Myanmar Onshore Block MOGE-3 2D & 3D Seismic Exploration ESHIA – Rev1

PTT Exploration and Production South Asia (PTTEP SA)

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FINAL REPORT

PTTEP SA

Myanmar Onshore Block MOGE-3
2D & 3D Seismic Exploration ESHIA – Rev 1

February 2017

Prepare by ERM-Siam Co., Ltd

Reference 0270975

For and on behalf of
ERM-Siam Co., Ltd.

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ABBREVIATIONS

AQS	Air Quality Standards
ALARP	As Low As Reasonably Practical
BOPD	Barrels of Oil per Day
BCF	Billion Cubic Feet
BBPC	British Burma Petroleum Company
BOC	Burmah Oil Company
CO	Carbon Monoxide
CIA	Cumulative Impact Assessment
DBH	Diameter at Breast Height
EBA	Endemic Bird Area
E&SMS	Environmental and Social Management System
ECC	Environmental Compliance Certificate
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EPAS	Environmental Perimeter Air Monitoring System
EQS	Environmental Quality Standards
ERM	Environmental Resources Management
ESHMP	Environmental, Social and Health Management Plan
ESHIA	Environmental, Social, and Health Impact Assessment
FAO	Food and Agriculture Organization
IVI	Importance Value Index
IOGC	Indian Oil and Gas Canada
IEE	Initial Environmental Examination
IFC	International Finance Corporation
KPH	Kilometre Per Hour
LEL	Lower Explosive Limit
MSL	Mean Sea Level
CH_4	Methane
MMCF	Million Cubic Feet
MMCFD	Million Cubic Feet per Day
MOECAF	Ministry of Environmental Conservation and Forestry
MIC	Myanmar Investment Commission
MMRD	Myanmar Marketing, Research and Development Co., Ltd.
MOGE	Myanmar Oil and Gas Enterprise
NAAQS	National Ambient Air Quality Standards
NCEA	National Commission for Environmental Affairs
NEP	National Environment Policy
NSDS	National Sustainable Development Strategy
NO_2	Nitrogen Dioxide
OSHA	Occupational Safety & Health Administration
PPV	Peak Particle Velocity
PFE	Permanent Forest Estate
PPE	Personal Protective Equipment

PEC	Predicted Environmental Concentration
PSC	Production Sharing Contract
PC	Project Contribution
PAS	Protected Areas System
PTTEPI	PTTEP International
PTTEP SA	PTTEP South Asia
REM	Resource and Environment Myanmar Ltd
SSHE	Safety, Security, Health and Environmental
SSHE MS	SSHE Management System
SO_2	Sulphur Dioxide
TKT	Thaketa
TDS	Total Dissolved Solids
TSP	Total Suspended Particulates
TM	Transverse Mercator
UXO	Unexploded Ordinance
UNCED	United Nations Conference on Environment and Development
USEPA	United Stated Environmental Protection Agency
VOC	Volatile Organic Compounds

Section 1

Executive Summary

1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

This Environmental, Social, and Health Impact Assessment (ESHIA)* presents an assessment of the potential environmental, social and health impacts associated with the proposed PTTEP South Asia Limited (PTTEP SA) Block MOGE-3 Onshore 2D and 3D Seismic Project in Myanmar (the 'Project').

The objectives of this ESHIA are to:

- Facilitate an understanding of the elements of the existing baseline conditions that are relevant to resources/receptors that could be significantly impacted by the Project;
- Identify the aspects of the Project likely to result in significant impacts to resources/receptors;
- Predict and evaluate the significance of the impacts of the Project;
- Identify the environmental, social and health aspects of the Project that need to be managed, and recommend appropriate and justified mitigation and enhancement measures;
- Determine the significance of residual impacts, taking into account the implementation of mitigation measures; and
- Generate plans for the management and monitoring of impacts.

The study area for this ESHIA includes:

- The physical and ecological study area includes the area around the seismic survey within Block MOGE-3. The proposed seismic area consists of approximately 1,000 km^2, within Thayet and Kanma Townships, Magway Region.
- The human use and quality of life study area includes the land and landowners affected by the Project's seismic activities within Thayet and Kanma Townships, Magway Region.

The ESHIA has been undertaken following a systematic process that predicts and evaluates the impacts the Project could have on aspects of the physical, biological, social/socio-economic and cultural environment, and identifies measures that the Project will take to avoid, minimize, mitigate, offset or compensate for adverse impacts; and to enhance positive impacts where practicable. This ESHIA Report has been structured according to the Draft EIA Procedures (2014), which are described further in ***Section 3***.

* *Note that, at the time of writing this report in 2014, the EIA Procedure had not yet been finalized and promulgated. As such, this report was originally referred to as an "Environmental, Social, and Health Impact Assessment (ESHIA) report", rather than an "Initial Environmental Examination (IEE) report". However, the contents of this*

report are aligned with what would be required in an IEE Report, despite the difference in title. As mentioned in Section 1.1, the term "ESHIA" throughout this report shall be understood to be equivalent to "IEE" as per the requirements of the EIA Procedure.

1.2 PROJECT DESCRIPTION

1.2.1 Project Location

Onshore Block MOGE-3 is located in the middle of the Dry Zone in Central Myanmar, Magway Region, and covers an area of 1,217 km^2. It is geographically situated at the west bank of the Ayeyarwady River, in the central Myanmar basin, at an elevation of 36.4 m (119.3 feet) above sea level.

The seismic survey will cover most of Block MOGE-3, approximately 1,000 km^2, consisting of approximately 2,500 km of source lines and 5,000 km receiver lines for the 3D survey, and 300 km seismic lines for the 2D survey (cumulative total of 7,800 km for all seismic lines).

1.2.2 Project Activities

1.2.2.1 Site Preparation

Prior to carrying out the seismic survey, along with reference to topographic maps, initial site reconnaissance will take place to determine locations of important features and potential hazards, including access, offsets, compensation areas, no-vehicle areas, no-drilling areas, etc. In terms of hazards, overhead or underground power lines and cables, rivers, streams, culverts, ditches, houses, bridges, steep gradients, holes, fences, animals, half-fallen trees, insect nests, etc will be considered.

1.2.2.2 Seismic Survey Overview

The seismic survey will be carried out using both explosive shots and Vibroseis (seismic vibrator), both of which act as a vibration source. The principle of seismic survey is based on the different acoustic properties of rock profiles in absorbing and reflecting acoustic waves. The acoustic energy from an explosion or ground impact will penetrate rock profiles with different acoustic properties. Part of this energy will be passed into the deeper layers of the profiles, while the remaining energy will be reflected back to geophones. The reflection time from different layers of the profiles, and amplitude of waves, will be recorded. The time taken for acoustic waves to reach rock profiles and reflect back implies the depth of the profiles. The speed of acoustic waves is proportional to the depth of rock profiles: acoustic waves take longer time passing through rock profiles that are low density, porous, and intervened with fluid than where acoustic waves pass through denser rocks.

Information obtained by geophones will be recorded and interpreted using a computer. This provides underground profiles, which will imply types and characteristics of geological structures, as well as potential petroleum

reservoirs. Information on other characteristics that will also be obtained include maps of mobile or flowing sediments, unconformity, geological history, sedimentation, etc. All information will be used as a guide to plan future petroleum exploration drilling.

1.2.2.3 Compensation Procedures

Crop compensation will be considered for the Project. Price appraisals for crop damage will be provided by respective township government departments, and will be approved by district administrator. A compensation committee will be organized, and composed of officials from MOGE, PTTEP SA and local township authorities. Damage measurement, calculation and payment will be carried out systematically.

1.2.2.4 Abandonment and Site Restoration

Once the survey and recording are finished, equipment will be removed and personnel will leave the site. The site will also be restored into its original state by burying all holes, as well as collecting all wastes and materials and transporting out of the site.

1.2.3 Project Schedule

Seismic Survey activities are tentatively expected to begin in September or October 2015, subject to final work program and schedule. Seismic acquisition will be completed within nine months after first shot record.

1.2.4 Employment and Accommodation

During seismic operations, a maximum number of 1,000 field staff will be required. Local staff will be preferentially hired where possible. Seismic survey staff will be accommodated at either the Base Camp, or in Field Camps.

1.3 DESCRIPTION OF THE SURROUNDING ENVIRONMENT

Existing environmental, social and health baseline data was collected for the Project, based on primary land use and livelihood surveys, secondary sources, and previous ESHIA reports,.

1.3.1 Environmental Resources

The proposed Project is located on predominantly level or gently sloping country in the Magway Region, which is in the Central Region of Myanmar. The elevation of Blocks MOGE-3 varies from about 12 m to 388 m above mean sea level (MSL). Magway has an average maximum temperature of 37.74 ^{o}C, an average mean temperature of 27.05 ^{o}C, and an average minimum temperature of 16.34 ^{o}C.

Air quality in the Project area is good with respect to Carbon Monoxide (CO), Volatile Organic Compounds (VOC), Nitrogen Dioxide (NO_2) and Sulphur

Dioxide (SO_2) but experiences elevated levels of both Particulate Matter (PM10) and Total Suspended Particulates (TSP) due to the dry climate.

24-hour equivalent noise levels in the Project area range from 44.12 dB (A) to 63.47 dB (A). Day noise levels were below the Myanmar National Environmental Quality (Emission) Guidelines (Draft). However, the night noise levels were above the guidelines, most likely due to motorbike traffic and diesel generator use for the production of electricity.

No significant vibration sources are expected to be located in the Project area, apart from intermittent, localized vibration from road vehicles.

Based on previous surveys near Block MOGE-3, uncontaminated soil conditions are expected to occur within the Project area.

Groundwater is the principal source of potable domestic water supply in Magway Region. Aquifers in the study area are the Eocene and Peguan Alluvian aquifers. Quality and quantity of groundwater varies depending on the lithology and depositional environments. In previous groundwatwer surveys of nearby Blocks, relatively high Total Dissolved Solids (TDS) levels were found, and Manganese and Selenium were found to exceed allowable limits.

Based on surveys of nearby regions, basic water quality parameters for surface water in the Project area are expected to be within normal ranges.

This forest type is mainly composed of numerous commercially important timber species including teak (*Tectona grandis*), which is central to forest management in Myanmar. Many other commercially important hardwood timber species are associated with teak including *Xylia xylocarpa* (Myanmar Iron Wood), *Pterocarpus macrocarpus*, *Gmelina arborea*, *Melitia pendula* and *Dalbergia oliveri*. A high diversity of vegetation including bamboos is observed in the different types of deciduous forests in Myanmar. Common wildlife species in Block MOGE-3 are jungle fowl, crow, snake, iguana, partridge, rabbit, barking deer and boar.

1.3.2 Social Resources

The Project area mainly consists of agricultural and forested areas; other areas include communities, water sources, unoccupied areas, roads, etc. Another important land use in Block MOGE-3 consists of a number of hand-dug oil well communities, especially in Padaukpin. The surface space typically required for complete drilling operations at a given location (including drilling, completion, and subsequent production) ranges from 1.2 to 12.1 ha. The space required for one drilling unit is about 4.6 m^2.

Central Myanmar has a relatively well developed transport system compared to other parts of Myanmar, including road, air, rail, and water. Most townships allow a maximum truck weight of 13 tons, and village roads allow no more than 6 tons, due to timber bridges. Previous traffic surveys in

Magway have indicated that the highways receive moderate traffic, with some highways carrying 80 to 100,000 vehicles per year.

The principal product of Magway Region is petroleum. It produces most of the oil and natural gas in Myanmar. There are a number of hand-dug oil well communities (ie. grass-roots oil wells dug with rudimentary equipment) in the region, which contributes income to a large number of residents. Other industries include cement, cotton weaving, and tobacco, iron and bronze.

Agriculture is also important. Rice is the most prominent crop in the Project area. Other crops of importance are oil seed crops such as groundnut and sesame, pulses and beans and cotton as industrial crop.

There are no officially designated or protected archaeological sites in the Project area; however there are numerous monasteries and pagodas found throughout the Project area.

There are no major tourist attractions located within Block MOGE-3, although small numbers of tourists may be interested in visiting the various pagodas scattered through the region.

1.3.3 Health Resources

In Myanmar, 70% of the population resides in rural areas. There are generally little sanitation services and access to drinking water in rural areas. The use of traditional medicine is widespread and forms an integral part of the country's health services. Health care services in most communities within the Project area are very basic and in most cases involve a midwife only.

1.4 SUMMARY OF IMPACT ASSESSMENT AND MITIGATION MEASURES

This ESHIA evaluates the impacts associated with the proposed Project. The ESHIA has been conducted in compliance with the relevant Myanmar legislative requirements, international conventions, and PTTEP SA corporate requirements.

The significance of each potential impact was determined based on ERM's robust impact assessment methodology, which is described in detail in ***Section 6***. After evaluating each impact and assigning impact significance, mitigation measures were proposed to reduce the likelihood and/or to limit the extent of potential impacts. Once mitigation measures were declared, residual impact significance was assigned. This is essentially a repeat of the impact assessment steps, considering the implementation of the proposed mitigation measures. ***Table 1.1*** presents the outcomes of the comprehensive assessment of identified impacts as a result of the various activities of the Project.

In addition, a cumulative impact assessment (CIA) was carried out, considering the impacts for the Project evaluated alongside potential impacts from other projects/activities/natural events in Block MOGE-3. No significant cumulative impacts were identified.

1.5 *MANAGEMENT PLAN*

The environmental, social and health management plan (ESHMP) outlines the mitigation measures that are to be employed by the Project to mitigate identified impacts, as well as outlines monitoring measures that will be undertaken to assess whether the mitigation measures are effective and if performance meets ESHIA commitments.

The purpose of the proposed mitigation measures is to manage identified impacts, comply with regulations and ensure that standards of international industry practice are adopted during the execution of all Project activities. Mitigation measures will be taken into account in Project implementation and execution such that potential adverse impacts are reduced to As Low As Reasonably Practical (ALARP).

In addition, monitoring will be required in order to demonstrate compliance with legal limits and PTTEP SA's Project requirements, which will also provide verification of the overall design and effectiveness of the implemented control measures. The recommended monitoring and mitigation measures are presented in detail in ***Section 8.***

1.6 *PUBLIC CONSULTATION AND DISCLOSURE*

In order to enhance stakeholder's understanding on the planned 2D and 3D seismic project activities, and obtain suggestions/concerns for developing appropriate mitigation measures, public consultation was conducted for this Project. The approach and methodology for public consultation is described in detail in ***Section 9*** of this ESHIA report.

Public consultation primarily consisted of two public meetings, covering two townships within the Project area of Block MOGE-3, Thayet Township and Kanma Township, carried out on February 4 and February 5, 2015.

Comments and recommendations of stakeholders obtained from the public consultation meetings in Kanma and Thayet Townships are summarized in ***Section 9*** and ***Annex H***. Some of the key issues related to the ESHIA study results were related to crop and land damage, compensation procedures, public notification of Project schedule, and whether the survey would pass through sensitive or restricted areas. All of the issues were responded to appropriately by PTTEP SA and ERM at the public meetings.

The implementation of the public consultation program achieved its goals in providing an opportunity for stakeholders to give opinions and recommendations on the Project. Opinions and recommendations obtained through public consultation have been used in the ESHIA study to help develop mitigation measures and monitoring programs on environmental, social and health impacts, as discussed in ***Section 9*** of this ESHIA report.

Table 1.1 Summary of Impact Assessment Outcome

Aspect	Project Activities/Impacts	Significance of Impacts	Residual Impact Significance
Environmental Impacts			
Air Quality	• Dust dispersion may occur from transportation on unpaved roads. • Dust dispersion may occur from shooting/recording. • Air pollutants emitted from fuel combustion.	**Negligible**	**Negligible**
Greenhouse Gas	• Combustion of fossil fuels in stationary and mobile combustion sources will produce greenhouse gases (e.g. carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)).	**Negligible**	**Negligible**
Noise and Vibration	• Increased noise during the seismic survey may disturb nearby residents or fauna. • Increased vibration may disturb nearby residents, settlements, or archaeological resources during shooting/recording.	**Minor**	**Negligible**
Topography and Soil	• Soil disturbance during seismic activities has the potential to increase soil erosion. • Potential impact to soils and agricultural land through compaction from seismic activities. • Potential for soil contamination from chemicals in explosives. • Potential for soil contamination from poor waste management and wastewater disposal.	**Minor**	**Negligible**
Groundwater	• Potential for groundwater hydrology and quality impacts from drilling of shot holes. Shot holes are to be drilled to a depth of 10-30 m, which is in the range of groundwater level (5-260 m). There is a potential for drilling to impact groundwater quality by introducing sediment or other contaminants to the groundwater from the surface. • If shooting/recording operates close to a groundwater well (less than minimum setback distance), the structure of the groundwater well could be impacted. • Potential for impacts to groundwater due to leaching through soil contaminated by poor waste management and wastewater disposal.	**Minor**	**Negligible**
Surface Water	• Vehicle transportation around the Project site and along access roads, as well as drilling of shot holes and shooting/recording, could disturb soil surface potentially, resulting in erosion and consequent sedimentation of waterways. • Potential for impacts to surface water due to runoff from soil contaminated by poor waste management and wastewater disposal.	**Minor**	**Negligible**
Flora and Fauna	• Vehicle/human treading during survey can lead to soil compaction that might inhibit root penetration and reduce water infiltration. • Terrestrial fauna could potentially be impacted by noise from vehicles transporting equipment and personnel, and noise from drilling equipment.	**Minor**	**Negligible**

Aspect	Project Activities/Impacts	Significance of Impacts	Residual Impact Significance
Social Impacts			
Land Use	• The survey team and/or vehicles may need to tread on crops along a 1-m wide path for the length of each seismic line (both source and receiver lines). • For drilling of one shot hole, the area of about 10 m^2 will be cleared of vegetation. • The path of the seismic vibrator (Vibroseis) trucks will require cleared vegetation and will compact soil along the source line (about 10 m total along the line).	**Moderate**	**Minor**
Transportation	• Transport to and from the working area will result in a temporary and local increase in vehicles on the roads. • Transport of explosives could result in potentially serious impacts, including damage or disruption to the existing transportation network due to accidental explosion. • The temporary closure of public roads for shooting/recording may result in inconvenience to public.	**Minor**	**Minor**
Socio-Economy	• Potential for positive impacts due to local employment and use of local businesses and services. • Potential for negative impacts due to disruption to agricultural and petroleum-based activities.	**Moderate**	**Minor**
Historical, Archaeological and Cultural Resources	• Shooting/recording, could potentially cause damage to nearby archaeological sites due to vibration impact.	**Moderate**	**Minor**
Health Impacts			
Worker Health and Safety	• Potential impacts to worker health and safety from various Project activities.	**Moderate**	**Negligible**
Public Health	• Potential impacts to public health from dust, noise, vibration, and possibly by transportation accidents due to Project activities.	**Minor**	**Negligible**

1.7 STATEMENT OF COMMITMENTS

PTTEP SA will at all times comply fully with the commitments, mitigation measures, and plans that have been presented in this ESHIA Report.

PTTEP SA shall fully implement the EMP, all Project commitments, and conditions, and is liable to ensure that all contractors and subcontractors of the Project comply fully with all applicable Laws, including the Environmental Conservation Law (2012), Environmental Conservation Rules and Environmental Impact Assessment Procedure (2015), as well as the EMP, Project commitments and conditions.

PTTEP SA and ERM hereby confirm that:

(1) The ESHIA Report is accurate, consolidated and complete;
(2) The ESHIA has been conducted in accordance with relevant laws, including the EIA Procedure (2015).
(3) The Project will fully follow the commitments, mitigation measures and plans set out in this ESHIA Report.

1 အစီရင်ခံစာအကျဉ်းချုပ်

1.1 နိဒါန်း

ဤ ပတ်ဝန်းကျင်၊ လူမှုရေး နှင့် ကျန်းမာရေးထိခိုက်မှု ဆန်းစစ်ခြင်း (ESHIA)* သည်၊ မြန်မာနိုင်ငံရှိ အဆိုပြု ကုမ္ဗဏီ PTTEP South Asia Limited (PTTEP SA) ၏ ကုန်းတွင်းလုပ်ကွက်အမှတ် MOGE-3 တွင် 2D နှင့် 3D ဆိုက်စမစ် စီမံကိန်းလုပ်ငန်း နှင့်စပ်လျဉ်း၍ ဖြစ်ပေါ်လာနိုင်သည့် ပတ်ဝန်းကျင်၊ လူမှုရေး နှင့် ကျန်းမာရေး သက်ရောက်မှုများ ၏ ဆန်းစစ်မှုကို တင်ပြထားခြင်း ဖြစ်ပါသည် ('စီမံကိန်း')။

ဤ ESHIA ၏ ရည်ရွယ်ချက်များမှာ အောက်ပါအတိုင်းဖြစ်ပါသည် -

- စီမံကိန်းကြောင့် သိသာထင်ရှားစွာ ထိခိုက်ခံရနိုင်သော သက်ဆိုင်ရာ အရင်းအမြစ်များ/ပတ်ဝန်းကျင်များ ဖြစ်သည့် တည်ရှိနေပြီးသော အခြေခံ အချက်အလက်အခြေနေ အကြောင်းအရာများကို သဘောပေါက်နားလည်အောင် ပံ့ပိုးပေးရန်၊
- အရင်းအမြစ်များ/ပတ်ဝန်းကျင်များ အပေါ် သိသိသာသာ ထိခိုက်စေနိုင်သော စီမံကိန်း၏ ကဏ္ဍများကို သတ်မှတ်ရန်၊
- စီမံကိန်းမှ ထိခိုက်မှုများ၏ အရေးပါမှုကို ကြိုတင်တွက်ဆပြီး အကဲဖြတ်ရန်၊
- စီမံခန့်ခွဲရန်လိုအပ်သော စီမံကိန်း၏ ပတ်ဝန်းကျင်၊ လူမှုရေး နှင့် ကျန်းမာရေး ကဏ္ဍများကို သတ်မှတ်လျက်၊ သင့်လျော်ပြီး ခိုင်လုံသည့် ထိခိုက်မှု လျှော့ချစေရေး နှင့် ပိုမိုကောင်းမွန်ရေး အစီအမံများကို အကြံပြုရန်၊
- ထိခိုက်မှုလျှော့ချရေးအစီအမံများ အကောင်အထည်ဖော်ဆောင်ရွက်လျက်၊ ကြွင်းကျန် သက်ရောက်မှုများ၏ အရေးပါမှုကို ဆုံးဖြတ်နိုင်ရန်၊ နှင့်
- သက်ရောက်မှုများကို စီမံခန့်ခွဲရေးနှင့် စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးရေး အတွက် အစီအစဉ်များ ရေးဆွဲရန်၊

ဤ ESHIA အတွက် လေ့လာမှုဧရိယာမှာ အောက်ပါတို့ပါဝင် ပါသည် -

- ရုပ်ပိုင်းဆိုင်ရာ နှင့် ဂေဟပိုင်းဆိုင်ရာလေ့လာရေးဧရိယာတွင် လုပ်ကွက်အမှတ် MOGE-3 အတွင်း ဆိုက်စမစ်တိုင်းတာရေး တစ်ပိုက်ဧရိယာပါဝင်ပါသည်။ အဆိုပြုဆိုက်စမစ် ဧရိယာတွင် မကွေးတိုင်းဒေသကြီး၊ သရက် နှင့် ကံမမြို့နယ် အတွင်း ခန့်မှန်းခြေ ၁,၇၇၇ စတုရန်းကီလိုမီတာခန့် ပါဝင်ပါသည်။
- လူအသုံးပြုမှုနှင့် လူမှုဘဝအရည်အသွေးလေ့လာရေး ဧရိယာတွင် မကွေးတိုင်းဒေသကြီး၊ သရက် နှင့် ကံမမြို့နယ် အတွင်း စီမံကိန်း၏ ဆိုက်စမစ်လုပ်ငန်းများကြောင့် ထိခိုက်ခံရနိုင်သော မြေ နှင့် မြေပိုင်ရှင်များ ပါဝင်ပါသည်။

ESHIA ကို ရုပ်ပိုင်းဆိုင်ရာ၊ ဇီဝပိုင်းဆိုင်ရာ၊ လူမှုရေး/လူမှု-စီးပွားရေးဆိုင်ရာ နှင့် ယဉ်ကျေးမှုဆိုင်ရာ ပတ်ဝန်းကျင်၏ ကဏ္ဍများပါဝင်နေသည့် စီမံကိန်း၏ သက်ရောက်မှုများကို ကြိုတင်တွက်ဆပြီး အကဲဖြတ်လျှက်၊ စီမံကိန်းမှ ဆိုးကျိုးသက်ရောက်မှုများများကို တာဆီးရန်၊ လျှော့ချရန်၊ ထေကာနိုင်ရန် သို့မဟုတ် လျော်ကြေးပေးရန် အစီအမံများကို သတ်မှတ်ကာ စနစ်ကျသောလုပ်ငန်းစဉ်ဖြင့်

ဆောင် ရွက်ခဲ့ပြီး ဖြစ်ပါသည်။ ဤ ESHIA စီရင်ခံစာကို မူကြမ်း EIA လုပ်ထုံးလုပ်နည်း (၂၀၁၄) နှင့်အညီ မိုဖြမ်းထားပါသည်။ ၎င်းကို ***အခန်း ၃*** တွင်လည်း ဆက်လက် ဖော်ပြထားပါသည်။

** ၂၀၁၄ ခုနှစ်၊ ဤအစီရင်ခံစာကို ရေးသားခဲ့သည့်ကာလတွင် EIA လုပ်ထုံးလုပ်နည်းအား အပြီးသတ် ပြဋ္ဌာန်းခြင်းမရှိသေးကြောင်း မှတ်ယူလိုပါသည်။ ထို့ကြောင့်၊ ဤအစီရင်ခံစာကို မူလအား ဖြင့် "ကနဦးပတ်ဝန်းကျင်ဆန်းစစ်ခြင်း (IEE) အစီရင်ခံစာ" ထက် "ပတ်ဝန်းကျင်၊ လူမှုရေး၊ နှင့် ကျန်းမာရေးထိခိုက်မှုဆန်းစစ်ခြင်း (ESHIA) အစီရင်ခံစာ" ဟု ရည်ညွှန်းထားရှိပါသည်။ သို့ရာတွင် ခေါင်းစဉ်အားဖြင့်ကွဲလွဲသော်လည်း၊ ဤအစီရင်ခံစာ၏ မာတိကာများသည် IEE အစီရင်ခံစာ တစ်စောင်တွင် ပါဝင်ရန်လိုအပ်သည်များနှင့်အညီ ဖြစ်ပါသည်။ အခန်း ၁.၁ တွင် ဖော်ပြထားသည့် အတိုင်း၊ ဤအစီရင်ခံစာတစ်လျှောက်သုံးနှုန်းထားသည့် "ESHIA" စကားရပ်သည်၊ EIA လုပ်ထုံးလုပ်နည်း၏ သတ်မှတ်ချက်များအရ "IEE" နှင့် တူညီကြောင်း မှတ်ယူရမည် ဖြစ်ပါသည်။*

1.2 *စီမံကိန်းဖော်ပြချက်*

1.2.1 စီမံကိန်းတည်နေရာ

ကုန်းတွင်းလုပ်ကွက်အမှတ် MOGE-3 သည် မြန်မာနိုင်ငံအလယ်ပိုင်း၊ ချောက်သွေ့ဇုန်၏ အလယ်ပိုင်း တွင် တည်ရှိပြီး၊ ဧရိယာ ၁,၂၁၇ စတုရန်းကီလိုမီတာ ကျယ်ဝန်းပါသည်။ ၎င်းနေရာ သည် ပထဝီအနေအထားအရ မြန်မာပြည်၏ အလယ်ပိုင်းချိုင့်ဝှမ်း၊ ဧရာဝတီမြစ်အနောက်ဘက်ကမ်း၊ ပင်လယ်ရေမျက်နှာပြင် အထက် ၃၆.၄ မီတာ (၁၁၉.၃ ပေ) တွင် တည်ရှိနေပါသည်။

ဆိုက်စမစ်တိုင်းတာရေးတွင် ကုန်းတွင်းလုပ်ကွက်အမှတ် MOGE-3 ၏ အများစု ခန့်မှန်းခြေ ၁,၀၀၀ စတုရန်း ကီလိုမီတာခန့် ပါဝင်မည် ဖြစ်ပါသည်။ 3D တိုင်းတာရေးအတွက် ပင်မထုတ်လွှတ်ရေးလိုင်း ခန့်မှန်း ခြေ ၂,၅၀၀ ကီလိုမီတာ နှင့် ဖမ်းယူရေးလိုင်း ၅,၀၀၀ ကီလိုမီတာခန့် တို့နှင့် 2D တိုင်းတာ ရေး အတွက် ဆိုက်စမစ်လိုင်း ၃၀၀ ကီလိုမီတာခန့် (ဆိုက်စမစ်လိုင်းအားလုံးအတွက် ဆက်စပ် စုစုပေါင်း ၇,၈၀၀ ကီလိုမီတာ) တို့ ပါဝင်သွားမည် ဖြစ်ပါသည်။

1.2.2 စီမံကိန်းလုပ်ငန်းများ

1.2.2.1 လုပ်ငန်းခွင်ပြင်ဆင်ခြင်း

ဆိုင်စမစ် တိုင်းတာရေး ဆောင်ရွက်မှုမစတင်မီ၊ မြေမျက်နှာသွင်ပြင်ပြမြေပုံများကိုမိုဖြမ်းလျှက်၊ သွားရေးလာရေး၊ ထေကာနိုင်ရေး၊ လျော်ကြေးပေးရေးဧရိယာများ၊ ယဉ်မဝင်နိုင်သောဧရိယာများ၊ မတူးဖော်သည့်ဧရိယာများ စသည်တို့အပါအဝင် ဖြစ်ပေါ်လာနိုင်သော ဘေးအန္တရာယ်များ နှင့် အရေးပါသောအင်္ဂါရပ်များ၏ တည်နေရာများကို ဆုံးဖြတ်နိုင်ရန်၊ ကနဦး လုပ်ငန်းခွင် ကင်းထောက် ခြင်း ကို ဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။ ဘေးအန္တရာယ်များ ဟု ဆိုရာတွင်၊ မြေပေါ်နှင့်အမြင့်တွင် သွယ်တန်းထားရှိသော ပါဝါလိုင်းများနှင့်ကြိုးများ၊ မြစ်များ၊ စမ်းချောင်းများ၊ မြေအောက် ပိုက်လိုင်းများ၊ မြောင်းများ၊ အိမ်များ၊ တံတားများ၊ မတ်စောက်သောလျှောစောက်များ၊ မြေအောက် လှိုင်ခေါင်းများ၊ ခြံစည်းရိုးများ၊ တိရိစ္ဆာန်များ၊ တချို့တဝက် လဲပြိုကျနေသောသစ်ပင်များ၊ ပိုးမွှားအသိုက်များ၊ စသည် တို့ကို ထည့်သွင်းစဉ်းစားသွားမည် ဖြစ်ပါသည်။

1.2.2.2 *ဆိုက်စမစ်တိုင်းတာရေး ခြုံငုံသုံးသပ်ချက်*

ဆိုက်စမစ်တိုင်းတာရေးကို ယမ်းဘီလူး နှင့် Vibroseis (ဆိုက်စမစ်တုန်ခါကိရိယာ) နှစ်မျိုးလုံးဖြင့် ဆောင်ရွက်သွားမည်ဖြစ်ပြီး၊ ၎င်းနှစ်မျိုးလုံးမှ တုန်ခါမှုရင်းမြစ် ဖြစ်ပေါ် စေပါသည်။ ဆိုက်စမစ်တိုင်းတာရေး၏ အဓိကအခြေခံသဘောတရားမှာ အသံလှိုင်းများ စုပ်ယူရာနှင့် အသံပြန်ရာတွင် ကျောက်ဖွဲ့အစည်းပုံအနေအထားများ၏ မတူညီသော အသံဂုဏ်သတ္တိများ အပေါ် အခြေခံပါသည်။ ဖောက်ခွဲခြင်း သို့မဟုတ် မြေပေါ်သက်ရောက်ခြင်းတစ်ခုမှ အသံစွမ်းအားသည် မတူညီသော အသံဂုဏ်သတ္တိများဖြင့် ကျောက်ဖွဲ့အစည်းပုံအနေအထားများကို ထိုးဖောက်သွားမည် ဖြစ်ပါသည်။ ဤစွမ်းအားများ၏ အချို့သည် ဖွဲ့အစည်းပုံအနေအထားများ၏ ပိုမိုနက်သော အလွှာများ ကို ဖြတ်သွားမည် ဖြစ်ပြီး၊ ကျန်စွမ်းအားများသည် ဖမ်းယူရေးကိရိယာများသို့ ပြန်လည်ရိုက်ခတ် လာမည် ဖြစ်ပါသည်။ လှိုင်းများ၏ ပမာဏနှင့် ဖွဲ့စည်းပုံအနေအထားများ၏ မတူညီသောအလွှာများမှ ပြန်လည်ရိုက်ခတ်လာသောအချိန်ကို မှတ်တမ်းတင်ထားရှိမည် ဖြစ်ပါသည်။ ကျောက်ဖွဲ့အစည်းပုံ အနေအထားများသို့ရောက်ရန် အသံလှိုင်းများ နှင့် ပြန်လည်ရိုက်ခတ်လာရန်အတွက် ကြာချိန်သည် ဖွဲ့စည်းပုံအခြေအထားများ၏ အနက်ကို ညွှန်းဆိုပါသည်။ အသံလှိုင်းများ၏ အမြန်နှုန်းမှာ ကျောက် ဖွဲ့အစည်းပုံအနေအထားများ၏ အနက် နှင့် အချိုးကျပါသည်။ သိပ်သည်းဆနည်းကာ စိမ့်ဝင်နိုင်ပြီး၊ အရည်များကြားဝင်ကာ ကျောက်ဖွဲ့အစည်းပုံအနေအထားများကို ဖြတ်သွားသော အသံလှိုင်းများ သည်၊ သိပ်သည်းဆများသောကျောက်များကို ဖြတ်သွားသော အသံလှိုင်းများထက် အချိန်ပိုကြာ မည် ဖြစ်ပါသည်။

ဖမ်းယူရေးကိရိယာများဖြင့်လက်ခံရရှိသော သတင်းအချက်အလက်များကို ကွန်ပျူတာကို အသုံး ပြုလျှက် မှတ်တမ်းတင်ပြီး၊ ကောက်ချက်ချ ယူမည် ဖြစ်ပါသည်။ ၎င်းမှ ဘူမိဗေဒဆိုင်ရာ ဖွဲ့အစည်း ပုံများ၏ အမျိုးအစားများ နှင့် သွင်ပြင်လက္ခဏာများကို ညွှန်းဆိုသည့် မြေအောက်ဖွဲ့စည်းပုံ အနေ အထားများ နှင့် ရေနံခိုအောင်းနိုင်မှုရှိမရှိ အလားအလာများကို ရရှိမည် ဖြစ်ပါသည်။ ဖမ်းယူရရှိမည့် အခြားသွင်ပြင်လက္ခဏာများဆိုင်ရာ သတင်းအချက်အလက်များတွင် အနည်အနစ်ကျောက်အလွှာ များ ရွှေ့လျားမှုနှင့် စီးဆင်းမှု၏ မြေပုံများ၊ ကျောက်အဖွဲ့အစည်းမျက်နှာပြင်များ၊ ဘူမိဗေဒဆိုင်ရာ သမိုင်းများ၊ အနည်အနစ်များ၊ စသည့် တို့ ပါဝင်မည် ဖြစ်ပါသည်။ သတင်းအချက်အလက်များ အားလုံးကို အနာဂတ် ရေနံရှာဖွေတူးဖော်ရေးကို စီစဉ်ရန် လမ်းညွှန်ချက်တစ်ခုအဖြစ် အသုံးပြု သွားမည် ဖြစ်ပါသည်။

1.2.2.3 *လျော်ကြေးပေးခြင်းဆိုင်ရာလုပ်ထုံးလုပ်နည်း*

စီမံကိန်းအတွက် သီးနှံလျော်ကြေးပေးချေခြင်းကို ထည့်သွင်းစဉ်းစားသွားမည် ဖြစ်ပါသည်။ သီးနှံ ပျက်စီးမှုအတွက် စျေးနှုန်းတန်းဖိုးများကို သက်ဆိုင်ရာမြို့နယ်အစိုးရဌာနများထံမှ သတင်းအချက် အလက်များကို ရယူသွားမည်ဖြစ်ပြီး၊ ခရိုင်အုပ်ချုပ်ရေးမှူးမှ အတည်ပြုသွားမည် ဖြစ်ပါသည်။ လျော်ကြေးပေးရေး ကော်မတီကို မြန်မာ့ရေနံနှင့်သဘာဝဓါတ်ငွေ့လုပ်ငန်း မှ အရာရှိများ၊ PTTE SA ကုမ္ပဏီ နှင့် ဒေသခံမြို့နယ်များမှ အာဏာပိုင်အဖွဲ့အစည်းများဖြင့် ဖွဲ့စည်းသွားမည် ဖြစ်ပါသည်။ ပျက်စီးတိုင်းတာခြင်း၊ တွက်ချက်ခြင်း နှင့် ပေးချေခြင်း တို့ကို ထိုကော်မတီမှ စနစ်တကျ တိုင်းတာဆောင်ရွက် သွားမည်ဖြစ်ပါသည်။

1.2.2.4 *စွန့်ခွာခြင်းနှင့် လုပ်ငန်းခွင်နေရာကိုနဂိုအတိုင်း ပြန်လည်ပြုပြင်ခြင်း*

တိုင်းတာရေးနှင့်မှတ်တမ်းတင်ပြုစုပြီးသောအခါ၊ ကိရိယာများကို ဖယ်ရှားပြီး လုပ်ငန်းအတွက် တာဝန်ရှိသူများသည်လည်း လုပ်ငန်းခွင်နေရာမှ ထွက်ခွာသွားမည် ဖြစ်ပါသည်။ လုပ်ငန်းခွင်နေရာကိုလည်း စွန့်ပစ်ပစ္စည်းများ အားလုံးနှင့် အခြားပစ္စည်းများကို လုပ်ငန်းခွင်နေရာမှ ပြန်လည်သယ်ယူခြင်း နှင့် ကျင်းများအားလုံးကို ပြန်ပိတ်ဖို့ခြင်းဖြင့် ယခင်မူလပုံစံနှင့် အနီးစပ်ဆုံး ရရှိအောင် ပြန်လည်ပြုပြင်သွားမည် ဖြစ်ပါသည်။

1.2.3 စီမံကိန်းအချိန်ဇယား

အပြီးသတ်လုပ်ငန်းအစီအစဉ် နှင့် အချိန်ဇယား တို့ အပေါ်မူတည်လျှက် ဆိုက်စမစ်တိုင်းတာရေး လုပ်ငန်းများကို ၂၀၁၅ ခုနှစ် စက်တင်ဘာလ သို့မဟုတ် အောက်တိုဘာလ ၌ စတင်ရန် အကြမ်းအားဖြင့် ရည်ရွယ်ထားပါသည်။ ဆိုက်စမစ်ဆောင်ရွက်ခြင်းသည် ပထမပစ်ချက် (first shot) ကိုမှတ်တမ်းတင်ပြီးနောက် ကိုးလအကြာ အတောအတွင်းတွင် ပြီးမြောက်မည် ဖြစ်ပါသည်။

1.2.4 အလုပ်သမား ငှားရမ်းခြင်း နှင့် နေရာထိုင်ခင်း

ဆိုက်စမစ်လည်ပတ်ရေးလုပ်ငန်းအတွင်း အများဆုံး ကွင်းဆင်းဝန်ထမ်း ဦးရေ ၁,၀၀၀ ကို လိုအပ်မည် ဖြစ်ပါသည်။ ဖြစ်နိုင်လျှင် ဒေသခံဝန်ထမ်းများကို ဦးစားပေး ငှားရမ်းခန့်အပ်သွားမည် ဖြစ်ပါသည်။ ဆိုက်စမစ်တိုင်းတာရေးဝန်ထမ်းများကိုရုံးစိုက်ရာစခန်းတွင် သို့မဟုတ် အလုပ်ကွင်းစခန်းတို့တွင် နေရာထိုင်ခင်းပြုလုပ်သွားမည် ဖြစ်ပါသည်။

1.3 ဆက်စပ်ပတ်ဝန်းကျင်ဖော်ပြချက်

စီမံကိန်းအတွက် ရှိနေပြီးသော ပတ်ဝန်းကျင်၊ လူမှုရေး နှင့် ကျန်းမာရေးဆိုင်ရာ အခြေခံအချက်အလက်များကို မူလ မြေအသုံးချမှု နှင့် အသက်မွေးဝမ်းကျောင်းစစ်တမ်းများ၊ တစ်ဆင့်ခံ အရင်းအမြစ်များ နှင့် ယခင် ESHIA အစီရင်ခံစာများအပေါ် အခြေပြု၍ ကောက်ယူစုဆောင်းခဲ့ပါသည်။

1.3.1 ပတ်ဝန်းကျင်ဆိုင်ရာအရင်းအမြစ်များ

အဆိုပြု စီမံကိန်းတည်နေရာသည် မြန်မာနိုင်ငံ၏ အလယ်ပိုင်းဖြစ်သည့် မကွေးတိုင်းဒေသကြီးတွင် အဓိကအားဖြင့် ဆင်ခြေလျှောနေရာပေါ်တွင် တည်ရှိပါသည်။ လုပ်ကွက်အမှတ် MOGE-3 သည် ပင်လယ်ရေမျက်နှာပြင် အထက် (MSL) ၁၂ မီတာ မှ ၃၈၈ မီတာ အတွင်းတွင် ရှိပါသည်။ မကွေးတွင် အမြင့်ဆုံးအပူချိန်မှာ ၃၇.၇၄ စင်တီဂရိတ်၊ ပူမှန်အပူချိန်မှာ ၂၇.၀၅ စင်တီဂရိတ် နှင့် အနိမ့်ဆုံးအပူချိန်မှာ ၁၆.၃၄ စင်တီဂရိတ်တို့ ဖြစ်ကြပါသည်။

စီမံကိန်းဧရိယာရှိ လေအရည်အသွေးသည် ကာဗွန်မိုနိုအောက်ဆိုက် (CO)၊ ဗိုလက်တိုင်း အော်ဂဲနစ်ကွန်ပေါင်း (VOC)၊ နိုက်ထရိုဂျင်ဒိုင်အောက်ဆိုက် (NO_2) နှင့် ဆာလဖာဒိုင်အောက်ဆိုက် (SO_2) တို့အားဖြင့်တိုင်းတာလျှင် ကောင်းမွန်သော အရည်အသွေးရှိနေပါသည်။ သို့ရာတွင် ခြောက်သွေ့သောဥတုရာသီကြောင့် အမှုန်ပါဝင်မှု (PM10) နှင့် လေထဲတွင်မျောပါနေသောအမှုန် (TSP) တို့၏ အဆင့်များသည် အနည်းငယ် မြင့်တက်တတ်ကြောင်းလည်း တွေ့ရှိရပါသည်။

စီမံကိန်း ဧရိယာရှိ ၂၄ နာရီ ဆူညံမှုအဆင့်မှာ ၄၄.၁၂ dB (A) မှ ၆၃.၄၇ dB (A) အထိဖြစ်ပသည်။ နေ့ဘက်ဆူညံမှုအဆင့်မှာ မြန်မာ အမျိုးသား ပတ်ဝန်းကျင်ဆိုင်ရာ အရည်အသွေး (ထုတ်လွှတ်မှု)

လမ်းညွှန်ချက်များ (အကြမ်း) အောက်ဘက်အဆင့်ကို ရောက်ရှိပါသည်။ သို့ရာတွင် ညဘက်ဆူညံမှု အဆင့်များသည် လမ်းညွှန်ချက်များ၏ အထက်ဘက်အဆင့်သို့ ရောက်ရှိပါသည်။ ဖြစ်နိုင်သည်မှာ မော်တိုဆိုင်ကယ်အသုံးပြုမှုများ နှင့် လျှပ်စစ်မီးရရှိရန်အတွက် ဒီဇယ်စက်များအသုံးပြုရသောကြောင့် ဖြစ်ပါသည်။

စီမံကိန်းဧရိယာတွင် လမ်းယာဉ်များကြောင့် ကြိုးကြားကြိုးကြား၊ သေးငယ်သော တုန်ခါမှု မှလွဲ၍ သိသာထင်ရှားသော တုန်ခါမှုအရင်းအမြစ်များ ရှိမနေပါ။

လုပ်ကွက်အမှတ် MOGE-3 အနီးအနားရှိ ယခင်တိုင်းတာရေးများတွင် အခြေခံပြု၍ စီမံကိန်းဧရိယာ အတွင်း ညစ်ညမ်းမှုမရှိသော မြေဆီလွှာအနေအထားများ ရှိပါသည်။

မြေအောက်ရေသည် မကွေးတိုင်းဒေသကြီးရှိ အိမ်းတွင်းသောက်သုံးနိုင်သောရေရှိရာ အဓိက အရင်းအမြစ် ဖြစ်ပါသည်။ လေ့လာရေးဧရိယာရှိ ရေအောင်းလွှာများသည် Eocene နှင့် Peguan Alluvian ရေအောင်းလွှာတို့ ဖြစ်ကြပါသည်။ မြေအောက် ရေအရည်အသွေးနှင့် ရရှိမှုအရေ အတွက်တို့မှာ ကျောက်သွင်ပြင်လက္ခဏာများ နှင့် အနည်ကျနေသာပတ်ဝန်းကျင်တို့အပေါ် မူတည် နေပါသည်။ လုပ်ကွက်အမှတ်များ အနီးအနား၏ ယခင် ရေအောက်တိုင်းတာရေးများတွင်၊ ရေထဲတွင်ပျော်ဝင်နေသောအရာများ၏ (TDS) အဆင့်များသည် အတော်အတန်မြင့်နေသည်ကို တွေ့ရှိခဲ့ရပြီး၊ Manganese နှင့် Selenium တို့သည် သတ်မှတ်ထားသည်ထက် ကျော်လွန်သွားသည်ကို တွေ့ရှိခဲ့ရပါသည်။

ဒေသအနီးတဝိုက်၏ တိုင်းတာမှုများအပေါ် အခြေခံလျှက်၊ စီမံကိန်းဧရိယာရှိ မျက်နှာပြင် ရေ အတွက် အခြေခံရေအရည်အသွေးသတ်မှတ်ချက်များသည် ပုံမှန်အနေအထားတွင် ရှိနေပါသည်။

ဤသစ်တောအမျိုးအစားမှာ အဓိကအားဖြင့် မြန်မာနိုင်ငံတွင် သစ်တောစီမံခန့်ခွဲရေးအတွက် အဓိကကျသော ကျွန်းသစ် (*Tectona grandis*) အပါအဝင် စီးပွားရေးအရ အရေးပါသော သစ်မျိုးစိတ်တို့ဖြင့် ရှိနေပါသည်။ အခြားသော စီးပွားရေးအရအရေးပါသော သစ်မာမျိုးစိတ်များမှာ *Xylia xylocarpa* (*မြန်မာ့သံသစ်*)၊ *Pterocarpus macrocarpus*၊ *Gmelina arborea*၊ *Melitia pendula* *နှင့်* *Dalbergia oliveri* *တို့အပါအဝင်* ကျွန်းသစ်များ နှင့် ဆက်နွယ်နေပါသည်။ ဝါးများအပါအဝင် မျိုးစုံသည့် သစ်ပင်ပေါက်တောများ ကို မြန်မာနိုင်ငံရှိ ရွက်ပြတ်သစ်တောများ ၏ အမျိုးအစားများဖြင့် စူးစမ်းလေ့လာ ပါသည်။ လုပ်ကွက်အမှတ် MOGE-3 ရှိ အဓိကတောရိုင်း တိရစ္ဆာန်မျိုးစိတ်တို့မှာ တောကြက်၊ ကျီးကန်း၊ မြွေ၊ ဖွတ်၊ ခါဇုက်၊ ယုန်၊ သမင် နှင့် တောဝက် တို့ဖြစ်ကြပါသည်။

1.3.2 လူမှုရေးဆိုင်ရာ အရင်းအမြစ်များ

စီမံကိန်းဧရိယာတွင် အဓိကအားဖြင့် စိုက်ပျိုးရေး နှင့် သစ်တောဧရိယာအချို့ ပါဝင်ကြပါသည်။ အခြား ဧရိယာများမှာ ရပ်ရွာများ၊ ရေအရင်းအမြစ်နေရာများ၊ လွတ်နေသောဧရိယာများ၊ လမ်းများ၊ စသည် တို့ ဖြစ်ကြ ပါသည်။ လုပ်ကွက်အမှတ် MOGE-3 ရှိ အခြားအရေးပါသော မြေအသုံးပြုမှုတွင် အထူး သဖြင့် ပိတောက်ပင် ကျေးရွာတွင် ရေနံလက်ယက်တွင်း လုပ်သောရပ်ရွာတို့ ပါဝင် ကြပါသည်။ မျက်နှာပြင်နေရာသည် ပေးထားသောတည်နေရာ (တူးဖော်ခြင်း၊ ပြီးမြောက်ခြင်း နှင့် နောက်ဆက်တွဲထုတ် လုပ်ခြင်း တို့အပါအဝင်) ဖြစ်သော ၁.၂ မှ ၁၂.၁ ဟက်တာ ရှိ ပြီးမြောက်ပြည့်စုံသည့် တူးဖော်ရေး လည်ပတ်ရေးလုပ်ငန်းများကို လိုအပ်ပါသည်။ တူးဖော်ရေးတစ်ယူနစ်အတွက် လိုအပ်သောနေရာမှာ ၄.၆ စတုရန်းမီတာခန့် ဖြစ်ပါသည်။

ကုန်းလမ်း၊ လေကြောင်း၊ မီးရထားလမ်း နှင့် ရေကြောင်း တို့အပါအဝင် မြန်မာနိုင်ငံ၏ အခြားနေရာ ဒေသ များနှင့် နှိုင်းယှဉ်လျှင် မြန်မာနိုင်ငံအလယ်ပိုင်းဒေသတွင် တော်တော်လေးကောင်းမွန်သော သယ်ယူပို့ဆောင်ရေးစနစ် ရှိပါသည်။ မြို့နယ်အများစုတွင် အများဆုံး အလေးချိန် ၁၃ တန်ချိန်ထရပ် ကားများကို ခွင့်ပြုထားပြီး၊ ကျေးရွာလမ်းများတွင် သစ်တံတားများရှိနေသောကြောင့် ၆ တန် ထက် ခွင့်မပြုပါ။ မကွေးတိုင်းဒေသကြီးရှိ ယခင် ယာဉ်အသွားအလာတိုင်းတာရေးများ အရ အဝေးပြေးလမ်းများတွင် တစ်နှစ်လျှင် ၈၀ မှ ၁၀၀ ,၀၀၀ ယာဉ်များ ဖြင့် အတန်အသင့်ယာဉ်အသွားအလာ ရှိပါသည်။

မကွေးတိုင်းဒေသကြီး၏ အဓိက ထွက်ကုန်မှာ ရေနံဖြစ်ပါသည်။ မြန်မာနိုင်ငံရှိ ရေနံ နှင့် သဘာဝ ဓာတ်ငွေ့ အများစုကို ယင်းနေရာမှ ထွက်ရှိပါသည်။ ဒေသတွင် ရေနံလက်ယက်တွင်း လုပ်သောရပ်ရွာ များ (ဥပမာ - ခေတ်နောက်ကျသော ကိရိယာများဖြင့် အောက်ခြေလူတန်းစား လက်ယက်တွင်းများ) ရှိပြီး၊ ၎င်းမှ ဒေသခံနေထိုင်သူများ၏ ဝင်ငွေအတွက် များစွာ အထောက်အပံ့ ပေးပါသည်။ အခြား လုပ်ငန်းများတွင် ဘိလပ်မြေ၊ ချည်ထည်ရက်လုပ်ခြင်း၊ နှင့် ဆေးလိပ်လုပ်ငန်း၊ သံ နှင့် ကြေး လုပ်ငန်း တို့ ပါဝင်ကြပါသည်။

စိုက်ပျိုးရေးလုပ်ငန်းလည် အရေးပါသော လုပ်ငန်းတစ်ရပ် ဖြစ်ပါသည်။ စီမံကိန်းဧရိယာတွင် စပါးမှာ အဓိကထင်ရှားသော သီးနှံမျိုးဖြစ်ပါသည်။ အခြားအရေးပါသော သီးနှံများမှာ ဆီထုတ်လုပ်နိုင်သည့် မြေပဲ နှင့် နှမ်း၊ ပဲမျိုးများ ပဲတောင့်မျိုးများ နှင့် လုပ်ငန်းသုံး သီးနှံအဖြစ် ဝါပင် တို့ ဖြစ်ကြ ပါသည်။

စီမံကိန်းဧရိယာတွင် တရားဝင်သတ်မှတ်ထားသော သို့မဟုတ် ထိန်းသိမ်းကာကွယ်ထားသော ရှေး ဟောင်းသုတေသနဆိုင်ရာနေရာများ ရှိမနေပါ။ သို့ရာတွင် စီမံကိန်းဧရိယာတစ်လျှောက် များပြား စွာသော ဘုန်းကြီးကျောင်းများ နှင့် ဘုရားပုထိုးများကို တွေ့ရှိရပါသည်။

လုပ်ကွက်အမှတ် MOGE-3 အတွင်း ကမ္ဘာ့ခရီးသွားများဆွဲဆောင်နိုင်သော အဓိက နေရာများ ရှိမနေပါ။ သို့ရာတွင် တချို့အနည်းစုခရီးသွားဧည့်သည်များသည် ဒေသရှိ ပြန့်နှံ့နေသော ဘုရား ပုထိုးများကို စိတ်ဝင်စားကောင်း စိတ်ဝင်စားနိုင် ပါသည်။

1.3.3 ကျန်းမာရေးဆိုင်ရာအရင်းအမြစ်များ

မြန်နိုင်ငံတွင်၊ လူဦးရေ ၇၀ % မှာ ကျေးလက်ဒေသတွင် နေထိုင်ကြပါသည်။ ကျေးလက်ဒေသများ တွင် မိလ္လာစနစ်ဆောင်ရွက်မှုများ နှင့် သောက်သုံးရေရရှိမှုမှာ ပုံမှန်အားဖြင့် အကန့်အသတ်ဖြင့် ဖြစ်ပါသည်။ တိုင်းရင်းဆေးအသုံးပြုမှုမှာ ကျယ်ပြန့်ပြီး၊ တိုင်းပြည်၏ ကျန်းမာရေးဝန်ဆောင်မှုများနှင့် တစ်သားတည်းဖြစ်နေပါသည်။ စီမံကိန်းဧရိယာအတွင်းရှိ ရပ်ရွာအများစုတွင် ကျန်းမာရေး စောင့် ရှောက်မှု ဝန်ဆောင်မှုများမှာ အလွန်အခြေခံကျသောအဆင့်တွင်ရှိနေပြီး၊ အချို့နေရာများတွင် ဝမ်းဆွဲလက်သည်တစ်ဦးသာ ရှိပါသည်။

1.4 ထိခိုက်မှုဆန်းစစ်ခြင်းနှင့် လျှော့ချရေးအစီအမံများ အကျဉ်းချုပ်

ဤ ESHIA သည် အဆိုပြုစီမံကိန်းနှင့်စပ်လျဉ်းသည့် သက်ရောက်မှုများကို တွက်ထုတ်ထားပါသည်။ ESHIA ကို သက်ဆိုင်ရာမြန်မာဥပဒေသတ်မှတ်ချက်များ၊ နိုင်ငံတကာကွန်ဗင်းရှင်းများ၊ နှင့် PTTEP SA ပူးပေါင်းမှု စံနှုန်းသတ်မှတ်ချက်များနှင့်အညီ ဆောင်ရွက်ခဲ့ခြင်း ဖြစ်ပါသည်။

အခန်း ၆ တွင် အသေးစိတ်ဖော်ပြပေးထားသော ERM ၏ ခိုင်ခံ့သော သက်ရောက်မှုဆန်းစစ်ခြင်း နည်းလမ်း အပေါ် အခြေပြု၍ ဖြစ်ပေါ်လာနိုင်သောသက်ရောက်မှု တစ်ခုချင်းစီ၏ အရေးပါမှုကို စိစစ်တွက်ချက်ထား ပါသည်။ သက်ရောက်မှုတစ်ခုချင်းစီ နှင့် သက်ရောက်မှုများ၏အရေးပါမှုကို တွက်ချက်ပြီးနောက်၊ ဖြစ်ပေါ်လာနိုင်သော သက်ရောက်မှုများ၏ ကြီးမားမှုကို ကန့်သတ်ရန် သို့မဟုတ် လျှော့ချနိုင်ရန် လျှော့ချရေးအစီအမံများကို အဆိုပြုခဲ့ပါသည်။ လျှော့ချရေးအစီအမံများကို တရားဝင်ကြေညာပြီးသည်နှင့် ကြွင်းကျန်သက်ရောက်မှု၏အရေးပါမှုကို တွက်ထုတ်ပါသည်။ ဤသည်မှာ အဆိုပြု လျှော့ချရေးအစီအမံများ အကောင်အထည်ဖော်ဆောင်ရွက်မှုကိုထည့်သွင်းလျှက် သက်ရောက်မှု ဆန်းစစ်ခြင်းအဆင့်များကို မရှိမဖြစ်ပြန်လည်ဖော်ပြရခြင်း ဖြစ်ပါသည်။ ***ဇယား ၁.၁*** တွင် စီမံကိန်းလုပ်ငန်းများ၏ အကျိုးဆက်အဖြစ် သတ်မှတ်ထားသော သက်ရောက်မှုများ၏ ဘက်ပေါင်းစုံ ဆန်းစစ်ခြင်းရလဒ်များကို တင်ပြထားပါသည်။

ထို့အပြင်၊ လုပ်ကွက်အမှတ် MOGE-3 ရှိ အခြားသော စီမံကိန်းများ/လုပ်ငန်းများ/သဘာဝ ဖြစ်စဉ် ဖြစ်ရပ်များမှ ဖြစ်ပေါ်လာနိုင်သည့်သက်ရောက်မှုများကြောင့် စီမံကိန်းအတွက် သက်ရောက်မှုများကို ထည့်သွင်းလျှက်၊ ဆက်စပ်ထိခိုက်မှုဆန်းစစ်ခြင်း (CIA) ကိုလည်း ဆောင်ရွက်ခဲ့ပါသည်။ သိသာထင်ရှားသော ဆက်စပ်ထိခိုက်မှုများ မရှိကြောင်း တွေ့ရှိ ရပါသည်။

1.5 *စီမံခန့်ခွဲမှုအစီအစဉ်*

ပတ်ဝန်းကျင်၊ လူမှုရေး နှင့် ကျန်းမာရေး စီမံခန့်ခွဲမှုအစီအစဉ် (ESHMP) သည် သတ်မှတ်ထားသော ထိခိုက်မှုများကို လျှော့ချရန်၊ စီမံကိန်းမှဆောင်ရွက်မည့် လျှော့ချရေးအစီအမံများကို အနစ်ချုပ်ဖော်ပြ ထားပါသည်။ ထို့အပြင်၊ လျှော့ချရေးအစီအမံများသည် ထိရောက်မှုရှိ မရှိ၊ ပြီးလျှင် ဆောင်ရွက်မှုများ သည် ESHIA ကတိကဝတ်များနှင့် ကိုက်ညီ မကိုက်ညီကို စိစစ်ဆောင်ရွက်သွားရန်၊ စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးရေးအစီအမံများ ကိုလည်း ဖော်ပြထားပါသည်။

အဆိုပြု လျှော့ချရေးအစီအမံများ၏ ရည်ရွယ်ချက်မှာ စီမံကိန်းလုပ်ငန်းများအားလုံး၏ဆောင်ရွက်မှု ကာလအတွင်း နိုင်ငံတကာလုပ်ငန်းဆောင်ရွက်မှု၏ စံနှုန်းများကို အသက်သွင်းဆောင်ရွက်မှုကို သေချာစေရန် စည်းမျဉ်းစည်းကမ်းများနှင့်အညီ၊ သတ်မှတ်ထားသောသက်ရောက်မှုများကို စီမံခန့်ခွဲရန် ဖြစ်ပါသည်။ စီမံကိန်း အကောင်အထည်ဖော်ဆောင်ရွက်ခြင်းတွင် ဖြစ်ပေါ်လာနိုင်သည့် ဆိုးကျိုးသက်ရောက်မှုများကို လျှော့ချနိုင်ရန် ကြောင်းကျိုးဆီလျော်လျှက် နည်းနိုင်သမျှနည်းသော ကျင့်သုံးမှု (ALARP) ကဲ့သို့သော လျှော့ချရေး အစီအမံများကို ထည့်သွင်းဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။

ထို့အပြင်၊ ဥပဒေဆိုင်ရာကန့်သတ်ချက်များ နှင့် PTTEP SA ၏ စီမံကိန်းသတ်မှတ်ချက်များ နှင့်အညီ ဆောင်ရွက်ကြောင်းပြသနိုင်ရန် စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးခြင်းကို လိုအပ်ပါသည်။ ၎င်းမှ အကောင်အထည် ဖော်ဆောင်ရွက်သည် ထိန်းချုပ်ရေးအစီအမံများ၏ အလုံးစုံဒီဇိုင်း နှင့် ထိရောက်မှုကို အတည်ပြုဆောင်ရွက်နိုင်မည်လည်း ဖြစ်ပါသည်။ အကြံပြုထားသော စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးရေး နှင့် လျှော့ချရေးအစီအမံများကို ***အခန်း ၈ တွင် အသေးစိတ် တင်ပြထား ပါသည်။***

1.6 *လူထုတွေ့ဆုံညှိနှိုင်းခြင်းနှင့် ထုတ်ပြန်ခြင်း*

စီစဉ်ထားသည့် 2D နှင့် 3D ဆိုက်စမစ် စီမံကိန်းလုပ်ငန်းများအပေါ် သက်ဆိုင်သူများနှားလည် သဘောပေါက်မှုကို မြှင့်တင်ရန် နှင့် သင့်လျော်သော လျှော့ချရေးအစီအမံများပြင်ဆင်ရန်အတွက် အကြံဉာဏ်များ/စိုးရိမ်မှုများကို လက်ခံရယူနိုင်ရန်၊ ဤစီမံကိန်းအတွက် လူထုတွေ့ဆုံညှိနှိုင်းမှုကို

ဆောင်ရွက်ခဲ့ပါသည်။ လူထုတွေ့ဆုံညှိနှိုင်းခြင်းအတွက် ချဉ်းကပ်မှု နှင့် နည်းလမ်းကို ဤ ESHIA အစီရင်ခံစာ၏ ***အခန်း ၉*** တွင် အသေးစိတ် ဖော်ပြထားပါသည်။

လူထုတွေ့ဆုံညှိနှိုင်းမှုတွင် အဓိကအားဖြင့် လုပ်ကွက်အမှတ် MOGE-3 ၏ စီမံကိန်းဧရိယာအတွင်း သရက်မြို့နယ် နှင့် ကံမမြို့နယ်တို့ဖြစ်သော မြို့နယ်နှစ်ခုတို့အကျုံးဝင်သည့် လူထုအစည်းအဝေး နှစ်ရပ်တို့ပါဝင် ပါသည်။ ၎င်းတို့ကို ၂၀၁၅ ခုနှစ် ဖေဖော်ဝါရီလ ၄ ရက်နေ့ နှင့် ဖေဖော်ဝါရီလ ၅ ရက်နေ့တို့တွင် ကျင်းပပြုလုပ်ခဲ့ပါသည်။

ကံမ နှင့် သရက် မြို့နယ်များတွင် လူထုတွေ့ဆုံညှိနှိုင်းမှုများမှ လက်ခံရယူခဲ့သော သက်ဆိုင်သူများ၏ မှတ်ချက်များ နှင့် အကြံပြုချက်များ ကို ***အခန်း ၉*** နှင့် ***နောက်ဆက်တွဲ H (Annex H)*** တို့တွင် အကျဉ်းချုပ်ဖော်ပြထားပါသည်။ ESHIA လေ့လာမှုရလဒ်များနှင့် စပ်လျဉ်းသည့် အဓိကအကြောင်းအရာအချို့မှာ သီးနှံ နှင့် မြေပျက်စီးမှု၊ လျော်ကြေးပေးချေမှုလုပ်ထုံးလုပ်နည်းများ၊ စီမံကိန်း၏ အချိန်ဇယားကို လူထုသို့ သတိပေးချက်များ၊ နှင့် တိုင်းတာရေးသည် ထိခိုက်လွယ်သော သို့မဟုတ် ကန့်သတ်ထားသော ဧရိယာများကို ဖြတ်သွားမှု ရှိ မရှိ တို့နှင့် ဆက်စပ် ပါသည်။ အကြောင်းအရာများ အားလုံးကို လူထုတွေ့ဆုံညှိနှိုင်းမှုအစည်းအစည်းများတွင် PTTEP SA နှင့် ERM တို့မှ ဆီလျော်စွာ တုန့်ပြန်ခဲ့ ပါသည်။

လူထုတွေ့ဆုံညှိနှိုင်းမှုအစီအစဉ်အကောင်အထည်ဖော်ခြင်းသည် ၎င်း၏ ဦးတည်ချက်များ ဖြစ်သည့် စီမံကိန်းအပေါ် အမြင်များ နှင့် အကြံပြုချက်များ ပေးရာတွင် သက်ဆိုင်သူများအတွက် အခွင့်အလမ်းတစ်ရပ်အဖြစ် အောင်မြင်ခဲ့ ပါသည်။ ဤ ESHIA အစီရင်ခံစာ၏ ***အခန်း ၉*** တွင် ဖော်ပြထားသည့် အတိုင်း၊ လူထုတွေ့ဆုံပွဲများမှ လက်ခံရယူခဲ့သော အမြင်များ နှင့် အကြံပြုချက်များကို ESHIA လေ့လာချက်တွင် ပတ်ဝန်းကျင်၊ လူမှုရေး နှင့် ကျန်းမာရေးထိခိုက်မှုများအပေါ် လျှော့ချရေး အစီအမံများ နှင့် စောင့်ကြပ်ကြည့်ရှုစစ်ဆေးရေးအစီအစဉ်များပြင်ဆင်ရာ၌ အသုံးပြုခဲ့ပြီးဖြစ်ပါသည်။

ဇယား ၁.၁ ထိခိုက်မှုဆန်းစစ်ခြင်းရလဒ်အကျဉ်းချုပ်

ကဏ္ဍ	စီမံကိန်းလုပ်ငန်းများ/သက်ရောက်မှုများ	သက်ရောက်မှုများ၏အရေးပါမှု	ကြွင်းကျန်သက်ရောက်မှု၏ အရေးပါမှု
ပတ်ဝန်းကျင်ဆိုင်ရာသက်ရောက်မှုများ			
လေအရည်အသွေး	• မြေသားလမ်းပေါ် သယ်ယူပို့ဆောင်မောင်းနှင်ခြင်းကြောင့် မြေမှုန့်များပြန့်နှံ့ထွက်ပေါ်နိုင်ခြင်း။ • ပစ်ချက်များ/မှတ်တမ်းတင်ခြင်းများ(shoting/recording) ကြောင့် မြေမှုန့်များပြန့်နှံ့ထွက်ပေါ်နိုင်ခြင်း။ • လောင်စာလောင်ကျွမ်းခြင်းမှထွက်ပေါ်လာသော လေထုညစ်ညမ်းမှုများ။	**မပြောပလောက်သော**	**မပြောပလောက်သော**
ဖန်လုံအိမ်ဓာတ်ငွေ့	• နေရာမရွှေ့သော လောင်စာ လောင်ကျွမ်းခြင်း နှင့် ရွှေ့လျားလောင်ကျွမ်းခြင်းအရင်းအမြစ်များ သည် ဖန်လုံအိမ်ဓာတ်ငွေ့များ (ဥပမာ - ကာဗွန်ဒိုင်အောက်ဆိုက် ဓာတ်ငွေ့ (CO_2)၊ မီသိန်း (CH_4) နှင့် နိုက်ထရပ် အောက်ဆိုက် (N_2O)) ကို ထုတ်လွှတ်ခြင်း။	**မပြောပလောက်သော**	**မပြောပလောက်သော**
ဆူညံမှုနှင့်တုန်ခါမှု	• ဆိုက်စမစ်တိုင်းတာရေးအတောအတွင်း တိုးပွားလာသော ဆူညံမှုကြောင့် အနီးအနားရှိ နေထိုင်သူများ သို့မဟုတ် တောရိုင်းတိရိစ္ဆာန်များ အပေါ် အနှောင့်အယှက်ဖြစ်ပေါ်နိုင်ခြင်း။ • ပစ်ချက်များ/မှတ်တမ်းတင်ခြင်းများ (shoting/recording) အတောအတွင်း တိုးပွားလာသော တုန်ခါမှုကြောင့် အနီးအနားရှိ နေထိုင်သူများ၊ အခြေချရွာများ၊ သို့မဟုတ် ရှေးဟောင်းသုတေသနဆိုင်ရာ အရင်းအမြစ်များ အပေါ် အနှောင့်အယှက်ဖြစ်ပေါ်နိုင်ခြင်း။	**အရေးမပါသော**	**မပြောပလောက်သော**
မြေမျက်နှာသွင်ပြင်နှင့် မြေဆီလွှာ	• ဆိုက်စမစ်လုပ်ငန်းများအတောအတွင်း မြေဆီလွှာပျက်စီးမှုကြောင့် မြေဆီလွှာတိုက်စားမှုများကိုတိုးပွားရန် အလားအလာရှိခြင်း။ • ဆိုက်စမစ်လုပ်ငန်းများမှ အနည်အနစ်များကျုံ့သွားခြင်း (compaction) ကြောင့် မြေဆီလွှာများ နှင့် စိုက်ပျိုးမြေများအပေါ် ဖြစ်ပေါ်လာနိုင်သည့် သက်ရောက်မှု။ • ဓာတုပစ္စည်းများဖောက်ခွဲခြင်းများကြောင့် ဖြစ်ပေါ်လာနိုင်သည့် မြေဆီလွှာညစ်ညမ်းမှု။ • စနစ်မကျသော စွန့်ပစ်ပစ္စည်း စီမံခန့်ခွဲမှု နှင့် ရေဆိုးစွန့်ပစ်မှုကြောင့် ဖြစ်ပေါ်လာနိုင်သော မြေဆီလွှာညစ်ညမ်းမှု။	**အရေးမပါသော**	**မပြောပလောက်သော**
မြေအောက်ရေ	• ဖောက်ကျင်း တူးဖော်ရေးကြောင့် မြေအောက်ရေ နှင့် အရည်သွေးအပေါ် ဖြစ်ပေါ်လာနိုင်သော သက်ရောက်မှု။ ဖောက်ကျင်းများကို ၁၀-၃၀ မီတာအနက်ထိတူးယူပြီး၊ ၎င်းမှာ မြေအောက်ရေအဆင့် (၅-၂၆ မီတာ) တွင် ကျရောက်သည်။ အနည်အနစ် သို့မဟုတ် အခြားညစ်ညမ်းမှုများသည် မျက်နှာပြင်မှ မြေအောက်ရေသို့ ထည့်သွင်းခြင်းဖြင့်၊ မြေအောက်ရေအရည်အသွေးကိုထိခိုက်ရန် တူးဖော်ရေးအတွက်အလားအလာရှိပါသည်။ • အကယ်၍ ပစ်ချက်များ/မှတ်တမ်းတင်ခြင်းများ (shoting/recording) သည် မြေအောက်ရေတွင်း (ကန့်သတ်ထားသောအကွာအဝေးအောက်လျှောနည်းသော) နှင့်နီးကပ်လျှင်၊ မြေအောက်ရေတွင်းဖွဲ့စည်းမှုအနေအထားကို သက်ရောက်နိုင်ခြင်း။ • စနစ်မကျသော စွန့်ပစ်ပစ္စည်း စီမံခန့်ခွဲမှု နှင့် ရေဆိုးစွန့်ထုတ်မှုကြောင့် ညစ်ညမ်းသွားသောမြေဆီလွှာကို ဖြတ်သန်းစီးဆင်းသွားသော ရေကြောင့် ဖြစ်ပေါ်လာနိုင်သည့် မြေအောက်ရေအပေါ် သက်ရောက်မှုများ။	**အရေးမပါသော**	**မပြောပလောက်သော**
မျက်နှာပြင်ရေ	• ဖောက်တွင်းများ နှင့် ပစ်ချက်များ/မှတ်တမ်းတင်ခြင်းများ (shoting/recording) အပါအဝင် စီမံကိန်းလုပ်ငန်းခွင်တဝိုက် နှင့် လမ်းများတွင် ယာဉ်သယ်ယူပို့ဆောင်ခြင်း မှ ဖြစ်ပေါ်လာနိုင်သည့် မြေဆီလွှာမျက်နှာပြင်ပျက်စီးမှု၊ ယင်းမှတစ်ဆင့် ရေလမ်းကြောင်းများအနည် တင်ခြင်းများ နှင့် တိုက်စားမှုများဖြစ်ပေါ်နိုင်ခြင်း။ • စနစ်မကျသော စွန့်ပစ်ပစ္စည်း စီမံခန့်ခွဲမှု နှင့် ရေဆိုးစွန့်ထုတ်မှုကြောင့် ညစ်ညမ်းသွားသောမြေဆီလွှာမှ စီးကျခြင်းကြောင့် မျက်နှာပြင်ရေ	**အရေးမပါသော**	**မပြောပလောက်သော**

ကဏ္ဍ	စီမံကိန်းလုပ်ငန်းများ/သက်ရောက်မှုများ	သက်ရောက်မှုများ၏အရေးပါမှု	ကြွင်းကျန်သက်ရောက်မှု၏ အရေးပါမှု
	အပေါ် ဖြစ်ပေါ်လာနိုင်သည့် သက်ရောက်မှုများ။		
တောရိုင်းတိရစ္ဆာန်နှင့် သဘာဝအပင်များ	• တိုင်းတာရေးကာလအတောအတွင်း ယာဉ်/လူများ နင်းလျှောက်ခြင်းကြောင့် အမြစ်တိုးဖောက်မှုကိုဟန့်တားနိုင်မှု နှင့် ရေစိမ့်ဝင်နိုင်မှု ကို လျော့ကျနိုင်သည့် မြေဆီလွှာကျုံ့ခြင်းများ ဖြစ်ပေါ်နိုင်ခြင်း။ • ယာဉ်သယ်ယူပို့ဆောင်ရေးကိရိယာများ နှင့် အမှုထမ်းများမှ ဆူညံမှု နှင့် တူးဖော်ရေးကိရိယာများမှ ဆူညံမှု တို့ကြောင့် ကုန်းနေတောရိုင်း တိရိစ္ဆာန်များ အပေါ် ထိခိုက်နိုင်ခြင်း။	**အရေးမပါသော**	**မပြောပလောက်သော**

ကဏ္ဍ	စီမံကိန်းလုပ်ငန်းများ/သက်ရောက်မှုများ	သက်ရောက်မှုများ၏အရေးပါမှု	ကြွင်းကျန်သက်ရောက်မှု၏ အရေးပါမှု
လူမှုရေးဆိုင်ရာ သက်ရောက်မှုများ			
မြေအသုံးချမှု	• တိုင်းတာရေးအဖွဲ့ နှင့်/သို့မဟုတ် ယာဉ်များသည် ဆိုက်စမစ်လိုင်း (ထုတ်လွှတ်မှု နှင့်ဖမ်းယူမှုလိုင်းများ) တစ်ခုချင်းစီအရှည်အတွက် ၁ မီတာ ကျယ်သည့် သီးနှံခင်းများအပေါ် နင်းလျှောက်ရန် လိုအပ်ကောင်းလိုအပ်နိုင်ခြင်း။ • ဖောက်ကျင်းတစ်တွင်းတူးဖော်ယူရန်အတွက် ၁၀ စတုရန်းမီတာခန့်ရှိသောဧရိယာ သစ်ပင်ပေါက်တောများကို ရှင်းလင်းခြင်း။ • ဆိုက်စမစ်တုန်ခါမှုကိရိယာ (Vibroseis) ထရပ်ကားများ၏ လမ်းကြောင်းအတွက် သစ်ပင်ပေါက်တောများ ကို ရှင်းလင်းရန်လိုအပ်ပြီး၊ ထုတ်လွှတ်မှုလိုင်း (စုစုပေါင်း ၁၀ မီတာ လိုင်းအရှည်) တစ်လျှောက် မြေဆီလွှာကျုံ့ဝင်ခြင်းများ ဖြစ်ပေါ်နိုင်ခြင်း။	**အတန်အသင့်ဖြစ်သော**	**အရေးမပါသော**
သယ်ယူပို့ဆောင်ရေး	• လုပ်ငန်းဧရိယာမှ အသွားအပြန်သယ်ယူပို့ဆောင်ခြင်းကြောင့် လမ်းများပေါ်တွင် ယာယီ နှင့် စီမံကိန်းတည်ရှိရာနေရာအတွင်းသာ တိုးပွားလာသော ယာဉ်များသွားလာခြင်း။ • ပေါက်ကွဲလွယ်ပစ္စည်းများသယ်ယူခြင်းကြောင့် မတော်တဆပေါက်ကွဲမှုကြောင့် ရှိနေပြီးနေသာ သယ်ယူပို့ဆောင်ရေးကွန်ယက် လမ်းကြောင်းအပေါ် ပျက်စီးမှု သို့မဟုတ် အနှောင့်အယှက်ဖြစ်မှုများ အပါအဝင် ဖြစ်ပေါ်လာနိုင်သည့် ပြင်းထန်သော သက်ရောက်မှုများ။ • ပစ်ချက်များ/မှတ်တမ်းတင်ခြင်းများ (shoting/recording) အတွက် လူသွားလမ်းများကို ယာယီပိတ်ထားခြင်းကြောင့် လူများအတွက် ဖြစ်ပေါ်လာနိုင်သည့် အဆင်မပြေမှုများ။	**အရေးမပါသော**	**အရေးမပါသော**
လူမှုစီးပွားရေး	• ဒေသခံများကို အလုပ်အကိုင် ခန့်အပ်ခြင်း နှင့် ဒေသခံစီးပွားရေး နှင့် ဝန်ဆောင်မှုများအသုံးပြုခြင်းကြောင့် ဖြစ်ပေါ်လာနိုင်သည့် အပြုသဘောဆောင်သော သက်ရောက်မှုများ။ • စိုက်ပျိုးရေးနှင့် ရေနံအခြေပြု လုပ်ငန်းများသို့ အနှောင့်အယှက်ဖြစ်စေခြင်းကြောင့် ဖြစ်ပေါ်လာနိုင်သည့် အပျက်သဘောဆောင်သော သက်ရောက်မှုများ။	**အတန်အသင့်ဖြစ်သော**	**အရေးမပါသော**
သမိုင်းဝင်၊ ရှေးဟောင်း နှင့် ယဉ်ကျေးမှုဆိုင်ရာ အရင်းအရင်းအမြစ်များ	• ပစ်ချက်များ/မှတ်တမ်းတင်ခြင်းများ (shoting/recording) မှ တုန်ခါမှုသက်ရောက်ခြင်းကြောင့် အနီးအနားရှိ ရှေးဟောင်းသုတေသန နေရာများသို့ ဖြစ်ပေါ်လာနိုင်သည့် ထိခိုက်မှုများ။	**အတန်အသင့်ဖြစ်သော**	**အရေးမပါသော**
ကျန်းမာရေးဆိုင်ရာ သက်ရောက်မှုများ			
အလုပ်သမားများကျန်းမာရေး နှင့် ဘေးအန္တရာယ်ကင်းရှင်းရေး	• စီမံကိန်းလုပ်ငန်းများအမျိုးမျိုးကြောင့် လုပ်သားများ၏ ကျန်းမာရေး နှင့် ဘေးအန္တရာယ်ကင်းရှင်းရေးဆိုင်ရာ ဖြစ်ပေါ်လာနိုင်သည့် သက်ရောက်မှုများ။	**အတန်အသင့်ဖြစ်သော**	**မပြောပလောက်သော**
ရပ်ရွာလူထုကျန်းမာရေး	• စီမံကိန်းလုပ်ငန်းများကြောင့် မြေမှုန့်များ၊ ဆူညံမှုများ၊ တုန်ခါမှုများ မှ ရပ်ရွာလူထုကျန်းမာရေး အပေါ် သက်ရောက်မှုများ နှင့် ဖြစ်နိုင်ခြေရှိသော သယ်ယူပို့ဆောင်ရေးဆိုင်ရာ မတော်တဆမှုများ။	**အရေးမပါသော**	**မပြောပလောက်သော**

1.7 *ကတိကဝတ်များ တင်ပြခြင်း*

PTTEP SA သည် ဤ ESHIA အစီရင်ခံစာတွင် တင်ပြထားသည့် ကတိကဝတ်များ၊ လျော့ချရေး အစီအမံများ နှင့် အစီအစဉ်များကို အစဉ်တစိုက် အပြည်အဝ လိုက်နာသွားမည် ဖြစ်ပါသည်။

PTTEP SA သည် EMP၊ စီမံကိန်းကတိကဝတ်များအားလုံး နှင့် စည်းကမ်းချက်များကို အပြည့်အဝ အကောင်အထည်ဖော် ဆောင်ရွက်မည်ဖြစ်ပြီး၊ စီမံကိန်း၏ ကန်ထရိုက်တာများ နှင့် ဆပ်ကန်ထရိုက်တာများအားလုံးမှ EMP၊ စီမံကိန်းကတိကဝတ်များ နှင့် စည်းကမ်းချက်များ အပြင်၊ ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဥပဒေ (၂၀၁၂)၊ ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးနည်းဥပဒေ နှင့် ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာလုပ်ထုံးလုပ်နည်း (၂၀၁၅) တို့ အပါအဝင် သက်ဆိုင်ရာဥပဒေများ အားလုံးကို အပြည့်အဝလိုက်နာဆောင်ရွက်စေရန် တာဝန်ရှိပါသည်။

PTTEP SA နှင့် ERM မှ အောက်ပါတို့ကို အတည်ပြုပါသည် -

(1) ESHIA အစီရင်ခံစာသည် တိကျ၊ ခိုင်မာပြီး ပြည့်စုံမှုရှိပါသည်။
(2) ESHIA ကို EIA လုပ်ထုံးလုပ်နည်း (၂၀၁၅) အပါအဝင်၊ သက်ဆိုင်ရာဥပဒေများ နှင့် အညီ ဆောင်ရွက်ခဲ့ပါသည်။
(3) စီမံကိန်းသည် ESHIA အစီရင်ခံစာပါ ကတိကဝတ်များ၊ လျော့ချရေးအစီအမံများကို နှင့် အစီအစဉ်များကို အပြည့်အဝ လိုက်နာဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။

Section 2

Introduction

2 INTRODUCTION

This Environmental, Social, and Health Impact Assessment (ESHIA) presents an assessment of the potential environmental, social and health impacts associated with the proposed PTTEP South Asia Limited (PTTEP SA) Block MOGE-3 Onshore 2D & 3D Seismic Project in Myanmar (the 'Project').

As per Article 23 and Annex 1 of the *EIA Procedure,* this Project falls under the category of ""Item 12: Onshore Oil and Gas Seismic Surveys" which is mentioned under the **Criteria for IEE Type Economic Activities**. The *EIA Procedure* stipulates that the Project is therefore required to submit the IEE to MONREC (formerly MOECAF) for review and obtain an Environmental Compliance Certificate (ECC). If the IEE is satisfactory, MOECAF will approve the IEE Report, and issue an ECC. The procedure is shown in *Error! Reference source not found.*.

Note that, at the time of writing this report in 2014, the EIA Procedure had not yet been finalized and promulgated. As such, this report was originally referred to as an "Environmental, Social, and Health Impact Assessment (ESHIA) report" as per the terms of the Production Sharing Contract (PSC), rather than an "Initial Environmental Examination (IEE) report". However, the contents of this report are aligned with what would be required in an IEE Report, despite the difference in title. As mentioned in Section 1.1, the term "ESHIA" throughout this report shall be understood to be equivalent to "IEE" as per the requirements of the EIA Procedure.

2.1 PRESENTATION OF THE PROJECT PROPONENT/PROJECT DEVELOPER

PTTEP SA is an Operator of Production Sharing Contract (PSC) of Block MOGE-3, which is located in Magway Region, in Central Myanmar.

Block MOGE-3 encompasses 1,217 km^2, and is located in the south of Magway Region, in the Dry Zone in the central Myanmar lowlands, as shown in ***Figure 2.1***. PTTEP SA plans to acquire 2D and 3D seismic data in Block MOGE-3, tentatively during Quarter 3 (Q3) of 2015. The surveys will cover the majority of the Block, over an area of approximately 1,000 km^2. Further details of the surveys will be provided in ***Section 4*** of this report.

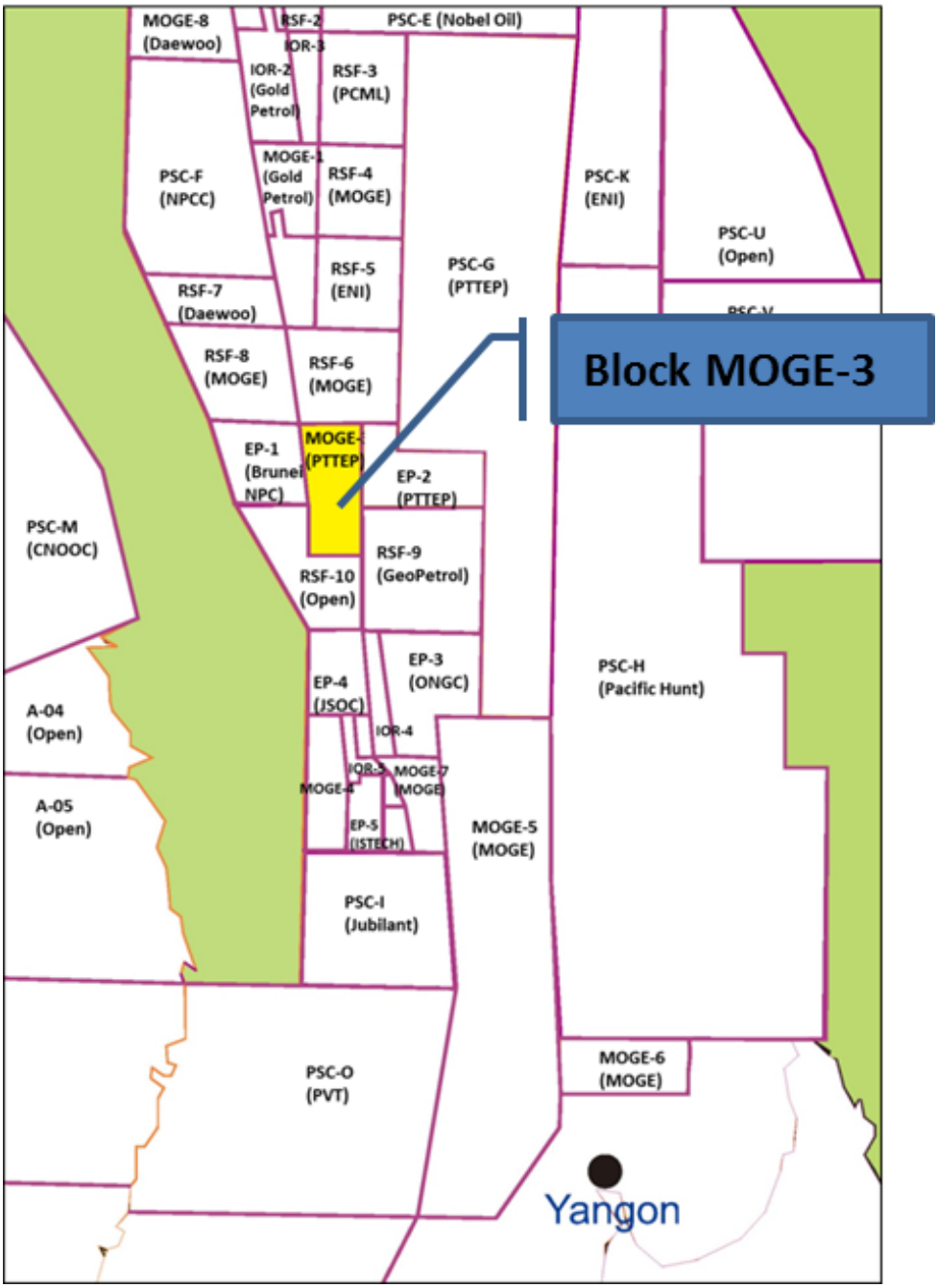
A list of the specific team members of PTTEP SA that were involved in the preparation of this ESHIA report are presented in ***Table 2.1***.

Table 2.1 PTTEP SA Key Persons for the ESHIA Study

Name	Position/Specialization
Peter John Brown	Safety, Security, Health and Environment Manager
Suphachittra Thongchavee	Government Affairs & External Relations Manager.
Wirote Wetmongkongorn	Onshore Exploration Manager
U Khin Maung Gyi	Advisor, PSC
U Tun Win	Geophysicist Advisor

Surasak Chonchirdsin	Senior Environmental Engineer
Tosapol Tongpet	Geophysicist
Hnin Pwint Lwin	Officer, Government &Stakeholder Affairs
Zar Chi Saint	Technical Assistant

Figure 2.1 Location of Block MOGE-3



Source: PTTEP SA, 2014

2.2 PRESENTATION OF ENVIRONMENTAL, SOCIAL AND HEALTH EXPERTS

2.2.1 *Overview*

Environmental Resources Management (ERM) has been contracted by PTTEP SA to prepare an ESHIA for the Project. This report presents the objectives, methodology and outcomes of the ESHIA.

ERM is a leading global provider of environmental, health, safety, risk, social consulting, and sustainability-related services. ERM has more than 150 offices in 40 countries and territories and employ more than 5,000 people. ERM has a 40-year track record of excellence on complex and challenging projects.

For this project, ERM also contracted the services of Resource and Environment Myanmar Ltd (REM). REM is a leading resource and environmental consulting firm in Myanmar, formed in Yangon in 1998. For this Project, REM's role consisted of conducting the public consultation presentations and discussions, under the supervision and guidance of ERM.

An overview of the environmental, social and health experts involved with the preparation of this ESHIA report are presented in ***Table 2.2***.

Table 2.2 Environmental, Social and Health Specialists for the MOGE-3 ESHIA

Organization/Company	Name	Position/Specialization
ERM	Cristina Pellegrino	Partner, IAP Practice
	Chris Brown	Senior Consultant, Project Manager
	Sarinya Rangsipatcharayut	Environmental Specialist
	Yingsak Maleewat	Social Impact Assessment Specialist
	Parichat Maleewong	Environmental Specialist
	Kanokphorn Chaivoraphorn	Principal Consultant, Health Specialist
	Sutawan Chittham	Environmental Specialist
REM (sub-consultant of ERM)	Dr. Win Maung	Principal Consultant, Ecology, Flora and Fauna Specialist
	Ngwe Moe	Principal Consultant, Health and Safety
	Zaw Naing Oo	Principal Consultant, Soil and Water Specialist
	Khin Ohnmar Htwe	Principal Consultant, Social Impact Assessment Specialist
	Ko Win Htet	Project Manager, Social Impact Assessment

2.2.2 *Declaration of ESHIA Experts*

ERM hereby state that the ESHIA Study has been carried out according to the Environmental Conservation Law (2012), Environmental Conservation Rules and Environmental Impact Assessment Procedure (2015). To our knowledge, all information contained in this report is accurate and a truthful representation of all findings as relating to the Project.

2.3 *OVERVIEW OF ESHIA REPORT*

2.3.1 *ESHIA Definition*

The ESHIA process is an interdisciplinary and multistep procedure to ensure that environmental, social and health considerations are incorporated into the decision making process regarding projects that may have environmental, social and/or health impacts. Simply defined, the ESHIA process helps identify the possible environmental, social and health effects of a proposed activity, and examines how those impacts can be mitigated.

Typically, an ESHIA is more comprehensive than an Environmental Impact Assessment (EIA), as it includes evaluation of potential impacts on social aspects and public health, whereas an EIA traditionally only assesses environmental impacts.

There is a certain degree of public confusion caused by the differing uses of the terms "EIA" and "ESHIA" in different contexts, and the tendency to use them interchangeably. In many cases, the term "EIA" is used generically to describe an impact assessment, but often it is in fact referring to an "ESHIA", because it contains social and health impact assessments. For example, the pending governing legislation for impact assessments in Myanmar is referred to as the Draft EIA Procedures; however, the procedures contain provisions for assessments of impacts to social and health aspects.

2.3.2 *ESHIA Objectives*

The objectives of this ESHIA are to:

- Facilitate an understanding of the elements of the existing baseline conditions that are relevant to resources/receptors that could be significantly impacted by the Project;
- Identify the aspects of the Project likely to result in significant impacts to resources/receptors;
- Predict and evaluate the significance of the impacts of the Project;
- Identify the environmental, social and health aspects of the Project that need to be managed, and recommend appropriate and justified mitigation and enhancement measures;
- Determine the significance of residual impacts, taking into account the implementation of mitigation measures; and

- Generate plans for the management and monitoring of impacts.

2.3.3 *ESHIA Scope*

The ESHIA study covers seismic activities in Block MOGE-3, transport to and from the seismic area, and other areas of potential impacts. The study will include an environmental, social and health impact assessment, and mitigation and monitoring measures.

The study area for this ESHIA includes:

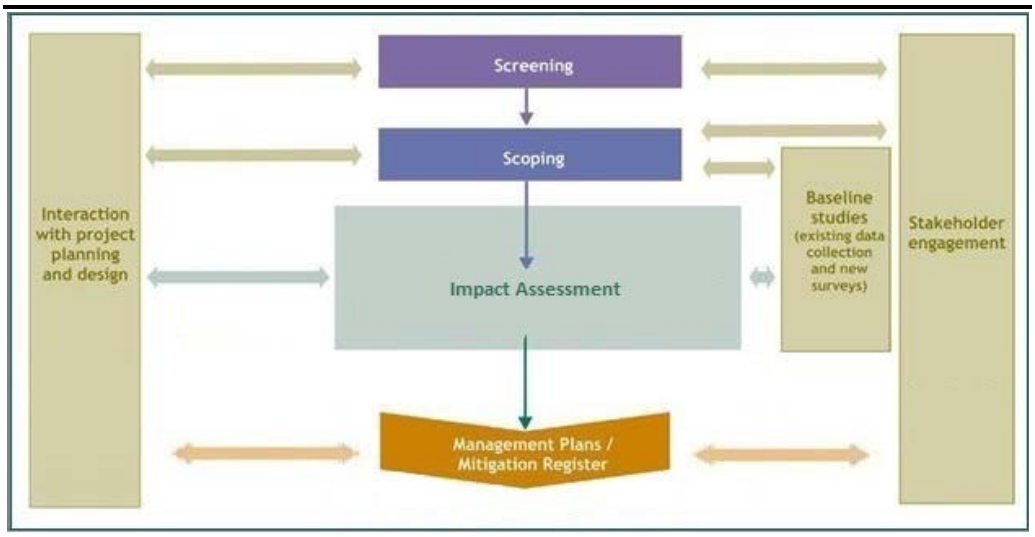
- The physical and ecological study area includes the area around the seismic survey within Block MOGE-3. The proposed seismic area consists of approximately 1,000 km^2, within Thayet and Kanma Townships, Magway Region.
- The human use and quality of life study area includes the land and landowners affected by the Project's seismic activities within Thayet and Kanma Townships, Magway Region.

2.3.4 *ESHIA Methodology Overview*

2.3.4.1 *Introduction*

The methodology for the ESHIA follows the overall approach illustrated in ***Figure* 2.2**. The ESHIA has been undertaken following a systematic process that predicts and evaluates the impacts the Project could have on aspects of the physical, biological, social/socio-economic and cultural environment, and identifies measures that the Project will take to avoid, minimize, mitigate, offset or compensate for adverse impacts; and to enhance positive impacts where practicable. The stages of the ESHIA process are described in this section.

Figure* 2.2 *Overview of ESHIA Process



Source: ERM, 2015

2.3.4.2 *Screening*

At the initial stage of the ESHIA, preliminary information was provided to aid in the determination of what legal and other requirements apply to the Project. This step was conducted utilizing a high level description of the Project and its associated facilities. The results of the screening exercise are reported in ***Section 6*** of this Report.

2.3.4.3 *Scoping*

Scoping has been undertaken to identify the potential Area of Influence for the Project (and thus the appropriate Study Area), to identify potential interactions between the Project and resources/receptors in the Area of Influence and the impacts that could result from these interactions, and to prioritize these impacts in terms of their likely significance.

This stage is intended to ensure that the ESHIA focuses on those issues that are most important for design, decision-making and stakeholder interest. The findings of the scoping exercise are reported in ***Section 6*** of this Report.

Table 2.3 presents the resources/receptors that are considered in the scoping stage, together with the changes that might indicate a Project-related impact.

Table 2.3 Resources/Receptors and Impacts Considered in Scoping

Resources/Receptors	Impacts
Environmental	
Surface Water	• Changes to physical, chemical or biological quality of seas; • Introduction of exotic species, changes in habitat quality, abundance, diversity; • Effluent discharge
Geology	• Changes to geology, geomorphology, topography
Soil	• Changes to physical and chemical properties and soil ecology
Groundwater	• Contamination of shallow or deep groundwater resources, change in ground water resources
Sediments	• Seabed morphology, physical and chemical properties, benthic organisms.
Fisheries	• Changes in fisheries productivity
Vegetation	• Changes to vegetation population, health, species abundance and diversity and impact on endangered and economic species, food chain effects
Wildlife	• Changes to wildlife assemblages, impact on endangered and economic species, food chain effects
Air	• Emissions of NOx, SOx, PM, CO, VOC, greenhouse gases (CO_2, CH_4, and N_2O), ozone, TSP etc
Noise and Vibration	• Change in noise or vibration levels
Aesthetics	• Physical presence of vessels or facilities, increased night time light
Waste	• Generation of wastes – hazardous and non-hazardous

Resources/Receptors	Impacts
Social / Socio-Economic	
Population and Physical Displacement	• Changes in population, total population, gender ratio, age distribution. Physical displacement from residence as a result of Project land take, or activities.
Social and Cultural Structure	• Disruption in local authority and governance structure; change in social behaviours; • Alterations to social and cultural networks; intra and inter-ethnic conflict;
Economy and Employment	• Change in national/local economy, employment, standard of living, occupation
Resource Ownership and Use	• Temporary or permanent displacement from land or water based livelihood activities; • Changes in ownership of such resources.
Cultural Resources	• Physical disturbance of shrines, burial grounds, archaeological resources or other desecration
Education and Skills	• Change in availability or quality of education or skills provision
Infrastructure and Public Services	• Improvement or pressure on existing urban/rural infrastructure or services including: transportation; power, water, sanitation, waste handling facilities etc
Community Health	
Mortalityand Key Health Indicators	• Change in the mortality profile of the community; changes in life expectancy, birth rates, death rates, maternal mortality rates etc
Environmental Change	• Decreased air quality (eg NOx, SOx, VOC, CO, PM), contamination of surface waters and potable ground water, increased vibration and noise, increased night time light beyond acceptable limits, changes to the visual environment.
Communicable and Non Communicable Diseases	• Change in incidence and/or prevalence of communicable and non-communicable diseases or disease causing factors
Vector Borne Diseases	• Changes in the incidence and/or prevalence of vector borne diseases, the density of these vectors and their breeding grounds.
Sexually Transmitted Diseases	• Changes in the incidence and/or prevalence of sexually transmitted diseases and the factors that contribute to this (external workforce, transport routes, etc)
Nutritional Status	• Changes to nutritional status and food security
Health Care/Recreational Facilities	• Changes in availability of and access to health care and recreational facilities including green space
Psychosocial/Lifestyle factors	• Drug use/abuse, prostitution, communal violence, crime, suicide and depression; changing expectations of quality of life

2.3.4.4 *Project Description*

In order to set out the scope of the Project features and activities, with particular reference to the aspects which can impact the environment, a Project Description has been prepared. Details of the Project facilities' design characteristics, as well as planned and unplanned Project activities, are provided in ***Section 4*** of this Report.

2.3.4.5 *Description of Surrounding Environment*

To provide a context within which the impacts of the Project can be assessed, a description of physical, biological, social/socio-economic and cultural conditions that would be expected to prevail in the absence of the Project is presented. The description of the surrounding environment is reported in

Section 5 of this Report. The section includes information on all resources/receptors that were identified during scoping as having the potential to be significantly affected by the Project.

2.3.4.6 Impact Assessment, Identification of Mitigation and Enhancement Measures, and Residual Impact Evaluation

Impact identification and assessment starts with scoping and continues through the remainder of the ESHIA Process. Once the significance of an impact has been characterised, the next step is to evaluate what mitigation and enhancement measures are warranted. Once mitigation and enhancement measures are declared, the next step in the ESHIA Process is to assign residual impact significance. Detailed methodologies for impact assessment, identification of mitigation and enhancement measures, and residual impact evaluation are presented in ***Section 6***. Methodology for cumulative impact assessment is presented in ***Section 7***.

2.3.4.7 Environmental, Social and Health Management Plan

The final stage in the ESHIA Process is definition of the basic management and monitoring measures that are needed to identify whether: a) impacts or their associated Project components remain in conformance with applicable standards; and b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted. The management and monitoring measures are presented in ***Section 8*** of this report.

2.3.4.8 Public Consultation and Disclosure

An effective ESHIA Process requires engagement with relevant stakeholders throughout the key stages. This assists in understanding stakeholder views on the Project and in identifying issues that should be taken into account in the prediction and evaluation of impacts.

Details of the public consultation and disclosure activities undertaken for this Project are presented in ***Section 9*** of this Report.

2.3.5 Report Structure

This ESHIA Report has been structured according to the Draft EIA Procedures (2014), which are described further in ***Section 3***. The structure of this ESHIA is as follows:

Section 3 describes the policy, legal and institutional framework relevant to the Project.

Section 4 presents the Project Description which has been used as the basis for this ESHIA. The section presents all phases of the Project. This section also provides information on the alternatives that have been considered for the Project.

Section 5 describes the environmental, social and health baseline relevant to the Project and its area of influence, which forms the basis for assessment of potential impacts.

Section 6 presents the details of the scoping phase, the details and findings of the impact assessment, the recommended mitigation and enhancement measures, and the conclusions as to significance of impacts considering implementation of mitigation measures.

Section 7 presents the details and findings of the cumulative impact assessment.

Section 8 describes how the Project will manage and ensure the implementation of the proposed mitigation measures and how achievement of the required standards of environmental and social performance will be monitored and audited through the Project's Environmental and Social Management System (E&SMS).

Section 9 presents details of the Stakeholder Engagement activities conducted in association with the Project, summarises the related findings and lays out plans for continuing engagement as the Project moves forward.

Annex A – PTTEP SSHE Management System

Annex B – Study on Crops, Livelihoods and Hand Dug Well Communities in Anticipated Villages Affected by MOGE-3 Seismic Activities, by Myanmar Marketing, Research and Development Co., Ltd. (MMRD)

Annex C – Crop Damage and Compensation Forms

Annex D – Instructions for Importing Explosives, Safe Explosive Handling, and Magazine Management, by MOGE

Annex E – Sampling Locations and Methodology for Previous Baseline Surveys in Blocks PSC-G & EP-2

Annex F – Land Use Survey Report, by REM

Annex G – Photographs of Land Conditions in Block MOGE-3, by REM

Annex H – Public Consultation Materials and Documentation

2.4 *STATEMENT OF COMMITMENTS*

PTTEP SA will at all times comply fully with the commitments, mitigation measures, and plans that have been presented in this ESHIA Report.

PTTEP SA shall fully implement the EMP, all Project commitments, and conditions, and is liable to ensure that all contractors and subcontractors of the Project comply fully with all applicable Laws, including the Environmental Conservation Law (2012), Environmental Conservation Rules and Environmental Impact Assessment Procedure (2015), as well as the EMP, Project commitments and conditions.

PTTEP SA and ERM hereby confirm that:

(1) The ESHIA Report is accurate, consolidated and complete;
(2) The ESHIA has been conducted in accordance with relevant laws, including the EIA Procedure (2015).
(3) The Project will fully follow the commitments, mitigation measures and plans set out in this ESHIA Report.

Section 3

Policy, Legal and Institutional Framework

3 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

3.1 CORPORATE ENVIRONMENTAL AND SOCIAL POLICIES

PTTEP SA's Safety Security Health and Environment (SSHE) Policy falls under PTTEP Myanmar Asset's SSHE Policy, which is as follows:

"

PTTEP Myanmar Asset is committed to safe Exploration and Production (E&P) Operations in Myanmar with an ultimate goal of "Target Zero -Nobody Gets Hurts in Our Operations" which covers:

- *Zero Injury;*
- *Zero Major Accident (e.g. zero major hydrocarbon leak, vehicle accident, ship collision); and*
- *Zero Spill or External Complaint (e.g. zero complaint by authorities/community/sea user).*

To accomplish this, PTTEP Myanmar Asset's personnel, including contractors, shall:

- *Implement the PTTEP Safety, Security, Health and Environmental Management System (SSHE-MS);*
- *Comply with Myanmar legal requirements and if non-existent or in conflict with PTTEP or international standards, apply the strictest applicable requirements;*
- *Perform hazard identification and SSHE risk assessments so that risks are As Low As Reasonably Practicable (ALARP);*
- *Hold employees accountable for SSHE performance by setting and monitoring SSHE Plans and KPis;*
- *Prevent major accidents by implementing asset integrity programs and addressing safety case recommendations;*
- *Ensure all employees and contractors are assessed and maintain the required level of job and SSHE competency;*
- *Apply "Stop Work Authority Policy" for unsafe work and improve SSHE culture through Behavioural-Based Safety (BBS) programs;*
- *Implement security management for potential threats to safeguard personnel, assets, information and reputation;*
- *Promote health and hygiene in the workplace by conducting health risk assessments, education and regular health inspections;*
- *Minimise environmental impact by strictly following the mitigation measures recommended in environmental, social and health impact assessments;*
- *Implement a waste management program to reduce waste, maximise energy efficiency and conserve resources;*
- *Report, investigate and analyse SSHE incidents to prevent recurrence and close out corrective actions with evidence;*
- *Ensure that emergency and crisis management plans are developed and effective; and*

- *Ensure policy and SSHE-MS compliance through regular SSHE audits and Senior Management visits with corrective actions follow up for continuous improvement.*

"

3.1.1 *SSHE Management System Manual*

It should be noted that PTTEP SA currently does not have its own internal SSHE policies, procedures or documentation. PTTEP SA is the concession holder for Block MOGE-3, and the operator is PTTEP International (PTTEPI). For this project, PTTEP SA will adopt all of PTTEPI's relevant SSHE policies and procedures. Throughout this section, SSHE policies, procedures and documents will be referred to as belonging to PTTEP SA, however they actually belong to PTTEPI and are being adopted by PTTEP SA for this Project.

The objective of PTTEP SA's SSHE Management System Manual is to serve as practical interpretation of Company SSHE policy with respect to their moral obligations for SSHE issues for all persons working on, visiting or affected by operations at sites for which PTTEP SA has responsibility.

The manual covers details on the areas specified in ***Table 3.1***. The document is designed to serve as a comprehensive guide for all Operational Assets to develop its own SSHE management system and related documents. This document also provides an overview of SSHE management system approach.

PTTEP SA's primary SSHE documents, including Emergency & Crisis Management Plan, and Spill Contingency Plan, are included in ***Annex A***. Additional SSHE documents are available from PTTEP SA upon request as needed.

Table 3.1 PTTEP SA SSHE Management System Standards

Item	Document	Document Number
1	Personal Protective Equipment (PPE) Standard	Myanmar-0550-STD-007
2	Incident Management Standard	Myanmar-0550-STD-010
3	Training and Competency Management Standard	Myanmar-0550-STD-008
4	Permit to Work Standard	Myanmar-0550-STD-009
5	SSHE Contractor Management Standard	Myanmar-0550-STD-011
6	Safety Case Standard	Myanmar-0550-STD-012
7	Life Saving Program Standard	Myanmar-0550-STD-013
8	SSHE Regulatory Compliance Standard	Myanmar-0550-STD-014
9	SSHE Risk Management Standard	Myanmar-0550-STD-015
10	SSHE KPIs & Performance Management Standard	Myanmar-0550-STD-016
11	Management of Change Standard	Myanmar-0550-STD-017
12	Audit and Review Standard	Myanmar-0550-STD-018
13	Occupational Health Management Standard	Myanmar-0550-STD-020

Item	Document	Document Number
14	Waste Management Plan	Myanmar-0550-PLN-001
15	Spill Contingency Plan	Myanmar-0550-PLN-002
16	PTTEP SA Tropical Revolving Storm Procedure	Myanmar-0550-PDR-002
17	Onshore Medical Emergency Response Plan (MERP)	Myanmar-0550-PDR-006
18	PTTEP SA Crisis Communications Plan	Myanmar-0550-PDR-008
19	PTTEP SA Emergency & Crisis Management Plan	Myanmar-0550-PLN-004
20	Blowout Contingency Plan	MYR-001

3.1.2 *Corporate Social Responsibility (CSR)*

PTTEPI employs CSR on a phased approach for all of its operating areas in Myanmar. This means that, during the initial exploratory phases, such as seismic operation, there is minimal investment into CSR, but if oil is discovered and operations move to a more permanent and profitable phase, local CSR activities are increased accordingly.

During the seismic Project, an example of CSR that may be conducted is mobile health check-up program twice a month in the operation area, provide medical equipment and medicine, and support to road upgrade program. In the future, if oil or gas is discovered, PTTEP SA will utilize increased budget for CSR programs. For example, there are currently a number of ongoing CSR activities taking place by PTTEPI under the Zawtika Project in Tanintharyi Region of Myanmar. These activities have the objective to uplift quality of life and gain favourable relations from all stakeholders in the operating area. The CSR program for the Zawtika Project consists of 3 main sectors: "Health, Education and Community Development Sector".

All of PTTEP SA's CSR activities are conducted in compliance with MOGE's Guidelines for Implementation of CSR Programmes, as well as approved budget. Although the CSR budget cannot be estimated at this time, PTTEP SA will apply an appropriate CSR programme in the area it operates in relation to the phase and schedule of its operations in that area, taking into consideration the local community development.

3.2 *POLICY AND LEGAL FRAMEWORK*

This section of the ESHIA report details the Policy and Legal for the Project, covering national requirements as well as applicable international treaties and conventions. The intent is to lay out the regulatory and non-regulatory performance requirements for all stages of the Project.

3.2.1 *The Constitution*

The latest enacted Constitution (May 2008) provides information on governing laws and regulations in Myanmar. The Constitution takes precedence over any other national legislation or international agreements. The general

provisions of the Constitution that relate to the Project are the requirement for Myanmar citizens to assist in:

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

3.2.2 *Administrative Divisions of Myanmar*

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

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

The administrative subdivisions are detailed in ***Table 3.2***, and an administrative map is presented in ***Figure 3.1***.

Table 3.2 Administrative Regions of Myanmar

Name	Capital	Population	Area
Ayeyarwady Region	Pathein	6,663,000	35,138
Bago Region	Bago	5,099,000	39,404
Chin State	Hakha	480,000	36,019
Kachin State	Myitkyina	1,270,000	89,041
Kayah State	Loikaw	259,000	11,670
Kayin State	Pa-an	1,431,377	30,383
Magway Region	Magwe	4,464,000	44,819
Mandalay Region	Mandalay	7,627,000	37,021
Mon State	Mawlamyaing	2,466,000	12,155
Rakhine State	Sittwe	2,744,000	36,780
Sagaing Region	Sagaing	5,300,000	93,527
Shan State	Taunggyi	4,851,000	155,801
Tanintharyi Region	Dawei	1,356,000	43,328
Yangon Region	Yangon	5,560,000	10,170
Naypyidaw Union Territory	Naypyidaw	925,000	N/A
Danu Self-Administered Zone	Pindaya	N/A	N/A
Kokang Self-Administered Zone	Laukkai	N/A	N/A
Naga Self-Administered Zone	Lahe	N/A	N/A
Pa-O Self-Administered Zone	Hopong	N/A	N/A

Name	Capital	Population	Area
Pa Laung Self-Administered Zone	Namhsan	N/A	N/A
Wa Self-Administered Division	Hopang	N/A	N/A

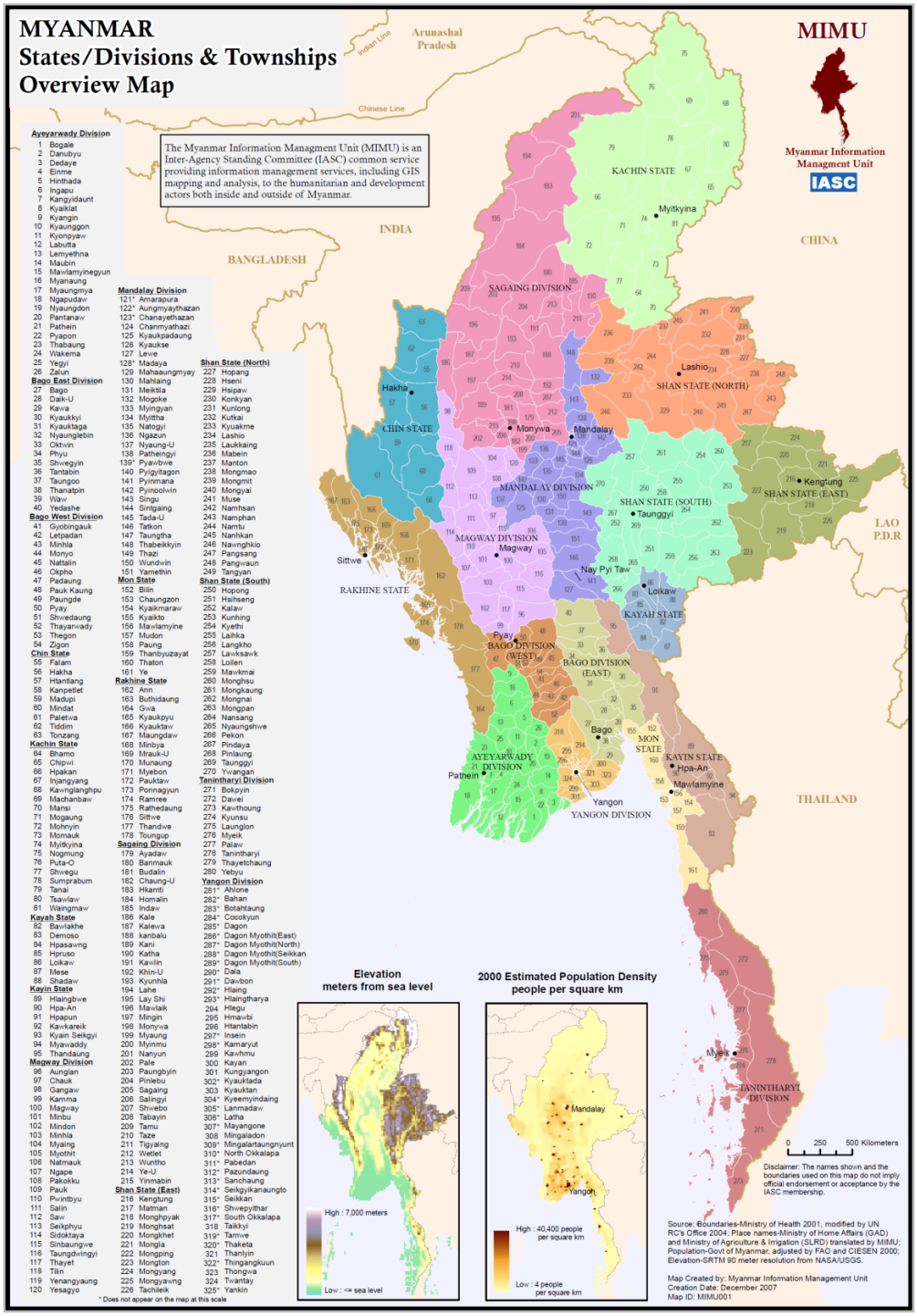
States and regions are divided into districts. Districts consist of townships, which are composed of towns, wards and village-tracts. Village-tracts are groups of adjacent villages. The administrative structure of the states, regions and self-administering bodies is defined in the Constitution.

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

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

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

Figure 3.1 Myanmar States/Regions and Townships



Source: Myanmar Information Management Unit

3.2.4 *Project-Relevant Legislation in Myanmar*

Note that, at the time of writing this report in 2014, Myanmar did not have effectively implemented regulatory requirements for environmental, social and health impact assessments (ESHIA). However, since that time, a number of environmental laws have been implemented. As such, this section will highlight he current legislation with respect to ESHIAs.

Table 3.3 provides a list of major environmental laws relevant to the Project.

Table 3.3 Environmental Laws in Myanmar Relevant to the Project

Laws and Regulations	Description
Constitution of the Republic of the Union of Myanmar, 2008	
The Constitution of the Union of Myanmar is the supreme law of the country and has provisions regarding the protection of the environment in Myanmar. Articles in the Constitution relevant to environmental protection are Articles 37, 42 and 390. They are quoted below:	
Article 37	(a) The Union is the ultimate owner of all lands and all natural resources above and below the ground, above and beneath the water and in the atmosphere in the Union; (b) The Union shall enact necessary law to supervise extraction and utilization of State owned natural resources by economics forces;
Article 42	The Union shall protect and conserve natural environment.
Article 390	Every citizen has the duty to assist the Union in carrying out the following matters: (a) preservation and safeguarding of cultural heritage; (b) environmental conservation; (c) striving for development of human resources; (d) protection and preservation of public property. These three Articles in the Constitution provide a basis for legalizing and institutionalizing environmental health impact assessment and social impact assessment.
The Environmental Conservation Law, 2012	
The Pyidaungsu Hluttaw enacted this law by Law No. 9 of 2012 on the date of 30th March, 2012. March, 2012. The legal mechanism for ESHIA has been put in this law. This law was enacted with the objectives of: (a) To enable to implement the Myanmar National Environmental Policy; (b) To enable to lay down the basic principles and give guidance for systematic integration of the matters of environmental conservation in the sustainable development process; (c) To enable to emerge a healthy and clean environment and to enable to conserve natural and cultural heritage for the benefit of present and future generations; (d) To reclaim ecosystems as may be possible which are starting to degenerate and disappear; (e) To enable to manage and implement for decrease and loss of natural resources and for enabling the sustainable use beneficially; (f) To enable to implement for promoting public awareness and cooperation in educational for dissemination of environmental perception; (g) To enable to promote international, regional and bilateral cooperation in the matters of environmental conservation; (h) To enable to cooperate with Government Departments, Government Organizations, International Organizations, non-government organizations and individuals in matters of environmental conservation.	
The Environmental Conservation Rules, 2014	
The Ministry of Natural Resources and Environmental Conservation, in exercise of power conferred under sub-section (a) of section 42 of the Environmental Conservation Law, issues this rules by No. 50 of 2014 on the date of 5 June, 2014.	
Rule 51	The Ministry shall assign duty to the Department for enabling to adopt and carry out the environmental impact assessment system.
Rule 52	The Ministry shall determine the categories of plan, business or activity which shall carry out environmental impact assessment

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

EIA Procedure(2015)

The EIA Procedure sets out the procedures for completing an IEE, EIA and/or EMP in Myanmar. This includes information on project categorisation, responsibilities of project developers and ministries, EIA review, monitoring and auditing, among other issues.

NEQ Guidelines (2015)

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

Myanmar Investment Law, 2016

3. The objectives of this Law are as follows:

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

Conservation of Water Resources and Rivers Law (2006)

Section 6 outlines prohibitions for the following activities:

- "No person shall anchor the vessels where vessels are prohibited from anchoring in the rivers and creeks.
- No person shall dispose of engine oil, chemical, poisonous material and other materials which may cause environmental damage, or dispose of explosives from the bank or from a

vessel which is plying, vessel which has berthed, anchored, stranded or sunk.

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

The aims of this Law are as follows:

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

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

The Forest Law, 1992	
The State Law and Order Restoration Council had enacted the following Law in 3 November, 1992 as Forest Law.	
Chapter II: Basic Principles	3. This Law shall be implemented in accordance with the following basic principles: a) to implement the forestry policy of the Government; b) to implement the environmental conservation policy of the Government; c) to promote the sector of public co-operation in implementing the forestry policy and the environmental conservation policy of the Government.
Chapter IV: Management of Forest Land	9. The functions and responsibilities of the Forest Department are as follows:- a) implementation of the forestry policy of the Government; b) implementation of the plans relating to conservation of water, bio-diversity and environment, sustained yield of forest produce and protection of forest covered land; c) management of forest land in accordance with the provision of this Law; d) submitting proposals to the Minister for the determination, alteration or cancellation of reserved forest, protected public forest and species of reserved trees; Whoever, within a forest land and forest covered land at the disposal of the Government: a) is desirous of carrying out any development work or economic scheme shall obtain the prior approval of the MONRAEC.
Chapter XII: Offences and Penalties	40. Whoever commits any of the following acts shall, on conviction be punished with fine which may extend to Kyat 5,000 or with imprisonment for a term which may extend to 6 months or with both: a) trespassing and encroaching in a reserved forest; b) pasturing domestic animals or permitting domestic animals to trespass in a reserved forest; c) breaking up any land, clearing, digging or causing damage to the original condition of the land without a permit in a reserved forest; d) causing damage to a water-course, poisoning in the water, using chemicals or explosives in the water in a reserved forest; e) catching animals, hunting or fishing in a reserved forest; f) kindling, keeping, carrying any fire or leaving any fire burning which may set fire to the forests in a reserved forest;

	h) violating any provision of the rule, procedure, order, directive or notification issued under this Law.
Rules On Protection Of Wildlife, And Protected Area Conservation Law (2003) And The Protection Of Wildlife, And Wild Plant And Conservation Of Natural Areas Rules (2002)	
Objectives	The objectives of this Law are as follows:- a) to implement the Government policy for wildlife protection; b) to implement the Government policy for natural areas conservation; c) to carry out in accordance with the International Conventions acceded by the State in respect of the protection and conservation of wildlife, ecosystems and migratory birds; d) to protect endangered species of wildlife and their natural habitats.
Protected Wildlife	15. The Director General shall, with the approval of the Minister: a) determine and declare endangered species of wild animal which are to be protected according to the following categories: i. completely protected species of wild animals; ii. normally protected species of wild animals; iii. seasonally protected species of wild animals; b) determine and declare the endangered species of wild plants and their nature habitats thereof; c) lay down and carry out measures for the preservation of protected wildlife species;
Taking Administrative Action	31. A Forest Officer may pass an administrative order causing a fine that may extend to Kyat 10,000 to be paid, on a person who kills, hunts, wounds or raises a seasonally protected wild animal without permission during the closed season.

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

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

National Environmental Policy (1994)

Under this policy, the main environmental body was the NCEA. Prior to the establishment of MONREC, environmental conservation was undertaken by various ministries and departments. In 1990, the NCEA was established to advise the government on environmental policy, to act as a focal point and as a coordinating body for environmental affairs and to promote environmentally sound and sustainable development. The NCEA's main mission is to ensure sustainable use of environmental resources and to promote environmentally sound practices in industry and other economic activities, objectives and mandates.

National Sustainable Development Strategy (2009)

Sustainable management of natural resources in Myanmar, from environmental perspective comprises 11 areas, in which mining sector development concerned are as follow:

- Sustainable forest resources management;
- Biodiversity conservation;
- Sustainable fresh water resources management ;
- Environmental quality management and enhancement;
- Sustainable management of land resources;
- Sustainable management for mineral resources utilization;
- Sustainable energy production and consumption; and

- Sustainable industrial, transport and communication development.

The Protection and Preservation of Cultural Heritage Regions Law, 1998

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

a) Ancient monumental zone;

b) Ancient site zone.

Objectives:

a) to implement the protection and preservation policy with respect to perpetuation of cultural heritage that has existed for many years;
b) to protect and preserve the cultural heritage regions and the cultural heritage therein so as not to deteriorate due to natural disaster or man-made destruction;
c) to uplift hereditary pride and to cause dynamism of patriotic spirit of citizens by protecting and preserving the cultural heritage regions;
d) to promote public awareness and will as to the high value of the protection and preservation of the cultural heritage regions;
e) to protect the cultural heritage regions from destruction;
f) to carry out protection and preservation of the cultural heritage regions in conformity with the International Convention approved by the State.

The Conservation of Antique Objects Law 2016

The objectives of this law are as follows:

a) to implement the policy of protection and preservation for the perpetuation of antique objects;
b) to protect and preserve antique objects so as not to deteriorate due to natural disaster or man-made destruction;
c) to uplift hereditary pride and to cause dynamism of patriotic spirit by protection and preservation of antique objects;
d) to have public awareness of the high value of antique objects;
e) to carry out in respect of protection and preservation of antique objects in conformity with the International Convention and Regional Agreement ratified by the State.

The Protection and Preservation of Ancient Monuments Law (2016)

3. The objectives of this law are as follows:
   a. To implement the protection and preservation policy for the perpetuation of ancient monuments which have existed for many years;
   b. To protect and preserve cultural heritage regions and ancient monuments so that they are not destroyed by natural disaster or man;
   c. To uplift hereditary pride and to cause dynamism of patriotic spirit of citizens by protecting and preserving cultural heritage regions;
   d. To promote public awareness and will as to the high value of the protection and preservation of cultural heritage regions;
   e. To explore and preserve new ancient monuments;
   f. To protect cultural heritage regions from destruction;
   g. To implement protection and preservation of ancient monuments in conformity with international conventions and regional agreements.

5. Every person desirous to engage in the following within the area of certain ancient monuments has to apply for the permission of the administration department:

(e) digging a ***well, pond*** or fish-breeding pond;

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

Myanmar Mines Law (Amended) (2015) & Myanmar Mining Rules – Notification No.125/96 (replacing Mining Law 1994)

The mining law was updated in 2015, replacing the 1994 Law. There have been the following amendments:

- Minerals- Gemstones administered under different law.
- Types of Permits- corresponding to type of business activity.
- Regional Authorities- Authority delegation for some types of permits.

Chapter II: Objectives	3. The objectives of this Law are as follows: a) To implement the Mineral Resources Policy of the Government; f) To protect the environmental conservation works that may have detrimental effects due to mining operation.
Chapter III: Application and Granting of Permit	4. A person or organization, desirous of carrying out any of the following operations, shall apply to the Ministry in accordance with the stipulations for obtaining permit 8. The Ministry may grant permit for the following operations: a) large scale production of industrial mineral or stone with local investment
Chapter IV: Duties of the Holder of Permit	12. The holder of permit shall: a) abide by the provisions of this Law, rules, orders and directives made there under; b) abide by the conditions contained in the permit; c) pay rent for the land related to the permit calculated in accordance with the rates prescribed by the rules made under this Law; d) pay rent for the land for each permit separately; 13. The holder of permit shall comply with the rules prescribed under this Law in respect of the following matters:- c) making provisions for safety and the prevention of accidents in a mine and their implementation; e) making provisions for the environmental conservation works that may have detrimental effects due to mining operation;
Chapter V: Right of Utilization of Land and Water for Mineral Production	15. If, in the interest of the State, it is necessary to acquire the land where mineral production could be undertaken on commercial scale, the Ministry shall co-ordinate with the relevant. Ministry for the acquisition of such land in accordance with the existing law. 16. If the holder of mineral production permit requires the use of public water for mineral production he shall first and foremost inform the Department of such requirement in accordance with the prescribed manner.
Chapter VI: Royalty	d) for industrial mineral or stone at the rate of 1% to 3%.
Chapter VII: Designation of Mineral Reserve Area and Gemstone Tract	21. The Ministry:- (a) may designate an area where mineral can be produced on commercial scale as Mineral Reserve Area by notification with the approval of the Government;
Chapter IX: Taking of Action by Administrative Means	28. If the holder of permit or a person managing on his behalf or any of the worker fails to comply with any of the orders or directives made under this Law, or contravenes any of the terms of the permit, the person issuing the permit may pass any of the following administrative orders:—

	a) suspending all or portion of the operations carried out under the permit; b) allowing continuation of the operation, after causing the payment of fine; c) cancelling the permit;

The Factories Act, 1974

This act contains the provisions for chemicals management and storage. Some chemicals are likely to require permits. It also requires all factories to have proper pollution control measures such as air pollution, sewage and wastewater treatment system.

Myanmar Fire Force Law, 2015

The objectives of Myanmar Fire Force Law are:

a) To take precautionary and preventive measure and loss of state own property, private property, cultural heritage and the lives and property of public due to fire and other natural disasters
b) To organize fire brigade systemically and to train the fire brigade
c) To prevent from fire and to conduct release work when fire disaster, natural disaster, epidemic disease or any kind of certain danger occurs
d) To educate, organize an inside extensively so as to achieve public corporation
e) To participate if in need for national security, peace for the citizens and law and order

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

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

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

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

Prevention from Danger of Hazardous Chemical and Associated Material Law (Pyidaungsu Hluttaw Law No 28/2013)

The objectives of this law are:

f) to prevent damage to environmental resources and living organisms due to chemicals and associated materials
g) to provide for the systematic control of businesses using chemicals and associated materials in accordance with government approvals
h) to carry out data gathering and to undertake education and research regarding the safe and systematic utilization of chemicals and associated materials
i) to achieve continuous improvements in worksite safety, health and environmental conservation

Chapter 7 – "Any person, who wants to do the business of chemical and associated materials, shall apply to the central body for the acquisition of the license, attached with the management plan for the environmental conservation in accord with the stipulations".

Chapter 8 – "20. License holder shall apply to the central supervising body in accord with the stipulation for the relevant chemicals and associated materials using for his chemicals and associated materials business" for a certificate.

"22. The registered certificate holder shall abide by the regulations contained in the registered certificate and shall follow the order and directives issued from time to time by the central supervising body".

Underground Water Act, 1930

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

Explosives Act (1887)

The President of the Union make rules consistent with this Act to regulate or prohibit, except under and in accordance with the conditions of a licence granted as provided by those rules, the manufacture, possession, use, sale, transport and importation of explosives, or any specified class of explosives.

Explosive Substances Act (1908)

Any person who unlawfully and maliciously causes, by any explosive substance, an explosion of a nature likely to endanger life or to cause serious injury to property shall, whether any injury to person or property has been actually caused or not, be punished with transportation for life or any shorter term, to which a fine may be added, or with imprisonment for a term which may extend ten years, to which a fine may be added.

Land Acquisition Act (1984)

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

The Land Acquisition (Mines) Act. 1885

To determine how mines or mineral extraction enterprises acquire land and pay compensation.

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

6. The Central Committee shall take the following necessary ***action in respect*** of on application matters which are in accordance with Section 5:-

(a) to get the recommendation of the concern Region or State Government;

(b) to get the recommendation of the Ministry of Mines for mining, and other concern Ministry for other purposes prescribe in Section4, Sub-section (d);

(c) to coordinate with the Ministry of Environmental Conservation and Forestry ,and other concern Ministries for the prevention of damage and destruction to the Forest land which are Reserved Forest, and Protected Public Forest; and for conservation of natural regions, watershed area and natural fisheries;

(d) to submit the necessary suggestion relate to explore the National Land Use Policy to the Union Government;

10. The Central committee shall permit the following ***land area*** of Vacant, Fallow and Virgin Lands in relation to commercial agriculture, and livestock breeding purposes:-

(c) Mining purpose shall be permitted with the agreement and coordination with the Union Government of the Ministry of Mine;

11. The Central Committee shall permit the following duration for right to use of Vacant, Fallow and Virgin Lands in relation to commercial agriculture, and livestock breeding purposes:-

d) For Mining purpose the duration of right to use land shall be permitted with the agreement and coordination with the Union Government of the Ministry of Mine;

19. The Central Committee shall resume the area required in the authorized land, if one of the following situation arises:-

(c) Except the permitted minerals , if other natural resources are found in the authorized land which are permitted for production of mining;

Myanmar Agenda 21 (1997)

The Myanmar Agenda 21 makes recommendations for the drafting and promulgation of a framework law which can further promote the integration of environmental and developmental concerns in the decision-making processes of the country.

The Myanmar Agenda 21 contains guidelines to address the following issues:

- increasing energy and material efficiency in production processes;
- reducing wastes from production and promoting recycling;
- promoting use of new and renewable sources of energy;
- using environmentally sound technologies for sustainable production;
- reducing wasteful consumption;
- increasing awareness for sustainable consumption.

Myanmar Insurance Law (1993)

The Myanmar Insurance is established under this Law as a legal entity having perpetual succession, capable of suing and being sued in its own name. The rules for establishing insurances in the country are established.

The Myanmar Insurance is established with the following aims:

- to overcome financial difficulties by effecting mutual agreement of insurance against social and economic losses which the people may encounter, due to common perils;
- to promote the habit of savings individually by effecting life assurance, thus contributing to the accumulation of resource, of the State;
- to win the trust and confidence of the people in the insurance system by providing effective insurance safeguards which may become necessary in view of the social and economic developments.

The Law On Standardization (2014)

The objectives of Law on Standardization are as follows:

- to enable to determine Myanmar Standards;
- to enable to support export promotion by enhancing quality of production organizations and their products, production processes and services;
- to enable to protect the consumers and users by guaranteeing imports and products are not lower than prescribed standard, and safe from health hazards;
- to enable to support protection of environment related to products, production processes and services from impact, and conservation of natural resources;
- to enable to protect manufacturing, distributing and importing the disqualified goods which do not meet the prescribed standard and those which are not safe and endangered to the environment;
- to support on establishing the ASEAN Free Trade Area and to enable to reduce technical barriers to trade.
- to facilitate technological transfer and innovation by using the standards for the development of national economic and social activities in accordance with the national development program.

Myanmar Port Authority Law 2015
"Any person who by himself or another so casts or throws any ballast or rubbish or any such other thing or so discharges any oil or water mixed with oil, or the master of any vessel from which the same is so cast, thrown or discharged, shall be punishable with fine not exceeding fifty thousand kyats, and shall pay any reasonable expenses which may be incurred in removing the same".
The Law Relating to Aquaculture, 1989
To avoid impacts to the environment from aquaculture.
The Petroleum Act (1939) and Rules (1937)
This act refers that the import, transport or store of any petroleum cannot be made save in accordance to the rules that may be defined by the President of the Union. "All receptacles containing dangerous petroleum shall have a stamped, embossed, painted or printed warning, either on the receptacle itself or, where that is impracticable, displayed near the receptacle, exhibiting in conspicuous characters the words "Petrol" or "Motor Spirit", or an equivalent warning of the dangerous nature of the petroleum". It also establishes the needs and exemptions from licenses and authorizes the testing of petroleum by the President of the Union and rules that might issue rules on that regard.
The Oilfields Act (1918)
This act provides clarification on activities within the oil and gas industry, and provides the Government with the power to define and alter limits of any notified oilfield. In addition, the Government may make rules for regulating all matters connected with many operations related to the extraction of oil and/or gas. The Act also provides guidance and issues such as preventing oil and gas wastes, reporting of fires, accidents and other occurrences and regulating the collection and disposal of both oil and gas.
Public Health Law, 1972
Purpose: to ensure the public health include not only employees but also resident people and cooperation with the authorized person or organization of health department. It is concerned with the protection of peoples' health by controlling the quality and cleanliness of food, drugs, environmental sanitation, epidemic diseases and regulation of private clinics. The project owner will cooperate with the authorized person or organization in line with the section 3 and 5 of said law. Section 3: The project owner will abide by any instruction or stipulation for public health. Section 5: The project owner will accept any inspection, anytime, anywhere if it is needed.
The Protection and Prevention of Communicable Disease Law, 1995
Chapter 5 of this law states that all persons are responsible for reporting an outbreak of a communicable disease to the nearest Health Officer.
The Control of Smoking and Consumption of Tobacco Product Law, 2006
3. The objectives of this Law are as follows; (a) to convince the public that health can be adversely affected due to smoking and consumption of tobacco product and to cause refraining from the use of the same; (b) to protect from the danger which affects public health adversely by creating tobacco smoke-free environment; (c) to obtain a healthy living style of the public including child and youth by preventing the habit of smoking and consumption of tobacco product; (d) to uplift the health, economy and social standard of the public through control of smoking and consumption of tobacco product;

(e) to implement measures in conformity with the international convention ratified by Myanmar to control smoking and consumption of tobacco product;

The Development of Employees and Expertise (Skill), 2013
5. (a) (1) If the employer has appointed the employee to work for an employment, the employment agreement shall be made within 30 days. But it shall not be related with government department and organization for a permanent employment. (2) If pre training period and probation period are stipulated before the appointment the said trainee shall not be related with the stipulation of sub-section (1). (b) The following particulars shall be included in the employment agreement: (1) the type of employment; (2) the probation period; (3) wage, salary; (4) location of the employment; (5) the term of the agreement; (6) working hour; (7) day off, holiday and leave; (8) overtime; (9) meal arrangement during the work hour; (10) accommodation; (11) medical treatment; (12) ferry arrangement to worksite and travelling; (13) regulations to be followed by the employees; (14) if the employee is sent to attend the training, the limited time agreed by the employee to continue to work after attending the training; (15) resigning and termination of service; (16) termination of agreement; (17) the obligations in accord with the stipulation of the agreement; (18) the cancellation of employment agreement mutually made between employer and employee; (19) other matters; (20) specifying the regulation of the agreement, amending and supplementing; (21) miscellaneous. (c) The worksite regulations contained in the employment agreement shall be in compliance with any existing law and the benefits of the employee shall not be less than those of the any existing law. (d) According to the employment agreement, the Ministry shall issue the notification for paying the stipulated compensation to the employee by the employer, if the work is completed earlier than the stipulated period or the whole work or any part of it have to be terminated due to unexpected condition or the work has to be terminated due to various conditions. (e) The employment agreement made under sub-section (a) shall be related with daily wage workers, piece rate workers who are appointed temporarily in the government department and

organization.

(f) The worksite regulations and benefits contained in the employment agreement mutually made between the employer and employee or among the employees shall be amended as necessary, in accord with the existing law.

(g) The employer shall send a copy of the employment agreement made between the employer and employee, to the relevant employment and labour exchange office within the stipulated period and shall get the approval of it.

(h) The employment agreement made before the enforcement of this law shall be confirmed up to the end of the term of the original agreement.

14. The employer shall carry out the training program in accord with the work requirement in line with the policy of the skill development team to develop the skill relating to the employment for the workers who are proposed to appoint and working at present.

15. The Employer:

(a) shall carry out the training for each work or compounding the work individually or group-wise by opening on-job training, training systematically at worksite, sending outside training and training by using information technology system, for arranging the training program to enhance the employment skill of the workers;

(b) appointing the youths of 16 years as apprentice, shall arrange the training for technology relating to the employment systematically in accord with the regulations prescribed by the skill development team.

30. (a) The employer of the industry and service business shall put in to the fund monthly as put in fees without fail for the total wages of the subordinates and the supervisors' salary for not less than 0.5%;

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

The Settlement of Labour Dispute Law, 2012

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

The Welfare of Labours of Oilfield Act, 1951 (After notification)

The act provide for the prevention of waste of oil or gas and also the prevention of environmental pollution by petroleum operations. For the labours' Working hours: Higher physical danger risk establishment (e.g. an oil rig): 8 hours/day or 40 hours/week, Medium physical danger risk establishment (e.g. factory, oilfield, open mine): 8 hours/day or 44 hours/week. If factory work is part of a continuous process (i.e. technical reasons): admissible 48 hours/week, 10 hours a day Max. 6 days/week (i.e. Sunday = weekly holiday). For Overtime: 2x normal pay rate. Work on weekly holiday = alternative day off within a period of 2 months. In Practice: No specific rules for offshore workers except in old law—oilfields act. Workers in industrial zones work around 11 hours a day, 6 days a week. Many in oilfields the same, but more dangerous jobs, 40/ week.

The Workmen Compensation Act, 1923 (amended 2005)

In the Workmen's compensation Act, 1923, the expression" Kyats 2,160 and Kyats 7,200" contained in clause A (i) of sub-section (1) of section 4, the expression "two hundred Kyats" contained in clause A (ii) of sub-section (1) of section 4, the expression "Kyats 3,024and Kyats 10,080" contained in clause B (i) of sub-section (1) of section 4, the expression "twelve hundred Kyats" contained in clause B (ii) of sub-section (1) of section 4, the expression.

• "one hundred Kyats" contained in the proviso of sub-section (1) of section 8 shall be substituted respectively by the expression "the amount of compensation prescribed by notification by the Ministry of Labour, with the approval of the Government."

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

The expression "ten Kyats" contained in sub-section (2) of section 8, the expression "twenty five Kyats" contained in sub-section (4) of section 8, the expression "three hundred Kyats" contained in the first proviso of sub-section

(1) of section 30 of the Workmen's Compensation Act, 1923 shall be substituted respectively by the expression "the amount of money prescribed by notification by the Ministry of Labour,

with the approval of the Government.

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

Labour Organization Law, 2012

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

Minimum Wages Law, 2013

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

Payment of Wages Law, 2016

Salaries are to be paid at the end of the month or, depending on the size of the employing enterprise, between 5-10 days before the end of the month. The employer is permitted and required to withhold income tax and social security payments. Other deductions, e.g. for absence, may only be withheld in accordance with the law.

Section 3 The employer (a) will pay for salary either Myanmar Kyats or Foreign Cash permitted by National Bank of Myanmar. When delivery the salary (b) If the employer needs to pay the other opportunities or advantages, he can pay cash together with other materials according employee's attitude.

Section 4 When the contract finish, employer need to pay the salary (not more than one month) to employees. For the permanent worker, need to pay per monthly. If more than 100 employees, need to pay within the 5 days from the end of month. If fire the employees, need to pay salary within two days after fire. When employee dies due to the accident, need to pay money as an insurance to employee's family within two days.

Section 9 When cut the salary due to the employees' absence, total cut salary not more than 50 % of his salary.

Section 10 Employer need to approval form the department as a penalty and cannot more than actual ravage rate when cut salary. No cut salary from the employees under 16 age.

Social Security Law, 2012

The Establishments Applied

Section 11. (a) The following establishments shall be applied with the provisions for compulsory registration for social security system and benefits contained in this Law if they employ minimum number of workers and above determined by the Ministry of Labour in co-ordination with the Social Security Board:

(i) production industries doing business whether or not they utilize mechanical power or a certain kind of power, works of production, repairing or services, or engineering works, mills, warehouses, establishments;

(ii) Government departments, Government organizations and regional administrative organizations doing business;

(iii) development organizations;

(iv) financial organizations,

(v) companies, associations, organizations and their subordinate departments and branch offices doing business;

(vi) shops, commercial establishments, public entertaining establishments;

(vii) Government departments and Government organizations doing business or transport businesses owned by regional administrative body, and transport businesses carried out with the permission of such department, body or in joint venture with such department or body;

(viii) construction works carried out for a period of one year and above under employment agreement;

(ix) works carried out with foreign investment or citizen investment or joint ventured businesses;

(x) works relating to mining and gemstone contained in any existing law;

(xi) works relating to petroleum and natural gas contained in any existing law;

(xii) ports and out-ports contained in any existing law;

(xiii) works and organizations carried out with freight handling workers;

(xiv) Ministry of Labour and its subordinate departments and organizations;

(xv) establishments determined by the Ministry of Labour from time to time, in co-ordination with the Social Security Board and with the approval of the Union Government; that they shall be applied with the provisions of compulsory registration for Social Security System and benefits contained in this Law.

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

(i) carrying out work by employing under stipulated minimum number of workers but more than one worker;

(ii) changing the employer or changing the type of business.

Section 48

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

Section 51

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

Section 53 (a) The employers and workers shall co-ordinate with the Social Security Board or insurance agency in respect of keepingplans for safety and health in order to prevent employment injury, contracting disease and decease owing to occupation and in addition to safety and educational work of the workers and accident at the establishment;

Section 54 -

(a) The employer shall report to the relevant township social security office immediately if a serious employment accident occurs to his insured worker. There shall not be any delay without sufficient cause to report as such.

(b) A team of officers and other staff who inspect the establishments, if it is found out the employment injury, death, and contracting disease, shall report to the relevant township social security office in accord with the stipulations.

The Protection of Rights of National Race Law, 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.
The Import and Export Law, 2012
7. A person who obtained any license shall not violate the conditions contained in the license.
Essential Supplies and Services Law, 2012

The objectives of this Law are as follows:

(a) to enable to safeguard the supplies and services which shall support the interest of the citizens;

(b) to enable to restrict and prohibit the supplies and services which may cause affect the interests of the citizens;

(c) to enable to prohibit the transport within the country, import and export of the supplies and animals which may arise danger, contagious disease and other unwanted matters.

The Motor Vehicles Law, 2015

The main objectives of this law are as follows:

(a) For the safe driving of motor vehicles in public areas through registration according to official rules and regulations.

(b) To provide driving licenses for driving particular types of motorized vehicles after qualification checks.

(c) For the easy flow of road users and for the protection against road risks and vehicle perils.

(d) To avoid traffic congestion and to use high technology transportation systems efficiently in order to implement protection against road risks and vehicle perils.

(e) To reduce environmental pollution caused by motor vehicles.

The Farmland Law, 2012

Rights of Person who has the Right to Use the Farmland

9. The person who has the right to use the farmland shall have the following rights:

(a) right to have the farmland in possession, right to use the farmland, right to enjoy the benefit arises from this right;

(b) right to sell, mortgage, lease, exchange and gift on the whole or part of the right to use the farmland in accord with the stipulated terms and conditions;

(c) right to accept the decision of the relevant court in accord with the existing law if the dispute arises relating the inheritance of the right to use the farmland;

(d) right to use the farmland so long as there is no breach of the stipulated terms and conditions;

(e) right to use common interest with the investment of village co-operative or with the private investors for the development of agriculture in the farmland;

(f) right to use common interest the farmland in accord with the Foreign Investment Law of the Republic of the Union of Myanmar by cooperating with the foreigner or the organization in which the foreigner is included.

Administration of the Farmland

32. In confiscating the farmland for the projects of the State interests, only the required minimum area shall be confiscated. The project shall be implemented to complete as soon as possible within the prescribed period and when the project is not carrying out, it shall be returned to the person or organization which has the original right to use the farmland.

Magway Region Municipal Law, 2016

A municipal law that outlines the municipal administration for Magway Region.

The Highways Law, 2000, and Amendments

The objectives of this Law are as follows: -

3. (a) 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,

(b) to give support in implementing the duty for security and convenience in road and communication

and quickness in flow of commodities;
(c) to give support in the modernization and development of the State by constructing highways within the State or by constructing highways which connect with neighbouring countries;
(d) to carry out systematically the works of extension, repair and maintenance for durability of highways;
(e) to supervise systematically in respect of traffic and use of highways

3.2.5 *International Treaties/Conventions*

Myanmar has ratified several international conventions. Those relevant to the Project are provided in ***Table 3.4***.

Table 3.4 International Conventions

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

No.	Conventions	Year (Ratified/Acceded/Accepted)
21	International Treaty on Plant Genetic Resources for Food and Agriculture, 2001	2004 (Ratification)
22	Catagena Protocol on Biosafety, Cartagena, 2000	2001 (Signatory)
23	Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, Rome, 1973	1994 (Acceptance)
24	United Nations Convention on the Law of the Sea, Montego Bay, 1982	1996 (Ratified)
25	Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, New York, 1994	1996 (Accession)
26	Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and their Destruction, Paris, 1993	1993 (Signatory)
27	Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea Bed and Ocean Floor and in the Subsoil there of, London, Moscow, Washington, 1971	1971 (Signatory)
Social, Labour and Health		
28	Universal Declaration of Human Rights (UNDHR)	signed
29	Convention on the Rights of the Child	1991 (acceded)
30	Convention on Elimination of All Forms of Discrimination against Women (CEDAW)	1997 (acceded)
31	Relevant ILO Conventions in force in Myanmar • C1 Hours of Work (Industry) • C14 Weekly Rest (Industry) • 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 • C87 Freedom of Association and Protection of the Right to Organize	

3.3 INSTITUTIONAL FRAMEWORK

3.3.1 *Overview of Project Approval Process*

Note that, at the time of writing this report in 2014, Myanmar did not have effectively implemented regulatory requirements for environmental, social and health impact assessments (ESHIA), including a defined approval process. However, since that time, a number of environmental laws have been implemented. As such, this section will highlight he current legislation with respect to the approval process for impact assessments.

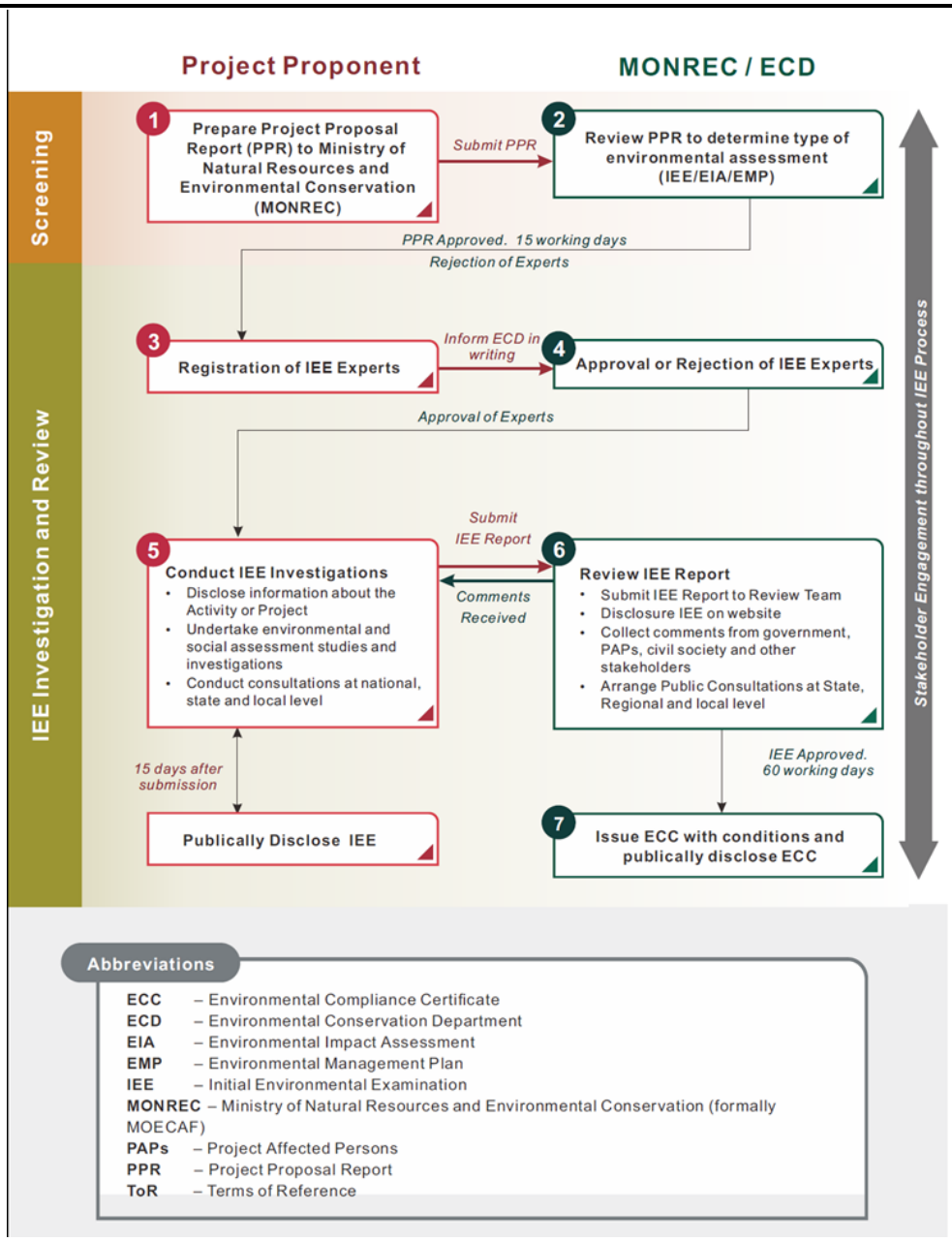
Key legislation governing the environmental approvals process for the proposed Project is the *EIA Procedure* (2015). According to the *EIA Procedure*, depending on project type and scale, location and the potential environmental impact, one of three levels of assessment will be allocated to a proposed development project:

- Environmental Impact Assessment (EIA);
- Initial Environmental Examination (IEE); or
- Neither an EIA nor an IEE - an environmental assessment is not required.

As per Article 23 and Annex 1 of the *EIA Procedure,* this Project falls under the category of ""Item 12: Onshore Oil and Gas Seismic Surveys" which is mentioned under the **Criteria for IEE Type Economic Activities**. The *EIA Procedure* stipulates that the Project is therefore required to submit the IEE to MONREC (formerly MOECAF) for review and obtain an Environmental Compliance Certificate (ECC). If the IEE is satisfactory, MOECAF will approve the IEE Report, and issue an ECC. The procedure is shown in ***Figure 3.2***.

Note that, at the time of writing this report in 2014, the EIA Procedure had not yet been finalized and promulgated. As such, this report was originally referred to as an "Environmental, Social, and Health Impact Assessment (ESHIA) report", rather than an "Initial Environmental Examination (IEE) report". However, the contents of this report are aligned with what would be required in an IEE Report, despite the difference in title. As mentioned in Section 1.1, the term "ESHIA" throughout this report shall be understood to be equivalent to "IEE" as per the requirements of the EIA Procedure.

Figure 3.2 IEE Review and Approval Process



3.3.2 *Additional Administrative Approvals and Permitting*

3.3.2.1 *Approval for Seismic Acquisition Services*

Approval for Provision of Onshore 2D and 3D Seismic Acquisition Services for Onshore Block MOGE-3 was provided by Myanma Oil and Gas Enterprise (MOGE) on January 18, 2016. The letter of approval is provided in ***Annex I***.

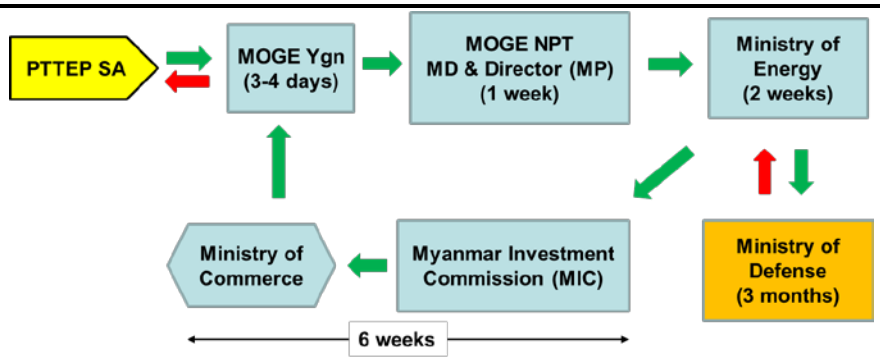
3.3.2.2 *Approval to Conduct Seismic Survey in Thae Phyu Reserved Forest Area*

PTTEP SA requested approval from MOGE to conduct seismic survey in Thae Phyu Reserved Forest Area on July 8, 2016. The approval is still pending. The request for approval can be found in ***Annex I***.

3.3.2.3 *Explosives Permitting*

Before importing explosives to Myanmar, PTTEP SA is required to obtain an Explosives Import Permit from the Ministry of Energy, by following the procedure outlined in ***Figure 3.3***.

Figure 3.3 Explosives Import Permit Procedure



3.4 *PROJECT'S ENVIRONMENTAL, SOCIAL AND HEALTH STANDARDS*

3.4.1 *National Environmental Quality (Emission) Guidelines*

Note that, at the time of writing this report in 2014, Myanmar did not have effectively implemented emission guidelines. However, Myanmar's National Environmental Quality (Emission) Guidelines were promulgated in 2015. As such, this section will highlight he current legislation with respect to the emissions guidelines.

Myanmar's National Environmental Quality (Emission) (NEQ) Guidelines were promulgated on December 29th, 2015. The Guidelines are largely based on International Finance Corporation (IFC) Environmental Health and Safety (EHS) Guidelines, and provide the basis for regulation and control of various environmental parameters, including noise and vibration, air emissions, and effluent discharges, from various sources.

Relevant excerpts from the guidelines are as follows:

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

7. Recognizing that these Guidelines are intended to prevent pollution through reducing the mass of pollutants emitted to the environment, dilution of air emissions and effluents to achieve maximum permitted values is not acceptable. Specified guideline values should be achieved, without dilution, at least 95 percent of the time that a project is operating, to be calculated as a proportion of annual operating hours.

8. Further reference should be made by projects to applicable industry-specific IFC EHS guidelines for advice on means of achieving guideline values set out in Annex 1.

9. As specified in the EIA Procedure, all projects are obliged to use, comply with and refer to applicable national guidelines or standards or international standards adopted by the Ministry. These Guidelines will henceforth be applied by the Ministry in satisfying this requirement until otherwise modified or succeeded by other guidelines or standards.

…

11. While these Guidelines generally apply to all projects subject to the EIA Procedure, it is the prerogative of the Ministry to decide how the Guidelines should be applied to existing projects as referred to in the EIA Procedure, as distinguished from new projects. At the Ministry's discretion less stringent levels or measures than provided for in these Guidelines may be specified as appropriate, and a timeframe agreed for a project to fully comply with these Guidelines.

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

13. Air emissions, noise, odor, and liquid / effluent discharges will be sampled and measured at points of compliance as specified in the project EMP and ECC. "

A summary of environmental standards that are relevant to the Project are shown below.

3.4.1.1 General

3.4.1.1(1) Wastewater

In addition to industry-specific wastewater guidelines applicable during project operations (*Section 3.4.1.2*), the guideline values in ***Table 3.5*** apply

during the construction phase of projects, covering storm water or surface water, and sanitary wastewater discharges from all project sites.

Table 3.5 Site Runoff and Wastewater Discharges (Construction Phase)

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

3.4.1.1(2) Noise Levels

General noise guidelines are presented in ***Table 3.6***.

Table 3.6 General Noise Level Standards

Receptor	One Hour LAeq (dBA)	
	Daytime (07:00 – 22:00)	Nighttime (22:00 – 07:00)
Residential, institutional, educational	55	45
Industrial, commercial	70	70

3.4.1.1(3) Odor

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

3.4.1.2 Industry-Specific Standards for Onshore Oil and Gas Projects

A list of standards specific to onshore oil and gas development is shown in ***Table 3.7***.

Table 3.7 Effluent and Emission Standards for Oil and Gas Development

Parameter	Guideline
Drilling fluids and cuttings	Treatment and disposal in accordance with applicable standards provided in the IFC EHS Onshore Oil and Gas Development guideline
Produced sand	Treatment and disposal in accordance with applicable standards provided in the IFC EHS Onshore Oil and Gas Development guideline
Produced water	Treatment and disposal in accordance with applicable standards provided in the IFC EHS Onshore Oil and Gas Development guideline For discharge to surface waters or to land: - 5-day Biochemical oxygen demand 25 mg/l - Chemical oxygen demand 125 mg/l - Chlorides 600 mg/l (average), 1,200 mg/l maximum - Heavy metals (total)[a] 5 mg/l - pH 6-9[b] - Phenols 0.5 mg/l - Sulfides 1 mg/l - Total hydrocarbon content 10 mg/l - Total suspended solids 35 mg/l
Hydrotest water	Treatment and disposal in accordance with applicable standards provided in the IFC EHS Onshore Oil and Gas Development guideline For discharge to surface waters or to land: - 5-day Biochemical oxygen demand 25 mg/l - Chemical oxygen demand 125 mg/l - Chlorides 600 mg/l (average), 1,200 mg/l maximum - Heavy metals (total) 5 mg/l - pH 6-9 - Phenols 0.5 mg/l - Sulfides 1 mg/l - Total hydrocarbon content 10 mg/l - Total suspended solids 35 mg/l
Completion and well work-over fluids	Treatment and disposal in accordance with applicable standards provided in the IFC EHS Onshore Oil and Gas Development guideline For discharge to surface waters or to land: - pH 6-9 - Total hydrocarbon content 10 mg/l
Storm water drainage	Storm water runoff should be treated through an oil/ water separation system able to achieve oil and grease concentration of 10 mg/l
Cooling water	The effluent should result in a temperature increase of no more than 3°C at edge of the zone where initial mixing and dilution take place; where the zone is not defined, use 100 meters from point of discharge
Sewage	Holding and discharge to municipal or centralized wastewater treatment systems or onboard treatment to achieve: - 5-day Biochemical oxygen demand 30 mg/l - Chemical oxygen demand 125 mg/l - Oil and grease 10 mg/l - pH 6-9 - Total coliform bacteria 400/100 ml - Total nitrogen 10 mg/l - Total phosphorus 2 mg/l - Total suspended solids 50 mg/l

Parameter	Guideline
Air Emissions	Achieve WHO ambient air quality guidelines, and apply the following guideline value to emissions: - Hydrogen sulfide 5 mg/Nm^{3}[c]

Note: [a] Heavy metals include: Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Silver, Vanadium and Zinc

Section 4

Project Description and Alternative Selection

4 PROJECT DESCRIPTION AND ALTERNATIVE SELECTION

4.1 PROJECT BACKGROUND

PTT Exploration and Production South Asia (PTTEP SA) was granted the production sharing contract (PSC) for Myanmar Onshore Block MOGE-3 in September 2014, owned by Myanmar Oil and Gas Enterprise (MOGE). Block MOGE-3 encompasses 1,217 km², and is located in the south of Magway Region, in the Dry Zone in the central Myanmar lowlands, as shown in ***Figure 4.1***.

PTTEP SA plans to acquire 2D and 3D seismic data in Block MOGE-3, tentatively beginning Quarter 3 (Q3) of 2015, subject to final work program and schedule.

4.1.1 *Concession Background*

The PSC contains a number of parties, as follows:

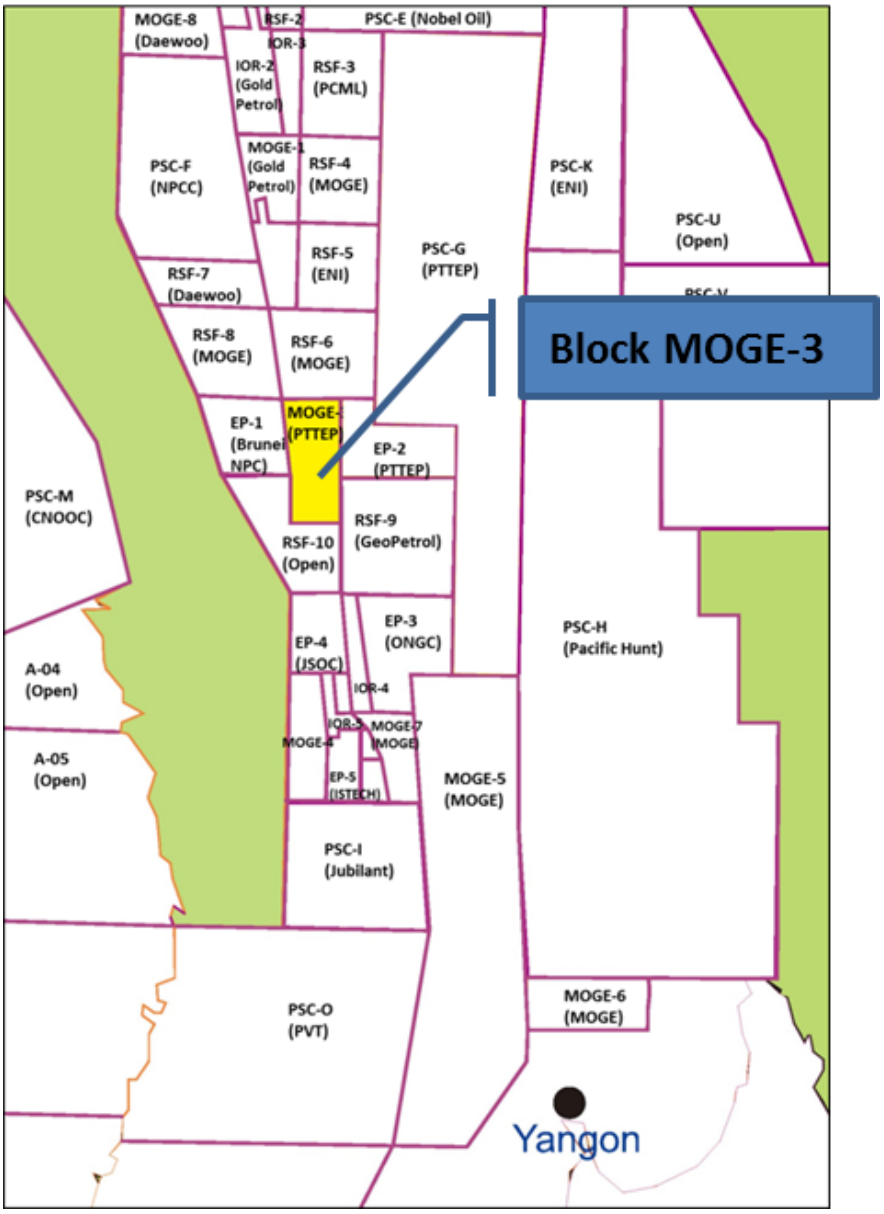
- Win Precious Resources (WPR)
- Palang Sophon Offshore Pte. Ltd.
- MOECO
- PTTEP SA
- MOGE

As part of the Production Sharing Contract (PSC), PTTEP SA must meet a number of PSC obligations for Block MOGE-3, which are shown in ***Table 4.1***.

Table 4.1 PTTEP SA's PSC Obligations with MOGE for Block MOGE-3

Contract Year	Minimum Work Program
Initial Exploration Period - Year 1	• Geological and Geophysical studies • Acquisition of 1000 km² new 3D seismic • Acquisition of 300 line-km new 2D seismic • Processing and interpretation
Year 2	• G&G studies • Drilling two (2) exploration wells
Year 3	• G&G studies • Drilling two (2) exploration wells
First Extension Period - Year 4 & 5	• G&G studies • Drilling three (3) exploration wells
Second Extension Period - Year 6	• G&G studies • Drilling two (2) appraisal wells

Figure 4.1 Location of Block MOGE-3



Source: PTTEP SA, 2014

4.1.2 *History of Previous Oil/Gas Activities*

In 1920, Burmah Oil Company (BOC) drilled shallow wells (<2500 ft) in Padaukpin area, with crude production of 40 Barrels of Oil per Day (BOPD), declining to 4 BOPD in 1926. In this same period, British Burma Petroleum Company (BBPC) drilled four wells in Sakangyi area, with the first well producing 100 BOPD.

MOGE has also drilled a total of 6 wells in Block MOGE-3, as follows:

- 1 well in Padaukpin area in 1995, with average depth of 7400 ft. Well was dry;
- 2 wells in Sakangyi area in 1972, with average depth of 4500 ft. Trace oil was found in one well; and

- 3 wells in Natmi area in 1972-1974, with average depth of 7457 ft. Total gas produced from Natmi Well-3 and Pyaye were 1.24 Billion Cubic Feet (BCF) and 25.10 BCF, respectively.

Current gas production of Pyaye well is approximately 0.3 Million Cubic Feet per Day (MMCFD), and the gas is sent directly to Thayet cement factory, which has a total daily consumption of approximately 2.8 MMCFD.

4.1.3 *Previous Surveys/Studies*

Previous operators (MOGE and Exspan Myanmar (L) Inc. Indonesia), have collected the following geophysical survey data for Block MOGE-3:

- Gravity (1966), MOGE, 502.48 km;
- Seismic (1994, DFS-V), MOGE, 242.30 km;
- Seismic (1998, SN 368), EXSPAN, 174.58 km; and
- Seismic (2011, SN 428), MOGE, 75.45 km.

4.1.4 *Purpose and Need for the Project*

With a view to ensuring future production of oil and gas resources, ongoing investment in oil and gas exploration activities is required. As an initial stage of oil and gas exploration in Block MOGE-3, seismic data are proposed to be collected for the areas of interest. Seismic data provide detailed information on subsurface geology that cannot be supplied by other geological and geophysical methods. Collection of seismic data is also essential for the accurate delineation of known reserves and the evaluation of previously identified leads and prospects. The purpose of the seismic survey is to facilitate full characterization of potential hydrocarbon reservoirs identified in the survey areas. Interpreted data from the seismic survey will be used to identify potential exploration well locations according to the obligations of the PSC. Once the geological structure is identified, exploration drilling can be conducted to confirm the presence of the hydrocarbons and the thickness and pressure of the reservoir.

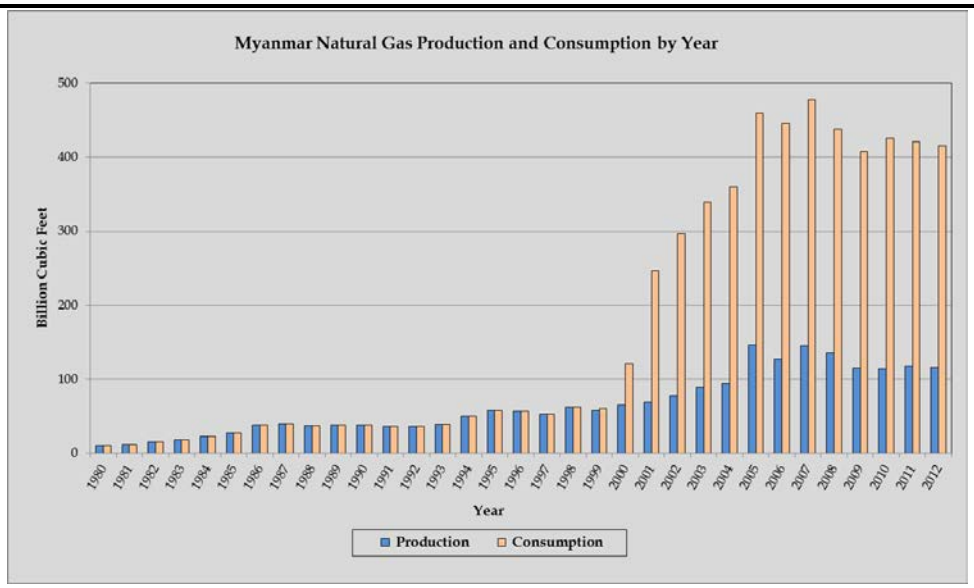
The demand for oil and gas in Myanmar is growing rapidly alongside its industrial development and growth. As of 2012, Myanmar meets less than half of its natural gas demand. Myanmar produces around 1.47 BCF of gas per day, and exports 1.2 BCF to Thailand. The 270 Million Cubic Feet (MMCF) kept in Myanmar met only 48 percent of domestic demand in 2011. The government estimates domestic natural gas demand will increase to 700 million cubic feet a day in 2016, and 800 million by 2020[1]. ***Figure 4.2*** shows Myanmar's natural gas consumption and production over the past 30 years.

[1] http://www.reuters.com/article/2012/03/29/myanmar-energy-idUSL3E8ET0G720120329

Similarly, the demand for crude oil is far greater than production in Myanmar. Myanmar currently produces a minimal amount of crude oil and condensates from the onshore Salin basin and offshore Yetagun field. Total liquids production has gradually increased over the past decade from 13,000 barrels per day (bbl/d) BOPD and refining capacity are insufficient to meet domestic demand for crude oil and products, making the country a net oil importer. ***Figure 4.3*** shows Myanmar's crude oil consumption and production over the past 30 years.

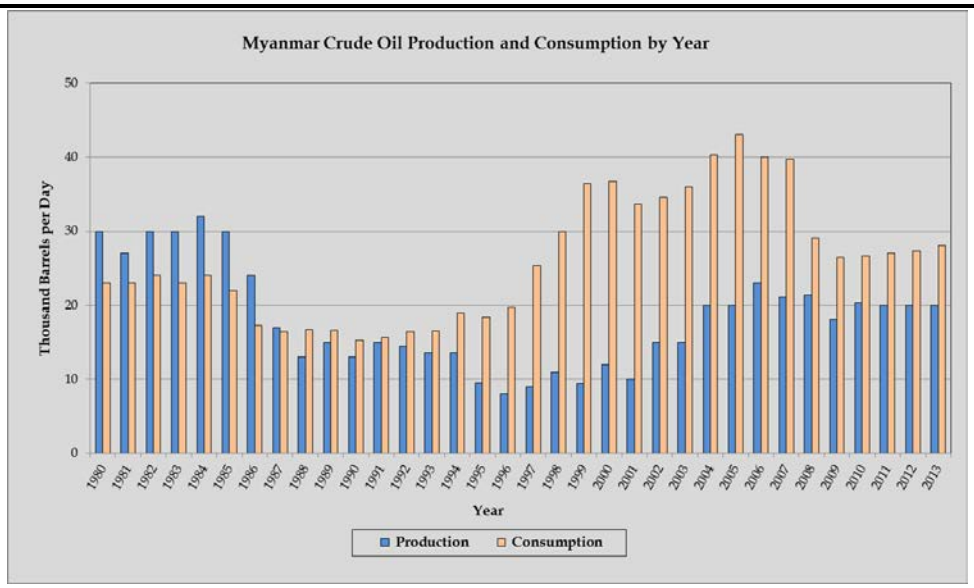
PTTEP SA, as the operator of the Myanmar onshore petroleum concession, is striving to develop and produce gas from potential gas reservoirs located within Block MOGE-3.

Figure 4.2 Myanmar's Gas Consumption and Production over 30 Years



Source: United States Energy Information Administration, 2014

Figure 4.3 Myanmar's Crude Oil Consumption and Production over 30 Years



Source: United States Energy Information Administration, 2014

4.2 PROJECT LOCATION

4.2.1 Concession Area

Onshore Block MOGE-3 is located in the middle of the Dry Zone in Central Myanmar, Magway Region, and covers an area of 1,217 km². It is geographically situated at the west bank of the Ayeyarwady River, in the central Myanmar basin, at an elevation of 36.4 m (119.296 feet) above sea level.

Topographically, Block MOGE-3 is generally flat, with rural areas, towns, villages, rice fields, cultivated fields and thin forest (open canopy). Populated areas are largely cleared of natural vegetation and adapted for farming and livestock. Land use consists of agricultural farming, as well as some areas of private hand-dug oil wells (discussed further in ***Section 5***). A Military Zone, DI-12, located near the center of Block MOGE-3, and Thae Phyu Reserved Forest, which covers approximately 800 ha, is located south of DI-12.

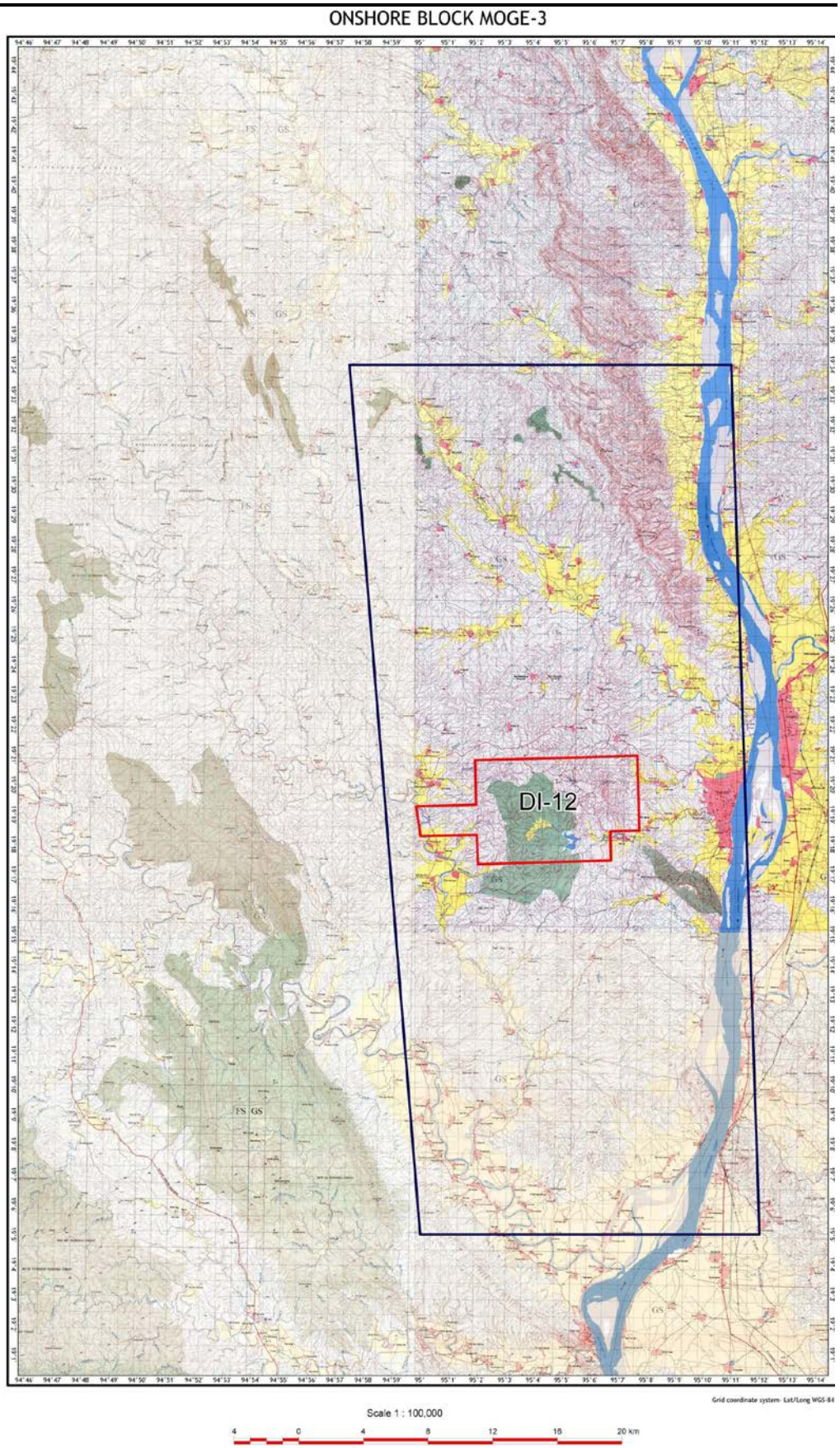
The boundary coordinates of Block MOGE-3 are shown in ***Table 4.2***, and a map of Block MOGE-3 is shown in ***Figure 4.4***.

Table 4.2 Boundary Coordinates of Block MOGE-3

Block	Point	Longitude	Latitude	X	Y
MOGE-3	A	94°57'30"E	19°34'00"N	390736.4538	2163862.466
	B	95°11'00"E	19°34'00"N	414338.8	2163734.266
	C	95°12'00"E	19°05'00"N	415839.9255	2110240.246
	D	95°00'00"E	19°05'00"N	394798.3847	2110348.317

Datum: WGS-84, Projection: Transverse Mercator (TM), Spheroid: Central Meridian TM96

Figure 4.4 Block MOGE-3 Block Boundaries



Source: PTTEP SA, 2014

4.2.2 *Seismic Survey Area*

The proposed seismic grid was designed based on available geological information; additional lines were also adjusted according to the terrain and geography conditions, based on topographical maps and information obtained from pre-survey scouting trips. The survey area covers almost the entire area of Block MOGE-3, with the exception of inaccessible mountainous areas, the Ayeyarwady River, and potentially the military area (DI-12) in the center of the block.

The seismic survey will cover approximately 1,000 km^2, consisting of approximately 2,500 km of source lines and 5,000 km receiver lines for the 3D survey, and 300 km seismic lines for the 2D survey (cumulative total of 7,800 km for all seismic lines).

Minor changes to the currently planned seismic line positions may occur in accordance with field conditions, such as unexploded ordinance (UXO)/mine contamination, available access roads, presence of hand-dug oil wells, or topographic conditions.

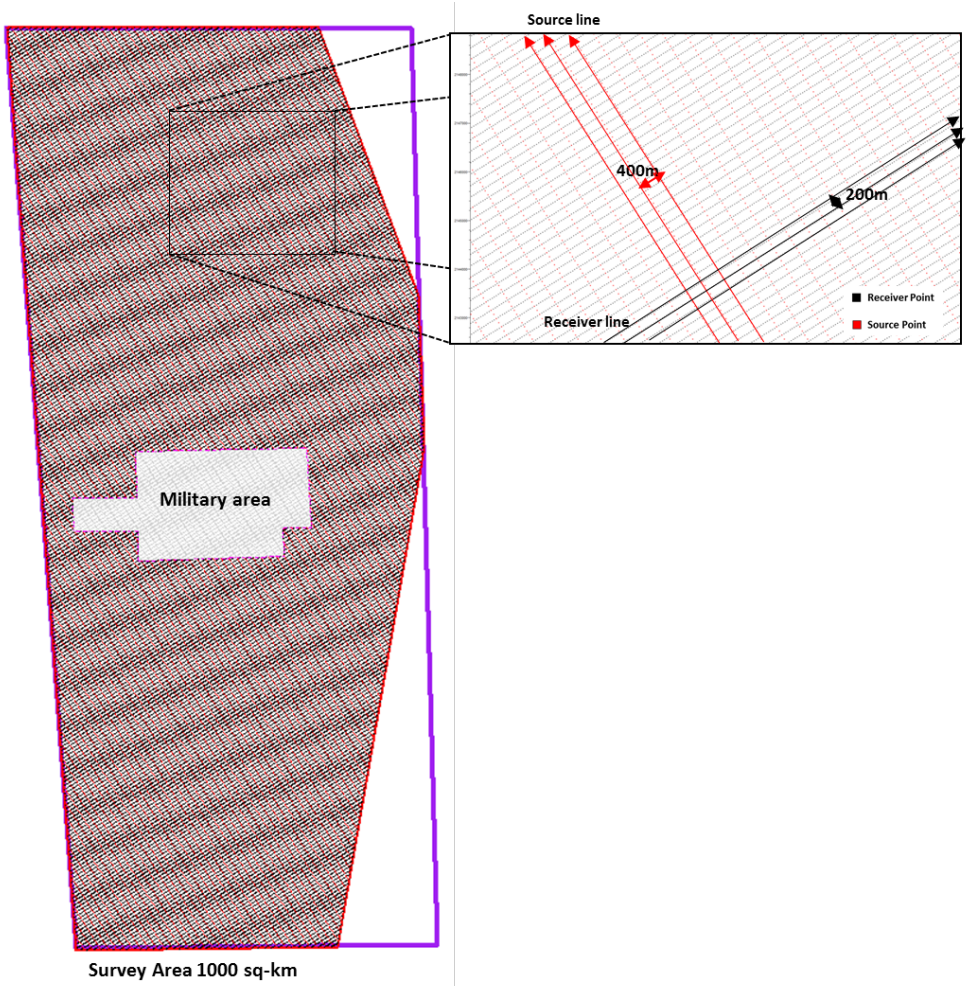
The seismic lines are designed to verify the prospects in Block MOGE-3. After the data from these lines are acquired, it will be infield-processed and interpreted, and additional lines may be selected based on the results of the initial lines. The corner coordinates of the survey area are shown in ***Table 4.3***, and an overview of the survey area is shown in ***Figure 4.5***.

Table 4.3 Survey Area for Block MOGE-3

Point No.	Longitude	Latitude	X	Y
A	94°57'30"E	19°34'00"N	390736.4	2163862.4
B	95° 8'15.69"E	19°33'55.60"N	409550.4	2163622.5
C	95°11'16.17"E	19°24'57.95"N	414731.1	2147069.6
D	95°11'25.98"E	19°20'6.61"N	414975.2	2138112.7
E	95° 8'36.60"E	19° 4'58.19"N	409895.5	2110212.7
F	95° 0'0.51"E	19° 4'56.94"N	394812.7	2110254.1
A	94°57'30"E	19°34'00"N	390736.4	2163862.4

Datum: WGS-84, Projection: Transverse Mercator (TM), Spheroid: Central Meridian TM96

Figure 4.5 Survey Area in Block MOGE-3



Source: PTTEP SA, 2014

4.3 COMPARISON AND SELECTION OF ALTERNATIVES

4.3.1 *No Project Option*

Petroleum demand in Myanmar is expected to continue rising, and therefore the no-project alternative would result in the loss of unrealized benefits, such as:

- No petroleum reserves would be extracted from this field. This would require potential future production from other energy sources such as hydropower and coal;
- No local employment opportunities; and
- No royalties would be obtained from future production and sale of the potential hydrocarbons produced from the field to benefit Myanmar.

The Project is therefore considered a favourable option compared to the no-project alternative.

4.3.2 *Project Option*

For the Project Option, the seismic survey in Block MOGE-3 considers various factors, including technical, environmental, social, and economic considerations, as summarized below.

4.3.2.1 *Technical Considerations*

A seismic reflection survey is one of the most common methods used to define sub-surface hydrocarbon deposits and geological structures. The acquired data from a seismic survey produces profiles of the sub-surface geology for interpretation by geophysicists. There are several technical criteria to consider with regards to carrying out the seismic survey, as noted in the following sections.

4.3.2.1(1) *Seismic Source*

Land seismic data acquisition relies primarily on two types of seismic sources– explosives and vibrator trucks (Vibroseis). Each has advantages and disadvantages. Surveys may be acquired using one type or both, depending on geophysical objectives, cost, and environmental constraints.

Advantages of using explosive sources include their light weight, low cost, lack of required maintenance and capacity for deployment in rugged terrain unreachable by vehicles. However, the process of drilling shot holes, burying the explosives and cleaning up after the operation is labor intensive, and with this option the survey geometry cannot be changed without drilling new shot holes. Additionally, explosive sources are subject to strict security regulations, and permission for use and transportation may be difficult to obtain in some places (*Bagaini et al, 2010*)[2].

A seismic vibrator, commonly known by its trademark name Vibroseis, is usually a truck-mounted device, and produces ground motion that propagates into the earth. Vibroseis trucks generally release less energy than is generated from shot holes. Disadvantages of vibrator trucks are that they require a large clearance path (approximately 5 meters on either side of the line), and therefore there are accessibility restrictions, and potential impacts due to the clearance path.

For the Project, given the remote location and access constraints of Block MOGE-3, PTTEP SA has decided to use explosive shots for 80-85% of the seismic survey, and will only use Vibroseis for approximately 15-20% of the survey, as required according to road access and site topography. Vibroseis and explosive locations will be specified based on examination of high resolution satellite maps. This is preferable from an environmental perspective, because less land clearance and plant removal activities will be

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[2] Bagaini, C., Bunting, T., El-Emam, A., Strobbia, A.L.C., "Land Seismic Techniques for High-Quality Data", Oilfield Review, Summer 2010:22, no. 2.

required. Additional details on the use of Vibroseis and explosive shots for seismic survey are presented in ***Section 4.4.2.2***.

4.3.2.1(2) 2D vs. 3D Seismic Survey

Past comparisons between 2D and 3D imaging have shown that 3D seismic survey poses a much lower risk to follow up exploration or production drilling than 2D seismic survey by providing[3]:

- A more complete evaluation of reservoirs;
- Confident guidance for horizontal directional drilling;
- A better understanding of the nature of the prospects;
- Fewer dry holes; and
- More optimal well locations with better production and longer life.

In terms of overall project development, 3D seismic survey is likely to result in better petroleum production effectiveness due to provision of more accurate images of subsurface characteristics, and reducing risk of investing resources to drill a dry hole.

3D seismic surveys are thus considered to be preferred to standalone 2D seismic surveys for the proposed Project as detailed, continuous sub-surface information is required.

3D seismic survey can provide information about the possible presence of petroleum reservoirs in Block MOGE-3. If sufficient oil or gas reserves are found in the future through exploration drilling, PTTEP SA would proceed with production. During production, PTTEP SA as a producer will contribute part of its revenue to the government via royalties and taxes, which will benefit local people.

For this Project, PTTEPSA will use primarily 3D seismic survey, with additional 2D seismic survey in limited areas.

4.3.2.2 Environmental Considerations

Seismic activities related to the proposed Block MOGE-3 project may have potentially significant impacts on the surrounding environment, including terrestrial organisms due to noise and vibration from seismic activities. However, these impacts will occur in limited areas around the seismic survey and for a short time period (cumulatively 270 days for 2D and 3D surveys, including preparatory activities). In addition, PTTEP SA has specified suitable environmental mitigation measures, such as plans for project schedule, survey, waste generated, etc., as well as a Safety, Security, Health and Environment

[3] Cooper, NM.,2003. "The Value of 3D Seismic in Today's Exploration Environment – In Canada and Around the World." Mustagh Resources Ltd, Calgary Alberta

(SSHE) Plan, which will be strictly implemented and followed. Therefore, it is expected that negative impacts can be eliminated or minimized.

In addition to technical, social, and economic considerations, the location of sensitive/protected areas was also considered before the location of the survey was finalized. The Project will avoid sensitive/protected areas, and minimum setback distances will be incorporated (discussed further in ***Section 4.4.1.3***) to avoid any potential environmental impacts.

4.3.2.3 *Social Considerations*

The social considerations for onshore seismic relate mainly to the land use of local people, as well as local archaeological sites that could be damaged by the vibration of seismic activities. The Project will establish minimum setback distances from seismic lines, to prevent damage to nearby structures. PTTEP SA will ensure that the Project schedule is properly communicated so that local people can make alternative plans while the survey is taking place. PTTEPSA will also provide compensation to affected land owners, as detailed in ***Section 4.4.2.8***.

4.3.2.4 *Economic Considerations*

The seismic site selection process incorporates the assessment of the economic value of potential petroleum hydrocarbon reservoirs and their commercial worth against the cost of the investment (including crop compensation, cost of seismic survey, etc.) for alternate seismic locations.

4.4 *DESCRIPTION OF PROJECT ACTIVITIES*

For this Project, PTTEP SA will utilize Sinopec International Petroleum Service Corporation (Sinopec) as the seismic contractor. Throughout this report, "Seismic Contractor" can be understood to refer to "Sinopec".

4.4.1 *Site Preparation Phase*

4.4.1.1 *Permitting and Coordination with Local Authorities*

The following licenses/permissions are required from the Myanmar government for 2D and 3D seismic acquisition in Block MOGE-3:

1. Explosive license: to import explosives to Myanmar;
2. Telecommunication permit: to obtain license to operate radio communication;
3. Formation of crop compensation committee, and agreement on crop prices;
4. Seismic equipment import permit; and
5. Temporary magazine construction.

PTTEP SA will notify and coordinate with MOGE and all necessary local authorities in the planning phase of the seismic survey. PTTEP SA commit to obtain all relevant licenses/permissions prior to undertaking the seismic survey.

4.4.1.2 *Access to Site*

Access to the seismic survey areas will be primarily by land vehicles, combined with some walking in less accessible areas. Most roads within the survey area are graveled or unstructured roads. If access through private land is required, the contractor will seek permission from land owners in writing prior to proceeding. Access for vehicles will be restricted to the shot lines to minimize impact on surrounding land. Typical road conditions in the Project area are shown in ***Figure 4.6*** and ***Figure 4.7***. Major roads, as well as some unpaved access roads in the seismic survey area, are shown in ***Figure 4.8***.

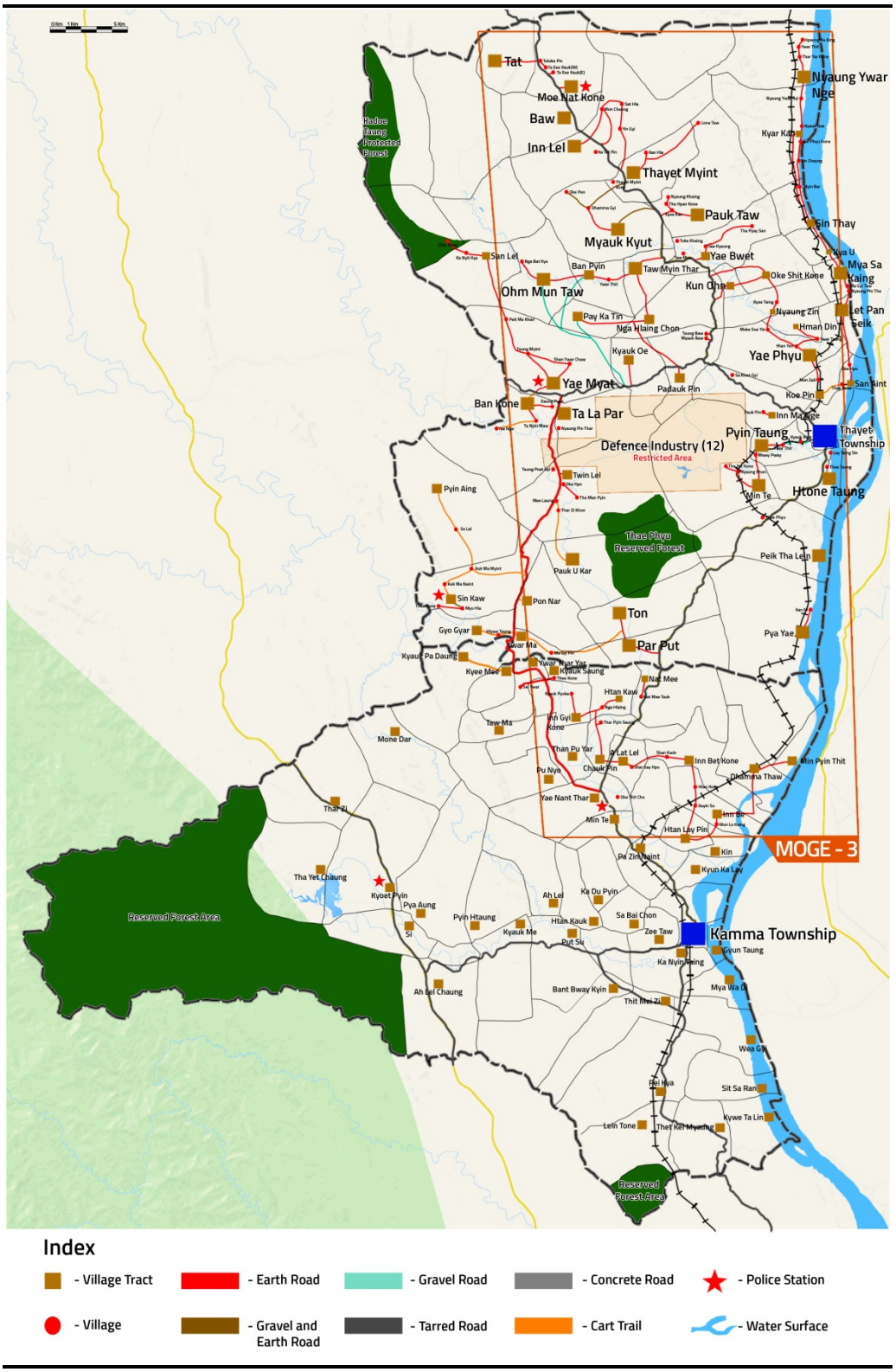
Figure 4.6 Bridge Crossing in Block MOGE-3

Source: REM, 2014

Figure 4.7 Road Section near Min Tone

Source: REM, 2014

Figure 4.8 Transportation Routes within the Project Area



Source: MMRD, 2014

4.4.1.3 *Site Reconnaissance*

Prior to carrying out the seismic survey, along with reference to topographic maps, initial site reconnaissance will take place to determine locations of important features and potential hazards, including access, offsets, compensation areas, no-vehicle areas, no-drilling areas, etc. In terms of hazards, overhead or underground power lines and cables, rivers, streams, culverts, ditches, houses, bridges, steep gradients, holes, fences, animals, half-fallen trees, insect nests, etc will be considered.

To prevent potential damage to nearby structures and to reduce the impacts from noise and vibration during seismic source generation, appropriate minimum setback distances have been established, based on international standard practices, as shown in ***Table 4.4***. Note that these distances were modified slightly following the results of PPV Tests conducted by the Seismic Contractor (Sinopec) (discussed further in Section 6.3.3) to increase safety and minimize impacts.

In case of obstacles or sensitive areas falling within the minimum setback distances, the survey team will deviate seismic lines from their planned locations, or reduce the quantity of explosives used, according to minimum setback distance standards of the Seismic Contractor. These will be verified and approved by PTTEP SA so that the vibration generated from the seismic source does not impact any obstacles or sensitive areas. The minimum setback distances may be further confirmed in the field with Peak Particle Velocity (PPV) tests (see ***Section 8***).

Table 4.4 Minimum Setback Distances for use of Explosive and Non-Explosive Sources

Obstruction/Structure	Explosive Sources		Non-Explosive Sources (Vibroseis)	Source
	Charge Size	Distance		
Residence, barn, or any building(s) with a concrete base, concrete irrigation structures (e.g., drop structures, head works), concrete lined irrigation canals, and concrete water pipelines.	Up to and including 12 kg	150 m	50 m	1
	>12 kg ≤20	200 m		
Water wells, developed spring,* observation well, or piezometer.	Up to and including 12 kg	150 m	100 m	1
	>12 kg ≤20	200 m		
High - Pressure Pipelines High - pressure pipelines are pipelines that operate at, or are intended to operate at a pressure in excess of 700 kilopascals. **Note**: All distances are measured from the centre of the pipeline.	≤2 kg	32 m	20 m	1
	>2 & ≤4 kg	50 m		
	>4 & ≤6 kg	55 m		
	>6 & ≤8 kg	64 m		
	>8 & ≤10 kg	70 m		
	>10 & ≤12 kg	78 m		

Obstruction/Structure	Explosive Sources		Non-Explosive Sources (Vibroseis)	Source
	Charge Size	Distance		
	>12 kg ≤20	100 m		
Low - pressure Pipelines Low-pressure pipelines are pipelines that operate at, or are intended to operate at a pressure of 700 kilopascals or less. **Note:** All distances are measured from the centre of the pipeline.	Up to and including 20 kg	3 m	6 m	1
Dugouts** Measured from the inside edge of high water mark	Up to and including 20 kg	50 m	25 m	1
Irrigation Canal (other than concrete lined) Irrigation canals that are more than 4 m wide	Up to and including 20 kg	10 m	20 m	1
Buried Water Pipelines (other than concrete lined)	Up to and including 20 kg	3 m	6 m	1
Dams Dam means a barrier constructed and having a storage reservoir capacity of at least 30,000 m^3, and which is at least 2.5 m in height when measured vertically to the top of the barrier.	Up to and including 20 kg	150 m	50 m	1
Cemetery Distance to the energy source is measured to the surveyed boundary of the cemetery.	Up to and including 20 kg	100 m	50 m	1
Buried Lines and Survey Monuments Telephone lines and telecommunication lines.	Up to and including 20 kg	2 m	2 m	1
Domestic Septic Tank or Mound A septic tank is defined as a tank that is used as a septic storage device. A mound is a septic storage device that is located above ground surface.	Up to and including 20 kg	15 m	15 m	1
Archaeological and Cultural Sites	All	150 m	100 m	2
Railways	All	50 m	40 m	2

Obstruction/Structure	Explosive Sources		Non-Explosive Sources (Vibroseis)	Source
	Charge Size	Distance		
Water Body (including lakes, streams, creeks, wetlands, wetland edge, riparian areas, muskeg areas, ephemeral or seasonal draws and dugouts)	All	50 m from the riparian area edge and if no riparian area, 50 m from the edge of the water body's high water mark or seasonal high water edge		3
Oil or Gas Well	Explosives ≤2.0 kg	32 m	20 m	4
	Explosives > 2.0 & ≤4.0kg	180 m		

Note:

* A developed spring is an area of local groundwater discharge that has had human intervention to make the water usable or attainable for domestic and/or non-domestic purposes, and is intended for long - term use.

** Dugouts are earthen excavations designed to collect runoff and store it for use during drier times. Typically, dugout capacity ranges from a few hundred cubic meters to thousands of cubic meters.

Sources:

1 "Distance Requirements" from Lands Division, Land Management Branch, Petroleum Land Use & Reclamation Section, Government of Alberta, Canada

2 Oil and Gas Setback Requirements for Environmental Protection and Consultation on First Nation Reserve Land", from Indian Oil and Gas Canada (IOGC) Guidelines

3 Policy and Procedures Document for Submitting the Geophysical Field Report Form (Government of Alberta, October 2006)

4 Canada Oil and Gas Geophysical Operations Regulations, SOR/96-117, Canada Oil and Gas Operations Act

4.4.2 *Seismic Survey Phase*

4.4.2.1 *Seismic Survey Overview*

The seismic survey will be carried out using both explosive shots and Vibroseis (seismic vibrator), both of which act as a vibration source. The principle of seismic survey is based on the different acoustic properties of rock profiles in absorbing and reflecting acoustic waves. The acoustic energy from an explosion or ground impact will penetrate rock profiles with different acoustic properties. Part of this energy will be passed into the deeper layers of the profiles, while the remaining energy will be reflected back to geophones. The reflection time from different layers of the profiles, and amplitude of waves, will be recorded. The time taken for acoustic waves to reach rock profiles and reflect back implies the depth of the profiles. The speed of acoustic waves is proportional to the depth of rock profiles: acoustic waves take longer time passing through rock profiles that are low density, porous, and intervened with fluid than where acoustic waves pass through denser rocks.

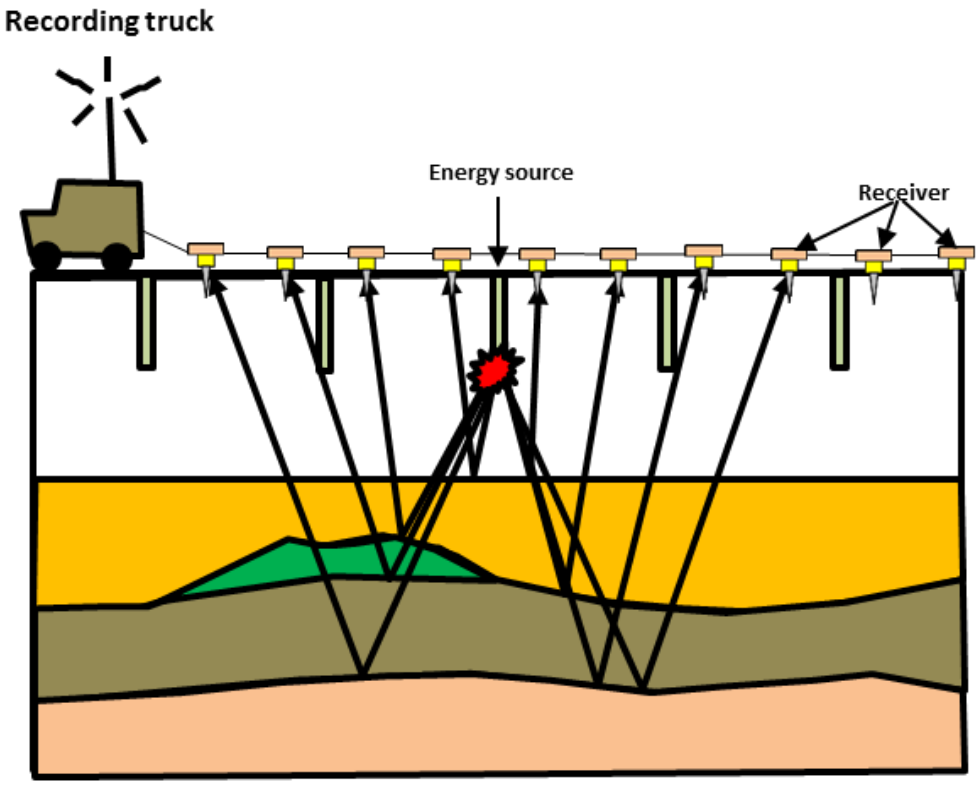
Information obtained by geophones will be recorded and interpreted using a computer. This provides underground profiles, which will imply types and characteristics of geological structures, as well as potential petroleum

reservoirs. Information on other characteristics that will also be obtained include maps of mobile or flowing sediments, unconformity, geological history, sedimentation, etc. All information will be used as a guide to plan future petroleum exploration drilling. An overview of the seismic survey principles can be seen in ***Figure 4.9*** and ***Figure 4.10***. Specifications for the seismic survey are shown in ***Table 4.5***.

The working unit for this 2D and 3D seismic survey will be divided into five units according to duties: Permitting Team, Survey Team, Drilling Team, Recording Team, and Site Restoration Team.

Figure 4.9 *Overview of Seismic Survey Process*

Figure 4.10 Seismic Survey using Explosives as Vibration Source



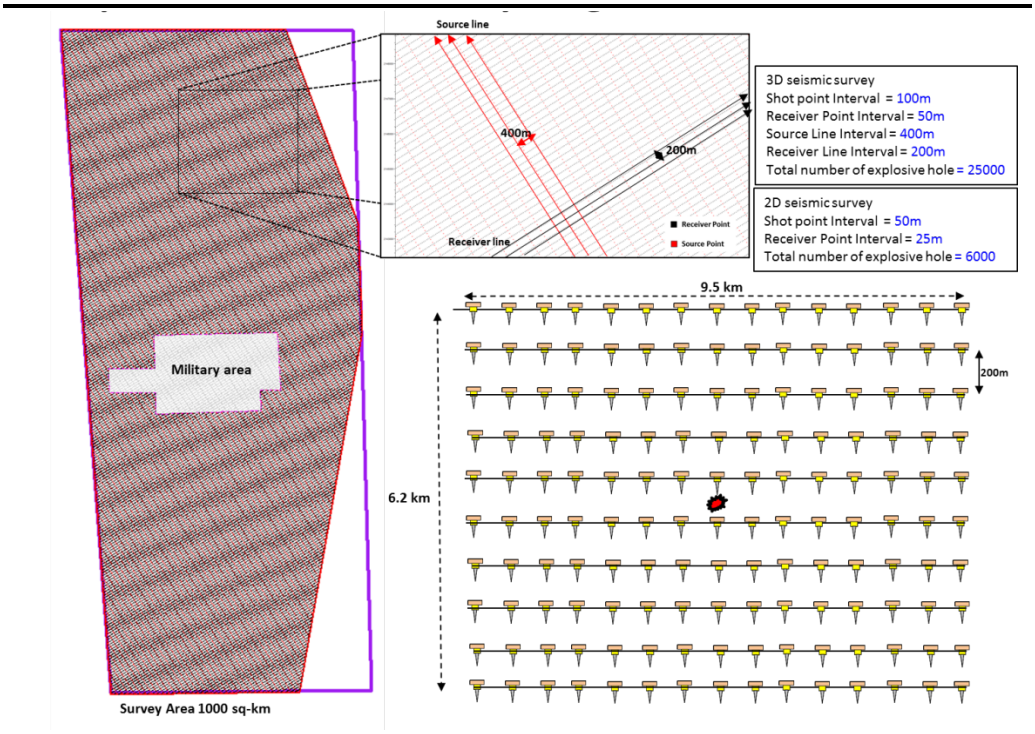
Source: PTTEP SA, 2014

Table 4.5 Seismic Survey Specifications

Parameter	2D Survey	3D Survey
Total Source Line Length (km)	300	2,500
Total Receiver Line Length (km)	-	5,000
Receiver Type	8 km marsh geophone rammed or flushed below the surface where possible or solidly coupled to terrain.	8 km marsh geophone rammed or flushed below the surface where possible or solidly coupled to terrain.
Number Of Channel/Group	640 (320 each side for split spread)	640 (320 each side for split spread)
Shot Point Interval	50 m	100 m
Receiver Point Interval	25 m	50 m
Source Line Interval	N/A	400 m
Receiver Line Interval	N/A	200 m
Minimum Offset	25m	447m
Maximum Offset	6000m	4750m
Record Length	6s	6s
Uphole Survey	N/A	Approximately 50 locations
Source Types	Explosive and Vibroseis	Explosive and Vibroseis

Parameter	2D Survey	3D Survey
Explosives - Shooting Method	Single source centred between receivers (Split Spread)	Single source centred between receivers (Split Spread)
Explosives - Charge And Depth	1-3Kg @ 10 m-30 m (subject to the field test)	1-3Kg @ 10 m-30 m (subject to the field test)
Total Number of Shot Holes	6,000	25,000
Seismic Vibrator - Number of Vibrators	4 units + 1 spare unit	
Seismic Vibrator - Sweep Length	Varies depending on parameter test	
Seismic Vibrator – Peak Force	282 kN	
Seismic Vibrator – Mass Weight	4,600 kg	

Figure 4.11 Overview of Seismic Survey



Source: PTTEP SA, 2014

4.4.2.2 *Vibration Sources*

The 2D and 3D seismic survey for this Project will be primarily carried out using 1 to 3 kg/shot point explosives (80 – 85%), while Vibroseis (seismic vibrator) will be used as required for approximately 15-20% of the survey. The method of generating ground vibration will differ across the Project area based on terrain, accessibility and other obstacles.

When using explosive charges for seismic surveys, explosive sources are placed in shot holes drilled to below the zone of near-surface weathering or unconsolidated sediments – usually from five meters to thirty meters deep.

Burying the source beneath this low-velocity layer increases the energy transmitted deeper into the ground and reduces the amount of energy that goes into creating undesirable by-products: source-generated signal in the form of seismic waves. The procedure for drilling of shot holes is explained in ***Section 4.4.2.3***.

When using seismic vibrator (Vibroseis), a large pad is lowered from the vehicle to the surface and then vibrated to generate seismic waves. During operations, the piston and baseplate assembly can be moved up and down at specific frequencies, transmitting energy through the baseplate and into the ground. Seismic vibrators propagate energy signals into the earth over an extended period of time as opposed to the near instantaneous energy provided by impulsive sources (*Bagaini et al, 2010*)[4]. The processes and techniques for recording and interpretation of data received from seismic vibrators are similar or identical to that of explosive sources. Vibrator trucks will require a clearance path of approximately 5 meters on either side of the line (10 meters total). They can be equipped with special tires or tracks for deployment in environmentally sensitive areas. In an urban environment, Vibroseis-generated waves are less than background noise generated by buses, trucks, and trains. For this reason, repeated signals are used in order to be distinguishable from background noise.

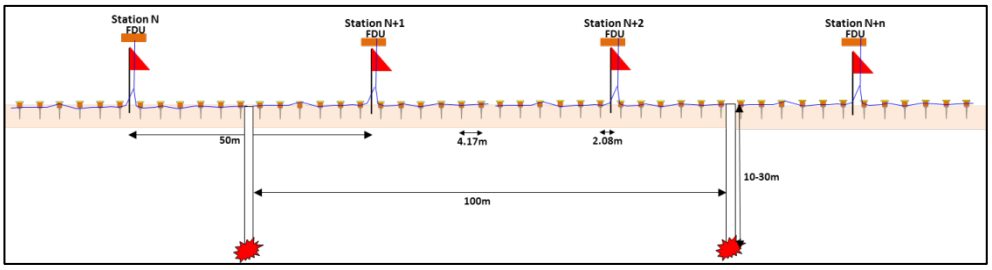
4.4.2.3 Shot Hole Drilling

After initial site reconnaissance has been completed, the Drilling Team will proceed to drill according to the chosen positions and magnitude. Shot points will be 100 m apart for 3D lines, and 50 m apart for 2D lines, and will be drilled to a depth of 10 to 30 m. The plotted holes will be marked by colored flags. An example of the shot and receiver configuration is shown in ***Figure 4.12.***

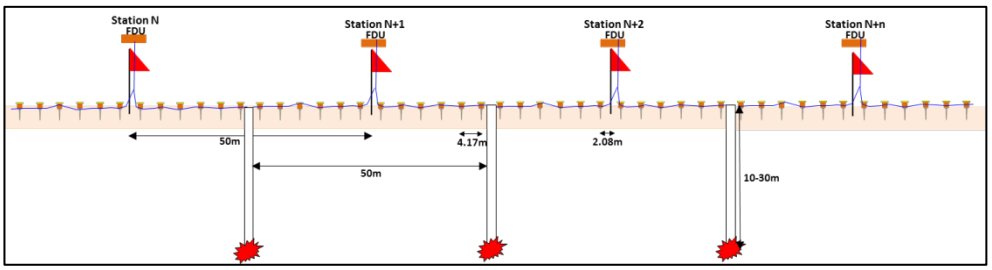
After consideration of geological features and target depth of reservoirs, a single-hole pattern is designed to be drilled by tractor-mounted drills. The hole dimension is to be a maximum of 30 m deep, with a diameter of 3 inches (or 7.62 cm). ***Figure 4.13*** illustrates an example of shot hole drilling.

[4] Bagaini, C., Bunting, T., El-Emam, A., Strobbia, A.L.C., "Land Seismic Techniques for High-Quality Data", Oilfield Review, Summer 2010:22, no. 2.

Figure 4.12 Shot and Receiver Configuration



3D Receiver and Source Layout



2D Receiver and Source Layout

Figure 4.13 Example of Shot Hole Drilling

Source: PTTEP SA, 2014

4.4.2.4 *Receivers/Geophones*

The receiver/geophone line will be aligned with shot holes. Receiving points for each receiver/geophone line will be located about 50 to 100 m apart. A geophone group consists of two strings of cables, with six geophones each. The cable acts as a receiver of signals to be relayed to the receiving point. The tips of geophones are made of brass, and can be pinned into the ground. An example of receiver deployment is shown in ***Figure 4.14***.

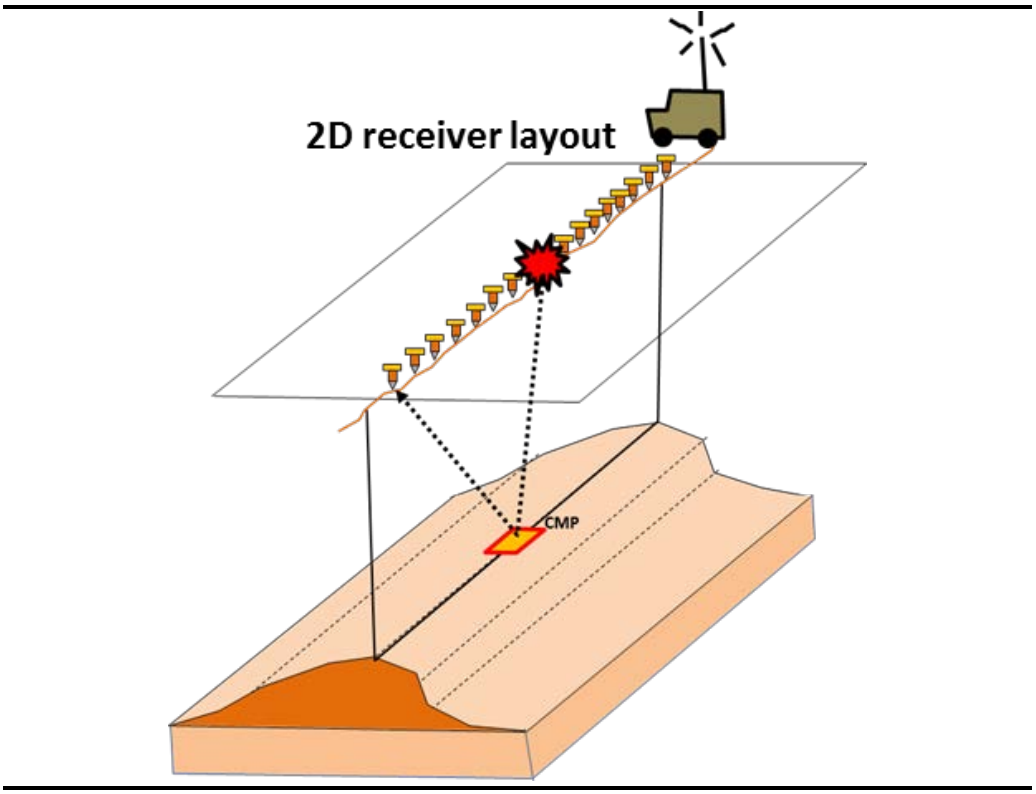
PTTEP SA will ensure that, to the extent possible, trees will not be cut down during the survey. In the case where cutting trees cannot be avoided, permission and approval of such actions will be obtained from relevant authorities and stakeholders.

Examples of 2D and 3D Seismic Survey Layouts are shown in ***Figure 4.15*** and ***Figure 4.16***, respectively.

Figure 4.14 Examples of Receiver Deployment

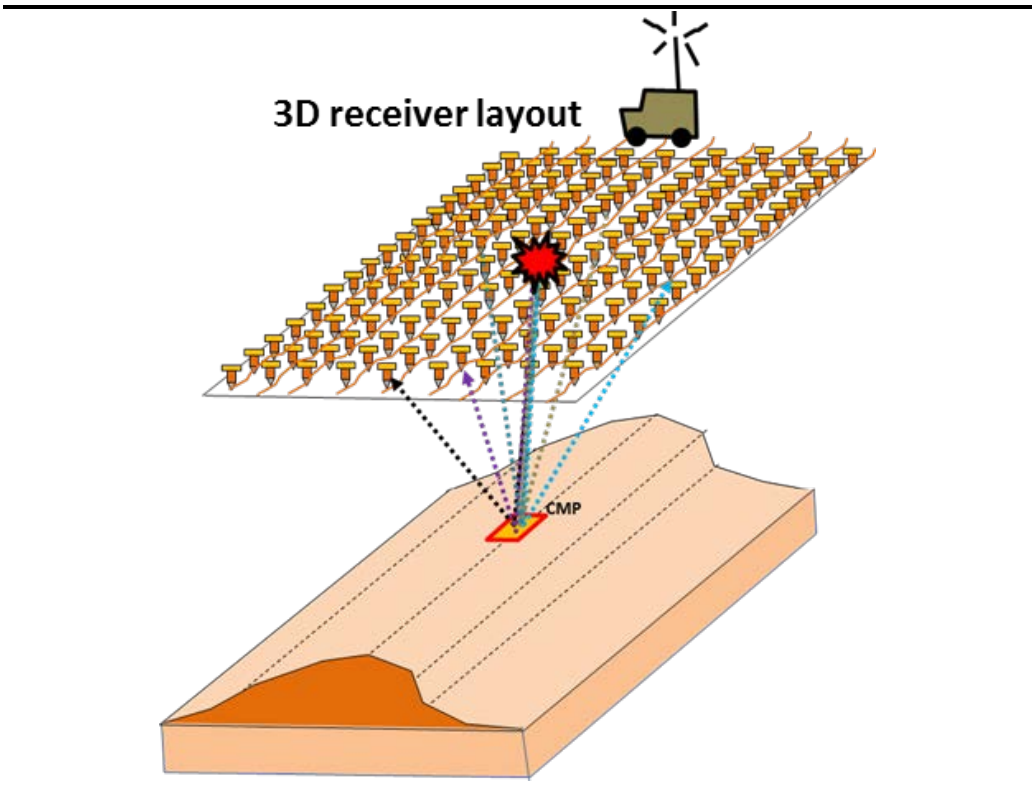
Source: PTTEP SA, 2015

Figure 4.15 2D Seismic Layout



Source: PTTEP SA, 2014

Figure 4.16 3D Seismic Layout



Source: PTTEP SA, 2014

4.4.2.5 *Vibration Source Equipment (Explosives, Detonators and Seismic Vibrator)*

4.4.2.5(1) *Explosives*

For the Project, PTTEP SA expects to use Orica Powergel Seismic Seismic Explosives, or equivalent. The explosives are an ammonium nitrate emulsion-type explosive, and the specifications are shown in ***Table 4.6***. They consist mainly of ammonium nitrate, which is the same substance typically used in fertilizers. Explosive powder is grey, odorless, and not a self-ignited substance. Explosives will be packed in a form of Water-in-Oil Emulsion Explosive, wrapped by plastic sheet and contained in a shockproof paper box. There will be approximately 31,000 holes in total for the entire survey, requiring a total of approximately 150 tons of explosives. Extra explosives are required in the case of miss-shots, which are expected to occur for around 10% of all shots, based on previous experience. For the import of explosives, detonators and ancillary equipment related to the seismic survey, PTTEP SA shall obtain permission from the Ministry of Interior.

Table 4.6 Specifications of Orica Powergel Emulsion Explosive

Density, g/ml	VOD, m/s (approx)	Explosion energy, MJ/kg	Hydrostatic head	Shelf life	Dimension, mm	Initiation/sensitivity
1.20+/-.05 gm/cc	5,000	3.00	60 m	> 12 months	63 x 200 for 0.5 kg canister	Standard seismic detonator

4.4.2.5(2) *Detonator*

PTTEP SA expects to use Orica Seismic Detonator Osd, or equivalent. The total detonator length to be loaded will be about 21 m per shot hole, and it is expected that approximately 31,000 detonators will be required for the seismic survey. 30 m long electrical wire will be connected to the detonator. There will also be spare detonators in case of miss-shots, which are expected for about 10% of total shots.

4.4.2.5(3) *Seismic Vibrator*

PTTEP SA will be using four KZ-28 model, IVI Minivib 15, or equivalent seismic vibrators for their operations. These vibrators are well suited for use in much of the terrain/topography to be encountered within the Project area. Four vibrator trucks, traveling in either a staggered or "Flying V" formation, will travel bumper-to-bumper (approximately 10-15 feet (3 – 5 m) apart for safety considerations), stopping to vibrate at each surveyed source point in sequence and in context with the overall source generation plan.

On existing roads and trails, the vibrator trucks will travel in an in-line, bumper to bumper formation. A vibrator scout on an ATV may be utilized to assist the vibrators in acquiring the source lines and to ensure that the vibrator trucks stay on the selected source routes. One set of four vibrators will be utilized for the Project to facilitate the recording operation.

Vibroseis trucks will travel between source points at speeds ranging between seven and ten miles per hour (mph). Each 4-wheel drive truck vibrator weighs about 31,000 kg. No additional clearing or grading of the existing roads and trails are proposed. Truck vibrators (and drills) would only be refueled at the designated staging areas and on existing roads/trails or source line/road intersections during seismic survey operations. The fuel consumption of the KX-28 is approximately 213 g/kWh per truck, which correlates to a volumetric fuel consumption of 95.53 L/hour (at 400 kW power) for each truck. ***Figure 4.17*** shows the seismic vibrators that will be used for the Project.

Figure 4.17 KZ-28 Seismic Vibrators

4.4.2.6 Shot Hole Loading

The explosives, which range from 1 to 3 kg /unit, are packed in a plastic shell with detonator and anchor. Shot holes will be prepared by a pre-loading method, where explosives will be placed at the time of drilling. After each shot hole is loaded, it will be buried with soil and marked by a flag. Shooting and recording will occur at a later stage. This method will be used for a single hole with a maximum depth of 30 m. ***Figure 4.18*** shows an example of a buried explosive shot, marked with a flag.

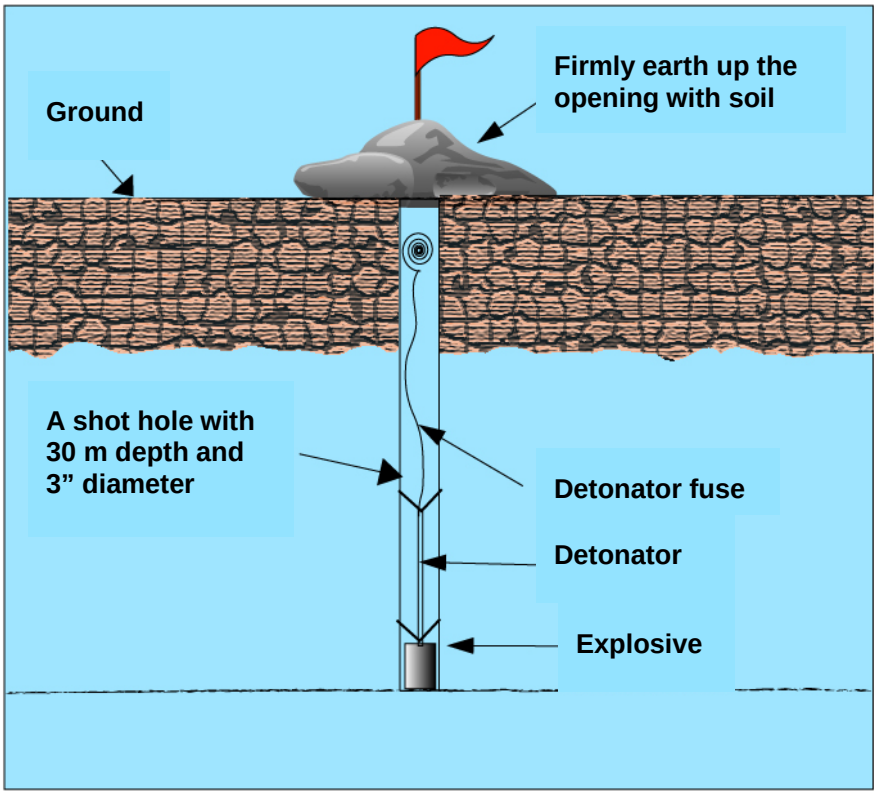
Figure 4.18 Explosive Shot with Flag

In loading the shot holes, staff must strictly follow safety regulations as follows:

- Explosives and detonators must be at least 50 m apart and will be combined when the loading operation takes place at the shot holes only;
- Once explosives, detonators, and anchors are loaded, the hole must be filled and compressed with soil or sand. Detonator wire must be connected in a short circuit and hidden in the hole at the depth of at least one foot (0.3 m) to prevent stealing or removal;
- Once loading is completed, the hole must be buried with soil and marked by a red flag; and
- At this stage, the Permitting Team will check the prepared documents. If documents are missing, additional documents will be drafted. All documents will be sent to the office to record cost of value as well as name and address of people that will be awarded compensation.

Explosives will be buried as shown in ***Figure 4.19***.

Figure 4.19 One Hole/Single Hole Pattern



Source: PTTEP SA, 2013

4.4.2.7 *Source Generation and Recording*

Recording of seismic vibrations from both sources will be carried out approximately 1 week after shot-hole drilling. Once the cables and geophones have been laid out along the line, the Vibroseis truck and/or explosives will be used to send vibrations as waves into the ground which are reflected off the different layers and recorded by geophones and transmitted to the data recording truck.

The recording team will record baseline information of soil/rock structure from the vibration generated by the seismic vibrator or explosives. On-field equipment includes cables and geophones, which are connected to a field recorder. Recording equipment will be placed according to the plotted locations along the seismic lines. Shooting and/or Vibroseis impulses will be done once per spot along the seismic line, then recording will be undertaken by a field recorder. Source generation (shooting and/or Vibroseis impulses) will be conducted one by one, sequentially, and not simultaneously. An example of a recorder truck is shown in ***Figure 4.20***, and examples of field equipment are shown in ***Figure 4.21***. Recording parameters for this survey are shown in ***Table 4.7***.

Shooting will be operated by a Shooting Team of five staff; one shooting controller and four signal senders using flags on four directions. On shooting, the shooting controller will blow a whistle to warn other staff to stay in the safety zone. The controller will blow a whistle again on finishing shooting.

Shooting will be activated by radio wave from field recorder; no staff will be present in the area.

Vibroseis operation will be done by licensed heavy duty drivers/operators. All appropriate safety regulations for operation of heavy duty vehicles will be followed.

The reflected wave from shooting/vibrating will be detected by a receiver, which will relay the wave through repeater circuit and land cable before entering a recording. The obtained information will be interpreted using a computer by a geophysicist. Examples of interpreted data for 2D and 3D seismic surveys are shown in ***Figure 4.22*** and ***Figure 4.23***, respectively.

If recording fails, e.g., in the case where dust disperses up to the hole surface, a new recording must be done. Monitoring procedure of explosives and detonators during shooting and recording are shown in ***Figure 4.24*** for pattern holes.

After source generation and recording, the line recovery crew and Permitting Team will join in to:

- Fill the shooting hole and/or reclaim the line site; and
- Announce the date, time, and location of survey, together with information on compensation, to community headman and landowner according to compensation agreement.

4.4.2.7(1) Miss-Shot Procedures

When shooting, a Shooter will be responsible for locating and detonating the actual shots, while an Observer will be present at a further distance to observe and record any anomalies during shooting. During the seismic program, Shooters are in constant contact with the Observers.

In case of a miss-shot, the firing line and detonators circuits (each cap of the pattern) must be checked using an approved blasting galvanometer. During this operation, the Shooter is to stay clear from the top of the shallow holes as much as possible.

The Shooter will then inform the Observer of his finding/readiness and attempt to shoot again. If the shot misfires again, the Shooter reports the fact to the Observer, disconnects, short circuits and grounds the firing line, then waits again for a safe period of a few minutes to elapse before checking the firing line and detonator circuits separately. The "good" charges must be identified and properly connected together. If the shot point remains within the contractual specifications, then the Shooter is to go through the normal firing sequence. The Observer must log in the observer report the abnormal pattern that will result in a reduced energy shot. The Shooter would ensure afterwards, as normal practice that all the good charges for this particular pattern have exploded.

For "faulty" charge(s), detonator's leads are to be cut under the soil surface (10 to 20 cm deep), short circuited and the hole is to be left covered with earth. Pulling on the wire is prohibited. The hole is then to be abandoned, i.e. the charge(s) left in the ground for self-destruction. The Observer is to precisely record in a logbook the details of charge(s) left (Shot Point Number, hole position).

In case of several bad charges in a shot point pattern, the Observer will order detonation/destruction for the good charges (no record), after which he must proceed as above for the bad charges. Relevant details of the operation are to be logged in the Observer daily report.

Figure 4.20 Example of a Recorder Truck

Source: PTTEP SA, 2015

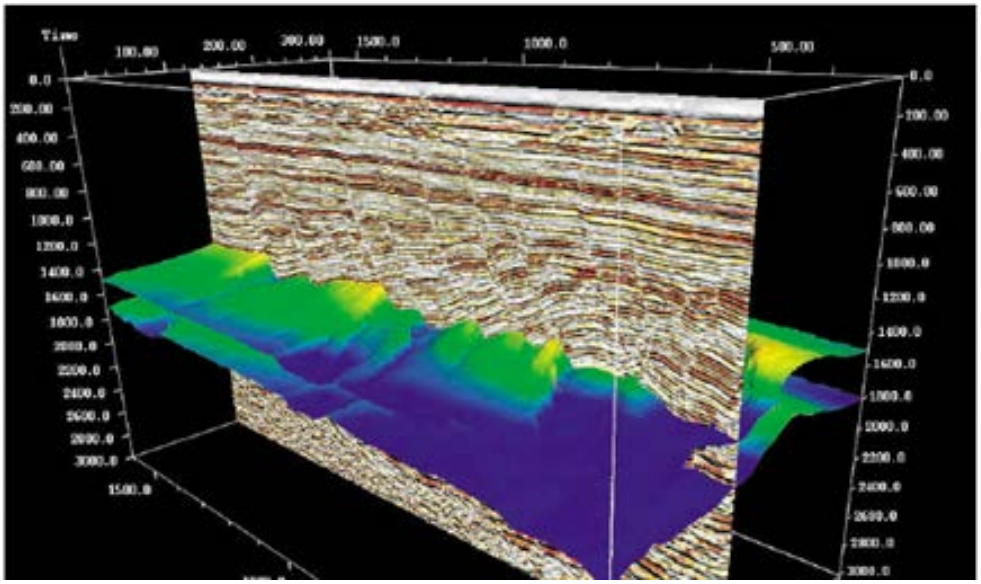
Figure 4.21 Examples of Field Equipment and Cable Wires

Source: http://www.Vibroseismic.com/page4_GT.html

Table 4.7 Recording Parameters

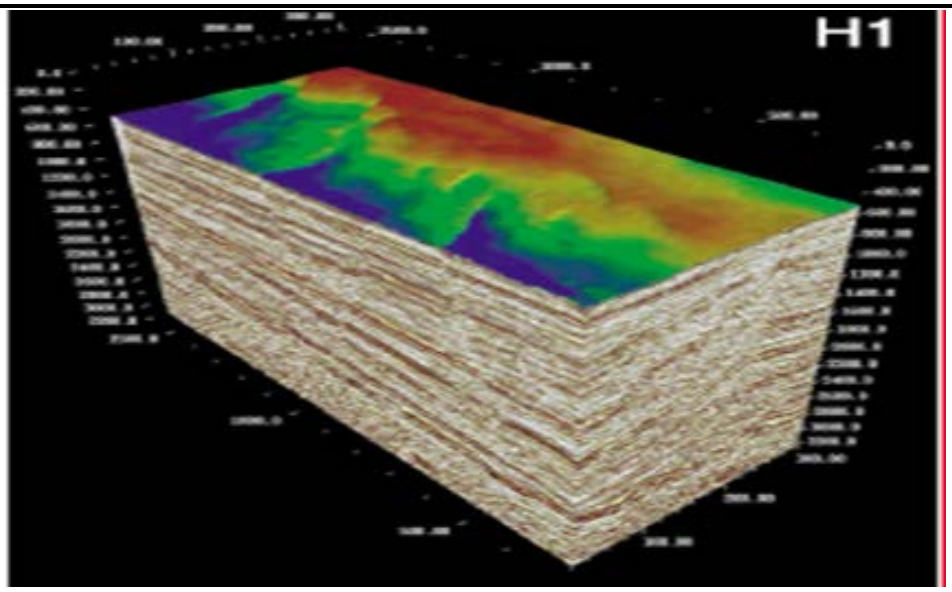
Parameter	Value
Sample Interval	2 ms
Low Cut Filter	Out
High Cut Filer	Nyquist Frequency (FIR)
Record Length	6 sec
Tape Format	IBM 3592
Data Format	SEG-D

Figure 4.22 2D Seismic Section Data



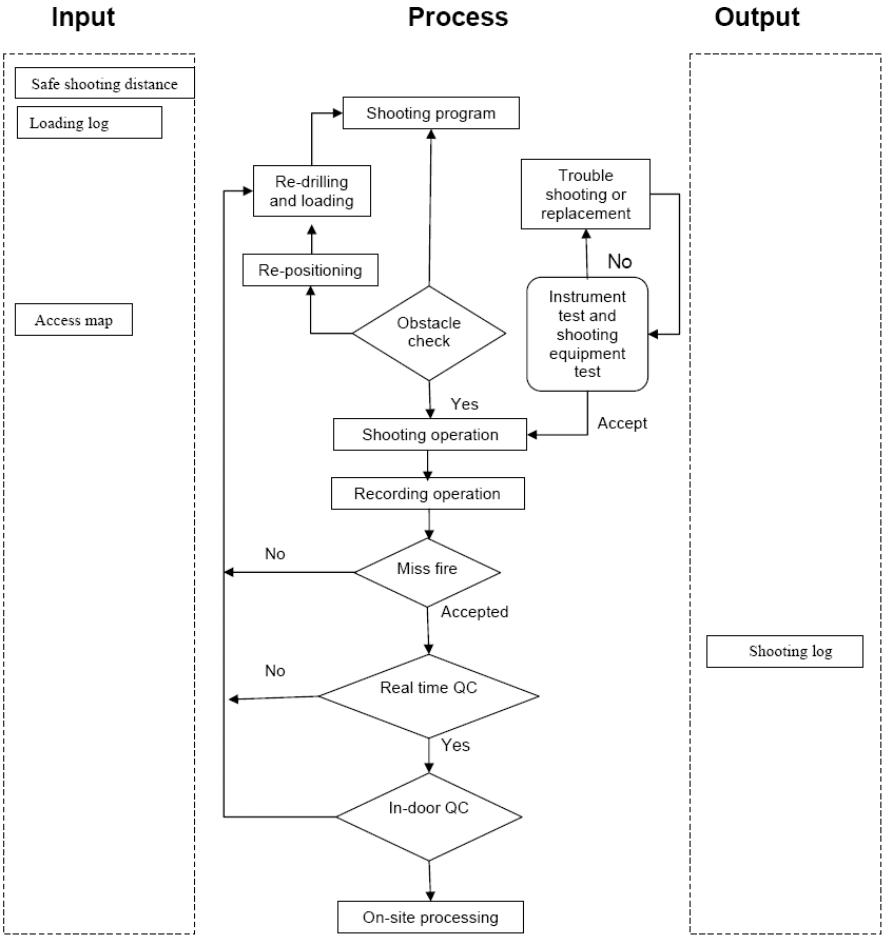
Source: PTTEP SA, 2014

Figure 4.23 3D Seismic Section Data



Source: PTTEP SA, 2014

Figure 4.24 Monitoring of Explosives and Detonators for Pattern Holes



4.4.2.8 *Compensation Procedures*

Crop Compensation

Crop compensation will be considered for the Project. Price appraisals for crop damage will be provided by respective township government departments, and will be approved by district administrator. A compensation committee will be organized, and composed of officials from MOGE, PTTEP SA and local township authorities. Damage measurement, calculation and payment will be carried out systematically.

A detailed compensation plan will be prepared after discussion with township/district/region authorities. The compensation approval process will be handled by a Compensation Committee.

PTTEP SA will seek MOGE's support to coordinate with respective ministries, departments, local authorities and affected villagers on the crop compensation for any damage caused by the seismic survey operations.

MOGE's criteria/practice for delineating crop compensation boundaries are detailed below:

- Explosive shot point = 15 feet (5 m) Radius; and
- Receiver line (geophone) = 1.5 feet (0.5 m) offset of each side (Total = 3 feet, or 1 m).

PTTEP SA employed a local company, Myanmar Marketing, Research and Development Co., Ltd. (MMRD) to conduct a Crop and Market survey for Block MOGE-3. This report is presented in ***Annex B*** of this ESHIA, and the results are summarized in ***Section 5***.

An overview of the Damage Assessment/Payment Procedure and Compensation Payment Approval Process are shown in ***Figure 4.25*** and ***Figure 4.26***, respectively. Examples of compensation forms, compensation vouchers, damage measurement procedures, crop prices, and list of compensation committee, can be found in ***Annex C.*** A photograph of measuring crop damage is shown in

Figure 4.27.

Figure 4.25 Damage Assessment and Payment Procedure

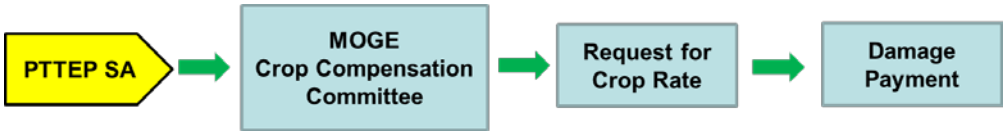


Figure 4.26 Compensation Payment Approval Process

Figure 4.27 Crop Damage Measurement

Forest Compensation

The Project is not expected to cause any damage to trees or forest during the survey. However, in case any accidental damage to trees or forest takes place due to the Project activities, PTTEP SA will compensate accordingly. The amount of compensation and specific procedures will be carried out under advice of MOGE, who will liaise directly with the Forest Department and other relevant departments and receive instructions and requirements accordingly.

4.4.2.9 Up-Hole Survey

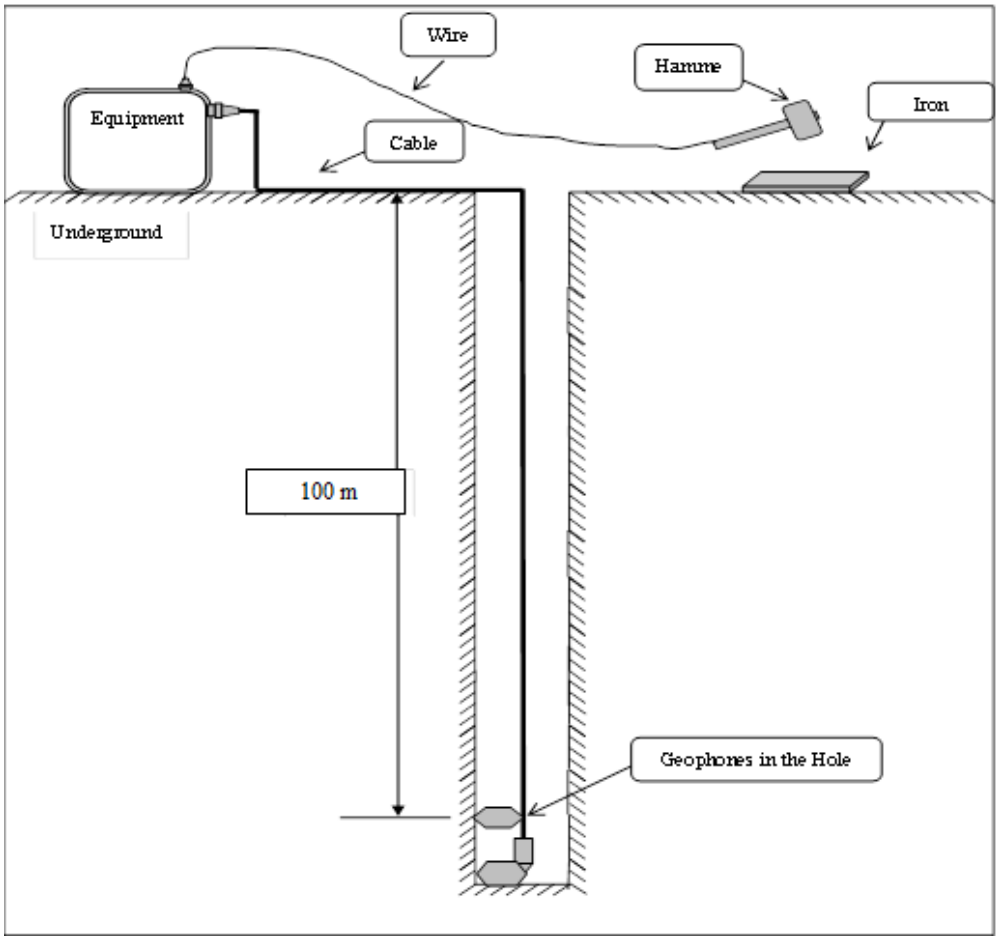
In order to produce more accurate receiver data at seismic observation points, and allow a cross-check for data processing, an up-hole survey will be carried out at approximately 50 locations, to make a series of depth vs. time observations between the surface and approximately 100 m. An additional objective of the up-hole survey is to determine dominant velocities and transition depths to confirm that the shot drilling program depths are below the base of the low velocity weathered layer.

The up-hole survey consists of drilling holes, placing geophones down the holes, and then initiating a surface source by using a heavy hammer striking a thick metal plate laid at the surface, 1 m from the hole. This is a more cost-effective and safer method to using down-hole explosive sources with surface geophone. This process is illustrated in ***Figure 4.28***.

The logging tool is a down-hole geophone assembly on a calibrated wire rope, as shown in ***Figure 4.29***. This tool has been shown to produce good data based on previous surveys by PTTEP SA.

The up-hole survey will be carried out simultaneously with the seismic survey, but with an independent crew, and far from the seismic survey locations to avoid the seismic noise interference.

Figure 4.28 Up-Hole Survey Procedure



Source: PTTEP SA, 2015

Figure 4.29 Down-Hole Geophone Tool

Source: PTTEP SA, 2015

4.4.3 *Abandonment and Site Restoration Phase*

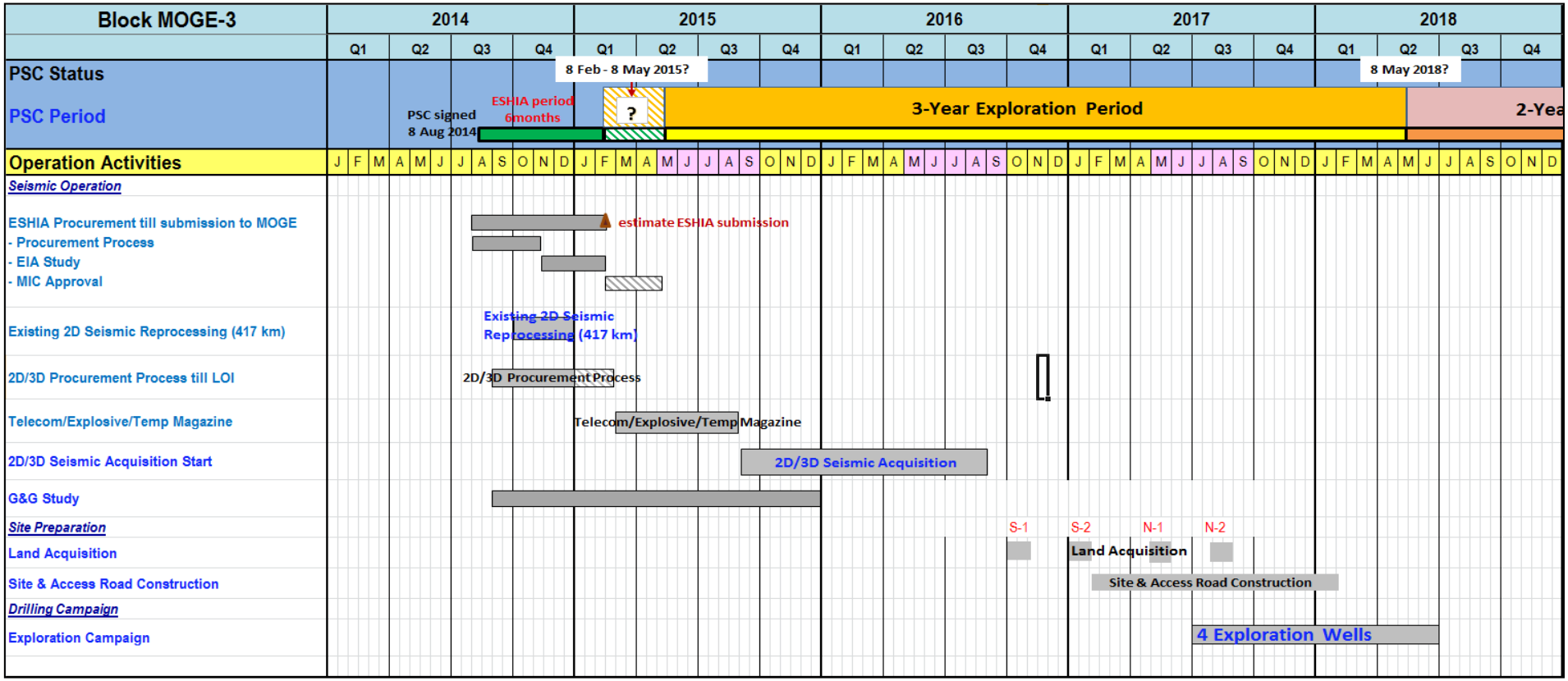
Once the survey and recording are finished, equipment will be removed and personnel will leave the site. The site will also be restored into its original state by burying all holes, as well as collecting all wastes and materials and transporting out of the site. It is expected to take approximately one month to complete the site restoration, including recording public complaints, if any.

Seismic survey activities, including abandonment, will be controlled by the Project quality plan (land acquisition) and Project SSHE plan. All staff must follow such standards in carrying out all activities throughout the Project period. This is to ensure that the survey meets its objectives and the survey quality meets the Project owner's demand, which also take into consideration environmental issues and health and safety risks to staff and community.

4.5 *PROJECT SCHEDULE*

Seismic Survey activities are tentatively expected to begin in September or October 2015, subject to final work program and schedule. Seismic acquisition will be completed within 9 months after first shot record. The full project schedule is shown in ***Figure 4.30***.

Figure 4.30 Tentative Project Schedule for Seismic Survey



4.6 EMPLOYMENT AND ACCOMMODATION

During seismic operations, a maximum number of 1,000 field staff will be required, as shown in ***Table 4.8***. Local staff will be preferentially hired where possible. Seismic survey staff will be accommodated at either the Base Camp, or in Field Camps, as described below.

Table 4.8 Estimated Work Force

Position	No. Positions
Special Services	68
Topographic Surveying	120
Line Clearing	20
Drilling	350
Recording	400
Security and Police	40
Other	2
Total	**1,000**

4.6.1 *Base Camp*

A base camp for the Project will be located in an existing building at Thayet Township in Magway Region in Central Myanmar. There will be approximately 60 staff located at the base camp, including geophysicists, party chiefs, permitting crew, Quality Control (QC) and supervisory staff, camp boss and client representatives, etc. Analysis and interpretation of the field data will be done in the base camp to obtain the most complete and precise data. An example of the base camp is shown in ***Figure 4.31***. The base camp will be connected to the local public utilities, and will adhere to the appropriate waste management and wastewater management measures as required by Myanmar law, PTTEP SA and as specified in the Environmental Management Plan (EMP) of this report.

Figure 4.31 Base Camp

4.6.2 *Field Camps ("Fly Camps")*

Temporary field camps (or "fly camps") will be set up to accommodate staff working in the field in remote areas located far from the base camp. The field camps will generally consist of temporary, tented facilities, and will be disassembled after the Project moves onward, typically within 1-2 weeks per camp. The maximum number of people at a single field camp will vary depending on the Project requirements, but will generally vary between 10 – 50 people.

Facilities at the field camps will vary depending on requirements, but may include latrine and shower blocks, kitchen, storeroom, technical workshop, mechanical workshop, fuel facilities, offices and tented accommodation for both senior and junior staff. They will be complemented by a fleet of vehicles. A maximum of approximately 1,000 people for the seismic crew are expected to work in the field throughout the duration of the Project. Private toilets will be utilized where possible, and all field camps will adhere to the appropriate waste management and wastewater management measures as required by Myanmar law, PTTEP SA, and as specified in the Environmental Management Plan (EMP) of this report.

4.7 *LOGISTICS AND UTILITIES*

4.7.1 *Logistics for Base Camp/Field Camps*

Services of a logistic and labour contractor will be hired to provide fuel supply, catering and transportation services to the base camp and field camps, and all aspects of SSHE Management will be observed by their personnel.

PTTEP SA will implement a security policy designed to minimize loss of life and property. The accommodating camp will be illuminated with security

lights. A fence will be also installed to prevent intrusions and ensure that all visitors will be screened. Security guards will be scheduled to guard the field office for 24 hours a day and the field working area from 06:00 to 18:00. The security plan will be developed prior to the field operation.

PTTEP SA will establish cordial relationship with local security officials and military security as an integrated part of the preparation of any seismic activity.

Guidelines for base and field camps will be drafted and posted in front of each applicable area to ensure that all personnel are aware of these guidelines. There will be frequent checks to ensure that standards are maintained. These guidelines will cover hygiene, sanitation, rubbish disposal, accommodation and food preparation by case of base and secondary camps. Also, the guidelines will be expanded to include electrical and mechanical safety, etc.

A summary of contractor responsibilities is as follows:

- Base Camp: the Seismic Contractor will provide, maintain and operate the Base Camp. The Base Camp shall include accommodation and messing, a medical centre, offices, warehouse space, and all other fittings and fixtures required to support the seismic Project. The Base Camp shall include accommodation and office facilities for PTTEP SA Field Representatives and other Contractors assigned to the Project. On completion of the seismic Project, the Seismic Contractor shall be responsible for closing the Base Camp facilities and restoring the location as near as possible to its condition prior to the seismic Project.
- Field Camps ("Fly Camps"): Seismic Contractor will provide, maintain and operate at its sole cost any Field Camps required to minimize travel time for field personnel to the site of the Project. When required, these Field Camps shall include facilities for PTTEP SA personnel and other PTTEP SA Contractors. On completion of the Project, Seismic Contractor shall be responsible for closing the Field Camp facilities and restoring the locations as near as possible to their condition prior to the Project.
- Regional Support: MOGE is supporting PTTEP SA to communicate with various other Governmental organizations. The Magway Government will support PTTEP SA for the compensation work.

4.7.2 *Transportation*

Approximately 112 vehicles in total will be required for this project, which include pick-up trucks, four-wheel-drive vehicles, personnel trucks, water truck, fuel truck, fuel storage facility, ambulance and explosive truck.

Equipment, materials and personnel will be transported in light four-wheel drive and pick-up trucks. If vehicular access is not possible, equipment and materials will be transported by foot. All personnel transportation will be

equipped with safety equipment such as safety belt for every seat. The vehicles required for the seismic survey are presented in ***Table 4.9***.

Three main tarred roads will be used for transportation during the Project: Thayet to Minhla (108 km), Thayet to Mindon (68 km) and Thayet to Kanma (45 km). Village to village tracts are also available for transportation in some locations.

Table 4.9 Vehicles Required for Seismic Survey

Type of Vehicle	Purpose	Number of Units
4 WD pick up cars	Client/Key personal transportation	20
4WD station wagon	Senior/Key personal transportation	16
Personnel trucks	Worker transportation support	38
Water trucks	Logistics support	20
Fuel truck	Logistics support	4
Fuel storage facility	Logistics support	4
Ambulance	SHE support	2
Explosive truck	Explosive transportation	8
Total		**112**

4.7.3 Explosives Management

All explosives management will be carried out by the Seismic Contractor (Sinopec) only. The Seismic Contractor shall conduct all activities in compliance with PTTEP's SSHE Policy (***Annex A***).

All explosives will be imported, transported, and stored according to the instructions from MOGE, which can be found in ***Annex D***, and will comply with all relevant laws and regulations. A summary of the explosive management requirements are presented below.

4.7.3.1 Explosives Importing and Permitting

The import of explosives and detonators requires appropriate documents and permission. The import, possessing, utilizing, and transporting licenses are to be provided by the Seismic Contractor under PTTEP SA authorization, upon award of Seismic Contract.

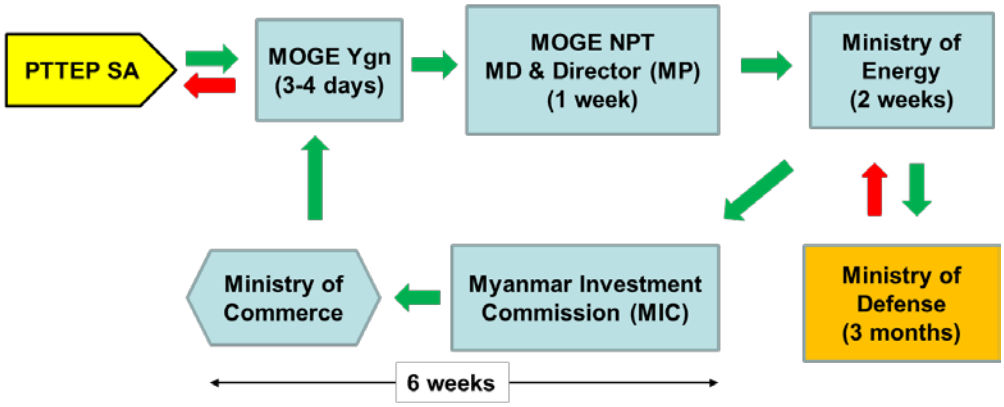
Prior to importing explosives to Myanmar, the site and mobile magazine containers must be inspected and approved by Explosives Magazine Site Selection Committee, chaired by representative of the Directorate of Ammunition Department, Defense Ministry.

When importing explosives to Myanmar, an appropriate Import Permit should be obtained from the Ministry of Energy in advance, stating the port of shipment, estimated date of import, and amount and description of explosives. In addition, a letter shall be sent to the Managing Director of

MOGE, noting the shipment and arrival details, so that MOGE can arrange customs clearance and security arrangements.

When transporting explosives from port to the portable magazine, MOGE will provide transportation and personnel, at appropriate rates to be charged to PTTEP SA. The permitting process for explosives import is shown in ***Figure 4.32***.

Figure 4.32 Explosives Import Permitting Process



4.7.3.2 *Explosives Storage*

Four temporary storage magazines will be used for storage of explosives for the Project. The first is located in Aunglan military compound, while another one is located in Taundwingyi military compound (2 hours driving distance from Aunglan), with 20 tons capacity each. PTTEP SA also plans to construct at least two (2) additional new magazines in Block MOGE-3.

Temporary storage of explosives will be located at a safe location determined by the Ministry of Defense. An example of a storage site is shown in ***Figure 4.33***, and layout of temporary explosive storage is shown in ***Figure 4.34*** and ***Figure 4.35***. The storage will be within 10 km of the field office. The storage location will not be located within a 1 km radius of any abode or residence. Site location criteria and other safety features include:

- No visual obstruction present;
- Permission from local police and 24-hour security guard for three shifts, eight hours per shift;
- The storage site shall have a lightning rod, spot lights, electrical generator, fire extinguisher, mobile telephone, and security booth outside the fence;
- Wooden containers with ground wires and air flow system; and
- Record of visitors who must exchange ID card at security guard point prior to entering the storage facility.

An explosive checking team will be assembled, consisting of officials from directorate of Ammunition Department (chairman), Defense Ministry, senior army officers from regiment in township, and senior officers from MOGE. They will be responsible for choosing the locations, design the building of temporary magazine, as well as checking the final building.

All explosives will be guarded according to military regulations. Appropriate reporting and documentation will be required for inventory and withdrawal of explosives. All explosives storage will adhere to the instructions from MOGE, which can be found in ***Annex D***. The optimum distances to be maintained from magazine site are shown in ***Figure 4.36***.

Figure 4.33 Example of Temporary Magazine

Figure 4.34 Design of Main Magazine at Aunglan Township

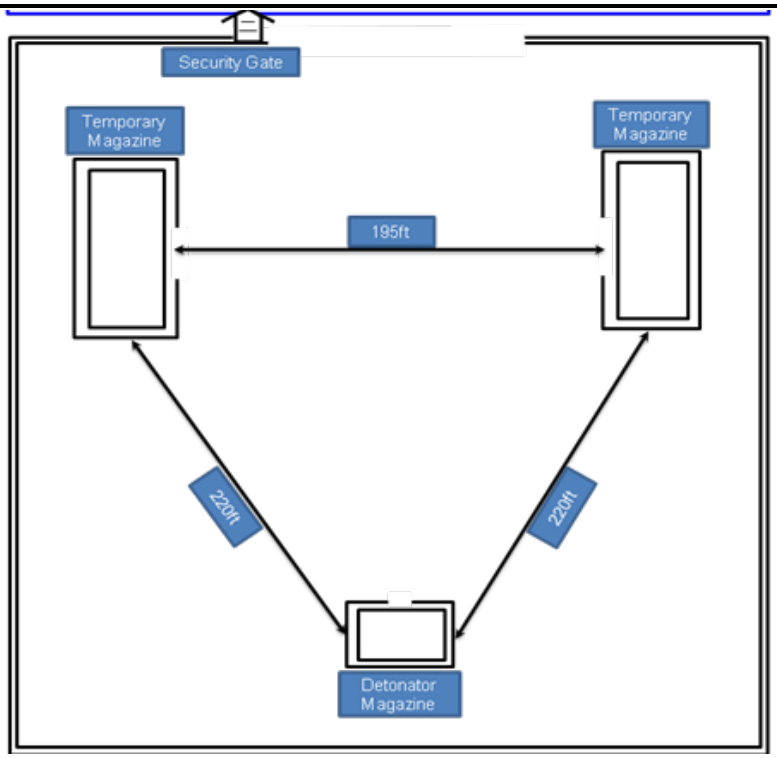


Figure 4.35 Design of Main Magazine at Taungdwingyi Township

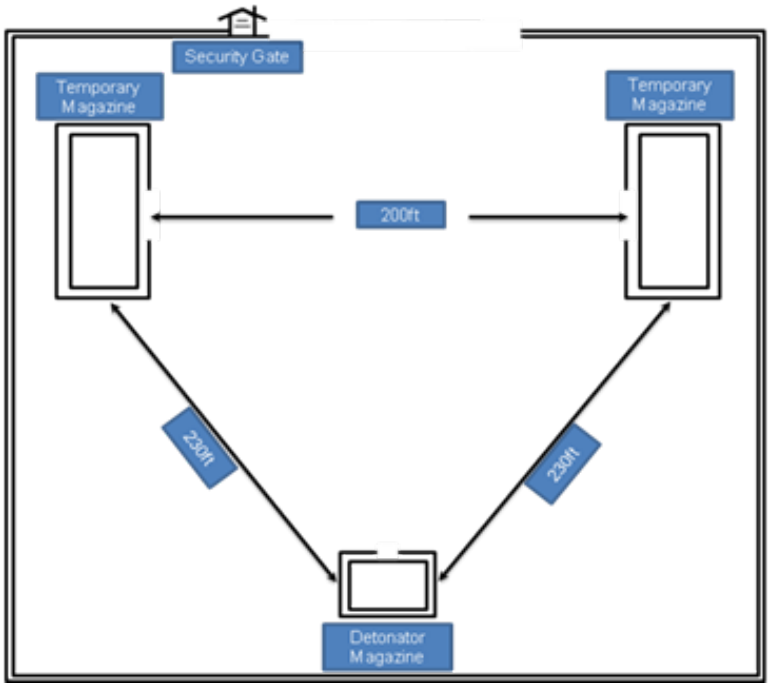


Figure 4.36 Optimum Distances from Magazine Site

Sr. No	Stock for storage (tons)	Distance between two Magazines	Distance between Magazine & Resident offices (in feet)	Public roads and navigable rivers distance (in feet)
1	1	115.	460	230
2	2	145	705	355
3	3	165	880	440
4	4	180	1020	510
5	5	195	1130	565
6	10	245	1490	745
7	20	305	1905	955

4.7.3.3 *Explosives Transport*

Explosives will be transported by explosive trucks provided by the Seismic Contractor, and transportation from the main military explosive storage location to the temporary magazines will be via firm security route planned by Chief Commander Office.

Explosive transportation in the survey area will be carried out by explosive-transportation registered vehicles, which are required to install safety equipment, such as siren, handheld fire extinguisher, and will adhere to a speed limit of 50 km/hour. All transportation of explosives will be assisted by police escorts.

Explosives and detonator products will be transported separately in fully-enclosed, locked, fire-resistant fixed containers or compartments, which are separate from the passenger compartment. Passengers will not be permitted during explosives transport. Vehicles transporting explosives will operate in a safe manner consistent with prevailing road and weather conditions. In no case will a vehicle transporting explosives be operated at a speed in excess of 50 km/hour. Vehicles transporting explosives will not be operated at greater than 80% of the manufacturer's rated carrying capacity. Example photographs of explosives transportation and storage can be seen in ***Figure 4.37***. Police cars will escort the shipment, and will be the first and the last car of the explosive transportation convoy.

Withdrawal of explosives from the main magazines will be report to be used exactly as expected to be used. District officers and military officers will check the amount and correctness of explosives withdrawal. They will sign documents as evidence for each withdrawal. They will also sign inventory documents to confirm the total amount used and the remaining for the inventory report. Every day a contractor convoy will bring the explosives from the field storage to the line. The collection of the remaining explosives will start at 3 pm to ensure that vehicles transporting explosives return before dark. At the work site, explosives and detonators will be contained in secured day-boxes until used or returned to storage magazines.

All explosives transport will adhere to the instructions from MOGE, which can be found in ***Annex D***.

Figure 4.37 Examples of Explosive Transport and Storage

4.7.4 *Water Use*

Domestic water will be trucked to the survey area on a daily basis by a local contractor, who will obtain the supplies on a commercial basis from local municipal facilities. In remote locations, field camps may use local groundwater or surface water sources. Water supply requirements are estimated to be a maximum of approximately 100 m^3/day for all 1,000 workers on the Project (100 L/person/day).

Domestic water is used for personal washing and cleaning needs of the staff on site. All drinking (potable) water will be sourced from local retail suppliers. The demand from the operation will have a beneficial impact on the local sales of bottled drinking water.

4.7.5 *Fuel Use*

During seismic operations, electricity will be supplied from diesel-fuelled generators. A list of all generators required for the Project is shown in ***Table 4.10***. In total, generators for the Project are expected to consume approximately 2,232 L of fuel per day.

Table 4.10 Generators for the Project

Generator (Gasoline)	Estimated Full-Load Fuel Consumption (L/unit/hour)	QTY	Fuel Use (L/day)
Yamaha 1KW	1 L/hr[1]	40	960
Yamaha 5KW	3 L/hr[1]	8	576
Honda 20KW	6 L/hr[2,3]	3	432
Honda 30KW	11 L/hr[2,3]	1	264
Total			**2,232**

Source:
[1] - http://powerequipment.honda.com
[2] - http://www.dieselserviceandsupply.com
[3] - http://www.perfectfuel.ca

In addition, diesel will be required to operate Project equipment and vehicles, as follows:

- 112 vehicles - General-use vehicles, assuming they are Class 2A (2,722 – 3,856 kg, light duty trucks) will consume an average of 5.95 L/km of diesel (U.S. Department of Energy, 2010[5]). Assuming an approximate distance travelled of 80 km/day, and 112 vehicles, the general-use vehicles for the Project will consume approximately 53,312 L/day.
- Generators - 2,232 L/day diesel (as above).

[5] http://cta.ornl.gov/data/chapter4.shtml

- 50 flushing drillers - Flushing drillers are expected to consume about 20 L/day of diesel each, with 50 drillers totalling 1,000 L/day.
- 4 KZ-28 Seismic Vibrators - The seismic vibrator (Vibroseis) trucks consume approximately 95.53 L/hour of diesel (at 400 kW power) for each truck, corresponding to a worst case of 4,585 L/day, assuming operation of 4 trucks for 12 hours per day.

Based on the above, it is anticipated that a total of 61,129 L/day of diesel will be required for the Project.

4.8 WASTE MANAGEMENT

4.8.1 General Waste Disposal Procedures

In accordance with the seismic survey agreement, the Seismic Contractor will dispose of waste according to the procedures shown in ***Table 4.11***, and will adhere to the following:

- Waste shall be well segregated into categories of hazardous waste, non-hazardous waste and recycled waste. Hazardous waste shall be disposed of as per regulatory requirements.
- All waste disposal must comply with the local environmental requirements. All litter will be picked up along the seismic line. Litter will be disposed of properly in designated areas.
- Seismic Contractor will manage its own waste generated day to day (will consult with local municipality or local districts).
- Medical waste disposal will abide by local government rules and crew medical staff instructions.

4.8.2 Solid Waste

All rubbish will be stored in the survey vehicles for proper disposal. Solid waste generation, estimated at 1 kg/day/worker, is expected to total 1,000 kg/day or about 270 tonnes over the course of the seismic survey (assuming 270 days). Domestic solid waste will be disposed of daily by the Seismic Contractor, using local municipal services where available, or by burning on site and burying. Any necessary waste management fees will be paid accordingly. No waste will be left in the field. Moreover, there will be a clean-up crew at the site to move equipment out of the site on a daily basis.

Any medical waste generated in a secondary camp will be brought to base camp a minimum of once per fortnight for correct disposal. All wastes will be stored appropriately while awaiting disposal.

Cleaning and restoration of the field camps will be carried out during and immediately after each phase of the survey, and will be the responsibility of each team in their respective area of operation. A clean-up crew ("Green Team") will ensure that the site is properly and adequately restored after the

survey operation is completed. The following measures will be taken in this regard:

- All restoration work will be conducted as per contract requirements;
- All survey markers and refuse will be removed;
- Erosion control measures will be taken where needed;
- Camp site will be cleaned so that no refuse or wastes are left behind; the waste will be properly disposed of;
- All ditches and sumps will be backfilled; an extra cap may be added at the top to account for compaction;
- Contaminated soil will be removed and properly disposed of, by burning or taken for washing;
- Photographs will be taken before and after the restoration measures at the camp site and seismic lines; and
- Following restoration, sites will be inspected to ensure the recommended measures have been strictly adhered to.

Table 4.11 Waste Disposal Procedure

Waste Type	Onsite Management (Handling/Storage)		Waste Transportation		Final Disposal	
	Method	Responsible Party	Transporting Container/Vehicle	Responsible for Transport	Method	Executing Party
Non-Hazardous Waste						
General non-hazardous waste (Except recyclable and biodegradable waste)	Non-HZW bins/bags	Seismic Contractor Under PTTEP SA's Supervision	Pick-up / ox cart / truck to designated disposal facilities	Seismic Contractor Under PTTEP SA's Supervision	Local villager / authorizer's landfill site / incinerator / open-burn site. **Note: if there are no facilities above available, on-site burn pit shall be made.**	Seismic Contractor Under PTTEP SA's Supervision
Biodegradable waste (food waste)	Food waste bins/bags	Seismic Contractor Under PTTEP SA's Supervision	Local vehicles (ox-cart, pick up) to villages	Seismic Contractor Under PTTEP SA's Supervision	Livestock feeding, if there is a demand. **Note: On-site landfill/bury is not recommended in order to avoid odor and flies & rats nuisance.**	Seismic Contractor Under PTTEP SA's Supervision
Reuse/Recycle wastes (metals, plastic etc.)	Recycle Waste bins / bags / containers	Seismic Contractor Under PTTEP SA's Supervision	Pick up / ox cart / truck to villagers / recycling shops	Seismic Contractor Under PTTEP SA's Supervision	Reuse or Recycling shops **Note: All empty containers with contained chemical and hazardous substances are not reusable/recyclable wastes.**	Seismic Contractor Under PTTEP SA's Supervision
Domestic sewage	Treated on site by septic tank and infiltration (for Base Camp) Pit Latrines (for Field Camps)	Seismic Contractor Under PTTEP SA's Supervision	Vacuums truck	Seismic Contractor Under PTTEP SA's Supervision	On-site treatment and maintenance **Note: For field camps, if there are no toilet facilities available nearby, pit latrines will be installed.**	Seismic Contractor Under PTTEP SA's Supervision
Hazardous Waste						

Waste Type	Onsite Management (Handling/Storage)		Waste Transportation		Final Disposal	
	Method	Responsible Party	Transporting Container/Vehicle	Responsible for Transport	Method	Executing Party
Used oils , oil & chemical drums/containers	Store in drums	Seismic Contractor Under PTTEP SA's Supervision	Trucks/trailers with labels to Thaketa (TKT)	Seismic Contractor Under PTTEP SA's Supervision	Hand over to MOGE	Seismic Contractor Under PTTEP SA's Supervision
Used chemical sacks/bags and oil contaminated rags including other hazardous waste	Store in red metal skips	Seismic Contractor Under PTTEP SA's Supervision	Trucks/trailers with labels to Thaketa (TKT)	Seismic Contractor Under PTTEP SA's Supervision	Hand over to MOGE	Seismic Contractor Under PTTEP SA's Supervision
Used batteries/light tubes	Store in HZW bins	Seismic Contractor Under PTTEP SA's Supervision	Trucks/trailers with labels to Thaketa (TKT)	Seismic Contractor Under PTTEP SA's Supervision	Keep in cool room for further disposal	Seismic Contractor Under PTTEP SA's Supervision
Medical waste	- Medical waste bins - Boxes for used needles	Seismic Contractor Under PTTEP SA's Supervision	Doubled red bags with "Medical Waste" label.	Seismic Contractor Under PTTEP SA's Supervision	Contacted Hospital	Seismic Contractor Under PTTEP SA's Supervision

4.8.3 *Wastewater Management*

The base camp will be located in Thayet, Magway Region, and will use the water and wastewater utility system from the local municipality. If necessary, a septic tank and soak away system will be installed at the base camp as well.

In the field camps, there is no permanent wastewater management system. Workers will use toilet facilities at nearby villages, schools, or temples, if available. For field camps that are not located near any existing toilet or wastewater management facilities, temporary pit latrines will be dug for the duration of the field camp activities, and will be dug/buried after the field camp is abandoned. All field camps will adhere to the appropriate waste management and wastewater management measures as required by Myanmar law, PTTEP SA and as specified in the Environmental Management Plan (EMP) of this report.

4.8.4 *Air Emissions*

Air emissions from the Project will include combustion products from fuel use and dust generated during seismic shots and from vehicular traffic, including Vibroseis trucks, on un-surfaced roads. The air emissions generated from the seismic survey activities include the combustion of approximately 61,129 L/day of diesel, which will be required to operate 112 vehicles as shown in ***Table 4.9*** (53,312 L/day), generators as specified in ***Table 4.10*** (2,232 L/day), 50 flushing drillers (1,000 L/day), and 4 KZ-28 Seismic Vibrators (4,585 L/day). This means that a total of approximately 16,504 m^3 of diesel will be required throughout the Project period (270 working days). Estimated air pollutant, dust, and GHG emissions for the Project are calculated in detail in ***Section 6***.

4.8.5 *Noise*

Noise will be generated from project vehicles, generators, compressors and explosives used as the seismic source. Explosives used for seismic shots will be in small amounts and buried before detonation. Resulting noise will be brief and at low levels; seismic shots will only be conducted during daylight hours. Detailed calculations of noise estimations are provided in ***Section 6***.

Section 5

Description of the Surrounding Environment

5 DESCRIPTION OF THE SURROUNDING ENVIRONMENT

5.1 SETTING THE STUDY LIMITS (SCOPING)

5.1.1 Study Area

The study area refers to the area that needs to be considered in order to adequately understand and describe the baseline conditions likely to be affected by the Project. For this Project, the study area boundary is generally limited to the 2D and 3D seismic acquisition survey area within Block MOGE-3. Therefore, for this Project, 'the study area' is equivalent to 'the Project area'.

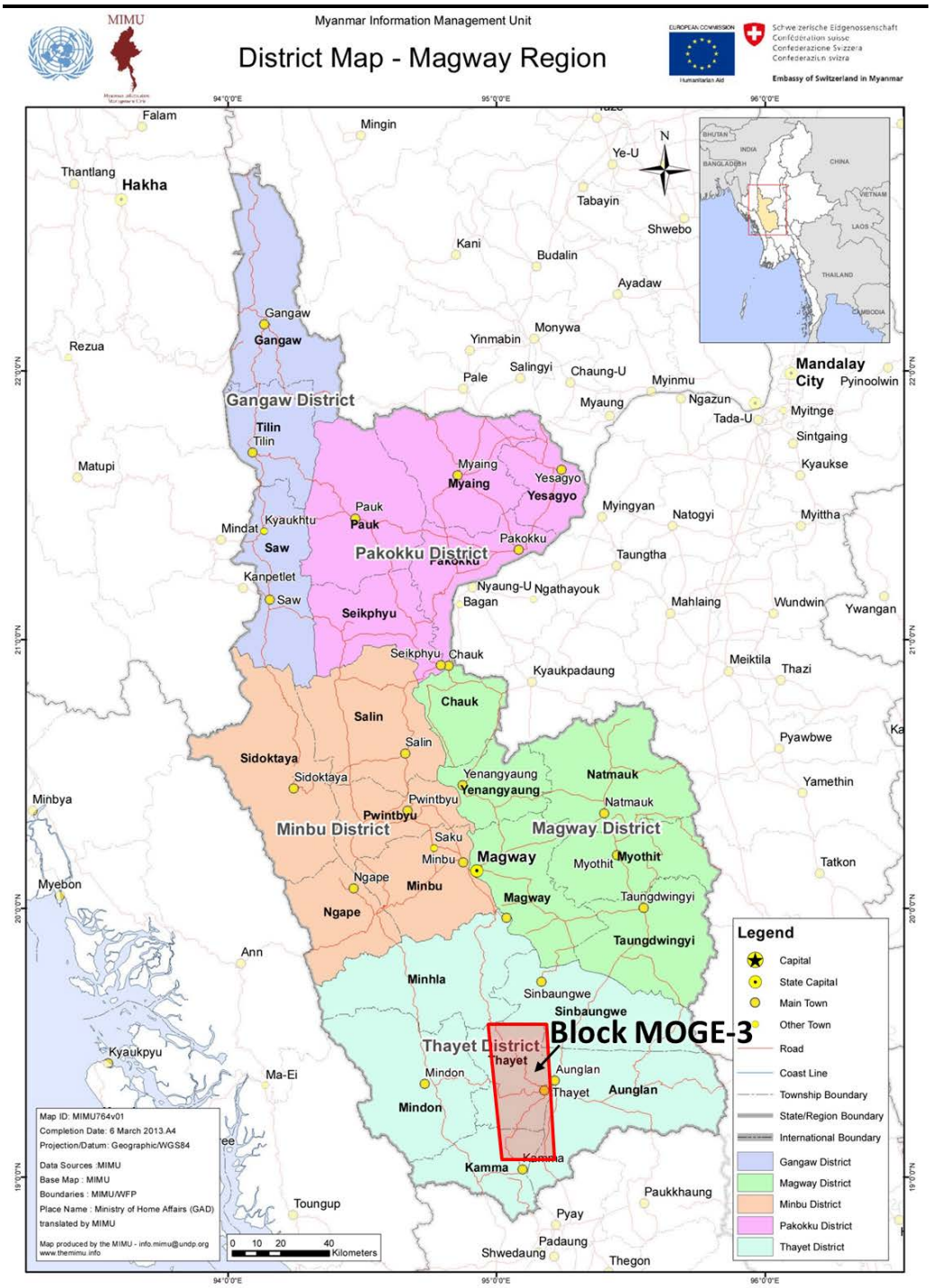
Block MOGE-3 is situated in central Myanmar, and covers an area of 1,217 km^2 (***Figure 5.1)***. The Project area covers most of Block MOGE-3, and includes most parts of Thayet Township and some parts of Kamma Township, both located in Thayet District, Magway Region of Myanmar (***Figure 5.2***).

5.1.2 Scope of Study

The environmental setting of the Project consists of physical resources, biological resources, socio-economics components in the seismic acquisition area.

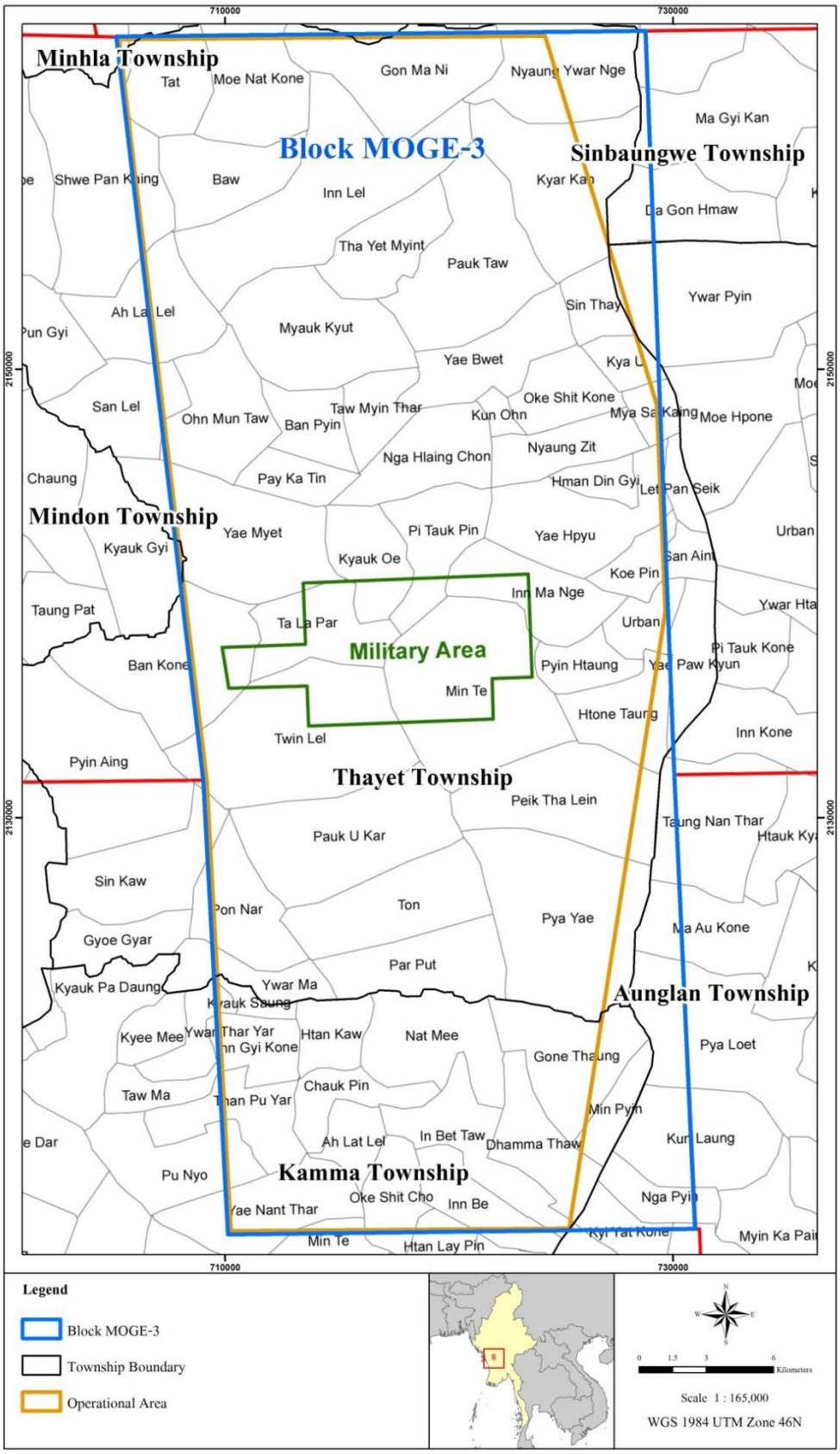
This section focuses on the environmental conditions and characteristics in the Project area of the proposed seismic activities, but also places the information in a regional context.

Figure 5.1 Project Location



Source: Adapted from http://www.themimu.info/sites/themimu.info/files/documents/Region%20Map_District_Magway_MIMU764v01_06Mar13_A4.pdf, Retrieved on 27 January 2015

Figure 5.2 Village Tracts within Seismic Operational Area of Block MOGE-3



5.2 METHODOLOGY AND OBJECTIVES

5.2.1 Data Sources

5.2.1.1 Secondary Data Sources

Secondary data sources for information on environmental, social and health baseline conditions in this report included the following:

- Government authority data;
- Internet research;
- Collation of in-house existing data archives; and
- Previous ESHIA reports carried out near the Project, as follows:
  - **Environmental, Social and Health Impact Assessment for 2D Seismic Survey of Onshore Blocks PSC-G & EP-2** - An ESHIA for the 2D Seismic Survey of Onshore Blocks PSC-G & EP-2 was completed for PTTEP SA in December, 2012.
  - **Environmental, Social and Health Impact Assessment for Onshore Exploration Drilling of Blocks PSC-G & EP-2** - An ESHIA for the onshore exploration drilling program in Blocks PSC-G & EP-2 was completed for PTTEP SA in November, 2013.

5.2.1.2 Primary Data Sources

Socio-economic baseline data was collected via two separate site survey reports in Block MOGE-3, as follows:

- **Study on Crops, Livelihoods and Hand Dug Well Communities in Anticipated Villages Affected by MOGE-3 Seismic Activities**: From 20th October to 30th October 2014, Myanmar Marketing, Research and Development Co., Ltd. (MMRD) carried out site visits (including small group discussion and stakeholder meetings) in Thayet and Kanma townships to obtain data on crops, livelihood, and hand dug well communities in villages potentially affected by MOGE-3 seismic activities. The survey covered a total number of 14 village tracts in Thayet Township, and 4 village tracts in Kanma Township, which were selected by consultation with the local authorities. This report will henceforth be referred to as "the Livelihood Study", and is presented in ***Annex B***.
- **An Outline Report on Land Use Survey for Seismic Project in Block MOGE-3**: REM carried out a survey on existing land uses in Block MOGE-3 from 2nd December – 21st December, 2014. The survey covered almost the entire area of Block MOGE-3, with the exception of inaccessible mountainous areas, the Ayeyarwady River, and the military area (DI-12) in the center of the block. The report will henceforth be referred to as "the Land Use Study", and is presented in ***Annex F***, and accompanying photographs are presented in ***Annex G***.

Onshore seismic activities do not have any sources of continuous emissions or effluent discharges, and most environmental impacts would be considered to be minor. Therefore, a primary baseline environmental survey was not considered as a requirement for this seismic ESHIA report. As this is an onshore seismic survey, the EIA Procedure would require an IEE Report. As discussed in Chapter 2, although this report has been referred to as an "ESHIA report", it is actually aligned with the content and requirements of an IEE Report. For an IEE Report, it is not practical or necessary to collect primary data for all environmental aspects. Secondary baseline data is sufficient in most cases to describe the background conditions in the Project Area, and to assess the potential impacts of the Project activities. Primary data would be collected as part of an EIA Report in the event that the activities proceed to the exploration phase in the future.

Physical and biological environmental baseline data was not collected specifically for this Project. However, data was previously collected from nearby Blocks PSC-G & EP-2, for the ESHIA of PTTEP SA's onshore projects, covering seismic activities during 2012 and drilling exploration during 2013, carried out by IEM.

The data obtained from the previous ESHIA reports in Blocks PSC-G & EP-2 covered portions of Magway Region, and provide a general representation of the environmental setting of Block MOGE-3. In particular, data from the baseline survey stations from the Blocks PSC-G & EP-2 2D seismic and drilling programs will be utilized as primary baseline for this Project. These surveys will, from hereafter in this report, be referred to as the "Blocks PSC-G & EP-2 2D Seismic Baseline Survey" and "Blocks PSC-G & EP-2 Drilling Baseline Survey". Details of the well locations and their relation to the Project, sampling locations, as well as methodology for the surveys, are shown in ***Annex E.***

5.3 PHYSICAL COMPONENTS

5.3.1 *Geography*

The topography of Myanmar can roughly be divided into four (4) physiogeographic zones, which are shown in ***Figure 5.3***, and described as follows[1]:

- **The Western Mountain Ranges**: comprise the Rakhine, Chin and Kachin hills in the west and the north of the country. The elevation in Rakhine State varies from 1,300 m to 1,500 m and in the Chin Hills from 1,500 m to 2,000 m.
- **The Shan Plateau Region:** includes the extensive Shan plateau and the mountain ranges in Kayah, Kayin and Mon States and Tanintharyi Region, rising to about 1,000 m in elevation.

[1] Kyaw Tint, Oliver Springate-Baginski and Mehm Ko Ko Gyi. (2011) Community Forestry in Myanmar: Progress & Potentials. Retrieved from http://www.burmalibrary.org/docs13/Community+Forestry+in+Myanmar-op75-red.pdf

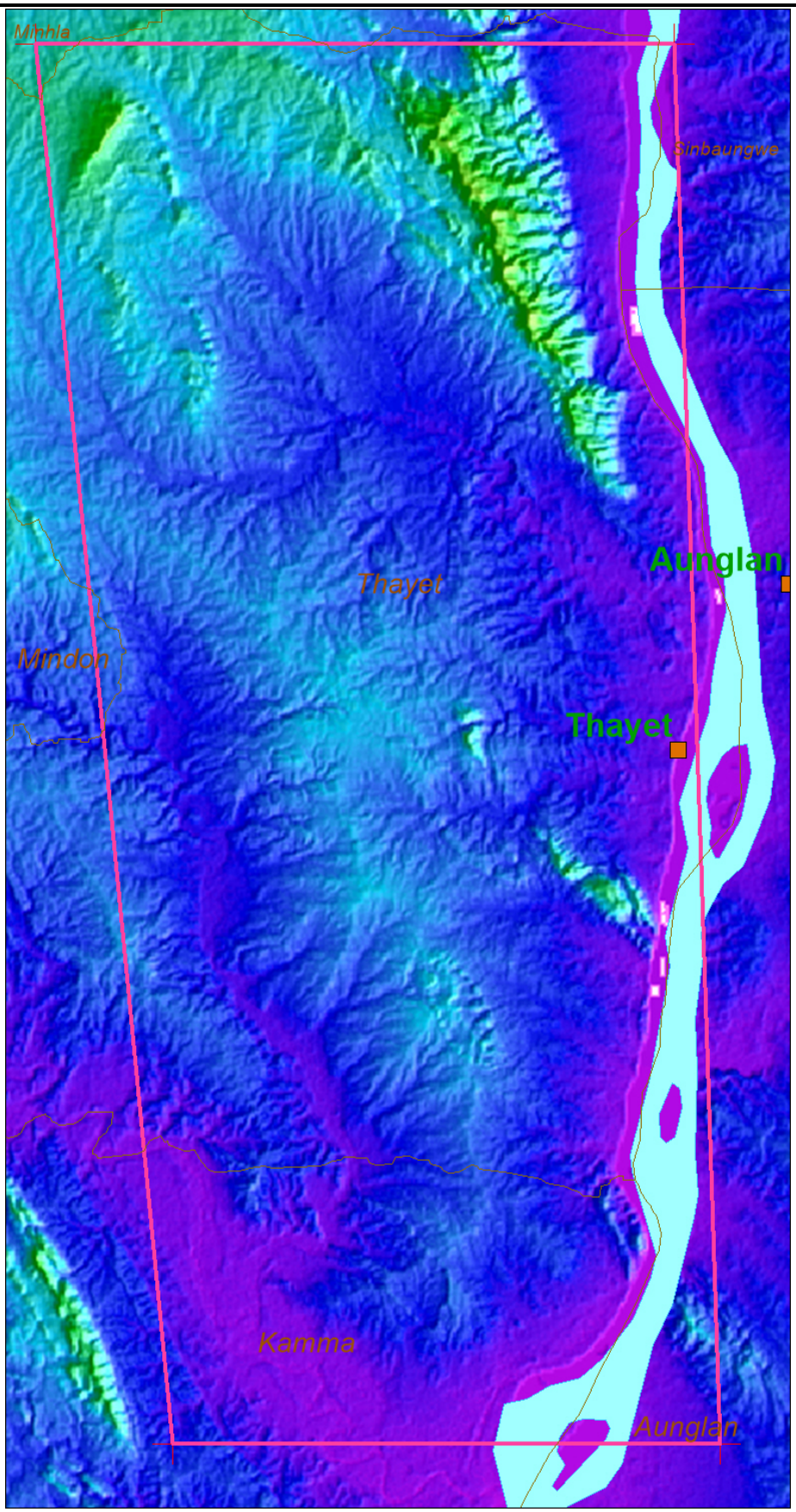
- **The Central Region:** includes the fertile agricultural valleys of the Ayeyawady, Chindwin and Sittaung Rivers. The topography is flat to undulating except the hills of the Bago Yoma which rise to about 1,000 m, and bear the finest teak forests of the country
- **The Ayeyarwady Delta and Coastal Region:** include coastal areas in Rakhine State, Mon State and Tanintharyi Region, which are alluvial plains. Some coastal areas are still covered by mangroves, although most areas suitable for rice cultivation have been cleared.

The proposed Project is located on predominantly level or gently sloping country in the Magway Region, which is in the Central Region. The elevation of Blocks MOGE-3 varies from about 12 m to 388 m above mean sea level (MSL). Topography in Block MOGE-3 is shown in ***Figure 5.4***.

Figure 5.3 Myanmar's Geographic Zones

Source: Adapted from http://www.mapsofworld.com/physical-map/maps/myanmar-physical-map.jpg

Figure 5.4 Topography in Block MOGE-3



Source: REM, 2015

5.3.2 *Climate*

The climate of Myanmar is roughly divided into three seasons: Summer, Rainy Season, and Winter Season. From the end of February to the beginning of May are Summer months, with highest temperatures during March and April. In Central Myanmar the temperature can reach above 43.3ºC, while in Northern Myanmar it is about 36.1ºC and on the Shan Plateau between 29.4ºC and 35ºC. Rainy Season, from mid-May to the end of October, with annual rain fall of less than 40 inches (1,016 mm) in Central Myanmar, while the coastal regions of Rakhine and Tanintharyi receive about 200 inches (5,080 mm). Winter, which starts from November and lasts to the end of February, can result in temperatures in hilly areas of over 914 m dropping to below 32ºF (0ºC)[2].

The Project area is located in the central plain of Myanmar, and is primarily located within the Dry Zone[3]. The climate of the Project area is controlled by the monsoon circulation system of South East Asia, which is also influenced by the presence of major landforms. The mountain ranges in Myanmar generally run north-south and act as effective climate barriers for the southwest monsoon (approximately in end of May through October) in the summer and the northeast monsoon in the winter (approximately in December through April). The average range of high and low temperature is from 44°C to 15°C[4].

The central region of Myanmar, which includes Block MOGE-3, lies within the following climatic zones:

- Tropical savannah climate (around the Dry Zone) with more pronounced dry seasons between the monsoon rains and thus lower precipitation, but similar mean temperatures to those in the tropical monsoon climate; and
- Tropical steppe climate (Dry Zone), semi-arid climate with less than 1,250 mm of precipitation per annum and mean annual temperatures in excess of 27° C.

5.3.2.1 *Temperature and Precipitation*

Temperature information for the study was obtained from the Meteorology and Hydrology Department of Magway District (adjacent to Thayet District), using the data from Magway weather station.

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[2] http://www.myanmar-embassy-tokyo.net/about.htm

[3] The Dry Zone is part of the central plain of Myanmar, sandwiched by the mountainous zone on the west, and the highlands on the east. It spreads across three regions—Sagaing (Sagaing, Shwebo and Monywa districts), Mandalay (Kyaukse, Myingyan, Meikhtila, Yamethin and Nyang-U districts) and Magwey (Pakokku, Magwe, Minbu and Thayet districts). (http://www.researchgate.net/publication/266261203_Water_resource_assessment_of_the_dry_zone_of_Myanmar)

[4] Report of MOGE-3 Block at Thayet Township in Magway Region (*PTTEPSA, 2013*)

Magway District lies in the tropical zone and consequently it has a considerably high temperature. During the 20-year period from 1988 to 2007, Magway had an average maximum temperature of 37.74 ºC, an average mean temperature of 27.05 ºC, and an average minimum temperature of 16.34 ºC. January is the coldest month, with average mean temperature of 20.73 ºC. The hottest month is May, with average mean temperature of 31.76 ºC.

According to ***Table 5.1***, Taungdwingyi receives the largest average annual rainfall, amounting to 999.74 mm. Myothit and Magway receive average annual rainfall of 921.77 mm and 900.43 mm, respectively. Natmauk gets rainfall of 798.0 mm. Chauk receives rainfall of 621.03 mm. (*IEM, 2013*)[5]

[5] International Environmental Management Co., Ltd (IEM). 2013. **Environmental, Social and Health Impact Assessment Onshore Exploration Drilling of Blocks PSC-G & EP-2**. prepared for PTTEP South Asia Limited.

Table 5.1 Average Annual Rainfall for Townships in Magway District (mm, 1988-2007)

Rainfall Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Taungdwingyi	0.00	1.52	3.30	11.68	136.40	159.00	145.03	184.66	180.59	122.94	50.55	4.06	999.74
Myothit	0.00	0.76	4.83	13.97	123.70	124.46	131.57	182.88	164.59	130.05	39.37	5.59	921.77
Magway	0.25	2.29	7.62	13.46	126.75	145.03	106.17	137.41	172.72	131.32	50.29	7.11	900.43
Natmauk	0.00	0.51	3.81	11.94	130.56	109.22	100.84	132.33	147.07	117.09	38.10	6.60	798.07
Chauk	0.00	0.76	4.83	11.18	98.30	73.15	44.96	103.38	141.99	114.30	24.13	4.06	621.03
Yenangyaung	0.00	1.27	2.79	6.10	87.38	72.64	61.47	80.26	120.90	87.12	26.16	3.05	549.15

Source: Meteorology and Hydrology Department, Magway in IEM, 2013

5.3.2.2 *Wind*

Dominant wind patterns in the Project area are driven primarily by regular southwest monsoon wind in the rainy season and northeast monsoon wind in the winter or cold-dry season. These wind patterns are mediated by more mountainous terrain to the west and east. Localized meteorological conditions are also influenced by diurnal thermal cycles and cloud cover.

Meteorology data collected during the Blocks PSC-G & EP-2 Drilling Baseline Survey included temperature, wind speed, wind direction and relative humidity. The survey was carried out from 10th August – 6th September, 2013 by using a Wireless Environmental Perimeter Air Monitoring System (EPAS). Results from the study are presented in ***Table 5.2,*** and can be summarised as follows:

- Average daily temperature: 24.0-30.5°C;
- Wind speed: 0.6-7.1 kilometre per hour (kph);
- Wind direction: South (S) and southeast (SE) in general; and
- Mean relative humidity: 73.0 to 108.5%.

Table 5.2 Meteorology Data Obtained from Air Quality Sampling Stations in Blocks PSC-G & EP-2 Drilling Baseline Survey during August 10-September 6, 2013

Well Name	Location		Temperature (Degree C)	Wind Speed (kph)	Wind Direction (Degree from North)	Relative Humidity (%)
EP2-1	U Yin(Location-1)	Avg	24.0	1.2	124.5 (SE)	100.0
		(Min- Max)	(24.0-24.0)	(0.1-2.3)		(100.0-100.0)
	U Yin (Location-3)	Avg	26.0	0.7	211.0 (SSW)	102.5
		(Min- Max)	(25.0-27.0)	(0.2-1.2)		(92.0-113.0)
EP2-3	Thit Khaung Tee (Location-1)	Avg	26.5	1.9	181.5 (S)	96.0
		(Min- Max)	(26.0-27.0)	(1.7 -2.1)		(95.0-97.0)
	Thit Khaung Tee (Location-2)	Avg	24.5	2.5	231.5 (SW)	103.5
		(Min- Max)	(24.0-25.0)	(2.3-2.6)		(100.0-107.0)
	Thit Khaung Tee (Location-3)	Avg	27.0	5.3	176.0 (S)	94.5
		(Min- Max)	(26.0-28.0)	(3.3-7.2)		(93.0-96.0)
EP2-2	Hpaung Tin (Location-1)	Avg	28.0	4.6	172.0 (S)	86.5
		(Min- Max)	(26.0-30.0)	(3.9-5.2)		(74.0-99.0)
	Hpaung Tin (Location-2)	Avg	26.0	2.5	169.5 (S)	100.5
		(Min- Max)	(25.0-27.0)	(2.1-2.9)		(100.0-101.0)
	Hpaung Tin (Location-3)	Avg	26.0	1.6	166.0 (SSE)	99.5
		(Min- Max)	(25.0-27.0)	(1.4-1.8)		(99.0-100.0)
G-3	War Thone Pyu (Location-1)	Avg	26.5	2.9	156.5 (SSE)	98.0
		(Min- Max)	(26.0-27.0)	(2.5-3.2)		(98.0-98.0)
	War Thone Pyu (Location-2)	Avg	28.5	6.9	135.5 (SE)	83.5
		(Min- Max)	(27.0-30.0)	(6.3-7.4)		(77.0-90.0)
	War Thone Pyu (Location-3)	Avg	31.0	1.7	198.0 (SSW)	73.0
		(Min- Max)	(29.0-33.0)	(1.4-1.9)		(63.0-83.0)
G-1	Htan Pin Kone Gyi (Location-1)	Avg	30.5	3.6	171.0 (S)	74.0
		(Min- Max)	(30.0-31.0)	(3.4-3.7)		(72.0-76.0)
	Htan Pin Kone Gyi (Location -2)	Avg	30.5	3.5	157.5 (SSE)	73.5
		(Min- Max)	(30.0-31.0)	(3.3-3.6)		(72.0-75.0)
	Htan Pin Kone Gyi (Location-3)	Avg	27.0	3.4	137.0 (SE)	86.5
		(Min- Max)	(24.0-30.0)	(2.4-4.3)		(73.0-100.0)
G-2	Nat Sone Hmaw (Location-1)	Avg	26.5	3.8	184.0 (S)	87.0
		(Min- Max)	(26.0-27.0)	(3.8-3.8)		(85.0-89.0)
	Nat Sone Hmaw (Location-2)	Avg	24.0	7.1	195.0 (SSW)	108.5
		(Min- Max)	(23.0-25.0)	(6.6-7.6)		(107.0-110.0)
	Nat Sone Hmaw (Location-3)	Avg	27.5	3.9	185.0 (S)	84.5
		(Min- Max)	(27.0-28.0)	(3.7-4.1)		(82.0-87.0)

Source: IEM, 2013

5.3.3 *Air Quality*

Baseline air quality data were collected during the Blocks PSC-G & EP-2 Drilling Baseline Survey, from 10th August – 6th September, 2013. Air quality and meteorological monitoring was undertaken continuously over 24 hours. Locations of air sampling stations from the survey are listed in ***Annex E***. A summary of the results of ambient air quality are shown in ***Table 5.3***.

WHO air quality guidelines (*2000, updated 2005*), National Ambient Air Quality Standards (NAAQS) of the United Stated Environmental Protection Agency (USEPA) and Thailand ambient air standard were used to compare the results of the baseline survey to provide an indication of the baseline status of air quality. The monitoring results show that concentrations of all pollutants of concern are all within their standards, except for Particulate Matter.

However, Particulate Matter was also found to exceed the applicable standard during various monitoring activities conducted across the country. The results of these monitoring activities are provided in ***Table 5.4***. Therefore, the values are likely to represent typical conditions in Myanmar. The existing baseline levels of dust (PM_{10} and TSP) in all regions are high enough to cause nuisance.

The selected communities where the air quality samples were collected were generally small to medium-sized in agriculture-based areas with only 100 to 300 households and an average population of 200 to 1,000 people each. Therefore, the composition of aerosol particles was most likely from wind-blown dust of mineral oxides from natural sources, weather and local activities rather than from mobile emissions and industrial sources.

The baseline data gathered at these locations is considered to be representative and typical of the Project area in Block MOGE-3. The variation in ambient air concentration will be more or less similar due to the same topography, land use and meteorological conditions.

Table 5.3 Ambient Air Quality Results from Blocks PSC-G & EP-2 Drilling Baseline Survey

Well Site	Location		TSPM 24-hr (µg/m³)	PM_{10} 24-hr (µg/m³)	NO_2 (ppb)	SO_2 (ppb)	CO (ppm)	VOC (ppm)
G-1	Htan Pin Kone Gyi (Location-1)	Avg	241.0	**57.5**	27	<DL	<DL	<DL
		(Min- Max)	(214-268)	(**55-60**)	(23-31)			
	Htan Pin Kone Gyi (Location-2)	Avg	253.5	**55.5**	29.5	<DL	<DL	<DL
		(Min- Max)	(236-271)	(**55-56**)	27-32			
	Htan Pin Kone Gyi (Location-3)	Avg	152.5	**74.0**	41	2.5	<DL	<DL
		(Min- Max)	(81-224)	(**53-95**)	(30-52)	(0-5)		
G--2	Nat Sone Hmaw (Location-1)	Avg	107.5	**67.5**	30.5	1.5	<DL	<DL
		(Min- Max)	(90-125)	(**62-73**)	(30-31)	(1-2)		
	Nat Sone Hmaw (Location-2)	Avg	75.0	40.0	44	<DL	<DL	<DL
		(Min- Max)	(31-119)	(36-44)	(42-46)			
	Nat Sone Hmaw (Location-3)	Avg	116.5	**58.5**	27	<DL	<DL	<DL
		(Min- Max)	(110-123)	(**57-60**)	(25-29)			
G-3	War Thone Pyu (Location-1)	Avg	325.0	64.0	23.5	<DL	<DL	0.2
		(Min- Max)	(267-383)	(**57-71**)	(22-2)			(0.1-0.3)
	War Thone Pyu (Location-2)	Avg	**317.0**	**50.5**	16.5	<DL	0.5	0.1
		(Min- Max)	(252-**382**)	(50-**51**)	(6-27)		(0-1)	
	War Thone Pyu (Location-3)	Avg	175.5	**64.0**	24	<DL	0.5	0.1
		(Min- Max)	(129-222)	(**60-68**)	(14-34)		(0-1)	(0-0.2)
EP2-1	U Yin (Location-1)	Avg	**333.5**	**53.5**	37.5	1	3	0.35
		(Min- Max)	(**318-349**)	(27-80)	(30-45)	(0-1)	(0-6)	(0.3-0.4)
	U Yin (Location-2)	Avg	253.5	45.5	23	<DL	0.5	0.1
		(Min- Max)	(202–305)	(31-60)	(10-36)		(0-1)	(0-0.2)
	U Yin (Location-3)	Avg	**320.0**	36.5	35	0.5	<DL	0.1
		(Min- Max)	(85-**555**)	(34-39)	(27-43)	(0-1)		(0-0.2)
EP2-2	Hpaung Tin (Location-1)	Avg	**789.5**	45.0	20	<DL	0.5	0.1
		(Min- Max)	(425-**1,154**)	(37-53)	(9^{c}-31^{d})		(0-1)	(0-0.2)
	Hpaung Tin (Location-2)	Avg	139.0	**51.5**	37.5	<DL	<DL	<DL
		(Min- Max)	(48-230)	(43-**60**)	(33-42)			
	Hpaung Tin (Location-3)	Avg	68.0	**66.0**	28	<DL	<DL	0.1
		(Min- Max)	(37-99)	(51-81)	(21-35)			(0-0.2)

Well Site	Location		TSPM 24-hr (µg/m³)	PM_{10} 24-hr (µg/m³)	NO_2 (ppb)	SO_2 (ppb)	CO (ppm)	VOC (ppm)
EP2-3	Thit Khaung Tee (Location-1)	Avg	**508.5**	34.5	27.5	<DL	0.001	0.1
		(Min- Max)	(**427-590**)	(33-36)	(26-29)		(0[c]-0.002[d])	
	Thit Khaung Tee (Location-2)	Avg	84.0	30.0	36.5	0.5	<DL	<DL
		(Min- Max)	(72-96)	(25-35)	(34-39)	(0-1)		
	Thit Khaung Tee (Location-3)	Avg	**531.0**	37.5	22	<DL	0.5	0.1
		(Min- Max)	(**498-564**)	(34-41)	(14-30)		(0-1)	(0-0.2)
	Mandalay Data 2007-2008[(1)]		**213**	**62**	**NA**	**NA**	**NA**	**NA**
	WHO Guidelines (24hr Average)		**NA**	**150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (Guideline)**	**200[(1)]**	**125 (Interim target-1) 50 (Interim target-2) 20 (Guideline)**	**NA**	**NA**
	NAAQS (USEPA) (8 hr Average)		**NA**	**NA**	**NA**	**NA**	**9**	**NA**
	Thailand Ambient Air Standard (24hr Average)[(2)]		**300**	**120**	**NA**	**120**	**NA**	**NA**

Note: **Bold** means exceed Thailand Ambient Air Standard for TSP and exceed WHO ambient air quality guidelines for PM_{10}.
NA means Not Available
DL means Detection Limit
(1) 1-hr averaging time
(2) Thailand Ambient Air Standard under the Notification of National Environmental Board No. 24, B.E. 2547 (2004) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992), published in the Royal Government Gazette No. 121 Special Part 104 D dated September 22, B.E.2547 (2004)

Table 5.4 Baseline Air Quality in Cities in Myanmar (Compiled from EIA Projects during 2009-2013)[6]

Location	Pollution Concentration (µg/m³)					
	TSP	PM_{10}	NO_2	SO_2	CO	VOC
Western Coastal Region						
Kyaukphyu (2009)	159	**136**	4	0.4	-	-
Middle Myanmar (2009-2013)						
Yenanchaung (2009)	154	**120**	4	0.2	-	-
Thaungtha (2009)	97	**80**	6	2	-	-
Sintgaing (2009)	174	**80**	12	1	-	-
Sintgaing (2009)	174	**80**	12	1	-	-
Nyaung Oo (2013)	258	**91**	45	1.25	0.3	0.01
Kyauk Pa Taung (2013)	276	**89**	43	1.75	0.3	0.04
Mandalay Port (2013)	102	**404**	38	<DL	0.3	0.1
Between Lower and Middle Myanmar (2009 – 2013)						
Taungoo (2013)	171	**137**	43	2	0.9	<DL
Pyay-Aunglan (2013)	**336.3**	**44.4**	30	0.2	1	0.1
Meikhtilar (2013)	195.9	**59.1**	29	0	0.1	0.04
Southern Myanmar (2009-2012)						
Mawlamyaing	213	**124**	57	2	0.7	<DL
Pyin Oo Lwin	156	**140**	3	2.6	-	-
Namthu	114	**31**	3	1	-	-
Namkham	270	**127**	2	1	-	-
Northern Myanmar (2013)						
Kathar	**415**	**76**	32	1	0.3	<DL
WHO Guidelines (24hr Average)	**NA**	**150 (Interim target-1)** **100 (Interim target-2)** **75 (Interim target-3)** **50 (Guideline)**	**200**[(1)]	**125 (Interim target-1)** **50 (Interim target-2)** **20 (Guideline)**	**NA**	**NA**
NAAQS (USEPA) (8 hr Average)	**NA**	**NA**	**NA**	**NA**	**9**	**NA**
Thailand Ambient Air Standard (24hr Average)[(2)]	**300**	**120**	**NA**	**120**	**NA**	**NA**

Note: **Bold** means exceed Thailand Ambient Air Standard for TSP and exceed WHO ambient air quality guidelines for PM_{10}.
NA means Not Available, DL means Detection Limit
(1) 1-hr averaging time
(2) Thailand Ambient Air Standard under the Notification of National Environmental Board No. 24, B.E. 2547 (2004) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992), published in the Royal Government Gazette No. 121 Special Part 104 D dated September 22, B.E.2547 (2004)

[6] Dr. Ohnmar May Tin Hlaing, Ms. Kaye Patdu, Ms. Cherine Capadocia (2014). **Myanmar Country Profile: Focus on Cities**. ASEAN – German Technical Cooperation Clean Air for Smaller Cities in the ASEAN Region. Retrieved from http://asialeds.org/sites/default/files/resource/file/Myanmar_country_profile.pdf

5.3.4 *Noise*

Ambient noise surveys for Blocks PSC-G & EP-2 Drilling Baseline Survey were also undertaken in six community locations (same locations as for air quality monitoring) between 10th-16th August, 2013. Ambient noise measurement data recorded in each community is summarized in ***Table 5.5***

Ambient noise measurements taken within Block PSC-G & EP-2 had 24-hour equivalent noise levels ranging from 44.12 dB (A) to 63.47 dB (A). The day and night noise levels were above the Myanmar National Environmental Quality (Emission) Guidelines (Draft). This is most likely the result of motorbike traffic and diesel generators used for the production of electricity. A similar noise profile is expected in the communities in Block MOGE-3.

Table 5.5 Ambient Noise Results from Blocks PSC-G & EP-2 Drilling Baseline Survey

Well Site	Community	Parameters					
		Leq	Leq-Day	Leq-Night	Lmin	Lmax	L90
G-1	Htan Pin Kone Gyi (Location-1)	55.72	54.55	**53.92**	47.9	71.2	60.96
	Htan Pin Kone Gyi (Location-2)	44.36	43.63	**45.66**	29.8	64.4	50.27
	Htan Pin Kone Gyi (Location-3)	52.26	45.98	**58.87**	33.4	73.8	62.9
G-2	Nat Sone Hmaw (Location-1)	48.12	48.09	**47.35**	36.9	54.4	52.13
	Nat Sone Hmaw (Location-2)	56.2	**56.51**	**56.68**	42.2	66.2	61.28
	Nat Sone Hmaw (Location-3)	53	51.64	**59.37**	29.6	64.8	62.79
G-3	War Thone Pyu (Location-1)	54.01	53.02	**52.65**	48.5	63.8	60.24
	War Thone Pyu (Location-2)	47.38	45.94	**52.09**	27.6	67.1	55.46
	War Thone Pyu (Location-3)	53.49	51.35	**54.41**	48	64.6	58.6
EP2-1	U Yin (Location-1)	55.28	**59.6**	**55.77**	34.6	76.8	72.12
	U Yin (Location-2)	52.7	47.67	**52.23**	35.1	70.2	58.16
	U Yin (Location-3)	56.24	**60.82**	**47.68**	28.4	85.4	77.52
EP2-2	Thit Khaung Tee (Location-1)	52.4	51.34	**54.02**	32.6	83	70.42
	Thit Khaung Tee (Location-2)	55.24	50.82	**55.71**	36.2	76	72.46
	Thit Khaung Tee (Location-3)	47.71	45.72	**50.13**	34.1	76.1	54.79
EP2-3	Hpaung Tin (Location-1)	44.12	41.04	**47.27**	33.2	60.5	50.58
	Hpaung Tin (Location-2)	48.93	47.87	**50.59**	37.2	74	53.74
	Hpaung Tin (Location-3)	49.92	49.11	**49.79**	36	78.7	57.33
National Environmental Quality (Emission) Guidelines (1)		**NA**	**55**	**45**	**NA**	**NA**	**NA**

Note: **Bold** means higher than guidelines
(1) Noise level guideline at residential, institution, educational.
Daytime: 07.00-22.00 Nighttime: 22.00-07.00

5.3.5 *Geology*

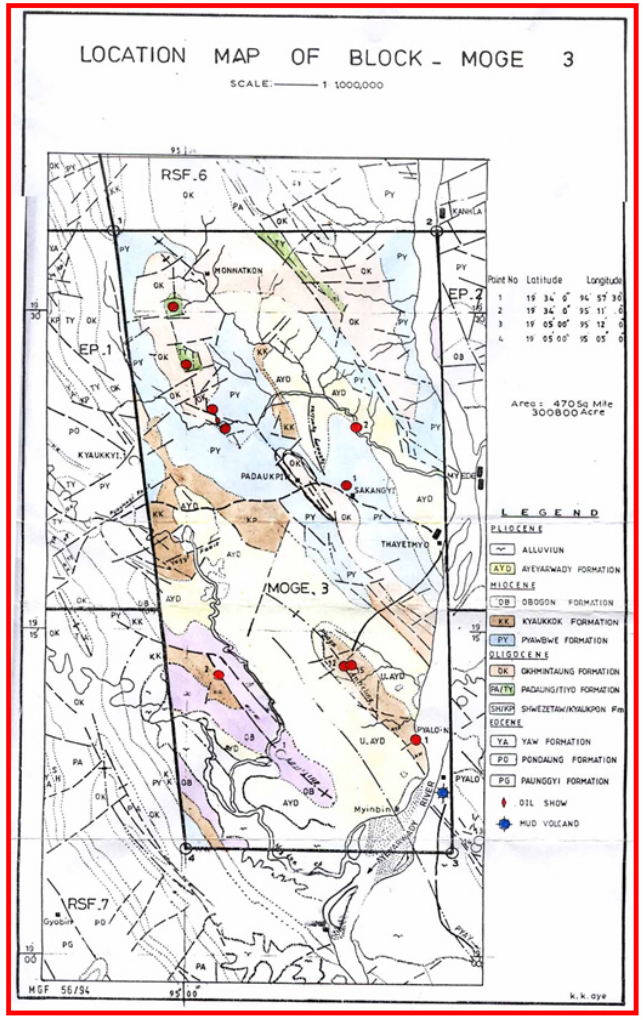
As described in ***Section 5.3.1***, the proposed Project is located in the central region. The central region lies between a range of mountains known to the Burmese as the Arakan Yoma on the west and the Shan Plateau in the east. It is a relatively low-lying terrain, drained by the Ayeyarwady River and its major tributaries. Rolling hills, ridges and small mountains are present in some areas. The region is characterized by folded small mountain ranges, a volcanic line and the Sagaing Fault zone, a regionally significant active right lateral strike-slip fault.

The central areas are underlain predominantly by orderly successions of Cenozoic clastic sedimentary strata of molasse facies. Some volcanics are present, particularly to the northwest of PSC-G associated with Mount Popa. The stratigraphic units range in age from Eocene to Holocene and can be categorized as: the Eocene units, Pegu Group, Ayeyarwady Formation, Terrace deposits and alluvium.

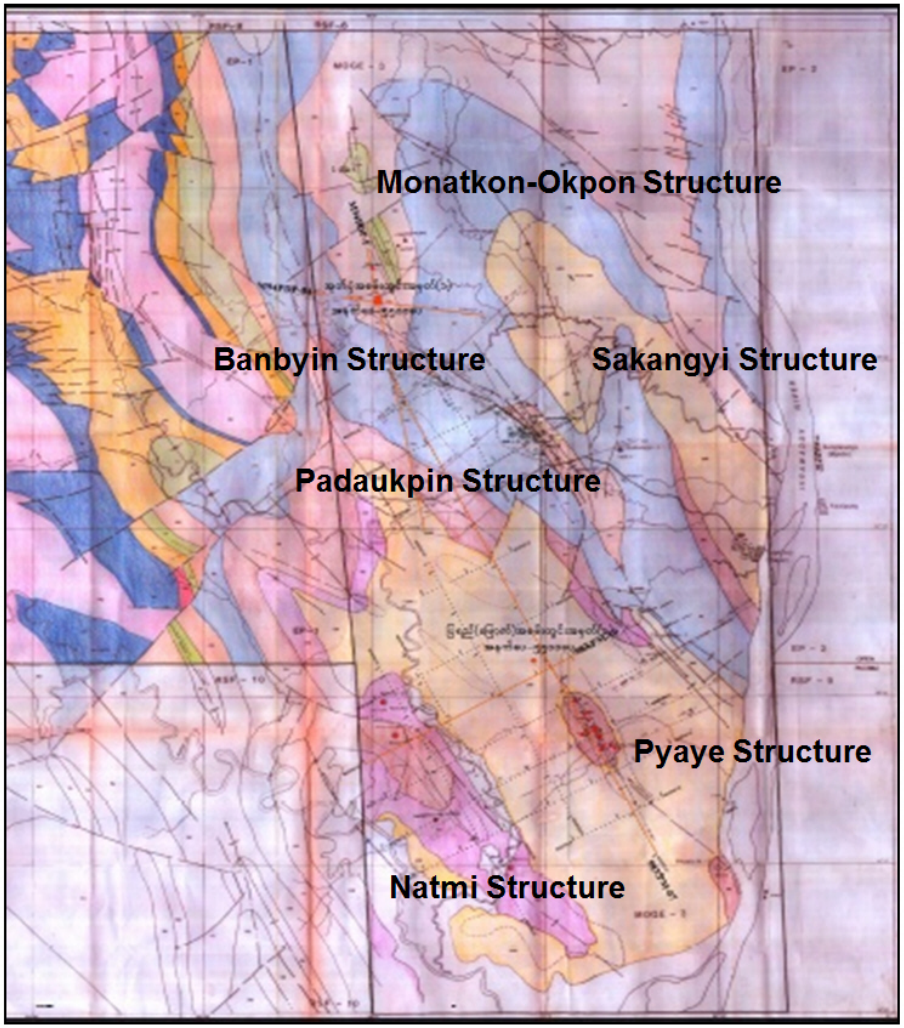
Geomorphology in Block MOGE-3 consists of rugged terrain, low rolling hills and flat lands, and trends in a general north-south configuration. Based on five surface geological reports prepared for Block MOGE-3, undertaken by PTTEP SA, there are six (6) geological structures (***Figure 5.5***), as noted below:

1. Monatkon-Okpon Structure – NNW-SSE direction anticline. Old wells drilled by BOC indicate oil indication from the Pondaung (Eocene) formation and gas from the Kyaukpon (Oligocene) formation.
2. Banbyin Structure – Southern plunge of Okpon anticline. The axis is in a NNW-SSE direction and plunges 10-16 degree to SE. The dips vary between 14-32 deg and the axis is cut by many cross faults and dies out under the Padaukpin structure.
3. Padaukpin Structure – A northerly plunging, thrusted, asymmetrical, elongated anticline. NNW-SSE trending. It is 8 miles (12. 9 km) extent, compartmentalized by cross faults. It is faulted longitudinal on both flanks. Thrusts are affected by strike slip faults.
4. Sakangyi Structure – An anticline, NNW-SSE trending, plunges 8 degrees towards NNW. The dips range from 18-30 degrees on the west flank and 12-20 degrees on the east. The axis is terminated in the north near Sakangyi village.
5. Natmi Structure – Natmi fold, running in NW-SE, parallel to the Pyaye-Pyalo structural trend. It is asymmetrical with strike, faulted on the NE flank and gentle on the SW flanks. The oldest formation exposed in the crest of the structure is the Kyaukkok formation, which is surrounded by the Ayeyarwady Formation.
6. Pyaye Structure - An asymmetrical anticline (2.5 square miles (6.5 square km) in length and 1 mile (2.6 km)in width), trending NW-SE, dipping 45 degrees on the east and 35 degrees on the west. The anticline is compartmentalized by several oblique faults. It is separated from the Pyalo structure in the SE by a saddle. In 1924, IBPC drilled first well in Pyaye and discovered gas at shallow depth (350-567 ft) (107 – 173 m).

Figure 5.5 Geological Map of Block MOGE-3



Location map of Block MOGE-3



Geological map of Block MOGE-3

5.3.6 Soil

5.3.6.1 Soil Type and Profiles

The soil classification system was modified in 1970 by the Land Use Division and according to the modern classification, there are 24 recognized main soil types. The characteristics of these soils are determined upon: (1) the physical and mineral composition of the parent material, (2) the relief (physical features), (3) the climate under which the soil material has been developed and, (4) the vegetation. Soil classification has generally been made on the basis of the distribution of the important land resources for agriculture[7].

Soil characteristics in the Project Area are classified as Meadow Soils (Gleysol) Lixisol, Luvisol and Nitisol (***Figure 5.6***).

Meadow Soils (Gleysol)

There are different subtypes of meadow soils. The meadow soils or paddy soils are widely occurring in the different parts of Myanmar in river plains, delta and low coastal plains and valleys. All types of Meadow Soils have thick solum and mostly have clayey texture. They are most suitable for paddy cultivation. The meadow soils of the Dry Zone in upper Myanmar have characteristic light colors.

Lixisol

Lixisols comprise soils that have a higher clay content in the subsoil than in the topsoil as a result of pedogenetic processes (especially clay migration) leading to an *argic* subsoil horizon. Lixisols have a high base saturation and low-activity clays at certain depths.

Red Brown Savanna Soils (Luvisol)

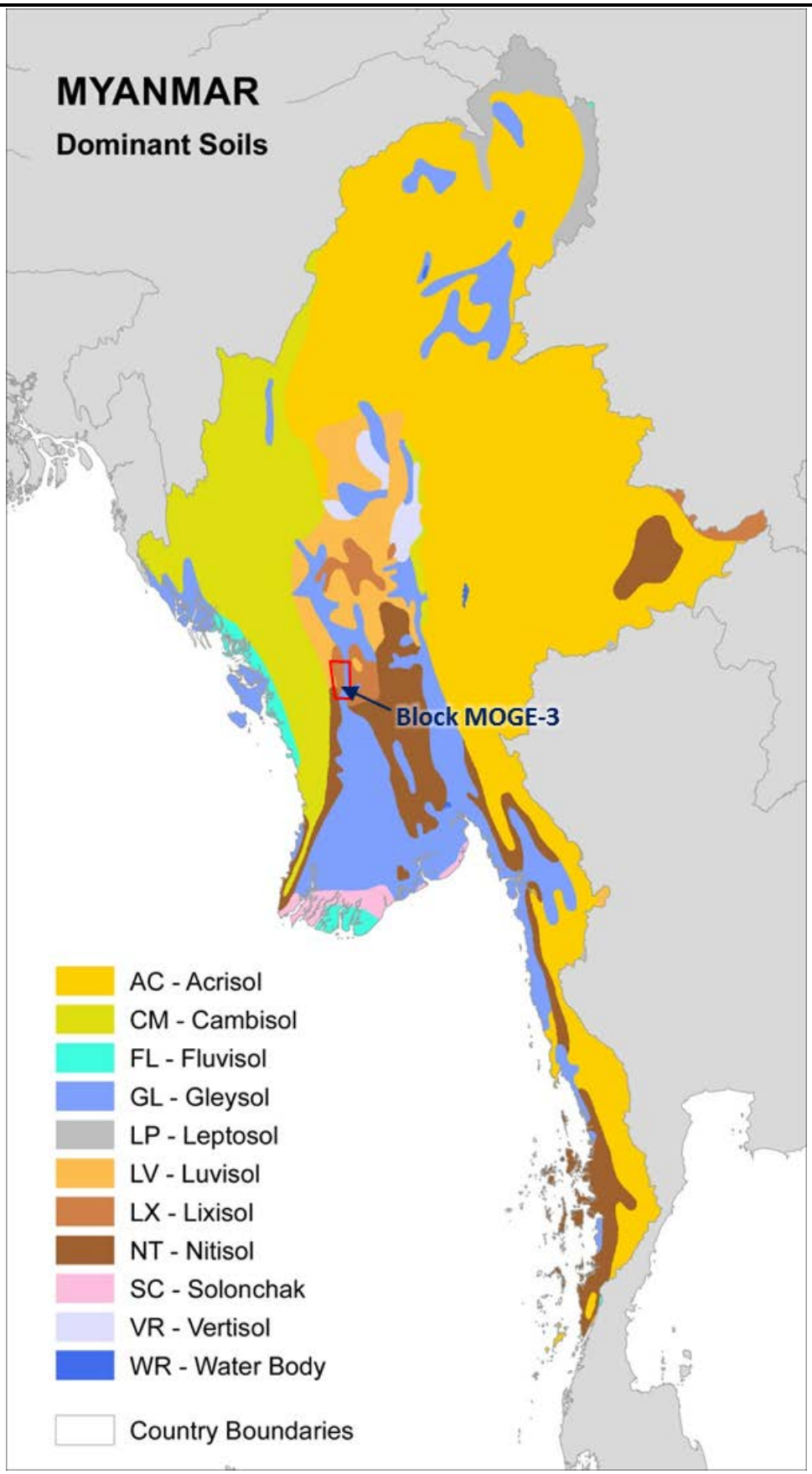
These soils are mostly found in the undulating relief of the hill slopes and low uplands. The soils are sandy and usually well drained. The soil reaction is about neutral in the top soil and neutral or slightly alkaline in the subsoil (pH ranges from 7.0 to 8.0). The soil contains a certain amount of lime and is rich in calcium and magnesium. The soils are low in other nutrients except potassium. These soils are the most important land resources of the Dry Zone area. Most of the areas are ploughed and cultivated.

[7] http://www.apipnm.org/swlwpnr/reports/y_ta/z_mm/mm.htm#soils

Light Forest Soils (Cinnamon) Nitosol

These soils mostly occur on the very gently sloping alluvial-deluvial under mountainous plains in the Dry Zone area and are also found on the lowest parts of the slopes in the Shan Plateau. The physical properties of these soils are very favorable and, in spite of being sandy, they are pervious and not heavy to work. They generally have good fertility, which is connected with their position in the under mountainous plains, and there is a permanent supply of nutrients from the surrounding mountains by the surface run-off. These soils are suitable for the cultivation of Ya crops (dry cropping on uplands).

Figure 5.6 Soil Types and Distribution in Myanmar



Source: Geographical distribution of 10 dominant soil types in Myanmar. Map created by FAO/NRL from Harmonized World Soil Database (HWSD) – FAO. Retrieved from http://www.fao.org/nr/myanmar/SoilMap_Myanmar_300dpi.jpg

5.3.6.2 *Soil Quality*

Soil quality sampling was carried out as part of the Blocks PSC-G & EP-2 Drilling Baseline Survey during 10th – 16th August, 2013. Soil samples were collected from drill-holes dug by a hand-auger drill. Soil sampling locations are shown in ***Annex E***.

Results from the survey showed that soils were predominantly sandy, 36%-96% across the sites sampled (except for G2 S4 with 22% sand only) with more or less equal, low proportions of silt and clay. Such soils have poor moisture holding capability and will tend to be drought sensitive. Organic matter varied from 0.09% to 1.81%. Soil conductivity ranged from 0.12 to 0.91, suggesting that soils salinity in these locations would not have an adverse effect on plant growth. Phosphorous ranged from 1 mg/kg to 147 mg/kg, which can be considered to range from low to moderately suitable for plant growth. Potassium ranged from 20 mg/kg to 204 mg/kg, which can be considered low-moderate for sandy soil types such as those encountered. Soil pH ranged from 7 to 9.2, which is within a normal range to support plant growth.

As there are no Myanmar soil quality standards, Thailand soil quality standards were used to compare with the results of the Blocks PSC-G & EP-2 Drilling Baseline Survey. Metals data shows that all values are below soil quality standard of Thailand for agricultural and residential purposes, with the exception of Arsenic. Arsenic levels at most locations were above standards for agriculture and residential use (3 mg/kg). This could be due to natural processes, resulting in a high natural level of arsenic in the soils. All soil samples were free from hydrocarbon contamination.

Similar, uncontaminated soil conditions are expected to occur within Block MOGE-3.

Table 5.6 Summary Soil Quality Results from Blocks PSC-G & EP-2 Drilling Baseline Survey

Parameter	Unit	G-1 well					G-2 well							Standard[1]	
		G1 S1	G1 S2	G S3	G1 S4	G1 S5	G2 S1	G2 S2	G2 S3	G2 S4	G2 S	G2 S6	G2 S7	1	2
pH	-	8.3	8.4	7.6	8.1	8.2	9.2	9.2	8.7	9.2	8.4	8.2	8.4	-	-
ECe	dS/m	0.39	0.34	0.43	0.45	0.36	0.91	0.12	0.43	0.33	0.33	0.34	0.36	-	-
Soil Texture	-	SL	SCL	LS	SL	LS	L	L	CL	C	SCL	SL	SL	-	-
% sand	%	60	54	80	76	82	46	46	40	22	54	72	54	-	-
% silt	%	24	20	10	10	10	38	38	24	34	24	14	32	-	-
% clay	%	16	26	10	14	8	16	16	36	44	22	14	14	-	-
OM	%	1.19	1.78	0.63	0.43	0.82	0.56	0.56	1.55	0.4	0.89	1.12	0.46	-	-
Phosphorus	mg/kg	147	3	2	9	10	10	9	5	28	7	19	26	-	-
Potassium	mg/kg	63	66	22	48	32	70	63	204	161	69	129	73	-	-
Chloride	mg/kg	4.4	16.1	5.8	11.7	2.9	17	9.1	14.6	14.6	14.6	10.2	7.3		
Kerosene Range	mg/kg	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	-	-
Diesel Range	mg/kg	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	<25.5	-	-
Heavy Oil Range	mg/kg	<102	<102	<102	<102	<102	<102	<102	<102	<102	<102	<102	<102	-	-
Gasoline Range	mg/kg	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	-	-
Benzene	mg/kg	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	6.5	15
Toluene	mg/kg	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	230	230
Ethylbenzene	mg/kg	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	520	520
Total Xylene	mg/kg	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	210	210
Arsenic (As)	mg/kg	**9**	**9**	<2	**6**	3	**4**	**4**	**7**	**10**	**6**	3	**5**	3.9	27
Cadmium (Cd)	mg/kg	1.11	2.95	0.05	0.39	5.02	0.8	0.78	1.64	1.15	5342	1.64	1.23	37	810
Total Chromium (Cr)	mg/kg	40	54	24	32	29	35	33	45	52	32	40	51	300	640
Lead (Pb)	mg/kg	13	12	4	5	4	7	7	11	12	5	7	7	400	750
Mercury (Hg)	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	23	610
Nickel (Ni)	mg/kg	74	97	15	37	40	50	48	62	90	46	41	83	1600	41000
Barium (Ba)	mg/kg	43	69	20	23	24	28	26	102	19	26	28	21	-	-
Copper (Cu)	mg/kg	22	36	4	9	7	15	14	21	29	16	11	24	-	-
Zinc (Zn)	mg/kg	51	62	9	26	26	34	33	40	66	30	29	52	-	-
Iron (Fe)	mg/kg	3.25	4.02	1.43	2.23	1.97	2.37	2.32	3	3.69	2.15	2.57	3.25	-	-
Manganese (Mn)	mg/kg	728	883	223	481	374	415	402	1301	569	489	507	504	1800	32000
Selenium (Se)	mg/kg	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	390	10000

Note: There are no Myanmar or WHO guideline values available for soil quality. Therefore, the results were compared to Thailand soil quality standard.

Bold means higher than the standard.

[1] Soil Quality Standard of Thailand in the Notification of National Environmental Board No. 25, B.E. (2004) issued under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992) published in the Royal Government Gazette No. 121 Special Part 119 D dated October 20, B.E.2547(2004)

1= Soil Quality Standards for Habitat and Agriculture 2 = Soil Quality Standard Soil Quality Standard for Other Purposes

Table 5.6 Summary Soil Quality Results from Blocks PSC-G & EP-2 Drilling Baseline Survey (Cont'd)

Parameter	Unit	G-3 well				EP-2 1 well				EP-2 2 well		EP-2 3 well		Standard[1]	
		G3 S1	G3 S2	G3 S3	G3 S4	EP2-1 S1	EP2-1 S2	EP2-1 S3	EP2-1 S4	EP2-2 S1	EP2-2 S2	EP2-3 S1	EP2-3 S2	1	2
pH	-	7.8	7	7.9	7.3	8.5	7	8	6.9	7.3	7	8.1	8.4	-	-
ECe	dS/m	0.15	0.12	0.39	0.17	0.25	0.24	0.71	0.66	0.2	0.18	0.38	0.39	-	-
Soil Texture	-	SCL	LS	SC	SCL	S	SL	LS	S	LS	LS	SL	CL	-	-
% sand	%	58	82	48	60	96	66	84	90	82	82	70	36	-	-
% silt	%	18	8	16	16	2	20	10	8	12	10	20	26	-	-
% clay	%	24	10	36	24	2	14	6	2	6	8	10	38	-	-
OM	%	0.46	0.09	1.81	1.12	0.05	0.56	0.73	0.59	0.4	0.59	0.43	1.32	-	-
Phosphorus	mg/kg	1	2	15	2	31	34	125	32	22	25	69	29	-	-
Potassium	mg/kg	70	56	94	65	22	90	111	144	40	88	47	181	-	-
Chloride	mg/kg	13.1	7.3	16.1	14.6	14.6	12.8	10.2	11.7	10.2	13.1	14.6	5.8	-	-
Kerosene Range	mg/kg	<25.5	<25.5	<25.5	<25.2	<25.5	<25.5	<25.5	<25.2	<25.5	<25.5	<25.5	<25.2	-	-
Diesel Range	mg/kg	<25.5	<25.5	<25.5	<25.2	<25.5	<25.5	<25.5	<25.2	<25.5	<25.5	<25.5	<25.2	-	-
Heavy Oil Range	mg/kg	<102	<102	<102	<102	<102	<102	<102	<102	<102	<102	<102	<102	-	-
Gasoline Range	mg/kg	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	-	-
Benzene	mg/kg	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	6.5	15
Toluene	mg/kg	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	230	230
Ethylbenzene	mg/kg	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	520	520
Total Xylene	mg/kg	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	<0.501	210	210
Arsenic (As)	mg/kg	**4**	**4**	**11**	**4**	2	**4**	3	<2	3	3	**6**	2	3.9	27
Cadmium (Cd)	mg/kg	0.13	0.19	1.53	0.16	0.16	0.16	0.42	0.07	0.12	0.09	0.55	0.16	37	810
Total Chromium (Cr)	mg/kg	41	44	48	40	14	27	13	8	22	22	50	14	300	640
Lead (Pb)	mg/kg	9	8	42	8	3	6	5	<3	5	5	10	3	400	750
Mercury (Hg)	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	23	610
Nickel (Ni)	mg/kg	27	53	77	50	14	37	19	9	27	18	76	14	1600	41000
Barium (Ba)	mg/kg	58	26	33	36	14	23	36	13	26	32	22	14	-	-
Copper (Cu)	mg/kg	11	10	22	15	3	10	5	3	7	5	20	3	-	-
Zinc (Zn)	mg/kg	17	29	46	32	11	28	17	9	18	13	60	11	-	-
Iron (Fe)	mg/kg	2.22	2.74	3.16	2.54	1.07	2.05	1.46	0.9	1.64	1.6	3.71	1.07	-	-
Manganese (Mn)	mg/kg	573	920	1091	737	184	488	773	364	495	716	491	184	1800	32000
Selenium (Se)	mg/kg	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	390	10000

Note: There are no Myanmar or WHO guideline values available for soil quality. Therefore, the results were compared to Thailand soil quality standard.

Bold means higher than the standard.

[1] Soil Quality Standard of Thailand in the Notification of National Environmental Board No. 25, B.E. (2004) issued under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992) published in the Royal Government Gazette No. 121 Special Part 119 D dated October 20, B.E.2547(2004)

1= Soil Quality Standards for Habitat and Agriculture 2 = Soil Quality Standard Soil Quality Standard for Other Purposes

5.3.7 *Surface Water*

5.3.7.1 *Surface Water Hydrology*

Block MOGE-3 lies in the Lower Ayeyarwady watershed (***Figure 5.7***) dominated by the Ayeyarwady River, which originates in the north of Myanmar in Kachin State, and flows through Block MOGE-3 from the north-east to the south along its eastern edge.

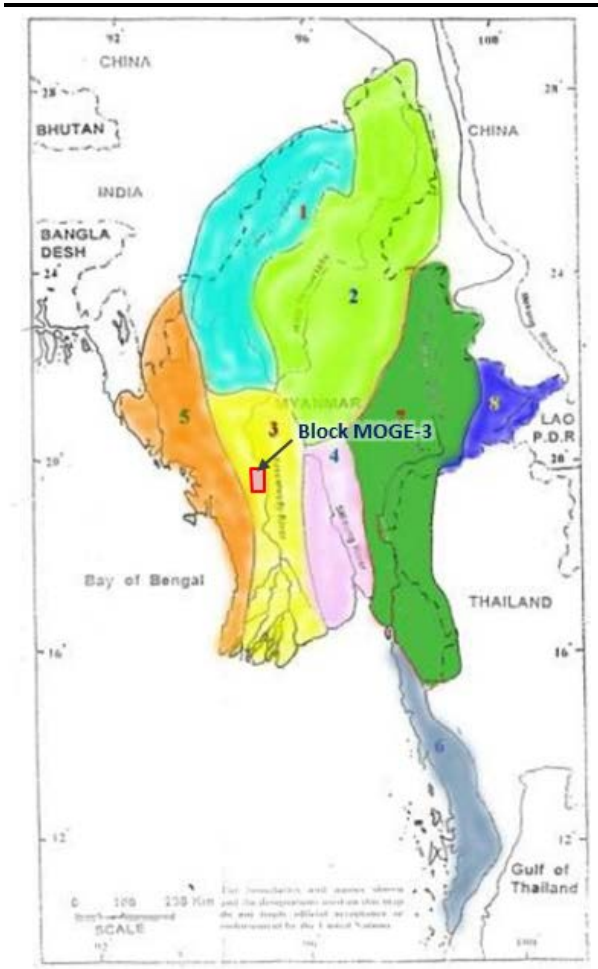
Total drainage area of Lower Ayeyarwady is about 95,600 km^2, with flow rates varying from 2,300 m^3/s in the summer to 32,600 m^3/s in the monsoon season.

5.3.7.2 *Surface Water Quality*

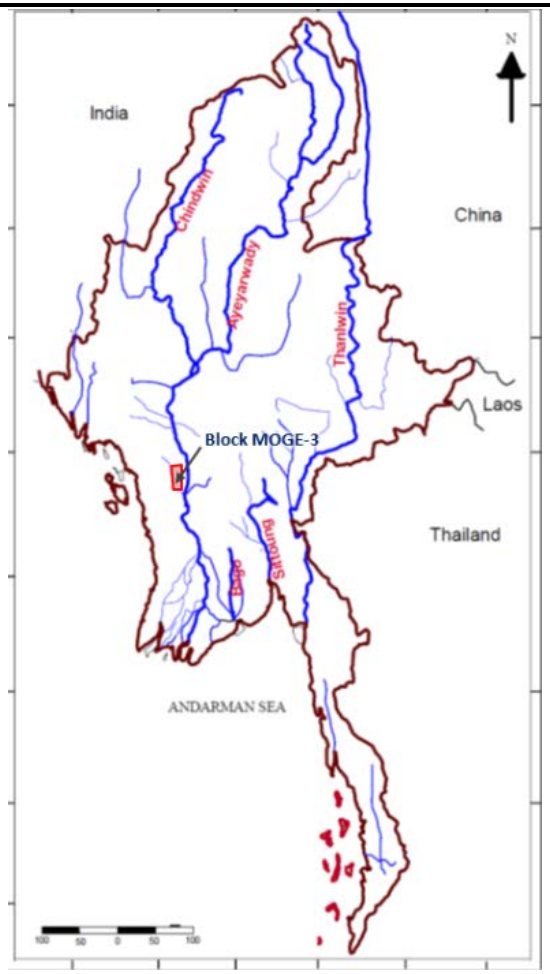
Surface water quality sampling was conducted as part of the Blocks PSC-G & EP-2 Drilling Baseline Survey. The locations and methodology of the survey are presented in ***Annex E***, and the results are presented in ***Table 5.7***. Since there are no specific surface water quality standards in Myanmar, results of surface water quality measurements from each station during the survey were compared with Thailand's surface water quality.

Arsenic (As) was detected above standards at G1 SW1, SW2, SW3, SW4 and SW5, G2 SW4 and G3 SW3. All heavy metals were well within water quality standards. Petroleum hydrocarbons were not detected in any surface water samples. Basic water quality parameters for surface water were all within normal ranges for Class 2 to Class 5 standards.

Figure 5.7 Myanmar River Basins[8]



(a) Myanmar River Basins



(b) Potential Water Resources

River Basin Number	Name of the River Basin	Drainage area (1000 * km²)	Surface water (km³)	Ground water (km³)
I	Chindwin	115.3	141.293	57.578
II	Upper Ayeyarwady	193.3	227.920	92.599
III	Lower Ayeyarwady	95.6	85.800	153.249
IV	Sittoung	48.1	81.148	28.402
V	Rakhine State	58.3	139.245	41.774
VI	Taninthari Division	40.6	130.927	39.278
VII	Thanlwin	158.0	257.918	74.779
VIII	Mekong	28.6	17.634	7.054
	Total	737.8	1081.885	494.713

Source: U Win Kyaw, WWD 2014, Myanmar, 19 Mar 2014)

Source: U Win Kyaw, WWD, 2014 Myanmar 19 March 2014 and http://www.a-a-r-s.org/ws-eowm/download/Plenary3/Myanmar.pdf

[8] Global Water Partnership on the ground: IWRM Promotion & Implementation in Myanmar, GWP strategy launch@ the World Water Day 2014 Celebration United Nations University, Tokyo Japan 21 March 2014. Presentation available in http://www.slideshare.net/fullscreen/globalwaterpartnership/gwp-on-the-ground-myanmar-case-21mar2014tokyo/3, Retrieved on 27 January 2015

Table 5.7 Surface Water Quality Results from Blocks PSC-G & EP-2 Drilling Baseline Survey

Parameter	Unit	G-1					G-2						Standard(1)			
		G1 SW1	G1 SW2	G1 SW3	G1 SW4	G1 SW5	G2 SW1	G2 SW2	G2 SW3	G2 SW4	G2 SW5	G2 SW6	Class 2	Class 3	Class 4	Class 5
pH		**10.3**	**9.09**	8.86	9.33	9.02	8.9	-	**9.04**	8.7	8.08	8	5.0-9.0	5.0-9.0	5.0-9.0	
Temp	°C	29.2	29.1	30.6	33.4	31.9	30.7	-	30.2	32.2	31.5	30.9	-	-	-	
Conductivity	µS	657	254	1064	1198	1595	591	-	444	327	217	214	-	-	-	lower than class 4
Salinity	ppt	0.3	0.1	0.5	0.6	0.8	0.3	-	0.2	0.1	0.1	0.1	-	-	-	
TDS	mg/l	467	180	753	849	1130	418	-	315	229	154	152	-	-	-	
TSS	mg/l	23	59	27	77	180	170	160	120	180	97	83	-	-	-	
DO	mg/l	8	8.1	7.7	8.1	7.5	7	-	7.7	7	7.1	6.8	>6.0	>4.0	>2.0	
Kerosene Range	mg/l	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	-			
Diesel Range	mg/l	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	-			
Heavy Oil Range	mg/l	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	-			
Gasoline Range	mg/l	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	-			
Benzene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	-			
Toluene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	-			
Ethyl benzene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	-			
Total Xylene	µg/l	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	-			
Arsenic (As)	mg/l	0.0217	0.0278	0.0212	0.0174	0.0292	<0.009	<0.009	0.00998	0.0135	<0.009	<0.009	0.01			
Cadmium (Cd)	mg/l	0.00253	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05			lower than class 4
Total Chromium (Cr)	mg/l	<0.006	<0.006	<0.006	0.0204	0.0188	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	-			
Lead (Pb)	mg/l	0.0101	0.0103	<0.007	0.0106	0.0107	<0.007	0.00924	<0.007	<0.007	<0.007	<0.007	0.05			
Mercury (Hg)	mg/l	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	0.002			
Nickel (Ni)	mg/l	0.0116	0.0104	<0.007	0.0508	0.0259	0.013	0.014	<0.007	<0.007	0.0201	0.0153	0.1			
Barium (Ba)	mg/l	<0.007	<0.007	<0.007	<0.007	0.0243	<0.007	0.0257	<0.007	<0.007	<0.007	<0.007	-			

Parameter	Unit	G-1					G-2						Standard(1)			
		G1 SW1	G1 SW2	G1 SW3	G1 SW4	G1 SW5	G2 SW1	G2 SW2	G2 SW3	G2 SW4	G2 SW5	G2 SW6	Class 2	Class 3	Class 4	Class 5
Copper (Cu)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.1			
Zinc (Zn)	mg/l	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	1.0			
Iron (Fe)	mg/l	0.378	1.52	0.0119	1.35	2.45	0.547	1.16	0.413	0.861	0.764	0.833	-			
Manganese (Mn)	mg/l	<0.006	0.135	<0.006	<0.006	0.0461	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	1.0			
Selenium (Se)	mg/l	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	-			

Note: There are no Myanmar or WHO guideline values available for surface water quality. The surface water quality results were compared to Thailand standard.

Bold means higher than the standard.

(1) Surface Water Quality Standards from the Notification of the National Environmental Board, No. 8, B.E. 2537 (1994), issued under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992) , published in the Royal Government Gazette, Vol. 111, Part 16, dated February 24, B.E.2537 (1994).

- Classification of surface water **Class 2**: Very clean fresh surface water resources used for: 1) Consumption which requires conservational water treatment processes before use; 2) Aquatic organism conservation; 3) Fisheries; 4) Recreation;
- Classification of surface water **Class 3**: Medium clean fresh surface water resource used for: 1) Consumption, but passing through an ordinary treatment process before use; 2) Agriculture;
- Classification of surface water **Class 4**: Fairly clean fresh surface water resource used for: 1) Consumption, but requires special water treatment process before use; 2) Industry; and
- Classification of surface water **Class 5**: The sources which are not classified in class 1-4 used for navigation.

Table 5.7 Surface Water Quality Results from Blocks PSC-G & EP-2 Drilling Baseline Survey (Cont'd)

Parameter	Unit	G-3			EP2-1			EP2-2	EP2-3		Standard			
		G3 SW1	G3 SW2	G3 SW3	EP2-1 SW1	EP2-1 SW2	EP2-1 SW3	EP2-2 SW1	EP2-3 SW1	EP2-3 SW2	Class 2	Class 3	Class 4	Class 5
pH		8.27	8.12	7.85	8.18	8.11	9.43	8.36	7.96	8.36	5.0-9.0	5.0-9.0	5.0-9.0	
Temp	°C	29.9	34.5	29.1	28.3	29.4	30.4	21.2	28.1	31.4	-	-	-	
Conductivity	µS	77.7	132.1	2680	220	61	300	316	632	330	-	-	-	
Salinity	ppt	0	0.1	1.3	0.1	0.1	0.1	0.1	0.3	1.1	-	-	-	lower than class 4
TDS	mg/l	548	93.7	64.4	156	164	212	224	447	234	-	-	-	
TSS	mg/l	370	1900	13	1200	2500	150	870	840	110	-	-	-	
DO	mg/l	5.7	6.6	5	7.3	7.4	7.7	7.4	7.7	6.2	>6	>4	>2	
Kerosene Range	mg/l	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	-			
Diesel Range	mg/l	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	-			
Heavy Oil Range	mg/l	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	-			
Gasoline Range	mg/l	<400	<400	<400	<400	<400	<400	<400	<400	<400	-			
Benzene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	-			
Toluene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	-			
Ethylbenzene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	-			
Total Xylene	µg/l	<12	<12	<12	<12	<12	<12	<12	<12	<12	-			
Arsenic (As)	mg/l	<0.009	<0.009	**0.0116**	<0.009	<0.009	0.00964	<0.009	<0.009	<0.009	0.01			
Cadmium (Cd)	mg/l	0.0184	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05			
Total Chromium (Cr)	mg/l	<0.006	0.0181	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	-			
Lead (Pb)	mg/l	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	0.05			
Mercury (Hg)	mg/l	0.00086	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	0.002			
Nickel (Ni)	mg/l	0.0199	0.0192	<0.007	<0.007	0.0727	0.0111	<0.007	<0.007	<0.007	0.1			
Barium (Ba)	mg/l	0.0475	0.0413	0.0251	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	-			lower than class 4

Parameter	Unit	G-3			EP2-1			EP2-2	EP2-3		Standard			
		G3 SW1	G3 SW2	G3 SW3	EP2-1 SW1	EP2-1 SW2	EP2-1 SW3	EP2-2 SW1	EP2-3 SW1	EP2-3 SW2	Class 2	Class 3	Class 4	Class 5
Copper (Cu)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.1			
Zinc (Zn)	mg/l	0.0651	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	1.0			
Iron (Fe)	mg/l	7.48	7.84	0.613	2.07	4.37	1.58	1.32	0.675	1.52	-			
Manganese (Mn)	mg/l	0.0569	0.0857	<0.006	0.0461	0.0727	0.934	<0.006	<0.006	<0.006	1.0			
Selenium (Se)	mg/l	<0.006	0.0418	0.0649	0.0603	0.0436	0.0598	0.0638	0.0631	0.0573	-			

Note: There are no Myanmar or WHO guideline values available for surface water quality. The surface water quality results were compared to Thailand standard.

Bold means higher than the standard.

(1) Surface Water Quality Standards from the Notification of the National Environmental Board, No. 8, B.E. 2537 (1994), issued under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992) , published in the Royal Government Gazette, Vol. 111, Part 16, dated February 24, B.E.2537 (1994).

- Classification of surface water **Class 2**: Very clean fresh surface water resources used for: 1) Consumption which requires conservational water treatment processes before use; 2) Aquatic organism conservation; 3) Fisheries; 4) Recreation;
- Classification of surface water **Class 3**: Medium clean fresh surface water resource used for: 1) Consumption, but passing through an ordinary treatment process before use; 2) Agriculture;
- Classification of surface water **Class 4**: Fairly clean fresh surface water resource used for: 1) Consumption, but requires special water treatment process before use; 2) Industry; and
- Classification of surface water **Class 5**: The sources which are not classified in class 1-4 used for navigation.

5.3.8 *Groundwater*

Information on local groundwater conditions was collected based on literature review, as well as results from the Blocks PSC-G & EP-2 Drilling Baseline Sampling Survey.

5.3.8.1 *Groundwater Use*

Groundwater is the principal source of potable domestic water supply in Magway Region. Groundwater is being exploited not only for domestic water supply but also for irrigation purposes in areas where conditions are favourable. Impoundments are used primarily for watering livestock and some domestic use.

On the basis of stratigraphy, there are 13 different types of aquifers in Myanmar, namely Alluvium, Irrawaddian, Peguan, Limestone, Igneous (or Volcanic) and Other Minor Aquifers. The Project area is underlain by the Eocene and Peguan Alluvian aquifers (***Figure 5.8***).

Quality and quantity of groundwater varies depending on the lithology and depositional environments. For instance, groundwater quality of Alluvial and Ayeyarwady aquifers is suitable for domestic use and irrigation purposes. However, in the water-scarce regions, groundwater from Pegu, Eocene and Plateau Limestone aquifers is not totally suitable for drinking purposes in terms of water quality, but is extracted for domestic use.

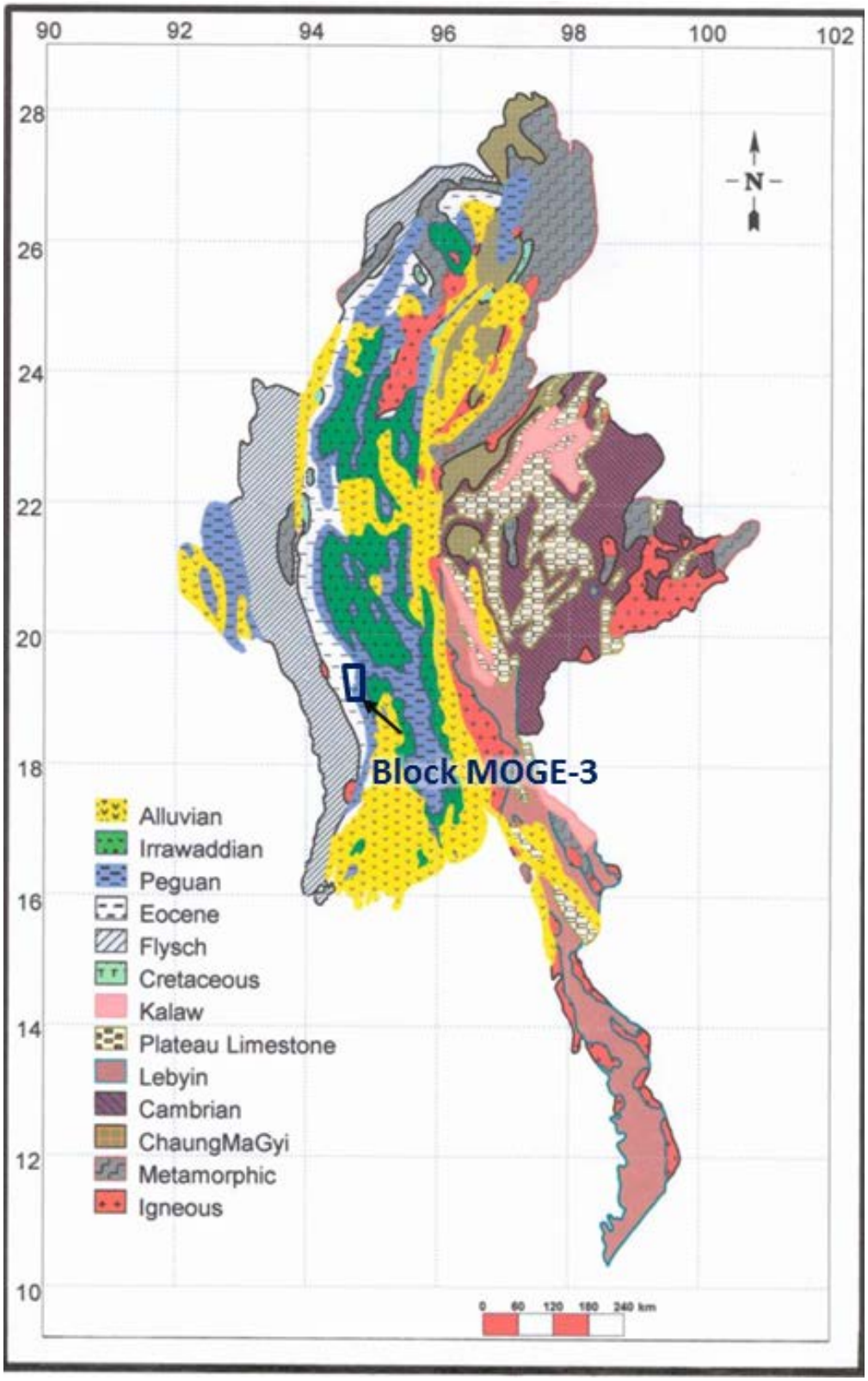
5.3.8.2 *Groundwater Quality*

During the Blocks PSC-G & EP-2 Drilling Baseline Sampling Survey, groundwater sampling was conducted at strategic community locations strategically selected within Block PSC-G & EP-2 (see ***Annex E***).

The result showed relatively high Total Dissolved Solids (TDS) levels, exceeding maximum allowable levels were recorded at G1-GW2, G2- GW6, G3-GW4, EP2-1 (GW1 & GW2) and EP2-2 (GW1, GW2 & GW3) (***Table 5.8***). Heavy metals detected in groundwater were Arsenic (As), Mercury (Hg), Nickel (Ni), Barium (Ba), Copper (Cu), Zinc (Zn), Iron (Fe), Manganese (Mn) and Selenium (Se). Manganese slightly over the maximum allowable level was detected at EP2-1 (GW5). Selenium was over the maximum allowable limit at most sample locations. No petroleum hydrocarbons were detected.

Due to the shared aquifers, similar groundwater quality would be expected in Block MOGE-3.

Figure 5.8 Major Aquifers of Myanmar Relative to Block MOGE-3



Source: Adapted from http://danishwater.dk/wp-content/uploads/2013/09/Ministry-of-Agriculture-and-Irrigation-Department-of-Water-Resources-Utilization-Sustainable-Development-and-Management-of-Groundwater-in-Myanmar.pdf. Retrived on 28 January 2015

Table 5.8 Summary of Groundwater Quality Results from the Blocks PSC-G & EP-2 Drilling Baseline Survey

Parameter	Unit	G1					G2						G3					Standard[1]	
		G1 GW1	G1 GW2	G1 GW3	G1 GW4	G1 GW5	G2 GW1	G2 GW2	G2 GW3	G2 GW4	G2 GW5	G2 GW6	G3 GW1	G3 GW2	G3 GW3	G3 GW4	G3 GW5	Suitable Allowance	Maximum Allowable
pH	-	7.82	8.15	7.81	7.84	7.74	7.98	8.08	7.87	8.36	7.78	8.56	7.63	7.74	-	7.28	7.18	7.0-8.5	6.5-9.2
Temp	°C	27.2	28.7	30.3	31.2	27.1	27.1	30.2	26.9	28.3	26.2	29.9	27.6	29.7	-	27.3	27.7	-	-
Conductivity	µS	471	1,078	3,720	815	580	1,149	1,131	986	411	824	2,620	803	2,460	-	2,890	806	-	-
Salinity	ppt	0.2	0.5	1.8	0.4	0.3	0.5	0.5	0.5	0.2	0.4	1.3	3.7	1.1	-	1.4	0.4	-	-
TDS	mg/l	334	765	**2,640**	578	412	812	102	700	291	585	**1,860**	570	**1,740**	-	**2,050**	572	<600	1,200
Kerosene Range	mg/l	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	-	-
Diesel Range	mg/l	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	-	-
Heavy Oil Range	mg/l	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	-	-
Gasoline Range	µg/l	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	-	-
Benzene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	-	-
Toluene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	-	-
Ethyl benzene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	-	-
Total Xylene	µg/l	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	-	-
Arsenic (As)	mg/l	<0.009	<0.009	<0.009	0.0126	0.0149	<0.009	<0.009	<0.009	0.0265	0.0215	<0.009	0.011	0.0343	0.039	0.0291	<0.009	Absent	0.05
Cadmium (Cd)	mg/l	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	Absent	0.01
Total Chromium (Cr)	mg/l	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-	-
Lead (Pb)	mg/l	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	Absent	0.05
Mercury (Hg)	mg/l	<0.0007	0.00086	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	0.0009	<0.0007	0.00076	<0.0007	<0.0007	Absent	0.001
Nickel (Ni)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00715	<0.01	0.00701	-	-
Barium (Ba)	mg/l	<0.018	0.104	0.0282	0.0323	0.00726	0.00929	0.0946	<0.018	<0.018	0.0157	0.0189	0.007	0.00751	0.00992	0.127	0.0119	-	-
Copper (Cu)	mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	0.0064	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	1.0	1.5
Zinc (Zn)	mg/l	<0.065	<0.065	<0.065	<0.065	0.00937	0.0191	<0.065	0.0103	<0.065	<0.065	<0.065	0.0106	<0.065	0.00918	0.0137	0.0102	5.0	15.0
Iron (Fe)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	0.17	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.19	<0.1	<0.1	0.5	1.0
Manganese (Mn)	mg/l	<0.035	<0.035	0.0588	0.038	<0.035	<0.035	<0.035	0.0064	<0.035	<0.035	0.00735	0.0727	0.0809	0.0684	0.0227	<0.035	0.3	0.5
Selenium (Se)	mg/l	**0.0272**	**0.0169**	**0.0168**	0.00919	<0.009	0.0099	<0.009	**0.0222**	<0.009	**0.0151**	**0.0495**	<0.009	**0.0583**	**0.0434**	**0.0426**	**0.0155**	Absent	0.01

Note: There are no Myanmar or WHO guideline values available for groundwater quality. The groundwater quality results were compared to Thailand standard.

[1] Standard from Notification of Ministry of Natural Resources and Environment B.E. 2551 (2008) from Thailand

Table 5.8 Summary of Groundwater Quality Results from the Blocks PSC-G & EP-2 Drilling Baseline Survey (Cont'd)

Parameter	Unit	EP2-1					EP2-2			EP2-3				Standard[1]	
		EP2-1 GW1	EP2-1 GW2	EP2-1 GW3	EP2-1 GW4	EP2-1 GW5	EP2-2 GW1	EP2-2 GW2	EP2-2 GW3	EP2-3 GW1	EP2-3 GW2	EP2-3 GW3	EP2-3 GW4	Suitable Allowance	Maximum Allowable
pH	-	7.71	7.95	7.47		7.46	7.26	7.97	7.47	7.14	7.80		8.21	7.0-8.5	6.5-6.2
Temp	°C	29	29.3	28.4		28.1	29.8	28.5	29.1	28	28.5		28.4	-	-
Conductivity	µS	1,788	2,450	898		928	3,090	2,430	2,150	1,189	1,178		1,557	-	-
Salinity	ppt	0.8	1.2	0.4		0.4	1.5	1.2	1	0.6	0.5		1.1	-	-
TDS	mg/l	**1,260**	**1,720**	637		658	**2,180**	**1,720**	**1,510**	844	833		733	<600	1,200
Keronsene Range	mg/l	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	-	-
Diesel Range	mg/l	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	<0.234	-	-
Heavy Range	mg/l	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	<0.467	-	-
Gasoline Range	µg/l	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	<400	-	-
Benzene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	-	-
Toluene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	-	-
Ethylbenzene	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	-	-
Total Xylene	µg/l	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	-	-
Arsenic (As)	mg/l	0.00905	0.0427	<0.009	<0.009	0.0104	<0.009	<0.009	<0.009	0.0124	<0.009	0.0148	<0.009	Absent	0.05
Cadmium (Cd)	mg/l	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	Absent	0.01
Total Chromium (Cr)	mg/l	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-	-
Lead (Pb)	mg/l	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	Absent	0.05
Mercury (Hg)	mg/l	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	Absent	0.001
Nickel (Ni)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
Barium (Ba)	mg/l	0.0523	0.35	0.0148	0.0112	0.0688	0.0253	0.023	<0.018	<0.018	0.0229	0.039	0.0412	-	-
Copper (Cu)	mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<1.0	1.5
Zinc (Zn)	mg/l	<0.065	<0.065	<0.065	<0.065	<0.065	<0.065	<0.065	<0.065	<0.065	<0.065	<0.065	<0.065	<5.0	15
15Iron (Fe)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5	1
Manganese (Mn)	mg/l	0.221	0.059	0.0179	0.0465	**0.622**	0.0122	0.0301	<0.035	0.0627	0.137	<0.035	<0.00847	<0.3	0.5
Selenium (Se)	mg/l	0.00771	0.00772	**0.0345**	**0.0585**	**0.0653**	**0.0864**	**0.0795**	<0.009	**0.0928**	**0.0749**	**0.0758**	**0.0826**	Absent	0.01

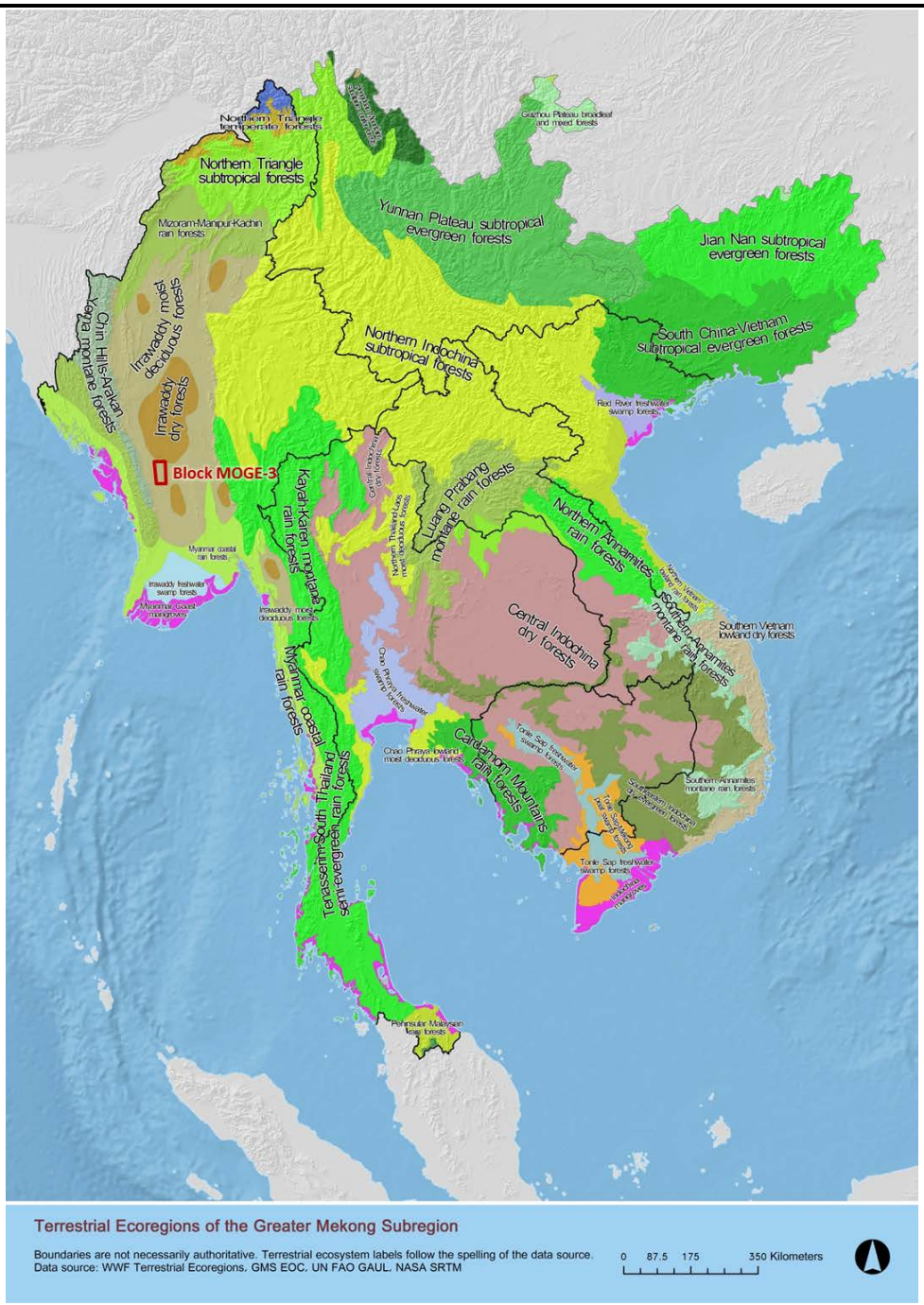
Note: There are no Myanmar or WHO guideline values available for groundwater quality. The groundwater quality results were compared to Thailand standard.
[1] Standard from Notification of Ministry of Natural Resources and Environment B.E. 2551 (2008) from Thailand

5.4 BIOLOGICAL COMPONENTS

5.4.1 Ecoregion

Ecoregions are biogeographic units, which are relatively large units of land or water that contain distinct assemblages of natural communities, sharing a majority of species, dynamics and environmental conditions. Under this classification scheme, ecoregions exist within "bioregions" and typically contain numerous "ecozones". Block MOGE-3 is covered entirely by the Irrawaddy Moist Deciduous Forest ecoregion (***Figure 5.9***) (*WWF, 2004*). This ecoregion is characterized by more mesic conditions and extensive forest cover where found in its undisturbed state.

Figure 5.9 Terrestrial Ecoregions in Myanmar



Source: http://www.gms-eoc.org/uploads/map/archives/map/GMS-Ecoregions_18.jpg

5.4.2 *Terrestrial Flora*

5.4.2.1 *Forest*

Due to different localities, topography and climatic conditions, the forest flora in Myanmar are diverse and vary from sub-alpine in the north through dry and moist mixed deciduous to tropical rain forests in the south. The Project area is in the Moist Deciduous Forest Region, at an altitude of 181 to 341 m above sea level.

This forest type is mainly composed of numerous commercially important timber species including teak (*Tectona grandis*), which is central to forest management in Myanmar. Many other commercially important hardwood timber species are associated with teak including *Xylia xylocarpa* (Myanmar Iron Wood), *Pterocarpus macrocarpus*, *Gmelina arborea*, *Melitia pendula* and *Dalbergia oliveri*. A high diversity of vegetation including bamboos is observed in the different types of deciduous forests in Myanmar.

A potentially rare plant species, the latpanphyu, or white silk cotton tree, has been sighted about 3 km from Outo village in Yesagyo township, in Magway Region[9]. However, this lies outside of Block MOGE-3.

Data on flora was collected from the Blocks PSC-G & EP-2 2D Seismic Baseline Survey. Ten sampling plots (0.225 ha) were set up to collect tree composition and their distribution in Ayeyarwady Moist Deciduous Forest Region, in the same region of the Project area. The result indicated that there were five leading dominant trees, including *Tectona hamiltoniana*, *Acacia catechu* Willd, *Anthocephalus cadamba* Miq., *Dalbergia paniculata* Roxb., and *Terminalia oliveri*, with Importance Value Index (IVI) values of 65.5, 26.4, 25.5, 22.1, 16.4, respectively. Presence of these tree species can be considered as an ecological indicator species for the ecoregion.

According to the results, the diversity indices of individual sample plots and all sample species indices are very low. Diversity value for all samples are as follows: Shannon Wiener index (H) is 2.76, Simpsons index (D) is 10.18, Brillouin (D) is 2.59.

Among the ten sample plots studied, 29 tree species were recorded, and for four species only one individual was found; these species are considered as unique species in the Project area.

Where encountered, forests within Block MOGE-3 are considered to be similar in species make up and diversity as those sampled in Blocks PSC-G & EP-2.

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[9] Myanmar Times, February 6-12, 2012, Volume 31, No. 613

5.4.2.2 *Reserved Forest*

According to the national classification for forests, the total area of the country is divided into five (5) classes: closed forest, open forest, other wooded land, inland water bodies and other land (***Figure 5.10***).

In Myanmar, different typologies of forest and differences in their legal status are found. Permanent Forest Estate (PFE) includes reserved forests and protected public forests constituted under the Forest Law and protected areas system (PAS) designated under the Protection of Wildlife and Protected Areas Law.

The total areas of Protected Reserved Forest/Non Reserved Forest in Thayet Township are about 13,682 acres, and some areas are under consideration for protection by Township Forest Department in Thayet. The natural species of the in Thayet Township are Teak, Pyinkado (*Xyliaxylocarpa*), Ingyin (*Pentacme*), In (*Dipterocarpus*), Taukkyan (*Terminalia tomentosa*), Thitya (*Shorea oblongifilia*), Nabe (*Lannea grandis*), Didu (*Salmalia insignis*), Letpan (*Salmalia malabarica*), Sha (*Acacia catechu*), and other woods with Bamboos etc.

Thae Phyu Reserved Forest is located within Block MOGE-3. The forest covers a total area of 26.6 km^2, which represents only 2.2 percent of Block MOGE-3 (***Figure 5.11***). Reserved Forest in the Project area are for timber production and are not protected areas. Therefore, the developers can carry out seismic activities in the area with appropriate discussion and approval with Ministry of Environmental Conservation and Forestry.

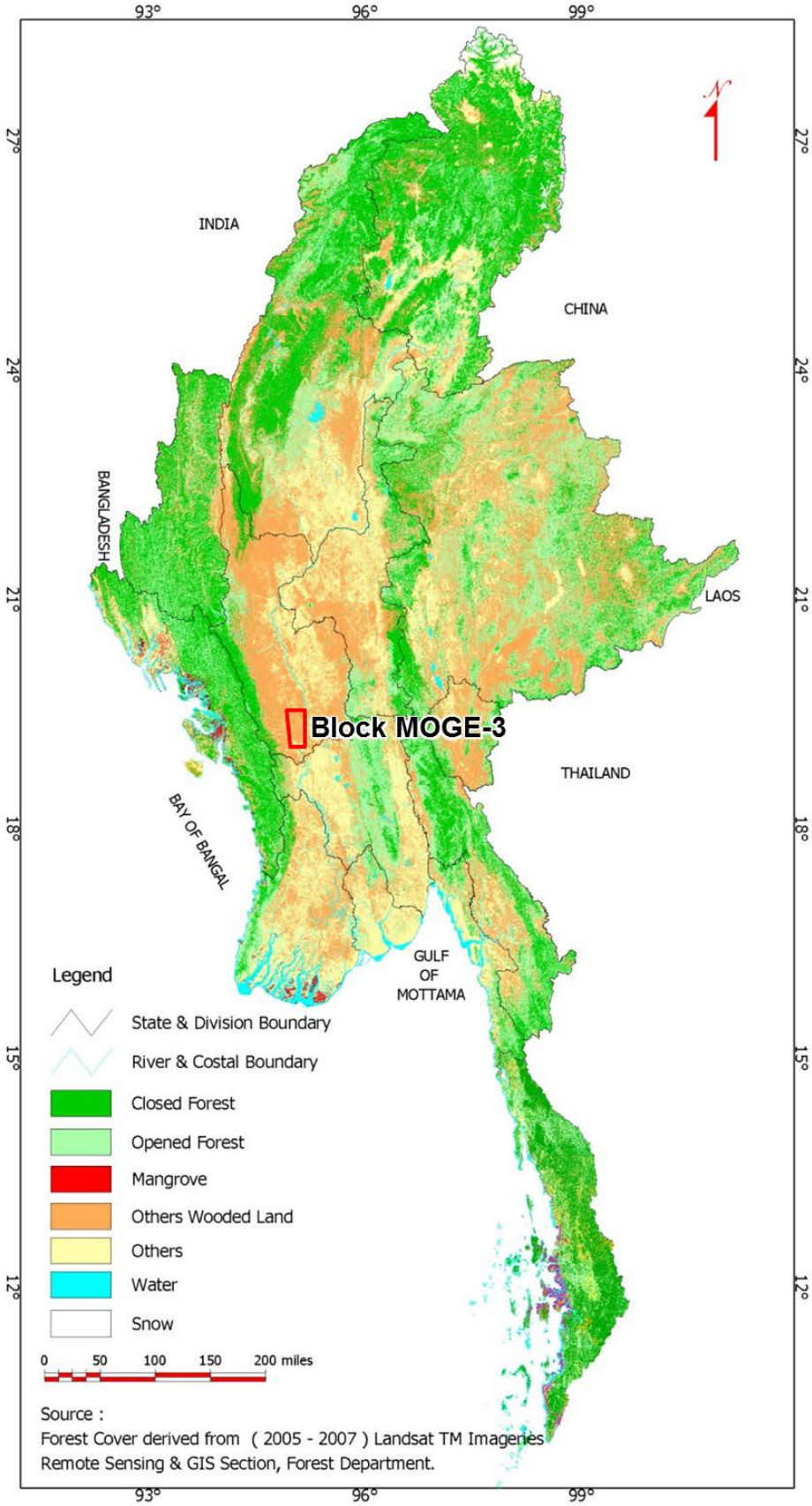
In addition, The Forest Department in Thayet Township provided a list of the flora and fauna types that can be found within Thae Phyu Reserved Forest, as shown in ***Table 5.9***. It is noted that there are no rare or endangered trees or animals found within the reserved forest.

Table 5.9 List of Flora and Fauna found within Thae Phyu Reserved Forest

No	Preserved/ Protected Forest Name	Types of Flora	Types of Fauna	Rare (Endangered) Trees and Animals
1	Thae Phyu	Pyinkado (Ironwood), Thitya (Yellow Balau), Inn Gyinn (Shorea oblongifolia), Tauk Gyant (Myanmar Walnut), In (Dipterocarpus Tuberculatus), Zin Pyune, Nabe (Lannea Coromandelica), Te, Phan Khar (Terminalia chebula), Didu (Salmalia insignis), Chin Yote (Garuga pinnata), Yinn Tike (Rose wood), Sitsay, Lwon Pho	Barking deer, Jungle Cat, Wild Pig (Boar), Heron, parrot	None

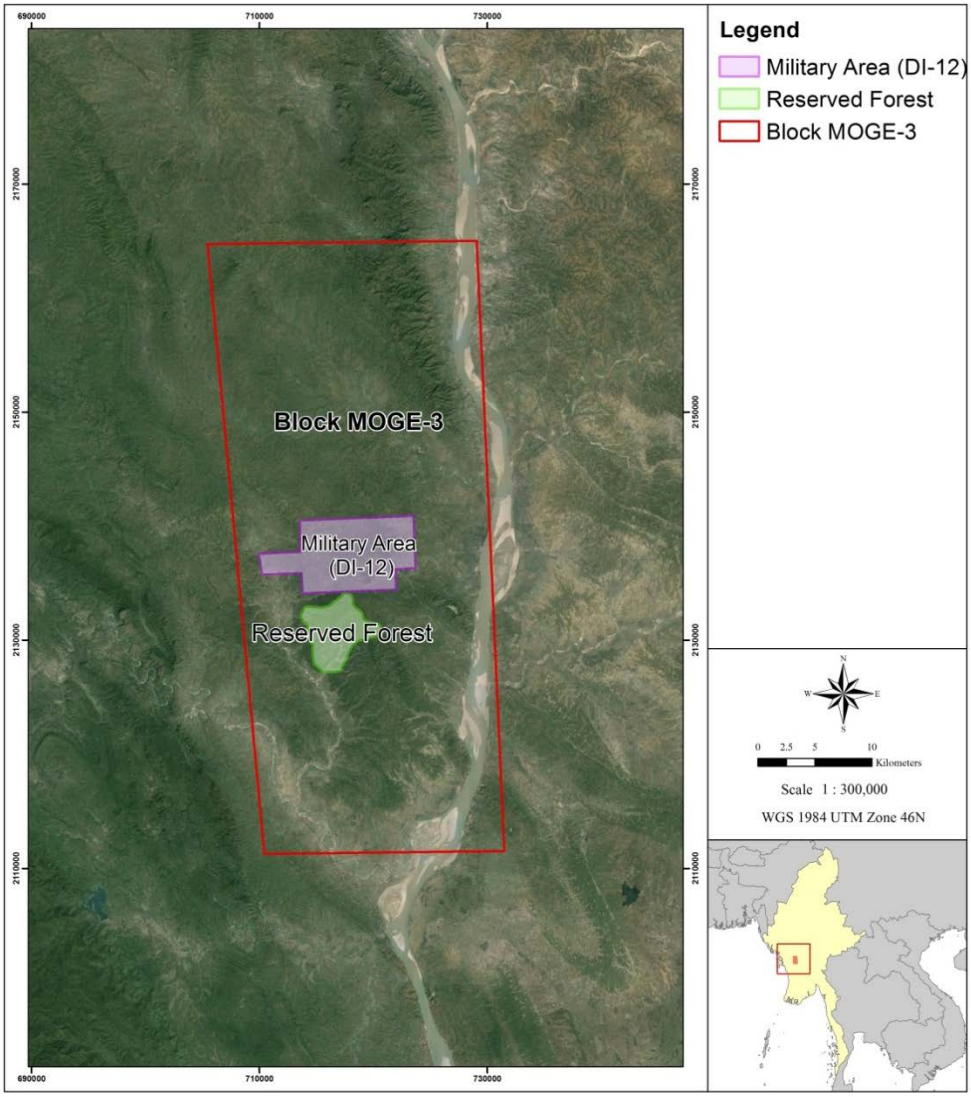
Source: Forest Department, Thayet, 2017

Figure 5.10 Forest Cover Status of Myanmar during 2005-2007



Source: National Biodiversity Strategy and Action Plan Myanmar, 2011 Retrieved from http://www.cbd.int/doc/world/mm/mm-nbsap-01-en.pdf

Figure 5.11 Reserved Forest in Block MOGE-3



Source: MMRD, 2014

5.4.3 *Terrestrial Fauna*

The principal approach for establishing a baseline for fauna within the Project area was through review of technical literature, previous surveys, and internet search. Based on a field investigation by Win Precious Resources (WPR)[10], the common wildlife species in Block MOGE-3 are jungle fowl, crow, snake, iguana, partridge, rabbit, barking deer and boar etc.

As mentioned above, the Moist Deciduous Forest Region ecoregion is prevalent within the Project area and covers all of Block MOGE-3. According to data from the Blocks PSC-G & EP-2 2D Seismic Baseline Survey, there are some endangered and endemic species in Moist Deciduous Forest Region. A list of fauna observed during the survey is presented in ***Annex E***.

Asian elephants (*Elephas maximus*) survive in this ecoregion, but their numbers have slowly decreased as their habitat has become more fragmented. Eld's deer (*Cervus eldi thamin*) occur in the ecoregion and listed as endemic species and Sambhur (*Cervus unicolor)* is a near-threatened species. Other important small species recorded include masked palm civet (*Paguma larvata*), leopard cat (*Felis bengalensis*), and Sunda pangolin (*Manis javanica*). Among the small mammal species data, Sunda pangolin (*Manis javanica)* is an endangered species and the Stump-tailed macaque (*Macaca arctoides melanota)* is listed as a vulnerable species.

There are seven national endemic turtle species in Myanmar, namely, Burmese Frog-faced Softshell Turtle (*Chitra vandijki)*; Burmese Star Tortoise (*Geochelone platynota)*; Arakan Forest Turtle (*Heosemys depressa)*; Burmese Roofed Turtle (*Kachuga trivitatta)*; Burmese Flapshell Turtle (*Lissemys scutata)*; Burmese Eyed Turtle (*Morenia ocellata)*; and Burmese Peacock Softshell (*Nilssonia Formosa)*.[11] These seven species are globally threatened species and endemic to Myanmar.

According to data from the Blocks PSC-G & EP-2 2D Seismic Baseline Survey in this ecoregion, yellow tortoise (*Indotestudo elongate)* are listed as endangered species. Burmese star tortoise (*Geochelone platynota)* is a critically endangered species. All recorded amphibian species are not listed under IUCN threatened species.

Many birds are found in this ecoregion, and they include both water and forest birds found in a wide variety of habitats. This ecoregion also corresponds to the Ayeyarwady Plains Endemic Bird Area (EBA), which are important places for habitat-based conservation of birds, as defined by Bird Life International. In addition to the white-throated babbler, the hooded treepie (*Crypsirina cucullata*) is also classified as vulnerable. A total of 37 bird

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[10] Report of MOGE-3 Block at Thayet Township in Magway Region, based on field investigation trip from 7th to 12th November 2013

[11] National Biodiversity Strategy and Action Plan Myanmar, 2011. Retrieved from http://www.cbd.int/doc/world/mm/mm-nbsap-01-en.pdf

species were recorded in the area during the Blocks PSC-G & EP-2 2D Seismic Baseline Survey, with a population density was 159 birds/km^2.

5.4.4 *Aquatic Ecology*

Information on aquatic biota data was obtained from review of literature, internet, previous surveys and site reconnaissance.

The freshwater fish fauna of Myanmar is one of the least known in Southeast Asia (*Kullander et al. 2004*). Myanmar is estimated to support at least 350 freshwater fish species, a significant fraction of which may be national endemic (*S. Kullander, C. Ferraris, Jr and Fang Fang in litt. 2004*). Since 1997, twenty-seven (27) new species of freshwater fish have been described from Myanmar, and all of them are endemic (*Kullander and Britz 2002*), and at least ten more new species are waiting publication (*Kullander et al. 2004*).

National endemic fish species include the miniature fish (*Danionell a translucida*) and (*D. mirifica*), the world's smallest freshwater vertebrates (*Britz 2003*). Considerable local endemism is thought to have gone without notice, as a result, fish species in Myanmar have been misidentified as better-known species from the Indian Sub-continent (*Kullander et al. 2004*). Moreover, because of patchy collecting effort, it is difficult to assess local endemism apart from the fish in Inlay Lake, which supports several national endemic species (*Kullander et al. 2004*).[12]

A total of at least 43 species of fish are likely present in Ayeyarwady River (*Fishbase.org 2003*). Due to the countries isolation it is likely that new species will continue to be discovered within this watershed and others. Recent discoveries include new species of spiny eel (*Macrognathus dorsiocellatus*).

A total of 22 fish species were recorded in the Ayeyarwady river during the Blocks PSC-G & EP-2 2D Seismic Baseline Survey. Fish is an important food source of the local people. Among the most common species are the Indian Glass Fish (*Parambassis ranga*) and the Tank Goby (*Glossogobius giuris*). Food and Agriculture Organization (FAO) (2003) reports 19 species of fish and three freshwater are harvested and raised for food.

[12] National Biodiversity Strategy and Action Plan Myanmar, 2011. Retrieved from http://www.cbd.int/doc/world/mm/mm-nbsap-01-en.pdf

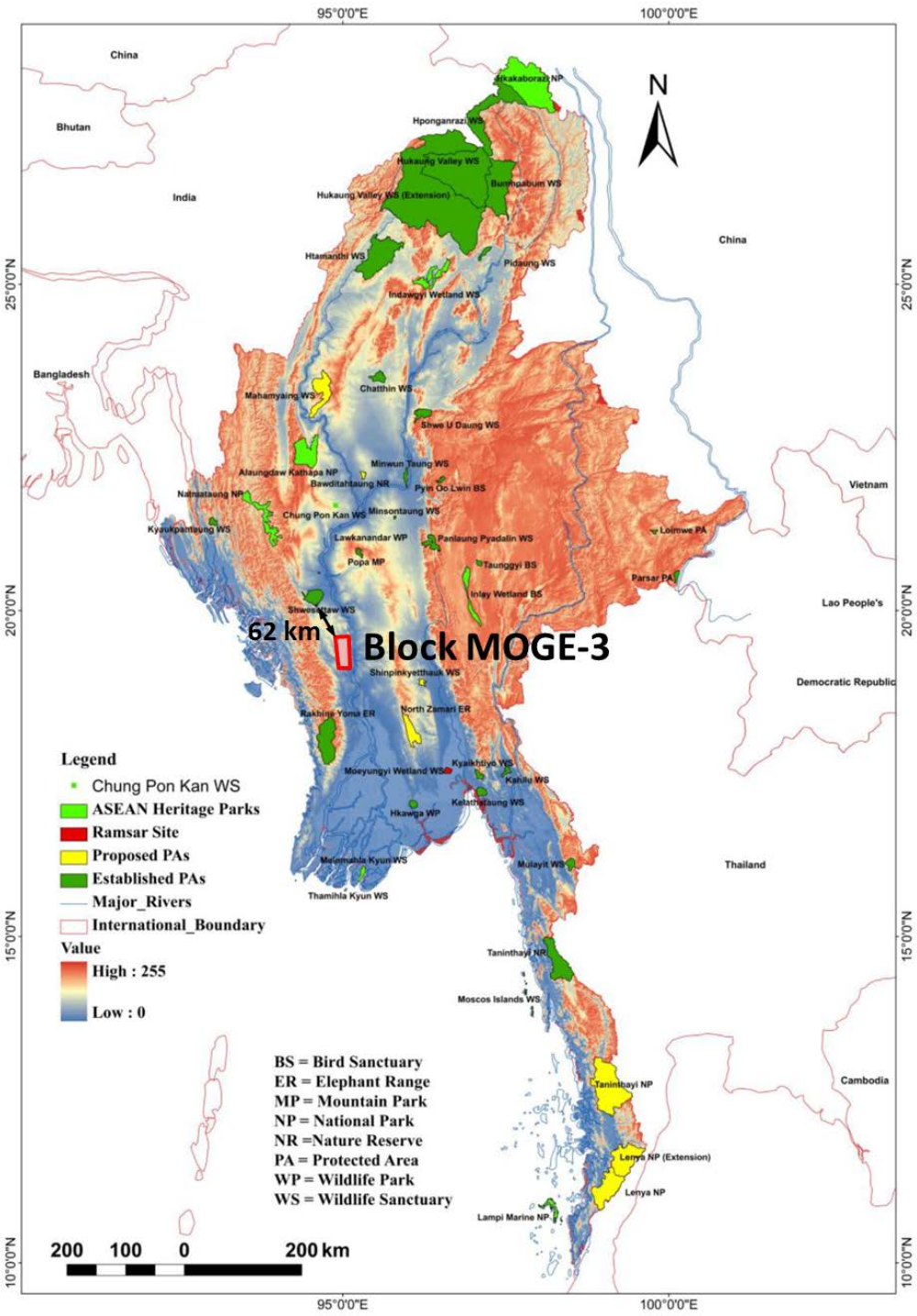
5.4.5 *Protected Areas*

A total of 43 protected areas have been established in Myanmar. The natural areas for protection are categorized as follows:

- Scientific Nature Reserve;
- National Park;
- Marine National Park;
- Nature Reserve;
- Wildlife Sanctuary;
- Geo-physically Significant Reserve; and
- Other Nature Reserve as determined by the Minister.

There are no environmental protected areas within Block MOGE-3. The nearest environmental protected area is Shwesettaw Wildlife Reserve (***Figure 5.12***) It is located in Magway Region, 62 km northwest of the Project. It occupies an area of 213.4 square miles (553 km^2) and was established in 1985. It is also designated as Important Bird Area and Key Biodiversity area.

Figure 5.12 Location of Protected Areas of Myanmar



Source: Fifth National Report to the United Nations Convention on Biological Diversity, Ministry of Environmental Convention and Forestry, March 2014

5.5 SOCIO-ECONOMIC COMPONENTS

5.5.1 Land Use and Livelihood

Block MOGE-3 lies at the south of Magway Region, in the dry zone of the central Myanmar lowlands, west of the Ayeyarwady River. Block MOGE-3 covers three townships, consisting of Thayet Township, Kanma Township and Aunglan Township in Thayet District. However, PTTEP SA's seismic survey activities will be undertaken in only Thayet and Kanma Townships.

Magway Region is situated in the central Myanmar lowlands. The landscape is distinct with rolling hills and badlands. The land area is highly cultivated, with little natural vegetation. The landscape is mostly covered with mosaic croplands/vegetation. The climate is classified as a tropical savanna (winter dry season), with a tropical very dry forest biozone.

Local people cultivate rice, chillies, beans and corn in river valleys and seasonal sandbars and cotton, beans and sesame in mountain valleys and uplands. Oil production takes place in the western margin of the lowlands, mainly to the west of the Ayeyarwady River. The soil in the area is high in nitosols, andosols, soil with deep, clay-enriched lower horizon with shiny ped surfaces.

In December, 2014, REM carried out a Land Use Study in Block MOGE-3. The report from this survey, which presents the complete results, is presented in ***Annex F***, and accompanying photographs are presented in ***Annex G***. A map summarizing the results from the Land Use Study is presented in ***Figure 5.13***. The study found that Block MOGE-3 is mostly covered with dry shrubland, agricultural areas, some areas of secondary forest, and sparsely populated villages. In addition, there are a number of "hand-dug oil well" communities, which are a unique phenomenon in Magway Region and discussed further in *Section 5.5.5.1*.

Another important land use is the presence of Military Industry (12) (Also known as DI-12) within Thayet Township. It is a military zone, consisting of approximately 72 km^2, and located southwest of Sa Khan Gyi Village. The precise activities within the zone are not known. PTTEP SA will consult with local military authorities regarding any required permissions if they wish to acquire seismic data within DI-12.

In addition to the Land Use Study, a Livelihood Study was carried out by MMRD in October 2014, to obtain data on local crop types and livelihood data in the region, including additional specific data on the hand-dug oil well communities. The report from this survey, which presents the complete results of the Livelihood Study, is presented in ***Annex B***. It was found that the economy of the townships in the Project area is chiefly agriculture-based, and the main products are rice, oil-seeds and pulses. In addition to the hand-dug oil wells, extensive lime quarries exist a few miles south of Thayet, as well a cement plant producing a total daily capacity of 156,000 tons, with a labor force of 758. Labor force participation is found mainly in 'agriculture' and

'livestock' (54% in Thayet Township and 67% in Kanma Township). Work force population engaging in secondary 'industry' sector is 6% in Thayet Township and 3% in Kanma Township; and in tertiary 'services' sector is 7% in Thayet Township and 4% in Kanma Township.

The net sown area of the Project Area is shown in ***Figure 5.16. Table 5.10*** and ***Table 5.11*** show a summary of land use in Thayet and Kanma Townships. Thayet consists of a high proportion of fallow land, covering 57.95% of total land area. Thayet also consists of 15.83% net sown area, and 10% infertile land. Kanma consists of a high proportion of cultivable waste land, covering 38.58% of total land area. Kanma also consists of 25.25% reserved forest, and 20.53% net sown area. Additional Land Use maps for Thayet and Kanma Townships are shown in ***Figure 5.14*** and ***Figure 5.15***, respectively.

Table 5.10 Land Use in Thayet Township

No.	Particular	Area (Acre)	% of Total Land
1	Net Sown Area	52,983	15.83
	(a) Paddy Land	16,933	5.06
	(b) Yar Land (suitable for Bean, Sesame, Cotton and others)	29,833	8.92
	(c) Kai/Kyun (suitable for corn, bean, onion, tobacco, vegetable and others)	4,994	1.49
	(d) Garden/Horticulture	616	0.18
	(e) High Yar Land (suitable for sesame)	607	0.18
2	Abandoned Land	-	-
3	Pasture Land	-	-
4	Infertile land	33,429	9.99
	(a) Industrial/Factory Land	16,095	4.81
	(b) Town/Village & Other Land	17,334	5.18
5	Reserved Forest	20,868	6.24
6	Fallow Land	193,927	57.95
7	Waste Land	-	-
Total		334,636	

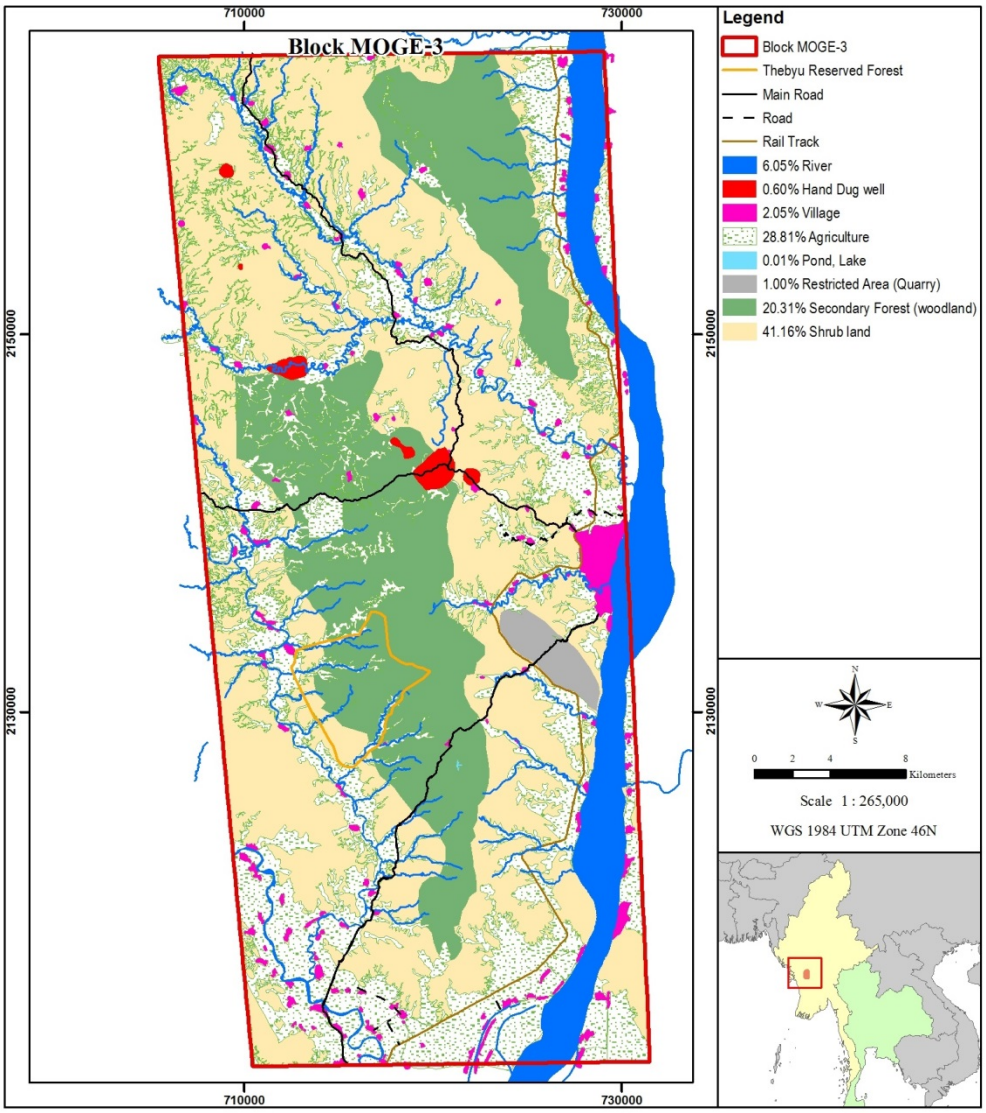
Source: GAD Township Profiles 2016, of Thayet Township

Table 5.11 Land Use in Kamma Township

No	Land of Type	Area(Acre)	% of Total Land
1	Net Sown Area	58,618	20.53
	(a) Paddy Land	21,085	7.39
	(b) Yar Land (suitable for Bean, Sesame, Cotton and others)	26,251	9.20
	(c) Kai/Kyun (suitable for corn, bean, onion, tobacco, vegetable and others)	11,152	3.91
	(d) Garden/Horticulture	130	0.05
	(e) High Yar Land (suitable for sesame)	-	-
2	Abandoned Land	-	-
	(a) Lel Area	-	-
	(b) Yar Area	-	-
	(c) Kine/Kyun	-	-
	(d) Garden / Horticulture	-	-
	(e) High Yar Land	-	-
3	Pasture Land	-	-
4	Industrial/Factory Land	-	-
5	Town/Village & Other Land	-	-
6	Reserved Forest	72,094	25.25
7	Cultivable waste land	110,144	38.58
8	Fallow Land	19,112	6.69
9	Waste Land	25,501	8.93
Total		285,469	100

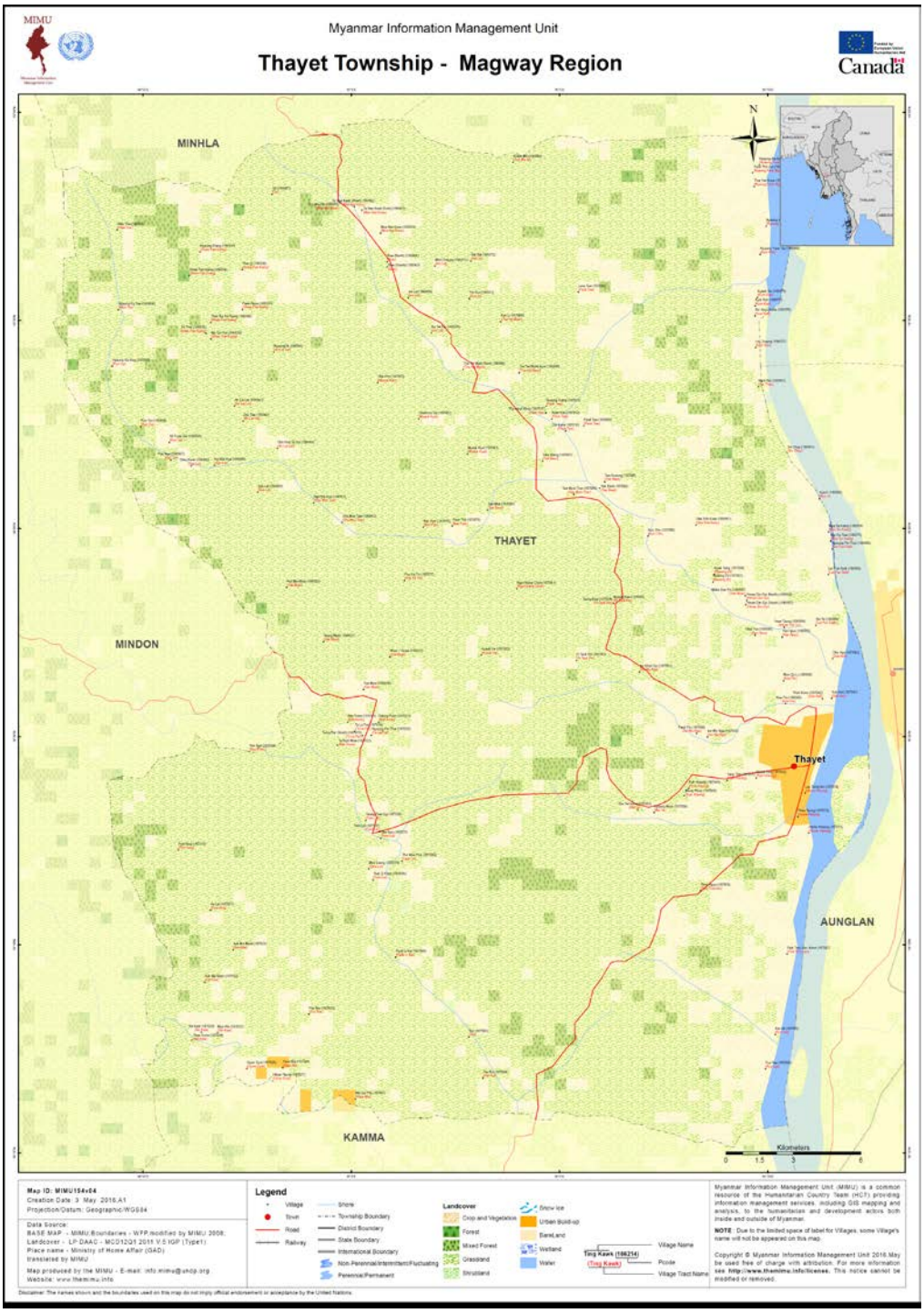
Source: GAD Township Profiles 2016, of Kamma Township

Figure 5.13 Land Cover of Block MOGE-3 in Magway Region



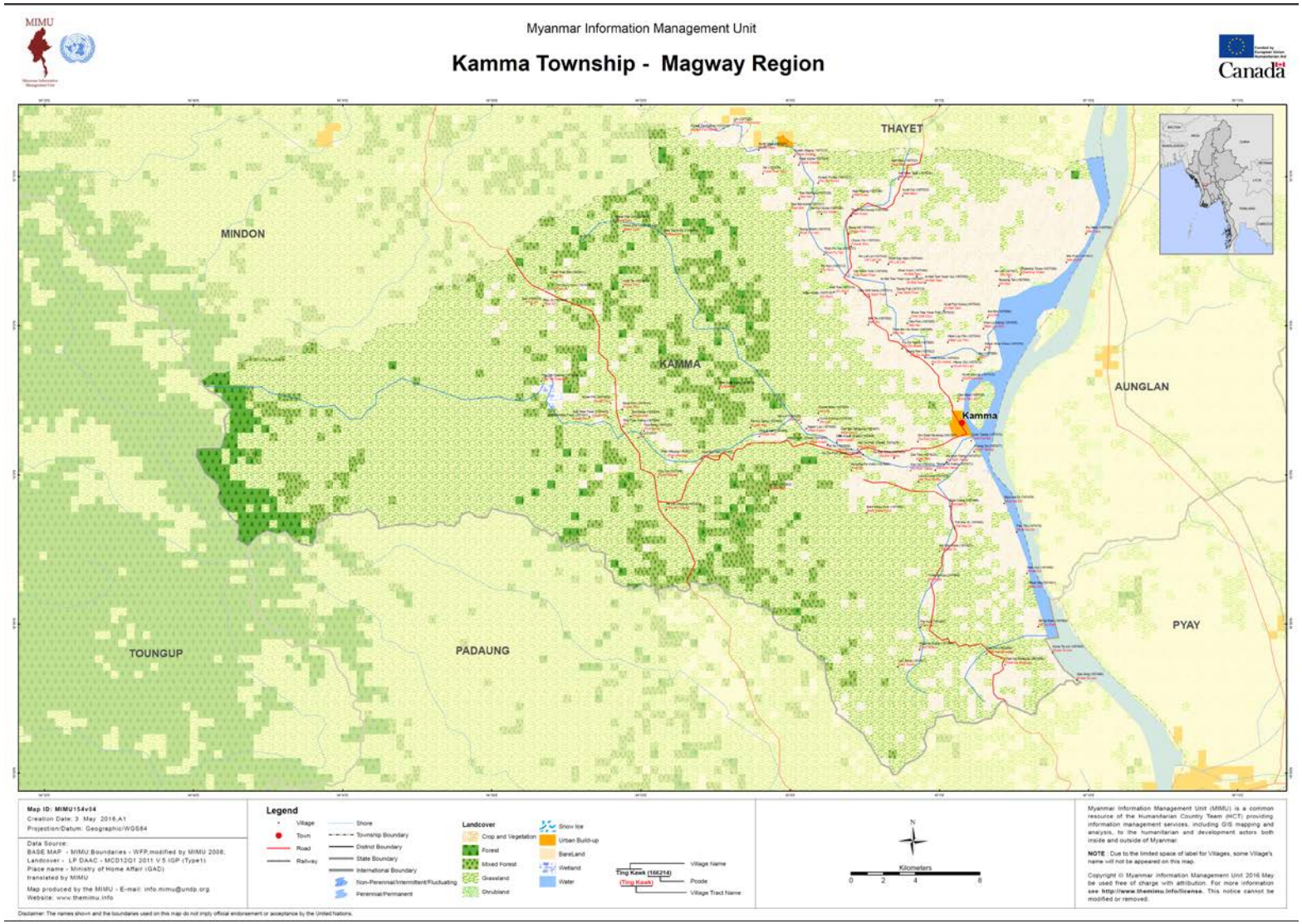
Source: ERM, 2015, based on data from field survey of REM, 2014

Figure 5.14 Land Use of Thayet Township



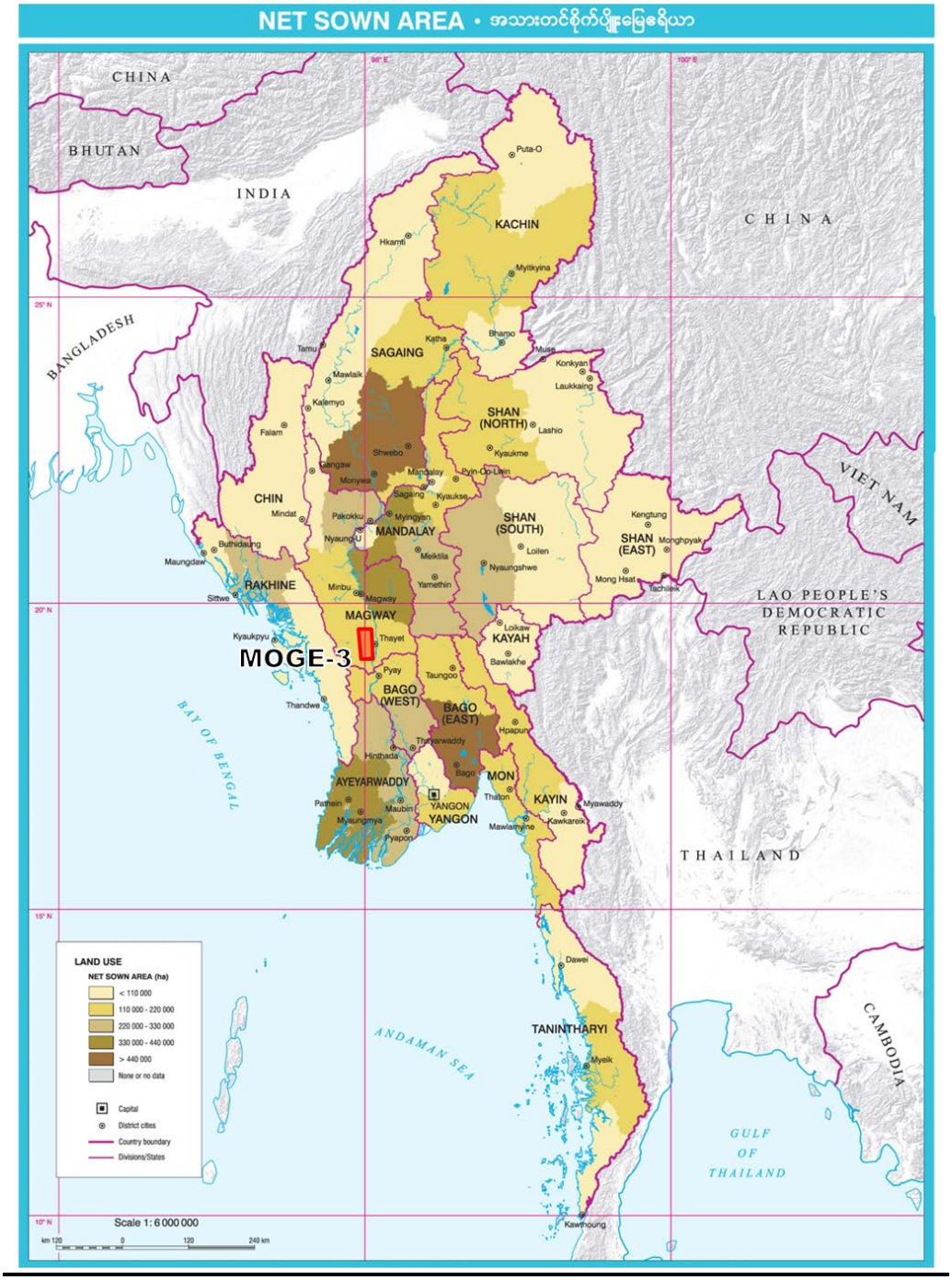
Source: MIMU, 2016

Figure 5.15 Land Use of Kanma Township



Source: MIMU, 2016

Figure 5.16 Net Sown Area of Project Area in Myanmar



Source: FAO, 2009

5.5.1.1 *Hand Dug Well Communities*

A notable feature within Magway Region is the presence of an informal oil drilling business, whereby local residents utilize rudimentary drilling equipment to extract shallow oil deposits. These are known as "hand-dug oil wells", and there are entire communities built around them within Magway Region. Thayet is one of eight townships in Magway region that is endowed with crude oil and natural gas. Thayet Township has initiated exploration and production of shallow sources of oil to supplement their agriculture incomes. For decades, companies have come to Thayet to explore for oil, many of which are engaged as a joint venture with MOGE. Individual drillers also carry out drilling and production activities for shallow petroleum in the region. In some rural areas, private production of crude oil can be seen as a support to food security of rural households.

The oil wells are drilled using traditional methods, where manual workers set up a tripod of metal or bamboo about 10-20 m high that are constructed over the well. The tripods support a pulley to which a drilling tool is attached. It takes between two to three months to drill 150 m with such techniques. A typical footprint for drilling, completion and subsequent production of hand dug oil wells ranges from 1.2 - 12.1 ha (3 - 10 acres). The space used for one drilling well unit is about 4.6 m^2. Operators often choose the well site location based upon perceived likelihood and localized communication; location approval is often found to be ambiguous. ***Figure 5.18*** shows examples of the existing hand dug well operations in Block MOGE-3.

Figure 5.17 Hand Dug Wells and Oil-Drilling Equipment in Block MOGE-3

Private hand-dug well

Drilling hand- dug well

Pipes and casing perforation on-site

Oil-drilling equipment shop

Source: MMRD, 2014

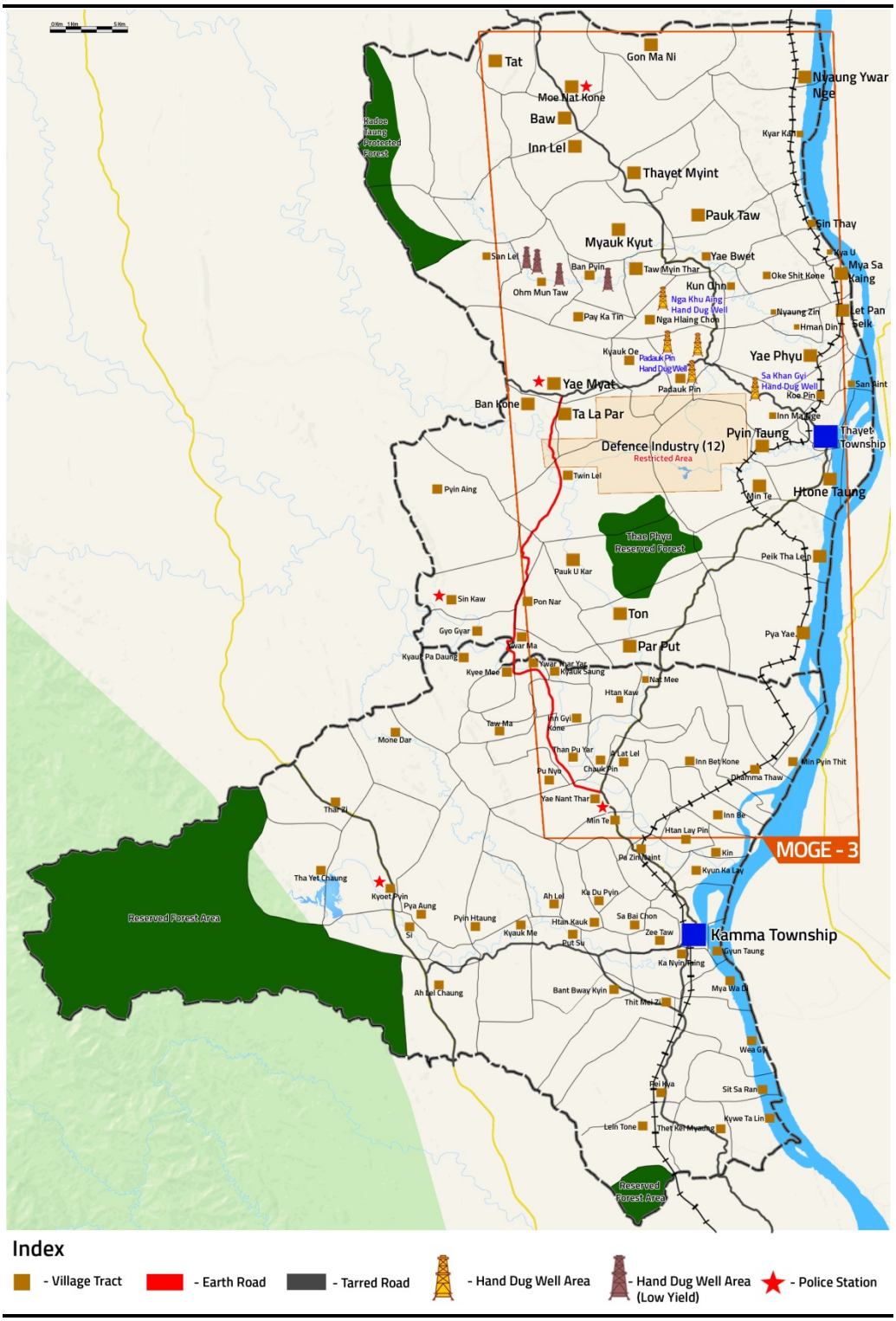
The land ownership situation is complicated for hand dug oil wells, whereby primary farm owners have transferred their ownership of the land, which they have cropped over the years, by selling the land based on mutual agreement with the private oil and gas operators. Land is transferred to an oil and gas operator to drill a well and keep it in production throughout the well's life.

During MMRD's Livelihood Study, site visits were conducted to hand- dug well sites in Padaukpin (Pa Tauk Pin), Nga-khu-aing (Nga-hlaing-chaung) and Sakhan-gyi site. It was found that the villages mainly dealt with on-shore oil exploration, and the activity was done by locals with local technical know-how and resources. The locations of hand-dug wells in the Project area are shown in ***Figure 5.18.***

Operating wells were found in Padaukpin, while the sites at Banpyin, Ngabatkya and Moenatkone have mostly been abandoned. The hand dug wells in Padaukpin ranged in depth from 37 to 305 m (120-1,000 feet). In Sakhan-gyi site, there are approximately 400 hand dug well owners.

The price of crude oil varies by quality and well site, with the price per 50 gallon barrel ranging from 90,000 to 120,000 kyat. The income earned from oil extraction depends on the yield per each well, which for example are 5 gallon barrels/well per day in Padaukpin and 40 gallon barrels per day in Nga-khu-aing.

Figure 5.18 Hand-Dug Well Locations in Project Area



Source: MMRD, 2014

5.5.2 *Transportation*

Most towns and cities of Myanmar are accessible only by land route. Only a few towns and cities are connected by rail link due to the condition of train services. Some towns are reachable by rivers, but this method is slow compared to road transportation. The major transportation network of Myanmar is shown in ***Figure 5.19***.

Central Myanmar has a relatively well developed transport system compared to other parts of Myanmar, including road, air, rail, and water. Due to its geography, central Myanmar, particularly Mandalay acts as the central hub for transport of people and goods with destinations further north, east and west in the country, as well as to China and India.

Figure 5.19 Myanmar Transportation Network

Source: Cartographic Section, Department of Field Support, United Nations, June 2012

5.5.2.1 *Road*

Myanmar has three main highways or corridors running north-south, as follows:

- Yangon-Mandalay Road – Approximately 695 km long, passes through major cities in central Myanmar such as Bago, Thungoo, Pyinmana, new capital Naypyidaw and Meikhtila.
- Yangon-Pyay Road – Good-condition highway funded by Japanese Government for construction. This road runs west of Pegu Range and has a length of 288 km.
- Western Union Highway - Part of proposed Pathein-Mongwa Highway. This road connects towns and cities on the west of Ayeyarwady River. The road is still under construction in most parts.

A number of additional important of roads extend from three main corridors include the following:

- Mandalay-Lashio Road - The road starts from Mandalay and ends in Lashio, from which another road extends up to Muse, which is a border town with China. This road is an important road on the China- Myanmar border trade route, and has length of 262 km.
- Meikhtila-Taunggyi Road - The road extends from Yangon-Mandalay Road at Meikhtila, which is on the way from Yangon-Mandalay Road to Taunggyi, the capital of Shan State. The total length is approximately 205 km.
- Pyay–Magway Road - The road is connected from Yangon-Pyay Highway, and runs along the east bank of Irrawaddy with a length of 202 km from Magway to Bagan, passing through Yenanchaung, which is a major oil drilling town in central Myanmar.

Mostly, roads in the townships allow a maximum weight of 13 tons and village roads allow a maximum of 6 tons, due to the presence of timber bridges. Heavy cargo, in excess of 13 tons, can use the Yangon-Pyay-Mandalay old road and district connected roads. Commonly, the width of the Yangon-Pyay – Mandalay and Yangon-Pyay-Thayet highway roads are about 4.6 m with two lanes, while village roads are about 3.0 m.

It should be noted that there are many culverts along the roads in Magway region across dried creeks, and it is dangerous in raining season due to flash flooding. During floods, users must consult with nearby village, to check that the roads are safe to pass.

Road traffic accident statistics during 2013-2014, reported by Road Transport and Administration Department, show that in 2014 Myanmar had a higher number of accidents, injuries and fatalities than 2013 (***Table 5.12***). The overall number of accidents, injuries and fatalities in 2014 were 10,818, 18,621 and 3,064, respectively. For Magway Region, the statistics are 923, 2,060 and 221, respectively, which was also higher than 2013.

Table 5.12 Road Traffic Accidents by States and Regions in Myanmar in 2013-2014

No.	State/Region	2014 January to October			2013 January to October		
		Accident	Injury	Fatality	Accident	Injury	Fatality
1.	Naypyitaw	279	472	143	306	450	172
2.	Kachin	352	507	136	259	445	109
3.	Kayah	102	140	33	95	150	20
4.	Kayin	313	629	96	294	537	62
5.	Chin	69	146	30	57	109	24
6.	Sagaing	1,241	2,302	312	530	881	144
7.	Taninthayi	252	406	97	3,16	624	76
8.	Bago	1,163	2,193	340	1,208	2,108	288
9.	Magway	923	2,060	221	785	1,610	179
10.	Mandalay	1,116	1,960	354	988	1,603	300
11.	Mon	434	712	193	456	723	203
12.	Rakhine	263	465	76	215	334	69
13.	Yangon	2,295	3,231	425	2,177	3,210	324
14.	Shan	401	742	137	341	665	106
15.	Shan(Lashio)	307	402	169	235	396	84
16.	Shan(Kyaington)	137	287	73	139	257	65
17.	Ayeyarwady	1,171	1,967	229	875	1627	190
	Total	10,818	18,621	3,064	9,276	15,729	2,415

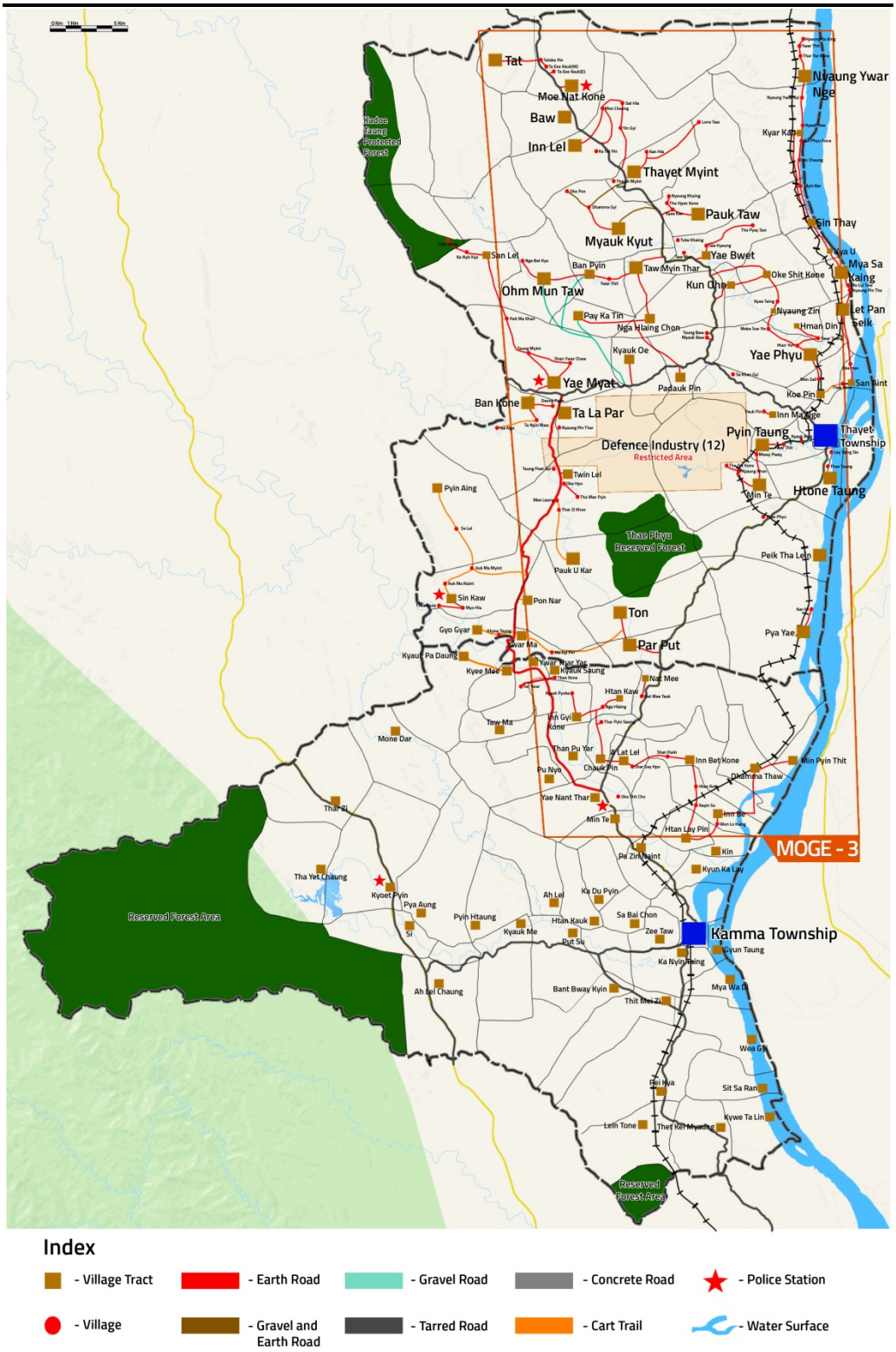
Source: Road Transport and Administration Department, 2014

Figure 5.20 shows the road section, road conditions and type of bridge seen on the route between Kanma and Thayet Townships. According to the Block MOGE-3 study by MMRD, the access road to the Project including condition of road and the railroad are shown in ***Figure 5.21***. The townships in the Project location can be easily reached from Yangon via road. The route between Thayet Township and Kanma Township includes crossing the Mindon Bridge (Yenatha).

Figure 5.20 Road Sections and Bridge between Kanma and Thayet Townships

Source: MMRD, 2014

Figure 5.21 Road and Railroad Routes in Block MOGE-3



Source: MMRD, 2014

5.5.2.2 *Railroad*

The railroad of Magway region is the Pyay to Nyaung-U and Myingyan railway, which runs through eastern Magway with connections to the national capital Naypyidaw, Yangon and Mandalay. The major stops in Magway on that line are Taunggyi and Natmauk. In addition, there are two rail lines running north from the Irrawaddy port of Pakokku, one to Chaung-U in Sagaing Region and the other to the Myittha River valley past Myaing and Kyaw.

5.5.2.3 *Air*

The three international airports of Myanmar are located in Mandalay, Naypyidaw and Yangon. The regional capital, Magway, has a small non-commercial airport with air traffic, mostly arriving from Bagan Airport approximately 113 km to the north along the Ayeyarwady River. However, Magway Airport does not have regularly scheduled flights.

5.5.2.4 *River Transport*

The Ayeyarwady River is a major transportation system in Magway Region. The river serves functions of transporting both goods and people in Magway Region.

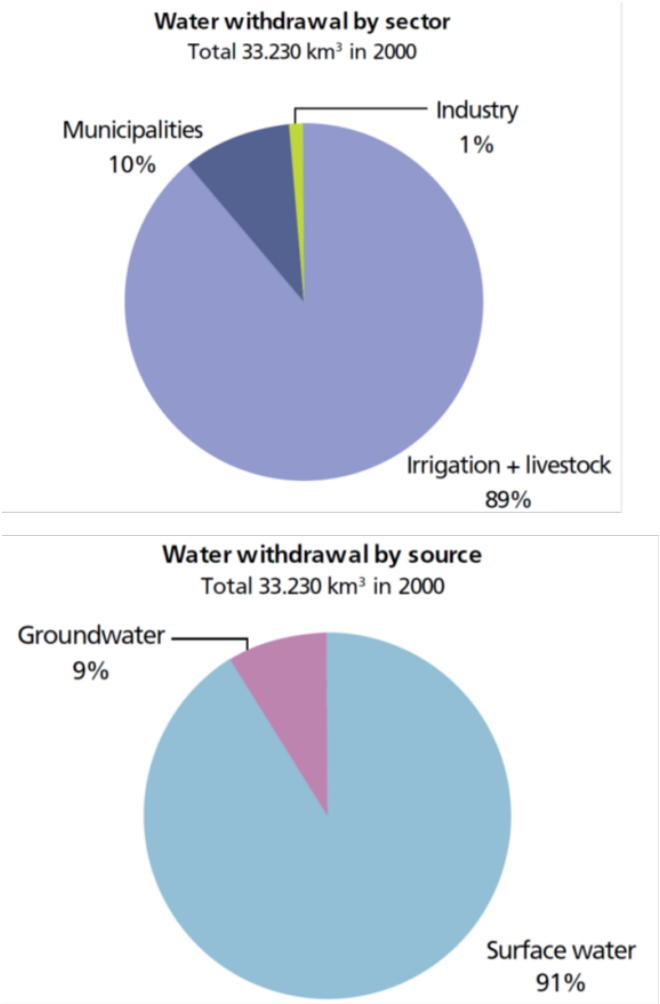
5.5.3 *Water Use*

According to FAO (2011), Myanmar had a total water withdrawal of about 33.23 km^3 in 2000, of which around 29.53 km^3 was used for agriculture (89%), 3.32 km^3 for municipalities (10%), and 0.33 km^3 for industries (1%), as shown in ***Figure 5.22***.

Approximately 30.24 km^3, or 91% of the total withdrawal of Myanmar comes from surface water and 2.99 km^3 or 9%, from groundwater that is mostly used for domestic proposes[13].

[13] Irrigation in Southern and Eastern Asia in Figures – FAO AQUASTAT Survey, 2011.

Figure 5.22 Water Withdrawal by Sector and Source



Source: FAO AQUASTAT Survey, 2011

5.5.3.1 *Irrigation and Agriculture Water Sources*

All irrigation in Myanmar is surface irrigation. Sprinkler and localized irrigation have been developed only on pilot farms, and altogether do not exceed 50 ha. Due to the rainfall and hydrological pattern of the country, the need for irrigation is highest in the central dry zone. The irrigation potential of Myanmar is estimated at 10.5 million ha, considering both water and soil resources. The total area equipped for irrigation was estimated in 2004 at 2,110,000 ha.

Irrigated areas were traditionally supplied through weirs for river diversion or dams and tanks, but wells and pumping in rivers have developed quite substantially in recent years. In 2000, out of a total irrigated area of 1,841,000 ha, 31% was supplied by canals 11% was supplied by tanks, 4% by tube wells, 46% by pumps and 8% by other types. Water sources for pump lift irrigation are mainly based on the flow of three major rivers, the Ayeyarwady, Chinwin and Sittaung.

Pump irrigation was promoted in the 1980s by programmes implemented by the Agricultural Mechanization Department. Water Resources Utilization Department has been implementing pump irrigation water supply

programme using high discharge capacity pumps since 1995. Other types of irrigation water supply include windmills, watermills, watering with buckets, ponds, etc. In the central dry zone, where most of the potential for economical run-of-the-river diversion schemes has been utilized through projects they were started in the 1980's, which includes dams, irrigation schemes and groundwater irrigation projects. Groundwater is mainly utilised through the use of diesel pumps. Salinization due to irrigation is mainly found in the central dry zone, near Meiktila in Mandalay Region, where groundwater is used for irrigation purposes. ***Figure 5.23*** shows a map of irrigated areas across Myanmar.

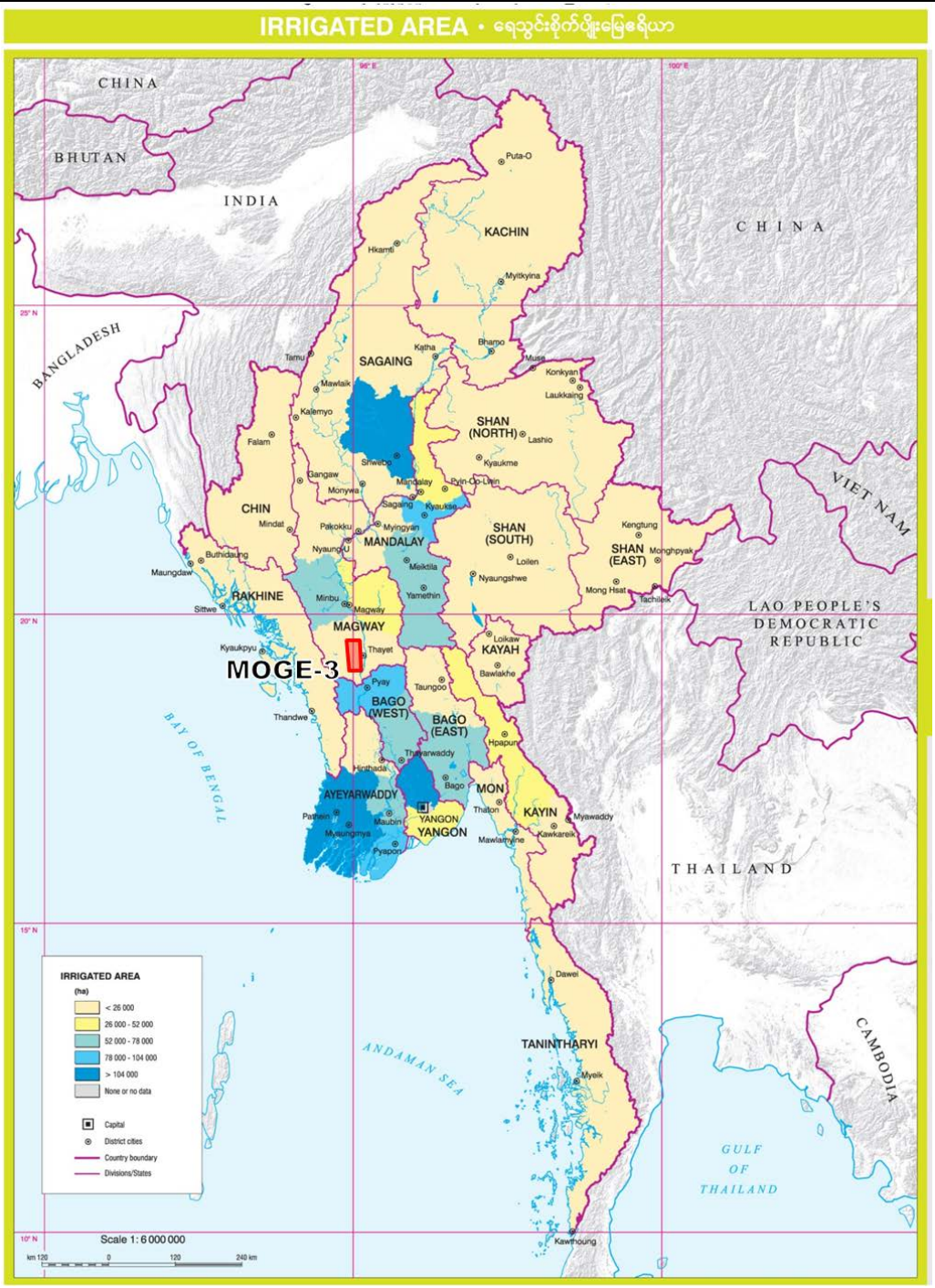
The Myanmar Government has 170 irrigation projects across the country, and covering an area of approximately 928,599 ha. Magway Region has the third highest number of government irrigation projects (31), which consists of 118,712 ha or 12.78% of all country's beneficial area from government irrigation projects, as shown in ***Table 5.13***.

Table 5.13 Government Irrigation Projects

State/Division	Government Irrigation Projects	Beneficial Area (ha)	Percentage of Beneficial Area
Kayah	2	1,275	0.14
Kayin	1	40	0.01
Chin	1	202	0.02
Sagaing	18	149,714	16.12
Thanintharyi	1	Water Supply	-
Bago	40	253,731	27.32
Magway	31	118, 712	12.78
Mandalay	42	135,392	14.58
Mon	7	25,820	2.78
Rakhine	4	182	0.02
Yangon	14	90,449	9.74
Shan	2	44,858	4.83
Ayeyarwady	7	108,224	11.66
Total	**170**	**928,599**	**100.00**

Source: FAO AQUASTAT Survey, 2011

Figure 5.23 Irrigated Area in Myanmar



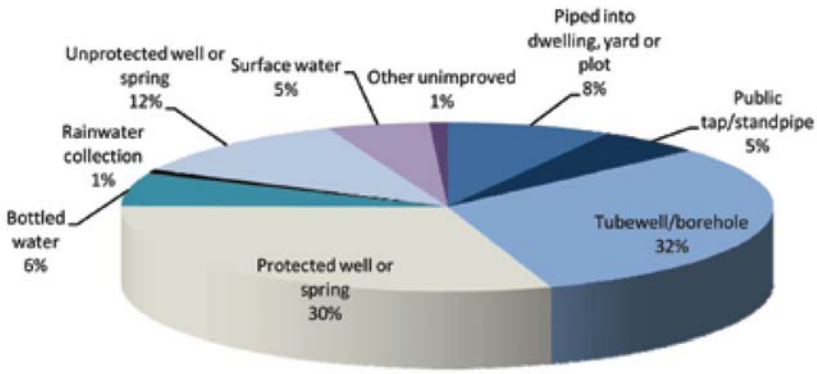
Source: FAO, 2009

5.5.3.2 *Drinking Water*

Based on a survey by Ministry of National Planning and Economic Development, Ministry of Health, and UNICEF in 2011, the distribution of drinking water sources in Myanmar is shown in ***Figure 5.24.***

Overall, 83.2% of Myanmar population use an improved source of drinking water, while 79.3% of Magway population use an improved source of drinking water, of which the most common source is from tube well/bore hole (53.9%)[14].

Figure 5.24 Percentage Distribution of Drinking Water Sources in Myanmar, 2009-2010



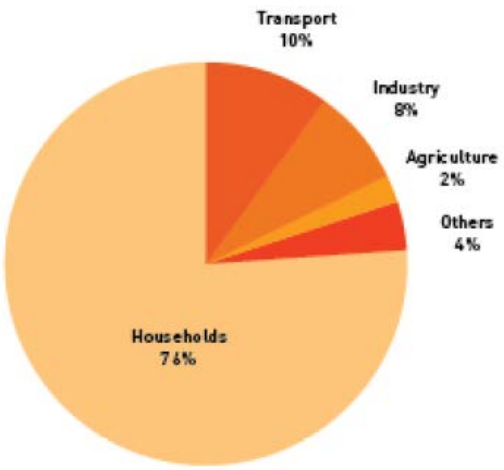
Source: Multiple Indicator Cluster Survey 2009-2010, Ministry of National Planning and Economic Development, Ministry of Health and UNICEF, October 2011

5.5.4 *Energy and Utilities*

In Myanmar, households consume about 76% of national energy production, followed by transportation sector (10%) and industry (8%), respectively (***Figure 5.25***)

[14] Multiple Indicator Cluster Survey 2009-2010, Ministry of National Planning and Economic Development, Ministry of Health and UNICEF, October 2011.

Figure 5.25 National Energy Consumption in Myanmar by Sector, 2010



Source: Wint Wint Kyaw et al. 2011

Myanmar remains dependent on biomass-energy, with wood accounting for approximately 70% of all primary energy supply in 2009. The second most significant energy source is natural gas, consisting of around 18.2% of energy supply. The primary energy supply in Myanmar from 2001to 2009 is shown in ***Table 5.14***.

Table 5.14 Total Primary Energy Supply in Myanmar, 2001-2009 (kilotons of oil equivalent)

Source	2001	2002	2003	2004	2005	2006	2007	2008	2009	% (2009)
Crude Oil and Petroleum Products	1,983	1,991	1,924	1,924	1,957	1,756	1,904	1,789	1,280	8.5
Natural Gas	1,205	1,033	1,264	1,428	1,508	1,305	1,511	1,721	2,741	18.2
Coal and Lignite	83	71	76	123	196	85	501	588	135	0.9
Hydro-electricity	728	772	743	788	926	988	1,277	1,541	363	2.4
Biomass (wood)	7,825	8,036	8,249	8,615	8,526	8,561	9,045	9,280	10,543	70.0
Total	**11,824**	**11,903**	**12,256**	**12,878**	**13,113**	**12,695**	**14,238**	**14,889**	**15,062**	**100.0**

Source: Ministry of Energy, "Developments in Myanmar Energy Sector", October, 2011

Myanmar has an estimated installed power capacity of 2,254 MW, and has grown annually at a rate of 10% since 2007. Up to 70% of the power generation capacity is from 18 hydropower plants, which generate up to a total of 1,270 MW during the rainy season and 1,000 MW during the dry season. Gas fired plants generate up to 350 MW.

Magway Region has 57 conserved dams/lakes, three dams/lakes that are not conserved by Irrigation Department, and 1102 small dams/lakes, with 30 river water pumping stations.

The newly-opened Kyeeohn Kyeewa multi-purpose dam and hydropower station are located at Mone Creek near Wunlo Village, 24 km from Mone Creek Dam Project, and 8 km from the Mezali Diversion Weir in Pwintbyu

Township, Minbu District, Magway Region. By storing water from Mone Creek Dam and from between the two dams, 74 megawatts of electricity will be generated.

Already-built Mezali Diversion Weir will irrigate 96,000 acres (38,850 ha) of farmland for monsoon paddy cultivation. In addition, more than 74,000 acres (29,947 ha)of land can be irrigated for summer paddy cultivation and for regional greening.

Kyeeohn Kyeewa multi-purpose dam, which is of zone dam type, can store 463,000 acre feet (571.1 million m^3). Still water storage of the dam is 35,350 acre feet (43.6 million m^3) and the area is 10,860 acres (4,395 ha). It is 3280 feet (1,000 m) long and 164 feet (50 m) high. Construction of the dam started in 2002-2003 and was completed 2011-2012[15].

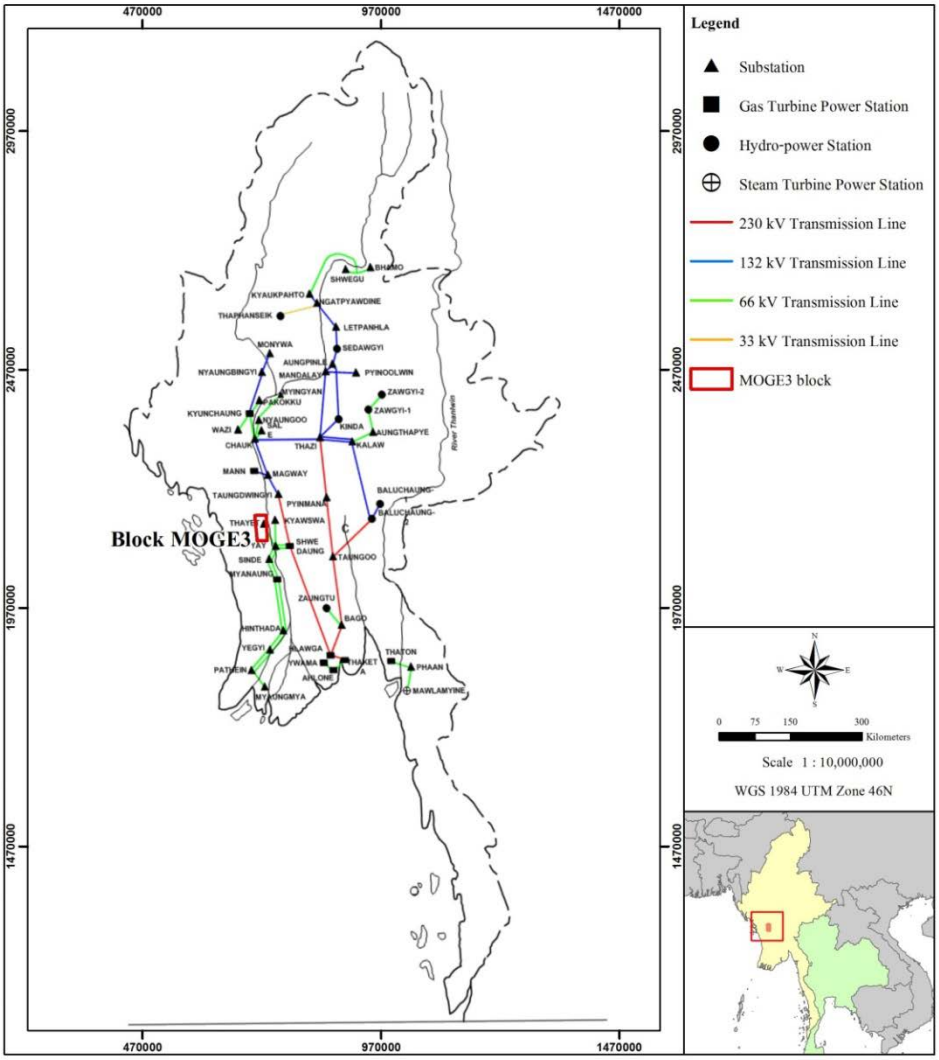
The Myanmar national grid system that connects to the substations, gas turbine power stations, hydro-power stations and stream turbine power stations is shown in ***Figure 5.26***.

Thayet 66 kV substation is located in the Project area within Block MOGE-3, which is the ending substation of 66 kV transmission line. Electric power supply distribution for public use in Thayet Township is limited, and Kanma Township electricity power distribution is much lower compared to Thayet Township, having only 325 kW, although the demand is 450 kW[16].

[15] Ministry of Agricultural and Irrigation, 2010.

[16] Study on Crops, Livelihood and Hand Dug Well Communities in Anticipated Villages by MMRD, November 2014.

Figure 5.26 Myanmar National Grid System



Source: Global Energy Network Institute, 2014

5.5.5 *Agriculture and Livestock*

5.5.5.1 *Agriculture*

The economy of the population residing in the Project area is predominantly based on farming/agriculture, where crops are produced for income as well as for subsistence. Agriculture and crop production in the Project area strongly depend on rainfall conditions, and crop cultivation is performed mostly during the rainy season.

Rainfall in Magway Region is highly seasonal, typified by a prominent growing season followed by a long dry spell. Crop production is limited by these rainfall patterns[17].

Rice is the most prominent crop in the Project area. The total sown area for cultivation is less than 100,000 ha, and the annual rice production is less than 250,000 tons, with a yield of approximately 2,875 to 3,445 kg/ha, as shown in ***Figure 5.27.***

21,012 ha of cropped area in Thayet Township are considered to have low cultivation potential. Average land size of 2 ha, farmer occupy the land for constituting in farming as well as Kanma Township.

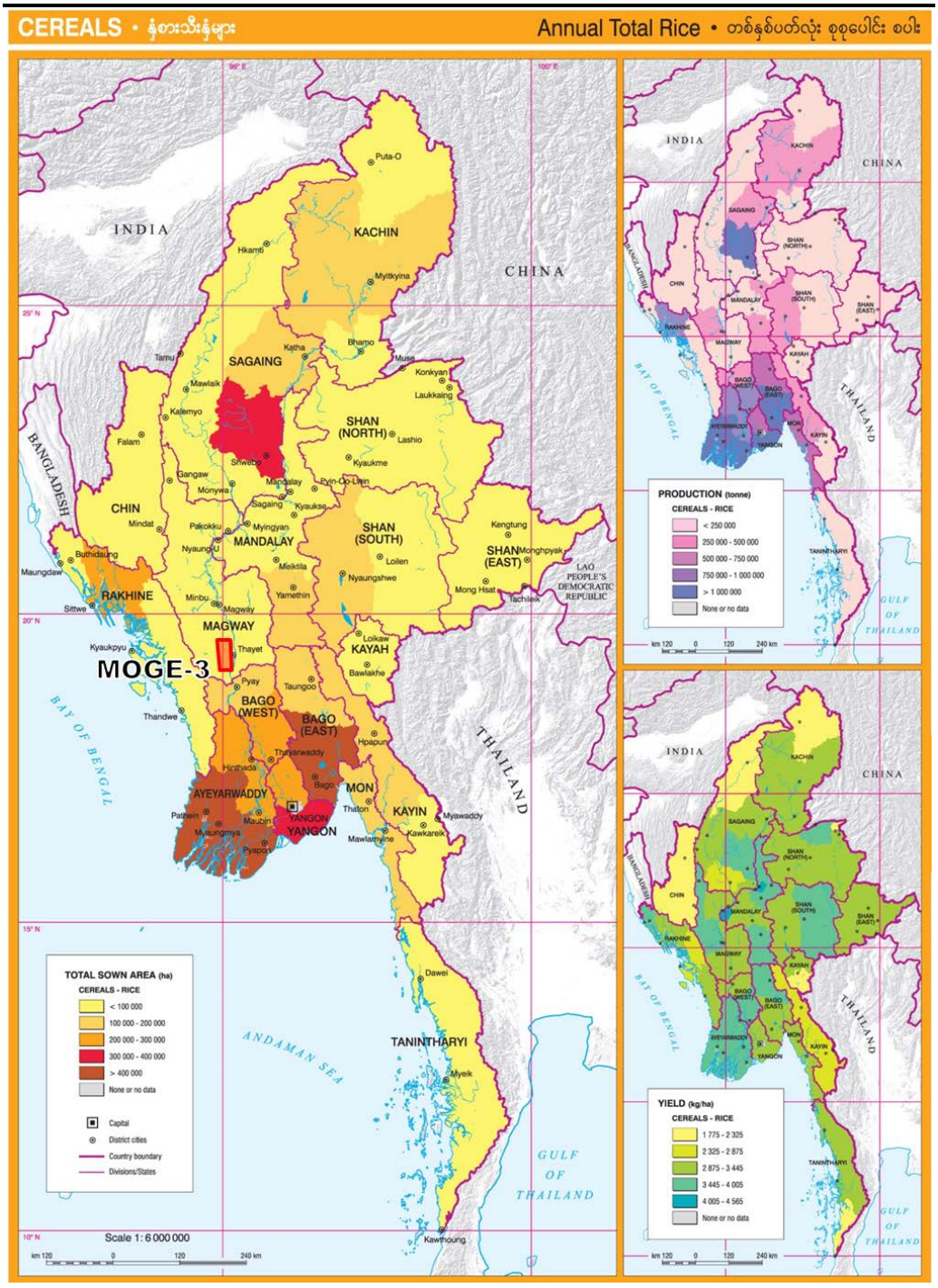
Aside from paddy rice, other crops of importance for farmers in the Project area are oil seed crops such as groundnut and sesame, pulses and beans, and industrial crop such as cotton.

In Thayet and Kanma Townships, paddy rice comprises 65% of crop production for Thayet and 62% for Kanma, respectively, followed by oil seed crop such as groundnut (13% for Thayet and 15% for Kanma). Other major crop production data for the Project area are presented in ***Table 5.15*** and ***Figure 5.28***.

The utilization of cropped area in Thayet Township is classified by type as shown in ***Table 5.16.*** The most common land type for cropped land in Thayet is "upland type", which consists of 55.81% of the cropped land area, followed by "paddy land", accounting for 32.22% of cropped land. Similarly in Kanma Township, the most common cropped land type is "upland type" (44.78%), followed by "paddy land" (35.97%).

[17] Study on Crops, Livelihood and Hand Dug Well Communities in Anticipated Villages by MMRD, November 2014

Figure 5.27 Myanmar Total Sown Area, Production and Yield Distribution for Rice



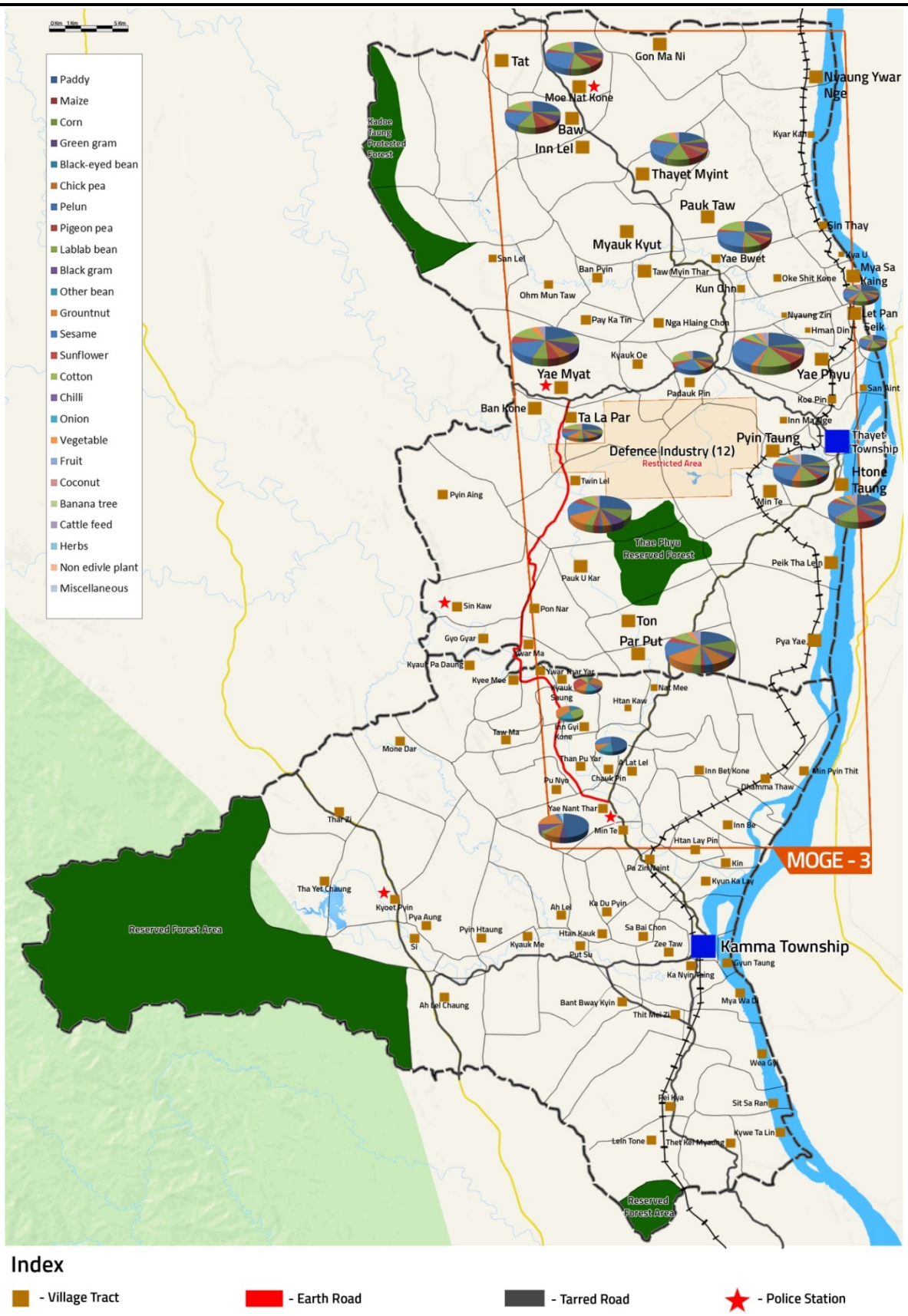
Source: FAO, 2009

Table 5.15 Sown Area, Yield and Production of Major Crops in each Township of Project Area in 2013-2014

No.	Crops	Thayet Township (Data as of February 2014)						Kanma Township (Data as of February 2014)					
		Sown area (ha)	Harvest area (ha)	Yield		Production		Sown area (ha)	Harvest area (ha)	Yield		Production	
				Unit	Quantity	In number	% of Total field crop			Unit	Quantity	In number	% of Total field crop
1	Paddy rice	10,619	10,619	Basket	80.19	2,104,249	64.57	12,404	12,404	Basket	84.58	2,592,576	61.98
2	Maize-monsoon	32	32	Basket	53.18	4,201	0.13	0	0	Basket	0	0	0
	Maize-winter	89	89	Basket	55.68	12,260	0.38	3,216	3,216	Basket	14.87	118,159	2.82
3	Green gram	3,363	3,363	Basket	15.04	124,982	3.83	2,223	2,223	Basket	13.66	80,527	1.93
4	Pigeon pea	2,832	2,832	Basket	17.27	120,837	3.71	270	270	Basket	18.39	12,248	0.29
5	Black gram	0	0	Basket	0	0	0	942	942	Basket	19.48	45,330	1.08
6	Groundnut-monsoon	722	722	Basket	55.33	98,764	3.03	1,575	1,575	Basket	52.41	204,032	4.88
	Groundnut-winter	2,411	2,411	Basket	68.84	410,080	12.58	3,758	3,758	Basket	69.72	647,490	15.48
7	Sesame	9,979	9,979	Basket	11.54	284,553	8.73	9,356	9,356	Basket	9.61	222,183	5.31
8	Sunflower	1,537	1,537	Basket	26.09	99,116	3.04	3,441	3,441	Basket	30.66	260,671	6.23
	Total	**31,583**	**31,583**		**-**	**3,259,042**	**100.00**	**37,185**	**37,185**		**-**	**4,183,216**	**100.00**
9	Long staple cotton	3,215	3,215	Viss	585.35	4,650,606	-	1,631	1,631	Viss	579.98	2,332,899	-
10	Sugar cane	0	0	Ton	0	0	-	948	613	Ton	22.85	34,618	-
11	Onion	318	318	Viss	4,705.25	3,698,326	-	191	191	Viss	4,972.63	2,347,081	-
	Total	**35,117**	**-**		**-**	**-**	**-**	**39,955**	**-**		**-**	**-**	**-**

Source: Township Profile, February 2014. GAD, Thayet Township and Kanma Township

Figure 5.28 Cultivation in Project Area



Source: MMRD, 2014

Table 5.16 Utilization of Land in each Township of Project Area

Type of Land	Thayet Township		Kanma Township	
	Cropped land (ha)	%	Cropped land (ha)	%
Paddy land or "Le"	6,770	32.22	8,533	35.97
Upland or "Ya"	11,728	55.81	10,623	44.78
Garden land	278	1.33	53	0.22
Alluvial land	1,990	9.47	4,513	19.03
Shifting land or "Taungya"	246	1.17	-	-
Total	**21,012**	**100.00**	**23722**	**100.0**

Source: Township Profile, March 2014, General administration Department, Thayet and Kanma Townships

5.5.5.2 *Livestock*

Farmers in Myanmar raise a variety of animals for both food and labor purposes, including duck, cattle, water buffalo, goats, sheep, chickens, and pigs. The GDP share of the livestock has increased slightly during the past decade, and livestock rearing is an important part of their livelihood[18].

Data on the livestock population of Myanmar during year 2013-2014 show that duck is the most prevalent livestock animal population, with 18.3 million, followed by cattle and chicken, which had populations of 14.9 million and 12.5 million, respectively.

In Magway Region, according to data from Ministry of Livestock, Fisheries and Rural Department, the highest livestock population is cattle, followed by chicken and pig, with 2,607,000, 2,564,000 and 2,443,000, respectively (***Table 5.17***). This is consistent with data from FAO that show Magway Region has a number of cattle more than 300,000 head of cattle, as shown in ***Figure 5.28.***

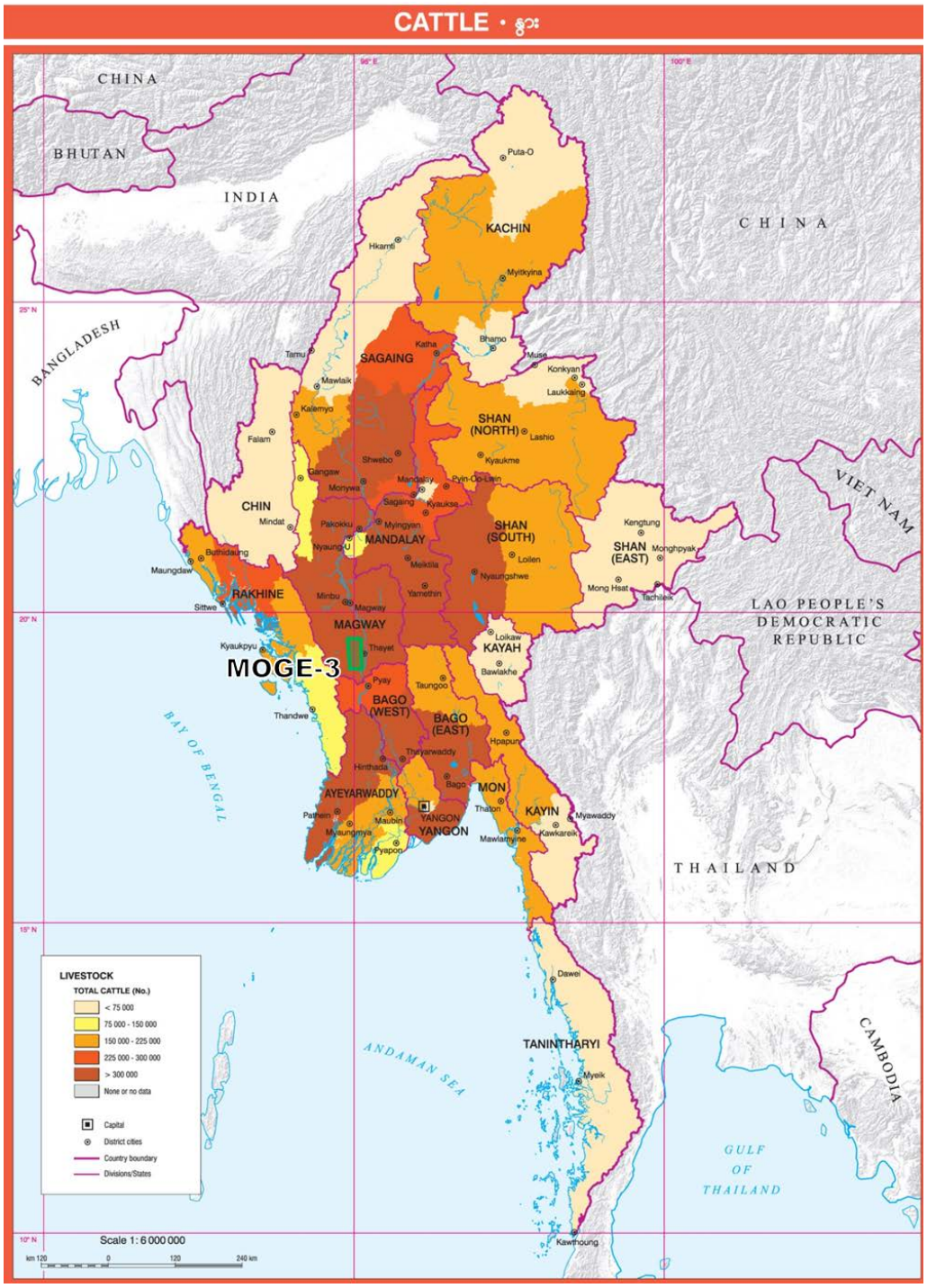
[18] http://www.nationsencyclopedia.com/economies/Asia-and-the-Pacific/Burma-Myanmar.html#ixzz3QBKSzl84

Table 5.17 Animal Population by State and Region in 2013-2014

No.	State /Region	Number of Animal Population in lakh (100,000 unit)							
		Buffalo	Cattle	Sheep/ Goat	Pig	Chicken	Duck	Turkey/ Geese/ Muscovy	Quail
1	Nay Pyi Taw	0.68	2.29	-	0.14	2.32	0.86	0.05	-
2	Kachin	2.67	3.58	-	0.62	8.9	2.61	0.56	-
3	Kayah	0.34	0.9	-	0.03	1.24	0.2	0.08	-
4	Kayin	0.92	3.56	-	0.82	3.7	3.4	0.47	-
5	Chin	0.48	1.68	-	0.94	3.58	0.35	0.09	-
6	Sagaing	4.67	23.99	2.07	3.69	11.15	2.85	0.6	3.95
7	Thanintharyi	1.55	1.58	-	0.35	2.05	5.17	0.29	-
8	Bago	3.12	14.91	-	0.64	9.68	71.75	1.36	-
	Bago (East)	2.59	7.42	-	0.3	6	63.03	0.81	-
	Bago (West)	0.53	7.49	-	0.34	3.68	8.72	0.55	-
9	Magway	1.49	26.07	5.73	24.43	25.64	2.96	0.15	-
10	Mandalay	0.7	21.86	2.36	10.9	6.74	4.45	0.57	3.97
11	Mon	0.91	4.9	-	1.05	3.88	14.4	0.8	-
12	Rakhine	3.88	11.02	-	3.11	3.13	3.64	1.27	-
13	Yangon	1.52	6.34	-	1.01	10.51	31.74	2.48	2.72
14	Shan	7.91	14.93	-	0.86	18.17	4	0.72	0.2
	Shan (South)	3.2	7.89	-	0.21	5.11	1.29	0.43	-
	Shan (East)	1.57	1.45	-	0.19	3.14	1.73	0.11	-
	Shan (North)	3.14	5.59	-	0.46	9.91	0.97	0.18	0.2
15	Ayeyarwady	2.34	12.33	-	1.05	14.98	34.94	3.79	0.18
	Union	**33.18**	**149.93**	**10.16**	**49.65**	**125.67**	**183.32**	**13.28**	**11.02**

Source: Livestock Sector, Ministry of Livestock, Fisheries and Rural Development

Figure 5.29 Myanmar Number of Total Cattle



Source: FAO, 2009

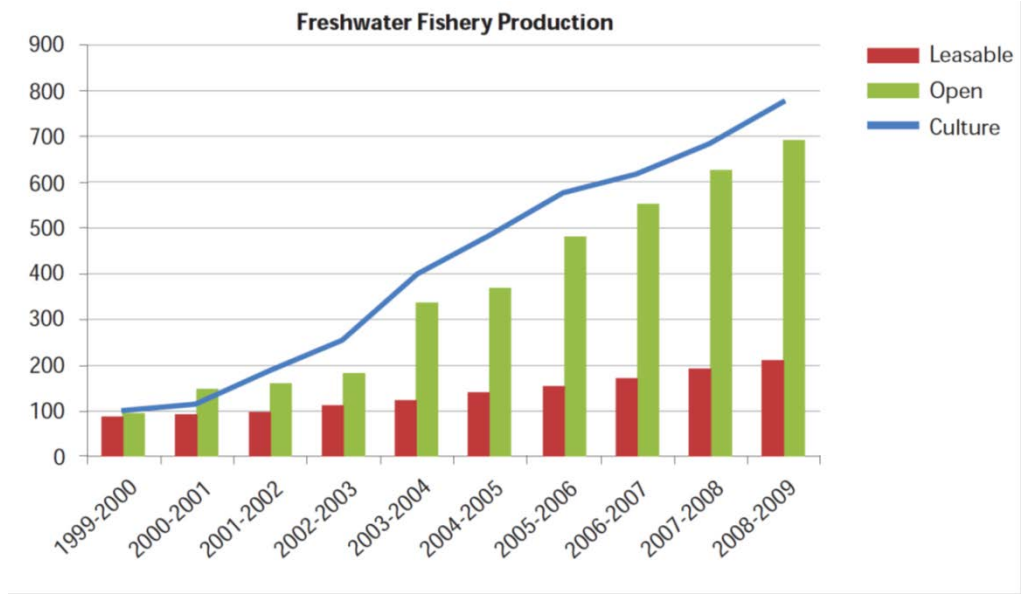
5.5.6 *Fisheries and Aquaculture*

5.5.6.1 *Inland Fisheries*

Inland fisheries in Myanmar are mostly associated with riverine and estuarine systems. Inland water bodies, such as natural lakes, reservoirs, river systems and ponds, cover about 8.1 million hectares, of which 1.3 million hectares are permanent, the remainder being seasonally inundated floodplains. Ayeyarwady, Chindwin, Sittatung and Thanlwin are the main rivers, and extend from the eastern part of the Bay of Bengal to the Gulf of Martaban and along the eastern edge of the Andaman Sea[19].

In 2008-2009, the total fish production in Myanmar was around 3,542,190 tons, of which 899,430 tons was from inland fish and accounted for approximately 26% of the total. Inland fishery production over a 10-year period is presented in ***Figure 5.30***. Data specific to Magway Region was not available at the time of writing this report.

Figure 5.30 Inland Fisheries Production in Myanmar



Source: Inland Fisheries Resource Enhancement and Conservation Practices in Myanmar, Department of Fisheries, Ministry of Livestock and Fisheries (2010)

The fishing techniques used in inland fisheries are drift net, gillnet, traps and pots, pole-and-line, stationary traps, and bamboo stake traps in the near shore of rivers.

5.5.6.2 *Aquaculture*

The aquaculture industry in Myanmar comprises freshwater culture, brackish-water systems, ornamental fish production and fingerling production. The Government of Myanmar has published a special plan to increase and develop

[19] http://www.fao.org/fi/oldsite/FCP/en/MMR/profile.htm

shrimp culture. Currently 407,000 acres have been established for shrimp and freshwater fish farming in Myanmar. Of the total aquaculture production during the year 2005 to 2006, an estimated 563.14 MT came from coastal aquaculture. As of 2004 to 2005, the total area of shrimp ponds was about 63,000 ha in the coastal regions[20].

Major fish species cultured include Roho (*Labeo rohita*), Catla (*Catla catla*), Common carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idellus*), Mrigal cap (*Cirrhinus mrigala*), Silver carp (*Hypophthalmichthys molitrix*), Tilapia (*Tilapia spp.*), Striped catfish (*Pangasius sutchi*), Philippine catfish (*Clarias batrachus*). Recently, Depeartment of Fisheries successfully cultivated another three species of freshwater fish, namely *Piratus branchatus*, *Notopterus chitala* and *Osphronnemus gouramy*.

Table 5.18 shows areas used for aquaculture in Myanmar, as well as quantities of catch, from 1996 – 2006.

Table 5.18 Aquaculture in Myanmar

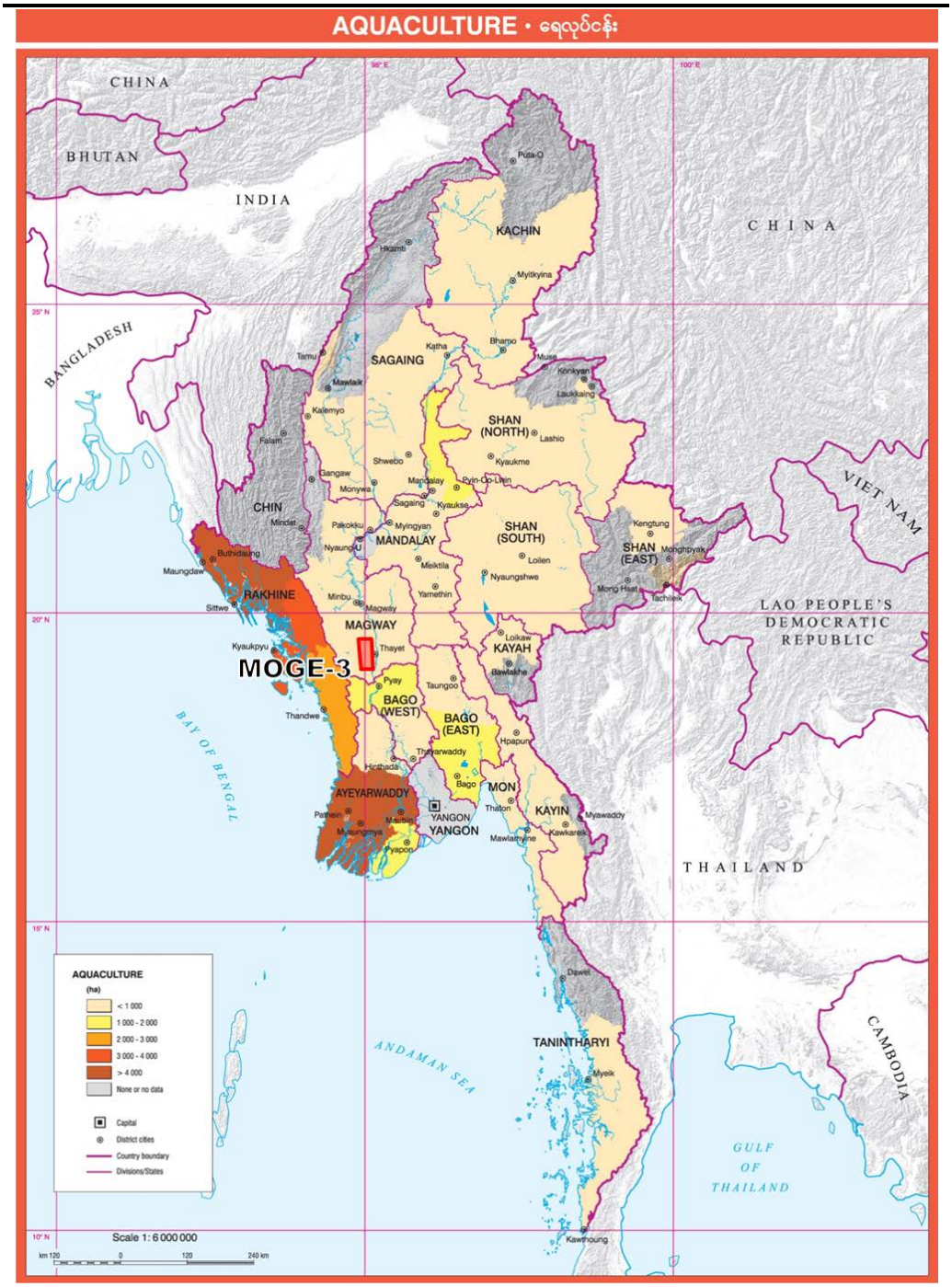
Fiscal Year	Area (Acre)		Total	
	Freshwater Fish	Shrimp and prawn	Acres	Production MT x (1000)
1996-1997	59,389	47,860	107,249	82.79
1997-1998	57,873	50,870	108,743	82.02
1998-1999	60,566	53,157	113,723	91.17
1999-2000	61,096	67,476	128,572	102.60
2000-2001	72,502	101,791	174,293	121.95
2001-2002	90,733	119,784	210,517	190.12
2002-2003	124,112	199,961	324,073	252.01
2003-2004	155,509	205,091	360,600	400.36
2004-2005	182,452	208,591	391,043	485.22
2005-2006	197,150	209,942	407,092	563.14

Source: Fisheries Statistics, Department of Fisheries, 2006

According from FAO, 2009 the aquaculture area in Magway Region is lesser than 100,000 ha, as shown in ***Figure 5.31***, based on data for fisheries and prawn ponds according to 2001 to 2002 survey.

[20] FAO, 2006

Figure 5.31 Myanmar Aquaculture Area



Source: FAO, 2009

5.5.7 *Waste Management*

5.5.7.1 *Solid Waste Management*

Municipal solid waste in Myanmar is composed mainly of organic waste (73%) followed by paper/cardboard (18%), wood (4%), plastic and textile (2% each) and other (1%)[21]. The sources of solid waste are shown in ***Table 5.19***.

Table 5.19 Sources of Solid Waste in Myanmar

Sources of Solid Waste	Percent Contribution
Kitchen	60
Market	15
Hotel	2
Garden	5
Commercial	10
Other	8

Source: Country Presentation for 2nd Meeting of the Regional 3R Forum, 4-6 October, 2010

In 2003, Magway Region households generated waste in urban areas of approximately 84,616 ton/year with rate per capita of 0.25 kg/person/day[22].

Township Development Committees under the Department for Development Affairs (DDA), Ministry of Progress of Border Area Development and National Races and Development Affairs (MPBND), manage municipal waste collection and disposal, however, waste management is very rudimentary over much of the country. The most sophisticated systems are only in place in more populated centers and even here significant gaps exist, particularly with regard to hazardous waste. The country is currently embarking on development of country-wide waste management planning process.

5.5.7.2 *Wastewater Management*

Myanmar's only wastewater treatment plant is located in Yangon, and is able to treat 12,300 m^3/day of sewage from six townships in the downtown area, for population of about 325,000.

In Magway Region, 96.7% of the urban population and 78.9% of the rural population has access to improved sanitary latrines as of 2012, as shown in ***Figure 5.32***.

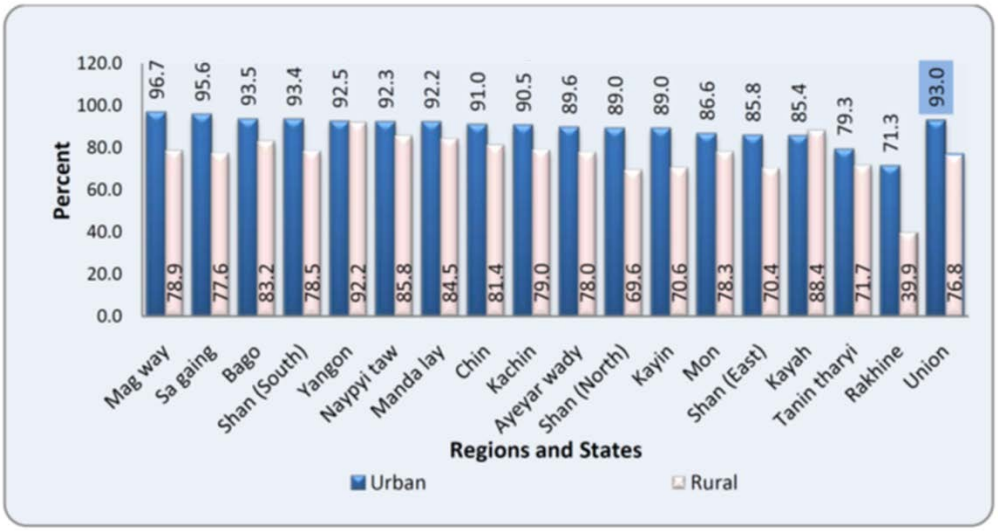
The disposal of wastewater and grey water management in the Project area is by various means, including flush/pour system to pipe sewer or septic tank,

[21] Country Presentation for 2nd Meeting of the Regional 3R Forum, 4-6 October, 2010.
[22] Myanmar National Environmental Performance Assessment (EPA) Report

pit latrine or open space. Slab toilets, composing toilets, bucket, hanging toilets, hanging latrine are also used[23].

[23] Public Health Statistics 2010, Ministry of Health.

Figure 5.32 Sanitary Latrine Coverage in Urban and Rural Population of Myanmar in 2012



Source: Public Health Statistics 2012, Ministry of Health, May 2014

5.5.8 *Tourism and Recreation*

Tourism is a recent and slowly developing sector in Myanmar. However, the number of visitors has been increasing in recent years, and the government has been encouraging tourism. The total number of international tourists arriving in Myanmar from 2011 to 2014 is shown in ***Table 5.20***.

In the 2013 to 2014 fiscal year, tourist numbers increased by 29.67% from the previous fiscal year (2012 to 2013).

Table 5.20 Number of International Tourist Arrivals in Myanmar, 2011-2014

Fiscal Year	Tourists (Number)			
	Total	by Air	by Sea	by Land
2011-2012	866,989	425,847,	137,437	303,705
2012-2013	1,309,225	660,281	159,282	489,662
2013-2014	1,967,680	826,308	227,118	914,254

Source: Ministry of Hotel and Tourism, posted by the National Planning & Economic Development of Myanmar website, February 2014

Note: Includes visitors with visa and daily or overnight travellers with border pass

Magway Mya Thalun Pagoda is a famous shrine of Magway Region, located on the top of Naguttama Hill. Mya Thalun Pagoda is the largest shrine in the region, and overlooks the riverbank of Ayeyarwady River and Minbu Shwesettaw. A pair of Buddha's Footprints is a famous place located in Settawya, which is a forest retreat. The latpanphyu, a very rare white silk cotton tree species, has been sighted in Outo village in Yesagyo Township in Magway Region, and has become a tourist attraction, with people coming to see it regularly based on belief of magical properties. However this is outside of Block MOGE-3.

There are no major tourist attractions located within Block MOGE-3, although small numbers of tourists may be interested in visiting the various pagodas scattered through the region.

5.5.9 *Demographics*

Estimation and classification of Myanmar's population is difficult due to the absence of reliable data and the complex ethnic identity. The last proper census was conducted in 1931 (an incomplete census was also conducted in 1983).

Based on reproductive and fertility health surveys, the World Health Organization estimated that in 2003, there were more than 52 million people in Myanmar, with a 2% population growth rate. Myanmar has multiple ethnicities. The largest ethnic group is the Burmans, which account for about two-thirds of the population. Other ethnic and indigenous peoples include Shan, Karen, Wa, Chin, Akha, Kachin, Karenni, Lahu, Kokang, Tavoyan, Pa-Oh, Naga, Mon, Kayan, Arakan, Rohingya, Palaung, Indian, Danu, and Chinese. The majority of the country's non-Burman ethnic groups live in the border regions[24].

According to the CIA World Factbook, the life expectancy of the total population in Myanmar is 63.39 years, and the literacy of the total population is 89.9%[25].

There are 135 distinct ethnic groups that have been officially recognized by the Burmese government. These are grouped into eight major national ethnic races (Kachin, Kyah, Kayin, Chin, Mon, Bamar, Rakhine and Shan) according to region rather than linguistic or ethnic affiliation. An ethnolinguistic map of Myanmar is shown in ***Figure 5.33***. The area of Block MOGE-3 in the Magway Region is composed of almost entirely Bamar people.

Population density of Magway Region is approximately 1-400 persons/km^2, however in the Project area, population density ranges from 100-200 persons/km^2 according to aggregation at township administrative level.

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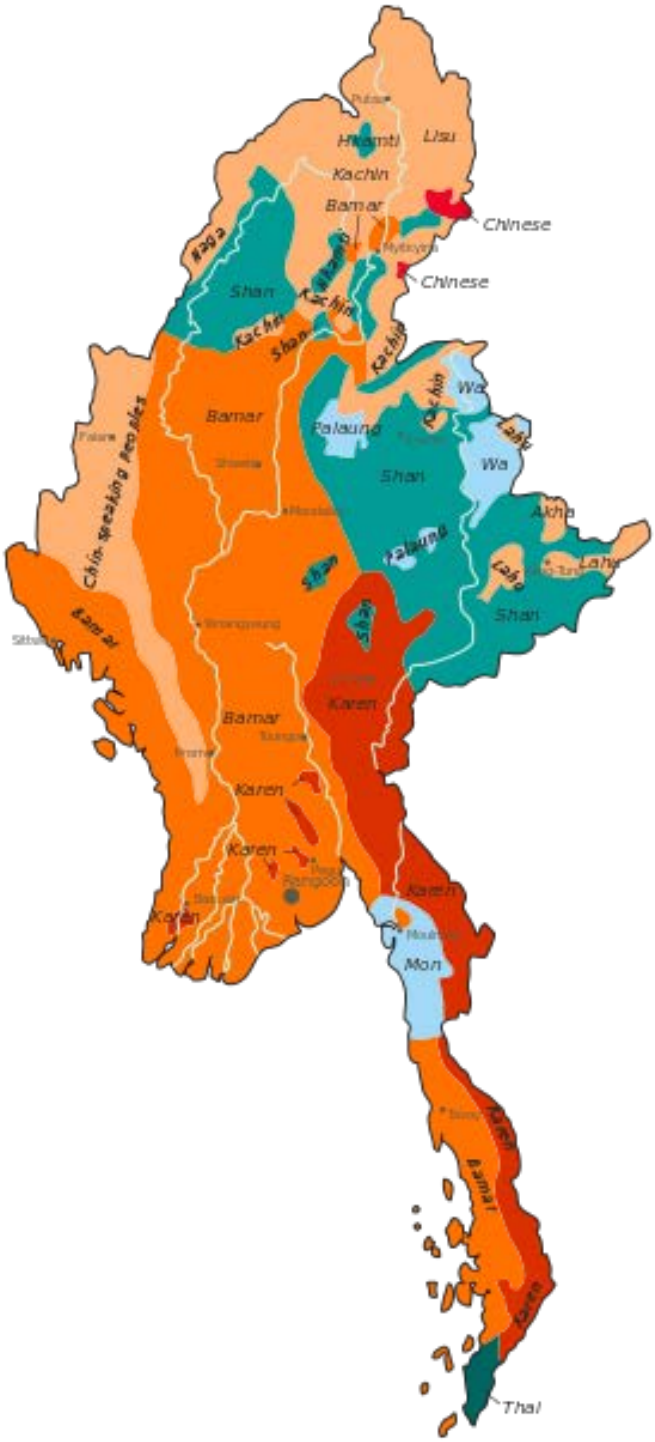
[24] The Burma Environmental Working Group, 2011

[25] CIA World Fact book

Figure 5.33 Ethno-Linguistic Map of Myanmar



Bamar;
Chin language speakers, Kachin, Lisu, Lahu;
Karen;
Chinese;
Shan, Khamti;
Thai;
Wa, Palaung, Mon.

Source: U.S. Central Intelligence Agency[26]

[26] http://en.wikipedia.org/wiki/List_of_ethnic_groups_in_Burma, accessed November 2014

5.5.10 *Socio-Economy*

5.5.10.1 *General*

Myanmar, like most Asian countries, is primarily an agriculture-based economy. However, efforts have been made by the government to develop the industrial sector, including the development of 19 industrial zones.

The country contains several natural resources such as timber, tin, antimony, zinc, copper, tungsten, lead, coal, limestone, precious stones, natural gas, hydropower, and some petroleum. It is a leading source of jade and gems. Its agricultural products are rice, beans, sesame, groundnuts, sugarcane, hardwood, fish and fish products. The manufacturing industries consist of agricultural processing, knit and woven apparel, wood and wood products, copper, tin, tungsten, iron, construction materials, pharmaceuticals, and fertilizer[27].

Myanmar is one of the poorest nations in south eastern Asia. Myanmar's GDP grows at an average rate of 2.9% annually – the lowest rate of economic growth in the Greater Mekong Sub-region. Agriculture, forestry, and fishing together constitute the largest contributor to Myanmar's economy. About half of all agricultural land in Myanmar is devoted to rice. As a whole, the sector accounts for nearly one-half of the country's gross domestic product and employs about two-thirds of the labor force[28].

The major occupations in Myanmar are in agricultural processing; wood and wood products; copper, tin, tungsten, iron; cement, construction materials; pharmaceuticals; fertilizer; natural gas; garments, jade and gems. The labor force in 2001 was 70% in agriculture; 7% in industry and 23% in services.

The principal product of Magway Region is petroleum. It produces most of the oil and natural gas in Myanmar. The following oil fields are located in the Magway Region: the Mann, Yenangyaung, Chauk, Kyauk-khwet, Letpando and Ayadaw oil fields[29].

Other industries include cement, cotton weaving, tobacco, iron and bronze production. Magway Region produces a large quantity of edible oil as well as petroleum, hence gaining a reputation as the "oil pot of Myanmar".

Agriculture is also important. The major crops are rice, sesame and groundnut. Other crops grown are millet, maize, sunflower, beans and pulses, tobacco, toddy palm, chili, onions, and potatoes. Famous products of the Region include: Thanaka (*Limonia acidissima*) and Phangar (*Chebulic myorobalan*) fruit.

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[27] WHO, 2004

[28] Hadden, 2008

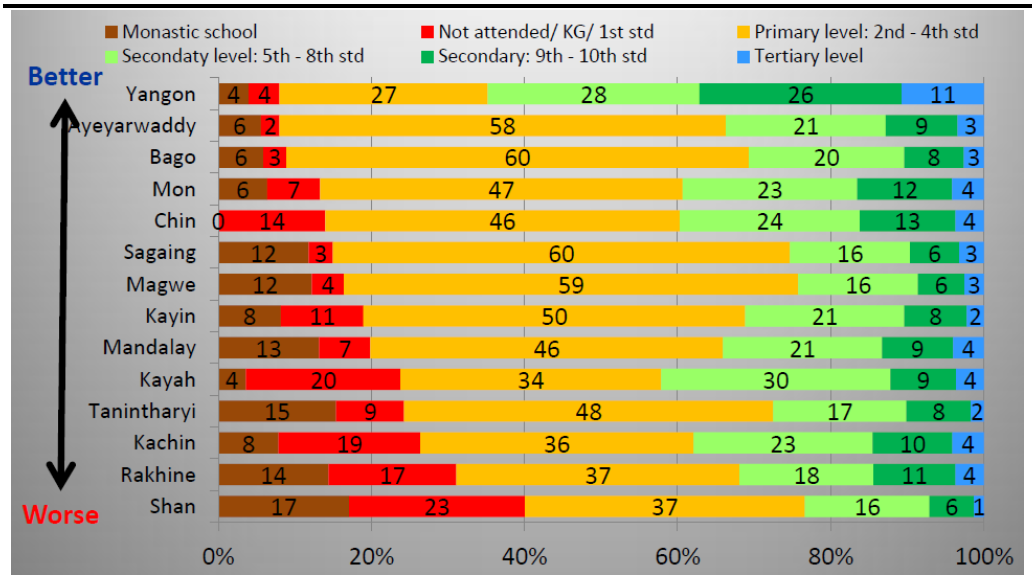
[29] Myanmar Ministry of Information, 2002

Farmers are heavily dependent on products from the natural forest, especially for fuel wood, pole, post and fodder to support their living and livestock. Poorer farmers and agricultural labourers supplement their incomes by cutting fuel wood, which contributes to overexploitation of forest resources and deforestation. Many landless people work as seasonal farm labourers, migrating to urban regions during non-planting and /or harvesting time to find temporary employment.

5.5.10.2 *Education*

Educational opportunities in Myanmar are extremely limited outside the main cities of Yangon and Mandalay. According to the official statistics, less than 16% of primary school students in the Region reach high school[30]. As shown in ***Figure 5.34***, Magway Region has relatively low numbers of "not-attended" students in comparison to the other regions in Myanmar, but only 25% have attended schools beyond primary level (2nd-4th std.), which is the highest portion of 59%.

Figure 5.34 Household Education Attainment Levels in Myanmar



Source: Poverty Profile, Integrated Household Living Conditions Survey (2011)

As of 2009, Magway Region had 3859 schools, of which only 70 were high schools. Only about 10% of the region's primary school students reach high school (Myanmar Central Statistical Organization, 2009). Most of the 12 colleges and universities in the region are located in Magway and Pakokku. In addition, the University of Medicine, Magway is one of the most selective universities in the country.

[30] Myanmar Central Statistical Organization, 2009

5.5.11 *Public Health*

In Myanmar, 70% of the population resides in rural areas. There are generally little sanitation services and access to drinking water in rural areas. The use of traditional medicine is widespread and forms an integral part of the country's health services.

Sanitary latrine coverage of the whole population in year 2012 was 93% for urban areas and 76.8% for rural areas, and access to improved drinking water was available for 80% of the whole population in Myanmar. For Magway Region, there is better access to sanitary latrines, with coverage of 96.7% for urban areas and 78.9% for rural areas. Access to improved drinking water for Magway Region was available to 87.7% of the population[31].

5.5.11.1 *Health Statistics*

The leading causes of morbidity and mortality in Myanmar are shown in ***Table 5.21*** and ***Table 5.22.*** The top three leading causes of morbidity are "other injuries of specified, unspecified and multiple body regions" (9.3%), followed by "Single spontaneous delivery" (6.2%), and "other complications of pregnancy and delivery" (5.2%), respectively. The top three leading causes of mortality are "human immunodeficiency virus (HIV)" (7%), followed by Septicaemia (5.7%) and "other injuries of specified, unspecified and multiple body regions" (5.3%).

Table 5.21 Leading Causes of Morbidity in Myanmar 2010

No.	Causes	Percent
1.	Other injuries of specified, unspecified and multiple body regions	9.3
2.	Single spontaneous delivery	6.2
3.	Other complications of pregnancy and delivery	5.2
4.	Diarrhoea and gastroenteritis of presumed infectious origin	5.0
5.	Other Viral Diseases	4.4
6.	Malaria	4.1
7.	Other pregnancies with abortive outcome	2.8
8.	Other arthropod-borne viral fevers and viral haemorrhagic fevers	2.5
9.	Gastritis and duodenitis	2.3
10.	Cataract and other disorders of lens	2.2
11.	Other maternal care related to fetus and amniotic cavity and possible delivery problems	2.1
12.	Other conditions originating in the perinatal period	1.7
13.	Other acute upper respiratory infections	1.6
14.	Fractures of other limb bones	0.4
15.	Other diseases of the respiratory system	0.4
	All other causes	49.8
	Total	**100.0**

Source: Health in Myanmar, 2012 by Ministry of Health

[31] Public Health Statistics 2012, Ministry of Health, May 2014.

Table 5.22 Leading Causes of Mortality in Myanmar 2010

No.	Causes	Percent
1.	Human immunodeficiency virus (HIV) disease	7.0
2.	Septicaemia	5.7
3.	Other injuries of specified, unspecified and multiple body regions	5.3
4.	Malaria	4.2
5.	Other disease of respiratory system	3.8
6.	Respiratory tuberculosis	3.7
7.	Slow fetal growth, fetal malnutrition and disorders related to short gestation and low birth weight	3.5
8.	Other disease of liver	3.4
9.	Heart failure	3.3
10.	Stoke, not specified as haemorrhage or infraction	3.2
11.	Intrauterine hypoxia and birth asphyxia	2.7
12.	Other heart disease	1.9
13.	Toxic effect of substance chiefly non-medicinal as to source	1.9
14.	Intracranial haemorrhage	1.5
15.	Pneumonia	1.3
	All other causes	47.6
	Total	**100.0**

Source: Health in Myanmar, 2012 by Ministry of Health

Diarrhoea has the highest number of cases per 100,000 population in Magway Region, with 714.9 of case per 100,000 population, and 0.4 deaths per 100,000 population, followed by malaria, which has 322.1 cases per 100,000 population, and 0.1 deaths per 100,000 population (***Table 5.23***).

Malaria remains a leading cause of morbidity and mortality in Myanmar. Considerable progress has been made over the past 20 years in reducing the burden. However, the disease is still a priority public health problem in the country.

Table 5.23 Indicators for Morbidity and Mortality of Diseases under Myanmar National Surveillance

Epidemiological Surveillance and Response (2012)																
Regions and States	Diarrhoea		Dysentery		Food Poisoning		Enteric Fever		Malaria		TB: sputum +ve		TB: sputum -ve		TB: Extra pulmonary	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Kachin	916.3	0.4	**280.5**	0.00	24.2	0.1	9.2	0.00	2,374.2	3.8	44.	1.0	80.0	1.9	58.6	0.2
Kayah	1,388.0	6.7	362.9	0.00	10.1	0.4	5.2	0.00	1,858.6	0.7	12.0	0.0	26.2	0.7	5.6	0.0
Kayin	907.5	0.0	203.2	0.00	17.1	0.1	2.3	0.00	970.0	1.4	74.1	0.1	155.7	0.1	8.4	0.0
Chin	1,803.1	5.4	520.9	0.21	15.5	0.8	34.5	0.00	2,613.6	1.9	23.2	0.4	58.3	0.6	78.5	0.0
Sagaing	846.9	0.9	234.1	0.00	11.0	0.1	12.7	0.08	1,085.6	1.6	46.7	0.3	55.0	0.4	36.0	0.1
Tanintharyi	862.3	0.3	251.2	0.08	41.5	0.5	2.6	0.00	2,166.9	1.2	56.5	0.2	182.9	1.2	88.0	0.5
Bago	549.0	0.2	162.7	0.00	11.3	0.2	10.3	0.00	484.5	0.6	48.6	0.5	98.9	0.9	13.0	0.1
Magway	**714.9**	**0.4**	**276.8**	**0.00**	**8.1**	**0.1**	**7.1**	**0.00**	**322.1**	**0.1**	**40.2**	**0.4**	**46.9**	**0.4**	**35.5**	**0.1**
Mandalay	547.5	0.1	174.4	0.00	9.8	0.1	11.1	0.00	279.5	0.1	54.0	0.4	44.9	0.3	42.6	0.1
Mon	755.3	0.2	146.5	0.00	8.1	0.3	10.6	0.00	362.2	0.6	66.0	0.8	173.2	1.8	18.7	0.1
Rakhine	1,150.4	0.4	421.1	0.03	17.2	0.2	17.6	0.03	1,752.8	0.6	43.9	0.7	47.1	0.5	16.8	0.1
Yangon	255.0	0.4	66.4	0.00	5.4	0.0	0.4	0.00	25.4	0.0	109.4	0.6	114.6	0.6	36.4	0.1
Shan (S)	672.4	1.1	200.4	0.00	11.2	1.0	5.2	0.00	845.3	1.5	39.2	0.6	47.2	0.4	21.9	0.2
Shan (N)	697.0	1.4	164.2	0.05	15.2	0.9	8.6	0.00	934.6	1.1	63.1	0.1	58.5	0.3	70.1	0.0
Shan (E)	1,015.1	0.5	279.6	0.00	15.3	0.2	2.9	0.00	209.5	0.0	101.7	0.7	160.9	0.2	37.6	0.0
Ayeyarwady	523.8	0.3	206.7	0.00	10.0	0.1	9.1	0.03	361.3	0.6	49.1	0.4	61.4	0.6	28.5	0.1
Naypyitaw	476.4	0.2	110.7	0.00	70.2	0.2	1.5	0.00	250.3	0.1	59.6	0.0	38.6	0.2	36.9	0.1
Union	**670.5**	**0.5**	**205.2**	**0.01**	**13.0**	**0.2**	**8.6**	**0.0.1**	**686.0**	**0.7**	**58.0**	**0.5**	**78.6**	**0.6**	**33.7**	**0.1**

Source: Public Health Statistics, 2012 by Ministry of Health, The republic of the Union of Myanmar

Note: (1) Number of cases per 100,000 populations.

(2) Number of deaths per 100,000 populations.

5.5.11.2 *Health Facilities and Medical Personnel*

According to information by Ministry of Health, in 2012 Myanmar had 987 public hospitals and 54,503 beds (***Table 5.24***). There were 28,077 doctors, which consist of 11,460 public doctors and 16,617 co-operative and private doctors. The number of others medical personnel are shown in ***Table 5.25***.

Health facilities in Magway Region according to township distribution are shown in ***Figure 5.35***. In 2011, the number of hospitals in Magway Region was 76, consisting of 2,552 sanctioned beds and 2,864 available beds[32].

Regarding health facilities, in each township in the Project area, there is at least one hospital in each township in the Project area as shown in ***Table 5.26***.

Table 5.24 Health Facilities in Myanmar

Health Facilities	1988-1989	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
Hospitals (Public Sector)	631	839	846	871	924	987
Total No. of Hospital Beds	25,309	36,949	38,249	39,060	43,789	54,503
No. of primary and Secondary Health Centers	64	86	86	86	86	87
No. of Maternal and Child Health Centers	348	348	348	348	348	348
No. of Rural Health Centers	1,337	1,473	1,481	1,504	1,558	1,556
No. of school Health Teams	80	80	80	80	80	80
No. of Traditional Medicine Hospitals	2	14	14	14	14	14
No. of Traditional Medicine Clinics	89	237	237	237	237	237

Source: Health in Myanmar, 2012 by Ministry of Health

Table 5.25 Health Manpower in Myanmar

Health Manpower	1988-1989	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
Total No. of Doctors	12,268	21,799	23,740	24,536	26,435	28,077
- Public	4,377	7,976	9,583	9,728	10,927	11,460
- Co-operative &private	7,891	13,823	14,808	14,808	15,508	16,617
Dental Surgeon	857	1,867	2,092	2,308	2,562	2,770
- Public	328	793	777	703	813	848
- Co-operative &private	529	1,074	1,315	1,605	1,749	1,922
Nurses	8,349	22,027	22,885	24,242	25,644	26,928
Dental Nurses	96	177	244	262	287	316
Health Assistants	1,238	1,788	1,822	1,845	1.899	1,536
Lady Health Visitors	1,557	3,197	3,238	3,278	3,344	3,371
Midwives	8,121	18,098	18,543	19,051	19,556	20,044
Health Supervisor (1)	487	529	529	529	541	612
Health Supervisor (2)	674	1,444	1,484	1,645	2,080	1,718

[32] Annual Hospital Statistics Report 2010-2011, Department of Health Planning, Ministry of Health, 2013.

Health Manpower	1988-1989	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
Traditional Medicine Practitioners						
- Public	290	945	950	890	890	885
- Private	2,500	5,163	5,397	5,737	5,737	5,867

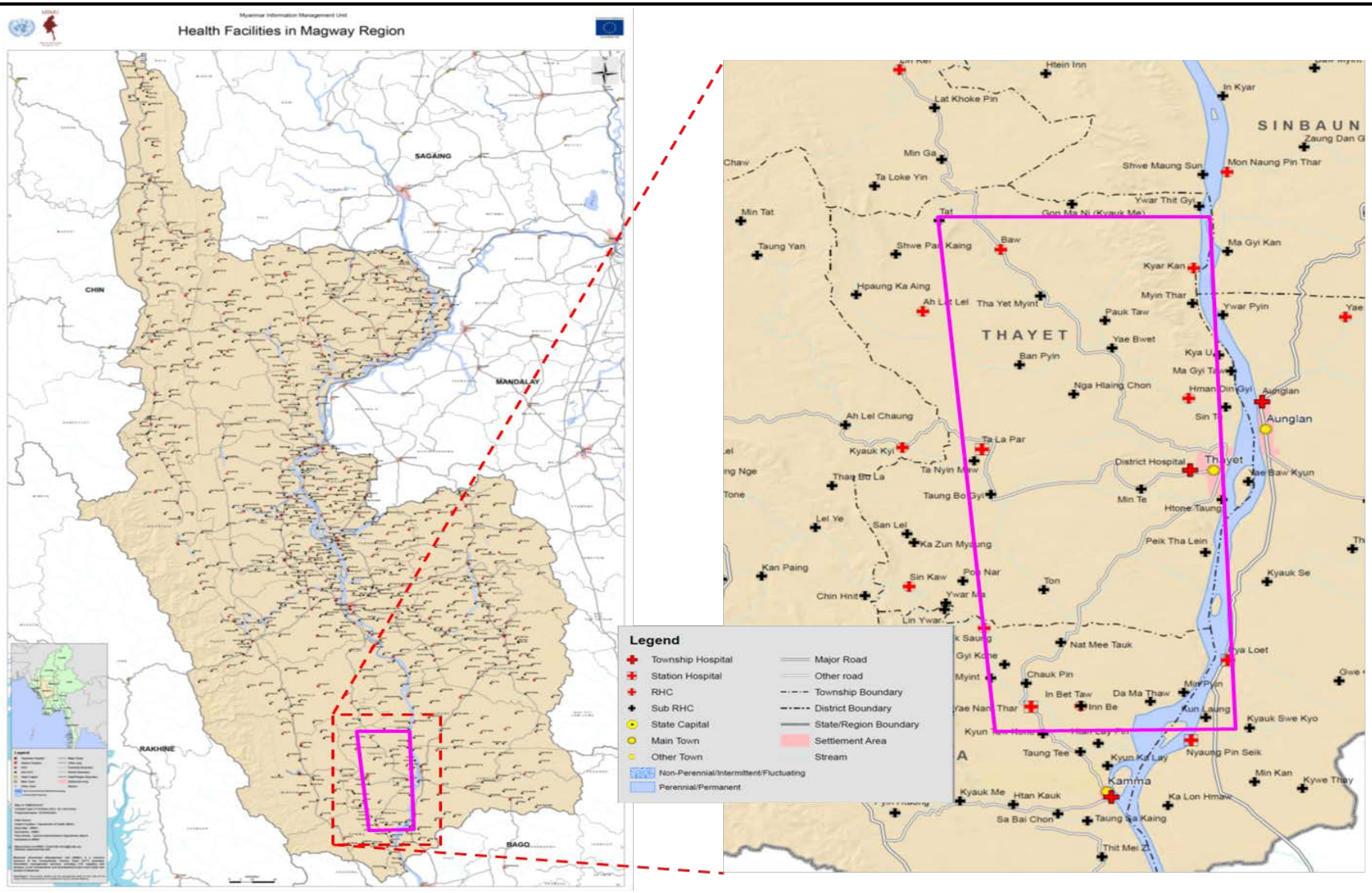
Source: Health in Myanmar, 2012 by Ministry of Health

Table 5.26 Number of Health Facilities and Medical Personal in each Township in Project Area

Township	Hospital			RHC	Sub-RHC	Physician	Nurse	Health Assistance
	District	Township	Station					
Thayet	1 (100 beds)	-	1 (16 beds)	5	25	15	19	6
Kanma	-	1 (25 beds)	1 (16 beds)	5	22	3	12	4

Source: Township Profiles 2014, of Thayet Township and Kanma Township

Figure 5.35 Health Facility Locations in Block MOGE-3



Source: Adapted From MIMU December 17, 2012 by ERM November, 2014

5.6 CULTURAL COMPONENTS

During REM's Land Use Study, it was found that there are no officially-designated heritage areas or archaeological zones approved by government in Block MOGE-3. However, there are a number of ancient pagodas which are in good condition, as well as some ruins, within the Project area.

According to a field survey carried out by MMRD in 2014, there are 36 monasteries and pagodas located throughout the Project area, as shown in ***Figure 5.36***.

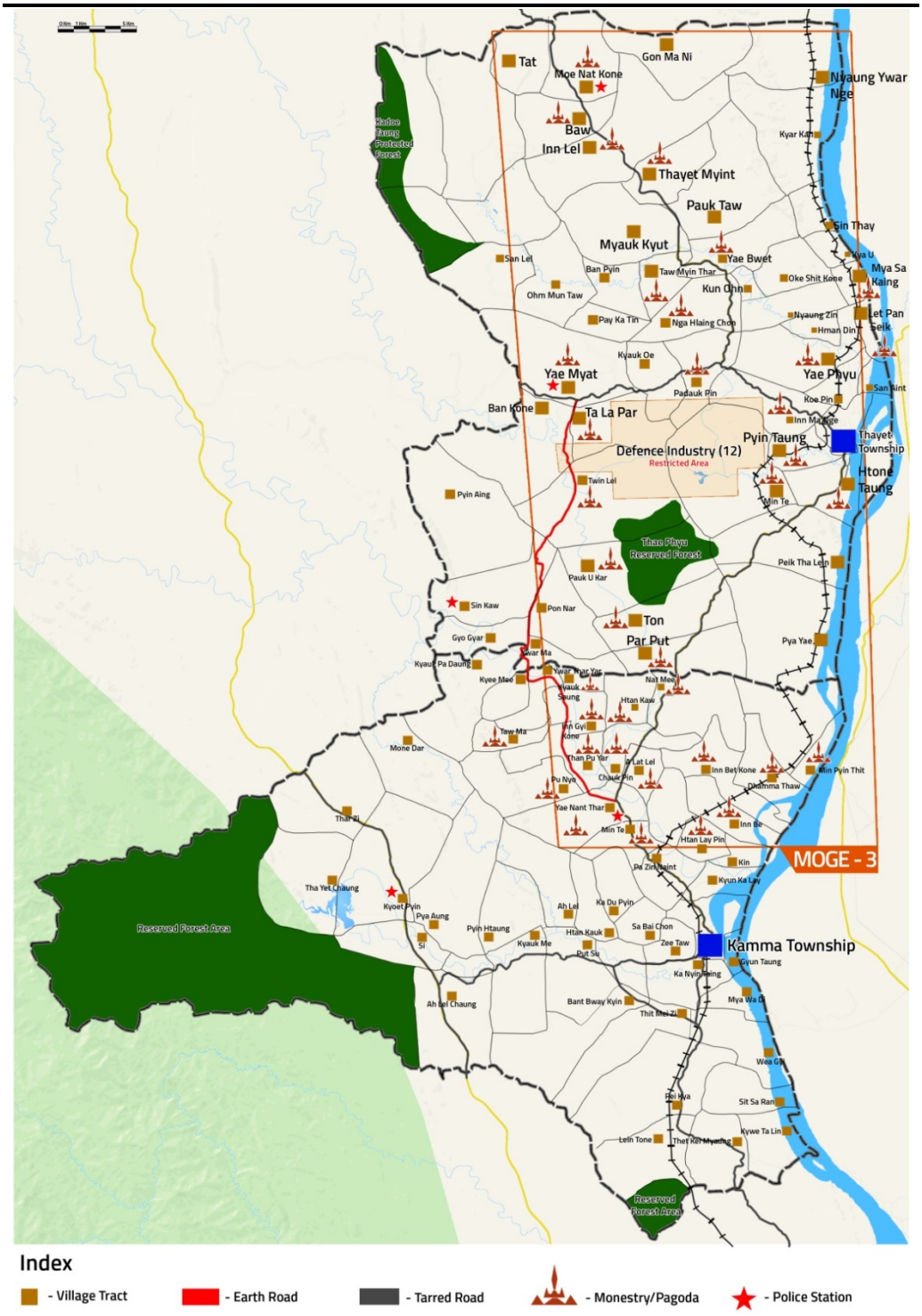
In addition, secondary information on Myanmar's ancient cities and sites from archaeological investigations of the Department of Archaeology, National Museum and Library shows that the nearest ancient cities of the Project area are Beikthano Pyu City and Sri Ksetra Pyu City. The sites are located approximately 54 km and 33 km from Block MOGE-3, respectively (***Figure 5.37***).

Beikthano Pyu City is located 19 km northwest of Taungdwingyi Township, Magway Region and 32 km from the east bank of the Ayeyarwady River, in the middle portion of the arid central plain of Myanmar. The ancient brick-walled city of Beikthano is shaped like a square. The brick fortification walls encompass the city area on its north, east and south sides. Its north-south length is nearly 3 km and its east-west length is 2.8 km long. The whole walled area of Beikthono city is approximately 900 ha in size.

Sri Ksetra Pyu City is located in the middle land between the dry zone of upper Myanmar and the wetter land to the south. Sri Ksetra is the largest city of Pyu and lies in the Nawin River valley in Pyay Township, Pyay District, Bago Region. It is roughly circular in shape, with north-south diameter of 4.4 km and east-west diameter 3.9 km. Its walled area encompasses approximately 1,880 ha. The high fortification wall is constructed of large, fired bricks, and has a circumference of 13.7 km, some sections of the wall are 4.6 m high[33].

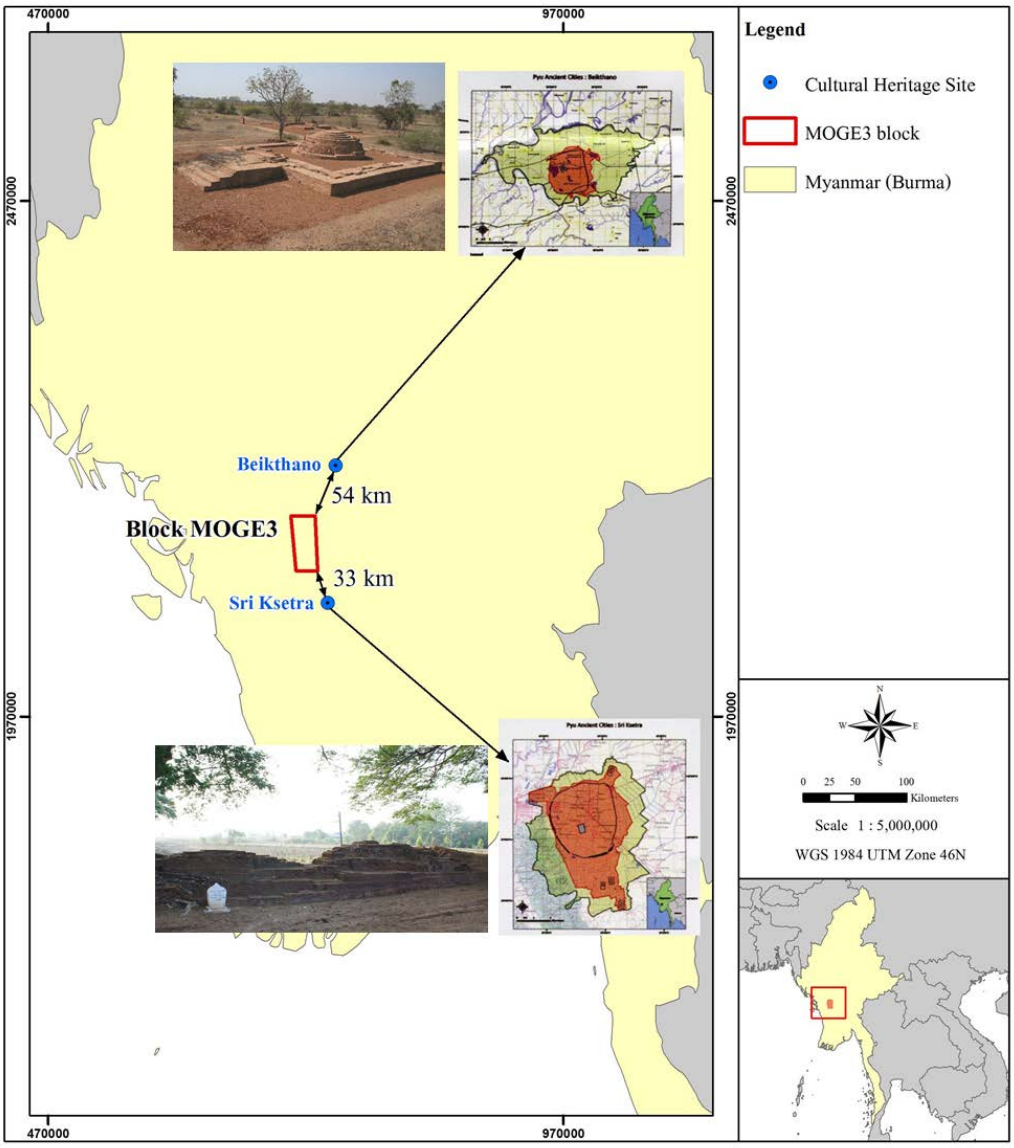
[33] Cultural Heritage Sites in Myanmar: Pyu Ancient Cities: Halin, Beikthano, Sri Ksetra, Department of Archaeology, National Museum and Library, Ministry of Culture, Myanmar.

Figure 5.36 Monastery and Pagodas Locations in Project Area



Source: MMRD, 2014

Figure 5.37 The Nearest Ancient Cities of Project Area



Source: Adapted from Cultural Heritage Sites in Myanmar, Department of Archaeology, National Museum and Library, Ministry of Culture, Myanmar

5.7 VISUAL COMPONENTS

Based on background secondary data, as well as site visits to the Project area by MMRD, REM, and ERM, the visual components of Block MOGE-3 consist primarily of dry, open landscape, with sparse and stunted vegetation, and limited forested and hilled areas. The elevation is fairly consistent, although some hilly/mountainous terrain exists in the northern portion of the Block.

In terms of man-made structures, the only significant visual components across Block MOGE-3 are pagodas, which are scattered throughout the Project area.

Figure 5.38 presents typical visual conditions within the Project area. Complete documentation of all photographs taken during site visits for this Project is presented in ***Annex G***.

Figure 5.38 Visual Landscape within Block MOGE-3

Source: REM, 2015

Section 6

Impact and Risk Assessment and Mitigation Measures

6 IMPACT AND RISK ASSESSMENT AND MITIGATION MEASURES

This section of the ESHIA provides an assessment of potential impacts arising from the Project. The impacts are organized by topic, and have been divided into three main aspects: environment, social and health. The contents presented in this section are as follows:

Section 6.1 Impact Assessment Methodology;

Section 6.2 Outcomes from Screening and Scoping;

Section 6.3 Environmental Impact Assessment;

Section 6.4 Social Impact Assessment;

Section 6.5 Health Impact Assessment; and

Section 6.6 Impact Assessment for Unplanned Events.

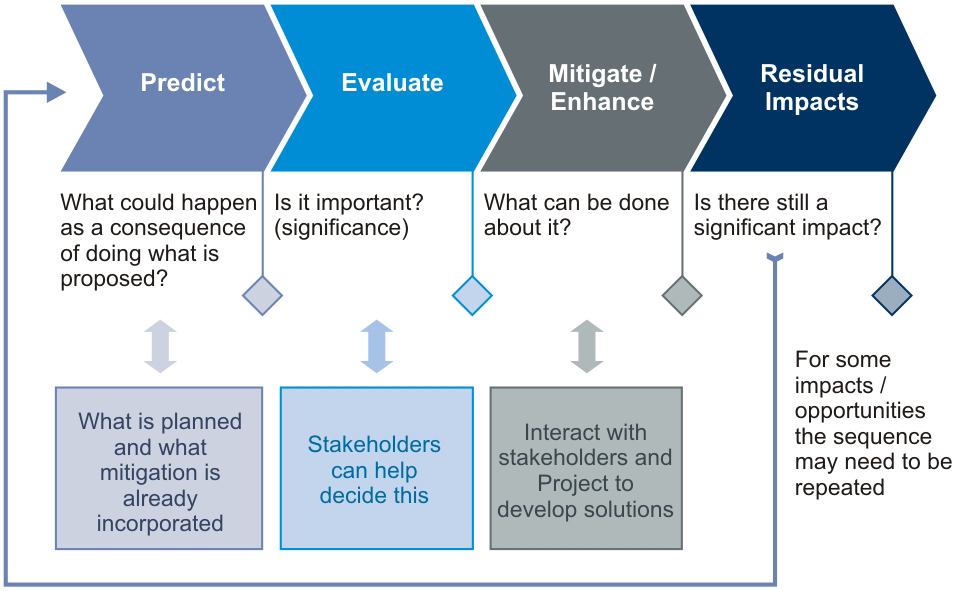
6.1 IMPACT ASSESSMENT METHODOLOGY

6.1.1 Impact Assessment

Impact identification and assessment starts with Scoping (described in ***Section 1***) and continues through the remainder of the ESHIA Process. The principal ESHIA steps are summarized in ***Figure 6.1*** and comprise:

- **Impact prediction:** to determine what could potentially happen to resources/receptors as a consequence of the Project and its associated activities;
- **Impact evaluation:** to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor;
- **Mitigation and enhancement:** to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts; and
- **Residual impact evaluation:** to evaluate the significance of impacts assuming effective implementation of mitigation and enhancement measures.

Figure 6.1 Impact Assessment Process



6.1.1.1 *Prediction of Impacts*

Prediction of impacts is essentially an objective exercise to determine what is likely to happen to the environment, social, or health aspects as a consequence of the Project and its associated activities. From the potentially significant interactions identified in Scoping, the impacts to the various resources/receptors are elaborated and evaluated. The diverse range of potential impacts considered in the ESHIA process typically results in a wide range of prediction methods being used, including quantitative, semi-quantitative and qualitative techniques.

6.1.1.2 *Evaluation of Impacts*

Once the prediction of impacts is complete, each impact is described in terms of its various relevant characteristics (e.g., type, scale, duration, frequency, extent). The terminology used to describe impact characteristics is shown in ***Table 6.1***.

The definitions for the "type" designations are shown in ***Table 6.1.*** Definitions for "extent", "duration", "scale", and "frequency" are resource/receptor-specific, but typical examples are shown in ***Table 6.1.***

Table 6.1 Impact Characteristic Terminology and Definitions

Characteristic	Definition	Designations	Definition
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct	Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected).
		Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
		Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc).	Local	The potential impact is limited to the Project area and vicinity.
		Regional	The potential impact covers a large area and/or affects the area beyond a local level.
		International	Potential impact may occur on a large scale at the regional level, and may expand to the national or international level.
Duration	The time period over which a resource / receptor is affected.	Temporary	Temporary potential impact occurs, or short-term impacts occur only occasionally.
		Short-term	Potential impact occurs over short term.
		Long-term	The potential impact occurs continuously for a long period of time and/or it is a permanent impact.
Scale	The size of the impact	No fixed designations	Intended to be a numerical value or a qualitative description of "intensity" or scale, e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.
Frequency	A measure of the constancy or periodicity of the impact.	No fixed designations	Intended to be a numerical value or a qualitative description of frequency, e.g. continuous, daily, weekly, etc.

The above characteristics and definitions apply to planned and unplanned events. An additional characteristic that pertains only to unplanned events is *likelihood*. The *likelihood* of an unplanned event occurring is designated using a qualitative scale, as described in ***Table 6.2***.

Table 6.2 Definitions of Likelihood Designations (for Unplanned Events only)

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Once impact characteristics are defined, the next step in the impact assessment phase is to assign each impact a 'magnitude'. As shown in ***Figure 6.2***, magnitude is typically a function of some combination (depending on the resource/receptor in question) of the following impact characteristics:

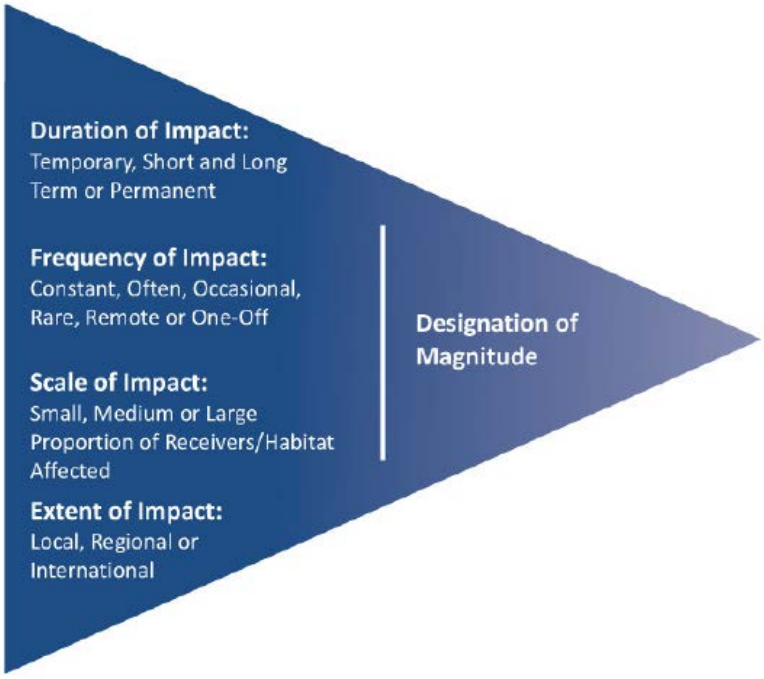
- Extent;
- Duration;
- Scale; and
- Frequency.

Additionally, for unplanned events only, magnitude incorporates the 'likelihood' factor discussed above.

Magnitude essentially describes the intensity of the change that is predicted to occur in the resource/receptor as a result of the impact. The magnitude designations themselves are universally consistent, but the definitions for these designations vary depending on the resource/receptor. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

Figure 6.2 Magnitude Designation



In the case of a *positive* impact, no magnitude designation (aside from 'positive') is assigned. It is considered sufficient for the purpose of the IA to indicate that the Project is expected to result in a *positive* impact, without characterizing the exact degree of positive change likely to occur.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilized, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation.

In addition to characterizing the magnitude of impact, the other principal impact evaluation step is definition of the sensitivity/vulnerability/ importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Other factors may also be considered, such as legal protection, government policy, stakeholder views and economic value.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations vary on a resource/receptor basis. Examples of receptor/resource sensitivity are provided in ***Table 6.3***. The sensitivity/ vulnerability/importance designations used herein for all resources/ receptors are:

- Low;
- Medium; and
- High.

Table 6.3 Example Definitions of Receptor Sensitivity

Sensitivity of Receptor	Example Definitions of Receptor Components			
	Abundance or quantity	**Condition**	**Adaptability**	**Value**
Low	Typically found/ Similar abundance in all area.	In a good and tolerant condition. Has experienced similar levels of change, which was acceptable.	Immediately adapts and accepts changes without difficulties.	Valuable but not site specific.
Medium	Abundance is limited in some areas.	Under some stressed condition.	Adapts/ accepts changes with some difficulties.	Valuable at local level, in current situation or under the protection of the law.
High	Very scarce. Specific characteristics.	Under high pressure and tends to worsen.	Cannot withstand the increasing pressure and experiences negative, permanent changes.	Highly valuable at the national and international level, or under the protection of the law.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterized, the significance can be assigned for each impact. Impact significance is designated using the matrix shown in ***Table 6.4***.

Table 6.4 Impact Significance

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/ importance designations. ***Figure 6.3*** provides a context for what the various impact significance ratings signify.

It is important to note that impact prediction and evaluation take into account any embedded controls (i.e., physical or procedural controls that are already planned as part of the Project design, regardless of the results of the ESHIA Process). This avoids the situation where an impact is assigned a magnitude based on a hypothetical version of the Project that considers none of the embedded controls.

Figure 6.3 Context of Impact Significances

An impact of **negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor significance** is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity/vulnerability/ importance. In either case, the magnitude should be well within applicable standards.

An impact of **moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of ESHIA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

6.1.2 *Identification of Mitigation and Enhancement Measures*

Once the significance of an impact has been characterised, the next step is to evaluate what mitigation and enhancement measures are warranted. For the purposes of this ESHIA, ERM has adopted the following Mitigation Hierarchy:

- **Avoid at Source, Reduce at Source:** avoiding or reducing at source through the design of the Project (e.g., avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity);
- **Abate on Site**: add something to the design to abate the impact (e.g., pollution control equipment, traffic controls, perimeter screening and landscaping);
- **Abate at Receptor:** if an impact cannot be abated on-site then control measures can be implemented off-site (e.g., noise barriers to reduce noise impact at a nearby residence or fencing to prevent animals straying onto the site);
- **Repair or Remedy**: some impacts involve unavoidable damage to a resource (e.g. agricultural land and forestry due to creating access, work camps or materials storage areas) and these impacts can be addressed through repair, restoration or reinstatement measures; and
- **Compensate in Kind, Compensate Through Other Means:** where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g., planting to replace damaged vegetation, financial compensation for damaged crops or providing community facilities for loss of fisheries access, recreation and amenity space).

The priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

6.1.3 *Residual Impact Evaluation*

Once mitigation and enhancement measures are declared, the next step in the ESHIA Process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the implementation of the proposed mitigation and enhancement measures.

6.2 OUTCOMES FROM SCREENING AND SCOPING

6.2.1 *Screening*

The primary objective of screening is to identify what ESHIA requirements apply to the Project. At the initial stage of the ESHIA, preliminary information was provided to aid in the determination of what legal and other requirements apply to the Project. This step was conducted utilising a high level description of the Project and its associated facilities (the details of which were described in ***Section 3***).

As described in the Policy, Legal and Institutional Framework in ***Section 3***, a number of environmental laws related to the requirement of ESHIAs are undergoing approval. Currently, ESHIAs are submitted to Myanmar Investment Commission (MIC) as part of application for an MIC permit. This ESHIA is aligned with the Draft EIA Procedure (2014), which includes specific requirements for the content and layout of EIA/ESHIA reports.

6.2.2 *Scoping*

Potential impacts have been identified through a systematic process whereby the features and activities (both planned and unplanned) associated with the preparation, operation and decommissioning of the Project have been considered with respect to their potential to interact with resources/receptors. Potential impacts have each been classified in one of three categories:

- **No interaction:** where the Project is unlikely to interact with the resource/receptor (e.g., wholly marine projects may have no interaction with the terrestrial environment);
- **Interaction likely, but not likely to be significant:** where there is likely to be an interaction, but the resultant impact is unlikely to change baseline conditions in an appreciable/detectable way; and
- **Significant interaction**: where there is likely to be an interaction, and the resultant impact has a reasonable potential to cause a significant effect on the resource/receptor.

As a tool for conducting scoping, the various Project features and activities that could reasonably act as a source of impact were identified, and these have been listed down the vertical axis of a Potential Interactions Matrix. The resources/receptors relevant to the baseline environment have been listed across the horizontal axis of the matrix. Each resulting cell on the Potential Interactions Matrix thus represents a potential interaction between a Project feature/activity and a resource/receptor.

The completed Potential Interactions Matrix is presented in ***Table 6.5***. Those cells that are coloured white are 'scoped out' of further consideration in the ESHIA Process. Those interactions that are grey are also 'scoped out', but the ESHIA report includes an explanation that presents the evidence base (e.g., past experience, documented data, etc.) used to justify the basis upon which

this decision was made. Those interactions that are shaded black are retained for further consideration in the ESHIA Process.

It should be noted that the list of project activities is not intended to be exhaustive but rather an identification of key aspects of the seismic survey operations that have the potential to interact with the environment/cause environmental impacts. The list of resources/receptors is also a focused list of the key aspects of the environment that are considered vulnerable or important in the context of onshore seismic survey activities in Block MOGE-3.

Table 6.6 shows the resources/receptors for which interactions are unlikely from all Project activities. Those resources/receptors with interactions that have been identified as likely, but which are not likely to lead to significant impacts are presented in ***Table 6.7***. Interactions that are likely to lead to significant impacts are presented in ***Table 6.8,*** and will be the focus of the impact assessment.

Table 6.5 Potential Interactions Matrix

PROJECT ACTIVITIES	Environmental Resources									Social Resources							Health Resources	
	Topography	Air Quality	Greenhouse Gas	Noise and Vibration	Soil	Surface Water and Hydrology	Groundwater	Flora and Fauna	Sensitive Ecosystems	Land Use	Transportation	Public Infrastructure	Aesthetics	Socio-Economy	Cultural and Archaeological Resources	Tourism and Recreation	Public Health	Occupational Health & Safety
Site Preparation																		
Transportation of Personnel and Equipment																		
Seismic Survey																		
Shot Hole Drilling																		
Receiver/Geophone Line Laydown																		
Shooting/Recording																		
Transportation of Personnel and Equipment																		
Waste and Wastewater Management																		
Abandonment and Site Restoration																		
Abandonment and Site Restoration																		
Transportation of Personnel and Equipment																		
Unplanned Events																		
Road Accidents																		
Accidental Explosion																		

Key:

	Interactions Identified as Unlikely
	Interactions Likely, but Not Likely to Lead to Significant Impacts
	Interactions are Likely to Result in Significant Impacts

Table 6.6 Interactions Identified as Unlikely for All Project Activities

Receptor/Resource	Justification for Expectation of Unlikely Interaction	In-place Control Measures and Operational Procedures
Tourism	• There are no significant tourist attractions within Block MOGE-3. • Project activities are short-term, and would not have any lasting impact on tourism activities.	• Appropriate minimum setback distances will be implemented to avoid any damage to pagodas and other cultural resources.
Aesthetics	• Project activities are short-term, and typically seismic activities would not be expected to significantly affect the aesthetics or visual components of the existing landscape of Block MOGE-3.	• None

Table 6.7 Interactions Identified as Likely, but that are Not Likely to Lead to Significant Impacts

Interaction (between Project Activity and Resource/Receptor)		Justification for Expectation of Non-Significant Impacts
Activity	Impact on Resource/Receptor	
Seismic Survey		
Shot Hole Drilling	Topography	• There are two main activities that could conceivably impact the topography around the Project area: site preparation for receiver/geophone laydown and drilling of shot holes. The majority of the Project area consists of a plateau with a low slope; therefore, excavation or soil filling will not be required. Thus, impacts from these activities on topography are negligible
	Sensitive Ecosystems	• The main sensitive ecosystem within Block MOGE-3 is the Ayeyarwady River. Seismic activities will avoid the Ayeyarwady River.
	Public Infrastructure	• Seismic drilling has the potential to impact public utilities, such as cables systems underground along the roads, and water supply pipes in the urban areas. • PTTEP SA will take all necessary precautions to detect and avoid seismic activities near public utilities, and will initiate appropriate setback distances.
Receiver/Geophone Line Laydown	Sensitive Ecosystems	• The main sensitive ecosystem within Block MOGE-3 is the Ayeyarwady River. Seismic activities will avoid the Ayeyarwady River.
	Transportation	• Depending on the seismic line layout, line laydown could conceivably intersect roadways, causing an impact to transportation. However, the impact is not considered significant because PTTEP SA will carefully plan the seismic line layout to minimize any potential impacts with local roads.

Interaction (between Project Activity and Resource/Receptor)		Justification for Expectation of Non-Significant Impacts
Activity	**Impact on Resource/Receptor**	
Shooting/Recording	Surface Water and Hydrology	• Residual chemicals from explosives and detonators could be carried to surface water. • However, quantities of ammonium in residuals from seismic activities are small in comparison to what would normally be used for fertilizer, and therefore impacts to soil (and subsequent impacts to surface water due to leaching or runoff) are expected to be minimal. Similarly, the detonator contains no substances known to be hazardous to the environment. Therefore, the residual from detonators is not expected to have a significant impact on the surface water quality.
	Flora and Fauna	• Flora or fauna in the vicinity of shot holes could be impacted by the sound or vibration of explosive shots. However, the impact is not considered significant because PTTEP SA will implement measures to reduce any impact to flora and fauna, including (see also ***Section 8***): • Avoid laying seismic lines near trees and large shrubs including areas with forests, garden forests, or areas with rare species.
	Sensitive Ecosystems	• The main sensitive ecosystem within Block MOGE-3 is the Ayeyarwady River. Seismic activities will avoid the Ayeyarwady River.
	Public Infrastructure	• Seismic shooting has the potential to impact public utilities, such as cables systems underground along the roads, and water supply pipes in the urban areas. • PTTEP SA will take all necessary precautions to detect and avoid seismic activities near public utilities, and will initiate appropriate setback distances.
Waste and Wastewater Management	Sensitive Ecosystems	• The main sensitive ecosystem within Block MOGE-3 is the Ayeyarwady River. Seismic activities will avoid the Ayeyarwady River.
Abandonment and Site Restoration		
Abandonment and Site Restoration	Topography	• During Abandonment and Site Restoration, the condition of the surrounding land will be, as much as possible, returned to its pre-Project condition. Therefore, all impacts associated with the presence and activities of the Project are likely to be reversed or negated during the abandonment and site restoration procedure. As all potential negative impacts will be mitigated by PTTEP SA (see ***Section 8)***, the significance of the positive impacts during Abandonment and Site Restoration are negligible.
	Flora and Fauna	
	Sensitive Ecosystems	
	Transportation	
	Public Infrastructure	
	Socio-Economy	
	Cultural and Archaeological Resources	

Interaction (between Project Activity and Resource/Receptor)		Justification for Expectation of Non-Significant Impacts
Activity	Impact on Resource/Receptor	
Transport of Equipment (All Project Phases)		
Transportation of Personnel and Equipment	Sensitive Ecosystems	• The main sensitive ecosystem within Block MOGE-3 is the Ayeyarwady River. Seismic activities will avoid the Ayeyarwady River.

Table 6.8 Interactions Identified that are Likely to Result in Significant Impacts

Interaction (between Project Activity and Resource/Receptor)		Justification for Expectation of Potentially Significant Impacts
Activity	Impact on Resource/Receptor	
Seismic Survey		
Shot Hole Drilling	• Air Quality • Greenhouse Gas	• Emissions will be released due to fuel combustion from the drillers. • High likelihood of occurrence (routine activity).
	• Noise and Vibration	• Potential increase in noise and vibration due to shot hole drilling. • High likelihood of occurrence (routine activity). • Requires careful management.
	• Soil • Surface Water and Hydrology • Groundwater • Flora and Fauna	• Drilling of the shot holes can create cuttings around the mouth of the holes. These cuttings could potentially cause sedimentation of waterways, or contamination of soil, groundwater, or surface water. This could also subsequently affect flora or fauna. • Additionally, some vegetation may need to be removed surrounding the shot holes. • Terrestrial fauna could also potentially be impacted by noise from drilling equipment. • High likelihood of occurrence (routine activity). • Potential for impacts if no mitigation/control measures in place.
	• Land Use	• Shot hole drilling will require clearance of land around each shot hole, which may affect land use for the duration of the Project.
	• Socio-Economy	• During the seismic survey, 1,000 workers will be employed for various Project activities. This will have a positive impact on socio-economy. • Project activities may temporarily disrupt some of the hand-dug oil well and agricultural activities in the Project area, thus having a potential negative impact on related employment/income.
	• Public Health • Occupational Health & Safety	• Workers will use equipment and machines to access the Project area, for drilling shot holes. Potential injuries may result from use of equipment. • The community may be impacted from Project activities in terms of dust, noise, vibration.

Interaction (between Project Activity and Resource/Receptor)		Justification for Expectation of Potentially Significant Impacts
Activity	Impact on Resource/Receptor	
Receiver/Geophone Laydown	• Land Use	• To access the Project area, the survey team and/or vehicles may need to tread on crops along a 1-m wide path for the length of each seismic line. In addition, each shot hole will require approximately 10 m² of area to be cleared of vegetation. • These clearance activities may impact existing land uses, including agricultural or hand-dug oil well communities.
	• Socio-Economy	• During the seismic survey, 1,000 workers will be employed for various Project activities. This will have a positive impact on socio-economy. • Project activities may temporarily disrupt some of the hand-dug oil well and agricultural activities in the Project area, thus having a potential negative impact on related employment/income.
Shooting/Recording	• Air Quality	• Dust emissions may occur during shooting. • High likelihood of occurrence (routine activity).
	• Noise and Vibration	• Potential increase in noise and vibration due to detonation of explosive shots during shooting. • High likelihood of occurrence (routine activity). • Requires careful management.
	• Soil	• Shooting of explosives in shot holes may affect the soil structure. • Residuals from explosives may contaminate soil. • High likelihood of occurrence (routine activity). • Requires careful management.
	• Groundwater	• If shooting/recording operates close to a groundwater well, the structure of the groundwater well may be impacted. • High likelihood of occurrence (routine activity). • Requires careful management.
	• Socio-Economy	• During the seismic survey, 1,000 workers will be employed for various Project activities. This will have a positive impact on socio-economy. • Project activities may temporarily disrupt some of the hand-dug oil well and agricultural activities in the Project area, thus having a potential negative impact on related employment/income.
	• Cultural and Archaeological Resources	• Shooting/recording will involve the detonation of explosives, which can cause damage to nearby sensitive cultural/archaeological resources due to vibration impact.

Interaction (between Project Activity and Resource/Receptor)		Justification for Expectation of Potentially Significant Impacts
Activity	Impact on Resource/Receptor	
		• High likelihood of occurrence (routine activity). • Requires careful management.
	• Public Health • Occupational Health and Safety	• Workers will use explosives during shooting/recording. Potential injuries may result from improper use of explosives. • The community may be impacted from improper use of explosives during shooting/recording.
Waste and Wastewater Management	• Soil • Surface Water and Hydrology • Groundwater • Flora and Fauna • Public Health	• Potential for soil contamination from waste management and wastewater. • Potential for subsequent contamination of groundwater and surface water due to leaching and/or runoff.
Abandonment and Site Restoration		
Abandonment and Site Restoration	• Land Use	• Abandonment/Site Restoration may return impacted land areas to their original land uses.
Transportation of Personnel and Equipment (All Phases)		
Transportation of Personnel and Equipment	• Air Quality • Greenhouse Gas	• Emissions will be released due to fuel combustion from vehicles during transportation. • High likelihood of occurrence (routine activity).
	• Noise and Vibration	• Potential increase in noise and vibration due to vehicle movement. • High likelihood of occurrence (routine activity). • Requires careful management.
	• Soil • Surface Water and Hydrology • Flora and Fauna	• Vehicles can compact soils and decrease infiltration of water into subsurface soil. These may lead to water-logging or increased surface run-off and can also cause soil erosion. • Flora/fauna could be affected by damage from vehicles. • Soil erosion can subsequently impact surface water sources and affect hydrology.
	• Transportation	• Transportation of personnel and equipment is expected to occur with variously sized trucks, and could increase local traffic.
	• Public Health • Occupational Health and Safety	• Potential for increased risks of traffic accidents.
Unplanned Events		
Road Accidents	Multiple	• Potential for adverse impacts to terrestrial environment, harm to living resources. • Potential for disruption to traffic. • Potential for harm to occupational health and safety. • Potential to strain and divert the community's medical resources.

Interaction (between Project Activity and Resource/Receptor)		Justification for Expectation of Potentially Significant Impacts
Activity	Impact on Resource/Receptor	
		• Major site accidents, including unplanned events, could result in medical emergencies beyond the capacity of project resources. • All unplanned events require careful management.
Accidental Explosion	Multiple	• Accidental explosion during seismic activities is a rare and unexpected occurrence. However, in the event that it does occur, it has the potential to have wide-reaching impacts to man y different receivers/receptors, including: o unintended air emissions; o excessive noise/vibration; o destruction of habitats or direct injury/death to flora/fauna; o alteration or impact to current land uses; o disruptions to transportation or public infrastructure; o damage to cultural/ archaeological resources; and o injury or death to public or workers. • All unplanned events require careful management.

6.3 ENVIRONMENTAL IMPACT ASSESSMENT (ALL PROJECT PHASES)

6.3.1 *Assessment of Impacts to Air Quality*

6.3.1.1 *Scope of Assessment*

As determined during scoping, potential impacts to air quality from the seismic survey may occur due to:

- Transportation of Personnel and Equipment (All Phases);
- Shot Hole Drilling; and
- Shooting/Recording.

6.3.1.2 *Summary of Relevant Baseline Conditions*

From the Blocks PSC-G & EP-2 Drilling Baseline Survey, air quality was found to be good with respect to CO, VOC, NO_2 and SO_2 at all regions within the proposed project area, and are not likely to affect the health and environment of the exposed population. However, the results from the baseline survey indicate that the 24-hour average levels of both PM10 and TSP did not meet the WHO guideline. Particulate Matter was also found to exceed the applicable standard during various monitoring activities conducted across the country (***Section 5.3.3***). Therefore, the values are likely to represent typical conditions in Myanmar.

6.3.1.3 *Assessment of Impacts*

Impacts to air quality from the Project consist of dust dispersion and air pollutants from vehicle transportation, shot hole drilling, and shooting/recording. The air quality impacts are assessed below.

Dust Dispersion from Vehicle Use

For this project, dust will be generated mostly from transportation on unpaved roads. Equipment, materials and workers will be transported in light 4-wheel drive and pick-up trucks. Approximately 112 vehicles will be used for the seismic survey each day. There are a number of highways and laterite or unpaved roads that will be used to access the various locations in the Project area. However, suspended dust particles from these roads are relatively large, and thus they are not expected to disperse, and will settle rapidly to the ground.

There could potentially be a short-term increase in dust near certain roads and along the seismic lines as a result of the Project activities. This might lead to slight increases in TSP and PM10 near those roads, but those increases would be short-term in duration and no different from any other vehicles currently travelling these roads.

Dust Dispersion from Shooting/Recording

For this seismic survey, each shot hole will have a diameter of 3 inches (7.62 cm) and depth of 10-30 m, and the shooting area for each shot hole will be approximately 10 m²; shooting will be done by a field recorder. This activity may cause dust dispersion around the mouth of the shot holes. It is expected that the contractor will shoot a total of approximately 31,000 shot holes over the course of the 270 day seismic operation. Each hole will be shot until the shooting for each area is completed as planned before moving to the next area.

The amount of dust dispersion from shooting can be estimated from an equation for mine explosion (US EPA, 1985) as shown below:

$$Emission = \frac{961A^{0.8}}{D^{1.8}M^{1.9}} \qquad \textbf{\textit{Eq. 6-1}}$$

Where

Emission = Quantity of dust dispersion with a particle size less than 30 micron (lb/shooting point; 1 lb = 0.454kg)

A = Shooting area (in ft²; 1 m² = 10.764 ft²)

D = Depth of shot hole (in ft; 1 m = 3.281 ft)

M = Percentage of soil moisture (In this case, 9.35% (from 2009 CNPC Pipeline EIA Baseline Survey[1]))

Table 6.9 provides an estimation of dust dispersion (dust emission) generated from a single hole. Considering the entire seismic area of 1,000 km², a total of approximately 31,000 shot holes, and survey duration of 270 days, the estimated dust dispersion per hectare is also presented in ***Table 6.9***.

Table 6.9 Dust Emissions Generated from Shot Holes

Type of Shot Hole	Min. Depth of Shot Hole (m)	Dust Emission (kg/shooting) point)	Total Dust Emission over entire Project (kg)	Total Dust Emission per Area (kg/ha/month)
Single-hole	10	0.49	15,253	0.02

The total amount of dust dispersion generated from all shot holes would be a maximum of 15,253 kg over 270 days, or approximately 0.02 kg/ha/month. Compared to the US EPA's air emission factor of 2,690 kg/ha/month of heavy construction activity[2], which is valid for activities scattered throughout a geographical area with moderate silt and semiarid climate, the total dust emission over the seismic area is considered to be low. Similarly, the Norwegian limit value for deposition of mineral dust from quarries is 5 g/m² per 30 days, which corresponds to 50.67 kg/ha/month[3], and is also much higher than the expected dust emission of the Project.

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1 EIA of the CNPC Myanmar-China Gas Pipeline Project, IEM, 2010

2 http://www.epa.gov/ttnchie1/ap42/ch13/final/c13s02-3.pdf

3 Norway, 2004. Forskrift om begrensning av forurensning, FOR 2004-06-01 nr 931. (Regulation on limitation of pollution).

Dust dispersion will only occur near the line survey over a short period of time, and this dust will quickly settle out near the shot hole. Moreover, community health will not be affected as the survey team will avoid community areas in accordance with the minimum setback distance standards.

Air Pollutants Generated by Fuel Combustion

Air pollutants will be generated from the release of exhaust from vehicles for transportation of equipment, material, and personnel, as well as from shot hole drilling activities, Vibroseis trucks, and generators. The quantity of diesel fuel expected to be consumed for each of these activities was described in ***Section 4.7.5***, and is summarized in ***Table 6.10***.

Table 6.10 Summary of Project Fuel Use

Equipment	Estimated Fuel Use (L/day)
Generators (4)	2,232
Vehicles (112)	53,312
Flushing Drillers (50)	1,000
Seismic Vibrators (4)	4,585
TOTAL	**61,129**

Based on a compilation of air pollution emission factors established by the U.S. Environmental Protection Agency (EPA), carbon monoxide, nitrogen oxides, and sulphur oxides will be emitted at estimated quantities shown in ***Table 6.11***.

Table 6.11 Estimated Emission of Air Pollutants from Project Activities

Air Pollutant	Emission Factor (kg/TJ)	Fuel Consumption (kg/day)	Fuel Consumption (TJ/day)	Estimated Emission of Air Pollutant (kg/day)	Total Estimated Emission (tonnes)
61,129 L/day Diesel from All Project Activities, 270 Days for Project					
Nitrogen Oxides (NO_x)	1,896	51,330.02	2.22	4,216.95	1,138.58
Sulphur Oxides (SO_x)	126			280.24	75.66
Carbon Monoxide (CO)	410			911.89	246.21

Sources: US.EPA[4]

Note: Density of diesel oil is 0.8397 kg/l, IEA (2004)[5]; Net Calorific Values is 43.33 TJ/Gg, IEA (2009)[6]

[4] "Compilation of Air Pollution Emission Factors, Volume 1, Stationary Point and Area Sources", Fifth Edition, January 1995; http://www.epa.gov/ttn/chief/ap42/ch03/bgdocs/b03s03.pdf.

[5] Densities of Oil Product, Energy Statics Working Group Meeting

[6] CO_2 Emission from Fuel Combustion, Documentation for Beyond 2020 Files

The magnitude of potential impacts is determined on the basis of two factors:

1. The increase in pollutant concentrations in air as a result of the Project (Project Contribution - PC or potential incremental impact); and
2. The total air pollutant concentrations arising as a result of the existing baseline added to the PC (the Predicted Environmental Concentration – PEC, or cumulative impact).

The PC and PEC are considered in the context of the relevant air quality standards (AQS). On the basis of the PC, PEC and the WHO Air Quality Guidelines and National Ambient Air Quality Standards (NAAQS) (USEPA), the magnitude is determined as shown in ***Figure 6.4***.

Figure 6.4 Determination of Magnitude of Potential Impacts due to Air Pollutants

Magnitude of Potential Impacts

	Undegraded Airshed (Baseline < AQS)	Degraded Airshed (Baseline >AQS)
Negligible	PC < 25% of AQS	PC <10% of AQS
Small	PC >25% of AQS, <50% of AQS, and PEC <100% of AQS	PC >10% of AQS, <15% of AQS
Medium	PC >25% of AQS, <50% of AQS, and PEC >100% of AQS; or PC >50% of AQS, <100% of AQS, and PEC <100% of AQS	PC >15% of AQS, <25% of AQS
Large	PC >100% of AQS	PC >25% of AQS

To obtain estimated concentrations (PC and PEC) of pollutants, the total emission quantities from ***Table 6.11*** are combined with a simplified box model, as follows:

$$C = \frac{Q}{dwM} \qquad \textbf{Eq. 6-2}$$

Where

C = Concentration of pollutants (mg/m^3)

Q = Emissions at source (mg/sec; from ***Table 6.11***)

d = Width (m) (smallest dimension assumed for worst case, i.e. average width of road (5 m))

w = Wind velocity (m/sec) (average wind velocity in Magway is 1.5 m/sec[7])

M = Mixing Height (m) (worst case 900 m, based on data from neighboring Thailand (Jaturong, 2009))

[7] Kyaw, W.W., Sukchai, S., Ketjoy, N., Ladpala, S., "Energy utilization and the status of sustainable energy in Union of Myanmar", Energy Procedia 9 (2011) 351 – 358, 9th Eco-Energy and Materials Science and Engineering Symposium

Given the low potential impact of Project activities on air quality, this simplified approach is considered suitable for providing a quantitative approximation to atmospheric pollutant concentrations. Estimated concentrations of pollutants due to the Project (based on 270 days of operation), as well as the equivalent potential impact magnitude, are presented in ***Table 6.12***.

6.3.1.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to air quality include the following:

- Regularly maintain all survey vehicles to ensure good operating conditions to minimize emissions;
- Compact shot holes firmly prior to shooting/recording to minimize soil dispersion (dust generation); and
- Limit vehicle speed to 30 km/hr on laterite roads and other unpaved roads within village tracts or community areas.

Table 6.12 Estimated Pollutant Concentrations and Potential Impact Magnitude

Air Pollutant	Total Estimated Emissions (tonnes)	Average Baseline Concentration (2009-2013, Middle Myanmar) (µg/m³)	Project Contribution (µg/m³)	Predicted Environmental Concentration (µg/m³)	AQS (µg/m³)	Equivalent Potential Impact Magnitude
Nitrogen Oxides (NO_x)	1,138.58	22.86	7.23	30.09	40 (1-year)[1]	Negligible
Sulphur Oxides (SO_x)	75.66	1.03	0.48	1.51	20 (24-hr)[1]	Negligible
Carbon Monoxide (CO)	246.21	0.3	1.56	1.86	9 (8 hr)[2]	Negligible

Note: [1]: WHO Guidelines (24hr Average)
[2]: NAAQS (USEPA) (8 hr Average)

6.3.1.5 *Significance of Impacts*

The significance of impacts to air quality from dust due to transportation and shooting/recording, as well as from air pollutants generated by fuel combustion, are assessed in ***Table 6.13.***

Table 6.13 Assessment of Potential Impacts on Air Quality from All Project Activities

Impact	• Dust dispersion may occur from transportation on unpaved roads • Dust dispersion may occur from shooting/recording • Air pollutants emitted from fuel combustion				
Nature	**Negative**	Positive	Neutral		
	Potential impacts to air quality would be considered to be adverse (negative).				
Type	**Direct**	Indirect	Induced	Cumulative	
	Impacts to air quality would be direct impacts through the release of dust and air pollutants from Project activities.				
Duration	**Temporary**	Short-term	Long-term	Permanent	
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Dust and pollutant emissions would not be constant, and would occur intermittently over the survey period.				
Extent	**Local**	Regional	International		
	Impacts would be limited to the survey area and hence would be considered to be local.				
Scale	The seismic survey will take place over an area of approximately 1,000 km^2. **Dust Dispersion from Vehicle Use** There could potentially be a short-term increase in dust near certain roads and along the seismic lines as a result of the Project activities. This might lead to slight increases in TSP and PM10 near those roads. But those increases would be short-term in duration and no different from any other vehicles currently travelling these roads. **Dust Dispersion from Shooting/Recording** The worst case total amount of dust dispersion generated for the Project from all shot holes is 0.02 kg/ha/month, which is much lower than comparable standards. Dust dispersion will only occur near the line survey over a short period of time and this dust will quickly settle out near the shot hole. Moreover, community health will not be affected as the survey team will avoid community areas in accordance with the minimum setback distance standard. **Air Pollutants Generated by Fuel Combustion** The quantities of SOx, NOx and CO emitted from the Project are substantially below the selected air quality standards and would produce only minor changes in ambient air quality levels in the Project area.				
Frequency	Dust and pollutant emissions will be released intermittently but repeatedly throughout the day for the duration of the seismic survey.				
Magnitude	Positive	Negligible	**Small**	Medium	Large
	Slight, short-term change in air quality is possible in some locations of the Project area, with air quality returning to background levels soon after completion of Project activities.				
Receptor/ Resource Sensitivity	**Low**	Medium	High		
	Existing air quality in the Project area is generally good, and resources/receptors are not expected to be especially sensitive to potential impacts to air quality. Most of the areas surrounding the survey are agricultural or rural areas, with some residential areas. Receptor/resource sensitivity is rated as Low.				

Significance	**Negligible**	Minor	Moderate	Major
	The combination of a Low Receptor/Resource Sensitivity and Small Impact Magnitude will result in an overall Negligible impact.			
Mitigation Measures	**Existing** • Regularly maintain all survey vehicles to ensure good operating conditions and minimize emissions. • Compact shot holes firmly prior to shooting/recording to minimize soil dispersion (dust generation). • Limit vehicle speed to 30 km/hr on laterite roads and other unpaved roads within village tracts or community areas.Switch off vehicles engines when not in use, in the parking lot of the field office and around the field working area. **Additional** • Minimize or avoid destruction of trees within and around the Project area, as they act as natural buffers to dust and air emissions. • Only work within the set areas, which will be: • For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m2/shot hole for shot-hole drilling. • For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total).			
Residual Significance	**Negligible**	Minor	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Negligible.			

6.3.2 *Assessment of Impacts to Greenhouse Gas*

6.3.2.1 *Scope of Assessment*

As determined during scoping, potential impacts to greenhouse gas from the seismic survey may occur due to:

- Transportation of Personnel and Equipment (All Phases); and
- Shot Hole Drilling.

6.3.2.2 *Summary of Relevant Baseline Conditions*

According to data from the World Resources Institute (2014), Myanmar's total GHG emissions (excluding land use change and forestry) in CO_2 equivalent were 161.22 million tons in 2011.

6.3.2.3 *Assessment of Impacts*

The main sources of GHG emissions during the seismic survey are from energy use in diesel generators and drilling rigs, and vehicle transportation.

GHG emissions are estimated for various project activities following the Tier 1 approach of IPCC (2006) for stationary combustion (generators and drillers) and mobile combustion (transportation), using volume-based approaches. GHG emissions are estimated using emission factors for the three main greenhouse gases (CO_2, CH_4 and N_2O), and converted to carbon dioxide equivalent, using global warming potentials.

Vehicle Transportation (Mobile Combustion)

During the seismic survey, general transportation involves the movement of water, equipment and personnel to and from the areas of seismic survey. General-use vehicles, assuming they are Class 2A (2,722 – 3,856 kg, light duty trucks) will consume an average of 5.95 L/km of diesel (U.S. Department of Energy, 2010[8]). Assuming an approximate distance travelled of 80 km/day, and 112 vehicles, the general-use vehicles for the Project will consume approximately 53,312 L/day.

GHG emissions from general road transportation are estimated following the Tier 1 approach of IPCC (2006) for mobile combustion (based on volume of fuel consumed).

Greenhouse gas emissions are estimated in terms of CO_2 equivalent according to IPCC emission factors and ***Equation 6-3*** (*IPCC, 2006*):

$$Emissions_{GHG,fuel} = FC_{fuel} \times EF_{GHG,fuel} \qquad \textbf{Eq. 6-3}$$

Where

$Emissions_{GHG,\,fuel}$	=	Emissions of a given GHG by type of fuel (kg)
FC_{fuel}	=	Fuel consumption (amount of fuel combusted) (TJ)
$EF_{GHG,\,fuel}$	=	Default emission factor of a given GHG by type of fuel (kg/TJ)

The type of fuel used for Project activities is diesel. To convert the consumption of diesel in volume (liters) to energy (TJ), the following conversion factors can be applied:

- 1 kg = 10^{-3} tonne = 10^{-6} Gg
- IPCC default net calorific value for gas/diesel oil = 43.33 TJ/Gg
- Density of Diesel = 0.8397 kg/L[9]

Fuel consumption for diesel (in terms of TJ of energy) can therefore be calculated as follows:

$$FC_{Diesel} = Diesel\ Use\ (L) \times Diesel\ Density\ (kg/L) \times 10^{-6}(Gg/kg) \times 43.33(TJ/Gg) \qquad \textbf{Eq. 6-4}$$

$$= Diesel\ Use\ (L) \times 3.6384 \times 10^{-5}(TJ/L)$$

The Emission Factor for diesel use by mobile combustion from IPCC (2006) is shown in ***Table 6.14***:

$$EF_{CO2,\,Diesel} = 75{,}344.1 \text{ kg } CO_2 \text{ eq/TJ}$$

Therefore, based on 53,312 liters of diesel consumed during the seismic survey for general transportation, and using ***Equations 6-3*** and ***6-4***,

$$Emissions_{CO2,\,Diesel}\ (\text{kg}) = 146{,}145 \text{ kg } CO_2$$

$$= 146.1 \text{ tonnes } CO_2$$

[8] http://cta.ornl.gov/data/chapter4.shtml

[9] IEA (2004), Density of Oil Products, Energy Statistics Working Group Meeting

It is expected that general transportation will generate CO_2 emission of 146.1 tonnes CO_2 eq/day. For a total of 270 days of seismic operations, the maximum total emission of greenhouse gases from general vehicle use is therefore estimated to be 39,447 tonnes.

Table 6.14 ***Emission Factor for Fuel Use by Mobile Combustion (Road Transportation – Consumption-Based))***

Types	Unit	CH_4	N_2O	CO_2	Total
Diesel	kg/TJ	3.9	3.9	74,100	
	kg CO_2 eq*/TJ	89.7	1,154.4	74,100	75,344.1

Source: IPCC (2006)
Note: * Global warming potentials (100 year time horizon): CO_2 = 1; CH_4 = 23; N_2O = 296

Seismic Vibrator (Vibroseis) Trucks

The seismic vibrator (Vibroseis) trucks are expected to consume approximately 95.53 L/hour (at 400 kW power) of diesel for each truck, corresponding to a worst case of 4,585 L/day, assuming operation of four trucks for 12 hours per day.

GHG emissions from seismic vibrator (Vibroseis) operation are estimated following the Tier 1 approach of the IPCC guideline (***Equation 6-3***) for mobile offroad combustion, with an emission factor for mobile offroad combustion of 82,661.1 kg CO_2 eq/TJ (from ***Table 6.15***) and fuel consumption of 4,585 L/day (0.167 TJ/day, estimated using ***Equation 6-4***). This results in CO_2 emissions of 13.79 tonnes CO_2 eq/day. For a total of 270 days of seismic operations, the maximum total emission of greenhouse gases from Vibroseis is therefore estimated to be 3,723.3 tonnes.

Table 6.15 ***Emission Factor for Fuel Use by Generators (Mobile Combustion – Offroad Transportation, Industry)***

Types	Unit	CH_4	N_2O	CO_2	Total
Diesel	kg/TJ	4.15	28.6	74,100	
	kg CO_2 eq*/TJ	95.45	8,465.6	74,100	82,661.1

Source: IPCC (2006)
Note: * Global warming potentials (100 year time horizon): CO_2 = 1; CH_4 = 23; N_2O = 296

Generators and Drillers (Stationary Combustion)

Diesel generators will be used as a source of power supply for the seismic survey, and the drillers will also consume diesel fuel. Fuel consumption of the generators is estimated to amount to approximately 2,232 L/day (see ***Section 4.8.4***), and the flushing drillers are expected to consume about 20 L/day each, with 50 drillers totalling 1,000 L/day.

Greenhouse gas emissions in terms of CO_2 equivalent are estimated according to the emission factors for stationary combustion presented in ***Table 6.16*** (*IPCC, 2006*), and ***Equations 6-3 and 6-4***, as follows:

$$EF_{CO2,\ Diesel} = 74{,}346.6 \text{ kg } CO_2 \text{ eq/TJ}$$

resulting in:

$$Emissions_{CO2,\ Diesel}\ (kg) = 8{,}743\ kg\ CO_2/day$$
$$= 8.74\ tonnes\ CO_2/day$$

It is expected that generators and drillers will generate GHG emissions of 8.74 tonnes of CO_2 eq/day. For a total of 270 days of operation, the total emission of greenhouse gases from generators and drillers during the seismic operation is therefore estimated to be at a maximum of 2,359.8 tonnes.

Table 6.16 Emission Factor for Fuel Use by Generators and Drillers (Stationary Combustion)

Types	Unit	CH_4	N_2O	CO_2	Total GHG
Diesel	kg/TJ	3	0.6	74,100	
	kg CO_2 eq*/TJ	69	177.6	74,100	74,346.6

Source: IPCC (2006)
Note: * Global warming potentials (100 year time horizon): CO_2 = 1; CH_4 = 23; N_2O = 296

Error! Bookmark not defined.Total Combined GHG Emissions

The total release of equivalent CO_2 during the seismic operations is estimated to be 45,530.1 tonnes of CO_2 eq, as shown in ***Table 6.17***. Compared to Myanmar's CO_2 release of 161.22 million tons in 2011 (WRI, 2014), the total GHG releases of this project are insignificant (approximately 0.03%), and therefore will not significantly impact the environment.

Table 6.17 Estimated Total GHG Emissions for Seismic Survey

Project Phase	Activity	One Time CO_2 Release (ton CO_2)
Entire Seismic Operation	General vehicle transportation	39,447.0
	Seismic vibrators (Vibroseis)	3,723.3
	Generators and drillers (stationary sources)	2,359.8
	Total	**45,530.1**

6.3.2.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to greenhouse gas include the following:

- Regularly maintain all survey vehicles to ensure good operating conditions to minimize emissions; and
- Limit vehicle speed to 30 km/hr on laterite roads and other unpaved roads within village tracts or community areas.

6.3.2.5 *Significance of Impacts*

The significance of impacts to greenhouse gas due to fuel combustion is assessed in ***Table 6.18***.

Table 6.18 Assessment of Potential Impacts on Greenhouse Gas from All Project Activities

Impact	• Combustion of fossil fuels in stationary and mobile combustion sources will produce greenhouse gases (e.g. carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)).				
Nature	**Negative**	Positive	Neutral		
	Potential impacts to greenhouse gas would be considered to be adverse (negative).				
Type	**Direct**	Indirect	Induced	Cumulative	
	Impacts to greenhouse gas would be direct impacts through the release of emissions from Project activities.				
Duration	**Temporary**	Short-term	Long-term	Permanent	
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. GHG emissions would not be constant, and would occur intermittently over the survey period.				
Extent	Local	Regional	**International**		
	Due to the nature of GHGs and global warming, impacts would be considered international.				
Scale	The total release of equivalent CO_2 during the seismic operations is estimated to be 45,530.1 tonnes of CO_2 eq. Compared to Myanmar's CO_2 release of 161.22 million tons in 2011 (WRI, 2014), the total GHG releases from this project are insignificant (approximately 0.03%), and therefore will not significantly impact the environment.				
Frequency	GHG emissions will be released intermittently but repeatedly throughout the day for the duration of the seismic survey.				
Magnitude	Positive	Negligible	**Small**	Medium	Large
	Minor emissions of GHG will be emitted as a result of the Project. Although the potential impacts from GHG emissions can affect the global atmosphere, the scale of impacts from this project is comparatively very limited. Magnitude is considered Small.				
Receptor/ Resource Sensitivity	**Low**	Medium	High		
	The "receptor" for potential impacts due to GHG emissions is essentially the global atmosphere. Although overall the atmosphere is sensitive to impacts from GHG emissions, the local atmosphere is not expected to be any more or less sensitive to potential impacts to GHG. Receptor/resource sensitivity is rated as Low.				
Significance	**Negligible**	Minor	Moderate	Major	
	The combination of a Low Resource Sensitivity and Small Impact Magnitude will result in an overall Negligible impact.				
Mitigation Measures	• Implement the same measures that will be used to mitigate impacts to air quality (***Section 6.3.1***).				
Residual Significance	**Negligible**	Minor	Moderate	Major	
	If the recommended mitigation measures are implemented, residual impact significance would be Negligible.				

6.3.3 *Assessment of Impacts to Noise and Vibration*

6.3.3.1 *Scope of Assessment*

As determined during scoping, potential impacts to noise and vibration from the seismic survey may occur due to:

- Transportation of Personnel and Equipment (All Phases);
- Shot Hole Drilling; and
- Shooting/Recording.

6.3.3.2 *Summary of Relevant Baseline Conditions*

From the Blocks PSC-G & EP-2 Drilling Baseline Survey, it was found that ambient noise measurements had 24-hour equivalent noise levels ranging from 44.12 dB (A) to 63.47 dB (A). These results indicate that the day noise levels were below the Myanmar National Environmental Quality (Emission) Guidelines (Draft). However, the night noise levels were above the guidelines, most likely due to motorbike traffic and diesel generator use for electricity.

No baseline data exists for vibration in the Project area. However, no significant vibration sources are expected to be located in the Project area, apart from intermittent, localized vibration from road vehicles.

6.3.3.3 *Assessment of Impacts*

Noise

During the seismic survey, noise will be generated from transportation of equipment, material, and personnel, from explosives, and from drilling shot holes. The sensitive receptors/resources that may be affected by potential impacts to noise and vibration in the Project area are nearby residences/communities, as well as some wildlife.

Based on methodology from the US Department of Transportation for estimation of construction and equipment noise, noise levels at various distances from a source can be calculated using ***Equation 6-5*** as follows:

$$L_{eq}(equipment) = L_w - 20 * \log_{10}(D/D_o) \qquad \textbf{\textit{Eq. 6-5}}$$

Where

L_{eq} *(equipment)*	=	the A-weighted, equivalent sound level at a receptor resulting from the operation of a single piece of equipment at distance D (dB(A))
Lw	=	Noise emission level of the particular piece of equipment at reference distance D_0 (dB(A))
D	=	Distance from the receptor to the piece of equipment (m)
D_0	=	Reference distance where the source noise emission level was measured

Source: FHWA[10]

The equation above assumes that there is no buffer from vegetation or topography between a source and a receptor and is therefore considered to represent a worst-case scenario.

For the Project, it is necessary to calculate the overall noise level produced by the simultaneous operation of several pieces of equipment. The overall noise level at a receptor is simply the sum (on an energy basis) of the individual

[10] http://www.fhwa.dot.gov/environment/noise/highway/hcn03.htm

contributions of each piece of equipment. Mathematically, the overall noise level at a receptor from several sources can be calculated using ***Equation 6-6***:

$$L_{eq}(total) = 10 * \log_{10}\left(\sum_{i=1}^{n} 10^{Leq\ (equipment)_i/10}\right) \qquad \textbf{Eq. 6-6}$$

Where

L_{eq} *(total)*	=	the A-weighted, overall equivalent sound level obtained by summing the individual equipment noise levels on an energy basis.
n	=	Number of sources
L_{eq} *(equipment)*$_i$	=	the A-weighted, equivalent sound level at a receptor resulting from the operation of a single piece of equipment at distance D from ith source, dB(A). Obtained from ***Equation 6-5***.

Maximum noise levels generated by the various pieces of equipment present during the seismic survey are listed in ***Table 6.19***.

Table 6.19 Noise Level from Survey and Drilling Equipment

Source	Maximum dB(A) at Source
Pickup Truck	75
Jack-hammer	89
Drilling Rig (auger)	84
Generator	81

Source: US Federal Highway Administration, US Department of Transportation, 2008; reference distance 50 ft (15.24 m); (https://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm)

Noise from Survey Vehicles and Drilling Equipment

Noise levels produced from survey vehicles (i.e. pickup trucks) are estimated to be at most 75 dB(A) at 15 m from the source. When compared to the Thailand noise level standard of a vehicle at less than 85 dB(A) at 7.5 m from the source (the Notification of Ministry of Natural Resource and Environment: the specification of noise level of vehicle on 7 July, 2003), the noise level of vehicles for the Project would not exceed the standard value. The further the distance from the noise source, the less noise is detected (***Table 6.20***). Moreover, survey activities are scheduled for daylight hours, thus vehicle noise will not contribute to noise levels at night when the ambient noise is the lowest. Therefore, vehicle noise will not occur continuously and will not affect people in the Project area.

Drilling equipment will generate noise in daylight hours during the drilling of shot holes. The combined noise (based on ***Equation 6-5***) will be about 90.69 dB(A) at 15.24 m from the source, declining to lower limits of ambient noise (approximately 74 dB(A)) at 100 m from the source (***Table 6.20***).

Table 6.20 Noise Decay for Survey Vehicles and Drilling Equipment

Distance from Source (m)	Noise Level (dB(A))	
	Seismic Vehicles	Drilling Equipment (i.e. jackhammer + drilling rig + generator)
15.24	75	90.69
100	58.66	74.35
250	50.70	66.39
500	44.68	60.37
750	41.16	56.85
1000	38.66	54.35

Noise from Explosives

Explosives for shooting will be used in minimal quantities, and will be buried. Therefore, the generated noise will be brief and at low levels. Moreover, seismic shots will only be conducted during daylight hours. Noise and vibration monitoring has been previously conducted during shot hole tests as part of a similar seismic survey, as shown in ***Table 6.21*** (*CGG Veritas, 2008*). The noise generated from firing two shot holes were monitored at a distance of 50 m. The measured noise levels were detectable but were only slightly above ambient background; and the maximum noise (L_{max}) measured was 72.4 dB(A). The measured L_{max} values were well below the ambient noise standards of Thailand (L_{max} not more than 115 dB(A)).

Table 6.21 Noise Measurement from Shot Hole Testing at 50 m from shot hole

No. of Shooting	Depth of Shot Hole (Meter)	Charge Size (Kilograms)	Noise Level (dB(A))	
			Background Noise	L_{max}
1	9	1.5	64.2	72.4
2	9	1.5	61.5	67.1

Source: CGGVeritas, 2008

The estimated noise levels represent a worst-case condition: the trees, other vegetation, and the topography surrounding the Project will lead to a far more rapid attenuation.

Overall, noise generated during the seismic survey is expected to be low level, of short duration, localised and confined to daytime only.

Vibration

Vibration can damage the structure of buildings and cause human responses such as stress and annoyance. This vibration assessment focuses on shooting/recording, as this is the Project activity with the highest potential for causing vibration impacts. This assessment is based on the peak particle velocity from explosion. Vibration impacts from the use of Vibroseis would be much lower than that of use of explosive shots. Therefore, only the impacts from explosive shots (i.e. the "worst case") will be assessed in this section.

Peak particle velocity (PPV) is a measure of the maximum rate of displacement of ground particles (with vertical, longitudinal and transverse components) resulting from vibrations produced by blasts. It is the most accepted and used indicator of vibration levels, and most regulations and standards prescribe vibration thresholds in terms of the PPV. PPV can be calculated using the following formula (Department of Mineral Fuels, Thailand):

$$PPV = 600\left(\frac{r}{\sqrt{W}}\right)^{-1.4} \qquad \textbf{\textit{Eq. 6-6}}$$

Where

PPV = Peak particle velocity (mm/sec)

r = Distance from charge to measured point (m)

W = Weight of explosive (kg) (In this case, 3.0 kg)

For this project, minimum setback distances from shot holes to various sensitive areas have been set at a range of 2 to 180 m (see ***Table 4.4***). At these minimum setback distances, the peak particle velocity based on Equation 6-6 is estimated to range from 0.90 to 490.56 mm/sec (***Table 6.22***).

Table 6.22 Explosion Vibration Level Measurement from Shot Hole to Sensitive Area at Minimum Setback Distance (for 3.0 kg shots)

Sensitive Area/Obstruction	Minimum Setback Distance for 3 kg Explosive Source (from Table 4.4) (m)	Peak particle velocity (mm/sec)	Safety standard[1] (mm/sec)	Safety standard[2] (mm/sec)
- Telecommunications lines - Telephone lines	2	490.56	-	-
- Low-pressure pipelines - Buried water pipelines (other than concrete lined)	3	278.08	-	-
- Irrigation canal	10	51.54	-	-
- Domestic Septic Tank or Mound	15	29.22	-	-
- Railways - Water body - High pressure pipeline - Dugouts	50	5.41	-	-
- Cemetery	100	2.05	Less than 50.8	Less than 2
- Archaeological and Cultural Sites	150	1.16	Less than 50.8	Less than 2
- Dams (earth or concrete) - Residence, barn, or building - Water wells, developed spring, observation well	150	1.16	Less than 50.8	Less than 10
- Oil or gas well	150	1.16	-	-

Sensitive Area/Obstruction	Minimum Setback Distance for 3 kg Explosive Source (from Table 4.4) (m)	Peak particle velocity (mm/sec)	Safety standard[1] (mm/sec)	Safety standard[2] (mm/sec)
- Monastery/school/medical nursing place/government offices	180	0.90	Less than 50.8	Less than 2

Note: (1) Widely accepted limit for residences near construction blasting and quarry blasting (Bu Min Bulletin 656, RI 8507, various codes, specifications and regulations).
(2) Safety standard of vibration from explosion followed by Australian Standard AS 2187-1983

The predicted peak particle velocities estimated for the Project minimum setback distances for sensitive receptors are lower than the safety standard values specified by various blasting standards[11].

More specific information on building damage and vibration is given in ***Table 6.23***. It is noted that the lowest limit for minor damage (13 mm/s) might be expected at a distance of 27 m from the shot hole. For this project, the only sensitive areas that are likely to be closer than 27 m are dirt roads and irrigation canals, and potentially telecommunication lines.

Table 6.23 Expected Damage at Various Peak Particle Velocities

Expected Damage	PPV (mm/s)
Lower limit for damage to plaster walls	13
Lower limit for dry wall structures	19
Minor damage	70
Greater than 50% chance of minor damage to structures	140
50% chance of major damage	190

Source: Australian Standards Explosive Code AS2187.2-1993

The frequency of vibrations is also important in assessing the effects of explosion on structures and human responses: lower frequencies typically cause higher levels of impacts. The standard of vibrations from mining and quarrying relates peak particle velocity to the vibration frequency and absolute displacement, e.g., the peak particle velocity is not to exceed 4.7 mm/s with 0.75 mm displacement at 1 Hz and the peak particle velocity is not to exceed 50.8 mm/s with 0.20 mm displacement at 40 Hz.

Vibration monitoring data were collected from previous seismic survey tests (***Table 6.24***). Although the charge size was only 1.5 kg, whereas the charge size for this project is up to 3.0 kg, the data can still be used for general comparison purposes. At a distance of 50 m, all vibration levels were well below the Australian and Thai standards. The maximum vibration recorded was 4.64

[11] Widely accepted limit for residences near construction blasting and quarry blasting (Bu Min Bulletin 656, RI 8507, various codes, specifications and regulations), and safety standard of vibration from explosion followed by Australian Standard AS 2187-1983

mm/sec at frequency of 11 Hz, much lower than the standard of 27.6 mm/s at frequency of 22 Hz.

Table 6.24 Vibration Measurement from Shot Hole Testing at 50 m from shot hole

No. of Shooting	Depth of Shot Hole (Meter)	Charge Size (Kilograms)	Vibration	
			PPV (mm/s)	Frequency (Hz)
1	9	1.5	4.45	14
2	9	1.5	4.64	11

Source: CGGVeritas, 2008

In addition, following the original preparation of this report in 2014, Sinopec conducted a number of PPV tests for both Vibroseis and explosive shots in the field in Block MOGE-3, testing the same types of equipment that would be used in the actual seismic survey. These reports are included in ***Annex I***, and the key results from these PPV tests are provided in ***Table 6.25***.

The results show that the Project's setback distances are adequate to avoid damage to any structures. For example, the most stringent standard regarding potential vibration damage recommends a maximum PPV of 2 mm/s for archaeological sites, monasteries, etc. PTTEP SA commits to a setback distance of at least 150 m from these types of buildings. As can be seen from the results below, PPV would be below 2 mm/s at this distance.

Table 6.25 PPV Tests Conducted by Sinopec

Type of Seismic Source	Distance to Seismic Source (m)	Longitudinal Vibration		Transverse Vibration		Vertical Vibration	
		PPV (mm/s)	Frequency (Hz)	PPV (mm/s)	Frequency (Hz)	PPV (mm/s)	Frequency (Hz)
Vibroseis - 2 Vibrators Operating Simultaneously	3	17.971	42.60	19.876	36.50	13.843	56.80
	6	15.812	73.10	8.319	30.10	10.541	46.50
	9	6.795	39.30	6.795	28.40	7.303	42.60
	12	6.223	42.60	6.922	42.60	5.715	32.00
	15	5.144	39.30	6.096	39.30	5.525	26.90
	30	3.048	25.60	2.032	39.30	2.667	46.50
	50	1.715	34.10	2.667	39.30	1.080	46.50
Vibroseis - 4 Vibrators Operating Simultaneously	3	19.05	56.80	20.32	39.30	14.415	56.80
	6	16.066	64.00	12.383	30.10	9.906	46.50
	9	9.208	46.50	8.636	30.10	7.355	42.60
	12	8.319	42.60	5.334	42.60	7.303	56.80
	15	7.811	39.30	5.144	56.80	6.985	46.50
	30	3.048	42.60	2.794	36.50	3.048	42.60
	50	1.969	18.90	2.985	36.50	1.334	23.20
3 kg Explosive Shot	50	10.160	16.50	5.080	14.60	20.130	26.90
	150	1.207	20.40	0.953	28.40	0.826	18.20
	250	1.016	16.50	0.445	20.40	1.778	28.40

350	0.699	34.10	0.318	42.60	2.350	36.50
400	Below detection limit					
500	Below detection limit					

Based on the above results, it can be concluded that vibration generated from shot hole firing and Vibroseis of this seismic survey will not exceed the vibration standards and will not affect the structure of buildings.

From the above assessment, shooting of seismic shots is not expected to impact building structures or communities provided the minimum setback distances are adhered to.

6.3.3.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to noise and vibration include the following:

- The maximum amount of explosives to be used is 3 kg/hole, hole depth shall be maximized (where practicable to do so) and holes will be backfilled and plugged appropriately, in order to reduce noise dispersion;
- Notify local representatives about the shooting/recording schedule, including the minimum setback distances, approximately one week in advance;
- Provide personal protective equipment (PPE) for workers, such as ear muff, protective goggles, and other gear according to the Project safety standard;
- Strictly follow the standard for minimum setback distances from shot holes and Vibroseis to sensitive areas (see ***Section 8***); and
- In addition to minimum setback distances, set a safety zone for people while shooting/recording of at least 50-m away from the four sides of each shot hole and also prohibit entry into safety zone while in operation.

6.3.3.5 *Significance of Impacts*

The significance of impacts to noise and vibration from the Project is assessed in ***Table 6.26.***

Table 6.26 Assessment of Potential Impacts on Noise and Vibration from Project Activities

Impact	• Increased noise during the seismic survey may disturb nearby residents or fauna. • Increased vibration may disturb nearby residents, settlements, or archaeological resources during shooting/recording.		
Nature	**Negative**	Positive	Neutral
	Potential impacts to noise and vibration would be considered to be adverse (negative).		

Type	**Direct**	Indirect	Induced	Cumulative
	Impacts to noise and vibration would be direct impacts from Project activities.			
Duration	**Temporary**	Short-term	Long-term	Permanent
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Noise and vibration from the Project would not be constant, and would occur intermittently over the survey period.			
Extent	**Local**	Regional	International	
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.			
Scale	The seismic survey will take place over an area of approximately 1,000 km^2. **Noise from Vehicles** Noise levels produced from survey vehicles (i.e. pickup trucks) are estimated to be at most 75 dB(A) at 15 m from the source. **Noise from Drilling Equipment** The combined noise from drilling equipment will be about 90.69 dB(A) at 15.24 m from the source, declining to lower limits of ambient noise (approximately 74 dB(A)) at 100 m from the source. **Noise from Explosives** Measured noise levels for explosives are expected to be only slightly above ambient background; and the maximum noise (Lmax) is expected to be 72.4 dB(A). **Vibration** For this project, minimum setback distances from shot holes to various sensitive areas have been set at a range of 2 to 180 m. At these minimum setback distances, the peak particle velocity from explosive shots is estimated to range from 0.90 to 490.56 mm/sec.			
Frequency	Noise and vibration will be released intermittently but repeatedly throughout the day for the duration of the seismic survey.			
Magnitude	Positive	Negligible	**Small**	Medium	Large
	Noise and vibration will be generated during the Project. Although the scale may be enough to cause nuisance to local population, the duration is short-term, and the frequency is intermittent. Noise/vibration levels will return to background levels shortly after Project activities conclude. Magnitude is considered Small.			
Receptor/ Resource Sensitivity	Low	**Medium**	High	
	Background (baseline) noise and vibration levels are generally low in the Project Area. Residents may not be accustomed to elevated noise and vibration levels from industrial or construction activities. In addition, there are some cultural/archaeological resources within the Project area. Resource sensitivity is rated as Medium.			
Significance	Negligible	**Minor**	Moderate	Major
	The combination of a Medium Resource Sensitivity and Small Impact Magnitude will result in an overall Minor impact.			
Mitigation Measures	**Existing** • The maximum amount of explosives to be used is 3 kg/hole, hole depth shall be maximized (where practicable to do so) and holes will be backfilled and plugged appropriately, in order to reduce noise dispersion. • Notify local representatives about the shooting/recording schedule, including the minimum setback distances, approximately one week in advance. • Provide personal protective equipment (PPE) for workers, such as ear muff, protective goggles, and other gear according to the Project safety standard. • Strictly follow the standard for minimum setback distances from shot holes and Vibroseis to sensitive areas (see ***Section 8***). • In addition to minimum setback distances, set a safety zone for people			

	while shooting/recording of at least 50-m and also prohibit entry into safety zone while in operation. **Additional** • Engineers or experts on shooting/recording shall be on site in the field during seismic activities to immediately take action if complaints or damages arise. • Limit survey activities and operations that may cause loud noise to daylight hours only (not later than 18:00). • Appropriately compensate for all damages resulting from Project activities under the supervision of Crop Compensation Committee, after assessment and approval of damages by the Committee.			
Residual Significance	**Negligible**	Minor	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Negligible.			

6.3.4 *Assessment of Impacts to Soil*

6.3.4.1 *Scope of Assessment*

As determined during scoping, potential impacts to soil from the seismic survey may occur due to:

- Transportation of Personnel and Equipment (All Phases);
- Receiver/Geophone Laydown;
- Shot Hole Drilling;
- Shooting/Recording; and
- Waste and Wastewater Management.

6.3.4.2 *Summary of Relevant Baseline Conditions*

From the Blocks PSC-G & EP-2 Drilling Baseline Survey, it was found that soils were all consistent in being predominantly sandy, 36% - 96% across the sites sampled (except for G2 S4 with 22 % sand only) with more or less equal, low proportions of silt and clay. Organic matter varied from 0.09 to 1.81%. Soil conductivity ranged from 0.12 to 0.91 suggesting that soils salinity in these locations would not be having an adverse effect on plant growth. Phosphorous ranged from 1 mg/kg to 147 mg/kg which can be considered to range from low to moderately suitable for plant growth. Potassium ranged from 20 mg/kg – 204 mg/kg which can be considered low-moderate for sandy soil types such as those encountered. Soil pH ranged from 7 to 9.2 which is within a normal range to support plant growth. All soil samples were free from hydrocarbon contamination. With the exception of Arsenic, metals data shows that all values are below standards for agricultural and residential purposes. Arsenic levels at most locations were above standards for agriculture and residential use (3 mg/kg). This could be due to natural processes, resulting in high natural level of arsenic in the soils.

Uncontaminated soil conditions are expected to occur within Block MOGE-3.

6.3.4.3 *Assessment of Impacts*

Project activities, such as traffic to the Project area, site preparation, drilling of shot holes, and shooting/recording, may impact soil resources. Physical scarring may be caused by clearing and leveling for seismic lines, access tracks and up-holes drilling. Clearing and leveling may also increase the risk of soil erosion. The spillage and leakage of fuels, oils and other chemicals may lead to soil contamination. Possible contaminant sources include fuel, oil and chemical storage areas at campsites, and vehicles and machinery used in the field.

Access to the Project Area

Vehicles and people crossing land to access the seismic lines can compact soils and decrease infiltration of water into subsurface soil. These may lead to water-logging or increased surface run-off and can also cause soil erosion. Moreover, soil compaction can also result in decreased seed germination, root expansion, and growth. The potentially impacted area is the treaded area along 7,800 km of source and receiver seismic lines. Given a treading area of approximately 1 m, the impacted area is about 7.8 km^2. This is equivalent to approximately 0.64% of Block MOGE-3 (1,217 km^2).

Soils near the Project are predominantly sandy and contain low moisture. The distribution of the soil shows mostly sand, followed by clay and silt. As a result, intrinsic erosion risk is potentially significant, though not extreme. If erosion is not managed, associated potential impacts could include excessive sedimentation of local waterways, loss of topsoil and reduction in soil fertility, and detrimental changes to hydrology in the Project area.

Site Preparation for Receiver/Geophone Laydown and Preparation of Shot Holes

The majority of the Project area consists of a low slope; therefore, excavation or soil filling will not be required. Nevertheless, the survey team needs to cut some grass or clear soil surface of about 10 m^2 per shot hole in order to drill shot holes. Therefore, the impact area considering a total of 31,000 shot holes is only about 0.31 km^2. This is only 0.03% of Block MOGE-3's area (1,217 km^2).

Drilling of Shot Holes and Loading of Explosives

The drilling team will drill shot holes that have a diameter of 3 inches (7.62 cm) and a depth of 10-30 m. Drilling of the shot holes create cuttings around the mouth of the holes every 50 - 100 m. The maximum amount of cuttings from drilling of a single hole can create approximately 0.137 m^3 of cuttings/hole or a total of 4,247 m^3 of cuttings from 31,000 holes. The amount of cuttings from a single hole is negligible in relation to the total Project area. After drilling, explosives will be loaded into the drilled holes, and the cuttings from the holes will be buried back into the same holes. Therefore, only a small amount of cuttings will be left, which will have minimal effect.

Shooting/Recording

Shooting of explosives in shot holes may affect the soil structure at low levels and in limited areas, but it is not expected to be a significant or long-term impact.

Explosives and detonators used for the seismic survey in this Project are PowerGel Seismic (Orica). The main composition of the emulsion explosives used in this seismic work is ammonium nitrate (approximately 60%), which is normally used as a fertilizer, and fuel oil. Ammonium (NH_4+) bonds to negatively charged surfaces of soil particles - clay in particular.

Ammonia is not a human health concern in drinking water at the levels typically observed in the environment, but it can be toxic to fish at high enough concentrations. The quantities of ammonium in residuals from seismic activities are small in comparison to what would normally be used for fertilizer, and therefore impacts to soil (and subsequent impacts to surface water due to leaching or runoff) are expected to be minimal.

The active components of the detonator are 1-5% PETN, 1-5% Barium, 1-5% Chromium, and 1-5% Barium Chromate. According to its MSDS, the detonator contains no substances known to be hazardous to the environment or not degradable in waste water treatment plants. In addition, the quantities of active components in a single detonator are small, shot holes are sparsely distributed, and residuals would be substantially diluted after transport through various media such as soil/water. Therefore, the residual from detonators is not expected to have a significant impact on the soil quality.

Soil Impact from Seismic Vibrator (Vibroseis) Trucks

Seismic vibrator (Vibroseis) trucks can compact soils and decrease infiltration of water into subsurface soil, which can cause soil erosion. The potentially impacted area is the treaded area along source lines. Assuming the seismic vibrator (Vibroseis) trucks are used for 15% of the length of the 3D seismic source lines, with a 10 m clearance path for trucks, 3.75 km^2 would be impacted. This is equivalent to approximately 0.31% of Block MOGE-3 (1,217 km^2).

Impacts from Waste Management and Wastewater

Management of Wastes from Worker Activities

Wastes generated from the Project are leftovers, plastic bags, foam box, paper, etc. The 1,000-person work crew is expected to generate about 1.0 tonnes of waste/day or 270 tonnes of waste over the 270-day survey, estimated at 1 kg/day/worker). Workers will collect waste to dispose in a communal bin at the field office, which will be collected and disposed by the municipal government. The Project will pay fee for waste collection and disposal to local government according to municipal regulations.

Management of Wastes from Shooting

Most of the explosives and plastic covered explosives will be completely burned during shooting; therefore, visible waste generated from shooting will only be the wire of detonator. After shooting, the shooting team will collect

wires to dispose or to re-use. Therefore, only a small amount of waste will remain in shot holes. The recovery team will check or collect some residues remaining in the shooting area to ensure that only minimal waste remains in the area.

Wastewater Management

The base camp will use the water and wastewater utility system from the local municipality. If necessary, a septic tank and soak away system will be installed at the base camp as well.

In the field camps, there is no permanent wastewater management system. Workers will use toilet facilities at nearby villages, schools, or temples, if available, or pit latrines. Field camps are anticipated to contain a maximum of 20 workers per camp, and will generally be abandoned within 2 to 3 weeks. Therefore, the quantity of waste produced is not expected to have long-term impacts to soil quality. Pit latrines will be dug/buried after the field camp is abandoned.

6.3.4.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to soil include the following:

- Avoid laying seismic lines near trees and large shrubs, including areas with forests, garden forests, or areas with rare species. The lines shall offset these sensitive items according to the set minimum setback distances (see ***Section 8***); and
- After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash, and burying shot holes with the dug-up cuttings. The buried cuttings will be compacted and the ground will be evenly leveled.

6.3.4.5 *Significance of Impacts*

The significance of impacts to soil from the Project is assessed in ***Table 6.27.***

Table 6.27 Assessment of Potential Impacts on Soil from Project Activities

Impact	• Soil disturbance during seismic activities has the potential to increase soil erosion. • Potential impact to soils and agricultural land through compaction from seismic activities. • Potential for soil contamination from chemicals in explosives. • Potential for soil contamination from poor waste management and wastewater disposal.			
Nature	**Negative**	Positive	Neutral	
	Potential impacts to soil would be considered to be adverse (negative).			
Type	**Direct**	Indirect	Induced	Cumulative
	Impacts to soil would be direct impacts from Project activities.			
Duration	Temporary	Short-term	**Long-term**	Permanent
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Soil impacts from the Project could potentially last for longer than the survey duration.			
Extent	**Local**	Regional	International	
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.			
Scale	The seismic survey will take place over an area of approximately 1,000 km^2. **Access to the Project Area** Given a treading area of approximately 1 m, the impacted area from vehicles/people is only about 7.8 km^2. This is equivalent to approximately 0.64% of Block MOGE-3 (1,217 km^2). **Receiver/Geophone Laydown** The impacted area from clearing areas around shot holes, considering a total of 31,000 shot holes, is only about 0.31 km^2. This is only 0.03% of Block MOGE-3's area (1,217 km^2). **Drilling of Shot Holes and Loading of Explosives** The maximum amount of cuttings from drilling of a single hole can create approximately 0.137 m^3 of cuttings/hole, or a total of 4,247 m^3 of cuttings from 31,000 holes. **Shooting/Recording** The quantities of residuals from explosives and detonators used in seismic activities are small, and impacts to soil (and subsequent impacts to surface water due to leaching or runoff) are expected to be minimal. **Waste/Wastewater** The 1,000-person work crew is expected to generate about 1.0 tonnes of waste/day or 270 tonnes of waste over the 270-day survey, estimated at 1 kg/day/worker). Wastewater quantities are not expected to be large enough to cause any long-term impacts to soil quality.			
Frequency	Impacts to soil will occur intermittently but repeatedly throughout the day for the duration of the seismic survey.			
Magnitude	Positive	Negligible	**Small**	Medium	Large
	Change of soil structure and potential reduction of soil quality in Project area is expected to be of Small magnitude.			
Receptor/ Resource Sensitivity	Low	**Medium**	High	
	Existing soil quality in the Project area is generally fair, but susceptible to erosion. Project is near sensitive resources with regards to soil quality, such as agricultural lands, which rely on soil quality for productivity. Overall sensitivity is rated as Medium.			

Significance	Negligible	**Minor**	Moderate	Major
	The combination of a Medium Resource Sensitivity and Small Impact Magnitude will result in an overall Minor Impact.			
Mitigation Measures	**Existing** • Avoid laying seismic lines near trees and large shrubs, including areas with forests, garden forests, or areas with rare species. The lines shall offset these sensitive items according to the set minimum setback distances (see ***Section 8***). • After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash, and burying shot holes with the dug-up cuttings. The buried cuttings will be compacted and the ground will be evenly leveled. **Additional** • Only work within the set areas, which will be: o For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m^2/shot hole for shot-hole drilling. o For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total). • In order to maintain soil structure and prevent soil erosion: o Minimize the disturbance of roots of plants, shrubs and trees; o Minimize the removal of trees on slopes; and o Avoid cutting down established trees, e.g. those with a Diameter at Breast Height (DBH) greater than 30 cm. • Level the ground around the shot holes prior to drilling them to reduce run-off and erosion. • Minimize non-operational movements of seismic vibrator (Vibroseis) trucks. • All hazardous materials and waste shall be stored, handled and disposed of in a manner that prevents soil contamination. Where appropriate, the use of impervious bunds, secondary containment and drip trays will be used. • Spills or leaks (i.e. of fuel or lubricants) shall be cleaned up immediately, and contaminated rags or other material shall be disposed of properly. • Field camps will use local wastewater facilities where possible, or will install pit latrines when in remote locations, and will properly bury the pit latrines when the camp is abandoned.			
Residual Significance	**Negligible**	Minor	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Negligible.			

6.3.5 *Assessment of Impacts to Groundwater*

6.3.5.1 *Scope of Assessment*

As determined during scoping, potential impacts to groundwater from the seismic survey may occur due to:

- Shot Hole Drilling;
- Shooting/Recording; and
- Waste and Wastewater Management.

6.3.5.2 *Summary of Relevant Baseline Conditions*

Groundwater is the principal source of potable domestic water supply in Magway Region. Aquifers in the study area are the Eocene and Peguan Alluvian aquifers. Quality and quantity of groundwater varies depending on the lithology and depositional environments. For instance, groundwater quality of Alluvial and Ayeyarwady aquifers is suitable for domestic use and irrigation purposes.

From the Blocks PSC-G & EP-2 Drilling Baseline Survey, relatively high TDS levels were found, and Manganese and Selenium were found to exceed allowable limits.

6.3.5.3 *Assessment of Impacts*

Drilling of Shot Holes

The shot holes are to be drilled to a depth of 10 to 30 m, which is in the range of groundwater level (5 to 260 m). There is a potential for drilling to impact groundwater quality by introducing sediment or other contaminants to the groundwater from the surface.

However, the Project team has specified a minimum setback distance from shot hole to groundwater wells (100 m for Vibroseis, 150 m for 3 kg explosives, see ***Table 4.4***). Additionally, if PTTEP SA discovers groundwater in the course of seismic operations, they will report to MOGE. In the unlikely case of drilling into a groundwater well that produces water, this hole will be plugged with heavy muds, typical of maintaining pressure when drilling oil or gas wells.

Shooting/Recording

If shooting/recording operates close to a groundwater well (i.e., less than minimum setback distance), the structure of the groundwater well may be impacted.

In 1978, several major studies were commissioned in Alberta, Canada to determine the effects of seismic shooting on water wells. Twenty areas were selected by The Alberta Research Council, The Alberta Department of Energy and Natural Resources and The University of Alberta. A basic objective was to establish seismic parameters, such as charge size and setback distance, which would demonstrably change the properties of a domestic water well. A down-the-hole TV camera was used to monitor physical damage in the wells. All projects started with one or two kilograms of explosive at distances of 180 metres or more. This was then intensified by shooting increasingly larger charges closer and closer to wells. All wells were eventually subjected to bombardment which peaked at 22 kilograms only six metres from wells. In one study, a charge of 15 kilograms was detonated only 3.9 metres from a

well. No damage was ever observed, and no permanent changes were observed which would have been noticeable in a domestic well[12].

The Project team has specified a minimum setback distance (150 m) from shot holes to groundwater wells with maximum charge of 3 kg; therefore, the impact is expected to be minimal.

The major residuals of explosives and detonators after shooting will be nitrogen compounds, carbon dioxide, and water. The remains of explosives and detonators will be collected and disposed. Therefore, shooting/recording is not expected to impact groundwater quality.

Impacts from Waste Management and Wastewater

As discussed in ***Section 6.3.4***, the quantities of waste and wastewater for the Project are not expected to be large enough to have a significant impact on soil quality. Similarly, the potential impacts to groundwater quality from leaching through soil are not expected to be significant.

Additional Data Obtained from Up-Hole Drilling

In addition to the above, PTTEP SA has conducted a number of "up-hole drilling" activities. The objective of up-hole drilling is to determine sound velocities near the ground surface. Although this is related to operation, the data obtained from these activities can also be used to inform the assessment regarding the presence of groundwater. Based on local information and the results of up-hole drilling, it is found that the most groundwater rich area in southern part of MOGE-3, near Yemyat Village and the villages near to the Pani stream and Mindone stream. Northern MOGE-3 shallow water wells are usually dry in summer season, but can be produced during the rainy season. Most of the region depends on Pon, Pani and Mindone Streams, manmade lakes and also the water from Ayeyarwaddy River for their water sources. The shallow water well in the middle and north of MOGE-3 are dry in the summer season.

Of 14 up-hole wells drilled in Block MOGE-3, no groundwater bearing layer was found – they were all dry holes. This data confirms further that the seismic activity is unlikely to have any impact on existing groundwater.

6.3.5.4 *Existing/In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to groundwater include the following:

- Set a minimum setback distance between shot holes and Vibroseis to groundwater wells (see ***Section 8***); and
- In the case where there are complaints or damage to groundwater wells, the responsible Project staff will review the damage in a timely

[12] Summary Of Previous Studies Of The Effect Of Seismic Shooting On Water Wells In Alberta, I. C. Ross ICI Canada Inc. Calgary March 1995

manner and establish a solution and/or compensation (after assessment and approval of damages by MOGE).

6.3.5.5 *Significance of Impacts*

The significance of impacts to groundwater from the Project is assessed in ***Table 6.28.***

Table 6.28 Assessment of Potential Impacts on Groundwater from Project Activities

Impact	• Potential for groundwater hydrology and quality impacts from drilling of shot holes. Shot holes are to be drilled to a depth of 10-30 m, which is in the range of groundwater level (5-260 m). There is a potential for drilling to impact groundwater quality by introducing sediment or other contaminants to the groundwater from the surface. • If shooting/recording operates close to a groundwater well (less than minimum setback distance), the structure of the groundwater well could be impacted. • Potential for impacts to groundwater due to leaching through soil contaminated by poor waste management and wastewater disposal.				
Nature	**Negative**	Positive	Neutral		
	Potential impacts to groundwater would be considered to be adverse (negative).				
Type	**Direct**	Indirect	Induced	Cumulative	
	Impacts to groundwater would be direct impacts from Project activities.				
Duration	Temporary	Short-term	**Long-term**	Permanent	
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Groundwater impacts from the Project could potentially last for longer than the survey duration.				
Extent	**Local**	Regional	International		
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.				
Scale	The seismic survey will take place over an area of approximately 1,000 km^2. **Drilling of Shot Holes** The shot holes are to be drilled to a depth of 10 to 30 m, which is in the range of groundwater level (5 to 260 m). **Shooting/Recording** The 2D & 3D seismic survey for this Project will be carried out using 1 to 3 kg/shot point explosives. Given the minimum setback distances, the vibration caused by the seismic shots is not expected to affect the structure of nearby groundwater wells. **Waste/Wastewater** The 1,000-person work crew is expected to generate about 1.0 tonnes of waste/day or 270 tonnes of waste over the 270-day survey, estimated at 1 kg/day/worker). Waste and wastewater quantities are not expected to be large enough to cause any long-term impacts to groundwater quality.				
Frequency	The Project activities will occur intermittently but repeatedly throughout the day for the duration of the seismic survey. However, impacts to groundwater would be expected to be infrequent or non-existent.				
Magnitude	Positive	Negligible	**Small**	Medium	Large
	Limited change in groundwater quality is possible, but it would likely be imperceptible, and would be short-term, and local extent, and occur infrequently. Groundwater quality impacts are likely to be within ambient / seasonal range or allowable criteria. Magnitude is rated as Small.				
Receptor/ Resource Sensitivity	Low	**Medium**	High		
	Groundwater quality in the Project area is generally fair. The groundwater resource does not support diverse habitat or populations within groundwater dependent ecosystems. However, it may be utilized by the local community for drinking water purposes, and therefore its sensitivity is ranked as Medium.				
Significance	Negligible	**Minor**	Moderate	Major	
	The combination of a Medium Resource Sensitivity and Small Impact Magnitude will result in an overall Minor impact.				

Mitigation Measures	**Existing** • Set a minimum setback distance between shot holes and Vibroseis to groundwater wells (see ***Section 8***). • In the case where there are complaints or damage to groundwater wells, the responsible Project staff will review the damage in a timely manner and establish a solution and/or compensation (after assessment and approval of damages by MOGE). **Additional** • When drilling shot holes, drilling chemicals that are composed of heavy metals or toxics that could leach into groundwater must not be used. • If groundwater is discovered in the course of seismic activities, it shall be reported to MOGE. • All hazardous materials and waste shall be stored, handled and disposed of in a manner that prevents soil contamination. Where appropriate, the use of impervious bunds, secondary containment and drip trays will be used. • Spills or leaks (i.e. of fuel or lubricants) shall be cleaned up immediately, and contaminated rags or other material shall be disposed of properly. • Field camps will use local wastewater facilities where possible, or will install pit latrines when in remote locations, and will properly bury the pit latrines when the camp is abandoned.			
Residual Significance	**Negligible**	Minor	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Negligible.			

6.3.6 *Assessment of Impacts to Surface Water*

6.3.6.1 *Scope of Assessment*

As determined during scoping, potential impacts to surface water from the seismic survey may occur due to:

- Transportation of Personnel and Equipment (All Phases);
- Receiver/Geophone Laydown;
- Shot Hole Drilling; and
- Waste and Wastewater Management.

6.3.6.2 *Summary of Relevant Baseline Conditions*

The dominant hydrological feature in the region is the Ayeyarwady River, which is adjacent to the eastern edge of Block MOGE-3. The monthly distribution of river flow closely follows the pattern of rainfall, i.e., about 80% during the monsoon season (May – October) and 20% in the dry season (November – April).

From the Blocks PSC-G & EP-2 Drilling Baseline Survey, it was found that Arsenic (As) was detected above Thailand Surface Quality standards at several locations. All other heavy metals were well within water quality standards, and petroleum hydrocarbons were not detected in any surface water samples.

Basic water quality parameters for surface water were all within normal ranges for Class 2 (Very clean fresh surface water resources) to Class 5 (The sources which are not classified in class 1-4 used for navigation) standards.

6.3.6.3 *Assessment of Impacts*

Some activities may affect surface water quality, such as transportation, site preparation for receiver/geophone laydown, shot hole drilling, and waste and wastewater management. These activities may damage some vegetation covering soil as described in ***Section 6.3.4*** and may also enhance soil erosion from the Project area to surface water. The quality of surface water may be affected if pollutants mix with surface runoff during rain and are carried to water resources in the vicinity. The storage and handling of fuels and lubricants may also contaminate surface and groundwater resources, if there are spillages that wash into surrounding areas or seep into the ground. Turbidity in surface water could also increase, resulting from an increase in suspended solids (SS). However, most of the Project area consists of a low slope, this seismic survey will take place during the dry season and the disturbed area for each line or shot hole is small; thus, soil erosion from the Project area to surface water will be minimal, and the quality of surface water around the Project area is not expected to be substantially affected.

Excessive water depletion is not expected to be an issue since seismic surveying is a temporary activity and only a limited quantity of water will be required.

These impacts would only affect the Project area over a short period of time, and vegetation will recover. In addition, the Project will take place during the dry season, and suitable mitigation measures will be prepared and strictly followed during the seismic survey. The company will drill holes for explosives at least 50 meters away from water resources (i.e canals). This will minimize or eliminate any potential impacts on surface water quality from drilling and shooting.

Impacts from Waste Management and Wastewater

As discussed in ***Section 6.3.4***, the quantities of waste and wastewater for the Project are not expected to be large enough to have a significant impact on soil quality. Similarly, the potential impacts to surface water quality from runoff are not expected to be significant.

6.3.6.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to surface water include the following:

- Offset seismic lines to not less than 50 m where shot holes or Vibroseis are located close to water resources such as rivers, canals, streams, and ponds; and

- After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash, and burying shot holes with the dug-up cuttings. The buried cuttings will be compacted and the ground will be evenly leveled.

6.3.6.5 *Significance of Impacts*

The significance of impacts to surface water from the Project is assessed in ***Table 6.18.***

Table 6.29 Assessment of Potential Impacts on Surface Water from Project Activities

Impact	• Vehicle transportation around the Project site and along access roads, as well as drilling of shot holes and shooting/recording, could disturb soil surface potentially, resulting in erosion and consequent sedimentation of waterways. • Potential for impacts to surface water due to runoff from soil contaminated by poor waste management and wastewater disposal.				
Nature	**Negative**	Positive	Neutral		
	Potential impacts to surface water would be considered to be adverse (negative).				
Type	**Direct**	Indirect	Induced	Cumulative	
	Impacts to surface water would be direct impacts from Project activities.				
Duration	Temporary	Short-term	**Long-term**	Permanent	
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Surface water impacts from the Project could potentially last for longer than the survey duration.				
Extent	Local	**Regional**	International		
	Potential impacts to surface water could be carried downstream and affect other areas, and hence would be considered to be regional.				
Scale	The seismic survey will take place over an area of approximately 1,000 km². Seismic survey activities could expose soil material that could be potentially mobilized in runoff. The periods with highest potential for erosion and transport of sediment will be periods of high rainfall. **Waste/Wastewater** The 1,000-person work crew is expected to generate about 1.0 tonnes of waste/day or 270 tonnes of waste over the 270-day survey, estimated at 1 kg/day/worker). Waste and wastewater quantities are not expected to be large enough to cause any long-term impacts to surface water quality.				
Frequency	Impacts to surface water would occur intermittently but repeatedly throughout the day for the duration of the seismic survey.				
Magnitude	Positive	Negligible	**Small**	Medium	Large
	Minor impacts to surface water are possible from Project activities. Water quality impacts are likely to be within ambient levels. Potential short-term localized effects on water quality but which are likely to return to equilibrium conditions within a short timeframe. There may be some minor alteration to existing drainage regimes and characteristics, although the frequency and magnitude of flooding upstream or downstream of the Project is not expected to be materially affected. Magnitude is considered Small.				

Receptor/ Resource Sensitivity	Low	**Medium**	High
	Local surface water quality is clean to fair. Some of the water resources in the Project area may support diverse populations of flora and / or fauna, and may have local importance in terms of provisioning services. However, in most cases, there is ample capacity and / or adequate opportunity for alternative sources of comparable quality. The Ayeyarwady River is a highly important water resource in the Project area, however the Project will avoid any activities in the its vicinity and it therefore will not be impacted. Overall the receptor/resource sensitivity is considered Medium.		
Significance	Negligible	**Minor**	Moderate	Major
	The combination of a Medium Resource Sensitivity and Small Impact Magnitude will result in an overall Minor impact.		
Mitigation Measures	**Existing** • Offset seismic lines to not less than 50 m where shot holes or Vibroseis are located close to water resources such as rivers, canals, streams, and ponds. • After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash, and burying shot holes with the dug-up cuttings. The buried cuttings will be compacted and the ground will be evenly leveled. **Additional** • Avoid or reduce removal of trees within and around the Project area, especially sloped areas, to prevent soil erosion into water resources. If possible, do not disturb roots of plants, shrubs, and small trees as these help maintain soil structure. • Level the ground around the shot holes prior to drilling them to reduce run-off and erosion. • Only work within the set areas, which will be: o For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m^2/shot hole for shot-hole drilling. o For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total). • Level the ground around the shot holes prior to drilling them to reduce run-off and erosion. • Workers shall not dispose of waste into water resources. • All hazardous materials and waste shall be stored, handled and disposed of in a manner that prevents soil contamination. Where appropriate, the use of impervious bunds, secondary containment and drip trays will be used. • Avoid refuelling or maintaining Project vehicles (including Vibroseis trucks) within 50 m of any water sources. • Spills or leaks (i.e. of fuel or lubricants) shall be cleaned up immediately, and contaminated rags or other material shall be disposed of properly. • Field camps will use local wastewater facilities where possible, or will install pit latrines when in remote locations, and will properly bury the pit latrines when the camp is abandoned.		
Residual Significance	**Negligible**	Minor	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Negligible.		

6.3.7 *Assessment of Impacts to Flora and Fauna*

6.3.7.1 *Scope of Assessment*

As determined during scoping, potential impacts to flora and fauna from the seismic survey may occur due to:

- Transportation of Personnel and Equipment (All Phases);
- Receiver/Geophone Laydown;
- Shot Hole Drilling; and
- Waste and Wastewater Management.

6.3.7.2 *Summary of Relevant Baseline Conditions*

Flora

Block MOGE-3 falls within the Ayeyarwady Moist Deciduous Forests Eco-region. This forest type is mainly composed of numerous commercially important timber species including teak. A high diversity of vegetation including bamboos is observed in the different types of deciduous forests in Myanmar.

From the Blocks PSC-G & EP-2 2D Seismic Baseline Survey, there were five leading dominant trees in study area are *Tectona hamiltoniana*, *Acacia catechu* Willd, *Anthocephalus cadamba* Miq., *Dalbergia paniculata* Roxb., and *Terminalia oliveri*. The surveys have revealed that diversity indices in this region are very low (Shannon Wiener index (H) 2.76, Simpson's index (D) 10.18, Brillouin (D) 2.59). Fringing the dry zone in the low hills is mixed deciduous forest which in turn is fringed by moist semi-evergreen forest.

Fauna

According to the Blocks PSC-G & EP-2 Seismic ESHIA, fauna typical of the Ayeyarwady Moist Deciduous Forests Eco-region include sambar (*Cervus unicolor*), masked palm civet (*Paguma larvata*), leopard cat (*Felis bengalensis*), and Sunda pangolin (*Manis javanica*). Many birds are also found in this ecoregion, and they include both water and forest birds found in a wide variety of habitats. A total of 37 bird species were recorded in the area during the Blocks PSC-G & EP-2 2D Seismic Baseline Survey, with a population density of 159 birds/km^2

Based on a field investigation by Win Precious Resources (WPR)[13], the common wildlife species in Block MOGE-3 are jungle fowl, crow, snake, iguana, partridge, rabbit, barking deer and boar.

[13] Report of MOGE-3 Block at Thayet Township in Magway Region, based on field investigation trip from 7th to 12th November 2013

6.3.7.3 *Assessment of Impacts*

Terrestrial Flora

During the seismic survey, the survey team must tread on existing land on a path with a width of 1 m along the approximately 7,800 km of source and receiver lines. The impacted area will be approximately 7.8 km^2. This can lead to soil compaction that might inhibit root penetration and reduce water infiltration. However, the impacts will be localized, short-term, and only slightly alter the original state. Thus, it is unlikely that vegetation growth will be significantly reduced. Some crop species may be impacted but the ground will be tilled and replanted with the next planting cycle. The survey team may need to cut some vegetation for drilling of shot holes, which may cause some vegetation loss in that area.

Terrestrial Fauna

Terrestrial fauna could potentially be impacted by noise from vehicles transporting equipment and personnel, and noise from drilling equipment. Noise level exceeding 55 dB is known to affect terrestrial fauna through physiological and behavioral changes (Checker, 1980), diminish habitat value, and disrupt survival activities (e.g., injury, energy loss, decreased food intake, disturbed habitat avoidance, and reproductive loss).

Maximum noise level generated by vehicles and drilling equipment are expected to be about 75 dB(A) and 90.69 dB(A), respectively, at 15.24 m from the source. Noise levels would decrease rapidly with distance, and would be expected to be lower than ambient levels within 100 m from the source. Terrestrial fauna has a wide range of habitat and is mobile and can adapt to changing conditions by moving away temporarily from Project activities. Moreover, large perennial vegetation, which is habitat for small animals, will not be cut. Ecology around the Project area is also expected to be capable of recovering rapidly after the survey.

Aquatic Biota

Significant impacts are not expected on water quality since the Project team has specified a suitable minimum setback distance from shot hole to water resources, as discussed in ***Section 6.3.6***. Thus, impacts on aquatic flora and fauna are also expected to be correspondingly low. Similarly, secondary impacts to freshwater fisheries are expected to be insignificant as a result of the minimum setback distances.

6.3.7.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to flora and fauna include the following:

- Offset seismic lines to not less than 50 m where shot holes or Vibroseis are located close to water resources such as rivers, canals, streams, and ponds;

- After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash, and burying shot holes with the dug-up cuttings. The buried cuttings will be compacted and the ground will be evenly leveled;
- Regularly maintain Project vehicles to ensure good operating conditions in order to minimize noise and vibration that might affect fauna;
- Limit vehicle velocity near forested areas to prevent noise from disturbing wildlife and to minimize collision with wildlife, and reduce erosion/compaction; and
- Shooting/recording and Vibroseis shall be carried out during daylight hours only.

6.3.7.5 *Significance of Impacts*

The significance of impacts to flora and fauna from the Project is assessed in ***Table 6.30.***

Table 6.30 Assessment of Potential Impacts on Flora and Fauna from Project Activities

Impact	• Vehicle/human treading during survey can lead to soil compaction that might inhibit root penetration and reduce water infiltration. • Terrestrial fauna could potentially be impacted by noise from vehicles transporting equipment and personnel, and noise from drilling equipment.				
Nature	**Negative**	Positive	Neutral		
	Potential impacts to flora and fauna would be considered to be adverse (negative).				
Type	**Direct**	Indirect	Induced	Cumulative	
	Impacts to flora and fauna would be direct impacts from Project activities.				
Duration	Temporary	**Short-term**	Long-term	Permanent	
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Impacts to flora and fauna from the Project would not be constant, and would occur intermittently over the survey period.				
Extent	**Local**	Regional	International		
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.				
Scale	The seismic survey will take place over an area of approximately 1,000 km^2. During the seismic survey, the survey team must tread on existing land on a path with a width of 1 m along the approximately 7,800 km of source and receiver lines. The impacted area will be approximately 7.80 km^2. Maximum noise level generated by vehicles and drilling equipment are expected to be about 75 dB(A) and 90.69 dB(A), respectively.				
Frequency	Impacts to flora and fauna would occur intermittently but repeatedly throughout the day for the duration of the seismic survey.				
Magnitude	Positive	Negligible	**Small**	Medium	Large
	Impacts from the Project are not expected to cause substantial changes in the populations of local flora and fauna. Magnitude of impacts to flora and fauna from the seismic survey is considered Small.				

Receptor/ Resource Sensitivity	Low	**Medium**	High	
	Thae Phyu Reserved Forest is located within Block MOGE-3. The forest covers a total area of 26.6 km². Reserved Forest in the Project area are for timber production and are not protected areas. Plant species to be removed for the seismic survey are mostly agricultural. There are potentially a number of threatened/endangered species in the Project area. Overall, resource/receptor sensitivity is rated as Medium.			
Significance	Negligible	**Minor**	Moderate	Major
	The combination of a Medium Resource Sensitivity and Small Impact Magnitude will result in an overall Minor Impact.			
Mitigation Measures	**Existing** • Regularly maintain Project vehicles to ensure good operating conditions in order to minimize noise and vibration that might affect fauna. • Limit vehicle velocity near forested areas to prevent noise from disturbing wildlife and to minimize collision with wildlife, and reduce erosion/compaction. • Shooting/recording and Vibroseis shall be carried out during daylight hours only (between 06:00 and 18:00). **Additional** • Implement the same measures that will be used to mitigate impacts to surface water quality (***Section 6.3.6***). • Only work within the set areas, which will be: o For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m²/shot hole for shot-hole drilling. o For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total). • Avoid laying seismic lines near trees and large shrubs, including areas with forests, garden forests, or areas with rare species. The lines shall be offset from sensitive areas according to the set minimum setback distances (see ***Table 4.4***). Avoid cutting trees with Diameter at Breath Height (DBH) greater than 30 cm. • The burning of wood, plant matter and weeds removed from the lines or other work activities is prohibited. • Project staff, including those of contractors and subcontractors, are prohibited from cutting or damaging trees that do not require removal or trimming for access or to undertake the seismic survey.			
Residual Significance	**Negligible**	Minor	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Negligible.			

6.4 SOCIAL IMPACT ASSESSMENT (ALL PROJECT PHASES)

6.4.1 Assessment of Impacts to Land Use

6.4.1.1 Scope of Assessment

As determined during scoping, potential impacts to land use from the seismic survey may occur due to:

- Receiver/Geophone Laydown;
- Shot Hole Drilling; and
- Abandonment and Site Restoration.

6.4.1.2 Summary of Relevant Baseline Conditions

The Project area mainly consists of agricultural and forested areas; other areas include communities, water sources, unoccupied areas, roads, etc. Another important land use in Block MOGE-3 consists of a number of hand-dug oil well communities, especially in Padaukpin. The surface space typically required for complete drilling operations at a given location (including drilling, completion, and subsequent production) ranges from 1.2-12.1 ha. The space required for one drilling unit is about 4.6 m^2.

6.4.1.3 Assessment of Impacts

The main project activity that affects land use is site preparation for receiver/geophone laydown and shot hole preparation. To access the Project area, the survey team and/or vehicles may need to tread on crops along a 1-m wide path for the length of each seismic line (both source and receiver lines). For drilling of one shot hole, the area of about 10 m^2 will be cleared of vegetation. Additionally, the path of the seismic vibrator (Vibroseis) trucks will require cleared vegetation and will compact soil along the source line (about 10 m total along the line). The total length of 3D source lines for this Project is about 2,500 km, and the total length of 3D receiver lines is about 5,000 km. There will be an additional 300 km of 2D seismic lines. Approximately 15% of the seismic activity will be carried out with Vibroseis. Therefore, the total area affected by Project activities is calculated as follows:

Clearance Area for Receiver Lines

$$A = 1\,m * 5{,}000{,}000\,m$$
$$= 5{,}000{,}000\,m^2$$

Clearance Area for Source Lines

$$A = (1\,m * 2{,}500{,}000\,m * 85\%) + (10\,m * 2{,}500{,}000\,m * 15\%) + (1\,m * 300{,}000\,m)$$
$$= 6{,}175{,}000\,m^2$$

Clearance for Shot Holes

$$A = 1\,m^2 * 31{,}000\ shot\ holes$$
$$= 31{,}000\,m^2$$

It is expected that the total area of impacted land from both treading and vegetation clearance for all 31,000 shot holes throughout the seismic survey would be approximately 11.2 km^2 or about 1.1% of the entire survey area. For any damaged agricultural land, the Project team will assess these impacts and compensate stakeholders with the market price of their agricultural products for any lost crops resulting from the seismic survey.

In addition to impacts to agricultural land, there is the potential for temporary impacts to hand-dug oil well communities near the seismic lines. Wherever possible, PTTEP SA will try to ensure that the seismic line layout avoids hand-dug oil wells. In some cases it may not be possible to completely avoid the wells, and therefore the activities of these hand-dug oil wells may need to temporarily halt during the seismic activities. However, adequate minimum setback distances (180 m for 3 kg explosives, 20 m for Vibroseis, as specified in ***Section 4.4.1***) will still be adhered to. Damage to oil wells caused by the Project is unlikely, however in the case that damage is attributed to the Project, compensation will be provided appropriately.

The drilling team will drill shot holes far from sensitive areas (i.e., community, water source, road, archaeological sites, and etc.) according to specified minimum setback distances. Severe or long-term damage to current land uses is not anticipated. Moreover, the Project team will recover the seismic survey area by filling and leveling the ground to prepare for the following agricultural cycle. In terms of compensation, if there is any impact on properties, crops of communities, or oil wells, PTTEP SA will cooperate with MOGE and Local Authorities to address these impacts on land use and resolve any disputes.

6.4.1.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to land use include the following:

- Notify regional government and local representatives of townships about the Project schedule and the survey procedures. Inform land owners about the time and location of the survey approximately one week in advance;
- Compensation for agricultural or oil well damage or losses will be paid to land owners or crop owners under the supervision of Compensation Committee, after assessment and approval of land area and unit rate by the Committee. This shall be done one week prior to the line survey; and
- After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash, and burying shot holes with the dug-up

cuttings. The buried cuttings will be compacted and the ground will be evenly leveled.

6.4.1.5 *Significance of Impacts*

The significance of impacts to land use from the Project is assessed in ***Table 6.31.***

Table 6.31 Assessment of Potential Impacts on Land Use from Project Activities

Impact	• The survey team and/or vehicles may need to tread on crops along a 1-m wide path for the length of each seismic line (both source and receiver lines). • For drilling of one shot hole, the area of about 10 m² will be cleared of vegetation. • The path of the seismic vibrator (Vibroseis) trucks will require cleared vegetation and will compact soil along the source line (about 10 m total along the line).			
Nature	**Negative**	Positive	Neutral	
	Potential impacts to land use would be considered to be adverse (negative).			
Type	**Direct**	Indirect	Induced	Cumulative
	Impacts to land use would be direct impacts from Project activities.			
Duration	Temporary	**Short-term**	Long-term	Permanent
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Impacts to land use from the Project would be fairly constant over the survey period, but would be expected to return to normal in the area surrounding each shot hole soon after shooting. In cases of vegetation removal, impacts may remain for a short duration after Project completion.			
Extent	**Local**	Regional	International	
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.			
Scale	The seismic survey will take place over an area of approximately 1,000 km². It is expected that the total area of impacted land from both treading and vegetation clearance during for all 31,000 shot holes throughout the seismic survey would be approximately 10.9 km², or about 1.1% of the entire survey area.			
Frequency	Impacts to land use would be a one-time event (for the area surrounding each line and shot hole).			
Magnitude	Positive	Negligible	Small	**Medium**	Large
	Although the duration of the impacts would be short-term, the scale of impacts is potentially large due to the broad Project area and substantial number of people that could be affected. Magnitude is therefore considered Medium.			
Receptor/ Resource Sensitivity	Low	**Medium**	High	
	The land that may be impacted is a very small fraction of Block MOGE-3. However, there are a number of sensitive land uses within the Block, including agriculture and hand-dug oil wells. Local people may be heavily dependent on current land uses to support their livelihood. Overall receptor sensitivity is rated as Medium.			

Significance	Negligible	Minor	**Moderate**	Major
	The combination of a Medium Resource Sensitivity and Medium Impact Magnitude will result in an overall Moderate impact.			
Mitigation Measures	**Existing** • Notify regional government and local representatives of townships about the Project schedule and the survey procedures. Inform land owners about the time and location of the survey approximately one week in advance. • Compensation for agricultural or oil well damage or losses will be paid to land owners or crop owners under the supervision of Compensation Committee, after assessment and approval of land area and unit rate by the Committee. This shall be done one week prior to the line survey. • After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash, and burying shot holes with the dug-up cuttings. The buried cuttings will be compacted and the ground will be evenly leveled. **Additional** • Only work within the set areas, which will be: o For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m^2/shot hole for shot-hole drilling. o For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total). • If the set areas will be extended, estimate appropriate compensation for agricultural damage or losses to be paid to land owner. • The Project shall be carried out as much as possible during the dry season or after the harvesting season, which will reduce damages to agricultural lands.			
Residual Significance	Negligible	**Minor**	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Minor.			

6.4.2 *Assessment of Impacts to Transportation*

6.4.2.1 *Scope of Assessment*

As determined during scoping, potential impacts to transportation from the seismic survey may occur due to:

- Transportation of Personnel and Equipment (All Phases); and
- Shot Hole Drilling.

6.4.2.2 *Summary of Relevant Baseline Conditions*

Central Myanmar has a relatively well developed transport system compared to other parts of Myanmar, including road, air, rail, and water. Due to its geography, central Myanmar acts as the central hub for transport of people and goods with destinations further north, east and west in the country, as well as to China and India. According to a previous Land Use Survey by REM in the region, most townships allow a maximum truck weight of 13 tons, and village roads allow no more than 6 tons, due to timber bridges.

Previous traffic surveys in Magway have indicated that the highways receive moderate traffic, with some highways carrying 80 to 100,000 vehicles per year.

6.4.2.3 *Assessment of Impacts*

Transport of Personnel and Equipment

Transportation of personnel and equipment is expected to occur with variously sized trucks, amounting to approximately 112 trips/day. There are several highways within the Project area that will be used for the Project, and local roads within districts and villages will also be used.

Transportation of personnel and equipment will be intermittent throughout the day. Transport to and from the working area will result in a temporary and local increase in vehicles on the roads. The increase of 112 trips per day will not result in a major increase in traffic.

Transport of Explosives

This seismic survey uses explosives as one of the seismic sources. Without proper mitigation measures, transport of explosives could result in potentially serious impacts, including damage or disruption to the existing transportation network due to accidental explosion.

Explosives and detonators will be imported into Myanmar. Explosives and detonators will be transported by truck to a temporary storage area. The storage site will be approximately 50 km away from the base camp. Based on maximum 3 kg of explosives per shot hole, and taking into account contingency for missed shots, a maximum of approximately 150,000 kg of explosives will be required for the entire seismic survey.

Explosives, detonators and accessories have been imported into Myanmar by the Seismic Contractor through PTTEP SA. PTTEP SA will prioritize the security of explosives and detonators to be used in the seismic works. The Seismic Contractor, under the contract with PTTEP SA, will take care of the transportation and security through the cooperation by MOGE and any other relevant authorities. PTTEP SA and the Seismic Contractor will manage the explosive and detonator inventory records strictly, and 24 hour security will be maintained at the explosive magazine sites.

Explosives transportation to the Project site will use registered vehicles that comply with transportation of dangerous materials requirements. Every day, a contractor convoy will transport the explosives from the field storage to the seismic line. At the work site, explosives and detonators will be contained in secured day-boxes until used or returned to storage magazines. Explosive and detonator products will be transported separately in fully-enclosed, locked, fire-resistant fixed containers or compartments, separate from the passenger compartment. The use of trailers will not be permitted during explosives transport. Vehicles transporting explosives will operate in a safe manner consistent with prevailing road and weather conditions.

The mitigation measures required by laws and implemented by the contractor will reduce impacts from explosives transportation for the seismic survey to people who live along transportation routes. Should the unlikely event of an

accident occur, it is conceivable that traffic could be affected in a short-term duration.

Temporary Road Closures during Shooting/Recording

Most vehicles using the highways and roads in the Project area are personal cars, pick-ups, and motorcycles. The vehicles may generate noise and vibration that can disturb the seismic recording. Therefore, during the shooting, the Project team will coordinate with traffic police for temporary road closures. All drivers must switch-off engines in order to prevent noise and vibration interference. These measures may have short-term impacts on local traffic and transportation infrastructure.

6.4.2.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to transportation include the following:

- Safety communication equipment must be installed on vehicles, such as safety belts and portable fire extinguisher etc;
- Strictly enforce speed limit of 30 km/hr within village tracts or community areas;
- Ensure all vehicles are in good operating condition and comply with Project safety standards;
- Drivers must be healthy, have valid licenses, and by no means allowed to drink alcohol or take forms of medicine or illicit drugs that can affect performance;
- All operations using or transporting explosives shall conform to the rules and regulations defined in licenses issued by the Ministry of Defense;
- Vehicles to be used in explosives transportation must be registered as explosives transport vehicles according to military regulations. Trailers are not allowed to be used for this purpose. Safety equipment, such as siren and portable fire extinguisher, etc. must be installed;
- Vehicles for explosives transportation must be specially designed according to relevant standards. Various vehicles' parts that may contact explosives must be constructed or covered by materials that will not create a spark;
- Limit vehicle speed for explosives transportation to 40 km/hr in field area (outside community) and 80 km/hr on highway. Limit vehicles speed to 30 km/hr on non-flat roads such as laterite and soil compacted roads;
- Transportation of explosives and detonators must be done separately and vehicles not loaded to over 80% of their carrying capacity;
- The transportation of explosives must be led and escorted by a police force; and

- The separation distance between transportation of explosives and transportation of detonators must be at least 50 m.

6.4.2.5 *Significance of Impacts*

The significance of impacts to transportation from the Project is assessed in ***Table 6.32.***

Table 6.32 Assessment of Potential Impacts on Transportation from Project Activities

Impact	• Transport to and from the working area will result in a temporary and local increase in vehicles on the roads. • Transport of explosives could result in potentially serious impacts, including damage or disruption to the existing transportation network due to accidental explosion. • The temporary closure of public roads for shooting/recording may result in inconvenience to public.				
Nature	**Negative**	Positive	Neutral		
	Potential impacts to transportation would be considered to be adverse (negative).				
Type	**Direct**	Indirect	Induced	Cumulative	
	Impacts to transportation would be direct impacts from Project activities.				
Duration	**Temporary**	Short-term	Long-term	Permanent	
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Disruptions to the transportation network from the Project would not be constant, and would occur intermittently over the survey period.				
Extent	**Local**	Regional	International		
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.				
Scale	The seismic survey will take place over an area of approximately 1,000 km^2. The increase of 112 trips per day will not result in a major increase in traffic. A maximum total of 150,000 kg of explosives will be transported throughout the seismic survey, amounting to approximately 556 kg/day. Temporary road closures during shooting/recording would be expected to occur over limited areas and for short duration only.				
Frequency	Transportation disruptions would occur intermittently but repeatedly throughout the day for the duration of the seismic survey.				
Magnitude	Positive	Negligible	**Small**	Medium	Large
	Considering the existing traffic in the Project area, the additional traffic load and temporary disruptions will have Small potential impact on local transportation.				
Receptor/ Resource Sensitivity	Low	**Medium**	High		
	Central Myanmar has a relatively well developed transport system compared to other parts of Myanmar. Previous traffic surveys in Magway have indicated moderate traffic, with some highways carrying 80 to 100,000 vehicles per year. However, the conditions of the local roads in some locations in the Project area are poor. Therefore receptor sensitivity is considered Medium.				
Significance	Negligible	**Minor**	Moderate	Major	
	The combination of a Medium Resource Sensitivity and Small Impact Magnitude will result in an overall Minor impact.				

Mitigation Measures	• General Mitigation Measures for Transportation and Project Vehicle Operation **Existing** o Safety communication equipment must be installed on vehicles, such as safety belts and portable fire extinguisher etc. o Strictly enforce speed limit of 30 km/hr within village tracts or community areas. o Ensure all vehicles are in good operating condition and comply with Project safety standards. o Drivers must be fit to drive and have a valid driving license. o The drinking of alcohol, taking prescription medicine or herbal remedies that can affect performance and/or the use of illicit drugs is prohibited for all staff, including drivers. **Additional** o Weight of the trucks shall not exceed the applicable limits, in order to reduce damage to road surfaces or structures. o Maintain and repair any public or private roads that are damaged by Project activities. • Mitigation Measures for Explosives Transportation **Existing** o All operations using or transporting explosives shall conform to the rules and regulations defined in licenses issued by the Ministry of Defense. o Vehicles to be used in explosives transportation must be registered as explosives transport vehicles according to military regulations. Trailers are not allowed to be used for this purpose. Safety equipment, such as siren and portable fire extinguisher, etc. must be installed. o Vehicles for explosives transportation must be specially designed according to relevant standards. Various vehicles' parts that may come into contact with explosives must be constructed or covered by materials that will not create a spark. o Limit vehicle speed for explosives transportation to 40 km/hr in field area (outside community) and 80 km/hr on highway. Limit vehicles speed to 30 km/hr on non-flat roads such as laterite and soil compacted roads. o Transportation of explosives and detonators must be done separately and vehicles not loaded to over 80% of their carrying capacity. o The transportation of explosives must have a police escort. o The separation distance between transportation of explosives and transportation of detonators must be at least 50 m. • Mitigation Measures during a Temporary Stop of Traffic while Shooting/Recording **Additional** o Coordinate with security personnel for temporarily stopping traffic. All vehicles waiting for traffic signal must switch off engine to prevent disturbing noise during shooting/recording. o Avoid shooting/recording near highways wherever possible, as well as near roads connecting townships and villages during rush hours (from 7:00-9:00 and 18:00-20:00). Minimum setback distances (see ***Table 4.4***)) must be strictly followed. o Put up signs along affected highways, as well as along roads connecting townships and villages to clarify the reason for traffic closure.
Residual Significance	Negligible | **Minor** | Moderate | Major If the recommended mitigation measures are implemented, residual impact significance would be Minor.

6.4.3 *Assessment of Impacts to Socio-Economy*

6.4.3.1 *Scope of Assessment*

As determined during scoping, potential impacts to socio-economy from the seismic survey may occur due to:

- Shot Hole Drilling;
- Receiver/Geophone Line Laydown; and
- Shooting/Recording.

6.4.3.2 *Summary of Relevant Baseline Conditions*

The principal product of Magway Region is petroleum. It produces most of the oil and natural gas in Myanmar. There are a number of hand-dug oil well communities (ie. grass-roots oil wells dug with rudimentary equipment) in the region, which contributes income to a large number of residents. Other industries include cement, cotton weaving, and tobacco, iron and bronze.

The price of crude oil varied by quality and well site, with the price per 50 gallon-barrel range from 90,000 to 120,000 kyat, yield varied of 5 to 40 gallon-barrel/well per day in Project area.

Agriculture is also important. Rice is the most prominent crop in the Project area. Other crops of importance are oil seed crops such as groundnut and sesame, pulses and beans and cotton as industrial crop.

6.4.3.3 *Assessment of Impacts*

Positive Impacts to Employment and Income

During the seismic survey, up to 1,000 workers may be employed. Some of the workers for non-skilled jobs will be sourced from the communities around the Project area. This employment will increase income of the local people and also stimulate local businesses and services. Workers will be employed for 6 to 9 months.

Negative Impacts to Employment and Income

The major occupation in the communities in the Project area is farming and agriculture. Rice is planted at a specific season while other crops are planted in a cycle throughout the year. Therefore, agriculture might be affected by the Project activities due to the impact on land use (see ***Section 6.4.1***).

Another important occupation in Block MOGE-3 consists of hand-dug oil well communities, as discussed in ***Section 6.4.1***. Project activities may temporarily disrupt some of the oil activities in the Project area, thus having a potential impact on related employment/income.

PTTEP SA's survey team will assess the above impacts, and provide compensation to farmers and oil well communities for their losses in cooperation with MOGE and local authorities.

6.4.3.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to socio-economy include the following:

- Where possible, hire local people for non-skilled work in proportion to the survey areas to minimize conflicts and to evenly distribute local income.

6.4.3.5 *Significance of Impacts*

The significance of impacts to socio-economy from the Project is assessed in ***Table 6.33.***

Table 6.33 Assessment of Potential Impacts on Socio-Economy from Project Activities

Impact	• Potential for positive impacts due to local employment and use of local businesses and services. • Potential for negative impacts due to disruption to agricultural and petroleum-based activities.				
Nature	Negative	Positive	**Neutral**		
	Potential impacts to socio-economy have both negative and positive components, and would therefore be considered to be neutral.				
Type	**Direct**	Indirect	Induced	Cumulative	
	Impacts to socio-economy would be direct impacts from Project activities.				
Duration	Temporary	**Short-term**	Long-term	Permanent	
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Impacts to socio-economy from the Project would last the duration of the seismic survey.				
Extent	**Local**	Regional	International		
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.				
Scale	During the seismic survey, up to 1,000 workers may be employed. Some of the workers for non-skilled jobs will be sourced from the communities around the Project area. Impacts to agriculture and petroleum-based businesses would be limited to those areas directly in the path of seismic lines, and disruptions would be short-term or temporary.				
Frequency	Impacts to socio-economy would occur constantly throughout the duration of the seismic survey.				
Magnitude	Positive	Negligible	Small	**Medium**	Large
	Considering the number of workers required for the Project, as well as the potential scale of negative impacts to local socio-economy, the overall magnitude is assessed as Medium.				
Receptor/ Resource Sensitivity	Low	**Medium**	High		
	There is likely to be a substantial desire for employment within the local community. In addition, communities involved with the local agriculture or petroleum industries are potentially very sensitive to any disruptions to their activities due to resulting loss of livelihood. Resource sensitivity is therefore considered Medium.				
Significance	Negligible	Minor	**Moderate**	Major	
	The combination of a Medium Resource Sensitivity and Medium Impact Magnitude will result in an overall Moderate impact.				

Mitigation Measures	**Existing** • Where possible, hire local people for non-skilled work in proportion to the survey areas to minimize conflicts and to evenly distribute local income. **Additional** • Enforce good behavior among the Project workers to prevent robbery, violence, and quarrels among workers as well as between workers (especially foreigners) and local residents. This will also prevent conflicts with nearby communities. • Establish a public relations team in the survey area to build up and maintain good relationships with communities and to receive news, opinions, and suggestions from local people throughout the Project period. • Provide information on planned Project to local residents one week prior to survey. • Consider re-locating any shot holes that come within the recommended setback distance (see ***Table 4.4***) of communities.			
Residual Significance	Negligible	**Minor**	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Minor.			

6.4.4 *Assessment of Impacts to Historical, Archaeological and Cultural Resources*

6.4.4.1 *Scope of Assessment*

As determined during scoping, potential impacts to historical, archaeological and cultural resources from the seismic survey may occur due to:

- Shooting/Recording.

6.4.4.2 *Summary of Relevant Baseline Conditions*

There are no officially designated or protected archaeological sites in the Project area. The nearest such sites are Beikthano and Sri Ksetra, which are located 54 km and 33 km from Block MOGE-3, respectively. However there are numerous minor monasteries and pagodas found throughout the Project area.

6.4.4.3 *Assessment of Impacts*

The main activity affecting these resources will be shooting/recording, which can cause a vibration impact. As outlined in ***Section 4.4.1***, a minimum setback distance of 150 m is deemed sufficient to prevent damage to archaeological sites/features and historical sites. At this distance, the peak particle velocity would be approximately 1.16 mm/s, which is below the vibration level that would be expected to cause any damage at all to sensitive archaeological sites. Implementation of these minimum setback distances will result in undetectable vibration at the sites.

As Beikthano and Sri Ksetra are located very far outside the extent of impacts from the Project, there will be no vibration impact to these sites. In addition, no impact is expected to any of the other temples or pagodas near the Project Area, as they will all be located further than 150 m from the seismic activities, which is far enough away to ensure that particle velocity (vibration) is less than 2 mm/s, as shown in ***Table 6.22***.

A detailed topographic survey of the seismic lines will be done prior to shooting. This topographic survey will determine the exact location of the seismic lines and distance to each of the archaeological sites. If any archaeological sites are within the minimum setback distance, the Project team will shift the seismic line or shot hole to an appropriate location to meet the minimum setback distance and to minimize the potential impact from vibration.

If the seismic line cannot be easily relocated to the minimum setback distance and the information is crucial to the integrity of the survey, a vibration test including PPV and Frequency will be conducted to determine the vibration values at various distances within 2,000 m using the charge. The data will be used to determine a site-specific minimum setback distance for this project to prevent any damage to archaeological sites.

6.4.4.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to historical, archaeological and cultural resources include the following:

- The survey team will offset the seismic lines away from archaeological sites for seismic survey according to the specified minimum setback distance (see ***Table 4.4***).
- Use the minimum quantity of explosives required in areas close to archaeological sites to prevent impacts to the sites.

6.4.4.5 *Significance of Impacts*

The significance of impacts to historical, archaeological and cultural resources from the Project is assessed in ***Table 6.34.***

Table 6.34 Assessment of Potential Impacts on Historical, Archaeological and Cultural Resources from Project Activities

Impact	• Shooting/recording, could potentially cause damage to nearby archaeological sites due to vibration impact.			
Nature	**Negative**	Positive	Neutral	
	Potential impacts to historical, archaeological and cultural resources would be considered to be adverse (negative).			
Type	**Direct**	Indirect	Induced	Cumulative
	Impacts to historical, archaeological and cultural resources would be direct impacts from Project activities.			
Duration	**Temporary**	Short-term	Long-term	Permanent
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days.			
Extent	**Local**	Regional	International	
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.			
Scale	The seismic survey will take place over an area of approximately 1,000 km². There are no officially-designated heritage areas or archaeological zones approved by government in Block MOGE 3. However, there are a number of ancient pagodas which are in good condition, as well as some ruins, within the Project area.			

	Minimum setback distances between shot holes and archaeological sites will be set, which should ensure vibration levels (PPV) of less than 2 mm/s for archaeological sites.
Frequency	Potential impact would occur intermittently but repeatedly throughout the day for the duration of the seismic survey.
Magnitude	Positive | Negligible | Small | **Medium** | Large Duration of impacts to historical, archaeological and cultural resources would be temporary, and extent would be local, however the scale of impacts could be potentially serious, and it is possible for structures or temples to be damaged. Potential impacts will occur repeatedly throughout the survey. Magnitude is therefore considered Medium.
Receptor/ Resource Sensitivity	Low | **Medium** | High Archaeological resources are by their nature quite sensitive to damage, and there are a number of temples, pagodas, and other cultural resources in the Project area. Some of the sites in the Project area have considerable cultural value for local stakeholders. Therefore the sensitivity is considered Medium.
Significance	Negligible | Minor | **Moderate** | Major The combination of a Medium Resource Sensitivity and Medium Impact Magnitude will result in an overall Moderate impact.
Mitigation Measures	**Existing** • The survey team will offset the seismic lines away from archaeological sites for seismic survey according to the specified minimum setback distance (see ***Table 4.4***). • Use the minimum quantity of explosives required in areas close to archaeological sites to prevent impacts to the sites. **Additional** • Project must invite MOGE to observe the works and receive suggestions where necessary. • Record current conditions of archaeological sites around the Project area before the survey starts in order to compare conditions before and after the survey. If changes occur, the Project shall be halted and MOGE shall be informed immediately. • If it is unsure whether the sites found are archaeological sites or not, the survey team will offset the seismic lines away from the sites by at least 150 m following setback distances for archaeological aspects. The Project staff must set mitigation measures if the archaeological sites are found to be at risk from seismic survey. • If an archaeological site is found to be closer to the seismic line than the minimum setback distances (see ***Table 4.4***), and the seismic line cannot be easily relocated, MOGE will be notified, and contact will be made with concerned department and authorities before proceeding with seismic operations for the line in question.
Residual Significance	Negligible | **Minor** | Moderate | Major If the recommended mitigation measures are implemented, residual impact significance would be Minor.

6.5 HEALTH IMPACT ASSESSMENT (ALL PROJECT PHASES)

6.5.1 Assessment of Impacts to Worker Health and Safety

6.5.1.1 Scope of Assessment

As determined during scoping, potential impacts to worker health and safety from the seismic survey may occur due to:

- Transportation of Personnel and Equipment (All Phases);
- Shot Hole Drilling; and
- Shooting/Recording.

6.5.1.2 Summary of Relevant Baseline Conditions

All workers, including those of subcontractors, will adhere with PTTEP's SSHE Policy and Procedures, including Personal Protective Equipment Standard, SSHE Training & Competency Standard, and SSHE Contractor Management Standard, which are provided in ***Annex A***.

6.5.1.3 Assessment of Impacts

During general project activities (transportation and waste disposal), workers will be handling explosives, some of which are dangerous. Vehicle accidents may also occur during transportation.

Workers will use equipment and machines to access the Project area, for site preparation and drilling shot holes. Potential injuries may result from use of vehicles, using sharp objects for cutting grass in the drilling area, and accidents from vehicles, etc.

PTTEP SA's Seismic Contractor will be required to submit a Safety, Security, Health and Environmental (SSHE) Management Plan, which includes a fully detailed hazard and risk assessment including mitigation and control measures that will be strictly enforced by the PTTEP SA. That will minimize potential health and safety risks. Compliance with the plan, control measures, mitigation requirements, and regulations will be enforced by PTTEP SA.

Shooting/Recording

During shooting/recording, generated noise and vibration may affect workers. However, the Project team has specified a safety distance between shot holes and shooting/recording team of 50 m. Maximum noise measurements at 50 m from shot holes during shooting/recording are expected to be between 65 and 75 dB(A). This noise level will not impact the health and safety of workers. In addition, shooting/recording will occur over a short time period (a few minutes) and the Project team will provide ear plugs or ear muffs to the shooting/recording team as a protective gear.

The likelihood of any incidents due to accidental explosion of explosives used for seismic activity is small, but the consequence to worker health/safety is

large, and could include injury or death. The impact due to accidental explosion is assessed under Unplanned Events in ***Section 6.6***.

6.5.1.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to worker health and safety include the following:

- Workers' training must be held before the Project starts to ensure that all workers and sub-contractors strictly follow PTTEP SA's safety management system and other standards relating to safety operation;
- Put up warning signs or symbols in risk prone areas, such as around shot holes during shooting/recording, which requires a safety zone of at least 50 m around shot holes. Workers and local people are prohibited to enter the area while shooting/recording;
- Provide personal protective equipment (PPE) to workers according to the Project safety plan, such as helmets, safety shoes, ear muffs, etc.
- All aspects of explosives use must follow regulations of Myanmar, including the Explosive Substances Act, as well as safety regulations of PTTEP SA and its seismic contractor;
- Limit vehicle speed to 30 km/hr on laterite roads and other unpaved roads within village tracts or community areas to minimize dust production and dispersion; and
- Transportation of explosives and detonators must be done according to the measures described for impacts to Transportation (above).
- Shot holes will be backfilled/compacted in order to lower the blast radius and spread.

6.5.1.5 *Significance of Impacts*

The significance of impacts to worker health and safety from the Project is assessed in ***Table 6.18.***

Table 6.35 Assessment of Potential Impacts on Worker Health and Safety from Project Activities

Impact	• Potential impacts to worker health and safety from various Project activities.				
Nature	**Negative**	Positive	Neutral		
	Potential impacts to worker health and safety would be considered to be adverse (negative).				
Type	**Direct**	Indirect	Induced	Cumulative	
	Impacts to worker health and safety would be direct impacts from Project activities.				
Duration	**Temporary**	Short-term	Long-term	Permanent	
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days.				
Extent	**Local**	Regional	International		
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.				
Scale	Impacts to worker health and safety from Project activities could be potentially serious; however the frequency and severity can be managed through appropriate safety precautions and mitigation measures.				
Frequency	Potential impacts to worker health and safety would occur constantly throughout the daytime during the seismic survey.				
Magnitude	Positive	Negligible	Small	**Medium**	Large
	Duration of impacts to worker health and safety would be temporary, and extent would be local, however the scale of impacts to workers could be potentially serious. Magnitude is therefore considered Medium.				
Receptor/ Resource Sensitivity	Low	**Medium**	High		
	Workers are not expected to be particularly sensitive to any health impacts. However, existing health facilities throughout the region are basic, with limited capacity to address any major accidents or illnesses. Existing road conditions are also generally quite poor, increasing the likelihood and severity of road accidents. Therefore the sensitivity of the workers to health impacts is considered to be Medium.				
Significance	Negligible	Minor	**Moderate**	Major	
	The combination of a Medium Resource Sensitivity and Medium Impact Magnitude will result in an overall Moderate impact.				
Mitigation Measures	**Existing** • Workers' training must be held before the Project starts to ensure that all workers and sub-contractors strictly follow PTTEP SA's safety management system and other standards relating to safety operation. • Put up warning signs or symbols in risk prone areas, such as around shot holes during shooting/recording, which requires a safety zone of at least 50 m around shot holes. Workers and local people are prohibited to enter the area while shooting/recording. • Provide personal protective equipment (PPE) to workers according to the Project safety plan, such as helmets, safety shoes, ear muffs, etc. • All aspects of explosives use must follow regulations of Myanmar, including the Explosive Substances Act, as well as safety regulations of PTTEP SA and its seismic contractor. • Limit vehicle speed to 30 km/hr on laterite roads and other unpaved roads within village tracts or community areas to minimize dust production and dispersion. • Transportation of explosives and detonators must be done according to the measures described in 8. Transportation (above). • Shot holes will be backfilled/compacted in order to lower the blast radius and spread. **Additional** • Record all statistics of injury and accident that occur during the Project operation.				

	• Security guards must be stationed at the field office and at the temporary explosives storage locations at all times. Nightwatchmen will be appointed as localized security of cable, geophones and preloaded shot holes in the field. • Nightwatchmen will be appointed as localized security of cable, geophones and preloaded shot holes in the field. • Educate workers about communicable diseases (including STDs and HIV/AIDS) and substance abuse. • Set up a first aid office and prepare an emergency plan for the survey area. Coordinate with local public health centers and hospitals to transfer patients if an emergency or accident occurs.			
Residual Significance	**Negligible**	Minor	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Negligible.			

6.5.2 *Assessment of Impacts to Public Health*

6.5.2.1 *Scope of Assessment*

As determined during scoping, potential impacts to public health from the seismic survey may occur due to:

- All Project Activities (General).

6.5.2.2 *Summary of Relevant Baseline Conditions*

Health care services in most communities within the Project area are very basic and in most cases involve a midwife only.

6.5.2.3 *Assessment of Impacts*

The local community may be affected by all Project activities: general activities, vehicles transport of personnel and equipment, site preparation, drilling of shot holes, and shooting/recording. The community may be impacted from these activities in terms of dust, noise, vibration, and possibly by transportation accidents. Also, people in the community might be stressed by a changing environment.

The Project team has prepared mitigation measures for dust dispersion from unpaved roads by vehicles such as limiting vehicle velocity. For noise and vibration impacts from transportation and jackhammer, and from shooting/recording, the Project team has specified a minimum setback distance from noise sources to the communities.

6.5.2.4 *Existing/ In-place Controls*

Existing/in-place controls included in the Project design to minimize impacts to public health include the following:

- Inform local organizations approximately one week prior to the survey to prepare the related organizations for any emergency;
- Follow appropriate measures for missed-shot scenarios (see ***Section 8***); and

- Follow appropriate measures for plugging shot holes (see ***Section 8***).

6.5.2.5 *Significance of Impacts*

The significance of impacts to community health and safety from the Project is assessed in ***Table 6.36***.

Table 6.36 Assessment of Potential Impacts on Public Health from Project Activities

Impact	• Potential impacts to public health from dust, noise, vibration, and possibly by transportation accidents due to Project activities.			
Nature	**Negative**	Positive	Neutral	
	Potential impacts to public health would be considered to be adverse (negative).			
Type	**Direct**	Indirect	Induced	Cumulative
	Impacts to public health would be direct impacts from Project activities.			
Duration	Temporary	**Short-term**	Long-term	Permanent
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. In the event of any impacts to public health, impacts could potentially last longer than the Project duration.			
Extent	**Local**	Regional	International	
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.			
Scale	There could potentially be a short-term increase in dust near certain roads and along the seismic lines as a result of the Project activities. Noise and vibration impacts are expected to occur only intermittently and for short duration. The increase of 112 trips per day will not result in a major increase in traffic.			
Frequency	Dust dispersion and noise will be frequent but intermittent throughout the survey. Road accidents, being unplanned events, can occur at any time. However, the frequency is expected to be very low.			
Magnitude	Positive	Negligible	**Small**	Medium	Large
	Duration of impacts to public health would be short-term, extent would be local, and the scale of impacts is expected to be limited. Magnitude is therefore considered Small.			
Receptor/ Resource Sensitivity	Low	**Medium**	High	
	Existing health facilities throughout the region are basic, with limited capacity to address any major accidents or illnesses. Existing road conditions are also generally quite poor, increasing the likelihood and severity of road accidents. Therefore the sensitivity of the local population to public health impacts is considered to be Medium.			
Significance	Negligible	**Minor**	Moderate	Major
	The combination of a Medium Resource Sensitivity and Small Impact Magnitude will result in an overall Minor impact.			
Mitigation Measures	**Existing** • Implement measures specified for potential impacts to Air Quality (***Table 6.13***), and Noise and Vibration (***Table 6.26***). • Inform local organizations approximately one week prior to the survey to prepare the related organizations for any emergency. • Follow appropriate measures for missed-shot scenarios (see ***Section 8***) • Follow appropriate measures for plugging shot holes (see ***Section 8***) **Additional** • Provide education on misfired shots to ensure that local people understand mitigation measures taken to ensure safety.			
Residual Significance	**Negligible**	Minor	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Negligible.			

6.6 UNPLANNED EVENTS

6.6.1 Road Accidents

Transportation accidents associated with the Project may occur during transportation of equipment and personnel.

According to Road Transport Administration Department of Myanmar, in 2014 in Magway Region, there were 923 traffic accidents, leading to 2,060 injuries and 221 fatalities[14]. In addition, accident statistics for all of Myanmar in 2012 are presented in ***Table 6.37***. It should be noted that, due to limited infrastructure and poor data gathering, accident statistics are likely to be underreported in Myanmar.

Table 6.37 Accidents and Fatalities Statistics in Myanmar (2012)[15]

Total Registered Vehicles	Total Road Length (km)	Number of Accidents	Number of Fatalities	Fatalities per 10,000 Vehicles
3,699,109	150,221	9,339	2,653	7.17

Ideally an analysis of the likelihood of traffic accidents and fatalities throughout the course of the Project would compare with statistics of accidents-per-vehicle-km. However, this data is not currently available in Myanmar, and therefore comparisons can only be made against the number of accidents per vehicle. Assuming 112 vehicles, and an average accident-per-vehicle ratio of 0.00252 (based on the data above), the total number of accidents involving Project vehicles expected over a 1-year period would be 0.28. Over the Project duration (270 days), this number would drop to 0.21 accidents. This would translate into an occurrence of about 1 in 5 projects having an accident. The likelihood of this unplanned event is therefore rates as Possible.

PTTEP SA's Emergency Response Procedures Manual will set out the management procedures to be put in place by the contractor to prevent and mitigate the potential impacts due to transportation accidents.

6.6.1.1 *Existing/ In-place Controls*

PTTEP SA's Emergency Response Procedures Manual will set out the management procedures to be put in place by the contractor to minimize the risk of road accidents as well as to mitigate the impacts if a road accident occurs. In addition, the in-place controls for Transportation (***Section 6.4.2.4***) will help to minimize the risk of road accidents.

6.6.1.2 *Significance of Impacts*

The significance of impacts due to road accidents from the Project is assessed in ***Table 6.38.***

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[14] http://www.myanmarrtad.com/?q=en/article/178
[15] http://www.unescap.org/sites/default/files/2.16.Myanmar.pdf

Table 6.38 Assessment of Potential Impacts due to Road Accidents from Project Activities

Impact	• Transportation accidents associated with the Project may occur during transportation of equipment and personnel.				
Nature	**Negative**	Positive	Neutral		
	Potential impacts due to road accidents would be considered to be adverse (negative).				
Type	**Direct**	Indirect	Induced	Cumulative	
	Impacts due to road accidents would be direct impacts from Project activities.				
Duration	**Temporary**	Short-term	Long-term	Permanent	
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days.				
Extent	**Local**	Regional	International		
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.				
Scale	Assuming 112 vehicles, and an average accident-per-vehicle ratio of 0.00252, the total number of accidents involving Project vehicles expected over the Project duration (270 days), is 0.21 accidents.				
Frequency	The frequency over the course of the Project is most likely to be zero occurrences. Transportation accidents would be a non-repeating, unplanned, event-related impact.				
Likelihood	Unlikely	**Possible**	Likely		
	Statistically, a single transportation accident would be expected to occur in about 1 in every 5 Projects.				
Magnitude	Positive	Negligible	**Small**	Medium	Large
	The magnitude rating is a composite of duration, extent, scale, frequency and likelihood, and in this case is Small.				
Receptor/ Resource Sensitivity	Low	**Medium**	High		
	Considering the possibility for injury or death, but taking into account the relative rarity of occurrence, human receptors would be considered to be of Medium sensitivity/vulnerability/importance to transportation accidents.				
Significance	Negligible	**Minor**	Moderate	Major	
	The combination of a Medium Resource Sensitivity and Small Impact Magnitude will result in an overall Minor Impact.				
Mitigation Measures	• Implement the same measures that will be used to mitigate impacts to transportation (***Section 6.4.2***).				
Residual Significance	Negligible	**Minor**	Moderate	Major	
	If the recommended mitigation measures are implemented, residual impact significance would be Minor.				

6.6.2 *Accidental Explosions*

Potential sources of explosion include dynamite shots, burning of garbage, discarded cigarettes, and the presence of diesel fuel on site during testing. Burning of garbage will be prohibited and smoking will be restricted to safe areas. Diesel is not easily ignited; it has a flash point of diesel in range of 40 to 100 ^{0}C, so the likelihood of a fire occurring is unlikely. Furthermore, the lower explosive limit (LEL) of diesel fuel is 0.6 percent, which equals concentration of approximately 6,000 ppm. It is unlikely that a fuel spill would cause this concentration when occurring in an open area.

Use of explosives for seismic work has an inherent risk of explosion. However, records of the Occupational Safety & Health Administration (OSHA) of the US Department of Labour indicate only one incident during seismographic work in 1985 resulting in fatalities as a result of misfiring of explosives (OSHA,

2003). In addition, a fatality was recorded in 2000 as a result of detonation of a charge (*IAGC, 2000*). Other incidents have resulted in injuries (*IAGC, 2003*). No injuries have been reported in Myanmar. There have also not been any explosions recorded under PTTEP SA's previous operations.

6.6.2.1 *Existing/ In-place Controls*

PTTEP SA's Emergency Response Procedures Manual will set out the management procedures to be put in place by the contractor to mitigate the impacts if an explosion occurs as well as to minimize the risk of an explosion. Appropriate missed shot procedures will also be followed as specified in ***Section 6.5.2***.

6.6.2.2 *Significance of Impacts*

The significance of impacts due to accidental explosion from the Project is assessed in ***Table 6.39.***

Table 6.39 Assessment of Potential Impacts due to Accidental Explosion from Project Activities

Impact	• Transportation, storage, handling, and use of explosives for seismic shooting may potentially pose a risk of accidental explosion if improperly managed.			
Nature	**Negative**	Positive	Neutral	
	Potential impacts from accidental explosion would be considered to be adverse (negative).			
Type	**Direct**	Indirect	Induced	Cumulative
	Impacts from accidental explosion would be direct impacts from Project activities.			
Duration	**Temporary**	Short-term	Long-term	Permanent
	The seismic survey will tentatively be carried out in Q3 2015 and last approximately 270 days. Explosion risks from the Project would occur intermittently over the survey period.			
Extent	**Local**	Regional	International	
	Potential impacts would be limited to the Project area and vicinity, and hence would be considered to be local.			
Scale	The risk of accidental explosion is very low. However, if a fire or explosion does occur, it has the potential to result in on-site injuries, operations being curtailed; official complaints, and medium scale and medium term impact on environment.			
Frequency	The frequency over the course of the Project is most likely to be zero occurrences. Accidental explosion would be a non-repeating, unplanned, event-related impact.			
Likelihood	**Unlikely**	Possible	Likely	
	Specific statistics are not readily available, but experience with similar projects and examination of existing data indicates that fire and explosion for seismic activities are generally very rare occurrences worldwide.			
Magnitude	Positive	Negligible	Small	**Medium**	Large
	The magnitude rating is a composite of duration, extent, scale, frequency and likelihood, and in this case is Medium.			
Receptor/ Resource Sensitivity	**Low**	Medium	High	
	Human, flora and fauna receptors are sensitive to the potential impact, but only a small number of resources will be within the potential impact range of accidental explosion.			
Significance	Negligible	Minor	**Moderate**	Major
	The combination of a Low Resource Sensitivity and Medium Impact Magnitude will result in an overall Minor Impact.			
Mitigation Measures	• Implement the same measures that will be used to mitigate impacts to transportation (***Section 6.4.2***). • Implement the same measures that will be used to mitigate impacts to worker health and safety (***Section 6.5.1***). • Implement the same measures that will be used to mitigate impacts to public health (***Section 6.5.2***).			
Residual Significance	Negligible	**Minor**	Moderate	Major
	If the recommended mitigation measures are implemented, residual impact significance would be Minor.			

Section 7

Cumulative Impact Assessment

7 CUMULATIVE IMPACT ASSESSMENT

According to IFC Performance Standard 1, cumulative impacts can be defined as follows: "impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted. Cumulative impacts are limited to those impacts generally recognized as important on the basis of scientific concerns and/or concerns from Affected Communities".

Essentially, cumulative impacts are those that arise from the combined effects of a Project's activity with external activities. How such impacts are assessed is strongly influenced by the status of the other activities (e.g., already in existence, approved or proposed) and how much data are available about them. This chapter will present the methodology and results used for assessing cumulative impacts related to the Project.

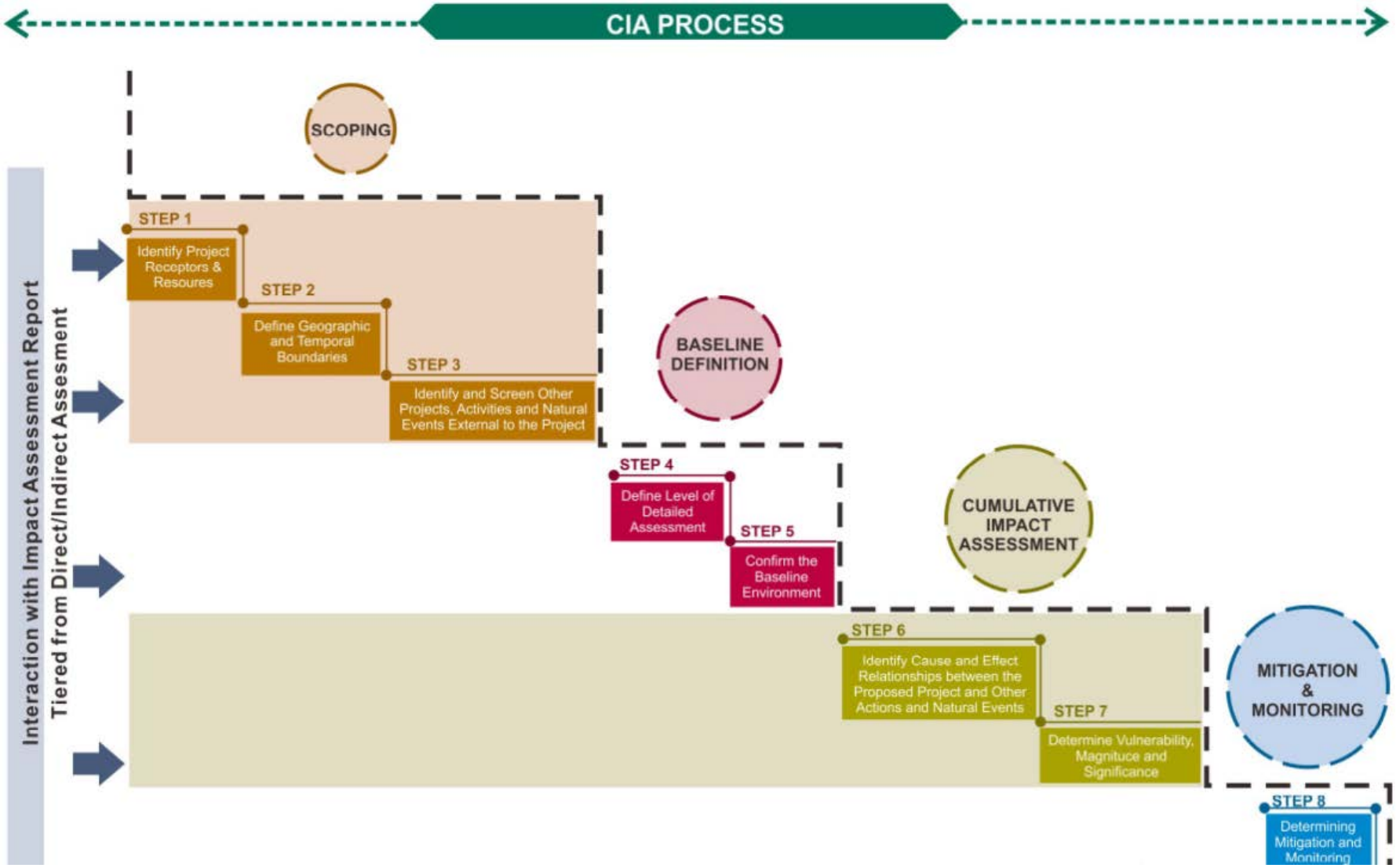
7.1 METHODOLOGY AND APPROACH

7.1.1 *Cumulative Impact Assessment Process Overview*

The Cumulative Impact Assessment (CIA) considers the residual direct and indirect impacts reported for the Project and evaluates these alongside potential impacts from other projects/activities/natural events that may affect common resources and receptors. The ultimate goal of this analysis is to capture the total effects of many actions over time that would be missed by evaluating each action individually.

The CIA describes the additive or synergistic result of the proposed Project as they potentially interact with other actions and natural events external to the Project. The CIA focuses on meaningful cumulative impact issues, rather than on all conceivable impact relationships. An overview of the CIA Process is shown in ***Figure 7.1***.

Figure 7.1 CIA Process Overview



7.2 CUMULATIVE IMPACT ASSESSMENT

7.2.1 Screening and Scoping

7.2.1.1 Project Resources/Receptors

The resources/receptors that could potentially be affected by cumulative impacts related to the Project are the same as those that were determined during the Scoping process for direct Project impacts, in ***Section 6.2***.

7.2.1.2 Geographic and Temporal Boundaries

The geographic boundaries for cumulative impacts are within Block MOGE-3. Project impacts are not anticipated to fall outside of Block MOGE-3, and therefore cumulative impacts would also be contained within the block.

The temporal boundaries for the CIA are the duration of the Project (9 months). Project impacts are not expected to last beyond the duration of the Project.

7.2.1.3 Other Projects/Developments in Block MOGE-3

There are some developments within Magway Region, including two hydropower plants (near Sidoktaya and Kyiohngyiwa), No. (13) Heavy Industry near Melhlataung Village, and No. (12) Sugar Factory (Nawaday) near Pyay, as well as other small scale factories. However, presently, there are no large scale industrial Projects operating or under development within Block MOGE-3.

Lime quarries exist south of Thayet, and there is State Economic Enterprise - a cement plant producing a total daily capacity of 156,000 tons, with a labor force of 758. Thayet Cement Factory is shown in ***Figure 7.2.***

Other industrial plants in MOGE-3 include Pakokku Cigarette Factory, Wazi Plant, Sale Fertilizer Plant, and Kyaunchaung Fertilizer Plant. Pakokku, Gangaw and Swa are well known for the production hand-woven cotton fabrics.

Hand-dug oil wells, as described in ***Section 5.5.1***, are another current activity within Block MOGE-3 that have the potential to give rise to cumulative impacts with the Project, particularly due to the close proximity and local value of the activity.

There are populations in MOGE-3 engaging in small and medium enterprises. The main types of industry are milling and manufacturing, such as milling rice, crushing pulses, extracting oil, and processing cotton; farm implements manufacture, and blacksmithing.

Figure 7.2 Thayet Cement Factory

Potential cumulative impacts were identified through a systematic process in a similar manner to the scoping process for direct potential Project impacts described in ***Section 6.2***. The features and activities associated with existing operations were considered with respect to their potential to interact with resources/receptors, and potential impacts were classified into one of three categories (No interaction, Not potentially significant, or Potentially significant). Similar to the assessment of direct potential Project impacts, a Potential Interactions Matrix has been developed for potential cumulative impacts from existing operations. The completed Potential Interactions Matrix for potential cumulative impacts is presented in ***Table 7.1***.

Based on the outcome of scoping, there are no significant cumulative impacts identified between the Project and existing or known planned activities within Block MOGE-3. In addition, minimum setback distances between seismic lines and existing structures and activities will be followed, as discussed in ***Section 8***, thus further minimizing the likelihood of any cumulative impacts occurring. Therefore, no further assessment of cumulative impacts will be carried out in this ESHIA Report.

Table 7.1 Potential Cumulative Impacts between the Project and other Developments

Other Developments	Environmental Resources									Social Resources							Health Resources	
	Topography	Air Quality	Greenhouse Gas	Noise and Vibration	Soil	Surface Water and Hydrology	Groundwater	Flora and Fauna	Sensitive Ecosystems	Land Use	Transportation	Public Infrastructure	Aesthetics	Socio-Economy	Cultural and Archaeological Resources	Tourism and Recreation	Public Health	Occupational Health & Safety
Thayet Cement Factory																		
Milling/Manufacturing Facilities																		
Hand-Dug Oil Wells																		

Key:	
	Interactions Identified as Unlikely
	Interactions Likely, but Not Likely to Lead to Significant Impacts
	Interactions are Likely to Result in Significant Impacts

Section 8

Environmental Management Plan

8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 PROJECT DESCRIPTION SUMMARY

PTT Exploration and Production South Asia (PTTEP SA) was granted the production sharing contract (PSC) for Myanmar Onshore Block MOGE-3 in September 2014, owned by Myanmar Oil and Gas Enterprise (MOGE). Block MOGE-3 encompasses 1,217 km^2, and is located in the south of Magway Region, in the dry zone central of the Myanmar lowlands. PTTEP SA plans to acquire 2D and 3D seismic data in Block MOGE-3, tentatively during Q3 of 2015.

8.2 PROJECT'S ENVIRONMENTAL, SOCIAL AND HEALTH POLICIES AND COMMITMENTS, LEGAL REQUIREMENTS AND INSTITUTIONAL ARRANGEMENTS

PTTEP SA currently does not have its own internal SSHE policies, procedures or documentation. PTTEP SA is the PSC holder for Block MOGE-3, and the operator is PTTEP International (PTTEPI). For this project, PTTEP SA will adopt all of PTTEPI's relevant SSHE policies and procedures. Throughout this section, SSHE policies, procedures and documents will be referred to as belonging to PTTEP SA, however they actually belong to PTTEPI and are being adopted by PTTEP SA for this Project.

PTTEP SA management is fully committed to providing a safe, secured and healthy workplace and conducting its operations in a manner that protects the environment. These commitments are in accordance with PTTEP SA's Vision, Missions, Values and SSHE Policy. Proactive individual involvement, responsibility and accountability are expected of all employees, contractors and third party personnel. PTTEP SA SSHE Management System (SSHE MS) is designed to align all stakeholders' efforts to enable attainment of these principles.

All levels of line management at PTTEP SA are responsible for implementing and maintaining its SSHE policy and SSHE MS. Both documents are reviewed and revised at regular intervals.

8.2.1 PTTEP SA's SSHE Vision, Missions, and Policy

Vision

PTTEP SA is an organization that strives to achieve excellence and a position of leadership by being an injury-free workplace, a leader in security and health management whilst committed to demonstrate environmental responsibility.

Missions

- Eliminate all incidents and injuries through hazard management and behaviour-based safety, whilst sustaining the quality of the environment.

- Create a SSHE culture where management, employees and contractors understand and uncompromisingly manage the SSHE risks in their working environment.
- Maintain a SSHE benchmark that is comparable to best practice worldwide.

Policy

PTTEP SA's Safety Security Health and Environment (SSHE) Policy falls under PTTEP Myanmar Asset's SSHE Policy, which is as follows:

"

PTTEP Myanmar Asset is committed to safe Exploration and Production (E&P) Operations in Myanmar with an ultimate goal of "Target Zero -Nobody Gets Hurts in Our Operations" which covers:

- *Zero Injury;*
- *Zero Major Accident (e.g. zero major hydrocarbon leak, vehicle accident, ship collision); and*
- *Zero Spill or External Complaint (e.g. zero complaint by authorities/community/sea user).*

To accomplish this, PTTEP Myanmar Asset's personnel, including contractors, shall:

- *Implement the PTTEP Safety, Security, Health and Environmental Management System (SSHE-MS);*
- *Comply with Myanmar legal requirements and if non-existent or in conflict with PTTEP or international standards, apply the strictest applicable requirements;*
- *Perform hazard identification and SSHE risk assessments so that risks are As Low As Reasonably Practicable (ALARP);*
- *Hold employees accountable for SSHE performance by setting and monitoring SSHE Plans and KPis;*
- *Prevent major accidents by implementing asset integrity programs and addressing safety case recommendations;*
- *Ensure all employees and contractors are assessed and maintain the required level of job and SSHE competency;*
- *Apply "Stop Work Authority Policy" for unsafe work and improve SSHE culture through Behavioural-Based Safety (BBS) programs;*
- *Implement security management for potential threats to safeguard personnel, assets, information and reputation;*
- *Promote health and hygiene in the workplace by conducting health risk assessments, education and regular health inspections;*
- *Minimise environmental impact by strictly following the mitigation measures recommended in environmental, social and health impact assessments;*
- *Implement a waste management program to reduce waste, maximise energy efficiency and conserve resources;*
- *Report, investigate and analyse SSHE incidents to prevent recurrence and close out corrective actions with evidence;*

- *Ensure that emergency and crisis management plans are developed and effective; and*
- *Ensure policy and SSHE-MS compliance through regular SSHE audits and Senior Management visits with corrective actions follow up for continuous improvement.*

"

8.2.2 PTTEP SA'S Environmental, Social and Health Management System

8.2.2.1 Roles and Responsibilities

8.2.2.1(1) Role of PTTEP SA

As well as having overall responsibility for the Project, PTTEP SA also have responsibility for monitoring the performance of all contractors. Where the mitigation measures do not result in the achievement of the objectives, PTTEP SA will work with contractor(s) to refine the measures.

The responsibility for implementation of the environmental monitoring and for the associated reporting lies with the PTTEP SA Survey Representative. It is expected that this person would be present during the seismic survey and will have responsibility for safety and environment on site.

8.2.2.1(2) Roles of Contractors

Contractors will be responsible for ensuring compliance with all relevant legal requirements, PTTEP SA procedures, as well as adherence to all environmental controls and mitigating measures.

Contractors will also be responsible under the contract for minimizing the potential environmental, social and health impacts of all contracted activities.

Contractors will need to demonstrate to the satisfaction of PTTEP SA how compliance with the mitigation measures will be ensured. They will also be expected to show to demonstrate commitment to the mitigation measures in all levels of their management structure.

8.2.2.2 Supporting Management Plans

8.2.2.2(1) SSHE Management System Manual

It should be noted that PTTEP SA currently does not have its own internal SSHE policies, procedures or documentation. PTTEP SA is the concession holder for Block MOGE-3, and the operator is PTTEP International (PTTEPI). For this project, PTTEP SA will adopt all of PTTEPI's relevant SSHE policies and procedures. Throughout this section, SSHE policies, procedures and documents will be referred to as belonging to PTTEP SA, however they actually belong to PTTEPI and are being adopted by PTTEP SA for this Project.

The objective of PTTEP SA's SSHE MS Manual is to serve as a practical interpretation of the Company's SSHE policy with respect to their moral obligations for SSHE issues for all persons working on, visiting or affected by operations at sites for which PTTEP SA has responsibility.

The manual covers details on the areas specified in ***Table 8.1***. The document is designed to serve as a comprehensive guide for all Operational Assets to develop its own SSHE management system and related documents. This document also provides an overview of the SSHE management system approach.

PTTEP SA's primary SSHE documents are included in ***Annex A.*** Additional SSHE documents are available from PTTEP SA upon request as needed.

Table 8.1 PTTEP SA SSHE Management System Standards

Item	Document	Document Number
1	Personal Protective Equipment (PPE) Standard	Myanmar-0550-STD-007
2	Incident Management Standard	Myanmar-0550-STD-010
3	Training and Competency Management Standard	Myanmar-0550-STD-008
4	Permit to Work Standard	Myanmar-0550-STD-009
5	SSHE Contractor Management Standard	Myanmar-0550-STD-011
6	Safety Case Standard	Myanmar-0550-STD-012
7	Life Saving Program Standard	Myanmar-0550-STD-013
8	SSHE Regulatory Compliance Standard	Myanmar-0550-STD-014
9	SSHE Risk Management Standard	Myanmar-0550-STD-015
10	SSHE KPIs & Performance Management Standard	Myanmar-0550-STD-016
11	Management of Change Standard	Myanmar-0550-STD-017
12	Audit and Review Standard	Myanmar-0550-STD-018
13	Occupational Health Management Standard	Myanmar-0550-STD-020
14	Waste Management Plan	Myanmar-0550-PLN-001
15	Spill Contingency Plan	Myanmar-0550-PLN-002
16	PTTEP SA Tropical Revolving Storm Procedure	Myanmar-0550-PDR-002
17	Offshore Medical Emergency Response Plan (MERP)	Myanmar-0550-PDR-006
18	PTTEP SA Crisis Communications Plan	Myanmar-0550-PDR-008
19	PTTEP SA Emergency & Crisis Management Plan	Myanmar-0550-PLN-004
20	Blowout Contingency Plan	MYR-001

8.2.2.2(2) Contractor Management

PTTEP SA requires its contactors to comply with its "SSHE Contractor Management Standard". The contractor is also required to carry out an SSHE Risk Assessment of their work and present a specific SSHE work plan. Workers must be formally trained in the general and specific SSHE issues at the site.

8.3 SUMMARY OF IMPACTS AND MITIGATION MEASURES

8.3.1 Introduction

This section outlines the mitigation measures that are to be employed to reduce the likelihood of impacts and/or to limit the extent of impact if one does occur. In addition, environmental monitoring measures will be undertaken to assess whether the mitigation measures are effective and if performance meets ESHIA commitments.

8.3.1.1 *Purpose of the ESHMP*

The purpose of the proposed mitigation measures is to manage identified impacts, comply with regulations and ensure that standards of international industry practice are adopted during the execution of all Project activities. Mitigation measures will be taken into account in Project implementation and execution such that potential adverse impacts are reduced to As Low As Reasonably Practical (ALARP).

The proposed mitigation measures are developed to provide a set of consistent tools which enable PTTEP SA to clearly identify the environmental impacts of the Project activities and to systematically implement cost effective measures which respond to, monitor, and control environmental performance. These mitigation measures would also be communicated to local government authority, i.e. MOGE, for reference purposes.

In addition, monitoring will be required in order to demonstrate compliance with legal limits and PTTEP SA's Project requirements, which will also provide verification of the overall design and effectiveness of the implemented control measures. The recommended mitigation measures are presented in ***Table 8.2.***

Table 8.2 Mitigation Measures during the Seismic Survey

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
Environmental Resources				
1. Topography and Soil Topography around the Project area might be changed due to the survey access, and drilling of shot holes. Project activities, such as traffic to the Project area, site preparation, drilling of shot holes, and shooting/recording, may impact soil resources. In particular, these activities may cause soil compaction or enhance soil erosion. The poor storage, handling and disposal of hazardous materials and waste can result in localized contamination of soil.	1.1 Only work within the set areas, which will be: • For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m^2/shot hole for shot-hole drilling. • For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total).	Areas along seismic lines, areas for shot hole drilling, path for Vibroseis, and geophone locations	Throughout periods of area adjustment and shot hole drilling	PTTEP SA
	1.2 Avoid laying seismic lines near trees and large shrubs, including areas with forests, garden forests, or areas with rare species. The lines shall offset these sensitive items according to the set minimum setback distances (***Table 8.3***).	Survey area and areas with large trees along seismic lines	During laying of seismic lines and area adjustment	PTTEP SA
	1.3 In order to maintain soil structure and prevent soil erosion: • Minimize the disturbance of roots of plants, shrubs and trees; • Minimize the removal of trees on slopes; and • Avoid cutting down established trees, e.g. those with a Diameter at Breast Height (DBH) greater than 30 cm.	Survey area and areas with large trees along seismic lines	During laying of seismic lines and area adjustment	PTTEP SA
	1.4 Level the ground around the shot holes prior to drilling them to reduce run-off and erosion.	Around shot holes	After shooting/recording	PTTEP SA
	1.5 After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash, and burying shot holes with the dug-up cuttings. The buried cuttings will be compacted and the ground will be evenly leveled.	Around shot holes	At shot holes after shooting/recording	PTTEP SA
	1.6 Minimize non-operational movements of seismic vibrator (Vibroseis) trucks.	Survey area	Throughout the survey duration	PTTEP SA
	1.7 All hazardous materials and waste shall be stored, handled and disposed of in a manner that prevents soil contamination. Where appropriate, the use of impervious bunds, secondary containment and drip trays will be used.	Survey area	Throughout the survey duration	PTTEP SA
	1.8 Spills or leaks (i.e. of fuel or lubricants) will be cleaned up immediately, and contaminated rags or other material will be disposed of properly.	Survey area	Throughout the survey duration	PTTEP SA
	1.9 Field camps will use local wastewater facilities where possible, or will install pit latrines when in remote locations, and will properly bury the pit latrines when the camp is abandoned.	Survey area	Throughout the survey duration	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
2. Air Quality and Greenhouse Gas Impacts on air quality from dust dispersion resulting from vehicle transportation and shooting/recording, as well as emission from engines.	2.1 Regularly maintain all survey vehicles to ensure good operating conditions and minimize emissions.	Project vehicles	Throughout the survey duration	PTTEP SA
	2.2 Switch off vehicles engines when not in use, in the parking lot of the field office and around the field working area.	Project vehicles	Throughout the survey duration	PTTEP SA
	2.3 Minimize or avoid destruction of trees within and around the Project area, as they act as natural buffers to dust and air emissions.	Around the survey area	Throughout the survey duration	PTTEP SA
	2.4 Only work within the set areas, which will be: • For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m^2/shot hole for shot-hole drilling. • For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total).	Areas along seismic lines, areas for shot hole drilling, path for Vibroseis, and geophone locations	Throughout the survey duration	PTTEP SA
	2.5 Compact shot holes firmly prior to shooting/recording to minimize soil dispersion (dust generation).	Around shot holes	Prior to shooting/recording	PTTEP SA
	2.6 Limit vehicle speed to 30 km/hr on laterite roads and other unpaved roads within village tracts or community areas.	Project routes	Throughout the survey duration	PTTEP SA
3. Noise and Vibration Increased noise during the seismic survey may disturb nearby residents or fauna. Increased vibration may disturb nearby residents, settlements, or archaeological resources during shooting/recording.	3.1 The maximum amount of explosives to be used is 3 kg/hole and hole depth shall be maximized (where practicable to do so) and holes will be backfilled and plugged appropriately, in order to reduce noise dispersion.	Around shot holes	During shooting	PTTEP SA
	3.2 Notify local representatives about the shooting/recording schedule, including the minimum setback distances approximately one week in advance.	Community area near the survey area	Throughout the survey duration	PTTEP SA
	3.3 Simultaneous firing of closely spaced firing lines shall be minimised to reduce the generation of noise and vibration.	Survey area	During shooting/recording	PTTEP SA
	3.4 Engineers or experts on shooting/recording shall be on site in the field during seismic activities to immediately take action if complaints or damage arises.	Survey area	During shooting/recording	PTTEP SA
	3.5 Provide personal protective equipment (PPE) for workers, such as ear muff, protective goggles, and other equipment according to the Project safety standards.	Survey area	During shooting/recording	PTTEP SA
	3.6 Strictly follow the standard for minimum setback distances from shot holes and Vibroseis to sensitive areas in ***Table 8.3***.	Survey area	Throughout the survey duration	PTTEP SA
	3.7 In addition to the setback distances, set a safety zone for people while shooting/recording and Vibroseis of at least 50-m, and	Around shot holes	During shooting/recording	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
	also prohibit entry into safety zone while in operation.			
	3.8 Limit survey activities and operations that may cause loud noise to daylight hours only (not later than 18:00).	Project machinery and vehicles, including shooting/recording in shot holes	Throughout the survey duration	PTTEP SA
	3.9 Appropriately compensate for all damages resulting from Project activities under the supervision of Crop Compensation Committee, after assessment and approval of damages by the Committee.	Agricultural area or land owners, including local people who receive impacts from the Project	Throughout the survey duration	PTTEP SA
4. Surface Water and Aquatic Biota Transportation, site preparation for laying of seismic lines, and shot hole drilling may affect surface water quality or enhance soil erosion from the Project area to surface water, affecting surface water quality and aquatic biota. Poor storage, handling and disposal of hazardous materials, waste and wastewater management also has the potential to affect surface water quality.	4.1 Offset seismic lines to not less than 50 m (as per ***Table 8.3***) where shot holes or Vibroseis are located close to water resources such as rivers, canals, streams, and ponds.	Project area near water resources	During laying of seismic lines	PTTEP SA
	4.2 Avoid or reduce removal of trees within and around the Project area, especially sloped areas, to prevent soil erosion into water resources. If possible, do not disturb roots of plants, shrubs, and small trees as these help maintain soil structure.	Survey area	Throughout the survey duration	PTTEP SA
	4.3 Only work within the set areas, which will be: • For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m^2/shot hole for shot-hole drilling. • For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total).	Areas along seismic lines, areas for shot hole drilling, path for Vibroseis, and geophone locations	Throughout the survey duration	PTTEP SA
	4.4 Level the ground around the shot holes prior to drilling them to reduce run-off and erosion.	Around shot holes	After shooting/recording	PTTEP SA
	4.5 After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash for re-use or disposal, and burying shot holes with the dug-up cuttings. The buried cuttings will be compacted and the ground will be evenly leveled.	Around shot holes	After shooting/recording	PTTEP SA
	4.6 Workers shall not dispose of waste into water resources.	Survey area	Throughout the survey duration	PTTEP SA
	4.7 All hazardous materials and waste shall be stored, handled and disposed of in a manner that prevents soil and surface water contamination. Where appropriate, the use of impervious bunds, secondary containment and drip trays will be used.	Survey area	Throughout the survey duration	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
	4.8 Avoid refuelling or maintaining Project vehicles (including Vibroseis trucks) within 50 m of any water sources.	Survey area	Throughout the survey duration	PTTEP SA
	4.9 Spills or leaks (i.e. of fuel or lubricants) shall be cleaned up immediately, and contaminated rags or other material will be disposed of properly.	Survey area	Throughout the survey duration	PTTEP SA
	4.10 Field camps will use local wastewater facilities where possible, or will install pit latrines when in remote locations, and will properly bury the pit latrines when the camp is abandoned.	Survey area	Throughout the survey duration	PTTEP SA
5. Groundwater Shot hole drilling and shooting/recording might cause damage to groundwater wells, and could block or redirect groundwater flow. There is also a potential for drilling to impact groundwater quality by introducing sediment or other contaminants to the groundwater from the surface. Poor storage, handling and disposal of hazardous materials, waste and wastewater management also has the potential to affect surface water quality.	5.1 Set a minimum setback distance between shot holes and Vibroseis to groundwater wells as shown in ***Table 8.3***.	Survey area	Prior to shooting/recording	PTTEP SA
	5.2 When drilling shot holes, drilling chemicals that are composed of heavy metals or toxics that could leach into groundwater must not be used.	Area for shot hole drilling	During shot hole drilling	PTTEP SA
	5.3 In the case where there are complaints or damage to groundwater wells, the responsible Project staff will review the damage in a timely manner and establish a solution and/or compensation (after assessment and approval of damages by MOGE).	Survey area	Throughout the survey duration	PTTEP SA
	5.4 If groundwater is discovered in the course of seismic activities, it shall be reported to MOGE.	Survey area	Throughout the survey duration	PTTEP SA
	5.5 All hazardous materials and waste shall be stored, handled and disposed of in a manner that prevents soil contamination. Where appropriate, the use of impervious bunds, secondary containment and drip trays will be used.	Survey area	Throughout the survey duration	PTTEP SA
	5.6 Spills or leaks (i.e. of fuel or lubricants) shall be cleaned up immediately, and contaminated rags or other material will be disposed of properly.	Survey area	Throughout the survey duration	PTTEP SA
	5.7 Field camps will use local wastewater facilities where possible, or will install pit latrines when in remote locations, and will properly bury the pit latrines when the camp is abandoned.	Survey area	Throughout the survey duration	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
6. Terrestrial Flora and Fauna Vehicle/human treading during survey can lead to soil compaction that might inhibit root penetration and reduce water infiltration, affecting flora. Terrestrial fauna could potentially be impacted by noise from vehicles transporting equipment and personnel, and noise from drilling equipment.	6.1 Only work within the set areas, which will be: • For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m^2/shot hole for shot-hole drilling. • For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total).	Areas along seismic lines, areas for shot hole drilling, path for Vibroseis, and geophone locations	Throughout the survey duration	PTTEP SA
	6.2 Avoid laying seismic lines near trees and large shrubs, including areas with forests, garden forests, or areas with rare species. The lines shall be offset from sensitive areas according to the set minimum setback distances in ***Table 8.3***. Avoid cutting trees with Diameter at Breast Height (DBH) greater than 30 cm.	Area with large trees along seismic lines	During laying of seismic lines and area adjustment	PTTEP SA
	6.3 The burning of wood, plant matter and weeds removed from the lines or other work activities is prohibited.	Area with large trees along seismic lines	During laying of seismic lines and area adjustment	PTTEP SA
	6.4 Project staff, including those of contractors and subcontractors, are prohibited from cutting or damaging trees that do not require removal or trimming for access or to undertake the seismic survey.	Forested areas around the Project site	During laying of seismic lines	PTTEP SA
	6.5 Regularly maintain Project vehicles to ensure good operating conditions in order to minimize noise and vibration that might affect fauna.	Project machinery and vehicles	Throughout the survey duration	PTTEP SA
	6.6 Limit vehicle velocity near forested areas to prevent noise from disturbing wildlife and to minimize collision with wildlife, and reduce erosion/compaction.	Survey area	Throughout the survey duration	PTTEP SA
	6.7 Shooting/recording and Vibroseis shall be carried out during daylight hours only (between 06:00 and 18:00).	Around shot holes	During shooting/recording	PTTEP SA
	6.8 If Project team becomes aware of presence of protected or endangered species, survey lines will be relocated accordingly.	Survey area	Throughout the survey duration	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
Social Resources				
7. Land Use Small and temporary alteration to land use due to site preparation for laying of seismic lines. Potential temporary impacts to agricultural land, as well as to hand-dug oil well communities near the seismic lines.	7.1 Notify regional government and local representatives of townships about the Project schedule and the survey procedures. Inform land owners about the time and location of the survey approximately one week in advance.	Survey area	Throughout the survey duration	PTTEP SA
	7.2 Compensation for agricultural or oil well damages or losses will be paid to land owners or crop owners under the supervision of Compensation Committee, after assessment and approval of land area and unit rate by the Committee. This shall be done one week prior to the line survey.	Survey area	Throughout the survey duration	PTTEP SA
	7.3 In case any accidental damage to trees or forest takes place due to the Project activities, PTTEP SA will compensate accordingly. The amount of compensation and specific procedures will be carried out under advice of MOGE, who will liaise directly with the Forest Department and other relevant departments and receive instructions and requirements accordingly.			
	7.4 Only work within the set areas, which will be: • For seismic shooting, about 1-m wide at the flank of the seismic lines and about 10 m^2/shot hole for shot-hole drilling. • For seismic vibrator/Vibroseis, about 5 m on either side of the seismic lines (10 m total). If the set areas will be extended, estimate appropriate compensation for agricultural losses to be paid to land owner.	Areas along seismic lines, areas for shot hole drilling, path for Vibroseis, and geophone locations	Throughout the survey duration	PTTEP SA
	7.5 After completion of the survey, return the affected area to its original state, as far as practicably possible, by collecting flags, wires of detonators, and trash for re-use or disposal, and burying shot holes with the dug-up cuttings. The buried cuttings will be compacted and the ground will be evenly leveled.	Around shot holes	After shooting/recording	PTTEP SA
	7.6 The Project shall be carried out as much as possible during the dry season or after the harvesting season, which will reduce damages to agricultural lands.	Survey area	Throughout the survey duration	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
8. Transportation Transportation of personnel and equipment might cause traffic disruptions, impact local roads and might increase accidents. Transport of explosives could result in potentially serious impacts, including damage or disruption to the existing transportation network due to accidental explosion.	8.1 **General Mitigation Measures for Transportation and Project Vehicle Operation**			
	• Strictly enforce speed limit of 30 km/hr within village tracts or community areas.	Roads around the Project area	Throughout the survey duration	PTTEP SA
	• Ensure all vehicles are in good operating condition and comply with Project safety standards.	Project vehicles	Throughout the survey duration	PTTEP SA
	• Drivers must be fit to drive and have a valid driving license.	Project vehicles	Throughout the survey duration	PTTEP SA
	• The drinking of alcohol, taking prescription medicine or herbal remedies that can affect performance and/or the use of illicit drugs is prohibited for all staff, including drivers.	Survey area and project vehicles	Throughout the survey duration	PTTEP SA
	• Weight of the trucks shall not exceed the applicable limits, in order to reduce damage to road surfaces or structures.	Project vehicles	Throughout the survey duration	PTTEP SA
	• Safety communication equipment must be installed on vehicles, such as, safety belts and portable fire extinguisher etc.	Project vehicles	Throughout the survey duration	PTTEP SA
	• Maintain and repair any public or private roads that are damaged by Project activities.	Around the survey area	Throughout the survey duration	PTTEP SA
	8.2 **Mitigation Measures for Explosives Transportation**			
	• All operations using or transporting explosives shall conform to the rules and regulations defined in licenses issued by the Ministry of Defense.	Around the survey area and explosives storage	Throughout the survey duration	PTTEP SA
	• Vehicles to be used in explosives transportation must be registered as explosives transport vehicles according to military regulations. Trailers are not allowed to be used for this purpose. Safety equipment, such as siren and portable fire extinguisher, etc. must be installed.	Vehicles transporting explosives	Throughout the survey duration	PTTEP SA
	• Vehicles for explosives transportation must be specially designed according to relevant standards. Various vehicles' parts that may come into contact with explosives must be constructed or covered by materials that will not create a spark.	Vehicles transporting explosives	Throughout the survey duration	PTTEP SA
	• Limit vehicle speed for explosives transportation to 40 km/hr in field area (outside community) and 80 km/hr on highway. Limit vehicles speed to 30 km/hr on non-flat roads such as laterite and soil compacted roads.	Vehicles transporting explosives	Throughout the survey duration	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
	• Transportation of explosives and detonators must be done separately and vehicles not loaded to over 80% of their carrying capacity.	Vehicles transporting explosives	Throughout the survey duration	PTTEP SA
	• The transportation of explosives must have a police escort.	Vehicles transporting explosives	Throughout the survey duration	PTTEP SA
	• The separation distance between transportation of explosives and transportation of detonators must be at least 50 m.	Vehicles transporting explosives	Throughout the survey duration	PTTEP SA
	8.3 **Mitigation Measures during a Temporary Stop of Traffic while Shooting/Recording**			
	• Coordinate with security personnel for temporarily stopping traffic. All vehicles waiting for traffic signal must switch off engine to prevent disturbing noise during shooting/recording.	Highways in Project area	Throughout the survey duration	PTTEP SA
	• Avoid shooting/recording near highways wherever possible, as well as near roads connecting townships and villages during rush hours (from 7:00-9:00 and 18:00-20:00). Minimum setback distances (as in ***Table 8.3***) must be strictly followed.	Highways in Project area	Throughout the survey duration	PTTEP SA
	• Put up signs along affected highways, as well as along roads connecting townships and villages to clarify the reason for traffic closure.	Highways in Project area	Throughout the survey duration	PTTEP SA
9. Water Supply Impacts on water supply may be caused by the need to use water during drilling of shot holes.	9.1 Provide notification about the time and location of the survey to Districts and Townships approximately one week in advance.	Survey area	Throughout the survey duration	PTTEP SA
	9.2 Strictly follow the standard for minimum setback distances from shot holes and Vibroseis to water resources in ***Table 8.3.***	Survey area	Throughout the survey duration	PTTEP SA
	9.3 Keep records of all complaints. Investigate and respond appropriately to received complaints	Survey area	Throughout the survey duration	PTTEP SA
10. Waste Management Increase domestic wastes and additional load for local municipal waste disposal systems.	10.1 Provide collection points for domestic wastes for all workers to dispose of their wastes.	Field office	Throughout the survey duration	PTTEP SA
	10.2 After shooting/recording, the recovery team will collect remaining materials, such as flags, wires of detonators, and trash for re-use or disposal. Cuttings will also be buried back into the holes and the ground will be evenly leveled.	Around shot holes	Throughout the survey duration	PTTEP SA
	10.3 Waste management plan will be implemented, which considers, where practicable to do so, waste minimisation and recycling, segregation of hazardous and non-hazardous waste	Survey area	Throughout the survey duration	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
	10.4 All waste to be disposed of appropriately and in line with local regulations or requirements.	Survey area	Throughout the survey duration	PTTEP SA
11. Socio-Economy There can be both positive and negative impacts on socio-economics, such as a positive impact on local employment and potential negative impacts from disturbances to traffic, communal utilities, and land use. Mitigation measures will enhance positive impacts and minimize negative impacts.	11.1 Where possible, hire local people for non-skilled work in proportion to the survey areas to minimize conflicts and to evenly distribute local income.	Field office	Throughout the survey duration	PTTEP SA
	11.2 Enforce good behavior among the Project workers to prevent robbery, violence, and quarrels among workers as well as between workers (especially foreigners) and local residents. This will also prevent conflicts with nearby communities.	Field office and Survey area	Throughout the survey duration	PTTEP SA
	11.3 Establish a public relations team in the survey area to build up and maintain good relationships with communities and to receive news, opinions, and suggestions from local people throughout the Project period.	Field office	Throughout the survey duration	PTTEP SA
	11.4 Provide information on planned Project to local residents one week prior to survey.	Survey area	One week before the planned survey	PTTEP SA
	11.5 Consider re-locating any shot holes that come within the recommended setback distance (see ***Table 8.3***) of communities.	Survey area	Throughout the survey duration	PTTEP SA
12. Cultural and Archaeological Resources Vibration from the survey may damage historical and archaeological sites.	12.1 Project must invite MOGE, the works and receive suggestions where necessary.	Survey area	Throughout the survey duration	PTTEP SA
	12.2 The survey team will offset the seismic lines away from archaeological sites for seismic survey according to the specified minimum setback distance in ***Table 8.3***.	Survey area	Throughout the survey duration	PTTEP SA
	12.3 Record current conditions of archaeological sites around the Project area before the survey starts in order to compare conditions before and after the survey. If changes occur, the Project shall be halted and MOGE shall be informed immediately.	Survey area	Throughout the survey duration	PTTEP SA
	12.4 If it is unsure whether the sites found are archaeological sites or not, the survey team will offset the seismic lines away from the sites by at least 150 m following setback distances for archaeological aspects. The Project staff must set mitigation measures if the archaeological sites are found to be at risk from seismic survey.	Survey area	Throughout the survey duration	PTTEP SA
	12.5 Use the minimum quantity of explosives required in areas close to archaeological sites to prevent impacts to the sites.	Survey area	Throughout the survey duration	PTTEP SA
	12.6 If an archaeological site is found to be closer to the seismic line	Survey area	Throughout the survey	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
	than the minimum setback distances (see ***Table 8.3***), and the seismic line cannot be easily relocated, MOGE will be notified, and contact will be made with concerned department and authorities before proceeding with seismic operations for the line in question.		duration	
Health Resources				
13. Worker Health and Safety Workers will be handling explosives, which can pose a danger to occupational health and safety. Potential injuries may result from use of vehicles, using sharp objects for cutting grass in the drilling area, and accidents from vehicles, etc. During shooting/recording, generated noise and vibration may affect workers.	13.1 Workers' training must be held before the Project starts to ensure that all workers and sub-contractors strictly follow PTTEP's safety management system and other standards relating to safety operation (see ***Annex A***).	Field office	Throughout the survey duration	PTTEP SA
	13.2 Put up warning signs or symbols in risk prone areas, such as around shot holes during shooting/recording, which requires a safety zone of at least 50 m around shot holes. Workers and local people are prohibited to enter the area while shooting/recording.	Survey area	Throughout the survey duration	PTTEP SA
	13.3 Provide personal protective equipment (PPE) to workers according to the Project safety plan (see ***Annex A***), such as helmets, safety shoes, ear muffs, etc.	Around shot holes	During shooting/recording	PTTEP SA
	13.4 All aspects of explosives use must follow regulations of Myanmar, including the Explosive Substances Act, as well as safety regulations of PTTEP SA and its seismic contractor.	Survey area	Throughout the survey duration	PTTEP SA
	13.5 Record all statistics of injury and accident that occur during the Project operation.	Survey area	Throughout the survey duration	PTTEP SA
	13.6 Security guards must be stationed at the field office and at the temporary explosives storage locations at all times.	Field office and a temporary explosives storage	Throughout the survey duration	PTTEP SA
	13.7 Nightwatchmen will be appointed as localized security of cable, geophones and preloaded shot holes in the field.	Survey area	Throughout the survey duration	PTTEP SA
	13.8 Limit vehicle speed to 30 km/hr on laterite roads and other unpaved roads within village tracts or community areas to minimize dust production and dispersion.	Communal roads and the Project area	Throughout the survey duration	PTTEP SA
	13.9 Transportation of explosives and detonators must be done according to the measures described **8. Transportation** (above).	Explosives transportation route	During explosives transportation	PTTEP SA
	13.10 Educate workers about communicable diseases (including STDs and HIV/AIDS) and substance abuse.	Survey area	Throughout the survey duration	PTTEP SA
	13.11 Set up a first aid office and prepare an emergency plan for the	Survey area	Throughout the survey	PTTEP SA

Impact Summary	Mitigation Measures	Location	Duration/Frequency of Mitigation Measure	Responsible Party
	survey area. Coordinate with local public health centers and hospitals to transfer patients if an emergency or accident occurs.		duration	
	13.12 Shot holes will be backfilled/compacted in order to lower the blast radius and spread.	Survey area	Throughout the survey duration	PTTEP SA
14. Public Health The community may be impacted from Project activities due to dust, noise, vibration, and possibly by transportation accidents. Also, people in the community might be stressed by a changing environment.	14.1 Inform local organizations approximately one week prior to the survey to prepare the related organizations for any emergency.	Survey area	Throughout the survey duration	PTTEP SA
	14.2 Provide education on misfired shots to ensure that local people understand mitigation measures taken to ensure safety.	Survey area	Throughout the survey duration	PTTEP SA
	14.3 Appropriate procedures shall be followed for misfired shots.	Survey area	Throughout the survey duration	PTTEP SA
	14.4 Appropriate procedures shall be followed for plugging and abandoning shot holes.	Survey area	Throughout the survey duration	PTTEP SA
	14.5 Follow all mitigation measures for impacts to Noise, Vibration, and Air Quality.	Survey area	Throughout the survey duration	PTTEP SA

Table 8.3 Required Minimum Setback Distances for Explosive and Non-Explosive Sources

Obstruction/Structure	Explosive Sources		Non-Explosive Sources (Vibroseis)	Source
	Charge Size	Distance		
Residence, barn, or any building(s) with a concrete base, concrete irrigation structures (e.g., drop structures, head works), concrete lined irrigation canals, and concrete water pipelines.	Up to and including 12 kg	150 m	50 m	1
	>12 kg ≤20	200 m		
Water wells, developed spring,* observation well, or piezometer.	Up to and including 12 kg	150 m	100 m	1
	>12 kg ≤20	200 m		
High - Pressure Pipelines High - pressure pipelines are pipelines that operate at, or are intended to operate at a pressure in excess of 700 kilopascals. **Note**: All distances are measured from the centre of the pipeline.	≤2 kg	32 m	20 m	1
	>2 & ≤4 kg	50 m		
	>4 & ≤6 kg	55 m		
	>6 & ≤8 kg	64 m		
	>8 & ≤10 kg	70 m		
	>10 & ≤12 kg	78 m		
	>12 kg ≤20	100 m		
Low - pressure Pipelines Low-pressure pipelines are pipelines that operate at, or are intended to operate at a pressure of 700 kilopascals or less. **Note:** All distances are measured from the centre of the pipeline.	Up to and including 20 kg	3 m	6 m	1
Dugouts** Measured from the inside edge of high water mark	Up to and including 20 kg	50 m	25 m	1
Irrigation Canal (other than concrete lined) Irrigation canals that are more than 4 m wide	Up to and including 20 kg	10 m	20 m	1
Buried Water Pipelines (other than concrete lined)	Up to and including 20 kg	3 m	6 m	1
Dams Dam means a barrier constructed and having a storage reservoir capacity of at least 30,000 m^3, and which is at least 2.5 m in height	Up to and including 20 kg	150 m	50 m	1

Obstruction/Structure	Explosive Sources		Non-Explosive Sources (Vibroseis)	Source
	Charge Size	Distance		
when measured vertically to the top of the barrier.				
Cemetery Distance to the energy source is measured to the surveyed boundary of the cemetery.	Up to and including 20 kg	100 m	50 m	1
Buried Lines and Survey Monuments Telephone lines and telecommunication lines.	Up to and including 20 kg	2 m	2 m	1
Domestic Septic Tank or Mound A septic tank is defined as a tank that is used as a septic storage device. A mound is a septic storage device that is located above ground surface.	Up to and including 20 kg	15 m	15 m	1
Archaeological and Cultural Sites	All	150 m	100 m	2
Railways	All	50 m	40 m	2

Obstruction/Structure	Explosive Sources		Non-Explosive Sources (Vibroseis)	Source
	Charge Size	Distance		
Water Body (including lakes, streams, creeks, wetlands, wetland edge, riparian areas, muskeg areas, ephemeral or seasonal draws and dugouts)	All	50 m from the riparian area edge and if no riparian area, 50 m from the edge of the water body's high water mark or seasonal high water edge		3
Oil or Gas Well	Explosives ≤2.0 kg	32 m	20 m	4
	Explosives > 2.0 & ≤4.0kg	180 m		

Note:

* A developed spring is an area of local groundwater discharge that has had human intervention to make the water usable or attainable for domestic and/or non-domestic purposes, and is intended for long - term use.

** Dugouts are earthen excavations designed to collect runoff and store it for use during drier times. Typically, dugout capacity ranges from a few hundred cubic meters to thousands of cubic meters.

Sources:

1 "Distance Requirements" from Lands Division, Land Management Branch, Petroleum Land Use & Reclamation Section, Government of Alberta, Canada

2 Oil and Gas Setback Requirements for Environmental Protection and Consultation on First Nation Reserve Land", from Indian Oil and Gas Canada (IOGC) Guidelines

3 Policy and Procedures Document for Submitting the Geophysical Field Report Form (Government of Alberta, October 2006)

4 Canada Oil and Gas Geophysical Operations Regulations, SOR/96-117, Canada Oil and Gas Operations Act

8.4 *MANAGEMENT AND MONITORING PLANS*

Monitoring will be required in order to demonstrate compliance with legal limits and PTTEP SA's Project requirements, and will also provide verification of the overall design and effectiveness of the implemented control measures. Details of the environmental monitoring program are presented in ***Table 8.4***.

8.5 *EMERGENCY PLAN*

Details on PTTEP SA's emergency plan are provided in PTTEP's SSHE Management System (see ***Annex A***).

8.6 *PUBLIC CONSULTATION AND DISCLOSURE*

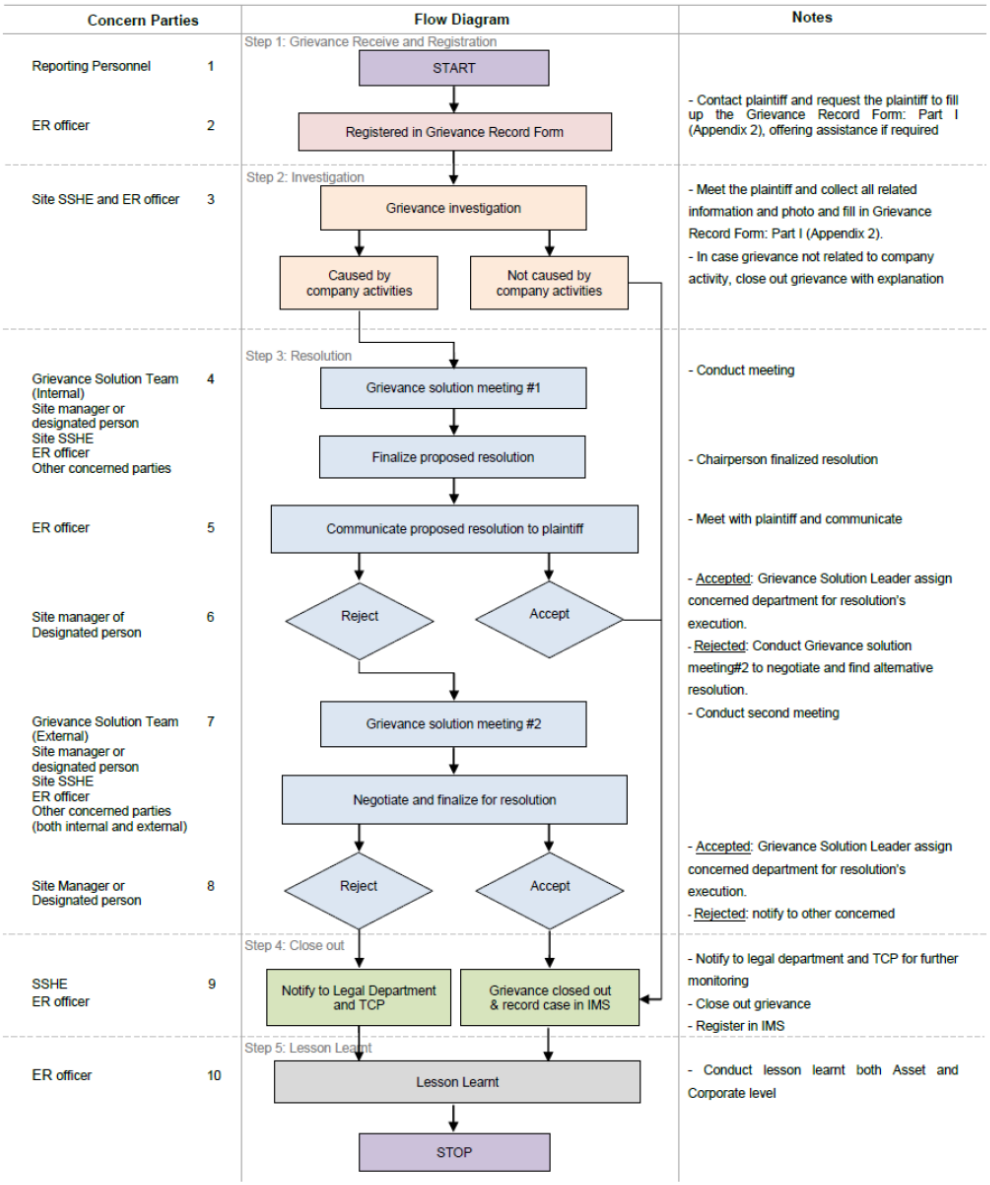
Details on PTTEP SA's ongoing public consultation and disclosure activities are provided in ***Section 9***.

8.7 *GRIEVANCE AND COMPLAINT HANDLING*

PTTEP SA will adhere to their Grievance Handling Guideline, which is included in ***Annex K***. The primary purpose of this grievance handling guideline is to establish a formal process allowing people, communities or groups to raise complaints regarding any impact related to activities of PTTEP or its subsidiaries, and also to ensure that these complaints are addressed and resolved in a timely manner.

Figure 8.1 shows a flow chart of PTTEP SA's Grievance Handling Procedure. Additional details and descriptions on the procedure can be found in the Grievance Handling Guideline in ***Annex K***.

Figure 8.1 PTTEP SA's Grievance Handling Procedure



8.8 STATEMENT OF COMMITMENTS

PTTEP SA will at all times comply fully with the commitments, mitigation measures, and plans that have been presented in this ESHIA Report.

PTTEP SA shall fully implement the EMP, all Project commitments, and conditions, and is liable to ensure that all contractors and subcontractors of the Project comply fully with all applicable Laws, including the Environmental Conservation Law (2012), Environmental Conservation Rules and Environmental Impact Assessment Procedure (2015), as well as the EMP, Project commitments and conditions.

PTTEP SA and ERM hereby confirm that:

(1) The ESHIA Report is accurate, consolidated and complete;

(2) The ESHIA has been conducted in accordance with relevant laws, including the EIA Procedure (2015).
(3) The Project will fully follow the commitments, mitigation measures and plans set out in this ESHIA Report.

Table 8.4 Monitoring Measures during the Seismic Survey

Environmental Factors	Monitoring Measures	Duration and Frequency of Monitoring	Location	Responsible Party
Environmental Resources				
1. Vibration	• Peak particles velocity (PPV) o Comparison with relevant vibration standards (i.e. DIN or Thailand Pollution Control Department Standard)	Once at distances of 15, 50, 120, 200 and 500 m from shot holes. Conducted prior to commencing seismic activities.	Project area	PTTEP SA
2. Groundwater Wells	• Record complaints and follow up on the outcome. • Record any damage to groundwater wells.	Throughout the Project period	Project area	PTTEP SA
Social Resources				
3. Land Use	• Record complaints and follow up on the outcome.	Throughout the Project period	Project area	PTTEP SA
4. Socio-Economy	• Record property damage and compensation. • Record any damage to hand dug oil wells and compensation.	Throughout the Project period	Project area	PTTEP SA
5. Historical and Archaeological Sites	• Records of damaged archaeological sites (if any).	Throughout the Project period	Project area	PTTEP SA
Health Resources				
6. Public Health and Safety	• Record any complaints related to public health and safety. • Record location, photograph and actions taken at all Misfire locations.	Throughout the Project period	Project area	PTTEP SA

Section 9

Public Consultation and Disclosure

9 PUBLIC CONSULTATION AND DISCLOSURE

9.1 METHODOLOGY AND APPROACH

In order to enhance stakeholder's understanding on the planned 2D and 3D seismic project activities, and obtain suggestions/concerns for developing appropriate mitigation measures, public consultation was conducted for this Project. The approach for public consultation was divided into six key steps, as shown in ***Table 9.1***.

Table 9.1 Approach to Public Consultation and Objectives

Step	Approach	Objective
1	Project Scoping	Identify key issues, and agree on assessment approach.
2	Stakeholder Identification	Identify potential concerns for the Project, and all potential stakeholders.
3	Stakeholder Verification	Verify and identify relevance of project stakeholders and design engagement strategy.
4	Public Consultation Plan	Develop public consultation strategy, participatory methodologies and plan.
5	Public Consultation Implementation	Conduct public consultation as per agreed approach.
6	Public Consultation Results and Disclosure Report	Describe actions necessary to implement mitigation measures identified during public consultation.

Public consultation is based on the stakeholders identified through the impact assessment process in the ESHIA for this Project. The potential impact/risks associated with these stakeholders were identified for each of the Project stages. The most critical stakeholders in the ESHIA stage were consulted and their feedback was integrated into the ESHIA report. This public consultation and disclosure section aims at building a positive public image, which is essential for maintenance of societal license.

9.1.1 *Project Scoping*

Project scoping is carried out to identify key issues, and to agree on an assessment approach. Scoping consists of review of Project information and key potential impact identification.

9.1.1.1 *Project Overview*

9.1.1.1(1) *Project Location*

The boundary coordinates of Block MOGE-3 are shown in ***Section 4 Table 4.2***, and a map of Block MOGE-3 is shown in ***Figure 4.4***.

The seismic lines are designed to verify the prospects in Block MOGE-3. After the data from these lines are acquired, it will be infield-processed and interpreted, and additional lines may be selected based on the results of the initial lines. The corner coordinates of the Project area are shown in ***Section 4 Table 4.3***, and an overview of the Project area is shown in ***Figure 4.5***.

The proposed seismic grid was designed based on available geological information; additional lines were also adjusted according to the terrain and geography conditions, based on topographical maps and information obtained from pre-survey scouting trips. The Project area covers almost the entire area of Block MOGE-3, with the exception of inaccessible mountainous areas, the Ayeyarwady River, and the military area in the center of the block.

Three townships are located within Block MOGE-3: Thayet Township, Kanma Township and Aunglan Township, however, only Thayet and Kanma are within the Project area.

9.1.1.1(2) Project Activities

The survey project comprises the following key activities:

1. Site Preparation Phase;
2. Seismic Survey Phase; and
3. Abandonment and Site Restoration Phase.

9.1.1.1(3) Project Implementation Schedule

Seismic Survey activities are expected tentatively to begin in September or October 2015. Seismic acquisition will be completed within 9 months after first shot record. The full project schedule is shown in ***Section 4 Figure 4.28***.

9.1.1.2 Potential Impacts

Based on the Project information above, the potentially significant impacts that might occur have been listed as follows (as assessed in ***Section 6***):

- Damage to land use for the duration of the project;
- Disrupt some of the hand-dug oil well and agricultural activities in the Project area;
- Dust, noise, vibration;
- Damage to crops and vegetation;
- Damage to nearby sensitive cultural/archaeological resources
- Quality of life of workers;
- Unplanned Event; and
- Environmental impact i.e. changing in soil, surface water, groundwater, flora and fauna.

9.1.2 *Stakeholder Identification and Verification*

Based on the potential impacts, groups of stakeholders who are likely to be directly impacted by the project were identified, as shown in ***Table 9.2***.

Table 9.2 Groups of Stakeholder Related to Potential Impacts

Potential Impacts	Relevant Groups of Stakeholder
• Damage to land use for the duration of the project	• Land Owner
• Disrupt some of the hand-dug oil well and agricultural activities in the Project area	• Hand-dug oil well investor, farmer and owner of agricultural area
• Dust, noise, vibration	• Communities
• Damage to crops and vegetation	• Owner of crops and vegetation
• Damage to nearby sensitive cultural/archaeological resources	• Township Administrative Officer • Religious groups
• Quality of life of workers	• Workers
• Unplanned Event	• Communities
• Environmental impact i.e. changing in soil, surface water, groundwater, flora and fauna	• Government agencies including MOGE, district officers and military officers • NGOs, • Academic Institute, • Environmental private organizations, • Mass media, and • Members of the Public

The targets of stakeholder verification were determined based on the communities potentially impacted by the project activities as follows:

- Community area overlapping the Project area;
- Agricultural area or land owners, including local people who potentially impacted by the project activities;
- A number of "hand-dug oil well" communities; and
- The presence of Military Industry.

From the stakeholder verification results, communities potentially impacted by the project activities are as follows:

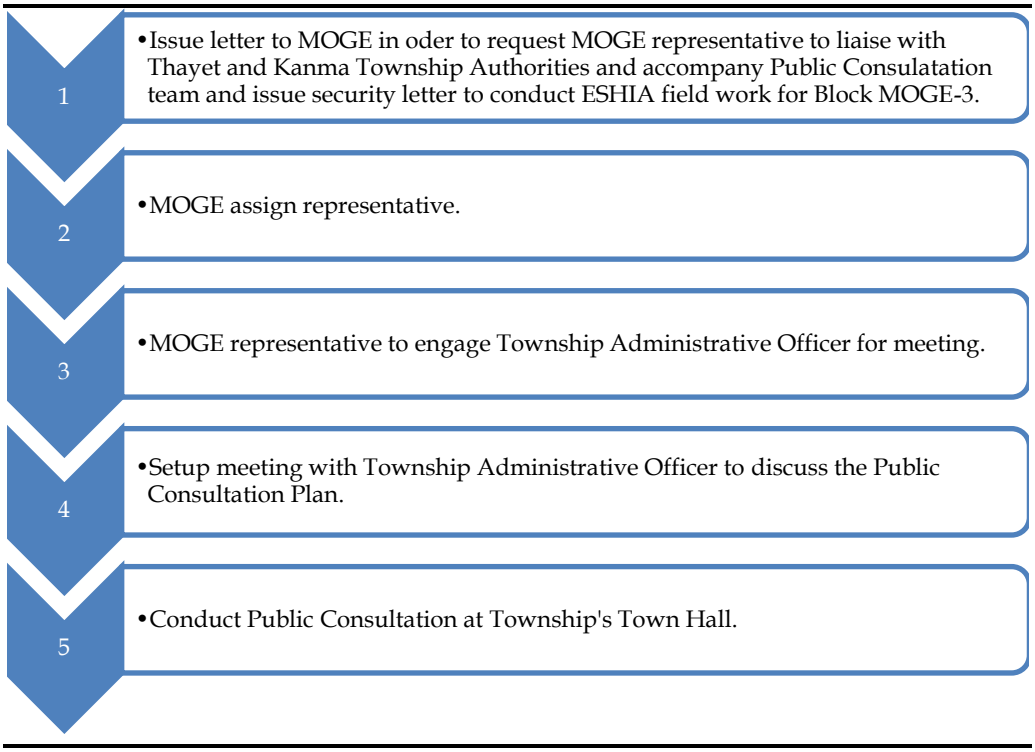
- Community area near the Project area in Block MOGE-3 to the south of Magway Region, in the dry zone of the central Myanmar lowlands, west of the Ayeyarwady River.
- Local people in Thayet and Kanma Townships who cultivate rice, chillies, beans and corn in river valleys and seasonal sandbars and cotton, beans and sesame in mountain valleys and uplands.
- "Hand-dug oil well" communities, which are a unique phenomenon in Magway Region.
- The presence of Military Industry within Thayet Township. It is a military zone, consisting of approximately 72 km^2, and located southwest of Sa Khan Gyi Village.

9.1.3 *Public Consultation Plan*

Public consultation was arranged by ERM, through local partner REM, with all key strategic stakeholders. Supervisory support was provided by PTTEP SA, and public consultation was conducted under Myanmar Oil and Gas Enterprise (MOGE)'s permission and direction.

The stakeholder engagement procedure for Block MOGE-3 was aligned with the consultation process highlighted in ***Figure 9.1***.

Figure 9.1 PTTEP SA's Public Consultation Process



Public consultation for the Project covered two townships within the Project area of Block MOGE-3, Thayet Township and Kanma Township. Public meetings were used to conduct public consultation for each Township.

The objectives of the public consultation meetings were to disseminate the results of the Project's environmental, social and health impact assessment and obtain concerns and suggestions regarding the Project's mitigation measures and monitoring program, to improve the Project's ESHIA Report.

9.1.4 *Public Consultation Implementation*

As part of the implementation process, it is important to clearly define the roles and responsibilities of those involved in the process. This helps to reduce confusion and increases the efficiency and effectiveness of the stakeholder engagement process.

Any commitments made to stakeholders during the engagement process should be followed-up. Not doing so can damage the existing relationship with the stakeholder.

All slides presented in Myanmar Language are presented in ***Annex H***.

9.1.5 *Public Consultation Results and Disclosure Report*

During Public Consultation, ERM maintained records (sign-up sheet, questions, answers, discussions, photos, etc.) to summarize into the ESHIA report and develop appropriate mitigation measures and monitoring programs to reflect public concerns/issues. Further details on disclosure of public consultation activities are provided in ***Section 9.5***.

9.2 *SUMMARY OF CONSULTATIONS AND ACTIVITIES UNDERTAKEN*

The public meetings were carried out as summarized below:

- Public consultation for Kanma Township on February 4th, 2015; and
- Public consultation for Thayet Township on February 5th, 2015.

A summary of the consultation activities is provided in ***Table 9.3***.

Table 9.3 Public Consultation Activity Implementation Details

Date, Time and Location	Stakeholders	Number of Participants
February 4th, 2015 at Meeting Hall, Kanma Township General Administration Office (10.00-12.00)	• Representatives from government agencies • Township authorities • Village heads • Village key people • Educational institute • NGOs • Mass media • Public	91 people
February 5th, 2015 at Meeting Hall, Thayet Township General Administrative Office (10.00-12.00)	• Representatives from government agencies • Township authorities • Village heads • Village key people • Educational institute • NGOs • Mass media • Public • Hand-dug oil well investor • District officers and • Military officers of MI-12 area	161 people

A list of participants' names and photos of meetings are presented in ***Annex H.***

9.3 RESULTS OF PUBLIC CONSULTATION

9.3.1 Comments/ Recommendations from the Public Consultation Meeting in Kanma Township, Magway Region

Comments and recommendations of stakeholders obtained from the public consultation meeting in Kanma Township are summarized in ***Annex H***. The main issues and clarifications related to the ESHIA study results are summarized in ***Table 9.4***.

Table 9.4 Comments/Recommendations and Clarifications from the Public Consultation Meeting in Kanma Township, Magway Region

Questions, Concerns and Recommendations	Clarifications
1. U Win Myint (*Township supporting committee*): Data presented should be organized in a single document, and two sets of hard copies should be shared with Township Administration Office.	Daw Hnin Pwint Lwin (*PTTEP SA*): Agreed to follow the suggestion.
2. U Toe Lwin (*Village Head*): Question regarding damage to land and crop and appropriate compensation. What is the compensation procedure for damage to ridge/dike over paddy fields?	U Tun Win (*PTTEP SA*): Explained methods and procedures for compensation.
3. U Thet Aung (*Village Head*): Questioned how the developer will operate in various type of lands e.g. Forest, Agricultural land etc.	U Khin Maung Kyi (*PTTEP SA*): Will inform in advance how, where and when the seismic exploration team will operate.

9.3.2 Comments/ Recommendations from the Public Consultation Meeting in Thayet Township, Magway Region

Comments and recommendations of stakeholders obtained from the public consultation meeting in Thayet Township are summarized in ***Annex H***. The main issues and clarifications related to the ESHIA study results are summarized in ***Table 9.5***.

Table 9.5 ***Comments/Recommendations and Clarifications from Public Consultation Meeting in Thayet Township, Magway Region***

Questions, Concerns and Recommendations	Clarifications
1. Capt. Thet Naing Win (*Defence Industry*): Will the seismic survey pass through any restricted areas? If there are plans to go through factory compound or other restricted areas, it is necessary to provide information in advance. We would like to know more about the seismic exploration area.	U Tun Win (*PTTEP SA*): There will not be passing through Factory compound but there would be condition to enter the outside area. It would be great if you can give access / permission for outside the factory compound.
2. U Maung Soe (*Pyitawgyi Ward*): Asked whether there would be explosions near religious buildings.	U Tun Win (*PTTEP SA*): No explosive operation will take place near religious buildings.
3. Officer (*Forest Department*): Raised concern that path and route seismic exploration should be informed in advance.	U Tun Win (*PTTEP SA*): We will surely inform in advance.
4. U Maung Gyi (*Township Reporter*): Will there be any damage to trees and forest because of explosive use in seismic exploration?	U Tun Win (*PTTEP SA*): There will be no damage to trees or forest due to exploration tasks.
5. U Myint Zaw (*Village Head, Talabar*): Will there be compensation for agricultural land without crops?	U Tun Win (*PTTEP SA*): There will be no crop-compensation if there is no crop, but there would be compensation for damage of paddy-field boundaries etc.

The implementation of the public consultation program achieved its goals in providing an opportunity for stakeholders to give opinions and recommendations on the Project. Opinions and recommendations obtained through public consultation have been used in the ESHIA study to help develop mitigation measures and monitoring programs on environmental, social and health impacts, are shown in ***Table 9.6***.

Table 9.6 Impact Issues, Opinions and Recommendations Obtained from Public Consultation Meetings, Including the Project's Mitigation Measures and Monitoring Programs

Impact Issues	Concerns/Recommendations from Public Consultation Meetings	Determined Mitigation Measures/Monitoring Programs
Socio-Economy	• Path and route of working in seismic exploration should be informed in advance	• Establish a public relations team in the Project area to build up and maintain good relationships with communities and to receive news, opinions, and suggestions from local people throughout the Project period. • Notify regional government and local representatives of townships about the Project schedule and the survey procedures. Inform land owners about the time and location of the survey at least two weeks in advance.
Land Use	• Damage to land and crop and appropriate compensation • Will there be compensation for agricultural land without crops?	• Compensation for agricultural or oil well damages or losses will be paid to land owners or crop owners under the supervision of Compensation Committee, after assessment and approval of land area and unit rate by the Committee. This will be done two weeks prior to the line survey.
Terrestrial Flora and Fauna	• Will there be any damage to trees or forest because of explosive use in seismic exploration?	• Avoid laying seismic lines near trees and large shrubs, including areas with forests, garden forests, or areas with rare species. The lines should offset these sensitive items according to the set minimum setback distances
Explosives Transportation	• Will the seismic survey pass through any restricted areas? If there are plans to go through factory compound or other restricted areas, it is necessary to provide information in advance.	• All operations using or transporting explosives shall conform to the rules and regulations defined in licenses issued by the Ministry of Defense. • Vehicles to be used in explosives transportation must be registered as explosives transport vehicles according to military regulations. Trailers are not allowed to be used for this purpose. Safety equipment, such as siren and portable fire extinguisher, etc. must be installed. • Notify regional government and local representatives of townships about the Project schedule and the survey procedures. Inform land owners about the time and location of the survey at least two weeks in advance.
Cultural and Archaeological Resources	• Will here be any explosion near religious buildings and archaeological sites etc.?	• Consider re-locating any shot holes that come within the recommended setback distance (***see Table 8.3 in Section 8***) of communities. • If it is unsure whether the sites found are archaeological sites or not, the survey team will offset the seismic lines away from the sites by at least 150 m following setback distances for archaeological aspects. The Project staff must set mitigation measures if the archaeological sites are found to be at risk from seismic survey.

9.4 FURTHER ONGOING CONSULTATIONS

The overall approach for ongoing public consultation is prepared following a cyclic process, described in ***Figure 9.2***.

Figure 9.2 Public Consultation Methodology

Further ongoing consultations will include, but not be limited to:

- Project must invite MOGE to observe the works and receive suggestions where necessary.
- Issue letter to MOGE in order to request MOGE representative to notify regional government and local representatives of townships about the Project schedule and the survey procedures. MOGE will assign representative and inform land owners about the time and location of the survey at least two weeks in advance.
- The contractor will seek permission from land owners in writing prior to proceeding.
- Establish a public relations team in the Project area to build up and maintain good relationships with communities and to receive news, opinions, and suggestions from local people throughout the Project period. Record complaints and follow up on the outcome.
- Formation of crop compensation committee and agreement on crop prices. Record compensation payments.

9.5 DISCLOSURE

The onsite Public Consultation was conducted once after the completion of the draft ESHIA report. Information from the draft ESHIA report was used to present to stakeholders during the Public Consultation meetings. Presentation/discussion topics included:

- Objective of Public Consultation;
- Introduction to MOGE and PTTEP SA organization;
- Overview of project description/information;
- Methodology of seismic activities;
- Sensitive existing environmental conditions;
- Key impact aspects;
- Proposed project mitigation measures and monitoring program; and
- Compensation.

Details on information dissemination before and after the public consultation meetings are detailed below:

- Before the activity: Information dissemination was carried out by mailing letters directly to MOGE prior to the public consultation meetings. Then, MOGE representative disseminated the Project's information to the Township Administrative Officer for a pre-engagement meeting. Letters issued by relevant organizations are provided in ***Annex H***.
- During the activity: Information dissemination during the Project's public consultation was carried out by media provided in ***Annex H***, and summarized as follows:
  - Slides and audio-visual materials; and
  - Video clip demonstration of seismic survey.
- After the activity: A summary of the results of the public consultation was disseminated by newspaper and Final ESHIA report upon the request from MOGE.

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