

**GEOHERMAL ENERGY UPSTREAM
DEVELOPMENT PROGRAM (GEUDP)
Waesano Geothermal Project
Environmental and Social Impact Assessment (ESIA)
Wae Sano Village, Sano Nggoang District
West Manggarai Regency, East Nusa Tenggara Province**



Maret 2019

GEUDP-WS-RPT-HSE-003 Rev 3 - Waesano ESIA

Abbreviation

ADHB	Current Market Prices / <i>Angka Dasar Harga Berlaku</i>
ADHK	Constant Market Prices / <i>Angka Dasar Harga Konstan</i>
AHP	Analytical Hierarchy Process
AMDAL	Environmental Impact Assessment / <i>Analisis Mengenai Dampak Lingkungan</i>
Aoi	Area of Interest
BAPEDAL	Environmental Impact Management Agency / <i>Badan Pengendali Dampak Lingkungan</i>
BAU	Business-as-Usual
BCM	Business Continuity Management
BFS	Bankable Feasibility Study
BIG	Geospatial Information Agency / <i>Badan Informasi Geospasial</i>
BKSDA	Natural Resources Conservation Agency / <i>Badan Konservasi Sumber Daya Alam</i>
BLHD	Regional Environmental Agency / <i>Badan Lingkungan Hidup Daerah</i>
BMKG	Meteorology, Climatology and Geophysics Agency / <i>Badan Meteorologi, Klimatologi dan Geofisika</i>
BOD	Biochemical Oxygen Demand
BOP	Blow Out Preventer
BPN	National Land Agency / <i>Badan Pertanahan Nasional</i>
B3	Hazardous Waste / <i>Bahan Beracun Berbahaya</i>
CEMP	Construction Environment Management Plan
CBS	Central Bureau of Statistic / <i>Badan Pusat Statistik</i>
CCT	Conditional Cash Transfers
CDCR	Community Development and Community Relation
CH	Critical Habitat
CMP	Construction Management Plan
COD	Chemical Oxygen Demand
CSR	Corporate Social Responsibility
Ditjen EBTKE	Directorate-General of New Energy, Renewable Energy and Energy Conservation / <i>Direktorat Jenderal Energi Baru Terbarukan dan Konservasi Energi</i>
DO	Dissolved Oxygen
DSL	Decent Standard of Living / <i>Kebutuhan Hidup Layak</i>
EHSG	Environmental, Health and Safety Guideline
ESAP	Environmental and Social Impact Action Plan
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESS	Environmental Social Safeguard
GEUDP	Geothermal Energy Upstream Development Project
GHG	Greenhouse Gas
GIS	Geographical Information System
GOI	Government of Indonesia
GR	Government Regulation

GRDP	Gross Regional Domestic Product
GRM	Grievance Redress Mechanism
HDI	Human Development Index
HSE	Health, Safety and Environment
IBA	Important Bird Area
IIFF	Indonesia Infrastructure Facility Fund
ILO	International Labor Organization
IPLT	Municipal Waste Treatment Facility / <i>Instalasi Pengolahan Lumpur Tinja</i>
IUCN	The International Union for Conservation of Nature
JKN	National Health Insurance / <i>Jaminan Kesehatan Nasional</i>
KIP	Smart Indonesia Card / <i>Kartu Indonesia Pintar</i>
KIS	Health Indonesia Card / <i>Kartu Indonesia Sehat</i>
KK	Head of Family / <i>Kepala Keluarga</i>
LARAP	Land Acquisition and Resettlement Action Plan
LER	Life Expectancy Rate
MEMR	Ministry of Energy and Mineral Resources
MKJI	Indonesia Highway Capacity Manual / <i>Manual Kapasitas Jalan Indonesia</i>
MOE	Ministry of Environment
MOF	Ministry of Finance
MW	Mega Watts
NCG	Non-Condensable Gases
NTT	East Nusa Tenggara / <i>Nusa Tenggara Timur</i>
OHS	Occupational Health and Safety
OP / BP	Operational Policy / Bank Procedures
OUR	Open Unemployment Rate / <i>Tingkat Pengangguran Terbuka</i>
PAPs	People Affected by Project
PCPD	Public Consultation and Public Disclosure
PIIM	Project Induced In Migration
PKH	Family Hope Programme / <i>Program Keluarga Harapan</i>
PLN	State Electricity Company / <i>Perusahaan Listrik Negara</i>
PLTP	Geothermal Power Plant / <i>Pembangkit Listrik Tenaga Panas Bumi</i>
PMU	Project Management Unit
PNS	Civil Servant / <i>Pegawai Negeri Sipil</i>
PPE	Personal Protective Equipment
RASKIN	Rice for Poor Program
RIDF	Regional Infrastructure Development Fund
RKL	Environmental Management Plan / <i>Rencana Pengelolaan Lingkungan</i>
RPL	Environmental Monitoring Plan / <i>Rencana Pemantauan Lingkungan</i>
RTM	Poor Household / <i>Rumah Tangga Miskin</i>
RTSM	Very Poor Household / <i>Rumah Tangga Sangat Miskin</i>
RTRW	Spatial Plan / <i>Rencana Tata Ruang Wilayah</i>
RUPTL	Electricity Procurement Business Plan / <i>Rencana Usaha Penyediaan Tenaga Listrik</i>
SAW	Simple Additive Weighting
SD	Elementary School / <i>Sekolah Dasar</i>
SEHEN	Energy Saving Lamps / <i>Super Ekstra Hemat Energi</i>

SMA	Senior High School / <i>Sekolah Menengah Atas</i>
SMI	<i>Sarana Multi Infrastruktur</i>
SMT	Site Management Team
SOP	Standard Operational Procedure
SPR	School Participation Rate / <i>Angka Partisipasi Sekolah</i>
SWMP	Solid Waste Management Plan
TBAAs	Traditional Birth Attendants
TDS	Total Dissolved Solid
TLPC	Toxicity Characteristic Leaching Procedure
VTMP	Vehicle & Traffic Management Plan
TPA	Final Disposal Area / <i>Tempat Pemrosesan Akhir</i>
TPS	Temporary Waste Storage / <i>Tempat Pembuangan Sementara</i>
TSS	Total Suspended Solids
UKL	Environmental Management Effort / <i>Upaya Pengelolaan Lingkungan</i>
UMR	Regional Minimum Wage / <i>Upah Minimum Regional</i>
UPL	Environmental Monitoring Effort / <i>Upaya Pemantauan Lingkungan</i>
WB	World Bank
WKP	Geothermal Work Areas / <i>Wilayah Kerja Panas Bumi</i>
WOR	Work Opportunity Rate / <i>Tingkat Kesempatan Kerja</i>
WPR	Workforce Participation Rate / <i>Tingkat Partisipasi Angkatan Kerja</i>

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1. Introduction

This Environmental and Social Impact Assessment (ESIA) assesses the activities to be undertaken by PT Sarana Multi Infrastruktur (PT SMI) for proposed geothermal exploration activities at Wae Sano Village in Flores Island – East Nusa Tenggara Province, Indonesia. PT SMI is the implementing agency for the Geothermal Energy Upstream Development Project (GEUDP – hereafter referred as “the Project”), which is a government-sponsored exploration drilling program in partnership with the World Bank within the Geothermal Infrastructure Facility (GIF) and based on the SMI Assignment from the Ministry of Finance (MoF) of the Republic of Indonesia. MoF and Ministry of Energy and Mineral Resources (MEMR) will exercise an overall oversight function over PT SMI and play an important role in terms of overall geothermal development coordination, respectively. The Directorate General of New Energy, Renewable Energy and Energy Conservation (EBTKE) will be responsible for setting the principles for site selection and facilitating the tendering process for the geothermal area (*Wilayah Kerja Pertambangan* or WKP) after exploration drilling has produced sufficient evidence of the productivity of geothermal resources and viability for further investments. *Badan Geologi*, the Geological Agency of Indonesia, will support project implementation through supplying geological data on the subproject candidates.

The program is focused on green field areas in the eastern part of Indonesia. Based on a recommendation from the MEMR, the first site was proposed at Wae Sano Village in the Flores islands. This activity is intended to accelerate renewable energy development in Indonesia and to promote sustainable development in the energy sector. This activity must consider environmental and social impacts.

The ESIA covers exploration activities including early civil works that are required to prove the status of geothermal resources prior to exploitation activities. The Project is still in the planning phase and layouts and operations may change according to the ongoing evaluation. The ESIA has looked at the impacts from the landscape perspective as well as reviewing and assessing the social and environmental impacts of early layout options. The nature and scale of the exploitation phase, including energy generation and transmission, will not be well understood at the time of the preparation of this ESIA. However the impacts will be considered as part of the project’s future area of influence. AECOM provides a screening of sensitive receptors and potential impacts and benefits based upon a generic exploitation scenario developed with the technical team.

The following sections provide an overview of the Waesano¹ Geothermal Exploration project activity, the objectives of this ESIA, and the structure of this document.

1.1. General

Indonesia is situated on the Pacific ‘Ring of Fire’ which creates a pattern from Sumatera, Java, Bali, Nusa Tenggara, Maluku to the north of Sulawesi and holds significant geothermal power potential. The Geological Agency of Indonesia estimates that Indonesia holds some 28,500 Mega Watts [MW] of geothermal resources. Given the need for new sources of energy to meet Indonesia’s growing demand, and the benefits of geothermal as an indigenous, renewable and environmentally-friendly energy source, the Government of Indonesia has set ambitious targets for geothermal development. However, the use of geothermal resource for power generation up until September 2016 only reached 1,513.5 MW, compared to 2006 at 852 MW².

Geothermal energy upstream development is expected to contribute to a 29% reduction of Green House Gas (GHG) emission by 2030, compared to the emission projection based on the Business-as-Usual (BAU) scheme. Therefore, the Government of Indonesia has set an ambitious target to increase the geothermal contribution for power generation to be 8% in 2025 based on MEMR Decree No. 5899 K/20/MEM/2016 regarding Issuance of Electricity Procurement Business Plan (RUPTL) of PT Perusahaan Listrik Negara (Persero) 2016-2025 (Minister of Energy and Mineral Resources, 2016).

Currently, Indonesia has 69 geothermal work areas (WKP) which are expected to meet the target of 7,239 MW of power produced by Geothermal Power Plants (PLTP) in 2025. One of the potential areas is Flores Island, which

¹ According to Statistical Center of Bureau (*Badan Pusat Statistik*), the written form of this village uses 2 words which are “Wae Sano”. However, the name of project will use is “Waesano” as one word.

² <http://www.ebtke.esdm.go.id/post/2016/11/10/1428/bisnis.panas.bumi.indonesia.masih.menarik.investor>

will be defined as Flores Geothermal Island³ by the Government of Indonesia through the MEMR in the near future. Flores Island has geothermal potential of 659 MW and geothermal resources of 745.5 MW. Flores Island currently suffers from electricity shortage by as much as 8.5 MW from the actual electricity demand, which is 13.5 MW⁴.

PT SMI is planning to implement GEUDP in the vicinity of Wae Sano and Sano Nggoang Villages, Sano Nggoang Sub-District, West Manggarai Regency, Flores Island – East Nusa Tenggara. As of yet, the steam field remains largely unexplored; however, it is expected that the main project will initially develop 10 – 32 MW of generating capacity. PT SMI has identified a primary commercial prospect area in the Sano Nggoang Sub-District.

Once the project moves to the production phase, it will include production wells, steam pipelines, separator stations, power generation facilities and reinjection wells. Early civil works will be required for the construction of access roads, well pads, pipelines and a base camp, as described in detail in **Section 3**.

The Project is currently seeking for government approval through the Republic of Indonesia legal process to assess environmental and social impacts and risks of the exploration phase of the project in the form of the Environmental Management Effort (UKL) and Environmental Monitoring Effort (UPL). This ESIA is developed in parallel with the UKL-UPL process, and has been prepared to reflect the requirements of the World Bank Safeguard Policies. PT SMI has implemented compliance with these guidelines to meet industry best practices.

This ESIA represents and assesses activities specific for the exploration phase of the Waesano Geothermal Exploration project activity.

1.2. Project Location

Administratively, the Waesano geothermal exploration prospect is located in Sano Nggoang sub-district, West Manggarai regency, Flores Island, East Nusa Tenggara province, Indonesia. With an area of 10 km², it is located in an area surrounding Lake Sano Nggoang, which is a crater lake of sulphur with a diameter of 2.5 km in the centre of Mount Waesano, located in the southwest of Flores Island. The lake is surrounded by three villages of Sano Nggoang Sub-District including Wae Sano, Sano Nggoang and Pulau Nuncung Village, on the southwest corner of Flores Island. At a maximum depth of 500 m, this lake is the deepest and largest volcanic lake in Eastern Indonesia. Geographically the site's coordinates are 8° 38' 26" - 8° 45' 26" SL and 119° 56' 41" - 120° 05' 02" EL (Figure 1-1).

1.3. Project Objective and Outline

The overall objective of the exploration phase of the Waesano geothermal site is to prove the viability of geothermal resources in Flores Island, after which a Bankable Feasibility Study (BFS) for the overall project would be completed. The exploration phase of the project will require early civil works including the construction of well pads, injection well pads, roadway corridors, pipeline corridors, and a base camp. Activities that may result in significant environmental, social or health impacts during activities for exploration phase of the project include:

- Permitting and field survey;
- Land acquisition;
- Workforce recruitment;
- Equipment and material mobilization;
- Land clearing and preparation;
- Access road improvement;
- Well pad and infrastructure development;
- Exploration drilling;
- Well testing;
- Site closure; and

³ <http://prodaya.com/indonesia-segera-tetapkan-flores-geothermal-island/>

⁴ <http://www.ebtke.esdm.go.id/post/2016/11/03/1413/7.239.mw.dari.69.wkp>

- Site rehabilitation and revegetation.

Details of these early civil works, together with a description of the main project, are provided in Section 3 of this ESIA.

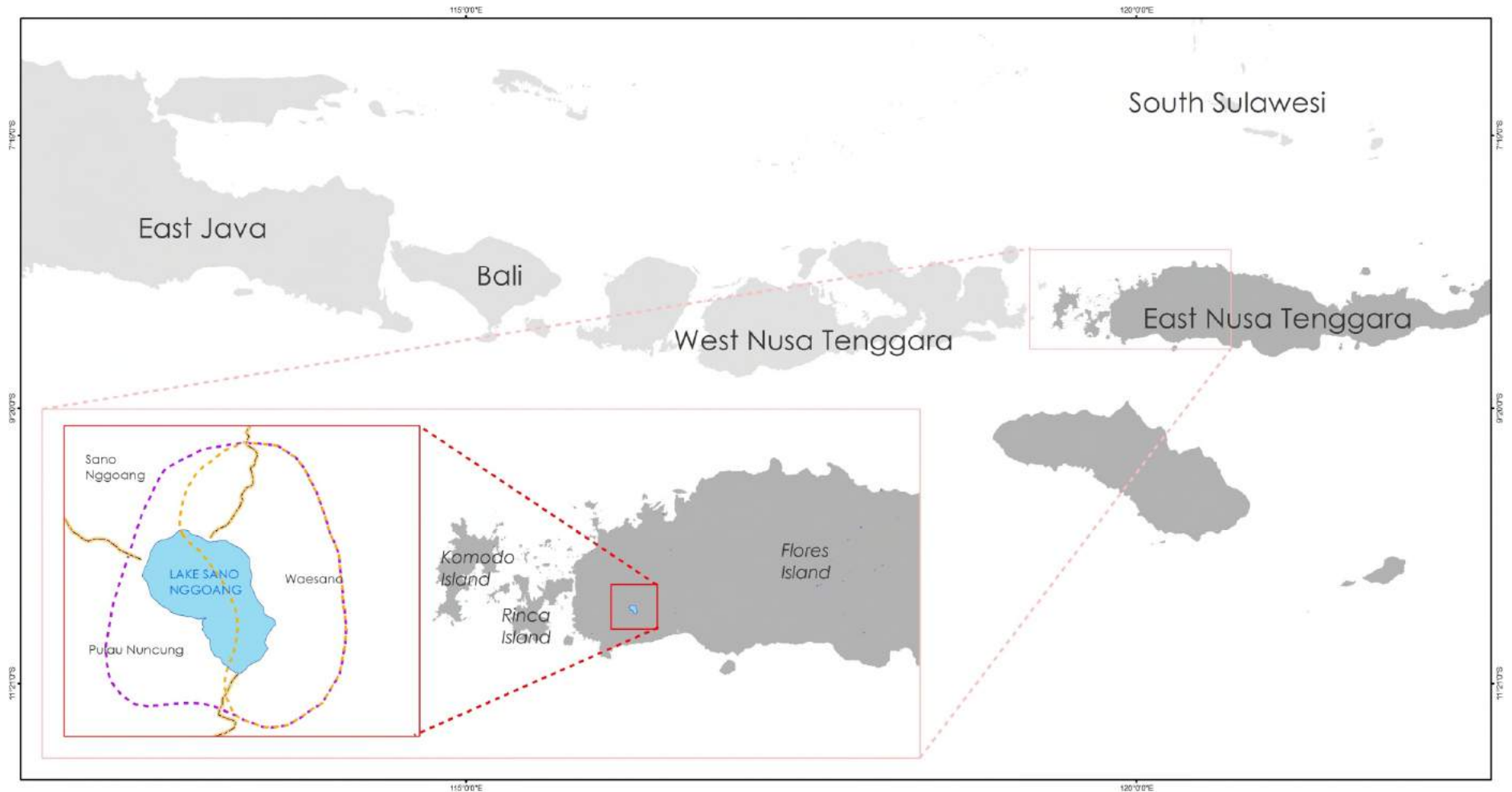


Figure 1-1 Proposed Location of Waesano Geothermal Exploration Project

1.4. Project Background and Current Status

Of note, the engineering design and feasibility study of the Project was still undergoing of completion at the time this ESIA is developed, resulting to numerous changes of the Project Description since April 2016 to the latest information received by AECOM in January 2018. Selected locations for well pads were confirmed after joint-walkthrough with representative of local community on 14 May 2018 and 2nd ESIA disclosure on 15 May 2018. These project design changes are recorded in the Section 3.4 Project Justification and Alternatives, of this document. However the baseline information and assessment of impacts are written mainly based on the primary data gathered during baseline survey, as described in the Section 4 Environmental and Social Impact Assessment Process, referring the Project Description information available prior to the survey on November 2017.

1.4.1. Project Components

Exploration well drilling activities will commence after the environmental documents have been approved by the Environmental Agency of West Manggarai Regency and the Environmental Permit is issued by the Regent of West Manggarai Regency. There will be a series of activities that take place, including:

- Permitting;
- Field surveys and geotechnical investigations;
- Detailed design;
- Land Acquisition;
- Civil works and Construction;
- Well Drilling;
- Well Testing;
- Capping and closure; and
- If not required for future use, demolition and rehabilitation.

It is expected that these activities will span approximately 35 months. Detailed Project timeline is seen in **Appendix F**.

The exploitation is a separate development phase that will not be part of the Waesano geothermal exploration project. For the ESIA, a generic exploitation scenario will be developed with the technical team. Based on the scenario, AECOM provides a screening of sensitive receptors and potential impacts and benefits. The timeline for exploitation phase will not be well understood at the time of the preparation of the ESIA until the feasibility study was completed.

1.4.2. Environmental and Social Impact Assessment

For the exploration phase, PT SMI requested that an ESIA is carried out in compliance with the World Bank Safeguard Policies. Further requirements of the exploration ESIA include:

- Undertaking a gap analysis to determine the scope of further environmental and social impact studies needed to ensure compliance with World Bank Safeguard Policies;
- Undertaking necessary supplemental baseline studies in support of the required impact assessments; and
- Production of this ESIA, integrating all baseline and impact assessment documents.

1.5. Exploration ESIA Objectives

Early civil works for the exploration phase of the Waesano Geothermal Exploration Project are significant project components that have the potential to result in environmental and social impacts. The main objectives for the ESIA are to assess the environmental and social risks of this phase of the project. Furthermore, the ESIA identifies measures to avoid, minimize, mitigate, and monitor these risks.

The broad goal of this effort is to confirm compliance of the exploration phase of the project with various environmental and social guidelines and standards. These include:

- Relevant World Bank Group environmental and social guidelines;
- Applicable local laws and regulations;
- Other international benchmarks and standards.

The Scope of Work for this ESIA study is designed to meet the following specific objectives:

- Characterize the proposed Project's environmental, social, health and safety aspects and impacts, develop relevant and realistic mitigation measures, and compile a robust Environmental and Social Management Plan (ESMP);
- Carry out an evaluation based on a comprehensive review of existing environmental and social information and documentation (UKL/UPL);
- Assess the Project's compliance with requirements under the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines); and
- Advise the Project Proponents on compliance with any other relevant environmental policies and guidelines.

This document has been prepared to be read as a stand alone document (i.e. it does not need to be read in conjunction with the UKL/UPL approved by the Republic of Indonesia). It has been structured and prepared with reference to the World Bank's safeguard policies and procedures triggered for the proposed Waesano Geothermal Exploration Project including:

- OP/BP 4.01 on Environmental Assessment;
- OP/BP 4.04 on Natural Habitats, since project interventions including drilling and access roads are near (or possibly within) protected areas including conservation areas and the unique acid lake environment, for which provisions of appropriate conservation and mitigation measures will be necessary during works;
- OP/BP 4.11 Physical Cultural Resources as a precautionary measure (some local cultural resources have been identified during scoping study);
- OP/BP 4.36 Forests, since forested areas may be part of the future project area of influence;
- OP/BP 4.12 on Involuntary Resettlement. If land acquisition is needed it is likely to be on a willing buyer /willing seller basis, but there may be some involuntary land purchases for road alignments, or future restrictions on access to forest resources, in the exploitation phase); and
- Policy OP 4.37 Safety of Dams is triggered due to the requirement for settling ponds and the safety issues relating to pond failure, or working in and around the ponds.

World Bank safeguard policies insist that the entire area of influence is assessed in this ESIA. In the Waesano Geothermal Exploration Project, the area of influence includes the extent of the impacts in the exploitation phase, even though this phase will be in the future and not funded under this project.

1.6. Exploitation Impact Screening Objectives

The main objectives of the screening of potential impacts during the exploitation phase is to identify potential show stoppers in the form of impacts that are not consistent with Indonesian laws or WB policies. It is to identify significant impacts that will require significant investigation and mitigation that may take time or be expensive to execute. All of this contributes to well informed, appropriate development recommendations at the end of the exploration phase. It was understood that the nature and scale of the exploitation phase, including energy generation and transmission, will not be well understood at the time of the preparation of this ESIA. Therefore, the approach to evaluating potential future exploitation is to develop a generic exploitation scenario together with the technical team for considering the project's impacts and future area of influence.

1.7. The Structure of the ESIA

Early civil works associated with exploration activities are required in preparation for the implementation of the main project. These early works will not be undertaken until an assessment of their environmental and social impacts has been completed and management plans for mitigation strategies are put in place through an ESMP that will be developed as part of this document. This ESIA has been arranged in one volume, organized in the following sections:

Section 1 – Introduction

Section 2 – Legislation and Relevant Standards

Section 3 – Project Description

Section 4 – Environmental and Social Impact Assessment Process

Section 5 – Stakeholder Engagement and Consultation

Section 6 – Environmental and Social Baseline

Section 7 – Potential Environmental Impacts and Mitigations

Section 8 – Potential Social Impacts and Mitigations

Section 9 – Cumulative Impacts

Section 10 – Exploitation Impact Screening

Section 11 – References

2. Legislation and Relevant Standards

2.1. Introduction

Legislation, guidelines, standards, documents and regulations listed in the following sections have been referred to during the preparation of this ESIA.

2.2. Indonesia Legislation

At the national level, the Government of Indonesia (GOI) promulgated Presidential Regulation Number 14 of 2017 on the Acceleration of Electricity Infrastructure Development and its amendment the Presidential Regulation Number 4 of 2016, and Law Number 21 of 2014 on Geothermal, to replace the Geothermal Law Number 27 of 2003. The 2014 Geothermal Law addresses the major issues impeding Indonesia's geothermal resources development that included the inappropriate and conflicting regulations that have created uncertainty over its implementation. These include removing geothermal undertakings as a mining activity and improved the structure of geothermal transactions. The 2014 Geothermal Law provides improvements to some of the issues that have hindered geothermal projects in Indonesia, namely distribution of authority of government institutions over direct and indirect use of geothermal resources, licensing procedures and resolving forestry issues in geothermal development. These include improved processes and procedures for tender of working areas and direct utilization licenses. Further, the declassification of geothermal as a "mining activity" allows greater latitude for the geothermal development in the protected and conservation forests.

The Regulation establishing the GEUDP scheme to PT SMI is the Ministry of Finance Regulation No. 62/PMK.08/2017 concerning Fund Management of Infrastructure Financing for the Geothermal Sector (PISP), which calls for the provision of geothermal data and information on behalf of the Ministry of Energy and Mineral Resources.

Refer to Director General of Fund and Risk Management, the Ministry of Finance Letter No. 34/PR/2018, PT Sarana Multi Infrastruktur (PT SMI), a state owned enterprise under the Ministry of Finance is assigned to conducting exploration drilling of Wae Sano area on behalf of the Indonesian Government using funds jointly provided by the Indonesia Government and the World Bank under the Geothermal Energy Upstream Development Project (GEUDP) fund. The Waesano is one of the prospective geothermal areas of government drilling scheme proposed by the Ministry of Mineral and Energy Resources (MEMR) under the MEMR letter No. 9553/03/MEM.E/2017. At regional level, the government of East Nusa Tenggara Province stipulates regulations on hydrology, watershed areas and spatial planning, while the government of West Manggarai Regency stipulates regulations on solid waste management and regency spatial planning.

Based on Law Number 32/2009 regarding Environmental Protection and Environmental Management and based on Minister of the Environment Regulation Number 05/2012 regarding Types of Business and/or Activities Mandated to Undertake Environmental Impact Assessment (AMDAL), the geothermal exploration in Waesano is not required to have an AMDAL document; instead, the activities should undertake a study on Environmental Management and Environmental Monitoring Efforts known as a UKL-UPL in Indonesia.

For land acquisition, the Project requires areas of land in Sano Nggoang Sub-district for the development of well pads and a number of supporting facilities such as an access road, lay down area, construction camp, etc. There are three (3) schemes to acquire the land and compensation: lease with right to purchase on private land; lease agreement on forestry land; and acquired land for access road improvement. The land tenure scheme on the protected forest area is based on Law Number 41/1999 regarding Forestry Land and Minister of Environment and Forestry Regulation No. Nomor P.27/MenLHK/Setjen/Kum.1/7/2018 regarding Borrow and Use Permit Guideline.

The numerous relevant national regulations including laws, Government Regulations (GR), presidential decrees, ministerial decrees, ministerial regulation, head of BAPEDAL (Environmental Impact Management Agency) decrees, and regional regulations of East Nusa Tenggara Province and West Manggarai Regency are listed in **Appendix D**. These regulations ensure that all major development activities can be managed sustainably with regards to environmental protection and conservation.

2.3. International Legislation

2.3.1. World Bank Safeguard Policies and Procedures

This ESIA was undertaken in accordance with the World Bank Safeguard Policy OP 4.01 on Environmental Assessment. The World Bank Safeguard Policy on Environmental Assessment categorises projects depending on the type, location, sensitivity, scale of the project and the nature and magnitude of its potential environmental impact. Under this system, the exploration phase assessed in this document would be a Category B project, defined as "a proposed project with potential limited adverse environmental or social risks and/or impacts on human populations or environmentally important areas that are site-specific, mostly reversible, and can be readily addressed through mitigation measures".

There are six out of ten Operational Manuals (OP/BP) under World Bank Environmental and Social Safeguard Policies that will be considered for the proposed Waesano Project including:

- OP/BP 4.01 on Environmental Assessment;
- OP/BP 4.04 on Natural Habitats, since project interventions including drilling and access roads are near (or possibly within) protected areas including conservation areas and the unique acid lake environment, for which provisions of appropriate conservation and mitigation measures will be necessary during works;
- OP/BP 4.11 Physical Cultural Resources as a precautionary measure, no known resources have been identified during screening;
- OP/BP 4.12 on Involuntary Resettlement. If land acquisition is needed it is likely to be on a willing buyer / willing seller basis, but there may be some involuntary land purchases for road alignments, or future restrictions on access to forest resources, in the exploitation phase;
- OP/BP 4.36 Forests since the forested areas may be part of the future project area of influence; and
- Policy OP 4.37 Safety of Dams is triggered due to the requirement for settling ponds and the safety issues relating to pond failure, or working in and around the ponds.

World Bank Safeguard Policies require that the entire area of influence is assessed in an ESIA report. In the Waesano Geothermal Exploration Project, the area of influence includes the extent of the impacts in the exploitation phase, even though this phase will be in the future and is not funded under this project.

The environmental elements that are required to be included in an ESIA (and the extent to which they are defined) are determined within the World Bank OP/BP 4.01 on Environmental Assessment. The screening and scoping process will consider these guidelines in the context of the proposed development, the geography and prevailing environmental conditions, to determine the extent and level of detail required to provide appropriate baseline information to underpin an ESIA.

2.3.1.1. Labor Influx Guidance Note

A key objective of the World Bank's environmental and social safeguard policies is to help avoid, minimize or mitigate adverse impacts of its projects on people and the environment. Bank-financed investment projects often involve construction of infrastructure civil works for which the required labor force and associated goods and services cannot be fully supplied locally. The migration to and temporary settlement of laborers in the project, referred to as *labor influx*, carries an array of potentially positive and negative impacts in terms of demands on public infrastructure, utilities, housing and sustainable resource management and the strain on social dynamics.

A guidance note for staff "Managing the Risks of Adverse Impacts on Communities from Temporary Project Induced Labor Influx" was issued by December 1, 2016, and disseminated to all World Bank operational staff. The primary objective of this guidance note is to ensure that World Bank staffs understand that temporary labor influx for Bank-supported construction works clearly is a project related impact that needs to be assessed and managed. The key principles to properly assessing and managing the risks of adverse impacts on communities that may result from temporary project induced labor influx include:

- Reduce labor influx by tapping into the local workforce. Depending on the size and the skill level of the local workforce, a share of the workers required for the project may be recruited locally;
- Assess and manage labor influx risk based on appropriate instruments, such as a Labor Influx Management Plan that addresses specific activities that will be undertaken to minimize the impact on the local community and a Workers' Camp Management Plan that addresses specific aspects of the establishment and operation of a workers' camp;
- Incorporate social and environmental mitigation measures into the civil works contract.

Finally, this guidance note explicitly addresses the sensitive issue of “fraternization” of the incoming labor force and makes practical suggestions for projects to proactively address the associated risks. The influx of workers and followers can lead to adverse social and environmental impacts on local communities, especially if the communities are rural, remote or small. These potential impacts have been identified. Once the contractor is appointed and the contractor decides on sourcing the required labor force, the mitigation plan will refer to the ESMP.

The project proponent will be required to establish civil works contracts that they manage with a view to (i) the size and characteristics of any labor influx; (ii) the existence and implementation of any mitigation measures in the Environmental And Social Management Plan (ESMP); and (iii) whether problems identified in the ESMP or similar to those arising under the Waesano project have arisen, or are likely to do so. Where needed, project-specific action plans responding to the findings of this review will be prepared and implemented.

2.3.1.2. World Health Organization (WHO) Guidelines

All air quality parameters measured during the monitoring period will be compared to the WHO's standards. Except for NH_3 and H_2S , values for the WHO standards are taken from Air Quality Guidelines Global Update (WHO, 2005). Interim targets (IT-1, IT-2, IT-3) are provided for some parameters in recognition of the need for a staged approach to achieving the recommended guidelines. For NH_3 and H_2S the standards are taken from WHO Air Quality Guidelines for Europe (WHO, 2000).

As for noise, values measured during the monitoring period will be compared to the WHO's standards taken from Occupational and Community Noise (WHO, 2001). In this document, the noise standards were provided in two terms i.e. daytime (L_d) and night-time noise (L_n). L_d is the A-weighted equivalent continuous sound pressure level measured from 7.00 am to 10.00 pm and L_n is measured from 10.00 pm to 07.00 am.

2.4. Corporate Requirements

PT SMI has extensive experience in managing the World Bank and other donors' safeguards policies under the Investment Guarantee Fund (IGF), Indonesia Infrastructure Facility Fund (IIFF) and the Regional Infrastructure Development Fund (RIDF). PT SMI is an infrastructure financing company established in 2009 as a state-owned enterprise (SOE) wholly owned by the GoI through the Ministry of Finance (MOF). PT SMI plays an active role in facilitating infrastructure financing, as well as preparing projects and serving in an advisory role for infrastructure projects in Indonesia.

PT SMI has developed a specific Operations Manual and Environmental and Social Management System (ESMS) for use on its programs supporting local government investments through various infrastructure funds. PT SMI's ESMS is based on the country system (i.e. Indonesian regulations). There are some guidelines that have been issued by PT SMI related to Environmental Social Safeguard (ESS), such as ESMS for Project, ESS for Multilateral requirements and currently is developing the ESS guidelines for Corporate level. All that guidelines has been covered about land acquisition, Health and Safety, and Indigenous Peoples and has been complied with International Safeguards Policies (WB, ADB, IFC).

The ESMS is overseen by the Environmental Social and Advisory Evaluation (ESAE) Division under the Risk Management Directorate. This ESAE Division is headed by an experienced team leader. Along with a small team of environmental and social specialists, PT SMI has committed to expand the ESAE Division and hire more environmental and/or social safeguard specialists in the near future to strengthen the ESAE Division. PT SMI has ready access to environmental and social consultants through its Project Advisory Division.

The Health, Safety and Environment Policy of PT SMI ensure a safe work place for all PT SMI employees and contractors to carry out their work without risk to themselves, others or the environment. When there is potential to cause injury or a negative environmental impact to people or the environment, PT SMI will identify and reduce risks as low as reasonably practicable as well as support the recovery and restorative of employees in the event of a work accident. PT SMI encourages energy and resource efficiency as well as reduction of waste, emissions and pollution prevention.

PT SMI's Environmental Protection Policy states that any activity that has the potential to impact the environment is managed in a responsible, proactive and risk management based approach. PT SMI has made a commitment to comply with all local Indonesian environmental legislative requirements and ensure all employees and contractors are aware of this commitment. PT SMI will minimize the disturbance to local flora and fauna, and prevent land, water and air pollution.

Environmental and Social Management Framework (ESMF)

In addition to the ESMS, PT SMI has been approved an ESMF for all of their Geothermal Energy Upstream Development Project (GEUDP) to provide reference and guidance for the project management staff, consultants, and other related parties participating in the GEUDP on a set of principles, rules, procedures and institutional arrangements to screen, assess, manage and monitor the mitigation measures of environmental and social impacts of the investments. The purpose of the ESMF is to ensure that all stakeholders involved in the project comply with the requirements, procedures and regulations related to environmental management in accordance to prevailing Government of Indonesia regulations and supplemental provisions in compliance with relevant World Bank Safeguard Policies.

3. Project Description

3.1. Project Overview

The Waesano Project will cover the exploration phase of geothermal development, including site selection, permitting and field survey, land acquisition, workforce recruitment, land clearing and preparation, equipment and material mobilization, access road improvement, infrastructure and well pad development, exploration drilling, well testing, site closure, and site rehabilitation and revegetation. Currently, the exploration activities will be carried out in a maximum area of 1.5 ha for slimhole well pad and 3.5 ha for standard hole well pad with the depth of each well reaches 1,500 – 2,500 meters.

The Project is planning 2 phases for drilling. Phase 1 will include three slimhole drillings selected at Well Pad A, B, or E. The scope of activities in Phase 2 will include one standard hole drilling at any selected well pad after Phase 1 is completed. Alternative locations for well pad are prepared to anticipate the Project change. The flow of overall Project sequent is illustrated in Figure 3-2. The baseline survey and assessment of this ESIA were conducted based on this information. In addition, the sensitivity analysis was conducted based on additional consultation with the community at the end of March 2017 and during a second site survey in November 2017 (see **Section 6.7**). Further consultation will be conducted prior to land acquisition process.

The selected well pads and supporting facilities based on project description information per 22 December 2017 and results of walkthrough on 14 May 2018 are listed in the following Table 3-1.

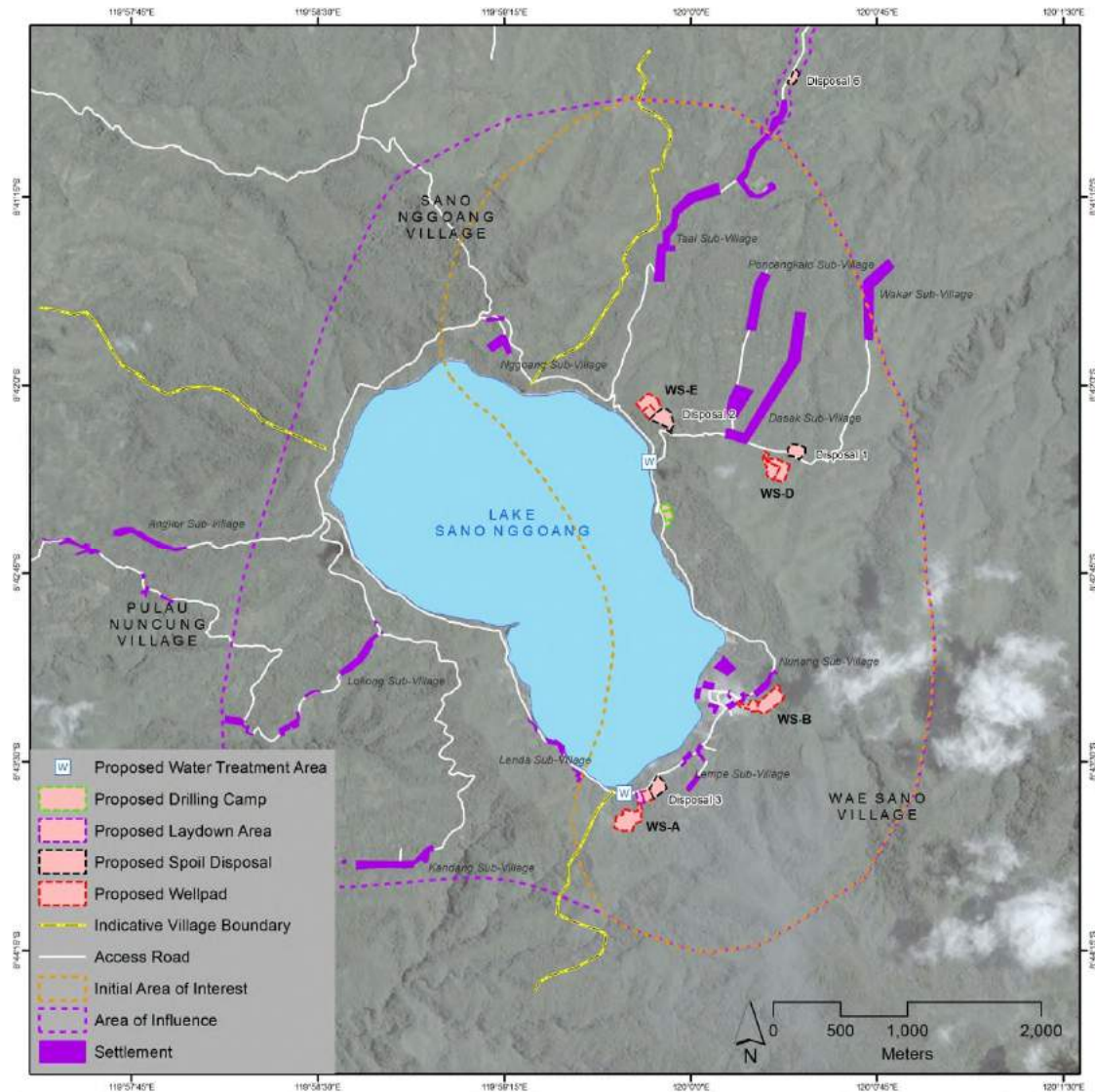
Table 3-1 Selected Well Pad and Supporting Facilities Proposed Location

Well Pads and Supporting Facilities	UTM 51S WGS84	
	X* (Easting)	Y* (Northing)
Well Pad WS-A (Phase 1)	169550	9033989
Well Pad WS-A (Phase 2)	169412	9033824
Well Pad WS-B (Phase 1)	170293	9034651
Well Pad WS-B (Phase 2)	170455	9034696
Well Pad WS-D (Phase 1)	170444	9036415
Well Pad WS-D (Phase 2)	170504	9036392
Well Pad WS-E (Phase 1)	169544	9036810
Well Pad WS-E (Phase 2)	169540	9036875
Spoil Disposal 1 (Drilling Material)	170631	9036529
Spoil Disposal 2 (Drilling Material)	169642	9036750
Spoil Disposal 3 (Civil Work Material) & Civil Contractor Camp	169627	9034052
Spoil Disposal 4 (Road Upgrade Material)	171196	9046945
Spoil Disposal 5 (Road Upgrade Material)	171605	9044839
Spoil Disposal 6 (Road Upgrade Material)	170587	9039275
Access Road Upgrade	From Trans Flores Road to Project Location	
Laydown Area	169496	9033973
Drilling Base Camp (Phase 1)	169685	9036036
Drilling Base Camp (Phase 2)	169665	9036107
Water Treatment Area 1	169381	9034010
Water Treatment Area 2	169548	9036443

Source: JACOBS, December 2017

Note*: Coordinates calculated from center point boundary

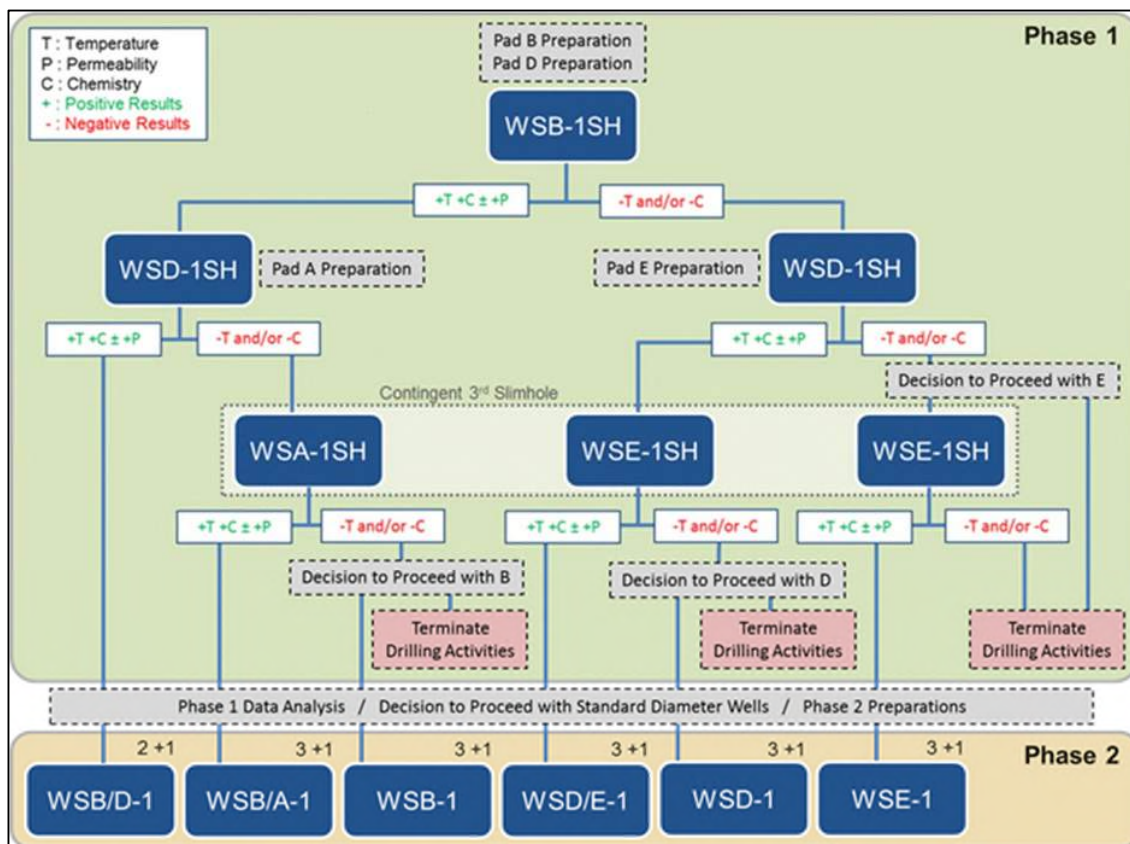
The potential geothermal areas and pad sites are located within Waesano Village, Sano Nggoang Sub District as shown in Figure 3-1.



Source: JACOBS, December 2017

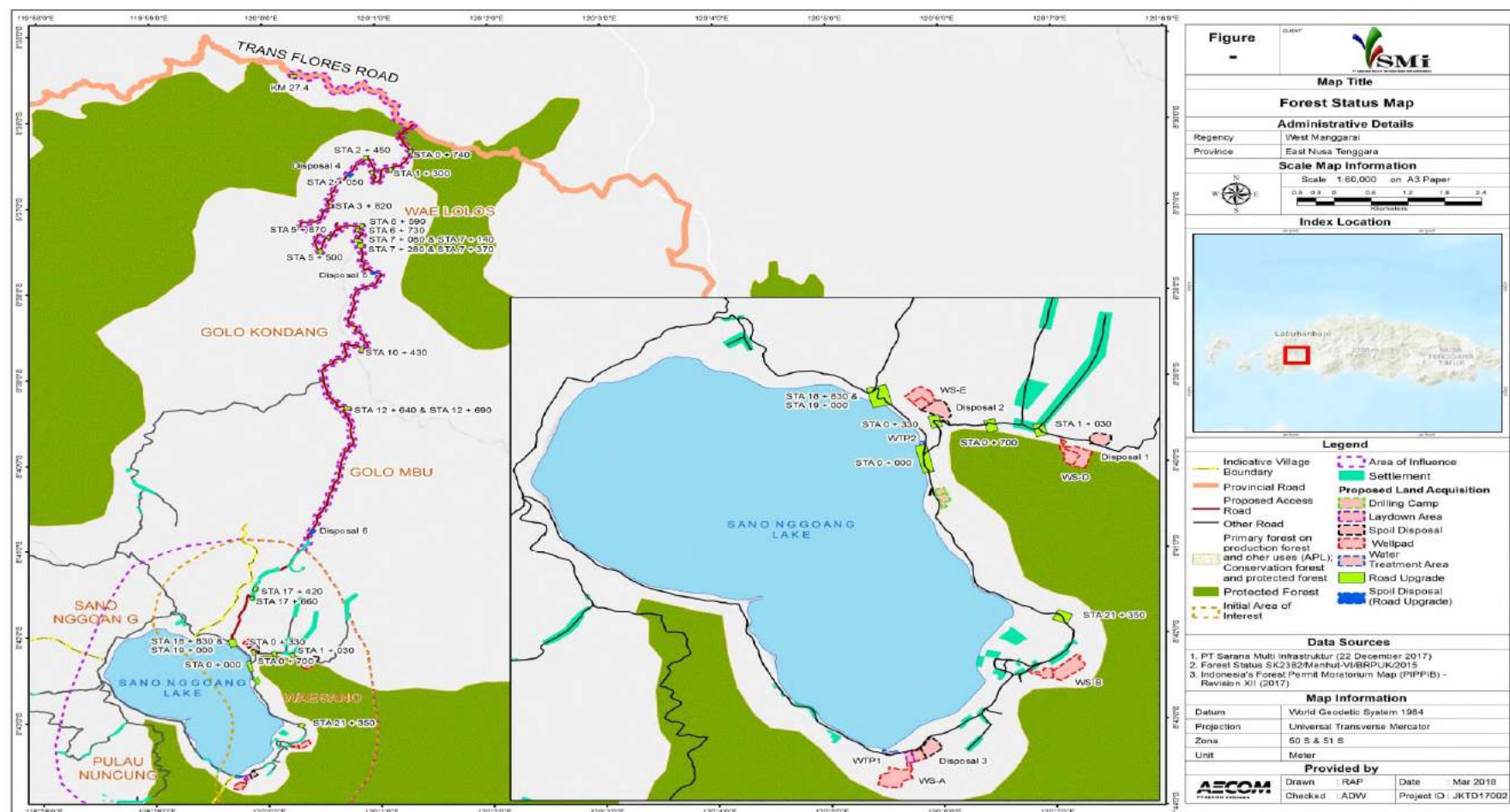
Figure 3-1 Proposed Well Pad / Site Locations

These prospect areas for the Project are surrounded mainly by forest area though most parts of the area have been converted to residences and agriculture areas. Based on the forest map issued by the Ministry of Environment and Forestry (Figure 3-3), the area surrounding the Lake Sano Nggoang is non-forest areas (no fill). The protected forest (green) is situated behind the non-forest areas from the lake direction. This forest is part of Sesok Natural Landscape (*Bentang Alam*). The ring road infrastructure has been built around the lake connecting the three villages of Sano Nggoang Sub District including Wae Sano, Sano Nggoang, and Pulau Nuncung Village.



Source: PT SMI, 2018

Figure 3-2 Flowchart of Waesano Exploration Project Sequent



To utilise geothermal energy, production wells are drilled down into the heated water contained within the Earth's crust - the geothermal reservoir. Once these geothermal reservoirs are tapped into, the heated water and steam rise to the surface where the steam is separated and used to power steam turbines, which then generate mechanical energy that can be harnessed as electricity. Brine and condensate are returned via reinjection wells back to the geothermal reservoir.

The development of a geothermal resource can be separated into the following phases:

The Geothermal Exploration Phases

Phase 1: Preliminary Survey

- Data collection
- ESIA and permits
- Planning for exploration

Phase 2: Engineering

- Surface and subsurface testing
- Infrastructure and civil engineering
- Drilling engineering
- Prefeasibility study

Phase 3: Exploration Drilling

- Land acquisition and permits
- Civil and infrastructure construction
- Well drilling
- Well testing
- Reservoir assessment

Phase 4: Project Review and Planning

- Evaluation and decision making
- Site clean-up, securing and, if required, remediation

The Geothermal Exploitation Phases

Phase 5: Project Review and Planning

- Feasibility study
- ESIA and permits
- Additional infrastructure and civil engineering
- Drilling plan

Phase 6: Construction

- Land acquisition and permits
- Additional infrastructure and civil construction
- Well drilling (production and reinjection), well testing, reservoir simulations
- Steam field separation plant and pipelines

- Power plant
- Substation and transmission

Phase 7: Start Up and Commissioning

Phase 8: Operations and Maintenance

- Managing well operations and brine reinjection
- Managing the geothermal resource, reservoir monitoring and simulations
- Generating electricity
- Managing emissions, noise and waste
- Well decommissioning
- Make up well drilling, well testing, reservoir simulations

It is understood that the exploitation is a separate development phase that will not be part of the Waesano Geothermal Exploration project. The nature and scale of the exploitation phase, including energy generation and transmission, will not be well understood at the time of the preparation of this ESIA. If the drilling concludes that the geothermal resource is sufficient for energy production, and there is sufficient demand for additional electricity generation on Flores Island, the resource could be developed. This development will occur beyond the life of the Waesano Geothermal Exploration project.

The environmental and social study boundaries of the Waesano project are limited by the area of interest and area of influence. The area of interest is the area where the project plan and/or activities will be conducted by the Waesano Geothermal Exploration project. Meanwhile the area of influence is the area of both environmental and social effects that is predicted to be impacted by geothermal exploration activities during the preliminary survey, as well as engineering and exploration drilling phases. In this case, the area of influence is determined based on the hydrological conditions, wind direction and speed and distribution of the settlement areas.

The likely activities at the exploitation phase include those listed above, but will include ongoing resource exploitation (abstraction and use of geothermal steam and the reinjection of separated brine and condensate), future well drilling and testing, the construction and operation of a geothermal power station, steam field facilities, access roads, and transmission lines. The scale of the development (number and location of wells, size and capacity of the power station(s), size and alignment of transmission infrastructure) is unknown until the resource is more fully explored, however the feasibility study indicates between 10 – 50MW could be possible, with a maximum expected capacity of 30 MW.

The exploration phase described below is a generic exploration scenario developed together with PT SMI's Technical Team.

3.2. Project Activities for Exploration Phase

The Waesano exploration project is divided into 11 activities:

- Permitting and Field Survey;
- Land Acquisition;
- Workforce Recruitment;
- Land Clearing and Preparation;
- Equipment and Material Mobilization;
- Access Road Improvement;
- Well Pad and Infrastructure Development;
- Exploration Drilling;
- Well Testing;

- Site Closure; and
- Site Rehabilitation and Revegetation.

3.2.1. Site Selection, Permitting and Field Survey

3.2.1.1. Site Selection

In geothermal projects, civil works are required for constructing access roads, drilling pads and power plant. These activities may lead to landscape modifications and alteration of natural features and cultural interest.

A drilling site including drill pad and area for associated facilities need a land of 1.5 – 3.5 ha. Thus, construction of drilling sites will potentially led to landscape modifications, vegetation change and losses, soil erosion, surface water pollution and alteration of natural features. The main objective of site selection is to locate the well sites by taking into account the environmental and social consideration.

This ESIA includes consultation with local community as part of the Site Selection process for the Waesano Project together with other engineering surveys such as civil and geoscience. This process is ongoing and all well pad locations were not confirmed during ESIA preparation. Background discussion on site selection process over the last 18 months with interactions between ESIA and design team could be seen in Sub Section 3.4.2.

3.2.1.2. Permitting

Prior to commencing the Waesano Exploration Project activities, the Directorate General of New Energy, Renewable Energy and Energy Conservation (EBTKE) as the Project proponent will secure all permits/approvals required. A number of agencies will also be informed about the project plan in West Manggarai Regency including affected community in Waesano. Socialization of the project have been carried out several times with stakeholders as part of public consultation. The public consultation was carried out on 3 November 2016 in Nunang Sub Village of Wae Sano.

This project has received support from the Government of West Manggarai Regency for its potential to alleviate a shortage of electric power in West Manggarai Regency and the potential for investment and infrastructure on Flores Island. The support of the Government of West Manggarai has been indicated by the issuance of Decree Regent of West Manggarai - East Nusa Tenggara Province Number 170 / KEP / HK / 2016 dated August 8, 2016 on the Establishment of Joint Secretariat for Utilization of Potential Waesano Geothermal for Electrical Energy in West Manggarai Regency (**Appendix A**).

According to the West Manggarai Regency Regulation Number 9 of 2012 on Spatial Plan of West Manggarai Regency 2012 – 2032, Point 2 of Article 13 states that the Sano Nggoang Sub-District is planned as the location of a geothermal power plant. The area has been confirmed for the utilization of geothermal energy, which means there are opportunities for the development of the area. Thus, the location of Waesano geothermal exploration sites in the Sano Nggoang Sub-District are in accordance with the Spatial Plan (RTRW) based on West Manggarai Regency Regulation Number 9 of 2012 (see Figure 3-4). The conformity of the proposed project area with the Spatial Plan of West Manggarai Regency is also confirmed by related local institution as stated in the Head of Public Works and Resettlements Agency Letter No. PUPR.760/477/VI/2018 (**Appendix B**).

In accordance with the Indonesian Law No. 21 of 2014 on Geothermal Permit, the geothermal permit is not required in the exploration phase with the aim of assessing the existence of geothermal resource. The permit will be required in the further Exploitation Phase and secured by a Business Entity that has a geothermal concession area awarded by Ministry of Energy and Mineral Resources following tender process.

With regard to the utilization of forestry area for the geothermal exploration, according to Ministry of the Environment and Forestry Regulation No. P.50/Menlhk/Setjen/Kum.1/6/2016 concerning the Guidance on Borrow-to-Use of Forestry Areas, article 4 and 5 stipulates that the utilization of forestry areas for non-forestry activities can only be done for the activities with strategic objectives including Geothermal related activities and shall be based on the Borrow-to-Use Permit.

Based on the Indonesia's Forest Permit Moratorium Map (PIPPIB) Revision XIII dated 4 December, 2017⁵, majority of the proposed well pads location is out of the PIPPIB border except for well pad WS-D and alternative WS-B1 (Figure 3-5)⁶. However, the Presidential Instruction Letter Number 6 of 2017 Clause Number 2 stated that an exception of PIPPIB applies for national vital project developments including geothermal, natural gas, electricity, and food safety program such as paddy field, corn, bean etc.

In addition, based on the forest status map (scale 1:250,000) from MoEF Decree No.SK3991 of 2104 dated 14 May 2014, the overall project location (include the community forest within the Waesano GEUDP area) is indicated located within the area of other purposes or APL (*Areal Penggunaan Lain*) and not considered to be Protected Forest area except the location of well pad WS-D and alternative WS-B1 (Figure 3-5).

A joint survey with Task Force Unit for Forest Management (*UPT Kesatuan Pengelolaan Hutan*) of West Manggarai Regency is required prior to applying any permit for drilling within the forest area.

The process of all permits mentioned above will require an Environmental Permit. Referring to Government of Indonesia Regulation (GR) No.27 of 2012 concerning Environmental Permit, the Project proponent shall conduct environmental and social assessment (documented in UKL-UPL or AMDAL report) to analyse the environmental and social feasibility (*Surat Keterangan Kelayakan Lingkungan Hidup* or SKKLH) of the Project prior to obtaining the environmental permit from the regent. The geothermal exploratory drilling works will require an UKL-UPL study and the exploitation works will require UKL-UPL or AMDAL – depending on the scale of Project in accordance with Minister of Environmental Regulation No.05 of 2012. Geothermal power plant development with capacity more than or equivalent with 55 MW will require an AMDAL study.

3.2.1.3. Field Survey

The first phase of pre-construction activities involves topographical and geotechnical surveys to determine the optimal location of drilling activities and support the required civil engineering design. This activity will be carried out by a small team of land and geotechnical drilling surveyors.

Geoscience survey activity aims to collect geoscientific data related to estimates of key reservoir parameters (temperature, depth, extent, etc.) prior to exploration drilling. The surveys typically begin with gathering samples and data from existing surface manifestations, and then proceeds to surface and sub-surface surveying using geological, geochemical, and geophysical methods. Other surveys will continue to be done, including the social and environmental impact assessment.

⁵ The PIPPIB area map revision XIII was issued by Ministry of Environment and Forestry and Forestry Decree No.SK.6556 dated 4th December 2017 according to Instruction Letter of the President of Indonesia No.6/2013. This letter instructs all governors and regents to refer this map for their reference prior to issue the new permit location for the new project (location permit is one of requirement for other permits, i.e. *Izin Pinjam Pakai Kawasan Hutan* (IPPKH) or Forest Land Lease Permit. This letter was issued by the President to improve forest management particularly primary natural forest and peat-land forest for reducing emission resulted by deforestation and forest degradation.

⁶ This statement is based on Head of Forest Gazette Agency (*Balai Pemantapan Kawasan Hutan* – BPKH) Region XIV letter dated 1st March 2018.

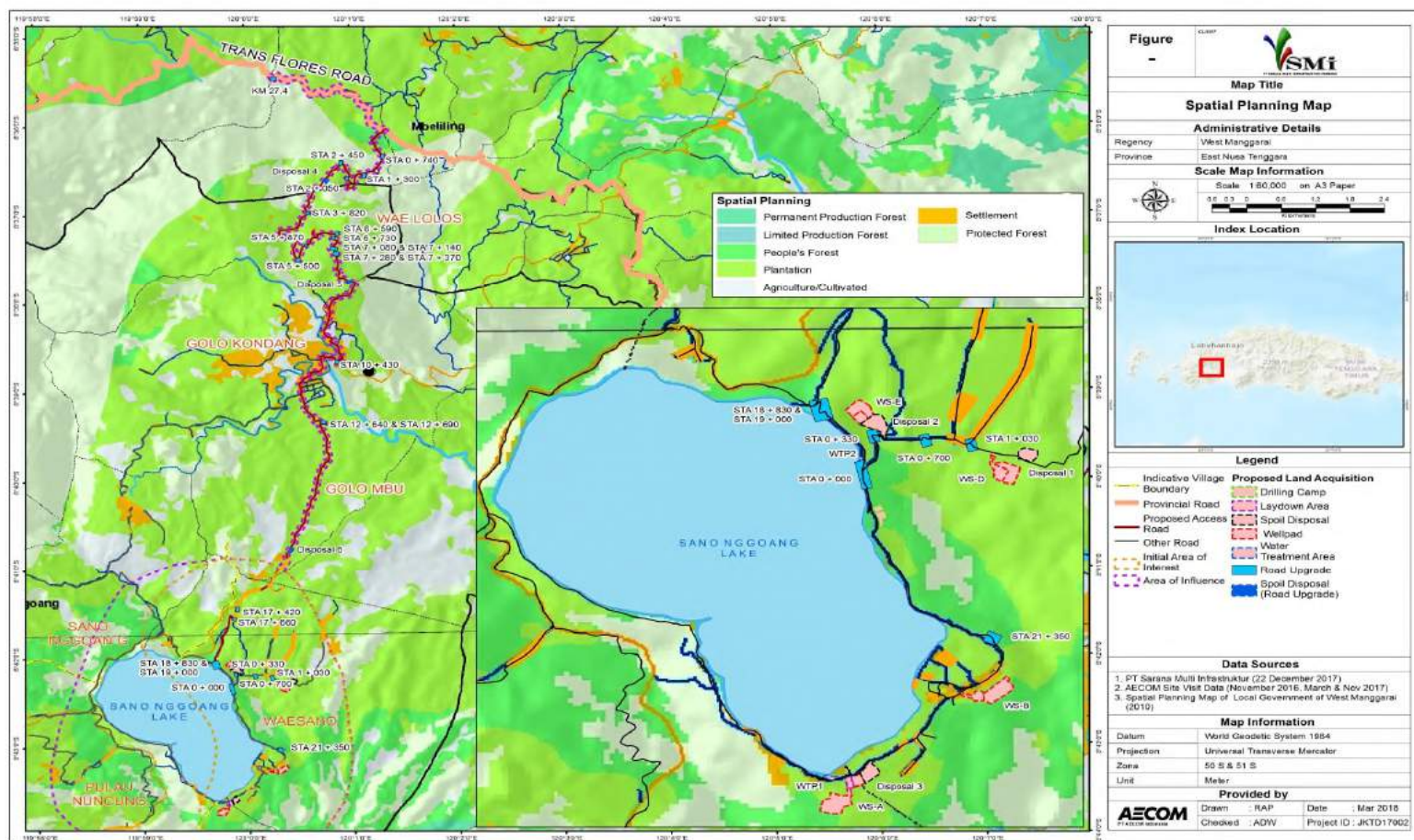


Figure 3-4 West Manggarai Regency Spatial Planning

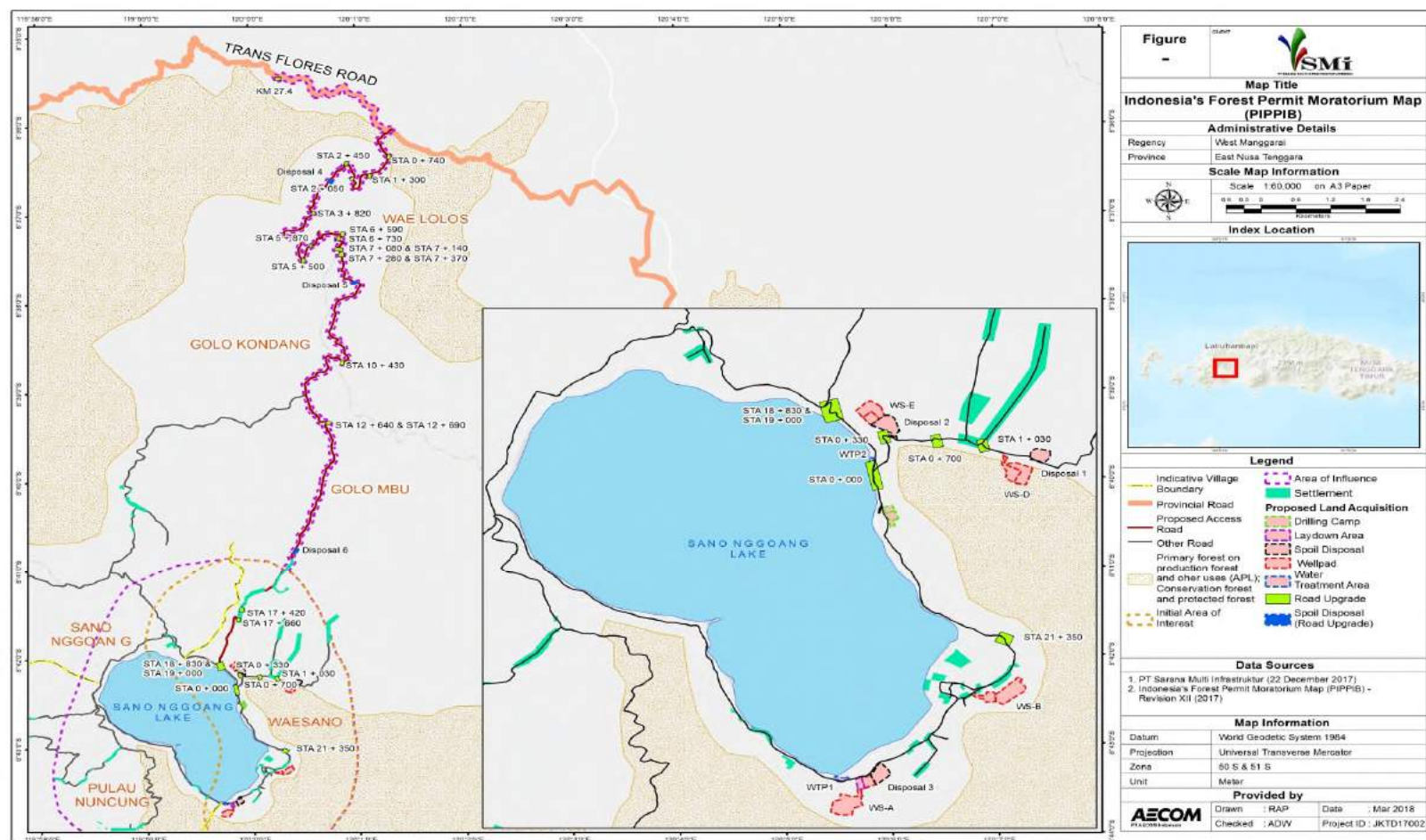


Figure 3-5 The Indonesia's Forest Permit Moratorium Map (PIPPIB)

3.2.2. Land Acquisition

Drilling exploration activities will require land for the development of exploration well pads, basecamp, staging area, and road upgrade (widening and improvement). Land acquisition will be completed prior to the commencement of land clearing. The status of ownership for each of the land parcels that will be acquired by the Project will be confirmed once the Project survey and civil design are finalised.

Exploration activities will be carried out in the area of each well pad that is designed in accordance with its objectives (slimhole and standard hole) with an area of approximately 0.54 – 1.03 ha (slimhole) and 1.35 – 2.38 ha (standard hole) for each well pad to accommodate related cut-and-fill civil works. It is often possible for a single well pad to accommodate more than one well as modern drilling techniques allow lateral penetration with directional drilling. In an effort to reduce the impact to the local community, the location of the well pads will be determined by considering appropriate distance from high sensitivity areas e.g. residential areas and areas that have high ecological and cultural value.

The following project components will require land. Detailed information with respect to required land area is presented in Table 3-2.

- 4 Well Pads (WS-A, WS-B, WS-D, WS-E)
- Spoil Disposal
- Road Upgrade
- Laydown Area
- Drilling Base Camp
- Civil Contractor Camp
- Water Treatment Area

Table 3-2 Land Requirement

Well pad and Supporting Facilities	Area (Ha)		Total
	Phase-1 (Slimhole)	Phase-2 (Standard)	
Well Pad WS-A	0.57	2.38	2.95
Well Pad WS-B	0.68	2.04	2.72
Well Pad WS-B1 (alternative)*	0.64	-	0.64
Well Pad WS-B4 (alternative)*	0.68	-	0.68
Well Pad WS-D	1.03	1.35	2.38
Well Pad WS-E*	0.79	3.15	3.94
Well Pad WS-E (alternative)	0.54	1.37	1.91
Spoil Disposal Area 1	1.05	-	1.05
Spoil Disposal Area 2	1.61	-	1.61
Spoil Disposal Area 3 & Civil Contractor Camp	1.18	-	1.18
Spoil Disposal Area 4 (Material Road Upgrade)	0.53	-	0.53
Spoil Disposal Area 5 (Material Road Upgrade)	0.37	-	0.37
Spoil Disposal Area 6 (Material Road Upgrade)	0.50	-	0.5
Road Upgrade	0.74	-	0.74
Laydown Area	0.35	-	0.35
Drilling Base Camp	0.53	0.29	0.82
Water Supply Intake 1	0.20	-	0.2
Water Supply Intake 2	0.23	-	0.23
Total	12.22	10.58	22.8

Source: JACOBS, December 2017

From Table 3-2, there are three categories of land ownership based on the proximity to the Project and the stage of development namely:

1. Road Upgrade for the access road from Trans Flores highway to Project Area. For the improvement of the access road as part of the Project, Regional Public Works and Spatial Planning Agency of West Manggarai is committed to acquire 23 land sections for road segments with a total acreage of 0.74 Ha in which the details can be seen in 3.2.6. This commitment is stated in Head of Regional Public Works and Spatial Planning Agency Letter No. PUPR.620/BM/946/V/2018 regarding the Statement to Supporting the Land Acquisition of Access Road required by the Waesano Geothermal Project (**Appendix C**). This acquisition process should be conducted according to the Indonesian Law Number 2 of 2012, in which for land with the total acre under 5 Ha, the acquisition process could be done directly between the government institution and the entitled parties. Although it will be managed by regional government, PT SMI will ensure that there is a transparent transaction framework through consultation and socialization, while compensation for communal land will be based on recognition of local customs if deemed necessary.
2. Project Area in the vicinity of the Project (includes all area in Table 3-2 except for Road Upgrade and WS-D). Land lease scheme will be used for lands in well pad areas (WS-A, WS-B, and WS-E) and supporting facilities such as the base camp, drilling camp, water supply intake, etc. Most of the land is in private ownership; the land lease process will be completed prior to commencement of construction activities. PT SMI will ensure that there is a transparent transaction framework through consultation and socialization, while compensation for communal land will be based on recognition of local customs.

3. WS-D. One of the potential well pad locations (WS-D) is located in forestry area and belongs to the government; therefore the Project will obtain a permit to borrow and use the forestry land in line with Law Number 41/1999 regarding Forestry Area.

Further summary on the land tenure scheme and process are presented in Table 3-3.

Table 3-3 Mechanism to Acquire the Land for the Project

Project Footprint	Land Tenure Scheme
The access road from Trans Flores Highway to Project Area.	Land will be acquired by Regional Public Works and Spatial Planning Agency of Manggarai Barat Regency
The road upgrade of access road will be carried out in 23 sections, that starts from KM 27.4 (Trans Flores) to STA 1+030 (Project Area at Sano Nggoang Lake) for about 22 Km length with a total acreage of 0.74 ha. The land acquisition, socialization and compensation to communities are under Local Government responsibility as stated in the Head of Regional Public Works and Spatial Planning Agency of Manggarai Barat Regency Letter No. PUPR.620/BM/946/V/2018 regarding the Statement to Supporting the Land Acquisition of Access Road required by the Waesano Geothermal Project (Appendix C).	
WS-A, WS-B, WS-E, Spoil Disposal Areas, Laydown Area, Drilling Base Camp, Water Intakes	Land Lease
<ol style="list-style-type: none"> 1. Socialization to provide explanation of the project 2. Land boundary and land ownership survey to set out project footprint and inventory the landowners within the boundary 3. Plants/crops and buildings inventory on the affected land 4. Recognition of landowners affected by the project 5. Socioeconomic census including Livelihood to the affected landowners 6. Prepare Abbreviated Land Acquisition and Resettlement Action Plan 7. Engage an independent third party to provide market land valuations; 8. Calculation of compensation value 9. Prepare Land Lease Agreement with land owner(s) and/or with the authorized party 	
WS-D (Proposed Well Pad within the Protected Forest)	Borrow and Use
<ol style="list-style-type: none"> 1. Land boundary survey to set out project footprint 2. Inventory the plants and its densities within the protected forest on WS-D 3. Secure Borrow-Use Permit from Minister of the Environment and Forestry 	

For the Exploration phase of Waesano Geothermal Project, the land will be firstly acquired by leasing to the owners. The lease scheme by PT SMI can be done in accordance with the SMI assignment letter issued by the Ministry of Finance. The lease agreement between PT SMI and land owners will be based on the needs of the Project with certain conditions that anticipating future mechanism of land purchasing by 3rd party (developer or assignment to IPP SOE) or even MEMR when the geothermal reserves found in the proposed area and Government would like to develop the prospect.

3.2.3. Workforce Recruitment

Exploration drilling of geothermal sites is a highly specialized activity and entails high capital costs, high risks and need for experienced personnel to ensure security. Therefore, there is a limited opportunity to utilize workers from the local community for specialty jobs during the exploratory phase. There is however the opportunity for labor and support staff to be recruited from the local community. Proponent workforce includes support and specialist staff for activities in the construction and operation phases shown as in Table 3-4. The workforce from contractors in the construction phase is presented in Table 3-5; the workforce for the operation phase (exploration) is shown in Table 3-6; and the organizational structure of construction and exploration works for the exploration team is shown in Figure 3-6.

Table 3-4 Indicative Project Owner Workforce

No	Position	Number
1	Site Manager	1
2	Community Liaison	1
3	Safety Officer	1
4	Environmental Officer	1
5	Construction Engineer	1 (may be national or expat)
6	Construction Supervisor	1 or 2 (may be national or expat)
7	Exploration Geologist	1
8	Rig Geologists	2
9	Well Test Engineer	1 (may be national or expat)
10	Drilling Engineer	1
11	Company Man	4 (may be national or expat)
12	Admin Officer	1
13	Site Accountant	1
14	Procurement Officer	1
15	Base Camp Manager	1
16	Base Camp Staff	5
17	Drivers	4
Total		26 - 27

Source: PT SMI, 15 December 2016

Table 3-5 Contractor Workforce during Construction

No	Position	Number
1	Project Manager	1
2	Project Assistant & Document Control	1
3	Civil & Structural Engineer	4
4	Mechanic	1
5	Electrician	1
6	Welder	1
7	Project Procurement	1
8	Financial / Cost Control	1
9	QA/QC	1
10	Environment, Health& Safety (EHS)	2
11	Security	10
12	Store Keeper	2
13	Survey / Geotechnical Investigation	10
14	Excavator Operators	4
15	Bulldozer Operators	2
16	Motor Grader Operators	1
17	Motor Roller Operators	2
18	Dump Truck Drivers	8
19	Crane Truck driver/Operators	2
20	Pick-up truck drivers	3

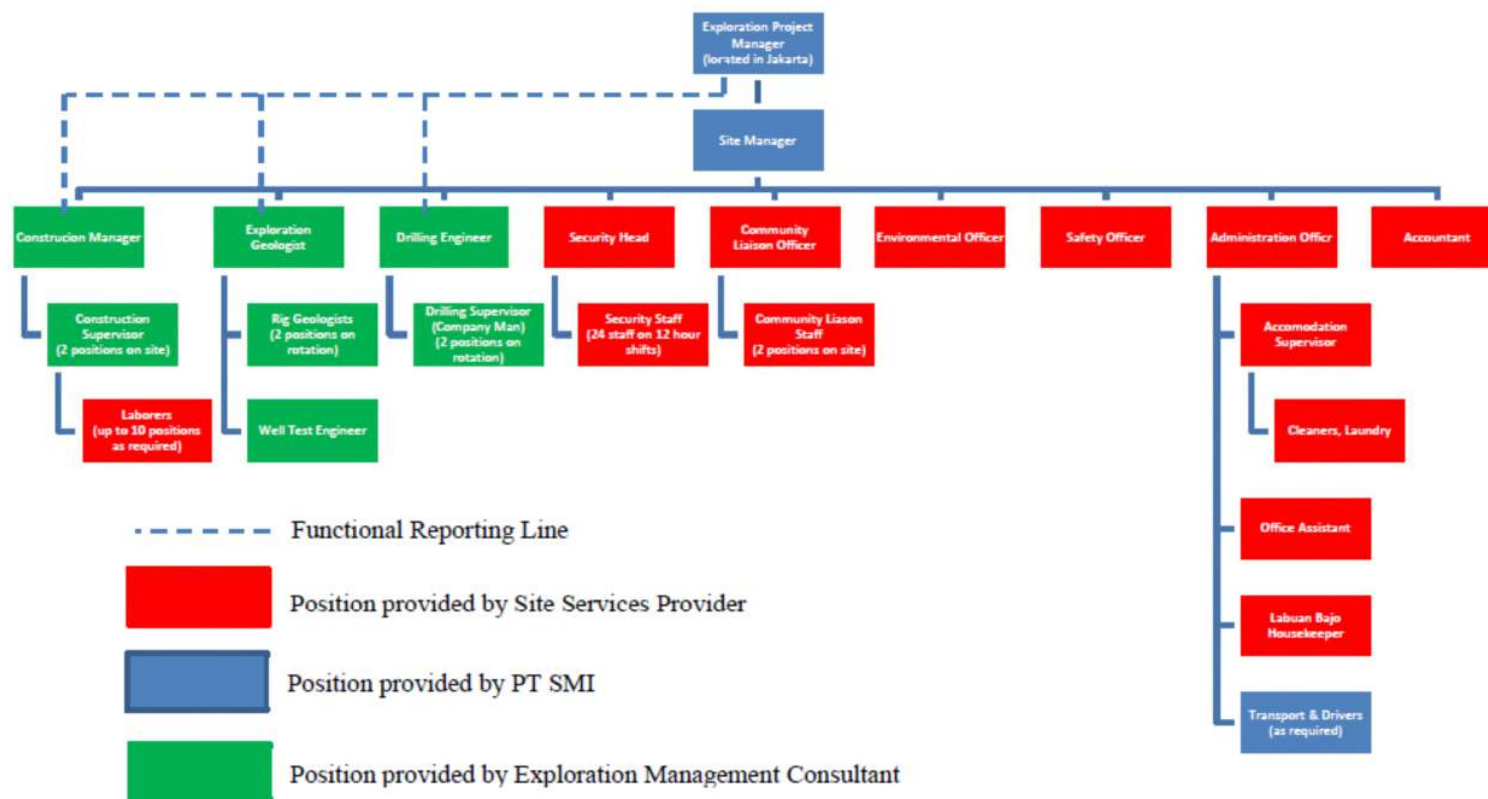
No	Position	Number
21	Water Tank Truck Drivers	1
22	Workers	10
Total		69

Source: PT SMI, 15 December 2016

Table 3-6 Contractor Workforce during Drilling

No	Position	Slimhole Drilling		Standard Drilling	
		Number	Note	Number	Note
Rig Contractor					
1	Rig Manager	1	on call	1	on call
2	Drillers	2	1 per shift	2	1 per shift
3	Assistant Drillers	2	1 per shift	2	1 per shift
4	Mechanic	1	on call	2	1 per shift
5	Electrician	1	on call	2	1 per shift
6	Roustabouts	4	2 per shift (local)	8	4 per shift (local)
7	Safety Officer	1	on call	1	on call
8	Cementing Engineer	1	on call	-	-
9	Mud Engineer	1	on call	-	-
10	Toolpusher	-	-	2	1 per shift
11	Derrickman	-	-	2	1 per shift
12	Roughneck	-	-	8	4 per shift
13	Top Driver Technician	-	-	1	on call
14	H ₂ S Technician	-	-	1	on call
15	Forklift Operator	-	-	1	on call
16	Rig Nurse	-	-	2	1 per shift
Drilling Services Contractor					
1	Directional Drilling	-	-	4	2 per shift (1 DD and 1 MWD)
2	Cementing	-	-	4	on call
3	Mud Logging	-	-	2	1 per shift
4	Drilling Fluids	-	-	2	1 per shift
5	Drilling Bits	-	-	1	on call
6	Air Drilling	-	-	6	3 per shift, when drilling production hole
7	Downhole Logging & Back-off Services	-	-	4	on call
Operator					
1	Drilling Manager	-	-	1	on call
2	Drilling Supervisor	1	on call	2	1 per shift
3	Senior Geologist	-	-	1	on call
4	Junior Geologist	-	-	1	on call
5	Drilling Engineer	1	Not onsite full time	1	on call
6	Well Testing Engineer	1	Not onsite full time	1	Not onsite full time
Total		18		65	

Source: JACOBS, 14 October 2017



Source: PT SMI, November 2018

Figure 3-6 Exploration Site Team

3.2.4. Equipment and Material Mobilization

Key facilities and equipment required for drilling activities include bulldozers, excavators, dump trucks, cranes, drilling rigs, pumps, generators, and others (Table 3-7). Construction material is shown in Table 3-8. Equipment and material will be mobilized from locations outside of Flores Island through Labuan Bajo. It will be transported to Waesano geothermal sites using land transport. Equipment mobilization activities will comply with a Standard Operating Procedure (SOP) developed by the proponent, and will involve arrangements with local authorities in West Manggarai Regency along the route as required. The construction equipment will be stored in the laydown area before being dispatched to the drilling site.

A nearby local quarry area is located at 184002 m Easting 9040574 m Northing Zone 51s, or Latitude : Longitude (80.972886 : 104.659937), and has been identified as a source for general stone materials required in development of the Project Site. This quarry is currently managed by PT Floresco under Class C mining licence. The quarry is situated to the North-East of the Exploration Site and required materials will need to be transported to the site by truck along existing public roads, with an estimated 2,400 truckloads being needed to transport approximately 12,000 m³ of rock material to the site.

Table 3-7 Construction Equipment

No.	Type of Equipment	No. of Units
1	Bulldozer	2
2	Excavator	3
3	Excavator with Breaker	2
4	Motor Scraper / Grader	1
5	Motor Roller (pad and smooth)	2
6	Dump Truck	8
7	Crane Truck	1
8	Crawler Crane	1
9	Drilling Rig	1
10	Welding Machine	1
11	Pick-up Truck	3
12	Concrete Mixer	3
13	Generator	2
14	6" Water Pump	3
15	Water jet pressure pump	1
16	Water Tank Truck	1
17	Fuel Tanker	1
18	Geotechnical drilling machine	1

Source: PT SMI, 2017

Table 3-8 Construction Material

No.	Type/Name of Material
1	Sub-base course
2	Base Course
3	Coarse aggregate for concrete
4	Fine aggregate for concrete
5	Reinforcement steel
6	Portland Cement

No.	Type/Name of Material
7	Reinforced Concrete Pipe culvert 600-800 mm diameter
8	Rock Gabion
9	HDPE liner for sumps
10	Geotextile
11	Geogrid
12	Temporary fencing

Source: PT SMI, 2017

Public roads will be used for access to the project site. A rig move assessment will be conducted prior to moving drilling equipment covering the following items:

- Distance moved;
- Permitting;
- Road conditions;
- Obstacles;
- Site readiness; and
- Transportation fleet readiness.

This assessment will be done by the Proponent team consisting of the Rig Superintendent/Tool pusher, Health, Safety and Environment (HSE) officer, and transportation supervisor.

3.2.5. Land Clearing and Preparation

The construction phase will commence with land clearing and preparation activities, which involve vegetation clearance, excavation/filling to required levels, and incorporation of appropriate sand, gravel and aggregates for compaction and structural stability.

As part of the land acquisition process, current land owners will be informed of pending construction activity, which will allow them to clear trees or harvest any crops. Any remaining vegetation will be cleared from the site and topsoil will be removed and stored. Cleared vegetation, where viable, will be mulched and retained with the topsoil and kept as a growth medium for landscaping or remediation activities.

Preparation work includes land levelling and clearing, excavation, and landfilling in order to lower and raise the project site. The levels of roadways and well pads will be designed to keep a balance between cut and fill for the construction operations and to minimize or eliminate excess spoil or the additional fill materials beyond quarried materials required for stabilisation.

This work will require mobilization of heavy equipment to the site by public roads, and to the corridor entry points. Prior to the mobilization of heavy equipment to the site, the initiator will conduct a route survey to ensure that an appropriate corridor is available, and will facilitate any temporary arrangements with the relevant authorities as required, such as raising power lines and services. This work includes an assessment of the load capacity of bridges and structures.

3.2.6. Access Road Improvement

Heavy equipment mobilization to the Waesano project site will use the existing public road for 22 kms. The road characteristics in the area are narrow, winding and pass through residential areas. Some of the existing bridges and culverts will need to be repaired or re-alignment in coordination with the Department of Public Works of West Manggarai Regency to ensure the safety of vehicles, drivers and the local community. A detailed study is required for the improvement of some road sections although there are several sections and bridges that can be used in their current state.

Some sections of local road are in very poor condition due to poor drainage and use of poor quality pavement. In its current condition it is essential to use 4WD vehicles especially during the rainy season. The project must cut/reshape the shoulders to lower the fall down from the road surface, improve the side drains and improve the road pavement. The existing condition of access roads is described as follows:

Table 3-9 The Existing Condition of Access Road

Road Section	Description
KM. 27.4	Tight curve. Needs re-alignment and bridge widening with area of 0.04 ha
STA. 0 + 740	Needs road widening and land acquisition 0.01 ha
STA. 1 + 300	Tight curve and steep grade. Needs land acquisition 0.03 ha which covers an area of road widening of 0.02 ha.
STA. 2 + 050	Tight curve and steep grade. Needs road widening and land acquisition of 0.01 ha
STA. 2 + 450	Tight curve and steep grade, road damaged and across small rivers. Needs land acquisition of 0.05 ha which covers an area of road widening of 0.01 ha.
STA. 3 + 820	Tight curve and across existing drainage. Needs road re-alignment and land acquisition of 0.01 ha
STA. 5 + 500	Tight curve. Needs land acquisition of 0.01 ha which covered area of road widening
STA. 5 + 870	Tight curve and across existing drainage. Needs land acquisition of 0.01 ha which covers an area of road widening
STA. 6 + 590	Tight curve and steep grade. Needs land acquisition of 0.02 ha which covers an area of road widening of 0.01 ha.
STA. 6 + 730	Tight curve and steep grade. Needs road widening and land acquisition of 0.01 ha
STA. 7 + 080 and STA. 7 +140	Tight curve and steep grade. Needs road widening and land acquisition of 0.01 ha
STA. 7 + 280 and STA. 7 + 370	Bridge (P: 25 m, L: 3.7 m). Tight S curve and steep grade. Needs upgrade of bridge deck and vertical re-alignment of road pavement of 0.03 ha and needs land acquisition of 0.10 ha.
STA. 10 + 430	Tight curve. Needs road widening and land acquisition of 0.01 ha
STA. 12 + 640 and STA. 12 + 690	Tight curve and steep grade. Needs land acquisition of 0.04 ha which covers an area of road widening of 0.03 ha.
STA. 17 + 420	Needs road widening and land acquisition of 0.01 ha
STA. 17 + 660	Needs road widening and land acquisition of 0.01 ha
STA. 18 + 830 and STA. 19 + 000	Outlet Lake Wae Sano, tight S curve and steep grade and across existing drainage. Needs road pavement (horizontal & vertical re-alignment) and new box culvert concrete of 0.02 ha which resists water acidity. Needs land acquisition 0.12 ha
STA. 19 + 700	Needs road widening and land acquisition of 0.05 ha
STA 21 + 350	Needs road widening and land acquisition of 0.02 ha
STA. 0 + 000	Road junction to WS-D. Needs land acquisition of 0.06 ha which covers an area of road widening of 0.03 ha.
STA. 0 + 330	Access road to WS-D. Needs land acquisition of 0.02 ha which covers an area of road widening of 0.01 ha.
STA. 0 + 700	Needs land acquisition of 0.06 ha which covers an area of road widening of 0.02 ha.
STA. 1 + 030	Bridge on the tight curve and steep grade. The bypass with box culvert application will be proposed for smooth long vehicle maneuver. Needs land acquisition of 0.11 ha for road widening and 0.04 ha for road pavement.

Source: JACOBS, December 2017 and January 2018

The overall access road from Trans Flores road (Labuan Bajo – Ruteng) to Lake Sano Nggoang is shown in Figure 3-7, Figure 3-8 and Figure 3-9.

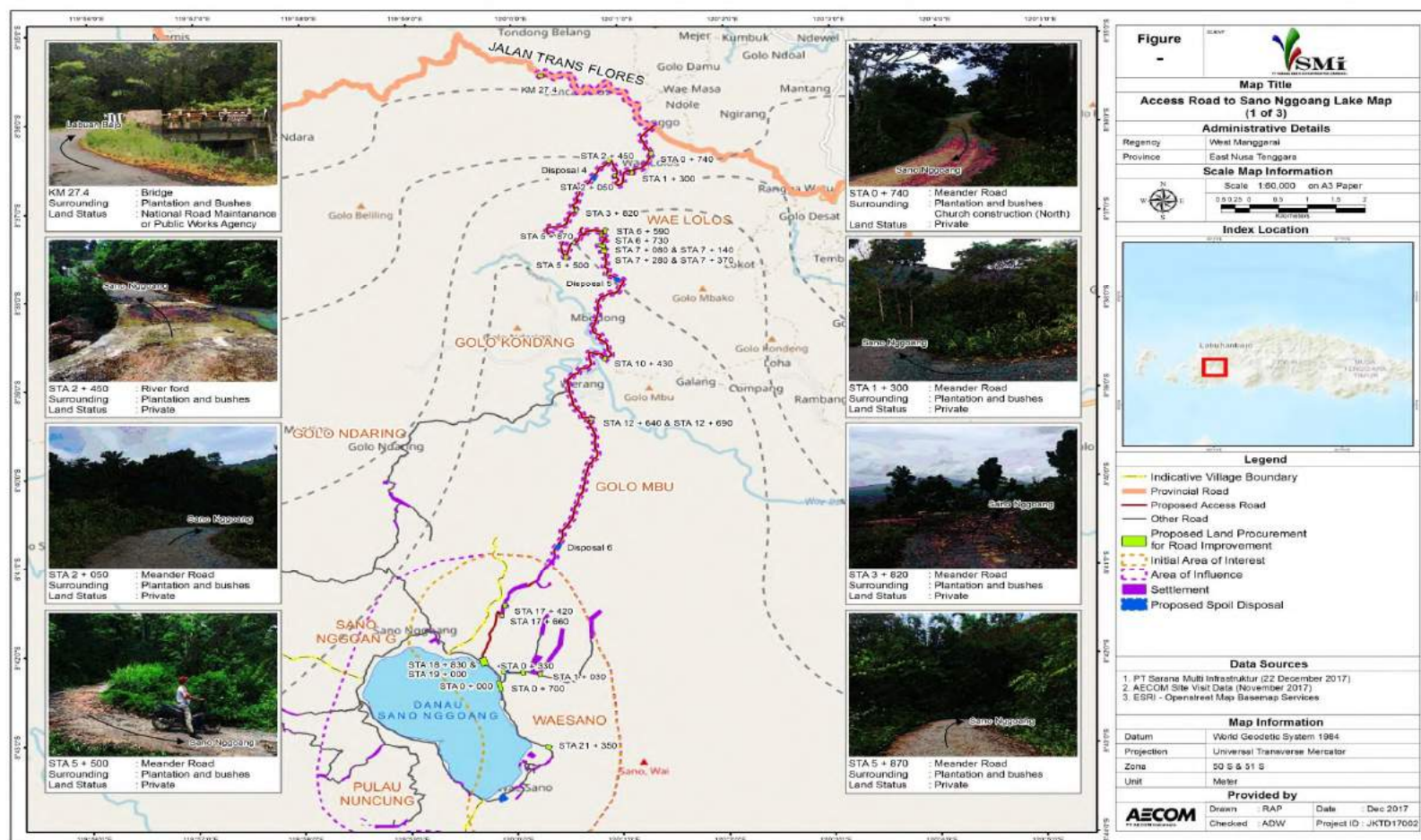


Figure 3-7 Overall Access Road to Lake Sano Nggoang (1)

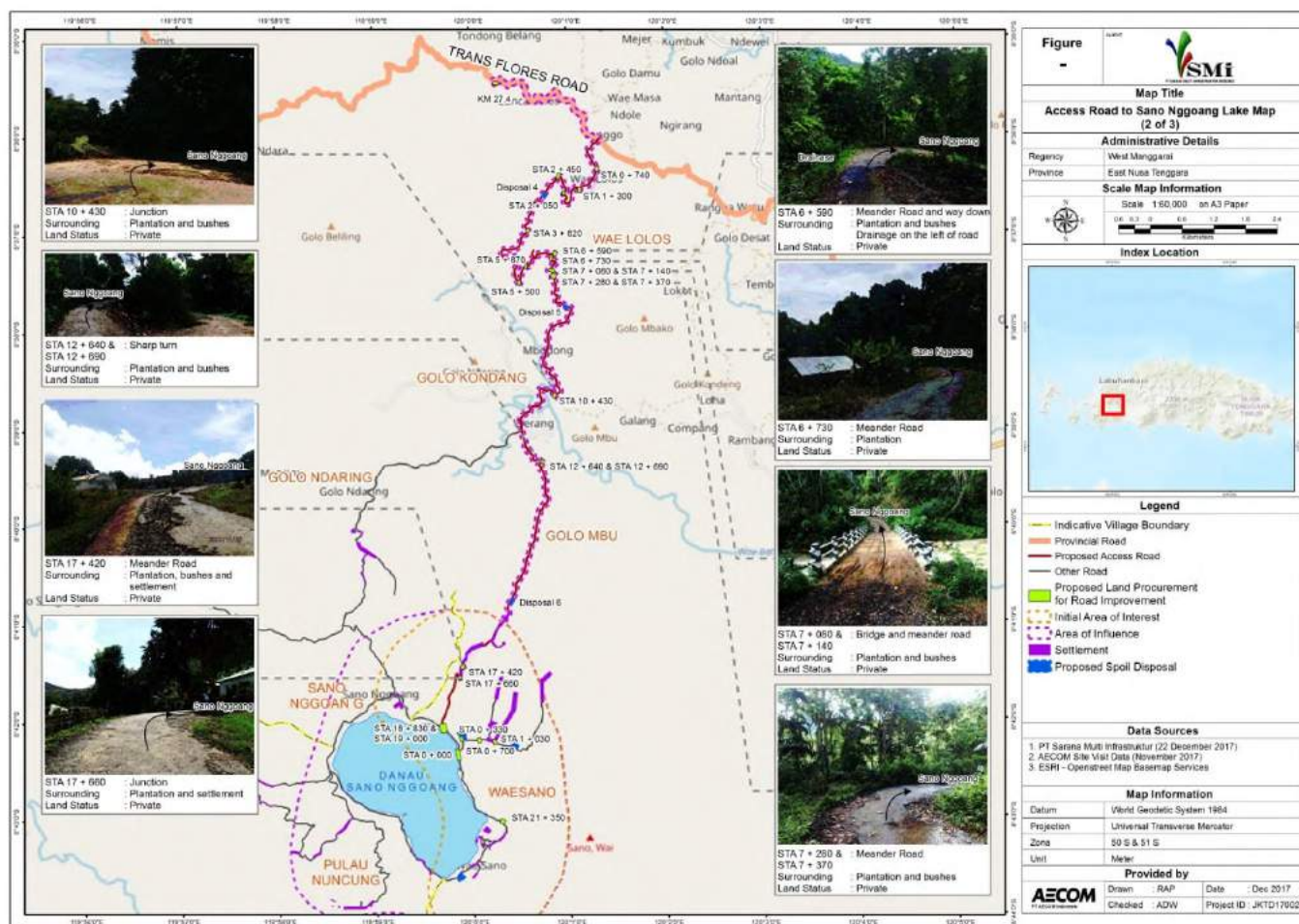


Figure 3-8 Overall Access Road to Lake Sano Nggoang (2)



3.2.7. Well Pad and Infrastructure Development

In the exploration phase, there are 4 planned well pads, to provide flexibility for the drilling program, although only 3 wells are currently planned to be drilled. Drilling will employ a 1,500 HP rig and requires each well pad area to be approximately 0.54 – 1.03 ha (slimhole) and 1.35 – 2.38 ha (standard hole) in size. This land area is necessary for the drilling rigs and supporting equipment, office and field crew accommodation container facilities, a generator, parking lot, drill mud and spoil management equipment, emergency assembly area (muster point) and others. Currently, 4 well pads (WS-A, WS-B, WS-D, WS-E) are planned for exploration but may not all be necessary depending on the outcomes of early drilling. However, well pad B and D are planned to be constructed using slimhole technology and then the Project will select the third slimhole drilling well whether at WS-A or WS-E. In Phase 2, the Project will select one of those slimholes to be location for standard hole drilling. The reason for choosing this technology is related to cost to schedule and impacts are much smaller than conventional/standard drilling.

The location of each well pad has been chosen based on the geothermal resource survey results and civil engineering inspection. A typical well pad layout is shown in Figure 3-10. Well pad locations includes a pond with an approximate capacity of 500 m³ to a depth of approximately 2.5 – 3.0 m (applied for Phase 1: Slimhole Drilling) and 3,000 m³ to a depth of approximately 4 m (applied for Phase 2: Standard Hole Drilling). In the short term the pond will be used during drilling for sediment interception and during storm events, for the interception of excess water run-off. Any water at the surface will be extracted and returned to the drilling process and will not leave the site; it is expected that there will be no excess water during typical drilling operations. The pond will also be used during the testing phase to collect geothermal fluids prior to reinjection.

As compliment the geothermal fluids will be tested for characteristics of hazardous waste in accordance with Indonesian legislation. If the spoil is shown to be hazardous, it will be treated as hazardous waste and stored in interim holding facilities on the well pad during drilling activities. In the interest of public safety, the well pads will be fenced off to prevent trespassers.

The general layout of each well pad (WS-A, WS-B, WS-D, and WS-E) and infrastructure is described in **Appendix E**.



- Logistics;
- Maintenance and stores;
- Mess;
- Water and sanitation;
- Genset; and
- Fencing

A small temporary workshop will be built at the site to provide routine maintenance and minor repair of vehicles and machinery at the well pad. All fuels and lubricants retained at the workshop will be stored in accordance with Indonesian regulations. Waste materials including spent oils, batteries, filters and general waste will be managed in accordance with the existing waste management systems.

As discussed before, the main objective of geothermal exploration is to prove the existence of the geothermal reservoir and performs a capacity test of the wellbore. Physical and chemical characteristics of the reservoir are recorded to obtain assurance of the potential of Waesano geothermal activity and to determine the development and construction potential for geothermal power plant. A typical of geothermal exploration drilling is shown in Figure 3-11.

3-24

Project will select the third slimhole drilling well whether at WS-A or WS-E. In Phase 2, the Project will select one of those slimholes to be location for standard hole drilling.

During drilling activities, it potentially can increase noise and impacts to air quality. The duration for engine emissions and noise will be 24hrs/day for the drilling operation.

The source of noise:

- Rig engine, compressors, boosters, pumping unit engine;
- Power system (mechanical drive such as belts, chains, couplings);
- Rig vibrations from moving parts;
 - rotating system which include top drive or rotary table
 - hoisting system which include mast and substructure
- Pneumatic and hydraulic equipment to operate equipment.

The source of air emission:

- Particulates during mud and cement mixing (mud and cement chemical dust);
- Engine exhaust (carbon monoxide, fly soot);
- Downhole gases discharged at shaker (carbon dioxide, H₂S, methane (decomposed organic matters);
- Water vapour (steam kicks).

The description of slimhole and standard hole are discussed below.



Source: <https://petrominer.com/>

Figure 3-11 Typical of Geothermal Exploration Drilling Rig in Indonesia

3.2.8.1. Standard Drilling

The depth of drilling may reach 1,500m to 2,500m, depending on the depth of the geothermal reservoir. Exploration wells are, therefore, often drilled deeper than typical production wells because of the need to get down to the basement level and determine the thickness of the permeable geothermal layers. The diameter of exploration wells depends on the drilling design, to be drilled with casing diameter less than 6" or full-size wells (9 $\frac{5}{8}$ " diameter production casing set within larger diameters at shallower depths).

The upper stages of each borehole are drilled with progressively smaller bore diameters. This minimises the risk of blow-outs by avoiding drilling an open hole deeper than the surface equipment (blow-out preventer) can contain, and more importantly, enables the casing of the side walls to seal off the upper strata from the inside of a well.

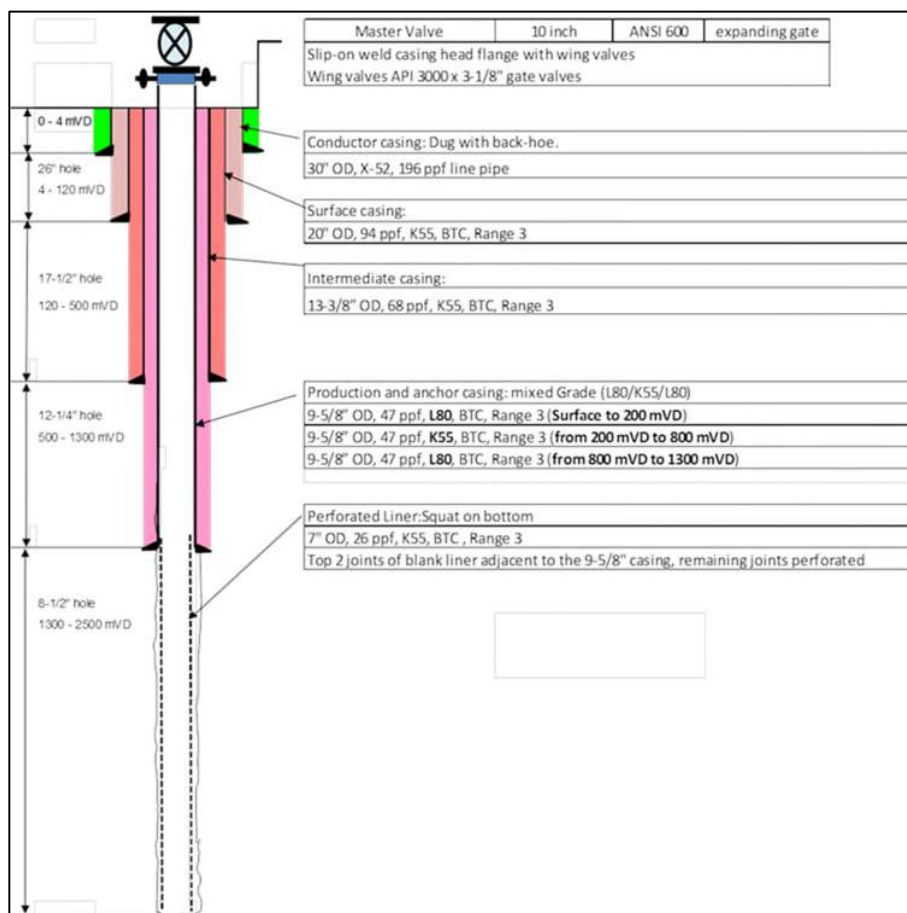
Important elements of the upper strata, such as groundwater aquifers, will therefore not be exposed to contamination from drilling mud and geothermal fluids that are moving up and down the well and will be guarded against subsurface blowouts into voids during the testing phase.

Drilling will take into account lithological rock formations, the pressure to be traversed, and will be conducted in accordance with standard operating procedures that apply to geothermal drilling activities. In geothermal drilling activity, it is common to experience the loss of drilling fluid circulation because of losses into the formation. Therefore, the loss control material should also be prepared, such as mica which is used to fill in the gaps, water, rice husks, etc.

To avoid the possibility of high pressure bursts during drilling, a Blow Out Preventer (BOP) will be mounted at the surface. In the event of bursts, the BOP will automatically shut down the well surface. Performance of the main valve and pressure gauge will be checked periodically to ensure that all measuring instruments and reaction mechanisms (mechanical and electrical) functions properly and there are no leaks. In addition, if a blow-out occurred and the BOP is enabled, then the high pressure and temperature will be managed by injecting cold fluid/ mud through the secondary valve. A typical well section for standard drilling is shown in Figure 3-12.



Figure 3-12 Typical of Standard Drilling Machine (Truck-Mount Type)



Source: Jacobs, 2017

Figure 3-13 Typical of Well Section for Standard Drilling

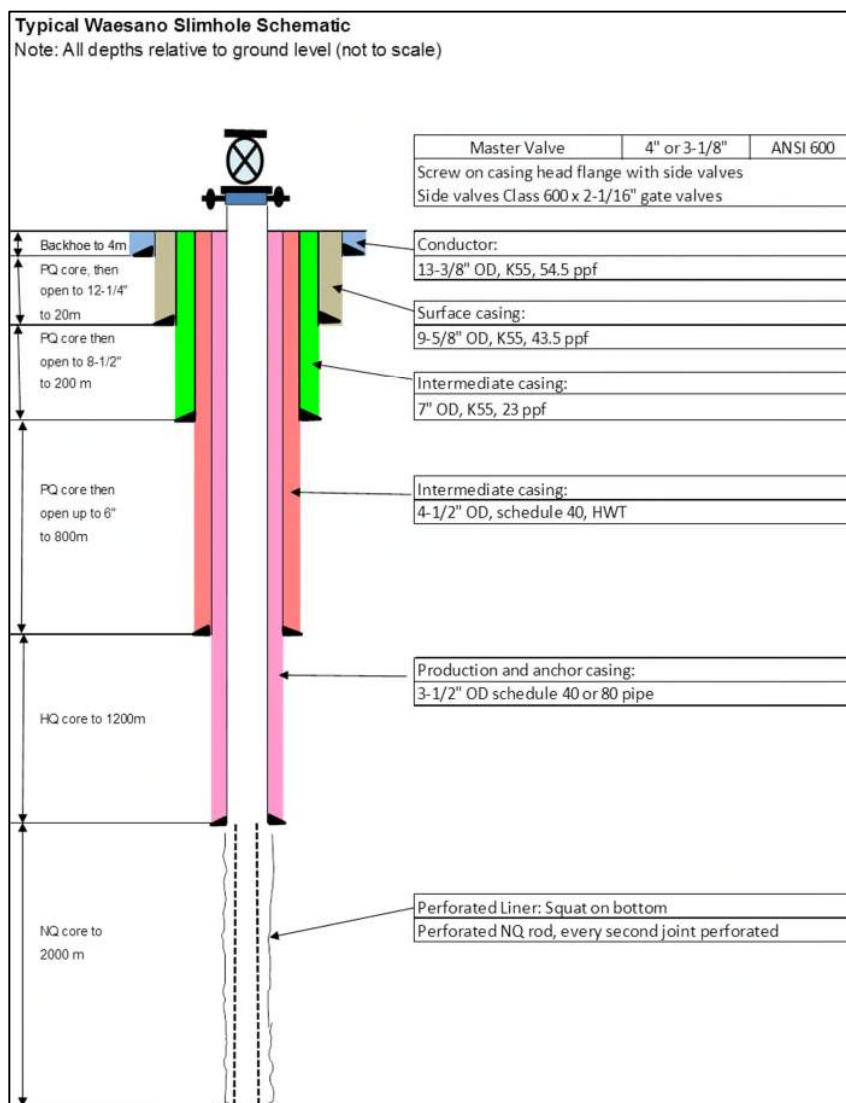
3.2.8.2. Slimhole Drilling

The depth of slimhole drilling may reach to 2,000m, depending on the depth of the geothermal reservoir. The diameter of exploration wells depends on the drilling design, to be drilled with a casing diameter of approximately 3". A typical truck and well section for slimhole drilling is shown in Figure 3-14 and Figure 3-15.



Source: <https://industriamarketing.com.au/>

Figure 3-14 Typical of Drilling Truck for Slimhole Drilling



Source: Jacobs, 2017

Figure 3-15 Typical of Well Section for Slimhole Drilling

3.2.8.3. Water Supply

A reliable water source is required to service the peak demand at any one well pad during drilling operations. Investigations into potential water sources and locations have been considered and it has been concluded that lake water from the Lake Sano Nggoang will be utilized as raw water for drilling purposes. Other water sources such as surface water or groundwater were dropped due to unreliable flows (low / no flow in dry season or insufficient hydrological information). The lake water is acidic and therefore requires treatment by using caustic soda, which is supplied in liquid form to neutralise the acidic water.

The lake water is taken by a suction lift pump, and then transferred to the temporary water treatment facility, which is located in an open area between Pad A and B. A similar facility will be provided at the Drilling Camp to facilitate water distribution to Pad D (or E, depending on the drilling sequence). Since the lake water is acidic, the pump material shall be selected to handle acidic water.

The lake water will be pumped to the water treatment facility, where liquid caustic is added via an injection quill for neutralizing the acid. To enhance the dosing, the water will be passed through a static mixer, prior to being stored in a storage tank, which is fabricated from a 20 ft container.

The water treatment facility will be constructed as a temporary and mobile installation so that the intake pump, chemical dosing equipment and water distribution pump can be moved between the two facility locations when required. The temporary facility includes utilising a Victaulic pipe which can be reconfigured according to operational requirements.

The treated water from the storage tank will be distributed to the required well pads, depending on the drilling sequence requirement. Besides the treated water distribution requirement for drilling activities, there will also be a requirement to transfer brine in between well pads for injection.

The water amount needed for drilling as shown in Table 3-10.

Table 3-10 Water Requirement for Drilling

Water Requirement	Slimhole Drilling	Standard Drilling
Peak discharge	250gpm (0.0158 m ³ /s)	1100gpm (0.0694 m ³ /s)
Average discharge	80gpm (0.005 m ³ /s)	550gpm (0.0347 m ³ /s)

Source: JACOBS, 2017

Generally, water lake pumping will be continuously undertaken in line with drilling operation. Likely duration of water take pumping could not be estimated in months or weeks. It will depend on water demand during the drilling operation demand.

At this time, the plan for provision of clean water for civil contractor base camp and drilling base camp will be supplied by tank truck where the water is taken from water source that does not interfere with the availability of water for the needs of the local community in coordination with related local institution. Based on the number of workers and the standard water requirement for medium cities, it is assumed the total domestic water requirement of 120 liters / person / day, thus the total water requirement can be calculated as follows:

- During construction: 120 liters / person / day x 96 persons = 11,520 liters / day or 11.52 m³ / day;
- During operation for slimhole drilling: 120 liters / person / day x 45 persons = 5,400 liters / day or 5.4 m³ / day;
- During operation for standard drilling: 120 liters / person / day x 92 persons = 11,040 liters / day or 11.04 m³ / day.

3.2.8.4. Drilling Chemicals

Based on lithologic and targeted drilling depths for the each well, the material needs will be the same. Materials for drilling mud include water mixed with bentonite (for the increase in mud viscosity), and certain materials such as Barium Sulphate (to increase the density) and others (see Table 3-11). Note that not all of these additives may be present in the drill fluid that will be used for this project. The supply of drilling mud and cementing materials will be carried out by expert contractors in this field. Caustic soda requirements for drilling are described in Table 3-15.

Table 3-11 Chemical Requirement for Drilling

No	Typical Name	Primary Application	Packing	Approx. Quantity per Std. well
1	Bentonite	Viscosifier	50 lbs bag x 48 bag (1200 x 1000mm) pallet	80,000 kg
2	Barium Sulphate	Density control		45,000 kg
3	Mixed Media LCM	Lost Circulation Control	100 lbs bag x 40 bags (1200 x 1000mm) pallet	Variable
4	Causticised Lignite	Lost Circulation Control & Deflocculant	50 lbs bag x 50 bag (1200 x 1000mm) pallet	1,500 kg

No	Typical Name	Primary Application	Packing	Approx. Quantity per Std. well
5	Chrome Free Lignosulphonate	Fluid loss & rheology control	50 lbs bag x 50 bag (1200 x 1000mm) pallet	500 kg
6	Mono Ethylene Glycol	Stuck Pipe Lubricant	50 lbs bag x 50 bag (1200 x 1000mm) pallet	100 kg
7	High molecular weight Polymer	Viscosifier, and fluid loss control additive	55 gal steel drum x 4 drum per (1200 x 1000mm) pallet	1,200 kg
8	Calcium Hydroxide	Flocculant	55 lbs bag x 50 bag (1200 x 1000mm) pallet	500 kg
9	Anionic Acrylic Copolymer	High Temp Dispersant, deflocculant	50 lbs bag x 40 bag (1200 x 1000mm) pallet	150 kg
10	Bacterially produced Polymer	Viscosifier	50 lbs bag x 40 bag (1200 x 1000mm) pallet	150 kg
11	Sodium Hydroxide	pH control	55 lbs bag x 50 bag (1200 x 1000mm) pallet	700 kg
12	Salts	Formation inhibition	"Solid form for drilling- 55 lbs bag x 50 bag (1200 x 1000mm) pallet	10,000 kg
13	Walnut shells Cellulose fibre	Lost Circulation Control	Liquid form for water supply- in 1 cu meter x 100 totes"	Variable
14	Sodium bicarbonate	Calcium removal	55 lbs bag x 50 bag (1200 x 1000mm) pallet	1000 kg
15	Magnesium oxide Zinc oxide	pH & H ₂ S control	55 lbs bag x 50 bag (1200 x 1000mm) pallet	<1mT
16	Tetra methyl phosphonium	Prevent bacterial decay of polymers	55 lbs bag x 50 bag (1200 x 1000mm) pallet	0-200 L
17	Sodium sulphite	Oxygen scavenger	55 lbs bag x 50 bag (1200 x 1000mm) pallet	
18	Citric Acid	pH control	5 gal pail x 54 pail in (1200 x 1000mm) pallet	
19	Filming Amine	Corrosion control	55 lbs bag x 50 bag (1200 x 1000mm) pallet	

Source: JACOBS, 2017

Table 3-12 Cement and Additives

Typical Name	Primary Application	Packing	Common / Brand Name	Delivery / Storage at Site
Local API Class "A" Cement	cement for cement grouting and remedial cementing job	60 lb bag x 56 bag (1200 x 1000mm) pallet	Holcim cement	Container van
API Class "G" Cement	cement for primary cementing job	94 lb bag x 40 bag (1200 x 1000mm) pallet	Holcim cement	Container van
Silica Flour	additives - avoid high temperature strength retrogression	110 lb bag 40 bag (1200 x 1000mm) pallet	Silica sand, Micro Silica, Silica Fume	Container vans for storage onsite. Open storage is
Cement Friction Reducer Additive	additives - cement rheology control	55 lbs bag x 50 bag (1200 x 1000mm) pallet	Different providers such as Messina,	acceptable, ONLY IF, lay-down area is
Cement Dispersant Additive	additives - cement rheology control	55 lbs bag x 50 bag (1200 x 1000mm) pallet	Tempo, Halliburton, Baker	designed to avoid flooding, materials
Cement Fluid Loss Additive	additives - fluid loss control	55 lbs bag x 50 bag (1200 x 1000mm) pallet	Hughes, COSL usually name the	are palletized, elevated from
Low Temperature Retarder	additives - Low Temperature Retarder	55 lbs bag x 50 bag (1200 x 1000mm) pallet	chemical as alphanumeric	ground, and fully covered with

Typical Name	Primary Application	Packing	Common / Brand Name	Delivery / Storage at Site
High Temperature Retarder	additives - High Temperature Retarder	55 lbs bag x 50 bag (1200 x 1000mm) pallet	code , distinct to providers	tarpaulins.
Calcium Chloride	additives - cement slurry accelerator (surface hole)	55 lbs bag x 50 bag (1200 x 1000mm) pallet		Delivery to Site at 19 pallets per flatbed truck-covered in tarpaulin, or in container van.
Cement Defoamer	additives - liquid surfactant	5 gal pail x 54 pail in (1200 x 1000mm) pallet		
Cement Anti-Settling Additive	additives -Anti-Settling	5 gal pail x 54 pail in (1200 x 1000mm) pallet		Drilling Contractor has option to maintain an off-site covered warehouse for the whole inventory required for the drilling campaign.
Sodium Silicate	additives - fluid loss control and loss circulation materials	55 gal steel drumx 4 drum per (1200 x 1000mm) pallet	Zonelock, Flocheck	
Lightweight additive	additives - Lightweight additive	90 lb bag	Cenosphere	
Free water Additives	additives - free water control	55 lbs bag x 50 bag (1200 x 1000mm) pallet	Coded based on supplier	

Source: JACOBS, 2018

Table 3-13 Diesel Fuel and Lubricant

Typical Name	Primary Application	Packing	Common / Brand Name	Delivery / Storage at Site
Diesel fuel	Drive rig equipment, water pumps, service vehicles	Pressure-tested and lined diesel fuel tank at drill pad and water supply	Local fuel	Diesel tank banded and lined with HDPE or thick plastic sheet to contain spills. Delivered to Site in 20,000 li fuel truck. Delivered to water pumps in bulk or in steel drums.
Lubricant	Rig equipment	55 gal steel drumx 4 drum per (1200 x 1000mm) pallet	Lub (Assorted)	Stored separately, area banded and lined with plastic sheet, with appropriate Hazard signage

Source: JACOBS, 2018

Table 3-14 Water Treatment Chemicals

Typical Name	Primary Application	Packing	Common / Brand Name	Delivery / Storage at Site
Caustic Soda (Sodium Hydroxide)	pH control	Liquid form 932% conc) for water supply treatment - in 1 cu meter totes	Caustic soda	Delivered in totes (see note below) by truck, stored in banded HDPE lined area. Transferred between laydown area and water treatment plant by truck.

Source: JACOBS, 2018

Table 3-15 Caustic Soda Requirement for Drilling

No	Drilling Condition	Slimhole Drilling (L/week)	Standard Drilling (L/week)
1	Peak	9000	35000
2	Average	2800	17000

Source: JACOBS, 2017

3.2.8.5. Drilling Equipment

Drilling equipment for exploration activity include a rig, mud pumps, drilling fluid circulating system, air compressors, BOP, cementing unit and other drilling equipment as presented in Table 3-16.

Table 3-16 Drilling Equipment (Standard Well)

No	Equipment	General Description
1	Draw works	Input: 1100 HP Electrical system: Electric and Mechanic
2	Mast	Height: 142 ft (treble) or 90 ft (super single)
3	Tubular Handling Equipment	Pipe spinner: hydraulics or pneumatic
4	Rotary system	Top drive or power swivel Minimum rating: 1000 HP Load rating: 250 Ton
5	Blow Out Preventers (BOP) Equipment	Including: large & small annular BOP, large & small double ram BOP, large & small mud cross, HT manual gate valve (4 pcs), HT HCR valve (1 pc), check valve (1 pc), adaptor flanges and BOP control unit
6	Auxiliary Power Generation	Output: 2 unit x 250 KVA Volt: 400 AC
7	Mud Pumps	Minimum Combined 2400 HP Number of pumps: 3 unit x 875 HP or 2 unit x 1300 HP
8	Solids Control / Mud System	Shaker type: derrick linear motion Number of shakers: 3 units Mixing hoppers: 2 units
9	Safety Equipment	Including: 3 H ₂ S sensor alarm system, SCABA
10	Tubular	Including: small and large drill pipe, drill collars, heavyweight DP, FS O'shots and access, fishing magnets, junk subs and RSJB, junk mills
11	Others	consist of: analog and digital instrument, rig site accommodation, driller/ tool pusher and water supply system

Source: JACOBS, 2017

3.2.8.6. Drilling Mud and Drilling Cuttings

Drilling mud is the fluid used in geothermal drilling. Drilling mud serves as a lubricant that reduces friction on the cutting bits and prevents congestion on the drilling shaft when it reaches the narrower part of the well body. The drilling activity will used water-based mud. In addition, drilling mud also uses other materials as additives. This material can be solid and liquid to function as ballast, viscofier, pH netraliser, and other additives. Drilling mud has the potential to be the one of the largest uses by volume due to fluid requirements for drilling wells with depths of about 1,500 to 2,500 m.

Drilling cuttings are a strip of rock formation and / or other material that is removed from the borehole during geothermal drilling. It can be separated from the drilling fluid via shale shakers, and the liquid fraction returned to the drilling mud tanks prior to reuse. The shale shaker is composed of a series of vibrating screens that remove the coarse-grained cuttings from the fluid. At the inlet the material is dispensed evenly across the vibrating screens.

The screens only allow solid particles of a certain size to pass through. The movement of the vibrating screens is designed to transport the oversize solids (drill cuttings) to the discharge end of the shaker. Several screens of varying sizes may be used to remove solids of different diameters. The estimated production of drilling mud and drilling cuttings for slimhole and standard drilling can be seen in the following table.

Table 3-17 Estimated Production of Drilling Mud and Drilling Cuttings

No.	Drilling Waste	Standard Drilling	Slimhole Drilling
1	Drilling Mud	3700bbls (440 m ³)	3700bbls (440 m ³)
2	Drilling Cuttings	400 m ³	55 m ³

Source: JACOBS, 2017

According to Ministry of Energy and Mineral Resources Regulation Number 21 of 2017 on Waste Management of Drilling Mud and Drilling Cuttings on Geothermal Activities mentioned that drilling mud and drilling cuttings from geothermal drilling using water and / or air substances are not included in the category of Hazardous Waste.

3.2.8.7. Drilling Waste Management

Drilling Sump

A typical well pad layout is shown in **Appendix E**; this shows a water/mud sump with a total capacity of approximately 3000 m³. The sump design for Waesano is to install a clean water divide in order to contain any solid waste produced by the drilling process. The drilling sump will be lined with HDPE to ensure that no leaching to soil or groundwater can occur through the base of the pond (refer to Figure 3-16).

Prior to reaching the drilling sump solids produced by the drilling process will be segregated using shale shakers and a solids control system, and gathered within a temporary storage facility, prior to being removed to a permanent drilling waste disposal facility. It is anticipated that the temporary storage facility at each well site will comprise a concrete lined cuttings pit with a drain that is connected to the drilling sump. For slimhole drilling, the waste volumes are expected to be small and so a designated HDPE lined temporary stockpile area will be provided next to the well pad. The drilling mud extracted at the shale shaker unit will be recycled back into the drilling fluids system to be re-used for the ongoing drilling process.

Following the completion of the drilling process any residual drilling waste (rock fines, bentonite mud) residing within the drilling sump will be removed using an excavator to prepare the sump for holding geothermal brine during well testing. The residual sump waste will be taken to the permanent waste disposal site where it will be added to the waste streams produced from other drilling locations.

Drilling mud and drilling cuttings from geothermal drilling (using air/aerated fluid or water based substances), by default, are not classified as hazardous waste, in accordance with Ministry of Energy and Mineral Resources Regulation Number 21 of 2017 relating to the management of drilling mud and drilling cuttings for geothermal activities. Notwithstanding this, sampling and laboratory testing of drill mud and drilling cuttings will be undertaken as a precautionary measure. If testing indicates that the drill mud and drilling cuttings material is classified as a hazardous waste it shall be handled and stored (temporarily) in accordance with the Indonesian standards for B3 hazardous waste, and ultimately disposed of off-site by a licensed hazardous waste operator to a licensed hazardous waste management facility. The required testing of drilling waste and reporting of results is further described in Waste Management Procedure below.

It is further noted that it may be possible for the drilling cuttings waste material to be used to produce construction materials such as concrete, retaining wall materials, or additives for bricks (in accordance with Annex II and III of Regulation of the Ministry of Energy and Mineral Resources No.21 of 2017), if the material is deemed suitable for use by a geotechnical engineer. However, given the relatively low waste volume anticipated during the initial exploration drilling stage and uncertainty of the amount of suitable quality rock it is considered unlikely to be worthwhile establishing a process for using the waste for construction purposes.

Other measures that will be implemented at each well pad to contain any wastes or potentially hazardous materials produced during the drilling process include:

- Construction of perimeter drains around the pad boundaries to prevent any offsite migration of contaminants due to rainfall run-off. This run-off will pass through an oil/water separator before discharging to the sump;
- Control of drilling sump level to avoid any overflow. A drain pipe and valve will be provided from the sump to facilitate draining the sump when required; and
- Containment of hazardous materials (e.g. fuel, mud additives) in secure areas, including effective sheltering from the weather, and with bunding to contain any spillages.

Permanent Waste Disposal Site

Subject to laboratory confirmation that the drilling waste produced from the Waesano drilling is not classified as hazardous, it will be consigned for permanent disposal within a landfill facility. The landfill facility will be located within the project area and its siting and construction design will take into account local geotechnical, hydrogeological and social/environmental considerations. Key features of the landfill will include:

- Sizing to sufficiently contain the maximum anticipated volume of all solid drilling waste produced during the exploration drilling phase including backfilling with topsoil as part of site reinstatement;
- Installation of impermeable liner to prevent infiltration of any waste products into the soil and groundwater system beneath the landfill. This will be the same liner material planned for the drilling sumps (as shown in Figure 3-16);
- Perimeter drains to intercept any overland flows into the landfill during rainfall run off events;

Burial of waste to at least 2 m below ground surface to minimise any potential surface exposure to the environment. This will be achieved by placing a low permeable cap 10^{-7} cm/s) on top of the landfill waste and covering it with top soil as part of the site reinstatement process.



Source: (SMI, 2018)

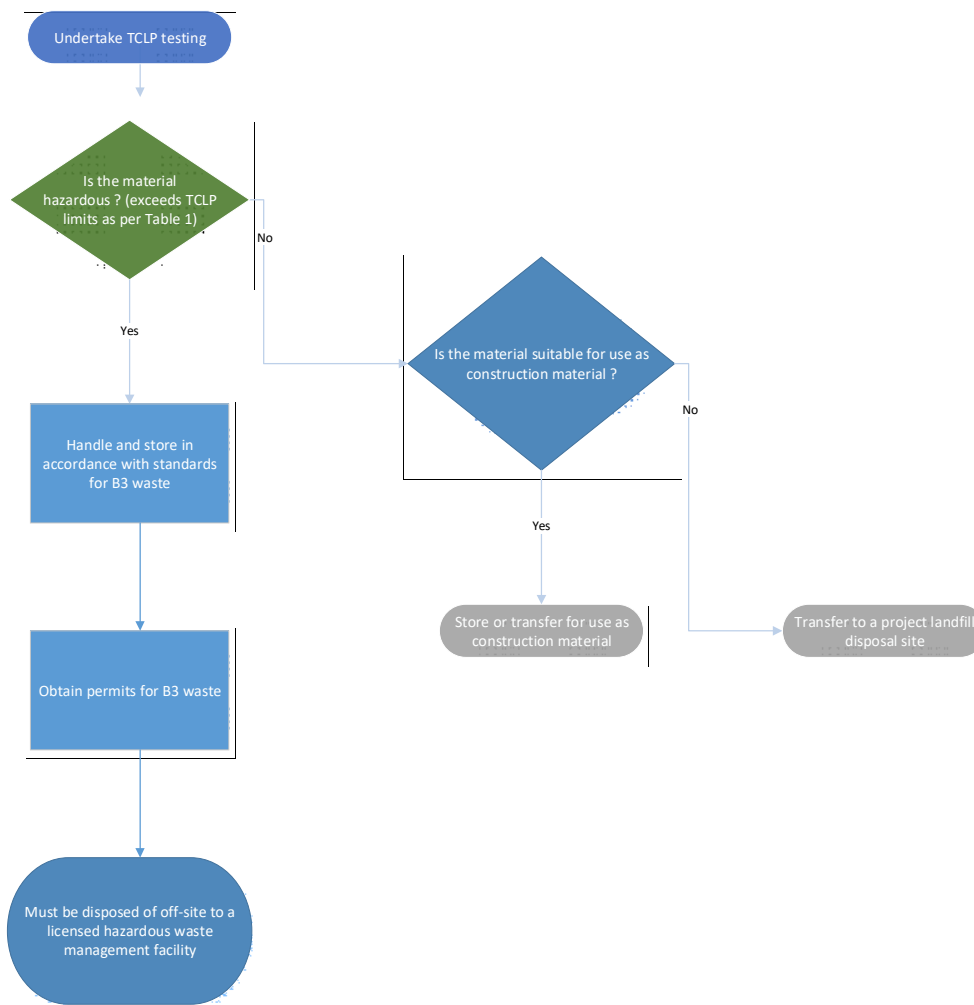
Figure 3-16 Typical Drilling Sump for Conventional Wells with Impermeable Lining and Clean Water Divide Structure

Waste Management Procedure

A number of measures will be put in place to manage and avoid potential adverse impacts associated with the use, storage and disposal of drilling mud and drilling cuttings waste. The measures outlined below are focused on the prevention of adverse outcomes, as follows:

- Safety Data Sheets (SDS) for all drilling mud and drilling fluids shall be provided and reviewed to determine that they comply with the Geothermal Waste Regulations as not containing hazardous substances;
- Drilling sumps must be lined with an appropriate material to prevent discharge to soil, groundwater and waterways. The drilling sumps must provide sufficient volume and should not be compromised. During drilling storage capacity must be checked hourly and a predetermined level must be set to trigger disposal (e.g. sumps must be maintained at or below 80% capacity);
- Representative drilling mud and drilling cuttings will be laboratory tested using Toxic Characteristic Leaching Potential (TCLP) testing technique. TCLP testing is to be undertaken in accordance with US-EPA Method 1311 or as set out in the Indonesian Hazardous Waste Regulations No. P. 63 of 2016. As a minimum one sample should be taken per 50m³ of waste material in the drilling sump. The results of these tests will determine how the material is stored and disposed of:
 - If TCLP testing indicates that the material is classified as a hazardous waste (exceeds the limits set out in Table 1 of this plan) it shall be handled and stored in accordance with the Indonesian standards for B3 waste.
 - Hazardous waste must be stored in an appropriate manner to prevent discharge to soil, groundwater and waterways;
 - All relevant permits and approvals from authorities must be obtained with regards to B3 waste;
 - The volume of any hazardous waste stored on site should be minimised by increasing the frequency of pick-ups where necessary. The producer of hazardous waste may store hazardous and toxic waste on-site for a maximum of 30 days, and such waste must be located in a weather proof and secure facility with bund structures to contain any spills or leaks;
 - Hazardous waste shall be disposed of off-site by a licensed hazardous waste operator to a licensed hazardous waste management facility.
- If testing confirms that the material is non-hazardous the drilling mud and drilling cuttings can be consigned for permanent disposal within a landfill facility located within the project area. Alternately if the material is determined appropriate by a geotechnical engineer, it could potentially be used to produce construction materials;
- Adequate waste transportation procedures shall be implemented to ensure accidental release does not occur during transfer of drilling mud and drilling cuttings. Material must be transported within appropriate containment structures and clearly labelled;
- In the event of a spill (oil or mud), during drilling or transportation, the spill is to be contained and appropriately remediated. Spill kits will be located on site, near site works. Containment methods will depend on spill site factors including the size of spill, location of the spill and the receiving environment. All staff shall be appropriately trained on how to use the spill kits and their location on the well pad must be clearly sign posted;
- The well pads will all be designed with perimeter drains to prevent off site migration of any wastes, including unforeseen spill events. The drains shall be designed to handle anticipated rates of overland flow that could occur during heavy rainfall events at the site, all drains will pass through an oil/water separator before discharging to the sump.

Figure 3-17 describes drilling mud and drill cuttings disposal flow chart.



Source: (SMI, 2018)

Figure 3-17 Drilling Mud and Drill Cuttings Disposal Flow Chart

3.2.8.8. Domestic Waste

Geothermal activities will produce liquid waste and solid waste including organic wastes and domestic waste during land clearing and preparation, access road improvement, well pad and infrastructure development, drilling activity as well as well testing. The UKL-UPL report estimates the number of workers will be approximately 96 persons during construction phase and 92 persons during operation phase include proponent project staffs. These people will generate various domestic waste items. Typical average volume of domestic waste generation in Indonesia is 2.5-2.75 liters / person / day or 0.625 – 0.70 kg / person / day (SNI 19-3983-1995⁷). Meanwhile, typical volume of wastewater is 80%⁸ of total water consumption; a worker will produce 96 liters / person / day.

Domestic waste reduction will be applied prior to waste disposal as much as possible. For example: use dispenser for drinking water instead of bottled water. On well pad areas and at the base camp, waste will be segregated and stored by organic and non-organic waste before being taken to the waste temporary storage (*Tempat Pembuangan Sementara/TPS*). Composting of organic waste will be applied whenever possible and reuse non-organic waste whenever possible before being sent to the nearest local final disposal area (*Tempat Pemrosesan Akhir/TPA*) in Labuan Bajo in coordination with Local Environmental and Cleanliness (DLHK).

⁷ SNI 19-3983-1995 regarding Specification of Waste Generation in Small and Medium City

⁸ Tchobanoglous and Burton, 1991

In terms of liquid waste, the well pads and road construction areas will be served by portable toilets. Portable toilets would be cleaned daily and discharge taken to the septic tank.

Toilets and septic tanks will be located away from sensitive spring water resources and surface water bodies (lake water) as far as practicable.

3.2.8.9. Hazardous Waste

The hazardous wastes from drilling activities may be come from remnants of contaminated oil-cotton waste as well as residual fluorescent lamps (TL), used batteries, solvents and contaminated containers. The procedures for hazardous wastes handling will refer to Government Regulation No.101 of 2014 on the Management of Hazardous Waste. The waste storage procedure will refer to the Bapedal Decree Number 01 of 1995 on Technical Procedures and Requirements for the Storage and Collection of Hazardous Waste.

Hazardous wastes will be stored within appropriate containers with packaging made from suitable materials in accordance with the characteristics of the hazardous waste. All containers of hazardous waste will be equipped with hazard symbols/ warning signs and labels refer to Minister of Environment Regulation Number 14 of 2013 on The Hazardous Waste Symbol and Label. Hazardous waste must be transported and disposed at a licensed hazardous waste management operator sites for the type of hazardous waste.

3.2.9. Well Testing

Where possible, both slimhole and standard wells will be flow tested after completion of drilling to measure the fluid characteristics of the reservoir at that location.

During well testing, there will be a horizontally discharge of steam from the top of the Atmospheric Test Tank (also called a Silencer), which will be accompanied by geothermal gas (mostly CO₂ and H₂S). In this tank, the two phase fluid will be separated into steam and brine. The gas will tend to lifted by the steam plume and disperse safely, although gas monitoring equipment will be used to confirm that safe levels of gas are not exceeded at ground level. The brine shall be directed out of the bottom of the tank via a measuring weir and into the well pad sump.

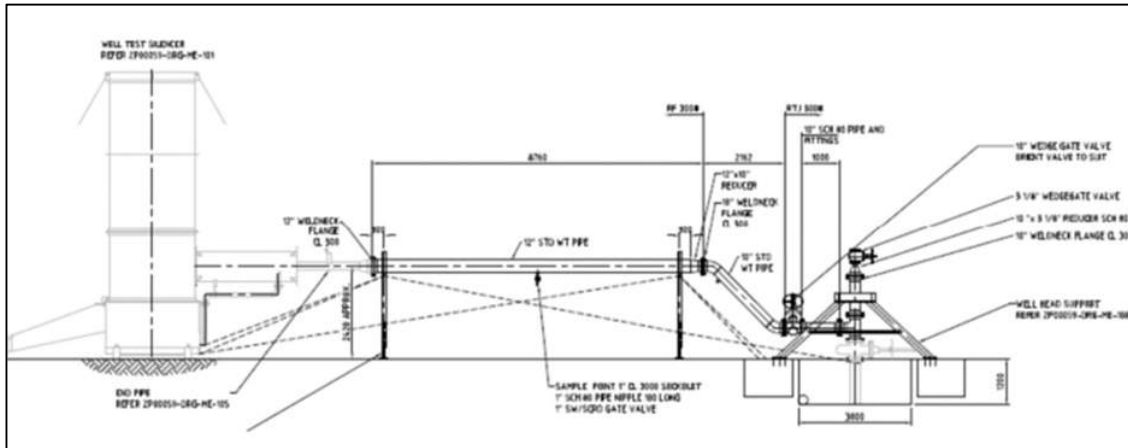
The duration of well testing will vary with the type and size of well (slimholes typically 1 week and standard size wells typically about 1 month). During the testing period, the flow rate being discharged from the well will vary from full discharge down to perhaps 20% discharge for standard wells (limited from time to time by the available injection capacity), while the slimholes will more likely be discharged at full capacity.

At regular intervals or continuously during flow testing, the liquid in the well pad sump shall be transmitted to other completed wells in the field for injection. Transmission shall be via carbon steel piping with propulsion pumps or gravity (if possible).

During normal drilling operations there will be minimal air discharges, although some hydrogen sulphide (H₂S) may be released from the mud tanks (the drilling rig contractor will provide monitoring equipment to detect and warn of abnormal levels of H₂S) and there may be some steam evolved from the mud tanks if the downhole temperature is high. In the event of a “kick” from the well, which would tend to discharge well bore fluid comprising drilling fluid, steam and brine, a diverter on the rig would direct any discharge away from the rig floor and towards the mud tanks. If the kick persists or is excessive then the blow out preventer equipment will be operated to isolate the well and prevent further discharge. The kick will then be controlled by pumping cold water into the well bore in order to de-pressurise the bore.

The impact of air quality degradation is caused by the discharge of downhole gas (H₂S) in the shaker and steam kicks area. H₂S gas dissolved in air that requires aerosols, like mist, will be lit with atmospheric oxygen to form more oxidized sulphur-containing compounds.

A schematic of the well test equipment set-up is shown in Figure 3-18.



Source: Jacobs, 2017

Figure 3-18 Typical Configuration Flow Testing

3.2.10. Site Closure

Wells that have been drilled and successfully tested to demonstrate an economical capacity, will then be temporarily shut-in. If the evaluation results conclude that the geothermal resource is adequate to produce energy and there is sufficient demand for additional power generation in Flores, then these resources can be further developed. However, if the evaluation results do not demonstrate economical steam, then the wells will still be shut in, but consideration will be given to future use for injection or monitoring purposes.

If overall the exploration program does not indicate an economically developable resource, then the wells will be plugged and abandoned.

The development (exploitation) will take place after the exploration project in Waesano is completed. Activities at the exploitation stage will likely include activities which have been mentioned above for the drilling of further construction wells, the construction and operation of power plants geothermal steam and brine pipelines, access roads and transmission lines and then the ongoing resource exploitation activities (abstraction and the use of geothermal steam and reinjection of separated brine), plus possible drilling and testing of make-up wells in the future.

3.2.11. Site Rehabilitation and Revegetation

Following completion of the exploration drilling program, the site rehabilitation plan will depend on whether the exploration results indicate that the project can be developed, or the prospect should be abandoned.

If the project is to be developed, then the exploration team will clean the site, removing and disposing of any debris as appropriate to the nature of the debris. Surplus materials (e.g. mud or cement chemicals and drilling consumables) will be removed by the drilling service contractor(s) and returned to their inventory. Some long lead materials may be retained by the Contractor and taken for use on subsequent projects. All drilling sumps will be drained (liquids will be pumped back into wells), and the low level drains left open to prevent a build-up of rain water. All wellhead valves will be chained and padlocked shut. Any cuttings pits will be covered over with top soil and replanted. The site will be handed over to MEMR for ongoing maintenance and security until a subsequent develop is awarded the concession and takes responsibility for the site.

If the project is deemed undevelopable, then the exploration team will plug and abandon each well by running gravel into the well and following with a cement plug. The well head will be cut off at cellar floor level and the cellar walls broken up and removed down to the cellar floor. The cellar excavation will be filled with gravel to ground level. The surface of the well pad will be ripped with a bulldozer to ensure free drainage and the surface will be covered with a layer of top soil, typically 150 - 200 mm thick. The pad surface will be contoured to ensure drainage

and planted with suitable species (grass, shrubs or trees), to be selected in consultation with the local community (who may wish to be able to use the pad area for such activities such as football or for farming).

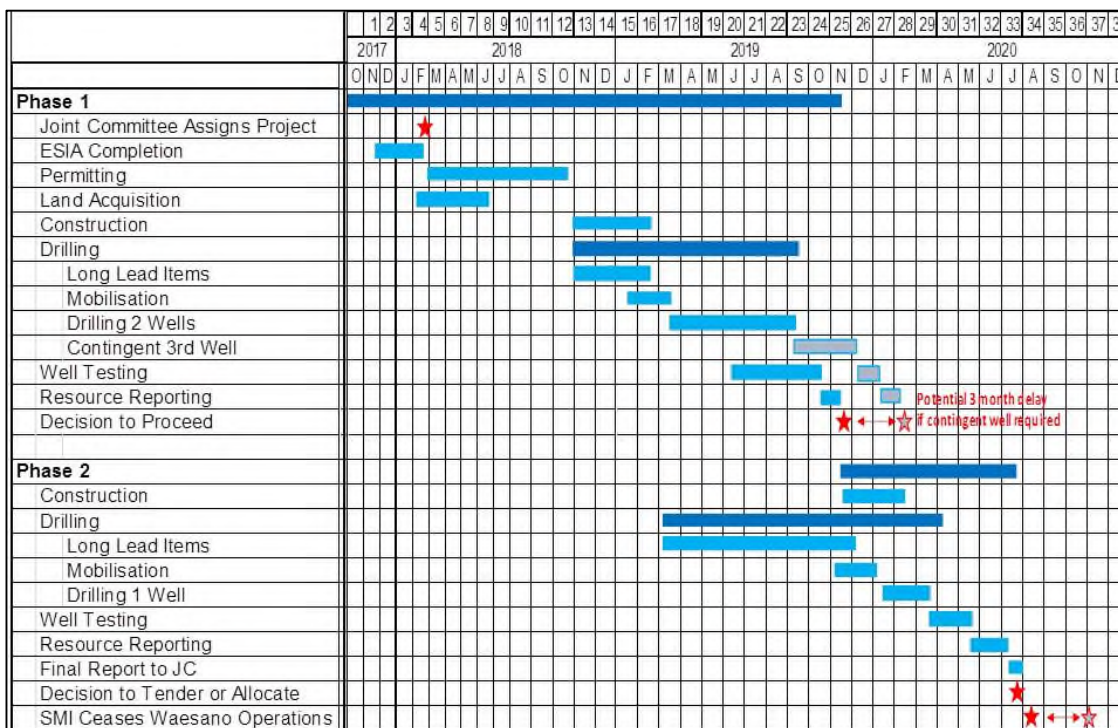
The well pad sumps will have their liners removed and the sump wall levelled down to existing ground level. The sump excavation will be filled with back-fill and a 150 – 200 mm layer of top soil and contoured as required. Any roads which the local community do not wish to retain will be ripped, spread with top soil and re-planted. Any permanent support buildings (such as warehouse or office) will be offered to the local community for their use – if they do not wish to use them then they will be demolished and the site covered in top soil and replanted. Cuttings pits will be covered with top soil and replanted.

3.3. Project Schedule

Based on project schedule provided by the proponent, construction of the proposed project would be divided into three main construction phases. The first construction phase is a road upgrade over three months from November 2018 to February 2019. The second construction phase is slimhole well pad construction taking place from November 2018 to February 2019. The last phase is standard well pad construction estimated to take approximately two months from November 2019 until January 2020. Two months activity to clean-up and finally secure the site, this will include rehabilitation of any locations that are not being retained for hand-over to a subsequent developer. Generally, the rehabilitation will be done by break up any concrete, back fill unused cellars and sumps and spread top-soil, the degree and details of rehabilitation to be agreed with individual land owners to whom Project Owner are returning the land.

Project schedule in detail is provided in **Appendix F** as per February 2018. The overall Project will be completed within 881 days. The project schedule is summarized in Table 3-18.

Table 3-18 Estimated Project Schedule



Source: PT SMI, February 2018

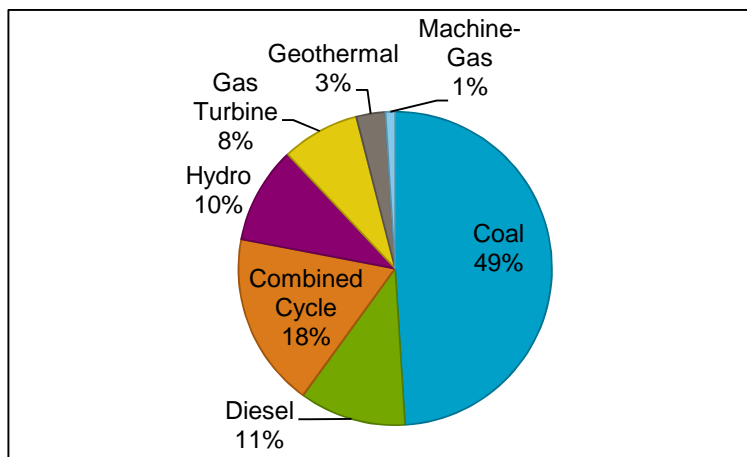
3.4. Project Justification and Alternatives

3.4.1. Project Justification

About 88% of Indonesia's population has access to electricity compared to less than 68% in 2010 (Directorate General of Electricity, Ministry of Energy and Mineral Resources, 2015). Eastern Indonesia lags behind the western area of the country, with some provinces such as West Papua only providing electricity to 45% of its population and East Nusa Tenggara, 58% of its population.

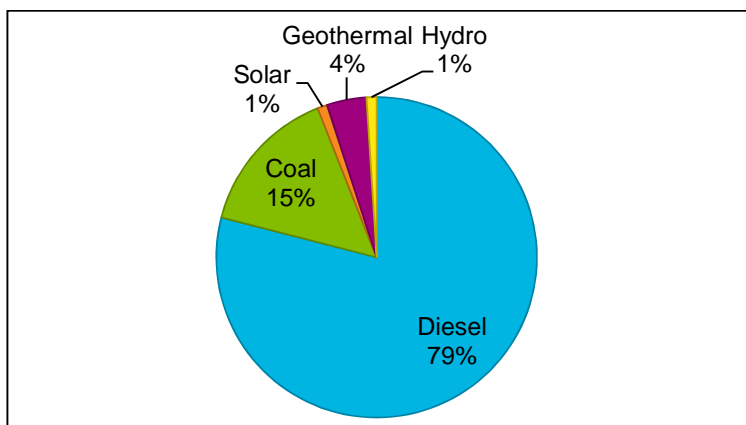
To meet the user demand, expansion of power plant installed capacity and further reaching transmission corridors are required. The power sector is quickly growing in order to meet these demands, primarily through the use of traditional energy sources. Indonesia's power generation capacity grew from 22.5GW in 2005 to 53GW in 2014, increasing to 55.5GW in 2015. The make-up of energy sources is shown in Figure 3-19 (Source: The Book of Electricity Statistics Number 29 of 2016). As shown, most electricity is generated from coal, with around 13% generated from geothermal and hydropower. In East Nusa Tenggara, 79% of electricity is generated from diesel, with around 4% generated from geothermal sources (Figure 3-20).

There is a growing global concern about the impacts of climate change and the anthropogenic contributing factors that have caused atmospheric warming. The burning of fossil fuels and the conversion of land use from forests to agricultural or grazing land are the two most significant factors that have increased global concentrations of CO₂, which is the main anthropogenic Greenhouse Gas (GHG) contributing to global warming, resulting in unprecedented levels of GHGs in the atmosphere. Primarily due to agriculture/land use change, global atmospheric concentrations of methane and nitrous oxide have also increased. Indonesia's contribution to global emissions is currently ranked number nine worldwide, in a three-way tie with the United Kingdom and Mexico. As Indonesia is the world's fourth most populous country, its per capita emissions are comparatively low. Eighty-one percent of Indonesia's emissions come from three primary sources: land use change (deforestation) (48%), the energy sector (20%), and peatland fires (13%).



Source: (Directorate General of Electricity, Ministry of Energy and Mineral Resources, 2015)

Figure 3-19 Indonesia Electrical Energy Sources (2013)



Source: (Directorate General of Electricity, Ministry of Energy and Mineral Resources, 2015)

Figure 3-20 East Nusa Tenggara Electrical Resources 2015

In order to address the threat of climate change and Indonesia's contributions to global emissions, the government has issued the National Action Plan to Reduce GHG Emissions (RAN-GRK). Former President of Indonesia Susilo Bambang Yudhoyono made a strong commitment to reduce GHG emissions by 26% by 2020, with an additional 15% reduction contingent upon international support. The plan focuses on several areas where reductions in emissions can be made including agriculture, forestry and peat lands, energy and transportation, industry, and waste handling. RAN-GRK provides guidance for the local government and other related institutions on GHG emission reduction planning. RAN-GRK includes a target for renewable energy of 4.4 million tons of CO_{2e} by 2020.

Taking into account the need to balance the energy needs of the country with the goal of reducing total emissions, the annual increase in power generation capacity is occurring against the backdrop of a commitment by Gol to increase the proportion of renewable energy in the country's energy mix from 7% in 2006 to 15% in 2025 via Presidential Decree No 5 of 2006. In 2014, this law has been updated in Government Regulation Government Regulation No 79 year 2014 stated in article 9 paragraph f.1 on National Energy Policy to increase the proportion of renewables to at least 23% by 2025:

- New and Renewable: $\geq 23\%$ (2025), $\geq 31\%$ (2050)
- Oil: $< 25\%$ (2025), $< 20\%$ (2050)
- Coal: $\geq 30\%$ (2025), $\geq 25\%$ (2050)
- Gas: $\geq 22\%$ (2025), $\geq 24\%$ (2050)

This new law clearly shows greater commitment by the government to support the development of renewable energy sources throughout Indonesia.

Many of the geothermal resources in Indonesia are also ideally located on islands with major population centers where electricity demand is high and continues to grow, though there are also resources in more remote locations such as Eastern Indonesia offering an opportunity for poverty alleviation through rural electrification, and/or displacing expensive diesel-fuelled generation.

The 2015 electricity statistics report (Directorate General of Electricity, Ministry of Energy and Mineral Resources, 2015) states that only a small amount of energy – 1,435 MW - was being generated from geothermal power. A report by the World Bank explains that low level of private sector participation is one of the reasons for the slower-than-desired geothermal development (World Bank Group, 2016). High resource risk is one of the key barriers exacerbated by exploration drilling costs. One of the solutions provided by Gol is giving mandate to PT SMI to finance and facilitate exploration drilling with a specific focus on the eastern islands.

3.4.2. Site Selection

The Waesano site location represents a number of factors which make it optimal for the development of a geothermal power generation facility.

The search for potential geothermal prospects is carried out through geological mapping, geochemical sampling of springs and streams along with geophysical surveying. The general location of geothermal power stations is initially constrained by the overall geothermal resource. However the physical footprint of the power station, well pads, and access roads required are small in comparison to the overall exploitation area. The use of directional drilling of wells to reach the geothermal resource allows for the adjustment of well cluster locations to minimize land acquisition and avoid resettlement and physical cultural resources or sensitive environmental features. At Waesano, the possible locations for the potential additional well clusters have been considered subject to a site selection process taking into account environmental and social considerations. In particular, PT SMI has not taken the option to develop more preferable locations from a technical drilling perspective in order to avoid sensitive areas of flora and fauna, the development of which would have caused in land severance issues and risk of more severe community impacts in the event of an accidental effluent discharge.

3.4.2.1. Initial Well Pad Selection

Initial planning provided to AECOM in April 2016 consisted of 6 Well pad sites, 1, 2, 3, 3', 4, and Well pad A', with preliminary geoscience studies identifying these locations as favourable for geothermal operations. Site surveys and evaluations were subsequently performed at each site (Figure 3-21).

Pad 1 – Located near Sano Nggoang Village in close proximity to an existing asphalt road which could be upgraded into a site access road. The site is comprised of a mix of flat areas and forested ridges, furthermore two houses on agricultural land are immediately adjacent/on-site. Further survey of the surrounding region will be needed to verify that these dwellings will not be impacted by drilling operations.

Pad 2 – Located near the Northern region of Wae Sano Village, the site is currently accessed via a small dirt track. Whilst the site itself is heavily forested in a somewhat mountainous area, significant land clearing works will be required as well as the construction of an access road for drilling equipment before the site can be considered ready for operations.

Pad 3 – The site is located in the Southern region of Wae Sano Village, in close proximity to village housing. A basic dirt track is the current access route to the location and will have to be upgraded to an appropriate access road. Investigation of the site suggested that the pad be moved to the west in order to prevent activities from impacting the local houses. The investigated area exhibited relatively flat terrain however dense vegetation and trees cover a large portion of the area and will require clearing.

Pad 3' – Investigated as an immediate westerly alternative to Pad 3, the site was considered in order to prevent disruption to the local houses of Wae Sano Village. Sharing the same current dirt track access route as Pad 3, which will again need to be upgraded during construction activities, the site is considerably steeper and ridged with denser vegetation and several large trees. Significant land clearing works will need to be completed before construction can commence in this area.

Pad 4 – Located to the East of Pad 1, the site is located in steep mountainous terrain. A narrow asphalt road runs in proximity to the site and could be upgraded into an access road for drilling equipment. However the road currently has agricultural rice plantations along certain areas, although the site itself currently only consists of a few trees with little other vegetation. Investigation of the surrounding area presented a possible alternative to the south-east with flat terrain and minimal vegetation needing clearing. This alternative is directly adjacent to the local health clinic and as such construction here would cause significant disruption to the local community.

Pad A' – The site is situated in the central region of Wae Sano Village, just off the eastern bank of Lake Sano Nggoang. A resort camp is located next to the site on the lake's edge, furthermore there appears to be no current access route for cars/trucks, therefore significant roadworks would need to be conducted linking the pad to the main access routes. The site itself is comprised of thick vegetation and large trees requiring more significant land clearing in conjunction with roadworks.

These initial sites exhibit significant topographical constraints at each site as well as existing local infrastructure being present. The Wae Sano region itself is comprised of steep, heavily ridged terrain which is densely forested in places, with occasional flatter areas often containing local structures such as houses/schools/community services/roads. Development of well pads in these in these initial areas would be exceedingly expensive and/or cause serious disruption to the local community. As such alternative well pad locations that presented as more socially and economically viable options were investigated.

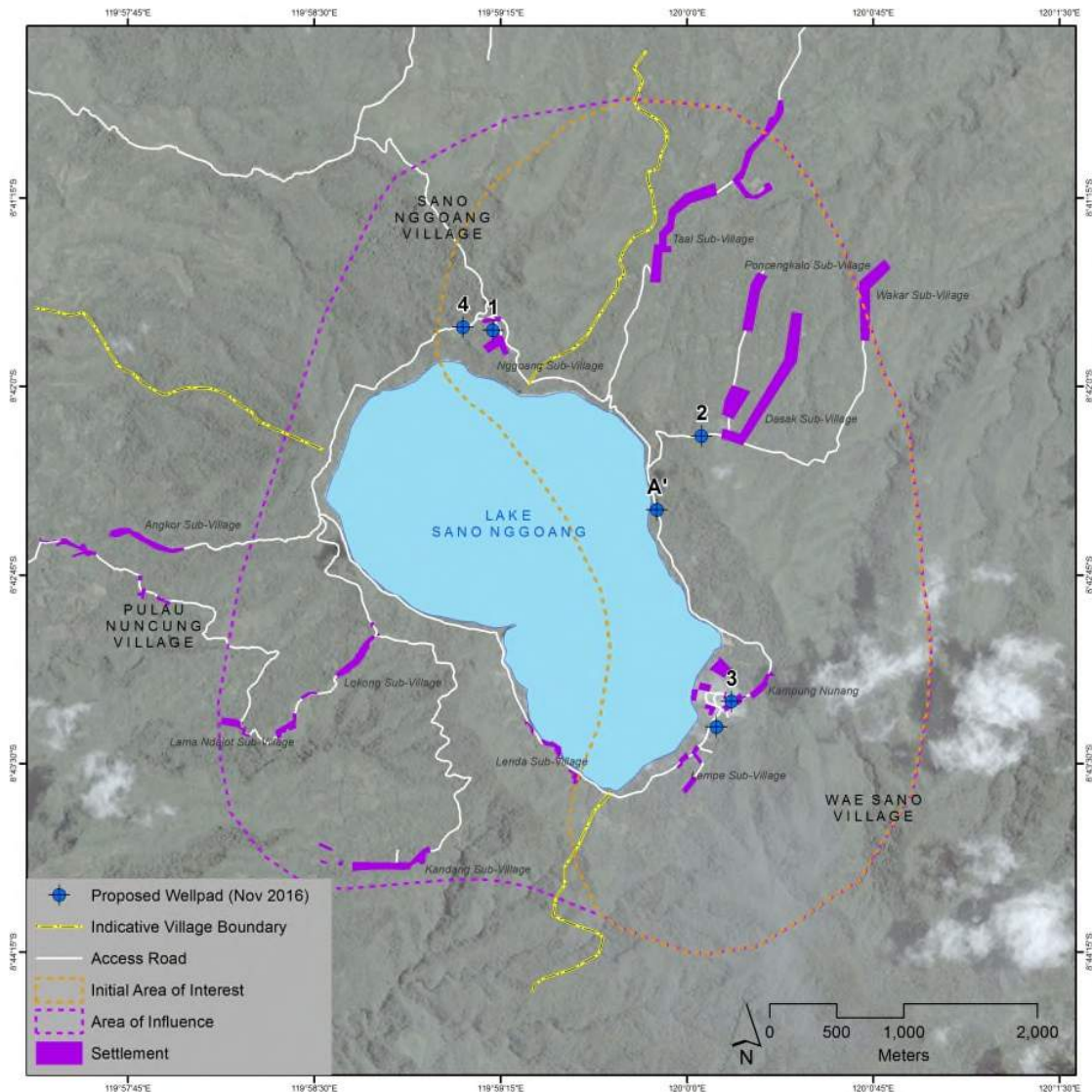


Figure 3-21 Overview of Initial Selected Well Pad Sites (April 2016)

In late 2016, the 6 initial well pad sites were relocated and re-designated to Well pads A, B, C, D, E, and F which presented as possible favourable alternatives to the initial well pad sites. All potential pad sites were inspected on foot and their viability evaluated as reported in the Jacobs Visit Report dated March 2017 (Figure 3-22). Results are summarised as follows.

Pad A – Located nearby the preliminary site location the pad is situated south-east of an existing road with a new access road being required to span the 150 m gap between the existing road and site. The site is also in close proximity to the edge of Lake Sano Nggoang, only 200 meters from the water's edge. The terrain has a gentle slope which will require moderate earthworks be conducted prior to pad construction. Furthermore a small house is located 150 meters away from the site on an opposite bank of an existing stream.

Pad B – The previous site location was poorly located, comprised of a deeply incised valley on top of a stream. The new site is located approximately 300 meters to the north, directly behind existing houses with an existing track approximately 150 m in length that is available for upgrade into an access road. The location is relatively flat with minor groundworks required in a slope and the back of the site required to construct a pad 100 meters by 60 m. There is also room on the opposing side of a small stream for a small rig camp and laydown if required. A topographical survey and study is required in order to optimize site layout. According to locals the land is privately owned.

Pad C – Site C is located in the centre of a ring of multiple houses with a graveyard and the lake edge also in very close proximity. Furthermore a fumerole is situated immediately adjacent to the site, with an existing stream running directly through the site. Despite the land possibly being available the pad would essentially be constructed in the centre of Wae Sano Village and therefore plans for developing this site have been abandoned.

Pad D – Located in very steep topography with thick forest, inspection of the site was difficult, whilst a preliminary location was found it was deemed that this site could only accommodate a very small pad. However further topographical analysis may provide a more favourable site location within the vicinity. Existing roads pass by close to the pad, although approximately 1.5km of upgrades along these roads would be required prior to pad construction in order to allow for access from the lake ring road, making this the most remote location of all the pads.

Pad E – The previous location for this site placed it in steep topography requiring a larger capital investment to develop a pad and access roads. Therefore the site was relocated 350 m to the east, placing it immediately adjacent to the main access road for the development and eliminating the need for an access road to be built. However site topography places the pad along a steep and narrow ridgeline with an available width of only 40 m at one point. Increasing the pad width to 50 m could be possible if retaining walls are constructed along the ridgeline, however careful study and topographical survey of this site is still needed in order to optimise the layout and begin construction.

Pad F – Preliminary location placed this pad on a narrow ridge which was feasible for a smaller pad however the ridge is currently occupied by a graveyard and a newly constructed road which ruled out the location as an option. Re-routing the road was considered however the topography of this region is comprised of a series of narrow ridges, making this impossible to achieve economically. Nearby locations were also surveyed for potential alternatives however all adjacent ridges were already occupied by houses, roads, and a school and no ideal alternative could be located, resulting in the abandonment of Pad F.

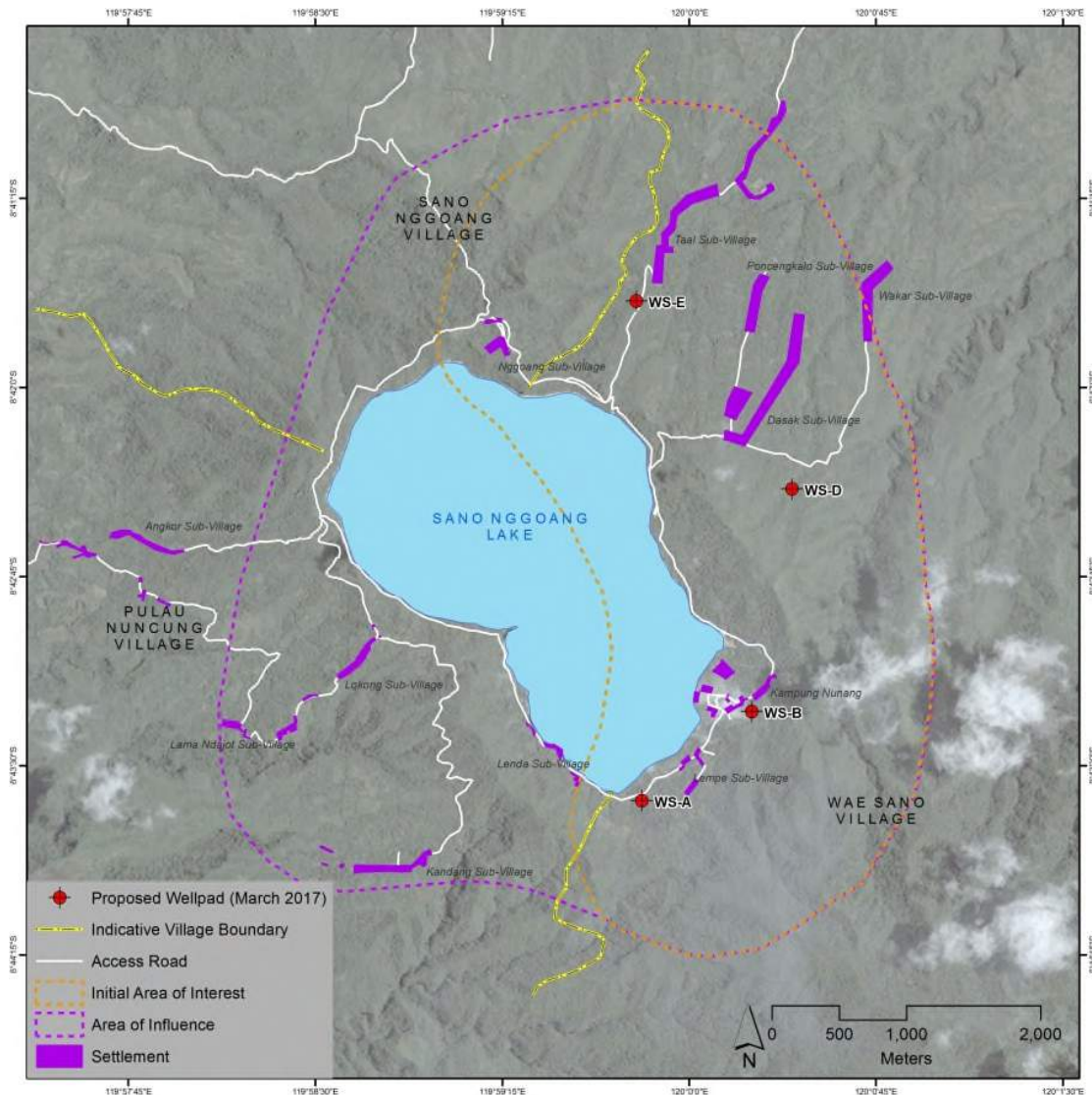


Figure 3-22 Overview of Selected Well Pad Sites (March 2017)

3.4.2.2. Alternative Selection

Post relocation and subsequent re-evaluation of the 6 initial sites concluded that only 4 of the new site locations were feasible for well pad construction. Those well pads include pads; A, B, D and E, resulting in the current development of construction plans for WS-A, WS-B, WS-D and WS-E and their respective support facilities (spoil disposal areas, drilling camps etc.), see Figure 3-23.

Well pad site selection was evaluated, with considerations made to drilling conditions, geothermal energy capacity, proximity to current infrastructure/developments, as well as local sites of importance i.e. landmarks and sacred sites.

A survey was conducted in November 2017 on Pads A, B, D, E in order to obtain further information about each site with findings detailed as follows:

Well pad A – Located in the Lempe Area, the land is reportedly privately owned and intersects with the historical village of the Lempe Family where the historical heritage *Compang*⁹ is located. It is considered a significant. However, based on an interview with *Tu'a Golo* of Lampe, the *Compang* can be relocated.

Well pad B – Located in the Nunang Area on privately owned land, a site visit to the proposed well pad location revealed that the location is inside of old historical village called *Kampung Laja* of the Nunang Family where several *Compang* and *Nekara* relics were found on-site in the area that was once used for activities and honouring ancestors. The boundary of the historical village was not clearly defined, and according to the local cultural leader the area is restricted for non-cultural activities.

Following these findings, the Project has defined new alternatives of **WS-B1** and **WS-B4**. However, the proposed new alternatives is located in the protected forest subject to confirmation regarding its land status with the Task Force Unit for Forest Management (*UPT Kesatuan Pengelolaan Hutan*) of West Manggarai Regency according to the Head of Forest Gazette Agency (*Balai Pemantapan Kawasan Hutan – BPKH*) Region XIV letter dated 1st March 2018. A joint survey with the Task Team is also required to confirm the land status.

Jacobs site survey on 13 May 2018 confirmed that well pad location alternatives of **WS-B1** and **WS-B4** were not feasible in terms of topographical condition. Therefore WS-B was selected as the most feasible one compared to the WS-B1 and WS_B-4. Although one family and Head of Wae Sano Village are very concerned with the distance between nearest settlement and proposed standard hole (approximately 60 m) and the existing location where the *Nekara* relics were found, Jacobs advised that WS-B is the best option location for the 1st standard drilling commencement. Further intensive consultations with Head of Wae Sano Village are required to ensure the social acceptance was in place.

Well pad D – Located in the Dasak area, the proposed area is in a protected forest subject to confirmation regarding its land status with the Task Force Unit for Forest Management (*UPT Kesatuan Pengelolaan Hutan*) of West Manggarai Regency according to the Head of Forest Gazette Agency (*Balai Pemantapan Kawasan Hutan – BPKH*) Region XIV letter dated 1st March 2018. A joint survey with the Task Team is also required to confirm the land status. There was no productive plants or planted crops by the community as the forestry land is restricted for agricultural activities. Approximately 500m to the south from proposed location, there is one historical site called Golo Lampang – the origin village of Mata Wae ancestors. Any potential impact or disruption to this area is potentially raising a conflict with the local community.

Well pad E – Located in the Taal Area, Well pad E is privately owned land, where agricultural plants were observed in the area, such as jackfruit and coconut trees. Based on a site visit to the area, the proposed location is located inside of an old historical village called *Kampung Wewa* where evidence of stone structures were found, indicating that traditional ancestral houses and settlement structures once existed here; therefore land release should be approved by the cultural leader (*Tua Golo*).

Following these findings, the Project has defined a new alternative of **WS-E**. The final location will be determined based on further consultation with cultural leaders and the community.

⁹ *compang bate*, which is an altar/mezbah that has been set by the ethnic group as the village spiritual centre that protects, provides, and arranges the ethnic group life sources (*naga beo/golo*).

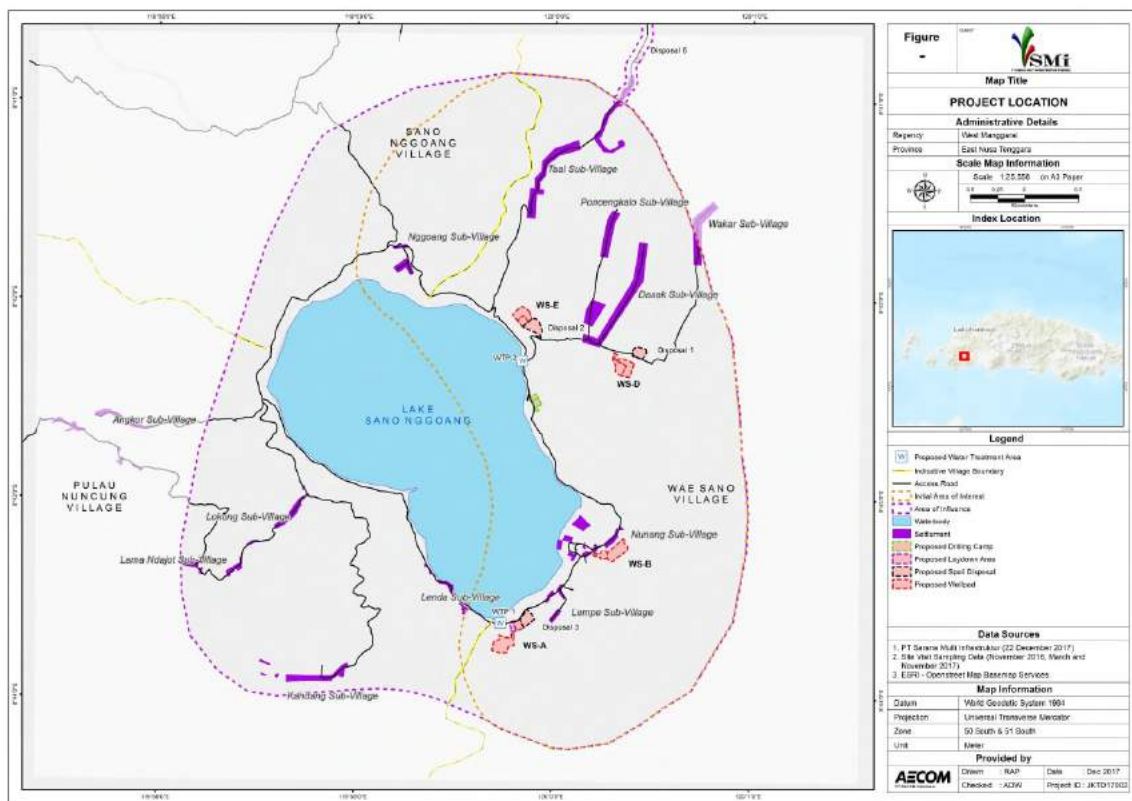
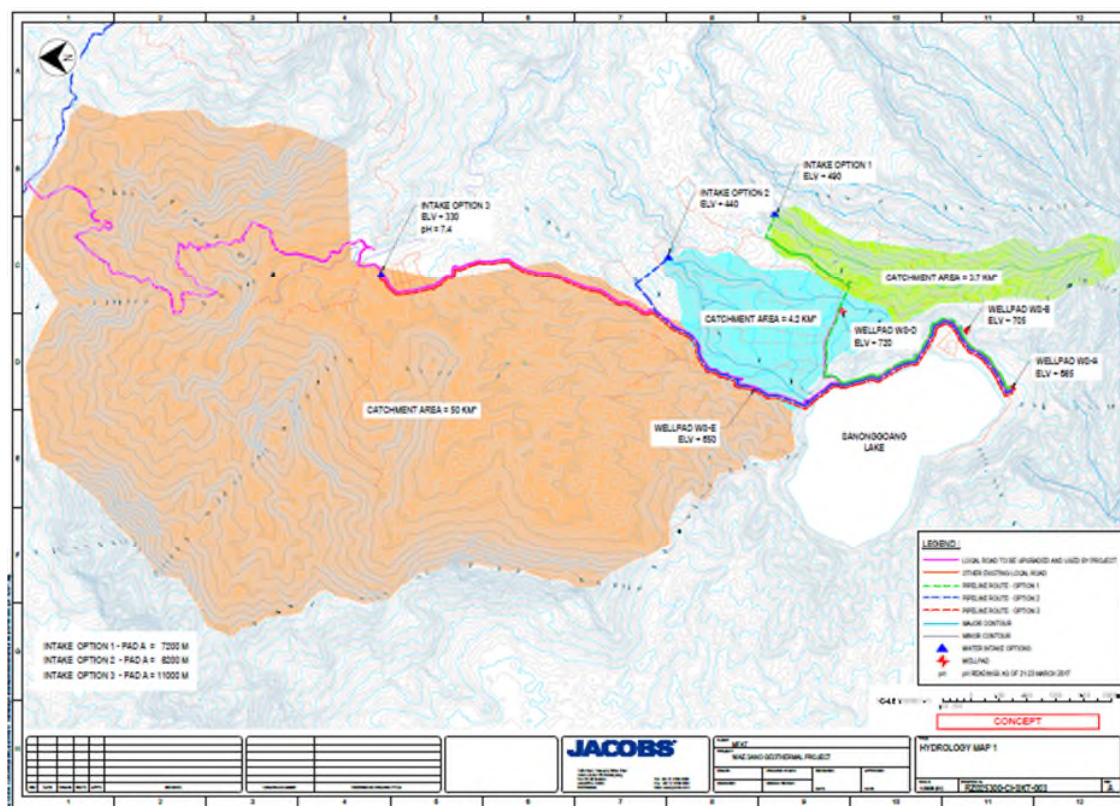


Figure 3-23 Overview of Current Well Pad Configuration

3.4.2.3. Water Supply Intake Alternative

Analysis of the lake water on site revealed that the water was highly acidic with a pH of 2.6, making it unsuitable for use in project activities without treatment from additional chemicals. As such several alternative sources of water were identified by determining catchment regions from maps of the wider area surrounding the site as detailed in Figure 3-24. Each catchment was then inspected on foot with the aid of a local guide and pH, water capacity, availability, of each catchment was inspected.



Source: Jacobs, 2017

Figure 3-24 Overview of Water Catchment Areas

Several water supply options have been investigated.

Option 1 – A centrally located stream in a remote, deeply incised valley approximately 2km north-east of WS-D, the catchment area occupies an area of around 3.7km². There are few settlements in the area, thus the concern for disrupting a village water supply is minimal. Stream gauging indicated a flow rate of 800L/s at the time of the visit, more than enough to supply the 100L/s water requirement for drilling. However the guide present indicated that the stream runs dry during the dry season, which requires verification by further inspection at a later date, although it appears likely that this intake option will only be viable during the wet season. A neutral pH measurement of 7.8 was observed which is acceptable for drilling purposes. The elevation difference between the catchment intake location and the highest well pad (WS-D) is approximately 230 meters which could be possible with a single pump.

Option 2 – A slightly larger catchment than Option 1, occupying an area of 4.2km² with an observed flow rate of 1,300L/s. The larger flowrate is due to the presence of lake water (acidic) flowing into the catchment resulting in a pH of 2.6 which will cause problems for drilling without the addition of neutralising agents. Another stream located slightly upstream from the lake water inlet was inspected and found to have a pH of 7.7, however the catchment is small for this steam and the guide present indicated a very low flowrate was observed in the dry seasons, making this an un-reliable source.

Option 3 – An extensive catchment occupying a 50km² region which is located at an existing major bridge crossing along the main access road to the site. It is expected that there will be enough flow in this river year round to satisfy project requirements although this is yet to be verified. However the distance between the catchment and the site is large in relation to Options 1 and 2, with the distance from this intake location to WS-A being 11km. Furthermore the elevation difference between the intake location and WS-D (the highest well pad) is approximately 390 meters which will require one or two intermediate pumping stations.

Option 4 – Although highly acidic, Lake Sano Nggoang still presents as an immediate reliable source of drilling water, however it will require additional treatment compared to Options 1-3 in order to be acceptable for use in drilling applications. An on-site water treatment facility will need to be constructed to adjust the pH from 2.6 to a neutral level.

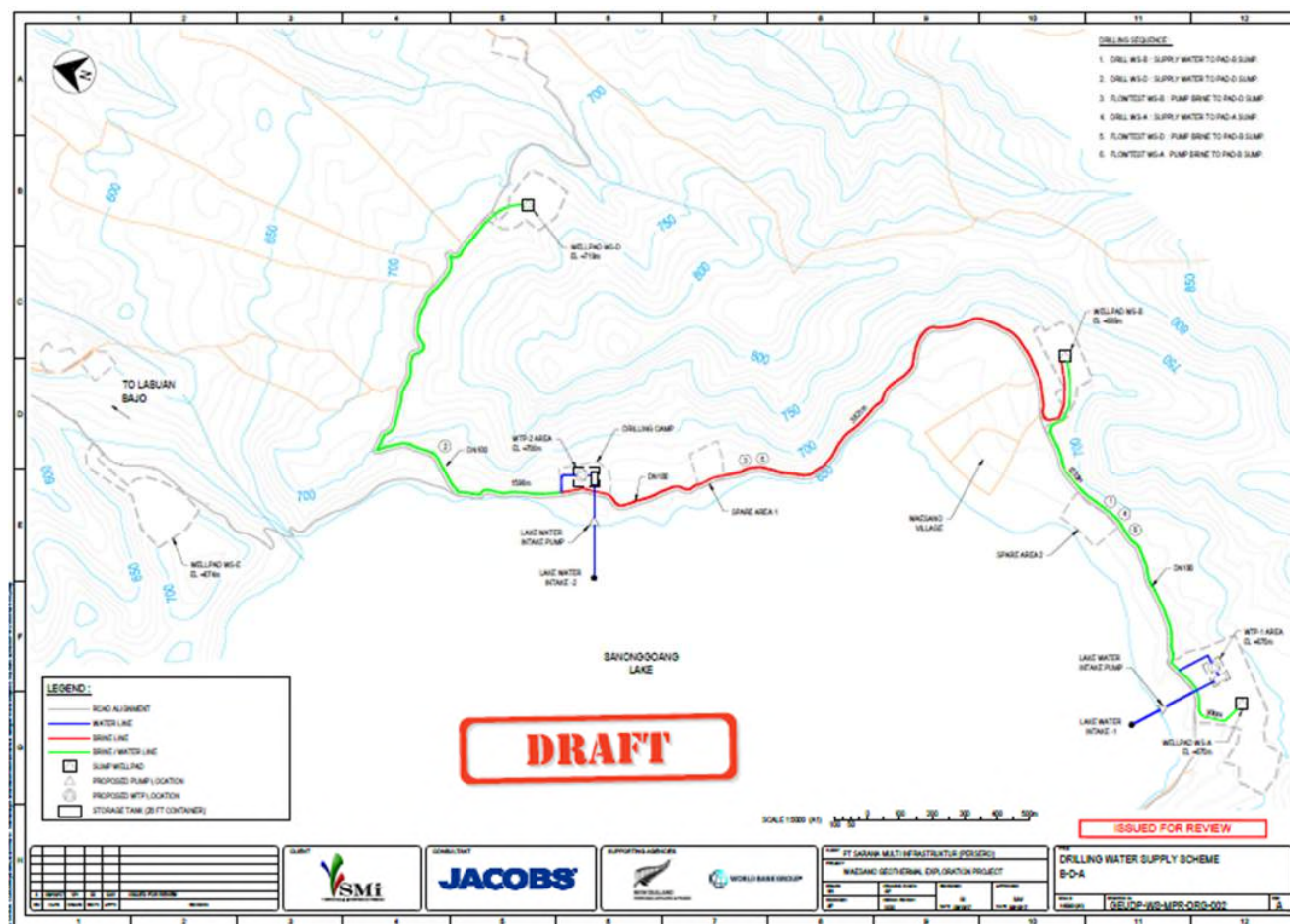
Initial evaluation of the catchment sites determined that the most reliable source of surface water is Option 3, yet Option 1 will be feasible on a seasonal basis possibly providing support in such periods. Although due to the length of drill water piping required for Option 3, a proposition could be made for an evaluation of potential groundwater sources in the vicinity of the site to confirm that Option 3 is still the most feasible option.

Following this analysis, it was decided that a close, year-round reliable source of water above all else was required in order to service the peak demands of any and all well pads; as such it was concluded that water from Lake Sano Nggoang will be utilized as raw water for drilling purposes.

The water will be pumped from the lake to two temporary water treatment facilities on-site to be mixed with liquid caustic soda in order to balance the pH. Facility one is situated in the open area between WS-A & WS-B and will provide drilling water for these pads, with facility two being located at the drilling camp and supplying water to WS-D and WS-E depending on the drilling sequence. Once at a facility acidic lake water will be treated and neutralised with liquid caustic soda which is added via an injection quill. A static mixer will then ensure adequate reaction completion, before storage of the treated water in a 20ft³ container.

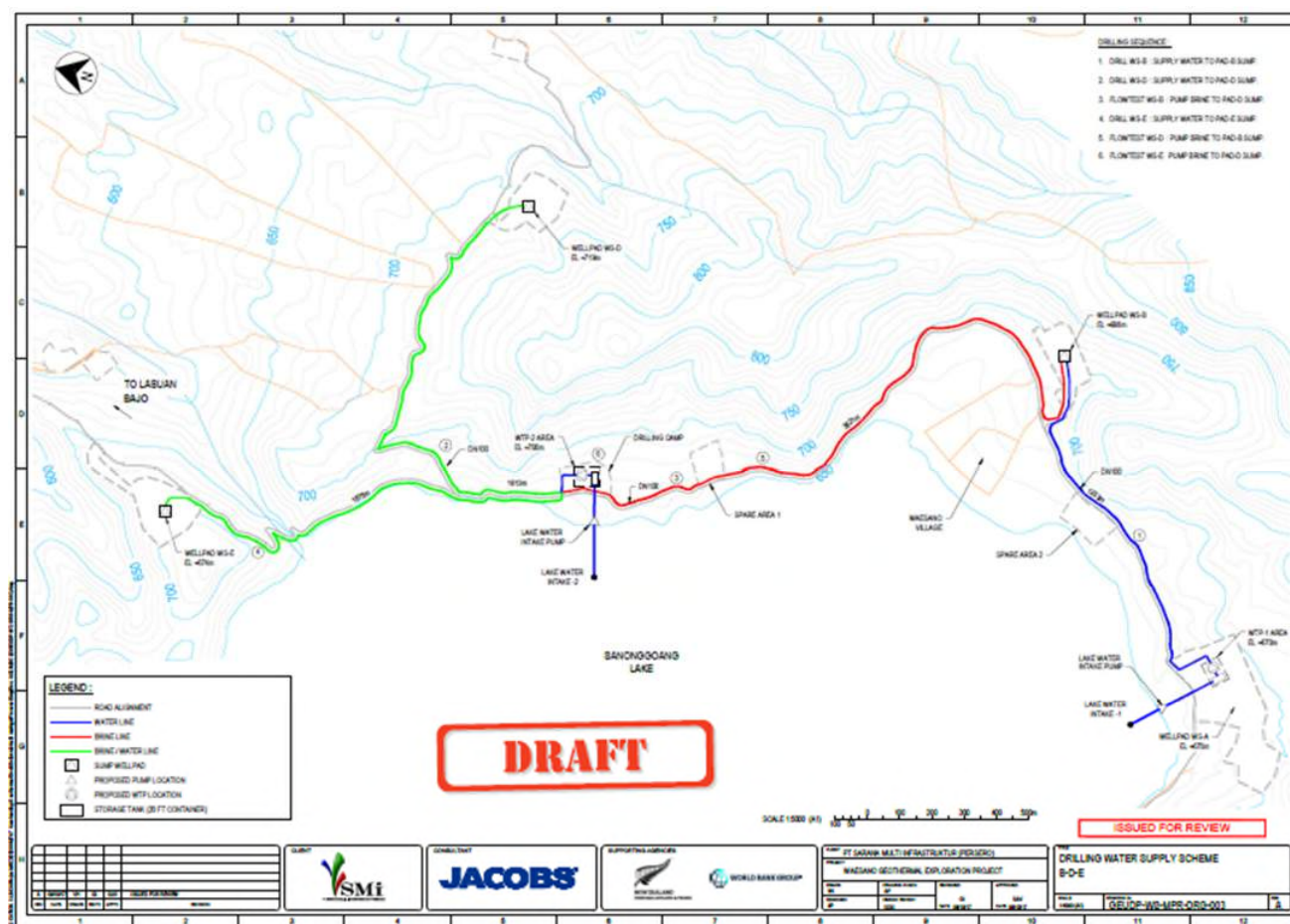
Both facilities are designed to be temporary and mobile with intake pumps, chemical dosing systems and water distribution pumps being able to be interchanged between each facility as required by drilling sequence water demands. Despite the possibility of sharing components as required, the facilities will operate independently of each other to service their respective intended well pads.

In addition to the treated water distribution requirement for drilling activities, there is also a requirement to transfer brine between well pads for injection into the wells. The brine produced from well testing will be collected in adjacent sumps to each well before being transferred to another well pad. Situations will occur where brine transfer will be required in conjunction to water distribution for drilling activities. Figure 3-25 and Figure 3-26 detail proposed pipeline conditions, whilst Figure 3-27 outlines technical specification for the water treatment facilities.



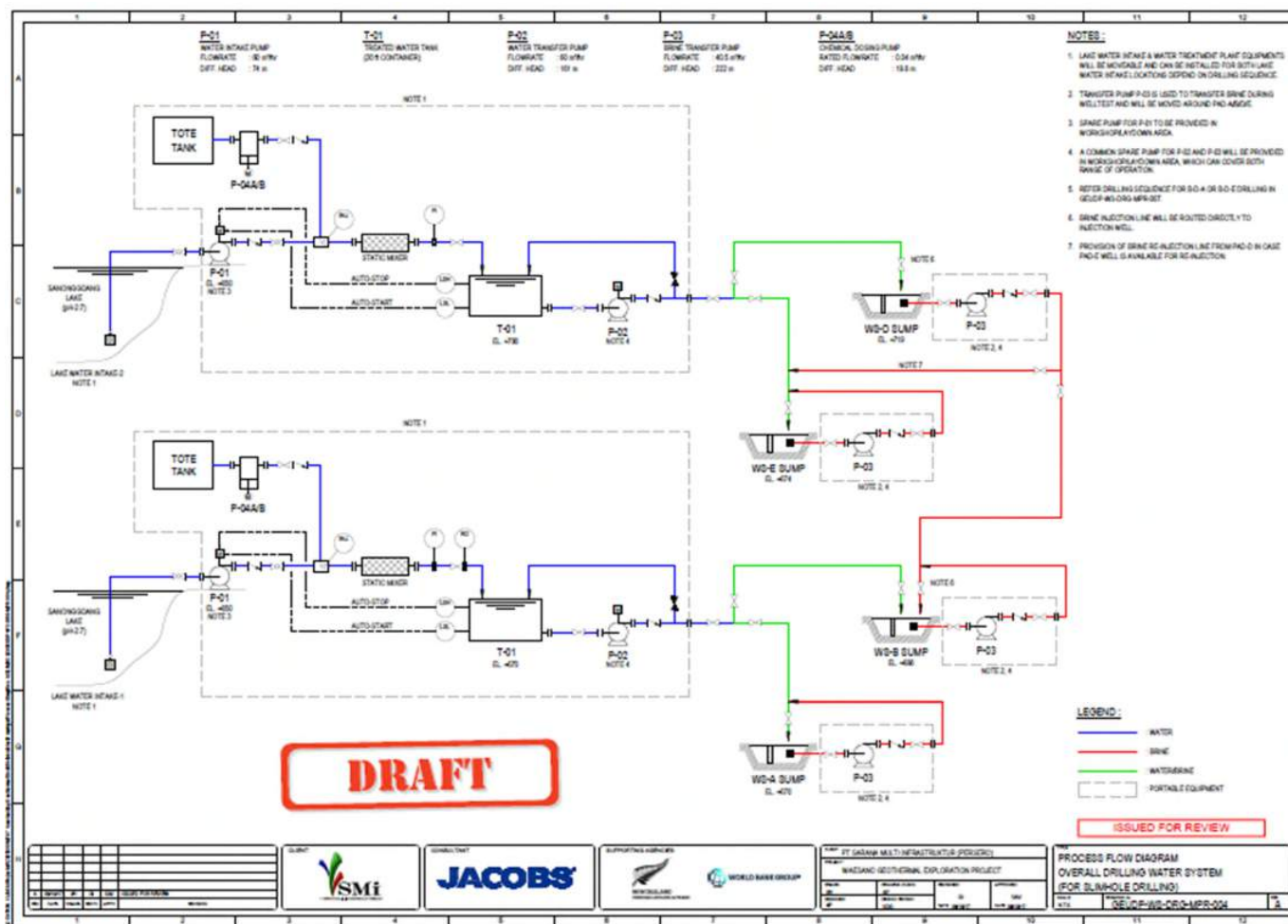
Source: Jacobs, 2017

Figure 3-25 Overview of Proposed Drilling Water Pipelines (October 2017)



Source: Jacobs, 2017

Figure 3-26 Overview of Proposed Hybrid Water/Brine Pipelines (October 2017)



Source: Jacobs, 2017

Figure 3-27 Lake Water Treatment Plant P&ID

The location of the water supply intake has changed – water treatment area 1 at WS-A near Sano Nggoang Lake and water treatment area 2 previously located at the drilling camp moved near the junction of Taal Sub-village. The locations of the water treatment area are shown in Figure 3-28.

Domestic water is intended to be brought to site by tanker truck as required.

Water and caustic soda consumption requirements are detailed in Table 3-19.

Table 3-19 Water Treatment System Requirements Based on Drilling Activities

Resource	Variable	Slimeholes	Standard Wells
Lake Water	Maximum dosing rate during drilling	250gpm	1100gpm
	Average dosing rate during drilling (continuous)	80gpm	550gpm
Liquid Caustic Soda	Maximum dosing rate during drilling	9000L/week	35000L/week
	Average dosing rate during drilling (continuous)	2800L/week	17000L/week

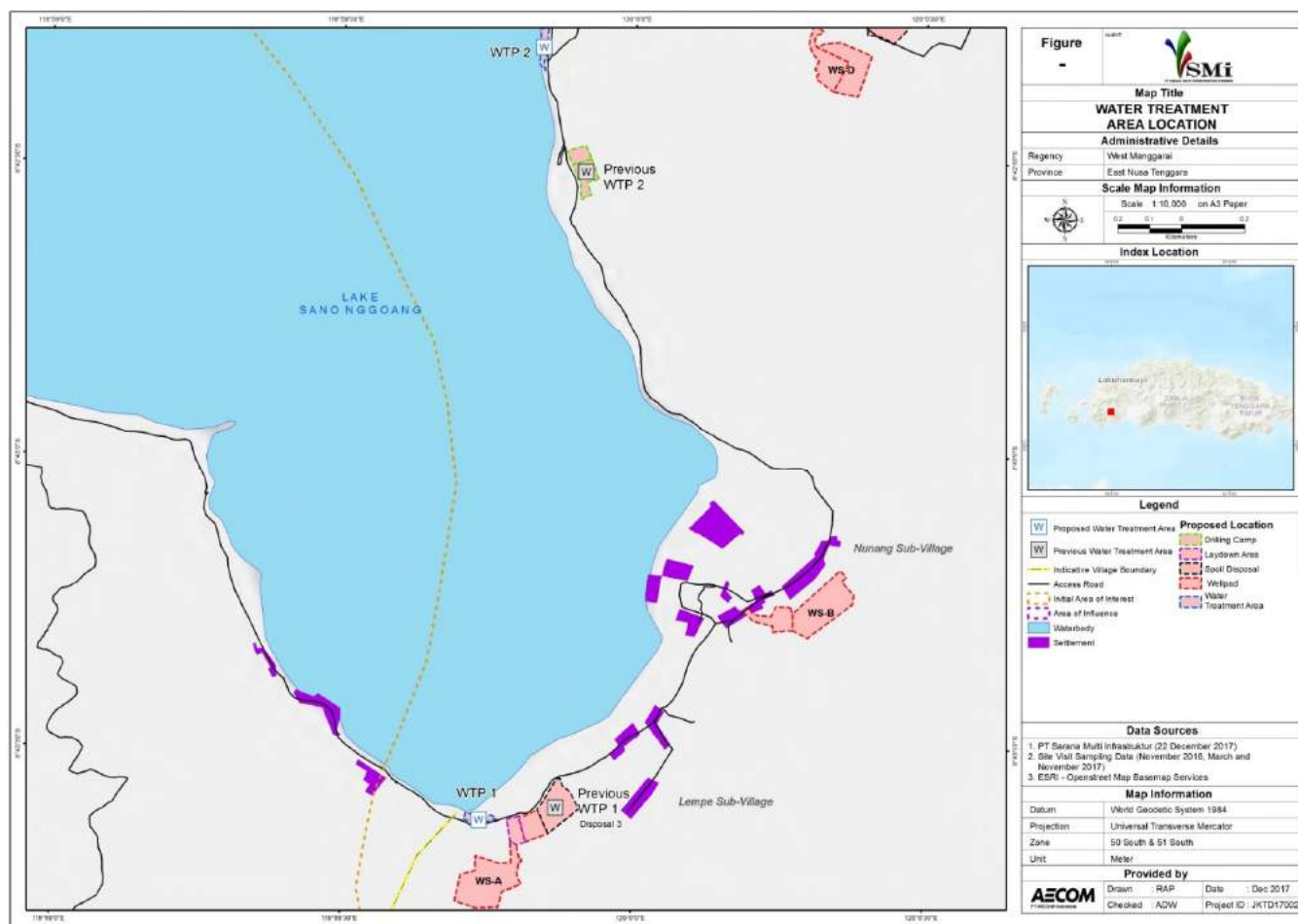


Figure 3-28 Water Treatment Area Location

3.4.2.4. Site Access

Current infrastructure located in the Wae Sano region is unable to allow for the transport of all required materials and equipment to the various sites by road, as such a combination of several access routes are to be utilized during operations. Proposed access routes are as follows with an overview of roads provided by the maps in Figure 3-7, Figure 3-8, and Figure 3-9.

Port facility at Labuan Bajo – Inspection of the existing wharf and meetings with the port authority revealed the port can handle vessels with a capacity of up to 11,000 tonnes. The wharf will likely be strong enough for offloading drilling equipment and it was reported that 40 tonnes excavators have previously been offloaded here with no issues. However there are no carnage facilities in the port although a Ro-Ro vessel containing a crane makes fortnightly visits to the port and could be used for offloading.

Trans-Flores National Road – The turnoff for the National Road is approximately 30km from the port and takes on average one hour to reach. The road should be adequate for drilling mobilization and is fully sealed. Minimal upgrade works are required; however a series of three hairpin bends will need local pavement widening in order to allow for the design vehicles to pass these bends without issue. There are also four existing bridges where approach road alignments are poor and more local pavement widening will be necessary along with minor bank trimming to allow for unhindered passage of design vehicles. The bridges themselves are of no concern with sufficient width and load capacity.

Provincial Road to Site – Spanning the 22km distance from the Trans-Flores National Road to Wae Sano Village, sections of this road are in poor condition with some only being passable by 4WD. Substantial upgrades and repair works are required to allow mobilization of drilling equipment. It should be noted that the majority of road works will be required in the first 8km as the road descends into the valley. A total of 30 re-alignments are needed, 13 steep sections need to be addressed and drainage issues fixed at 35 locations. Existing pavement is composed of rounded river rock, which is currently failing and requires upgrades with imported crushed rock. A new bridge is needed, along with a bridge deck upgrade and 3 new low-level ford crossings.

Design Vehicle – Taking into consideration the existing and proposed road conditions at the site, it is suggested that the adopted design vehicle for this project be a single prime mover and lowboy trailer that is large enough to transport 40' containers. Specifications for vehicle dimension would be in the order of 15m length, with a trailer 2.8m wide. There are some existing steep road grades that will likely require that 2nd helper vehicles to pass these sections, although this will need to be reviewed as road upgrades are completed.

Further Alternatives are still being investigated to transport the piling rigs used to install the conductor casing, as traditionally larger vehicles than the design vehicle listed above have been used for this task. However larger vehicles will require yet further road upgrades as such is economically unfavourable at this point, hence the continued alternatives investigation.

3.4.3. The No Project Scenario

The evolution of renewable technologies in most countries of the world is well advanced and is demonstrating a viable and sustainable source of energy which is making a significant contribution to the worldwide energy mix. This project represents a major step forward by Indonesia in joining the transition to renewable energy technologies. As with any project which is developing new and innovative technology the investment by PT SMI to bring such a project to this stage of development represents a significant commitment and effort to win a place in the Indonesian energy mix.

Indonesia already has a substantial reliance on fossil fuel thermal power generation, and a substantial shortfall in available power on a per capita basis. Although this Waesano geothermal project represents a small contribution to the overall energy demand of both East Nusa Tenggara and Indonesia, it is reasonable to assume that this power contribution will be made up by thermal power generation plants with resulting GHG emissions, should this project not proceed.

From an environmental and social perspective, the project is located within a rural agricultural setting and forest land. A 'no project' scenario would not result in some of the benefits being brought by the project (such as improved access roads, potential rural electrification, PT SMI community investment plans, and some job opportunities).

However, the project does have the potential to result in flora and fauna disturbance, reduced water and air quality without the correct mitigation measures being implemented. Overall it is believed that mitigation measures are available to limit predicted impacts and subject to their implementation; the 'no project' scenario would result in a loss of potentially beneficial opportunities being realised within in the project area.

3.5. Project Activities for Exploitation Phase

Further Exploitation Phase will be undertaken by a Business Entity that will have a license to carry out exploitation phase in Waesano Geothermal concession area to be awarded by Ministry of Energy and Mineral Resources following tender process. The overall exploitation phase is consisted of activities are listed in Phase 5 to 8 (see **Section 3.1**). The exploitation phase activities described in brief below are expected to impact the surrounding environment and community at the project site.

3.5.1. Land Acquisition

The power plant operation will require land acquisition for the main facility including the power house, operation control room, cooling tower, steam pipelines, access road and supporting facilities including a switchyard, transmission line, etc. The power plant will require a maximum of 1 ha, irrespective of the generation technology selected (binary plant normally has a larger footprint than condensing steam plant, but either should fit within this 1 ha area). It is most likely that access will be by extension from existing roads and, given the rugged topography, this will require approximately 3 km of new road to be constructed.

Some new well pads may be required. For a prospective maximum project capacity of only 30 MW, based on international experience and average geothermal well capacities, a further 4 production wells will likely be required, plus 2 injection wells. It may be feasible to drill the additional production wells from the same pads as used for exploration drilling (by using directional drilling to laterally spread the production zones of the various wells), but for conservative planning purposes an additional 2 well pads may be required, which will also provide sufficient pad capacity for the injection wells. It is anticipated that these additional pads will still be within the identified area of interest, generally interspersed between the exploration pads.

The power plant will also need to be located close to the well pad area, with a possible location being towards the southern end of the lake, close to Pad A.

The well pads will be connected to the power plant by above-ground pipes supported clear of the ground. Where possible, these will run alongside well pad access roads, although in some areas it may be necessary to run across country, in which case a simple pipeline corridor will be required, approximately 3 m in width, inclusive of a track for vehicular access along the pipeline route.

3.5.2. Workforce Recruitment

Once the power plant operation plan has been completed, the work force for power plant operation and maintenance will be recruited. The Project will provide this job opportunity for all workforces particularly those living on Flores Island. The recruitment process will be fair and transparent.

3.5.3. Drilling Production and Reinjection Well

There are few differences between the drilling of exploration wells and subsequent production and injection wells; the production wells may be of larger diameter (9-5/8 inch production casing), whilst the injection wells are often drilled slightly shallower than the exploration and production wells.

3.5.4. Production Well Testing

A well completion test is undertaken as the final stage of the drilling activity. Before moving the drilling rig to a new location, a pressure measurement is taken while injecting water into the well, along with temperature and pressure measurements conducted to obtain injectivity and transmissivity of the well. A typical well completion test lasts less than 48 hours.

Horizontal well testing is then undertaken to provide more accurate information on flow output, brine and steam characteristics. This involves the temporary installation of pipes and a steam/gas separator adjacent to the well being tested and a rock muffler. The horizontal testing procedure lasts 6 to 12 weeks. Vertical well testing is not undertaken.

Wells are later converted, if suitable, into production wells. Unsuitable wells can be used for reinjection or are abandoned.

3.5.5. Power Plant and Supporting Facilities Construction

Following successful completion of a sufficient number of wells and confirmation of capacity, construction of the power plant will proceed. In addition to similar phases of access opening and site preparation, building the power plant involves earthworks, foundation for buildings and significant work on the superstructure, including delivery of heavy equipment to the site (turbines, generator and transformers).

3.5.6. Steam Production and Pipelines

A mixture of steam, gases and water (brine) is extracted from the production wells and sent to the separators via two phase pipelines. Due to reduced pressure, part of the brine flashes to steam.

Production clusters will be connected to the separators, scrubbers and the power plant by insulated steel pipes. Two phase pipes carrying steam and brine will be used from clusters to a common separator, while other clusters will have on-site separators, with a steam pipe to the power plant. These pipes are laid on concrete foundations with gliding rails for free movement in axial direction for expansion of the pipeline at start-up of the power plant. Rupture discs will be located on the steam pipelines immediately downstream of the separators.

Condensation build-up in the steam pipelines is collected in condensate pots and discharged regularly (every few minutes) through automatic release valves (steam traps). The flashed fluid is collected in an open drain to transfer it to a thermal pond on the power plant site from where it can be reinjected. To provide this “scrubbing” action in the steam pipeline, it is proposed that the power plant is located at least 900m from any separator. At the power plant the steam flows through scrubbers for a final clean before delivery to the turbine.

In order to control steam pressure with varying power plant load, and in case of a power plant trip, surplus steam is released to the atmosphere via a rock muffler (steam venting system) to control noise.

Where possible, pipelines will be routed along other corridors such as roads. Thermal insulation will result in an outside pipe temperature estimated at about 50°C, which is low enough to avoid personal injury.

Depending on the results of the production well tests, some if not all the wells may be determined as non-artesian (i.e. brine and steam from the reservoir will not flow upward through a well without some form of stimulation). Stimulation operations typically involve injection of air at high pressure to lower the water level in the well. Upon sudden termination of the injection, the well will eject water and start to flash steam to promote ongoing flow. During periods of power plant maintenance or trip, it is not desirable to fully shut down non-artesian production wells as well stimulation is required to restart production, which has time and cost implications, as well as other environmental impacts including energy use. During such periods, these wells may be maintained in production with significantly reduced flow rates (bleed flow) with steam directly venting to atmosphere.

The steam may be used in a conventional steam turbine, coupled to a generator. Steam exhausting from the turbine goes through a condenser (heat exchanger which causes the steam to condense). The water from the condenser is cooled in conventional forced draft wet cooling towers. By contrast to conventional thermal plant, geothermal steam plant uses direct contact condensers, and actually generates surplus condensate, over and above the evaporative water losses to atmosphere from the cooling tower. Surplus condensate is returned to the steam field for reinjection.

Alternatively, the steam may be used in a binary plant, wherein the steam is passed through heat exchangers, where it condenses (the condensate is again returned to the steam field for reinjection) and gives up its heat content to preheat and then evaporate a secondary (binary) working fluid, which in turn is expanded through a turbine-generator, condensed and returned to the heat exchangers for further evaporation and use in a closed cycle

process. The condensation of the binary fluid is normally undertaken in dry, air cooled, heat exchangers, resulting in a slightly larger ground footprint for the power plant.

Both types of power plant will discharge non-condensable gas (NCG) to the atmosphere. The amount of gas and its composition cannot be determined until after exploration drilling, but typical geothermal projects in Indonesia have from less than 2% up to about 5% NCG content in the steam. The NCG is primarily carbon dioxide (CO₂), with some hydrogen sulphide (H₂S). The power plant developer will need to undertake appropriate discharge modelling, but normal industry practise is to discharge the NCG into the cooling tower plume (either wet or dry cooling towers) which provides sufficient buoyancy that the gas is adequately diluted to below 24 hour exposure levels before it returns to ground, if in fact it does return. H₂S abatement is not normally required and is not anticipated to be needed at Waesano.

3.5.7. Power Generation and Supply

Power from the Waesano Thermal Power Unit will be sent to the grid (existing by the time of commissioning) at the PLN Units switchyard via a dedicated line. The Project will be responsible for the construction of the transmission line and will acquire land for the tower bases and any area required to ensure the safe operation of the transmission line through a fair negotiated settlement as per its willing buyer / willing-seller process. In addition, compensation will be provided by the Project to secure the transmission line Right-of-Way.

3.5.8. Reinjection Wells and Pipelines

During operations, reinjection pipelines will contain water that is >100°C, but they will be insulated to give a surface temperature not greater than 50°C. Each separator will be connected to dedicated wells at clusters for brine reinjection. Condensate from the power plant is reinjected through a 'cold' (40°C) reinjection well(s). Condensate flow is significantly less than brine flow.

Reinjection pipelines, similar to production pipelines, will be routed along existing corridors such as roads. In order to minimise risk of pollution, all pipelines will be constructed in accordance with applicable international codes, which call for testing to pressures higher than maximum operating pressures and will not fail under normal operation or during seismic events within design criteria. Damage from external sources, such as large trucks, is very unlikely as the loads incurred are generally lower than seismically induced loads.

If a reinjection pipeline did fail the brine will be diverted via an emergency dump valve to a large emergency brine dump flash tank. The brine and condensate reinjection pipelines will be located above ground (except for where they cross beneath roads) to allow early identification of leaks and corrective action in the event that one occurs. The residual amount of spillage would depend on the location of the pipe failure with the worst case being if the failure is near the reinjection well pad and drains the entire brine pipeline volume.

3.5.9. Decommissioning

Geothermal facilities can be removed after their useful life in a process called decommissioning, although to date no geothermal projects worldwide have in fact been finally shut-down as they can be kept operating at some reduced output as resources tend to decline and then stabilise at a lower capacity. Following decommissioning, the site would be restored (reclaimed) to approximate its original condition or to some standard that results in stable environmental conditions. Typical activities during the decommissioning/reclamation phase include closure of all facilities and wells; removal of aboveground components and gravel from well pads, access roads (if not maintained for other uses), and other ancillary facility sites; recontouring the surface; and revegetation. Impacts would be similar to those addressed for the construction phase; however, many of these impacts would be reduced by implementing good industry practices. Rehabilitation during this phase would also ensure that impacts beyond the life of the geothermal energy development are avoided or minimized.

4. Environmental and Social Impact Assessment Process

4.1. Overview

This Environmental and Social Impact Assessment (ESIA) has been prepared to satisfy lender requirements for the financial close out of the Project, in parallel with preparation of Indonesia regulatory environmental document required for the currently planned Waesano Geothermal Exploration i.e. UKL-UPL. The ESIA process is also aligned with international best practice standards in developing an impact assessment, and is illustrated in Figure 4-1.

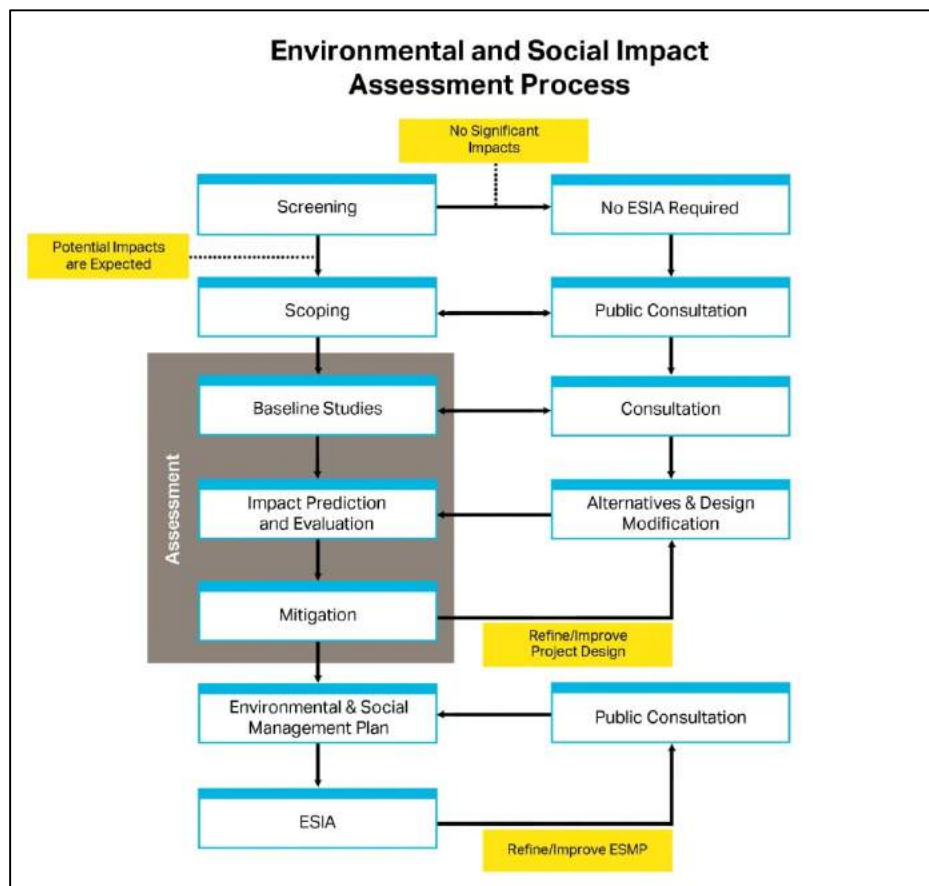


Figure 4-1 ESIA Process

4.2. Screening

Screening represents a preliminary assessment of the likely project impacts on the environment; its objective is primarily to determine if an ESIA is required. In the context of World Bank evaluation that is dependent upon the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts, projects can be categorised as follows:

CATEGORY A

Projects are expected to have significant adverse social and/or environmental impacts that are diverse, irreversible, or unprecedented.

CATEGORY B

Projects are expected to have limited adverse social and/or environmental impacts that can be readily addressed through mitigation measures.

CATEGORY C

Projects are expected to have minimal or no adverse impacts, including certain financial intermediary projects.

CATEGORY FI

Projects that involve investment of Bank funds through a financial intermediary, in sub projects that may result in adverse environmental impacts.

Waesano Geothermal Exploration Project is considered a Category B project, because exploration phase impacts are considered to be site specific, localized, reversible and/or mitigatable, requiring preparation of an ESIA, and aiming to as possible to avoid areas with environmental and social sensitivity which have been identified in this ESIA. However, although potential impacts will be significantly reduced by considering this sensitivity analysis results during the current Project design process, it represents the commencement of a major undertaking in an existing rural area with little development, therefore a number of mitigation strategies and monitoring measures are proposed.

4.3. Scoping

The scoping exercise of any environmental impact assessment process determines the extent to which a project will interact with environmental or social elements. Through the scoping exercise the priorities and extent of baseline studies and assessments are determined. The cornerstone of the scoping study is an impact matrix which examines the potential environmental and social impacts of the project. The important consideration for this stage is the potential for an impact, since the objective is to define both an assessment of the impacts and the project's responses or mitigations, but as importantly defines the need to undertake baseline assessments which will define the current state of the environmental or social element being considered. Thus even if it is expected that an impact will be eliminated by mitigation, it is important that the project acknowledges the potential for the impact, and establishes parameters against which the success of mitigation strategies can be measured.

World Bank Safeguard Policy OP 4.01 Environmental Assessment requires that this stage marks the start of interaction with local communities, if it has not commenced already, to determine the key issues that need to be developed, and in order to be sure that impacts on the community and any sensitive receptors will be defined as part of the environmental impact assessment process. It is important to understand the values that the local community places upon their physical and social environment that may be impacted by the project.

The scoping exercise sets the Terms of Reference for a project. If an impact has the potential to be significant (see later definition), then it warrants that the current environmental condition of the relevant environmental element is determined by baseline measurements. Further, if the interaction of the project with the environmental element is complex or difficult to predict, the impact warrants a detailed study to define the anticipated impact, and the effects of any mitigation.

4.3.1. Interaction Matrix

The interaction matrix indicates the linkage between a potentially impacted activity plan component and a potentially affected environmental or social component. The interaction table is shown in Table 4-1 below.

4.3.2. Preliminary Assessment of Impacts

This ESIA for the Waesano Geothermal Exploration Project is prepared in parallel with an Environmental Management and Monitoring Effort prepared under Indonesian legislation (UKL-UPL), and therefore covers all impacts that are also assessed in the UKL-UPL. As part of the ESIA, public consultation was undertaken on 3rd of November 2016 in Wae Sano Village Office, Sano Nggoang Sub-District, West Manggarai Regency. The feedback from these meetings was also used to inform the development of this preliminary assessment. The initial assessment of potential impacts and need for a baseline study is shown in Table 4-2. It summarizes potential environmental and social impacts with the caveat that all such information requires further analysis as part of the full ESIA study process, as described in subsequent sections.

Table 4-1 Impacts Interaction

Environmental and Social Component	Land Acquisition	Workforce Recruitment and Management	Equipment and Material Mobilisation	Land Clearing and Preparation	Access Road Improvement	Well Pad and Infrastructure Construction	Exploration Drilling	Well Testing	Site Closure	Site Restoration and Revegetation
A. ENVIRONMENTAL										
Physical and Chemical										
Air quality			√	√	√	√	√	√		
Noise			√	√	√	√	√	√		
Land cover & spatial planning				√						√
Soil			√	√	√	√	√	√		
Surface water quality			√	√	√	√	√			
Surface hydrology & hydraulics				√		√	√			
Groundwater quantity							√			
Environmental health			√	√	√	√	√	√		
Sustainability & climate change			√	√	√	√	√			
Biological										
Flora				√	√	√	√	√		
Terrestrial Fauna				√	√	√	√	√		
B. SOCIAL										
Socio-Economic										
Livelihood and income	√	√	√		√	√				
Population and migration		√			√					
Ecotourism			√	√	√	√	√	√		
Community Health and Safety										
Community health			√					√		
Traffic, Transport, and Community safety			√	√	√	√	√		√	
Community Amenity										
Public facility and infrastructure			√		√		√			
Visual			√	√	√	√	√			
Socio-Cultural										
Social fabric and community perception	√	√								
Cultural heritage	√			√		√				
Labour Rights and OHS										
Labour rights		√								
Occupational health and safety			√	√	√	√	√	√	√	√

Table 4-2 Preliminary Assessment of Impact

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
1	Air quality	Equipment and material mobilization , land clearing and preparation, access road improvement, and well pad and infrastructure development	Air quality deterioration during land clearing and preparation, infrastructure & well pad development, access road improvement, and equipment and material mobilization	Impacts of air quality deterioration during the construction phase are potentially significant for nearby community activities and residential areas where the project vehicles pass, especially during the dry season. Potential increases of pollutant concentration (CO, NOx, SOx) from the vehicle emission due to the burning of fossil fuel and particulate distribution (local dust) are likely from the following activities: <ul style="list-style-type: none"> - site preparation activities of 12.17 ha area of Phase-1 and 10.58 ha area of Phase-2; - Fugitive dust emissions (PM10 and PM2.5) during construction derived from excavation in the well pad and other supporting facilities construction; - mobilization of construction material and equipment; and - access road improvement. 	Identification of nearby sensitive receivers which may be impacted by emissions from proposed development. A discussion of the potential impacts and recommendations.
2	Air quality	Exploration drilling	Air quality deterioration due to emissions from off-road equipment	Impacts of air quality deterioration during the operational phase are potentially significant for nearby community activities and residential areas. Potential increases of pollutant concentration (CO, NOx, SOx) are likely from exploration drilling rig and vehicle emission due to the burning of fossil fuel.	Identification of nearby sensitive receivers that may be impacted by emissions from proposed development. A discussion of the potential impacts and recommendations.
3	Air quality	Well testing	Air quality deterioration due to H2S emissions during well testing	Impacts of air quality deterioration during well testing potentially significant for nearby community and workers activities and residential areas. Potential increase of H ₂ S concentration is likely from bursts of heated steam emitted from well testing.	Identification of nearby sensitive receivers which may be impacted by emissions from proposed development. A discussion of the potential impacts and recommendations.
4	Noise	Equipment and material mobilization, land clearing and preparation, access road improvement, well pad and infrastructure development	Noise level increase due to construction noise	Impact of noise level generation during the construction phase is potentially significant for nearby community activities and residential areas is likely from the following activities: <ul style="list-style-type: none"> - site preparation activities of 12.17 ha area of Phase-1 and 10.58 ha area of Phase-2; 	<ul style="list-style-type: none"> • Identify potential sensitive receptors and calculate impacts of the proposed construction upon them. • Determine noise reduction treatments that may be required for

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
				<ul style="list-style-type: none"> - construction of power plant and supporting facilities - equipment and material mobilization 	the plant to achieve compliance with criteria.
5	Noise	Exploration drilling	Noise level increase due to exploration drilling	Drilling activities will involve the use of machinery which will generate noise. Impact of noise level generation during the exploration drilling and well testing is potentially significant for nearby community activities and residential areas is likely from equipment and material mobilization.	<ul style="list-style-type: none"> • Identify potential sensitive receptors and calculate impacts of the proposed construction upon them. • Determine noise reduction treatments that may be required for project activities to achieve compliance with criteria.
6	Noise	Well testing	Noise level increase due to well testing	Noise-generation during well testing and proving will result from vertical discharging process during vertical well testing and another noise associated with general operations at the well pads and base camp.	<ul style="list-style-type: none"> • Identify potential sensitive receptors and calculate impacts of the proposed plant upon them • Determine noise reduction treatments that may be required for the plant to achieve compliance with criteria.
7	Land Cover and Spatial Planning	Equipment and material mobilization, land clearing and preparation, access road improvement, and well pad and infrastructure development	Impact from construction of civil infrastructure	The land use change of the existing land use will impact the condition of agriculture, crop community livelihoods, and settlement environment. The project development has the potential to impact the existing land use by using land for proposed well pads, spoil disposal area, road access, and base camp.	<ul style="list-style-type: none"> • Identify land cover and land use based on spatial planning • Aerial photograph on land cover
8	Soil	Land clearing and preparation, well pad and infrastructure development	Soil erosion impact	The possibility of landslides or erosion should be anticipated at locations with a slope of more than 30%. Cut and fill associated with construction of access roads in areas with steep slopes has the potential to increase the probability of the occurrence of landslides which can in turn lead to erosion impacts.	Baseline data study on soils

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
9	Soil	Equipment and material mobilization, land clearing and preparation, access road improvement, well pad and infrastructure construction, and exploration drilling	Land contamination due to poor handling, storage and accidental spill of petroleum products	The potential for land contamination by chemical and petroleum products from equipment maintenance activities, fuel storage areas, refuelling stations, vehicle/equipment wash down areas. The contamination is likely from spill of lubricants, diesel oil and gasoline.	Baseline data study on soils
10	Soil	Well testing	Land contamination due to pipe leakage during well testing	Pipe leakage may occur during the well testing, releasing geothermal fluid (brine water) to the soil. Small leaks are more likely to occur rather than major pipeline leakage at the connection between pipes.	Baseline data study on soils
11	Surface water quality	Land clearing and preparation, well pad and infrastructure development	Lake water quality deterioration due to land clearing and preparation and also landslide and erosion	Lake water quality deterioration is potentially significant during construction activity from site preparation activities for the 12.17 ha area of Phase-1 and 10.58 ha area of Phase-2. Soil erosion has the potential to occur during construction due to land clearing, excavation, earthworks and civil works for well pad and infrastructure development. These activities result in clearing of vegetation and exposure of top soil to the direct effects of rainfall and surface runoff.	<ul style="list-style-type: none"> • Water quality baseline and impact assessment. • Determine treatments that may be required for the plant to achieve compliance with regulations. • Water quality assessment for surface water.
12	Surface water quality	Exploration drilling	Lake water quality deterioration due to potential for spent drilling fluids to reach water bodies	Accidental release or spill of drilling waste, fluid, and mud will result to temporary turbidity if this is released to a water body. Temporarily, spilled drill mud (depending on volume spilled) would manifest as a plume on the water surface which will impact baseline water clarity and disrupt local photosynthetic activities	<ul style="list-style-type: none"> • Water quality baseline and impact assessment. • Determine treatments that may be required for the plant to achieve compliance with regulations. • Water quality assessment for surface water.
13	Surface Hydrology and Hydraulics	Land clearing and preparation, and well pad and infrastructure development.	Water balance alteration	Construction of access road, well pads, pipelines and base camp all have the potential to alter the natural flow of water resources. This has the potential to interfere with the existing surface water flow direction especially when the access road crosses spring water channels.	Baseline data study on run-off potential and impact assessment.

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
14	Surface Hydrology and Hydraulics	Exploration drilling	Potential of surface water deficit due to water abstraction during exploration drilling	The drilling activities will be supplied by lake water abstraction. The estimated average demand for water during the drilling is about 80 gpm for slimhole drilling, and 550 gpm for standard drilling, and 250 gpm for slimhole drilling and 1100 gpm for standard drilling at peak conditions. This has the potential to decrease lake water volume.	Baseline data study and impact assessment.
15	Groundwater quantity	Exploration drilling	Potential of groundwater deficit due to water abstraction during exploration drilling	The Project will not use groundwater as the alternatives for water supply during well drilling. Meanwhile, the scoping survey identified some groundwater sources around the well pads area. However, following the field survey undertaken by the Project in late 2017, it was decided that the project will extract water from the lake. Therefore, it is unlikely to create a disturbance to community water resources.	No further assessment required
16	Environmental Health	Land clearing and preparation	Impacts from land clearing and preparation due to green waste generation	Vegetation clearing has the potential to generate organic waste from vegetation cutting and tree stump removal.	Baseline data study and waste impact assessment
17	Environmental Health	Equipment and material mobilization, land clearing and preparation, access road improvement, and well pad and infrastructure development construction	Domestic solid waste impact from construction workers	Potential environmental issues areas associated with domestic waste generation include solid waste generated from the activities of workers in the basecamp. Domestic solid waste generation includes organic and inorganic waste.	Baseline data study and waste impact assessment
18	Environmental Health	Equipment and material mobilization, land clearing and preparation, access road improvement, and well pad and infrastructure construction	Domestic liquid waste during construction	Potential environmental issues associated with domestic waste generation include domestic wastewater generation from basecamp activities. Domestic sewage is not characterized as hazardous and toxic (B3). However these pollutants can cause impacts to receiving water bodies, including depletion of dissolved oxygen, eutrophication, aesthetic problems due to its unsightly appearance as well as odour and turbidity as a result of the presence of suspended solids	Baseline data study and waste impact assessment

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
19	Environmental Health	Equipment and material mobilization, land clearing and preparation, access road improvement, and well pad and infrastructure construction, exploration drilling & well testing	Hazardous and toxic (B3) solid waste and liquid waste	Various potential types of hazardous and toxic (B3) waste would be generated from the workshop and vehicle maintenance activities, including used filter, used/damage hoses, used batteries/electronic equipment; and used/expired solid/powder chemical/additives. While the liquid waste include lubricants, hydraulic fluid and chemical drilling additives.	Potential hazardous waste generation and impact assessment
20	Environmental Health	Exploration drilling	Impact from drilling mud and drilling cuttings	Drilling activities will produce drilling mud and drilling cuttings in the form of rock debris. One of the important activities is the management of drilling mud and cuttings. These have the potential to be generated in large volumes. Waste drilling mud and cuttings shall be managed in accordance with the applicable regulation.	Baseline data study and waste impact assessment
21	Climate Change	Equipment and material mobilization, land clearing and preparation, access road improvement and well pad and infrastructure development	Greenhouse gas (GHG) emissions during preparation and development	GHG for this project are associated with burning of diesel fuel from off-road and on-road equipment as well as worker vehicle trips. Cumulative increase in GHG concentrations in the atmosphere globally can be attributed to various sources such as burning of fossil fuel, agricultural by-products, land clearing and others.	GHG inventory and assessment of potential impacts
22	Climate Change	Exploration drilling & Well testing	Greenhouse gas emissions during drilling & well testing	The operational greenhouse gas emissions are associated with drilling rig operation, operational worker vehicle trips, and fugitive GHG emissions during well testing.	GHG inventory and assessment of potential impacts
23	Flora	Access Road Improvement and Infrastructure & Well Pad Development	Impacts to vegetation during preparation and development	Construction activities for exploratory drilling will involve land clearing and drilling site preparation for well pad construction. These activities may directly impact vegetation.	Flora identification and baseline study and impact assessment
24	Flora	Exploration drilling & Well testing	Impacts to vegetation during drilling and well testing	Flora disturbance is a potentially significant impact of exploration drilling and well testing which is expected to generate particulate/waste which will attach to plants. This potentially will cause the plant to wither and die.	Flora identification and baseline study and impact assessment
25	Terrestrial Fauna	Equipment and Material Mobilization, and	Impacts to sensitive wildlife species during preparation and development	Construction activities have the potential to impact wildlife inside and outside of the project footprint in several ways including civil	Biodiversity baseline study and impact assessment focused on wildlife listed in:

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
		Infrastructure & Well Pad Development		infrastructure works, construction of new access roads, and direct and indirect impacts to wildlife.	IUCN Red List (except Least Concern) Protected Indonesian Flora and Fauna
26	Terrestrial Fauna	Exploration drilling & Well testing	Impacts to sensitive wildlife species during drilling and well testing	The drilling and well testing have the potential to directly and indirectly impact wildlife. Direct impacts may result from wildlife encounters on the well pads, at the road corridors or base camp. Mobile wildlife such as mammals, birds and herpetofauna may also be impacted by direct contact to hot pipelines. Indirect impacts may occur due to accidental events, such as the exposure of soil or water to hazardous materials and the subsequent spreading of these materials offsite.	Biodiversity baseline study and impact assessment focused on wildlife listed in: IUCN Red List (except Least Concern) Protected Indonesian Flora and Fauna
27	Livelihood and income	Land acquisition	Impact from land acquisition to loss of land and disturbance to community livelihood	The Project exploration requires use of land including renting land for well pads and their supporting facilities (e.g. basecamp, laydown area), and purchasing land for access road widening. The existing land condition of these areas is dominated by small scale community plantations such as candle nut and coffee. Loss of land due to land acquisition (either through renting or purchasing land) has the potential to create disturbance to community income and livelihoods reliant upon plantation activities.	Direct interviews with land owners to identify the loss of land and livelihood changes had not been conducted through a government process at the time the ESIA baseline was undertaken. General baseline information from secondary data and interviews with village leaders and community figures as part of the ESIA process will be used as a basis for undertaking the impact assessment.
28	Livelihood and income	Workforce recruitment, access road improvement, equipment and material mobilization, and well pad and infrastructure development	Increase job and business opportunities resulting to improvement of community livelihood condition	The number of workers required for Project exploration is relatively small, and some of them can be sourced from local villagers and/or within the region. Approximately 96 people will be hired during well pad and supporting facility construction and over 65 people will be hired during the drilling stage. In addition, there would be the need for sub-contracting work tasks such as for quarry materials, access road improvement, and drilling maintenance, as well as supplies for domestic goods and services	Collect secondary data on the socio-economic profile of the community in Sano Nggoang and Wae Sano where the Project facilities will be developed, including employment rate, distribution of occupation/livelihood, level of poverty and income, and other relevant information that will be useful for the

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
				that the locals can provide. These job and business opportunities have the potential to have positive impacts to improve local community conditions.	project to optimise the potential positive benefits to the community.
29	Livelihood and income	Equipment and material mobilization, and access road improvement	Disturbance to community economic activities (e.g. agricultural and ecotourism activities)	Areas surrounding Wae Sano Village and Sano Nggoang Sub-district are considered green undeveloped areas where the dominant community livelihood is from agriculture. There is also potential for improved ecotourism opportunities around Lake Sano Nggoang. Tourists currently come to the area for bird watching activities, and to visit cultural sites. Although both activities are still relatively undeveloped, the Project activities may create a level of disturbance to community livelihood.	Social baseline will be used to understand existing land use and community livelihoods, including agriculture and ecotourism that may be affected by the project footprint. This will be used as basis for understanding the level of potential disturbance and developing appropriate mitigation.
30	Population and migration	Workforce recruitment, access road improvement	The Project induced influx migration	It is understood that the required skills and experience for the majority of the workforces will not likely be sourced from local villages. The presence of non-locals will temporarily increase the village population and in-migration number. Although the number is small, it is likely that the Project presence would trigger migration of people seeking opportunities from the Project. In addition, the local and regional road improvement will enable more access to Sano Nggoang and Wae Sano areas for people to visit the area for leisure.	Baseline data gathering regarding migration trends will be conducted as a basis to assess impacts associated with increased presence of non-locals in the area (workers and non-locals seeking opportunities from the project). In addition, the social baseline study will also seek to understand community experience with the presence of outsiders.
31	Ecotourism	Equipment and material mobilization, land clearing and preparation, access road improvement, well pad and infrastructure development, exploration drilling	Disturbance to ecotourism activities	Sano Nggoang Lake has a small existing ecotourism market, with people visiting for bird watching activities and to visit cultural sites. There is a camping area for bird watchers, which is often used by foreigners. While the industry is still undeveloped, there is likelihood that the Project activities will create a disturbance to these ecotourism activities in the short-term.	Further baseline data collection to better understand community ecotourism activities, the significance of the ecotourism for community livelihoods/level of dependency. In addition identify stakeholder participation in the ecotourism development in the area.

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
32	Ecotourism	Equipment and material mobilization, access road improvement	Positive impact to ecotourism	Ecotourism activities in the Sano Nggoang and Wae Sano areas are still quite undeveloped - likely due to limited access. The Project development plan will include improvements to the regional road from Labuan Bajo (the port) and local roads to access the proposed well pad areas, which may encourage more visitors resulting in positive impacts to ecotourism.	As above
33	Community health	Equipment and material mobilization	Increased dust emissions and temporary increased noise disturbance on community health	Public health disturbance is a derivative impact from air quality decreasing and noise increasing from construction activities. This impact is potentially significant for the nearby community around the project area.	Identification of community health conditions, health behaviour, and disease status.
34	Community health	Well testing	H ₂ S exposure risk on community health	During the well testing, there is a risk of H ₂ S exposure from unplanned events to the nearby community. It is understood that the nearest community resides approximately 80 m from well pad WS-B.	As above
35	Traffic, transport, and community safety	Equipment and material mobilization	Traffic disturbance from construction vehicles and drill rig trucks passing on existing road corridors and villages	Civil infrastructure works will consist of the improvement of road corridors and the construction of well pads. Equipment and material for civil works including delivery of rig parts via various types and sizes of trucks for exploration drilling will be delivered from Labuan Bajo to the project site via the Trans Flores Road and the local road network	Baseline data study on traffic condition, traffic counting and impact assessment
36	Traffic, transport, and community safety	Exploration drilling	Traffic disturbance from exploration drilling and well testing	Exploration drilling will involve employees travelling from base camp to the well pads, as well as occasional maintenance vehicle support. However due to insignificant number of workers and relatively small scale of activities compare to exploitation phase, the potential impact is unlikely significant.	No further assessment required
37	Traffic, transport, and community safety	Site closure	Traffic disturbance from site closure activity which will involve vehicles and drill rig trucks passing on existing road corridors and villages	Traffic management of post operation vehicles and drilling rig trucks passing on existing road corridors and villages. This activity may potentially generate traffic issues.	Baseline data study on traffic condition, traffic counting and impact assessment

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
38	Community safety	Equipment and material mobilization, access road improvement	Safety risk of road users and community residing along the access road	The increased traffic congestion on public roads resulting from project construction mobilization has the potential to create a safety hazard for road users. Exposure to safety hazards can potentially lead to injury, especially to vulnerable users, such as pedestrians crossing roads and children who may play near the project area.	Baseline data on community used of roads, community safety behaviour and awareness, road and transportation quality/condition, and if possible, historical traffic incidents in the area.
39	Community amenity	Equipment and material mobilization, access road improvement	Impacts on public road quality and community access	The Project development plan will include improvement of the regional road from Labuan Bajo (the port) and local roads to access the proposed well pad areas, creating positive impacts to community access e.g. to other villages, sub-districts, and plantation areas which may improve the economic status of some villagers.	Information regarding road quality condition and the use of roads to be obtained as a basis to identify opportunities for the Project to create positive impacts to community amenities.
40	Community amenity	Exploration drilling	Disturbance to community water resources	The Project has a number of alternatives for water supply during well drilling, including surface water and the lake. Meanwhile, the scoping survey identified existing issues in the community in obtaining clean water, due to dry areas. However, following the field survey undertaken by the Project in late 2017, it was decided that the project will extract water from the lake. Therefore, it is unlikely to create a disturbance to community water resources, as the lake water quality is unusable for domestic purposes.	No further assessment required
41	Visual	Equipment and material mobilization, land clearing and preparation, access road improvement and well pad and infrastructure development	Visual impact during preparation and development	During construction, the existing visual landscape will be altered through land preparation activities and the construction of roadways, pipelines and well pads. The visual landscape may also be altered by waste accumulation, mobilization of heavy equipment and the final construction of project components	Baseline data study and visual impact assessment
42	Visual	Exploration drilling	Visual impact during drilling	Well drilling will result in few impacts over and above those encountered in the construction. Additional impacts could result from drill rig installation and activity, though these are likely to be short-term and will not significantly alter the overall panorama. They will	Baseline data study and visual impact assessment

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
				also provide supplemental lighting if night drilling activities are required which may have its own impacts.	
43	Social fabric and community perception	Land acquisition	Disputes in the community on land ownership	Land is an important asset for an agricultural-based community, including in the Sano Nggoang and Wae Sano area. One of the most common issues raised during land acquisition in areas where traditional land ownership still applies is disputes over ownership. Project development resulting in land acquisition often creates competition between communities to obtain the benefits (compensation) from land compensation.	Information regarding land ownership status and legality (certification), and land tenure, including historical data and identification of any cultural attachment to the land.
44	Social fabric and community perception	All project activities	Changes in community perception and disturbance to local cultural values, norms, and practices	The presence of non-local workers will introduce new social pressures stemming from the introduction of different cultures, religions, and social behaviours. Community tension and conflict may increase if it is not effectively managed.	Baseline data gathering on community cultural values, customs, and traditions.
45	Cultural heritage	Land clearing and preparation, and well pad and infrastructure development	Impacts on tangible cultural heritage and disturbance to access to the cultural sites	The community surrounding the proposed Project area of interest is a traditional cultural community, whose cultural values are still attached to its tangible cultural heritage, including land in the old kampong areas and historical value of Sano Nggoang Lake. Changes of land used for the Project development has the potential to adversely impact these tangible cultural heritages. In addition, there are some cultural and communal sites near the Project area where community access to the sites should remain intact.	Assessment of potential existence of tangible cultural objects within the project footprint that are of significance for the community.
46	Labor rights	Workforce recruitment and management	Impacts on general working conditions	It is anticipated that there will be more contractors than staff hired for the project. There are potential risks of violation of labor rights from both the project and contractors.	Assessment of potential risk for the project to violate regulated labor rights, with particular attention on the treatment of locals.

No	Environmental and Social Component	Source of Impact	Potential Impact	Preliminary Assessment	Proposed Studies
47	Occupational health and safety	All project activities	OHS risks to workers	There are potential OHS risks for project construction workers as they are likely to be exposed to a number of physical activities which have the potential to lead to injuries and, in some case, death.	Assessment of potential risk for the project to violate labor working conditions and increase worker's exposure to OHS risks.

4.4. Baseline Studies

Following scoping assessment, the development of the impacts matrix was used to determine the need to gather baseline data that will define the existing environmental or social condition for each environmental element that may be impacted. This is necessary for a number of reasons in the environmental assessment process. It is not possible for most impacts to determine the significance of an impact without the context of understanding the current environmental condition. If the current condition of a particular environmental or social element shows good quality, it may be that the project impact will make a significant difference to the existing condition, or it may indicate that there is a strong assimilative capacity to deal with the impact, depending on the nature of the impact and the parameters being considered. Similarly, if the existing condition for an environmental or social element is poor, then that may mean that a project impact might not be so significant, or it could mean that there is little assimilative capacity in the existing environment to absorb an impact.

The focal point of the environmental impact process is to define the existing environmental values, to a level that will enable project impacts to be described, and establish baseline conditions for monitoring any changes that will occur due to project impacts. For environmental elements, both physical and ecological, the appropriate level of baseline assessment is determined in the scoping process. The levels, of which environmental baselines need to be assessed, can range from a simple desktop survey of secondary information that may be already available, to a full field assessment of the particular environmental parameter involved and the development of project specific primary data. For the social/community aspects it is necessary to assess existing secondary data that may exist in government records or other community census information, but it is essential that a degree of community consultation takes place to define the key community issues.

4.4.1. Desktop Review

The collection of baseline data for the Waesano Geothermal Exploration Project was conducted by the collection of both primary and secondary data. A multi-disciplinary team of experienced scientists and environmental professionals was assembled to carry out the required resources assessment, generation and analysis of baseline data and predict of potential impacts and recommendations of mitigation plan. The available data referenced for this study is listed in Table 4-3.

Table 4-3 Data Source for Baseline Studies

Data	Source
Satellite Photographs	Ortho photo PT Jacobs (2017)
Meteorological Data	Meteorology, Climatology and Geophysics Agency (BMKG)
Climate (Rainfall, Air temperature, relative humidity, wind speed and wind direction)	PT SMI (GEUDP ES Screening Report, 2016)
Air Quality and Odour Level	Primary Data
Noise Level	Primary Data
Physiography	Mapping Data of Geospatial Information Agency (BIG)
Geology and Geomorphology	Geology Map (Geology Research and Development Centre, Directorate of Geology) – Komodo (1978) and Ruteng (1994) Sheet. PT SMI (GEUDP Pre-Feasibility Study of Wai Sano Geothermal Project) Spatial Planning Agency (West Manggarai Regency Spatial Planning, 2010)
Soil	Geology Agency PT SMI (GEUDP Pre-Feasibility Study of Wai Sano Geothermal Project) Spatial Planning Agency (West Manggarai Regency Spatial Planning, 2010)
Land Use and Forest Status	Topographical Map of Indonesia scale 1:25.000 (<i>Peta Rupa Bumi Indonesia</i>), BIG (2001) Production Forest Utilization Map (SK. 2382/Menhut-VI/BRPUK/2015), Ministry of Environment and Forestry (2015) Indonesia's Forest Permit Moratorium Map (PIPPIB) Revision XII (2017)

Data	Source
Surface Water Quality and Quantity	Primary Data
Groundwater Quality and Quantity	Primary Data
Watershed Data	Watershed data webGIS Data from Ministry of Environmental and Forestry
Terrestrial Biodiversity – Flora and Fauna	Natural Resources Conservation Agency (BKSDA) BirdLife Indonesia PT SMI (GEUDP ES Screening Report, 2016)
Aquatic Biota	Primary Data
Demography and Population	Local Social Agency Central Statistics Agency PT SMI (GEUDP ES Screening Report, 2016) Sano Nggoang Sub-District (Nempung Cama Riang Puar / NCRP Wae Sano Village) PT SMI (Pre-Socialization Activity Report)
Local Economy, Income and Employment	Primary Data Local Social Agency Central Statistics Agency Culture and Tourism Agency PT SMI (GEUDP ES Screening Report, 2016) BirdLife Indonesia (Mbeliling Landscape Ecotourism Potential Assessment Report, Wae Sano Village and Liang Ndara Village, 2014) PT SMI (Pre-Socialization Activity Report)
Social Culture	Primary Data Local Social Agency Central Statistics Agency Culture and Tourism Agency PT SMI (GEUDP ES Screening Report, 2016) BirdLife Indonesia (Mbeliling Landscape Ecotourism Potential Assessment Report, Wae Sano Village and Liang Ndara Village, 2014) Sano Nggoang Sub-District (Nempung Cama Riang Puar / NCRP Wae Sano Village)
Public Health	Central Statistics Agency PT SMI (GEUDP ES Screening Report, 2016) Public Health Center (Puskesmas)

4.4.2. Field Survey and Primary Data Gathering

Primary data gathering were conducted as many as three times in 2016 to 2017. The scope of work for each baseline study is describes as follows.

Table 4-4 History of Baseline Studies

Time	Location	Scope of Work
4 – 10 November 2016	The drilling exploration points plan are: a. Pad 1 located in Nggoang Sub-Village, Sano Nggoang Village; b. Pad 2 located in Dasak Sub-Village, Wae Sano Village;	Observation and primary data collection needed consist of: 1. Social survey of the host community at Nunang sub-village; 2. Identify potential affected people associated land acquisition; 3. Inventory of land potentially affected by land acquisition; 4. Physical social resources;

Time	Location	Scope of Work
	<ul style="list-style-type: none"> c. Pad 3 located in Nunang Sub-Village, Wae Sano Village; d. Pad 3' located in Nunang Sub-Village, Wae Sano Village e. Pad 4 located in Nggoang Sub-Village, Sano Nggoang Village; f. Pad A' located in Taal Sub-village, Wae Sano Village. 	<ul style="list-style-type: none"> 5. Sampling of water quality in at least five locations that represent the ecosystem of the river (three samples) and the ecosystem of the lake (two samples); 6. Rapid assessment on the target location that represents the forest ecosystem and the area surrounding the proposed and determined site project based on secondary data research paper; 7. Analysis of environment physical aspects including: surface water (rivers and lakes) quality and quantity, groundwater quality, air and noise qualities, soil structure and landscaping; 8. Bird and bat surveys at the target sites representing forest and lakes ecosystems in and around the proposed and determined project site based on secondary data research paper; 9. Inventory of existing tourism industry and its development plan; 10. Mapping the affected location using Google Earth satellite imagery and overlaying it with forest status and spatial planning maps; 11. Spatial analysis with GIS - if possible.
20 – 25 March 2017	<ul style="list-style-type: none"> • Baseline study in Pulau Nuncung Village • Participatory mapping activity located in Wae Sano, Sano Nggoang, and Pulau Nuncung Villages. 	<p>The scope of additional baseline study are as follows:</p> <ul style="list-style-type: none"> 1. Primary and secondary data collection in Pulau Nuncung Village for environment and social baseline with parameters that need to be analysed, including: <ul style="list-style-type: none"> • socio-economic data; • groundwater data; • surface water data; • cultural heritage places; and • flora and fauna. 2. Preparing sensitivity map based on participatory mapping in 3 villages.
22 – 30 November 2017	<ul style="list-style-type: none"> a. WS-A located in Lempe Sub-village, Wae Sano Village; b. WS-B located in Nunang Sub-village, Wae Sano Village; c. WS-D located in Dasak Sub-village, Wae Sano Village; d. WS-E located in Taal Sub-village, Wae Sano Village; e. Spoil Disposal 1 (Drilling material) located in Dasak Sub-village, Wae Sano Village; f. Spoil Disposal 2 (Drilling material) located in Taal/Dasak Sub-village, Wae Sano Village; g. Spoil Disposal 3 (Drilling material) located in Lempe Sub-village, Wae Sano Village; 	<p>The main objective of this task is to get additional environment and social data gathering on the current project location. The additional data that will be gathered are focusing in the new area where the well pads, laydown and ancillary facilities, and access road improvement from Trans Flores to site are proposed in the current Project Description. The following data requirements are as follow:</p> <ul style="list-style-type: none"> 1. Lake water level survey by using static gauge installation; 2. Conduct a bird, mammal and herpetofauna rapid/screening survey of the lake, lake edge and river using a targeted sampling approach; 3. Identification of water uses survey on river downstream of the lake; focusing on uses that may be affected by damming and abstracting lake water; 4. Secondary data based mapping and observation of land use, land cover and sensitive receptors on neighboring sites (such as nearest community settlement) of new locations referring to the changes in the Project Description; 5. Relevant additional social, cultural, economy, and ecotourism baseline related to potential impacts from

Time	Location	Scope of Work
	h. Access Road upgrade from Trans Flores to site location (exclude STA 21+350)	damming and abstracting lake water, and impacts from the new project footprint for well pad and its supporting facilities; and
	i. Laydown area located in Lempe Sub-village, Wae Sano Village;	6. Additional data and information on land use and ownership due to changes in project footprint and land acquisition area including for well pad areas and road upgrading.
	j. Drilling Base Camp located in Taal Sub-village, Wae Sano Village;	Of note, as explained in the Section 1.4 Project Background and Current Status, some of the road widening plan were not yet confirmed, while the recent well pads alternative were just planned in December 2017, therefore were not visited during this additional baseline survey.
	k. Water Treatment Area 1 located in Lempe Sub-village, Wae Sano Village;	
	l. Water Treatment Area 2 located in Taal Sub-village, Wae Sano Village.	

4.4.3. Study Limitations

The attached Report (the “Report”) has been prepared by AECOM for the benefit of the client (“PT SMI”) in accordance with the agreement between AECOM and SMI, including the scope of work detailed therein (the “Agreement”). Given the current stage of the Project design process, this ESIA document has gone through a series of revisions due to some changes in a number of proposed locations for the Project facilities at the time the initial primary data gathering for this ESIA was carried out and throughout report preparation.

The information, data, recommendations and assessments contained in the Report (collectively, the “Information”):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the “Limitations”);
- represents AECOM’s professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to Consultant which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement;
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

Further study limitations as follows:

- During the previous ESIA draft there was a limited timeframe provided to develop the report and undertake the site visit within the first week after kick-off meeting, based on the Project design provided to AECOM in 27 October and 3 November 2017. Of note, some of the road widening locations were not confirmed prior to site visit, while the three (3) well pad alternatives of WS-B1, WS-B4, and WS-E (alternative) were only identified in 22 December 2017, due to the cultural sensitivity of the original locations that were just identified during the site visit. These new proposed areas were surveyed during the ESIA disclosure process which included join-walkthrough visit with local community;

- One season baseline survey and sampling was performed considering adequacy of the dry season data for impact assessment purpose such as for air quality, and less variation between seasons. Secondary data was presented for the second season;
- Regency level data is used to describe some of social baseline due to limited information from sub-district and village office; and
- The interview and social economic inventory of landowners could not be conducted since the Project was still in the process of land boundary and ownership mapping at the time the ESIA disclosure and joint-walkthrough survey were conducted.

These study limitations are expected to be addressed after the second round of public consultation for ESIA and ESMP disclosure and consultation which is planned to be conducted prior to design finalisation.

4.5. Impact Prediction and Evaluation

The definition of impacts needs to be an objective exercise; it predicts the potential for the project and its associated activities to change the existing environmental values as a consequence of its implementation. The cornerstone of impact prediction is the project description, which needs to define all the elements of the project and associated activities. Often, given the timing of the need for ESIA, detailed design of the project and project elements may not be available, if that is the case that it is necessary to provide as much definition as possible as to the parameters that will be employed in a detailed design. As suggested in Figure 4-1, the prediction and evaluation of impacts, is often an iterative process, involving the project design team in the optimisation of project design to mitigate against the potential impacts of the project. In the case of environmental impacts, this may be something such as the relocation, or alteration of footprints in the alignments to avoid loss of ecosystems, and in the case of social elements it could include aspects of timing, use of local resources or other aspects of interaction with the community that may enhance potential benefits, or reduce potential negative effects.

The impact assessment process does not only consider planned project components under normal conditions, but must include consideration of the interaction of the project with unplanned or abnormal conditions that may exist through life of the project. These unplanned interactions may be project derived, such as accidents, spills or changes necessitated by external circumstances, or they may be related to abnormal or extreme environmental conditions that could possibly occur through life of the project such as extreme storms or seismic events.

4.5.1. The Definition of Impacts

Environmental and social impacts can be both positive and negative, it may even be possible through mitigation strategies to turn potentially adverse impacts into positive outcomes, hence the cyclic nature of the development of impacts and mitigation strategies, in which the potential for these improvements can be explored. Table 4-5 provides a description of the terminologies that are used throughout ESIA to define and describe impacts.

Table 4-5 Impact Assessment Terminology

Term	Definition
Impact Severity and Impact Magnitude	
Severity	The severity of an impact is a function of a range of considerations including impact magnitude, impact duration, impact extent, and legal and guideline compliance
Magnitude	Estimate of the size of the impact (e.g. the size of the area damaged or impacted the % of a resource that is lost or affected etc.), which influence the level of severity
Impact Nature	
Negative Impact	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor
Positive Impact	An impact that is considered to represent an improvement on the baseline, or introduces a new desirable factor

Term	Definition
Neutral Impact	An Impact that is considered to represent neither an improvement nor deterioration in baseline conditions
Impact Duration	
Temporary	Impacts are predicted to be of short duration and intermittent/occasional in nature
Transient	Impacts that are predicted to last only for a limited period (e.g. during construction) but will cease on completion of the activity, or as a result of mitigation/reinstatement measures and natural recovery
Long-term	Impacts that will continue over an extended period (e.g. operational noise) but cease when the Project stops operating. These will include impacts that may be intermittent or repeated rather than continuous if they occur over an extended time period
Permanent	Impacts that occur once for development of the Project and cause a permanent change in the affected receptor or resource (e.g. the destruction of a cultural artefact or loss of a sensitive habitat) that endures substantially beyond the Project lifetime
Impact Extent	
Local	Impacts are on a local scale (e.g. restricted to the vicinity of the plant)
Regional	Impacts are on a broader scale (effects extend well beyond the immediate vicinity of the facilities and affect West Manggarai Regency)
Extensive	scale.

It is important that the ESIA process defines both the potential for a project to have an impact environmentally or socially, but also what the net outcome of that impact will be after mitigation measures are applied. The ESIA does not only describe the direct impacts of the project itself, but also the way in which the project will interact with other influences that may derive a social or environmental impact. Thus there are a number of different types of impact that need to be considered as described in Table 4-6.

Table 4-6 Definition of Impact Type

Impact Type	Definition
Direct Impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment (e.g. between occupation of a plot of land and the habitats which are lost).
Secondary Impact	Impacts that follow on from the primary interactions between the project and its environment as a result of subsequent interactions within the environment (e.g. loss of part of a habitat affects the viability of a species population over a wider area).
Indirect Impact	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (e.g. presence of project promotes service industries in the region).
Cumulative Impact	Impacts that act together with other impacts or the impacts from non-project related activities to affect the same environmental resource or receptor.
Residual Impact	Impacts that remain after mitigation measures have been designed into the intended activity.

4.5.2. Evaluation of Impacts

In evaluating the significance or importance of impacts, several factors are taken into consideration. These include an assessment of project component and its effect on the existing environment, as measured by its baseline and the potentially affected sensitive receptors. The impact is then assessed based on its potential severity, sensitivity, and likelihood of the unplanned events. The steps involved in the evaluation of impacts and level of impact are shown in Figure 4-2.

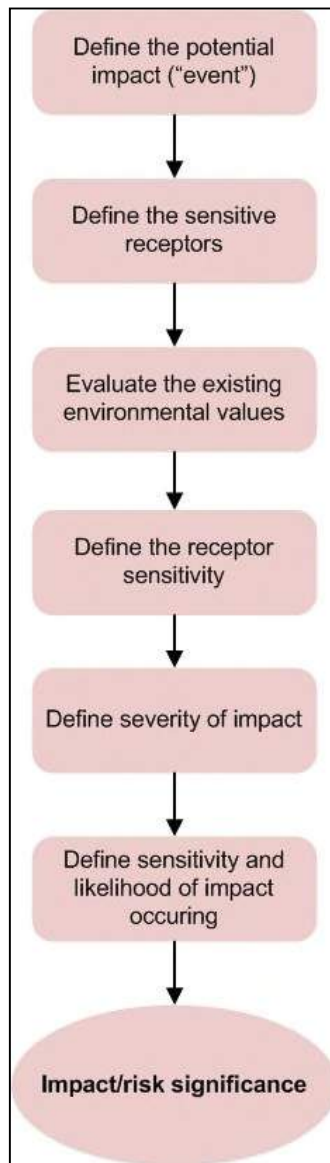


Figure 4-2 Impact Assessment Process

4.4.5.1. Impact Criteria

The evaluation of impact will be determined with impact severity, nature and sensitivity of the receiving environment and likelihood of occurrence.

- Impact Severity: the severity of an impact is a function of a range of considerations including impact magnitude, impact duration, impact extent, and legal and guideline compliance;
- Nature and sensitivity of the receiving environment: the characteristics of the environmental or social receptor will be taken into consideration with respect to its vulnerability or sensitivity to an impact,
- Likelihood of occurrence: how likely or probable is it that this impact will occur.

a. Impact severity

The criteria described above are used to determine impact severity is further defined as follows:

- Impact magnitude: the magnitude of the change that is induced, such as the percentage of resource that might be lost, the predicted change in the level of a pollutant, or a quantitative measure of losses or benefits to the community;
- Impact duration: time period over which the impact is expected to last;
- Impact extent: the geographical extent of environmental change, or the or the degree to which social impact may reach into the immediate, surrounding, or even general community;
- Regulations standards and guidelines: the status of the impact in relation to regulations or prevailing legislation, comparison of the predicted outcome with recognised standards and guidelines the relevant to the project, its location and context.

Wherever possible, severity of an impact should be described in quantitative terms, based on numerical values, compared to regulatory limits, project standards or guidelines, or the number of people that have the potential to be impacted. However in some instances it is necessary to take a more qualitative approach in the definition of some outcomes, either because qualitative estimates are simply not possible, or because numerical evaluations are just not relevant (this is particularly true of some of the social elements, such as community perception).

Definitions of impact severity levels are as follow:

- High: a major alteration of the existing environment that is likely to be irreversible or will result in the loss of that environmental value for a period of time.
- Medium: an alteration to the existing environment that will modify its current status, but will not stop its role in the environment or is easily reversed.
- Low: an alteration to the existing environment but few sensitive receptors or a change that will be transient.
- Slight: measurable but no effective change to the current environmental value.

b. Nature and sensitivity of the receiving environment

The criteria under which the sensitivity of the receiving environment is assessed can be described as:

- Abundance
 - Rarity: *is the impacted receptor a rare occurrence of that environmental state, or social parameter (such as an endangered species or habitat);*
 - Size or extent: *necessary to define the amount of loss that may apply to the impact on a particular environmental or social element.*
- Adaptability
 - Resilience: *what is the ability of the particular environmental or social element to withstand the change (for instance social/health impacts may have different outcomes of a very old or very young members of the community);*
 - Ability to recover: *what is the potential to recover from the impact, how complete will recovery be and how long will it take.*
- State
 - Degree of disturbance: *is the state of the environmental or social element in its natural condition, or has it been disturbed by other activities in the past;*
 - Uniqueness: *is the particular environmental condition a unique situation, or is it a fairly common occurrence, what is the potential to replicate the situation by way of offset or compensation;*
 - Establishment: *how well-established is this particular environmental/social condition, is its future tenuous or is it likely to persist.*
- Value
 - Implicit value: *how important is it to retain particular environmental/social condition, in the context of its interrelationship with the broader environment. With the loss of this particular environmental/social condition lead to further breakdown of the existing environment;*
 - Recognised value: *has the environmental condition been recognised in some formal sense, such as a declaration of a conservation area or National Park.*

c. Likelihood of occurrence

For **unplanned events**, or extreme situations the likelihood that the particular environmental condition will exist can be ascribed a qualitative probability, as per the categories defined in Table 4-7.

Table 4-7 Likelihood Categories

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions, i.e. the event is heard of and associated with the industry.
Possible/Likely	The event is likely to occur at some time during normal operating conditions, i.e. an incident has occurred in the industry before.
High Likelihood / Inevitable	The event will occur during normal operating conditions (is inevitable), or the event happens several times per year at a location

Likelihood is estimated on the basis of experience and available evidence that such an outcome has previously occurred. Impacts resulting from routine or planned events (normal operations) are classified as having a high likelihood of occurrence.

4.4.5.2. Evaluation of Significance

For the purposes of ascribing significance to the impacts in this ESIA, the terminology that has been adopted is described in Table 4-8.

Table 4-8 Terminology for Impact Significance

Significance	Definition
Positive Impact	An impact that is considered to represent an improvement on the baseline or introduces a new desirable factor
Negligible Impact	Magnitude of change is comparable to natural variation
Minor Impact	Detectable but is not significant - should be further mitigated if possible but is an acceptable risk
Moderate Impact	Significant, amenable to mitigation, should be further mitigated if possible borderline acceptability.
Major Impact	Significant; amenable to mitigation; must be mitigated - not acceptable
Critical Impact	Intolerable; not amenable to mitigation; alternatives must be identified – Project Stopper

Definitions of impact significance are as follow:

- Critical: highly significance changes of the existing environment that is likely to be irreversible.
- Major: a major alteration of the existing environment that will result in the loss of that environmental value for a period of time.
- Moderate: an alteration to the existing environment that will modify its current status but will not stop its role in the environment or is easily reversed.
- Minor: an alteration to the existing environment but few sensitive receptors or a change that will be transient.
- Negligible: measurable but no effective change to the current environmental value.
- Positive: should a positive impact is identified; no magnitude or sensitivity is assessed. It is considered sufficient to indicate that the project is expected to result in a positive impact, without identifying the significance of the impact that is likely to occur.

It must be noted that critical impacts are not acceptable for planned operations, and can only be tolerated in the instance of unplanned or incidental events, and only then when the likelihood of occurrence has been reduced through project planning to least low or unlikely.

a. Evaluation of impacts from the planned project activities

The significance of each impact is determined by comparing the impact severity against the sensitivity of the receptor in the impact significance matrix provided in the Table 4-9.

b. Impacts of unplanned events

Unplanned event impacts are defined to which probability of occurrence may be ascribed, severity of the impact needs to be considered in conjunction with the likelihood of its occurrence as described in Table 4-10.

Table 4-9 Determining the Significance of Impacts

		Sensitivity of Receptor		
		Low	Medium	High
Impact Severity	Slight	Negligible	Negligible	Minor
	Low	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Critical

Table 4-10 Unplanned Event Impacts Significance

		Impact Likelihood		
		Unlikely	Possible/Likely	Inevitable
Impact Severity	Slight	Negligible	Negligible	Minor
	Low	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Critical

Impacts assessed as Negligible will require no additional management or mitigation that, because either the magnitude of the impact is sufficiently small for the receptor sensitivity is sufficiently low, and adequate controls or included in the project design. Negligible impacts are therefore deemed to be insignificant, and do not require any further remedial action.

Impacts that are evaluated to be minor, moderate or major will require the implementation of further management or mitigation measures. Moderate to major impacts are therefore considered to be significant. For potentially major impacts the object of mitigation is to reduce the residual risk to a moderate level.

In the development of mitigation measures to reduce moderate impact, the emphasis is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable. It will not always be practical to reduce moderate impact of minor ones in consideration of the cost effectiveness of project.

Impacts evaluated as critical cannot be managed mitigated, and therefore demand selection of alternatives to eliminate the potential sources in. They cannot be contemplated as part of the normal operation of the project, and can only be considered if project design has taken every possible step to reduce the probability of occurrence to as low as possible.

c. Evaluation of Community and Social Impacts

For the assessment of social impacts the same approach has been undertaken as for the environmental impacts; however the terminologies have been altered slightly to consider community interpretation. So rather than refer to potential impacts of having a graded scale of significance (any social issue is of major significance to some or many parties), the term urgency is used to indicate the prioritization process that is necessary in dealing with community and social issues.

The level of impact significance (or urgency) for various social concerns are evaluated as per Table 4-11.

Table 4-11 Determining the Significance (Urgency) of Community and Social Impacts

		Sensitivity of Receptor		
		Low	Medium	High
Impact Severity	Slight	Negligible	Negligible	Minor
	Low	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Critical

Significance of social impacts for various social concerns is defined as per Table 4-12.

Table 4-12 Assessment of the Significance (Urgency) of Community and Social Impacts

Impact Significance	Community Displacement	Social And Public Amenity	Community Health
Positive	An outcome that will derive an economic benefit to the community.	The provision of community amenity or amenities that have previously been unavailable	An outcome that can be expected to improve community health

Impact Significance	Community Displacement	Social And Public Amenity	Community Health
Negligible	For Community Displacement – only applies to mitigated outcomes where relocation will preserve lifestyles but may not satisfy cultural needs. Will induce minimal economic Displacement. Mitigated Economic Outcomes where long term solutions may be found by some effort by either party.	Will challenge the perceptions and may cause unease that will need to be clarified amongst insignificant number of people within the community.	Does not apply
Low	For Community Displacement – only applies to mitigated outcomes where relocation will preserve lifestyles but may not satisfy cultural needs. Will induce some economic Displacement affects small proportion of households; scale at local level, and of a short duration. Mitigated Economic outcomes that can only be resolved by one-off compensatory actions that may not be sustainable.	Likely to impact few individuals and will impair current lifestyles or customs. Will challenge the perceptions and may cause unease that will need to be clarified amongst some groups within the community, scale at local level, and of a short duration. Will change daily function or remove resources for small number of family or household.	Does not apply
Medium	For Community Displacement – only applies to mitigated outcomes where relocation will not preserve lifestyles and values. Will induce some economic Displacement affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact larger in scale to district level.	Likely to impact some groups of people and will impair current lifestyles or customs. Will challenge the perceptions and may cause unease that will need to be clarified amongst a large proportion of the community, larger scale to district level at longer duration. Will change daily function or remove resources for a number of family or household.	That there may be health impacts on sensitive groups in the community that can be avoided.
High	Will require both physical and economic displacement (or relocation of any individuals). Will induce major economic displacement, change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.	Likely to impact a large number of people, over a majority of the area of influence, and will impair current lifestyles or customs. Will change daily function or remove resources for larger community groups over a regional or national area.	That any member of the community will be injured or suffer health impacts if an impact were to occur. That any member of the community may be in harm's way due to a project activity.

4.6. Mitigation

The assessment process is intended to identify impacts and benefits associated with project activities and ways of dealing with them during the planning and design stage of the project. The ultimate goal of the assessment process is to reduce the negative impacts and enhance the benefits or positive impact of any intended activity. Planned mitigation measures will be described, and additional measures or controls will be recommended were impacts are still considered to be unacceptable.

In deciding appropriate mitigation strategies there is a hierarchy of response, as indicated in Figure 4-3.

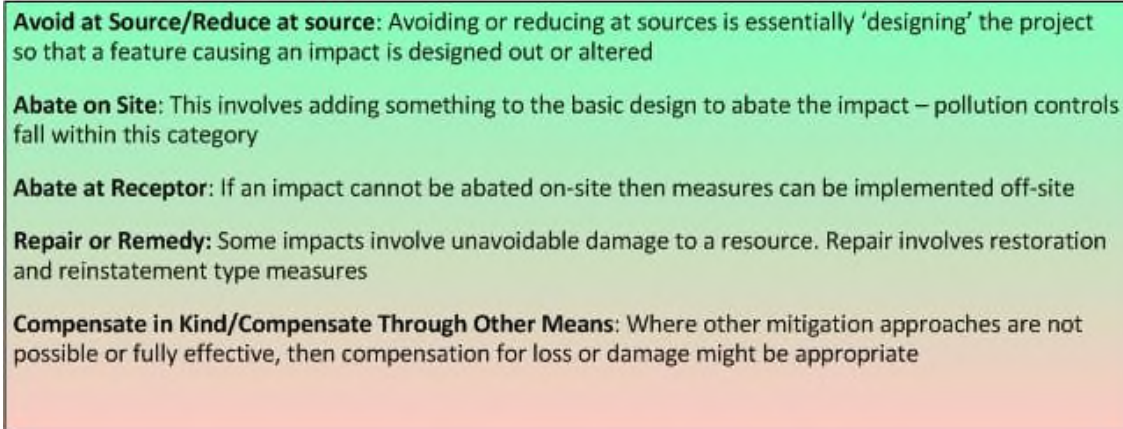


Figure 4-3 Mitigation Hierarchy

It is the nature of the industry that some impacts are just not reversible, but the positive outcomes of the project outweigh the residual impact, hence the need for the ESIA process to develop the best possible outcomes from the implementation of a project.

There is also the possibility of unplanned events and extreme and unusual environmental conditions that may lead to major or even critical impacts. It is incumbent on the project proponent to reduce the probability of such events to as low as reasonably practical, and even after this is a necessary part of the mitigation process to define a response should the event occur. There is again a hierarchy of response to such occurrences:

- **Control:** this is a response to deal with potential negative impacts at the time and an emergency situation may be occurring, it can include such things as bushfire fighting capacity, or even stop work plans for extreme weather events;
- **Recovery:** in the event that the emergency situation has occurred it is important to identify how project proponents will respond to the potentially negative impacts such recovery plans could include response plans for containing or neutralising spills, or compensation packages were affected parties.

Many mitigation or control measures will require a degree of management to ensure their success in reducing potential impacts to the residual level (mitigated impacts significance) that is expected through the ESIA process. Generally implementation of mitigation measures aim to reduce the severity of impacts, however in some cases where the degree of magnitude and extent of the Project activities which influence the level of severity could not be reduced, mitigations will be proposed to manage sensitivity of the receiving environment and community. These are as proposed in some of the social impacts management e.g. in the case where the scope of land acquisition could not be reduced, mitigations in the form of livelihood restoration to reduce community vulnerability will be proposed. Most of these residual (mitigated) outcomes still require a degree of monitoring through project implementation to ensure that the mitigation management process is effective.

The mitigation measures (both social and environmental) that have been proposed for this exploration ESIA have been considered with their application into the future for the project proper. In as much as possible the Project seeks to establish environmental and social mitigation strategies that are robust and will continue to be applied as the project progresses. It is these management and monitoring efforts that report to the environmental and social management plan (ESMP) as part of the ESIA.

4.7. Environmental and Social Management Plan

The environmental performance of the project should be monitored and the extent of the monitoring should be commensurate with the projects risks is in with projects compliance requirements.

The outcome of the environmental assessment process is a series of residual impacts of varying severity, and varying reliance on the mitigation strategies that reduce the severity raw environmental impacts of risks associated

with the project. Although many of the mitigation strategies are implemented through the design of the project, there will be a significant number of impacts will need to be mitigated by ongoing management through the construction and operation phases of the project. There are also a number of remedial actions will take place as part of the project decommissioning or closure. The ESMP indicates a commitment on behalf of the project proponent to the management of these environmental and social initiatives throughout the implementation and closure of the project.

The ESMP consists of a set of mitigation, monitoring, and institutional measures to be taken during implementation and operation of the project to avoid, reduce, or compensate adverse social and environmental impacts. It will include the priority of such tasks; indicate responsibilities within the organisation; and the timelines for their achievement. It will include reference to a number of more detailed management plans and procedures to be followed within the organisation, such as environmental monitoring programs, community safety and security policies, community consultation plans, maintenance procedures and schedules. It should also describe the desired outcomes is measurable events and parameters to the extent that is possible, this should include performance indicators, targets, or acceptance criteria that can be tracked over defined time periods, and indicates resources that will be committed for implementation of the plan. It should also indicate responses that will need to be undertaken, in the event that performance criteria are not being met for instance it should recommend immediate remedial action is an element of pollution abatement infrastructure seems to be failing. We measures and actions are identified as being necessary for the project to comply with applicable laws and regulations these should be included in the ESMP.

As shown in Figure 4-3, the development of the ESMP is an iterative process, as part of the ESIA process public disclosure of the findings of the environmental and social analysis is an important step, and often the ESMP will be refined on the basis of community feedback. Also throughout the project as the realities of project implementation become more apparent, is often the case that procedures are modified and optimised, or simply that a better way of doing things becomes more obvious than it was at the planning stage of the project. Thus the ESMP, and its underlying monitoring and management procedures are living set of documents, which reflect the current status of the environmental and social management approach and plans.

ESMP shall generally align with the Indonesian Regulation impact assessment (AMDAL) which also contains an environmental management and monitoring plan (RKL-RPL). As for the current stage of Waesano Geothermal Exploration, the required management and monitoring plan is presented in the UKL-UPL (environmental management and monitoring effort). It contains all of the elements of an ESMP, but because of a slightly narrower requirement, it does not address all of the issues required by the World Bank Safeguard Policies which has been adopted in the GEUDP ESMF. Of note, World Bank Safeguard Policies make it clear that compliance with local regulatory processes is fundamental in the environmental management of a project. The proposed ESMP for the Project includes UKL-UPL measures as well as additional measures that address the further needs for compliance with World Bank Safeguard Policies and the GEUDP ESMF.

4.8. Multi-Criteria Spatial Analysis for Baseline Environmental and Social Identification and Classification

4.8.1. Introduction to Multi-Criteria Spatial Analysis

It is important to identify and map areas that are environmentally suitable or not suitable for geothermal development, which entails targeting and drilling of geothermal wells leading to the eventual development for geothermal exploitation. The developable/suitable area can be assessed by analyzing a sensitivity index based on the sensitivity of environmental parameters. The spatial distributions of environmental parameters are needed in order to clearly illustrate the spatial distribution of the sensitivity index. Each parameter is visualized in one map layer by using Geographic Information System (GIS) analysis tools.

Application of GIS alone could not overcome the inconsistency of professional opinion on deciding and assigning relative importance to each of many criteria considered in a suitability analysis. The Analytical Hierarchy Process (AHP) method (Saaty, 1980) is used in combination with GIS to address this issue. This method is widely used by decision makers to set priorities in multi-criteria decision making.

Spatial analysis is conducted based on Simple Additive Weighting (SAW) method. The result of this assessment is suitability index map based on environmental parameters.

4.8.2. Environmental Variable Identification and Sensitivity Classification

The first stage is to identify the environmental parameters that would be needed for the spatial analysis. The baseline environmental and social parameters include existing topographic condition (slope), spatial planning, forestry status, potential sensitive receptors, hydrology, disaster prone area index, geology, hydrogeology, and land cover. In addition, the analysis also includes the result of participatory mapping with local community and their inputs captured during the baseline study to identify social sensitive areas.

Afterwards, the selected parameters are layered into a sensitivity index and assigned weight for each parameter. The sensitivity classification of each environmental variable refers to government regulation and expert judgement as shown in Table 4-13.

Table 4-13 Sensitivity Classification

Parameter	High	Medium	Low	Classified based on	Data Sources
Land Cover	Waterbody, Settlement, Forest	Cropland, Farm land, Paddy Field	Shrubs land, Savanna	Expert Judgement	Topographical Map of Indonesia Scale 1:25000
Forestry Status	Protected forest*	Limited production forest	Non Forestry	Expert Judgement	Deforestation Map, General Directorate of Forestry Planning (2009-2011)
Geology	Lake	Young Volcanic Deposit		Expert Judgement	Geological Map of Komodo (1978) and Ruteng (1994) Quadrangle, Geological Survey of Indonesia (1978)
Hydro-geology	Regions without exploitable ground water			Expert Judgement	Hydrogeology Map of Indonesia, Flores Sheet, Directorate of Environmental Geology (1983)
Potential Sensitive Receptor	0-200m buffer from settlement, school, village office, and for cultural heritage**	200-500m buffer from cultural heritage*; 200-2000m buffer from settlement, school, and village office	>500m buffer from cultural heritage; >2000m buffer from settlement, school, and village office	Ministry of Industry Regulation Number 35 of 2010 on technical guidance for industrial area, and Expert Judgement	Wae Sano and Sano Nggoang Villages Map, BirdLife (2012), AECOM Site Visit (2016)
Slope	>30%	15-30%	0-15%	Ministry of Industry Regulation Number 35 of 2010 on technical guidance for industrial area	ASTER Global Digital Elevation Model (2011)
Hydrology	0-50m buffer from river and lake, 0-200m from water spring	50-100m buffer from river and lake, 200-400m from water spring	>100m buffer from river and lake, >400m from water spring	GR Number 38 of 2011 regarding River and expert judgement	Indonesia Topography Map (Peta Rupa Bumi Indonesia) – Badan Informasi Geospasial

Parameter	High	Medium	Low	Classified based on	Data Sources
Prone Disaster	-	Moderate risk to natural disaster	-	BNPB	Disaster Prone Area Index Map
Spatial Planning	Residential	Production forest, limited production forest, non-production forest	Farm land, agriculture, industrial area	Expert Judgement	Spatial Planning Map, Government of West Manggarai Regency, NTT (2010)

**Restricted area. Protected forest might cause the issue for biodiversity due to the endemic species and permitting issue for forestry land use due to the additional time on time schedule.*

***Restricted area. Cultural heritage refers to any objects formally acknowledged by the government or listed in the regional cultural agency as regulated in Act No. 11 Year 2010 concerning Cultural Heritage, as well as objects and sites with cultural of significance for the local community including cemeteries and natural sites of importance for locals.*

Although there is no specific regulation requirements for restricted distance of project activities from cultural heritage areas or cemeteries, it is important to ensure the project footprint is not overlapping with the cultural heritage locations, or else, further consultation with locals is required.

4.8.3. Analytical Hierarchy Process (AHP)

The analytical hierarchy process (AHP) is a decision support tool which can be used to solve problems in complex decision making. The AHP uses a multi-level hierarchical structure of objectives, criteria and alternatives options to help set priorities. The AHP also combines multiple criteria by assigning a priority scale based on preference.

The relative importance between two criteria is measured according to a numerical scale from 1 to 9, as shown in Table 4-14.

Table 4-14 Scale of Relative Importance by Saaty (1980)

Intensity of importance	Definition	Explanation
1	Equally Importance	Two activities contribute equally to objective
3	Weak importance of one over another	Experienced and judgment slightly favor one activity over another
5	Essential or strong importance	Experienced and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favoured and its dominance demonstrated in practice
9	Absolute importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between two adjacent judgments	When compromise is needed
Reciprocals of above nonzero	If activity <i>i</i> has one of the above nonzero numbers assigned to it when compared with activity <i>j</i> , then <i>j</i> has the reciprocal value when compared with <i>i</i> .	

The scale of relative importance is used as a reference to make the light classification of relative importance scale which is used in this assessment as shown in Table 4-15.

Table 4-15 Scales of Relative Importance (modified from Saaty, 1980)

Intensity of importance	Definition
1	Equally Importance
2	Weak importance of one over another
3	Essential or strong importance
4	Demonstrated importance
5	Absolute importance
Reciprocals of above nonzero	If activity <i>i</i> has one of the above nonzero numbers assigned to it when compared with activity <i>j</i> , then <i>j</i> has the reciprocal value when compared with <i>i</i> .

Pairwise comparison is used in order to obtaining the weights of importance of decision criteria. Both qualitative and quantitative criteria can be compared using (expert) judgment in scale of relative importance table. In this study, 3 (three) expert judgment are combine in order to obtain weights of importance of decision criteria. To united several questionnaire from several expert is using mean geometric equation:

$$GM = \sqrt[n]{(X_1)(X_2) \dots (X_n)}$$

Whereas:

GM= Geometric Mean

X_1 = Expert 1

X_2 = Expert 2

X_n = Expert n

With comparison matrix:

Criteria	1	2	3	n
1	1	GM_{12}	GM_{13}	GM_{1n}
2	GM_{21}	1	GM_{23}	GM_{2n}
3	GM_{31}	GM_{32}	1	GM_{3n}
n	GM_{n1}	GM_{n2}	GM_{n3}	1

5. Stakeholder Engagement and Consultation

The section summarises the following stakeholder engagement and consultation undertaken for the Project – further details are presented in the Stakeholder Engagement Plan (SEP) (see **Appendix H**):

- Consultation activities during the development of ESIA, including ESIA scoping and two rounds of ESIA baseline consultation (the second (2nd) round of ESIA baseline consultation was undertaken due to changes in the Project alternatives);
- ESIA disclosure and consultation, including disclosure of proposed environment and social management measures; and
- Proposed future stakeholder engagement and grievance management.

5.1. Stakeholder Engagement during ESIA Development

This section describes the public consultation and socialization activities that have been undertaken throughout the ESIA development. The objective of stakeholder engagement activities undertaken as part of the ESIA process is to address relevant requirements of the World Bank in relation to consultation and disclosure requirements, as has also been adopted in the GEUDP ESMF. It requires that consultations should be at least conducted in two rounds, once during ESIA preparation and baseline data collection, and another during presentation of the draft ESIA and ESMF. The first consultation will provide inputs to the scoping of the ESIA to screen and scope out issues, and the consultation plan should be tailored to the needs of the stakeholders.

In addition, a detailed Stakeholder Engagement Plan is developed, including consultation required to mitigate the identified specific impacts. The document includes stakeholder analysis, proposed consultation for women and vulnerable group, and timeframe of program throughout the Project exploration phase (see **Appendix H Stakeholder Engagement Plan**).

5.1.1. Pre-ESIA Baseline Socialisation and Public Consultation

In 2016, SMI carried out pre-socialization and a first round of public consultation for the ESIA on the Waesano exploration geothermal site which included a public meeting on 15 September 2016 and 3 November 2016. The objective was to undertake screening by gathering information to inform the Inception Report.

Socialization was carried out in accordance with Ministry of Environment Regulation Number 17 of 2012 regarding Guidelines for Community Involvement in the Environmental Impact Assessment Process. Stakeholders involved in the consultations included social/community leaders, sub-district and village heads from villages in the Project area as well as local government officials. The results are used as basis for ESIA scoping.

5.1.2. First Round of ESIA Baseline Study

Site visits were undertaken from 3 – 6 November 2016 for Waesano and Sano Nggoang Villages and 21 – 23 March 2017 for additional study in Pulau Nuncung Village. The objective was to gather baseline data as well as investigate impacts.

First survey was conducted from 3 to 6 November 2016 in Sano Nggoang Sub-districts to gather baseline information including livelihood condition, cultural activities, health and safety condition and community perception, focusing the 2 villages of Sano Nggoang and Wae Sano. In addition to this, consultation with local community was also conducted from 21 to 23 March 2017, focused on participatory sensitivity mapping with local community to draws sensitive receptors e.g. cultural site, religious place, springs etc. to minimize potential impact from project development to sensitive area, also additional social baseline data gathering of community in Pulau Nuncung Village. History of first round consultation is presented in Table 5-1.

Table 5-1 First Round of ESIA Baseline Consultation

Time	Stakeholders Consulted	Key Issues Discussed with Stakeholders	Location of Interest
3-6 November 2016	Community of Wae Sano and Sano Nggoang Villages, interview for the first round baseline study	Livelihood condition, cultural activities, health and safety condition and community perception of the 2 villages	Wae Sano and Sano Nggoang Villages
21-23 March 2017	Group discussion with Head of villages, Cultural leader, youth, women and household	Participatory sensitivity mapping, used for sensitivity analysis	Wae Sano, Sano Nggoang, and Pulau Nuncung Villages
21-23 March 2017	Interview with Pulau Nuncung village government	Livelihood condition and cultural of importance for locals, and community perception	Pulau Nuncung Village

Since this baseline consultation more focus on gathering information regarding community condition and asses potential project impacts, less information regarding the Project activities was shared. The results of consultation feed into Section 6 to 8 of this ESIA.

5.1.3. Second Round of ESIA Baseline Study

Due to changes in the Project alternatives, an additional baseline study was undertaken from 22 – 30 November 2017. A number of stakeholder consultations were conducted in order to obtain a better understanding of the environmental and social issues in the community surrounding the new project locations. Consultation dates and locations are identified in Table 5-2.

Table 5-2 Second Round of ESIA Baseline Consultation

Time	Stakeholders Consulted	Key Issues Discussed with Stakeholders	Location of Interest
26 November 2017	Wae Sano Village Head	Overview of Wae Sano community and village development	Wae Sano Village
27 November 2017	Community Leader Nunang Clan/Family – Former of Head of Wae Sano Village	History of Nunang family, ancestors, archeological findings, historical/old village, and the history/cultural value of Lake Sano Nggoang	Wae Sano Village
	Tu'a Golo of Nunang Sub-village (Well pad B)	History of Mata Wae People, historic village, cultural asset and activity, land identification	Wae Sano Village
	Local community of Wae Sano Village	Land cover and land status survey of well pad A, B, D, E	Wae Sano Village
28 November 2017	Tu'a Golo of Lempe Sub-village (Well pad A)	History of Lempe family, historic village, cultural asset and activity, land identification	Wae Sano Village
	Tu'a Golo of Dasak Sub-village (Well pad D)	History of Dasak family, historic village, cultural asset and activity, land identification	Wae Sano Village
	Head of Sano Nggoang Sub-district	Consultation for the land owners regarding land acquisition	Sano Nggoang Sub-district
	Head of Local Government Security Personnel	Consultation for the land owners regarding land acquisition	Sano Nggoang Sub-district
	Local community of Sano Nggoang Sub-district	Land cover and land status survey of access road improvement	Sano Nggoang Sub-district
29 November 2017	Tu'a Golo of Taal Sub-village (Well pad E)	History of Nggoang/Taal family, historic village, cultural asset and activity, land identification	Sano Nggoang Village

Time	Stakeholders Consulted	Key Issues Discussed with Stakeholders	Location of Interest
	Cultural and Tourism Office of West Manggarai regency	Regional tourism plan in West Manggarai and Wae Sano Village in particular	West Manggarai Regency
	Burung Indonesia Foundation/ NGO	Tourism program in Wae Sano Village area and its surrounding area	Wae Sano Village
	Sano Nggoang Homestay Owner	Tourism activity and local economy	Sano Nggoang Village

Similar to the main objective of the first round of baseline consultation, the results of this second round of ESIA baseline consultation are used to update the baseline information and assessment of impacts in the Section 6 to 8.

5.2. ESIA Disclosure and Join-Walkthrough Survey

The ESIA draft has been disclosed through another consultation and disclosure event with the project affected communities. The ESIA was disclosed and verbally summarised in an informal presentation on 15th May 2018. Stakeholder's comments recorded from this consultation event is fed back to the Project team to address outstanding issues, and are included as part of this Final ESIA.

A number of key issues were raised during the disclosure event that are considered essential for finalisation of the Project design process and planning (see **Appendix H**). In addition to the ESIA disclosure session, a join-walk through visit was conducted in 14th – 15th May 2018 with local community and land owners. All of the proposed areas for the main well pads were visited, excluded the road widening areas. The proposed locations for Well Pad A, D, and E were confirmed during the join-walkthrough survey and have been acknowledged by local community and land owners, however during the ESIA disclosure meeting there were disagreement from some community members and land owners with regard to Well Pad B location, due to the found of “nekara” by the Head of Village which he believed as a sacred object.

5.3. Proposed Future Stakeholder Engagement

5.2.1. Proposed Grievance Mechanism

The World Bank Safeguard Policy requires the establishment and implementation of a suitable grievance mechanism that allows all groups in a community to submit their concerns, complaints or grievances, and through which the Project can receive and facilitate resolution in a timely manner.

As stated in the ESMF for the GEUDP, the Project has developed a Grievance Redress Mechanism (GRM) to serve as an effective tool for early identification, assessment, and resolution of complaints on stakeholder engagement issues. Based on ESMF for GEUDP, the following steps will be taken for handling grievances:

- Step 1: Access point / complaint uptake;
- Step 2: Grievance log;
- Step 3: Assessment, acknowledgement, and response;
- Step 4: Appeal; and
- Step 5: Resolve and follow up.

To ensure continuous processing of grievance handling in a timely manner, dedicated resources and regular monitoring of grievance resolution status are required.

Further details of the proposed Grievance Mechanism for the Project is described in the SEP (see **Appendix H**).

5.2.2. On-Going and Future Community Consultation

Continuous and future consultation and engagement with stakeholders and the community have been planned for by the Project, including for the following purposes:

- Engagement with local government and land owners for the remaining land acquisition process;
- Collaboration with community organisations for community development implementation;
- Consultation and collaboration with the community for CSR activities;
- Occassional stakeholder meetings with local and regional government; and
- Additional consultation and engagement would also be required to manage the potential significant environmental and social impacts identified in the ESIA through measures defined in the ESMP.

A list of stakeholders proposed to be engaged at various stages of the project is presented in the Stakeholder Identification and Analysis section of the SEP (see **Appendix H**). The SEP specifies ongoing and proposed future stakeholder and community engagement activities to be undertaken by PT SMI beyond the ESIA process and throughout the lifecycle of the Project, including the required engagement measures observed in the ESMP.

6. Environmental and Social Baseline

6.1. Description of Baseline Study Boundary

This section presents the baseline environmental and social information relevant to the impact assessment. The assessment area covers three villages of Sano Nggoang Sub-district, namely Wae Sano, Sano Nggoang and Pulau Nuncung Villages in West Manggarai Regency of East Nusa Tenggara Province. It is understood that the location of drilling sites and access roads have not been concluded yet and the final project footprint may not be known until implementation; therefore, the baseline description includes a broad, landscape-based description of notable aspects, highlighting high risk, 'no go areas', as well as low risk areas. The collected data at sample sites or representative sites is used to describe the baseline in general terms. Site specific data have been collected for preferred or proposed sites as advised by PT SMI.

The latest study area was advised by PT SMI's consultant in October 2017 with 4 well pads (WS-A, WS-B, WS-D and WS-E). Baseline study has been carried out based on the previous study area in November 2016 and the current study area in November 2017. The study area map is shown in Figure 6-1.

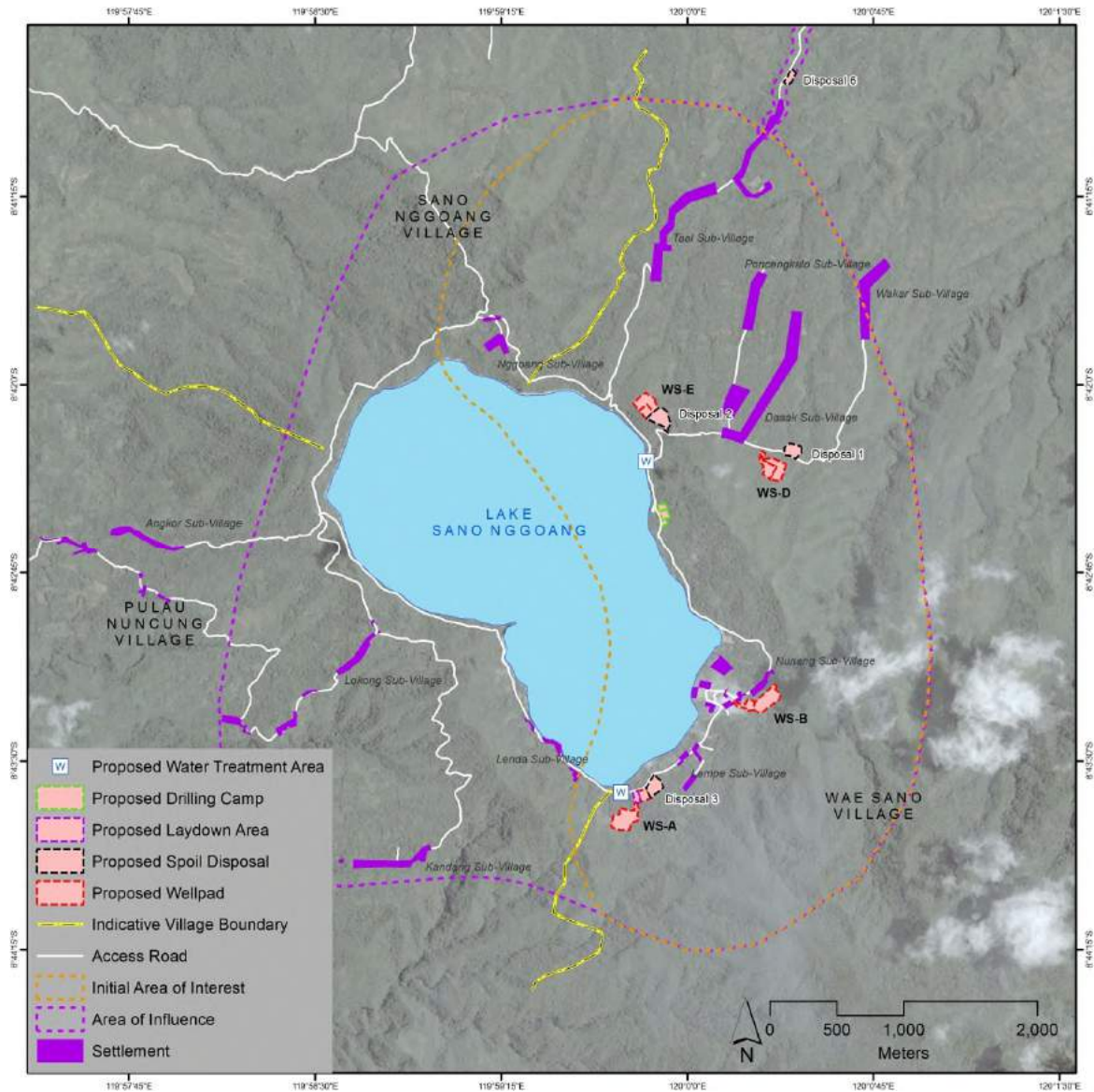


Figure 6-1 Study Area

The study area covers a 1,531 ha “area of interest” for the Waesano geothermal development project. This area of interest is located within two villages of Sano Nggoang Sub-district, namely Wae Sano and Sano Nggoang Villages. Meanwhile, area of influence (Aoi) covers broader receiving environment for study boundary, not subjected to the specific well pad or drilling sites, to allow flexibility of site selection during the current Project design process. The following discussion is compiled from the existing data provided from various sources and primary data gathered in November 2016 and November 2017.

6.2. Physical Environment

6.2.1. Climate

West Manggarai Regency and East Nusa Tenggara Province has only two seasons, the dry season and the rainy season. From June to September the wind flow comes from Australia containing little moisture, resulting in the dry season. From December to March the wind flow contains a great deal of moisture from Asia and the Pacific Ocean, resulting in the rainy season. The transitional period between these seasons is from April–May and October–November.

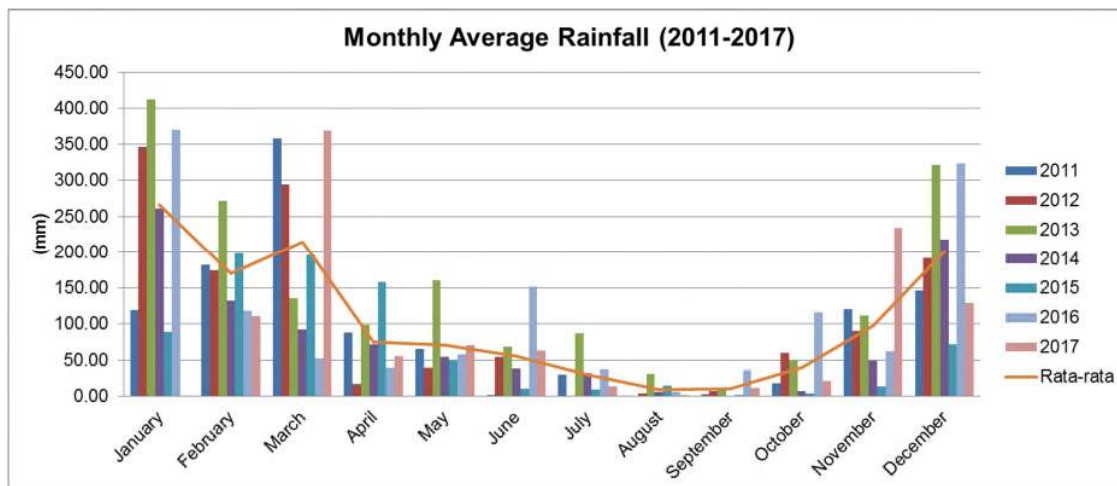
In the context of this seasonal cycle, it is however noted that because West Manggarai is in relative close proximity to the Australian continent, it experiences a shortened wet season compare to the region closer to Asia.

Based on Schmidt-Ferguson climate type, West Manggarai has a varied climate type of type B (wet) o type E (slightly dry). Labuan Bajo Station represents Komodo Sub-district and its surrounding areas have climate type E (slightly dry); Werang Station represents Sano Nggoang Sub-district and its surrounding areas have climate type D (moderate). Meanwhile, Rangu Station which represents Kuwus Sub-district and its surrounding areas have climate type C (slightly wet) and Compang Station which represents Macang Pacar Sub-district and its surrounding have climate type B (wet) (KPHP , 2016).

Based on West Manggarai's location, much of the moisture is carried in from the Pacific Ocean. Climatic data presented in this section has been sourced from *Badan Meteorologi, Klimatologi, dan Geofisika* (BMKG) online for the Komodo Meteorological Station which is located approximately 36 km to the south east of the project site. There was no nearest meteorological station to the project area which provides representative climate data of project area. This data includes rainfall, temperature and humidity and covers the period from 2011 to 2015.

6.2.1.1. Rainfall

Average monthly rainfall over the period 2011-2017 is 101 mm, with the average monthly rainfall in the wet season ranging from 170 mm - 267 mm and the dry season ranging from 4 mm - 86 mm (Figure 6-2). The highest rainfall average occurred in March 2013, which reached up to 412 mm and the lowest recorded rainfall of 0 mm occurred in August 2011, July 2012 and September 2014.

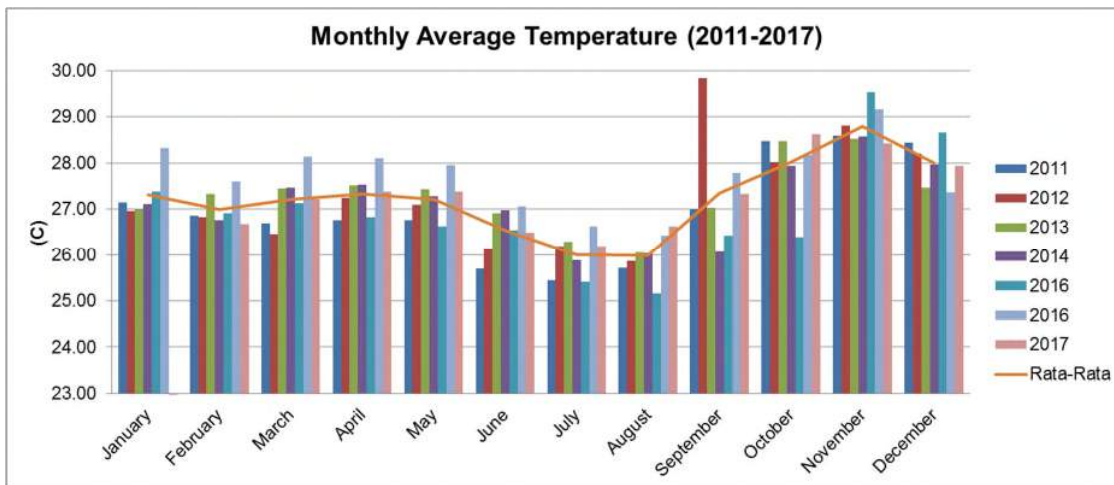


Source: BMKG Online, 2017

Figure 6-2 Monthly Average Rainfall (2011-2017)

6.2.1.2. Air Temperature

The monthly average temperature during the period 2011-2017 is around 27.3°C (Figure 6-3). The average monthly temperature was highest in September 2012, reaching 29.83°C and the lowest occurred in August 2015 of 25.15 °C. Overall, there is limited temperature fluctuation across the year.

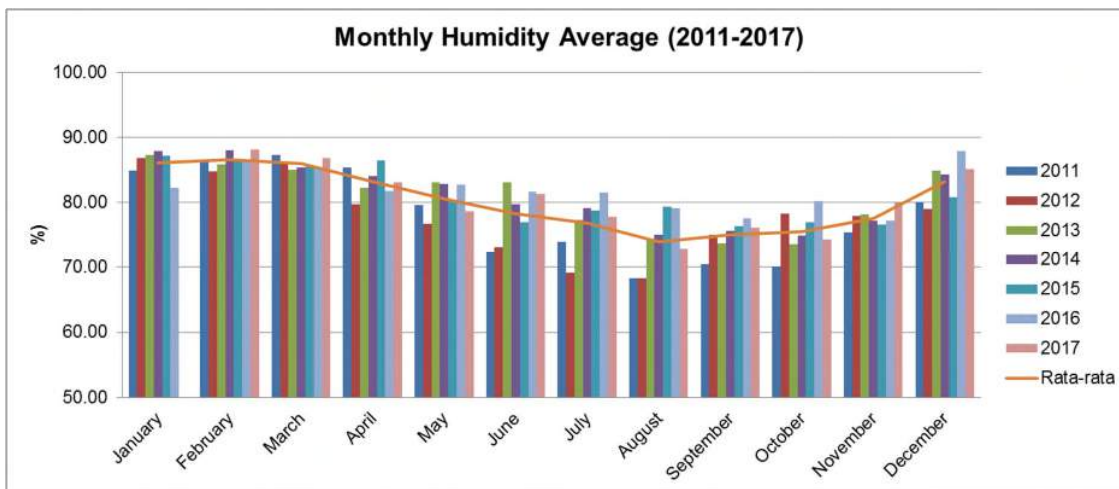


Source: BMKG Online, 2017

Figure 6-3 Monthly Average Temperature (2011 – 2017)

6.2.1.3. Relative Humidity

Average monthly humidity during the period 2011-2017 was around 80.14% (Figure 6-4). Monthly humidity in 2017 was highest in February, reaching 88.11% and the lowest was in August 2011 reaching 68.26%.

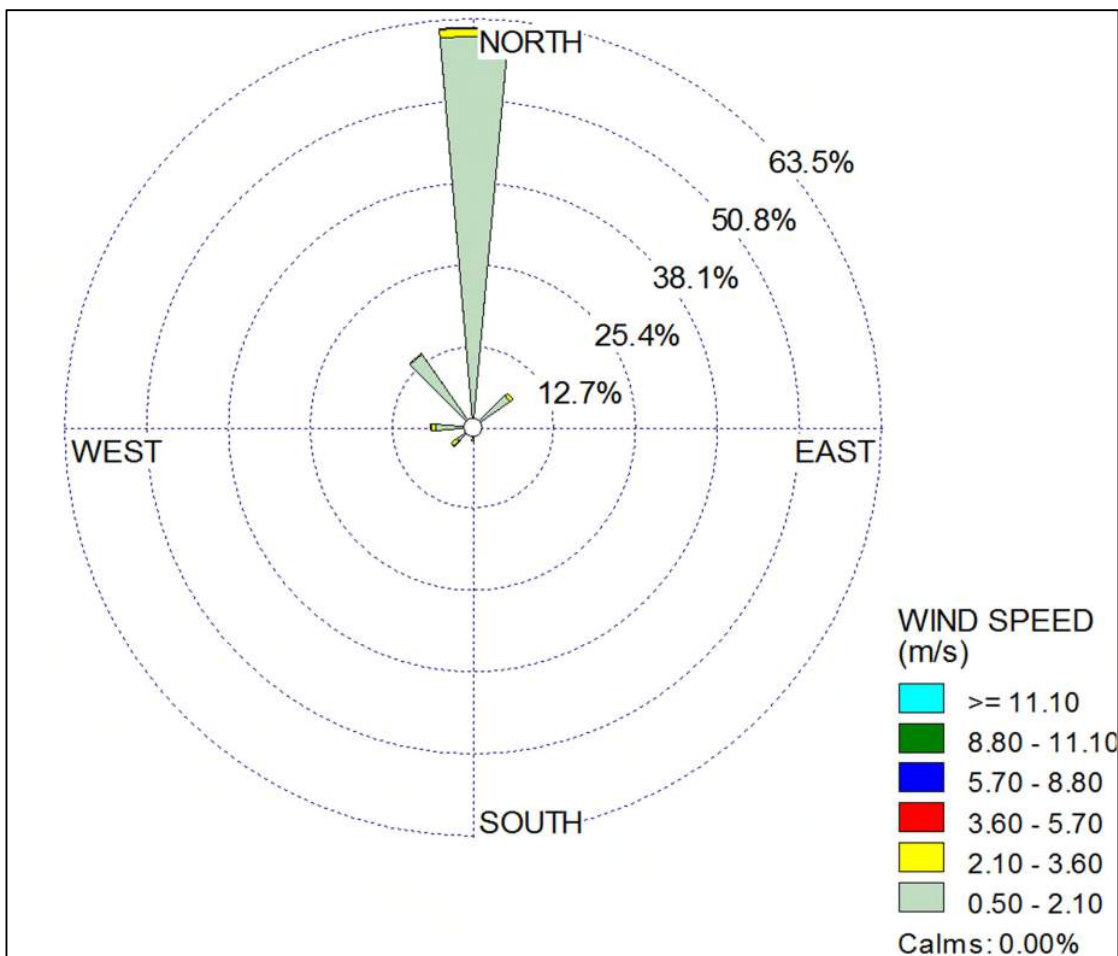


Source: BMKG Online, 2017

Figure 6-4 Monthly Humidity Average (2011-2017)

6.2.1.4. Wind Speeds and Directions

From the observation data, prevailing winds in the study area are primarily from the north (more than 60% of time) as influenced by the sea breeze since the meteorological station is close to the sea. The wind distribution is shown in Figure 6-5. The wind speeds mostly range from 0.5 to 2.1 m/s. Calm winds were not recorded by the station.



Source: BMKG Online, 2017

Figure 6-5 Wind-Rose Depicting Annual Wind Direction Distribution (Period of 2011-2016)

6.2.2. Topography

The project area is defined by mountainous areas in the southern region of the project boundary with higher altitudes and steeper terrain (Figure 6-6 and Figure 6-7). The topography in the north undulates at a lower altitude. Golo Tawasano and Poco Dedeng mountains in the south reach an approximate altitude of 1,250 masl, giving an abrupt decline in topography leading to Lake Sano Nggoang which lies at approximately 650 masl. A saddle connects these mountains to another high-altitude area offset from the lake shoreline. Wai Sano Volcano in the southeast region lies at a lower altitude at 900 masl. In contrast to the south, the land in the north undulates downhill from the lake.

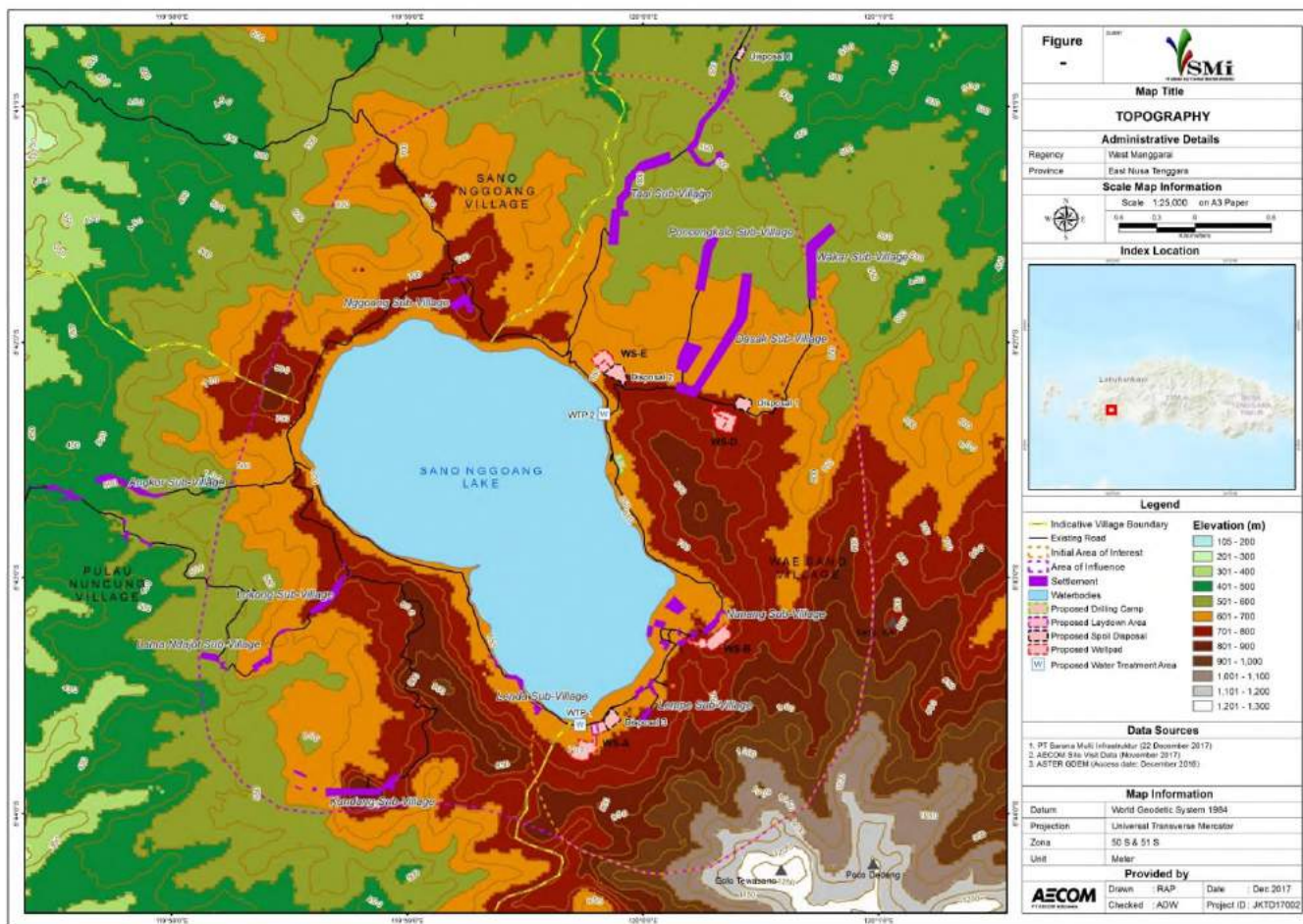


Figure 6-6 Topography Map



Note: Study location in Sano Nggoang Village



Note: Study location in Dasak Sub-Village – Wae Sano Village

Source: PT SMI Baseline Study, 2016

Figure 6-7 Aerial View

6.2.3. Geology, Geophysics, Geochemistry and Geohydrology

6.2.3.1. Geology

Mt. Wai Sano is an upper Quaternary andesitic volcano resting on the older Quaternary andesites of Pegunungan Geliran. Some pumiceous debris is incorporated in the Wai Sano pyroclastics. Wai Sano is regarded as an older Quaternary volcano since no historic eruptions have been recorded. Badan Geologi (2004) refers to older Tertiary marine sediments, presumably underlying the volcanics. Based on Geological Regional Map (Komodo Quadrangle, 1978 and Ruteng Quadrangle, 1994, see **Appendix J**), the study area is mostly categorised as Young Volcanic Products. The details describes as below:

The still active volcanoes are Mt. Sangeang Api on Sangeang Island, and Mt. Wai Sano on Flores Island, both are stratovolcanoes. There are three main cones and some crater lakes on the top of Mt. Sangeang Api. In the centre of Mt. Wai Sano there is a crater lake, circular in outline, about 2.5 km in diameter. Some hot springs and fumaroles with sulphur deposits occur along the lake. Particularly, eruptive products of Mt. Wai Sano mainly consist of tuff, sandy tuff, and pumice tuff; white in color and brittle. Some small outcrops of lava and breccia composed of pyroxene andesite, vesicular andesite, basalt, and olivine basalt are found in this volcano.

The geological map of the study area is presented in Figure 6-8.

6.2.3.2. Geophysics

The project landscape is defined based on a low resistivity zone (Schlumberger $<10 \text{ ohm-m}$ ($AB/2=1000\text{m}$)). The low resistivity zone coincides with the volcanic crater (Lake Sano Nggoang). Geology Office (*Badan Geologi*) has more recently carried out a MT survey covering an expansive area. The maps in the report appear to show a large area of low resistivity at a depth which is very promising, and with an up-doming in the base of the conductor which could represent an up flow zone.

6.2.3.3. Geochemistry

Referring to the Waesano Geothermal Chemistry Survey Report (Jacobs, September 2016), a two-day geochemistry sampling survey was completed for the Waesano geothermal prospect from July 13 to 14, 2016. Water, gas and stable isotope samples were collected. Following is a summary of results and interpretation:

- The Waesano thermal activity on the shore of Lake Sano Nggoang includes hot springs with vigorous gas bubbling and some sulphur deposition. There are no discrete gas or steam vents. The hot spring water flows into the lake which is acidic. Lake floor activity is unknown but there are gas bubbles near the lake shore.
- The sample from the hottest spring at Waesano (WS-02, 97°C) can be considered closest in composition to the deep reservoir water. This water is near-neutral pH, saline, sodium chloride brine with 20,000 ppm chloride. All other springs are variably diluted and cooled by cold groundwater. Some are acidic as a result of surface oxidation of H_2S .
- The origin of the high salinity is uncertain but may be developed by the addition of a small amount of sedimentary formation water to less saline geothermal brine. The ultimate recharge is local meteoric water.
- Several aspects of the chemistry point to high temperatures ($>250^\circ\text{C}$) beneath Waesano:
 - A high-chloride, boron-rich composition.
 - Sodium, potassium and calcium geothermometer temperatures of 240-250°C.
 - A large a $\delta^{18}\text{O}$ isotopic shift of about 10% from local groundwater.
 - Geothermal gases CO_2 , H_2S and H_2 in proportions typical of high-temperature systems, with geothermometer temperatures of 250-300°C.

- The new gas chemistry data has been particularly useful in adding weight to the overall indicators of high resource temperature.
- The absence of fumarolic activity and the generally low silica concentrations are probably related to the low mass flowrate through the Waesano thermal area.
- An up flow rate of >10 kg/s of 20,000 ppm Cl brine is estimated across the resource area, based on the annual rainfall volume over the lake and a constant lake chloride.
- The low-chloride Werang and Bobok springs located to the north of the lake may be heated groundwater flowing out from the Waesano thermal areas, possibly with some lake water mixed in. The chemistry of Nampar Mancing provides no evidence of current high temperatures nearby. The water has high chloride and boron of uncertain origin.
- Overall, the chemistry of the Waesano springs is positive in terms of temperature, but there are some aspects of chemistry that are unresolved, including the excess boron and sulphate in the lake (characteristic of magmatic vapour) and the indications of high gas content and/or buried sulphur.
- The development implications of the fluid chemistry have been considered:
 - The high salinity of the reservoir water does not present any unusual constraints (including calcite scaling).
 - The possibility that the salinity has some input from sedimentary formation waters may mean the reservoir host rocks have limited permeability.
 - There are indirect indications of possible deep magmatic acidity.
 - Production from the Waesano resource is likely to affect surface thermal activity which in turn could change the chemistry of Lake Sano Nggoang and have environmental implications.
 - Ingress of acidic lake water into the producing reservoir needs to be avoided.

6.2.3.4. Geo-hydrology

Based on the geo-hydrological map of the study area taken from the hydrogeological map of Indonesia Flores Sheet (Soetrisno S, 1983), the aquifer system is anticipated through fissured and porous comprised sandy tuffs with intercalations of pumiceous breccia tuff. The productivity of the aquifer is considered poor and without exploitable groundwater. The depth to groundwater is generally high and controlled by topography. Water springs with small yields were located within the study area (see Figure 6-9).

Observation and interviews with the community within the study area advised that locals mainly use a spring water drain from the surrounding ridges (Golo Tewasano, Poco Dendeng, and Sano Wai) for their daily domestic purposes (i.e. drinking water, bathing, etc.). They are highly dependent on spring water for a clean water source due to the groundwater scarcity. The nearest waterbody, Lake Sano Nggoang, is situated in the west portion of the study area and is not used for any purposes, because the quality of water is poor (very low pH).

The groundwater quantity data was also obtained from the initial baseline study in November 2016. Groundwater sampling was conducted in three water springs (WS) (Figure 6-9). Average water discharge (springs) is shown in Table 6-1.

Table 6-1 Water Discharge and Groundwater Sources

No.	Code	Location	Average water discharge (l/s)
1	GW01	WS Nggoang	0.11
2	GW02	WS Nunang	0.12
3	GW03	WS Lempe	Pipeline-1 : 0.63
			Pipeline -2 : 0.19
			Pipeline -3 : 0.39

Source: PT SMI Baseline Study, 2016

Data from the water springs around well pad areas identified during the field visit in 2017 are shown in Table 6-2.

Table 6-2 Identification Results of Water Spring Sources around Well Pads

No.	Coordinate (E)	Coordinate (N)	Description
1	170157	9034583	This water spring is used by Nunang Sub-villagers (as many as 35 households).
2	170068	9034417	This water spring is used by Lempe Sub-villagers (as many as 35 households).
3	170060	9034335	This water spring is the first source that was built by the community of Nunang and Lempe Sub-villages in order to access clean water and it is still used today.
4	170206	9035120	This water spring is only used by one person because the location is far from the settlement and the water discharge is very small.
5	170318	9035194	This water spring is private property that flows to a homestay in the area of Nunang Sub-village.
6	169508	9034082	This water spring is located around Lake Sano Nggoang and is used by 2 households who live on the edge of the lake. This water source is never dry. During the dry season, Lempe villagers also take advantage of this spring.
7	169139	9037725	This water spring is used by the community in Taal Sub-village (as many as 60 households).

Source: PT SMI Baseline Study, 2017

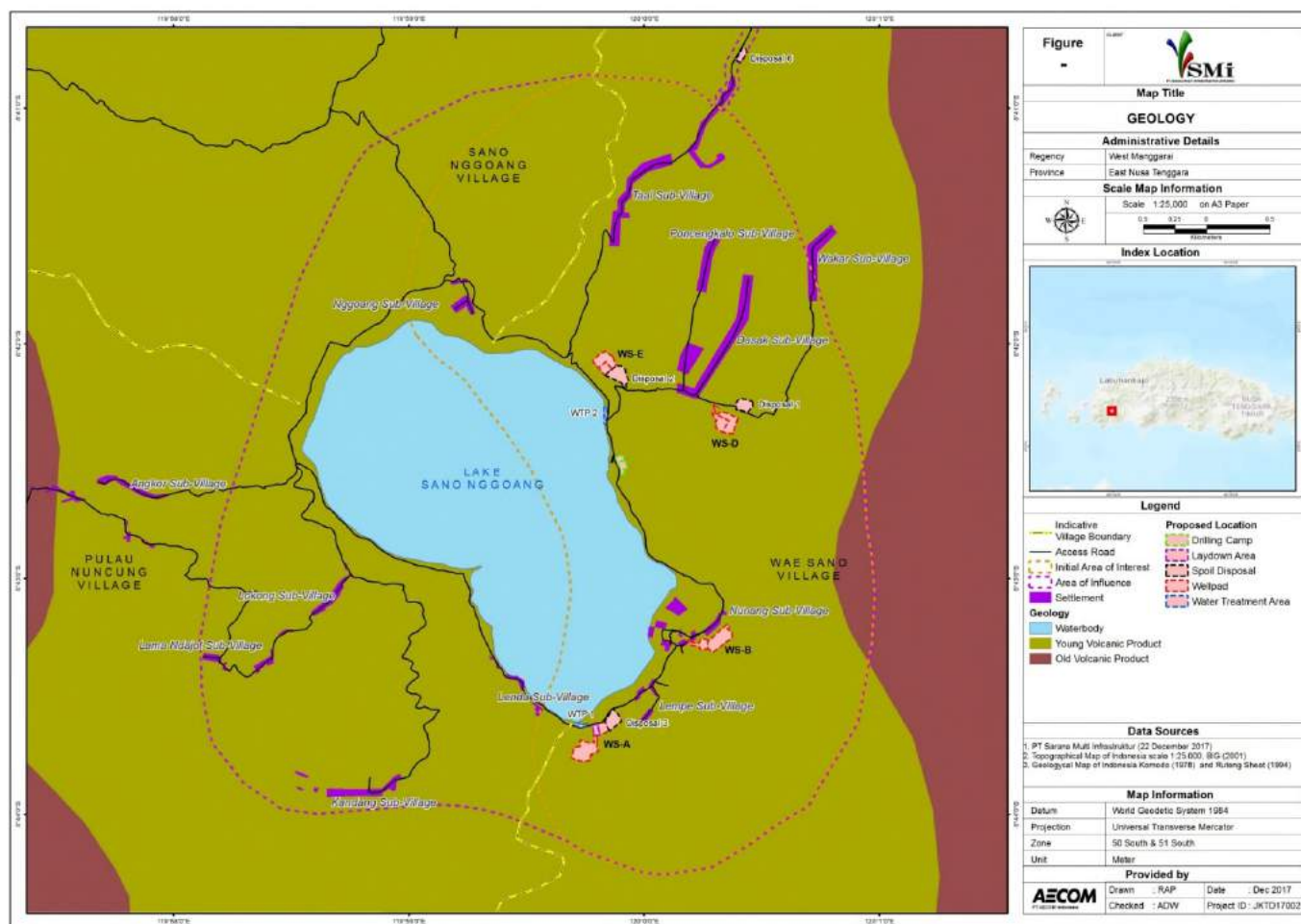


Figure 6-8 Geological Map

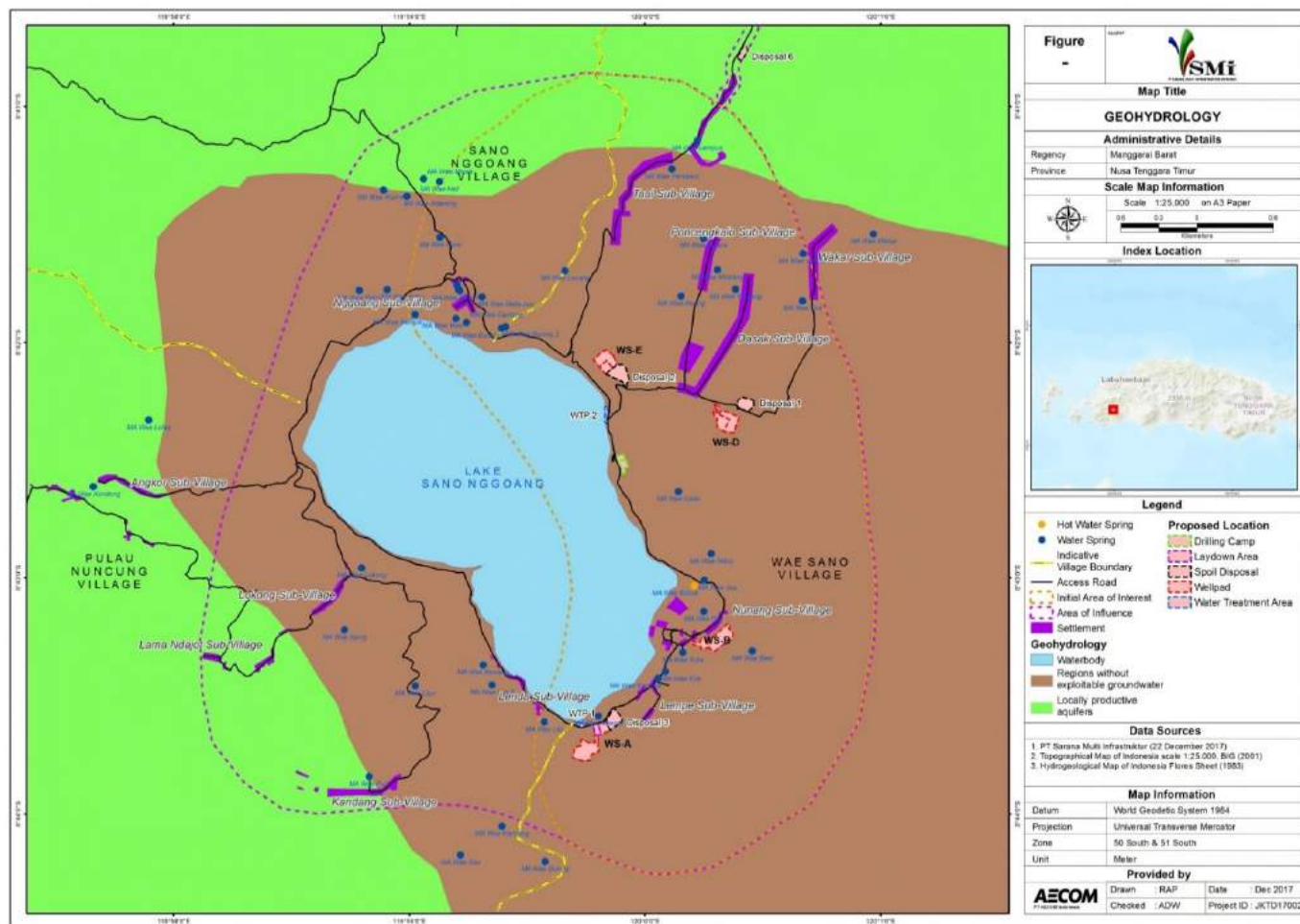


Figure 6-9 Geo-hydrology Map

6.2.4. Hydrology

Hydrology in West Manggarai Regency is divided into 138 watersheds spread over 7 sub-districts. The watershed consists of 11 watersheds on large islands and 126 watersheds on small islands. From the 138 watersheds in West Manggarai Regency there are 3 large watersheds. The first is Jamal Lembor Watershed that includes 8 districts, and crosses Manggarai Regency at the upstream of watershed. The Reo Watershed covers the sub-districts of Kuwus and Macang Pacar as upstream watersheds. The third is Nanga Nae Watershed that passes 3 sub-districts of Komodo, Sano Nggoang, and Boleng (Regional regulation No. 9 of 2012 on Spatial Planning of West Manggarai Regency 2012 – 2032).

The Sano Nggoang Sub-district is crossed by two major rivers including the Wae Rancang located in Werang Village. Sano Nggoang Sub-district is also separated by the Wae Longge River in the east bordering the Welak Sub-district. In the northeast the Wae Sapo River separates Sano Nggoang with Mbeliling District. There is no river flows within the Area of Influence. The nearest river to the study area is the Wae Rancang River which is 5 km away from the study area. Other perennial rivers are not found around the study area, but there are traces of river branches that only flow during the rainy season (ephemeral) (Direktorat Jenderal Pengendalian DAS dan Hutan Lindung Kementerian Lingkungan Hidup dan Kehutanan (PDASHL), 2016).

Lake Sano Nggoang

Lake Sano Nggoang has a total area of 511 Ha. Static measurements of surface water levels at Lake Sano Nggoang were conducted briefly at two locations in Lempe and Dasak Sub-village for two days (28th – 29th November 2017), from 7 AM to 5 PM with 2 hour intervals. Table 6-3 presents the results of those measurements.

Table 6-3 Results of Surface Water Level Measurements at Lake Sano Nggoang (in Units)

Time	Measurement 1 (Lempe Sub-village) (E = 829651, N = 9034071)		Measurement 2 (Dasak Sub-village) (E = 829849, N = 9036361)	
	28 th Nov 2017	29 th Nov 2017	28 th Nov 2017	29 th Nov 2017
7 AM	66 – 68)*	68 -70)*	67	69
9 AM	66 – 68)*	67 - 68)*	67	69
11 AM	66 – 68)*	67 - 72)*	67	69
1 PM	66 – 68)*	69 - 71)*	67	69
3 PM	66 – 68)*	70 - 72)**	67	72)**
5 PM	69	72)***	69	72)***

Source: PT SMI Baseline Study, 2017

Note:

*) Rippling water (up and down)

**) in rainy condition

***) after rainy condition

Based on two days of observation in the rainy season, it is clear that the lake water is affected by rainfall. At the time of measurement, the river flow condition was dry and no flow to and from the lake. At the time of observation, the lake was in a low level condition, as seen from the outlet of the dry lake areas. This outlet only flooded when there is overflow from the lake. Based on the information of villagers around the lake, the lake water and lake outlet water is not used for domestic activities such as drinking, cooking and bathing due to its poor quality. There were no fishing activities in the area around the lake. Figure 6-10 shows the measurement activities of water level and hydrological conditions around the lake.



Measurement in Lempe Sub-village



Measurement in Dasak Sub-village



The condition of dry river around well pad A (WS-A)



The condition of lake outlet that dries up

Source: PT SMI Baseline Survey, 2017

Figure 6-10 Hydrological Condition in the Study Area

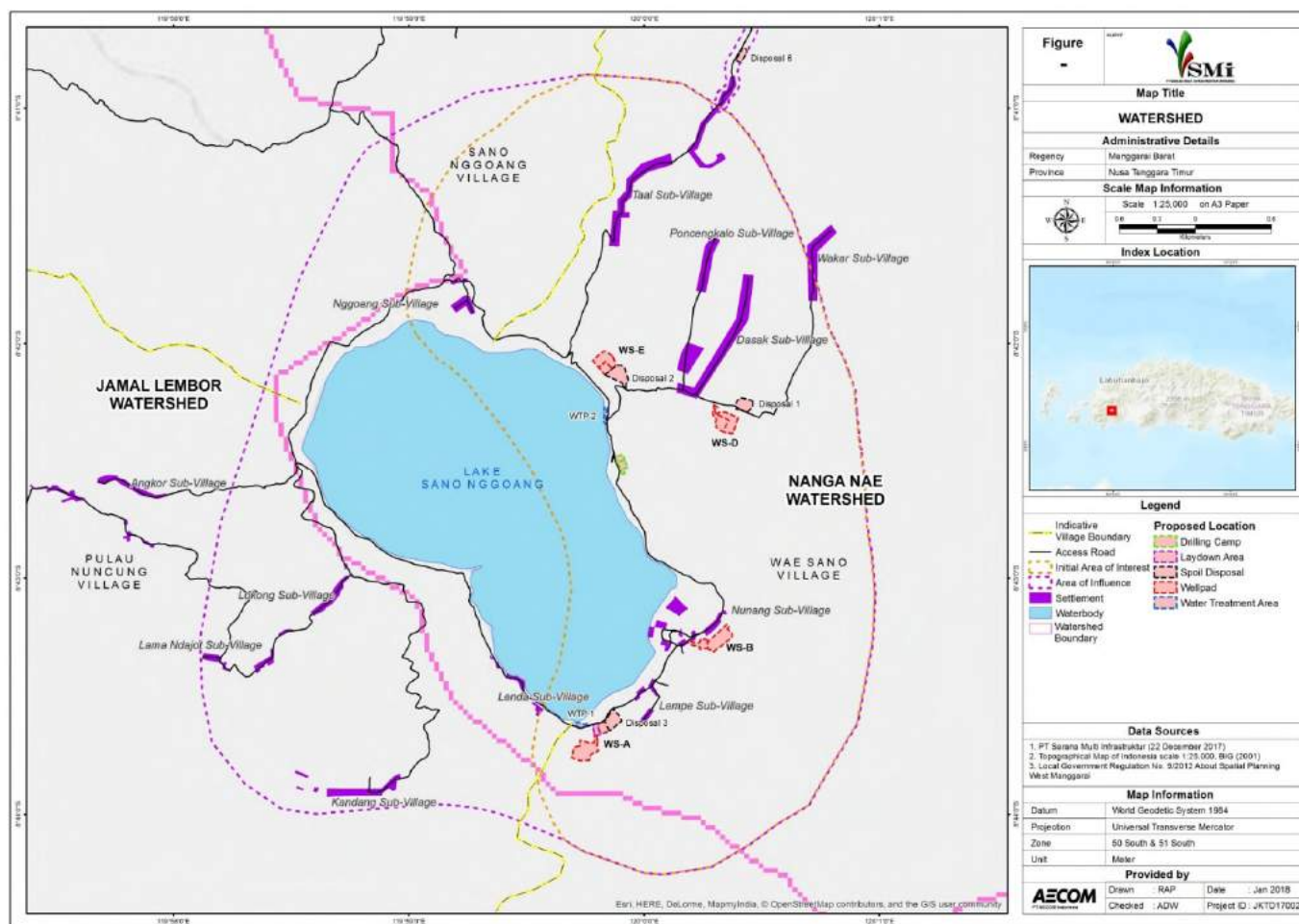


Figure 6-11 Watershed Map

6.2.5. Soil Texture

Soil testing was carried out and includes soil texture, soil percolation rate and C-organic content. Sampling activity was conducted in four locations, respectively taken two samples from depths of 0-30 cm and 30-60 cm. The sampling locations for all samples in the study are shown in Figure 6-24.

Samples of soil physics test results are shown in the following table.

Table 6-4 Soil Testing Result

Location Code	Depth (cm)	Texture (%)			Screen of 1 mm + aquadest (Wt 1) (gr)	Screen of 1 mm + NaOH 5% (Wt 2) (gr)	>Screen of 1 mm
		Sand	Silt	Clay			
SL A1	0-30	32	54	14	1.7751	2.6202	3.2561
SL A1	30-60	31	47	22	1.95655	3.2226	2.5531
SL 3	0-30	30	50	20	2.6501	2.3946	2.5484
SL 3	30-60	21	42	37	0.4775	1.9067	5.2639
SL 2	0-30	20	61	19	1.8127	2.4139	3.5335
SL 2	30-60	19	48	33	0.4645	0.8575	6.5562
SL 1	0-30	36	53	11	2.2246	2.4495	2.8583
SL1	30-60	32	51	17	0.4801	1.4738	5.6154

Location Code	WAS (%)	Percolation Rate (cm/hours)			COLE (Clod Method)	C-organic (%)	Texture (USDA)
		F (6)	F (U)	Ix			
SL A1	59.61	7.871	9.756	-4.25	0.007	3.9	Silt loam
SL A1	62.24	2.363	3.884	-9.55	0.06	3.48	Loam
SL 3	47.47	32.337	53.151	-9.55	0.652	5.82	Silt loam
SL 3	79.97	10.835	17.81	-9.55	0.07	5.41	Clay loam
SL 2	57.11	4.253	6.991	-9.55	0.015	4.56	Silt loam
SL 2	64.86	0.591	0.612	-0.69	0.044	4.77	Silty clay loam
SL 1	52.41	4.017	6.602	-9.55	0.021	4.18	Silt loam
SL1	75.43	1.49	2.171	-7.32	0.015	4.02	Silt loam

Source: Baseline Study PT. SMI, 2016

Location Code:

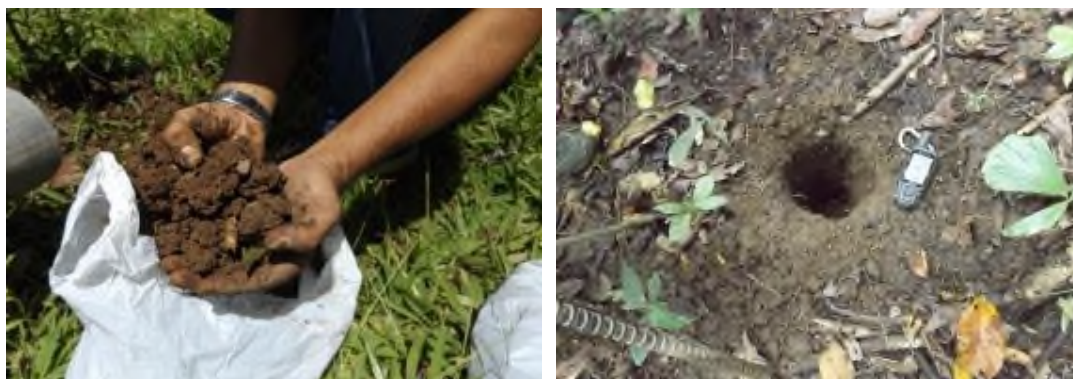
SLA1 : Wae Sano Village

SL 1 : Sano Nggoang Village

SL 2 : Wae Sano Village

SL 3 : Wae Sano Village

The soil texture is the level of refinement soil conditions which occur because of differences in the composition and content fraction of sand, silt and clay contained in the soil (National Land Agency). There are 12 classes of soil texture that is distinguished by the percentage of the three fractions land depicted in the triangular structure of the soil. Based on the triangle structure, the samples were identified as having a dominant texture of silty loam. The soil sample is shown in Figure 6-12.



Source: Baseline Study PT. SMI, 2016

Figure 6-12 Soil Sample

6.2.6. Land Use and Land Cover

6.2.6.1. Access Road Area

The proposed project access road is comprised of forest, savanna, farm land, paddy field and settlement areas. The land cover map of the project access road area based on land cover data from Indonesian Morphological Map Scale 1 : 25,000 (Geospatial Information Agency) can be seen in Figure 6-13. Most of the land cover within the road widening area is crop land/plantation and shrubs.

6.2.6.2. Well Pads and Auxiliary Facilities Area

The proposed well pads and auxiliary facility locations are comprised of vegetation, settlement area, cultivated land and water bodies. Most of the western project boundary is divided by Lake Sano Nggoang, forest cover fringes the lake and continues to span further in the southern region. A small portion of the southern boundary incorporates protected forest land. Access roads surround and lead to the lake, in the north-west and south-west areas these roads are flanked with settlements regions which continue onto crop and farm land. The cultivated land also surrounds the river network in the north. Table 6-5 identifies the land cover in the project area. The land cover in study area can be seen in photographs in Figure 6-14 and on a map in Figure 6-15.

Table 6-5 Land Cover and Land Use Composition in Study Areas

Well-Pad and Auxiliary Facilities	Type of Land Cover	Type of Land Use
Well-pad WS-A	cultivated land, shrubs, and dry forest land	Plantation/mixed cultivated land, such as candlenut, coffee, and shrubs
Well-pad WS-B	cultivated land, shrubs, and dry forest land	Plantation/mixed cultivated land, such as candlenut, coffee, and shrubs
Well-pad WS-D	shrubs	Plantation/mixed cultivated land, such as candlenut and shrubs
Well-pad WS-E	cultivated land and shrubs	-
Spoil Disposal Area 1 (Well pad drilling)	cultivated land and shrubs	Plantation/mixed cultivated land, such as candlenut and shrubs
Spoil Disposal Area 2 (Well pad drilling)	cultivated land and shrubs	Plantation/mixed cultivated land, such as candlenut and shrubs
Spoil Disposal Area 3 (Well pad drilling) & Civil Contractor Camp	cultivated land and shrubs	Plantation/mixed cultivated land, such as candlenut, coffee, and shrubs
Spoil Disposal Area 4 (material road upgrade)	cultivated land	Plantation/mixed cultivated land, such as candlenut and shrubs

Well-Pad and Auxiliary Facilities	Type of Land Cover	Type of Land Use
Spoil Disposal Area 5 (material road upgrade)	Mixed grass and shrubs, savanna	Plantation/mixed cultivated land, such as candlenut and shrubs
Spoil Disposal Area 6 (material road upgrade)	Mixed grass and shrubs, savanna	Plantation/mixed cultivated land, such as candlenut and shrubs
Laydown Area	cultivated land	Plantation/mixed cultivated land, such as candlenut, coffee, and shrubs
Drilling Base Camp	dry forest land	Plantation/mixed cultivated land, such as candlenut and shrubs
Water Supply Intake 1	cultivated land	Plantation/mixed cultivated land, such as paddy field and shrubs
Water Supply Intake 2	shrubs, and dry forest land	shrubs

Source: *) Indonesian Morphological Map Scale 1 : 25,000 (Geospatial Information Agency)

**) PT SMI Baseline Study, November 2017

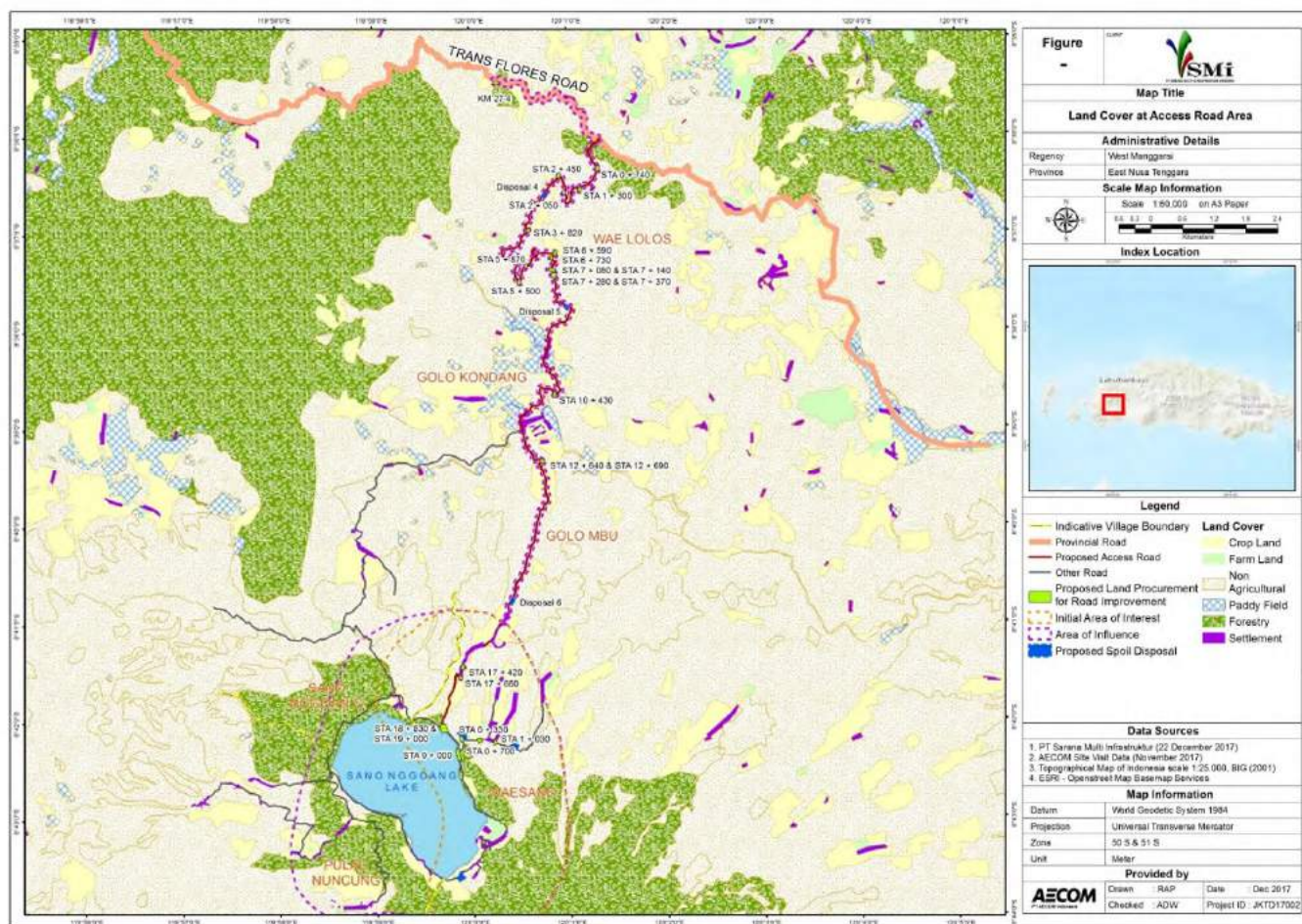


Figure 6-13 Land Cover at Access Road Area



Note: this aerial photograph is a sample of land cover that includes settlements and agricultural area (e.g. candlenuts) at the study area.

Source: PT SMI Baseline Study, 2016

Figure 6-14 Land Cover in Study Area

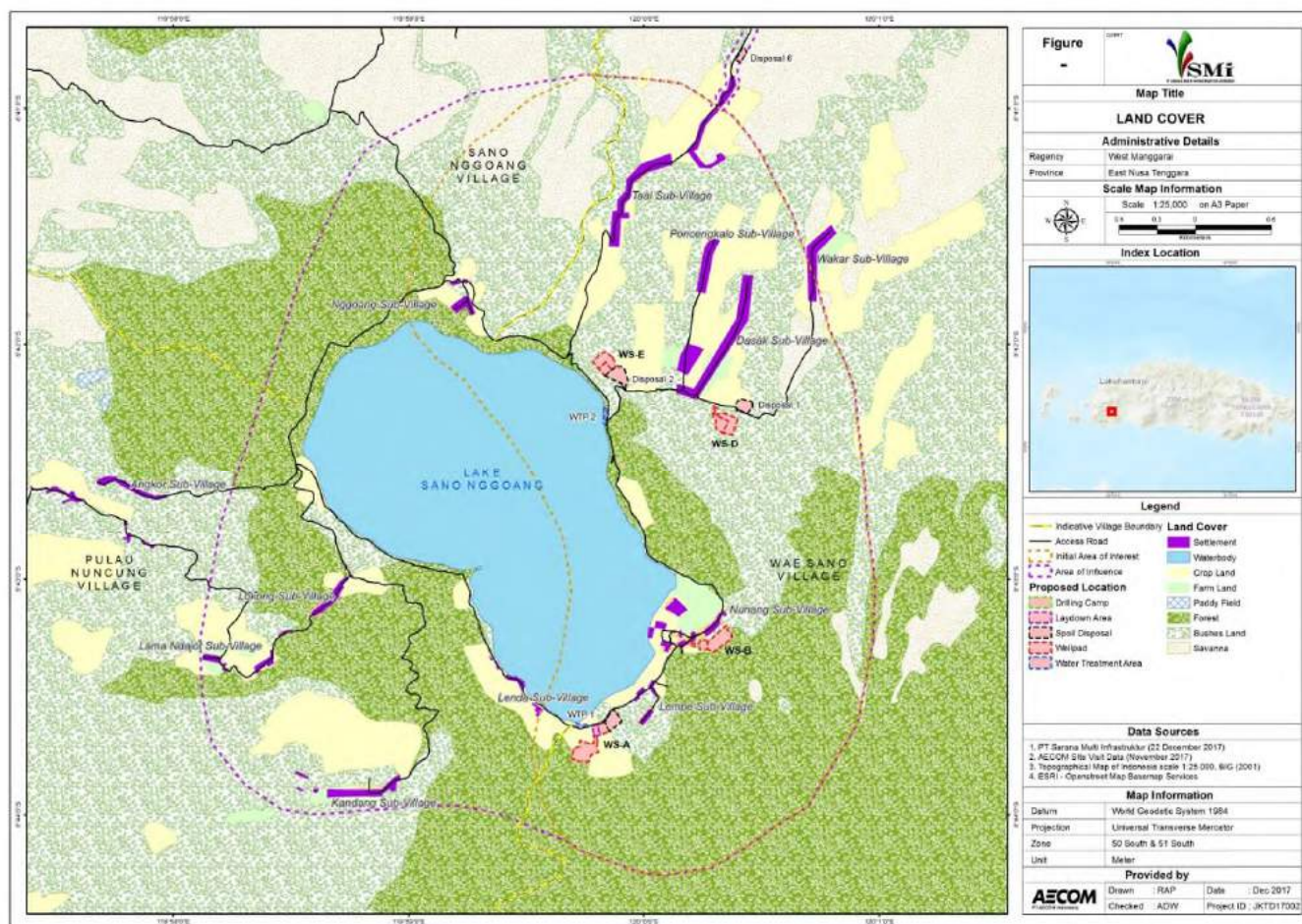


Figure 6-15 Land Cover Map

6.2.7. Air Quality

The project area is located in the hills and close to forests that have a very good environmental quality, particularly for ambient air quality. The settlement area is approximately 34 hectares, or only 2.22% of the percentage of the total project area. Other activities in the area of study are limited, as well as activity on the road/highway. Therefore the sources of pollution from human activities can be assumed to be very little.

Primary air quality data was obtained in November 2016. Ambient air quality monitoring was undertaken at three locations including Sano Nggoang and Golo MBU in Werang. These locations are located in the settlement area and can be considered to represent the sensitive receptor area. Eleven parameters (Table 6-6) were measured for a period of 24 hours.

The concentrations of pollutants at AQ3 are higher than the two other locations. AQ3 is a resident's house located at a roadside, thus the concentrations of pollutants here were highly influenced by the number of vehicles that passed the road at the time of the measurements. This was confirmed by the high concentration of CO at this location. The concentrations of pollutants at other locations are also influenced by vehicles. The high concentration of CO at a location is proportional to the high concentration of other pollutants.

All parameters measured during the monitoring period do not exceed either Government of Indonesia Standards or WHO Air Quality Guidelines. This suggests that the ambient air in the study area is in a non-degraded condition. The results of the monitoring, along with a comparison against the aforementioned standards are provided in Table 6-6 and the sampling location map can be seen on Figure 6-24.

Table 6-6 Air Quality Measurement Result

No	Parameter ^a	Measurement Time	Unit	Quality Standards		Measurement Result ^d		
				Gol ^b	WHO ^c	AQ1	AQ2	AQ3
1.	NO ₂	24 hours	µg/m ³	150	-	14	16	28
2.	SO ₂	24 hours	µg/m ³	365	125 (IT-1) 50 (IT-2) 20 (guideline)	6	8	17
3.	CO	24 hours	µg/m ³	10,000	-	468	415	945
4.	O ₃	1 hour	µg/m ³	235	-	2	3	6
5.	NH ₃	24 hours	µg/m ³	1,400	270	<0.062	<0.062	<0.062
6.	H ₂ S	24 hours	µg/m ³	28	150	<0.0010	<0.0010	<0.0010
7.	TSP	24 hours	µg/m ³	230	-	30	24	56
8.	PM ₁₀	24 hours	µg/m ³	150	150 (IT-1) 100 (IT-2) 75 (IT-3) 50 (guideline)	19	18	40
9.	PM _{2.5}	24 hours	µg/m ³	65	35 (IT-1) 25 (IT-2) 15 (IT-3) 10 (guideline)	7	6	12
10.	Pb	24 hours	µg/m ³	2	-	<0.1	<0.1	<0.1
11.	F	24 hours	µg/m ³	3	-	<0.12	<0.12	<0.12
12.	Cl ₂ & ClO ₂	24 hours	µg/m ³	150	-	<10	<10	<10

Notes:

- NO₂ = Nitrogen Dioxide; SO₂ = Sulphur Dioxide; CO = Carbon Monoxide; O₃ = Ozone; NH₃ = Ammonia; H₂S = Hydrogen Sulphide; TSP = Total Suspended Particulates; PM₁₀ = Particulate matters of less than 10 microns; PM_{2.5} = Particulate matters of less than 2.5 microns; Pb = lead; F = Total Fluoride; Cl₂ & ClO₂ = Chlorine & Chlorine Dioxide;
- Air quality standards of the Government of Indonesia (Gol) are taken from the Government Regulation No. 41 of 1999 on Air Pollution Control except for NH₃ and H₂S. For these two parameters, the standards are taken from the Decree of the State Minister of Environment No 50 of 1996 regarding Odor Standards;
- Values for WHO standards are taken from Air Quality Guidelines Global Update (WHO, 2005). PM_{2.5} and PM₁₀ values are in 99th percentile. Interim targets (IT-1, IT-2, IT-3) are provided in recognition of the need for a staged approach to achieving the recommended guidelines. For NH₃ and H₂S the standards are taken from WHO Air Quality Guidelines for Europe (WHO, 2000);
- Measurement results are based on Baseline Study in 2016. Measurement Locations: AQ1 = Near School yard; AQ2 = Sano Nggoang Village; AQ3 = Golo MBU Village in Werang.

6.2.8. Noise

Primary ambient noise monitoring was undertaken in November 2016. Measurements were made at three locations, which were the same as the air quality measurement locations (Figure 6-24). Monitoring was undertaken over a 24-hour period, and results were divided into Ld, Ln and Ldn (Table 6-7).

The noise level at the project area is mostly dominated by natural factors, such as birds and insects; still others come from the sound of vehicles passing the sampling points. The noise at AQ3 is higher than the two other locations. AQ3 is a resident's house located at a roadside, thus the noise here was highly influenced by the number of vehicles that passed the road at the time of measurement. This was confirmed by the high Ld and Ln at this location. Noise at the other locations also looks to be influenced by vehicles.

The results show that the noise intensity in the study area during the day and night time (Ldn) are well within the quality standard of 55 dB (A) as stipulated in the *Decree of the Minister of the Environment on 48 1996* regarding Ambient Noise Level Standards. The results also show that daytime noise (Ld) was significantly higher than the night time (Ln) however they are still lower than the WHO's guidelines. Complete results of measurements of noise levels in the field are shown in Table 6-7.

Table 6-7 Noise Level Measurement Result

Parameter ^a	Unit	Quality Standards		Measurement Result		
		Gol ^b	WHO ^c	AQ1	AQ2	AQ3
Ld	dB(A)	-	55	46	44	49
Ln	dB(A)	-	45	39	43	44
Ldn	dB(A)	55	-	45	45	49

Notes:

- Ld is the A-weighted equivalent continuous sound pressure level for the day time period from 7.00 am to 10.00 pm. Ln is the A-weighted equivalent continuous sound pressure level for the night time period from 10.00 pm to 7.00 am. Ldn is The A-weighted equivalent continuous sound pressure level for day - night time period with 5 decibel penalty applied to night-time levels;
- Noise quality standards of the Government of Indonesia (Gol) are based on Decree of the Environment State Ministry No. 48 of 1996 regarding Ambient Noise Level Standards;
- Values for WHO standards are taken from Occupational and Community Noise (WHO, 2001).
- Location Code: AQ1: Near School yard; AQ2 : Sano Nggoang Village; AQ3 : Golo MBU Village in Werang

6.2.9. Lake Water Quality

The existing source of water pollution in this area is primarily caused by natural causes. Since the number of residents in the lake area is small, the sources of the pollution from domestic or human activities are relatively small. Surface water quality was undertaken in November 2016 at four locations in the vicinity of Lake Sano Nggoang (

Figure 6-16). The sampling locations selected are locations that are close to sensitive receptors. The parameters that have been sampled refer to the regulation standards. Based on the results of laboratory analysis, some parameters exceed the quality standards at all sampling locations, including Total Dissolved Solid (TDS), pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), ammonia, iron, manganese, zinc, chloride, sulfate and sulfur. The results are compared with *Government Regulation No. 82 year 2001*, in which water quality standards are stipulated based on the use of the water, e.g., drinking water, irrigation, fish cultivation etc.

The high level of metal is caused by the existence of volcanic activity in the area around the lake. Due to the very low pH (reaching 2.81), the organisms living in the lake are also limited, including nekton species. Only poultry such as ducks were observed on the edge of the lake.

Total Dissolved Solid (TDS)

Based on laboratory tests, TDS concentrations results exceed the quality standard (1,000 mg/l) at all sampling points. TDS concentrations ranged between 1500 mg/l -1635 mg/l. The high concentration of TDS could be due to the close proximity to the volcanic ash deposition, causing chemicals to dissolve into the water. According to

(Effendi, 2003), the concentration of TDS is strongly influenced by the weathering of rocks, runoff from the ground and anthropogenic influences (such as domestic and industrial waste).

pH

pH or acidity is a parameter to determine the levels of acid / alkalinity. The pH of water determines the solubility and biological availability of chemical constituents such as nutrients and heavy metals (Rao, 1989). Impact of volcanic ash can bring down the pH levels due to sulfur dioxide gas dissolved in the water. Other processes affecting the water pH are the bacterial degradation of organic and conversion of inorganic matter as they utilize oxygen (Rasolofomanana, 2009). Results of pH measurement at all sampling points showed a very low pH, which ranges from 2.81 - 3.85, while the quality standards appropriate regulatory of pH is 6-9. Low pH levels also lead to corrosive water.

Biochemical Oxygen Demand (BOD)

BOD defines the amount of oxygen required by microorganisms to break down organic matter in the water body, and provides a good indication of the level of organic pollution. Water with high BOD levels will typically have low oxygen levels as microorganisms use up available oxygen to breakdown organic matter, leaving no oxygen for other organisms. BOD values at all sampling locations exceeded the Regulatory Limit (RL) based on *Government Regulation No. 82 Year 2001* regarding class I (2 mg/l). The laboratory results showed BOD concentration ranging from 220.7mg/l – 227.3 mg/l. Most likely, there is a large quantity of organic waste, such as rotting vegetation, dead plants, leaves or grass clippings in the lake; therefore there will be a lot of bacteria present working to decompose this waste. In this case, the demand for oxygen will be high (due to all the bacteria) so the BOD level will be high.

Chemical Oxygen Demand (COD)

COD is a measurement of oxygen demand for chemical oxidation. High COD has a negative impact on the environment as the oxygen for living organism is consumed for chemical oxidation. Similar to BOD, COD is also used as an indicator of water pollution. Generally high COD Indicates reduced water quality. Results of laboratory tests conducted on all of the sampling points showed high concentrations of COD that exceeded the quality standard (10 mg/l), ranging from 524.1 mg/l - 750.3 mg/l. Similar to BOD, this is most likely a result of natural geochemical processes.

Dissolved Oxygen (DO)

DO is the amount of dissolved oxygen in the water. DO concentration is related to the flow of water that causes the diffusion of oxygen from the air into the water. DO is affected by several factors such as temperature, pressure, turbulence and pollution levels. Low DO concentration generally indicates reduced water quality. Results of measurements at all sampling points showed concentration below the standard (6 mg/l), ranging from 2.14 mg/l - 2.38 mg/l. When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by bacteria.

Ammonium (NH₄⁺)

Ammonia compound is highly toxic to aquatic organisms even at relatively low levels. Elevated ammonia levels can also lead to reduced growth of species raised in intensive aquaculture systems (Schuler, 2008). Based on study of (Wickins, 1976) cited in (Schuler, 2008), a concentration of 0.45 mg/l NH₃-N led to a 50% decrease in growth of five species of penaid shrimp. The results of measurements in three of the four sampling locations showed concentrations that exceeded the quality standard (0.5 mg/l) ranging from 0.849 mg/l - 0.930 mg/l. Based on nitrogen cycle, ammonium (NH₄⁺) results is from the bacterial degradation of organic matters (ammonification). The higher organic matters the higher ammonium concentration. High concentrations of ammonia represent high organic content as well. Organic nitrogen comes from a number of sources, including domestic waste, such as garbage, human and animal wastes; beside it comes from industrial waste as well as natural water exposed to plant debris (Huheey, 1993).

Iron (Fe)

Iron in the water can be dissolved, suspended and incorporated with other organic and inorganic substances. Iron can be dissolved in the water when the lake has a very deep bottom, a low water pH (acidic) and contains a lot of dissolved carbon dioxide. In surface water, Fe content greater than 1 mg/l is rarely found. Laboratory test results show that the Fe content ranging from 1,081 mg/l – 2,104 mg/l, where this concentration exceeds a predetermined quality standard (0.3 mg/l). The iron content in the water is an indication of the influence of volcanic rocks on the quality of water. The closer to the volcanic area, the greater the Fe content. In addition, it also can be caused by low oxygen levels in the waters. Overall, this is caused by natural factors.

Manganese (Mn)

Manganese can also be found at the bottom of the reservoir where anaerobic conditions occur due to decomposition processes. Greater levels can occur in ground water and in deep lakes. High manganese content can cause odor and a brownish color to the water. Results of laboratory testing done at all sampling points showed manganese values which ranged from 0.303 mg/l – 1.052 mg/l, significantly exceeding the quality standard (0.1 mg/l).

Chloride (Cl)

Weathering of rocks and soil releases chloride to the water. Most chlorides are soluble. Chloride levels generally increase with increasing levels of minerals. The results of laboratory testing in four sampling points, showed three with a value of chloride that exceeded the quality standard (600 mg/l), ranging between 620.07 mg/l - 631.37 mg/l. Chloride can also come from man-made sources, but mostly this is caused by natural factors.

Sulphat (SO₄)

According to (Syahrul, 2012), the solubility of sulfates in the water can be caused by geological aspects, such as high solubility of the mineral gypsum and pollution. Based on the measurements, the sulfate content at all sampling points exceeded the quality standard (400 mg/l), ranging between 718.91 mg/l - 750.08 mg/l. Sulfate anions may occur naturally in water, and high levels of sulfate in water come from gaseous sulfur dioxide from volcanic eruptions (Sutriati, 2012).

Sulphur as H₂S

Sulfur may be found in nature in the form of the pure element or as sulfide or sulfate minerals. H₂S is a gas that arises from biological activity when bacteria breakdown organic material in the absence of oxygen (anaerobic). This gases also arise from volcanic activity (Ratcliff in Wibowo, 2012). The toxicity of H₂S increases with a decrease in pH value (Effendi, 2003). Dihydrogen sulfide can be corrosive to metal. Results of measurements that have been done at all sampling points showed a high sulfur content that far exceeded the quality standard (0.002 mg/l), ranging between 0.058 mg/l - 0.720 mg/l.

The result of the analysis of surface water quality in the study area is shown in Table 6-8.

6.2.10. Groundwater Quality

Utilisation of groundwater in the local area is mostly used for primary consumption since there are limited surface water sources that exist. Groundwater in the study area is in the form of springs (Figure 6-16). Primary groundwater data was also obtained as part of the field studies, with sampling conducted at three locations (springs) and two additional locations.

Based on the analysis of groundwater quality, all parameters sampled were found to be within the standard criteria as stipulated in the *Regulation of the Minister of Health 416 in 1990*. The analysis results of groundwater quality in the study area are shown in Table 6-9. The laboratory results show that the groundwater quality is good. All parameters meet the regulation standard.



Source: PT SMI Baseline Study, 2016

Figure 6-16 Surface Water (Lake) and Groundwater (spring) Sampling

Table 6-8 Surface Water Quality Measurement Result

No.	Parameter	Unit	Standard	SW01	SW02	SW03	SW04	Method
A. Physical								
1.	Temperature	°C	± 3°C	29	27	28.5	24	SNI 06-6989.23-2005
2.	TDS	mg/L	1,000	1,635	1,595	1,600	1,500	SNI 06-6989.27-2005
3.	TSS	mg/L	50	13	10	15	28	SNI 06-6989.3-2004
B. Chemical								
1.	pH	-	6-9	2.96	3.05	2.81	3.85	SNI 06-6989.11-2004
2.	BOD (5 days 20°C)	mg/L	2	227.25	223.19	223.95	220.70	SNI 6989.72:2009
3.	COD	mg/L	10	728.35	748.96	750.26	524.11	SNI 6989.2:2009
4.	DO	mg/L	6	2.14	2.15	2.15	2.38	Direct reading
5.	Phosphate (PO ₄ ³⁻) total	mg/L	0.2	<0.119	<0.119	<0.119	<0.119	SNI 06-6989.31-2005
6.	Nitrate (NO ₃ -N)	mg/L	10	0.24	0.18	0.22	0.10	APHA ed.22nd 4500-NO3-B,2012
7.	Ammonium (NH ₄ ⁺)	mg/L	0.5	0.920	0.849	0.930	0.375	SNI 06-6989.30-2005
8.	Arsenic (As)	mg/L	0.05	<0.004	<0.004	<0.004	<0.004	PHA ed. 22nd 3111 B, 2012
9.	Cobalt (Co)	mg/L	0,2	<0.050	<0.050	<0.050	<0.050	SNI 6989.68-2009
10.	Barium (Ba)	mg/L	1	<0.001	<0.001	<0.001	<0.001	APHA ed. 22nd 3111 B, 2012
11.	Boron (B)	mg/L	1	<0.001	<0.001	<0.001	<0.001	APHA ed. 22nd 3111 B, 2012
12.	Selenium (Se)	mg/L	0.01	<0.004	<0.004	<0.004	<0.004	APHA ed. 22nd 3111 B, 2012
13.	Cadmium (Cd)	mg/L	0.01	<0.006	<0.006	<0.006	<0.006	SNI 6989.16-2009
14.	Chromium (Cr) VI	mg/L	0.05	<0.010	<0.010	<0.010	<0.010	APHA ed.22nd 3500 Cr6+ B,2012
15.	Copper (Cu)	mg/L	0.02	<0.006	<0.006	<0.006	<0.006	SNI 6989.6-2009
16.	Iron (Fe)	mg/L	0.3	2.104	1.931	2.094	1.081	SNI 6989.4-2009
17.	Lead (Pb)	mg/L	0.03	<0.010	<0.010	<0.010	<0.010	SNI 6989.8:2009
18.	Manganese (Mn)	mg/L	0.1	1.036	1.020	1.052	0.303	SNI 6989.5-2009
19.	Mercury (Hg)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	APHA ed. 22nd 3111 B, 2012
20.	Zinc (Zn)	mg/L	0.05	0.127	0.111	0.142	0.103	SNI 6989.7:2009
21.	Chloride (Cl ⁻)	mg/L	600	631.37	620.07	626.47	566.17	SNI 6989.19-2009
22.	Cyanide (CN)	mg/L	0.02	<0.001	<0.001	<0.001	<0.001	APHA ed. 22nd 3500 CN-, 2012
23.	Fluoride (F)	mg/L	0.5	0.35	0.25	0.28	0.07	APHA ed. 22nd 4500-F-D, 2012
24.	Nitrite as N	mg/L	0.06	<0.024	<0.024	<0.024	<0.024	SNI 06-6989.9-2004
25.	Sulphate (SO ₄ ²⁻)	mg/L	400	750.08	730.11	718.91	704	SNI 6989.20-2009

No.	Parameter	Unit	Standard	Sampling Location				Method
				SW01	SW02	SW03	SW04	
26.	Free Chlorine (Cl)	mg/L	0.03	<0.03	<0.03	<0.03	<0.03	APHA ed. 22nd 4500-Cl-B, 2012
27.	Sulphur as H ₂ S	mg/L	0.002	0.720	0.722	0.728	0.058	APHA ed. 22nd 4500 S2-F, 2012
C. Chemical Organic								
1.	Oil and Grease	µg/L	1,000	<170	<170	<170	<170	APHA 22nd 5520 B, 2012
2.	Detergent as MBAS	µg/L	200	<100	<100	<100	<100	APHA 22nd 5540 C, 2012
3.	Phenol	µg/L	1	<1	<1	<1	<1	APHA 22nd 5530, 2012
4.	Potential Redox	mV	-	259.9	259.4	265.4	257.4	Direct reading
D. Microbiology								
1.	Fecal coliforms	MPN/100ml	100	<10	<10	<10	<10	SNI 01-2897-1992
2.	Total coliforms	MPN/100ml	1,000	<10	<10	<10	<10	SNI 01-2897-1992

Source: PT SMI Baseline Study, 2016

Note:

*) GoI Regulation No.82 of 2001 on Water Quality Management and Water Pollution Control

Red font: exceeding the standard limit

MBAS: Methylene Blue Active Substance (surfactant)

MPN: Most Probable Number

Location Code:

SW01: Lake

SW02: Lake Outlet

SW03: Lake

SW04: Lake (50 m away from lake outlet)

Table 6-9 Groundwater Quality Measurement Result

No.	Parameter	Unit	Standard	Sampling Location					Method
				GW01	GW02	GW03	GW04	GW05	
A.	Physical								
1	Odour	-	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	APHA ed. 22nd 2150 B, 2012
2	Total Dissolved Solid (TDS)	mg/L	1.500	96	90	76	179	76	SNI 06-6989.27-2005
3	Turbidity	NTU	25	3	2	2	6.1	2	APHA ed. 22th 2130 B, 2012
4	Taste	Tasteless	Normal	Normal	Normal	Normal	Normal	Normal	APHA ed. 22nd 2160 C, 2012
5	Temperature	°C	± 3°C	22.5	22.9	24.9	23.6	24.9	SNI 06-6989.23-2005
6	Colour	PtCo	50	2	1	1	2.4	1	APHA ed. 22nd 2120 C, 2012
B.	Chemical								
1	Mercury (Hg)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	APHA ed. 22nd 3111 B, 2012
2	Arsenic (As)	mg/L	1.0	<0.004	<0.004	<0.004	<0.004	<0.004	APHA 22nd 3114 C, 2012
3	Iron (Fe)	mg/L	1.0	<0.052	<0.052	<0.052	<0.052	<0.052	SNI 6989.4-2009
4	Cadmium (Cd)	mg/L	0.01	<0.006	<0.006	<0.006	<0.001	<0.001	SNI 6989.16-2009
5	Hexavalent Chromium (Cr ⁶⁺)	mg/L	0.05	<0.010	<0.010	<0.010	<0.010	<0.010	APHA ed. 22nd 3500 Cr6+ B,2012
6	Manganese (Mn)	mg/L	0.5	<0.022	<0.022	<0.022	<0.022	<0.022	SNI 6989.5-2009
7	Selenium (Se)	mg/L	0.01	<0.004	<0.004	<0.004	<0.001	<0.001	APHA ed. 22nd 3111 B, 2012
8	Zinc (Zn)	mg/L	15	0.030	0.049	0.043	0.030	0.035	SNI 6989.7-2009
9	Lead (Pb)	mg/L	0.05	<0.010	<0.010	<0.010	<0.005	<0.005	SNI 6989.8-2009
10	Fluoride (F)	mg/L	1.5	0.26	0.43	0.20	0.39	0.27	APHA ed. 22nd 4500-F-D, 2012
11	Total hardness as CaCO ₃	mg/L	500	44	56	44	27.60	71.39	SNI 06-6989.12-2004
12	Chloride (Cl ⁻)	mg/L	600	48.70	46.92	43.12	56.62	38.55	SNI 6989.19-2009
13	Nitrate, as NO ₃ -N	mg/L	10	0.090	0.047	0.039	1.35	0.051	APHA ed. 22nd 4500-NO3-B, 2012
14	Nitrite, as NO ₂ -N	mg/L	1.0	<0.024	<0.024	<0.024	<0.024	<0.024	SNI 06-6989.9-2004
15	pH	-	6.5 – 8.5	7.53	7.11	7.40	6.64	6.83	SNI 06-6989.11-2004

No.	Parameter	Unit	Standard	Sampling Location					Method
				GW01	GW02	GW03	GW04	GW05	
16	Cyanide (CN)	mg/L	0.1	< 0.001	< 0.001	<0.001	<0.001	<0.001	APHA ed. 22nd 3500 CN-, 2012
17	Sulphate (SO ₄)	mg/L	400	15.52	15.87	14.85	1.25	3.75	SNI 6989.20-2009
18	Surfactant (MBAS)	mg/L	0.5	<0.10	<0.10	<0.10	<0.10	<0.10	APHA 22nd 5540 C, 2012
19	Phenol	mg/L	-	<0.001	<0.001	<0.001	-	-	APHA 22nd 5530, 2012
20	KMnO ₄	mg/L	10	1.82	1.47	1.42	5.14	0.14	APHA 22nd 4500, 2012
C. Microbiology									
1	Total Coliform	MPN/100ml	50	<2	<2	<2	8	<2	SNI 01.2897.1992
2	Faecal Coliform	MPN/100ml	-	< 2	< 2	< 2	<2	<2	SNI 01-2897-1992

Source: PT SMI Baseline Study, 2016

Note:

*) Ministry of Health Regulation No.416/1990 of Water Quality Management and Water Pollution Control

Location Code:

GW01: Sano Nggoang Village

GW02: Wae Sano Village

GW03: Wae Sano Village

Location Code:

GW04: Kandang Village

GW05: Lenda Village

6.2.11. Traffic

Baseline traffic data in the study area was obtained through direct survey. Traffic measurement was performed at four locations that will be passed via the access road to the project site (Figure 6-17) and sampling location presented in Figure 6-24, namely:

1. Point 1 (LL01), road that connects Wae Sano to Sano Goang/Taal/Werang, and vice versa.
2. Point 2 (LL02), road that connects Wae Sano/Taal/Werang to Sano Goang, and vice versa.
3. Point 3 (LL03), road that connects Wae Sano/Sano Goang to Taal/Werang, and vice versa.
4. Point 4 (LL04), road that connects Werang to Labuan Bajo, and vice versa.

The access road to the project site is a paved road with a road width of around 3 m. There are two categories of road at project site, paved road and unsealed road. The location of traffic sampling was on paved road. The condition of paved roads is in fairly good condition with minor damage at several locations.

In order to understand the traffic patterns on the site, traffic measurements were carried out for three days representing the current state holidays (Saturday and Sunday) and a weekday (Monday) with measurements every 2 hours, divided into three time windows: morning, noon, and evening. Morning time starting from 7 – 9 AM, noon at 11 AM – 1 PM, and evening at 3 – 5 PM. Traffic measurements were performed by counting the number of vehicles that pass through these roads as well road characteristic information which is then converted by calculation to obtain the level of service (LoS) based on the *Indonesian Highway Capacity Manual* (MKJI).

In calculating the volume of traffic based on MKJI, vehicles are classified into three classes; heavy vehicles (HV), light vehicle (LV), and motorcycles (MC). Heavy vehicles include bus, macro bus, mini truck, medium truck, and heavy truck. Light vehicles include cars, minibus, and pick-up. Public transportation at the study area is rarely found; public transportation is only available on the Labuan Bajo – Werang route. The results of total vehicles in the study area are presented in the following table.

Table 6-10 Traffic Volume Calculation in Study Area

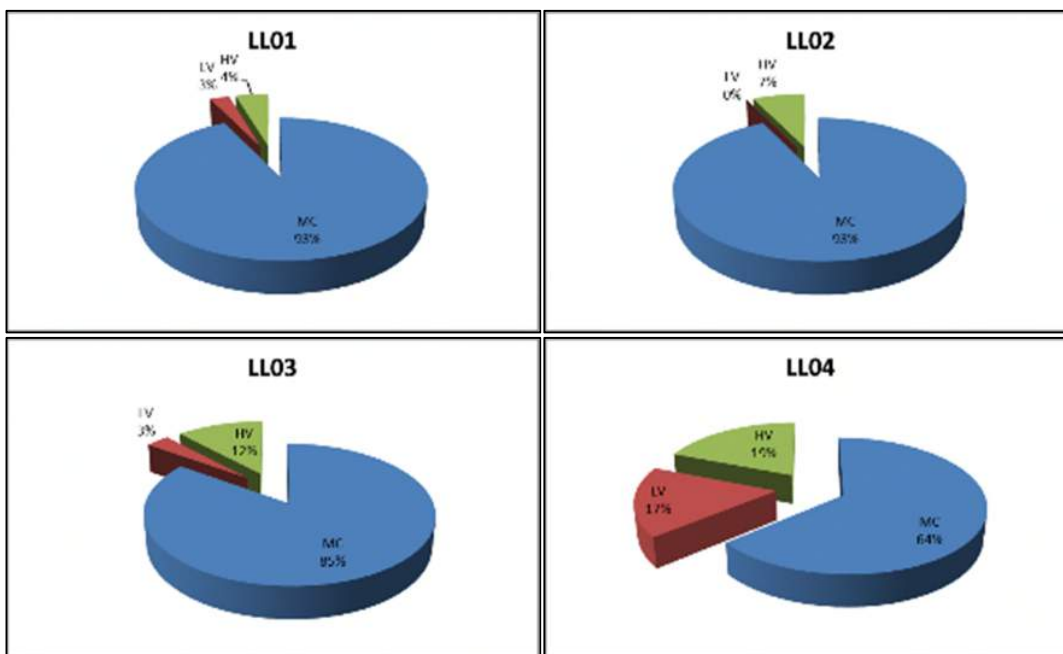
Location	Vehicle								
	Weekend (Saturday)			Weekend (Sunday)			Weekday (Monday)		
	MC	LV	HV	MC	LV	HV	MC	LV	HV
LL01	40	1	5	135	4	3	69	2	4
LL02	32	0	6	80	0	2	30	0	3
LL03	51	1	7	57	4	5	50	1	10
LL04	196	63	69	110	12	27	185	56	50

Source: PT SMI Baseline Study, 2016



Source: PT SMI Baseline Study, 2016

Figure 6-17 Typical Road in Study Area



Source: PT SMI Baseline Study, 2016

Figure 6-18 Percentage of Vehicles in Study Area

The LoS is a measurement used to determine the quality of a road to serve traffic flow through it. The criteria of road service can be seen in Table 6-11.

Table 6-11 Road Service Criteria Level

Level of Service	Characteristic	V/C Limit
A	Free traffic flow conditions with high speed and low traffic volume	0.00 – 0.20
B	Steady flows, but the operation speed began to be restricted by traffic conditions	0.21 – 0.44
C	Steady flows, but the speed and vehicles movement are controlled	0.45 – 0.74
D	Approaching a steady flow, the speed can still be controlled. V/C can be tolerated	0.75 – 0.84
E	Unstable flow, speed sometimes stalled, demand was approaching the capacity	0.85 – 1.00
F	Forced flow, low speed, volume above the capacity, long queues (traffic)	> 1.00

Source: Manual Kapasitas Jalan Indonesia (MKJI), 1997

The level of service calculation results at the study area are presented in the Table 6-12.

Table 6-12 Result of V/C Ratio

Location	Ratio V/C		
	Weekend (Saturday)	Weekend (Sunday)	Weekday (Monday)
LL01	0.003	0.009	0.005
LL02	0.003	0.005	0.002
LL03	0.004	0.005	0.005
LL04	0.030	0.020	0.030

Source: PT SMI Baseline Study, 2016

Traffic volume measurements indicate that the motorcycle is the most often used mode of transport for the local community. The highest traffic volume from the 4 sampling locations is LL04, because LL04 is located on the main road that connects Werang (capital of the sub-district) and Labuan Bajo. From the calculation of V/C ratio, all sampling points are classified as category A of LoS because it has a value of V/C ratio below 0.02. Category A

means that the road has free traffic flow. There is only one access road that is connected to the project area and main road (Labuan Bajo – Ruteng).

6.3. Biological Environment

The discussion of biological environment below is subjected to describe the biological baseline in broader area since the locations for Project site and its supporting facilities including infrastructures are not confirmed yet when the field survey was undertaken and therefore the baseline is 'landscape approach'. Referring to Sub Section 3.1 and 3.4.2, the proposed locations for Project site are indicated within the non-forest area, except proposed well pad WS-D and WS-B1 (alternative of well pad WS-B). The forest area discussed in this section is referred to the forest boundary as mentioned in those sub section.

The study area is situated within the area where the BirdLife International (Yayasan Burung Indonesia) has conducted biodiversity assessment particularly birds in 2012. Based on the assessment, BirdLife International released an Important Bird Area (IBA) covering the Sesok Forest. Referring to IFC Guidance Note 6 of IFC PS 6, there are two endemic bird species are categorized in Endangered according to IUCN Red List category may trigger Critical Habitat (CH)¹⁰. One of them is a key biodiversity for justification of Important Bird Area (IBA) by BirdLife International (Yayasan Burung Indonesia)¹¹. The description those endangered bird species is discussed in Sub Section 6.3.2.3. Although a full assessment of CH is not conducted, five criteria for identification of CH in accordance with the IFC GN6 are used to consider the potential CH within study area. Those criteria are:

- Globally or nationally Critically Endangered or Endangered species;
- Restricted-range or endemic species;
- Concentrations of migratory and congregatory species;
- Highly-threatened and unique ecosystems;
- Key evolutionary processes.

Further description on potential CH within study area is discussed in Sub Section 6.4.3.4.

6.3.1. Flora

Data on the flora within the study area is very limited compared to the neighbouring protected forest, Mbeliling Nature Reserve. In general, the floral habitat types in the study area are lowland tropical rain forest, industrial plant forest and sub-montane forest with an altitude of 600 – 1,230 meters above sea level. The dominant trees include *Eucalyptus urophylla*, *Calliandra calothyrsus*, *Artocarpus*, *Syzygium*, *Prunus sp*, *Elaeocarpus sp*, *Podocarpus imbricatus* and *Prunus arborea*.

The description of flora in this section is based upon brief observations utilizing a rapid assessment approach. It is intended to provide a general overview of the potential areas that may be selected as the location for exploration drilling sites for the Waesano Geothermal project, in particular the proposed well pads at WS-A, WS-B, WS-D, WS-E and its alternatives. The location of the other proposed auxiliary facilities include the spoil disposal area for each well pad, temporary water treatment plant and civil construction camp (see the project description in Section 3). The information is then used as input for the preparation of environmental management and monitoring.

In general, the project location can be categorized as modified habitat that has been affected by human activities over a long period of time, except for proposed well pad WS-D. Although well pad WS-D is indicated in the forest area, the field observation advised that vegetation composition of area proposed for well pad WS-D is not different with the most non-forest area. It was reported by local community that the previous head village has engaged the

¹⁰ Critical Habitat is a concept developed by the International Finance Corporation (IFC) in its Performance Standard 6 (PS6) on Biodiversity Conservation and Sustainable Management of Living Resources. Critical Habitat is a description of the areas of the planet of highest biodiversity conservation. It takes into account both global and national priorities and builds on the conservation principles of 'vulnerability' (threat) and 'irreplaceability' (rarity/restricted distribution).

¹¹ Yayasan Burung Indonesia has released their Data Zone regarding Important Bird Area (IBA) within Sesok Forest based on their assessment conducted in 2012. Detailed information regarding this IBA is provided in **Appendix G**.

local community to plant the commercial plants at their lands and nearest forest area in the year 80s¹². Common types of cultivation plants are candlenuts, coffee, areca nuts, bamboo, coconut and white pepper.



Source: PT SMI Baseline Study, 2016

Figure 6-19 Typical of Flora Habitat within the Study Area

6.3.1.1. Access Road

All segments of the proposed access road will be sited in non-forestry area (*Areal Penggunaan Lain* or APL). No sensitive habitat along the access roads was observed.

6.3.1.2. Vegetation in WS-A and Spoil Disposal Area 3

The site is located in Lempe Sub-village, Wae Sano Village and not far from the village border between Wae Sano and Pulau Nuncung Villages. The type of flora in this area is categorized by a mixture of shrubs and gardens. Vegetation types found in the area include Candlenut (*Aleurites moluccana*) Bijaema (*Elacocarpus petiolata*), Areca nut (*Areca catechu*), Cocoa, Bamboo (*Bambusa sp*), Haubesi (*Olea paniculata*), and Gamal (*Gliricidia sepium*). The vegetation density is estimated to be less than 1,000 trees / ha. Candlenut, areca nut and cocoa have economic value to the local people and are often found sporadically, while Gamal is often found to be the boundary of land owned by local people. Bamboo is left to grow wild and is used by local people as an alternative material for home

¹² The previous Wae Sano Village Head engaged local community in his local economic development program. The main objective of the program is to increase local community income level by increasing the agricultural commodity production with plantation of commercial trees as much as possible.

building purposes. No vegetation species were observed that are protected either by Indonesian Government conservation regulations or the categorization of international conservation agencies.

6.3.1.3. Vegetation in WS-B

The site is located in Nunang Sub-village and its location is relatively close to the *Compang* (andesite stone) site which is a sign that the place was once inhabited by the ancestors or the predecessors of the community who currently reside in Nunang Sub-village and other sub-villages in Wae Sano Village. This location is called *Lingko Laja* by the local people.

The vegetation types found on this site are similar to the well pad site WS-A. No vegetation species were observed that are protected either by Indonesian Government conservation regulations or the categorization of international conservation agencies.

6.3.1.4. Vegetation in WS-D

The site is located in the forest area that is not far from Dasak Sub-village. This site contains undulating ground with vegetation density categorized as high (> 70%). Vegetation observed includes Candlenut (*Aleurites moluccana*), Bijaema (*Elacocarpus petiolata*), Haubesi (*Olea paniculata*) and Bamboo. The site sensitivity to landscape alteration caused by land clearing is considered low and its effects on ecosystems in this area is not significant, as there no species of protected flora were found.

6.3.1.5. Vegetation in WS-E

The location of the WS-E site is on the village road to Dasak Sub-village with a relatively flat and open surface compared to WS-E site. It is categorized as low vegetation density (less than 1,000 trees / ha) and combined with shrubs and corn crops and trees around them, such as coconut, candlenut and others. The site sensitivity to landscape alteration caused by land clearing is considered low and its effects on ecosystems in this area is not significant, as there are no protected species.

6.3.1.6. Vegetation in Spoil Disposal Area 1 and 2

Spoil Disposal Area 1 is located in the north and not far from WS-D. The vegetation found in this site is classified as shrubs and bamboo plants that are scattered sporadically.

Spoil Disposal Area 2 is used to dispose drilling material from WS-E, which is located adjacent to the well pad area. There is almost no vegetation found with high structure. During the survey, it was observed that the land at this site is corn plantation that has been harvested. The site sensitivity to landscape alteration caused by land clearing is considered low and its effects on ecosystems in this area is not significant, as no protected species were found.

6.3.1.7. Vegetation in Drilling Basecamp

The site is close to the Camping Ground location on the shores of Lake Sano Nggoang, Wae Sano Village. This site ground surface is relatively flat with vegetation density categorized as moderate (41% - 70%). Candlenut can be found easily on this site. In addition, other types of trees such as Hue (*Eucalyptus Alba*), Bijaema (*Elacocarpus Petiolata*), Haubesi (*Olea Paniculata*), Kakau or pine mountain (*Casuarina Equisetifolia*), Manuk molo (*Decaspermum Fruticosum*) and Oben (*Eugenia Littorale*) were observed. The site sensitivity to the landscape alteration caused by land clearing is considered low and its effects on ecosystems in this area is not significant, as no protected species were found.

6.3.1.8. Vegetation in Spoil Disposal Area (Road Upgrading) 4, 5, and 6

Currently, there are three locations (Spoil Disposal Area 4, 5 and 6) selected as a disposal area for excavation materials for road upgrading. These three locations are located on the side of the road that connects Wae Sano and Wae Lolos Villages (entrance of Trans-Flores Road). In general, the vegetation that grows in these three locations is garden plants such as bananas, cassava, coconut, candlenut, gamal and shrubs. Gamal plants are used as a barrier or fence. No protected species were found.



6.3.2. Terrestrial Fauna

The study area is located close to forests which are part of the Mbeliling landscape, namely Blok Sesok protected forests. Dusun (Sub-village) Nunang, the study area, is a popular location to observe the endemic bird species of Flores Island by tourists and wildlife watchers. The habitat value of the area, particularly for endemic birds, has been recognised by Yayasan Burung Indonesia (Birdlife Indonesia) who have been actively engaging with the local communities to support conservation of protected wildlife. Considering the importance of bird conservation in this area, the terrestrial fauna observations during the study are focused on birds.

Similar to flora observations, a rapid assessment method was used to provide a general overview. In addition to visual and sound observations, interviews with local communities were also conducted. Observations were carried out at project sites for drilling, particularly in Lempe, Nunang, and Dasak Sub-villages. However, no frequency / point counting of wildlife were undertaken.

The species of birds identified in the study area are listed in the table below (Table 6-13). Eight species of them are categorized as protected species by the Government of Indonesia Regulation¹³ and all of them are considered as Least Concern (Lc) by IUCN Red List Data Book¹⁴. Two migratory bird species were also recorded during observation and interview, while two of listed birds are endemic species to Flores. Further description of those protected birds, migratory birds, and endemic birds is discussed below. The existence of these birds was recorded when perched on a tree or flying during the survey. There were no bird's nests observed during the survey. Therefore, records of bird species encountered during observations on each site do not illustrate that they are species of resident birds at each site. The data further illustrates the regional distribution of these birds at study sites and surrounding areas. Most likely, the birds nest in protected forests in the Blok Sesok that belong to the Mbeliling Landscape and are on project sites searching for food.

6.3.2.1. Protected Species

GR No.9 of 1999 has includes all birds of several bird families in protected birds including Accipitridae Family - Bonelli's Eagle (*Aquila fasciata*), Nectariniidae Family - Flame-breasted Sunbird (*Nectarinia Solaris*), Alcedinidae Family - White-rumped Kingfisher (*Caridonax fulgidus*). The other protected species is Common Hill Myna (*Gracula Religiosa Mertensi*). Justification for protection of those species is significant population declining due to poaching and decresing of their habitat caused by deforestation.

6.3.2.2. Migratory Bird

Two migratory birds are recorded during baseline survey based on interview with local guide for bird watching who is living in Nunang Village (Mr.Hendrikus) including Oriental honey buzzard (*Pernis ptilorhynchus*) and Rainbow Bee-Eater (*Merops ornatus*). This information was also confirmed by a local professional bird watcher (Mr.Samuel Rabenak) who has involved in several bird monitoring initiated by Birdlife Indonesia within Lesser Sunda Islands (Sumbawa – Flores).

There is no reliable information or data regarding specific migration route of those bird species within the study area. The observation of John C. Mittermeier, Irfan Rosyadi, and K. David Bishop in 2013¹⁵ advised that the fieldwork and increased coverage by birdwatchers, however, has revealed numerous observations of Oriental Honey Buzzard in the Lesser Sundas (J. Hornbuckle, J. Eaton pers. comm.), proving that the species is a regular visitor to this part of Wallacea, with substantial numbers occurring annually. Germi (Germi F. , 2005) and Germi & Waluyo (Germi F. &, 2006) documented large numbers of honey buzzards traveling eastwards across the Lombok Strait into the Lesser Sundas in autumn, including nearly 8,000 individuals in September to November 2005. Based on those observations, it might be considered that the existing honey buzzards within the study area are part of

¹³ Government of Indonesia released list of protected vegetation and wildlife species under Government Regulation No.7 of 1999 regarding Preservation of Vegetation and Wildlife.

¹⁴ The IUCN Red List of Threatened Species (also known as the IUCN Red List or Red Data List), founded in 1964, is the world's most comprehensive inventory of the global conservation status of biological species. The International Union for Conservation of Nature (IUCN) is the world's main authority on the conservation status of species.

¹⁵ John C. Mittermeier, Irfan Rosyadi, and K. David Bishop did the observation in Wallacea Region and documented in their paper wit the title "The status of Oriental Honey Buzzard *Pernis ptilorhynchus* in Wallacea, with a description of the first record for Ternate"

large numbers of honey buzzards traveling eastwards across the Lombok Strait into the Wallacea via Lesser Sundas.

Regarding the movement pattern of Rainbow Bee-Eater, most of Ornithologist agreed that its patterns of movement are complex and not completely understood. After breeding, southern populations move north between February and June (mostly between March and May) to spend the winter in northern Australia, New Guinea or eastern Indonesia. They return to their breeding areas in southern Australia between August and early November, though mostly between mid-September and mid-October. In northern Australia, part of the population is present throughout the year, with some individuals moving to different habitats during the non-breeding season, while other birds from the population migrate to southern Australia. The Rainbow Bee-Eater observed within the study area in November might be part of large numbers of returning Rainbow Bee-Eater to their breeding areas in southern Australia.

6.3.2.3. Endemic Bird

Flores crow (*Corvus Florensis*) has a very small population, which is subject to a continuing decline in the face of rampant deforestation on its island home, Flores Island (Figure 6-21). It thus qualifies as Endangered¹⁶. These rather diminutive crows were observed within the areas for proposed locations of well pad during baseline survey.



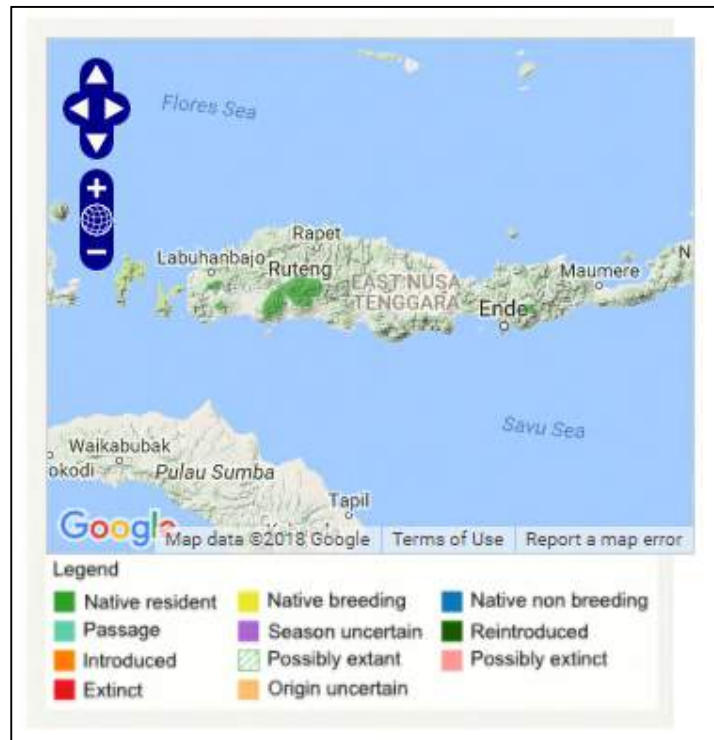
Source: <http://datazone.birdlife.org/species/factsheet/22705956>

Figure 6-21 Distribution Area of Flores crow

Flores scops-owl (*Otus alfredy*) is known from only two locations in a very small range compared to Flores crow (Figure 6-22), within which its very small population is in decline as a result of continuing habitat loss and degradation. For these reasons it is classified as Endangered. This Flores scops-owl was observed within the area which is indicated for well pad WS-B during baseline survey.

¹⁶ <http://datazone.birdlife.org/species/factsheet/22705956>

Further study is recommended to have better understanding on the occurrence of these endemic species within the the areas for proposed locations of well pad particularly at forest area (WS-D and WS B-1) prior to conducting a Critical Habitat Assessment according to IFC GN 6.



Source: <http://datazone.birdlife.org/species/factsheet/Flores-Scops-Owl>

Figure 6-22 Distribution of Flores scops-owl

6.3.2.4. Critical Habitat

Referring to the five criteria of IFC GN6 for Critical Habitat, the most study area triggers Critical Habitat based on three criteria as discussed below.

Globally or nationally Critically Endangered or Endangered species

Although Flores crow (*Corvus Florensis*) and Flores scops-owl (*Otus alfredy*) are not categorized in protected species, both of them are globally endangered species according to IUCN Red List criteria.

Restricted-range or endemic species

There are two endemic bird species categorized in Endangered by IUCN Red List criteria observed during baseline survey including Flores crow (*Corvus Florensis*) and Flores scops-owl (*Otus alfredy*). Flores crow is one of key biodiversity used by BirdLife International to justify Sesok Forest as one of Important Bird Area in Flores Island with criteria A1 (Globally threatened species) and A2 (Restricted-range species).

Highly-threatened and unique ecosystems

Lake Sano Nggoang and its entire ecosystem is widely published as a unique ecosystem. With depths of up to 500m, it is said to be among the world's deepest crater lakes. The lake and an overall surrounding area of 5,500

hectares are mostly protected area due to the remaining forests and endemic bird species such as the native Flores crow and the Flores monarch. Besides the birds, there is an abundance of attractive flora and fauna that can be spotted in this area. Although this ecosystem is not highly-threatened currently, the uniqueness of this ecosystem is considered to be conserved.

In conclusion, the area has critical habitat because of the unique lake and the presence of endangered bird species. Critical habitat is at least one of the five criteria, and in this case it is clear that it meets the criteria. It is expected that there will be no significant conversion or degradation of critical habitat.



Source: <http://datazone.birdlife.org/site/factsheet/sesok-iba-indonesia#>

Figure 6-23 Important Bird Area surrounding Lake Sano Nggoang

Table 6-13 Types of Birds in Study Area

No	Local Name	Latin Name	Nama International	Conservation Status			WS-A	WS-B	WS-D	WS-E
				GoI	IUCN	Distribution				
1	Elang Bonelli***	<i>Aquila fasciata</i>	Bonelli's Eagle	Protected	Lc	East Africa, Middle East, South Asia, China, South East Asia, Nusa Tenggara, and Timor Leste				X
2	Cekakak Tunggir Putih**	<i>Caridonax fulgidus</i>	White-rumped Kingfisher	Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara	X	X	X	X
3	Bubut Alang-alang**	<i>Centropus bengalensis</i>	Lesser Coucal	Not Protected	Lc	Sumatra, Kalimantan, Jawa, Bali, Sulawesi, Maluku, Nusa Tenggara	X	X	X	
4	Kepodang Kuduk Hitam**	<i>Oriolus chinensis</i>	Black-naped Oriole	Not Protected	Lc	Sumatra, Kalimantan, Jawa, Bali, Sulawesi, Nusa Tenggara	X	X	X	X
5	Kehicap Ranting***	<i>Hypothymis azurea</i>	Black-naped Monarch	Not Protected	Lc	Sumatra, Kalimantan, Jawa, Bali, Sulawesi, Nusa Tenggara	X	X	X	X
6	Tiong Emas**	<i>Gracula Religiosa</i>	Common Hill Myna	Protected	Lc	Jawa – Lesser Sunda Islands (Sumbawa and Flores)	X	X	X	X
7	Cikukua Tanduk**	<i>Philemon buceroides</i>	Helmeted Friarbird	Not Protected	Lc		X		X	X
8	Celepuk Maluku**	<i>Otus magicus</i>	Moluccan scops owl	Not Protected	Lc	Maluccas, Nusa Tenggara	X			
9	Celepuk Wallacea**	<i>Otus silvicola</i>	Wallace's Scops-Owl.	Not Protected		Sumbawa and Flores	X			
10	Srigunting Wallacea***	<i>Dicrurus densus</i>	Wallacean Drongo	Not Protected	Lc	Sumbawa, Maluku, Nusa Tenggara	X	X	X	

No	Local Name	Latin Name	Nama International	Conservation Status			WS-A	WS-B	WS-D	WS-E
				GoI	IUCN	Distribution				
11	Burung Madu Matari***	<i>Nectarinia Solaris</i>	Flame-breasted Sunbird	Protected	Lc	Sumatra, Kalimantan, Jawa, Bali, Sulawesi, Nusa Tenggara		X		
12	Itik Gunung***	<i>Anas superciliosa</i>	Pacific black duck	Not Protected	Lc	Indonesia, Papua New Guinea, Australia, NZ				
13	Walik Kembang***	<i>Ptilinopus melanospilus</i>	Black-Naped Fruit Dove	Not Protected	Lc	Sulawesi, Maluku, Nusa Tenggara	X	X	X	X
14	Sikep Madu Asia*	<i>Pernis ptilorhynchus</i>	Oriental honey buzzard	-	Lc	Migrant - Siberia				
15	Kirik-kirok Australia*	<i>Merops ornatus</i>	Rainbow Bee-Eater	-	Lc	Migrant - Australia				
16	Tiong Lampu Biasa**	<i>Eurystomus orientalis</i>	Oriental Dollarbird	-	Lc	Wide geographic range – Native in several countries including Indonesia	X			
17	Itik Benjut*	<i>Anas gibberifrons</i>	Sunda teal	Nt	Lc	Sumatra, Kalimantan, Jawa, Bali, Sulawesi, Nusa Tenggara				
18	Tesia Timor***	<i>Tesia everetti</i>	Russet-capped Tesia	Not Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara Sumbawa, Flores	X	X	X	
19	Kipasan Flores*	<i>Rhipidura diluta</i>	Brown-capped Fantail	Not Protected	Lc	Lesser Sunda Islands (Sumbawa and Flores).				
20	Kacamata Wallacea***	<i>Zosterops Wallacey</i>	Yellow spectacle white-eye	Not Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara	X	X		
21	Paok la'us***	<i>Pitta elegans</i>	Elegans Pitta	Not Protected	Lc		X	X	X	X
22	Kacamata biasa***	<i>Zosterops palpebrosus</i>	Oriental white-eye	Not Protected	Lc		X			
23	Ayam hutan Hijau***	<i>Gallus Varius</i>	Green junglefowl	Not Protected	Lc		X	X	X	X

No	Local Name	Latin Name	Nama International	Conservation Status			WS-A	WS-B	WS-D	WS-E
				GoI	IUCN	Distribution				
24	Kancilan emas***	<i>Pachycephala pectoralis</i>	Rusty breasted Whistler	Not Protected	Lc		X	X	X	
25	Gagak Flores***	<i>Corvus Florensis</i>	Flores crow	Not Protected	Ed	Limited Distribution of Bird (BST) – Endemic to Flores	X	X	X	X
26	Pergam Hijau***	<i>Ducula aenea</i>	Green imperial pigeon	Not Protected	Lc		X	X	X	X
27	Kepudang sungu sumba***	<i>Coracina doherty</i>	Sumba cicadabird	Not Protected	Lc		X	X		
28	Gelatik batu kelabu***	<i>Parus Major</i>	Spotted Kestrel	Not Protected	Lc		X			
29	Elang ular jari pendek***	<i>Circaetus gallicus</i>	Short-toed snake-eagle	Not Protected	Lc		X			
31	Seriwang Asia***	<i>Tersiphone paradisi</i>	Tenggara paradise flycatcher	Not Protected	Lc		X	X	X	
32	Bondol taruk***	<i>Lonchura molucca</i>	Black face munia	Not Protected	Lc		X			X
33	Kangkok ranting***	<i>Cuculus saratus</i>	Oriental cuckoo	Not Protected	Lc		X		X	X
34	Raja udang merah api***	<i>Ceyxeritchaca sp</i>	Oriental dwarf-kingfisher	Not Protected	Lc		X			
35	Cekakak sungai***	<i>Todiramphus chloris</i>	Collared kingfisher	Not Protected	Lc		X			
36	Opor jambul***	<i>Lophozosterops dohertyi</i>	Crested white-eye	Not Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara	X			
37	Uncal buau***	<i>Macropigya emiliana</i>	Ruddy cuckoo dove	Not Protected	Lc			X	X	X
38	Caladi tilik***	<i>Dendrodopos moluccensis</i>	Sunda pigmy woodpecker	Not Protected	Lc			X	X	X
39	Perkici Flores***	<i>Trichoglossus weberi</i>	Flores Lorikeet	Not Protected	Lc			X	X	
40	Nuri pipi merah***	<i>Geoffroyus geoffroyi</i>	Red-chicked parrot	Not Protected	Lc			X	X	

No	Local Name	Latin Name	Nama International	Conservation Status			WS-A	WS-B	WS-D	WS-E
				GoI	IUCN	Distribution				
41	Sepah kerdil***	<i>Pericrocotus lansbergei</i>	Little minivet	Not Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara		X		
42	Anis Nusa Tenggara***	<i>Zoothera dohertyi</i>	Chesnut-backed Thrush	Not Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara		X	X	
43	Anis Kembang***	<i>Zoothera interpres</i>	Chesnut-capped thrush	Not Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara		X	X	
44	Perling kecil***	<i>Aplonis minor</i>	Short-tailed Starling	Not Protected	Lc			X		
45	Tikusan Seruling***	<i>Rallina fasciata</i>	Red-legged Crake	Not Protected	Lc			X		
46	Celepuk Flores***	<i>Otus alfredy</i>	Flores scops-owl	Not Protected	Ed	Limited Distribution of Bird (BST) – Endemic to Flores		X		
47	Punai flores***	<i>Treron floris</i>	Flores Green pigeon	Not Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara		X		
48	Pergam Punggung hitam***	<i>Ducula lacermulata</i>	Dark-backed imperial pigeon	Not Protected	Lc	Limited Distribution to Bird (BST) – Endemic of Nusa Tenggara		X	X	
49	Cabai emas***	<i>Dicaeum igniferum</i>	Golden-rumped Flowerpecker	Not Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara		X		
50	Cabai dahi hitam***	<i>Nectarinia solaris</i>	Black-fronted flowerpecker	Not Protected	Lc			X		
51	Burung-madu matari***	<i>Anthreptes malacensis</i>	Flame-breasted sunbird	Not Protected	Lc	Limited Distribution of Bird (BST) – Endemic to Nusa Tenggara		X	X	

No	Local Name	Latin Name	Nama International	Conservation Status			WS-A	WS-B	WS-D	WS-E
				GoI	IUCN	Distribution				
52	Burung madu kelapa***	<i>Streptopelia Chinensis tigrina</i>	Plain-throated sunbird	Not Protected	Lc			X		X
53	Tekukur biasa***	<i>Geopelia Striata</i>	Spotted dove	Not Protected	Lc				X	X
54	Perkutut Loreng***	<i>Hypothymys asurea</i>	Barret dove	Not Protected	Lc				X	X
55	Kehicap ranting***	<i>Chalcophaps indica</i>	Black-naped monarch	Not Protected	Lc				X	
56	Delimukan Zamrud***	<i>Dicaeum igniferum</i>	Emerald dove	Not Protected	Lc				X	

Source: Site Pbservation, 4-10 November 2016 and 22-28 November 2017

Notes:

*) interview; **) audible; ***) seen

RI = protected by GoI refer to GoI Regulation No. 7/1999 regarding Preservation of Plants and Animals.

IUCN: Lc = Least concern; Ed = Endangered; Nt = Near threatened; V= Vulnerable; Cr = Critically endangered; Cd = Conservation dependent; Insp = Invasive Alien species

6.3.3. Aquatic Biota

Plankton and benthos data was obtained via primary sampling undertaken as part of the environmental baseline studies in November 2016. Data collection was conducted in four different locations in the area of Lake Sano Nggoang. The sampling points can be seen on Figure 6-24.

6.3.3.1. Phytoplankton

The types of phytoplankton found in the sampling points include Bacillariophyceae (diatoms), Chlorophyceae (green algae), Cyanophyceae (cyanobacteria), Cryptophyceae (cryptophytes), and Dinophyceae (dinoflagellates) (Table 6-14). The highest abundance was observed at SW2 which reached 69,305,143 cells / m³. Diatoms were the phytoplankton type most commonly found, and the most common type found in freshwater. Details of the phytoplankton communities in the study area are shown in Figure 6-24.

Table 6-14 Phytoplankton Abundance in Study Area (Cell/m³)

Organism	SW1	SW2	SW3	SW4
CLASS: BACILLARIOPHYCEAE				
<i>Achnanthes sp.</i>	12,331	361	0	1,080,000
<i>Fragilaria sp.</i>	18,085	722	602	132,000
<i>Nitzschia sp.</i>	2,466	0	0	12,000
<i>Navicula sp.</i>	7,398	361	0	108,000
<i>Amphora sp.</i>	822	0	0	36,000
<i>Tabellaria sp.</i>	0	0	0	1,716,000
<i>Surirella sp.</i>	0	0	0	60,000
CLASS: CHLOROPHYCEAE				
<i>Ulothrix sp.</i>	2,543,439	186,947	195,789	16,080,000
<i>Pleurotaenium sp.</i>	0	2,165	0	24,000
<i>Coelastrum sp.</i>	0	0	0	0
CLASS: CYANOPHYCEAE				
<i>Spirulina sp.</i>	4,110	361	301	0
CLASS: CRYPTOPHYCEAE				
<i>Cryptomonas sp.</i>	0	69,112,782	49,873,684	0
CLASS: DINOPHYCEAE				
<i>Peridinium sp.</i>	5,754	1,444	301	0
Total Taxa	8	8	5	9
Abundance (cell/m³)	2,594,405	69,305,143	50,070,677	19,248,000
Diversity Index	0.13	0.02	0.03	0.63
Uniformity Index	0.06	0.01	0.02	0.29
Dominance Index	0.96	0.99	0.99	0.71

Source: Environmental Baseline Study, PT. SMI 2016

Location:

SW 1: Lake; SW 2: Lake Outlet; SW 3: Lake; SW 4: 50 m away from lake outlet

The phytoplankton is assessed using Ln by an enumeration method (census-SRC and strip-SRC). Based on the uniformity index and dominance, the condition of phytoplankton in all locations has nearly the same value, ranging from 0.01 to 0.29 for uniformity index and from 0.71 to 0.99 for dominance index. The distribution of individuals

among species is very uneven. A dominance index close to 1 indicates that there are species that dominate in a particular location.

6.3.3.2. Zooplankton

Zooplankton is at the second trophic level in aquatic ecosystems, and its existence depends on the presence of phytoplankton. Zooplankton serves as an intermediary for the process of energy transfer from primary producers (phytoplankton) to higher levels organisms in the food chain, such as fish. Zooplankton was found in the study area including Rotifer, Protozoa, crustaceans, Pelecypoda, Diptera, Nematodes and Polychaeta. More detail regarding zooplankton communities in the study area can be seen in Table 6-15.

Table 6-15 Zooplankton Abundance in Study Area (Cell/m³)

Organism	SW1	SW2	SW3	SW4
PHYLUM: ROTIFERA				
<i>Philodina sp.</i>	1.233	361	0	2.256
<i>Polyarthra sp.</i>	411	0	0	451
<i>Asplanchna sp.</i>	411	0	0	1.805
<i>Brachionus sp.</i>	411	180	0	5.865
<i>Notholca sp.</i>	0	0	301	26.617
<i>Lepadella sp.</i>	0	0	0	16.241
<i>Filinia sp.</i>	0	0	0	451
PHYLUM: PROTOZOA				
<i>Arcella sp.</i>	411	0	150	3.158
<i>Tintinnopsis sp.</i>	0	0	150	0
PHYLUM: CRUSTACEAE				
<i>Eudiaptomus sp.</i>	1.644	0	0	0
<i>Nauplius (stadia)</i>	0	180	301	902
PHYLUM: PELECYPODA				
Larva Pelecypoda (sp1)	0	0	150	902
GASTROPODA				
Larva Gastropoda (sp1)	0	180	301	0
DIPTERA				
Larva Chironomid (sp1)	5.754	1.805	902	0
PHYLUM: NEMATODA				
Larva Nematoda (sp1)	4.521	1.083	2.556	5.414
PHYLUM: POLYCHAETA				
Larva Polychaeta (sp1)	411	1.083	451	451
Total Taxa	9	7	9	12
Abundance (cell/m³)	15.207	4.872	5.262	64.513
Diversity Index	1,66	1,59	1,66	1,73
Uniformity Index	0,76	0,82	0,75	0,69
Dominance Index	0,25	0,25	0,28	0,25

Source: Environmental Baseline Study, PT. SMI 2016

Location:

SW 1: Lake; SW 2: Lake Outlet; SW 3: Lake; SW 4: 50 m away from lake outlet

Based on the laboratory analysis results using an enumeration method (census-SRC) and the calculation using Ln, the number of zooplankton taxa were found at each point of observation ranging between 7-12 taxa. Most taxa

were found on SW4 (Lake Sano Nggoang, 50 m from the lake outlet). The highest abundance was in SW4, reaching 64,513 individual/m³.

6.3.3.3. Benthos

Macrobenthic organisms were only found in the benthic sample taken at SW3; these were all *Potamon* sp., a type of freshwater crab, and they were found at a density of 21 individuals per m² (PT SMI, 2016). No microbenthic species were found in the samples taken at locations SW 1, SW 2 and SW 4. As a result, the dominance index for the site was 1, indicating complete dominance by a single species.

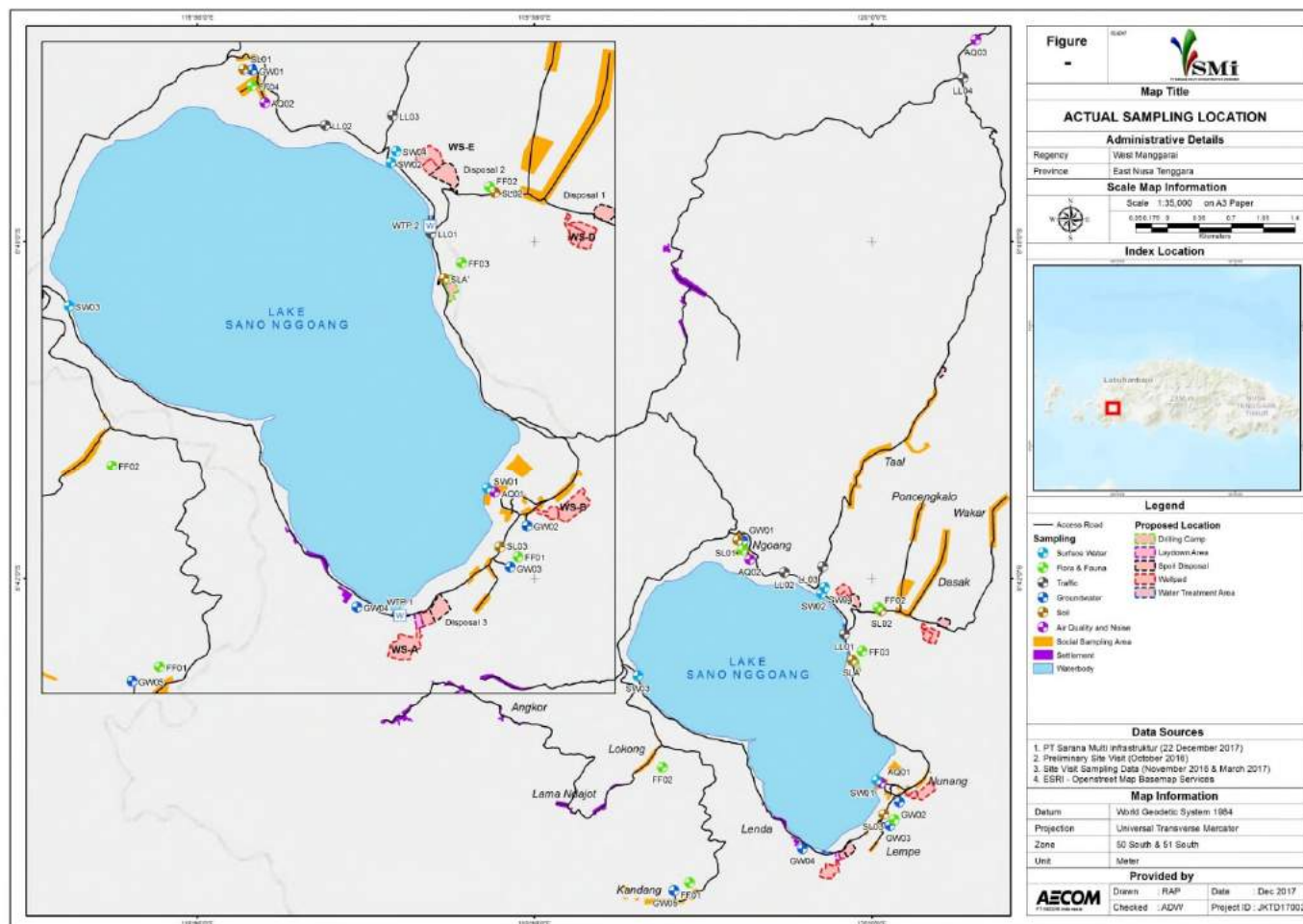


Figure 6-24 Sampling Location Map

6.4. Social, Economic, and Cultural

The social, economic, and cultural component of the baseline study addresses factors such as the demography, economic status and cultural resources of the local community within the study area as refer to Figure 6-1. In particular, these factors will be considered for Wae Sano, Sano Nggoang, and Pulau Nuncung Villages in Sano Nggoang Sub-district, West Manggarai Regency in relation with the potential interaction with the Project, see Figure 6-25.

The project site of Wae Sano geothermal is located in Sano Nggoang Sub-district. The actual well-pads will be located in Wae Sano and Sano Nggoang Village. Pulau Nuncung Village is the nearest village (located at the west part of Lake Sano Nggoang) to the the geothermal site which will not contain a well-pad. This village is included in the scope of study area due to the potential for indirect impacts from geothermal exploration activity in this area, such as air quality impact due to mobilization and construction of well pad and supporting facilities as well as the requirement of local labor during construction and operation phases.

The data used for this portion of the baseline study includes both secondary sources such as government census data, as well as household surveys with residents in Wae Sano, Sano Nggoang and Pulau Nuncung villages. A total of 96 household representatives were interviewed, comprising 88 male and 8 female respondents, male respondent interviewed more than female respondents as most of men as head of household / family. For men, the age of the respondents ranged from 26-84 years old, and for women it ranged from 35-55 years old. These respondents lived at Nunang, Lempe, Ta'al, Dasak, and Wakar sub-villages (*Dusun*) in Wae Sano village; Nggoang, Golo Mburing, Cowang Anak, and Bokak Rangka Sub-villages (*Dusun*) in Sano Nggoang village; and Lokong and Kandang sub-village (*Dusun*) in Pulau Nuncung village. Further details are provided in Table 6-16.

Table 6-16 Total Respondents according to Sample Location

Location	Total Respondents (Head of Family)
Wae Sano Village	46
Sano Nggoang Village	22
Pulau Nuncung Village	28
Total	96

The following sections will summarise particular info relevant to interaction with the Project activities and potential impacts, while more information on community baseline profile is attached to this report in the **Appendix I**.

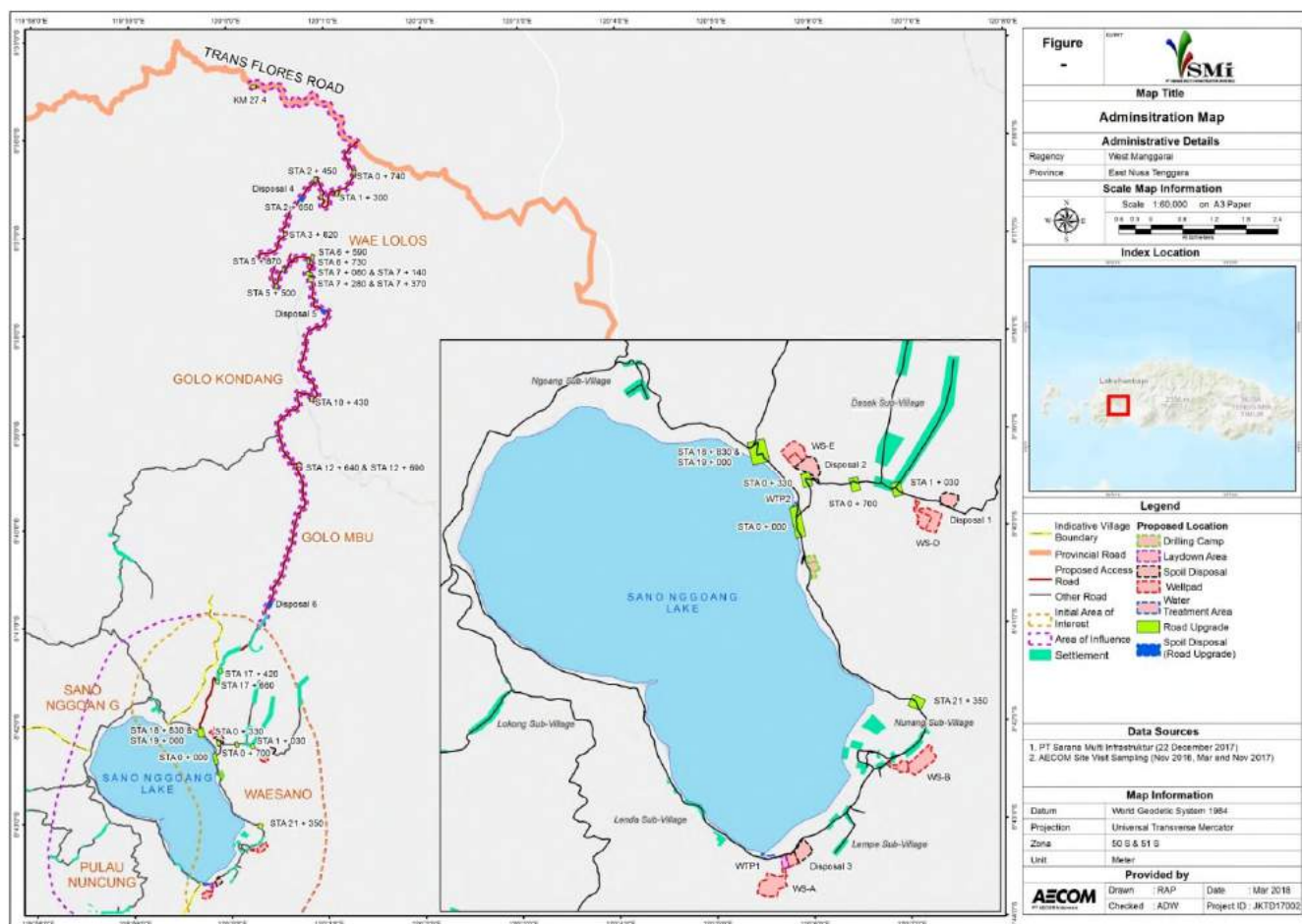


Figure 6-25 Administrative Map of Sano Nggoang Sub-District

6.4.1. Demography

Demography data is used as the information to observe human resources condition in the location surrounding project area. It can be utilized as the reference for workforce needs of Wae Sano geothermal exploration activity and information to predict the total population affected by the geothermal exploration in this area.

6.4.1.1. Population

Total population in West Manggarai Regency is about 257,582 people with up to 2.34% population growth rate in 2015-2016. This is an increase of 0.05% from the previous year. Similar population growth rate was also recorded in Sano Nggoang Sub-district about 1%. The growth rate in both areas is relatively insignificant; this indicates minimal changes in the population or less exposure toward large number of in-migration.

At the village level, it was identified from consultation during the ESIA study that there are not many in-migrations occurred in Wae Sano, Sano Nggoang and Pulau Nuncung villages. In the meantime, it was reported that young-adult men in the regency are usually moving to cities to seek for job opportunities. This has resulted to low population growth of those villages. The total population of the three villages in 2016 was 2,904 people, this was only 1.12% of the West Manggarai Regency population.

At sub-district level, the population density in Sano Nggoang Sub-district in 2016 was recorded about 59 people per km². From the total population of approximately 14,368 people, the population of Wae Sano Village accounted for some 8.38% of the population in Sano Nggoang Sub-district, with the similar population density as its sub-district, namely 60 people per km². However, both are less populated than the West Manggarai regency in general, while Sano Nggoang and Pulau Nuncung Village are even less dense areas.

The interaction between population density and environmental quality seen in case of a rising population density will lead to environmental change, such as climate change and land-use change (Hunter, 2000). Referring to the standard of environmental quality scale (*Decree of Ministry of Environment No. 2 of 1988*), population density in Sano Nggoang Sub-district is under 5,000 people per km² with score 5, which places it in the "Very Good" category. Therefore, it can be inferred that the population carrying capacity within the study area is still in accordance with the applicable standard of environmental quality¹⁷.

6.4.1.2. Workforce

The method of workforce count in Indonesia as stipulated by the law number 13 of 2003¹⁸ aligns with the international standard (i.e. ILO), that is 15-64 years old. The Regency statistic data (2016) identified there were 153,492 people in the productive age category who lived in West Manggarai Regency; approximately 109,577 among the number was categorised as workforce, while 43,915 people was non-workforce population (such as school children and non-working mother).

The Workforce Participation Rate (WPR) of West Manggarai Regency in 2016 was 71.38%. This number is similar to the previous year, which was 71.39%. Meanwhile the Open Unemployment Rate (OUR) was 2.36% of total workforce and it is similar to previous year. This number is relatively low, especially with quite high rate of work opportunity, which was about 97.64%. This may indicate low job demand toward the Project from workforce at the regency level.

It was identified from Sano Nggoang Sub-district in Figure (2016), the total workforce in Sano Nggoang Sub-district, Wae Sano Village, Sano Nggoang Village, and Pulau Nuncung Village were 9,075 people, 742 people, 719 people, and 376 people, respectively. Meanwhile the unemployed number were 2,165 people in Sano Nggoang Sub-district, 390 people in Wae Sano village, 233 people in Sano Nggoang Village and 54 people in Pulau Nuncung

¹⁷ The score of criteria and range of city population density, which refers to the standard of environmental quality from Decree of Ministry of Environment No. 2 of 1988 is as follows: Score 1 = very bad population density (>20,000 people per km²); Score 2 = bad population density (15,000 – 20,000 people per km²); Score 3 = moderate population density (10,000 – 14,999 people per km²); Score 4 = good population density (5,000 – 9,999 people per km²); and Score 5 = very good population density (<5,000 people per km²)

¹⁸ <https://www.ilo.org/dyn/natlex/docs/ELECTRONIC/64764/71554/F1102622842/IDN64764.pdf>

Village. These provide initial indication on potential job opportunity demand toward the Project from the Sub-district and villages.

6.4.1.3. Education

Community indicators of quality and well-being in a given area can be observed from community participation in education which is shown by the magnitude of School Participation Rate (SPR) in the school-age population category. The increase of school participation illustrates the achievement in education sector, especially relating to the expansion of education facilities.

Based on 2017 Statistical Data of West Manggarai Regency, SPR of female is generally higher for all age category compare to the male population in the same age range. Average SPR of the regency was over 50%.

One of the barriers in education aspect is the lack of outreach and access of education services, especially for underprivileged community or residents living in the rural and remote areas. This generates the low rate of school participation. This issue was identified in the three villages within the study area. As there are only 3 senior high schools in Sano Nggoang Sub-district and none in Wae Sano Village, Sano Nggoang Village and Pulau Nuncung Village, young people who want to continue to Senior High School or equivalent must leave their villages.

The average education level of community working in study area is Elementary School graduated. Only very small number has Diploma IV or Bachelor degree in 2015 (i.e. approximately 3% of the population of the three villages). This number would be useful for the Project to understand the general overview of the potential job seeker's education level in the three villages.

6.4.1.4. Community Welfare

In 2016, West Manggarai Regency was 15th of 22 regencies in East Nusa Tenggara Province with respect to the Human Development Index (HDI) with a score of 60.63. This consists of life expectancy of 66.19, school life expectancy of 10.67, average school life expectancy 6.82 and capita income of IDR 7,149,000 per year (Central Bureau of Statistics of East Nusa Tenggara Province, 2017).

6.4.2. Socio-Economy

6.4.2.1. Regional Economic

The highest proportion of income for West Manggarai Regency in 2016 was produced by agricultural, forestry, and fishery sector (42.63%), followed by agriculture, forestry, and fishery sectors (42.12%), followed by government administration, defense, and compulsory social insurance (12.78%); construction sector (12.31%); while others were under 10%. There were no major shifts in economic structure noted with regard to industry sector between 2012 and 2016. The rate of economic growth was slightly increased from 34.45% in 2015 to 4.76% in 2016. The highest growth came from the accommodation and food and beverage services sector at 5.96% and the lowest growth occurred in the water supply, waste management and recycling services sector at 2.28%. The agricultural, forestry, and fishery sector which is the backbone of the economy in West Manggarai Regency only grew 0.23% (remained constant).

6.4.2.2. Livelihood

Most of people in West Manggarai Regency work in the agricultural sector (73.40%), then followed by the services sector with 9.26%; trading, hotel, and restaurant for about 4.93%; transportation and communication sector for 4.22% and manufacturing industry sector 4.08% (Central Bureau of Statistics of West Manggarai Regency, 2017).

In Sano Nggoang Sub-district, communities also depend on farming for their livelihood, including in Wae Sano, Sano Nggoang, and Pulau Nuncung Villages, where the majority of community works as farmer (92.98%), as presented in the Sano Nggoang Sub-district in Figure (2016) data.

This is also identified from the ESIA survey, majority of the interviewed households in Wae Sano, Sano Nggoang, and Pulau Nuncung Village are working as farmer for their primary livelihood. Only some of them were working in

service and private sector, as well as entrepreneurship. In addition to their primary job, some community members in the study area also have a secondary income source. This strategy was taken to be able to meet the household needs if they just depend on the main livelihood. It was identified from the ESIA survey that the secondary activity done by the community in study area is usually still in the same sector as the main activity, as it probably the only skills that the household has.

These information could be used by the Project to understand the available job skills in the community within the Project affected area, which are mostly in agricultural works. Only a small percentage of community that has been familiar with industrial skills. In the other side these show community dependency toward agricultural land, in which the Project might acquire for its development.

The interview results found that the Wae Sano people have experienced major changes in their livelihoods in recent history. During the 1970s and 1980s, government policies changed their settlement and living arrangement system and centralized the expanses of rural settlements into kampong and villages. Previously they lived in a dispersed location within small clusters of settlement units on the basis of joint field management. The village administration forced the locals to move into villages and kampongs as they are today (Wae Sano, Sano Nggoang, and Pulau Nuncung Villages).

This change is followed by modifications in their livelihood patterns where gardening or subsistence farming are grouped and converted to long-term plantations, namely coconut and candlenut. They cultivated these crops in several areas in Sano Nggoang which used to be a savanna changed it to forest and plantation. For example, the Taal kampong was once a grassland area. Gradually they also abandoned their subsistence system and began growing produce for the market, which is prone to market rises and drops in crop value. Under such conditions the Wae Sano community is particularly vulnerable to market influence. They no longer have independence in the market. When previously the communities fulfilled their subsistence by cultivating the land, now their subsistence is based on the income generated by the sales of the candlenut crop or other plantation resources or by selling livestock.

These livelihood changes altered the direction of their land management, from being communal land to individual ownership. *Adat* and customs are still being used as guidance, but the current land ownership system has affected communal bonding by reducing close relationships built by owning land together.

Further livelihood information specific on the land acquisition affected people could not be gathered during the development of this ESIA due to lack of Project Description detail locations, however general baseline informations on each of the community livelihood that could be affected by the Project in the three villages where the Project will be developed are presented in the following sub sections.

6.4.2.3. Agriculture

As presented by Figure 6-15 regarding land cover map, some of West Manggarai area is covered by farm land and crop land. The total area of paddy field in West Manggarai Regency in 2016 was about 36,361 ha, with productivity of a wet paddy at 5.79 ton/ha and dry paddy at 1.46 ton/ha. Sano Nggoang Sub-district has high output in the agricultural sector that contributes to West Manggarai Regency. Overall crop production is 12,597 tonnes produced from 3,170 ha of total plantation area in 2016. These are also observed within the surrounding of the Project area; some of the proposed well pad areas are also located within the crop field or plantation land.

In general, types of tree planted by the farmers in both Manggarai Regency and Sano Nggoang Sub-district area are traditional plants, such as candlenut, cashew, coffee, and clove. The largest farm plantation commodities in 2016 were coffee, candlenut and cocoa. In Sano Nggoang, 2016 with 285.83 tonnes, this number was decreased compared to production in 2015 with 345.05 tonnes.

Candlenut was also becomes the superior commodity in villages located at the plateau within the surrounding of the Project area, such as Sano Nggoang and Wae Sano Village (Figure 6-26). According to the history, the head of Sano Nggoang Village brought the first seed of candlenut plant in 1969. First plantation happened in 1980 and the plant bears routinely every year. Community will sell the candlenut to the collectors who come to the villages. Then, commodity will be brought to Ruteng before sent to Surabaya. For the local community in the potentially

affected villages, candlenut become one of the source of income for some households. Although mostly use the commodity for household consumption need. Some use it for household consumption need (Figure 6-27).



Source: Baseline Study PT. SMI, 2016

Figure 6-26 Candlenut Grow in Surrounding Lake Sano Nggoang in Mbeiling Forest Area



Source: Baseline Study PT. SMI, 2016

Figure 6-27 A Woman Drying Candlenut Crops Traditionally

The community activity in farming is supported by the landscape surrounding the settlements in Lake Sano Nggoang, Wae Sano and Sano Nggoang Village with the presence of community's dry paddy field. Generally, besides candlenut, the communities also plant coconut trees, enau, vegetables, fruits, and seasonal plant, such as banana, cassava, pineapple, and others. Land surrounding Lake Sano Nggoang is very fertile; so many different plant species can grow well in this area (Figure 6-28). Agricultural also has cultural value for community. They use some traditional system called *lodok* to open and manage the land ownership between family member. A *Lodok* areas are opened together with other extended family members and the result will be equally distributed into several parts by drawing radial lines starting from the middle to the outside of area. The division line forms a pattern which looks like a spider web, the typical of this land tenure division in Flores is shown in Figure 6-29.

Community dependence and value toward agricultural land and activities indicate potential high sensitivity of land for the potentially affected people; these should be considered by the Project in acquiring land, particularly when it affects agricultural land.



Source: Baseline Study PT. SMI, 2016

Figure 6-28 Vegetation Surrounding Lake Sano Nggoang



Source: (www.liputan6.com, 2016)

Figure 6-29 Typical of Land Tenure (*Lingko*) in Flores, East Nusa Tenggara

6.4.2.4. Animal Farming

Animal farming was recorded as one of the important household commodity, both for income and family consumption. In Sano Nggoang Sub-district, most of the domesticated animals are buffaloes and pigs, as presented in the Sub-district in Figure Statistic data (Central Bureau of Statistics of West Manggarai Regency, 2017). These were as also found in Wae Sano, Sano Nggoang and Pulau Nuncung Village that were surveyed during the ESIA study.

6.4.2.5. Forestry

The large of forest area in West Manggarai in 2017 was 275,489.60 Ha; most i.e. about 45% is marine national park while almost 20% is national park. The large of forestry area based on its status within the the Project area (i.e. the Project Area of Interest and Area of Influence), is shown in the following table and Figure 3-3.

Table 6-17 Forest Large Area Based on the Forestry Status

No.	Forest Status	Area of Interest		Area of Influence	
		Large Area (Ha)	Percentage (%)	Large Area (Ha)	Percentage (%)
1	Lake	216.4	14	508.1	20
2	Protected forest	48.8	3	63.3	2
3	APL (designated for other uses)	1,265.8	83	1,993.9	78
Total		1,531.1	100	2,565.3	100

Source: Baseline Study PT. SMI, 2017

Within the Project area, the main forest is Blok Sesok forest which is located surrounds Lake Sano Nggoang (Figure 6-20). Based on profile data of Wae Sano Village (Wae Sano Village, 2014), the forest area in Wae Sano Village is 20,000 hectares, which consists of 19,000 hectares of state-owned forests, 918 hectares of community and customary forests (*hutan rakyat* and *hutan adat*), 30 hectares of sectoral institutions owned forest/agroforestry and 1,052 hectares of individual property. From the total area of 19,000 hectares of state-owned forests, about 18,000 hectares has status as protected forests¹⁹. Meanwhile, Pulau Nuncung Village has a total forest area of 250 hectares, consists of 50 hectares protected forest, 100 hectares of community forest (*hutan rakyat*)²⁰, 50 hectares of customary forest (*hutan adat*)²¹ and 50 hectares of natural forest²² (*hutan alami*) (Pulau Nuncung Village, 2014).

Unfortunately no map was provided in the Village Profile data to show the exact location of each of these different types of forest in the three villages. However the ESIA study identified that the forest is utilised by community for coffee and candlenut plantation.

6.4.2.6. Industry

In 2016, the number of small industries and home industries in West Manggarai Regency had increased, although the total number is still relatively small. This also affected the labor requirements. There is an increase in the number of workers including 10 people for small enterprises and 360 people in the home industries (Central Bureau of Statistics of West Manggarai Regency, 2017).

Most industrial enterprises located in West Manggarai Regency are agriculture and forestry industry. In the three villages there were a number of small businesses have existed and grown in the last few years, along with the growth of tourism.

Government of Wae Sano has implemented economic enhancement program for household by forming several business groups in 2010. These business groups are formed by considering business potential which can be developed in Wae Sano Village, based on great potential on natural resources and tourism e.g. with the existence of Lake Sano Nggoang. They are including travel agent, home stay, crafting, local food processing, fish farming, and beverage shop. These information could be useful for the Project to acknowledge for potential business partnership in relation with its provision of goods and services. Some of these growing industries are described as follow.

¹⁹ Protected forest is defined as forest areas which primarily function to protect life-support system by managing waterworks, preventing flood, controlling erosion, preventing seawater intrusion, and maintaining soil fertility.

²⁰ Community forest (*hutan rakyat*) is right forest area which is subjected to property rights according to GOI law No. 41/1999.

²¹ Customary forest (*hutan adat*) is defined as state forest areas located within the local customary law, has strong cultural values for local community, and is usually managed communally for the community interest according to GOI law No. 41/1999.

²² Natural forest (*hutan asli*) is defined as primary forest, untouched by human activities..

a. Palm Tree. Community use palm tree to produce sugar sap as well as use its fibers as additional roof material for housing (seen in Figure 6-30).



Source: PT. SMI Baseline Study, 2016

Figure 6-30 Utilization of Ijuk from Palm Tree for Roof Material

b. Betel Leaves. Eating betel leaf (seen in Figure 6-31) is generally one of community habits in East Nusa Tenggara. The betel from Wae Sano and Sano Nggoang Village is well-known with its quality and ordered by the community from other areas. Usually, betel is sold on the market day at Werang Village, the capital of Sano Nggoang Sub-district. The betel is sold in bunches of 15 trunks, each bunch costing 1000 rupiahs. This bunch then tied in bundles of 15 bunches and each bundle costing 20,000 rupiahs (USD 1.50).



Source: PT. SMI Baseline Study, 2016

Figure 6-31 Many Betel Plants are Planted at Garden or Yard in Wae Sano Village

c. Pandan Leaves. Many people in Wae Sano Village use pandan leaves to be wattled and made into several crafts, such as *kopiah*, a typical hat worn by Manggarai men to attend formal meetings. Pandan leaves are also mainly used to make a mat (seen in Figure 6-32). Depending on the quality of the weave, *Kopiah*/hat prices range from 25,000 - 150,000 rupiahs (USD 1.88-11.28).



Source: PT. SMI Baseline Study, 2016

Figure 6-32 Community Weaving Pandan Leaves

d. Ikat Fabric (*Songke*). Ikat fabric produced by the handcrafter in Wae Sano Village is well-known as *Songke*. In general, this fabric is produced by using Manggarai design, so that it is called by *Songke Manggarai* (see in Figure 6-33). *Songke* is usually used for the guest-welcoming ceremony at Wae Sano Village, Sano Nggoang Sub-district. Usually, *Songke* in the form of scarf is laid around guest's neck as the welcoming sign.

Generally, women of Flores produce wide weaving scarf to be used as a blanket for man and sarong for women. *Songke* of Manggarai is longer than general weaving sarong – 2 meters. Other than used as sarong which can be wound around the waist, women can use *songke* as *kemben*. In addition, head of *Songke* can be used in marriage customary and for covering the corpse. *Songke* fabric can be obtained directly from the handcrafter in Wae Sano Village or on the market day at Werang Village. The price of *Songke* is in the range of 30,000 – 100,000 rupiahs (USD 2.26) for scarf and 200,000 – 500,000 rupiahs (USD 15.03-37.59) for sarong. *Songke* also can be found at souvenir shops in Labuan Bajo.



Source: PT. SMI Baseline Study, 2016

Figure 6-33 *Gedogan* Weaving Tools and Several Pattern of *Songke* from Manggarai and Variation of Products (sarong, scarf, and cap)

e. Bamboo. Many communities plant bamboo in their farms and usually use it for house wall. Many houses in Wae Sano Village and Sano Nggoang Village use bamboo for its house walls (Figure 6-34).

f. Homestay

There are many homestay in Wae Sano Village which are managed by the local people in a group, church, or individually. Total homestay group in Wae Sano Village are approximately 15. The cost for staying in homestay ranges from 100,000 – 350,000 rupiahs (USD 7.52-26.31) per person per night.



Source: PT. SMI Baseline Study, 2016

Figure 6-34 Bamboo Trees Planted by Community and Used For House Wall

6.4.2.7. Others Potential Natural Resources

In the study area there are few potential resources that have the potential to be utilized by the Project for construction activities. Based on data from the Sano Nggoang Sub-district, the main potential quarrying material is sand and stone. In Wae Sano Village, the greatest quarry potential is ground rock located in the Dusun Ta'al. Based on information from the Head of Wae Sano Village, the potential construction material available the village includes brick in Dusun Nunang and Dusun Ta'al (owned by individuals), rock and sand materials in the Dusun Nunang (owned by individuals), and sand and stones in Dusun Ta'al belong to communal. Similarly, sand and stones could also be found in Sano Nggoang Village (owned by individuals). Unfortunately based on the Sub-district in Figure data (2016), most of these quarries did not have permit yet; the only quarry with permit is located in Golo Leleng Village in Wae Sapo and Wae Longge managed by PT Floresco under Class C mining licence.

6.4.2.8. Ecotourism

Tourism potential in Wae Sano²³ can be developed to boost the local economy in the study area especially ecotourism, including the following natural resources areas. Based on the interview result, the tourists came for recreation, enjoying the Lake Sano Nggoang scenery, bird watching, tracking to the peak of the mountain and enjoying the experience of living in a non-tourist location such as resident's home (homestay) and living a life as a village people. The location and significance of these tourism areas for the community should be considered when planning the Project development, as some of them are in the proximity of the Project facilities location (see Figure 6-35).

Concerning to the potential ecotourism and bird conservation, Birdlife Indonesia or Yayasan Burung Indonesia engaged people of Nunang Sub-village to build their capacity for receiving tourist in their village. Yayasan Burung Indonesia initiated two programs including technical assistance for preparing homestay and English Course. About 12 households were involved in homestay development and at least 10 villagers attended English Course. According to Yayasan Burung Indonesia, the number of tourist visits to Wae Sano Village in 2014 (271 tourists) significantly increased compare to 2012 (85 tourists) and 2013 (76 tourists). Their living duration is only 1-2 days only. However, those numbers are less compared to tourist visits to village near Mbeliling Nature Reserve, Liang Nda. The number of tourist visits to Liang Da in 2014 (800 tourists) was also significantly increased compare to 2012 (244 tourists) and 2013 (400 tourists).

²³ Wae Sano region (meaning in Manggarai language: water lake) covers an area around Lake Sano Nggoang (meaning in Manggarai language: smoldering or boiling lake), which consists of three villages: Wae Sano, Sano Nggoang and Pulau Nuncung

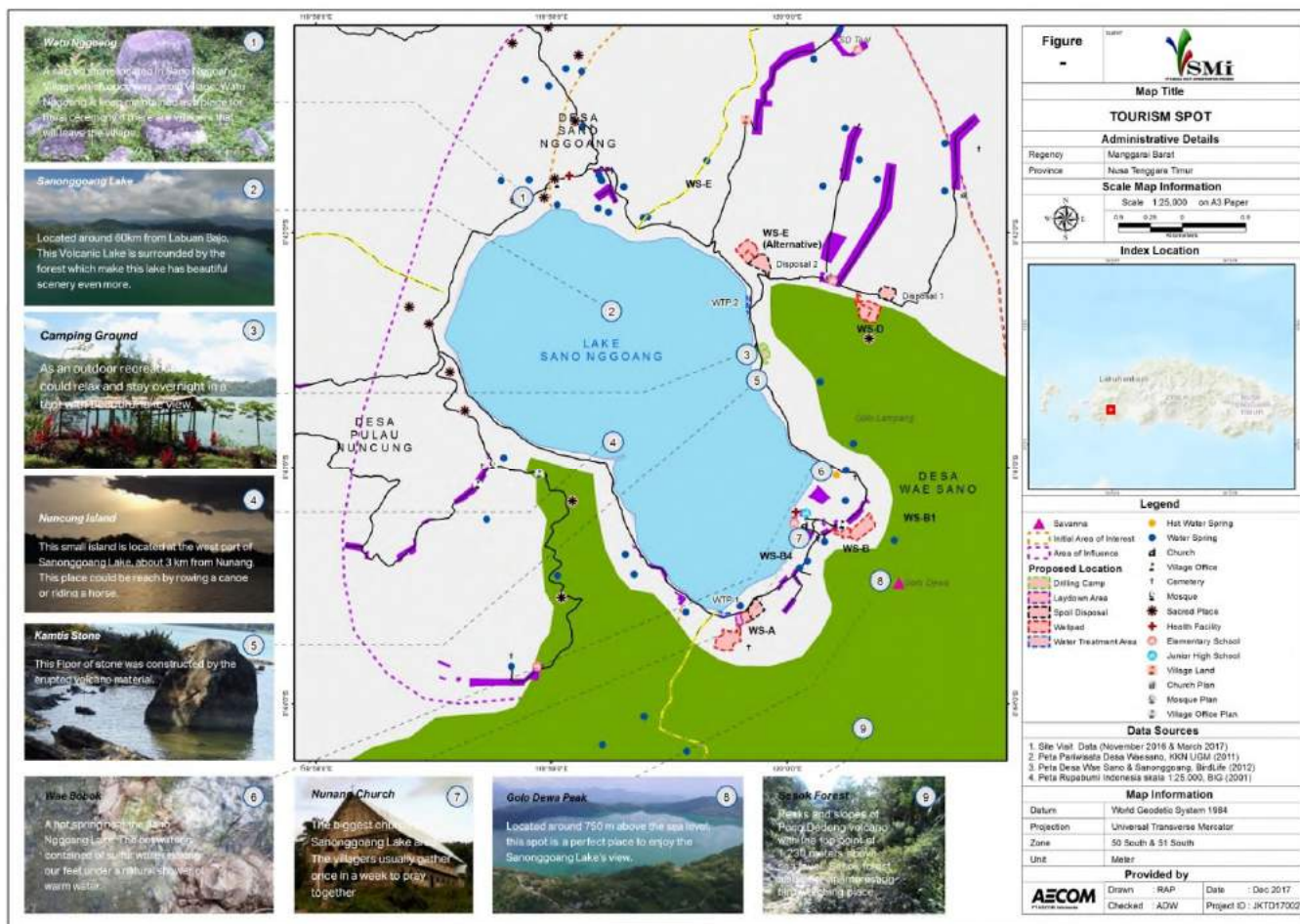


Figure 6-35 Tourism Locations within the Area Surrounding the Project

a. Lake Sano Nggoang²⁴. This lake is the largest lake in East Nusa Tenggara and has an interesting ecotourism potential (Figure 6-36). The lake is the biggest volcanic lake in Eastern Indonesia and the water is clear green. It is located on Wae Sano volcano with an area of 513 hectares and perimeter of 7.8 km and a depth of 600 meters, which is located at an altitude of 750 m above the sea level. Lake Sano Nggoang located at Wae Sano village, Sano Nggoang Sub-district, West Manggarai Regency.

This volcanic lake is situated in the southeast of Mbeliling Forest area and Sesok Forest Block. Mbeliling Forest itself plays an important role as a store and source of water for the surrounding areas including Labuan Bajo.

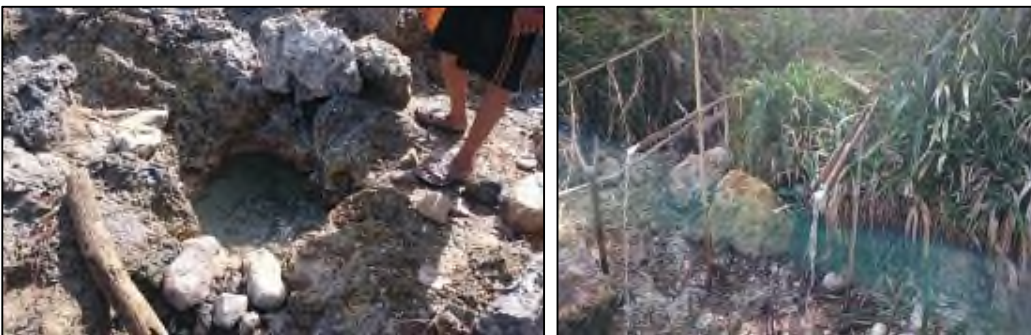


Source: PT. SMI Baseline Study, 2016

Figure 6-36 Lake Sano Nggoang

b. Sesok Forest. It located in the upper Nunang sub-village, peaks and slopes of Poco Dedeng volcano with the top point of 1,230 meters above sea level. Sesok forest also offer an interesting bird watching place with combination between water birds species come to Lake Sano Nggoang and other species of birds inhabit in the forest surrounding the lake. This forest is dominated by semi-preserved green tropical forest vegetation green.

c. Wae Bobok. It is a hot springs which located about 10 meters near Sano Nggoang. It used by the community in Wae Sano village for a daily bath. The tourists are also use the warm water for bathing. Its condition is still natural and has not been developed yet (Figure 6-37).



Source: Baseline Study PT. SMI, 2016

Figure 6-37 Wae Bobok, Source of Hot Water near Lake Sano Nggoang

d. Golo Dewa Peak. For cultural and religious tourism, tourist can visit a complex of old village on Golo Mblecek hills. This village is the village ancestor of Nunang community that supposedly originated from the Minangkabau and partly of the Bima Kingdom. In addition, there is an old church on the banks of the lake which is the center of the first Catholic religion spread in the Wae Sano village and surroundings.

²⁴ Lake's coordinate: 809'- 8036'S, 122045-122051'E

e. Pulau Nuncung Village. This village is located at the west part of Lake Sano Nggoang, about 3 km or 45 minutes by walk from Nunang sub-village.

f. Kamtis Stone, from the erupted volcano material.

g. Other local attractions in the three affected villages have cultural and religious value for communities, including Nunang Church and Watu Nggoang (see Section 6.4.3.4 for more details).

Table 6-18 Tourism Destination in Sano Nggoang District

No.	Tourism Object	Location	Distance from District Capital (Werang) (Km)	Distance from Labuan Bajo (Km)	Type of Tourism Object	Road Condition toward the Tourism Object
1	Lake Sano Nggoang	Nunang sub-village, Wae Sano village	13	65	1. a 100° C hot water 2. Medium hot water 3. area of 16 km 4. Tracking 5. Bird watching	Asphalt road
2	Cunca Rami/Waterfall	Pinggong, Golo Ndaring village	2	50	Waterfall with a height of about 250 meters	Asphalt road
3	Cunca Lolos/ Waterfall	Tembel, Wae Lolos village	5	50	Waterfall with a height of about 150 meters	Ground path about 750 meters
4	Wae Bobok/ Overflowing water	Pereng, Golo Mbu village	1	55	Water overflowing above the mountain peaks as high as about 7 m and the surrounding area is paddy fields	Asphalt road
5	Cunca Wae Tahu/ Waterfall	Wae Munting, Nampar Macing village	10	100	Waterfall with a height of about 250 meters	Ground path about 750 meters
6	Burung Dewa Sano/Endemic Bird	Paku, Golo Manting village	10	65	Bird species that only found in the Mbeliling forest	Asphalt road
7	Cunca Murung/ Waterfall	Rami Rii, Poco Golo Kempo village	15	50	Waterfall with a height of about 150 meters	Ground path about 1 km
8	Watu Nggoang/Lighted Stone	Nggoang, Sano Nggoang village	13	65	In the years before 1970 this stone is lit up at night.	Asphalt road
9	Watu Panggal	Daleng, Watu Panggal village	13	50		Asphalt road

Source: (Kecamatan Sano Nggoang, 2016)

Note: *) the nearest to project site of Waesano Geothermal Exploration

Tourism Infrastructure

Wae Sano village infrastructure for tourism is more developed than Sano Nggoang. Nunang Sub-village in Wae Sano is the centre of all Lake Sano Nggoang tourism activities. In this sub-village, tourists can get a homestay, food and drink and a tour guide²⁵. Currently there are 12 homestays²⁶ owned by both individual and community group in Nunang and three in Lempe Sub-village as the accommodation facilities. The most challenge for tourist development in the village is related to the electricity infrastructure; the houses that provide room for homestay use solar cell or generator for lighting at night. The village also has tourism business group covering homestay, processed food and drink, tracking, studio, woven handicrafts, poultry, bamboo crafts, fresh water fish, brown sugar processing, cashew nuts, medicinal plants, palm oil processing and clay handicrafts groups. Meanwhile, the development of ecotourism in Sano Nggoang Village is still limited; no homestay is available in the village, therefore no tourist stays in the village and none of the Sano Nggoang Village people work as a tour guide. Tourists usually just pass through this village as part of the trip walking around the lake.

A Village Ecotourism Institution has been established in Wae Sano Village to accommodate the interest and need of Wae Sano Village citizens to develop an integrated ecotourism. This establishment was facilitated by Burung Indonesia, a non-government organization which is active in arranging various activities in Wae Sano area and its surroundings. The institution has been cooperating with the Wae Sano Village government in managing ecotourism of Lake Sano Nggoang with profit sharing system, where 30% of revenues will be incorporated into the village treasury, 30% to institution treasury and 40% for conservation.

Based on interviews with the Culture and Tourism Agency of West Manggarai Regency in 2017, the program of increasing tourism in 2017-2018 in Wae Sano Village includes access road development along the 2 km to the Savana (location of bird ecotourism) near Lake Sano Nggoang. The land status for the access road during the ESIA study is still in the land acquisition phase.

In 2018, tourism development in Wae Sano Village had not become the main focus / program of West Manggarai Regency government; this is because approximately 90% of funds from the Culture and Tourism Agency will be focused on improving Batu Licin tourism in Labuan Bajo.

6.4.2.9. Public Amenities

The road condition in the study area in Wae Sano and Sano Nggoang Villages is already paved, so that it can facilitate the accessibility of the public to get to / from the villages. Only Pulau Nuncung Village has an unpaved road. To meet the daily needs of the community, the government of Sano Nggoang Sub-district provides a weekly market that operates on certain days every week. For example in Werang Village ($\pm 5-6$ km from study area) there is the Werang Inpres Market which operates every Saturday. In other villages the markets operate every Monday, Thursday and Tuesday.

Based on BPS data, in 2016 economic institutions in Sano Nggoang Sub-district includes 1 village unit cooperative (KUD) with 20 members, 5 savings and credits cooperatives (KSP) with a total of 432 members, 1 multipurpose cooperative (KSU) with 31 members, 1 farmer cooperative with 63 members, and 2 combined farmer group (GAPOKTAN) with a total membership of 344 people (Central Bureau of Statistics of Sano Nggoang Sub-district, 2017). Most respondents surveyed in 2016 illustrate that all these economic institutions are still active and helpful to the community when experiencing cash difficulties for various needs. These economic institutions also help to buy various agricultural produce, especially candlenut and coffee.

6.4.2.10. Women in Economy

Women has a quite significant role in the household as can be seen from their primary involvement in agricultural activities such as candlenut harvesting and processing. Women also contributes to household income through

small-scale home industry such as crafting from pandan leaves, weaving ikat fabric/ songket, and helping for managing homestay for tourists.

In relation to the Project the ESIA survey identified a number of concern and expectation, including the needs of electricity to support household activities, to get decent lighting, improve the local economy include household industries as well as improve the advancement of their villages (Wae Sano, Sano Nggoang and Pulau Nuncung Villages). Some of them have no concern to the project development but a few concerns are about the negative impact from the project development include disturb of natural beauty of Lake Sano Nggoang, they also afraid if fire occurs during drilling activities.

6.4.2.11. Community Income and Expenditure

The income level of community in an area can be used as a measure of community welfare in general. There are many factors that affect the level of income of a household. Some research showed that the factor of education level, age, type of work, the level of ownership of household assets, family, and the distance from home to business premises significantly impact on household income levels.

The ESIA survey identified the following information regarding income and expenditure of households in the three affected villages of Wae Sano, Sano Nggoang and Pulau Nunung which will be useful to understand the current community welfare status when assessing the potential future impact of the Project to community livelihood.

Based on the survey results with a questionnaire to the 96 heads/members of households, 72 respondents (75%) have the level of household income is less than 500,000 rupiahs (USD 37.54) per month. About 13 respondents (13.5%) were with level of household income in the range 500,000 (USD 37.54) to 1,000,000 rupiahs (USD 75.08) per month and the rest, 11 respondents (12.3%), has income level above 1,000,000 rupiahs (USD 75.08). More information on the household income level can be seen in Table 6-19.

Table 6-19 Household Income per Month in Study Area

No.	Village	Income (Rupiah/Month)			Total Household
		<500.000	500.000 – 1.000.000	>1.000.000	
1	Wae Sano	35	6	5	46
2	Sano Nggoang	13	5	4	22
3	Pulau Nuncung	24	2	2	28
Total		72	13	11	96
Percentage (%)		75.00	13.54	11.46	100,00

Source: PT. SMI Baseline Study, 2016

The BPS set food poverty line (FPL) in September 2015, and specifically for rural communities in West Manggarai Regency East Nusa Tenggara Province the FPL was 263,746 rupiahs (USD19.80) / month / capita. With an average number of household members as many as 4 people, based on data from household income levels of respondents and the defined FPL, the group of households that are below the poverty line in the study area (which is household with income level less than 500,000 rupiahs (USD 37.54) per month) are a total of 72 households (i.e. 75%).

Besides the head of families, some family members also worked and earned money; 46.88% was having less than 500,000 rupiahs per month, only small number (7.29%) have an income of between 500,000 to 1 million rupiahs (USD 37.54 to 75.08) or more than 1,000,000 rupiahs per month (4.17%).

Meanwhile, Regional Minimum wage (*Upah Minimum Regional, UMR*) in West Manggarai Regency in 2016 was about 1,425,000 rupiahs per month (equal to USD 104.78) or 17,100,000 rupiahs per year (equal to USD 1,257.41) with Decent Standard of Living or DSL (*Kebutuhan Hidup Layak, KHL*) of 1,365,101 rupiahs²⁷ (USD 100.38) (Central Bureau of Statistics of East Nusa Tenggara Province, 2017). Based on the family member income information, it can be inferred that most of respondents (54.17%) have income below the Regional Minimum Wage (UMR).

²⁷ <https://ntt.bps.go.id/linkTableDinamis/view/id/318>

Analyzing the economic level of household condition would be better if it not only takes into account the household income level but also the household expenditure level. This is important because in general there is a real difference between income and expenditure levels. By taking into account the household income and expenditure levels, it can also distinguish between the concept of subjective poverty, absolute poverty and relative poverty. Data on the household expenditure level per month is presented in Table 6-20. The data indicates that the percentage of the highest household expenditure level in the range of 500,000 to 1,000,000 rupiahs per month amounted to 31.25%, while the expenditure level less than 500,000 rupiahs per month amounted to 36.46%, and the remaining 15.63% of respondents spent more than 1,000,000 rupiahs per month. Comparison between income and expenditure shows that some of respondents have higher expenditure than their income, this indicate a negative cash flow each month.

This community low level of welfare might indicate potential high expectation toward the Project economic benefits to community in increase income, such as through provision of free electricity which is then expected to boost tourism development in the area.

Table 6-20 Household Expenditure per Month

No.	Village	Expenditure (Rupiah/Month)				Total Household
		Do not answer	<500,000	500.000 – 1.000.000	>1.000.000	
1	Wae Sano	10	18	15	3	46
2	Sano Nggoang	0	5	10	7	22
3	Pulau Nuncung	6	12	5	5	28
Total		16	35	30	15	96
Percentage (%)		16.67	36.46	31.25	15.63	100.00

Source: Baseline Study PT. SMI, 2016

6.4.2.12. Poverty

According to Nusa Tenggara Timur Province statistic data (2017), the Regional Minimum Wage (UMR) in West Manggarai Regency in 2016 was about IDR 1,425,000 rupiahs per month (equal to USD 104.78) or about USD 3.5 per day. It is still considered low, as it very close to the global poverty line of USD 1.90 per day. Compared to the Indonesia data in the same year, minimum wage in West Manggarai Regency is lower than East Nusa Tenggara Province with IDR 1,525,000 per month (USD 113.41). This could indicate potential high expectation from the regional community and stakeholders toward the Project positive impact for the regency.

On poverty BPS (Central Bureau of Statistic) defines poor people as those who have an average expenditure per capita per month below the poverty line. In 2016, the number of poor people in West Manggarai Regency is 19.35% or 49,550 people with a poverty line of 282,412 rupiahs (USD 20.77) per capita per month. It was identified that 10,266 families fall under pre-prosperous category. However, the number of pre-prosperous families in West Manggarai Regency in 2016 has been decreasing compared to 2014, since the implementation of national government poverty alleviation program, such as *Beras Miskin Program* (Raskin, rice subsidy program for the poor).

In Sano Nggoang Sub-district, the number of poor households (RTM) which have been identified by BPS is 1,571 households (Central Bureau of Statistics of Sano Nggoang Sub-district, 2016) or about 6,284 people (with average 4 members per household in the Sano Nggoang Sub-district, see Table 1-2 in **Appendix I**) and the number of very poor households (RTSM) is 158 households.

The exact number of poor household in the three villages was not available during the ESIA survey, however it was identified from consultation with the Village Officers and community in Wae Sano Village that in order to help the poor people, various social programs have been implemented in the community.

In August 2016, the government distributed Raskin to Sano Nggoang Sub-District, amounting to 263,430 kg or about 92.98% of the RASKIN (rice subsidy program) program target. Wae Sano, Sano Nggoang and Pulau Nuncung Village have 134,147 and 98 poor households respectively. Each of poor households was given government programs of 180 kg of rice (Sano Nggoang Sub-district, 2016). In addition, there were very poor families (RTSM) in Wae Sano and Sano Nggoang Villages which amounted to 39 households and 7 households,

respectively. Each of very poor family in Wae Sano and Sano Nggoang Villages were also given government program funds amounted to 1,972,756 rupiahs and 2,267,857 rupiahs, consecutively, through *Keluarga Harapan Program* (PKH) (Central Bureau of Statistics of West Manggarai Regency, 2017).

6.4.3. Socio-Culture

6.4.3.1. Overview

The Manggarai ethnic group primarily live in Manggarai Regency, West Manggarai Regency and East Manggarai Regency on Flores Island. The Manggarai people practice a patrilineal heritage structure, with the lineage inherited by the males. The Manggarai language consists of several dialects, these being Pae, Mabai, Rejong, Mbaen, Pota, Central Manggarai, East Manggarai and West Manggarai. The first four dialects are the languages from a separate ethnic group that conforms to the Manggarai people in ancient times²⁸.

According to the Manggarai people, they need five main things to survive:

- a. *mbaru bate kaeng*, which is a place to live in
- b. *uma bate duat*, which is a garden/lingko as a livelihoods source
- c. *wae bate tekku*, which is a water spring for drinking, bathing, washing and other activities
- d. *natas bate labar*, which is a collective large yard in the village used for a playground and to hold big rituals such as *caci*, *sae kaba*, etc.
- e. *compang bate*, which is an altar/mezbah that has been set by the ethnic group as the village spiritual centre that protect, provide, and arrange the ethnic group life sources (*naga beo/golo*).

The community of Sano Nggoang Sub-district, especially in Wae Sano Village is referred to as Mata Wae (the Eye of Wae) which is a sub-ethnic group of the Manggarai tribe and has a clear territory (*hamente*) derived from the Sano Ngoang region and its surroundings. They generally have the same identity and traditions as other sub-ethnic groups in Manggarai. They are distinguished by their dialect and some special traditions. But in particular they recognize themselves as Mata Wae people, which is a different identity.

There are three versions of the origin of Mata Wae ancestors, the first is said to be from Minangkabau (Minang-Sumatra), the second version is said to originate from Goa (South Sulawesi) and the third version is said that they came from Sumba Island.

The history of Mata Wae community originated from an area called Lampang which is an old village where the ancestors of the villagers of Wae Sano, Sano Nggoang and Pulau Nuncung settled for the first time. Lampang is located in the hilly area of Wae Sano Village north of Lake Sano Nggoang. Based on the results of interviews and focus group discussions (FGD) conducted in 2017 with community leaders in Dasak, Taal, and Lempe Sub-villages as well as Wae Sano Village, it was discovered that all the people in the region came from the same ancestor – Lampang old village. Therefore, although there was no special ritual or cultural ceremony being practices associated with the presence of Lake Sano Nggoang, however due to the historical attachment of the lake as Mata Wae people ancestor location, the Lake is considered as one of the community cultural heritage of importance.

In Wae Sano Village, the Mata Wae community is divided into three major clans / families – Lako, Nando and Dese. Loko people mostly live in the village of Sano Nggoang and Lempe Sub-villages, and the Nando people live in Taal Sub-village. The Dese people are migrant community that married into the Wae Sano community. The identity of the community remains internal to the community, basing social position on history and marriage.

In general, the Mata Wae people are the local community of Sano Nggoang area. They have a distinct recognition of their identity as the sub-ethnic of Manggaraian, still acknowledge the presence of Tua Golo as their respected leader for social and customary matters (including land disputes), and recognise a customary area which is the old village (see Section 6.4.3.4). However, they are not considered as vulnerable indigenous people category defined in the World Bank Safeguard Policy which has been adopted in the GEUDP ESMF. There are few characteristics considered i.e. Mata Wae community is identified as a dominant group within the affected area, while their cultural practices and traditional land tenure system are fading since the presence of church and

²⁸<http://suku-dunia.blogspot.co.id/2014/12/sejarah-suku-manggarai.html>

introduction of national government land certification program in the 1980s. This is also has been confirmed in the GEUDP Environmental and Social Screening Report, dated 25 March 2016, which stated that no indigenous people residing within the Project area of interest.

6.4.3.2. Land in the Life of the Manggarai and Mata Wae People

In Manggarai culture, land is the mother, the source of life and provides the personal and community identities for the Manggarai people. Land is also a prerequisite to build a village. As such, for the Manggarai people, a conflict related to land is always a serious matter.

In Manggarai culture, with and through land, a system is formed, rules and ethics are tied, solidarity is preserved and furthermore the life and all its aspects are cultivated. From this perspective, Manggarai people know the term 'gendang one lingko pe'ang' which means that Manggarai people do not only believe that village with its centre, mbaru gendang (drum house), is vital but also lingko, as soil and arable land for the people, is the source of life.

Lingko, as seen in Figure 6-29, was formed when Manggarai people moved from a nomadic lifestyle to a sedentary life, which required a residential area (*beo* – village). New settlements were obtained by clearing away the forest, a practice known as *lingko*. In each *beo* the number of *lingko* depends on the ability of citizens to clear away the nearby forested area, as well as the population of each *beo*. Each *lingko* has a different size and is given a unique name, often referring to natural features such as local plants or rivers. Where *lingkos* border a neighbouring *lingko*, a borderline (called a *rahit*) is implemented to define the ownership rights of each *lingko*.

The division of *lingko* – known as the *lodok* system - reflects the traditional layout of the Manggarai village dwellings. Pillar houses (*mbrang niang*) are built encircling a main central pillar, such that a circle is formed around the pillar (*Sri bonkok*). This central pillar forms an altar and/or a place for offerings, such as at *penti* (New Year). The roof of the dwellings is cone shaped and made from palm tree or reed.

In the study area, the land was traditionally (pre-Indonesian independence) managed under *tu'a golo* authority. However, in line with the development era and laws development of Indonesia, particularly Agrarian law, the pattern of land ownership management in the study area is evolving from communal to more individual systems. The present role of the *tu'a golo* focusses on conflict resolution and customary rituals and / or ceremonies, such as the 'ground breaking ceremony' for developments.

Based on the information collected from the interviews from the secretary of Wae Sano Village and several village officers and custom leaders, the status of land within the study area are generally owned through a right of ownership. Proof of ownership of private land in the study area is mostly via payment receipts from the Land & Building Tax (L&B Tax) rather than land ownership certificates released by the National Land Agency (NLA).

Detail information of land status for each of the proposed Project facilities can be referred in the Preliminary LARAP Document (**Appendix L**).

6.4.3.3. Traditional Custom of Manggarai and Mata Wae

Manggarai society is led by the *tu'a golo*, who has authority for all areas of the region including villages, land, forests and waterways. His subordinates are the *tu'a beo* (sub-village leaders) and the *tu'a teno*, who is responsible for managing land related matters. The *tu'a teno* is elected by consensus from landowners.

The main responsibilities of the *tu'a golo* are mainly as problem solver and leading the customary ceremony, while *tu'a teno* roles are more as mediator in resolving land dispute issues. In Wae Sano study area²⁹, there are nine *tu'a golo*³⁰ whom still performing their tasks and roles well.

²⁹ Wae Sano reflects the area surrounding Lake Sano Nggoang, consists of Wae Sano village, Sano Nggoang village and Pulau Nuncung village.

³⁰ The distribution of *golo* had been done before the distribution of administrative was applied and sometimes the number is not equally with the distribution of government structure. For example, in Wae Sano village, administratively there are seven sub

Usually the customary activities in the village surrounding Wae Sano is marriage, death and built a new house/new building, while the custom ceremony related to the agricultural cycle is rarely being held. Marriage ceremony is usually being held between the months of June until October, as these months are harvesting months so quite a lot of money circulating in the community. Meanwhile, death ceremonial will be held when a person is die and sometimes without any preparation. Usually in the death ceremonial, citizens really need the existence of economic institutions to overcome the sudden situation. *Adat* ceremonies usually lead by a *tu'a golo*.

Now, the intensity of conflict in three villages in Wae Sano tends to rarely occur at least in the last one year. Conflicts mostly happen among the native citizens on the issue of land borderline and family matters. If a conflict happens, the problem is usually solved in the family and custom institutions under *tu'a golo* authority. The friction is generally solved through *Lonto Leok* (consensus), with Manggarai customary ways, especially in solving land disputes. In *Lonto leok* forum, the Manggarai customary and cultural symbols are used and in this forum the land dispute is pursued to be peacefully solved. The number of case solved at the village level is small if the problems cannot be solved at the family level and custom institutions.

The roles of these traditional leaders were continuously fading with the presence and roles of government institution (e.g. head of village, government agency, etc.).

6.4.3.4. Cultural Heritage in Study Area

The existing traditional custom and culture of the traditional Manggarai community among others are as follow, however some of these practices are no longer or decreasing performed:

- a. The Manggarai traditional dance such as *Caci* Dance, *Ndundu Ndake* Dance, *Tetek Alu* Dance, *Pacek Mawo* Dance, *Tuk Mawo* Dance, *Sanda* Dance and *Kiris* Dance. Each traditional dance has its own meaning which has been told for generations and still practiced and preserved until now.
- b. *Tuak* (palm wine): the traditional custom mechanism in which when a family wants to have a word or two in traditional manner with other people and especially with *Tu'a Golo* brings palm wine made from sap of palm, cigarette and money as the offerings.
- c. *Curu* and *kapu* tradition: welcoming guests, respect and family concept of local community to tourists³¹

Meanwhile, there are few remaining and old buildings in the study area which have cultural and religious value for community that are:

- a. The church and pastor's house of Wae Sano parish, built from wood and located at the edge of Lake Sano Nggoang. This church is the center of the first spread of Catholic in Wae Sano village and the surrounding area.
- b. The old village residence at the top of Golo Mbelecek Hill, at the east side of Nunang. This village is the Nunang's ancestor village. According to the community, their ancestor is from Minangkabau and some of them came from Bima Kingdom.
- c. Artefact as *compang*³² and an old cemetery at the Puncak Lampang; an old village of the Nunang citizens' ancestors
- d. Watu Nggoang in Dusun Nggoang, Sano Nggoang village, the stone is located was an old village and the grave of Nggoang ancestor. Before 1970 the stone was believed to be shine at night, but not known the cause of the stone do not shine anymore. Until this study was conducted, the place was still preserved and used as the place to deliver offerings to the ancestors on a particular ceremony or when a village citizen wants to live outside the village. Nggoang sub-village people requested not to disturb or move the shrine place by any reason because it is believed would cause any unwanted matters.
- e. Lampang old village – north of Lake Sano Nggoang, considered as cultural heritage due to historical attachment of Mata Wae people, as the lake area was known as location of Mata Wae ancestor when

villages but only three golo; Sano Nggoang has three sub village and three golo with different names; Pulau Nuncung has four sub villages and two golo

³¹*Curu* is the welcoming guest tradition by parading them all the way to the house. At the house, the guests are welcomed by *kapu* tradition, which is welcoming by using a white rooster as a sign of sincerity and sense of family. To add the feast, palm wine also served, the signature drink to overcome thirsty and fatigue after a long trip. In the end of the procession, the guests are usually give money as an expression of prayer to God and to respect the ancestor spirit.

³²*Compang* is a place to put the sacrifice or used as an altar for the *beo* (village) citizens; usually placed in the centre of the *beo*

they first came to settle in Sano Nggoang. However the inherited cultural value of the lake has started to fade with the presence of church and government development program. There was no special ritual or cultural ceremony being practices pertaining to lake.

Settlements are marked inside the *golo* where there should be a drum or large traditional house for the *golo*, then the *compang* or stone or place of study, then there is the entrance and exit as a mark of kampong, and there is *natas* as public place. There are many old kampongs that have been abandoned, marked also with the former gardens and cemeteries that are still preserved and hereditary existence from generation to generation. Such as the former kampong of Golo Lampang, as the origin of all residents or clans in Wae Sano, then kampong Wewa which is the origin of Taal Sub-village community, and there is also kampong of former community in Sano Nggoang as well. The former land of kampong and its assets in it is maintained by the citizens up to now. Indicative location of these physical cultural resources (PCR) within the study area based on the result of participatory mapping with local community in March 2017 is shown in Figure 6-38. This PCR mapping is also considered in the sensitivity analysis to allow better understanding on some of the culturally sensitive area during the current Project site selection process (the original participatory map with community scratch is attached in the SEP, see **Appendix H**).

6.4.3.5. Religion and Belief

Besides the traditional structure, other social institutions that have effect on Manggarai community in this study area is the religious institution, in this case is Catholic Church³³ and the government institution which is represented by the village government (the head of the village and its subordinates). These three pillars influence the social life of Wae Sano citizens and its surrounding area. However, the traditional customary structure has continuously fading with the presence and roles of such religious institution. This as was also seen from the increase roles of women in the community. It was observed that the women roles are not longer limited in the domestic activities in the house, but also actively involved in the social institutions in the village³⁴.

Both in West Manggarai Regency and Sano Nggoang Sub-district, Catholic religion is professed by more than 74% population. Islam becomes the second largest faith in these areas, with 57,597 people in West Manggarai Regency and 3,622 people in Sano Nggoang Sub-district. Likewise in the villages of study area, there are only two religions professed by the community which are Catholic and Islam. The majority of local people in this area are Catholics, with 1,132 people in Wae Sano Village, 840 people in Sano Nggoang Village, and 560 people in Pulau Nuncung Village, respectively.

³³ Catholic Church in Flores has a long history, which is since the arrival of Dominican nuns from Portugal in Flores Timur in the 16th century. In Manggarai, the situation was different because this region never been visited by the Portuguese and was controlled by the Gowa Kingdom and Bima Kingdom and converted to Islam since the early of the 17th century. The control was confirmed by Bongaya Treaty in 1667 between The Kingdom of Bima and the Dutch when the Dutch control the colonialism. The SVD missionaries opened a place in Ruteng in 1920s and started to protect the implementation of the Muslim law and in 1928 the Dutch approved Manggarai to have a king selected by the people itself. Maribeth Erb, op cit. page 258

³⁴One of them is Maria Sumur Habur, the Head of Ecotourism Lake Sano Nggoang Institution. She is active in the establishment and management of community institution since the early year 2000 and at the previous village election (2016) she was proposed to be one of the candidates, but in the end she refused the offer. In-depth interview in Wae Sano Village, 4 October 2016



6.5. Community Health

Community health status is one of the most important factors which can affect the productivity level of community. Information regarding any health problem identified in the community could help the Project in managing working conditions for its labors while providing more understanding in managing potential adverse impact of the Project activities. Health information could help the Project to understand the current community health condition in relation with the potential impacts in which the community may be exposed to.

6.5.1. Health Status

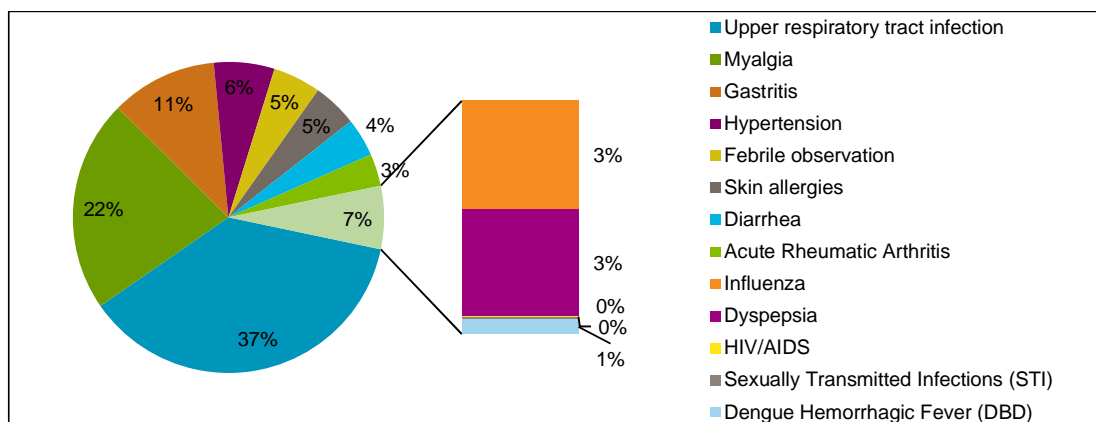
The Human development index (HDI) and life expectancy rate (LER) generally indicates the success level of a region's economic and health development. High life expectancy shows good community health conditions, health knowledge and education levels, as well as good access to health services. In 2016, West Manggarai Regency HDI was about 60.63, ranking 15th out of 22 regencies in East Nusa Tenggara Province. The LER of this regency is 66.82, school expectancy rate is 10.67, the school average rate 6.82, and expenditure per capita is IDR 7,149,000 (equal to approximately USD 529) per year (Central Bureau of Statistics of East Nusa Tenggara Province, 2017). According to Central Bureau of Statistics of East Nusa Tenggara from 2017, LER of this province in 2016 was 66.04.

Other health indicators that could provide a general overview of community health condition are the infant birth and mortality numbers. High mortality numbers indicate poor community health conditions. In West Manggarai Regency 2017 data shows that there were 4,740 live born infants to 14 succumbing to infant mortality in 2016 (Central Bureau of Statistics of West Manggarai Regency, 2017), this is show that the infant mortality is less than 1%.

Data on community health status at the village level was not available at the time the ESIA survey was conducted, however information on disease concerns, health facilities and housing conditions in the following sections would help to better understand the current community health condition.

6.5.2. Disease Prevalence

According to statistics of West Manggarai Regency in 2016, the diseases most suffered by the community are including Upper respiratory tract infection (URTI) and myalgia (Figure 6-39). HIV/AIDS increased in West Manggarai Regency by 8 patients from the previous year and sexually transmitted infections (STI) increased by 8 patients from the previous year 72 patients. Dengue Hemorrhagic Fever spreads significantly in West Manggarai Regency, and has been identified in 383 patients; this number almost triples in the cases in 2015. Disease prevalent in Sano Nggoang Sub-district in 2016 is not provided by BPS (Center of Statistic Bureau).



Source: (Central Bureau of Statistics of West Manggarai Regency, 2017)

Figure 6-39 Disease Cases in Study Area

Health data at the village level on disease occurrence was not available, however from consultation with the community in the three villages of Wae Sano, Sano Nggoang and Pulau Nuncung during the ESIA survey, it was identified that influenza, cough, and common fever were the most common illnesses in the community. There was no concern related to respiratory illness or STIs identified during the survey.

6.5.3. Health Facility

Availability of adequate health facilities and qualified medical personnel is a key to enable the success development in health field, while for the Project it would provide information the extent of local capacity in relation to managing the working condition of its labor. Statistical data of West Manggarai Regency shows the integrated health center (Posyandu) and village health center (Poskesdes) is the main health facility for people to get treatment. The spread of active Posyandu units in each sub-district also plays an important role in dealing with health problems from an early age.

In 2016, there were 2,085 active Posyandu units recorded in the West Manggarai Regency and as many as 9.83% are active cadres in Sano Nggoang Sub-district. People in West Manggarai who get reference treatment to others health facilities such as government hospitals, private hospitals and physician practices are relatively small. This Regency has one public hospital that is West Manggarai Regional Public Hospital located in Labuan Bajo Street, East Nusa Tenggara Province. In addition, the available private hospital is Siloam Hospital which is located in Labuan Bajo as well. Both hospitals are prioritized communities in the West Manggarai Regency. On the availability of health personnel, West Manggarai Regency Statistic data (2017) identified there were was 1 specialist doctor, 16 general practitioners and 6 dentists who worked in several community health centers (puskesmas) in 2016; other health workers include 369 nurses, 213 midwives, and 238 other medical personnel.

Meanwhile, health facilities in Sano Nggoang sub-district is dominantly by integrated health centers (Posyandu) (42 units) and village health centers (Poskesdes) (9 units). If the community of Sano Nggoang sub-district referred to the hospital, then they had to go to Labuan Bajo for getting treatment in West Manggarai Regional Public Hospital.

At village level, Wae Sano Village has 1 Pustu (auxiliary puskesmas) and 3 Posyandu (integrated health center); Sano Nggoang village has 2 Poskesdes (village health center) and 4 Posyandu; and Pulau Nuncung Village only has 2 Posyandu. There are 2 nurses in the Pustu of Wae Sano Village, and there are 1 nurse and 1 midwife in the Poskesdes of Sano Nggoang Village.

6.5.4. Housing

In 2016, West Manggarai statistical data (Central Bureau of Statistics of West Manggarai Regency, 2017) showed that about 85.84% of housing status is private property. The second largest percentage is free lease status at approximately 8%. Only a small percentage of people stay in rent houses (4.2%).

In densely populated urban areas where housing ownership can be a social issue and is often used to indicate levels of poverty, when a majority of the community is able to live their own homes, it can indicate a relatively good level of community welfare. Further information regarding community living condition should be considered to better understand the level of community welfare, such as availability of clean water, electricity and sanitation, as discussed in the following sections.

6.5.4.1. Residential Buildings

Based on Statistic Center Bureau (BPS) data in 2015 (Central Bureau of Statistics of West Manggarai Regency, 2016), the largest type of roof used as part of housing is dominantly by zinc roof with percentage of 95.35% followed by palm fiber/thatch typed roof about 2.58%. While the largest type of wall is still dominated by the bamboo about 36.95%, followed by wooden and brick walls respectively 35.87% and 22.62%. The largest type of floor dominated by cement floor of about 57.29%, while the ground floor about 25.03%. This condition was as similarly observed in the residential areas in the three villages of Wae Sano, Sano Nggoang, and Pulau Nuncung.

6.5.4.2. Clean Water Sources

Clean water source obtained by households in West Manggarai Regency dominated by protected spring water at 39.66% and unprotected spring water at 17%. One of the mountain spring waters is called *Golo Lampang* which is widely used by the community for household needs. Community in Wae Sano village mostly use mountain spring water of *Poco Dedeng* that streamed using a pipeline to the settlement. Others clean water sources include bottled water and drilled wells/ pumps. This was also identified in the three villages.

6.5.4.3. Electricity and Fuel Sources

The most lighting source used by households in West Manggarai Regency is electricity from PLN (State Electricity Company) about 47%. Furthermore, there are still many people who use light source instead of electricity in form of traditional lamp (*pelita/sentir*) or torch about 34.91%, this is because PLN has not been able to reach the area or the population cannot afford to use the electricity from PLN.

Meanwhile, community in study area generally uses *SEHEN* (*Super Ekstra Hemat Energi*) lamp or lamp that uses solar power, provided by PLN or other private company, or individual generator for source of light. *SEHEN* lamp is still actively used by the community but it has begun to decrease due to the difficulty in charging batteries or for nonpayment customers. They usually charged for 37,000 rupiahs per month for subscription to use lamp or they should pay 3 million rupiahs for installation per unit.

The current solar home system is not sufficient to provide electricity for 24 hours. This limited electricity is used for domestic purposes only. No electric-based public utilities (i.e. public lighting, public telephone, etc.) are provided.



Figure 6-40 Solar Home System for SEHEN Lamp

The use of wood as fuel is very dominating in West Manggarai Regency which is about 85.14%, while users of kerosene is only about 14.58% and other fuel users around 0.35%. This condition lead to high community expectation toward the electricity generated from the Project during operation to be distributed locally.

6.5.4.4. Sanitation

Another important facility for measuring the welfare level is the ownership of toilet, because it affects the health of environment. In 2016, the households which have own toilet in West Manggarai Regency approximately 55.34%. Fecal landfills are still dominated by making holes and burying waste (about 49.92%), while 24.37% of people use tanks as fecal landfills and 21.14% of people choose to defecate on shore/vacant land/yard; the rest choose to

defecate in ponds/paddy fields/rivers/lake/sea (Central Bureau of Statistics of West Manggarai Regency, 2017). This is due to not having a toilet in their house. This reflects low awareness of community on health and environment sanitations.

6.5.4.5. Community Safety

In 2016, the total traffic violations and accidents are 1,016 and 24 cases respectively. From the 24 traffic accidents, there were 19 victims died, 10 serious injured and 12 light injured. All victims died get compensation from PT Jasa Marga, a state-controlled toll road operator that constructs and provides toll road services in Indonesia. However, the financial loss in 2016 was almost twice higher than 2015. The following table presents the number of violation and accidents in West Manggarai from 2012 to 2016.

Table 6-21 Number of Traffic Violations and Accidents in West Manggarai, 2012 - 2016

Year	Total Traffic Violation	Total Accident	Death (person)	Serious Injured (person)	Light Injured (person)	Financial Loss (in thousand rupiahs)
2012	3,073	24	8	39	24	176,450
2013	2,116	21	14	8	5	73,100
2014	3,889	28	9	14	23	92,250
2015	1,300	35	20	9	31	47,000
2016	1,016	24	19	10	12	82,650

Source: (Central Bureau of Statistics of West Manggarai Regency, 2017)

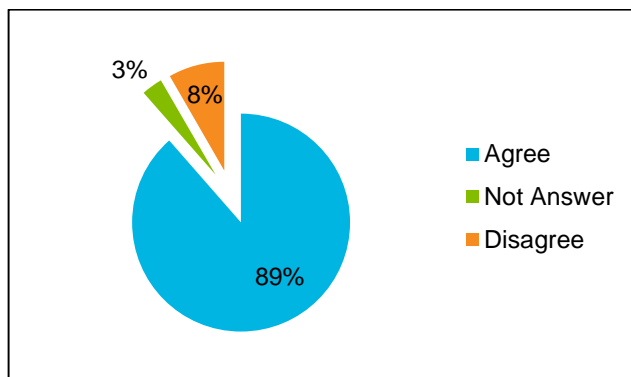
6.6. Community Perception

Execution of community involvements during the development of the ESIA and UKL-UPL are explained as follows:

1. Pre-Socialization;
2. First Round of Public Consultation;
3. Pre-Public Consultation Second Round and Participatory Social Mapping; and
4. Consultation during the Socio-Economic Baseline Survey.

The pre-socialization held in order to socialize the Waesano Geothermal Exploration activity in East Nusa Tenggara. Then, the public consultation first round held to inform the Waesano Project description and potential environmental and social issues, to conduct communication between stakeholders in this ESIA process and to capture the communities' concerns against the project. Due to some gaps identified from the 1st round of consultation, another consultation session was conducted before the second round of stakeholder consultation which is planned to be conducted after the completion of ESIA. In addition to these, consultation with local community was also conducted during the ESIA socio-economic baseline survey.

Based on the socio-economic baseline survey using questionnaire which includes community perception conducted in November 2016 and March 2017, the result of community perception was obtained. Of 96 respondents, most of them (85 respondents) agree to the project plan and about 8% and 3% respectively who disagree and was not answer, see Figure 6-41.



Source: PT. SMI Baseline Study, 2016

Figure 6-41 Community Feedback to the Project

Electricity and lighting are the main reason for respondent to agree with the project. About 35% of respondents said they wanted to get decent lighting, about 7% want the existence of electricity to improve the local economy, and 26% said that electricity would support the needs of the community (include activities of the household). Respondents who disagree to the project plan (3%) have the perception that the project activity would pose a risk to the authenticity of Lake Sano Nggoang and its surrounding area. They were also afraid of the negative impacts caused by the project if there is no agreement between the proponent and the affected land owners.

Such responses and feedbacks are presented in Table 6-22.

Table 6-22 Community Perception to Project in Study Area

No	Response to Project	Number of Respondents	Reason
1	Agree	85	<ul style="list-style-type: none"> - Improve community welfare, local economy, including household industries; - Electricity is needed by the community and provides many advantages and supports household activities; - Facilitate access to information and many activities; - Geothermal electricity is environmentally friendly energy; - Have seen the study case of Ulumbu Manggarai Geothermal Power Plant; - Increase the advancement of Wae Sano Village and tourism in Lake Sano Nggoang - Job opportunities - Plenty of natural resources that cannot be managed by the local community - Reducing the Wae Sano volcanic activity - Save the use of petroleum
2	Disagree	8	<ul style="list-style-type: none"> - Activities will disturb the authenticity of Lake Sano Nggoang; - Communities are concerned about the risks of activities, such as explosions, air pollution, land and plantation disruptions and other impacts that may disrupt local people; - Do not interfere with community settlements.
3	Not Answer	3	-

Source: PT. SMI Baseline Study, 2016 and 2017

Many respondents expressed concern that the project may lead to environmental pollution (15%), natural disasters and environmental damage (17%), and about 14% of respondents expressed fear of failure in the process of geothermal development. Environmental damage feared by the respondents refers to drilling activities that may impact the ecosystem balance, increase in the emergence of diseases, affect the beauty of the natural and local environment, or causing environmental pollution such as air pollution that will disrupt the community health.

As many as 33% of respondents expressed that they expected the project to succeed, and 11% of respondents expect the project workers should be from the local area. They also expect that the project will improve the local economy, the others community expectation are shown in Figure 1-34 in **Appendix I Community Baseline Profile**.

6.7. Thematic and Sensitivity Mapping

Environmental parameters are sorted based on their importance to each other in order to make the pairwise comparison easier as shown in Figure 6-42 below. Afterwards, the pairwise comparison could be generated as presented in Table 6-16. Of note, the potential sensitive receptor was determined based on participatory mapping with local community in March 2017.

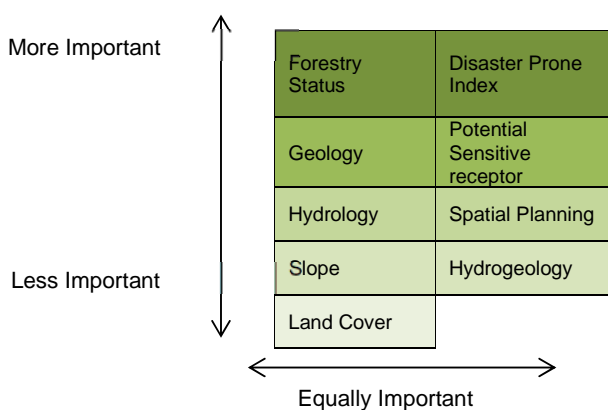


Figure 6-42 Environmental Parameters

Once the pairwise comparison matrix is built, it is then normalized in order to derive the weights. The matrix is normalized by dividing the entries on each row by the row totals on each column. The sum of the entries on each column will be equal to 1. Finally, the weights are built by averaging the entries on each row of the normalized pairwise comparison matrix.

Table 6-23 Pairwise Comparison Matrix

Criteria	Slope	Spatial Planning	Forestry Status	Potential Sensitive Receptor	Hydrology	Disaster Prone Index	Geology	Hydrogeology	Land Cover
Slope	1.00	0.69	0.41	0.41	0.84	0.69	0.58	0.69	0.69
Spatial Planning	1.44	1.00	0.84	0.69	0.58	0.41	0.48	0.69	1.00
Forestry Status	2.47	1.19	1.00	2.47	1.71	1.00	1.44	2.92	2.47
Potential Sensitive Receptor	2.47	1.44	0.41	1.00	1.19	0.69	0.69	1.44	2.92
Hydrology	1.19	1.71	0.58	0.84	1.00	0.33	0.48	1.44	1.19

Criteria	Slope	Spatial Planning	Forestry Status	Potential Sensitive Receptor	Hydrology	Disaster Prone Index	Geology	Hydrogeology	Land Cover
Disaster Prone Index	1.44	2.47	1.00	1.44	3.00	1.00	1.44	2.47	2.47
Geology	1.71	2.08	0.69	1.44	2.08	0.69	1.00	1.44	2.47
Hydrogeology	1.44	1.44	0.34	0.69	0.69	0.41	0.69	1.00	0.69
Land Cover	1.44	1.00	0.41	0.34	0.84	0.41	0.41	1.44	1.00
Total Row	14.60	13.02	5.68	9.33	11.94	5.63	7.22	13.55	14.90

Afterward the pairwise comparison matrices are normalized in order to derive the weights. Matrices are normalized by dividing the entries on each row by the row totals on each column. The sum of the entries on each column will be equal to 1. Finally, the parameters weight vector is built by averaging the entries on each row of normalized pairwise comparison matrix. The results can be seen in Table 6-24.

Table 6-24 Normalized Pairwise Comparison Matrix

Thematic	Slope	Spatial Planning	Forestry Status	Potential Sensitive Receptor	Hydrology	Disaster Prone Index	Geology	Hydrogeology	Land Cover	Weight	Weight (%)
Slope	0.07	0.05	0.07	0.04	0.07	0.12	0.08	0.05	0.05	0.0677	7%
Spatial Planning	0.10	0.08	0.15	0.07	0.05	0.07	0.07	0.05	0.07	0.0783	8%
Forestry Status	0.17	0.09	0.18	0.26	0.14	0.18	0.20	0.22	0.17	0.1780	18%
Potential Sensitive Receptor	0.17	0.11	0.07	0.11	0.10	0.12	0.10	0.11	0.20	0.1199	12%
Hydrology	0.08	0.13	0.10	0.09	0.08	0.06	0.07	0.11	0.08	0.0891	8%
Disaster Prone Index	0.10	0.19	0.18	0.15	0.25	0.18	0.20	0.18	0.17	0.1772	18%
Geology	0.12	0.16	0.12	0.15	0.17	0.12	0.14	0.11	0.17	0.1402	14%
Hydrogeology	0.10	0.11	0.06	0.07	0.06	0.07	0.10	0.07	0.05	0.0767	8%
Land Cover	0.10	0.08	0.07	0.04	0.07	0.07	0.06	0.11	0.07	0.0729	7%
Total Row	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	100%

The final stage is checking the consistency of the judgments using this following formula. First, calculate the maximum eigen value for both physical and socio-economic parameters matrices.

$$\lambda_{\max} = \sum (\text{RowSum}_i \times \text{Weight}_i) / \text{Count}_i$$

$$CI = \lambda_{\max} - N / N - 1$$

$$CR = CI / RI$$

Where:

- N = Number of parameters (N=9)
- λ_{\max} = Maximum eigen value of N order matrix
- CI = Consistency Index
- RI = Random Index (RI = 1.45)
- CR = Consistency Ratio

CONSISTENCY ASSESSEMENT	
eigen value (λ)	9.34
number of parameters (n)	9.00
$\lambda - n$	0.34
CI	0.04
CR *	0.03

The results show the consistency ration is less than 0.1 which means the inconsistencies are tolerable and the judgments are reliable.

6.7.1. Spatial Analysis Method Using Simple Additive Weighting

Spatial analysis uses a Simple Additive Weighting (SAW) method which is represented as a weighted overlay method in Geographic Information System (GIS) software. When the data base is complete, it would be used within GIS to identify the suitability index in the Wae Sano area. The entry of these data will generate some raster layers in a common format as illustrated in Figure 6-43. This method has made it possible to relate and manipulate the data to build the suitability index model.

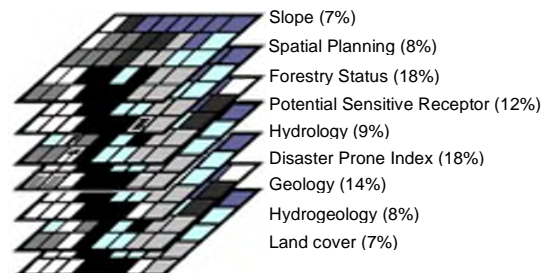


Figure 6-43 Weighting Data

In this assessment, the condition used as the limit between class range is subjective based on the expert judgement. The layers of each parameter will be reclassified to a common measurement scale of 1 to 3 (Low, Medium, and High Sensitivity index). Then the cell values are multiplied by their weight factor, and the results are added together to create the output raster as shown in following equation.

$$Ts = \sum_{i=0}^n x_i \cdot w_i$$

Where

Ts = Suitability value

x_i = raster cell value

w_i = weight factor

The result from the weighted sum method is the range of maximum and minimum total score of pixels. In order to identify the most suitable part the result is classified according to a suitability index classification. The latter classification generates a Sensitivity Index. The results of each sensitivity parameter are described in **Appendix K Sensitivity Map by Parameter**.

6.7.2. Participatory Sensitivity Mapping

Due to limitations in the scope of visited areas and the timeline of the ESIA baseline survey, a participatory method was used to identify potential sensitive environmental and social receptors within the Project area of influence. This was conducted in March 2017 and therefore has considered the new indicative well pads i.e. WS-A, WS-B, WS-D, and WS-E (see **Section 4.2**).

The result of the participatory sensitivity mapping is presented in the following Figure 6-44. The process and community involvement to produce the map are described in the **Appendix H Stakeholder Engagement Plan**.

6.7.3. Result of Sensitivity Analysis

Based on the spatial analysis and participatory mapping with the community, the following recommendations are proposed for the Project to consider during the planning and development stage. The result of the sensitivity index in each well pad location is summarized in Figure 6-44. WS-A, WS-B, and WS-D are categorized as high sensitivity. WS-A well pad has high sensitivity because it located 200 m from a water spring. WS-B well pad also have high sensitivity because they are located 200 m from settlement areas. Meanwhile, WS-D has high sensitivity because it is located in protected forest area. WS-E is categorized as medium-low class sensitivity.

Table 6-25 Sensitivity Index (Well pads)

No	Parameter	Sensitivity Index			
		WS-A	WS-B	WS-D	WS-E
1	Slope	Medium (Slope 15% - 30%)	High (Slope > 30%)	Low (Slope 0% - 15%)	High (Slope > 30%)
2	Sensitive Receptor	Medium (Radius 2000 m)	High (Radius 200 m)	Medium (Radius 2000 m)	Medium (Radius 2000 m)
3	Spatial Planning	Low (Plantation/Farm area)	Low (Plantation/Farm area)	Low (Plantation/Farm area)	Low (Plantation/Farm area)
4	Hydrology	High (Radius 50 m)	High (Radius 50 m)	High (Radius 50 m)	Medium (Radius 100 m)
5	Geology	Low (Young volcanic product)	Low (Young volcanic product)	Low (Young volcanic product)	Low (Young volcanic product)
6	Forestry	Low (Non-forestry)	Low (Non-forestry)	High (Protected Forest)	Low (Non-forestry)
7	Hydrogeology	Low (Region without exploitable groundwater)	Low (Region without exploitable groundwater)	Low (Region without exploitable groundwater)	Low (Region without exploitable groundwater)
8	Prone Disaster	Medium (Medium Disaster)	Medium (Medium Disaster)	Medium (Medium Disaster)	Medium (Medium Disaster)
9	Land Cover	Medium (Crop Land)	Low (Bush Land)	Low (Bush Land)	Low (Bush Land)
Sensitivity Results		Medium-High	High	High	Low-Medium
Descriptions		WS-A is considered a highly sensitive area due to its relatively close distance to a water spring which is used by the community as their main source of clean water. Near the location of WS-A is the historical heritage <i>Compang</i> which is considered as a significant cultural heritage. However, based on an interview with <i>Tu'a Golo</i>	WS-B is considered a highly sensitive area due to its relatively close distance to community settlement areas. It is located inside of an old historical village called <i>Kampung Laja</i> for the Nunang Family. Well testing and drilling activities have a number of potential adverse impacts to villagers. The boundary of the historical village was not clearly defined, and according to the local	WS-D is considered a high sensitivity area due to the location of WS-D is located inside the protected forest area. Most of the area is shrubs. No crops, water source or settlement areas were identified. Further investigation should be conducted to identify the extent of impact and required measures to manage	WS-E is considered a low – medium sensitivity area. Most of the surrounding is shrubs. No crops, water source or settlement areas were identified. The only parameter with high significance is related to slope percentage rise. Appropriate design shall be used to manage this risk.

No	Parameter	Sensitivity Index			
		WS-A	WS-B	WS-D	WS-E
	Lampe, the <i>Compang</i> can be relocated.		cultural leader the area is restricted for non-cultural activities.		potential adverse impacts to the protected forest area.

Source: Results of GIS based spatial analysis, 2017

Table 6-26 Sensitivity Index (Auxiliaries Facilities)

No	Parameter	Sensitivity Index						
		Drilling Basecamp	Laydown Area	Spoil Disposal 1	Spoil Disposal 2	Spoil Disposal 3	Water Supply Intake (WTP) 1	Water Supply Intake (WTP) 2
1	Slope	Low (Slope 0% - 15%)	Low (Slope 0% - 15%)	Medium (Slope 15% - 30%)	Medium (Slope 15% - 30%)	Low (Slope 0% - 15%)	Low (Slope 0% - 15%)	Low (Slope 0% - 15%)
2	Sensitive Receptor	Medium (Radius 2000 m)	Medium (Radius 2000 m)	Medium (Radius 2000 m)	Medium (Radius 2000 m)	High (Radius 200 m)	Medium (Radius 2000 m)	Medium (Radius 2000 m)
3	Spatial Planning	Medium (Community Forestry)	Low (Plantation/Farm area)	Low (Plantation/Farm area)	Low (Plantation/Farm area)	Low (Plantation/Farm area)	Low (Plantation/Farm area)	Medium (Community Forestry)
4	Hydrology	Medium (Radius 100 m)	Medium (Radius 100 m)	Medium (Radius 100 m)	Medium (Radius 100 m)	Medium (Radius 100 m)	High (Radius 50 m)	High (Radius 50 m)
5	Geology	Low (Young volcanic product)	Low (Young volcanic product)	Low (Young volcanic product)	Low (Young volcanic product)	Low (Young volcanic product)	Low (Young volcanic product)	Low (Young volcanic product)
6	Forestry	Low (Non-forestry)	Low (Non-forestry)	Low (Non-forestry)	Low (Non-forestry)	Low (Non-forestry)	Low (Non-forestry)	Low (Non-forestry)
7	Hydrogeology	Low (Region without exploitable groundwater)	Low (Region without exploitable groundwater)	Low (Region without exploitable groundwater)	Low (Region without exploitable groundwater)	Low (Region without exploitable groundwater)	Low (Region without exploitable groundwater)	Low (Region without exploitable groundwater)
8	Prone Disaster	Medium (Medium Disaster)	Medium (Medium Disaster)	Medium (Medium Disaster)	Medium (Medium Disaster)	Medium (Medium Disaster)	Medium (Medium Disaster)	Medium (Medium Disaster)
9	Land Cover	Medium (Crop Land)	Medium (Crop Land)	Medium (Crop Land)	Medium (Crop Land)	Low (Shrubs Land)	Medium (Crop Land)	Low (Shrubs Land)
Sensitivity Results		Medium	High	Medium	Medium	High	High	High

No	Parameter	Sensitivity Index						
		Drilling Basecamp	Laydown Area	Spoil Disposal 1	Spoil Disposal 2	Spoil Disposal 3	Water Supply Intake (WTP) 1	Water Supply Intake (WTP) 2
	Descriptions	Drilling basecamp is considered a medium sensitivity area. Most of the surrounding area is crops. Water source and settlement areas were identified at a medium distance. The other parameter with medium significance related to spatial planning and prone to disaster of flood, land subsidence, and tornado as most common disaster at West Manggarai Regency.	Laydown area is similar to WS-A and is considered highly sensitive due to its relatively close distance to a water spring which is used by the community for their main source of clean water. Near WS-A a historical heritage called <i>Compang</i> was found; it is considered as a significant cultural heritage. However, based on an interview with Tua Golo Lampe, the <i>Compang</i> can be relocated.	Spoil disposal 1 is considered a medium sensitivity area. Most of the area is crops. A water source and settlement areas were identified at a medium distance. The other parameter with medium significance is related to disasters due to the slope percentage rise. Appropriate design shall be used to manage risk and slope percentage.	Spoil disposal 2 is considered a medium sensitivity area. Most of the area is crops. A water source and settlement areas were identified at a medium distance. The other parameter with medium significance is related to disasters due to the slope percentage rise. Appropriate design shall be used to manage risk and slope percentage.	Spoil disposal 3 is similar to WS-A condition, considered high sensitive area due to its relatively close distant to water spring which is used by community for their main source of clean water. Near the location of WS-A found the historical heritage called <i>Compang</i> and considered as a significant cultural heritage. However, based on interview with Tua Golo Lampe, the <i>Compang</i> is allowed to be relocated.	WTP 1 is considered a highly sensitive area due to its relatively close proximity to Lake Sano Nggoang and water springs used by the community for their main source of clean water. Further investigation should be conducted to identify the extent of impact and required measures to manage potential adverse impact to the water spring and waterbodies.	WTP 2 is considered highly sensitive due to its relatively close proximity to Lake Sano Nggoang. Further investigation should be conducted to identify the extent of impact and required measures to manage potential adverse impact to the waterbodies.

Source: Results of GIS based spatial analysis, 2018

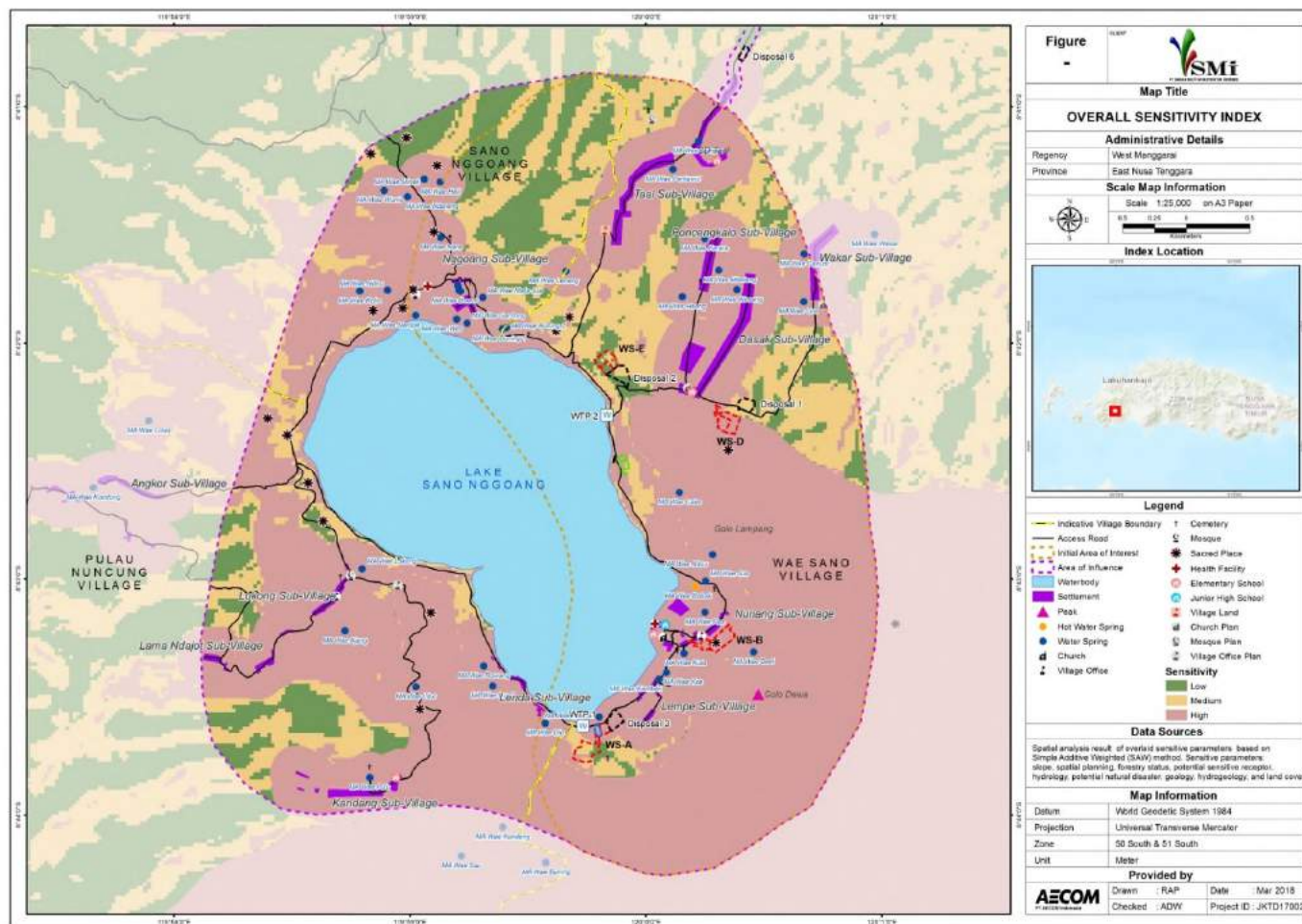


Figure 6-44 Sensitivity Map

7. Potential Environmental Impacts and Mitigations

7.1. Overview

The section describes potential environmental impacts (as defined by Indonesian law and World Bank Guidance) resulting from exploration phase activities. Using the approach defined in Section 3, first an assessment is made of unmitigated potential impacts. Secondly, project responses or mitigation measures are described, and finally the significance of the residual impact is defined. Details for entry into the ESMP are provided here where required. For ease of cross reference, ESMP issues have been assigned a number. For every project activity, the following potential impacts have been considered:

- Air quality and odour;
- Noise;
- Land cover and spatial planning;
- Soil;
- Surface water quality;
- Surface hydrology and hydraulics;
- Environmental health and waste management;
- Terrestrial ecology flora;
- Terrestrial ecology fauna;
- Sustainability and climate change.

As described in Section 3, the assessment of impact significance both before and after mitigation is defined by the severity of any possible impact, the sensitivity of environmental receptors and the probability that an event will occur. In this section potential impacts with no net change to environmental conditions are not reported. Each of the environmental disciplines above has been considered for the various project components during the exploration phase. This ESIA considers activities associated with exploration phase and activities from a generic exploitation scenario. Section 7.2 provides a summary of the residual environmental significance (after mitigation) of identified impacts.

It should be noted that the number of well pads mentioned in the project description indicates 6 well pads and only 3 selected well pads for the exploration phase. This analysis addresses all proposed well pads (6 plus base camp and reinjection well).

7.2. Impact Matrix

A complete inventory of impacts for the project is presented below; complete details will be provided in the subsequent sections.

IMPACTS INVENTORY

Air Quality and Odour

Significance

		Raw	Mitigated
AQ001	Emission from Off-road and On-road Equipment	Moderate	Minor
AQ002	Fugitive Dust Emissions	Moderate	Minor
AQ003	Emission from Off-road Equipment	Moderate	Minor
AQ004	H ₂ S Emissions during Well Testing	Moderate	Minor

Noise

Significance

		Raw	Mitigated
NO001	Construction Noise	Moderate	Minor
NO002	Drilling Noise	Moderate	Minor
NO003	Well Testing Noise	Major	Moderate

Land Cover and Spatial Planning

Significance

		Raw	Mitigated
LU001	Construction of Civil Infrastructure	Minor	Negligible
LU002	Site Rehabilitation and Revegetation	Minor	Negligible

Soil

Significance

		Raw	Mitigated
SO001	Surface Water Quality Degradation Due to Landslide and Erosion	Minor	Negligible
SO002	Poor Handling, Storage and Accidental Spill of Chemical and Petroleum Products	Moderate	Negligible
SO003	Pipe Leakage during Well Testing	Minor	Negligible

Surface Water Quality

Significance

		Raw	Mitigated
SWQ001	Surface Water Quality Degradation Due to Land Clearing and Preparation	Minor	Negligible
SWQ002	Potential for Spent Drilling Fluids to Reach Water Bodies	Minor	Negligible
SWQ003	Potential for Spent Brine Water	Moderate	Negligible

Surface Hydrology and Hydraulics

Significance

		Raw	Mitigated
HYD001	Water Resource Alteration	Minor	Negligible
HYD002	Potential of Surface Water Deficit Due to Water Abstraction	Minor	Negligible

Environmental Health and Waste Management

Significance

		Raw	Mitigated
WAS001	Green Waste	Minor	Negligible
WAS002	Domestic Solid Waste	Minor	Negligible
WAS003	Domestic Liquid Waste	Minor	Negligible
WAS004	Hazardous and Toxic (B3) Solid Waste	Moderate	Minor
WAS005	Hazardous and Toxic (B3) Liquid Waste	Major	Minor
WAS006	Drilling Mud and Drilling Cuttings	Minor	Negligible

Terrestrial Ecology Flora

		Significance	
		Raw	Mitigated
FLO001	Impacts to Vegetation during Preparation and Development	Minor	Negligible
FLO002	Impacts to Vegetation by the Drilling	Minor	Negligible
FLO003	Impacts to Vegetation by the Well Testing	Minor	Negligible

Terrestrial Ecology Fauna

		Significance	
		Raw	Mitigated
FAU001	Impacts to Sensitive Wildlife Species during Preparation and Development	Moderate	Minor
FAU002	Impacts to Sensitive Wildlife Species during Drilling	Moderate	Minor
FAU003	Impacts to Sensitive Wildlife Species during Well Testing	Moderate	Minor

Sustainability and Climate Change

		Significance	
		Raw	Mitigated
SUS001	Greenhouse Gas Emissions during Preparation and Development	Negligible	Negligible
SUS002	Greenhouse Gas Emissions during Exploration and Well Testing	Negligible	Negligible

7.3. Air Quality and Odour

7.3.1. Overview

Geothermal power plants have the potential to emit air pollutants during construction and exploration drilling. Air emissions during the construction are associated primarily with land clearing and construction activities, which may be stationary (on-site) or mobile (transport-related). During exploration drilling, the sources of air emissions can be divided into two categories: stationary sources which consist of point and fugitive sources within the drilling site, and mobile sources which are related to transport vehicles of workers.

The sensitive receptors of potential air quality impacts due to the geothermal exploration project are the local residents close to the project area. Based on sensitivity mapping in Figure 6-44, the expected sensitive receptors are Nggoang, Dasak, Nunang Lempe, and Taal Sub-villages, which are the settlement areas closest to the proposed well pad locations.

7.3.2. Construction of Civil Infrastructure

Project construction activities would involve the use of off-road construction equipment and on-road vehicles. Exhaust emissions in the form of CO, NO_x, SO₂, PM₁₀, and PM_{2.5} would be generated from the combustion of diesel fuel from this equipment. In addition, fugitive dust emissions in the form of PM₁₀ and PM_{2.5} would result from vehicle traffic and other earth moving activities associated with the construction over unpaved areas. The California Emissions Estimator Model (CalEEMod) version 2016.3.1 was used to quantify the construction emissions associated with the proposed project. It should be noted that CalEEMod is American and therefore uses the English rather than the metric system for units.

According to its user guide (ENVIRON International Corporation, 2013), the purpose of CalEEMod is to provide a uniform platform for government agencies, land use planners, and environmental professionals to estimate potential emissions associated with both construction and operational use of a land use project. It is intended that these emission estimates are suitable for use in California Environmental Quality Act (CEQA) compliant documents for air quality and climate change impacts. However, individual user may develop additional uses for the model's emission estimates to show compliance with their local agency rules.

CalEEMod utilizes widely accepted models for emission estimates combined with appropriate default data that can be used if site-specific information is not available. In addition, a user is given the opportunity to provide default values and existing regulation methodologies to use in their specific regions. If no information was provided by the user, appropriate state-wide values were utilized if regional differences could not otherwise be defined. The CalEEMod user's guide also warns that a large majority of the default data associated with locations and land use is based on surveys of existing land uses. Caution should be taken if the project deviates significantly from the types and features included in the survey that forms the substantial evidence supporting the default data. In these situations site specific data that is supported by substantial evidence should be used if available.

Indonesia does not have specific regulation or guidance regarding methodologies for construction emission estimates. Thus for this project CalEEMod is utilised. The emission estimates were calculated using the latest available data, assumptions, and emission factors at the time this document was prepared. Future studies might use updated data, assumptions, and emission factors that are not currently available.

Based on project schedule provided by the proponent, construction of the proposed project would be divided into four main construction phases. The first construction phase is the upgrade of the main access road. This phase is estimated to take approximately three months. This first phase is proposed to begin in November 2018 and be completed in February 2019. The second construction phase is the slimhole well pad construction, which would take place simultaneously with phase one. The second major construction phase is estimated to take approximately three months and would begin in November 2018 and be completed in February 2019. The last phase is the standard well pad construction, estimated to take approximately two months starting in January 2020 and ending in March 2020. The last phase is site closure estimated to take approximately two months starting in May 2020 and ending in July 2020. Table 7-1 below lists the construction phases and the corresponding construction schedules that were used for the emission estimates of the proposed project.

Various construction emission sources were considered in CalEEMod for emission calculations. The major emission sources that were modelled in CalEEMod for the construction of the proposed project include the following:

- Exhaust from off-road construction equipment;
- Exhausts from on-road vehicles and mobile equipment associated with worker commute trips, vendor commute trips, and hauling trips;
- Fugitive emissions from grading, wheel entrained dust, entrainment of dust from turbulent air currents in unpaved roads, wind erosion from exposed construction material stockpiles, material transport, etc.

Table 7-1 Proposed Project Construction Schedule

Phase Name ^(a)	CalEEMod Phase Type	Start Date (month/day/year)	End Date (month/day/year)	Approx. Land Area	Approx. Sub-Phase Duration
Upgrade Main Access Road	Grading (mass)	November 2018	February 2019	0.74 ha	3 Months
Slimhole Well pad Construction	Grading (fine)	November 2018	February 2019	0.54 – 1.03 ha	3 Months
	Building Construction	November 2018	February 2019	0.54 – 1.03 ha	3Months
Standard Well pad Construction	Grading (fine)	January 2020	March 2020	1.35 – 2.38 ha	2 Months
	Building Construction	January2020	March 2020	1.35 – 2.38 ha	2 Months
Site closure	Demolition	May 2020	July 2020	0.54 – 2.38	2 Months

Notes:

(a) Based on proponent's schedule construction phases. Well Pad Construction included construction of other facilities and drill rig mobilization.

Off-Road Construction Equipment

Emissions of CO, NO_x, SO₂, PM₁₀, and PM_{2.5} from off-road construction equipment were quantified in CalEEMod using emission factors derived from the OFFROAD 2011 air quality model (ENVIRON International Corporation, 2013) for off-road equipment based on the equipment type and equipment horsepower rating. Table 7-2 below summarizes the construction equipment list that was utilized in the CalEEMod model to quantify emissions from off-road construction equipment.

Table 7-2 Construction Equipment for the Proposed Project Construction

Phase Name	Construction Equipment	Purpose	Quantity	Usage Hours/Day	Hp
Access Road	Excavators	Grading	2	8	158
	Graders	Grading	1	8	187
	Rubber Tired Dozers	Grading	1	8	247
	Scrapers	Grading	2	8	367
	Tractors/Loaders/Backhoes	Grading	2	8	97
	Off-highway trucks	Grading	9 *	6	402
Slimhole Well Pad Construction	Cranes	Building Construction	1	7	231
	Forklifts	Building Construction	3	8	89
	Generator Sets	Building Construction	1	8	84
	Tractors/Loaders/Backhoes	Building Construction	3	7	97
	Welders	Building Construction	1	8	46
	Excavators	Grading	2	8	158
	Graders	Grading	1	8	187
	Rubber Tired Dozers	Grading	1	8	247

Phase Name	Construction Equipment	Purpose	Quantity	Usage Hours/Day	Hp
Standard-hole Well Pad Construction	Scrapers	Grading	2	8	367
	Tractors/Loaders/Backhoes	Grading	2	8	97
	Excavators	Grading	1	8	158
	Graders	Grading	1	8	187
	Rubber Tired Dozers	Grading	1	8	247
	Tractors/Loaders/Backhoes	Grading	3	8	97
	Cranes	Building Construction	1	7	231
	Forklifts	Building Construction	3	8	89
	Generator Sets	Building Construction	1	8	84
	Tractors/Loaders/Backhoes	Building Construction	3	7	97
Site Closure	Welders	Building Construction	1	8	46
	Concrete/Industrial Saws	Demolition	1	8	81
	Excavators	Demolition	3	8	158
	Rubber Tired Dozers	Demolition	2	8	247

Note: * Nine off-highway trucks represent one water truck and eight dump trucks

On-Road Construction Equipment

Exhaust emissions associated with on-road vehicles were quantified in CalEEMod using the model default vehicle fleet mixes, the emission factors derived from the EMFAC2014 on-road mobile source emission factor model together with default estimates regarding the number and length of on-road vehicle trips for workers and vendors. The estimated vehicle trips and trip length for the proposed project are summarized in Table 7-3 below. To account for the emissions that would be generated from the on-road mobile equipment during off-site transport, additional vendor trips and vehicle miles travelled were added in the on-road vehicle emission estimates.

Table 7-3 Estimated Construction Vehicle Trips and Trip Length for the Proposed Project

Phase Name	Off-road Equipment Count	Worker Trip Number	Vendor Trip Number	Hauling Trip Number	Worker Trip Length (mile)	Vendor Trip Length (mile)	Hauling Trip Length (mile)
Upgrade Main Access Road	8	20	0	50 ^(c)	16.8	6.6	20
Slim-hole Well pad Construction	17	96 ^(a)	38 ^(b)	50 ^(c)	16.8	6.6	20
Standard Well pad Construction	17	32 ^(d)	13 ^(b)	13 ^(c)	16.8	6.6	20
Site Closure	6	15 ^(e)	0	0	16.8	6.6	20

Notes:

- (a) 96 workers trips are based on total number of construction workers from proponent;
- (b) Number of vendor trips was assumed 40% of the worker trips;
- (c) 50 hauling trips were based on a maximum of 400 cubic yards of soil imported to the well pads per day using haul truck capacity of 8 cubic yards. 13 hauling trips were based on 100 cubic yards of imported soil.
- (d) Number of worker trips during standard well pad construction was assumed to be one-third (1/3) of the worker trips during slim-hole Well pad construction.
- (e) Estimated by CalEEMod

Fugitive Dust Emissions

Fugitive dust emissions in the form of PM₁₀ and PM_{2.5} would be generated by various source activities occurring at the project construction site. The evaluation of fugitive emissions during construction incorporated emissions sources such as dust from material movement and vehicle traffic resulting from construction. Material movement during construction is mostly associated with the grading phases. Fugitive emissions from material movement were quantified in CalEEMod based on model defaults assumptions along with additional project estimate of 400 cubic yards soil imported per day. Fugitive dust emissions associated with vehicle traffic such as worker and vendor commute trips and hauling trips were calculated in the model based on emission factors from EMFAC2014 along with the estimated number of trips and vehicle miles travelled, which is summarized in Table 7-3 above. Emissions associated with the proposed construction activities were quantified in the CalEEMod model.

Since Indonesia does not have regulations regarding thresholds for construction emissions, for the purposes of this study, the impact of construction emissions were assessed based on thresholds established by the South Coast Air Quality Management District in southern California (SCAQMD, 2015). The proposed Project would result in construction-related emission impacts should they exceed any of the following SCAQMD daily thresholds of significance.

Table 7-4 presents a summary of the peak daily construction emissions per phase. As shown in the table, the SCAQMD daily emissions thresholds would not be exceeded by the peak daily construction emissions. The largest contributor to the peak daily construction emissions is the upgrade of the main access road and slimhole well pad construction.

Table 7-4 Peak Daily Emissions for Each Construction Phase and Year (Unmitigated)

Phase Name	Peak Daily Emission (lb/day) ^(a)				
	NO _x	CO	SO ₂	PM ₁₀ Total	PM _{2.5} Total
Threshold ^(b)	100	550	150	150	55
Upgrade Main Access Road	60	36	0	10	6
Significant? ^(c)	NO	NO	NO	NO	NO
Slimhole Well pad Construction	60	36	0	12	6
Significant? ^(c)	NO	NO	NO	NO	NO
Standard well pad Construction	27	19	0	8	5
Significant? ^(c)	NO	NO	NO	NO	NO
Site Closure	33	22	0	4	2
Significant? ^(c)	NO	NO	NO	NO	NO

Notes:

(a) The emission estimates presented in this table were calculated using the latest available data, assumptions, and emission factors at the time this document was prepared. Future studies might use updated data, assumptions, and emission factors that are not currently available.

(b) thresholds established by the South Coast Air Quality Management District (SCAQMD, 2015).

(c) Significance is determined by comparing the highest peak daily emissions directly to the thresholds.

AQ001 Emissions from Off-road and On-road Equipment

Activity: Equipment and material mobilization, land clearing and preparation, access road improvement and well pad and infrastructure development.

Description: Construction off-road and on-road equipment will generate emissions due to the burning of fuels from equipment operation. Fugitive dust emissions would be also generated by various during land clearing and when equipment is moving over unpaved land.

NO_x peak daily emission during the construction stage is not predicted to exceed the SCAQMD thresholds. Therefore the severity of the impact is assessed as low. The NO_x emissions are expected to disperse to the community areas; however its concentration in the air is expected to be completed short-term minor impact during construction. Thus the sensitivity of the impact is

concluded as medium. With low magnitude and medium sensitivity, without mitigation the impact is considered to have a moderate significance.

Mitigation: The UKL-UPL requires a number of mitigation measures including using vehicles that have passed emissions tests, periodic machine maintenance, limit the hours of operation for heavy equipment or operations and attention will be paid to operations in the proximity of community areas, and equipping the workers with proper PPE. In addition to the ESIA, a Vehicle & Traffic Management Plan (VTMP) should be prepared, that will include:

- Exhaust emissions from off-road and on-road equipment operating within the site, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the contractor by ensuring that emissions are minimized through regular servicing of machinery to meet the relevant emission standards;
- Vehicle selection strategy to consider impact on total emissions;
- Ensure that the engines of all vehicles and machinery on site are not left running unnecessarily;
- Schedule of vehicle movement and number of vehicles in transit at any given time to limit emissions generation; and
- Plant and equipment to be used in the project to comply with recognized performance design standards;
- Personnel working on-site would have at all times with them appropriate PPE; and
- Conduct air quality monitoring at boundary areas of nearby settlements.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Medium Severity	Low Sensitivity	Minor

AQ002 Fugitive Dust Emissions

Activity: Equipment and material mobilization, land clearing and preparation, access road improvement and well pad and infrastructure development.

Description: Fugitive dust emissions would be generated by various source activities occurring at the project construction site such as earthmoving for excavation and civil works associated with the well pad construction, removal of well cuttings, vegetation clearing, stockpiling of soils, and equipment and vehicle movement. Earthmoving for excavation and civil works associated with the well pad construction, vegetation clearing, stockpiling of soils, and equipment and vehicle movement will generate emissions due to fugitive dust.

Fugitive dust emissions (PM_{10} and $PM_{2.5}$) during construction are not predicted to exceed the SCAQMD emission thresholds. Therefore the severity of the impact is assessed as low.

The dust emissions are expected to disperse within the source location only. Thus the sensitivity of the impact is medium. With low magnitude and medium sensitivity, without mitigation the impact is considered minor significance.

Mitigation: The UKL-UPL requires a number of mitigation measures including road watering especially during dry season, limit the hours of operation for heavy equipment or operations and attention will be paid to operations in the proximity of community areas, control vehicle speed on site especially during the dry season and windy conditions, covering trucks and equipping the workers with proper PPE for dust protection. In addition, the following mitigations measures will be included in the ESMP:

- Minimize the amount of excavated material on site;
- For manageable stockpile volumes, geotextiles can be used to cover soil heaps to prevent erosion and dust generation by wind;
- Vehicle washing facilities provided to minimise the quantity of material deposited on public roads;
- Restrict heights from which materials are dropped, as far as practicable, to minimize the fugitive dust arising from unloading/loading;
- Spray stations to moisten loads and avoid dust shedding;
- Temporary suspension of material handling activities during high wind events;
- Consideration of the location of stockpiles for temporary storage areas with respect to the location of sensitive receptors and prevailing wind;
- Avoiding double handling of material wherever reasonably practicable;
- Field supervisors to have responsibility to monitor conditions and adjust the frequency of watering; and
- Sealing/re-vegetation of completed earthworks as soon as reasonably practicable after completion.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Medium Severity	Low Sensitivity	Minor

7.3.3. Exploration Drilling

Indonesia does not have specific regulations regarding thresholds for other operational emissions. For the purposes of this study, the impacts of operational emissions were assessed based on thresholds established by the South Coast Air Quality Management District in southern California (SCAQMD, 2015). The proposed Project would result in operational-related emissions that exceed any of the following SCAQMD daily thresholds of significance in Table 7-5.

Table 7-5 SCAQMD Thresholds for Operational Emissions

Air Pollutant	Emission Threshold (Pounds/day)
Carbon Monoxide (CO)	550
Nitrogen Oxides (NO _x)	100
Sulphur Oxides (SO _x)	150
Particulates (PM ₁₀)	150
Particulates (PM _{2.5})	55

Source: (SCAQMD, 2015)

Table 7-6 presents average daily pollutant emissions associated with the whole exploration drilling of the proposed Project. This table contains daily emissions as well as significance determinations. As shown in this table, the SCAQMD daily emissions thresholds would not be exceeded by the average daily operational emissions of NO_x. The largest contributor to these daily NO_x emissions is the drill rig operation.

Table 7-6 Peak Daily Operational Emissions for the Proposed Project (Unmitigated)

Source	Peak Daily Emission (lb/day)								
	NO _x	CO	SO ₂	Fug PM ₁₀	Exh PM ₁₀	PM ₁₀ Total	Fug PM _{2.5}	Exh PM _{2.5}	PM _{2.5} Total
Whole Operation Phase	14	11	0	0.6	0.6	1.2	0.2	0.6	0.8
Significant?	No	No	No	NA	NA	No	NA	NA	No

Notes: The emission estimates presented in this table were calculated using the latest available data, assumptions, and emission factors at the time this document was prepared.

AQ003 Emissions from Off-road Equipment

Activity: Exploration drilling

Description: Drill rigs will generate emissions due to the burning of fossil fuel. No daily emission during the drilling stage is predicted to exceed the SCAQMD thresholds. Therefore the severity of the impact is considered low.

The emissions are expected to disperse to the community area in the short-term during construction at low levels. However their concentrations in the air are expected to be restored after the drilling is completed. Thus the sensitivity of the impact is considered medium. With low severity and medium sensitivity, without mitigation the impact is considered to have minor significance.

Mitigation: The UKL-UPL required mitigation measure periodic air drilling machine and electrical generator maintenance. In addition, the following mitigations measures will be included in the ESMP:

- Exhaust emissions from drill rigs will be controlled by the contractor by ensuring that emissions are minimized through regular servicing of machinery to meet the relevant emission standards;
- Drill rig selection strategy to consider impact on total emissions; and
- Drill rigs used in the project shall comply with recognized performance design standards.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	Medium Sensitivity	Moderate	Low Severity	Low Sensitivity	Minor

7.3.4. Well Testing

AQ004 H₂S Emissions during Well Testing

Activity: Well testing

Description: Following completion of the drilling, each well would be flow tested for some hours through to the atmosphere. The well testing may emit H₂S that has potential to cause adverse health effects due to short-term exposures (e.g., one hour or less). The amount of H₂S emitted would vary from well to well based on the number of steam entries discovered during exploration.

Because the adverse health effect can occur over a short period of time, it is assumed that the exposure event could occur under the worst-case conditions during which there would be low wind speeds and stable atmospheric conditions during which time little or no dispersion of the pollutant would occur. These conditions are typical of early morning periods shortly before or shortly after sunrise.

The H₂S emission would be controlled during well testing in order to limit its emission volume. Therefore the severity of the impact is assessed as medium.

The H₂S concentration in the air is expected to be restored after the well testing is completed. Thus the sensitivity of the impact is assessed as medium. With medium severity and medium sensitivity, the impact is considered to have moderate significance.

Mitigation: A number of mitigation measures we required in the UKL/UPL, including:

- Socialization with local community and village leader prior to the commencement of well testing, especially on evacuation procedures in the event of an early warning alarm;
- Secure the well location and establish safe and dangerous zones around the exploration areas;
- Equipping the workers with proper PPE, especially to those located in dangerous zones;
- Drilling and well testing shall include an H₂S response plan and early warning alarm;
- Install danger signage and barriers including wind socks/wind direction flag, signage of strictly prohibited to enter construction area for unauthorized personnel;
- Evacuation of community surround the well pads area in case of H₂S is exceed the threshold; and
- If the results of H₂S monitoring exceeding the standard, it will be an evaluation of the well testing results carefully and determines the next step so that the concentration of H₂S in the ambient air is meeting the standard.

In addition in the ESIA, mitigation will include a requirement to plan timing of vertical well testing based on weather conditions (low wind), to ensure well integrity to avoid leakage.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Medium Severity	Low Sensitivity	Minor

7.4. Noise

7.4.1. Overview

Construction activity inevitably creates some degree of noise emissions at locations in close proximity to the construction site. It is, however, a temporary source of noise. The noise levels generated by construction works will have the potential to impact sensitive receptors. Noise levels at a receptor depends on several factors such as number and type of equipment and machinery used, the distance between the noise sensitive receptor and the construction site and level of attenuation likely due to ground absorption, air absorption and barrier effects.

For impact assessment, specific noise criteria for the Project were established with reference to the IFC Guidelines (IFC, 2007) and Decree of the Environment State Ministry No. 48 of 1996 regarding Ambient Noise Level Standards (MENLH, 1996) as presented in Table 7-7.

Table 7-7 Project-Specific Noise Criteria

Receptor ^(a)	Period	Criterion Leq (dB(A))
Off-site and On-site Sensitive Receptors (External Façade)	Day-time (07:00-22:00)	55 ^(b)
	Night-time (22:00 – 07:00)	45 ^(b)
	Day-night-time (00:00 – 24:00)	58 ^(c)

Receptor ^(a)	Period	Criterion Leq (dB(A))
Industrial (at Well pad Boundary)	Day-time (07:00-22:00)	70 ^(b)
	Night-time (22:00 – 07:00)	70 ^(b)

Note:

(a) Off-site sensitive receptors are residences outside the well pad boundary; on-site sensitive receptors are worker accommodations inside the well pad boundary;

(b) Noise impacts should not exceed the criterion values or result in an increase in ambient levels of more than 3 dB(A);

(c) Five (5) decibels is added to predicted/measured night-time noise (22.00 to 07.00 am).

The following impacts are assessed in this document:

- The Project construction phases would result in ambient noise levels that exceed the project-specific criteria as shown in Table 7-7;
- The drilling operations would result in ambient noise levels that exceed all the project-specific criteria as shown in Table 7-7.

To estimate the noise from construction activities, Road Construction Noise Model (RCNM) version 1.1 (FHWA, 2006) was used. RCNM estimated the impact of noise from heavy equipment commonly used in construction activities. The types and number of construction equipment used during each construction phase were based on the predicted results of CalEEMod model. To estimate the noise impact conservatively (worst case), at each phase of construction it is assumed that all equipment will operate simultaneously and at full load at the same location. RCNM estimated incremental noise at one receptor point using the following formula (FHWA, 2006):

$$CNL_i = SPL_i - 20 \log \frac{D}{50} - 10 G \log \frac{D}{50}$$

Where:

CNL_i = Incremental noise level at a receptor resulting from equipment i, in dB(A)

SPL_i = Sound pressure level of equipment i at the reference distance of 50 feet (15 m), in dB(A)

UF = usage factor that accounts for the fraction of time that the equipment is in use, in %

D = distance from the receiver to equipment i, in feet

G = a constant that accounts for topography and ground effects

The ground absorption factor (G) was determined 0.6 corresponding to typical cultivated land and dry forest which was assumed across the Project location. This is a conservative approach in order to make a general noise contour. The combination of noise from several pieces of equipment operating during the same time period is obtained from decibel addition of the Corrected Noise Level (CNL) of each single piece of equipment found from the above formula.

It is assumed that construction activities will only take place during the day and thus no assessment is made against a night time standard. The exploration drilling will take place day and night (24 hours) thus the assessment is made against all the noise standards (daytime, night time and day-and-night time).

7.4.2. Construction Noise

For determining noise impacts associated with the Project, the following construction phases have been assessed:

- Phase-1: Upgrade Main Access Road;
- Phase-2: Slim-hole Well pad Construction;
- Phase-3: Standard-hole Well pad Construction; and
- Phase-4: Site Closure.

The first construction phase involves upgrading the main access road. This phase is estimated to take approximately three months. The second phase, which occurs simultaneous to phase 1 is the slimhole well pad construction which is estimated to take approximately three months. The third phase is the standard well pad

construction estimated to take approximately two months. The last phase is site closure of all wellpads estimated to take approximately two months.

Type and number of construction equipment used in each construction phase and their reference sound pressure levels are listed in Table 7-8. Predicted noise levels at various distances for each phase are presented in Table 7-9. Based on the predicted noise emission levels at various distances shown in this table, the distances to various noise levels for each phase have been presented in Table 7-10.

Table 7-8 Equipment List Used in the Project Construction Phases

Equipment	Quantity ^(a)			Phase 4	SPL at 50 feet ^(b)
	Phase-1	Phase-2	Phase-3		
Crane	-	1	1	-	73
Excavator	2	2	1	3	77
Forklift	-	3	3	-	75
Generator Set	-	1	1	-	78
Grader	1	1	1	-	81
Rubber Tired Dozers	1	1	1	2	78
Scraper	2	2	-	-	80
Tractors/Loaders/Backhoes	2	5	6	-	74
Welder	-	1	1	-	70
Concrete/Industrial Saws	-	-	-	1	83

Notes:

(a) Quantity was based on CalEEMod prediction results (see Table 7-2);

(b) SPL at 50 feet was based on default values from RCNM.

Table 7-9 Predicted Noise Levels at Various Distances for Each Construction Phase

Construction Phase	Predicted L _{eq} (dB(A))						
	50 m	100 m	250 m	500 m	1,000 m	2,000 m	5,000 m
Phase-1	72	63	51	42	33	24	12
Phase-2	73	64	52	43	34	25	13
Phase-3	72	63	51	42	33	24	12
Phase-4	73	68	55	47	39	32	21

Notes: The noise levels are predicted based on the expected summation of noise sources.

Table 7-9 show that the greatest potential noise impacts are associated with Phase-2 construction phase. AQ1 and AQ2 were assessed for cumulative construction noise impacts based on the measured baseline noise levels at these locations. AQ1 was assessed based on its distance to the WS-B as for AQ2 was assessed based on its distance to the WS-E. For worst case assessment, only Phase-2 noise contribution to the baseline was assessed at AQ1 and AQ2 and evaluated against the impact criteria as provided in Table 7-10.

Table 7-10 Construction Noise Impacts at Representative Sensitive Receptors (Without Mitigation)

Representative Sensitive Receptor	Nearest Wellpad	Distance to Wellpad (m)	Noise Contribution (Phase 2) dB(A)	Baseline Noise (L _d) dB(A)	Cumulative Noise (L _d) dB(A)	Change in Baseline Noise dB(A)	Compliance Status (Yes/No)
AQ-1 (Nunang Sub-village)	WS-B	375	53	46	53	+7	No
AQ-2 (Sano Nggoang Village)	WS-E	740	45	44	47	+2	Yes

Notes:

(a) Noise levels are rounded to one decimal value;

(b) Compliance status was determined by comparing the cumulative day-time noise (L_d) to the relevant Project Specific Noise Criteria as provided in Table 7-7.

Cosiderable adverse impact is expected at AQ-1. AQ2 is not expected to be impacted by construction noise. AQ1 is not the nearest residence to the WS-B. The nearest residence is only 80 meters away from WS-B. At this distance, phase 2 noise contribution is predicted to be 70 dB(A) which makes cumulative noise also 70 dB(A). This results a baseline noise increase of more than 10 dB(A) which is a major adverse impact. Thus, a noise barrier needs to be included at WS-B construction site in order to reduce noise impact to the residential area.

NO001 Construction Noise

Activity: Equipment and material mobilization, land clearing and preparation, access road improvement and well pad and infrastructure development.

Description: Construction activities will involve the use of machinery which will generate noise, as well as a number of activities associated with civil works which are inherently noisy.

Many of the well pad sites are relatively close to community settlements with the nearest of 80m, thus the magnitude of the impact is assessed as medium. Based on the noise impact assessment, the greatest potential noise impacts are associated with Phase-2 construction phase. Phase-2 noise contribution to the baseline was assessed at AQ1 and AQ2 and evaluated against the impact criteria. Cosiderable adverse impact is expected at AQ-1. AQ2 is not expected to be impacted by construction noise. However the nearest residence to WS-B which is only 80 meters away is predicted to experience a noise baseline increase of more than 10 dB(A). Thus the sensitivity of the impact is assessed as high. With medium magnitude and high sensitivity, without mitigation the impact is considered major significance.

Mitigation: The UKL-UPL required a number of mitigation measures to including using vehicle with exhaust and silencer in accordance with the manufacturer's specifications, especially vehicles that potentially cause noise, limit the hours of mobilization for equipment and material and attention will be paid to operations in the proximity of community areas, and equipping the workers with proper PPE. In addition, the following mitigations measures will be included in the ESMP:

- Whenever avoidance for construction at Wellpad WS-B is not possible, install proper noise barrier wall to reduce noise spread to the nearest settlement i.e. Nunang Sub-village;
- Limit the hours of operation for specific loud pieces of equipment or operations. Attention will be paid to operations in the proximity of community areas;
- Limit exposure of workers handling noisy and vibrating equipment;
- Construction activities should be limited to daylight hours although scheduling may require overnight operations on occasion;
- Use of hoarding/temporary noise barriers where noisy activities are to be conducted close to sensitive receivers;
- Require contractors to adopt and adhere to a Vehicle & Traffic Management Plan (VTMP); and
- Develop an effective grievance mechanism to record and respond to noise complaints.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	High Sensitivity	Moderate	Medium Severity	Low Sensitivity	Minor

7.4.3. Exploration Drilling

During well drilling activities, noise will result from:

- Operation of heavy equipment, drilling, sludge pumps, compressors and generators
- Mechanical or electrical works during pipeline installation

Well pad locations have been selected as far from villages as is practicable, either through distance or topography. This design strategy aims to reduce the potential for noise and other types of pollution. The drilling activities will take place in areas that are geographically or topographically isolated from the community.

In order to provide a conservative assessment approach, noise levels from the drilling activities have been estimated at one well pad and the worst case noise emissions to each receiver location have been assessed.

Type and number of construction equipment used in each construction phase and their reference sound pressure levels are listed in Table 7-11. Predicted noise levels at various distances for each phase are presented in Table 7-12. Based on the predicted noise emission levels at various distances shown in this table, the distances to various noise levels for each phase are presented in Table 7-13.

Table 7-11 Equipment List Used in the Well Drilling Phase

Equipment	Quantity ^(a)	SPL at 50 feet ^(b)
Drill Rigs	1	77
Generator Set	1	78

Notes:

(a) Quantity was based on CalEEMod prediction results (see Table 7-2);

(b) SPL at 50 feet was based on default values from RCNM.

Table 7-12 Predicted Noise Levels at Various Distances for Well Drilling Phase

Distance (m)	Predicted L _{eq} (dB(A))
50	67
100	62
250	49
500	41
1,000	33
2,000	25
5,000	15

Notes:

The noise levels are predicted based on the expected summation of noise sources.

AQ1 and AQ2 were assessed for cumulative drilling noise impacts based on the measured baseline noise levels at these locations. AQ1 was assessed based on its distance to the WS-B as for AQ2 was assessed based on its distance to the WS-E. The drilling noise contribution to the baseline was assessed at AQ1 and AQ2 and evaluated against the impact criteria as provided in Table 7-13.

Table 7-13 Drilling Noise Impacts at Representative Sensitive Receptors (Without Mitigation)

Representative Sensitive Receptor	Nearest Wellpad	Period	Noise Contribution dB(A) ^(a)	Baseline Noise (L _d) dB(A) ^(a)	Cumulative Noise (L _d) dB(A) ^(a)	Change in Baseline Noise dB(A) ^(a)	Compliance Status ^(c) (Yes/No)
AQ-1 (Nunang Sub-village)	WS-B	Day	44	46	48	2	Yes
		Night	44	39	45	6	No
		Day-and-night	47 ^(b)	45	49	4	No

Representative Sensitive Receptor	Nearest Wellpad	Period	Noise Contribution on dB(A) ^(a)	Baseline Noise (Ld) dB(A) ^(a)	Cumulative Noise (Ld) dB(A) ^(a)	Change in Baseline Noise dB(A) ^(a)	Compliance Status ^(c) (Yes/No)
AQ-2 (Sano Nggoang Village)	WS-E	Day	36	44	45	1	Yes
		Night	36	43	44	1	Yes
		Day-and-night	39 ^(b)	45	46	1	Yes

Notes:

(a) Noise levels are rounded to one decimal value.

(b) Five (5) decibels is added to predicted night-time noise (22.00 to 07.00 am)

(c) Compliance status was determined by comparing the cumulative day-time noise (Ld) to the relevant Project Specific Noise Criteria as provided in Table 7-7.

Cosiderable adverse impact is expected at AQ-1. AQ2 is not expected to be impacted by construction noise. AQ1 is not the nearest residence to the WS-B. The nearest residence is only 80 meters away from WS-B. At this distance, drilling noise contributions are predicted 62 dB(A) for day-time and night time noise and 64 dB(A) for day-and-night time noise. This results a baseline noise increase of more than 10 dB(A) which is a major adverse impact. Thus, a noise barrier needs to be included at WS-B construction site in order to reduce noise impact to the residential area.

NO002 Drilling Noise

Activity: Exploration drilling

Description: Drilling activities will involve the use of machinery which will generate noise.

Many of the well pad sites are near community settlements, thus the magnitude of the impact is assessed as medium. Drilling noise contribution to the baseline was assessed at AQ1 and AQ2 and evaluated against the impact criteria. Cosiderable adverse impact is expected at AQ-1. AQ2 is not expected to be impacted by drilling noise. However the nearest residence to WS-B which is only 80 meters away is predicted to experience a noise baseline increase of more than 10 dB(A). Thus the sensitivity of the impact is assessed as high. With medium magnitude and high sensitivity, without mitigation the impact is considered major significance.

Mitigation: If well pad locations need to be changed, a suitable distance should be maintained between the new well pad locations and local villages. Mitigation measures required in the UKL UPL include:

- Whenever avoidance for construction at Wellpad WS-B is not possible, install proper noise barrier wall to reduce noise spread to the nearest settlement i.e. Nunang Sub-village;
- Periodic air drilling machine and electrical generator maintenance;
- Select equipment with noise-reducing features;
- Equipping the workers with proper PPE; and
- Setting the buffer zone.

The ESIA and ESMP further require an effective grievance mechanism to record and respond to noise complaints.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	High Sensitivity	Moderate	Medium Severity	Low Sensitivity	Minor

7.4.4. Well Testing

Noise-generation during well testing and proving will result from:

- Vertical discharging process during vertical well testing
- Noise associated with general operations at the well pads and base camp (e.g., generator operation)

The well testing activities will be isolated from local communities and substantial noise generation will only last 4 to 8 hours.

NO003 Well Testing Noise

Activity: Well testing

Description: Well testing operation will generate noise from high pressure steam release. The noise will reach 110 dB at the source. Thus the magnitude of the impact is assessed as medium.

Mostly the Well pad sites are close to the community settlements; these make the sensitivity of this impact become high. There is one sensitive receptor that is less than 100 meters to a well pad which is Nunang Sub-village. With medium magnitude and high sensitivity, without mitigation the impact is considered major significance

Mitigation: The UKL/UPL requires some mitigation measures including usage of silencer, setting the buffer zone, socialization to local community and community leaders prior to well testing activity, and periodic well testing machine maintenance and electricity generator maintenance. Socialisation is needed prior to well testing activity. In addition, ESIA requires the following:

- Whenever avoidance for construction at Wellpad WS-B is not possible, install proper noise barrier wall to reduce noise spread to the nearest settlement i.e. Nunang Sub-village;
- Vertical discharge tests will be conducted at times advised and agreed to by nearby communities;
- Design of atmospheric separators for production testing to be optimized for noise abatement; and
- Develop an effective grievance mechanism to record and respond to noise complaints.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	High Sensitivity	Major	Medium Severity	Medium Sensitivity	Moderate

7.5. Land Cover and Land Use Plan

7.5.1. Overview

Spatial planning involves management and modification of nature into the human built environment. Any development that changes the physical, biological and chemical structure of the land is defined as land use change. This section focuses on the physical change of land required for the civil works and exploration phase of the Project.

7.5.2. Construction of Civil Infrastructure

The project may cause land-use changes that are incompatible with existing uses. These changes will result mainly from land clearing and preparation.

However, this geothermal activity is already included in the spatial planning for West Manggarai 2012-2032 including the development plan of Sano Nggoang Geothermal Power Plant (Article 13-(2)e), Geothermal Mining

Area (Article 31-c) surrounding Sano Nggoang Lake in Sano Nggoang Sub-district, and Structure Plan Implementation on Geothermal Energy Utilization in Sano Nggoang Lake (Article 45) even though those have not yet been shown in the map in detail (see **Appendix B** for the articles of West Manggarai Spatial Planning 2012-2032).

Figure 3-4 shows alignment of project development area in relation to spatial planning documents. The proposed well pads and auxiliary facilities lie within areas designated as farm land and community forest. The access roads to all well pads and auxiliary facilities use existing roads, and entrance access points will be built to connect existing roads to the well pad locations.

Table 7-14 compares the location of proposed infrastructure associated with the Project with the current land use and land use plan. Based on land use data, the proposed well pads are located in forest (2), crop land (2), bush land (1) and settlement (1) while the access road is located on existing roads.

Table 7-14 Land Cover and Spatial Planning by Project Infrastructure

No	Infrastructure	Land Cover*)	Land Use (Spatial Planning)
Proposed Well Pad (1)			
1	Well Pad – A	Dry land (field) and bushes	Farm Land/Area and Community Forest
2	Well Pad – B	Dry land (field) and bushes	Farm Land/Area and Community Forest
3	Well Pad – D	Forest and bushes	Community Forest
4	Well Pad – E (Alternative)	Dry land (field) and bushes	Farm Land/Area
Auxiliary Facilities			
5	Drilling Base Camp	Bushes	Community Forest
6	Laydown Area	Dry land (field)	Farm Land/Area
7	Spoil Disposal 1 (Well pad drilling)	Dry land (field) and bushes	Farm Land/Area
8	Spoil Disposal 2 (Well pad drilling)	Dry land (field) and bushes	Farm Land/Area
9	Spoil Disposal 3 (Well pad drilling) & Civil Contactor Camp	Dry land (field) and bushes	Farm Land/Area
10	Spoil Disposal Area 4 (material road upgrade)	Dry land (field) and bushes	Farm Land/Area
11	Spoil Disposal Area 5 (material road upgrade)	Dry land (field) and bushes	Farm Land/Area
12	Spoil Disposal Area 6 (material road upgrade)	Savana	Farm Land/Area

*) Reference: Environmental Baseline Section 6.2.6 Land Use and Land Cover

Project development area has the potential to decrease the carrying capacity of the forest-crop-farm area, which may alter the water balance in the area. Increased development area may cause erosion and will increase the likelihood of flood events.

LU001 Construction of Civil Infrastructure

Activity: Land clearing and preparation

Description: The Project will alter the existing land use of the area of impact. The well pads will be constructed upon land that is currently community forest, crop land, and bushes. It is further near to adjacent settlement areas. Access road improvements, new connector roads and the basecamp will be located on similar land uses.

Project development will result in land use changes affecting agriculture and community livelihoods and thus requires mitigation measures.

- Mitigation: A number of project planning mechanisms and mitigation measures which align with the UKL-UPL requirements, as follows:
- Minimize the project footprint within the most sensitive areas, such as areas near settlements;
 - Restoration to pre-existing condition before project commenced or to an alternative as selected by land owner after completion of the activity;
 - Revegetation of cleared areas should be conducted following the completion of exploration activities in order to restore ecological function; and
 - The ESIA and ESMP further require a continuous coordination and communication with the local government to keep relevant authorities informed of project updates and status.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	Medium Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

7.5.3. Site Rehabilitation and Revegetation

During the decommissioning and site reclamation phase, the exploration wells are abandoned, all temporary facility structures and infrastructure are removed, and all the disturbed areas at the project site are reclaimed. Well abandonment involves plugging, capping, and reclaiming the well site. Removal and reclamation includes break up any concrete, back fill unused cellars and sumps and spread top-soil, the degree and details of rehabilitation to be agreed with individual land owners to whom Project Owner are returning the land, and replanting vegetation to facilitate natural rehabilitation.

LU002 Land Cover Alteration

Activity: Site rehabilitation and revegetation

Description: The Project will alter the existing land use of the area of impact. The well pads will be constructed upon land that is currently community forest, crop land, and bushes. It is further near to adjacent settlement areas. Access road improvements, new connector roads and the basecamp will be located on similar land uses.

Project development will result in land use changes affecting agriculture and community livelihoods and thus requires mitigation measures.

- Mitigation: A number of project planning mechanisms and mitigation measures which align with the UKL-UPL requirements. ESIA requires a number of mitigation measures to be undertaken include:
- Minimize the project footprint within the most sensitive areas, such as areas near settlements;
 - Restoration to pre-existing condition before project commenced or to an alternative as selected by land owner after completion of activity ;
 - Revegetation of cleared areas should be conducted following the completion of exploration activities in order to restore ecological function; and
 - The ESIA and ESMP further require a continuous consultation with landowners and coordination with the local government to keep relevant authorities informed of project updates and status.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	Medium Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

7.6. Soil

7.6.1. Overview

Though there have not been any significant landslides or erosion reported in the study area, the possibility of landslides or erosion should be anticipated at locations with a slope of more than 30%. Cut and fill associated with construction of access roads in areas with steep slopes has the potential to increase the probability of the occurrence of landslides which can in turn lead to erosion impacts.

Soil erosion has the potential to occur during construction due to land clearing, excavation, earthworks and civil works for well pad and infrastructure development. These activities result in clearing of vegetation and exposure of top soil having direct effects of rainfall and surface runoff. Exposed soils and spoil heaps are subject to the risk of erosion and subsequent transport of sediments into Sano Nggoang Lake during rain events, with the potential to result in impaired water quality and sedimentation of watercourses.

In term of contaminated soil or land, it contains pollutants that have the potential to have an adverse effect on human health and the environment. This can be an issue on agricultural land that affects the soil, or if it infiltrates into the surface or groundwater. Surface water and groundwater infiltration can result in the transportation of pollutants downstream to other locations.

There is potential for land contamination by chemical and petroleum products from:

- Equipment maintenance activities (spill of lubricants)
- Fuel storage areas (spill of diesel oil and gasoline)
- Refueling stations (spill of diesel oil and gasoline)
- Vehicle/equipment wash down areas (spill of lubricants)

In addition, pipe leakage may occur during the well testing, releasing geothermal fluid (brine water) to the soil. Geothermal fluid or brine water is a hot liquid. The piping system for the Wae Sano GEUDP will be located within the well pad area. Small leaks are more likely to occur rather than major pipeline leakage at the connection between pipes.

7.6.2. Soil Erosion

SO001 Landslide and Erosion

Activity: Land clearing and preparation

Description: If landslides and soil erosion occurs, it will potentially transport sediment and damage the natural characteristics of the lake. The erosion/landslide potential is assessed as low because the project area is a relatively flat area with a slope of 0-30%. The impacted areas of WS-A, WS-B, and WS-E have medium run-off coefficient values (0.5) whereas in WS-D the run-off coefficient is relatively small at 0.1.

The existing condition of the lake water quality has been degraded, particularly for sediment due to natural runoff. There are only a few people that live along the lake and they do not use the water for household needs. This condition will be temporary and will cease after construction is over. Therefore the significance is assessed as minor.

Mitigation: The UKL/UPL requires a number of measures to build perimeter drainage around the well pad area, avoidance of land clearance outside well pad corridors, compacting soil minimum 20 cm thickness by using compactor, and installing a retaining wall.

In addition, the ESIA requires the following measures to meet international standards:

- Stabilization of batters by planting crops or physical stabilization;
- Installation of interception measures such as sediment ponds or drains; and
- Build terraces for steep slopes (over 30%).

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	Medium Sensitivity	Minor	Slight Severity	Low Likelihood	Negligible

7.6.3. Land Contamination

SO002 Poor Handling, Storage and Accidental Spill of Chemical and Petroleum Products

Activity: Equipment and material mobilization, land clearing and preparation, access road improvement, and well pad and infrastructure construction.

Description: Chemical and petroleum products are normally found and used in equipment and maintenance areas, fuel storage areas, refuelling stations and vehicle/equipment wash down areas. The spill of any of the mentioned potential pollutants or improper storage may result in direct contamination of soils, which may require immediate response and clean-up operations, therefore potential for soil contamination is assessed as moderate. However, the severity is considered medium since the impact will be temporary during construction. The likelihood is considered as likely activities will involve many vehicles

Mitigation: Measures to be undertaken include:

- All equipment and facilities at well pads will meet international design standards for safe storage and dispensing of chemicals, lubricants and fuels, containment of spilled materials, including bunded areas, perimeter drains and interception traps;
- Barriers, containment systems and pollution interception measures will be inspected regularly as part of operations to ensure suitability for purpose, proper function and condition; and
- Any accidental spills will be managed in accordance with spill response procedures.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium Severity	Likely	Moderate	Low Severity	Unlikely	Negligible

7.6.4. Well Testing

SO003 Pipe Leakage during Well Testing

Activity: Well testing

Description: Pipelines transporting geothermal fluid (brine water) during the well testing is likely to affect the soil in the event of pipe leakage. However, the severity is considered low since the drilling fluid

is water-based and categorised as non-hazardous waste. Leaks are more likely to occur at the connection between pipes. Therefore the impact of pipe leakage during well testing is assessed as minor.

Mitigation: Measures to be undertaken include:

- Prepare response plan for pipe leakage;
- Consider leakage in pipe design and construction;
- Check the consistency of pipes in terms of the quality of pipe materials;
- Corrosion control and inspection;
- Use of blowout prevention equipment such as shutoff valves and other related well control equipment; and
- If leakage is identified, response plans will be activated.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Low Severity	Likely	Minor	Low Severity	Unlikely	Negligible

7.7. Surface Water Quality

7.7.1. Overview

Surface water quality within the vicinity of the geothermal exploration project may be impacted through sedimentation from surface run-off as a consequence of land clearing and earthmoving activities, leaching of soil heaps, accidental spills of drilling fluids, fuel, and chemical products, and washout of sediment pond and pipe leakage. The project area of interest drains into Sano Nggoang Lake with a diameter of 2.5 km and maximum depth of 500 m. This lake is the largest and deepest volcanic lake in eastern Indonesia. It is the main waterbody that will be affected by the exploration activities. Small streams draining from the lake are not considered to be affected by the project since the downstream of the lake is not used by the community. However, the small stream is only flow during wet season. The lake is located approximately 100 m away from the closest proposed well pad (Well Pad A). In addition, the access road improvement might impacted to the surface water quality particularly at STA 2 and STA 7 which near by small stream.

The sensitive receptors of potential water quality impacts associated with the project are the surrounding communities in terms of social, cultural and economic aspects. The lake water has a low pH and is unsuitable for domestic purposes. In addition, the lake is attracted local and international tourists which benefit the livelihoods of local communities. Social, cultural and economic impacts are discussed in more detail in Section 8.

The impact assessment is based upon the methodology provided in Section 3. The potential sensitive receptors include local communities and the lake. The impact analysis will evaluate impacts against the baseline condition, define the receptors, determine the severity and magnitude of the impact as well as its likelihood. Some impacts resulting from the project may be major or minor in nature, and mitigation measures will further reduce impacts. Impacts to surface water quality are based upon the potential to exceed Indonesian and international water quality standards.

The qualitative impact assessment of the water quality impacts due to exploration activities indicates that the surface water quality of adjacent water bodies are not expected to adversely affect sensitive receptors. Since most of the water-based drilling mud is likely to be reused or returned to the drilling process, it is expected that there will be a limited amount of excess water during typical drilling operations.

It is anticipated that the mitigated outcomes of impacts to surface water quality will be of negligible to minor significance, and a water quality monitoring program will be put in place to ensure that those mitigation measures are effective.

7.7.2. Land Clearing and Preparation

The elevation of the study area ranges from 550 m to 1,100 m, with numerous steep slopes, since the area is located adjacent to a mountainous area. Land clearing and preparation for construction will involve removing trees, stumps, bushes, roots and rocks, which will expose soil and increase the potential for erosion during periods of rainfall.

Surface runoff occurs when rainfall intensity exceeds the soil's infiltration rate. This condition occurs during the rainy season from December to March and possibly during storm events in the dry season. Surface runoff can cause erosion of surface soils and transport of vegetation debris into the lake resulting in increased turbidity and potential transport of contaminants.

Land clearing and construction work in the highlands can potentially cause erosion of loose soil into the lake leading to sedimentation, turbidity and siltation. Prolonged and high levels of sedimentation impacts lake water quality and storage capacity over time. However, the activities associated with the Waesano geothermal exploration project are expected to have a negligible impact on lake storage capacity. The lake is not used as a water source by the surrounding community or as habitat for sensitive aquatic communities, except for phytoplankton, zooplankton, benthos and bacteria. Regardless, mitigation measures will be implemented to prevent project construction and operation from potentially contaminating nearby streams and water bodies draining into the lake.

The two main indicators of declining water quality due to erosion are Total Dissolved Solids (TDS) and Total Suspended Solids (TSS). Government Regulation No. 82 of 2001 regarding water quality management and water pollution control for class I water courses defines the TDS and TSS thresholds as 1,000 mg/L and 50 mg/L, respectively. The baseline studies of TDS at all sampling sites exceeded this threshold, while TSS at all sampling sites met the threshold. Land preparation works have the potential to increase turbidity in the lake. High turbidity might result in a negative perception of the geothermal exploration activities. This is because any significant change to Sano Nggoang Lake would result in cultural and economic impacts on the community (see Section 8).

SWQ001 Surface Water Quality Degradation

Activity: Land clearing and preparation, access road improvement and well pad and infrastructure development

Description: The potential for surface water degradation due to land clearing and preparation as well access road improvement is assessed as minor. It is likely to cause increased sedimentation to the lake through creeks proximate to the well pads and to the small stream near by STA 2 and STA 7 of access road improvement. This has the potential to adversely impact baseline water quality. The severity is considered medium as the closest proposed well pad (Well pad A) is approximately located within 100 meters.

The sensitivity of receptors is considered low as the lake water do not used for household needs. The existing condition of surface water quality and biota inside has been degraded due to natural condition.

Mitigation: A number of measures were required in UKL/UPL, such as building perimeter drainage around the well pad area, provide settling ponds and land clearing activities will be scheduled to avoid periods of heavy rainfall and strong winds as much as practicable.

In addition, the ESIA requires the following measures to meet international standards:

- Delineate the areas that will be cleared before any land clearing or earthmoving activity begins to limit the area of disturbance. If possible, conduct the clearing by phases to minimize area of disturbance and sediment generation at any given time;

- Ensure detailed design of access roads minimizes the disruption of the surface water flow regime. Provide adequate drainage to minimize contamination of proximal creeks with mud and dust from vehicle and equipment movement;
- Consider phasing plan to minimize the period of exposure for cleared areas;
- Use of interim control mechanisms such as sheeting to stabilize batters and slopes prior to permanent stabilization;
- Planting cover crops on affected areas as soon as possible for long term erosion control; and
- To manage impacts from bridge building and ford construction, measures to be undertaken include diverting water away from working areas, minimising work in the water way, and no discharge of materials and other sediment control measures.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Low Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

7.7.3. Exploration Drilling

Water based mud, a mixture of water, bentonite and surfactants, is injected during well drilling in exploration to support the well and remove cuttings. The drilling waste, composed of liquid waste (mud) and solid waste (cuttings), is transferred to a shale shaker to separate the cuttings from mud. Drilling mud waste management is in accordance with regulation of Minister of Energy and Mineral Resources Regulation Number 21 of 2017 on Drilling Mud Waste and Drilling Cuttings Management on Geothermal Activities.

Accidental release or spill of drilling waste, fluid, and mud will result to temporary turbidity if this is released to a water body. While water-based drilling muds are non-toxic, it takes time before the fine clays of the drill muds are settled out of the water column. Temporarily, spilled drill mud (depending on volume spilled) would manifest as a plume on the water surface which will impact baseline water clarity and disrupt local photosynthetic activities.

SWQ002 Potential for Spent Drilling Fluids to Reach Water Bodies

Activity: Exploration drilling

Description: Accidental release of drilling fluid is a significant issue, particularly where the liquid waste might flow to Sano Nggoang Lake thus deteriorating the water quality. The drilling fluid is water-based and categorised as non-hazardous waste. However, the severity is considered medium since this impact is irreversible also the fine mud are difficult to settle / flocculate in the water. Accidental release of liquid drilling waste is unlikely to occur since the Project has proper design to manage this impact. From this consideration the impact of potential for spent drilling fluids to reach water bodies is assessed as minor significance.

Mitigation: A number of project planning mechanisms and mitigation measures are required in the UKL-UPL, include collecting drill mud produced from drilling activities into a sump pit and be pumped for reuse (a closed-loop fluid system) or reinjection into injection well to minimize excess drilling waste, drilling mud circulation pond as well as drilling mud residual pond needs to be provided. ESIA requires a number of mitigation measures to be undertaken include:

- Construct ponds with impervious lining such as HDPE or geomembranes underlain by clay to catch drilling muds in case of accidental spills;
- Design capacity of the pond for collection should be equal if not exceed volume of drill fluid required during initial hydraulic test;
- Install oil traps on the pond inlet; and

- Prepare a Spill Response Plan.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium Severity	Unlikely	Minor	Low Severity	Unlikely	Negligible

SWQ003 Potential for Spent Brine Water

Activity: Well testing

Description: During, the exploratory phase, limited amounts of brine water will be generated during well testing, where mixture of steam, gases and geothermal fluid are released through an atmospheric separator. If released to the surface water or shallow groundwater aquifers, geothermal fluids could cause crop damage and render the water unfit for most purposes. Therefore, the severity for this impact is considered medium. The brine water will be re-injected into the injection well following extraction through a separate well; therefore potential for discharge into the environment is quite low. However, there are potential where geothermal fluids may be released into the local environment due to leakage/spillage of geothermal fluids as they are piped from the extraction well to holding ponds and then on to reinjection wells, also potential of “well blow-out” from a drilling well when high formation pressure is encountered, so that the likelihood is considered likely. From this consideration the impact of potential for brine water to reach water bodies is assessed as moderate significance.

Mitigation: A number of project planning mechanisms and mitigation measures are required in the UKL-UPL, include managing the drilling waste properly and brine water to be reinjected into the injection well by reference to Minister of Environment Regulation No. 13 of 2007. ESIA requires a number of mitigation measures to be undertaken include:

- Testing injection wells will be prepared and pipelines installed, before the deeper exploration wells are developed;
- Latent capacity will be maintained in the ponds to contain fluids in the event of pipe or pump failures or accidental releases; and
- Precautions should be made to prevent blow-outs through standard good practice, including: proper cementing, pressure monitoring and provision of blow out preventers and related well control equipment.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium Severity	Likely	Moderate	Low Severity	Unlikely	Negligible

7.8. Surface Hydrology and Hydraulics

7.8.1. Overview

The project area is located along the foothills of the Waesano volcano, and the bulk of the proposed project area footprint is located in agricultural areas.

A Water Management Plan will be developed to manage surface water runoff from the adjacent catchments. Civil structure such as culverts, weirs and drains should be included in the design

7.8.2. Land Clearing and Preparation

Construction of access roads, well pads, pipelines and base camp all have the potential to alter the natural flow of water resources.

The Project will require water for soil conditioning during construction which will be sourced from Sano Nggoang Lake.

Road construction will be on cut and fill area. This has the potential to interfere with the existing surface water flow direction especially when the access road crosses spring water channels or streams. The new road corridors are likely to obstruct water flow. Appropriate drainage and flood control structures will be therefore introduced.

The well platforms and base camp facilities will have concrete foundations. Water will be required in the concrete mix. Similarly, water demand for concrete mix will be obtained from lake water.

HYD001 Water Resources Alteration

Activity: Land clearing and preparation and well pad and infrastructure development.

Description: The construction of well pads may impact spring water channel diversions. The severity is considered low as surface water flow and water spring mostly found only on well pad B. While sensitivity of the resource is considered medium since the community do utilize water from springs for domestic and agricultural purposes and therefore their sensitivity is medium.

Mitigation: Measures to be undertaken include:

- Once alignments are finalized, surface water demands will be assessed. Linear and cross drainage design will consider continuity of supply;
- Cut and fill should not impact paddy fields or other agricultural land outside the project footprint;
- Casual storage of spoil heaps to consider surface hydrology;
- Civil design will necessarily include a number of hydraulic designs, in particular drains and culverts to ensure continuous hydraulic flows. When access roads cross a paddy field, culverts should be included in the design to maintain adequate flows; and
- Grievance mechanism to ensure that affected parties can report abnormalities in surface water.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	Medium Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

7.8.3. Exploration Drilling

The estimated average demand for water during drilling is about 80 gpm for slimhole drilling and 550 gpm for standard drilling. Peak demand is expected to be 250 gpm for slimhole drilling and 1,100 gpm for standard drilling. The drilling activities will be supplied by lake water abstraction.

The lake water will be pumped to the water treatment facility, where liquid caustic is added via an injection quill for neutralizing the acidic nature of the lake water. The water treatment facility will be constructed as a temporary and mobile installation so that the intake pump, chemical dosing equipment and water distribution pump can be moved

between the two facility locations when required. The temporary facility includes utilising Victaulic pipe which can be reconfigured according to operational requirements.

HYD002 Potential of Surface Water Deficit Due to Water Abstraction

Activity: Exploration drilling

Description: The potential for the project to cause a surface water deficit due to water abstraction is assessed at minor significance. The severity is considered medium as sustained extraction of surface water from Sano Nggoang Lake may result in a water imbalance from the existing condition. The impact is anticipated to be more pronounced during the dry season. However, the sensitivity is considered low since the lake water is not used by the community due to its quality and this will not affected the community in the downstream. In addition, during the dry season there are periods where there is naturally no surface discharge of water from the lake to the river downstream; this naturally occurring ephemeral phenomena means the ecosystem is adapted to periods of no flow and will not be adversely affected by minor changes to flow due to the abstraction.

The critical natural habitat impacts relate not only to wildlife but to the lake ecosystem from deliberate or accidental discharges of water and sediment or over-abstraction of water. Surface water impacts have been assessed as Minor or Moderate without mitigation and Negligible with mitigation. The abstraction rate and total volume required is insignificant compared to the overall volume of the lake and the abstraction can be managed so that it will not significantly degrade the unique ecosystem/critical habitat. Any reduction in lake level during dry periods would be measured in millimetres, and would be within the natural seasonal variation of lake level.

Mitigation: The UKL/UPL requires ensuring water extraction from Lake Sano Nggoang shall not exceed the water demand for drilling, so it does not reduce significantly the volume of lake water. In addition to ESIA, measures to be undertaken include:

- Development of a Water Management Plan considering project water requirements and lake water balance;
- Installation of weirs or collection boxes to ensure that appropriate flow regimes can be maintained;
- Eliminate water loss by efficient pipeline design;
- Use of ponds to collect excess water to be used for drilling activities;
- Re-use of drilling mud; and
- Grievance mechanism to ensure that affected parties can report abnormalities in surface water or groundwater flow.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Low Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

7.9. Environmental Health and Waste Management

7.9.1. Overview

Activities of construction workers and contractors, vehicles and equipment to and from the well pad sites will lead to a localized increase in organic and domestic waste; Project activities may also result in the potential release of

fuel and chemicals due to accidental spills or loss of containment of fuel storage facilities and chemicals required for construction, drilling, well testing.

Improper waste management (including improper handling, inadequate storage, and lack of redundancy measures for containment) can release pollutants to the environment which may impact local ecology, surface and groundwater quality, baseline soil quality, and human health through various pathways (ground and surface water, surface run-off, dust or dispersion through air, and direct ingestion or inhalation). In order to provide the appropriate management measures to handle wastes for the various phases of this project, it is important to be able to characterize wastes for various stages of the project development and identify appropriate handling and storage protocols as well as existing regulatory requirements for each waste item. The succeeding sections present wastes/waste streams from major activities of the project, their composition and corresponding regulatory requirements for handling and storage, if any, prior to the discussion of the appropriate mitigation and control measures to prevent or minimize the generation and accidental release of these materials

7.9.2. Land Clearing and Preparation

The majority of activity associated with the exploration phase will take place in an undeveloped area where vegetation would need to be cleared. Vegetation clearing has the potential to generate organic waste from vegetation cutting and tree stump removal.

Very few receptors would be impacted by the improper management of vegetation waste. However, the lake ecosystem can be impacted from the disposal of vegetation waste into water body (which might increase concentration of BOD and reduce DO).

Land owners that have sold or leased their land will be given the opportunity to remove valuable materials or plants from their land prior to clearing. The owners will be encouraged to harvest plants and crops that can be replanted at a different site. Upon clearing, land owners will be offered the surplus cleared vegetation in the first instance, after which local people will be permitted to utilize it as a fire-wood.

WAS001 Green Waste

Activity: Land clearing and preparation

Description: Impacts from green waste from land preparation is assessed as minor significance. Land and vegetation clearance has the potential to generate organic waste from vegetation and tree stump removal. However, very few receptors would be impacted by the improper management of vegetation waste. Therefore the sensitivity is considered low.

Mitigation: Measures to be undertaken include:

- A Waste Management Plan that includes appropriate collection and storage facilities, and involves appropriate disposal methods as required;
- Encourage reuse of green waste locally for composting/fire wood or landscaping purposes; and
- Manage regular disposal schedules to remove waste from the site where necessary.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	Low Sensitivity	Minor	Slight Severity	Low Sensitivity	Negligible

7.9.3. Construction of Civil Infrastructure

Domestic Solid Waste

Potential environmental issues associated with domestic waste generation include:

- Poor management of domestic waste leading to nuisance odour attracting pests such as flies and rodents which are common disease vectors;
- Waste such as plastic can holders and plastic bottles can be harmful to wildlife;
- Leachate from domestic waste can impact groundwater and has the potential to raise chemical and biological oxygen demand in the receiving water body (lake); and
- Improper storage and disposal of organic domestic waste (e.g., food scraps) has the potential to cause odour issues due to decomposition of organic matter and emission of gases such as methane, hydrogen sulphide, and ammonia.

Domestic solid waste is generated from the workers in the basecamp. With reference to SNI 19-3983-1995, solid waste generation for workers is approximately of 2.75 liters/person/day or 0.70 kg/person/day. The total estimated volume of domestic solid waste with the labor force during construction of 96 persons is estimated to be 264 liters / day or 67.2 kg / day and 253 liters / day or 64 kg / day during operations.

Domestic Liquid Waste

While domestic sewage is not characterized as hazardous and toxic (B3) liquid waste, it can contain high nutrient (N and P), suspended solids and pathogen (e.g., faecal coliform) concentrations. These pollutants can cause adverse impacts to receiving water bodies, including depletion of dissolved oxygen, eutrophication, aesthetic problems due to its unsightly appearance as well as odour and turbidity as a result of the presence of suspended solids. Domestic wastewater generation will come from basecamp activities. Typical average volume of wastewater is 80% of total water consumption; a worker will produce 96 liters / person / day.

The domestic sewage will be treated in portable toilet and septic tank. Well pads and road construction areas will be served by portable toilets. Portable toilets would be cleaned daily and discharge taken to the septic tank. Toilets and septic tanks will be located away from sensitive groundwater resources aquifer recharge areas, and surface water bodies as far as practicable.

Hazardous and Toxic (B3) Solid Waste

"Hazardous and toxic waste" or "B3 waste" is defined as any waste containing dangerous and/or toxic material, which due to its nature, concentration, or amount, could damage or pollute the environment or endanger the human health. B3 waste includes combustible, inflammable, reactive, toxic, infectious, and corrosive materials.

Various potential types of hazardous and toxic (B3) waste would be generated from the workshop and vehicle maintenance activities, including:

- Used filters;
- Used/damaged hoses;
- Used batteries/electronic equipment; and
- Used/expired solid/powder chemical/additives.

Construction and any demolition activities required for the drilling exploration can generate hazardous waste from materials such as used light-bulbs and contaminated packaging/containers and used rags/gloves. Hazardous and toxic waste has the potential to contaminate soil and groundwater. The amount of waste generated during the exploration phase is likely to be small and highly localized.

Hazardous and Toxic (B3) Liquid Waste

During construction, drilling and well testing of the exploratory works and engines used to operate and generate electrical energy will use diesel fuel. Diesel contains a number of toxic elements, and poses a human health risk if

it contaminates the environment. Other hazardous and toxic liquid waste used in smaller amounts during the exploratory works will likely include lubricants, hydraulic fluid and chemical drilling additives as mentioned in subsection 7.9.1. These substances can accidentally be spilled during re-fuelling equipment and storage tanks, vehicle and equipment maintenance and storage, handling and transport of used oil and lubricants. Other incidental spills could be associated with equipment failures such as ruptured tanks and hoses. Sensitive receptors from hazardous and toxic liquid waste include nearby soils, groundwater/water spring, water body/lake and vegetation.

WAS002 Domestic Solid Waste during Construction and Operation

Activity: Whole of Project.

Description: The number of workers during construction will be approximately 96 persons and 92 persons during operations. These people will generate various domestic waste items such as food packaging waste. The severity of this impact is considered medium as the volume will be generated approximately 264 liters / day during construction and 253 liters / day during operations. The sensitivity is low due to the low volumes of waste being generated.

Mitigation: Both the UKL/UPL and the ESIA require similar mitigation measures. This includes preparation of a Waste Management Plan that includes suitable disposal bins, maximises reuse and recycling, appropriate collection and storage facilities, and involves appropriate disposal methods as required. In addition, the Project needs to provide temporary storage for domestic solid waste, and coordinate with local sanitary service/agency in term of transporting waste to the nearest landfill location.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Low Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

WAS003 Domestic Liquid Waste

Activity: Whole of Project.

Description: Domestic liquid waste (sewage) is not characterized as hazardous and toxic (B3) liquid waste, but it can contain high nutrient, suspended solids and pathogen bacteria. Based on total workers during well pad and infrastructure development, 9.20 m³/day of domestic wastewater will be produced during constructions and 8.80 m³/day of domestic wastewater will be produce during operations. The severity of this impact is considered low since the Project will provide portable toilet with septic tank. The sensitivity is also low as the waste will be treated on site and should not affect the local community.

Mitigation: A number of measures have been proposed in the UKL-UPL, including:

- Provide a Waste Management Plan that includes collecting black and grey waters to septic tank (refer to national standard SNI 2398-2002 on Septic Tank with Leach Pit), providing oil separator at base camp outlet prior to discharge to public sewerage system, and appropriate disposal methods as required;
- Discharges from kitchen and washroom facilities into the septic tank are to be directed through grease traps, and appropriate disposal methods as required;
- Implement portable toilets in well pads, road work areas and workers camp to treat wastewater discharge as per Project design; and
- Portable toilets shall be used with septic tank which has function as effluent removal system.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Low Sensitivity	Minor	Low Severity	Slight Sensitivity	Negligible

WAS004 Hazardous and Toxic (B3) Solid Waste

Activity: Whole of Project

Description: General hazardous waste generated during construction and operations is assessed as moderate significance. The generation of solid hazardous waste will require appropriate waste management procedures in accordance with the regulation. If not properly managed, hazardous waste disposal could become a significant impact, however, the amount of waste generated during the exploration phase is likely to be small and highly localized; therefore, the impact is considered as medium severity. The sensitivity is medium as it has potential to contaminate soil.

Mitigation: The UKL-UPL requires a number of mitigation measures including provide temporary hazardous waste storage (*Tempat Penampungan Sementara*/TPS B3) as per regulation standard requirements and removed the hazardous waste from site by licensed hazardous waste transporter and disposed in licensed facility in accordance with the Government Regulation No. 101 of 2014 on Hazardous Waste Management. In addition, the following mitigations measure will be included in the ESMP:

- Provide a Waste Management Plan that includes appropriate segregation of waste streams, includes appropriate collection and storage facilities, and involves appropriate storage and disposal methods as required. Assignment of roles and responsibilities to employees in managing hazardous and toxic waste shall be stipulated in this document.
- Prepare a Spill Response Plan.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Low Severity	Medium Sensitivity	Minor

WAS005 Hazardous and Toxic (B3) Liquid Waste

Activity: Whole of Project

Description: During construction, drilling and well testing, engines used to operate and generate electrical energy will use diesel fuel which contains a number of toxic elements. Other hazardous and toxic liquid waste used in smaller amounts during the exploration works will likely include lubricants, hydraulic fluid and chemical drilling additives. If not properly managed, liquid hazardous waste disposal could become a significant impact. However, the amount of waste generated during the exploration phase is likely to be small and highly localized; therefore, the impact is considered as medium severity. Sensitive receptors from hazardous liquid waste include nearby soils, surface water and vegetation. Thus, the sensitivity of these receptors is considered as high.

Mitigation: The UKL-UPL requires a number of mitigation measures including provide temporary hazardous waste storage (*Tempat Penampungan Sementara*/TPS B3) as per regulation standard requirements and removed the hazardous waste from site by licensed hazardous waste transporter and disposed in licensed facility in accordance with the Government Regulation No.

101 of 2014 on Hazardous Waste Management. In addition, the following mitigations mMeasure to be undertaken in ESMP include:

- Provide a Waste Management Plan that includes appropriate segregation of waste streams, describes appropriate collection and storage facilities, and requires appropriate storage and disposal methods. The assignment of roles and responsibilities to employees in managing hazardous and toxic waste shall be stipulated in this document;
- Provide temporary hazardous waste storage (*Tempat Penampungan Sementara*/TPS B3) as per regulation requirements;
- Hazardous and toxic waste will be removed from site by licensed hazardous waste transporter and disposed in licensed facility; and
- Prepare a Spill Response Plan.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	High Sensitivity	Major	Low Severity	Medium Sensitivity	Minor

7.9.4. Exploration Drilling

Drilling mud is a lubricant fluid used in geothermal drilling. Drilling mud serves as a lubricant that reduces friction on the cutting bits and prevents congestion on the drilling shaft when it reaches the narrower part of the well body. The drilling activity will use a water-based mud. Drilling cuttings are strips of rock formation and/or other material that is removed from the borehole during geothermal drilling. It can be separated from the drilling fluid via shale shakers, and the liquid fraction is returned to the drilling mud tanks prior to reuse.

In order to be able to reuse drilling fluids or reduce the amount of drill mud used, the following options are available:

- Water can be recovered through mud cleaning where the drilling fluid is dewatered by removal of solid cuttings with the use of shale shakers, screens or cyclones. The water can then be reclaimed to mix a new batch of drill fluid and the solid cuttings can be disposed as solid waste.
- As much as practicable, closed liquid loop systems can be used to recover drill fluids and minimize spillage or loss.
- Spent drilling slurries can be injected into underlying strata as an immediate measure to control land subsidence if present or prevent pore collapse from the extraction of fluids. However, reinjection can only be applied if drill fluid is conclusively tested as non-hazardous waste, soil will not be chemically contaminated, and permeable and confined strata is present that will prevent resurfacing of the fluid;
- There are some occasions in exploration drilling where it is desirable to drill without clay-based fluids, especially in strata where clay-based fluids have the potential to damage the formation. This usually results in drilling without any fluid returning to the surface.
- Handling of drilling mud and drilling cuttings will be transported to a temporary pond and will then either be re-used or stockpiled (refers to the Regulation of the Ministry of Energy and Mineral Resources No. 21 of 2017 concerning Waste Management of Drilling Muds and Drilling Cutting on Geothermal Activities).
- Drilling mud and drilling cuttings will be collected in a temporary pond before the next stage of management is undertaken to avoid spillage to water bodies. Subsequent waste shall be utilized on site for construction materials such as concrete, retaining wall materials, raw materials or additives for bricks, etc. in accordance with applicable regulations.

The estimated production of drilling mud and drilling cuttings respectively are 70 m³ and 55 m³ for slimhole drilling and 440 m³ and 400 m³ for standard drilling.

WAS006 Drilling Mud and Drilling Cuttings

Activity: Exploration drilling

Description: Drilling mud and drilling cuttings are categorised as non-hazardous waste. The impact from exploration drilling is assessed as minor significance. Severity impact is considered as medium since its volume which can be reach 440 m³ for drilling mud and 400 m³ for drilling mud at the maximum (standard drilling). While the sensitivity is low as the local community is unlikely to be affected and the characteristic of mud and waste is as non-hazardous waste, therefore it will not harm to biotic environment. In addition, the waste can utilized in site as a construction material.

Mitigation: The UKL/UPL requires drilling mud and drilling cuttings managed in accordance with MEMR Regulation No. 21 of 2017 on Drilling Mud and Drilling Cutting Management for Geothermal Drilling Activity. In addition, this ESIA requires the following measures:

- Provide a Waste Management Plan that includes appropriate collection and storage facilities, as well as treatment and disposal methods as required;
- Closed liquid loop systems can be used to recover drill fluids and minimize spillage or loss;
- Water can be recovered through mud cleaning where the drilling fluid is dewatered by removal of solid cuttings with the use of shale shakers, screens or cyclones. The water can then be reclaimed to mix a new batch of drill fluid and the solid cuttings can be disposed;
- Prepare a Spill Response Plan;
- Landfill facility with the key features should be provided when it was confirmed that the drilling waste from the Waesano is classified as non-hazardous waste:
 - Sizing to sufficiently contain the maximum anticipated volume of all solid drilling waste produced during the exploration drilling phase including backfilling with topsoil as part of site reinstatement;
 - Installation of impermeable liner to prevent infiltration of any waste products into the soil and groundwater system beneath the landfill. This will be the same liner material planned for the drilling sumps;
 - Perimeter drains to intercept any overland flows into the landfill during rainfall run off events;
 - Burial of waste to at least 2 m below ground surface to minimise any potential surface exposure to the environment. .

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Low Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

7.10. Terrestrial Ecology Flora

7.10.1. Overview

The Project Area is located on the northern part of Sesok Forest and approximately 3 to 4 km southeast of the nearest border of Mbeliling Nature Reserve. Data on the floral diversity within the study area is very limited compared to the neighbouring protected forest, Mbeliling Nature Reserve. The main flora habitat types in the study area are lowland forest, cultivation forest and sub-montana forest with an elevation of 600-1,230 meters above sea level. The area is dominated by Ampupu (*Eucalyptus urophylla*), Kaliandra (*Calliandra calothyrsus*), Jackfruit (*Artocarpus*, *Syzygium*), Wild cherry (*Prunus* sp), Blueberry Ash (*Elaeocarpus* sp), Jamuju (*Podocarpus imbricatus*) and Kalkman (*Prunus arborea*).

Referring to the baseline data (Section 6), the proposed locations for exploration drilling are situated primarily within the cultivation forest. The potential impacts discussed below are identified based upon an assessment of exploration drilling activity's impacts to flora (approximately 2 ha per drilling site).

7.10.2. Construction of Civil Infrastructure

This project has the potential to impact habitats and vegetation inside and outside of the project footprint in several ways:

- Inside the project footprint, vegetation communities will be directly impacted during site preparation for well pad construction and access road improvements. Land clearing will use an excavator and wheel loader. This impact is considered relatively minor as the Project Area is categorized as Forest for Other Land Uses and is currently dominated by agriculture and plantation. Additionally, the construction area in the project footprint is relatively small compared to the overall Project Area.
- Indirect impacts to habitat and vegetation adjacent to works areas can include deposition of dust generated by increased traffic/construction activities, spillage of chemicals, improper wastewater discharge and dumping of solid waste.

FLO001 Impacts to Vegetation during Preparation and Development

Activity: Land clearing and preparation; and access road improvement

Description: Construction activities for exploratory drilling will involve land clearing and drilling site preparation for well pad construction, existing access road improvement, and supporting infrastructures preparation such as water supply, direction kit and temporary workers accommodation. These activities will directly impact the vegetation.

The severity is considered medium, as the amount of tree stands that must be cut down are estimated to be less than 1,000 trees/ha. The species of flora located within the project site non-protected industrial plantation and sub-montane forest, therefore sensitivity is considered low. Impacts to vegetation during site preparation and development are assessed as minor.

Mitigation: A number of measures were required in UKL/UPL, such as ensuring no tree species are classified as protected which will be cut. If there is a tree species are classified as protected, the tree need to be registered and moved by the Project to other places that will not be disturbed by project activities. In addition, the ESIA requires the following measures:

- Vegetation surveys of proposed permanent and temporary works areas once the final well pad locations are known; surveys should identify species of conservation interest and/or mature trees. Where possible, the alignment/boundary of works areas should be modified to avoid direct impacts to plant species of conservation interest and/or mature trees. If modification of boundaries is not possible, transplantation of rare/protected plant species should be considered;
- Clearly delineate areas for land preparation/other activities in the field to prevent loss of vegetation outside of designated works areas;
- Construction should not be permitted within 5 m of the drip line of large trees of conservation interest to avoid damage to tree roots;
- Wash vehicles periodically or consideration of temporary wash facilities to ensure that seeds from exotic and invasive species are not introduced by vehicle traffic during construction;
- Develop top-soil management plan;
- Restoration to pre-existing condition before project commenced or to an alternative as selected by land owner after completion of the activity
- Revegetation of areas outside the project footprint that are affected by construction activities. Native plant species should be used. If planting takes place during the dry season, the planted areas should be watered regularly until properly established; and
- Inspections of vehicles and equipment upon mobilization to limit the potential for carrying seeds of non-native/ invasive plant species.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Low Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

7.10.3. Exploration Drilling

FLO002 Impacts to Vegetation by the Drilling

Activity: Exploration drilling

Description: Exploratory drilling will involve drilling and well testing, and drilling mud and cuttings management. The severity is considered medium, due to potential vegetation loss caused by inadvertent discharge of geothermal fluids. No known species of flora located in the project site are protected species, therefore sensitivity is considered low. Impacts to vegetation by the drilling are assessed as minor.

Mitigation: Measures to be undertaken include:

- Clearly delineate areas for land preparation/other activities in the field to prevent loss of vegetation outside of designated works areas;
- Restoration to pre-existing condition before project commenced or to an alternative as selected by land owner after completion of the activity;
- Development of a revegetation plan utilizing native vegetation to address vegetation loss due to inadvertent discharge of geothermal fluids.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Low Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

7.10.4. Well Testing

FLO003 Impacts to Vegetation from Well Testing

Activity: Well testing

Description: Adverse effects on the exposed plants may occur at distances of 5–50 m from the well silencer for over-spray during the horizontal discharge and at 50–350 m from the wellhead during vertical discharge. Salinity was identified as a significant cause of plant damage including drying of leaf tissues which occurs first at the tip of older leaves and progresses along the margins as severity increases, resulting in abnormal defoliation. The severity is considered medium. No known species of flora located in the project site are protected species, therefore sensitivity is considered low. Impacts to vegetation by the well testing are assessed as minor.

Mitigation: A number of measures were required in UKL/UPL and ESIA. The measures to be undertaken include:

- If feasible, apply cover on the potential exposed plants at distances of 5–50 m from the well silencer as necessary;
- Clean water spraying on plants might be applied as an alternative in case application of cover is not feasible;
- This mitigation will not be applied during the wet season since rain will wash-off salt spray during horizontal discharge.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Low Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

7.11. Terrestrial Ecology Fauna

7.11.1. Overview

The Project Area is located within the Sesok Forest and near the Mbeliling Nature Reserve where an Important Bird Area (IBA) has been established by Birdlife International, an international bird conservation organization. There are at least four endemic bird species (Flores Hawk-eagle, Wallace's Scops-owl, Russet-capped Tesia, and Brown-capped Fantail) living in the areas surrounding Sano Nggoang Lake including the Study Area. Nunang, a sub-village of Wae Sano Village is located 1.5 km from the protected forest and is known as an ecotourism destination over the last 10 years. Sano Nggoang Lake and the presence of endemic bird species have attracted people to come to Nunang for sightseeing and bird watching.

7.11.2. Construction of Civil Infrastructure

Construction activities have the potential to impact wildlife inside and outside of the project footprint in several ways:

- Civil infrastructure works will result in permanent habitat loss, directly affecting fauna utilizing these areas. The land area to be cleared is primarily agricultural land or forest, and these impacts are considered relatively small since the total area to be cleared or disturbed by the project is less than 50ha and is surrounded by similar habitat. There would be no direct impacts to the core zone of Sesok Forest or Mbeliling Nature Reserve.
- Construction of new access roads will inhibit movement of wildlife and fragment habitats in the Project Area. It may also cause vehicular strikes due to increase vehicular activities in the area.
- Direct impacts to wildlife may also occur inside the construction boundaries if wildlife enter into the construction site and pose risks to individuals within and across the site boundary. Mitigation to appropriately handle wildlife entry into construction sites will reduce risks to both animals and the construction crews. Other direct impacts to wildlife particularly less mobile animals (herpetofauna) may also occur inside the construction boundaries if the accidental blow out during drilling is occurred.
- Sources of indirect impacts on fauna also include noise from the construction activities, general increased in human activity, evening light pollution, which have the potential to stress or disorientate wildlife in the project area. Mitigation activities that reduce noise and evening pollution will minimize these impacts.

Some species of conservation interest are known to occur within/close to proposed works areas.

FAU001 Impacts to Sensitive Wildlife Species during Preparation and Development

Activity: Equipment and material mobilization, land clearing and preparation and Infrastructure & Well Pad Development

Description: Construction activities for exploratory drilling will involve land clearing and drilling site preparation, well pad construction, existing access road improvement, material and equipment mobilization, and supporting infrastructures preparation such as water supply, direction kit and temporary workers accommodation.

The severity is considered medium, since the amount of tree stands that must be cut down are estimated to be less than 1,000 trees/ha, moreover the disturbance of fauna is secondary impact to noise increases. Baseline studies recorded 8 species of protected birds that are often found around the project site and are expected to stay away from the location where the project activity

takes place; therefore sensitivity is considered medium. Impacts to Sensitive Wildlife Species during preparation and development are assessed as moderate. In addition, the footprint of land clearance is small and the amount of forest habitat removed will be minimal and will be modified forest, and vegetation will be restored following the project.

Mitigation: Given that previous ecological surveys conducted for the ESIA baseline studies provide only high-level assessment of ecological resources in the Project Area, it is recommended detailed surveys are conducted to provide a more comprehensive assessment of baseline ecological conditions mammals, birds and herpetofauna (less mobile wildlife). These surveys should focus on the footprint of the proposed development plus all areas 100m from the footprint. Surveys should be conducted by suitably qualified ecologists using established survey methodologies.

UKL-UPL required management plan that is similar to noise impact (such as using vehicle with exhaust and silencer in accordance with the manufacturer's specifications, and limit the hours of mobilization for equipment and material and attention will be paid to operations in the proximity of community areas), no wildlife species classified as protected in the project area prior to land clearing and preparation, and if there is a wildlife species are classified as protected, the wildlife to be registered and moved by the Project to other places that will not be disturbed by project activities.

Other mitigation includes:

- Reduction of habitat disturbance, such as not exceeding the specified project footprint;
- Training of construction crews on the appropriate response to wildlife encounters that may occur in the project area;
- Instruction to construction crews to refrain from harassing wildlife including poaching and hunting;
- Instructions to the construction foreman to stop work in the event that large or interest conservation wildlife enter the work area;
- Proper disposal of construction and worker waste to avoid any attracted animals for leftovers;
- Fencing/hoarding around works areas to prevent animal entry and minimize light/disturbance impacts;
- For the activities in Well Pad D (WS-D), habitat enhancement/creation to compensate for direct/indirect and permanent/temporary impacts to habitat for key species of conservation interest should be comply with relevant applicable regulation as well as obligation as stated in the Borrow and Use Permit of the protected forest area;
- Prohibit hunting and poaching of wildlife;
- Provide banner informing prohibitions of hunting and poaching of wildlife; and
- Collaboration with Indonesia BirdLife Foundation to conduct specific monitoring and protection in particular for critically endangered species with providing signage and socialization.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Low Severity	Medium Sensitivity	Minor

7.11.3. Exploration Drilling and Well Testing

The drilling and well testing have the potential to directly and indirectly impact wildlife. Direct impacts may result from wildlife encounters on the well pads, at the road corridors or base camp. Mobile wildlife such as mammals, birds and herpetofauna may also be impacted by direct contact with hot pipelines.

Indirect impacts may occur due to accidental events, such as the exposure of soil or water to hazardous materials and the subsequent spreading of these materials offsite through groundwater or surface flows. Mitigation measures would reduce the likelihood of significant impacts. Indirect impacts may also result from erosion, spilling of light and noise from drilling activities during the evenings. Mitigation would also reduce these risks and the likelihood of significant impacts.

FAU002 Impacts to Sensitive Wildlife Species during Drilling

Activity: Exploration drilling

Description: Noise and lights from the drilling activities, general increases in human activity, and evening light pollution have the potential to stress or disorientate wildlife and lead to them leaving the area. The severity is considered medium. Baseline studies recorded 8 species of protected birds that are currently often found around the project site, therefore sensitivity is considered medium. Impacts to sensitive wildlife species during drilling assessed as moderate.

Mitigation: As well as noise management in Section 7.4.3, a number of measures for noise also required in UKL-UPL for periodic air drilling machine and electrical generator maintenance, select equipment with noise and light-reducing features, and setting the buffer zone. In addition, ESIA requires the following:

- Fencing around work areas to prevent animal entry and minimize light/disturbance impacts during the night time. An application unidirectional light is an alternative if the fencing is not feasible;
- Installation of safety barriers such as fences to avoid wildlife contact with hot pipelines, should temperatures exceed safe levels;
- Instruction to the site foreman to stop work in the event that large or interest conservation wildlife enters the work area;
- Training for crews, during operation of the well pads, on the appropriate response to wildlife encounters that may occur on the well pad site;
- Prohibit hunting and poaching of wildlife;
- Provide banner informing prohibitions of hunting and poaching of wildlife and
- Training for base camp occupants on the appropriate response to wildlife encounters that may occur and instruction to occupants to refrain from harassing wildlife.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Low Severity	Medium Sensitivity	Minor

FAU003 Impacts to Sensitive Wildlife Species during Well Testing

Activity: Well testing

Description: Noise from the well testing activities, general increases in human activity, and evening light pollution, have the potential to stress or disorientate wildlife and lead to them leaving the area.

The severity is considered medium. Baseline studies recorded 8 species of protected birds that are currently often found around the project site, therefore sensitivity is considered medium. Impacts to sensitive wildlife species during drilling assessed as moderate.

Mitigation: Same as FAU002

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Low Severity	Medium Sensitivity	Minor

7.12. Sustainability and Climate Change

7.14.1. Overview

Greenhouse gas (GHG) emissions for this project are associated with burning of diesel fuel from off-road and on-road equipment as well as worker vehicle trips. Cumulative increase in GHG concentrations in the atmosphere globally can be attributed to various sources such as burning of fossil fuel, agricultural by-products, land clearing and others. Geothermal energy and its associated activities however, contribute less in terms of GHG emissions, compared to traditional fuel sources, and is commercially proven to be renewable potentially reducing a country's dependence of fossil fuels and generation of GHG emissions (Geothermal Handbook: Planning and Financing Power Generation by the International Bank for Reconstruction and Development, World Bank Group, June 2012).

The CalEEMod air quality model was used to quantify GHG emissions associated with proposed project construction and operations following the same estimation methodology and assumptions specified in the above sections related Construction Emissions. Within CalEEMod, CO₂, CH₄, and N₂O emissions factor data for construction equipment and motor vehicles are derived from the OFFROAD2011 and Emission Factors 2014 (EMFAC2014) models. CO₂, CH₄, and N₂O emission factors were selected for calculations based on the equipment type, horsepower rating, and corresponding equipment tier standards. Maximum daily and annual CO₂, CH₄, N₂O, and CO_{2e} emissions from the proposed construction-related activities were quantified by the CalEEMod model for construction year.

The CalEEMod model does not analyse emissions from construction-related electricity consumption, natural gas consumption, water use, or wastewater treatment. Construction-related emissions from the use of these utilities vary based on the amount of power and water used during construction and other unknown factors that render them too uncertain to quantify. In addition, they are typically small contributors to construction GHG emissions. As such, these sources of GHG were not included in the quantification.

7.14.2. Construction GHG Emissions

Table 7-15 presents annual CO_{2e} emissions associated with the construction of the proposed Project. The highest estimated GHG emissions during the construction are 333 MT CO_{2e} within the year 2018. According to the IFC Performance Standard 3 (IFC, 2012) for a project that is expected to produce more than 25,000 MT CO_{2e}/year, the project proponent is required to report their annual Scope 1 and 2 GHG emissions. Scope 1 emissions are direct emissions from the facilities owned or controlled within the physical project boundary as for Scope 2 emissions are indirect emissions associated with the off-site.

For comparison, these total GHG emissions for this proposed project was then compared to the national inventory of GHGs from energy sectors (PUSDATIN ESDM, 2015). The PUSDATIN ESDM reported that total GHG emissions from all energy sectors (for business as usual scenario) in 2013 were estimated as 475 million MT CO_{2e}. On the basis of the available data and assumptions made, emissions from the operations are negligible.

Table 7-15 Annual Construction Greenhouse Gas Emissions (Unmitigated)

Phase Name	Year	CO _{2e} Emission (MT/year) ^{(a), (b)}
Upgrade Main Access Road	2018	137
	2019	131
Slim-hole Well pad Construction	2018	196
	2019	99
Standard-hole Well pad Construction	2020	135
Total	2018	333
	2019	230
	2020	135

Notes:

(a) Emissions might not add precisely due to rounding.

(b) The emission estimates presented in this table were calculated using the latest available data, assumptions, and emission factors at the time this document was prepared.

SUS001 Greenhouse Gas Emissions during Preparation and Development

Activity: Land clearing and preparation, equipment and material mobilization, access road improvement and well pad and infrastructure development.

Description: Construction vehicles and equipment will generate greenhouse gases due to the burning of fossil fuels and clearing of vegetation will result in the loss of sequestering capacity for carbon dioxide. The construction of the project will be a net generator of greenhouse gas.

Mitigation: Measures to be undertaken include:

- Use of low emission vehicles for mobilization activities;
- Use generators with low emissions;
- Ensure that the engines of all vehicles and machinery on site are not left running unnecessarily;
- Conduct regular maintenance of vehicles and equipment to minimize emissions; and
- Disturbed areas that will no longer be developed can be revegetated with local vegetation to serve as buffer for future activities and operation and to increase local sequestering capacity for greenhouse gases.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Magnitude	Low Sensitivity	Negligible	Low Magnitude	Low	Negligible

7.14.3. Exploration Drilling and Well Testing

The operational GHG emissions are associated with drilling rig operation, operational worker vehicle trips, and fugitive GHG emissions during well testing. The CalEEMod air quality model was used to quantify GHG emissions associated with drilling rig operation and operational worker vehicle trips. Fugitive GHG emissions during well testing can be considered negligible.

Table 7-16 presents annual CO_{2e} emissions associated with the operations of the proposed Project. Total estimated GHG emissions during the project operations are 1,074 MT CO_{2e}/year. According to the IFC Performance Standard 3 (IFC, 2012) for a project that is expected to produce more than 25,000 MT CO_{2e}/year, the project proponent is required to report their annual Scope 1 and 2 GHG emissions. Scope 1 emissions are direct

emissions from the facilities owned or controlled within the physical project boundary as for Scope 2 emissions are indirect emissions associated with the off-site.

For comparison, these total GHG emissions for this proposed project was then compared to the national inventory of GHGs from energy sectors (PUSDATIN ESDM, 2015). The PUSDATIN ESDM reported that total GHG emissions from all energy sectors (for business as usual scenario) in 2013 were estimated as 475 million MT CO₂e. On the basis of the available data and assumptions made, emissions from the operations are negligible.

Table 7-16 Annual Operational Greenhouse Gas Emissions (Unmitigated)

Source	Year	CO ₂ e Emission (MT/year) ^{(a), (b)}
Drill Rig Operation	2018	974
Worker Commuter Trips	2018	99
Sum	2018	1,074

Notes:

(a) Emissions might not add precisely due to rounding.

(b) The emission estimates presented in this table were calculated using the latest available data, assumptions, and emission factors at the time this document was prepared.

SUS002 Greenhouse Gas Emissions during Exploration and Well Testing

Activity: Exploration drilling and well testing

Description: Drill rig will generate emissions due to the burning of fossil fuel. During well testing, there is a potential to emit bursts of heated steam containing CO₂. However this high GHG emission may not impact any sensitive receptor directly especially in the short term period. This makes the sensitivity of the impact is considered low. The combination of low severity and low sensitivity results negligible significance of the impact.

Mitigation: Measures to be undertaken include:

- Use of low emission fuel for drill rig;
- Use a well testing strategy to minimize CO₂ emissions from steam release during testing.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	Low Sensitivity	Negligible	Low Severity	Low Sensitivity	Negligible

8. Potential Social Impacts and Mitigations

8.1. Overview

This section reviews the exploration phase activities and describes the potential social impacts, as defined by Indonesian Law and World Bank Safeguard Policies. Using the approach defined in Section 4 Environmental and Social Impact Assessment Process, significance is first assigned to the raw or unmitigated potential impact. Then, the planned project response or mitigation measures are described, and finally, the significance of the residual impact (post mitigation) is defined.

For each project exploration activity, the following social, health and safety issues have been considered:

- Land acquisition and economic displacement;
- Socio-economics;
- Community health;
- Traffic, transport, and community safety;
- Community amenities;
- Visual impact;
- Socio-cultural; and
- Labor rights and occupational health and safety (OHS) issues.

8.2. Impacts Matrix

An inventory of all of the recognised social and community impacts is presented in the impacts inventory below. Details of each of the recognised impacts and their background are presented in the subsequent sections.

IMPACTS INVENTORY

Land acquisition and Economic Displacement

Significance

		Raw	Mitigated
DISP001	Impact to Loss of Agricultural Land	Moderate	Minor
DISP002	Disturbance to Community Livelihood and Income	Moderate	Minor
DISP004	Land Disputes	Moderate	Minor

Socio-Economics

Significance

		Raw	Mitigated
ECON001	Local Employment and Business Opportunities	Positive	Positive
ECON002	Project Induced In-migration (PIIM) Impacts	Minor	Negligible
ECON003	Positive Impact to Tourism	Positive	Positive
ECON004	Disturbance to Bird Watching Ecotourism	Moderate	Minor

Community Health

Significance

		Raw	Mitigated
PH001	Dust Emissions and Temporary Noise Disturbance to Community Health	Moderate	Minor
PH002	H ₂ S Exposure and Impacts to Community Health	Moderate	Negligible

Traffic, Transport, and Community Safety

Significance

		Raw	Mitigated
TTS001	Dust Emissions and Temporary Noise Disturbance to Community Health	Moderate	Minor
TTS002	Safety Risk of Road Users and Community Residing along the Access Road	Moderate	Negligible

Community Amenity

Significance

		Raw	Mitigated
AMEN001	Impacts on Quality of Public Road and Community Access	Positive	Positive

Visual Impact

Significance

		Raw	Mitigated
VIS001	Visual Impact during Preparation and Development	Minor	Negligible

Socio-Cultural

Significance

		Raw	Mitigated
SOC001	Social Fabric and Community Perception	Moderate	Minor
SOC002	Impacts on Cultural Heritage	Moderate	Negligible

Labor Rights and OHS

Significance

		Raw	Mitigated
LOHS001	Violation of Labor Rights and Working Conditions	Minor	Negligible
LOHS002	OHS Risks	Moderate	Minor

8.3. Land Acquisition and Economic Displacement

8.3.1. Overview

The Project exploration activities require land for the development of exploration well pads, access road widening, a basecamp, and other supporting facilities such as a logistical base for administrative and emergency services, a warehouse, laydown area and spoil disposal, as detailed in Section 4 Project Description. Land leasing and purchase scheme apply for the following total land areas of 17.60 Ha:

- Land for four exploration well pads and their supporting facilities will be leased from the land owner – it is estimated that the Project will lease a maximum 1.03 ha of land for each of slimhole well pad or 3.15 ha for each of standard well pad, and about 10 ha of total areas for supporting infrastructure (total areas of 16.86 Ha); and
- Land for road widening to support the mobilization of drilling rigs and material, land clearing equipment and materials and personnel will be purchased – a total of approximately 0.74 Ha of land at 22 locations will be acquired.

The Project plan for land acquisition will be conducted through three schemes i.e. rental process for well pads and main exploration facilities areas; willing seller – willing buyer for road widening in which the process will be led by the Regional Road Agency; and granted land dedicated for public purposes. Land procurement process for the Project will be facilitated by SMI as the Project proponent. However, at the current Project stage, location and details of land requirements could not yet be fully confirmed; therefore, direct consultation with the potential affected land owners could not be conducted. Although the Project has some proposed well pad points, these well pad locations are indicative only and it is possible that drilling pads may be moved anywhere within the Project AOI, depending on changing Project needs.

Since the confirmed location and land requirements were not yet available at the time this ESIA was developed, direct consultation with the potential affected land owners could not be conducted. Therefore, details of the socio-economic data on affected people could not be conducted to identify the extent and significance of land acquisition impacts. General information of the entire area of influence will be used instead.

8.3.2. Impact to Loss of Agricultural Land

The Project has planned the location of well pads and their supporting facilities will be located at distance from settlement and areas that have ecological and cultural significance, to reduce significant impacts to the local community. However, land requirements for these Project exploration facilities will have direct impacts to landowners through the loss of land, in particular to the following sensitive receptors:

- Owners/households of land areas where the drilling exploration activities are conducted within Wae Sano Village – impact will be temporary for approximately two (2) years of land lease during exploration phase; and
- Those who will experience permanent loss of land due to acquisition for road upgrading locations along the existing public road within Sano Nggoang Sub-district.

Observation and interviews with local communities during the baseline survey undertaken for this ESIA identified that the land use within the proposed Project AOI is predominated community/private-owned mixed plantation land such as candlenut, coffee, cacao, coconut, clove, and pepper. The majority of the interviewed households are working as farmers as their primary livelihood. Only some of them were working in the service and private sector or entrepreneurship as the household's main income source. This indicates that the community has a strong livelihood connection to agricultural land. However the baseline also identified that these community plantations are considered small-scale undeveloped plantations, still managed traditionally within the family (i.e. minimum used of external labors). Therefore, in addition to their primary income, most households would also have a secondary income source from casual labor as they can not depend only on the land.

In term of ownership status, although the communities in the study area are still living traditionally, it was also identified from the ESIA baseline that the ownership of land in West Manggarai has shifted from communal to individual ownership; this may make negotiation of voluntary land acquisition less complicated.

DISP001 Impact to Loss of Agricultural Land

Activity: Land acquisition and compensation

Description: The ESIA baseline indicates that the land use within the AOI is predominantly plantation land, however the land is mostly undeveloped small-scale plantation land, with most households having multiple sources of income; therefore, sensitivity is assessed as medium.

The Project has indicated that acquisition of land will occur on a voluntary basis, through willing seller-willing buyer or rental, in which adequate compensation will be offered based on a fair negotiation process with the land owner; however the land will be fully restricted during the approximately 2 years of lease, while for the road widening it will be permanent loss. Therefore, severity is considered medium.

Mitigation: Preliminary LARAP has been developed to reflect land acquisition implementation plan/procedures specifically for the Project's land acquisition process. This document will be treated as a living document with the method potentially updated to better fit the Project future development. The document has included recommendation for consultation with local customary leader in relation to cultural sensitive areas, also coordination with relevant government agency pertaining to forestry boundary in adjacent to the proposed Project facilities locations (see **Appendix L Preliminary LARAP**).

Once sites are confirmed, the Project will complete a full Land Acquisition and Resettlement Action Plan (LARAP) that will apply the principles of World Bank OP 4.12 on Involuntary Resettlement which has been adopted in the Resettlement Policy of GEUDP ESMF. The following mitigation measures are proposed to manage impacts related to loss of agricultural land, which will be included in the full LARAP:

- Gather socio-economic data of each of the affected people as a basis to identify vulnerability associated with loss of agricultural land;
- Further consultation with each of the Cultural Leaders/Family Clan owners of the proposed land is required to enable the land release, along with appropriate disclosure and consultation to all affected persons regarding the Project land acquisition process;
- Prioritize willing buyer-willing seller negotiations for land lease or land purchase;
- Compensation framework to be developed in accordance with Indonesia regulation and World Bank safeguard policies, to ensure fair compensation for land, crops, structures, and replacement value; and
- (GRM) to be established to allow all groups of affected people to share their concerns and complaints regarding the land acquisition process.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Medium Severity	Low Sensitivity	Minor

8.3.3. Disturbance to Community Livelihood and Income

The assessment of the Project's land acquisition impacts to community livelihoods includes those parties that are directly and indirectly affected by the land rights transfer, by either temporary lease or permanent purchase. The World Bank Safeguard Policy expected compensation for the indirect or economically affected parties shall be aligned with the compensation process for those directly affected due to loss of assets or physical displacement. Indirect or economically affected parties may include:

- Those that own assets on land they do not own i.e. sharecroppers that are not acknowledged under the government compensation scheme;
- Parties whose source of income is partially or fully derived from working on the land (e.g. agricultural laborers);
- Those who become restricted in accessing forests and other natural resources, including people affected by restricted access to income sources; and
- Vulnerable people which are defined in World Bank OP 4.12 as "at-risk" groups including people who, by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage or social status may be more directly affected by the land acquisition and associated loss of land and/or livelihood.

Within the Project AOI, direct impact to loss of land includes impacts on commercial crops such as candlenut, bettlenut, coffee, as well as to various food crops that are grown locally and used for domestic household consumption such as coconut, palm sugar, cacao, rice, corn, peanuts, soybean, and common vegetables such as chilli, tomatoes, sweet potato, bananas, and cassava. Most of these plantations are small-scale and managed by the family and so generally do not use external farming labor or sharecroppers. However, to sustain livelihoods, communities are also engaged in small-scale land-related activities, generally for secondary income sources, such as small retail shops, homestays, raising chickens and ducks, other animal husbandry, including buffalo, cows, pigs and goats. These indicate potential Project land acquisition impacts on community livelihoods beyond loss of land.

DISP002 Disturbance to Community Livelihood and Income

Activity: Land acquisition and compensation, well pad and infrastructure development, access road improvement, and equipment and material mobilization

Description: The social baseline identified the agricultural sector as the main source of income not only at the regional level, but also for the local community of Wae Sano and Sano Nggoang. Due to challenges in capital, skill, and infrastructure, the agricultural sector within the Project AOI is relatively undeveloped and less productive, and large portions of agricultural products are used for domestic consumption only. Thus there is a high community economic attachment to land beyond the loss of agricultural production; therefore, sensitivity is assessed as medium.

Severity is assessed as medium considering most land acquisition impact will be temporary for approximately 2 years of a land lease; therefore, the impacts to community livelihood are predicted to be moderate for raw significance, but could be negligible after implementation of the proposed mitigation measures, as below. Of note, individual impacts on each of the affected land owners/households should be identified once socio-economic data has been gathered as part of the land acquisition process/LARAP implementation.

Mitigation: The UKL-UPL observed a number of mitigation measures to manage land acquisition impacts to community income, including consultation with the identified affected people and cultural leaders (*Tu'a Golo* and Member of *Wau*) regarding the compensation mechanism, assistance in the use of compensation, and prioritising the land acquisition-affected people to receive benefits from the community development program.

In addition, the following mitigations measures will be included in the proposed LARAP to manage further disturbance to community livelihoods and loss of income, aligned with World Bank expectations:

- Identification of vulnerable parties affected by the Project based on socio-economic data for each of the affected land owners and their households;
- Compensation for economic loss or displacement will be provided, as in accordance with the World Bank OP 4.12 with particular attention to ensuring that economically affected parties, including vulnerable people, receive compensation pertaining to and reflecting the loss of livelihood or access to income sources;
- Livelihood restoration program to be provided for the significantly affected and vulnerable people – The program is covered by the Community Development Program that was developed by PT Sarana Multi Infrastruktur (Persero)³⁵; and
- Develop and disclose a community GRM to provide an opportunity for community members, including vulnerable groups, to share their concerns and formally lodge complaints regarding the land acquisition process.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Medium Severity	Low Sensitivity	Minor

8.3.4. Land Disputes

Land disputes are common during land acquisition activities, particularly those undertaken for project development, as it often raises community expectations for potentially higher compensation value compared to a common personal transaction between community members. As identified from the social baseline survey, the potentially affected land within the Project AOI is generally individually owned. However, there were a number of communal land areas which were identified by the community as historic areas within the location of Well Pads B (a detailed description is presented earlier in Section 4 Project Description).

Potential disputes over land acquisition may include:

- Even for individually-owned land where the owner is a willing seller, there remains potential for land ownership disputes between community members. For example, land may be acknowledged by more than one owner, especially in the case of inherited land (e.g. siblings), and the boundaries of parcels may be disputed; and
- Disagreement from locals associated with the acquisition of land areas with cultural significance.

Baseline interviews indicated that land issues were often related to boundary disputes between community land and protected forest. Another recent dispute was with the Public Works Agency concerning old land areas that were about to be acquired without consulting with the cultural leader, resulting in the cancellation of the acquisition process. Alternative resolutions for the land dispute were identified from consultation with some of the local cultural leaders (*tu'a golo*). Reportedly, in the Manggarai and Mata Wae culture, land disputes are usually solved by the family and customary institutions under the *tu'a golo* authority through *Lonto Leok* (consensus forum discussion), using local customs. Customary and cultural symbols are used in the forum with the aim of a peaceful resolution. This indicates the importance of cultural leader's roles in land matters-related decisions.

³⁵ A community development program called *Desa Bhakti Untuk Negeri II* (DBUN II) was developed by PT SMI to address potential adverse impacts to the surrounding community and environment within the area of influence for the Waesano Geothermal Exploration activities. According to the assessment conducted by *Yayasan Dian Desa* (YDD-a NGO assigned by PT SMI in implementing the program), DBUN II activities are divided into two programs, namely Category A which the program consists of education facilities improvement and rehabilitation of water supply infrastructure, and Category B which consists of entrepreneurship capacity building for four components i.e. fabric weaving handicrafts, processing of honey and cashew nuts (non-timber forest product) and carbonizing of candle nut waste. Category A and fabric weaving handicraft programs has been started since October 2018 whilst the others would be commenced in 2019.

DISP003 Land Disputes

Activity: Land acquisition and compensation

Description: Considering the small areas of land over a large area that are required for exploration activities, and that most of them will be acquired only temporarily through leasing, severity is assessed as low. Meanwhile, sensitivity is assessed as high. Although the Project is aiming to build the well pads and other project infrastructure on individually owned land, potential land disputes could arise when the acquisition of communally owned land cannot be avoided, as decisions for communal land release are dependent on the cultural leader. Potential disputes between community members over individually owned land are also present, because land within the Project AOI do not normally have a formal land certification; therefore there may be disputes over boundaries of inherited land.

Impact significance is considered Moderate, however with the proposed mitigation measures, the significance is expected to be reduced to Minor.

Mitigation: The UKL-UPL recommended further consultation regarding the most appropriate compensation mechanism for land lease and its process, ensuring consent form from the affected people, and ensuring transparency in the acquisition process including methods for determination of compensation value. These will be included as part of the LARAP.

In addition, the following are required:

- Prioritize willing buyer-willing seller negotiations for land lease or land purchase;
- Consult widely with *tu'a golo* and other community leaders to identify legal or traditional land owners;
- Community development and community relations team to be directly responsible for management of community issues throughout the duration of the Project life;
- Maintain a record to monitor community disputes and Project responses;
- Develop and disclose a community GRM to provide an opportunity for community members to share their concerns and formally lodge complaints regarding the land acquisition process; and
- Should any land disputes arising from the Project, issues will be addressed through further consultation with the cultural leader in a culturally appropriate manner.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	High Sensitivity	Moderate	Low Severity	Medium Sensitivity	Minor

8.4. Socio-Economic

8.4.1. Overview

All phases of the Project have the potential to interact with the socio-economic conditions in the local community. Whether it be through the employment of local personnel in their workforce or the import of foreign workers; the Project, if approved, will be interacting with the socio-economic circumstances of the local community throughout its implementation.

While the Project may adversely affect the sources of income for some local community members, it may also offer employment opportunities and/or increased revenue to local businesses. For example, the Project will impose exploration activities (e.g. land clearing, road access improvement and well drilling) and will therefore increase the local population in the short-term, bringing more visitors to the area. Such a population increase provides an opportunity for new business ventures and may create employment opportunities for unskilled and non-technical labor. This would have a positive economic impact to the local community, but it also comes with a range of potential risks of benefit competition with locals, over burdening public facilities and infrastructure, health issues, and disturbance to the local environment, including the existing ecotourism potential.

8.4.2. Local Employment and Business Opportunities

Engagement with the community during the ESIA baseline study identified a low interest in working for the Project. This may be due to the fact that the skills sets of the local people, which are mostly agricultural in nature, may not match those required for the Project. The baseline identified over 70% of the regency population works in the agricultural sector, and only about 5% works in the manufacturing industry or has been exposed to industrial type of work. The remaining 20% of the local population works in the services, transportation or communication industry.

The Project estimates a peak number of workers during the exploration stage at approximately 140 workers; this includes the manpower required by contractors for well pad construction and drilling. The peak of employment would occur within the first year of Project exploration. A detailed breakdown of the workforce and project duration is described in Section 4 Project Description, of this document. Given the nature of geothermal work, which mostly requires specific skills, the local people would likely only able to satisfy the requirement of non-skilled support workers for the project, i.e. approximately 20% of the total Project workforce requirements. To optimise the Project benefits on local employment, the Project should ensure that the local community will be informed and given equal opportunity to apply for and be employed by The Project. This may be achieved through an overarching local hiring policy, placing employment advertisements in prominent public places and community spaces and delivering training.

The presence of the Project workforce will require a number of goods and services which are expected to be sourced from local enterprises and small businesses, e.g. in-migrant workers will require basic needs of food and services during their stay in the Project area, while some contractors are also likely to stay in the community. In addition, the Project has committed to, wherever possible, sourcing exploration resources and materials from the local community/area, including quarry materials, transportation, hardware and other general materials supply. These are opportunities for locals to obtain a benefit from direct and indirect business partnerships with the Project. As identified in the ESIA baseline, tourism supporting facilities and infrastructures (such as accommodation, food stalls, and car rental service) are a growing local business in the Wae Sano and Sano Nggoang area. Further, there has been growth in the number of mining and quarry businesses in the last 5 years.

ECON001 Local Employment and Business Opportunities

Activity: Recruitment of workforce, access road improvement, and equipment and material mobilization, well pad and infrastructure development

Description: There will be a positive effect to the local economy from hiring local workers for exploration activities. Although it is likely that only a low number of local workers would be employed i.e. for non-skilled labor requirements for land preparation and well drilling (estimated to be 30 people), it is expected that that these non-skilled positions will be sourced from locals and/or within West Manggarai Regency.

While the quality and quantity of service able to be provided by local communities might be limited, the socio-economic impacts to business opportunities are assessed to be positive. The indirect effects from the Project activities and the presence of non-local workers would be expected to generate business and enterprise in the accommodation, food and entertainment sectors, and provide a multiplier effect on the local economy. Further, effective implementation of the ESMP would render the mitigated significance positive.

Mitigation: The UKL-UPL requires a number of measures to optimise the Project's positive impacts to employment and business opportunities including: (a) Prioritising local workers in accordance with the Project qualifications; (b) Coordination with the local manpower agency and village government for the local recruitment process; (c) Transparency of the process to avoid social jealousy between community members; (d) Ensuring wages for the local workers are in accordance with applicable regulations; and (e) Providing opportunities for local business in the procurement of goods and services to support the Project activities, including non-formal or indirect services e.g. transportation services/car rental, food catering and homestays for workers.

Measures related to workforce management should be included in a Labor Management Plan (LMP) which should be developed by the Project in accordance with applicable national and regional regulation, as well as the World Bank Safeguard Policy (Managing the Risks of Adverse Impacts on Communities from Temporary Project Induced Labor Influx). In addition, the following measures are recommended to ensure that proper engagement and consultation are conducted, aligning with World Bank expectations:

- Develop a transparent, clear and neutral procedure of local worker recruitment which is appropriately disclosed to the local community; coordinate with the sub-district or village government and leaders (e.g. posters of recruitment process to be installed at sub-district and village government office);
- As part of the Project social responsibility, to optimize positive impacts on business opportunities for locals, to develop and implement community development/ empowerment plan for potential local business partners through (a) Consultation with the local business to identify need and potencies for development; and (b) Implement a series of training sessions targeted at improving community capacity to provide materials and services required by the Project; and
- Grievance redress mechanism (GRM) to be established to allow all groups of affected people to share their concerns and complaints regarding the Project worker recruitment process.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
-	-	Positive	-	-	Positive

8.4.3. Project Induced In Migration (PIIM)

Project induced in-migration (PIIM) involves temporary or permanent movement of people into the area considered as the Project Area of Influence (AOI), in anticipation of, or in response to, the real and perceived economic and social opportunities and benefits associated with the delivery of the Project. A number of social risks typically arise due to influx migration including:

- Risk of social dispute between migrants and locals in economic competition, resulting in changes to the social fabric – the risk is higher based on the community's low education level and unfamiliarity with industrial activities resulting in even lower chances to obtain benefits from the Project;
- Increased health issues, risk of communicable diseases and burden on local health services – the baseline identified a minimal number of communicable disease associated with influx migration, however poor health facilities and services were observed;
- Increase in traffic, potential road accidents, and crime as the Project AOI is relatively undeveloped with low existing traffic flow;

- Increased burden on and competition for public service provisions, including pressure on accommodations and rent although there are a number of accommodation for tourism purposes already existing; and
- Local inflation of prices of land, housing, and goods and services, triggered by increased land purchase by in-migrants.

These risks are likely to occur at the Project AOI considering that the majority of semi-skilled and skilled workers (approximately 80% of the total workforce requirements) will be sourced from outside of the community. In addition, the movement of non-locals into the Project AOI would not be limited to the project workforce, but also other parties seeking benefits from the Project, e.g. business people, traders, suppliers, and informal service providers that could not be found in the local villages.

The significance of the potential risks of PIIM to the local community have been compared to the baseline condition. The ESIA baseline identified that although population growth in West Manggarai Regency has been gradually increasing since 2014, at the sub-district level the population density in Sano Nggoang Sub-district remains relatively low. The population of Sano Nggoang Sub-district was 14,241 people in 2015, while the total population of the villages within the Project AOI was only about 15% of the Sano Nggoang Sub-district population. The estimated number of people working for the Project outside Sano Nggoang Sub-district will increase the local population by only around 2%. While the actual in-migration numbers are likely to be bigger, it is unlikely to be significant compared to the existing population, growth and density.

The baseline also identified that the communities in Wae Sano and Sano Nggoang are accepting of the presence of non-locals, such as tourists and researchers staying in the villages. This indicates a lower potential risk of disputes between locals and in-migrants.

ECON002 Project Induced In-migration (PIIM) Impacts

Activity: Workforces recruitment and provisions of goods and services

Description: The severity of the impact is assessed as medium, considering the majority of the Project workforce will enter the community and stay temporarily over approximately 2 years during the exploration stage. Further, the relative increase in population from in-migration and tourism is not likely to be significant compared to the baseline. Although the number of workforce requirements are relatively insignificant compared to the population of the Project AOI, the area of impact may be larger since the suitability of accommodation in Sano Nggoang District may not be appropriate for worker accommodation, and therefore Labuan Bajo, which has better infrastructure and services, may also be used.

Potential sensitive receptors of PIIM risks to the local community are the communities of Wae Sano and Sano Nggoang. While the increased non-local presence presents a small risk, it also presents potential benefits such as increased sale of goods and services. The small number of potential in-migration from the Project will result in an impact significance assessed as Minor.

Mitigation: The management of adverse impacts from labor influx will refer to the WB Guidance Note on Managing the Risks of Adverse Impacts on Communities from Temporary Project Induced Labor Influx and the analysis of Labor Influx Management – considering the small number of workers requirements throughout the Project exploration phase of approximately 2 years, the proposed mitigation measures could be conducted as part of Project labor management, community development, and the stakeholder engagement plan, including:

- PIIM risk reduction planning, which involves effective and ongoing engagement with the local community to optimise employment and business opportunities for locals, while consulting the community regarding predicted PIIM, which includes disclosure of the potential benefits and risks associated with these changes;
- Community empowerment program to increase their capacity to absorb benefits not only from the Project but also other potential economic opportunities to improve their livelihoods;

- Build close coordination of stakeholder strategies, and incorporate it in the Project stakeholder engagement plan (SEP), particularly working closely with the village government to better understand if any potential social conflicts or tensions may result with the presence of in-migrants; and
- In relation to labor management, particularly those assigned in the workers camps, strengthening the contractor's worker management and health and safety policies and procedure to ensure inclusion of international OHS standards to minimise risks of communicable disease spread to local community.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	Medium Sensitivity	Minor	Slight Severity	Low Sensitivity	Negligible

8.4.4. Positive Impact to Ecotourism

Attractions within the Project AOI include the pristine natural scenery of Lake Sano Nggoang, bird watching and trekking to the Golo Dewa Peak– these located a bit less than 1 km from the nearest well pads. The area also has the potential of cultural tourism e.g. through its traditional village lifestyle. Despite their potential, the ESIA baseline identified that development and operation of these attractions are limited due to poor road access (barely passable), poor electricity supply and limited accommodation. According to locals, tourist accommodation was mostly recently built with the support of the BirdLife Foundation who encourage birdwatching activities within Wae Sano and the surrounding area for research purposes and tourism which brings economic opportunities to locals.

The presence of the Waesano Project is expected to further boost tourism potential at Lake Sano Nggoang and Sesok Forest. During exploration, there will be access road widening, then blacktop on the road surface once the exploration activities have been completed by the Project in coordination with Regional Public Works and Spatial Planning Agency (*Dinas Pekerjaan Umum dan Penataan Ruang*) which will potentially open up ecotourism opportunities. Considering that the Project exploration phase of approximately within 2 years duration, further road improvement and maintenance will be managed by the Regional Public Works and Spatial Planning Agency.

ECON003 Positive Impact to Tourism

Activity:	Project activities, in particular access road improvement
Description:	Project development would result in improved road access to Sano Nggoang Lake and the surrounding area.
Mitigation:	Due to short-term duration of the exploration activities (approximately 2 years duration), the expectation for the mitigation plan is that local government and/or other parties to further maintain the road as an access to Sano Nggoang Lake and the surrounding area.
	<ul style="list-style-type: none"> • Grievance redress mechanism (GRM) to be established to allow all groups of affected people to share their concerns and complaints.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
-	-	Positive	-	-	Positive

8.4.5. Disturbance to Bird Watching Activities

Wae Sano and Sano Nggoang have a number of promising natural areas and sites that have tourism potential. However, the number of tourists visiting the Wae Sano area was quite small from 2012 to 2014, with the average number of visitors at about 12 visitors per month. Based on consultation with locals, most of the birdwatcher tourists are foreigner tourists from overseas or national researchers from the Burung Foundation. The area has some natural destinations such as waterfalls that are unknown to outsiders, but provide potential for future ecotourism. No visitors were observed during the baseline survey; this might related to limited infrastructure to access and within the area.

Although the Project presence may create potential positive impacts to local tourism with the access road improvement and increase exposure to non-locals (i.e. Positive Impact to Ecotourism, see Section 8.4.4), the Project activities also have potential adverse impacts to the natural environment which may result in disturbance to bird watching activities. The increase in noise and light exposure has the potential to disturb tourists seeking peace and quiet, particularly to the birdwatchers who rely on the activity of undisturbed birds. In addition, an increase in the number of tourists would bring more people and more noise to the area which may affect the birdwatching experience. However, as discussed in the previous Section 7.11, the Project will aim to keep safe distance with the important bird area, as will be consulted with the BirdLife Foundation.

ECON004 Disturbance to Bird Watching Ecotourism

Activity: Well pad and infrastructure development and drilling activities

Description: During the land preparation and well drilling, increased noise and light exposure may bring negative impacts to tourists. The Project exploration duration of activities will last for approximately 2 years, during which time there will be high intensity noise and light exposure on adaily basis. Therefore severity is assessed as medium. Sensitivity is considered medium considering limited number of tourists per month, resulting in low economic significance for community livelihoods.

Mitigation: UKL-UPL requires a number of mitigation measures to avoid further impacts of the Project to ecotourism, including: adequate consultation and information disclosure regarding the Project activities to local communities involved in ecotourism business and related stakeholders such as the *Yayasan Burung Indonesia* (BirdLife Foundation) prior to the commissioning of well construction and drilling, and implementation of a grievance redness mechanism (GRM) regarding ecotourism issues.

In addition, the following are proposed:

- Proper environmental management to reduce noise should be in place during the land preparation and well drilling (see Section 7);
- Minimize the amount of artificial lighting used at the pad sites and use directional lighting (downward facing lighting);
- Implement the Stakeholder Engagement Plan and Grievance Mechanism.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Low Severity	Medium Sensitivity	Minor

8.5. Community Health

8.5.1. Overview

At the current stage of the Project exploration, potential public health and safety issues may arise as an impact from Project activities. These are discussed in the following sub-sections, as follows:

- Exposure to dust emissions and temporary noise disturbance; and
- Risk from hydrogen sulphide (H₂S) gas leaks in an unplanned event.

8.5.2. Dust Emissions Impact and Temporary Noise Disturbance to Community Health

Construction of road upgrades will produce dust, also known as TSP (Total Suspended Particulates). The increase in vehicular mobilization for delivery of materials and equipment during the land preparation and well drilling development to the Project area, from the provincial Trans Flores Road, through the local access roads of Sano Nggoang Sub-district, and to Wae Sano Village will also result in elevated noise levels. The derivative impacts of decreased air quality and increased noise will potentially create a disturbance to the health of the community residing along the road.

As identified in the baseline, the Project AOI is a rural area, where noise levels during the day-and-night time (L_{dn}) are, on average, below 50 dba – this is well below noise level standard from the Government of Indonesia, also well as within the quality standards from WHO. The area along the local roads of Sano Nggoang Sub-district is dominated by agricultural land including mixed-plantation and paddy rice. There are only three locations where the community resides along the road, posing a bigger risk of health issues associated with generation of dust and noise.

In addition, temporary noise disturbance may affect local communities throughout the drilling and well testing portion of Project exploration. The nearest residential area to Project facilities is located approximately 80 m from Well Pad WS-B, while most of the other proposed locations are within plantation areas. However, it is understood that some of the drilling locations are adjacent to agricultural areas, where the local community frequently harvests plantation/forest products, although not on a daily basis.

PH001 Dust Emission Impacts and Temporary Noise Disturbance on Community Health

Activity:	Land preparation, improvement of the access road, mobilization of equipment and material, well development and drilling activities
Description:	<p>Local communities residing along the public roads from the Trans Flores Road to the local roads of Sano Nggoang and communities near the proposed well pads are considered sensitive receptors that may experience health impacts from increased noise and dust. These people may potentially be exposed to TSP and will face increased noise levels from construction and drilling, which could result in impacts to their health. While the baseline survey identified upper respiratory infection as the most common disease in West Manggarai Regency, it was not identified as a major health issue by the community in Wae Sano or Sano Nggoang. This is likely because the residents of these villages are not often exposed to environmental factors that cause this disease. Therefore sensitivity is assessed as medium.</p> <p>Severity is assessed as medium considering the scale of road upgrade/construction activities and frequency of mobilization of materials and equipment that emit dust, although it will only occur in the short term.</p>
Mitigation:	Several mitigation measures, presented in Section 7 Environmental Impact Assessment, can minimize dust emissions and noise generated during the Project exploration stage, such as frequent road watering, speed limits, and information disclosure/consultation with local

community and village leader regarding the Project activities with may create impact on air quality and dust, prior to commissioning the work.

The UKL-UPL recommends the provision of a community health awareness program regarding respiratory illness and collaboration with the local health centre for free medication. The recommended health program should be included as part of the Project social responsibility/community development plan, and the mitigation measures should be integrated into the SEP.

In addition, to align with World Bank expectations, the Project is expected to establish a grievance mechanism that is accessible for all community groups to report dust/emissions/noise issues. Should any complaint be received, the Project will undertake an immediate investigation as part of the grievance resolution procedure.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Medium Severity	Unlikely Sensitivity	Minor

8.5.3. Impact from H₂S Exposure on Community Health

Hydrogen sulphide gas exposure may occur when geothermal fluids are released during drilling activities, or during the testing and proving phases. Based on the baseline study, H₂S concentrations were not detected at any sampling locations which show that they are well within the quality standard of the Government of Indonesia and WHO. H₂S emissions can be a hazard that could affect community health and safety if present in high concentrations at unacceptable levels for a long period of time/prolonged exposure.

Generally, H₂S emissions from the exploration phase are considered relatively small and would not have a measurable impact on the surrounding environment. However, risks to community health are still present if any unplanned H₂S exposure incidents occur, as it will result in an odour which may cause eye irritation or respiratory damage.

PH002 H₂S Exposure and Impacts to Community Health

Activity: Well testing

Description: H₂S is known to be toxic to humans at high concentrations, and may have long-term negative impacts at lower concentrations. H₂S exposure can involve, among other symptoms, cardiovascular and gastrointestinal disturbances. Respiratory symptoms may include shortness of breath, bronchitis, and pneumonia. Blood-related symptoms might include easy bruising, abnormal blood counts, anemia, or clotting disorders. During well testing, the potential occurrence of H₂S emissions would be as a result of the bursts of heated steam. This may correlate with adverse health effects to the nearby community. However considering the Project scale of activities, existing design in place, and preference to develop the well at a safe distance from residential areas resulting in the low likelihood of unplanned events, impact significance is assessed as Moderate.

Mitigation: It is expected that proper design of the well pad and engineering measures to be in place, also the requirements in the UKL-UPL to manage H₂S impacts, among others include evacuation of community surround the well pads area in case of H₂S is exceed the threshold, regular road watering to reduce the dust exposure, control vehicle speed on site to reduce friction on roads that cause exposure to dust and H₂S emissions into the air, coordination with community health center of Sano Nggoang for providing information disclosure/consultation with local community and village leader regarding the Project activities with may create H₂S exposure, also collaboration with community public health of Sano Nggoang for free medication to community as CSR initiatives.

In addition, the following additional measures are required to ensure minimal H₂S risk to community:

- Emergency Response Plan (ERP) to include a process for unplanned H₂S leaks;
- The ERP should include measures that are applicable for anyone in the AOI, therefore a wide community should be involved during the ERP planning process; and
- The ERP to be consulted and a simulation-drill should be conducted with a nearby community to ensure community acknowledge the evacuation procedure should the risk present.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
High Severity	Unlikely	Moderate	Low Severity	Unlikely	Negligible

8.6. Traffic, Transport, and Community Safety

8.6.1. Overview

The Trans Flores Road is the main regional access that connects Labuan Bajo and West Manggarai Regency in East Nusa Tenggara Province. The Trans Flores Road is categorized as a provincial paved road that connects Flores Island, west to east. It crosses Labuan Bajo, Ruteng, Aimere, Bajawa, Maumere, Moni, Ende, to Larantuka. The traffic condition on the Trans Flores Road is generally free flowing and mostly utilized by passengers/light vehicles. After the intersection of the Trans Flores Road, the Project mobilisation from Trans Flores Road to Werang (capital of Sano Ngoang Village) will traverse through a local road (Werang – Sano Nggoang Road). The Werang – Sano Nggoang Road is a damaged paved road; it has higher traffic flow on Saturdays during market day.

The transport and delivery of equipment and materials to and from the project site is expected to increase vehicular traffic along the road corridor, and may pose safety risks and nuisances to community residents, particularly during construction and site closure, while traffic during drilling activities will be much less, therefore considered negligible and scoped out in the preliminary scoping assessment (see Section 4.3).

8.6.2. Traffic Impacts

Civil infrastructure works will consist of the improvement of road corridors and the construction of well pads. Equipment and material for civil works will be delivered from Labuan Bajo to the project site via Trans Flores Road and the local road network. Road improvement and widening at existing road will be conducted. Once road construction and widening is completed, these roads will be utilized for delivery equipment and material for well pads construction.

About 90 – 110 trucks will be mobilized (for standard drilling) and re expected to increase vehicular traffic during site preparation and construction, however based on the traffic survey, the existing road network is currently operating well below capacity. Both Labuan Bajo to Werang and Werang to Sano Goang currently experiences free traffic flows.

TTS001 Traffic Impacts of Vehicles and Drill Rig Trucks Passing on Existing Road Corridors and Villages

Activity: Equipment and material mobilization

Description: Traffic impact due to construction activities and drilling rig deployment is assessed as moderate. Equipment and material will be delivered to the project site using existing public roads. Road improvements will be conducted during infrastructure construction. Traffic disruption is expected

to occur on road bends due to heavy vehicles slowly driving on the roadways. It is anticipated that many of these vehicles will cause traffic congestion on the local roads and interchanges. Therefore the severity is considered medium. The sensitivity is medium as the community will be affected by the project's use of Trans Flores Road.

Mitigation: A number of measures for ESIA and UKL-UPL required include prior to construction, a Construction Management Plan (CMP) will be developed that includes provisions for traffic management.

Contractors will be required to adopt and adhere to a Vehicle & Traffic Management Plan (VTMP) for affected roadway segments. The VTMP shall include at minimum the following:

- Coordination with related government agency regarding the affected road routes ;
- Public consultation about implementation plan of equipment and material mobilization;
- Appropriate placement by construction contractors of temporary traffic cones/barricades and direction delineators to maintain one through lane in each direction during peak hours;
- Construction staging and idling vehicles should be away from sensitive receptors to the extent feasible;
- Installation of safety signs and barricades ;
- Safety inductions for vehicle drivers and construction contractors;
- Strict enforcement of a 20- km hour speed limit through the villages; and
- Disciplinary action for project-related traffic breaches of the VTMP.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Low Severity	Medium Sensitivity	Minor

8.6.3. Risk to Community Safety

One of the potential safety issues for local communities is the increased traffic associated with Project mobilization of equipment and material. Project activities contributing to increased traffic include deliveries to the well pads and daily mobilization between the base camp and the well pads. Furthermore, during the drilling phase, transport of heavy equipment on large flatbed trucks may cause traffic delays, congestion and increased safety hazards.

Many of the Project components are in close proximity to villages and local roads that are utilized by the local community. As the Project area is rural, the roads are also used by a significant number of pedestrians, for transport to schools, religious buildings, plantation land, markets, and between neighbours; therefore increased traffic on these and new roadways can be a risk to public safety. Although Project mobilization at this exploration stage is relatively limited, past traffic accidents resulting in death or injuries have been recorded within the Project AOI, as discussed in the baseline section of this document, which describes the recorded regional traffic accidents from 2012-2016, collected by the national statistics agency / Badan Pusat Statistik (BPS).

On local roads, the baseline also reported poor safety behaviours of pedestrian (e.g. walking on the road), speeding, and motorcyclists not wearing helmets. Although there were no recent road incidents recorded on local roads, the increased traffic from the Project has the potential to exacerbate community vulnerability toward safety risks.

TTS002 Safety Risk of Road Users and Community Residing along the Access Road

Activity: Mobilization of equipment and material

Description: The risk to community safety is considered Moderate, considering that likely incidents to occur in road where poor safety awareness and behavior are observed. Although potential incidents may lead to injury, however there will be a relatively low number of vehicles mobilized as compare to exploitation project requirements. This phase will further be for a short period of time over 2 years. Particularly vulnerable groups would be exposed to the risks of traffic incidents are children, pedestrians walking on the road side, and local farmers accidentally encroaching upon the well drilling areas.

Mitigation: A number of mitigation measures will be implemented to manage potential safety risks to the community, which align with the UKL-UPL requirements, as follows:

- A Vehicle & Traffic Management Plan (VTMP) will require: installation of traffic signs along the road traversed by the Project traffic, establishment of a speed limit for Project vehicles when going through villages or in the presence of groups of pedestrians, provision of defensive driving training for all drivers, the creation of new pathways in areas of high pedestrian traffic, and disciplinary action for endangering pedestrians;
- To manage visitors entering the Project footprint area where facilities are in operation, a Security Management Plan (SMP) will be developed, including the assignment of site security personnel, site registry or identification system, and measures for response to trespassers;
- Implement Journey Management Plan;
- As part of the Project social responsibility, initiate a safety awareness campaign program for local community e.g. Sessions in local schools to provide information about the dangers of road traffic. These measures will be included in the Community Development Plan; and
- Establish a grievance redress mechanism that is accessible for all community groups to report safety issues related to the Project activities. Should any complaint be received, the Project will undertake an immediate investigation as part of the grievance resolution procedure.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium Severity	Likely (Medium Likelihood)	Moderate	Low Severity	Likely (Medium Likelihood)	Negligible

8.7. Community Amenities

Community amenities such as access roads, public transportation, water resources, markets, schools, and other social infrastructures are crucial to creating a more sustainable community. The Project activities, which include construction of well pads and its associated infrastructure, may create a disturbance to community health, as discussed in the previous Section 8.5. Conversely, the improvement of local roads to allow mobilization of the Project equipment and vehicles has the potential to result in a positive impact to community access.

The Project has initially identified that some sections of local road are in poor condition due to improper drainage and poor pavement quality. Improvements have been planned to improve some of the existing public road segments to support mobilization during exploration. Although there are some risks associated with increased traffic from Project mobilization, improvements to roads will result in some positive impacts.

AMEN001 Impacts on Quality of Public Road and Community Access

Activity: Access road improvement

Description: The improved road condition allows for more economic related activities to occur such as increased tourists numbers which could trigger further development of the tourism industry in the area, as well as easier access to the city and markets. Improved roadways would also make transport more time efficient and safer.

Therefore the impacts from public road improvement is assessed as Positive. Mitigation measures, however, are still required to prevent adverse impact from the Project mobilization of heavy equipment and material.

Mitigation: To optimise potential positive impacts of the Project to social infrastructure, the following measures are recommended:

- Ensure ongoing maintenance of the access road quality in coordination with Regional Public Works and Spatial Planning Agency, including regular checks on any damage that may trigger traffic incidents or extreme dust which would impact the health and safety of locals and general road users; and
- Coordination with related government institutions, i.e. public works agency, prior to the road upgrades process to ensure alignment with regional development planning and future road maintenance, including construction of local footpath and installation of signage – this to be included in the proposed SEP.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
-	-	Positive	-	-	Positive

8.8. Visual Impact

The Project exploration activities have the potential to impact landscape resources due to the presence of its supporting facilities, construction and operational activities, which would affect visual view of local community as well as perceptions of natural landscape for tourists visiting Sano Nggoang for its view. Local community residential located less than 1 km from settlement area. The ESIA baseline study also identified a number of tourism areas in the vicinity of the Project AOI, including bird watching and trekking to the Golo Dewa Peak for Lake Sano Nggoang view. This is included in the sensitivity analysis as one of the sensitive receptors which will be noticed during the Project design process.

Visual impacts may be associated with the Project activities, including land clearing and preparation, well pad and infrastructure development, exploration drilling, well testing, well flow test pipeline alignment, heavy machinery and vehicles mobilisation, worker activities, and waste dump site. During construction, the existing visual landscape will be altered through land preparation activities and the construction of roadways, pipelines and well pads. The visual landscape may also be altered by waste accumulation, mobilization of heavy equipment and the final construction of project components. Waste generation is potential source of adverse visual impacts if not storage and disposed of properly. Mobilization of heavy equipment will create temporary adverse visual impacts throughout the construction and construction of roadways, pipelines and well pads will result in a permanent change to the landscape. Meanwhile, during operational of the Project exploration well drilling will result in few additional impacts from:

- Drill rig installation and activity, these are likely to be short-term and will not significantly alter the overall panorama; and

- Supplemental lighting if night drilling activities are required. Sensitive receptors include people living and working adjacent to the well pad, as well as wildlife. Nighttime light spill may result in visual pollution for sensitive human receptors, and can affect the behaviour of wildlife, particularly nocturnal species such as bats and many species of amphibians and mammals.

VIS001 Visual Impact during Preparation and Development

Activity: Land clearing and preparation, equipment and material mobilization, access road improvement well pad and infrastructure development, and exploration drilling.

Description: Visual impact is assessed as minor significance. Sensitive receptors are largely comprised of people living and working near the Project components. The proposed locations would result in a significant change to the existing rural landscape. However, with the presence of some sensitive receptors would be affected, sensitivity is considered as medium. In the meantime, severity is considered low. Although the proposed well pad locations would result in a significant change to the existing rural landscape, the indicative well pad of the proposed location is relatively small in the context of the entire Project Area.

Mitigation: Measures to be undertaken include:

- Consideration of areas with value of importance for tourism during the site selection (see Section 6.7 Thematic and Sensitivity Mapping);
- Consider tree/shrub planting around project components;
- Minimize visual impact during design of the pipeline route;
- Keep design for pipeline and drilling rig, color and structure material compatible with the natural settings, where possible and practicable;
- Store excavation material away from residences and the existing roads;
- Clean and tidy temporary waste storage areas;
- Provide proper waste disposal;
- Construction site management to ensure that heavy equipment remains in designated areas;
- Socialization to the community regarding the project components and activities;
- Ensure site rehabilitation to be conducted refer to the baseline condition and previous land use of the affected area

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Low Severity	Medium Sensitivity	Minor	Low Severity	Low Sensitivity	Negligible

8.9. Socio-Culture

8.9.1. Overview

The communities residing within the Project AOI are predominantly composed of the ethnic group known as the Manggaraian, and in particular the sub-ethnic group Mata Wae, which is a traditional agricultural society. Stakeholder consultation conducted during the development of this ESIA found that although the daily life of Wae

Sano and Sano Nggoang community is still influenced by traditional values, attachment to customary land, cultural values and norms have been weakened in the last decades. This change was influenced by the previous national government development program during the 1990s in eastern Indonesia, which acknowledged individual land ownership as opposed to communally-owned assets. Cultural leaders still have a strong influence on any land transactions by a family clan member, however land compensation may be conducted with each individual land owner. The baseline also identified the absence of a customary system of land use and a decrease in cultural practices performed in the community's daily life.

In terms of relations with other ethnic groups, a small number of non-Manggarai people were observed to inhabit the area, with reported harmonious relationships amongst the groups. There are no records of significant disputes or conflict occurring between community groups, as told by village leaders. With the development of tourism in the wider region, communities have also become familiar with tourists and researchers visiting the area, and therefore are expected to have a good acceptance level for in-migrants.

8.9.2. Social Fabric and Community Perception

The implementation of the Project will influence community perceptions both positively and negatively for a variety of reasons which were expressed during stakeholder engagement meetings. During interviews conducted with the community in the Wae Sano area in November 2016, over 88% of respondents agreed with the development of the Waesano geothermal exploration project plan, with only about 8% disagreeing. Most participants cited improved access to electricity as their main reason for supporting the Project. Those who disagreed were mostly concerned that the Project would pose a risk to the 'authenticity' and preservation of Lake Sano Nggoang and the surrounding area. In general, the locals are a very traditional community with minimal exposure to industrial activities, as there is little development in the area.

Despite the predominantly positive attitudes towards the Project and the generally harmonious characteristic of the community, the Project activities may result in adverse impacts on the environment and agricultural activities which may trigger social tension and discord if not managed properly. Furthermore, the PIIM (both from migrant workers and non-locals seeking for opportunities from the Project) will introduce different cultural practices, religion/s, pressures and social behaviours to the community. Some concerns were recorded during the baseline consultation associated with the non-local workers recruited by the Project which has the potential to result in a change to the social fabric and socio-cultural values in community life. The identified concern from the community must be taken into consideration during Project planning and development of a social management plan.

SOC001 Disturbance to Local Cultural Values, Norms, and Practices, and Changes in Community Perception

Activity: All project activities

Description: The Project activities will introduce new social pressures stemming from the introduction of different cultures, religions, and social behaviors from the non-local workforces. Community tension and conflict may also increase if the Project impacts on the environment are not effectively managed. Although the baseline identified generally positive perceptions and support from the local community toward the Project, the traditional socio-cultural structure and strong social bonds combined with the increased presence of non-locals due to PIIM and potential adverse impacts to environment result in a medium assessment of sensitivity.

Considering the scale of the Project at the current stage of exploration and relatively small number of workforce requirements – therefore less risks for significant cultural clashes issues with local customs, severity is considered medium, therefore the significance of impacts on community social fabrics and community perceptions are predicted to be Moderate.

Mitigation: The following measures are proposed to ensure proper management of potential adverse impacts of the Project on social fabric and community perception, in order to prevent further escalation of issues which could result in conflict and rejection to the presence of the Project. These measures are also aligned with the UKL-UPL requirements:

- Development and implementation of a stakeholder engagement plan (SEP) which includes ongoing stakeholder engagement and consultation not only at macro/regional level with the government, but also at local level with the cultural groups and the local community;
- Disclosure of information regarding land acquisition mechanism, jobs and business opportunities widely to the local community within the Project AOI, along with information about the Project activities, as part of the SEP;
- In terms of workforce management, providing a proper induction/training to all workers concerning local culture and customs, and encourage workers appreciation toward these cultures, as part of the Project Code of Conduct; and
- Develop and disclose a community GRM to provide the community with the opportunity to formally lodge complaints related to the Project workforce behaviour or other social-related issues.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Low Severity	Low Sensitivity	Minor

8.9.3. Impacts on Cultural Heritage

A number of culturally significant places and structures in connection with natural resources were identified within the Project AOI, including the following as reported in the baseline study: a) the old village residence at the top of Golo Mbelecek Hill, at the east side of Nunang, which was the Nunang's ancestral village; b) old artefact of stone used as an altar and the center of the traditional house (locally named *compang*), and c) Lampang old village on the north of Lake Sano Nggoang, which considered as cultural heritage due to historical attachment of Mata Wae people, as the lake area was known as location of Mata Wae ancestor when they first came to settle in Sano Nggoang. There were some concerns regarding the Project's potential disturbance to cultural heritage as identified during the baseline consultation, particularly pertaining to the proposed location of Well Pad A, B and E, where *Compang* and *Nekara* (old relics) were found, and the Project plan to use lake water for well drilling. Although the traditional cultural value of the aforementioned objects has started to fade with the presence of church and national government development program in the area, these culturally important structures and sites are included as sensitive receptors the Project should be aware of.

The Project has aimed to avoid the aforementioned old villages area, however would still prefer to use lake water due to limited other water sources within the vicinity proposed Project footprint. With the identified cultural objects and a long traditional history of Manggaraian/Mata Wae customs, there is the potential for other objects and/or sites with cultural significance that may not be formally recorded by the government but are locally acknowledged by the community. Other potential impacts may occur affecting access to cultural sites such as to watersprings/waterfalls found in some locations within the Sano Nggoang Sub-district. Water resources should also be considered a sensitive receptor due to the importance of them culturally and for life and livelihoods.

SOC002 Impacts on Cultural Heritage

Activity:	Land clearing and preparation, and well pad development and construction of the supporting infrastructure
Description:	The local Manggaraian/Mata Wae community respects land and water resources as their valuable property, while Lake Sano Nggoang is considered having historical cultural value, although this has started to fade. This is in addition to the other identified cultural heritage sites within the proposed Project AOI. These sites, however do not have the protections of formal acknowledgement from the government as cultural heritage objects; therefore, sensitivity of the receptors is assessed as medium.

Severity is also predicted to be medium, largely due to the identified *Compang* and *Nekara* within the proposed area for Well pads A, B, and E. Although these objects are allowed to be relocated with further consultation and approval from the cultural leaders and the family clan owners, further mitigation actions must be undertaken to enable the Project to do it. Impact significance is assessed as Moderate.

Mitigation: In addition to proper Project planning and design that considers cultural sensitivity within the Project AOI, the following will be conducted to reduce the potential impacts on cultural heritage:

- Consult with cultural leaders and family clan owners of the affected land area regarding the process to avoid significant cultural areas, or if avoidance is not possible, to consult the culturally acceptable ways to relocate any cultural objects identified within the proposed Project facilities locations. In addition, consultation should be conducted pertaining to the Project plan to use Lake Sano Nggoang water for well drilling purposes. These consultation should start early during the current Project design process, prior to land acquisition process;
- Use the Sensitivity Map developed for this ESIA (Section 6.4 Social Baseline) which identifies some of the areas of cultural significance, in determining well pads locations and confirming the Project description/process including the intake of lake water for well drilling;
- Further consultation and coordination with the regional cultural agency and local university to confirm the sensitivity mapping results and identify potential disturbance of access to cultural sites; and
- Development of a cultural heritage chance finds procedure which should be understood by the Project contractors and workers.

Raw Severity	Sensitivity	Raw Significance	Mitigated Severity	Sensitivity	Mitigated Significance
Medium Severity	Medium Sensitivity	Moderate	Low Severity	Low Sensitivity	Negligible

8.10. Labor Rights and OHS

8.10.1. Overview

The World Bank Guidance Note on Occupational Health and Safety (World Bank, 2011) states that all occupational health and safety programs aim to foster a safe work environment, including the protection of employers, suppliers, customers, family members, nearby communities, and other members of the public who could be affected by a company's operations.

Higher risks of violation of labor rights may present particularly in a large-scale project involving large number of workforces and multiple contractors and sub-contractors. Although the Waesano Project at the exploration stage will only employ a small number of workers, potential issues still present as it will involve local workers that may not be familiar with the formal employment process and the extent of rights they should be entitled to when working with the Project. The World Bank requires all its funded projects to apply the same standards based on International Labor Organization (ILO) requirements. This includes a range of labor management requirements including provision of a grievance mechanism for workers.

Occupational health and safety (OHS) issues may occur during the exploration phase including: exposure to geothermal liquids and gases, exposure to high temperatures, working in confined spaces and noise and physical hazards from vehicle movements.

8.10.2. Impacts on Labor Rights and Working Conditions

It is anticipated that some portions of personnel working on site from well drilling and construction of exploration supporting facilities will be employed through contractors and/or sub-contractors providing specific services to the Project. The use of contracted/sub-contracted services for smaller works is usually staffed by local people. The Project will need to ensure that there is no discrimination, unhealthy working environment, or inadequate waging system for all workers, in particular with those who are considered more vulnerable to violation to labour rights such as workers under sub-contractors, informal/casual/non-skilled labour, and local workers.

The main risk with Project workforce management will be not only ensuring fulfillment of labor rights requirements, but making a reasonable effort to ensure that contractors are compliant. This includes ensuring gender equality and equal opportunity for locals to obtain benefit from the Project direct and indirect employment (including indirect business opportunities to provide services for workers). Negligence in workforce management by contractors could impact worker rights, for example in relation to the waging system. If the Project proponent does not take steps to ensure the implementation of adequate workforce management by its contractors, then negative impacts to worker's rights may result.

The other potential impact related to labor is from the demobilization of the workforce at the end of the Project exploration, with no certainty of continuance of workforce employment in the exploitation stage. Local people will be facing the end of their contract and some of them are casual laborers who will become unemployed without any benefits or severance entitlements. The Project needs to anticipate this issue, as social risks due to high community expectations for further Project benefits may be high.

LOHS01 Potential Violation of Labor Rights and Working Conditions

Activity: Workforce recruitment and management

Description: It should be understood that the pursuit of economic growth through employment creation and income generation should be accompanied by the protection of the fundamental rights of workers. The potential impacts on violation of labor rights and working condition from the Project activities, including gender inequality and unequal opportunity, are considered to be Minor. While there is a likelihood that a violation may occur, particularly to workers under sub-contractors, informal/casual/non-skilled labor, and local workers, the Project will only employ a small number of locals within a very short time period.

Mitigation: The Project is committed to appropriate working conditions and terms of employment consistent with national law and relevant international standards to be included in its Labor Management Plan (LMP) or Company Regulations. Working conditions and terms of employment include aspects such as wages and benefits; hours of work; overtime arrangements and overtime compensation; breaks; rest days; and leave for illness, maternity, vacation or holiday.

In addition, the LMP will establish, maintain and improve the worker-management relationship to promote fair treatment, gender equality, non-discrimination and equal opportunity of workers, and enable a grievance mechanism for workers.

To ensure consistency across the project with the contractors, there will be inclusion in the contract requirements for all contractors and suppliers that they will comply fully with the laws and regulations of the government of Indonesia and the LMP.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Low Severity	Likely (Medium Likelihood)	Minor	Slight Severity	Likely (Medium Likelihood)	Negligible

8.10.3. OHS Risks

The project will result in exposure to risks for the project workforce through the Project exploration activities that could potentially lead to accidents causing injuries. Although there will be minimum risk on road for workers during mobilization of vehicle, however the following occupational health and safety (OHS) risks are frequently present throughout the remaining Project phases of exploration:

- Occupational exposure to geothermal gases, mainly H₂S, may occur during non-routine release of geothermal fluids (e.g. pipeline failures) and maintenance work in confined spaces. The significance of H₂S hazards may vary depending on the location and geological formation particular to the drilling area. Exposure to heat will occur during construction activities and during the operation and maintenance of pipes, wells, and related hot equipment and from non-routine exposure such as potential blowout accidents during drilling as well as malfunctions of the steam containments and transport installations.
- Issues can also result from the use of heavy equipment and dangerous materials during the drilling phase and from entry into confined spaces such as into well pads for drilling activities, and other construction-related areas. The potential degree of accidents in confined spaces may vary among geothermal facilities depending on the space design, on-site equipment, and presence of groundwater or geothermal fluids. In addition, consideration should be given to potential fires caused by equipment sparks, welding, or cigarettes.
- Further health and safety issues may arise from temporary noise disturbances during the exploration, drilling and construction phases. Noise from these operations can range from levels of 45 to 120 decibels (dBa), and originates from equipment operations such as air drilling, mud drilling, discharging wells after drilling, well testing, and operation of diesel engines and heavy machinery. The threshold for pain in humans from noise is 120 dBa at 2,000–4,000 Hz.

LOHS002 OHS Risk

Activity: All project activities

Description: The OHS risks from the Project activities are assessed as Moderate significance. Although there is a high likelihood of OHS incidents occurring during exploration activities, the workforce is relatively small compared to the exploitation phase. Risks will be reduced with the OHS procedures and proper supervision in place.

Mitigation: The Project will prepare an Occupational Health & Safety Plan (OHS). Measures included in the OHS Plan should include, but not be limited to the following in accordance with Indonesia government regulation on OHS and aligned with the World Bank safeguard policy expectations:

- The Project will take steps to prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, as far as reasonably practicable, the causes of hazards. In a manner consistent with good international industry practice, as far as reasonably practicable, the causes of hazards, in a manner consistent with good international industry practice, as reflected in various internationally recognized sources;
- Detailed OHS management measures to be included are: (a) Installation of H₂S monitoring and warning systems based on an assessment of project area locations that are prone to H₂S emissions and occupational exposure; (b) Reduce the time required for working in environments with elevated temperatures and ensure access to drinking water; (c) Shield surfaces where workers may come in close contact with hot equipment, including hot pipelines; (d) Provide fire suppression equipment in all vehicles and confined spaces; (e) Use appropriate procedures for storing and transporting hazardous materials, including appropriate signage indicating their locations; and (f) Require use of Personal Protective Equipment (PPE), including insulated gloves and shoes, self-contained breathing apparatuses such as masks and emergency oxygen supplies, and earplugs;

- Provide emergency response teams to facilities and workers in locations with high exposure risks, and documentation and reporting of occupational accidents, diseases, and incidents;
- To ensure all contractors and sub-contractors working on the site or in the immediate vicinity of the Project activities comply with the Projects OHS policies and plan to conduct daily safety assessment/inspection and a weekly OHS management meeting; and
- Provide OHS orientation training/induction to all employees for awareness of basic hazards, site-specific hazards, safe working practices, and emergency procedures, and provide workers with a fact sheet or other readily available information about the chemical composition of fluids they may come in contact with, in both liquid and gaseous phases, with an explanation of potential implications for human health and safety.

Raw Severity	Likelihood	Raw Significance	Mitigated Severity	Likelihood	Mitigated Significance
Medium Severity	Likely (Medium Likelihood)	Moderate	Low Severity	Likely (Medium Likelihood)	Minor

9. Cumulative Impact

9.1. Overview and Approach

Although not a specific requirement of World Bank OP. 4.01 Environmental Assessment, it states that the “EA evaluates a project’s potential environmental risks and impacts in its area of influence”. The area of influence may encompass cumulative impacts resulting 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.

For the purposes of this assessment, cumulative impacts are defined as the incremental impact of the project after mitigation, considered in the context of other projects and activities in the area, from the perspective of the sensitive receptors identified during this impact assessment.

The Waesano Geothermal Exploration Project represents a very new activity in the immediate vicinity of the site. No future major infrastructure projects are planned for this area. As such, there are not many operational aspects which will interact cumulatively with other anthropogenic activities. Well drilling activities however will have typical environmental impacts associated with any civil works, and as such have the possibility to interact with other activities in a number of ways.

Current and future activities which have been considered in preparing cumulative impacts are:

- Agricultural activity in the area;
- Tourism activity;
- Government development programs to improve access roads to bird watching areas; and

The use of access roads including by locals mobilising between villages, to Labuan Bajo Port, and tourist mobilization.

9.2. Cumulative Impact Assessment

Brief outlines of recognised potential cumulative impacts during the Project exploration phase are provided in Table 9-1.

Table 9-1 Summary of Potential Cumulative Impacts

Environmental Element	Other Contributing Anthropogenic Activities	Nature of the Cumulative Impact	Potential Cumulative Significance
Land Cover and Spatial Planning	Agricultural and tourism activities are expected to grow with the increase in population, triggered by the local road improvement for Project access which can be used for local economic development. In addition, there is a government development program to improve access roads for better access to bird watching areas.	These local community activities have the potential to increase land demands that may result in land use conversion for farming and tourism purposes; however considering the size of the local population and their capacity, as well as existing challenges in the agricultural and tourism sectors, the development of the area is expected to be in small scale. Therefore, no major changes in land use are anticipated.	Minor

Environmental Element	Other Contributing Anthropogenic Activities	Nature of the Cumulative Impact	Potential Cumulative Significance
Geology Geomorphology and Soils	No known cumulative impacts	No known cumulative impacts	Nil
Surface Hydrology and Water Resources	Agricultural and domestic activities	Construction water use may be competing with other water demands during the dry season; this can be mitigated by the import of water from further afield. However, the Project will primarily use lake water, which is not used for domestic or agricultural purposes. Therefore, they are not expected to be competing and the cumulative significance is assessed as Negligible.	Negligible
Surface Water Quality	Agricultural activities	During construction, the potential for erosion of exposed soils may coincide with cropping cycles. This may lead to an increased contribution of sediment to receiving waters. Even in cases such as rain events when runoff might occur, sediments are likely to be filtered through grassland areas prior to discharge into the lake; this is expected to attenuate sediment concentration during flow. Potential pollution to surface water will also occur during the Project operation, such as from domestic waste. However, the other anthropogenic activities from agricultural production within the well pads are dominated by plantations and therefore are not likely to create cumulative impacts on lake water quality.	Negligible
Waste Management	All other anthropogenic activities in the area	Waste management issues are associated with many aspects of domestic life. It is expected that the Waesano Exploration Project will utilise an existing landfill nearest the project area which may put a strain on the existing facility. .	Minor
Terrestrial Ecology – Land Bound Species	The use of access roads by locals and visitors to mobilise between villages, tourist	The amount of traffic is expected to increase as a result of the road improvements implemented by the Project. However this	Minor

Environmental Element	Other Contributing Anthropogenic Activities	Nature of the Cumulative Impact	Potential Cumulative Significance
	locations and to Labuan Bajo Port.	additional anthropogenic activity is not expected to make any appreciable reduction of ecosystem availability. Additional use of roads in the area has the potential to lead to incidental wildlife mortality.	
Terrestrial Ecology – Avian Species	No known cumulative impacts	The project will result in short-term impacts to avian communities; however, it is not expected to have a cumulative impact with other projects.	Nil
Terrestrial Ecology – Flora	Agricultural and tourism activities, also government development programs to improve access roads to bird watching areas	Anthropogenic activities in addition to the Project are not expected to make any appreciable reduction of ecosystem availability.	Negligible
Terrestrial Aquatic Ecology	Agricultural activities	As per surface water quality	Negligible
Ecosystem Services	No known cumulative contributor	No known cumulative contributors	Nil
Sustainability and Climate Change	Other project development in the area include a government development program and construction activities in the area to promote tourism	These anthropogenic activities would occur on a relatively small scale, therefore there is a negligible contribution to sustainability and climate change.	Negligible
Traffic and Transport	The use of access roads by locals and visitors to mobilise between villages and to Labuan Bajo Port; and Government development program to improve access roads to bird watching areas	Increased uses of the road may lead to congestion and interruption of local service during construction only (short-term). However, considering the existing baseline which showed low traffic density, the cumulative impact is considered to be Minor. These impacts will be mitigated by coordination with the transport department in Labuan Bajo and communication with other users.	Minor
Socio-Economic, Health and Cultural	Other project development in the area includes a government development program to promote tourism development	Development of other projects within the area of influence would increase the presence of non-locals, result in changes in land use from agricultural to industry, and exacerbate environmental impacts which would affect local livelihoods. These changes may result in changes in community livelihoods and the community fabric (socio-cultural structure),	Minor

Environmental Element	Other Contributing Anthropogenic Activities	Nature of the Cumulative Impact	Potential Cumulative Significance
		introduction to communicable diseases from non-locals, and potential increases in crime due to population increase. However, considering the extent of the identified potential anthropogenic activities, the cumulative impact is considered Minor.	

9.3. Mitigation

Project activities, as defined in this ESIA (refer to Section 7 and 8), it is recommended for the Project to undertake a number of additional measures to manage cumulative impacts, as follows:

- Impacts on land cover will be managed at the planning stage of the Project; engineering measures will be applied to minimise land requirements for exploration activities;
- Cumulative impacts of waste to be managed through implementation of the Waste Management Plan (WMP);
- Recommended measures to manage the cumulative impact on land bound terrestrial ecology is included in the process of Project selection of alternatives by considering sensitive ecological areas, to prevent further disturbance to terrestrial habitat;
- To manage cumulative impacts of increased traffic that may result in traffic jams or safety incidents for locals, install traffic signs not only near the well pad areas, but also along the Project access road segments that intersect with public roads. The Project should also enforce safe driving regulations including the maximum speed limit, and support the improvement of community safety awareness e.g. through educational posters in the area that will be seen by the public;
- Coordinate with the government with regard to its development plan for maintaining and improving the quality of public roads within their area of jurisdiction; and
- Potential cumulative impacts on social and community livelihoods, from the Project side to be managed through the stakeholder engagement plan (SEP) and the proposed community development plan (CDP) which will be developed as part of the Project corporate social responsibility (CSR).

10. Exploitation Impacts Screening

World Bank Safeguard Policies require that the entire area of influence is assessed in an ESIA report. In the Waesano Geothermal Exploration Project, the area of influence includes the extent of the impacts in the exploitation phase, even though this phase will be in the future and is not funded under this project. Further Exploitation Phase will be undertaken by a Business Entity that will have a license to carry out exploitation phase in Waesano Geothermal concession area to be awarded by Ministry of Energy and Mineral Resources following tender process.

This chapter provides an initial screening of impacts for the Project's future exploitation stage based on AECOM's experience with geothermal exploitation projects of a similar scale. Detailed scoping and assessment of impacts from the Project's exploitation activities will need to be conducted again once the description and design of the Project is confirmed based on the results of the current exploration stage.

This chapter will be structured as follows:

- Screening of potential environmental and social impacts of the Project's potential exploitation scheme; and
- Project categorization based on Government of Indonesia and World Bank Safeguard Policy

10.1. Screening of Impacts on Exploitation Phase

10.1.1. Screening of Environmental Impacts

Table 10-1 shows potential environmental impacts and mitigation measures for the exploitation phase. The sensitive receptors likely to be affected by the project are the local residents and terrestrial flora and fauna within and close to the current Project Area of Influence (AOI).

The table below presents not only the screening on all potential environmental impacts during the Project exploitation phase, but also a preliminary assessment of **key environmental elements that are likely to be significantly impacted** by the construction and operation of the Project during the exploitation phase.

Table 10-1 Screening of Environmental Impacts and Mitigation in the Exploitation Phase

Project Exploitation Activities	Environmental Aspects and Issues	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
Drilling Activity of Well Pad Development and Reinjection Well	Air quality	<p>Air quality degradation caused by air pollution may occur during mobilization, drilling activities and during well discharge testing. Expected gases from vehicle emission and exploited/exposed ground include CO, CO₂, H₂S, SO₂, N₂, steam, etc.</p> <p>Air quality degradation is unlikely to be significant due to minimum vehicle and heavy equipment activities that will only occur in the short term during drilling activities.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No. 41 of 1999 on Air Pollution Control</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Ensuring that emissions are minimized through regular servicing of machinery to meet the relevant emission standards Vehicle selection strategy to consider impacts on total emissions Ensure that the engines of all vehicles and machinery on site are not left running unnecessarily Prepare Vehicle & Traffic Management Plan (VTMP) Plant and equipment to be used in the project to comply with recognized performance design standards Personnel working on-site would have appropriate PPE Conduct air quality monitoring at boundary of sensitive receptors
	Noise level	<p>A noise level increase may occur from heavy machinery operations during drilling activities or during well testing; this will keep animals away from the project sites and will likely cause a nuisance to nearby residents.</p> <p>Noise level increase is unlikely to be significant due to minimum vehicle and heavy equipment activities that will only occur short term during drilling activities.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>MOE Decree No. KEP-48/MENLH/11/1996 on Noise Level Standard</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Select equipment with noise-reducing features Install noise abatement on equipment where feasible Consider installation of acoustic barriers near sensitive receptors; Install vibration isolation for mechanical equipment Develop an effective grievance mechanism to record and respond to noise complaints
	Hazardous waste	<p>During drilling activity, various types of hazardous and toxic (B3) waste may be generated from the workshop and vehicle maintenance activities, including used filters, used hoses, used batteries, and used/expired chemical or additives.</p> <p>Hazardous waste impact is unlikely to be significant as it is expected that drilling activities will</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No. 101 of 2014 on Hazardous and Toxic (B3) Waste Management</p>	<ul style="list-style-type: none"> Provide a Waste Management Plan in accordance with regulations Prepare a Spill Response Plan.

Project Exploitation Activities	Environmental Aspects and Issues	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
		conducted in a short term period and waste generated is expected to be minor.	World Bank OP 4.01 Environmental Assessment	
	Drilling mud waste and cuttings	<p>The chemical characteristics of drilling mud and cuttings will be influenced by any additives used in the drilling fluids. The waste mud will result to temporary turbidity in spill incident occur.</p> <p>Drilling mud waste and cuttings is unlikely to be significant as this will be generated over a short period during drilling activities and this waste is not categorized as hazardous waste.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>MEMR Regulation No. 21 of 2017 on Drilling Mud Waste and Drilling Cuttings Management on Geothermal Activities</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> • Provide a Waste Management Plan in accordance with regulation applied • Prepare a Spill Response Plan
	Surface water quality	<p>Impacts on degradation of surface water quality may occur as a result of discharged brine. Although the brine will be reinjected into the well, there are concerns if there is spill incidents resulting to water released to water bodies can disrupt the quality of surface water.</p> <p>Surface water quality degradation is unlikely to be significant due to the closed-loop system and the brine water being reinjected to the well.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No. 82 of 2001 on Water Quality Management and Water Pollution Control</p> <p>MOE Regulation No. 13 of 2007 on Waste Water Management Requirements and Mechanism for Oil and Gas Upstream and Geothermal Business and Activities through Injection</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> • Appropriately case and seal reinjection wells • Prepare a Spill Response Plan

Project Exploitation Activities	Environmental Aspects and Issues	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
	Surface water resources	<p>Water usage during drilling activities has the potential to impact the natural flow of water resources and lake water. Sustained extraction of surface water may decrease the volumetric rate of flow of the waterways. The impact is anticipated to be more pronounced during the dry season.</p> <p>The baseline study of exploration shows that there is an issue regarding scarcity of water resources. Therefore the impact is likely to be significant.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No 42 Year 2008 regarding Water Resources Management</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Avoid overexploitation of freshwater resources – find multiple sources, consider streams with high flow rates, drilling during rainy season, use storage dams or ponds, and taking no more than 1/3 of the seasonal low flow from surface water features Identify other water uses such as farm irrigation and ensure sustainable abstraction rates that do not interfere with domestic water use, fishing etc. Reuse of cooled water for other plant uses, or use closed loop systems. Conduct flow monitoring in the wet and dry season to understand the baseline flow rates in the water bodies that will be utilized during drilling so as to not over-extract.
	Geothermal features such as hot spring	Interference to geothermal features may occur from pumping or reinjection of geothermal water, or from abstraction of surface water. It isn't likely to be significant in the normal process.	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Identify and avoid significant features (resources such as cultural, historical, spiritual, scientific, biological, landscape, ecotourism etc.) Avoid damaging or disturbing geothermal features where possible Model the geothermal reservoir and geothermal features. Monitor activity to identify interference from pumping or reinjection. Adjust production and reinjection where necessary to mitigate significant impacts. Provide barriers and avoid disturbances from construction and operations where necessary
	Groundwater and geothermal reservoir	Over-abstraction of the geothermal resource, leading to subsidence, saline intrusion, impacts on aquifer levels, and reduced geothermal yield. The alternatives for water sources have been prepared. Therefore the impact of groundwater issues is unlikely to be significant .	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No 43 Year 2008 regarding Groundwater</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Modelling of geothermal abstractions and reinjections Locate make up and reinjection wells to maximise the efficient use of the geothermal resource and avoid land subsidence Monitor ground subsidence, groundwater levels and water quality Construct and maintain wells to avoid interference with groundwater

Project Exploitation Activities	Environmental Aspects and Issues	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
	Groundwater quality	<p>Groundwater contamination may occur as a result of interference with geothermal water from reinjection wells.</p> <p>Another impact is caused by discharge of sulphur, silica, and carbonate precipitates collected from cooling towers, air scrubber systems, turbines, and steam separators to land.</p> <p>Groundwater quality degradation is unlikely to be significant since the Project has designed a lined water pond to contain the contamination.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>MoH Regulation No. 416 of 1990 on Clean Water Quality Standard</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Prepare wells with appropriate casing and well head protection to prevent contamination Monitor well levels and pressure to identify leaks early and repair casing or decommission wells to avoid further contamination Detailed analysis of aquifer structure and existing groundwater use in the development area Determination of existing groundwater users in the vicinity of the operational wells (e.g. 1 km) should be identified. In addition, some of technical information about existing groundwater wells (e.g. depth, flow, etc.) should be collected. Sludge/precipitates to be stored in bounded areas.
	Terrestrial ecology flora	<p>Direct impact to vegetation during exploitation drilling may not different with direct impact of exploratory drilling when the drilling is undertaken.</p> <p>Vegetation loss resulted by exploitation drilling is unlikely to be significant compared to the similar impact of exploratory drilling, except the area for production and injection drilling well are significantly wider than area for exploratory drilling.</p> <p>Project concern to the forest area is likely avoiding any vegetation loss within Sesok protected forest as implementation of mitigation hierarchy for biodiversity conservation.</p>	<p>Indonesian Law No.5 of 1990 regarding Natural Living Resources Conservation</p> <p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Avoid drilling within protected forest
	Terrestrial ecology fauna	<p>Project concern to the wildlife is also likely avoiding any wildlife population declining within Sesok protected forest – a home of endemic bird species</p>	<p>Indonesian Law No.5 of 1990 regarding Natural Living Resources Conservation</p>	<ul style="list-style-type: none"> Avoid drilling within protected forest

Project Exploitation Activities	Environmental Aspects and Issues	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
		as implementation of mitigation hierarchy for biodiversity conservation.	GR No 27 Year 2012 regarding Environmental Permit World Bank OP 4.01 Environmental Assessment	
Construction of Power Plant and the Supporting Facilities, including transmission lines	Air quality	<p>Air quality degradation caused by air pollution may occur during mobilization and construction.</p> <p>Fugitive dust emissions can be generated by various construction activities such as earthmoving for excavation and civil works associated with the well pad construction, removal of well cuttings, vegetation clearing, stockpiling of soils, and equipment and vehicle movement.</p> <p>Air quality degradation is unlikely to be significant due to minimal Project vehicle and heavy equipment mobilization which would only occur in the short term during drilling activities.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No. 41 of 1999 on Air Pollution Control</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Ensure that emissions are minimized through regular servicing of machinery to meet the relevant emission standards; Vehicle selection strategy to consider impact on total emissions; Ensure that the engines of all vehicles and machinery on site are not left running unnecessarily Prepare Vehicle & Traffic Management Plan (VTMP) Comply with recognized performance design standards
	Noise level	<p>A noise level increase may occur from operation of heavy machinery during mobilization and construction activities, a potential nuisance to nearby communities.</p> <p>Noise level increase is unlikely to be significant due to minimal Project vehicle and heavy equipment mobilization which would only occur over a short period of time during drilling activities</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>MOE Decree No. KEP-48/MENLH/11/1996 on Noise Level Standard</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Implement speed control and other required transportation management procedures, especially adjacent to sensitive receptors Reduce project traffic routing through the community areas wherever possible Inform home owners on traffic-related noise of the anticipated project schedule Require contractors to adopt and adhere to a Vehicle & Traffic Management Plan (VTMP) Develop a grievance mechanism to record and respond to noise complaints

Project Exploitation Activities	Environmental Aspects and Issues	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
	Hazardous Waste	<p>During construction of power plant and facilities, various potential types of hazardous and toxic (B3) waste may be generated from the workshop and vehicle maintenance activities, including used filters, used hoses, used batteries, etc.</p> <p>Hazardous waste impact is unlikely to be significant due to waste generation which will only occur in the short term during drilling activities.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No. 101 of 2014 on Hazardous and Toxic (B3) Waste Management</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Provide a Waste Management Plan in accordance with local and World Bank regulation Prepare a Spill Response Plan
	Erosion and sedimentation	<p>Land clearing on steep slopes can form an open area that is prone to erosion and increased surface runoff. If not properly managed, surface runoff may carry sediment to water bodies.</p> <p>Erosion and sedimentation is unlikely to be significant after sediment control measures are implemented.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No. 82 of 2001 on Water Quality Management and Water Pollution Control</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Batter surface stabilisation using vegetation by planting crops or masonry stabilization Installation of barriers such as sediment ponds and drains Consider gabion traps and retaining systems Build terraces for steep slopes
	Surface water quality	<p>As a result of erosion, sediment runoff to the rivers / lake can cause turbidity and degradation of surface water quality (physical-chemical-microbiology).</p> <p>Surface water quality degradation is likely to be significant particularly during rainy season.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No. 82 of 2001 on Water Quality Management and Water Pollution Control</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Delineate the areas that will be cleared before any land clearing or earthmoving activity begins to limit the area of disturbance. If possible, conduct the clearing in phases to minimize area of disturbance and sediment generation at any given time Ensure detailed design of access roads minimizes the disruption of the surface water flow regime. Provide adequate drainage to minimize contamination of proximal creeks with mud and dust from vehicle and equipment movement Consider a phasing plan to minimize the period of exposure for cleared areas

Project Exploitation Activities	Environmental Aspects and Issues	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
				<ul style="list-style-type: none"> Use of sediment control devices such as silt traps and sedimentation ponds during land clearing activities Use of interim control mechanisms such as sheeting to stabilize batters and slopes prior to permanent stabilization Plant cover crops on affected areas as soon as possible for long term erosion control Land clearing activities will be scheduled to avoid clearing activities during heavy rainfall or strong wind as much as practicable
	Terrestrial ecology flora	<p>Construction activities will involve land clearing and drilling site preparation for well pad construction, existing access road improvement, material and equipment mobilization, and supporting infrastructures preparation. These activities may directly impact vegetation.</p> <p>This impact is unlikely to be significant since the Project Area is categorized as Forest for Other Land Uses and is currently dominated by agriculture and plantation, lacking native vegetation.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No. 7 of 1999 on Flora and Fauna Conservation</p> <p>World Bank OP 4.04 Natural Habitat</p>	<ul style="list-style-type: none"> Where possible, the alignment/boundary of work areas should be modified to avoid direct impacts to plant species of conservation interests and/or mature trees. If modification of boundaries is not possible, transplantation of rare/protected plant species should be considered Clearly delineate areas for land preparation/other activities in the field to prevent loss of vegetation outside of designated work areas Construction should not be permitted within 5m of the drip line of large trees of conservation interest to avoid damage to tree roots Consideration of temporary wash facilities to ensure that seeds from exotic and invasive species are not introduced by vehicle traffic during construction Develop top-soil management plan Revegetation of areas affected by construction activities outside of the project footprint. Native plant species should be used. If planting takes place during the dry season, the planted areas should be watered regularly until properly established.
	Terrestrial ecology fauna	Civil infrastructure work will result in permanent habitat loss, directly affecting fauna utilizing these areas. Direct impacts to wildlife may also occur inside the construction boundaries if wildlife enter into the	GR No 27 Year 2012 regarding Environmental Permit	<ul style="list-style-type: none"> Reduction of habitat disturbance, such as not exceeding the specified project footprint by fencing or pinning flags Training of construction crews on the appropriate response to wildlife encounters that may occur in the project area

Project Exploitation Activities	Environmental Aspects and Issues	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
		<p>construction site and pose risks to individuals within and across the site boundary.</p> <p>The disturbance to terrestrial fauna is likely to be significant since habitat loss is expected and there are 9 species of protected birds identified in the area, based on Indonesian regulation.</p>	<p>GR No. 7 of 1999 on Flora and Fauna Conservation</p> <p>World Bank OP 4.04 Natural Habitat</p>	<ul style="list-style-type: none"> Proper disposal of construction and worker waste Fencing/hoarding around work areas to prevent animal entry and minimize light/disturbance impacts Habitat enhancement/creation to compensate for direct/indirect and permanent/temporary impacts to habitat for key species of conservation interest. This should be provided on a 3:1 ratio, preferably on-site
Geothermal Production/ Operation and Maintenance	Air quality	<p>Air quality degradation caused by H₂S emissions via venting may occur during power plant operation, there is a potential to emit Non Condensable Gasses (NCGs) containing H₂S.</p> <p>The air quality degradation to the community around the project area is likely to be significant in the long term.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>GR No. 41 of 1999 on Air Pollution Control</p> <p>World Bank OP 4.01 Environmental Assessment</p>	<ul style="list-style-type: none"> Consider technological options that include total or partial re-injection of gases with geothermal fluids Personnel in charge of testing, venting and commissioning would have at all times with them a personal gas detection kit for H₂S, emergency mask and PPE. It is important that potentially toxic levels of H₂S be monitored during the initial installation and commissioning; When total re-injection is not feasible, venting of H₂S, if based on an assessment of potential impact to ambient concentrations, the H₂S level will not exceed applicable ambient standard; If necessary, use of abatement systems to remove H₂S emissions from non-condensable gases Installation of a H₂S gas monitoring network, taking into account the location of emissions sources and areas of community use Emergency planning (in case of well blowouts and pipeline failures) involving community input to allow for effective response to monitoring system warnings
	Noise level	<p>Power plant operation will generate noise from operating equipment that is sourced from the steam turbine and cooling tower. During normal operation, noise of 55 dB (A) can be heard from a distance up to 500 m.</p>	<p>GR No 27 Year 2012 regarding Environmental Permit</p> <p>MOE Decree No. KEP-48/MENLH/11/1996 on Noise Level Standard</p>	<ul style="list-style-type: none"> Consultation with communities near power plant that may be impacted Select equipment with noise-reducing features Consider installation of acoustic barriers near sensitive receptors Design of power plant equipment to be optimized for noise abatement Develop an effective grievance mechanism to record and respond to noise complaints.

Project Exploitation Activities	Environmental Aspects and Issues	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
		Noise disturbance to the nearby communities and/or fauna around the project area is likely to be significant for the long term period.	World Bank OP 4.01 Environmental Assessment	
	Surface water quality	As a result of geothermal operations, sediment will settle at the bottom of the cooling tower in the form of sludge. The sludge deposits are composed of dust particles and the oxidized dissolved H ₂ S gas forms a sulphide sediment, while the phosphate and chlorine remain soluble in cooling tower water. The sludge will be reinjected to the well and/or discharged to the sediment pond. The overflow from the water pond may reach water bodies. Surface water quality degradation is unlikely to be significant due to the minor volume.	GR No 27 Year 2012 regarding Environmental Permit GR No. 82 of 2001 on Water Quality Management and Water Pollution Control World Bank OP 4.01 Environmental Assessment	<ul style="list-style-type: none"> • Reuse of cooled water for other plant uses, or use closed loop systems • Design sediment ponds for a 50-year rainfall event • Regular inspection and maintenance of sediment ponds • Drain the sediment pond properly and regularly

10.1.2. Screening of Social Impacts

This section assesses the general potential social impacts of the exploitation phase, since the nature and scale of the exploitation phase, including energy generation and transmission, was not well understood at the time of the preparation of this ESIA. However the impacts need to be considered as part of the Project's future area of influence.

All phases of the Project during exploitation would have the potential to interact with the local community, although it would be in a more established manner compared to the exploration program, considering that the community would be accustomed to the presence of the Project and geothermal project activities. Therefore it is unlikely to create a significant adverse impact to local communities, with the exception of a few components identified in the screening process, based on a general understanding of projects of similar scale.

The Table 10-2 presents a screening of all potential social impacts expected during the Project exploitation phase. The table also provides a preliminary assessment of the **key social elements that are likely to be significantly impacted** by the construction and operation of the Project facilities

Table 10-2 Screening of Social Impacts and Mitigation During the Exploitation Phase

Project Exploitation Activities	Social Aspects and Issue	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
Project Review and Planning: Survey and Permitting	Socio-cultural/ social fabric and perception	<p>At the exploitation stage of Project development, the community and stakeholders would already be familiar with the Project presence, as it is understood that the Project is currently starting to build relations with the local community and stakeholders through public consultation and socialisation, and has communicated with the local and regional government for the exploration survey and permitting process. In addition, the Project has planned to implement a number of community development programs as part of its environmental and social responsibilities and external relations strategy.</p> <p>Therefore the impact of the Project review and planning for exploitation phase to socio-cultural structure is unlikely to be significant.</p>	<p>Government Regulation No 27 Year 2012 regarding Environmental Permit</p> <p>Government Regulation No 47 Year 2012 regarding corporate social and environmental responsibility</p> <p>World Bank OP4.01 Environmental Assessment</p>	<p>Development and implementation of the following plans:</p> <ul style="list-style-type: none"> Stakeholder consultation and engagement plan Community development plan

Project Exploitation Activities	Social Aspects and Issue	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
Field Development: Land Acquisition	Livelihood and income/ Economic displacement	<p>The exact area of influence of the Project exploitation will not be confirmed until after the completion of the exploration phase, however based on the current plan for well development, it is likely that Project development will be close to the two villages of Wae Sano and Sano Nggoang. It is understood that some of the areas that will be affected by exploration drilling are currently plantation areas.</p> <p>Impacts from the Project land acquisition requirement (e.g. for power plant, pipeline, supporting facilities, transmission line) to economic displacement of vulnerable and/or economically affected people, including loss of income sources and livelihood from the loss of farming land, is likely to be significant, particularly for the affected farmers who depend on agricultural land for their livelihoods.</p>	<p>Law No. 2 Year 2012 and Presidential Regulations No. 71 Year 2012 regarding procurement of land for public interest</p> <p>World Bank OP 4.12 Involuntary Resettlement</p>	<p>Develop a LARAP which integrates Indonesia Regulation with World Bank requirements, including:</p> <ul style="list-style-type: none"> • Prioritize voluntary acquisition mechanism (willing buyer-willing seller negotiations) for land lease or land purchase • The location of well pads will be located at a distance from residential areas and areas that have ecological and cultural values • Should any significant social impacts from voluntary land acquisition be identified, the Project will apply the requirements of the World Bank OP 4.12 on Involuntary Resettlement to avoid, remedy or mitigate the impacts • Adequate and well-documented consultation with the community to identify legal or traditional land owners; • Collect all data about project affected people and vulnerable groups in the area; and • Develop and implement a grievance redress mechanism (GRM) and Stakeholder Engagement Program for community involvement
	Socio-cultural/ social fabric and perception	<p>Impacts from land acquisition during the exploitation phase on community perception is likely to be significant. Although the community and stakeholders would already be familiar with the process, which is expected to be similar to the land acquisition process for the exploration phase, the land area to be acquired for the exploitation would be larger (for the power plant, pipeline, supporting facilities, and transmission line). It is also expected that there will be high demand for high land compensation value in the second phase of land acquisition.</p>	<p>Law No. 2 Year 2012 and Presidential Regulations No. 71 Year 2012 regarding procurement of land for public interest</p> <p>World Bank OP 4.12 Involuntary Resettlement</p>	<p>As required in Indonesia regulation as well as World Bank standards, adequate consultation and/ or socialisation needs to be conducted to ensure all groups of affected people receive sufficient and similar information regarding the Project land acquisition process.</p> <p>In addition, the grievance redress mechanism (GRM) should be developed to enable access to all groups of affected people to submit their concerns regarding the land acquisition process.</p>

Project Exploitation Activities	Social Aspects and Issue	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
Construction of Power Plant and the Supporting Facilities; and Drilling Activity of Well Pad Development and Reinjection Well	Livelihood and income/ local employment and business opportunities	A positive impact to local employment and business opportunities is expected during the exploitation phase and would require a larger workforce than the exploration phase.	Government Regulation No 27 Year 2012 regarding Environmental Permit World Bank OP4.01 Environmental Assessment	Optimise potential benefit to job and business opportunities for locals through an internal labor policy, as well as clear requirements on local content in contract of work with contractors and suppliers.
	Livelihood and income/ Disturbance to Agricultural Activities	Construction activities will generate dust, noise, and waste impacts, and are likely to be significant particularly in areas where community agricultural activities such as plantations and paddy fields are present.	Government Regulation No 27 Year 2012 regarding Environmental Permit World Bank OP4.01 Environmental Assessment	Adequate consultation and/or socialisation needs to be conducted to ensure the potential lyaffected community (particularly farmers working in near the Project facilities) receive sufficient information regarding the Project construction plan and scope of activities. In addition, the grievance redress mechanism (GRM) should be developed to enable access to all groups of affected people to submit their concerns regarding the Project construction impacts to their livelihoods.
	Livelihood and income, and socio-cultural/ influx migration	Disturbance to local economic and socio-cultural structures due to interaction with in-migrants seeking jobs and business opportunities from the Project is unlikely to be significant . The project scale would not bring in a significant number of people or goods and services. While exploitation may bring in more people from outside of the community, community and stakeholders would already be familiar with the presence of non-locals.	World Bank OP4.01 Environmental Assessment	Optimise the use of the local workforce and goods and services to minimise the influx of migration numbers. Adequate consultation and/ or socialisation needs to be conducted to ensure that the local community receives sufficient information regarding the Project scale and workforce requirements.

Project Exploitation Activities	Social Aspects and Issue	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
	Community amenity/ public facility and infrastructure	<p>Disturbance to public transportation and public roads would occur in the area during mobilization.</p> <p>Based on the relative small scale of the project, potential impacts on public transport and road infrastructure is unlikely to be significant due to short-term and minimal vehicle and heavy equipment mobilization during construction.</p>	World Bank OP4.01 Environmental Assessment	Development and implementation of a Vehicle & Traffic Management Plan (VTMP). In addition, for Project vehicle traffic, the community would be informed and consulted about the project's VTMP.
	Community amenity/ water resources	<p>There is potential for disturbance to community water resources, as it is understood that the usage of water for the geothermal project will be at its highest during exploitation drilling activities. Therefore the impact is likely to be significant. Although the water intake for the exploitation phase has not yet been confirmed, the baseline identified that there is an existing community issue in the community related to difficulties in obtaining clean water resources. The community can only get clean water from a spring, since groundwater from wells is often dry while lake water is unsuitable for drinking.</p>	World Bank OP4.01 Environmental Assessment	<p>Consultation with the community to map clean water resources</p> <p>Further consultation to be conducted should the intake water be from the same water resources that are used by community for clean water, daily household needs, or agricultural activities</p> <p>In addition, ensure the proper implementation of the grievance redress mechanism (GRM) to enable access to all groups of affected people to submit their concern regarding the Project construction impacts to their livelihoods</p>
	Community amenity/ visual impacts	<p>Similar to exploration impacts, the presence of Project exploitation facilities and development (in larger scale than exploration phase) will create visual disturbance to local community and tourist visiting Sano Nggoang for its view. However, after approximately 2 years of exploration phase it is likely that local community would have been familiar with the Project presence. Meanwhile, as been occurred in other areas in Indonesia where geothermal project is developed, its presence surprisingly create some kind of attraction for local community and domestic tourists. Therefore the impact is unlikely to be significant.</p>	World Bank OP4.01 Environmental Assessment	Consultation of the Project planned construction and operation for exploitation phase involving local community and those participate in the local tourism industry. This will be done early during the Project exploitation design process.

Project Exploitation Activities	Social Aspects and Issue	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
	Socio-cultural structure/ perception, acceptance, and socio-cultural values	Impacts from the Project construction during the exploitation phase to community perception is likely to be significant . Although the community and stakeholders would have already been familiar with the Project presence, it is anticipated that there will be high demand for local employment and business, whilst there are only limited opportunities from the Project with such scale.	Government Regulation No 27 Year 2012 regarding Environmental Permit World Bank OP4.01 Environmental Assessment	Ensure the proper implementation of the grievance redress mechanism (GRM), socializing the community on project activities, and the implementation of the stakeholder engagement program.
	Cultural heritage	Potential impacts to tangible cultural heritage during construction activities are likely to be significant , referring to the current Project exploration area, potential impacts to cultural objects are identified. This include potential disturbance to old village areas (spread surrounding the Lake Sano Nggoang), the buried cultural objects (such as <i>Compang</i> and <i>Nekara</i>) also the culturally historical value of the lake itself.	World Bank OP4.01 Environmental Assessment	As recommended as part of this ESIA, a cultural heritage (CH) chance find protocol/ procedure shall be developed and to be in place during the whole Project development stage.
	Community health	The increased dust emission impact to community health, from vehicle traffic on unpaved roadways increases public exposure to Total Suspended Particles (TSPs) potentially creating new, or exacerbating existing, respiratory health conditions amongst the community. These are unlikely to be significant due to minimal Project vehicles and heavy equipment mobilization which would only occur in the short term during the construction phase.	Government Regulation No 27 Year 2012 regarding Environmental Permit World Bank OP4.01 Environmental Assessment	Implementation of grievance redress mechanism (GRM) to enable community to submit concern if any impacts from the Project to community health is occurred.

Project Exploitation Activities	Social Aspects and Issue	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
	Community safety and security	<p>There may be impacts to community safety due to the Project equipment and material mobilization, as the Project will use some public road segments. People living and/or working adjacent to project roadways and vulnerable groups (i.e. children, elderly) are at a greater risk of impact.</p> <p>Other risks associated with Project exploitation activities are safety issues concerning locals adjacent to the area. Additional pipes to be laid for exploitation will increase the public's risk of accidental burns if the public unintentionally come into contact with the pipes when they are hot and/ or during occasional times when steam is released. The pipes also present a tripping hazard.</p> <p>Impacts are likely to be significant.</p>	World Bank OP4.01 Environmental Assessment	<p>It is expected that the Vehicle & Traffic Management Plan (VTMP) for the exploration construction and operations has been effectively implemented; therefore the additional traffic and risk should be manageable.</p> <p>In addition, it is expected that a number of design measures will be applied to minimise exposure of the Project facilities to the community.</p>

Project Exploitation Activities	Social Aspects and Issue	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
	OHS and labor and working condition	<p>The following are potential risks to OHS and labor and working conditions, however risks are not likely to be significant:</p> <ul style="list-style-type: none"> Exposure to geothermal liquids and gases – mainly H₂S – during a non-routine release of gas which can cause eye irritation and respiratory damage. Exposure to high temperatures during non-routine events (e.g. pipeline maintenance, blowouts during drilling) can cause serious burns. Working in confined spaces can increase the risk of workplace accidents. Exposure to high level of noise from drilling and / or construction activities can damage hearing unless proper PPE is used. Exposure to physical hazards (accident and injury) from vehicle movements during routine access to the well pad and pipelines. Improper and unfair working conditions (e.g. Salary level, performance management systems, leave entitlements, Worker Grievance Mechanism) that do not adhere fully with the laws and regulations of the Government of Indonesia concerning the employment of labor and working conditions, which by default includes eight of the ILO conventions and relevant UN conventions. 	World Bank Environmental and Social Framework (ESF) – ESS2 regarding labor and working condition	<p>The establishment and implementation of an OHS Plan, inclusive of all appropriate safety measures, will aid in mitigating potential OHS risks.</p> <p>The establishment and implementation of an effective Human Resource Policy, compliant with the referred labor policies, will help to ensure impacts are mitigated.</p>
Geothermal Production/ Operation and Maintenance	Livelihood and income/ local and regional economic	Project development is expected to trigger local economic development, creating positive impacts for local and regional income.	<p>Government Regulation No 27 Year 2012 regarding Environmental Permit</p> <p>World Bank OP4.01 Environmental Assessment</p>	Development and implementation of a community development plan to optimise the Project benefit to improve local economic opportunities and to avoid dependency on Project employment.

Project Exploitation Activities	Social Aspects and Issue	Potential Impacts, Sensitive Receptor, and Area of Influence	Triggered Indonesia Regulation and World Bank Safeguard Policy	Potentially Required Mitigation Measures
	Socio-cultural/ social fabric and perception	Impacts from the Project operation activities during exploitation phase to community perception is unlikely to be significant . Community and stakeholders would have already been familiar with the Project presence.	Government Regulation No 27 Year 2012 regarding Environmental Permit World Bank OP4.01 Environmental Assessment	Ensure the proper implementation of the grievance redress mechanism (GRM), socializing the community on project activities, and the implementation of the stakeholder engagement program.
	Community health	Non-condensable geothermal gas will be released into the atmosphere from the power plant, containing a small amount of CO ₂ and H ₂ S (approximately 2-5% of the steam consumption). There is a risk, albeit small, that the H ₂ S could result in odour, eye irritation and respiratory damage to the nearby public. Therefore potential impact to public health is likely to be significant particularly in location in adjacent with residential area or community activities.	Government Regulation No 27 Year 2012 regarding Environmental Permit World Bank OP4.01 Environmental Assessment	Implementation of grievance redress mechanism (GRM) to enable the community to submit concerns if any impacts from the Project to community health occurs.
	OHS and labor and working condition	Risks to OHS and labor working conditions would still be present during the operation stage of Project exploitation, however it is expected to be lower as the Project would have a lower workforce number (most will be employed directly by the Company, and less contractors will be involved). In addition, a more established OHS procedure and Human Resources Policy will be in effect.	World Bank Environmental and Social Framework (ESF) – ESS2 regarding labor and working condition	The establishment and implementation of the OHS Plan, inclusive of all appropriate safety measures, will aid in mitigating potential risks. The establishment and implementation of an effective Human Resource Policy, compliant with the referred labor policies, will help to ensure impacts are mitigated.

10.2. Project Categorized According to Indonesia Regulation and World Bank Safeguard Policy

10.1.3. Indonesian Regulation

Based on Minister of Environment Regulation No. 5 of 2012 on Types of Business/Activity Plans that are compulsory to have an Environmental Impact Assessment, the exploitation stage will require either an Environmental Management and Monitoring Efforts (*Usaha Pengelolaan Lingkungan – Usaha Pemantauan Lingkungan / UKL – UPL*) or an Environmental Impact Assessment (*Analisis Mengenai Dampak Lingkungan / AMDAL*) study dependent on the area and capacity of the power plant. There are three conditions for Geothermal development during the Exploitation Stage for an AMDAL study, they are:

- a. Permit area (*Wilayah Kerja Panas Bumi / WKP* of geothermal) ≥ 200 ha;
- b. Open area for geothermal activity ≥ 50 ha; and
- c. Power plant capacity ≥ 55 MW

The other condition which requires an AMDAL study is if the geothermal project activity will be developed in a protection area and/or is directly adjacent to a protection area.

If the area or scale is not triggered by the above conditions, the exploitation stage development will only require a UKL-UPL document. Based on the initial project description provided for similar Geothermal exploitation projects of similar scale (see Section 3.5 Project Activities for Exploitation Phase) and referring to the conditions above (i.e. potential capacity of 30 MW and potential open area less than 50 ha), **the exploitation activity of Waesano Geothermal Project will likely require a UKL-UPL study only.**

Since the activity plan is within the regency area as per MOE decree No.08/2013 article 12 on the Assessment of EIA Documents and Issuance of Environmental Permit, the assessment of EIA documents will be conducted by the Environmental Assessment Committee of the regency (DLHK Manggarai Barat), with the provision that if the regency has a license as a Committee. If not then the assessment will be conducted by the Environmental Assessment Committee of the province (BLHD Kupang).

Licensing of Geothermal Activities requires:

- a. Geothermal Permit (*Izin Panas Bumi / IPB*)
- b. Borrow and Use Permit of Forestry Area if the production well is located within a protection forestry area;
- c. Recommendation Letter from the Environmental Agency (*Surat Keterangan Kelayakan Lingkungan Hidup / SKKLH*) which will produce an Environmental Permit (*Izin Lingkungan / IL*);
- d. Environmental Management and Protection Permits, such as a Landfill Permit, Hazardous Waste Management Permit, Temporary Hazardous Waste Storage, etc.

The national and local regulations applicable to exploitation activities are the same as exploration, as described in Section 2.

10.1.4. World Bank Safeguard Policy

Referring to the environmental and social screening assessment presented in the Table 10-1 and Table 10-2, based on the latest project description provided for exploitation phase, it falls into **Category B**. In accordance with World Bank OP4.01 Environmental Assessment risk category, projects that are classified as Category B are those with less adverse impacts on environmental and social aspects that can be avoided or mitigated as opposed to a Category A project that has more significant impacts.

The following considerations are used to define the category:

- Potential impacts from the exploitation phase will be similar to impacts experienced during Project exploration; therefore, it is expected that the Project would have already established and implemented a number of required mitigation measures that would reduce exploitation phase impacts. These include a stakeholder engagement plan, community development plan, land acquisition and livelihood restoration plan, grievance redress mechanism, and a range of environmental and waste management procedures;
- Although the potential impacts of land acquisition would be significant for affected farmers with loss of income from agricultural land, the relative project scale and land requirement is small;
- Potential impacts on ecotourism and visual impacts are likely to be significant in the short-term but are expected to be positive in the long term as the project infrastructure development and plan for a community development program would improve ecotourism potential in the future;
- With regards to potential impacts to cultural heritages, it is suggested for the Project to conduct consultation with local community early during the Project exploitation design process, therefore avoidance to significant impacts can be planned;
- Potential impacts on fauna from the construction activities include increased human activities and evening light pollution, which have the potential to stress or disorientate wildlife in the project area. However, proper mitigation activities such as reduction of habitat disturbance, reduced noise and evening pollution will minimize these impacts; and
- The potential environmental impacts from operation and maintenance activities such as air quality degradation and noise disturbance would be a significant impact for geothermal operational activity. This impact will occur over a long period during geothermal operation. Nevertheless, technological approaches as well as monitoring will aim to minimize the impact.

It should be noted that the screening assessment would need to be updated once the complete Project Description for the exploitation phase is available at the end of exploration activities. This includes more details on the location of the power plant, confirmation of the power capacity, location of wells to be exploited, arrangement for security, number and process for workforce recruitment, selection of suppliers and contractors, location of supporting facilities such as the transmission line, workforce accommodation, and waste management facilities.

11. References

- Badan Pusat Statistik Kabupaten Manggarai Barat. (2016). *Indikator Kesejahteraan Rakyat Kabupaten Manggarai Barat 2015-2016*. Kabupaten Manggarai Barat: Badan Pusat Statistik Kabupaten Manggarai Barat.
- Badan Pusat Statistik Kabupaten Manggarai Barat. (2016). *Kabupaten Manggarai Barat Dalam Angka 2016*. Kabupaten Manggarai Barat: Badan Pusat Statistik Kabupaten Manggarai Barat.
- Badan Pusat Statistik Kabupaten Manggarai Barat. (2016). *Produk Domestik Regional Kabupaten Manggarai Barat*. Kabupaten Manggarai Barat: Badan Pusat Statistik Kabupaten Manggarai Barat.
- Badan Pusat Statistik Kabupaten Manggarai Barat. (2017). *Kabupaten Manggarai Barat Dalam Angka 2017*. Kabupaten Manggarai Barat: Badan Pusat Statistik Kabupaten Manggarai Barat.
- Badan Pusat Statistik Kecamatan Sano Nggoang. (2016). *Kecamatan Sano Nggoang Dalam Angka 2016*. Kabupaten Manggarai Barat: Badan Pusat Statistik Kecamatan Sano Nggoang.
- Central Bureau of Statistics of East Nusa Tenggara Province. (2017). *Statistics of East Nusa Tenggara Province*. Retrieved January 26, 2017, from Statistics of East Nusa Tenggara Province: http://ntt.bps.go.id/backend1812/tabelExcelIndo/Indo_23_15723773.xls
- Central Bureau of Statistics of East Nusa Tenggara Province. (2017). *Statistics of East Nusa Tenggara Province*. Retrieved January 26, 2017, from Statistics of East Nusa Tenggara Province: <http://ntt.bps.go.id/linkTabelStatis/view/id/530#accordion-daftar-subjek3>
- Central Bureau of Statistics of Sano Nggoang Sub-district. (2016). *Sano Nggoang Sub-district in Figures 2016*. West Manggarai Regency: Central Bureau of Statistics of Sano Nggoang Sub-district.
- Central Bureau of Statistics of Sano Nggoang Sub-district. (2017). *Sano Nggoang Sub-district in Figures 2017*. West Manggarai Regency: Central Bureau of Statistics of Sano Nggoang Sub-district.
- Central Bureau of Statistics of West Manggarai Regency. (2016). *West Manggarai Regency in Figures 2016*. West Manggarai Regency: Central Bureau of Statistics of West Manggarai Regency.
- Central Bureau of Statistics of West Manggarai Regency. (2017). *West Manggarai Regency in Figures 2017*. West Manggarai Regency: Central Bureau of Statistics of West Manggarai Regency.
- Directorate General of Electricity, Ministry of Energy and Mineral Resources. (2015). *Electricity Statistic 2015*. Jakarta: Directorate General of Electricity, Ministry of Energy and Mineral Resources.
- Direktorat Jenderal Pengendalian DAS dan Hutan Lindung Kementerian Lingkungan Hidup dan Kehutanan (PDASHL). (2016). *Peta Batas DAS Seluruh Indonesia*. Jakarta: Direktorat Jenderal Pengendalian DAS dan Hutan Lindung Kementerian Lingkungan Hidup dan Kehutanan (PDASHL).
- Effendi, H. (2003). *Telaah Kualitas Air, Bagi Pengelolaan Sumber Daya dan Lingkungan Perairan*. Yogyakarta: Kanisius.
- ENVIRON International Corporation. (2013). *CalEEMod User's Guide Version 2013.2*. Retrieved February 20, 2015, from <http://www.caleemod.com/>
- Germi, F. &. (2006). *Additional information on the autumn migration of raptors in east*. Forktail.
- Germi, F. (2005). *Raptor migration in east Bali, Indonesia: observations from a bottleneck watch*. Forktail.
- Government of Indonesia. (2015, September 24). *Intended Nationally Determined Contribution Republic of Indonesia*. Retrieved from Intended Nationally Determined Contribution: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Indonesia/1/INDC_REPUBLIC%20OF%20INDONESIA.pdf
- Huheey, J. K. (1993). *Inorganic Chemistry Principles of Structure and Reactivity, 5th ed.* U.S.A: Harper Collins College.
- Hunter, L. M. (2000). *Population and Environment: A Complex Relationship*. Retrieved 19, 2017, from [www.rand.org](http://www.rand.org/pubs/research_briefs/RB5045.html): http://www.rand.org/pubs/research_briefs/RB5045.html
- IFC. (2007). *Environmental, Health, and Safety General Guidelines*. Retrieved August 2016, from International Finance Corporation: <https://www.ifc.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final+-+General+EHS+Guidelines.pdf?MOD=AJPERES>
- Jacobs. (2017). *Civil Preliminary Site Visit Report, Wae Sano Geothermal Project*. Jakarta: Jacobs.
- Jacobs. (September 2016). *Waesano Geothermal Chemistry Survey*. Auckland.

- Kecamatan Sano Nggoang. (2016). *Monografi Kecamatan Sano Nggoang*. Kabupaten Manggarai Barat: Kecamatan Sano Nggoang.
- KPHP . (2016). *Profil Kesatuan Pengelolaan Hutan Produksi Manggarai Barat*. Manggarai Barat, Nusa Tenggara Timur, Indonesia: KPHP .
- Lembaga Ekowisata Desa Wae Sano. (2014). *Laporan Kajian Potensi Ekowisata Desa Wae Sano*. Kecamatan Sano Nggoang, Kabupaten Manggarai Barat: Lembaga Ekowisata Desa Wae Sano.
- MENLH. (1996, November 25). Keputusan Menteri Negara Lingkungan Hidup Nomor Kep-48/Menlh/11/1996. *Baku Mutu Tingkat Kebisingan*. Kementerian Negara Lingkungan Hidup.
- Pulau Nuncung Village. (2014). *Profile data of Pulau Nuncung Village*. West Manggarai Regency: PuLau Nuncung Village.
- PUSDATIN ESDM. (2015, December). *Data Inventory Emisi GRK Sektor Energi*. Retrieved September 8, 2016, from www.esdm.go.id :
https://www.google.com.hk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKewi0y5ji79TPAhWM5SYKHY_VBsUQFggaMAA&url=http%3A%2F%2Fwww.esdm.go.id%2Fpublikasi%2Fkajian-energi-indonesia%2Fdoc_download%2F1609-data-inventory-emisi-grk-sektor-ener
- Rao, S. S. (1989). *Acid Stress and Aquatic Microbial Interactions*. Florida: CRC Press.
- Rasolofomanana, L. V. (2009). *Characterization of Ranomafana Lake Water Quality - Antsirabe Madagascar*. Antsirabe: University of Stavanger.
- Saaty, T. (1980). *The Analytic Hierarchy Process*. New York. International, Translated to Russian, Portuguese, and Chinese, Revised editions, Paperback (1996, 2000), Pittsburgh: RWS Publications: McGraw Hill.
- Sano Nggoang Sub-district. (2016). *Monograph of Sano Nggoang Sub-district*. West Manggarai Regency: Sano Nggoang sub-district.
- Sano Nggoang Sub-district. (2016). *Sano Nggoang Sub-district Monograph*. West Manggarai Regency: Sano Nggoang Sub-district.
- SCAQMD. (2015, March). *SCAQMD Air Quality Significance Thresholds*. Retrieved September 8, 2016, from South Coast Air Quality Management District: <http://www.aqmd.gov/docs/default-source/ceqa/handbook/scaqmd-air-quality-significance-thresholds.pdf>
- Schuler, D. J. (2008). *Acute Toxicity of Ammonia and Nitrite to White Shrimp (L. vannamei) at Low Salinities*. Virginia: Virginia Polytechnic Institute and State University.
- SMI. (2018). *Drilling Waste Management Plan*. Jakarta: SMI.
- Sutriati, A. (2012, Desember). Kualitas Air Sungai dan Air Sumur Paska Letusan Gunung Merapi Tahun 2012. *Buletin Geologi Tata Lingkungan Vol.22*, 129-142.
- Syahrul, S. S. (2012). *Kajian Analisis Kualitas Air Danau UNHAS: Pembahasan Khusus pada Proses Eutrofikasi*. Makassar: Universitas Hasanuddin.
- Syahrul, Sri Suryani, Bannu. (2012). *Kajian Analisis Kualitas Air Danau UNHAS: Pembahasan Khusus pada Proses Eutrofikasi*. Makassar: Universitas Hasanuddin.
- Wae Sano Village. (2014). *Profil Data of Wae Sano Village*. West Manggarai Regency: Wae Sano Village.
- Wae Sano Village Ecotourism Institution. (2014). *Wae Sano Village Ecotourism Potency Study Report*. Sano Nggoang Sub-District, West Manggarai Regency: Wae Sano Village Ecotourism Institution.
- Wickins, J. (1976). The Tolerance of Warm-Water Prawns to Recirculated Water. *Aquaculture* 9, 19–37.
- World Bank. (2011). *Guidance Notes on Tools for Pollution Management; Targeting Occupational Health and Safety*. Retrieved January 23, 2017, from <http://www.worldbank.org/en/topic/environment/publication/sourcebook-pollution-management-policy-tools>: <https://siteresources.worldbank.org/INTRANETENVIRONMENT/Resources/244351-1279901011064/OccupationalHealth.pdf>
- World Bank Group. (2016). *Geothermal Energy Upstream Development Project (P155047) Combined Project Information Document and Integrated Safeguards Datasheet*. Washington: World Bank Group.
- www.liputan6.com. (2016, February 6). *Sawah Lodok, Sajian Alam Budaya Manggarai yang Memikat*. Retrieved November 2016, from Liputan6: <http://www.liputan6.com/lifestyle/read/2429565/sawah-lodok-sajian-alam-budaya-manggarai-yang-memikat>