၉၊၄၁၊၄၂၊၄၆၊၅၄ (ခ)(ဂ)၊၅၈)	၂၀၁၉
လယ်ယာမြေအက်ဥပဒေ (ဥပဒေအမှတ်၁၁)	၂၀၁၂
လယ်ယာမြေဥပဒေ	၂၀၁၂
အမျိုးသားမြေအသုံးချမှုမူဝါဒ	၂၀၁၆

ဇယား- အဆိုပြုထားသောစီမံကိန်းအတွက်အခြားဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
ရေကြောင်းအတားအဆီးများအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၂၆)	၂၀၁၃
မြန်မာ့သတ္တုတွင်းဥပဒေ (ဥပဒေအမှတ်၁၃)	၂၀၁၈
အီလက်ထရောနစ်ဆက်သွယ်ဆောင်ရွက်ရေးဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၆)	၂၀၁၄
ဆက်သွယ်ရေးဥပဒေ (ဥပဒေအမှတ်၃၁)	၂၀၁၃
ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံတော်ဖွဲ့စည်းပုံအခြေခံဥပဒေ (ပိုဒ်ခွဲ၂၄၊၄၅၊၃၄၉၊၃၅၉)	၂၀၀၈

စံချိန်စံညွှန်းသတ်မှတ်ခြင်းဆိုင်ရာဥပဒေ (ဥပဒေအမှတ်၂၈)	၂၀၁၄
ပတ်ဝန်းကျင်ထိန်းသိမ်းစောင့်ရှောက်ခြင်းဥပဒေ (ဥပဒေအမှတ်၇၊၁၄၊၁၅၊၂၄၊၂၅၊၂၉)	၂၀၁၂
ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးနည်းဥပဒေများ (စည်းမျဉ်း၅၅၊၆၉(က)၊ (ခ))	၂၀၁၄
(EIA) ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာလုပ်ထုံးလုပ်နည်း(ပိုဒ်ခွဲ၁၀၂မှ၁၁၀၊၁၁၃၊၁၁၅၊၁၁၇)	၂၀၁၅
အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာအရည်အသွေး(ထုတ်လွှတ်မှု)လမ်းညွှန်ချက်များ	၂၀၁၅
အလုပ်ရုံများအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ၁၉၅၁ခုနှစ် (ပြည်ထောင်စုလွှတ်တော်ဥပဒေအမှတ်၁၂/၂၀၁၆)	၂၀၁၆
ပုဂ္ဂလိကစက်မှုလုပ်ငန်းဥပဒေ	၁၉၉၀
မြန်မာ့အာမခံဥပဒေ (ဥပဒေအမှတ်၁၅၊၁၆)	၁၉၉၃
မြန်မာနိုင်ငံမီးသတ်တပ်ဖွဲ့ဥပဒေ(ဥပဒေအမှတ်၂၅)	၂၀၁၅
လျှပ်စစ်ဥပဒေ	၂၀၁၄
လျှပ်စစ်နည်းဥပဒေ	၂၀၁၅
ရေနံနှင့်ရေနံထွက်ပစ္စည်းဆိုင်ရာဥပဒေ	၂၀၁၇
ပို့ကုန်သွင်းကုန်ဥပဒေ	၂၀၁၂
မြန်မာနိုင်ငံအင်ဂျင်နီယာကောင်စီဥပဒေ (ဥပဒေအမှတ်၂၀၊၂၄၊၂၅၊၃၁ (က)၊၃၇)	၂၀၁၃
မူပိုင်ခွင့်ဥပဒေ	၂၀၁၉
ပိုးသတ်ဆေးဥပဒေ (ပြည်ထောင်စုလွှတ်တော်ဥပဒေအမှတ်၁၄/၂၀၁၆)	၂၀၁၆
သစ်တောဥပဒေ	၁၉၉၂
ဇီဝမျိုးစုံမျိုးကွဲများကာကွယ်စောင့်ရှောက်ခြင်းနှင့်ကာကွယ်စောင့်ရှောက်ထားသော ဒေသများဥပဒေ	၂၀၁၈
ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများထိန်းသိမ်းရေးဥပဒေ (ဥပဒေအမှတ်၈၊၁၁ (က)၊၁၃၊၁၉၊၂၄ (ခ)၊၃၀)	၂၀၀၆
ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများထိန်းသိမ်းရေးနည်းဥပဒေ	၂၀၁၃
ရေချိုငါးလုပ်ငန်းဥပဒေ (ဥပဒေအမှတ်၃၆၊၄၀၊၄၁)	၁၉၉၁
တိရစ္ဆာန်ကျန်းမာရေးနှင့်ဖွံ့ဖြိုးရေးဥပဒေ(ဥပဒေအမှတ်၁၇)	၂၀၁၀
မြေသြဇာဥပဒေ(ဥပဒေအမှတ်၇)	၂၀၀၂

(ခ) နိုင်ငံတကာကွန်ဗင်းရှင်းများ၊သဘောတူညီစာချုပ်များအကျဉ်းချုပ်

မြန်မာနိုင်ငံသည် အထက်ဖော်ပြပါ ပြည်တွင်း ဥပဒေများအပြင် အောက်ဖော်ပြပါ နိုင်ငံတကာကွန်ဗင်းရှင်းများ၊ သဘောတူစာချုပ်များတွင် လက်မှတ်ရေထိုးထားသည့် အဖွဲ့ဝင်နိုင်ငံ

ဖြစ်ပါသည်။ ဤနိုင်ငံတကာ နိုင်ငံတကာကွန်ဗင်းရှင်းများ၊ သဘောတူစာချုပ်များသည် အဆိုပြုစီမံကိန်း၏ လုပ်ရှားဆောင်ရွက်ချက်များနှင့်သက်ဆိုင်ပါသည်။

ဇယား-အဆိုပြုစီမံကိန်းနှင့်ဆက်စပ်သည့်နိုင်ငံတကာကွန်ဗင်းရှင်းများ၊သဘောတူညီစာချုပ်များ

နိုင်ငံတကာကွန်ဗင်းရှင်းများ၊သဘောတူညီစာချုပ်များ	ဆောင်ရွက်ချက်များ
လူ့ပတ်ဝန်းကျင်ဆိုင်ရာကုလသမဂ္ဂညီလာခံ၏ကြေငြာချက်	၁၉၇၂
အိုဇုန်းလွှာကိုကာကွယ်ရန် Vienna ကွန်ဗင်းရှင်း၊ ၁၉၈၅	၁၉၉၈
အိုဇုန်းလွှာကိုပျက်စီးစေသောအရာများအပေါ် Montreal ညှိနှိုင်းချက်မှတ်တမ်း	၁၉၉၃
Basel ကွန်ဗင်းရှင်း၊ ၁၉၈၉	၂၀၁၅
ကုလသမဂ္ဂရာသီဥတုပြောင်းလဲခြင်းဆိုင်ရာမူဘောင်သဘောတူညီချက် (UNFCCC)၊ နယူးယောက်၊ ၁၉၉၂ နှင့် ကျိုတို ညှိနှိုင်းချက်မှတ်တမ်း ၁၉၉၇	၁၉၉၄နှင့်၂၀၀၅
ဇီဝမျိုးစုံမျိုးကွဲများဆိုင်ရာကွန်ဗင်းရှင်း၊ Rio de Janeiro၊ ၁၉၉၂	၁၉၉၄
အာရှ၏အနည်းဆုံးကုန်ကျစရိတ်ရှိသောဖန်လုံအိမ်ဓာတ်ငွေ့လျှော့ချရေးနည်းဗျူဟာ (၁၉၉၈ ALGAS)	၁၉၉၈
ကုလသမဂ္ဂအစီအစဉ် 21	၁၉၉၇
မြန်မာနိုင်ငံတွင်ပြဌာန်းထားသည့်သက်ဆိုင်ရာ ILO ကွန်ဗင်းရှင်း • C1 Hours of Work • Unemployment Convention • C14 Weekly Rest • C17 Workmen’s Compensation (Accidents) • Workmen's Compensation (Occupational Diseases) Convention • C19 Equality of Treatment (Accident Compensation) • C26 Minimum Wage Fixing Machinery • C29 Forced Labour Convention • C42 Workmen’s Compensation (Occupational Diseases) Revised 1934 • C52 Holidays with Pay • C63-Convention concerning Statistics of Wages and Hour of Work • C87- Freedom of Association and Protection of the Right to Organise Convention • C182- Worst Forms of Child Labour Convention	
အပြည်ပြည်ဆိုင်ရာသဘာဝပတ်ဝန်းကျင်ဆိုင်ရာဥပဒေ	၂၀၁၇

(ဂ) ဝန်ခံကတိပြုလွှာအကျဉ်းချုပ်

စီမံကိန်းအဆိုပြုသူသည် အောက်ဖော်ပြပါအချက်များအား လေးစားလိုက်နာ ဆောင်ရွက်သွားမည်ဖြစ်ပါကြောင်းဝန်ခံကတိပြုပါသည်။

(က) လုပ်ငန်းလုပ်ဆောင်သူအနေဖြင့် ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးအစီရင်ခံစာတွင် ဖော်ပြထားသော သဘာဝပတ်ဝန်းကျင်ထိန်းသိမ်းရေးကတိကဝတ်များ၊ ပတ်ဝန်းကျင်ထိခိုက်မှု လျှော့ချရေးနည်းလမ်းများ၊ စီမံခန့်ခွဲမှုအစီအစဉ်များအားအစီရင်ခံစာတွင် ဖော်ပြထားသည့် ဥပဒေ စည်းမျဉ်းစည်းကမ်းများဖြစ်သည့် Environmental Conservation Laws နှင့် 2012 Environmental Conservation Rules 2015 များနှင့်အညီလိုက်နာဆောင်ရွက်သွားပါမည်။

(ခ) ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးအစီရင်ခံစာတွင် ဖော်ပြထားသည့် သဘာဝပတ်ဝန်းကျင်ထိန်းသိမ်းရေးနှင့် လူမှုစီးပွားဖွံ့ဖြိုးတိုးတက်ရေးခံယူချက်များအတိုင်းတသွေမတိမ်းလုပ်ဆောင်သွားပါမည်။

(ဂ) အစီရင်ခံစာတွင် ပါရှိသည့် စီမံကိန်း၏ သက်ဆိုင်ရာဥပဒေများ၊ နည်းဥပဒေများနှင့် လမ်းညွှန်ချက်များအားသိရှိပြီးလေးစားလိုက်နာသွားပါမည်။

(ဃ) အစီရင်ခံစာတွင် ချမှတ်ရေးဆွဲထားသော ပတ်ဝန်းကျင် ထိခိုက်မှု ရှောင်လွှဲနိုင်သည့် နည်းလမ်း များ၊ ထိခိုက်မှုလျှော့ချရေးနည်းလမ်းများနှင့် စောင့်ကြည့်လေ့လာရေး အစီအစဉ်များကို အပြည့်အဝလိုက်နာဆောင်ရွက်သွားမည်ဖြစ်ပါသည်။

(ဃ) အဆိုပြုစီမံကိန်း၏ သဘာဝပတ်ဝန်းကျင်၊ လူမှုနှင့် ကျန်းမာရေးအကျိုးပြု မူဝါဒများ

စီမံကိန်းအဆိုပြုသူ၏ရေရှည်တည်တံ့ရေးစံနမူနာမှာ"ရေရှည်တည်တံ့ရေး ဆောင်ရွက်ချက်ဟူသည် အစုရှယ်ယာရှင်များအတွက် တန်ဖိုးတစ်ခုဖန်တီးပေးနိုင်ခြင်း နှင့် အနာဂတ်မျိုး ဆက်သစ်များအထိသဘာဝအရင်းအမြစ်များအားမပျက်မစီးအသုံးပြုနိုင်ခြင်းအားဖြင့် လူသားများ၊ သဘာဝပတ်ဝန်းကျင်နှင့် လူမှုအသိုင်းအဝိုင်းအပေါ် အကျိုးပြုနိုင်ခြင်းပေတည်း။ " ဟူ၍ ဖြစ်ပါသည်။ စီမံကိန်းအဆိုပြုသူ၏ အဓိကမူဝါဒများနှင့် ကတိကဝတ်များမှာအောက်ပါအတိုင်းဖြစ်ပါသည်။

- ပြည်သူလူထု၊ အလုပ်သမားများ နှင့် ဒေသခံများ၏ ကျန်းမာရေးနှင့် ဘေးကင်းလုံခြုံမှုအား အကာအကွယ်ပေးခြင်း။
- ဒေသခံများ၏ လူ့အခွင့်အရေး၊ စီးပွားရေးနှင့် လူမှုဖွံ့ဖြိုးတိုးတက်ရေးများအား အကာအကွယ်ပေးခြင်း။

- သဘာဝပတ်ဝန်းကျင် ကာကွယ်ရေး နှင့် ဇီဝမျိုးကွဲများနှင့် ဂေဟစနစ် ထိန်းသိမ်း စောင့်ရှောက်ခြင်း။
- လုပ်ငန်းစဉ်များ၊ ဝန်ဆောင်မှုများ၊ ထုတ်ကုန်များ၏ အရည်အသွေးအား အဆက်မပြတ် မြှင့်တင်ခြင်း။
- လုပ်ငန်းခွင်အတွင်း သဘာဝပတ်ဝန်းကျင်၊ ကျန်းမာရေး၊ ဘေးကင်းလုံခြုံမှု နှင့် သန့်ရှင်း စင်ကြယ်မှု နှင့် သက်ဆိုင်သော မြန်မာနိုင်ငံ ဥပဒေများ၊ နည်းဥပဒေများ နှင့် စက်မှုဇုန် စံချိန်စံညွှန်းများနှင့် ကိုက်ညီမှုရှိခြင်း။
- ဝန်ထမ်းများအား အားပေးလှုံ့ဆော်ပေး၍ ကန်ထရိုက်တာ များအား အောင်မြင်စေရန် စေ့စပ် ညှိနှိုင်းပေးနိုင်သော HSE ထူးချွန်မှုကို မြှင့်တင်ပေးနိုင်သော တက်ကြွသော ခေါင်းဆောင်မှု။
- HSE စွမ်းဆောင်ရည်ကို ကုမ္ပဏီ၏ လုပ်ဆောင်ချက်များနှင့် အညီ တိုင်းတာရန်နှင့် မြှင့်တင်ရန် လိုအပ်သော ရည်မှန်းချက်နှင့် ဗျူဟာများ ချမှတ်ခြင်း။
- ကျွန်တော်တို့၏ စီမံကိန်းများတွင် ရေရှည်တည်တံ့သောဖွံ့ဖြိုးတိုးတက်မှု နိယာမများကို အကောင်အထည်ဖော်ခြင်း။
- မလိုလားအပ်သည့် အဖြစ်အပျက်များ ကင်းစင်သော ရည်မှန်းချက်အတွက် HSE အား စီမံခန့်ခွဲခြင်း။
- အဆင့်မြင့် သဘာဝပတ်ဝန်းကျင်ကာကွယ်ရေးနှင့် စွမ်းအင်ထိရောက်မှု နည်းစနစ်များကို အသုံးပြုခြင်းအားဖြင့် ကျွန်ုပ်တို့၏ လုပ်ငန်းစဉ်များတွင် သတ်မှတ်ထားသော မဟာဗျူဟာ များနှင့်အညီ အဆက်မပြတ်တိုးတက်မှုကို ရှာဖွေနိုင်ခြင်း။

(c) တံတားများ(bridges) နှင့်မြေအောက်မြောင်းများ(culverts) အတွက်အမျိုးသား ပတ်ဝန်းကျင် ဆိုင်ရာ အရည်အသွေး(ထုတ်လွှတ်မှု) လမ်းညွှန်ချက်အကျဉ်းချုပ်

တံတားများနှင့်ခုံးကျော်တံတားအပါအဝင်အဝေးပြေးလမ်းမကြီးများ (Large and Seal Roads) ဖောက်လုပ်ခြင်း၊ အသုံးပြုခြင်းနှင့် ပြုပြင်ထိန်းသိမ်းခြင်း လုပ်ငန်းများတွင် ဤလမ်းညွှန် ချက်များကိုလိုက်နာရမည်။

စွန့်ထုတ်အရည်အဆင့်သတ်မှတ်ချက်များ(Effluent Levels)

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

[a] Standard unit

အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာအရည်အသွေး(ထုတ်လွှတ်မှု)

လမ်းညွှန်ချက်ပါဆူညံသံအဆင့်သတ်မှတ်ချက်

အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာအရည်အသွေး(ထုတ်လွှတ်မှု) လမ်းညွှန်ချက်ပါ ဆူညံသံ အဆင့်သတ်မှတ်ချက်များသည် အောက်ဖော်ပြပါဇယားတွင်ဖော်ပြထားသည်။

Receptor	OneHourLAeq(dBA)	
	နေ့ (၇:၀၀-၂၂:၀၀) (၁၀:၀၀-၂၂:၀၀အများပြည်သူအားလပ်ရက်များအတွက်)	ည (၇:၀၀-၂၂:၀၀) (၂၂:၀၀-၁၀:၀၀အများပြည်သူအားလပ်ရက်များအတွက်)
လူနေအိမ်, အဖွဲ့အစည်းဆိုင်ရာ, ပညာရေး	၅၅	၄၅
စက်မှု, စီးပွားဖြစ်	၇၀	၇၀

Source:NEQG(December 2015)

၁.၃။ စီမံကိန်းဆိုင်ရာဖော်ပြချက်အကျဉ်းချုပ်

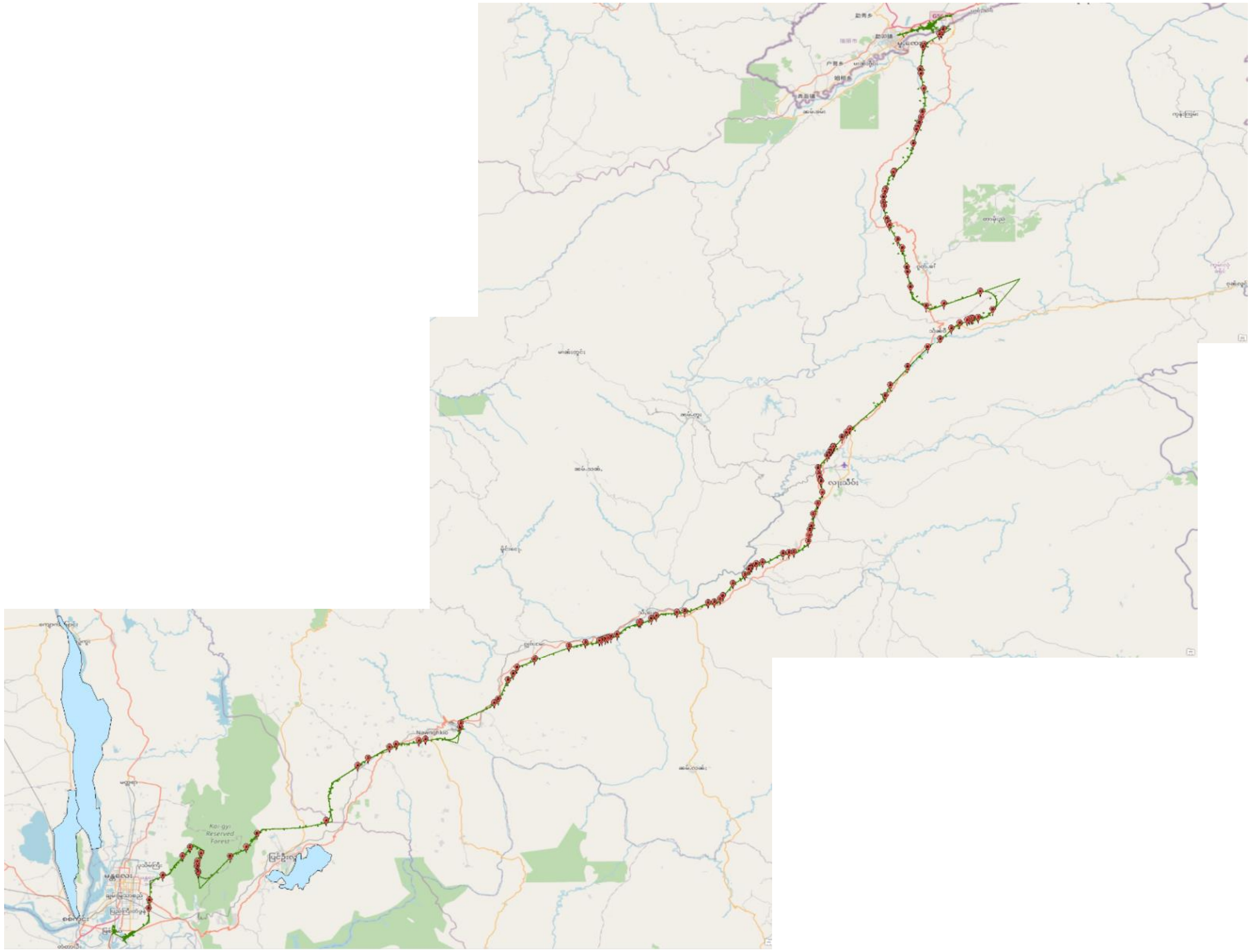
၁.၃.၁။စီမံကိန်းဧရိယာ

မူဆယ်-မန္တလေးရထားလမ်းတွင်အောက်ဖော်ပြပါ တည်ဆောက်မှုများပါဝင်မည်ဖြစ်ပါသည်။

- ပင်မရထားလမ်း၏၁၆.၉ရာခိုင်နှုန်းရှိပြီးစုစုပေါင်းအလျား၆၉.၃၀၉ကီလိုမီတာရှိသည့်တံတား အသစ်၁၂၄စင်း
- တံတားတစ်စင်းလျှင်ပျမ်းမျှရေပြင်ညီအလျား၄၂မီတာရှိပြီးပင်မရထားလမ်းတလျှောက် စုစုပေါင်းရေပြင်ညီအလျား၃၁၁၉၀မီတာရှိသည့်မြေအောက်မြောင်း(culverts)၇၂၉ခု
- top ဧရိယာစုစုပေါင်း၃၃၀၀၀စတုရန်းမီတာရှိသည့်တံတား(frame bridges) ၅၀စင်း
- ဧရိယာစုစုပေါင်း၅၆၄၄.၂စတုရန်းမီတာရှိသည့်တံတား(rigid frame bridges) ၃စင်း
- စုစုပေါင်းအလျား၂၇၂၅မီတာနှင့်ဧရိယာစုစုပေါင်း၂၈၉၄၅.၂စတုရန်းမီတာခုံးကျော်တံတား (road-over bridges) ၂၅စင်း
- topဧရိယာစုစုပေါင်း၃၀၃၈.၄စတုရန်းမီတာရှိသည့်လူသွားခုံးကျော်တံတား(pedestrian overpasses) ၉စင်း
- topဧရိယာစုစုပေါင်း၆၈၁၂.၂စတုရန်းမီတာရှိသည့်မြေအောက်လမ်းကူး(underpass bridges) 13စင်း
- စုစုပေါင်းအလျား၈၂.၇မီတာရှိသည့်ရေသွယ်တံတား(aqueduct) ၁စင်း
- ဧရိယာစုစုပေါင်း၇၆၆.၉စတုရန်းမီတာရှိသည့်တံတား(new platform bridges) ၁၃စင်း
- စုစုပေါင်းရေပြင်ညီအလျား၁၀၄၀.၄၆မီတာရှိသည့်လမ်း၏မြေအောက်မြောင်း (new road culverts)၇၃ခု
- စုစုပေါင်းရေပြင်ညီအလျား၆၈.၆မီတာရှိသည့်လမ်း၏တိုးချဲ့မြေအောက်မြောင်း (new road culverts)၂ခု
- အလျား၃၅.၃မီတာနှင့်ဧရိယာ၅၂.၉စတုရန်းမီတာတံတား (new evacuation exit bridge) ၁စင်းတို့စသဖြင့်ပါဝင်ပါသည်။

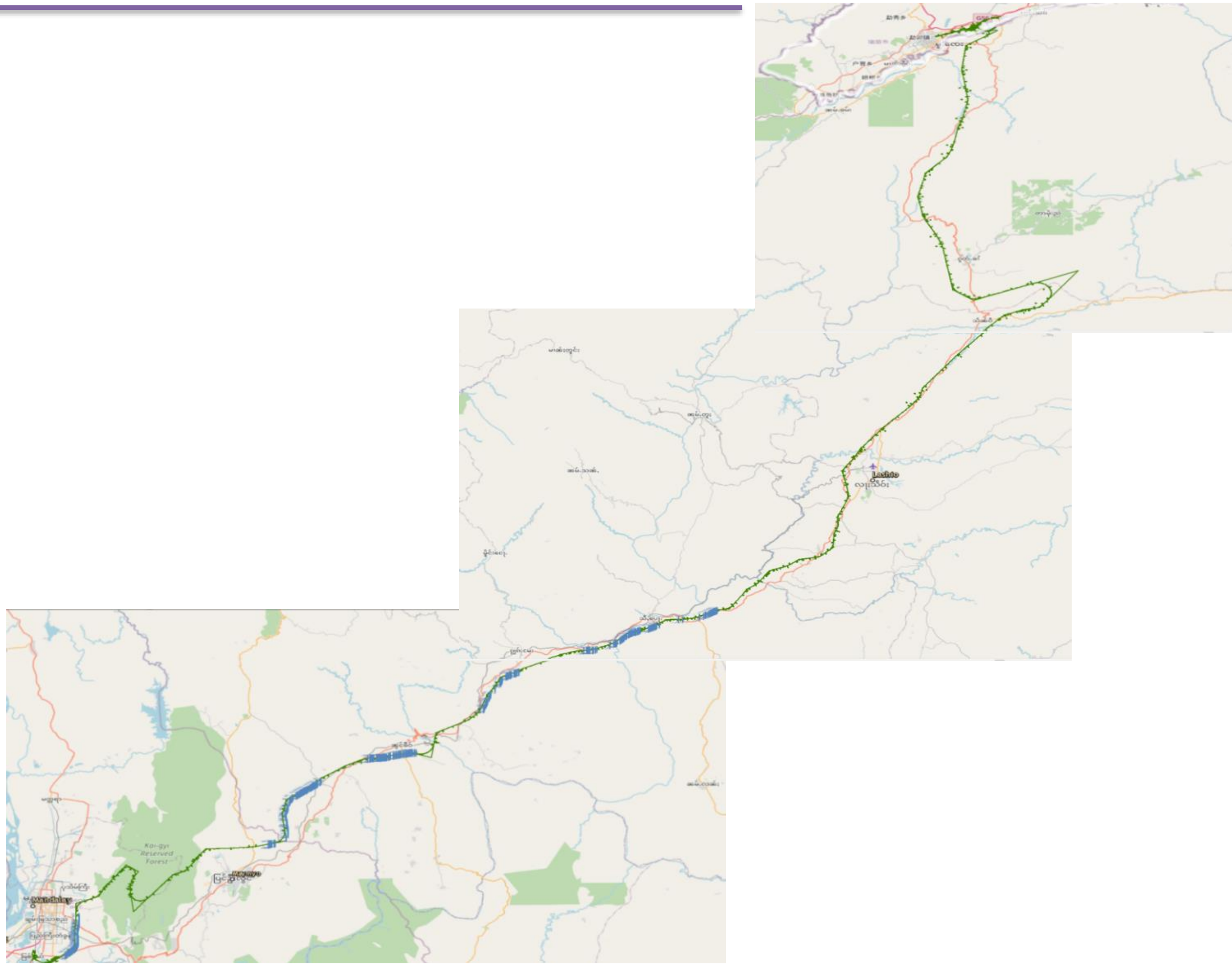
၁.၃.၂။ စီမံကိန်းတည်နေရာ

ရထားလမ်းတလျှောက်တံတားများ၊အဓိကမြစ်ကူးတံတားများနှင့်မြေအောက်မြောင်းများ၏တည်နေရာများကိုပုံ(၁.၁)၊(၁.၂)၊(၁.၃)များတွင်ဖော်ပြထားပါသည်။



ပုံ(၁.၁) မူဆယ်-မန္တလေး ရထားလမ်းတလျှောက် တည်ဆောက်မည့် တံတားများ၏ တည်နေရာပြမြေပုံ

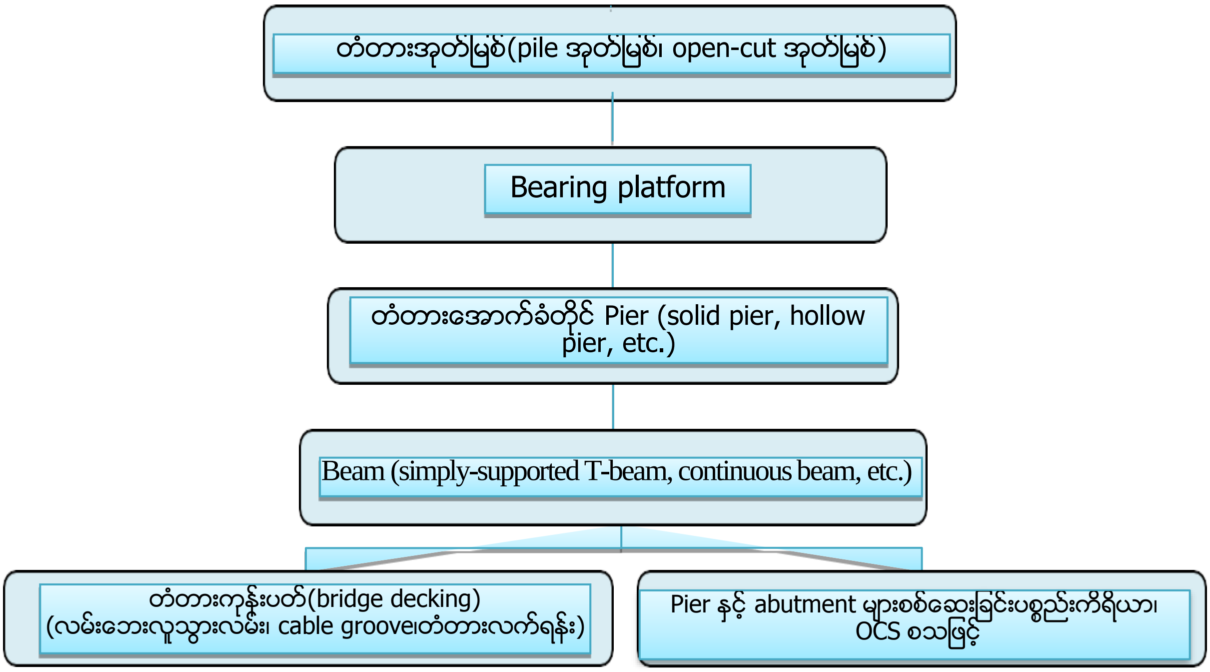
ပုံ(၁.၂) မူဆယ်-မန္တလေး ရထားလမ်းတလျှောက်တည်ဆောက်မည့်အဓိကတံတားကြီးများ၏တည်နေရာပြမြေပုံ



ပုံ(၁.၃)မူဆယ်-မန္တလေး ရထားလမ်းတလျှောက်တည်ဆောက်မည့်
မြေအောက်မြောင်းများ(Culverts)၏တည်နေရာပြမြေပုံ

၁.၃.၃။ယေဘုယျတံတားတည်ဆောက်ခြင်းနည်းလမ်းများအတွက်ပဏာမထင်မြင်ချက်

ရထားလမ်းအသစ်တစ်ခုအတွက် တံတားတည်ဆောက်ခြင်းကို အောက်ပါအဆင့်များ အတိုင်း အဓိကထားဖြင့် ခွဲခြားထားပါသည်။ တံတားဆိုင်ရာ အချက်အလက်များအတွက် ပြန်လည်ကွင်းဆင်း လေ့လာတိုင်းတာခြင်း၊ အခြေခံအုတ်မြစ်တည်ဆောက်ခြင်း၊ bearing platform တည်ဆောက်ခြင်း၊ တံတားအောက်ခံတိုင်(pier)နှင့် တံတားအောက်ခံ (abutment)တည်ဆောက်ခြင်း၊ beamနှင့် တံတားမျက်နှာပြင် (bridge decking) တည်ဆောက်ခြင်း အစရှိသဖြင့် အဆင့် များ ပါဝင်ပါသည်။



ပုံ(၁.၄)တံတားတည်ဆောက်ခြင်းလုပ်ငန်းစဉ်အဆင့်ဆင့်ဇယား

(က) တံတားအုတ်မြစ်တည်ဆောက်ခြင်း

ယေဘုယျအားဖြင့်တံတားအုတ်မြစ်ကို ပုံမှန်လုပ်ရိုးလုပ်စဉ် နည်းလမ်းဖြင့် တည်ဆောက်ကြပါသည်။

-အကယ်၍တံတားpile အုတ်မြစ်လုပ်ငန်းခွင်နေရာ၏ ပထဝီဝင်နှင့် ဘူမိအနေအထား ကောင်းမွန်လျှင် manual dig pile ကိုအသုံးပြုနိုင်သည်။

-cast-in-situ bored pile ကိုယေဘုယျအားဖြင့် percussive drilling (အပေါ်မှရိုက်သွင်းခြင်း) သို့မဟုတ် rotary drilling (လှည့်၍သွင်းခြင်း)ပြုလုပ်ခြင်းဖြင့်လွန်ဖြင့်တွင်းတူးလောင်းသည်။

Open-cut အုတ်မြစ်သည် ယေဘူယျအားဖြင့် အကာအကွယ်မဲ့ ဆောက်လုပ်ရေး လုပ်ငန်းဖြစ်ပါသည်။စက်ဖြင့်မြေတူးဖော်ခြင်းကိုအဓိကထား၍လုပ်ဆောင်ပြီးလူအားဖြင့်မြေတူးဖော်ခြင်းကိုအရန်အားဖြင့်လုပ်ဆောင်ပါသည်။

(ခ) တံတားအောက်ခံတိုင်(pier)တည်ဆောက်ခြင်း

တံတားအောက်ခံတိုင်(pier)တည်ဆောက်ခြင်းကို အောက်ဖော်ပြပါအတိုင်း ပြုလုပ်မည်ဖြစ်ပါသည်။

(i) တံတားအောက်ခံတိုင်(pier)၏အမြင့်အရ integral formwork casting နည်းလမ်းနှင့် tripod setting-up formwok နည်းလမ်းများအား အသုံးပြု၍ တံတားအောက်ခံတိုင် (pier)အား တည်ဆောက်မည်ဖြစ်သည်။

(ii) တံတားအောက်ခံတိုင် (pier)၏အုတ်မြစ်ပုံစံ၊ ရေမျက်နှာပြင် အနိမ့်အမြင့်(water depth)နှင့် ရေကြီးမှုကြောင့်ရေစီးသည့်ပမာဏ (flood discharge) အခြေအနေပေါ်မူတည်၍ woven-bag cofferdam, reingorced concrete cofferdam, steel sheet pile cofferdam နှင့် single & double wall steel cofferdamများ အသုံးပြုခြင်းအား ရေထဲ၌ တံတားအောက်ခံတိုင် (pier) အုတ်မြစ် တည်ဆောက်ရာတွင် အကူအညီတည်ဆောက်ရေး လုပ်ဆောင်ချက်အဖြစ်ပြုလုပ်သင့်ပါသည်။

(ဂ) ရက်မ(Beam) တည်ဆောက်ခြင်း

Simply-supported T-beamအားစက်ရုံတွင် ကြိုတင်ပြုလုပ်၍ တံတားတည်ဆောက်မည့် လုပ်ငန်းခွင်သို့ရက်မ(beam) သယ်ယူပို့ဆောင်ပေးသည့်ယာဉ်ဖြင့် ပို့ဆောင်ပြီးနောက် bridge erecting စက်ဖြင့်တပ်ဆင်တည်ဆောက်ပါသည်။ Small –span continuous beam မှာ bracket cast-in-place construction နည်းလမ်းကိုအသုံးပြုပြီး continuous beam နှင့် continuousrigid frameတံတားများအား cantilervering casting နည်းလမ်းဖြင့် တည်ဆောက်ပါသည်။

- Prestressed simply-supported T-beam အား bridge-erecting နည်းလမ်းဖြင့်တည်ဆောက်ပါသည်။
- continuous beam နှင့် continuous rigid frame အားcantilervering castingနှင့် cast-in-place construction နည်းလမ်းများဖြင့်တည်ဆောက်ပါသည်။

(ဃ) သတ်မှတ်အရှိန်နှုန်း

ခရီးသည်တင်ရထား၏သတ်မှတ်အရှိန်နှုန်း - တစ်နာရီလျှင် ၁၆၀ကီလိုမီတာ နှင့် နှစ်လမ်းသွား လမ်းကြောင်းရထားလမ်းပိုင်းအတွက် - တစ်နာရီလျှင်၂၀၀ကီလိုမီတာ (ဒေသတွင်း ရထား လမ်းပိုင်းအတွက်ကန့်သတ်အရှိန်နှုန်း - တစ်နာရီလျှင် ၁၆၀ကီလိုမီတာသတ်မှတ်ထားသည့် အရှိန်နှုန်းများအားအောက်ဖော်ပြပါဇယားတွင်ဖော်ပြထားပါသည်။

S/N	Mileage scope	Speed limit
1	CK0+000~CK11+800	160km/h
2	CK323+685~CK369+803	160km/h

၁.၃.၄။ စီမံကိန်းအကောင်အထည်ဖော်မှုအချိန်ဇယား

ရထားလမ်းကြောင်းတစ်ခုလုံးတည်ဆောက်ရန်အချိန်ဇယားအရတံတားများအတွက်ခွင့် ပြုထားသောတည်ဆောက်ရေး အချိန်ဇယားမှာအောက်ပါအတိုင်းဖြစ်ပါသည်။

- ရွှေလီမြစ်အဓိကမဟာတံတားကြီးအတွက် ၂၆လ

-နမ်မမြစ်အဓိကတံတားအတွက်၃၂လ

- နမ်တူမြစ်ငယ်မြစ်အဓိကမဟာတံတားကြီးအတွက် ၂၃လ

- ဂုတ်ထိပ်နမ်ဘန်တန်နှစ်လမ်းသွားအဓိကမဟာတံတားအတွက်၅၄လ

တံတားတည်ဆောက်ရန်အချိန်ဇယားအားအောက်ဖော်ပြပါဇယားတွင်ဖော်ပြထားပါသည်။

<table>
<tr><th>Phase</th><th colspan="2">Item</th><th>Duration</th></tr>
<tr><td>အကြိုတည်ဆောက်ရေးကာလ</td><td colspan="2">တံတားအမျိုးအစားအားလုံး</td><td>၆လ</td></tr>
<tr><td rowspan="5">တည်ဆောက်ရေး ကာလ</td><td rowspan="4">အဓိက တံတားများ</td><td>ရွှေလီမြစ်နှစ်လမ်းသွားအဓိကမဟာ တံတားကြီး</td><td>၂၆လ</td></tr>
<tr><td>နမ်မမြစ်အဓိကတံတား</td><td>၂၄လ</td></tr>
<tr><td>နမ်တူမြစ်ငယ်မြစ်အဓိကမဟာတံတား ကြီး</td><td>၂၃လ</td></tr>
<tr><td>ဂုတ်ထိပ်နမ်ဘန်တန်နှစ်လမ်းသွားအဓိ ကမဟာတံတား</td><td>၄၈လ</td></tr>
<tr><td colspan="2">အခြားတံတားများ</td><td><၂၃လ</td></tr>
</table>

၁.၃.၅။ အခြားနည်းလမ်းဖြင့်ဆောင်ရွက်နိုင်မှုအကျဉ်းချုပ်

စီမံကိန်းပြုလုပ်ခြင်းမရှိသည့်အခြားနည်းလမ်းစီစစ်ချက်၊တံတားတည်နေရာအခြားနည်းလမ်းစီစစ်ချက်၊တည်ဆောက်ရေးနည်းလမ်းများအခြားနည်းလမ်းစီစစ်ချက်၊လုပ်ငန်းစဉ်အခြားနည်းလမ်းစီစစ်ချက်များသည်အခြားနည်းလမ်းဖြင့်ဆောင်ရွက်နိုင်မှုအဖြစ်အသုံးပြုရာတွင်ပါဝင်သော လည်းလုပ်ငန်းဖြစ်နိုင်ခြေလေ့လာခြင်း (Feasibility Study (FS)) အဆင့်တွင် တံတားများ (bridges) နှင့်မြေအောက်မြောင်းများ (culverts)၏ အသေးစိတ် တိကျသော တည်နေရာ လမ်းကြောင်းအား စီမံကိန်း အကောင်အထည်ဖော်မည့်သူမှ မသတ်မှတ်ထားသောကြောင့် လုပ်ငန်းဖြစ်နိုင်ခြေ လေ့လာခြင်းအဆင့်တွင် တံတားတည်နေရာ အခြားနည်းလမ်း စီစစ်ချက်ကို မပြုလုပ်နိုင်ပေ။ ထို့ကြောင့် အခြားနည်းလမ်းဖြင့် ဆောင်ရွက်နိုင်မှုတွင် စီမံကိန်းပြုလုပ်ခြင်း မရှိသည့်အခြားနည်းလမ်းစီစစ်ချက်၊ တည်ဆောက်ရေးနည်းလမ်းများ အခြားနည်းလမ်းစီစစ်ချက်၊ လုပ်ငန်းစဉ်အခြားနည်းလမ်းစီစစ်ချက်များကိုသာဖော်ပြထားပါသည်။

(က) စီမံကိန်းပြုလုပ်ခြင်းမရှိသည့်အခြားနည်းလမ်းစီစစ်ချက်

ဤအခြားနည်းလမ်းစီစစ်ချက်သည် မူဆယ်-မန္တလေး ရထားလမ်း တလျှောက်တွင် တံတားများ (bridges)နှင့် မြေအောက်မြောင်းများ (culverts)များ တည်ဆောက် အကောင်အထည်ဖော်ခြင်းကိုတားမြစ်သည်။ စီမံကိန်းဆောင်ရွက်ခဲ့ခြင်းမရှိပါက သဘာဂပတ်ဝန်းကျင် နှင့်ဒေသခံပြည်သူများအပေါ်ထိခိုက်မှုများသက်ရောက်နိုင်မည်မဟုတ်ပါ။သို့သော်စီမံကိန်းဆောင် ရွက်ခဲ့ခြင်းမရှိပါက ဒေသံခံပြည်သူများ၏ လူနေမှုဘဝအပေါ်တွင် ကောင်းမွန်သော အကျိုးသက် ရောက်မှုများရှိနိုင်မည်မဟုတ်ပေ။ ထို့ကြောင့် ပတ်ဝန်းကျင်နှင့် လူမှုရေး ရှုထောင့်မှလည်း ထည့်သွင်း စဉ်းစားရန်လိုအပ်ပါသည်။ အခြားနည်းလမ်း စီစစ်ချက်အရ စီမံကိန်းပြုလုပ်ခြင်း မရှိသည့် အခြားနည်းလမ်းသည် ဆန်းစစ်လေ့လာချက်အရ စီမံကိန်း ကြောင့်ဖြစ်ပေါ်လာနိုင့်သည့် ပတ်ဝန်းကျင်ထိခိုက်မှုများအား လျော့နည်းသက်သာစေရန် လုပ်ဆောင်နိုင်သောကြောင့်သင့်တော် အခြားနည်းလမ်းမဟုတ်ပေ။ဤအခြားနည်းလမ်းသည်နိုင်ငံခြားရင်းနှီးမြှုပ်နှံမှုနှင့်အလုပ်အကိုင်အ ခွင့်အလမ်းများကို ဆုံးရှုံး မှုများကို ဖြစ်ပေါ်စေနိုင်သည်။ မြေယာအသုံးပြု မှုအတွက် Resettlent Action Plan စနစ်တကျရေးဆွဲ အကောင်အထည်ဖော်ဆောင်ရန် လိုအပ်ပါသည်။

(ခ) တည်ဆောက်ရေးနည်းလမ်းများအခြားနည်းလမ်းစီစစ်ချက်

မူဆယ်-မန္တလေးရထားလမ်း၏ တစ်စိတ်တစ်ဒေသမှာ တံတားဖြစ်သည့်အတွက် ဆောက်လုပ်ရေးကာလအတွင်း တံတားဖြစ်မြောက်ရေး နည်းလမ်းများသည်လည်း ပတ်ဝန်းကျင် လေ့လာဆန်းစစ်ခြင်းအစီရင်ခံစာအတွက် အဓိကထည့်သွင်းစဉ်းစားရမည့် အချက်များတွင် တစ်ခု အပါအဝင်ဖြစ်သည်။ အမျိုးမျိုးသောအခြားနည်းလမ်းစိစစ်ချက်များ၏ ကနဦးလေ့လာ ဆန်းစစ်ချက်သည် ပိုမိုကောင်းမွန်သည့် နည်းလမ်းများရွေးချယ်ရာတွင် အဓိကကျသော အချက်တစ်ချက် ဖြစ်သည်။ ယခုစီမံကိန်းတွင် ထည့်သွင်းစဉ်းစားသည့် အဓိကတံတား ဆောက်လုပ်ရေးနည်းလမ်း များမှာ

- သံမဏိဒိုင်းခွေမုခ်ခုံးတံတား (Steel truss arch bridge) နှင့်
- ကြိုးတံတား (Cable-stayed bridge) တို့ဖြစ်သည်။

တံတားတည်ဆောက်ရေးနည်းလမ်းအတွက် အခြားနည်းလမ်း စိစစ်ချက်အရ သဘာဝ ပတ်ဝန်းကျင် ရှုထောင့်မှာကြည့်ပါကတံတားအုတ်မြစ်တည်ဆောက်ရေးလုပ်ငန်းနှင့် အနီးစပ်ဆုံး တူညီသည်။ သို့ဖြစ်ပါ၍ နည်းပညာနှင့် စီးပွားရေးရှုထောင့်အရ သံမဏိဒိုင်းခွေမုခ်ခုံး တံတားသည် ပို၍သင့်တော်သော တံတားတည်ဆောက်ရေး နည်းလမ်း ဖြစ်သည်။

(ဂ) လုပ်ငန်းစဉ်အခြားနည်းလမ်းစီစစ်ချက်

တိုင်စိုက်ခြင်းသည်ပတ်ဝန်းကျင်အပေါ်သက်ရောက်မှုအများဆုံးရှိသည့်အရေးကြီးဆုံးတံ တားတည်ဆောက်ခြင်းလုပ်ငန်းစဉ်များထဲမှတစ်ခုဖြစ်ပါသည်။တံတားအောက်ခံတိုင် စိုက်စက်အသုံးပြုခြင်းသည် အသုံးပြုမည့် တံတားအောက်ခံတိုင် အမျိုးအစား ပေါ်မူတည်ပြီး မတူညီသော အောက်ခံတိုင် စိုက်စက်အမျိုးအစားများသည် တိုင်ရိုက်ခြင်း လုပ်ငန်းစဉ်အပေါ် သက်ရောက်မှုရှိသည်။ဆောက်လုပ်ရေးနည်းလမ်းပေါ်အခြေခံသောတံတားအောက်ခံတိုင်အုတ်မြစ် အမျိုးအစားများမှာအောက်ပါအတိုင်းဖြစ်သည်။

- ဖောက်လုပ်မိုလောင်းအောက်ခံတိုင်နည်းလမ်း (Bored Cast-In-Place Pile Method)
- ပြင်ဆင်ပြီးတိုင်ရိုက်နည်းလမ်း (Driven Pile)

တံတားအောက်ခံတိုင် အခြားနည်းလမ်းကို ဆန်းစစ်ပြီးနောက် အောက်ခံတိုင် ဆောက်လုပ်ရေး နှစ်မျိုးလုံး၏ကုန်ကျစရိတ်သည် မြင့်မားနေသည်။ သဘာဝပတ်ဝန်းကျင်

ရှုထောင့်အရ နည်းလမ်းနှစ်ခုလုံးမှ သက်ရောက်မှုများသည် နည်းပညာထိန်းချုပ်မှုနှင့် သင့်တော်သော စက်ပစ္စည်းကိုသုံး၍ စီမံခန့်ခွဲနိုင်သည်။ သဘာဝပတ်ဝန်းကျင်၊ လူမှုရေးနှင့် ဇီဝမျိုးကွဲများဆိုင်ရာအထိခိုက်မခံသောနေရာများတွင် အသင့်တော်ဆုံးအုတ်မြစ်အမျိုးအစားသည် wet drilling action ဖြင့် ဖောက်လုပ်၍ မိုလောင်းရသော In-situ အောက်ခံတိုင်ဖြစ်သည်။ အကြောင်းအရင်းမှာယင်းနည်းလမ်းသည် မည်သည့်မြေအမျိုးအစား၊ မြေအလွှာနှင့် ရေမျက်နှာပြင် အနိမ့်အမြင့်အတွက်သင့်တော်သော Reverse Rotary Method ဖြင့် ဖောက်လုပ်၍ရခြင်း ကြောင့်ဖြစ်သည်။

၁.၄။ရှိရင်းစွဲပတ်ဝန်းကျင်အခြေအနေဖော်ပြချက်အနှစ်ချုပ်

(က) ပတ်ဝန်းကျင်ထိရှလွယ်သည့်နေရာများ

မူဆယ်-မန္တလေးရထားလမ်းသည် ရှည်လျားသည့် လမ်းကြောင်းဖြစ်သည့်အတွက် ရထားလမ်းကြောင်းတစ်လျှောက်ရှိ စိုက်ပျိုးမြေများ၊သစ်တောဧရိယာများ၊ သဘာဝ ရေထွက်များအားလုံးအား ပတ်ဝန်းကျင်အရထိရှလွယ်သည့်နေရာများဖြစ်ပါသည်။

(ခ) စေတီများနှင့်ဘုရားများ

လေ့လာချက်များအရ ရထားလမ်းတစ်လျှောက် နေရာအနှံ့အပြားမှာ ရှေးဟောင်း သမိုင်းဝင် စေတီပုထိုးများရှိပြီး ၎င်းစေတီပုထိုးများကို ယာယီသတ်မှတ် လမ်းကြောင်း ဖြတ်သန်း မသွားစေရန်ပြုလုပ်သွားရမည်ဖြစ်ပါသည်။

(ဂ) တွင်းထွက်သတ္တုသိုက်များ

ရှိရင်းစွဲဘူမိဗေဒမှတ်တမ်းများအရတွင်းထွက်သတ္တုသိုက်များတွင် ခဲ-ဇင့်-ငွေ၊ အန်တီမိုနီ၊ ရွှေ ပါဝင်နေမည်ဟုမျှော်မှန်းရသည်။ ကျောက်မီးသွေးနှင့် ဖော့စဖရပ်သတ္တုသိုက် များလည်း တွေ့နိုင်သည်။ အချို့သောသတ္တုသိုက်များသည် ရထားလမ်းနှင့် ဝေးရာတွင်ရှိနေသည်။ တွင်းထွက် သတ္တုသိုက်များသည် N-S direction အတိုင်းရှိနိုင်ပြီးဥမင်လိုဏ်ခေါင်း၊ တံတား၊ ရထားဘူတာနှင့် ရထားလမ်းဆောက်လုပ်ရေး ကာလများအတွင်းတွင်လည်း ရှာတွေ့နိုင်သည်။ ဥပမာအနေဖြင့် ဖယောင်းတောင်ရွှေသည် ဆောက်လုပ်ရေးမှ ဝေးနိုင်ပြီး ရွှေတွေ့ရှိမှုများကို ရှမ်းပြည်နယ် အနောက်ဘက်တစ်လျှောက်တွင် တွေ့နိုင်သည်။ ရတနာသီဂီ ခဲ-ဇင့်-ငွေ သတ္တုသိုက်အတွက်မူ

ခပ်ဆင်ဆင်သတ္တုသိုက်များကို ပြင်ဦးလွင်၊ နောင်ချို နှင့် ကျောက်မဲတစ်လျှောက်တွင် တွေ့နိုင်သည်။ ဘော်တွင်းသတ္တုတွင်းနှင့် မိုဟိုချောင်းသတ္တုတွင်းများမှ သတ္တုသိုက်များသည် သီပေါ၊ လားရှိုး၊ ကွတ်ခိုင်နှင့် နမ့်ဖက်ကာဒေသများတစ်လျှောက်တွင် ထပ်မံတွေ့ရှိနိုင်သည်။

(ဃ) သတ္တုလုပ်ငန်းများ

မူဆယ်-မန္တလေးရထားလမ်းတစ်လျှောက်တွင် တွင်းထွက်သတ္တုလုပ်ငန်းများ ရှိသည်။ သို့ရာတွင် သတ္တုတွင်းလုပ်ငန်းများအားလုံးသည် ရထားလမ်းဥမင်လိုဏ်ခေါင်းများမှ သက်ရောက်မှုဇုန်များနှင့် ဝေးရာတွင်ရှိသည်။

(င) စစ်တပ်နယ်မြေများ

နမ့်ဖက်ကာ၊လားရှိုးနှင့်ပြင်ဦးလွင်နယ်မြေနှင့်အခြားနယ်မြေအချို့တွင်စစ်တပ်ဇရိယာများရှိပါသည်။

(စ) ရေကာတာနှင့် ရေအားလျှပ်စစ်

မြစ်ငယ်မြစ်နှင့် ရွှေလီမြစ်များတွင် ရေအားလျှပ်စစ်နှင့် စိုက်ပျိုးရေးအတွက် ဆောက်လုပ်ထားသော ရေကာတာများတည်ရှိသည်။ နမ္မတူ-မြစ်ငယ်မြစ်ပေါ်တွင် ရဲရွာရေကာတာသည် ဆောက်လုပ်ပြီးစီးပြီး ဖြစ်သည်။ နမ္မတူရေကာတာ နှင့် အထက်ရဲရွာရေကာတာတို့သည် ဆောက်လုပ်ဆဲဖြစ်ပြီးအလယ်ရဲရွာရေကာတာနှင့် ဒီးဒုတ်ရေကာတာတို့သည် ဆောက်လုပ်ရန်စီစဉ်ထားဆဲဖြစ်သည်။ ရွှေလီမြစ်ပေါ်ရှိရွှေလီ ၁ ရေအားလျှပ်စစ် စီမံကိန်းသည် ဆောက်လုပ်ပြီးဖြစ်ပြီး ရွှေလီ၂ နှင့် ၃ သည် ဆောက်လုပ်ဆဲကာလဖြစ်သည်။ ရထားလမ်းတစ်လျှောက်နှင့် အနီးတစ်ဝိုက်တွင် သဘာဝရေကန်များ၊ ရေအိုင်များ၊ ရေတံခွန်များ၊ စမ်းချောင်းများနှင့် ရေလှောင်ကန်အသေးစားများရှိနိုင်ပြီးဒေသခံပြည်သူသည် ၎င်းတို့မှ ရေကိုစိုက်ပျိုးရေးနှင့် အိမ်သုံး ရေအဖြစ်အသုံးပြုခြင်းကို အလေ့အကျင့်ရနေပြီးဖြစ်သည်။

(ဆ) လေထုနှင့်အသံအရည်အသွေး

စက်မှုလုပ်ငန်းများတိုးတက်ဖွံ့ဖြိုးသော နယ်မြေမဟုတ်ခြင်းကြောင့် မူဆယ်- မန္တလေးရထားလမ်းကြောင်းတလျှောက် လေထုအရည်အသွေးသည် ကောင်းမွန်ပြီးအဓိကအရင်းအမြစ်သည် မော်တော်ယာဉ်သွားလာမှုများကြောင့်ဖြစ်သည့် ဆူညံသံဖြစ်သည်။

(၈) ရေအရည်အသွေး

ရထားလမ်းကြောင်းတစ်လျှောက်ရှိမြစ်ချောင်းများအတွင်းမှရေအရည်အသွေးအားလုံးအား ကောက်ယူတိုင်းတာခဲ့ပြီးပြည်သူ့ကျန်းမာရေးဦးစီးဌာနတွင်စမ်းသပ်စစ်ဆေးပါသည်။

ကောက်ယူထားသော water sample များ

Sample -1, Shweli River
Sample -2, Nant Paung Stream
Sample -3, Nant Khaing Stream
Sample -4, Namtu Stream
Sample -5, Pan Phet Stream
Sample -6, A-T Stream
Sample -7, Sint In Stream
Sample -8, Kho Lone Stream
Sample -9, Dokehtawady River
Sample -10, KyinThi Stream
Sample -11, Gok Twin Stream
Sample -12, Yae Ni Stream
Sample -13, Se Taw Gyi Canal,
Sample -14, Myaung Ma Gyi Stream,
Sample -15, Myaing Gyi Stream,
Sample -16, Dokehtawady River

ကောက်ယူထားသောနမူနာများသည် မူဆယ်-မန္တလေးရထားလမ်းတစ်လျှောက် တိုင်းတာမှုများ ဖြစ်သည်။ရေအရည်အသွေးတိုင်းတာမှုရလာဒ်များအရအိမ်သုံးရေအတွက်သင့်တော်ကောင်းမွန်ပါသည်။

(၉) မြေအရည်အသွေး

မြေအရည်အသွေးအား ရထားလမ်းတစ်လျှောက်ရှိ ဥမင်လှိုဏ်ခေါင်းနှင့် တံတား တည်ဆောက်ရေး စီမံကိန်းအနီးတွင် အဓိကထား ကောက်ယူသွားမည်ဖြစ်ပြီး စိုက်ပျိုးရေးဦးစီး ဌာန ရန်ကုန်မြို့တွင် စမ်းသပ်စစ်ဆေးပါသည်။ တိုင်းတာမှုရလာဒ်များအား ပတ်ဝန်းကျင် ထိခိုက်မှု ဆန်းစစ်ခြင်းအစီရင်ခံစာတွင်ဖော်ပြသွားပါမည်။

(၁၀) တုန်ခါမှုအတိုင်းအတာ

တုန်ခါမှုအဆင့်များသည် အဆိုပြု မူဆယ်-မန္တလေးရထားလမ်းတစ်လျှောက် တိုင်းတာခဲ့ သည်။ တိုင်းတာခဲ့သောနေရာများမှာ ပြင်ဦးလွင် အုတ်ဖိုရွာ (ဘုန်းကြီးကျောင်း) ၊ နောင်ချို - ရွှေပြည်ညွန့်ရွာ၊ ဂုတ်ထိပ်၊ သီပေါ (ဘော်ကြိုဘုရားနား)၊ သီပေါအလွန် (စံလောင်း)၊ လားရှိုး၊

ဆည်နီ၊ နမ့်ဖက်ကာနှင့် မူဆယ်တို့ဖြစ်သည်။ တိုင်းတာမှုအားလုံးသည် လက်ခံနိုင်သော အဆင့်အတွင်းရှိပါသည်။

(၄)မြေအောက်ရေတွေ့ရှိမှုနှင့် ဖြန့်ဖြူးရေး

ရထားလမ်းတစ်လျှောက် မြေအောက်ရေသည် အောက်ပါအတိုင်း အမျိုးအစားများ တွေ့ရှိနိုင်သည်။

၁. Loosely cemented soil နှင့် သက်တမ်းနုသောကျောက်များတွင်းရှိ pore-water

၂. ကျောက်တုံးများနှင့် ပုံဆောင်ခဲကျောက်ဆောင်များရှိ bedrock fissure

၃. ကာဗွန်ကျောက်များရှိ karst water

၄. မြေတွင်းမှ geothermal water

မြန်မာနိုင်ငံရှိရေအောင်းလွှာများသည် ရှေးနှစ်ပေါင်းများစွာမှ ယနေ့ခေတ်အထိ တည်ရှိခဲ့ပြီး ကမ်းခြေပိုင်းမှ တောင်မြောက်မဟာဗျူဟာကျကျ ထိန်းချုပ်ထားသောချိုင့်ဝှမ်းများအထိရှိသည်။ အဓိက မြေအောက်ရေ စီးဆင်းမှုမှာ ဖွန်လမှ စက်တင်ဘာအထိတိုးသော မုတ်သုံမိုးရွာသွန်းမှုကြောင့်ဖြစ်သည်။ မိုးရေချိန်မှာမြစ်ဝကျွန်းပေါ်ဒေသများတွင် ၃၀၅၀ မီလီမီတာထိ၊မြောက်ဘက်ပိုင်းတွင် ၃၈၁၀ မီလီမီတာ၊ အရှေ့ဘက်တောင်တန်းဒေသများတွင် ၂၀၀၀ မီလီမီတာနှင့် အလယ်ပိုင်းခြောက်သွေ့ဒေသများတွင် ၇၆၀ မီလီမီတာထိရှိနိုင်သည်။ အကြီးဆုံးရေအောင်းလွှာသည်ဧရာဝတီမြစ်ဝှမ်းဖြစ်ပြီး IGBM မြစ်ဝှမ်းသည် ရေထွက်များသောရေအောင်းလွှာဖြစ်သည်။

(၅) ဘူမိနည်းပညာဆိုင်ရာစရိုက်လက္ခဏာများ

မူဆယ်-မန္တလေးရထားလမ်းတစ်လျှောက်ရှိဘူမိနည်းပညာဆိုင်ရာစရိုက်လက္ခဏာများမှာ

i. Karst
ii. Landslide and Talus
iii. Unstable Rocks and Rock-Fall
iv. Bedding
v. Seismic Liquefaction
vi. Soft Soil and Mollisol
vii. Expansive Soil
viii. Expansive Rock
ix. High Ground Stress

(ဍ) လူမှုစီးပွားရေး

အဆိုပြုရထားလမ်းသည် ရှမ်းပြည်တွင် အများအပြားဖြတ်သွားပြီးမန္တလေးဒေသများတွင် တစ်စိတ် တစ်ပိုင်းဖြတ်သွားမည်ဖြစ်သည်။ ဤဒေသနှစ်ခုတွင် မတူညီသော လူမှုစီးပွားရေး ဆိုင်ရာ အခြေအနေများရှိသည်။ ရထားလမ်းဖြတ်သွားမည့် ရှမ်းပြည်နယ်ဒေသများရှိ လူမှုစီးပွားဆိုင်ရာ အခြေအနေများသည် လယ်ယာစိုက်ပျိုးရေးလွှမ်းမိုးပြီးဖွံ့ဖြိုးမှုနည်းပါးသည်။

(ပ) ရှေးဟောင်းယဉ်ကျေးမှုအမွေအနှစ်

လေ့လာချက်များအရ ရှေးဟောင်းသမိုင်းဝင်စေတီ ပုထိုးများသည် ယာယီသတ်မှတ် လမ်းကြောင်း အတွင်းပါဝင်ခြင်းမရှိသော်လည်းလေ့လာဆန်းစစ်သွားမည်ဖြစ်ပါသည်။

၁.၅။ဖြစ်ပေါ်နိုင်သည့်ထိခိုက်မှုများနှင့်လျော့နည်းသက်သာစေရန်လုပ်ဆောင်ရမည့်နည်းလမ်းများ အကျဉ်းချုပ်

ဆောက်လုပ်ရေးကာလနှင့် လုပ်ငန်းလည်ပတ် လုပ်ဆောင်ရေးကာလအတွင်းစီမံကိန်း ကြောင့် ဖြစ်ပေါ်နိုင်သည့် ထိခိုက်မှုများနှင့် လျော့နည်းသက်သာစေရန်လုပ်ဆောင်ရမည့်နည်းလမ်း များအကျဉ်းချုပ်အားအောက်ဖော်ပြပါဇယားတွင်ဖော်ပြထားပါသည်။

ဇယား - ဖြစ်ပေါ်နိုင်သည့် ပတ်ဝန်းကျင်နှင့် လူမှုရေးထိခိုက်မှုများနှင့် လျော့နည်းစေရန် လုပ်ဆောင်ချက်များအကျဉ်းချုပ်

အမျိုးအစား	အချက်အလက်	ဖြစ်နိုင်ချေရှိသောပတ်ဝန်းကျင် နှင့် လူမှုရေးဆိုင်ရာထိခိုက်မှုများ	လျော့နည်းသွားစေရန်လုပ်ဆောင်ချက်များ
အကြိုဆောက်လုပ်ရေးကာလ			
လေထုပတ်ဝန်းကျင်	ဖုန်မှုန့်ထုတ်လွှတ်မှု	လုပ်ငန်းခွင်အကြိုပြင်ဆင်ရေးလုပ်ငန်းများမှထွက်သောဖုန်မှုန့်များ	• အကြိုတည်ဆောက်ရေးလုပ်ငန်းခွင်အတွင်းရေဖြန်းခြင်း • လက်ကိုင်ရေဖြန်းကိရိယာများအသုံးပြုခြင်း • လုပ်ငန်းခွင်ကိုမထွက်ခွာမီယာဉ်ဘီးများကိုသန့်ရှင်းရန်နှင့် သယ်ယူသောပစ္စည်းများကိုဖုံးအုပ်ထားရန်။
	မော်တော်ယာဉ်မှ ဓာတ်ငွေ့ထုတ်လွှတ်မှု	မော်တော်ယာဉ်များနှင့် စက်ပစ္စည်းများမှထွက်သော CO_2, CO, NO_xနှင့် SO_2 ကဲ့သို့သောဓာတ်ငွေ့များ	• သယ်ယူတင်ချချိန်များလျှော့ချရေးအစီအစဉ်များ • လုပ်ငန်းဆိုင်းငံ့ချိန်များလျှော့ချရန် • အင်ဂျင်ကောင်းသောစက်ပစ္စည်းများအသုံးပြုရန်
	ဆူညံသံ	လုပ်ငန်းခွင်ရှင်းလင်းရေးနှင့် မြေဖယ်ရှားခြင်းလုပ်ငန်းများတွင် အသုံးပြုသောစက်ပစ္စည်းများမှ ထွက်သောဆူညံသံ	• ညအချိန်တွင် ဆူညံစေသောစက်ပစ္စည်းများလည်ပတ်မှုကိုရှောင်ကြဉ်ရန်။ • ဆူညံသောစက်ပစ္စည်းများတစ်ပြိုင်နက်တည်းအသုံးပြုခြင်းကိုရှောင်ကြဉ်ရန်။ • စက်ပစ္စည်းများပုံမှန် ပြုပြင်ထိန်းသိမ်းခြင်း။
မြေပေါ်ရေပတ်ဝန်းကျင်	စွန့်ပစ်အရည်	- မြေဖယ်ရှားခြင်းလုပ်ငန်းများကြောင့် နီးစပ်ရာရေအရင်းအမြစ် ညစ်ညမ်းခြင်း။ - လောင်စာဆီနှင့် ချောဆီများကိုင်တွယ်မှု မမှန်ကန်ခြင်း။ - ဆောက်လုပ်ရေးလုပ်သားများအတွက် စခန်းများ ပြင်ဆင် ရခြင်းကြောင့် မြေပေါ် ရေအရည်အသွေးကို ထိခိုက်စေ နိုင်သည်။	• ယာယီမိလ္လာကန်များနှင့် အခြားစွန့်ပစ်ကန်များထားရန်။ • ကောင်းသော ရေနုတ်မြောင်းစနစ်ပါဝင်သော ယာယီအနည်ကျကန်များ ထားရှိရန်။ • အရည်ပစ္စည်းများကိုမြေပေါ်ရေသို့တိုက်ရိုက် မစွန့်ပစ်ရ။ • ဆီ၊ ဆီချေးနှင့် အခြားဓာတုပစ္စည်းများကို MSDS အရကိုင်တွယ်ရန်။
	စွန့်ပစ်အစိုင်အခဲ	လုပ်ငန်းခွင်ပြင်ဆင်ရေး လုပ်ငန်းများမှ မြေစိုင်ခဲများနှင့် အလုပ်သမားများ၏ အိမ်သုံးစွန့်ပစ်ပစ္စည်းများ	• မလိုအပ်သောမြေဖယ်ရှားမှုများကန့်သတ်ရန်။ • အလွန်အကဲယမ်းခွဲခြင်းကိုတားဆီးရန်။ • အိမ်သုံးစွန့်ပစ်ပစ္စည်းများကိုလျှော့ချ၊ ပြန်သုံး၊ ပြန်လည်ပြုပြင်ပြီးသုံးစနစ်။

			• အကြိုဆောက်လုပ်ရေးကာလအပြီးရှင်းလင်းသွားသောနေရာများကိုသစ်ပင်ပြန်စိုက်ပေးခြင်း။
	ရေနုတ်မြောင်းနှင့် ရေကြီးခြင်း	- ဇလဗေဒအခြေအနေများဆန်းစစ်မှု မလုံလောက်ခြင်း။ - စိုက်ပျိုးမြေများရေကြီးနိုင်မှု။ - မြေပေါ်ရေအရည်အသွေးထိခိုက်မှု။	• ရေနုတ်မြောင်းစနစ်သည် ရှိရင်းစွဲအခြေအနေထက် ပိုကောင်းကြောင်း သေချာ ရမည်။ • ယခင် ရေကြီးမှုမှတ်တမ်းများနှင့် ရေကြီးမှုခန့်မှန်းခြင်းများအပေါ် အခြေခံ၍ ရေနုတ်မြောင်းစနစ်များဒီဇိုင်းဆွဲခြင်း။
မြေဆီလွှာနှင့် မြေအောက် ရေပတ်ဝန်း ကျင်	မြေဆီလွှာအရည် အသွေး	- လုပ်ငန်းခွင်ရှင်းလင်းရေးနှင့် သစ်ပင်များခုတ်ခြင်းမှ ထွက်သော မြေစိုင်ခဲများ	• CDC ၏ ဥပဒေနည်းဥပဒေများအရစနစ်တကျ စွန့်ပစ်ခြင်း။ • ဒီဇယ်နှင့် ချောဆီများစိမ့်ထွက်ခြင်းကိုကာကွယ်ရန် စနစ်တကျ ကိုင်တွယ်ခြင်း။
ဇီဝမျိုးစုံမျိုး ကွဲများ	အပင်မျိုးစုံမျိုးကွဲများ	စီမံကိန်းတစ်လျှောက် အပင်ခုတ်မှုများ	• လမ်းနံဘေးသစ်ပင်များနှင့် ခြိမ်းခြောက်ခံရသစ်ပင်များကိုခုတ်ပစ်ခြင်းမပြုရန်။ • IUCN မှ သတ်မှတ်စာရင်းပါ အပင်များကိုနစ်ကြိမ်ခုတ်ဖြတ်မိပါက ပြန်လည်စိုက်ပေးရန်။
	တိရစ္ဆာန်မျိုးစုံမျိုးကွဲ များ	နေ့တိုက် သတ္တဝါများ နှင့် ရေနေသတ္တဝါများ အပေါ် သက်ရောက်မှု	• တိရစ္ဆာန်များအတွက် ခြိမ်းခြောက်ခံရအပင်များကို ခုတ်ထွင်ခြင်း နှင့် ညအချိန် အလုပ်လုပ်ခြင်းကိုရှောင်ကြဉ်ရန်။ • အသံလှိုင်းတားမှုများ လိုအပ်သလို ပြုလုပ်ပေးရန်။ • တိရစ္ဆာန်မျိုးစုံမျိုးကွဲများ ပေါ်များသော နေရာတွင် တွင်းနက်များမရှိစေရန်။
လူထုပတ်ဝန်း ကျင်	ကောင်းသောသက် ရောက်မှု	အလုပ်အကိုင်ဖန်တီးမှု	• ဒေသခံအလုပ်သမားတတ်နိုင်သမျှ အသုံးပြုရန်။
	လူမှုစီးပွားဆိုင်ရာ ထိခိုက်မှု	အမြင်ပသာဒ - လုပ်ငန်းခွင်ရှင်းလင်းရေးအတွက် အပင်ခုတ်ခြင်းများ	• လိုအပ်ချက်များအရဆောက်လုပ်ရေးနှင့် ဖြိုဖျက်ရေးမှ စွန့်ပစ်ပစ္စည်းများကို ထိရောက်စွာနှင့် အချိန်မီဖယ်ရှားခြင်း။
		မြေအသုံးပြုမှု	• RAP အရထိခိုက်မည့်အဆောက်အအုံများနှင့် သီးပင်များအတွက် သင့်တော်သော လျော်ကြေး။

ဆောက်လုပ်ရေးကာလ			
ဒေသတွင်းလေအရည်အသွေး	ဖုန်မှုန့်ထုတ်လွှတ်မှု	- ဆောက်လုပ်ရေးလုပ်ငန်းမှဖုန်မှုန့်များ - လုပ်ငန်းခွင်သုံးစက်ကြီးများ နှင့် အခြား ပေါ့ပါးသောယာဉ်များမှ ထွက်သောဖုန်မှုန့်များ	• ဆောက်လုပ်ရေးပစ္စည်းများကိုင်တွယ်သည့် လုပ်ငန်းများမှ ဖုန်မှုန့်ကိုလျှော့ချရန် အဖုံးအကာများနှင့် ထိန်းချုပ်ရေးကိရိယာများအသုံးပြုခြင်း။ • ဘိလပ်မြေများကိုစနစ်တကျ ကိုင်တွယ်ခြင်း။ • သယ်ယူပို့ဆောင်ရေးယာဉ်များကို အကာအကွယ်များတပ်ဆင်ခြင်း။ • ဖုန်မှုန့်လျှော့ချရေးအတွက် ရေဖြန်းခြင်း။
	မော်တော်ယာဉ်ဓာတ်ငွေ့များထုတ်လုပ်မှု	-ဆောက်လုပ်ရေးစက်များနှင့်မော်တော်ယာဉ်များ မှ ဓာတ်ငွေ့ထုတ် လွှတ်မှု၊	• အထွတ်အထိပ်စီးဆင်းမှုကိုရှောင်ကြဉ်ရန် လူနှင့် ပစ္စည်းများသယ်ယူ ပို့ဆောင်ရေး ကိုအချိန်ဇယားဖြင့်လုပ်ရန်။ • မော်တော်ယာဉ်လှုပ်ရှားမှုများကိုလျှော့ချရန်။ • လုပ်ငန်းခွင်အချိန်ကိုလျှော့ချရန်။
	ဆူညံသံ	- ဆောက်လုပ်ရေးစက်များအထူးသဖြင့်(ပိုင်တိုင်စိုက်သည့် စက်များ) ကြောင့်ဆူညံသံများ၏သက်ရောက်မှုများ	• ပြင်းထန်သောဆူညံသံအနီးတစ်ဝိုက်ရှိ အလုပ်သမားများသည် နားကြပ်များကို ဝတ်ဆင်ကြပြီးသူတို့၏ အလုပ်ချိန်ကို ကန့်သတ်ခြင်းဖြင့် အန္တရာယ်ကင်းစေရန် လုပ်ဆောင်မှုအဖြစ် ပြုလုပ်ပါသည်။ • ထိခိုက်လွယ်သောခံစားရမည့်သူ များရှိပါကညအချိန်တွင် စက်ကိရိယာများကြီးများဖြင့် ဆောက်လုပ်ရေးလုပ်ငန်းများမရှိအောင် ပြုလုပ်ထားရမည်။ • ပတ်ဂန်းကျင် ထိခိုက်လွယ်သော နေရာတွင် press piling စက်များဖြင့် ပိုင်တိုက်စိုက်ခြင်း။

	တုန်ခါမှု	- အုတ်မြစ်တည်ဆောက်ခြင်းအတွက် ပိုင်စက်များကြောင့် တုန်ခါမှုများသက်ရောက်ခြင်း	• ပတ်ဝန်းကျင်အထိခိုက်မခံသောနေရာများ အနီးတွင်press piling စက်များဖြင့် ပိုင်တိုက်စိုက်ခြင်းကို ပြုလုပ်ရမည်။ • လူများသည် ညအချိန်များတွင် ယင်းတို့၏အိမ်များမှနေ၍ တုန်ခါမှုကို ပိုမိုခံစားနိုင်သည့်အတွက် ညအချိန်အလုပ်လုပ်ခြင်းကို ရှောင်ကြဉ်ရန်။
မြေပေါ်ရေ	မြေပေါ်ရေနှင့် ဇလဗေဒ	- ယာဉ်များနှင့် စက်များအသုံးပြုခြင်းကြောင့် မြေကြီး ကျစ်လစ်ပြီးရေအများအပြားစီးဆင်းခြင်း - ရေစီးနှုန်းများပြောင်းလဲခြင်း - မြေတိုက်စားမှုများများပြားလာပြီးနောက် မြစ်ကြမ်းပြင် နှင့် မြစ်ကမ်းပါးများတည်ငြိမ်မှု ပြောင်းလဲလာခြင်း - ရေကြီးရေလျှံမှုနှုန်းများပြာလာခြင်း - ရေလမ်းကြောင်းများတွင် အနည်ကျမှု များတိုးလာခြင်း - ရေထဲတွင် အမှုန်များကြောင့် ရေညစ်ညမ်းခြင်း - မြေညစ်ညမ်းခြင်းနှင့် နောက်ပိုင်းတွင် ရေလမ်းကြောင်း များညစ်ညမ်းလာခြင်း - လောင်စာဆီများ၊ ဆီများ၊ ဆောက်လုပ်ရေးပစ္စည်းများမှ ယိုဖိတ်စိမ့်ထွက်ခြင်းမှ ညစ်ညမ်းမှုဖြစ်ခြင်း	• ချဉ်းကပ်လမ်းများသည် ကမ်းနားနှင့်ဆိုင်သော ဇုန်များကို ရှောင်ရှားပြီး သင့်တော်သော ဆောက်လုပ်ရေးပစ္စည်းများကို အသုံးပြုပြီးဆောက်လုပ်သင့် သည်။ • ရေနေသတ္တဝါများအတွက် လုံလောက်သောရေအနက် ကိုထိန်းသိမ်းရန် တံတားများနှင့်မြေအောက်မြောင်းများကိုစီးဆင်းမှုနည်းသောလမ်းကြောင်းတွ င် တည်ဆောက်သင့်ပါသည်။ • ဆီများစစ်ထုတ်သည့် ကိရိယာသို့ဆီခံဇန်းများကိုကားပါကင် ဧရိယာများတွင် အသုံးပြုပြီးပုံမှန် စစ်ဆေး၍သန့်ရှင်းရပါမည်။ • သဘာဝချောင်းများမပြောင်းလဲစေရန် သို့ ချောင်းကမ်းပါးသွင်ပြင် လက္ခဏာ များမပြောင်းလဲစေရန် သို့ ရေနေသတ္တဝါများ၏ လမ်းကြောင်းကို အတားအဆီး မဖြစ်စေရန် တံတားများကိုဒီဇိုင်းဆွဲရပါ မည်။
	စွန့်ပစ်အမှိုက်များ	(က) ဆောက်လုပ်ရေးလုပ်ငန်းခွင်မှ ထွက်လာသော စွန့်ပစ် မြေကြီးများနှင့် အခြားသောအမှိုက်များ (ခ) ယာယီဆောက်လုပ်ရေးရုံးခန်း နှင့် အခြားသော အဆောက်အအုံများမှ စွန့်ပစ်သောအစိုင်အခဲနှင့် အရည် စွန့်ပစ်အမှိုက်များ	• ဆောက်လုပ်ရေးနှင့်အခြားစွန့်ပစ်ပစ္စည်းအမျိုးအစားများကိုလျှော့ချခြင်း၊ ပြန်လည်အသုံးပြုခြင်းနှင့် ထုတ်ကုန်အသစ်အဖြစ် ပြန်လည် အသုံးပြုခြင်း ပြုလုပ်ရပါမည်။ • ဆောက်လုပ်ရေးရုံးနှင့်အခြားအဆောက်အဦးများတွင် မိလ္လာကန် ကဲ့သို့ ယာယီ မိလ္လာ အထောက် အပံ့များတပ်ဆင်ခြင်းများ ပြုလုပ်ရမည်။ • စွန့်ပစ်ပစ္စည်းများကိုမြစ်ထဲသို့တိုက်ရိုက်စွန့်ပစ်ခြင်းကို ရှောင်ရှားခြင်းကို ပြုလုပ် ရမည်။

	မြေအောက်ရေအရည်အသွေး	-မြေဆီလွှာညစ်ညမ်းခြင်းနှင့် နောက်ဆက်တွဲ မြေအောက်ရေ ညစ်ညမ်းခြင်း -လောင်စာဆီများ၊ ဆီများနှင့် ဆောက်လုပ်ရေးပစ္စည်းများမှ ဖိတ်ကျ စိမ့်ထွက်ခြင်းကြောင့် ညစ်ညမ်းခြင်း	• စွန့်ပစ်အမှိုက်များ စွန့်ပစ်ရာ နေရာမှ စိမ့်ထွက်အရည်များကို ထိန်းချုပ်ရမည်။ • တံတားဆောက်လုပ်ခြင်း နေရာ မှ လောင်စာဆီများ၊ ဆီများနှင့် ချောဆီများကို ထိန်းချုပ်ရမည်။
မြေဆီလွှာ ပတ်ဝန်းကျင်	မြေဆီလွှာညစ်ညမ်းခြင်း	- မော်တော်ယာဉ်များနှင့် စက်ယန္တရားကြီးများ အသုံးပြုခြင်းကြောင့် မြေကျစ်လစ် သိပ်သည်းခြင်းကို လျော့ကျစေပြီး မြေဆီလွှာ တိုက်စားခြင်းကို တိုးမြင့်စေခြင်း - မြေယာရှင်းလင်းခြင်းနှင့် ပြင်ဆင်ခြင်း လုပ်ဆောင်ချက်များမှ သီးနှံဆုံးရှုံးခြင်း ဖြစ်စေပြီးမြေကျစ်လစ်သိပ်သည်းခြင်းကိုလျော့ကျစေခြင်း - မြေဆီလွှာညစ်ညမ်းခြင်းနှင့် မြေဆီလွှာ အရည်အသွေးများဆုံးရှုံးခြင်း	• မြေဆီလွှာကို ဂရုတစိုက် ဖယ်ရှားပြီး နောက်ဆက်တွဲ ပြန်လည်တည်ထောင်ခြင်း အတွက် ထိန်းသိမ်းထားရမည်။ • မြေဆီလွှာတိုက်စားမှုနှင့် ပေါလော ပေါ်နေသော အစိုင်အခဲများကြောင့် ရေညစ်ညမ်းမှု ဖြစ်နိုင်ခြေကို လျော့ချရန်အတွက် ပြောင်းလဲနေသော မြေမျက်နှာပြင်၏ ပုံသဏ္ဍာန်ကို တည်ငြိမ်စေရန် ပြုလုပ်ရမည်။ • တံတားတည်ဆောက်ခြင်းနှင့် ပတ်သတ်၍ ဆောက်လုပ်ရေး ကြောင့် အနှောက် အယှက် ဖြစ်စေသော ရေလမ်းကြောင်း၏ အောက်ခံလွှာကို ပြန်လည် အစားထိုးရမည်။ • မြေဆီလွှာ ညစ်ညမ်းမှုကို လျော့ချရန် စက်များကို ပုံမှန် ထိန်းသိမ်းပြီး လောင်စာဆီနှင့် ဆောက်လုပ်ရေးပစ္စည်းများကို စနစ်တကျ သိုလှောင်ရမည်။
သဘာဝ ပတ်ဝန်းကျင်	ဇလဗေဒအခြေအနေ/ မြောင်းသွယ်ပုံစနစ်	- တံတားများတည်ဆောက်ခြင်းကြောင့် မြေဆီလွှာ တိုက်စားခြင်းနှင့်မြစ်များသို့မဟုတ်ချောင်းများ၏ကြမ်းပြင် နှင့် ကမ်းပါးတည်ငြိမ်မှု၏ နောက်ဆက်တွဲပြောင်းလဲမှုများ မြင့်မားလာခြင်း	• လူဖန်တီးထားသော ကမ်းပါးများကို အသုံးပြုရမည်။ • မည်သည့် ပြဿနာကို အတည်ပြုပြီးပါက ထပ်မံပြီး လျော့ချရေးအစီအမံများကို ထည့်သွင်းစဉ်းစားရမည်။ • ချောင်းများနှင့် ရေထွက်စမ်း ချောင်းများ ဖြတ်သန်းသွားစေရန် မြေအောက်မြောင်းများနှင့် ပိုက်လိုင်းစနစ်များ တည်ဆောက်ရမည်။
	ရေနေဂေဟဗေဒ	- အနည်အနှစ်များစီးဆင်းမှုများပြား လာခြင်းကြောင့် သစ်ပင်ပန်းမန်များနှင့် သတ္တဝါများ အပေါ် ဆိုးကျိုးသက်ရောက်နိုင်ခြင်း	• သားပေါက်သည့် ရာသီသို့ ငယ်ရွယ်စဉ် အချိန်ကဲ့သို့ နှစ်တစ်နှစ်၏ ထိခိုက်လွယ်သော အချိန်များတွင် တောရိုင်း တိရိစ္ဆာန်အား နှောက်ယှက်ခြင်းများ လျော့ချရန် ဆောက်လုပ်ရေးအလုပ်များအား အဆင့်လိုက်ခွဲ၍ လုပ်ဆောင်ရမည်။

		- ဆီ၊ လောင်စာနှင့် ဘိလပ်မြေသို့ အခြားသော ပစ္စည်းများ ရေလမ်းကြောင်းအတွင်း ဝင်ရောက်ခြင်းမှ ရေနေ အပင်များနှင့် တိရိစ္ဆာန်များအပေါ်တွင် ထိခိုက် နိုင်ခြင်း	• ငါးများနှင့် အခြားသော ရေနေ သတ္တဝါများ ဖြတ်သန်းသွားလာ နိုင်ရန် မြေအောက်မြောင်းများ ကို ပုံစံထုတ်ရပါသည်။ ငါးများ တစ်နေရာမှ တစ်နေရာသို့ ပြောင်း ရွှေ့သည့် အချိန်ကိုလည်း ရှောင်ရပါမည်။ • ငါးများ မြေအောက်မြောင်းများ ကို ဖြတ်သန်းသွားသည့်အခါ အကာအကွယ်ပေးရန် မြေအောက်မြောင်းအခြေ ပုံစံ တွင် baffle ပါဝင်ပေးရမည်။
	ကုန်းတွင်းပိုင်း ဂေဟဗေဒ	- ဆောက်လုပ်ရေးလုပ်ငန်းများကြောင့် (ရှားပါးပြီးထိခိုက်လွယ်သောမျိုးစိတ် များအပါအဝင်) မျိုးစိတ်များအား အနှောက်အယှက်ပေးခြင်း၊ မျိုးသုဉ်းခြင်းနှင့် နေထိုင်ကျက်စားရာ ဒေသပျောက်ဆုံးခြင်း	• clear span bridgeသည် ledge တစ်ခုထက် ဖြစ်နိုင်ခြေ ရှိသော ဒီဇိုင်းတစ်ခုမဟုတ်သည့် နေရာတွင် ကွန်ကရစ်စင် သို့ gravel side bar သို့ manmmel tunnelပုံစံ အဖြစ် ထောက်ပံ့ပေးရမည်။ • ကမ်းပါးဇရိယာများအတွင်း ငှက်သေတ္တာများကို ထားပေးထားရမည်။ • အသိုက်ဖွဲ့သည့် ငှက်များနှင့် လင်းနို့များအတွက် တံတားပုံစံပြုလုပ်ရာတွင် ထည့်သွင်းစဉ်းစားရမည်။
လူ့ပတ်ဝန်းကျင်	**လူမှုစီးပွားဆိုင်ရာ ကောင်းသော သက်ရောက်မှု** အလုပ်အကိုင်အခွင့်အလမ်း	ဒေသတွင်းထိခိုက်နိုင်သော လူထုအတွက် အမြဲတမ်း အလုပ်အကိုင် ခန့်ထားမှု	• သက်ဆိုင်ရာလုပ်ငန်းများအတွက် လေ့ကျင့်ရေးအစီအစဉ်များဖန်တီးပေးရန်။ • ကျွမ်းကျင်မှုမလိုအပ်သောအလုပ်အကိုင်အခွင့်အလမ်းများကိုဒေသခံများ အတွက် ဖန်တီးပေးရန်။ • ဒေသခံအလုပ်သမားများသုံးရန် သဘောတူစာချုပ်တွင် ထည့်ရန်။
	ဒေသခံပြည်သူများ၏ ကျွမ်းကျင်မှု တိုးတက်ရေး		• ဆောက်လုပ်ရေးမတိုင်ခင်သာမကဆောက်လုပ်ရေးကာလအတွင်းပါ ဒေသခံအလုပ်သမားများအတွက် လေ့ကျင့်ရေးအစီအစဉ်များဖန်တီးပေးရန်။ • ဆောက်လုပ်ရေး ပူးတွဲကန်ထရိုက်တာများရွေးချယ်ရာတွင် တင်ဒါစနစ်အနေဖြင့် ဒေသခံပြည်သူထဲမှ ရွေးရန်။

	ဒေသစီးပွားနှင့် လုပ်ငန်းများ တိုးတက်နိုင်မှု		• ဆောက်လုပ်ရေးအလုပ်သမားများမှ အနီးအနားကျေးရွာများရှိ အစားအသောက် နှင့် လူသုံးကုန်ပစ္စည်းများဝယ်ယူခြင်း။ • ကန်ထရိုက်တာနှင့် ပူးတွဲကန်ထရိုက်တာများအား တင်ဒါစနစ်အနေဖြင့် အသေးစားဒေသစီးပွားရေး လုပ်ငန်းများ ပေါ်ထွက်လာစေရေး လုပ်ဆောင်ပေးရန် တိုက်တွန်းခြင်း။
	လူမှုစီးပွားထိခိုက်မှု ဆန္ဒမပါသောနေရာ ပြောင်းရွှေ့ရမှု	မြစ်ကမ်းပါးနှင့် မြေအောက်မြောင်းများတလျှောက် PAP များ၏ အသက်မွေးဝမ်းကျောင်းများ ပြောင်းလဲမှု အချို့ပါဝင်သောအဆောက်အအုံသို့/နှင့် ပြန်လည်နေရာချခြင်း	• RAP တဦးချင်းစီထိခိုက် နစ်နာသောအဆောက် အဦးများ နှင့် သီးနှံများအတွက်လျော်ကြေးငွေ နှင့် အသက်မွေးဝမ်းကြောင်း ပြန်လည်ထူထောင်ရေးအတွက် အကူအညီပေးရမည်။
	လူမှုစီးပွားထိခိုက်မှု မြစ် နှင့် ချောင်းများ ပိတ်ဆို့မှု	- မြစ်အထက်ပိုင်းများတွင် ပိတ်ဆို့ထားခြင်းကြောင့် စိုက်ပျိုးမြေများကိုထိခိုက်စေနိုင်သည်။ - တံတားအုတ်မြစ်ချခြင်းအတွက် ရေကာတာများ တည်ဆောက်ခြင်းကြောင့် မြစ်အောက်ပိုင်းရှိရေပြတ်လပ်မှုကို ဖြစ်စေသည်။ - တံတား၏အုတ်မြစ်သည် အထူးသဖြင့် ချိုင့်ဝှမ်းကူးတံတားတွင် တောင်တန်းကိုပိတ်ဆို့နိုင်သည်။	• ရေလွှမ်းမိုးမှုအလားအလာကို လျှော့ချရန်အတွက် ရေပမာဏကိုစီးဆင်းရန်အခြား ရေလမ်းကြောင်းပြင်ဆင်ခြင်း။ • မြစ်ကူးတံတားနှင့် ချိုင့်ဝှမ်းကူးတံတားနှစ်ခုလုံးကိုမိုးရာသီတွင် ဆောက်လုပ်ခြင်းမပြုရန်။ • လယ်ယာမြေများနှင့် ကျေးရွာများအနီးရှိ မြစ်အထက်ပိုင်း ရေကြီးမှုကို ကာကွယ်ရန် အခြားရေလမ်းကြောင်းအသုံးပြုရန်။
	လူမှုရေးတင်းမာမှု	- အလုပ်နေရာများပြားလာခြင်း - လူမှုရေးတင်းမာမှု အန္တရာယ် - လူသစ်များ အလုပ်အကိုင်ရှာဖွေမှုကြောင့် လူမှုရေး ပြဿနာများဖြစ်နိုင်သည်။	• ဆောက်လုပ်ရေးလုပ်သားများအနေဖြင့် ဒေသခံဓလေ့ထုံးတမ်းများ၊ အလေ့အကျင့်များနှင့် ပက်သက်၍ အသိပညာမြှင့်တင်ပေးရန်။ • ဆောက်လုပ်ရေးလုပ်သားများ ဝင်ရောက်လာမည့်အကြောင်း ဒေသခံစီးပွားရေး လုပ်ငန်းများအား အသိပေးရန်။ • ငွေပေးချေခြင်းသည် သက်ဆိုင်ရာ အလုပ်သမားဥပဒေ၏ အနိမ့်ဆုံးလုပ်အားခ သတ်မှတ်ချက်များနှင့် ကိုက်ညီရမည်။

	လူမှုရေးဝန်ဆောင်မှုများအပေါ် သက်ရောက်မှု	- ဆောက်လုပ်ရေးကာလအတွင်းလူဦးရေတိုးတက်လာမှုကြောင့် လူမှုရေးဝန်ဆောင်မှုများအသုံးပြုမှု မြင့်တက်လာခြင်း	• ဒေသခံအလုပ်သမားများခန့်ထားရန်။ • ဆောက်လုပ်ရေးလုပ်သားများအတွက် ကိုယ်ပိုင် ကျန်းမာရေး ဝန်ဆောင်မှုများထားရှိပေးရန်။
	လူထုနှင့် အငြင်းပွားမှု	- ရှမ်းလူမျိုးစုများနှင့် ရှမ်းမဟုတ်သောလူမျိုးစုများအကြား အငြင်းပွားမှု - ရှမ်းမဟုတ်သည့် ရွှေ့ပြောင်းအလုပ်သမားများ၏ ဒေသခံအမျိုးသမီးများအပေါ် လိင်ပိုင်းဆိုင်ရာ အနှောင့်အယှက် ပေးခြင်းကဲ့သို့သော ဒေသခံလူထုအပေါ်ရန်လိုသော အပြုအမူများ	• ဒေသခံအလုပ်သမားများတတ်နိုင်သမျှ များများအသုံးပြုရန်။ • နိုင်ငံခြားသားအလုပ်သမားများ၏ ညထွက်ချိန်ကိုကန့်သတ်ရန်။ • နိုင်ငံခြားသားအလုပ်သမားများသည် ဒေသခံတို့၏ ယဉ်ကျေးမှုကို အလေးထားရန်။
	ယာဉ်ကြောပိတ်ဆို့မှုများပြားလာခြင်း	လူထုစိုးရိမ်ပူပန်မှု မြင့်တက်ခြင်း	• ဒေသသုံးယာဉ်ကြောပိတ်ဆို့မှုအချိန်ကိုရှောင်ကြဉ်ရန်။ • ဒေသတွင်းလမ်းများပိတ်ဆို့ခြင်းမရှိစေရန် သင့်တော်သောဆောက်လုပ်ရေးစီမံခန့်ခွဲမှုစနစ် ထားရှိခြင်း။ • ဖြစ်နိုင်ကတခြားလမ်းကြောင်းများထားရှိအသုံးပြုရန်။ •
	ပြစ်မှုတိုးပွားလာမှုနှင့် လုံခြုံရေး	ရွှေ့ပြောင်းဆောက်လုပ်ရေးအလုပ်သမားများဝင်ရောက်လာမှုကြောင့် မူးယစ်ဆေးဝါးနှင့် အရက်မှဖြစ်သောနှောင့်ယှက်မှု၊ ခိုးဝှက်မှုများနှင့် အနီးအနားကျေးရွာများအတွင်းအကြမ်းဖက်မှုများ	• ဒေသခံအလုပ်သမားတတ်နိုင်သမျှ အသုံးပြုရန်။ • ဒေသခံပြည်သူများသည် ဆောက်လုပ်ရေးအလုပ်သမားများ၏အပြုအမူများနှင့် ပက်သက်၍ ကောင်းသော အကျိုးဆက်များသာ မျှော်လင့်ကြောင်းကို ကန်ထရိုက်တာများမှ သဘောတူညီမှုစာချုပ်များတွင် ထည့်သွင်းရန်။ • ဆောက်လုပ်ရေးလုပ်သားများခွဲခြားသိရှိရန်။ • ဆောက်လုပ်ရေးလုပ်ငန်းခွင်များတွင် ခြံစည်းရိုးထားရှိခြင်း၊ အလုပ်သမားများ ညဘက်တွင် အပြင်မထွက်ခြင်းဖြင့် တားမြစ်ထားရှိရန်။ • ပြစ်မှုနှင့် အကြမ်းဖက်မှုများမရှိစေရန် ဘေးကင်းရေးအင်အားစုများထားရှိရန်။

	ဒေသသုံးလမ်းများ ပျက်စီးနိုင်မှု	ဆောက်လုပ်ရေးလုပ်ငန်းခွင်များသို့ ဆက်သွယ်ထားသောလမ်းသည် ဒေသသုံးလမ်းများကိုထိခိုက်နိုင်သည်။	• ဒေသသုံးလမ်းများအစား မြို့ရှောင်လမ်းအသုံးပြုရန်။ • ရွာလမ်းများနှင့် တံတားများအသုံးမပြုရန် မဖြစ်နိုင်ပါကလမ်းနှင့် တံတားများ၏ ခံနိုင်ရည်အားထက် မကျော်လွန်စေရန်။ • ရွာလမ်းများပျက်စီးခဲ့ပါက ပြန်လည်ပြုပြင်ပေးရန်။
	တိုင်းရင်းသား လက်နက်ကိုင်အဖွဲ့ အစည်းများနှင့် အငြင်းပွားမှု		• စီမံကိန်းဖွဲ့စည်းမှုအဆင့်တိုင်းအတွက် ပွင့်လင်းမြင်သာမှု ရှိရန်။ • စီမံကိန်း၏ မည်သည့်ဖွံ့ဖြိုးမှု အဆင့်မဆို တိုင်းရင်းသား အဖွဲ့အစည်းများအား အသိပေးရန်။ • အငြင်းပွားဖွယ်ရာများရှိခဲ့ပါကယင်းတို့နှင့် တိုင်ပင်ဆွေးနွေးရန်။
	လူထုကျန်းမာရေးနှင့် ဘေးကင်းလုံခြုံရေး လေမှတဆင့်ကူး စက်သောရောဂါများ	လူဦးရေတိုးပွားလာမှုကြောင့် တီဘီ၊ တုပ်ကွေးနှင့် ဦးနှောက်အမြေးရောင်ရောဂါ ကဲ့သို့သော လေမှတဆင့် ကူးစက်နိုင်သောရောဂါများ။	• ဆောက်လုပ်ရေးလုပ်သားများအတွက် ကျန်းမာရေးစစ်ဆေးချက်
	ဖုန်မှုန့်	ဒေသခံပြည်သူများအား လည်ချောင်းနှင့် အသက်ရှူ လမ်းကြောင်းဆိုင်ရာရောဂါများဖြစ်စေနိုင်သည်။	• ရေဖြန်းခြင်းဖြင့် လမ်းများကိုစိုစွတ်စေခြင်း • အစေ့များသိုလှောင်မှုနှင့် တောင်ပို့မျက်နှာပြင်များတတ်နိုင်သမျှ အမြန်ဆုံး ဆောင်ရွက်ရန်။ • ကားဘီးနှင့်ကားဘော်ဒီများကိုသန့်ရှင်းခြင်း
	ရေမှတဆင့်ဖြစ်သော ရောဂါများ	မြေစိုင်ခဲများနှင့် အိမ်သုံးစွန့်ပစ်ပစ္စည်းများ စွန့်ပစ်မှု မမှန်ကန်သည့်အခါ မြေအောက်ရေညစ်ညမ်းမှု ဖြစ်စေနိုင် သည်။	• မိုးရာသီတွင် ဆောက်လုပ်ရေးလုပ်ငန်းချိန်များရှောင်ကြဉ်ရန်။ • အချည်းအနှီးမြေဆီလွှာများ ရေရင်းမြစ်ထဲမဝင်စေရန် နှင့် မြေစာပုံများ မြေပေါ် ရေနှင့် အဝေးတွင် ထားရှိရန်။
	ခြင်မှတဆင့် ကူးစက်သော ရောဂါများ	ငှက်ဖျားရောဂါသည် မြန်မာနိုင်ငံအထက်ပိုင်းတွင် အဖြစ် များခြင်းကြောင့် အဆိုပါထိခိုက်မှုသည် အလယ် အလတ် ဖြစ်သည်။	• မိုးရာသီတွင် ဆောက်လုပ်ရေးလုပ်ငန်းချိန်များတတ်နိုင်သမျှ ရှောင်ကြဉ်ရန်။ • ဆောက်လုပ်ရေးကာလအတွင်းဖုံးအုပ်ထားခြင်းမရှိသောရေသေကန်များမရှိစေ ရန်။

	လိင်မှတဆင့် ကူးစက်သော ရောဂါများ	HIV/AIDS ကဲ့သို့သောကူးစက်နိုင်သောရောဂါများ	• အလုပ်သမားများနှင့် ဒေသခံပြည်သူလူထုအတွက် ကျန်းမာရေး ဗဟုသုတဆိုင်ရာ အသိပေးအစီအစဉ်များဖော်ဆောင်ပေးခြင်း။
	ဆူညံသံမှတဆင့် ဖြစ်သောရောဂါများ	ဆူညံသံမြင့်မားမှုကြောင့် အကြားအာရုံဆုံးရှုံးခြင်းများ ဖြစ်နိုင်သည်။	• ဆူညံသံကိုလျှော့ချရန် စီမံကိန်းအတွင်းထရပ်ကားများ၏ အမြန်နှုန်းကို လျှော့ချရန်။ • ညအချိန်အလုပ်လုပ်ခြင်းကိုရှောင်ကြဉ်ရန်။ •
	ဗိသုကာနှင့်ရှေးဟောင်း သုတေသနအမွေအနှစ်	ရှေးဟောင်းသုတေသနသို့မဟုတ် ယဉ်ကျေးမှုဆိုင်ရာ အရေးပါမှု၏ လူသိများသောသို့မဟုတ် မသိသော အဂ်ါရပ်များပျက်စီးခြင်း	• ယဉ်ကျေးမှုနှင့် ရှေးဟောင်းသုတေသနဆိုင်ရာအရေးပါသော စာရင်းကို ရေးဆွဲရမည်။ ဤအဂ်ါရပ်များအား အန္တရာယ် ဖြစ်စေနိုင်သော လုပ်ဆောင်မှုများကိုရှောင်ကြဉ်ရမည်။ • ပျက်စီးမှုကိုရှောင်လွှဲ၍မရနိုင်သည့်နေရာတွင်ရှေးဟောင်းသုတေသနဆိုင်ရာစုံစမ်းစစ်ဆေးမှုများပြုလုပ်ရမည်။ •
	သာယာအဆင်ပြေမှု နှင့် စိတ်အနှောက် ဖြစ်မှု	- ဆောက်လုပ်ရေးကာလအတွင်းသာယာအဆင်ပြေမှု ဆုံးရှုံးခြင်း - ဆောက်လုပ်ရေးယာဉ်အသွားအလာ နှင့် လည်ပတ်မှုမှ ဆူညံသံ	• သာယာအဆင်ပြေမှုနှင့် စိတ် အနှောက်အယှက်ဖြစ်မှုကို လျှော့ချရန် စနစ်ကျသော ဆောက်လုပ်ရေး စီမံခန့်ခွဲမှုစနစ် တစ်ခုတည်ဆောက်ရမည်။ • အများသုံးလမ်းမပေါ်မသွားမီ ယာဉ်၏ဘီးများကို ဆေးရမည်။
	အမြင်ပသာဒ	လူထု၏ စိုးရိမ်ပူပန်မှုများတိုးပွားလာခြင်း	• အပန်းဖြေ ဇရိယာများအား ရှောင်ရှားခြင်းနှင့် ဘေးနံများကို အစိမ်းရောင်များဖြင့် အလှဆင်ရမည်။
အခြား	အန္တရာယ်များသော ပစ္စည်းများနှင့် ဆီများကိုစီမံခန့်ခွဲမှု	ဆောက်လုပ်ရေးလုပ်ငန်းတွင် အသုံးပြုသော အန္တရာယ်များ သောပစ္စည်းများနှင့် လောင်စာဆီများကို ဖျက်ဆီးခြင်း	• ယိုဖိတ်စိမ့်ထွက်မှုကို ထိန်းချုပ် သော လုပ်ဆောင်ချက်များကို ပြုလုပ်ရမည်။ ဓာတုပစ္စည်းများနှင့် လောင်စာဆီများ ကိုင်တွယ် ဖြေရှင်းရန်အတွက် အလုပ်သမား များအား သင်တန်းပေး ရမည်။

သုံးစွဲမှုကြောင့် သက်ရောက်မှု	ရေသုံးစွဲမှု	ဆောက်လုပ်ရေးလုပ်ငန်းများကိုဆိုဒ်မဝင်ခင် ကြိုတင်ပြင်ဆင်ခြင်းဖြင့် ရေသုံးစွဲမှုကိုလျှော့ချနိုင်သည်။	• ဆောက်လုပ်ရေးသုံးရေကို လျှော့ချရန်။ • အိမ်သုံးရေသုံးစွဲမှုကို လျှော့ချရန်။
	လောင်စာသုံးစွဲမှု	ဒီဇယ်အင်ဂျင် အသုံးပြု မီးစက်များကို အသုံးပြုခြင်းမှ ထွက်သောဖုန်မှုန့်နှင့် ဆူညံသံများသည် ပတ်ဝန်းကျင်ကို ထိခိုက်စေနိုင်သည်။	• ဒီဇယ်အင်ဂျင်အသုံးပြုမှုကို ထိန်းချုပ်ရန်နှင့် အသုံးမလိုချိန်တွင် မလည်ပတ်ရန်။ • အစားထိုးအသုံးပြုမှု စနစ် • ဇီဝလောင်စာအတွက် ပြည်တွင်းကုန်ကြမ်းထုတ်လုပ်မှုကို လှုံ့ဆော်ရန်။
လုပ်ငန်းလည်ပတ်ရေးကာလ/ လုပ်ငန်းခွင်ပြုပြင်ထိန်းသိမ်းရေးကာလ			
ဒေသတွင်းလေအရည်အသွေး	ဆူညံသံနှင့် တုန်ခါမှု	တံတားပေါ်တွင် မြန်နှုန်းမြင့် ရထားလမ်းဖြတ်သန်းသွားခြင်း	• အများပြည်သူပိုင်ဇရိယာ အနီးနားတွင် အသံလုံစေသော စီမံချက်များ ပြုလုပ်ထားရမည်။ • ယာဉ်၏ဘီးကို ပြုပြင်ထိန်း သိမ်းခြင်း၊ ယာဉ်ပြုပြင် ထိန်းသိန်းခြင်း နှင့် elastic solution ပြုလုပ်ခြင်းအားဖြင့် အသံနှင့် တုန်ခါမှုများကို ထိန်း ချုပ်နိုင်သည်။
ရေထုပတ်ဝန်းကျင်	ရေထုညစ်ညမ်းမှု	ရေနောက်ကျိခြင်းများတိုးပွားလာခြင်း၊ အသေးစားပြုပြင်ထိန်းသိမ်းမှု လုပ်ဆောင်ချက်များမှ တဆင့် ဆီ နှင့် အရောင်သုတ်ဆေးများရေထဲတွင် များပြား လာခြင်း	• မှန်ကန်သော ထိန်းချုပ်ခြင်းနှင့် ဆီများ သို့ အရောင်သုတ်ဆေးကို စိမ့်ထွက်ခြင်း ကို ရှောင်ရှားရမည်။
	မြေပေါ်ရေဇလဗေဒ	• မြစ်အထက်ပိုင်းမှ ရေစီးဆင်းရန်အဟန့်အတားဖြစ်နိုင်ခြင်း • ရေအဟုန်လျော့ကျခြင်းနှင့် ရေအနက်တိုးလာခြင်း • ရေကြီးရေလျှံမှုများဖြစ်မှု များပြားလာခြင်း • ရေစီးကြောင်းပြောင်းလဲခြင်းနှင့် ရေတိမ်ပိုင်း/ ရေကန်များ ပြောင်းလဲခြင်း။	• မြေအောက်မြောင်းများ၏ အထက်ပိုင်းနှင့် အောက်ပိုင်းတွင် ရေလမ်းကြောင်းများနက်ခြင်းသို့ ကျယ်ခြင်းများမဖြစ်သင့်ပါ။ • လုပ်ငန်းခွင်တွင် အသုံးပြုမည့် သို့ သိုလှောင်မည့် အရာဝတ္ထု တစ်ခုချင်းစီအတွက် ထိခိုက်မှု ဆန်းစစ်ခြင်းကို လုပ်ဆောင်ရမည်။ သင့်တော်သော ထိန်းချုပ်မှု အစီအမံများကိုလည်းလုပ်ဆောင်ရပါမည်။ • တံတားနှင့် ပတ်သတ်ပြီး အဓိကရေလွှမ်းမှုဖြစ်ရပ်တွင် အတားအဆီးဖြစ်မည့် over-deck flow ကို ခွင့်ပြုရန် open parapet များကို အသုံးပြုရပါသည်။
	မြေပေါ်ရေ အရည်အသွေး	• မြစ်အထက်ပိုင်း ရေများတွင် အောက်ဆီဂျင် ပါဝင်မှု လျော့နည်းခြင်းနှင့်	• သဘာဝရေစီးကြောင်းများ လွှပ်လပ်စွာစီးဆင်းခြင်းကို တားဆီးခြင်းများ မပြုလုပ်ရပါ။

		မြစ်အောက်ပိုင်းရေအရည်အသွေးလျော့ကျခြင်း။	
မြေဆီလွှာ ပတ်ဝန်းကျင်	မြေဆီလွှာညစ်ညမ်းခြင်း	ဆီနှင့် တံတား၊ မြေအောက်မြောင်း အရောင်သုတ်ဆေးများ ယိုစိမ့်ခြင်းကြောင့် မြေဆီလွှာညစ်ညမ်းမှု ဖြစ်ခြင်း	• ပြုပြင်ထိန်းသိမ်းခြင်းအတွင်း ဆီနှင့် အရောင်သုတ်ဆေးများ စိမ့်ထွက်ခြင်းကို မှန်ကန်သော စီမံခန့်ခွဲမှုနှင့် ထိန်းချုပ်ခြင်းများ ပြုလုပ်ရပါမည်။
ဇီဝမျိုးစုံမျိုးကွဲများ	ရေနေဂေဟစနစ်နှင့် ကုန်းမြေဂေဟစနစ်	• ကျက်စားရာနေရာများခွဲခြားထားသော မြစ်လမ်းကြောင်းများ အဆက်ပြတ်ခြင်းကြောင့် မျိုးစိတ်အရေအတွက်နှင့် ဒေသခံမျိုးစုံမျိုးကွဲများလျော့နည်းခြင်း • မြေအောက်မြောင်း၏ ရေအလျင်တိုးပွားခြင်းသည် ငါးများ နေရာဒေသပြောင်းရွှေ့နေခြင်းနှင့် မြစ်အထက်ပိုင်းရှိငါးရစ်ဖြစ်ခြင်းကိုအနှောက်အယှက်ဖြစ်စေပါသည်။	• လက်ရှိနေရင်း ကျက်စားရာဒေသ အင်္ဂါရပ်များကို လုပ်ငန်းခွင် ဒီဇိုင်းတွင် ထည့်သွင်းပြီးပြောင်းလဲမှုမှ ကာကွယ်ရမည်။ • ကျက်စားရာနေရာများဆုံးရှုံးမှုကို လျော်ကြေးပေးရန် နှင့် လုပ်ငန်းခွင်အတွက် ရှုခင်းများနှင့် ဂေဟဆိုင်ရာအလားအလာများများတိုးတက်စေရန် နောက်ထပ်ကျက်စားရာဒေသများကိုဖန်တီးပေးရမည်။ • နို့တိုက်သတ္တဝါများအတွက် အတားအဆီးများကိုဖန်တီးပေးရမည်။ • တောရိုင်းတိရစ္ဆာန်ဖြတ်ကူးနိုင်သည့် အလားအလာရှိသည့် နေရာများတွင် ဆိုင်းဘုတ်များထားရမည်။
လူ့ပတ်ဝန်းကျင်	မတော်တဆမှုများ	ရထားစီးနင်းသူများနှင့် ဒေသခံပြည်သူများ၏ ရထားလမ်း မတော်တဆမှုများ	• သံလမ်းနှင့် ပတ်သတ်သော ရထားအသွားအလာ ဘေးအန္တရာယ်ကင်းရှင်းရေး အကြောင်း ရထားစီးနင်းသူများနှင့် ဒေသခံနေထိုင်သူများကို အသိပညာပေးခြင်း
	လူမှုစီးပွားဆိုင်ရာ ကောင်းသောသက်ရောက်မှု	အလုပ်အကိုင်အခွင့်အလမ်း	• အဆိုပြုထားသော စီမံကိန်းသည် တံတားနှင့် ရေတံခွန်များ၏ ပြုပြင်ထိန်းသိမ်းရေး လုပ်ငန်းစဉ်တစ်လျှောက် ဒေသဆိုင်ရာ စီးပွားရေးကို တိုးမြှင့်ပေးသောကြောင့် အပြုသဘောသက်ရောက်မှုရှိသည်ဟု မျှော်လင့်ရသည်။ ဆောက်လုပ်ရေးကာလအတွင်း အသက်မွေးဝမ်းကျောင်းမှု သက်ရောက်ခဲ့သည့် PAP များအတွက် RAP အရ အကောင်အထည်ဖော်ရမည်။
		ဒေသခံလူထုဖွံ့ဖြိုးမှု	• ဒေသခံပြည်သူများအား လိုအပ်သောဝန်ဆောင်မှုများ (သယ်ယူပို့ဆောင်ရေး၊ ဘာသာရေးနေရာများသို့ ခရီးသွားများ၊ ဒေသတွင်းခရီးသွား ဧည့်လမ်းညွှန်များ) အလုပ်အကိုင်များ ဖန်တီးပေးခြင်းဖြင့် စီမံကိန်း၏ ကောင်းသော

			သက်ရောက်မှုများကို တိုးမြှင့်နိုင်သည်။ • လူမှုဆန်းစစ်ချက်အရ ဒေသခံပြည်သူများသည် လူထုလိုအပ်ချက်အရ အများဆုံးဖြစ်ပြီး ရပ်ရွာဖွံ့ဖြိုးရေးကိုလည်း အထောက်အကူပြုသည်။
		အမြင်ပသာဒ	• ဒေသခံလူထုအတွက် လိုက်ဖက်သော တံတားဆောက်လုပ်ရေးဒီဇိုင်း။
	လူမှုစီးပွားဆိုင်ရာ ထိခိုက်မှု	ရွှေ့ပြောင်း အလုပ်သမားများ၏ တရားမဝင် အခြေချ နေထိုင်မှု	• ဆောက်လုပ်ရေးပြီးပါက ဆောက်လုပ်ရေးအလုပ်သမားများပါ ဖယ်ရှားပေးရန် ကန်ထရိုက်တာ ပူးတွဲကန်ထရိုက်တာများနှင့် သဘောတူညီမှုစာချုပ်ထဲတွင် ထည့်သွင်းစဉ်းစားရန်။ • ဥပဒေ နည်းဥပဒေများနှင့် အညီ အလုပ်သမားများကို ထိန်းချုပ်ခြင်း။ • ဒေသခံအလုပ်သမား အများအပြားအသုံးပြုရန်။
		လူထုကျန်းမာရေးနှင့် ဘေးကင်းလုံခြုံရေး - မတော်တဆဖြစ်ရပ်များ	• ကျူးကျော်ဝင်ရောက်ခြင်းနှင့် နှောင့်ယှက်ဖျက်ဆီးခြင်းများကို တားဆီးရန် လုံလောက်သော အကာအကွယ်နှင့် ခြံစည်းရိုးများ ထားရှိရန်။ • ဒေသခံပြည်သူများနှင့် အနီးအနားပတ်ဝန်းကျင်အတွက် ဘေးအန္တရာယ် ကင်းရှင်းရေး ဆိုင်းဘုတ်များ ထားရှိရန်။
		သာယာအဆင်ပြေမှုနှင့် စိတ်အနှောင့်အယှက်ဖြစ်မှု - အပန်းဖြေမှု အခွင့်အလမ်းများလျော့ကျခြင်းဥပမာ - ငါးများခြင်းနှင့်အမြင်ပသာဒဆုံးရှုံးခြင်း။	• တတ်နိုင်သမျှ တံတားနှင့် မြေအောက်မြောင်းမှာသို့ အနီးတွင် အများသုံး အပန်းဖြေနေရာများဖန်တီးရမည်။ • တံတားနှင့် မြစ်များဝန်းကျင်တွင် သစ်ပင်များပြန်လည်စိုက်ပျိုးရမည်။
သုံးစွဲမှုများ	လျှပ်စစ်သုံးစွဲမှု	- တံတားအတွက် လုံလောက်သောအလင်းရောင်ပေးရန် ဒေသသုံးလျှပ်စစ်ကိုအသုံးပြုခြင်းကြောင့် ဒေသခံလူထုအပေါ် အနှောင့်အယှက်ဖြစ်စေသည်။	• LED မီးနှင့် ဝပ်သုံးနည်းသောမီးအိမ်များအသုံးပြုပါ။ • တံတားအတွက် အလင်းပေးရန် ဖြစ်နိုင်ပါကနေရောင်ခြည်စွမ်းအင်ကို အသုံးပြုပါ။
လုပ်ငန်းဖျက်သိမ်းကာလ			
လေထု ပတ်ဝန်းကျင်	ဖုန်မှုန့်နှင့် ဓာတ်ငွေ့ထုတ်လွှတ်မှု	• ဒီဇယ်နှင့် ထရပ်ကားများအသုံးပြုမှု	• အင်ဂျင်ကောင်းသောစက်များနှင့် ဆာလဖာပါဝင်မှုနည်းသော လောင်စာကို အသုံးပြုရန်နှင့် ဖုန်မှုန့်ထုတ်လွှတ်မှုအတွက် ရေဖြန်းရန်။

	ဆူညံသံ	• စက်ပစ္စည်းများ အသုံးပြုမှုနှင့် ယမ်းခွဲခြင်းလုပ်ငန်းမှ ထွက်သော ဆူညံသံသည် ပတ်ဝန်းကျင်ရှိလူထုအတွက် အနှောင့်အယှက်ဖြစ်စေနိုင်သည်။	• ဒေသခံပြည်သူများအတွက် အနှောင့်အယှက်မဖြစ်စေရန် ယမ်းခွဲခြင်း လုပ်ငန်း များကို အချိန်ဇယားချမှတ်ခြင်းနှင့် ကြိုတင်သတိပေးခြင်းများ ပြုလုပ်ရန်။ • လူနေဧရိယာများနှင့် အထိခိုက်မခံသောနေရာများအနီးတွင် အသံလုံ အတား အဆီးများထားရှိရန်။
	တုန်ခါမှု	• ယမ်းခွဲခြင်းလုပ်ငန်းတွင် အသုံးပြုသော ဖောက်ခွဲရေး ပစ္စည်းများကြောင့် အနီးအနားပတ်ဝန်းကျင်ကို အနှောင့် အယှက်ဖြစ်စေနိုင်သည်။	• လွန်တူးယမ်းခွဲခြင်းလုပ်ငန်းများမဆောင်ရွက်မီ ဖြစ်နိုင်ချေရှိသော တုန်ခါမှုများ ကို ဒေသခံလူထုကို ကြိုတင်အသိပေးရန်။ • သင့်တော်သောလွန်တူးယမ်းခွဲခြင်းနည်းလမ်းကိုအသုံးပြုရန်။ • လူနေဧရိယာများ နှင့် ဇီဝမျိုးကွဲများရှိသောနေရာများတွင် ထိန်းချုပ် ယမ်းခွဲ စနစ်ကို အသုံးပြုရန်။
ရေထုပတ်ဝန်းကျင်	မြေပေါ်ရေဇလဗေဒ	• မြေဆီလွှာသိပ်သည်းမှုကြောင့် ကမ်းပါးနေရာများမှ စိမ့်ထွက်ရေ • မော်တော်ယာဉ်များမှ လောင်စာနှင့်ဆီများဖိတ်ကျမှု	• ဆောက်လုပ်ရေးကာလတွင် သင့်တော်သောရေစီမံခန့်ခွဲမှု • မော်တော်ယာဉ်ရပ်နားစခန်းများတွင် ဆီစိမ့်ခံခွက်များ အသုံးပြုရန် နှင့် ၎င်းတို့ကို ပုံမှန်သန့်ရှင်းရန်။ • မြစ်ထဲသို့ ဆီ၊လောင်စာနှင့် ကွန်ကရစ်များစိမ့်ထွက်ကျခြင်းကိုထိန်းချုပ်ရန်။
မြေဆီလွှာပတ်ဝန်းကျင်	တူးဖော်မြေများ တိုက်စားမှု	• တံတား/မြေအောက်မြောင်းများဖယ်ရှားမှုကြောင့် မြေသားဖယ်ရှား/ပြောင်းလဲမှုနှင့် တူးဖော်မြေများတိုက်စားမှု • ကွန်ကရစ် အကြွင်းအကျန်များ	• မြေဆီလွှာတိုက်စားမှုနှင့် ဆိုင်းငံ့ထားသောအစိုင်အခဲများမှ ရေညစ်ညမ်းမှု အလားအလာကိုအနည်းဆုံးဖြစ်စေရန် ပြောင်းလဲသွားသောမြေမျက်နှာပြင်များကိုထိရောက်စွာတည်ငြိမ်စေခြင်း • ကွန်ကရစ်အကြွင်းအကျန်များအတွက် စနစ်ကျသောစွန့်ပစ်နည်းလမ်းအသုံးပြုရန် နှင့် လူနေဧရိယာများအနီးတွင် အသုံးမပြုရန်။

ဇီဝမျိုးစုံမျိုးကွဲများ	ရေနေအပင်နှင့် တိရစ္ဆာန်များအပေါ် သက်ရောက်မှု	• စမ်းချောင်းများ၏ အနည်အကျစီးဆင်းမှုမှ • ရေအရင်းအမြစ်ထဲသို့ဝင်သည့် ဆီ၊လောင်စာနှင့် အခြားပစ္စည်းများ	• ဆီနှင့်လောင်စာဆီများ မြစ်နှင့် ချောင်းများထဲသို့ ယိုဖိတ်ခြင်းကိုရှောင်ကြဉ်ပါ။ • ရေနေအပင်များနှင့် တိရစ္ဆာန်များကိုအထိအခိုက်မဖြစ်စေရန် စနစ်ကျသော တံတားဖြိုဖျက်ခြင်းနည်းလမ်းကိုအသုံးပြုပါ။ • ကျန်ရှိနေသောကွန်ကရစ်နှင့် သံမဏိကိုယ်ထည်များကိုဥပဒေနှင့် စည်းမျဉ်းများ အရစွန့်ပစ်ပါ။
	ကုန်းမြေအပင်များနှင့် တိရစ္ဆာန်များအပေါ် သက်ရောက်မှု	• ယာဉ်လှုပ်ရှားမှုများနှင့် ကျက်စားရာနှောင့်ယှက်မှုများ • ရေအရင်းအမြစ်ထဲသို့ဝင်သည့် ဆီ၊လောင်စာနှင့် အခြားပစ္စည်းများ	• ရှိရင်းစွဲနေရင်းဒေသအင်္ဂါရပ်များကိုဆောက်လုပ်ရေးဒီဇိုင်းတွင် ထည့်သွင်းစဉ်းစားရန်နှင့် ပြောင်းလဲမှုများမှ ကာကွယ်ရန်။ • ကျက်စားရာဒေသများဆုံးရှုံးမှုကိုလျော့ကြေးပေးရန်နှင့် ရှခင်းနှင့် ဂေဟစနစ် အလားအလာများတိုးတက်စေခြင်း။ • အသုံးပြုခွင့်ကိုကန့်သတ်မှုများရှိခဲ့ပါကအခြားနည်းလမ်း ပြင်ဆင်ပေးရန်။
လူ့ပတ်ဝန်းကျင်	**လူမှုစီးပွားဆိုင်ရာ ထိခိုက်မှု** ဒေသခံပြည်သူ အတွက်အလုပ်အကိုင် ဆုံးရှုံးခြင်းနှင့် အစိုးရဝင်ငွေကျဆင်း ခြင်း	• စီမံကိန်းပြုလုပ်ခဲ့စဉ်ကရရှိခဲ့သောကောင်းကျိုးများနှင့် ပြောင်းပြန်အခြေအနေသို့ ရောက်ရှိသွားနိုင်သည်။ • အလုပ်အကိုင်များဆုံးရှုံးခြင်းနှင့် ခရီးသွားလုပ်ငန်းများမရှိတော့ခြင်းကြောင့် နိုင်ငံ့ဝင်ငွေ ဆုံးရှုံးခြင်း	• ဝန်ထမ်းများအတွက် အခြားသော အသက်မွေးဝမ်းကျောင်း ခွင့်ပြုရန် ကျယ်ပြန့်ပြီး ပြည့်စုံသော ကြိုတင်သတိပေးချက်ကိုစောစီးစွာ ပြုလုပ်ရန်။ • စီမံကိန်းရေးဆွဲသူသည် ၎င်းတို့၏ဝန်ထမ်းများ ဆန္ဒမပါသော အငြိမ်းစားယူရမှုအတွက် အခြားသောသင့်တော်သည့် အလုပ်များဖန်တီးပေးခြင်းခြင့် ကြိုတင် ပြင်ဆင်ထားရန်။
	အမြင်ပသာဒ	• လုပ်ငန်းခွင်ကြောင့် ယာယီအမြင်ပသာဒထိခိုက်မှု • ဆိုဒ်အတွင်းမော်တော်ယာဉ်များသွားလာမှု • လူနေအိမ်များအနီးတွင် သံမဏိကိုယ်ထည် အကြွင်းအကျန်များ စွန့်ပစ်ခြင်း	• အမြင်ပသာဒထိခိုက်မှုများအတွက် သင့်လျော်သောစိစစ်မှု • ဖြိုဖျက်မည့် တံတားအနီးတွင် အပင်များစိုက်ပျိုးခြင်း • လူနေရပ်ယာများအနီးတွင် ကွန်ကရစ် အကြွင်းအကျန်များကို မစွန့်ပစ်ရန်နှင့် စနစ်ကျသော စွန့်ပစ်နည်းစနစ်များအသုံးပြုရန်။

၁.၆။ ထပ်ဆင့်တိုးပွားနိုင်သောသက်ရောက်မှုများနှင့် လျော့နည်းသက်သာစေရန် လုပ်ဆောင်ရမည့် နည်းလမ်းများအကျဉ်းချုပ်

စီမံကိန်း၏ ဆောက်လုပ်ရေးအကြိုကာလ၊ ဆောက်လုပ်ရေးကာလ၊ လုပ်ငန်းလည်ပတ်မှုကာလနှင့် စီမံကိန်းဖျက်သိမ်းခြင်းကာလများတွင် ထပ်ဆင့်တိုးပွားနိုင်သောသက်ရောက်မှုများနှင့် လျော့နည်းသက်သာစေရန် လုပ်ဆောင်ရမည့် နည်းလမ်းများအကျဉ်းချုပ်ကိုအောက်ပါဇယားတွင် ဖော်ပြထားပါသည်။

ဇယား -ထပ်ဆင့်တိုးပွားလာနိုင်သောပတ်ဝန်းကျင်ထိခိုက်မှုဖော်ပြချက် အကျဉ်းချုပ်

စီမံကိန်းကာလ	အမျိုးအစား	ဖြစ်နိုင်ချေရှိသောသက်ရောက်မှု	လျော့ချရေးနည်းလမ်းများ
အကြိုဆောက်လုပ်ရေး ကာလ	ကျက်စားရာ ဒေသများ ဆုံးရှုံးမှု	- အပင်များဖယ်ရှားခြင်း - အပင်နှင့် တိရစ္ဆာန်များအတွက် အန္တရာယ်ဖြစ်စေ နိုင်သောအပူချိန် အပြောင်းအလဲ	- အစားထိုးစားကျက်များဖန်တီးပေးခြင်း - ရထားလမ်းမှ ကာကွယ်ရန် ခြံစည်းရိုးများထားရှိပေးခြင်း - တိရစ္ဆာန်များအတွက် ဖြတ်လမ်းများဆောက်လုပ်ပေးခြင်း - အပင်ခုတ်ခြင်းများအနည်းဆုံးအဆင့်သို့ လျှော့ချခြင်း။ - မြေတူးခြင်းလုပ်ငန်းများလျှော့ချခြင်း။
	သစ်တောရှင်းလင်းခြင်း	- ရာသီဥတု အပြောင်းအလဲကို ဖြစ်စေသော ဖန်လုံ အိမ်ဓာတ်ငွေ့ - မျိုးစိုးများနှင့် လေထုညစ်ညမ်းမှုကြောင့် အသက်ရှူ လမ်းကြောင်းဆိုင်ရာရောဂါများ - ခြောက်သွေ့သောမြေကို ဖြစ်စေပြီး သီးပင် မဖွံ့ဖြိုးခြင်းကို ဖြစ်စေသည်။	- လုပ်ငန်းခွင်တွင် မော်တော်ယာဉ်များမလိုအပ်ပဲလုပ်ငန်းဆိုင်းငံ့ထားခြင်းကိုရှောင်ကြဉ်ရန်။ - ဆောက်လုပ်ရေးလမ်းကြောကိုအကောင်းဆုံးဖြစ်အောင် စီစဉ်ရန်။ - သစ်မာမျိုးစိတ်များစိုက်ပျိုးပေးရန်။ - သစ်ပင်များ ပြန်လည်စိုက်ပျိုးရေးနှင့် သစ်တောများ ပြန်လည် ထူထောင်ရေး - သဘာဝကာဖွန်ကန်များကိုကာကွယ်ခြင်း။ -အပင်များရှင်းလင်းရေးကိုအနည်းဆုံးထားရှိရန်။

ဆောက်လုပ်ရေး ကာလ	ရေရှားပါးမှု	ဆောက်လုပ်ရေးလုပ်ငန်းများနှင့် လုပ်သားများအတွက် ရေအသုံးပြုမှုကြောင့် ရေရှားပါးမှု	- ရေရှည်တည်တံ့သောရေစီမံခန့်ခွဲမှု - ပြန်အသုံးပြုသောရေ - အသိပညာပေးအစီအစဉ်များ
	ရေညစ်ညမ်းမှု	လောင်စာနှင့် သုတ်ဆေးများ ဖိတ်စင်ကျမှုများ ကြောင့် ရေညစ်ညမ်းခြင်း	- အချို့သောရိုးရှင်းသောလမ်းညွှန်ချက်များကိုလိုက်နာခြင်းဖြင့် အနီးအနားရှိ မြစ်များနှင့် ရေကန်များရှိရေညစ်ညမ်းမှုအပြင် မြေအောက်ရေနှင့် သောက်သုံးရေတို့ကိုပါ ကာကွယ်ရန်။ - ဆောက်လုပ်ရေးစွန့်ပစ်ပစ္စည်းများကို မြစ်များနှင့် ချောင်းများမှ စွန့်ပစ်ခြင်းကိုရှောင်ကြဉ်ရန်။ - ရေပြတ်လပ်မှုကိုတားဆီးရန်နှင့် သန့်စင်ရန်လိုအပ်သည့် ညစ်ညမ်းရေ ပမာဏကို လျှော့ချရန်။
	တရားမဝင် ကုန်ကူးမှု	ဆောက်လုပ်ရေး ပစ္စည်းများ သယ်ယူပို့ဆောင်စဉ် ကျောက်စိမ်း၊ ရှားပါးတိရစ္ဆာန်များ၊ သစ်ခွ နှင့် အခြား သဘာဝ သယံဇာတများသည် တရားမဝင် ကုန်ကူးမှု ဖြစ်နိုင်သည်။	- နိုင်ငံတွင်းမှ မထွက်ခွာမီစစ်ဆေးရေးဂိတ်တိုင်းတွင် သေချာစစ်ဆေးရန်။ - ကားများသည် စစ်ဆေးရန်များပြုလုပ်ရန် လုံလောက်သော အချိန် ပမာဏကြာရပ်ပေးရမည်။ - သက်ဆိုင်ရာအဖွဲ့အစည်းများနှင့် ပူးပေါင်းပါဝင်ရန်။
လုပ်ငန်းလည်ပတ်ကာလ	မြေအသုံးချမှု	- အနီးအနားစိုက်ပျိုးမြေများအပေါ် ထိခိုက်မှု - စွယ်စုံမြေယာများဆုံးရှုံးမှု - မွေးမြူရေး လုပ်ငန်းအတွက် လမ်းကြောင်း ဆက်သွယ်ရန် ခက်ခဲမှု	- မြေအသုံးချမှုပုံစံပြောင်းလဲမှုများကိုလျှော့ချရန်။ - စိုက်ပျိုးမြေ၊ သမိုင်းဝင်မြေ၊ ရှေးဟောင်းသုတေသနမြေ၊ သစ်တော မြေ နှင့် ဂေဟစနစ်အထိခိုက်မခံသော ဒေသများတွင် တတ်နိုင်သမျှ မြေအသုံးမပြုရန်။
	အမြင်ပသာဒ	- ထိုဧရိယာ၏ မြို့ပြဖွံ့ဖြိုးတိုးတက်မှုကို အထောက် အကူပြုရန် - ရှုခင်းပုံစံတဖြည်းဖြည်းပြောင်းလဲမှု - အလုပ်၏ အတိုင်းအတာကြောင့် အပင်များ ရှင်းလင်း ရန် လိုအပ်ချက်	- အပင်စိုက်ခြင်းကဲ့သို့သောသဘာဝရှုခင်းအကာအကွယ်များ - အစားထိုးသစ်ပင်စိုက်ပျိုးခြင်း - သိုလှောင်ရုံများ၏ တည်နေရာနှင့်အရောင်အသွေးကို ဗိသုကာ လက်ရာရှုထောင့်မှ ထည့်သွင်းစဉ်းစားခြင်း။

	ရေရှားပါးမှု	လုပ်ငန်းလည်ပတ်မှုကာလအတွင်း စီမံကိန်းနား တစ်ဝိုက် ဖွံ့ဖြိုးတိုးတက်လာမှုကြောင့် လူဦးရေလည်း တိုးပွား နိုင်ပြီးထိုမှတဆင့် ရေအသုံးပြုမှု တိုးပွားလာ နိုင်မှုကြောင့် ဒေသခံပြည်သူများ ရေရှားမှုကို ခံစားရ နိုင်သည်။	- ရေရှည်တည်တံ့သောရေစီမံခန့်ခွဲမှု - ပြန်အသုံးပြုသောရေ - အသိပညာပေးအစီအစဉ်များ
	လူကုန်ကူးမှု တိုးမြင့်လာခြင်း	- သယ်ယူပို့ဆောင်ရေးလွယ်ကူလာမှုကြောင့် လူကုန်ကူးမှုများလည်း တိုးမြင့်လာနိုင်သည်။	- လူကုန်ကူးမှုတားမြစ်ရေးအဖွဲ့အစည်းများနှင့် ပူးပေါင်းရန်။
	မူးယစ်ဆေးဝါးကုန်သွယ်မှု တိုးမြင့်လာခြင်း	သယ်ယူပို့ဆောင်ရေးလွယ်ကူလာမှုကြောင့် မူးယစ် ဆေးဝါးကုန်သွယ်မှုများလည်းတိုးမြင့်လာနိုင်သည် ။ အထူးသဖြင့် ရှမ်းပြည်နယ်တွင် မူးယစ်ဆေးဝါး ကုန်သွယ်ရေးနှန်းများ မြင့်တက်လာနိုင်သည်။	- ရှမ်းပြည်နယ်အတွင်းမူးယစ်ဆေးဝါးများထုတ်လုပ်သည့် ဓာတုပစ္စည်းများနှင့် ဆေးဝါးများရောင်းချခြင်းကိုကန့်သတ်ရန်။ - အစိုးရအနေဖြင့် မူးယစ်ဆေးဝါးရောင်းဝယ်မှုတွင် အဓိကပါဝင် ပက်သက်သူများကိုအာရုံစိုက်ပြီးမူးယစ်ဆေးဝါး ထိန်းချုပ်မှုနှင့် အကျင့်ပျက်ခြစားမှုတိုက်ဖျက်ရေး ကြိုးပမ်းမှုများကို နှစ်ဆတိုးရန်။ - အသိပညာပေးရေးနှင့် အန္တရာယ်လျှော့ချရေးများကို အစားထိုးရန်။

၁.၇။ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုနှင့် စောင့်ကြည့်လေ့လာရေးအစီအစဉ်အကျဉ်းချုပ်

ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုအစီအစဉ်ကိုစီမံကိန်းအကောင်အထည်ဖော်သည့်ကာလတစ်လျှောက်လုံးတွင်လုပ်ဆောင်ရမည်ဖြစ်ပြီးဆောက်လုပ်ရေးနှင့် လုပ်ငန်းလည်ပတ်ရေးကာလအတွင်းတာဝန်ဝတ္တရားများကိုသတ်မှတ်ရမည်ဖြစ်ပါသည်။ပတ်ဝန်းကျင်ဆိုင်ရာထိခိုက်သူများ၊ထိခိုက်မှုများအားလျော့ချခြင်း အတွက်ဆောက်ရွက်မည့်လုပ်ငန်းအစီအစဉ်များ၊အချိန်ဇယား၊အကောင်အထည်ဖော်မည့်အဖွဲ့အစည်းသို့မဟုတ်အစရှိသည့်တာဝန်ရှိအဖွဲ့အစည်းများ အားအောက်ဖော်ပြပါဇယားတွင်ဖော်ပြထားပါသည်။

ဇယား - ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုအစီအစဉ်အကျဉ်းချုပ်

ပတ်ဝန်းကျင်ထိခိုက်မှုများ	လျော့ချခြင်းအတွက် ဆောင်ရွက်မည့်လုပ်ငန်း အစီအစဉ်များ	အချိန်ဇယား	တာဝန်ရှိ အဖွဲ့အစည်း
ဒီဇိုင်းကာလ			
ရထားလမ်းကြောင်းတလျှောက်Bridges နှင့် Culverts တည်ဆောက်ခြင်း	Bridges နှင့် Culverts တည်ဆောက်ရေးလုပ်ငန်းခွင်နှင့် လုပ်ငန်းခွင်သို့သွားရာလမ်းများကိုပတ်ဝန်းကျင်ထိခိုက်မှုမရှိစေရန် စီစဉ်ရမည်။	ဒီဇိုင်းကာလအတွင်း	မြန်မာ့မီးရထား / CREEC
ယဉ်ကျေးမှုအမွေအနှစ်များ	ရထားလမ်းကြောင်းတလျှောက် Bridges နှင့် Culverts များညှိနှိုင်း တည်ဆောက်ခြင်းဖြင့် ရှောင်ရှားမည်။	ဒီဇိုင်းကာလအတွင်း	မြန်မာ့မီးရထား / CREEC
ဆောက်လုပ်ရေးကာလ			
ထေထုညစ်ညမ်းမှုနှင့် ဖုန်မှုန့်များ	NEQGစံနှုန်းများအတိုင်းယာဉ်များနှင့် စက်များကိုပုံမှန် ပြုပြင် စစ်ဆေးရမည်။ ဖုန်မှုန့်များမဖြစ်စေရန်ဆောက်လုပ်ရေးကာလအတွင်းရေဖျန်းသင့်သည်။ ပစ္စည်းများတင်ဆောင်လာသောမော်တော်ယာဉ်များသည်ပစ္စည်းများဖိတ်စင်မှုနှင့်ဖုန်မှုန့်များလျော့ချရန်အတွက်ဖုံးအုပ်ထားသင့်သည်။	တည်ဆောက်ရေးအစနှင့် တည်ဆောက်ရေးကာလတလျှောက်လုံး	ကန်ထရိုက်တာ/ ဆောက်လုပ်ရေးဝန်ဆောင်မှုပေးသူ
ဆူညံသံ	လုပ်ငန်းခွင်အတွင်း ဆူညံသံသတ်မှတ်ချက်သည် NEQG စံနှုန်းများအတိုင်းတင်းကြပ်စွာလိုက်နာရမည်။ ပြင်းထန်သောဆူညံသံအနီးတစ်ဝိုက်ရှိအလုပ်သမားများသည်နားကြပ်များကိုဝတ်ဆင်ကြပြီးအလုပ်ချိန်ကိုကန့်သတ်ခြင်းဖြင့် အန္တရာယ်ကင်းစေရန် ပြုလုပ်ပါသည်။ လူနေအိမ်များ၊ကျောင်းများနှင့်ဆေးရုံများအပါအဝင်တိတ်ဆိတ်သောနေရာများအတွက်ဆူညံသံအကာအကွယ်များ(ကျောက်နံရံနှင့် စိုက်ခင်းများ)	တည်ဆောက်ရေးအစနှင့် တည်ဆောက်ရေးကာလတလျှောက်လုံး	ကန်ထရိုက်တာ/ ဆောက်လုပ်ရေးဝန်ဆောင်မှုပေးသူ
တုန်ခါမှု	လမ်းကြောင်းနှင့်ကပ်လျက်ရှိသည့်အလုပ်ခွင်နေရာများတွင်တုန်ခါမှုအဆင့်ကန့်သတ်ချက်များသည် EHS လမ်းညွှန်ချက်များ လက်စွဲတွင်ဖော်ပြထားသည့် အတိုင်းအမြင့်ဆုံး ခွင့်ပြုထားသောတန်ဖိုးများနှင့်ကိုက်ညီရမည်။	တည်ဆောက်ရေးအစနှင့် တည်ဆောက်ရေးကာလတလျှောက်လုံး	ကန်ထရိုက်တာ/ ဆောက်လုပ်ရေးဝန်ဆောင်မှုပေးသူ

မြေပေါ်ရေ			
စွန့်ပစ်ရေမှ ညစ်ညမ်းခြင်း	ဆောက်လုပ်ရေးလုပ်ငန်းမှထုတ်လုပ်သောစွန့်ပစ်ရေများသည်မြစ်နှင့်ဆည်မြောင်းစနစ်သို့တိုက်ရိုက်ပင်ရောက်ခြင်းကိုကာကွယ်ရန်အတွက်မှန်ကန်သောဆောင်ရွက်မှုများကိုပြုလုပ်ရမည်။	တည်ဆောက်ရေး ကာလတလျှောက်လုံး	ကန်ထရိုက်တာ/ ဆောက်လုပ်ရေး ဝန်ဆောင်မှု ပေးသူ
မြေဖို့ခြင်းကြောင့် ရေနုတ်မြောင်းများပိတ်ဆို့ခြင်း	ရေနုတ်မြောင်းများကိုမြေဖို့ခြင်းကြောင့် ပိတ်ဆို့မှုမရှိစေရန် သေချာအောင် ပြုလုပ်ထားရမည်။		
ရေနံနှင့် အမဲဆီ၊ အိမ်သုံးစွန့်ပစ် ပစ္စည်းများ	ရေနံနှင့်ချောဆီကိုယိုစိမ့်မှုမှန်သမျှကိုရှောင်ပါ သင့်လျော်သောစွန့်ပစ်ပစ္စည်းစီမံခန့်ခွဲမှုစနစ်ကိုအသုံးပြုပါ		
မြေဆီလွှာနှင့် မြေအောက်ရေ			
မြေဆီလွှာညစ်ညမ်းမှု ဖြစ်ပေါ်နိုင်ခြင်း	သင့်တော်သောစွန့်ပစ်ပစ္စည်းစီမံခန့်ခွဲမှုစနစ်	တည်ဆောက်ရေး ကာလတလျှောက်လုံး	ကန်ထရိုက်တာ/ ဆောက်လုပ်ရေး ဝန်ဆောင်မှုပေး သူ
လောင်စာဆီနှင့် ချောဆီယိုစိမ့်မှုဖြစ်ခြင်း	ကွန်ကရစ်ကြမ်းခင်း (သို့) မစိမ့် ထွက်နိုင်သောအခင်းအပေါ်တွင် သိုလှောင်ထားခြင်း		
ဆောက်လုပ်ရေးအပျက်အစီးများ နှင့်အိမ်သုံးစွန့်ပစ်ပစ္စည်းများ	ဒေသတွင်း CDC၏ စည်းမျဉ်းများအတိုင်း သတ်မှတ်ထားသော အစိုင်အခဲ စွန့်ပစ် ပစ္စည်းများကိုစွန့်ပစ်ရမည်။		
သစ်ပင်ပန်းမန်များနှင့် တိရစ္ဆာန်များ			
အပင်များဆုံးရှုံးခြင်းနှင့် Avenue Plantation	သစ်တောဉပဒေအောက်ရှိသစ်တောပြုန်းတီးမှု လျော်ကြေးပေးရန် မူဝါဒအရ ရှင်းလင်းခံရသည့် စိုက်ခင်းဧရိယာအားအစားထိုးစိုက်ပေးရမည်။	ဆောက်လုပ်ရေး လုပ်ဆောင်မှုပြီး သည့်နောက်	ကန်ထရိုက်တာ/ ဆောက်လုပ်ရေး ဝန်ဆောင်မှုပေးသူ
လူမှုရေး			
ဆက်သွယ်ရာလမ်းများဆုံးရှုံးခြင်း	လမ်းဆုံနှင့် အခြားလမ်းများတွင် ယာယီဆက်သွယ်ရန် လမ်းများ ဖောက်လုပ်ပေး သင့်ပါသည်။	ဆောက်လုပ်ရေးကာလ အတွင်း	

ယာဥ်ကြောပိတ်ဆို့ခြင်း	ဆောက်လုပ်ရေးကာလအတွင်း ယာဥ်ကြော ပိတ်ဆို့မှုများရှိပါက, သယ်ယူ ပို့ဆောင်ရေး နှင့် ယာဥ်ထိန်းရဲဌာနတို့ ပူးပေါင်း၍ ပိတ်ဆို့မှုကို သက်သာ ရာရစေရန် ဆောင်ရွက် သင့်သည်။	ဆောက်လုပ်ရေးကာလ အတွင်း	ကန်ထရိုက်တာ/ မြန်မာ့မီးရထား
မော်တော်ယာဥ်များ၊ လူများ၊ မွေးမြူရေးတိရစ္ဆာန်များ၊ ဆိုင်းဘုတ်များ	အန္တရာယ်ကင်းရှင်းရေးပညာရေးနှင့်ဒဏ်ငွေ။ တံတားနှင့်လမ်းတံတားဆောက်လုပ်ရေးဧရိယာများအတွင်းလုံလောက်သောယာဥ်အသွားအလာစီးဆင်းမှုကိုခွင့်ပြုရန်နှင့် ဆိုင်းဘုတ်များထားရှိရန်။ ရေဒီယို၊ တီဗွီနှင့် သတင်းစာများမှ တစ်ဆင့်အနှောင့်အယှက်ဖြစ်စေခြင်း သို့မဟုတ် ဝင်ရောက်ခွင့်ကို ကန့်သတ်ခြင်းများဖြစ်စေသော ဆောက်လုပ်ရေးလုပ်ငန်းအချို့ကို အများ ပြည်သူသို့ ကြေငြာချက်များထုတ်ပြန်ရမည်။	ဆောက်လုပ်ရေးကာလ အတွင်း	ကန်ထရိုက်တာ/ ဆောက်လုပ်ရေး ဝန်ဆောင်မှုပေးသူ
ရေကြောင့်ဖြစ်သောရောဂါများနှင့် အင်းဆက်ပိုးများကြောင့် ဖြစ်သော ရောဂါများ ဖြစ်ပွားမှုများပြားလာခြင်း	ရေသေမဖြစ်ပေါ်စေရန်ဆောက်လုပ်ရေးဧရိယာအားလုံးတွင်ကောင်းမွန်သောရေနုတ်မြောင်းနှင့်မိလ္လာနှင့်အမှိုက်စွန့်ပစ်နေရာများကိုလုံလောက်စွာထားပါ။	ဆောက်လုပ်ရေးကာလ အတွင်း	ကန်ထရိုက်တာ/ မြန်မာ့မီးရထား
စခန်းကုန်လှောင်ရုံနှင့် သိုလှောင်ရုံများတည်နေရာ	စခန်းကုန်လှောင်ရုံနှင့် သိုလှောင်ရုံများသည် စာချုပ်ပါ သတ်မှတ်ချက်များ နှင့် အညီ ဖြစ်ရမည်။	ဆောက်လုပ်ရေးကာလ အတွင်း	ကန်ထရိုက်တာ/ မြန်မာ့မီးရထား
လုပ်ငန်းလည်ပတ်ရေးကာလ			
ဆူညံသံနှင့် တုန်ခါမှု	ခိုင်လုံသည့်နေရာတွင်သင့်လျော်သောအစီအမံများကိုထည့်သွင်း စဥ်းစားသင့်သည်။ ဆူညံသံနှင့်တုန်ခါမှု ညစ်ညမ်းမှု စည်းမျဥ်းများနှင့် ယင်း၏ သက်ရောက်မှုများအကြောင်းလူထုပညာ ပေးသင့်ပါသည်	လုပ်ငန်းလည်ပတ်ရေး ကာလအတွင်း	မြန်မာ့မီးရထား
bridges နှင့် culvertsများ ပြုပြင်ထိန်းသိမ်းမှု	ပြုပြင်ထိန်းသိမ်းမှုအဆင့်အတွင်းအိမ်သုတ်ဆေးအကြွင်းအကျန်များနှင့်ဆီပါဝင်မှုကို ထိန်းချုပ်သင့်သည်	လုပ်ငန်းလည်ပတ်ရေး ကာလအတွင်း	မြန်မာ့မီးရထား

ဇယား - ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုအစီအစဥ်အကောင်အထည်ဖော်ခြင်းအတွက် စုစုပေါင်းကုန်ကျစရိတ်

စီမံကိန်းလုပ်ငန်းများ	စောင့်ကြည့်လေ့လာရမည့် အချက်များ	တည်နေရာများ	အတိုင်းအတာများ (နည်းလမ်းများနှင့် ကိရိယာများ)	တိုင်းတာမှုကြိမ်နှုန်း	ခန့်မှန်းကုန်ကျစရိတ်	တာဝန်ရှိအဖွဲ့အစည်း
အကြိုဆောက်လုပ်ရေးနှင့် ဆောက်လုပ်ရေးကာလများအတွင်း						
ဓာတ်ငွေ့ထုတ်လွှတ်မှု နှင့် ဖုန်မှုန့်ထွက်ရှိမှု	ပတ်ဝန်းကျင်လေထုအရည်အသွေး	လုပ်ငန်းခွင်အတွင်း နှင့် အနီးအနားရှိ အဆောက်အအုံများ	ဖုန်မှုန့်တိုင်းတာရေးမီတာ၊ CO, CO_2, SO_2, နှင့် NO_x မီတာများဖြင့် မျက်မြင်စစ်ဆေးခြင်းနှင့် စောင့်ကြည့် လေ့လာခြင်း	ဆောက်လုပ်ရေးလုပ်ငန်းများအတွင်း အနည်းဆုံး တစ်လတစ်ကြိမ်သို့မဟုတ် လိုအပ်သည့် အခါတိုင်း	တစ်ကြိမ်လျှင် တစ်သိန်းကျပ်	ဆောက်လုပ်ရေးကန်ထရိုက်တာ(များ)
ဆောက်လုပ်ရေးစက်ပစ္စည်းများ	ပတ်ဝန်းကျင်မှ ဆူညံသံနှင့်ပက်သက်၍ တိုင်ကြားခြင်း	လုပ်ငန်းခွင်အတွင်း နှင့်အနီးအနားရှိ အဆောက်အအုံများ	ဆူညံသံတိုင်းတာရေးမီတာဖြင့် စောင့်ကြည့်လေ့လာခြင်း	ဆောက်လုပ်ရေးလုပ်ငန်းများအတွင်းအနည်းဆုံးတစ်လတစ်ကြိမ် သို့မဟုတ် လိုအပ်သည့်အခါတိုင်း	တစ်ကြိမ်လျှင် ၅သောင်းကျပ်	ဆောက်လုပ်ရေးကန်ထရိုက်တာ(များ)
ယိုဖိတ်ခြင်းဇရိယာ	မြေဆီလွှာနှင့် ရေအရင်းအမြစ်ညစ်ညမ်းမှု	လုပ်ငန်းခွင်နှင့် အနီးအနားစိုက်ပျိုးမြေများအနီးစပ်ဆုံး ရေအရင်းအမြစ်များ	မျက်မြင်စစ်ဆေးခြင်း ယိုဖိတ်မှုများကို မှတ်တမ်းတင်ခြင်းနှင့် စာရွက်စာတမ်း	နေ့စဉ်	တစ်ရက်လျှင် ၂၀၀၀ ကျပ်	ဆောက်လုပ်ရေးကန်ထရိုက်တာ(များ)
ဆောက်လုပ်ရေးစွန့်ပစ်ပစ္စည်းစီမံခန့်ခွဲမှုနှင့် အဆိပ်သင့်စွန့်ပစ်ပစ္စည်း ကိုင်တွယ်မှု	ထွက်ရှိသောအဆိပ်သင့်/ အဆိပ်မသင့် စွန့်ပစ်ပစ္စည်းများ		ကိုင်တွယ်အသုံးပြုခြင်းနှင့် ဖို့မြေသို့ပို့ဆောင်ခြင်းတို့နှင့် စပ်လျဉ်း၍ အဆိပ်သင့်/မသင့်နိုင်သော စွန့်ပစ်ပစ္စည်းများကို ခန့်မှန်းခြင်း။	စွန့်ပစ်ပစ္စည်းထုထည်ပေါ်မူတည်၍ အပတ်စဉ် သို့မဟုတ် လစဉ်	တစ်ရက်လျှင် ၁၂၀၀၀ကျပ်	ဆောက်လုပ်ရေးကာလကန်ထရိုက်တာများ၊ လုပ်ငန်းလည်ပတ်ကာလအော်ပရေတာများ
စက်ပစ္စည်းများနှင့် ဆောက်လုပ်ရေးပစ္စည်းများ သိုလှောင်မှု	ပတ်ဝန်းကျင်မှ တိုင်ကြားချက်များ၊ စက် နှင့် ဆောက်လုပ် ရေး ပစ္စည်း	စီမံကိန်းလုပ်ငန်းခွင်	မှတ်တမ်းတင်ခြင်းနှင့် စာရွက်စာတမ်းများ	လစဉ်	-	ဆောက်လုပ်ရေးကန်ထရိုက်တာများ

	များ သို့လှောင်မှုနှင့် ပက်သက်သော မှတ်တမ်း များနှင့် စာရွက်စာတမ်းများ					
ပိုလျှံနေသောမြေသားများ သိုလှောင်မှု	ပတ်ဝန်းကျင်မှ တိုင်ကြား ချက်များ၊ မှတ်တမ်းများနှင့် စာရွက်စာတမ်းများ	စီမံကိန်းလုပ်ငန်းခွင်	မှတ်တမ်းတင်ခြင်းနှင့် စာရွက်စာတမ်းများ	လစဉ်	-	ဆောက်လုပ်ရေးက န်ထရိုက်တာများ
ဆောက်လုပ်ရေးယာဉ်များ နှင့် စက်ပစ္စည်းများကြောင့် ဖြစ်သော ယာဉ်ကြော အနှောင့် အယှက်များကို စောင့်ကြည့်လေ့လာမှု	ယာဉ်ကြောနှင့်ဆက်စပ်၍ တိုင်ကြားချက်များ	ဆောက်လုပ်ရေး လုပ်ငန်းခွင်မှ မီတာ ၅၀၀ အတွင်း	မျက်မြင်စစ်ဆေးခြင်းနှင့် ရရှိသောတိုင်ကြားချက်များကို မှတ်တမ်းတင်ထားခြင်း	ဆောက်လုပ်ရေးလုပ်ငန်း ကာလအတွင်း	-	ဆောက်လုပ်ရေးက န်ထရိုက်တာများ
ဒေသခံပြည်သူ၏ ယဉ်ကျေးမှုနှင့် လုံခြုံရေးအပေါ် သက်ရောက်မှု	အလုပ်သမား စုစုပေါင်း အတွင်းမှ ဒေသခံလုပ်သား ရာခိုင်နှုန်း	ဆောက်လုပ်ရေး လုပ်ငန်းခွင်	မူလအလုပ်သမားအုပ်ချုပ်ရေးမူများ ကို တင်ပြခြင်းနှင့် ဒေသခံ အချိုးကို တွက်ချက်ခြင်း	သုံးလတစ်ကြိမ်	-	ဆောက်လုပ်ရေးက န်ထရိုက်တာများ
ဆောက်လုပ်ရေးကာလအ တွင်းအလုပ်သမားများ၏ ကျန်းမာရေးနှင့် ဘေးကင်းရေးကို စောင့်ကြည့်လေ့လာခြင်း	လုပ်ငန်းခွင်အတွင်းထိခို က်မှုများကိုကျန်းမာရေးမှ တ်တမ်းတင်ခြင်း	ကန်ထရိုက်တာမှ ရည်ညွှန်းသောဆေး ရုံဆေးခန်းများ	လက်ခံရရှိသော ဖြစ်ရပ်များကိုဆေးမှတ်တမ်းတင်ခြင်း	လက်ခံရရှိသော ဖြစ်ရပ်ပေါ်မူတည်၍	ဖြစ်ရပ်များေ ပါ်မူတည်၍	ဆောက်လုပ်ရေးက န်ထရိုက်တာများ

လုပ်သားစခန်းများပြင်ဆင်ခြင်း	အနီးအနားပတ်ဝန်းကျင်/ စီမံကိန်းတိုင်ကြားချက်များ	ဆောက်လုပ်ရေးလုပ်ငန်းခွင်များ	တိုင်ကြားချက်နှင့် ၄င်း၏အမျိုးအစားများကို မှတ်တမ်းတင်ခြင်း	ပြင်ဆင်မှုကာလအတွင်း တစ်ကြိမ်နှင့် ဆောက်လုပ်ရေးမစတင်မီ	-	ဆောက်လုပ်ရေးကန်ထရိုက်တာများ
လုပ်ငန်းခွင်ရှင်းလင်းခြင်း	အလုပ်သမားများ၏ ထိခိုက်မှုများ	ဆောက်လုပ်ရေး လုပ်ငန်းခွင်	ဆောက်လုပ်ရေးကာလအတွင်း အလုပ်သမားများ၏ ထိခိုက်မှုများအတွက် မှတ်တမ်းပုံစံပြင်ဆင်ခြင်း	လစဉ်	-	ဆောက်လုပ်ရေးကန်ထရိုက်တာများ
လုပ်ငန်းလည်ပတ်ကာလနှင့် ပြုပြင်ထိန်းသိမ်းရေးကာလအတွင်း						
အဆိပ်သင့်/အဆိပ်မသင့် စွန့်ပစ်ပစ္စည်းများစီမံခန့်ခွဲမှု	ထွက်ရှိသောအဆိပ်သင့်/ အဆိပ်မသင့် စွန့်ပစ်ပစ္စည်းများ	စွန့်ပစ်အစိုင်အခဲအတွက် သတ်မှတ်ထားသောဖို့မြေတွင်	စွန့်ပစ်ပစ္စည်းများနှင့် ၄င်းတို့၏ အရေအတွက်ကိုမှတ်တမ်းများဖြင့် သိမ်းဆည်းခြင်း	သုံးလတစ်ကြိမ်	မသတ်မှတ်နိုင်ပါ	လုပ်ငန်းလည်ပတ်ကာလအတွင်း အော်ပရေတာ များ
အရေးပေါ်အခြေအနေ အတွင်း အန္တရာယ်များ စီမံခန့်ခွဲမှု	အရေးပေါ်အခြေအနေ မှတ်တမ်းများ	ရထားလမ်းကြောင်း ဧရိယာအနီး တစ်ဝိုက်	ဖြစ်နိုင်ချေရှိသောယိုစိမ့်မှုများအုတ်မြစ်နှင့် သီးသန့်ဧရိယာများတွင်ဖြစ်နိုင်ချေရှိသော ထိခိုက်မှုများကို မျက်မြင်စောင့်ကြည့်လေ့လာခြင်း	အပတ်စဉ် သို့မဟုတ် လိုအပ်သလို	မသတ်မှတ်နိုင်ပါ	ရထားလမ်းစီမံကိန်း၏ စောင့်ကြည့်လေ့လာရေးအဖွဲ့
လုပ်သားများ၏ ကျန်းမာရေးနှင့် ဘေးအန္တရာယ်ကင်းရှင်းရေး	အလုပ်ခွင် ကျန်းမာရေးနှင့် မတော်တဆဖြစ်ရပ် မှတ်တမ်းများ	အလုပ်ခွင်	အလုပ်ခွင်ထိခိုက်ဒဏ်ရာများကိုဆေးမှတ်တမ်းတင်ခြင်း	လစဉ်	မသတ်မှတ်နိုင်ပါ	ရထားလမ်းစီမံကိန်း၏ စောင့်ကြည့်လေ့လာရေးအဖွဲ့

၁.၈။ လူထုပူပေါင်းပါဝင်ခြင်းနှင့်တိုင်ပင်ဆွေးနွေးခြင်းအကျဉ်းချုပ်

လူထုပူပေါင်းပါဝင်ခြင်းနှင့် တိုင်ပင်ဆွေးနွေးခြင်း အကျဉ်းချုပ်လုပ်ငန်းစဉ်တွင် လူနေရပ်ကွက်များအတွင်းကွင်းဆင်းဆောင်ရွက်ခြင်း၊ အဓိကအုပ်စုများနှင့်ဆွေးနွေးခြင်းနှင့် လူထုတွေ့ဆုံပွဲများပြုလုပ်ခြင်းတို့ ပါဝင်သည်။ စီမံကိန်းအတွက် လူထုတွေ့ဆုံပွဲများ ပြုလုပ်ခြင်းပြီးမြောက်ရန် စီမံကိန်းတစ်ခုလုံးအတွက် အနည်းဆုံးလူထုတွေ့ဆုံပွဲ ၁၉ ပွဲပြုလုပ်ခဲ့ပါသည်။

(က) လူနေရပ်ကွက်များအတွင်းကွင်းဆင်းဆောင်ရွက်ခြင်းနှင့် အဓိကအုပ်စုများနှင့် ဆွေးနွေးခြင်း

လူနေရပ်ကွက်များအတွင်း ကွင်းဆင်းဆောင်ရွက်ခြင်းအတွက် ရှိရင်းစွဲ လူမှုစီးပွားအခြေအနေများကိုဖော်ထုတ်ရန်နှင့် စီမံကိန်းနှင့် ပက်သက်၍ လူထု၏ စိတ်ခံစားမှု၊ သဘောထားများနှင့် ပြင်ဆင်ထားမှုအတိုင်းအတာကိုသိရှိနားလည်ရန် ရထားလမ်းတစ်လျှောက်ရှိ ၈၇ ရွာသို့ ကွင်းဆင်းဆောင်ရွက်ခဲ့သည်။တိကျသောအချက်အလက်များရရှိရန် ရှိရင်းစွဲအချက်အလက်များကို လူမှုရေးဆိုင်ရာကျွမ်းကျင်သူများ၊ လူမှုရေးအတိုင်ပင်ခံများ၊ ရပ်ရွာအာဏာပိုင်များနှင့် ဒေသခံလူထုတို့မှတဆင့် ကောက်ယူမည်ဖြစ်သည်။ ရပ်ရွာအတွင်း ကွင်းဆင်းလေ့လာမှုများအတွင်း ဒေသခံ လူထုမှ စီမံကိန်းနှင့် ပက်သက်၍ မျှော်လင့်ထားသောကောင်းကျိုးများနှင့် စိုးရိမ်ပူပန်နေသောအကြောင်းအရာအများစုမှာအောက်ပါအတိုင်းဖြစ်သည်။

- မြေအသုံးချမှုအတွက် လျော်ကြေးပေးရန်။
- စမ်းချောင်းများနှင့် သဘာဝရေပူစမ်းများပိတ်ဆို့ခြင်း။
- တောင်တန်းဒေသစိုက်ပျိုးရေးအပေါ် ထိခိုက်မည်ကိုစိုးရိမ်ခြင်း။

(ခ) လူထုတွေ့ဆုံပွဲများ ပြုလုပ်ခြင်း

လူထုတွေ့ဆုံပွဲများတွင် ဒေသခံအဓိကသက်ဆိုင်သူများ၊ လွှတ်တော်ကိုယ်စားလှယ်များ၊ အစိုးရ မဟုတ်သောအဖွဲ့အစည်းများ၊ သတင်းမီဒီယာများစသဖြင့် တတ်ရောက်ကြပြီး ၎င်းတို့မှ သိလိုသည်များကိုမေးမြန်းကြပါသည်။ လူထုတွေ့ဆုံပွဲနှင့် ပူးပေါင်းပါဝင်မှုတွင် ရှာဖွေ တွေ့ရှိချက်များကို အနှစ်ချုပ်ခြင်းဖြင့် အောက်ဖော်ပြပါများသည်အဆိုပြု တံတားနှင့် မြေအောက်မြောင်းများ စီမံကိန်းနှင့်ပတ်သက်သောဆွေးနွေးမှုများမှ တွေ့ရှိလာသောလူထုစိုးရိမ်ပူပန်မှုများ ဖြစ်ပါသည်။

(၁) မြစ်ကူးတံတားများအတွက်

- မြစ်အထက်ပိုင်း ဇရိယာများတွင် ရေကြီးမှုနှင့် အောက်ပိုင်းဇရိယာများတွင် မြစ်များ ပိတ်ဆို့မှုမှ တဆင့်ဖြစ်သောရေရှားပါးမှုကြောင့် စိုက်ပျိုးမြေများပျက်စီးခြင်း
- မြေဂရန်ရှိ/မဲ့သောမြေများအသုံးပြုမှုအတွက် သင့်တော်သောလျော်ကြေး
- တံတားနှင့် မြေအောက်မြောင်းစီမံကိန်းမှ အသုံးပြုမည့် မြေဇရိယာပမာဏကို လူသိ ရှင်ကြား ကြေညာရန်
- စီမံကိန်းပြင်ပတွင် အပင်ခုတ်ခြင်းကိုကန့်သတ်ရန်
- စွန့်ပစ်အရည်နှင့် အစိုင်အခဲများ မြစ်ထဲသို့ မစွန့်ပစ်ရန်
- စီမံကိန်းလုပ်ငန်းခွင်များအနီးတွင် ရွှေ့ပြောင်းအလုပ်သမားများ အခြေချနေထိုင်မှုကို တားဆီးရန် မူဝါဒ

(၂) တောင်ကြားဖြတ်တံတားများနှင့် မြေအောက်မြောင်းများအတွက်

- ဆောက်လုပ်ရေးမှ မြေစိုင်ခဲများကိုစိုက်ပျိုးမြေများအနီးတွင် မစွန့်ပစ်ရန်
- ပြည်သူပိုင်မြေကိုထိခိုက်မှုနည်းရန်
- ဆောက်လုပ်ရေးကာလအတွင်း သဘာဝ ရေနုတ်မြောင်းစနစ်နှင့် သဘာဝရေပူစမ်းများ ပိတ်ဆို့ခြင်းကိုရှောင်ကြဉ်ရန်
- ဆောက်လုပ်ရေးကာလအတွင်းရွာလမ်းများနှင့် ကျွဲနွားများကျက်စားရာ လမ်းများကို ပိတ်ဆို့မှုမရှိစေရန်
- ရထားလမ်းတစ်လျှောက် တောရိုင်းတိရစ္ဆာန်များကိုထိခိုက်မှုနည်းစေရန်
- နိုင်ငံခြားသားနှင့် ရွှေ့ပြောင်းအလုပ်သမားများကိုထိန်းချုပ်ရန်
- စီမံကိန်းလုပ်ငန်းခွင်များအနီးတွင် ရွှေ့ပြောင်းအလုပ်သမားများ အခြေချနေထိုင်မှုကို တားဆီးရန် မူဝါဒ
- ဒေသခံလူထုအတွက် အလုပ်အကိုင်အခွင့်အလမ်းများဖန်တီးပေးရန် မူဝါဒ
- စီမံကိန်းအကောင်အထည်ဖော်မှုလုပ်ငန်းတိုင်းအတွက် တင်ဒါစနစ်

- ရထားလမ်းသည် လယ်ယာစိုက်ပျိုးမြေများကို ဖြတ်သွားခြင်းမပြုရန်
- ဒေသသုံးလမ်းနှင့်ဆုံသည့်နေရာရှိပါကလူကူးမိုးပျံတံတားဆောက်လုပ်ပေးရန်
- ဆောက်လုပ်ရေးကာလအတွင်းယာဉ်ကြောပိတ်ဆို့မှုများတိုးမလာစေရန်
- ဆောက်လုပ်ရေးပစ္စည်းများသယ်ယူပို့ဆောင်ရေးကြောင့် လမ်းများပျက်စီးခြင်း

၁.၉။ အနှစ်ချုပ်သုံးသပ်ချက်

တံတားများနှင့်မြေအောက်မြောင်းများဆောက်လုပ်ရေးကာလအတွင်းအဓိကအားဖြင့်ဇီဝမျိုးစုံမျိုးကွဲ(ရေနေသတ္တဝါ)၊ မြစ်ရေထုထည် နှင့် အရေအသွေး၊ မြစ်ကမ်းပါး ရေတိုက်စားမှု အပေါ်တွင် ပတ်ဝန်းကျင်ဆိုင်ရာထိခိုက်မှုများရှိပါသည်။ အဓိကဖြစ်ပေါ်နိုင်သော လူမှုရေး ထိခိုက်မှုများမှာ ယာယီမြေအသုံးချမှု နှင့် တံတား နှင့် မြေအောက်မြောင်းများ ဆောက်လုပ်ရေးအတွက် မြေယာ ရယူမှုများအပြင် စွန့်ပစ်အစိုင်အခဲများကြောင့် စိုက်ပျိုးမြေများထိခိုက်ခြင်းတို့ဖြစ်သည်။ အနှစ်ချုပ် အရ ပတ်ဝန်းကျင် နှင့် လူမှုရေးထိခိုက်မှုများ အားလုံးသည် ဤအစီရင်ခံစာတွင် တင်ပြထားသည့် သင့်တော်သော လျှော့ချရေး နည်းလမ်း များဖြင့် လက်ခံနိုင်သည့် အဆင့်သို့ လျော့နည်းအောင် ပြုလုပ်နိုင်သည်။ တံတားများနှင့် မြေအောက် မြောင်းများ၏ ပတ်ဝန်းကျင်နှင့် လူမှုရေးထိခိုက်မှုများ၏ သဘာဝအရဆောက်လုပ်ရေး ကာလ အတွင်းရှိထိခိုက်မှုများသည် လုပ်ငန်းလည်ပတ်မှုကာလနှင့်လုပ်ငန်းဖျက်သိမ်းကာလထက်ပိုများမည်ဖြစ်သည်။မြေအသုံးချမှုအတွက်မှု Resettlement Action Plan (RAP) အပြင် သင့်တော်သောလျော်ကြေးနှင့် ပြန်လည်နေရာချထားရေးများ ပြုလုပ်ပေးရန်လိုအပ်သည်။

1.0. EXECUTIVE SUMMARY

1.1. Summary of Introduction

As part of the governments national transport strategy Ministry of Transport and Communication (MOTC) intends to improve transport capacities of the Country by constructing the Railway between Muse to Mandalay. So, the Memorandum of Understanding (MOU) on Feasibility Study for Muse-Mandalay Railway Project between Myanmar Railways, the Ministry of Transport and Communications of the Republic of the Union of Myanmar and China Railway Eryuan Engineering Group Co. Limited (CREEC), China Railway Group Limited, the People's Republic of China signed on October 22, 2018. According to this MOU, CREEC will conduct Feasibility Study (FS) for the new railway for high speed electric trains from Mandalay to Muse.

The new railway project will contain over 120 bridges and 700 culverts and so, it is necessary to conduct Environmental Impact Assessment (EIA) for railway bridges and culverts according to the Environmental Conservation Law, 2012 and Environmental Impact Assessment Procedure, 2015. Ever Green Tech Environmental Services and Training Co., Ltd. was appointed by CREEC to conduct Environmental Impact Assessment (EIA) for the proposed bridge and culvert project. This EIA study will cover construction and operation of railway bridges and culverts along the new railway alignment. The total length of the main railway line is 409.960 km. The total length 124 bridges along the MMR line is 69.309km, accounting for 16.9% of the main line and 729 culverts with a total length of 31,190 horizontal linear meters.

(a) Project Proponent and the EIA Team

The followings are the brief of project proponent for the FS of Muse-Mandalay Railway.

Project Developer	
Project Developer	Ministry of Transport and Communications (MOTC) Myanma Railways (MR)
Type of Project	Railway Bridges and Culverts
Project Location	Muse-Mandalay Railway starts from Muse port of entry at the north, goes south to Mandalay

Contact Persons	1.U Myo Win (GeneralManager) Upper Myanmar Administration (MR) Upper Myanmar Administration Department, Mandalay Station, Mandalay, Myanmar Tel：+95-2-35172 Fax：+95-2-35829 E-mail：myowingmupper@gmail.com
	2.U Phyo Htet Kyaw [Assistant GeneralManager (Planning)] Planning and Administration Department, (MR) Nay Pyi Taw Station Compound, Nay Pyi Taw, Myanmar Tel：+95-6777164(office)/+95-9-43124800(mobile) Fax：+95-67-77164

Below is the background information on Ever Green Tech Environmental Services and Training Co., Ltd., (Third party) who will conduct the EIA.

Ever Green Tech Environmental Services & Training Co., Ltd.	
Company Name	Ever Green Tech Environmental Services and Training Co., Ltd.
Company Registration Number (DICA)	3344/2015-2016 (Ygn)
Transitional Third Party Registration Number	0047
Contact Address	1/9, Baho Road, 16th Quarter, Hlaing Township, Yangon
Telephone Number	09-5099230, 5099232
E-mail	green.evergreentech@gmail.com 11kyawswar@gmail.com
Contact person	Dr. Kyaw Swar Tint Ph.D. (Mining) Principal Environmental and Social Consultant 09-797111000 11kyawswar@gmail.com

(b) Selected Consultants for Conducting EIA

The following are the lists of consultants who participate in conducting EIA.

	No.	Name	Degree	Responsibility	Area of Expertise
Our Consultants	1	Dr. Kyaw Swar Tint	Ph.D. (Mining)	Environmental and Social Specialist	(a) Air Pollution Control (b) Noise and Vibration (c) Environmental Management and Monitoring
	2	Mr. Min Aung	M.Sc. (Chemistry)	Local Environmental Specialist	(a) Water Pollution Control (b) Modelling of Water Quality (c) Soil and Ground Water Pollution Control
	3	Dr. Thein Tun	Ph.D. (Metallurgy)	Local Environmental Specialist	(a) Risk Assessment and Hazard Management (b) Facilitation of Meeting (c) Occupational Safety and Health
	4	Dr. Myo Min Tun	Ph.D. (Metallurgy)	Local Environmental Specialist	(a) Evaluation of Alternatives (b) Traffic and Transportation System (c) Resources Utilization Management (d) Waste Management
	5	Dr. Ohn Thike	Ph.D. (Mining)	Local Environmental Specialist	(a) Geotechnical (b) Slope Stability
	6	Ms. Nandar Nwe	M.S. in EIA/EMS (YTU), Dip; in Applied Psychology (YU)	Local Environmental Specialist	Social Impact Assessment (Household Survey)
	7	Ms. Thazin Htwe	M.S. in EIA/EMS (YTU), Dip; in Applied Psychology(YU)	Local Environmental Specialist	Social Impact Assessment (Public Consultation and Stakeholder Engagement)
	8	Mr. Yaw Ma Nar	B.Sc. (Forestry); Dip in EIA/EMS	Field Coordinator	Project Coordinator

	9	Dr. Nyo Nyo Lwin	Ph.D. (Botany)	Local Environmental Specialist	Flora Diversity
	10	Dr. Nyunt Lwin	Ph.D. (Zoology)	Local Environmental Specialist	Fauna Diversity
	11	Dr. Wyne Nwe Nwe Oo	Ph.D. (Biotechnology)	Local Environmental Specialist	Flora Diversity
	12	Dr. Khon Aung	M.B.B.S. (Ygn)	Local Health Specialist	Health Impact Assessment
	13	Dr. Sao Hone Pha	Ph.D. (Electronics)	Consultant	GIS and Remote Sensing
	14	Dr. Tin Aung Myint	Ph.D. (Geology)	Consultant	Engineering Geology
	15	Dr. Win Swe	Ph.D. (Geography)	Consultant	Hydrology and Socio-economic
	16	Ms. May Thet Zaw	M.E. (Civil)	Consultant	Construction Impacts and Risk Assessment
	17	Ms. Nay Chi Win Maung	M.E. (Civil)	Consultant	Waste management
	18	U Aung Naing Tun	L.L.B; MBA	Consultant	Legal Requirements
Foreign Consultant	19	Mr. Cheng Liang shuang	M.Sc. (Conservation of Soil & Water)	Consultant	Water resources and high speed railway design

(c) Objectives of the EIA Study

The objectives of an EIA are to:

- Ensure that social and environmental considerations are explicitly addressed and incorporated into the development decision-making process;

- Anticipate and avoid, minimize or offset significantly adverse biophysical, social and other relevant impacts of proposed developments;
- Protect the productivity and capacity of natural systems and the ecological processes which maintain their functions; and
- Promote development that is sustainable and that optimizes resource use and management opportunities.

(d) Scope of the EIA Study

The EIA Study for the proposed railway bridges and culverts will cover FS for the following:

- The construction and operation of railway bridges and culverts along the new railway alignment.
- The total length 124 bridges along the MMR line is 69.309km, accounting for 16.9% of the main line and 729 culverts with a total length of 31,190 horizontal linear meters.
- Most of the bridges

1.2. Summary of Legal and Other Requirements

(a) Laws and Regulations Related to the Proposed Project

The following table describes laws and regulations which are directly or indirectly associated with the proposed project.

Table - Laws and Regulations Related to Workmens' Right, Occupational Safety and Health

Laws and Regulations	Year
The Labor Organization Rules, (No. 1,7 to 11)	2012
Second Amendment to the Labor Dispute Settlement Law (Law No.17)	2019
Labor Disputes settlement Act (Law No.5)	2014
Employment and Skill Development Law, (Law No. 5, 14, 30(a,b))	2013
The Leave and Holiday Act, 1951 (Law Amended July, 2014)	2014
Minimum Wages Law (Law No. 12, 13 (a to g)	2013
Payment of Wages Act (Law No. 3,4, 5, 14, 8 with 7,10)	2016
The Social Security Law (Law No. 11(a), 15(a), 18(b), 48, 49, 75)	2012
Law Amending the Workmen's Compensation Act	2005
Prevention and Control of Communicable Diseases Law (Law No. 3, 4, 9, 11)	1995
The Control of Smoking and Consumption of Tobacco Product Law (Law No. 9)	2006
The Prevention of Hazard from Chemical and Related Substances Rules	2013

(Law No. 8,15,16,17, 20, 22, 23, 27)	
Occupational safety and health Law (Pyidangsu Hluttaw Law No 8)	2019
Workmen's Compensation Act	2005
The Traditional Drug Law (Law No.7)	1996
Law Relating to Overseas Employment (Law No.3)	1999
Prevention from Danger of Chemical and associated Materials Law (Law No.28)	2013

Table - Laws and Regulations Related to Natural Environment

Laws and Regulations	Year
Pesticide Law Pyidaungsu Hluttaw Law No. 14/2016	2016
Forest Law	1992
Protection of Biodiversity and Protected Area Law	2018
Conservation of Water Resources and Rivers Law (Law No. 8, 11(a), 13, 19, 24(b), 30)	2006
Conservation of Water Resources and Rivers Rules	2013
The Freshwater Fisheries Law (Law No. 36,40,41)	1991
Animal Health and Development Law (Law No.17) (Law No.17)	2010

Table - Laws and Regulations Related to Cultural and Heritage

Laws and Regulations	Year
The Protection of rights of National Race Law, (Law No. 5)	2015
Protection and Preservation of Cultural Heritage Regions Laws (Law No. 15, 16)	2019
The Protection and Preservation of Antique Objects Law (Law No. 12,15 20)	2015
The Protection and Preservation of Ancient Monuments Law (Law No. 12,15 20)	2015
Law on the preservation and protection of ancient buildings	2015
Law Protecting Ancient Objects (Law No.43)	2015
Law Concerning Religious Conversion (Law No.48)	2015

Table - Laws and Regulations Related to Communities' Development, Health and Safety

Laws and Regulations	Year
Law Regarding Population Control & Health (Law No. 28)	2015
Vacant, Fallow, Virgin Land Management Law (Law No. 4(d), 5(d),7)	2012
Land Acquisition, Resettlement and rehabilitation Law (Section 39,41,42,46,54,(b and c),58)	2019
The Law Relating to Private Health Care Services (Law No.5)	2007
Public Health Law (Law No. 3, 5)	1972

Table - Laws and Regulations Related to Transportation and Communication

Laws and Regulations	Year
Railway Transportation Service Law (Section 28 to 39, 42 and 43)	2016
The bridges Law (Law No 16)	2019
Law Amending on the Utilization of Roads and Bridges (Law N0.25)	2014
The Law Amending the Embankment Act (Law No.2)	1998

Table - Laws and Regulations Related to Land Acquisition

Laws and Regulations	Year
Vacant, Fallow, Virgin Land Management Law (Law No. 4(d), 5(d),7)	2012
Land Acquisition, Resettlement and rehabilitation Law (Section 39,41,42,46,54(b and c),58)	2019
Farm Land Law	2012
Farmland Act (Law No.11)	2012
National Land Use Policy	2016

Table - Other Relative Laws and Regulations for the Proposed Project

Laws and Regulations	Year
Myanmar Mining Law (Law No. 13)	2018
Law Amending the electronic transactions law (Law No 6)	2014
Telecommunication Law (Law No 31)	2013
Natural Disaster Mangement Law (No 21)	2013
Constitution of the Republic of the Union of Myanmar (Articles 24,45,349,359)	2008
Law on standardization (Law No.28)	2014
Environmental Conservation Law (Law No.7(o), 14,15,24,25,29)	2012
Environmental Conservation Rules (Rule 55, 69 (a), (b))	2014
EIA Procedures (Article 102 to 110, 113, 115, 117)	2015
National Environmental Quality (Emission) Guidelines (Section 2.1.9)	2015
Law Amending the Factories Act 1951 (Pyidaungsu Hluttaw Law No. 12/2016)	2016
Private Industrial Enterprise Law	1990
The Myanmar Insurance Law (Law No. 15, 16)	1993
Myanmar Fire Force Law, (Law No. 25)	2015
The Electricity Law	2014

The Electricity Rule	2015
Myanmar Petroleum and Petroleum Products Law (No. 9(a)€,10€,11)	2017
The Export and Import Law (Section 6,7)	2012
The Myanmar Engineering Council Law (Law No. 20,24,25,31(a), 37)	2013
Patent Law	2019
Pesticide Law Pyidaungsu Hluttaw Law No. 14/2016	2016
Forest Law	1992
Protection of Biodiversity and Protected Area Law	2018
Conservation of Water Resources and Rivers Law (Law No. 8, 11(a), 13, 19, 24(b), 30)	2006
Conservation of Water Resources and Rivers Rules	2013
The Freshwater Fisheries Law (Law No. 36,40,41)	1991
Animal Health and Development Law (Law No.17)	2010
The Fertilizer Law (Law No.7)	2002

(b) International Agreements and Conventions

In addition to the domestic laws listed above, Myanmar is also a signatory to the following international conventions, and these may have relevance to the proposed survey activities.

Table - International Agreements and Conventions Relevant to the Proposed Project

International Agreements and Conventions	Status
Vienna Convention for the Protection of the Ozone Layer, 1985	1998
Montreal Protocol on Substances that Deplete the Ozone Layer, 1989	1993
Basel Convention, 1989	2015
United Nations Framework Convention on Climate Change (UNFCCC), New York, 1992 and Kyoto Protocol 1997	1995 and 2005
Convention on Biological Diversity, Rio de Janeiro, 1992	1994
Asia Least Cost Greenhouse Gas Abatement Strategy (1998 ALGAS)	1998
United Nations Agenda 21	1997
Relevant ILO Conventions in force in Myanmar • C1 Hours of Work • C14 Weekly Rest • C17 Workmen's Compensation (Accidents) • C19 Equality of Treatment (Accident Compensation) • C26 Minimum Wage Fixing Machinery • C29 Forced Labour Convention • C42 Workmen's Compensation (Occupational Diseases) Revised 1934 • C52 Holidays with Pay	
International Environmental Law (IEL)	2017

(c) Summary of Statement of Commitments

The developer have to commit to comply with the followings:

a) We, Myanma Railway (MR) commit to follow the environmental commitments, mitigation measures, management plans illustrated in the EIA report. We also commit to follow the Environmental Conservation Laws 2012, the Environmental Conservation Rules 2015 that stated in EIA.
b) Comply with the commitments of the environmental and socio-economic development revealed in the Environmental Impact Assessment report.
c) Acknowledge and comply the laws, regulations and guidelines associated with the project, included in the report.
d) Comply and proceed the alternative methods, mitigation measures and monitoring plans included in the report for the reduction of the negative environmental impacts; and take responsibility for the environmental impacts due to non-compliance of the commitment.

(d) Summary of Project's Environmental, Social and Health Policies

Project developer's sustainability model is "To operate in a sustainable manner means to create value for stakeholders, and to use resources so that the needs of future generations will not be compromised, respecting people, the environment and the society as a whole." The main policy and commitment of project developer can be identified in the following points:

- the protection of public safety, the health and safety of the workforce and the local communities
- the protection and promotion of human rights, the economic and social development of local communities;
- the protection of the environment and the conservation of biodiversity and ecosystems;
- the continuous improvement of the quality of the processes, services and products of our activities and operations;
- the compliance with Myanmar laws, regulations and industrial standards regarding the environment, health, safety and hygiene at work in all of our operations
- visible and active leadership that promotes HSE excellence, which engages and motivates employees and contractors alike to succeed
- setting objectives and targets for measuring and improving HSE performance in line with Company activities and strategic objectives
- manage HSE in order to achieve our objective of incident free operations
- implementing sustainable development principles in our activities

- seek and achieve continuous improvement in our processes, consistent with our strategic objectives and priorities, by adopting the most advanced systems for environmental protection and energy efficiency

(e) Summary of National Environmental Quality (Emissions) Guideline for Bridges and Culverts

This guideline applies to construction, operation and maintenance of large, sealed road projects including associated bridges and overpasses.

Effluent Levels

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

[a] Standard unit

Noise level set in NEQG

In NEQG, the noise level is set as shown in the following table.

Receptor	**One Hour LAeq**	
	Daytime (7:00-22:00) (10:00-22:00 for public holidays)	**Night Time (22:00-7:00) (22:00-10:00 for public holidays)**
Residential, institutional,	55	45
Industrial, commercial	70	70

Source: NEQG (December 2015)

1.3. Summary of Project Description

1.3.1. Project Area

The MMR line sets 124 new bridges with a total length of 69.309km, accounting for 16.9% of the main line; 729 culverts with a total length of 31,190 horizontal linear meters, 42 horizontal linear meters/bridge on average; 50 frame bridges with a total top area of 33,000m^2; 3 rigid frame bridges with a total area of 5,644.2m^2; 25 road-over bridges with a total length of 2,725m and a total area of 28,945.2m^2; 9 pedestrian overpasses with a top area of 3,038.4m^2; 13 underpass bridges with a top area of 6,812.2m^2; 1 aqueduct with a total length of 82.7m; 4 new platform bridges with a total area of 766.9m^2; 73 new road culverts with a total length of 1,040.46 horizontal linear meters, 2 road culvert extensions with a total length of 68.6 horizontal linear meters; 1 new evacuation exit bridge with a length of 35.3m and an area of 52.95m^2.

1.3.2. Project Location

The locations of railway bridges, major river crossing bridges and culverts are shown in the following figures.

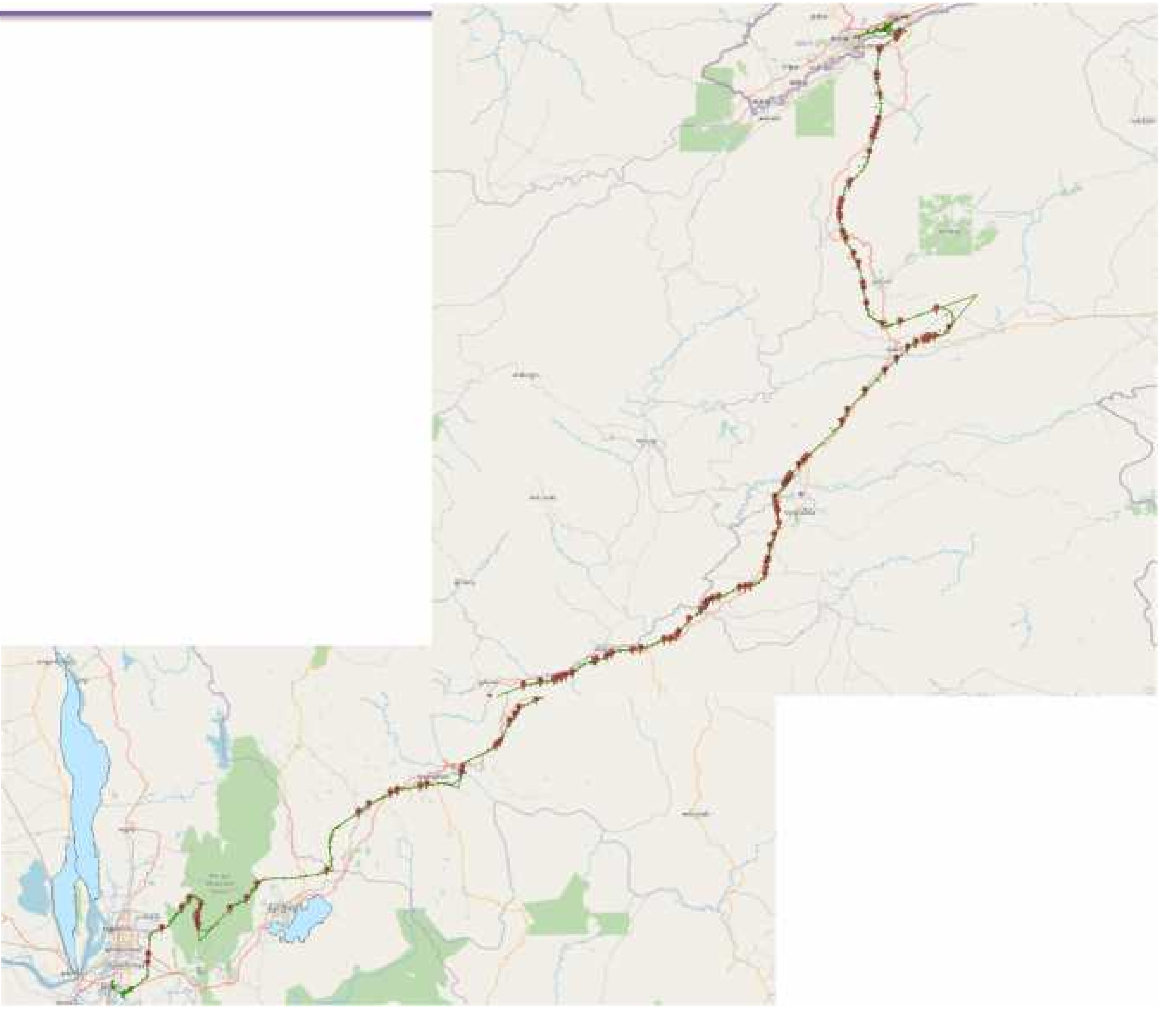


Figure - Location of Bridges along the Muse-Mandalay Railway Line (Source: EIA Team, 2020)

Figure - Location of Super Major Bridges along the Muse-Mandalay Railway Line (Source: CREEC, 2019)

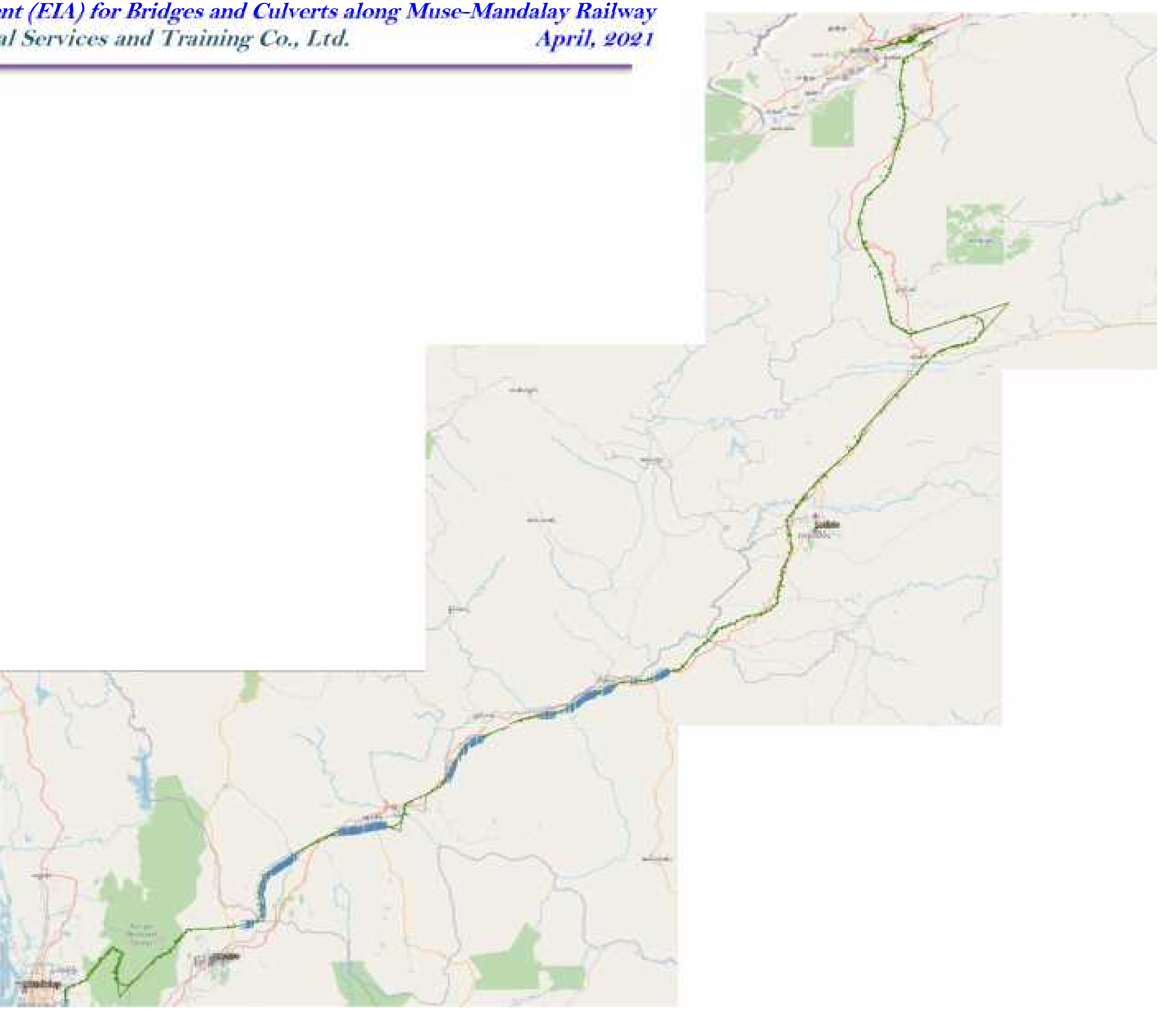


Figure - Location of Culverts along the Muse-Mandalay Railway Line (Source: EIA Team, 2020)

1.3.3. Summary of Process Description

The common bridge construction of a new railway is mainly divided into the following steps: re-survey of bridge data, foundation construction, construction of bearing platform, construction of pier and abutment, construction of beam and bridge decking as follow.

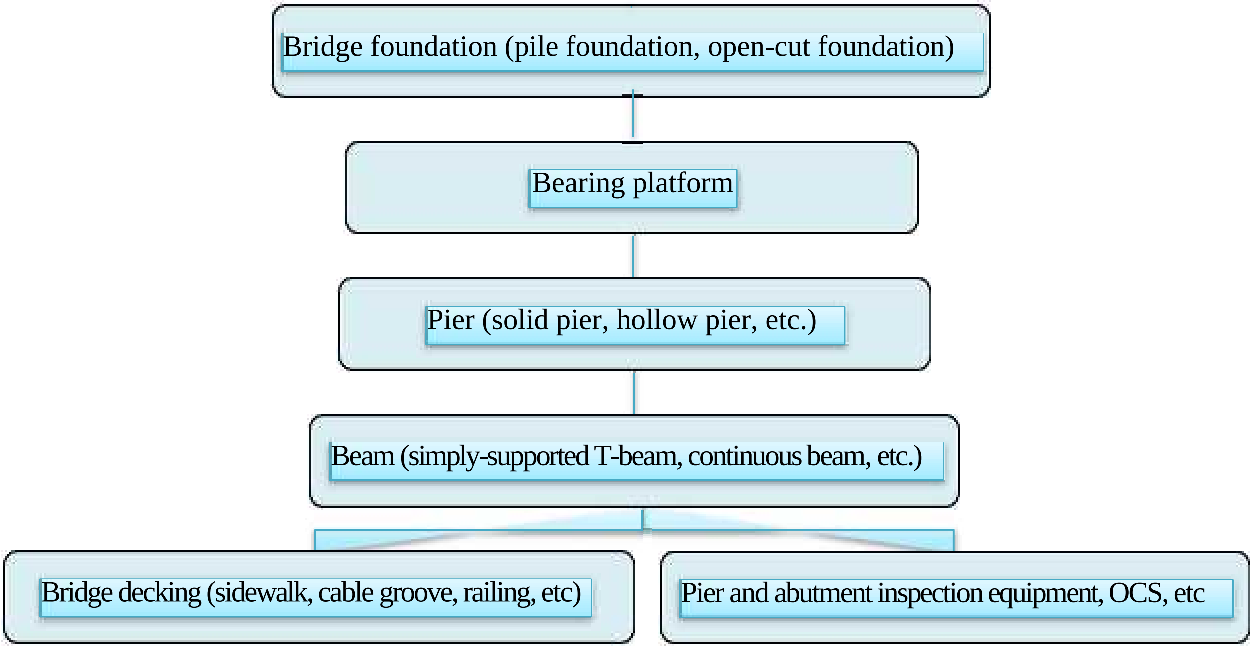


Figure - Flow Chart of Bridge Construction Process

(a) Construction of Bridge Foundation

The bridge foundation is generally constructed by routine method, and the manual dig pile can be used if the site and geological conditions of the bridge pile foundation are good; the cast-in-situ bored pile is generally drilled by percussive drilling or rotary drilling; the open-cut foundation is generally adopted with the unprotected construction, taking excavator as the main and artificial excavation as the auxiliary.

(b) Pier Construction

The pier construction will be made as follow:

(i) According to the height of the pier, the integral formwork casting method and the tripod setting-up formwork method are used in the pier construction;

(ii) The foundation construction of pier in the water, depending on the pier foundation form, water depth and flood discharge conditions, should take construction measures such as woven-bag cofferdam, reinforced concrete cofferdam, steel sheet pile cofferdam and single & double wall steel cofferdam to assist the construction.

(c) Beam Construction

The simply-supported T-beam is prefabricated centrally in the factory, transported to the bridge site by the girder transporter, and then installed in place by the bridge-erecting machine. When the small-span continuous beam has the condition, the bracket cast-in-place construction is adopted, and the other continuous beam bridges and continuous rigid frame bridges are constructed by cantilevering casting method.

- The prestressed concrete simply-supported T beam is constructed by bridge-erecting
- Continuous beam and continuous rigid frame are constructed by cantilevering casting or cast-in-place construction.

(d) Design speed

Design speed of passenger trains: 160 km/h, and 200km/h for the sections reserved with double-track conditions (with speed limit of 160km/h for local sections) as follow:

S/N	Mileage scope	Speed limit
1	CK0+000~CK11+800	160km/h
2	CK323+685~CK369+803	160km/h

1.3.4. Implementation Schedule

According to the construction schedule of the whole line, the allowable civil construction periods for bridges controlling the total construction period of the line are as follows: 26 months for Shwe Li River super major bridge, 24 months for Nam Ma River Major Bridge, 23 months for Nam Tu miy Nge-R River Super Major Bridge, 54 months for Gohteik Nam ban ton double track super major bridge as follow:

<table>
<tr><th>Phase</th><th colspan="2">Item</th><th>Duration</th></tr>
<tr><td>Pre-construction Phase</td><td colspan="2">All types of bridges</td><td>6 months</td></tr>
<tr><td rowspan="5">Construction Phase</td><td rowspan="4">Key bridges</td><td>Shwe Li River double-track super major bridge</td><td>26 months</td></tr>
<tr><td>Nam Ma River super major bridge</td><td>24 months</td></tr>
<tr><td>Nam Tu miy Neg-R River super major bridge</td><td>23 months</td></tr>
<tr><td>Gohteik Nam ban ton River super major bridge</td><td>48 months</td></tr>
<tr><td colspan="2">Other Bridges</td><td>< 23 months</td></tr>
</table>

1.3.5. Summary of Alternative Analysis

Although the alternative analysis will have to conduct no project alternative, location alternative, construction methods alternative, Location alternative analysis cannot be made during FS stage because detailed alignment with exact locations of bridges and culverts are not designated by the developer during FS stage. So, the alternative analysis will mention only no action alternative and construction methods alternative.

(a) The "No Action" Alternative

This alternative avoids the implementation of bridges and culverts along the Muse-Mandalay Railway. In no project scenario case, there will be no impact on natural environment and local communities. But there will be positive impacts on residents' life quality in "Project Scenario" case. So, it is necessary to considervfrom environmental and social perspectives. According to the "No Action" alternative analysis, the "No-Action" alternative is not a feasible alternative, as it would lead to loss of significant foreign direct investment as well as significant employment opportunities – direct employment opportunities are currently estimated at 5200000 Nos. (on average) during the 5 years of construction period.

(b) Summary of Construction Method Alternatives

Some of the Muse-Mandalay railway alignment is in bridge and as such the method of forming the bridge during the construction phase is one of the key factors for the EIA Study. The engineering feasibility of the various alternative options play a key factor in the selection of the preferred options. The main bridge construction methods considered for this project are:

- Steel-truss Arch Bridge
- Cable-stayed Bridge

According to the alternative analysis for bridge construction method, it will be nearly the same with the pile foundation process form the environmental point of view. So, steel-truss arch bridge will be more flexible with technical and economic point of views.

(c) Summary of Process Alternative Analysis

Normally, piling activity depends on the ground conditions and also the important process in bridge construction with most environmental impacts. The usage of types of piling machine is depending on the type of piles used, different types of piling machine may affect the procedure of pile driving too. Type of pile foundations based on construction method are as follows:

- Bored Cast-In-Place Pile Method
- Driven Pile

After analyzing alternative piling methods of bridge, operation costs for implementing both pile construction is high respectively. From environmental perspective, the impacts from both methods can be managed by technical control and utilizing proper machinery. In environmentally, socially and biodiversity sensitive areas, the most favorable type of foundation is bored cast in-situ pile with the action of wet drilling of pile bored because it can be drilled by reverse rotary method of drilling and this action is suitable for any soil type and consistency of strata, and all water table depths.

1.4. Summary of Description of the Surrounding Environment

(a) Environmentally Sensitive Areas

Most of the environmentally sensitive areas along the bridges and culverts are residential areas (villages), natural springs, rivers, factory, Nawng Hkio Golf Club, Gohteik bridge, agricultural lands and forest areas including Kai Gyi Reserved Forest.

(b) Temples and Pagodas

According to the GIS study, there will have no famous temples and pagoda within the affected area of the bridges construction.

(c) Mineral Deposits

According to the existing geological records and possible structural trends, there would be lead-zinc-silver, antimony, gold that could be expected in it. Coal and phosphorous deposits might also be found as well. Some deposits are a little far from the proposed railway line. Why mentioned here is that mineral deposits are trending approximately N-S direction and those could be probably found during construction of the line such as tunneling, bridge, station and railway line etc.,. For example, although Phayaung taung gold is far from the construction, gold occurrences are sporadically found along the western margin of Shan scarp, trending N-S direction. For Yadanatheingi lead-zinc-silver deposit, similar deposits and occurrences could be estimated in Pyin Oo Lwin, Naungcho and Kyaume as regional structural trending passing in these areas. Similarly, deposits at Bawdwin mine and Mohochaung mine, they might also be extended more or less into Hsipaw, Lasho, Kutkai and Nam Hpatkar areas.

(d) Mining Areas

There wiilbe Mohochuane Mine (Pb,Zn), Bawdwin Mine (Pb, Zn), Sintaung (Coal), Nanma (Coal), Yadanatheingi (Pb, Zn), Naungthakaw (Fe), Pauktaw (Fe), Inya (Fe), Kyadwinye Iron Mine (Fe), Aniskan (Ba) and Phayauntaung (Au) Mine arond the Muse-Mandalay Railway line. However, all of the mining areas are far from the impact zone of the railway bridges.

(e) Military Areas

There are military areas in Nam Hpak Ka, Lashio, Pyin Oo Lwin and other places along the route.

(f) Dams and Hydropower

There are also several dams especially constructed on Myitnge river and Shweli river for hydropower demand and cultivation purposes. On Nam Tu-Myitnge river, Yeywa Dam has completed. Namtu Dam and upper Yeywa dam are still under construction and Middle Yeywa dam and Deedoke dam are planned to be constructed. On Shwe Li river Shwe Li I hydropower project is already finished and Shwe Li II and III is also under construction. There are many natural lakes, ponds, waterfalls, springs and small reservoirs found around or along the line and local people get used to them for agricultural and domestic utilization in the area.

(g) Air Quality and Noise Level

Air quality and noise level along the Muse-Mandalay Railway is relatively good due to the less development of industrialization and the main source will be noise from vehicle movement.

(h) Water Quality

Water quality were tested in the following river and bridges.

Sample -1, Shweli River

Sample -2, Nant Paung Stream

Sample -3, Nant Khaing Stream

Sample -4, Namtu Stream

Sample -5, Pan Phet Stream

Sample -6, A-T Stream

Sample -7, Sint In Stream

Sample -8, Kho Lone Stream

Sample -9, Dokehtawady River

Sample -10, Kyin Thi Stream

Sample -11, Gok Twin Stream

Sample -12, Yae Ni Stream

Sample -13, Se Taw Gyi Canal,

Sample -14, Myaung Ma Gyi Stream,

Sample -15, Myaing Gyi Stream,

Sample -16, Dokehtawady River

Water samples are collected all of the rivers along the Muse-Mandalay Railway and tested in Public Health Department. According to the testing results all of the surface water are suitable for domestic use.

(i) Soil Quality

Soil samples are collected along the railway line and all of the sample were tested in Department of Agricultural, Yangon. According to the testing results, all of the samples are suitable for agricultural purposes.

(j) Vibration Measurement

Vibration levels were measured at points along the proposed Muse-Mandalay Railway. The measurements are taken in places which are Pyin Oo Lwin-Oak Pho Village (Monastery), Naung Cho- Shwe Pyi Nyunt Village, Goke Hteik, Hsipaw (near Baw Gyo Pagoda), Beyond Hsipaw (San Laung), Lashio, Hseni, Nam Hpat Kar and Muse. All of the vibration levels are within the acceptable level.

(k) Occurrence and Distribution of Groundwater

Groundwater along the line occurs as four types; 1. Pore-water in loosely cemented soil and younger rock, 2. Bedrock fissure water in clastic and crystalline rocks, 3. Karst water in carbonate rocks and 4. geothermal water from the earth.

The major aquifers of Myanmar range from Precambrian to Recent age and vary from coastal and north-south trending tectonically controlled basins. The major groundwater recharge is from monsoonal rainfall, which extends from June to September, ranges up to 3050 mm in the deltaic area, 3810 mm in the north, ~2000 mm in the eastern mountainous region, and only 760 mm in the central dry zone. The largest aquifer is the Irrawaddy river basin, which like the IGBM basin is the most prolific aquifer, however, much of the aquifers of the basin have been identified to have groundwater enriched with As. The other aquifers are in the Thanlwin, the Chindwin, and the Sittaung rivers.

(l) Geotechnical Characteristics

The geotechnical characteristics along the Muse-Mandalay Railway are:

i. Karst
ii. Landslide and Talus
iii. Unstable Rocks and Rock-Fall
iv. Bedding
v. Seismic Liquefaction
vi. Soft Soil and Mollisol
vii. Expansive Soil
viii. Expansive Rock
ix. High Ground Stress

(m) Socio-economic

The proposed line mostly passes through mostly in Shan State and partly in Mandalay Regions. These two regions have different socio-economic conditions. Mandalay region is urban area and the living standard is relatively high. But the socio-economic conditions in Shan State where the railway alignment will pass is dominated by agriculture and underdeveloped.

(n) Cultural and Heritage

The nearest cultural relics will be Gokhteik Bridge and Baw Kyo Pagoda with the distance of 980 m and 1079.05 m away horizontally respectively from the proposed alignment.

1.5. Summary of Potential Environmental Impacts and Mitigation Measures

The summary of potential environmental impacts and mitigation measures on the project during pre-construction, construction phase, operation phase and decommissioning phase are shown in table below.

Table - Summary of Potential Environmental Impacts and Mitigation Measures

Category	Item	Expected Environmental and Social Impacts	Mitigation Measures
PRE-CONSTRUCTION PHASE			
Air environment	Fugitive Dust Generation	Air pollution due to the movement of dozer and trucks for site clearing and ground levelling activities.	-sprinkling of water during pre-construction -Water will be sprayed by using handheld spray

		.	-before leaving the construction site, wheels will be cleaned and goods carried should be covered
	Vehicular Emission	- gaseous emissions such as CO_2, CO, NO_x and SO_2 during the operation of vehicles and machineries (3 dozers and 5 trucks)	- require plan to reduce in loading and unloading time and plan to reduce in idle time during working hours - use good engines conditions for every machinery used -generator with good engine conditions should be used
	Noise	Impacts of noise by site clearing and earth working vehicle (3 dozer) and delivery vehicles (5 trucks) traveling to and from the site	-Limit working at night and avoid the operation of noisy equipment and machineries at night if it is necessary to make operation at night; - Use phase wise construction (not to running noisy equipment at the same time) - regular maintenance of machineries
Surface Water Environment	Liquid Waste	-The temporary water pollution in nearest water sources due to earth working activities (soil erosion and sedimentation) - improper handling of fuel oil and lubricants -Preparation of construction camps can also can have negative impacts on the surface water environment because of the disposal of liquid waste and spills of hazardous liquids.	-The temporary septic tanks and other waste water facilities sedimentation pond with suitable drainage system around the dumping sites should be used during the rainy season - liquid material storage containment areas should not drain directly to the surface water - oil, grease and other chemicals should be handled as per MSDS.
	Solid Waste	- solid wastes of unsuitable soil materials from site clearing activities and domestic solid waste from pre-construction workers	- limit unnecessary earthworks - prevent over-excavation - reduce, reuse and recycle of domestic wastes - vegetation of bare area after the pre-construction state
	Drainage and flooding	- inadequate assessment of hydrological conditions - cost to rebuild the structures, potential flooding of agricultural land and property -impact to surface water quality	- ensure that drainage patterns are improved from the existing conditions - design drainage works based on the historical flood data and flood forecasting
Soil and Ground	Soil Quality	unsuitable soil materials- were generated from site	-systematic disposal according to the rules and regulations of CDC

water Environment		clearing and tree cutting (bushes and small trees) activities	- follow CDC rules and regulations for solid waste management - take special care on handling of diesel and lubricants to avoid leakage
Biodiversity	flora diversity (high)	too much tree cutting along the railway project	avoid tree cutting of road side plants and fence plants and re-planting the trees at twice of cutting and re-planting at other place for IUCN red list trees
	Fauna Diversity	Impact on mammals and aquatic species	-avoid working at night for fauna species and cutting the fence plants -Sound proof measurement shall be constructed surrounding the construction site as needed -Borrow pit will be away from fauna diversity abundance area
Human Environment	Positive socio-economic	- job creation	- use local people as much as possible
	Negative Socio-economic Visual Impacts	- too much tree cutting for the site clearance	- efficient and timely removal of all demolition and construction wasters as per requirements
	Land Acquisition	- relocation of a large number of residences cannot be avoided - influx may cause rise in the consumption of consumer goods in the local area, which will tend to boost up the local economy	- proposed project has provided compensation to the affected persons irrespective of their legally tenable ownership rights for the affected land - local labors shall be utilized for the construction purpose and all the activities related to construction worker shall be confined to the project site only to minimize conflict
	Land Use and Involuntary resettlement	Resettlement or/and relocation of buildings and other assets, involving some changes in livelihood of PAPs along the river bank and along the culverts	Compensation for affected structures and standing crops and assistance of livelihood restoration as per RAP
CONSTRUCTION PHASE			
Local air environment	Fugitive Dust Generation	- construction phase will mainly result in nuisance impacts in the form of dust - emission from on-site heavy-duty off-road vehicles, other light-duty vehicles	- minimizing dust from material handling sources by using covers or control equipment - proper handling of cement material - requiring and monitoring for minimal traffic speed on-site

		- dust emission from the construction equipment	- covering the loads of all vehicles hauling materials likely to give off dust emissions - applying water as a dust suppressant as needed
	Vehicular Emissions	- emission of CO, CO2, NOx and Sox from the operation of generator, concrete mixer, vehicles and construction machineries	- transportation of personnel and materials will be scheduled such as to avoid period of peak flow - reduce the overall number of vehicular movements - reduction of on-site construction time
	Noise	- Impacts of noise by construction machineries especially by piling machine for foundation	- Workers in vicinity of strong noise will wear earplugs and their working time will be limited as a safety measure. - Selecting low-noise equipment as needed, especially near the residential area and/or sensitive receptor. - No construction activities with heavy equipment during night time if there are any sensitive receptors. - Piling by press piling machine in environmental sensitive area.
	Vibration	- Impacts of vibration by pilling machine for foundation	-Piling will be done by press pilling machine near environmentally sensitive areas - Avoid night time activities. People are more aware of vibration in their homes during the night time hours
Surface water environment	Surface water hydrology and channel morphology	- Increase in surface runoff from soil compaction due to the use of vehicles and machinery - Change in flow velocities - Increase erosion and subsequent changes in bed and bank stability - Increase flood risk - Increase sedimentation of watercourses - Pollution from suspended material	- Access roads will avoid riparian zones and should be built using appropriate construction materials. - Bridges and culverts will incorporate a low flow channel to retain sufficient water depth for aquatic life at such times; An appropriate water management system is used during the construction period, including, for example, efficient land drainage and the use of constructed ponds for receiving site runoff to reduce the impact of runoff on nearby watercourses;
	Wastes	- increase silt load in the river	- ensure no waste material are dumped in the river, including reinforced concrete debris

		- accidental spillage of concrete and liquid waste into the river - spillage of lead-based paint used for bridge coating process	- avoid any leakage of oil and lubricant from vehicles and machineries used in construction phase - use the zinc-based coating paint instead of lead-based coating - soil material removed from the construction process should be recycled - during piling works ensure that pumped water is filtered through a silt trap before being discharged to the river -
Soil Environment	Soil contamination	- soil contamination from spillage of diesel oil during the pile driving activities especially in valley crossing bridges - discharge of concrete residue near farmland	- Soil will be carefully removed and stored for subsequent reinstatement; - Effective stabilization of altered landforms so as to minimize soil erosion and the potential for water pollution from suspended solids; - With regard to bridge construction, where the substratum of a watercourse is disturbed by construction, this will be replaced - Installing all erosion-control measures prior to starting ground-disturbing activities-Frequently maintaining erosion-control measures - Maintain the vehicles and machines regularly and store fuel and construction materials systematically to reduce soil contamination
	Waste	- Surplus soil waste and other waste from construction -Solid and liquid wastes discharged from temporary construction office and other facilities	- Reduce, reuse and recycle of construction and other type of waste - Installation of temporary sanitation facility such as septic tank at construction office and other facilities - Avoid waste dispose to the river directly
	Groundwater quantity and quality	- leakage of oil and fuel can permeate into the groundwater -causing pollutants such as heavy metals to enter groundwater - cause effect in water table for the valley crossing bridge at deep depth	- seepage waste from waste disposal site will be controlled systematically - control the leakage of fuel, oil and lubricants from bridge construction site

Natural Environment	Ecology	- in accidental leakage of oil and fuel can impact to the ecology - physical presence of both bridged and culvert may affect ecological populations in a number of ways	- existing habitat features should be incorporated into site design and protected from change - holes and ledges should be incorporated onto the design of culverts for use as nesting sites -baffles should be incorporated into the design of the culverts base to provide shelter for fish as they pass through the culvert
	Aquatic Ecology	- Negative impact on flora and fauna from increased sediment loading of streams - Harm to aquatic flora and fauna from oil, fuel, cement or other substances entering watercourses	- Phasing of construction work to minimize disturbance to wildlife at sensitive times of year, such as during the breeding season or when young are being raised; - Designing the culvert to allow for the passage of fish and other aquatic life, Avoid fish migration period - Baffles will be incorporated into the design of the culvert base to provide shelter for fish as they pass through the culvert;
	Terrestrial ecology	- Habitat loss, disturbance to, or loss of, species (including rare and sensitive species) due to construction work	- Where clear span bridges are not a feasible design then a ledge, either in the form of a concrete shelf or gravel side bar, or mammal tunnels will be provided; - Bird boxes will be provided within the riparian areas; - Consideration will be given to the provision of features within the bridge design to encourage nesting birds and bats.
Human Environment	Positive Socio-economic (Local employment and job opportunities)	- create permanent employment opportunities for the local affected communities	- training program for welding will be opened before the construction phase - unskilled and semi-skilled job opportunities will be offered to the local communities as much as possible - developer will encourage construction sub-contractor to use local labor force as part of tender requirement.
	Skill Development for Local People	- Local people hired by the proposed project would remain in communities with skills acquired during project construction including concrete work for offices and other facilities, steel work for oil tanks, stone work for	- training programs (e.g. maintaining of vehicles, welding, wiring, masonry building etc.) will be implemented prior to and during the construction phase because majority of the local people may not be adequately skilled to qualify for positions requiring skilled labor, if required

		retaining wall and the bridge construction technique (like pile driving activities, beam installation and pier construction)	- local construction sub-contractors will be chosen as first priority during tender process
	Potential to Growth of Local Economy and Business	- local expenditure by employees will have multiplier effects in various sectors of the economy - Changes in the local economy structure such as opening of new markets for products and services	- Local business for food and consumer goods in nearest villages should boost by buying required things regularly - The project developer should establish a policy to encourage services and materials from local in relation to construction works
	Negative Socio-economic Impacts Blockage of River and Stream	- cause the damage to the agricultural land because the blockage of upstream near the river - cause the water shortage to the downstream river due to construction of coffer dam for the bridge foundation process - foundation of the bridge can block the mountain stream especially in valley crossing bridge	- alternative water way will prepare to flow the water volume for the reduction of potential to flood - Both river crossing bridge and valley crossing bridge will not construct during the rainy season - Use alternative water way for the upstream flood near the farm land and village.
	Impact due to population influx	- Increased number of work locations - Risk of social conflicts - influx of newcomers seeking opportunities associated with the project could also create various social problems	- raise awareness amongst construction workers about local traditions and practices - inform local businesses about the expected influx of construction workers - payment will comply with applicable Labour Law legislation in terms of minimum wages - raise awareness amongst construction workers about local traditions and practices
	Impacts on Social Services	- increase of population during construction phase will increase temporary pressure on existing infrastructure and services including health care, food, shelter, water, transport and recreational facilities	- by appointing local construction workers - Own health care facilities will be supported to workers during construction period.
	Community Health and Safety	- temporary health impacts such as increase of stress levels of commuters and residents living nearby construction sites	-project site should be fully fenced and access points should not be available for the public - temporary sanity facilities should be provided at all construction sites

		- community health include noise, vibration, dust generation that may cause respiratory diseases and accidents.	- arrange construction activities and schedule to minimize the impact on surrounding communities
	Conflict between Communities	- type of violent and aggressive conflict between non-Shan communities and Shan Ethnic Minority -hostile attitudes of non-Shan migrants to local community such as sexual harassment of migrant workers to ethic local women	- use local people as much as possible - limit night out for foreign workers -limit the use of foreign workers
	Increased in Traffic	- cause public anxiety - temporary blockage of village roads - increase the risk to the employees and local community	- use traffic control plan - limit to off-peak hours - use alternative road that will not pressure on the public road
	Increase in Crime and Security	- inflow of skilled migrant construction workers and crime including drug and alcohol abuse, assault, theft and violence in nearest villages	- use local labor force as much as possible - management of construction camp should be adequately formalized - construction site should be fenced and all of the construction workers should not allow going out at night
	Public Road Damage	- cause the damage to the public road and village roads used of construction materials	- use bypass road instead of public roads - use public roads as per the resistance of roads and bridge if avoidable - repair the public roads if they are damaged by construction activities
	Controversy with EAOs	- controversy between EAOs and the parties taking part directly in the project	- have transparency in every development of the project - inform the EAOs before any development of the project - discuss and negotiate with EAOs if any conflicts occur
	Health and safety Increase Infection of Air-borne Diseases	- lead to overcrowded conditions where air-borne disease such as tuberculosis, influenza and meningitis can spread easily	- providing medical check for workers who are susceptible infection of air-borne diseases
	Fugitive Dust Emissions	-cause some local people in nearest villages to	- wetting of roads by water spraying

		bronchial and other respiratory tract diseases	- seeding storage mound surfaces as soon as is practicable -watering roadways - wheel or body washing
	Increase infection of Water Borne Diseases	- loose soil from earthworks may be washed into river - irresponsible dumping of domestic solid waste can lead to underground water contamination	- avoid construction time during rainy seasons -construction activities will ensure that no loose soil is permitted into watercourses and stockpiles are located away from surface water
	Potential to increase Infections from Mosquito	- impact can be rated as medium because malaria is still a health problem in Upper Myanmar Region	- avoid construction time in rainy seasons as much as possible - no stagnant pools of water during the construction phase
	Increase Risk of Sexually Transmitted Infections	- lead to an increase risk of sexually transmitted infections such as HIV/AIDS, gonorrhea and chlamydia	- MR will provide information and education about safe sex and implement HIV control program for migrant construction workers
	Health impact related to Increase in Noise Level	- hearing loss and impairment are known to occur as a result of exposure to acute, high decibel noise - impacts on mood, performance, fatigue and cognition	- reduce speed limits for trucks in the project area to reduce noise level -avoid working at night
	Amenity and nuisance	- Temporary loss of amenity during construction phase Noise from construction traffic and operations - Mud on roads	-develop a Systematic construction management system to reduce public amenity and nuisance - Wash wheels before going to public road
	Architectural and archaeological heritage	- Damage to known or unknown features of archaeological or cultural importance	- Make the list of cultural and archeological importance and avoid the activities that will harmful to these features. - Archaeological investigations will be carried out where damage is unavoidable.
	Visual Impacts	- increase in people unease - blockage of the river views by constructing of the river crossing bridges - damage to the natural environment of rivers and streams	- avoid recreational area and/or side wall covers with green colour -site housekeeping to keep project area clean and limit visual intrusion - replantation after the construction activities
Utilities	Beam of truss bridge	Natural resources consumption	Use ready-made beam from China

Other	Management of hazardous materials and oil	Spoil of fuel or hazardous substance that is used for construction work	Measures for spill control and leakage control system Training workers on appropriate handling of chemicals and fuels
Impact on Utility Consumption	Water usage	Water usage can be reduced by preparation of construction materials beforehand on site	- reducing process water use -minimizing domestic water consumption
	Fuel Consumption	By using the diesel engine generator for the construction process, it can affect the air quality because of the emission of the dust and noise to the surrounding environment.	- need to control the usage of diesel engine generator and not operate if there are not in use - replacements as a part of general upgrades to the system - stimulate the production of domestic raw material for biofuels
OPERATION PHASE//ONGOING SITE MAINTENANCE			
Local air environment	Noise	-Travelling of high-speed rails on the bridge - traffic flows will increase on the approach roads causing increased sound emissions and additional noise in the neighborhood	- re-planting the trees especially native species in the places near residential area or biodiversity sensitive area - reduce the speed of the train when passing through the bridge
	Vibration	- Heavy freight train passing the bridges cause huge vibration due to the interaction with railing - Traveling of high-speed rails on the bridge can cause the vibration impacts near the residential areas.	- sound proof measurement will be taken near the public area - reduce the speed of train while passing through the bridge - reduce the noise level by increasing the effective mass of the bridge structure
Surface Water Environment	Surface water hydrology	• Upstream potential impediment to flow • Decrease water velocity and increased depth • Increase flood risk • Loss of pools/riffles, alteration of natural bed slope, • decreased water turbulence and oxygenation, increased bank erosion downstream • damage to the stream or river near because of using the water from the stream for cleaning trash	• watercourses should not be deepened or widened up or downstream of culverts; • artificial bank reinforcement should be avoided if possible; • oil interceptors or drip trays are used in vehicle parking areas, and are inspected and cleaned regularly; • a risk assessment is carried out for each substance to be used or stored on site, and the appropriate containment measures installed. • Proper control and avoid leakage of oil and paint

			• Use the zinc-based paint instead of lead-based paint for bridge maintenance
Soil Environment	Soil contamination	• Soil contamination which is caused by leakage of oil and paint bridges and culverts maintenance	- Proper management and control of leakage of oil and paint during maintenance • - dispose systemically the residue of paint after maintenance process
Biodiversity	Aquatic Ecology & Terrestrial Ecology	• Interruption of river corridor isolating habitats with potential decrease in species numbers and local biodiversity • Increased water velocities in culvert may impede fish migration and spawning upstream • Changes to deposition, depth and water velocities may result in the loss of sensitive plant, invertebrate and fish species • Turbidity may contribute to reduced ecological diversity • Potential downstream changes to the aquatic community • Shading of the watercourse may reduce aquatic flora in the vicinity of the bridge • Potential barrier to fish migration and the movement of aquatic mammals along the river corridor • Direct and indirect effects from oil, fuel or other substances entering the aquatic environment	- existing habitat features will be incorporated into site design and protected from change - further habitats will be created to compensate for habitat losses and to improve the landscape and ecological potential for the site; - Potential barrier created to the upstream migration of wildlife - Creation of barriers to mammals - Provide sign boards in places where there is a potential for wildlife crossing.
Human environment	Accidents	• Railway accidents of passengers and local people	Enlightening passengers and residents about traffic safety specific to railways
	Positive Socio-Economic (Employment Generation)	• - direct employment opportunities would be increased for the local people	Positive impact is expected since the proposed project would boost regional economic activities along the maintenance process of the bridge and culverts. For PAPs whose livelihood had been affected during

			construction stage, monitoring of the implementation of the RAP will be conducted.
	Local Community Development	- Many local and foreigners will travel during operation phase since the transportation becomes easy • - High capital investment in Shan Region and CSR activities will have potential to community development potential	- This positive impact of the project can be enhanced by creating jobs for providing necessary services (transportation, tour trips to religious places, local tourist guide) to foreigners by local people - According to the social survey, local people are the most of the public needs, and it will also support community development
	Visual Impact	- From constructing of the new bridge like "Gote Hteik" Viaduct, it can increase the rate of the visitors coming to the new bridge	- use the bridge construction design that are suited to the local community
	Negative Socio-economic (Illegal Resettlement of Migrate Workers)	- affect to the local people because some of the migrate workers remain as illegal citizens after the construction of each bridge site - increase the population of the local people and can have a conflict with local people	- make a contract with the sub-contractors to remove workers after the construction is finished - control the workers according to law and regulations - use local workers as much as possible
	Community Health and Safety Accidents	- cause the railway accidents of passengers and local people when passing through the bridge - risk of harm to humans falling from the structure into the watercourse and also into the valley.	- needs to have an installation of adequate fencing and other site security to prevent trespass and vandalism - put the safety signboards for the local people and surrounding environment.
	Amenity and Nuisance	• Possible alteration of rights of way or reduction in access to riparian habitats • Reduced recreation opportunities e.g. angling and boating Loss of visual amenity	• Create public recreation place at or near the bridge and culvert as its possible. Replantation around the bridges and river
Utility Consumption	Electricity Consumption	- electricity is used to provide the adequate lightning for the bridge	- use LED lights and/or lower wattage lamps • - use alternative source like solar system for lighting of the bridges

		• - electricity is used from the local community, it can affect to the local people usage	
DECOMISSIONING PHASE			
Air Environment	Vehicular Emission and dust Generation	Use of Dozer and truck	• Use machineries with good engine with low sulphur content fuel for gaseous emission. Spray water for dust control
	Noise	cause the noise impact to the near village and surrounding environment because of the use of equipment and blasting operation	• scheduling blasting activities sa as not to disturb to local people and notify them prior to undertaking such as activity • noise barriers should be erected at appropriate location like the residential areas and sensitive areas
	Vibration	usage of the explosive in the blasting operation can cause the vibration impact to the surrounding environment	• Informing people of the possible vibration before drilling and blasting activities take place • Proper drilling pattern and drilling method to reduce vibration • Use delay for control blasting or reduce the number of drill hole per blast near the residential area or biodiversity sensitive area
Water Environment	Surface water hydrology	• Surface runoff from bank areas due to soil compaction • Pollution of surface water Fuel and oil spillages from vehicular activities.	• an appropriate water management system is used during the construction period, including, for example, efficient land drainage and the use of constructed ponds for receiving site runoff to reduce the impact of runoff on nearby watercourses • oil interceptors or drip trays are used in vehicle parking areas, and are inspected and cleaned regularly • control the spillage of the oil, fuel and concrete into the river
Soil Environment	Erosion of exposed soil	• Erosion of exposed soil and removal or alteration of soil on site for bridge/ culvert removal • Discharge of the residue of the concrete from the demolition of bridge and culvert	• Effective stabilization of altered landforms so as to minimize soil erosion and the potential for water pollution from suspended solids • Use systematic dispose method for the residue of concrete near the residential areas and do not discharge near the residential areas

Biodiversity	Negative impact on Aquatic flora and fauna	• From increased sediment loading of streams • From oil, fuel, cement or other substances entering watercourses.	Avoid the spillage of oil and fuel into river and stream Use systematic method for bridge demolition not to cause damage to the aquatic flora and fauna Dispose the residue of the concrete structure and steel structure according to the law and regulations
	Negative impact on terrestrial flora and fauna	• From vehicular activities, disturbance and habitat severance • From oil, fuel, cement or other substances entering watercourses	existing habitat features should be incorporated into site design and protected from change; further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential for the site; where access restrictions result, arrangements for alternative access should be made with the provision of gates, bridges or stiles
Human Environment	Negative Socio-Economic Impacts Loss of jobs for local people and revenues for the government	• tends to reverse the benefits that are got from the operation of the proposed project on closing the project • negative impacts resulting in loss of jobs and indirect employment depending on the proposed project and of associated services for tourism as well as loss of revenues for the government	Extensive and comprehensive warning to employees to allow them to source alternative livelihood should be taken early The project developer should prepare their employees for forced retirement by providing applicable jobs at other factories under the same developer, if feasible.
	Visual Impact	• Temporary visual impact from work being carried out on site • Transportation of vehicular equipment on site • Discharge of residue and steel structure near the residential area	Appropriate screening for visual impacts Vegetation and plantation near the decommissioning bridge Use systematic dispose method for the residue of concrete near the residential areas and do not discharge near the residential areas

1.6. Summary of Cumulative Impacts and Mitigation Measures

The summary of potential cumulative impacts and mitigation measures on the project during pre-construction, construction phase, operation phase and decommissioning phase are shown in table below.

Table: Summary of Cumulative Impacts and Mitigation Measures

Phase	Category	Cumulative impacts	Mitigation Measures
Pre-construc-tion	Loss of habitat	- removing trees - extreme temperature swing that are harmful to plants and animals	- restoration or development of a (substitute) habitat - placing wildlife fences as protection against rail ways line - constructing fauna passageways - minimum clearing of vegetation - keep the width and length of the earthwork
	Deforesta-tion	- greenhouse gas which contribute to climate change - respiratory disease from smog and air pollution - cause dryer soil and the inability to grow crop - forest preserve soil, preventing floods and landslides, especially mountainous areas and on slopes - soil can be washed by rainfalls and humus is dispersed by wind	- to avoid unnecessary idling of construction vehicles at the construction sites - construction truck traffic plan will be optimized - reduce density of stand stocking - planting hardwood species -afforestation - replenish vegetation of multipurpose trees and other vegetation - Plan carbon off-set measures
Construc-tion	Water Scarcity	- use a large amount of water for construction process and for the construction workers that can lead to more problems of water scarcity	- sustainable water management - reclaimed water - awareness and education -water from construction activities should be recycled by use of sedimentation ponds
	Water pollution	- soil erosion percent will increase due to deforestation - pollution of water from the in accidental spillage of fuel and paint	- prevent water pollution of nearby rivers and lakes as well as groundwater and drinking water by following some simple guidelines - avoid the discharge of residue from construction activities into rivers and streams -prevent water shortages and reduces the amount of contaminated water that needs treatment
	Illegal Trading	- during the transportation of construction materials and for maintenance of construction machineries,	- proper inspection at every gate before going out of the country - stop enough time for inspection - cooperate with respective

		jade, endangered species, wood and orchid and other natural resources can be the main objects in illegal trading	organizations
Operation	Land use	- impact on the agriculture in the area - versatile land will be lost - proposed route husbandry is much harder to assess	- reduce alternation in land use pattern - avoid land use for agricultural land, histological areas, archeological areas, forest area and ecologically sensitive areas as much as possible
	Visual Impact	- contribute to the increasing urbanization of that area - gradual change of character	- Installation of natural visual barriers such as vegetation - replacement planting and vegetation barriers - location and color of storage tank will be selected with consideration of architecture view
	Water Scarcity	- due to the development of the area, population can also increase - lead to water scarcity problems currently faced by the local people	- sustainable water management - rainwater harvesting and recycled wastewater allow to reduce scarcity and ease pressures on groundwater and other natural water bodies - construction period should be started in the late rainy season in order to be able to store rainwater in storage tanks throughout the whole rainy season
	Increase in Human Trafficking	- since the transportation becomes easy, the increase in human trafficking rate could also occur	- corporation with human trafficking team in every trip to Mandalay to Muse Permanent Immigration Team should be made - confiscate by the government under the Anti-Trafficking in Persons Law
	Increase in Trade Off Drugs	- since the transportation becomes easy and the profits of trade off drugs are high, the rate trading off drugs would increase especially in Shan State	- trading off the chemicals and drugs used to manufacture drugs into Shan State should be restricted - government should redouble its drug control and anti-corruption efforts, focusing on major players in the drug trade

1.7. Summary of Environmental Management and Monitoring Plan

Table - Summary of Environmental Management Action Plan

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing / Responsible Organization
DESIGN PHASE			
Bridges and Culverts construction along the railway alignment	The construction accesses and construction sites for bridge and culvert will be arranged in a concept of environmental protection to reduce excavation, maintain physical physiognomy and protect surface water as far as possible.	During Design stage	MR / CREEC
Cultural Heritage	Avoided by adjustment of Bridge and Culvert construction along the railway alignment	During Design stage	MR / CREEC
CONSTRUCTION PHASE			
Air Pollution & Dust	Vehicles and machinery are to be regularly maintained so that emissions conform to NEQG Standards. Water should be sprayed during construction phase, wherever it is required to avid dust. Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.	Beginning with and continuing throughout construction	Contractor / Construction services provider
Noise	Noise standard at processing sites, will be strictly enforced as per NEQG noise standards. Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. Noise barriers (Stone walls and plantation) for silence zones including residential, schools and hospitals .	Beginning and through construction	Contractor / Construction services provider
Vibration	The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak velocity as given in article project EHS guidelines Manual	Beginning and through construction	Contractor / Construction services provider
Surface Water			
Contamination from Wastes	All justifiable measures will be taken to prevent the waste-water produced in construction from entering directly into river and irrigation system	Throughout construction period	Contractor / Construction services provider
Blockage of drainage due to earth filling	Earth filling will ensure not to block natural drainage system		
Oil and Grease & Domestic Wastes	Avoid any leakage of oil and lubricant Use proper waste management system		

Soil and Ground Water			
Potential to soil contamination	Proper waste management system	Throughout construction period	Contractor / Construction services provider
Leakage of fuel oil and lubricants	Store over concrete floor or impermeable pad		
Construction debris and domestic Wastes	Solid wastes according to the rules and regulations of local CDC.		
Flora And Fauna			
Loss of trees and Avenue Plantation	Areas of tree plantation cleared will be replaced according to Compensatory afforestation Policy under the Forest Law.	After Completion of construction activities	Contractor / Construction services provider MR
Social			
Loss of Access	Temporary access should be built at the interchange and other roads.	During construction	
Traffic jams and congestion	If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department	During construction	Contractor / Construction services provider MR
Safety with vehicles, people and livestock and signage	Safety education and fines. Allow for adequate traffic flow around bridge and culvert construction areas Provide adequate signage, barriers and flag persons for safety precautions. Communicate to the public through radio, TV & newspaper announcements regarding the scope and time-frame of projects, as well as certain construction activities causing disruptions or access restrictions	During construction	Contractor / Construction services provider
Increase in disease Water-borne Insect-borne Communicable diseases	Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. Provide adequate sanitation and waste disposal at construction camps. Provide adequate health care for workers and locate camps away from vulnerable groups	During construction At start-up Throughout construction	Contractor / Construction services provider MR
Location of camps depots and storage areas	Location of camps depots and storage areas shall be as per the contract specifications.	Throughout construction	Contractor / Construction services provider MR
OPERATION PHASE			
Noise and Vibration	Suitable measures should be considered where warranted. The public shall be educated about the regulations of noise and vibration pollution and its implications.	During operation	MR
Maintenance of bridges and culverts	Paint residues and oil contant should be controlled during maintenance stage	During operation	MR

Table - Overall Budget for Implementation of the EMP

Project activities	Parameters to be monitored	Locations	Measurements (Methods and Equipment)	Frequency of measurement	Cost estimates (Kyats)**	Responsibilities
During Pre-Construction and Construction phase						
Gaseous emission, and PM generation	Ambient air quality (CO, CO_2, SO_2, NO_x)	Within the site and surrounding establishments	Visual investigation and monitoring by handheld PM meter and CO, CO_2, SO_2, NO_x meter	During the construction activities at different locations at least per month or every complaints or if necessary	100000 Kyats per once	Construction contractor(s) (as a part of contractor's financial offer)
Construction machineries	Noise complaints from the neighboring	Within the site and surrounding establishments	Monitoring by noise level meter	During the construction activities at different locations at least per month or every complaints or if necessary	50000 Kyats per once	Construction contractor(s) (as a part of contractor's financial offer)
Area of spillage	Soil contamination and water resource pollution	Project sites and agricultural lands nearby, nearest surface water resources	Visual observation; Recording and documentation of spillage	Daily	12000 Kyats per day	Construction contractor(s) (as a part of contractor's financial offer)
Management of construction waste and handling of hazardous waste	Amount of hazardous and nonhazardous waste generated	Project sites and agricultural lands nearby, nearest surface water resources	Estimation of the hazardous waste and non-hazardous waste in relation to the handling and transporting to the landfill	Weekly or monthly depending on the volume of waste	12000 Kyats per day	Contractor(s) during construction and operators during operation

Storage of the machines and construction materials of the project components	Complaints from neighboring communities and records and documentation of the temporary area for storage of materials or machineries	Project sites	Recording and documentation	Monthly	-	Construction contractor(s)
Storage of surplus soil particle from	Complaints from neighboring communities and records and documentation of the temporary area for storage of materials or machineries	Project sites	Recording and documentation	Monthly	-	Construction Contractor(s)
Monitoring the traffic disturbance due to the vehicles and machineries movement and other related construction activities	Traffic complaint	Within 500 m from the construction site	Visual observation and recording complaint received	During the duration of the construction activities	-	Construction Contractor(s)
Impacts of culture and privacy of local communities	% of local labor to total labor	Construction site	Reporting labor origin governorates and calculating the native's ratio	Quarterly	-	Construction Contractor(s)

Monitoring health and safety of the workers during the construction of the project components	Health records about occupational injuries	Clinic / hospital referred by the contractor	Medical reporting on received cases	on received case	The cost is undefined, depending on the cases	Construction Contractor(s)
Base camp preparation for the workers	Neighbors /project' complaints	Project construction sites	Recording of complaint and type of complaint	Once during the preparation and prior to start the construction phase	-	Construction Contractor(s)
Site clearance	Worker's injuries	Construction site location	Preparation of recording form of workers injures during the construction	Monthly	-	Construction Contractor(s)
During Operation and Maintenance						
Management of the hazardous and nonhazardous waste	Amount of hazardous and nonhazardous waste generated	At the designated landfill for solid waste	Record keeping of the admitted waste and their quantity	Quarterly	Undefined	Operators during operation
Management of risks during the emergency situations (fire, soil contamination, water resource contamination and smoke)	Records of emergency situations	At surrounding the alignment area	visual monitoring for possible leak and for possible damage on the foundation and isolated area	Weekly or if required	Undefined	Monitoring team of Railway Project
Workers' health and safety	Workplace health and accidents record	Workplace	Medical reporting on workplace injuries	Monthly	undefined	Monitoring team of Railway Project

1.8. Summary of Public Consultation and Participation

Public consultation will be made by household survey, focus group discussion and public consultation meetings. In fulfillment of the public consultation for the project, at least 19 public meetings for the whole project including six stakeholder meetings for scoping reports in total will be held so far.

(a) Household Survey and Focus Group Discussion

For household survey, 87 villages along the railway were conducted to evaluate primary socio-economic conditions of the project area and to understand the mood, perceptions and extent of preparedness of the people towards the proposed project. To get the accurate data, primary data collection will be conducted by social specialist, social consultants, local authorities and local people. During household survey, the most important positive outcomes from the project expected by the local people and most of their concerns about proposed project are as follow:

- Compensation to land use if they don't have permit to land right;
- the blockage of streams and natural springs; and
- worry to damage on the hill-side cultivation.

(b) Public Consultation Meetings (PCMs)

In public consultation meeting that was organized with participation of local stakeholders, parliament members, NGO and mass media, etc. are attended and asked questions that they want to know. By summarizing all of the findings from public consultation and participation process, the following are the most public concerns come out from public consultation and participation process related to the proposed bridges and culverts project.

(i) For River Crossing Bridges

- The damage of agricultural land due to flood in upstream area and water scarcity in downstream area due to the blockage of river
- Proper compensation to land use with or without land grant;
- Declare the exact dimensions of land use area bridges and culverts and will have to use according to the proclamation;
- Limit tree cutting outside of the project area;
- Not to dispose any solid to liquid wastes into river;
- Policy to prevent the settlement of migrant workers near the project sites;

(ii) For Valley Crossing Bridges (Viaduct) and Culverts

- Not to dispose soil material from construction near the agricultural lands;
- Less damage to public own land;
- Avoid blockage of natural drainage system and natural spring during construction phase;
- Avoid blockage of village road and road to cattle grazing area during construction phase;
- Less damage to wildlife along the railway line;
- Control foreign and migrant workers;
- Policy to prevent the settlement of migrant workers near the project sites;
- Policy to ensure job opportunities to local people;
- Tender system for every project implementation works;
- Not to separate the agricultural lands by the railway;
- Construct flyover when meet the public road;
- Not to increase in traffic during construction phase;
- Road damage during transportation of construction materials;

1.9. Conclusion

The important environmental impact during construction of bridges and culverts will be impact on biodiversity (aquatic lives), and river water quantity & quality. The key social impacts will be temporary land use and land acquisition for bridges and culverts construction and impact on agricultural lands nearby due to the solid waste disposal. As for conclusion, all of the environmental and social impacts can be mitigated to proper mitigation measures to acceptable level described in this report. So, the EIA team will focus about the impact assessment on biodiversity, hydrology and surface water pollution. Moreover, the EIA team will also focus on socio-economic impacts such as blockage of village road and impacts related to migrant worker during construction phase. According to the nature of the environmental and social impacts for railway bridges and culverts, the impact due to construction phase will be more than operation and decommissioning phase. For the land use, it is necessary to prepare comprehensive Resettlement Action Plan (RAP) for proper compensation and resettlement.

2. INTRODUCTION

2.1. Presentation of the Project Proponent

As part of the governments national transport strategy Ministry of Transport and Communication (MOTC) intends to improve transport capacities of the Country by constructing the Railway between Muse to Mandalay. On October 22, 2018, Myanma Railways (MR) and China Railway Eryuan Engineering Group Co., Ltd (CREEC) signed and entered into the Memorandum of Understanding on Feasibility Study (FS) for Muse-Mandalay Railway Project. According to this MOC, CREEC will conduct FS for Muse-Mandalay Railway alignment. As part of the MOU in order to meet regulatory requirements the of the ECD, CREEC will conduct the Environmental Impact Assessment (EIA) for the Project. There will necessary to construct bridges and culverts along the railway line, as the proposed railway will cross with rivers, streams and public road. So, it is necessary to conduct EIA for the railway bridges and culverts according to the Environmental Impact Assessment Procedure, 2015 in Myanmar.

2.2. Study Scope

This EIA report will cover the construction and operation of bridges and culverts (124 new bridges with a total length of 69.309km, accounting for 16.9% of the main line; 729 culverts with a total length of 31,190 horizontal linear meters) along the railway line.

2.3. Brief of the Project Proponent

The followings are the brief of project proponent.

Project Developer	
Project Developer	Myanma Railways (MR) under the Ministry of Transport and Communications (MOTC)
Type of Project	Railway Bridges and Culverts
Project Location	Muse-Mandalay Railway starts from Muse port of entry at the north, goes south to Mandalay

Contact Person	1.U Myo Win (GeneralManager) Upper Myanmar Administration (MR) Upper Myanmar Administration Department, Mandalay Station, Mandalay, Myanmar Tel : +95-2-35172 Fax : +95-2-35829 E-mail : myowingmupper@gmail.com
	2.U Phyo Htet Kyaw [Assistant GeneralManager (Planning)] Planning and Administration Department, (MR) Nay Pyi Taw Station Compound, Nay Pyi Taw, Myanmar Tel : +95-6777164(office)/+95-9-43124800(mobile) Fax : +95-67-77164

2.4. Brief of the Environmental Assessment Practitioner

Below is the background information on Ever Green Tech Environmental Services and Training Co., Ltd., (Third party) who will conduct the ESIA.

Ever Green Tech Environmental Services & Training Co., Ltd.	
Company Name	Ever Green Tech Environmental Services and Training Co., Ltd.
Company Registration Number (DICA)	3344/2015-2016 (Ygn)
Transitional Third Party Registration Number	0047
Contact Address	1/9, Baho Road, 16th Quarter, Hlaing Township, Yangon
Telephone Number	09-5099230, 5099232
E-mail	green.evergreentech@gmail.com 11kyawswar@gmail.com

Contact person	Dr. Kyaw Swar Tint Ph.D. (Mining) Principal Environmental and Social Consultant 09-797111000 11kyawswar@gmail.com

2.5. Selected Consultants for Conducting EIA

The following are the lists of consultants who participate in conducting EIA.

	No	Name	Degree	Responsibility	Area of Expertise
Our Consultants	1	Dr. Kyaw Swar Tint	Ph.D. (Mining)	Environmental and Social Specialist	(a) Air Pollution Control (b) Noise and Vibration (c)Environmental Management and Monitoring
	2	Mr. Min Aung	M.Sc. (Chemistry)	Local Environmental Specialist	(a) Water Pollution Control (b) Modelling of Water Quality (c) Soil and Ground Water Pollution Control
	3	Dr. Thein Tun	Ph.D. (Metallurgy)	Local Environmental Specialist	(a) Risk Assessment and Hazard Management (b) Facilitation of Meeting (c) Occupational Safety and Health
	4	Dr. Myo Min Tun	Ph.D. (Metallurgy)	Local Environmental Specialist	(a) Evaluation of Alternatives (b) Traffic and Transportation System (c) Resources Utilization Management (d) Waste Management
	5	Dr. Ohm Thike	Ph.D. (Mining)	Local Environmental Specialist	(a) Geotechnical (b) Slope Stability
	6	Ms. Nandar Nwe	M.S. in EIA/EMS (YTU), Dip; in Applied Psychology (YU)	Local Environmental Specialist	Social Impact Assessment (Household Survey)
	7	Ms. Thazin Htwe	M.S. in EIA/EMS (YTU), Dip; in Applied Psychology(YU)	Local Environmental Specialist	Social Impact Assessment (Public Consultation and Stakeholder Engagement)
	8	Mr. Yaw	B.Sc. (Forestry);	Field	Project Coordinator

		Ma Nar	Dip in EIA/EMS	Coordinator	
	9	Dr. Nyo Nyo Lwin	Ph.D. (Botany)	Local Environmental Specialist	Flora Diversity
	10	Dr. Nyunt Lwin	Ph.D. (Zoology)	Local Environmental Specialist	Fauna Diversity
	11	Dr. Wyne Nwe Nwe Oo	Ph.D. (Biotechnology)	Local Environmental Specialist	Flora Diversity
	12	Dr. Khon Aung	M.B.B.S. (Ygn)	Local Health Specialist	Health Impact Assessment
	13	Dr. Sao Hone Pha	Ph.D. (Electronics)	Consultant	GIS and Remote Sensing
	14	Dr. Tin Aung Myint	Ph.D. (Geology)	Consultant	Engineering Geology
	15	Dr. Win Swe	Ph.D. (Geography)	Consultant	Hydrology and Socio-economic
	16	Ms. May Thet Zaw	M.E. (Civil)	Consultant	Construction Impacts and Risk Assessment
	17	Ms. Nay Chi Win Maung	M.E. (Civil)	Consultant	Waste management
	18	U Aung Naing Tun	L.L.B; MBA	Consultant	Legal Requirements
Foreign Consultant	19	Mr. Cheng Liang shuang	M.Sc. (Conservation of Soil & Water)	Consultant	Water resources and high speed railway design

2.6. The Need of EIA

An EIA and EMP are required for environmentally approvals from Environmental Conservation Department (ECD, Nay Pyi Daw) and Environmental Conservation Department (ECDs, Mandalay and Shan Region). The Environmental Conservation Department under Ministry of Natural Resources and Environmental Conservation is the lead authority for this EIA process and the development needs to be authorized by this department in accordance with this Environmental Conservation Law (2012). Although the proposed project is FS stage, the environmental impacts associated with the proposed project require investigation in compliance with this Environmental Conservation Law (2012) and the EIA (Environmental Impact Assessment) procedures (2015).

2.7. Purpose and Objectives of the EIA Study

The Environmental Conservation Department under Ministry of Natural Resources and Environmental Conservation is the lead authority for this EIA process and the development needs to be authorized by this Department in accordance with this Environmental Conservation Law (2012). The environmental impacts associated with the proposed project require investigation in compliance with the EIA (Environmental Impact Assessment) procedures (2015). The main purpose of an EIA is to provide the relevant authorities with sufficient information on the proposed activities to allow them to make an informed decision on whether or not the EIA should be authorised. This EIA will be conducted according to Environmental Impact Assessment Procedures, 2015. The objectives of an EIA are to:

- Ensure that social and environmental considerations are explicitly addressed and incorporated into the development decision-making process;
- Anticipate and avoid, minimize or offset significantly adverse biophysical, social and other relevant impacts of proposed developments;
- Protect the productivity and capacity of natural systems and the ecological processes which maintain their functions; and
- Promote development that is sustainable and that optimizes resource use and management opportunities.

An EIA functions as a planning tool which helps determine the social, economic and Environmental impacts of a proposed project through Public Participation (PP) and independent specialist assessment. Through the EIA, potential negative and positive impacts are identified and recommendations are made for reducing or avoiding negative impacts, and enhancing positive impacts.

The findings of an EIA are transferred into clear and measurable objectives that must be achieved during construction, operation and decommissioning of a proposed project. These objectives, and plans for achieving them, are captured in an Environmental Management Plan (EMP). The EMP is a public document and typically becomes a component of the project financing terms and conditions should the project go ahead.

The basic guiding principles of the EIA are:

- To inform decision-makers and result in appropriate levels of Environmental protection and community well-being;
- To provide timely information and outputs which assist with design and engineering modifications that reduce negative impacts;
- To identify any significant Environmental effects and key issues (i.e. the matters that must be taken into account when making decisions) and apply the necessary mitigation measures;
- To provide opportunities to inform and involve Interested and Affected Parties (I&APs), incorporating their inputs and concerns explicitly into the documentation and decision-making;
- To allow opportunities for participation by the authorities involved;
- To ensure that the EIA team has implemented appropriate methodologies and experts from the relevant disciplines, and to ensure the team has assessed potential interrelationships between the biophysical, social and economic issues; and
- To provide, as far as possible, an objective, rigorous and balanced assessment of the issues.

2.8. About the EIA and EMP Report

EIA is a formal process used to predict how the proposed project will affect natural resources such as water, air, land, socio-economic and wildlife. It is desirable to ensure that the development options under consideration are sustainable. It also aims to make recommendations for the mitigation of the potential negative impacts and enhancement of the positive ones.

EMP is a site specific plan developed to ensure that the project is implemented in an environmental sustainable manner where all contractors and subcontractors, including consultants, understand the potential environmental impacts arising from the proposed project and take appropriate actions to properly manage that risk. EMP also ensures the project implementation is carried out in accordance with the design by taking appropriate mitigation actions to reduce adverse environmental impacts during its life cycle.

The EIA and EMP reports will contain:

(a) the present status of air, noise, water, land, biological, socio-economic and health components of the environment;

(b) identification and evaluation of positive and negative impacts due to the development of the project;

(c) proposed pollution control measures, environmental management plan (EMP) to be adopted for mitigation of adverse impacts;

(d) measures for the improvement of the community around the area, and

(e) post-project environmental quality monitoring programme.

In making impact assessment, Green Tech ESIA Team mostly referred to the pollution limits set by Myanmar National Emission Guidelines, USEPA, OSHA and WHO.

2.9. Scope of EIA Study

This EIA study will cover the construction and operation of railway bridges and culverts along the Muse-Mandalay Railway. The limit of the study area will be within 1km beside the railway bridges and 500m beside the railway culverts according to the AOI of scoping process. Based on the impact assessment, the EIA study for the proposed railway project will be focused on

(i) Impacts on air environment (air quality, noise & vibration)

(ii) Impacts on surface water environment;

(iii) Impacts on soil and ground water environment;

(iv) Impacts on biodiversity environment; and

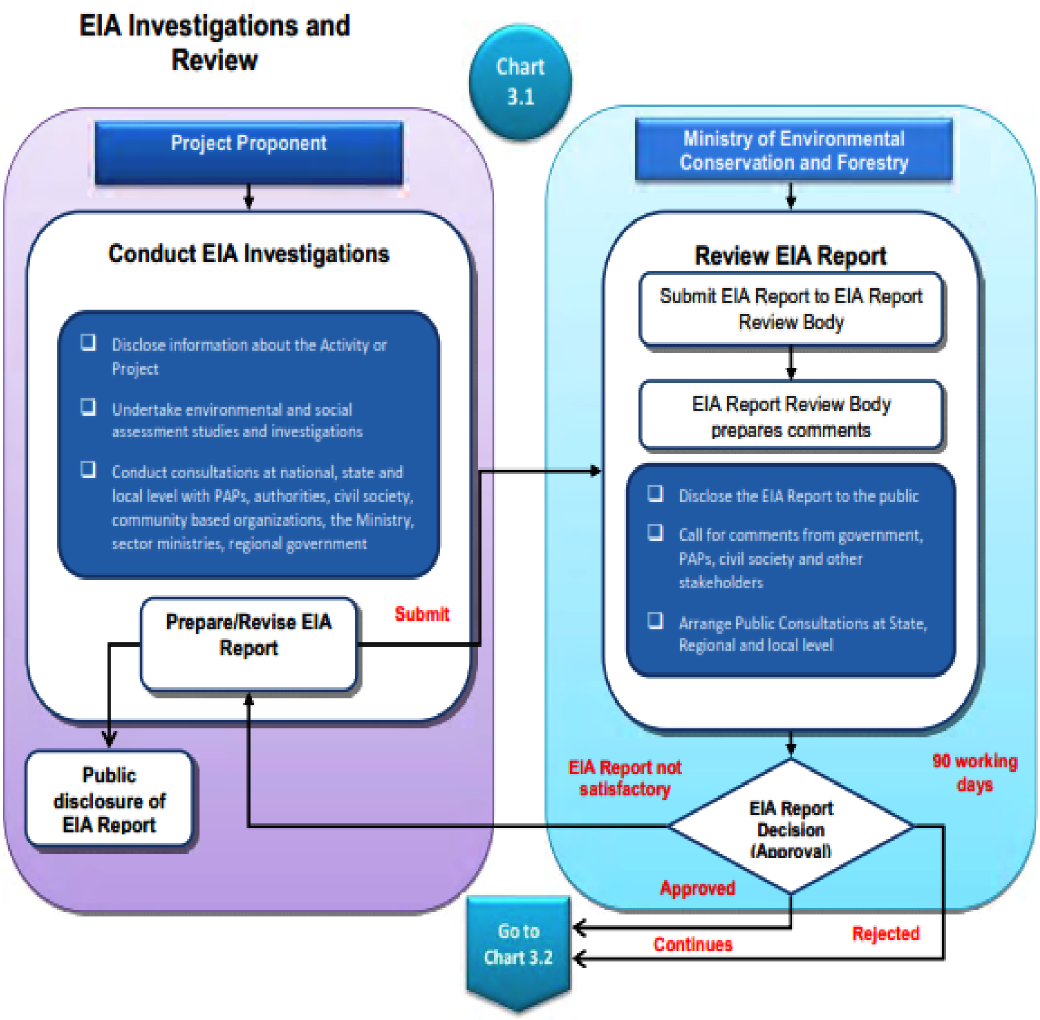
(v) Impacts on human environment (socio-economic, visual, health, utilities, cultural and heritage.).

3.0. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

This chapter sets out the relevant legal and policy context in Myanmar and documents the environmental and social standards with which the proposed project has to comply with, as well as the international standards that the project will follow.

3.1. National Requirements

The EIA has been undertaken in accordance with the Myanmar Environmental Impact Assessment Procedure which was promulgated on December 29th, 2015, and provides legislation for environmental and social governance of economic development in Myanmar, under the Environmental Conservation Law 2012 and Environmental Conservation Rules 2014 of the National Environmental Policy for Myanmar 1994. An overview of the process (from the Myanmar EIA Procedure, 2015) is shown in Figure 3.1.



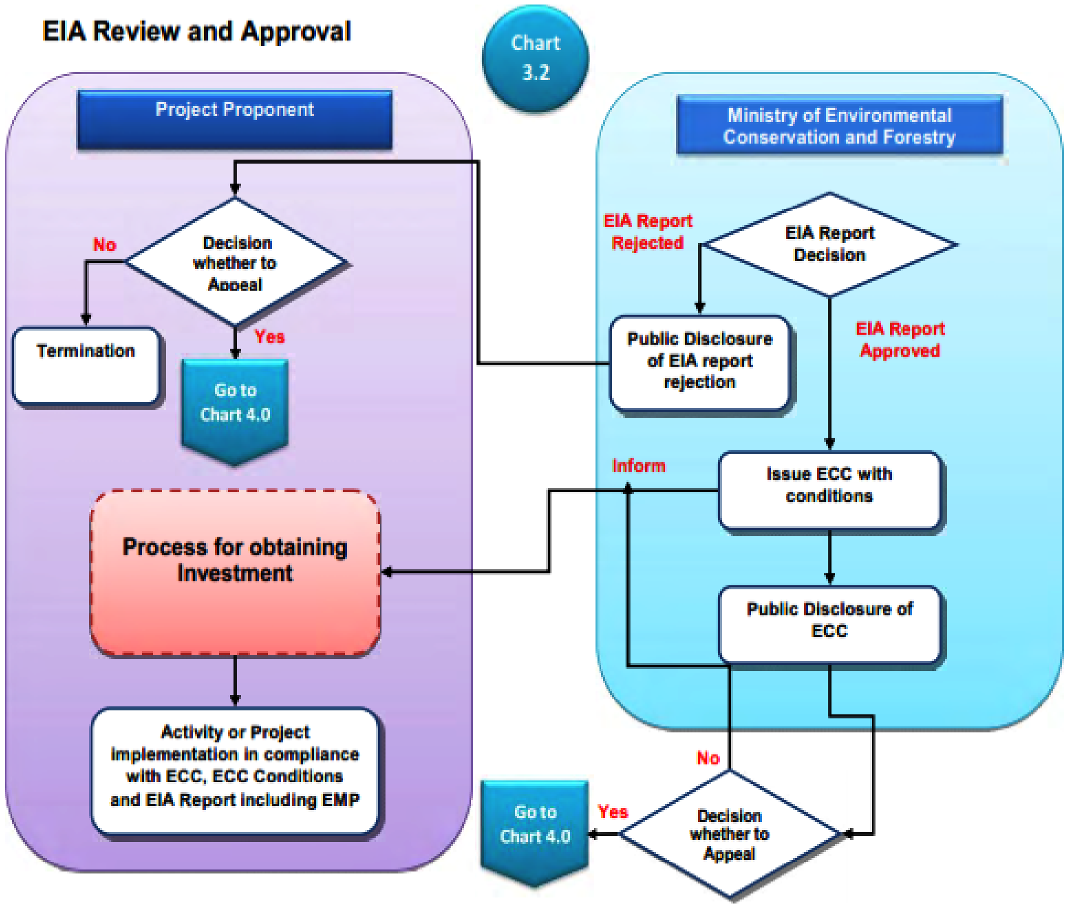


Figure 3.1 EIA Review and Approval Process

3.2. Laws and Regulations Related to the Railway Bridges and Culverts

Myanmar has promulgated several laws and regulations concerning protection of the environment. The following table describes laws and regulations which are directly or indirectly associated with the proposed project.

Table 3.1 - Laws and Regulations Related to Workmens' Right, Occupational Safety and Health

Laws and Regulations	Year	Purposes
The Labor Organization Rules, (No. 1,7 to 11)	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
Second Amendment to the Labor Dispute Settlement Law (Law No.17)	2019	▪ 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.

Labor Disputes settlement Act (Law No.5)	2014	▪ Concerning the safety, health and welfare of the employees ▪ Recreation of the employees, at or away from place of work ▪ Related personnel problems, including any individual grievance which the Works Committee may decide to consider ▪ Provision of the best means for utilizing the ideas and suggestions of the employees and encouragement of them to put forward ideas and suggestions ▪ Any matter affecting the industry concerned which it shall decide to take into its consideration
Employment and Skill Development Law, (Law No. 5, 14, 30(a,b))	2013	▪ To facilitate employment which is appropriate to the age and ability of the job seeker ▪ To help workers obtain employment and to provide stability of employment and skills development for employees ▪ To help employers obtain appropriate employees
The Leave and Holiday Act, 1951 (Law Amended July, 2014)	2014	▪ To allow worker for leave and holiday allowances, religious or social activities with earn allowance, and benefits for Health allowances. ▪ Concerned workers: Daily wage workers/ temporary workers/permanent workers.
Minimum Wages Law (Law No. 12, 13 (a to g)	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 Act (Law No. 3,4, 5, 14, 8 with 7,10)	2016	(a) Pay in local currency or foreign currency recognized by the Central Bank of Myanmar. This may be in cash, check or deposit into the bank account of Employee. (b) Moreover, pay can be in the means of··· (1) Totally in cash OR half the cash and half in things set according to the local price to those employees working in trade, manufacturing and service sectors. (2) Totally in cash OR half the cash and half in things set as local price according to local traditions or common agreement to those working in agriculture and livestock sectors. But, this must be for the sake of the employees and their families. And, it also must be reasonable/fair. (3) An employee will receive the payment for 60 days when he/she is in Alternative Civil Service.
The Social Security Law (Law No. 11(a), 15(a), 18(b), 48, 49, 75)	2012	▪ The employers and workers will 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.
Law Amending the Workmen's Compensation Act	2005	To protect personal injury caused to a workman by accident arising out of and in the course of his employment and to compensate in accordance with the provisions of Workman Compensation Act
Prevention and Control of	1995	To prevent the outbreak of Communicable Diseases, by implementing following project activities;

Communicable Diseases Law (Law No. 3, 4, 9, 11)		(a) immunization of children by injection or orally; (b) immunization of those who have attained majority, by injection or orally, when necessary; (c) carrying out health educative activities relating to Communicable Disease.
The Prevention of Hazard from Chemical and Related Substances Rules (Law No. 8,15,16,17, 20, 22, 23, 27)	2013	▪ Performing the sticking pictogram for being least the health impacts and accident injuries in the occupational area according to the prescribed standards and norms of the Globally Harmonized System GHS); ▪ Making the necessary arrangements to be safety of the occupational area and issuing orders and directives for preventing and decreasing the accident; ▪ Laying down the proliferation plans on knowledge, and safety of chemical and related substances to administrators, license holders, public and workers; ▪ Cooperating with local and foreign governmental departments, organizations and non-governmental organizations in respect of safety management for chemicals hazard.
Occupational safety and health Law (PyidangsuHluttaw Law No 8)	2019	▪ The purpose to effectively implement measures related to safety and health at every industry, prevent by the workplace accidents and occupational diseases and set occupational safety and health standards.
Workmen's Compensation Act	2005	▪ To protect personal injury caused to a workman by accident arising out of and in the course of his employment and to compensate in accordance with the provisions of Workman Compensation Act
Law Relating to Overseas Employment (Law No.3)	1999	▪ To enable the beneficial and systematic utilization of human resources of the State for building a modern and developed State; ▪ To enable those seeking overseas employment to get employment opportunities and to secure such employment systematically; ▪ To ensure that there is no loss of the rights and privileges of workers and that they receive the rights they are entitled to; ▪ To enable the systematic utilization within the country of the knowledge experience and skills gained abroad, according to the type of overseas employment undertaken,
Prevention from Danger of Chemical and associated Materials Law (Law No 28)	2013	▪ To prevent from damaging the environmental resources and from endangering the lively creatures due to the chemical and associated materials ▪ To control systematically for the safety in carrying out in accord with the approval for chemical and associated materials business ▪ To carry out the data information acquiring system and to widely do the educating and research works in order to utilize the chemical and associated materials systematically ▪ To carry out continuous development for worksite safety, health and environmental conservation.

Table 3.2 - Laws and Regulations Related to Natural Environment

Laws and Regulations	Year	Purposes
Pesticide Law Pyidaungsu Hluttaw Law No. 14/2016	2016	▪ To direct the Myanmar Agriculture Service to analyze and test pesticides or any active ingredient received as samples as to conformity with the content of ingredient as claimed on the label; and to undertake bio-efficacy trials on crops for determining effectiveness in practical use.
Forest Law	1992	▪ To implement forest policy and environmental conservation policy, to promote public cooperation in implementing these policies, to develop the economy of the State, to prevent destruction of forest and biodiversity, to carry out conservation of natural forests and establishment of forest plantations and to contribute towards the fuel requirement of the country.
Protection of Biodiversity and Protected Area Law	2018	▪ To protect wildlife, wild plants and conserve natural areas, to contribute towards works of natural scientific research, and to establish zoological gardens and botanical gardens.
Conservation of Water Resources and Rivers Law (Law No. 8, 11(a), 13, 19, 24(b), 30)	2006	▪ To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.
Conservation of Water Resources and Rivers Rules	2013	▪ To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.
The Freshwater Fisheries Law (Law No. 36,40,41)	1991	▪ To further develop the fisheries; ▪ To prevent the extinction of fish; ▪ To safeguard and prevent the destruction of freshwater fisheries waters; ▪ To obtain duties and fees payable to the State; ▪ To manage the fisheries and to take action in accordance with the Law.
Animal Health and Development Law (Law No.17)	2010	▪ To carry out animal health and development work and promote livestock development; ▪ To prevent outbreak of contagious disease in animals and to control the outbreak systematically when occurs; ▪ To inspect imported animal, animal product and animal feed; ▪ To issue recommendation certificate concerning animal, animal product and animal feed for export; ▪ To protect animals by law from being ill-treated.

Table 3.3 - Laws and Regulations Related to Transportation and Communication

Laws and Regulations	Year	Purposes
Railway Transportation Service Law (Section 28 to 39, 42 and 43)	2016	▪ To be safe environment for construction site ▪ To attain required land use pemissions validly
The bridges Law (Law No 16)	2019	▪ To systematically supervise, supervise and charge bridges on the construction of new bridges, construction of new bridges, upgrades, extensions, inspections of bridges ▪ To ensure the safety and security of the users of the bridge and to be able to continuously carry out matters related to the maintenance and strength of the bridge ▪ Safe and secure use of the bridge will speed up the flow of passengers and goods, improve transportation costs, improve the socio-economic life of citizens and raise living standards ▪ To accelerate the development of the country by constructing, upgrading, expanding, inspecting, repairing and maintaining the bridge for its longevity
The Law Amending the Embankment Act (Law No.2)	1998	▪ Prohibitions on damaging or trespassing on embankments; or constructing and maintaining embankments without prior permission
Law Amending the Law on the Utilization of Roads and Bridges (Law No.25)	2014	▪ to promote traffic convenience and contribute to the development of the national economy by prescribing matters concerning the construction, upgrading, maintenance, management, etc. of roads and bridges.

Table 3.4 - Laws and Regulations Related to Communities' Development, Health and Safety

Laws and Regulations	Year	Purposes
Law Regarding Population Control & Health (Law No. 28)	2015	▪ To improve living standards while alleviating poverty in the country; ▪ To ensure sufficient quality healthcare; and ▪ To develop maternal and child health
Vacant, Fallow, Virgin Land Management Law (Law No. 4(d), 5(d),7)	2012	The Central Committee may allow the businesses applied for the right to cultivate or utilize vacant, fallow and virgin lands for making foreign investment with the approval of the Myanmar Investment Commission. The Central Committee may, when the investors granted under the foreign investment law or organization consisting of the investors granted under the foreign investment law, apply for obtaining the right to cultivate or utilize the vacant, fallow and virgin lands, permit after scrutiny only the businesses which are unable to be carried out by the citizens.

Land Acquisition, Resettlement and rehabilitation Law (Section 39,41,42,46,54(b and c),58)	2019	▪ In this law, it is stipulated that the government holds rights to take over land provided that compensation is made to the original land owner. No private ownership of land is permitted ▪ To prevent potential impacts on environmental and social sectors due to land use for projects
The Law Relating to Private Health Care Services **(Law No.5)**	2007	▪ Develop private health care services in accordance with the national health policy; ▪ To participate and carry out systematically by private health care services in the national health care system as an integral part; ▪ To enable utilizing effectively the resources of private sector in providing health care to the public; ▪ To enable the public to choose as desired in fulfilling their needs for health by establishing private health care services; To enable provision of quality service at fair cost and to take responsibility.
Public Health Law (Law No. 3, 5)	1972	To promote and safeguard public health and to take necessary measures in respect of environmental health.

Table 3.5 Laws and Regulations Related to Cultural and Heritage

Laws and Regulations	Year	Purposes
The Protection of rights of National Race Law, (Law No. 5)	2015	▪ Consists of four bills, as submitted to the legislature; Buddhist Women's Special Marriage Bill, Religious Conversion Bill, Monogamy Bill and Population Control Bill.
Protection and Preservation of Cultural Heritage Regions Laws (Law No. 15, 16)	2019	▪ To implement the protection and preservation policy with respect to perpetuation of cultural heritage that has existed for many years; to protect and preserve the cultural heritage regions and the cultural heritage.
The Protection and Preservation of Antique Objects Law (Law No. 12,15 20)	2015	▪ To implement the policy of protection and preservation for the perpetuation of antique objects; ▪ To protect and preserve antique objects so as not to deteriorate due to natural disaster or man-made destruction; ▪ To uplift hereditary pride and to cause dynamism of patriotic spirit by protection and preservation of antique objectives; ▪ To have public awareness of the high value of antique objectives;

		▪ To carry out in respect of protection and preservation of antique monuments in conformity with the International Convention and Regional Agreement ratified by the State.
The Protection and Preservation of Ancient Monuments Law (Law No. 12,15 20)	2015	▪ To implement the policy of protection and preservation for the perpetuation of ancient monuments; ▪ To protect and preserve ancient monuments so as not to deteriorate due to natural disaster or man-made destruction; ▪ To uplift hereditary pride and to cause dynamism of patriotic spirit by protecting and preserving ancient monuments; ▪ To have public awareness of the high value of ancient monuments; ▪ To protect and preserve ancient monuments from destruction; ▪ To search and maintain ancient monuments; ▪ To carry out in respect of protection and preservation of ancient monuments in conformity with the International Convention and Regional Agreement ratified by the State.
Law on the preservation and protection of ancient buildings	2015	▪ To implement the policy of protection and preservation for the perpetuation of ancient monuments ▪ To protect and preserve ancient monuments so as not to deteriorate due to natural disaster or man-made destruction ▪ To uplift hereditary pride and to cause dynamism of patriotic spirit by protecting and preserving ancient monuments ▪ To have public awareness of the high value of ancient monuments ▪ To protect and preserve ancient monuments from destruction ▪ To search and maintain ancient monuments ▪ To carry out in respect of protection and preservation of ancient monuments in conformity with the International Convention and Regional Agreement ratified by the State.
Law Protecting Ancient Objects (Law No.43)	2015	▪ To implement the policy of protection and preservation for the perpetuation of antique objects ▪ To protect and preserve antique objects so as not to deteriorate due to natural disaster or man-made destruction ▪ To uplift hereditary pride and to cause dynamism of patriotic spirit by protection and preservation of antique objects ▪ To have public awareness of the high value of antique objects To carrout in respect of protection and preservation of antique objects in conformity with the International Convention and Regional Agreement ratified by the State.

Law Concerning Religious Conversion (Law No.48)	2015	▪ To move freely from own religion to another religion, from one religion to atheism, from atheism to one religion

Table 3.6. Laws and Regulations Related to Land Acquisition

Laws and Regulations	Year	Purposes
Vacant, Fallow, Virgin Land Management Law (Law No. 4(d), 5(d),7)	2012	▪ The Central Committee may allow the businesses applied for the right to cultivate or utilize vacant, fallow and virgin lands for making foreign investment with the approval of the Myanmar Investment Commission. ▪ The Central Committee may, when the investors granted under the foreign investment law or organization consisting of the investors granted under the foreign investment law, apply for obtaining the right to cultivate or utilize the vacant, fallow and virgin lands, permit after scrutiny only the businesses which are unable to be carried out by the citizens.
Land Acquisition, Resettlement and rehabilitation Law (Section 39,41,42,46,54(b and c),58)	2019	▪ In this law, it is stipulated that the government holds rights to take over land provided that compensation is made to the original land owner. No private ownership of land is permitted ▪ To prevent potential impacts on environmental and social sectors due to land use for projects
Farm Land Law	2012	▪ Establish a system of land registration for farmers including provision of land use certificates (LUCs) that create rights to sell, exchange, access credit, inherit and lease the land. Government retains the power to revoke the LUCs if any of the conditions of use are not complied with in full.
Farmland Act (Law No.11)	2012	▪ To minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses ▪ To assure that to the extent possible federal programs are administered to be compatible with state, local units of government, and private programs and policies to protect farmland
National Land Use Policy	2016	▪ NLUP sets out principles and objectives for land governance reform (including involuntary resettlement) to guide the preparation of a future Land Law. While generally aspirational in nature, it does call for formation of a National Land Use Council as well as State and District Land Use Committees to commence implementing the objectives of the policy. In relation to involuntary resettlement, the NLUP specifically calls for comprehensive mitigation measures covering resettlement and livelihood restoration; special attention to the needs of landless, women and ethnic minorities; comprehensive consultation and participatory planning; and effective grievance redress procedures. It is unclear what the current status of the NLUP is with respect to other existing instruments and to what extent the provisions of the NLUP will be applied.

Table 3.7 - Other Relative Laws and Regulations for Proposed Project

Laws and Regulations	Year	Purposes
Natural Disaster Mangement Law (No 21)	2013	▪ To implement natural disaster management programmes systematically and expeditiously in order to reduce disaster risks; ▪ To form the National Committee and Local Bodies in order to implement natural disaster management programmes systematically and expeditiously ▪ To coordinate with national and international government departments and organizations, social organizations, other nongovernment organizations or international organizations and regional organizations in carrying out natural disaster management activities ▪ To conserve and restore the environment affected by natural disasters ▪ To provide health, education, social and livelihood programmes in order to bring about better living conditions for victims.
Constitution of the Republic of the Union of Myanmar (Articles 24,45,349,359)	2008	- To conserve the natural environment, - To prevent and upgrade the rights and lives of the workers
Environmental Conservation Law (Law No.7(o), 14,15,24,25,29)	2012	- To enable to implement the Myanmar National Environmental Policy; - 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;
Environmental Conservation Rules (Rule 55, 69 (a), (b))	2014	- To implement correctly according to the environmental management plan
EIA Procedures (Article 102 to 110, 113, 115, 117)	2015	- To develop the environmental impacts and to draw the environmental management plan;
National Environmental Quality (Emission) Guidelines (Section 2.1.9)	2015	These national Environmental Quality (Emission) Guidelines (hereafter referred to as Guidelines) provide the basis for regulation and control of noise and vibration, air emissions, and liquid discharges from various sources in order to prevent pollution for purposes of protection of human and ecosystem health.
Myanmar Fire Force Law, (Law No. 25)	2015	▪ 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 ▪ To organize fire brigade systemically and to train the fire brigade ▪ To prevent from fire and to conduct release work when fire disaster, natural disaster, epidemic disease or any kind of certain danger occurs

		▪ To educate, organize an inside extensively so as to achieve public corporation ▪ To participate if in need for national security, peace for the citizens and law and order
The Myanmar Engineering Council Law (Law No. 20,24,25, 31(a), 37)	2013	▪ To uphold and upgrade the dignity, ethics and quality of the Myanmar citizen engineers, graduate technicians and technicians who are practicing engineering works; ▪ To explore using engineering technology and information technology combined the good methods, research and development activities by which the natural resources and human resources of the State may be beneficially applied with least impact environment;

3.3. International Agreements and Conventions

In addition to the domestic laws listed above, Myanmar is also a signatory to the following international conventions, and these may have relevance to the proposed survey activities. Refer to the following Table.

Table 3.8. International Agreements and Conventions Relevant to the Proposed Project

International Agreements and Conventions	Status	Purposes
Vienna Convention for the Protection of the Ozone Layer, 1985	1998	Aims at the protection of the ozone layer, including requirements for limiting the production and use of ozone depleting substances.
Montreal Protocol on Substances that Deplete the Ozone Layer, 1989	1993	Aims at the protection of the ozone layer, including requirements for limiting the production and use of ozone depleting substances.
Basel Convention, 1989	2015	The Convention regulates the transboundary movements of hazardous wastes and provides obligations to its parties to ensure that such wastes are managed and disposed of in an environmentally sound manner.
United Nations Framework Convention on Climate Change (UNFCCC), New York, 1992 and Kyoto Protocol 1997	1995 and 2005	Provide a framework for intergovernmental efforts to tackle climate change. Recognises that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases.
Convention on Biological Diversity, Rio de Janeiro, 1992	1994	Aims to promote national policies for the conservation of wild flora, fauna and habitat that needs to be included in planning policies. The three main goals are: (1) the conservation of the biological diversity; (2) the sustainable use of its components; (3) fair and equitable sharing of the benefits.

Asia Least Cost Greenhouse Gas Abatement Strategy (1998 ALGAS)	1998	Develop national and regional capacity for preparation of GHG inventories. Assist in identifying GHG abatement options and preparation of a portfolio of abatement projects for each country.
United Nations Agenda 21	1997	Building on the National Environment Policy of Myanmar, takes into account principles contained in the Global Agenda 21. Myanmar Agenda 21 also aims at strengthening and promoting systematic environmental management in the country.
Relevant ILO Conventions in force in Myanmar • C1 Hours of Work • C14 Weekly Rest • C17 Workmen's Compensation (Accidents) • C19 Equality of Treatment (Accident Compensation) • C26 Minimum Wage Fixing Machinery • C29 Forced Labour Convention • C42 Workmen's Compensation (Occupational Diseases) Revised 1934 • C52 Holidays with Pay		Sets out legal instruments drawn up by the ILO's constituents (governments, employers and workers) and setting out basic principles and rights for workers.

3.4. National and International Guidelines for Proposed Project

EIA assessment was undertaken in accordance with Myanmar's National Environmental Quality (Emission) (NEQ) Guidelines which were promulgated on December 29th, 2015 and provide the basis for regulation and control of various environmental parameters, including noise, air emissions, and effluent discharges. Moreover, beside the national guidelines and international guidelines and standards are referred to the impact assessment as follow:

(a) World Health Organization Guidelines (WHO);
(b) National Ambient Air Quality Standard (NAAQS), USEPA;
(c) IFC Guidelines for Waste Management Facilities, 2007;
(d) IFC Guidelines for Water and Sanitation, 2007; and
(e) IFC Guidelines for Occupational, Health and Safety, 2007;

3.5. National Environmental Quality (Emissions) Guideline for Proposed Project

(a) Air Quality

General guideline values for air emissions are described in current NEQG and the project shall apply theses guideline values for air quality parameters such as SO2, NO2, particulate matters (PM10 and PM2.5).

Table 3.9. Air Quality for Railways

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

[a]Particulate matter 10 micrometers or less in diameter

[b] Particulate matter 2.5 micrometers or less in diameter

(b) Water Quality

This guideline applies to construction, operation and maintenance of large, sealed road projects including associated bridges and overpasses. While roads do not typically give rise to significant point source effluents or air emissions, discrete point source sanitary wastewater and storm water should achieve the following source effluent levels and general air emissions guidelines shall apply. Issues relating to sourcing of construction materials are included in the guideline for Construction Material Extraction, while those related to vehicle service areas are included in the guideline for Retail Petroleum.

Table 3.10. Effluent Levels for Railways

Parameter	Unit	Guideline Value
Aluminium	mg/l	3
Ammonia	mg/l	10
		20(electroplating)

Arsenic	mg/l	0.1
Cadmium	mg/l	0.1
Chemical oxygen demand	mg/l	250
Chromim (hexavalent)	mg/l	0.1
Chromim (total)	mg/l	0.5
Copper	mg/l	0.5
Cyanides (free)	mg/l	0.2
Cyanides (total)	mg/l	1
Flourides	mg/l	20
Iron	mg/l	3
Lead	mg/l	0.2
Mercury	mg/l	0.01
Nickel	mg/l	0.5
Oil and grease	mg/l	10
pH	SU[a]	6-9
Phenols	mg/l	0.5
Silver	mg/l	0.2
Sulfide	mg/l	1
Temperature increase	°C	<3[b]
Tin	mg/l	2
Total nitrogen	mg/l	15
Total phosphorus	mg/l	5
Total suspended solids	mg/l	50
		25(electroplating)
Volatile organic halogens	mg/l	0.1
Zinc	mg/l	2

(c) Noise Level

(i) Noise level set in NEQG

According to the NEQG that has been prescribed by Ministry of Environmental Conservation and Forestry on 29th December, 2015, under Chapter 1 (General Provision), Section 1, sub-section 1.3 mentioned the following requirement for noise levels;

Noise prevention and mitigation measures should be taken by all projects where predicted or measured noise impacts from a project facility or operation exceed the applicable noise level guideline at the most sensitive point of reception. Noise impacts should not exceed the levels shown below, or result in a maximum increase in background levels of three decibels at the nearest receptor location off-site.

In NEQG, the noise level is set as shown in Table below and noise prevention and mitigation measures should be taken by all projects where the predicted or measured noise impacts from a project facility or operation exceed the applicable noise level guideline at the most sensitive point of reception. Noise impact should not exceed the levels shown below, or result in a maximum increase in background levels of three decibels at the nearest offsite receptor location.

Table - Noise Level set in NEQG

Receptor	One Hour LAeq	
	Daytime (7:00-22:00)	Night Time (22:00-7:00)
Residential, institutional, Educational	55	45
Industrial, commercial	70	70

Source: NEQG (December 2015)

It is noted that NEQG does not mention a guideline value to be specified for railway noise.

3.6. Penalties and other Administrative Punishment

The developer must know the penalties and other administrative punishment granted as EIA Procedures in Myanmar as follow:

No	Non-Compliance	Penalties	Specific Administrative Punishment of the Ministry
1.	Failure or delay in timely submission of reports within Period prescribed by Ministry	100 to 500 US$ or equivalent Myanmar Kyat + 10-25 US$/ day unit cured or equivalent Myanmar Kyat	-Issue Enforcement Notice
2.	Obstruction or interference with an official in the course of their duties	250 to 5,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice -Criminal prosecution
3.	Failure to provide information to the Ministry or any representative	1,000 to 5,000 US$ or equivalent Myanmar Kyat	-Suspension of Approval of EMP, EMP-CP, EMP-OP in whole or in part
4.	Failure to provide information to the Ministry Inspector or any representative when requested in regard to inspection and monitoring	250 to 5,000 US$ or equivalent Myanmar Kyat	- Issue Enforcement Notice

5.	Undertaking or allowing any preparatory or other construction works without the prior approval by the Ministry of a reserved EMP or EMP-CP	1,000 to 5,000 US$ or equivalent Myanmar Kyat +50 to 500 US$/ day until cured or equivalent Myanmar Kyat	-Criminal prosecution
6.	Operating/implementing without a permit, or approval by the Ministry of an EMP or EMP-Op	1,000 to 5,000 US$ or equivalent Myanmar Kyat +50 to 500 US$/ day unit cured or equivalent Myanmar Kyat	- Criminal prosecution
7.	Non-compliance with an Enforcement Notice or Suspension Notice issued by the Ministry	2,000 to 10,000 US$ or equivalent Myanmar Kyat +100-500 US$/day unit cured or equivalent Myanmar Kyat	-Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part
8.	Failure to notify to the Ministry of any knowledge of any event of an imminent of Environmental damage	1,000 to 5,000 US$ or equivalent Myanmar Kyat	- Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part
9.	Failure to take reasonable steps to prevent an imminent thread of damage to the Environment, social, human health, livelihoods, or property, where application based on the EMP, EMP-CP or EMP-OP	2,500 to 10,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part
10.	Non-compliance with conditions in ‘the ECC and allowable Emission Limit Values	1,000 to 10,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part
11.	Failure to take pay compensation amounts required in respected in respect of social impacts	1,000 to 10,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in

			part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part
12.	Failure to fully restore social conditions upon resettlement	1,000 to 10,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part

Notes:

1. All penalty amounts set forth in this Annex are denominated in United States Dollars (US$) and are subject to annual inflation adjustment.
2. Abbreviations are as follows;

EMP = Environmental Management Plan

EMP-CP = Environmental Management Plan – Construction Phase

EMP-OP = Environmental Management Plan –Operational Phase

3.7. Project's Environmental, Social and Health Policies

The main policy and commitment of Project Developer can be identified in the following points:

1. the protection of public safety, the health and safety of the workforce and the local communities
2. the protection and promotion of human rights, the economic and social development of local communities;
3. the protection of the environment and the conservation of biodiversity and ecosystems;
4. the continuous improvement of the quality of the processes, services and products of our activities and operations;
5. the compliance with Myanmar laws, regulations and industrial standards regarding the environment, health, safety and hygiene at work in all of our operations
6. setting objectives and targets for measuring and improving HSE performance in line with Company activities and strategic objectives

7. manage HSE in order to achieve our objective of incident free operations
8. implementing sustainable development principles in our activities
9. seek and achieve continuous improvement in our processes, consistent with our strategic objectives and priorities, by adopting the most advanced systems for environmental protection and energy efficiency
10. creating a culture in which employees, Contractors and Visitors share these commitments and understand that working safely is a condition of employment.

3.7.1 Sustainability Policy

Project Developer's sustainability model is "To operate in a sustainable manner means to create value for stakeholders, and to use resources so that the needs of future generations will not be compromised, respecting people, the environment and the society as a whole."The developer adheres to a sustainability policy, which is composed of the following principles:

1. *Stakeholder relations* – "Engaging stakeholders and involving them in company's business are both prerequisites for sustainability and for the construction of reciprocal value."
2. *Human Rights* – "The respect of Human Rights represents the basis for an inclusive growth of societies, of the territories and, consequently, of the companies that work there."
3. *Relations with communities and contribution to local development* – "Dialogue, the respect of local communities, the evaluation of impacts are all preconditions for an effective cooperation, targeted at creating territorial value."

Climate strategy – "To satisfy the world's energy demand, by containing, at the same time, emissions of gases that have an impact on climatic change, is one of the greatest challenges of modern society."

3.8. Statement of Commitments

The followings are the commitments of the project developer and environmental assessment practitioner.

3.8.1 Commitments of Project Developer

The project developer will have to comply with the followings:

a) Comply with the commitments of the environmental and socio-economic development revealed in the Environmental Impact Assessment report.
b) Acknowledge and comply the laws, regulations and guidelines associated with the project, included in the report.
c) Comply and proceed the alternative methods, mitigation measures and monitoring plans included in the report for the reduction of the negative environmental impacts; and take responsibility for the environmental impacts due to non-compliance of the commitment.
d) Give priorities for the occupational health and safety of the workers.
e) Utilize the exact amount of fund as stated in proposed expenditure for cooperate social responsibility funds.
f) Take responsibility for all of the works and absence of the contractors, sub-contractors, officers and representatives of the company in operating the processes.
g) Take responsibility to support after discussion for the impacted people to ensure for their stable livelihood not lower than before the project; and resettlement and rehabilitate the impacted local people, government organizations and other related people and organizations.
h) Take responsibility to compensate, support, resettle and rehabilitate the effected people to ensure for their stable livelihood not lower than before the project after discussion with the relevant local authorities, related organizations and local people.

(Signature)

Name -

Occupation –

3.8.2. Commitments of the Environmental Assessment Practitioner

The EIA report was written by Ever Green Tech Environmental Services and Training Co., and EIAs in this report were designed by the following criteria;

(a) The designed EIA complied with the National Constitution, Environmental Conservation Law, EIA Procedures, and National Environmental Quality Guideline.

(b) This EIA also complied with the existing or future Labor laws, Occupational Health and Safety Laws, Rules and Procedures.

(c) These environmental impact protection procedures are designed of incident avoiding, mitigation and replacing for the project proponent who commits to follow the environmental impact protection procedure.

(d) This environmental management report is systematically designed not only for environmental impact protection procedures and occupational safety and health but also emergency management planning and social welfare programs.

(e) All facts including in this report are systematically surveyed without bias. As a third party, we commit and take full responsibility for all facts in this report.

(Signature)

Name -

Occupation -

4.0. PROJECT DESCRIPTION AND ALTERNATIVE SELECTION

4.1. Project Background

As part of the governments national transport strategy Ministry of Transport and Communication (MOTC) intends to improve transport capacities of the Country by constructing the Railway between Muse to Mandalay. On October 22, 2018, Myanma Railways (MR) and China Railway Eryuan Engineering Group Co., Ltd (CREEC) signed and entered into the Memorandum of Understanding on Feasibility Study (FS) for Muse-Mandalay Railway Project. According to this MOC, CREEC will conduct FS for Muse-Mandalay Railway alignment. As part of the MOU in order to meet regulatory requirements the of the ECD, CREEC will conduct the Environmental Impact Assessment (EIA) for the Project. There will necessary to construct bridges and culverts along the railway line, as the proposed railway will cross with rivers, streams and public road.

Muse-Mandalay Railway will have to pass a lot of valleys, rivers, streams and road crossings, so the proposed Muse-Mandalay Railway will include 124 major bridges and at least 700 culverts along the railway line for every intersection with natural terrains. As there will also include bridges and culverts along the proposed railway line and so it is necessary to conduct separate EIA for railway bridges and culverts according to the Environmental Impact Assessment Procedure, 2015 in Myanmar.

4.2. Major Bridge along the Railway Line

Muse-Mandalay Railway is located in Shan State and Mandalay Region. The line starts from Muse Port in the north and ends at Mandalay, the second largest city, in the south, connecting important towns like Muse, Lashio, Kyankme, Pyinoolwin and the central area. The total length of the main line is 409.960km. The line sets 124 new bridges with a total length of 69.309km, accounting for 16.9% of the main line; 729 culverts with a total length of 31,190 horizontal linear meters, 42 horizontal linear meters/bridge on average; 50 frame bridges with a total top area of 33,000m^2; 3 rigid frame bridges with a total area of 5,644.2m^2; 25 road-over bridges with a total length of 2,725m and a total area of 28,945.2m^2; 9 pedestrian overpasses with a top area of 3,038.4m^2; 13 underpass bridges with a top area of 6,812.2m^2; 1 aqueduct with a total length of 82.7m; 4 new platform bridges with a total area of 766.9m^2; 73 new road culverts with a total length of 1,040.46 horizontal linear meters, 2 road culvert extensions with a total length of 68.6 horizontal linear meters; 1 new evacuation exit bridge with a length of 35.3m and an area of 52.95m^2. The distribution of bridges and culverts along the line is shown in the following figures and tables.

Table 4.1 Table of New and Reconstructed Bridge

Item		General super major, major and medium bridge		Special bridge		Total	
Name	Type	Qty (Nr.)	Total length (m)	Qty (Nr.)	Total length (m)	Qty (Nr.)	Total length (m)
Unit 2 (Border-Lashio west)	Special double-track super major bridge			1	1366.47	1	1366.47
	Three-track major bridge	2	468.8			2	468.8
	Double-track super major bridge	2	1101.06			2	1101.06
	Double-track major bridge	1	142.8			1	142.8
	Double-track medium bridge	2	164.81			2	164.81
	Single-track super major bridge	15	15691.52			15	15691.52
	Single-track major bridge	29	9070.97			29	9070.97
	Single-track medium bridge	3	267.03			3	267.03
	Subtotal	54	26906.99	1	1366.47	55	28273.46
Unit 3-1 (Lashio west-Mandalay south)	Special double-track super major bridge			1	1843.93	1	1843.93
	Three-track major bridge	2	399.61	1	274.35	3	673.96
	Double-track medium bridge	1	110.85			1	110.85
	Single-track super major bridge	26	28531.57	1	647.31	27	29178.88
	Single-track major bridge	27	8173.66	1	306.8	28	8480.46
	Single-track medium bridge	9	747.10			9	747.10
	Subtotal	65	37962.79	4	3072.39	69	41035.18
Total for whole line	Three-track major bridge	4	868.41	1	274.35	5	1142.76
	Double-track super major bridge	2	1101.06	2	3210.38	4	4311.44
	Double-track major bridge	1	142.8			1	142.8

Item		General super major, major and medium bridge		Special bridge		Total	
	Double-track medium bridge	3	275.66			1	275.66
	Single-track super major bridge	41	44223.09	1	647.31	42	44870.4
	Single-track major bridge	56	17244.63	1	306.8	59	17551.43
	Single-track medium bridge	12	1014.13			12	1014.13
	Subtotal	119	64869.78	5	4438.84	124	69308.62

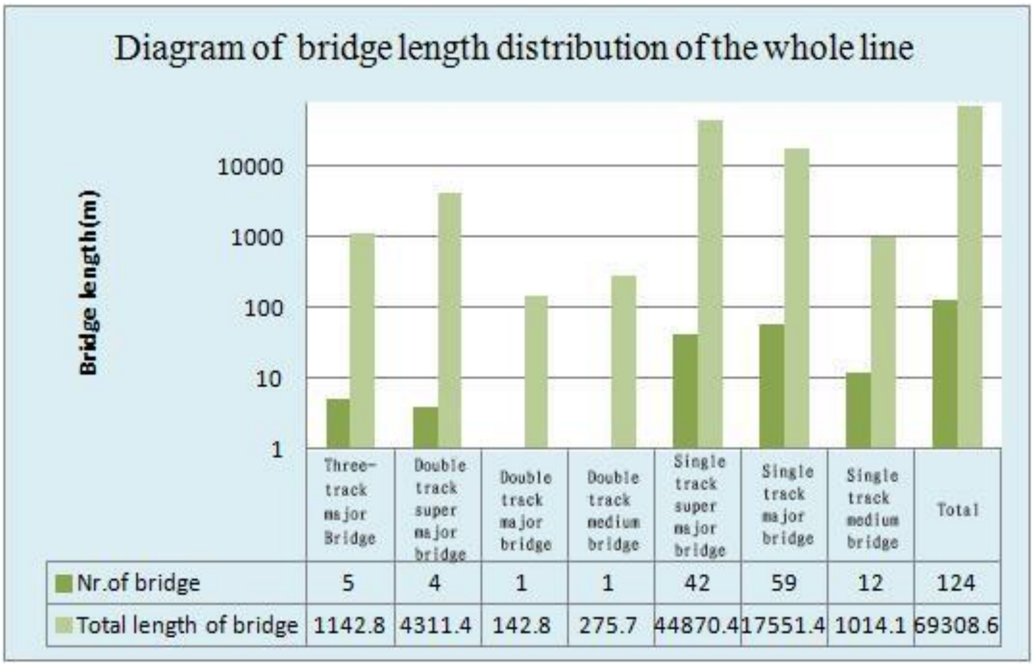


Figure 4.1 - Diagram of Bridge Length Distribution for the Whole Line

Table 4.2 - New Culverts

Description	Classification	New construction		Remarks
		Quantities	Total length (m)	
Unit 2 (Border-Lashio west)	Culvert	276	10310	
	Sub-total	276	10310	
Unit 3-1 (Lashio west-Mandalay south)	Culvert	442	20579	
	Sub-total	442	20579	

Unit 3-2 (Mandalay meter-gauge connecting line)	Culvert	11	301	
	Sub-total	11	301	
Total		729	31190	

Table 4.3 Overpass Structures to be Constructed or Reconstructed

Description	Road-over bridge			Pedestrian overpass		
	Quantities	Length	Area	Quantities	Length	Area
	(set)	(m)	(m2)	(set)	(m)	(m2)
Unit 2 (Border-Lashio west)	8	980	8802.5	4	328.8	1315.2
Unit 3-1 (Lashio west-Mandalay south)	17	1745	19420	5	430.8	1723.2
Total	25	2725	28945.2	9	759.6	3038.4

Table 4.4 New Frame Bridges

Description	Frame bridges		
	Quantities	Length perpendicular to the railway	Area
	(set)	(m)	(m^2)
Unit 2 (Border-Lashio west)	20	618.50	13228
Unit 3-1 (Lashio west-Mandalaysouth)	26	1263.3	18802
Unit 3-2 (Mandalay meter-gauge connecting line)	4	51.80	970
Total	50	1933.6	33000

Table 4.5 New Rigid Frame Bridges

Description	Rigid frame bridges		
	Quantities	Length perpendicular to the railway	Area
	(set)	(m)	(m^2)
Unit 3-1 (Lashio west-Mandalay south)	3	89.2	5644.2
Total	3	89.2	5644.2

Table 4.6 Underpass Bridges

Description	Underpass bridges		
	Quantities (set)	Length perpendicular to the railway (m)	Area (m^2)
Unit 2 (Border-Lashio west)	6	238.0	2561.2
Unit 3-1 (Lashio west-Mandalay south)	7	362	4251.0
Total	13	600	6812.2

Table 4.7 New Aqueducts

Description	Aqueducts		
	Quantities (set)	Length (m)	Remarks
Unit 2 (Border-Lashio west)	1	82.7	
Total	1	82.7	

Table 4.8 New Highway Culverts

Description	Highwayculverts		
	Quantities (set)	Total length (m)	Remarks
Unit 2 (Border-Lashio west)	24	352.35	
Unit 3-1 (Lashio west-Mandalay south)	36	504.61	
Unit 3-2 (Mandalay meter-gauge connecting line)	13	183.5	
Total	73	1040.46	

Table 4.9 Evacuation Exit Bridges

Description	Evacuation exit bridges		
	Quantities (set)	Length (m)	Area (m^2)
Unit 3-1 (Lashio west-Mandalay south)	1	35.3	52.95
Total	1	35.3	52.95

Table 4.10 New Platform Bridges

Description	Platform bridges		
	Quantities (set)	Length (m)	Area (m^2)
Unit 2 (Border-Lashio west)	2	87.625	241.85
Unit 3-1 (Lashio west-Mandalay south)	2	190.25	525.09
Total	4	277.88	766.94

Table 4.11. Key Major Bridge Crossing

SN	Number of tracks	Central mileage	Co-ordinate		Bridge name	Span pattern (m)	Total length (m)	Category
			longitude	latitude				
1	Double-track	CK4+520	97.977823	24.029836	Shwe Li Double-track Super Major Bridge	2×(9×32+(60+2×104+60)m continuous beam +5×32+1×24+16×32)m	1366.47	Special Super Major Bridge
76	Single-track	CK178+158	97.521676	22.708027	Nam Ma River Major Bridge	2×32+(44+72+44)m continuous beam+2×32	306.80	Special Major Bridge
88	Single-track	CK213+725	97.227620	22.564938	Nam Tu miy Nge-R River Super Major Bridge	3×32+(48+80+48)m continuous steel structure +11×32	647.31	Special Super Major Bridge
103	Double-track	CK274+871	96.867700	22.339101	Gohteik Nam banton River Double-track Super Major Bridge	2(6×32+(1×48+2×36)msteel-concrete composite beam+(148+2×260+148msteel-concrete double-layer rigid frame+2×50msteel-concrete composite beam+18×32)	1843.91	Special Super Major Bridge

Fig 4.2- Shwe Li Double-track Super Major Bridge (N 97.977823 E 24.029836)

Fig 4.3- Nam Ma River Major Bridge (N 97.521676, E 22.708027)

Fig 4.4- Nam Tu Myit Nge River Super Major Bridge (N 97.227620, E 22.564938)

Fig 4.5-Gohteik Double-track Super Major Bridge (N 96.867700, E 22.339101)

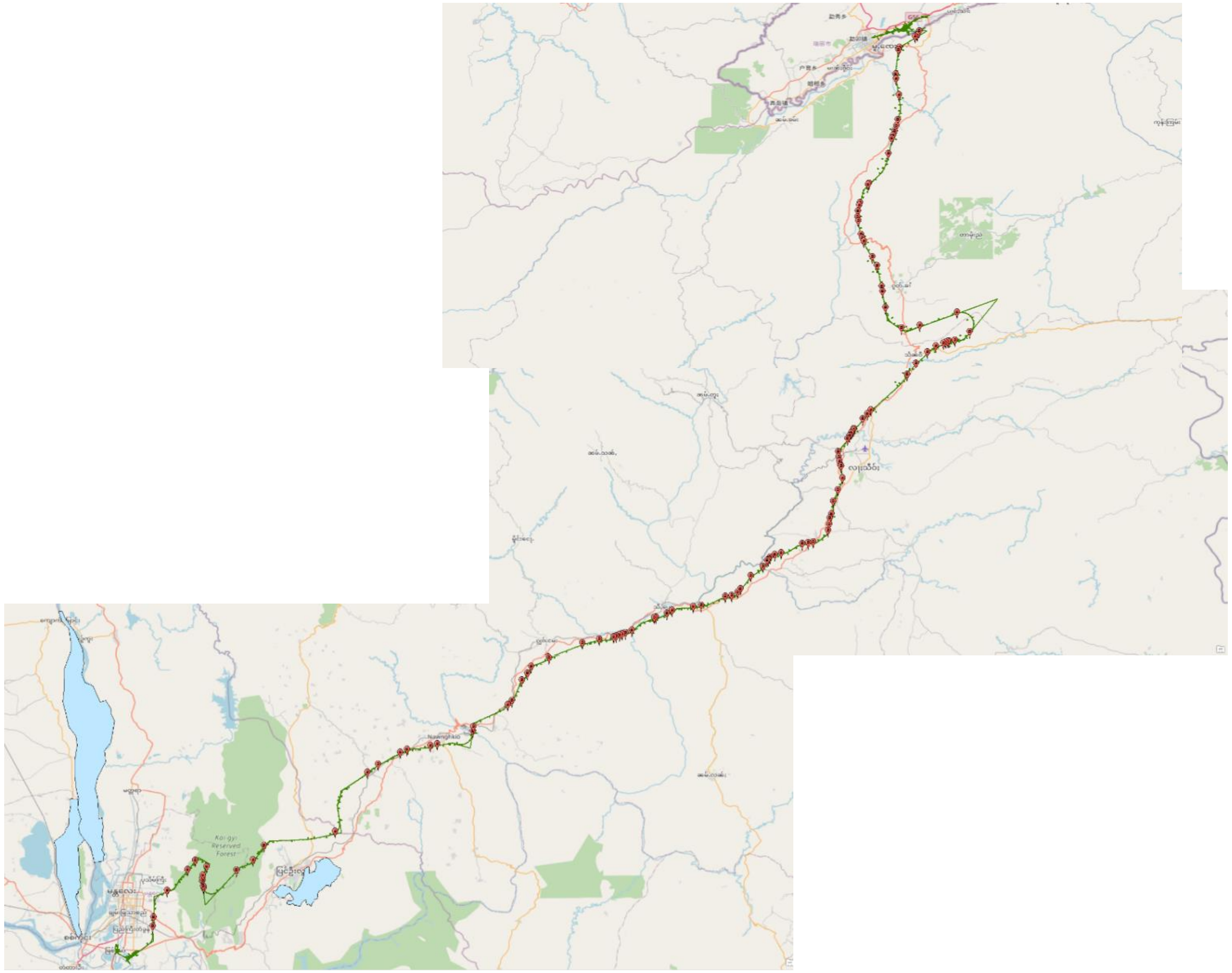


Fig. 4.6- Location of Bridges along the Muse-Mandalay Railway Line (Source: EIA Team, 2020)

Fig. 4.7- Location of Super Major Bridges along the Muse-Mandalay Railway Line (Source: CREEC, 2019)

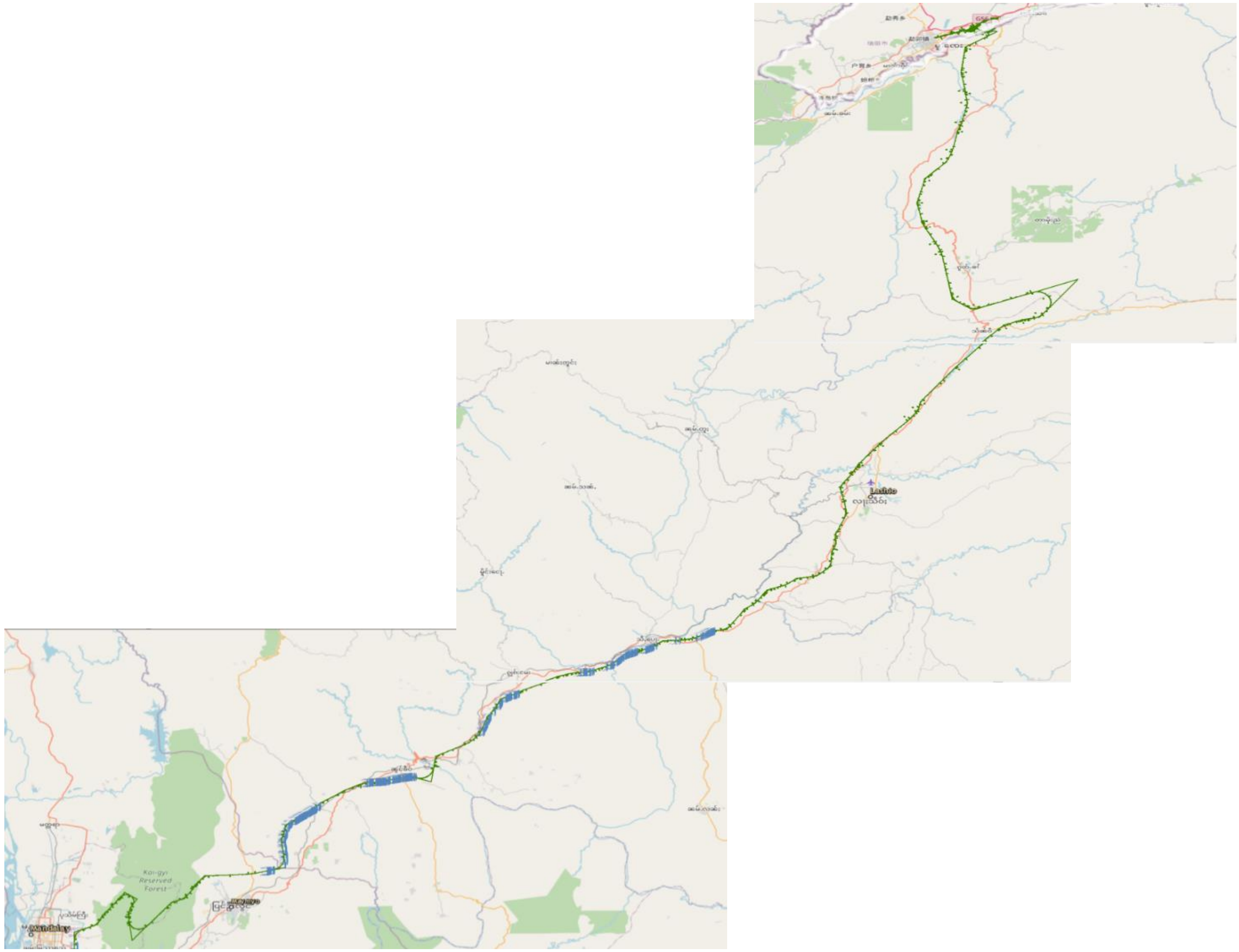


Fig. 4.8 - Location of Culverts along the Muse-Mandalay Railway Line (Source: EIA Team, 2020)

4.3. Project Development and Implementation Time Schedules

According to the construction schedule of the whole line, the allowable civil construction periods for bridges controlling the total construction period of the line are as follows: 26 months for Shwe Li River super major bridge, 24 months for Nam Ma River Major Bridge, 23 months for Nam Tu miy Nge-R River Super Major Bridge, 54 months for Gohteik Nam ban ton double track super major bridge.

Table 4.12. Implementation Schedule for Bridges

Phase	Item		Duration
Pre-construction Phase	**All types of bridges**		**6 months**
Construction Phase	Key bridges	Shwe Li River double-track super major bridge	26 months
		Nam Ma River super major bridge	24 months
		Nam Tu miy Neg-R River super major bridge	23 months
		Gohteik Nam ban ton River super major bridge	48 months
	Other Bridges		< 23 months

4.4. Workforce for Bridge and Culvert Construction

The following workforce will be required for construction and operation of bridges and culverts.

(a) For Bridge Construction

No.	Types of Workforce	Quantity	Remarks
1.	Administration	5	For each construction sites
2.	Environmental and Safety Engineer	2	For each construction sites
3.	Civil Engineer	1	For each construction sites
4.	Mechanical Engineer	1	For each construction sites

5.	Electrical Engineer	1	For each construction sites
6.	Machine Operators	10	For each construction sites
7.	Skillful Workers	25	For each construction sites
8.	General Workers	50	For each construction sites
	Total	95	

(b) For Culvert Construction

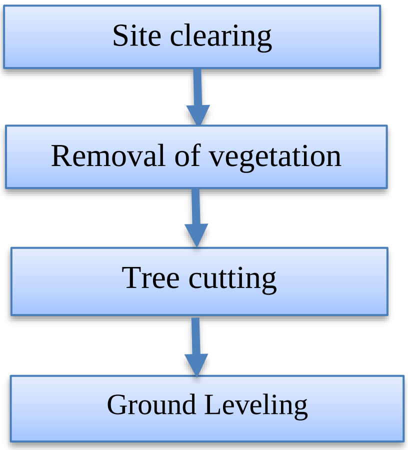
No.	Types of Workforce	Quantity	Remarks
1.	Administration	2	For each construction sites
2.	Environmental and Safety Engineer	1	For each construction sites
3.	Civil Engineer	1	For each construction sites
4.	Electrical Engineer	1	For each construction sites
5.	Machine Operators	5	For each construction sites
7.	Skillful Workers	5	For each construction sites
8.	General Workers	20	For each construction sites
	Total	35	

4.5. Description of the Process

The following phases will include in bridges and culverts construction.

4.5.1. Pre-construction phase

Pre-construction activities will involve removal of select vegetation, tree cutting for the access road and temporary camp for the workers and other facilities and the ground leveling (earth moving activities). The ground leveling for the bridge and river is leveled the ground to get the access road and align the ground with the bridge.



4.5.2. Construction Phase

Construction activities will involve the grading and excavation of soils for the installation of pier and beam and fueling facilities. Project development and construction activities also include temporary camp for construction workers, access road construction, site preparation and development (e.g. construction of bridges and site utilities).

4.5.2.1 Bridge Construction Methods

The common bridge construction of a new railway is mainly divided into the following steps: foundation construction, construction of bearing platform, construction of pier and abutment, construction of beam and bridge decking as follow:

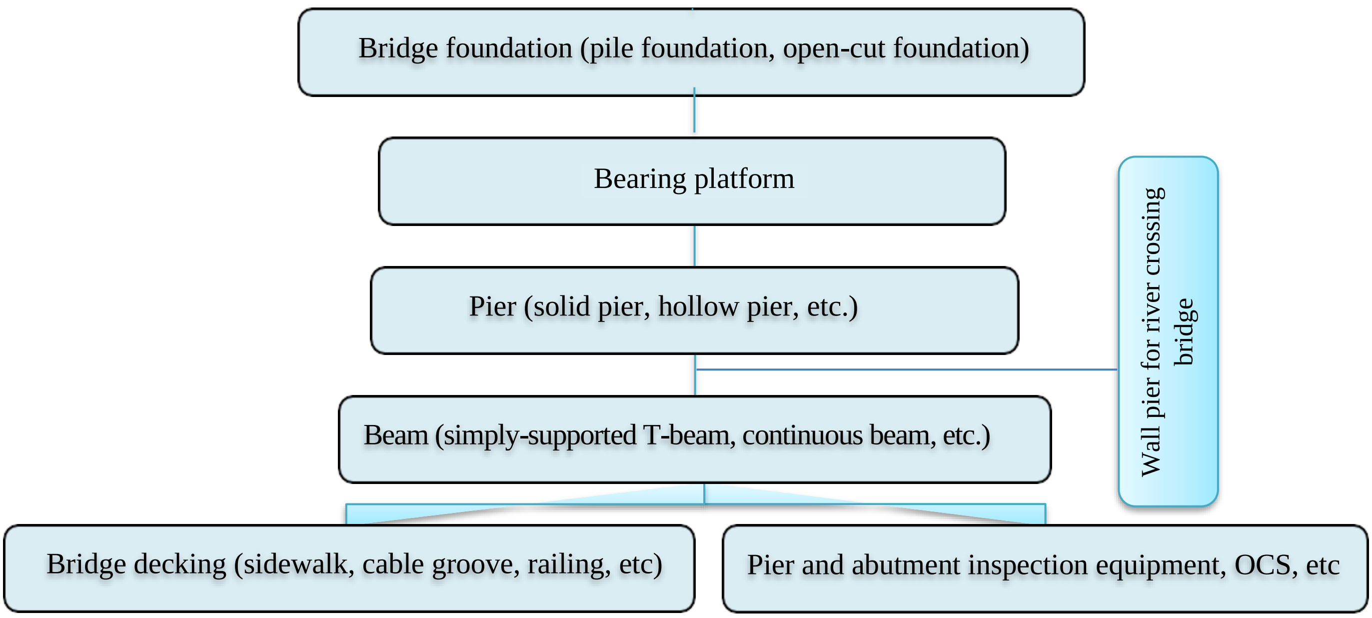


Figure. 4.9 - Flow Chart of Bridge Construction Process

(a) Construction of Bridge Foundation

The bridge foundation is generally constructed by routine method, and the manual dig pile can be used if the site and geological conditions of the bridge pile foundation are good; the cast-in-situ bored pile is generally drilled by percussive drilling or rotary drilling; the open-cut foundation is generally adopted with the unprotected construction, taking excavator as the main and artificial excavation as the auxiliary.

(b) Pier Construction

The pier construction will be made as follow:

(i) According to the height of the pier, the integral formwork casting method and the tripod setting-up formwork method are used in the pier construction;

(ii) The foundation construction of pier in the water, depending on the pier foundation form, water depth and flood discharge conditions, should take construction measures such as woven-bag cofferdam, reinforced concrete cofferdam, steel sheet pile cofferdam and single & double wall steel cofferdam to assist the construction.

Piers are of two basic types:

Column Piers: Concrete column piers may have a solid cross-section, or a box section may be the shape chosen for structural and aesthetic reasons.

Wall piers: Wall piers are generally less economical and less pleasing from an aesthetic point of view. They are very often adopted in cases where particular conditions exist, e.g. piers in rivers with significant hydrodynamic actions or in bridges with tall piers where box sections are adopted. Wall piers are more suitable for river crossing bridge.

(c) Beam Construction

The simply-supported T-beam is prefabricated centrally in the factory, transported to the bridge site by the girder transporter, and then installed in place by the bridge-erecting machine. When the small-span continuous beam has the condition, the bracket cast-in-place construction is adopted, and the other continuous beam bridges and continuous rigid frame bridges are constructed by cantilevering casting method.

- The prestressed concrete simply-supported T beam is constructed by bridge-erecting
- Continuous beam and continuous rigid frame are constructed by cantilevering casting or cast-in-place construction.

Figure 4.10– Construction of Railway T-beam Erecting by Floating Method

Figure 4.11 - Construction Site of Continuous Beam and Continuous Rigid Frame Bridge

(d) Erecting by Cantilevering Casting Method

(i) Bridge Decking

The ballast track will be used on the bridge. The width of ballast trough, the thickness of ballast and the waterproofing & drainage system of the bridge deck will be designed according to the series of beam drawings. The sidewalk steel anchor beams, sidewalk width, etc. will follow the series of beam drawings. When the bridge is located in the 9-magnitude seismic zone, the general bridge beam will be arranged with steel-concrete combined beams, and the width of the sidewalk will be consistent with that of T-beam. The track on the bridge will be ballast track, and the thickness of ballast bed under the rail sleeper shall not be less than the required minimum thickness.

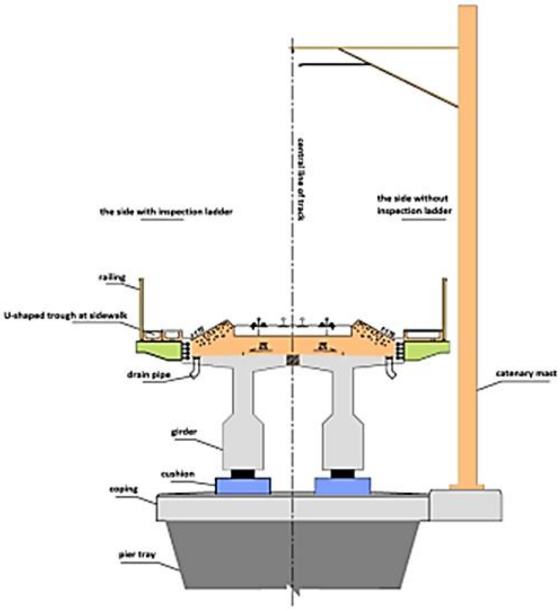


Figure 4.12 - Deck arrangement of general single-track bridge

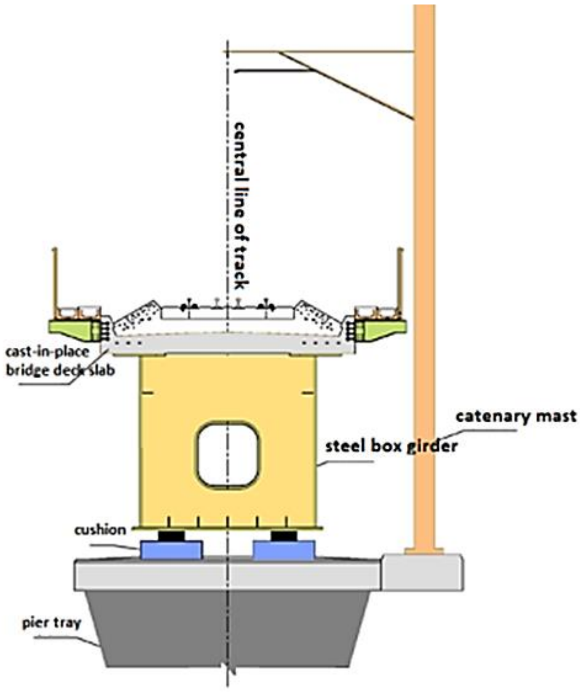


Figure 4.13 - Railway deck with steel-concrete combined beams

(ii) Suspension Bridge Construction

The type of bridge is a type of bridge in which the deck (load-bearing portion) is hug below suspension cables on vertical suspenders. The suspension cables must be anchored at each end of the bridge since any load applied to the bridge is transformed into a tension in these main cables. The main cables continue beyond the pillars to deck-level supports, and further continue to connections with anchors in the ground. The roadway is supported by vertical suspender cables or rods, called hangers. In some circumstances, the towers may sit on a bluff or canyon edge where the road may proceed directly to the main span, otherwise the bridge will usually have two smaller spans, running between either pair of pillars and the highway, which may be supported by suspender cables or their own trusswork. In the latter case, there will be very little arc in the outboard main cables.

4.6. Description of Key Bridge Crossings

CK4+520 Shwe Li River Super Major Bridge

Figure 4.14 – Shwe Li River

Figure 4.15 - Design Sketch of Shwe Li River Super Major Bridge

(a) Natural overview and main control factors

(1) Topography

The terrain near the bridge is flat and open, less fluctuating. The bridge site is located at the Shwe Li River crossing the border between Myanmar and China. The survey area belongs to Shan State Plateau, densely distributed with hills, Shwe Li River is about 90m wide, with a large amount of water running all year round. Close to the small-mileage abutment is a valley, with both sides covered by vegetation. The bridge site is of 760m~825m ground elevation, 65m relative height difference and convenient traffic conditions.

(2) Hydrogeological characteristics

Shwe Li River has a constant water level of 762m, flowing all year round. The water flow is rushing, easy to wash against the bridge pier. The width of the river at the bridge site is about 190m. Due to atmospheric precipitation and groundwater runoff recharge, the seasonal variation of river water level is large.

(i) Surface water

Surface water is dominated by stream water and river water. The stream water is seasonally flowing, combined into a stream in rainy seasons, reduced or dried up in dry seasons.

(ii) Groundwater

The groundwater in the section is well developed. The Quaternary cover layer contains abundant Quaternary pore water. The bedrock contains fissure water and is mainly replenished by atmospheric precipitation.

(b) Preliminary comments on the construction method

Underwater drilling should be carried out since the main pier foundation is located within the Shwe Li River. It is necessary to build a drilling platform and use double-wall steel cofferdam to assist the construction; the pier is constructed by replicated moulding, the continuous beam is constructed by adopting light cradle cantilever symmetric casting method, the sequence of shut is: mid span-left side span-right side span; ordinary simply supported T-beams are prefabricated in factory, transported to the bridge site, and erected by using the bridge-erecting crane. The estimated total construction period of the bridge is 26 months.

Ck178+156 Nam Ma River Major Bridge

Figure 4.16- Design Sketch of Nam Ma River Major Bridge

(a) Natural overview and main control factors

(1) Topography

The survey area is located in the low hilly area of the Shan State Plateau. The bridge spans the Nam Ma River and has a ground elevation of 423 to 490 m. The relative height difference is about 67 m and the natural cross slope is 25 to 30°. The terrain of the bridge site is undulating and the vegetation is dense. There is no roads and access roads near the bridge, and the traffic conditions is not so good.

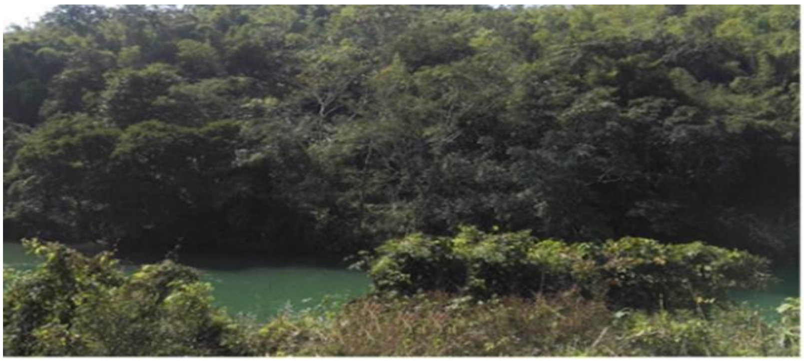


Figure 4.17 - Nam Ma River

(2) Hydrogeological characteristics

The Nam Ma River has a basin length of about 105km, a drainage area of about 2702.5 km2, and a 100-year flow rate about 485 m3/s at the bridge site. The water in the river is mainly replenished by atmospheric precipitation and groundwater runoff, and the seasonal variation of river water level is large.

The three elements of hydrology are: H1/100=428.1m, Q1/100=485m3/s and V1/100=1.5m/s.

(i) Surface water

Surface water is mainly river water, which is greatly affected by seasons. It is replenished by atmospheric precipitation and is mainly discharged in the form of evaporation and infiltration.

(ii) Groundwater

The main types of groundwater are Quaternary pore water and bedrock fissure water. The Quaternary pore water is mainly stored in the fine round gravel layer, and the water volume is abundant; the underlying bedrock rock mass is broken, and the local bedrock fissure water is relatively developed, which is replenished by rainfall and river water. Surface water and groundwater are not corrosive.

(b) Design basis for bridge aperture

The bridge spans the Nam Ma River at a river surface of about 50m wide, and the river bottom to the rail surface is about 69m. The bridge scheme is determined and the span is arranged according to the railway elevation, topography, hydrology and geological conditions.

(c) Introduction to the bridge scheme

(1) Recommended scheme: main span (44+72+44) m continuous beam

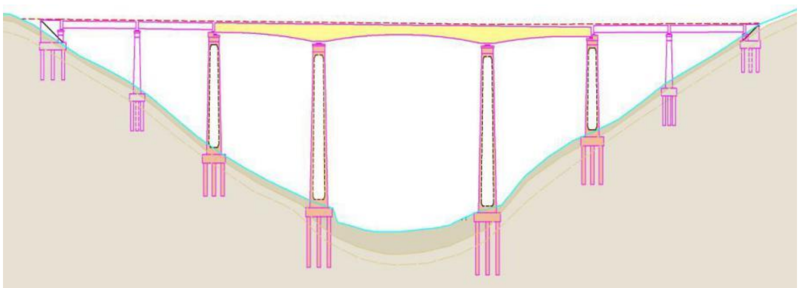


Fig. 4.18 - Overall layout of the Nam Ma River Major Bridge

The center mileage of the Nam Ma River Bridge is CK178+158, the span pattern is 2×32m+(44+72+44)m continuous beam+2×32m, the total length of the bridge is 308.27m, the bridge range is CK178+003.2~CK178+310; T-shape abutment is adopted with a height of 5m, approach bridge and main bridge piers adopt rectangular hollow piers, with the maximum pier height of 56m, the foundation is bored pile foundation, the diameter of abutment and approach bridge piles is D=1.25m, the pile diameter of main bridge side pier and main bridge main pier is D=1.5m.

CK213+725 Nam Tu Miy Nge-R River Super Major Bridge

Figure 4.19 - Design sketch of Nam Tu miy Nge-R River Super Major Bridge

(a) Natural overview and main control factors

(1) Topography

The bridge site is located in the low hilly area of the Shan State Plateau. The bridge spans the Nam Tu miy Nge-R River. The ground elevation is 397-433m, the relative height difference is about 46m, and the natural cross slope is 5-30°. The terrain of the bridge site is undulating, with dense vegetation, access roads, and the traffic conditions are not so good.

(2) Hydrogeological characteristics

Nam Tu miy Nge-R River, the upper reaches of the river is the intersection of Nam Tu River and Nam Ma River. The length of the basin is about 230km, and the drainage area is about 14100 km^2, the main slot is about 96m wide. The water in the river is mainly replenished by atmospheric precipitation and groundwater runoff, and the seasonal variation of river water level is large.

The three elements of hydrology are: $H_{1/100}$=402.3m, $Q_{1/100}$=2998m^3/s and $V_{1/100}$=3.09m/s.

(i) Surface water

Surface water is mainly river water, which is greatly affected by seasons. It is replenished by atmospheric precipitation and is mainly discharged in the form of evaporation and infiltration.

(ii) Groundwater

Groundwater is mainly Quaternary pore water and bedrock fissure water. The Quaternary pore water is mainly stored in the fine round gravel layer, and the water volume is abundant; the underlying bedrock rock mass is broken, and the local bedrock fissure water is relatively developed, which is replenished by rainfall and river water. Surface water and groundwater are not corrosive.

(2) Design basis for bridge aperture

The bridge spans the Nam Tu miy Nge-R River at a river surface of about 97m wide, and the river bottom to the rail surface is about 28m. The bridge scheme is determined and the span is arranged according to the railway elevation, topography, hydrology and geological conditions.

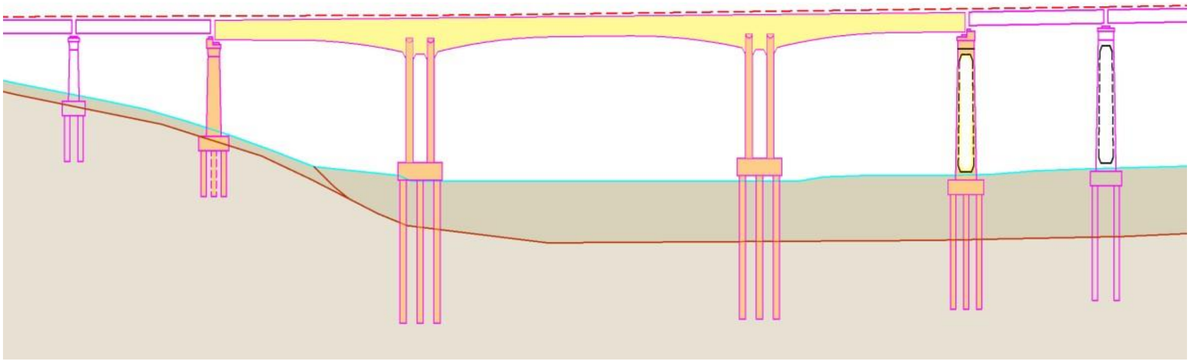


Figure 4.20- Overall layout of Nam Tu miy Nge-R River Super Major Bridge

The center mileage of Nam Tu miy Nge-R River Super Major Bridge is CK213+725, the span pattern is 3×32m+(48+80+48)m prestressed concrete continuous rigid frame +11×32m, the total length of the bridge is 647.306m, the bridge range is CK213+532.238 ~CK214+179.544; T-shaped abutment is adopted with the height of 5m, and round-end hollow piers are adopted for approach bridges and side piers, twin-legged thin-wall pier is adopted for the main pier, with the maximum pier height is 28m, the foundation is bored pile foundation, the pile diameter of abutment and approach bridge is D=1.25m The pile diameter of the main bridge side pier is D=1.5m, and the pile diameter of main bridge main pier is D=2.0m.

CK274+880 Gohteik Nam Ban Ton Double Track Super Major Bridge

(1) Topography

The bridge site is located in the central part of the Shan State Plateau, under Lashio administrative division. It belongs to the medium and low mountain erosion and dissolution landform. The terrain is undulating and the gullies are developed, showing a "V" shape. The bridge spans the famous Nam pan hse C River Grand Valley. The bridge site is of 400-810m ground elevation, 410m relative height difference, with lateral gullies developed. The small-mileage (north shore) end of the bridge is of steep terrain, 30°-70° natural cross slope, with cliffs locally. While the large mileage end (south shore) is of gentle slope, 10°-30° natural cross slope. Slope surface on both sides of the bridge exposes bedrock, well covered by vegetation, mainly shrubs, trees and bamboo. In the bridge site, there are access roads to reach the top of the slopes at both ends, and only a small road is available at the bottom of the Valley. There are villages distributed on the hilltops, namely, Goke Hteik, Gokteik and other villages. The bridge site is about 370m away from the Mandalay - Lashio meter-gauge railway and about 900m away from the famous meter-gauge Gohteik Railway Viaduct upstream of the river.

Figure 4.21 - Meter-gauge Gohteik Railway Viaduct

Muse-Mandalay Railway crosses Myanmar-China oil-gas pipeline in CK274+340-+390, and runs parallel in CK274+570-CK275+230, keeping a distance of about 60-113m. The buried depth of the oil-gas pipeline is about 1.8m, most of which are buried in the upper soil layer, and the underground river is buried in the strongly weathered dolomite limestone.

The proposed Nam ban ton River super major railway bridge is almost parallel to the proposed Gok Teik super major road bridge from Lashio (Hispaw) to Mandalay when crossing the Nam pan hse C grand valley, and it is located at 200-230m downstream of the road bridge. Between the two bridges is the Myanmar-China oil-gas pipeline project.

Figure 4.22 - Lashio-Mandalay Go hteik Cable-stayed Road Bridge

(2) Surface water and Hydrological Conditions

The project area belongs to the Ayeyarwady River system. The surface water in the proposed bridge site is mainly Nam ban ton River and the Nam Tu River in the deep valley on the left side of the line, running all year round; and the surface water at both ends of the bridge is mainly seasonal gully water, which mainly replenished by atmospheric precipitation, and the water quantity varies with the season.

(i) Nam Tu River

It is also known as Nanmu Tu River, is one of the main rivers in Shan Plateau, and is defined as the tropical running river, belonging to the Ayeyarwady River system. The length of the basin is about 230km, and the area of the basin is about 14,100 km^2, the 100-year flow at the bridge site is about 14,837m^3/s, and the width of the main trough is about 96m. The line spans its branch Nam pan hse C River. The length of Nam pan hse C River basin is about 36.5km and the drainage area is about 809km^2. The Nam Tu River is a non-navigable river all the year round. The river source of Nam Tu River is divided into two branches: the north branch originates from Mong Si, and the south branch originates in the mountains of the Nebo Basin. It flows from the southeast to the northwest then westward into the Ayeyarwady River.

(ii) Nam ban ton River

The canyon is a narrow "V" shape, which is formed by the dissolution of the tributary of Nam Tu River along the carbonate fault depression, with steep slopes and steep cliffs on both sides. The cutting depth can reach about 200m, and the number in the shallow part is generally 10~100m. At the bottom of the canyon, three underground rivers have been formed along the river, one of which is at the bottom of the Nam ban ton River Bridge on this line. The bottom of the valley is Nam ban ton River, the width of the river is about 7.0~30.0m, and the surface layer of the river bed is pebbles, drifting stones and stones. The water quality is clear, can be used as drinking water. The maximum water depth of the river is about 3.5 m, the upstream velocity of the river is fast, about 2.0~3.0m/s; the downstream velocity is about 1.0m/s, and the riverbed ratio is about 5%. The flow direction is runoff from west to east. The flood season is from May to October and the dry season is from November to April of the following year. The velocity and flow of the river vary greatly with seasonality.

According to the engineering geological mapping, a gully is developed about 260 m from the proposed bridge on the west side of the north bank of the proposed bridge site, and dry up in the gully during the survey period; the western canyon on the south bank is about 785m away from the proposed bridge, and a gully is developed during the survey period, and the water in the gully flows into the bottom of the canyon valley in a waterfall.

The historical maximum water-level elevation of the upper-stream river section of the bridge site area (at the inlet of the underground river) is about 408.60m and its maximum velocity is about 6.0m/s; and the historical maximum water-level elevation of the downstream river section (at the outlet of the underground river) is about 402.40m and its maximum velocity is about 5.0m/s.

Figure 4.23 - Gohteik Nam Ban Ton River

4.7. Types of Railway Bridges

The following are the types of bridges along Muse-Mandalay Railway.

4.7.1. River-crossing Bridges

The route crosses the larger rivers such as Shwe Li River, Nam Paw River, Nam Hkai River, Nam Tu River, Nam Yao River, Nam Tu Miy Neg-R River, Nam Ma River and Nam ban ton river, all of which belong to the Ayeyarwady River water system. According to the data collected on the spot, Shwe Li River is a navigable channel. This design is based on grade VI waterway. In this design, the main span (60+2x104+60) m continuous girder bridge is adopted to cross the waterway.

Table 4.13 - Distribution table of bridges crossing main rivers

S/N	Mileage	River name	Engineering measures	Remarks
1	CK4+520	Shwe Li River	Shwe Li River super major bridge main span (60+2x104+60) m continuous girder bridge	Navigation requirements
2	CK17+796	Nam Paw River	Nam Paw River medium bridge (2x24) m simply supported girder bridge	
3	CK23+027	Nam Paw River	Nam Paw River major bridge (7x32) m simply supported girder bridge	
4	CK57+370	Nam Hkai River	Nam Hkai River major bridge (2x24+6x32+2x24) m simply supported girder bridge	
5	CK122+950	Nam Yao River	Nam Yao River 1# super major bridge (60x32) m simply supported girder bridge	
6	CK126+835	Nam Yao River	Nam Yao River 2# super major bridge (85x32) m simply supported girder bridge	
7	CK178+156	Nam Ma River	Nam Ma River major bridge 2x32+(43+72+44) m continuous girder bridge	
8	CK213+725	Nam Tumiy Neg-R River	Nam Tumiy Neg-R River super major bridge main span (48+80+48) m continuous girder bridge	
9	CK274+880	Nam ban ton River	Gohteik Nam ban ton River super major bridge (148+2x260+148) m steel-concrete double-layer composite rigid frame	

4.7.2. Bridge for Road Crossing

The project has crossed several times with the existing NH3 Highway (Muse to Lashio, Lashio to Mandalay) in Myanmar, which is called the Myanmar-Yunnan Highway.

(1) NH3 Highway

NH3 highway, also known as "Stilwell Highway" in history, has the part in Chinese border, as No. 320 National Highway Western-Yunnan Section. The length in China is 850 kilometers long; it starts from Kunming to Shwe Li Wanding Port, the length from the Wanding port to the destination Lashio, Myanmar is 603 kilometers. It is an important transportation route connecting Southeast Asian countries. At present, it can reach Yangon, Bangkok, the capital of Thailand, to India in the west and Singapore in the southeast. There is onlyNH3 highway along the line, which is a two-way two-lane road with an existing width of 8m and asphalt concrete pavement.

Figure - Picture of NH3

The line also crosses NH3 highway several times, and some sections are parallel with the existing highway, so the traffic is relatively convenient. For the purpose of not affecting ground traffic, this project adopts girder bridge and frame bridge for railway crossing highway, and adopts road relocation or interchange culvert for lower grade roads.

Table 4.14 - Individual situation of main crossed roads along the line

S/N	Mileage	Crossing method and engineering measures	Remarks	S/N
1	CK9+880	CK9+560 Muse Station 2# frame bridge 2-10 m	NH3	Highway underpass
2	CK31+650	CK31+330 Kawng wing super major bridge (33x32) m simply supported girder bridge	NH3	Railway overcrossing highway
3	CK62+290	CK62+290 Pang nin Road-over bridge 5x32 m	NH3	Highway overcrossing railway
4	CK88+100	Man peng 1# tunnel	NH3	Highway overcrossing railway

5	CK133+665	CK133+990 Sam lou super major bridge 5x32 m simply supported girder bridge	NH3	Railway overcrossing railway
6	CK151+630	Hang lu tunnel	NH3	Railway overcrossing railway
7	CK154+900	Hang lu tunnel	NH3	Highway overcrossing railway
8	CK153+200 (After broken chain)	CK152+453 Hka shi super major bridge 49x32 m simply supported girder bridge	NH3	Railway overcrossing highway
9	CK164+559	CK164+559 Kawng has super major bridge 25x32 m simply supported girder bridge	NH3	Railway overcrossing highway
10	CK198+180	CK198+040 Hsup lang major bridge 12x32m simply supported girder bridge	NH3	Railway overcrossing highway
11	CK266+560	Tunnel	NH3	Overcrossing highway railway
12	CK272+880	Tunnel	NH3	Highway overcrossing railway
13	CK273+680	CK273+680 2-16m rigid frame bridge	Road under construction	Highway underpass
14	CK279+884	CK279+884 2-16m rigid frame bridge	Road under construction	Highway underpass
15	CK291+050	CK291+519 Hu ka 1# super major bridge 25x32m simply supported girder bridge	NH3	Railway overcrossing highway
16	CK394+550	Mandalay Road-over bridge 9x25m	NH3	Highway overcrossing railway

4.7.3. Bridge for Oil and Gas Pipelines

According to the survey data, there are many crossings between the newly built railway and the existing oil and gas pipelines, which have certain influence on the railway route. The main underground pipeline is the Myanmar-China oil and gas pipeline, with the diameter of 813mm-1,016mm. The starting point of Myanmar-China oil pipeline is located in Maday Island on the west coast of Myanmar. They enter China from Shwe Li, Yunnan Province, via Rakhine, Magwe, Mandalay and Shan State of Myanmar. The total length of crude oil and natural gas pipelines is 793km. Among them, the design capacity of Myanmar-China crude oil pipeline is

22 million tons/year, and the gas transmission capacity of Myanmar-China natural gas pipeline is 12 billion cubic meters/year. On July 28, 2013, gas transmission to China started.

The line is also intersected with a small number of local water supply and drainage pipelines, underground communication cables, oil and gas pipelines and other pipelines. When the railway crosses the underground pipeline, in principle, the method of relocation, reconstruction, in-situ protection are adopted. On the premise of meeting the relevant provisions regarding pipeline protection, railway culverts or railway bridges can be adopted for passing.

Figure - Path of Myanmar-China oil and gas pipeline

Table 4.15 - Summary table of intersections between Myanmar-China oil and gas pipelines and the project

S/N	Intersection mileage	Measures taken	remarks
1	CK239+500	CK239+193 Pawk ang 1# super major bridge 25x32m simply supported girder bridge	Railway overcrossing highway
2	CK266+725	Pass through by Kyaunggon tunnel	Railway underpass
3	CK274+350	Gohteik Nam ban ton River super major bridge2(6x32+(1x48+2x36) steel-concrete composite girder+(148+2x260+148m) steel-concrete double-layer composite rigid frame+2x50m steel-concrete composite girder+18x32)	Railway overcrossing highway

4.8. Railway Culverts

Culverts will generally follow the natural trend of gully flow and be located in the mainstream of the original gully and in a stable gully bed position. The flow surface and longitudinal slope of culvert will be determined comprehensively based on topography, geology, critical slope and other factors, which should be adapted to its function and avoid stagnant water in culvert. If the culvert is controlled by the line elevation, and its entrance and exit is low, the necessary trench drainage should be carried out in the downstream.

4.8.1. Railway Culverts Structures

Culverts should be in the forms of frame culvert, circular culvert and slab culvert, etc.

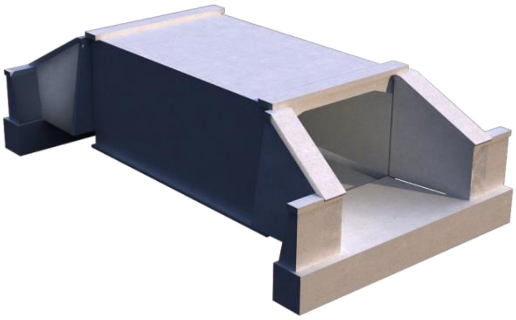


Figure 4.24 -Schematic Diagram of Railway Frame Culvert Structure

Figure 4.25 - Schematic Diagram of Railway Circular Culvert Structure

Siphon is generally used to irrigate the intake structure of ditch through railway, and the shaft reinforced concrete inverted siphon should be used.

4.8.2. Culvert Aperture

The aperture of culvert will be determined based on the factors such as function and flow rate, etc; the aperture of flood discharge culvert should not be less than 1.25m; and the aperture of traffic culvert should not be less than 3.0 m. The top of culvert should not be higher than the surface and bottom of foundation bed. When the culvert top controls the shoulder elevation, the culvert top can be flush with the shoulder. The aperture of culverts should be appropriately increased on the basis of the aperture determined by the flow rate in the following conditions.

(i) When the length of the long culvert in the station is more than 50 m.
(ii) Steep slope culvert with staggered abutment.
(iii) It is located in the gully and the water in the ditch contains sediment, small stones and so on.
(iv) Flood discharge and interchange (aperture increase or double-hole setting).
(v) The entrance of the culvert is flat, and the water accumulation or the height of the water in front of the culvert is not allowed to be limited. When the culvert is still necessary to be set through its comparison with the minor bridge, it will be considered to increase its aperture or set with double-hole.

4.8.3. Railway Culvert Construction

(a) Culvert Ground and Foundation

The culvert foundation generally adopts the monolithic foundation. When the culvert is placed in rock strata with high bearing capacity, the separated foundation can be used. When the allowable bearing capacity of culvert ground or the foundation settlement after acceptance does not meet the requirements, the ground replacement or ground reinforcement can be used for strengthening.The line of the culvert will be excavated to bedding level with material taken away by dump truck or wagon for reuse or disposal. Construction of the foundation will involve steel fixing, shuttering, transport of concrete to the works and placing concrete within the shuttering.

(b) Construction of Culverts

The above culvert types will also require construction of a headwall which will be constructed in a similar manner to that described previously for drainage outfall works. Headwalls are likely to be reinforced concrete although they may have a stone facing or other finish applied following the main headwall works. Headwall construction will involve excavation, steel fixing, shuttering, concreting and backfilling operations. The construction stage flow chart of culverts is as follows:

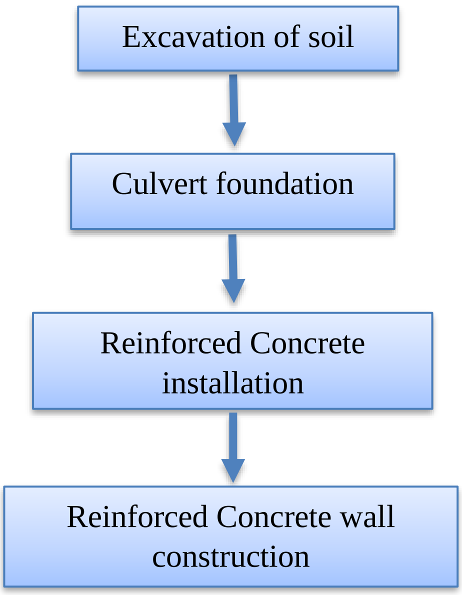


Figure 4.26 - Flow Chart of Culverts Construction Method

(c) Culvert Entrance and Exit

The entrance and exit of culvert generally adopts wing wall type; when its entrance and exit are connected with rectangular groove, the wing wall can be canceled. The entrance and exit of culvert should be paved in the forms of standard paving, shallow ditch paving and deep groove paving, etc based on the terrain.

Figure 4.27- Design Sketch of Railway Culvert

(d) Cross-line Structures

(1) In general, in order to facilitate the construction, the maximum span of the bridge should not be more than 30m. The standard span of 16m, 20m, 25m and 30m can be selected.

Figure 4.28 - Design Sketch of Road-over Overpasses

(2) The clear width of road surface and the width of sidewalk should be identical with that of the existing roads.

(3) Hand railings will be provided on both sides of a cross-line Road-over bridge or pedestrian overpass and shielded anti-throwing nets should be provided to ensure the safety of railway traffic.

(4) For the cross-railway hole span of the cross-line road-over bridge, a reinforced anti-collision wall should be set up on the outside of the traffic lane, and the rest of the bridge span should be provided with the ordinary anti-collision wall.

(5) The reinforced concrete U-shaped aqueduct is generally used in the aqueduct.

4.9. Project Organization

The project will be carried out by the Myanma Railways (MR), Ministry of Transport and Communications (MOTC) of the Republic of the Union of Myanmar. However, the construction of the project will be done by the CREEC under the supervision of MR and MOTC. The organization chart for the construction phase of the proposed railway bridges and culverts is described as follows. The professionals and work crews have not been selected for the project during FS stages.

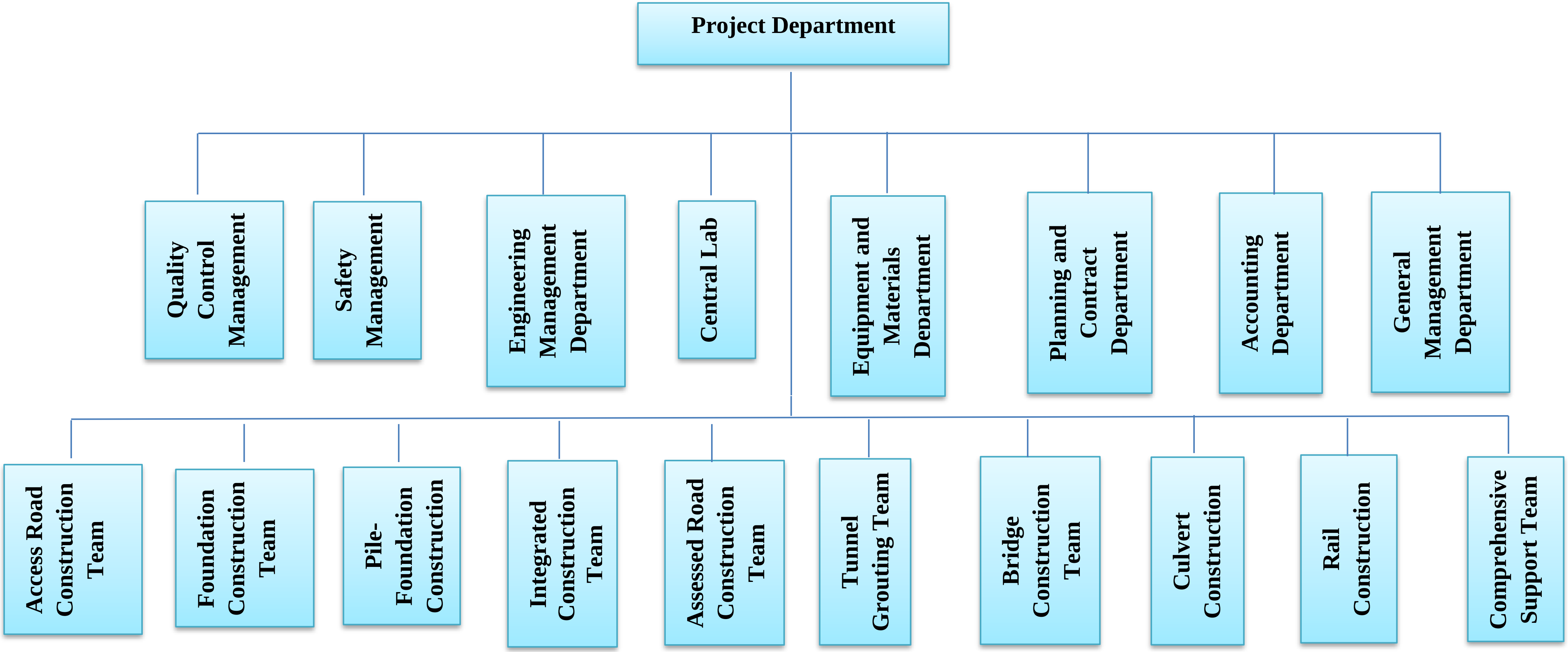


Figure 4.29 - Organization Chart

4.10. Design Speed

Design speed of passenger trains: 160 km/h, and 200km/h for the sections reserved with double-track conditions (with speed limit of 160km/h for local sections) as follow:

S/N	Mileage scope	Speed limit
1	CK0+000~CK11+800	160km/h
2	CK323+685~CK369+803	160km/h

4.11. Raw Materials for Bridge and Culverts

The required raw materials such as the cement, sand and chipping or gravel and lime are sourced from nearby areas especially from Mandalay. Steel rods, bridge girdles and beams are imported from China. The estimated quantity for the construction of railway bridges and culverts is shown in the following table.

Table 4.16 - List of Raw Materials

No.	Item	Unit	Estimated Quantity
1	Jet grouting piles	m	12614.4
2	C30 concrete	m^3	88577.6
3	Crushed stone	m^3	43035.12
4	Sand mixed with crushed stones	m^3	38612.92
5	High pressure jet grouting piles	Nr.	181280
6	CFG pressure jet grouting piles	m	2225970
8	C35 concrete	m^3	51521.3
9	HPB300 rebar	kg	1099549
10	HPB400 rebar	kg	21372157
11	Inverted filter of sand and gravel	m^3	3072.2
12	Φ100mm PV pipe	m	4916
13	Adhesive	-	21301.9
14	C40 fiber concrete	m^2	1165.1
15	TQF Class C waterproof layer	m^2	21030.5
16	M10 cement mortar	m^3	1052
17	Polyurethane waterproofing coating	m^2	19883.8
18	M10 Mortar rubble	m^3	5455.3
19	Geotextile	m^2	8656.8
20	Vertical angle steel	kg	18449.5
21	Transverse railing angle steel	kg	8235.8

22	Steel plate	kg	4324.8
23	Φ16 bolt with nut	kg	276.3
24	Φ16 U-shaped bolt	kg	1471.9
25	Φ22 U-shaped bolt	kg	1196.2
26	Steel pipe	-	31681.8
27	Fiberglass polyester power cable trough	m	965.9

4.12. Land Use for Bridges and Culverts

The main line length of Muse-Mandalay Railway is 409.960km, with 124 new bridges (69.309km in total length), 60 new tunnels (152.160km in total length). The total length of bridge and tunnel is 221.469km, accounting for 54.02% of the main line length. There are 36 stations along the whole line.The meter-gauge railway link from Mandalay South to Myitnge is 4.170 km long, without bridge and tunnel works, and Myitnge Station is to be renovated. The land use for main line of Muse-Mandalay Railway is 37,320,512m², including 25,951,997m² permanent land use and 11,368,515m² temporary land use. Land use for the meter-gauge connecting line from Mandalay South to Myitnge is 292,909m², including 189,699m² permanent land use and 103,210m² temporary land use. The land use along the line consists of permanent new land use and temporary land use, land use quantities and specifications are detailed in the table below.

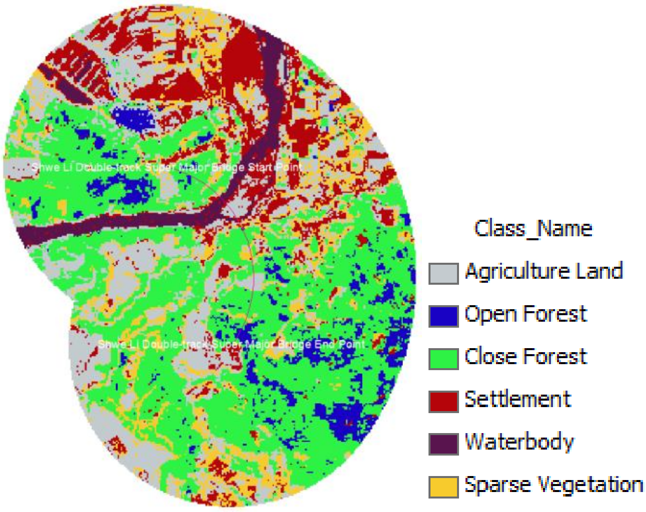
Land use item		Land use quantity (m^2)			Land use specifications (m^2/km)		
		New land use	Temporary land use	Sub-total	New land use	Temporary land use	Sub-total
Total for main line from Muse to Mandalay South	Section subgrade	9,262,532	2,793,158	12,055,690	68,025	20,513	88,538
	Including land use for other disciplines	25,951,997	11,368,515	37,320,512	63,304	27,731	91,035
Total for Muse-Mandalay South	Section subgrade	9,425,986	2,893,158	12,319,144	67,168	20,616	87,784
	Including land use for other disciplines	26,141,696	11,471,725	37,613,421	63,124	27,701	90,825

Source: Feasibility Study Report for MMR (CREEC)

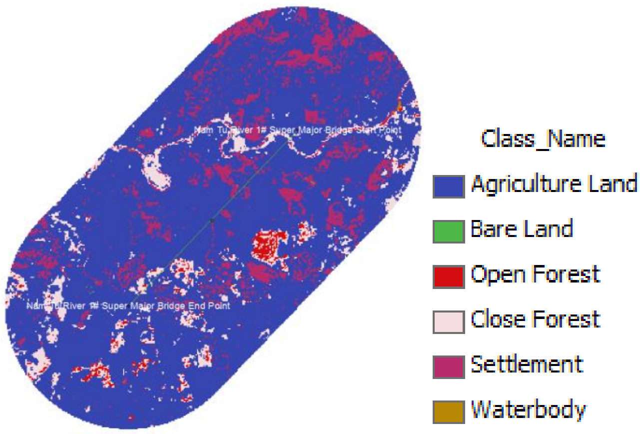
4.13. Land Use Land Cover Map (LULC)

According to the GIS study, the land use classes within 1 km buffer around railway bridges are as follow:

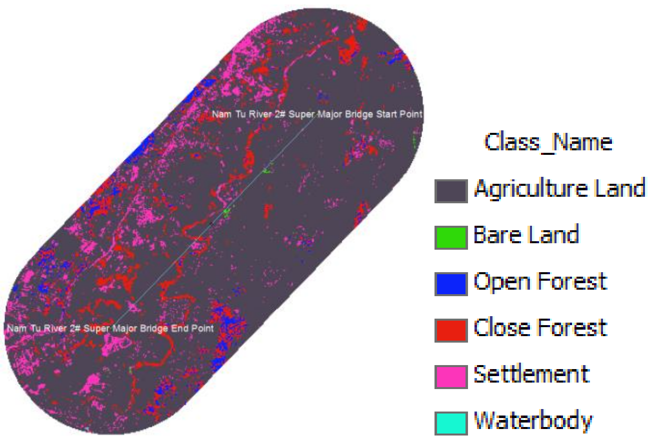
No.	Bridges
1	1_Shwe Li Double-track Super Major Bridge
2	2_Nam Tu River 1# Super Major Bridge
3	3_Nam Tu River 2# Super Major Bridge
4	4_Nam Tu miy Nge-R River Super Major Bridge
5	5_Gohteik Nam ban ton River Double-track Super Major Bridge
6	6_Taung Kyun Station 4# Super Major Bridge
7	7_NAM PAW Major Bridge
8	8_Nam Hkai River Major Bridge
9	9_ Kutkai 1# Super Major Bridge
10	10_ Man Peng 2# Super Major Bridge
11	11_Nawng Yen Double-track Medium Bridge
12	12_Nam Yao River Major Bridge
13	13_Nam Ma River Major Bridge
14	14_Ke Mang Super Major Bridge
15	15_San Lau 1# Super Major Bridge
16	16_San Lau 2# Major Bridge
17	17_Kong Tha Major Bridge
18	18_Gong Sa Major Bridge
19	19_ Hko Long Major Bridge
20	20_ Kyin Thi Major Bridge
21	21_ Hslpaw 1# Major Bridge
22	22_Hslpaw 2# Super Major Bridge
23	23_Kyang Yin 1# Super Major Bridge
24	24_Kyang Yin 2# Major Bridge
25	25_Kyaung Gon Medium Bridge
26	26_Hu Ka 1# Super Major Bridge
27	27_Hu Ka 2# Super Major Bridge
28	28_Sin Byu In Station Three-track Major Bridge
29	29_Da Bei Shan Major Bridge
30	30_Sakangyi Station Double-track Medium Bridge
31	31_Taung Kyun 1# Major Bridge
32	32_Taung Kyun 2# Major Bridge
33	33_Taung Kyun Station 1#Three-track Major Bridge
34	34_Taung Kyun Station 2# Three-track Major Bridge
35	35_Taung Kyun Station 3# Super Major Bridge



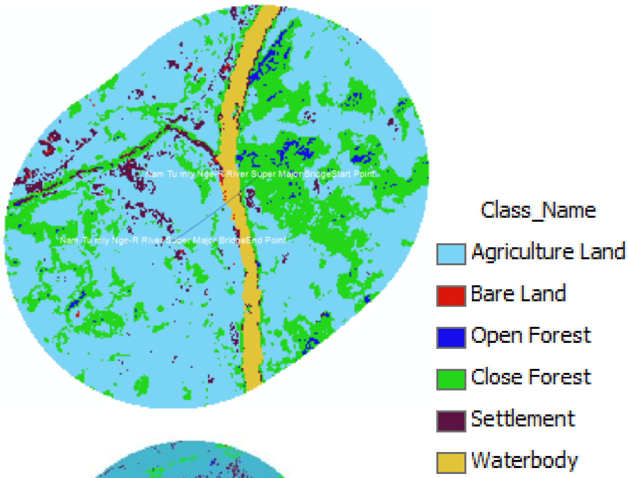
Area of LULC Classes (1Km Buffer Around Nam Hkai River Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.0569	1.480229
Bare Land	1.6383	42.619667
Open Forest	0.8601	22.37513
Close Forest	1.264	32.882414
Waterbody	0.0247	0.64256



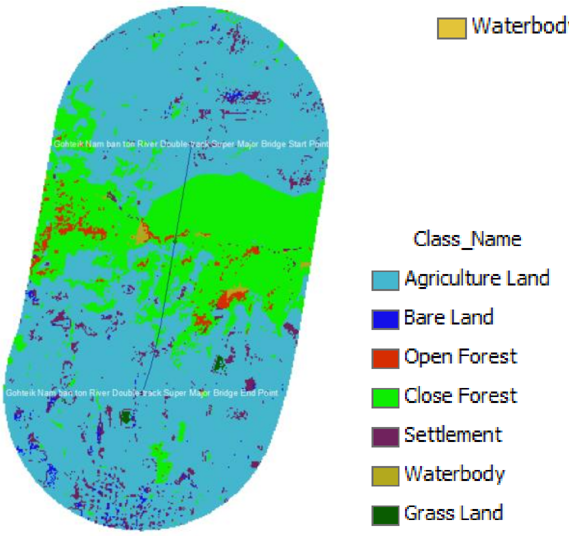
Area of LULC Classes (1Km Buffer Around Nam Tu River 1# Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	5.707	80.3984
Bare Land	0.002	0.028175
Open Forest	0.1047	1.47498
Close Forest	0.5113	7.203032
Settlement	0.7708	10.858785
Waterbody	0.0026	0.036628



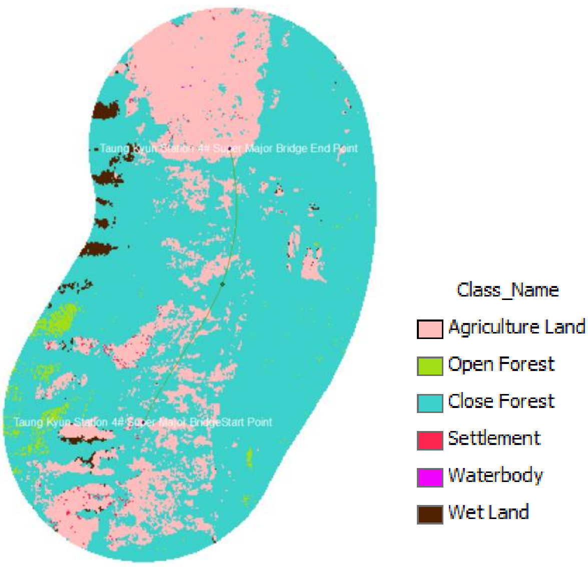
Area of LULC Classes (1Km Buffer Around Nam Tu River 2# Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	7.1922	82.369783
Bare Land	0.0065	0.074442
Open Forest	0.2573	2.946768
Close Forest	0.6798	7.785515
Settlement	0.5948	6.812039
Waterbody	0.001	0.011453



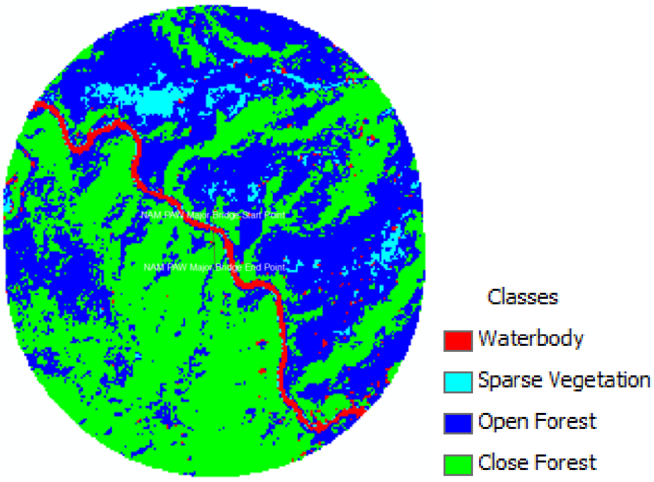
Area of LULC Classes (1Km Buffer Around Nam Tu miy Nge-R River Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	2.9018	65.374997
Bare Land	0.0086	0.19375
Open Forest	0.0586	1.320206
Close Forest	1.1073	24.946493
Settlement	0.1488	3.352333
Waterbody	0.2136	4.81222



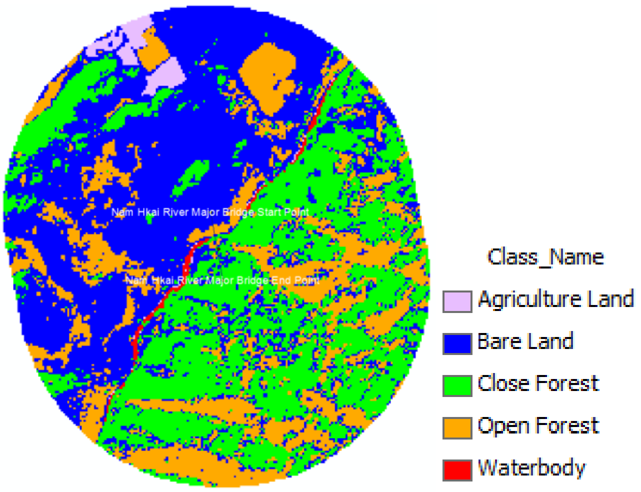
Area of LULC Classes (1Km Buffer Around Gohteik Nam ban ton River Double-track Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	4.7109	68.990818
Bare Land	0.0441	0.645842
Open Forest	0.1038	1.520144
Close Forest	1.6808	24.615204
Settlement	0.2536	3.713955
Waterbody	0.0245	0.358801
Grass Land	0.0106	0.155236



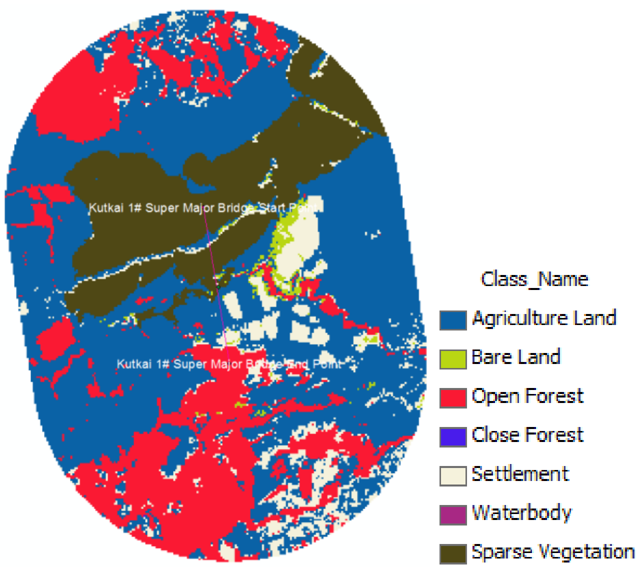
Area of LULC Classes (1Km Buffer Around Gohteik Nam ban ton River Double-track Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	4.7109	68.990818
Bare Land	0.0441	0.645842
Open Forest	0.1038	1.520144
Close Forest	1.6808	24.615204
Settlement	0.2536	3.713955
Waterbody	0.0245	0.358801
Grass Land	0.0106	0.155236



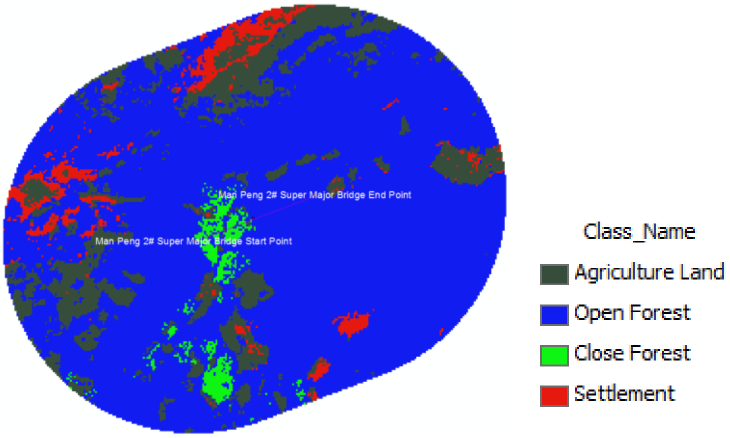
Area of LULC Classes (1Km Buffer Around NAM PAW Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Water Body	0.1055	2.871139
Close Forest	1.8505	50.360593
Open Forest	1.5948	43.401823
Sparse Vegetation	0.1237	3.366444



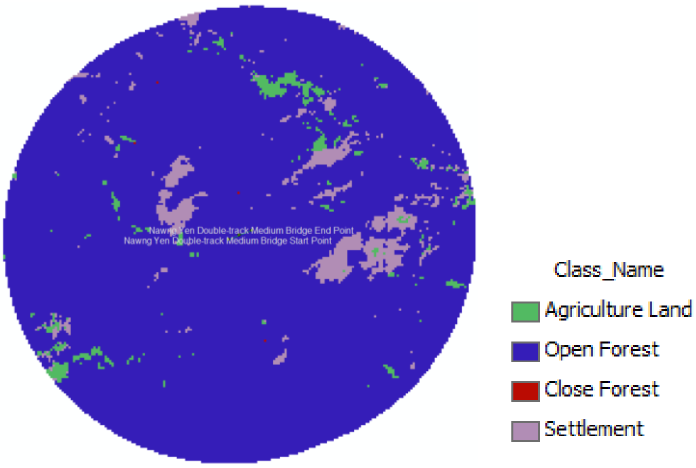
Area of LULC Classes (1Km Buffer Around Nam Hkai River Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.0569	1.480229
Bare Land	1.6383	42.619667
Open Forest	0.8601	22.37513
Close Forest	1.264	32.882414
Waterbody	0.0247	0.64256



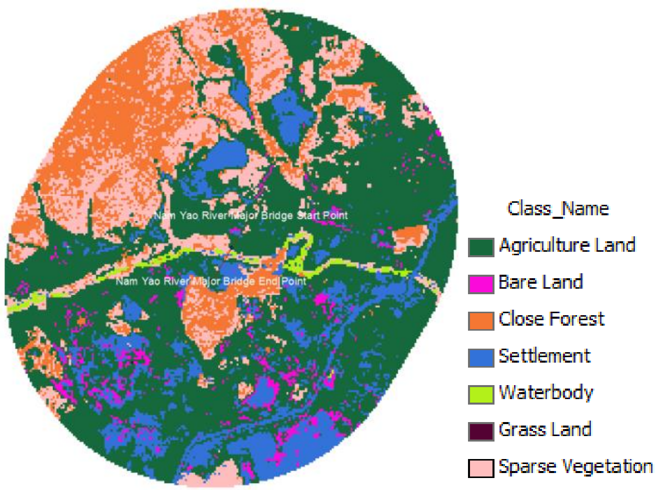
Area of LULC Classes (1Km Buffer Around Nam Hkai River Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.0569	1.480229
Bare Land	1.6383	42.619667
Open Forest	0.8601	22.37513
Close Forest	1.264	32.882414
Waterbody	0.0247	0.64256



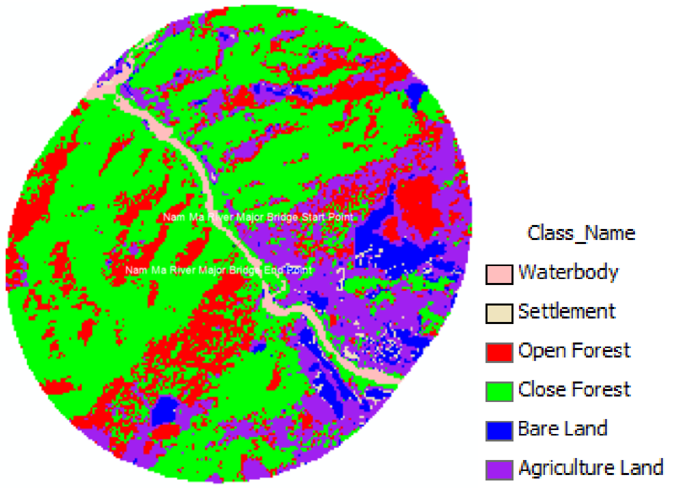
Area of LULC Classes (1Km Buffer Around Man Peng 2# Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.6859	15.247305
Open Forest	3.5352	78.586195
Close Forest	0.0941	2.091808
Settlement	0.1833	4.074692



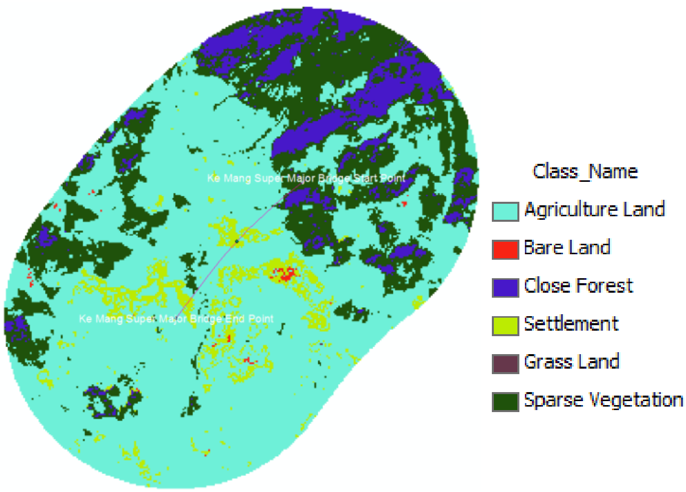
Area of LULC Classes (1Km Buffer Around Nawng Yen Double-track Medium Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.069	2.050947
Open Forest	3.1364	93.225931
Close Forest	0.0004	0.01189
Settlement	0.1585	4.711233



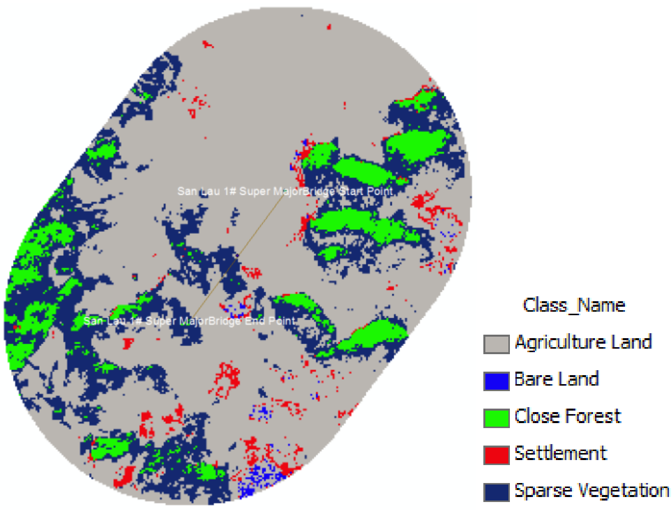
Area of LULC Classes (1Km Buffer Around Nam Yao River Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	1.9834	51.025186
Bare Land	0.1152	2.963649
Close Forest	0.6043	15.546294
Settlement	0.5035	12.953101
Waterbody	0.0379	0.97502
Grass Land	0.0001	0.002573
Sparse Vegetation	0.6427	16.534177



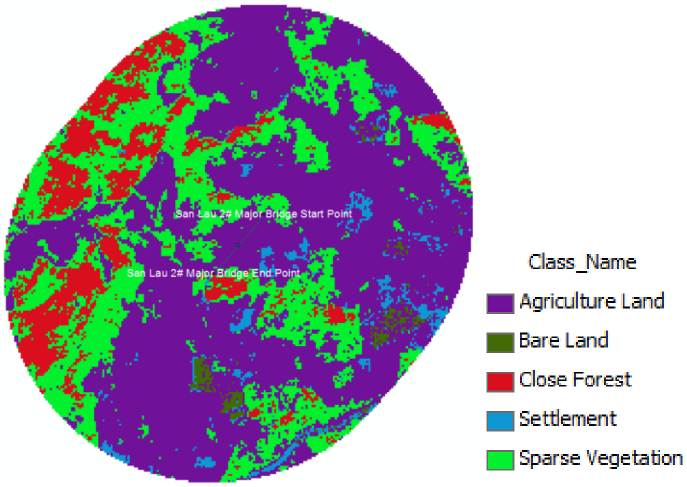
Area of LULC Classes (1Km Buffer Around Nam Ma River Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.7617	20.092324
Bare Land	0.1865	4.919546
Close Forest	1.9443	51.287259
Open Forest	0.7763	20.477447
Waterbody	0.0909	2.397784
Settlement	0.0313	0.82564



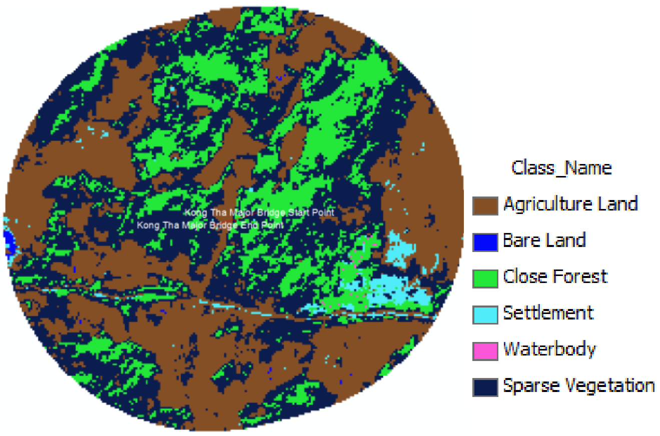
Area of LULC Classes (1Km Buffer Around Ke Mang Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	3.4042	63.121396
Bare Land	0.0104	0.192839
Close Forest	0.4271	7.919378
Settlement	0.2537	4.704159
Grass Land	0.0002	0.003708
Sparse Vegetation	1.2975	24.058519



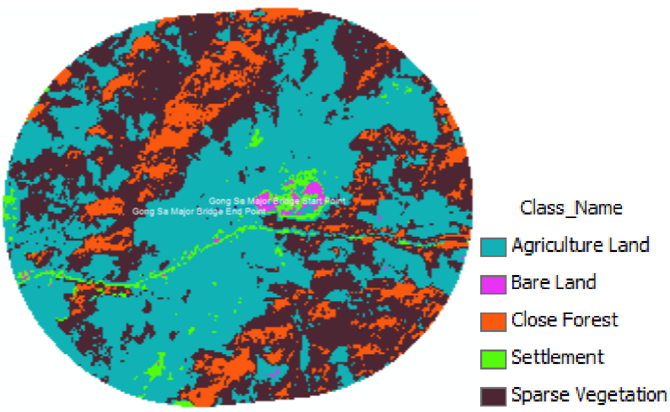
Area of LULC Classes (1Km Buffer Around San Lau 1# Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	3.3447	68.529104
Bare Land	0.0226	0.463048
Close Forest	0.3813	7.812404
Settlement	0.1167	2.39105
Sparse Vegetation	1.0154	20.804393



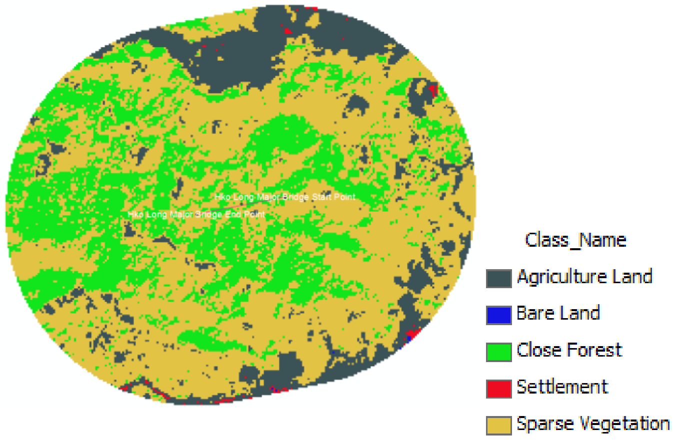
Area of LULC Classes (1Km Buffer Around San Lau 2# Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	2.2409	57.642247
Bare Land	0.0417	1.072641
Close Forest	0.4234	10.891038
Settlement	0.1121	2.883527
Sparse Vegetation	1.0695	27.510546



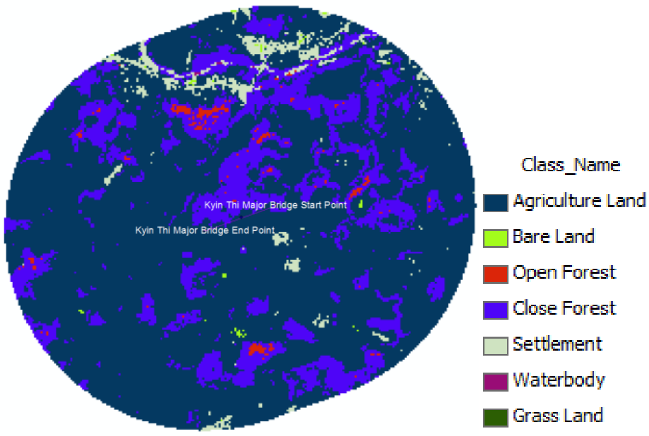
Area of LULC Classes (1Km Buffer Around Kong Tha Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	1.4072	38.737028
Bare Land	0.0067	0.184436
Close Forest	0.6717	18.490379
Settlement	0.0743	2.045311
Waterbody	0.0022	0.060561
Sparse Vegetation	1.4706	40.482286



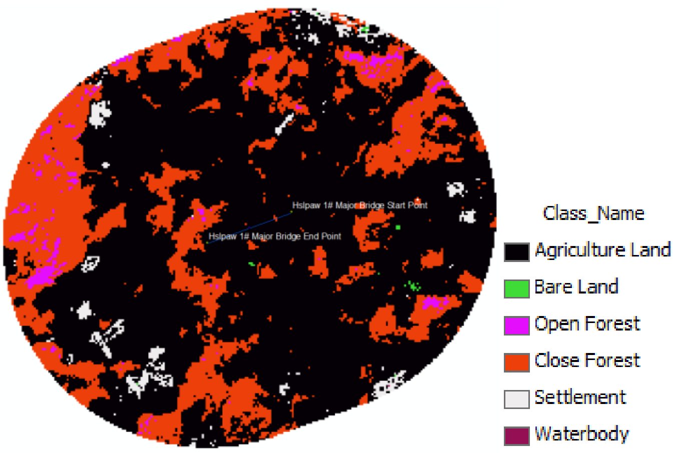
Area of LULC Classes (1Km Buffer Around Gong Sa Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	1.8555	46.987769
Bare Land	0.0231	0.584973
Close Forest	0.4165	10.547241
Settlement	0.0863	2.185419
Sparse Vegetation	1.5675	39.694598



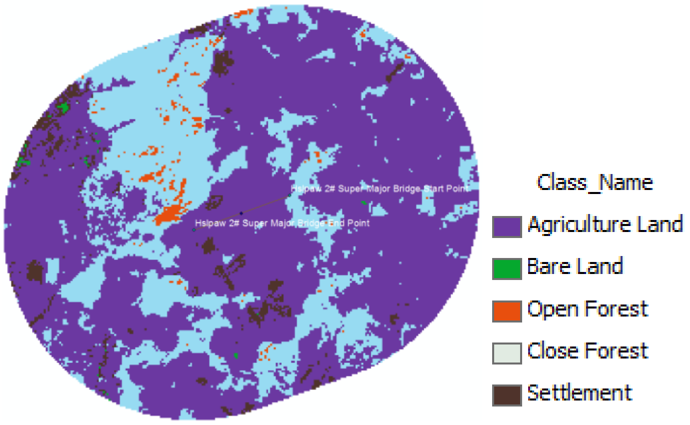
Area of LULC Classes (1Km Buffer Around Hko Long Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.5999	14.691189
Bare Land	0.001	0.024489
Close Forest	1.1528	28.231376
Settlement	0.012	0.293873
Sparse Vegetation	2.3177	56.759073



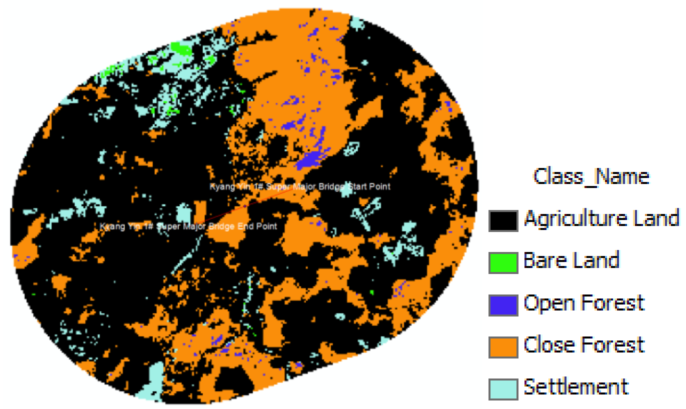
Area of LULC Classes (1Km Buffer Around Kyin Thi Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	2.9254	75.205018
Bare Land	0.0063	0.161958
Open Forest	0.0283	0.727525
Close Forest	0.8182	21.03396
Settlement	0.1106	2.843261
Waterbody	0.001	0.025708
Grass Land	0.0001	0.002571



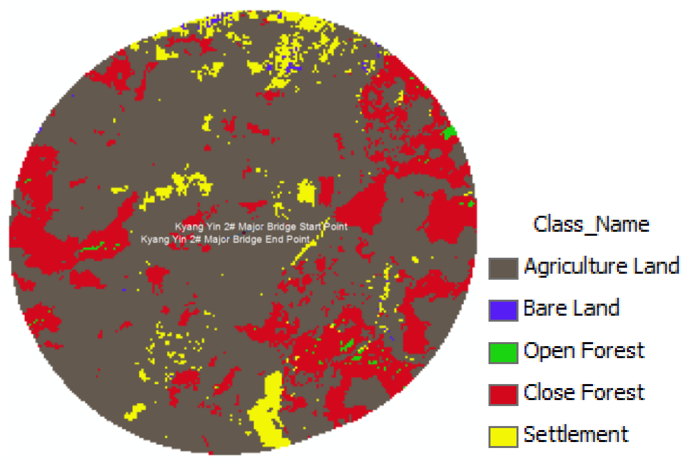
Area of LULC Classes (1Km Buffer Around Hslpaw 1# Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	2.8176	70.154122
Bare Land	0.0031	0.077185
Open Forest	0.0611	1.521301
Close Forest	1.0485	26.106118
Settlement	0.0859	2.138784
Waterbody	0.0001	0.00249



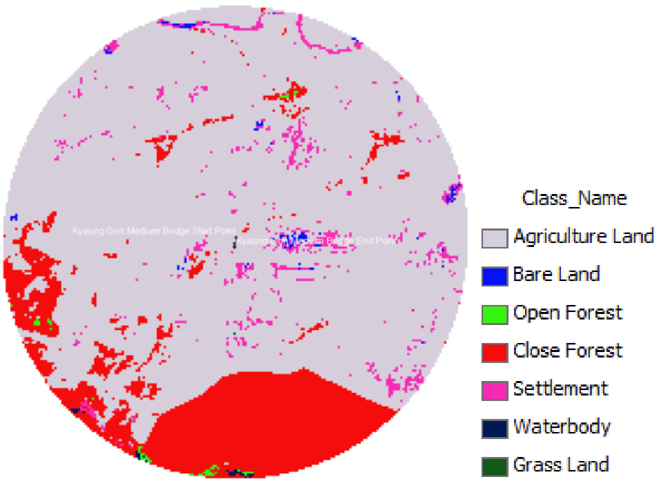
Area of LULC Classes (1Km Buffer Around Hslpaw 2# Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	2.8813	68.377711
Bare Land	0.0065	0.154255
Open Forest	0.0442	1.048934
Close Forest	1.1626	27.590299
Settlement	0.1192	2.828801



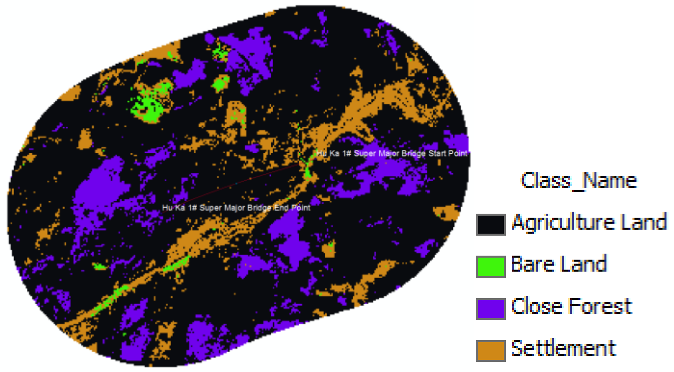
Area of LULC Classes (1Km Buffer Around Kyang Yin 1# Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	2.9529	66.027906
Bare Land	0.0191	0.427083
Open Forest	0.0462	1.033049
Close Forest	1.234	27.592684
Settlement	0.22	4.919279



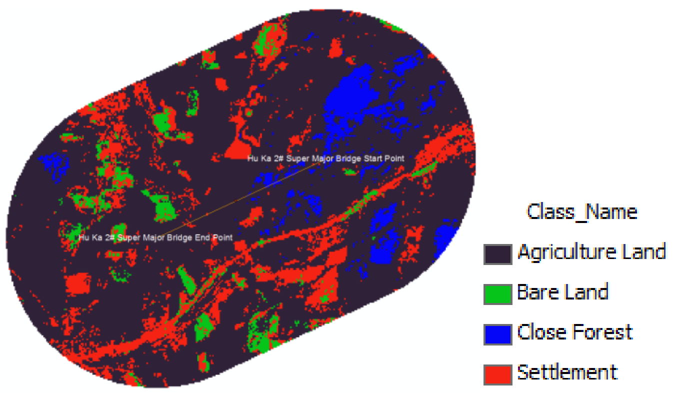
Area of LULC Classes (1Km Buffer Around Kyang Yin 2# Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	2.5913	74.232268
Bare Land	0.009	0.257821
Open Forest	0.013	0.372407
Close Forest	0.7075	20.26756
Settlement	0.17	4.869944



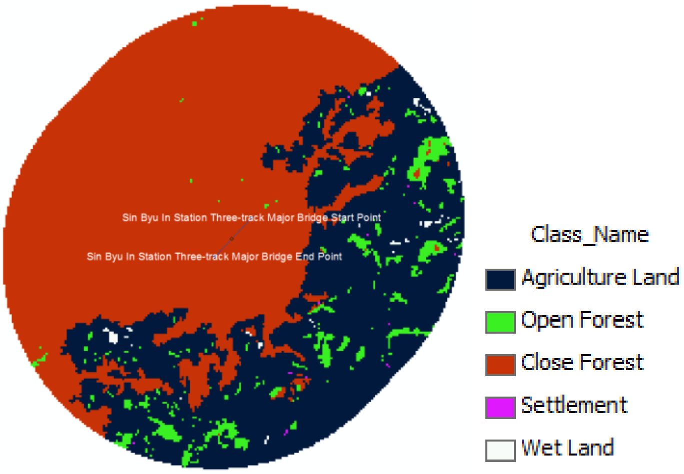
Area of LULC Classes (1Km Buffer Around Kyaung Gon Medium Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	2.5756	79.888337
Bare Land	0.0113	0.350496
Open Forest	0.0064	0.198511
Close Forest	0.5288	16.401985
Settlement	0.0984	3.052109
Waterbody	0.0034	0.105459
Grass Land	0.0001	0.003102



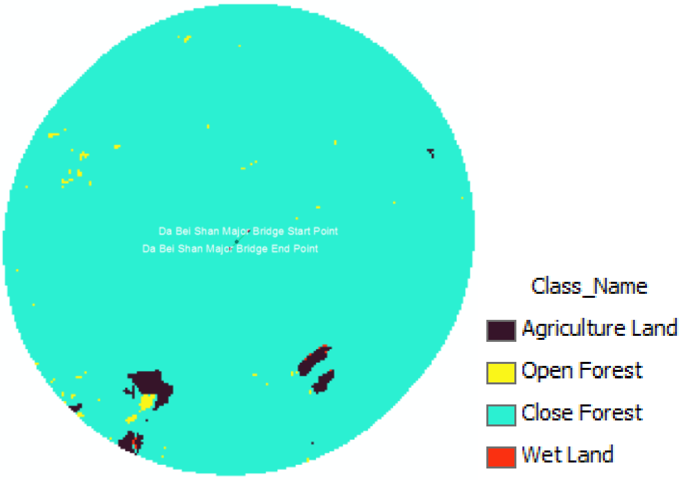
Area of LULC Classes (1Km Buffer Around Hu Ka 1# Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	3.9297	74.619752
Bare Land	0.059	1.120331
Close Forest	0.6954	13.204717
Settlement	0.5822	11.0552



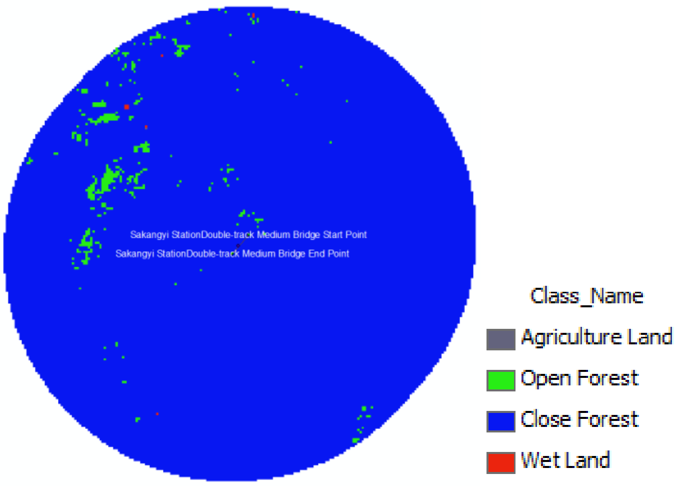
Area of LULC Classes (1Km Buffer Around Hu Ka 2# Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	4.2806	75.701199
Bare Land	0.2176	3.848194
Close Forest	0.3025	5.349627
Settlement	0.8539	15.10098



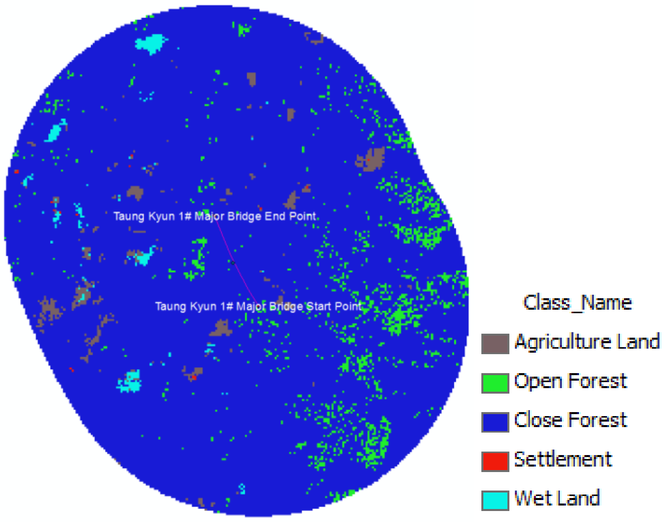
Area of LULC Classes (1Km Buffer Around Sin Byu In Station Three-track Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	1.3681	37.465768
Open Forest	0.1324	3.625808
Close Forest	2.1395	58.590755
Settlement	0.0016	0.043816
Wet Land	0.01	0.273853



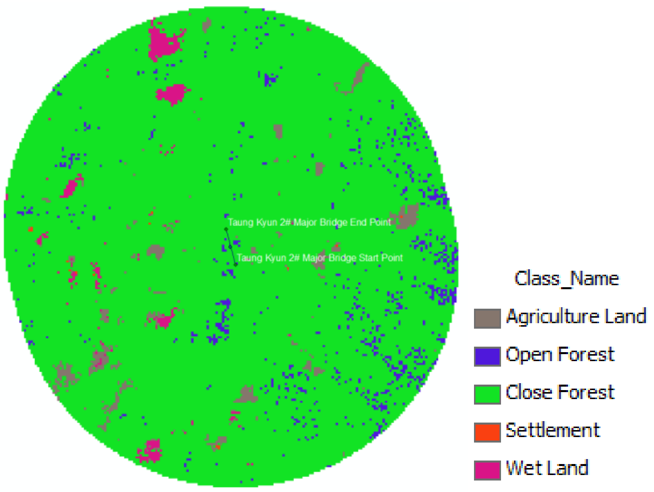
Area of LULC Classes (1Km Buffer Around Da Bei Shan Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.0407	1.209869
Open Forest	0.0138	0.410226
Close Forest	3.3083	98.344233
Wet Land	0.0012	0.035672



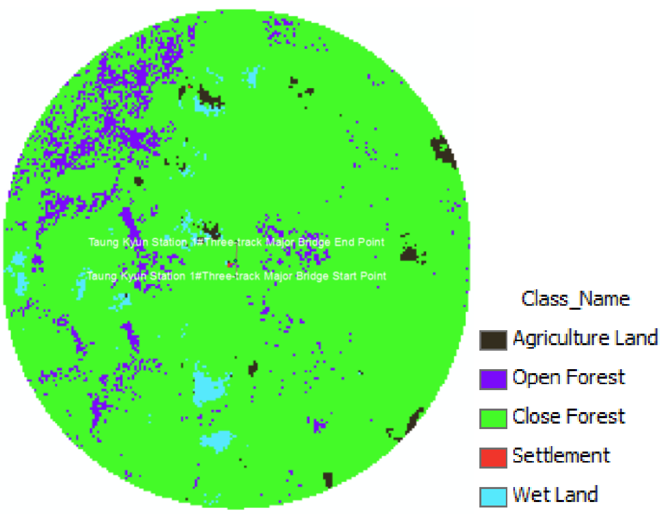
Area of LULC Classes (1Km Buffer Around Sakangyi Station Double-track Medium Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.0001	0.002976
Open Forest	0.044	1.309524
Close Forest	3.315	98.660714
Wet Land	0.0009	0.026786



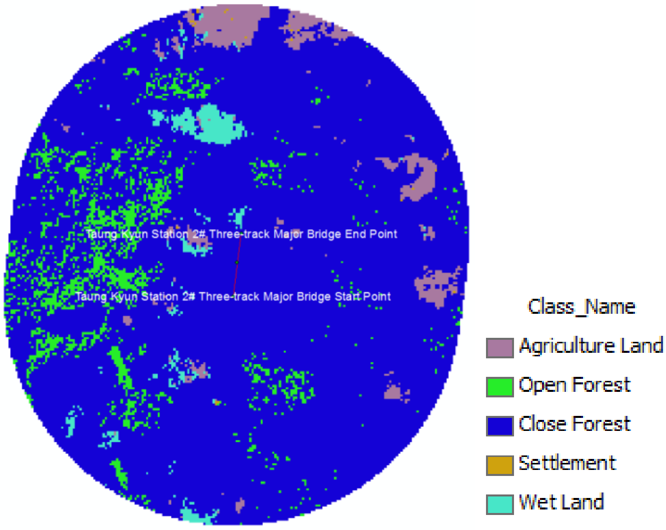
Area of LULC Classes (1Km Buffer Around Taung Kyun 1# Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.0754	1.843205
Open Forest	0.1763	4.309776
Close Forest	3.8042	92.996309
Settlement	0.0017	0.041558
Wet Land	0.0331	0.809152



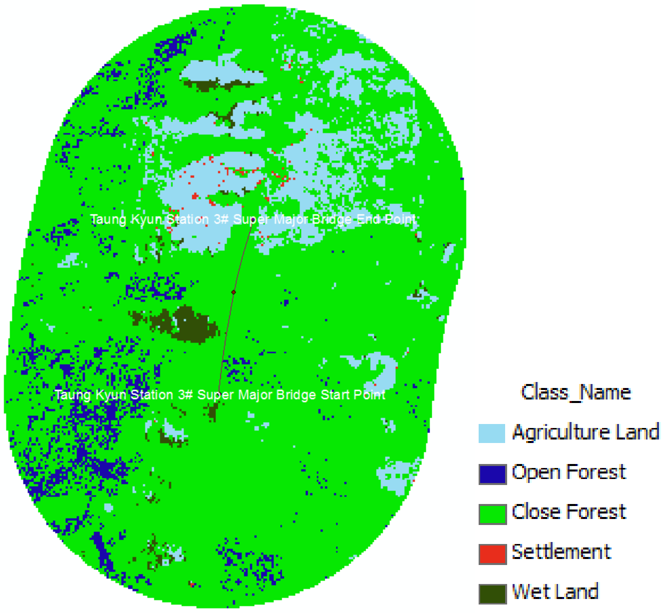
Area of LULC Classes (1Km Buffer Around Taung Kyun 2# Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.0786	2.263108
Open Forest	0.0972	2.798653
Close Forest	3.2477	93.510121
Settlement	0.0015	0.043189
Wet Land	0.0481	1.38493



Area of LULC Classes (1Km Buffer Around Taung Kyun Station 1#Three-track Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.0375	1.093167
Open Forest	0.2228	6.494869
Close Forest	3.1133	90.75618
Settlement	0.0004	0.01166
Wet Land	0.0564	1.644123



Area of LULC Classes (1Km Buffer Around Taung Kyun Station 2# Three-track Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.1453	3.935643
Open Forest	0.2484	6.728243
Close Forest	3.2231	87.301931
Settlement	0.0025	0.067716
Wet Land	0.0726	1.966467



Area of LULC Classes (1Km Buffer Around Taung Kyun Station 3# Super Major Bridge)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	0.5846	12.152583
Open Forest	0.2582	5.367425
Close Forest	3.8768	80.590375
Settlement	0.0121	0.251533
Wet Land	0.0788	1.638083

By studying the above, the LULC for bridges and culverts are such that agricultural land (39.7961%), open forest (9.9299%), close forest (35.6943%), water body (0.3984%), bare land (4.1877%), settlement area (3.3493%), wetland (0.1193%), grassland (0.0092%), and sparse vegetation (6.5489%).

4.14. Description of the Alternative

Although the alternative analysis will be conducted no project alternative, location alternative, construction methods alternative, Location alternative analysis cannot be made during FS stage because detailed alignment with exact locations of bridges and culverts are not designated by the developer during FS stage. So, the alternative analysis will mention only no action alternative and construction methods alternative.

4.14.1. The "No Action" Alternative

This alternative avoids the implementation of bridge construction along the Muse-Mandalay Railway. In no project scenario case, there will be no impact on natural environment and local communities. But there will be positive impacts on residents' life quality in "Project Scenario" case. So, it is necessary to considervfrom environmental and social perspectives.

(a) From an Environmental Perspective

Although the development of the proposed project will have more or less environmental impacts, the levels of acceptability will be decided in conjunction with threshold criteria as shown in the following table.

Threshold Criteria to Determine the Acceptability of Environmental Impacts

Level of Acceptability	***Threshold Criteria for Potential Impacts***
Unacceptable	Exceeds legal or regulatory standard, e.g. water quality standard. Increases level of risk to public health. Extinction of biological species, loss of genetic diversity, rare or endangered species, critical habitat.
Normally Unacceptable	Conflict with policies or land-use plans. Loss of populations of commercial biological species. Large scale loss of productive capacity of renewable resources.
May be Acceptable with Mitigation	Avoidance of spread of biological disease, pests, feral animals or weeds. Some loss of threatened habitat.
Normally Acceptable	Some loss of populations and habitats of non-threatened species. Modification of landscape without downgrading special aesthetic values. Emissions demonstrably less than the carrying capacity of the receiving environment.

Source: Modified from Sippe (1999)

The "No Action" alternative will be considered according to the above table for the environmental perspective.

All of the project's related environmental impacts can be mitigated to allowable levels with proper mitigation measures and so the proposed project can be considered as may be acceptable with mitigation. The "No-Action" alternative is not a feasible alternative, as it would lead to loss of significant foreign direct investment as well as significant employment opportunities – direct employment opportunities are currently estimated at 700 (on average) during the 5 years of construction period, including some migrant workers and some local people. But this work force condition may change depending on the workforce requirement of the construction site condition and the worker readiness from the project developer, and so the job opportunity for local people is estimated as 350 people.

(b) From an Socio-economic Perspective

A "no-project" option will mean that the status quo remains and all the social impacts related to the existence of the projects are not envisaged. This implies that if the project were not to proceed, none of the positive or negative impacts identified in this study will materialize. A no-project option will see all the anticipated project benefits not realized. The construction of the bridge is necessitated for the railway because the railway project has to cross valley, rivers, streams and some road passing. So, the benefits of this option will include loss of foreign capital investment, loss of transportation development in the regions, loss of employment opportunities for local people, loss of infrastructure development, loss of increased business opportunities for local services, loss of skill development and improved services and of community development potential among other benefits of the project.

There will only one transportation road (Muse-Mandalay Highway) from Mandalay to Muse and the existing railway is long from Mandalay to Lashio. So, the proposed high speed railway will be played and keeps playing an important role in the economic and social development of regions worldwide due to its ability to haul large quantities of goods and significant numbers of people over long distances and reasonable travel times. According to the social impact assessment, all of the socio-economic impacts can be mitigated with proper mitigation measures and so no project option is not feasible for the current development of transportation sector in Shan Region.

4.14.2. Locative Alternative

All of the alternative analysis was done within 1km beside the proposal alignment except for household that were accounted based on 100m beside the railway alignment. Alternative analysis for bridges and culverts will be based on the type of land use that the bridge will pass through the sensitive forest areas. The land use type will be studied by GIS and remote Sensing Method based on buffer width 1km around the rail track center. There are five different portions at which area calculation of land over classes are as follows:

(1) Shweli East – Man Hawang Section
(2) Nam Hpak Ka to Lashio West Section
(3) San-Lau Myin Gwin
(4)Myin Gwin Om Ma Ka
(5) Om Ma Ka Mandalay East

(1) Shweli East – Man Hawang Section

In this section, the geological conditions of the proposed main line is good, the amount of demolition will be small and the project implementation and resettlement will be relatively simple. After that, the bridges in this section did not pass the sensitive forest area so alternative consideration is not needed.

(2) Nam Hpak Ka to Lashio West Section

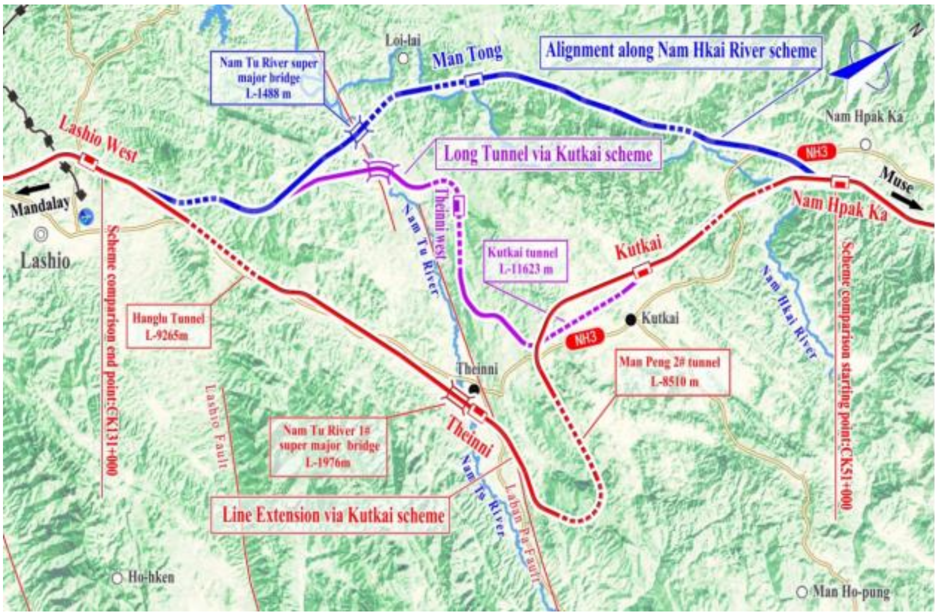


Figure 4.30 - Schematic Map for Alignment Scheme of Nam Hpak Ka-Lashio West Section

The proposal main line will pass through the two economic centers of Kutkai and Theinni,and it will promote local economic development. Furthermore, the Ministry of Transport and Communicaitons of Myanmar attaches great importance to the economic development of Kutkai area and hopes that the route will pass through Kutkai. In this section Man Peng 2 Super Major Bridge is needed to be considered for alternatives because it has the largest land used area or passing forest areas. And Kutkai1 Super Major Bridge has the longest bridge but smallest land used area. Therefore Kutkai 1 Super Major Bridge is not needed to consider for location alternative. The bridges passed through the sensitive forest and land used area are shown below.

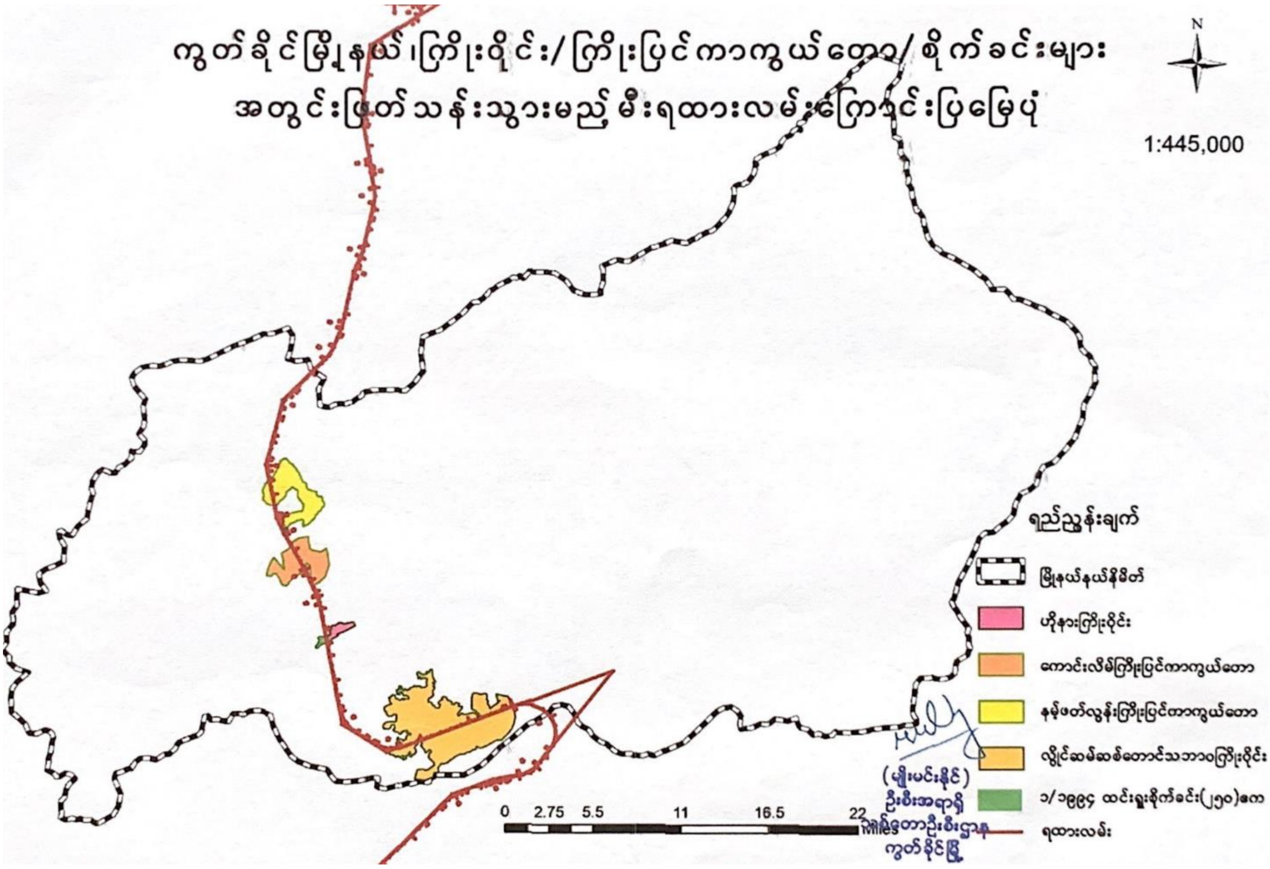


Figure 4.31.. Forest Area and Forest Plantation that the Railway will Pass in Kuit Kai Region

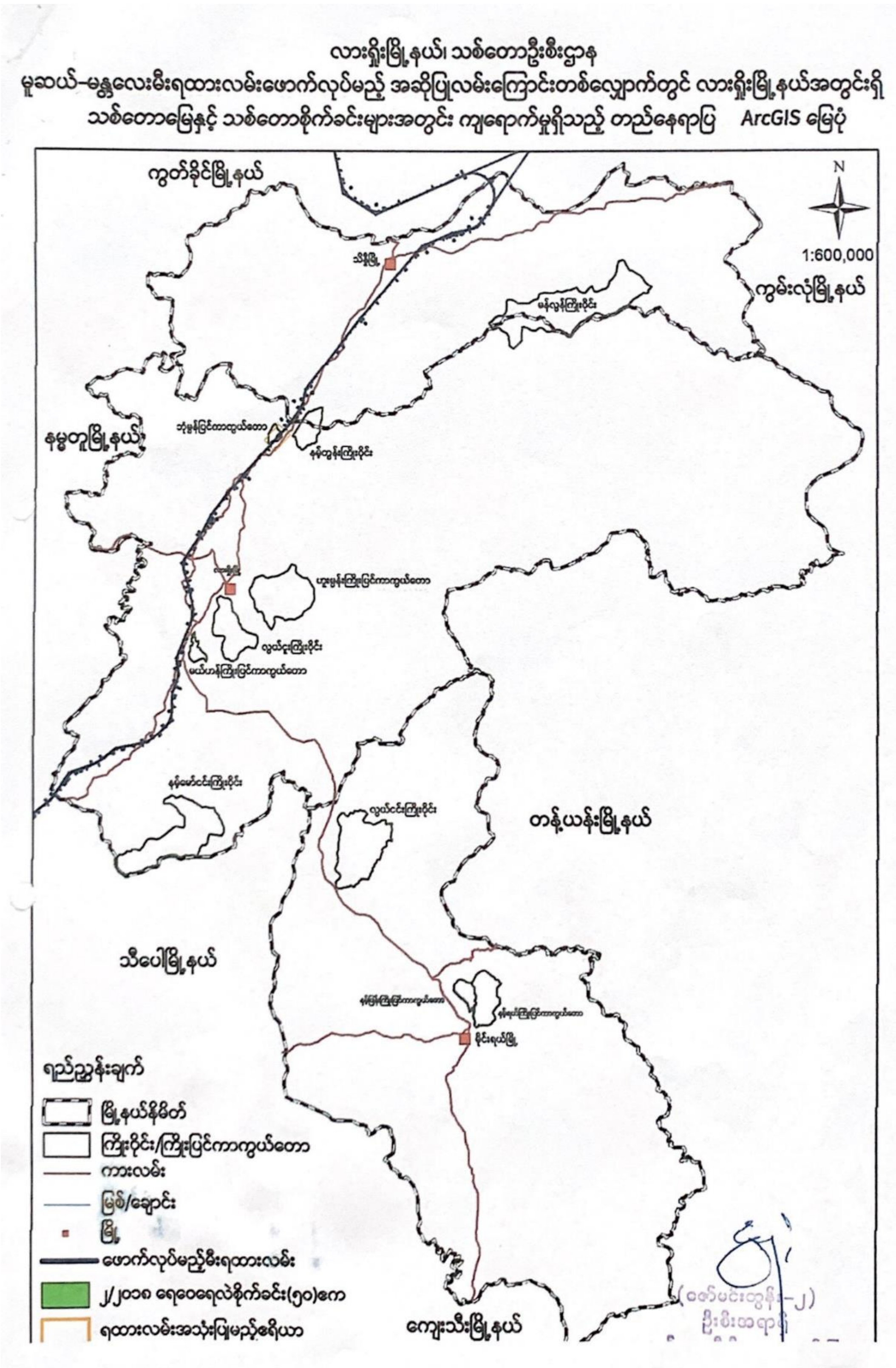


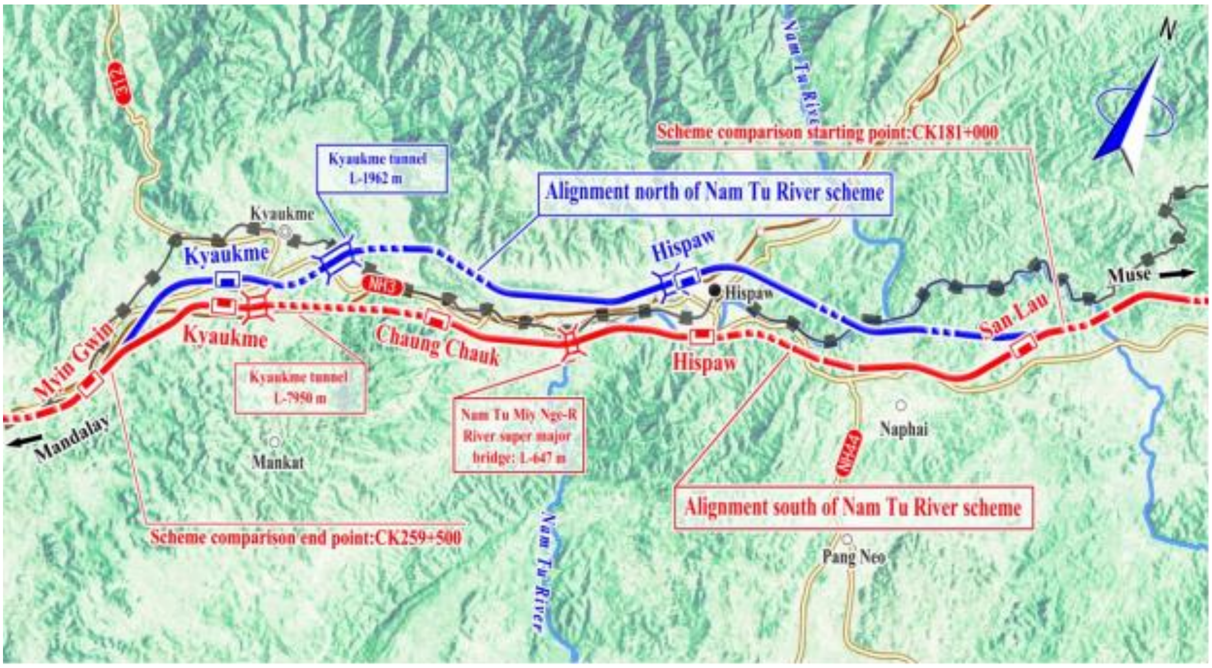
Figure 4.32. Forest Area and Forest Plantation that the Railway will Pass in Lashio Region

No.	Bridges	Forest	Sensitive Forest Areas (km^2)
1.	Nam Hkai River Major Bridge	Nam Palon	2.124
2.	Kutkai 1 Super Major Bridge	Honar Reserved Forest	1.051
3.	Man Peng 2 Super Major Bridge	Loi Sam Sit	3.629
4.	Nawang Yen Double Track Medium Bridge	Loi Sam Sit	3.317

According to the study about the data from forest department and GIS study, Nam Hkai River Major bridge and Man Peng 2 Super Major Bridge pass the forest in Kutkai region. So, in general the location of all bridges between Nam Hpak Ka – Lashio West Section can be considered based on the alternative analysis of railway alignment.

Man Peng 2 Super Major Bridge

(3) San-Lau Myin Gwin



Schematic Map of the alignment scheme of San lau-Myin Gwin Section

This line is adjacent to the mountain on the south and the river on the north however the station is closely adjacent to the NH3 Highway Bridge and it will facilitate the travel of passengers. And then, this route is good construction condition and convenient in traffic condition. Ke Mang Super Major Bridge is the longest bridge and Kyang Yin 1 Super Major Bridge is passed through the large sensitive area in this section. So Kyang Yin 1 Super Major Bridge will be considered for location alternative. The bridges passed through the sensitive forest and land used area are shown below.

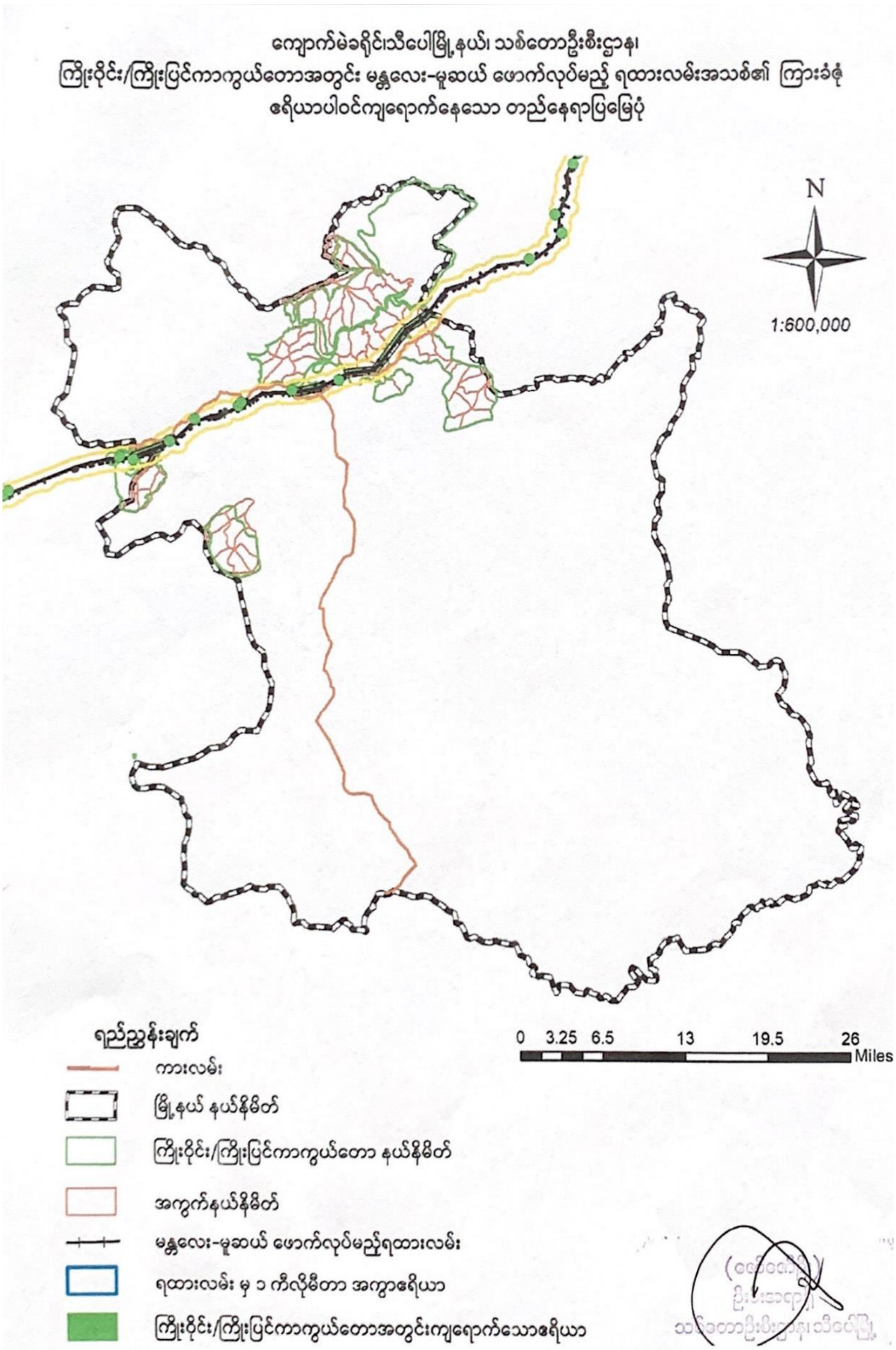


Figure 4.33. Forest Area and Forest Plantation that the Railway will Pass in Thipaw Region

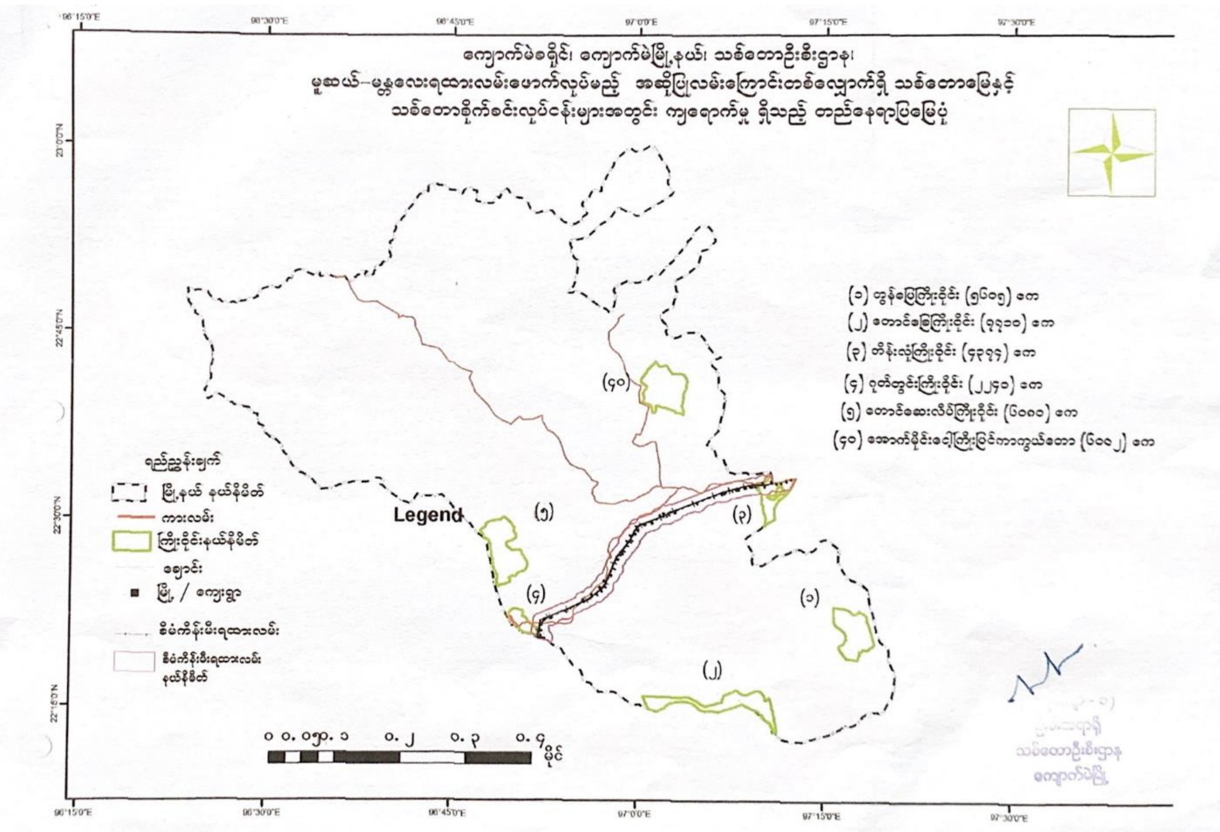


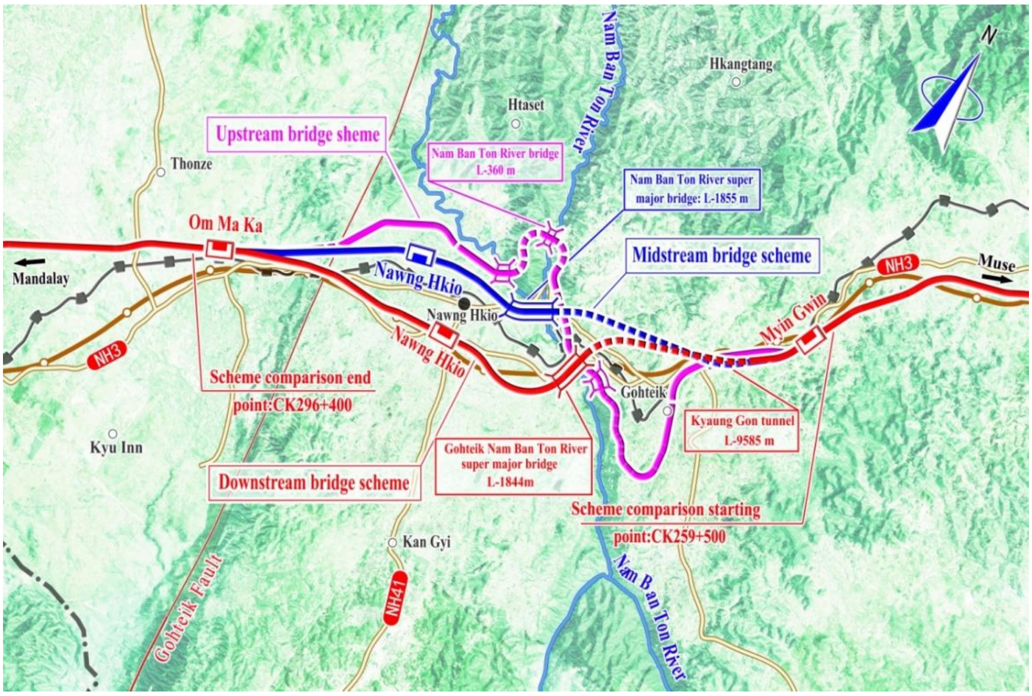
Figure 4.34. Forest Area and Forest Plantation that the Railway will Pass in Kyauk Mae Region

No.	Bridges	Forest	Sensitive Forest Areas (km2)
1.	Ke Mang Super Major Bridge	Namtu Forest	0.427
2.	San Lau 1 Super Major Bridge	Namtu Forest	0.381
3.	San Lau 2 Super Major Bridge	Namtu Forest	0.423
4.	Kang Tha Major Bridge	Namtu Forest	0.672
5.	Gong Sa Major Bridge	Namtu Forest	0.417
6.	Hko Long Major Bridge	Pang Hsauk Forest	1.153
7.	Kyin Thi Major Bridge	Tain Lone Forest	0.847
8.	Hsipaw 1 Major Bridge	Tain Lone Forest	1.110
9.	Hsipaw 2 Major Bridge	Tain Lone Forest	1.207
10.	Kyang Yin 1 Super Major Bridge	Tain Lone Forest	1.280
11	Kang Yin 2 Major Bridge	Tain Lone Forest	0.721

According to the above table, Kyang Yin 1 Super Major Bridge pass the forest in Hsipaw region. So, in general the location of all bridges between San Lau – Myin Gwin Section can be considered based on the alternative analysis of railway alignment.

Kyang Yin 1 Super Major Bridge

(4) Myin Gwin - Om Ma Ka



Schematic Map for the alignment scheme of Myin Gwin-Om Ma Ka section

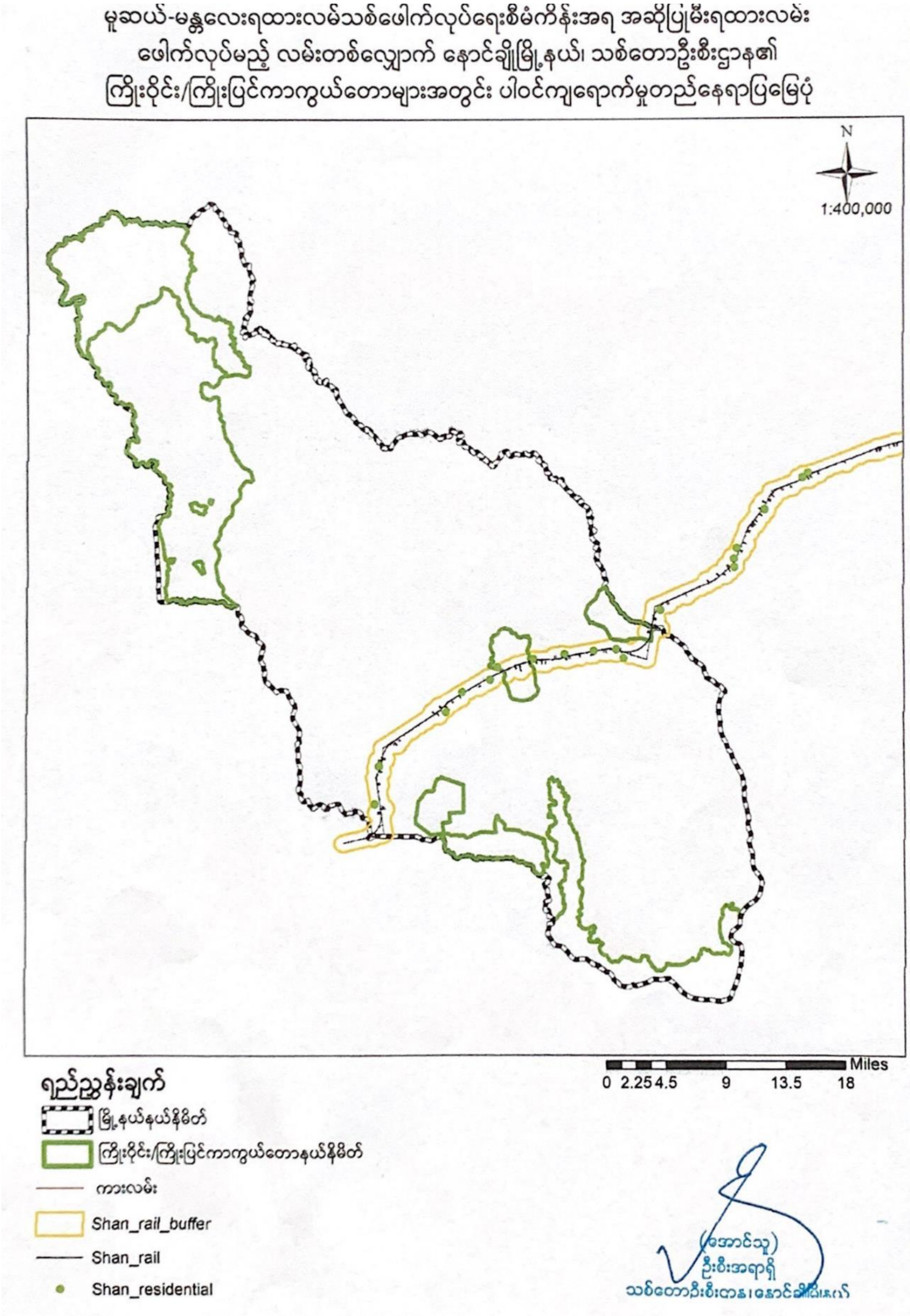
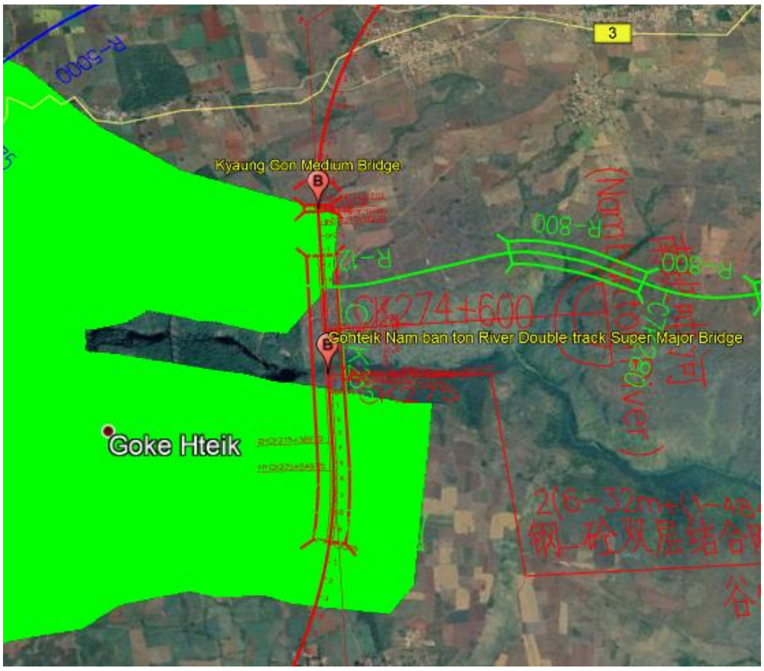


Figure 4.35. Forest Area and Forest Plantation that the Railway will Pass in Naung Cho Region

According to the above table, Gohteik Nam Ban Ton River Double Track Super Major Bridge pass through the forest near Naung Cho region.



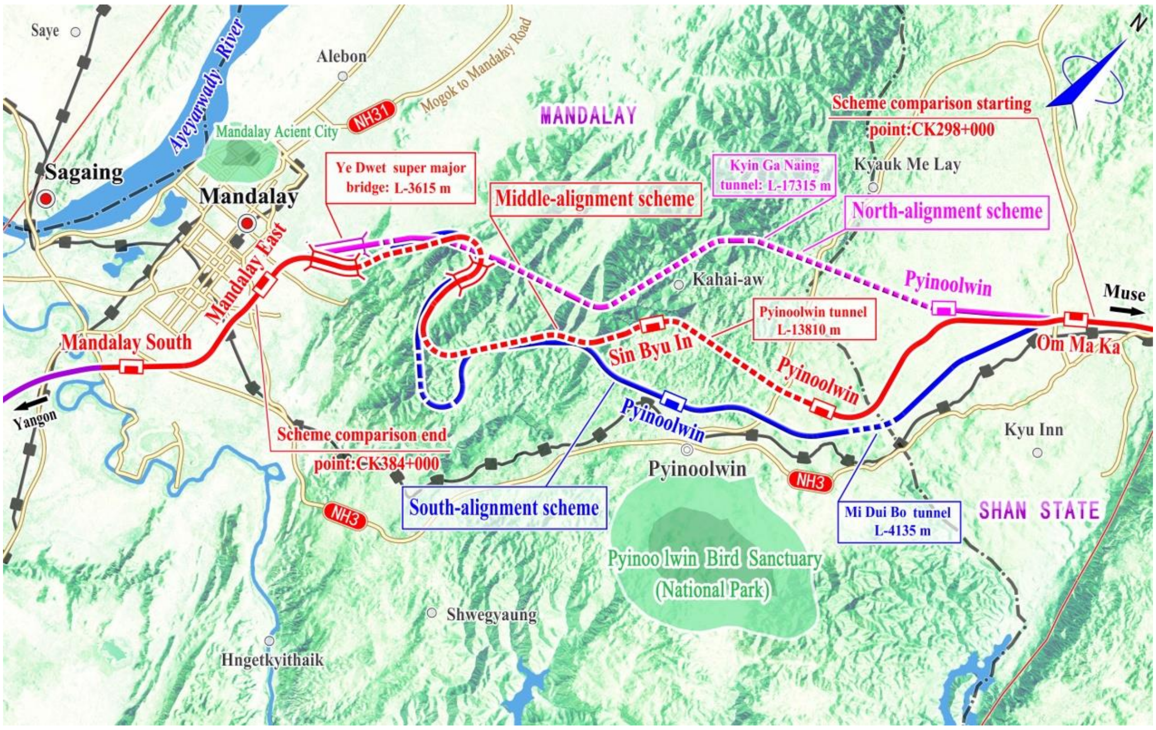
Gohteik Nam Ban Ton River Double Track Super Major Bridge

The bridges passed through the sensitive forest and land used area are shown below.

No.	Bridges	Forest	Sensitive Forest Areas (km^2)
1.	Kaung Gon Medium Bridge	Goketwin	0.535
2.	Gohteik Nam Ban Ton River Double Track Super Major Bridge	Goketwin	1.785
3.	Hu Ka 1 Super Major Bridge	Nawng Cho Forest	0.6954
4.	Hu Ka 2 Super Major Bridge	Nawng Cho Forest	0.3025

This section crosses the Nam Ban Ton River by the Nam Ban Ton River Super Major Bridge but it has less high piers and larger main span. The geological condition of this section is relatively good and it does not cross the fault. Gohteik Nam Ban Ton River Double Track Super Major Bridge is the longest bridge and passed through the large sensitive areas so location alternative for railway alignment should be considered for this bridge.

(5) Om Ma Ka - Mandalay East



Schematic Map for the alignment scheme of Om ma ka–Mandalay section

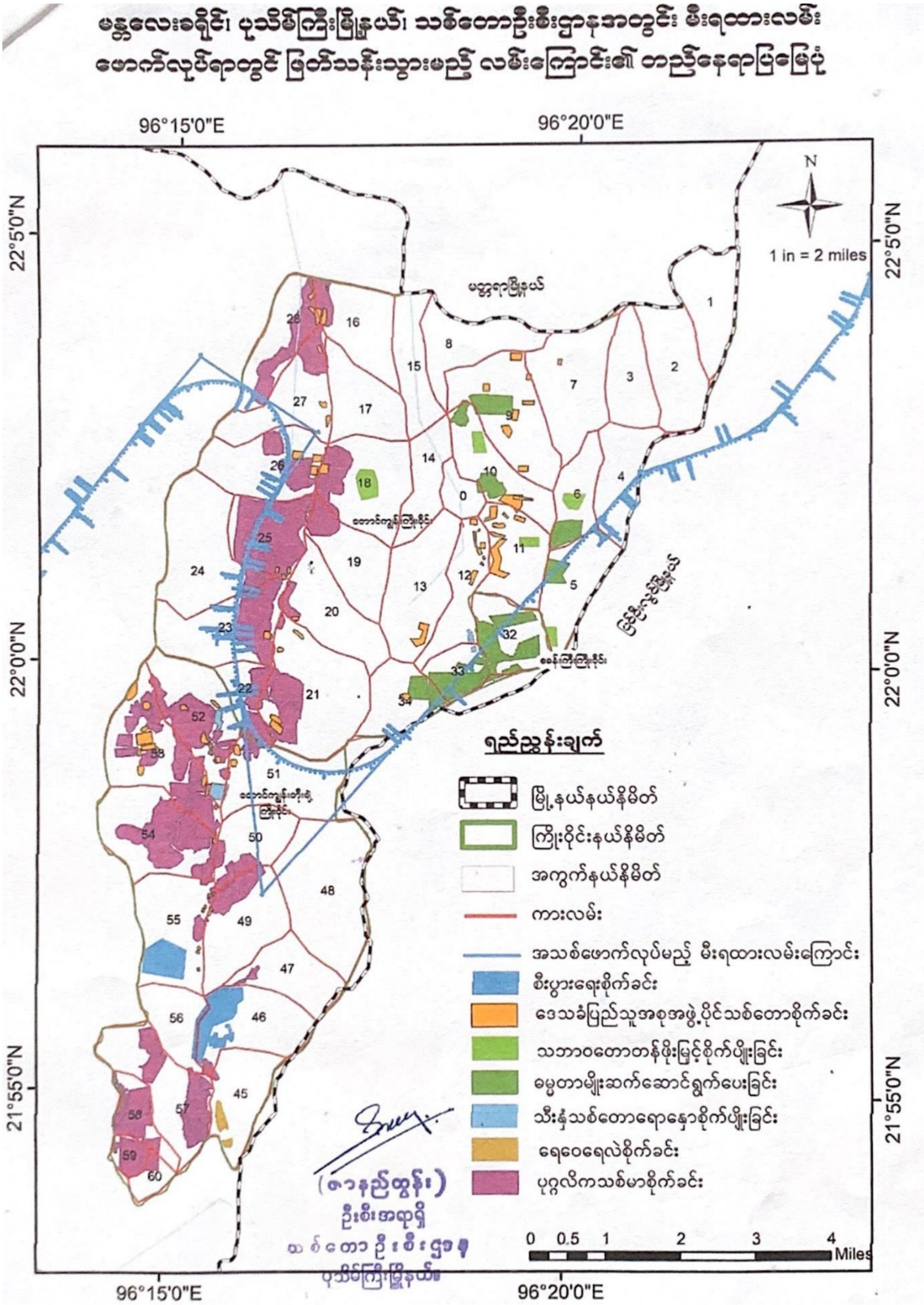
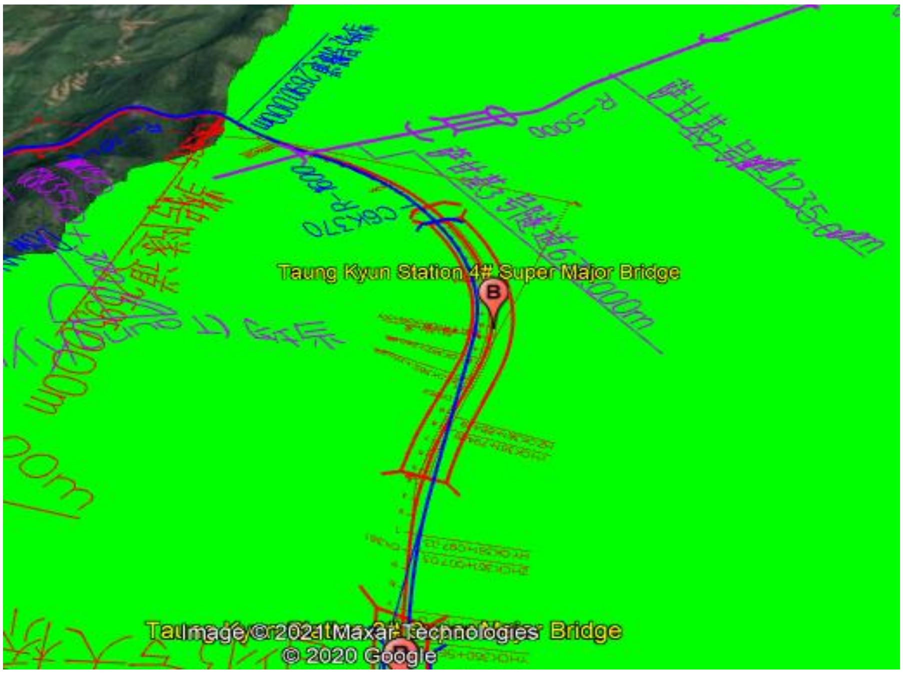


Figure 4.36. Forest Area and Forest Plantation that the Railway will Pass in Pathein Gyi Region

Om Ma Ka Madalay East section passed through the two economic centers of Pyin Oo Lwin and Madalay. The demolition amount is small and no impact on groundwater in Pyin Oo Lwin City. Taung Kyun Station 4 Three Track Major Bridge is needed to consider for location alternatives because it is the longest bridge and large sensitive forest areas. The bridges passed through the sensitive forest and land used area are shown below.

No.	Bridges	Forest	Sensitive Forest Areas(km^2)
1.	Sin Byu In Station Three Track Major Bridge	Taung Khaung Forest	2.272
2.	Da Bei Shan Major Bridge	Taung Kyung & Extended	3.322
3.	Sakangyi Station Doble Track Medium Bridge	Taung Kyun & Extended	3.359
4.	Taung Kyun 1 Major Bridge	Taung Kyun & Extended	3.9805
5.	Taung Kyun 2 Major Bridge	Taung Kyun & Extended	3.345
6.	Taung Kyun Station 1 Three Track Major Bridge	Taung Kyun & Extended	3.336
7.	Taung Kyun Station 2 Three Track Major Bridge	Taung Kyun & Extended	3.472
8.	Taung Kyun Station 3 Three Track Major Bridge	Taung Kyun & Extended	4.135
9.	Taung Kyun Station 4 Three Track Major Bridge	Taung Kyun & Extended	5.453

According to the above table, Taung Kyun Station 4 Three Track Major Bridge pass through the forest near Pyin Oo Lwin region. So, in general the location of all bridges between Om Ma Ka - Mandalay East Section can be considered based on the alternative analysis of railway alignment.



Taung Kyun Station 4 Three Track Major Bridge

4.14.3. Construction Method Alternatives (Alternative Analysis for Bridge Type)

This alternative analysis will include different construction alternatives such as steel truss arch bridge, cable stay bridge including single-span, two-span and three-span arrangements. This analysis for bridge construction methods will consider from the technical, traffic, environmental, social, economic, and financial point of view. Full analysis will be included in EIA report. The following are some construction method of bridges.

(a) Steel Truss Arch Bridge

The steel-concrete double rigid frame bridge has a high pier with small span, therefore the construction difficulty is not large and the construction period is short. The deck type steel truss arch bridge has a large span, the arch may be cantilevered in sections using a creeping crane that is mounted on top of the arch. The crane lifts rib sections from barges or pontoons below. The bridge deck is then constructed from both ends, meeting in the middle. The high strength-to-weight ratio of steel minimizes the structural weight of superstructures and thus minimize the substructure costs, which is particularly beneficial in poor ground conditions.

Figure 4.37 - Design sketch of Deck type steel truss arch bridge

(b) Cable-Stayed Bridge

A cable-stayed bridge is a structure with several points in each span between the towers supported upward in a slanting direction with inclined cables and consists of main tower(s), cable-stays, and main girders. In comparison with the continuous girder bridges, the internal forces due to both dead load and live load are much smaller in cable-stayed bridges. For mechanical point of view, a cable-stayed bridge is a statically indeterminate continuous girder with spring constraints. The cable-stayed bridges are also highly efficient in use of materials due to their structural members mainly works in either tension or compression (axial forces). Cable-stayed bridges have the second-longest spanning capacity (after suspension bridges), and they are practically suitable for spans up to around 1000 m.

Figure 4.38 - Design sketch of cable-stayed bridge

(c) Comparison of the Preferred Alternatives

The following table shows the overall considerations for bridge construction methods.

Construction method	Technical Perspective	Economic Perspective	Environmental Perspective
Cable-stayed bridge	Cable-stayed method of construction is used for constructing bridges that span more than 300m	In cable-stayed bridge, it is more expensive to install them when compared to some of the other options. It is usually replaced with an arch bridge because of the effectiveness of the design and its overall tensile strength when combined with the final cost in comparison.	Environmental impact will be depended on the bridge foundation process. It will be nearly the same with the piling activity.
Steel-truss arch bridge	In steel-truss arch bridge, it is suitable to use for span length of about 50 to 170m and it can be used in poor ground conditions.		

According to the above table, environmental impact of both of the construction methods will be near the same and so the alternative selection of construction method will be based on technical and economic perspectives. From the technical perspective, steel-truss arch bridge can be used for the short length of bridge and cable-stayed bridge is more suitable for the longer length. From the economic perspective, steel-truss arch bridge is more suitable than cable-stayed bridge in choosing the bridge construction method. According to the above table, steel-truss arch bridge is more suitable to use the length of less than 700 meters.

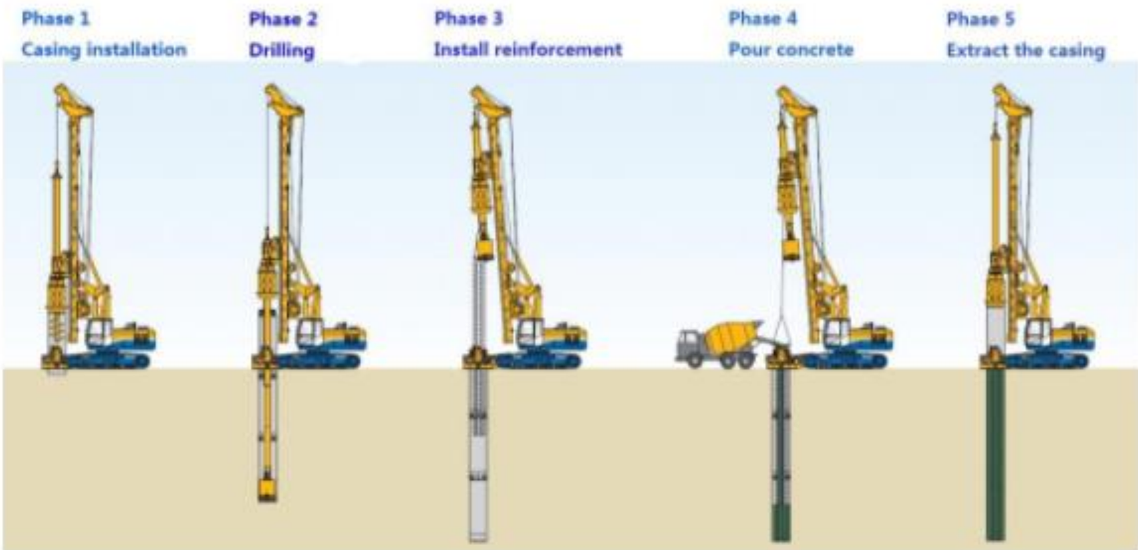
4.14.4. Construction Method Alternative (Alternative Analysis for Pilling Machine)

Piling is one of the most important process in bridge construction with most environmental impacts. Piling is used to strengthen the soil on ground and able to support the load of bridges. Piles have to be driving into the ground by using piling machine, there is few different types of piling machine in the market and all of them have different usage. The usage of types of piling machine is depending on the type of piles used, different types of piling machine may affect the procedure of pile driving too. Location of site affect the usage of type of piling machine too, because some of the piling machines make noisy voice and it may affect the nearby resident. So, alternative analysis for pilling machine and pilling method will be made as process alternative. The following are the type of pile foundations based on construction method.

(a) Bored Cast-In-Place Pile Method

Cast in-situ piles can be either driven or bored. Driven cast in-situ piles are economical for light to moderate loading conditions. Driven cast in-situ piles are difficult to use for deep penetrations and grounds having boulders and other major obstructions. In there, bridge construction is super structure high load condition and thus, driven cast in-situ piles as alternative analysis are not considered in this study.

Bored cast in-situ piles are the type formed by drilling holes with or without liners. If the liners are left permanently, they are termed as cased pile and as uncased pile if the liners are removed. Installing a cast-in-place pile starts with drilling a vertical hole into the soil, using a cast-in-place piling machine. The machine can be outfitted with specially designed drilling tools, buckets, and grabs to remove the soil and rock. Piles can be drilled to a depth of up to 60 meters and a diameter of up to 2.4 meters. The drilling process may include driving a temporary steel cylinder, or sleeve, into the soil. This remains in place in the upper portion of the hole until the pile is poured. Once the hole is drilled, a structure of reinforcing steel rebar is built and lowered into the hole, then the hole is filled with concrete. The top of the pile may be capped with a footing or pier near ground level to support the structure above. Excavated bore walls and bottoms are usually protected by casing tubes covering the whole length of the bore and water in it, but only a casing tube may be used in some cases depending on properties of soil layers. Suitable for very high working loads and where ground heave conditions are to be avoided.

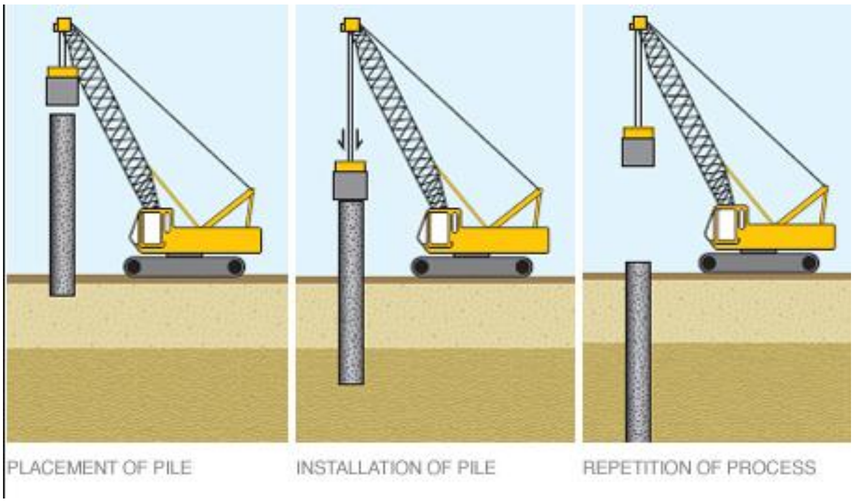


Source: basiccivilengineering.com

Figure 4.39 - Cast-in-situ Pile Foundation

(b) Driven Pile (Precast Pile)

Precast pile is a long, slender column made of preformed material and having a predetermined shape and size that can be installed by impact hammering, vibrating or pushing it into the ground to a design depth or resistance. When piles are driven into the granular soils, they displace the equal volume of soil. This helps in compaction of soil around the sides of piles and results in the densification of soil. The piles which compact the soil adjacent to it is also called as compaction pile. This compaction of soil increases its bearing capacity. Multiple pile types with various section properties are available to resist almost any load demand. Pile lengths for some pile types can be easily adjusted and spliced in the field to accommodate variations in subsurface conditions.



Source: saudifoundations.com

Figure 4.40 - Driven Pile Foundation

(c) Comparison of the Preferred Alternatives

The preferred construction method would be predominantly determined by engineering factors including safety, geological conditions, site conditions / constraints, accessibility, programme and cost effectiveness. Environmental considerations have also been taken into account to minimize the potential noise, air quality, water quality and cultural heritage impacts as well as waste management aspects.

(i) Environmental Perspective

The potential environmental issues associated with each of the bridge construction methods are shown in the following table.

Table – Environmental Perspective of Bridge Construction Methods

Piling Method	Environmental Perspective
Bored Cast-in-Place Pile Method	➢ The main concern in using these piles will be the disposal of the augured earth materials especially in case of contaminated soils. ➢ In river crossings bridges, dewatering process for construction of foundation causes changes of water flow, higher level of turbidity.
Driven Pile Method	➢ Near residential areas, by hammering in driving the piles may cause sound pollutions. Noise levels associated with typical impact pile driving activities depend upon the hammer and pile type used. Noise from impact pile driving operations typically ranges from around 80 to 135 dBA. ➢ Driven piles can be caused by installing to vibrations can result in complaints from people nearby, who may become aware of pre-existing problems with their own houses and property that they then blame on piling vibration. ➢ In underwater works, driving a pile into the sediment with an impact hammer introduces high intensity impulsive sound waves can potentially cause injury in aquatic life at high received levels. ➢ In river crossings bridges, dewatering process for construction of foundation causes changes of water flow, higher level of turbidity.

According to the above table, all of the bridge construction techniques have their own environmental perspective. From the environmental point of view, Bored Cast-in-Place Pile Method may be the less environmental impact. So, Bored Cast-in-Place Pile Method will be the most suitable method from the environmental point of view.

(ii) Technical perspective

Genarally, the anticipated geological conditions along the alignment are critical in the selection of the construction methods. The type of soil, rock and the presence of water have a fundam ental impact on the selection. The considerations for technical perspective will be as follow:

Piling Method	Pros	Cons
Bored Cast-in-Place Pile Method	➢ It is suitable for very high working loads and where ground heave conditions are to be avoided. ➢ Piles of variable lengths can be extended through soft, compressible, or swelling soils into suitable bearing material. ➢ Vibration is relatively low, reducing disturbance of adjacent piles or structures. ➢ Large excavations and subsequent backfill are minimized. ➢ With the action of wet drilling of pile bored, it can be drilled by reverse rotary method of drilling and this action is suitable for any soil type and consistency of strata, and all water table depths.	➢ Bored piles would not be suitable in loose water-bearing sand, and under-reamed bases cannot be used in cohesionless soils since they are susceptible to collapse before the concrete can be placed by dry drilling of pile bored . ➢ It is difficult to construct cast in situ piles where the underground water flow is heavy. ➢ Bored cast in-situ pile is not available as speedy construction because after the concrete is poured in cast in situ piles it requires sufficient time to lapse for gaining the designed strength which requires time. ➢ As all the work is carried out at site open conditions, weather plays a decisive role in quality as well as the pace of work. The mix design may need to be revised and adjusted accordingly and heavy rains and floods might cause delay in the work
Driven Pile Method	➢ Pre-cast piles can be used under high loading conditions and with minimum construction time at site. These pre-cast piles can also be prestressed and hence will have a higher load capacity. ➢ Piles can be precast to the required specifications. ➢ A pile driven into glandular soil compacts the adjacent soil mass and as a result the bearing capacity of the pile is increased. ➢ Driven piles may conveniently be used in place where it is advisable not to drill holes for fear of meeting ground water under pressure	➢ Driven piles cannot be used economically in ground containing boulders, or in clay when ground heave would be detrimental. ➢ Driven piles are not suitable in soils of poor drainage qualities because the type of clayey soils is not compacted when driven piles are drilled through it. This results in increase in pore water pressure and decrease in bearing capacity of the soil. ➢ Precast or prestressed concrete piles must be properly reinforced to withstand handling stresses during transportation and driving. And advance planning is required for handling and driving. ➢ Where the foundations of adjacent structures are likely to be affected due to the vibrations generated by the driving of piles, driven piles should not be used.

The foundation method for each bridge has been selected based on the engineering and site issues/ constraints. Process alternative will be considered by Bored Cast-in-place Pile Method.

Economic Perspective

The economic perspective for bridge foundation method is shown in following table:

Piling Method	Economic Perspective
Bored Cast-in-place Pile Method	Once the piles are casted no maintenance is needed. It is higher capacity than driven piles. Bored piles construction needs heavy equipment and fewer elements for the implementation, need access to the location so need more cost, which eventually the cost is relatively expensive.
Driven Pile Method	Driven piles need more and small equipment for the implementation and thus, cost is relatively expensive. Repairing job is easier just to add a new pile as a factor of integrity and reliability issues.

From the above table, bored cast-in-place pile method is more suitable than other piling methods due to its flexibility and economy.

Overall Considerations

The following table show the overall considerations for bridge foundation methods.

Table - Overall Considerations for Bridge Foundation Methods

	Environmental perspective					Economic Perspective				Technical perspective							
Types of pile foundation	Surface Water quality	Surface water flow pattern	Higher Noise level	Vibration	Soil erosion by disposal of augured earth materials	Extra Maintenance cost	Faster repairing job	Relative high implementation cost	Speedy Construction	Actions affected to adjacent structures	Increase of bearing capacity pile	Accessibility of piles of variable lengths	Capable of High working loads	Suitable for all types of soil in river	Delay work by weather condition	Clayey soil	Sandy soil condition
Driven Pile Foundation	√	√	√	√		√	√	√	√	√	√		√				√
Bored cast in-situ pile foundation	√	√			√			√				√	√	√	√	√	

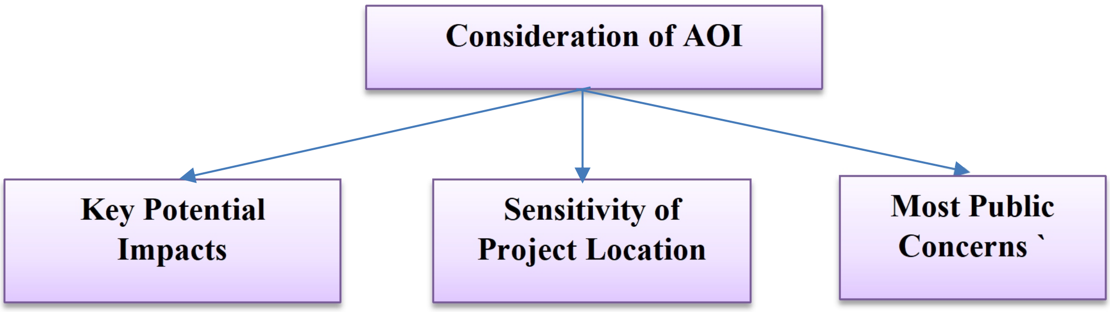
According to the above table, operation costs for implementing both pile construction is high respectively. From environmental perspective, the impacts from both methods can be managed by technical control and utilizing proper machinery. But both pile foundations technically have observed respective limitations. For the river crossing bridge, using driven pile can produce high intensity impulsive sound waves and it can cause injury in aquatic life at high received levels. In environmentally, socially and biodiversity sensitive areas, the most favorable type of foundation is bored cast in-situ pile with the action of wet drilling of pile bored because it can be drilled by reverse rotary method of drilling and this action is suitable for any soil type and consistency of strata, and all water table depths. But inland conditions, the foundation type should be selected based on location and type of structures, ground condition, depth of the soil layer capable of supporting the piles and etc.

5. DESCRIPTION OF THE SURROUNDING ENVIRONMENT

5.1. Setting the Study Limits

The AOI for the railway bridge will be considered based on the key potential impacts and project locations for traction substations and transmission lines, and most public concerns as follow:

(a) Consideration AOI by significance of key potential impacts;
(b) Consideratin by AOI by sensitive of project location; and
(c) Consideration by AOI by most public concerns.



5.1.1. Considerations of AOI by Key Potential Impacts

AOI will be considered by accessing key potential impacts as follow:

Table – Key Potential Environmental Impacts

		Project Actions/Activities	Soil Quality	Soil Erosion	Top Soil	Surface water Quality	Surface water flow patterns	Sediments deposition	Groundwater quality	Hydrogeological flow patterns	Air quality	Noise and Vibrations	Landscape	Flora	Fauna	Aquatic Lives	Protected and designated sites	Cultural Heritage
Pre-Construction & Construction Phase	1.	Clearance of existing land, vegetation and building	√	√	√	√	-	√	-	-	√	√	√	√	√	-	-	-
	2.	Temporary sites used for construction works (material storage and equipment maintenance camps, concrete batching plants, crushing plants) and housing of construction workers	√	-	-	√	-	-	-	-	√	√	√	√	√	-	-	-
	3.	Pilling for bridge	-	-	-	√	√	√	-	√	-	√	-	-	-	√	-	-
	4.	Superstructure of bridges and culverts	-	-	-	√	-	-	-	-	-	√	-	-	-	-	-	-
	5.	Construction traffic and machinery movement	-	-	-	-	-	-	-	-	√	√	-	-	-	-	-	-
	6.	Impoundment, and other changes to the hydrology of watercourses or aquifers	-	-	-	√	√	√	-	√	-	-	-	-	-	√	-	-
	7.	Rivers/Stream crossings (building the bridges & culverts)	-	-	-	√	√	√	-	√	-	-	-	-	-	√	-	-
	8.	Usage, storage, transport, handling or production of hazardous substances	√	√	-	√	-	-	√	-	-	-	-	√	√	√	-	-
Operational Phase	1.	Presence of permanent ways, bridges and culverts	-	-	-	-	√	-	-	√	-	-	√	-	-	√	-	-
	2.	Trains Passing	-	-	-	-	-	-	-	-	√	√	-	-	√	-	-	-
	3.	Maintenance of bridges and culverts	-	-	-	√	-	-	-	-	-	√	-	-	-	√	-	-

Table – Key Potential Socio-economic Impacts

		Project Actions/ Activities	Land and Property	Community Health and Safety	Community tensions	Disruption of utilities	Economy	Employment	Education and training	Workforce related impacts	Communities "Quality of Life"
Pre-Construction & Construction Phase	1.	Above ground construction, earthworks, cut and fill or excavations	√	√	√	-	-	√	-	√	-
	2.	Temporary sites used for construction works (material storage and equipment maintenance camps, concrete batching plants, crushing plants) and housing of construction workers, placement of borrow pits and landfill	√	√	√	√	√	√	√	√	-
	3.	Haulage roads during construction site	√	√	√	-	-	-	-	-	-
	4.	Construction traffic and machinery movement	-	√	√	-	-	-	-	-	-
	5.	Manipulation with hazardous materials during construction and transport of raw materials	√	√	√	-	-	-	-	-	-
	6.	Aesthetic	-	-	√	-	-	-	-	-	√
	7.	Rising the number of foreign workers	√	√	√	√	√	√	√	√	√
Operation phase	1.	Security and Maintenance of bridges and culverts	-	-	-	-	-	√	-	√	-
	2.	Trains passing	-	√	-	-	√	-	-	√	-
	3.	Accidents	-	√	√	-	-	-	-	√	-
	4.	Presence of permanent ways and bridges	-	-	√	-	-	√	-	-	-

According to the above considerations for key impacts, the most possible environmental impacts will be impact on air environment (noise and vibration), impact on water environment, impact on aquatic lives and impact on socio-economic environment.

5.1.2. Considerations of AOI by Most Public Concerns

The most public concerns for railway bridges and culverts through public consultation process will be land use, surface water pollution, blockage of natural drainage system, settlement of migrant workers. So, considerations of AOI will be covered about these public concerns.

Table – Considerations of AOI for Railway Bridges and Culverts

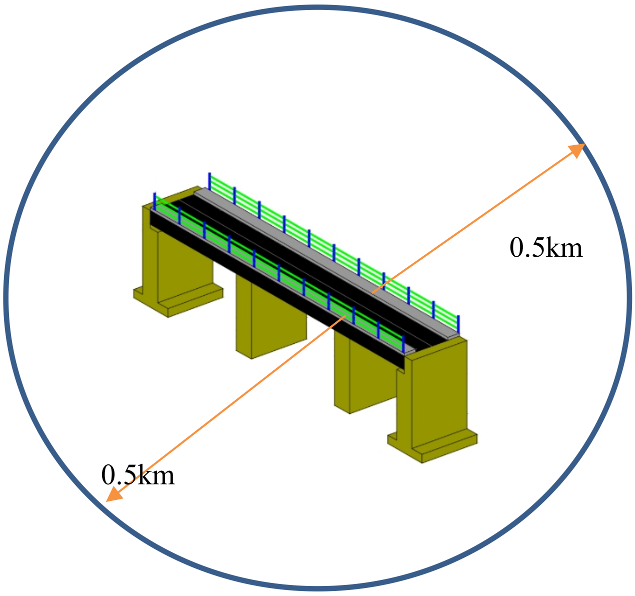
Duration	Potential Impacts	Possible Affected Persons	Baseline Study	Reasons for Considering AOI
During construction phase	- Impact on surface water quality and change in hydrology regime	- Aquatic lives	Existing surface water qualities are good due to less industrialization in rural area.	Impact on surface water quality due to the blockage of river during construction phase will be within 500m beside the project site with proper mitigation measures.
	- Noise from pilling machine	- Local residents - Fauna diversity - Aquatic lives	There are some villages, agricultural lands, ground water body near the tunnel construction site.	During construction phase, the most noisy equipment will be pilling machine and the maximum recorded noise level when the piles are driven in hard soil condition was 108.76 dB (Leq = 95.8 dB) that for the soft soil condition was 95.1 dB (Leq=90.65 dB). So, the noise level will reduce to 55.8 to 50.7 dB in open space after the distance of 1km. If there have some barrier like trees and mountain, the noise level will reduce to 50dB to 45dB. So, the noise level will reduce within 500m range.
	- Vibration from pilling machine	- Local residents - Fauna diversity - Aquatic lives		According to the EPA Standard equivalent to Birith Standard 7385-2 the vibration level will allow in 12.5 mm/s in residential area and 6mm/s for sensitive area and the vibration produced by pilling machine is 16.3576mm/s (typical) - 38.557mm/s (upper range). [FTA Manual]. The vibration level will reduce within 500m range.

	- Biodiversity	-Aquatic lives	Nature Reserve, National Park, Protected Area, National Park and ASEAN Heritage Park, Wildlife Sanctuary, Bird Sanctuary, Wildlife Park, Mountain Park, Wildlife Sanctuary and ASEAN Heritage Park, Elephant Range and Wildlife Sanctuary) are not included along Muse-Mandalay.	Impact on aquatic lives due to the blockage of river and water pollution will effect within 500m radius of the proposed project.
	- Increase in traffic	Within 1km radius	Most of the construction site are rural area and less dense populated area	Most of the construction sites of bridges are in rural area and there will very little impact on increase in traffic.
During operation phase	- Noise		The existing nosie quality is good and below the NEQ due to less industrilization in rural area.	During construction phase, the most noisy equipment will be pilling machine and the maximum recorded noise level when the piles are driven in hard soil condition was 108.76 dB (Leq = 95.8 dB) that for the soft soil condition was 95.1 dB (Leq=90.65 dB). So, the noise level will reduce to 55.8 to 50.7 dB in open space after the distance of 1km. If there have some barrier like trees and mountain, the noise level will reduce to 50dB to 45dB. So, the noise level will reduce within 500m range.
	- Vibration		The existing vibration level will be good due to less industrilization in rural area.	According to the EPA Standard equivalent to Birith Standard 7385-2 the vibration level will allow in 12.5 mm/s in residential area and 6mm/s for sensitive area and the vibration produced by pilling machine is 16.3576mm/s (typical) - 38.557mm/s (upper range). [FTA Manual]. The vibration level will reduce within 500m range.

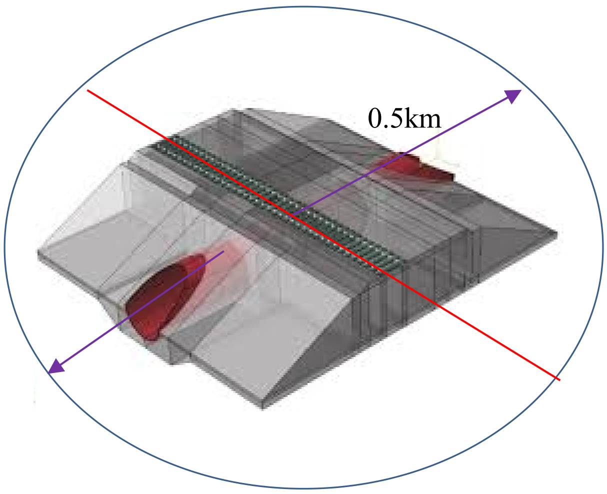
According to the above considerations for key potential impacts, the proposed AOI of 500m beside the railway bridge and culverts will be covered.

5.1.3. Determination of AOI for Railway Bridges and Culverts

After considering all of the above three attentions for AOI, all of the EIA studies (hydrology, biodiversity, cultural and heritage, social, noise & vibration, land use) will be assessed 500m beside the centre line of the bridges and culverts. Reasons for consideration of 500m beside the centre line of the bridges and culverts are as shown in the following table.



Consideration of Area of Influence (AOI) for Railway Bridges



Consideration of Area of Influence (AOI) for Railway Culverts

No.	Type of Project	Quantity	Study Limit
1.	Bridges (44 m to 3600m)	124	Within 0.5km beside the bridge

The study limit for railway culverts will be included in the study limit of railway alignment and so the study limit of railway culverts will also be 0.5km beside the railway culverts.

5.2. Methodology and Objectives for Environmental Baseline Study

Environmental baseline study will conduct by the following methodology and objectives.

5.2.1. Ambient Air Quality

Objectives

Ambient air quality monitoring collects and measures samples of ambient air pollutants to evaluate the status of the atmosphere as compared to clean air standards and historical information. Monitoring helps in assessing the level of pollution in relation to ambient air quality standards. Standards are a regulatory measure to set the target for pollution reduction and achieve clean air.

Methodologies

Ambient Air Quatity monitoring will be conducted by Haz-Scanner EPAS by the following methodologies.

Fig - Haz-Scanner EPAS for Ambient Air Quality Monitoring

Monitoring Parameters

The parameters for ambient air quality monitoring will be SO_2, NO_2, CO_2, CO, H_2S, O_3, $PM_{2.5}$ and PM_{10}.

Sampling Rate and Sensors

Determination and analysis of ambient air qualities were conducted by using Haz-Scanner Environmental Perimeter Air Station (EPAS).

Sampling rate of air quality will be recorded automatically every one minute for important gases (Sulfur dioxide, Nitrogen dioxide, Carbon dioxide, Carbon monoxide, Hydrogen sulfide, Particulate matter, Hydrogen sulfide and Ozone) to describe ambient air quality.

Sampling pump was adjusted to 2 liter/min. Different analysis methods will be integrated in the instrument, such as particulates 90° Infrared Light Scattering for particulate matters (PM_{10}, $PM_{2.5}$), electrochemical sensors for toxic gases (SO_2, NO_2, CO, H_2S), NDIR (optional sensor) for (CO_2) and Gas Sensing Semiconductor- GSS technology (optional sensor) for O_3.

Table - Important Gases for Ambient Air Quality

No.	Parameters	Analysis Methods
1.	Sulfur dioxide (SO_2)	Electrochemical sensors
2.	Nitrogen dioxide (NO_2)	Electrochemical sensors
3.	Carbon Dioxide (CO_2)	NDIR (optional sensor)
4.	Carbon monoxide (CO)	Electrochemical sensors
5.	Hydrogen Sulfide (H_2S)	Electrochemical sensors
6.	Particulate matter 2.5 ($PM_{2.5}$)	Infrared Light Scattering
7.	Particulate matter 10 (PM_{10})	Infrared Light Scattering
8.	Ozone (O_3)	Gas Sensing Semiconductor- GSS technology (optional sensor)

5.2.2. Existing Noise Level

Objectives

As the construction and operation of railway bridges will impact on existing noise level, existing noise level will have to monitor as baseline study.

Methodology

The approach will be based on SANS 10328:2008, 'Methods for Environmental noise impact assessments' as well as the IFC PS and Equator Principles. The technical guidelines will be based on good engineering practice, SANS 10103:2008, 'The measurement and rating of Environmental noise with respect to annoyance and to speech communication' and the IFC EHS Guidelines for noise.

Scope of Work

Proposed project along railway network generally rural and agricultural nature of the existing environment, noise levels can be predicted to be low. So, measure the present ambient noise levels will be done at every points where the main bridges exist along the proposed railway project.

Noise Level Monitoring Equipment

To monitor the existing noise level, the team will use TES-1353H Integrating Sound Level Meter which is applicable with IEC61672-1: 2003, IEC60651: 1979, ANSI S1.4: 1983 and IEC60804: 1985 standards. Existing noise level will be monitored in both day time (07:00 to 22:00) and night time (22:00 to 07:00).

Figure - TES 1353H Integrating Sound Level Meter

Noise Quality Monitoring Results

The results for noise level monitoring will be calculated by using Panel V8.01 Software as follow:

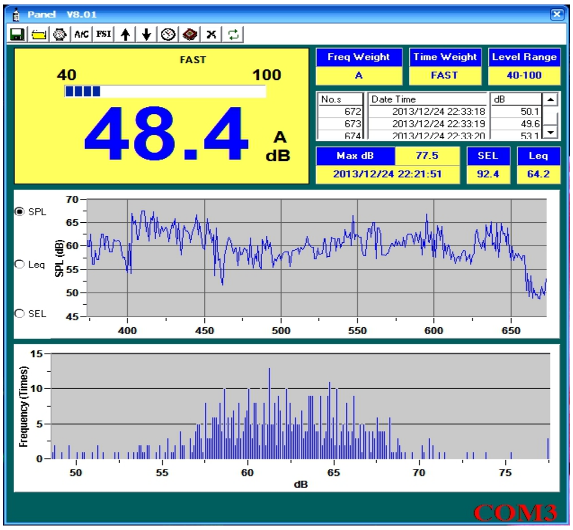


Figure - Integrating Sound Level Software (Panel V8.01)

Noise Level Monitoring Standard

Noise level monitoring results will be compared with Myanmar Emission Guidelines, 2015 for residential, institutional and educational areas as follow:

Table - Noise Level Monitoring Standard

Receptor	One Hour LAeq (dBA)[a]	
	Day time (07:00-22:00) (10:00-22:00 for Public holidays)	Night time (22:00-07:00) (2200-10:00 for Public holidays)
Residential, Institutional, Educational	55	45

Source: Myanmar Emission Guidelines (2015)

5.2.3. Existing Water Quality

Objectives

As the railway bridge construction will impact on existing water quality, existing water quality will have to monitor and test in qualified laboratory.

Methodology

Sampling Method

Water samples will be collected in terms of Grab sampling method (especially for the river with regular flow rate) with the following approaches;

- Rinsing the water bottle with river water
- Hold uncapped bottle upside down and submerse it
- Tip bottle upright and allow water to fill bottle
- Remove bottle from water and screw on cap

Sample Handling and Preservation

- use water resistant label for each sample bottle with the date, time, and site number/name
- documentation is done in field logbook
- store the samples in ice box immediately after sampling and transport for laboratory analysis.

5.2.4. Existing Vibration Level

Objectives

Vibration impact assessment will be made to monitor the existing vibration level and to predict the vibration level of railway on bridge when the rail travel during operation phase.

Methodology

Existing vibration level will monitor by using g vibration level by ground blast vibration meter (Vibro Series) and prediction of vibration level at nearest local residents within 1km radius of the proposed bridge project.

Vibro Vibration Meter

Analysis Method

The laboratory testing results of water samples are presented in the following table. Almost all of the water qualities are desirable as permissible limits of National Drinking Water Quality Standard expect for some water qualities (Colour and Turbidity) in Nant Paung Stream.

5.2.5. Existing Soil Quality

Objective

The objectives of the soil quality assessment for will be as follow:

- To assess the current physical and chemical status of the greenfield area targeted for the development;
- To determine the pre-development land capability of the soil cover to be affected by the proposed project; and
- To assess the expected impacts posed on the soil resource by the proposed development.

Methodologies

The entire area comprises greenfields. In terms of the legislation it is proposed to conduct a soil investigation based on the Soil Classification System for SA, 1991. Such an assessment will include a physical investigation of the soil cover to be disturbed by the bridge construction. The scope of work entails the following:

- Conduct a desktop study as a prerequisite prior to a field visit;
- Conduct a field visit during which a physical assessment of the soil covering the areas to be disturbed will take place;
- Compile soil, land use and land capability maps for the assessed area; and
- Compile a report on the findings and results of the assessed area.

Desktop Study

A desktop study will be conducted to gain a general understanding of the soil resource covering the area in question. Existing broad scale maps will be obtained and reviewed to address the input requirements for the EIA report.

In-field Soil Assessment

In preparation for a field visit soil survey locations will be generated to optimise coverage of the expected soil types. Actual field mapping and classification will be supported by soil profiling to serve as a platform for detail level mapping. During soil mapping, the extent of ecologically sensitive areas, such as wetlands, will be identified and delineated on the basis of soil types. The following attributes listed recorded at each location point:

- Soil form and depth;
- Estimated soil texture and structure;
- Content of coarse fragments;
- Underlying material;
- Current land use; and
- Land capability.

Sampling of Representative Areas

Chemical balance in the soil profile may be subjected to disturbance during the planned development and post-activity restoration. In order to obtain fertility status of the soil resource prior to commencement of any development activities, a sampling program is recommended in conjunction with the soil mapping exercise.

The sampling of major delineated units is good practice. A maximum of 4 sample locations are deemed sufficient to exhibit the required soil properties and chemical status. The following analysis package is proposed and will be submitted to the laboratory of the Department of Agricultural:

- Particle size distribution on selected samples (3-fraction testing);
- pH (water);
- Exchangeable cations Na, K, Ca, Mg (Saturated paste method);
- Phosphorus (Bray1 method);
- Organic carbon content on selected topsoil samples (Walkley Black method); and
- Electrical conductivity (indication of salt presence).

Testing of Soil Quality

All of the soil samples will be tested in National Laboratory under the Myanma Research and Innovation Department.

5.2.6. Baseline Hydrological Environment

Objectives

It aims at assessing sensitivity of the baseline hydrological environment and the potential impacts of the proposed development upon it and proposes mitigation measures in order to ensure that the potential adverse impacts of the proposed project development on the hydrological environment will be slight and neutral. For railway bridge construction, the potential impact will be impact on surface water quality during construction. So, the impact study for surface water quality will be based during construction phase. The potential impacts on the surface water environment from the proposed project development, in the absence of suitable mitigation measures, are considered to be as follows:

- Direct impacts of the project construction on the hydrological environment for example contamination of surface water (if encountered in excavations) from the spillage/leakage of fuels from vehicles and fuel/ waste storage areas and water from waste dump.

- Direct impacts from overburden dumping site and waste rock dumping site where vegetation has been removed through release of soil loaded surface water runoff into local watercourses due to soil erosion from dumping site.

Methodology

The following tasks are proposed

- Compilation of a baseline report to characterise the existing hydrology and water quality of the area;
- Development of floodlines for the area;
- Development of a stormwater management plan for the site.

Scope of Work

The scope of work for the surface water assessment will be below.

Site Visits for Surface Water Quality

Two site visits will be conducted. The first visit will be a reconnaissance visit to understand the site location of tunnel and the next site visit is to set up the baseline monitoring program and take field measurements.

Field Survey Methodology

Water Quality Testing

All of the surface and ground water quality will be tested in Water Quality Testing Laboratory under the Department of Occupational Health.

Significance Criteria

Relevant documentation gathered from diverse sources categorize impact into five (5) categories to aid in assessing the potential impacts of the proposed development on the hydrological environment in terms of how significant an impact may be on the overall environment as follows:-

Imperceptible Impact: An impact capable of measurement but without noticeable consequences.

Slight Impact: An impact which causes noticeable changes in the character of the environment without affecting its sensitivities.

Moderate: An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends.

Significant Impact: An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.

Profound Impact: An impact which obliterates sensitive characteristics.

Blockage of Natural Drainage System

The EIA team will make study on potential to blockage of natural drainage system due to the surplus soil and waste rock dumping site during tunnel construction.

Existing Water Quality Monitoring

Existing water quality will be monitored by focusing on surface water qualities because of bridge and culverts construction, and operation will not impact on ground water quality.

Monitoring of Surface Water Quality: The locations that the surface water samples will be take in the nearest river or water body of the proposed bridges construction site.

Water Quality Testing

All of the surface and ground water quality will be tested in Water Quality Testing Laboratory under the Department of Occupational Health.

5.2.7. Existing Biodiversity Situation

Objectives

- Undertaking the collection of baseline environmental data;
- Characterisation of the baseline Environment;
- Identification, and assessment of key adverse impacts that may result from the activities of the project;
- Identification, assessment and recommendations of appropriate and practical mitigation measures to remove or minimize the adverse impacts identified; and
- Providing specialist ecological input into the Environmental and Social Management Plan (ESMP).

Methodology

This section considers the effects that the proposed project might have on biological, nature conservation resources including habitats, species, and individual sites of nature conservation value. It addresses effects at all stages of the project cycle, including site clearance and construction, operation, and decommissioning.

Desk Based Research

Data on statutory designated sites within 5 km of the proposed project boundary, non-statutory designated sites within 2 km, and protected species within 2 km were requested or gathered from the existing records. Publications mainly consulted included: National Biodiversity Strategy and Action Plan 2011 and National Biodiversity Strategy and Action Plan 2015-2020.

Study Area and Biodiversity Opportunity Areas

Muse-Mandalay Railway starts from Muse port of entry at the north, goes south to Mandalay, the second largest city in Myanmar, and connects cities, towns such as Muse port of entry, Lashio, Pyin Oo Lwin and so on. Biodiversity Opportunity Areas are areas identified as being particularly beneficial for implementing conservation measures.

Proposed Method of Assessment

The assessment will address habitats, plant and animal species and sites of special importance for any of these. It will address these receptors in their scientific, ecosystem functioning, and nature conservation aspects only. It will not address them in respect of their contribution to agriculture or the landscape, nor in their socio-economic aspects. These matters will be addressed in the appropriate chapter.

- ✓ London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, 1990 (Date Ratified: 1993)
- ✓ United Nations Framework Convention on Climate Change (UNFCCC), New York, 1992 (Date Ratified: 1994)
- ✓ Convention on Biological Diversity, Rio de Janeiro, 1992 (Date Ratified: 1994)
- ✓ Stockholm Convention on Persistent Organic Pollutants (POPs), 2001 (Date Ratified: 2004 (Accession))

Desk-based Studies

- ✓ Records will also be requested from governmental and non-governmental natural history and conservation groups that are likely to be consulted as part of the ecological assessment process.
- ✓ An air-photo assessment of border networks in an 2-5 km buffer around the proposed project site will be conducted.
- ✓ A further search for published literature and reports of previous surveys relevant to the survey area will be conducted.

Field Surveys

A number of habitat and species surveys have been and will be undertaken and he following additional field surveys will be required:

- ✓ initial surveys of areas for which access was not available in May 2019 (follow-on surveys that arise from the findings);
- ✓ scientifically botanical surveys
- ✓ scientifically fauna surveys
- ✓ scientifically bat surveys

Interview Survey for Flora and Fauna

In addition to the field observation, secondary data will also surveyed by interviewing local residents and through literature review. In the interview survey, the surveyor visited the residents in and around the survey area and asked about the name of plants and animals existing in and around the area.

Data Analysis of Plant species

Samples of some species were not directly identified in field. After field trip, plant identification will be conducted based on available literatures such as key to the families of the flowering plants, issued by Department of Botany, Yangon University (1994), Backer *et. al.*(1963), Kress *et. al.* (2003), Gardner *et al.* (2000), Caton *et al.* etc., and verification will be also conducted by recorded field photographs and some useful internet websites. Finally, the threatened levels of plant species of the survey area will be chacked and mentioned in accordance with “The IUCN Red List of Threatened Species, 2018”

Data Analysis of Fauna Species

- ✓ **Bird Species:** The recorded species will be then identified using reference books.
- ✓ **Mammal Species:** All data recorded in the survey area will be entered into the field data sheet. Information on some species will obtained from interviews with the local people.

Consultation

The following groups having a statutory role in the EIA process will be consulted:

- ✓ the local authority Planning and Biodiversity officer
- ✓ Environment Agency and
- ✓ Non-Governmental Organization

In addition, a wide range of non-statutory natural history and nature conservation groups will be consulted.

Procedure Impact Assessment

.In order to assess the likely significant environmental impacts, potential Impacts of the Proposed Project will be preliminary identified based on the project description and overall environmental conditions. The impacts of flora and fauna will be classified as A to D in accordance with the following criteria, assuming no specific measures toward the impacts are taken:

1) A-: Significant negative impact A+: Significant positive impact
2) B-: Some negative impact B+: Some positive impact
3) C: Impacts are not clear, need more investigation
4) D: No impact or impacts are negligible, no further study required

5.2.8. Existing Visual Condition

As bridge and culvert construction will cause some visual impact and the followings are the methodologies for visual impact study.

Objectives

The objectives of the Visual Impact Assessment (VIA) will be to:

- Assess the baseline conditions of the visual context within which the proposed project will take place;
- Determine what visual receptor groups may potentially be affected by the project;
- Establish what visual impacts may potentially arise as a result of the project and determine their social significance; and
- Investigate possible methods with which the potential impacts may be mitigated.

Methodologies

The specific scope of works is briefly described below:

- The VIA will assess the value of the study area as a visual resource, as a function of its perceived aesthetic value, and will assess the magnitude and significance of the potential visual impact of the proposed activities;
- A Visual Resources Analysis will be carried out, which will identify elements that are considered to be of visual significance. Conversely elements that detract from the visual quality of the landscape will also be identified;
- A Visual Receptor Analysis will be done which will identify receptors that may be negatively impacted upon by the proposed activity. This will include adjacent landowners as well as significant commuting routes and areas where large groups of people may congregate;
- The VIA will also explore potential visual mitigation strategies and implementation measures that need to be considered during construction and implementation, operations and possible closure of the proposed project.

5.2.9. Cultural and Heritage

Objectives

The preparation of cultural and heritage impact accessment involves the listing of

- Classified or listed monuments and sites together with their protective perimeter, and the perimeters of Areas of Protection of Architectural, Urban and Landscape Heritage,
- Known Archaeological areas and areas of high archaeological potential.
- Declaration file that contains the description of works, the surface area used as a basis for calculating the preventive archaeology fees and impacts on the subsurface.

Methodology

In fact, there are possible necessaries to do cultural heritage assessment as follows;

1. Baseline data for the existing cultural heritage sites
2. The potential impacts on the cultural heritage sites and landscape
3. Making cultural map
4. Writing the strong mitigation and monitoring plans to reduce the negative impacts

5.3. Public Administration and Planning

As the project will be in FS stage, the detailed data for the project construction and operation phase have not been identified. Generally, the construction of the project will be also be conducted by CREEC and/or tender winning company after the international tendering process. The operation of the Muse-Mandalay Railway will be conducted by MR and tender winning company.

5.4. Environmental Protection Zone

Myanmar has published 59 environmental protection zones. Among them, 11 types of sensitive zones defined by the state are Nature Reserve, National Park, Protected Area, National Park and ASEAN Heritage Park, Wildlife Sanctuary, Bird Sanctuary, Wildlife Park, Mountain Park, Wildlife Sanctuary and ASEAN Heritage Park, Elephant Range and Wildlife Sanctuary, there are 52 sensitive areas in total. There are 2 types of environmentally sensitive zones defined by international organizations, namely, biosphere protected areas issued by UNESCO and important wetlands published by the International Wetland Convention, with a total of seven sensitive zones. The list of sensitive areas is shown in the table below.

Table 5.1- Environmental Sensitive Areas in Myanmar

S/N	Sensitive area name	Level	Promulgation time	Area (km2)	Administra-tive Authority	Relation with line location
Nature Reserve						
1	Bawdi Tahtaung N.R	National	2008	73	Forest Department	Not involve
2	Taninthayi Nature Reserve	National	2005	1699.99	Forest Department	Not involve
National Park						
1	Emawbum	National	2017	1603.25	Forest	Not involve

					Department	
2	In Khaing Bum National Park	National	2017	300.52	Forest Department	Not involve
3	Lenya N.P	National	2002	1761	Forest Department	Not involve
4	Taninthayi N.P	National	2003	2072	Forest Department	Not involve
5	Lenya N.P(Extension)	National	2004	1864.39	Forest Department	Not involve
6	Bawi Pa Taung	National	2017	581.05	Forest Department	Not involve
Protected Area						
1	Shark P.A	National	2004	11836.17	Forest Department	Not involve
2	Irrawaddy Dolphin P.A	National	2005	327.53	Forest Department	Not involve
3	Loimwe Protected Area	National	1996	42.84	Forest Department	Not involve
4	Parsar Protected Area	National	1996	77.03	Forest Department	Not involve
National Park and ASEAN Heritage Park						
1	Lampi Marine National Park	National	1996	204.84	Forest Department	Not involve
2	Alaungdaw Kathapa National Park	National	1989	1402.79	Forest Department	Not involve
3	Natmataung National Park	National	2010	713.54	Forest Department	Not involve
4	Hkakabo Razi National Park	National	1996	3812.46	Forest Department	Not involve
Wildlife Sanctuary						
1	Pidaung Wildlife Sanctuary	National	1927	122.07	Forest Department	Not involve
2	Bumhpabum Wildlife Sanctuary	National	2004	1854.43	Forest Department	Not involve
3	Htamanthi Wildlife Sanctuary	National	1974	2150.73	Forest Department	Not involve
4	Shinpinkyetthauk W.S	National	2006	72	Forest Department	Not involve
5	Minwuntaung Wildlife Sanctuary	National	1972	205.88	Forest Department	Not involve
6	Mulayit Wildlife Sanctuary	National	1939	138.54	Forest Department	Not involve
7	Thamihla Kyun Wildlife Sanctuary	National	1970	0.88	Forest Department	Not involve

8	Kyaikhtiyoe Wildlife Sanctuary	National	2001	156.23	Forest Department	Not involve
9	Minsontaung Wildlife Sanctuary	National	2001	22.61	Forest Department	Not involve
10	Kyauk Pan Taung Wildlife Sanctuary	National	2001	130.61	Forest Department	Not involve
11	Shwe-U-Daung Wildlife Sanctuary	National	1929	117.97	Forest Department	Not involve
12	Lawkananda Wildlife Park	National	1995	0.47	Forest Department	Not involve
13	Mahamyaing W.S	National	2002	1180	Forest Department	Not involve
14	North Zarmayi Elephant PA	National	2012	983.21	Forest Department	Not involve
15	Moscos Islands Wildlife Sanctuary	National	1927	49.18	Forest Department	Not involve
16	Moeyungyi Wetland Sanctuary	National	1988	103.6	Forest Department	Not involve
17	Meinmahla Kyun Wildlife Sanctuary	National	1993	136.7	Forest Department	Not involve
18	Kelatha Wildlife Sanctuary	National	1942	23.93	Forest Department	Not involve
19	Panlaung-Pyadalin Cave Widlife Sanctuary	National	2002	333.8	Forest Department	Not involve
20	Hponkanrazi Wildlife Sanctuary	National	2003	2703.95	Forest Department	Not involve
21	Shinmataung	National	2012	24.44	Forest Department	Not involve
22	Chatthin Wildlife Sanctuary	National	1941	269.36	Forest Department	Not involve
23	Kahilu Wildlife Sanctuary	National	1928	160.55	Forest Department	Not involve
24	Shwesettaw Wildlife Sanctuary	National	1940	464.28	Forest Department	Not involve
25	Hukaung Valley Wildlife Sanctuary (Extension)	National	2010	6669.22	Forest Department	Not involve
26	Southern Extension	National	2017	3550.7	Forest Department	Not involve
27	Hukaung Valley Wildlife Sanctuary	National	2004	6371.37	Forest Department	Not involve

28	Chung Pon Kan Wildlife Sanctuary	National	2013	2.2	Forest Department	Not involve
Bird Sanctuary						
1	Wethtikan Wildlife Sanctuary	National	1939	4.4	Forest Department	Not involve
2	Taunggyi Wildlife Sanctuary	National	1920	16.06	Forest Department	Not involve
3	Pyin-Oo-Lwin Widlife Sanctuary	National	1927	127.25	Forest Department	Not involve
Wildlife Park						
1	Hlawga Park	National	1989	6.24	Forest Department	Not involve
Mountain Park						
1	Popa Mountain Park	National	1989	128.54	Forest Department	Not involve
Wildlife Sanctuary and ASEAN Heritage Park						
1	Inlay Lake Wildlife Sanctuary	National	1985	640.91	Forest Department	Not involve
2	Indawgyi Wildlife Sanctuary	National	2004	814.99	Forest Department	Not involve
Elephant Range						
1	Rakhine Yoma Elephant Range	National	2002	1755.7	Forest Department	Not involve

Table 5.2. International Environmental Sensitive Zone in Myanmar

S/N	Sensitive area name	Level	Promulgation time	Area (km2)	Administrative Authority	Relation with line location
Biosphere Protected Areas						
1	Inlay Lake Wildlife Sanctuary	National	2015	640.91	Forest Department	Not involve
2	Indawgyi Wildlife Sanctuary	National	2017	814.99	Forest Department	Not involve
Wetland of International Importance						
1	Moeyungyi Wetland Widlife Sanctuary	National	2004	103.59	Forest Department	Not involve
2	Inlay Lake Ramsar Site	National	2018	57.98	Forest Department	Not involve
3	Meinmahla Kyun Wildlife Sanctuary	National	2017	500	Forest Department	Not involve
4	Indawgyi Wildlife Sanctuary	National	2016	478.84	Forest Department	Not involve
5	Gulf of Mottama	National	2017	425	Forest Department	Not involve

The above mentioned environmentally sensitive areas are not included in the railway. Totally 4 sensitive areas, Shwe-U-Daung Wildlife Sanctuary, Pyin-Oo-Lwin Wildlife Sanctuary, Minwuntaung Wildlife Sanctuary and Irrawaddy Dolphin P.A are close to Railway. Please refer to the following table for the details.

Table 5.3. Environmentally Sensitive Areas along Muse-Mandalay

Name of sensitive areas	Level	Issuing time	Area (km2)	Administrative Authority	Protected object	Position relationship with the line
Shwe-U-Daung Wildlife Sanctuary	National	1929	117.97	Forest Department	Elephant, gaur, banteng, rusa, serow, bear	About 87km away from the line
Pyin-Oo-Lwin Widlife Sanctuary	National	1927	127.25	Forest Department	Muntjac, birds,	About 5km away from the line
Minwuntaung Wildlife Sanctuary	National	1972	205.88	Forest Department	Muntjac, birds,	About 18km away from the line
Irrawaddy Dolphin P.A	National	2005	327.53	Forest Department	Irrawaddy Dolphin	About 12.5km away from the line

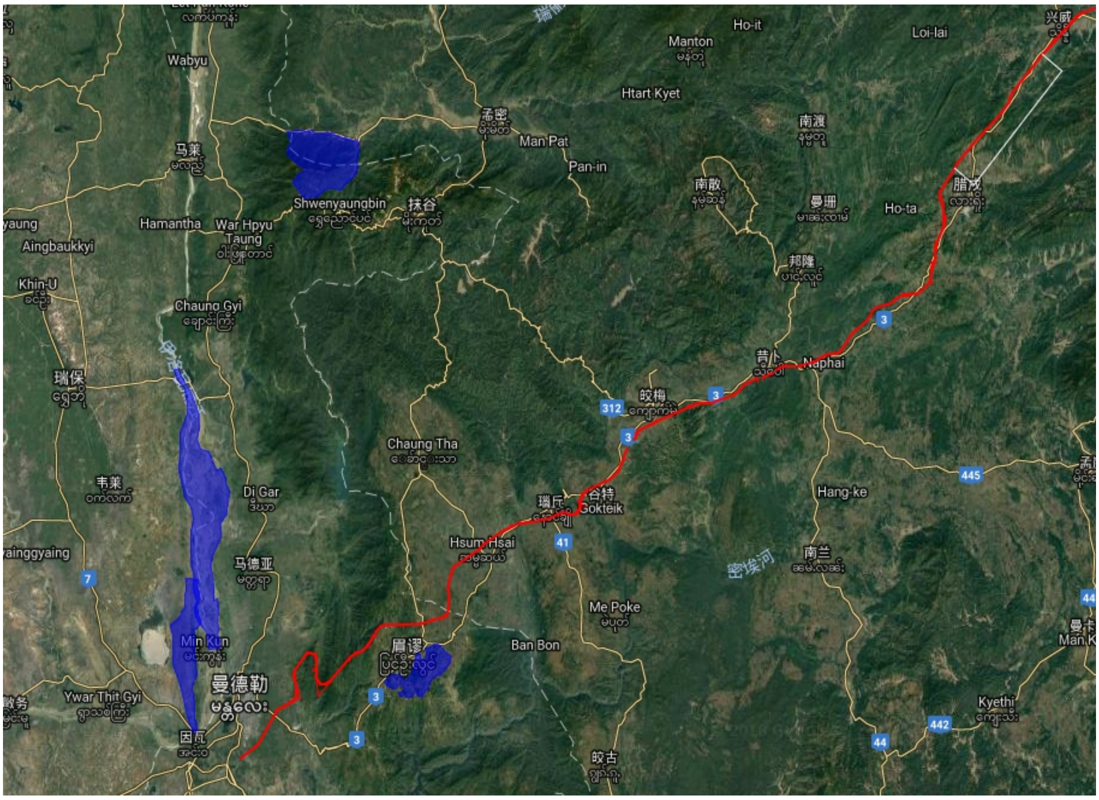


Figure 5.1. Distribution Map of Environmentally Sensitive Areas along the Railway

Figure 5.2. Location Plan of Railway and Shwe-U-Daung Wildlife Sanctuary

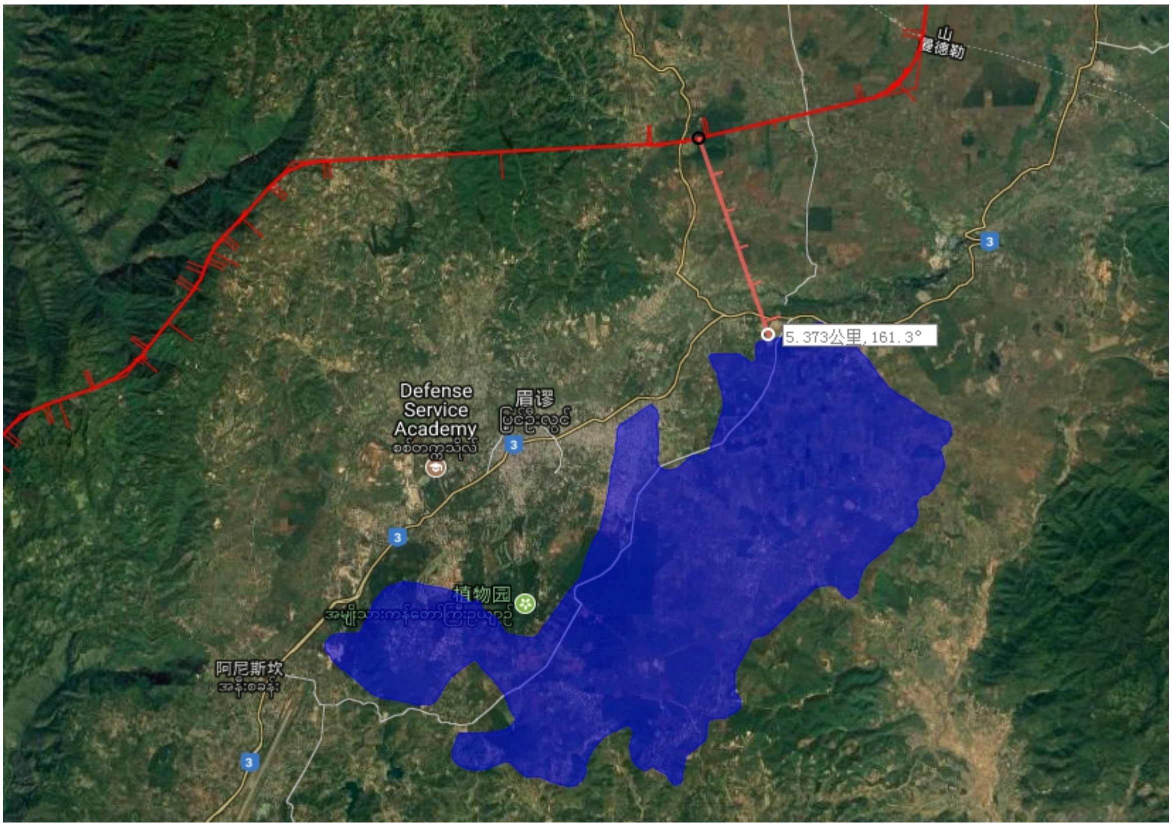


Figure 5.3. Location Plan of Railway and Pyin-Oo-Lwin Wildlife Sanctuary

Figure 5.4. Location Plan of Railway and Irrawaddy Dolphin P.A

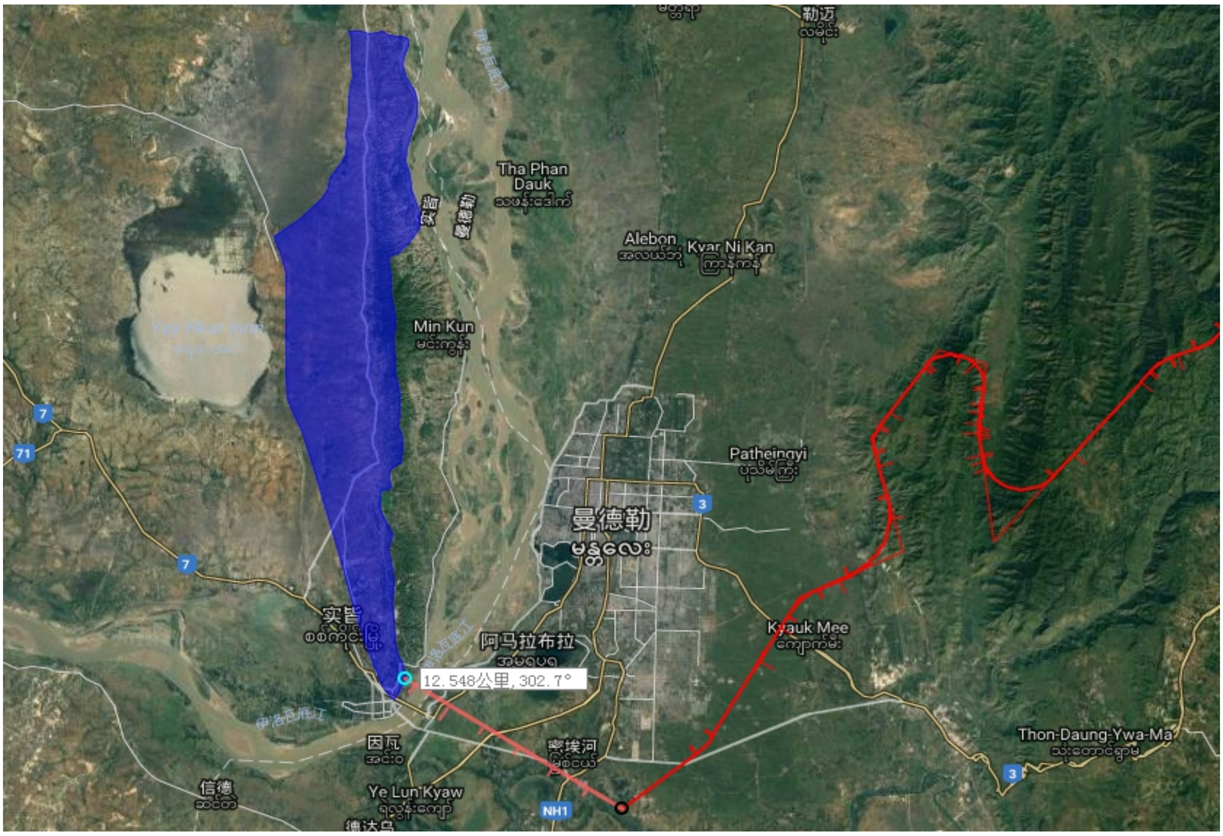


Figure 5.5. Location Plan of Railway and Minwuntaung Wildlife Sanctuary

5.5. Physical Environment

5.5.1. Topography

The topography along the Muse-Mandalay Railway can be divided into two geomorphological zones. The geomorphological features of each zone are as follows:

Shan State plateau: Muse~Mandalay East section belongs to Shan State plateau. Most of the area has an altitude of 700-1500 m and above. The top of the plateau is generally a planation surface with relatively low-lying relief. The surface relief is generally tens of meters to 100m, with deep valley development. The terrain is generally high in the north and low in the south, intercalated with the geomorphic unit of plateau basin. See figure.

Ayeyarwady basin: Mandalay East ~ Mandalay South section belongs toAyeyarwady basin. The area is generally peneplain and low hilly area. The terrain is flat and open. The area between Mandalay and Meiktila West is Mandalay-Thazi valley area, which develops in the north-south direction. The Ayeyarwady tributary system is relatively developed in the middle and east of the valley. The surface of the area is dominated by the Miocene-Pliocene strata. The surface red weathering crust is well developed. The low-lying area is distributed with a swamp facies gray fine sand layer and cultivated soil. Thin river fine sand layers and sand gravel layers are developed along the banks of main rivers. The overall terrain is high in the west and low in the east, with an altitude of 80-180m. It is mainly characterized by the geomorphological characteristics of flat valleys intercalated with hummocky topography with very small relief. The overall terrain is flat, with surface relief ranging from a few meters to more than ten meters. See figure.

Shan State plateau

(Source: CREEC, April 2019)

Ayeyarwady basin

(Source:CREEC, April 2019)

5.5.2. Engineering Geology

(a) Formation Lithology

The stratigraphic development spans are large in Myanmar, ranging from the Proterozoic to the Cenozoic. There are basically sedimentary deposits from the Proterozoic to the Quaternary strata in the Shan State plateau. The Ayeyarwady stratigraphic zone is the Mesozoic and Cenozoic marine sedimentary zone. See table 5.4.

Table 5.4. Lithology features along Muse-Mandalay Railway

Age and lithology / Geomorphic unit: group	System	series	Shan State plateau	Ayeyarwady basin
Cainozoic	Quaternary system (Q)	Holocene series (Q_4)	Clay, silty clay, medium fine sand - silt, partially gravel.	Sand gravel and fine silt, occasionally clay lens.
	Neogene system (N)	Pliocene - Miocene (N_2-N_1)	Silty-sand mudstone, siltstone, fine sandstone, marl; partially coal seam and coal vein.	Argillaceous siltstone, silty mudstone and fine sandstone.
		Miocene (N_1)	/	Medium coarse sandstone and fine sandstone, siltstone and silty mudstone, partially conglomerate with iron sand
Mesozoic	Jurassic (J)		Mudstone and silty mudstone/ sandstone, locally gypsum can be seen	/
	Triassic (T)		Shale, silty mudstone and limestone.	/
Palaeozoic	Upper Paleozoic (Pz_2)		Dolomite, limestone, dolomitic limestone and argillaceous limestone.	/
	Lower Paleozoic (Pz_1)	Silurian (S)	Calcareous mudstone, silty mudstone, siltstone, and mud limestone, etc.	/
		Ordovician (O)	Marl, limestone, siltstone and dolomite, hard calcareous sandstone; partially visible in the top layer is a set of fuchsia shale.	/

		Cambrian (∈)	Metamorphic sandstone, quartzite, phyllite, partially mica schist, argillaceous slate	/
Proterozoic	Upper Proterozoic (Pt_2)	Sinian-Cambrian (Z-∈)	Clastic rock, dolomite, limestone, argillaceous sandstone, and clastic flysch intercalated with siliceous rock.	/
		Precambrian(An∈)	Shallow metamorphic mudstone, phyllite, slate, metamorphic sandstone, quartzite, marble, etc.	/
	Lower Proterozoic (Pt_1)		Clastic and carbonate rock, schist, phyllite, slate intercalated with marble, tectonic rock, coastal shallow clastic rock, dolomite.	/

(Source:CREEC, April 2019)

The most typical strata passed through by tunnels of the entire line consist of: upper paleozoic (Pz_2) dolomite, dolomite limestone and argillaceous limestone, Sinian-Cambrian (Z-∈) argillaceous sandstone, Silurian (S) argillaceous limestone, and Ordovician (O) siltstone with limestone and shale, as shown in the following figures.

Dolomite

Argillaceous sandstone

Argillaceous Limestone **Siltstone with Limestone and Shale**

(Source:CREEC, April 2019)

(b) Geodetic Background

Muse-Mandalay Railway runs across the northern region of Myanmar from north to south. The project is within the two first-order tectonic units of the Gangdese-Nyainqentanglha fold system (II) and the India-Myanmar-Sumatra fold system (III). See figure 5.6.

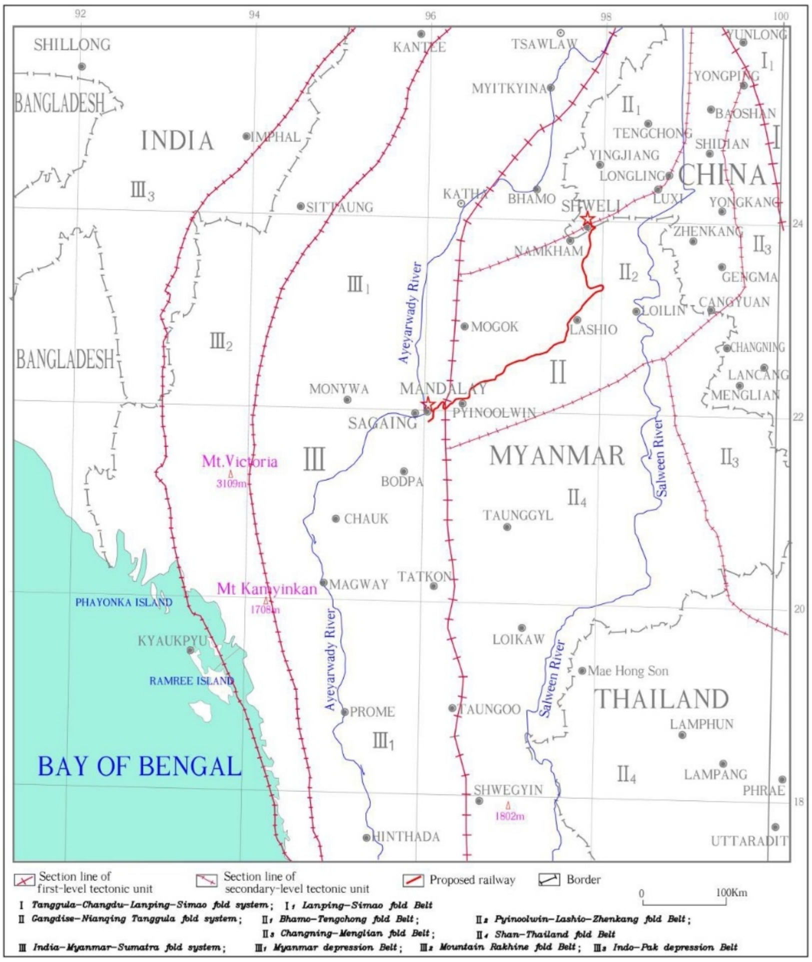


Figure 5.6. Zoning Map of Regional Tectonic Elements

(c) New Tectonic Movement Characteristics

The line is located in the Shan - Thailand area (composed of the Shan State plateau and the northern plateau of Thailand), which turned into a relatively stable plot after the end of the Mesozoic, with the overall uplift as the main, and the difference activity is not obvious. The topography of the plateau is slightly higher in the north and gradually decreases to the south. The height of the mountains is between 1000m and 1500m and the highest is about 2000m. On the basis of the large-scale overall intermittent uplift, there is still a significant fault-block differential movement in the survey area due to the impact of fault activities.

(d) Main Structural Features along the Line

(i) Fold

The proposed railway, stretching across a wide area, is located on the east side of the Mandalay-Thazi synclinorium.

Mandalay-Thazi synclinorium: The west of Mandala-Meiktila section is the Mandalay-Thazi valley area. The development of this valley is controlled by the Mandelay-Thazi synclinorium, the syncline deformation structure of the late new age stratum. The Miocene-Pliocene mudstone and argillaceous siltstone are widely distributed in the syncline core, and there are thin Quaternary alluvial deposits in the core. The wings (mainly the west wing) are distributed with the Miocene sandstone and mudstone intercalated with conglomerate. From the distribution of the stratum, the syncline should be relatively gentle, and the axial plane tends to the west side, which also includes some sub-level wide anticlines and synclines. The near-SN Sagaing fault zone passes through the middle of the syncline valley, resulting in the complexity of deformation in the zone.

(ii) Fault

Main fault structures in the area are in varying directions, NNW, near-SN, NE and NEE. There are six main faults near the Railway: Bangpaman fault (F_9), Kyankme fault (F_{7-1}) and Kunlong fault (F_{7-2}) - the branch faults of Nantinghe fault (F_7), Lashio fault (F_8), Gohteik fault (F_6) and Sagaing fault (F_4). Among them, the active faults of Holocene are the

Nantinghe fault (F_7) and the Sagaing fault (F_4). The outline Map of Regional Tectonics sees figure 5.7.

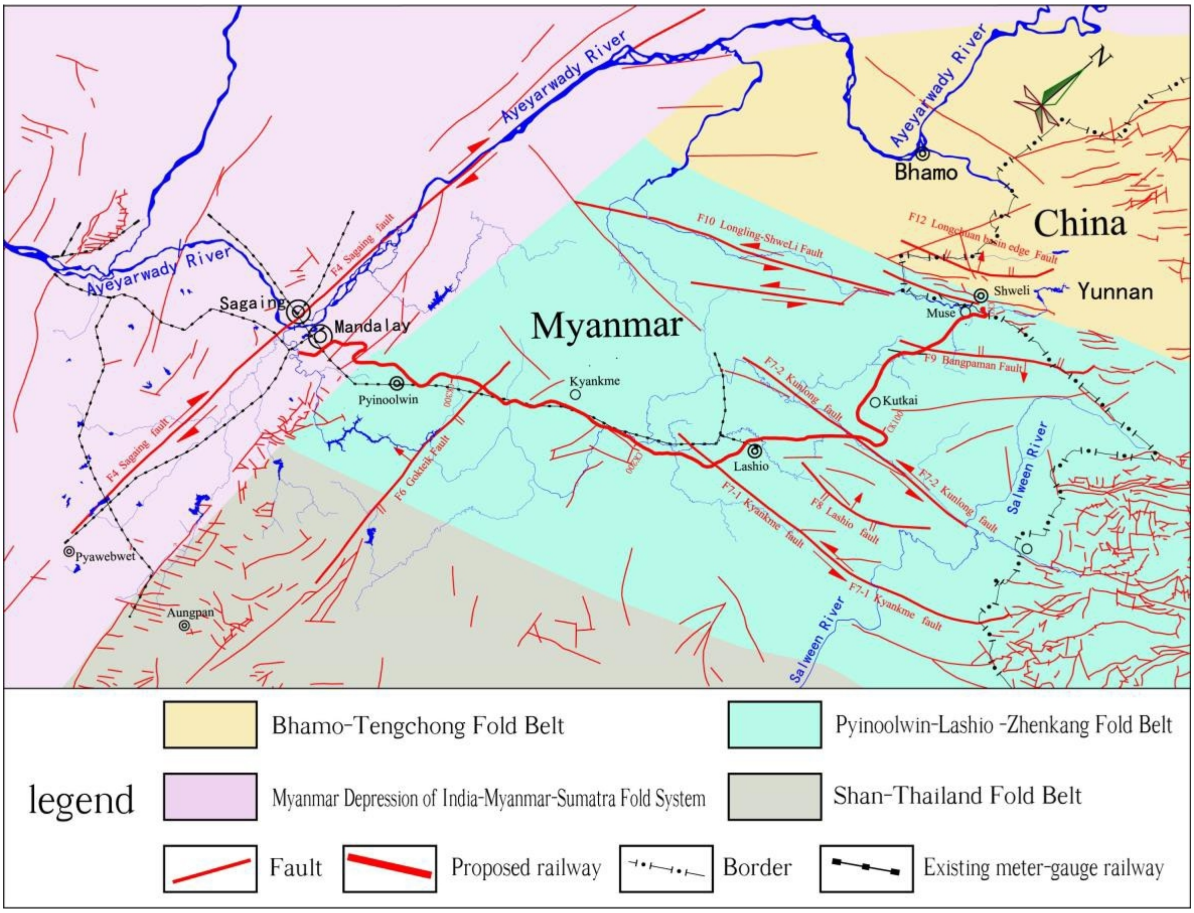


Figure 5.7. The outline Map of Regional Tectonics

Ground Motion Parameter Zoning

The seismic peak ground acceleration along the line and the characteristic period of the seismic response spectrum (10% probability of exceedance in 50 years) are shown as in Table 5.5.

Table 5.5. Zoning of Seismic Ground Motion Parameters of Muse-Mandalay Railway

Mileage	Length(km)	Seismic peak ground acceleration (g)	Characteristic period of the seismic response spectrum (s)
CK0+000~CK219+600	249	0.2	0.45
CK219+600~CK272+700	39.5	0.3	0.45
CK272+700~CK338	65.8	0.2	0.45

+500			
CK338+500~CK382 +700	44.2	0.3	0.45
CK382+700~CK398 +300	15.6	≥0.4	0.45

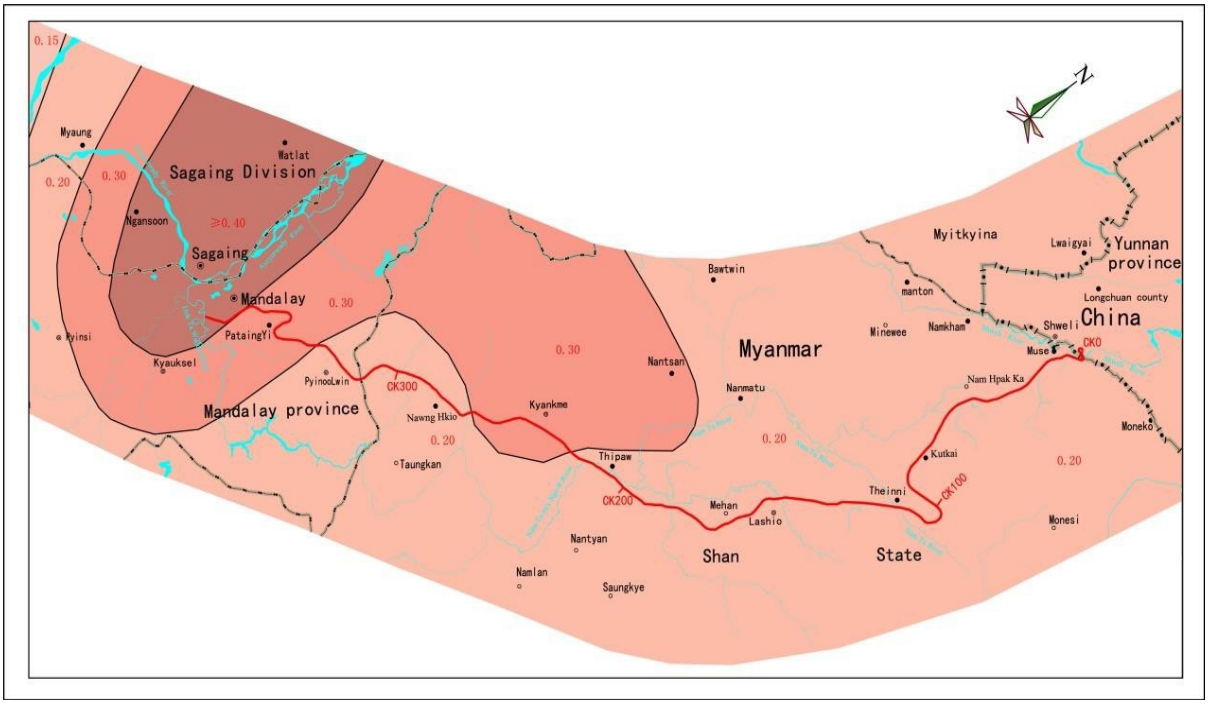


Figure 5.8 - Zoning Map of Seismic Ground Motion Parameters along the Line

(Source:CREEC,April 2019)

(e) Features of Engineering Geology

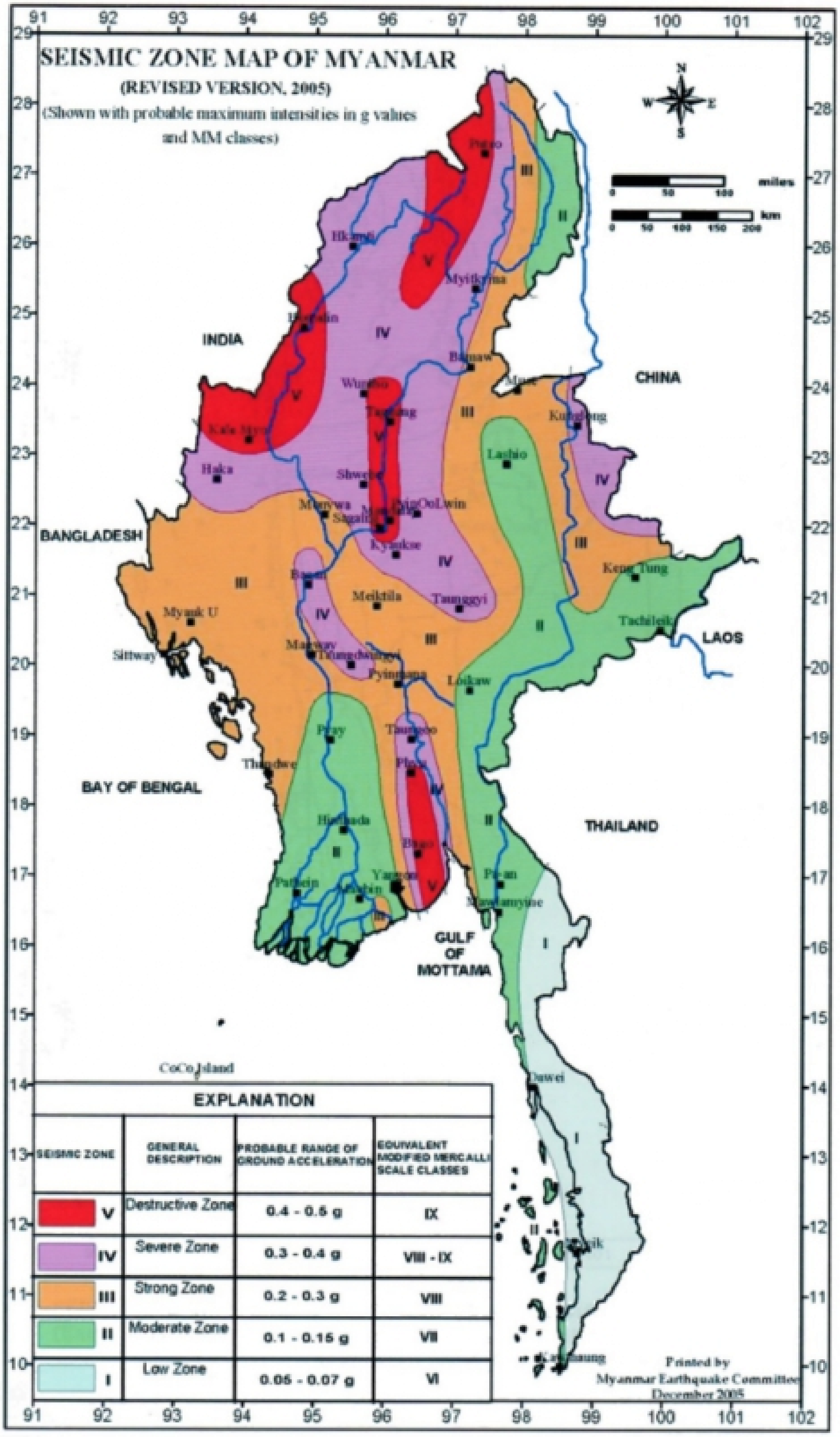
The surveyed area is basically located on the Shan State plateau, belonging to the Shan-Thailand upwraping area, and the terrain and geological conditions are very complex. Affected by neotectonic movement, the geological action along the railway is intensive. The terrain is undulating, the valleys are intertwined, the geotechnical structure is loose and broken, and carbonates are widely distributed. There is developed adverse geology along the line, and various kinds of geological disasters occur frequently.

The main line-side engineering geological problems include high intensity seismic region and deep active fault, karst, high ground temperature, landslide, talus, bedding, rockfall, liquefaction of sand soil, high ground stress (rockburst and soft rock large deformation), mining area and goaf, harmful gases, radioactive product, soft soil, mollisol and expansive rock and soil.

(f) Seismicity

Geographically, Myanmar is a land located at the southern part of major earthquake belt, known as the Alpide Belt (Richter, 1958) which is a young orogenic belt formed by the collision of Australian-Indian Plate and Eurasian Plate. Due to this seismotectonic situation, the country is exposed to hazard of large earthquakes. A seismic zone map of Myanmar (see Fig. 5.9) shows that the Innwa-Mandalay-Sagaing area lies very close to the Sagaing Fault, the main source of earthquakes in Myanmar and it is the largest, and perhaps the youngest and presumably the most active fault in Myanmar (see also Win Swe & Win Naing, 2004).

Seismicity along the course of the Sagaing Fault is quite well known since the days of the Myanmar kings, because many of ancient royal capitals of Myanmar, such as Hanthawady (Bago), Kaetumade (Taunggoo), Ava (Innwa), Zayyarpura (Sagaing), Yadanapura (Amarapura), and Yadanapon (Mandalay), and Tagaung were incidently located on or close to the Sagaing fault zone. The intermittent slips along the fault have caused earthquakes at (from north to south) Putao (1908), Tagaung (1946), Thabeikkyin (2012), Sagaing (1956), Innwa (1839), Swa (1929), Phyu (1930) and Yangon (1927).



Revised by Dr. Maung Thein, U Tint Lwin Swe and Dr. Sone Han (December 2005)

Figure 5.9- Sensitive Zoning of Myanmar

(g) Earthquake and active faults

The Neotectonic movement in the study area is intensive, and historical seismic activities, especially strong earthquake activity of Magnitude 6 and above, are mainly distributed in or near the boundary fault zone of neotectonic zoning with the active fault zone since late Pleistocene as the boundary, or on or near the active fault zone since late Pleistocene within the neotectonic zoning.Faults structures within the region is well-developed, there are six large faults, including three Holocene active faults, three early and middle Pleistocene or beginning of late Pleistocene faults. The development of Quaternary fault basin along the active fault zone is often the section with the most intense neotectonic movement on the fault zone, and also the section with the most concentrated strong earthquake activities in history.

Kunlong Fault (F7-2) is a branch of the regional Nanting River Fault extending to Mong Mit, Mong Yin, Theinni, and Kunlong, with a strike of N70-90°E, dipping toward southeast or northwest with an angle of about 50°-80° and a length of 150km. The faults are mainly developed in the Ordovician, Silurian, Triassic, Jurassic, Cretaceous and Cenozoic strata. They are grayish green and grayish white compresso-crushed zones with the width of up to hundreds of meters, with intensive mylonitization, widely existing crushing and schistosity of fault gouge. A number of hot springs and erupting high-pressure gas springs emerge along the fault zone. The line intersects with the fault with a small angle (about 30°) at CK118+180 in forms of general subgrade and bridge, which has great impacts on nearby projects.

Kyaukme Fault (F7-1) extends to Kyaukme and Hsipaw. Kyaukme Fault has a general strike of N70 - 80°E, dips towards southeast or northwest with an angle of 50°-80° and is 100km long. It is mainly developed in the Precambrian, Cambrian, Ordovician, Silurian, Permian, Triassic, Jurassic, Cretaceous and Cenozoic strata. The width of faulted fracture zone ranges from tens of meters to hundreds of meters. The crushed zone is dislocated due to intensive extrusion, forming considerable mylonites, and the extruded lens and tectonites generally form grey, black and white strips, indicating activities for several ages. The line intersects with the fault with a large angle (about 80°) at about CK158+600 in forms of general subgrade and bridge, which has great impacts on the project.

Sagaing Fault (F4) is a nearly south-north high-angle right-lateral strike-slip fault located in central Myanmar. Shan State dolomites are located east of it, while Indo-Myanmar arc basin formed after the Eocene due to subsidence is located west of it. The fault has obvious control over the eastern margin of Myanmar Central Basin. A right-lateral strike-slip fault zone is gradually formed after the Miocene. Strata, water system dislocations and seismic activities indicate that the fault is a Holocene active fault.

The areas that the line passes through belong to high-intensity seismic zones. The impact of earthquake on the project is not only the damage to the project by earthquake vibration, but also the harm of secondary disasters caused by the earthquake, such as the damage of renewed landslide and rolling rocks to the project, and a large quantity of loose rock masses generated by earthquake that cause debris flow hazards, dammed lakes and threats of collapse. In principle, the selected route in earthquake area shall bypass new active fracture or pass through at a large angle when the fracture is narrow, and shall not be in the fault zone, especially not to set important structures such as bridge and tunnel in areas of concentrated fractures, the junction, ends and turning point of the main active fractures, and line extension shall not be in the upper part of the reverse fault. When the Line crossing active fracture zone, simple engineering forms such as subgrade, ordinary bridge span or short tunnel are preferred for passing, and complex engineering forms such as bridge with high piers and long spans, and deep buried long tunnel shall be prevented, so as to minimize the harm of active fracture to the railway engineering.

(h) Karst

The carbonate rocks (limestone and dolomite) along the line are mainly distributed on the Shan State plateau (Muse-Mandalay section). According to statistics, there are 25 places with karst conditions along the line, with a total length of 297.08km, accounting for 72.46% of the line length. The strata consist of upper Paleozoic (Pz_2) dolomite with dolomite limestone; karst is weakly-strongly developed, with surface karst trace, solution crack, karren, karst cave, karst depression and sinkhole.

Karst cave

Karst depression

(Source: EIA Team, 2019)

(i) Landslide and talus

Landslides along the line are mainly distributed in Muse-Mandalay section on Shan State Plateau; they are bypassed by the alignment, thus having no impact on the alignment. Landslides and talus at a total of 24 locations are near the alignment.

Landslide **Talus**

(Source : EIA Report, 2019)

(j) Dangerous rock & rockfall

Rockfall mostly occurs on the slope of deep-cut valley in hard rock and steep slope on the verge of some basins, posing great hazards to the Project. The alignment shall bypass sections with high mountains, steep slopes, rock formations deeply cut by joints and dense overhanging rocks wherever possible; if this is impossible, comprehensive treatment measures such as clearing, slope protection with wire mesh and support shall be taken to ensure safety during construction and operation.

Dangerous rock &Rockfall

(Source: EIA Team, 2019)

(k) Bedding

The distribution of sedimentary rocks along the line is long, and the angle between the strike of the rock stratum and the line in some sections is less than 45°, posing a bedding problem. Excavation is likely to cause bedding slide, especially in soft rock which softens easily when meeting water. The bedding has a big impact on slope stability.

Bedding

(Source: EIA Team, 2019)

(l) Earthquake-induced liquefaction

The line is located in a high seismic intensity area, where Quaternary loose saturated sandy soil is prone to earthquake-induced liquefaction. Sand liquefaction problems exist in Lashio basin (Lashio Station) and Thazi valley in Ayeyarwady basin. Saturated sand layers within 20m depth below the surface on the riverbed, flood plain and terrace in tributaries of Ayeyarwady River are prone to sand liquefaction. Liquefiable sandy soil has a big impact on bridge and subgrade works, to which great importance needs to be attached; appropriate anti-liquefaction measures shall be taken to eliminate its impact on the Project.

(m) Soft soil and loose soft soil

Soft soil and loose soft soil are mainly distributed along the line in basins (Shwe Li, Lashio and Theinni basins) and Ayeyarwady basin area (Mandalay), ranging from 0-5m to 5-15m in thickness; 0-5m thick soft soil and loose soft soil are distributed sparsely in paddy fields, water pond and low-lying gullies. Give their big impact on the Project, soft soil and loose soft soil shall be subject to checking calculation by worksite. Soft soil along the line is under significant seasonal influence, mainly because of valley facies soft plastic silty clay as a result of poor drainage; special attention shall be given to the adverse effect of steep cross slope on the Project. Soft soil and mollisol have great influence on the project and are easy to produce large and uneven settlement. The bridge foundation should be open-cut spread foundation or pile foundation based on the soft soil and the underlying layer properties, and the foundation pit retaining wall should be strengthened at the same time.

(n) Expansive soil

Weathered red clay and Neozoic(N) residual soil in Sinian-Cambrian (Z- ∈) and upper Paleozoic (Pz_2) carbonatite areas are weakly expansive, and moderately-highly expansive locally; most of them have a high liquid limit. Subgrade in expansive soil area should be of low fill and shallow cut type, with gentle cut slope or enhanced anti-slip retaining works; attention should be given to slope protection. For bridges, open-cut spread foundation or pile foundation shall be adopted depending on the property of expansive soil and the underlying stratum; meanwhile, wall protection for the foundation pit shall be enhanced. All foundations shall be placed below the zone affected by abrupt change in atmosphere and provided with a proper drainage system.

Red clay

Residual Soil of Neogene System (N)

The clay stone and mudstone of the Neogene System (N) are generally weathered to be soil-like along the line. The minerals include montmorillonite, kaolin, etc., which may become softening and disintegrated with water and shrink and crack without water. So, it is the weak expansive rock with weak expansion. The line should keep away from the front mountain slope of the expansive rock and the combination zone of different geomorphic units and should pass perpendicular to the axis of the ridge. Expansive rock is of little influence on bridge works.

5.5.3. Occurrences of Mineral deposits along the Muse-Mandalay Railway Line

A Brief Account on the Mineral Deposits of Myanmar

Myanmar, the second largest country in Southeast Asia, occupies geologically and tectonically a key position located in the northeast corner of the Indian Ocean. Tectonically Myanmar has collided with the Indian continent in the Naga Hills and is juxtaposed with the eastern end of the India-Asia collision zone and Himalayas to the east. It is found that Myanmar has a several number of world-class metallic mineral deposits, including copper, nickel, tin and tungsten, offshore and onshore reserves of oil and gas, and an abundance of gemstones especially ruby, sapphire and jade, etc.

(1) Tin-Tungsten Deposits

Although more than 122 mineral occurrences have been recorded (Gossens, 1978), only about ten can be economically worked as large and medium sized mines especially in Thannitharyi Region, Southern Myanmar. The larger tin-tungsten mines in Myanmar are: – Mawchi in Kayan State, Heinda, Heinze, Hermyingyi, Kanbauk, Yadanabon, Kyaukmetaung and Nanthila mines, whereas Mawchi, Hermyingyi, Yadanabon and Nanthila mines work on vein deposits and the other work on placer deposits.

(2) Lead-Zinc-Sliver Deposits

Although 39 mineral occurrences are listed by Gossens in 1978, only three are of economic important to be developed as mines. They are, in order of importance: Bawdwin mine and Yadanatheingi mine in Northern Shan State and Bawzaing mine in Southern Shan State. Lead mineralization occurred as massive type, disseminated type and stock work and irregular stringers.

(3) Copper Deposits

Out of 45 mineral occurrences of copper ore, only three are of economic importance. These are Monywa deposit which is an only one world-class deposit (now producing by Chinese Companies), Shangalon deposit (about 16 miles SW of Kawlin), and Sabe-Taung deposit (about 12 miles ESE of Kyaukse).

(4) Nickel and Chromite Deposits

The Nickel deposits occur in close association with the Ophiolite Belt of Jurassic-Cretaceous age emplaced in northern Chin Hills (Mwetaung) within Western Ophiolite Belt in West Mynamar and Tagaung- Innettaung within Tagaung-Myitkyina Belt or Eastern Ophiolite Belt in northern Myanmar. At least 15 chromite occurrences are known at Mwetaung and Tagaung Taung.

(5) Manganese

Residual Manganese deposit originated in Mergui Group of Carboniferous age occurs in Tanintharyi region, Southern Myanmar.

(6) Antimony Deposits

Out of 30 mineral occurrences of stibnite listed by Goossens in 1978, only four have been developed as small mines. These are Thabyu, Lebyin, Natsan and Painchit mines in fold thrust belt zone in Sibumasu block. Mining of antimony ore in the slate hosted in Taungnyo Group of Permo-carboniferous age is carried out at Kadaik Area of Mon State.

(7) Iron Deposits

Out of 48 iron oxide occurrences listed by Goossens in 1978, only six may be said to be of some economic importance. These are Pangpet in Southern Shan State, Kyatwinye and Inya, near Pyin Oo Lwin, Khogyum, Mah Putah and Kathaing Taung.

(8) Coal

Clegg (1944) listed 11 occurrences of Mesozoic coals and 60 occurrences of Tertiary coals. At present, two mines are producing Tertiary coals. They are Kalewa (Sagaing Region) and Namma mines (Near Hsipaw). Tigyit (near Pinlaung in S Shan State), Kesi-Mansan (Shan States) and Kawmapyin, Mawtaung (Tanintharyi Region) deposits are very promising target areas for producing coals.

(9) Gemstones

Myanmar is quite famous for its gemstones, especially ruby, sapphire and jade. In fact, the Myanmar rubies, sapphires and jadeite jades are the finest in the world. The two most famous localities of gemstones are the Mogok-Kyatpyin area for rubies and sapphires, and the Tawmaw-Phakant area for jades. Other famous ruby and sapphire areas are Mong Hsh area, Wan Ying and Wan Hatt in Shan Plateau. Amber in Hu Kaung basin in Northern Myanmar is also famous.

(10) Oil & Gas

Myanmar is fairly rich in oil & gas. Oil & gas have been found in large quantities in the Minbu and Chindwin basins accumulated in en-echelon anticlines trending roughly NNW-SSE. The reservoir rocks are commonly Oligocene-Miocene sandstones and occasionally Eocene sandstones. The Petroleum geology of offshore Myanmar are found in Late Miocene deltaic sandstone in Moattama offshore, in Early Miocene marine sandstone in Thanintharyi shelf and early Pliocene deep marine sandstone in Rakhine coastal area.

(11) Gold

In Myanmar, placer gold has long been extracted. At present, there is no primary world class gold deposit in Myanmar. Recently Myanmar government and local mining companies are dynamically exploring gold and have discovered many promising deposits in the locally well-known areas such as Kyaukpahto area, Thabeikkyin area, Phayaung Taung, Yamethin East area (Modi-Momi area) and Meyongale-Meyongyi area, etc.

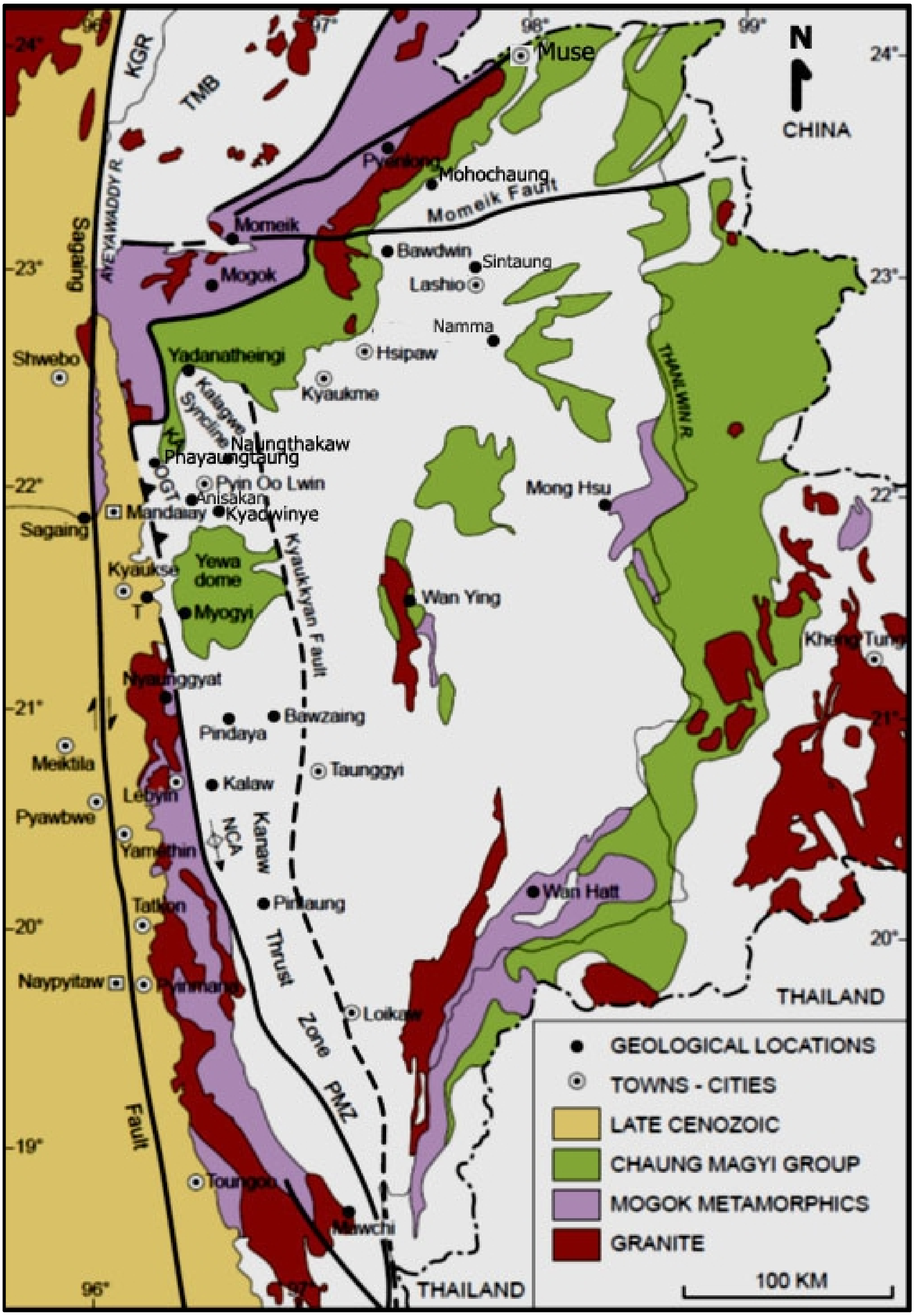


Figure 5.10. Map of part of Shan Plateau showing mineral and gemstone locations described in text.

(Modified from Mitchell, 2018)

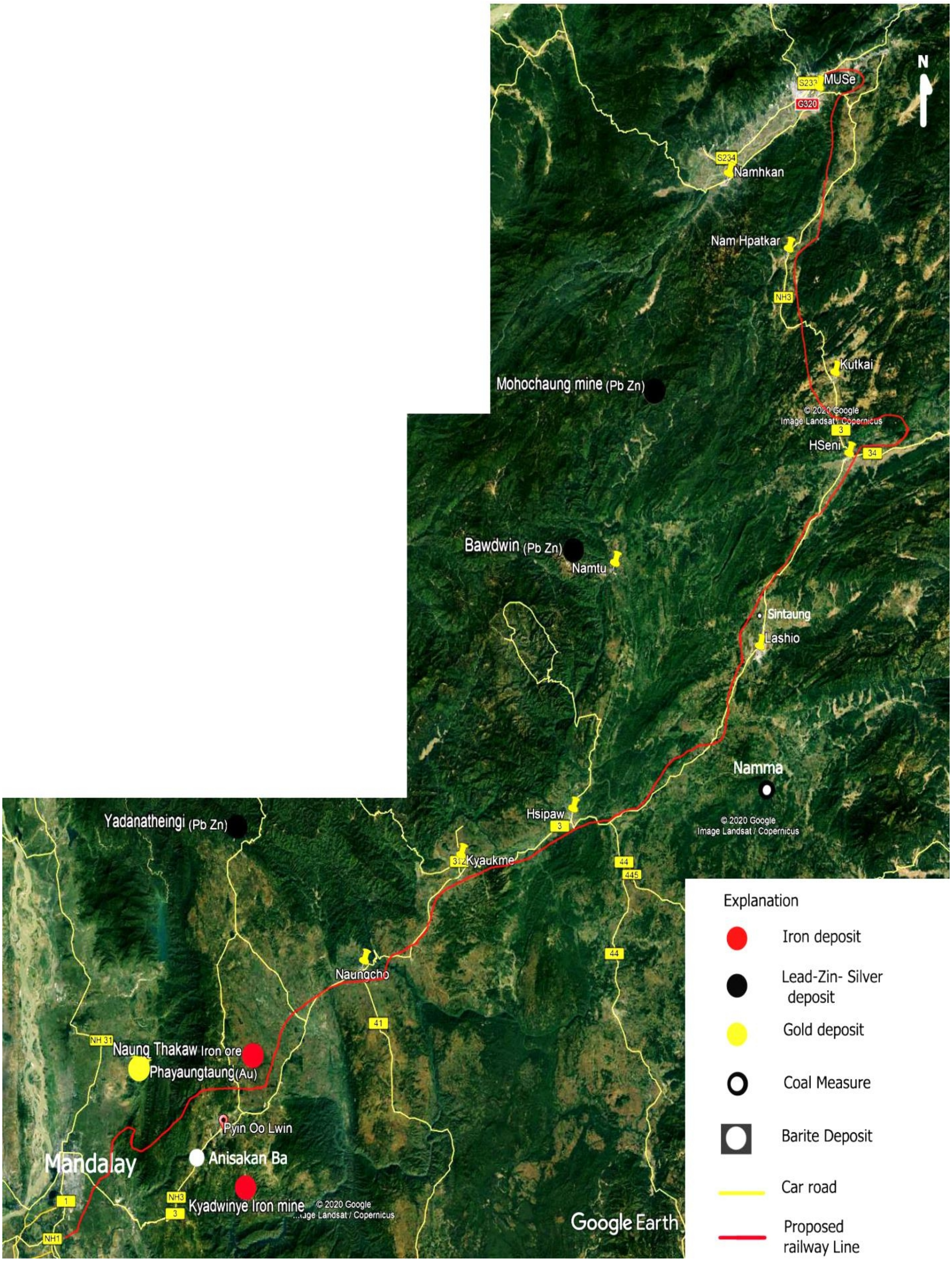


Figure 5.11. Satellite image showing the location of proposed railway line and localities of known mineral deposits along and around it. (Tin Aung Myint, 2020)

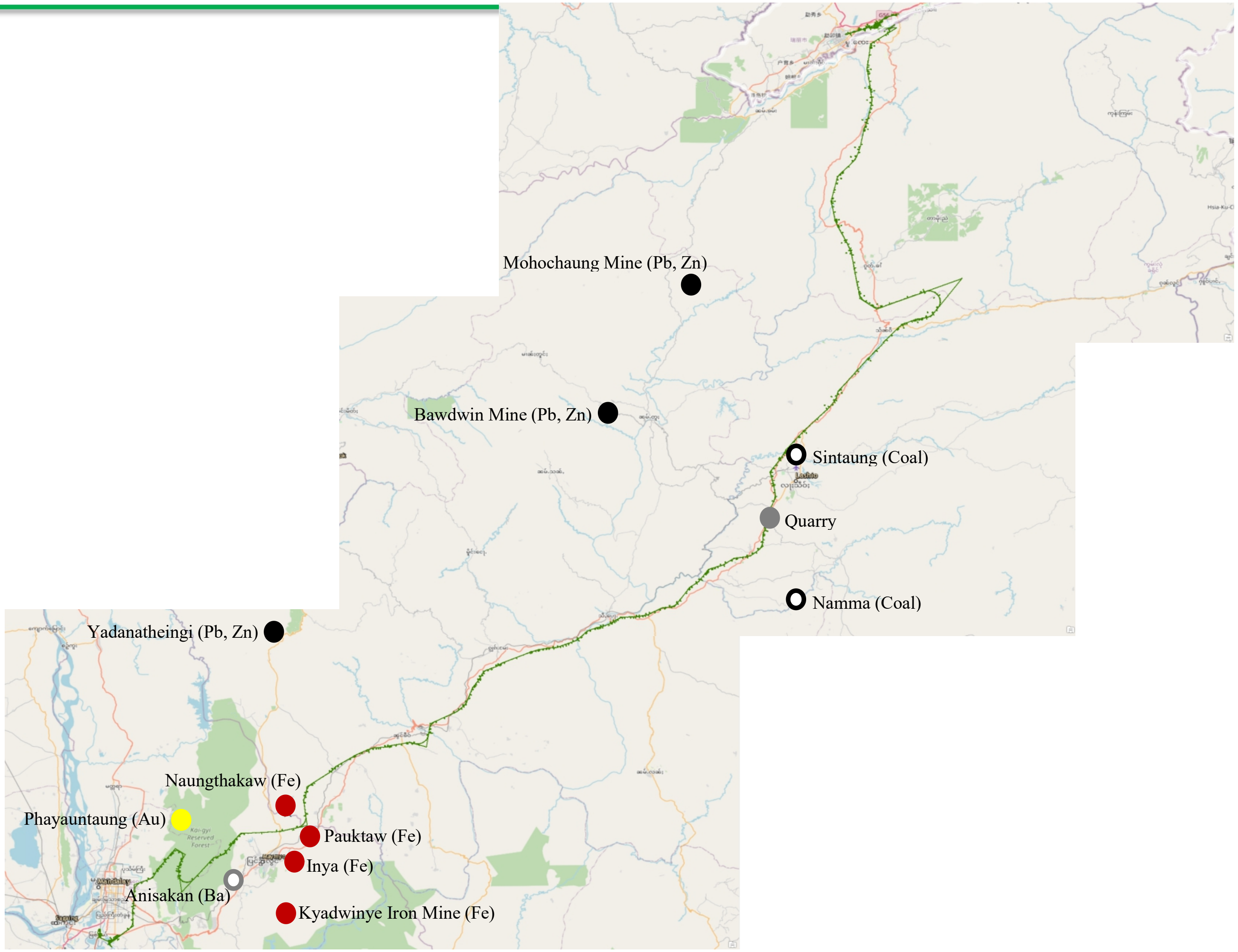


Figure 5.12. GIS image showing the location of proposed railway line and localities of known mineral deposits along and around it

Conclusion and Suggestion for Mineral Resources for Bridges and Culverts

All known deposits and occurrences mentioned here are typically exposed along and around the proposed Muse-Mandalay railway line. But some exposed the line between Nanhphtka-Muse are missing because of insurgent area and difficulty to do field works. Consequently there is also missing some geological information for that area. According to the existing geological records and possible structural trends, there would be lead-zinc-silver, antimony, gold that could be expected in it. Coal and phosphorous deposits might also be found as well.
Regarding Figure (5.12), some deposits are a little far from the proposed railway line. Why mentioned here is that mineral deposits are trending approximately N-S direction and those could be probably found during construction of the line such as tunneling, bridge, station and railway line etc.,. For example, although Phayaung taung gold is far from the construction, gold occurrences are sporadically found along the western margin of Shan scarp, trending N-S direction. For Yadanatheingi lead-zinc-silver deposit, similar deposits and occurrences could be estimated in Pyin Oo Lwin, Nawnghkio and Kyaume as regional structural trending passing in these areas. Similarly, deposits at Bawdwin mine and Mohochaung mine, they might also be extended more or less into Hsipaw, Lashio, Kutkai and Nam Hpatkar areas. For those reason, those deposits are plotted on the map as well.
Suggestion here is that if some precious mineral deposits or occurrences found along the line, it is needed to officially inform the authorized person from government and local community as well. Those communities should do monitoring work and help the construction railway project for mutual benefit. Legal law enforcement should act to give penalty for those people who carry away it from the line or make mineral dressing in situ.

5.5.4. Hydrology and Meteorology

5.5.4.1. Hydrogeology

There are three types of groundwater along the line, which are pore water in Quaternary loose rock, bedrock fissure water and karst water.

(a) Pore water in Quaternary loose rock

It mainly occurs in the pores between Quaternary unconsolidated sediment particles of various geneses; the aquifers are mostly distributed in layers with even water content; in natural state, the free level of groundwater is consistent with the burial patterns of strata. Pore water in loose rocks along the line generally occurs in Quaternary alluvial-proluvial and deluvial-proluvial layers, red weathering crust and coastal marine deposit formation. Pore water in Quaternary alluvial-proluvial and deluvial-proluvial layers is mainly distributed on both sides of the Ayeyarwady River and its tributaries and within certain scope of the Shan State Plateau Quaternary Basin (such as Theinni, Lashio and Hispaw basins) and river banks. In red weathering crust on the surface of the Shan State Plateau Area, the shallow groundwater is generally buried 1–10m deep and mostly developed along the interface of red weathering crust and bedrock.

(b) Bedrock fissure water

Bedrock fissure water occurs in diagenetic fissures, structural fissures and weathered fissures in consolidated and semi-consolidated rocks of various geologic ages (which are mainly clastic rocks, magmatic rocks and metamorphic rocks). The distribution of aquifer is restricted by the development of diagenetic fissures.

Bedrock fissure water along the line is mainly distributed in sandstone, mudstone and other clastic rock areas in Triassic, Jurassic, Silurian, Ordovician and Sinian-Cambrian strata on the Shan State Plateau; bedrock fissure water is generally buried 8–15m deep and locally emerges in the form of spring from both sides of intrenched streams and ravines.

(c) Karst water

It means the groundwater occurring in the karst channels, fissures and caves of carbonate rocks. The occurrence, runoff and discharge conditions of this groundwater depend on karst development and distribution characteristics. The karstic fissure water aquifers along the line are distributed in the soluble rock areas on the Shan State Plateau from Muse–Na Hpai–Lashio to the northeast of Mandalay. Carbonate rocks widely distributed in this section have medium–strong water abundance. Water is mainly concentrated in Upper Palaeozoic (Pz2) and Sinian-Cambrian (Z-∈) pure carbonate rocks of high karstification level, and karst forms including karst depressions, funnels, underground rivers and karst caves are moderately–heavily developed. Karst water level is affected significantly by surface elevation and topography and water often emerges as spring in mountain front areas and valley slope areas.

(d) Underground hot spring

Four hydrothermal activity zones exist along the line; they are respectively located in Bangpaman fault zone, Kunlong fault zone and its branch fault, Lashio fault zone and Hispaw south-Kyang yin fault zone. Bangpaman low-medium temperature hydrothermal activity zone is near the depression (Nam Maw River) in the northwest of CK36+000~CK41+200 Bangpaman fault, with its spring water at 30~45°C. It has a small impact on the Project since the line passes via subgrade and bridge. Kunlong hot spring zone: regional data show multiple hot springs and high pressure gas springs in approximate EW direction along Kunlong fault zone, are developed in upper Paleozoic soluble rock formation; field survey shows one hot spring with water at 75~85°C is observed 3.2km to the right of CK97+300 and located in a branch of Kunlong fault. According to characteristics of fault extension, CK101+900~103+000 of Nawng Yen 1# Tunnel is likely to encounter low-medium temperature terrestrial heat. Lashio medium-temperature hydrothermal activity zone: it runs in NE direction along Lashio fault which is covered with Neozoic strata near the line and does not cross the line; this medium-temperature hydrothermal activity zone has no impact on the line. Hispaw south-Kyang yin hot spring zone: a fault of unknown nature perpendicular to the line exists in CK217+000~CK218+000 section. Field survey found one hot spring with water at 45°C, 650m to the right of the line which passes this hot spring zone via subgrade and bridge; due to its proximity to the line, the hot spring has some impact on the alignment. The hot spring discovered in the field survey is given in Fig. 5.13.

Fig. 5.13. Distribution of groundwater along the line (a) bedrock fissure water entered into a stream (b) spring came out from mountain front area in well-known Peikchinmyaung Cave, (c) karst water emerges along valley slope as water fall and geothermal water from well-known Lashio hot spring. (From Google Earth-https://lh5.googleusercontent.com)

(e) Major river water system features and hydrology along the line

The water system along the route is mainly the Ayeyarwady River and its tributaries. The route passes through larger rivers, including the Shwe Li River, and rivers within the territory of Myanmar like the Nan Paw River, the Nam Hkai River, the Nam Tu River, the Nam Yao River, the Nam Tu miy Nge-R River, the Nam Ma River and Nam ban ton River. The Shwe Li River and Nam Tu River are the first tributaries of Ayeyarwady River; the Nam Paw River, Nam Hkai River, Nam Yao River, Nam Ma River and Nam ban ton River belong to the tributaries of Nam Tu River.

(1) The Ayeyarwady River, one of the large rivers in the Indo-China Peninsula and the longest river in Myanmar with 2030km long within the country, runs from north to south across Myanmar, passing through the northern mountains, the central dry regions and the southern delta. The River, which has more than 30 tributaries with a drainage area of 430,000 km² covering 8 divisions (states) of Kachin state, Chin State, Mandalay Division, Sagaing division, Magway division, Bago Division, Ayeyarwady Division and Rangoon Division, 32 counties and 90 towns. Myanmar scholars divide the Ayeyarwady River into three parts: upstream, midstream and delta. The Ayeyarwady River generally flows windingly from north to south and reaches the sea at southwest corner, facing the Bay of Bengal in the west and linking with the Andaman Sea in the south. With many rivers in the vicinity and flowing into the sea simultaneously, a unique landform forms. The main tributaries of the Ayeyarwady River are the Chindwin River, the Myitnge, the Mu River, the Yaw River, the Mon River and the Nam tu River.

Ayeyarwady River

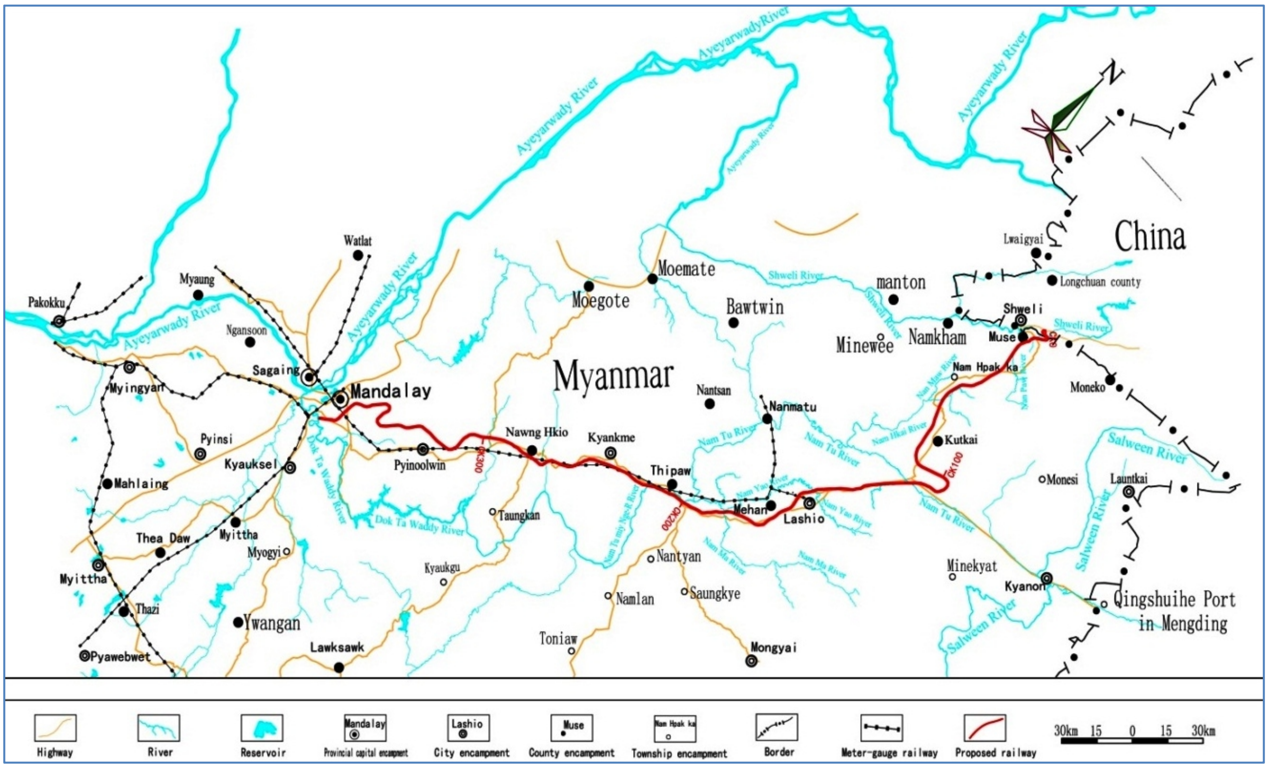


Figure 5.14 – Map of Surface Water System along the Line

(Source:CREEC,April 2019)

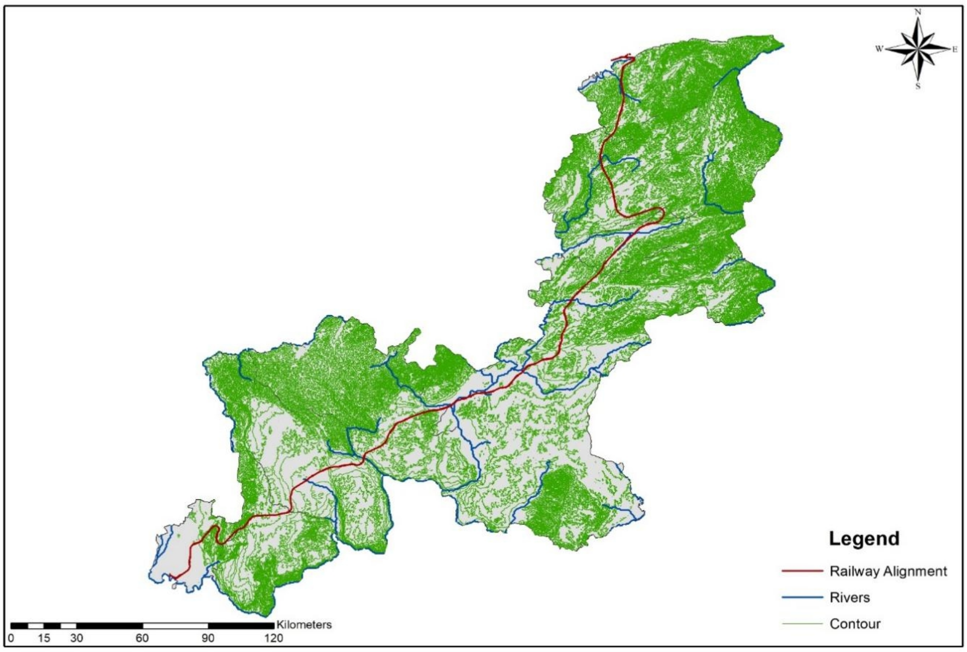
(2) Shwe Li River, called Nam Mao River by Dai ethnic group, also known as Mengmao River. The total length of Shwe Li River is about 332km and the drainage area is about 5,576km^2. It is an important river in the west of Yunnan Province, China. Its main stream and tributary are all parts of Ayeyarwady river system. In China, through Tengchong, Longling and Lianghe, Longchuan, there are Mangshi River (Longchuan River) flows into Shwe Li River in Mangshi (Dehong). Shwe Li River has a length of about 53km located in China and a width of about 100-200m. After Ruili, it flows to west along the Myanmar-China border and flows into Ayeyarwady River. The once-in-a-hundred-year flow of Shwe Li River connecting line at the bridge location is 2,870m^3/s.

Shwe Li River

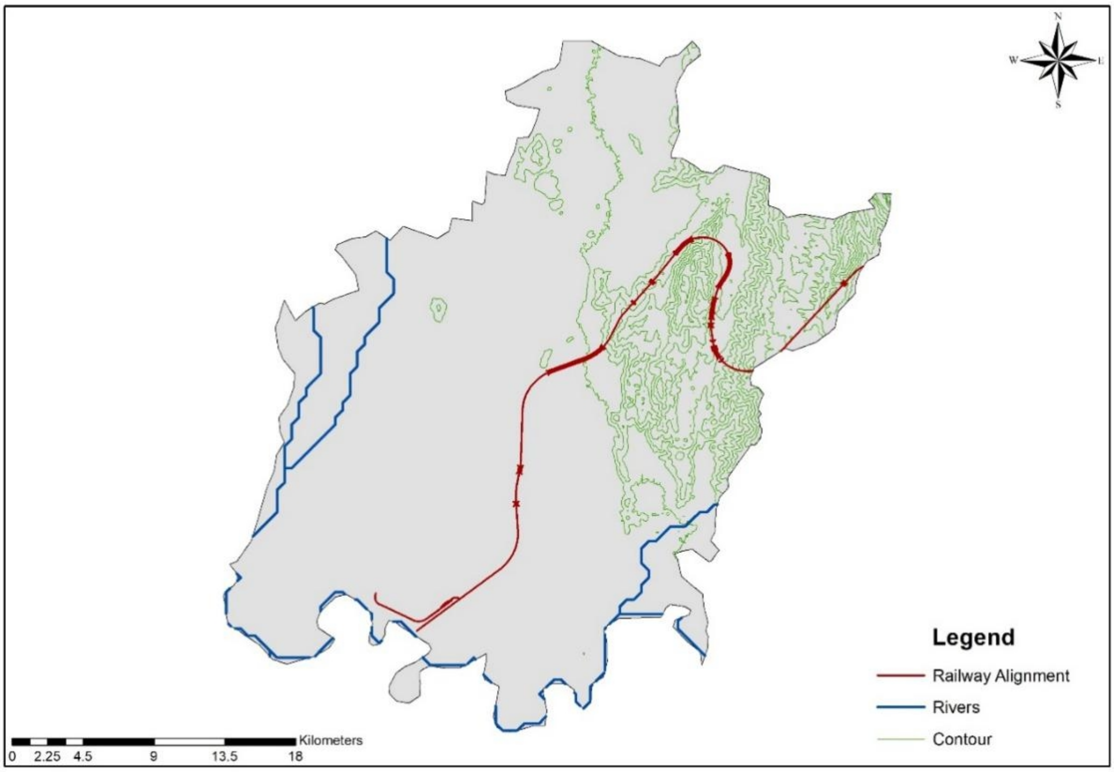
(3) Nam Ma River, a tributary of Nam Tu River, is about 105km long, and the drainage area is about 2,702.5km^2. The width of main channel of the bridge location is about 50m, and the once-in-a-hundred-year flow is about 485 m^3/s.

(4) Nam Tu - Myit Nge River, the upstream of which is the intersection of Nam Tu River and Nam Ma River. The basin length is about 230km, and the drainage area is about 14,100km^2, and the main channel of the bridge location is about 96m wide, and the once-in-a-hundred-year flow is about 2,231m^3/s. For the tributary Nam ban ton River, the basin length is about 36.5km, and the drainage area is about 809km^2. For the tributary Nam pan his River, the basin length is about 50km, and the drainage area is about 681km^2. These two rivers finally flow into the Nam Tu - Myit Nge River.

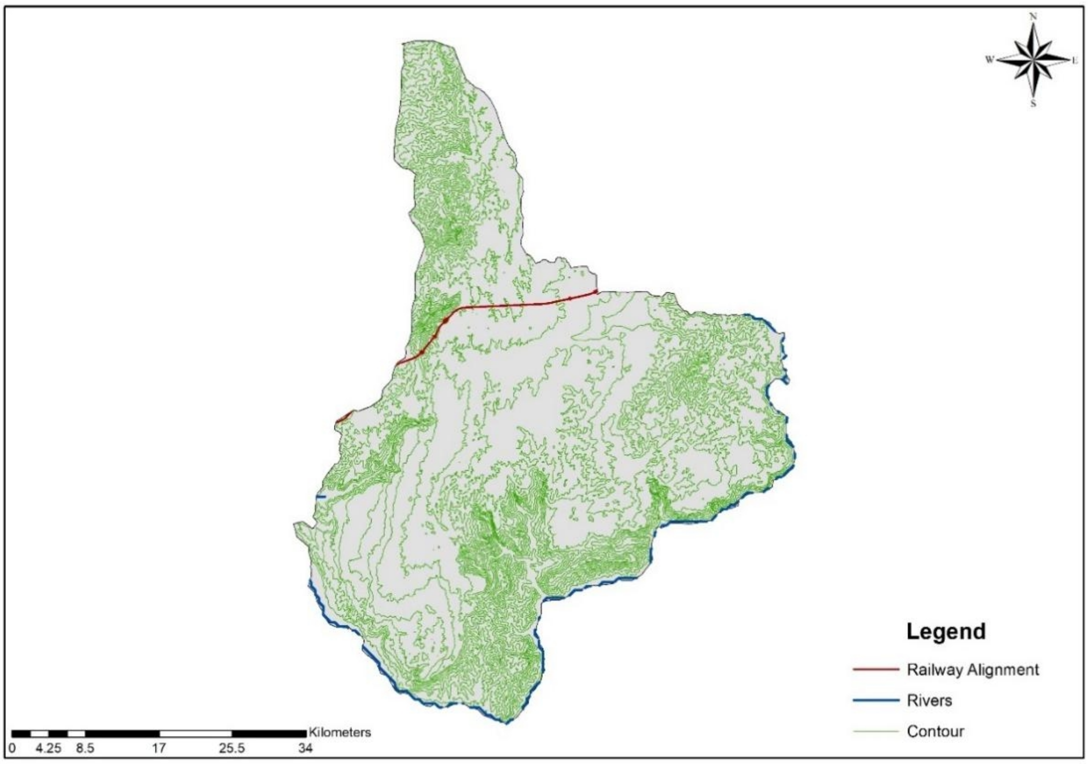
This project mainly passes through Shan Plateau in northern mountain area of Myanmar, and goes through Pyinoolwin and then into the Ayeyarwady river basin in Mandalay plain. The rainfall in Shan Plateau is mostly sudden rainstorm. In a year, the rainy season is long with abundant rainfall. The rainfall intensity is large but the duration is short. The terrain within this area is severely cut by the water flow, forming plenty of gullies and valleys, and the catchment condition is good. The surface water is relatively developed, and the vegetation is dense. The surface is easy to form ponding, so the flow and water level of the mountain river changes greatly with the seasons. The scope of study area and area of influence will be within 500 m of the railway alignment.



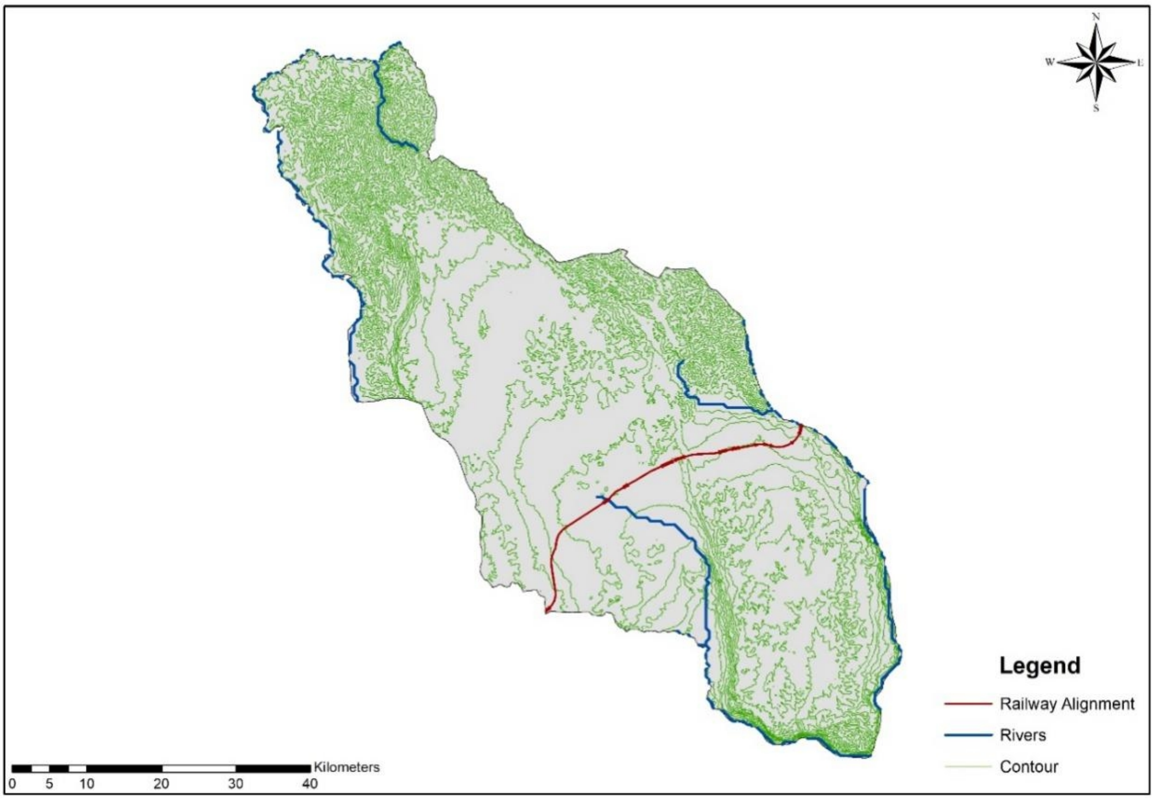
Mandalay – Muse Railway



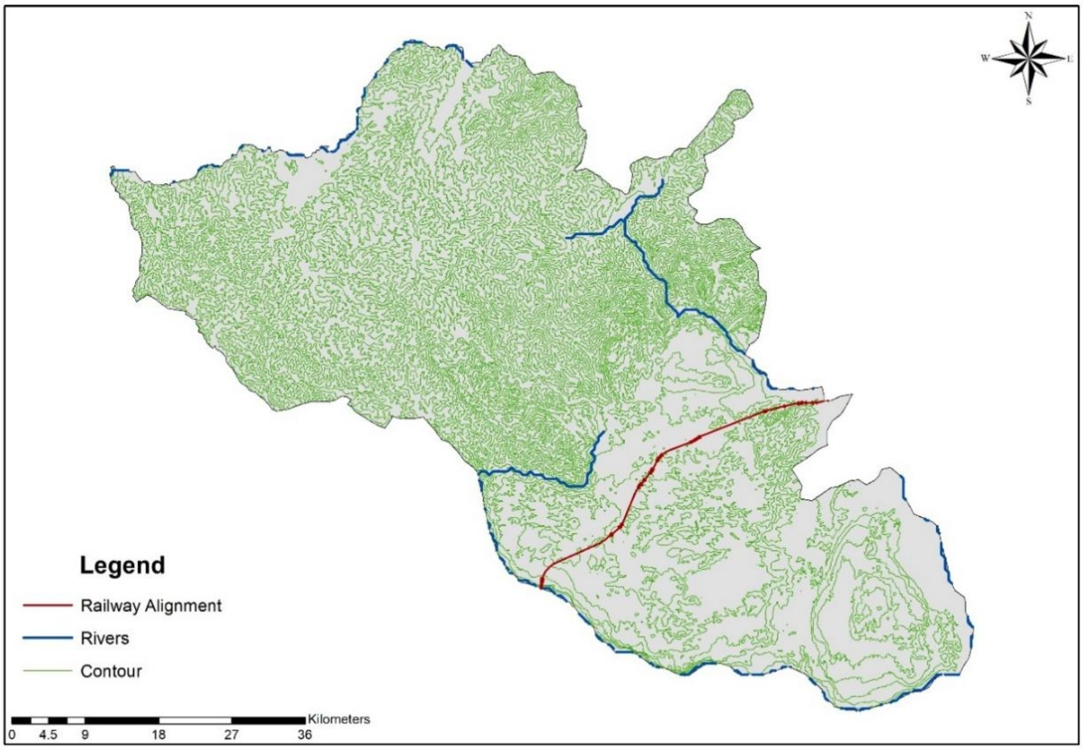
Major Rivers in Mandalay in Topography Map



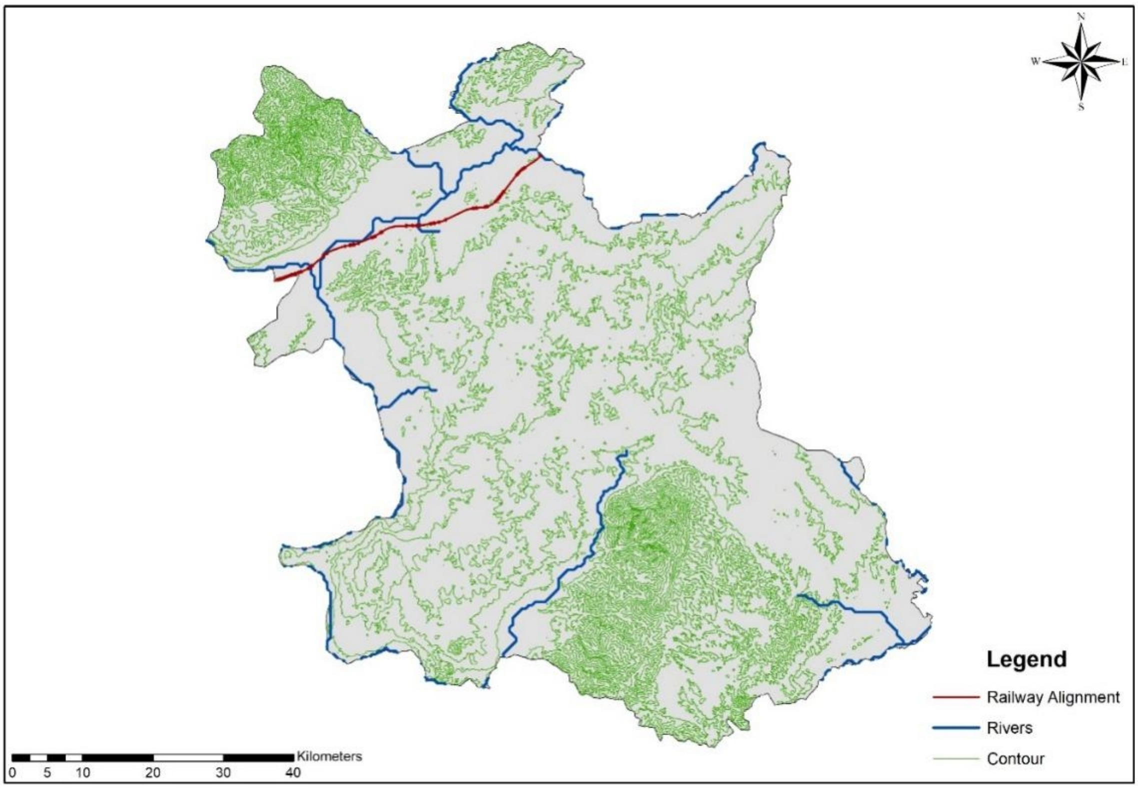
Major Rivers in Topography Map (Pyin Oo Lwin)



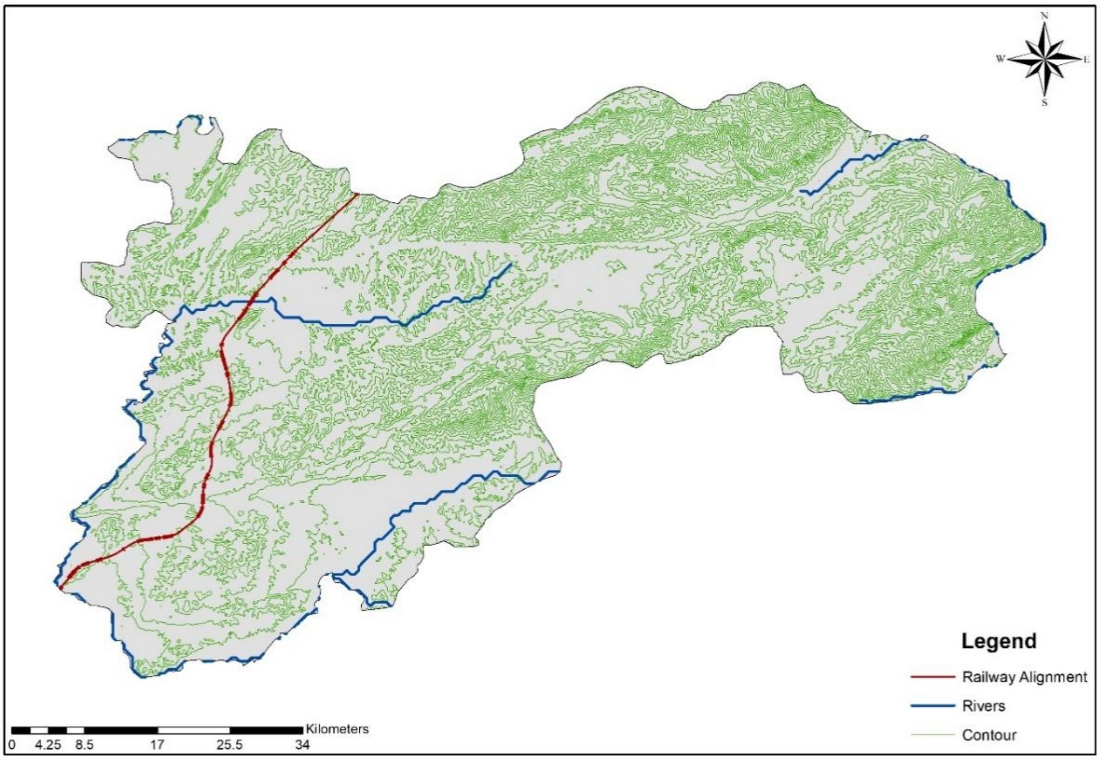
Major Rivers in Topography Map (Nawnghkio)



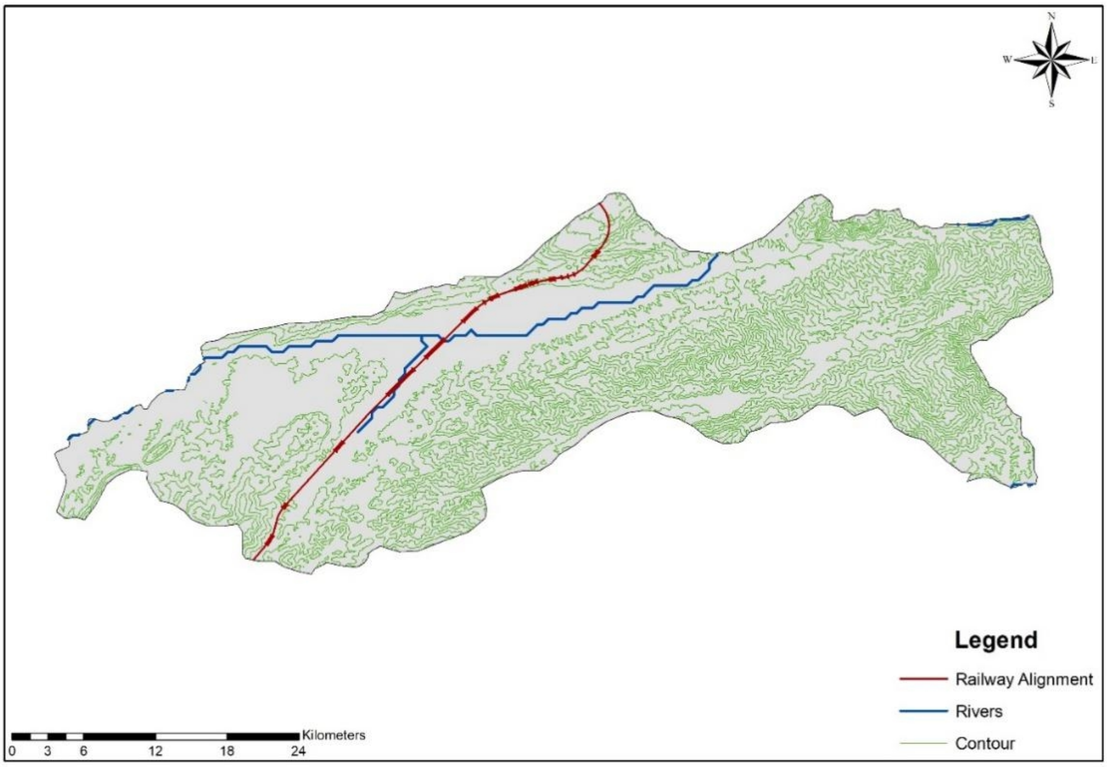
Major Rivers in Topography Map (Kyaukme)



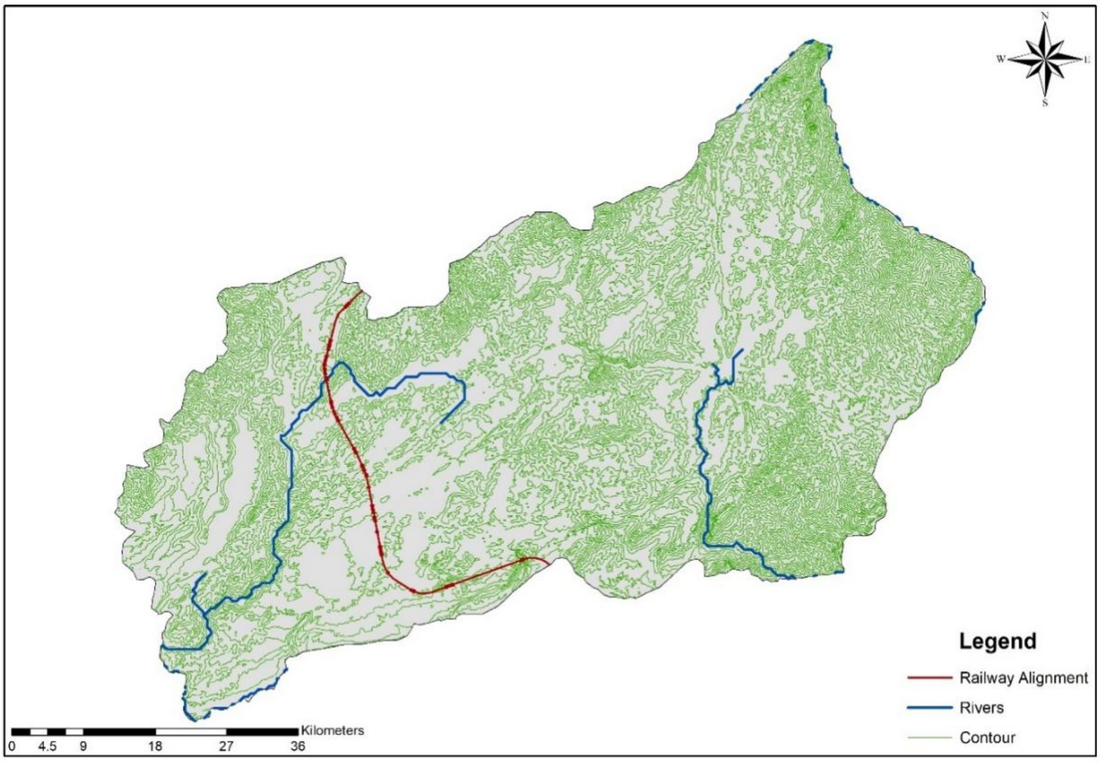
Major Rivers in Topography Map (Hsipaw)



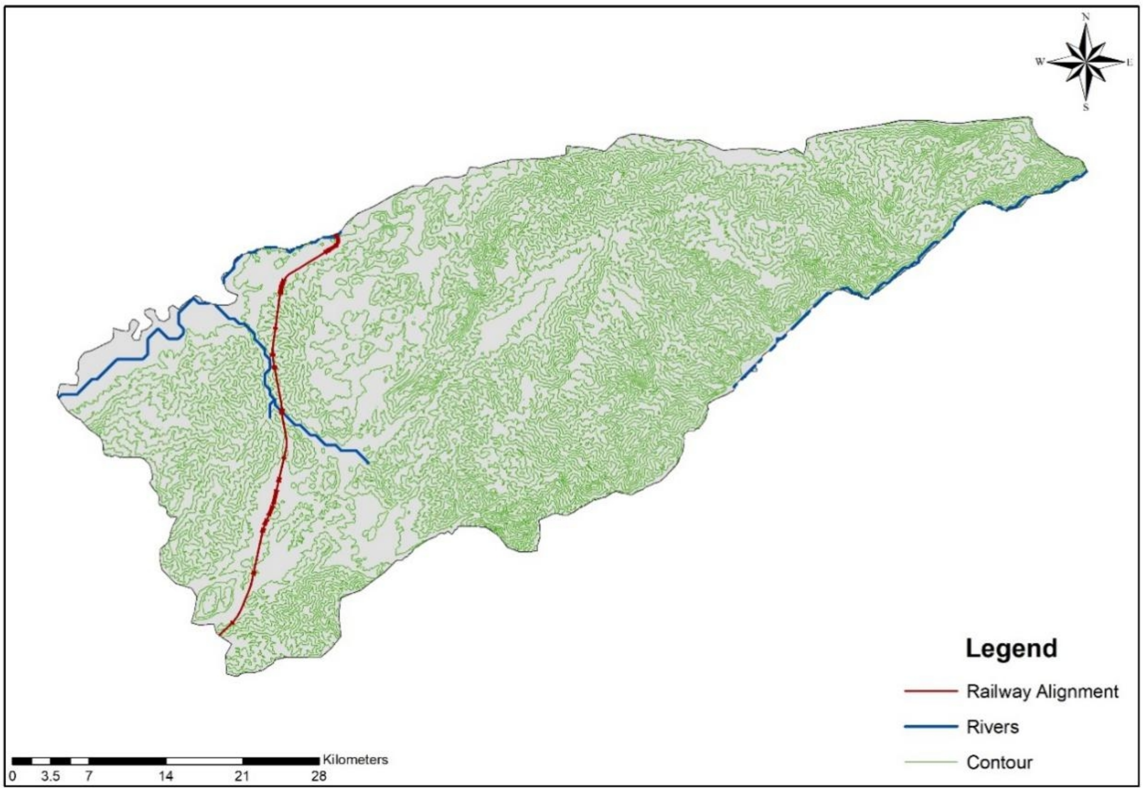
Major Rivers in Topography Map (Lashio)



Major Rivers in Topography Map (Hseni)



Major Rivers in Topography Map (Kutkai)



Major Rivers in Topography Map (Muse)

(f) Hydrologically Sensitive Area

In order to inform the hydrological impact assessment, a site walkover was carried out by the hydrologist to record observations and features of watershed area, natural spring and surface water body as shown in the following figures.

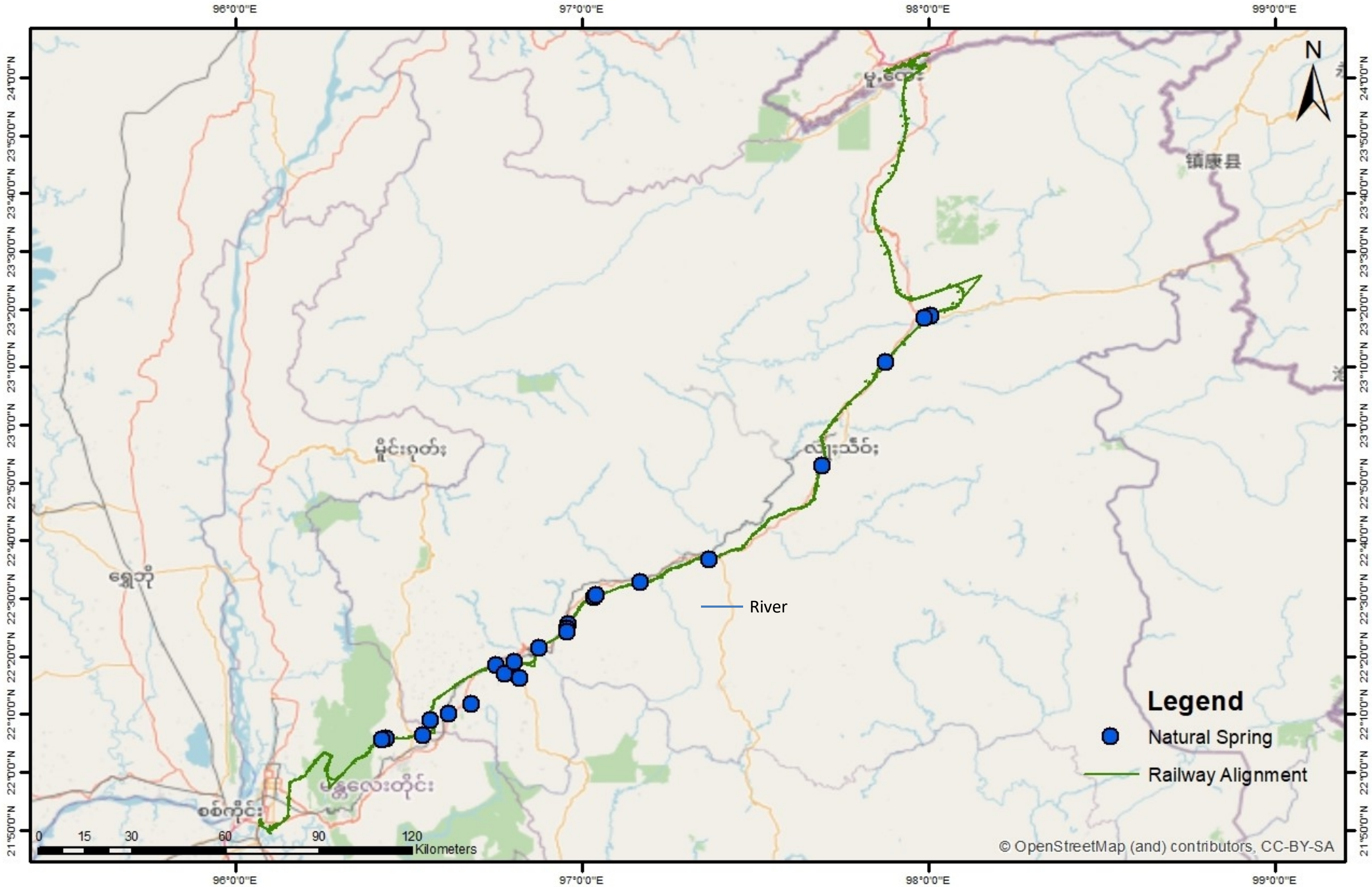


Figure 5.15. Natural Springs and Rivers along the MMR (Source: EGT EIA Team, 2020)

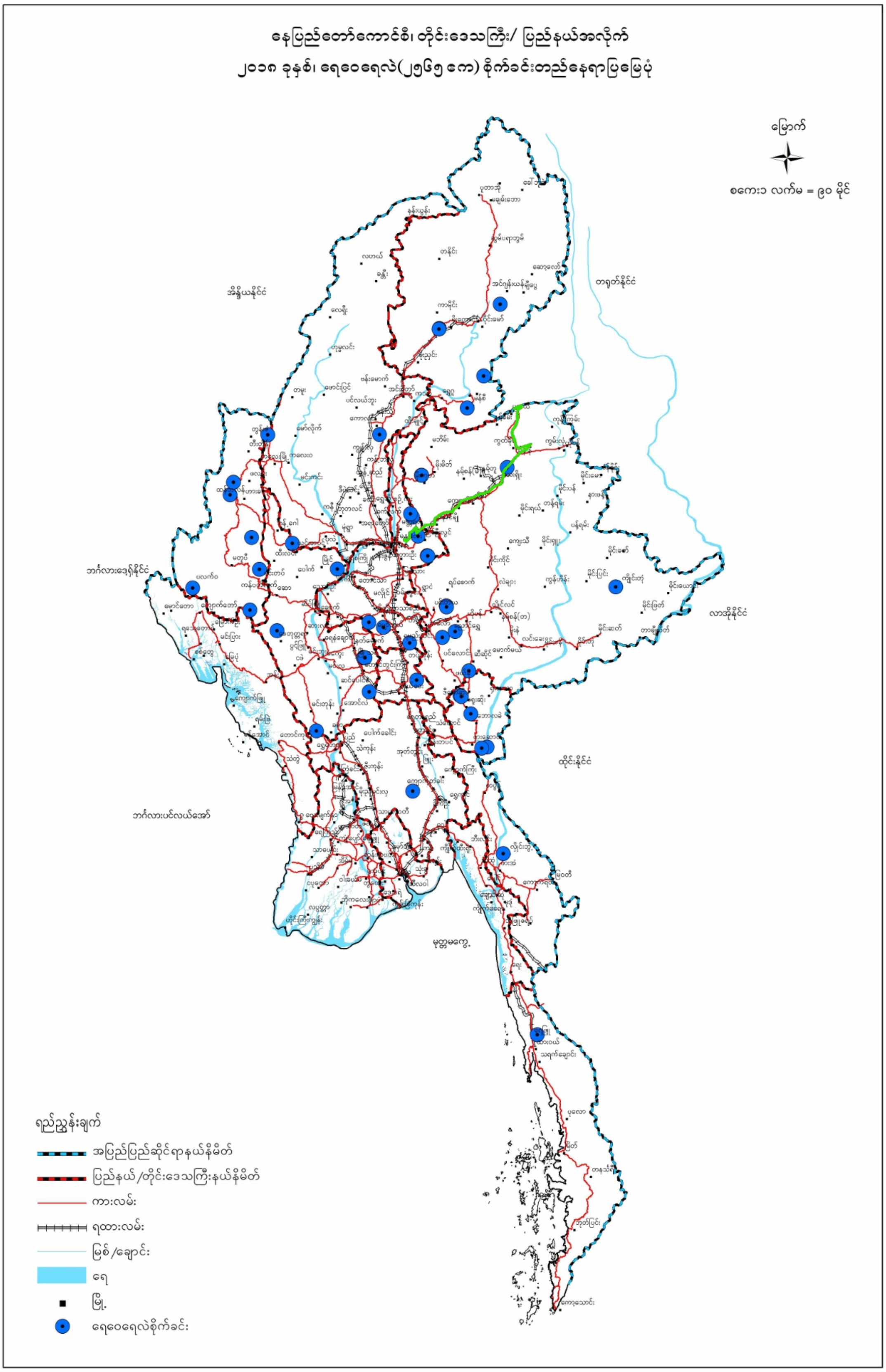


Figure 5.16. Locations of Plantation for Watershed (Source: DOF, 2018)

No.	Village Name (Natural Spring)	Location	Description	Baseline Study
1.	Mang Chat	23.313305°, 98.008298°	Natural water spring	Occurrence and flow pattern
2.	Wane Line	23.309188°, 97.988722°	Natural water spring	Occurrence and flow pattern
3.	Nar Chat	23.181866°, 97.877292°	Natural water spring	Occurrence and flow pattern
4.	Mehan	22.883921°, 97.694954°	Natural water spring	Occurrence and flow pattern
5.	Pang Hsauk	22.611549°, 97.367325°	Natural water spring	Occurrence and flow pattern
6.	Nwang Ann	22.546527°, 97.166665°	Natural water spring	Occurrence and flow pattern
7.	Pang Ywang	22.508405°, 97.039741°	Natural water spring	Occurrence and flow pattern
8.	Mway Taw	22.503216°, 97.033525°	Natural water spring	Occurrence and flow pattern
9.	Na Ai Hkant	22.425912°, 96.961091°	Natural water spring	Occurrence and flow pattern
10.	Khite Tone Home	22.414476°, 96.957989°	Natural water spring	Occurrence and flow pattern
11.	Kone Kaw (Kyaukme)	22.405297°, 96.957967°	Natural water spring	Occurrence and flow pattern
12.	Kyaung Gone	22.358234°, 96.877519°	Natural water spring	Occurrence and flow pattern
13.	Myat Chae Nu	22.271596°, 96.821246°	Natural water spring	Occurrence and flow pattern
14.	Taung Quarter	22.316893°, 96.803754°	Natural water spring	Occurrence and flow pattern
15.	Ngokkalay	22.281051°, 96.775510°	Natural water spring	Occurrence and flow pattern
16.	Lone Yone	22.308319°, 96.750980°	Natural water spring	Occurrence and flow pattern

17.	Kon Gyi	22.196934°, 96.678743°	Natural water spring	Occurrence and flow pattern
18.	Kyein Ga Naing	22.166371°, 96.615714°	Natural water spring	Occurrence and flow pattern
19.	Anauk Kyu Inn	22.148223°, 96.563513°	Natural water spring	Occurrence and flow pattern
20.	Middle Pin Lain	22.105234°, 96.539294°	Natural water spring	Occurrence and flow pattern
21.	Kone Kaw (Pyin Oo Lwin)	22.095427°, 96.435934°	Natural water spring	Occurrence and flow pattern
22.	Pan Oo Taung	22.092211°, 96.423717°	Natural water spring	Occurrence and flow pattern
23.	Pyin Oo Lwin Watershed	22.100212°, 96.465955°	Watershed Area	Watershed condition
24.	Lashio Watershed	23.046681°, 97.758647°	Watershed Area	Watershed condition
25.	Shweli River (Muse)	24.01721°, 97.90384°	Surface water body	Water quality
26.	Nant Paung Stream (Muse)	23.85798°, 97.97741°	Surface water body	Water quality
27.	Nant Khaing Stream (Kutkai)	23.57058°, 97.81950°	Surface water body	Water quality
28.	Namtu Stream (Thenni)	23.28817°, 97.95394°	Surface water body	Water quality
29.	Pan Phet Stream (Thenni)	23.13200°, 97.84320°	Surface water body	Water quality
30.	A-T Stream (Lashio)	22.99409°, 97.76455°	Surface water body	Water quality
31.	Sint In Stream (Lashio)	22.70178°, 97.53847°	Surface water body	Water quality
32.	Kho Lone Stream (Hsipaw)	22.61445°, 97.39456°	Surface water body	Water quality

33.	Dokehtawady River (Hsipaw)	22.60728°, 97.30748°	Surface water body	Water quality
34.	Kyin Thi Stream (Kyauk Me)	22.56428°, 97.20963°	Surface water body	Water quality
35.	Goke Twin Stream (Nawnghkio)	22.35489°, 96.83371°	Surface water body	Water quality
36.	Yae Ni Stream (Pathein Gyi)	21.99596°, 96.12399°	Surface water body	Water quality
37.	Se Taw Gyi Cananl (Pathein Gyi)	21.91917°, 96.18635°	Surface water body	Water quality
38.	Myaung Ma Gyi Stream (Amarapura)	21.85159°, 96.12443°	Surface water body	Water quality
39.	Myaing Gyi Stream (Min Village)	21.84470°, 96.10187°	Surface water body	Water quality
40.	Dotehtawady River (Myit Nge)	21.83646°, 96.07781°	Surface water body	Water quality

5.5.4.2. Meteorological Characteristics

The climate along the line belongs to tropical monsoon climate zone, which can be divided into three seasons: cool, hot and rainy season.

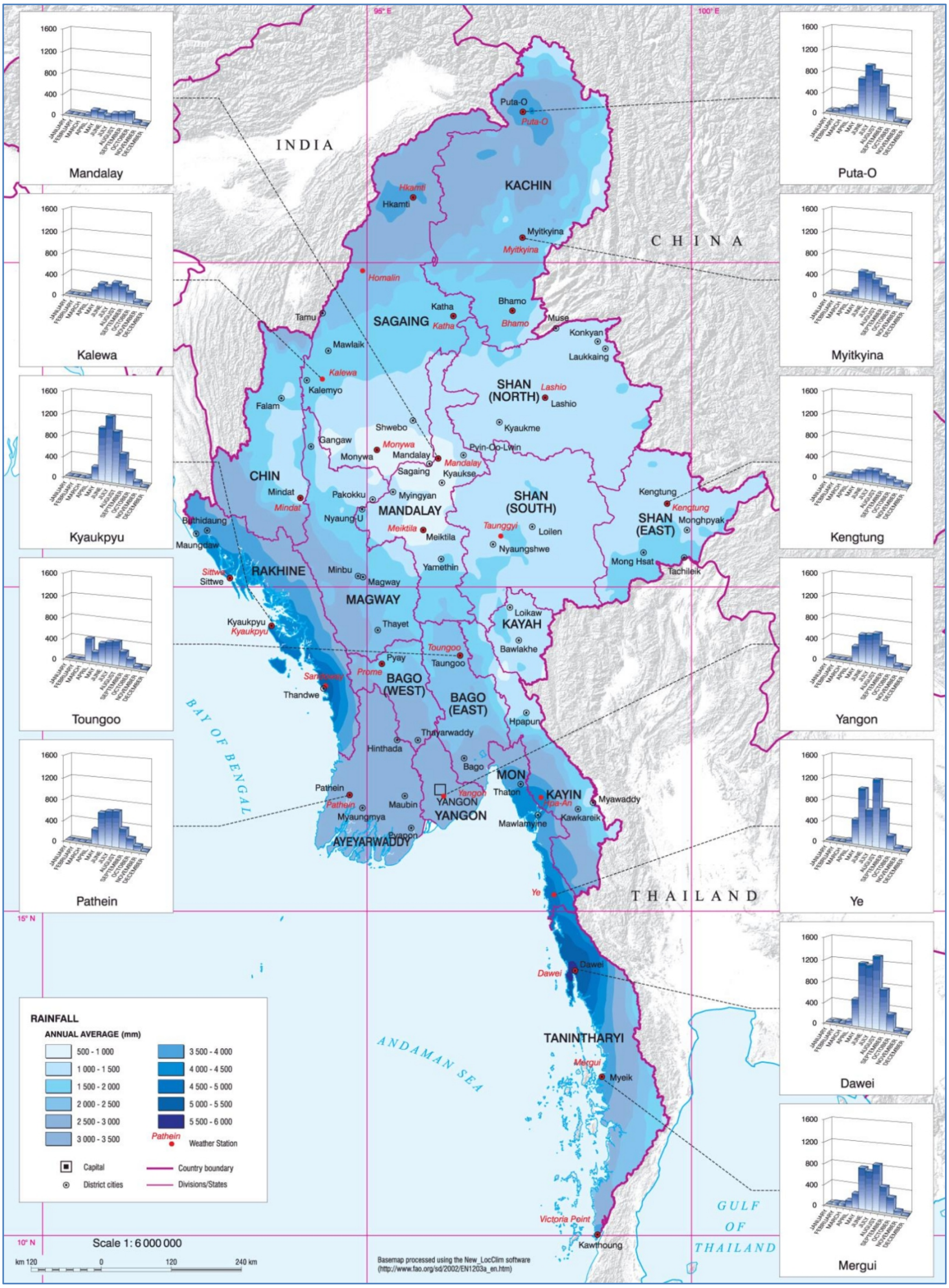
The cool season is generally after mid-September, when the temperature rises and the cyclone gradually weakens. At about mid-November, cool season has officially arrived, until March of the when it turns into the hot season. The cool season is most typical from December to January, with frequent weak northeast wind or northwest wind; it is always sunny with plenty sunshine. The average monthly temperature is between 15 °C and 22 °C, which is the mildest and most pleasant season.

The hot season generally begins in early March. The temperature rises rapidly and reaches the highest peak in the whole year in April~May. The average monthly temperature is generally above 25 °C. Temperature at the middle and lower reaches of the Ayeyarwady River are generally above 30 °C, with the highest temperature above 40 °C. In addition to the occasional heavy rains along the coast, the hot season generally has little rainfall and strong evaporation. The rainy season generally begins after mid-May and is in full swing after mid-June. After mid-September, the rainy season begins to turn into a cool season.

According to the rainfall statistics of major cities along the line, the rainfall in Shan Plateau is moderate. The average annual rainfall of Lashio is 1329mm. The middle reaches of the Ayeyarwady River have the least rainfall, which is less than 1000mm, and have become a famous arid area in Myanmar. The average annual rainfall in Mandalay is 901mm. The meteorological parameters of main areas along the line are shown in Table 5.6.

Table 5.6. Main Areas Meteorological Parameters along the Line

Content		Ruili	Muse	Kutkai	Theinni	Lashio	Mandalay
Temperature (℃)	Highest temperature in history	36.0	35.0	35.0	34.0	28.0	41.5
	Lowest temperature in history	3.7	-	-	0.4	-1.9	12.4
	Average highest temperature in 2009	28.0	30.7	30.7	29.9	32.5	32.3
	Average lowest temperature in 2009	16.9	14.2	9.7	15.0	12.1	21.8
Rainfall	Annual average rainfall (mm).	1364	1329	1771	1453	1329	901
	Annual average rainy days (day)	150	93	108	97	94	83



[Source: http://dwms.fao.org/atlases/myanmar/atlas_en.htm]

Figure 5.17 - Rainfall Map of Myanmar with Monthly Distribution

5.5.5. Ambient Air Qualtiy Monitoring

Emission of air pollutants can occur from a wide variety of activities during the construction, operation, and decommissioning phases of the project. These activities can be point sources, fugitive sources, and mobile sources and by process such as Transportation, vehicles Movements, combustion, materials storage, or other specific processed. projects will prevent or minimize impacts by ensuring that emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standard, and emission do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. Following is the US National Ambient Air Quality Standards (NAAQS) guidelines values for ambient air quality standard applicable as a reference standard for the current project since there is no national ambient air quality standard currently in Myanmar.

Survey Item

The parameters for air quality survey were SO_2, NO_2, CO_2, CO, CH_4, H_2S, O_3, $PM_{2.5}$, and PM_{10}, Solar Radiation, Odour, Temperature, Relative Humidity, Wind Speed and Wind Direction, Noise and Vibration.

Survey Location

The air quality survey was carried out in Seven locations. AS-1, AS-2, and AS-7were located near railway station project area.. The details of the location of air quality survey points are presented in figure below during August 2019.

Table 5.7 - Location of Air Sample (AS) of the Muse-Mandalay Railway Project

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
1	AS0	21°51'11.93"N,	96° 4'17.38"E	Myitnge Railway Station
2	AS-1	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone
3	AS-2	22° 2'13.97"N,	96°27'57.83"E	Pyin Oo lwin Railway Station
4	AS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone
5	AS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station
6	AS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station
7	AS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Survey Methodology

Sampling and analysis of ambient air quality were conducted by referring to the recommendation of the United States Environmental Protection Agency (U.S. EPA). The Haz- Scanner Environmental Perimeter Air Station (EPAS) was used to collect ambient air survey data. Sampling rate or air quality data were measured automatically every one minute and directly read and recorded onsite for measured parameters (SO_2, NO_2, CO_2, CO, H_2S, O_3, CH_4,PM_{10}, $PM_{2.5}$), as shown in Table. Sampling pump was operated at 2 L/min. Different analysis methods are integrated in the instrument, such as Particulates 90° Infrared Light Scattering for particulate matters (PM_{10}, $PM_{2.5}$), electrochemical sensors for toxic gases (SO_2, NO_2, CO, H_2S), NDIR (optional sensor) for (CO_2, CH_4) and Gas Sensing Semiconductor- GSS technology (optional sensor) for O_3.

Table 5.8 - Sampling and Analysis Method for Air Quality

No.	Parameter	Analysis Method
1	Sulfur dioxide (SO_2)	On site reading
2	Nitrogen dioxide (NO_2)	On site reading
3	Carbon Dioxide (CO_2)	On site reading
4	Carbon monoxide (CO)	On site reading
5	Hydrogen Sulfide (H_2S)	On site reading
6	Particulate matter 2.5 ($PM_{2.5}$)	On site reading
7	Particulate matter 10 (PM_{10})	On site reading
8	Methane (CH_4)	On site reading
9	Hydrogen Sulfide (H_2S)	On site reading
10	Solar Radiation	On site reading
11	Wind Direction	On site reading
12	Wind Speed	On site reading
13	Temperature	On site reading
14	Relative Humidity	On site reading
15	Ordor	On site reading
16	Noise and Vibration	On site reading

Figure - Air Sampling Location Point One, AS0, 21°51'11.93"N, 96° 4'17.38"E Myitnge Railway Station

Figure - Air Sampling Location Two, AS1, 21°52'48.75"N, 96°13'34.70"E Ohn Chaw Tar Zone

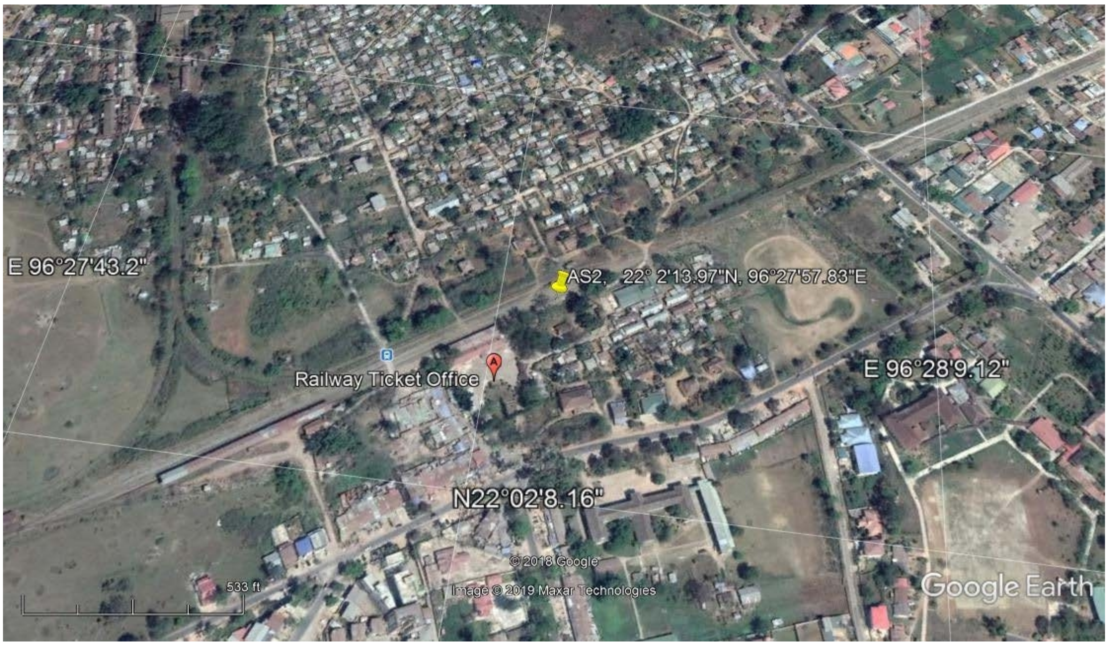


Figure - Air Sampling Location Point Three, AS2, 22° 2'13.97"N, 96°27'57.83"E Pyin Oo lwin Railway Station

Figure - Air Smapling Location Four, AS3, 22° 3'30.29"N, 96°29'51.88"E Pyin Oo Lwin Industrial Zone Public Area

Figure -Air Smapling Location Five, AS4, 22°21'4.94"N, 96°54'50.62"E Naung Peng Rail way station

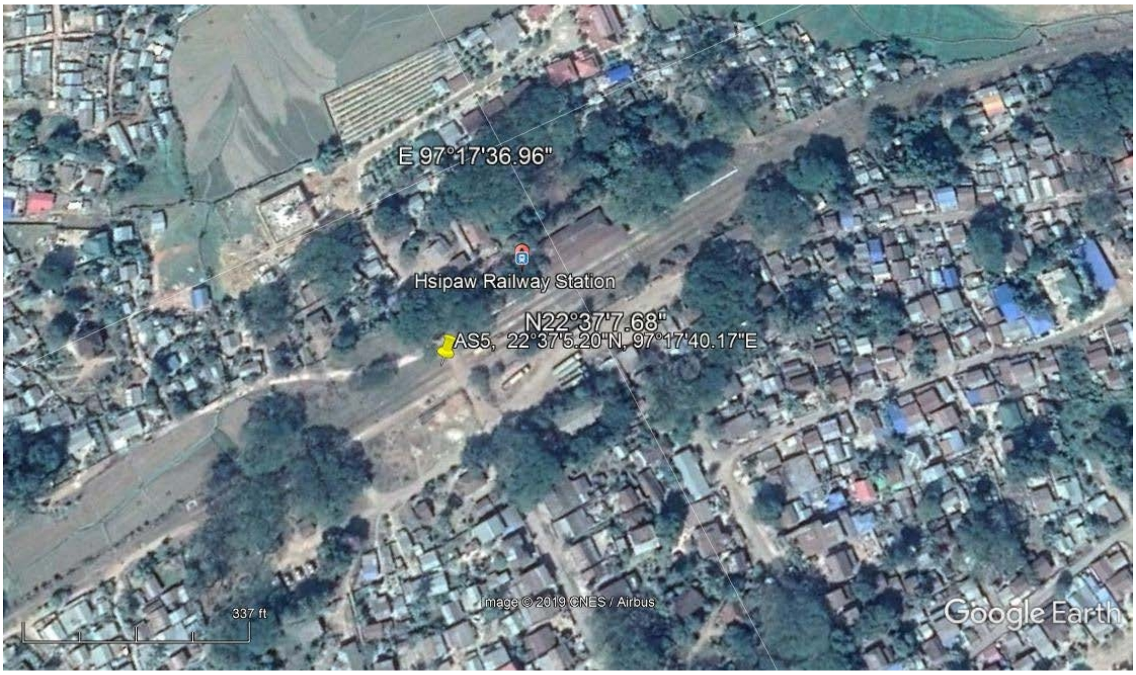


Figure - Air Sampling Location Point Six, AS5, 22°37'5.20"N, 97°17'40.17"E Hsipaw Railway Station

Figure - Air Sampling Location Point Seven, AS6, 22°58'22.88"N, 97°43'50.33"E

Lashio Railway Station

Table - General Conditions of Ambient at the Time of Sampling on Points

Sr.	Latitude(N)	Longitude(E)	Air Temp	WBT	Dew Point	Humidity
1	21°51'11.93"N,	96° 4'17.38"E	31.6°	33.2°	30.6°	74.6%
2	21°52'48.75"N,	96°13'34.70"E	40°	28.8°	27°	51.1%
3	22° 2'13.97"N,	96°27'57.83"E	36°	28.3°	26.7°	55.5%
4	22° 3'30.29"N,	96°29'51.88"E	34°	28.2°	28.1°	66.2%
5	22°21'4.94"N,	96°54'50.62"E	34°	28.2°	26.7°	70.9%
6	22°37'5.20"N,	97°17'40.17"E	33°	27.2°	27.5°	64.3%
7	22°58'22.88"N,	97°43'50.33"E	33.11°	27.7°	26.6°	61.5%

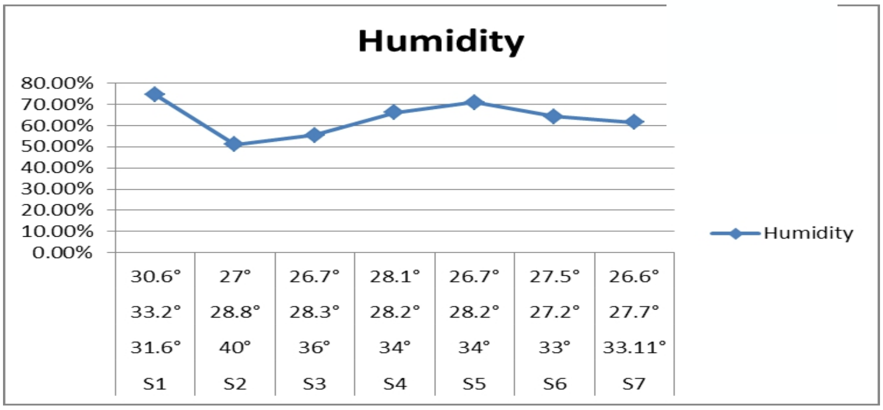


Figure – Humidity

Table - Wind Speed and Direction

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	
1	AS0	21°51'11.93"N,	96° 4'17.38"E	AS0, Myitnge Railway Station
2	AS-1	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone
3	AS-2	22° 2'13.97"N,	96°27'57.83"E	Pyin Oo lwin Railway Station
4	AS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone Public Area
5	AS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station
6	AS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station
7	AS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Wind speed and wind direction of proposed Muse Mandalay Railway Project site had been measured by using EPAS.

Table - Wind Speed and Air Direction of AS1

Date	Time	WDir, Deg.	WSpM,mps	Date	Time	WDir, Deg.	WSpM,mps
19-5-2019	11:46:01	292	4.8	19-5-2019	12:54:01	264	8.7
19-5-2019	11:50:01	298	3.4	19-5-2019	12:55:01	257	6
19-5-2019	12:00:01	176	2.3	19-5-2019	12:56:01	249	6.3
19-5-2019	12:10:01	134	0.8	19-5-2019	12:57:01	265	6.6
19-5-2019	12:20:01	22	0	19-5-2019	12:58:01	242	5.4
19-5-2019	12:30:01	284	0	19-5-2019	12:59:01	252	5.8
19-5-2019	12:40:01	225	7.4	19-5-2019	13:00:01	231	6.6
19-5-2019	12:50:01	253	4.8	19-5-2019	13:01:01	254	8.1
19-5-2019	12:51:01	240	5.3	19-5-2019	13:04:01	236	9.6
19-5-2019	12:52:01	248	7	19-5-2019	13:05:01	233	10.5
19-5-2019	12:53:01	260	8.2	19-5-2019	13:07:01	240	8.3

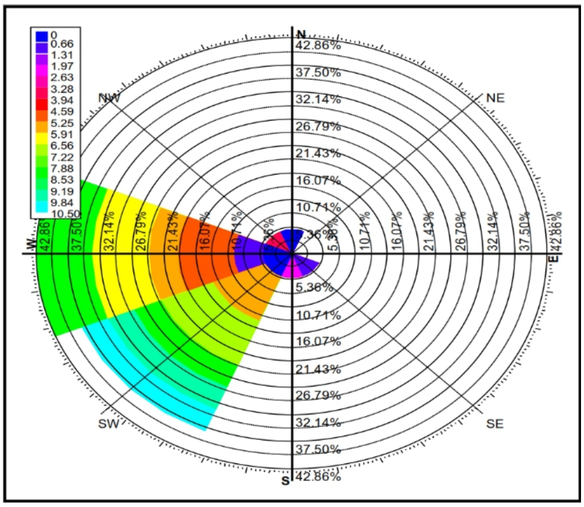


Figure - Wind Rose Diagram at AS1 at Myitnge Railway Station

Table - Wind Speed and Air Direction of AS2

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
2	AS-2	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone

Date	Time	WDir, Deg.	WSpM, mps	Date	Time	WDir, Deg.	WSpM, mps
19-5-2019	14:40:01	161	1	19-5-2019	15:21:01	148	0
19-5-2019	14:45:01	166	1	19-5-2019	15:24:01	170	0.2
19-5-2019	14:50:01	178	0.4	19-5-2019	15:27:01	193	0.2
19-5-2019	14:55:01	147	2	19-5-2019	15:30:01	151	0
19-5-2019	15:00:01	160	0.7	19-5-2019	15:33:01	208	0.3
19-5-2019	15:05:01	154	0.2	19-5-2019	15:34:01	179	3.2
19-5-2019	15:10:01	132	0.1	19-5-2019	15:36:01	280	0.8
19-5-2019	15:11:01	157	0.6	19-5-2019			
19-5-2019	15:12:01	131	0.2	19-5-2019			
19-5-2019	15:15:01	149	0.5	19-5-2019			
19-5-2019	15:18:01	149	0	19-5-2019			

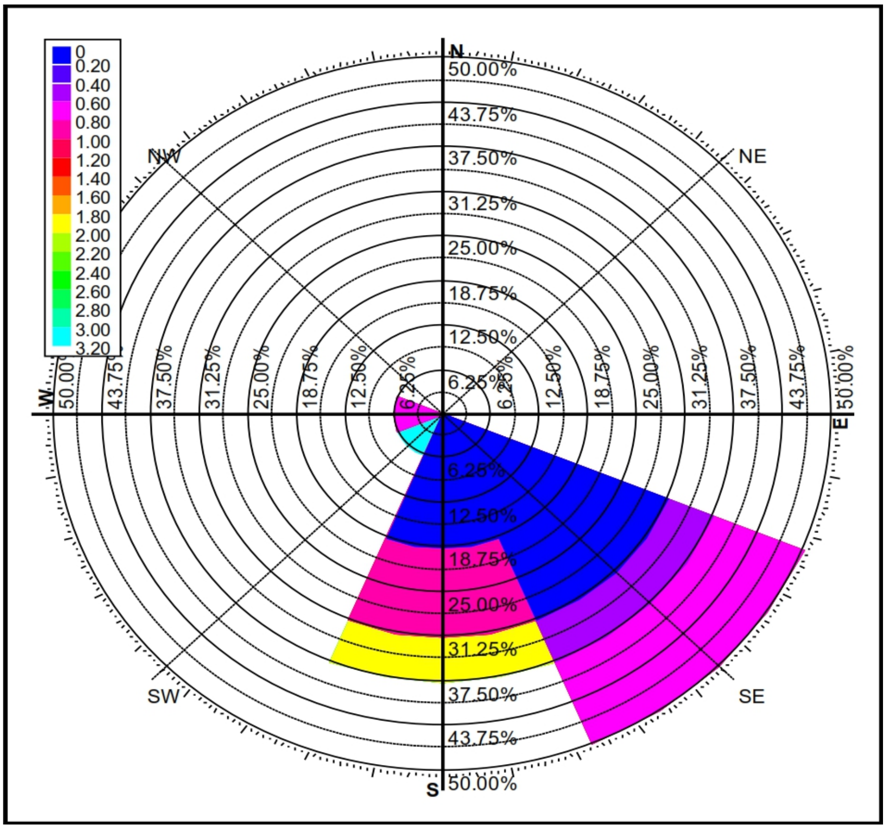


Figure - Wind Rose Diagram at AS2

Table - Wind Speed and Air Direction of AS3

Sr. No	Sample Name	Coordinates		Remar
		Latitude(N)	Longitude(E)	Sensitive Areas
4	AS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone Public Area

Date	Sample point	Time	Wind Speed (km/h)	Wind Direction (degree)	Wind Direction (cardinal point)
20.5.2019	Air Sample 3	8: 00 AM	1.6	312°	NW
		9: 00 AM	3.1	328°	NNW
		10: 00 AM	2.2	310°	NW
		11: 00 AM	6.2	66°	SSW
		12: 00 PM	4.2	56°	ESE
		13: 00 PM	2.1	129°	SE
		14: 00 PM	6.1	160°	SSE
		15: 00 PM	4.2	201°	SSW

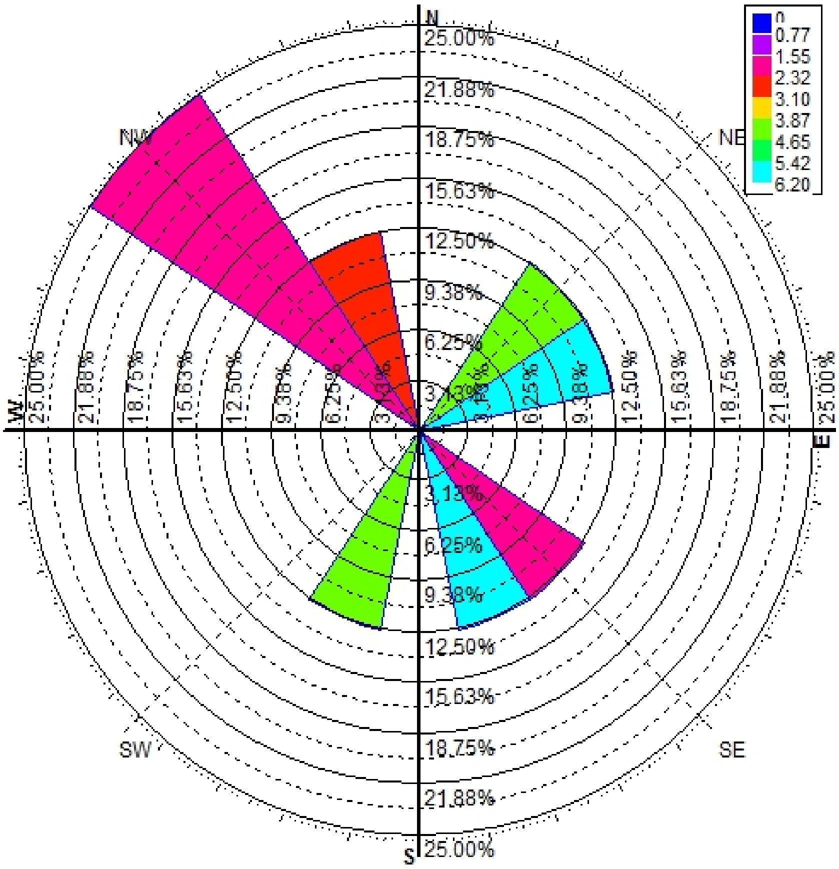


Figure - Wind Rose Diagram for AS3

Table - Wind Speed and Air Direction of AS4

Sr. No	Sample Name	Coordinates		R
		Latitude(N)	Longitude(E)	Sensitive Areas
5	AS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station

Date		Sample point	Time	Wind Speed (km/h)	Wind Direction (degree)	Wind Direction (cardinal point)
21.5.2019		Air Sample 4	8: 00 AM	7.2	358°	N
			9: 00 AM	6.5	315°	NW
			10: 00 AM	4.4	293°	WNW
			11: 00 AM	5.8	319°	NW
			12: 00 PM	7.1	312°	NW
			13: 00 PM	5.4	352°	N
			14: 00 PM	5.1	18°	NNE
			15: 00 PM	6.4	329°	NNW

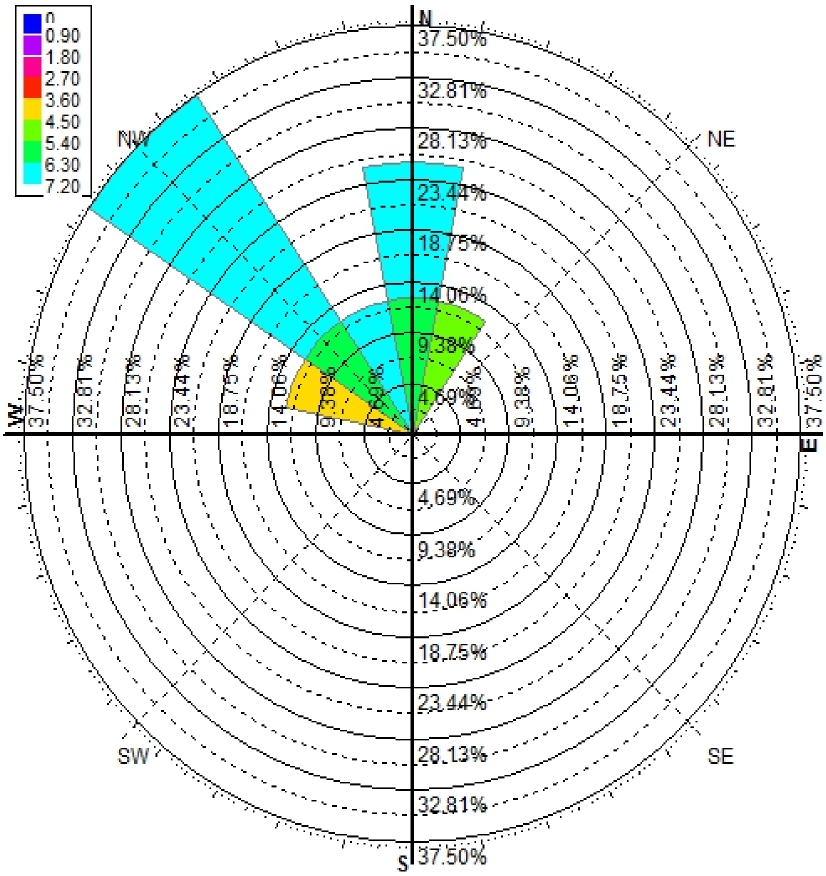


Figure - Wind Rose Diagram at AS4

Table - Wind Speed and Air Direction of AS5

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
6	AS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station

Date	Sample point	Time	Wind Speed (km/h)	Wind Direction (degree)	Wind Direction (cardinal point)
22-5-.2019	Air Sample 5	8: 00 AM	5.6	182°	S
		9: 00 AM	4.6	292°	WNW
		10: 00 AM	4.3	38°	NE
		11: 00 AM	5.2	327°	NW
		12: 00 PM	3.2	178°	S
		13: 00 PM	3.5	51°	NE
		14: 00 PM	2.1	69°	ENE
		15: 00 PM	3.1	340°	NNW

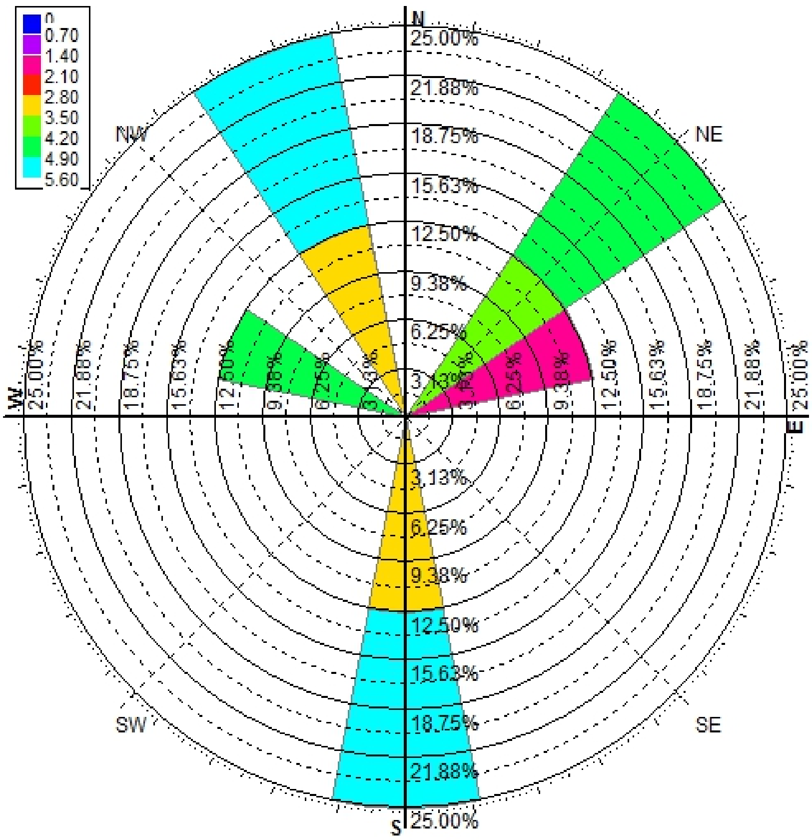


Figure - Wind Rose Diagram at AS5

Table - Wind Speed and Air Direction of AS6

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
7	AS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Date	Sample point	Time	Wind Speed (km/h)	Wind Direction (degree)	Wind Direction (cardinal point)
23-5-2019	Air Sample Point AS-6	9: 00 AM	1.6	246°	WSW
		10: 00 AM	1.3	198°	SSW
		11: 00 AM	2.9	221°	SW
		12: 00 PM	2.8	269°	W
		13: 00 PM	4.6	216°	SW
		14: 00 PM	2.7	64°	ENE
		15: 00 PM	6.7	66°	ENE
		16: 00 PM	5.5	331°	NNW

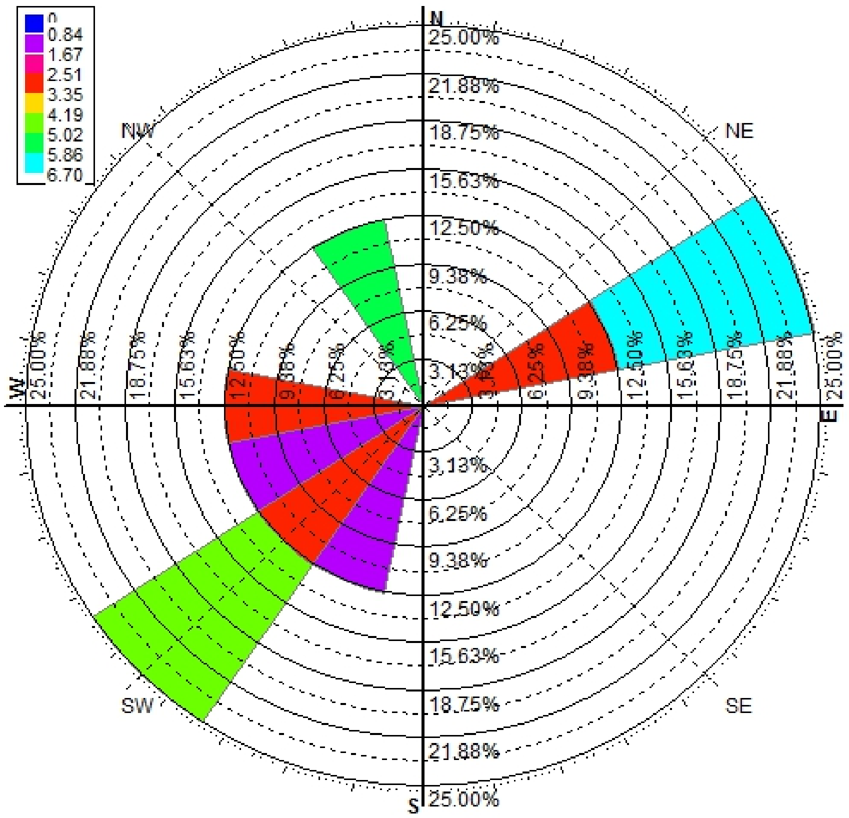


Figure - Wind Rose Diagram at AS6

5.5.5.1. Measurement of Air Quality for Dry Season Comparing with the Air Quality Standards and Guidelines

CO, CO_2, NO_2, SO_2, O_3, PM_{10} and $PM_{2.5}$ are measured at the proposed MUSE-MANDALAY RAILWAY PROJECT Project site from myitnge to lashio (7 points). The site is in the pre construction stage and the collected data shown below are due to the movement of vehicles along the road and the transportation works. The standards for applicable to the possible air pollutants were determined from review of Myanmar National Environmental Emission Guideline and World Health Organization (WHO) Guideline. The average concentrations of pollutants at three sampling points for about 8 hours total, 8 hours for each are shown in the table below.

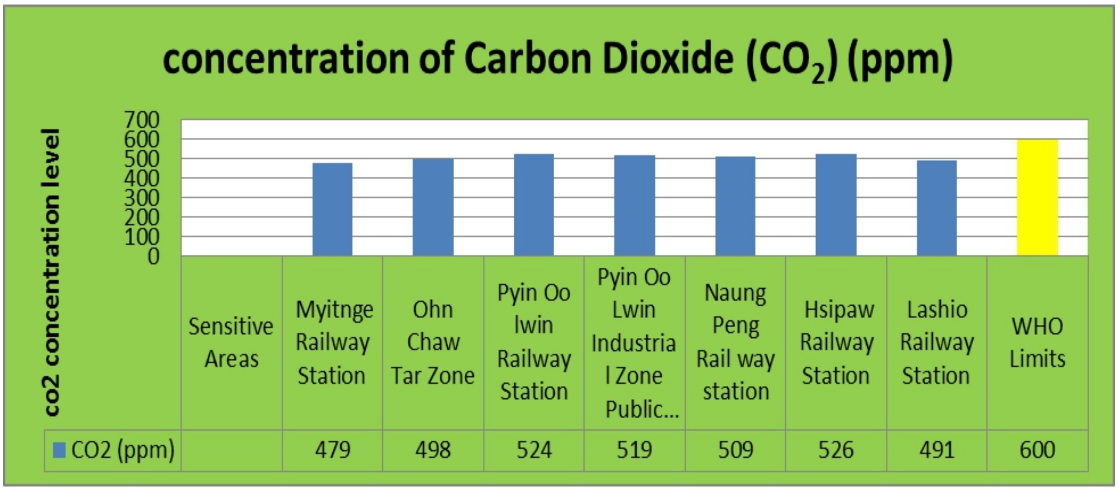
Table - Average concentrations of pollutants at the sample points for 8 hours for each

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
1	AS0	21°51'11.93"N,	96° 4'17.38"E	Myitnge Railway Station
2	AS-1	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone
3	AS-2	22° 2'13.97"N,	96°27'57.83"E	Pyin Oo lwin Railway Station
4	AS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone Public Area
5	AS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station
6	AS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station
7	AS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Sample Time	Sensitive Areas	Average Value Parameters					
		CO_2 (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppb)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
Time 8 hours for each points	Myitnge Railway Station	479	6	1	31	29	11
	Ohn Chaw Tar Zone	498	15	4	29	43	22
	Pyin Oo lwin Railway	524	3	2	21	22	10
	Pyin Oo Lwin Industrial Zone Public Area	519	7	1	21	21	14

	Naung Peng Rail way	509	11	3	12	26	10
	Hsipaw Railway Station	526	5	1	21	28	17
	Lashio Railway Station	491	9	1	19	29	18

The chart below show that the concentration of Carbon Dioxide (CO_2) measured in all the sampling times at sampling point was between the ranges of 479 ppm – 526 ppm.



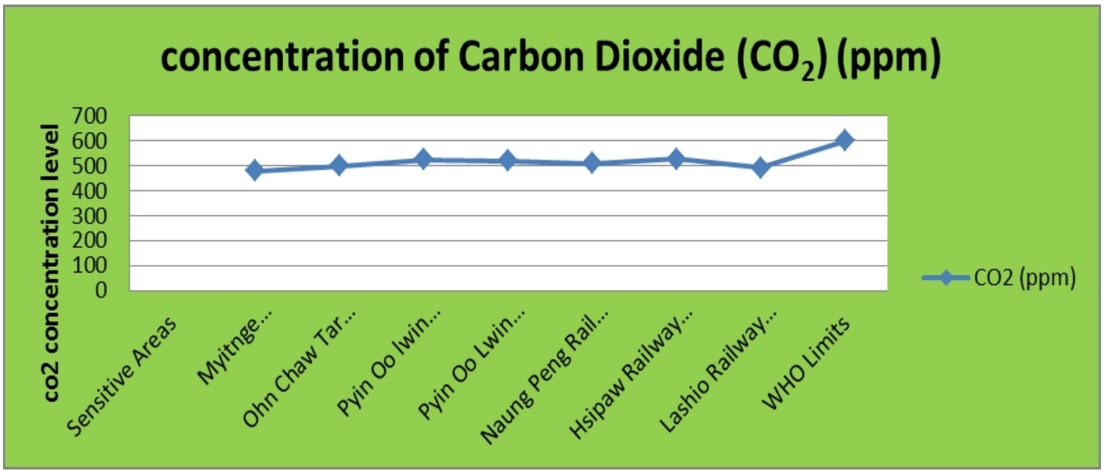
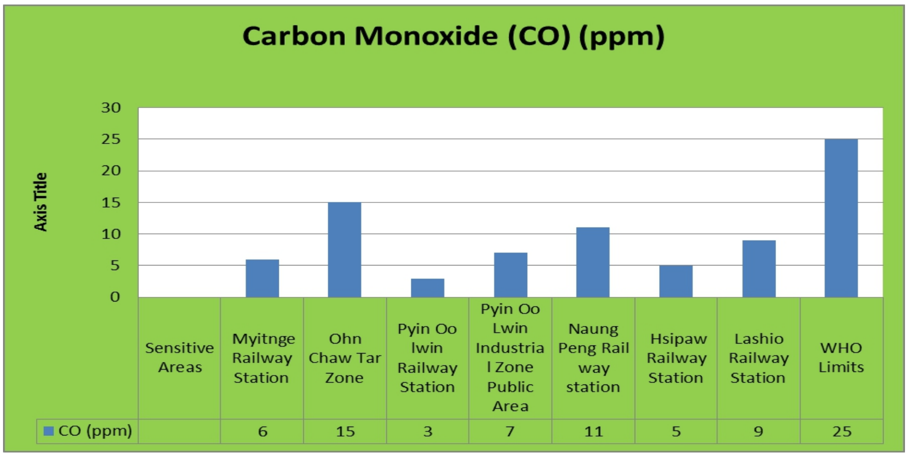


Figure – Concentration of Carbon Dioxide

The concentration of Carbon Dioxide measured in all the sampling times at sampling point was below the World Health Organization (WHO) Guidelines, which specifies 600 ppm for the limitation of CO_2 concentration. CO_2 concentration of 526 ppm was the highest and 479 ppm was the lowest at the proposed area.

The chart below show that the concentration of Carbon Monoxide (CO) measured in all sampling times at sampling point 1 was between the ranges of 5 ppm – 15 ppm



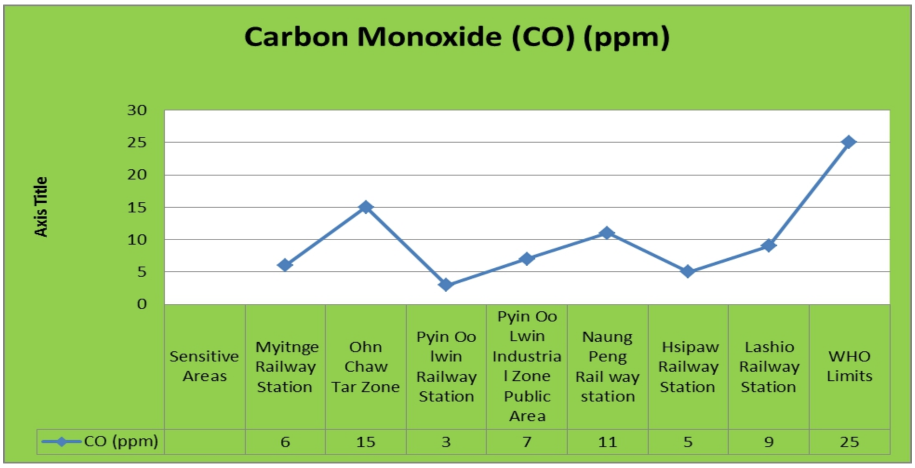
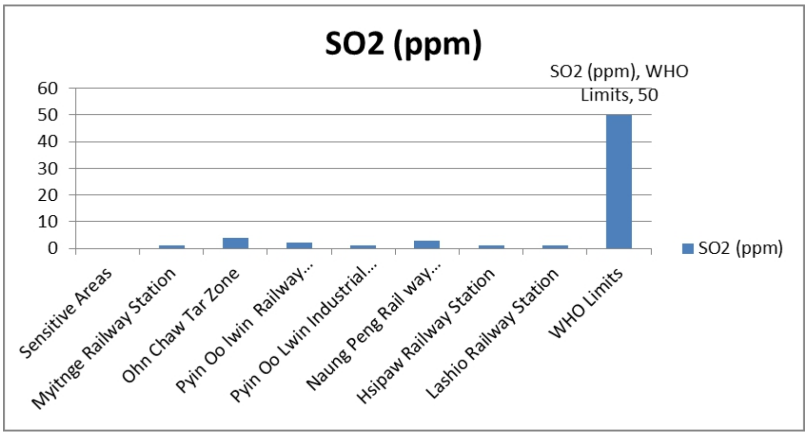


Figure – Concentration of Carbon Monoxide

The concentration of Carbon Monoxide measured in all the sampling times at sampling point 1 was below the World Health Organization (WHO) Guidelines, which specifies 25 ppm for the limitation of CO concentration. CO concentration of 15 ppm was the highest and 5 ppm was the lowest at the proposed area.

The chart below show that the concentration of Sulfur Dioxide (SO_2) measured in all sampling times at sampling point was between the ranges of 1 ppm and 4 ppm.



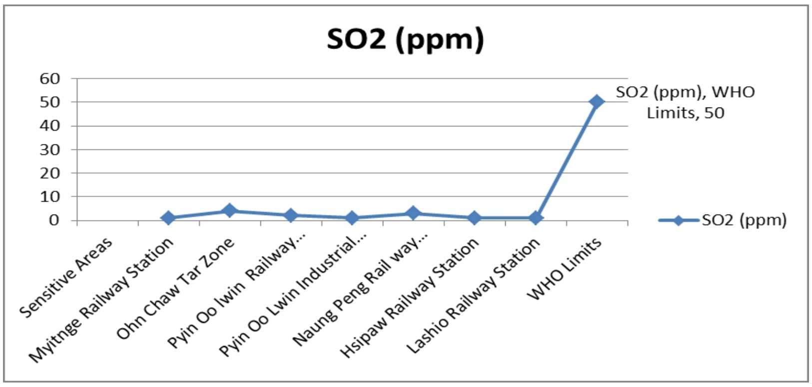
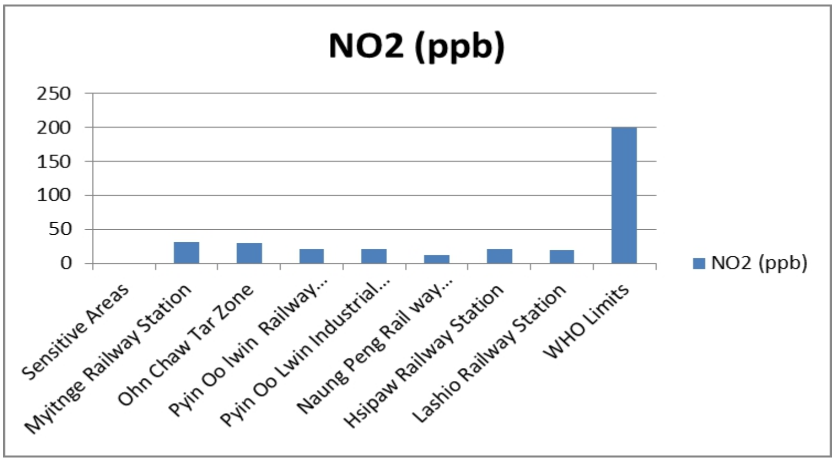


Figure – Concentration of Sulfur Dioxide

The concentration of Sulfur Dioxide measured in all the sampling times at the sampling point 1 was below the World Health Organization (WHO) Guideline, which specifies 50 ppm for the limitation of SO_2 concentration. SO_2 concentration of 4 ppm was the highest and 1 ppm was the lowest at the proposed area.

The chart below show that the concentration of Nitrogen Dioxide (NO_2) measured in all sampling times at sampling point 1 was between the ranges of 12 ppb – 31 ppb.



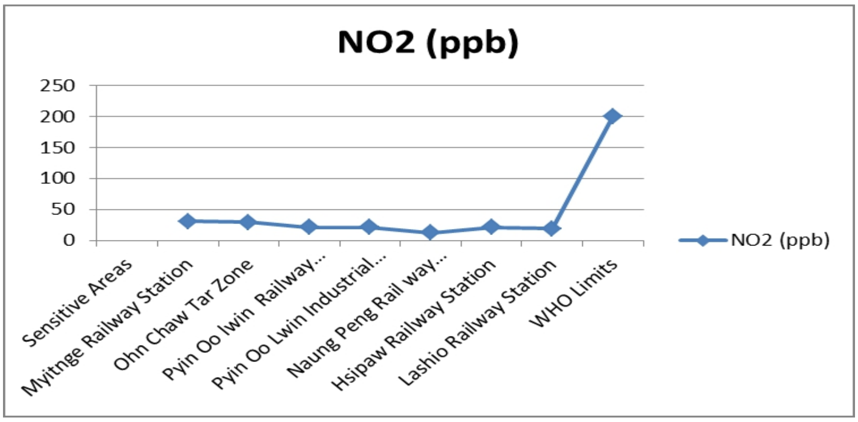
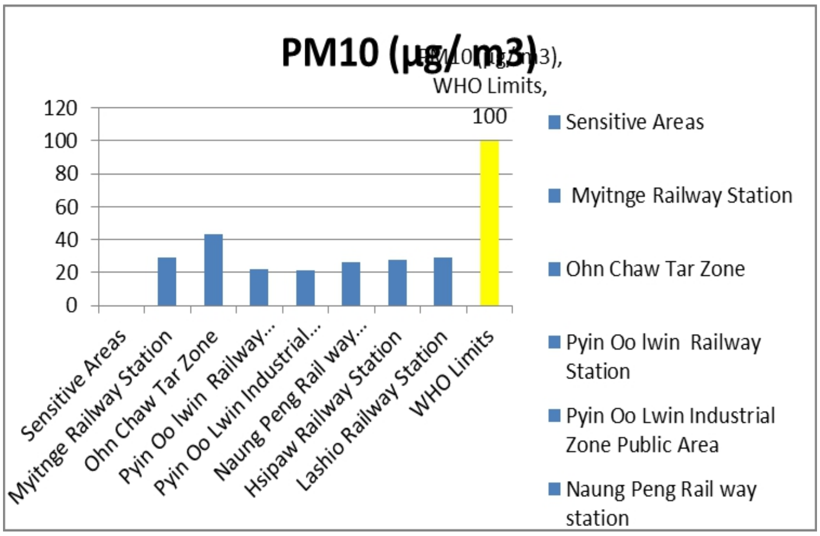


Figure – Concentration of Nitrogen Dioxide

The concentration of Nitrogen Dioxide measured in all the sampling times at sampling point 1 was below the Myanmar National Environmental Quality Emission Guideline (NEQEG), which specifies 200 ppb for the limitation of NO_2 concentration. NO_2 concentration of 31 ppb was the highest and 12 ppb was the lowest at the proposed area.

The chart below show that the concentration of Particulate Matter (PM_{10}) measured in all sampling times at sampling point was between the ranges of 21µg/m³ – 43µg/m³.



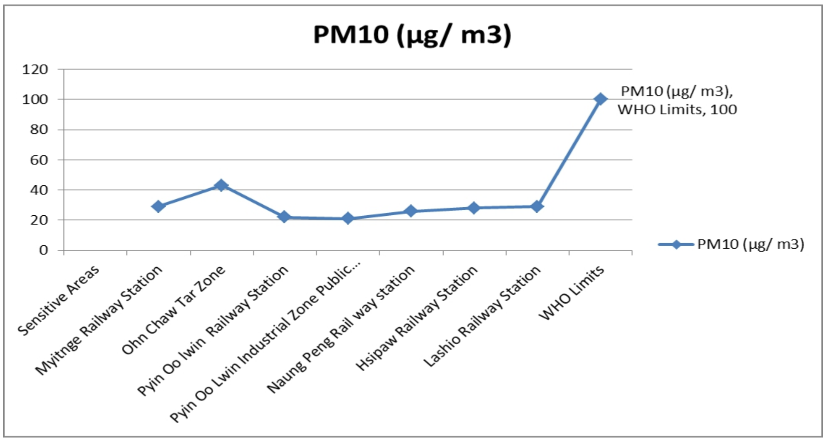
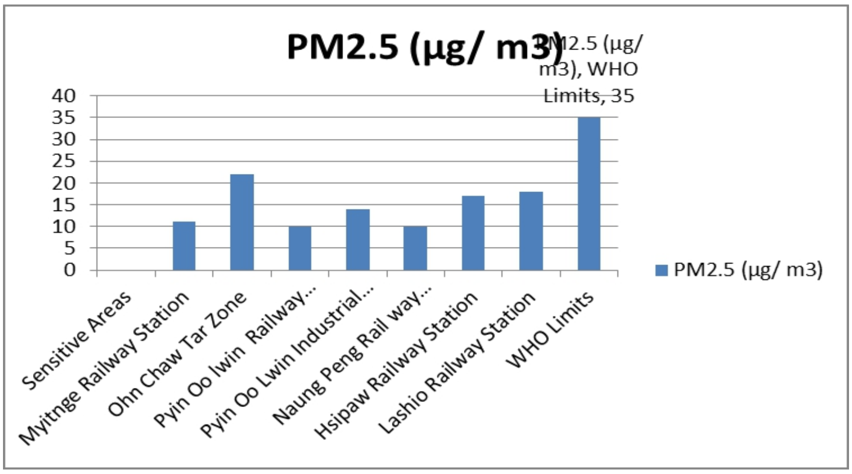


Figure – Concentration of Particulate Matter

The concentration of Particulate Matter measured at sampling point was below the limit of World Health Organization (WHO) Guideline which specifies 100µg/m³ for the limitation of PM10 concentration. PM_{10} concentration of 43µg/m³ was the highest and 21µg/m³ was the lowest at the proposed area.

The chart below show that the concentration of Fine Particulate Matter ($PM_{2.5}$) measured in all sampling times at sampling point was between the ranges of 10 µg/m³ – 22µg/m³.



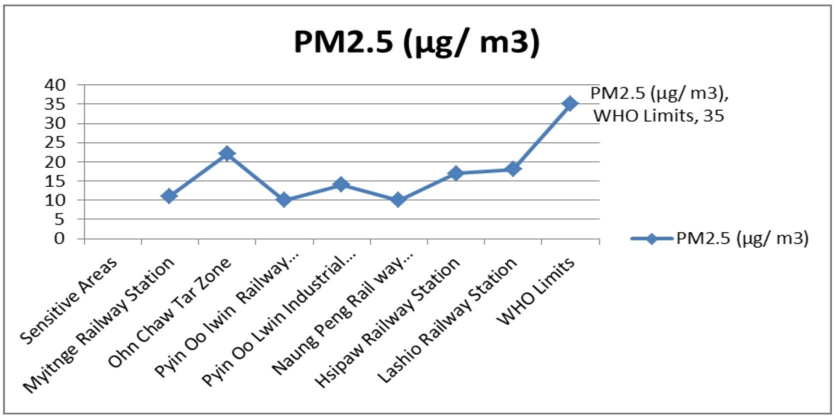


Figure – Concentration of Fine Particulate Matter

The concentration of Fine Particulate Matter measured in all the sampling times at the sampling point 1 was below the World Health Organization (WHO) Guideline which specifies 35µg/m^3 for the limitation of $PM_{2.5}$ concentration. $PM_{2.5}$ concentration of 22µg/m^3 was the highest and 10µg/m^3 was the lowest at the proposed area.

5.5.5.2. Measurement of Air Quality for Wet Season Comparing with the Air Quality Standards and Guidelines

CO, CO_2, NO_2, SO_2, O_3, PM_{10} and $PM_{2.5}$ are measured at the proposed Muse- Mandalay Railway Project site from Pyinoolwin to Muse (8 points). The site is in the pre construction stage and the collected data shown below are due to the movement of vehicles along the road and the transportation works. The standards for applicable to the possible air pollutants were determined from review of Myanmar National Environmental Emission Guideline and World Health Organization (WHO) Guideline. Eight sampling points for about 8 hours total, 8 hours for each are shown in the table below.

Table - Measuring Points of Air Quality

S/N	Name of Places	GPS Coordinate	
		Latitude (N)	Longitude €
1	Oak Pho Village (Pyin Oo Lwin)	22°.071081°	96°.399531°
2	Shwe Pyi Nyunt Villag (Naung Cho)	22°.304525°	96°.833933°
3	Baw Gyo Pagod (Hsipaw)	22°.583272°	97°.233222°
4	Sam Laung	22°.676006°	97°.507519°
5	Lashio West (NE 350m)	22°.984836°	97°.706414°
6	Theinni	23°.306658°	97°.974528°
7	Nam Hpak Ka	23°.689414°	97°.817433°
8	Muse	24°.000783°	97°.940464°

Moreover, the further parameters for air quality that are temperature and air humidity were measured at the proposed Muse- Mandalay Railway Project site from Pyinoolwin to Muse (8 points).

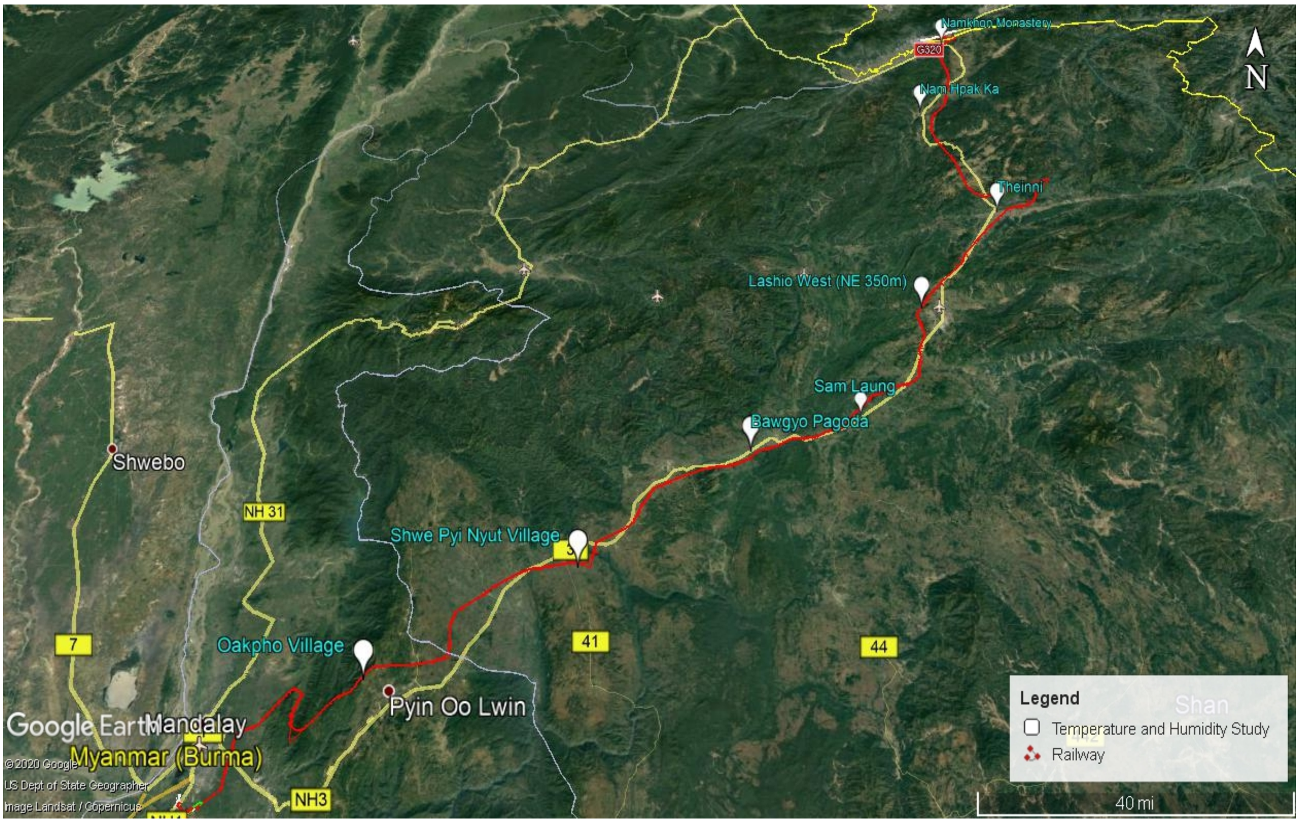
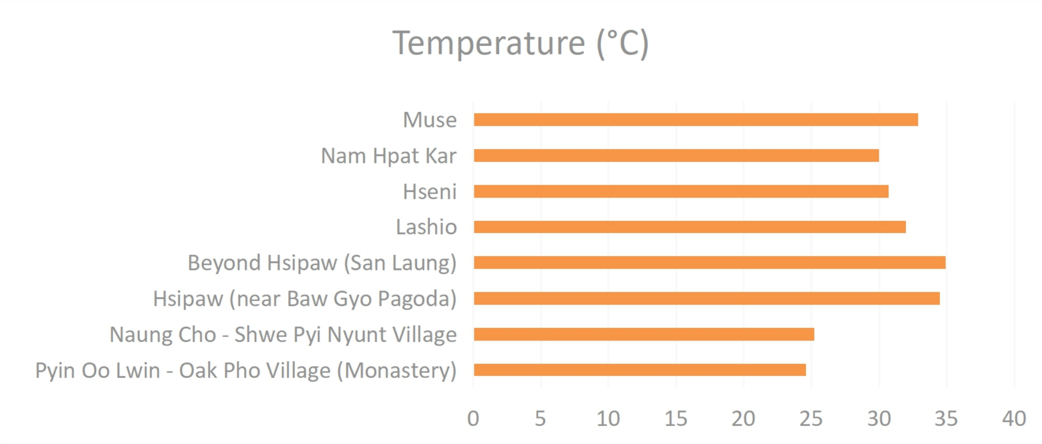


Figure - Locations of Temperature and Humidity Study along the Proposed Project Muse-Mandalay Railway

Table - General Conditions of Ambient at the time of Sampling on Points

No.	Place	Location		Temperature (°C)	Air Humidity (%RH)
		Latitude(N)	Longitude(E)		
1	Pyin Oo Lwin - Oak Pho Village (Monastery)	N 22° 04' 15.87"	E 096° 23' 58.30"	24.6	98.7
2	Naung Cho - Shwe Pyi Nyunt Village	N 22° 18' 16.29"	E 096° 50' 02.16"	25.2	93.9
3	Hsipaw (near Baw Gyo Pagoda)	N 22° 34' 59.78"	E 097° 13' 59.62"	34.5	71.9
4	Beyond Hsipaw (San Laung)	N 22° 40' 33.66'	E 97° 30' 17.4"	34.9	62.9
5	Lashio	N 22° 59' 05.41"	E 097° 42' 23.09"	32	59.9
6	Hseni	N 23° 18' 23.97"	E 097° 58' 28.30"	30.7	72.6
7	Nam Hpat Kar	N 23° 41' 21.89"	E 097° 49' 02.76"	30	72.4
88	Muse	N 24° 00' 03.10"	E 097° 56' 25.90"	32.9	64.8

Temperature Results for Muse-Mandalay Railway



	Pyin Oo Lwin - Oak Pho Village (Monastery)	Naung Cho - Shwe Pyi Nyunt Village	Hsipaw (near Baw Gyo Pagoda)	Beyond Hsipaw (San Laung)	Lashio	Hseni	Nam Hpat Kar	Muse
Temperature (°C)	24.6	25.2	34.5	34.9	32	30.7	30	32.9

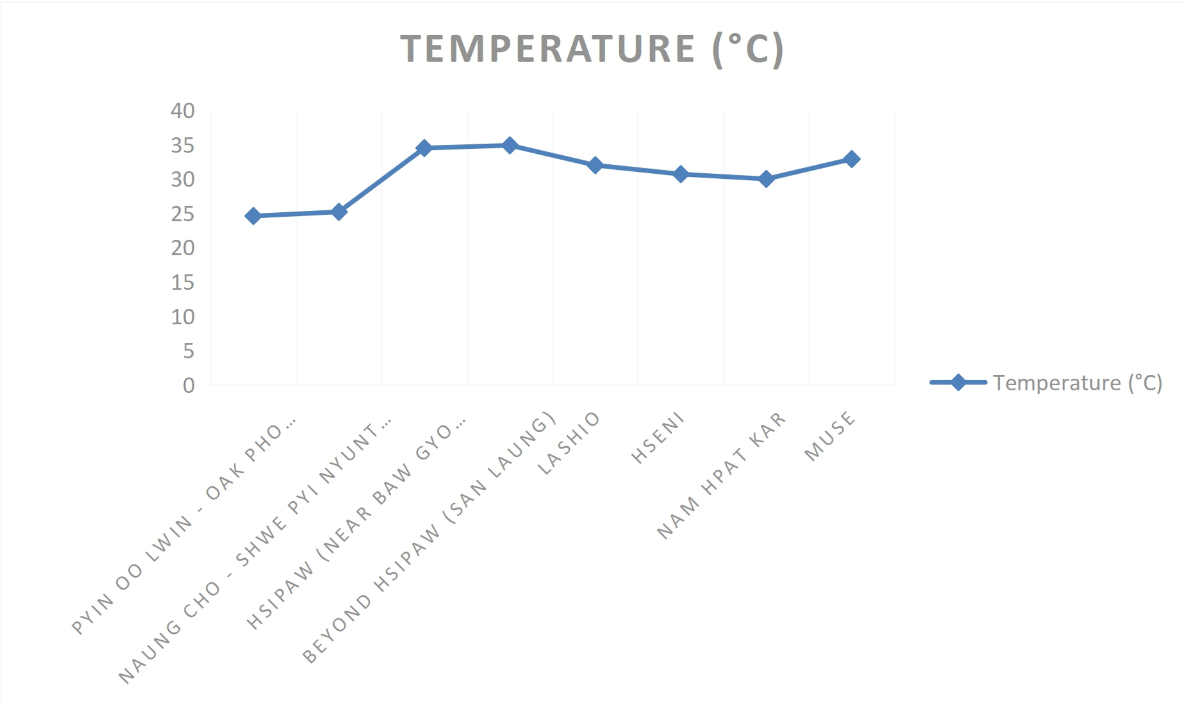
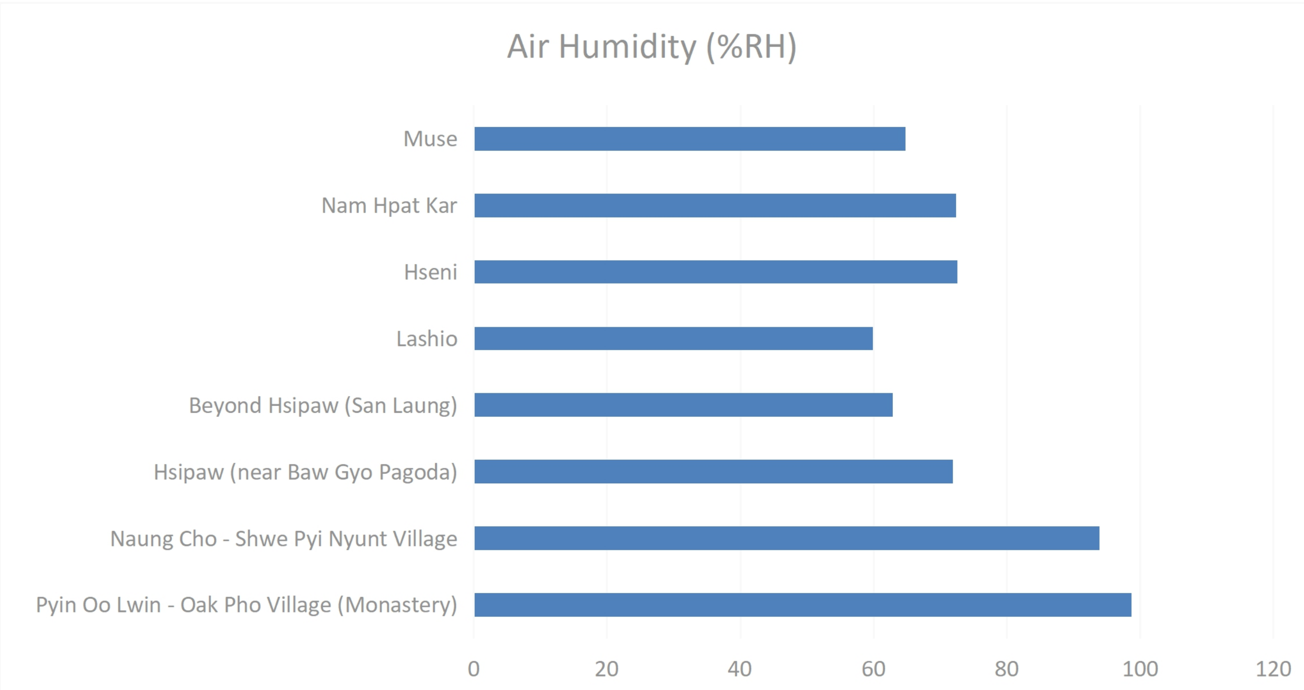


Figure – Temperature Results in Muse-Mandalay Region

Air Humidity Results for Muse-Mandalay Railway



	Pyin Oo Lwin - Oak Pho Village (Monastery)	Naung Cho - Shwe Pyi Nyunt Village	Hsipaw (near Baw Gyo Pagoda)	Beyond Hsipaw (San Laung)	Lashio	Hseni	Nam Hpat Kar	Muse
Air Humidity (%RH)	98.7	93.9	71.9	62.9	59.9	72.6	72.4	64.8

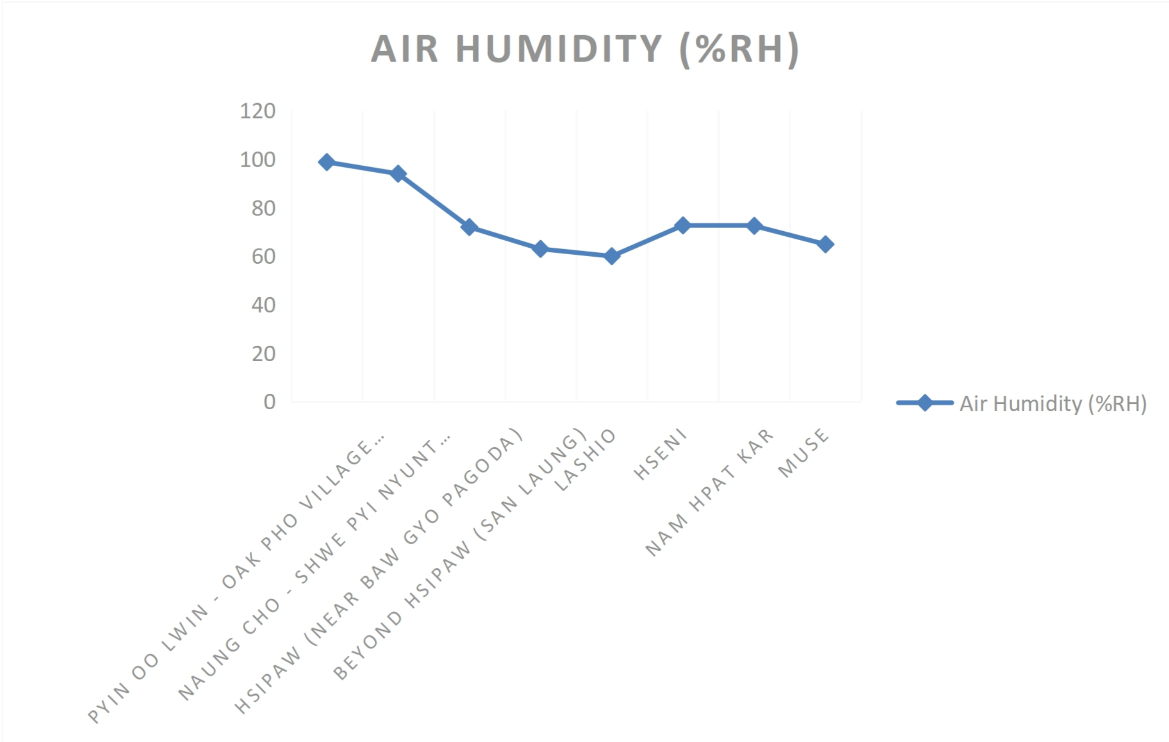


Figure – Air-Humidity Results for Muse-Mandalay Region

Figure -Recorded Photos for Measuring Temperature and Air Humidity

5.5.5.3. Air Dispersion Comparison at Average 8 hours on No Project and Project Conditions (Construction Phase)

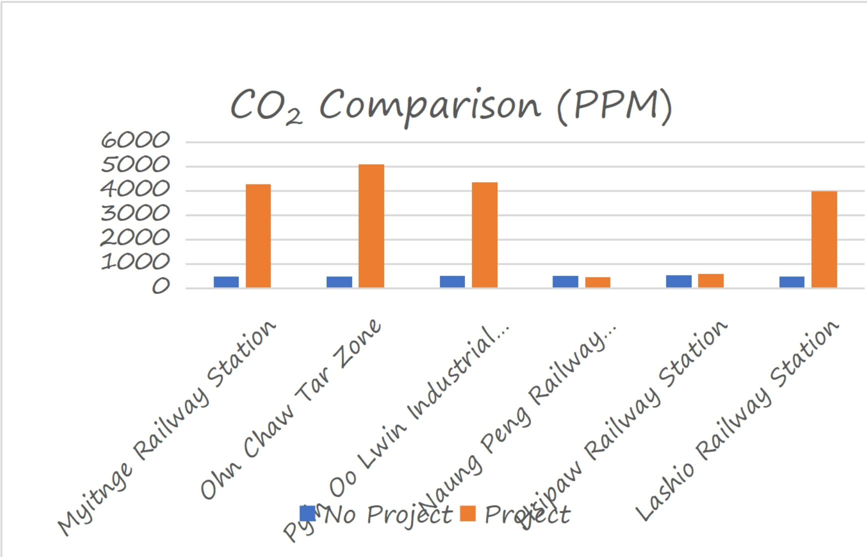
The air dispersion is predicted by using AERMOD VIEW modelling software. Wind speeds, wind directions and gas emission rate are used as input data. And the software gives the concentration level of gases as results. The machines and their emission rates are assumed to be able to predict the possible concentration levels of gases in the construction phase. At Naung Peng Railway Station and Hsipaw Railway Station, the wind speed is measured over 6 km/s and 4 km/s average, thus the concentration levels at those points are lower compared to the other points. The prediction is done by assuming the construction works are 8 hours continuous operation. But the actual construction work will be discontinuous operation meaning the concentration levels can be lower than the predicted model. The concentration levels of pollutants are shown in following tables and figures.

Table – Average Concentration of pollutants at the sample points for 8 hours for each in No Project Condition

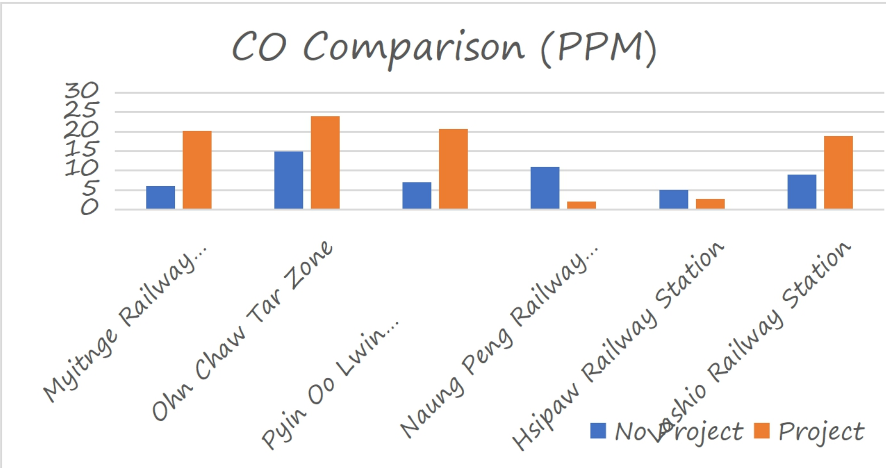
Sample Time	Sensitive Areas	Average Value Parameters					
		CO_2 (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppb)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
Time 8 hours for each point	Myitnge Railway Station	479	6	1	31	29	11
	Ohn Chaw Tar Zone	498	15	4	29	43	22
	Pyin Oo Lwin Industrial Zone Public Area	519	7	1	21	21	14
	Naung Peng Railway Station	509	11	3	12	26	10
	Hsipaw Railway Station	526	5	1	21	28	17
	Lashio Railway Station	491	9	1	19	29	18

Table – Average Concentration of pollutants at the sample points for 8 hours for each in Project Condition

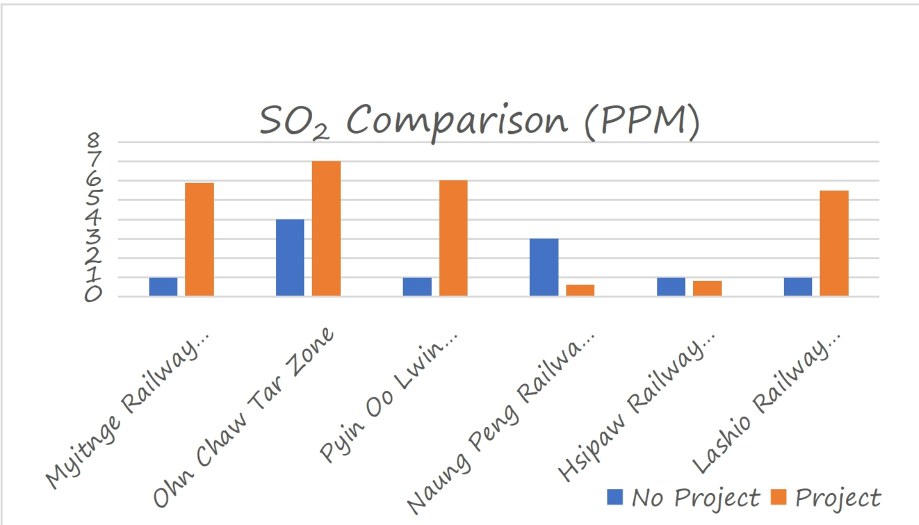
Sample Time	Sensitive Areas	Average Value Parameters					
		CO_2 (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppb)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
Time 8 hours for each point	Myitnge Railway Station	4268	20.1	5.88	45.8	4.03	3.92
	Ohn Chaw Tar Zone	5085	24	7.01	54.6	4.796	4.669
	Pyin Oo Lwin Industrial Zone Public Area	4366	20.6	6.02	46.85	4.12	4.01
	Naung Peng Railway Station	463.4	2.19	0.639	4.97	0.437	0.426
	Hsipaw Railway Station	592	2.8	0.817	6.36	0.559	0.544
	Lashio Railway Station	3992	18.8	5.5	42.8	3.77	3.67


CO_2 Comparison (PPM)
6000
5000
4000
3000
2000
1000
0
Myitnge Railway Station
Ohn Chaw Tar Zone
Pyin Oo Lwin Industrial...
Naung Peng Railway...
Hsipaw Railway Station
Lashio Railway Station
No Project
Project

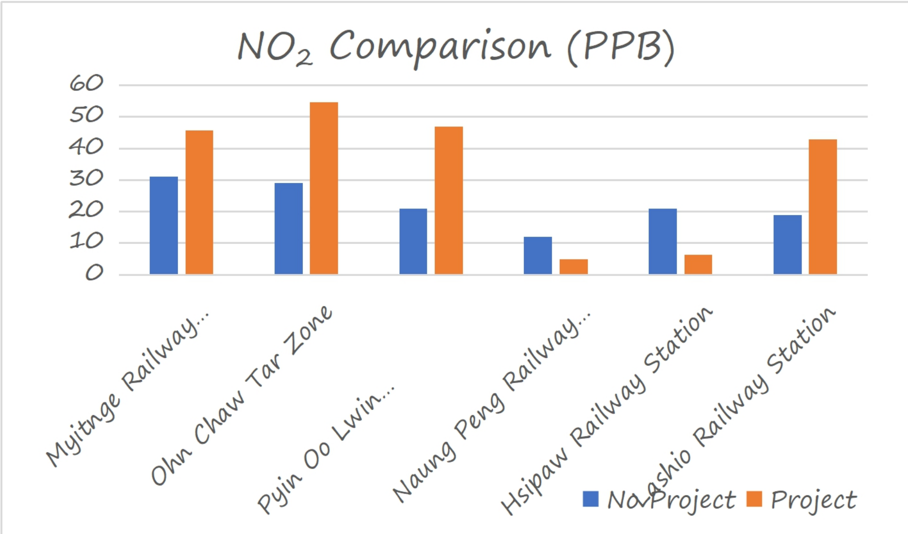
CO_2


CO Comparison (PPM)
30
25
20
15
10
5
0
Myitnge Railway...
Ohn Chaw Tar Zone
Pyin Oo Lwin...
Naung Peng Railway...
Hsipaw Railway Station
Lashio Railway Station
No Project
Project

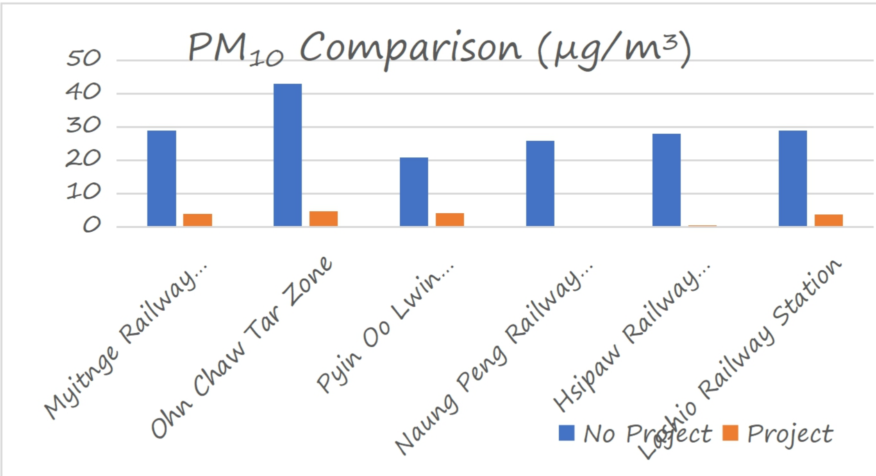
CO


SO_2 Comparison (PPM)
8
7
6
5
4
3
2
1
0
Myitnge Railway...
Ohn Chaw Tar Zone
Pyin Oo Lwin...
Naung Peng Railwa...
Hsipaw Railway...
Lashio Railway...
No Project
Project

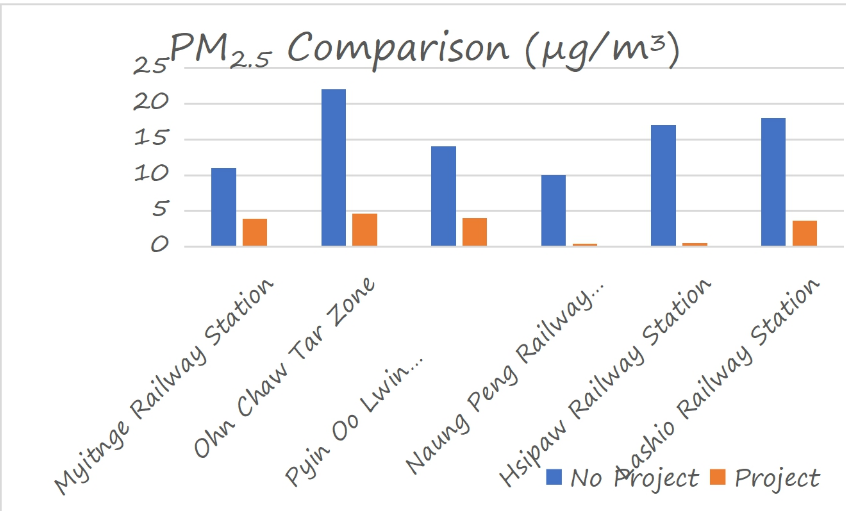
SO_2



NO_2



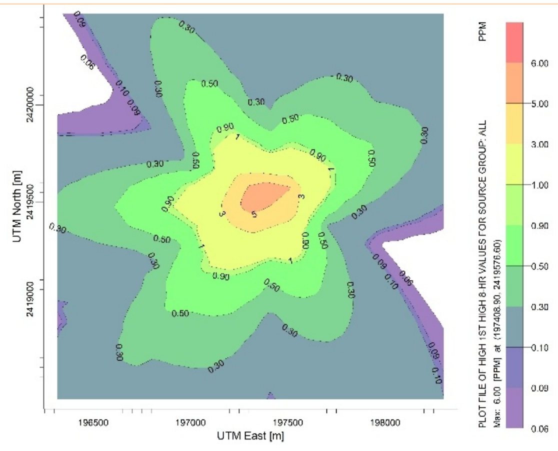
PM_{10}



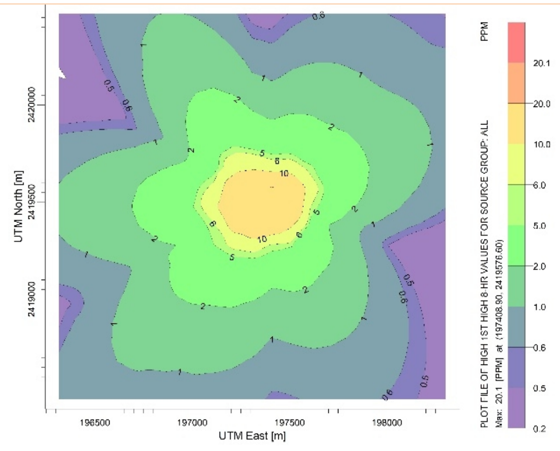
$PM_{2.5}$

Myitnge Railway Station

CO

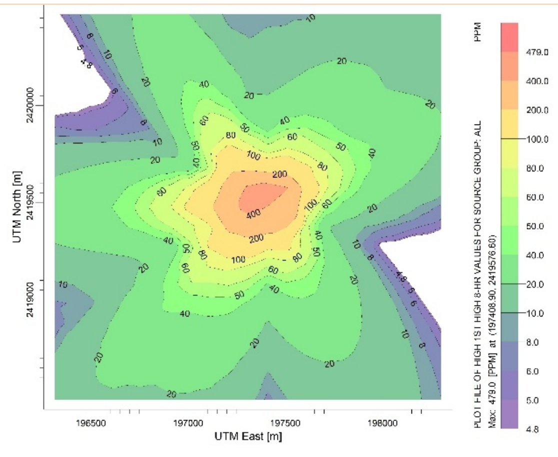


No Project Condition

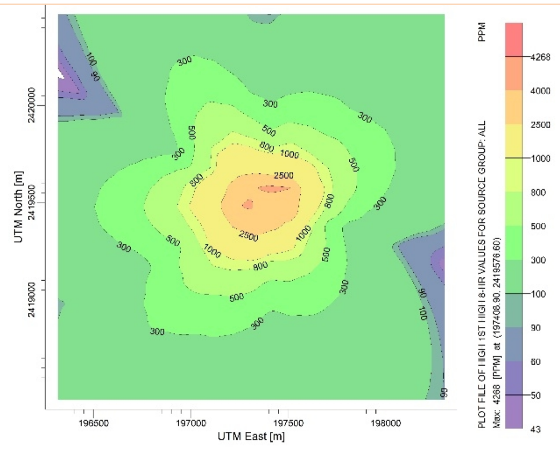


Project Condition

CO_2

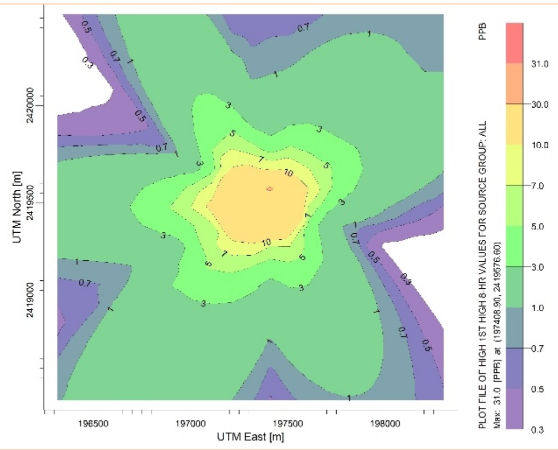


No Project Condition



Project Condition

NO_2



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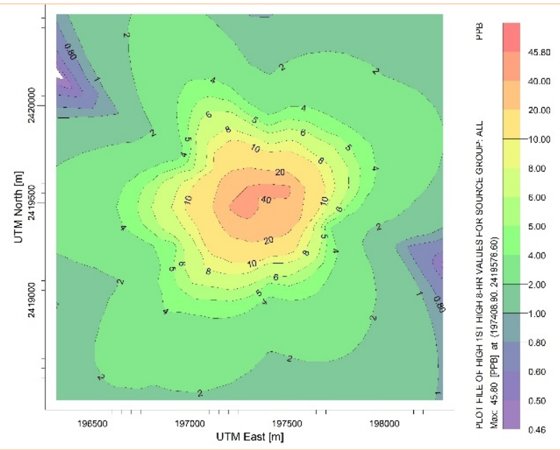

Project Condition

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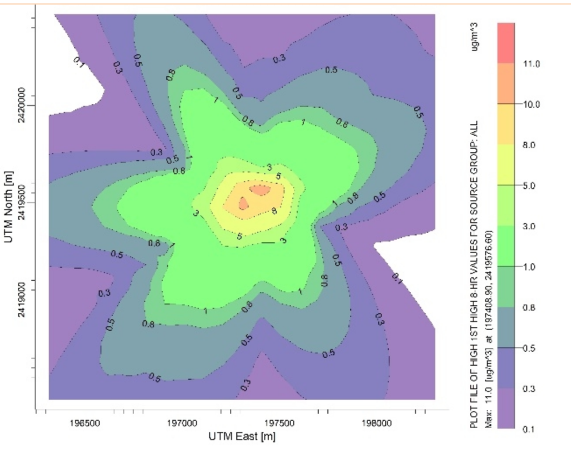

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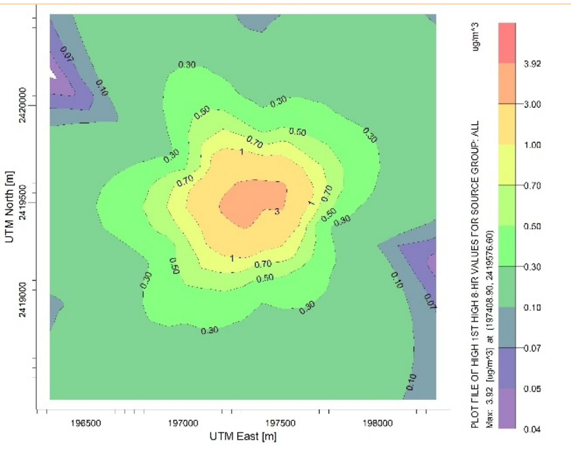
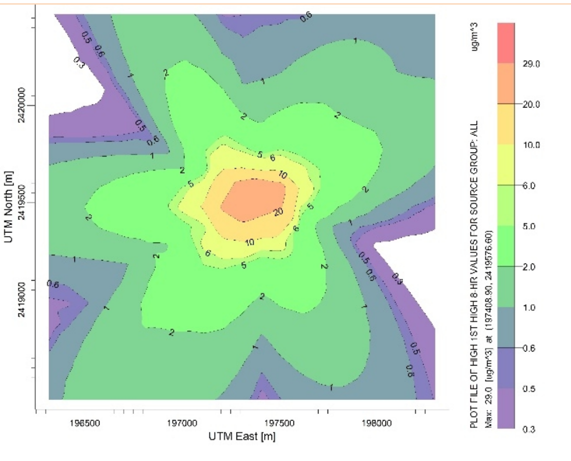


Project Condition

PM_{10}



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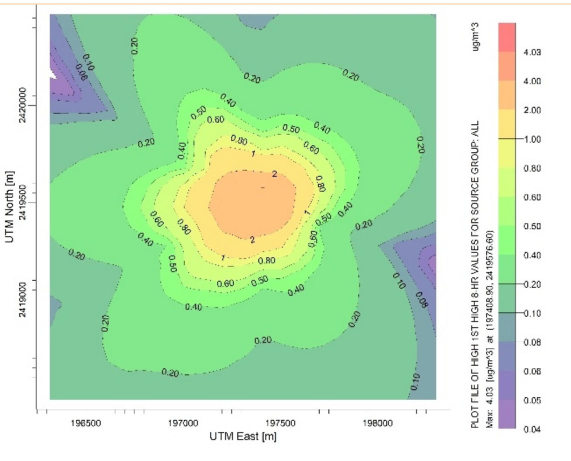

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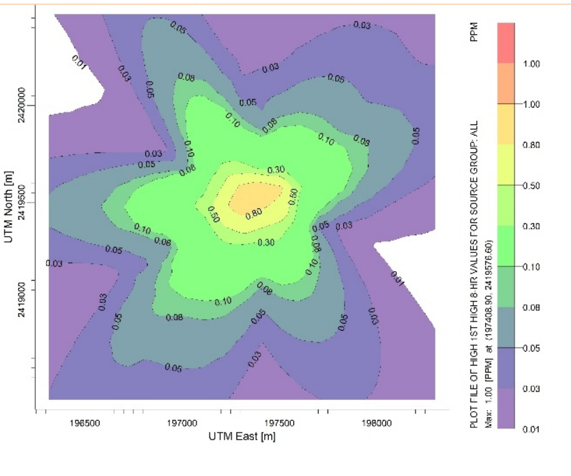

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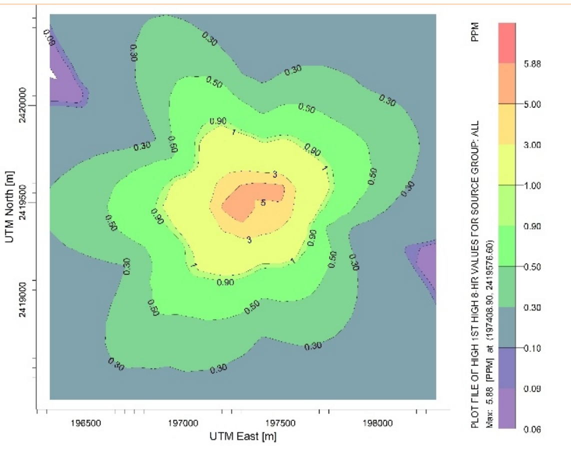
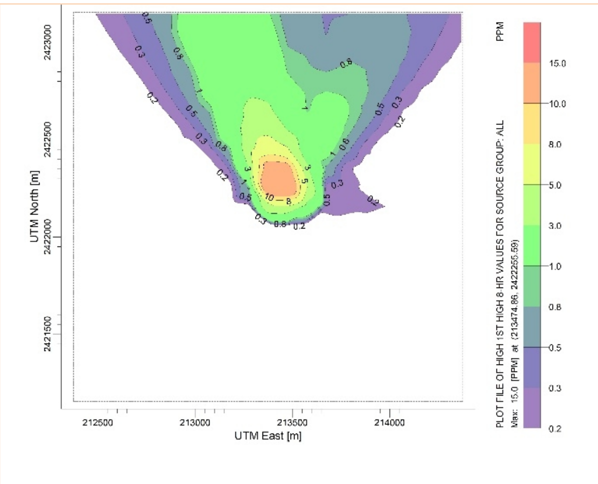


Project Condition

Ohn Chaw Tar Zone

CO



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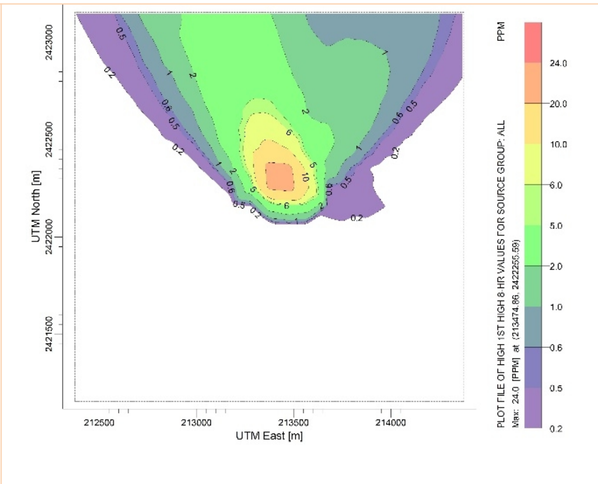

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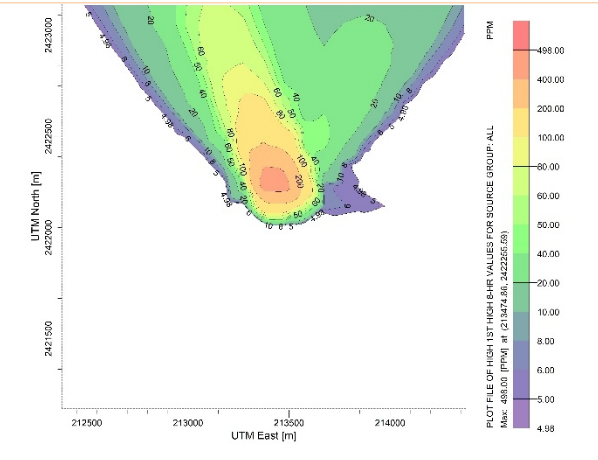

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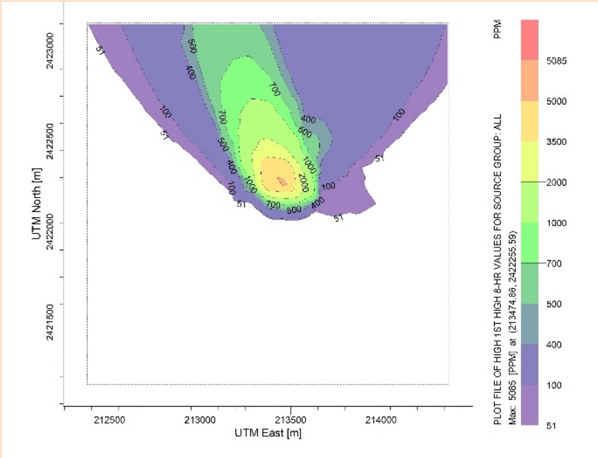

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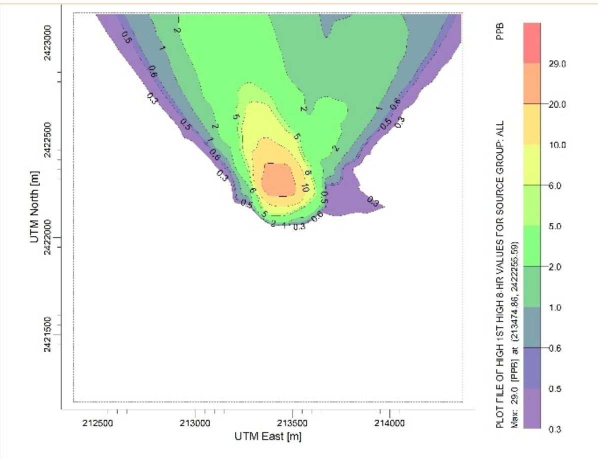

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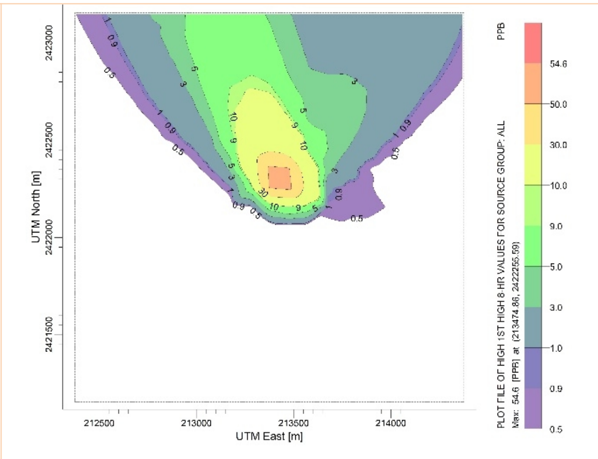

Project Condition

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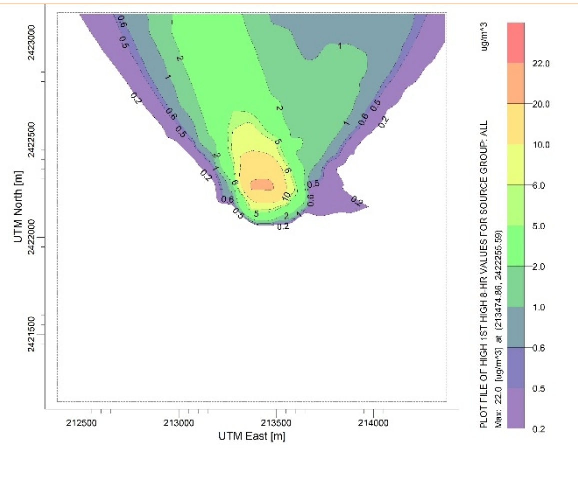

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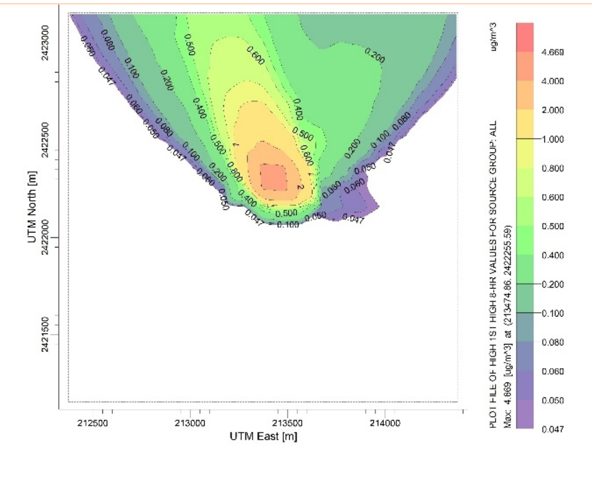

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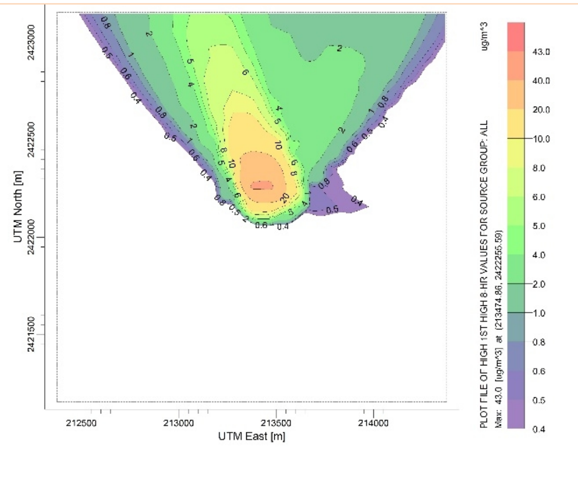

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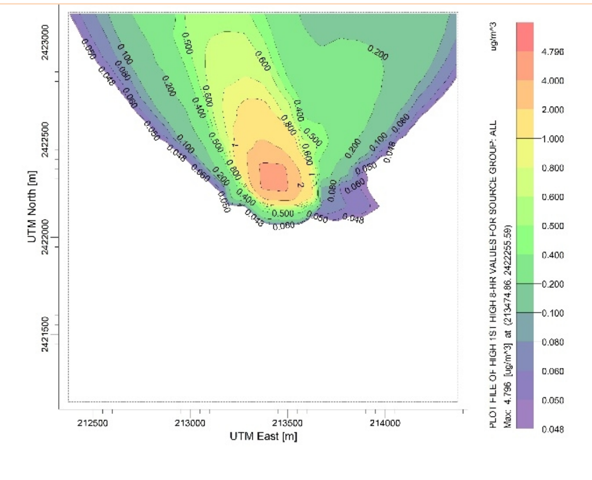

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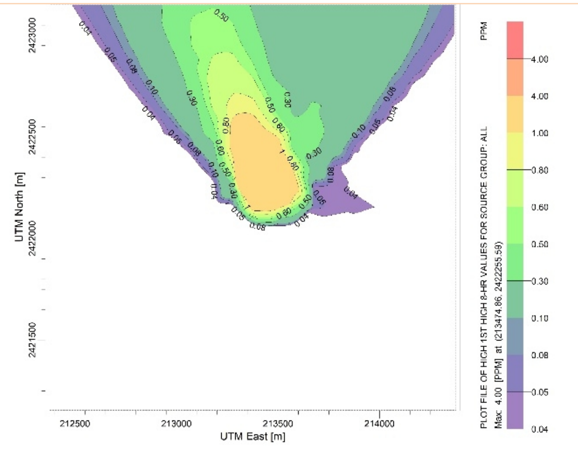

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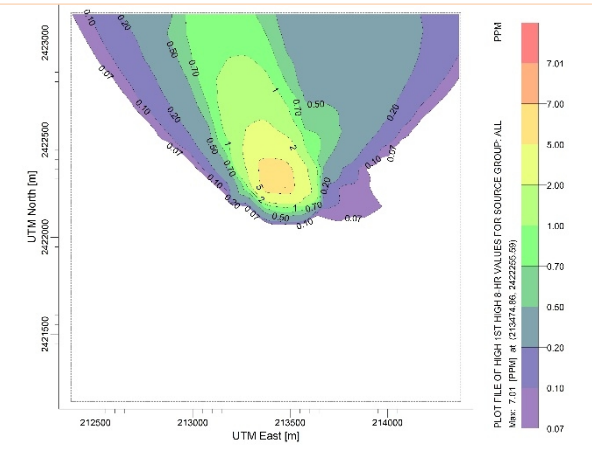
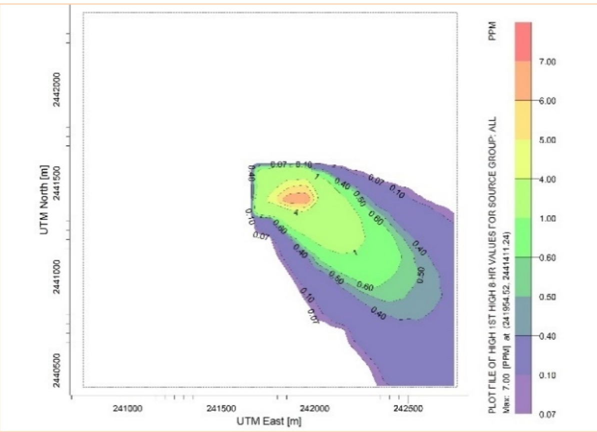


Project Condition

Pyin Oo Lwin Industrial Zone Public Area

CO



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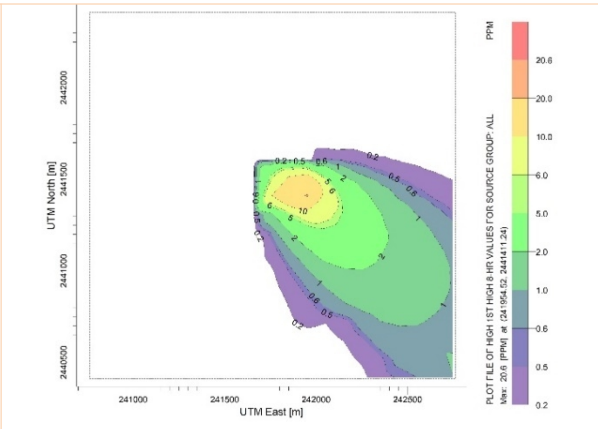

Project Condition

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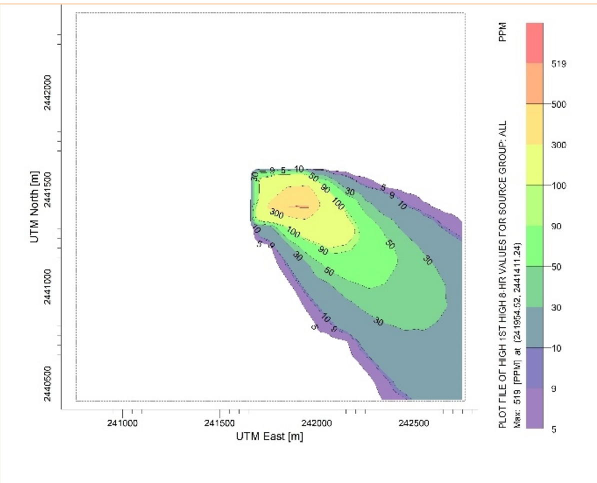

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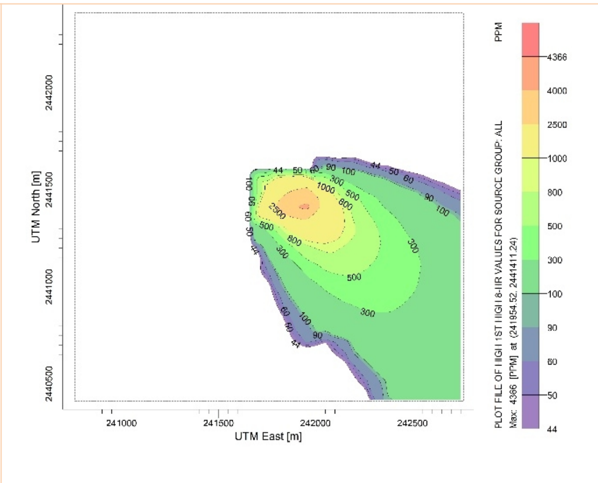

Project Condition

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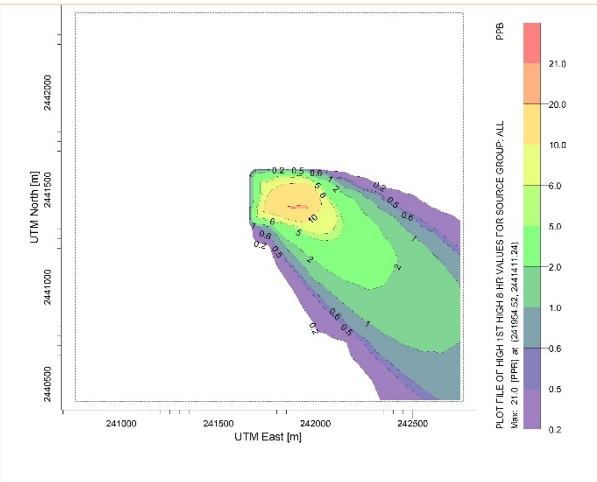

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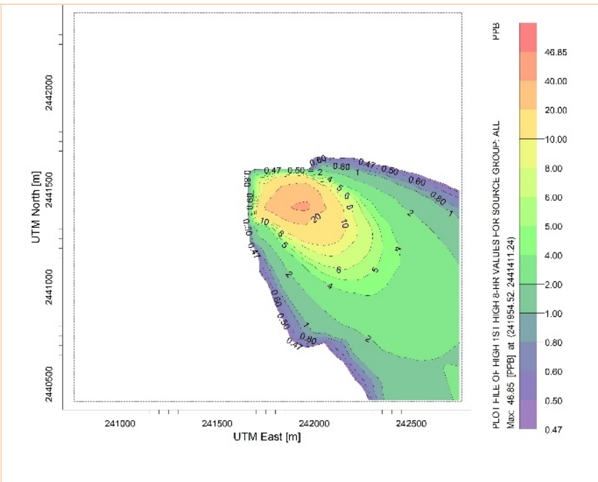

Project Condition

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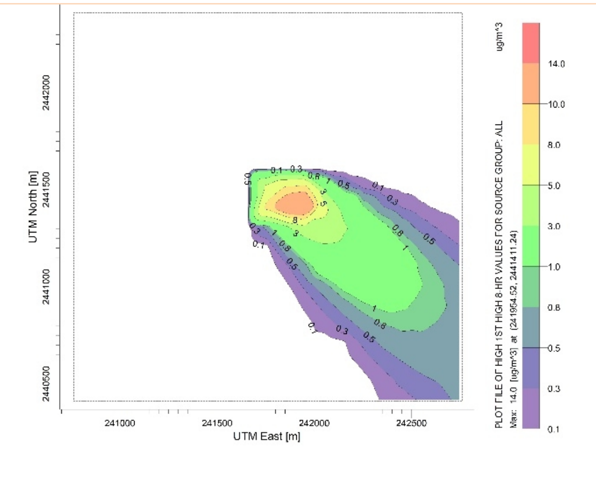

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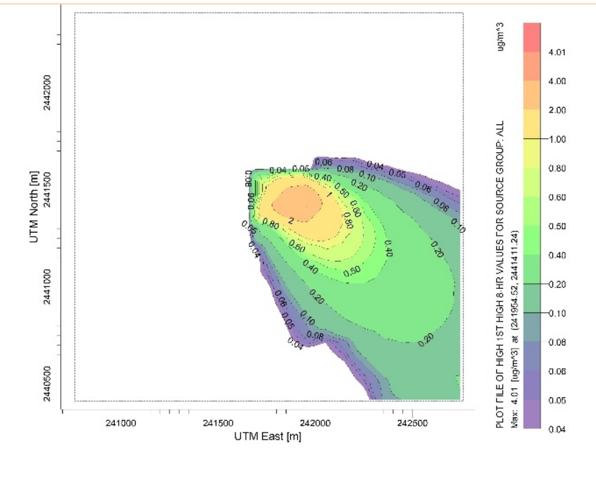

Project Condition

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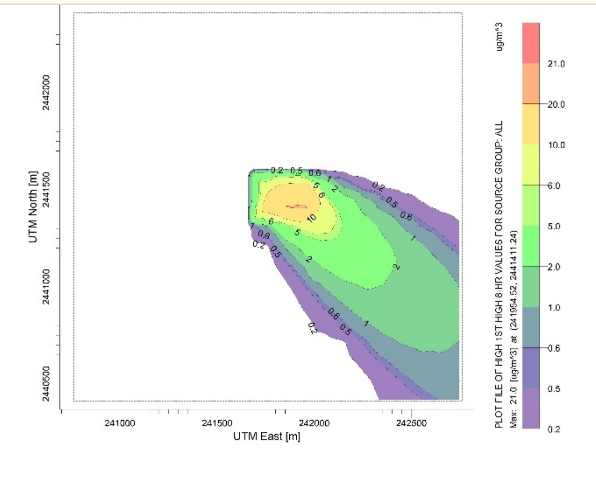

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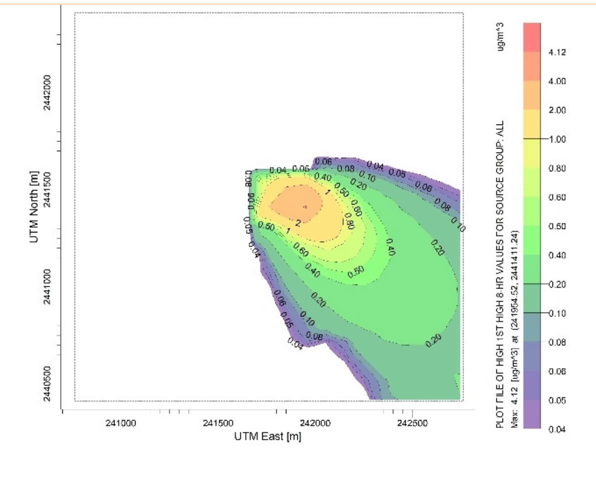

Project Condition

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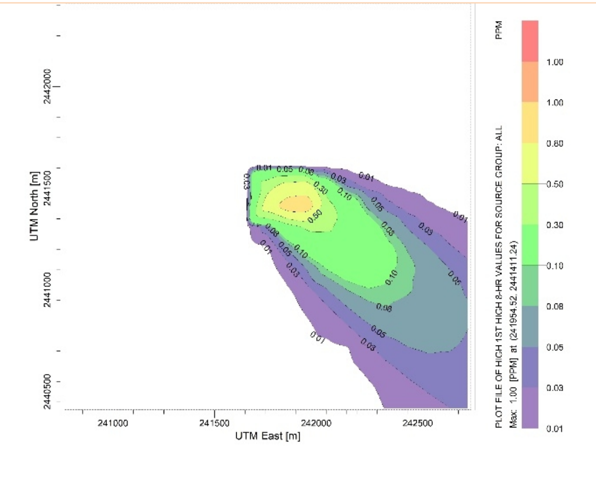

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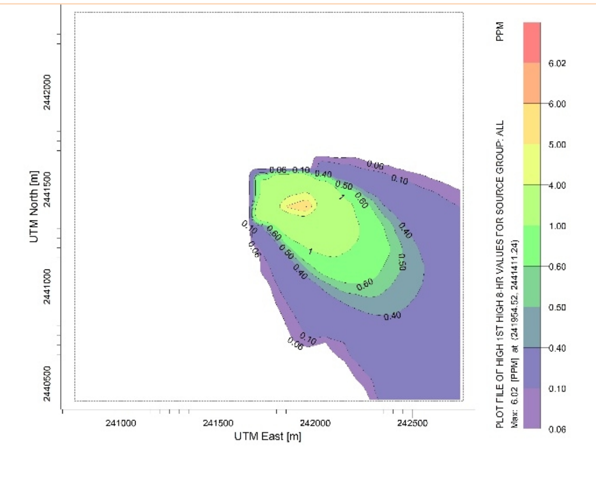
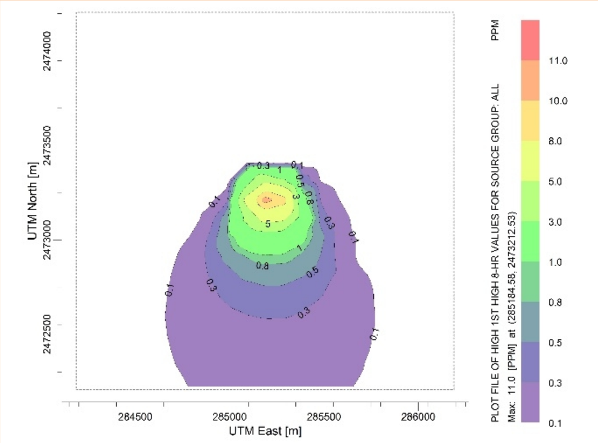


Project Condition

Naung Peng Railway Station

CO



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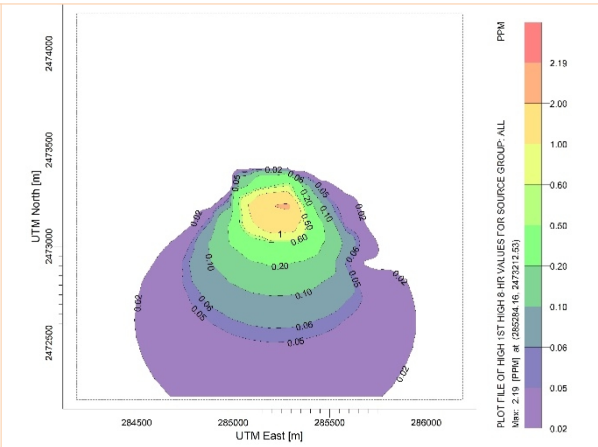

Project Condition

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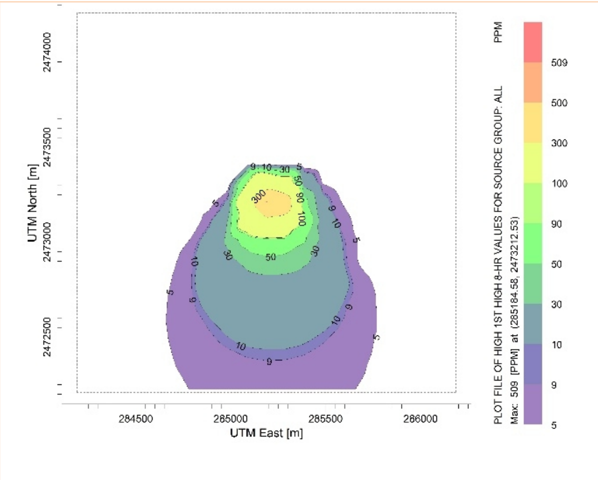

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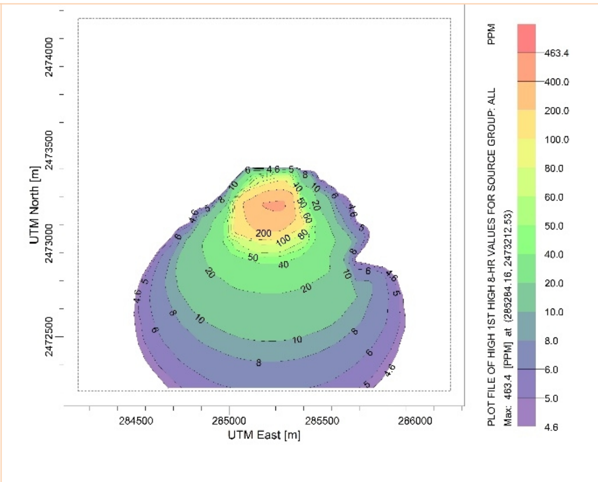

Project Condition

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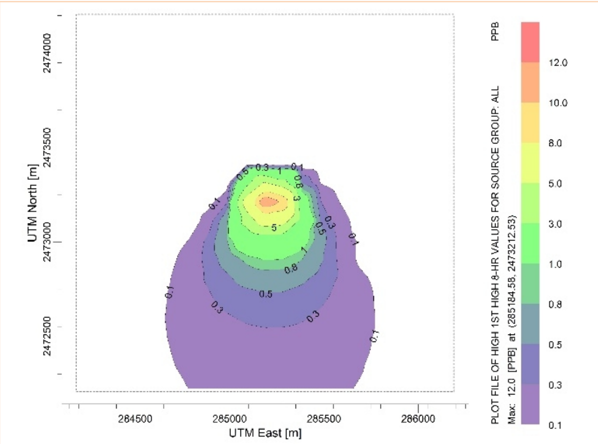

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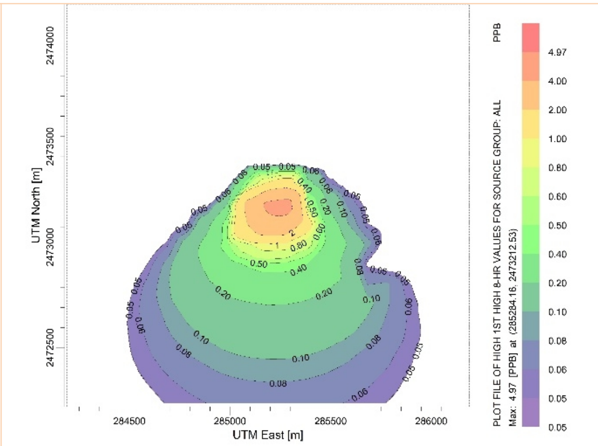
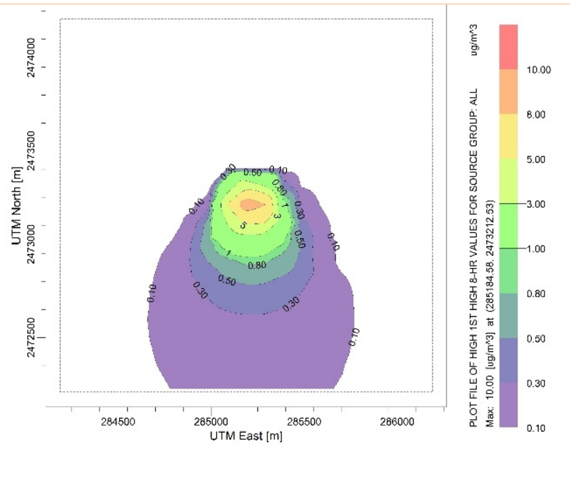


Project Condition

$PM_{2.5}$



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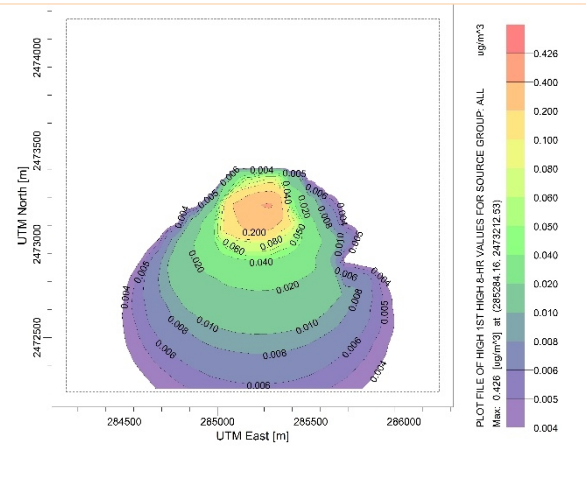

Project Condition

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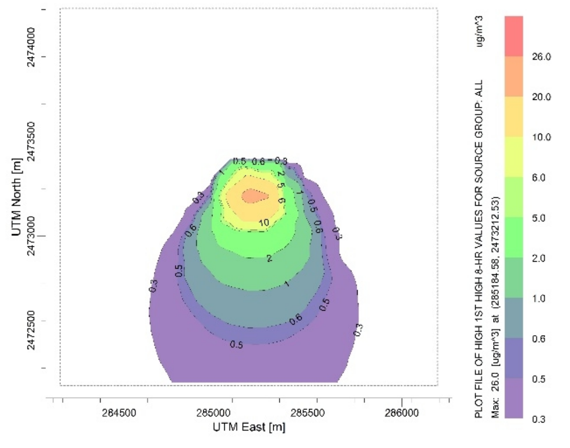

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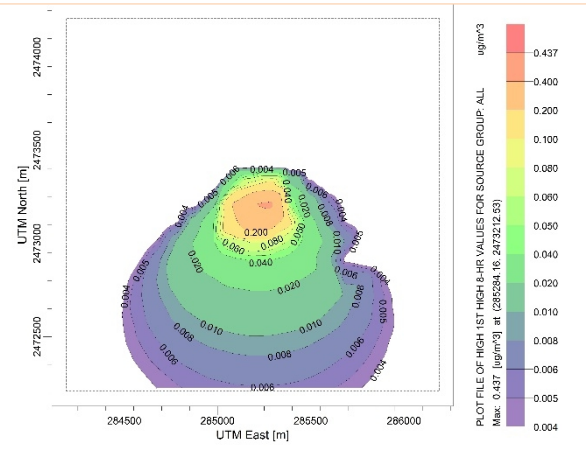
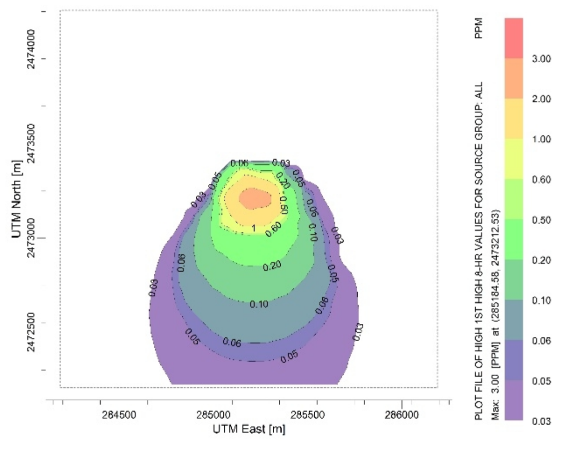


Project Condition

SO_2



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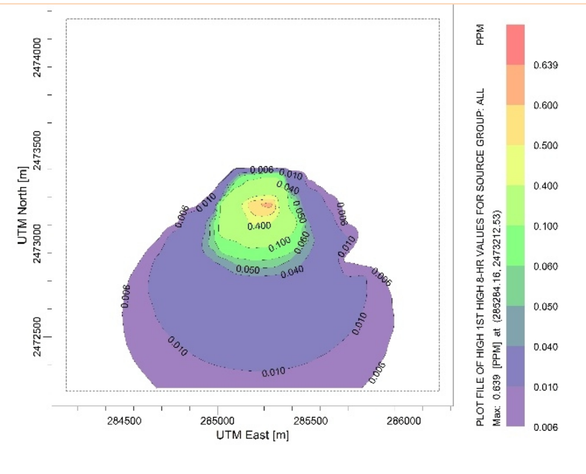
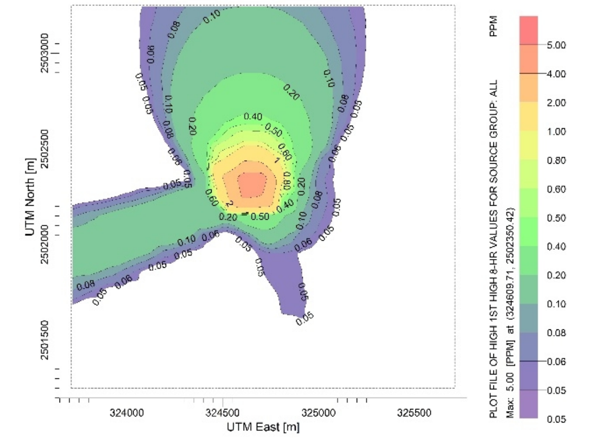


Project Condition

Hsipaw Railway Station

CO



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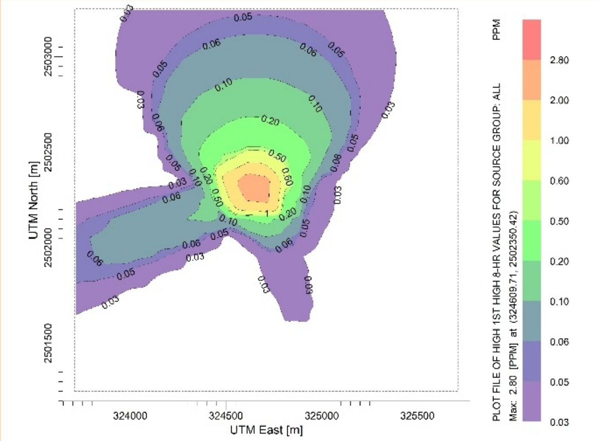

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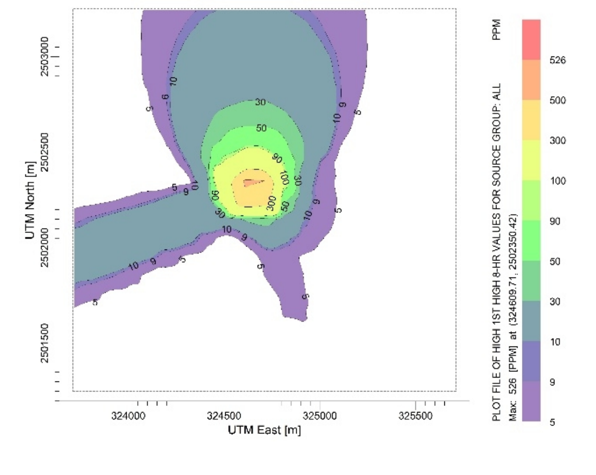

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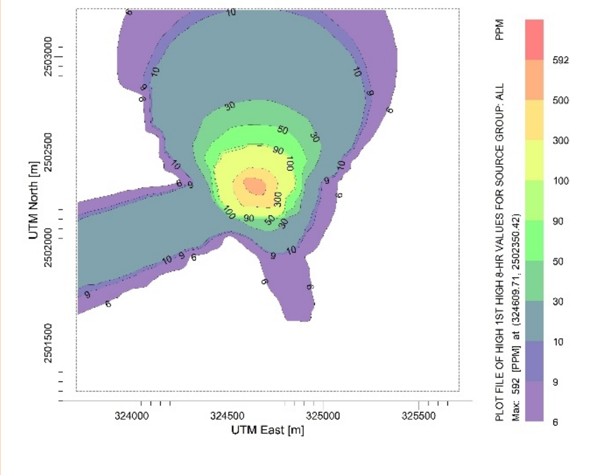

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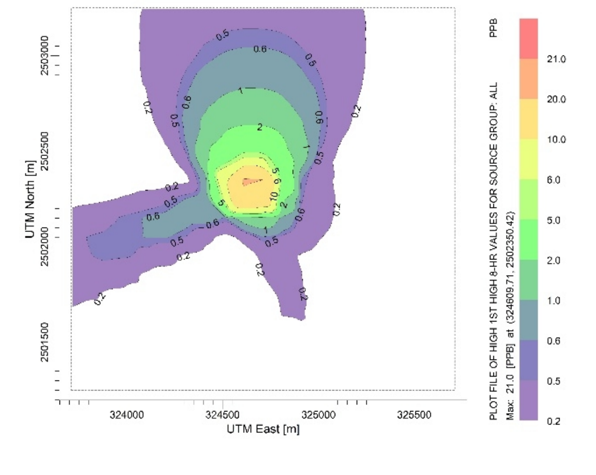

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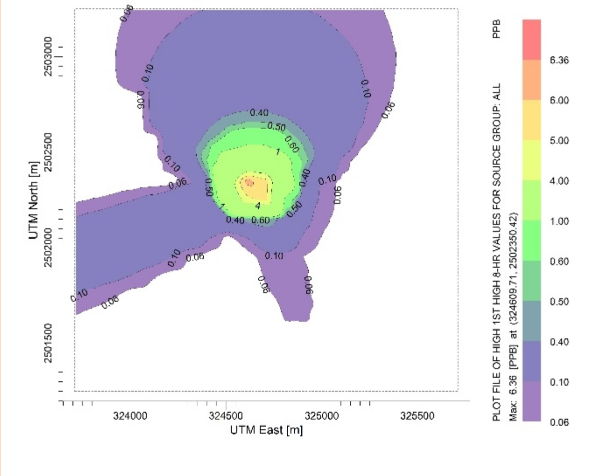

Project Condition

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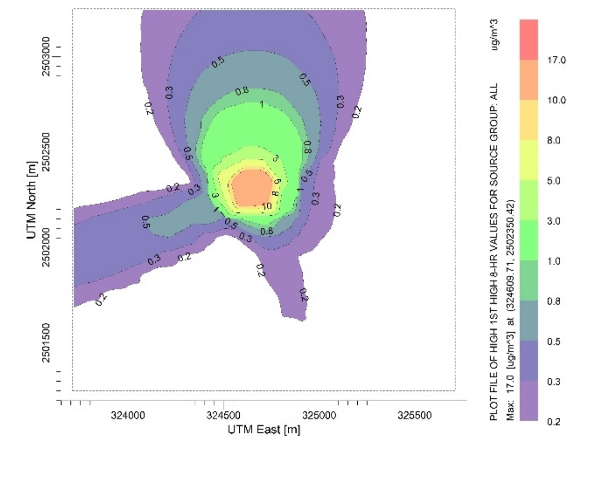

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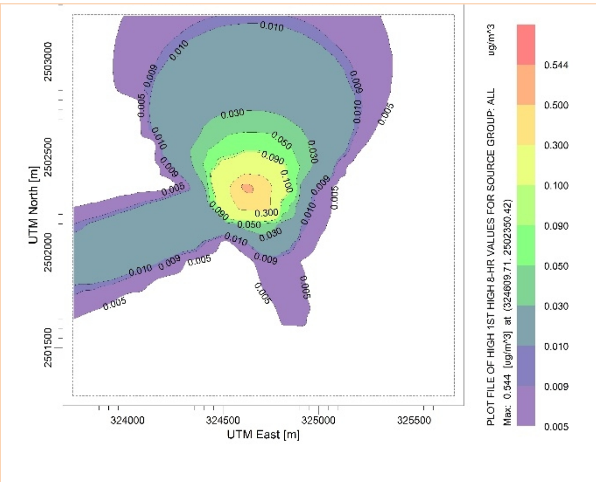

Project Condition

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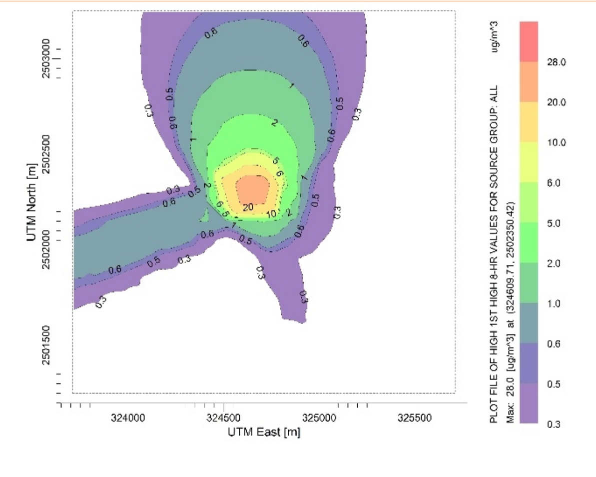

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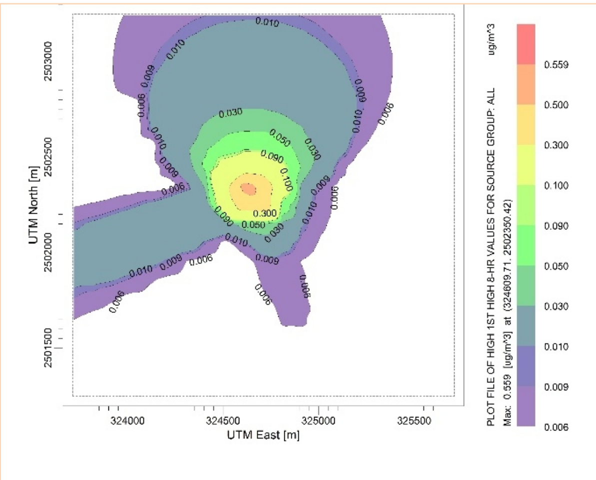

Project Condition

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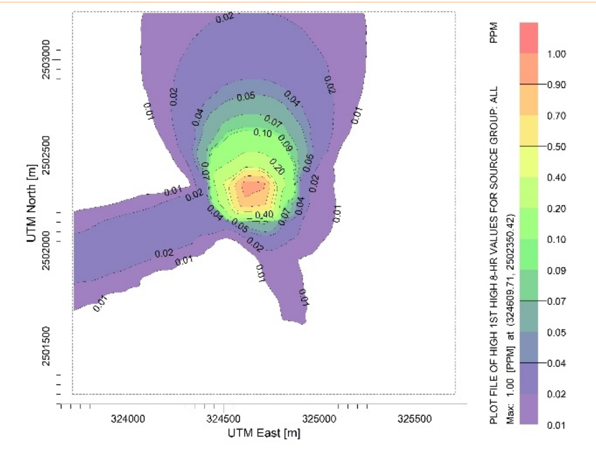

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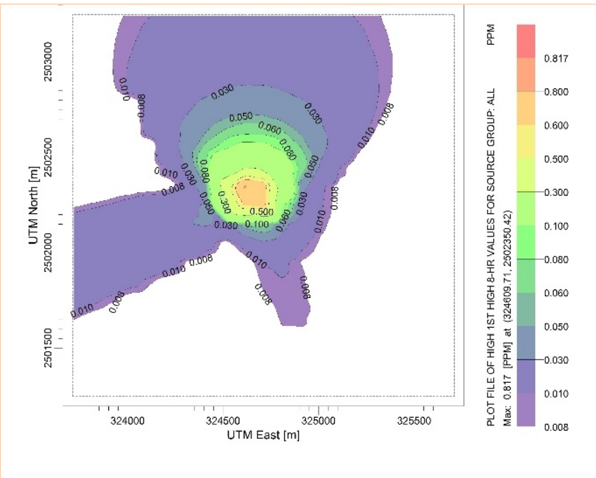
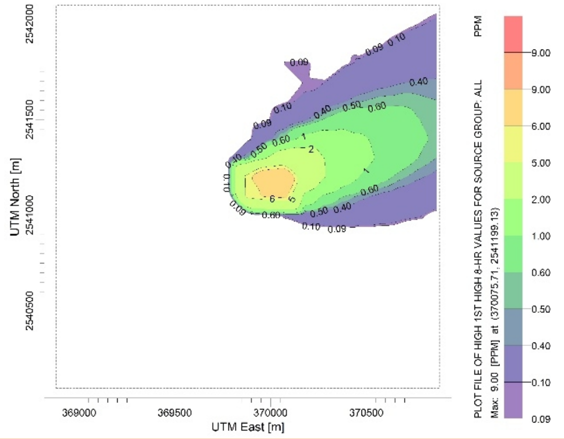


Project Condition

Lashio Railway Station

CO



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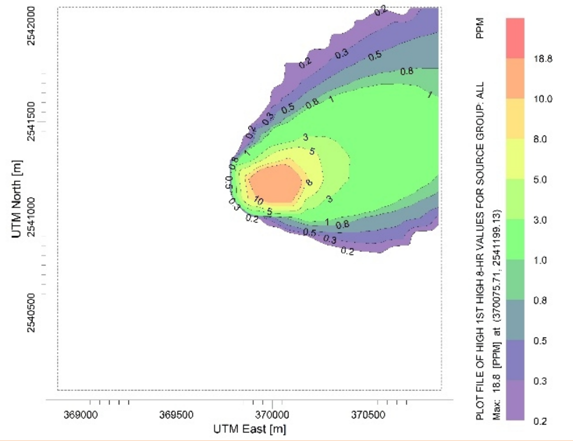
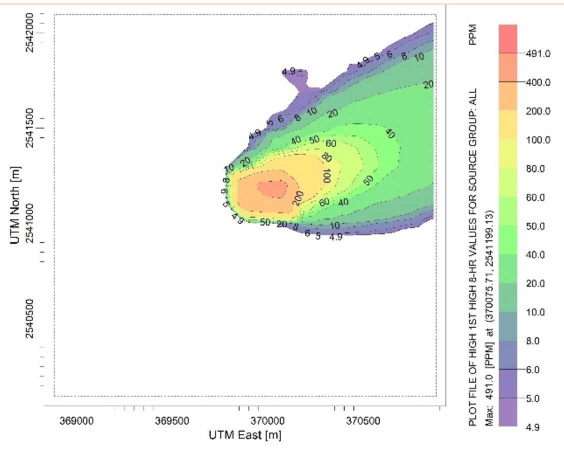


Project Condition

CO_2



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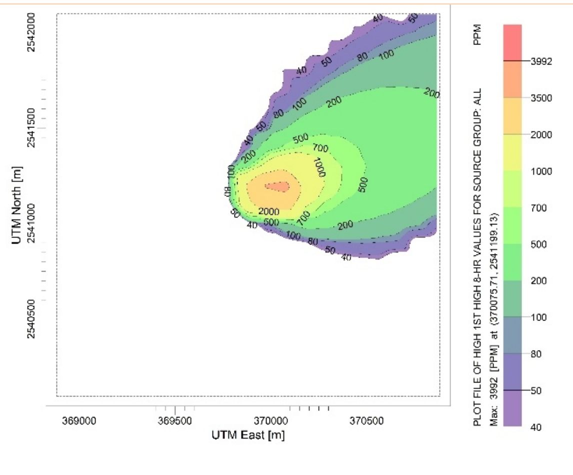

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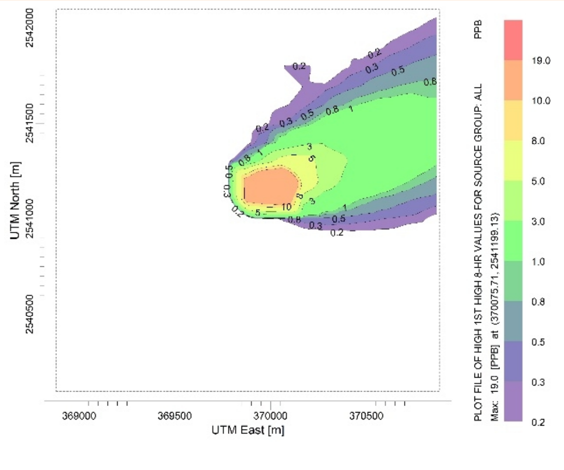

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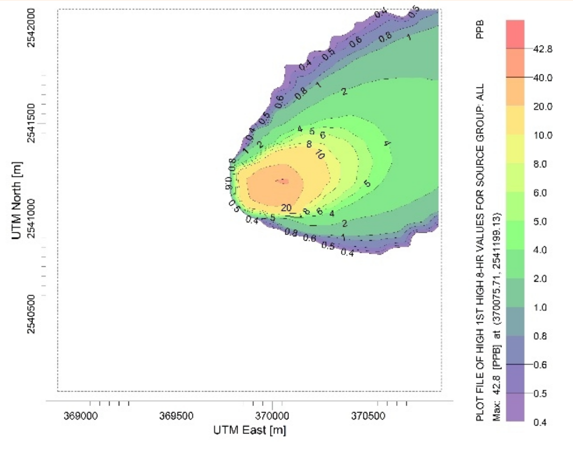

Project Condition

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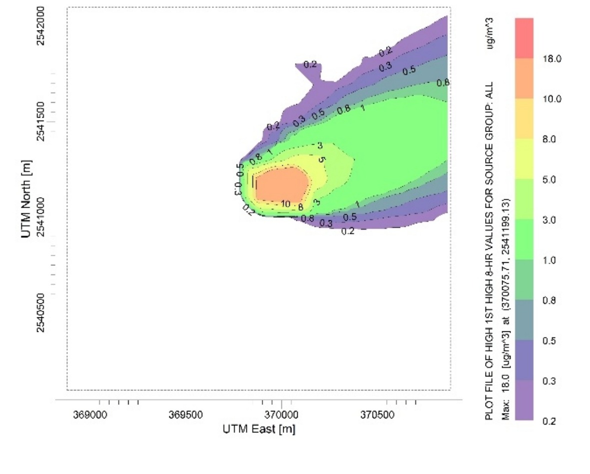

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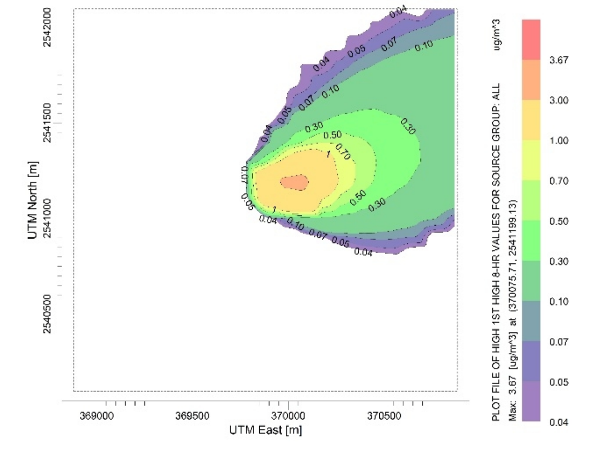
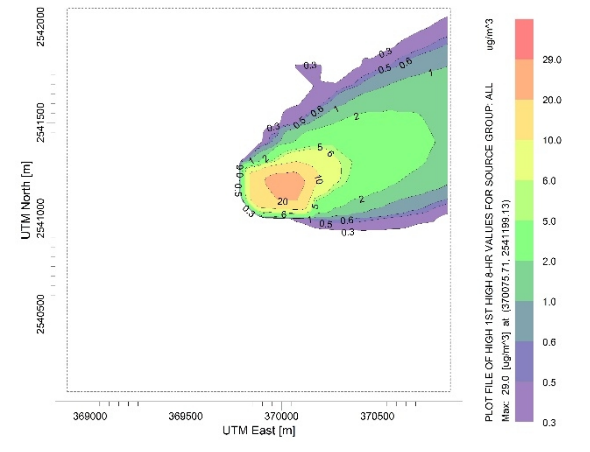


Project Condition

PM_{10}



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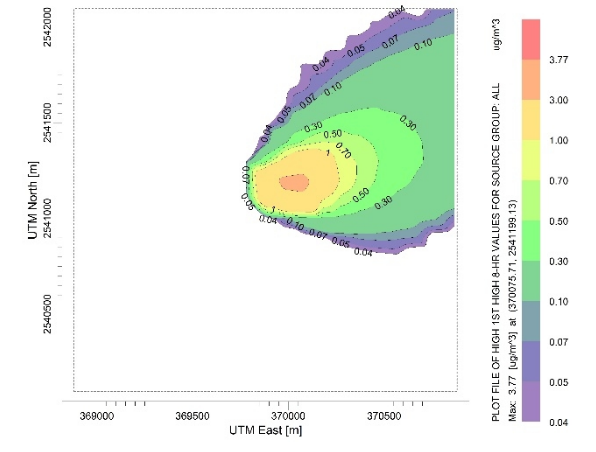
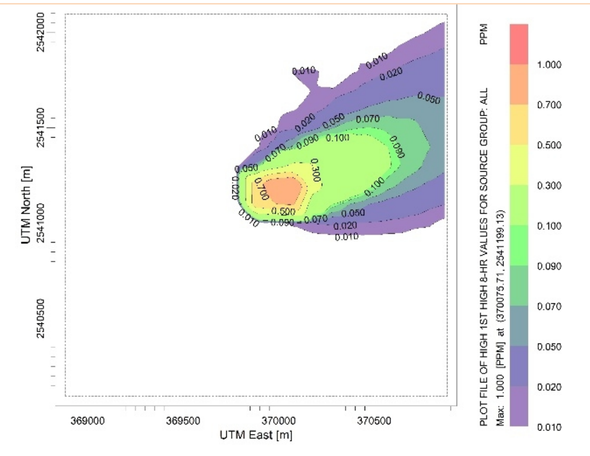


Project Condition

SO_2



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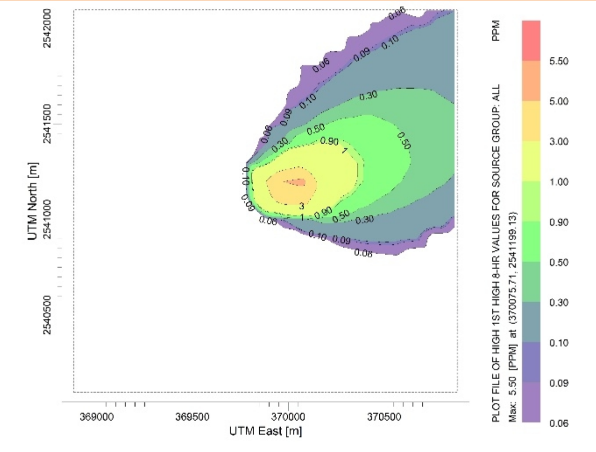


Project Condition

5.5.6. Existing Noise Level Monitoring

Noise in our daily environment fluctuates over time. Some fluctuations are minor, but some are substantial. Some noise levels occur in regular patterns, but others are random. Some noise levels fluctuate rapidly, but others slowly. Some noise levels vary widely, but others are relatively constant. Various noise descriptors have been developed to describe time-varying noise levels. The following are the noise descriptors most commonly used in noise analysis.

- **Equivalent Sound Level (L_{Aeq})**: Leq represents an average of the sound energy occurring over a specified period. In effect, Leq is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A-weighted equivalent sound level (Leq[h]) is the energy average of A- weighted sound levels occurring during a one-hour period, and is the basis for noise abatement criteria (NAC).
- **Percentile-Exceeded Sound Level (L_{xx})**: Lxx represents the sound level exceeded for a given percentage of a specified period (e.g., L10is the sound level exceeded 10% of the time, and L90 is the sound level exceeded 90% of the time).
- **Maximum Sound Level (L_{max})**: L_{max} is the highest instantaneous sound level measured during a specified period.
- **Day-Night Level (L_{dn})**: Ldn is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during nighttime hours between 10 p.m. and 7 a.m.
- **Community Noise Equivalent Level (CNEL)**: Similar to Ldn, CNEL is the energy average of the A-weighted sound levels occurring over a 24-hourperiod, with a 10-dB penalty applied to A-weighted sound levels occurring during the nighttime hours between 10 p.m. and 7 a.m., and a 5-dB penalty applied to the A-weighted sound levels occurring during evening hours between 7 p.m. and 10 p.m.

The vegetation along the surface is dense. The project area is mainly located in rural areas, with a small number of residential areas. No obvious noise and vibration sources are observed, and acoustic environment and vibration environment are good.

Noise Level Guidelines

As Myanmar is still attempting to regulate the noise level standards for different sectors, World Bank IFC General Environmental, Health and Safety Guidelines are used for reference. They can be used to address impacts of noise beyond property boundary of the facilities. The guidelines show the impacts should not exceed the levels presented in the following table, or result in a maximum increase in background level of 3 dB at the nearest receptor location off-site.

Table - NEQG Noise Level Standards

Noise Level Guidelines		
	One Hour L_{Aeq} (dBA)	
Receptor	Day time 07:00 – 22:00	Night time 22:00 – 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Study Methods

Measurement time

The noise under investigation is measured for sufficient time to establish that the measured value adequately represents the subject source noise. The source noise is measured over a time interval of at least 15 minutes or, if the noise continues for less than 15 minutes, the duration of the source noise.

Typical monitoring periods should be sufficient for statistical analysis and may last 48 hours with the use of noise monitors that should be capable of logging data continuously over this time period, or hourly, or more frequently, as appropriate (or else cover differing time periods within several days, including weekday and weekend workdays). The type of acoustic indices recorded depends on the type of noise being monitored, as established by a noise expert.

Measurement location

Normally, when undertaking a noise assessment, it is essential to make note of the following on a site map:

- location of noise source
- background noise measurement location
- source noise measurement location

- topography between noise source and sensitive receivers.

Table - Measurement location

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
1	NS-0	21°51'11.93"N,	96° 4'17.38"E	AS0, Myitnge Railway Station
2	NS-1	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone
3	NS-2	22° 2'13.97"N,	96°27'57.83"E	Pyin Oo lwin Railway Station
4	NS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone Public Area
5	NS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station
6	NS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station
7	NS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Noise Measurement Results

The noise environment at the project is dominated by human activities, with most activities during daytime hours.

The noise monitoring results are summarized in the following table to demonstrate baseline noise levels at the monitoring sites. There has been no development in the area since this time that would have led to a change in the baseline noise environment. As most of the monitoring stations are near the Muse-Mandalay Road, all of the cumulative noise level are mainly sourced from vehicle movement in Muse-Mandalay Road.

Existing Noise Levels

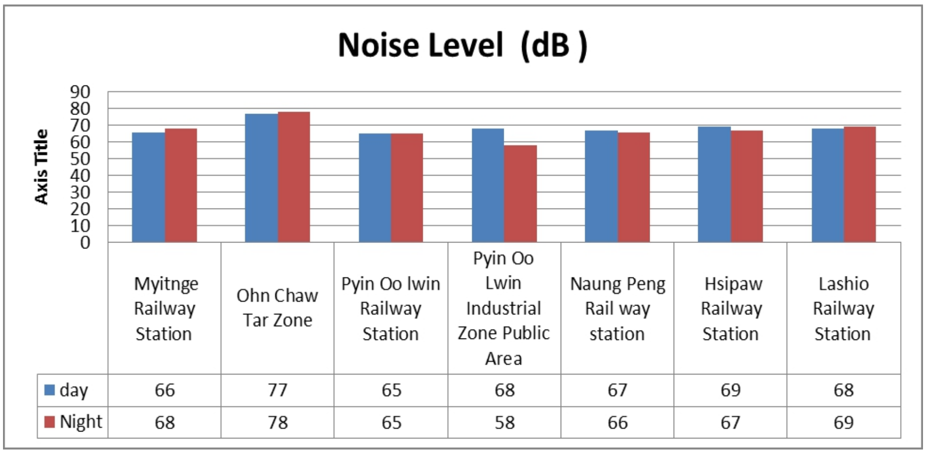
Noise level survey at the vicinity of the project was done by the team. The noise stations, the noise levels and their coordinates are shown in the following table.

Table - Noise Measurement Results

Sample Name	Sensitive Areas	Noise Level (dB)		Latitude(N)	Longitude(E)
		day	Night		
NS-1	Myitnge Railway Station	66	68	21°51'11.93"N,	96° 4'17.38"E
NS-2	Ohn Chaw Tar Zone	77	78	21°52'48.75"N,	96°13'34.70"E
NS-3	Pyin Oo lwin Railway Station	65 65	65 65	22° 2'13.97"N,	96°27'57.83"E
NS-4	Pyin Oo Lwin Industrial Zone Public Area	68	58	22° 3'30.29"N,	96°29'51.88"E
NS-5	Naung Peng Rail way station	67	66	22°21'4.94"N,	96°54'50.62"E
NS-6	Hsipaw Railway Station	69	67	22°37'5.20"N,	97°17'40.17"E

NS-7	Lashio Railway Station	68	69	22°58'22.88"N,	97°43'50.33"E

According to NEQG Noise Level Standards, limit of noise level for industrial, commercial is 70DbA at daytime and night time. But at Ohn Chaw Tar zone, the noise level around this area is a little bit beyond the limit because of Ohn Chaw Tar Zone is near highway road and also this road is used mostly for transportation.



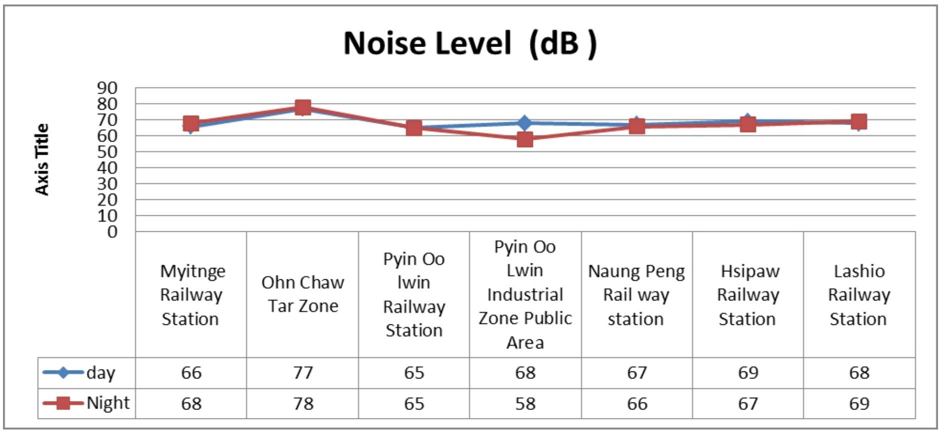


Figure – Noise level near Ohn Chaw Tar Zone

Noise Level Monitoring along Muse-Mandalay Railway

For noise quality measurement, more sampling points are added more to measure specifically for EIA Study at the proposed Muse- Mandalay Railway Project site from Pyinoolwin to Muse (8 points).

Table - Measurement location

No.	Place	Coordinates	
		Latitude(N)	Longitude(E)

1	Pyin Oo Lwin - Oak Pho Village (Monastery)	N 22° 04’ 15.87”	E 096° 23’ 58.30”
2	Naung Cho - Shwe Pyi Nyunt Village	N 22° 18’ 16.29”	E 096° 50’ 02.16”
3	Goke Hteik	N 22° 20’ 08.94”	E 096° 51’ 53.42”
4	Hsipaw (near Baw Gyo Pagoda)	N 22° 34’ 59.78”	E 097° 13’ 59.62”
5	Beyond Hsipaw (San Laung)	N 22° 40’ 33.66’	E 97° 30’ 17.4”
6	Lashio	N 22° 59’ 05.41”	E 097° 42’ 23.09”
7	Hseni	N 23° 18’ 23.97”	E 097° 58’ 28.30”
8	Nam Hpat Kar	N 23° 41’ 21.89”	E 097° 49’ 02.76”
9	Muse	N 24° 00’ 03.10”	E 097° 56’ 25.90”

Figure – Noise Level Monitoring

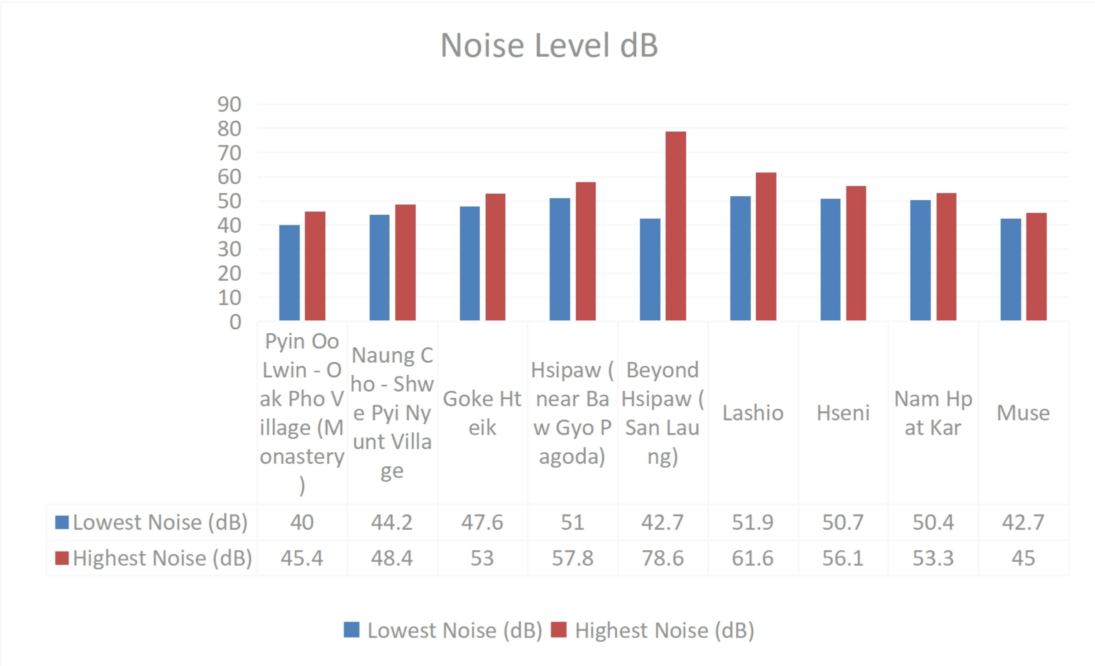
Figure - Noise Study location along the Proposed Muse-Mandalay Railway Project

Noise Level Monitoring Results

Noise level survey at the vicinity of the project was done by the team. The noise stations, the noise levels and their coordinates are shown in he following table.

Table - Noise Level Results

No.	Place	Location	Noise (dB)	
			Lowest	Highest
1	Pyin Oo Lwin - Oak Pho Village (Monastery)	N 22° 04’ 15.87” E 096° 23’ 58.30”	40	45.4
2	Naung Cho - Shwe Pyi Nyunt Village	N 22° 18’ 16.29” E 096° 50’ 02.16”	44.2	48.4
3	Goke Hteik	N 22° 20’ 08.94” E 096° 51’ 53.42”	47.6	53
4	Hsipaw (near Baw Gyo Pagoda)	N 22° 34’ 59.78” E 097° 13’ 59.62”	51	57.8
5	Beyond Hsipaw (San Laung)	N 22° 40’ 33.66’ E 97° 30’ 17.4”	42.7	78.6
6	Lashio	N 22° 59’ 05.41” E 097° 42’ 23.09”	51.9	61.6
7	Hseni	N 23° 18’ 23.97” E 097° 58’ 28.30”	50.7	56.1
8	Nam Hpat Kar	N 23° 41’ 21.89” E 097° 49’ 02.76”	50.4	53.3
9	Muse	N 24° 00’ 03.10” E 097° 56’ 25.90”	42.7	45



	Pyin Oo Lwin - Oak Pho Village (Monastery)	Naung Cho - Shwe Pyi Nyunt Village	Goke Hteik	Hsipaw (near Baw Gyo Pagoda)	Beyond Hsipaw (San Laung)	Lashio	Hseni	Nam Hpat Kar	Muse
Lowest Noise (dB)	40	44.2	47.6	51	42.7	51.9	50.7	50.4	42.7
Highest Noise (dB)	45.4	48.4	53	57.8	78.6	61.6	56.1	53.3	45




Figure - Recorded photos for noise level monitoring

5.5.7. Existing Water Quality Monitoring

Water Quality Sampling Points

Water qualities will be tested in all of the rivers and streams along the railway alignment as follow:

Sample -1, Shweli River

Sample -2, Nant Paung Stream
Sample -3, Nant Khaing Stream
Sample -4, Namtu Stream
Sample -5, Pan Phet Stream
Sample -6, A-T Stream
Sample -7, Sint In Stream
Sample -8, Kho Lone Stream
Sample -9, Dokehtawady River
Sample -10, Kyin Thi Stream
Sample -11, Gok Twin Stream
Sample -12, Yae Ni Stream
Sample -13, Se Taw Gyi Canal,
Sample -14, Myaung Ma Gyi Stream,
Sample -15, Myaing Gyi Stream,
Sample -16, Dokehtawady River

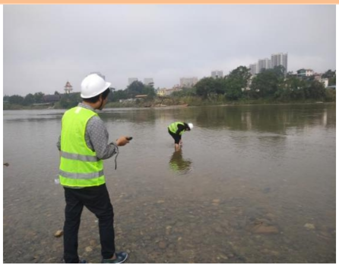
As the total construction period of all of the railway will be 5 years, the water quality will be collected for two seasons to cover the construction period.

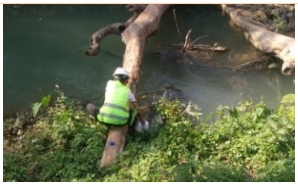
5.5.7.1. Water Quality for Dry Seasons

The locations will also be illustrated as shown in the following figures.

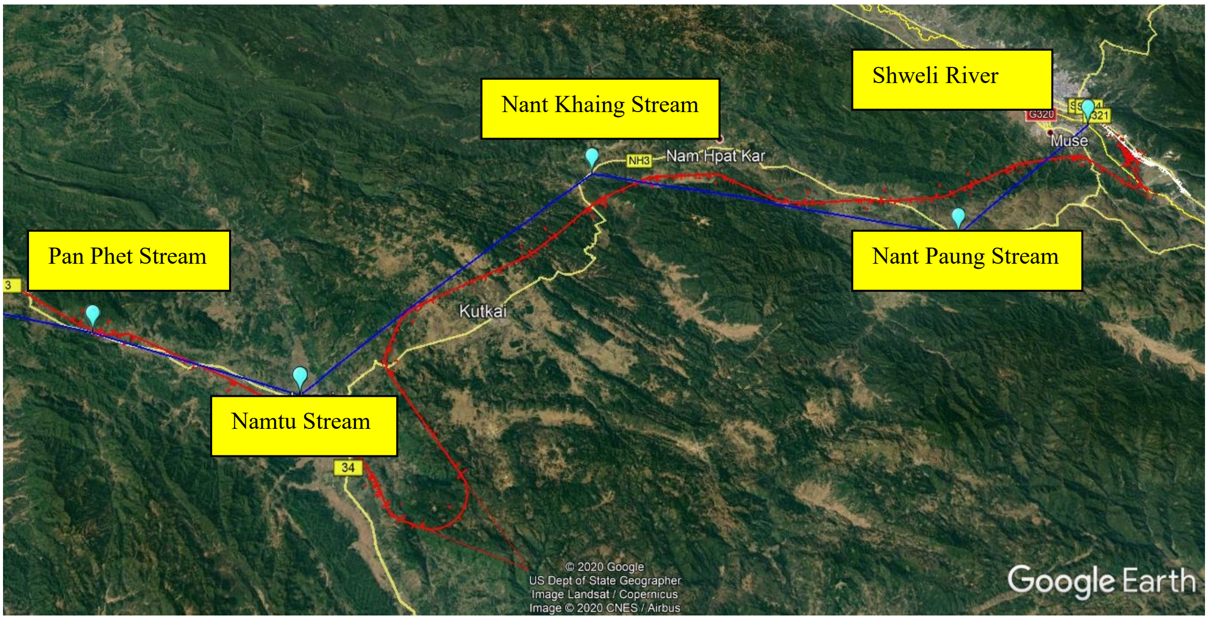
Table 5.9- Locations of the Water Quality Sampling

The exact locations and recorded photos during water quality sampling are as follow:

SN	Name	GPS Corrdinate		Collected Water Samples
		Lattitude	Longitude	
1	Shweli River (Muse)	24.01721°	97.90384°	
2	Nant Paung Stream (Muse)	23.85798°	97.97741°	
3	NantKhaing Stream (Kutkai)	23.57058°	97.81950°	
4	Namtu Stream (Thenni)	23.28817°	97.95394°	
5	Pan Phet Stream (Thenni)	23.13200°	97.84320°	
6	A-T Stream (Lashio)	22.99409°	97.76455°	

7	Sint In Stream (Lashio)	22.70178°	97.53847°	
8	Kho Lone Stream (Hsipaw)	22.61445°	97.39456°	
9	Dokehtawady River (Hsipaw)	22.60728°	97.30748°	
10	Kyin Thi Stream (Kyauk Me)	22.56428°	97.20963°	
11	Goke Twin Stream (Naung Cho)	22.35489°	96.83371°	
12	Yae Ni Stream (Pathein Gyi)	21.99596°	96.12399°	
13	SeDaw Gyi Stream (Pathein Gyi)	21.91917°	96.18635°	

14	Myaung Ma Gyi Stream (Amarapura)	21.85159°	96.12443°	
15	Myaing Gyi Stream (Min Village)	21.84470°	96.10187°	
16	Dokehtawady River (Myit Nge)	21.83646°	96.07781°	



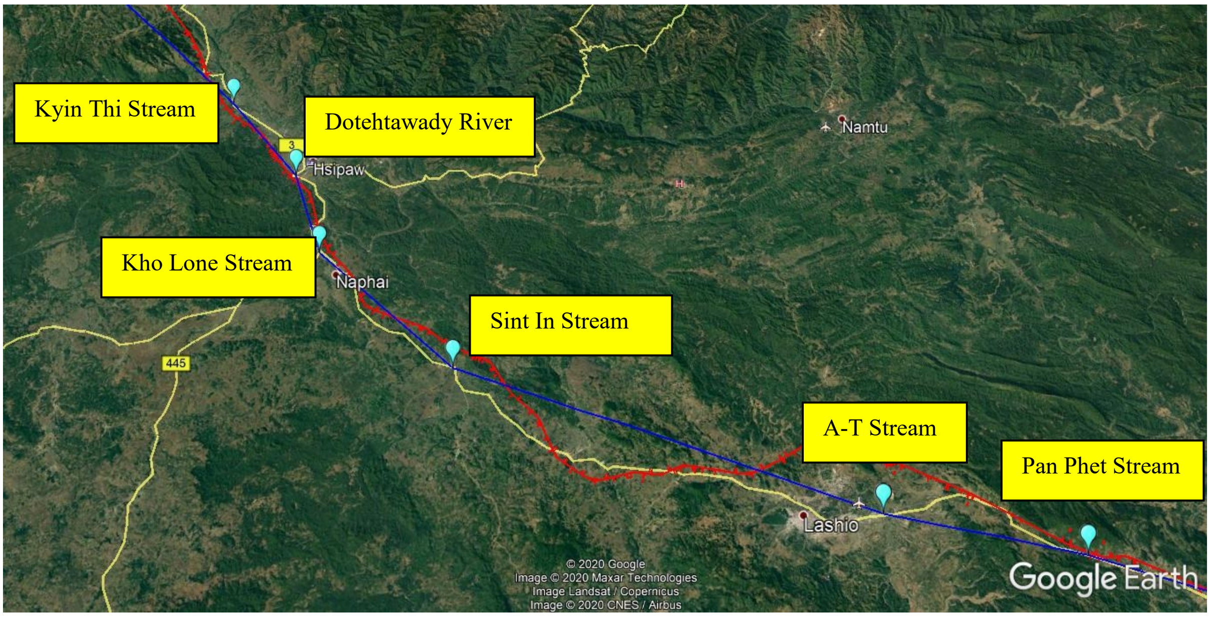

Kyin Thi Stream
Dotehtawady River
Namtu
Hsipaw
Kho Lone Stream
Naphai
Sint In Stream
445
A-T Stream
Pan Phet Stream
Lashio
© 2020 Google
Image © 2020 Maxar Technologies
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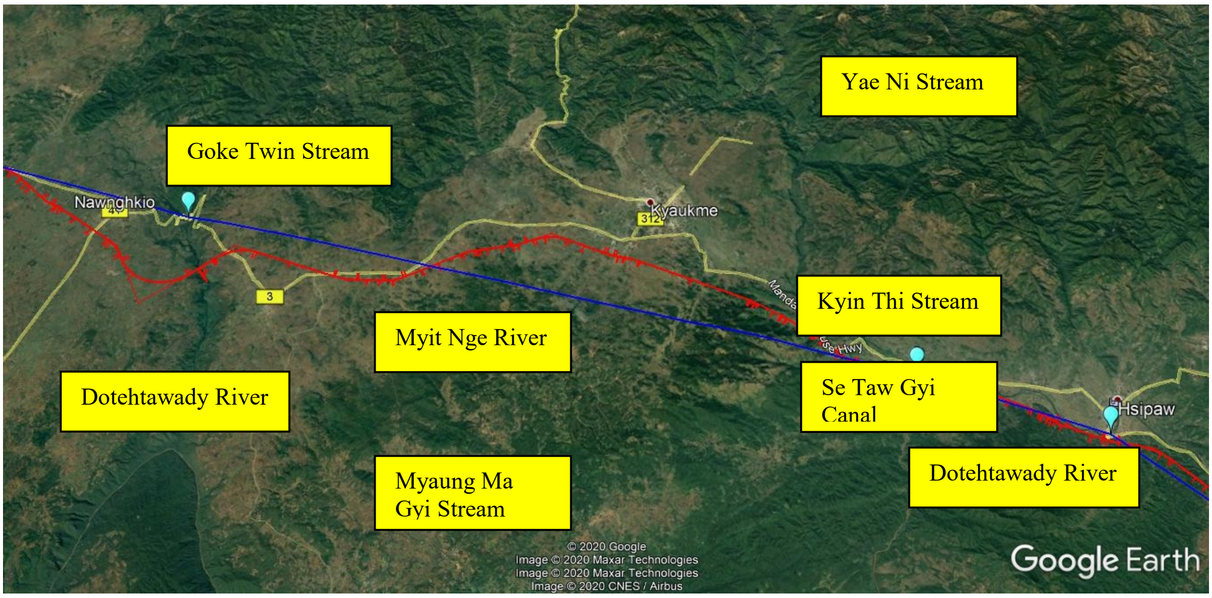
Image © 2020 CNES / Airbus
Google Earth


Yae Ni Stream
Goke Twin Stream
Nawnghkio
Kyaukme
Kyin Thi Stream
Myit Nge River
Se Taw Gyi Canal
Hsipaw
Dotehtawady River
Myaung Ma Gyi Stream
Dotehtawady River
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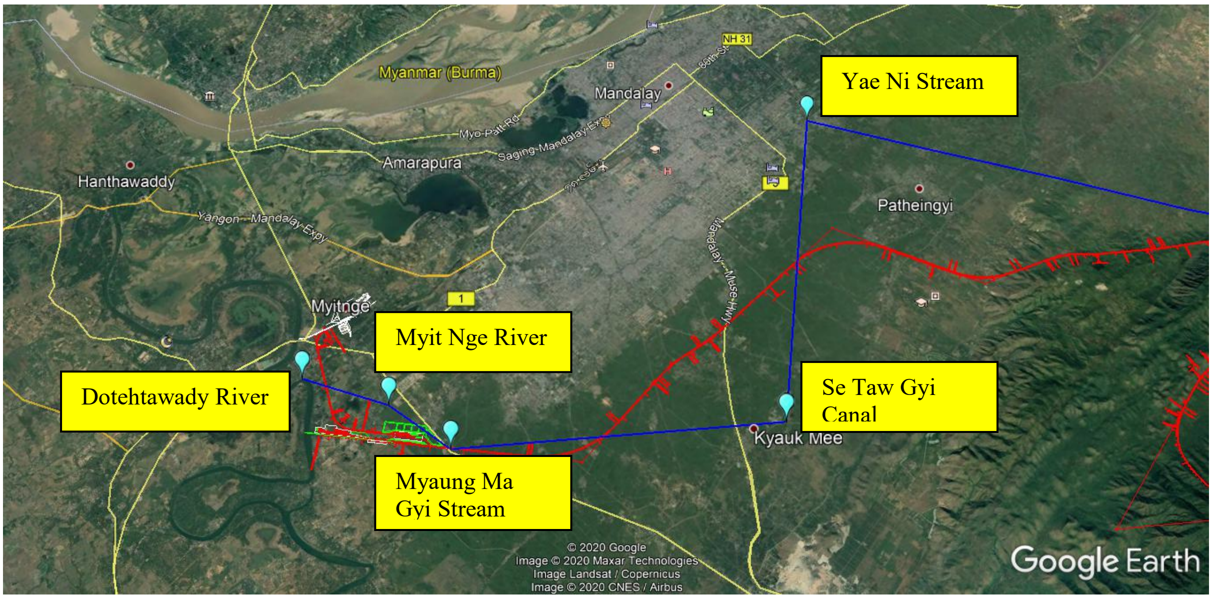


Figure - Locations of Water Quality Sampling for Dry Season

Table 5.10. Water Quality Testing Results for Dry Season

Analyses	Unit	Shwe Li River	Nant Paung Stream	Nant Khaing Stream	Nmatu Stream	Pan Phat Stream	A-T Stream	Sint In Stream	Kho Lone Stream	Dokehtawady River	Kyin Thi Stream	Gok Twin Stream	Yae Ni Stream	Se Taw Gyi Canal	Myaung Ma Gyi Stream	Myaing Gyi Stream	Dokehtawady River	Max. Permissible Limit
Colour (TCU)	Pt-Co	4	38	2	3	2	7	2	1	4	20	5	9	4	30	20	2	20
Turbidity	NTU	1	35	1	2	Nil	2	1	Nil	1	5	2	2	2	5	7	Nil	5
Total dissolved solvents (TDS)	mg/l	74.5	134	185	226	238	197	212	277	176	128	193	92.8	235	125	264	186	1000
Chloride	mg/l	6.75	4.5	11.25	13.5	6.75	9	6.75	6.75	6.75	6.75	9	4.5	99	6.75	18	4.5	250
Total hardness (as Ca CO_3)	mg/l	85	170	200	200	170	260	230	180	210	200	200	90	100	130	170	220	500
Iron	mg/l	0.25	1.95	0.2	0.2	0.2	0.25	0.15	0.1	0.25	0.8	0.3	0.6	0.25	1.1	0.55	0.15	1
pH		7.47	7.79	8.19	8.03	7.43	8.27	7.75	7.46	8.18	7.88	6.87	7.35	7.59	7.65	7.9	7.95	6.5-8.5
Sulphate	mg/l	5	25	5	4	4	6	23	120	20	9	4	10	4	12	9	7	400
Calcium	mg/l	18	24	20	12	10	16	12	8	12	16	10	26	36	12	8	20	200
Magnesium	mg/l	11.2	30.8	42	47.6	40.6	61.6	56	44.8	50.4	44.8	49	7	2.8	28	42	47.6	150
Electrical conductivity	µs/cm	141.4	267	363	447	458	410	427	548	367	243	379	181.8	462	253	538	367	1500

5.5.7.2. Water Quality Testing Results for Wet Seasons

Water quality will also be collected for wet seasons as follow:

Location of Water Quality Sampling in Wet Seasons

The following table shows the locations of water quality sampling in wet seasons.

Table 5.11. Location of Water Samples in Wet Season

SN	Name	GPS Corrdinate		Collected Water Samples
		Lattitude	Longitude	
1	**Namkhon Monastery (Muse)**	24.00058°	97.940547	
2	**Nam Paw Stream (Muse)**	23.85798°	97.97741°	
3	**Natural Spring Near Nam Paw Stream (Muse)**	23.800891°	97.920002°	

4	**Nam Khaing Stream (Kutkai)**	23.57058°	97.81950°	
5	**Namtu Stream (Theinni)**	23.28817°	97.95394°	
6	**Pan Phet Stream (Theinni)**	23.13200°	97.84320°	
7	**Nant Lam Stream (Hsipaw)**	22.61445°	97.39456°	
8	**Dokehtawady River (Hsipaw)**	22.60728°	97.30748°	
9	**Kyin Thi Stream (Hsipaw)**	22.56428°	97.20963°	

10	**Goke Twin stream (Naung Cho)**	22.35489°	96.83371°	
11	**Wel Laung Stream (Pyin Oo Lwin)**	22.082172°	96.580458°	
12	**Nartaungkya Stream (Pathein Gyi)**	21.880704°	96.226655°	
13	**Sedaw Gyi Cannal**	21.91917°	96.18635°	
14	**Dokehtawady(Myit Nge River)**	21.83646°	96.07781°	

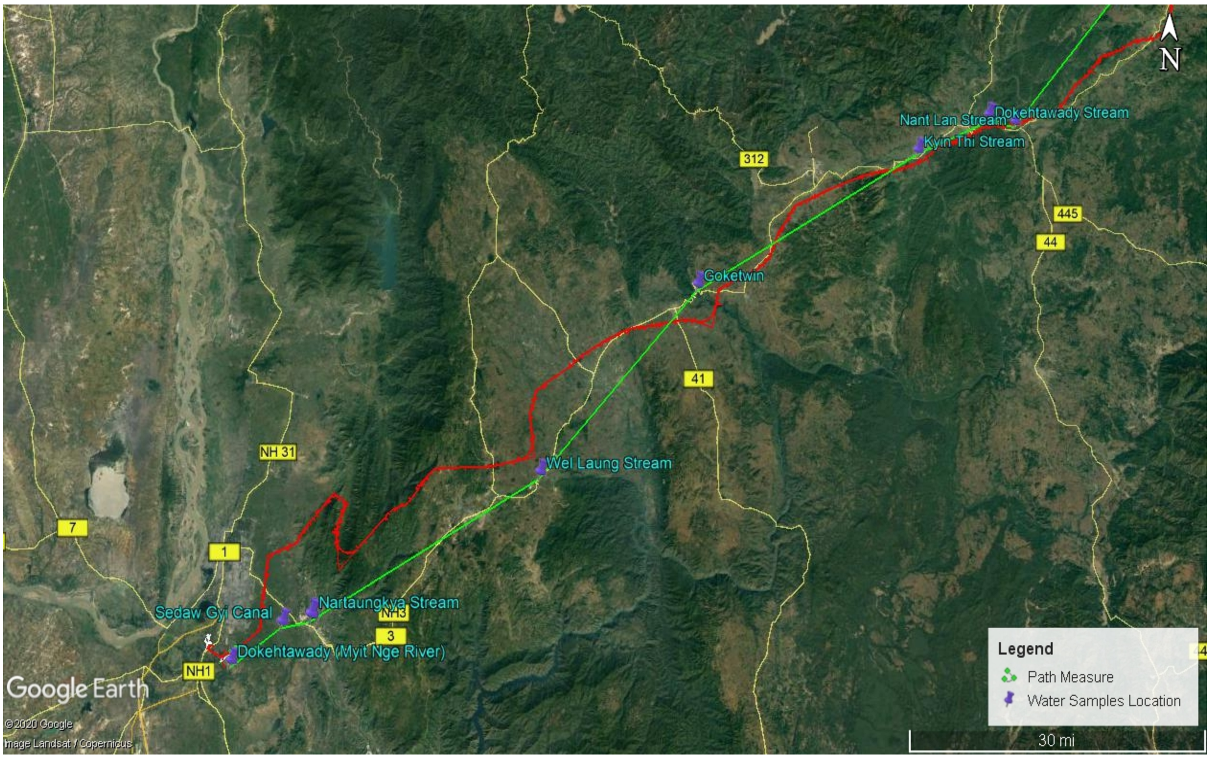


Figure - Locations of Water Quality Sampling for Wet Season

Table 5.12. Water Quality Testing Results for Wet Season

Analyses	Unit	Namkhon Monastery	Nam Paw Stream	Natural Spring Near Nam Paw Stream	Nam Khaing Stream	Namtu Stream	Pan Phet Stream	Nant Lam Stream	Dokehtawady	Kyin Thi Stream	Goke Twin stream	Wel Laung Stream	Nartaungkya Stream	Sedaw Gyi Cannal	Dokehtawady(Myit Nge River)
Calcium	mg/l	24	33	44	49	69	63	73	34	32	42	79	70	29	50
Chloride	mg/l	7.68	7.68	8.65	6.72	12.49	8.65	12.49	8.65	12.49	8.65	21.14	15.37	8.16	9.13
Conductivity	µs/cm	0.244	0.329	0.691	0.447	0.568	0.578	0.658	0.431	0.297	0.377	0.740	0.592	0.258	0.454
Magnesium	mg/l	<5	<5	6	6	9	7	10	<5	5	6	11	9	<5	8
pH	-	7.44	7.36	7.08	7.64	7.24	7.43	7.36	7.2	7.17	7.14	7.1	7.11	7.15	7.2
Sulphate	mg/l	ND	ND	2.1	ND	3.6	ND	46.2	3.9	ND	ND	2.4	2.1	ND	6.6
Total Hardness as $CaCO_3$	mg/l	88.5	157.5	381	328.5	264	412.5	345	200	116	170	403	300	95.5	197
Total Iron	mg/l	0.5	0.2	ND	0.1	0.2	<0.1	0.1	0.5	1	1	ND	0.1	1	<0.1
Total Dissolved Solids	mg/l	95	128	380	280	360	360	258	190	80	172	320	198	103	196
Turbidity	NTU	9.47	36.2	9.29	21.1	24.4	11.5	24.4	35.5	55.6	35.8	10.5	47.6	48.8	14.1

5.5.8. Vibration Level Monitoring

Vibration levels were measured at points along the proposed Muse-Mandalay Railway. The measurements are taken in places which are Pyin Oo Lwin-Oak Pho Village (Monastery), Naung Cho- Shwe Pyi Nyunt Village, Goke Hteik, Hsipaw (near Baw Gyo Pagoda), Beyond Hsipaw (San Laung), Lashio, Hseni, Nam Hpat Kar and Muse. The following figures shows the location of vibration level assessment.

Hseni

Testing

Hsipaw (near Baw Gyo Pagoda)

Lashio

Naung Cho (Shwe Pyi Nyunt Village)

Pyin Oo Lwin (Oak

for V

Figure - Recorded Seismograph Results Along the Proposed Project Muse-Mandalay Railway

Figure - Location of Vibration Monitoring in Google Map

Table 5.13. Measuring Results for Vibration Level

Place	Location	L(mm/s)	V(mm/s)	T(mm/s)
Pyin Oo Lwin - Oak Pho Village (Monastery)	N 22° 04’ 15.87” E 096° 23’ 58.30”	1.85	0.475	0.350
Naung Cho - Shwe Pyi Nyunt Village	N 22° 18’ 16.29” E 096° 50’ 02.16”	-	-	-
Goke Hteik	N 22° 20’ 08.94” E 096° 51’ 53.42”	-	-	-
Hsipaw (near Baw Gyo Pagoda)	N 22° 34’ 59.78” E 097° 13’ 59.62”	-	-	-
Beyond Hsipaw (San Laung)	N 22° 40’ 33.66’ E 97° 30’ 17.4”	-	-	-
Lashio	N 22° 59’ 05.41” E 097° 42’ 23.09”	0.275	0.375	0.275
Hseni	N 23° 18’ 23.97” E 097° 58’ 28.30”	-	-	-
Nam Hpat Kar	N 23° 41’ 21.89” E 097° 49’ 02.76”	-	-	-
Muse	N 24° 00’ 03.10” E 097° 56’ 25.90”	0.250	0.175	0.225

Range of L, V, T – from 0.1 mm/s to 200 mm/s

Range of Air Overpressure – from 100 to 140 dB Linear Peak

L – Love Wave: A major type of surface wave having a horizontal motion that is shear or transverse to the direction of propagation (travel).

V – Peak Particle Velocity (also known as PPV)

T – Travel Time: The time required for a wave train to travel from its source to the point of observation.

5.5.9. Existing Soil Quality Monitoring

As the construction of tunnel will impact on soil quality during construction stage, soil quality will be monitored and will have to be tested in laboratory. Soil qualities were collected along the railway line as shown in the following figures.

Sample Point Selection

To determine the chemical composition of soil quality, the sample points are selected at the project site, rivers' bank and inside the farm land.

Table 5.14. Locations of Soil Sample Points for Dry Season

SN	Name	GPS Corrdinate		Collected Soil Samples
		Lattitude	Longitude	
1	Phat Man Soil (I)	23.84672°	97.96399°	
2	Lower Nam Phat Loon Soil (I)	23.57058°	97.81950°	

3	Theinni Soil(I)	23.28817°	97.95394°	
4	Hang Lu Soil(I)	23.13200°	97.84320°	
5	Pang Huauk Soil	22.61445°	97.37921°	
6	Hsipaw Soil (I)	22.60728°	97.30748°	
7	Kyin Thi Soil(I)	22.56428°	97.20963°	
8	Goke Twin Soil	22.35489°	96.83371°	

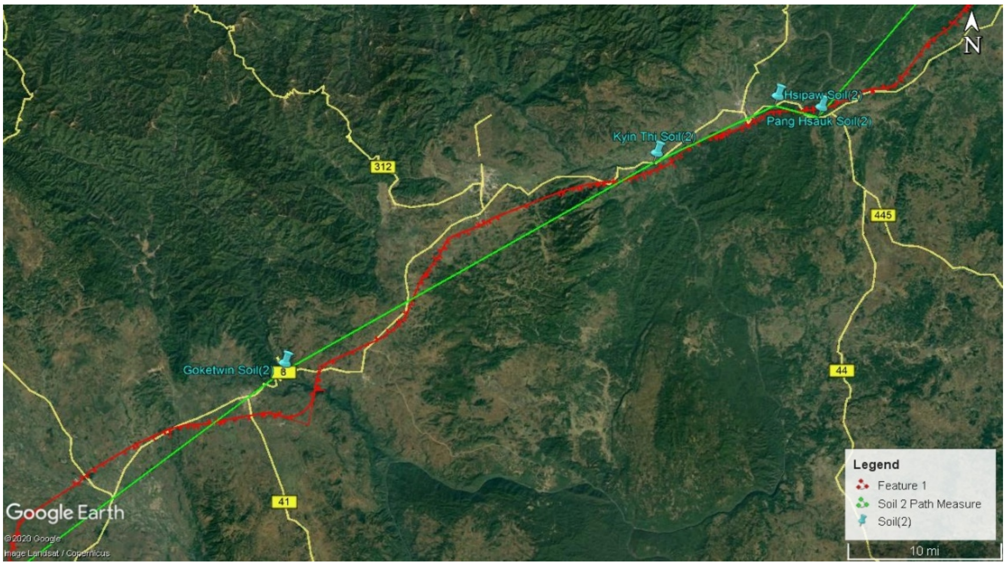
9	Sedaw Gyi Soil	21.91917°	96.18635°	
10	Myit Nge Soil	21.83646°	96.07781°	

Figure - Locations of Soil Quality Sampling along the Railway Line for Dry Season

Table 5.15. Locations of Soil Sample Points for Wet Season

SN	Name	GPS Corrdinate		Collected Soil Samples
		Lattitude	Longitude	
1	Phat Man Soil (II)	23.800891°	97.9200002°	
2	Lower Nam Phat Loon Soil (II)	23.569606°	97.819422°	
3	Theinni Soil(II)	23.288344°	97.954061°	
4	Hang Lu Soil(II)	23.119017°	97.836422°	
5	Pang Huauk Soil(II)	22.611375°	97.378211°	

6	Hsipaw Soil (II)	22.621989°	97.334172°	
7	Kyin Thi Soil(II)	22.564178°	97.209489°	
8	Goke Twin Soil(II)	22.354586°	96.833431°	
9	Sedaw Gyi Soil(II)	21.872109°	96.182244°	
10	Myit Nge Soil(II)	21.819177°	96.106333°	



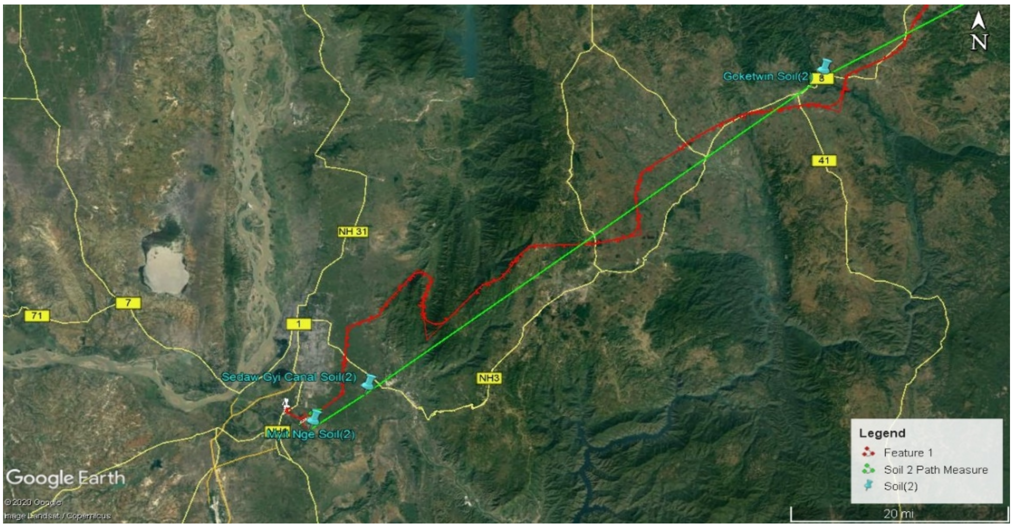


Figure - Locations of Soil Quality Sampling along the railway Line in Wet Season

Table - Soil Quality Results (Dry Season)

Sr No.	Sample (Soil 1)	pH Soil:Water 1:2.5	Texture	Organic Carbon	Total N	CEC	Available Nutrients		Water Soluble Meq/q100gm		Interpretation of results	
							P	K_2O	Cl^-	$SO_4^=$	Cl^-	$SO_4^=$
1	Hang Lu	Slightly alkaline	Sandy Loam	Low	Medium	High	Low	Medium	0.19	0.37	Low	Low
2	Kyin Thi	Moderately alkaline	Sandy clay loam	Very low	Low	High	Medium	High	0.30	0.14	Low	Low
3	Sedaw Gyi Cannal	Moderately alkaline	Sandy Loam	Medium	Low	Very High	Very High	High	0.19	0.21	Low	Low
4	Hsipaw	Moderately alkaline	Sandy Loam	Very Low	Very low	Medium	Medium	High	0.15	0.18	Low	Low
5	Goke Twin	Moderately alkaline	Loamy sandy	Very Low	Low	Medium	Low	Medium	0.23	0.14	Low	Low
6	Myit Nge	Moderately alkaline	Sandy Loam	Low	Medium	Very high	High	High	0.80	0.25	Low	Low
7	Pang Hsauk	Moderately alkaline	Sandy Loam	Low	Medium	Very high	Medium	Medium	0.23	1.01	Low	Low
8	Phat Man	Moderately alkaline	Sandy Loam	Low	Medium	Medium	Medium	Medium	0.19	0.18	Low	Low
9	Lower Nam Phat Loon	Slightly alkaline	Sandy Loam	Medium	Medium	Medium	Low	Medium	0.23	0.33	Low	Low
10	Theinni	Moderately alkaline	Loamy sandy	Medium	Low	High	Medium	Low	0.15	0.18	Low	Low

Table - Soil Quality Results (Dry Season)

Sr No.	Sample (Soil 2)	pH Soil:Water 1:2.5	Texture	Organic Carbon	Total N	CEC	Available Nutrients		Water Soluble Meq/q100gm		Interpretation of results	
							P	K_2O	Cl^-	$SO_4^=$	Cl^-	$SO_4^=$
11	Phat Man	Slightly alkaline	Clay	Low	Medium	High	Low	High	0.38	0.21	Low	Low
12	Goke Twin	Moderately alkaline	Loam	Very low	Low	Medium	Low	Medium	0.19	0.21	Low	Low
13	Pang Hsauk	Moderately alkaline	Sandy loam	Very low	Low	High	Low	Medium	0.34	0.14	Low	Low
14	Hang Lu	Moderately alkaline	Sandy loam	Very low	Low	Medium	Low	Medium	0.27	0.14	Low	Low
15	Kyin Thi	Moderately alkaline	Sandy loam	Low	Low	Medium	Medium	High	0.30	0.10	Low	Low
16	Myit Nge	Moderately alkaline	Sandy loam	Low	Medium	Very high	Medium	High	0.49	0.25	Low	Low
17	Lower Nam Phat Loon	Moderately alkaline	Sandy loam	Very low	Low	Medium	Medium	Medium	0.34	0.21	Low	Low
18	Sedaw Gyi Canal	Moderately alkaline	Clay loam	Low	Medium	Very high	High	High	0.38	0.10	Low	Low
19	Hsipaw	Moderately alkaline	Sandy loam	Medium	Medium	High	Medium	High	0.23	0.10	Low	Low
20	Theinni	Moderately alkaline	Sandy clay loam	Very low	Low	Very High	Medium	Medium	0.19	0.25	Low	Low

Table - Soil Quality Results (Wet Season)

Sr No.	Sample (Soil 1)	Moisture	pH soil:water 1:2.5	Texture				Organic Carbon %	Humus %	Total N	CEC	Exchangeable Cations Meq/100gm						Available Nutrients	
				Sand %	Silt %	Clay %	Total %					Ca^{++}	Mg^{++}	K^{+}	Na^{+}	H^{+}	Al^{++}	P ppm Olsen	K_2O Mg/ 100gm
1	Hang Lu	3.54	7.50	69.90	16.72	13.38	100.00	1.77	3.06	0.22	26.98	24.95	1.31	0.36	0.36	-	-	7.47	16.80
2	Kyin Thi	5.35	7.93	48.90	26.72	24.38	100.00	0.82	1.41	0.15	32.09	25.43	1.34	3.99	1.33	-	-	8.46	148.42
3	Sedaw Gyi Cannal	4.08	7.75	62.90	25.72	11.38	100.00	3.35	5.78	0.15	41.67	33.66	4.62	2.28	1.11	-	-	61.31	106.99
4	Hsipaw	1.46	7.81	76.90	10.72	12.38	100.00	0.79	1.35	0.03	21.43	19.92	0.64	0.43	0.44	-	-	10.56	20.10
5	Goke Twin	0.78	8.15	86.90	4.72	8.38	100.00	0.04	0.07	0.18	14.25	11.49	1.91	0.26	0.59	-	-	4.84	12.09
6	Myit Nge	7.66	7.78	56.90	20.72	22.38	100.00	1.10	1.90	0.23	43.67	34.98	6.17	0.94	1.58	-	-	13.87	44.20
7	Pang Hsauk	7.70	7.69	71.90	11.72	16.38	100.00	1.63	2.81	0.21	47.54	43.21	3.43	0.41	0.49	-	-	10.83	19.50
8	Phat Man	10.02	7.91	63.90	13.72	22.38	100.00	1.04	1.80	0.21	19.08	14.08	4.22	0.38	0.39	-	-	10.23	18.02
9	Lower Nam Phat Loon	11.71	7.33	70.90	13.72	15.38	100.00	2.03	3.50	0.24	18.70	14.34	3.58	0.33	0.44	-	-	5.44	15.63
10	Theinni	8.00	8.07	86.90	4.72	8.38	100.00	0.35	0.61	0.15	26.85	24.80	1.38	0.21	0.47	-	-	9.14	9.79

Table - Soil Quality Results (Wet Season)

Sr No.	Sample (Soil 2)	Moisture	pH soil:water 1:2.5	Texture				Organic Carbon %	Humus %	Total N	CEC	Exchangeable Cations Meq/100gm						Available Nutrients	
				Sand %	Silt %	Clay %	Total %					Ca^{++}	Mg^{++}	K^{+}	Na^{+}	H^{+}	Al^{++}	P ppm Olsen	K_2O Mg/ 100gm
11	Phat Man	4.48	7.38	33.9	22.72	43.38	100.00	1.41	2.43	0.22	26.10	16.57	7.95	0.76	0.82	-	-	7.54	35.81
12	Goke Twin	4.54	8.20	46.9	31.72	21.38	100.00	0.17	0.29	0.11	22.11	19.20	1.99	0.24	0.68	-	-	6.27	11.30
13	Pang Hsauk	2.44	8.08	70.9	15.72	13.38	100.00	0.71	1.22	0.18	39.50	36.97	1.03	0.24	1.00	-	-	4.51	11.07
14	Hang Lu	1.36	7.94	66.9	19.72	13.38	100.00	0.95	1.64	0.14	19.78	17.98	1.28	0.23	0.29	-	-	3.65	10.95
15	Kyin Thi	3.45	7.95	66.9	19.72	13.38	100.00	1.01	1.89	0.16	23.91	17.05	5.90	0.48	0.47	-	-	9.53	22.38
16	Myit Nge	2.44	8.01	53.9	30.72	15.38	100.00	1.71	2.94	0.22	51.19	45.45	3.90	0.96	0.89	-	-	11.90	44.92
17	Lower Nam Phat Loon	1.57	8.00	76.9	13.72	9.38	100.00	0.79	1.36	0.16	22.60	19.30	2.57	0.29	0.44	-	-	10.16	13.41
18	Sedaw Gyi Canal	4.63	8.06	36.9	26.72	36.38	100.00	1.54	2.65	0.22	55.20	44.46	6.64	1.81	2.30	-	-	16.35	84.91
19	Hsipaw	3.73	7.82	53.90	34.72	11.38	100.00	2.20	3.79	0.24	34.79	29.58	3.29	0.48	1.44	-	-	10.80	22.43
20	Theinni	1.42	7.77	54.90	24.72	20.38	100.00	0.95	1.64	0.18	49.16	44.94	3.21	0.26	0.75	-	-	10.55	12.17

5.5.10. Existing Biodiversity Environment

This Environmental Impact Assessment (EIA) report identifies potential environmental impacts associated with the proposed of Mandalay-Muse New Railway Project's Bridges and culverts Construction. The project sites is located that on the route of Mandalay-Muse areas. Study area was divided into two parts, Part I (plain area, Armarapura and Patheingyi) and Part II (hill area, Pyin Oo Lwin to Muse).Study sites were allocated into six study sites in Part I and forty nine study sites in Part II. The biodiversity survey was conducted from May 2019 to November 2019. The base line study and specimen collection of terrestrial fauna, especially as major groups are vertebrate (birds, reptiles, lizards and fishes especially visual observation) and invertebrate (butterflies, dragonflies and damselflies visually during survey). A total of (64) plant species and (89) fauna species were recorded in Part I and (80) plant species and (112) fauna species in Part II. Regarding the population and density: in study Part I, the highest abundance were found in (5) species, as very common, (48) species were found as uncommon in plant species and (7) species, as very common, (13) species were found as uncommon in bird species; (9) species as very common, (2) species as uncommon in insect species. According to surveyed results, the highest density was found as Mimosaceae family (7.81%) species and the lowest was found (24) families (1.56%) in plant species. The highest density was found in Columbidae (10.811%) and the lowest species was found in (18) families (2.703 %) in bird species. In study site Part II, the base line study and specimen collection of terrestrial fauna, especially as major groups are vertebrate (birds, reptiles, lizards and fishes especially visual observation) and invertebrate (butterflies, dragonflies and damselflies visually during survey). According to the survey results, total of 112 fauna species recorded in and around the Mandalay-Muse New Railway Project Area. According to the survey results, about total Mammals fauna 7 species 5 order and 6 families were recorded. According to the survey results, surrounding of the Mandalay-Muse New Railway Project area, about total Avian fauna 59 species 12 order and 30 families were recorded. Surrounding of the Pyin Oo Lwin area, about 39 species of Avian Fauna belonging to 9 order and 23 families were recorded with different population abundance. Surrounding of the Naung Hkio to Kyaukme Survey about 30 species of Avian Fauna belonging to 7 order and 18 families were investigated that the different categorize bird species as insectivore, omnivores and carnivorous. Biodiversity team observed that the surrounding of Lashio to Muse survey, about 22 species of Avian Fauna belonging to 3 order and 12 families were recorded. During survey period, about 9 species of reptilian species belonging to 2 order and 7 families were recorded at the study site. Biodiversity survey group are observed that there are about total 26 species of Butterfly as well as male and female belonging to 7 families in surrounding of the all project area. The survey team investigated that the surrounding of the site of Project Construction Area, about 13 species Dragonfly and Damselfly species belonging to one order and 2 families (Libellulidae and Coenagrionidae) were recorded with different population abundance. This report is a review of the Environmental Impact Assessment Report (EIAR) for flora, in and around the Mandalay-Muse New Railway Project Area. A total of 80 flora species were recorded during the survey periods. The habit of identified species consists of seven different types, including tree, shrub, herb, climber, bamboo and parasitic shrub. Some of tree species are planted for landscaping beside the rail way yard and some of trees are planted and culturally retained for water resources around the village sites. Most of shrubs and herbs were naturally grow on road sites and understorey layer of tree species. In the conservation point of view: according to IUCN red list, in study Part I, all of plant species are last concern (LC). Almost bird species are last concern (LC) except (1) species (Hooded Treepie) is near threatened (NT) and (1) species (White-vented Myna) is vulnerable (VU). For Part II study area, According to the IUCN Red List, four Least Concerned species and two near threatened status noted from the survey area. The identification of the possible impact of the project recommended mitigation measures for all negative impacts identified. Environmental Impact Assessment is the prediction of consequences to the environment of a proposed project development measures. It could be both positive or negative impacts and one of the most important tools for achieving sustainable development. This report identifies potential environmental impacts associated with the proposed of communication, commercial trades and others. The survey team investigated that four types of impacts as well as negative and positive impacts, reduction of the species diversity (negative impact), loss of habitats(negative impact), noise impact (negative impact), as fauna and flora were observed in these projects. Next, the family income can be improved concerning with the project during the construction and operation period. The result of project can make the working opportunities of local people (both manual laborer and technicians). The impacts on environmental condition will be analyzed statistically and evaluated according to International Association of Impact Assessment-IAIA Guidelines as the impact factors, impacted items and impact degree are determined. As the assumption, by the advantages of the project, it may be support for communication, commercial trades and other factors of developed country. Regarding with EIA Assessment, this report is a review of the Environmental Impact Assessment Report (EIAR) for flora, in and around the Mandalay-Muse New Railway Project Area. A total of 164 flora species were recorded during the survey periods. The habit of identified species consists of seven different types, including tree, shrub, herb, climber, bamboo and parasitic shrub. Some of tree species are planted for landscaping beside the rail way yard and some of trees are planted and culturally retained for water resources around the village sites. Most of shrubs and herbs were naturally grow on road sites and understorey layer of tree species. According to the IUCN Red List, four Least Concerned species and two near threatened status noted from the survey area. The identification of the possible impact of the project recommended mitigation measures for all negative impacts identified. Environmental Impact Assessment is the prediction of consequences to the environment of a proposed project development measures. It could be both positive or negative impacts and one of the most important tools for achieving sustainable development. This report identifies potential environmental impacts associated with the proposed of communication, commercial trades and others. The survey team investigated that four types of impacts as well as negative and positive impacts, reduction of the species diversity (negative impact), loss of habitats(negative impact), noise impact (negative impact), as fauna and flora were observed in these projects. Next, the family income can be improved concerning with the project during the construction and operation period. The result of project can make the working opportunities of local people (both manual labourer and technicians). The impacts on environmental condition will be analysed statistically and evaluated according to International Association of Impact Assessment-IAIA Guidelines as the impact factors, impacted items and impact degree are determined. As the assumption, by the advantages of the project, it may be support for communication, commercial trades and other factors of developed country.

Biodiversity Survey Team for Mandalay-Muse New Railway Project

Sr.	Biodiversity Survey Team	Official Position	Status (All Technical Specialists)
1.	Dr Nyo Nyo Lwin	Professor Department of Biology, Yangon University of Education	Team Leader Ecology & Biodiversity Senior Consultant
2.	Prof. Weine Nway	Head of Department	Team Leader

	Nway Oo	Department of Biotechnology Technological University (Kyaukse)	Ph.D (Biotechnology) Member of NBSAP, 2011
3.	Dr. Nyunt Lwin	Lecturer Department of Zoology Kyuause University	Team Leader Ph.D (Ecology)
4.	Dr Wah Wah Khaing	Associate Professor Department of Botany, Pathein University	Research Member Ph.D (Environmental Science, YU) (Flora Expert)
5.	Dr Theingyi Soe Myint	Lecturer Department of Zoology, University of Yangon	Research Member Ph.D (Ichthyology, YU) Ichthyologist
6.	U Htoo Htoo Aung Lwin	Assistant Lecturer Department of Zoology, University of Yangon	Research Member Ph.D (Candidate, YU) Ichthyologist
7.	Dr. Thein Tun Oo	Lecturer Department of Botany, Yadanabon University	Research Member PhD (Botany) (Flora Expert)
8.	Dr. Ye Ye Win	Lecturer Department of Botany, Yadanabon University	Research Member PhD (Botany) (Flora Taxonomist)
9.	U Shein Htet Aung	;istant Lecturer ɔartment of Zoology, Mandalay University	Research Member PhD Prelim (Zoology); MSc, MRes (Ornithology) (Fauna Expert)
10.	U Kyaw Lwin	Carrier Researcher	Research Member Field specialist, Insect, mammal and herpet
11.	U Naing Oo	Carrier Researcher	Research Member Field Specialist, Plant

(1) Aims and Objectives

To collect and identify of plant and animal species in study area

To record dominant species of plants and animals

To analysis of composition of plants and animals

To assess the potential impacts and to suggest the mitigation measure

(2) Methods

The animals and floristic data, and ecological data collection were conducted by the following methods in the study area.

(i) Study area and study sites

The study area is conducted on Muse-Mandalay Railway from Amarapura Township to Patheingyi Township. Six study sites were allocated by based on habitats in this study area and remarked on Google Earth. Site I (Sauk Taw Wa) I is at Latitude 21°50'31.20"N and Longitude 96° 7'10.68"E; Site II (Sin Bo) is at 21°52'0.33"N and 96° 8'46.74"E; Site III (Ngwe Taung) at 21°53'34.23"N and 96°10'13.57"E; Site IV (Tha Le Kone) at 21°55'16.12"N and 96°11'1.27"E; Site V (Ye Kyi, South) is at 21°57'7.26"N and 96°11'7.77"E and Site VI (Yetagon Taung) is situated at 21°57'50.59"N and 96°12'41.48"E

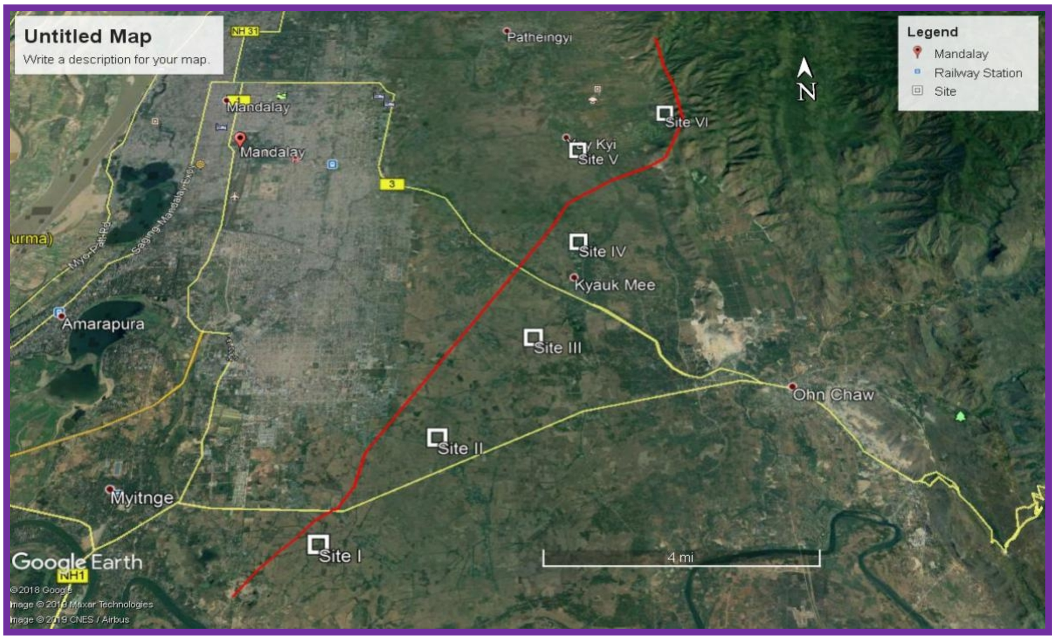


Figure - Map of biodiversity study sites

(ii) Study design

Classification of landscape based on satellite data: is often used to classify the landscape into different vegetation categories and decide about the sampling strategy. We have also followed same strategy of classifying the landscape into discernible units. Further, we have used ground truth points to calibrate the classification of the landscape into distinct units.

At each sampling site, an appropriate data collection line was designated to cover the area of each sampling site. One permanent transect line running from north to south with 50 m width was established in each study site.

Vegetative sampling was made based on plot method. Sampling with quadrat plots were allocated along the either side of each transect line. The minimum distance between two plots was 100m. Each plot was measured a length of 30m and width of 10m. Plants species as well as their total number within each plot were recorded.

(iii) Survey methods

Five kinds (Birds, Fish & Crust, mammals, herpets and insects) animals were surveyed for the diversity assessment. Animals were observed and recorded using a binocular. The photos were taken with digital camera. Most animal species were spotted with binoculars and photographs were taken, some species which could not be recorded on photographs although their occurrence was also recorded were included. The animals were surveyed two times, once in the morning from 7:00 am to 10:00 am and once in the evening from 3:00 pm to 6:00 pm and conducted a month. Line transect count method was carried out, walking along the study points. Data counting were used by direct and estimation methods, followed after Bibby *et al.*(2008). Some mammals and herpets were surveyed as interviewed methods.

Plate 1 Interview (Questionnaires' Survey) and Field survey

(iv) Insects

Insects were caught and taken as voucher specimens. Flying insects were caught by insect net; beetles were collected by digging the grounds, peering the tree barks with the knife. Some beetles in the trees were shaken out and fall down on the ground; these insects were collected by hands and a pairs of forceps.

(v) Fish & Crustacea

Fish & crust were recorded by direct catching method in/near the paddy field.

(vi) Herpet

Snakes, lizards and frogs were caught and taken as voucher species and were identified. Snakes were caught by snake stick, lizards were shot by rubber bands, and frogs were collected in their roosting habitats. Some snakes were surveyed as interviewed methods.

(vii) Birds

Birds were recorded using the watching methods with the help of binoculars. Species identification was examined using the field guide books. Counting of bird number and habitat utilization were observed. Species richness and observed frequency were assessed for species diversity.

(viii) Mammals

Direct count method, remains of animal's body parts such as skin, spines, antlers, etc.

Footprints and interviewed methods were used for mammal survey.

(3) Data analysis

Relative abundance

The recorded data was analyzed as follows after Bisht *et al*., 2004:

$$\text{Relative abundance} = \frac{\text{No. of individuals of a species}}{\text{No. of individuals of all species}}$$

The average relative abundance was categorized adopted by Bisht *et al*. (2004)

uC = uncommon having relative abundance of less than 0.0100

C = common having relative abundance of 0.0100 and above but less than 0.0500

vC = very common having relative abundance of 0.0500 and above

Diversity

The relative diversity (RDi) of families was calculated using the following formula (Torre-Cuadros *et al.,* 2007):

$$\text{RDi} = \frac{\text{No. of species in a family}}{\text{Total number of species}} \times 100$$

(4) Identification

Birds were identified following Symthies (2001) and Robson (2015). Mammals were identified followed after by according to mentioned references, U Tun Yin (1993) and Francis C.M, (2008). Identification and classification of herptiles followed after Smith (1935, 1943), Das (2010) and Guraraja (2010). Identification and classification of insect species were classified according to Hill (1983), Ghosh (1940), Pathak and Khan (1994) and Borror and Delong (1964). Plant species were checked against Handley and Chit Ko Ko (1987), Kress *et al*. (2003) and consulted with Department of Botany, Yadanabon University.

Plate 2 Identification for some species

(5) Observation and Results

64 species of flora belong to 54 genera under 40 families were recorded. Among them, 56 species are trees, 6 species are climbers, 4 species are herbs, 3 species are shrub, 1species is bamboo and also 1 species is grass. In fauna recorded, there are 89 species belonging to ; among these, 22 species are insects, 4 species are fishes, 1 species is crab, 10 species are herpet, 37 species are bird and 5 species are mammals.

5.5.10.1. Flora

In the study area, the highest dominant of flora were covered by paddy field and follower after Mango and banana orchards and some are gardens.

Paddy field

Mango orchard

Thapay garden Banana and Gandama garden

Figure - Occurrence of plant species at study sites

Table - List of flora species and types of plant in study area

No.	Family	Scientific name	Myanmar name	Types
1	I. Anacrdiaceae	*Mangifera india* L.	Thayet	Tree
2		*Lannea coromandelica* L.	Nabe	Tree
3	II. Caesalpiniaceae	Tamarindus indica L.	Magyi	Tree
4		*Cassia fistula*	Ngu	Tree
5		*Delonix regia*	Sein-ban	Tree
6		*Bauhinia acuminata*	Swe-daw	Tree
7	III. Moraceae	*Ficus glomerata*	Thapan	Tree
8		*Ficus sp.*	Nyaung	Tree
9		*Artocarpus heterophyllus*	Peinne	Tree
10		*Streblus asper L.*	Ownne	Tree
11	IV. Combretaceae	*Terminalia oliveri*	Than	Tree
12		*Terminalia belerica*	Thit-Seint	Tree
13		*Terminalia catappa*	Banda	Tree
14	V. Verbenaceae	*Tectona hamiltoniana*	Dahat	Tree
15		*Tectona grandis*	Kyun	Tree
16	VI. Euphorbiaceae	*Phyllanthus emblica*	Zee byu	Tree
17		*Phyllanthus distichus*	Thin baw Zee Pyu	Tree
18		*Ricinus communis*	Kyetsu	Tree
19	VII. Arecaceae	*Cocos nucifera*	Ohn	Tree
20		*Borassus flabellifer L.*	Htan	Tree
21		*Arenga nana*	Yone	Tree
22	VIII. Annonaceae	*Carica papaya*	Thin baw pin	Tree
23	IX. Averrhoaceae	*Averrhoa carambola*	Zaung-yar	Tree
24	X. Meliaceae	*Chukrasia tabularis*	Yinma	Tree
25		*Azadirachta indica*	Tama	Tree
26		*Swietenia macrohyplla*	Mahogany	Tree
27	X. Fabaceae	*Pterocarpus macrocarpus L.*	Paduck	Tree
28	XII. Mimosaceae	*Leucaena Leucocephala*	Bawzagaing Aweya	Tree
29		*Acacia leucophloea L.*	Htanaung	Tree
30		*Albizzia lebbek Benth*	Kokko	Tree
31		*Abarema clypearia L.*	Mezali	Tree
32		*Pithecellobium dulce L.*	Ta yoke mangyi	Tree
33	XIII. Olacaceae	*Hesperethusa crenulata L.*	Thanakhar	Tree
34	XIV. Myrtaceae	*Psidium acidum*	Malaka	Tree
35		*Eugeniapractermissa L.*	Thapyay	Tree

36	XV. Bignoniaceae	*Iroxylum indicum*	Kyaung sha	Tree
37	XVI. Dipterocarpaceae	*Shorea siamensis*	Ingyin	Tree
38	XVII. Moringaceae	*Moringa oleferaa*	Dant tha lon	Tree
39	XVIII. Rhamnaceae	*Zizyphus mauritiana*	Zi	Tree
40		*Ziziphus jujuba L.*	Zi	Tree
41	XIX. Sapotaceae	*Mimusops elengi*	Khayay	Tree
42		*Sideroxylon burmanicum*	Thit-cho	Tree
43	XX. Boraginaceae	*Cordia dichotoma*	Thanat pin	Tree
44	XXI. Oleaceae	*Schrebera swietenioides*	Taw-gwebyu	Tree
45	XXII. Bombacaceae	*Bomasc ceiba L.*	Lappan	Tree
46	XXIII. Tiliaceae	*Corchorus capsularis L.*	Chawphyu	Tree
47	XXIV. Combretaceae	*Combretu acuminatum*	Nabu	Climber
48	XXV. Nyctaginaceae	*Bougainvillea glabra L.*	Sekkupan	Climber
49	XXVI. Papilionaceae	*Abrus precatorius L.*	Zinywe	Climber
50	XXVII. Connaraceae	*Cnestis ramiflora L.*	Kawetout	Climber
51	XXVIII. Cucurbitaceae	*Trichosanthes bracteata*	Kyi-arh	Climber
52		*Momordica dioca*	Kyet-hin-ga	Climber
53	XXIX. Aizoaceae	*Trianthema secandra*	Payan-na-war	Herb
54	XXX. Musaceae	*Musa sapientum*	Taw-nga-pyaw	Herb
55	XXXI. Verbenaceae	*Clerodendrum macrosiphon L.*	Ngayanpadu	Herb
56	XXXII. Euphorbiaceae	*Croton tiglium L.*	Kanaso	Herb
57	XXXIII. Asteraceae	*Ismelia versicolor*	Gandama	Herb
58	XXXIV. Scrophulariaceae	*Scoparia dulcis L.*	Thagar	Shrub
59	XXXV. Malvacea	*Uerna lobata*	Wetchi-pane	Shrub
60	XXXVI. Solanaceae	*Physalis minima L.*	Bauk	Shrub
61	XXXVII. Poaceae	*Bamvusa tuldoides*	War	Bamboo
62	XXXVIII. Muscaceae	*Musa* spp.	Nget-pyaw	Banana
63	XXXIX. Graminae	*Cynodon dactylon*	Myesa-myet	Grass
64	XXXX. Cyperaceae	*Carex nubigena*	Myet-monnyin	

Tree = 56 species; Climber= 6 species; Herb= 5 species; Shrub = 3 species; Bamboo = 1 species; Banana = 1 species Grass =2 species

Composition and Abundance of Plant Species

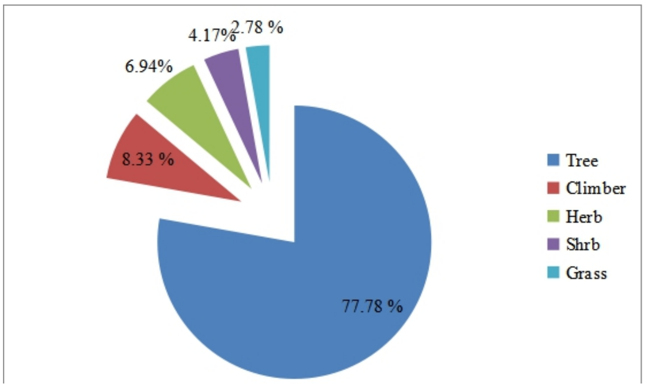

4.17%
2.78 %
6.94%
8.33 %
77.78 %
Tree
Climber
Herb
Shrb
Grass

Table - Occurrence and abundance of recorded plant species

No.	Scientific name	Myanmar name	Site I	Site II	Site III	Site IV	Site V	Site VI	Total	Abundance	Relative Abundance
1	*Mangifera india* L.	Thayet	18	200	280	20	40	17	575	0.351	vC
2	*Lannea coromandelica* L.	Nabe	0	0	0	0	12	4	16	0.010	C
3	Tamarindus indica L.	Magyi	8	0	0	2	9	0	19	0.012	C
4	*Cassia fistula*	Ngu	0	0	0	0	0	6	6	0.004	uC
5	*Delonix regia*	Sein-ban	4	0	0	0	8	6	18	0.011	C
6	*Bauhinia acuminata*	Swe-daw	2	0	0	0	6	4	12	0.007	uC
7	*Ficus glomerata*	Thapan	0	0	0	0	1	7	8	0.005	uC
8	*Ficus sp.*	Nyaung	1	2	0	0	2	3	8	0.005	uC
9	*Artocarpus heterophyllus*	Peinne	0	0	0	2	0	6	8	0.005	uC
10	*Streblus asper L.*	Ownne	0	0	0	0	0	3	3	0.002	uC
11	*Terminalia oliveri*	Than	0	0	0	0	0	8	8	0.005	uC
12	*Terminalia belerica*	Thit-Seint	0	0	0	0	0	3	3	0.002	uC
13	*Terminalia catappa*	Banda	3	2	4	0	0	4	13	0.008	uC
14	*Tectona hamiltoniana*	Dahat	0	0	0	0	0	2	2	0.001	uC
15	*Tectona grandis*	Kyun	0	0	0	0	0	8	8	0.005	uC
16	*Phyllanthus emblica*	Zee byu	0	0	0	0	1	3	4	0.002	uC
17	*Phyllanthus distichus*	Thin baw Zee Pyu	0	0	0	0	0	2	2	0.001	uC
18	*Ricinus communis*	Kyetsu	0	0	0	0	0	4	4	0.002	uC
19	*Cocos nucifera*	Ohn	2	1	0	2	1	3	9	0.005	uC
20	*Borassus flabellifer L.*	Htan	0	0	3	2	0	0	5	0.003	uC
21	*Arenga nana*	Yone	0	0	0	0	0	2	2	0.001	uC
22	*Carica papaya*	Thin baw pin	6	5	2	3	0	4	20	0.012	C
23	*Averrhoa carambola*	Zaung-yar	0	0	0	0	0	2	2	0.001	uC
24	*Chukrasia tabularis*	Yinma	0	0	0	0	0	3	3	0.002	uC

25	*Azadirachta indica*	Tama	3	1	5	2	1	8	20	0.012	C
26	*Swietenia macrohyplla*	Mahogany	0	0	0	0	0	1	1	0.001	uC
27	*Pterocarpus macrocarpus L.*	Paduck	3	0	0	0	1	5	9	0.005	uC
28	*Leucaena Leucocephala*	Bawzagaing Aweya	6	2	3	5	1	8	25	0.015	C
29	*Acacia leucophloea L.*	Htanaung	2	0	0	0	1	3	6	0.004	uC
30	*Albizzia lebbek Benth*	Kokko	3	2	1	2	1	4	13	0.008	uC
31	*Abarema clypearia L.*	Mezali	1	2	3	4	1	6	17	0.010	C
32	*Pithecellobium dulce L.*	Ta yoke mangyi	1	2	2	1	0	0	6	0.004	uC
33	*Hesperethusa crenulata L.*	Thanakhar	0	0	0	0	1	0	1	0.001	uC
34	*Psidium acidum*	Malaka	3	0	0	0	0	4	7	0.004	uC
35	*Eugeniapractermissa L.*	Thapyay	3	24	20	80	14	8	149	0.091	vC
36	*Iroxylum indicum*	Kyaung sha	0	0	0	0	0	8	8	0.005	uC
37	*Shorea siamensis*	Ingyin	0	0	0	0	0	4	4	0.002	uC
38	*Moringa oleferaa*	Dant tha lon	2	4	10	18	9	11	54	0.033	C
39	*Zizyphus mauritiana*	Zi	4	1	3	8	2	6	24	0.015	C
40	*Ziziphus jujuba L.*	Zi	0	0	0	0	0	6	6	0.004	uC
41	*Mimusops elengi*	Khayay	0	0	0	0	2	3	5	0.003	uC
42	*Sideroxylon burmanicum*	Thit-cho	0	0	0	0	0	1	1	0.001	uC
43	*Cordia dichotoma*	Thanat pin	0	0	0	0	0	1	1	0.001	uC
44	*Schrebera swietenioides*	Taw-gwebyu	0	0	0	0	0	2	2	0.001	uC
45	*Bomasc ceiba L.*	Lappan	3	2	6	1	4	8	24	0.015	vC
46	*Corchorus capsularis L.*	Chawphyu	2	0	0	6	0	0	8	0.005	uC
47	*Combretu acuminatum*	Nabu	0	0	0	0	3	3	6	0.004	uC
48	*Bougainvillea glabra L.*	Sekkupan	0	0	0	1	0	3	4	0.002	uC
49	*Abrus precatorius L.*	Zinywe	0	0	0	0	2	1	3	0.002	uC
50	*Cnestis ramiflora L.*	Kawetout	0	0	2	1	1	2	6	0.004	uC
51	*Trichosanthes bracteata*	Kyi-arh	0	0	0	0	1	1	2	0.001	uC

52	*Momordica dioca*	Kyet-hin-ga	2	1	1	3	0	1	8	0.005	uC
53	*Trianthema secandra*	Payan-na-war	0	0	0	0	0	3	3	0.002	uC
54	*Musa sapientum*	Taw-nga-pyaw	0	0	0	0	0	2	2	0.001	uC
55	*Clerodendrum macrosiphon L.*	Ngayanpadu	0	0	0	10	0	0	10	0.006	uC
56	*Croton tiglium L.*	Kanaso	0	0	0	0	0	3	3	0.002	uC
57	*Ismelia versicolor*	Gandama	0	0	0	350	0	0	350	0.213	vC
58	*Scoparia dulcis L.*	Thagar	0	0	0	2	1	0	3	0.002	uC
59	*Uerna lobata*	Wetchi-pane	0	0	0	0	0	4	4	0.002	uC
60	*Physalis minima L.*	Bauk	0	0	0	2	0	0	2	0.001	uC
61	*Bamvusa tuldoides*	War	0	0	0	0	0	3	3	0.002	uC
62	*Musa* spp.	Nget-pyaw	8	3	4	40	0	10	65	0.040	vC
63	*Cynodon dactylon*	Myesa-myet								0.000	vC
64	*Carex nubigena*	Myet-monnyin	8	9	0	0	0	0	17	0.010	C
			98	263	349	567	126	237	1640		

Table - Composition of plant species recorded

No.	Scientific name	Myanmar name	Site I	Site II	Site III	Site IV	Site V	Site VI	Total	% Composition
1	*Mangifera india* L.	Thayet	18	200	280	20	40	17	575	35.061
2	*Lannea coromandelica* L.	Nabe	0	0	0	0	12	4	16	0.976
3	Tamarindus indica L.	Magyi	8	0	0	2	9	0	19	1.159
4	*Cassia fistula*	Ngu	0	0	0	0	0	6	6	0.366
5	*Delonix regia*	Sein-ban	4	0	0	0	8	6	18	1.098
6	*Bauhinia acuminata*	Swe-daw	2	0	0	0	6	4	12	0.732
7	*Ficus glomerata*	Thapan	0	0	0	0	1	7	8	0.488
8	*Ficus sp.*	Nyaung	1	2	0	0	2	3	8	0.488
9	*Artocarpus heterophyllus*	Peinne	0	0	0	2	0	6	8	0.488
10	*Streblus asper L.*	Ownne	0	0	0	0	0	3	3	0.183

11	*Terminalia oliveri*	Than	0	0	0	0	0	8	8	0.488
12	*Terminalia belerica*	Thit-Seint	0	0	0	0	0	3	3	0.183
13	*Terminalia catappa*	Banda	3	2	4	0	0	4	13	0.793
14	*Tectona hamiltoniana*	Dahat	0	0	0	0	0	2	2	0.122
15	*Tectona grandis*	Kyun	0	0	0	0	0	8	8	0.488
16	*Phyllanthus emblica*	Zee byu	0	0	0	0	1	3	4	0.244
17	*Phyllanthus distichus*	Thin baw Zee Pyu	0	0	0	0	0	2	2	0.122
18	*Ricinus communis*	Kyetsu	0	0	0	0	0	4	4	0.244
19	*Cocos nucifera*	Ohn	2	1	0	2	1	3	9	0.549
20	*Borassus flabellifer L.*	Htan	0	0	3	2	0	0	5	0.305
21	*Arenga nana*	Yone	0	0	0	0	0	2	2	0.122
22	*Carica papaya*	Thin baw pin	6	5	2	3	0	4	20	1.220
23	*Averrhoa carambola*	Zaung-yar	0	0	0	0	0	2	2	0.122
24	*Chukrasia tabularis*	Yinma	0	0	0	0	0	3	3	0.183
25	*Azadirachta indica*	Tama	3	1	5	2	1	8	20	1.220
26	*Swietenia macrohyplla*	Mahogany	0	0	0	0	0	1	1	0.061
27	*Pterocarpus macrocarpus L.*	Paduck	3	0	0	0	1	5	9	0.549
28	*Leucaena Leucocephala*	Bawzagaing Aweya	6	2	3	5	1	8	25	1.524
29	*Acacia leucophloea L.*	Htanaung	2	0	0	0	1	3	6	0.366
30	*Albizzia lebbek Benth*	Kokko	3	2	1	2	1	4	13	0.793
31	*Abarema clypearia L.*	Mezali	1	2	3	4	1	6	17	1.037
32	*Pithecellobium dulce L.*	Ta yoke mangyi	1	2	2	1	0	0	6	0.366
33	*Hesperethusa crenulata L.*	Thanakhar	0	0	0	0	1	0	1	0.061
34	*Psidium acidum*	Malaka	3	0	0	0	0	4	7	0.427
35	*Eugeniapractermissa L.*	Thapyay	3	24	20	80	14	8	149	9.085
36	*Iroxylum indicum*	Kyaung sha	0	0	0	0	0	8	8	0.488
37	*Shorea siamensis*	Ingyin	0	0	0	0	0	4	4	0.244

38	*Moringa oleferaa*	Dant tha lon	2	4	10	18	9	11	54	3.293
39	*Zizyphus mauritiana*	Zi	4	1	3	8	2	6	24	1.463
40	*Ziziphus jujuba L.*	Zi	0	0	0	0	0	6	6	0.366
41	*Mimusops elengi*	Khayay	0	0	0	0	2	3	5	0.305
42	*Sideroxylon burmanicum*	Thit-cho	0	0	0	0	0	1	1	0.061
43	*Cordia dichotoma*	Thanat pin	0	0	0	0	0	1	1	0.061
44	*Schrebera swietenioides*	Taw-gwebyu	0	0	0	0	0	2	2	0.122
45	*Bomasc ceiba L.*	Lappan	3	2	6	1	4	8	24	1.463
46	*Corchorus capsularis L.*	Chawphyu	2	0	0	6	0	0	8	0.488
47	*Combretu acuminatum*	Nabu	0	0	0	0	3	3	6	0.366
48	*Bougainvillea glabra L.*	Sekkupan	0	0	0	1	0	3	4	0.244
49	*Abrus precatorius L.*	Zinywe	0	0	0	0	2	1	3	0.183
50	*Cnestis ramiflora L.*	Kawetout	0	0	2	1	1	2	6	0.366
51	*Trichosanthes bracteata*	Kyi-arh	0	0	0	0	1	1	2	0.122
52	*Momordica dioca*	Kyet-hin-ga	2	1	1	3	0	1	8	0.488
53	*Trianthema secandra*	Payan-na-war	0	0	0	0	0	3	3	0.183
54	*Musa sapientum*	Taw-nga-pyaw	0	0	0	0	0	2	2	0.122
55	*Clerodendrum macrosiphon L.*	Ngayanpadu	0	0	0	10	0	0	10	0.610
56	*Croton tiglium L.*	Kanaso	0	0	0	0	0	3	3	0.183
57	*Ismelia versicolor*	Gandama	0	0	0	350	0	0	350	21.341
58	*Scoparia dulcis L.*	Thagar	0	0	0	2	1	0	3	0.183
59	*Uerna lobata*	Wetchi-pane	0	0	0	0	0	4	4	0.244
60	*Physalis minima L.*	Bauk	0	0	0	2	0	0	2	0.122
61	*Bamvusa tuldoides*	War	0	0	0	0	0	3	3	0.183
62	*Musa* spp.	Nget-pyaw	8	3	4	40	0	10	65	3.963
63	*Carex nubigena*	Myet-monnyin	8	9	0	0	0	0	17	1.037
			98	263	349	567	126	237	1640	

Diversity of Plants

Table - Diversity of plant species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	Total no. species	Rdi
1	Anacrdiaceae	2	3.13
2	Caesalpiniaceae	4	6.25
3	Moraceae	4	6.25
4	Combretaceae	3	4.69
5	Verbenaceae	2	3.13
6	Euphorbiaceae	3	4.69
7	Arecaceae	3	4.69
8	Annonaceae	1	1.56
9	Averrhoaceae	1	1.56
10	Meliaceae	3	4.69
11	Fabaceae	1	1.56
12	Mimosaceae	5	7.81
13	Olacaceae	1	1.56
14	Myrtaceae	2	3.13
15	Bignoniaceae	1	1.56
16	Dipterocarpaceae	1	1.56
17	Moringaceae	1	1.56
18	Rhamnaceae	2	3.13
19	Sapotaceae	2	3.13
20	Boraginaceae	1	1.56
21	Oleaceae	1	1.56
22	Bombacaceae	1	1.56
23	Tiliaceae	1	1.56
24	Combretaceae	1	1.56
25	Nyctaginaceae	1	1.56
26	Papilionaceae	1	1.56
27	Connaraceae	2	3.13
28	Cucurbitaceae	1	1.56
29	Aizoaceae	1	1.56
30	Musaceae	1	1.56
31	Verbenaceae	1	1.56
32	Euphorbiaceae	1	1.56
33	Asteraceae	1	1.56
34	Scrophulariaceae	1	1.56
35	Malvacea	1	1.56
36	Solanaceae	1	1.56
37	Poaceae	1	1.56

38	Muscaceae	1	1.56
39	Graminae	1	1.56
40	Cyperaceae	1	1.56
	Total no. of species	64	

Conservation Status

Table - Plant species found in Myanmar assessed on the IUCN Red List of Threatened Species

No.	Scientific name	Common name	Category	Occurrence of study area	
				Present	Absent
1	*Anisoptera scaphula*		CR		
2	*Dipterocarpus baudii*		CR		-
3	*Dipterocarpus dyeri*		CR		-
4	*Dipterocarpus gracilis*		CR		-
5	*Dipterocarpus grandifloras*		CR		-
6	*Dipterocarpus kerrii*		CR		-
7	*Dipterocarpus turbinatus*		CR		-
8	*Hopea apiculata*		CR		-
9	*Hopea helferi*		CR		-
10	*Hopea sangal*		CR		-
11	*Magnolia gustavii*		CR		-
12	*Nardostachys jatamansi*	Spikenard/muskroot	CR		-
13	*Parashorea stellata*	White Seraya	CR		-
14	*Shorea farinose*		CR		-
15	*Sonneratia griffithii*		CR		-
16	*Vatica lanceaefolia*		CR		-
17	*Afzelia xylocarpa*		CR		-
18	*Anisoptera costata*		EN		-
19	*Cleidiocarpon laurinum*		EN		-
20	*Cypripedium lichiangense*		EN		-
21	*Dalbergia oliveri*		EN		-
22	*Dipterocarpus a latus*		EN		-
23	*Dipterocarpus costatus*		EN		-

24	*Heritiera fomes*		EN	-
25	*Hopea ferrea*		EN	-
26	*Illicium gritfithii*		EN	-
27	*Magnolia rostrata*		EN	-
28	*Paphiopedilum areeanum*		EN	-
29	*Paphiopedilum bellatulum*	Enchanting Paphiopedilum	EN	-
30	*Paphiopedilum charlesworthii*	Charlesworth Paphiopedilum	EN	-
31	*Paphiopedilum concolor*	One Colored Paphiopedilum	EN	-
32	*Paphiopedilum insigne*	Splendid Paphiopedilum	EN	-
33	*Paphiopedilum parishii*	Parish's Paphiopedilum-	EN	-
34	*Paphiopedilum spicerianum*	Spicer's Paphiopedilum	EN	-
35	*Paphiopedilum wardii*	Ward's Paphiopedilum	EN	-
36	*Shorea gratissima*		EN	-
37	*Shorea henryana*	White Meranti	EN	-
38	*Shorea roxburghii*	White Meranti	EN	-
39	*Taxus wallichiana*	East Himalayan Yew, Himalayan Yew	EN	-
40	*Vatica cinerea*		EN	-
41	*Aquilaria malaccensis*	Agarwood, Aloewood, Eaglewood, Lign-aloes	VU	-
42	*Burretiodendron esquirolii*		VU	-
43	*Cayratia pedata*		VU	-
44	*Cephalotaxus mannii*	Mann's Yew Plum	VU	-
45	*Cleidiocarpon cavaleriei*		VU	-
46	*Curcuma candida*		VU	-
47	*Cycas pectinate*		VU	-
48	*Cycas siamensis*		VU	-
49	*Dipterocarpus retusus*		VU	-
50	*Eleiotis rottleri*		VU	-
51	*Halophila beccarii*	Ocean Turf Grass, Species code: Hb	VU	-
52	*Hopea griflithii*		VU	-

53	*Hopea odorata*		VU	-
54	*Intsia bijuga*	Borneo Teak, Moluccan Ironwood	VU	-
55	*Magnolia nitida*		VU	-
56	*Paphiopedilum hirsutissimum*	Shaggy Paphiopedilum	VU	-
57	*Paphiopedilum villosum*	Villose Paphiopedilum	VU	-
58	*Picea brachytyla*	Sargent's Spruce	VU	-
59	*Picea farreri*	Farrer's Spruce	VU	-
60	*Pterocarpus indicus*	Amboyna Wood, Burmese Rosewood	VU	-
61	*Taiwania cryptomerioides*	Coffin Tree, Taiwan Cedar, Tai	VU	-

- Absent; CR = Critical Endanger , EN = Endanger species; VU = Vulnerable Species

Plate 1 Occurrence of some plant species

Zizyphus mauritiana Zi

Tamarindus indica L. Magyi

Pithecellobium dulce L.,Ta yoke mangyi

Leucaena Leucocephala, Bawzagaing Aweya

Phyllanthus emblica, Zee byu

Bomasc ceiba L. Lappan

Evaluation of Biomass along railway Bridge and Culverts

Forest acts an important part of the global cycle, storing carbon in both trees and soil. The large quantity of woody tissue of a tree in forest can accumulate the highest carbon density of all living things. The world forest is prominent sites to study of climate change, not only in terms of total net carbon emission but also in term of global storage capacity. Therefore this study focuses on carbon emissions but also in terms of aboveground biomass of different species. Aboveground biomass is an essential aspect of studies of carbon stocks and the effects of deforestation and carbon sequestration on the global carbon balance. Selected species that have been assessed were Tectona grandis (Teak), Xyliaxylo carpa (Pyinkadoe), Pterocarpus macrocarpus (Padauk), Pinus kesiya (Htinyu), Gmelina arborea (Yemane), Cassia mimosoides (Mezali), Vernicia fordii (Tansi), Quercus dealbata (Kywatsr), Amoora rohituk (Thitni), Neonauclea excels (Thitpayaung), Shorea obtuse (Thitya), Shorea siamensis (Ingyin), Terminalia crenulata (Taukkyant), Cephalostachyum pergracile (Tin-wa), Thyrsostachys oliveri (Thatnat-wa), Dendrocalamus strictus (Hmyin-wa), Bambusa tulda (Thaik-wa). For estimation of aboveground biomass, the first is to estimate wood volume of each species depending on the diameter at breast height (DBH) and tree height (H).

The mixed forest which has been focused on study area was established on Shan State and Mandalay region such as Kutkai, Hsipaw, Kyaukme, Nawnghkio and Pyin Oo Lwin. Pterocarpus macrocarpus (Padauk) has received the highest value in volume while Bambusa tulda (Thaik-wa) has the lowest value. The DBH, tree height and values of volume for each species was described in the following table .

Table - Volume per stem (m^3) and biomass per stem (kg) of different species

No:	Species		DBH (cm)	Tree Height (m)	Volume/stem (m3)	Biomass (kg/stem)
	Common Name	Scientific Name				
1	Teak	Tectona garndis	25	20	0.412388	409.0059225
2	Pyinkadoe	Xylia xylocarpus	28	20	0.517299	513.0570292
3	Pakdauk	Pterocarpus macrocarpus	32	25	0.84457	837.6441293
4	Pine	Pinus kesiya	20	18	0.237535	235.5874114
5	Yemane	Gmelina arborea	22	18	0.287418	285.0607677
6	Mezali	Cassia mimosoides	25	15	0.309291	306.7544419

7	Tung si	Vernicia fordii	19	18	0.214376	212.6176388
8	Kywatsr	Quercus dealbata	15	25	0.185574	184.0526651
9	Thitni	Amoora rohituk	25	17	0.350529	347.6550341
10	Thitphayau ng	Neonauclea excelsa	24	20	0.380056	376.9398582
11	Thitya	Shorea obtuse	23	21	0.366497	363.4917434
12	Ingyin	Shorea siamensis	21	23	0.334628	331.8837658
13	Taukkyan	Terminalia crenulata	28	18	0.465569	461.7513263
14	Bamboo (Tin-wa)	Cephalostachyum pergracile	9.5	18	0.053594	53.15440969
15	Thanat_wa	Thyrsostachys oliveri	7	15	0.024248	24.04954824
16	Hmyin-wa	Dendrocalamus strictus	7	16	0.025865	25.65285146
17	Thaik-wa	Bambusa tulda	6.5	14	0.000462	0.458086633
18	Coffee		2	3.5	0.000462	0.458086633
19	Macadama		3	15	0.004454	4.417263963

Aboveground biomass of above species in which most of them is regarded as commercially important species in Myanmar such as Teak, Pyinkadoe, Padauk, Ingyin and Thitya. Among these species, Pterocarpus macrocarpus (Padauk) has the highest value of aboveground biomass. According to the result, Tectona grandis (Teak), Xyliaxylo carpa (Pyinkadoe), and Neonauclea excels (Thitpayaung) have high aboveground biomass so that they can be regarded as highly prioritized species for reforestation activities for railway projects. Aboveground biomass based on the tree was shown in the following figure.

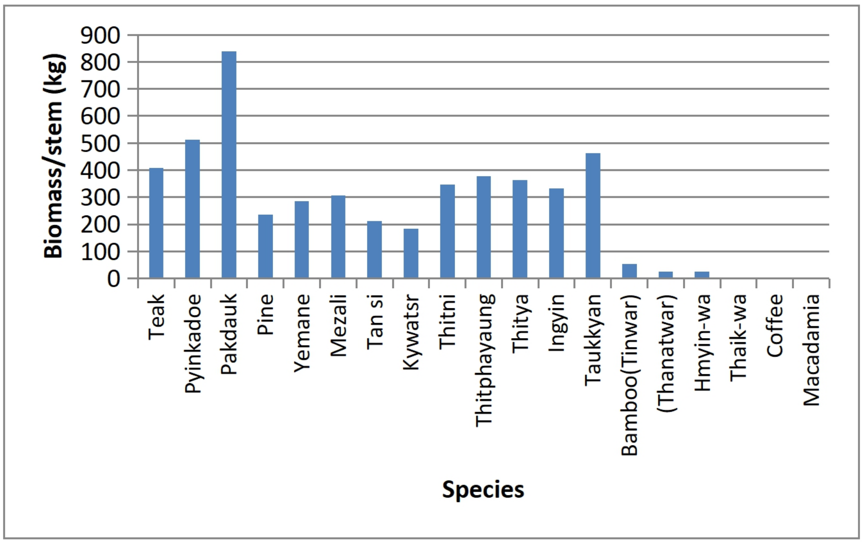


Figure - Comparison of above ground biomass of different species

According to the result, Hsipaw has the highest value of aboveground biomass having 4321kg, followed by Naung Cho has the second largest area having 2279kg, Pyin Oo Lwin has 1314kg, Kutkai has 940kg and Kyaukme has the smallest aboveground biomass 285 kg. In Hsipaw, Tansi, Padauk, Teak, Yemane, Mezali and Pyinkadoe are present and padauk has the largest aboveground biomass compared with the other. So, these species can be regarded as highly prioritized species for reforestation activities for railway project and padauk can be regarded as the most important species. Therefore, this native species can be replanted in appropriate area away from the railway or around the degraded forest and need to be reforestation with approximate amount. Aboveground biomass of bridge and culverts passing through the forest was represented in the following figure.

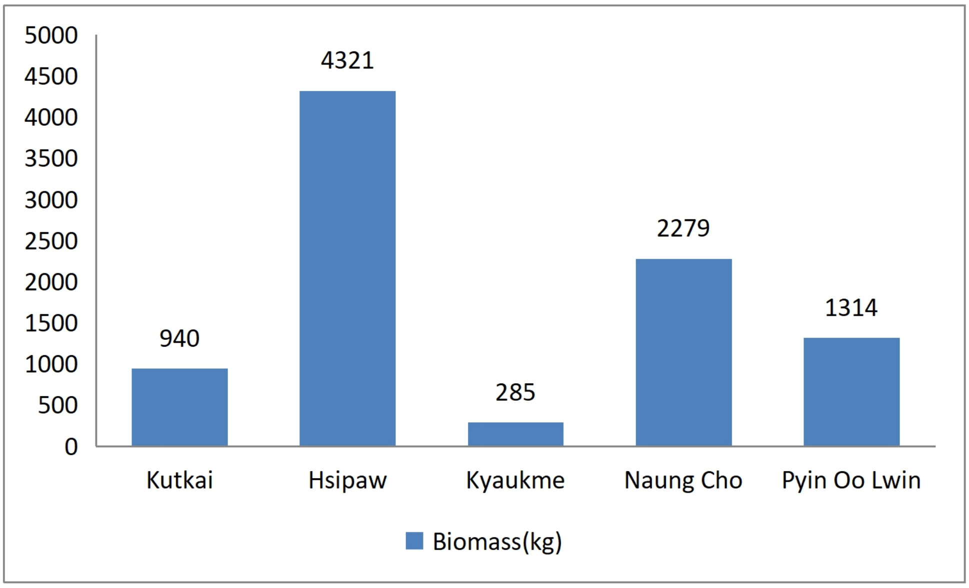


Figure - Comparison of above round biomass of study site passing the bridge and culverts

5.5.10.2. Fauna

Occurrence of fauna species at study sites

Table - List of recorded insect species from study area, Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
I	**Homoptera**			
1.	Cercopidae	*Philaenus spumarius*	Froghopper	-
2.	Cicadellidae	*Idioscopus nitidulus*	Mango Hopper	-

II	**Hemiptera**			
3.	Lygaeidae	*Graptostethus argentatus*	Graptostethus Bugs	-
4.	Coreinae	*Cletus bipunctatus*	The Squash Bugs	-
5.	Pseudococcidae	*Drosicha mangiferae*	Mango Mealy Bug	-
6.	Diaspididae	*Aulacaspis tuberculis*	Mango Scale	-
III	**Coleoptera**			
7.	Rhysodidae	*Rhysodes taprobanae*	Wrinkled Bark Beetle	-
8.	Cerambycidae	*Batocera rufomaculata*	Red-spotted Longhorn Beetle	-
9.		*Batocera rubus*	White-spotted Longhorn Beetle	-
10.		*Laccoptera quadrimaculata*	Tortoise Beetles	-
11.	Curculionidae	*Hypomeces squamosus*	Gold-dust Weevil	-
IV	**Hymenoptera**			
12.	Formicidae	*Formica rufa*	Wood ant	-
V	**Lepidoptera**			
13.	Papilionidae	*Papilio demoleus*	Lime Butterfly	-
14.		*Papilio polytes romulus*	Common Mormon	-
15.		*Papilio memnon agenor*	Great Mormon	-
16.	Pieridae	*Ixias pyrene*	The Great Orange Tip	-
17.		*Catopsilia pomona*	The Common Emigrant	-
18.		*Eurema hecabe*	The Common Grass Yellow	-
19.		*Eurema laeta*	The Spotless Grass Yellow	-
20.	Nymphalidae	*Junonia lemonias*	The Lemon Pansy	-
21.		*Phalantha phalantha*	The Sun Loving Butterfly	-
VI	**Odonata**			
22.	Gomphidae	*Ictinogonphus rapax*	Dragonfly	-

Table - List of recorded fish and crustacea species from study area, Armarapura and

Patheingyi at Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
Fish				
I	**Siluriformes**			
1.	Clariidae	*Clarias batrachus*	Magur	Nga-kun
II	**Perciformes**			
3.	Chanidae	*Channa punctatus*	Spotted snakehead	Nga-yant-pa-naw
4.		*Channa striatus*	Striped or Banded snakehead	Nga-yant-gaung-shay
Crustacea				
III	**Decapoda**			
5.	Parathelphusidae	*Paratelphusa hydrodromus*	Rice field crab	Pa-zun-lone

Table - List of recorded herpet species from study area, Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
Amphibian				
I	**Anura**			
1.	Bufonidae	*Dusttaphrynus melanostiauts*	Common toad	hpar-pyoke
2.	Dicroglossidae	*Fejervarya greenii boulenger*	Paddy frog	hpar-paung-zin
3.		*Fejervary liconocharis*	Paddy frog	kyaw-san-kay
4.	Microhylidae	*Kaloula pulchra*	Bull frog	hpar-kon-nyin
Reptile				
II	**Squamata**			
5.	Viperidae	*Daboia siamensis*	Viper	mwe-pwe
6.	Elpidae	*Naja* sp.	Cobra	Mywey-hauk
7.	Gekkonidae	*Gekko gecko*	House lizard	Totk-taet
8.		*Hemidactylus frenatus*	Asian House gecko	Eain-myaung
9.	Agamidae	*Calotes mystaceus*	Tree or ground lizard	poke-thin-nyo
10.	Scincidae	*Eutropis macularia*	Skink	king-lekk-shaw

Table - List of recorded bird species from study area, Armarapura and Patheingyi at

Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
I	**Ciconiiformes**			
1.	Ardeidae	*Ardeola bacchus**	Chinese Pond-heron	byaing-auk
2.		*Mesophoyx intermedia**	Intermediate Egret	tharrawaddy-byaing
3.	Bubulcus	*Bubulcus coromandus**	Cattle Egret	kywe-kyaung-byaing
4.	Alcedinidae	*Alcedo atthis**	Common Kingfisher	pain-nyin
II	**Suliformes**			
5.	Phalacrocoracidae	*Microcarvbo niger**	Little Commorant	aw-yaw
III	**Falconiformes**			
6.	Columbidae	*Columba livia*	Rock Pigeon	kho
7.		*Streptopelia tranquebarica*	Red-collared Dove	gyo-ni-pu
8.		*Spilopelia chinensis*	Spotted Dove	gyo-le-pyauk
9.		*Treron phoenicoptera*	Yellow-footed Green Pigeon	ngu
IV	**Psittaciformes**			
10.	Sturnidae	*Psittacula krameri*	Rose-ringed Parakeet	kyae-kyute
V	**Cuculiformes**			
11.	Centropdinae	*Centropus sinensis*	Greater Coucal	bok
VI	**Coraciiformes**			
12.	Meropidae	*Merops orientalis*	Green bee-eater	hnet-pa-sin-hto
13.	Upupa	*Upupa epops*	Common Hoopoe	bi-daung-bo
VII	**Piciformes**			
14.	Ramphastidae	*Megalaima haemacephala*	Coppersmith Barbet	hnget-padain
VIII	**Passeriformes**			
15.	Corvidae	*Corvus splendens*	House Crow	kyi-gan
16.	Sturnidae	*Acridotheres tristis*	Common Myna	zayet
17.		*Acridotheres javanicus*	White-vented Myna	Zayet-hpin-phyu
18.		*Acridotheres fuscus*	Jungle Myna	taw-zayet
19.	Pycnonotidae	*Pycnonotus caer*	Red-vented Bulbul	but-phin-ni
20.	Oriolidae	*Oriolus xanthornus*	Black-hooded oriole	hnet-wah
21.	Dicruridae	*Dicrurus macrocercus*	Black-Drongo	lin-me-swae
22.		*Dicrurus leucophaeus*	Ashy Drongo	lin-me-swae

23.	Corvidae	*Dendrocitta vagabunda*	Rufous Treepie	hna-phar-kyuu
24.		*Crypsiprinia cucullata*	Hooded Treepie	hna-phar-kyuu
25.	Aegithinidae	*Aegithina tiphia*	Common Iora	shwe-pyi-soe
26.	Laniidae	*Lanius collurioides*	Burmese Shrike	hnet-be-lue
27.		*Lanius cristatus*	Brown Shrike	wa-yon-hnget
28.	Nectarinidae	*Nectarinia asiatina*	Purple Sunbird	witye-soak-hnet
29.	Dicaeidae	*Dicaeum crueniatum*	Scarlet-backed Flowerpecker	-
30.	Plaeciodae	*Lonchura punctulata*	Scaly-breasted Munia	sar-wati
31.	Passeridae	*Passer domesticus*	House Sparrow	sar kalay
32.		*Passer montanus*	Eurasian Tree Sparrow	thit-pin-sar
33.	Estrildidae	*Lonchura punctulata*	Scaly-breasted Munia	sar-pauk
34.	Motacilla	*Motacilla alba*	White Wagtail	mye-nyaung-hnget
35.	Muscicapidae	*Saxicola caprata*	Pied Bushchat	
36.	Cisticolidae	*Prinia inornata*	Plane Prinia	hnget-let-ma
37.		*Orthotomus sutorius*	Common Tailorbird	hnan-pyi-soak

* Waterbirds; Order 8; Family 26; Waterbirds 5; Terrestrial birds 32

Table - List of recorded mammal species from study area, Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
I	**Primate**			
1.	Cercopithecidae	*Macaca mulatta*	Rhesus macaque	myaut-sat
II	**Rodentia**			
2.	Sciuridae	*Callosciurus erythreus*	Pallas's squirrel	shin-nga-paw
3.	Muridae	*Rattus rattus*	Black rat	kywet-net
4.	Chrioptera		Microbat	Lin-noe
5.			Macrobat	Lin-swe

Table - Occurrence and abundance of insect species recorded from Armapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Common name	Study sites						Total		
			I	II	III	IV	V	VI			
1	Philaenus spumarius	Froghopper	0	5	3	2	1	0	11	0.049	C
2	*Idioscopus nitidulus*	Mango Hopper	0	6	2	1	0	0	9	0.040	C
3	Graptostethus argentatus	Graptostethus Bugs	0	3	1	2	0	0	6	0.027	C
4	Cletus bipunctatus	The Squash Bugs	0	2	1	0	0	0	3	0.013	C
5	Drosicha mangiferae	Mango Mealy Bug	0	3	2	6	1	0	12	0.054	vC
6	Aulacaspis tuberculis	Mango Scale	0	4	2	6	2	0	14	0.063	vC
7	Rhysodes taprobanae	Wrinkled Bark Beetle	0	1	2	1	0	0	4	0.018	C
8	Batocera rufomaculata	Red-spotted Longhorn Beetle	0	2	1	1	0	0	4	0.018	C
9	Batocera rubus	White-spotted Longhorn Beetle	0	1	0	0	0	0	1	0.004	uC
10	Laccoptera quadrimaculata	Tortoise Beetles	0	1	1	0	0	0	2	0.009	uC
11	Hypomeces squamosus	Gold-dust Weevil	0	5	4	4	0	0	13	0.058	vC
12	Formica rufa	Wood ant	6	7	5	2	1	6	27	0.121	vC
13	Papilio demoleus	Lime Butterfly	2	1	3	4	1	2	13	0.058	vC
14	Papilio polytes romulus	Common Mormon	0	5	4	1	0	0	10	0.045	C
15	Papilio memnon agenor	Great Mormon	2	4	1	3	0	4	14	0.063	vC
16	Ixias pyrene	The Great Orange Tip	0	2	5	3	0	4	14	0.063	vC
17	Catopsilia pomona	The Common Emigrant	0	3	2	1	0	4	10	0.045	C
18	Eurema hecabe	The Common Grass Yellow	0	4	2	1	1	3	11	0.049	C
19	Eurema laeta	The Spotless Grass Yellow	0	2	2	1	1	3	9	0.040	C
20	Junonia lemonias	The Lemon Pansy	0	6	4	1	0	4	15	0.067	vC
21	Phalantha phalantha	The Sun Loving Butterfly	0	7	2	1	0	6	16	0.072	vC
22	*Ictinogonphus rapax*	Dragonfly	3	0	0	2	0	0	5	0.022	C
	Total no. of individuals		10	74	49	41	8	36	218		
	Total no. of species		3	21	20	18	8	9	21		

Table - Occurrence and abundance of fish and crustacea species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Common name	Study sites						Total	Abundance	Relative abundance
			I	II	III	IV	V	VI			
1	*Clarias batrachus*	Magur	1	1	0	0	0	0	2	0.154	vC
2	Channa punctatus	Spotted snakehead	1	2	0	0	0	0	3	0.231	vC
3	Channa striatus	Striped or Banded snakehead	2	1	0	0	0	0	3	0.231	vC
4	*Paratelphusa hydrodromus*	Rice field crab	1	2	1	1	0	0	5	0.385	vC
	Total no. of individuals		5	6	1	1	0	0	13		
	Total no. of species		4	4	1	1	0	0	4		

Table - Occurrence and abundance of herpet species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Common name	Study sites						Total	Abundance	Relative abundance
			I	II	III	IV	V	VI			
1	*Bufo bufo*	Common toad	1	0	2	0	1	0	4	0.154	vC
2	Fejervarya greenii boulenger	Paddy frog	1	0	0	0	0	0	1	0.038	vC
3	Fejervary liconocharis	Paddy frog	0	1	0	0	0	0	1	0.038	vC
4	Kaloula pulchra	Bull frog	+	+	+	+	-	-		QS	Questionnaires' Survey
5	Daboia siamensis	Viper	+	+	+	+	+	-		QS	-
6	Naja sp.	Cobra	+	+	+	+	+	+		QS	-
7	Gekko gecko	House lizard	2	0	1	0	2	1	6	0.231	vC
8	Hemidactylus frenatus	Asian House gecko	1	2	1	0	1	2	7	0.269	vC
9	Calotes mystaceus	Tree or ground lizard	1	0	0	1	1	1	4	0.154	vC
10	Eutropis macularia	Skink	1	0	0	1	0	1	3	0.115	vC
	Total no. of individuals		7	3	4	2	5	5	26		
	Total no. of species		9	6	6	5	6	5	10		

Table - Occurrence and abundance of bird species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Common name	Study sites						Total	Abundance	Relative Abundance
			I	II	III	IV	V	VI			
1	*Ardeola bacchus**	Chinese Pond-heron	3	0	0	3	0	0	6	0.025	C
2	*Mesophoyx intermedia**	Intermediate Egret	0	4	0	2	0	0	6	0.025	C
3	*Bubulcus coromandus**	Cattle Egret	1	0	4	0	0	0	5	0.020	C
4	*Alcedo atthis**	Common Kingfisher	1	0	0	0	0	0	1	0.004	uC
5	*Microcarvbo niger**	Little Commorant	1	0	0	0	0	0	1	0.004	uC
6	*Columba livia*	Rock Pigeon	2	0	0	0	0	5	7	0.029	C
7	*Streptopelia tranquebarica*	Red-collared Dove	0	0	0	0	0	2	2	0.008	uC
8	*Spilopelia chinensis*	Spotted Dove	6	5	3	6	1	15	36	0.148	vC
9	*Treron phoenicoptera*	Yellow-footed Green Pigeon	0	0	0	0	0	1	1	0.004	uC
10	*Psittacula krameri*	Rose-ringed Parakeet	2	0	0	0	0	0	2	0.008	uC
11	*Centropus sinensis*	Greater Coucal	0	0	0	0	1	0	1	0.004	uC
12	*Merops orientalis*	Green bee-eater	4	0	0	0	0	18	22	0.090	vC
13	*Upupa epops*	Common Hoopoe	0	0	0	0	0	3	3	0.012	vC
14	*Megalaima haemacephala*	Coppersmith Barbet	0	0	0	0	0	2	2	0.008	uC
15	*Corvus splendens*	House Crow	17	2	0	0	0	0	19	0.078	vC
16	*Acridotheres tristis*	Common Myna	4	0	0	0	0	0	4	0.016	C
17	*Acridotheres javanicus*	White-vented Myna	3	0	0	0	0	0	3	0.012	C
18	*Acridotheres fuscus*	Jungle Myna	6	0	0	0	0	0	6	0.025	C
19	*Pycnonotus caer*	Red-vented Bulbul	0	3	2	0	2	0	7	0.029	C
20	*Oriolus xanthornus*	Black-hooded oriole	0	0	0	0	0	1	1	0.004	uC
21	*Dicrurus macrocercus*	Black-Drongo	0	1	1	0	0	10	12	0.049	C
22	*Dicrurus leucophaeus*	Ashy Drongo	0	0	0	0	0	9	9	0.037	C
23	*Dendrocitta vagabunda*	Rufous Treepie	0	0	0	0	0	3	3	0.012	C

24	*Crypsiprinia cucullata*	Hooded Treepie	0	0	0	0	0	2	2	0.008	uC
25	*Aegithina tiphia*	Common Iora	0	0	0	1	0	11	12	0.049	C
26	*Lanius collurioides*	Burmese Shrike	0	0	0	0	1	4	5	0.020	C
27	*Lanius cristatus*	Brown Shrike	1	0	0	1	0	0	2	0.008	uC
28	*Nectarinia asiatina*	Purple Sunbird	0	0	0	0	0	0	4	0.016	C
29	*Dicaeum crueniatum*	Scarlet-backed	0	0	0	0	0	2	2	0.008	uC
30	*Lonchura punctulata*	Scaly-breasted Munia	3	0	0	0	0	0	3	0.012	C
31	*Passer domesticus*	House Sparrow	12	10	0	0	0	0	22	0.090	vC
32	*Passer montanus*	Eurasian Tree Sparrow	0	0	0	0	0	0	9	0.037	C
33	*Lonchura punctulata*	Scaly-breasted Munia	0	0	0	0	0	16	16	0.066	vC
34	*Motacilla alba*	White Wagtail	0	0	1	0	0	17	18	0.074	vC
35	*Saxicola caprata*	Pied Bushchat	1	0	0	0	0	0	1	0.004	uC
36	*Prinia inornata*	Plane Prinia	0	2	2	0	0	0	4	0.016	C
37	*Orthotomus sutorius*	Common Tailorbird	0	0	0	0	1	0	1	0.004	uC
	Total no. of individuals		67	27	13	13	6	121	247		
	Total no. of species		16	7	6	5	5	17	37		

* = waterbirds, uC = Uncommon, C = Common, vC = Very common

Waterbirds = 5 species ; Terrestrial birds = 32 species, uC = 13 species; C = 17 species ; vC = 7 species

Table - Occurrence and abundance of mammal species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Secific name	Common name	Study sites						Total	Abundance	Relative Abundance
			I	II	III	IV	V	VI			
1	*Macaca mulatta*	Rhesus macaque	0	0	0	0	0	20	20	0.690	vC
2	Callosciurus erythreus	Pallas's	2	1	3	0	0	1	7	0.241	vC
3	Rattus rattus	Black rat	1	1	0	0	0	0	2	0.069	vC
4		Microbat	+	+	+	+	+	+	QS		Questionnaires' Survey
5		Macrobat	+	+	+	+	+	+	QS		-
	Total no. of individuals		3	2	3	0	0	21	29		
	Total no. of species		4	4	3	2	2	4	5		

Composition and diversity

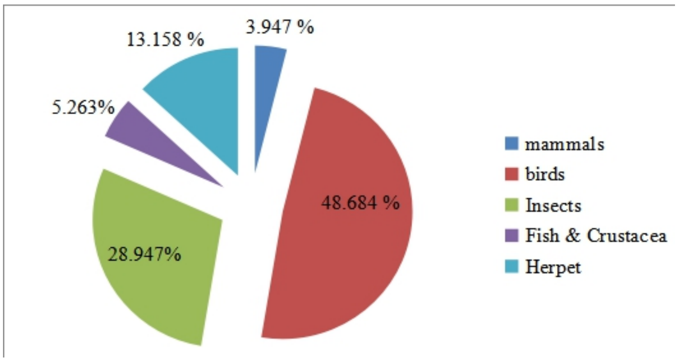


Figure - Species composition of mammals, birds, insects, fish & crustacea and herpet recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

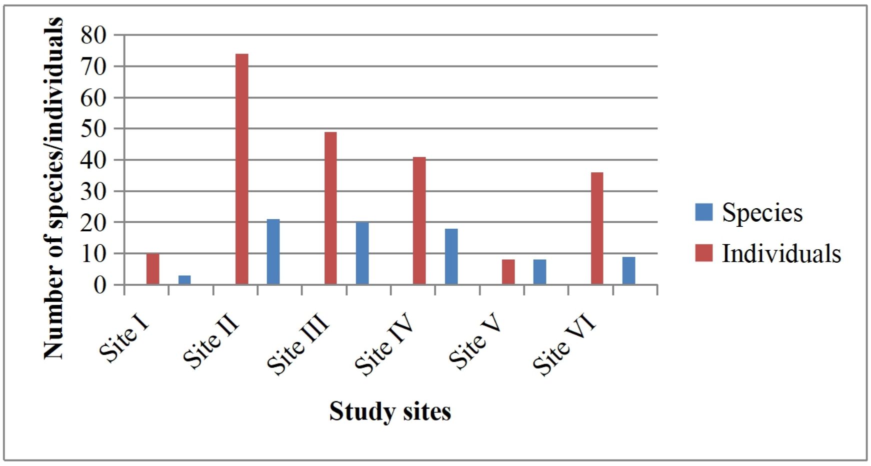


Figure - Composition of insect species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

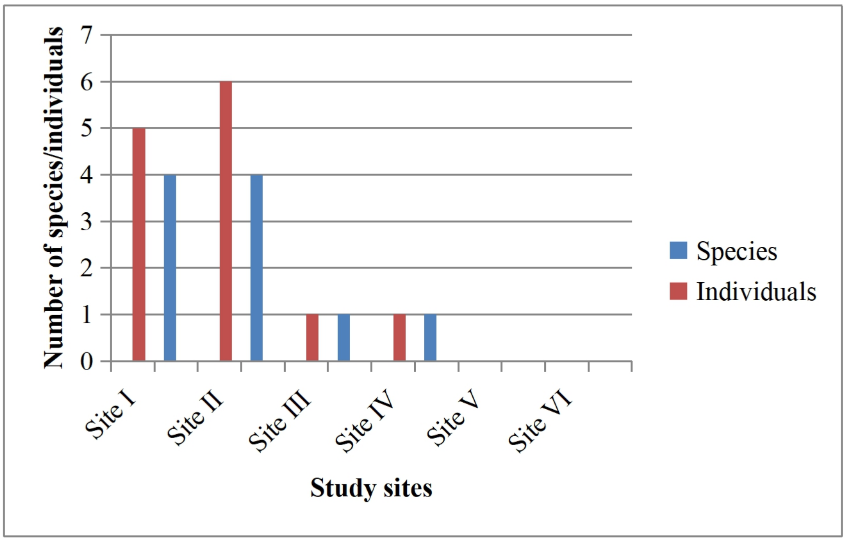


Figure - Composition of fish and crustacea species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

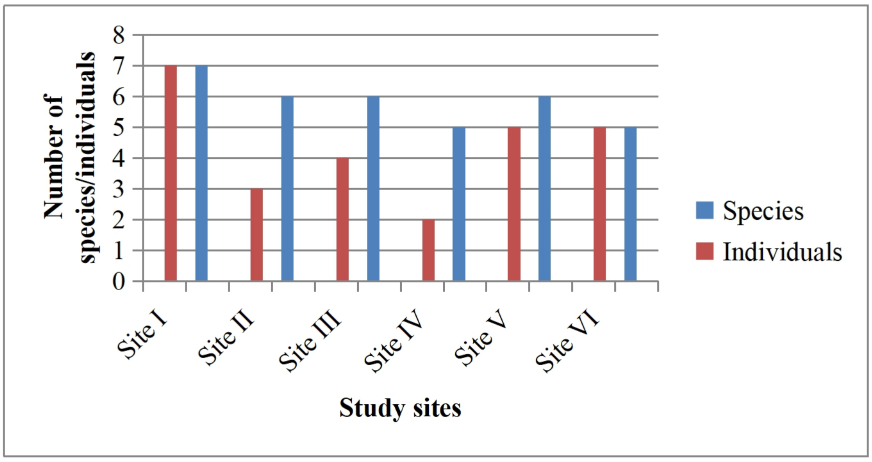


Figure - Composition of herpet species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

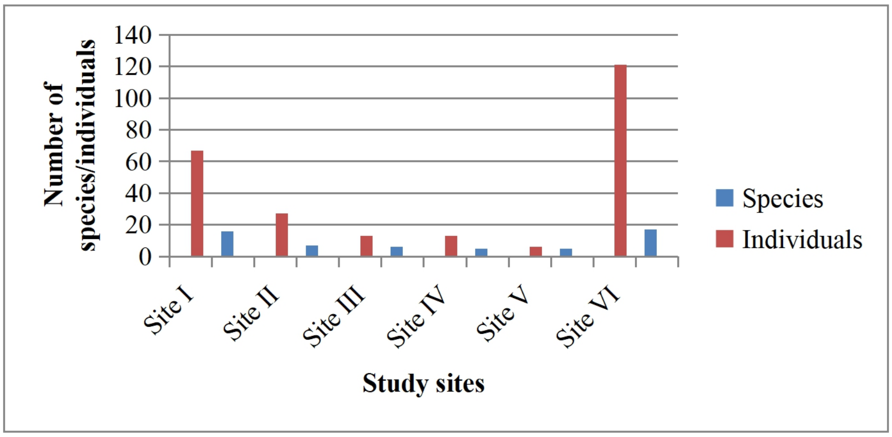


Figure - Composition of bird species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

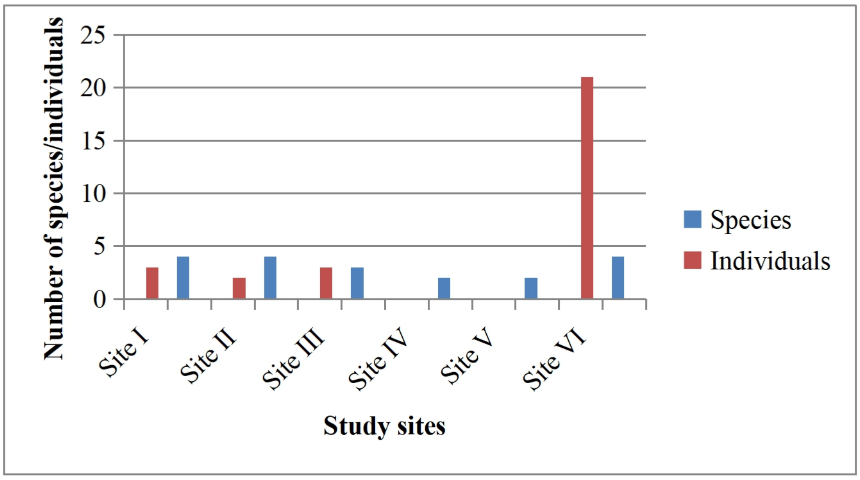


Figure - Composition of mammal species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

Diversity

Table - Diversity of insect species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi (%)
1.	Cercopidae	1	4.545
2.	Cicadellidae	1	4.545
3.	Lygaeidae	1	4.545
4.	Coreinae	1	4.545
5.	Pseudococcidae	1	4.545
6.	Diaspididae	1	4.545
7.	Rhysodidae	1	4.545
8.	Cerambycidae	3	13.636
9.	Curculionidae	1	4.545
10.	Formicidae	1	4.545
11.	Papilionidae	3	13.636
12.	Pieridae	4	18.182
13.	Nymphalidae	2	9.091
14.	Odonata	1	4.545
	Total no. of species	22	

Table - Diversity of insect species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi
1.	Clariidae	1	25
2.	Chanidae	2	50
3.	Parathelphusidae	1	25
	Total no. of species	4	

Table - Diversity of herpet species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi
1.	Bufonidae	1	10
2.	Dicroglossidae	2	20
3.	Microhylidae	1	10
4.	Viperidae	1	10
5.	Elpidae	1	10
6.	Gekkonidae	2	20
7.	Agamidae	1	10
8.	Scincidae	1	10
	Total no. of species	10	

Table - Diversity of bird species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi
1.	Ardeidae	2	5.405
2.	Bubulcus	1	2.703
3.	Alcedinidae	1	2.703
4.	Phalacrocoracidae	1	2.703
5.	Columbidae	4	10.811
6.	Sturnidae	1	2.703
7.	Centropdinae	1	2.703
8.	Meropidae	1	2.703
9.	Upupa	1	2.703
10.	Ramphastidae	1	2.703
11.	Corvidae	1	2.703
12.	Sturnidae	3	8.108
13.	Pycnonotidae	1	2.703
14.	Oriolidae	1	2.703
15.	Dicruridae	2	5.405
16.	Corvidae	2	5.405
17.	Aegithinidae	1	2.703
18.	Laniidae	2	5.405
19.	Nectarinidae	1	2.703
20.	Dicaeidae	1	2.703
21.	Plaeciodae	1	2.703
22.	Passeridae	2	5.405
23.	Estrildidae	1	2.703
24.	Motacilla	1	2.703
25.	Muscicapidae	1	2.703
26.	Cisticolidae	2	5.405
	Total no. of species	37	

Table - Diversity of mammal species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi
1.	Cercopithecidae	1	25
2.	Sciuridae	1	25
3.	Muridae	1	25
4.	Chrioptera	2	50
	Total no. of species	5	

Habitat Utilization and IUCN Conservation Status

Table - Conservation and Habitat utilization of insect species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Feeding	Occurrence sites	IUCN status
1	*Philaenus spumarius*	Feeding on the inflorescence and flowers	II, III, IV, V	-
2	*Idioscopus nitidulus*	piercing the tissues and sucking the plant sap	II, III, IV	-
3	*Graptostethus argentatus*	flowers and shoots, feeding on insect egg	II, III, IV	-
4	*Cletus bipunctatus*	Feed by sucking the sap from the leaves of mango	II, III	-
5	*Drosicha mangiferae*	Feed on leaves, especially on the flushes	II, III, IV, V	-
6	*Aulacaspis tuberculis*	suck the sap of leaves and other tender parts reducing vigor of plants	II, III, IV, V	-
7	*Rhysodes taprobanae*	Feed on terminal growth and larvae	II, III, IV	-
8	*Batocera rufomaculata*	Feed on boring long tunnels through branches and stems	II, III, IV	-
9	*Batocera rubus*	Feed and tunnel under the bark or into the wood	II	-
10	*Laccoptera quadrimaculata*	Feed by scraping the surface tissues of the leaves	II, III	-
11	*Hypomeces squamosus*	Feeding on the foliage of plants	II, III, IV	-
12	*Formica rufa*	Eat woody plants	All	-
13	*Papilio demoleus*	Feeding on flowering shrub	All	LC
14	*Papilio polytes romulus*	Feeding on flowering shrub	II, III, IV	LC
15	*Papilio memnon agenor*	Feeding on flowering shrub	I, II, III, IV,	LC

16	*Ixias pyrene*	Feeding on flowering shrub	II, III, IV	LC
17	*Catopsilia pomona*	Feeding on flowering shrub	II, III, IV	LC
18	*Eurema hecabe*	Feeding on flowering shrub	II, III, IV, V, VI	LC
19	*Eurema laeta*	Feeding on flowering shrub	II, III, IV, V, VI	LC
20	*Junonia lemonias*	Feeding on flowering shrub	II, III, IV, V, VI	LC
21	*Phalantha phalantha*	Feeding on flowering shrub	II, III, IV	LC
22	*Ictinogonphus rapax*	Dragonfly	I, IV	LC

Table - Conservation and habitat utilization of fish and crustacea species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Feeding	Habitat	IUCN status
1.	*Clarias batrachus*	Aquatic	Paddy field	LC
2.	Channa punctatus	-	-	LC
3.	Channa striatus	-	-	LC
4.	*Paratelphusa hydrodromus*	-	-	-

Table - Conservation and habitat utilization of herpet species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Feeding	Habitat	IUCN status
1.	*Bufo bufo*	invertebrates	open countryside, fields, copses, parks and gardens	LC
2.	*Fejervarya greenii boulenger*	Insects	Forest, wetland	-
3.	*Fejervary liconocharis*	Insects	Forest, wetland	-
4.	*Kaloula pulchra*	Insects	Forest, wetland, grassland	LC
5.	*Daboia siamensis*		Burrow or climb into shrubby trees	LC
6.	*Naja sp.*		dense or open forests,	LC

			plains, agricultural lands (rice paddy fields, wheat crops), rocky terrain, wetlands	
7.	*Gekko gecko*	insects	roaming walls and ceilings	LC
8.	*Hemidactylus frenatus*	insects	Savanna, desert, forest and rock areas.	LC
9.	*Calotes mystaceus*	Feeds on crickets, grasshoppers, moths, and other insects.	Forest, trees near city parks	NE, Not Evaluated
10.	*Eutropis macularia*	eating various types of insects		NE, Not Evaluated

Table - Conservation and habitat utilization of bird species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No	Secific name	Common name	Feeding	Habitat	IUCN Status
1	*Ardeola bacchus**	Chinese Pond-heron	insects, fish, crustaceans	wetlands, ponds	LC
2	*Mesophoyx intermedia**	Intermediate Egret	insects, fish, frogs, crustaceans	wetlands, ponds	LC
3	*Bubulcus coromandus**	Cattle Egret	insects, spiders, frogs, earthworm	Woodland, near lakes, rivers, in swamps	LC
4	*Alcedo atthis**	Common Kingfisher	aquatic insects, fish, water beetles	slow-flowing streams and rivers, and lakes with well-vegetated banks.	LC
5	*Microcarvbo niger**	Little Commorant	mainly fish	Ponds and lakes	LC
6	*Columba livia*	Rock Pigeon	scavengers, and frequently feed on human garbage	open and semi-open environments	LC
7	*Streptopelia tranquebarica*	Red-collared Dove	scavengers, insects	woodland, semi open environments	LC
8	*Spilopelia chinensis*	Spotted Dove	scavengers, insects	light forests and gardens as well as in urban areas.	LC
9	*Treron phoenicoptera*	Yellow-footed Green Pigeon	mainly fruits	dense forest areas	LC
10	*Psittacula krameri*	Rose-ringed Parakeet	fruits, vegetables, pellets, seeds	forest	LC
11	*Centropus sinensis*	Greater Coucal	insects, eggs	from jungle to cultivation and urban gardens	LC

12	*Merops orientalis*	Green bee-eater	insects, bees, waps and ants	urban and sub-urban neighborhoods	LC
13	*Upupa epops*	Common Hoopoe	insects, small reptiles, frogs and plant matters	lightly vegetated ground on which to forage and vertical surfaces with cavities	LC
14	*Megalaima haemacephala*	Coppersmith Barbet	flower petals	gardens, groves and sparse woodland	LC
15	*Corvus splendens*	House Crow	refuse, small reptiles and mammals	from small villages to large cities	LC
16	*Acridotheres tristis*	Common Myna	insects, arachnids, crustaceans and reptiles, small mammals and seed	open woodland, cultivation and around habitation	LC
17	*Acridotheres javanicus*	White-vented Myna	insects, arachnids, crustaceans and reptiles, small mammals and seed	cities and cultivated areas	VU
18	*Acridotheres fuscus*	Jungle Myna	insects, arachnids, crustaceans and reptiles, small mammals and seed	forest and cultivation	LC
19	*Pycnonotus caer*	Red-vented Bulbul	fruits, petals of flowers	open forest, plains and cultivated lands	LC
20	*Oriolus xanthornus*	Black-hooded oriole	insects and fruit, especially figs	open woodland and cultivation	LC
21	*Dicrurus macrocercus*	Black-Drongo	mainly on insects	open country	LC
22	*Dicrurus leucophaeus*	Ashy Drongo	mainly on insects	tall forest habitat	LC
23	*Dendrocitta vagabunda*	Rufous Treepie	feeding on fruits, nectar and seeds	open forest consisting of scrub, plantations and gardens	LC
24	*Crypsiprinia cucullata*	Hooded Treepie	feeding on fruits, nectar and seeds	lowland forests	EN, NT
25	*Aegithina tiphia*	Common Iora	mainly on insects	trees	LC

26	*Lanius collurioides*	Burmese Shrike		lowland forests	LC
27	*Lanius cristatus*	Brown Shrike	prey on thorns. Small birds and lizards	taiga, forest to semi-desert	LC
28	*Nectarinia asiatina*	Purple Sunbird	feed mainly on nectar	found in gardens with suitable flowers	LC
29	*Dicaeum crueniatum*	Scarlet-backed	the figs of Ficus fistulosa and F. grossularoides	lowland forests and occasionally gardens	LC
30	*Lonchura punctulata*	Scaly-breasted Munia	mainly grass seeds apart from berries and small insects.	tropical plains and grasslands.	LC
31	*Passer domesticus*	House Sparrow	seeds of grains and weeds	in urban or rural settings	LC
32	*Passer montanus*	Eurasian Tree Sparrow	mainly on seeds, invertebrates	lightly wooded open countryside	LC
33	*Lonchura punctulata*	Scaly-breasted Munia			LC
34	*Motacilla alba*	White Wagtail	insects and small vertebrates	near-constant tail wagging, a trait that has given the species	LC
35	*Saxicola caprata*	Pied Bushchat	mainly on insects	open habitats including scrub, grassland and cultivation	LC
36	*Prinia inornata*	Plane Prinia	mainly on insects	open habitats such as long grass or scrub,	LC
37	*Orthotomus sutorius*	Common Tailorbird	eed on a range of beetles and bugs.	in the undergrowth or trees	LC

Table - Conservation and habitat utilization of mammal species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

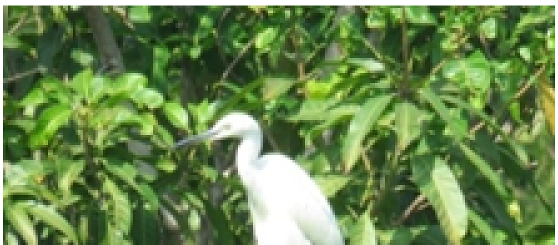
No.	Scientific name	Feeding	Habitat	IUCN status
1.	*Macaca mulatta*	leaves, flowers, seeds, and fruit	grasslands to arid and forested areas	LC
2.	*Callosciurus erythreus*	leaves, flowers, seeds, and fruit	Forest habitats	LC
3.	*Rattus rattus*	seeds, fruit, stems, leaves, fungi, and a variety of invertebrates and vertebrate	around fences, ponds, riverbanks, streams, and reservoirs.	LC

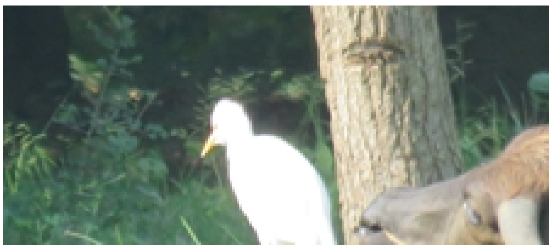
Table - Endangered Animals of Myanmar

Rank	Animal Name	Scientific Name	Conservation Status (IUCN)	Occurrence in study area
1	White-bellied heron	*Ardea insignis*	Critically Endangered	Absent
2	Baer's Pochard	*Aythya baeri*	Critically Endangered	Absent
3	Spoon-billed Sandpiper	*Calidris pygmaea*	Critically Endangered	Absent
4	Sumatran Rhinoceros	*Dicerorhinus sumatrensis*	Critically Endangered	Absent
5	Hawksbill turtle	*Eretmochelys imbricata*	Critically Endangered	Absent
6	Fish-eating crocodile	*Gavialis gangeticus*	Critically Endangered	Absent
7	Flatback tortoise	*Geochelone platynota*	Critically Endangered	Absent
8	Irrawaddy river shark	*Glyphis siamensis*	Critically Endangered	Absent
9	Arakan forest turtle	*Heosemys depressa*	Critically Endangered	Absent
10	Slender-billed vulture	*Gyps tenuirostris*	Critically Endangered	Absent
11	White-rumped vulture	*Gyps bengalensis*	Critically Endangered	Absent
12	Sunda pangolin	*Manis javanica*	Critically Endangered	Absent
13	Black ibis	*Pseudibis davisoni*	Critically Endangered	Absent
14	Javan rhinoceros	*Rhinoceros sondaicus*	Critically Endangered	Absent
15	Myanmar snub-nosed monkey	*Rhinopithecus strykeri*	Critically Endangered	Absent
16	Helmeted hornbill	*Rhinoplax vigil*	Critically Endangered	Absent
17	Pink-headed duck	*Rhondonessa caryophyllacea*	Critically Endangered	Absent
18	Red-headed vulture	*Sarcogyps calvus*	Critically Endangered	Absent

(Source: world data; Endanger species of Myanmar)

Plate 1 Occurrence of recorded some fauna species





Mesophoyx intermedia, Intermediate Egret

Bubulcus coromandus, Cattle Egret

Microcarvbo niger, Little Commorant

Corvus splendens, House Crow

Acridotheres javanicus, White-vented Myna

Acridotheres fuscus, Jungle Myna

Lanius cristatus, Brown Shrike

Lanius collurio, Red-backed Shrike

Lanius cristatus, Brown Shrike

Saxicola caprata, Pied Bushchat

Ictinogonphus rapax, Dragonfly

Paratelphusa hydrodromus

5.5.10.3. Impact Assessment, Potential Impacts on Fauna and Flora and Mitigation Measures

(i) Impact Assessment on the Fauna and Flora of the Project Area

The impacts of the fauna and flora on Mandalay-Muse New Railway Project were assessed by the index matrix based on four criteria, Magnitude (M), Duration (D), Extend (E) (area), Probability (P) of the impacts. According to International Association of Impact Assessment-IAIA Guidelines as the impact factors, impacted items and impact degree are determined the following words;

Significant Point (SP)	Impact Significance
< 15	No impact (-)
15-29	Low impact (U)
30-44	Moderate significant (C)
45-59	High significant (B)
> 60	Very high significant (A)

Magnitude

If the impact is only insignificant, the index value is 1

If the impact is only in small and will have no effect, the index value is 2

If the impact is the moderate and will result in minor changes, the index value is 3

If the impact is thehigh and will result in significant changes, the index value is 4

If the impact is very high and will result in permanent changes, the index value is 5

Duration

If the impact is between 0-1 year in limited time of the project duration, index value is 1

If the impact is between 2-5 yearin limited time of the project duration, index value is 2

If the impact is between 6-15 year in limited time of the project duration, index value is 3

If the impact is the life of operation in the project duration, index value is 4

If the impact is over shoot the project duration, index value is 5

Extend (Area)

If the impact is thelimited to the site, the index value is 1

If the impact is the limited to the local area, the index value is 2

If the impact is the limited to the region, the index value is 3

If the impact is the limited to the national, the index value is 4

If the impact is the limited to the international, the index value is 5

Probability

If the impact is the very improbable, the index value is	1
If the impact is the improbable, the index value is	2
If the impact is the probable, the index value is	3
If the impact is the high probable, the index value is	4
If the impact is the definite, the index value is	5

(ii) Current Environmental Aspects

According to the recorded data, plenty of fauna, especially as major groups are vertebrate (mammals, birds, reptiles (Turtle and Tortoise and lizards) and invertebrate (butterflies, dragonflies, damselfly and many kinds of insects visually during survey) about 500 Meter and 1000 Meter surrounding in and around the project area are discovered because of there are enough food sources in these study area.

IUCN and CITES Appendices

(i) Fauna survey

In fauna survey, four fauna species were recorded as threatened species under the IUCN RedList and CITES appendices in this project area at the survey time.According to interview survey results, on the mammals species, Northern Pig-Tailed *Macaca leonine and* Marbled Cat *Pardofelis marmorata* were recorded as VU- Vulnerable status. On reptile's survey, King Cobra *Ophiophagus Hannah* and Yellow-Headed-Tortoise *Indotestudo elongate* were recorded as VU- Vulnerable and EN- Endangered status. Near Threatened (NT) and Least Concern (LC) meanclose to become extinct in the nature without include threatened species.

CITES

The Convention in International Trade in Endangered Species (CITES) is a United Nations Treaty organization, the largest and thus most powerful of the international treaties to protect endangered animals and plants. At present, 177 countries are members (Parties) of CITES.

There is a three species CITES list in the study area. Myanmar as a party country of CITIES we have to follow the rules and regulations of CITIES convention. According to the CITIES Convention

Appendix I lists species that are the most endangered among CITES-listed animals and plants. They are threatened with extinction and CITES prohibits international trade in specimens of these species except when the purpose of the import is not commercial, for instance for scientific research. In these exceptional cases, trade may take place provided it is authorized by the granting of both an import permit and an export permit (or re-export certificate). Article VII of the Convention provides for a number of exemptions to this general prohibition. Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. It also includes so-called "look-alike species", i.e. species whose specimens in trade look like those of species listed for conservation reasons. International trade in specimens of Appendix-II species may be authorized by the granting of an export permit or re-export certificate. No import permit is necessary for these species under CITES (although a permit is needed in some countries that have taken stricter measures than CITES requires). Permits or certificates should only be granted if the relevant authorities are satisfied that certain conditions are met, above all that trade will not be detrimental to the survival of the species in the wild.

Appendix III is a list of species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation. International trade in specimens of species listed in this Appendix is allowed only on presentation of the appropriate permits or certificates.

SN	Order/Family	Species	Common Name	Local Name	CITES	Appendix
Reptile						
1	Viperidae	*Daboia siamensis*	Viper	Mwe-pwe	√	III
2	Gekkonidae	*Gekko gecko*	House lizard	Totk-taet	√	II
Mammal						
3	Cercopithecidae	*Macaca mulatta*	Rhesus macaque	myaut-sat	√	II

Wild Life Trade

Wildlife Trade is a global epidemic. The Illegal Wildlife Trade is a multi-million dollar business run by dangerous criminal syndicates that deal in the harvesting and trading of wild species and their body parts. With high demand from a growing Asian middle class stoking the fire, this trade is the biggest threat facing wildlife today.

Myanmar is a global hub for illegal wildlife trade. Because of our remaining wilderness and abundant wildlife our forests are a prime source for some of the most poached species such as tigers, Asian elephants and pangolins. To make matters worse, Myanmar is situated next to the notorious lawless Golden Triangle region, the global illegal wildlife hypermarket.

Each year, hundreds of millions of plants and animals are caught of harvested from the wild and then sold as food, pets, ornamental plants, leather, tourist curios, and medicine. While a great deal of this trade is legal and is not harming wild populations, a worrying large proportion is illegal and threatens the survival of many endangered species. (WWF Myanmar,2020)

According to the UNODC report(2018) , Myanmar is a strategically relevant country in the illegal wildlife trade, nestled between several important source, transit and destination countries. Yet, as transportation infrastructure in the country and the region continues to improve and expand, the importance of Myanmar as a transit location for wildlife smuggling may also increase in the future. We have to consider about wildlife trade and any other smuggling process and have to cooperate with the regional authorities.

While the majority of illegal wildlife trade happens at a commercial level, tourists sometimes participate unknowingly by buying or traveling with illegal items. These are most often bought as souvenirs or gifts for friends and families. When buying souvenirs and gifts, make sure that you are not contributing to the illegal trade in wildlife. That is why the local authorities have to made the awareness program for local communities and tourists.

Summary of globally threatened species in Myanmar

Taxonomic Group	Global Threat Status			
	Critically Endangered	Endangered	Vulnerable	Total
Mammals	4	9	26	39
Birds	4	8	33	45
Reptiles	4	10	7	21
Invertebrates	0	0	1	1
Plants	13	12	13	38
Total	25	39	80	144

Source : Myanmar: Investment Opportunities in Biodiversity Conservation, 2005

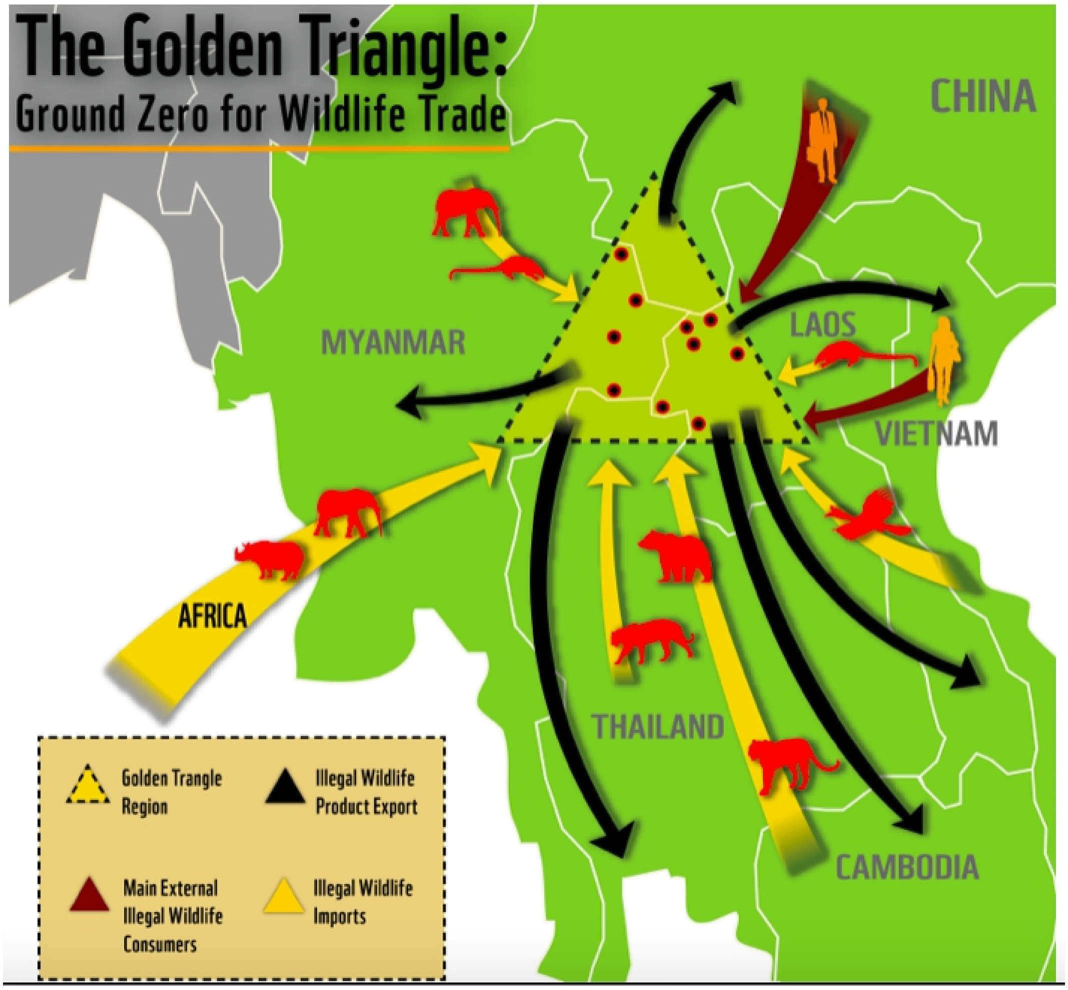


Fig- Showing the Wildlife Trade Path

Overview of available information on species in use or trade and estimates of legal and illegal trade, by taxonomic group

	Species Overview	Legal Trade Estimates	Illegal Trade estimates
Mammals	~ 5,400 species (Wilson and Reeder, 2005); > 1,000 utilized for food and medicine (TRAFFIC, 2010); ~ 900 CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade11: ~ 280,000 ' whole ' 12 wild- sourced mammals annually. Overall, legal international trade, particularly in non-CITES species, appears to be unquantified.	No global estimates, but estimates for some taxa and commodities exist (1,215 rhinos illegally killed in 2014 (TRAFFIC, 2015), 17,000 elephants killed in 2011 at MIKE sites (CITES CoP16 Doc.53.1 Addendum), ~18,750 ivory seizures over the period 1989-2013 recorded in ETIS (CITES Standing

			Committee document SC65 Doc.42.1), ~227,000 pangolins killed in Asia between 2000 and 2013 (Challender et al., 2015)); many reports of instances of ITW.
Birds	~ 10,000 species (BirdLife International, 2013b); ~ 4,500 utilized, for example as pets, food, or for sport hunting (BirdLife International, 2008); ~ 3,300 traded (Butchart, 2008); ~ 1,500 CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 90,000 'whole' wild- sourced birds annually. Several million birds each year in domestic and international trade, particularly finches, weavers, parrots and raptors (BirdLife International, 2015b).	No global estimates although regional estimates for some taxonomic groups exist (25 million birds illegally killed in the Mediterranean per year (BirdLife International, 2015b)); many reports of instances of ITW.
Reptiles	~ 10,000 species (Pincheira-Donoso et al., 2013; Uetz and Hošek, 2015); ~ thousands utilized and traded (e.g. ~3,500 species/subspecies of reptiles and amphibians imported as pets into the EU (Newman, 2014); ~ 800 CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 1.8 million 'whole' wild- sourced reptiles annually. Overall, legal international trade, particularly in non-CITES species, appears to be unquantified.	No global estimates, but estimates for some species and commodities exist; many reports of instances of ITW.
Amphibians	~ 7,400 species (Frost, 2014); > 200 utilized for food, > 260 for pet trade and many for medicinal purposes (Carpenter et al., 2007); ~ 150 CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 15,000 'whole' wild- sourced amphibians annually. For example, more than 20 million wild- caught live amphibians (CITES and non-CITES species) legally imported into the United States 2001-2009 (Herrel and van der Meijden, 2014).	No global estimates, but estimates for some taxa and commodities exist; many reports of instances of ITW.

Fish	~ 33,000 species (Froese and Pauly, 2014); > thousands utilized (e.g. 1,200 traded as aquarium fish (Cato and Brown, 2003) , ~ 800 traded for food (Ababouch, 2005); ~ 100 CITES-listed; five species of sharks, one sawfish and the genus Manta were listed at the most recent CoP (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 40,000 'whole' wild- sourced fish annually. Global catch of 90 million tonnes annually (FAO, 2012).	Global illegal and unreported fishing estimated at 11-12 million tonnes annually (Agnew et al., 2009).
Invertebrates	~ 1,000,000 species (Roskov et al., 2014); > thousands utilized (e.g. > 2,000 insect species (Ramos-Elorduy, 2009) and > 300 marine invertebrate taxa are used as food (Anderson et al., 2011)); ~ 2,200 CITES-listed, predominantly corals (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 2.5 million 'whole' wild-sourced invertebrates annually. Marine and freshwater mollusc and crustacean catch alone > 13 million tonnes in 2012 (FAO, 2014a). Up to 30- 50 tonnes of red and black13 coral and > 2,500 tonnes of shells also traded each year (Tissot et al., 2010).	No global estimates, but estimates for some taxa and commodities exist; many reports of instances of ITW.
Timber	~ 100,000 species of trees (BCGI, 2007) - not all produce exploitable timber; > 1,600 traded commercially (Mark et al., 2014); ~ 700 CITES-listed trees; five species and two genera were listed at the two most recent CoPs (UNEP-WCMC (Comps.), 2016).	137 million m3 roundwood, 124 million m3 sawnwood, 77 million m3 wood-based panels and 223 million tonnes of pulp/paper products in 2013 (FAO, 2015a).	8-10 per cent of the value of global wood products (Seneca Creek Associates and Wood Resources International, 2004); In 2004, just under half of all tropical logs, sawn timber and plywood in trade were estimated to be illegally sourced (Lawson and MacFaul, 2010).
Plants	~ 300,000 species (BGCI, 2014); > 20,000 traded for medicinal purposes	CITES trade: ~ 24 million 'whole' wild-sourced plants annually.	No global estimates, but estimates for some taxa and commodities exist; many reports of

	alone (WHO et al., 1993); ~ 30,000 CITES-listed, the majority orchids (UNEP-WCMC (Comps.), 2016).		instances of ITW.

Source: UNEP 2017

(ii) Flora Survey

In flora survey, there are a number of species of flora in the various parts of Mandalay, Pyin Oo Lwin, Naung Hkio, and Lashio, some of which are Least Concerned and Near Threatened species could be found in different parts of the Project area. Potential impacts to flora and fauna include (i) destruction of vegetation for earth works, and (ii) temporary habitat occupation which will disturb fauna movements at certain locations of the alignment.

Potential Impacts on Fauna And Flora

(i) Natural Environment

Muse - Mandalay Segment is Shan plateau topography, most of which are at an altitude of 700m ~ 800m or above, the top of the plateau surface generally presents relatively low and gentle planation surface, the surface fluctuation is generally tens to hundreds of meters, deep valleys are developed. Most of the natural vegetation is secondary evergreen broad-leaved forest with partial residual tropical monsoon rain forest.

Along the railway site area, different forest types were observed accordingly to the elevation, namely: **(1) hill semi evergreen forest (2) tropical mix evergreen and deciduous forest (3) semi-indaing forest (4) Open degraded forest and farmland ecosystem**.

During the survey none of the trees are in the list of threatened plant species. It is expected hundreds of trees along the railway track will be cut or removed. Impacts on flora, fauna and biodiversity are expected to be limited and temporary because trees observed along the railway line are commonly found in public parks, other greenery areas and along the roads in Mandalay to Muse.

Figure - Images Showing Vegetation Scenery Result of the Survey Area

Identification and Assessment/ Analysis Impacts

The following method will be applied to assess the environmental impacts of the Mandalay-Muse Railway New Project mainly on Biodiversity. Conclusively, each source of impact has been assessed by four parameters; Magnitude, Duration, Extend (area) and Probability.

(i) Impact assessments on the fauna and flora of the project area

Table 5.16. Impact index value and categories of fauna and flora in the Mandalay-Muse Railway New Project

No.	Impacts	Magnitude	Duration	Extend (area)	Probability	Total	Category
	Fauna						
1	Reduce Terrestrial Fauna	3	4	2	3	27	Low impact (U)
2	Habitat Loss	3	5	2	3	30	Moderate significant (C)

3	Noise Impact	3	3	2	3	24	Low impact (U)
	Flora						
4	Loss of trees and other plant species	3	5	2	3	30	Moderate significant (C)

(Source: International Association of Impact Assessment-IAIA, 2014, www.iaia.org)

(ii) Impact on Biodiversity and Ecosystem

The most area where the alignment passes has been heavily influenced by human activities of township building and agriculture farmland cultivation. Investigated plants are common species in this area. Due to the influence from local residents, there is a not important fauna and flora resource in the alignment corridor. For this reason, proposed project is little impacts on wild animals in human habitation area. Bats have long been known as the cave-dwellers par excellence. The degree of ecological dependence on caves as shelter is highly variable for bats. Most bats species are able to use multiple kinds of roosts in caves.

From the point of view **of the bats,** caves must be protected to allow species most dependent on this kind of shelter to maintain viable populations. From the point of view of the cave communities, all bat species, independent of their conservation status, must be locally protected in project areas. Even in the case of bat species, the control must be carefully managed, allowing the maintenance of a minimum population size to support the cavernicoles dependent on vampire bat guano. On the other hand, bat guano is an important food source for many subterranean organisms, especially for species restricted to subterranean habitats, totally dependent on the resources present in these habitats and prone to rapid extinction following any ecological disequilibrium. Therefore, protecting bats is a fundamental part of any program or action on project by contractors for conservation of subterranean systems.

Through the field survey, it was observed that biodiversity in the project area was rich because of there are enough food sources and available conditions for wild animals in these areas.Though clearing the vegetation due to the implementation of the project, greening of the public space along and near the rail -road will help to mitigate the change of biodiversity and ecosystem. Therefore, the development of the project will be able to cause any significant impact on biodiversity and ecosystem of the region. The avoidance is essential to maintain the integrated habitat and is the most effective way to protect local resources.

In the course of construction and operation of tunnel conditions for development of flora and fauna should not be disturbed; deforestation and cutting down of bushes, change of hydrological mode of water objects, deterioration of ways of animals migration, reduction of the sizes of populations, extinction of species are inadmissible.

Construction and operation of the Project will have only a minimal effect on existing flora and fauna. During construction, a short-term impact on ecology is likely to occur in and around the sites, material stockpiling areas, and worksites due to vegetation clearance. A permanent but relatively minor impact on ecology is likely to occur due to the alignment of any unstable section. Vegetative cover stripped from these locations will be kept for landslide and slope protection. Contractors will be responsible for putting new vegetation in removal sites. Construction vehicles should use temporary roads constructed to minimize damage to agricultural land and local access roads. Where local roads are used, they will be repaired to their original condition after the completion of work. Compaction around trees will be performed carefully to avoid damage to the tree drip-line.

Potential impacts from construction worker camps include poaching of edible animals and birds in the locality, despite prohibitions. The contractors will be responsible for providing adequate knowledge to workers regarding the protection of fauna. Workers will be trained regarding nature protection and the need to avoid cutting down trees during construction. Contractors will be responsible for supplying appropriate fuel in the work camps to prevent fuelwood collection.

Potential impact on Aquatic and Terrestrial Environment

Construction Phase	Operation Phase	Decommissioning Phase
Aquatic		
Drainage Works and Use of Machines -Negative impact on flora and fauna from increased sediment loading of river/stream **Machines Maintenance** -Harm to aquatic fauna from oil,fuel,cement or others substances entering water resources	**Physical Present of Culverts** -Interruption of river corridor isolating habitats with potential decrease in species numbers and local biodiversity. -Potential barrier created to the upstream mitigation of wildlife. -Reduced daylight in enclosed culvert tunnel inhibit plant life. -Increased water velocities in culvert may impede fish migration	**Decommissioning activities** -Negative impact on aquatic flora and fauna From increased sediment loading of streams. **Materials management** -Harm to aquatic flora and fauna from oil, fuel, cement or other substances entering watercourses.

	and spawning upstream. **Physical presence of the bridge** -Changes to deposition, depth and water velocities may result in harm some invertebrates and fish species. Turbidity may contribute to reduced ecological diversity. -Potential downstream changes to the aquatic community. -Shading of the watercourse may reduce aquatic flora in the vicinity of the bridge. -Potential barrier to fish migration and the movement of aquatic mammals along the river. **Materials Management** -Direct and indirect effects from soil, fuel or other substances entering the aquatic environment	
Construction Phase	Operation Phase	Decommissioning Phase
Terrestrial Ecology		
Earthworks and Excavations -Habitat removal, fragmentation or severance -Disturbance to species.	**Physical Presence of Culverts** -Alternation or loss of terrestrial habitats. -Creation of barriers to mammals -Alternation of the channel bank habitat. **Physical Presence of Bridges** -Loss of riparian by virtue of land use adjacent to a watercourse for development. -Upstream impoundment may cause an inundation pf terrestrial and riparian habitats. -Destabilisation of nearby wetlands- potential waterlogging of riparian areas – death of some trees, shrubs and flowers.	**Decommissioning Activities** -Negative impact on terrestrial flora and fauna from vehicular activities, disturbance and habitat severance. **Materials management** -Harm to terrestrial flora and fauna from oil, fuel, cement or other substances entering watercourses.

The Anthropogenic Impact

Human impact on the environment or anthropogenic impact on the environment includes changes to ecosystems, biodiversity, and natural resources caused directly or indirectly by humans.

The largest anthropogenic sources of pollution are industry, energy, transport and agriculture. The effect comes from stationary pollution sources (industry, energetics), and from mobile ones – the vehicles. Transport is a specific and dynamic source of pollution. Its caused physical pollution falls into all urban areas: the residential and industrial areas, hospitals and recreational areas.(EIB)

The negative impact of transport on the environment and the public can occur in three areas: environmental pollution, quality of life, use of resources.

Target economic activity will not increase air pollution, on the contrary, it will be reduce by the reduction of fuel consumption amount by locomotives. After the construction of the railway, the speed of train will highly and stable , better conditions for the operation of as modern trains, faster passing for long trains will be made as well as the duration of train stand will be reduced and the traffic will be diverted from the city and will reduce the disturbance to wildlife.

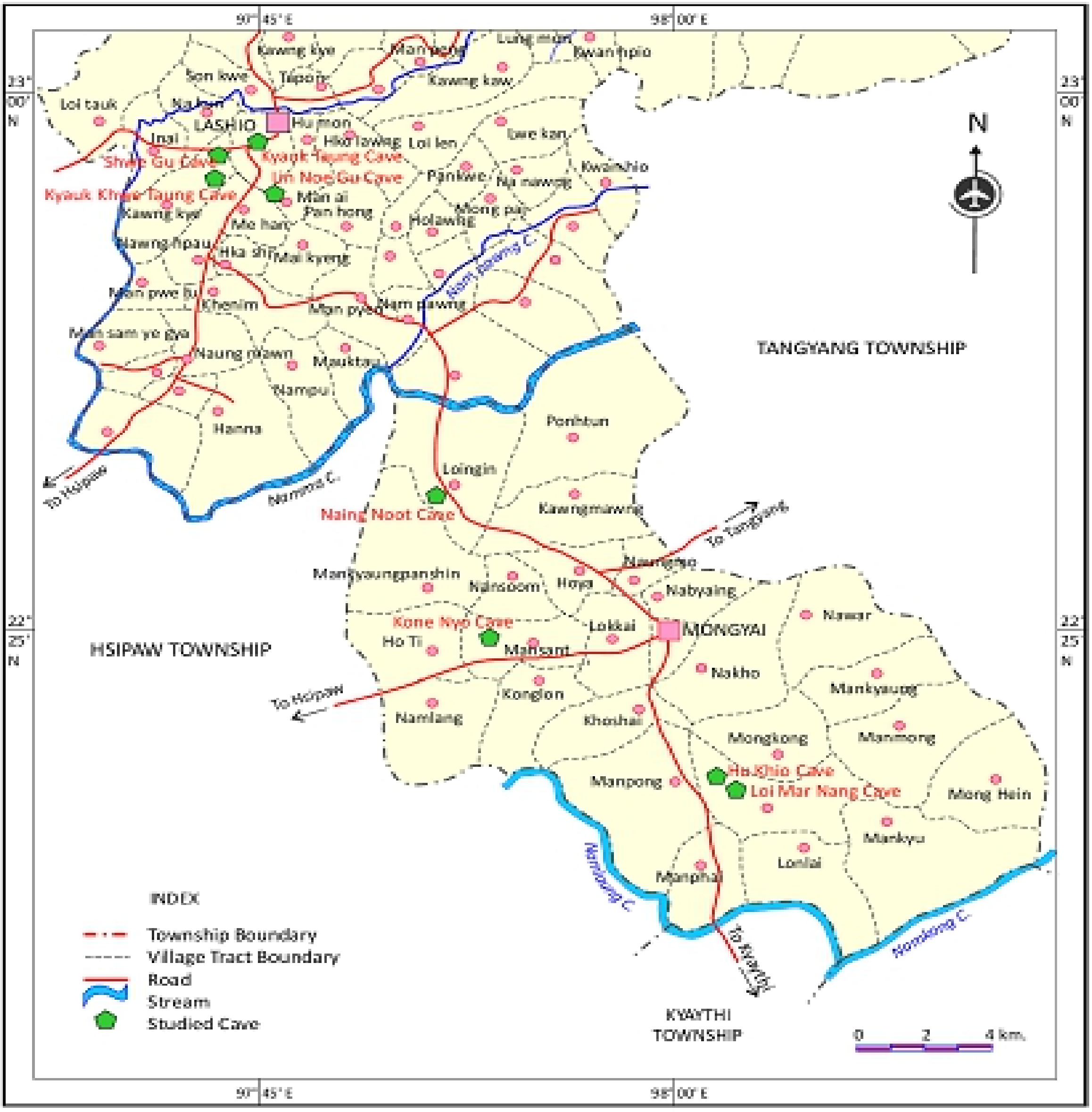
Fauna Injury or Mortality

Construction has the potential to result in injury or mortality of some individuals of less mobile fauna species, and other small terrestrial fauna that may be sheltering in vegetation within the project area. The potential injury or mortality of individuals is highly unlikely to affect an ecologically significant proportion of any local populations. More mobile native fauna, such as native birds, bats, terrestrial, and arboreal mammals are likely to be able to evade injury during construction activities.

Some Limestone Caves near Lashio Area

Shan State covers almost a quarter of Myanmar and is the most mountainous area in the country. This state also constitutes the largest part of the Northern Indo-Chinese biogeographic zone in Myanmar (Tun Yin, 1993). Most caves in the State are important archaeological sites that feature splendid pieces of ancient cultures.

Limestone caves (*Rhinolophus pearsonii* and Malayan Horseshoe bat *Rhinolophus malayanus*are also recorded in Shwe Gu Cave (between 22˚ 57' 16.0" N and 97˚ 43' 27.2" E, elevation 829m), Kyauk Taung Cave (between 22˚ 56' 14.50" N and 97˚ 44' 04.82" E, elevation 825m), Kyauk Khwe Taung Cave (between 22˚ 56' 07.67" N and 97˚ 42' 50.05" E, elevation 875m)) were conducted and bat species use caves for alternate refuge, some species rely on caves for day roosting and protection from predators. According to the survey results, as bats species, about total Mammals fauna 3 species one order and 2 families were recorded in Lashio area. Leschenaulti's Rousette or Fulvous fruit bat *Rousettus leschenaultia*, Pearson's horseshoe bat.



Source: Land Records Department, Lashio

Figure - Location map of studied cave

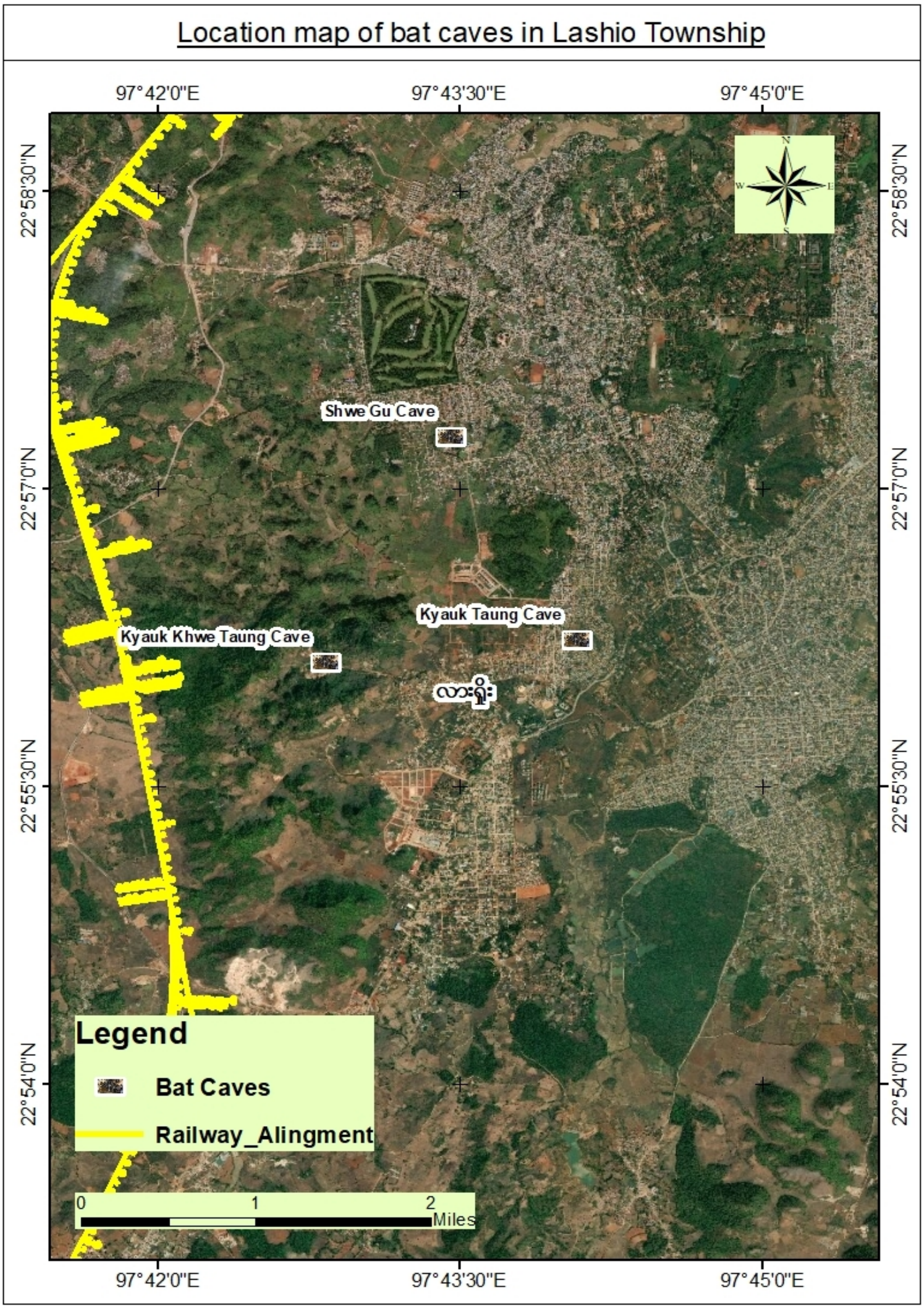


Figure - Map of the study sites of bat caves in Lashio

No	Name	Estimated distance from railway (km)
1	Shwe Gu Cave	3.340
2	Kyauk Taung Cave	3.890
3	Kyauk Khwe Taung Cave	1.745

Figure - Image of Shwe Gu Cave

Figure - Image of Kyauk Taung Cave

Figure - Image of Kyauk Khwe Cave

Disturbance and Destructive Effects on the Protected Area

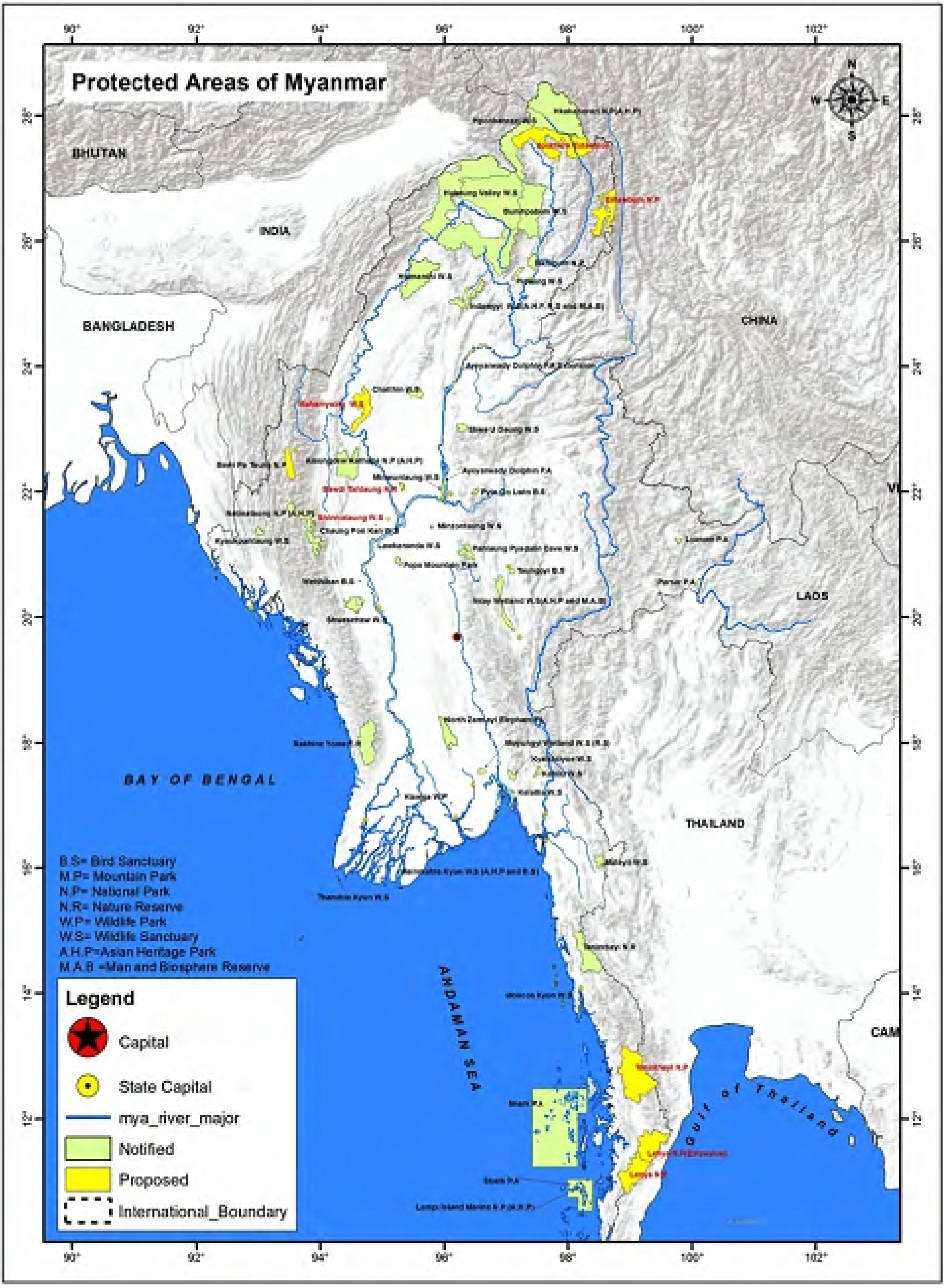


Figure - Map of Protected Areas of Myanmar
(Source: WCS, Protected Areas, 2017)

Protected Areas are one of the most important tools for biodiversity conservation, safeguarding ecosystems services and preserving cultural landscapes. As of 2018, Myanmar has 42 Protected Areas. Seven of the Protected Areas are ASEAN Heritage Parks (AHPs) recognised for their biodiversity value within ASEAN countries; and five are Ramsar Sites (wetlands of international importance).

The above mentioned environmentally sensitive areas (such as Nature Reserve, National Park, Protected Area, National Park and ASEAN Heritage Park, Wildlife Sanctuary, Bird Sanctuary, Wildlife Park, Mountain Park, Wildlife Sanctuary and ASEAN Heritage Park, Elephant Range and Wildlife Sanctuary) are not included along Muse-Mandalay. Among them, totally 4 sensitive areas, Shwe-U-Daung Wildlife Sanctuary (87km away from the line) , Pyin-Oo-Lwin Wildlife Sanctuary (5km away from the line) , Minwuntaung Wildlife Sanctuary (18km away from the line) and Irrawaddy Dolphin P.A are close to Railway with 12.5km away from the line respectively. Shwe U Daung used to be a habitat for critically endangered species of Hairy Rhinoceros (*Dicerorhinus sumatraensis*), and the conservation priority for this site will be critical for restoring this rhinoceros. In addition, Shwe U Daung Wildlife Sanctuary serves as an important habitat for Asian elephant (endangered). Minwuntaung Wildlife Sanctuary serves as Key species protected for Barking deer, Hog deer, Avifauna. Although these areas were not close to the project area, but well planned management should be done for implementation around forest and environment.

Table - Environmentally Sensitive Areas along Muse-Mandalay

Name of sensitive areas	Level	Issuing time	Area (km2)	Competent department	Protection object	Position relationship with the line
Shwe-U-Daung Wildlife Sanctuary	National	1929	117.97	Forest sector	Elephant, gaur, banteng, rusa, serow, bear	About 87km away from the line
Pyin-Oo-Lwin Widlife Sanctuary	National	1927	127.25	Forest sector	Muntjac, birds,	About 5km away from the line
Minwuntaung Wildlife Sanctuary	National	1972	205.88	Forest sector	Muntjac, birds,	About 18km away from the line
Irrawaddy Dolphin P.A	National	2005	327.53	Forest sector	Irrawaddy Dolphin	About 12.5km away from the line

Figure - Location Plan of Railway and Shwe-U-Daung Wildlife Sanctuary

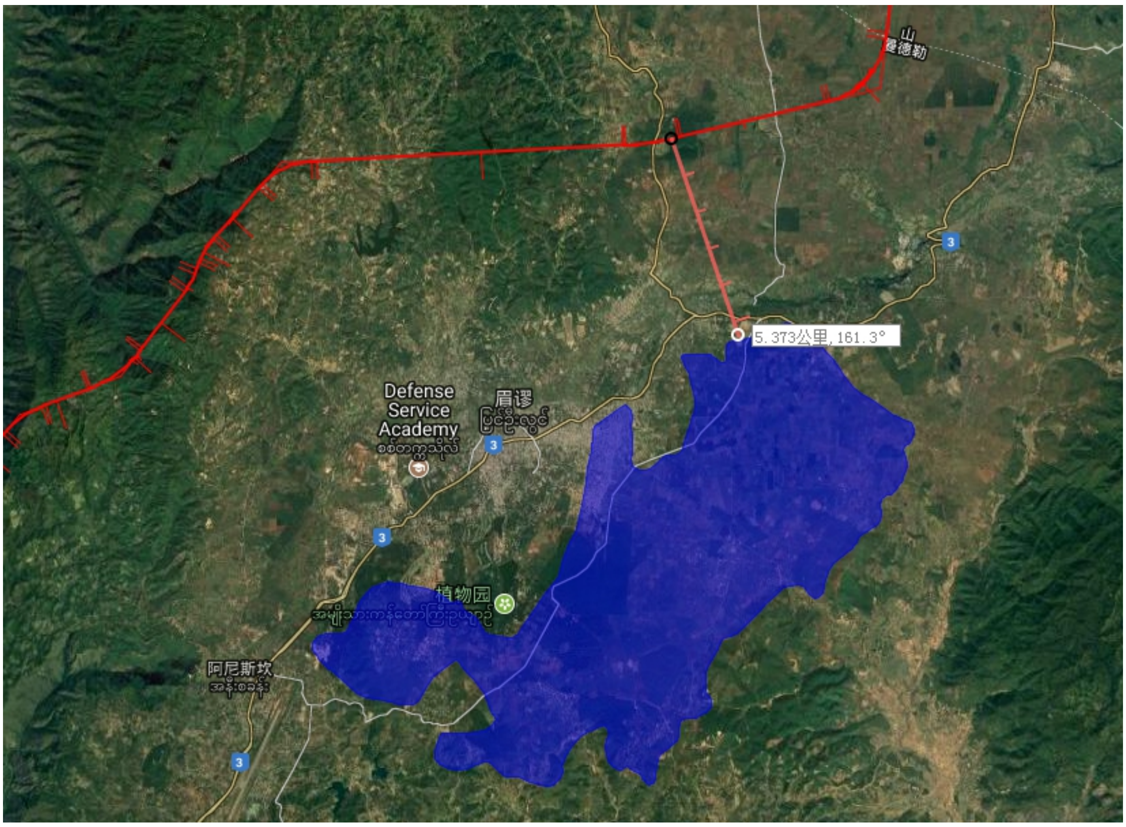


Figure - Location Plan of Railway and Pyin-Oo-Lwin Wildlife Sanctuary

Figure - Location Plan of Railway and Irrawaddy Dolphin P.A

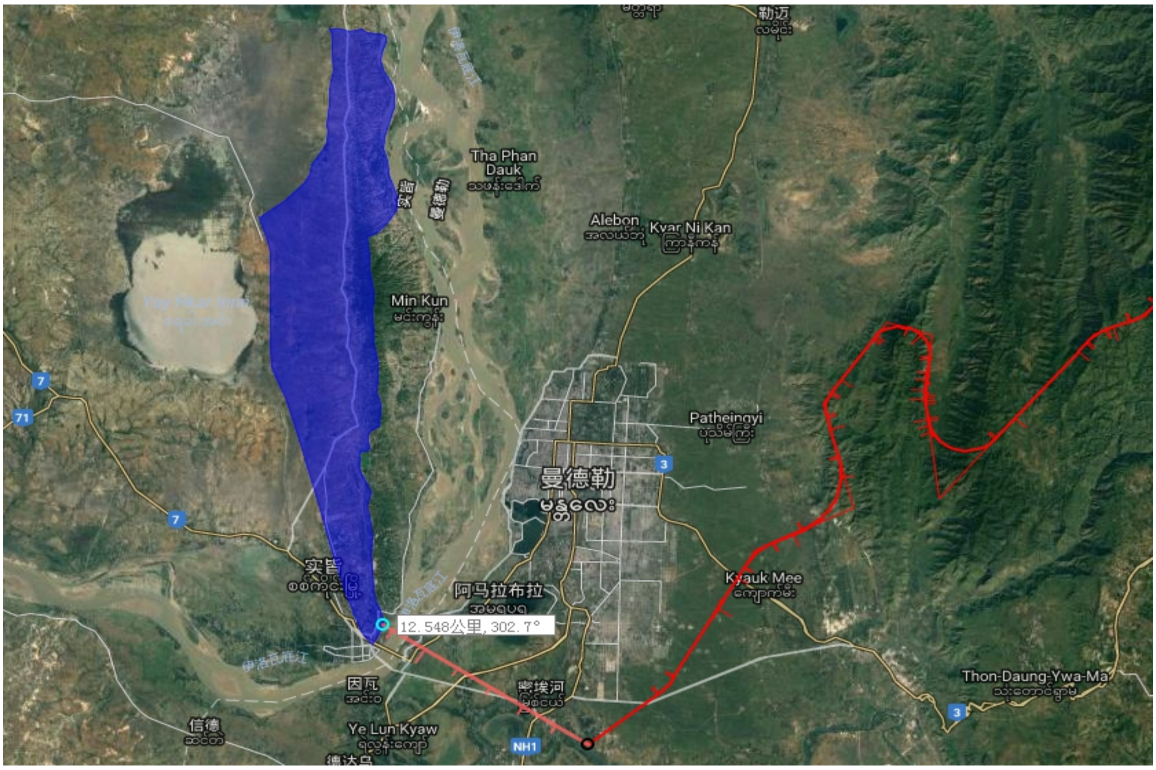


Figure - Location Plans of Railway and Minwuntaung Wildlife Sanctuary

5.5.10.4. Biological Resource Management Plan Bridges and Culverts

The Critical role that biological resources play in sustaining human life has in the last two decades received considerable if belated attention. In 1992 a board framework for the conservation and use of the world's biological resources – The Convention on Biological Diversity (CBD) – was agreed by the United Nations Conference on Environment and Development (the Earth Summit). Despite increasing recognition, however, the worlds' biological resource continues to be lost at an alarming rate, and particularly so in developing countries where many of the remaining resources are concentrated. (World Bank 2002)

The overarching objective of "Biological Resource Management Plan" is to provides strategies and management actions necessary to sustain the country's biological resources.

Recommended biological resource management objectives for proposed railway project are to:

- ✓ Protect species and habitats of along the railway project
- ✓ Maintain and preserve native biological diversity
- ✓ Reduce the spread of invasive species and provide integrated controls of noxious weeds
- ✓ Where and when feasible, improve degraded habitats in a strategic manner to increase landscape connectivity and native diversity
- ✓ Reduce and minimize fragmentation of habitats
- ✓ Maintain landscape that provide regional connectivity to habitats surrounding railway project.
- ✓ To meet these objectives, BRMP provides a set of generally directives for proposed railway project operation.
- ✓ Develop a flora replantation plan particularly for native species
- ✓ Educated employees of environmental responsibilities during inductions including treating all native fauna species as protected.

Biodiversity Richness in Myanmar

Taxonomic group	Species	Number
Species of vascular plants of Gymnosperms and angiosperms		11,800
Mammals		258
Bird species		1,056
Reptile	Snakes	153
	Lizards	87

	Turtles and tortoise	32
Amphibians	Frogs and toads	79
	Caecilians	2
	Salamander	1
Fresh water fish		310
Marine water fish		465
Medicinal plant		841
Bamboo		96
Rattan		37

Protected Areas & Species

According to the data of Forest Department, there are 36 protected area and 577 wildlife species (completely protected), 318 wildlife species (normally protected), and 914 wildlife species (seasonally species) in Myanmar. Elephant, Indian Bison, Serow, Braking Deer, *Green Pea Fowl Pavo muticus* are protected species in Shan State.

Preventing Wildlife-train Collisions

According to the literature learning railways can be deadly for animals ranging from elephants to deer and frogs. Railway fragment habitat and can affect all kinds of wildlife in varying ways. Collision is the most common cause of mortality, but some animal (especially Avian and Bat) dies from electrocution and collisions which already explain in our report with the IFC guidelines. “The mammal species receiving the most attention are frequently the larger ones, such as moose, bears or elephants as they cause more damage to trains, disrupt the normal operation of the train network, or hold higher conservation and economic status,” according to the editors of the 2017 book Railway Ecology. Although the tracks formed a barrier the herpet species such as toad and some frogs, which can't cross while migrating. Especially toad may not be able to jump or climbs over rails more than 6 inches. Some of the toads appear to have died from desiccation due to extreme heat from the tracks.

Mammals

Large mammal group includes species such as deer, bears, Gaur. Large mammals generally stand at least 1.5 ft at the shoulder, and have a length of at least 2ft. As suggested by many studies, large mammals typically prefer large, open crossing structure, such as bridge underpasses and box culverts. Studies indicate that an open field of view must exist in order for large mammals to use a bridge crossing. A large mammal is more likely to pass under a bridge if suitable habitat is clearly visible on the other side. The need for an open field of view also correlates with the preference for a large openness ratio. This will be mitigate the wildlife-train collisions and other additional accidence.

Bridge underpasses and box culverts

Photo Source: Shaw 2020

Bats

Bats will be use bridges for both day roosting and night roosting. Day root protects bats from predators and buffer weather changes while resting and rearing their young. Night roots are where bats gather to digest food in between nightly feeding bouts.

Amphibians

Including species such as frogs, toads, snakes, lizards and tortoise. Bridges are generally placed at streams: however, for many amphibians and reptiles, movement and migrations are not associated with streams, but between upland and wetland areas. Travel distance to the bridge can be an important factor in facilitating movement of amphibians/reptiles. Smaller structure such as pipes and culverts should be used in conjunction with bridged crossing.

Aquatic

The construction stage should be avoiding fish breeding season (end of June to August).

Sensitive Season

The Ayeyawady Dolphin Protected Area (ADPA) stretches 74 km of river starting from Mingun in the south up to Kyaukmyaung and Singu townships in the north. And Irrawaddy dolphin breed in December through June. The proposed railways project far from Mingun (10.87 miles), Kuaukkmyaung (50.78 miles), and Singu (43.03 miles) respectively. According to the variation of breeding season on difference species, educated employees of environmental responsibilities during inductions including treating all native fauna species as protected.

Ecoregions in Myanmar

Myanmar as a country, one of the richest biodiversity hotspots in the world. MONREC (Ministry of Natural Resources and Environmental Conservation) defined Ecoregions in Myanmar. An ecoregion (ecological region) is an ecologically and geographically defined area that is smaller than a bioregion, which in turn is smaller than a biogeographic realm. Ecoregions cover relatively large areas of land or water and contain characteristic, geographically distinct assemblages of natural communities and species. The biodiversity of flora, fauna, and ecosystems that characterize an ecoregion tends to be distinct from that of other ecoregions. Biodiversity or conservation ecoregions are relatively large areas of land or water where the probability of encountering different species and communities at any given point remains relatively constant, within an acceptable range of variation. According to the WWF, we can take these steps based on ecoregions, - trends in environmental change, - current protection status of key landscapes and habitats. Based on the data of MONREC, Myanmar have the 19 ecoregions all around the country. These are as follow:

Ecoregions

SN	Ecoregion	Area (km^2)	%
1	Central Indochina dry forests	4.0	0.0
2	Chin Hills-Arakan Yoma montane forests	29,810.7	4.4
3	Eastern Himalayan alpine shrub and meadows	5,316.6	0.8
4	Eastern Himalayan broadleaf forests	285.5	0.0

5	Eastern Himalayan Subalpine conifer forests	38.5	0.0
6	Irrawaddy dry forests	35,459.4	5.2
7	Irrawaddy freshwater swamp forests	15,308.8	2.3
8	Irrawaddy moist deciduous forests	139,806.4	20.7
9	Kayah-Karen montane rain forests	56,113.1	8.3
10	Lower Gangetic Plains moist deciduous forests	3.0	00
11	Mizoram-Manipur-Kachin rain forests	71,183.0	10.5
12	Myanmar Coast Mangroves	15,889.0	2.4
13	Myanmar coastal rain forests	66,338.2	9.8
14	Northeast India-Myanmar pine forests	83.0	0.0
15	Northern Indochina subtropical forests	139,582.7	20.6
16	Northern Triangle subtropical forests	54,595.4	8.1
17	Northern Triangle temperate forests	10,813.4	1.6
18	Nujiang Langcang Gorge alpine conifer and mixed forests	4,635.2	0.7
19	Tenasserim-South Thailand semi evergreen rain forests	30,734.1	4.5
	Total	676,000.0	100.0

Source : IFC (2017)

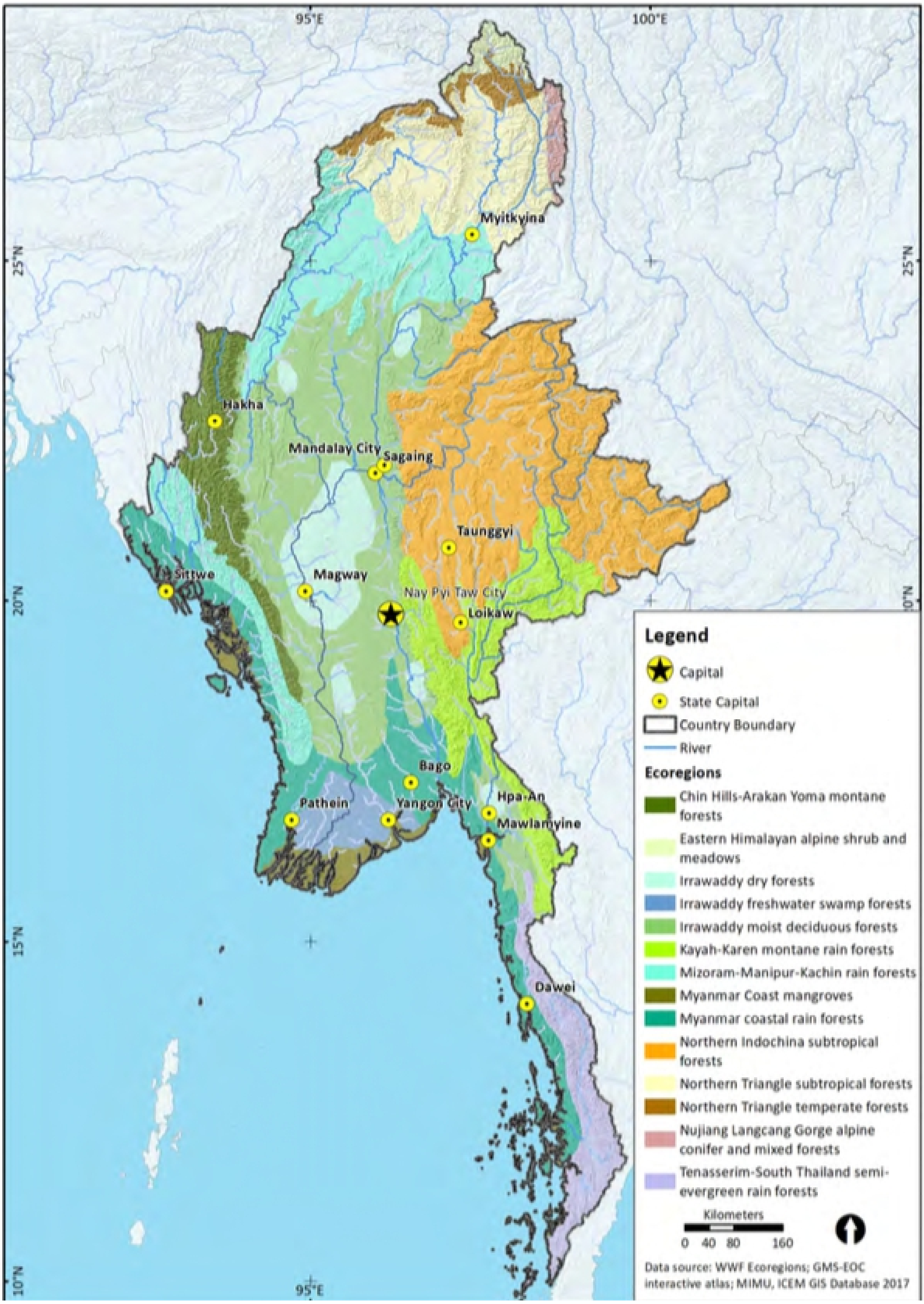


Figure - Ecoregions in Myanmar

Source: IFC (2017)

Thit Ta Pin Taung Protected Forest Area

As the railway route is close to Thit Ta Pin Taung Protected forest area, which is environmental sensitive area of water resources for the local community of surrounding villages and to protect near forest areas in Pyin Oo Lwin Township. As Thit Tapin Taung is massive, it’s extremely difficult to carry out conservation work. However locals said there are colonial-era stone posts and fences demarcating the area. So to conduct the project, the old posts and fences may be kept or new ones erected. Either way, the main task is conservation. The area around Thit Tapin Taung is within the forest and the Forestry Department is responsible to conduct conservation work there and has been planting 150 acres of pine trees. There are three lakes at Thit Tapin Taung which have supplied water to Pyin Oo Lwin town since the colonial era. Residents also rely on it for drinking water. Some 16 areas of the lake were recognised as watershed areas. Due to the disappearing forest, the lakes have decreased in size, said an official of the Forestry Department.

Construction of railway line may result in the deterioration of lowered infiltration rate of soil water content, reduction of available water content of soil by the elimination of surface vegetation and thus the construction should avoid to this area.




Image of Thit Ta Pin Taung Area

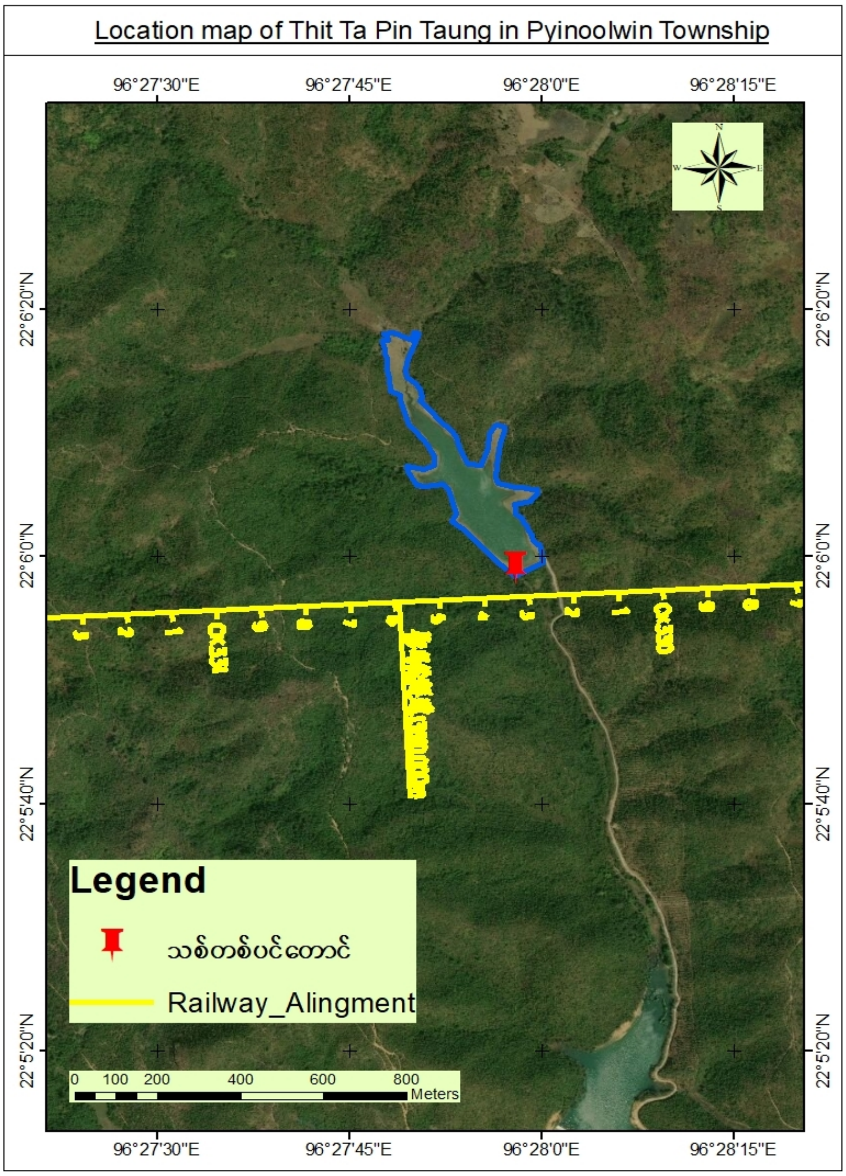


Figure - Location Map of Thit Ta Pin Taung

No	Name	Estimated distance from railway (km)
1	Thit Ta Pin Taung	0.075

Mehon-Doke-hta Wady River key biodiversity area (KBA)

The neighboring predictable area of particular biodiversity importance is the Mehon-Doke-hta Wady River key biodiversity area which found between the Pyin Oo Lwin Wildlife Sanctuary. Although, this area does not have any legal status but it is considered as an International Bird Area (IBA) by Birdlife International.

Overall, the biodiversity recorded in the Project's direct and indirect impact zones was not found to be unique, but, the ecosystems, habitats and species documented are relatively widespread and should considered most important from a conservation perspective.

Overall Suggestions

- The project is huge, long and also will drill into the mountains, underlay soil for the railway track and use a lot of construction materials. It is going to surely affect the ecosystem, original forest areas, water resources and farmlands, even if they use highest technology methods.
- As BRI, large infrastructure project, often have an irreversible environmental impact. If it is implemented in a forested area, it will surely create deforestation, and this contributes tends to climate change in the host country.
- Deforestation will be driven by the conversion of forests into plantations for agricultural commodities like bananas and rubber, supported by authorized investment and these rapidly expanding plantations grow tissue culture bananas, and the clonal genetic material and monoculture production require constant applications of chemical fertilizers and pesticides will be poisoned local communities' water supplies and ecosystems.
- It is important to note that, some areas in Myanmar are environmentally, politically and socially sensitive, so, project implementation needs to be handled carefully and must take those issues into consideration.
- Large areas of near protected forest in the project areas would be cut down to make way for power stations, as the railway line's 100 mph trains and it will be using electricity and thus many hectares of forest would be axed and also a threat to the nature of the Shan highlands because, the high-speed railway would create a lot of noise and vibration.

- Trees and plants along the planned proposed route may be removed or cut. These may include culturally important and old trees. There is a possibility of impacts due to the management of plants in order to recover trees felled during construction period.
- As for animal ecology, they constitute an important component of the natural ecosystem. The animal communities are important because of their uses as sources of biodiversity conservation and research studies, recreation, and more importantly the provision of protein in the diet of rural communities. The study area is an important habitat for some species of animals. For the present and foreseeable future, this study area is the important vegetation zone as regards conservation and utilization.
- Ecologically, the animal population plays an important role in the transfer of food energy and cycling of essential elements in the ecosystem. The study area is endowed with a large variety of animal species. The Phylum Arthropoda dominated the invertebrate community and is represented by insects, spiders, etc. Occurrence, abundant and diversity butterfly species were depend on the cultivated plant species. In this area was variety of cultivated plants and butterfly species and other insect races are more diverse and abundant.
- Bird species are found in vary habitat and depend on available food, breeding habitat and shelter for them. In this study, the most dominant species were found in bird fauna. On the whole, birds have received more attention than other groups of vertebrates in this area. This, no doubt, is due partly to the efforts of the others ornithologists society and partly to the fact that most birds are conspicuous and easy to observe. The avian population was preponderant in terms of numbers and types. They include Spotted Dove, Green bee-eater, House sparrow and House crow.
- The mammalian community was made up of diverse organisms. The most abundance of mammal species was Rhesus macaque (Monkey) and the small mammals encountered were mainly included Squirrel and Common Rat.
- Animal's habitats are the specific environment or ecological conditions in which species lives. Most habitat descriptions are based on vegetation, which reflects the climate, soil type, and other features of the local environment, and which supports the animal life in a given location. Efforts to measure habitat variables often focus on vegetation structure and attempt to quantify the presence and abundance of different plant species in the habitat.
- It is concluded that the abundance of animal species depend on food availability and

suitable habitat. However habitat can change over time due to the harvesting and utilization of the natural resources by human being and seasonal change. As the habitat changes along multifaceted biological and environmental gradients, a particular animal species can appear increase or decrease in number.

- Night lightning during construction should be restricted to the construction site.
- This project will significantly improve the local transportation condition, thus bring substantial benefits to the local economy, people's income and agricultural restructuring. It will also provide an easier access for the roadside residents to market, service and education. As a result, life quality of the local residents will be improved, and poverty alleviated. As the negative impacts to environment will be minimized and mitigated, this project has received strong supports from local people and governments. As a general conclusion, this EMP has found this Project environmentally acceptable, provided all mitigation measures designed for this Project is well implemented.
- No major rivers will be affected by the proposed project. Provided the mitigation measures being put in place, the negative impacts to other surface water bodies will be minimized.
- With appropriate management of construction camps, proper treatment of the wastewater generated, and proper disposal of the solid waste from the camps, the impact of the camps will be minimized
- For constructing the bridge use the shortest distance of the river
- Conservation of flora and fauna diversity
- Activities which are harmful for the breeding of different fish species should be avoided
- Complete all resettlements activities before the starting of the project activities.- Careful implementation of the pre-construction mitigative measure will make the construction period impacts less.
- The most effective mitigative measure will be keeping the disturbance to natural vegetation to a minimum, cutting or clearing trees where it is absolutely necessary and having contractors work in among the trees, not to clear all trees and then work. No herbicides will be used for clearing of vegetation and trees. This approach will be effective.

Mitigation Measure

Mitigation measures are required for items which are expected to cause impact on the environment. By due execution of these mitigation measures, proposed rail way project will be able to become an environmentally friendly mode of transportation. Implementation of appropriate mitigation measures during the construction and operation phases will minimize the negative impacts of the project to acceptable levels.

The most effective mitigative measure will be keeping the disturbance to natural vegetation to a minimum, cutting or clearing trees where it is absolutely necessary and having contractors work in among the trees, not to clear all trees and then work. No herbicides will be used for clearing of vegetation and trees.Mitigation measures at preconstruction/construction stages shall be proposed below.

Mitigation Measure Construction phase

-Phasing of construction work to minimise disturbance to wildlife at sensitive times of year, such as during the breeding season or when young are being raised; especially breeding season of fish between May to August.

-Storage of fuel, equipment and construction materials so as to minimise the risk of soil contamination or water pollution

-Access roads should avoid riparian zones and should be built using appropriate construction materials.

Mitigating the impacts of the operational phase

-Although siting and design of a development for bridges and culverts are the primary means for avoiding or reducing its environmental impacts, further measures can be introduced to minimise impacts occurring from the ongoing management of the site.

-The measures have been arranged according to their primary receptor, however it should be noted that many of the following mitigation measures are interrelated. For example, correct storage, use and disposal of chemicals used for site maintenance would reduce the risk of soil contamination, pollution of surface and groundwaters, and harm to terrestrial and aquatic ecology.

Mitigation the impacts of the decommission phase

The project requires the removal of structure and around stations. Decommission would be carried out by licensed contractors, in accordance with relevant regulatory requirements, and the project environmental management

Protecting ecology

Measures designed to prevent or reduce impacts to water or land will also help to prevent adverse impacts on ecology. The following list identifies further measures to reduce or avoid impacts to terrestrial and aquatic species and their habitats:

-Existing habitat features should be incorporated into site design and protected from change;

-Further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential for the site;

Culverts should be wide enough to allow for ledges and above the normal water level for the passage of mammals and should link to the banks up and downstream of the culvert;

-The design of the culvert should base to provide shelter for fish as they pass through the culvert;

-Bat and bird boxes should be provided within the riparian areas;

-Where clear span bridges are not a feasible design then a ledge, either in the form of a concrete shelf or gravel side bar, or mammal tunnels should be provided;

-Consideration should be given to the provision of features within the bridge design to encourage nesting birds and bats.

Table - Mitigation Measures in Preconstruction stage

Item of Impact	Mitigation Measure	Implementation Organization	Responsible Organization
Biota and Ecosystem Human habitation area Reserved forest and Protected area	- Construction yards shall be planned to keep damages to trees and plants to a minimum. - Removed trees and plants shall be replanted at proper locations as exsitu. - Road side trees shall be removed and replanted at proper location as much as possible. - Training of construction workers to raise awareness of environmental protection requirements,	Contractor	Related state organizations

Impact on Geology	- Construction yards shall be planned to keep damages to trees and plants to a minimum. - Construction yards shall be located as far as possible from reserved forest and protected area. - In case of finding of mineralized zones along the tunnel alignment during excavation, it will be brought to the notice of the local authorities for the directions from their end. - Appropriate blasting design will be adopted which will consider safety and for ecology.	Contractor	

Table - Mitigation Measures in Operation Stage

Item of Impact	Mitigation Measure	Implementation Organization	Responsible Organization
Biota and ecosystem Human habitation area Reserved forest and Protected area	- Fences shall be installed at Embankment and Cutting sections in order to prevent animals from entering the railway tracks. - Removed and replanted plants shall be improve - Replenish vegetation at the station regularly - Proper maintenance of trees and other vegetation along the rail way yard	Contractor	Related state organizations

Table – Mitigation Measures in Decommission Phase

Item of Impact	Mitigation Measure	Implementation Organization	Responsible Organization

To Protect Environment Reserved f	The project requires the removal of structure and around stations. Decommission would be carried out by licensed contractors, in accordance with relevant regulatory requirements, and the project environmental management.	Contractor	Related organizations

The following list identifies further measures to reduce or avoid impacts to fauna species and their habitats:

(a) Further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential for the site.
(b) Ensure there is selective clearing of the vegetation this allows future re-growth and regeneration. This will ensure minimal disruption of wild fauna's natural movement, territoriality, and other ecological processes.
(c) With regards to environmental aspect, the location of project area already occupied with landscape and wild plants of small forest type. Terrestrialorganisms may not be affected by the presence of construction of the building by control the habitat loss and noise.

Monitoring

Monitoring initiate a mechanism for implementing mitigation measures for the potential negative environmental impacts and monitor the efficiency of these mitigation measures based on relevant environmental indicators. Monitoring shall be making continuous during construction and operation phases of this project. Furthermore, environmental monitoring of the project will be undertaken regularly through of its operation to ensure that the measures are being implemented properly.

Habitat and Wildlife Population Management

Lower numbers of wildlife species near railways can be achieved by controlling populations (e.g., selective hunting, trapping), or by habitat modification. Changes in habitat structure along railway verges may also increase animals' capability to detect and evade the train.

Population control of a particular species may sometimes be used to reduce its numbers near railways. This method should only be applied on very common species, or those that can compromise human safety due to collisions. This method has been used to prevent collision with vehicles on roads (Glista et al. 2009), but its use in railways may not be as necessary since most animals will not affect trains' movements.

White Wagtail *Motacilla alba* Crested Myna *Acridotheres cristatellus*

Common Myna *Acridotheres tristis*


Collared Myna *Acridotheres albocinctus*


Red-Vented Bulbul *Pycnonotus cafer*


Streak-Eared Bulbul *Pycnonotus blanfordi*

Red-Whiskered Bulbul *Pycnonotus jocosus*

Coppersmith Barbet *Megalaima haemacephala* Grey-Headed Parakeet *Psittacula finschii*

Oriental Magpie Robin *Copsychus saularis*


Vinous-Breasted Starling *Sturnus burmannicus*


Grey Bushchat *Saxicola ferrea*


Siberian Stonechat *Saxicola maura* Plain Flowerpecker *Dicaeum concolor*


Large-Billed Crow *Corvus macrorhynchos*

Siberian Stonechat *Saxicola maura* Plain Flowerpecker *Dicaeum concolor*


Large-Billed Crow *Corvus macrorhynchos*


Scaly-Breasted Munia *Lonchura punctulata*


Pied Bushchat *Saxicola caprata* (Male & Female)


Long-Tailed Shrike *Lanius schach*


Burmese Shrike *Lanius collurioides* Brown Shrike *Lanius cristatus*

Grey-Chinned Minivet *Pericrocotus solaris* (Male)

Green Bee-Eater*Meropus orientialis*

Scarlet Minivet *Pericrocotus flammeus* (Male & Female)

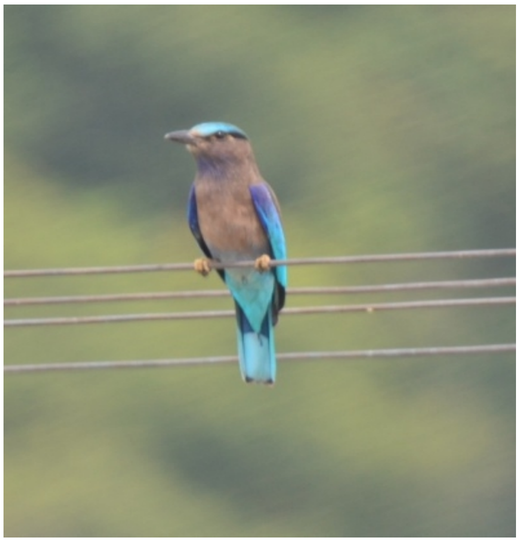
Olive-Backed Sunbird *Nectarinia jugularis*

Scarlet-Backed Flowerpecker *Dicaecum cruentatum* (Male)

Ashy Drongo *Dicrurus leucophaeus*

Bronzed Drongo *Dicrurus aeneus*

Black-Drongo *Dicrurus macrocercus*



Indian Roller *Coracias benghalensis*

Grey-Headed Canary Flycatcher *Culicicapa ceylonensis*

Plain Flowerpecker *Dicaeum concolor*

Rufous Treepie *Dendrocitta vagabunda*


White-Throated Babbler *Turdoides gularis* Black-Crested Bulbul *Pycnonotus melanicterus*


House Sparrow *Passer domesticus*


Eurasian Tree Sparrow *Passer montanus*

Plain-Backed Sparrow *Passer flaveolus*

Oriental White-Eye *Zosterops palpebrosus* Slender-Billed Oriole *Oriolus tenuirostris*

Spotted-Dove *Streptopelia chinensis*

Oriental Turtle-Dove *Streptopelia orientalis* Greater Coucal *Centropus sinensis*

Plain Martin *Riparia paludicola*


Rock Pigeon*Columba livia*


White Throated Kingfisher *Halcyon smymensis* Lesser Kestrel *Falco naumanni* (Female)


Black-Shouldered Kite *Elanus caeruleus*


Pied Harrier *Circus melanoleucos* Indian Pond Heron *Ardeola* grayii


Lesser Fish Eagle *Ichthypphaga ichthyaetus*

Mountain Hawk Eagle *Spizaetus nipalensis*

Black Kite *Milvus migrans*

Plate 1. Bird Species Recorded from Mandalay-Muse New Railway Project Area

Garden Fence Lizard *Caltoes versicolor*

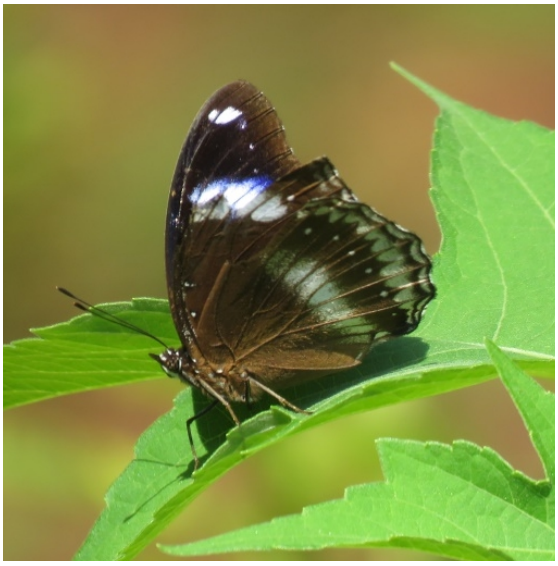
East Indian Brown Mabuya *Mabuya multifasciata*

Plate 2. Reptile species recorded from Mandalay-Muse New Railway Project Area

Common Grass Yellow *Eurema hecabe*

Gray Pansy *Junonia atlites* (Male)

Lemon Pansy *Junonia lemonias*



Great Eggfly *Hypolimnas bolina* (Male)

Common Rose *Pachliopta aristolochiae*

Blue Tiger *Danaus limniace*

Plained Tiger *Danaus chrysippus*

Psyche *Leptosia nina*

Peacock Pansy *Junonia almanac*


Redbase Jezebel *Delias pasithoe*


Common Sailor *Neptis hylas*

Yellow Pansy *Junonia hierta* (Male)


Chinese Bushbrown *Mycalesis gotama*


Dark-Branded Bushbrown *Mycalesis mineus*

Common Cruiser *Vindula erota*

Common Bush Brown *Mycalesis perseus*

Cabbage White *Pieris canidia*

Redspot Jezebel *Delias descombesi*

Lime Blue *Chilades lajus*

Dark Pierrot *Tarucus ananda*

Common Five Ring *Ypthima baldus*

Lime butterfly *Papilio demoleus*

Plum Judy *Abisara echerius*

Bamboo Treebrown *Lethe Europa*

Tailles Lime Blue/ Small Purple Line Blu

Common Redeye *Caltoris philippina*

Copper Flash *Rapala phertima*

Asian Grizzled Skipper *Spialia galba*

Plate 3. Butterfly Species Recorded from Mandalay-Muse New Railway Project Area

Crocothemis servilia Ruddy Marsh Skimmer (Male & Female)

Ground Skimmer/Chalky Percher *Diplacodes trivilis* (Male & Female)

Slender Skimmer/ Green Marsh Hawk *Orthetrum sabina*

Crimson-tailed Mash Hawk *Orthetrum pruinosum* (Male)

Crimson Mash Glider *Trithemis aurora* (Male)

Scalet March Hawk *Aethriamanta brevipennis* (Male)

Fulvous Forest Skimmer *Neurothemis fulvia*

Yellow-tailed Ashy Skimmer or common chaser *Potamarcha congener* (Male)

Blue Marsh Hawk *Orthetrum glaucaum* (Male)

Plate 4. Dragonfly Species Recorded from Mandalay-Muse Railway New Project Areas


Prunus cerasoides


Bauhinia purpurea


Eucalyptus ovata


Emblica officinalis


Castanopsis tribuloides


Quercus sp.


Quercus helferiana


Diospyros kaki


Schima wallichii

Prunus communis

Gmelina arborea

Senna siamea

Pinus insularis

Prunus persica

Albizia chinensis

Colona floribunda

Dendrocalamus latiflorus

Caryota urens

Colona floribunda

Terminalia bellerica

Albizia odoratissima

Schleichera oleosa

Bombax ceiba

Dillenia pentagyna

Dalbergia cultrata

Millettia macrostachya

Morus indica

Ficus glomerata

Tectona grandis

Dendrocalamus latiflorus

Chukrasia tabularis

Shorea siamensis

Bambusa tulda

Strychnos nux -blanda

Shorea obtusa

Musa itinerans

Plate 5. Investigated Plant Species in Project Area

Paddy field

Cabbage

Metman Yard

Irrigated field

Pineapple

Califlower

Corn

Aster flower

Plate 6. Cultivated Land Areas

ACTIVITIES PHOTOS

Preliminary Survey in the Project Area





Interview (Questionnaires' Survey), Field survey and Study Sites of Mandalay-Muse Railway Project

5.6. Infrastructure and Services

5.6.1. Transportation

(1) Mandalay Province

Mandalay is located in the central part of Myanmar. Compared with other places, Mandalay has a better transportation system, including roads, aviation, railways and waterways. The main mode of transportation in central Myanmar is highway. Three of the six main highways in Myanmar are located in Mandalay Province and adjacent Magwe Province, with Mandalay as the main hub. Starting from Mandalay, the network extends northward through Muse in northern Shan State to Kachin State and China, westward to western Myanmar and India, and southward toYangon.

The existing railway in Myanmar is basically in north-south direction, the branch line is in east-west direction, and the central railway station in Mandalay is the main hub. The main railway lines for passenger and freight transport are located between Rangoon and Mandalay. Starting from Mandalay, the railway branch lines extend eastward to Shan State, westward to Magwe Province and northward to Kachin State.

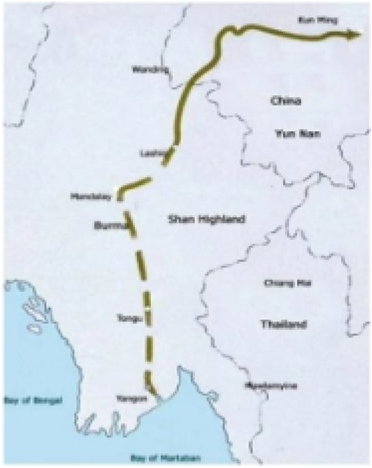
Mandalay has an international airport and serves as the central hub of central Myanmar. Most flights fly to Shan State in the East and Kachin State in the north. In addition, there are a few international flights, including direct flights to Kunming, China. Mandalay has a major port where passengers and goods are frequently transported to towns along the Ayarwaddy River.

(2) Shan State

Shan State's road network is not as developed as Mandalay Province. The most common transport route into northern Shan State is National Highways NH3 Highway, 450 km long. Lashio and Muse, which are major cities in northern Shan State, are connected to Mandalay through the NH3 Highway.

NH3 Highway

NH3 highway, also known as "Stilwell Highway” in history, has the part in Chinese border, as No. 320 National Highway Western-Yunnan Section. The length in China is 850 kilometers long; it starts from Kunming to Shwe Li Wanding Port, the length from the Wanding port to the destination Lashio, Myanmar is 603 kilometers. It is an important transportation route connecting Southeast Asian countries. At present, it can reach Yangon, Bangkok, the capital of Thailand, to India in the west and Singapore in the southeast. There is onlyNH3 highway along the line, which is a two-way two-lane road with an existing width of 8m and asphalt concrete pavement.



The line also crosses NH3 Highway several times, and some sections are parallel with the existing highway, so the traffic is relatively convenient. For the purpose of not affecting ground traffic, this project adopts girder bridge and frame bridge for railway crossing highway, and adopts road relocation or interchange culvert for lower grade roads.

Table - Individual Situation of Main Crossed Roads along the Line

S/N	Mileage	Crossing method and engineering measures	Remarks	S/N
1	CK9+880	CK9+560 Muse Station 2#frame bridge 2-10m	NH3	Highway underpass
2	CK31+650	CK31+330Kawng wing super major bridge(33×32)m simply supported girder bridge	NH3	Railway overcrossing highway
3	CK62+290	CK62+290 Pang nin Road-over bridge 5×32m	NH3	Highway overcrossing railway
4	CK88+100	Man peng1# tunnel	NH3	Highway overcrossing railway
5	CIK133+66 5	CKI133+990Sam lou super major bridge5×32m simply supported girder bridge	NH3	Railway overcrossing highway
6	CK151+630	Hang lu tunnel	NH3	Highway overcrossing railway
7	CK154+900	Hang lu tunnel	NH3	Highway overcrossing railway

8	CK153+200 (After broken chain）	CK152+453Hka shi super major bridge 49×32m simply supported girder bridge	NH3	Railway overcrossing highway
9	CK164+559	CK164+599 Kawng has super major bridge 25×32m simply supported girder bridge	NH3	Railway overcrossing highway
10	CK198+180	CK198+040 Hsup lang major bridge 12×32m simply supported girder bridge	NH3	Railway overcrossing highway
11	CK266+560	Tunnel	NH3	Highway overcrossing railway
12	CK272+880	Tunnel	NH3	Highway overcrossing railway
13	CK273+680	CK273+680 2-16m rigid frame bridge	Road under construction	Highway underpass
14	CK279+884	CK279+884 2-16m rigid frame bridge	Road under construction	Highway underpass
15	CK291+050	CK291+519 Hu ka1#super major bridge 25×32m simply supported girder bridge	NH3	Railway overcrossing highway
16	CK394+550	Mandalay Road-over bridge 9×25m	NH3	Highway overcrossing railway

Highway Bus Station

No.	Existing Bus Station	Location	Relation with the project
1	Chan Mya Shwe Pyi Highway Station	Mandalay	Existing Mandalay-Muse Highway
2	Thiri Pa Day Thar Highway Station	Pyin Oo Lwin	Existing Mandalay-Muse Highway
3	Lashio Bus Station	Lashio	Existing Mandalay-Muse Highway
4	Kyaukme Highway Bus Terminal	Kyaukme	Existing Mandalay-Muse Highway
5	Muse Highway Bus Station	Muse	Existing Mandalay-Muse Highway

Underground Pipelines

According to the survey data, there are many crossings between the newly built railway and the existing oil and gas pipelines, which have certain influence on the railway route. The main underground pipeline is the Myanmar-China oil and gas pipeline, with the diameter of 813mm-1,016mm. The starting point of Myanmar-China oil pipeline is located in Maday

Island on the west coast of Myanmar. They enter China from Shwe Li, Yunnan Province, via Rakhine, Magwe, Mandalay and Shan State of Myanmar. The total length of crude oil and natural gas pipelines is 793km. Among them, the design capacity of Myanmar-China crude oil pipeline is 22 million tons/year, and the gas transmission capacity of Myanmar-China natural gas pipeline is 12 billion cubic meters/year. On July 28, 2013, gas transmission to China started.

The line is also intersected with a small number of local water supply and drainage pipelines, underground communication cables, oil and gas pipelines and other pipelines. When the railway crosses the underground pipeline, in principle, the method of relocation, reconstruction, in-situ protection are adopted. On the premise of meeting the relevant provisions regarding pipeline protection, railway culverts or railway bridges can be adopted for passing.

Path of Myanmar-China Oil and Gas Pipeline

Table- Summary table of intersections between Myanmar-China oil and gas pipelines and the Project

No.	Intersection Mileage	Measure Taken	Remarks
1	CK229+100	Pass through by Kyankme tunnel	Railway underpass
2	CK239+500	CK239+193Pawk ang1#super major bridge 25×32m simply supported girder bridge	Railway overcrossing highway
3	CK266+725	Pass through by Kyaunggon tunnel	Railway underpass
4	CK274+350	Gohteik Nam ban ton River super major bridge 2(6×32+(1×48+2×36) steel-concrete composite girder+(148+2×260+148m)steel-concrete	Railway overcrossing highway

		double-layer composite rigid frame+2×50msteel-concrete composite girder+18×32)	

5.7. Socio-Economic Components

5.7.1. National income

Among the areas passed by Muse -Mandalay Railway, except Muse, Lashio and Mandalay, where the per capita income is higher and the people are richer, the other areas have low per capita income and there are more rural poor people.

Figure - Typical Village Building along the Line

Figure – Agricultural Lands along the Railway Line

5.7.2. Domestic water supply

In the area along Muse-Mandalay Railway, except parts of the city in Muse, Lashio, Mandalay and other cities have good urban water supply, the living water supply in other towns and rural areas along the line mainly relies on the extraction of shallow groundwater. Groundwater is generally buried at a depth of about 2-3 m. Most of the villages along the railway line are used natural spring water as drinking and domestic water.

Figure – Typical Village Well along the Line

Figure – Domestic Use for Natural Spring along the Line

5.7.3. Education

The towns of Sintgaing and Pyinoolwin in Mandalay have good basic and higher education. Other towns are too far away from educational centers and lack good teachers and facilities. There are more rural families in Shan State, and it is difficult for their children to go to middle schools. The main reason is that rural areas are far from cities and towns, and poverty in rural families force children to drop out of school and start working to support their families.

5.7.4. Socio-economic Indicators

Mandalay Region Figures at a Glance

Number of Districts	7
Number of Townships/Sub Townships	30
Total Population	6,165,723
Population Male	2,928,367 (47.49%)
Population Female	3,237,356 (52.51%)
Percentage of urban population	35%
Area (Km^2)	30,888.1
Population density (per Km^2)	199.6
Median age	28.2

Number of private households	1,323,191
Sex ratio	91 males per 100 females
Literacy rate (persons aged 15 years and over)	93.8%

Type of Identity Card (persons aged 10 years and over)	Number	Percent
Citizenship Scrutiny	3,903,980	75.8
Associate Scrutiny	4,394	0.1
Naturalised Scrutiny	14,200	0.3
National Registration	55,423	1.1
Religious	44,273	0.9
Temporary Registration	14,579	0.3
Foreign Registration	1,003	Less than 0.1%

Foreign Passport	4,360	0.1	
None	1,104,228	21.4	
Labour force participation	Both sexes	Male	Female
Age 10 and over	58.1%	73.2%	44.8%
Age 15 and over	63.9%	81.7%	48.6%
Age 15 – 64	67.9%	85.4%	52.4%
Employment to population ratio	Both sexes	Male	Female
Age 10 and over	56.2%	70.8%	43.3%
Age 15 and over	62.0%	79.3	47.1%
Age 15 – 64	65.7%	82.8%	50.7%
Material for housing	Wall	Floor	Roof
Dhani/Theke/In leaf	2.0%	-	14.0%
Bamboo	72.1%	24.8%	6.7%
Earth	0.1%	23.0%	-
Wood	6.0%	29.5%	0.1%
Corrugated sheet	0.2%	-	74.6%
Tile/Brick/Concrete	18.4%	21.5%	2.0%
Other	1.2%	1.2%	2.6%
Main source of energy for cooking			
Electricity	21.3%		
LPG	0.1%		
Kerosene	Less than 0.1%		
Biogas	0.1%		
Firewood	62.0%		
Charcoal	15.6%		
Coal	0.3%		
Other	0.5%		
Main source of energy for lighting			
Electricity	39.4%		
Kerosene	0.4%		
Candle	14.0%		
Battery	22.4%		
Generator (private)	11.1%		
Water mill (private)	0.7%		

Solar system/energy	8.1%
Other	3.9%
Main source of drinking water	
Tap water/piped	11.2%
Tube well, borehole	46.6%
Protected well/spring	18.4%
Bottled/purifier water	9.4%
TOTAL Improved	*85.6%*
Unprotected well/spring	2.0%
Pool/pond/lake	3.5%
River/stream/canal	5.3%
Waterfall/rainwater	1.4%
Other	2.2%
TOTAL Unimproved	*14.4%*
Main source of water for non-drinking use	
Tap water/piped	14.9%
Tube well, borehole	53.8%
Protected well/spring	15.0%
Unprotected well/spring	2.0%
Pool/pond/lake	5.3%
River/stream/canal	5.8%
Waterfall/rainwater	1.0%
Bottled/purifier water	0.1%
Other	2.1%

Availability of communication amenities	
Radio	39.6%
Television	52.7%
Landline phone	4.5%
Mobile phone	40.9%
Computer	3.7%
Internet at home	7.8%
% with none of the items	24.0%
% with all of the items	0.5%
Availability of Transportation equipment	
Car/Truck/Van	4.4%

Motorcycle/Moped	58.2%
Bicycle	39.6%
4-Wheel tractor	1.5%
Canoe/Boat	1.7%
Motor boat	0.5%
Cart (bullock)	28.0%

Shan State Figures at a Glance

Number of Districts	14
Number of Townships/Sub-Township	83
Total Population	5,824,432
Population Male	2,910,710 (49.97%)
Population Female	2,913,722 (50.03%)
Percentage of urban population	24%
Area (Km^2)	155,801.38
Population density (per Km^2)	37.4

Median age	24.4		
Number of private households	1,169,569		
Sex ratio	100 males per 100 females		
Literacy rate (persons aged 15 years and over)	64.6%		
Type of Identity Card (persons aged 10 years and over)	Number	Percent	
Citizenship Scrutiny	2,754,540	59.9	
Associate Scrutiny	5,805	0.1	
Naturalised Scrutiny	16,043	0.4	
National Registration	141,594	3.1	
Religious	18,259	0.4	
Temporary Registration	22,253	0.5	
Foreign Registration	5,071	0.1	
Foreign Passport	11,249	0.2	
None	1,626,375	35.3	
Labour force participation	Both sexes	Male	Female
Age (10 and over)	67.0%	76.6%	57.4%
Age (15 and over)	74.4%	85.9%	63.1%
Age (15 – 64)	77.5%	88.6%	66.4%

Employment to population ratio	Both sexes	Male	Female
Age (10 and over)	65.5%	74.9%	56.3%
Age (15 and over)	73.0%	84.2%	61.9%
Age (15 – 64)	75.9%	86.8%	65.1%
Material for housing	Wall	Floor	Roof
Dhani/Theke/In leaf	0.5%	-	16.5%
Bamboo	47.9%	30.7%	0.4%
Earth	1.3%	11.2%	-
Wood	20.2%	29.3%	0.1%
Corrugated sheet	0.9%	-	75.3%
Tile/Brick/Concrete	28.4%	27.6%	7.1%
Other	0.8%	1.2%	0.6%

Main source of energy for cooking	
Electricity	15.1%
LPG	0.2%
Kerosene	0.1%
Biogas	0.7%
Firewood	76.7%
Charcoal	6.8%
Coal	0.2%
Other	0.2%
Main source of energy for lighting	
Electricity	33.4%
Kerosene	4.0%
Candle	17.3%
Battery	3.8%
Generator (private)	2.0%
Water mill (private)	10.2%
Solar system/energy	26.6%
Other	2.7%
Main source of drinking water	
Tap water/piped	20.0%
Tube well, borehole	5.6%

Protected well/spring	17.7%
Bottled/purifier water	11.4%
TOTAL Improved	*54.7%*
Unprotected well/spring	9.0%
Pool/pond/lake	4.2%
River/stream/canal	9.9%
Waterfall/rainwater	17.3%
Other	4.9%
TOTAL Unimproved	*45.3%*

Main source of water for non-drinking use	
Tap water/piped	24.2%
Tube well, borehole	6.9%
Protected well/spring	19.9%
Unprotected well/spring	8.6%

Pool/pond/lake	4.8%
River/stream/canal	12.4%
Waterfall/rainwater	17.3%
Bottled/purifier water	0.2%
Other	5.7%
Availability of communication amenities	
Radio	23.3%
Television	54.6%
Landline phone	4.9%
Mobile phone	34.4%
Computer	2.9%
Internet at home	3.9%
% with none of the items	34.1%
% with all of the items	0.4%
Availability of Transportation equipment	
Car/Truck/Van	4.5%
Motorcycle/Moped	63.6%
Bicycle	12.3%
4-Wheel tractor	6.9%
Canoe/Boat	1.6%

Motor boat	0.7%
Cart (bullock)	17.8%

5.7.5. Overview of Important Economic Nodes along the Proposed Project

Myanmar is located in the west of Indo-China Peninsula in Southeast Asia. It is bordered by India and Bangladesh in the northwest, China in the northeast, Thailand and Laos in the southeast, the Andaman Sea in the south, the Bay of Bengal in the southwest and the total length of the coastline is 1930 km. The country has seven provinces, seven states and two central municipalities directly under the Central Government. Its territory area is about 67.65×104 km^2. It is the fortieth largest country in the world and the second largest country in Southeast Asia. In 2017, the total population was 53.39 million, ranking 26th in the world, with an urbanization rate of 34.7%.

In recent years, the government has carried out economic system reform aimed at establishing a market economy, encouraged the development of private enterprises and actively introduced foreign capital. The gross domestic product (GDP) has grown significantly. The total GDP in2015/16 is about 55.813 billion USD, and the per capita GDP is about 1064 USD. Compared with 2014/15, it has increased by 7%, and the average growth rate in recent years is about 7%, which is much higher than the average growth rate of the Association of Southeast Asian Nations (ASEAN) of 4.5%.

This line directly attracts Shan and Mandalay provinces. The main economic data of the two provinces are shown in the table below.

Table - Major Economic Indicators for the Fiscal Year 2015/2016 along the Line

Indicator	Unit	Mandalay Province	Shan State	Total
Area	10^4 km^2	3.7	15.58	19.28
Population	10,000 persons	615	619	1234
Population density	person/km^2	166	40	64
GDP	100 million USD	53.53	61.36	114.89
Per capita GDP	USD	870.48	991.25	931.06

Muse: Muse is located on the northern border of Shan State, with a population of about

450,000 (2014). Muse Port is the largest land trade port between Myanmar and China, with a trade volume of 5.8 billion USD in fiscal year 2017-2018, accounting for 86% of the border trade between Myanmar and China, ranking the first.

Lashio: Lashio is a city in northern Myanmar. It is a military, political, economic and transportation center in northern Shan State. It is also an important gateway to China in northern Myanmar. It is about 130 km away from the border port city Wanding of Yunnan Province in China. It is the end point of the Sino-Myanmar Highway. Lashio is about 280 km away from Mandalay, Myanmar's second largest city, with a population of about 610,000. The main crops are rice, corn, tea, coffee and tobacco. The main minerals are coal, iron, oil, natural gas, rutile and a variety of non-ferrous metals. The meter-gauge railway links Mandalay, and the highway connects Taunggyi, capital of Shan State, in the south, and Yunnan, China, in the north. Rangoon, Myanmar's second largest city can also be reached by airlines.

Mandalay: Mandalay provincial capital, the 2nd largest city in Myanmar, is located at the intersection of the four economic corridors in the country (north-south, east-west, northeast-southwest corridors). It is an economic, educational, transportation and medical center in northern Myanmar. As of October 2017, the total population of Mandalay City was 17.227 million, accounting for 27% of the province. The GDP in fiscal year 2015/2016 was about 2.5 billion USD, accounting for 41% of the province. The industrial structure of agriculture, industry and service industry was 3.5: 38.0: 58.5, mainly in service industry.

5.7.6. Population and Nationality

Myanmar has a rich and colorful culture. There are 135 ethnic groups, including Bama and some ethnic minorities, such as Kachin, Kaye, Karen, Mon, Ruokai and Shan. Two states/provinces with different ethnic groups living are passed by this project. Details are as follows:

Shan State: The total population is about 6.19 million. The main ethnic groups are Wa, Shan, Kachin, Lahu, Balang and Chinese.

Mandalay Province: The total population is about 6.15 million. The main ethnic groups are Burmese and Dai. The nations along the line are shown in the table below.

Table -Nationalities Distribution along the Project Area

State/Region	Main nation	Other nations

Mandalay Region	Bamar	Mostly are Han-Chinese, Indians and Shan, etc.
Shan State	Shan	Pa-O, Dai, Dongan Qiao, Danu, Blang, etc.

Generally speaking, the population of Lashio and Ayeyarwady River Plain is denser, while the population of Ruokai Mountains is sparse, and part of it belongs to no-man land.

5.8. Public Health Components

In Myanmar, there are better public health systems in Muse, Lashio and Mandalay urban areas, including municipal hospitals and community (private) medical points. The public health system in other remote areas is incomplete.

Malaria is a major public health problem in Myanmar. In the region where the project is located, the incidence of malaria is ≤5 cases per 1000 people, and the mortality rate of malaria is the highest in Shan State (6-7 cases per 100,000 people), followed by Mandalay Province (≤ 1 case per 100,000 people). The main cause of death is the inadequate medical service system.

In addition to malaria, dengue fever is a disease that occurs mainly in high-density cities and towns. The rainy season from May to June is the peak period of dengue fever spreading. The spreading of dengue fever is mainly caused by the bite of Aedes mosquitoes. According to preliminary investigation, more people in Shan State than in Mandalay Province do not use mosquito nets, and the incidence rate is higher.

5.9. Traffic Condition

Since the project is near located in the relatively populated municipal area and the nature of the project is highly interrelated with the traffic conditions especially in daytime, EIA team took a traffic study and prepared vehicle movements summaries at Muse-Mandalay Road. The purpose of the traffic study is to study the counts of vehicle movements through NH3 road and to know the peak period hours. This peak hour will help to reduce the cumulative traffic impacts due to the more vehicles during construction and operation phases of the proposed project.

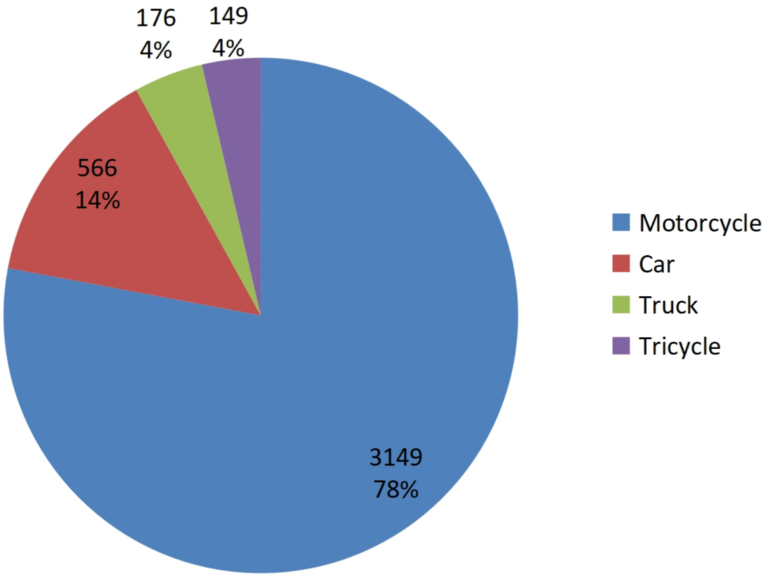
Materials and Methods

EIA team uses both of the video record and self counted by surveyors to the vehicles entering the NH3 Road. The reason to choose this point for traffic study is to analyse the vehicles entering the NH3 road during working and weekend days.

Summary of Vehicle Movements in Weekend Day

	SUMMARY OF VEHICLE MOVEMENTS				
	LOCATION: NH3 Rd				
TOWNSHIP: Lashio			CITY: Lashio		
OBSERVER: EIA Team			DATE: 20.8.2019 (Sat)		
WEATHER: Clear			Weekend Day		
REMARK:					
	VEHICLE MOVEMENTS				
TIME		Types of Vehicles			Total
BEGIN	Motorcycle	Car	Truck	Tricycle	
7:00(Am) – 10:00 (Am)	850	157	49	47	1103
11:00(Am) – 2:00 (Pm)	561	96	34	27	718
4:00(Pm) – 7:00 (Pm)	986	184	56	51	1277
7:30(Pm) – 9:30 (Pm)	752	129	37	24	942
	Traffic Volume				4040
4:00(Pm) – 7:00 (Pm)	Peak Period Hours	1277			
	Peak Period Traffic Volume				
4:00(Pm) – 7:00 (Pm)	986	184	56	51	

According to the traffic count result in weekend day, morning peak hour occurs at 7:00-10:00 am, midday peak at 11:00 am-2:00 pm, evening peak at 4:00-7:00 pm and night peak at 7:30-9:30 pm. At morning peak hour, peak volume is 1103 vehicles. In this period, vehicles coming from NH3 road as the time is inbound hours at the beginning of weekend day. At midday peak hour, peak volume is 718 vehicles. In this period, vehicles moving in all inbound and outbound directions were about the same amount. At evening peak hour, peak volume is 1277 vehicles. At night peak hour, peak volume is 942 vehicles. Comparing to morning peak volume, the peak volume recorded between 4:00-7:00 pm is significantly high. And weekend day peak volume is 4040 vehicles.



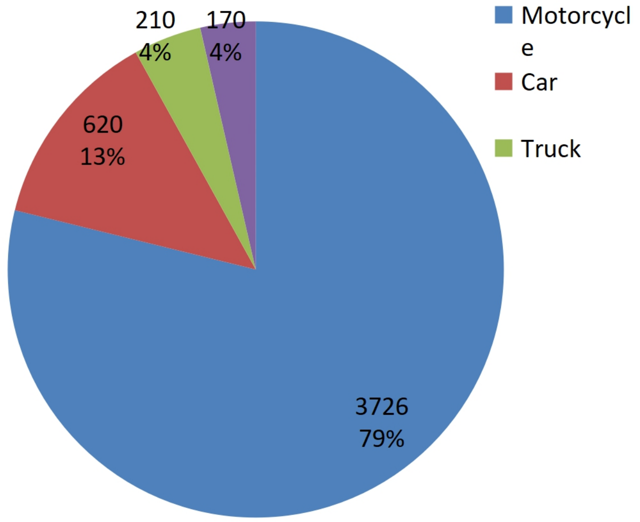
Types of Vehicles Counted in Mandalay-Lashio Road (Weekend Day)

Summary of Vehicle Movements in Working Day

	SUMMARY OF VEHICLE MOVEMENTS				
	LOCATION: NH3 Rd				
TOWNSHIP: Lashio			CITY: Lashio		
OBSERVER: EIA Team			DATE: 19.8.2019 (Fri)		
WEATHER: Clear			Working Day		
REMARK:					
	VEHICLE MOVEMENTS				
TIME		Types of Vehicles			Total
BEGIN	Motorcycle	Car	Truck	Tricycle	
7:00(Am) – 10:00 (Am)	971	163	62	51	1247
11:00(Am) – 2:00 (Pm)	657	108	39	28	832
4:00(Pm) – 7:00 (Pm)	1205	207	67	59	1538

	SUMMARY OF VEHICLE MOVEMENTS				
	LOCATION: NH3 Rd				
TOWNSHIP: Lashio			CITY: Lashio		
OBSERVER: EIA Team			DATE: 19.8.2019 (Fri)		
WEATHER: Clear			Working Day		
REMARK:					
	VEHICLE MOVEMENTS				
TIME		Types of Vehicles			Total
BEGIN	Motorcycle	Car	Truck	Tricycle	
7:30(Pm) – 9:30 (Pm)	893	142	42	32	1109
	Traffic Volume				4726
7:00(Am) – 10:00 (Am)	Peak Period Hours	1538			
	Peak Period Traffic Volume				
7:00(Am) – 10:00 (Am)	1205	207	67	59	

According to the traffic count result in working day, morning peak hour occurs at 7:00-10:00 am, midday peak at 11:00 am-2:00 pm, evening peak at 4:00-7:00 pm and night peak at 7:30-9:30 pm. At morning peak hour, peak volume is 1247 vehicles. In this period, vehicles coming from NH3 road as the time is inbound hours at the beginning of work day. At midday peak hour, peak volume is 832 vehicles. In this period, vehicles moving in all inbound and outbound directions were about the same amount. At evening peak hour, peak volume is 1538 vehicles. At night peak hour, peak volume is 1109 vehicles. Comparing to morning peak volume, the peak volume recorded between 7:00-10:00 am is significantly high.



Types of Vehicles Counted in Mandalay-Lashio Road (Working Day)

Conclusion for Traffic Study

According to the study, the vehicle movements in weekend day is greater 14.5% generation rate of in working day vehicles volume as many visitors coming to Pyin Oo Lwin, Thi Paw and Muse.

5.10. Cultural Components

5.10.1. The Distribution of Archaeology and Cultural Heritage in Mandalay Region

The distribution of cultural relics and monuments along the project is as follows:

- **Amarupa Ancient City**: located in the southwest of Mandalay City, the ancient city was built in 1364, and for more than 500 years, it has been the capital for the Awa Dynasty, and Aungzeya Dynasty for several times. The proposed railway line is about 9 km away from the ancient city.

- **Innwa Ancient City**: Located in the southwest of Mandalay, on the west bank of the Ayarwaddy River. Sagaing was built in the 14th century and was the capital of the Shan Kingdom from 1760 to 1764. The proposed railway line is about 13 km away from the ancient city.

Innwa is a major site including a lot of archaeological monuments and sites. In assessment project, these sites must be explored to identify how significant features of archaeological evidences will be come out in making assessment of impacts as well as the appropriate plan for mitigation process.

The existing risk especially disaster risk management is not efficient to protect and preserve the cultural environment of Innwa area. The topographic feature of the site is distinctively risky with the river confluence and erosion as well as the transportation and heavy loading of shipping. The elevation and features of Innwa is facing with the very crowded development plan recently.

The significant feature found nearby the project area is the concrete structure concerning with the ancient warfare and brick monastery concerned with the ancient religious dedication. Furthermore, it is closely related to the area of city walls and moats, which challenged by the river erosion due to the heavy loading of shipping and some other river formation. The earthquake is also the most important risk for this area.

(a) Queen Me Nu Brick Monastery - Maha Aungmye Bonzan Monastery (1822)

It is popularly known as Me Nu Ok Kyaung "Me Nu's Brick Monastery" that was built in 1818 by Nanmadaw Me Nu, the famous Chief Queen of Bagyidaw. For the residence of her religious Preceptor, the Nyaunggan Sayadaw, the Queen Me Nu donated this monastery. The earthquake of 1838, damaged it, and in 1873, it was restored by Sinbyumashin, Queen of Mindon, and a daughter of Nanmadaw Me Nu. The building is markedly different from traditional Burmese monasteries, which are constructed with wood, not masonry.

Figure - Queen Me Nu Brick Monastery

(b) Tha Bye Dan Fortress (1878)

The remain of Thabyedan (Thapyaytan) fortress was built by King Mindon between 1874 and 1878 to defend against the British during the third Anglo-Burmese War. It is near the Innwa Bridge. It could be related to the risk of deterioration such as human threats and development plans. But, the appropriate mitigation plan can provide the preservation of cultural significance of this site and the cultural landscape should also be emphasized in every stages of the development plans in many ways.

Figure - Tha Bye Dan Fortress

Figure - Description Pillar of Tha Bye Dan Fortress

(c) Innwa Bridge (1934)

Innwa bridge was built by British Colonial Government and it has 16 span cantilever bridge was the only structure to span the Ayeyarwady River until recently. Although now superseded by a parallel 2005 road bridge, it is still in use for railway and local road traffic.

Figure - Innwa Bridge

(d) Innwa City Wall (East and North) (14th -19th Century AD)

The northern part of Innwa is nearby the bank of Ayeyarwady River and the Eastern partis on the bank of Duthavati (Myitnge) River. These two areas are usually eroded by rivers in every rainy season. Because of the water transportation and tourism development, the challenges of this ancient urban landscape are often impacting on the landscape. The most risky impact is wasting sewage and garbage around the cultural heritage monuments.

In both of north and east, there are the places of jetty that the local and tourist can enter into the ancient cultural area by waterway. These jetties should be measured to get the loading of using the waterway to be accessible. In the time of heavy rain, these parts were usually flooded not to be accessible by car or some vehicles. Therefore, the flash flood is also the major risk for cultural heritage. The development plan can frighten the cultural landscape by their preparedness of construction and operation processes. But, it is depending on their respective types of plan. As for oil storage tanks project, even though it may be considered the various types of risks for the cultural heritage, there can be drawn out these possible impacts of visual and cumulative aspect.

(e) U-bein Bridge

Also known as the "Valentine Bridge", located in the southwest side of Mandalay City, spanning across Taungthaman Lake, built in 1851, with a 160-year history. The bridge is built of 1086 pieces of teak trees, the length of which is 1.2 km. The whole bridge is built of teak. It is the most precious treasure in Myanmar with its ancient color and rich local characteristics. The proposed railway line is about 7 km away from the bridge.

Figure - Location Plan of Railway and Cultural Relics

Consideration of Potential Impact to Cultural and Heritage in Mandalay Region

Although the tunneling will use drilling and blasting process that will impact on archeological site, there will no tunnel construction in Mandalay Region and the nearest archeology and cultural heritage site is 7km away from the railway alignment. So there will be no impact on cultural and heritage in Mandalay Region due to railway tunnels construction.

5.10.2. The Distribution of Archeology and Cultural Heritage in Shan State

Being a mountainous region, most of the Pagodas as well as some shrines are found in mountains as shown in the following figures.

Figure – Some Pagodas in Mountain

Some Shan people worship 'Guardian Spirits' by enshrining as their traditional belief as shown in the following figures.

Figure – Some Shrines beside the Road and in Mountain

5.10.3. Key Archaeology and Cultural Heritage along the Railway Line

The archaeological and cultural heritage along the railway includes:

1. Archaeological remains

2. Historic buildings

3. Historic Landscape

The study area that has been used for the current desk based data collection is defined by the route alignment of the Proposed Scheme, and an area extending 300m in all directions, sufficient to capture any features likely to be directly affected by the Proposed Scheme and taking into account any future minor design/route changes. A second study area of 500m in all directions of the route alignment has been considered to establish potential impacts on the setting of designated heritage assets.

Name of cultural heritage	Approximate distance to nearest part of proposed route (meter)	Latitude	Longitude	Category	Description	Location
Yan Tine Aung Pagoda	3278.95	22° 55.986'N	97° 43.809'E	Pagoda	Yan Tine Aung Pagoda is located at the entrance of Lashio city. The Pagoda is very famous in Lashio city.	**Lashio**
Lashio Hot spring	5707.79	22° 59.453'N	97° 46.477'E	Landscape	Lashio Hot Spring is famous tourist attraction in northern Shan State. This natural hot spring is made with the multiple swimming pool and the private bathrooms for the visiting people.	
Mansu Shan Buddhist Monastery	7107.79	22° 57.270'N	97° 45.802'E	Building	Thiri Mingalar Mansu Monastery, which has gained prominence as the home of Sayadaw Maha Thaddamma Zawtika Zay Baddanda Ponnya Nanda, who is known for anyone who needs it, regardless of religion or race stands in the big compound in downtown Lashio in Shan State.	
Hu Mon Dam	10363.75	22° 55.969'N	97° 48.020'E	Dam	Hu Mon Dam is special for whom want to relax and swim. The well-known activity is that the visitors can ride the water slide with their own along the flowing water slope.	
Sasana Year 2500 Pagoda	5568.79	22° 57.035'N	97° 44.945'E	Pagoda	-	
Baw Kyo Pagoda	1079.05	22° 35.030'N	97° 14.025'E	Pagoda	Built in the 12th century, the temple is located in Bawgyo village, several miles from the town of Hsipaw. Every march, the temple is the site of a Buddhist festival that commemorates the pagoda's founding.	**Hsipaw**
Haw Sao Pha (Shan Palace)	2458.94	22° 37.650'N	97° 18.247'E	Building	Haw Sao Kya Seng with the age of 96 years was built in 1924 for Saopha Sao Kya Seng (1947 to 1959) who was a politician, a mining engineer, an agriculturalist and the last Saopha of Hsipaw State, Myanmar, and Inge Sargent, known as Maha Devi. Sao Kya Seng was considered by the Shan people as one of the Shan national leaders who promoted federalism and democracy, together with Sao Shwe Thaik and Sao Hkun Hkio.	
Hsipaw Hot Spring	4939.53	22° 38.204'N	97° 16.281'E	Landscape	It is situated in Kyankhin Village, Hsipaw Township, Northern Shan State. Organizer normally stores the hot water from the spring to 30 foot long, 15 foot wide and 4 foot deep concrete tank and collects 200MMK per vistor to raise funds for preservation of the natural hot spring. People who want to	

					take a hot spring bath can swim at two concrete tanks within the area. Hot spring bathing assists with cardiovascular disease and nervous system imbalance. An average of 200 people visits the hot spring in each day.	
Gokhteik	981.83	22° 20.612'N	96° 51.566'E	Landscape	The Gohteik viaduct is between the two towns of Pyin Oo Lwin, the summer capital of the former British colonial administrators of Burma, and Lashio, the principal town of northern Shan State. It is the highest bridge in Myanmar and when it was completed, the largest railway trestle in the world. The bridge was constructed in 1899 by the Pennsylvania and Maryland Bridge Construction Company, and opened in 1900. The viaduct measures 689 metres (2,260 ft) from end to end. The Viaduct is described as "a monster of silver geometry in all the ragged rock and jungle, its presence was bizarre".	**Nawng Hkio**
Inn Wine Waterfall	11935.17	22° 10.657'N	96° 43.384'E	Landscape	Naung Cho City's Inn Wine waterfall is known to be one of the most beautiful waterfalls in Myanmar and has become one of the top places interested by tourist to visit along with the peaceful nature of Naung Cho City. It is situated near Sin Shwe Le (2) Sugar Manufacturing Industry.	
Upper Yeywa Hydropower Plant	23395.31	22° 14.596'N	97° 5.846'E	Dam	The construction of 280-megawatt Upper Yeywa hydropower project is planned to finish in 2022 and it will produce 1.409 billion kilowatts hours of electricity annually, according to Ministry of Electricity and Energy. Hydropower Implementation Department is developing Upper Yeywa hydropower project on Dotawady River about 20 miles away from Kyaukme in northern Shan State. The electricity generated from the dam project will be accessed to national grid and it will be provided 2.7 million people (about 6.6 per cent of total population) more, announced the ministry.	
Pwe Kouk Waterfall	4460.77	22° 4.142'N	96° 33.383'E	Landscape	The water fall is located suburb of Pyin Oo Lwin, and small waterfall and park, and it is the type of multiple waterfall. This sightseeing spot is almost for Myanmar people, and there is a pagoda, close to the waterfall, MaharAnhtoo Kanthar Pagoda. This pagoda is famous for Myanmar people.	**Pyin Oo Lwin**
Pate Chin Myaung Cave	6261.10	22° 5.757'N	96° 37.216'E	Landscape	Peik Chin Myaung is a limestone stalactite cave situated south of Wetwun village, 23 km from Pyin Oo Lwin, Myanmar. The cave was firstly developed by local Nepalese or Gakhar and later co-opted by the Myanmar government as a tourist attraction in 1990. The cave covers an area of 45 acres, where local plants named Peik Chin, alike long pepper vine used to grow by the mouth of the cave. It is estimated to be 230 million to 310 million years old from the formation of limestone and hillocks. After the establishment of shrines with many Buddhist stupas inside the cave, it has also been called Maha Nadamu cave.	

Shwe Myin Tin Pagoda	6790	22° 2.319'N	96° 28.906'E	Pagoda	Shwe Myin Tin Pagoda is located 0.42 kilometer from Mandalay-Muse Highway.	
Dat Taw Gyaint Waterall	7242.92	21° 58.817'N	96° 23.216'E	Landscape	Dat Taw Gyaint is a tufa waterfall formed by limestone rich water from a karst spring. It, also commonly known as Anesakan Falls, is a magical waterfall with a blue, natural and refreshing swimming hole. Nestled at the bottom of a jungle canyon, this waterfall sits beside a small temple and is one of the best hidden gems in Myanmar. Dat Taw Gyaint Waterfall is located along the road from Mandalay to Pyin Oo Lwin near a small village known as Anesakhan	
Purcell Tower	7960.58	22° 1.603'N	96° 27.846'E	Building	Purcell Tower stands in the heart of the town, Pyin Oo Lwin. The clock was one of the few made in 1934 by Gillete and Johnson Co. of England in commemoration of the Silver Jubilee of the reign of King George V of Britain.	
Taung Kyaung Gyi Monastery	8150	22° 1.485'N	96° 27.867'E	Building	-	
Orchid Nan Myaing Hotel	8464.88	22° 0.928'N	96° 27.035'E	Building	Orchid Hotel Nan Myaing is a hotel in a good neighborhood, which is located at Pyinoolwin. Not only well positioned, but Orchid Hotel Nan Myaing is also one of hotels near the following Atumashi Monastery within 34.77 km and Kuthodaw Pagoda within 34.82 km. 24-hours front desk is available to serve from check-in to check-out, or any assistance what is needed.	
Candacraig Hotel	9037.58	22° 1.073'N	96° 28.694'E	Building	It is a historic building in Pyin Oo Lwin. Dating from 1904 and formerly the British Club, this colonial pile comes complete with side turrets and is set in attractively manicured gardens. There's a slightly spooky air to the place – many locals believe it's haunted and it has been closed for long-delayed renovations for a while. But the gates are normally open, so cycle in for a look.	
National Kandawgyi Botinical Garden	11097.99	21° 59.637'N	96° 28.168'E	Landscape	The National Kandawgyi Botanical Gardens (formerly National Botanical Gardens) is a 177 hectare botanical garden located in the Alpine town of Pyin Oo Lwin, situated at an elevation of 1000 meters (3,605 ft) and 69 km (43 mi) by road from Mandalay. It was first established in 1915 as the Maymyo Botanical Gardens by Alex Roger, a Forest Officer. The original site was 30 acres and was modelled after the Kew Gardens of England with the help of an amateur gardener called Lady Cuffe. The Botanical Gardens has three museums. The Fossils Museum houses fossils of mammals, reptiles, and invertebrates, and the Petrified Wood Museum displays fossils of plants, colorful stones, toddy-palm	

					roots, as well as things made from fossils of plants. The Butterfly Museum has various species of butterflies from Nepal, Taiwan, South America, Japan and South East Asia.	
Thitsar Myaing (Tapsy Villa)	8924.87	22° 1.111'N	96° 28.309'E	Building	These are the representatives of architecture, town planning, and infrastructure introduced by British Colonial Regime during the period of the end of Second World War. Nowadays most of these buildings is changed to hotels, restaurants, and tourist attractions.	
Cherry Myaing (Linduden)	9872.51	22° 0.592'N	96° 28.536'E	Building		
Hinthar Myaing (Jacobstowe)	9696.14	22° 0.689'N	96° 28.277'E	Building		
Thazin Myaing	9584.93	22° 0.741'N	96° 28.455'E	Building		
Gandamar Myaing (Croxton)	9116.12	22° 1.004'N	96° 28.218'E	Building		
Htinshu Myaing	9155.99	22° 0.974'N	96° 28.516'E	Building		
Yuzana Myaing (Knowle)	10273.76	22° 0.369'N	96° 28.421'E	Building		
Maha Ganda Yone Monastery	5594.70	16° 51.189'N	96° 9.586'E	Building	The monastery is known for its strict adherence to the Vinaya, the Buddhist monastic code. The monastery was first established by Agatithuka Sayadaw, a Thudhamma-affiliated monk around 1908, as a meditation monastery for forest-dwelling monks. A thousand Buddhist monks and novices line up every morning, at 10 o'clock, to receive their meal of the day at Mahar Gandar Yone Monastery.	**Mandalay**
Shwenandaw Monestery	5870.45	22° 0.040'N	96° 6.821'E	Building	Shwenandaw Monastery (Golden Palace Monastery) was built in 1878 by King Thibaw Min, who dismantled and relocated the apartment formerly occupied by his father, King Mindon Min, just before Mindon Min's death, at a cost of 120,000 rupees. The building was originally part of the royal palace at Amarapura, before it was moved to Mandalay, where it formed the northern section of the Hmannan (Glass Palace) and part of the king's royal apartments. The building was heavily gilt with gold and adorned with glass mosaic work. The monastery is known for its teak carvings of Buddhist myths, which adorn its walls and roofs. The monastery is built in the	

					traditional Burmese architectural style. Shwenandaw Monastery is the single remaining major original structure of the original Royal Palace today.	
Maha Atulawaiyan (Atumashi) Kyaungdawgyi	5980.14	22° 0.064'N	96° 6.756'E	Building	The Atumashi Monastery (formally Maha Atulaveyan Kyaungdawgyi) was built in 1857 by King Mindon at a cost of 500,000 rupees. The original structure burned down in 1890 after a fire in the city destroyed both the monastery and the 30 feet (9.1 m) tall Buddha image, as well as complete sets of the Tipitaka. During the fire, a 19.2-carat diamond, which adorned the Buddha image (originally given to King Bodawphaya by Maha Nawrahta, the Governor of Arakan) disappeared as well. In 1996, Burma's Archaeological Department reconstructed the monastery with prison labor.	
Kuthodaw Pagoda	6193.64	22° 0.281'N	96° 6.774'E	Pagoda	Kuthodaw Pagoda (formally titled Mahalawka Marazein) contains the world's largest book lied at the foot of Mandalay Hill and was built during the reign of King Mindon. In the grounds of the pagoda are 729 kyauksa gu or stone-inscription caves, each containing a marble slab inscribed on both sides with a page of text from the Tripitaka, the entire Pali Canon of Theravada Buddhism. In 2013, UNESCO plaque indicating that the Maha Lawkamarazein or Kuthodaw Inscription Shrines at Kuthodaw Pagoda, were inscribed on to the Memory of the World Register.	
Sanda Muni Pagoda	6369.83	22° 0.211'N	96° 6.587'E	Pagoda	Sandamani Pagoda is a Buddhist stupa located southwest of Mandalay Hill and was commissioned by King Mindon Min in 1874 as a memorial to Mindon Min's younger brother, Kanaung Mintha. This pagoda contains the graves of the Kanaung, Sagu Mintha, Malun and Maingpyin Princes. It also contains an iron image of the Buddha cast by Bodawpaya of the Konbaung dynasty in 1802. The statue reportedly weighs 40,924.8 pounds (18,563.2 kg).	
Kyauktawgyi Pagoda	6708.50	22° 0.268'N	96° 6.396'E	Pagoda	Kyauktawgyi Pagoda in Amarapura was built in 1847 by King Bagan Min on the model of the Ananda Pagoda at Bagan. It exemplifies a type of architecture, which though borrowed from the Indian designs at Pagan, was constructed entirely by Burmese architects. The artistic interest of the temple lies in the numerous frescoes with which its four porches are adorned. The pagoda is crowned with a five-tiered pyatthat roof.	
Mahawizaya yanthi Pahtoedawgyi	6879.92	21° 54.677'N	96° 3.390'E	Pagoda	Pahtodawgyi is a Buddhist pagoda located in Amarapura, north of the Taungthaman Lake. It was built in 1819 by King Bagyidaw.	**Manadalay**
Mandalay Palace	6960.92	21° 59.579'N	96° 5.772'E	Building	The Mandalay Palace known as The Famed Royal Emerald Palace is the last royal palace of the last Burmese monarchy. The palace was constructed	

					between 1857 and 1859 and was the primary royal residence of King Mindon and King Thibaw, the last two kings of Myanmar. The palace is famous for Great Audience Hall, Lion Throne Room, Watch Tower, Royal Mausoleums and Glass Palace. Throughout the British colonial era, the palace was seen by the Burmese as the primary symbol of sovereignty and identity. Much of the palace compound was destroyed during Second World War by allied bombing; only the royal mint and the watch tower survived. A replica of the palace was rebuilt in the 1990s with some modern materials. Today, Mandalay Palace is a primary symbol of Mandalay and a major tourist destination.	
Su Taung Pyae Pagoda	7340.74	22° 0.892'N	96° 6.449'E	Pagoda	Su Taung Pyae Pagoda is located at the top of the Mandalay Hill. Mandalay Hill is known for its abundance of pagodas and monasteries, and has been a major pilgrimage site for Burmese Buddhists for nearly two centuries. A panoramic view of Mandalay from the top of Mandalay Hill alone makes it worthwhile to attempt a climb up its stairways.	
Bagaya Monastery	7663.28	21° 55.144'N	96° 3.537'E	Building	This magnificent monastery is also known as Maha Waiyan Bontha Bagaya Monastery. During King Hsinbyushin's reign (1763–1776), Maha Thiri Zeya Thinkhaya, town officer of Magwe built the monastery in the Bagaya monastic establishment and dedicated to Shin Dhammabhinanda. The monastery, which was built with 267 gigantic teak wood posts, has a structure of great dimensions: 188 feet (57 m) high in length and 103 feet (31 m) in width. The monastery is decorated with splendid Burmese architectural works such as carvings, floral arabesques, the ornamentation with curved figurines and the reliefs of birds and animals as well as small pillars decorated on the wall, the artistic works of Inwa Era. . It is one of the famous tourist attractions in Myanmar.	
Mahar Myat Muni Pagoda	7855.09	21° 57.111'N	96° 4.707'E	Pagoda	The Mahamuni (literal meaning; The Great Sage) Buddha Temple is a Buddhist temple and major pilgrimage site, located southwest of Mandalay. Ancient tradition refers to only five likenesses of the Buddha, made during his lifetime; two were in India, two in paradise, and the fifth is the Mahamuni Buddha image in Myanmar. The temple has a central shrine and is framed by an extensive grass lawn. A major annual pagoda festival is held in early February, at the end of the Buddhist Lent to celebrate the history of the pagoda.	
U-bein Bridge	7000	21° 53.495'N	96° 3.471'E	Landscape	U Bein Bridge is a crossing that spans the Taungthaman Lake near Amarapura. The 1.2-kilometre (0.75 mi) bridge was built around 1850 and	

					is believed to be the oldest and once longest teakwood bridge in the world. It features 1,086 pillars that stretch out of the water, some of which have been replaced with concrete.	
Maha Aungmye Bonzan Monastery	8963.03	21° 51.502'N	95° 59.070'E	Building	Maha Aungmye Bonzan Monastery is commonly known as the Me Nu Brick Monastery. The monastery was built by Queen Nanmadaw Me Nu in 1818. This monastery is one of the finest specimens of Myanmar architecture during the Konbaung Period (19th century). Its architecture is in simulation of wooden monasteries with multiple roofs and a prayer hall of seven-tiered superstructure.	
Amarapura Ancient City	9000	21° 54.228'N	96° 2.966'E	Archaeolog ical Remains	Amarapura is a former capital of Myanmar during the Konbaung period (1783–1821 and 1842–1859). It is historically referred to as Taungmyo (Southern City) in relation to Mandalay. Amarapura today is part of Mandalay, as a result of urban sprawl. The township is known today for its traditional silk and cotton weaving, and bronze casting. It is a popular tourist day-trip destination from Mandalay.	
Shwe In Bin Monastery	9256.34	21° 57.972'N	96° 3.956'E	Building	Shweinbin Monastery was built in the tradition of Burmese teak architecture in 1895 by a Sino-Burmese merchant married to a Burmese woman of royal extraction. The monastery's construction strictly adheres to traditional rules of Burmese monastic architecture and includes all of the designated pyatthat-crowned pavilions.	
Soon U Ponya Shin Pagoda	9863.10	21° 54.121'N	95° 59.547'E	Pagoda	One of the most tourist attraction places on Sagaing Hills is Soon U Pon Nya Shin Pagoda and is connected by a set of covered staircases that run up the 240 meters hill and is one of the oldest temples on Sagaing Hills. It was built in 1312 by Minister Pon Nya. An annual Pagoda festival is held on Full Moon Day of Warso, the fourth month of the Myanmar Calendar, which falls in July of each year. It is famously known to have the earliest Soon (food) offered by angels before any human	**Sagaing**
Uminkoeze Pagoda	9850.68	21° 54.298'N	95° 59.697'E	Pagoda	Uminkoeze pagoda is situated in Sagaing Hill, Sagaing.	
Sagaing City	13000	21° 54.952'N	95° 57.728'E	Landscape	Sagaing is the capital of the Sagaing Region and is located in the Irrawaddy River, 12 mi to the south-west of Mandalay on the opposite bank of the river. Sagaing with numerous Buddhist monasteries is an important religious and monastic centre. The pagodas and monasteries crowd the numerous hills along the ridge running parallel to the river. The central pagoda, Soon U Ponya Shin Pagoda, is connected by a set of covered staircases that run up the 240 m (790 ft) hill.	

Mingun Pahtodawgyi	17206.57	22° 3.051'N	96° 1.055'E	Archaeological Remains	The Mingun Pahtodawgyi is an incomplete monument stupa in Mingun. The ruins are the remains of a massive construction project begun by King Bodawpaya in 1790 which was intentionally left unfinished. The pahtodawgyi is seen as the physical manifestations of the well-known eccentricities of Bodawpaya. The completed stupa would have been the largest in the world at 150 metres (490 ft). Huge cracks are visible on the structure from the earthquake of 23 March 1839.	
Mingun Bell	17319.29	22° 3.180'N	96° 1.070'E	Archaeological Remains	King Bodawpaya also had a gigantic bell cast to go with his huge stupa. The Mingun Bell, weighing at 90 tons, is today the second largest ringing bell in the world. The weight of the bell in Burmese measurement, is 55,555 viss or peiktha (1 viss = 1.63 kg), handed down as a mnemonic "Min Hpyu Hman Hman Pyaw", with the consonants representing the number 5 in Burmese astronomy and numerology.	
Mya Thein Tan Pagoda	17609.28	22° 3.351'N	96° 0.992'E	Pagoda	Mya Thein Tan Pagoda also known as Hsinbyume Pagoda is a large pagoda on the northern side of Mingun in Sagaing Region and was built in 1816 by Bagyidaw. It is dedicated to the memory of his first consort and cousin, Princess Hsinbyume. The pagoda's design is a great departure from Burmese pagoda design norms. It is based on descriptions of the mythical Sulamani pagoda on Mount Meru, and the lower parts of the pagoda represent the mountain. Seven concentric terraces represent the seven mountain ranges going up to the Mount Meru according to Buddhist mythology.	

There are no well-known cultural heritage such as Archaeological remains, Historic buildings and Historic landscapes within the 500 meters of EIA study area. Pagoda, monasteries and religious areas will also be avoided although it does not consider as historical places.

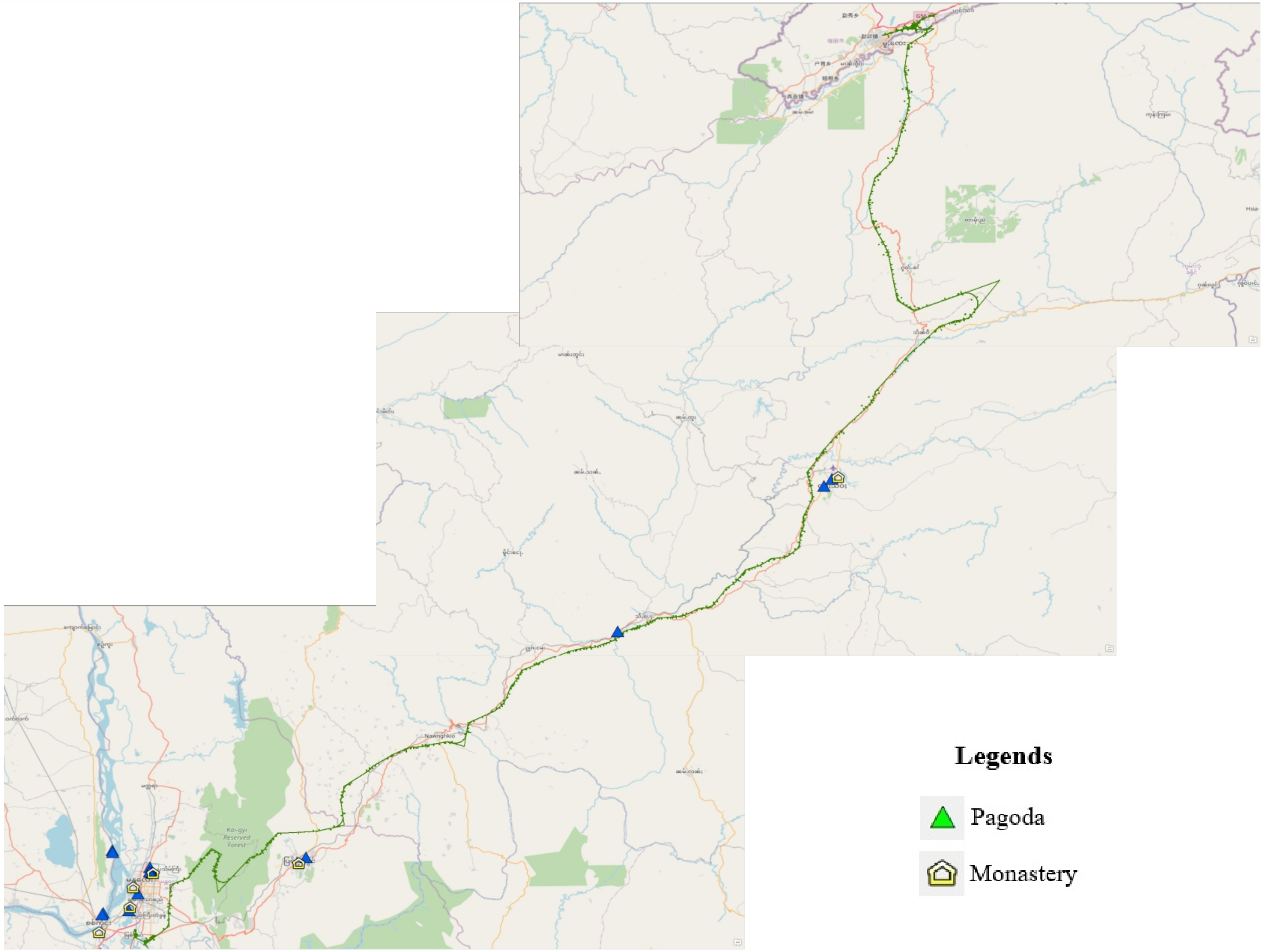


Figure - Pagodas and Monastries within 500 km along the Alignment

5.11. Visual Components including where applicable landscape, city scape and sea scape using three dimensional models

After the project, bridges and culverts along the alignment can be displeasing scenery for local people and tourists as follow:

Before Project (Shwe Li River)

After Project (Bridge)

After Project (Culvert)

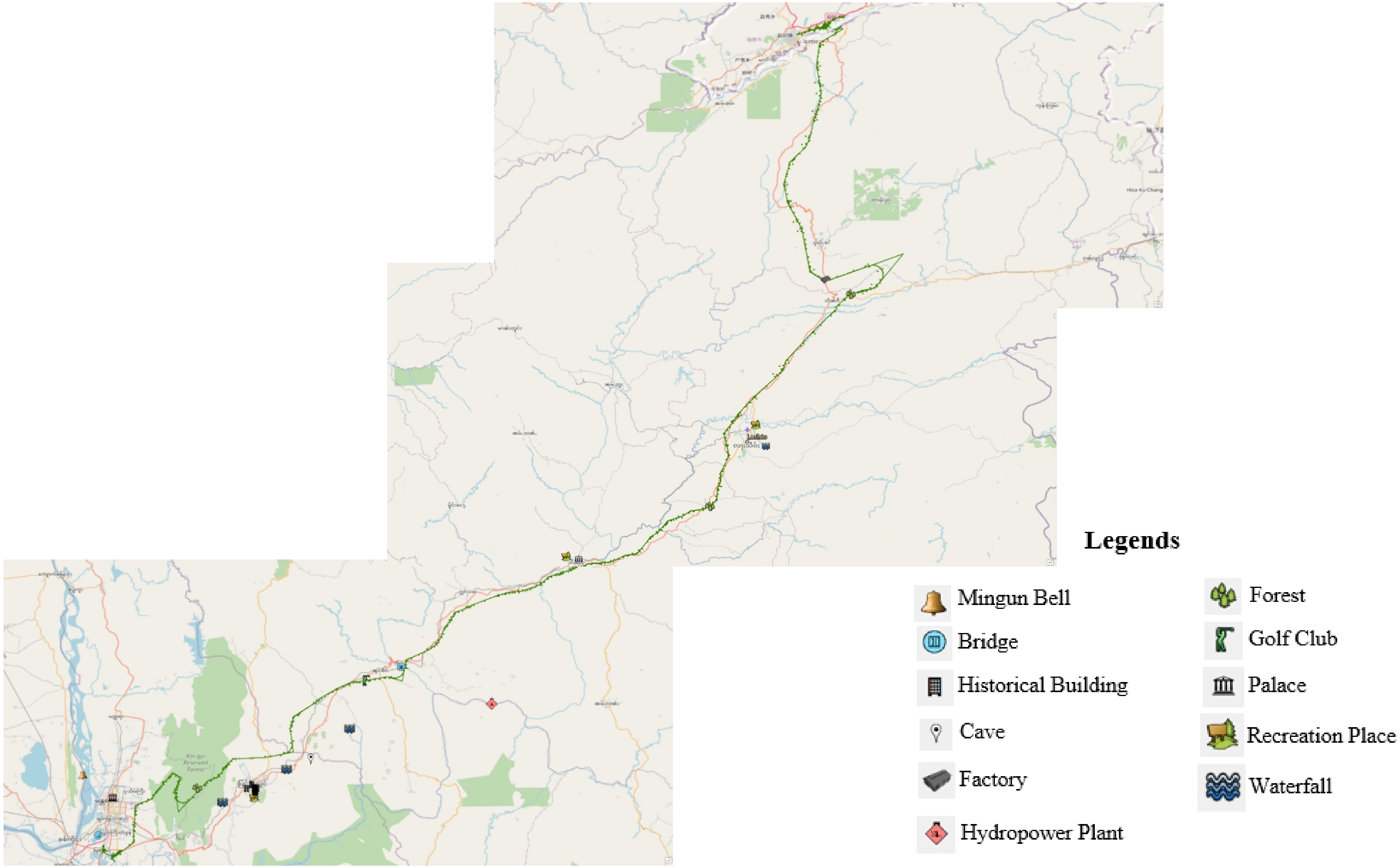


Figure - Visually Sensitive Areas along the Railway

Consideration of Sensitive Areas by Overlay Mapping System

Overlay mapping system can consider the new map that descripe the multivariate data set. For each area, we can attibute

Data layers must be referenced to the same coordinate system (e.g., the same UTM and SPC zones), the same map projection (if any), and the same datum (horizontal and vertical, based upon the same reference ellipsoid). Furthermore, locations must be specified with coordinates that share the same unit of measure.

Once the geometric stage is completed we can consider the new map as area observations for a multivariate data set. For each area we can have a large number of attribute values such as population density, type of land use, flood risk, etc. Using this information we can look for relationships in the data – for example, to see if it is possible to build a regression model based on the attributes so that one dependent attribute can be found or estimated using one or more other independent attributes.

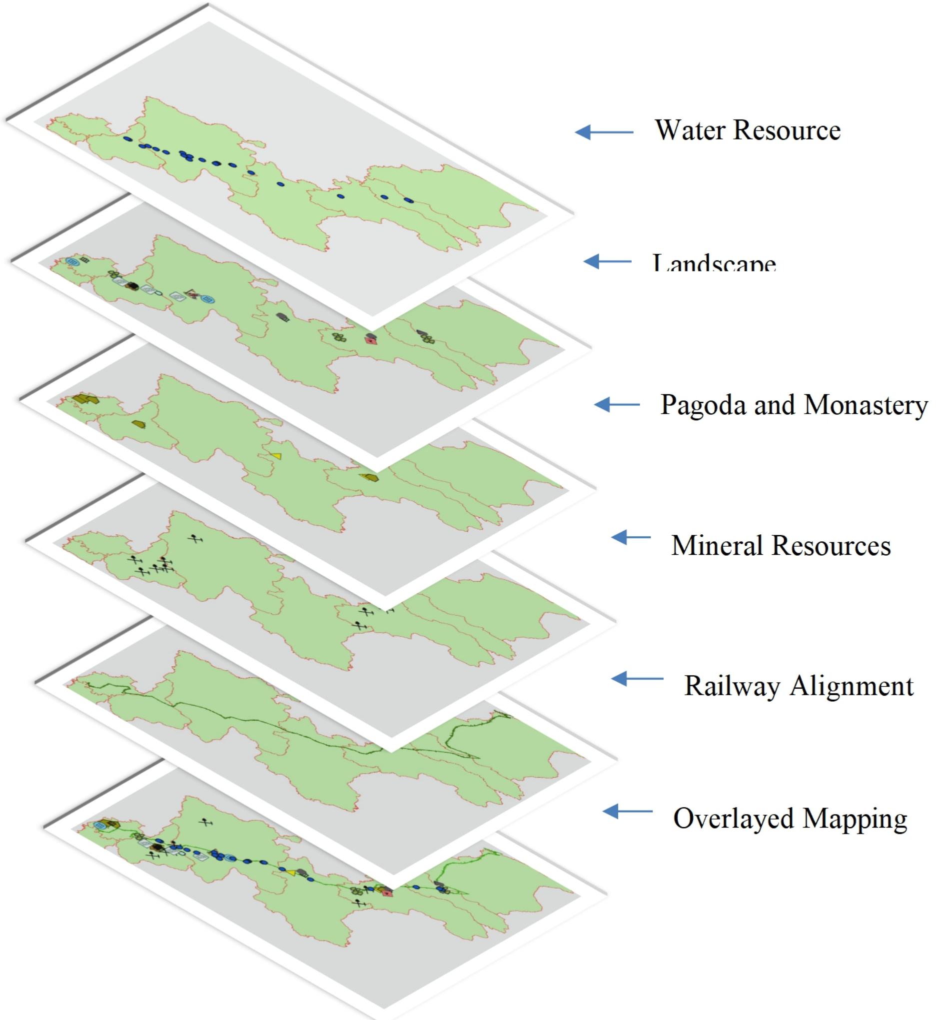


Figure - Overlayed Mapping to Consider Sensitive Areas

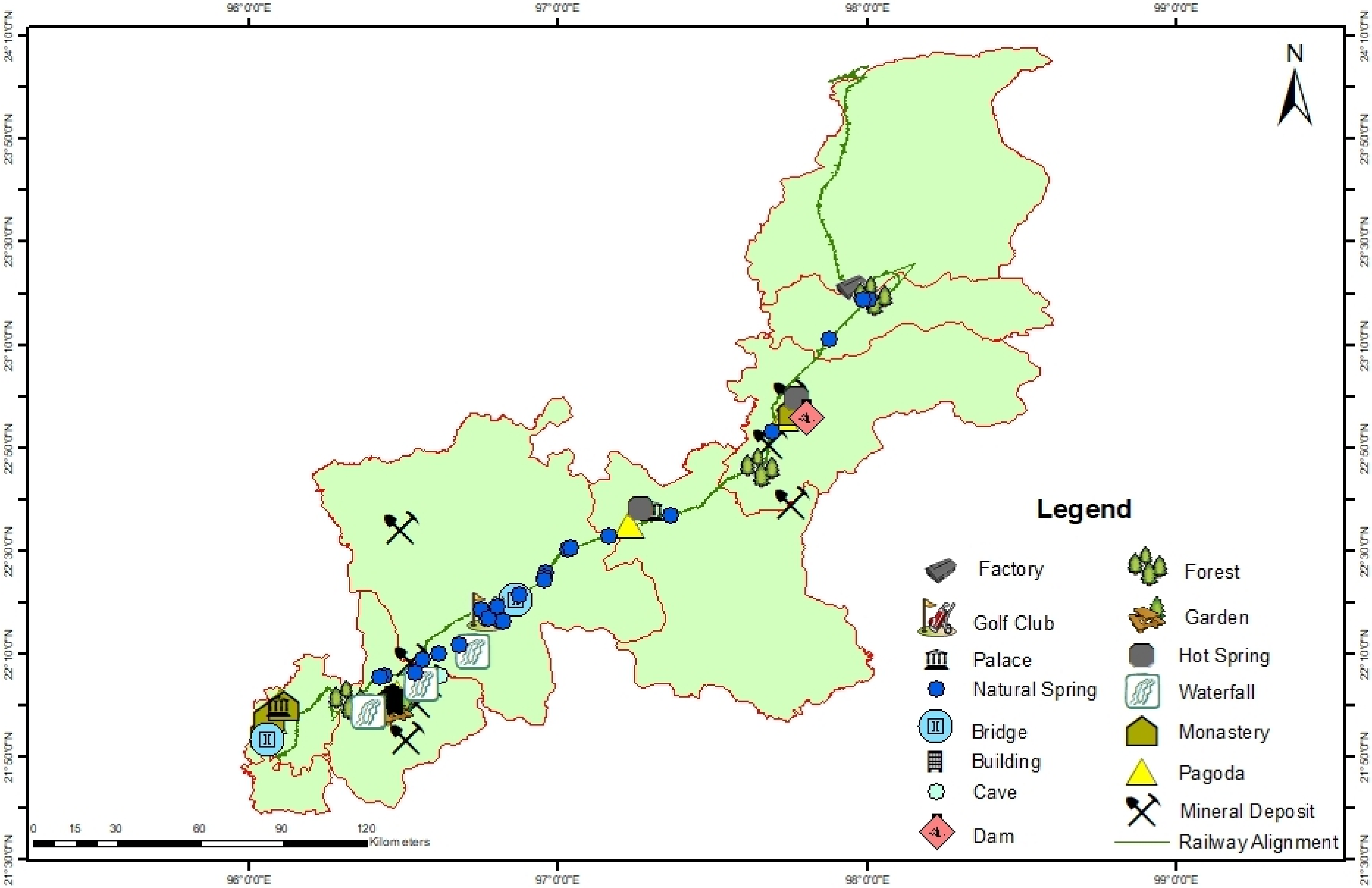


Figure - Overlayed Map of Sensitive Areas along the Muse-Mandalay Railway

According to the overlay mapping system for the whole alignment, the most senvitive areas within 500 m along the railway bridges will be as follow:

Table – Sensitive Areas near the Bridges along the MMR Alignment (Within 1km Radius)

		Residential Area		*Historical, Archaeological, Cultural and Heritage*		*Mineral Abundance Areas*		*Surface Water Resources*		*Landscape and Visual*	
		Village	*Location*	*Sensitive Zone*	*Location*	*Resources Area*	*Location*	*Resources*	*Location*		
Border to Muse Station (24.006486°, 97.954332°)	Shwe Li Double-track Super Major Bridge	Nan Soon	24.030702, 97.982782	-	-	-	-	Shwe Li River	24.033068°, 97.977441°	Forest Area	Agricultural Land
	Nam Pang Double-track Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Muse Double-track Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Muse Station (24.006486°, 97.954332°) to Pang Hkam Station (23.924275°, 97.930225°)	Man Hk wng 1# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Man Hk wng 2# Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Man Hk wng 3# Major Bridge	Kaung Khan	23.989151, 97.927925	-	-	-	-	-	-	Forest Area	Agricultural Land
	Nam Paw Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Pang Hkam Station Double-track Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land

Pang Hkam Station (23.924275°, 97.930225°) to Man Hwang Station (23.840273°, 97.935907°)	Nam Paw Major Bridge	-	-	-	-	-	-	Nam Paw River	23.888668°, 97.933014°	Forest Area	Agricultural Land
Man Hwang Station (23.840273°, 97.935907°) to Na Hpai Station (23.735083°, 97.907042°)	Man Hwang Major Bridge	Nan Om	23.826240, 97.935353	-	-	-	-	-	-	Forest Area	Agricultural Land
	Kawng Wing Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Kho Mung 1# Super Major Bridge	Phat Mhan	23.977210, 97.916416	-	-	-	-	-	-	Forest Area	Agricultural Land
	Kho Mung 2# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Kho Mung 3# Major Bridge	-	-	-	-	-	-	-	-	-	Agricultural Land
	Man Shao Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Na Hpai Station (23.735083°, 97.907042°) to Nan Hpak Ka Station (23.660356°, 97.852678°)	Khai Tal 1# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Khai Tal 2# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Nan Hpak Ka Station (23.660356°, 97.852678°) to Pang Nin Station	Nam Hpak Ka Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Nam Maw Hkam Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land

(23.570530°, 97.851733°)	Pang Kai 1# Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Pang Kai 2# Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Nam Hkai River Major Bridge	-	-	-	-	-	-	Nam Hkai River	23.604513°, 97.841143°	Forest Area	Agricultural Land
	Pang Nin Station Double-track Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Pang Nin Station (23.570530°, 97.851733°) to Kutkai Station (23.469516°, 97.894684°)	Pang Nin Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Gang Ka 1# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Gang Ka 2# Major Bridge	Mang Lon	23.532197, 97.872483	-	-	-	-	-	-	Forest Area	Agricultural Land
	Gang Ka 3# Super Major	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Kutkai Station (23.469516°, 97.894684°) to Mang Peng Station (23.371909°, 97.931348°)	Kutkai 1# Super Major Bridge	Ho Nar	23.468220, 97.892402	-	-	-	-	-	-	Forest Area	Agricultural Land
	Kutkai 2# Major Bridge	Nam Khone	23.439460, 97.895019	-	-	-	-	-	-	Forest Area	Agricultural Land
	Palaung Super Major Bridge	Man Nawng	23.418225, 97.902488	-	-	-	-	-	-	Forest Area	Agricultural Land
Mang Peng Station (23.371909°, 97.931348°) to Nwang Yen Station (23.399132°, 98.055187°)	Mang Peng 1# Major Bridge	Factory	23.365911, 97.948227	-	-	-	-	-	-	Forest Area	Agricultural Land
	Mang Peng 2# Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land

Nwang Yen Station (23.399132°, 98.055187°) to Laban Pa Station (23.333072°, 98.059699°)	Nawang Yen Double-track Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Nawang Yen Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Laban Pa Three track Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Laban Pa Station (23.333072°, 98.059699°) to Theinni Station (23.293231°, 97.985080°)	Laban Pa Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Shang Quan 1# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Shang Quan 2# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Shang Quan 3# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Lang ming Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Theinni Super Major Bridge	Mang Chat	23.313305, 98.008298	-	-	-	-	Natural Spring	23.313305, 98.008298	Forest Area	Agricultural Land
		Mang Sar Tone	23.309274, 97.999011	-	-	-	-	-	-		
		Wane Line	23.309188, 97.988722	-	-	-	-	Natural Spring	23.309188, 97.988722		
Theinni Station (23.293231°, 97.985080°)	Nam Tu River 1# Super Major Bridge	Nawng On	23.278872, 97.969783	-	-	-	-	Nam Tu River	23.289810°, 97.976761°	Forest Area	Agricultural Land

to Sam Lou Station (23.201112°, 97.894590°)	Nam Tu River 2# Super Major Bridge	Pan Sone	23.259018, 97.938860	-	-	-	-	-	-	Forest Area	Agricultural Land
	San lou Super Major Bridge	Nan Onn	23.206558, 97.902174	-	-	-	-	-	-	Forest Area	Agricultural Land
Sam Lou Station (23.201112°, 97.894590°) to Hang Lu Station (23.127267°, 97.840565°)	Ban pa 1# Major Bridge	Nam Maw Heik	23.164425, 97.869158	-	-	-	-	-	-	Forest Area	Agricultural Land
	Ban pa 2# Super Major Bridge	Pang Phat	23.144800, 97.854208	-	-	-	-	-	-	Forest Area	Agricultural Land
Hang Lu Station (23.127267°, 97.840565°) to Lashio North Station (23.048538°, 97.759070°)	Kawng ai Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Lashio North Station Three Track Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Lashio North Station (23.048538°, 97.759070°) to Lashio West Station (22.981536°, 97.705398°)	He bo Super Major Bridge	Ho Pate	23.044302, 97.756349	-	-	-	-	-	-	Forest Area	Agricultural Land
	Dang nao 1#Major Bridge			-	-	-	-	-	-	Forest Area	Agricultural Land
	Dang nao 2#Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Nam Yao River Major Bridge	-	-	-	-	-	-	Nam Yao River	23.011512°, 97.722750°	Forest Area	Agricultural Land
	Na gang 1#Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land

	Na gang 2#Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Na gang 3# Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Lashio West Station (22.981536°, 97.705398°) to Mehan Station (22.870083°, 97.688677°)	Ke ning 1# Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Ke ning 2# Super Major Bridge	Khar Shi	22.950894, 97.695643	-	-	-	-	-	-	Forest Area	Agricultural Land
	Ho yau 1# Super Major Bridge	Kaung Ma Kyan	22.938349, 97.694631	-	-	-	-	-	-	Forest Area	Agricultural Land
	Ho yau 2# Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Gong bang Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Man Hpai Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Mehan Super Major Bridge	Mal Han	22.883921, 97.694954	-	-	-	-	Natural Spring	22.883921, 97.694954	Forest Area	Agricultural Land
		Lwin Lount	22.870793, 97.688123G	-	-	-	-	-	-		
Mehan Station (22.870083°, 97.688677°) to Nam Un Station (22.771006°, 97.656280°)	Hka shi Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Pein nyaung 1# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Pein nyaung 2# Major Bridge	San Pyat	22.814816, 97.667802	-	-	Quarry	22.849777, 97.689589	-	-	Forest Area	Agricultural Land
	Ho hko Super Major Bridge	Khay Ninn	22.794086, 97.675568	-	-	-	-	-	-	Forest Area	Agricultural Land

	Nam hpuk tok Super Major Bridge			-	-	-	-	-	-	Forest Area	Agricultural Land
Nam Un Station (22.771006°, 97.656280°) to Sint Eng Station (22.733224°, 97.555773°)	Kawng has Super Major Bridge	Naung Mon	22.764907, 97.637856	-	-	-	-	-	-	Forest Area	Agricultural Land
	Naung koj Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Pa sa Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Nam hung 1# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Sint Eng Station (22.733224°, 97.555773°) to San Lau Station (22.673916°, 97.487782°)	Nam hung 2 # Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Bang jia dao 1#Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Bang jia dao 2# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Bang jia dao 3# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Nam Ma River Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Ke mang Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
San Lau Station (22.673916°, 97.487782°) to Kong Tha Station (22.627581°, 97.411773°)	San Lau 1# Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	San Lau 2# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Kong Tha Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Gong Sa Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land

Kong Tha Station (22.627581°, 97.411773°) to Hsipaw Station (22.597323°, 97.300881°)	Hko Long Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Hsup lang Major Bridge	Soot Lan	22.619744, 97.363305	-	-	-	-	-	-	Forest Area	Agricultural Land
	Kywang hkon Medium bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Nawng ein Medium Bridge	Hsipaw Township	22.606170, 97.305293	-	-	-	-	-	-	Forest Area	Agricultural Land
		Nwang Eain	22.602100, 97.302230	-	-	-	-	-	-		
Hsipaw Station (22.597323°, 97.300881°) to Hsipaw South Station (22.570027°, 97.237676°)	Yao pu Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Bang Zhen Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Hsipaw South Station (22.570027°, 97.237676°) to Chaung Chauk Station (22.539479°, 97.144750°)	Nam Tu miy Nge-R River Super Major Bridge	Kyin Thi	22.564065, 97.222827	-	-	-	-	Nam Tu Myi Nge-R River	22.565116°, 97.227588°	Forest Area	Agricultural Land
	Kyin thi Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Hsipaw 1# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Hsipaw 2# Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Kyang yin 1# Super Major Bridge	Nam Onn	22.555872, 97.187512	-	-	-	-	-	-	Forest Area	Agricultural Land
	Kyang yin 2# Major Bridge	Ngon Sai	22.543566, 97.181939	-	-	-	-	-	-	Forest Area	Agricultural Land
	Nawng ung Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land

Chaung Chauk Station (22.539479°, 97.144750°) to Kyaukme Station (22.492722°, 97.020461°)	Loi law Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Mwe taw Super Major Bridge	Pang Ywang	22.508405, 97.039741	-	-	-	-	Natural Spring	22.508405, 97.039741	Forest Area	Agricultural Land
		Mway Taw	22.503216, 97.033525	-	-	-	-	Natural Spring	22.503216, 97.033525		
Kyaukme Station (22.492722°, 97.020461°) to Myin Gwin Station (22.422319, 96.966095)	Pawk ang 1# Super major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Pawk ang 2#Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Pa pu Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Myin Gwin Station (22.422319, 96.966095) To Nam Ba Ton River Station (22.341234, 96.871000)	Kong kan Major Bridge	Khite Tone Home	22.414476, 96.957989	-	-	-	-	Natural Spring	22.414476, 96.957989	Forest Area	Agricultural Land
		Kone Kaw	22.405297, 96.957967	-	-	-	-	Natural Spring	22.405297, 96.957967		
	Man tang Mediun Bridge	-	-	-	-	-	-	-	-	-	Agricultural Land
	Kyaung gon MediuBridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Nam Ba Ton River Station (22.341234, 96.871000) to Nawng Hkio Station (22.310013, 96.801553)	Gohteik Nam Ban ton River Double track Super Major Bridge	-	-	Gohteik Bridge	22.343533, 96.859433	-	-	Nam Ba Ton River	22.339885°, 96.867818°	Forest Area	Agricultural Land
Nawng Hkio Station	Nawng Hkio Super Major	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land

(22.310013, 96.801553) to Ommakha Station (22.275012, 96.677853)	Bridge										
	Nan mao Super Major Bridge	-	-	Nawng Hkio Golf Club	22.306280°, 96.765162°	-	-	-	-	Forest Area	Agricultural Land
	Hu Ka 1#Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Hu Ka 2#Super Major Bridge	Ommakha	22.282294°, 96.689727°	-	-	-	-	-	-	Forest Area	Agricultural Land
Ommakha Station (22.275012, 96.677853) To Gangaw Station (22.216818, 96.590718)	Da Bang Yang Major Bridge	Kyin Ganai	22.268749, 96.658752	-	-	-	-	-	-	Forest Area	Agricultural Land
	Dang Gang Bei Major Bridge	Samasal	22.247475, 96.641875	-	-	-	-	-	-	Forest Area	Agricultural Land
Gangaw Station (22.216818, 96.590718) to Pyinoolwin Station (22.105295°, 96.540374°)	Mi Dui Bo Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Sin Byu In Station (22.082622°, 96.403790°) to Sakangyi Station (22.024931°, 96.339346°)	Sin Byu In Station Three track Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Da Bei Shan Major Bridge	-	-	-	-	-	-	-	-	Forest Area	-
	Sakangyi Station Double	-	-	-	-	-	-	-	-	Forest Area	-

	Track Medium Bridge										
Sakangyi Station (22.024931°, 96.339346°) to Taung Kyun Station (22.004728°, 96.259483°)	Taung Kyun 1# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Taung Kyun 2# Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Taung Kyun station 1# three track Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Taung Kyun Station (22.004728°, 96.259483°) To Tok Kha Taung Station (22.016022°, 96.220754°)	Taung Kyun station 2# three track Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Taung Kyun station 3# Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Taung Kyun station 4# Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Taung Kyun station 5# Super Major Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
	Tok hka taung Medium Bridge	-	-	-	-	-	-	-	-	Forest Area	Agricultural Land
Tok Kha Taung Station (22.016022°, 96.220754°) to Mandalay East Station	Ye dwet Super Major Bridge	Lain Pin	21.976874°, 96.177334°	-	-	-	-	Sedawgyi Canal	21.981115°, 96.178485°	Forest Area	Agricultural Land
		Yankin Taung	21.978723°, 96.165871°	-	-	-	-				

(21.945631°, 96.157707°)											
Mandalay East Station (21.945631°, 96.157707°) to Mandalay South Station (21.840919°, 96.115836°)	Jiao Mi Yu Major Bridge	Thant Zin Gone	21.923191°, 96.148111°	-	-	-	-	Paw Taw Mu Canal	21.944724°, 96.154545°	Forest Area	Agricultural Land
		Thale Gone	21.915023°, 96.155310°	-	-	-	-				
	U Inge Eli Single Track Major Bridge	Ywar Shay	21.910429°, 96.155531°	-	-	-	-	-	-	-	Agricultural Land

According to the above table, most of the environmentally sensitive areas beside the bridges and culverts are residential areas, natural springs, rivers, Nawng Hkio Golf Club, Gohteik Bridge, factory and Kai Gyi Reserved forest.

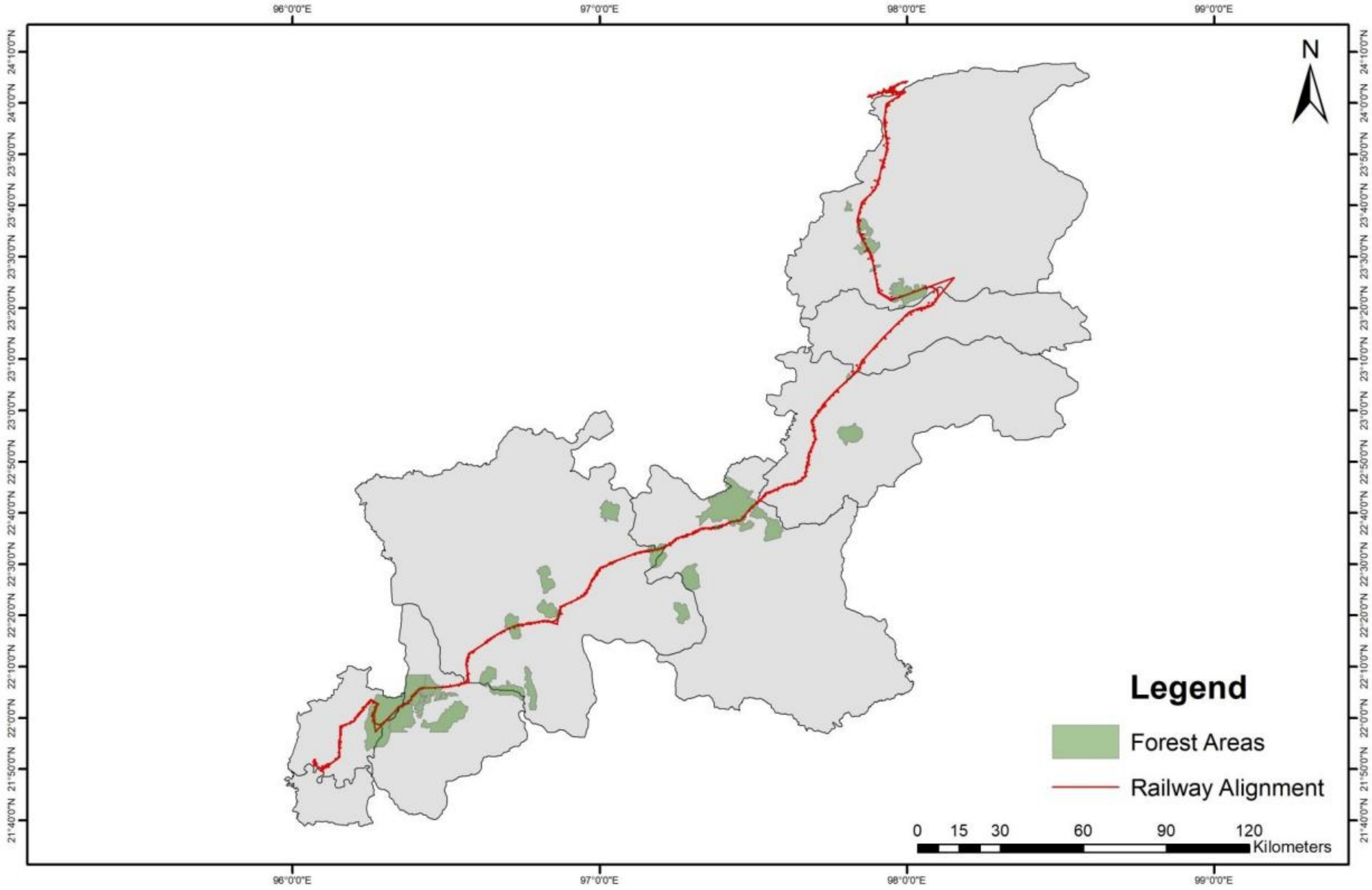


Figure – Forest Area along the Railway Line in Argic Map

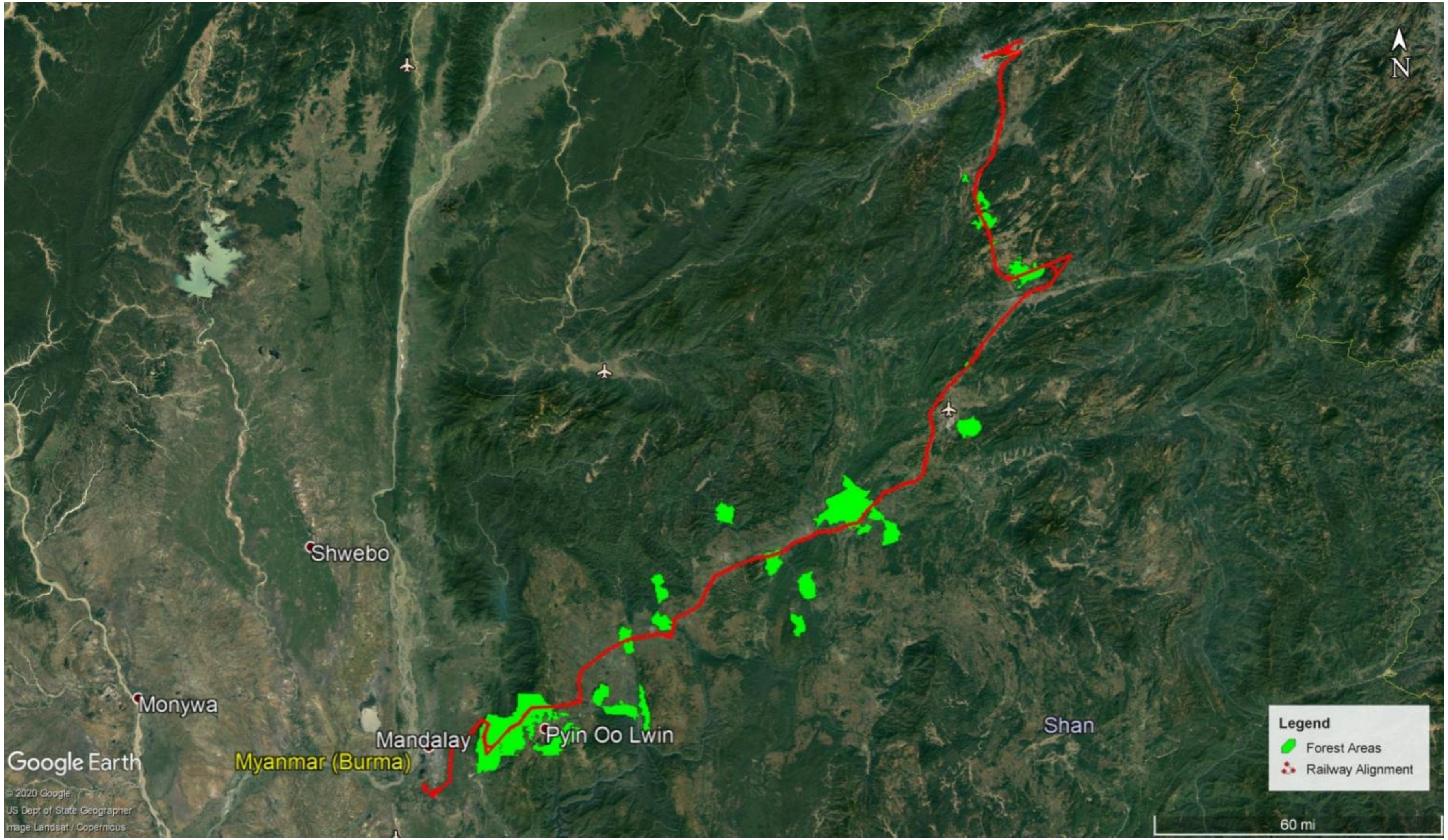


Figure – Forest Area along the Railway Line in Google Map

Table – Forest Area where the Railway will Pass

S/N	Railway Passing Region	Forest		Forest Plantation		Private Plantation		CF Plantation	
		Name	Area (Acres)	No. of owners	Area (Acres)	No. of owners	Area (Acres)	No. of owners	Area (Acres)
1.	**Muse**	-	-	-	-	-	-	-	-
2.	**Kutkai**	Ho Nar Reserved Forest	217	2	217	-	-	-	-
		Nam Hpak Loon Protected Forest	892	-	-	-	-	-	-
		Kaung Lain Protected Forest	1510	-	-	-	-	-	-
		Loi Sam Sit Natural Protected Forest	5352	-	-	-	-	-	-
3.	**Hseni**	-	-	-	-	-	-	-	-
4.	**Lashio**	Bone Mon Protected Forest	540	1	50	-	-	-	-
5.	**Hsipaw**	Tein Lon Reserved Forest	611	47	5530	3	32	6	678.47
		Namma Reserved Forest	2590	-	-	-	-	-	-
		Pang Hsauk Protected Forest	815	-	-	-	-	-	-

6.	**Kyaukme**	Tein Lon Reserved Forest	1702	-	-	-	-	35	189.79/20
		Goketwin Reserved Forest	15	-	-	1	15	-	-
7.	**Nawnghkio**	Nawnghkio Reserved Forest	2300	13	2370	15	1357	-	-
		Goketwin Extended Reserved Forest	653	-	-	-	-	-	-
8.	**Pyinoolwin**	Taung Kyun Reserved Forest	-	-	-	-	-	-	-
		Taung Kyun Extended Reserved Forest	-	-	-	-	-	-	-
		Sakhan Gyi Reserved Forest	-	-	-	-	-		-
		Taung Khaung Reserved Forest	-	2	717.87	-		4	24
		Taung Pyo Extended Reserved Forest	-	2	646.65	1	150	4	21.41
9.	**Mandalay**	Taung Kyun Reserved Forest	-	2	930	-	-	2018-19	3
		Taung Kyun Extended Reserved Forest	-	3	168	1	6	2018-19	2
		Sakhan Gyi Reserved Forest	-	4	377.5	-	-	-	-

6.0. IMPACT AND RISK ASSESSMENT AND MITIGATION MEASURES

6.1. Impact Assessment Methodology

Impacts will be assessed using information gathered during the baseline assessment in combination with previously collected data and the detailed project plan. The significance of the identified impacts will be determined using the approach outlined in Table 6.1. This incorporates two aspects for assessing the potential significance i.e. occurrence and severity, which are further sub-divided as indicated. The impact ranking will be described for both pre and post implementation of mitigation/management measures conditions.

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic Environmental system that can be attributed to human activities. The significance of the aspects/impacts of the process was rated by using a Matrix Method modified by Green Tech EIA Team. The significances of the impacts were determined through a synthesis of the criteria below:

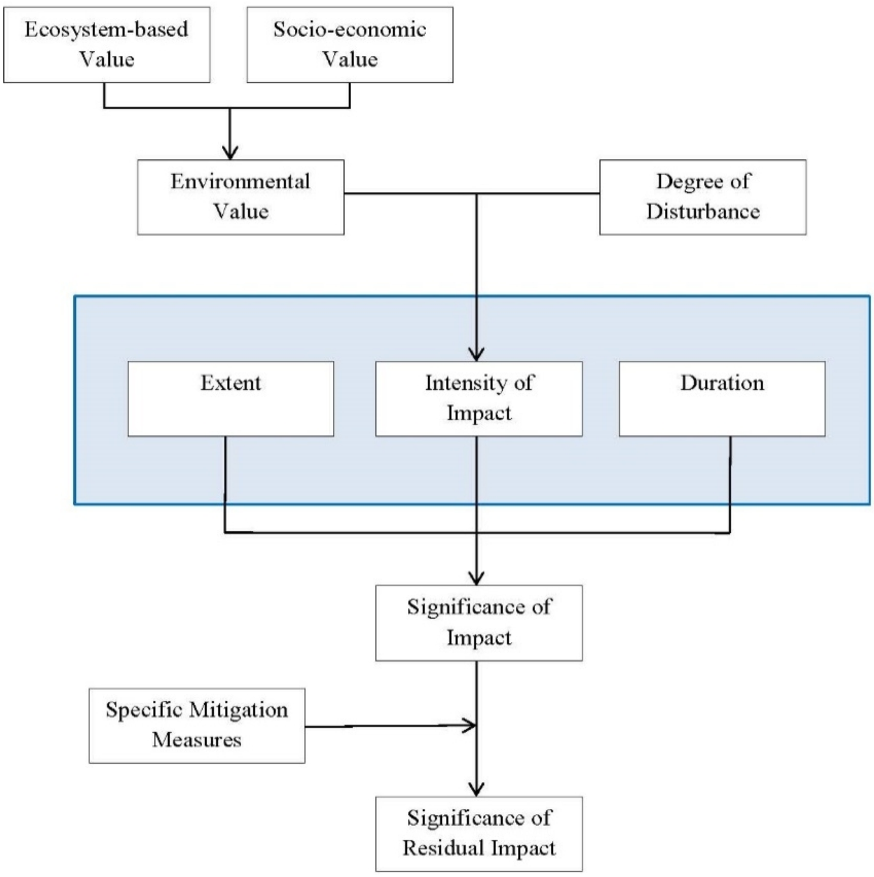


Figure 6.1. Methodological Framework for Impact Assessment

The significances of the impacts were determined through a synthesis of the criteria below:

1. Scale

No.	Description	Rating	Score
1.	Impact will be affected (Distance = 100 m or Area =1000 m^2)	Site	1
2.	Impact will be affected (Distance = 1000 m or Area = 10 km^2)	Limited	2
3.	Impact will be affected (Distance = 1000 m to 10 km or Area = 10 km^2 to 100 km^2)	Local	3
4.	Impact will be affected (Distance = 10 km to 100 km or Area = 100 km^2 to 1000 km^2)	District	4
5.	Impact will be affected (to the distance exceeding 100 km or Area = 1000 km^2)	Regional	5

Note: For linear objects areal gradations are used. If the area cannot be evaluated, the linear distance is used.

2. Duration

No.	Description	Rating	Score
1.	One day to one month	Very short term	1
2.	One month to two years	Short term	2
3.	Two years to ten years	Medium term	3
4.	Ten years to the whole life of operation	Long term	4
5.	Permanent and irreversible impact on nature	Permanent	5

3. Severity for the Environment

No.	Description	Rating	Score
1.	Isolated parts will be damaged and easy to mitigate/restore	Very low	1
2.	Isolated parts will be damaged and hard to mitigate/restore	Low	2
3.	Large parts will be damaged and easy to mitigate/restore	Low to Medium	3
4.	Large parts will be damaged and hard to mitigate/restore	Medium	4

5.	Large parts will be permanently destroyed	High	5

4. Frequency

No.	Description	Rating	Score
1.	Less than twice a year	Rare	1
2.	3 to 4 times per year	Intermittent	2
3.	Once a month	Regular	3
4.	1-3 times per week	Very Often	4
5.	More than 3 times per week	Continuous	5

5. Probability

No.	Description	Rating	Score
1.	Impact is very unlikely to occur under normal conditions but may occur in exceptional circumstances	Very Seldom	1
2.	Impact is unlikely to but may occur at some time under normal operating conditions	Seldom	2
3.	Impact is likely to occur at some time under normal conditions	Probable	3
4.	Impact is very likely to occur at some time under normal conditions	Highly probable	4
5.	Impact will occur under normal operating conditions	Certain	5

Table- Impact Rating Table

Consequence

Likelihood

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
6	12	18	24	30	36	42	48	64	60	66	72	78	84	90
7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

- Very Low (0- 25)
- Low (26- 50)
- Low to Moderate (51-75)
- Moderate (76-100)
- Moderate to High (101-125)
- High (126 to 150)

Mitigation Requirement for Impact Significance

No.	Impact Significance	Mitigation Requirement
1	Very Low (Negligible)	No mitigation required
2	Low	Required a small number of additional mitigations
3	Low to Moderate	Require more or less additional mitigations
4	Moderate	Require a number of additional mitigations
5	Moderate to High	Require a number of additional mitigation or modification of the project design
6	High	Require additional mitigations plus modification of the project design or alternative action may be required

Prediction Confidence

Although not explicitly included in the criteria tables, there is uncertainty associated with the information and methods used in an ESIA because of its predictive nature. The certainty with which an impact analysis can be completed depends on a number of factors including:

- Understanding of natural/ecological and socio-economic processes at work now and in the future; and
- Understanding of present and future properties of the affected resource.

The level of prediction confidence for an impact analysis will be discussed when there are questions about the factors reviewed above. Where the level of prediction confidence makes a prediction of the impact problematic, a subjective assessment is made based on the available information, the applicability of information on surrogates and on professional opinion.

The level of prediction confidence is sufficiently low in some cases that an estimate of Environmental consequence cannot be made with a sufficient degree of confidence. Undetermined ratings are accompanied by recommendations for research or monitoring to provide more data in the future.

Development of Mitigation Measures

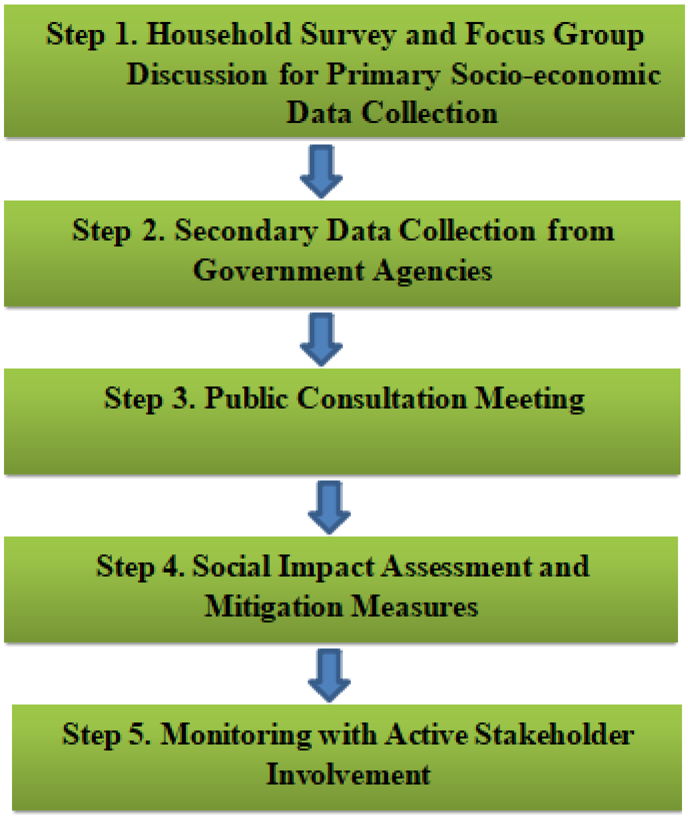
A common approach to describing mitigation measures for critical impacts is to specify a range of targets a predetermined acceptable range and an associated monitoring and evaluation plan. To ensure successful implementation, mitigation measures will be unambiguous statements of actions and requirements that are practical to execute. The following summarize the different approaches that may be used in prescribing and designing mitigation measures:

- Avoidance: e.g. mitigation by not carrying out the proposed action on the specific site, but rather on a more suitable site;
- Minimization: mitigation by scaling down the magnitude of a development, reorienting the layout of the project or employing technology to limit the undesirable Environmental impact;
- Rectification: mitigation through the restoration of Environments affected by the action;
- Reduction: mitigation by taking maintenance steps during the course of the action; and Compensation: mitigation through the creation, enhancement or acquisition of similar Environments to those affected by the action.

6.1.1. Social Impact Assessment (SIA) Methodology

The first phase of the Social Impact Assessment (SIA) will provide a baseline description of the study area, specifically focusing on the communities living and working in close proximity to the proposed development. The potential impacts of the proposed development on the social environment will be identified and assessed in terms of an agreed assessment methodology in the EIA phase. Mitigation measures will be proposed to enhance the positive impacts and reduce the significance of the negative impacts. SIA study area was considered after the discussions with key informers project managers from Myanma Railways (MR) and China Railway Eryuan Engineering Group Co., Ltd. (CREEC). and the heads of Village General Administrative Offices of nearest villages that the railway pass or cross nearby. Google Map and census are also used for the determination of SIA study area during pilot survey. To assess

the baseline socio-economic conditions that may result from the development of the proposed project, the SIA team employed both quantitative and qualitative approaches as follow:
Socioeconomic impact assessment for proposed project was conducted by the following procedures.



Main Steps in SIA Study

Step I: Household Survey and Focus Group Discussion

The collection of primary data will consist of focus group discussions and household surveys in the target study areas. Household sample survey will conduct to evaluate primary socio-economic conditions of the project area and to understand the mood, perceptions and extent of preparedness of the people towards the proposed project. The household survey will carry out to tap the baseline socio-economic conditions of project area and to assess project perceptions and attitudes of the local people. To get the accurate data, primary data collection will conduct by social specialist, social consultants, local authorities and local people.

(a) Survey Team

The team was formed with researchers from social, medical, and engineering sciences having research experiences in the field of social impact assessment and social management planning.

(b) Development of Survey Questionnaire

Socioeconomic aspects to be included in questionnaire will base on site visits and issues identified by interviews with local people and village heads during pilot survey. Items will formulate by the consultants and reviewed by social assessment team members as to clarity of item wordings and relevance to the socioeconomic domains measured. The survey questionnaire will designed to collect information as to the following household characteristics:

- household composition (age, gender, educational status, religion, ethnicity, language used and marital status);
- occupations;
- ownership of agricultural fields and livestock;
- energy sources and facilities;
- agricultural and other economic activities;
- daily movement patterns;
- income and expenditure patterns;
- access to and use of community services/facilities and natural resources;
- health and nutrition; and
- views/concerns/suggestions on the proposed project.

(c) Recruitment and Training

The enumerators will receive a training program prior to commencing with the fieldwork. The training program will include a briefing on the objectives of the survey, socioeconomic aspects to be measured, interview techniques as well as a detailed explanation of each question and its relevance to the survey objectives, how to pose the question and how to code the answer. Discussions will also held among participants about the socioeconomic conditions and initial questionnaire items will revise based on the discussion results. A set of guidelines will give to each enumerator for administration of survey questionnaire. In the field data collection activities, the enumerators will supervise by experienced supervisors with household survey.

(d) Data Collections

The project related data, factory layout plans and design parameter will be provided by China Railway Eryuan Engineering Group Co., Ltd. (CREEC). Primary data for public concerns, socio-economic and health profiles will be conducted by household survey.

(e) Data Analysis

In household survey data collection period, field supervisors will check and ensure the control of data quality. During field surveys, information obtained through household survey and interviews will corroborate through direct observation by the study team aiming at assessing social and cultural infrastructure existed in the project area, physical assets of people, and living conditions. Observations will back up by photographic records. Quantitative data will be coded and processed using SPSS statistical package. Qualitative data will be coded using standard methods.

6.1.2. Health Impact Assessment Methodology

There is no universally agreed formula for assessing public health significance, although assessments are mostly based on a subjective judgment about the magnitude of the potential health impacts (size of the affected population and scale of the positive or negative health impact); its likelihood of occurrence; and the degree of confidence in the impact actually occurring (based on scientific and other evidence of the health impact occurring in similar circumstances elsewhere). The following table shows a Health Impact Significance Rating Methodology of Green Tech EIA Team.

Table 6.1 - Health Impact Significance Rating Methodology

	Likelihood of Occurrence of Health Impact			**Health Impact Rating**
	Low	Medium	High	
Magnitude of Health Impact	Unlikely to occur	Likely to occur sometimes	Likely to occur often	
None	No significance	No significance	No significance	0
Low	Very Low	Low	Medium	1
Medium	Low	Medium	High	2
High	Medium	High	Very High	3

When analyzing health impacts, it is important to consider the magnitude, likelihood and public health significance of the potential impacts. This analysis will involve expert judgment based on a consideration of the evidence gathered and its applicability to the local context and the specific project.

Distributional, health equity and inequality impacts will be analyzed by examining how particular sub-groups within a population, particularly vulnerable groups, are likely to be affected by the project. The scoping and community profiling steps are likely to have already identified potentially vulnerable groups through existing local information on these individuals/groups or through community surveys and meetings with key informants e.g. community leader, community health worker or local NGO.

Health equity/inequality impacts occur when the projects benefits and harms are unevenly distributed. This includes where the risk is equally distributed, such as air pollution, but the impact is disproportionate – affecting particularly children, older people and those with existing ill health.

Analysis of health impacts will involve systematically determining the range of potential impacts, their relative importance and where, when and how likely they are to occur. The information for the HIA will be obtained from the primary data collection (household survey), literature review, community profile and Health Data from Pubic Health Department as well as knowledge and expertise of the HIA Consultant.

6.1.3. Risk Assessment

The following procedure should be used to reduce risks to a tolerable level (see figure 6.2):

a) Identify the likely users for the product or system, including vulnerable consumers and others affected by the product;
b) Identify the intended use, and assess the reasonably foreseeable misuse, of the product or system;
c) Identify each hazard (including reasonably foreseeable hazardous situations and events) arising in the stages and conditions for the use of the product or system, including installation, operation, maintenance, repair and destruction/disposal;
d) Estimate and evaluate the risk to the affected user group arising from the hazard(s) identified: consideration should be given to product s or systems used by different user groups; evaluation can also be made by comparison with similar products or systems;
e) If the risk is not tolerable, reduce the risk until it becomes tolerable.

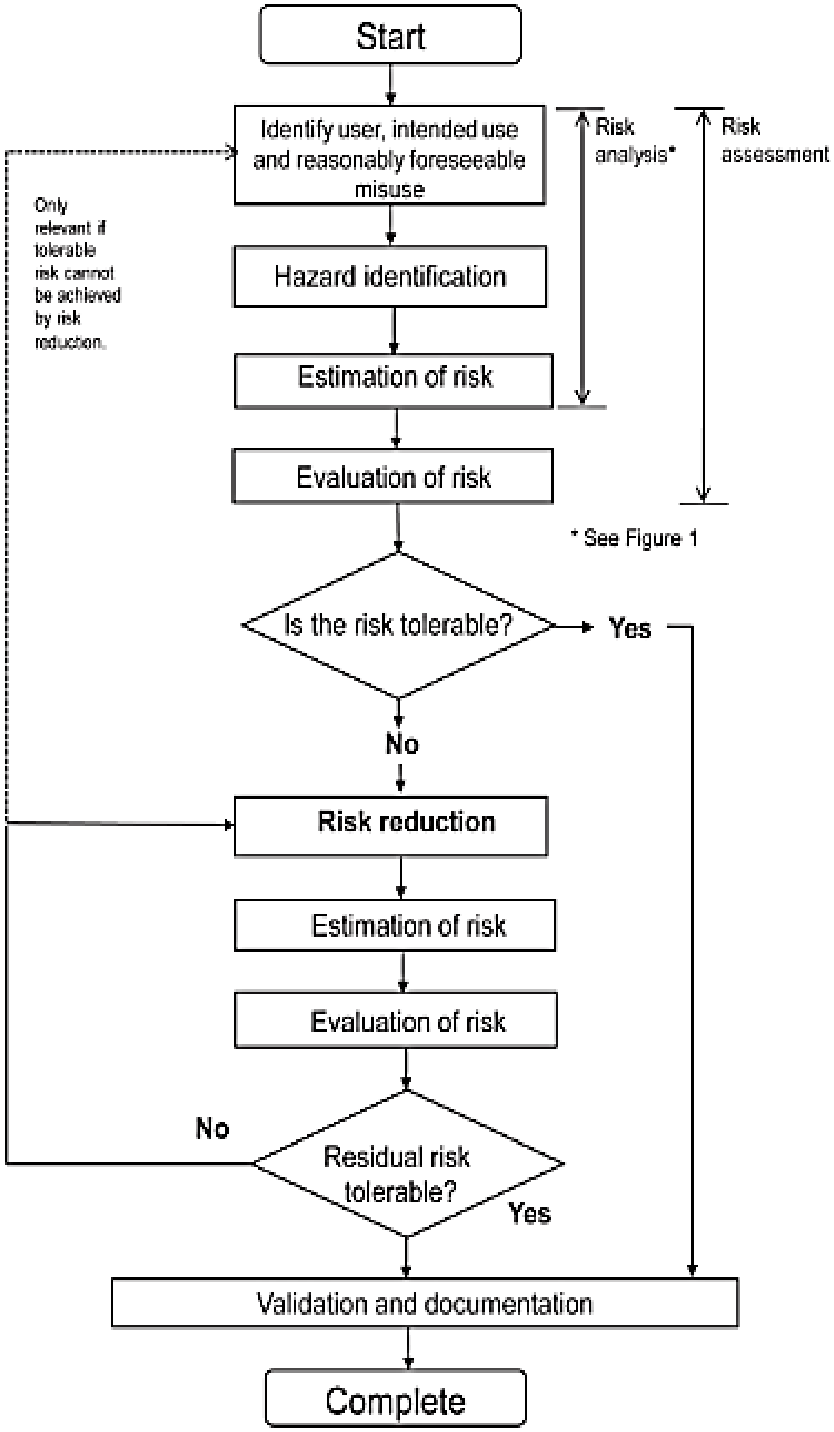
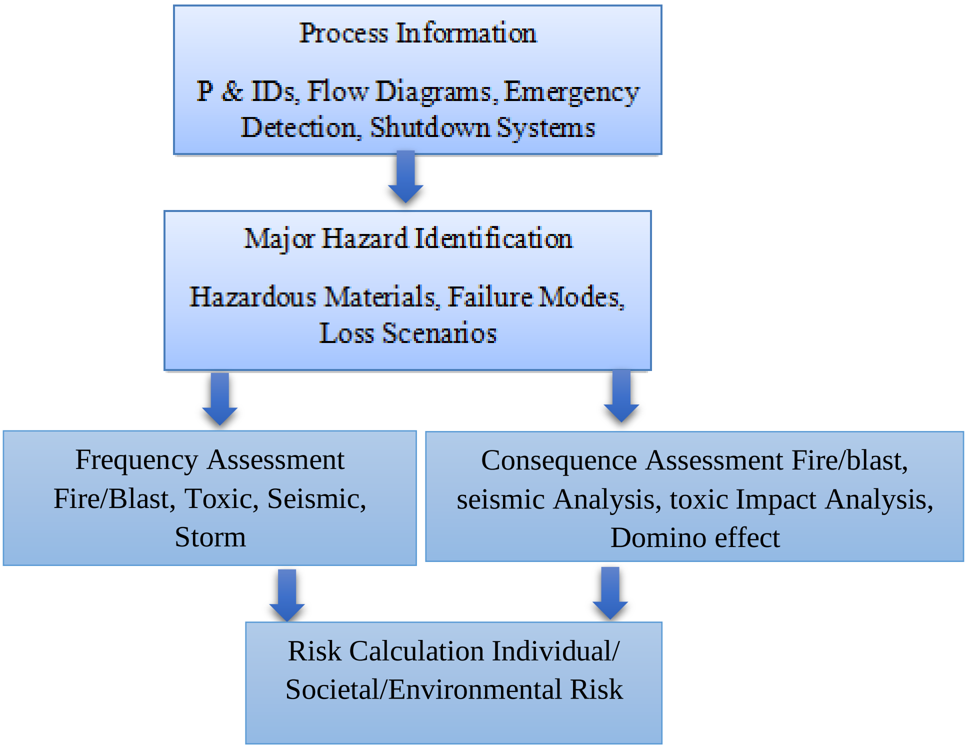


Figure 6.2 - Iterative Process of Risk Assessment and Risk Reduction

Risk Assessment Flow Diagram

Objectives

The following is the flow chart for risk assessment procedure.



Risk Calculation

Risk due to hazards at a storage tank terminal and its surroundings is composed of summation of all risks given no escalation (i.e. no domino effects) of undesired events and all risks given an escalation (i.e. domino effects) of undesired events:

$$Risk = \Sigma\ Risk\ |No\ Escalation + \Sigma Risk\ |Escalation$$

Table - Tolerability of Environmental Risk (Category Definitions) – Loss of Containment

Category	Definitions	
6	Catastrophic	- Major airborne release with serious off-site effects - Site shutdown - Serious contamination of ground water or water course with extensive loss of aquatic life
5	Major	- Serious toxic effect on beneficial or protected species - Widespread but not persistent damage to land - Evacuation of local populace - Temporary disabling and hospitalization - Serious toxic effect on beneficial or protected species - Widespread but not persistent damage to land - Significant fish kill over 5-mile range

4	Serve	- Hospital treatment required - Public warning and off-site emergency plan invoked - Hazardous substance releases into water course with 1/2-mile effect
3	Significant	- Severe and sustained nuisance, e.g. strong offensive odors or noise disturbance - Major breach of permitted emissions limits with possibility of prosecution - Numerous public complaint
2	Noticeable	- Noticeable nuisance off-site, e.g. discernible odors - Minor breach of permitted emission limits, but no environmental harm - One or two complaints from the public
1	Minor	- Nuisance on site only (no off-site effects) - No outside complaint.

UK HSE, “Safety and environmental standards for fuel storage sites”, Process Safety Leadership Group, 2009. Environment Agency for England and Wales, “Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and Appraisal of BAT”, July 2003

Table - Tolerability Criteria of Environmental Risk

Category	Definition	Acceptable if frequency less than	Acceptable if reduced as low as is reasonably practical and frequency	Unacceptable if frequency above
6	Catastrophic	1.0E-06 per year	1.0E-04 to 1.0E-06 per year	1.0E-04 per year
5	Major	1.0E-06 per year	1.0E-04 to 1.0E-06 per year	1.0E-04 per year
4	Serve	1.0E-06 per year	1.0E-04 to 1.0E-06 per year	1.0E-02 per year
3	Significant	1.0E-04 per year	1.0E-04 to 1.0E-06 per year	1.0E-01 per year
2	Noticeable	1.0E-02 per year	~1.0E+01 to 1.0E-02 per year	~1.0E+01 per year
1	Minor	All shown as acceptable	-	-

Earthquake and Flood Risk Assessment Methodology

LIKELIHOOD (probability) How likely is the event to occur at some time in the *(Linear Scale time specific matrix)*	**CONSEQUENCES** What is the Severity of injuries /potential damages / financial impacts (if the risk event actually occurs)? *(Logarithmic Scale, property industry specific matrix)*				
	Insignificant No Injuries First Aid No Envir Damage << $1,000 Damage	Minor Some First Aid required Low Envir Damage << $10,000 Damage	Moderate External Medical Medium Envir Damage <<$100,000 Damage	Major Extensive injuries High Envir Damage <<$1,000,000 Damage	Catastrophic Death or Major Injuries Toxic Envir Damage >>$1,000,000 Damage
Almost certain - expected in normal circumstances (100%)	MODERATE RISK	HIGH RISK	HIGH RISK	CRITICAL RISK	CRITICAL RISK
Likely – probably occur in most circumstances (10%)	MODERATE RISK	MODERATE RISK	HIGH RISK	HIGH RISK	CRITICAL RISK
Possible – might occur at some time. (1%)	LOW RISK	MODERATE RISK	HIGH RISK	HIGH RISK	CRITICAL RISK
Unlikely – could occur at some future time (0.1%)	LOW RISK	MODERATE RISK	MODERATE RISK	HIGH RISK	HIGH RISK
Rare - Only in exceptional circumstances 0.01%)	LOW RISK	LOW RISK	MODERATE RISK	MODERATE RISK	HIGH RISK

Figure - 5x5 Risk Matrix
Source: kevinian.com

Fire Risk Assessment Methodology

Six-Step Method

This method entails a two-fold process:

1. Identifying the fire hazards (i.e. readily combustible or highly flammable materials, sources of heat, and unsatisfactory structural features).

2. Assessing the fire risk (i.e. the likelihood that a fire will occur and the consequences of such a fire on the people in the workplace).

The overall process may be carried out in six steps:

Step 1: Identify hazards,

Step 2: Identify people at risk,

Step 3: Remove/reduce hazards,

Step 4: Assign the risk category,

Step 5: Decide if existing fire safety arrangements are OK or need improving,

Step 6: Record findings.

Step 1: Identification of Hazards

Identifying hazards entails noting readily combustible materials or highly flammable substances. These would include such things as paints and thinners, flammable solvents, solvent-based adhesives, flammable gases, some plastic foams, large areas of bare hardboard, highly flammable and/or reactive chemicals etc.

It also entails noting sources of heat such as flames or sparks from processes, sources of frictional heat, ovens, kilns, incinerators, oil or gas fired equipment or heaters, matches and lighters, ducts or flues, light bulbs close to flammable materials, electrical wander leads, any electrical equipment, faulty wiring, portable heaters, etc.

Structural features that would constitute hazards by promoting the rapid spread of fire should therefore be identified. These would include such things as ducts and flues, unstopped holes that have been cut into fire resisting walls for the provision of services such as cables and pipe work, large areas of hardboard, chipboard, or blockboard, un-compartmented roof spaces. Excessively long escape routes and dead-end conditions that would prejudice the means of escape should also be identified.

Step 2: Identification of People at Risk

In identifying people who would be especially at risk in a fire, consideration should be given to any who are asleep, any who are present in large numbers, any who are unfamiliar with the layout of the premises and/or the exit routes, those who may be exposed to a particular or specific fire risk, those who have impairments such as sight, hearing, or mobility and young people or children.

Also taken into consideration should be any people who would be unable to react quickly enough or are unaware of the danger of fire because they are in remote areas, because they have learning difficulties, or because they are outside contractors who are unaware of the fire risks.

Step 3: Removal/Reduction of Hazards

The removal or reduction of hazards entailed in this stage of the risk assessment can have enormous benefits insofar as, at the end of the process, it will have produced a much safer environment.

For each of the hazards that have been identified in step 1, the question should be asked, "could it be removed, reduced, replaced, separated, protected, repaired, or cleaned?"

For example, the removal of excessive amounts of combustibles, the reduction in the areas of combustible wall linings, replacement of tungsten filament bulbs with fluorescent light fittings and solvent based adhesives being replaced with water-based ones, separating sources of heat from combustibles, protecting electrical equipment with thermostats, repairing damaged electrical flexes and damaged furniture, cleaning dirty flues and ducts.

At this stage it should be decided whether any of these removals or reductions are to be undertaken immediately, in the medium term, or in the long term.

Step 4: Assignment of Risk Category

On completion of step three, depending upon what hazards still remain it should be possible to assign a risk category to the workplace or, more likely, to individual parts of it.

The risk categories could be 'Low', 'Normal' and 'High': -

Low: There is hardly any risk from fire, few combustibles materials, no highly flammable substances, and virtually no sources of heat.

Normal: There are sufficient quantities of combustible materials and sources of heat to be of greater than low fire risk but that a fire would be likely to remain confined, or to spread but slowly.

High: There is a serious risk to life from fire, or there are substantial quantities of combustible materials, or there are any highly flammable substances, or there exists the likelihood of the rapid spread of fire, heat or smoke.

Step 5: Adequacy or Improvement of Fire Precautions

In this step, it is necessary to decide whether the existing fire safety measures are adequate or are in need of improvement. Possible improvements could include such steps as:

- Reduction of evacuation times/escape route lengths,
- Protection of escape routes,
- Provision of additional escape routes,
- Installation of a fire alarm system or more fire alarm call points,
- Provision of more fire signs,
- Installation of fire detection systems,

- Installation of a sprinkler system,
- Installation of an emergency lighting system,
- Institution of better programmes of fire safety training,
- Provision of, or increasing the number of fire extinguishers
- Provision of regular training and practice of fire and evacuation drills.

Step 6: Recording Findings

This simply entails recording the findings of the fire risk assessment, and should include the significant hazards found to be present, the details of any staff who are especially at risk, and the date on which the assessment was made.

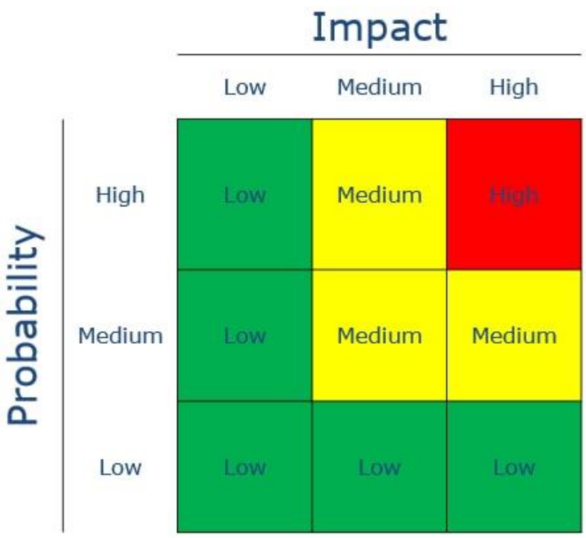


Figure: Classification of Fire Risk Level

Based on the fire incidents from 1983-2007, the States and Divisions have been categorized into the probability of High, Medium and Low level. Following criteria has been used:

High Probability: More than 100 average annual fire cases

Medium Probability: Between 100 and 50 average annual fire cases

Low Probability: Less than 50 average annual fire cases

Property loss level	Criteria
High Property Loss	Less than 100 Million Kyats
Medium Property loss	Between 100 to 200 Million Kyats
Low Property loss	More than 200 Million Kyats

Potential Risk and their Sources

Category	Potential Risk	Source
Risk in Culvert (Construction Phase)	Structural Collapse	- Structural overload of culvert - deterioration of culvert leading to loss strength
	Slope instability	- water leakage of the culvert leading to saturation of fill or foundation material - headwall has been subjected to erosion and collapses taking with it a portion of the road pavement
	Erosion by overtopping flows	- flow over the road
	Cross catchment flooding	- blockage or insufficient hydraulic capacity of the culvert
Risk in Bridge	Bridge structure risk by human factor	- due to terrorist such as explosion
Occupational and Community Health and Safety Risk	Slips and trips	- Spill and oil in the workplace - equipment used in site
	Electricity	- direct or indirect touch of electric wire
	Airborne fibres and toxins	- The erosion of the already installed, improperly taken down or stored asbestos as well as from the products that contain it.
	Asbestos	- demolition process
	Unintended collapse	- demolition process
	Material handling	- use of excavators and dump trucks
	Hand and vibration syndrome	-piling activity
	Noise	- piling activity
	Moving objects	- transport of material
	Working from height	- fall from height and from the installation of pier and beam
Disaster Risk	Earthquake risk	- seismic waves and fault zone near the working site
	Earthquake induced liquefaction risk	- high excess pore-water pressure generated by and accumulated during strong earthquake ground shaking or other rapid loading
	Flood risk	- high flow or overflow of water from a river or similar source of water occurring over a period of time - heavy rain spell - climate change - blocking of river channels by landslides
	Fire risk	- fire incidents from temporary facilities - flammable materials used on site - vehicle collision due to derailment -overheating due to high speed

		- electrocution - overheating of roof-mounted compressor heating and air conditioner units - burning locomotives - flammable materials carried on train

6.1.4. Impact Identification and Mitigation for Each Project Phase

The following phases will be considered in conducting of EIA for the proposed railway bridge and culvert project, site by site. The impact identification and mitigation measure for the bridge is also significant that of culverts.

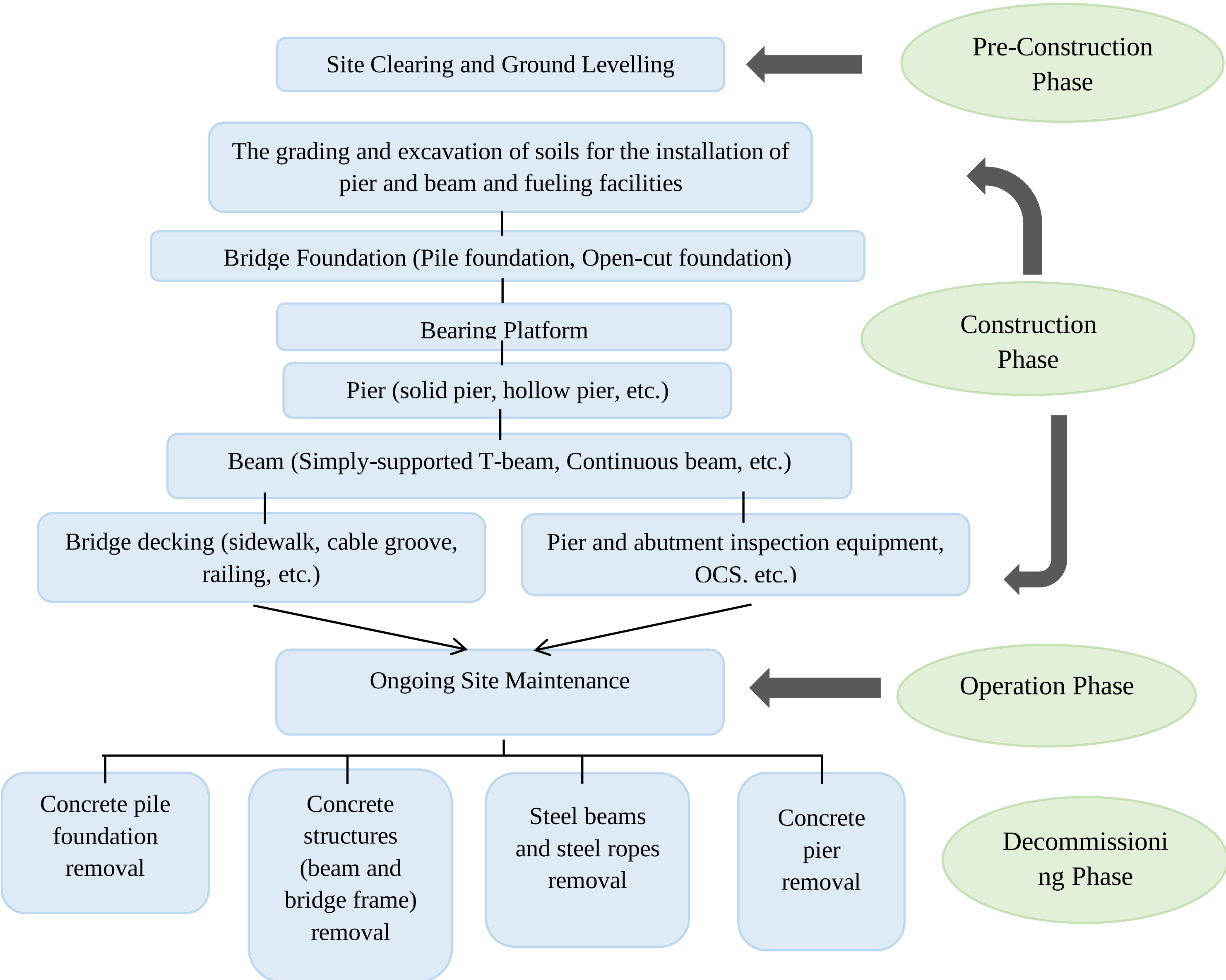


Figure - Construction of Bridge Flow Chart

(i) Pre-construction phase

Pre-construction activities will involve removal of select vegetation, tree cutting for the access road and temporary camp for the workers and other facilities and the ground leveling (earth moving activities). The ground leveling for the bridge and river is leveled the ground to get the access road and align the ground with the bridge.

(ii) Construction Phase

Construction activities will involve the grading and excavation of soils for the installation of pier and beam and fueling facilities. Project development and construction activities also include temporary camp for construction workers, access road construction, site preparation and development (e.g. construction of bridges and site utilities).

(iii) Operation Phase/ongoing site maintenance

The operational activities of railway bridge include the maintenance of bridge and culverts along the railway road.

(iv) Decommissioning Phase

Although the proposed project is long-term project, decommissioning of the project would occur at the end of its lifespan. The goal of project decommissioning will be to remove the steel structure as a whole and return the site to a condition as close to a pre-construction state as feasible. The physical removal of the structures and equipment will be the reversal of the construction process. All areas disturbed by the proposed project would be restored to pre-project conditions and/or to conditions acceptable to the CDC rule and regulations. During decommissioning phase, all concrete and steel structures and equipment would be dismantled and removed. The major activities that will be required for the decommissioning of the proposed project are:

(a) Concrete pile foundation removal;
(b) Concrete pier removal;
(c) Concrete structures (beam and bridge frame) removal,
(d) Steel beams and steel ropes removal,
(e) Electrical supply system removal

6.2. Anticipated Impacts and Mitigation Measures

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities. Anticipated environmental impacts for the proposed Bridge and Culvert construction project along the Muse-Mandalay railway line will be conducted into the entire life of the project.

The construction of bridges and culverts have the potential to affect the environment in many ways. They can differ widely in terms of their mode of operation and location, and key issues are likely to vary from site to site. Therefore, it is recommended that expert advice on detailed technical issues be obtained. The issues arising for all environmental receptors will change over time as the site is prepared and managed and following the end of operations. Developers and site operators should therefore consider the impacts arising from both construction activities and operational practices, and following the end of on-site activities.

Potential impacts are discussed here in broad terms only as their nature and intensity will depend on the physical characteristics of the project and the composition of any polluting materials. An EIA of proposed bridge and culvert construction activities should take these factors into account in assessing potential impacts on the environment.

This Environmental Scoping Study (ESS) aims to identify the potential positive and negative impacts (both biophysical and social) associated with the proposed project. The potential impacts have been identified through baseline investigations and below are preliminary analysis per phase on construction and operation of proposed project.

6.2.1. Anticipated Impacts during Pre-construction Phase

Pre-construction activities will involve site clearing and ground leveling. Site clearing will include for the preparation of foundation of bridge (pile foundation) and temporary camp for the workers and some tree cutting and temporary access road construction. Ground leveling will include sand filling and earth moving activities. The duration of pre-construction period will be about 6 months. Some of the impacts related to the above pre-construction activities will be as following.

(1) Impacts on Air Environment
(2) Impacts on Surface Water Environment
(3) Impacts on Soil and Groundwater Environment
(4) Impacts on Biodiversity Environment
(5) Impacts on Human Environment

(1) Anticipated Impacts on Air Environment during Pre-construction Phase

The major impacts on air quality during the pre-construction phase will be fugitive dust generation, vehicular emissions and increased in noise level due to the site clearing and sand filling activities.

(a) Fugitive Dust Generation (Particular Matter Emission)

During pre-construction phase, the main source of air pollution will be dust generation (PM) due to the movement of dozer and trucks for site clearing, ground levelling activities and temporary access road construction for each bridge construction site. Short-term impacts will be experienced by the workers, pedestrians passing near the project site and local residents nearby.

Significant of Impacts on Fugitive Dust Generation (Particular Matter Emission) during Pre-construction Phase before Mitigation Measures

The nature of impact on air quality during pre-construction phase will not be significance due to minor earth working activities and pre-construction period for each bridge construction site as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive dust generation	Site clearing, ground levelling and access road construction	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Highly Probable (-4)	Low (-40)

Consideration of Mitigation Requirement for Fugitive Dust Generation (Particular Matter Emission)

The intensity of mitigation required for air environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation required considered by EIA team	Intensity of Mitigation Required	Responsibility
1.	Fugitive Dust Generation	Low (-40)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Dust Generation

Due to the minor mitigation requirement, dust will be countered by sprinkling of water during pre-construction phase. It is also the most cost-effective dust suppressant. Water will not use that may have pressure on water available of local people especially for seasonal streams or natural springs. Water will be sprayed by using handheld spray. Before leaving the construction site, wheels will be cleaned and goods carried should be covered. Vehicles delivering materials will be covered to reduce spills and dust blowing off the load.

Significant of Impacts on Fugitive Dust Generation (Particular Matter Emission) during Pre-construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive dust generation	Site clearing, ground levelling and access road construction	Negative (-)	Site (-1)	Short term (-2)	Very Low (-1)	Very Often (-4)	Seldom (-2)	Very Low (-24)

Residual Impact

After mitigation measure, there will be no residual impact for fugitive dust generation.

(b) Vehicular Emissions

Site clearing and earth working vehicle (3 dozer) and delivery vehicles (5 trucks) used in site produced gaseous emissions such as CO_2, CO, NO_x and SO_2 during the operation of vehicles and machineries during the pre-construction phase including both on-site and the public.

Significant of Impacts on Vehicular Emissions during Pre-construction Phase before Mitigation Measures

The nature of impact on air quality during pre-construction phase will not be significance due to minor earth working activities and pre-construction period as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vehicular emission	Site clearing and ground levelling	Negative (-)	Local (-3)	Short term (-2)	Very Low (-1)	Very Often (-4)	Highly Probable (-4)	Low (-48)

Consideration of Mitigation Requirement for Vehicular Emissions

The intensity of mitigation required for air environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation required considered by EIA team	Intensity of Mitigation Required	Responsibility
1.	Vehicular Emission	Low (-48)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Vehicular Emission

Due to the minor mitigation requirement on vehicular emission, there will require a plan to reduce in loading and unloading time and plan to reduce in idle time during working hours. Vehicles used during pre-construction phase will avoid local traffic time and will also reduce vehicular emission. Moreover, pre-construction services provider(s) will have to use good engines conditions for every machinery used and low sulphur content fuel oil to reduce gaseous emission. Generator with good engine conditions should be used.

Significant of Impacts on Vehicular Emissions during Pre-construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vehicular emission	Site clearing and ground levelling	Negative (-)	Local (-3)	Short term (-2)	Very Low (-1)	Very Often (-4)	Probable (-3)	Low (-42)

Residual Impact

After mitigation measure, there will be no residual impact for vehicular emission.

(c) Increased in Noise Level

Site clearing and earth working vehicle (3 dozer) and delivery vehicles (5 trucks) traveling to and from the site produced noise which will increase existing noise level in pre-construction phase. All of the calculation of predicted noise level during pre-construction phase will be based on Patrick Breysse, and Peter S.J. Lees., School of Public Health, Johns Hopkins University, Bloomberg, 2006. The required data for calculation of the noise levels will be used typical construction equipment prepared by “Handbook of Noise Control” as follow:

Typical Construction Equipment Noise Emission Levels

Equipment Type	Noise Level (dBA at 50 Feet)
Dozer	87
Truck (Medium and Heavy)	84

Source: Harris, C.M. "Handbook of Noise Control," McGraw Hill, New York, 1979

According to the vehicle used in pre-construction phase, there will be no significant impact.

Significant of Impacts on Air Environment during Pre-construction Phase before Mitigation Measures

The nature of impact on air quality during pre-construction phase will not be significance due to minor earth working activities and pre-construction period as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Noise from dozer and trucks	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Highly Probable (-4)	Low (-40)

Consideration of Mitigation Requirement for noise

The intensity of mitigation required for air environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation required considered by EIA team	Intensity of Mitigation Required	Responsibility
1.	Noise	Low (-40)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Noise

According to the requirement of minor mitigation measures for noise during pre-construction phase, the following mitigation measures will do:

- Limit working at night and avoid the operation of noisy equipment and machineries at night if it is necessary to make operation at night;
- Use phase wise construction (not to running noisy equipment at the same time); and
- Regualar maintenance of machineries and use good engine machineries.

Significant of Impacts on Air Environment during Pre-construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Noise from dozer and trucks	Negative (-)	Site (-1)	Short term (-2)	Very Low (-1)	Very Often (-4)	Probable (-3)	Low (-28)

Residual Impact

After mitigation measure, there will be no residual impact for noise.

(2) Anticipated Impacts on Surface Water Environment during Pre-construction Phase

During pre-construction phase, impacts on surface water environment will be described as follow.

(a) Liquid Wastes

The temporary water pollution in nearest water sources due to earth working activities (soil erosion and sedimentation). The mobilization and transport of soil particles may, in turn, result in sedimentation of surface drainage networks, which may result in impacts to the water quality of the river near the bridge. In addition, improper handling of fuel oil and lubricants may constitute a risk for pollution of surface water during rainy season.

Significant of liquid Waste during Pre-construction Phase before Mitigation Measures

Impact on nearby surface water bodies and natural water spring will be low probability and not significant due to the volume of earth work in pre-construction phase as follow:

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase in turbidity, oil and grease in nearest surface water bodies	Site clearing and earth working activities	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Highly probable (-4)	Low (-30)

Consideration of Mitigation Requirement for Liquid Wastes

The intensity of mitigation measures for surface water environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Intensity of Mitigation	Responsibility
1.	Increase in turbidity, oil and grease in nearest surface water bodies	Low (-30)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Liquid Wastes

Although impact rating is very low, pre-construction service provider(s) will have to do the following mitigation measures to protect the surface water quality during the pre-construction phases of the proposed project. The temporary tanks and other waste water facilities retention pond with suitable drainage system around the dumping sites should be used during the rainy season. The liquid material storage containment areas should not drain directly to the surface water. The oil, grease and other chemicals should be handled as per MSDS.

Significant of liquid Waste during Pre-construction Phase after Mitigation Measures

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase in turbidity, oil and grease in nearest surface water bodies	Site clearing and earth working activities	Negative (-)	Site (-2)	Short term (-2)	Low (-2)	Rare (-1)	Seldom (-2)	Very Low (-18)

Residual Impact

After mitigation measure, there will be no residual impact for liquid waste.

(b) Solid Wastes

Solid wastes of unsuitable soil materials from site clearing activities and domestic solid wastes from pre-construction workers.

Significant of Solid Waste during Pre-construction Phase before Mitigation Measures

Impact on nearby surface water bodies and natural water spring will be low probability and not significant due to the volume of earth work in pre-construction phase as follow:

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase in turbidity, oil and grease in nearest surface water bodies	Site clearing and earth working activities	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Highly probable (-4)	Low (-30)

Consideration of Mitigation Requirement for Solid Waste

The intensity of mitigation measures for surface water environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Intensity of Mitigation	Responsibility
1.	Increase in turbidity, oil and grease in nearest surface water bodies	Low (-30)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Solid Wastes

The following prevention measures will do to reduce surface water pollution during pre-construction phase.

(a) Limit unnecessary earthworks;

(b) All stacking and loading areas will be provided with proper drains to prevent run off from the site to enter any water body;

(c) Prevent over-excavation;

(d) Working in a small area at a point of time (phase wise construction);

(e) Reduce, reuse, and recycle of domestic wastes; and

(f) Vegetation of bare areas after the pre-construction state.

(g) Avoid construction time during rainy season

Significant of Solid Waste during Pre-construction Phase after Mitigation Measures

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase in turbidity, oil and grease in nearest surface water bodies	Site clearing and earth working activities	Negative (-)	Site (-1)	Short term (-2)	Very Low (-1)	Rare (-1)	Probable (-3)	Very Low (-20)

Residual Impact

After mitigation measure, there will be no residual impact for solid waste.

(c) Drainage and flooding

Inadequate assessment of the hydrological conditions in the Project Area and poor design could result in damage to Project structures, including bridges and culverts. This in turn would result in several impacts including cost to rebuild the structures, potential flooding of agricultural land and property and impacts to surface water quality.

Significant of Drainage and flooding during Pre-construction Phase before Mitigation Measures

Impact on nearby surface water bodies and natural water spring will be low probability and not significant due to the volume of earth work in pre-construction phase as follow:

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Drainage and flooding	Inadequate assessment of hydrological conditions	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Probable (-3)	Very low (-24)

Consideration of Mitigation Requirement for drainage and flooding

The intensity of mitigation measures for surface water environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Intensity of Mitigation	Responsibility
1	Inadequate assessment of hydrological conditions	Very low (-24)	Yes	Yes	Monir	Pre-construction service provider(s)

Mitigation Measures for Drainage and Flooding

Consideration in the design phase has be given to the issue of drainage and culverts to ensure that drainage patterns are improved from the existing conditions and that increased run-off does not occur or result in flooding of areas previously undisturbed. During design, all drainage works have been designed based on the historical flood data and flood forecasting.

Significant of Drainage and flooding during Pre-construction Phase after Mitigation Measures

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Drainage and flooding	Inadequate assessment of hydrological conditions	Negative (-)	Site (-1)	Short term (-2)	Low (-2)	Rare (-1)	Seldom (-2)	Very low (-15)

Residual Impact

After mitigation measure, there will be no residual impact for drainage and flooding.

(3) Impacts on Soil Environment During Pre-Construction Phase

Impacts on soil and ground water environment during pre-construction phase will include the followings:

Impacts of Soil Quality

A small amount of domestic wastes will be produced from pre-construction workers. Moreover, some biomass- unsuitable soil materials-were generated from site clearing and tree cutting (bushes and small trees) activities during pre-construction phase. Some earth soil will also be produced from earth cutting activities. All of these solid wastes will have more or less impact on soil quality. As there will be farm land nearby and so this type of impact will be significant in nature.

Significant of Impacts on Soil Quality before Mitigation Measures

Domestic wastes from pre-construction workers will be large quantity along the railway. Amount of scrub produced will also be large quantity along the railway line especially in deep forest area because there will be large number of trees to fell down. Earth and soil materials will also be produced from earth cutting activity, So, impacts on soil and ground water environment during pre-construction phase will be high as shown in the following table.

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination	Domestic wastes and unusable materials in soil	Negative (-)	Site (-1)	Short term (-2)	Low (-2)	Rare (-1)	Probable (-3)	Very low (-20)

Consideration of Mitigation Requirement for Soil Quality during Pre-construction Phase

The intensity requirement of mitigation measures for soil and ground water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Soil contamination	Very Low (-20)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Impact on Soil during Pre-construction Phase

All of the solid wastes produced from pre-construction phase will systematically dispose according to the rules and regulations of CDC. Accordingly, pre-construction services provider(s) will follow CDC rules and regulations for solid waste management during the pre-construction phase. Moreover, MR will take special care on handling of diesel and lubricants to avoid leakage.

Significant of Impacts on Soil Quality after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination	Domestic wastes and unusable materials in soil	Negative (-)	Site (-1)	Short term (-2)	Low (-2)	Rare (-1)	Seldom (-2)	Very low (-15)

Residual Impact

After mitigation measure, there will be no residual impact for soil environment.

(4) Anticipated Impacts on Biodiversity Environment during Pre-construction Phase

There will have too much tree cutting along the railway project and so there will have high impact on flora diversity. Increase in noise during pre-construction phase may affect the feeding, breeding and movement of wildlife in near construction site.

Impacts on Flora Diversity

There will have tree cutting along the bridge and culverts and also for the preparation of temporary construction camps. Therefore, there will have high impact on flora diversity.

Impact index value and categories of fauna and flora in the Mandalay-Muse Railway New Project

No.	Impacts	Magnitude	Duration	Extend (area)	Probability	Total	Category
	Flora						
1.	Loss of trees and other plant species	3	5	2	3	30	Moderate significant (C)

(Source: International Association of Impact Assessment-IAIA, 2014, www.iaia.org)

Consideration of Mitigation Requirement for Biodiversity Environment during Pre-construction Phase

The intensity requirement of mitigation measures for biodiversity environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Impact on flora diversity	Moderate (-30)	Yes	Yes	Moderate	Pre-construction service provider(s)

Mitigation Measures for Impacts on Biodiversity Environment

The pre-construction service provider will conduct the following mitigation measures.

Flora Diversity

According to the consideration of intensity of mitigation measures (moderate scale), it is necessary to avoid tree cutting of road side plants and fence plants and re-planting the trees at twice of cutting and re-planting at other place for IUCN red list trees. So, MR will do or will force pre-construction service provider(s) to avoid tree cutting as much as possible at project site and no tree cutting beside the railway road construction. MR also limit operation of noisy machineries and working at night during pre-construction phase.

(5) Impacts on Human Environment during Pre-construction Phase

Socio-economic

Positive Socio-economic

The positive socio-economic impact during pre-construction will be job creation. The work force for each site and total site clearance are shown in following tables:

Project phase	Duration	Total work force	Total site clearing area for all bridges and culverts	Number of equipment used (for each site)	Quality
Pre-construction Phase	6 months	200	For one bridge – 0.5 acres For all bridges (0.5x124) – 62 acres For one culvert–0.115 acres For all culverts (0.115x729) – 83.835 acres	Dozer Heavy Truck	3 5

For site clearing of all bridges and culverts during pre-construction phase, it will use 10 groups of employees. Each group contains 20 employees. Each group will take 6 months for clearing of approximately 12 bridges and 73 culverts.

Significant of Impacts on Job Opportunities during Pre-Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Job opportunities	Pre-construction Activities	Positive (+)	Limited (+2)	Short term (+2)	Low (+2)	Regular (+3)	Probable (+3)	Low (+36)

Consideration of Mitigation Requirement for Job Opportunities during pre-construction phase

The intensity of mitigation requirement for job opportunities according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1	Job Opportunities	Low (+36)	Yes	Yes	Moderate	Pre-construction service providers

Enhance Measure for Positive Socio-economic Impacts

- Use local people as much as possible
- Ensure to put this policy to contractor(s) and sub-contractor(s) in their agreement contract

Significant of Impacts on Job Opportunities during Pre-Construction Phase after Enhance Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Job opportunities	Pre-construction Activities	Positive (+)	Local (+3)	Short term (+2)	Low (+2)	Regular (+3)	Highly probable (+4)	Low (+49)

Negative Socio-economic

(a) Visual Impact during Pre-construction Phase

Visual impacts during pre-construction phase is mainly from the visual pollutants like construction materials and waste from site clearance and also from the tree cutting of the alongside the railway.

Significant of Visual Impact before Mitigation Measure

Since there will have too much tree cutting for the proposed project, the significance of the impacts is shown as follows:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual impact	Tree cutting and waste from site clearance	Negative (-)	Site (-1)	Short term (-2)	Low (-2)	Rare (-1)	Probable (-3)	Very low (-20)

Consideration of Mitigation Requirement for Visual Impact during Pre-construction Phase

The intensity requirement of mitigation measures for visual impact according to the consideration of impact rating is as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Visual impact	Very low (-20)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Visual Impacts

The efficient and timely removal of all demolition and construction wastes as per requirement. Proper disposal of soil materials and other wastes. Roads providing access to the site should be maintained free of dust and mud.

Significant of Visual Impact after Mitigation Measure

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual impact	Tree cutting	Negative (-)	Site (-1)	Short term (-2)	Low (-2)	Rare (-1)	Seldom (-2)	Very low (-15)

Residual Impact

After mitigation measure, there will be no residual impact for visual impact.

(b) Land Use

Land use will affect socio-economic situation of local people. It can also cause the loss of forest areas, agricultural lands, histological areas, ecologically sensitive areas and blockage of village roads. Site clearing area for the pre-construction phase will be at least 150 acres.

Significant of Impact for Land Use before Mitigation Measures

Since there will have too much tree cutting for the proposed project, the significance of the impacts is shown as follows:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Socio-economic situation of local people	Temporary land use	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Highly probable (-4)	Low (-30)
	Permanent land use	Negative (-)	Limited (-2)	Permanent (-5)	High (-5)	Rare (-1)	Highly probable (-4)	Low to moderate (-60)

Consideration of Mitigation Requirement for Land Use during Pre-construction Phase

The intensity requirement of mitigation measures for land use and involuntary resettlement according to the consideration of impact rating is as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Temporary Land use	Low (-30)	Yes	Yes	Moderate	Pre-construction service provider(s)
2.	Permanent Land use	Low to moderate (-60)	Yes	Yes	Moderate	Pre-construction service provider(s)

Mitigation measures for Land Use

Avoid land use for agricultural land, histological areas, archeological areas, forest area and ecologically sensitive areas as much as possible. Use overhead bridge as much as possible, Reasonable compensation for land use as per compensation program in RAP. Compensation for affected structures and standing crops and assistance of livelihood restoration as per RAP. If there will be indigenous local people, it is necessary to conduct indigenous People Plan (IPP).

Significant of Land Use after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Socio-economic situation of local people	Temporary land use	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Probable (-3)	Very Low (-24)
	Permanent land use	Negative (-)	Limited (-2)	Permanent (-5)	Medium (-4)	Rare (-1)	Highly probable (-4)	Low to moderate (-55)

Residual Impact

After mitigation measures, the impact significant remains low to moderate. There will be some residual impact for land use. The mitigation measure for this impact will be according to the reasonable compensation for land use as per compensation program in RAP.

6.2.2. Anticipated Impacts during Construction Phase

In the construction activities of the bridges and culverts, it includes the excavation of soils and piling activity for the bridge. It can also involve the construction of temporary camp for the workers. Some of the impacts related to the above construction activities will be as following.

(1) Impacts on Air Environment
(2) Impacts on Water Environment
(3) Impacts on Soil Environment
(4) Impacts on Biodiversity Environment
(5) Impacts on Human Environment

(1) Anticipated Impacts on Air Environment during Construction Phase

The construction and decommissioning phases of bridge and culvert developments have the potential to affect local air quality and climate. During these activities, local air quality may decline as a result of gaseous and particulate emissions from vehicle movements on and off site.

Impacts on air quality during construction phase will be as follow:

(a) Fugitive dust generation from transportation of construction materials and construction activities,

(b) Vehicular emissions related to the transportation of personnel and construction materials

(c) Noise from the transportation of construction materials and construction activities

(d) Vibration from the construction activities

(a) Fugitive Dust Generation

The construction phase will mainly result in nuisance impacts in the form of dust. Large uncertainties are associated with emission estimates for these types of activities, resulting mostly in fugitive emissions. It will include emissions from on-site heavy-duty off-road vehicles, other light-duty vehicles and dust emissions as a result of the construction activities. Particulate matter (PMs) were released from transportation of construction materials and construction activities such as during excavation, movement of earth materials, unloading and mixing of construction materials, contact of construction machinery with bare soil, traffic movement on unpaved roads, transport of demolition waste, and exposure of bare soil and soil piles to wind. Although construction is not a long time, construction activities will affect particularly in dry season. Travelling of vehicles and access road can produce dust generation.

The impact of fugitive dust sources on air quality depends upon the quantity as well as the drift potential of the dust particles emitted into the atmosphere. Large dust particles (i.e. over 100 mm in diameter) will settle close to the source and particles that are between 30 and 100 mm in diameter would likely undergo impeded settling.

The main dust impacts are likely to arise from particles with less than 30 mm in diameter, which have a greater potential to disperse over greater distance. Dust emissions vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing weather.

According to USEPA AP-42, construction dust particles are grouped into various particle sizes. Their size ranges are 1.25 mm, 3.75 mm, 7.5 mm, 12.5 mm, 22.5 mm, and the percentage of particles in each class was estimated to be 7%, 20%, 20%, 18% and 35%, respectively. Based on field measurements of suspended dust emissions from heavy construction projects like building and road construction, an approximate emission factor for construction operations is: 1.2 tons per acre of construction per month of activity. This value applies to construction operations with: (1) medium activity level, (2) moderate silt content (30%), and (3) semiarid climate (50 % of precipitation-evaporation (PE) index.

Normally, the particles (greater than 10 microns) will disperse following wind direction and will fall off in the distance of 6-9 meters from construction site. Moreover, for particulate matter smaller than 10 microns, the dispersion distance could be greater than a radius of (200-700) m from project site and the sensitive receptors are considered to be those within a 2 km radius of proposed site. The following tables shows the estimated distance travelled between the relationship of wind speed and dust size particles.

Table : 10 Micron Particle

Wind Speed (mph)	Distance Traveled (miles)
3.1	0.55
6.2	1.1
12.4	2.3
24.8	4.6
37.3	6.9
49.7	9.2

Table : 2.5 Micron Particle

Wind Speed (mph)	Distance Traveled (miles)
3.1	2.2
6.2	4.5
12.4	9
24.8	18
37.3	27
49.7	36.1

Emission Rate (Q)

The dust emission rate will be estimated according to equation (1):

$$Q(mg/s) = \frac{0.04\ (tons/acre/day) \times area \times 10^6 (mg/kg)}{24 \times 60 \times 60 (s/d)} \qquad \text{Equation (1)}$$

$$Q(mg/s) = \frac{40\ (kg/acre/day) \times area \times 10^6 (mg/kg)}{24 \times 60 \times 60 (s/d)}$$

The land use for main line of Muse-Mandalay Railway will be 37, 320,512 m^2 (9222 acres) during project life. By calculation of dust emission with above equation, it will be resulted Q = 4269444 mg/s

Dust Concentration (C)

The dust concentration is estimated by using equation (2):

$$C(mg/m^3) = \frac{Q(mg/s)}{d(m) * W(m/s) * M(m)} \qquad \text{Equation (2)}$$

Where,

C = Dust Concentration (mg/m3)

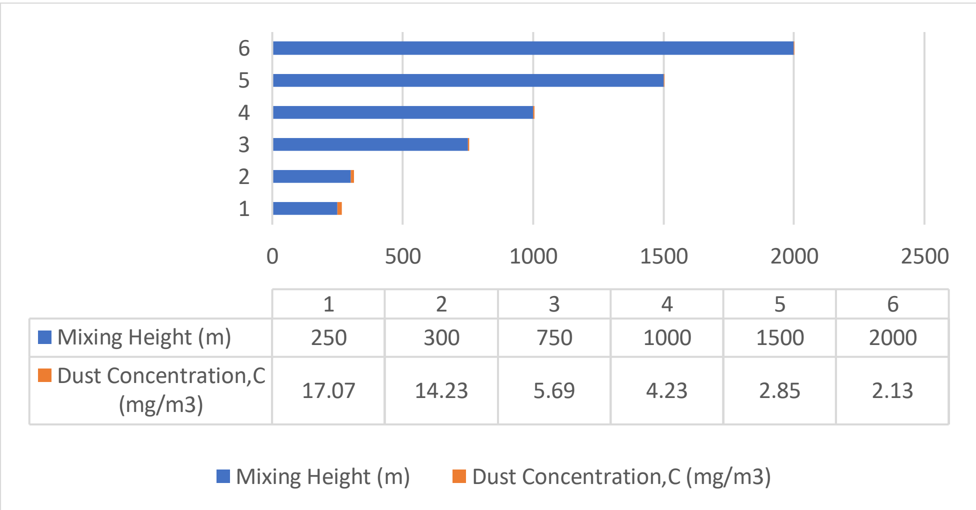
Q = Emissions at Source (mg/s)

d = Width (the smallest dimension is used for worst case scenario) (m) = 500 m

W = Average maximum wind speed (m/s)

M = Mixing Height (m)

According to the wind speed condition, wind speed during a year is about 1m / s ~ 3m / s in Myanmar. Thus, assume that average maximum wind speed will be 2 m/s in the calculation. However, the mixing height data is not available in the Meteorology Department. Therefore, the measurement of mixing height data is adopted from the atmospheric simulation models (EU) in which the default mixing height vary from very unstable stage to extremely stages in total six stages with default values of mixing height values (2000m, 1500m, 1000m, 750m, 300m, 250m).



	1	2	3	4	5	6
Mixing Height (m)	250	300	750	1000	1500	2000
Dust Concentration,C (mg/m3)	17.07	14.23	5.69	4.23	2.85	2.13

The above chart shows the estimated results of dust concentration at source varying mixing heights. In construction time, all the railway bridges and culverts would be carried out part by part with different sub-contractors. Thus, the same whole amount of dust emission could not generate at all sections.

Significant of Impacts on Fugitive Dust Emission during Construction Phase before Mitigation Measures

Impacts on air environment during construction phase will not be significant because of the small number of heavy construction machineries used for railway project. Most of the construction work will be carried out by human activities.

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive dust emission	Construction activities	Negative (-)	limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Highly Probable (-4)	Low (-40)

Consideration of Mitigation Requirement for fugitive dust emission during Construction Phase

The intensity of mitigation measures for air environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Dust generation	Low (-40)	No	Yes	Minor	Construction service providers

Mitigation Measures for Dust Emission during Construction Phase

Like pre-construction phase, dust will be efficiently countered by sprinkling of water during construction phase for minor mitigation measures. Water can be sprayed by using handheld spray. The Safeguards during construction related to dust control will include:

- Minimizing dust from material handling sources by using covers or control equipment;
- Minimizing dust from open area sources, including storage piles by using enclosures or covers, or increasing moisture content;

- Use of dust suppression techniques such as applying water or non-toxic chemicals to minimize dust from vehicle movements Other mitigation measures include maintaining good housekeeping practices throughout the construction phase. These low-cost measures include:
- Properly enclosing the site through use of appropriate hoarding and screening.
- Perform mixing and unloading operations of solid materials on-site (to minimize off-site impacts).
- Proper handling of cement material.
- Requiring and monitoring for minimal traffic speed on-site
- Covering the loads of all vehicles hauling materials likely to give off dust emissions.
- Ensuring adequate maintenance and repair of demolition and construction machinery and vehicles.
- Prohibiting burning of material for and resulting from site clearance.
- Covering excavated soils and demolition wastes with impervious sheeting.
- Ensuring the timely removal of demolition waste to local authorities approved site for landfilling or reclamation and reuse.
- Applying water as a dust suppressant as needed.
- Identifying periods where site activities may create higher levels of dust (e.g. at times of demolition, heavy traffic or excavation) and planning accordingly to have adequate water supply available and implement dust suppression techniques to decrease emissions into the atmosphere and to ensure maximum efficiency, facility trucks and equipment will be inspected on a regular basis and have a regular maintenance schedule. Trucks and machinery will be turned off when not in use to reduce power consumption as well as the emission of pollutants.

Moreover, the construction services provider(s) will do the following activities to control dust during construction phase are shown in the following table.

Recommended Actions for Dust Control during Construction Phase

Fugitive Dust Source Category	Dust Control Actions
Earth-moving	▪ For any earth moving which is more than 30 m from all property lines, conduct watering as necessary to prevent visible dust emissions from exceeding 100 cm in length in any direction.

	▪ Physical barrier is required to install to prevent dust moving to the surrounding. ▪ Fascial masks need to be provided to the constriction workers during potentially dusty operations
Disturbed surface areas (except completed grading areas)	▪ Apply dust suppression in a sufficient quantity and frequency to maintain a stabilized surface; ▪ Areas, which cannot be stabilized, as evidenced by wind driven dust, must have an application of water at least twice per day to at least 80 percent of the unstabilized area. Damping down shall take place on a continual basis.
Disturbed surface areas (completed grading areas)	▪ Apply water to at least 80 percent of all inactive accessible disturbed surface areas on a daily basis when there is evidence of wind driven fugitive dust.
Inactive disturbed surface areas	▪ Apply dust suppressants in sufficient quantity and frequency to maintain a stabilized surface.
Unpaved roads	▪ Water all roads used for any vehicular traffic at least twice per day of active operation; or ▪ Water all roads used for any vehicular traffic once daily and restrict vehicle speed to 15 mph.
Track-out control	▪ Downwash of trucks (especially tyres) prior to departure from site.

Significant of Impacts on Fugitive Dust Emission during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive dust emission	Construction activities	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Seldom (-2)	Low (-30)

Residual Impact

After mitigation measure, there will be no residual impact for fugitive dust generation.

(b) Gaseous Emissions

Some gases such as carbon monoxide (CO), Carbon dioxide (CO2), nitrogen oxides (NOx), and sulfur oxides (SOx) were emitted from the operation of generator, concrete mixer, vehicles and construction machineries into the atmosphere during the construction phase (including both on-site and the public roads).

Air Dispersion Comparison at Average 8 hours on No Project and Project Conditions (Construction Phase)

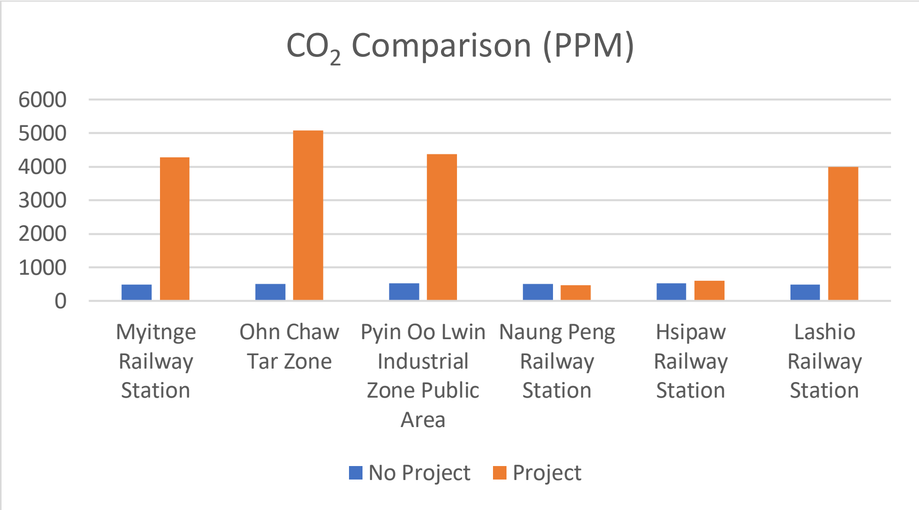
The air dispersion is predicted by using AERMOD VIEW modelling software. Wind speeds, wind directions and gas emission rate are used as input data. And the software gives the concentration level of gases as results. The machines and their emission rates are assumed to be able to predict the possible concentration levels of gases in the construction phase. At Naung Peng Railway Station and Hsipaw Railway Station, the wind speed is measured over 6 km/s and 4 km/s average, thus the concentration levels at those points are lower compared to the other points. The prediction is done by assuming the construction works are 8 hours continuous operation. But the actual construction work will be discontinuous operation meaning the concentration levels can be lower than the predicted model. The concentration levels of pollutants are shown in following tables and figures.

Table – Average Concentration of pollutants at the sample points for 8 hours for each in No Project Condition

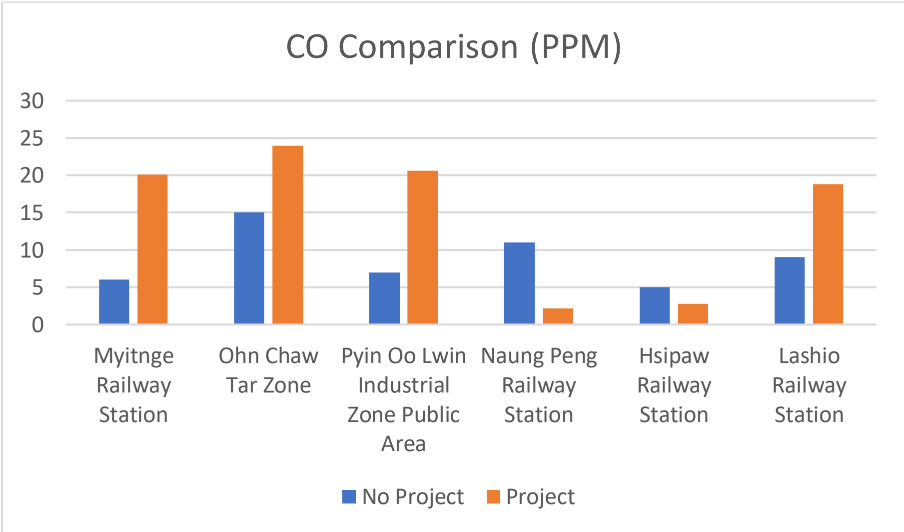
Sample Time	Sensitive Areas	Average Value Parameters					
		CO_2 (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppb)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
Time 8 hours for each point	Myitnge Railway Station	479	6	1	31	29	11
	Ohn Chaw Tar Zone	498	15	4	29	43	22
	Pyin Oo Lwin Industrial Zone Public Area	519	7	1	21	21	14
	Naung Peng Railway Station	509	11	3	12	26	10
	Hsipaw Railway Station	526	5	1	21	28	17
	Lashio Railway Station	491	9	1	19	29	18

Table – Average Concentration of pollutants at the sample points for 8 hours for each in Project Condition

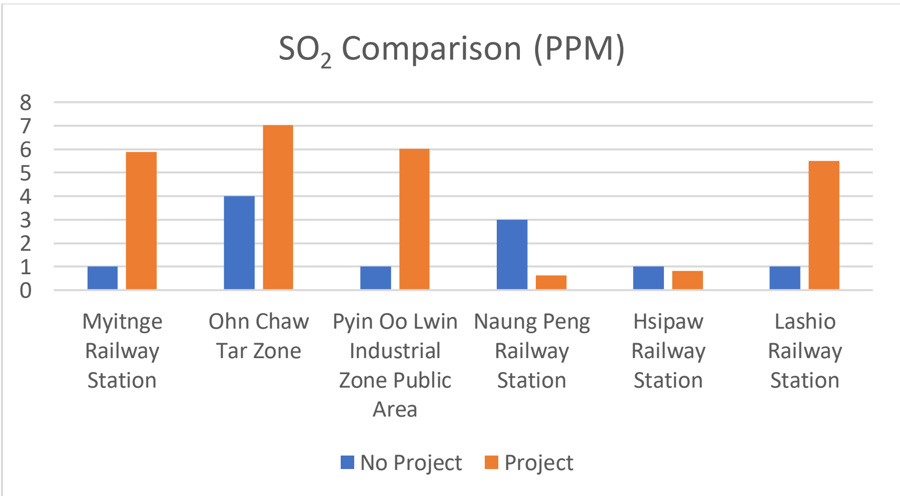
Sample Time	Sensitive Areas	Average Value Parameters					
		CO_2 (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppb)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
Time 8 hours for each point	Myitnge Railway Station	4268	20.1	5.88	45.8	4.03	3.92
	Ohn Chaw Tar Zone	5085	24	7.01	54.6	4.796	4.669
	Pyin Oo Lwin Industrial Zone Public Area	4366	20.6	6.02	46.85	4.12	4.01
	Naung Peng Railway Station	463.4	2.19	0.639	4.97	0.437	0.426
	Hsipaw Railway Station	592	2.8	0.817	6.36	0.559	0.544
	Lashio Railway Station	3992	18.8	5.5	42.8	3.77	3.67


CO_2 Comparison (PPM)
6000
5000
4000
3000
2000
1000
0
Myitnge Railway Station
Ohn Chaw Tar Zone
Pyin Oo Lwin Industrial Zone Public Area
Naung Peng Railway Station
Hsipaw Railway Station
Lashio Railway Station
No Project
Project

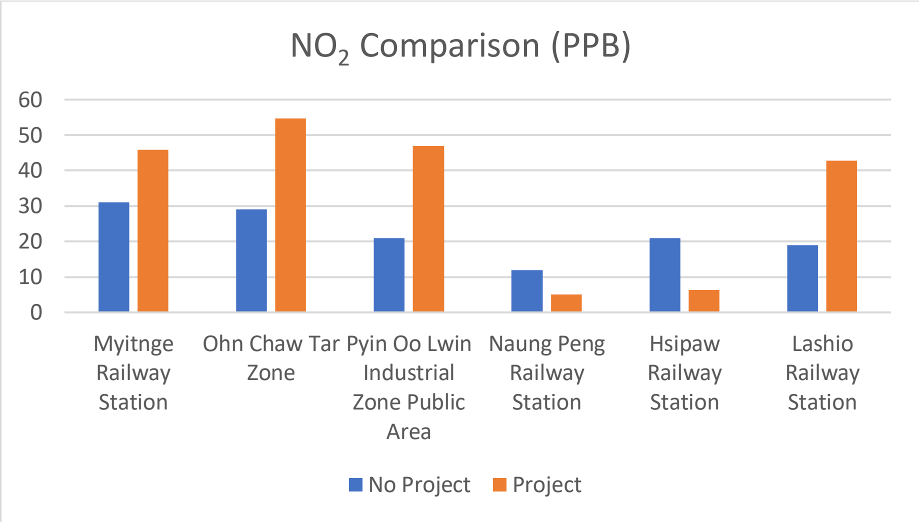
CO_2


CO Comparison (PPM)
30
25
20
15
10
5
0
Myitnge Railway Station
Ohn Chaw Tar Zone
Pyin Oo Lwin Industrial Zone Public Area
Naung Peng Railway Station
Hsipaw Railway Station
Lashio Railway Station
No Project
Project

CO


SO_2 Comparison (PPM)
8
7
6
5
4
3
2
1
0
Myitnge Railway Station
Ohn Chaw Tar Zone
Pyin Oo Lwin Industrial Zone Public Area
Naung Peng Railway Station
Hsipaw Railway Station
Lashio Railway Station
No Project
Project

SO_2



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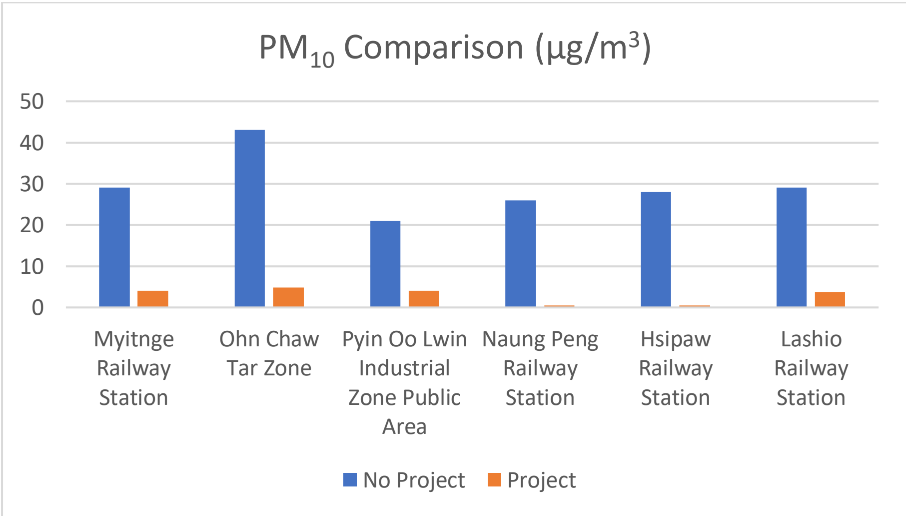
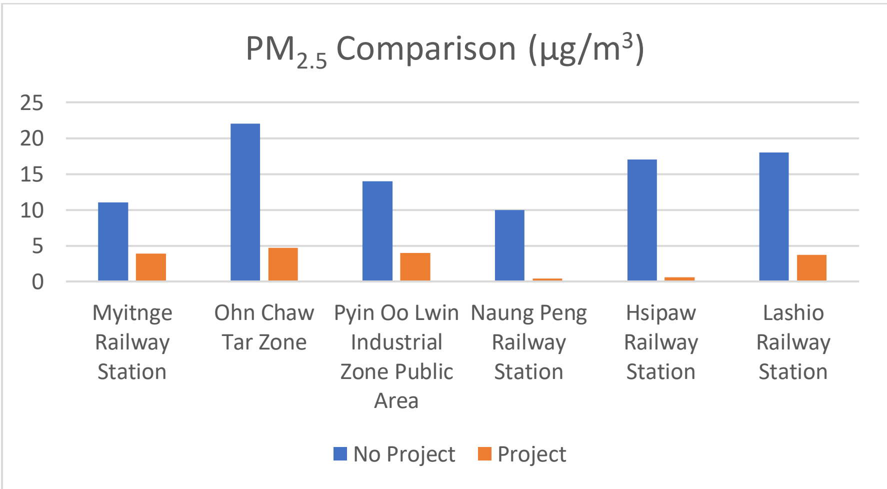


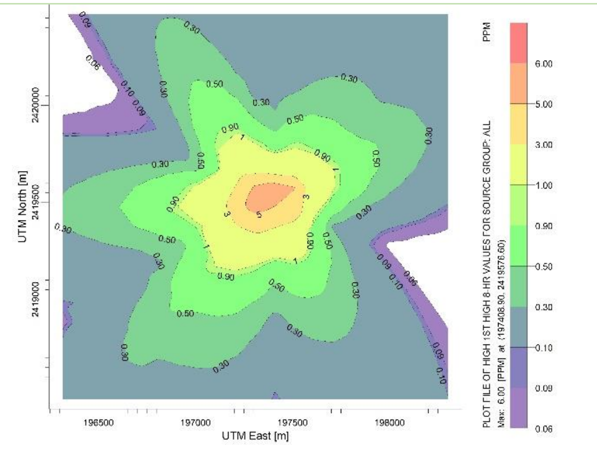
PM_{10}



$PM_{2.5}$

Myitnge Railway Station

CO



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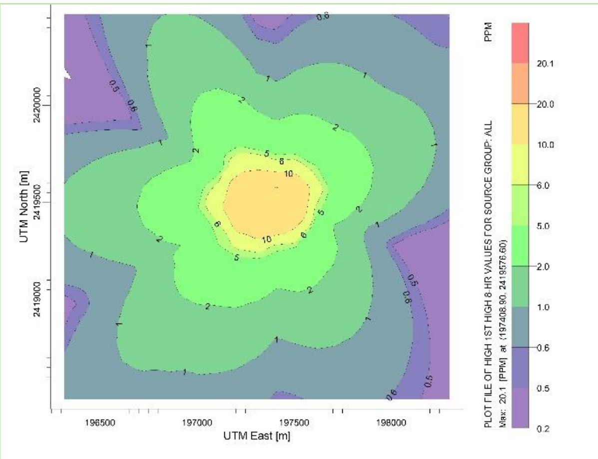
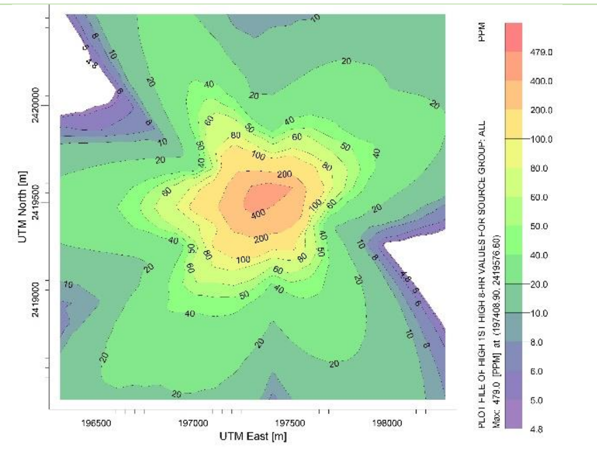


Project Condition

CO_2



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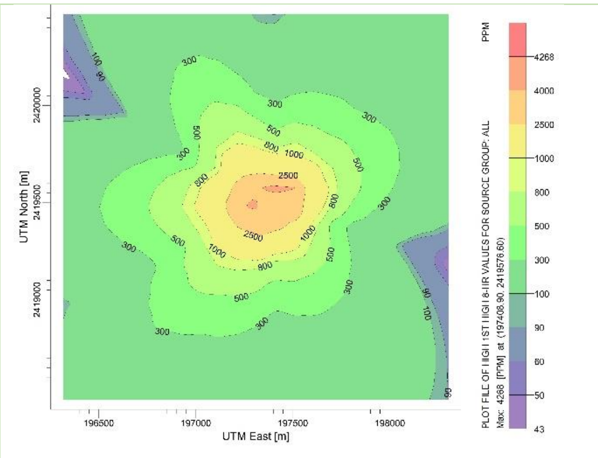

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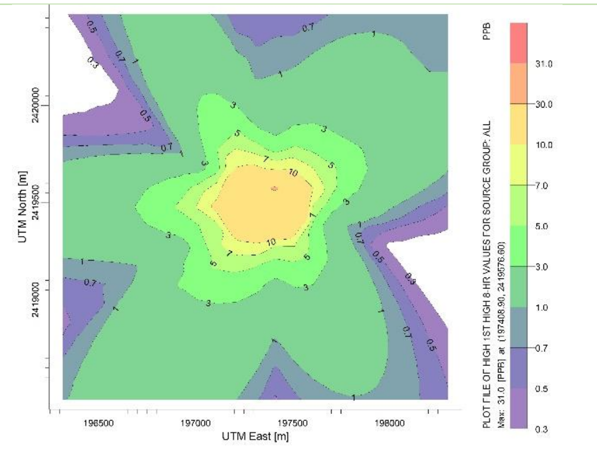

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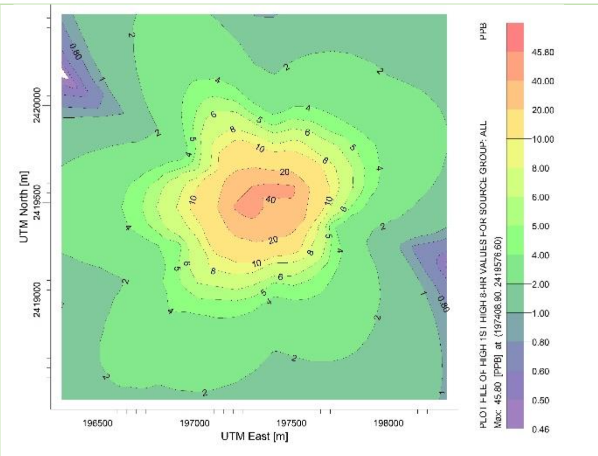
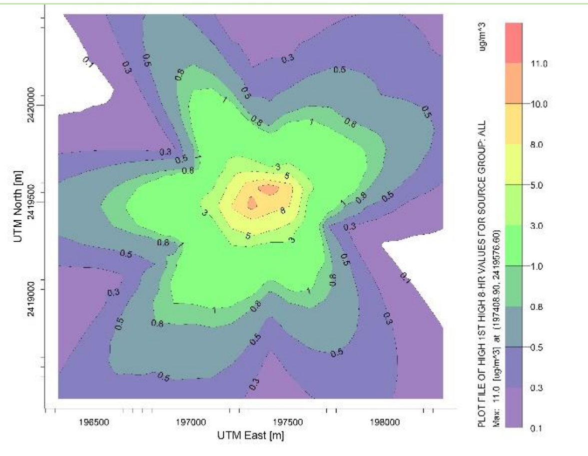


Project Condition

$PM_{2.5}$



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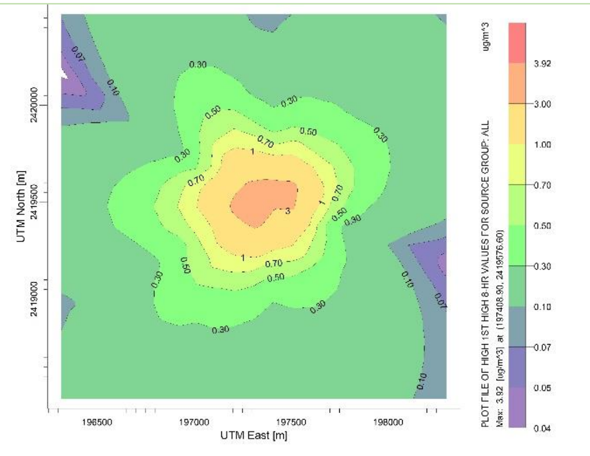
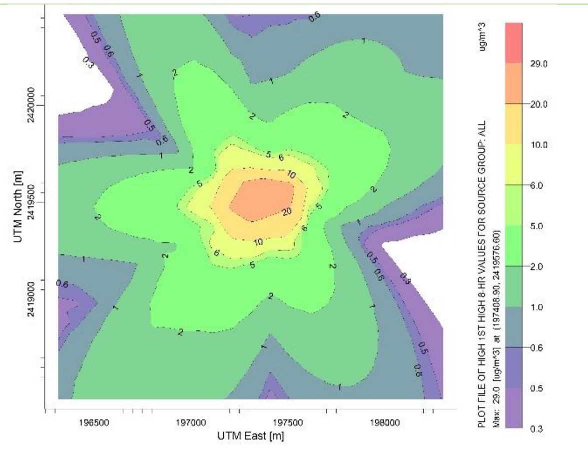


Project Condition

PM_{10}



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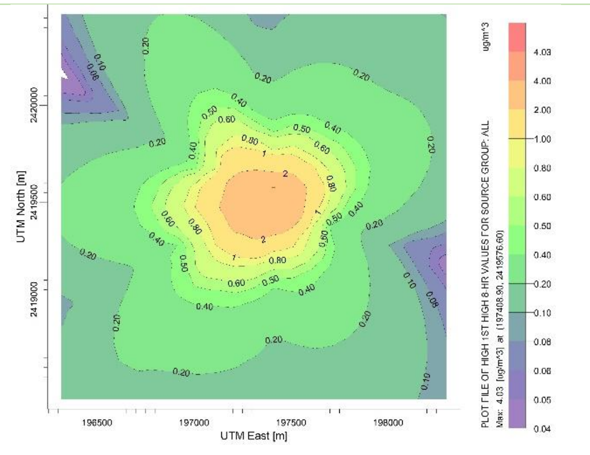
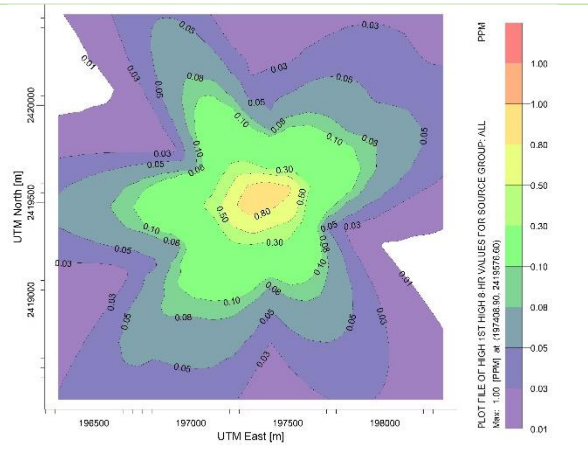


Project Condition

SO_2



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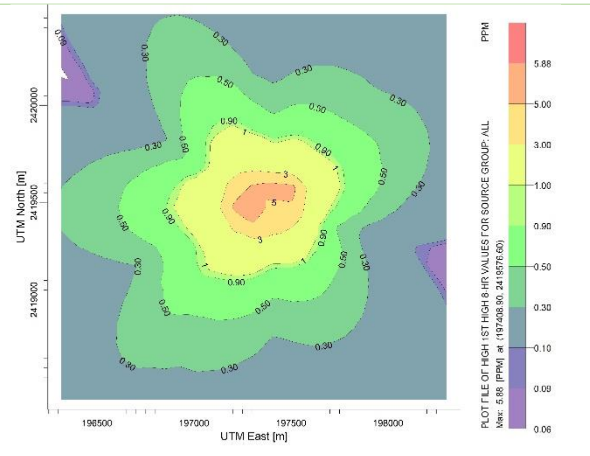
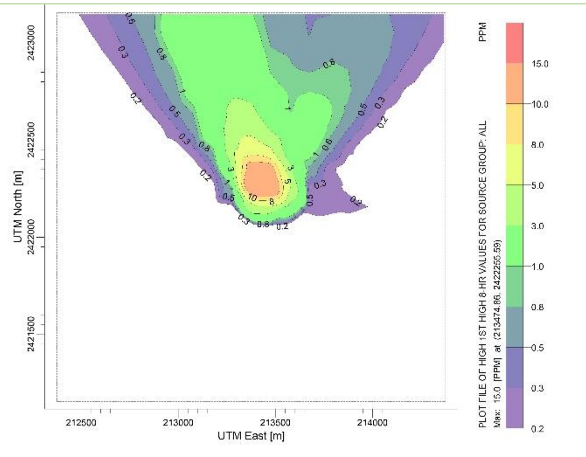


Project Condition

Ohn Chaw Tar Zone

CO



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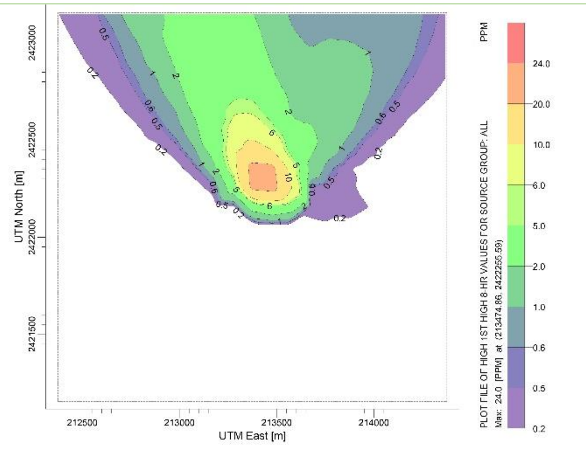

Project Condition

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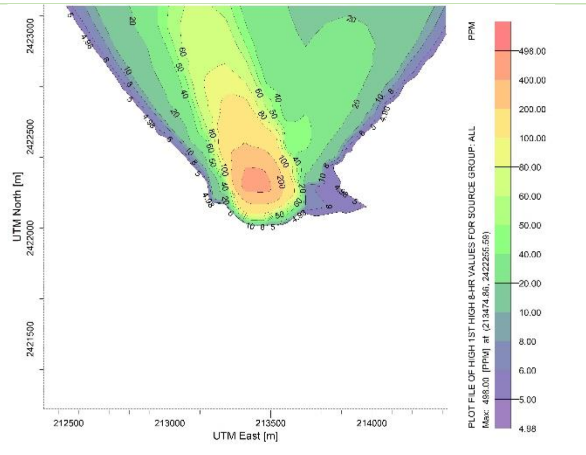

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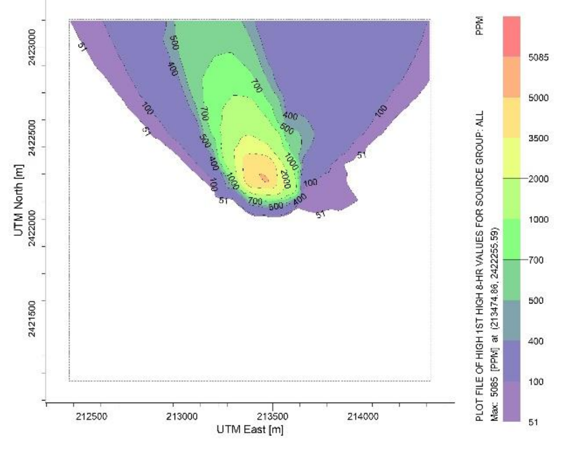

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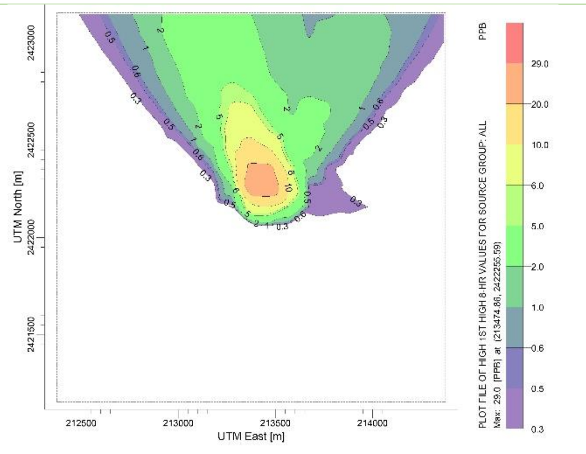

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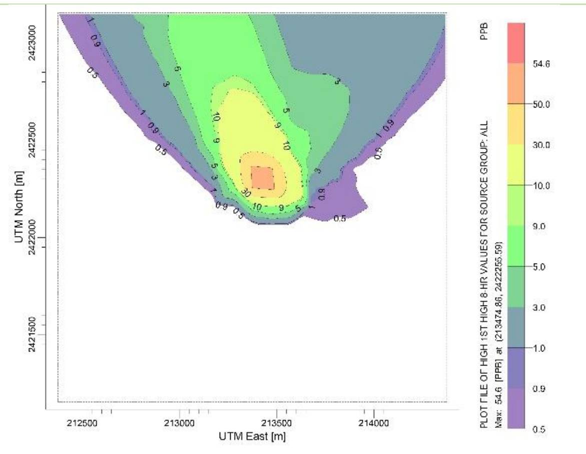
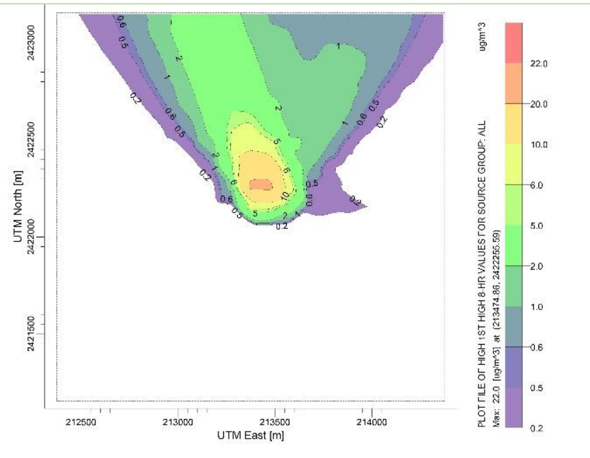


Project Condition

$PM_{2.5}$



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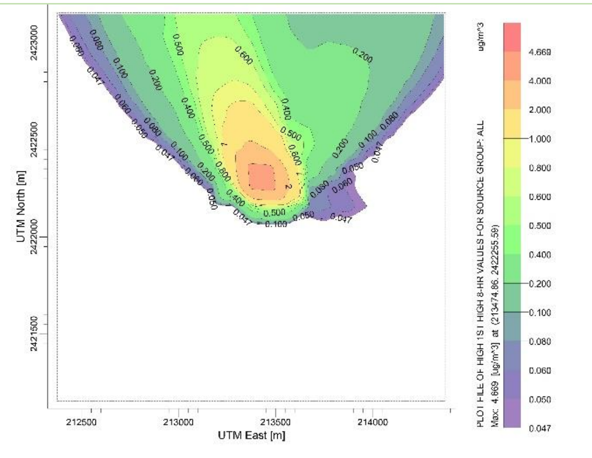
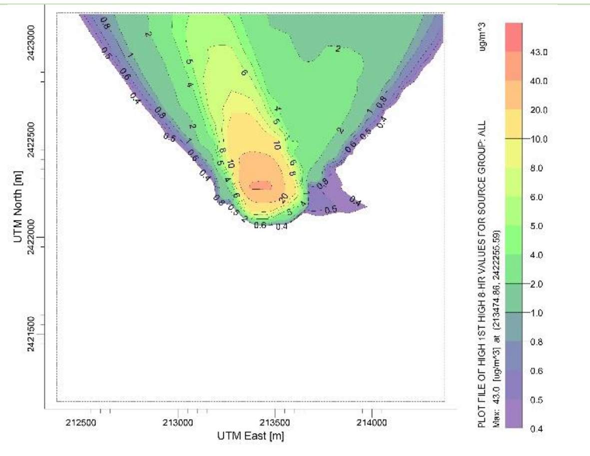


Project Condition

PM_{10}



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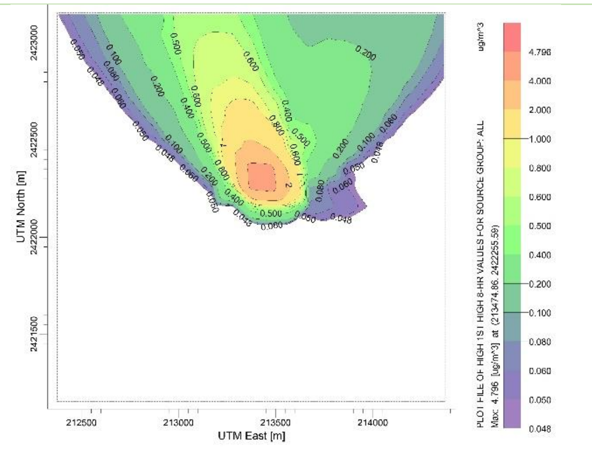
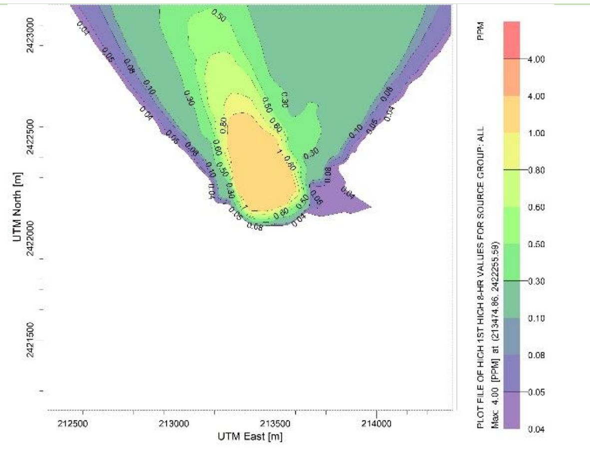


Project Condition

SO_2



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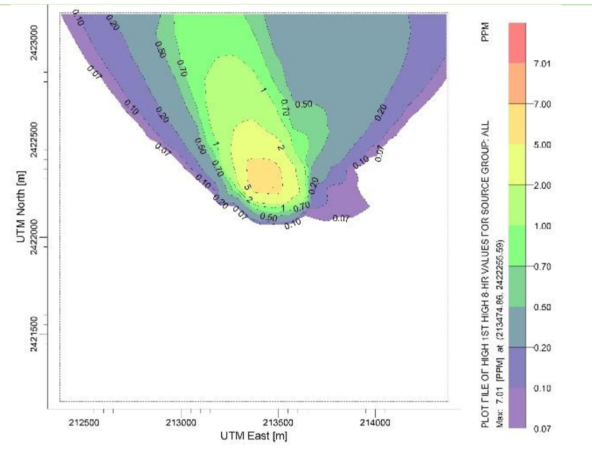
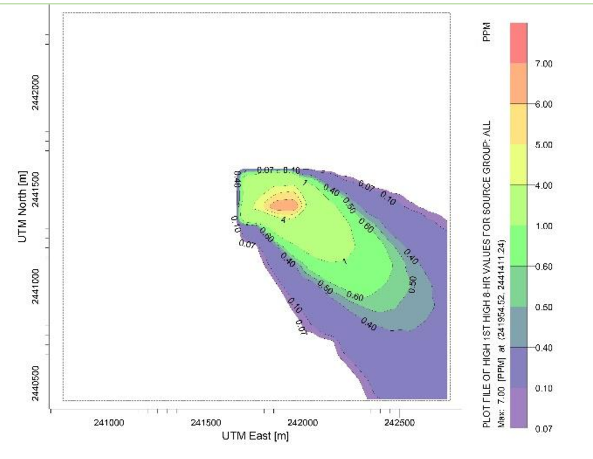
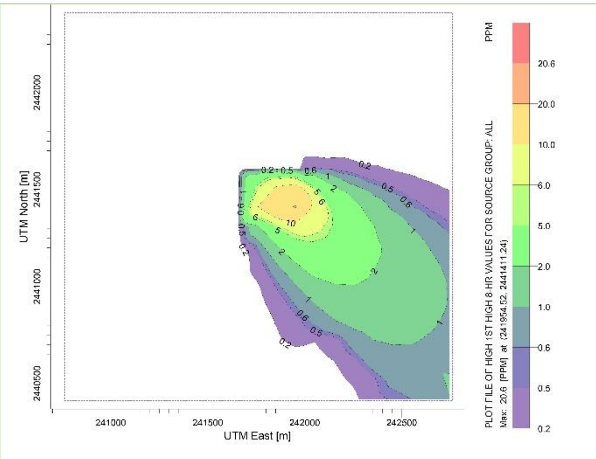


Project Condition

Pyin Oo Lwin Industrial Zone Public Area

CO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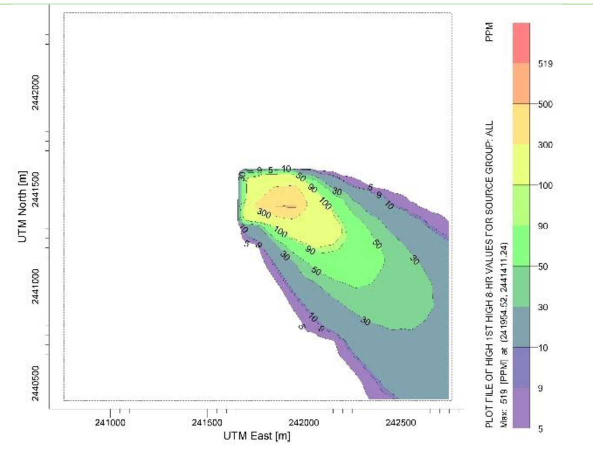
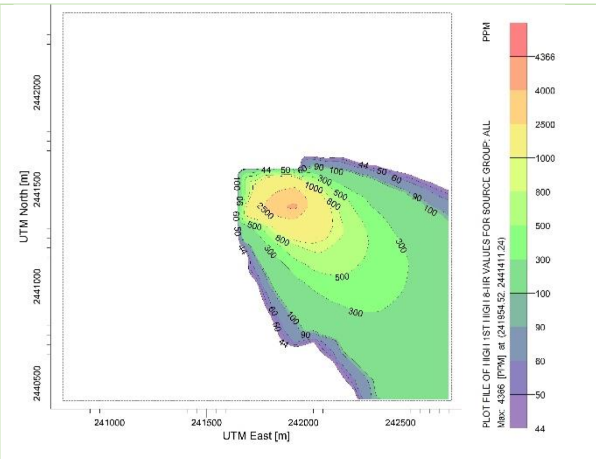
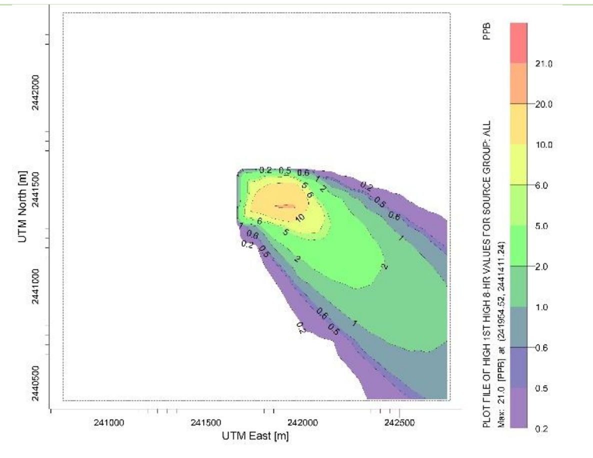
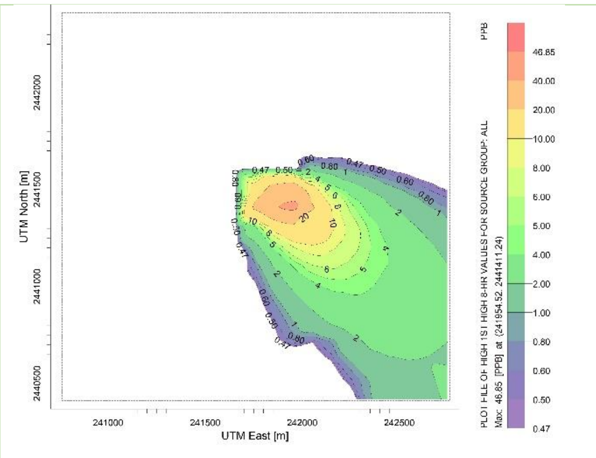
	
No Project Condition	Project Condition

NO_2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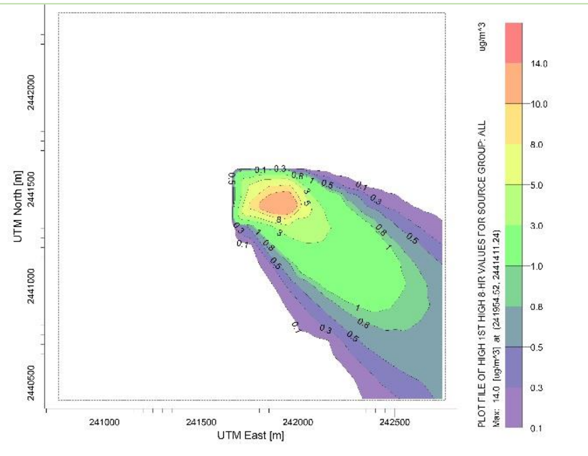
$PM_{2.5}$



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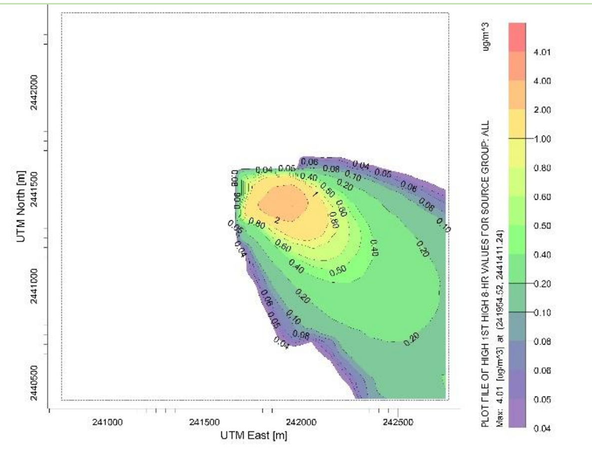

Project Condition

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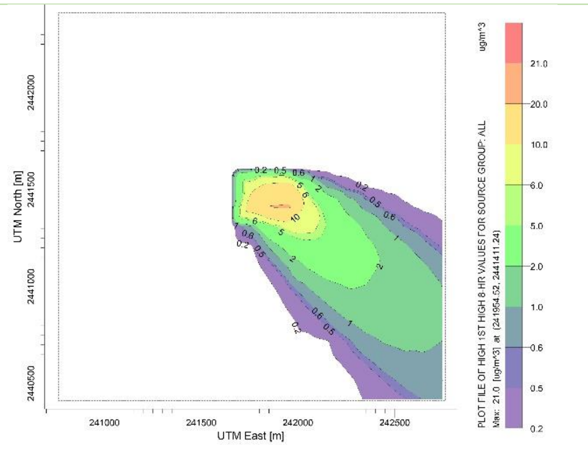

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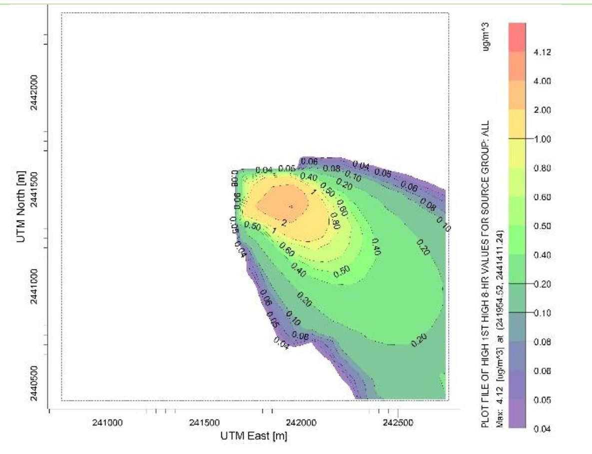

Project Condition

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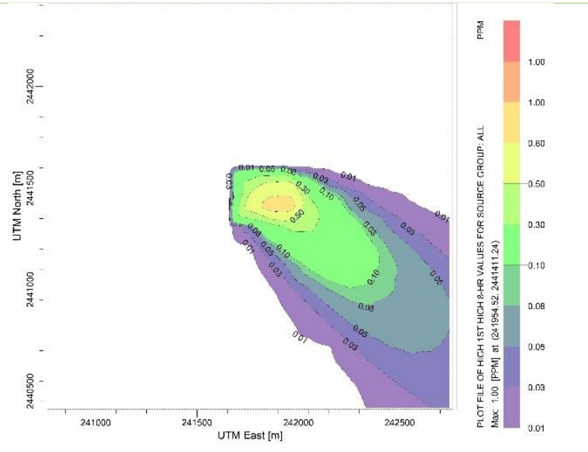

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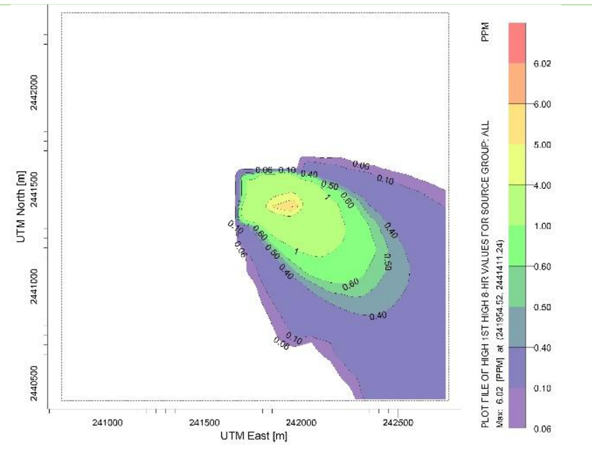
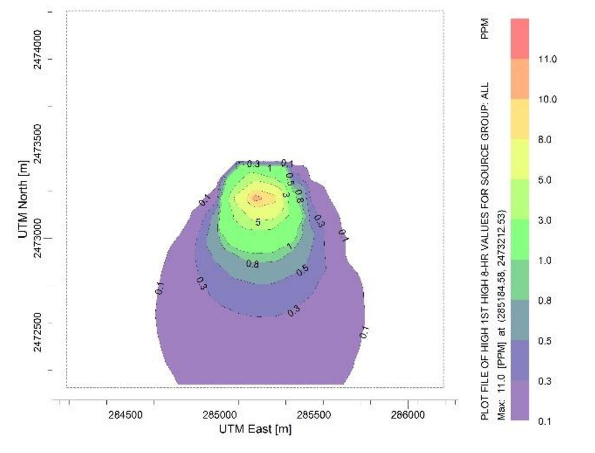


Project Condition

Naung Peng Railway Station

CO



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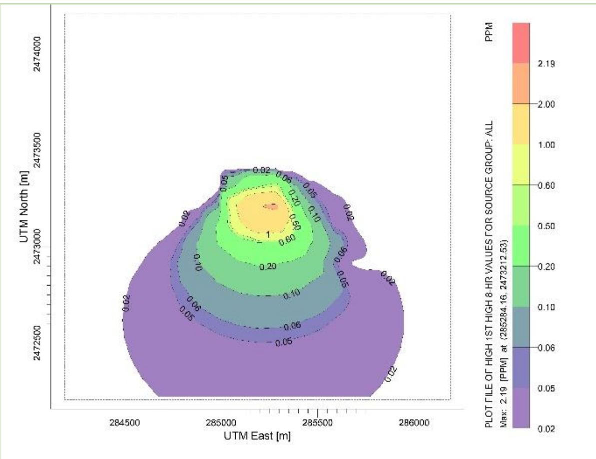

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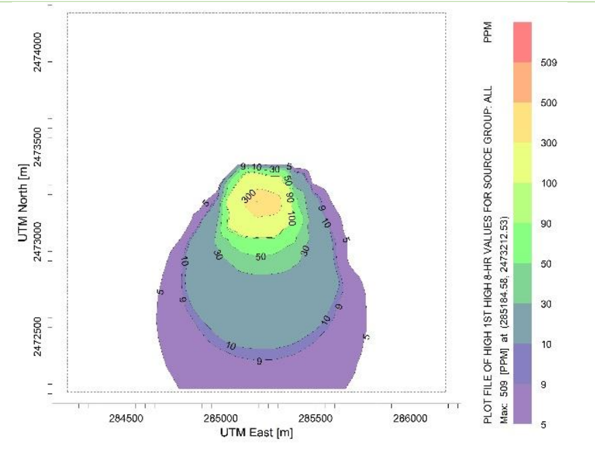

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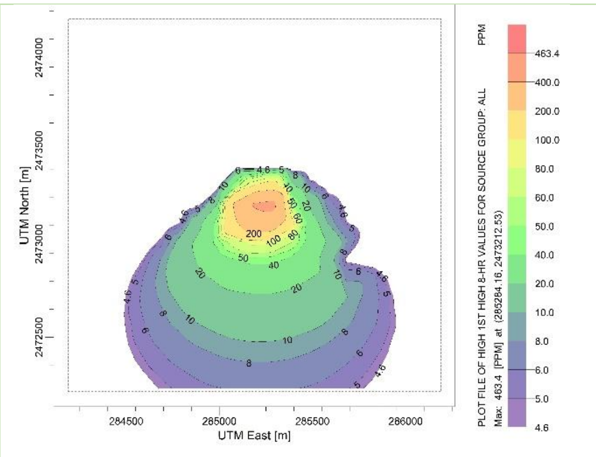

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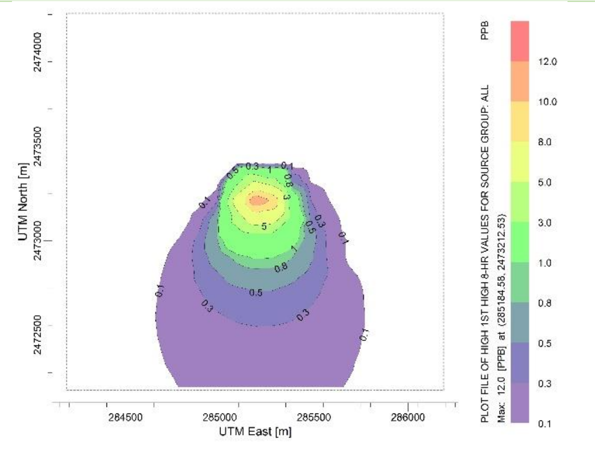

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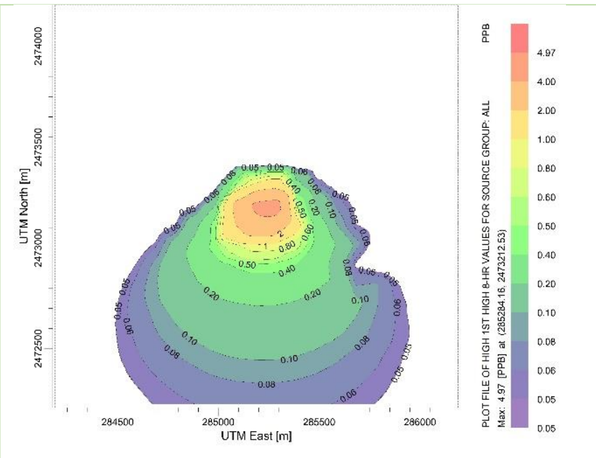

Project Condition

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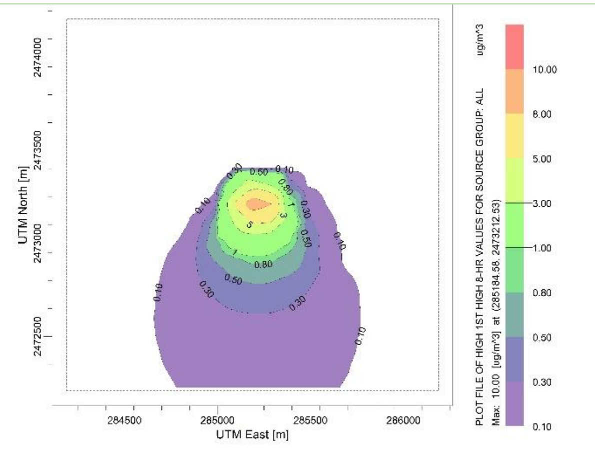

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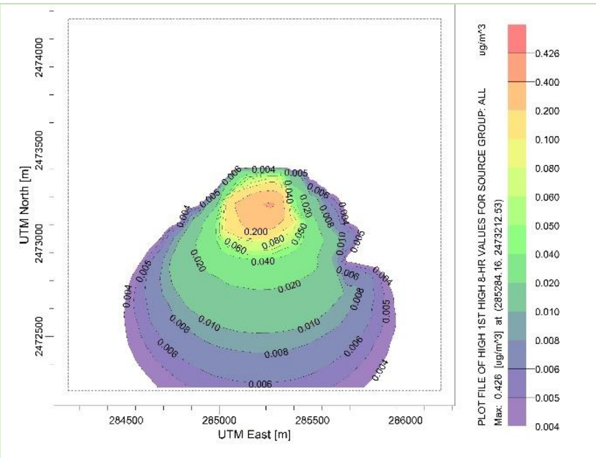

Project Condition

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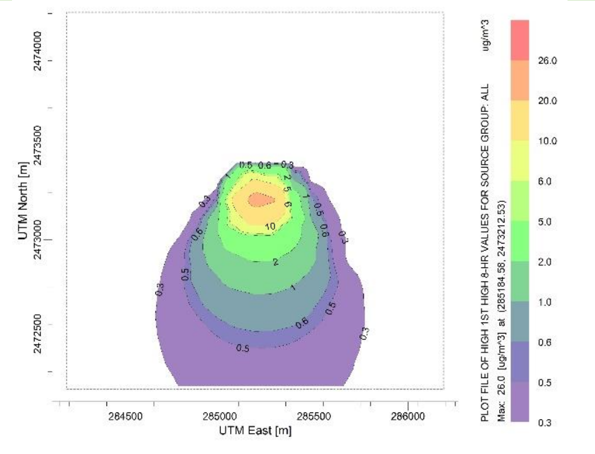

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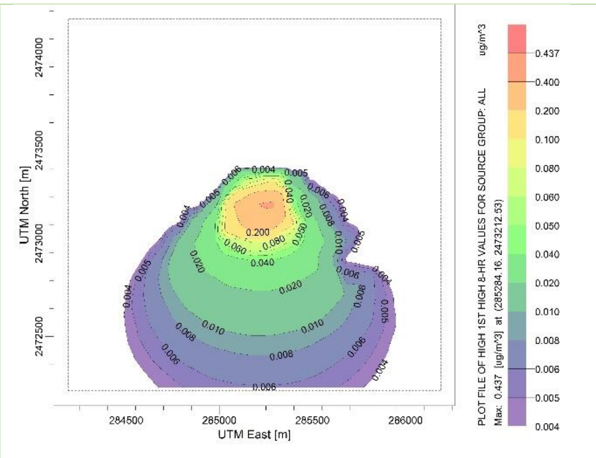
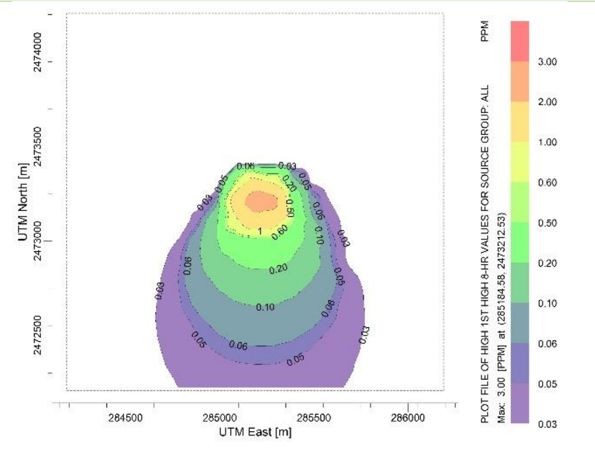


Project Condition

SO$_2$



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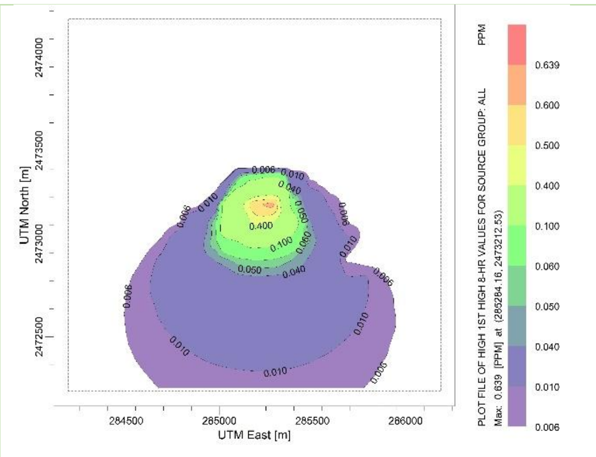
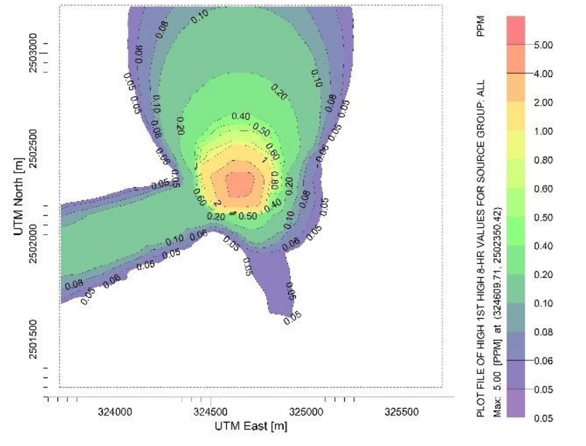


Project Condition

Hsipaw Railway Station

CO



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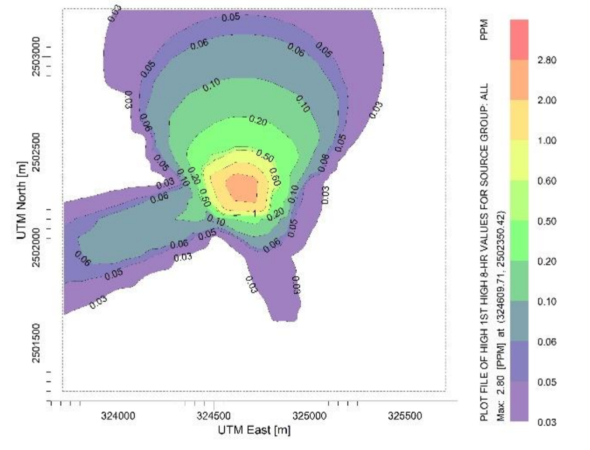
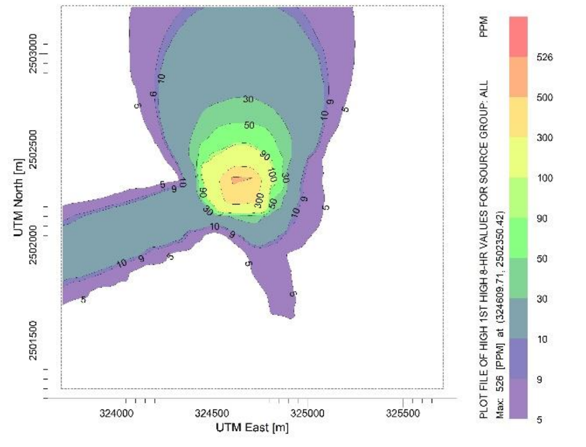


Project Condition

CO_2



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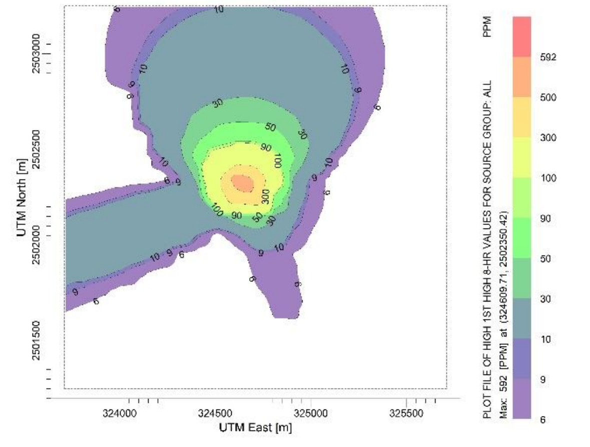

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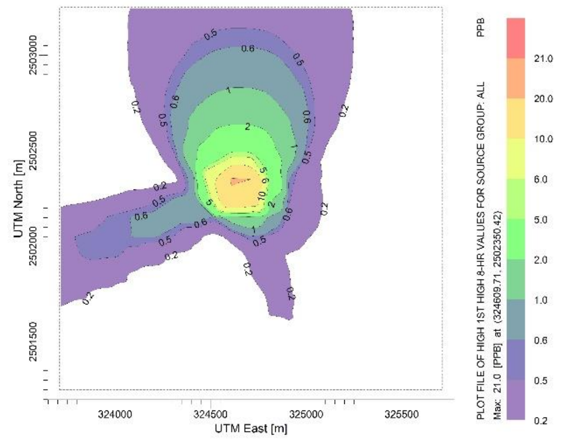

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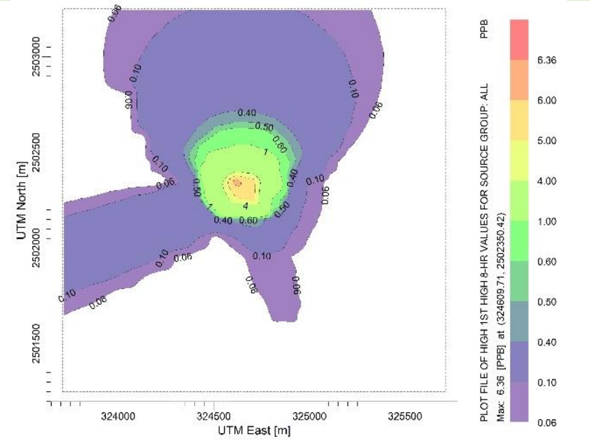
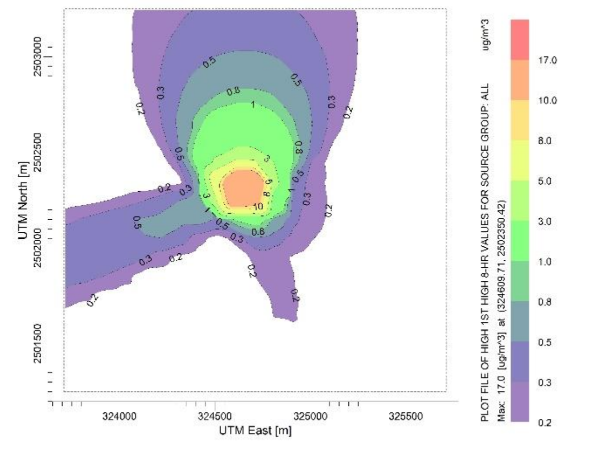


Project Condition

$PM_{2.5}$



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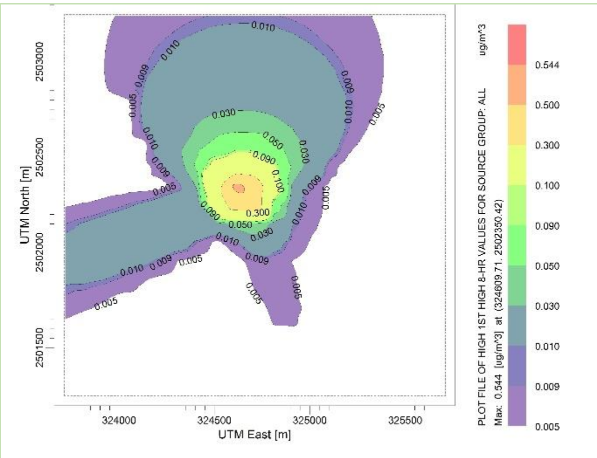
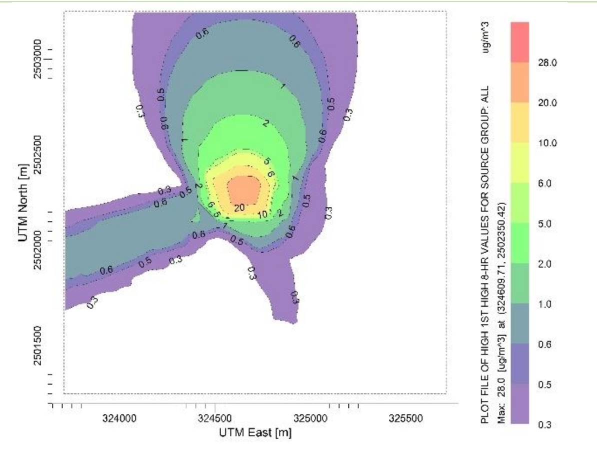


Project Condition

PM_{10}



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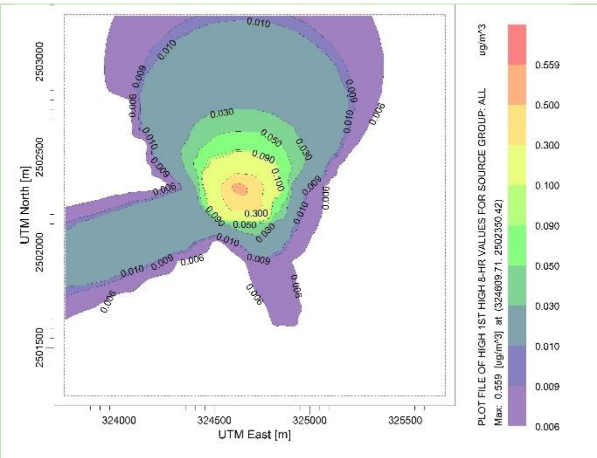

Project Condition

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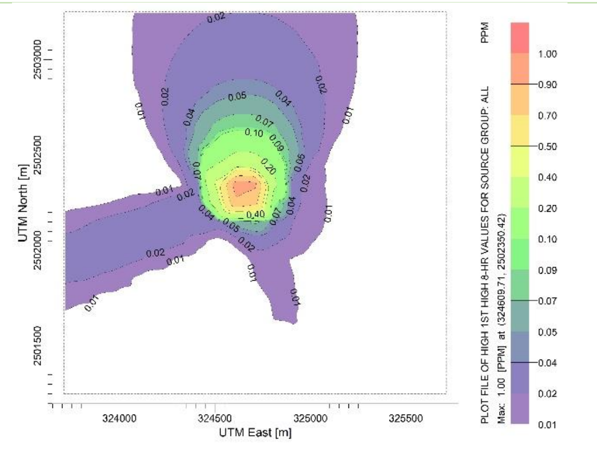

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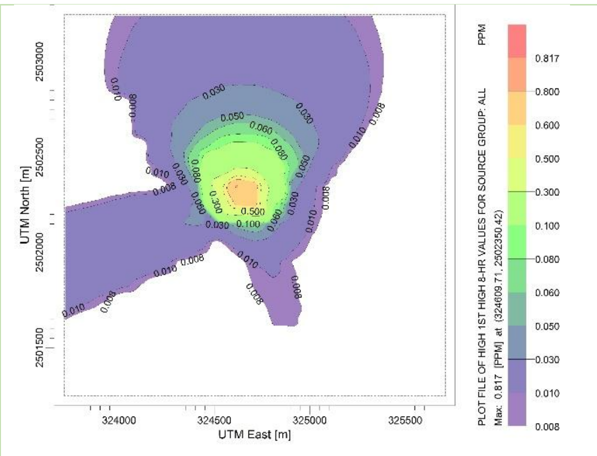
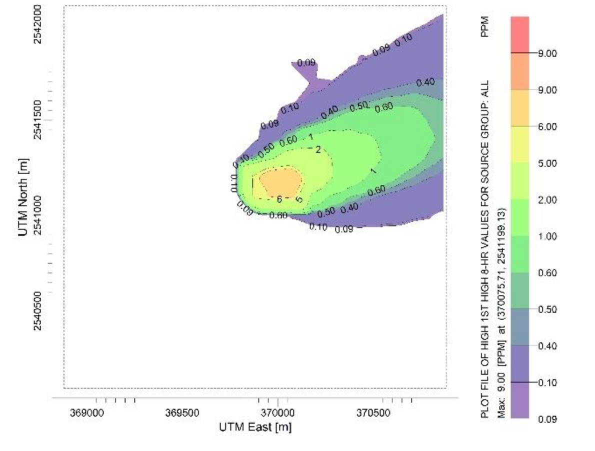


Project Condition

Lashio Railway Station

CO



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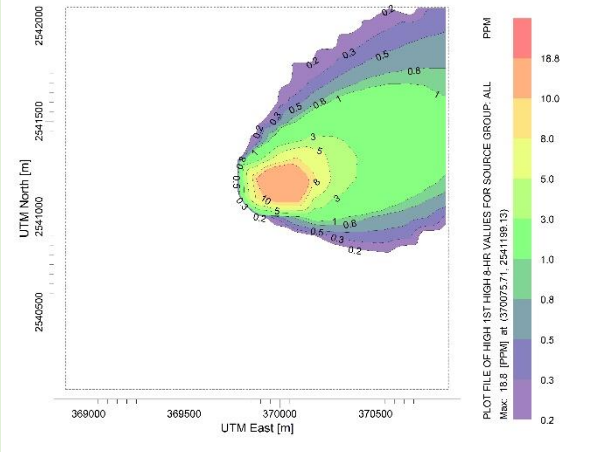

Project Condition

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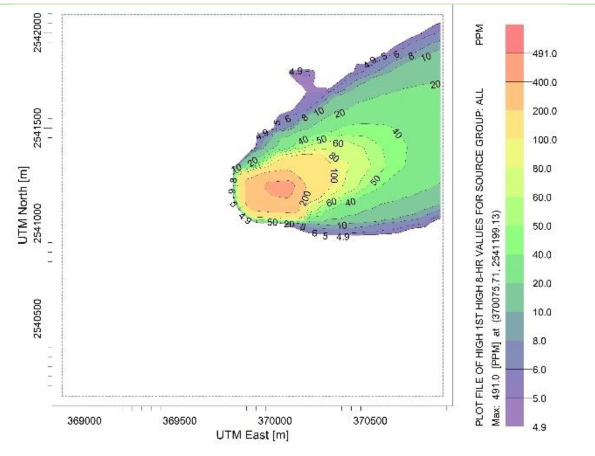

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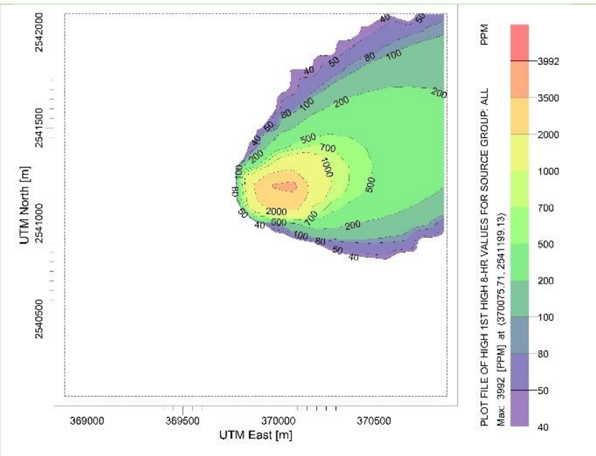

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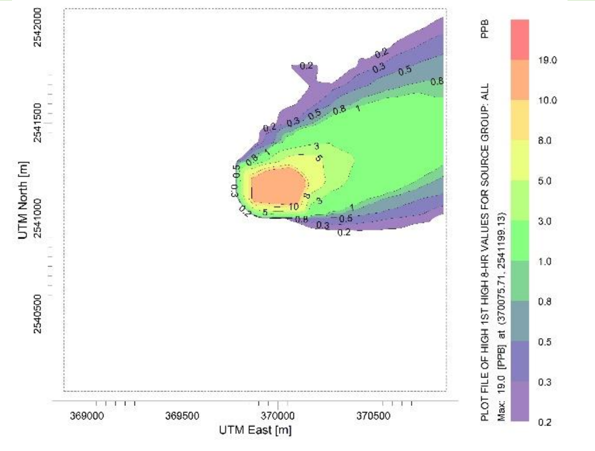

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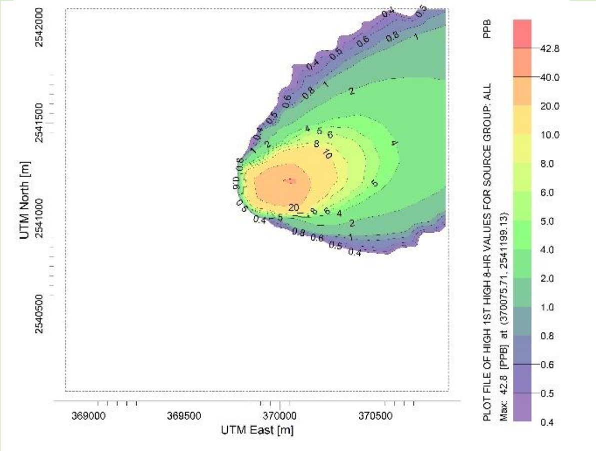
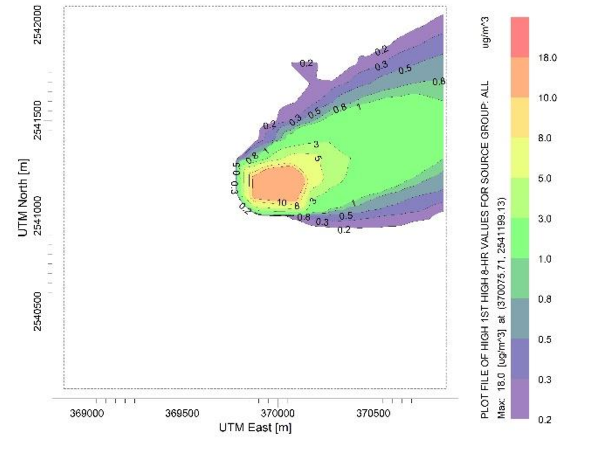


Project Condition

$PM_{2.5}$



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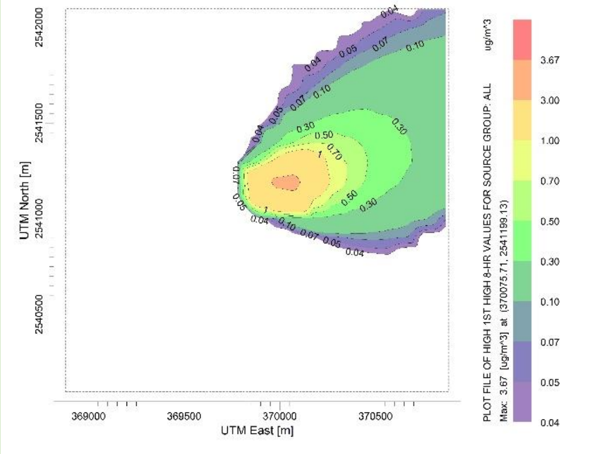

Project Condition

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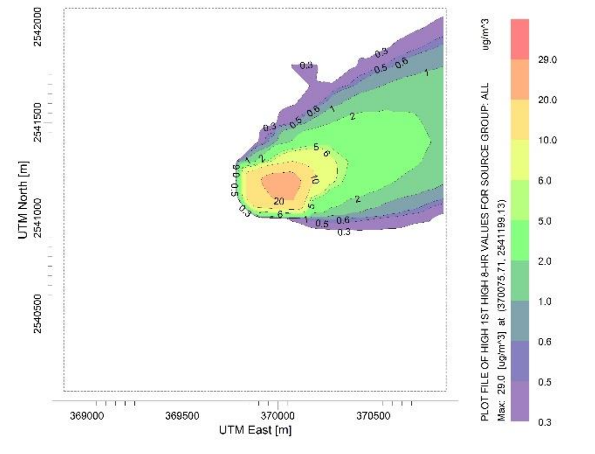

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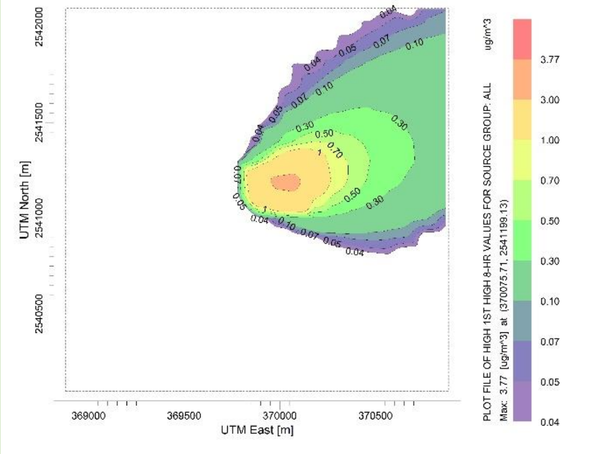

Project Condition

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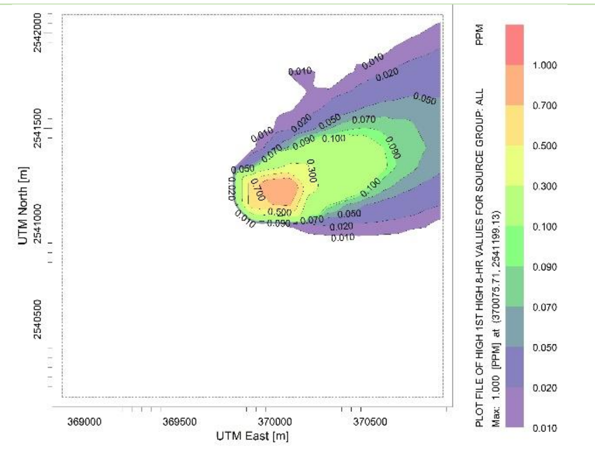

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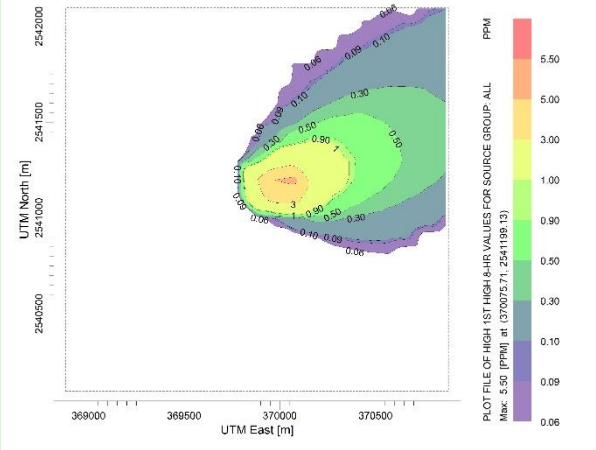

Project Condition

Methodologies to Predict Gaseous Emissions during Construction Phase

Emission of pollutants will be estimated by using the simple estimation method (e.q 1). The method is to multiply relevant emission factor by activity rate.

$Em = EF \times AR$ (Equation 1)

Where,

Em = Emission load

EF = Emission factor

AR = Activity data (can also be expressed in terms of production rate)

However, gaseous emission from the vehicular moments at the project site will be used the equation (2).

$Em = Fc \times EF$ (Equation 2)

Where,

Em = Emission rate

Fc = Fuel consumption

EF = Emission factor

Emission Factors of Pollutants

Activity	Pollutant	Emission factor	Unit
Bulldozing (activities include land clearing, site excavation, levelling, road and drainage construction)	CO	36[a] , 18[b]	g/kg
	CO_2	3090[a] , 3090[b]	g/kg
	NO_x	42[a], 16[b]	g/kg
Vehicles traveling on unpaved road	CO	36[a] , 18[b]	g/kg
	CO_2	3090[a] , 3090[b]	g/kg
	NO_x	42[a], 16[b]	g/kg

Source: Adapted from USEPA

[a] Heavy- duty Vehicles-HDV that use diesel engine with moderate emission control system

[b] Light Duty Vehicles-LDV that use gasoline engine with moderate emission control system

where,

s = material silt content (%)

k = particle size multiplier (dimensionless, <10µm = 0.35),

M = material moisture content (%)

U = mean wind speed, meters per second (m/s) (miles per hour [mph])

W = mean vehicle weight (tons)

k = constant value for vehicles traveling on unpaved road (for industrial road-1.5, for public road- 1.8)

a = constant value for vehicles traveling on unpaved road (for industrial road-0.9, for public road- 1)

b = constant value for vehicles traveling on unpaved road (for industrial road-0.45, for public road- ND

Vehicle Type	**Average Fuel Economy (mpg) miles-per-gallon**
Passenger Cars	23.3
Motorcycles	43.5
Diesel Buses (Diesel Heavy-Duty Vehicles)	7.2
Other 2-axle, 4-Tire Vehicles	17.1
Single unit 2-Axle 6-Tire or More Trucks	7.3
Combination Trucks	5.8

Source: EPA

Examples of silt content of various soil types are given below (EPA, 1999).

Soil type	**Silt content (%)**
Silt loam	52
Sandy load	33
Sand	12
Loamy sand	12
Clay	29
Clay loam	29
Loam	40

Assumptions for combustible emissions according to machines

Assumptions for Combustible Emissions					
Type of Construction Equipment	Num. of Units	HP Rated	Hrs/day	Days/yr	Total hp- hrs
Water Truck	1	300	8	240	576000
Diesel Road Compactors	1	100	8	90	72000
Diesel Dump Truck	2	300	8	90	432000
Diesel Excavator	1	300	8	15	36000
Diesel Hole Trenchers	1	175	8	15	21000
Diesel Bore/Drill Rigs	1	300	8	15	36000
Diesel Cement & Mortar Mixers	1	300	8	240	576000
Diesel Cranes	1	175	8	240	336000
Diesel Graders	1	300	8	90	216000
Diesel Tractors/Loaders/Backhoes	2	100	8	90	144000
Diesel Bull Dozers	1	300	8	90	216000
Diesel Front End Loaders	1	300	8	90	216000
Diesel Fork Lifts	2	100	8	90	144000
Diesel Generator Set	6	40	8	240	460800

Emission factors (EF) with type of construction equipment (g/hp-hr)

Emission Factors							
Type of Construction Equipment	VOC g/hp-hr	CO g/hp-hr	NOx g/hp-hr	PM-10 g/hp-hr	PM-2.5 g/hp-hr	SO2 g/hp-hr	CO2 g/hp-hr
Water Truck	0.440	2.070	5.490	0.410	0.400	0.740	536.000
Diesel Road Compactors	0.370	1.480	4.900	0.340	0.330	0.740	536.200
Diesel Dump Truck	0.440	2.070	5.490	0.410	0.400	0.740	536.000
Diesel Excavator	0.340	1.300	4.600	0.320	0.310	0.740	536.300
Diesel Hole Trenchers	0.510	2.440	5.810	0.460	0.440	0.740	535.800
Diesel Bore/Drill Rigs	0.600	2.290	7.150	0.500	0.490	0.730	529.700
Diesel Cement & Mortar Mixers	0.610	2.320	7.280	0.480	0.470	0.730	529.700
Diesel Cranes	0.440	1.300	5.720	0.340	0.330	0.730	530.200
Diesel Graders	0.350	1.360	4.730	0.330	0.320	0.740	536.300
Diesel Tractors/Loaders/Backhoes	1.850	8.210	7.220	1.370	1.330	0.950	691.100
Diesel Bull Dozers	0.360	1.380	4.760	0.330	0.320	0.740	536.300
Diesel Front End Loaders	0.380	1.550	5.000	0.350	0.340	0.740	536.200
Diesel Fork Lifts	1.980	7.760	8.560	1.390	1.350	0.950	690.800
Diesel Generator Set	1.210	3.760	5.970	0.730	0.710	0.810	587.300

Emission Calculations Results with type of construction equipment (tons/yr)

Emission Calculations							
Type of Construction Equipment	VOC tons/yr	CO tons/yr	NOx tons/yr	PM-10 tons/yr	PM-2.5 tons/yr	SO2 tons/yr	CO2 tons/yr
Water Truck	0.279	1.314	3.485	0.260	0.254	0.470	340.227
Diesel Road Compactors	0.029	0.117	0.389	0.027	0.026	0.059	42.544
Diesel Dump Truck	0.209	0.985	2.614	0.195	0.190	0.352	255.170
Diesel Excavator	0.013	0.052	0.182	0.013	0.012	0.029	21.276
Diesel Hole Trenchers	0.012	0.056	0.134	0.011	0.010	0.017	12.399
Diesel Bore/Drill Rigs	0.024	0.091	0.284	0.020	0.019	0.029	21.014
Diesel Cement & Mortar Mixers	0.387	1.473	4.621	0.305	0.298	0.463	336.228
Diesel Cranes	0.163	0.481	2.118	0.126	0.122	0.270	196.318
Diesel Graders	0.083	0.324	1.126	0.079	0.076	0.176	127.657
Diesel Tractors/Loaders/Backhoes	0.294	1.303	1.146	0.217	0.211	0.151	109.669
Diesel Bull Dozers	0.086	0.328	1.133	0.079	0.076	0.176	127.657
Diesel Front End Loaders	0.090	0.369	1.190	0.083	0.081	0.176	127.633
Diesel Fork Lifts	0.314	1.231	1.358	0.221	0.214	0.151	109.622
Diesel Generator Set	0.614	1.909	3.032	0.371	0.361	0.411	298.232
Total Emissions	2.599	10.034	22.811	2.005	1.952	2.931	2125.647

Air emissions are expected to be limited due to the short duration and scope of construction operations. The impact is negative, direct, temporary, intermittent, reversible, localized and short - term.

Significant of Impacts on Air Environment during Construction Phase before Mitigation Measures

Impacts on air environment during construction phase will not be significant because of the small number of heavy construction machineries used for railway project. Most of the construction work will be carried out by human activities.

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vehicular emission	Construction activities	Negative (-)	Local (-3)	Short term (-2)	Low (-2)	Continuous (-5)	Highly Probable (-4)	Low to moderate (-63)

Consideration of Mitigation Requirement for Air Environment during Construction Phase

The intensity of mitigation measures for air environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Gaseous emissions	Low to moderate (-63)	No	Yes	Moderate	Construction service providers

Mitigation Measure for Gaseous Emissions

Minimizing of Gaseous Emissions during Construction Phase

For minor mitigation requirement, certain mitigation measures will be adopted to limit atmospheric impacts to as great an extent as possible during construction phase. For instance, the transportation of personnel and materials will be scheduled such as to avoid periods of peak flow where congested conditions are more likely, and to reduce the overall number of vehicular movements. In addition to careful traffic management, close adherence to the recommended maintenance regime will be applied to both on-site and off-site vehicles.

Improved Maintenance: Recognizing that significant emission reduction will be achieved through regular equipment maintenance.

Reduction of On-site Construction Time: Rapid on-site construction will reduce the duration of traffic interference and therefore, reduce emissions from traffic delay. Off-site fabrication of structural components can also enhance the quality of work, as the production takes place in controlled settings and external factors such as weather and traffic do not interfere.

Significant of Impacts on Air Environment during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vehicular emission	Construction activities	Negative (-)	Local (-3)	Short term (-2)	Low (-2)	Very Often (-4)	Probable (-3)	Low (-49)

Residual Impact

After mitigation measure, there will be no residual impact for vehicular emission.

(c) Noise Impact during Construction Phase

All kinds of machinery and equipment at the construction site, including loaders, excavators, bulldozers, concrete mixers, piling and heavy-duty mixers, etc, are the most important sources of construction noise. Secondly, in the process of bridges engineering construction of this section, construction noise will also be generated; large temporary construction facilities will radiate noise outward in the process of working, mainly intermittent noise such as percussion collisions, and equipment noises from crane, concrete mixer, internal machinery and other equipment noise. These noises will have a certain impact on nearby residential areas, schools, hospitals and other sensitive points.

According to the limit of noise at boundary of construction and its measuring method in different construction stage.

The equivalent sound pressure level of noise averaged over 8 hours (the length of a typical work shift) can be calculated by the following equation.

$$L_{ex,8} = 10\,\mathrm{Log}_{10}\left(\frac{\left[\sum_{i=1}^{n}(t_i \times 10^{0.1\,SPL_i})\right]}{8}\right)$$

in which,

$L_{ex,8}$ is the equivalent sound exposure level in 8 hours,

$\sum$ is the sum of the values in the enclosed expression for all activities from i = 1 to i = n,

i is a discrete activity of a worker exposed to a sound level,

t_i is the duration in hours of i,

SPL_i is the sound level of i in dB(A),

n is is the total number of discrete activities in the worker’s total workday.

Construction Noise Restriction

Construction Stage	Main noise sources	Noise Limitation LeqdB(A)	
		Daytime	Night
Earth work	Bulldozer, excavator, loader	75	55
Piling	Pile driver	8.5	Ban
Structure	Concrete mixer, vibrator, electric saw etc.	70	55
Fixture	Crane, elevator	65	55

The forecast noise value of the main construction equipment is as follows:

S/N	Equipment	No. of Equipment	Noise values at 50m distance dB(A)
1.	Truck	6	84
2.	Bulldozer	2	85
3.	Excavator	2	85
4.	Concrete mixer	4	85
5.	Piling Machine	1	95
6.	Grader	4	85
7.	Generator	1	82
8.	Welding Machine	5	73

The equivalent noise level for 8 hours ($L_{eq.8}$) for every machinery running at the same time with discrete duration of 1 hour measured at 50m away is calculated by the above equation and results in **90.3755 dB(A)**.

In order to determine an estimate of a sound pressure level at a distance the **Inverse Square Law** can be used. According to the inverse square law, it can be shown that for each doubling of distance from a point source, the sound pressure level decreases by approximately 6 dB(A). The formula to calculate sound attenuation over distance for a **point source** is:

$$Lp(R2) = Lp(R1) - 20 \cdot Log_{10}(R2/R1)$$

Where:

Lp(R1) = Known sound pressure level at the first location (typically measured data or equipment vendor data)

Lp(R2) = Unknown sound pressure level at the second location

R1 = Distance from the noise source to location of known sound pressure level

R2 = Distance from noise source to the second location

By using the Inverse Squared Law, the same sound pressure level at 500 m and 1000 m away are determined. At the distance of **500 m** away the sound level pressure will be dropped to **70.3755 dB(A)** and at **1000 m**, it will be **64.3549 dB(A)**.

Significant of Impacts on Noise during Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Noise from construction equipment	Negative (-)	Limited (-2)	Short term (-2)	Medium (-4)	Continuous (-5)	Highly Probable (-4)	Low to Moderate (-72)

Consideration of Mitigation Requirement for noise impacts during Construction Phase

The intensity of mitigation measures for air environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Noise	Low to Medium (-56)	Yes	Yes	Minor to Moderate	Construction service providers

Mitigation Measures for Noise

(i) Prevention and control measures of noise influences during construction

During the construction period of this project, in the concentrated area of buildings sensitive to sound environment, the construction work that produces environmental noise pollution at night shall not be carried out. If it is necessary to work due to special needs, the residents and schools nearby should be notified.

Combining with the actual situation of the project, the following countermeasures are put forward for the acoustic environment impact during the construction period:

- Machines with high noise, such as generators and air compressors, should be located as far as possible in remote areas and away from sensitive points such as residential areas. If it is difficult to select reasonable locations, noise isolation measures should be taken, and regular maintenance of machinery should be carried out, and strict operating rules should be followed.
- Reasonably arrange construction time, and try not to carry out construction or arrange low noise construction work at night. Construction machinery with high noise level

(such as pile driver) should avoid construction at night. If construction shall be carried out continuously due to special needs, the communication among residents should be done well at the same time.

- Organize transport routes scientifically, coordinate vehicle travel time and avoid traffic jams. Measures such as slowing down and banning honking should be taken in night transportation.

Optimize the construction plan, arrange the construction period reasonably, reduce the environmental noise hazard to the lowest level, and list the measures to reduce the environmental noise pollution as the content of construction organization design in the bidding process, and make it clear in the contract.

Significant of Impacts on Noise during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Noise from construction equipment	Negative (-)	Limited (-2)	Short term (-1)	Low to medium (-3)	Very Often (-4)	Probable (-3)	Low (-42)

Residual Impact

After mitigation measure, there will be no residual impact for noise.

(d) Vibration Impact during Construction Phase

Construction activity can result in varying degrees of ground vibration, depending on the equipment and methods employed. Operation of construction equipment causes ground vibrations which spread through the ground and diminish in strength with the distance. Buildings founded on the soil in the vicinity of the construction site respond to these vibrations, with varying results ranging from no perceptible effects at the lowest levels, low rumbling sounds and fellable vibrations at moderate levels and slight damage at the highest levels. Ground vibrations from construction activities very rarely reach the levels that can damage structures, but can achieve the audible and fillable ranges in buildings very close to the site. A possible exception is the case of old, fragile buildings of historical significance where special care must be taken to avoid damage. The construction vibration criteria include special consideration for fragile buildings. The construction activities that typically generate the most severe vibrations are blasting and impact of pile driving. Vibration levels for construction equipment have been published based on measured data near various types of equipment. Since the primary concern with regard to construction vibration is building damage, construction vibration is generally assessed in terms of peak particle velocity (PPV).

On the construction stage of the project, the machines and tools that cause vibration will be used. The main activities that cause vibration are such as pile driver, digging, drilling, or demolition. The vibration effect assessment process during construction is as follows;

1.Vibration source level of the equipment at the reference distance 25 feet or 7.62 meters as shown in the following table.

2.Assess the vibration propagation on single source base by the equation

$PPVequip = PPVref \times (D/25)1.5$

When

PPV $_{equip}$ = Particle velocity in in/sec of the equipment at specific distance

PPV $_{ref}$ = Reference vibration level in in/sec at 25 feet

D = Distance from the source to receptor (feet)

3.Vibration level at different distances during construction stage

From Table 1, the machine that causes the maximum vibration level in case of having construction activities is pile driver. The vibration level at 25 feet, or 7.62 meters, from the source has particle velocity 1.518 in/sec. Then, next step is to assess the vibration level from construction activities at different distances, as shown in Table 2. The vibration level from construction activities will decrease when the distance increases, in other words, at distances; 15, 30, 50, 100, 200, 500, 1,000 and 1,500 meters, the peak particle velocity (PPV) is 13.63, 4.97, 2.29, 0.81, 0.29, 0.073, 0.026 and 0.014 millimetres/sec accordingly.

Table - Vibration level caused by construction equipment

Equipment		PPV (at 25 feet)		
		in/sec	mm/sec	Approximate Lv at 25ft
Pile Driver (Impact)	Upper Range	1.518	38.557	112
	Typical	0.644	16.358	104

Equipment		PPV (at 25 feet)		
		in/sec	mm/sec	Approximate Lv at 25ft
Pile Driver (Vibratory)	Upper Range	0.734	18.644	105
	Typical	0.170	4.318	93
Clam Shovel Drop (Slurry Wall)		0.202	5.131	94
Hydro mill (Slurry Wall)	In Soil	0.008	0.203	66
	In Rock	0.017	0.432	75
Vibratory Roller		0.210	5.334	94
Hoe Ram		0.089	2.261	87
Large Bulldozer		0.089	2.261	87
Caisson Drilling		0.089	2.261	87
Loaded Trucks		0.076	1.930	86
Jack Hammer		0.035	0.889	79
Small Bulldozer		0.003	0.076	58
RMS velocity in decibels (VdB) re 1 micro-inch/second				

Source: TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT/ Federal Transit Administration 2006

Table - Vibration Level of Construction Machines by Distance

Machine	Distance		Peak Particle Velocity (PPV)	
	feet	meter	in/sec	mm/sec
Pile Driver (as max vibration level machine)	50	15	0.537	13.63
	98	30	0.196	4.97
	164	50	0.090	2.29
	328	100	0.032	0.81
	656	200	0.011	0.29
	1,640	500	0.003	0.073
	3,281	1,000	0.001	0.026
	4,921	1,500	0.0005	0.014

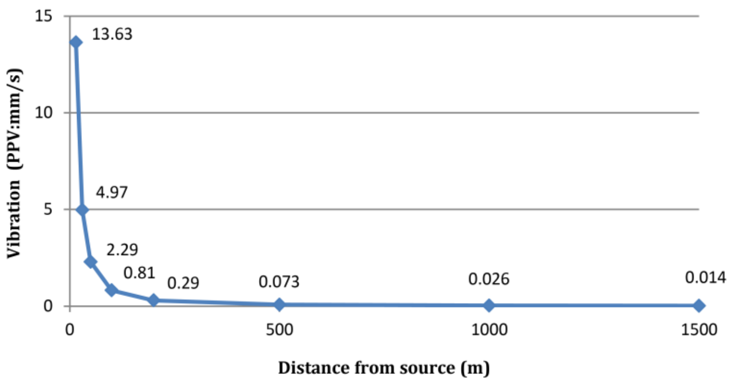

Figure - Vibration Distance-Decay (Pile driver)

Vibration Level (Peak Particle Velocity)	Human Reaction	Building Effects
0.006-0.019 in/sec	Threshold of perception; possibility of intrusion	Vibrations unlikely to cause damage of any type
0.08 in/sec	Vibration readily perceptible	Recommended upper level to which ruins and ancient monuments should be subjected
0.1 in/sec	Level at which continuous vibrations begin to annoy people	Virtually no risk of "architectural" damage to normal buildings
0.2 in/sec	Vibrations annoying to people in buildings	Threshold at which there is a risk of "architectural" damage to normal dwelling- houses with plaster wall and ceilings
0.4-0.6 in/sec	Vibrations considered unpleasant by people subjected to continuous vibrations	Vibrations at a greater level than normally expected from traffic, but would cause "architectural" damage and possible minor structural damage

Source: Final Report on Vibrations Due to Pile Driving at the Mobile River Bridge Sit Research Project 930-839R

Potential Effect of Vibration due to Piling

From the pile driving activity, the maximum PPV is 0.537 in/sec. According to the above table, the vibration can be considered unpleasant by people subjected to continuous vibrations and vibrations at a greater level may also cause minor structural damage.

4.Vibration level in vulnerable area during construction stage

From Table that shows the vibration level caused by construction equipment at reference distance 25 feet (7.62meters), the pile driver has maximus vibration level at 1.518 in/sec.

During the construction work, operation of the construction machinery and traffic of heavy duty trucks carrying construction material are expected, causing vibration and impact residences in the vicinity is expected. Although the specific number of construction vehicles is not yet determined, the amount of noise from different types of construction machinery shall be assumed per below. In National Environmental Quality Guidelines (2015) there are no standards for construction vibration. As shown in Table 3 criteria for vibration effects on buildings are provided in the manual.

Table: Construction Vibration Damage Criteria

Building Category	PPV (inch/sec)	Approximate Lv*
Reinforced concrete, steel, or timber (no plaster)	0.5	102
Engineered concrete and masonry (no plaster)	0.3	98
Non-engineered timber and masonry buildings	0.2	94
Buildings extremely susceptible to vibration damage	0.12	90

* :An RMS vibration velocity level in VdB relative to 1 micro-inch/second.

Source: FTA (2006).

In the manual, vibration criterion level by land use category is also provided, as shown in Table.

Table: Approximate Distances to Vibration Criterion-Level Contours

Land Use Category	Vibration Criterion Level (VdB)	Approximate Vibration Contour Distance (feet)
Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, such as outdoor amphitheaters, concert pavilions, and National Historic Landmarks with significant outdoor use.	65	175
Residences and buildings where people normally sleep. This category includes homes and hospitals, where nighttime sensitivity to noise is of utmost importance.	72	130
Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches, where it is important to avoid interference with such activities as speech, meditation, and concentration. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, and concert halls fall into this category, as well as places for meditation or study associated with cemeteries, monuments, and museums. Certain historical sites, parks, and recreational facilities are also included.	75	70

Source: FTA (2006).

Pile Driving Activity

- Using cofferdams and silt curtains, where feasible, to minimize discharge of sediment into the river.
- Using a vibratory pile driver to the extent feasible particularly for the initial pile segment.
- Limiting the periods of pile driving to no more than 10-12 hours/day. (in rare circumference it is possible that piling may extend further than 12 hours depending on the practicality of driving)
- Monitoring locations to characterize the hydro-acoustic field surrounding pile driving operations, which also includes a nearfield component to evaluate the performance of underwater noise attenuation systems that are integral to the project.
- Monitoring water quality parameters such as temperature and suspended sediment concentrations in the vicinity of the pile driving.
- Pile tapping (i.e. a series of minimal energy strikes) for an initial period to frighten fish so that they move from the immediate vicinity of pile driving activity.

Bridge Construction and Dredging

Since the proposed bridge alignment spans extensive shallows, it would be necessary to dredge an access channel for tugboats and barges to utilize during construction of the approach spans. These vessels would be instrumental in the installation of cofferdams, pile driving, the construction of pile caps and bridge piers, and the erection of steel truss superstructure and other components. As noted earlier, temporary, access platforms would be constructed near the construction areas to provide access for construction vehicles. The impacts caused by dredging can be mitigated by the following measures:

- Dredging would only be conducted during non-monsoon seasons.
- Use of an environmental bucket with no barge overflow unless the contractor develops a method of treating the overflow water to ensure that any discharge does not result in a substantial visible contrast with the receiving water
- Armoring of the channel to prevent re-suspension of sediment during the movement of construction vessels, installation and removal of cofferdams and pile driving

Traffic-Induced Bridge Vibration on Concrete Pier

The bullet train which has the speed of 320km/h produces 20-40Hz of vibrations. So as in general, it can be assumed that the proposed project may produce less vibration than bullet train which means less than 40Hz. The experimental results showed that vibration did not generate a significant impact on concrete strength. A concrete vibration test stand with a 48Hz and an amplitude 0.5 mm-0.8 mm as the vibration source. The impacts of bridge vibration on concrete pier would not be significant. For ground-borne vibration, the relevant frequency range is defined in ISO 14837 Mechanical vibration – ground-borne noise and vibration arising from the rail systems – as the range between 1 and 80 Hz. The practical consideration of vibration for bridge designs include:

- Increased span length, fundamental frequency, mass or damping ratio lowers the acceleration in the bridge deck. This further implies that concrete bridges are preferable to steel bridges because of the larger mass of the deck and the higher damping ratio. Short-span bridges are also more problematic than long-span bridges if the combined effect of the span length and the fundamental frequency is considered.
- From a dynamical point of view, constructing multi-span bridges that are continuous over the supports is preferable to solutions consisting of series of simply supported bridges.
- Axle load spreading lowers the maximum acceleration of the bridge deck, especially for short-span bridges (<30m).
- Important effects, such as shear deformation, shear lag and eccentricity, can be accounted for in a simplified manner by adjusting the structural parameters.

Significant of Impacts on Vibration during Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vibration	pile driver, digging, drilling, or demolition	Negative (-)	Limited (-2)	Short term (-2)	Medium (-4)	Very Often (-4)	Highly Probable (-4)	Low to Moderate (-64)

Consideration of Mitigation Requirement for vibration impacts during Construction Phase

The intensity of mitigation measures for air environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Vibration	Low to Moderate (-64)	Yes	Yes	Minor to Moderate	Construction service providers

Mitigation Measures for Vibration

- Route heavily loaded trucks away from the residential streets, if possible select streets with fewest homes, if no alternatives are available.
- Operate earth moving equipment on the construction lot as far away from vibration sensitive sites as possible
- Avoid night time activities. People are more aware of vibration in their homes during the night time hours.
- Avoid impact pile driving where possible in vibration sensitive areas. Drilled piles or the use of a sonic or vibratory pile driver causes lower vibration levels where the geological conditions permit their use.

Significant of Impacts on Vibration during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vibration	pile driver, digging, drilling, or demolition	Negative (-)	Limited (-2)	Short term (-2)	Low to medium (-3)	Very Often (-4)	Probable (-3)	Low (-49)

Residual Vibration Impact

As described above, the vibration value on the areas beyond the areas of bridge and cutting at 30m from the railway outer rail center meets the standard requirement and lower than 80dB. So there would be no residual vibration impact on the residential areas beyond one mile and the bridge is more than one mile away from the residential areas.

Residual Impact on Air Environment

During the construction phase, there would be no residual impact on the air environment after conducting the mitigation measures. Since the impact rating on the air environment during the operation is low, there would be no residual impact.

(2) Anticipated Impacts on Water Environment during Construction Phase

(a) Surface Water Hydrology and Channel Morphology

Construction of wall piers in river crossing bridge can change the flow of velocities of water and it can be increased erosion and subsequent changes in bed and bank stability. And it can also be increased in flood risks. It can be increased in sedimentation of watercourses. Bridges and culverts can potentially alter the flow regimes of the river thereby affecting water velocity, depth, depositional patterns and channel morphology and river bank erosion. Surface water quality could be affected by a number of factors during operations on site. Construction activities may encourage soil erosion and increase the sediment loads of nearby streams, while accidental leaks/spills of oil/fuel from storage tanks or construction, maintenance and decommissioning vehicles can also pollute surface waters.

Significant of impact for Surface Water Hydrology and Channel Morphology before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
erosion and sediment mobilization	Bridge Construction	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Continuous (-5)	Probable (-3)	Low (-48)
change in flow regime	Bridge Construction	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Continuous (-5)	Probable (-3)	Low (48)

Pollution can happen from suspended material and disturbance of contaminated soil and subsequent pollution of water resources can be occurred. Spills or leaks of fuel, oil and construction materials can be pollutant and it can decrease the quality of water.

Significant of Impacts on Surface Water Environment during Construction Phase

Impact on water environment during construction phase will not be significant due to the amount of wastewater produced during construction phase (the volume of nearest water bodies is very much greater than the volume of wastewater disposed by construction site) and the time of construction phase.

Consideration of Mitigation Requirement for Surface Water Environment during Construction Phase

The intensity of mitigation measures for surface water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Required Mitigation Scale	Responsibility
1.	erosion and sediment mobilization	Low (-48)	Yes	Yes	Moderate	Construction Service Providers
2.	change in flow regime	Low (-48)	Yes	Yes	Moderate	Construction Service Providers

Mitigation Measures for Surface Water Environment during Construction Phase

In order to minimize potential impacts on the water environment in the design and running of bridge and culverting operations, the project proponent must ensure that:

- Access roads will avoid riparian zones and should be built using appropriate construction materials.
- Bridges and culverts will incorporate a low flow channel to retain sufficient water depth for aquatic life at such times;
- An appropriate water management system is used during the construction period, including, for example, efficient land drainage and the use of constructed ponds for receiving site runoff to reduce the impact of runoff on nearby watercourses;
- With regard to bridges, open parapets will be used to allow some over-deck flow in the event of the bridge
- Culverts should be inserted below an existing river bed level to allow for bed formation within the culvert;
- Watercourses should not be deepened or widened up or downstream of culverts;
- Artificial bank reinforcement should be avoided if possible;
- With regard to bridges, open parapets should be used to allow some over-deck flow in the event of the bridge opening becoming blocked in a major flood event;
- Bridge soffit levels and flood spans should be at least 1 metre above the maximum known flood level to allow floating debris to pass freely through the structure;
- Oil interceptors or drip trays are used in vehicle parking areas, and are inspected and cleaned regularly;
- A risk assessment is carried out for each substance to be used or stored on site, and the appropriate containment measures installed.

Significant of impact for Surface Water Hydrology and Channel Morphology after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
erosion and sediment mobilization	Bridge Construction	Negative (-)	Local (-3)	Short term (-2)	Low (-2)	Very Often (-4)	Seldom (-2)	Low (-42)
change in flow regime	Bridge Construction	Negative (-)	Local (-3)	Short term (-2)	Low (-2)	Very Often (-4)	Seldom (-2)	Low (-42)

Residual Impact

After mitigation measure, there will be no residual impact for surface water hydrology and channel morphology.

(b) Wastes

Bridge construction activities may increase silt load in the river during construction at bridge sites and may result in accidental spillage of concrete and liquid waste into the river. The discharge of domestic wastes from the workers cause the surface water pollution. This may impact upon the biodiversity of the rivers. Excavation of river bed materials will be required during the construction of the bridge piers (only around 5 piers will be constructed within the river itself). The spillage of lead-based paint used for bridge coating process can cause the surface water pollution. The discharge of dust particles from the welding of steel structure and beam installation can also cause the surface water pollution. The unsuitable soil material from foundation preparation will also produce. All of the construction wastes will have potential to surface water pollutions if they are not properly managed. Drainage and seepage from construction waste dumping site will have potential to surface water pollution during rainy season.

Significant of Impacts on Waste during Construction Phase before Mitigation Measures

Impact on water environment during construction phase will not be significant due to the amount of wastewater produced during construction phase (the volume of nearest water bodies is very much greater than the volume of wastewater disposed by construction site) and the time of construction phase.

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface Water Pollution	Construction Debris	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Regular (-3)	Highly probable (-4)	Low (-42)
	Oil and Lubricants	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Probable (-3)	Low (-30)
	Domestic Wastes	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Probable (-3)	Low (-42)
	Hazardous waste	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Seldom (-2)	Very low (-18)

Consideration of Mitigation Requirement for Surface Water Environment during Construction Phase

The intensity of mitigation measures for surface water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Required Mitigation Scale	Responsibility
1.	Construction Debris	Low (-42)	No	Yes	Minor	Construction Service Providers
2.	Oil and Grease	Low (-30)	No	Yes	Minor	Construction Service Providers
3.	Domestic waste	Low (-42)	No	Yes	Minor	Construction Service Providers
4.	Hazardous waste	Very low (-18)	No	Yes	Minor	Construction Service Providers

Mitigation Measures for Wastes

Impact	Mitigation Measure
Discharge of liquid waste	• Provide coffer dams, silt fences, sediment barriers or other devices to prevent migration of silt during construction within streams. • Perform dewatering and cleaning of cofferdams to prevent siltation by pumping from cofferdams to a settling basin or a containment unit. • During piling works ensure that pumped water is filtered through a silt trap before being discharged to the river • Upstream downstream erosion protection • Segregate the wastes according to the requirements
Domestic waste	• Ensure no waste material are dumped in the river, including reinforced concrete debris • Waste water channels from the site should be connected to septic tank during construction to prevent wastewater from entering the nearest waterbodies

	• Compact soil as soon as building foundations are formed to prevent erosion, especially during the wet season • Ensure that no concrete waste is dumped in the water • Provide portable toilets at bridge construction sites to prevent defecation by workers into the river • Carefully collect all polystyrene (from expansion joints) so that it does not litter the local environment
Oil and grease	• Avoid any leakage of oil and lubricant from vehicles and machineries used in construction phase • Store the oil and lubricants on impermeable floor like concrete floor • Avoid construction works during the rainy season • Regular maintenance of the machineries and vehicles
Hazardous waste	• Ensure that no hazardous liquids are placed within 10 meters of the river • Use the zinc-based coating paint instead of lead-based coating
Construction debris	• Working in a small area at a point of time (phase wise construction) • Minimize the time of exposure of any waste and erodible land exposed to stormwater runoff • Minimize land clearing activities to those of required work areas. • Using sediment controls with special care taken during the rainy season • Soil material removed from the construction process should be recycled • Storage of fuel, oils and chemicals should be on an impermeable base, away from drains and watercourses.

Significant of Impacts on Waste during Construction Phase after Mitigation Measures

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface Water Pollution	Construction Debris	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Regular (-3)	Probable (-3)	Low (-36)
	Oil and Lubricants	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-24)
	Domestic Wastes	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Seldom (-2)	Low (-36)
	Hazardous waste	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Very Seldom (-1)	Very low (-12)

Residual Impact on Water Environment

After conducting the mitigation measures, there would be no residual impact on water environment.

(3) Anticipated Impacts on Soil and Groundwater Environment during Construction Phase

Soil Contamination

Impacts on soil quality due to construction of bridge are as follow.

- Soil contamination from spillage of diesel oil during the pile driving activities especially in valley crossing bridges
- Result from the poor managed fuels, oils and other hazardous liquids used during the projected works
- Discharge of lead-based paint residue used from bridge coating process after finished coating
- Discharge of concrete residue near farmland

Significant of Impacts on Soil Contamination during Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination	Leakage of fuel oil	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Regular (-3)	Probable (-3)	Low (-36)

Consideration of Mitigation Requirement for Soil Contamination

The intensity of mitigation requirement for soil contamination according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Soil contamination	Low (-36)	No	Yes	Minor	Pre-construction provider(s)

Mitigation Measures for Soil Contamination

- Soil will be carefully removed and stored for subsequent reinstatement;
- Effective stabilization of altered landforms so as to minimize soil erosion and the potential for water pollution from suspended solids;
- Installing all erosion-control measures prior to starting ground-disturbing activities-frequently maintaining erosion-control measures;
- Maintain the vehicles and machines regularly
- Filling and refilling of oil and lubricant will be strictly controlled and subject to formal procedures
- Storage of fuel, equipment and construction materials so as to minimise the risk of soil contamination or water pollution

Significant of Impacts on Soil Contamination during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination	Construction activities	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Regular (-3)	Seldom (-2)	Low (-30)

Waste

During construction phase, construction debris such as packing materials and domestic wastes from construction offices and other facilities. There will have potential to soil contamination and ground water pollution if these solid wastes are not properly disposed. Moreover, seepage from construction waste dump site will also impact on soil and ground water qualities.

Significant of Impacts on Soil Environment during Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
waste	Construction debris and domestic waste	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Regular (-3)	Probable (-3)	Low (-36)

Consideration of Mitigation Requirement for wastes

The intensity of mitigation requirement for wastes according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Waste	Low (-36)	No	Yes	Minor	Pre-construction provider(s)

Mitigation Measures for Waste during Construction Phase

Excavated material will either be reused on site, sold for use on other reclamation or construction projects, or as a last resort sent for disposal at a public dump or landfill. The waste material may be removed from the sites by truck, or preferably by barge and impacts will be limited to the effects associated with increases in vehicle movements. Other construction waste, including general refuse, will also be disposed of in a responsible manner and will not give rise to significant impacts. Mitigation measures will include: segregation of wastes for disposal; observing the requirements of the dumping license; and meeting the requirements of the Waste Disposal Ordinance.

Significant of Impacts on Soil Environment during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
waste	Construction debris and domestic waste	Negative (-)	Limited (-2_	Short term (-2)	Low (-2)	Regular (-3)	Seldom (-2)	Low (-30)

Groundwater Quality

Earthworks and site drainage can reduction in water table and changes to groundwater distribution and flow. Construction activities may also have significant impacts on groundwater hydrology and quality. The leakage of oil and fuel can permeate into the groundwater. The site may need to be drained to provide suitable conditions for the engineering works to occur, resulting in temporary changes to ground flow. Also, soil contaminated from a previous land use may be disturbed during construction works, causing pollutants such as heavy metals to enter ground water. It can cause the effect in water table for the valley crossing bridge (viaduct)at deep depth.

Significant of Impacts on Groundwater Quality during Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Groundwater quality	Leakage of oil and fuel	Negative (-)	Limited (-2)	Short term (-1)	Low (-2)	Regular (-3)	Probable (-3)	Low (-30)

Consideration of Mitigation Requirement for groundwater quality

The intensity of mitigation requirement for groundwater quality according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Groundwater quality	Low (-30)	No	Yes	Minor	Pre-construction provider(s)

Mitigation Measures for Groundwater Quality

- Seepage water from waste disposal site will be controlled systematically
- Control the leakage of fuel, oil and lubricants from bridge construction site

Significant of Impacts on Groundwater Quality during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
change in flow regime	Leakage of oil and fuel	Negative (-)	Limited (-2)	Short term (-1)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-20)

Residual Impact on Soil

There would be no residual impact on the soil in all phases in proposed project.

(4) Anticipated Impacts on Biodiversity Environment during Construction Phase

Ecology

The removal of native vegetation and its replacement with bridge and culvert engineering structures can cause direct damage, disturbances, fragmentation or loss of terrestrial and aquatic habitats and ecology. Construction and decommissioning activities could also result in the increased sediment loading of streams and changes in turbidity may impact adversely upon aquatic populations. In addition to this, local ecological populations may be adversely affected by pollution incidents attributed to fuel leaks and oil spills associated with construction, maintenance and decommissioning operations on site. The physical presence of both bridge and culvert engineering structures may affect ecological populations in a number of ways. The local ecology may be disrupted as habitat corridors become severed. In addition, culverts may act as barriers to the migration of fish and small mammals. Bridges in particular will cause some shading of the river bank and bed thereby potentially altering the aquatic flora present in the river bed. Ecological impacts may operate over a longer time-scale, as populations take time to respond to environmental changes.

Mitigation Measures for Ecology

Measures designed to prevent or reduce impacts to water or land will also help to prevent adverse impacts on ecology. The following list identifies further measures to reduce or avoid impacts to terrestrial and aquatic species and their habitats:

- existing habitat features should be incorporated into site design and protected from change;
- further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential for the site;
- culverts should be wide enough to allow for ledges approximately 500mm wide and 300mm above the normal water level for the passage of mammals and should link to the banks up and downstream of the culvert;
- baffles should be incorporated into the design of the culvert base to provide shelter for fish as they pass through the culvert;

- holes and ledges should be incorporated onto the design of culverts for use as nesting sites;
- where access restrictions result, arrangements for alternative access should be made with the provision of gates, bridges or stiles;
- bat and bird boxes should be provided within the riparian areas;
- where clear span bridges are not a feasible design then a ledge, either in the form of a concretes
- consideration should be given to the provision of features within the bridge design to encourage nesting birds and bats.

Aquatic Ecology

Drainage works and use of vehicles can be negative impact on flora and fauna from increased sediment loading of streams. And it can be harmed to aquatic flora and fauna from oil, fuel, cement or other substances entering watercourses. It can cause the habitat loss and increase water turbidity. The sedimentation can also increase in river during construction phase and it can be impact to the water quality and fish and other aquatic species during construction. It can affect the aquatic environment because of the removal of vegetation.

Consideration of Mitigation Requirement for aquatic ecology

The intensity of mitigation requirement for aquatic ecology according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Aquatic Ecology	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Aquatic Ecology

- Phasing of construction work to minimize disturbance to wildlife at sensitive times of year, such as during the breeding season or when young are being raised;
- Designing the culvert to allow for the passage of fish and other aquatic life, Avoid fish migration period

- Baffles will be incorporated into the design of the culvert base to provide shelter for fish as they pass through the culvert
- Phasing of construction work to minimise disturbance to wildlife at sensitive times of year, such as during the breeding season or when young are being raised; especially breeding season of fish between May to August.

Terrestrial Ecology

Earthworks and excavations can be habitat removal, fragmentation or severance and disturbance to, of loss of species (including rare and sensitive species) due to construction work.

Consideration of Mitigation Requirement for terrestrial ecology

The intensity of mitigation requirement for terrestrial ecology according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	terrestrial ecology	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Terrestrial Ecology

- Where clear span bridges are not a feasible design then a ledge, either in the form of a concrete shelf or gravel side bar, or mammal tunnels will be provided;
- Bird boxes will be provided within the riparian areas;
- Consideration will be given to the provision of features within the bridge design to encourage nesting birds and bats.

Potential Loss of Habitats Impact

During Construction period, clearing habitats for project plant is the principal cause of habitat destruction. The loss of the habitats during the construction period is expected to have indirect impacts on surrounding habitat areas and associated biota. The vegetation also supports good shelter for many wildlife species. Habitat destruction is currently ranked as the primary cause of species extinction worldwide. Clearing of existing vegetation which may leads to loss of habitat. Some places in the construction area are likely to be lost due to direct and indirect construction activities for resident animals.

Potential Noise Impact

In **Construction and Operation period**, the animals can run away by the noise of construction machines and equipment of the project. So, the habitats of fauna can be moved being shocked because of human impacts by labors and using of mining on limestone caves for creation of project purposes during construction and operation period. The terms habitat loss and habitat reduction are also used in a wider sense, including loss of habitat from other factors, such as noise pollution.

Flora and Fauna Impacts

The removal of native vegetation and its replacement with bridge and culvert engineering structures can cause direct damage, disturbances, fragmentation or loss of terrestrial and aquatic habitats and ecology. Construction and decommissioning activities could also result in the increased sediment loading of streams and changes in turbidity may impact adversely upon aquatic populations. The physical presence of both bridge and culvert engineering structures may affect ecological populations. In addition, culverts may act as barriers to the migration of fish and small mammals. Ecological impacts may operate over a longer time-scale, as populations take time to respond to environmental changes Loss of vegetation due to construction.

Biodiversity Impact and Activities causing to the Impact

Impact	Activities Causing to The Impact	Remark
Habitat damage, fragmentation and loss Species disturbance and loss	▪ Wildlife disturbance and relocation through increased noise, light and human ▪ Unexpected clearance of land, deforestation and conversion of habitats providing important ecosystem services for tourism developments or supporting infrastructure ▪ Construction of access rail road and other infrastructure that open up previously inaccessible areas to development ▪ Poor construction practices leading to soil erosion	

Significant of Impacts on Natural Environment (Biodiversity) during Construction Phase before Mitigation Measures

No.	Impacts	Magnitude	Duration	Extend (area)	Probability	Total	Category
Fauna							
	Reduce Terrestrial Fauna	3	4		3	27	Low impact (U)
	Habitat Loss	3	5	2	3	30	Moderate significant (C)
	Noise Impact	3	3	2	3	24	Low impact (U)

(Source: International Association of Impact Assessment-IAIA, 2014, www.iaia.org)

Consideration of Mitigation Requirement for Biodiversity Environment during Construction Phase

The intensity requirement of mitigation measures for biodiversity environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Reduce terrestrial fauna	Yes	Yes	Minor to Moderate	Construction service provider(s)
2.	Habitat loss	Yes	Yes	Moderate	Construction service provider(s)
3.	Noise impact	No	Yes	Minor to moderate	Construction service provider(s)

Mitigation Measures for Flora and Fauna

- Re-vegetation and restoration management plan
- Tree cutting should not occur during bird nesting seasons
- Poaching of wildlife shall be strictly prohibited
- Ensure that lower wattage lamps are used in street lights which direct light downwards to reduce glare

Residual Impact on Ecology

The cleared land strip along the railway line will be permanently occupied by the track and the free-vegetation buffer at the sides of the track throughout the operational life of the railway. This will cause the fragmentation of the habitats and dividing into the number of discrete parts.

So this can lead to a reduction in genetic diversity within populations along the railway. But this residual impact would be very low.

(5) Anticipated Impacts on Human Environment during Construction Phase

The potential impacts of a development for bridges and culverts on the human environment may take a variety of forms. The potential for socio-economic and health impacts (real and perceived) arising from bridge and culvert developments is likely to be small. Such operations usually require comparatively small staffing levels and, as a result, employees are not likely to have a significant effect on local socio-economic issues. However, such social issues should be considered when scoping an EIA.

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Other issues that commonly need to be addressed are the visual impact of the engineering structures and any additional buildings associated with it. Any restrictions to access that may arise as a result of the development should also be considered, as should the creation of nuisances such as noise and vibration from traffic during the construction and decommissioning phases, dust in the air, and mud and slow vehicles on public roads. Also, the amenity use of nearby streams or lakes may be affected if reduced water quality causes harm to fish.

Impacts on architectural and archaeological heritage may arise from site preparation and construction, as features may be removed or disturbed. The likelihood of there being any unrecorded sites and their potential for discovery should also be examined.

Project phase	Duration	Total work force	Number of equipment used	Quality
Construction Phase	5 years	700	Truck Bulldozer Excavator Concrete mixer Piling machine Grader Generator Welding machine	6 2 2 4 1 4 1 5

(a) Socio-economic

Disruption of services and roads where construction activities occur near to highways by earthworks and excavations and construction-related employment problems can be. The baseline social conditions of a community (community profiles) are the existing conditions and past trends associated with the human environment in which the proposed activity is to take place. The description of baseline conditions includes the relationship with the biophysical environment, historical background, social resources, culture, attitudes and social conditions, economic and population characteristics.

Social impact assessment (SIA) process focuses on evaluating the impacts development has on community social and economic well-being. This analysis relies on both quantitative and qualitative measures of impacts. Assessing proposed developments in a socioeconomic context will help both the developer and affected community to identify potential social equity issues, evaluate the adequacy of social services and determine whether the project may adversely affect overall social well-being.

SIA scoping intended to gain an initial understanding of the socio- economic environment of the proposed railway project area. Through scoping initial socio-economic issues that may influence project decisions were identification and these will be considered during development of the terms of reference for the impact assessment phase.

This SIA scoping through assessment of the social environment along the railway link in South Africa within affected local municipalities. Through this assessment Transnet will evaluate the impacts its proposed railway development may have on community’s social and economic well-being.

(1) Economic Impacts

The project will create opportunities for employment and supplier business, for the duration of the project construction. These will be through increase in income generating sources. The project will bring positive benefit if the Project and Contractors give first priority when employing the displaced persons in work such as forest clearance along the ROW, road repair and maintenance, water supply work, afforestation, planting of seeds, nursery work, fencing, construction of retaining walls etc. These do not require much expertise and can easily be taken up by locals.

Another source of income may be through increase in sales of fresh vegetables, dairy products and food to workers and traveler through roadside stalls or small outlets/shops near worker camps.

The anticipated impacts are positive but limited to the construction period and to urban centre such as Muse, Lashio, and Mandalay where skilled and semi-skilled construction workforce is expected to be sourced. To a lesser extent, semiskilled construction labor may also be sourced from peri-urban areas along the transmission line route. (i.e. municipalities of Muse, Lashio, and Mandalay), and low skilled positions such as vegetation clearance, cleaning and house-keeping at accommodation camps, security guards, etc. may be sourced in the settlements of the Study Area along the line route. Employment related to demining has not been confirmed at this stage and will depend on whether the authorized demining operator selected is a private company.

(2) Positive socio-economic Impacts

(i) Local employment and job opportunities

The construction phase of the project will have a positive impact on the local labor market. It is anticipated that the operational phase will also create permanent employment opportunities for the local affected communities though some level of technical skills and qualifications may be needed.

In addition to creating job opportunities for construction workers, the project may also lead to indirect employment creation in the informal sector, for instance in terms of food stalls for the convenience of construction workers. Additionally, more informal employment opportunities may be created through a multiplier effect from the project's activities. The direct employment opportunities are currently estimated at 700 (on average) during the 5 years of construction period, including some migrant workers and some local people. But this work force condition may change depending on the workforce requirement of the construction site condition and the worker readiness from the project developer, and so the job opportunity for local people is estimated as 350 people.

Significant of Impacts on Local Employment and Job Opportunities during Construction Phase

According to the social survey, most of the young people are going to the border city of Myanmar-China (Shwe Li) for job seeking. So, the significant for the job opportunities are as follow.

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Job opportunities	Construction activities	Positive (+)	Limited (+2)	Medium term (+3)	Medium (+3)	Regular (+3)	Probable (+3)	Low (+48)

Consideration of Mitigation Requirement for local employment and job opportunities

The intensity of mitigation requirement for local employment and job opportunities according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Job opportunities	Low (+48)	yes	Yes	Moderate	Construction provider(s)

Enhancement Measures for Local Employment and Job Opportunities

The project developer will do the following mitigation measures for ensuring job opportunities for local people.

(a) Training program for welding will be opened before the construction phase.

(b) Unskilled and semi-skilled job opportunities will be offered to the local communities as much as possible.

(c) As the population of females is slightly higher than that of males in the township, employment opportunities for construction works will be created to ensure that the local female population also has equal chance for these opportunities (Gender Equality).

(d) The developer will encourage construction sub-contractor to use local labor force as part of tender requirement.

(e) It is necessary to make tendering process in every project implementation works to ensure job opportunities for local rental services, machineries rental services, local service companies and other relative businesses.

Impact Significance of Local Employment and Job Opportunities after Enhancement Measures

If job creating is provided to local people, the impact will become low after enhancement actions as follow:

Anticipated Impact	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Potential to Increase in household income	Positive (+)	Limited (+2)	Medium term (+3)	Medium (+3)	Very often (+4)	Highly probable (+4)	Low to Medium (+64)

Job opportunities for local people is one of the most public needs according to the primary data collection and through public meeting. So, the project developer will intensely consider to create job opportunity for local people during construction phase.

(ii) Skill Development for Local People

Local people hired by the proposed project would remain in communities with skills acquired during project construction including concrete work for offices and other facilities, steel work for oil tanks, stone work for retaining wall and the bridge construction technique (like pile driving activities, beam installation and pier construction). Communication skills for local people will also improve in office works during construction period.

Impact Significance of Skill Development without Enhancement Measures

According to the primary data collection, most of the sub-contractors for minor construction works in nearest villages are not too familiar with modern construction technique. So, the impact significance of local skill development during construction phase without enhancement measures can be considered very low as follow:

Components	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Local skill development	Positive (+)	Local (+3)	Long term (+4)	Low to Moderate (+3)	Intermittent (+2)	Very Seldom (+1)	Low (+30)

Enhancement Measures for Skill Development for Local People

The project developer will do the following enhancement measures for local skill development.

(a) Training programs (e.g. maintaining of vehicles, welding, wiring, masonry building etc.) will be implemented prior to and during the construction phase because majority of the local people may not be adequately skilled to qualify for positions requiring skilled labor, if required.

(b) Local construction sub-contractors will be chosen as first priority during tender process.

(c) The project developer will encourage construction contractors and sub-contractors to stimulate local skill development as part of tender requirement.

Impact Significance of Skill Development after Enhancement Measure

Skill development for local people will be great benefit for local engineers near the construction sites. However, local skill development is not the public needs according to the public consultation. So, the impact significance of local skill development during construction phase can be considered as low to moderate after enhancement measures as follow:

Components	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Local skill development	Positive (+)	Local (+3)	Long term (+4)	Low to Moderate (+3)	Intermittent (+2)	Probable (+3)	Low to Moderate (+50)

(iii) Potential to Growth of Local Economy and Business

The construction and operation phase of the project will have temporary positive impacts on the local economy. In addition to the economic benefits derived from employment, the proposed development will also contribute to the local and regional economy in other ways. For instance, local expenditure by employees will have multiplier effects in various sectors of the economy, thereby stimulating business activity and further employment creation.

Changes in the local economy structure such as opening of new markets for products and services, increased demand for consumer goods and inflation of local prices can all have some positive outcomes on the local and regional economy for example profits that will be injected into the local and regional markets.

The project could also have finical impacts – in other words, an impact on government revenues and expenditures. In particular, payment of business and personal tax could contribute to government revenue at a national level, while rates and payment for services could strengthen the income base of the area.

Impact Significance of Growth of Local Economy and Businesses without Enhancement Measures

Since the construction period is 5 years, the required food and consumer goods are bought from the nearest villages. According to the primary data collection, there are no construction contractors and business for construction materials in nearest villages. So, this kind of impact during construction period will be considered as very low for local people in nearest villages and low for local business without enhancement measures as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Growth of local economy	Growth of economy in nearest villages	Food and consumer goods for construction workers	Positive (+)	Local (+3)	Short term (+2)	Low (+2)	Regular (+3)	Seldom (+2)	Low (+36)
	Growth of business in nearest villages	Supply of construction services and materials	Positive (+)	Local (+3)	Short term (+2)	Low (+2)	Intermittent (+2)	Very Seldom (+1)	Very Low (+21)

Enhancement Measures for Growth of Local Economy and Businesses

Any food and consumer goods that can be bought in nearest villages should be preferred as first priority. Local business for food and consumer goods in nearest villages should boost by buying required things regularly. The project developer should encourage construction contractors and sub-contractors to stimulate the emergence of local small business as part of tender requirement. The project developer should establish a policy to encourage services and materials from local in relation to construction works. Any construction services and construction materials that can be available in nearest villages should be preferred as first priority if feasible and should encourage construction contractors and sub-contractors to stimulate the emergence of local small business as part of tender requirements. But after the construction period is over, the construction site should be restored as the normal condition and make sure there would be no permanent business left in the construction site.

Impact Significance of Local Economy and Businesses after Enhancement Measures

Impact significance can be raised by enhancement measures as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Growth of local economy	Growth of economy in nearest villages	Food and consumer goods for construction workers	Positive (+)	Limited (+2)	Short term (+2)	Low to Moderate (+3)	Very often (+4)	Highly probable (+4)	Low to Moderate (+56)
	Growth of business in nearest villages	Supply of construction services and materials	Positive (+)	Limited (+2)	Short term (+2)	Low to Moderate (+3)	Intermittent (+2)	Probable (+3)	Low (+35)

Comments for Growth of Local Economy and Businesses

As some parts of the places along the proposed project are just developing, the boost in local economy will have advantage for local people during construction period. The project developer should have policy to support local businesses, especially in nearest villages.

(3) Negative Socio-economic Impacts

(i) Blockage of River and Stream

Water Blockage due to River Crossing Bridge

The negative socio-economic impacts during construction phase will be the blockage of drainage system and it can cause the flood in nearest farm land. It can cause the damage to the agricultural land because the blockage of upstream near the river. It can also cause the water shortage to the downstream river due to construction of coffer dam for the bridge foundation process.

Water Blockage due to Valley Crossing Bridge (Viaduct)

The foundation of the bridge can block the mountain stream especially in valley crossing bridge. It may affect the gardeners who will use the water from the stream near valley.

Impact Significance of blockage of river and stream during construction phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Blockage of river and stream	Bridge foundation process	Negative (-)	Local (-3)	Medium term (-3)	Low to moderate (-3)	Continuous (-5)	Probable (-3)	Low to moderate (-72)

Consideration of Mitigation Requirement for Blockage of River and Stream during Pre-construction Phase

The intensity requirement of mitigation measures for Blockage of River and Stream according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	blockage of river and stream	Low to moderate (-72)	No	Yes	Moderate	Construction provider(s)

Mitigation Measures for Blockage of River and Stream

MR will use alternative waterway (manmade drainage system that can drain the large water volume) to avoid potential to flood due to the blockage of natural drainage system during pre-construction phase. The alternative water way will prepare to flow the water volume for the reduction of potential to flood. It will also prepare for cross-pass over or under public roads and village roads and culverts for natural springs. Both river crossing bridge and valley crossing bridge (viaduct)will not construct during the rainy season. Use alternative water way for the upstream flood near the farm land and village.

Impact Significance of blockage of river and stream during construction phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Blockage of river and stream	Bridge foundation process	Negative (-)	Local (-3)	Medium term (-3)	Low (-2)	Very often (-4)	Seldom (-2)	Low (-48)

(ii) Impact due to Population Influx

The social impacts described in the pre-construction phase will continue into the Construction Phase with more workers, increased number of work locations, more frequent transportation of construction materials as additional workers are brought in to complete the work, the risk of social conflicts, risks of spread of communicable diseases, health and safety risks, waste generation and sewage and increased pressure on resources, are all expected to increase. Socio-cultural differences and conflicts between migrant workers, and the local community

As news regarding the proposed project spreads, expectations regarding possible employment opportunities may also take root. Consequently, the area surrounding the site or construction areas may experience an influx of job seekers. The magnitude of this impact depends on the severity of unemployment in surrounding areas. It could be expected that migrant labors will flock to the area. It is likely that a large enough number of job seekers will flock into the area to have fairly significant population impact on the immediate social environment. This population increase may impact on the area in terms of additional demand for services and infrastructure.

An influx of newcomers seeking opportunities associated with the project could also create various social problems. Tension or conflict can be created as a result of religious or ethnic rivalries.

Single men predominately occupy the construction camps which could create social conflicts, usually as a result of cultural differences, alcohol abuse or being away from their wives or girlfriends for extended periods of time. A possible reason for conflict will be the perception among locals that the outsiders are taking up jobs that could have gone to unemployed members of the local community. An influx of unemployed job seekers could also add to the potential for conflict.

Impact Significance of Population Influx during Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Population influx	Increase in workers	Negative (-)	Local (-3)	Medium term (-3)	Low to moderate (-3)	Very often (-4)	Probable (-3)	Low to moderate (-63)

Consideration of Mitigation Requirement for Population Influx during Construction Phase

The intensity requirement of mitigation measures for population influx according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Population influx	Low to moderate (-63)	Yes	Yes	Moderate	Construction provider(s)

Mitigation Measures for Population influx

- Ensure that employment procedures and policy is communicated to local stakeholders, especially local Labour Department, and Local Administrative Offices.
- Have clear rules and regulations for access to the construction village to control loitering.
- Consult with local Labour Department to establish standard operating procedures for the control and removal of loiterers at the construction site.
- Construction workers will be clearly identifiable by wearing proper construction uniforms displaying the logo of the construction company. Construction workers must also be provided with identification tags.
- Unskilled job opportunities will be afforded to the local communities as far as possible. Even if Transnet uses a recruiting agency, the local Labour Department, and Local Administrative Offices will be utilised for recruitment process.
- Equal opportunities for employment will be created to ensure that the local female population also has access to these opportunities.
- Individuals with the potential to develop their skills will be afforded training opportunities.
- Mechanisms will be developed to provide alternative solutions for creating job security upon completion of the project.
- Payment will comply with applicable Labour Law legislation in terms of minimum wages.
- Indirect formal and / or informal employment opportunities to local individuals
- Through consultation with relevant key stakeholders, identify the segment that might benefit from informal indirect opportunities, and promote skills development and subsidisation initiatives that are sustainable.
- Encourage, in consultation with key stakeholders, construction workers to use local services.
- Raise awareness amongst construction workers about local traditions and practices.
- Inform local businesses about the expected influx of construction workers so that they could plan for extra demand.
- Ensure that the local community communicates their expectations of construction workers' behavior with the construction sub-contractor, and formalise a written agreement between the community and sub-contractor.

Impact Significance of Population Influx during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Population influx	Increase in workers	Negative (-)	Local (-3)	Medium term (-3)	Low (-2)	Regular (-3)	Seldom (-2)	Low (-40)

(iii) Impacts on Social Services

The increase of population during construction phase will increase temporary pressure on existing infrastructure and services including health care, food, shelter, water, transport and recreational facilities. As proposed project is very close to urban area and little number of workers (at least 70 workers for each working site), there will have little impact on local health care facilities and local food consumption. There is very limited social survey such as accommodation, health care facility and food along the railway. Impact significances related to population influx during construction period will be considered as follow:

Significant of Impacts on Social Services without Mitigation Measures

There will be a little impact existing public health care facility because there were few public health care facilities in nearest villages and most of the construction workers cannot afford for private health care facilities in nearest villages.. Moreover, proposed projects are situated in the existing facility of project and the requirements for housing, recreational facilities and water for additional people will be provided by the existing facilities. All of the impact significance related to population influx during construction period are as follow:

Anticipated Impact	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase pressure on housing, recreational facilities, and water	Negative (-)	Limited (-2)	Short term (-2)	Very low (-1)	Continuous (-5)	Very seldom (-1)	Low (-30)
Increase pressure on health care facility	Negative (-)	local (-3)	Short term (-2)	Low to Moderate (-3)	Regular (-3)	Highly Probable (-4)	Low to moderate (-56)
Increase pressure on adequate amount of local food	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Continuous (-5)	Very seldom (-1)	Very low (-30)

Mitigation Measures for Impacts on Social Services

All of the impacts due to increase in population can be mitigated by appointing local construction workers and it will also reduce pressure on health care facilities for construction workers. Own health care facilities will be supported to workers during construction period. No mitigation measures is required for pressure on housing, recreational facilities and water for additional workers because the impact rating is very low. Similarly, impact significant of pressure on local food consumption is very low and no mitigation measure is required. All of the impacts associated with population influx can be minimized by the use of local labor force. Own health care facilities should be supported to additional workers during construction period.

Significant of Impacts on Social Services after Mitigation Measures

If own health care facilities should be provided for workers during construction phase, impact due to population influx will be very low after mitigation measures as follow:

Components	Anticipated Impact	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase pressure on health care facility	Anxiety of existing workers	Negative (-)	Site (-1)	Short term (-2)	Low to Moderate (-3)	Intermittent (-2)	Seldom (-2)	Very Low (-24)

(iv) Conflict between Communities

The types of violent and aggressive conflict between non-Shan communities and Shan Ethnic Minority were overwhelmingly perceived to be one-off incidents between individuals from different communities and exposures that were often fuelled by alcohol and anti-social behavior, and not always related to the migrant's ethnic origin. The sporadic and "one off" nature of these incidents were reported by all the communities – both migrant and local, across urban and rural communities alike.

A higher frequency of violence and abuse could probably be among ethnic minority groups especially Shan and non-Shan migrants in the project construction area, perpetrated by individuals from both immigrants and other ethnic minority groups. A significant conflict between individual communities could be a higher frequency of incidents of name-calling, spitting, hostile attitudes, damage to property and racially motivated violence against them. This would suggest that the dynamics of race and religion negatively influence the sort of reception that the communities receive.

The other significant social problems between communities may be the hostile attitudes of non-Shan migrants to local community such as sexual harassment of migrant workers to ethnic local women and hostility of that workers to low skilled local labors.

Significant of Impacts for Conflict between Communities before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Conflict between communities	Increase in workers	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-28)

Consideration of Mitigation Requirement for conflict between communities

The intensity of mitigation requirement for conflict between communities according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Conflict between Communities	Low (-28)	Yes	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Conflict between Communities

- Use local people as much as possible.
- Limit night out for foreign workers.
- Limit the use of foreign workers.
- When making an agreement contract with contractors and subcontractors, it must include the fact that they have to use local workers as much as possible.
- Raise awareness to respect custom of local people for foreign and migrant workers.

Significant of Impacts for Conflict between Communities after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Conflict between communities	Increase in workers	Negative (-)	Limited (-2)	Medium term (-3)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

(v) Increased in Traffic

Traffic Congestion – Road traffic congestion in surrounding area during construction period can cause public anxiety. It can also lead to temporary blockage of village roads.

As the construction operations will last about 5 years, traffic flows can be increased by the activities such as construction of new extension road, transportation of construction workers and construction materials will lead to increasing in traffic volumes to and from the site. This will lead to an increase the risk of accidents to the employees and in the local community as well as present the potential for nuisance from the increase or if the traffic presents delays to the public. Additionally, equipment, material and construction debris in and out of the site not be secured correctly, there is a risk that this transported material could become a hazard and further increase the rates of accident and injury. Disruption of access to infrastructure or social resource due to construction activity will cause nuisance and to a certain extent additional cost to the public in terms of longer travel period due to diversion or traffic. It will also pose risk of accident to motorist at night if these blockages and disruption are not clearly demarcated. Local traffic time (Weekend day 4:00 – 7:00pm and working day 7:00 – 10:00 am) is significantly high. It can cause the traffic problem for the Muse-Mandalay Highway road.

Significant of impact for Traffic Congestion during Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Traffic congestion	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Probable (-3)	Low (-35)

Consideration of Mitigation Requirement for Traffic Congestion

The intensity of mitigation requirement for Traffic Congestion according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Traffic congestion	Low (-35)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Increased in Traffic during Construction Phase

Traffic control plan which is to be prepared by the contractor, and ensuring that traffic into and out of the site will occur mainly during the daytime, especially for heavy machinery, and will do so in an ordered manner. In addition, the movement of heavy machinery during the construction phase will be limited to off-peak hours and prior notification will be provided to minimize the potential negative impacts of traffic on local communities. Affected communities will be notified regarding the construction schedule during the construction and rehabilitation phase. In addition, a traffic re-routing plan will be provided for the construction phase, with alternative routes delineated where feasible. Any road damage sustained by transportation of heavy equipment will be repaired. It can use alternative road that will not pressure on public road. And need to avoid hauling of construction materials at local traffic time and hauling of heavy construction materials at night. Temporary construction road should be used that does not pressure on existing public road if feasible does not impact on forest and agriculture land and use proper traffic management plan and safety sign along the transportation road.

Significant of impact for Traffic Congestion during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Traffic congestion	Construction activities	Negative (-)	limited (-2)	Medium term (-3)	Very Low (-1)	Rare (-1)	Seldom (-2)	Very Low (-18)

Residual Impact

There would be no residual impact because of the increased traffic when the construction activities are over.

(vi) Increase in Crime and Security

An inflow of skilled migrant construction workers and their dependents from other areas may increase in social pathologies and crime including drug and alcohol abuse, assault, theft and violence in nearest villages.

Impact Significance of Increase in Crime and Security before Mitigation Measures

The impact can be considered as moderate without mitigation measures and the impact rating is as follows:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase crime and security	Public security	Migrant construction workers	Negative (-)	Limited (-2)	Short term (-2)	Low to moderate (-3)	Intermittent (-2)	Seldom (-2)	Low (-28)

Mitigation Measures for Increase in Crime and Security

This kind of impact can be mitigated by the use of local labor force as much as possible. The developer should encourage the construction contractors or sub-contractors to ensure that the local community communicates their expectations of construction workers' behavior, and formalize between the community and them. The developer also needs to continue to work with the local and regional police personnel and local administrative members in the resolution of potential increase in crime and violence. Management of construction camp should be adequately formalized and have communication channels with local police force in order to take measures for any inappropriate behavior that may occur. Construction workers should be clearly identifiable. Construction site should be fenced and all of the construction workers should not allow going out at night. Security force should be organized and trained to put a stop to crime and violence.

Impact Significance of Crime and Security after Mitigation Measures

After systematically control of foreign and migrant workers and continuous cooperation with local administrative office and police force, the impact will be low as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase crime and security	Public security	Migrant construction workers	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

(vii) Public Road Damage

Transportation of construction materials for the construction process like concrete and other construction material, it can cause the damage to the public road and village roads.

Significant of Impact for Public Road Damage before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Public road damage	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-28)

Consideration of Mitigation Requirement for Public Road Damage

The intensity of mitigation requirement for Public Road Damage according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Public road damage	Low (-28)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures

- Use bypass road instead of public roads.
- Use public roads as per the resistance of roads and bridge if unavoidable.
- Repair the public roads if they are damaged by construction activities.

Significant of Impact for Public Road Damage after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Public road damage	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

(viii) Controversy with EAOs

The proposed project can be in the vicinity of territory of Ethnic Armed Organizations. Thus, it can lead to controversy between EAOs and the parties taking part directly or indirectly in the project.

Significant of impact for Controversy with EAOs before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Controversy with EAOs	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-28)

Consideration of Mitigation Requirement for Controversy with EAOs

The intensity of mitigation requirement for according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Controversy with EAOs	Very Low (-12)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures of Controversy with EAOs

- Have transparency in every development of the project.
- Inform the EAOs before any development of the project.
- Discuss and negotiate with EAOs if any conflicts occur.

Significant of impact for Controversy with EAOs after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Controversy with EAOs	Construction activities	Negative (-)	Limited (-1)	Medium term (-3)	Low (-2)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

(ix) Visual Impacts

- Increase in people unease
- siting of construction camps may cause a number of issues such as loss of plantation and vegetation, permanent physical and visual impact on the area, siltation and pollution risks
- blockage of the river views by constructing of the river crossing bridges
- damage to the natural environment of rivers and streams

Significant of Impacts for Visual Impacts during Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual Impact	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Very often (-4)	Probable (-3)	Low (-49)

Consideration of Mitigation Requirement for Visual Impacts

The intensity of mitigation requirement for Visual Impacts according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Visual impact	Low (-49)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Visual Impacts

- Avoid recreational area and/or side wall covers with green colour
- Enclose the construction camp sites with non-transparent fencing to minimize the visual impacts on nearby areas especially for travelers
- Site housekeeping to keep project area clean and limit visual intrusion.
- Efficient and timely removal of all demolition and construction wastes according to the CDC requirements.
- Replantation after the construction activities

Significant of Impacts for Visual Impacts during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual Impact	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Very Low (-1)	Intermittent (-2)	Seldom (-2)	Low (-24)

(x) Amenity and Nuisance

- Temporary loss of amenity during construction phase
- Noise from construction traffic and operations
- Mud on roads
- Vibration from the construction near the residential areas

Significance impact during construction phase for visual impact before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Amenity and nuisance	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Very often (-4)	Probable (-3)	Low (-49)

Consideration of Mitigation Requirement for Amenity and Nuisance

The intensity of mitigation requirement for Amenity and Nuisance according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Amenity and nuisance	Low (-49)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Amenity and Nuisance

- Develop a systematic construction management system to reduce public amenity and nuisance
- Wash wheels before going to public roads

Significance impact during construction phase for Amenity and Nuisance after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Amenity and nuisance	Construction activities	Negative (-)	Site (-1)	Medium term (-3)	Low (-2)	Intermittent (-2)	Very Seldom (-2)	Very Low (-24)

Residual Impact on Socio-economic during Construction Phase

The impact on livelihood and economic of the community is still be residual because the commercial places are fully affected and need to be relocated somewhere else and so the income will be affected. This also impact people whose livelihood is linked with existing modes of transportation. The permanent land loss will cause effects on the agricultural activity.

Mitigation Measures for Amenity an Nuisance

Land loss is not sufficiently large to result in a material effect through diminishing the quality of life as replacement could be made in locality or be compensated for. Payments for loss of business (temporary or permanent), loss of livelihood, loss of wages employment will be provided to affected parties, as compensation.

(b) Occupational Health and safety

Risk of injury on construction site and risk of injury through construction traffic by earthworks and excavations and adverse reaction to perceive health issues.

Community Potential Health Impact

During construction phase, the anticipated health related impacts are as follows:

(a) Increase Infection of Air-borne Diseases

An influx of construction workers from other places can lead to overcrowded conditions where air-borne diseases such as tuberculosis, influenza and meningitis can spread easily.

Impact Significance for Increase Infection of Air-borne Diseases before mitigation measures

According to the secondary data collection, infections of TB is one of the common disease in Upper Myanmar. So, impact rating for air-borne diseases will be considered as follow:

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	-	√	-	√ (HIR 1)	-	-
Construction workers	-	√	-	-	√	-	-	√ (HIR 2)	-

Mitigation Measures for Infection of Air Borne Diseases

This potential impact will be minimized by providing medical check for workers who are susceptible infection of air-borne diseases.

(b) Fugitive Dust Emissions

During construction phase, the main source of air pollution will be dust generation due to site clearing, ground levelling activities, construction activities and transportation of construction materials. Dust will expose some local people in nearest villages to bronchial and other respiratory tract diseases.

Impact Significance for Fugitive Dust Emissions before mitigation measures

The impact will be little on local people in nearest villages.

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	-	√	-	√ (HIR 1)	-	-
Construction workers	-	√	-	-	√	-	-	√ (HIR 2)	-

Mitigation Measures for Fugitive Dust Emission

Dust can be controlled by:

(a) Wetting of roads by water spraying;
(b) Seeding storage mound surfaces as soon as is practicable;
(c) Spraying exposed surfaces of mounds regularly;
(d) Restricting vehicle speeds;
(e) Watering roadways and
(f) Wheel or body washing

(c) Increase Infection of Water Borne Diseases

Project activities could become sources of pollution, as a result of infiltration into the surface stream. The incidence rate of water borne diseases such as cholera and diarrhea will increase if there will be no proper sanitation practices at the construction site. Improper waste disposal of construction debris will also have potential to increase water borne diseases because the project site is very close to surface water resources. The possible negative impacts considered significant are:

- Loose soil from earthworks may be washed into river.
- Irresponsible dumping of domestic solid waste can lead to underground water contamination, due to contaminants emanating from various products into the groundwater and filtering through to the aquifers. This will be a particular problem during the rainy season.
- Potential surface water pollution can emanate from waste products generated by construction activities entering the surface drainage.

Impact Significance for Increase Infection of Water Borne Diseases before mitigation measures

According to the secondary data collection, infections of water borne diseases such as diarrhea are still the public healthcare problems in Upper Myanmar Region and so the impact will be considered as follow:

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	√	-	-	√ (HIR 1)	-	-
Construction workers	-	√	-	-	√	-	-	√ (HIR 2)	

Mitigation Measures for Increase Infection of Water Borne Diseases

Avoid construction time during rainy seasons. If it is not possible to avoid rainy seasons, proper sanitation system will be provided for construction workers during construction period. Construction debris will be disposed at suitable location that does not impact on local nearest rivers. Construction activities will ensure that no loose soil is permitted into watercourses and stockpiles are located away from surface water. All mixing of cement will be carried out in a designated area away from surface water and areas of potential runoff. All areas of fuel storage will be banned to prevent hydrocarbon pollution of surface water.

(d) Potential to Increase Infections from Mosquito

Stagnant pools of water during the construction phase will cause bleeding zone for mosquitoes and can cause potential to cause infections from mosquitoes especially in rainy season.

Impact Significance of Infections from Mosquito before mitigation measures

The impact can be rated as medium because malaria is still a health problem in Upper Myanmar Region.

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	√	-	-	√ (HIR 1)	-	-
Construction workers	-	√	-	-	√	-	-	√ (HIR 2)	

Mitigation Measures for Infections from Mosquito

Avoid construction time in rainy seasons as much as possible. Ensure that there are no stagnant pools of water during the construction phase. Proper temporary or permanent drainage system will be compensated if there will be the blocked of natural drainage system during construction phase.

Impact Significance of Infections from Mosquito after mitigation measures

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	√	-	-	√ (HIR 1)	-	-
Construction workers	-	√	-	-	√	-	-	√ (HIR 2)	

(e) Increase Risk of Sexually Transmitted Infections

During construction phase, the improved economic status of the area and the influx of new migrant workers, living away from their families, can also lead to an increased risk of sexually transmitted infections such as HIV/AIDS, gonorrhoea and chlamydia. Major outbreaks of infectious diseases can have a devastating effect not only on or near the project site but also on local communities.

Impact Significance of Increase Risk of Sexually Transmitted Infections before mitigation measures

Impact rating for sexually transmitted infection (448 people in Upper Myanmar Region in 2017) can be considered as moderate in Upper Myanmar Region.

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
Local people	-	√	-	-	√	-	-	√ (HIR 2)	-

Mitigation Measures for Increased Risk of Sexually Transmitted Infections

MR will provide information and education about safe sex and implement HIV control program for migrant construction workers.

(f) Health Impact Related to Increase in Noise Level

Construction activities normally generate a lot of noise. Noises will also arise from various construction machinery at site. Pilling operation will also produce high noise level. Both acute loud noise and chronic lower level noise have been associated with a variety of negative health effects. Hearing loss and impairment are known to occur as a result of exposure to acute, high decibel noise (greater than 85 dB). Noise annoyance can lead to stress related impacts on health such as feelings of displeasure, interference with thoughts, feelings, and activities and disturbed sleep and can have impacts on mood, performance, fatigue, and cognition.

Impact Significance of Increase in Noise Level before mitigation measures

The impact will be considered as low for local people due to the distance of nearest villages inside the construction site as follow:

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	-	√	-	√ (HIR 1)		-
Workers at site	-	√	-	-	-	√	-	-	√ (HIR 2)

Mitigation Measures Health Impact Related to Increase in Noise Level

1. Reduce speed limits for trucks in the project area to reduce noise level.
2. Alert residents of anticipated noise, including time, duration, decibel levels, and machinery to be used to protect public health.
3. Avoid working at night

Residual impact

After mitigation measure, there will be no residual impact on occupational health and safety.

(c) Impacts on Cultural Heritage

Architectural and Archaeological Heritage

- risk of physical damage to historic structures near the route as a result of operation of construction equipment, deposits of materials and general construction activity; and
- risks of vibration from piling during construction

For Construction Phase

Damage to known or unknown (buried) features of archaeological or cultural importance during construction phase.

Significance impact during construction phase for Architectural and Archaeological Heritage before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Architectural and archaeological heritage	Piling during construction	Negative (-)	Site (-1)	Medium term (-3)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-24)

Consideration of Mitigation Requirement for Architectural and Archaeological Heritage

The intensity of mitigation requirement for Architectural and Archaeological Heritage according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Archaeological and archaeological heritage	Very Low (-24)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Architectural and Archaeological Heritage

These risks will be mitigated by compliance with relevant international standards, including:

- management operations should aim to minimise disturbance to adjacent residential and recreational uses;
- sites of archaeological or cultural interest should be preserved in situ where possible, as relocation is rarely possible, thorough archaeological investigations should be carried out where damage is unavoidable.
- implementation of an archaeological watching brief using a Government-approved archaeologist and chance finds procedure along the rest of the route during construction;
- complying with relevant national law on the protection of cultural heritage;
- design modifications to avoid impacting on buried locations of likely archaeological interest and importance; and
- prior consultation with protected area sponsors and managers, local communities and other key stakeholders.
- Blasting and percussive piling near historic structures will not be permitted. Where piling is essential bored piles and casings driven by torque and hydraulic pressure will be used

Significant impact during construction phase for Architectural and Archaeological Heritage after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Architectural and archaeological heritage	Piling during construction	Negative (-)	Site (-1)	Medium term (-3)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Very Low (-10)

Residual impact

After mitigation measure, there will be no residual impact on architectural and archaeological heritage.

(d) Impacts on Utilities Consumption during Construction Phase

(i) Water Usage

Maximum water consumption rate for a person per day = 100 gallons

Total workforce for construction = 41 nos

Water consumption rate per day (work force) = 4100 gallons

Water is one of the important factors for the preparation of the construction material like the mixing of the cement concrete, etc. The amount of water usage can be reduced by preparation of the construction materials beforehand on site. Water can be taken from the surface water source or underground sources. The spring water or underground can be the source for the nearby villages unlike cities which have many water utilities companies. There would be no problem in local water consumption because the proposed project uses water from the reservoir and nearby rivers. Drinking water will be providing by outsource suppliers.

Significance of impact on water usage during Construction Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Water Scarcity	Preparation of construction material	Negative (-)	Limited (-2)	Short term (-2)	Low to moderate (-3)	Regular (-3)	Probable (-3)	Low (-42)

Consideration of Mitigation Requirement for water usage

The intensity of mitigation requirement for water according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1	Water scarcity	Low (-42)	Yes	Yes	Moderate	Construction Service Provider(s)

Mitigation Measure for Water Usage

Minimizing Water Consumption

As the proposed project uses groundwater for cleaning and domestic uses, water conservation measures are needed to be taken. The reduction in the amount of water consumed in a project will have several environmental and economic benefits, including conservation of water resources and consequently, lower wastewater discharge volumes. Water conservation during construction phase can be conducted as follows:

(a) Reducing process water use
(b) Minimizing domestic water consumption

Reducing process water use

All of the cleaning water should be recycled and reused as the cooling purpose. Limewater from treatment plant must be recycled. This potentially allows less costly and less water consumption.

Minimizing domestic water consumption

Domestic water consumption will be minimized by implementing water efficient fixtures such as 3 liters WC flushing cistern, sensor operated urinals and taps to minimize the wastage of water together with other water conservation measures if feasible. Furthermore, to ensure ongoing water conservation, an employee education and awareness programmed will be introduced for the employee of the proposed project. Dry type urinals will also be used selectively. The following are specific measures:

(a) Awareness campaign to disseminate knowledge on strategies and technologies that can be used for water conservation;

(b) New employees will be issued standard water information packed. The information should include water conservation plans, water conservation methods being adopted in the complex and a list of essential and nonessential water uses;

(c) Manager of proposed project shall periodically remind the staff for water conservation efforts.

(d) Proper methods of water use will be placed in the toilets and other areas of water consumption

Significance of impact on water usage during Construction Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Water usage	Preparation of construction material	Negative (-)	Limited (-2)	Short term (-2)	Low to Moderate (-3)	Intermittent (-2)	Seldom (-2)	Low (-28)

Residual impact

After mitigation measure, there will be no residual impact on water consumption.

(ii) Fuel Consumption

Construction activities are also the main source for environmental impacts resulting from the material processing, transportation and use of equipment during the construction process. In construction of the bridge, use the diesel fuel for pile driving activities, deck construction and installation of the beam.

Significance of impact on Fuel Consumption before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fuel Consumption	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Rare (-1)	Seldom (-2)	Very Low (-21)

Consideration of Mitigation Requirement for fuel consumption

The intensity of mitigation requirement for fuel consumption according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1	Fuel consumption	Very low (-21)	No	Yes	Minor	Construction service provider(s)

Mitigation Measure for Energy Consumption

- Assessing the feasibility of solutions, considering cost and carbon emissions associated with their installation and operations, as well as their effect on user safety and comfort
- Need to control the usage of diesel engine generator and not operate if there are not in use
- Replacements as a part of general upgrades to the system
- Stimulate the production of domestic raw materials for biofuels
- Using more efficient equipment when replacing old equipment (such as motors and transformer unit
- Preventative maintenance of operational processes and pipes so as to improve efficiency and minimize losses

Significance of impact on Fuel Consumption after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fuel Consumption	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

Residual impact

After mitigation measure, there will be no residual impact on fuel consumption.

6.2.3. Anticipated Impacts during Operation/Maintenance Phase

As in the bridges and culverts, the operation/maintenance activities include the ongoing site maintenance and painting of the bridge. Some of the impacts related to this operation phase are as follows:

(1) Impacts on Air Environment

(2) Impacts on Surface Water Environment

(3) Impacts on Soil Environment

(4) Impacts on Biodiversity Environment

(5) Impacts on Human Environment

(1) Anticipated Impacts on Air Environment during Operation Phase

(a) Noise impact during Operation Phase

It can cause by travelling of high-speed rails on the bridge. This train noise impact can significant in the residential area and can cause the environmental nuisance. These noises will adversely affect the sensitive points such as nearby residential areas, schools and hospitals, etc. During the operation on the bridge, traffic flows will increase on the approach roads causing increased sound emissions and additional noise in the neighborhood. According to the National Environmental Quality Guidelines (2015), noise standards for sensitive targets are as follows:

Table - Noise attainment values of sensitive targets

Sensitive targets	One-hour equivalent sound level (dBA)	
	Daytime 07：00-22：00	Night time 22：00-07：00
Residential areas, education institutions	55	45
Industrial park, commercial district	70	70

The equivalent sound level of unobstructed noise on both sides of the railway may not meet the standards of residential areas and educational institutions in the National Environmental Quality Guidelines (2015).

Significant of Impacts on Noise during Operation Phase before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Travelling of high-speed rails	Negative (-)	Limited (-2)	Long term (-4)	Low to medium (-3)	Continuous (-5)	Seldom (-2)	Low to moderate (-63)

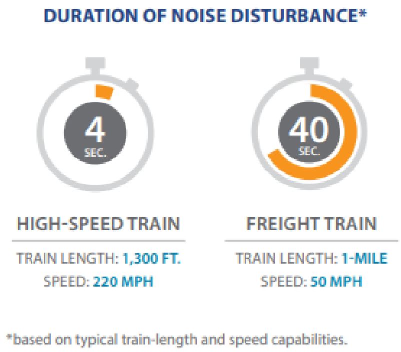
Consideration of Mitigation Requirement for Noise

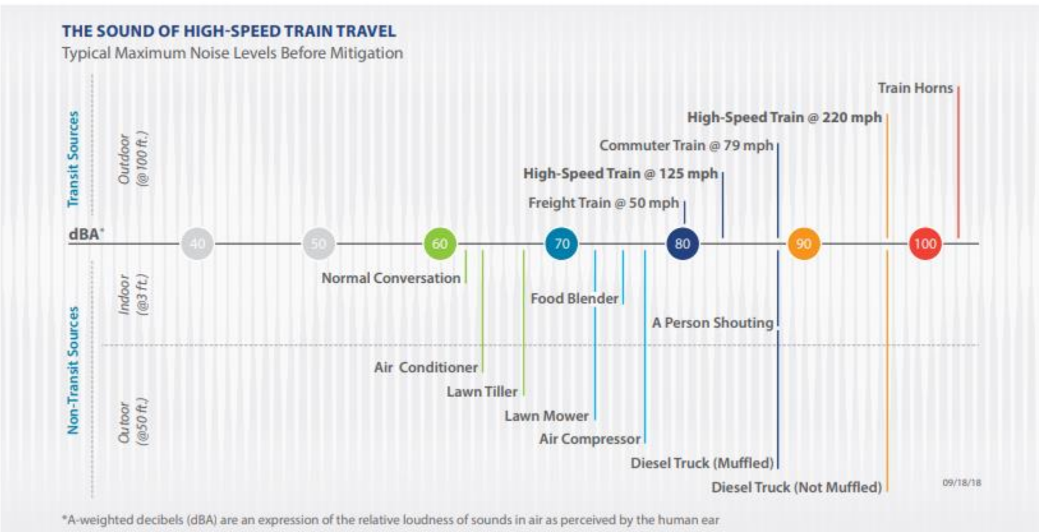
The intensity of mitigation requirement for noise according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Noise	Low to moderate (-63)	Yes	Yes	Moderate	Operator(s)

Methodologies for Operation Noise Level Prediction

Railway noise is generated from a variety of sources, each contributing to the total noise output. Sources include rolling noise generated by the contact between wheel and rail during normal movement and braking; aerodynamic noise generated by the train pushing air (particularly for high speed trains).





Source: California High-Speed Rail Authority

For noise generated by rail cars and electric locomotives (that is, without including horn noise) will be used by the following equation.

SELcars = Leqref + 10log (Tpassby) + 30log(S/Sref)

For locomotives, which can be modeled as moving monopole point sources, the corresponding equation is as follows:

SELlocos = SELref + 10log (Nlocos) – 10log(S/Sref)

The total train sound exposure level is computed by logarithmically adding SELlocos and SELcars

The parameters that apply to the equations above are:

SELcars = Sound exposure level of railcars
Leqref = Level equivalent of railcar
Tpassby = Train passby time, in seconds
S = Train speed, in miles per hour
Sref = Reference train speed
SELlocos = Sound exposure level of locomotive
SELref = Reference sound exposure level of locomotive
Nlocos = Number of locomotives

The reference speed of the train is 160 km/hr but in the FS study, it is stated that 120 km/hr is the maximum average speed available in current condition. Thus, the noise level of a train passing is assumed 85 dB(A) and the maximum sound level of an electric locomotive is assumed to be 85 dB(A) and the no. of locomotives is 18. The noise level of the train will be calculated by using the above equations.

SELcars = Leqref + 10log (Tpassby) + 30log(S/Sref)

SELcars = 85 + 10log (4) + 30log(74.56/99.42)

SELcars = **87.27 dB(A)**

SELlocos = SELref + 10log (Nlocos) – 10log(S/Sref)

SELlocos = 85+ 10log (18) – 10log(74.56/99.42)

SELlocos = **98.80 dB(A)**

SELtrain = SELcars + SELlocos

= **99.10 dB(A)**

Mitigation Measures for noise during operation phase

The residual noise impact can be mitigated by re-planting the trees especially native species in the places near residential area or biodiversity sensitive area. It is also need to reduce the speed of the train when passing through the bridge. It is also needed to control the design like reduction the impact of excitation forces arising from the wheel rail contact and moving masses and reduction the noise level by increasing the effective mass of the bridge structure. Sound proof measurement will be taken near the public area.

Significant of Impacts on Noise during Operation Phase after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Travelling of high-speed rails	Negative (-)	Limited (-2)	Long term (-4)	Low (-2)	Continuous (-5)	Very Seldom (-1)	Low (-48)

Residual Impact

After mitigation measure, there will be no residual impact on noise.

(b) Vibration Impact during Operation

In the operation period, the railway vibration is mainly the mechanical vibration produced by wheel-rail interaction and excitation in the process of train operation on the bridge. Heavy freight train passing the bridges cause huge vibration due to the interaction with railing, which are evidenced by the fatigue of the construction of a bridge. By comparing with other similar projects, the standard of 80dB & 80 dB for day and night is adopted. According to initial estimate, the railway vibration value on bridge and cutting at 30m from the railway outer track center line is lower than 80dB by day and night, and the railway vibration value in the areas beyond the areas of embankment, bridge and cutting at 30m from the railway outer rail center line meets the standard requirements of the day and night 80 dB & 80 dB.

There are no guidelines for vibration regulated by NEQG. The vibration level in the field survey of the project will be referred as a baseline data in pre-construction stage and used for comparison in the construction and/or operation stage.

Significant of Impacts on Vibration during operation phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vibration	Passage of heavy freight train	Negative (-)	Limited (-2)	Long term (-4)	Low to medium (-3)	Continuous (-5)	Seldom (-2)	Low to moderate (-63)

Consideration of Mitigation Requirement for Vibration

The intensity of mitigation requirement for vibration according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Vibration	Low to moderate (-63)	Yes	Yes	Moderate	Operator(s)

Mitigation Measure for Vibration

- Sound proof measurement will be taken near the public area
- Sound and vibration will be controlled by wheel maintenance, vehicular maintenance and elastic solution
- Reduce the speed of the train while passing through the bridge
- Reduce the noise level by increasing the effective mass of the bridge structure

Significant of Impacts on Vibration during operation phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vibration	Passage of heavy freight train	Negative (-)	Limited (-2)	Long term (-4)	Low (-2)	Continuous (-5)	Very Seldom (-1)	Low (-48)

Residual impact

After mitigation measure, there will be no residual impact on vibration.

(2) Impacts on Surface Water Environment during Operation Phase/ Ongoing site maintenance

Surface Water Hydrology

Upstream impounded waters from the cons will reduce the oxygenation and downstream water quality may be reduced by increased of turbidity. Maintenance vehicles can also pollute surface water. It can also affect the residential area near the bridge.

In the operation phase, as the physical presence of bridge can be upstream potential impediment to decrease flow water velocity and increase depth-increased flood risk and changing in deposition regime upstream, caused by changes in flow and potential flood risk and changes to riffle /pools. And downstream potential increased water velocity, and turbulence and erosion. It can cause the loss of pools/riffles, alternation of natural bed slope, decreased water turbulence and oxygenation and increased bank erosion downstream. Loss of riparian habitat by virtue of land use adjacent to a watercourse for development.

Significance of Impact for Surface Water Hydrology before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water Hydrology	Presence of bridge	Negative (-)	Site (-1)	Long term (-4)	Very Low (-1)	Continuous (-5)	Seldom (-2)	Low (-42)
	Maintenance of bridge	Negative (-)	limited (-2)	Very Short term (-1)	Low to moderate (-3)	Rare (-1)	Probable (-3)	Very low (-24)

During Maintenance

Potential impact of bridge and culvert during maintenance are as follow:

- Cleaning activities, including annual water flush of all decks, drains, bearings, joints, pier caps, abutment seats, concrete rails, and parapets each spring.
- Spot painting of rusted steel
- Repairing cracked or spalled concrete
- Cleaning trash from a stream
- Stream channel maintenance including debris removal, stabilizing banks and correcting erosion problems.

By maintaining the bridge, it can damage to the stream or river near because of using the water from the stream for cleaning trash. By painting of the rusted steel, the purifying level of water can be decreased. It can cause the surface water pollution by in accidental drop of paint into the river during the maintenance of the bridge.

Consideration of Mitigation Requirement for Surface Water Hydrology

The intensity of mitigation requirement for Surface Water Hydrology according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1	Surface water hydrology	Presence of bridge	Yes	Yes	Moderate	Operator(s)
		Maintenance of bridge	No	Yes	Minor	Operator(s)

Mitigation Measures for Surface Water Hydrology

- watercourses should not be deepened or widened up or downstream of culverts;
- artificial bank reinforcement should be avoided if possible;
- oil interceptors or drip trays are used in vehicle parking areas, and are inspected and cleaned regularly;
- a risk assessment is carried out for each substance to be used or stored on site, and the appropriate containment measures installed.
- With regard to bridges, open parapets will be used to allow some over-deck flow in the event of the bridge opening becoming blocked in a major flood event;
- Will not blockage natural free flow water system
- Use the zinc-based paint instead of lead-based paint for bridge maintenance
- Provide purification system for the in accidental
- Oil absorption mats shall be provided to remove oils from waste water
- Proper control and avoid leakage of oil or paint

Significance of Impact for Surface Water Hydrology after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water Hydrology	Presence of bridge	Negative (-)	Site (-1)	Long term (-4)	Very Low (-1)	Very often (-4)	Seldom (-2)	Low (-36)
	Maintenance of bridge	Negative (-)	limited (-2)	Very Short term (-1)	Low (-2)	Rare (-1)	Seldom (-2)	Very low (-15)

Residual impact

After mitigation measure, there will be no residual impact on surface water environment.

(3) Impacts on Soil Environment during Operation Phase

Soil Contamination

Soil contamination which is caused by leakage of oil and paint during bridges and culverts maintenance. It can cause damage from the residue of paint after maintenance process. It can affect the gardeners near the valley crossing bridge (viaduct)because of the residue of the paint. It can also cause the soil contamination near the bridge foundation area of valley crossing bridges by the in accidental drop of paint. Spot painting of rusted steel and repairing cracked or spalled concrete for the valley crossing bridge (viaduct)can cause the soil damage.

Significant of Impacts on Soil Environment during Operation Phase before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination	Leakage of oil and paint during maintenance	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Probable (-3)	Low (-30)

Consideration of Mitigation Requirement for Soil Contamination

The intensity of mitigation requirement for Soil Contamination according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1	Soil contamination	Low (-30)	No	Yes	Minor	Operator(s)

Mitigation Measures for Soil Contamination during Operation/ Ongoing Site Maintenance

- Control the proper leakage of oil and paint during painting
- Dispose systemically the residue of paint after maintenance process
- Use zinc-based coating paint instead of lead-based paint

Significant of Impacts on Soil Environment during Operation Phase after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination	Leakage of oil and paint during maintenance	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Rare (-1)	Seldom (-2)	Very Low (-15)

Residual impact

After mitigation measure, there will be no residual impact on soil environment.

(4) Impacts on Natural Environment (Biodiversity) during Operation Phase

(a) Aquatic Ecology

Physical presence of the bridge can be following impacts:

- Changes to deposition, depth and water velocities may result in the loss of sensitive plant, invertebrate and fish species
- Turbidity may contribute to reduced ecological diversity
- Potential downstream changes to the aquatic community
- Shading of the watercourse may reduce aquatic flora in the vicinity of the bridge
- Potential barrier to fish migration and the movement of aquatic mammals along the river corridor so that it can affect to the fishermen near the village
- Potential loss of fish species and aquatic mammals because of noise and vibration during passing through the bridge

Materials management from ongoing site maintenance can be faced the following impacts:

- direct and indirect effects from oil, fuel and/ or other substances entering the aquatic environment

Significance of Impact for aquatic ecology before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Aquatic Ecology	Oill and paint	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Probable (-3)	Low (-30)

Consideration of Mitigation Requirement for aquatic ecology

The intensity of mitigation requirement for aquatic ecology according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Aquatic Ecology	Low (-30)	No	Yes	Minor	Construction Service Provider(s)

(b) Terrestrial Ecology

Upstream impoundment may cause an inundation of terrestrial and riparian habitats. Destabilization of nearby wetlands - potential waterlogging of riparian areas – death of mature trees, shrubs and flowers. It can cause the potential loss of wildlife species because of the noise and vibration from the passage of rails in the valley crossing bridge. It can have risk of harm to wildlife animals falling from the structure when passing through the valley crossing bridge.

Significance of Impact for terrestrial ecology before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Terrestrial Ecology	Passage of rails and maintenance process	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Probable (-3)	Low (-30)

Consideration of Mitigation Requirement for terrestrial ecology

The intensity of mitigation requirement for terrestrial ecology according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	terrestrial ecology	Low (-30)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Aquatic Ecology and Terrestrial Ecology

- Existing habitat features will be incorporated into site design and protected from change;
- Further habitats will be created to compensate for habitat losses and to improve the landscape and ecological potential for the site;
- Potential barrier created to the upstream migration of wildlife
- Creation of barriers to mammals
- Provide sign boards in places where there is a potential for wildlife crossing

Significance of Impact for Natural Environment (Biodiversity) Environment after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Terrestrial Ecology	Passage of rails and maintenance process	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Rare (-1)	Seldom (-2)	Very Low (-15)
Aquatic Ecology	Direct and indirect effect of oil and paint	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Rare (-1)	Seldom (-2)	Very Low (-15)

Residual impact

After mitigation measure, there will be no residual impact on aquatic and terrestrial ecology.

(5) Impact for Human Environment during Operation and Maintenance Phase

Socio Economic

The anticipated socio-economic impacts during operation phase will be both positive and negative impacts as follow:

Positive Socio-economic

The anticipated positive socio-economic impacts during operation phase are as follow:

(i) Employment Generation

The proposed project will bring various employment opportunities during the operational period. The direct employment opportunities would be increased for the local people. The employment for the preparation of painting and during the painting for maintenance will need about 200 workers for all bridges and culverts.

Significance of Impacts on employment generation before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Positive socio-economic impacts	Employment generation	Positive (+)	Limited (+2)	Short term (+2)	Low (+2)	Regular (+3)	Seldom (+2)	Low (+30)

Consideration of Mitigation Measures for Impacts on Livelihood and Economic

The intensity of mitigation requirement for Impacts on Livelihood and Economic according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Employment generation	Low (+30)	Yes	Yes	Minor	Operators

Mitigation Measures

Positive impact is expected since the proposed project would boost regional economic activities along the maintenance process of the bridge and culverts. For PAPs whose livelihood had been affected during construction stage, monitoring of the implementation of the RAP will be conducted.

Significance of Impacts on employment generation after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Positive socio-economic impacts	Employment generation	Positive (+)	Limited (+2)	Short term (+2)	Low (+2)	Very Often (+4)	Probable (+3)	Low (+42)

(ii) Local Community Development

Many local and foreigners will travel during operation phase since the transportation becomes easy. Local will be developed by mean of services for tourists, transportation and providing other necessary supplies. High capital investment in Shan Region and CSR activities will have potential to community development potential.

Impact Significance of Local Community Development without Enhancement Measures

This kind of impact can be considered as low without enhancement measures as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Development in nearest villages	Operation of Railway	Positive (+)	Local (+3)	Long term (+4)	Low (+2)	Intermittent (+2)	Seldom (+2)	Low (+36)

Enhancement Measures for Local Community Development

This positive impact of the project can be enhanced by creating jobs for providing necessary services (transportation, tour trips to religious places, local tourist guide) to foreigners by local people. According to the social survey, local people are the most of the public needs, and it will also support community development.

Impact Significance of Local Community Development after Enhancement Measures

The significant of impact will be considered as low to moderate after enhancement measures as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Development in Muse and nearest villages	Operation of Railway	Positive (+)	Local (+3)	Long term (+4)	Low (+2)	Regular (+3)	Highly Probable (+4)	Low to Moderate (+63)

The developer already had CSR policy and budget allocation for community development purposes. Corporate social responsibility (CSR) is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society. The developer is intending to use at least 2 % of annual net benefit after tax for every year in CSR activities. So, with enhancement measures, community development potential will be great benefits for local people.

(iii) Improved in Tourism Sector

It can have the positive visual impact for the local people and foreigners. A breathtaking view can be seen from the "Gote Hteik" Viaduct and other bridges.

Significance of Impacts on Visual Impact during Operation Phase before Mitigation Measure

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual Impact	Construction of new bridge	Positive (+)	Limited (+2)	Short term (+2)	Very Low (+1)	Very Often (+4)	Very Seldom (+1)	Low (+25)

Consideration of Mitigation Measures for Impacts on Visual Impact

The intensity of mitigation requirement for visual impact according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Visual impact	Low (+25)	No	No	Minor	Operator(s)

Enhancement Measure for Visual Impact

- Use the bridge construction design that are suited to the local community with very wonderful design near the Gote Hteik bridge..

Significance of Impacts on Visual Impact during Operation Phase after Mitigation Measure

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual Impact	Construction of new bridge	Positive (+)	Limited (+2)	Short term (+2)	Low (+2)	Very Often (+4)	Seldom (+2)	Low (+36)

Negative Socio-Economic Impacts during Operation and Maintenance Phase

The anticipated negative socio-economic impacts during operation phase are as follow:

(i) Illegal Resettlement of Migrate Workers

It can affect to the local people because some of the migrate workers remain as illegal citizens after the construction of each bridge site. It can increase the population of the local people and can have a conflict with local people.

Impact Significance of Increased in Resettlement of migrate workers

The impact will be considered as medium without mitigation measures as follow:

Significance of Impacts on illegal resettlement of migrate workers during Operation Phase before Mitigation Measure

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Illegal resettlement of migrate workers	Increase in population	Negative (-)	Limited (-2)	Permeance (-5)	High (-5)	Rare (-1)	Probable (-3)	Low (-48)

Consideration of Mitigation Measures for Impacts on Resettlement of migrate workers

The intensity of mitigation requirement for resettlement of migrate workers according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Illegal resettlement of migrate workers	Low (-48)	Yes	Yes	Moderate	Operator(s)

Mitigation Measures for resettlement of migrate workers

- Make a contract with the sub-contractors to remove workers after the construction is finished
- Control the workers according to law and regulations
- Use local workers as much as possible

Significance of Impacts on illegal resettlement of migrate workers during Operation Phase after Mitigation Measure

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Illegal resettlement of migrate workers	Increase in population	Negative (-)	Limited (-2)	Permeance (-5)	High (-5)	Rare (-1)	Very Seldom (-1)	Very Low (-24)

(ii) Amenity and Nuisance

It is possible alteration of rights of way or reduction in access to riparian habitats. Reduced recreation opportunities e.g. angling and boating. Loss of visual amenity. It can cause the collection of unsightly litter behind the structure. It can cause the noise impact residential area near bridge.

Significant of Impacts for Amenity and Nuisance during Operation Phase before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Amenity and Nuisance	Reduction of recreation opportunities	Negative (-)	Limited (-2)	Long term (-4)	Low (-2)	Intermittent (-2)	Probable (-3)	Low (-40)

Consideration of Mitigation Requirement for amenity and nuisance

The intensity of mitigation requirement for amenity and nuisance according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Amenity and nuisance	Low (-40)	No	Yes	Minor	Operator(s)

Mitigation Measures for Amenity & Nuisance

It is needed to create public recreation place at or near the bridge and culvert as its possible. It also requires to have a replantation around the bridge and river.

Significant of Impacts for Amenity and Nuisance during Operation Phase after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Amenity and Nuisance	Reduction of recreation opportunities	Negative (-)	Limited (-2)	Long term (-4)	Very Low (-1)	Rare (-1)	Seldom (-2)	Very Low (-21)

(iii) Community Health and Safety

Accident

It can cause the railway accidents of passengers and local people when passing through the bridge. It can have risk of harm to humans falling from the structure into the watercourse and also into the valley.

Significance of Impacts on Occupational Health and Safety before Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Accident	Falling from the structure	Negative (-)	Site (-1)	Long term (-4)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-28)

Consideration of Mitigation Requirement for Impacts on Occupational Health and Safety

The intensity of mitigation requirement for Community Health and Safety according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Accident	Low (-28)	No	Yes	Minor	Operator(s)

Mitigation Measures for Accident

Safety concerns should be addressed for workers and working environment. It also needs to have an installation of adequate fencing and other site security to prevent trespass and vandalism. It can be mitigated by enlightening passengers and residents about traffic safety specific to railways. It also requires to put the safety signboards for the local people and surrounding environment.

Significance of Impacts on Occupational Health and Safety after Mitigation Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Accident	Falling from the structure	Negative (-)	Site (-1)	Long term (-4)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

Residual Impact

The residual potential health impact on the nearest resident area is initially low, there would be no residual impact. And there would be no significant residual impact on amenity and nuisance since these impacts are potentially low and not significant.

(iv) Impacts on Utility Consumption

Electricity Consumption

In the operation and maintenance of the bridges, electricity is used to provide the adequate lightning for the bridge and it is also need to provide for the safety signboards that are used in the entrance and exit of the bridge. If the electricity is used from the local community, it can affect to the local people usage.

Significant of Impacts for electricity consumption during Operation Phase before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Local people electricity usage	Provide lighting for the bridge	Negative (-)	Limited (-2)	Long term (-4)	Low (-2)	Continuous (-5)	Probable (-3)	Low to moderate (-64)

Consideration of Mitigation Requirement for electricity consumption

The intensity of mitigation requirement for electricity consumption according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Electricity Consumption	Low to moderate (-64)	Yes	Yes	Moderate	Operators

Mitigation Measures for Electricity

- Use LED lights and/or lower wattage lamps
- Implementing good housekeeping measures such as turning off equipment and lights when not in use
- Use alternative source like solar system for lighting of the bridges

Significant of Impacts for electricity consumption during Operation Phase after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Electricity consumption	Provide lighting for the bridge	Negative (-)	Limited (-2)	Long term (-4)	Very low (-1)	Very often (-4)	Very seldom (-1)	Low (-30)

Residual impact

After mitigation measure, there will be no residual impact on electricity consumption.

6.2.4 Anticipated Impacts during Decommissioning Phase

In the decommissioning phase of the project, it will involve the removal of steel structure, concrete pile foundation, concrete pier, structure (beam and bridge frame) and electric supply system. Some of the impacts related to the decommissioning phase are as follow:

(1) Impacts on Air Environment

(2) Impacts on Water Environment

(3) Impacts on Soil Environment

(4) Impacts on Biodiversity Environment

(5) Impacts on Human Environment

(1) Impacts on Air Environment during Decommissioning Phase

(i) Gaseous Emission and Dust Generation

Temporary vehicular emissions and dust generation associated with site remediation can be occurred. Vehicles likes crane, dozer and truck used in decommissioning phase can produce dust and vehicular emissions.

Significant of Impacts on vehicular emission and dust generation before mitigation measures

The impact significance of dust generation and gaseous emissions during decommissioning phase will be very low as follow:

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive Dust Generation	Use of dozer and truck	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Very Often (-4)	Probable (-3)	Low (-35)
Gaseous Emissions	Use of dozer and truck	Negative (-)	Local (-3)	Very Short term (-1)	Very Low (-1)	Intermittent (-2)	Highly Probable (-4)	Low (-36)

Consideration of Mitigation Requirements for Air Environment

The requirement of mitigation measures for air environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern	Mitigation Requirement	Mitigation Scale	Responsibility
1.	Fugitive Dust Generation	Low (-35)	No	Yes	Minor	MR
2.	Gaseous Emissions	Low (-36)	No	No	Minor	MR

Mitigation measure for vehicular emission and dust generation

According to the above table, minor mitigation measures are required for air quality during decommissioning phase as follow:

(a) Spray water for dust control;

(b) Use machineries with good engine with low sulphur content fuel for gaseous emission.

Significant of Impacts on Air Quality after mitigation measures

The impact significance of dust generation and gaseous emissions during decommissioning phase will be very low as follow:

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive Dust Generation	Use of dozer and truck	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Very Often (-4)	Probable (-3)	Low (-35)
Gaseous Emissions	Use of dozer and truck	Negative (-)	Local (-3)	Very Short term (-1)	Very Low (-1)	Intermittent (-2)	Highly Probable (-4)	Low (-36)

Residual impact

After mitigation measure, there will be no residual impact on Gaseous Emission and Dust Generation.

(ii) Noise

For small bridge demolition process, the use of equipment like crane, dozer and truck can produce noise to the surrounding environment. For long bridge demolition process, it is also needed to the explosive for the removal of concrete structure. It can also cause the noise impact to the near village and surrounding environment. Temporary noise nuisance caused to communities proximal to the decommissioning activities.

Significant of Impacts on Noise during Decommissioning Phase before mitigation measures

The impact significance of noise during decommissioning phase will be very low as follow:

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Use of explosive for demolition	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Highly probable (-4)	Low (-36)

Consideration of Mitigation Requirements for Air Environment

The requirement of mitigation measures for air environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern	Mitigation Requirement	Mitigation Scale	Responsibility
1.	Noise	Low (-36)	No	Yes	Minor	Decommissioning service provider(s)

Mitigation Measure for Noise

- Machine with high noise should be located as far as possible in remote areas and away from sensitive points such as residential areas. If it is difficult to select reasonable locations, noise isolation measures should be taken, and regular maintenance of machinery should be carried.
- Scheduling blasting activities so as not to disturb local people and notify them prior to undertaking such as activity
- Noise barriers should be erected at appropriate location like the residential areas and sensitive areas.
- Reasonably arrange construction time, and try not to carry out construction or arrange low noise construction work at night

Significant of Impacts on Noise during Decommissioning Phase after mitigation measures

The impact significance of noise during decommissioning phase will be very low as follow:

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Use of explosive for demolition	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Intermittent 9 (-2)	Seldom (-2)	Very low (-20)

Residual impact

After mitigation measure, there will be no residual impact on noise.

(iii) Vibration

For long bridge demolition process, it is required to use blasting operation for the removal of concrete structure. For the usage of the explosive in the blasting operation can cause the vibration impact to the surrounding environment.

Significant of Impacts on Vibration during Decommissioning Phase before mitigation measures

Component	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vibration	Use of explosive for demolition	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Highly probable (-4)	Low (-36)

Consideration of Mitigation Requirement for vibration impacts during Decommissioning Phase

The intensity of mitigation measures for air environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Vibration	Low (-36)	Yes	Yes	Minor to Moderate	Decommissioning service provider(s)

Mitigation Measure for Vibration

- Informing people of the possible vibration before drilling and blasting activities take place
- Proper drilling pattern and drilling method to reduce vibration
- Use delay for control blasting or reduce the number of drill hole per blast near the residential area or biodiversity sensitive area

Significant of Impacts on Vibration during Decommissioning Phase after mitigation measures

Component	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vibration	Use of explosive for demolition	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Intermittent 9 (-2)	Seldom (-2)	Very low (-20)

Residual impact

After mitigation measure, there will be no residual impact on vibration.

(2) Impacts on Water Environment during Decommissioning Phase

Surface Water Hydrology

Surface water pollution can increase in surface runoff from bank areas during decommissioning due to soil compaction from the removal of steel structure and concrete pier. It can also be flood risk by the removal process of bridge concrete. Pollution of surface water will cause by fuel and oil spillages from vehicular activities.

Significant impact for Surface Water Hydrology during Decommissioning Phase before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Removal of bridge structure	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Highly probable (-4)	Low (-36)

Consideration of Mitigation Requirement for Surface Water Hydrology impacts during Decommissioning Phase

The intensity of mitigation measures for Surface Water Environment according to the consideration of impact rating and public concerns are as follow

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Surface water pollution	Low (-36)	No	Yes	Minor	Decommissioning service provider(s)

Mitigation Measures for Surface Water Hydrology during decommissioning phase

- Appropriate water management system is used during the decommissioning period, including, for example, the efficient land drainage and the use of constructed ponds for receiving site runoff to reduce the impact of runoff on nearby watercourses
- Oil interceptors or drip trays are used in vehicle parking area, and are inspected and cleaned regularly
- Control the spillage of the oil, fuel and concrete into the river

Significant impact for Surface Water Hydrology during Decommissioning Phase after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Removal of bridge structure	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-20)

Residual impact

After mitigation measure, there will be no residual impact on water environment.

(3) Impact on Soil Environment during Decommissioning Phase

- Erosion of exposed soil and removal or alteration of soil on site for bridge/ culvert removal
- Discharge of the residue of the concrete from the demolition of bridge and culvert

Significant Impact for Soil Environment during Decommissioning Phase before mitigation measure

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil erosion	Removal or alternation of soil for bridge demolition	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Highly probable (-4)	Low (-36)

Consideration of Mitigation Requirement for vibration impacts during Decommissioning Phase

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Soil erosion	Low (-36)	No	Yes	Minor to Moderate	Decommissioning service provider(s)

Mitigation Measures for Soil Environment during Decommissioning Phase

Mitigation Measure for Erosion of Exposed Soil

- Effective stabilization of altered landforms so as to minimize soil erosion and the potential for water pollution from suspended solids
- Use systematic dispose method for the residue of concrete near the residential areas and do not discharge near the residential areas

Significant Impact for Soil Environment during Decommissioning Phase after mitigation measure

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil erosion	Removal or alternation of soil for bridge demolition	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-20)

Residual impact

After mitigation measure, there will be no residual impact on soil environment.

(4) Impact on Natural Environment (Biodiversity) during Decommissioning Phase

Negative impact on Aquatic flora and fauna

- From increased sediment loading of streams
- From oil, fuel, cement or other substances entering watercourses.
- Pollution of water by removal of concrete structure and beam can cause the impact of the fish species and aquatic animals
- During the blasting operation, it can cause the noise for the aquatic species
- If the construction activities start in rainy season, it can disturb the fish species especially in fish breeding times

Significant of Impacts on Aquatic flora and fauna during Decommissioning Phase before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Aquatic flora and fauna	Removal of concrete structure and beam	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Highly probable (-4)	Low (-36)

Consideration of Mitigation Requirement for aquatic flora and fauna

The intensity of mitigation requirement for aquatic flora and fauna according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Aquatic flora and fauna	Low (-36)	No	Yes	Minor	Decommissioning service provider(s)

Mitigation measure for Aquatic flora and fauna

- Avoid the spillage of oil and fuel into river and stream
- Use systematic method for bridge demolition not to cause damage to the aquatic flora and fauna
- Dispose the residue of the concrete structure and steel structure according to the law and regulations
- Avoid the construction activities especially during the rainy season

Significant of Impacts on Aquatic flora and fauna during Decommissioning Phase after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Aquatic flora and fauna	Removal of concrete structure and beam	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Intermittent (-2)	probable (-3)	Low (-25)

Negative impact on terrestrial flora and fauna

- From vehicular activities, disturbance and habitat severance
- From spillage and discharge of oil, fuel, cement or other substances to the valley
- Cause noise impact to the wildlife species because of blasting

Significant of Impacts on terrestrial flora and fauna during Decommissioning Phase before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Terrestrial flora and fauna	Spillage and discharge of oil and fuel,	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Highly probable (-4)	Low (-36)

Consideration of Mitigation Requirement for terrestrial flora and fauna

The intensity of mitigation requirement for terrestrial flora and fauna according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Terrestrial flora and fauna	Low (-36)	No	Yes	Minor	Decommissioning service provider(s)

Mitigation measure for terrestrial flora and fauna

- Existing habitat features should be incorporated into site design and protected from change;
- Further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential for the site;
- Where access restrictions result, arrangements for alternative access should be made with the provision of gates, bridges or stiles

Significant of Impacts on terrestrial flora and fauna during Decommissioning Phase after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Terrestrial flora and fauna	Spillage and discharge of oil and fue	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Intermittent (-2)	probable (-3)	Low (-25)

Residual impact

After mitigation measure, there will be no residual impact on biodiversity environment.

(5) Impact on Human Environment during Decommissioning Phase

(i) Socio-economic

Negative Socio-economic Impacts

Generally, it tends to reverse the benefits that are got from the operation of the proposed project on closing the project. As an example, it would have to face the cases like giving up job opportunity and losing the State currency.

Loss of Jobs for Local People and Revenues for the Government

In the event of the project closure, there will be potential negative impacts resulting in loss of jobs and indirect employment depending on the proposed project and of associated services for tourism as well as loss of revenues for the government.

Impact Significant of Loss of Jobs and Revenues for the Government

As Myanmar is developing country, loss of job opportunities and revenues for regional government will be greatly affect on GDP. So, impact significant will be considered as low to moderate for loss of jobs due to insignificant number of workers and moderate for loss of revenues due to important of income from services in Upper Myanmar.

Components	Anticipated Impact	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Loss of jobs	Decline in local economy	Negative (-)	Local (-3)	Permanent (-5)	Low (-2)	Regular (-3)	Highly probable (-4)	Low to Moderate (-70)
Loss of revenues	Decline in regional economy	Negative (-)	Regional (-5)	Permanent (-5)	Moderate (-4)	Rare (-1)	Certain (-5)	Moderate (-84)

Mitigation Measures for Loss of Jobs and Revenues for the Government

Extensive and comprehensive warning to employees to allow them to source alternative livelihood should be taken early. The project developer should prepare their employees for forced retirement by providing applicable jobs at other factories under the same developer, if feasible.

Impact Significant of Loss of Jobs and Revenues for the Government after Mitigation Measures

After mitigation measures for loss of jobs and revenues for the government, the impacts can be rated as follow:

Components	Anticipated Impact	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Loss of jobs	Decline in local economy	Negative (-)	Local (-3)	Permanent (-5)	Low (-2)	Regular (-4)	Very seldom (-1)	Low (-50)
Loss of revenues	Decline in regional economy	Negative (-)	Regional (-5)	Permanent (-5)	Moderate (-4)	Rare (-1)	Probable (-3)	Low to Moderate (-56)

Comments for Loss of Jobs for Local People and Revenues for the Government

The developer should have a plan to reuse the Railway for other business purpose under the same company or other partner company to retain the revenue for the government.

(ii) Visual Impact

- Temporary visual impact from work being carried out on site
- Transportation of vehicular equipment on site
- Discharge of residue and steel structure near the residential area

Significant of Impacts on Visual Impact during Decommissioning Phase before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual impact	Discharge of residue and demolition work	Negative (-)	Limited (-2)	Very short term (-1)	Low to medium (-3)	Intermittent (-2)	Highly probable (-4)	Low (-36)

Consideration of Mitigation Requirement for visual impact

The intensity of mitigation requirement for visual impact according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Visual impact	Low (-36)	No	Yes	Minor	Decommissioning service provider(s)

Mitigation Measures for Visual Impacts

- Appropriate screening for visual impacts
- Vegetation and plantation near the decommissioning bridge
- Use systematic dispose method for the residue of concrete near the residential areas and do not discharge near the residential areas

Significant of Impacts on Visual Impact during Decommissioning Phase after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual impact	Discharge of residue and demolition work	Negative (-)	Limited (-2)	Very short term (-1)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-20)

6.3. Risk Assessment

6.3.1. Risk in Culvert (Construction Phase)

Firstly, the people and property which might be affected by the hazard in which all possible elements at risk within the zone of influence of the failure must be considered, either directly (road users) or indirectly (adjacent property and people) – the 'elements at risk' – must be identified.

Type of Hazard	Elements which may be affected by the hazard
• Structural collapse • Slope instability (Afflux, leakage out of barrel, headwall collapse) • Erosion by overtopping flows • Cross catchment flooding	• Road users; • Buildings (occupied and unoccupied); • Pedestrians; • Road and furnishings; • Vehicles; • Infrastructure (e.g. railways); • Structures; • Services (e.g. water supply, power poles); • Other property.

(a) Structural collapse (Construction Phase)

Structural collapse of a culvert could occur due to structural overload of the culvert (e.g., inadequate design) or to deterioration of the culvert leading to loss of strength (e.g., corrosion of metal pipes, corrosion of reinforcing steel). Collapse of the culvert barrel could subsequently lead to development of a void or depression on the road surface.

The factors that could contribute to this failure mechanism include:

- Culvert type (e.g., reinforced concrete pipes, either butt jointed, spigot and socket, with or without banding on joints, buried corrugated metal pipes (BCMS) spirally wound or not, etc.).
- Depth of cover
- Culvert condition – e.g., evidence of corrosion of steel elements, longitudinal cracking of concrete, corrosion/scour of the invert.
- Loss of supporting material

The failure mechanism typically develops over time; however, a certain rainfall event may trigger a failure. The potential consequences of this failure mechanism include:

- Void/sinkhole on the road surface causing an accident.
- Repair costs.

(b) Slope Instability (Construction Phase)

Slope Instability caused by Afflux

Afflux is the temporary buildup of water at the inlet side of the culvert. This failure mechanism involves damming of water on the upstream side due to blockage of the inlet by debris or vegetation, or insufficient hydraulic capacity. Stored water may lead to saturation of fill and/or increase in pore pressure in the embankment, contributing to slope instability on the downstream side.

The factors contributing to the ponding of water on the upstream side of the culvert include:

- Hydraulic capacity of the culvert
- Potential for blockage at the inlet (or within culvert).

The factors contributing to instability of the embankment given storage of water are dependent on

- Location of the road embankment (e.g., a steep slope)
- Embankment material and compaction
- Foundation material – potential for low strength materials and strain weakening materials
- Embankment condition and downstream slopes.

The potential consequences of this failure type include:

- Void in the road causing an accident/loss of life
- Debris flow causing loss of life or damage down slope of the failure
- Repair costs
- Road closure

Slope Instability Caused by Leakage out of Barrel

This failure mechanism involves instability from water leaking out of the culvert leading to saturation of fill or foundation materials below the culvert. Leakage may occur through open joints caused by separation of pipe segments due to soil creep or differential settlement, or deterioration of the culvert. This may be observed by settlement at the road surface, stepping of the culvert, or movement of the road embankment.

The factors that could contribute to this failure are related to both leakages out of the culvert and slope instability.

The factors contributing to the leakage out of the culvert include:

- Condition of the culvert – joint condition, pipe separation through settlement or other, culvert deterioration (corrosion of invert).

The factors contributing to instability of the embankment given leakage out of the culvert:

- Scour undermining the toe
- Observed condition of the embankment – evidence of instability, slumping
- Embankment material and compaction
- Foundation material – potential for low strength materials and strain weakening materials
- Downstream slope, e.g. localized slumping.

The potential consequences of this failure type include:

- Void in the road causing an accident.
- Debris flow causing loss of life or damage down slope of the failure.
- Repair costs.
- Road closure.

Slope Instability Caused by Headwall Collapse

This failure mode occurs when the headwall (at either the inlet or outlet) has been subjected to erosion and collapses taking with it a portion of the road pavement.

Factors contributing to this failure mechanism	The potential consequences for this failure type
· Depth of soil at road embankment · The distance from the headwall to the edge line (EL) · The amount of erosion caused by nesting animals, poor compaction, etc. · Additional lanes providing a squeeze-point at this location · Guard rail is bolted to the headwall.	· Collapse of headwall and loss of pavement · Repair costs · Road closure.

Slope Instability caused by Undermining at Inlet or Outlet

This involves instability of the road embankment caused by localized erosion and undermining at the inlet or outlet sides of the culvert.

This failure mode occurs when the embankment at the culvert inlet or outlet is eroded causing undercutting and instability of the road embankment.

Factors contributing to outlet or inlet erosion	Potential consequences for this failure type
· Energy dissipation measures at the inlet or outlet · Erosion protection measures at the inlet or outlet · Evidence of scour at the inlet or outlet · Water energy – grade and roughness.	· Void in road causing accident · Repair costs · Road closure.

(c) Erosion by Overtopping Flows (Construction Phase)

This involves erosion due to flows over the road. This hazard involves the erosion of the downstream side of a road embankment due to flows over the road surface caused by blockage or insufficient capacity of the culvert. This can lead to a void on the edge of the road embankment, or complete washout of the road embankment.

Water on the road may also lead to damage to the road pavement surface and accidents.

Factors contributing to flow over the road embankment	The potential consequences for this failure type
· Hydraulic capacity of culvert; and · Potential for blockage at inlet. · Factors contributing to an embankment failure by overtopping flows include: · Embankment geometry – gully line concentrating flows; · Surface cover on slope (vegetation); · Slope of embankment; and · Amount of water and its velocity.	· Damage to road pavement; · Void in road caused by embankment failure or sinkhole; · Debris flow causing loss of life or property damage downstream; · Water washing cars away; · Repair costs; and · Road closure.

(d) Cross Catchment Flooding (Construction Phase)

Cross catchment flooding involves the redirection of surface runoff flows away from the culvert due to blockage or insufficient hydraulic capacity of the culvert. The diverted flows may inundate areas not normally affected by surface runoff flows.

This mechanism involves the culvert either being blocked or having insufficient hydraulic capacity such that it causes cross catchment flooding (beyond the immediate and obvious area around the culvert).

The factors contributing to this mechanism include:

• Hydraulic capacity of the culvert;

• Potential for blockage; and

• Geometry of road embankment (and opportunity for water to dissipate).

The potential consequences for this failure type include:

• Property damage/injury or loss of life;

• Repair costs; and

• Road closure.

6.3.2. Risk in Railway Bridge (Operation Phase)

(1) Bridges over railways

Bridge type	Hazard/Risk	Mitigation Measure
Single Clear Span	Collision with retaining abutment wing walls may be hard head-on impact causing passenger trauma	Use approach deflection walls to avoid head-on impact with wall.
Multiple continuous and Pier- Redundant Superstructure with frangible piers	Collision with frangible piers may lead to secondary accidents on adjacent tracks due to resulting debris, if any.	Design frangible piers to minimize debris after collapse.
	Frangible piers may fail due to collision loads from a minor derailment leading to undue disruption of rail services.	Design frangible piers to avoid hard impact with train but with enough strength to avoid failure due to minor collision loads (Refer to AS5100.2) or Use independent deflection walls to avoid impact with the frangible piers and prevent their failure due to a minor collision load.

Multiple simply supported spans with Heavy Pier	Head-on hard impact with heavy pier may lead to passenger trauma and/or cause train to concertina and/or bridge collapse	Use crash wall integral with the pier to resist side impact with No approach deflection walls to avoid head-on impact with the piers
Multiple simply supported spans with frangible piers or piers with inadequate strength to resist train impact	Impact with piers will most likely lead to bridge collapse and passenger trauma.	Essential use of independent deflection walls to avoid impact with the piers.

(2) Railway Under bridges

Bridge Superstructure	Hazard/Risk	Mitigation Measure
Beam & deck slab or box girder under bridges	Derailed train may not be retained on the bridge. Train falling off the bridge would be a catastrophic event	"Guard-rails" to contain train on bridge after minor, low-speed derailment
Through-girder bridge – Steel or Concrete	Impact with the girder's end on approaches constitutes a hard impact with possible bridge collapse and passenger trauma	Use approach deflection walls to avoid head-on impact with the girder's end
	Impact within bridge could damage beams	Design for collision loads within the bridge
	Impact within bridge could dislodge bridge off bearings	Design bearings for collision loads within the bridge
Through-truss bridge	Impact with the girder's end on approaches constitutes a hard impact with possible bridge collapse and passenger trauma	Use approach deflection walls to avoid head-on impact with the girder's end
	Impact with truss within bridge can cause bridge collapse or dislodge bridge off bearings	Design bearings for collision loads within the bridge

Bridge Structure Risk by Human Factor

In risk assessment, it should include assessment in which factors such as social/economic impact of bridge loss, significance in terms of defense/security of a region, state, and/or the entire nation, average daily traffic, average daily truck traffic, distance to the nearest detour, and symbolic importance. Thus, we need to investigate terrorists' attacks to public transport infrastructure. Terrorists often justify their bloody acts on the basis of perceived social, economic and political unfairness, or they take inspiration from religious beliefs or spiritual principles. Many forms of terrorism were inspired by warfare between races, struggles between the rich and poor or battles between political outcasts and elites.

Due to terrorist attacks such as explosion, there can be adverse effects such as the following:

- Collapse of train
- Effect on life of humans, fatalities and injuries
- Structural collapse of bridge
- Effect to economy such as cost to rebuild asset, cost to respond to and recover from attack, cost resulting from disruption of product or service, long term costs due to environmental damage.

Bridge facilities are part of society's critical infrastructure; their safe and reliable services are of key importance as they are expensive to construct and operate. Little information is however available on deterred terrorist attacks. World-wide expenditures for managing terrorist attack risk are being out of proportion with their effect.

Bridges are perceived as dangerous (attractiveness/ media). They are easy to access for a vehicle-borne improvised explosive device, difficult to control and to avoid misconduct, and difficult to access by emergency services after an event. Consequences of explosion in a tunnel can be high.

It is plausible that terrorist attacks will aim for:

1. Maximizing number of fatalities
2. Maximizing traffic disruption
    a. Structural damage
    b. Operations management support systems damages

Due to terrorist attacks such as explosion, there can be adverse effects such as the following:

- Effect on life of humans, fatalities and injuries
- Threats to the integrity of the structure (e.g., resulting in replacement of the facility or major repairs)
- Damage that inhibits the structure's functionality for an extended period of time, such as closure of the facility for 30 days or more.
- Contamination of a bridge resulting in extended closure or loss of functionality

- Effect to economy such as cost to rebuild asset, cost to respond to and recover from attack, cost resulting from disruption of product or service, long term costs due to environmental damage

To reduce impacts of explosion, immediate rescue, and preparedness are required. Additional strength and capacity of technical and operational systems are also required.

Risks due to terrorist attacks in bridge infrastructures may be important and it might be efficient to take measures for their management. Focus should be directed not only on structural integrity but more so on security of personnel/ users of the railway bridge systems.

6.3.3. Occupational Health and Safety Risk

Construction sites are high risk working environments. Employees are expected to work at great heights with heavy machinery and potentially dangerous building materials. It is crucial that health and safety regulations are closely followed to reduce the chance of injury and protect the lives of workers. Most common health and safety risk in a construction site include:

- Slips and trips
- Electricity
- Airborne fibres and toxins
- Asbestos
- Unintended collapse
- Material handling
- Hand and vibration syndrome
- Noise
- Moving objects
- Working from height

(i) Occupational Health and Safety Risk during Construction Phase

The project is a major infrastructure development project that will involve a number of skilled and unskilled laborer. These workers will be working at site, maneuvering heavy machinery and material. Risk of injuries and accident at the work site cannot be ignored. The workers may have to use power tools in making the elevated structure and there are risks of accidents and injuries. The risk of fire and electrocution will also be considered at work sites during a major project. Exposure of works in to hazardous fumes and flames is another occupational hazard during construction. Falling from heights may also happen if the workers do not use proper safety measures when working at heights above 2 m from ground level. Stagnant water collected from rains and waste at construction sites may lead to spread of mosquitoes and flies and may increase the risk of spreading vector-borne diseases to workers and neighboring communities. Unhygienic site conditions will lead to spread of domestic pests. Communicable diseases also need significant consideration due to the involvement of migrant labor.

Mitigation Measure

Relevant labor laws should be strictly complied with pertaining to the health and safety of workers, employees and others.

- All workers and staff should be provided with Personal Protective Equipment (PPE) appropriate to their job on-site.
- All construction sites should be surrounded with secure tamper-proof fence, with security lighting, regular security patrols and other security measures.
- All materials and components should be stored and stacked safely in dedicated secure areas.
- Avoid use of any paints containing lead or its compounds as well as high VOCs
- Avoid roofing materials containing asbestos.
- Smoking should be prohibited near areas of fire or explosion risk.
- Sufficient supply of potable water should be ensured for all workers and employees on-site.
- Ensure that first aid kits are available in all work areas, supplied with adequate material to treat common workplace injuries.
- Dedicated transport should be provided at all work sites to take injured persons to hospitals if needed. Record of all nearest hospitals and health centers should be kept at each construction sites.
- A regular medical facility should be provided at each labour camp with suitable qualified staff and equipment to treat minor ailments and injuries.
- An effective alarm system should be established to warn track workers of approach of trains on existing IR lines in parallel route alignment.

- Protect all electric sub-stations, high-tension towers and other areas from electrocution risk by providing security fencing and lights, warning signs and security patrols.
- Ensuring moving equipment is outfitted with audible back-up alarms
- Using inspected and well-maintained lifting devices that are appropriate for the load, such as cranes, and securing loads when lifting them to higher job-site elevations.
- Dust suppression techniques will be implemented, such as applying water or non-toxic chemicals to minimize dust from vehicle movements

Potential Impacts on Employees from Accidents and Fall

During the construction phase, an increased risk of accidents may occur due to operation of heavy construction equipment. In addition, employees risk electrocution during the operation of equipment if it is not correctly handled, or has not been regularly maintained. There is an increased risk of falls from elevated positions during construction activities, as well as falls from ground level into unsecured open trenches. In addition should construction debris not be removed in a timely manner, it might lead to risk of trips, falls and injury.

Mitigation Measures

Appropriate working gear (such as nose, ear mask and clothing) and good construction site management shall be provided. Safety signal devices should be installed to ensure safety during construction. The contractor shall ensure that the construction site is fenced and hygienically kept with adequate provision of facilities including waste disposal receptacles, sewage, fire-fighting and clean and safe water supply. A well-stocked First Aid kit shall be maintained at each construction site. The medical personnel shall also be responsible for primary treatment of ailments and other minor medical cases as well as providing some health education to the workforce.

If the storage, transportation and disposal of these waste materials are not managed properly, the waste will contaminate the surrounding environment, contaminating soils and decreasing visual amenity.

(ii) Occupational Health and Safety during Operation Phase

Accidents

There is a risk of accidents due to improper working practice such as maintenance work at depot and inspection of the proposed project structure. Associated risks from accidents and incidents could affect health and safety of workers and others on site.

Mitigation Measure

Health and Safety Management Plan for operational stage will be developed and implemented by the proposed organization which will be created for the operation of the proposed project. All workers undertaking maintenance work will be provided with appropriate personal protective equipment (PPE). Security guards will be deployed all the maintenance process of the bridges and culverts. Emergency Response Plan will be established by the Project Proponent.

Occupational Health and Safety during Decommissioning Phase

(i) Accidents

- Risk of accident or injury to authorized and unauthorized persons on site

Mitigation Measure for Accidents

- Safety concerns should be addressed by such measures as implementing strict health and safety procedures, and the installation of adequate fencing and other site security to prevent trespass and vandalism

(ii) Electrical Hazard

- Risk from the removal of electrical supply from the site

Mitigation Measures for Electrical Hazard

Recommended measures to prevent, minimize, and control electrical hazards at power stations include:

• Consider installation of hazard warning lights inside electrical equipment enclosures to warn of inadvertent energization;

• Use of voltage sensors prior to and during workers' entrance into enclosures containing electrical components;

• Deactivation and proper grounding of live power equipment and distribution lines according to applicable legislation and guidelines whenever possible before work is performed on or proximal to them;

• Provision of specialized electrical safety training to those workers working with or around exposed components of electric circuits. This training will include, but not be limited to, training in basic electrical theory, proper safe work procedures, hazard awareness and identification, proper use of PPE, proper lockout/tagout procedures, first aid including CPR, and proper rescue procedures. Provisions will be made for periodic retraining as necessary.

6.3.4. Disaster Risk

Earthquake Risk

The topography along the Muse-Mandalay Railway can be divided into two geomorphological zones. The geomorphological features of each zone are as follows:

Shan State plateau: Muse-Mandalay East section belongs to Shan State plateau.

Ayeyarwady basin: Mandalay East-Mandalay South section belongs to Ayeyarwady basin.

The stratigraphic development spans are large in Myanmar, ranging from the Proterozoic to the Cenozoic. There are basically sedimentary deposits from the Proterozoic to the Quaternary strata in the Shan State plateau. The Ayeyarwady stratigraphic zone is the Mesozoic and Cenozoic marine sedimentary zone.

Muse-Mandalay Railway runs across the northern region of Myanmar from north to south. The project is within the two first-order tectonic units of the Gangdese-Nyainqentanglha fold system (II) and the India-Myanmar-Sumatra fold system (III).

There are six main faults near the Railway: Bangpaman fault (F_9), Kyankme fault (F_{7-1}) and Kunlong fault (F_{7-2}) – the branch faults of Nantinghe fault (F_7), Lashio fault (F_8), Gohteik fault (F_6) and Sagaing fault (F_4). Among them, the active faults of Holocene are the Nantinghe fault (F_7) and the Sagaing fault (F_4).

Faults structures within the region is well-developed, there are six large faults, including three Holocene active faults, three early and middle Pleistocene or beginning of late Pleistocene faults.

Although rare, bridge collapses caused by **earthquakes** can be devastating. Earthquakes with magnitude of about 2.0or less are usually called micro earthquakes; they are not commonly felt by people and are generally recorded only on local seismographs. Events with magnitudes of about 4.5 or greater, there are several thousand such shocks annually, are strong enough to be recorded by sensitive seismographs all over the world. Although the Richter Scale has no upper limit, the largest known shocks have had magnitudes in the 8.8 to 8.9 range. The Richter Scale is not used to express damage. An earthquake in a densely populated area which results in many deaths and considerable damage may have the same magnitude as a shock in a remote area that does nothing more than frightens the wildlife. Large magnitude earthquakes that occur beneath the oceans may not even be felt by humans.

Magnitude	Earthquake Effects	Estimated Number Each Year
2.5 or less	Usually not felt, but can be recorded by seismograph.	900,000
2.5 to 5.4	Often felt, but only causes minor damage.	30,000
5.5 to 6.0	Slight damage to buildings and other structures.	500
6.1 to 6.9	May cause a lot of damage in very populated areas.	100
7.0 to 7.9	Major earthquake, Serious damage.	20
8.0 or greater	Great earthquake, Can totally destroy communities near the epicenter.	One every 5 to 10 years

Earthquake Magnitude Classes

Earthquakes are also classified in categories ranging from minor to great, depending on their magnitude.

Class	Magnitude
Great	8 or more
Major	7 to 7.9
Strong	6 to 6.9
Moderate	5 to 5.9
Light	4 to 4.9
Minor	3 to 3.9

Source: UPSeis

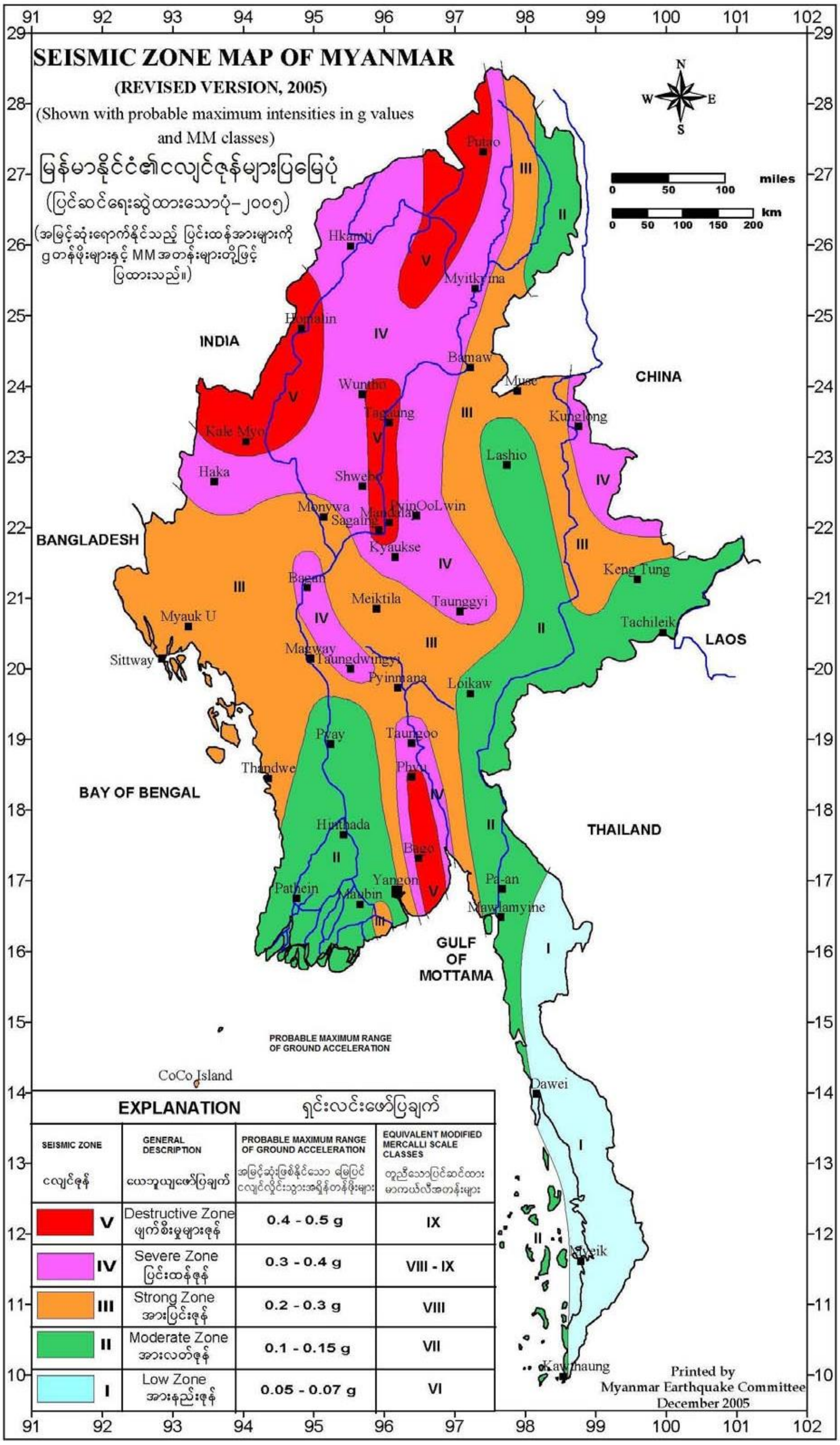
Effects of earthquake on bridge include:

- Collapse of train
- Effect on life of humans, fatalities and injuries
- Structural collapse of bridge
- Effect to economy such as cost to rebuild asset, cost to respond to and recover, cost resulting from disruption of product or service, long term costs due to environmental damage.

Since earthquake is a natural hazard, it cannot be mitigated and only control measures and prevention will be possible.

Earthquakes in last 50 Years (Source: volcanodiscovery.com)

Region	Date	Magnitude (Richter Scale)	Location
Mandalay-Sagaing	11.11.2012	5.0	Pyin Oo Lwin
	30.3.2013	5.0	Pyin Oo Lwin
	9.9.2013	5.0	Mandalay
	18.1.1986	5.1	Mandalay
	1.1.1988	5.2	Mandalay
	26.6.2014	5.2	Mandalay
	28.11.2019	5.2	Pyin Oo Lwin
	11.11.2012	5.6	Pyin Oo Lwin
Shan State	1.3.2015	5.2	Lashio
	1.3.1989	5.8	Lashio
	23.4.1984	5.9	Lashio
	9.7.1995	5.9	Lashio
	23.4.1992	6.1	Lashio
	23.4.1992	6.2	Lashio



Source: MIMU [Myanmar Information Management Unit]

Figure - Seismic Zone Map of Myanmar

Calculation of Probability

As stated in the above table, the probability of earthquakes, which can be slight to moderate damage (Richter scale 5-6.9), be occurred in 50 years can be taken as "Almost Certain".

An earthquake of magnitude 7.0 Richter scale occurred in Sagaing, 39km Northwest of Mandalay, on 16th July, 1956. A strong earthquake occurred on 24th July, 1485 near this location, which is also along the Sagaing fault. So, the return period of a strong earthquake to be occurred can be taken as 471 years where the probability for a strong earthquake to be occurred in 50 years can be calculated as 10.6%. It can be taken as "Likely".

Calculation of Consequences

Before Mitigation

Mandalay-Sagaing Region

Earthquakes occurred in Mandalay-Sagaing Region are generally 5.0-5.5 Richter Scale, which can be minor and slight damage to structures. However, since this region is classified as Severe to Destructive zone in Seismic Zone Map of Myanmar, the consequences can be taken as "Moderate".

However, according to records, earthquake in 1485 in Sagaing destroyed 3 well known pagodas and the one which happened in 1956 severely damaged several pagodas and 40 to 50 people were killed by this one. So, strong earthquakes of magnitude 7.0 Richter scale and above can be taken as "Catastrophic" since the region is also classified in the Severe to Destructive Zone.

Shan State

Earthquakes in this region are generally 5.5-6.5 Richter Scale, which can be moderate damage to structures, but it is classified as Moderate zone in Seismic Zone Map of Myanmar. So, the consequences can be taken as "Moderate".

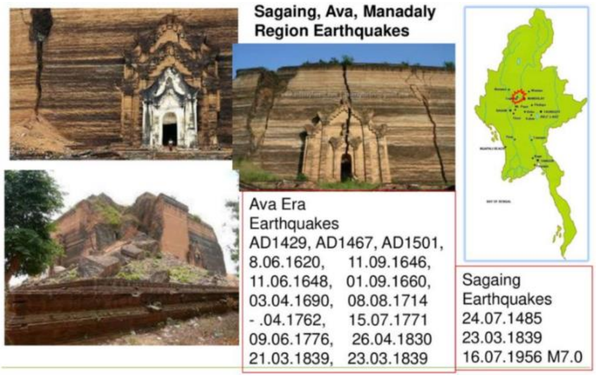


Fig. Past earthquakes in Sagaing, Ava (Innwa) and Mandalay Region

Risk Assessment Table Depending on 5x5 Matrix

Region	Consequences	Probability	Initial Risk	Mitigation Measures	Consequences after mitigation	Probability after mitigation	Reduced Risk
Mandalay-Sagaing	3	5	15 (High Risk)	• Structures should be designed to withstand an earthquake of magnitude up to Richter Scale 8.0. • Selection of bridge construction methods which can have minimum impact by an earthquake. • If outdoors, find a clear spot away from buildings, trees, streetlights and power lines. Keep lying on the ground and stay there until the shaking stops. • If indoor, go below table until the shaking stops. Avoid lift and staircase.	1	5	5 (Moderate Risk)
Mandalay-Sagaing (Richter Scale 7.0 & above)	5	4	20 (Critical Risk)		3	4	12 (High Risk)
Shan State	3	5	15 (High Risk)		1	5	5 (Moderate Risk)

Residual risk even after mitigation measures cannot be mitigated more since earthquake is a natural disaster but it can be controlled by proper emergency planning after an earthquake.

- To organize search and rescue of people trapped under debris.
- Medical officer to ensure provision of proper Medical Aid to the injured.

Mitigation Measure for Earthquake Risk

- Continuation, extension and expansion of the neotectonics and active fault studies along the Sagaing, Kyaukkyan and Kabaw faults.
- Preparation of the probabilistic seismic zone map of Myanmar (which may be used as a seismic risk map)
- Regular precise GPS measurements along the Sagaing fault, especially between Bago and Mandalay
- Training of some seismologist and earthquake engineer
- Upgrading of the existing seismological stations, and the installation of some more modern-type seismological stations in some suitable locations, such as Hpa-an, Pathein, Bago, Pyimana, Kalemyo and Muse.

6.3.5. Earthquake Induced Liquefaction Risk

Liquefaction is a soil behavior phenomenon in which saturated soil losses a substantial amount of strength due to high excess pore-water pressure generated by and accumulated during strong earthquake ground shaking or other rapid loading.

In Muse-Mandalay Railway alignment, it is observed that some sections of railway line are located in a high seismic intensity area, where Quaternary loose saturated sandy soil is prone to earthquake-induced liquefaction. Sand liquefaction problems exist in Lashio basin (Lashio Station) and Thazi valley in Ayeyarwady basin. Saturated sand layers within 20 m depth below the surface on the riverbed, flood plain and terrace in tributaries of Ayeyarwaddy River are prone to sand liquefaction.

Mitigation Measures for Liquefaction Hazards

Mitigation measures against liquefaction are

- The infrastructures should be supported on deep foundations, such as piles, that extend through the liquefiable soil to deeper strong and stable strata.
- The liquefaction of a soil can be prevented by compacting the soil and increasing its relative density by means of vibratory rollers, compaction piles, vibrio-flotation, blasting, etc.
- stabilizing soil is performed by injecting chemicals or cement grout into the soil

- By restoring to extensive ground water pumping in which the effective stress at a point increases as the water table is lowered, the liquefaction can be prevented to some extent.
- The liquefaction hazard can be reduced to some extent by providing coarse sand blankets and drains in the soil deposit.
- Applying a surcharge load to a soil deposit and construction of stone columns, the possibility of liquefaction is reduced by means of increasing the effective stress.

6.3.6. Flood Risk

A flood is a high flow or overflow of water from a river or similar source of water occurring over a period of time. Heavy rain spell can result in an extra volume of water in the waterways, leading to a rise in the water level of streams and rivers. A flood happens when the carrying capacity of the waterways fails to hold the total volume of increased water at any given time. Nowadays, all the countries' climate is changing - temperatures are getting hotter and the monsoon season is getting shorter. That' s why flooding cause of climate change, appear as a threat for us.

Many factors can go into the making of a flood;

The main causes of floods are:

- ❖ Continuous heavy rain
- ❖ Bad drainage facilities
- ❖ Blocking of river channels by landslides
- ❖ Narrowness of the river
- ❖ Change in the course of river
- ❖ Inefficient engineering design in the construction of embankments,
- ❖ dams and canals
- ❖ Failure of hydraulic and other control measures
- ❖ Destruction of mangroves and trees which do not grow back
- ❖ Deforestation and removal of root system
- ❖ Sediment deposit or silting of the river bed
- ❖ Rapid urbanization with no proper drainage facility
- ❖ Storm surge

- Tsunami
- More and more, flooding factors are also linked to climate change.

Climate Change and Flooding

Connecting climate change to floods can be a tricky endeavor. Not only do myriad weather- and human-related factors play into whether or not a flood occurs, but limited data on the floods of the past make it difficult to measure them against the climate-driven trends of floods today. However, as the IPCC (Intergovernmental Panel on Climate Change) noted in its special report on extremes, it is increasingly clear that climate change "has detectably influenced" several of the water-related variables that contribute to floods, such as rainfall, extreme weather events, etc. Floods are made more likely by the more extreme weather patterns caused by long-term global climate change. Change in land cover—such as removal of vegetation—and climate change increase flood risk.

Extreme floods can be triggered by intense precipitation, longer duration, close repetition of precipitations or a combination of these. "While it is difficult to make a direct link between an individual extreme event and climate change, it is clear that we need to be prepared to face more intense and more frequent extreme hydro-meteorological events due to climate change," says Pascal Peduzzi, Director of the United Nations Environment Programme's (UNEP) Global Resource Information Database in Geneva.

Climate change endangers the railways system when subjected to flooding events. Flood events have caused property damage along with service disruptions, by the inundation of underground infrastructures (e.g., tunnels and alignment). Therefore, it is important to evaluate flood risks in railways systems to plan for flood disasters and set mitigation strategies efficiently.

Flash Flood

Flash floods are floods that rise and fall rapidly with little or no advance warning. A flash flood occurs when water overflows on or inundates land that is normally dry. Rivers can overflow their banks to cause flooding, and sea waters can be pushed towards land by massive winds, which then cause flooding. Rainfalls over an extended period can cause major rivers to overflow their banks. Rivers can overflow their banks, causing flooding during heavy rains, severe storms and dam breaks. Huge amounts of water flowing in rivers are due to incessant heavy rains and melting of snow, resulting in severe flooding. Flash flood normally happens during the monsoon season. Around this time, potholes can overflow fast, breaking and damaging the river banks. Flash floods are common in mountainous regions. Lack of vegetation and denudation of the mountain areas are the major causes of flash floods.

Flash flood damages can be reduced by establishing a proper flood control management structure to manage floods and reduce their ill effects. Taking precautionary steps, measures, and actions with the help of the government will deliver communities, agricultural land, infrastructure, and livelihoods in flash flood-prone areas to safety.

River Flood

A river flood occurs when a river overspills its banks; that is, when its flow can no longer be contained within its channel. Flooding is a natural and regular reality for many rivers, helping sculpt soil and spread nutrients in alluvial valleys and supporting many ecosystems – such as swamps and bottomland forests – adapted to occasional inundation.

River floods have also been life-giving forces for human societies dependent on them for agriculture and soil fertility. Nonetheless, humans often perceive floods negatively because of the damage and loss of life they often wreak where natural floodways have become heavily developed and populated.

Mandalay Region

In Mandalay Region, both flash floods and river floods can occur because of its vicinity to Ayeyarwaddy River.

Calculation of Probability

Before Mitigation

Flash floods may occur at least once a year, so, the probability can be taken as “Likely”. For river floods, it is estimated that it might occur at some time, and so, the probability can be taken as “Possible”.

Calculation of Consequences

Before Mitigation

Flash floods can be low environmental damage, and so, the consequences can be taken as "Minor". River floods can be medium damage to environment, so, it can be classified as "Moderate".

After Mitigation

After proper mitigation measures and flood control measures, consequences of flash floods can be reduced to "Insignificant" and river floods "Minor".

Shan State

In Shan State, only flash floods mostly occur.

Calculation of Probability

Before Mitigation

Flash floods may occur at least once a year, so, the probability can be taken as "Likely".

Calculation of Consequences

Before Mitigation

Flash floods can be low environmental damage, and so, the consequences can be taken as "Minor".

After Mitigation

After proper mitigation measures and flood control measures, consequences of flash floods can be reduced to "Insignificant".

Flood Risk Assessment Table

Region & Flood Type	Consequences	Probability	Initial Risk	Mitigation Measures	Consequences after mitigation	Probability after mitigation	Reduced Risk
Mandalay (Flash Flood)	2	4	8 (Moderate Risk)	• Proper design of structures • Design foundations to be able to withstand erosion which can be caused by floods	1	4	4 (Moderate Risk)
Mandalay (River Flood)	3	3	9 (High Risk)		2	3	6 (Moderate Risk)
Shan State (Flash Flood)	2	4	8 (Moderate Risk)		1	4	4 (Moderate Risk)

Control Measure for Flood Risk

Preparedness Scale for Flood Risk Climate Change

Example preparedness scale for flooding and climate change;

We should prepare for unforeseen events and then identified the hazards with reactive action plans and set short-term forecast and plan. To implement long-term sustainable planning, a specific risk due to flooding and climate change, could impact on these parts on proposed project.

Risk Control

Professional meteorologists should monitor the weather around the clock using all available weather models. If the predictive models show that something may occur on a section of the line that could adversely affect traffic, a storm warning will be generated. Then this warning will be received by the head of the Central Directorate of the Railways. When it is confirmed, the storm warning will become an order not only notifying about the danger, but also ordering the necessary security measures, for example, the preparation of equipment and deploying personnel to a certain part of the rail.

Every year, just before the rain fall, specialists should inspect dams, bridges and tracks; measure river beds near construction of bridges; and clean debris from channels, and drainage ditches, and the openings of small bridges and pipes. The main canals and other objects of the irrigation system should also be inspected, because if they are breached or destroyed, the safety and normal functioning of the railway infrastructure facilities could be compromised. Control measurements should be taken before and during the flood period.

Prior to the floods, engineering structures and infrastructure are provided with anti-washout materials, tools, fuel and work clothes. If there are not enough workforces, additional workers should be hired for this period.

If there are any sudden deformations of the roadbed that could lead to its full or partial failure and cause interruptions in the movement of trains, emergency and recovery operations involving material, technical and human resources should be carried out.

It takes thousands of workers to ensure the safe passage of flood and storm water, and railway safety of trains depends on the cohesiveness of response.

Impacts of flooding on the railway system are,

Bridges

Extreme weather events (Hurricanes, Heavy Rain) would damage by floods from record-breaking storms. We have to consider what can be done to protect bridges (from our proposed project) from flood-related damage and destruction. In these facts, bridges can be damaged by floods;
(i) Large items, log jam, such trees, other appliances, or even whole structures, get picked up by flash flood water and slammed into a support pier, road bed, or other part of a bridge, causing structural damage.
(ii) Smaller pieces of debris accumulate upstream from a bridge, forming a large mass. The bundle moves downstream, lodges on the side of the bridge, and applies pressure to it, compromising its structural integrity.
(iii) An accumulation of debris limits the flow of water around a bridge. Concentrating water flow raises its height and increases the pressure it applies to the structure.
(iv) Water rises above the roadbed, tearing out the asphalt or other vulnerable parts of the structure.

Picture Source: BMI, 2017

- ❖ By eliminates the possibility that large objects or masses from bridge foundation it also eliminates the risk associated with scour (by flood risk).
- ❖ By building metal deck can be lifted by powerful aquatic forces.
- ❖ By consider use of matting, artificial grass/planting. Nowadays, taking steps to prevent flood damage may cost more money but it could save in repair and replacement in log terms.

6.3.7. Fire Risk

In Muse-Mandalay railway system, it will be constructed as Rapid transit, or mass transit, used to quickly transport passengers by railway. Rapid transit systems travel underground (subway), through tunnels, over bridges, along elevated platforms and in open electrified territory. High-speed rail is popular mode of passenger travel in major cities and metropolitan areas, moving thousands of passengers every hour.

Fire risk in a **bridge construction site** can be caused by:

- Fire incidents from temporary facilities
- Flammable materials used on site

Fire hazards on a **bridge** can be caused by:

- Vehicle collision due to derailment
- Overheating due to high speed
- Electrocution
- Overheating of roof-mounted compressor heating and air conditioner units
- Burning locomotives
- Flammable materials carried on the train

Fire Risk Assessment Table

<table>
<tr><th>Region & Flood Type</th><th>Property Loss</th><th>Probability</th><th>Initial Risk</th><th>Mitigation Measures</th><th>Property loss after mitigation</th><th>Probability after mitigation</th><th>Reduced Risk</th></tr>
<tr><td>Mandalay</td><td>Medium</td><td>High</td><td>Medium risk</td><td rowspan="2">• Control fire properties of combustible items
• Provide for suppression of the fire
• A key strategy to prevent fire is to remove one or more of heat, oxygen, or fuel</td><td>Medium</td><td>Medium</td><td>Medium Risk</td></tr>
<tr><td>Shan State</td><td>Medium</td><td>Medium</td><td>Medium Risk</td><td>Medium</td><td>Low</td><td>Low Risk</td></tr>
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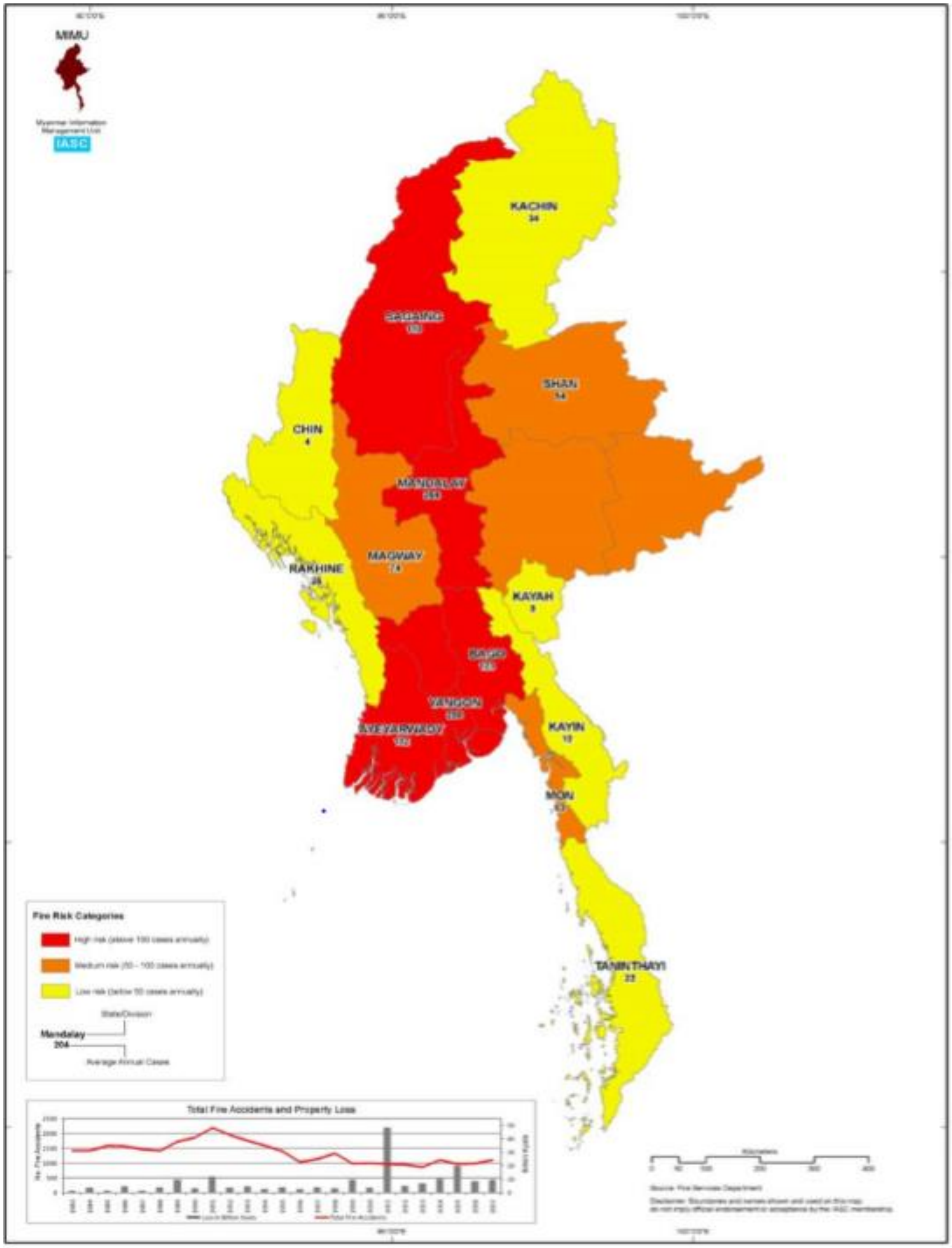


Figure: Fire Risk Map (Based on fire cases from 1983-2007)

The fire case of last 25 years (1983-2007) reflect decreasing trend at figure.

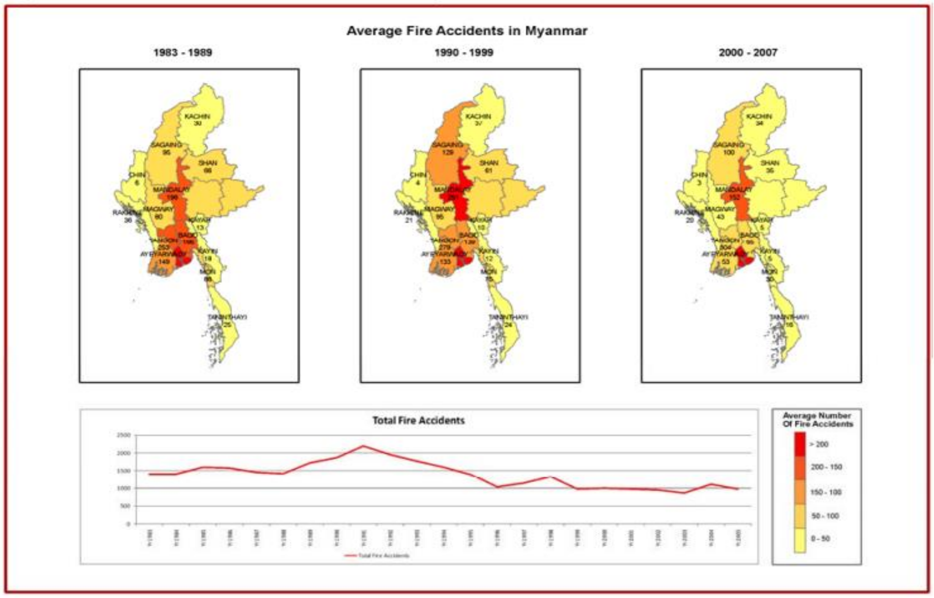


Figure: Annual Average Fire Cases

The average annual financial loss reflects increasing trend at figure.

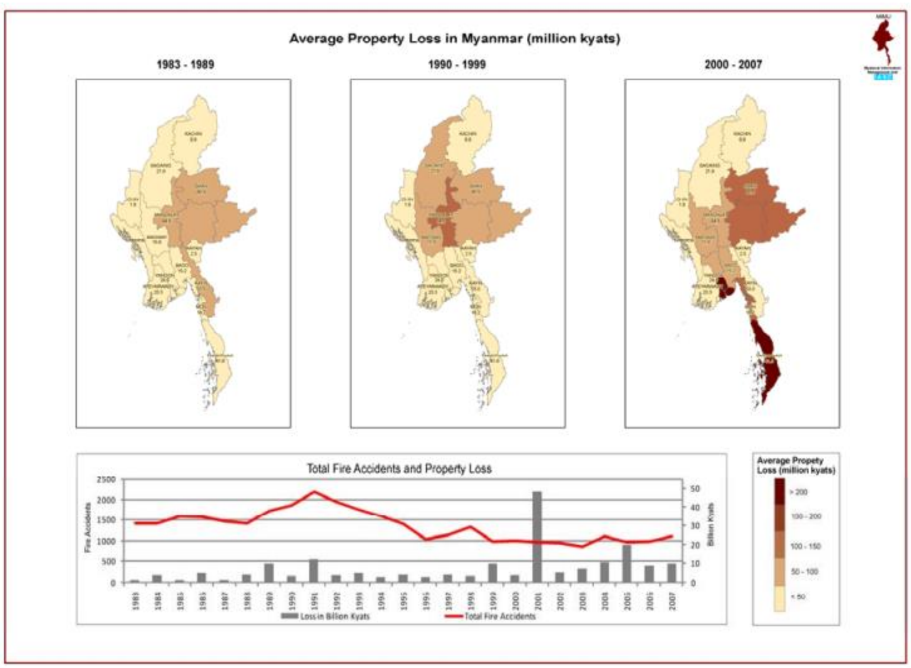


Figure: Average Annual Financial Losses due to Fire

Prevention Measure for Fire Hazard

The safest way to deal with fire is to prevent it. A fire needs three elements: heat, oxygen and fuel. Without heat, oxygen and fuel, a fire will not start or spread. A key strategy to prevent fire is to remove one or more of heat, oxygen or fuel.

The goals for fire protection are universal; only the means chosen to achieve them vary. These goals can be simply stated in the following list.

- Prevent the fire or retard its growth and spread.
  - Control fire properties of combustible items.
  - Provide adequate compartmentation.
  - Provide for suppression of the fire.
- Protect occupants from the fire effects.
  - Provide timely notification of the emergency.
  - Protect escape routes.
  - Provide areas of refuge where necessary and possible.
- Minimize the impact of fire.
  - Provide separation by tenant, occupancy, or maximum area.
  - Maintain the structural integrity of property.
  - Provide for continued operation of shared properties.
- Support fire service operations.
  - Provide for identification of fire location.
  - Provide reliable communication with areas of refuge.
  - Provide for fire department access, control, communication, and water supply.

For explosion caused by flammable materials carried on the train, it can be mitigated by safe handling measures according to MSDS of relative materials. It must be handled properly since explosion can lead to serious damage to bridge such as collapse of the bridge and fatality of passengers.

Due to explosion, there can be adverse effects such as the following:

- Collapse of train
- Effect on life of humans, fatalities and injuries

- Structural collapse of bridge
- Effect to economy such as cost to rebuild asset, cost resulting from disruption of product or service, long term costs due to environmental damage

To prevent electrocution, regular maintenance of overhead lines and other electrical equipment should be done. All electrical equipment and installations designed, constructed, installed, maintained, protected, and used to prevent danger. Proper pest control should be maintained to avoid rodent damage to electric wiring and equipment.

Firefighters should familiarize themselves with the electrocution hazards of high-voltage overhead catenary lines, electrified third rails, diesel-electric locomotives, diesel-multiple units and transformers on railway property in electrified territory.

If a passenger train catches fire when the train is disabled or stranded on a bridge, a rescue train should be summoned to transfer and transport passengers. If there is not enough time to wait for the rescue train, additional resources from the fire department will be required.

After determining what is burning, ensure that the train is de-energized and movement stopped with the operator. Fire extinguishers should be located in each coach and should be able to be used for small fires in the control car or heating/ air conditioning units. When passenger trains are caught in fire, water can be used to extinguish fire as long as the rail, trolley line or power is shutoff.

For burning locomotives, an electrical or diesel fire is expected. Most rapid transit locomotives are powered by electric or diesel-electric locomotives that carry up to 5,000 gallons of diesel fuel. An on-board automatic fire suppression system, which will activate 2 minutes after the initial fire alarm is received, can be installed.

The engineer can also manually activate the system right away or acknowledge there is no fire present and deactivate the system from the control car before suppression agents discharge. These dry chemical agents will discharge in the electrical compartments and equipment rooms.

If the locomotive is burning and disabled, the train will not be able to continue to a safe area to evacuate passengers. It is ideal for the passenger cars to be separated from the locomotive, so the passengers can be safely moved to the rear of the train away from the isolated burning locomotive. A rescue train will likely be requested.

Additional alarms to assist with evacuation will be required. Any time a train is burning over water; marine units should be requested for the potential of panicking jumpers. Depending on location and terrain, lines may have to be stretched down the tracks. Firefighters must not be committed on a bridge until all train movement in both directions is stopped and rail de-energized.

For extreme emergencies, such as derailments or collisions resulting in fire and entrapment, firefighters may have to perform rapid passenger rescues and evacuation from a commuter train. Whether dealing with unbreakable polycarbonate windows, emergency release handle locations, force entry techniques for bi-parting doors, or activating cantilevered top escape hatches, training with local transit emergency management should help prepare first responders locate and operate these access/egress points.

Mitigation Measures for Fire Risk

- Controlling the type of combustible materials used during the bridge construction
- Installing fire-resistance reinforced concrete structure inside the bridge
- Control the speed when passing through the bridge
- Electrical systems should support life safety operations, fire emergency operations and normal operations.
- Do not overload outlets
- Provide adequate space for electronic and other equipment that produces heat
- Quickly and appropriate dispose of spills and garbage
- Ensure employees smoke in designated areas and have an appropriate place to dispose of cigarette butts

7.0. CUMULATIVE IMPACT ASSESSMENT

Cumulative Impact Assessment is the process of assessing potential effects on receptors from environmental and social impacts caused by the combined influence of more than one project. Evaluation of potential cumulative impacts is an integral element of an impact assessment.

7.1. Methodology and Approach

The analysis of cumulative impacts in this section follows the processes recommended by EIA procedure (2015) and the regulations at Section 42 of the Environmental Conservation Law. Cumulative impacts in relation to an activity are defined in the EIA Regulations (Government Notice R543) as meaning “the impact of an activity that in itself may not be significant, but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area”. Cumulative impacts were assessed by taking into consideration of potential environmental impacts of the proposed project and other related activities that had happened in the past, currently is happening at present and likely to happen in the future. In general, the proposed project cumulative impact railway facilities depending on the resource considered. The potential cumulative impact for the proposed project encompasses the area of physical disturbance along the proposed project construction ROW and adjacent areas that could have localized impacts associated with temporary access roads and aboveground facilities. The actions considered in the cumulative impact analysis may vary from the proposed project in nature, magnitude, and duration. These actions are included based on their likelihood of occurrence, and only projects with either ongoing or reasonably foreseeable impacts are identified.

7.2. Existing and Future Private and Public Projects and Developments

The followings are the existing private and public infrastructure, factory and industrial sector related to the proposed project.

7.2.1. Existing Private and Public Project and Developments

Being a mountainous region, northern Shan State have a lot of small to medium bridges and culverts. Among them, Gohteik Viaduct is the most longest and famous railway bridge in northern Shan State.

(a) Gohteik Viaduct

The largest railway trestle in the world upon its completion in 1901, the Gohteik Viaduct is the highest bridge in Myanmar. It is located in Nawnghkio, western Shan State, Myanmar. The bridge is between the two towns of Pyin Oo Lwin, the summer capital of the former British colonial administrators of Burma, and Lashio, the principal town of northern Shan State. It is the trestle in the world. It is located approximately 100 km northeast of Mandalay.

Figure 7.1- Gohteik Viaduct

7.2.2. Future Private and Public Projects and Developments

The future project will be railway power supply system (traction substations and transmission line along the railway) and other infrastructure and developments related to the proposed project such as quarry mine sites, concrete blending plants and illegal villages after the construction of large bridges.

Figure 7.2- Some Quarry Mine Site in Shan Region

Source: Frontier Myanmar

Figure 7.3 - Illegal Villages

7.3. Assessment and Mitigation Measures of Potential Cumulative Impacts

Cumulative impacts for the proposed railway bridges and culverts will be as follow:

7.3.1. Cumulative Impacts during Pre-Construction Phase

The pre-construction activities will have clearing away of trees along bridge and culvert construction activities. Greenhouse gases emission in this phase will mainly be produced from vehicle movement and deforestation as cumulative impacts combination of current and future private and public developments. Moreover, it is observed that the consequences of the deforestation effect include as follows:

7.3.1.1. GHGs Emission and Deforestation as Cumulative Impacts

Forests preserve soil, preventing floods and landslides, especially in mountainous areas and on slopes. Tree roots and vegetation, infact, hold and anchor the soil and humidity keeps humus compact. At the time when trees are cut down, the soil is washed by rainfalls and humus is dispersed by wind. . While the structure of roots keeps the soil compact, vegetal organic material in decomposition combines with minerals forming a sort of giant sponge which, following a slow, regular rhythm releases water in surrounding areas. Humidity coming from forests, especially tropical forests, creates clouds and governs microclimates, which also play a role holding moisture. For this reason forests prevent desertification, produce rainfalls and provide freshwater. In deforested areas, there is less water in the air to be returned to the soil. This then causes dryer soil and the inability to grow crops. In the other hand, the principal emissions from vehicles (by volume) are greenhouse gases, which contribute to climate change by trapping heat like extreme weather, and they also contribute to respiratory disease from smog and air pollution. In vehicles, the principal greenhouse gas is carbon dioxide (CO_2), but vehicles also produce the greenhouse gases nitrous oxide and methane. Not all vehicles have the same impact though. The vehicle's level of CO_2 emissions is linked to the amount of fuel consumed and the type of fuel used. It can increase the cause of global warming because of the vehicles used in site clearing activities.

Figure 7.4. Terrace Farming in Northern Shan State

Mitigation Measure for Deforestation

- Pre-construction activities should not exceed the proposed construction boundaries by more than 15 m to avoid the secondary impact of construction and increasing the areas that would require clearing and rehabilitation
- Construction yards shall be located as far as possible from reserved forest and protected area and planned to keep damages to trees and plants to a minimum.
- Replenish vegetation of multipurpose trees and other vegetation on routine along the railway line
- Plan possible carbon off-set measures, available through existing off-set schemes or incorporated into the project (e.g. planting more trees at proper locations that is valuable method for sequestering carbon and for increasing oxygen production and Use of fast growing species)
- reduced density of stand stocking;
- shorter length of the cutting cycles;
- planting hardwood species;
- regeneration from seedlings rather than sprouts;

- Afforestation.
- Traffic management and speed optimization can cut CO2 emissions. Reductions in CO2 of about 20% can be obtained by techniques to mitigate periods of peak flow where congested conditions are more likely, manage excess speeds, and smooth traffic flow for both on-site and off-site vehicles .
- Vehicles for projects should be used energy-efficient machinery and the providers apply proper fuel oil and its suitable fuel management system.
- Training drivers on safe and fuel efficient driving techniques can save a substantial amount of fuel to be burnt. By implementing driver training as part of a fuel management programme, a fleet's fuel consumption can typically be reduced by at least 5%.
- Preventative vehicle maintenance is one of proactive management strategies for significant emission reduction.
- Ensuring vehicles are closely matched to the tasks they are expected to perform will improve both fuel and overall operational efficiency to reduce greenhouse effects. (e.g. Engine and transmission characteristics, i.e., making sure the engine power is appropriately matched to the loads that will most typically be moved and Body size and type and etc.)
- Avoiding carrying heavier loads because of releasing of more emissions.
- It is required to predict real time carbon emissions, and to assess the variability of emission factors with the equipment's action (e.g., digging, dumping, hauling, idling) in order to improve environmental assessment models.

7.3.1.2. Loss of Habitat as Cumulative Impacts

Clearing habitats for project plant is the primary cause of habitat destruction. Removing trees thins the forest canopy which is meant to block sun rays as good shelter during the day and holds in the heat at night. This damaging disruption leads to extreme temperature swings that are harmful to plants and animals. Many animals, insects, and plants lose their habitats. The loss of the habitats is expected to have indirect impacts on surrounding habitat areas and associated biota. Habitat destruction is currently ranked as the primary cause of species extinction worldwide. Clearing of existing vegetation which may leads to loss of habitat. Some places in the construction area are likely to be lost due to direct and indirect construction activities for resident animals.

Figure 7.5. Loss of Habitat due to Deforestation and Population Increased

Mitigation Measure for Loss of Habitat

A large range of measures may contribute to a reduction of the fragmenting effect of bridge and culvert infrastructure. These measures, as this article shows through practical examples, include: a restoration or development of a (substitute) habitat, placing wildlife fences as protection against railway lines, constructing fauna passageways and sound-reducing provisions. Clearing of vegetation should be kept to a minimum, keeping the width and length of the earth works to a minimum and the floodplain. Wetland habitats identified should be retained within the development footprint in its current state.

7.3.2. Cumulative Impacts during Construction Phase

Cumulative impacts during construction phase will be as follow:

7.3.2.1. Water Scarcity

Most of the villages in Northern Shan Region are currently facing with water scarcity problems.

The proposed project will use a large amount of water since it is involving construction processes which need to use water and a large group of workers will also use water which can lead to more problems of water scarcity.

Mitigation Measure for Water Scarcity

1.Sustainable water management: Improving water infrastructure must be a priority, as water conservation and efficiency are key components of sustainable water management.

2.Reclaimed water: Rainwater harvesting and recycled wastewater also allow to reduce scarcity and ease pressures on groundwater and other natural water bodies. Groundwater recharge, that allows water moving from surface water to groundwater, is a well-known process to prevent water scarcity.

3.Awareness & Education: Education is critical to solve the water crisis. Employees must be educated about water scarcity and must be trained to get knowledge on how to save water as much as possible.

Moreover, construction period should be started in the late rainy season in order to be able to store rainwater in storage tanks throughout the whole rainy season. Water usage of local people must not be disturbed. Besides, water from construction activities should be recycled by use of sedimentation ponds.

7.3.2.2. Water Pollution

In the construction area, the soil erosion percent will increase because of the deforestation. The water pollution will increase due to the construction of the bridge and in accidental spillage of the fuel and oil. The proposed project will use a large amount of water since it is involving construction processes which need to use water and the paint. Due to the construction activities, this can lead to water pollution problems currently faced by the local people.

Mitigation Measure for Water Pollution

- Prevent water pollution of nearby rivers and lakes as well as groundwater and drinking water by following some simple guidelines
- Use environmentally household products, such as washing powder, household clearing agents and toiletries

- Avoid the discharge of residue from construction activities into rivers and streams
- Prevent water shortages and reduces the amount of contaminated water that needs treatment

7.3.2.3. Illegal Trading as Cumulative Impact

During the transportation of construction materials and for maintenance of construction machineries, jade, endangered species, wood, orchid, and other natural resources can be the main objects in illegal trading.

Mitigation Measures for Illegal Trading

- Proper inspection at every gate before going out of the country
- Stop enough time for inspection
- Cooperate with respective organizations

7.3.3. Cumulative Impacts during Operation Phase

Cumulative impacts during construction phase will be as follow:

7.3.3.1. Land Use

There will have alternation of land use as cumulative impact.The proposed bypass will have a cumulative impact on the agriculture in the area. The route and the economic growth are planned to stimulate ultimately affect the way land and it can also increase the overall impact. As the development takes place, the land take area will be increased. Most versatile land will be lost and therefore there is not significant on the National or local level. In terms of the cumulative impact on agricultural practice, the impact of the proposed route on husbandry is much harder to assess.

Mitigation Measures for Land Used

According to the primary data collection by household survey, most of the farmers want to ll their farm lands are willing to handover their lands with reasonable price and want to employ with the higher salary in the proposed project. So, to reduce alternation in land use pattern and reduce income for local economy, MR will appoint local people especially people who sold their farm lands to MR. It is also need to avoid for agricultural land, histological areas, archeological areas, forest area and ecologically sensitive areas as much as possible.

7.3.3.2. Visual Impact

There will have potential to visual impact as cumulative impact due to the potential to increase of bridge and culvert near the river area and valley areas. The cumulative impact of the proposed round-boat, structures and other infrastructure and link roads will be particularly significant with the farmland and the urban edge along the road will contribute to the increasing urbanisation of that area, resulting in a gradual change of character. In spite of the careful route planning, there will be a need for it to be cleared from vegetation, trees and the like, however due to its small width the extent of the work and consequently the visual changes will be negligible.

After the project, bridges and culverts along the alignment can be displeasing scenery for local people and tourists.


Before Project (Shwe Li River) After Project (Bridge)

After Project (Culvert)

Mitigation Measure for Visual Impact

Visual impacts will be prevented through the installation of natural visual barriers such as vegetation. Landscape management and site restoration plans will be in place with recommended mitigation measures such as replacement planting, and vegetation barriers. The design and color of the bridges and culverts will be selected with consideration of architecture view.

7.3.3.3. Increase in Water Scarcity as Cumulative Impact

The areas in the vicinity of the project may be developed after the construction project. Due to the development of the area, population can also increase and this can lead to water scarcity problems currently faced by the local people especially in Shan Region.

Mitigation Measure for Water Scarcity

1.Sustainable water management: Improving water infrastructure must be a priority, as water conservation and efficiency are key components of sustainable water management.

2.Reclaimed water: Rainwater harvesting and recycled wastewater also allow to reduce scarcity and ease pressures on groundwater and other natural water bodies. Groundwater recharge, that allows water moving from surface water to groundwater, is a well-known process to prevent water scarcity.

3.Awareness & Education: Education is critical to solve the water crisis. Employees must be educated about water scarcity and must be trained to get knowledge on how to save water as much as possible.

Moreover, construction period should be started in the late rainy season in order to be able to store rainwater in storage tanks throughout the whole rainy season. Water usage of local people must not be disturbed. Besides, water from construction activities should be recycled by use of sedimentation ponds.

7.3.3.4. Increase in Human Trafficking as Cumulative Impact

Since the transportation becomes easy, the increase in human trafficking rate could also occur. Regionally, Shan state registered with 37 cases, followed by Mandalay region and with 10 cases.

There were 22 domestic trafficking in persons in terms of forced labor, prostitution and forced marriage during the period. In 2019, 358 people including 297 females were victimized in connection with 239 human trafficking cases across the country. During the whole 2020, 167 people including 39 young girls were victimized while 339 traffickers were charged in connection with the cases.

Mitigation Measures for Impacts of Increase in Human Trafficking

The corporation with human trafficking team in every trip to Mandalay to Muse Permanent Immigration Inspection Team should be made. The people who smuggle women and children are sentenced to at least 10 years or up to lifetime sentence or fine while money or property received through trafficking will be confiscated by the government under the Anti-Trafficking in Persons Law.

7.3.3.5. Increase in Trade Off Drugs as Cumulative Impact

Since the transportation becomes easy and the profits of trade off drugs are high, the rate of trading off drugs would increase especially in Shan State.

Mitigation Measures for Trade off Drugs

Trading off the chemicals and drugs used to manufacture drugs into Shan State should be restricted. The government should redouble its drug control and anti-corruption efforts, focusing on major players in the drug trade. Education and harm reduction should replace. At the community level, the government should focus more on education and harm reduction.

8.0. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

In order to manage the physical, biological and sociological impacts identified in the impact assessment, MR has committed to implement an environmental management plan of the project (EMP). This management plan will form the basis for the development of an integrated management system for environmental and community issues. EMP is a site specific plan developed to ensure that the project is implemented in an environmental sustainable manner where all contractors and subcontractors, including consultants, understand the potential environmental impacts arising from the proposed project and take appropriate actions to properly manage that risk. EMP also ensures the project implementation is carried out in accordance with the design by taking appropriate mitigation actions to reduce adverse environmental impacts during its life cycle.

In construction & operation environmental management plan for proposed project , the following plans should be considered:

- Environmental Management and Monitoring Plan
- Traffic Management Plan
- Occupational and Community Health & Safety Risk and Management Plan
- Disaster Management Plan
- Waste Management Plan
- Community Development and Rehabilitation Plan
- Cultural Heritage Management Plan

8.1. Project Description by Project Phase

The following phases will be covered in conducting of EIA for the proposed project.

(i) Pre-construction phase

Pre-construction activities will involve removal of select vegetation, tree cutting for the access road and temporary camp for the workers and other facilities and the ground leveling (earth moving activities). The ground leveling for the bridge and river is leveled the ground to get the access road and align the ground with the bridge.

(ii) Construction Phase

Construction activities will involve the grading and excavation of soils for the installation of pier and beam and fueling facilities. Project development and construction activities also include temporary camp for construction workers, access road construction, site preparation and development (e.g. construction of bridges and site utilities).

(iii) Operation Phase/ongoing site maintenance

The operational activities of railway bridge include the maintenance of bridge and culverts along the railway road.

(iv) Decommissioning Phase

Although the proposed project is long-term project, decommissioning of the project would occur at the end of its lifespan. The goal of project decommissioning will be to remove the steel structure as a whole and return the site to a condition as close to a pre-construction state as feasible. The physical removal of the structures and equipments will be the reversal of the construction process. All areas disturbed by the proposed project would be restored to pre-project conditions and/or to conditions acceptable to the CDC rule and regulations. During decommissioning phase, all concrete and steel structures and equipments would be dismantled and removed. The major activities that will be required for the decommissioning of the proposed project are:

(a) Concrete pile foundation removal;
(b) Concrete pier removal;
(c) Concrete structures (beam and bridge frame) removal,
(d) Steel beams and steel ropes removal,
(e) Electrical supply system removal

8.2. Project's Environmental and Socio-economic Legal Requirements and Guidelines Related to Impacts

Laws and Regulations	Year	Purposes
National Environmental Quality (Emission) Guidelines (Section 2.1.9)	2015	These national Environmental Quality (Emission) Guidelines (hereafter referred to as Guidelines) provide the basis for regulation and control of noise and vibration, air emissions, and liquid discharges from various sources in order to prevent pollution for purposes of protection of human and ecosystem health.
Conservation of Water Resources and Rivers Law (Law No. 8, 11(a), 13, 19, 24(b), 30)	2006	To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.
Conservation of Water Resources and Rivers Rules	2013	To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.
Forest Law	1992	To implement forest policy and environmental conservation policy, to promote public cooperation in implementing these policies, to develop the economy of the State, to prevent destruction of forest and biodiversity, to carry out conservation of natural forests and establishment of forest plantations and to contribute towards the fuel requirement of the country.
The Bridges Law (Law No 16)	2019	• To systematically supervise, supervise and charge bridges on the construction of new bridges, construction of new bridges, upgrades, extensions, inspections of bridges • To ensure the safety and security of the users of the bridge and to be able to continuously carry out matters related to the maintenance and strength of the bridge • Safe and secure use of the bridge will speed up the flow of passengers and goods, improve transportation costs, improve the socio-economic life of citizens and raise living standards • To accelerate the development of the country by constructing, upgrading, expanding, inspecting, repairing and maintaining the bridge for its longevity to prevent potential impacts on environmental and social sectors due to land use for projects
Land Acquisition, Resettlement and Rehabilitation Law (Section 39, 41, 42, 46, 54(b and c), 58)	2019	• In this law, it is stipulated that the government holds rights to take over land provided that compensation is made to the original land owner. No private ownership of land is permitted

		• To prevent potential impacts on environmental and social sectors due to land use for projects
The Freshwater Fisheries Law (Law No. 36, 40, 41)	1991	• To further develop the fisheries; • To prevent the extinction of fish; • To safeguard and prevent the destruction of freshwater fisheries waters; • To obtain duties and fees payable to the State; • To manage the fisheries and to take action in accordance with the Law.
Prevention and Control of Communicable Diseases Law (Law No. 3, 4, 9, 11)	1995	To prevent the outbreak of Communicable Diseases, by implementing following project activities; (a) immunization of children by injection or orally; (b) immunization of those who have attained majority, by injection or orally, when necessary; (c) carrying out health educative activities relating to Communicable Disease.
Myanmar Fire Force Law, (Law No. 25)	2015	• 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 • To organize fire brigade systemically and to train the fire brigade • To prevent from fire and to conduct release work when fire disaster, natural disaster, epidemic disease or any kind of certain danger occurs • To educate, organize an inside extensively so as to achieve public corporation • To participate if in need for national security, peace for the citizens and law and order
Minimum Wages Law (Law No. 12, 13 (a to g)	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.
Law Amending the Law on the Utilization of Roads and Bridges (Law No.25)	2014	to promote traffic convenience and contribute to the development of the national economy by prescribing matters concerning the construction, upgrading, maintenance, management, etc. of roads and bridges.

8.3. Summary of Impacts and Mitigation Measures

The summary of potential environmental impacts and mitigation measures on the project during pre-construction, construction phase, operation phase and decommissioning phase are shown in table below.

Table - Summary of Potential Environmental Impacts and Mitigation Measures

Category	Item	Expected Environmental and Social Impacts	Mitigation Measures
PRE-CONSTRUCTION PHASE			
Air environment	Fugitive Dust Generation	Air pollution due to the movement of dozer and trucks for site clearing and ground levelling activities. .	sprinkling of water during pre-construction -Water will be sprayed by using handheld spray -before leaving the construction site, wheels will be cleaned and goods carried should be covered
	Vehicular Emission	- gaseous emissions such as CO_2, CO, NO_x and SO_2 during the operation of vehicles and machineries (3 dozers and 5 trucks)	- require plan to reduce in loading and unloading time and plan to reduce in idle time during working hours - use good engines conditions for every machinery used -generator with good engine conditions should be used
	Noise	Impacts of noise by site clearing and earth working vehicle (3 dozer) and delivery vehicles (5 trucks) traveling to and from the site	-Limit working at night and avoid the operation of noisy equipment and machineries at night if it is necessary to make operation at night; - Use phase wise construction (not to running noisy equipment at the same time) - regular maintenance of machineries
Surface Water Environment	Liquid Waste	-The temporary water pollution in nearest water sources due to earth working activities (soil erosion and sedimentation) - improper handling of fuel oil and lubricants -Preparation of construction camps can also can have negative impacts on the surface water environment because of the disposal of liquid waste and spills of hazardous liquids.	-The temporary septic tanks and other waste water facilities sedimentation pond with suitable drainage system around the dumping sites should be used during the rainy season - liquid material storage containment areas should not drain directly to the surface water - oil, grease and other chemicals should be handled as per MSDS.

	Solid Waste	- solid wastes of unsuitable soil materials from site clearing activities and domestic solid waste from pre-construction workers	- limit unnecessary earthworks - prevent over-excavation - reduce, reuse and recycle of domestic wastes - vegetation of bare area after the pre-construction state
	Drainage and flooding	- inadequate assessment of hydrological conditions - cost to rebuild the structures, potential flooding of agricultural land and property -impact to surface water quality	- ensure that drainage patterns are improved from the existing conditions - design drainage works based on the historical flood data and flood forecasting
Soil and Ground water Environment	Soil Quality	unsuitable soil materials-were generated from site clearing and tree cutting (bushes and small trees) activities	-systematic disposal according to the rules and regulations of CDC - follow CDC rules and regulations for solid waste management - take special care on handling of diesel and lubricants to avoid leakage
Biodiversity	flora diversity (high)	too much tree cutting along the railway project	avoid tree cutting of road side plants and fence plants and re-planting the trees at twice of cutting and re-planting at other place for IUCN red list trees
	Fauna Diversity	Impact on mammals and aquatic species	-avoid working at night for fauna species and cutting the fence plants -Sound proof measurement shall be constructed surrounding the construction site as needed -Borrow pit will be away from fauna diversity abundance area
Human Environment	Positive socio-economic	- job creation	- use local people as much as possible
	Negative Socio-economic Visual Impacts	- too much tree cutting for the site clearance	- efficient and timely removal of all demolition and construction wasters as per requirements
	Land Acquisition	- relocation of a large number of residences cannot be avoided - influx may cause rise in the consumption of consumer goods in the local area, which will tend to boost up the local economy	- proposed project has provided compensation to the affected persons irrespective of their legally tenable ownership rights for the affected land - local labors shall be utilized for the construction purpose and all the activities related to construction worker shall be confined to the project site only to minimize conflict
	Land Use and Involuntary resettlement	Resettlement or/and relocation of buildings and other assets, involving some changes in livelihood of PAPs along the river bank and along the culverts	Compensation for affected structures and standing crops and assistance of livelihood restoration as per RAP

CONSTRUCTION PHASE			
Local air environment	Fugitive Dust Generation	- construction phase will mainly result in nuisance impacts in the form of dust - emission from on-site heavy-duty off-road vehicles, other light-duty vehicles - dust emission from the construction equipment	minimizing dust from material handling sources by using covers or control equipment proper handling of cement material requiring and monitoring for minimal traffic speed on-site covering the loads of all vehicles hauling materials likely to give off dust emissions applying water as a dust suppressant as needed
	Vehicular Emissions	- emission of CO, CO_2, NOx and Sox from the operation of generator, concrete mixer, vehicles and construction machineries	transportation of personnel and materials will be scheduled such as to avoid period of peak flow reduce the overall number of vehicular movements reduction of on-site construction time
	Noise	- Impacts of noise by construction machineries especially by piling machine for foundation	Workers in vicinity of strong noise will wear earplugs and their working time will be limited as a safety measure. Selecting low-noise equipment as needed, especially near the residential area and/or sensitive receptor. No construction activities with heavy equipment during night time if there are any sensitive receptors. Piling by press piling machine in environmental sensitive area.
	Vibration	- Impacts of vibration by pilling machine for foundation	Piling will be done by press pilling machine near environmentally sensitive areas Avoid night time activities. People are more aware of vibration in their homes during the night time hours
Surface water environment	Surface water hydrology and channel morphology	- Increase in surface runoff from soil compaction due to the use of vehicles and machinery - Change in flow velocities - Increase erosion and subsequent changes in bed and bank stability - Increase flood risk - Increase sedimentation of watercourses - Pollution from suspended material	Access roads will avoid riparian zones and should be built using appropriate construction materials. Bridges and culverts will incorporate a low flow channel to retain sufficient water depth for aquatic life at such times; An appropriate water management system is used during the construction period, including, for example, efficient land drainage and the use of constructed ponds for receiving site runoff to reduce the impact of runoff on nearby watercourses;
	Wastes	- increase silt load in the river - accidental spillage of concrete and liquid waste into the river	- ensure no waste material are dumped in the river, including reinforced concrete debris - avoid any leakage of oil and lubricant from vehicles and machineries used in construction phase

		- spillage of lead-based paint used for bridge coating process	- use the zinc-based coating paint instead of lead-based coating - soil material removed from the construction process should be recycled - during piling works ensure that pumped water is filtered through a silt trap before being discharged to the river
Soil Environment	Soil contamination	- soil contamination from spillage of diesel oil during the pile driving activities especially in valley crossing bridges - discharge of concrete residue near farmland	- Soil will be carefully removed and stored for subsequent reinstatement; - Effective stabilization of altered landforms so as to minimize soil erosion and the potential for water pollution from suspended solids; - With regard to bridge construction, where the substratum of a watercourse is disturbed by construction, this will be replaced - Installing all erosion-control measures prior to starting ground-disturbing activities- Frequently maintaining erosion-control measures - Maintain the vehicles and machines regularly and store fuel and construction materials systematically to reduce soil contamination
	Waste	- Surplus soil waste and other waste from construction -Solid and liquid wastes discharged from temporary construction office and other facilities	- Reduce, reuse and recycle of construction and other type of waste - Installation of temporary sanitation facility such as septic tank at construction office and other facilities - Avoid waste dispose to the river directly
	Groundwater quantity and quality	- leakage of oil and fuel can permeate into the groundwater -causing pollutants such as heavy metals to enter groundwater - cause effect in water table for the valley crossing bridge at deep depth	- seepage waste from waste disposal site will be controlled systematically - control the leakage of fuel, oil and lubricants from bridge construction site
Natural Environment	Ecology	- in accidental leakage of oil and fuel can impact to the ecology - physical presence of both bridged and culvert may affect ecological populations in a number of ways	- existing habitat features should be incorporated into site design and protected from change - holes and ledges should be incorporated onto the design of culverts for use as nesting sites

			-baffles should be incorporated into the design of the culverts base to provide shelter for fish as they pass through the culvert
	Aquatic Ecology	- Negative impact on flora and fauna from increased sediment loading of streams - Harm to aquatic flora and fauna from oil, fuel, cement or other substances entering watercourses	- Phasing of construction work to minimize disturbance to wildlife at sensitive times of year, such as during the breeding season or when young are being raised; - Designing the culvert to allow for the passage of fish and other aquatic life, Avoid fish migration period - Baffles will be incorporated into the design of the culvert base to provide shelter for fish as they pass through the culvert;
	Terrestrial ecology	- Habitat loss, disturbance to, or loss of, species (including rare and sensitive species) due to construction work	- Where clear span bridges are not a feasible design then a ledge, either in the form of a concrete shelf or gravel side bar, or mammal tunnels will be provided; - Bird boxes will be provided within the riparian areas; - Consideration will be given to the provision of features within the bridge design to encourage nesting birds and bats.
Human Environment	Positive Socio-economic (Local employment and job opportunities)	- create permanent employment opportunities for the local affected communities	- training program for welding will be opened before the construction phase - unskilled and semi-skilled job opportunities will be offered to the local communities as much as possible - developer will encourage construction sub-contractor to use local labor force as part of tender requirement.
	Skill Development for Local People	- Local people hired by the proposed project would remain in communities with skills acquired during project construction including concrete work for offices and other facilities, steel work for oil tanks, stone work for retaining wall and the bridge construction technique (like pile driving activities, beam installation and pier construction)	- training programs (e.g. maintaining of vehicles, welding, wiring, masonry building etc.) will be implemented prior to and during the construction phase because majority of the local people may not be adequately skilled to qualify for positions requiring skilled labor, if required - local construction sub-contractors will be chosen as first priority during tender process
	Potential to Growth of Local Economy and Business	- local expenditure by employees will have multiplier effects in various sectors of the economy - Changes in the local economy structure such as opening of new markets for products and services	- Local business for food and consumer goods in nearest villages should boost by buying required things regularly - The project developer should establish a policy to encourage services and materials from local in relation to construction works
	Negative Socio-economic	- cause the damage to the agricultural land because the blockage of upstream near the river	- alternative water way will prepare to flow the water volume for the reduction of potential to flood

	Impacts Blockage of River and Stream	- cause the water shortage to the downstream river due to construction of coffer dam for the bridge foundation process - foundation of the bridge can block the mountain stream especially in valley crossing bridge	- Both river crossing bridge and valley crossing bridge will not construct during the rainy season - Use alternative water way for the upstream flood near the farm land and village.
	Impact due to population influx	- Increased number of work locations - Risk of social conflicts - influx of newcomers seeking opportunities associated with the project could also create various social problems	- raise awareness amongst construction workers about local traditions and practices - inform local businesses about the expected influx of construction workers - payment will comply with applicable Labour Law legislation in terms of minimum wages - raise awareness amongst construction workers about local traditions and practices
	Impacts on Social Services	- increase of population during construction phase will increase temporary pressure on existing infrastructure and services including health care, food, shelter, water, transport and recreational facilities	- by appointing local construction workers - Own health care facilities will be supported to workers during construction period.
	Community Health and Safety	- temporary health impacts such as increase of stress levels of commuters and residents living nearby construction sites - community health include noise, vibration, dust generation that may cause respiratory diseases and accidents.	-project site should be fully fenced and access points should not be available for the public - temporary sanity facilities should be provided at all construction sites - arrange construction activities and schedule to minimize the impact on surrounding communities
	Conflict between Communities	- type of violent and aggressive conflict between non-Shan communities and Shan Ethnic Minority -hostile attitudes of non-Shan migrants to local community such as sexual harassment of migrant workers to ethic local women	- use local people as much as possible - limit night out for foreign workers - limit the use of foreign workers
	Increased in Traffic	- cause public anxiety - temporary blockage of village roads - increase the risk to the employees and local community	- use traffic control plan - limit to off-peak hours - use alternative road that will not pressure on the public road
	Increase in Crime and Security	- inflow of skilled migrant construction workers and crime including drug and alcohol abuse, assault, theft and violence in nearest villages	- use local labor force as much as possible - management of construction camp should be adequately formalized - construction site should be fenced and all of the construction workers should not allow going out at night

	Public Road Damage	- cause the damage to the public road and village roads used of construction materials	- use bypass road instead of public roads - use public roads as per the resistance of roads and bridge if avoidable - repair the public roads if they are damaged by construction activities
	Controversy with EAOs	- controversy between EAOs and the parties taking part directly in the project	- have transparency in every development of the project - inform the EAOs before any development of the project - discuss and negotiate with EAOs if any conflicts occur
	Health and safety Increase Infection of Air-borne Diseases	- lead to overcrowded conditions where air-borne disease such as tuberculosis, influenza and meningitis can spread easily	- providing medical check for workers who are susceptible infection of air-borne diseases
	Fugitive Dust Emissions	-cause some local people in nearest villages to bronchial and other respiratory tract diseases	- wetting of roads by water spraying - seeding storage mound surfaces as soon as is practicable -watering roadways - wheel or body washing
	Increase infection of Water Borne Diseases	- loose soil from earthworks may be washed into river - irresponsible dumping of domestic solid waste can lead to underground water contamination	- avoid construction time during rainy seasons -construction activities will ensure that no loose soil is permitted into watercourses and stockpiles are located away from surface water
	Potential to increase Infections from Mosquito	- impact can be rated as medium because malaria is still a health problem in Upper Myanmar Region	- avoid construction time in rainy seasons as much as possible - no stagnant pools of water during the construction phase
	Increase Risk of Sexually Transmitted Infections	- lead to an increase risk of sexually transmitted infections such as HIV/AIDS, gonorrhea and chlamydia	- MR will provide information and education about safe sex and implement HIV control program for migrant construction workers
	Health impact related to Increase in Noise Level	- hearing loss and impairment are known to occur as a result of exposure to acute, high decibel noise - impacts on mood, performance, fatigue and cognition	- reduce speed limits for trucks in the project area to reduce noise level -avoid working at night
	Amenity and nuisance	- Temporary loss of amenity during construction phase Noise from construction traffic and operations - Mud on roads	-develop a Systematic construction management system to reduce public amenity and nuisance - Wash wheels before going to public road
	Archaeological heritage	- Damage to known or unknown features of archaeological or cultural importance	- Make the list of cultural and archeological importance and avoid the activities that will harmful to these features.

			- Archaeological investigations will be carried out where damage is unavoidable.
	Visual Impacts	- increase in people unease - blockage of the river views by constructing of the river crossing bridges - damage to the natural environment of rivers and streams	- avoid recreational area and/or side wall covers with green colour -site housekeeping to keep project area clean and limit visual intrusion - replantation after the construction activities
Utilities	Beam of truss bridge	Natural resources consumption	Use ready-made beam from China
Other	Management of hazardous materials and oil	Spoil of fuel or hazardous substance that is used for construction work	Measures for spill control and leakage control system Training workers on appropriate handling of chemicals and fuels
Impact on Utility Consumption	Water usage	Water usage can be reduced by preparation of construction materials beforehand on site	- reducing process water use -minimizing domestic water consumption
	Fuel Consumption	By using the diesel engine generator for the construction process, it can affect the air quality because of the emission of the dust and noise to the surrounding environment.	- need to control the usage of diesel engine generator and not operate if there are not in use - replacements as a part of general upgrades to the system - stimulate the production of domestic raw material for biofuels
OPERATION PHASE//ONGOING SITE MAINTENANCE			
Local air environment	Noise	-Travelling of high-speed rails on the bridge - traffic flows will increase on the approach roads causing increased sound emissions and additional noise in the neighborhood	- re-planting the trees especially native species in the places near residential area or biodiversity sensitive area - reduce the speed of the train when passing through the bridge
	Vibration	- Heavy freight train passing the bridges cause huge vibration due to the interaction with railing - Traveling of high-speed rails on the bridge can cause the vibration impacts near the residential areas.	- sound proof measurement will be taken near the public area - reduce the speed of train while passing through the bridge - reduce the noise level by increasing the effective mass of the bridge structure
Surface Water Environment	Surface water hydrology	• Upstream potential impediment to flow • Decrease water velocity and increased depth	• watercourses should not be deepened or widened up or downstream of culverts; • artificial bank reinforcement should be avoided if possible;

		• Increase flood risk • Loss of pools/riffles, alteration of natural bed slope, • decreased water turbulence and oxygenation, increased bank erosion downstream • damage to the stream or river near because of using the water from the stream for cleaning trash	• oil interceptors or drip trays are used in vehicle parking areas, and are inspected and cleaned regularly; • a risk assessment is carried out for each substance to be used or stored on site, and the appropriate containment measures installed. • Proper control and avoid leakage of oil and paint • Use the zinc-based paint instead of lead-based paint for bridge maintenance
Soil Environment	Soil contamination	• Soil contamination which is caused by leakage of oil and paint bridges and culverts maintenance	- Proper management and control of leakage of oil and paint during maintenance - dispose systemically the residue of paint after maintenance process
Biodiversity	Aquatic Ecology & Terrestrial Ecology	• Interruption of river corridor isolating habitats with potential decrease in species numbers and local biodiversity • Increased water velocities in culvert may impede fish migration and spawning upstream • Changes to deposition, depth and water velocities may result in the loss of sensitive plant, invertebrate and fish species • Turbidity may contribute to reduced ecological diversity • Potential downstream changes to the aquatic community • Shading of the watercourse may reduce aquatic flora in the vicinity of the bridge • Potential barrier to fish migration and the movement of aquatic mammals along the river corridor • Direct and indirect effects from oil, fuel or other substances entering the aquatic environment	- existing habitat features will be incorporated into site design and protected from change - further habitats will be created to compensate for habitat losses and to improve the landscape and ecological potential for the site; - Potential barrier created to the upstream migration of wildlife - Creation of barriers to mammals - Provide sign boards in places where there is a potential for wildlife crossing.

Human environment	Accidents	• Railway accidents of passengers and local people	Enlightening passengers and residents about traffic safety specific to railways
	Positive Socio-Economic (Employment Generation)	• - direct employment opportunities would be increased for the local people	Positive impact is expected since the proposed project would boost regional economic activities along the maintenance process of the bridge and culverts. For PAPs whose livelihood had been affected during construction stage, monitoring of the implementation of the RAP will be conducted.
	Local Community Development	- Many local and foreigners will travel during operation phase since the transportation becomes easy • - High capital investment in Shan Region and CSR activities will have potential to community development potential	- This positive impact of the project can be enhanced by creating jobs for providing necessary services (transportation, tour trips to religious places, local tourist guide) to foreigners by local people - According to the social survey, local people are the most of the public needs, and it will also support community development
	Visual Impact	- From constructing of the new bridge like “Gote Hteik” Viaduct, it can increase the rate of the visitors coming to the new bridge	- use the bridge construction design that are suited to the local community
	Negative Socio-economic (Illegal Resettlement of Migrate Workers)	- affect to the local people because some of the migrate workers remain as illegal citizens after the construction of each bridge site - increase the population of the local people and can have a conflict with local people	- make a contract with the sub-contractors to remove workers after the construction is finished - control the workers according to law and regulations - use local workers as much as possible
	Community Health and Safety Accidents	- cause the railway accidents of passengers and local people when passing through the bridge - risk of harm to humans falling from the structure into the watercourse and also into the valley.	- needs to have an installation of adequate fencing and other site security to prevent trespass and vandalism - put the safety signboards for the local people and surrounding environment.
	Amenity and Nuisance	• Possible alteration of rights of way or reduction in access to riparian habitats • Reduced recreation opportunities e.g. angling and boating • Loss of visual amenity	•Create public recreation place at or near the bridge and culvert as its possbible. • Replantation around the bridges and river

Utility Consumption	Electricity Consumption	- electricity is used to provide the adequate lightning for the bridge - electricity is used from the local community, it can affect to the local people usage	- use LED lights and/or lower wattage lamps - use alternative source like solar system for lighting of the bridges
DECOMISSIONING PHASE			
Air Environment	Vehicular Emission and dust Generation	Use of Dozer and truck	•Use machineries with good engine with low sulphur content fuel for gaseous emission. Spray water for dust control
	Noise	cause the noise impact to the near village and surrounding environment because of the use of equipment and blasting operation	•scheduling blasting activities sa as not to disturb to local people and notify them prior to undertaking such as activity •noise barriers should be erected at appropriate location like the residential areas and sensitive areas
	Vibration	usage of the explosive in the blasting operation can cause the vibration impact to the surrounding environment	•Informing people of the possible vibration before drilling and blasting activities take place •Proper drilling pattern and drilling method to reduce vibration •Use delay for control blasting or reduce the number of drill hole per blast near the residential area or biodiversity sensitive area
Water Environment	Surface water hydrology	• Surface runoff from bank areas due to soil compaction • Pollution of surface water Fuel and oil spillages from vehicular activities.	•an appropriate water management system is used during the construction period, including, for example, efficient land drainage and the use of constructed ponds for receiving site runoff to reduce the impact of runoff on nearby watercourses •oil interceptors or drip trays are used in vehicle parking areas, and are inspected and cleaned regularly •control the spillage of the oil, fuel and concrete into the river
Soil Environment	Erosion of exposed soil	• Erosion of exposed soil and removal or alteration of soil on site for bridge/ culvert removal • Discharge of the residue of the concrete from the demolition of bridge and culvert	•Effective stabilization of altered landforms so as to minimize soil erosion and the potential for water pollution from suspended solids •Use systematic dispose method for the residue of concrete near the residential areas and do not discharge near the residential areas

Biodiversity	Negative impact on Aquatic flora and fauna	• From increased sediment loading of streams • From oil, fuel, cement or other substances entering watercourses.	• Avoid the spillage of oil and fuel into river and stream • Use systematic method for bridge demolition not to cause damage to the aquatic flora and fauna • Dispose the residue of the concrete structure and steel structure according to the law and regulations
	Negative impact on terrestrial flora and fauna	• From vehicular activities, disturbance and habitat severance • From oil, fuel, cement or other substances entering watercourses	• existing habitat features should be incorporated into site design and protected from change; • further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential for the site; • where access restrictions result, arrangements for alternative access should be made with the provision of gates, bridges or stiles
Human Environment	Negative Socio-Economic Impacts Loss of jobs for local people and revenues for the government	• tends to reverse the benefits that are got from the operation of the proposed project on closing the project • negative impacts resulting in loss of jobs and indirect employment depending on the proposed project and of associated services for tourism as well as loss of revenues for the government	• Extensive and comprehensive warning to employees to allow them to source alternative livelihood should be taken early • The project developer should prepare their employees for forced retirement by providing applicable jobs at other factories under the same developer, if feasible.
	Visual Impact	• Temporary visual impact from work being carried out on site • Transportation of vehicular equipment on site • Discharge of residue and steel structure near the residential area	• Appropriate screening for visual impacts • Vegetation and plantation near the decommissioning bridge • Use systematic dispose method for the residue of concrete near the residential areas and do not discharge near the residential areas

8.4. Overall Budget for Implementation of the EMP

Project activities	Parameters to be monitored	Locations	Measurements (Methods and Equipment)	Frequency of measurement	Cost estimates (Kyats)**	Responsibilities
During Pre-Construction and Construction phase						
Gaseous emission, and PM generation	Ambient air quality (CO, CO2, SO2, NOx)	Within the site and surrounding establishments	Visual investigation and monitoring by handheld PM meter and CO, CO2, SO2, NOx meter	During the construction activities at different locations at least per month or every complaints or if necessary	100000 Kyats per once	Construction contractor(s) (as a part of contractor's financial offer)
Construction machineries	Noise complaints from the neighboring	Within the site and surrounding establishments	Monitoring by noise level meter	During the construction activities at different locations at least per month or every complaints or if necessary	50000 Kyats per once	Construction contractor(s) (as a part of contractor's financial offer)
Area of spillage	Soil contamination and water resource pollution	Project sites and agricultural lands nearby, nearest surface water resources	Visual observation; Recording and documentation of spillage	Daily	12000 Kyats per day	Construction contractor(s) (as a part of contractor's financial offer)
Management of construction waste and handling of hazardous waste	Amount of hazardous and nonhazardous waste generated	Project sites and agricultural lands nearby, nearest surface water resources	Estimation of the hazardous waste and non-hazardous waste in relation to the handling and transporting to the landfill	Weekly or monthly depending on the volume of waste	12000 Kyats per day	Contractor(s) during construction and operators during operation

Storage of the machines and construction materials of the project components	Complaints from neighboring communities and records and documentation of the temporary area for storage of materials or machineries	Project sites	Recording and documentation	Monthly	-	Construction contractor(s)
Storage of surplus soil particle from	Complaints from neighboring communities and records and documentation of the temporary area for storage of materials or machineries	Project sites	Recording and documentation	Monthly	-	Construction Contractor(s)
Monitoring the traffic disturbance due to the vehicles and machineries movement and other related construction activities	Traffic complaint	Within 500 m from the construction site	Visual observation and recording complaint received	During the duration of the construction activities	-	Construction Contractor(s)
Impacts of culture and privacy of local communities	% of local labor to total labor	Construction site	Construction site Reporting labor origin governorates and calculating the native's ratio	Quarterly	-	Construction Contractor(s)
Monitoring health and safety of the workers during the construction of the project	Health records about occupational injuries	Clinic / hospital referred by the contractor	Medical reporting on received cases	on received case	The cost is undefined, depending on the	Construction Contractor(s)

components					cases	
Base camp preparation for the workers	Neighbors /project' complaints	Project construction sites	Recording of complaint and type of complaint	Once during the preparation and prior to start the construction phase	-	Construction Contractor(s)
Site clearance	Worker's injuries	Construction site location	Preparation of recording form of workers injures during the construction	Monthly	-	Construction Contractor(s)
During Operation and Maintenance						
Management of the hazardous and nonhazardous waste	Amount of hazardous and nonhazardous waste generated	At the designated landfill for solid waste	Record keeping of the admitted waste and their quantity	Quarterly	Undefined	Operators during operation
Management of risks during the emergency situations (fire, soil contamination, water resource contamination and smoke)	Records of emergency situations	At surrounding the alignment area	visual monitoring for possible leak and for possible damage on the foundation and isolated area	Weekly or if required	Undefined	Monitoring team of Railway Project
Workers' health and safety	Workplace health and accidents record	Workplace	Medical reporting on workplace injuries	Monthly	undefined	Monitoring team of Railway Project

8.5. Management and Monitoring Sub-Plans

8.5.1. Environmental Monitoring Program

8.5.1.1. Objective

The purpose of environmental monitoring is to evaluate the effectiveness of implementation of Environmental Management Plan (EMP) by periodically monitoring the important environmental parameters within the impact area, so that any adverse affects are detected and timely action can be taken. Main objectives of environment monitoring plan include:

(a) Identify all environment changes which may cause adverse effects on environment by the project implementation;

(b) Monitor discharge sources (gas emission, waste water and solid waste) and operation of environmental protection equipments in order to ensure that these activities will comply with legislative requirements;

(c) Check monitoring process and inspect installation system and equipments in respect of pollution prevention and control;

(d) Prevent potential incidents;

(e) Propose appropriate environment protection measures based on results of environmental monitoring;

(f) Overcome and repair all weak-points based on results of environment monitoring program.

8.5.1.2. Legal Requirements

The Prevention of Hazard from Chemical and Related Substances Rules (Law No.8,15,16,17,20,22,23,27)

- Performing the sticking pictogram for being least the health impacts and accident injuries in the occupational area according to the prescribed standards and norms of the Globally Harmonized System GHS);
- Making the necessary arrangements to be safety of the occupational area and issuing orders and directives for preventing and decreasing the accident;
- Laying down the proliferation plans on knowledge, and safety of chemical and related substances to administrators, license holders, public and workers;

- Cooperating with local and foreign governmental departments, organizations and non-governmental organizations in respect of safety management for chemicals hazard.

Forest Law

- To implement forest policy and environmental conservation policy, to promote public cooperation in implementing these policies, to develop the economy of the State, to prevent destruction of forest and biodiversity, to carry out conservation of natural forests and establishment of forest plantations and to contribute towards the fuel requirement of the country.

Protection of Biodiversity and Protected Area Law

- To protect wildlife, wild plants and conserve natural areas, to contribute towards works of natural scientific research, and to establish zoological gardens and botanical gardens.

Conservation of Water Resources and Rivers Rules

- To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact

Animal Health and Development Law (Law No.17)

- To carry out animal health and development work and promote livestock development;
- To prevent outbreak of contagious disease in animals and to control the outbreak systematically when occurs;
- To inspect imported animal, animal product and animal feed;
- To issue recommendation certificate concerning animal, animal product and animal feed for export;
- To protect animals by law from being ill-treated

8.5.1.3. Overview Maps

The monitoring location would be within the project site, surrounding establishment, and vicinity around the project area. The overview map of Muse-Mandalay railway alignment is divided into six sections and these sections are shown in the figures below. It is also covered for monitoring of the bridge and culvert.

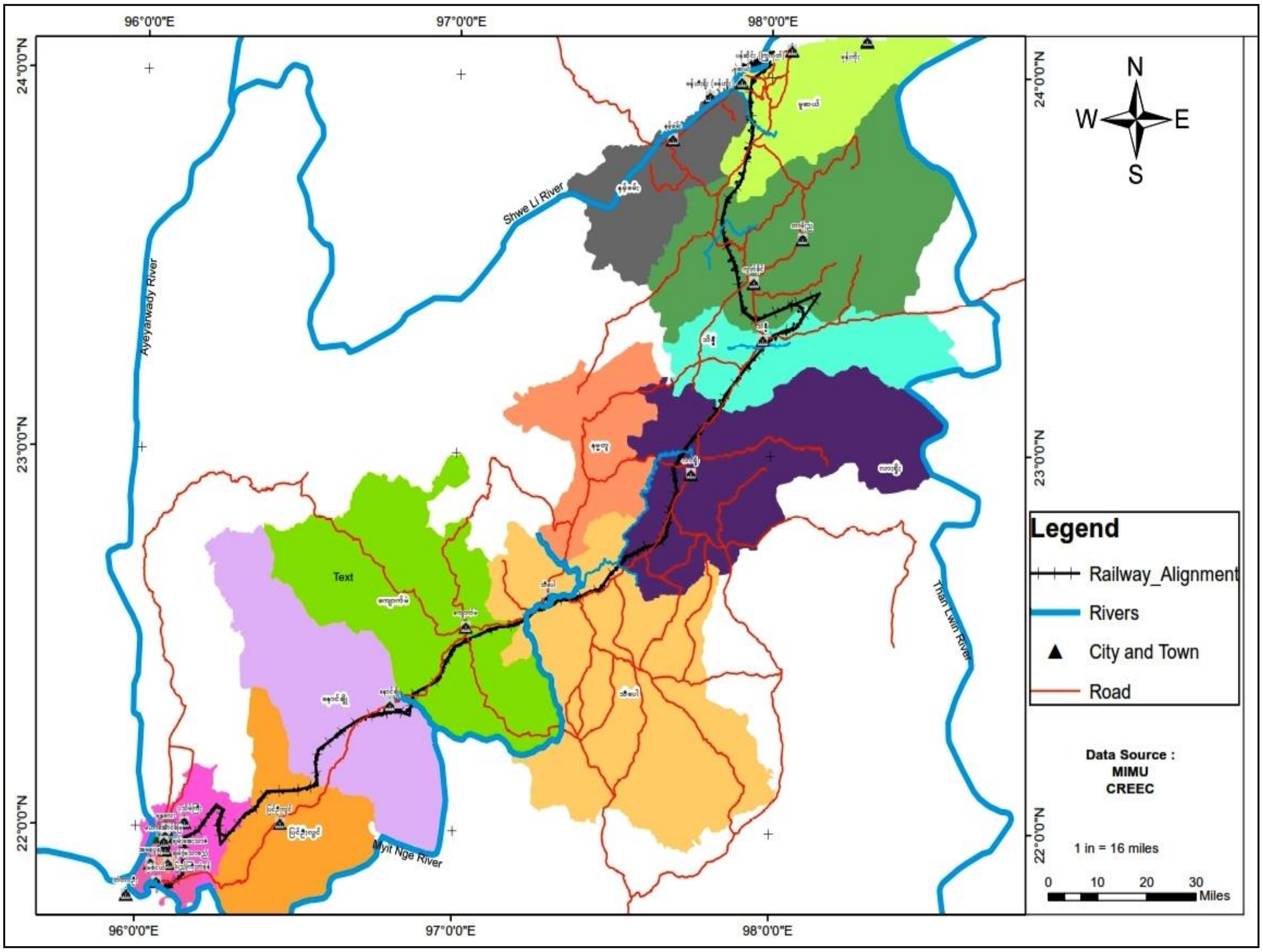


Figure 8.1 – Map of Alignment Plan of Muse-Mandalay Railway Line

8.5.1.4. Management Plans for Environmental Monitoring

An executive agency of the Muse-Mandalay Railway Project is MR. They will be organizing a project Environmental Management and Monitoring Team (EMMT) for assist the implementation of the proposed project.

The environmental monitoring team will accomplish regular environmental monitoring. The environmental officer or environmental coordinator will be fully responsibility for environmental affair and environmental monitoring. The following table will be the organization plan for the environmental monitoring team of the proposed project.

No.	Group Member	Quantity
1.	Environmental Officer (or) Coordinator	1
2.	Occupational Health and Safety Officer (or) Coordinator	1
3.	Site Manager	1
4.	Supervisor	1
5.	Worker &Staff	8

The following will be the organization structure of environmental monitoring team.

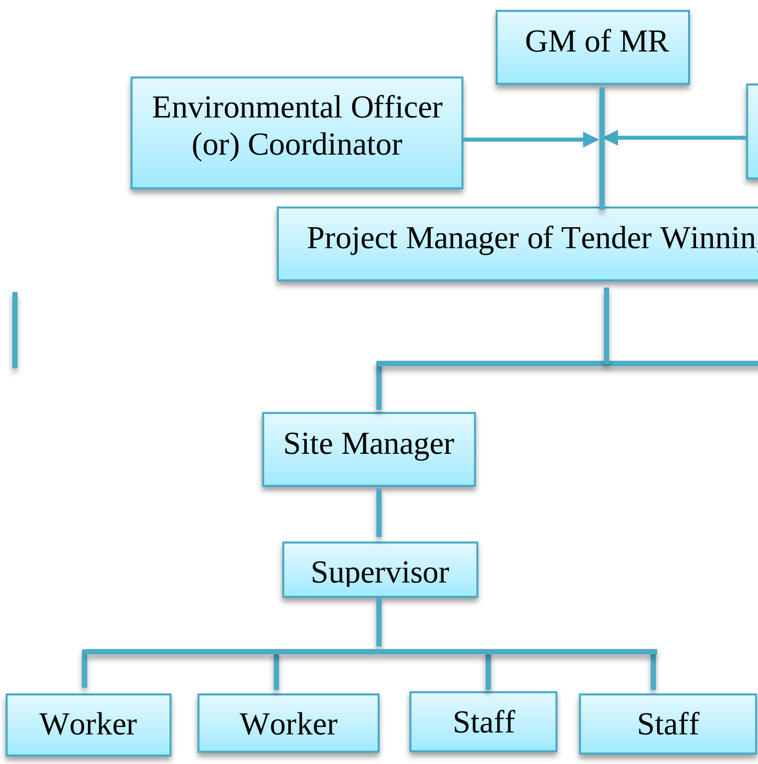


Figure 8.2. Organization Structure for Environmental Monitoring Team

Apart from having an Environmental Management Plan, it is necessary to have a permanent staff charged with the task of ensuring its effective implementation of mitigation measures and to conduct environmental monitoring. Environmental monitoring can also be done by registered third party monitoring agency. Detailed function of the environmental officer but not limited are as follow:

Environmental Officer

The major duties and responsibilities of the environmental officer or person-in-charge for environmental monitoring of proposed project will be as given below:

(a) To implement the environmental management plan,

(b) To assure regulatory compliance with all relevant rules and regulations,

(c) To ensure regular operation and maintenance of pollution control devices,

(d) To minimize environmental impacts of operations by strict adherence to the EMP.

(e) To initiate environmental monitoring as per approved schedule.

(f) Review and interpretation of monitored results and corrective measures in case monitored results are above the specified limit,

(g) Maintain documentation of good environmental practices and applicable environmental laws as ready reference,

(h) Maintain environmental related records,

(i) Coordination with regulatory agencies, external consultants, monitoring laboratories,

(j) Maintain of log of public inconvenience and the action taken,

(k) Ready to solve any complaints from local people about environmental and social issues especially in waste water and traffic.

8.5.1.5. Environmental Monitoring Team for Monthly Monitoring

Environmental monitoring team for monthly monitoring has to organize representatives from MR, representatives from tender winning company for project construction and/or operation, representative persons from General Administrative Office (GAO), Department of Industrial Supervision and Inspection (DOISAI), Departmnet of Transportation (DOT), Environmental Conservation Department (ECD), local communities and local NGOs & CBOs as follow:

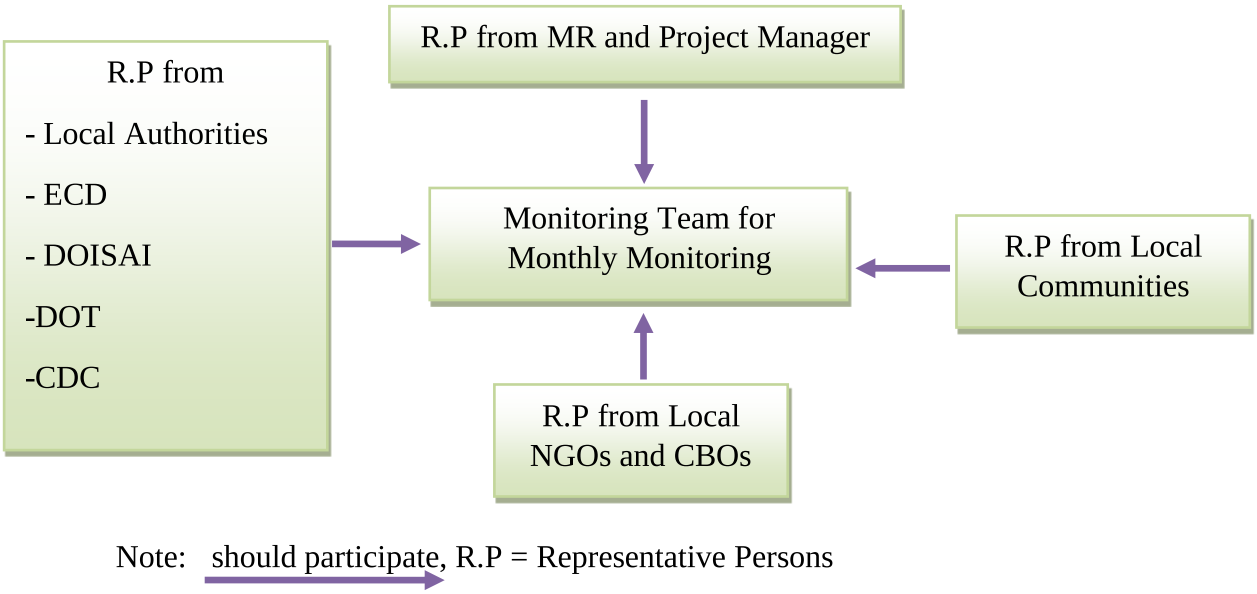


Figure 8.3 - Proposed Environmental Monitoring Team for Monthly Monitoring

8.5.1.6. Considerations for Environmental Monitoring

The following factors will be considered during the environmental monitoring.

(a) Monitoring will be done by registered third party monitoring agency or proposed environmental monitoring team of the proposed team. and at least three representatives from proposed monitoring team will be participated in every monitoring process.

(b) If monitoring results show constantly (3 consecutive years) and significantly (e.g. less than 75 percent) better than the required levels, frequency of monitoring can be reduced (IFC, World Bank, 2007).

(c) By studying the wind rose, the most dominant wind direction and wind speed for every season can be predicted and monitoring station for dust, noise and gas emissions will be carried out at that wind direction

8.5.1.7. Environmental Management Training Program

Environmental management training program is an important part in EMP. Training and human resource development is an important link to achieve sustainable operation of the facility and environmental management.

Training Program for Construction Phase

During construction phase, construction contractor must ensure that project staffs are trained on labor safety and environment protection during construction phase.

Training Program for Operation Phase

In operation phase, all staff of proposed plant will be trained on environment safety throughout training courses to be familiar with operation processes and guidelines, fire fighting exercises and practices, etc. Project Management Board will be established and maintain training programs that are regularly updated to help staff at all levels and related functional departments are aware of their responsibility on environment protection. For successful functioning of the project, relevant EMP's will be communicated to the following groups of people:

Employees

Employees must be made aware of the importance of safety, waste segregation and storage, and energy conservation. This awareness will be provided through leaflets and periodic in-house meetings. They will be informed about their responsibilities for successful operation of various environmental management schemes inside the premises.

Site Staff

Relevant personnel at site will be trained for:

(a) Collection, segregation and storage of the solid and waste generated during operation,
(b) Operation and maintenance of sewage treatment plant and reclamation system,
(c) Requirements of the emergency response plan in case of an emergency,
(d) Techniques for waste minimization, water conservation and energy conservation,
(e) Applicable environmental, health and safety regulations and compliance requirements,
(f) Functioning of the environmental management system including environmental monitoring, reporting and documentation needs.

8.5.1.8. Record Keeping

Record keeping and reporting of performance is an important management tool for ensuring sustainable operation. Records will be maintained for regulatory, monitoring and operational issues.

Typical record keeping requirements for the site is summarized in following table.

Record Keeping Requirements

Parameter	Particulars
Resources Use	- Daily quantity of electrical power consumption through power meter - Daily quantity of water use for cooling system and domestic use through water meter
Solid Waste Handling and Disposal	- Daily quantity and management of domestic solid waste from workers' dormitory
Monitoring and Survey	-Records of all monitoring carried out as per the finalized monitoring protocol.
Complaints from Nearest Residents	- Records of all complaints about the traffic from the nearest villages
Employee Health and Safety Record	- Daily record for accidents at the workplace
Others	- Equipment inspection and calibration records, where applicable - Vehicle maintenance and inspection records

8.5.1.9. Environmental Audits and Corrective Action Plans

To assess whether the implemented EMP is adequate, MR will conduct periodic environmental audits. Environmental audit is an independent and objective oriented examination of whether the practice complies with expected standards. Broadly, environmental audit means a check on some aspects of environmental management, and implies some kind of testing and verification.

There are two levels of Environmental Audits, i.e. Environmental Impact Audit and Environmental Management Audit. Environmental Impact Audit involves comparing the impacts predicted in an EIA with those that actually occur after implementation of the project while Environmental Management Audit involves checks against adherence to plans, mitigation measures and general compliance of terms and conditions. These audits will be followed by Corrective Action Plans (CAP) to correct various issues identified during the audits.

8.5.1.10. Reporting Monitoring Results

Results of recorded in files to monitor and audit monitoring will be carried out strictly as required by the related national regulations and the monitoring results of required parameters should be reported to local authorities monthly and copies to MOl (Mandalay), ECC (Mandalay), MCDC and Quarter Administrative Offices.

8.5.2. Traffic Management Plan

8.5.2.1. Objective

The primary objectives of this Traffic Management Plan are:

- To ensure efficiency and safety of the movement of people, goods, or vehicles.
- To manage potential adverse impacts on traffic flows and pedestrian movements to ensure road and pedestrian network performance is maintained at an acceptable level.

'Traffic' in this sense refers to the interaction of vehicles, mobile plant (machinery) and pedestrians. Areas where pedestrians are exposed to the risk of a collision between mobile plant and vehicles should be identified, for example, in a warehouse where forklifts and workers both operate.

8.5.2.2. Legal Requirements

The highways Law (Law No.24)

- To cause easier communication and transportation among states and divisions by constructing the highways and to strengthen national solidarity and friendship and to cause all-round development in all regions and areas in economic and social sectors,
- To give support in implementing the duty for security and convenience in road and communication and quickness in flow of commodities; and to supervise systematically in respect of traffic and use of highways.

Law Amending the Law on the Utilization of Roads and Bridges (Law No.25)

- to promote traffic convenience and contribute to the development of the national economy by prescribing matters concerning the construction, upgrading, maintenance, management, etc. of roads and bridges

8.5.2.3. Overview Maps and Site Layout Maps

The traffic management plan consideration combined with the geographical location of the project, the railway will be divided into 6 sections including Mandalay beyond, Mandalay, Pyinoolwin, Lashio (including Kyaukme), Muse and China, shown in the figure below.

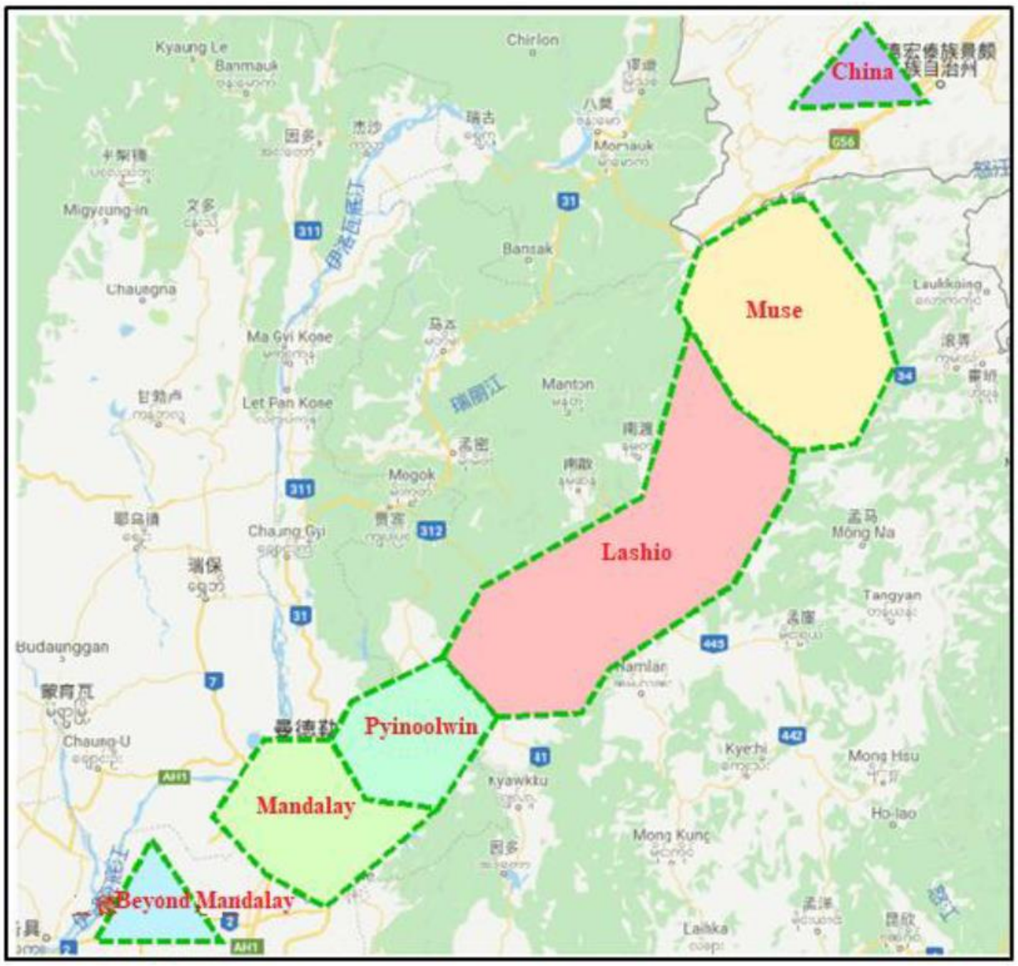


Figure 8.4. Schematic Diagram of Selected Division

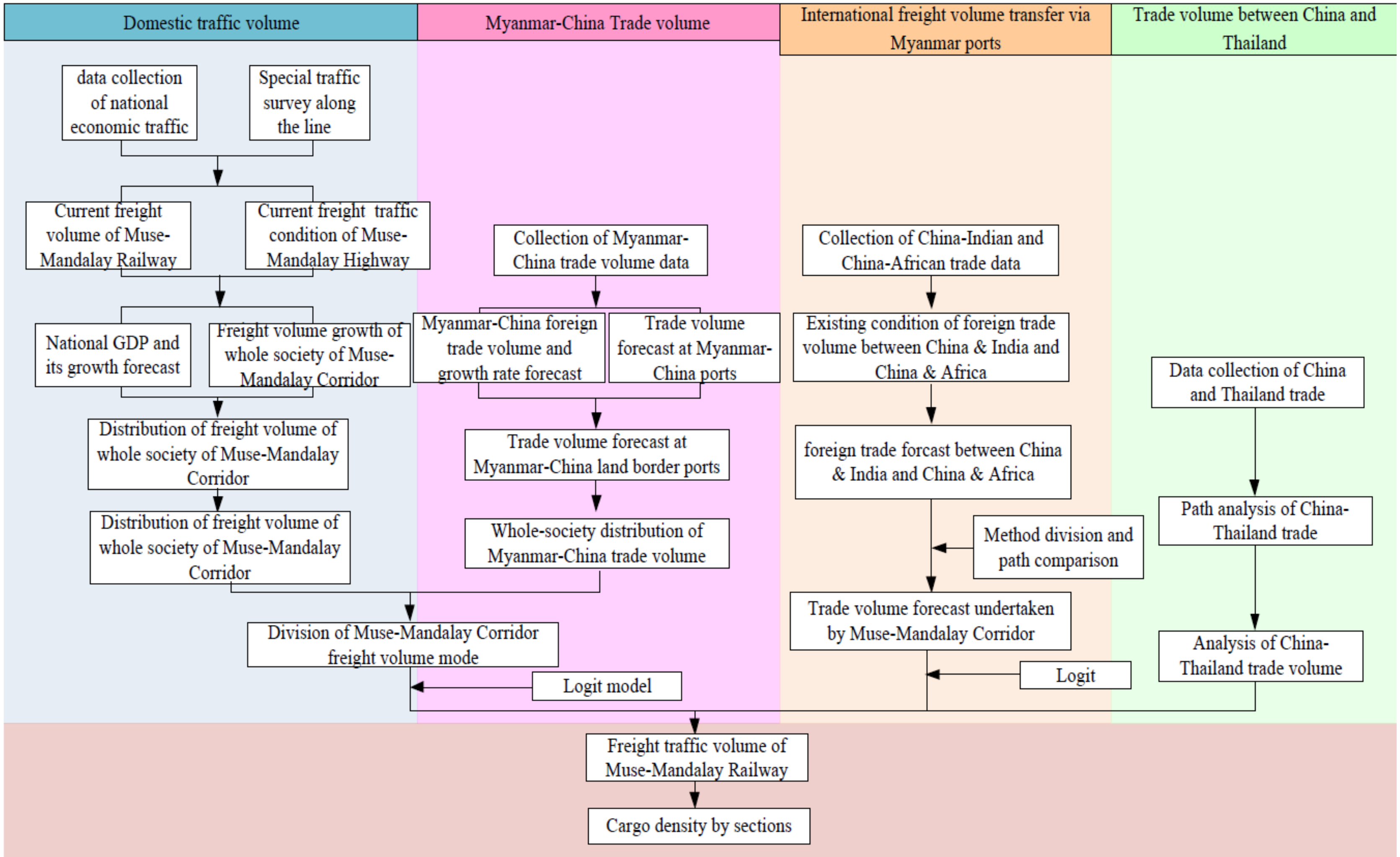


Figure 8.5. Techical Roadmap of Freight Traffic Volume Forecasting for Muse-Mandalay Railway

8.5.2.4. Management Actions and Monitoring Plans

For operation phase, traffic management will not be needed to consider. Traffic Management Plan for Construction Phase is discussed in this section.

Construction site vehicle incidents should be prevented by the effective management of transport operations throughout the construction process.

Key issues in dealing with traffic management on site are:

- Keeping pedestrians and vehicles apart
- Minimizing vehicle movements
- People on site
- Turning vehicles
- Visibility
- Signs and instructions

(a) Keeping pedestrians and vehicles apart

The majority of construction transport accidents result from the inadequate separation of pedestrians and vehicles. This can usually be avoided by careful planning, particularly at the design stage, and by controlling vehicle operations during construction work.

The following actions will help keep pedestrians and vehicles apart:

Entrances and exits – separate entry and exit gateways for pedestrians and vehicles should be provided;

Walkways – firm, level, well-drained pedestrian walkways that take a direct route should be provided where possible;

Crossings – where walkways cross roadways, a clearly signed and lit crossing point should be provided where drivers and pedestrians can see each other clearly;

Visibility – drivers driving out onto public roads should be made sure that they can see both ways along the footway before they move on to it;

Obstructions – walkways should not be blocked so that pedestrians have to step onto the vehicle route; and

Barriers – a barrier should be installed between the roadway and walkway.

(b) Minimizing vehicle movements

Good planning can help to minimize vehicle movement around a site. For example, landscaping to reduce the quantities of fill or spoil movement.

To limit the number of vehicles on site:

- Car and van parking for the workforce and visitors should be provided away from the work area;
- Entry to the work area should be controlled; and
- Storage area should be planned so that delivery vehicles do not have to cross the site.

People on site

Employers should take step to make sure that all workers are fit and competent to operate the vehicles, machines and attachments they use on site by, for example:

- Checking when recruiting drivers/ operators or hiring contractors;
- Training drivers and operators;
- Managing the activities of visiting drivers.

People who direct vehicle movements (signalers) must be trained and authorized to do so. Accidents can also occur when untrained or inexperienced workers drive construction vehicles without authority. Access to vehicles should be managed and people alerted to the risk.

Turning vehicles

The need for vehicles to reverse should be avoided where possible as reversing is a major cause of fatal accidents. One-way systems can reduce the risk, especially in storage areas. A turning circle could be installed so that vehicles can turn without reversing.

Visibility

If vehicles reverse in areas where pedestrians cannot be excluded, the risk is evaluated and visibility becomes a vital consideration.

The following list should be considered:

Aids for drivers – mirrors, CCTV cameras or reversing alarms that can help drivers to see movement all around the vehicle;

Lighting – so that drivers and pedestrians on shared routes can see each other easily. Lighting may be needed after sunset or in bad weather;

Clothing – pedestrians on site should wear high-visibility clothing.

Sign and instructions

All drivers and pedestrians must know and understand the routes and traffic rules on site. Standard road signs should be used where appropriate. Induction training for drivers, workers and visitors should be provided and instructions should be sent out to visitors before their visit.

Pedestrian routes should be:

- Kept clear and free of tripping hazards
- Segregated from vehicle routes
- Adequately signed
- Provided with crossing points that have a clear view

Vehicle routes should be;

- Segregated from pedestrian routes
- Designed to minimize reversing
- Suitable for the vehicles that need to use them with appropriate speed limits
- Designed to avoid steep gradients and sharp bends
- Designed with ramps, signage, and berms as required
- Designed to take into account loading and unloading areas

Hoarding, barriers, lighting and signs will be required at startup. As construction progresses, pedestrian and traffic routes will change and barriers, traffic cones, and signs will need to be moved to ensure that there is adequate pedestrian and vehicle separation. Fixed barriers should be used to separate vehicles from pedestrian walkways and to protect loading and unloading areas on site.

Injuries from construction site vehicles can be quite serious; an injured worker may be out of commission for weeks, months, or even longer.

Trucks, earth-moving equipment, and other heavy vehicles are essential on construction sites. These vehicles not only help workers with large scale projects but also make their jobs a little less strenuous. Unfortunately, these vehicles, when placed in the hands of other workers, can also be dangerous. Furthermore, dangerous vehicles that pass through construction zones can also threaten the lives of those working nearby.Distracted and inattentive drivers can easily run over or back over road construction workers or collide with other vehicles. Similarly, unsafe drivers on public roads pose their own threats while passing through construction zones.

The following are meant to control and limit the following common vehicle accident types:

- **Collisions and rollovers.** The most common type of accidents with any kind of vehicle is a collision or rollover. These occur as a result of erratic driving, failure to pay attention, and reckless driving. These types of accidents are extremely dangerous to construction workers who aren't protected inside vehicles. Also, because construction vehicles are significantly larger and heavier than normal vehicles, they can inflict even greater damage when they collide with workers or other vehicles.
- **Back-up accidents.** A back-over incident occurs when a vehicle strikes a worker who is standing, walking, or kneeling behind the vehicle. Nearly 70 workers a year die from back-over incidents that could have been avoided. These kinds of incidents can happen for a variety of reasons. Drivers may not be able to see workers in their blind spots, injured workers may fail to hear backup alarms, drivers may fail to check their surrounding properly, etc.
- **Cargo spills.** Unsecured cargo can pose an extreme threat when it spills or falls out of a vehicle. In addition to causing debris that can affect the safety of other drivers, the weight of the cargo could potentially crush nearby workers.
- **Pinning.** When drivers fail to pay attention or inadvertently leave vehicles in motion, workers on the ground can become stuck or pinned between the vehicle and other objects. This pinning can result in severe crush injuries.

According to the traffic study data done on NH_3 Road along the railway, morning peak hour occurs at 7am to 10am, midday peak at 11am to 2pm, evening peak at 4pm to 7pm and night peak at 7:30pm to 9:30pm.

According to the study, the vehicle movements in weekend day is 14.5% greater generation rate that of in working day vehicle volumes as many visitors coming to Pyin Oo Lwin, Thi Paw and Muse.

To avoid traffic accidents as much as possible, transportation vehicles to and from the construction site should not be operated during peak hours if possible.

8.5.3. Occupational and Community Health and Safety Risk and Management Plans

8.5.3.1. Objective

The primary objectives are:

- To secure the health, safety and welfare of employees and other people at work.
- To eliminate workplace risks at the source, and
- To involve employers, employees and the organization that represent them in the formulation and implementation of health, safety and welfare standards.

8.5.3.2. Legal Requirements

Occupational safety and health Law (Pyidaungsu Hluttaw Law No 8)

- The purpose to effectively implement measures related to safety and health at every industry, prevent by the workplace accidents and occupational diseases and set occupational safety and health standards

Workmen's Compensation Act

- To protect personal injury caused to a workman by accident arising out of and in the course of his employment and to compensate in accordance with the provisions of Workman Compensation Act

The Law Relating to Private Health Care Services

- Develop private health care services in accordance with the national health policy;
- To participate and carry out systematically by private health care services in the national health care system as an integral part;
- To enable utilizing effectively the resources of private sector in providing health care to the public;
- To enable the public to choose as desired in fulfilling their needs for health by establishing private health care services;
- To enable provision of quality service at fair cost and to take responsibility.

Public Health Law (Law No. 3,5)

To promote and safeguard public health and to take necessary measures in respect of environmental health.

8.5.3.3. Overview and Layout Map

The contemplation for the occupational safety and health for this sub-plan is considered as shown in the figure below.

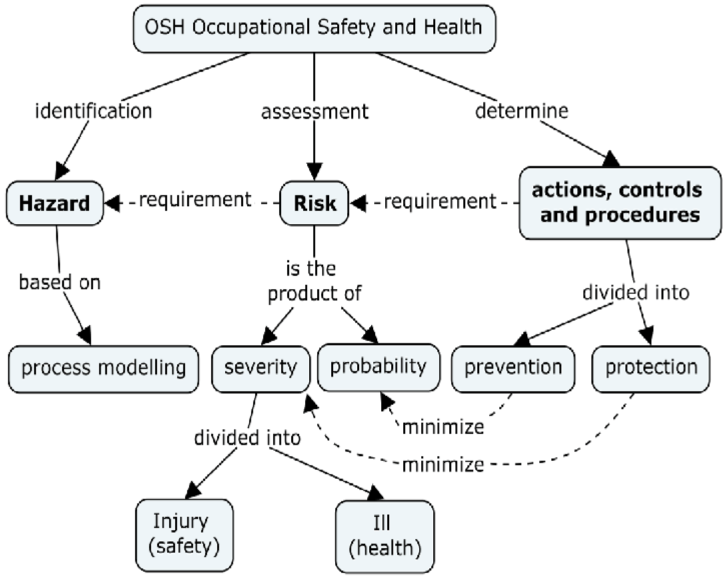


Figure 8.6. Mind Map of Occupational Health and Safety Risk

8.5.3.4. Management Actions and Monitoring Plans

To ensure health and safety of workers, the following measures shall be implemented by the contractor:

- Prior to commencement of site works, the following plans shall be prepared by the contractor and approved by the Project Supervision Consultant:
    - Occupational and Community Health and Safety Plan consistent with international standards (e.g., the World Bank Group's Environment, Health and Safety Guidelines of 2007) and Labor Law of Myanmar. The Plan shall address health and safety hazards associated with construction activities (e.g., working at heights, excavations, etc.) establishment and operation of construction/worker's camps, casting yard, use of heavy equipment, transport of materials and other hazards associated with various construction activities.
    - Emergency Response Plan to prevent, mitigate, respond to and recover from emergency events that could occur due to project activities such as accidents, spills of hazardous substances, fire, extreme weather events, and other crises.

- Appoint an environment, health and safety manager to look after implementation of required environmental mitigation measures, and to ensure that health and safety precautions are strictly implemented for the protection of workers and the general public in the vicinity of construction areas
- Conduct orientation for construction workers regarding health and safety measures, emergency response in case of accidents, fire, etc., and prevention of HIV/AIDS and other related diseases
- Provide first aid facilities that are readily accessible by workers.
- Provide firefighting equipment at the work areas, as appropriate, and at construction camps.
- Provide adequate drainage in workers camps to prevent water logging/accumulation of stagnant water and formation of breeding sites for mosquitoes.
- Provide adequate housing for all workers at the construction camps.
- Provide reliable supply of potable water.
- Provide separate hygienic sanitation facilities/toilets and bathing areas with sufficient water supply for male and female workers
- Establish clean canteen/rest area.
- Ensure proper collection and disposal of solid wastes within the construction camps consistent with local regulations.
- Provide fencing on all areas of excavation greater than 2 m deep.
- Provide appropriate personnel safety equipment such as safety boots, helmets, gloves, protective clothes, breathing mask, goggles, and ear protection
- Ensure reversing signals are installed on all construction vehicles.
- Implement precautions to ensure that objects (e.g., equipment, tool, debris, precast sections, etc.) do not fall onto or hit construction workers.
- Implement fall prevention and protection measures whenever a worker is exposed to the hazard of falling more than two meters, falling into operating machinery or through an opening in a work surface. Based on a case-specific basis, fall prevention/protection measures may include installation of guardrails with mid-rails and toe boards at the edge

of any fall hazard area, proper use of ladders and scaffolds by trained employees, use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard, fall protection devices such as full body harnesses, etc.

- Strictly impose speed limits on construction vehicles along residential areas and where other sensitive receptors such as schools, hospitals, and other populated areas are located.
- Educate drivers on safe driving practices to minimize accidents and to prevent spill of hazardous substances and other construction materials during transport

Moreover, Occupational health and safety management plan for the proposed railway bridges and culverts will also include the following:

a) Emergency and First-aid Procedures
b) Medical Precautionary Measures
c) Maintenance and Troubleshooting Precautions
d) Housekeeping
e) Safety awareness
f) Safety training

When an accident occurs at the construction site, it is essential that the proper steps are taken to secure the safety of the injured person. These steps include:

Getting medical care: The first and most important steps to follow after a work site injury is assessing and treating the damage. Even if the injury seems minor, a medical professional should diagnose and treat the injury before the injured person attempts to return to work. A minor bump on the head could mask a concussion, or a bruised abdomen could be a sign of internal injuries.

Taking note of where, when, and how the accident occurred: If the victim is physically capable, he should make sure to record the significant aspects of the accident, including time, place, and potential cause.

Reporting the injury: The injured person absolutely must inform his supervisor or superior of the accident as soon as possible. Make sure to record the name and position of the person who accepted the report and the date the report was submitted.

First-aid program should include the following elements:

- **Emergency medical services (EMS) response time**: Contact local EMS or nearest hospital to assess the response time to the facility in an emergency. This will help to determine whether or not employees should be trained in first-aid on site. If an EMS or ambulance from nearest hospital can reach workers at the site within 3 to 4 minutes in a life-threatening emergency, then the EMS is considered "in near proximity" to the workplace. If this is the case, then employees trained in first-aid are not required (but are still recommended) on site.
- **Trained personnel**: Employees who have taken first-aid training course should be assigned responsibility for providing first aid. Employers should ensure that at least one of their employees takes a first-aid course or arrange for such a program to be taught at the workplace. It is recommended that 15 to 20 percent of the workforce should be trained in first aid.
- **Written procedure**: Have a qualified medical professional provide written "standing orders" for basic first-aid treatment procedures. Have the doctor designate what is to be done in the case of a serious injury and what hospitals are to be used for emergency treatment. Local police and fire telephone numbers should be prominently displayed in enough places so that all employees can access them.
- **First-aid kit**: First-aid supplies must be easily accessible when they are required. The contents of the first-aid kit must be stored in a sealed weatherproof container with individual sealed packages for each type of item and must be checked by the employer before being sent out on each job and at least weekly to ensure that expended supplies are replaced.
- **Communications**: Let everyone in the organization know who the trained first-aid personnel are; state that these persons are the only ones who should render first-aid assistance. Be sure to keep the list up-to-date. Also, publicize the names and phone numbers of local police and fire departments, as well as others outside the organization who should be called.
- **Medical log**: Maintain a medical or first-aid log convenient to your first-aid kits; ensure that every use of the first-aid kit, even for giving out a bandage, is noted, including: date, time, person receiving treatment, person giving treatment, what injury or symptom was treated, what treatment was given, and first-aid materials used.

- **Appropriate means of transporting injured workers to medical aid**: If a worker is injured, after the first-aid procedure, choose the transportation mode to transport the injured worker to be able to arrive at a medical aid as fast as possible.

First aid is immediate, temporary treatment given in the event of accident or illness.

Eye: Contact lenses, if worn, will be removed. Irrigate the eyes immediately with large amounts of water for 15 minutes. Occasionally hold the eyelids apart to insure complete irrigation. Apply a dry protective dressing. Call for emergency medical assistance.

For “flash burns” cover the eye with cold (preferably iced) compresses for 5 to 10 minutes; then repeat. Apply a dry protective dressing. Call a physician. Don’t rub the eye. Don’t use ointments or drops unless prescribed by a physician.

Skin: For skin contact with irritants, flush the areas with large amounts of water, and then wash with soap and water. Remove contaminated clothing. If mucous membranes are irritated, flush with water. Wash cuts and scrapes with mild soap and water. Avoid contamination. Apply a dry sterile dressing.

For thermal bums, cold water is an effective first aid measure. If skin is not broken, immerse bum part in clean cold water or apply clean ice to relieve pain. Do not disturb or open blisters. Prevent contamination. Bandage loosely with a clean dry dressing. Call for emergency medical assistance.

Electrical Shock and Electrical Burns: Disconnect and turn off power. Remove victim from contact. Use no conducting materials if the rescuer must resort to pulling the victim from the live contact. The rescuer must first protect himself by use of insulated materials such as gloves. If not breathing, administer CPR as soon as electrical contact is broken. Call for emergency medical assistance. Continue CPR until spontaneous breathing has been restored or until a physician arrives. Administer oxygen. Keep comfortably warm. Keep horizontal until there is no further evidence of shock. Treat electrical bums as thermal bums. For electrical bums apply clean, cold (iced) compresses. Prevent contamination. Cover with a clean, dry dressing. Call for emergency medical assistance.

Developing First Aid Procedures

It is important to keep up-to-date written first aid procedures at the workplace. All workers must know where first aid kits are located and how to call for first aid personnel. To develop and keep workplace first aid procedures current, consider:

- **Drills** – Conduct a drill at least once a year. It will test the workers' awareness of how to call for first aid, how well the communication system works, and the ability of first aid attendants to respond. It will also help to determine if the first aid services are adequate to deal with injuries and illnesses most likely to happen in the workplace.
- **Maintaining the system** – A worker should be assigned to manage the first aid services at the workplace. The duties should include ensuring that required first aid attendant(s), supplies, facilities, and equipment are always available.

Medical Precautionary Measures

The following medical precautionary measures will be conducted by MR.

(a) Periodic health examinations will do with the cooperation with Public Health Office (Upper Myanmar). The potential health effects of non-work related factors, such as smoking, must be considered.

(b) An effective educational, training, and industrial hygiene program will be instituted. The program will cover the following: (a) the nature and potential hazards of welding, cutting and gouging; (b) proper and safe use of equipment; and (c) emergency and first aid procedures.

(c) Medical personnel will be available on-site or by phone for advice and consultation. Emergency phone numbers will be posted near the telephones. At least one person on each shift will be trained in first aid, as well as qualified to administer oxygen and cardiopulmonary resuscitation (CPR).

(d) The following will be readily available: (a) first aid supplies approved by a physician; (b) stretchers and blankets for transportation; (c) oxygen inhalation equipment; and (d) approved instant acting eye washes and showers.

(e) Good personal hygiene practices are very important. Employees will wash their face and hands before eating, and it is recommended they not be permitted to eat, drink, or smoke in the work area. Food and beverages will not be stored in the work area. Contaminated clothing will be changed.

(f) Protection against skin conditions, such as chemical burns, rashes, and dermatitis can be provided by appropriate protective clothing and equipment, as well as the use of protective creams or lotions.

Maintenance and Troubleshooting Precautions

Faulty or improperly maintained equipment can cause property damage, physical injury, or possibly death by fire or electrical shock. Here is a list of some important items to check when troubleshooting or maintaining equipment.

(a) Stop operating immediately if equipment is malfunctioning.
(b) Do not perform any maintenance unless you are qualified to perform such work.
(c) Make test readings carefully.
(d) Protect the equipment from heat, excessive wet conditions, oil or grease, corrosive atmospheres, and inclement weather.
(e) Replace parts only with manufacturer's recommended replacement parts.
(f) Keep all protective devices and covers in position.

House Keeping

The following measures will be practiced at the proposed plant.

(a) Regular cleaning of the floors with service water.
(b) Avoid dumping of wastes, damaged equipment and items anywhere inside the plant affecting aesthetics and increasing risk of fire and other hazards.
(c) Maintaining hygienic conditions in areas like canteens, near drinking water sources and toilets.
(d) Maintaining green belt along the project boundaries to suppress noise, fugitive dust and to improve the aesthetics.
(e) Developing a positive outlook in the employees for improving the working place, both in railway area and office clean and well maintained.

Safety Awareness

Safety awareness must be promoted among project managers and employees by:

(a) Imparting regular training.
(b) Installing/displaying safety caution boards and safety posters mentioning Do's & Don'ts at different vulnerable locations.
(c) Arranging safety & housekeeping competition etc.
(d) To procure and maintain personal protective equipment in good working condition.

Safety Training

Training programmes in safety and accident prevention will be organized at all levels of employees with a view to familiarize them with the general safety rules, safety procedures in various operational activities and to update their knowledge in safety and accident prevention, industrial hygiene and emergency equipment. These training programmes will be conducted periodically in a planned manner to refresh their knowledge. Training shall be imparted for:

Safe working and maintenance practices.

(a) Use of proper tools and tackles.
(b) Use of personal protective equipment.
(c) Handling emergency situation.

Development of an Environmental Health and Safety Plan

An Environmental Health and Safety Plan will be prepared for the demolition, construction, operation and decommissioning phases of the Project to ensure compliance with the Ministry of Health's Guideline for Occupational Health and Safety and the IFC guidelines.

A safety committee will be formed by LEC and regular safety meetings will be organized. General mitigation measures aimed at employees and contractors include the following:

- Provision of training about the fundamentals of occupational health and safety procedures.
- Provision of appropriate PPE (for example: latex gloves, working overalls, safety boots, safety helmets, safety glasses, hearing protection).
- Ensuring that especially sensitive or dangerous areas (like areas exposed to high noise levels, areas for especially hazardous work, etc.) are clearly marked, and barricaded if appropriate.
- Ensuring that all maintenance work necessary for keeping machines and other equipment in a good state is regularly carried out.
- Ensuring that the workers (and especially those doing hazardous work or otherwise exposed to risks) are qualified, well-trained and instructed in handling their equipment, including health protection equipment.

- Provision of adequate loading and off-loading space.
- Development of an emergency response plan.
- Provision of appropriate lighting during night-time works (if any)
- Enforcement of speed limits for vehicles entering and exiting the site.

A basic first aid program will be extended to all employees and will ensure that in the event of an accident or injury, someone with first aid knowledge will be present to render initial assistance until further medical attention can be made available. Qualified personnel will provide instruction on the necessary theoretical as well as practical skills required. The advanced first aid program will be an extension of the basic first aid program attended by selected employees, including supervisors and the Health and Safety Officer, and will train participants in the recognition and initial management of serious injuries and illnesses. Employee health and safety orientation will train all employees on the basic rules of work, safety procedures, site-specific hazards, and emergency procedures. A visitor orientation and control program will be implemented if visitors will be entering areas of the site where hazardous conditions or substances are present. Supervisory personnel and safety representatives will attend training on accident investigation and reporting procedures.

Employees and contractor personnel will be provided health and safety training prior to commencing work or a new assignment on this project. The training will consist of basic hazard awareness, identification of site-specific hazards and how they are controlled, safe work practices, potential risks to health and precautions to prevent exposure, hygiene requirements, PPE requirements and proper use, equipment labeling, accident prevention and reporting, and emergency procedures for fire, evacuation, or natural disaster.

All employees, contractors and visitors will be informed of their responsibility to participate in the creation of a healthy and safe environment by reporting unsafe and hazardous conditions when detected and performing work in a safe manner by following the correct work procedure.

Hazardous areas will be marked with appropriate signs, which identify the hazard and associated safety measures. All signs will conform to international standards and will be designed to be understood by all employees and visitors. Signs may contain both text and pictures, as necessary, to ensure that any illiterate employees or visitors would be made aware of the hazard.

Containers of hazardous materials will be labeled with the contents and associated hazards. A color coding system will be implemented to allow immediate visual identification of containers or equipment which contains hazardous substances.

Emergency personnel will be made aware of the types of fuel and of other hazardous materials and typical amounts stored onsite, and storage locations to expedite emergency response. Local emergency response personnel will be invited to inspect the site periodically to ensure familiarity with potential hazards present

8.5.4. Disaster and Risk Management Plan

Disaster means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made cause, or by accident or negligence which result in substantial loss of life or human suffering or damage to, or degradation of, environment, and is of such nature or magnitude as to be beyond the coping capacity of the community of the affected area. Disaster Management implies continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary as expedient for

- Prevention of danger or threat to any disaster.
- Mitigation or reduction of risk of any disaster or its severity or consequences.
- Capacity building.
- Preparedness to deal with any disaster.
- Prompt response to any threatening disaster situation or disaster.
- Assessing the severity of magnitude of effect of every disaster.
- Evacuation rescue & relief.
- Rehabilitation and reconstruction.

8.5.4.1. Objective

The overall objective of a disaster management plan is to make use of the combined resources created or available at the site and/or off-site services to achieve the following:

- To minimize the effects the accident on people and property;
- Affect the rescue and medical treatment of casualties;
- Safeguard other people, outside the project boundary

• Evacuate people to safe areas with utmost care and with minimum casualties;

• Inform and collaborate with statutory local and state authorities;

• Initially contain and ultimately bring the incident under control;

• Preserve relevant records and equipment for the subsequent enquiry into the cause and circumstances of the emergency;

• Investigate and take steps to prevent recurrence of similar incidents

8.5.4.2. Legal Requirements

Natural Disaster Management Law (No 21)

- To implement natural disaster management programmes systematically and expeditiously in order to reduce disaster risks;
- To form the National Committee and Local Bodies in order to implement natural disaster management programmes systematically and expeditiously
- To coordinate with national and international government departments and organizations, social organizations, other nongovernment organizations or international organizations and regional organizations in carrying out natural disaster management activities
- To conserve and restore the environment affected by natural disasters
- To provide health, education, social and livelihood programmes in order to bring about better living conditions for victims

Myanmar Fire Force Law (Law No.25)

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

National Environmental Quality (Emission) Guidelines (Section 2.1.9)

These national Environmental Quality (Emission) Guidelines (hereafter referred to as Guidelines) provide the basis for regulation and control of noise and vibration, air emissions, and liquid discharges from various sources in order to prevent pollution for purposes of protection of human and ecosystem health.

Prevention from Danger of Chemical and Associated Materials Law (Law No. 28)

- To prevent from damaging the environmental resources and from endangering the lively creatures due to the chemical and associated materials;
- To control systematically for the safety in carrying out in accord with the approval for chemical and associated materials business;
- To carry out the data information acquiring system and to widely do the educating and research works in order to utilize the chemical and associated materials systematically;
- To carry out continuous development for worksite safety, health and environmental conservation.

8.5.4.3. Overview Maps

The strongest earthquake (Kyaukkyan Fault) is happened in the railway line near Naungcho town, it should be conscious and thoroughly made any structures that must be resisted the magnitude (>R.M.8) of earthquake. The satellite image of Kyaukkyan Fault near Naungcho town is shown in the figure below.

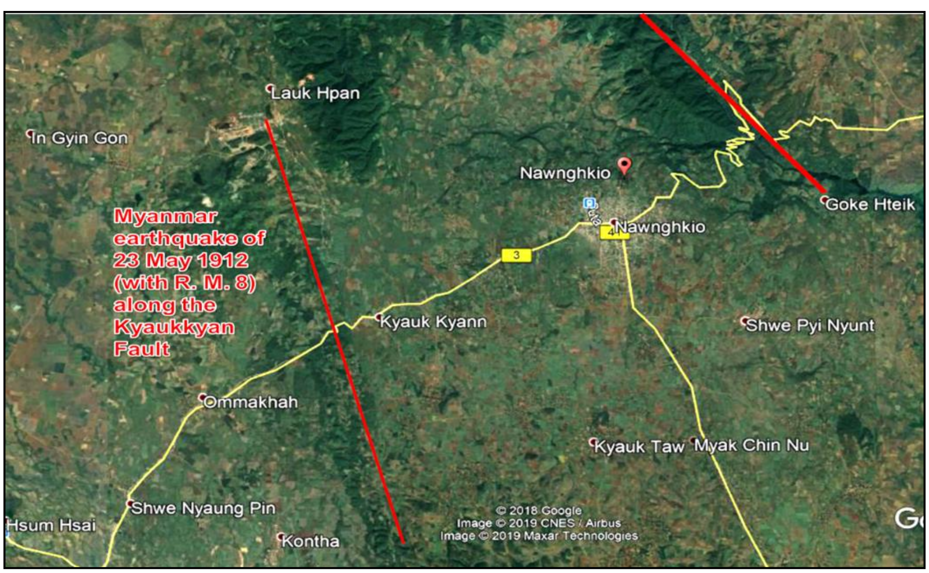


Figure 8.7. Satellite Image of Kyaukkyan Fault near Naungcho Town

8.5.4.4. Management Actions and Monitoring Plans

Dangerous conditions or events that threaten or have the potential for causing injury to life or damage to property or the environment is called hazard. Hazards can be categorized in various ways, but based on the origin, they worldwide are basically grouped in two broad headings:-

1. Natural Hazards (hazards with meteorological, geological or even biological origin)

e.g. Flood, Lightning strikes, etc.

2. Manmade Hazards (hazards with human-caused or technological origin)

e.g. Fire, Structural failure etc.

Vulnerability

Vulnerability may be defined as the probability of exposure of a village, city or a community to a hazard. A society or project may be vulnerable to various hazards to different extents depending upon various reasons including environmental, geographical, social, economic etc.

Disaster

A disaster occurs when a hazard such as earthquake, flood or windstorm coincides with a vulnerable situation. It is hence the product of are two main components: Hazard and Vulnerability. A disaster seriously disrupts the normal functioning of a society, causing widespread human, material, economic or environmental losses that exceed the society's capability to cope without external relief.

8.5.4.5. Types of Disasters

The followings may be the type of disasters related to the proposed project.

1. Fire
2. Escape, intentional release or threat to release due to – oil, gas, chemicals or radioactive, biological or flammable materials
3. Accidents – Collision, grounding and sinking of ships, transport or work place accidents.
4. Natural calamities – Flood and Earth quake

Evaluation of Earthquake Induced Liquefaction Potential

It is required to determine the liquefaction level to take suitable anti-liquefaction measures for relative project items. In proposed project, evaluation of liquefaction characteristics of soils will be tested by Standard Penetration Test (SPT). The liquefaction characteristic of a soil depends on several factors, such as ground acceleration, grain size distribution, soil density, thickness of the deposits and especially the position of the ground-water table. During performing SPT in-situ test for liquefaction, it is observed that the assessments have been extended to a depth of 40 m below existing ground level. It is considered that below this depth, liquefaction is improbable and also unlikely to influence behavior of facilities founded near to the surface.

Calculation of Cyclic Stress Ratio (SR_{eq})

The cyclic shear stress ratios (SR_{eq}) induced by earthquake ground motions, at a depth z below the ground surface, using the following equation

$$SR_{eq} = 0.65\left(\frac{\sigma_o\, a_{max}}{g\, \sigma'_o}\right) r_d$$

Where;

a_{max} = maximum horizontal acceleration at the ground surface

σ_o = total vertical stress

σ'_o = effective vertical stress at depth

r_d = stress reduction coefficient that accounts for the flexibility of the soil column

According to the above questions, the values of peak ground acceleration a_{max} of the areas that are prone to sand liquefaction along the railway line are shown in the following table:

S/N	O-D mileage	Project item	Ground motion peak acceleration (g)
1.	CK376+740～CK377+960	Bridge	0.3
2.	CK379+800～CK381+000	Subgrade	0.3
3.	CK381+400～CK383+040	Subgrade	0.3
4.	CK386+450～CK387+560	Subgrade	0.3
5.	CK387+560～CK387+880	Subgrade	0.4
6.	CK388+320～CK389+240	Subgrade	0.4
7.	CK390+320～CK394+300	Subgrade	0.4
8.	CK397+400～CK398+300	Subgrade	≥0.4
9.	LC1K0+000 ～ LC1K4+169.87	Subgrade	≥0.4

Calculation of Cyclic Resistance Ratio (SR)

This is estimated based on either empirical correlation with the SPT N_m value allowing for the effects of the soil fines content (FC).

Empirical charts have been prepared to determine the cyclic strength based on corrected SPT blow count, (N_1) 60 , calculated as follows:

$$(N_1)_{60} = C_n \frac{ER_m}{60} N_m$$

Where,

C_n = correction coefficient for overburden pressure

ER_m = actual energy efficiency delivered to the drill rod

Calculation of factor of Safety (FS)

The Factor of Safety against liquefaction is defined as

$$FS = \frac{(SR)}{(SR_{eq})}$$

The following figure shows the flow chart of the Seed and Idriss simplified method for liquefaction analysis.

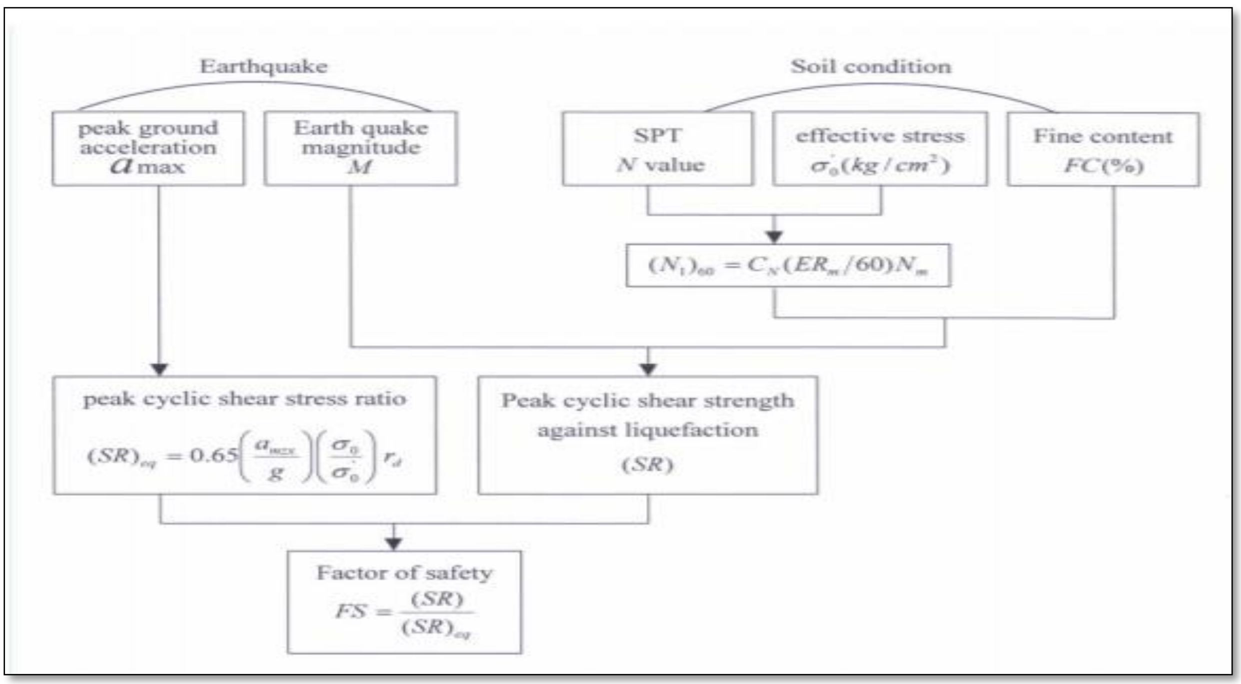


Figure 8.8 Flow Chart of Seed and Idriss Method for Liquefaction Potential Estimation

If the cyclic stress ratio caused by an earthquake is greater than the Cyclic Resistance Ratio of the in-situ soil, then liquefaction could occur during the earthquake and vice versa. Liquefaction is predicted to occur when FS ≤ 1.0, and liquefaction predicted not to occur when FS > 1. The higher the factor of safety, the more the resistance is against liquefaction. By observing the resulted values of FS, the relative project items can be taken corresponding anti-liquefaction measures. For example, bridges shall use pile foundations to pass through the liquefied soil layer or adopt other corresponding anti-liquefaction measures in face of the same.

General Rainfall Conditions around Proposed Project

In Myanmar, annual rainfall in the delta region is approximately 2,500 mm (98.4 in), while average annual rainfall in the Dry Zone in central Myanmar is less than 1,000 mm (39.4 in). In specific, about 812 mm (32.0) inch of precipitation falls annually in Mandalay and around 1758 mm (69.2) inch per year in Shan State (climate-data 2020).

The floods in Myanmar, mainly occur during the monsoon months (June to October). The type of floods occur in Myanmar may be generally classified into two; the wide spread flood and flash flood. The wide spread flood mostly occurs along Ayeyarwady, Chindwin, Sittoung and Thanlwin which are major rivers and the flash flood usually occur at the small rivers and stream. The main cause of wide spread flood is heavy rainfall striking at the head water regime for considerable period (1 to 3 days), the flood wave forming at the head water started to move downward and causing flood along the river up to the deltaic area. The flash flood is caused by heavy rainfall fell on the source and the flood wave move downward swiftly. Observation shows that the percentages of occurrence of floods (exceeding danger level) in medium and large rivers of Myanmar are 6% in June, 23% in July, 49% in August, 14% in September and 8% in October. The severe floods had occurred in 2004, 1974,1997,1976,1991,1973,1988 and 1997, and order of the years are arranged with respect to their intensities. (Ref; *Department of Meteorology And Hydrology (Myanmar) 2020)*

8.5.4.6. Emergency Planning and Response Procedure

A plan to deal with major emergencies is an important element of Occupational Health & Safety programs.

Besides the major benefit of providing guidance during an emergency, developing the plan has other advantages. An emergency plan promotes safety awareness and shows the organization's commitment to the safety of workers. The lack of an emergency plan could lead to severe losses such as multiple casualties and possible financial collapse of the organization.

An emergency is an unplanned event when a project operation loses control, or could lose control, of a situation that may result in risks to human health, property, or the environment, either within the facility or in the local community. Emergency incident response plan for proposed railway project is proposed to mitigate harms on humans and environment in the project area and its vicinity in case of incident. This plan provides the management structure, key responsibilities, emergency assignments and general procedures to follow during and immediately after an emergency. Moreover, it is necessary to establish ERP to address the immediate requirements for a major disaster or emergency in which normal operations are interrupted and special measures must be taken to:

(a) Save and protect the lives of employees;
(b) Manage immediate communications and information regarding emergency operations and work site safety;
(c) Provide essential services and operations;
(d) Provide and analyze information to support decision-making and action plans; and
(e) Manage resources effectively in an emergency operation.

An emergency plan specifies procedures for handling sudden or unexpected situations. The objective is to be prepared to:

- Prevent fatalities and injuries
- Reduce damage to buildings, stock, and equipment
- Protect the environment and the community
- Accelerate the resumption of normal operations

When the organization's plan involves using outside resources, such as fire, police or ambulance, other appropriate organizations should also be consulted.

Having identified the hazards, the possible major impacts of each should be itemized, such as:

- Sequential events (e.g. a fire after an explosion)
- Evacuation

- Casualties
- Damage to plant infrastructure
- Loss of vital records/ documents
- Damage to equipment
- Disruption of work

Based on these events, the required actions such as the following are determined.

- Declare emergency.
- Sound the alert.
- Evacuate danger zone.
- Close main shutoffs.
- Call for external aid.
- Initiate rescue operations.
- Attend to casualties.
- Fight fire.

Also consider what resources are required and their location, such as:

- Medical supplies.
- Auxiliary communication equipment.
- Power generators.
- Respirators.
- Chemical and radiation detection equipment.
- Mobile equipment.
- Emergency protective clothing.
- Firefighting equipment.
- Ambulance.
- Rescue equipment.
- Trained personnel.

The emergency plan includes:

- All possible emergencies, consequences, required actions, written procedures, and the resources available.

- Detailed lists of emergency response personnel including their cell phone numbers, alternate contact details, and their duties and responsibilities.
- Floor plans.
- Large scale maps showing evacuation routes and service conduits (such as gas and water lines).

Development of an Emergency and Response Plan

The EPRP must comply with the IFC Occupational Safety Guidelines and Performance Standards. The EPRP must include:

- Roles and responsibilities of emergency personnel;
- Emergency contacts and communications systems/protocols, including procedures for interaction with local and regional emergency authorities;
- Specific emergency response procedures;
- Design and implementation of an emergency alarm system audible across the entire site;
- An evacuation plan which must be read and practiced by all employees and contractors. The evacuation plan will include emergency escape routes, procedures for accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation;
- Identification of supplies and resources to be utilized during an emergency event, including emergency equipment, facilities, and designated areas; and
- A training plan, which includes specific training and drill schedules for personnel who are responsible for rescue operations, medical duties, spill response, and fire response.

If an emergency develops, all persons on the project site must be notified immediately and efforts must be coordinated with others in the vicinity surrounding the project area in order to reduce impacts, if applicable. If an emergency is imminent, but has not yet begun, steps must be initiated to immediately advise persons in the vicinity of the emergency to evacuate and notifications will be made to the local ECD, the County Superintendent, local police, and all other authorities which have responsibility regarding the emergency.

If there is a slowly developing emergency or unusual situation where an emergency is not imminent, but could occur if no action is taken, project personnel will notify the ECD, the County Superintendent, local police, and all other authorities of the potential problem and keep them advised of the situation. These agencies will be requested to indicate if there are any immediate actions that will be taken to reduce the risk or severity of the emergency and if necessary, what preventative actions have to be implemented. In an emergency situation, equipment and supplies have to be needed on short notice. Therefore, the LEC must maintain an accurate inventory of emergency response equipment and supplies.

The EPRP will include an evacuation plan which will be read and practiced by all employees and contractors. The evacuation plan will include emergency escape routes, procedures for accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation. In general, the following evacuation procedures will be followed:

- Alert the Emergency Response Team to assist in the evacuation.
- Use communications tools that are appropriate for the type of incident and the time of occurrence, such as alarms or loud speakers.
- When communicating an evacuation, speak clearly and succinctly: “We have a [state the type of emergency]. Evacuate to [state the assembly point]”.
- Turn equipment off, if possible.
- Take emergency supplies and staff rosters, if possible.
- Account for personnel.
- Wait at the assembly point for further instructions.

The EPRP will have specific information on fire safety and explosion response, which will provide additional details specific to these emergencies.

Elements of ERP

Emergency Preparedness and Response Plan that is commensurate with the risks of the facility and that includes the following basic elements:

(a) Communication systems
(b) Emergency resources
(c) Training and updating
(d) Business Continuity and Contingency

Additional information is provided for key components of the emergency plan, as follows:

(1) Worker Notification and Communication

Alarm bells, visual alarms, or other forms of communication will be used to reliably alert workers to an emergency. Related measures according to IFC Guidelines include:

(a) Testing warning systems at least annually (fire alarms monthly), and more frequently if required by local regulations, equipment, or other considerations; and

(b) Installing a back-up system for communications on-site with off-site resources, such as fire departments, in the event that normal communication methods may be inoperable during an emergency.

Community Notification

If a local community may be at risk from a potential emergency arising at the facility, the company will implement communication measures to alert the community, such as:

(a) Audible alarms, such as fire bells or sirens;

(b) Fan out telephone call lists;

(c) Vehicle mounted speakers;

(d) Communicating details of the nature of the emergency;

(e) Communicating protection options (evacuation, quarantine); and

(f) Providing advice on selecting an appropriate protection option

Media and Agency Relations

Emergency information will be communicated to the media through:

(a) A trained, local spokesperson able to interact with relevant stakeholders, and offer guidance to the company for speaking to the media, government, and other agencies.

(b) Written press releases with accurate information, appropriate level of detail for the emergency, and for which accuracy can be guaranteed.

(2) Emergency Resources

(a) Fire Services

MR will consider the level of local firefighting capacity in the event of a major emergency or natural disaster. If insufficient capacity is available, firefighting capacity will be acquired that may include personal fire engine, pumps, water supplies, trucks, and training for personnel.

(b) Medical Services

MR will provide first aid attendants for the facility as well as medical equipment suitable for the personnel, type of operation, and the degree of treatment likely to be required prior to transportation to hospital during emergency case.

(c) Availability of Resources

Appropriate measures for managing the availability of resources in case of an emergency in Upper Myanmar region include:

(i) Maintaining a list of external equipment, personnel, facilities, funding, expert knowledge, and materials that may be required to respond to emergencies. The list will include personnel with specialized expertise for spill clean-up, flood control, engineering, water treatment, safety, environmental science, etc., or any of the functions required to adequately respond to the identified emergency.

(ii) Providing personnel who can readily call up resources, as required.

(iii) Tracking and managing the costs associated with emergency resources.

(iv) Considering the quantity, response time, capability, limitations, and cost of these resources, for both site-specific emergencies, and community or regional emergencies.

(v) Considering if external resources are unable to provide sufficient capacity during a regional emergency and whether additional resources may need to be maintained on-site.

Note: All of these resources will have alternate facilities.

(d) Mutual Aid

Mutual aid agreements decrease administrative confusion and provide a clear basis for response by mutual aid providers. Where appropriate, mutual aid agreements will be maintained with other organizations to allow for sharing of personnel and specialized equipment.

(e) Contact List

The company will develop a list of contact information for all internal and external resources and personnel in Upper Myanmar region. The list will include the name, description, location, and contact details (telephone, email) for each of the resources, and be maintained quarterly. The contact list will include General Administrative Office (Upper Myanmar), Myanmar Police Force (Upper Myanmar), Public Health and Medical Services (Upper Myanmar), Fire Services Department (Upper Myanmar), Fire Services Department (Upper Myanmar), Department of Relief & Resettlement (Mandalay) and Department of Relief & Resettlement (Mandalay) etc.

(3) Training and Updating

The emergency preparedness facilities and emergency response plans require maintenance, review, and updating to account for changes in equipment, personnel, and facilities. Training programs and practice exercises provide for testing systems to ensure an adequate level of emergency preparedness. Programs will:

(i) Identify training needs based on the roles and responsibilities, capabilities and requirements of personnel in an emergency

(ii) Develop a training plan to address needs, particularly for flood control, firefighting, spill response, and evacuation. Conduct annual training, at least, and perhaps more frequent training when the response includes specialized equipment, procedures, or hazards, or when otherwise mandated

(iii) Provide training exercises to allow personnel the opportunity to test emergency preparedness, including:

- Desktop exercises with only a few personnel, where the contact lists are tested and the facilities and communication assessed.
- Response exercises, typically involving drills that allow for testing of equipment and logistics.
- and what aspects require improvement.
- Update the plan, as required, after each exercise. Elements of the plan subject to significant change (such as contact lists) will be replaced.`
- Record training activities and the outcomes of the training.

(4) Business Continuity and Contingency

Measures to address business continuity and contingency include:

(i) Identifying replacement supplies or facilities to allow business continuity following an emergency. For example, alternate sources of water, electricity, and fuel are commonly sought.

(ii) Using redundant or duplicate supply systems as part of facility operations to increase the likelihood of business continuity.

(iii) Maintaining back-ups of critical information in a secure location to expedite the return to normal operations following an emergency.

Proposed Organization for ERP Team

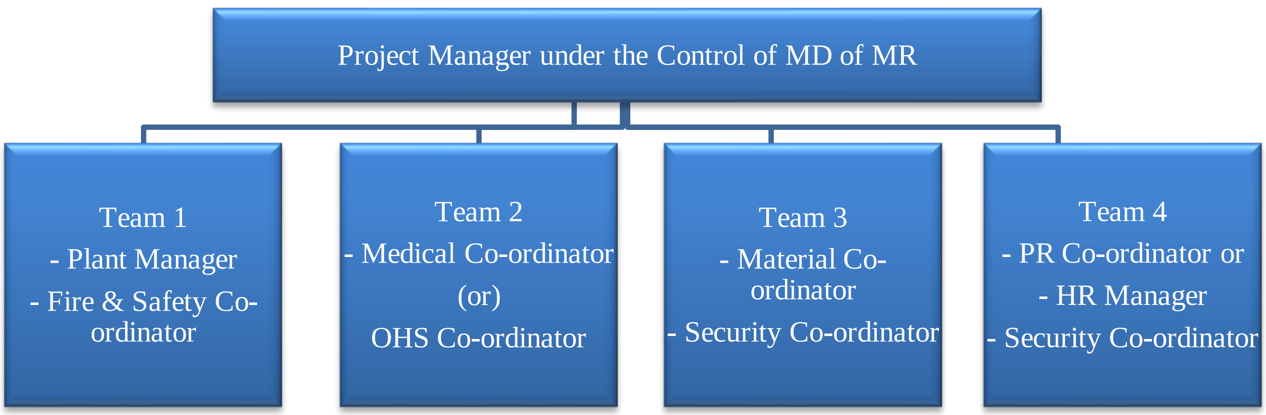


Figure 8.9. Proposed Organization for ERP Team

Proposed Duty Allocation for EPR Team

The followings are the proposed duty allocation for EPR team.

Chief Emergency Controller (General Manager)

- Take control and declare emergency.
- Focal person for all team.
- Contact Authorities.

Plant Manager

- Take steps. Make Emergency shut-down of activities. Put everything in Safe condition.
- Evacuate.

- Commence initial emergency case, till Fire Department or other agencies comes to take up.
- Identify materials requirements and call Material Manager.

Medical Coordinator

- Establish Emergency Center, Treat affected persons,
- Transfer/Remove Patients.
- Assign and Deploy staff.
- Contact Authorities.

Material Coordinator

- Dispatch necessary Supplies.
- Arrange Purchases.
- Providing equipment perform shutdown procedures, damage assessments, emergency repairs and equipment protection.

Fire & Safety Coordinator

- Be Overall in-charge for Fire and Safety.
- Coordinate with Area Coordinator and Direct the Operations.
- Coordinate with City and Other Fire-tenderers.

Public Relationship Coordinator & Security Coordinator

- Remove Crowd
- Arrange Gate security
- Contact Police
- Arrange evacuation
- Contact outside Agencies if asked.
- Handle news media
- Mobilize vehicles
- Arrange Food, clothing to Officers inside.

Emergency Control Center

- Adequate Internal phones
- Adequate external phones

- Workers Tally
- Map showing hazardous storages, Fire horns, Safety equipment, Gates and side gates, Assembly points, List of persons.

Evacuation Plan

Emergency Action Plan includes evacuation plans and procedures for implementation based on local needs. These could be:

- Demarcation/prioritization of areas to be evacuated;
- Notification procedures and evacuation instructions;
- Safe routes, transport and traffic control;
- Safe areas/shelters; and
- Functions and responsibilities of members of evacuation team.

Any precarious situation during floods will be communicated either by an alert situation or by an alert situation followed by a warning situation. An alert situation would indicate that although failure of flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is imminent as a result of an impending failure of the dam. It would normally include an order for evacuation of delineated inundation areas. The most vulnerable/submergence area in the downstream will be demarcated with the help of flood wave travel time analysis and accordingly would be planed the evacuation plan in inundation areas.

Evacuation Team

The evacuation team will comprise of following officials/representatives:

- Chief District Officer (CDO) or designated officer to immediately relocate people to places at higher elevation;
- Engineer-in-charge of the project;
- Superintendent of Police (SP) or his designated officer to maintain law and order;
- Chief Medical Officer (CMO) of respective district hospital to tackle morbidity of affected people;
- Head of the affected village/s to execute resettlement operations with the aid of district machinery and project proponents; and

- Sub-committees at village level.

The Engineer-in-Charge will be responsible for the entire operation including prompt determination of the flood situation time to time. Once the red alert is declared, the entire local state machinery will come into full swing and start evacuating people in inundation areas delineated in the inundation map. For successful execution, mock drills and demonstration exercise will be annually conducted. CDO is expected to monitor the entire operation.

8.5.4.7. Emergency Response for Fire

Typically, railway facilities can be considered as one of the fire hazard industry and proposed plant must have fire control plan. In order to achieve this target, firefighting system have to be designed in compliance with requirements of local firefighting station or the American National Fire Fighting Association (NFPA) standards as shown in table below.

Table - American National Fire Fighting Association (NFPA) Standards

No.	Parameters	Proposed Capacity
1.	Maximum water pressure	14 bar
2.	Fire water flow	12.0 liters/m^2/min

Structural Response During Fire Event

The structural response during a fire is determined by the high temperature material properties and the temperature of the bridge members. The bridge system involves a complex interaction between components and substantial temperature gradients throughout the structure. The end boundary conditions of the fire-affected span, such as expansion joints and multi-span continuity, will also have an effect on structural response. The most accurate way to predict high temperature bridge response is to use refined analysis methods such as 3D non-linear finite element analysis (FEA). Behavior approximations are possible based on strain compatibility if the temperature distribution is known. Any type of structural analysis requires knowledge of two things; the temperatures developed in the structure and high temperature material properties. The methodology involved a coupled, three-step procedure that simulates the fire event and heat transfer to the bridge, performs a thermal analysis to determine the material temperatures at all locations, and performs a non-linear structural analysis that is programmed with the high temperature material properties. This procedure involves advanced software and computer resources that typically exceed those available to bridge engineers. While they can serve as a model methodology for engineers if the tools are available, the most valuable use is to serve as benchmarks for evaluating structural temperature and response using simpler engineering analysis methods. Knowing the high temperature structural response of bridges is useful for predicting behavior prior to fire events. The maximum deflection at high temperatures is determined by thermal expansion effects, reduced material strength, the reduced modulus of materials at high temperatures, and the effects of creep. When the structure cools after the fire event, a substantial amount of this deflection recovers. It is even possible in some cases to have some positive residual camber if localized yielding occurs during the fire. If the deflection recovers, the geometry of the bridge is still suitable for its intended traffic use. Any affect on load rating needs to be determined based on a survey of localized damage and post-fire material properties. Predicting the maximum high temperature deflection of structures is interesting, but the most important aspect is to predict the presence of permanent deformation after the fire. Although not practical in most cases, a rigorous fire engineering analysis could be performed in the design process to predict the ability of a bridge to remain serviceable following fire events. The most important engineering problem is to evaluate the post-fire strength and serviceability of the bridge structure. Any permanent deflections will be obvious and their impact can be assessed without the need for high temperature modeling.

Fire Fighting Equipment

The proposed project will be equipped with the following firefighting systems:

(a) Firewater system and posts; and
(b) Firefighting foam and
(c) Portable Fire extinguishers.

All of the firefighting facilities will be equipped according to the rules and regulations of local firefighting station (Upper Myanmar).

(a) Firewater System and Posts

Firewater posts will be equipped with the interval of 80m or according to the local firefighting station's rules and regulations. Tools and accessories will be provided in box at each post.

(b) Firefighting Foam

Firefighting foam is foam used for fire suppression. Its role is to cool the fire and to coat the fuel, preventing its contact with oxygen, resulting in suppression of the combustion.

Types of foam are aqueous film forming foams (AFFF), film-forming fluoroprotein (FFFP), alcohol-resistant fluoroprotein foam (AR-FP), and alcohol-resistant film-forming fluoroprotein (AR-FFFP). Every type of foam has its application. High-expansion foams are used when an enclosed space, such as a basement or hangar, must be quickly filled. Low-expansion foams are used on burning spills. AFFF is best for spills of jet fuels, FFFP is better for cases where the burning fuel can form deeper pools, and AR-AFFF is suitable for burning alcohols. The most flexibility is achieved by AR-AFFF or AR-FFFP. AR-AFFF must be used in areas where gasolines are blended with oxygenates, since the alcohols prevent the formation of the film between the FFFP foam and the gasoline, breaking down the foam, rendering the FFFP foam virtually useless.

General Guidelines for the Storage and Handling of Foam Concentrates

The effective life of foam concentrates can be maximized through optimal storage conditions and proper handling. Foam concentrates have demonstrated effective firefighting performance with contents stored in the original package under proper conditions for more than 10 years. To optimize the effective life and performance of firefighting foams they will be stored in the following ways:

Do not expose to direct sunlight or any heat source. The product will be maintained within the recommended temperature range - refer to specific foam concentrate product data sheet for recommended storage temperatures. The storage area will not be susceptible to flooding.

Fire Protection Products recommends tracking of inventory batch numbers and rotating inventory to ensure older batches are used first. Foam color may differ from batch to batch, and foam color can also change during aging. Mixing firefighting foam concentrates (different types, brands, products) for long-term storage is not recommended. However, it is appropriate to use in conjunction with comparable firefighting foam type for immediate incident response. Contact the manufacturer prior to topping off existing stock with any new foam other than the original product.

Inspection

The foam concentrate will be inspected periodically in accordance with any of the following standards: NFPA 11, EN 13565 -2, or other relevant standard. A representative concentrate sample will be sent to qualified laboratory for quality analysis per the applicable standard. An annual inspection and sample analysis is typically sufficient. In case of any doubts, please contact the manufacturer.

Specific guidelines on the storage of foam concentrate

Totes/Original Packing (Optimum Storage)

The following guidelines are recommended when storing foam concentrates in totes**:**

- Totes are best stored in an environmentally controlled, indoor warehouse
- The storage area around the tote will be clean
- The tote will be stored on the floor and on a rack system rated for the volume of foam concentrate being stored
- Tote will be kept closed and sealed during storage

(c) Portable Fire Extinguishers

Fire Extinguishers of suitable type e.g. CO_2 and DCP extinguishers shall be provided in the proposed project and shall be distributed in vulnerable areas. The extinguishers shall be checked/inspected at regular intervals for replenishment according to the rules and regulations of firefighting station (Amarpura).

Safety Equipment and Personal Protective Appliances for Fire Fighting

Safety and personal protective appliances shall be provided in adequate numbers and shall be distributed in different sections according to requirement. A list of such appliances that must be available in the plant is given in the Table below.

Table - List of Safety Equipment for Fire Fighting

No.	Safety Equipment
1.	Gas Mask
2.	Compressed air breathing apparatus
3.	PVC hand gloves
4.	Electrical hand gloves
5.	PVC apron
6.	Face shield of different colour
7.	Goggles of different types
8.	Safety belt
9.	Safety helmet
10.	Leather hand gloves
11.	Chargeable hand set
12.	Ear muffs and ear plugs
13.	Smoke exhauster cum blower

Proposed Organization for Fire Fighting Team

Firefighting organization is proposed for MR as follow:

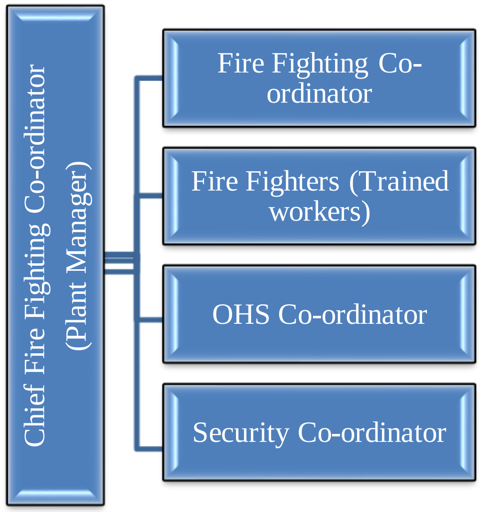


Figure 8.10. Proposed Organization for Fire Fighting Team

Role and Responsibilities of Fire Fighting Team

The following role and responsibilities for firefighting team but not limited are recommended to the project operator(s)/

Team Members	Role	Responsibilities
Plant Manager	Chief co-coordinator	• Make Emergency shut-down of activities. Put everything in Safe condition. • Commence initial emergency case, till firefighting department (Upper Myanmar) comes to take up.
Firefighting leader	Firefighting co-coordinator	• Be Overall in-charge for Fire and Safety. • Coordinate with Local firefighting station.
Trained workers and securities	Fire fighters	• Put off fire by using available equipment.
Safety officer	OHS co-coordinator	• Establish Emergency Center, Treat affected persons, Transfer/Remove Patients. • Workers Tally • Map showing hazardous storages, Fire horns, Safety equipment, Gates and side gates, Assembly points, List of persons.
Security leader	Security co-coordinator	• Remove Crowd • Arrange Gate security • Contact Police if necessary • Handle news media • Mobilize vehicles

8.5.4.8. Emergency Response to Structural Collapses

The personnel involved in a structural collapse response will be highly dependent on the type of event. In general, following personnel will be involved in most responses to a large structural collapse:

- Firefighters
- Emergency managers
- Skilled support personnel, including construction, trade services, utility, transit, public works, and other private-sector workers
- Employees
- Volunteers, both organized and independent

Response Activities at a Structural Collapse

Several phases and operations occur in a structural collapse such as

- Phase 1: arrival on scene
- Phase 2: pre-rescue operations
- Phase 3: rescue operations
- Phase 4: selected debris removal
- Phase 5: debris removal and termination

Arrival on the scene is concerned with command and coordination functions. Carrying out these functions requires establishing a chain of command, positioning equipment, and setting up a staging area from which operations can be managed.

Pre-rescue operations involve assessing possible hazards at the site. At the same time, the incident command establishes a perimeter and, in coordination with the police, maintains access into and out of the site.

During rescue operations, command implements an action plan to search for remaining victims. If the location of victims is unknown or if victims are potentially buried, then debris must be removed.

Finally, general debris removal begins when it has been ascertained that no live victims remain at the site.

Work at a building collapse can be extremely demanding physically. The combination of hazards that particular responders face depends on their roles during the response and the zones in which those roles must be carried out.

Internal Department

The primary focus of disaster management system is to mitigate the effects of disaster on port community wherever possible or practical, while preparing to respond when disaster occur. The role and responsibilities specifically for each phase being

Specific responsibilities – Response Phase

- Activate the disaster management response team and also crisis response team.
- Activate the relevant / workplace emergency team for the first strike response including traffic and pollution
- Thereafter assist emergency services to respond to the event.
- Assist with providing relief for persons affected by disaster.

Specific responsibilities – Recovery Phase

- Satisfy immediate, essential personal and port community needs to extent of port capability.
- Maintain liaison and timely communication with district disaster coordinator.
- Contribute to the recovery function coordinated by District Disaster coordinating authority.
- Coordinate the recovery of physical infrastructure.
- Coordinate activities with relevant Disaster district initiatives and plans.
- Participate in long term recovery, reconstruction and rehabilitation
- Communicating regarding restoration of Plant activities.

8.5.4.9. Flood

DEPT	ACTION
EMT	• Signal Station passes weather message to On-scenne Commender and Planning Leader • HM places on-site action group alert • Conservator apprises Chairman of weather developments who places CMG on alert if necessary.
Civil Dept.	• Drainage system of the bridge and culverts • Sand bags to be used around sensitive areas including water supply

E & M Dept.	• All the outside installations and equipment shall be properly secured. • Cyclone field units to be made alert
Administration	• To make standby arrangements for transportation to evacuate population to cyclone centres and relief centres. • Arrange food and water.

8.5.4.10. Relife Work after an Earthquake

ACTION
To contact the District Collector, Relief Commissioner, Army, fire force and seek assistance for project site.
To assist the Chairman to assess relief requirements. Arrange Food, shelter & transportation
To provide and hire if necessary, earthmoving equipments, cranes, forklifts, bull dozers etc.
Deploy engineers to direct or guide earth moving equipment and cranes to remove the debris
To organise Search and Rescue of persons trapped under debris.
Medical officer to ensure provide of proper Medical Aid to the injured

- If outdoors, find a clear spot away from buildings, trees, streetlights, and power lines. Keep lying on the ground and stay there until the shaking stops. Injuries can occur from falling trees, street-lights and power lines, or building debris.
- If on vehicle, pull over to a clear location, stop and stay with your seatbelt fastened until the shaking has stopped. Trees, power lines, poles, street signs, and other overhead items may fall during earthquakes. Stopping will help reduce your risk. Once the shaking has stopped, proceed with caution. Avoid bridges or ramps that might have been damaged by the quake.
- If indoor – Go below bed / table until the shaking stops. Avoid lift and Staircase.

8.5.5. Waste Management Plan

8.5.5.1. Objective

The purpose of the waste management plan is the following:

- To develop action plans for achieving the objectives of the waste management plan;
- Monitor discharge sources (waste water and solid waste) and operation of environmental protection equipment in order to ensure that these activities will comply with legislative requirements; and
- To provide guidance on how to minimize, handle, contain, control, re-use, recycle and dispose of all waste generated.

8.5.5.2. Legal Requirements

Prevention from Danger of Chemical and Associated Materials Law (Law No 28)

- To prevent from damaging the environmental resources and from endangering the lively creatures due to the chemical and associated materials
- To control systematically for the safety in carrying out in accord with the approval for chemical and associated materials business
- To carry out the data information acquiring system and to widely do the educating and research works in order to utilize the chemical and associated materials systematically
- To carry out continuous development for worksite safety, health and environmental conservation

Conservation of Water Resources and Rivers Law (Law No 8, 11(a), 13,19,24(b),30)

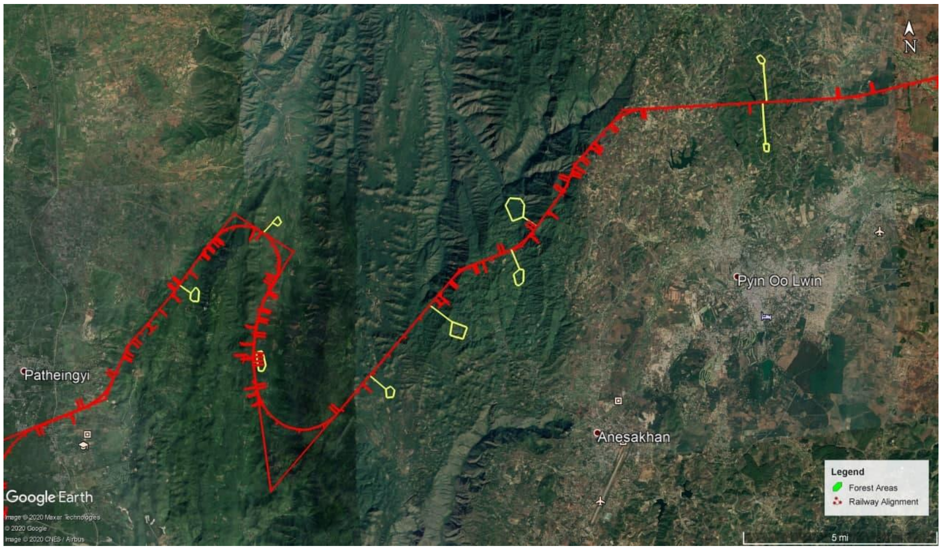
- To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.

The Prevention of Hazard from Chemicals and Related Substances Rules (Law No.8, 15, 16, 17, 20, 22, 23, 27)

- Performing the sticking pictogram for being least the health impacts and accident injuries in the occupational area according to the prescribed standards and norms of the Globally Harmonized System GHS);
- Making the necessary arrangements to be safety of the occupational area and issuing orders and directives for preventing and decreasing the accident;
- Laying down the proliferation plans on knowledge, and safety of chemical and related substances to administrators, license holders, public and workers;
- Cooperating with local and foreign governmental departments, organizations and non-governmental organizations in respect of safety management for chemicals hazard.

8.5.5.3. Overview Maps

The proposed waste dumping sites along the railway alignment for the waste management plan are shown in the following figures.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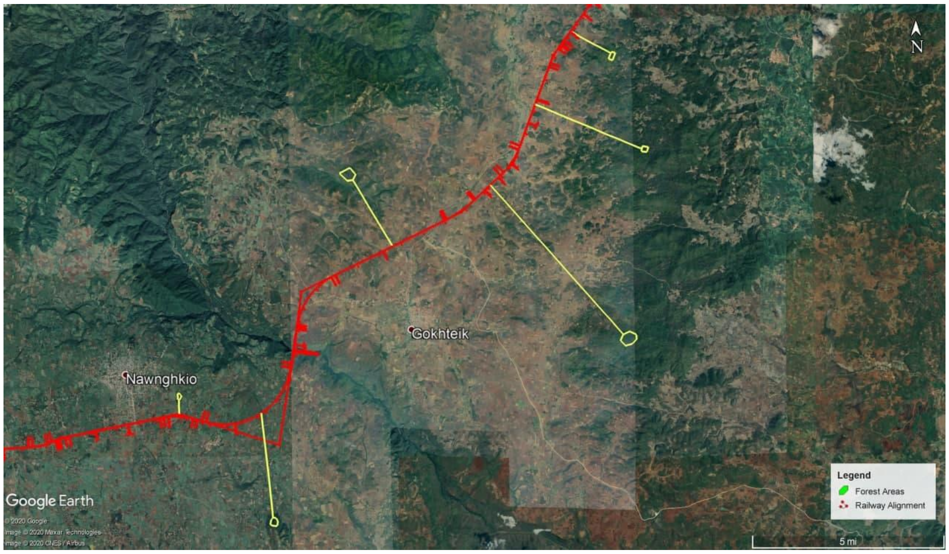
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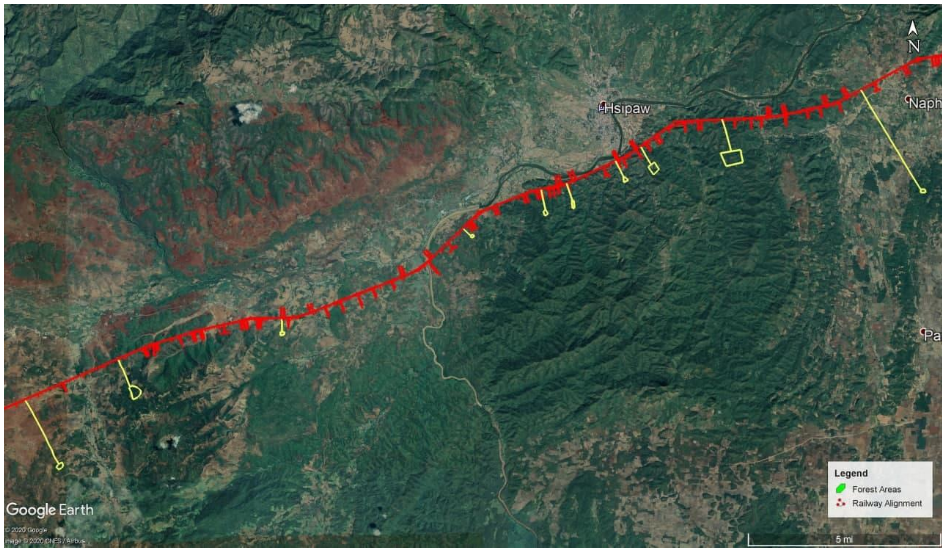
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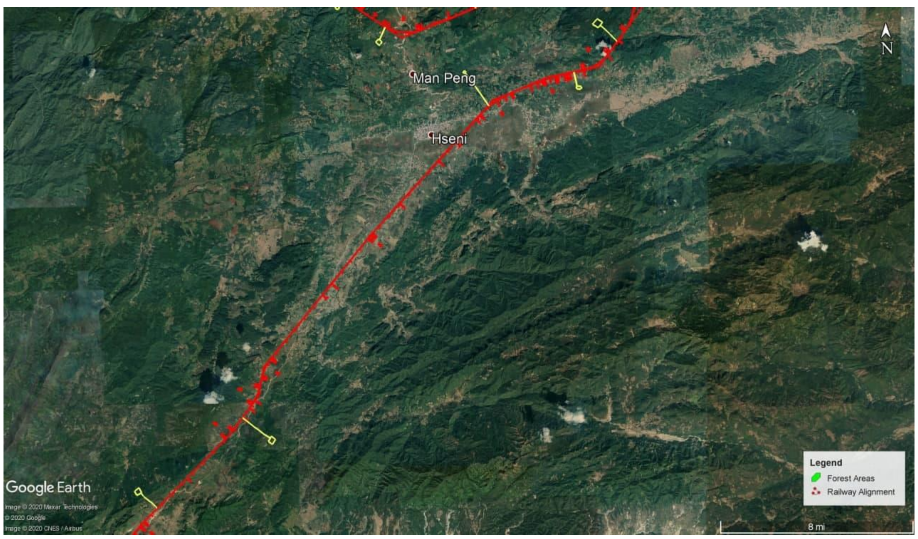
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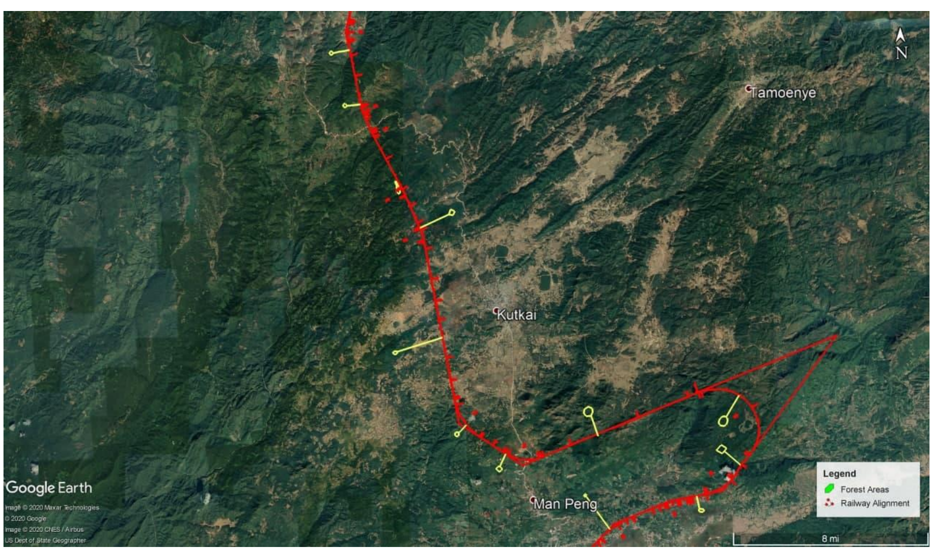
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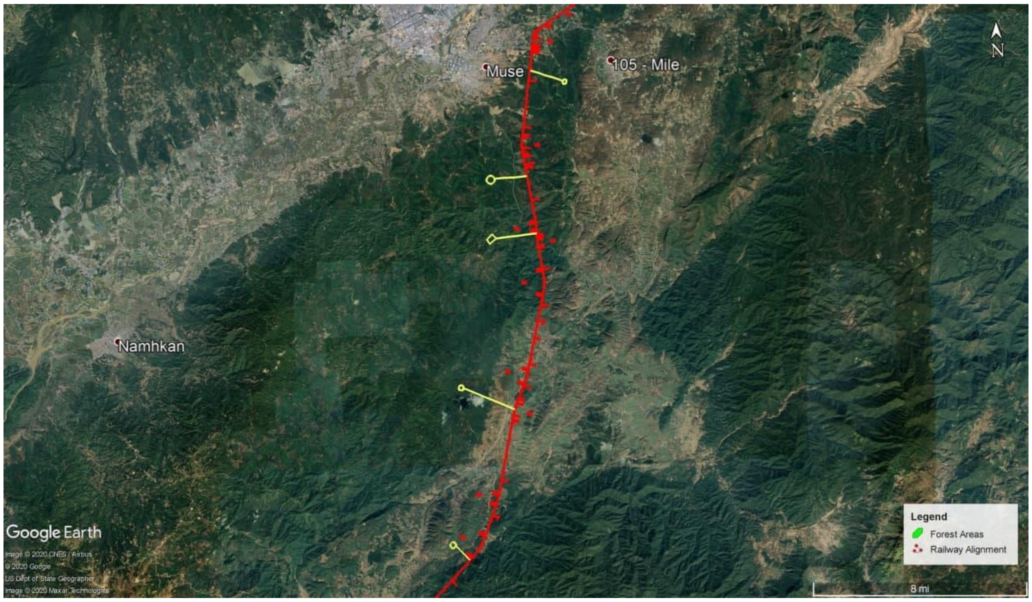


Figure - Waste dumping sites along the railway alignment

8.5.5.4. Management and Monitoring Plans

The waste management plan will thus have a positive contribution in reducing disposal costs, minimizing waste going to landfill sites, and an overall contribution to integrated waste management according to the rules and regulations of CDC. Adherence to the waste management plan should be exercised by all employees, contractors and service providers to ensure proper waste management is applied. This will be undertaken when appointed and through regular auditing. Service providers and contractors are required to furnish evidence of proper waste management (i.e., classification, quantities and disposal).

To help manage waste effectively, the Project has committed to implementing the "hierarchy of waste management" with a focus on waste prevention; and then a decreasing focus on waste reuse; recycling; recovery and elimination. Only when waste prevention cannot be achieved will the waste be reused, recycled or used as a source of energy.

(a) Waste avoidance
(b) Re-use
(c) Recycling
(d) Energy recovery
(e) Treatment
(f) Disposal

Solid Waste during Construction

In a bridge construction site, types of solid wastes include:

- Agro-waste (Organic)
- Industrial waste (Inorganic)
- Non-hazardous waste

Agro-waste

Agro-waste includes rice, vegetable residue, and kitchen waste from temporary facilities of workers. A certain amount of domestic waste will be generated from construction workforce. The establishment of labor camps will also effect on environment through improper waste (solid & garbage /sewage) disposal. Management of domestic waste can be done by as follows:

- Domestic waste generated during construction period shall be cleaned up in time and collected every day.
- Food waste can be reused as farmyard manure.
- The rest of the waste should be transported to the garbage dump for disposal.
- The stacking position of construction materials should be far away from the water body.

Industrial waste & Non-hazardous waste

Industrial waste mainly consists of construction debris. Non-hazardous waste includes waste gypsum, lime sludge, and lime stone waste, etc. Raw construction and demolition debris can be diverted and used as a resource. Some materials that can be diverted include:

- Landscape and land clearing debris
- Gravel and aggregate products
- Concrete
- Plastics
- Insulation materials

In operation phase, it will be mainly maintenance works. Maintenance is done to preserve bridges and their components, prevent future deterioration, and sustain or improve their condition. A few things that should be done to preserve bridges include:

- Washing and cleaning
- Sealing deck joints
- Clearing drainage area

- Sealing cracks
- Painting exposed elements
- Removing trash and other debris
- Protecting against scour
- Lubricating bearings

We should try to reduce source of waste because when source of waste is reduced, the life-cycle of material use, energy use, and waste generation can also be reduced. Source reduction prevents waste from being generated, e.g., designing new bridges for adaptability to prolong their life, use of construction methods that allow disassembly and facilitate reuse of materials, and employing alternative framing techniques. It can also conserve landfill space, reduces the environmental impact of producing new materials, and can cut down the overall project expenses through avoided purposes.

Valuable construction and demolition materials for further use are an effective way to save money and conserve natural resources. Much construction debris can be recycled. Concrete and rubble can be recycled into aggregate and concrete products. Metals like steel, copper, and brass are also valuable resources to recycle.

The following methods can be used to recycle waste:

1. **Site-separated**: This uses multiple boxes for each type of waste. Separating waste on the job site gives immediate feedback to everyone on the job and can help to ensure that the project's recycling goals are met. Site separation also promotes a responsible atmosphere on the job site and is the best method for diversion goals. It does, however, take up more space and requires a high level of supervision.
2. **Commingled recycling**: This type of recycling uses one container. The hauler sorts everything off-site. This makes it easier for the field staff to manage waste on-site. Commingled recycling requires little storage space and is the best option for sites that are tight on space.
3. **Hybrid recycling**: This type of recycling combines site-separation and commingled recycling. For instance, one box for wood, one box for concrete, and one box for non-recyclable waste. It optimizes the weight vs. sorting effort. The total number of boxes can be reduced by working in phases. It reduces work for sorting haulers, which reduces hauling fee.

Benefits of reducing disposal of construction and demolition waste include:

1. Reduction in overall building project expenses through avoided purchase costs and donation of recovered materials to qualified charities, which offers a tax benefit. Transportation costs also come down with onsite material reuse.
2. Fewer disposal facilities which educe associated environmental issues.
3. Conserve landfill space.
4. The environmental impact associated with the extraction and consumption of virgin resources and the production of new materials is offset.

Disposal options for excavated waste

Solid wastes will be removed and transported to dumping site or landfill on a daily basis. Wastes which cannot be reused or recycled, such as debris from excavation works which cannot be reused in foundation works, will be disposed of in a permitted disposal facility. Excavated soil, sediment, or tailings can be disposed of either on site, in an approved repository constructed for this purpose or another location where the exposure pathways allow the material to be beneficially reused, or off site in a permitted disposal facility. Solid wastes will be removed and transported to dumping site or landfill on a daily basis.

Selection of Landfill

An ideal sanitary landfill:

1. Will meet local zoning and land use criteria, including local road weight limits and other limitations;
2. Is easily accessible by solid waste vehicles in all weather conditions;
3. Safely protects surface and groundwater quality;
4. Controls landfill gas;
5. Has access to earth cover material that can be easily handled and compacted;
6. Is located where the landfill's operation will not affect external environmentally sensitive areas;
7. Should not be very close to significant water bodies (water courses or dams);
8. Will be that no major power transmission or other infrastructure like sewers, water supply lines should be crossing through landfill developmental area;
9. Comprises enough land and internal capacity to provide a buffer zone from neighboring properties and is able to be expanded; and

10. Will be the most economic site available given haul distances to user communities and other economic considerations.

Sewage and Domestic Wastewater

Wastewater comes from ordinary living processes: bathing, toilet flushing, laundry, dishwashing, etc. from temporary facilities.

Wastewater is broken into two categories, depending upon the source.

1. Gray water: Gray water is from showers, laundry, dishwashing and sinks other than the kitchen sinks.
2. Black water: Black water is from toilets and kitchen sinks.

Wastewater also includes rainwater that has accumulated pollutants as it runs into oceans, lakes, and rivers. Pollutants are unwanted chemicals or materials that contaminate air, soil, and water.

Sewage treatment involves three stages: primary treatment, secondary treatment, and tertiary treatment.

Primary treatment physically separates solids and liquids. The wastewater passes through a grating that strains out large particles. The remaining water is left to stand in a tank, where smaller sediments (particles of sand, clay, and other materials) settle to the bottom. These sediments are called sludge. At this point, this liquid part of the wastewater still contains many pollutants and is not safe for exposure to humans or the environment.

In secondary treatment, the liquid part of the wastewater passes through a trickling filter or an aeration tank. A trickling filter is a set of pipes with small holes in it that dribbles water over a bed of stones or corrugated plastic. Bacteria in the stones or plastic absorb pollutants from water and break them down into substances that are not harmful. An aeration tank is a tank that contains bacteria that break down pollutants. The liquid part of the wastewater from primary treatment is pumped into the tank and mixed with the bacteria. Air is bubbled through the tank to help the bacteria grow. As bacteria accumulate, they settle to the bottom of the tank and form sludge. The sludge is removed from the bottom of the tank and buried in landfills.

After secondary treatment, the water is generally free from the majority of pathogens and heavy metals. It still contains high concentrations of nitrate and phosphate, minerals that can over-stimulate the growth of algae and plants in natural waters, which can ultimately cause them and the surrounding organisms to die. Tertiary treatment removes these nutrients from the wastewater. One method of tertiary treatment involves using biological, chemical, and physical processes to remove these nutrients. Another method is to pass the water through a wetland or lagoon.

Wastewater should be treated before discharging to the land, or to surface or groundwater. At least secondary treatment should be done before discharging.

Hazardous Waste

In a bridge construction and maintenance works, most common hazardous waste includes paint from painting works, fuel oils from transportation and lubricants from lubricating works. The surrounding water that includes fuel oil and lubricants can cause waste oil (increase in oil and grease content in nearest water bodies) for a while.

Paint

Temporary Onsite Storage

- Appropriate clean, dry, weatherproof, watertight containers.
- Labeling of paint waste containers onsite
- Container Storage area shall be secured
- Removal waste shall be deposited and sealed in containers or roll-offs concurrent with generation
- Containers shall be labeled prior to filling
- Close containers when they are not in use
- Maintain a daily waste transfer log, which will detail how much and what type of waste was placed in the container, and by whom.
- Do not over accumulate.
- Store in a cool, dry area, away from direct sunlight.

Figure: Lead Storage

(Ref. https://www.dot.ny.gov/main/business-center/contractors/construction-division/construction-repository/Lead_Paint_Final.pdf)

Transport and Disposal

- Evidence presented that the transporter is a registered licensed professional driver.

- Hazardous paint waste (lead-based paint) is required to be transported using a hazardous waste manifest typically prepared by the transporter or contractor.

- Transport to an approved treatment, storage, or disposal facility (TSDF) is required.

- Transported by truck over public highway. Highway shipment is the most common because road vehicles can gain access to most industrial sites and approved TSDFs.

Environmental Precautions

- Keep out of drains, sewers, ditches, and waterways.

- Minimize use of water to prevent environmental contamination.

- Methods for Containment: Contain and/or absorb spill with inert material (e.g. sand, vermiculite), then place in a suitable container. Do not flush to sewer or allow entering waterways. Use appropriate Personal Protective Equipment (PPE).

- Methods for Clean-Up: Scoop up material and place in a disposal container. Provide ventilation.

Waste Oil

1) Engine oil or fuel filters will be crushed and evacuated of oil. Filters will be stored in clearly labeled bunded filter ponds for collection and recycling by a licensed contractor There will be a prior agreement with the MCDC for the disposal of any hazardous waste generated.
2) Temporary sedimentation pond on the waterway to nearest water courses
3) Hydrocarbon wastes such as waste oils, fuels, lubricants and hydraulic fluids generated from the maintenance of light vehicles, plant and equipment will be stored in approved containers and conditions onsite prior to removal offsite for treatment and disposal by a licensed waste management contractor at a licensed waste management facility.
4) Pump all of the remaining fuel oil inside the tanks and pipe lines. Care has to be taken the remaining oil are not disposed to nearest water bodies directly.
5) Other miscellaneous oil/hydrocarbon wastes will be stored in designated bins for collection by a licensed contractor for energy recovery and/or disposal. Coolants will be stored in a separate tank for collection and reconditioning by suppliers.

Lubricants

Handling

- Prevent small spills and leakage to avoid slip hazard.
- Prevent small spills and leakage to avoid slip hazard. Material can accumulate static charges which may cause an electrical spark (ignition source).
- When the material is handled in bulk, an electrical spark could ignite any flammable vapors from liquids or residues that may be present (e.g., during switch-loading operations).
- Use proper bonding and/or earthing procedures. However, bonding and earthing may not eliminate the hazard from static accumulation.
- Consult local applicable standards for guidance.

Storage

- Do not store in open or unlabeled containers.
- Store in cool, dry, ventilated area, away from heat and ignition sources. Use good personal hygiene. Always keep the container close and the type of container used to store the material may affect static accumulation and dissipation.

Spill Management

Land Spill: Stop leak. Recover by pumping or with suitable absorbent.

Water Spill: Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants. Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted.

Disposal Considerations

- Use material for its intended purpose or recycle if possible. Oil collection services are available for used oil recycling or disposal.
- Place contaminated materials in containers and dispose of in a manner consistent with applicable regulations. Contact your sales representative or local environmental or health authorities for approved disposal or recycling methods.

Diesel Oil

Handling

- Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk. DO NOT reuse empty containers without commercial cleaning or reconditioning. Ground/bond line and equipment during pumping or transfer to avoid accumulation of static charge. Do not breathe gas/vapour/spray. In case of insufficient ventilation, wear suitable respiratory equipment.
- If ingested, seek medical advice immediately. Avoid contact with skin and eyes. Practice good personal hygiene. Wash hands after handling and before eating. Launder work clothes frequently. Discard saturated leather goods.
- Diesel is a flammable liquid and is dangerous unless handled and stored properly. Children and pets should have no access to the storage tanks to avoid accidents. Adult access to the tanks should be limited to only those who need access for refueling or maintenance of the tanks.
- The fuel should be stored in an isolated area away from residences. An above-ground container may be installed in a building or under a lean-to. This location helps prevent water from harming the tank and prevents radiant heat from evaporating the diesel.

Storage

- Store at cool, ventilated and specified place.
- Store in tightly closed containers in cool, dry, isolated, well-ventilated area, and away from incompatibles. Ground all equipment containing material.
- Keeping the fuel away from ignition sources is important. While diesel has a higher ignition point than gasoline, it is still flammable. Any electrical outlets nearby should be rated for explosions. No smoking should be allowed within 50 to 100 feet of the storage area.
- If a small amount of diesel fuel needs to be restored, keep it in portable 5-gallon gas cans that can take to the gas station. For larger amounts, store in special storage containers, such as 55-gallon drums or a stand-alone tank.
- Larger diesel tanks, made of metal or specially formulated polyethylene, can be installed above ground or below ground, depending on the site and local regulations.

These tanks can also be mounted on the back of trucks when necessary. The exact size of the tank is, of course, dependent on how much fuel needs to be stored.

Disposal Considerations

- Preferred waste management priorities are: (1) recycle or reprocess; (2) incineration with energy recovery; (3) disposal at licensed waste disposal facility. Ensure that disposal or reprocessing is in compliance with government requirements and local disposal regulations. Consult local or regional authorities.
- On large scale absorb and landfill , allow for atmospheric evaporation.

Fuel Oil

Handling

- Precautions for safe handling: Provide adequate ventilation. Use personal protective equipment as required.
- Do not breathe vapor/aerosol. Avoid contact with skin, eyes and clothing. Take any precaution to avoid mixing with combustibles. Ensure proper process control to avoid excess waste discharge (temperature, concentration, pH, time).
- Do not allow to enter into surface water or drains. Obtain special instructions before use. (Do not handle until all safety precautions have been read and understood.).
- Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Ensure equipment is adequately earthed. Use explosion-proof equipment. Use only non-sparking tools.
- Product may release Hydrogen Sulphide: A specific assessment of inhalation risks from the presence of hydrogen sulphide in tank head spaces, confined spaces, product residue, tank waste and waste water, and unintentional releases should be made to help determine controls appropriate to local circumstances.
- Hygiene measures: Keep good industrial hygiene. Wash hands immediately after handling the product. When using, do not eat, drink or smoke. Keep away from food, drink and animal feeding stuffs. Separate working clothes from town clothes. Take off contaminated clothing. Wash contaminated clothing before reuse.

Storage

- Conditions for safe storage, including any incompatibilities

- Technical measures: Store in a dry, cool and well-ventilated place. Bund storage facilities to prevent soil and water pollution in the event of spillage.
- Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
- Product may release Hydrogen Sulphide: A specific assessment of inhalation risks from the presence of hydrogen sulphide in tank head spaces, confined spaces, product residue, tank waste and waste water, and unintentional releases should be made to help determine controls appropriate to local circumstances.
- Packaging materials: Keep only in the original container. Suitable material: Carbon steel. Stainless steel.
- Unsuitable material: synthetic material.

Disposal Considerations

- Do not allow to enter into surface water or drains. Dispose of empty containers and wastes safely. Refer to manufacturer/supplier for information on recovery/recycling. Recycling is preferred to disposal or incineration.
- If recycling is not possible, eliminate in accordance with local valid waste disposal regulations.
- Additional information: Handle contaminated packages in the same way as the substance itself. Dispose of contaminated materials in accordance with current regulations. Do not pierce or burn, even after use. Never use pressure to empty container.

Treatment of Hydrocarbon-Containing Wastewater

Concentrations of petroleum hydrocarbons in wastewater may decrease due to natural processes of decomposition and chemical oxidation, evaporation and biological degradation by native microflora. In natural environments, however, these processes are relatively slow. To enhance the oil contaminant removal from wastewater, the mechanical, chemical, physicochemical and biological methods, as well as their combinations, are employed, providing the required purification rate at reasonable costs. Importantly, the choice of a treatment method in each case is determined by the source of wastewater, the diversity and levels of contaminants, and the subsequent intended use of treated effluents.

Treatment of petroleum wastewater usually involves two stages, firstly, physical (mechanical) pre-treatment to remove free oil & grease fractions and suspended particles. Secondly, an advanced treatment, usually involving a combination of different physicochemical and biological methods, to decrease the pollutant level to acceptable discharge values

a) The sedimentation treatment, which is used to separate bulk free oil from water, is mechanically achieved by gravity in API (American Petroleum Institute) or CPI (Corrugated Plate Interceptor) separators and dissolved air floatation (DAF) units. During wastewater sedimentation, insoluble solids are also removed, which prevents clogging and wearing of devices used in subsequent treatment stages.

b) Mechanical treatment techniques, while allowing the reuse of roughly purified water in the operation cycle, are inefficient in the recovery of finely dispersed oil, dissolved organics, metals and colloids. The mechanical step is followed by the physiochemical step, in which small-sized suspended solids and dispersed oil are further reduced by agglomeration into large-sized particles to ease the removal by filtration, sedimentation or floatation.

All hazardous waste areas should be inspected weekly. Any concerns should be documented and fixed. If there are any spills, clean up and disposed of properly. Waste analysis and waste determination records should be kept. Among several options available for hazardous waste management, the most desirable method is to reduce the quantity of waste at its source or to recycle the materials for some other productive use. However, some amount of hazardous waste needs to be treated, or disposed. Hazardous wastes must be deposited in secure landfills, which provide at least 3 meters (10 feet) of separation between the bottom of the landfill and the underlying bedrock or groundwater table.

8.5.6. Community Development and Rehabilitation Plan

8.5.6.1. Objectives

A community development and rehabilitation plan aim to:

- supporting people with disabilities to maximize their physical and mental abilities, to access regular services and opportunities, and to become active contributors to the community and society at large;

- activating communities to promote and protect the human rights of people with disabilities for example by removing barriers to participation;
- Facilitating capacity building, empowerment and community mobilization of people with disabilities and their families.

8.5.6.2. Legal Requirements

Village Regional Development Law (Law No. 39)

- To ensure that people in rural areas have access to personal hygiene and home pollution prevention activities by working together with the relevant government departments, government agencies, and non-governmental organizations
- To ensure the continuity of the development of rural areas and the social development of the rural population.
- To maximize the efficiency of human resources and finances that can be achieved in rural development activities, including the participation of the people

Law Regarding Population Control & Health (Law No. 28)

- To improve living standards while alleviating poverty in the country;
- To ensure sufficient quality healthcare; and
- To develop maternal and child health

Land Acquisition, Resettlement and Rehabilitation Law (Section 39,41,42,46,54 (b and c), 58)

- In this law, it is stipulated that the government holds right to take over land provided that the compensation is made to the orginal land owner. No private ownership of land is permitted
- To prevent potential impacts on environmental and social sectors due to land use for projects

8.5.6.3. Overview Map

As the line pass through the Muse to Mandalay, there are many residential areas (e.g. villages, towns) along the railway. The locations of nearby residential areas along the project are shown in the following figure.

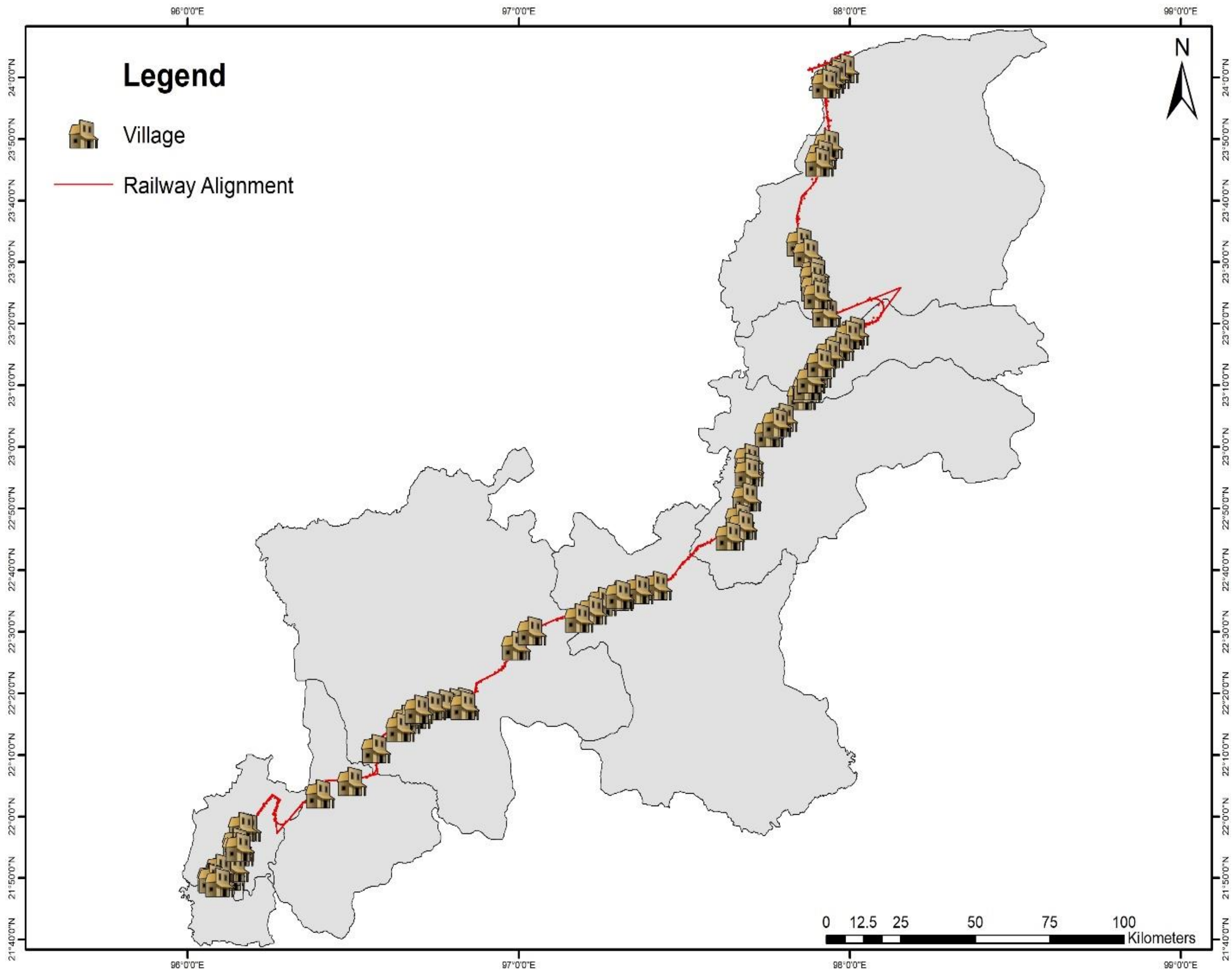


Figure – Residential Areas along the Railway

8.5.6.4. Management Actions and Monitoring Plans

Building Trust – Mobilizing Community

Community mobilization is done by bringing together as many stakeholders as possible to raise people's awareness of and demand for a particular programme, to assist in the delivery of resources and services, and to strengthen community participation for sustainability and self-reliance. A lot can be achieved when people from different parts of the community share a common goal and actively participate in both identifying needs and being part of the solution. Community mobilization helps to empower communities and enable them to initiate and control their own development.

Community Implementation Agreement (Ownership and Sustainability)

Ownership and sustainability is dependent on community involvement through all phases of the project from project start up, through project implementation and until project handover. The ambitions for community involvement depend on the role of community expected to play in the project if they are expected to take an active part in project implementation and take over the project activities once the project is finalized. Therefore the level of ambitions is ranging from community awareness raising and community consultations to community commitment, community investment through money, materials or human resources and community ownership of the project in the long run.

Providing Job Opportunity (Road Construction, Handicraft training, etc,.)

The community roads give a direct impact on improvement of livelihood and living environment; for instance, transportation of products and purchase of commodities. The implemented projects are High Labor Intensive Work and Hybrid Method with both mechanical and manual. The road constructions improve the awareness of unemployment of the local people during the project life cycle.

Townships along the railway	Kyaukme	Lashio	Hsipaw	Muse	Theinni	Naungkhio	Kutkai	Pyin Oo Lwin
Unemployed Persons	1500	9700	1900	2350	1000	1800	6200	5600

In the awareness of unemployment for local people, the training associated with construction techniques and heavy machinery driving should be done before the actual construction phase because the lack of the experience can be substituted by the other experienced labor workers.

The villagers will be given more job opportunities mainly work on construction site. However, women in the villages will not be suitable for construction works. So, job opportunities will also be created for women.

Unskilled or semi-skilled men and women are hired from nearby villages and are trained to handle day-to-day work procedures. To become a certified heavy machine operator, there should be at least 12 weeks training program and 2 week practical work. If villagers are not trained beforehand, they will not be certified for such works and only get manual labor works. When they are certified, they can also work in large construction sites in the future as well.

The special training program such as making handicrafts, sewing clothes, broom making, etc. will be given to women. For these training programs, the trainers will be Shan and Burmese language speaking volunteers from the villages who will be trained beforehand for the program. Since some of the villagers are unable to speak Burmese, Shan Language will be needed at some time. After the training program, they will be capable of making handicrafts, clothes and broom which can be sold in the market. A souvenir shop will be opened at the subway stations so that villagers can sell their products. This way, women will be given job opportunities in the future as well.

Agriculture

Villages in Northern Shan State mainly cultivate betel, seasonal crops, flower, paddy and fruits. Proper cultivating techniques will be presented to the farmers.

To achieve higher yields, however, hybrid rice, heavily reliant on fertilizers and pesticides, needs more water and often requires mechanized farming equipment, all of which are either in short supply or beyond the financial reach of most Shan farmers, whose traditional rice-growing methods entailed few if any imported goods or equipment. According to researcher Hkun Seng, there have been no government programs to train the farmers how to grow the new rice or how to use the fertilizers and pesticides. The Lashio Township government put out a pamphlet on how to grow the rice - but only in English. To make matters worse, the instructions for the fertilizers and pesticides are all in Chinese, unreadable to most in Shan state. The lack of information has made it nearly impossible for farmers to know the proper concentrations to use or what precautions to take when handling the pesticides and fertilizers. All most farmers are told is that they have to spray six kinds of pesticides at least six times within 120 days. Farmers have reportedly become ill, and a few reportedly have died, after improperly using the pesticides.

So, proper usage of pesticides and insecticides will be introduced and instructions to use them will be written to Burmese language and labeled on the bottles. The disadvantages of using them will also be informed to the farmers and usage of manure as much as possible will be suggested. Techniques for sustainable production of rice and application of resource conserving techniques (RCTs) will be introduced and recommended to the farmers.

During construction phase, for the source of food for employees on site, the agricultural products will be bought from the villagers.

Animal Husbandry

Villages in Northern Shan State mostly raise chicken for eggs and meat.

Modern animal husbandry will be introduced to the villagers. Modern animal husbandry can produce more and earn much more.

- Well-fed animals grow more quickly, they become bigger, yield more meat. They can be sold at a better price.
- Animals produce manure. Your soil will become richer and better. Your harvests will be better. You will make more money.
- Animals that are well fed and looked after are healthy. They have more young ones and your herd will be better and bigger. You can sell animals and earn more money. Animal husbandry is a capital that can produce a lot.

How to improve animal husbandry

If animal husbandry is to produce more, the animals must be raised in a different way.

- A farmer who wants to earn more money must look after his animals himself.
- He must both grow crops and look after his animals.
- The farmer must learn to look after animals.

- Chicken must be raised in a stress-free environment so that they can produce larger eggs and higher quality meat.
- There should be enough space for them to roam so that they can forage for bugs and other critter.

He must:

- Feed them better: especially the young animals; he must lay in reserves for the dry season; give the animals enough to drink.
- look after them better:
- Build a shelter for them, protect the animals against parasites and diseases, and look after them if they are hurt.

Improving Rural Transportation

Rural transport is the movement of people and goods in rural areas by any conceivable means, for any conceivable purpose along any conceivable route and plays as an important role in the local economy. The transportation fare of using the train will be subjected to a reasonable price which is convenient for the villagers so that they can use the train to transport conveniently. They can also reduce transportation fees when they go and sell their agricultural products at a large city like Mandalay.

Improving Water Resource

To promote community health an easily accessible water supply should be available that provides sufficient safe water to meet community needs. There are many types of water resources such as protected spring, dug well, borehole, piped water supply, rainwater harvesting, and ponds and lakes. The water supply such as wells and boreholes should be done for accomplishing the basic healthy life of individual indigenous people. Sometimes the best option for improving water quality is to treat water in the home by boiling. Bringing water to a rolling boil will destroy pathogens in the water and make it safe to drink. Therefore the knowledge sharing should be done for improving the local people’s hygiene and for avoiding the diarrhea especially in the children.

Providing Renewable Energy Supply for Rural Area

Providing access to electricity in rural areas is a major challenge. The fuel is generally of poor quality, and energy is used inefficiently; the power supply is unreliable and access to it limited.

This not only has an adverse effect on economic productivity; more importantly, it also affects people's quality of life and is having a strong impact on the environment. The unsustainable use of locally sourced biomass and an increasing dependence on fossil fuels are causing environmental degradation at local (land degradation), regional (air, water and soil pollution) and global levels (greenhouse gas – GHG emissions contributing to climate change). Providing solar energy make an improvement of rural economies with new sources of revenue, employment and business opportunities, product and policy innovation, capacity building, and, most notably, affordable energy. But the use of candles is surprisingly high. Given the high cost of candles, there is likely to be a strong economic case for switching to lower-cost and higher-quality alternatives in local community. Therefore there is large potential for using solar PV to meet the demand for lighting in rural areas, particularly the sunny dry zone. If battery systems are used and energy management is already practiced, solar PV systems can offer a safe and increasingly inexpensive alternative to using candles for lighting.

Community Health Assessment and Improvement Process

The main objective is to avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine. This is done by providing the local clinics, supporting the facility requirements and improving the district hospitals.

Preceed-Proceed is a health promotion assessment and planning process. Communities precede by defining their desired outcome and conduction social, epidemiological, educational, ecological, adminstrative, and policy assessements to identify causes of health issues. Then, the proceed with intervention and evaluation.

Preceed – 1. Social Assessment (defining end result)

2. Epidemiological Assessment (identifies community health priorities)
3. Educational and ecological Assessment
4. Adminstrative and policy Assessement

Proceed – 5. Implementation

6. Process Evaluation
7. Impact Evaluation
8. Outcome Evaluation

8.5.6.5. Corporate Social Responsibility (CSR) Fund

It promises to set up CSR fund after negiotiation with local authorities and local communities along the railway alignment. They also promise environmental mitigation and monitoring costs will not take account as CSR fund.

Developer's Policies for Socio-economic Development of Local People

The company's policies for local socio-economic development are shown in the following table.

No.	Description	Company's Policy
1.	Local Community Development Policy	Appoint local people with relevant skills as much as possible and at least 50% of local people will be appointed during operation phase.
2.	Corporate Social Responsibility (CSR) Policy	Contribute some percent of the annual net profit after tax as CSR fund

8.5.7. Cultural Heritage Management Plan

8.5.7.1. Objective

A cultural heritage management plan aims to:

- Safeguard the cultural heritage values of a place;
- Develop and ensure attractive, competitive and multifunctional historic urban areas;
- Manage and balance conflicting uses/ functions and the different demands of "users" of an historic urgan area: local ecomony, citizens, tourists, property owners, conservators, etc.

8.5.7.2. Legal Requirements

The Protection of rights of National Race Law (Law No.5)

- Consists of four bills, as submitted to the legislature; Buddhist Women's Special Marriage Bill, Religious Conversion Bill, Monogamy Bill and Population Control Bill.

Protection and Preservation of Cultural Heritage Regions Laws (Law No.15,16)

- To implement the protection and preservation policy with respect to perpetuation of cultural heritage that has existed for many years; to protect and preserve the cultural heritage regions and the cultural heritage.

The Protection and Preservation of Antique Objects Law (Law No. 12,15,20)

- To implement the policy of protection and preservation for the perpetuation of antique objects;
- To protect and preserve antique objects so as not to deteriorate due to natural disaster or man-made destruction;
- To uplift hereditary pride and to cause dynamism of patriotic spirit by protection and preservation of antique objectives;
- To have public awareness of the high value of antique objectives;
- To carry out in respect of protection and preservation of antique monuments in conformity with the International Convention and Regional Agreement ratified by the State.

Law Concerning Religious Conversion (Law No.48)

- To move freely from own religion to another religion, from one religion to atheism, from atheism to one religion

8.5.7.3. Overview Maps

Among cultural heritages along the railway, Baw Gyo Pagoda and Gohteik Bridge are the closet ones to the railway. The distances from the railway to them are shown in the figures below.

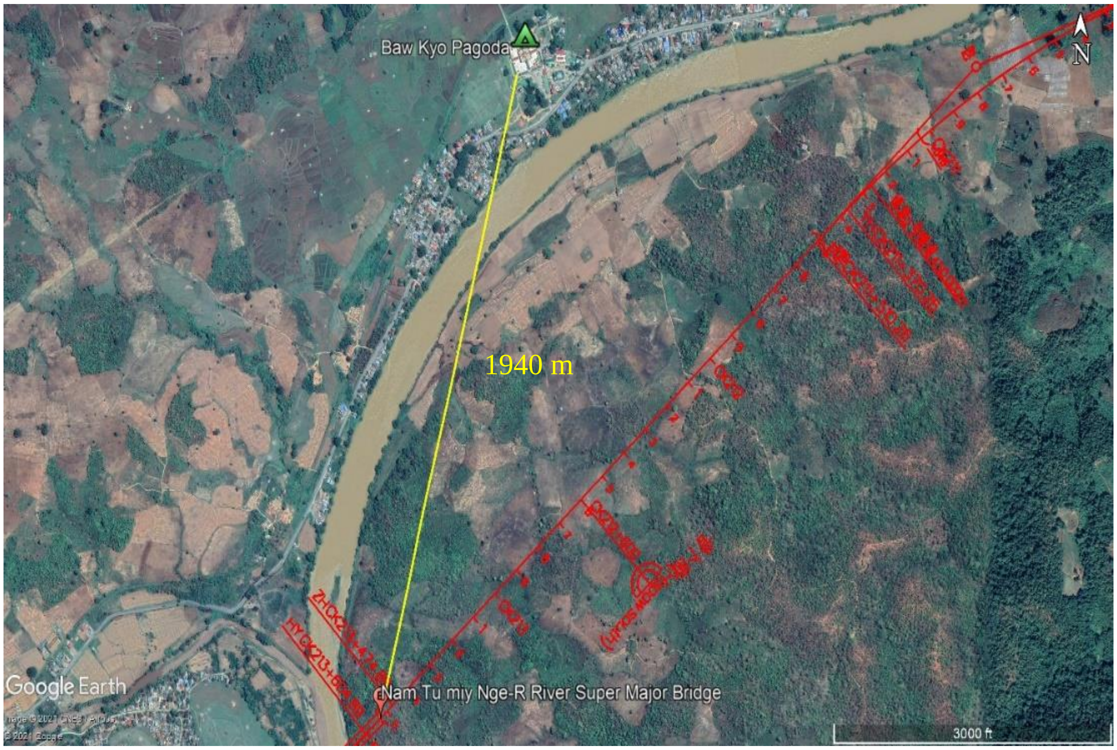


Figure – Distance from Nam tu Myi Nge-R River Super Major Bridge to Baw Gyo Pagoda

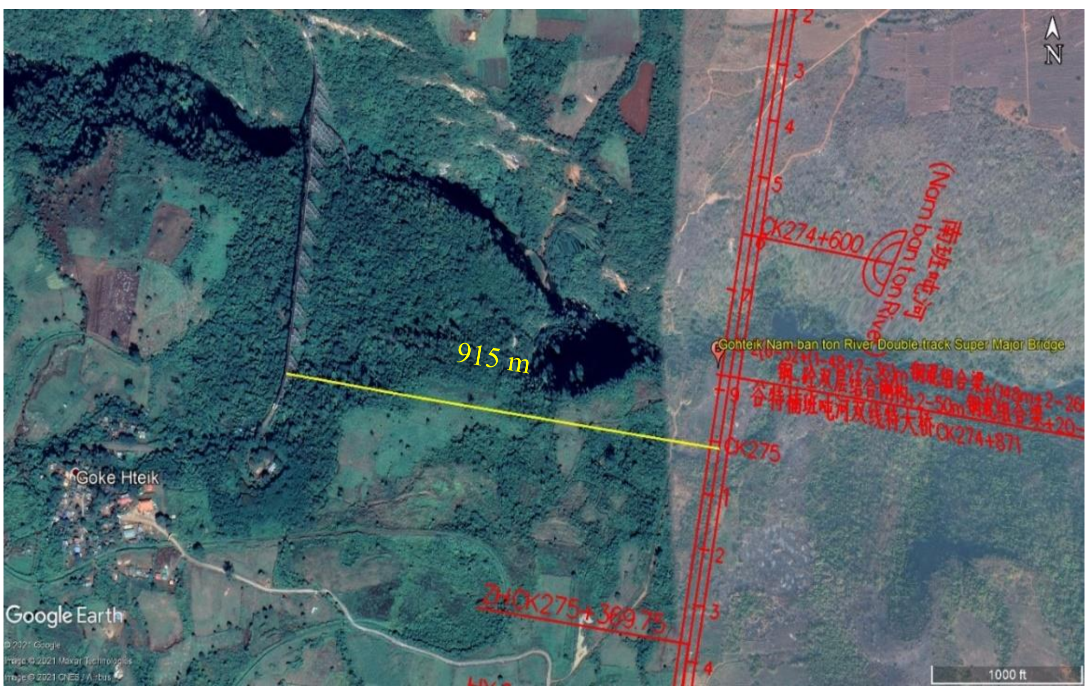


Figure – Distance from New Gohteik Nam Ban Ton River Double-Track Super Major Bridge to Existing Goke Hteik bridge

8.5.7.4. Management Actions and Monitoring Plans

During Construction Phase of proposed project, any heritage resources, located in close proximity to the project may be impacted through:

- Direct impact to historical (e.g. demolition) and sites of terrestrial archaeological potential (e.g. excavation); and
- Indirect vibration impact on historical buildings due to drilling and piling activities during construction phase that may lead to the structural damage or interference of normal activities;

General cultural heritage management measures should include:

- provision by the nominated undertaker to its contractors of locations and descriptions of all known cultural heritage assets within and adjacent to construction works, including restrictions to construction methods to protect cultural heritage assets;
- an historic environment investigation programme detailing the implementation of archaeological and heritage investigation and recording works prior to and during construction;
- the nominated undertaker will require its lead contractors to monitor compliance against the programme of historic environment investigation and recording works using appropriately qualified environmental management staff;
- during all stages, the nominated undertaker will require its lead contractors to facilitate archaeological and built heritage specialists undertaking the works as specified as an appropriate mitigation measure (including purposive investigation); and
- All archaeological, built heritage and historic landscape intervention, recording, analysis, dissemination and archiving will be undertaken by a suitably qualified and demonstrably experienced organization.

The cultural heritage management plan should include the following:

- The lead contractor will carry out works in such a way as to ensure that disturbance to all heritage assets is managed in accordance with accepted historic environment practice and, where disturbance cannot reasonably be avoided, is controlled and limited as far as reasonably practicable.
- implementation of controls on the movement of construction vehicles and machinery in areas of heritage interest (e.g. archaeological remains and historic buildings);
- The development and implementation of a procedure for soil stripping and excavation

before commencement of such works. This procedure will identify the interface of those works with areas of identified archaeological investigations;

- procedures adopted to preserve archaeological remains in situ beneath earthworks; and
- Procedures for the recording, dismantling, storage and re-erection of buildings of heritage significance.

Metal Detectors

During site preparation and construction, the use of metal detectors will be prohibited within areas of identified/defined archaeological interest unless deployed by archaeological specialists or other appointed persons in the execution of their activities.

Human remains

Should human remains be discovered during construction, either during archaeological works or as part of construction activity, the nominated undertaker and its lead contractors will comply with all relevant legislative and project-specific requirements.

Treasure Act

During the course of construction, if artifacts are located that are deemed by their material content or context to be treasure, then all necessary measures to comply with the requirements of the Act and any project-specific requirements will be implemented.

Measures in relation to unexpected discoveries of heritage assets

Should, during the course of construction works, artifacts and / or remains of archaeological interest or expected interest be located unexpectedly, these will immediately be reported to the lead contractor's project manager. The project manager will obtain specialist archaeological advice to undertake and prepare an appropriate response.

If that advice indicates that there is potential for the finds to be of national importance, then the Procedure for the unexpected discovery of archaeological remains of national importance procedure will be followed (see below).

Measures in relation to unexpected discovery of archaeological remains of national importance

Should heritage assets of potential national importance be unexpectedly revealed during construction, the unexpected discovery of archaeological remains of national importance will be implemented. Mitigation or investigation and recording may include the following, as appropriate:

- investigation and assessment of discoveries to determine their significance if this cannot be determined from the asset as found;
- assessment of potential project impacts to inform the design of appropriate mitigation or investigation and recording measures;
- preparation of a written scheme of investigation for any stage of archaeological work required;
- excavation, recording and reporting on any discoveries; and
- Recording and implementing measures to preserve any discoveries in situ, if required or if appropriate.

Monitoring

The nominated undertaker will require its lead contractors to implement appropriate monitoring of the consequences of construction work, as required, on all cultural heritage assets (designated and non-designated) to ensure the effectiveness of management measures and compliance with agreed approaches to construction activities and cultural heritage assets.

Risk assessments identifying appropriate surveys, for example, structural or condition surveys and vibration monitoring will be undertaken at locations of archaeological or built heritage interest adjacent to the construction site prior to, during and following construction works.

Noise and Vibration Management

- Best practicable means will be applied during construction works to minimize noise (including vibration) at nearby cultural heritage properties and other sensitive receptors arising from construction activities.
- Measures to reduce potential noise and vibration impacts
- To reduce potential noise and vibration impacts, the following measures should be taken:
- Noise and vibration control at source – for example, the selection of quiet and low vibration equipment, review of construction programme and methodology to consider quieter methods, location of equipment on site, control of working hours, the provision of acoustic enclosures and the use of less intrusive alarms, such as broadband vehicle reversing warnings;
- Screening – for example, local screening of equipment, perimeter hoarding or the use of temporary stockpiles

8.5.8. Environmental Management Action Plan

Environmental management action plan should be carried out throughout all project implementation phases and the responsibilities for construction and operation phases. Environmental impact; mitigation measures taken or to be taken; time frame and implementing responsible organization parameters are presented in the following Tables.

Table – Summary of Environmental Management Action Plan

Environmental Impact	**Mitigation Measures Taken or To Be Taken**	**Time Frame**	**Implementing / Responsible Organization**
DESIGN PHASE			
Muse-Mandalay railway alignment	The proposed railway alignment was selected to minimize the land disturbance to avoid displacement of people or households and environmentally sensitive areas in least.	During Design stage	MR / Project Developer
Cultural Heritage	Avoided by adjustment of railway alignment	During Design stage	MR / Service Provider
Loss of Water Bodies	Utmost care taken to avoid railway alignment crossing water bodies	During Design stage	MR / Project Developer
CONSTRUCTION PHASE			
Air Pollution & Dust	Vehicles and machinery are to be regularly maintained so that emissions conform to NEQG Standards. Water should be sprayed during construction phase, wherever it is required to avid dust. Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.	Beginning with and continuing throughout construction	Contractor / Construction services provider
Noise	Noise standard at processing sites, will be strictly enforced as per NEQG noise standards. Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. sound proof measurement will be taken for silence zones including schools and hospitals.	Beginning and through construction	Contractor / Construction services provider
Vibration	The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak velocity as given in article project EHS guidelines Manual	Beginning and through construction	Contractor / Construction services provider
Surface Water			
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into river and irrigation system	Throughout construction period	Contractor / Construction services provider
Blockage of drainage due to earth filling	Earth filling will ensure not to block natural drainage system		

Oil and Grease & Domestic Wastes	Avoid any leakage of oil and lubricant Use proper waste management system		
Soil and Ground Water			
Potential to soil contamination	Proper waste management system	Throughout construction period	Contractor / Construction services provider
Leakage of fuel oil and lubricants	Store over concrete floor or impermeable pad		
Construction debris and domestic Wastes	Solid wastes according to the rules and regulations of local CDC.		
Flora And Fauna			
Loss of trees and Avenue Plantation	Areas of tree plantation cleared will be replaced according to Compensatory afforestation Policy under the Forest Law.	After Completion of construction activities	Contractor / Construction services provider MR / Project Developer
Social			
Resettlement or/and relocation of buildings and other assets, involving some changes in livelihood of project affected peoples	Compensation and assistance of livelihood restoration that will be elaborated in the entitlement matrix of updated Abbreviated Resettlement Plan	During construction	MR / Project Developer
Loss of Access	Temporary access should be built at the interchange and other roads.	During construction	
Traffic jams and congestion	Transportation vehicles should not be operated during peak hours if possible. If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department	During construction	Contractor / Construction services provider MR / Project Developer
Safety with vehicles, people and livestock and signage	Safety education and fines. Allow for adequate traffic flow around construction areas Provide adequate signage, barriers and flag persons for safety precautions. Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions	During construction	Contractor / Construction services provider
Increase in disease Water-borne Insect-borne Communicable diseases	Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. Provide adequate sanitation and waste disposal at construction camps. Provide adequate health care for workers and locate camps away from vulnerable groups	During construction At start-up Throughout construction	Contractor / Construction services provider MR / Project Developer

Location of camps depots and storage areas	Location of camps depots and storage areas shall be as per the contract specifications.	Throughout construction	Contractor / Construction services provider MR / Project Developer
Safety of employees	When an accident occurs at the workplace, the injured person should be given medical care, where, when, and how the accident occurred should be taken note, and the injury should be reported. Safety awareness must be promoted among employees and all employees should receive safety training.	Beginning with and continuing throughout construction	Contractor / Construction services provider MR / Project Developer
Earthquake Hazards	Selection of railway route which can have minimum impact by an earthquake. Railway tracks should be made so that it can withstand earthquake impact as much as possible.	Throughout construction	Contractor / Construction services provider MR / Project Developer
OPERATION PHASE			
Noise and Vibration	Suitable measures should be considered where warranted. The public shall be educated about the regulations of noise and vibration pollution and its implications.	During operation	MR / Project Developer
Waste			
Generation of municipal solid waste in stations and common passenger areas	Collection and separation of waste in the trains and stations Proper disposal of waste according to local CDC's instruction	During operation	MR / Project Developer
Surface Water			
Oil pollution	Suitable treatment shall be taken for treatment oil before discharging the wastewater especially in depot areas	During operation	MR / Project Developer
Maintenance of Storm Water Drainage system	The urban drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	During operation	
Disposal of final treated effluent from treatment plan	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	During operation	MR / Project Developer
Social			
Railway accidents of passengers and local people	Enlightening passengers and local residents about traffic safety specific to railways	During operation	MR / Project Developer
Traffic safety at stations	Enlightening passengers and local residents about traffic safety at the stations Traffic officers will be assigned to solve any problems regarding traffic.	During operation	MR / Project Developer
Traffic jams and congestion	On-street parking will be restricted outside the station. Drop off/ pickup areas should be provided and	During operation	MR / Project Developer

	passenger cars should be allowed to stop in these areas for only limited amount of time.		
Explosion caused by terrorism	Proper Emergency Response System	During operation	MR / Project Developer
Accidents caused by structural and operational failure	Proper Emergency Response System	During operation	MR / Project Developer
Fire	All machinery, equipment and plant should be suitable for its application, be installed (and protected) in accordance with both the manufacturer's instructions and the appropriate standard, and be properly maintained by a competent person. Appropriate signs and instructions on safe use of the equipment may be necessary. Proper Emergency Response System	During operation	MR / Project Developer
Flood Hazards	Proper preparation should be done for unforeseen events. Specialists should inspect dams, bridges and tracks; measure river beds near bridges; and clean debris from channels, and drainage ditches, and the openings of small bridges and pipes.	During operation	MR / Project Developer

8.5.9. Parameters, Responsibilities, and Monitoring

Monitoring frequency will be sufficient to provide representative data for the parameter being monitored. Monitoring data will be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Monitoring will be carried out throughout all project implementation phases and the responsibilities for monitoring for construction and operation phases. The parameters to be monitored; location of the monitoring sites; frequency of monitoring, responsibilities and monitoring parameters are presented in the following tables.

Implementation Schedule and Projected Budgets for Sub-Plans

Sub-plan	Implementation Schedule	Projected budgets	Responsibilities
Environmental monitoring program	During the duration of the construction activities at different locations	- Depending on the cases	Monitoring team of Railway Project and construction contractor(s)

Traffic management plan	During the duration of the construction activities	- Depending on the cases	Construction Contractor(s)
Risk management plan	During the duration of the construction activities and operation phase	- Depending on the cases	Monitoring team of Railway Project
Occupational health and safety plan	During the duration of construction activities and operation	The cost is undefined, depending on the cases	MR and Construction Contractor(s)
Disaster risk and management plan	During the operation	Depending on the cases	MR
Emergency planning and response procedures	During the construction activities and operation	Depending on cases	MR and Construction Contractor(s)
Waste management plan	During the construction activities	For area of spillage – 12000kyats per day For management of construction wastes and handling of hazardous waste – 12000kyats per day	Construction Contractor(s)
Water intake management plan	During the construction activities	- Depending on the cases	Construction Contractor(s)
Storm water management plan	During the construction activities	- Depending on the cases	Construction Contractor(s)
Cultural heritage management plan	During the construction activities	- Depending on the cases	Construction Contractor(s)
Community development and rehabilitation plan	Prior to operation phase	Undefined	MR and Construction Contractor(s)

9. PUBLIC CONSULTATION AND PARTICIPATION PROCESS

Public participation is a process that is designed to enable all interested and affected parties (I&APs) to voice their opinion and/ or concerns which enables the practitioner to evaluate all aspects of the proposed development, with the objective of improving the project by maximizing its benefits while minimizing its adverse effects. I&APs include all interested stakeholders, technical specialists, and the various relevant organs of state who work together to produce better decisions. Public participation empowers local people so that they regard the development projects as their own. Public participation (community involvement) also reduces the impact of uncertainties and stress caused by the proposed project.

9.1 Methodology and Approach

9.1.1. Objectives of Public Participation in an EIA

Public participation is an essential and regulatory requirement for EIA process according to the EIA Procedure, 2015. The public participation process will be designed to provide sufficient and accessible information to I&APs in an objective manner to assist them to:

During the Scoping Phase:

- Raise issues of concern and suggestions for enhanced benefits;
- Verify that their issues have been recorded;
- Assist in identifying reasonable alternatives

During the Impact Assessment Phase:

- Contribute relevant information and local and traditional knowledge to the Environmental assessment;
- Verify that their issues have been considered in the Environmental studies; and
- Comment on the findings of the Environmental assessments.

So, public participation is a process that is designed to enable all interested and affected parties (I&APs) to voice their opinion and/ or concerns which enables the practitioner to evaluate all aspects of the proposed development, with the objective of improving the project by maximizing its benefits while minimizing its adverse effects. I&APs include all interested.

stakeholders, technical specialists, and the various relevant organs of state who work together to produce better decisions. Public participation empowers local people so that they regard the development projects as their own. Public participation (community involvement) also reduces the impact of uncertainties and stress caused by the proposed project.

In this study, effective public consultation and participation approaches in the form of stakeholder identification, focus group discussions, public meetings and public disclosure process will be conducted.

9.1.2. Methodology Used in Public Consultation and Participation Process

Public participation have been conducting by the following procedures:

(a) Stakeholder engagement and identification;
(b) Focus group discussion;
(c) Household survey;
(d) Public consultation meetings; and
(e) Public disclosure process.

The EIA includes the activities undertaken during detailed design stage to engage the stakeholders, and planned information disclosure measures and processes for carrying out consultation with affected people and facilitating their participation during implementation stage. Five rounds of engagements have been undertaken as follow:

Table 9.1- Public Consultation and Stakeholder Engagement Process

Round	Method	Stakeholders
Round 1. Stakeholders Identification and Focus group discussions	Conduct discussion with local authorities, by studying GIS Map and social specialists' study	Head of GAMs along MMR and Villages Heads
Round 2: Information sharing and issues identification	Conduct house hold survey in local residents which the railway pass through or cross nearby	Village leaders and local people in project affected areas (nearest villages)

Round 3: Public Consultation meetings	(a) Invitation letters, handout, and report for current situation were distributed. (b) Posters and presentations were used during the meeting.	Regional Government, Key stakeholders in civil society, government officials and local authorities of Mandalay Region & Shan State, NGO's, INGO and CBO's, community leaders, and local communities
Round 5: Public disclosure	Distribution of executive summary, announcement of EIA Report in website	Regional Government, Key stakeholders in civil society, government officials and local authorities of Mandalay Region & Shan State, NGO's, INGO and CBO's, community leaders, and local communities

9.1.2.1. Round 1: Stakeholder Engagement and Identification

The involvement of the following groups or organisations in the stakeholder engagement process will be considered to be particularly important:

- Relevant Government Departments at the National, Provincial and Local level;
- Directly affected communities in the project area;
- Representatives of the local industries;
- Environmental groups and Non-Governmental Organisations (NGO)s;
- Community Based Organisations;
- Academic/research Organisations;
- International donors/funders active in the project area;
- Local communities; and
- The media.

So, the following stakeholders can be considered as key stakeholder for the proposed bridges and culverts project.

(a) Myanma Railways (MR)
(b) CREEC
(c) Local People (around the proposed railway project area)

(d) Village Administrative Offices (around the proposed railway project area)
(e) Environmental Conservation Departments in Lashio, Pyin Oo Lwin, Mandalay
(f) Head of Local Administration Offices (around the proposed railway project area);
(g) City Development Committee (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(h) Department of Public Health (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(i) Planning and Statistics Department (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(j) Department of Settlement and Land Record (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(k) Department of Archaeology and National Museum (Mandaly)
(l) Department of Water Resources Utilization Department (Mandalay, Lashio, Muse);
(m) Department of Labour (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(n) Myanmar Police Force (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(o) Local Media, and
(p) NGOs and CBOs.

9.1.2.2. Round 2: Information Sharing and Issues Identification

(a) Focus Group Discussions

Focus group discussions was carried out with heads of village administration office and elders from almost all of the nearest villages. Through these discussions, information will collect for consideration of PAPs (Project Affected Persons) and potential environmental and socio-economic impacts. Some recorded photos for example of focus group discussions are show in the following.

Sar Toe

Nyaung Pin Zout

Anauk Kyu Yinn Village

Taung Quarter

Myo Pyin Gyi

Sat Kway

Pan Kham Village

Ngon Sai Village

Min Ywar

Khie Tone Hone Village

Khar Shi Village

Mal Han Village

Nan Onn Village

Kaung Khan Village

(b) Household Surveys

Household sample survey was conducted to evaluate primary socio-economic conditions of the project area and to understand the mood, perceptions and extent of preparedness of the people towards the proposed project. The household survey was carried out to tap the baseline socio-economic conditions of project area and to assess project perceptions and attitudes of the local people over a period of twenty days. To get the accurate data, primary data collection will be conducted by social specialist, social consultants, local authorities and local people.

Sample Size Determination

i. Sample size

The sample size was determined using Yamane's formula. The sampling error was considered as 4 % as the confident level was set at 96%.

$$\mathbf{n} = \frac{N}{1 + Ne^2}$$

Where,

n = sample size

N =total number of households in the study area

e = desired margin error

In order to have a clear understanding about the sampling error "e" value, the correlation between sample size and "e" value were presented in the following table.

Table: Correlation between Sample Size and Sampling Error

Size of Population	Sample Size (n) for Precision (e) of:			
	±3%	±5%	±7%	±10%
500	a	222	145	83
600	a	240	152	86
700	a	255	158	88
800	a	267	163	89
900	a	277	166	90
1,000	a	286	169	91
2,000	714	333	185	95
3,000	811	353	191	97
4,000	870	364	194	98
5,000	909	370	196	98
6,000	938	375	197	98
7,000	959	378	198	99
8,000	976	381	199	99
9,000	989	383	200	99
10,000	1,000	385	200	99

Source: Updated from Glenn D. Israel, 2003

This formula is not applicable for small population below 500 sizes of population, so the small size population was calculated 30% of each population's size. Then sample size was distributed according to the number of households in each village. However, the selection was done by the number of households located in the project affected part of the village. Thus, the sampled households were more or less differed from village to village. The following presented the sample households distributed in the survey.

ii. Sampling Method

The sampling unit was individual household in the study area. The sampling was carried out by stratified random sampling with the following steps.

- ***Step-1***, Households information were preliminary accessed during the pilot survey. The information includes baseline information of socio-economic activities and their concerns about the proposed projects.
- ***Step-2***, The households in each ward will be geographically classified sub-groups such as
  - households located nearby water sources by the proposed project
  - households located along the accessed roads to the proposed project site
  - households located beside the railway alignment of the proposed project
  - households located near the cultural and heritage site
- Step-3, The respondent households were randomly selected from each group according to the sample size.

The following table shows the list of household survey for proposed project. All of the villages are situated near the railway alignment.

Township	Village and Village Tract
Mandalay (Myit Nge)	Sar Toe Village Grouop (Sar Toe, Sat Kway, Myo Pyin Gyi) Danone Village, Nyaung Pin Ni Village, Nyaung Pin Zout Village, Myit Laung Village, Ashay Thar Yar Gone Village, Min Ywar Village, Pyauk Sake Kone Village, Sin Bo Village, Pauk Chine Village, Min Su Village, Saut Taw Wa Village
Mandalay (Pathein Gyi)	Than Ma Taw Village, Thansin Kone Village, Let Kaung Village, Tha le Kone Village, Yan Kin Taung Village, Lane Pin (Ashay and Anauk) Village
Pyin Oo Lwin	Thet Kan Kone (Hmyawt Taw) Village, Kone Kaw Village, Pin Lein (Middle) Village, Ashay Pin Lein Village, Pan U Taung Village
Naung Cho	Taung Quarter, Myat Chae Nu Village, Kone Gyi Ma Village,

	Ngoke Ka Lay Village, Ohmm Ma Khar Village, Kyin Ganai Village, Ban Bway Village, Samasal Village, Lone Yone Village, Anauk Kyu Yinn Village
Kyauk Me	Khie Tone Hone Village, Nar Kite Khan Village, Naung Ann Village, Ngon Sai Village, Know Kaw Village, Kyaung Kone Village, Mway Taw Village
Hsipaw	Kyin Thi Village, Twan Kar Village, Naung Eain Village, Swat Lann Village, Ho Naung Village, Pan Sauk Village, Nam Aun Village
Lashio	Khar Shi Village, Naung Mon Village, San Pyat Village, Lwin Lount Village, Khay Ninn Village, Mal Han Village, Kaung Ma Kyan Village, Naung Laing Village Nam Tom Village, Ho Pate Village, Pan Hat Village
Theinni	Nan Onn Village, Man Sar Tone Village, Nar Chat Village, Nan Maw Hate Village, Pan Kham Village, Man Chat Village, Pan Sone Village, Pan Phat Village, Naung On Village, Wane Line Village
Kutkai	Nam Hpat Kar Village, Pang Sa Lorp Village, Ho Nar Village, Nan Khone Village, Nam Hpat Lun Village, Kawng Lein Village, Mhan Lone Village, Pa Gyo Village
Muse	Nan Pann Village, Nan Kon Village, Nan Sonn Village, Kaung Khan Village, Wane Mine Village, Nan Onn Village, Mhan Haunn Village, Phat Mhan Village, Mine Mine Village, Yaw Han Par Village

Sample Size Determination of sample size for each township

1.Mandalay (Myit Nge) Township	**Households**	**Sample Size**
Sar Toe Village Group (Sar Toe, Sat Kway, Myo Pyin Gyi)	1319	426
Da None Village	969	380
Nyaung Ni Pin Village	180	140
Nyaung Pin Zout Village	267	188
Myit Laung Village	404	246

Ashay Thar Yar Gone Village	217	162
Pyauk Sake Kone Village	215	160
Sin Boe Village	325	214
Pauk Chine Village	86	76
Min Su Village	95	83
Saut Taw Wa Village Group (Min Ywar Village, War Yone Pin Village)	917	372
2.Mandalay (Pathein Gyi)Township	**Households**	**Sample Size**
Than Ma Taw Village	1541	445
Thansin Kone Village	597	306
Let Kaung Village	250	179
Tha le Kone Village	601	307
Yan Kin Taung Village	1594	449
Lane Pin Village	406	247
3.Pyin Oo Lwin Township	**Households**	**Sample Size**
Thet Kan Kone (Hmyawt Taw) Village	126	105
Kone Kaw Village	150	121
Pin Lein (Middle) Village	159	127
Ashay Pin Lein Village	382	238
Pan U Taung Village	714	334
4.Naung Cho Township	**Households**	**Sample Size**
Taung Quarter Village	1121	402
Mak Hki Nu Village	1032	390
Kone Gyi Ma Village	904	370
Ngoke Ka Lay Village	580	301
Ong Ma Hkar Village	822	356
Kyein Ga Naing Village,	1515	443
Bant Bway Village	1643	453
Hsan Ma Hse Village	1478	440
Long Yon Village	1315	424
Ah Nauk Kyu Inn Village	537	289
5.Kyaukmae Township	**Households**	**Sample Size**
Nar Aik HkantVillage Group (Khie Tone Hone Village, Kone Kaw Village)	288	198
Naung Ann Village	109	93
Ngon Sai Village	80	71
Sai Khawng Village	36	35
Kyaung Kone Village	171	135

Mway Taw Village	108	93
6.Hsipaw Township	**Households**	**Sample Size**
Kyin Thi Village	423	253
Twan Kar Village	124	104
Naung Eain Village	90	79
Swat Lann Village	120	101
Ho Naung Village	156	125
Pan Sauk Village	55	51
Nam Aun Village	253	181
7.Lashio Township	**Households**	**Sample Size**
Hkar Shi Village	462	266
Nawng Mun Village	1982	476
San Pyat Village	137	113
Lwin Lount Village	410	248
Hkay Nin Village	514	283
Mae Han Village	1218	414
Kaung Ma Kyan Village	80	71
Naung Laing Village	290	199
Ho Peik Village & Pan Hat Village	839	359
8.Theinni Township	**Households**	**Sample Size**
Nar Chat Village	30	29
Nan Maw Hate Village	114	97
Pan Kham Village	95	83
Pan Sone Village	325	214
Pan Phat Village	354	226
Nam On Village	107	92
Pan Lawt Village Group (Man Chat Village, Wane Line Village, Man Sar Tone Village, Naung Onn Village)	505	280
9.Kutkai Township	**Households**	**Sample Size**
Nam Hpat Kar Village	1667	455
Pang Sa Lorp Village	245	177
Ho Nar Village	12	12
Nan Khone Village	40	38
Nam Hpat Lun Village	192	147
Kawng Lein Village	212	159
Mhan Lone Village	28	27
Pa Gyo Village	25	25

10.Muse Township	**Households**	**Sample Size**
Nam Pang Village	448	261
Nan Sonn Village	86	76
Kaung Khan Village	198	151
Wane Mine Village	181	141
Nam Aun Village Group (Phat Man Village, Man Haung Village)	717	334
Man Hai Village	576	300
Man Mai Village	63	58

Recorded photos for household survey in Mandalay (Myit Nge)


Sar Toe Village


Nyaung Pin Ni Village


Nyaung Pin Zout Village


Myit Laung Village


Danone Village


Myo Pyin Gyi


Sat Kway


Min Ywar Village


PyaukSake Kone Village


Ashay Thar Yar Gone Village


Saut Taw Wa Village


Pauk Chine Village


Min Su Village


Sin Bo Village

Recorded photos for household survey in Naung Cho Township


Taung Quarter


Myat Chae Nu


Anauk Kyu Yinn


Kone Gyi Ma


Lone Yone

Kyin Ganai


Ohmm Ma Khar


Ngoke Ka Lay

Ban Bway

Samasal

Recorded photos for household survey in Kyauk Me Township

Khie Tone Hone


Nar Kite Khan


Naung Ann


Ngon Sai


Know Kaw


Kyaung Kone


Mway Taw

Recorded photos for household survey in Lashio Township

Khar Shi


Naung Mon


San Pyat


Lwin Lount


Khay Ninn


Mal Han


Kaung Ma Kyan


Nam Tom


Pan Hat

Recorded photos for household survey in Theinni Township


Nan Onn


Man Sar Tone


Nar Chat


Nan Maw Hate


Pan Kham


Man Chat


Pan Sone


Pan Phat


Naung On

Wane Line

Some Recorded photos for household survey in Muse

Nan Pann

Nan Kon

Nan Sonn

Kaung Khan

Wane Mine

Nan Onn

Mhan Haunn

Yaw Han Par

Phat Mhan

Mine Mine

Most Public Needs and Concerns during Household Survey

As household survey was conducted in more than 70 villages and so the results of household survey cannot be made very detailed to cover 70 villages. The following are the most important public concerns resulted by the household survey for the proposed project:

- Worry about the damage of agricultural land, forest area, historical places and archeological sites;
- Proper compensation to land use whether the villager don't have land use permit or not;
- the blockage of rivers and water pollution;
- bridge collapse during operation;
- noise & vibration;
- discuss openly and transparency before starting any stage of project; and
- Ensure job opportunities for local people.

9.1.2.3. Round 3: Public Consultation Meetings (PCMs)

The aim of PCMs are to:

(a) To announce the process and procedure of EIA;
(b) To discuss about the possible environmental and social impacts;
(c) To discuss about the alternative ways to avoid the possible impacts; and
(d) To discuss effective mitigation measures most public concerns about the proposed project.

(a) Summary of PCMs for Scoping Proposal

Public meeting for scoping proposal were made six times from the date of (25.6.2019) to (2.7.2019) in six township, namely, Mandalay (Myit Nge), Naung Cho, Kyauk Mae, Lashio, Thein Ni and Muse as follow:

Table 9.2- Public Consultation Meetings for Scoping Proposal

No.	Meeting	Location	Date
1	Public Meeting for Scoping Proposal	Zaytawon Monastery, Myit Nga Mandalay	(25.6.2019)
2	Public Meeting for Scoping Proposal	Township Hall, Naung Cho	(26.6.2019)
3	Public Meeting for Scoping Proposal	Meeting Hall (GAO), Kyauk Me	(27.6.2019)
4	Public Meeting for Scoping Proposal	Meeting Hall (GAO), Lashio	(29.6.2019)
5	Public Meeting for Scoping Proposal	Township Hall, Thein Ni	(1.7.2019)
6	Public Meeting for Scoping Proposal	City Hall, Muse	(2.7.2019)

These townships will place railway stations and so public meetings are held at these townships initially. The following are the summary of discussions about the project and their exceptions from participants during the meeting.

9.2. Summary of Consultations and Activities Undertaken

Summary of Public Meeting Mandalay (Myit Nga Township)

Firstly, public consultation meeting for scoping proposal was held at the Zaytawon Monastery, Myit Nge Township, Mandalay in June 25, 2019. Over 200 people from local authorities, local people and other social communities groups from Myitnge region and other stakeholder are attended. The key discussion about this PCM is the compensation about land use and the not to use historical areas and places.

Recorded Photos from Public Meeting Mandalay (Myit Nga Township)

Summary of Public Meeting (Naung Cho Township)

Then, public consultation meeting for scoping proposal was held at the Naung Cho Township Hall in June 26, 2019. Over 100 people from local authorities, local people and other social communities groups from Naung Cho Township region and other stakeholders who are interest the project are attended. The key discussions are the land acquisition and compensation, announce the precise railway alignment and the impact on natural water spring.




Recorded Photos from Public Meeting Naung Cho

Summary of Public Meeting (Kyauk Mae Township)

Public consultation meeting for scoping proposal was held at the Kyauk Me General Administrative Office Meeting Hall in June 27, 2019. Over 120 people from local authorities, local people and other social communities groups from Kyauk Me Township region and other stakeholders who are interest the project are attended. The key discussion during public meeting are about the environmental baseline study, land acquisition and proper compensation, impact on national level security and impact on water resources.




Recorded Photos from Public Meeting Kyauk Mae

Summary of Public Meeting for Scoping Report (Lashio Township)

Public consultation meeting for scoping proposal was held at the Lashio General Administrative Office Meeting Hall in June 29, 2019. Over 120 people from local authorities, local people and social communities' groups from Lashio Township region and other stakeholders who are interest the project are attended. The key discussions during public meeting are about the registration of third party, proper land compensation, proper fair price, impacts on natural spring and national level security.

Recorded Photos from Public Meeting Lashio

Summary of Public Meeting for Scoping Report (Thein Ni Township)

Public consultation meeting for Thein Ni Township was held at Theinni Township Hall in 1st July, 2019. Over 120 people from local authorities, local people and other social communities' groups from Thein Ni Township are attended. The key discussions during public meeting are land aquisation and proper compensation to land use, impact on natural water resources, impact on agricultural lands, impact on public safety.

Summary of Public Meeting for Scoping Report (Muse Township)

We held the 6th Public Consultation Meeting at the Muse City Hall in 2nd July, 2019. Over 100 people from local authorities, local people and other participants from Muse Township are attended. The key discussion during public meeting are the compensation to tree cutting, impact to national security, impact to religious and national security.

Summary of Public Conservation Meeting for EIA

Ever Green Tech and MR hold 19 PCM in 9 townships along the MMR both for scoping and EIA reports.

First PCM

Time	Location	Participant		Key Discussion	Recorded Photo
		Composition	Number		
25.6.19 1:00 pm to 4:00 pm	Mandalay Myit Nge)	Local authorities	20	Proper compensation for land used; No or Less impact to monastery and pagoda; Not to pass railway through villages; Beware increase in human trafficking; Not to cause accidental cases to local people due to high speed train	   
		NGOs	12		
		local people	180		
26.6.19 1:00 pm to 4:00 pm	Naung Cho	Local authorities	15	Transparence for the project information in every stage; Not to use agricultural land or proper compensation for land use; Railway accidents when crossing with village road; Not to damage natural spring along the railway; Ensure job opportunities for local people.	
		NGOs	12		
		local people	120		

<table>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="3">27.6.19
1:00 pm
to 4:00 pm</td><td rowspan="3">Kyauk Mae</td><td>Local authorities</td><td>20</td><td rowspan="3">• Proper compensation measures for land used;
• Proper arrangement for sustainable livelihood for project affected persons;
• Keep the alignment away from village and forest areas;
• Blockage of natural drainage system and natural spring;
• Prepare warning signs along the railway line in local language;
• Need to care for natural springs along the project area</td><td rowspan="3">-
</td></tr>
<tr><td>NGOs</td><td>12</td></tr>
<tr><td>local people</td><td>115</td></tr>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="4">29.6.19
1:00 pm to 4:00 pm</td><td rowspan="4">Lashio</td><td colspan="2">Participant</td><td rowspan="4">• Damage to agricultural lands along the railway;
• Need sufficient compensation for every land used;
• Damage to water resources by the project;
• Worry for road accidents along the railway;
• Need detailed assessment for socio-economic impacts;</td><td rowspan="4"></td></tr>
<tr><td>Local authorities</td><td>22</td></tr>
<tr><td>NGOs</td><td>10</td></tr>
<tr><td>local people</td><td>110</td></tr>
</table>

1.7.2019 1:00 pm to 4:00 pm	Thein Ni	Local authorities	12	• Blockage of village roads along the railway line; • Need to construct over pass, when the railway and road cross point • Use warning signs in local languages along the railway line; • Avoid or less impact to agricultural lands. • Appropriate compensations are required for affected farmers. • Need to care for natural springs along the project area	
		NGOs	6		
		local people	102		
First PCM					
2.7.2019 1:00 pm to 4:00 pm	Muse	Local authorities	22	• Appropriate compensations are required for affected persons. • Tree plantation for cutting of trees • Need transparency for the project. • Want to care for road safety. • Need to care for natural springs along the project area • Keep away the alignment from the village • - Need to protect illegal trades due to project development	
		NGOs	4		
		local people	60		

First PCM					
31.8.2019 1:00 pm to 4:00 pm	Pyin Oo Lwin	Local authorities NGOs local people	22 10 125	• Noise and vibration from the train; • Replantation of trees for cutting of trees; • Choose electrical power not to pressure on local electricity use; • Compensate the farm and agricultural land of local people fairly and transparently- • To protect the local people for their right with existing laws and regulation • Not allow cross over the natural spring which are the main water source of local people • Not to reduce the water catchment area due to railway line (in Pyin Oo Lwin) region • To control natural resources that can be damage during construction and operation phases • Not to take surplus soil and rock from tunnel construction	
First PCM					
17.8.2019 1:00 pm to 4:00 pm	Mandalay (Pathin Gyi)	Local authorities NGOs local people …	16 13 150	• To reduce the damage of natural resources, trees and forest and the responsible agency have to undertake the compensation of damage • To emphasize the public concerns • To ensure job opportunities for local people, experts and engineers • To make RAP for proper compensation for land use • To prepare comprehensive assessment for implementation phase • Surface water pollution due to bridge construction	

<table>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="3">7.9.2019
1:00 pm
to 4:00 pm</td><td rowspan="3">Hsipaw</td><td>Local authorities</td><td>20</td><td rowspan="3">Not to damage natural spring
Compensate, rebuild and relocate the local residents which are removed for the railroad before the project are started
Proper and sufficient compensation to local people without delay
Worry to relocate the place of local people who are poor and to protect them by the laws
- Build overpass and underpass where the joint with the road which the local people are using it</td><td rowspan="3"></td></tr>
<tr><td>NGOs</td><td>12</td></tr>
<tr><td>local people
...</td><td>180</td></tr>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="3">22.10.2019
1:00 pm
to 4:00 pm</td><td rowspan="3">Kuitkai</td><td>Local authorities</td><td>20</td><td rowspan="3">To reduce house demolishing and land acquisition as much as possible
Policy to control human trafficking
Control migrant workers who can be settlement near the project area after construction phase
If possible, the railway alignment is away far from the village
Worry to disturb the local electricity use
Do not allow soil and other material getting from project construction to carry the other place
Appropriate compensations are required for affected farmers and land owners
Not allow to destroy natural springs along the project area</td><td rowspan="3"></td></tr>
<tr><td>NGOs</td><td>8</td></tr>
<tr><td>local people
...</td><td>180</td></tr>
</table>

<table>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td rowspan="2">Time</td><td rowspan="2">Location</td><td colspan="2">Participant</td><td rowspan="2">Key Discussion</td><td rowspan="2">Recorded Photo</td></tr>
<tr><td>Composition</td><td>Number</td></tr>
<tr><td rowspan="4">10.10.2019
1:00 pm
to 4:00 pm</td><td rowspan="4">Mandalay Pathein Gyi</td><td>Local authorities</td><td>15</td><td rowspan="4">• To provide compensation for house demolishing and land acquisition according to laws and regulations
• To control noise during operation phase
• To provide sidewall along the railway
• To make comprehensive assessment for implementation phase
• To provide job opportunities
• To make open tender system for all implementation process
• - To prevent human trafficking and drug handling</td><td rowspan="4"></td></tr>
<tr><td>NGOs</td><td>10</td></tr>
<tr><td>local people</td><td>60</td></tr>
<tr><td>...</td><td></td></tr>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td rowspan="3">11.10.2019
1:00 pm
to 4:00 pm</td><td rowspan="3">Pyin Oo Lwin</td><td>Local authorities</td><td>16</td><td rowspan="3">• To emphasize on the public voices and concern
• To avoid the blockage of natural springs
• To avoid the damage of religious and archeological places
• To provide resettlement action or compensation for house demolishing and land acquisition;
• To provide support for the basic infrastructure (such as, school, hospitals, road) of project related places and nearby areas;
• To make compensation for tree cutting;
• Not to damage the natural resources buried under the ground;
• Not to damage the buried archeological resources;
• To prevent the settlement of migrant workers near the project sites</td><td rowspan="3"></td></tr>
<tr><td>NGOs</td><td>12</td></tr>
<tr><td>local people</td><td>90</td></tr>
</table>

<table>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td rowspan="3">1.9.2019
1:00 pm
to 4:00 pm</td><td rowspan="3">Naung Cho</td><td>Local authorities</td><td>18</td><td rowspan="3">• -They want very less amount of damage size on their garden land and farm land.
• -If any damage, they would like to get appropriate compensation;
• -The use of electricity from local resources;
• -Need to care for natural springs along the project area
• How the railway alignment pass through the natural springs and farm lands
• -Want to care about the railway pass for accidents and dangerous
• -When the alignment in detail design, local people want to care the roads and bridge that already exits
• Secure job opportunities for local people
• The illegal trade of unhealthy food from China
• - Prevent zero dollar tourism from other place</td><td rowspan="3"></td></tr>
<tr><td>NGOs</td><td>9</td></tr>
<tr><td>local people</td><td>200</td></tr>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td rowspan="4">21.10.2019
1:00 pm to 4:00 pm</td><td rowspan="4">Hispaw</td><td colspan="2">Participant</td><td rowspan="4">• To avoid the blockage of natural springs
• Having anxious to get damage on the religious buildings and historical places or buildings
• Worry for water resources are damaged by the project.
• To provide resettlement action or compensation for house demolishing and land acquisition
• Want job opportunity favor for local peoples
• Noise from blasting process
• To emphasize the public concerns and their livelihood changes
• Not to dispose soil material and other waste from construction near the agricultural lands
• Control foreign and migrant workers</td><td rowspan="4"></td></tr>
<tr><td>Local authorities</td><td>22</td></tr>
<tr><td>NGOs</td><td>10</td></tr>
<tr><td>local people</td><td>110</td></tr>
</table>

<table>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td rowspan="3">25.10.2019
1:00 pm to 4:00 pm</td><td rowspan="3">Thein Ni</td><td>Local authorities</td><td>12</td><td rowspan="3">

- Need transparency for the project, when the project is being started to build.
- Keep away the railway from the village area (limited area for relocation)
- Want job opportunity favor for local peoples
- Worry to disturb the local electrical power source
- Don’t want to destroy the roads that are connecting village to village by the project
- Want over pass, when the railway and road meet points.
- Noise and vibration
- Warning signs should be in local languages (Shan, Burmese, and other native languages)
- Want to avoid grazing ground and agricultural land if possible
- Appropriate and definite compensations are required for affected farmers.
- Need to care for natural springs along the project area

</td><td rowspan="3"></td></tr>
<tr><td>NGOs</td><td>6</td></tr>
<tr><td>local people</td><td>102</td></tr>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td>8.9.2019
1:00 pm to 4:00 pm</td><td>Lashio</td><td>Local authorities</td><td>22</td><td>

- To avoid the agricultural land and provide compensation for any damages
- To avoid the damage of water resources
- To improve the security to protect Myanmar national with laws as a lot of foreigners can ether into the country from this railway.
- To consider the national security
- To provide electricity and job opportunities
- To prioritize the safety on road crossing
- To provide compensation for house demolishing and land acquisition with current prices.
- To implement the project after compensation process.

</td><td></td></tr>
</table>

		NGOs	10	• To replant the trees the railway • To make sure that the railway is readily accessible by local people. • To discuss with Ministry of Construction before choosing the railway alignment-	
		local people	200		
Second PCM					
24.10.2019 1:00 pm to 4:00 pm	Muse	Local authorities	22	• To make sure that the project activities would not harm to the socioeconomic conditions • Need to care for natural springs along the project area • Want warning signs along the railway and both side. • To make sure that the implementation agency compensate to the affected person directly • Compensation should be done before the project beginning and paid transparently • Replanting trees as compensation for tree cutting • Limit tree cutting outside the project area •	
		NGOs	10		
		local people	85		
		...			
Second PCM					
6.9.2019 1:00 pm to 4:00 pm	Kyuk Mae	Local authorities	16	• To provide sidewall along the railway • Impact to fauna diversity due to noise • To build underpass and overpass for the local people and animals • To compensate transparently for losing lands and household • Replant trees along the railroad • Worrying of human traffic and drugs • Suggest to build railroad after getting peace • Declare the width of the railway line and land use of other facilities openly	
		NGOs	13		
		local people	180		
		...			

Second PCM					
23.10.2019 1:00 pm to 4:00 pm	Kuikhai (Nantphat kha)	Local Authorities	14	• Minimize or avoid the farmland and agricultural land • Compensation will pay for affected farmers and land owners as soon as possible • To provide job opportunities • Want to avoid grazing ground - If possible, the railway alignment is away far from the village • Reasonable railway fee that can be affordable to local people	
		NGOs	6		
		local people	100		
		...			

Review

During PCMs, the major difficulties are as follows:

No.	Challenges	Response
1.	The detailed railway alignment that pass the exact location	During FS stage, precise railway alignment cannot be got and proposed alignment can be changed during implementation stage
2.	Compensation for land use	Proper compensation will be made by organizing compensation team with local authorities during implementation phase
3.	Not believe all of the Chinese Project	International official tender will be made for selection of project developer(s)
4.	Commitments for compensation	Compensation will be made by organizing compensation
5.	The blockage of village roads, seasonal streams and natural springs	Will use adequate bridges and culverts along the railway line not to block any public worry
6.	Noise during operation phase	Will made sound barrier in some environmentally and socially sensitive areas
7.	Trees cutting outside of the project corridor	Limit tree cutting and replanting as per local forestry department if cutting No tree cutting outside of the project corridor
8.	The use of electricity in local	Power supply will be sourced that no pressure on local electricity use Source electricity from China if possible Will not construct power supply system in local for this purpose
9.	Quarry mine for extraction of road stone	Will not extract lime stone for railway subgrade without permission from Government
10.	Secure job opportunities for local people	Tender will be made transparency for every project development stage
11.	Take other natural resources (logs, metals and wild animals) during construction of railway and tunnels	Strictly control construction contractor(s) not to take other resources during construction phase
12	Blockage of spring water due to blasting process in tunneling	Beware the alternation of waterway during tunneling
13.	Avoid pagoda and monastery areas	Will avoid pagoda and monastery areas
14.	Avoid forest area to reduce tree cutting	Will avoid forest area as much as possible and will replant if cutting is made.

9.3. Results of Consultations

Key Findings from the Public Meetings Related to the Proposed Bridges and Culverts Project

The followings are the summary of key findings from public meetings for scoping proposal:

1. Less damage to public own land;
2. Reasonable compensation to land use;
3. Keep away from historic and archeological place;
4. Keep away from forest area;
5. Declare the exact dimensions of land use area bridges and culverts and will have to use according to the proclamation;
6. Limit tree cutting outside the project area.
7. Avoid blockage of natural drainage system and natural spring during construction phase;
8. Avoid blockage of village road and road to cattle grazing area during construction phase;
9. Construct culverts when meet the public road;
10. Not to dispose soil material from construction near the agricultural lands;
11. Less damage to wildlife along the railway line;
12. Policy to prevent the settlement of migrant workers near the project sites;
13. Policy to ensure job opportunities to local people;
14. Road damage during transportation of construction materials; and
15. Create job opportunities for local people at Muse-Mandalay Railway road where the economic conditions can be reduced due to the development of railway line;

The public concern table for construction of bridge and culvert is as follows:

No.	Township Names	Village Names	Public Concerns								Public Needs	
			Traffic and road damage	Land Acquisition and compensation to land use	Water pollution	Damage to Agricultural Lands	Pressure on water supply facility	Impact to Insufficient water of agricultural land	flood to agricultural land	Impact on water resources	Job Opportunities	Water supply
1	Mandalay (Myit Nge and Pathein Gyi, Pyin Oo Lwin)	Sar Toe, Sat Kway, Myo Pyin Gyi, Da None, Nyaung Ni Pin, Nyaung Pin Zout, Myit Laung, Ashay Thar Yar Gone, Pyauk Sake Gone, Sin Boe, Pauk Chine, Min Su, Min Ywar, War Yone PinThan Ma Taw, Thansin Kone, Let Kaung, Tha Le Kone, Yan Kin Taung, Lane PinThet Kan Kone, Kone Kaw, Pin Lein (Middle), Ashay Pin Lein, Pan U Taung	√	√	-	-	√	-	-	-	√	√
2	Naung Cho	Taung Quarter, Mak Hki Nu, Kone Gyi Ma, Ngoke Ka Lay, Ong Ma Hkar, Kyein Ga Naing, Bant Bway, Hsan Ma Hse, Long Yon, Ah Nauk Kyu Inn	√	√	-	√	√	-	-	-	√	√
3	Kyaukmae	Khie Tone Hone, Kone Kaw, Naung Ann, Ngon Sai, Sai Khawng, Kyaung Kon-e, Mway Taw	√	√	-	√	√	-	-	-	√	√
4	Hsipaw	Kyin Thi, Twan Kar, Naung Eain, Swat Lann, Ho Naung, Pan Sauk, Nam Aun	√	√	-	√	√	-	-	-	√	√

5	Lashio	Hkar Shi, Nawng Mun, San Pyat, Lwin Lount, Hkay Nin, Mae Han, Kaung Ma Kyan, Naung Laing, Ho Peik, Pan Hat	√	√	√	√	√	√	√	√	√	√
6	Theinni	Nar Chat, Nan Maw Hate, Pan Kham, Pan Sone, Pan Phat, Nam On, Man Chat, Wane Line, Man Sar Tone, Naung Onn	√	√	√	√	√	√	√	√	√	√
7	Kutkai	Nam Hpat Kar, Pang Sa Lorp, Ho Nar, Nan Khone, Nam Hpat Lun, Kawng Lein, Mhan Lone, Pa Gyo	√	√	-	√	√	-	-	-	√	√
8	Muse	Nam Pang, Nan Sonn, Kaung Khan, Wane Mine, Phat Man, Man Haung, Man Hai, Man Mai	√	√	√	√	√	√	√	√	√	√

10 to 30 % of respondents

31 to 60 % of respondents

61 to 90 % of respondent

9.4. Further Public Consultation Meetings

After submission of EIA Report, MR will hold following PCMs.

SN	PCM	Responsibilities	Remarks
1.	Land Compensation	MR	Places where every affected people can attend
2.	Before starting key project development	MR	Places where every affected people can attend
3.	Once for any conflict between communities	MR	Places where every affected people can attend

9.5. Public Disclosure Process

EIA investigation

The EIA procedure of Myanmar (2015) requires that the Project Proponent shall undertake: 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.

In accordance with the guideline,

1. Sharing of relevant information about the proposed project was done by focus group discussions which was carried out with heads of village administration office and elders from almost all of the nearest villages.

2. Information regarding the proposed project was disseminated to the local community by sharing pamphlet and brochure which have images related to the project.

3. During Public Meeting, facts regarding the proposed project and potential impacts were presented in a transparent behaviour using Power Point presentation and posters.

Submission of EIA Report

The EIA procedure of Myanmar (2015) requires that not later than fifteen (15) days after submission of the EIA Report to the Department, the Project Proponent shall disclose the

EIA Report to civil society, PAPs (project affected persons) , 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.

In accordance with the guideline, draft EIA report will be made publicity on MR website and all comment and response will be accompanied in the final EIA report. The accessibility of final EIA report will be announced in local newspaper.

9.6. Grievance Redress Mechanism (GRM)

A grievance redress mechanism (GRM) must be made available to parties who have grievances or are not satisfied with any part of the development of proposed project and compensation process. A grievance redress mechanism (GRM), will be established to prevent and address community concerns, and reduce risks. The GRM is also an integral part of the monitoring and information system. It aims to ensure that feedback is received, that the voices from the poor and marginalized groups are heard, and that the issues raised are resolved effectively and expeditiously. It helps ensure that vulnerable households are treated equitably.

The GRM will be accessible to diverse members of the community and stakeholders. Multiple types of media, including face-to-face meetings, written forms, telephone conversations, or e-mail, will be available for raising issues, concerns and grievances.

The GRM aims to resolve concerns promptly, in an impartial and transparent process tailored to the specific community, and at no cost and without retribution to the complainant/s. The GRM will be communicated to different stakeholders. It is intended that information about the GRM be disseminated widely in meetings and through pamphlets and brochures in Myanmar language, and ethnic languages as needed/relevant. Specifically, information will be provided about how and where to lodge complaints/grievances. Villagers will be encouraged to seek clarification or remediation through the mechanism if they have any questions or complaints/ grievances.

Grievance Redress Monitoring Indicators

Grievance redress monitoring indicators will include:

- Number of complaints/ grievances registered.

- Percentage of grievances resolved.
- Percentage of grievances resolved within stipulated time period.
- Time required to resolve complaints.
- Percentage of complainants satisfied with response and grievance redress.
- Percentage of project beneficiaries that have access to the GRM.

9.6.1. Grievance Redress Committee (GRC)

In order to address grievances, a Grievance Redress Committee (GRM) will be formed for dealing with any grievances as they arise. This will include representatives from MMQ, representatives from Village Administrative Office of nearest project sites, representatives from Land Use Department (if necessary), representatives from Township Administrative Office, and representative from Village Administrative Office and PAPs.

9.6.2. Role and Responsibility of GRM Team

The GRM

The proposed GRM follows the existing approach taken for managing complaints about local issues by members of the public in Myanmar. Residents' complaints or concerns are generally taken to local government (village and township level) representatives for resolution; therefore this system is integrated into the GRM.

In their capacity as implementing agencies, the MMQ will establish a Public Complaints Unit (PCU) within the PMU early during project implementation prior to the start of planning and design of sub-projects and prior to negotiations for public complains. The PCU will deal with complaints from affected people and stakeholders throughout implementation of the project. This will include nearby residents, construction workers, and will involve village and township level government.

The PMU will be the key contact point for local government representatives who may require information about the project or who have an issue they would like to discuss. The PMU will issue public notices and leaflets in local languages early in the subproject design process to inform people and organizations within the project area of the GRM. The PCU's phone number, fax, address, email address will be disseminated.

The PMU will maintain a complaints database which indicates the household making the grievance, the nature of the issue, the date the report was received and also dealt with and the result. Dispute receipt and resolution will be reported regularly in project quarterly reports.

9.6.3. Grievance Mechanism Procedures

The procedure for handling grievances should be as follows.

(i) The affected person will file his grievance in writing, to the Village Leader. The grievance note will be signed and dated by the aggrieved person. Where the affected person is unable to write, he will obtain assistance to write the note and emboss the letter with his/her thumbprint.

(ii) The Head of Village Administrative Office or Village Leader will notify the Grievance Committee and respond within 14 days during which any meetings and discussions to be held with the aggrieved person will be conducted. If the grievance relates to valuation of assets, an independent value will be requested to revalue the assets, and this may necessitate a longer period of time. In this case, the aggrieved person will be notified by the VOC's head or Village Leader that his/her complaint is being considered.

(iii)If the aggrieved person does not receive a response or is not satisfied with the outcome within the agreed time, he/she may lodge his/her grievance to the Local General Administration Department.

Table - Township, district and state level committees for the grievance redress mechanism

No	Committee Member	Member Role
Township Level Redress Committee (TRC)		
	A person elected from citizen	Chairperson
	A person elected from experts	Member
	A person elected from CSOs	Member
	Deputy admin officer – township level (General Administrative Department)	Member
	Township level officer	Member
District Level Redress Committee (DRC)		
	A person elected from citizen	Chairperson
	A person elected from experts	Member
	A person elected from CSOs	Member
	Deputy admin officer – district level (General Administrative Department)	Member
	District level officer	Member
State Level Redress Committee (SRC)		
	The president appointed mayor as a minister	Chairperson
	In Yangon, there are four districts and each district can elect one representative	4 Members
	Appointed from government	4 Members

9.6.4. GRM Steps and Time frame

Procedures and time frames for the grievance redress process are as follows:

Stage 1: Access to GRM. If a concern arises, the affected person will resolve the issue of concern directly with the contractor, or make his/her complaint known to either the PCU directly, or through the local village or township government, whichever level of authority he/she is most comfortable with;

Stage 2: Official Complaint to PCU. If a complaint is filed at local government level, the government representative will submit an oral or written complaint to the PCU. For an oral complaint the PCU must make a written record. For each complaint, the PCU must assess its eligibility. If the complaint is not eligible, for instance it is determined that the issue is outside the scope of the project, PCU will provide a clear reply within five working days to the affected person;

Stage 3: PCU Complaint Resolution. The PCU will register the complaints informing the respective local and district government, the PMU and contractors. The PCU, with support of the social specialist and other PICs depending on the issue will take steps to investigate and resolve the issue. This may involve instructing the contractor to take corrective actions. Within seven days of the redress solution being agreed upon, the contractor should implement the redress solution and convey the outcome to the PMU;

Stage 4: Stakeholder Meeting. If no solution can be identified by the PCU or if the affected person is not satisfied with the suggested solution under Stage 3, within two weeks of the end of Stage 3, the PCU will organize a multi-stakeholder meeting under the auspices of the head of local government, where all relevant stakeholders will be invited. The meeting will result in a solution acceptable to all, and identify responsibilities and an action plan. MMQ will implement the agreed redress solution and convey the outcome to the PMU within seven working days. The invitees to this meeting will depend on the nature of the complaint. For example, if the complaints relate to health, land disputes, or labor issues, the appropriate specialist in this field will be invited to the stakeholder meeting. This may include officers from the Department of Agricultural Land Management and Statistics (land rights issues), Myanmar Chamber of Commerce (business/commercial issues), various non-government organizations (NGOs) (gender or equity issues), Ministry for Ethnic Affairs (if ethnic group household involved), Ministry of Health (health issues), Ministry of Environmental Conservation and Forestry (environmental issues), and Ministry of Labor (labor issues); and

Stage 5: District Administration Officer Resolution. If the multi-stakeholder meeting cannot resolve the problem, and the affected person remains unsatisfied, the PMU will set up a meeting with the District Administration Officer to identify a solution.

10.0. CONCLUSION

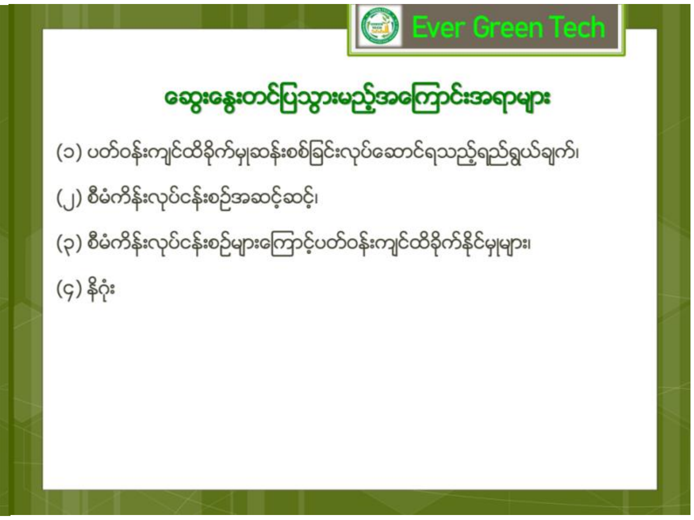
This EIA report for railway bridges and culverts will cover the environmental and socio-economic issues related to the proposed project. The assessment will not cover the political and commercial considerations about the proposed project. According to the nature of construction and operation of railway bridges and culverts, the key impacts will be blockage of rivers and water pollution during construction phase and the noise and vibration during the operation period. The most public concerns about the construction and operation of bridges and culverts during public consultation process are the are change in hydrological regime and the surface water pollution during construction phase.

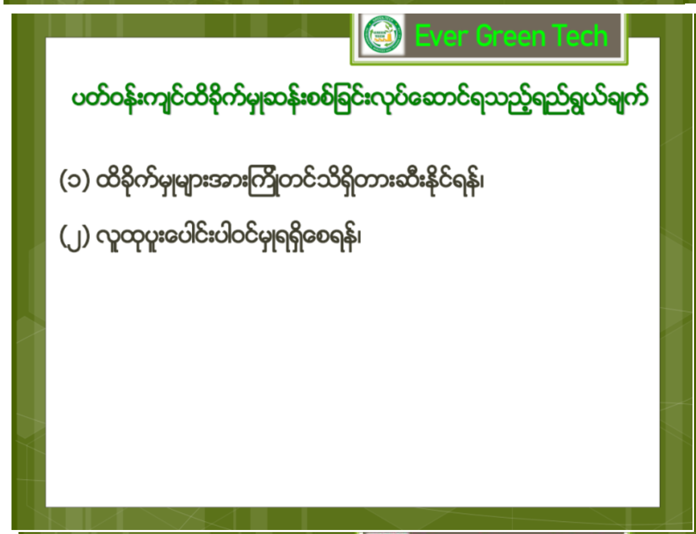
According to the environmental impact assessment, the important environmental impact during construction of bridges and culverts will be impact on biodiversity (aquatic lives), and river water quantity & quality. According to the social impact assessment, the key social impacts will be temporary land use and land acquisition for bridges and culverts construction and impact on agricultural lands nearby due to the solid waste disposal. As for conclusion, all of the environmental and social impacts can be mitigated to proper mitigation measures to acceptable level described in this report. For the land use, it is necessary to prepare comprehensive Resettlement Action Plan (RAP) for proper compensation and resettlement before the implementation stage.

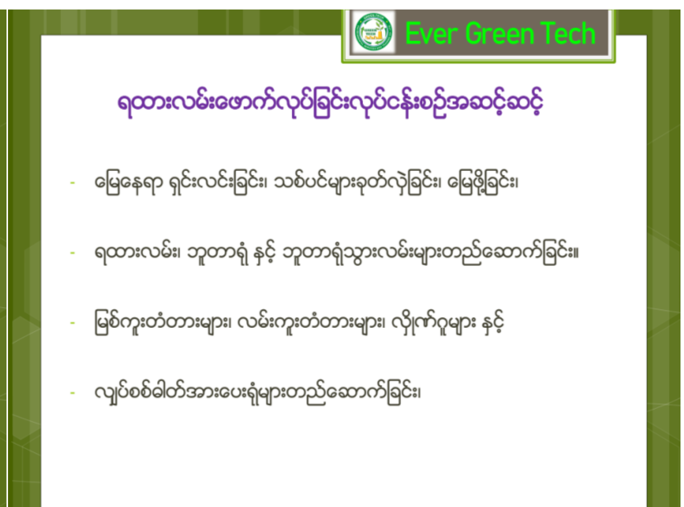
APPENDICES

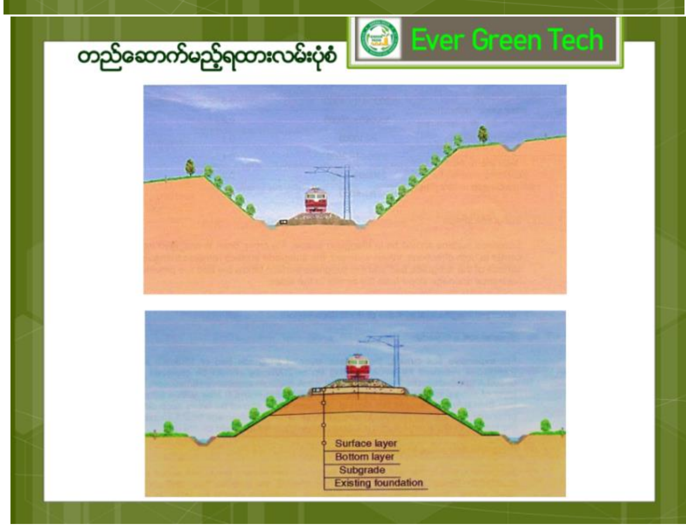
APPENDIX A

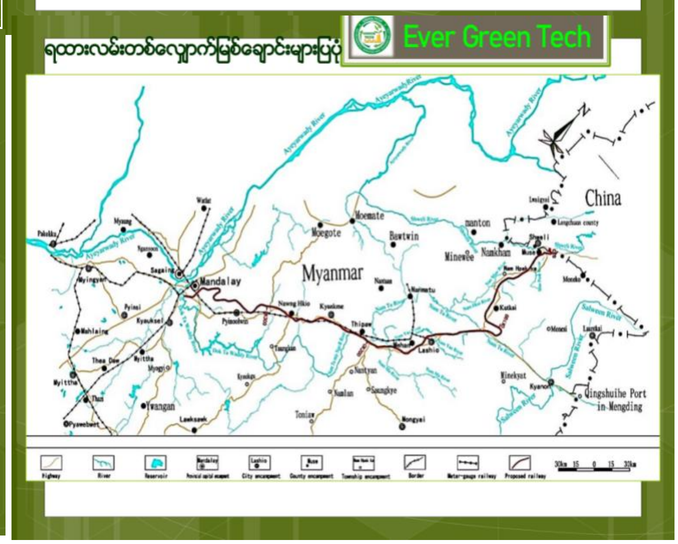
EXAMPLE OF PPT PRESENTATION DURING PUBLIC MEETING



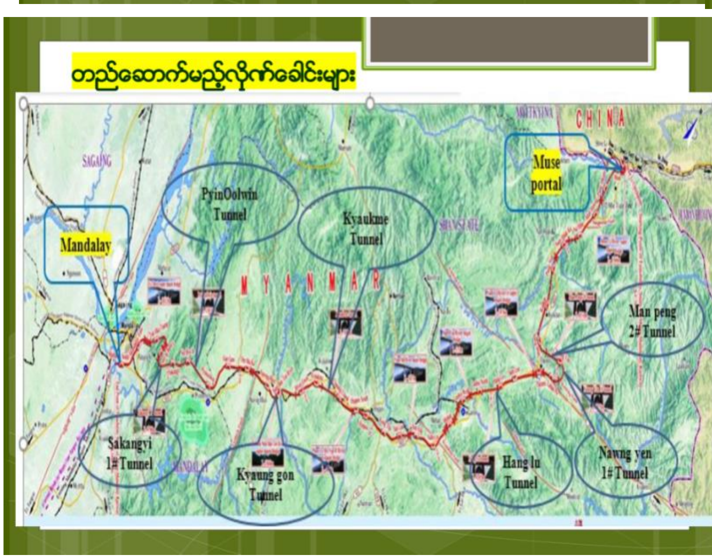


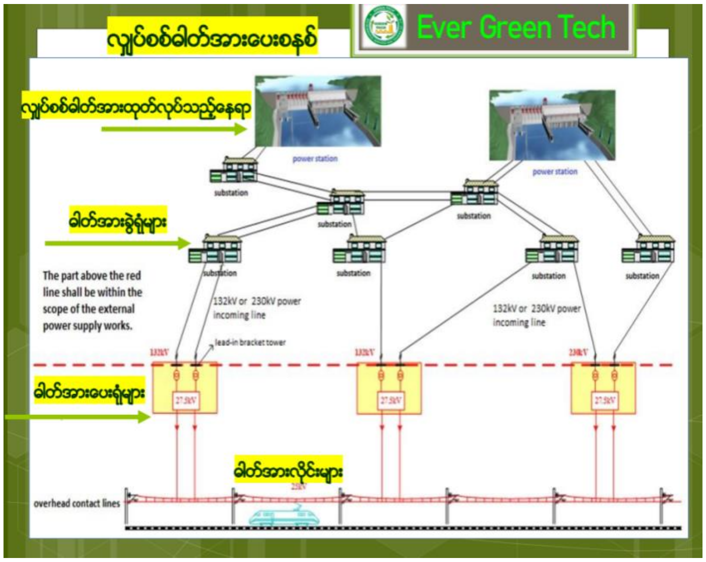


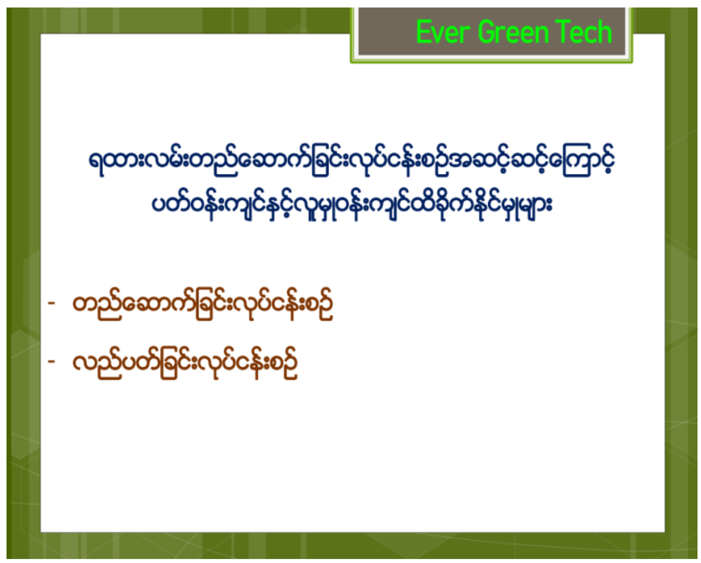




Type	General super major , major and medium bridge		Special bridge		Total	
	Quantities (Nr.)	Total length (m)	Quantities (Nr.)	Total length (m)	Quantities (Nr.)	Total length (m)
Double-track medium bridge	1	110.85			1	110.85
Single-track super major bridge	26	28531.57	1	647.31	27	29178.88
Single-track major bridge	27	8173.66	1	306.8	28	8480.46
Single-track medium bridge	9	747.10			9	747.10
Subtotal	65	37962.79	4	3072.39	69	41035.18
Three-track major bridge	4	868.41	1	274.35	5	1142.76
Double-track super major bridge	2	1101.06	2	3210.38	4	4311.44
Double-track major bridge	1	142.8			1	142.8
Double-track medium bridge	3	275.66			1	275.66
Single-track super major bridge	41	44223.09	1	647.31	42	44870.4
Single-track major bridge	56	17244.63	1	306.8	59	17551.43
Single-track medium bridge	12	1014.13			12	1014.13
Subtotal	119	64869.78	5	4438.84	124	69308.62





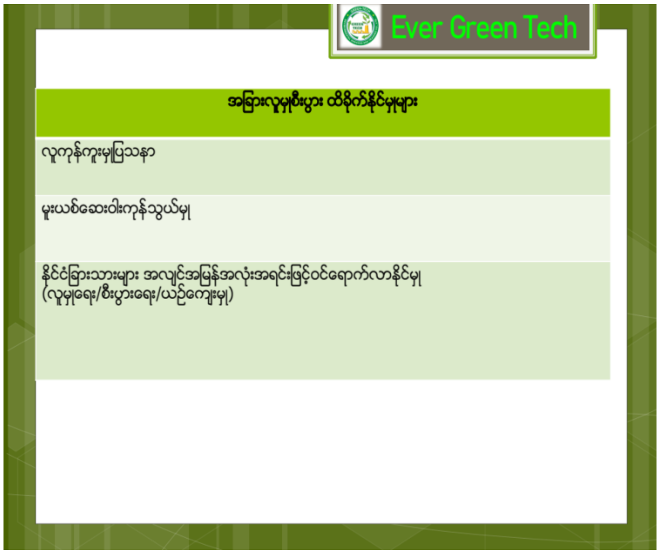


ပတ်ဝန်းကျင်အပေါ်အဓိကထိခိုက်နိုင်မှုများ

အကြောင်းအရာ	ထိခိုက်နိုင်မှု	လျော့နည်းစေရန်နည်းလမ်း
တည်ဆောက်ခြင်းလုပ်ငန်းစဉ်		
သစ်ပင်ခုတ်လှဲခြင်း	ရာသီဥတုပြောင်းလဲ ခြင်း၊ မြေသားများပြို ကျခြင်း၊ မြေဆီလွှာ တိုက်စားခြင်း နှင့် အနယ်ပို့ချခြင်း	- သစ်တောဧရိယာများရှောင်ရှားရန် - လိုအပ်သလောက်သာခုတ်လှဲရန် - အရေးကြီးအပင်များ ရွှေ့စိုက်ရန်
မြေဖို့ခြင်း နှင့် မြေသားစုပုံခြင်း	လယ်ယာမြေများထိခိုက်ခြင်း၊ မြစ်ချောင်းများထိခိုက်ခြင်း	- ပိုလျှံမြေအား စုပုံမည့်နေရာတွင်ပြန်လည် အသုံးပြုရန် - တူးယူစုပုံရမည်ဆိုပါက ပတ်ဝန်းကျင်ထိ ခိုက်မှုနည်းပါးသည့်နေရာတွင်စုပုံရန်
တံတားတည်ဆော က်ခြင်း	မြစ်ချောင်းများနောက်ကျိခြင်း/ပိ တ်ဆို့ခြင်း	- မြစ်ချောင်းများထိခိုက်ခြင်းမရှိစေရန် စနစ်တကျတည်ဆောက်ရန်
ဥမင်လိုဏ်ခေါင်းတ ည်ဆောက်ခြင်း	ဆူညံသံ နှင့် တုန်ခါမှု	- ထိန်းချုပ်ယမ်းခွဲသည့်စနစ်ကျင့်သုံးရန်
လည်ပတ်ခြင်းလုပ်ငန်းစဉ်		
ဆူညံသံ နှင့် တုန်ခါမှု	အနီးရှိပြည်သူများ နှင့် ဇီဝမျိုးကွဲများ	- အသံကာစနစ်တပ်ဆင်ရန်/ သစ်ပင်များ စိုက်ပျိုးပေးရန် - ရထားနှင့် ရထားလမ်းတွင် တုန်ခါမှု လျော့နည်းစေသည့် စနစ်တပ်ဆင်ရန်

လူမှုဝန်းကျင်အပေါ်ထိခိုက်နိုင်မှုများ

ထိခိုက်နိုင်မှု	ထိခိုက်နိုင်မည့်သူ	လျော့နည်းစေရန်နည်းလမ်း
မြေနေရာ အသုံးပြုခြင်း	စီမံကိန်းဧရိယာ အတွင်းကျရောက်သ သည့်နေရာရှိသူများ	- လိုအပ်သည့်ပမာဏအတိုင်း သာဖောက်လုပ်ရန် - အများပိုင်မြေများအားရှောင်လွှဲရန် - သင့်တော်သည့်နစ်နာကြေးပေးရန်
ကုန်ထုတ်လမ်းများ ပိတ်ဆို့ခြင်း	လမ်းတစ်လျှောက် က်နေရာရှိသူများ	- လမ်းကူးနေရာများပြုလုပ်ပေးရန်
ရေစီးကြောင်းများ/ ရေထွက်ပေါက်များ ပိတ်ဆို့ခြင်း	လမ်းတစ်လျှောက် က်နေရာရှိသူများ	- ရေထွက်မြောင်းများ ပြုလုပ်ပေးရန်
ယာဉ်ကြောပိတ်ဆို့မှု	ဒေသခံပြည်သူများ	- ဂုံးကျော်လူကူးတံတား (သို့) ဂုံးကျော်ရထားလမ်းတည်ဆောက်ပေးရန်
ရထားမတော်တဆမှု	လမ်းတစ်လျှောက် က်ပြည်သူများ/ တိရစ္ဆာန်များ	- ရထားလမ်းတစ်လျှောက်ကာရံ ပေးရန်
ဒေသခံများစီးပွားရေး	ကားလမ်းဘက်ရှိ လူနေရပ်ကွက်များ နှင့် ကားဆရာများ	- မြို့မှ ဘူတာရုံသို့ သွားရောက်သည့် ပို့ဆောင် ရေးဝန်ဆောင်မှုအား ဒေသခံများအားလုပ်ကိုင် ခွင့်ပေးရန် - ဘူတာရုံဘက်ခြမ်းတွင် ဆိုင်ခန်းများဖွင့်လှစ် ခွင့်ပေးရန်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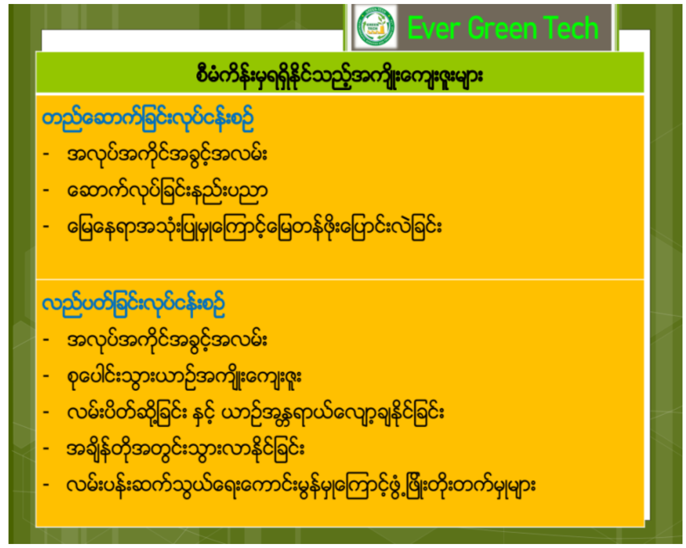
အခြားလူမှုစီးပွား ထိခိုက်နိုင်မှုများ
လူကုန်ကူးမှုပြဿနာ
မူးယစ်ဆေးဝါးကုန်သွယ်မှု
နိုင်ငံခြားသားများ အလျှင်အမြန်အလုံးအရင်းဖြင့်ဝင်ရောက်လာနိုင်မှု
(လူမှုရေး/စီးပွားရေး/ယဉ်ကျေးမှု)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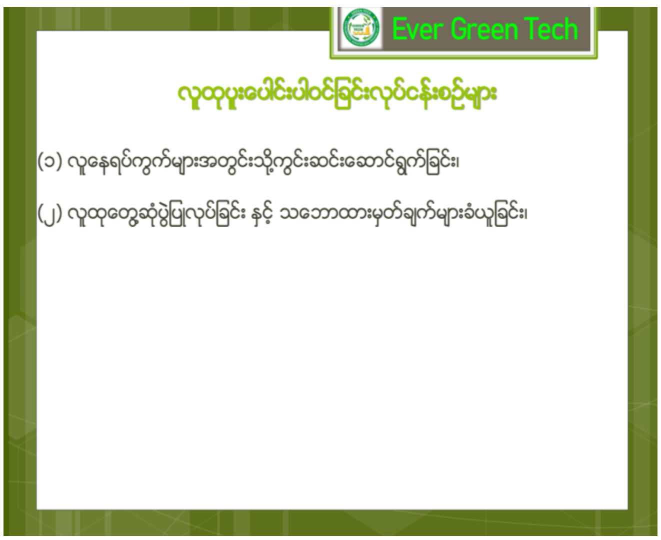
စီမံကိန်းမှရရှိနိုင်သည့်အကျိုးကျေးဇူးများ
တည်ဆောက်ခြင်းလုပ်ငန်းစဉ်
- အလုပ်အကိုင်အခွင့်အလမ်း
- ဆောက်လုပ်ခြင်းနည်းပညာ
- မြေနေရာအသုံးပြုမှုကြောင့်မြေတန်ဖိုးပြောင်းလဲခြင်း
လည်ပတ်ခြင်းလုပ်ငန်းစဉ်
- အလုပ်အကိုင်အခွင့်အလမ်း
- စုပေါင်းသွားယာဉ်အကျိုးကျေးဇူး
- လမ်းပိတ်ဆို့ခြင်း နှင့် ယာဉ်အန္တရာယ်လျော့ချနိုင်ခြင်း
- အချိန်တိုအတွင်းသွားလာနိုင်ခြင်း
- လမ်းပန်းဆက်သွယ်ရေးကောင်းမွန်မှုကြောင့်ဖွံ့ဖြိုးတိုးတက်မှုများ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(၁) လူနေရပ်ကွက်များအတွင်းသို့ကွင်းဆင်းဆောင်ရွက်ခြင်း၊
(၂) လူထုတွေ့ဆုံပွဲပြုလုပ်ခြင်း နှင့် သဘောထားမှတ်ချက်များခံယူခြင်း၊


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ကျင်းပပြီးစီးခဲ့သော လူထုတွေ့ဆုံပွဲဆိုင်ရာ မှတ်တမ်းဓါတ်ပုံများ (မြစ်ငယ်မြို့-၂၅၊ ၆၊ ၂၀၁၉)


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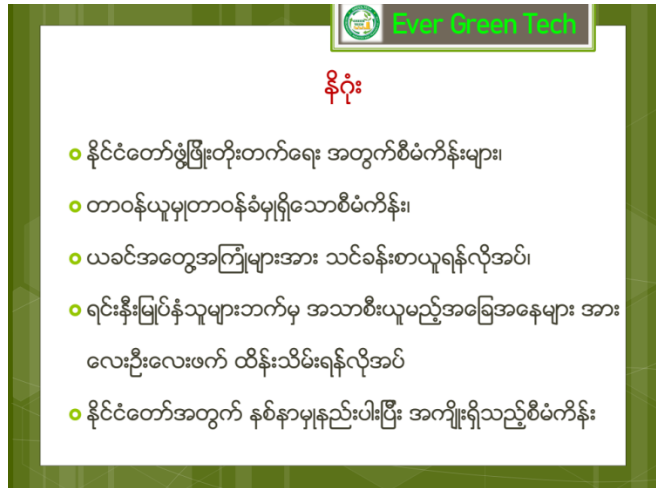
တွေ့ဆုံဆွေးနွေးပွဲများမှတွေ့ရှိချက်အကျဉ်းချုပ်
▪ လယ်မြေ၊ စိုက်ပျိုးမြေများအား ထိခိုက်မှုအနည်းဆုံးဖြစ်စေချင်
▪ နယ်ထိခိုက်မှုရှိပါက သင့်တော်/ထိုက်သင့်/လုံလောက် သော နစ်နာကြေးပေးရန်
▪ သစ်ပင်များခုတ်လှဲခြင်းမပြုရန် (သို့) လိုအပ်သရွေ့သာ ခုတ်ယူရန်၊
▪ လမ်းကူးအန္တရာယ်အား ဂရုစိုက်ပေးရန် (ကာရံထားရှိရန်)
▪ သဘာဝ ရေစီးကြောင်းများနှင့် ရေထွက် များအား မပိတ်ဆို့စေရန်၊
▪ လူသွားလမ်းများ/ကုန်ထုတ်လမ်းများအားမပိတ်ဆို့စေရန်၊
▪ ကျေးရွာသွားလမ်းများ၊ ရွာချင်းဆက်လမ်းများ မပိတ်ဆို့စေလို၊
▪ ကျွဲနွားများ စားကျက်မြေများသို့သွားသောလမ်းများအား မပိတ်ဆို့စေလို၊
▪ ကားလမ်းဆုံသည့်နေရာများကို ဂုံးကျော်အဖြစ်တည်ဆောက်ပေးစေလို၊
▪ ရထားလမ်းဝန်းကျင်ရှိသတိပေးစာသားများကို ဒေသခံဘာသာဖြင့်ရေးသားပေးရန်၊
▪ ရထားလက်မှတ်ခ သင့်တင့်စေရန်၊
▪ ဒေသခံအလုပ်အကိုင်အခွင့်အလမ်း သေချာမှုရှိစေရန်
▪ ရွှေ့ပြောင်းလုပ်သားများကြောင့် ဒေသခံများမထိခိုက်စေရန်၊
▪ နိုင်ငံတော်ပိုင်သယံဇာတများဆုံးရှုံးမှုမရှိစေရန် (လမ်းခင်းကျောက်၊ သစ်တော၊ ပိုလျှံမြေသားများ၊
▪ တာဝန်ယူမှုတာဝန်ခံမှုရှိစေရန် (တည်ဆောက်ရေးကာလ၊ လည်ပတ်ခြင်းကာလ)


မြန်မာ့မီးရထား
ဒေသအာဏာပိုင်များ
ရင်းနှီးမြုပ်နှံသူ
ဒေသခံပြည်သူ သူများ
အရပ်ဖက်အဖွဲ့ အစည်းများ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နိဂုံး
နိုင်ငံတော်ဖွံ့ဖြိုးတိုးတက်ရေး အတွက်စီမံကိန်းများ၊
တာဝန်ယူမှုတာဝန်ခံမှုရှိသောစီမံကိန်း၊
ယခင်အတွေ့အကြုံများအား သင်ခန်းစာယူရန်လိုအပ်၊
ရင်းနှီးမြုပ်နှံသူများဘက်မှ အသာစီးယူမည့်အခြေအနေများ အား လေးဦးလေးဖက် ထိန်းသိမ်းရန်လိုအပ်
နိုင်ငံတော်အတွက် နစ်နာမှုနည်းပါးပြီး အကျိုးရှိသည့်စီမံကိန်း


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အချိန်ပေးတက်ရောက်ဆွေးနွေးပေး
သည့်အတွက် ကျေးဇူးအထူးတင်ရှိပါသည်။
ဆက်သွယ်အကြံပြုရန်
ဒေါက်တာကျော်စွာတင့်
၀၉ - ၅၀၉၉၂၃၂
Email: 11kyawswar@gmail.com

EXAMPLE OF SUGGESTION LETTER DURING PCMs